RCA Solid State

Power Devices

Power Transistors
Triacs
SCR's

RCA Power Devices

This DATABOOK contains complete technical information on the full line of RCA solid-state power devices: power transistors, power hybrid circuits, triacs, and SCR's. A complete index of these types is included on the following pages.

The index to devices is followed by a series of product matrix charts that provide a quick reference to key parameters and device packages to facilitate type selection. A cross-reference guide then indicates recommended RCA replacements for more than 2000 popular industry types. Next general operating considerations for solid-state power devices are discussed, and symbols and special terms used to characterize these devices are listed.

The DATABOOK also contains four major data sections that provide detailed ratings and characteristics for each of the various types of devices. For the convenience of the reader, the *Power Transistor Technical Data* are further subdivided according to JEDEC Types, Pro Election Types and General Industry Types. Data pages for individual devices are given as nearly as possible in alpha-numerical sequence of the basic family type numbers. Because many devices may be included in the same basic family, individual type numbers are not necessarily in sequence.

If you don't find a type number where you expect it to be, check the Index to Devices.

General information such as test circuits and waveforms, dimensional outlines, suggested mounting arrangements, and lead forms for plastic packages are included in an Appendix at the back of the book. The Appendix also includes abstracts of relevant RCA application notes. The final pages contain listings of RCA sales offices, manufacturers' representatives, and authorized distributors.

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Printed in USA/7-81

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Power Transistor Product Classification Chart

Type No.	Page No.	V_{CEO} [Max.] V	P_T [Max.] W	h_{FE}/I_C[A]	File No.
2N697	58	$40^{\triangle}$	2	40-120/0.15	16
2N699	58	$80^{\triangle}$	2	35-100/0.001	22
2N1479*	64	40	5	20-60/0.2	135
2N1480*	64	55	5	20-60/0.2	135
2N1481*	64	40	5	35-100/0.2	135
2N1482*	64	55	5	35-100/0.2	135
2N1487*	69	40	75	15-45/1.5	139
2N1488*	69	55	75	15-45/1.5	139
2N1489*	69	40	75	25-75/1.5	139
2N1490*	69	55	75	25-75/1.5	139
2N1613	58	75	3	30-100/0.001	106
2N1700	64	40	5	20-80/0.1	141
2N1702	69	40	75	15-60/0.8	141
2N1711	58	$50^{\triangle}$	3	100-300/0.15	26
2N1893	58	80	3	40-120/0.150	34
2N2102	58	65	5	40-120/0.150	106
2N2270	58	45	5	50-200/0.150	24
2N2405	58	90	5	60-200/0.150	34
2N3053	58	40	5	50-250/0.150	960
2N3053A	58	60	5	50-250/0.150	960
2N3054	71	55	25	25-150/0.5	527
2N3055	76	60	115	20-70/4	994
2N3055* (Hometaxial)	80	60	115	20-70/4	1077
2N3439*	85	350	10	40-160/0.02	64
2N3440*	85	250	10	40-160/0.02	64
2N3441*	88	140	25	25-100/0.5	529
2N3442*	92	140	117	20-70/3	528
2N3583	97	175	35	40-200/0.750	138
2N3584*	97	250	35	25-100/1	138
2N3585*	97	300	35	25-100/1	138
2N3715	100	60	150	50-150/1	1058
2N3716	100	80	150	50-150/1	1058
2N3771*	102	40	150	15-60/15	974
2N3772*	102	60	150	15-60/10	974
2N3773	106	140	150	15-60/8	526
2N3791	110	-60	150	50-150/-1	1059
2N3792	110	-80	150	50-150/-1	1059
2N3878	112	50	35	40-200/0.5	766
2N3879*	112	75	35	12-100/4	766
2N4036	116	-65	7	40-140/-0.15	216
2N4037	116	-40	7	50-250/-0.15	216
2N4063	85	350	10	40-160/0.020	64
2N4064	85	250	10	40-160/0.020	64
2N4231A	119	40	75	25-100/1.5	1102
2N4232A	119	60	75	25-100/1.5	1102
2N4233A	119	80	75	25-100/1.5	1102
2N4240	97	300	35	30-150/0.750	138
2N4314	116	-65	7	50-250/-0.150	216
2N4347	96	120	100	15-60/2	528
2N4348	106	120	120	15-60/5	526
2N4898	122	40	25	20-100/0.5	1150
2N4899	122	60	25	20-100/0.5	1150
2N4900	122	80	25	20-100/0.5	1150
2N4904	124	-40	87.5	25-100/-2.5	1068
2N4905	124	-60	87.5	25-100/-2.5	1068
2N4906	124	-80	87.5	25-100/-2.5	1068
2N4913	126	40	87.5	25-100/2.5	1067
2N4914	126	60	87.5	25-100/2.5	1067
2N4915	126	80	87.5	25-100/2.5	1067
2N5038*	128	90	140	50-250/2	698
2N5039*	128	75	140	30-250/2	698
2N5050	133	125	40	25-100/0.75	1098
2N5051	133	150	40	25-100/0.75	1098
2N5052	133	200	40	25-100/0.75	1098
2N5202	112	50	35	10-100/4	766
2N5239	135	225	100	20-80/0.4	321
2N5240	135	300	100	20-80/0.4	321
2N5293	138	70	36	30-120/0.5	322
2N5294	138	70	36	30-120/0.5	322
2N5295	138	40	36	30-120/1	322
2N5296	138	40	36	30-120/1	322
2N5297	138	60	36	20-80/1.5	322
2N5298	138	60	36	20-80/1.5	322
2N5301	142	40	200	15-60/15	1029
2N5302*	142	60	200	15-60/15	1029
2N5303*	142	80	200	15-60/10	1029
2N5320	145	75	10	30-130/0.5	325
2N5321	145	50	10	40-250/0.5	325
2N5322	145	-75	10	30-130/-0.5	325
2N5323	145	-50	10	40-250/-0.5	325
2N5415	148	-200	10	30-150/-0.05	336
2N5416	148	-300	10	30-120/-0.05	336
2N5490	151	40	50	20-100/2	353
2N5491	151	40	50	20-100/2	353
2N5492	151	55	50	20-100/2.5	353
2N5493	151	55	50	20-100/2.5	353
2N5494	151	40	50	20-100/3	353
2N5495	151	40	50	20-100/3	353
2N5496	151	70	50	20-100/3.5	353
2N5497	151	70	50	20-100/3.5	353
2N5629	154	100	200	25-100/8	1141
2N5630	154	120	200	20-80/8	1141
2N5631	154	140	200	15-60/8	1141
2N5632	156	100	150	25-100/5	1094
2N5633	156	120	150	20-80/5	1094
2N5634	156	140	150	15-60/5	1094
2N5671*	158	90	140	20-100/15	383
2N5672*	158	120	140	20-100/15	383
2N5781	160	-65	10	20-100/-1	413
2N5782	160	-50	10	20-100/-1.2	413
2N5783	160	-40	10	20-100/-1.6	413
2N5784	160	65	10	20-100/1	413
2N5785	160	50	10	20-100/1.2	413
2N5786	160	40	10	20-100/1.6	413
2N5838	165	250	100	8-40/3	410
2N5839	165	275	100	10-50/2	410
2N5840	165	350	100	10-50/2	410
2N5871	169	-60	115	20-100/-2.5	1066
2N5872	169	-80	115	20-100/-2.5	1066
2N5873	169	60	115	20-100/2.5	1066
2N5874	169	80	115	20-100/2.5	1066
2N5875	171	-60	150	20-100/-4	1065
2N5876	171	-80	150	20-100/-4	1065
2N5877	171	60	150	20-100/4	1065
2N5878	171	80	150	20-100/4	1065
2N5879	173	-60	160	20-100/-6	1064
2N5880	173	-80	160	20-100/-6	1065
2N5881	173	60	160	20-100/6	1065
2N5882	173	80	160	20-100/6	1065
2N5885	175	60	200	20-100/10	1041
2N5886	175	80	200	20-100/10	1041

***JAN-type versions also available** $^{\triangle}$ V_{CER}

Power Transistor Product Classification Chart

Type No.	Page No.	V_{CEO} [Max.] V	P_T [Max.] W	h_{FE}/I_C[A]	File No.
2N5954	177	-80	40	20-100/-2	675
2N5955	177	-60	40	20-100/-2.5	675
2N5956	177	-40	40	20-100/-3	675
2N6032*	182	90	140	10-50/50	462
2N6033*	182	120	140	10-50/50	462
2N6043	185	60	75	1000-20000/4	1151
2N6044	185	80	75	1000-20000/4	1151
2N6045	185	100	75	1000-20000/3	1151
2N6050	187	60	150	750-18000/6	1185
2N6051	187	80	150	750-18000/6	1185
2N6052	187	100	150	750-18000/6	1185
2N6055	227	60	100	750-18000/4	563
2N6056	227	80	100	750-18000/4	563
2N6057	187	60	150	750-18000/6	1185
2N6058	187	80	150	750-18000/6	1185
2N6059	187	100	150	750-18000/6	1185
2N6077	190	275	45	12-70/1.2	492
2N6078	190	250	45	12-70/1.2	492
2N6079	190	350	45	12-50/1.2	492
2N6098	194	60	75	20-80/4	485
2N6099	194	60	75	20-80/4	485
2N6100	194	70	75	20-80/5	485
2N6101	194	70	75	20-80/5	485
2N6102	194	40	75	15-60/8	485
2N6103	194	40	75	15-60/8	485
2N6106	197	-70	40	30-150/-2	676
2N6107	197	-70	40	30-150/-2	676
2N6108	197	-50	40	30-150/-2.5	676
2N6109	197	-50	40	30-150/-2.5	676
2N6110	197	-30	40	30-150/-3	676
2N6111	197	-30	40	30-150/-3	676
2N6121	205	45	40	25-100/1.5	1149
2N6122	205	60	40	25-100/1.5	1149
2N6123	205	80	40	20-80/1.5	1149
2N6124	205	-45	40	25-100/-1.5	1149
2N6125	205	-60	40	25-100/-1.5	1149
2N6126	205	-80	40	20-80/-1.5	1149
2N6129	207	40	50	20-100/2.5	1233
2N6130	207	60	50	20-100/2.5	1233
2N6131	207	80	50	20-100/2.5	1233
2N6132	207	-40	50	20-100/-2.5	1233
2N6133	207	-60	50	20-100/-2.5	1233
2N6134	207	-80	50	20-100/-2.5	1233
2N6211*	209	-225	35	10-100/-1	507
2N6212*	209	-300	35	10-100/-1	507
2N6213*	209	-350	35	10-100/-1	507
2N6214	209	-400	35	10-100/-1	507
2N6246	212	-60	125	20-100/-7	677
2N6247	212	-80	125	20-100/-6	677
2N6248	212	-100	125	20-100/-5	677
2N6249	216	200	175	10-50/10	523
2N6250	216	275	175	8-50/10	523
2N6251	216	350	175	6-50/10	523
2N6253	80	45	115	20-70/3	1077
2N6254	80	80	150	20-70/5	1077
2N6259	106	150	250	15-60/8	526
2N6260	71	40	29	20-100/1.5	527
2N6261	71	80	50	25-100/1.5	527
2N6262	92	150	150	20-70/3	528
2N6263	88	120	20	20-100/0.5	529
2N6264	88	150	50	20-60/1	529
2N6282	219	60	160	750-18000/10	1001
2N6283*	219	80	160	750-18000/10	1001
2N6284*	219	100	160	750-18000/10	1001
2N6285	219	-60	160	750-18000/-10	1001
2N6286	219	-80	160	750-18000/-10	1001
2N6287	219	-100	160	750-18000/-10	1001
2N6288	197	30	40	30-150/3	676
2N6289	197	30	40	30-150/3	676
2N6290	197	50	40	30-150/2.5	676
2N6291	197	50	40	30-150/2.5	676
2N6292	197	70	40	30-150/2	676
2N6293	197	70	40	30-150/2	676
2N6306*	222	250	125	15-75/3	885
2N6307	222	300	125	15-75/3	885
2N6308*	222	350	125	12-60/3	885
2N6312	119	-40	75	25-100/-1.5	1102
2N6313	119	-60	75	25-100/-1.5	1102
2N6314	119	-80	75	25-100/-1.5	1102
2N6326	225	60	200	6-30/30	1040
2N6327	225	80	200	6-30/30	1040
2N6354	128	120	140	20-150/5	582
2N6371	80	40	117	15-60/8	1077
2N6372	177	80	40	20-100/2	675
2N6373	177	60	40	20-100/2.5	675
2N6374	177	40	40	20-100/3	675
2N6383*	227	40	100	1000-20000/5	609
2N6384*	227	60	100	1000-20000/5	609
2N6385*	227	80	100	1000-20000/5	609
2N6386	231	40	65	1000-20000/3	610
2N6387	231	60	65	1000-20000/5	610
2N6388	231	80	65	1000-20000/5	610
2N6420	234	-175	35	40-200/-0.5	1100
2N6421	234	-250	35	25-100/-1	1100
2N6422	234	-300	35	25-100/-1	1100
2N6423	234	-300	35	30-150/-0.75	1100
2N6465	177	100	40	15-150/1.5	888
2N6466	177	120	40	15-150/1.5	888
2N6467	177	-100	40	15-150/-1.5	888
2N6468	177	-120	40	15-150/-1.5	888
2N6469	212	-40	125	20-150/-5	677
2N6470	212	40	125	20-150/5	677
2N6471	212	60	125	20-150/5	677
2N6472	212	80	125	20-150/5	677
2N6473	197	100	40	15-150/1.5	676
2N6474	197	120	40	15-150/1.5	676
2N6475	197	-100	40	15-150/-1.5	676
2N6476	197	-120	40	15-150/-1.5	676
2N6477	237	130	50	25-150/1	680
2N6478	237	150	50	25-150/1	680
2N6479	240	60	87	20-300/12	702
2N6480	240	80	87	20-300/12	702
2N6486	243	40	75	20-150/5	678
2N6487	243	60	75	20-150/5	678
2N6488	243	80	75	20-150/5	678
2N6489	243	-40	75	20-150/-5	678
2N6490	243	-60	75	20-150/-5	678
2N6491	243	-80	75	20-150/-5	678
2N6496	128	110	140	12-100/8	698
2N6500	112	90	35	15-60/3	766
2N6510	246	200	120	10-50/3	848
2N6511	246	250	120	10-50/4	848

***JAN-type versions also available**

Power Transistor Product Classification Chart

Type No.	Page No.	V_{CEO} [Max.] V	P_T [Max.] W	h_{FE}/I_C[A]	File No.
2N6512	246	300	120	10-50/4	848
2N6513	246	350	120	10-50/4	848
2N6514	246	300	120	10-50/4	848
2N6530	249	80	65	1000-10000/5	873
2N6531'	249	100	65	500-10000/3	873
2N6532	249	100	65	1000-10000/5	873
2N6533	249	120	65	1000/10000/3	873
2N6542	253	300	100	12-60/1.5	1096
2N6544	253	300	125	12-60/2.5	1096
2N6546*	253	300	175	12-60/5	1096
2N6569	76	40	100	15-200/4	994
2N6576	257	60	120	2000-20000/4	1152
2N6577	257	90	120	2000-20000/4	1152
2N6578	257	120	120	2000-20000/4	1152
2N6594	76	-40	100	15-200/-4	994
2N6609	260	-140	150	15-60/-8	1061
2N6648*	264	-40	70	1000-20000/-5	1013
2N6649*	264	-60	70	1000-20000/-5	1013
2N6650*	264	-80	70	1000-20000/-5	1013
2N6666	266	-40	65	1000-20000/-3	1069
2N6667	266	-60	65	1000-20000/-5	1069
2N6668	266	-80	65	1000-20000/-5	1069
2N6669	269	30	40	20-100/5	1071
2N6671	271	300	150	10-40/5	1090
2N6672	271	350	150	10-40/5	1090
2N6673	271	400	150	10-40/5	1090
2N6674	275	300	175	8-20/10	1164
2N6675	275	400	175	8-20/10	1164
2N6676	278	300	175	8 min./15	1165
2N6677	278	350	175	8 min./15	1165
2N6678	278	400	175	8 min./15	1165
2N6686	281	160	200	25-100/10	1171
2N6687	281	180	200	25-100/10	1171
2N6688	281	200	200	20-80/10	1171
2N6689	275	300	175	8-20/10	1164
2N6690	275	400	175	8-20/10	1164
2N6691	278	300	175	8 min./15	1165
2N6692	278	350	175	8 min./15	1165
2N6693	278	400	175	8 min./15	1165
2N6702	285	90	50	30 min./0.2	1187
2N6703	285	110	50	30 min./0.2	1187
2N6704	285	130	50	30 min./0.2	1187
2N6738	288	300	100	10-40/5	1291
2N6739	288	350	100	10-40/5	1291
2N6740	288	400	100	10-40/5	1291
2N6751	292	400	150	8-40/5	1244
2N6752	292	450	150	8-40/5	1244
2N6753	292	500	150	8-40/5	1244
2N6754	292	500	150	8-40/5	1244
2N6771	296	300	40	20-100/0.3	1292
2N6772	296	350	40	20-100/0.3	1292
2N6773	296	400	40	20-100/0.3	1292
2N6774	300	300	175	8 min./15	1313
2N6775	300	350	175	8 min./15	1313
2N6776	300	400	175	8 min./15	1313
40250	71	40	29	25-100/1.5	112
40250VI	71	40	5.8	25-100/1.5	112
40251	80	40	117	15-60/8	112
40310	458	35	29	20-120/1	962
40311	458	30	5	70-350/0.050	962
40312	458	60^{Δ}	29	20-120/1	962
40313	458	300^{Δ}	35	40-250/0.100	962
40314	458	40	5	70-350/0.050	962
40316	458	40^{Δ}	29	20-120/1	962
40317	458	40	5	40-200/0.010	962
40318	458	300^{Δ}	35	50 min./0.500	962
40319	458	-40	5	35-200/-0.050	962
40321	458	300^{Δ}	5	25-200/0.020	962
40322	458	300^{Δ}	35	75 min./0.500	962
40323	458	18	5	70-350/0.050	962
40324	458	35	29	20-120/1	962
40325	458	35	117	12-60/8	962
40327	458	300^{Δ}	5	40-250/0.020	962
40346	85	175^{Δ}	10	25 min./10	211
40346VI	85	175^{Δ}	4	25 min./10	211
40346V2	85	175^{Δ}	10	25 min./10	211
40347	64	40	8.75	25-100/0.45	88
40347VI	64	40	4.4	25-100/0.45	88
40348	64	65	8.75	30-125/0.30	88
40348VI	64	65	4.4	30-125/0.30	88
40360		Same as RCA1A01			
40362	458	70^{Δ}	5	35-200/-0.050	962
40363	458	70^{Δ}	115	20-70/4	962
40366	58	65	5	40-120/0.150	215
40367	64	55	5	35-100/0.200	215
40372	71	55	25	25-150/0.5	527
40373	88	140	25	25-100/0.5	529
40374	97	175	5.8	40-200/0.750	138
40375	112	50	5.8	40-200/0.5	766
40385	85	350	1	40-160/0.020	215
40389	58	40	5	50-250/0.150	960
40390	85	250	3.5	40-160/0.020	64
40391	116	-40	3.5	50-250/-0.150	216
40392	58	40	7	50-250/0.150	960
40394	116	-40	7	50-250/-0.150	216
40406	462	-50	1	30-200/0.0001	219
40407	462	50	1	40-200/0.001	219
40408	462	90	1	40-200/0.01	219
40409	462	90^{Δ}	3	50-250/0.15	219
40410	462	90^{Δ}	3	50-250/0.15	219
40411	462	250^{Δ}	150	35-100/4	219
40412	85	250^{Δ}	10	40 min./0.030	211
40412VI	85	250^{Δ}	4	40 min./0.030	211
40537	458	-55^{Δ}	5	50-300/-0.050	320
40538	458	-55^{Δ}	5	15-90/-0.500	320
40631	464	45^{Δ}	36	20-70/2	965
40634		Same as RCA1A05			
40635		Same as RCA1A06			
40636		Same as RCA1B01			
40814		Same as RCA1A07			
40815		Same as RCA1A08			
40829	177	80	5.8	20-100/2	675
40831	177	40	5.8	20-100/3	675
40850	466	300	35	25 min./0.75	964
40851	466	350	45	12 min./1.2	964
40852	466	350	100	12 min./1.2	964
40854	466	300	175	8 min./10	964
40871		Same as RCA1C03			
40872		Same as RCA1C04			
40913	88	150	5.8	20-60/1	529
40979		Same as RCA1C10			
40980		Same as RCA1C11			
41500	197	25	40	25 min./1	772
41501	197	-25	40	25 min./-1	770

***JAN-type versions also available** $^{\Delta}$ V_{CER}

Power Transistor Product Classification Chart

Type No.	Page No.	V_{CEO} [Max.] V	P_T [Max.] W	h_{FE}/I_C[A]	File No.
BD142	306	45	117	12.5-160/4	701
BD181	308	45	117	20-70/3	700
BD182	308	60	117	20-70/4	700
BD183	308	80	117	20-70/3	700
BD201	311	45	60	30 min./1	1282
BD202	311	-45	60	30 min./-1	1282
BD203	311	60	60	30 min./1	1282
BD204	311	-60	60	30 min./-1	1282
BD239	313	45	30	40 min./0.2	669
BD239A	313	60	30	40 min./0.2	669
BD239B	313	80	30	40 min./0.2	669
BD239C	313	100	30	40 min./0.2	669
BD240	313	-45	30	40 min./-0.2	670
BD240A	313	-60	30	40 min./-0.2	670
BD240B	313	-80	30	40 min./-0.2	670
BD240C	313	-100	30	40 min./-0.2	670
BD241	315	45	40	25 min./1	671
BD241A	315	60	40	25 min./1	671
BD241B	315	80	40	25 min./1	671
BD241C	315	100	40	25 min./1	671
BD242	315	-45	40	25 min./-1	672
BD242A	315	-60	40	25 min./-1	672
BD242B	315	-80	40	25 min./-1	672
BD242C	315	-100	40	25 min./-1	672
BD243	317	45	65	30 min./0.30	673
BD243A	317	60	65	30 min./0.30	673
BD243B	317	80	65	30 min./0.30	673
BD243C	317	100	65	30 min./0.30	673
BD244	317	-45	65	30 min./-0.30	674
BD244A	317	-60	65	30 min./-0.30	674
BD244B	317	-80	65	30 min./-0.30	674
BD244C	317	-100	65	30 min./-0.30	674
BD277	319	-45	70	30-150/-1.75	667
BD278	320	45	75	15-75/4	969
BD278A	320	45	75	15-75/4	969
BD311	322	60	150	20 min./5	1261
BD312	322	-60	150	25 min./-5	1261
BD313	322	80	150	25 min./4	1261
BD314	322	-80	150	25 min./-4	1261
BD500	324	-50	75	15-90/-5	1108
BD500B	324	-80	75	20-120/-3.5	1108
BD501B	324	80	75	20-120/3.5	1108
BD533	326	45	50	20 min./0.01	1236
BD534	326	-45	50	20 min./-0.01	1236
BD535	326	60	50	20 min./0.01	1236
BD536	326	-60	50	20 min./-0.01	1236
BD537	326	80	50	15 min./0.01	1236
BD538	326	-80	50	15 min./-0.01	1236
BD550	329	110	150	15-75/4	1109
BD550B	329	250	150	10-50/2	1109
BD643	335	45	62.5	1500 min./0.5	1241
BD645	335	60	62.5	1500 min./0.5	1241
BD647	335	80	62.5	1500 min./0.5	1241
BD649	335	100	62.5	1500 min./0.5	1241
BD750	337	-90	200	15-60/-7.5	1251
BD750A	337	-120	200	25-100/-5	1251
BD750B	337	-100	250	15-60/-7.5	1251
BD750C	337	-130	250	25-100/-5	1251
BD751	337	90	200	15-60/7.5	1251
BD751A	337	120	200	25-100/5	1251
BD751B	337	100	250	15-60/7.5	1251
BD751C	337	130	250	25-100/5	1251
BD795	340	45	65	40 min./1	1242
BD796	340	-45	65	40 min./-1	1242
BD797	340	60	65	40 min./1	1242
BD798	340	-60	65	40 min./-1	1242
BD799	340	80	65	30 min./1	1242
BD800	340	-80	65	30 min./-1	1242
BD801	340	100	65	30 min./1	1242
BD802	340	-100	65	30 min./-1	1242
BD895	342	45	70	750 min./3	1240
BD895A	342	45	70	750 min./4	1240
BD897	342	60	70	750 min./3	1240
BD897A	342	60	70	750 min./4	1240
BD899	342	80	70	750 min./3	1240
BD899A	342	80	70	750 min./4	1240
BD901	342	100	70	750 min./3	1240
BDX18	76	-60	115	20-70/-4	994
BDX23	344	95	117	20-70/4	1287
BDX24	346	40	29	25-100/1.5	1286
BDX33	348	45	70	750 min./4	693
BDX33A	348	60	70	750 min./4	693
BDX33B	348	80	70	750 min./3	693
BDX33C	348	100	70	750 min./3	693
BDX33D	348	120	70	750 min./3	693
BDX34	348	-45	70	750 min./-4	694
BDX34A	348	-60	70	750 min./-4	694
BDX34B	348	-80	70	750 min./-3	694
BDX34C	348	-100	70	750 min./-3	694
BDX53	352	45	60	750 min./3	1213
BDX53A	352	60	60	750 min./3	1213
BDX53B	352	80	60	750 min./3	1213
BDX53C	352	100	60	750 min./3	1213
BDX83	354	45	125	750 min./1	955
BDX83A	354	60	125	750 min./1	955
BDX83B	354	80	125	750 min./1	955
BDX83C	354	100	125	750 min./1	955
BDY29	357	75	220	15-60/15	819
BDY37	359	140	150	15-60/8	863
BDY37A	361	140	250	15-60/8	1256
BDY55	363	60	117	20-70/4	1215
BDY56	363	120	117	20-70/4	1215
BDY57A	365	80	175	20-60/10	1209
BDY58R	367	160	175	20-60/10	1206
BDY71	370	55	29	80-200/0.5	859
BDY90	372	100	40	30-120/5	1289
BDY91	372	80	40	30-120/5	1289
BDY92	372	60	40	30-120/5	1289
BFT19	374	-150	5	20 min./-10	683
BFT19A	374	-250	5	20 min./-10	683
BFT19B	374	-350	5	20 min./-10	683
BFT28	376	-100	5	20 min./-10	815
BFT28A	376	-150	5	20 min./-10	815
BFT28B	376	-200	5	20 min./-10	815
BFT28C	376	-250	5	20 min./-10	815
BU126	379	300	80	15-60/1	968
BU323	380	350	175	150-2000/6	1312
BU323A	380	400	175	150-2000/6	1312
BUW40	383	300	40	20-100/0.3	1308
BUW40A	383	350	40	20-100/0.3	1308
BUW40B	383	400	40	20-100/0.3	1308
BUW41	387	300	100	10-40/5	1275
BUW41A	387	350	100	10-40/5	1275
BUW41B	387	400	100	10-40/5	1275
BUW64A	391	90	50	30 min./0.2	1199
BUW64B	391	110	50	30 min./0.2	1199

Power Transistor Product Classification Chart

Type No.	Page No.	V_{CEO} [Max.] V	P_T [Max.] W	h_{FE}/I_C[A]	File No.
BUW64C	391	130	50	30 min./0.2	1199
BUX10A	394	125	150	20-70/10	1216
BUX11	396	200	150	20-60/6	1221
BUX11N	396	160	150	20-60/8	1221
BUX12	399	250	150	20-60/5	1229
BUX13	401	325	150	15-60/4	1230
BUX14	403	400	150	15-60/3	1203
BUX15	405	500	150	15-60/2	1227
BUX16	407	200	100	15-130/0.4	800
BUX16A	407	250	100	15-130/0.4	800
BUX16B	407	300	100	15-130/0.4	800
BUX16C	407	350	100	15-130/0.4	800
BUX17	410	150	150	20 min./4	818
BUX17A	410	250	150	20 min./4	818
BUX17B	410	300	150	15 min./4	818
BUX17C	410	350	150	15 min./4	818
BUX18	413	200	120	15-100/1	862
BUX18A	413	275	120	15-100/1	862
BUX18B	413	325	120	15-100/1	862
BUX18C	413	375	120	15-100/1	862
BUX20A	415	125	140	20-60/20	1264
BUX21	417	200	250	20-60/12	1172
BUX31	420	400	150	8-40/4	1283
BUX31A	420	450	150	8-40/4	1283
BUX31B	420	500	150	8-40/4	1283
BUX32	424	400	150	8-40/6	1285
BUX32A	424	450	150	8-40/6	1285
BUX32B	424	500	150	8-40/6	1285
BUX37	428	400	35	20 min./15	1243
BUX39	430	90	120	15-45/12	1211
BUX40A	432	125	120	15-80/10	1217
BUX41	434	200	120	15-45/5	1222
BUX41N	434	160	120	15-45/8	1222
BUX42	437	250	120	15-45/4	1218
BUX43	439	325	120	15-60/3	1214
BUX44	442	400	120	15-45/2	1210
BUX45	445	500	120	15-45/1	1231
BUX47	447	400	107	5 min./6	1284
BUX66	449	-150	35	10-150/-1	870
BUX66A	449	-250	35	10-150/-1	870
BUX66B	449	-300	35	10-150/-1	870
BUX66C	449	-350	35	10-150/-1	870
BUX67	449	150	35	10-150/1	871
BUX67A	449	250	35	10-150/1	871
BUX67B	449	300	35	10-150/1	871
BUX67C	449	350	35	10-150/1	871
BUX97	453	350	60	10-70/1	1288
BUX97A	453	400	60	10-70/1	1288
BUX97B	453	450	60	10-70/1	1288
BUY69A	455	400	100	15 min./2.5	1237
BUY69B	455	325	100	15 min./2.5	1237
BUY69C	455	200	100	15 min./2.5	1237
MJ2955	76	-60	150	20-70/-4	994
MJ15001	469	140	200	25-150/4	1093
MJ15002	469	-140	200	25-150/-4	1093
MJ15003	472	140	250	25-150/5	1060
MJ15004	260	-140	250	25-150/-5	1060
MJ15022	508	200	250	15-60/8	1293
MJ15024	508	250	250	15-60/8	1293
RCA1A01	475	70	5	40-200/0.010	651
RCA1A02	475	-50	7	30-200/-0.0001	651
RCA1A03	475	95△	10	70-300/0.300	651
RCA1A04	475	-95△	10	70-300/-0.300	651
RCA1A05	475	-75△	5	50-250/-0.150	651
RCA1A06	475	75△	5	50-250/0.150	651
RCA1A09	475	175	10	20-100/0.010	651
RCA1A10	475	-175	10	40-250/-0.010	651
RCA1A11	475	175	10	40-250/0.001	651
RCA1A15	475	100	10	20-100/0.010	651
RCA1A16	475	-100	10	40-250/-0.010	651
RCA1A18	475	10	7	40-250/0.010	651
RCA1A19	475	-10	7	40-250/-0.010	651
RCA1B01	478	95	115	20-70/4	647
RCA1B04	479	200	150	15-75/2	908
RCA1B05	479	250	150	15-75/2	908
RCA1B06	485	100	150	10-50/4	648
RCA1B09	479	250	150	40 min./2	908
RCA1C03	486	100	40	50-250/1	652
RCA1C04	486	-100	40	50-250/-1	652
RCA1C05	487	50	40	20-120/3	644
RCA1C06	487	-50	40	20-120/-3	644
RCA1C07	489	65	75	20-120/4	646
RCA1C08	489	-65	75	20-120/-4	646
RCA1C09	491	65	75	20-120/4	645
RCA1C10	492	40	40	50-250/1.5	642
RCA1C11	492	-40	40	50-250/-1.5	642
RCA1C12	486	120	40	40-250/1	652
RCA1C13	486	-120	40	40-250/-1	652
RCA1E02	494	175	35	30-150/0.3	653
RCA1E03	494	-175	35	30-150/-0.3	653
RCA410	495	200	125	30-90/1	509
RCA411	497	300	125	30-90/1	510
RCA413	499	325	125	20-80/0.5	1281
RCA423	499	325	125	30-90/1	1281
RCA431	499	325	125	15-35/2.5	1281
RCA1000	227	60	90	750 min./4	594
RCA1001	227	80	90	750 min./4	594
RCA3054	138	55	36	25-100/0.5	618
RCA3055	194	60	75	20-70/4	618
RCA3441	237	150	36	20-150/0.5	666
RCA3773	472	140	150	15-60/8	1060
RCA6340	502	140	200	30-120/10	1205
RCA6341	502	150	200	30-120/10	1205
RCA8638C	472	140	200	25-150/5	1060
RCA8638D	472	120	200	25-150/5	1060
RCA8638E	472	100	200	10-100/7.5	1060
RCA8766	505	350	150	100 min./6	973
RCA8766A	505	350	150	100 min./4	973
RCA8766B	505	400	150	100 min./6	973
RCA8766C	505	400	150	100 min./4	973
RCA8766D	505	450	150	100 min./6	973
RCA8766E	505	450	150	100 min./4	973
RCA9116C	260	-140	200	25-150/-5	1061
RCA9116D	260	-120	200	25-150/-5	1061
RCA9116E	260	-100	200	10-100/-7.5	1061
RCA9166A	508	250	250	30 min./3	1293
RCA9166B	508	200	250	30 min./3	1293
RCS258	102	60	250	15-60/10	974
RCS579	222	250	125	12 min./3	886
TIP29	511	40	30	15-150/1	990
TIP29A	511	60	30	15-150/1	990
TIP29B	511	80	30	15-150/1	990

△ V_{CER}

Power Transistor Product Classification Chart

Type No.	Page No.	V_{CEO} [Max.] V	P_T [Max.] W	h_{FE}/I_C[A]	File No.
TIP29C	511	100	30	15-150/1	990
TIP30	513	-40	30	15-150/-1	988
TIP30A	513	-60	30	15-150/-1	988
TIP30B	513	-80	30	15-150/-1	988
TIP30C	513	-100	30	15-150/-1	988
TIP31	515	40	40	10-50/3	991
TIP31A	515	60	40	10-50/3	991
TIP31B	515	80	40	10-50/3	991
TIP31C	515	100	40	10-50/3	991
TIP32	517	-40	40	10-50/-3	987
TIP32A	517	-60	40	10-50/-3	987
TIP32B	517	-80	40	10-50/-3	987
TIP32C	517	-100	40	10-50/-3	987
TIP41	519	40	65	15-150/3	992
TIP41A	519	60	65	15-150/3	992
TIP41B	519	80	65	15-150/3	992
TIP41C	519	100	65	15-150/3	992
TIP42	521	-40	65	15-150/-3	996
TIP42A	521	-60	65	15-150/-3	996
TIP42B	521	-80	65	15-150/-3	996
TIP42C	521	-100	65	15-150/-3	996
TIP47	523	250	40	30-150/0.3	978
TIP48	523	300	40	30-150/0.3	978
TIP49	523	350	40	30-150/0.3	978
TIP50	523	400	40	30-150/0.3	978
TIP100	526	60	80	1000-20000/3	1153
TIP101	526	80	80	1000-20000/3	1153
TIP102	526	100	80	1000-20000/3	1153
TIP120	528	60	65	1000 min./3	998
TIP121	528	80	65	1000 min./3	998
TIP122	528	100	65	1000 min./3	998
TIP125	531	-60	65	500 min./-0.75	997
TIP126	531	-80	65	500 min./-0.75	997
TIP127	531	-100	65	500 min./-0.75	997
TIP562	533	300	100	20 min./1	1212
TIP563	533	400	100	20 min./1	1212

Triac Product Classification Chart

Type No.	Page No.	V_{DROM} (Max.) V	P_{GM} W	$I_{T(RMS)}$ (Max.) A	File No.
2N5441	601	200	40	40	593
2N5442	601	400	40	40	593
2N5443	601	600	40	40	593
2N5444	601	200	40	40	593
2N5445	601	400	40	40	593
2N5446	601	600	40	40	593
2N5567	580	200	16	10	457
2N5568	580	400	16	10	457
2N5569	580	200	16	10	457
2N5570	580	400	16	10	457
2N5571	580	200	16	15	458
2N5572	580	400	16	15	458
2N5573	580	200	16	15	458
2N5574	580	400	16	15	458
2N5754	545	100	10	2.5	414
2N5755	545	200	10	2.5	414
2N5756	545	400	10	2.5	414
2N5757	545	600	10	2.5	414
2N5806*	601	200	10	25	913
2N5807*	601	400	10	25	913
2N5808*	601	500	10	25	913
2N5809*	601	600	10	25	913
2N6342A	593	200	20	12	1084
2N6343A	593	400	20	12	1084
2N6344A	593	600	20	12	1084
2N6346A	593	200	20	12	1084
2N6347A	593	400	20	12	1084
2N6348A	593	600	20	12	1084
BTA20C	562	300	16	6	1298
BTA20D	562	400	16	6	1298
BTA20E	562	500	16	6	1298
BTA21C	565	300	16	8	1299
BTA21D	565	400	16	8	1299
BTA21E	565	500	16	8	1299
BTA22B	568	200	16	10	1300
BTA22C	568	300	16	10	1300
BTA22D	568	400	16	10	1300
BTA22E	568	500	16	10	1300
BTA22M	568	600	16	10	1300
BTA23B	571	200	16	12	1301
BTA23C	571	300	16	12	1301
BTA23D	571	400	16	12	1301
BTA23E	571	500	16	12	1301
BTA23M	571	600	16	12	1301
MAC15-4	596	200	20	12	1086
MAC15-6	596	400	20	12	1086
MAC15-8	596	600	20	12	1086
MAC15A-4	596	200	20	12	1086
MAC15A-6	596	400	20	12	1086
MAC15A-8	596	600	20	12	1086
SC141B	574	200	10	6	1167
SC141D	574	400	10	6	1167
SC141E	574	500	10	6	1167
SC141M	574	600	10	6	1167
SC146B	574	200	10	10	1167
SC146D	574	400	10	10	1167
SC146E	574	500	10	10	1167
SC146M	574	600	10	10	1167
T2300A	542	100	10	2.5	911
T2300B	542	200	10	2.5	911
T2300D	542	400	10	2.5	911
T2300F	542	50	10	2.5	911
T2301A	542	100	10	2.5	911
T2301B	542	200	10	2.5	911
T2301D	542	400	10	2.5	911
T2301F	542	50	10	2.5	911
T2302A	542	100	10	2.5	911
T2302B	542	200	10	2.5	911
T2302D	542	400	10	2.5	911
T2302F	542	50	10	2.5	911
T2303F	545	50	10	2.5	912
T2304B	548	200	10	0.5	441
T2304D	548	400	10	0.5	441
T2305B	548	200	10	0.5	441
T2305D	548	400	10	0.5	441
T2306A	607	100	10	2.5	406
T2306B	607	200	10	2.5	406
T2306D	607	400	10	2.5	406
T2310A	542	100	10	1.9	911
T2310B	542	200	10	1.9	911
T2310D	542	400	10	1.9	911
T2310F	542	50	10	1.9	911
T2311A	542	100	10	1.9	911
T2311B	542	200	10	1.9	911
T2311D	542	400	10	1.9	911
T2311F	542	50	10	1.9	911
T2312A	542	100	10	1.9	911
T2312B	542	200	10	1.9	911
T2312D	542	400	10	1.9	911
T2312F	542	50	10	1.9	911
T2313A	545	100	10	1.9	912
T2313B	545	200	10	1.9	912
T2313D	545	400	10	1.9	912
T2313F	545	50	10	1.9	912
T2313M	545	600	10	1.9	912
T2316A	607	100	10	2.5	406
T2316B	607	200	10	2.5	406
T2316D	607	400	10	2.5	406
T2320A	550	100	10	2.5	1042
T2320B	550	200	10	2.5	1042
T2320C	550	300	10	2.5	1042
T2320D	550	400	10	2.5	1042
T2320E	550	500	10	2.5	1042
T2320F	550	50	10	2.5	1042
T2322A	550	100	10	2.5	1042
T2322B	550	200	10	2.5	1042
T2322C	550	300	10	2.5	1042
T2322D	550	400	10	2.5	1042
T2322E	550	500	10	2.5	1042
T2322F	550	50	10	2.5	1042
T2323A	550	100	10	2.5	1042
T2323B	550	200	10	2.5	1042
T2323C	550	300	10	2.5	1042
T2323D	550	400	10	2.5	1042
T2323E	550	500	10	2.5	1042
T2323F	550	50	10	2.5	1042
T2327A	550	100	10	2.5	1042
T2327B	550	200	10	2.5	1042
T2327C	550	300	10	2.5	1042
T2327D	550	400	10	2.5	1042
T2327E	550	500	10	2.5	1042
T2327F	550	50	10	2.5	1042
T2500B	553	200	16	6	615
T2500D	553	400	16	6	615

***JAN-type versions also available**

Triac Product Classification Chart

Type No.	Page No.	V_{DROM} (Max.) V	P_{GM} W	$I_{T(RMS)}$ (Max.) A	File No.
T2506B	607	200	16	6	406
T2506D	607	400	16	6	406
T2700B	555	200	16	6	351
T2700D	555	400	16	6	351
T2706B	607	200	16	6	406
T2706D	607	400	16	6	406
T2710B	555	200	16	6	351
T2710D	555	400	16	6	351
T2716B	607	200	16	6	406
T2716D	607	400	16	6	406
T2800A	558	100	16	8	1314
T2800B	558	200	16	8	1314
T2800C	558	300	16	8	1314
T2800D	558	400	16	8	1314
T2800E	558	500	16	8	1314
T2800F	558	50	16	8	1314
T2800M	558	600	16	8	1314
T2801A	558	100	16	6	1314
T2801B	558	200	16	6	1314
T2801C	558	300	16	6	1314
T2801D	558	400	16	6	1314
T2801E	558	500	16	6	1314
T2801F	558	50	16	6	1314
T2801M	558	600	16	6	1314
T2802A	558	100	16	8	1314
T2802B	558	200	16	8	1314
T2802C	558	300	16	8	1314
T2802D	558	400	16	8	1314
T2802E	558	500	16	8	1314
T2802F	558	50	16	8	1314
T2802M	558	600	16	8	1314
T2806B	607	200	16	8	406
T2806C	607	300	16	8	406
T2806D	607	400	16	8	406
T2806M	607	600	16	8	406
T2850A	577	100	16	8	1168
T2850B	577	200	16	8	1168
T2850D	577	400	16	8	1168
T2850E	577	500	16	8	1168
T2850M	577	600	16	8	1168
T2856B	607	200	16	8	406
T2856C	607	300	16	8	406
T2856D	607	400	16	8	406
T4100E	580	500	16	15	458
T4100F	580	50	16	15	458
T4100M	580	600	16	15	458
T4101E	580	500	16	10	457
T4101F	580	50	16	10	457
T4101M	580	600	16	10	457
T4106B	607	200	16	15	406
T4106D	607	400	16	15	406
T4106M	607	600	16	15	406
T4110E	580	500	16	15	458
T4110F	580	50	16	15	458
T4110M	580	600	16	15	458
T4111E	580	500	16	10	457
T4111F	580	50	16	10	457
T4111M	580	600	16	10	457
T4113B	585	200	16	15	443
T4113D	585	400	16	15	443
T4113E	585	500	16	15	443
T4113M	585	600	16	15	443
T4114B	585	200	16	10	443
T4114D	585	400	16	10	443
T4114E	585	500	16	10	443
T4114M	585	600	16	10	443
T4115B	585	200	16	6	443
T4115D	585	400	16	6	443
T4115E	585	500	16	6	443
T4115M	585	600	16	6	443
T4116B	607	200	16	15	406
T4116D	607	400	16	15	406
T4116M	607	600	16	15	406
T4117B	607	200	16	10	406
T4117D	607	400	16	10	406
T4117M	607	600	16	10	406
T4120B	580	200	16	15	458
T4120D	580	400	16	15	458
T4120E	580	500	16	15	458
T4120F	580	50	16	15	458
T4120M	580	600	16	15	458
T4121B	580	200	16	10	457
T4121D	580	400	16	10	457
T4121E	580	500	16	10	457
T4121F	580	50	16	10	457
T4121M	580	600	16	10	457
T4126B	607	200	16	15	406
T4126D	607	400	16	15	406
T4126M	607	600	16	15	406
T4700B	588	200	16	15	300
T4700D	588	400	16	15	300
T4700E	588	500	16	15	300
T4700F	588	50	16	15	300
T6000B	590	200	16	16	1004
T6000C	590	300	16	16	1004
T6000D	590	400	16	16	1004
T6000E	590	500	16	16	1004
T6000F	590	50	16	16	1004
T6000M	590	600	16	16	1004
T6001B	590	200	16	16	1004
T6001C	590	300	16	16	1004
T6001D	590	400	16	16	1004
T6001E	590	500	16	16	1004
T6001F	590	50	16	16	1004
T6001M	590	600	16	16	1004
T6006B	590	200	16	16	1004
T6006C	590	300	16	16	1004
T6006D	590	400	16	16	1004
T6006E	590	500	16	16	1004
T6006M	590	600	16	16	1004
T6260B	598	200	40	25	1195
T6260C	598	300	40	25	1195
T6260D	598	400	40	25	1195
T6260E	598	500	40	25	1195
T6260M	598	600	40	25	1195
T6261B	598	200	40	25	1195
T6261C	598	300	40	25	1195
T6261D	598	400	40	25	1195
T6261E	598	500	40	25	1195
T6261M	598	600	40	25	1195
T6401B	601	200	40	30	459
T6401D	601	400	40	30	459
T6401E	601	500	40	30	459
T6401F	601	50	40	30	459
T6401M	601	600	40	30	459
T6404B	605	200	42	40	487
T6404D	605	400	42	40	487
T6404E	605	500	42	40	487

Triac Product Classification Chart

Type No.	Page No.	V_{DROM} (Max.) V	P_{GM} W	$I_{T(RMS)}$ (Max.) A	File No.
T6405B	605	200	42	25	487
T6405D	605	400	42	25	487
T6405E	605	500	42	25	487
T6406B	607	200	42	40	406
T6406D	607	400	42	40	406
T6406E	607	500	42	40	406
T6406M	607	600	42	40	406
T6407B	607	200	40	30	406
T6407D	607	400	40	30	406
T6407E	607	500	40	30	406
T6407M	607	600	40	30	406
T6411B	601	200	40	30	459
T6411D	601	400	40	30	459
T6411E	601	500	40	30	459
T6411F	601	50	40	30	459
T6411M	601	600	40	30	459
T6414B	605	200	42	40	487
T6414D	605	400	42	40	487
T6415B	605	200	42	25	487
T6415D	605	400	42	25	487
T6416B	607	200	40	40	406
T6416D	607	400	40	40	406
T6416M	607	600	40	40	406
T6417B	607	200	40	30	406
T6417D	607	400	40	30	406
T6417M	607	600	40	30	406
T6420B	601	200	40	40	593
T6420D	601	400	40	40	593
T6420E	601	500	40	40	593
T6420F	601	50	40	40	593
T6420M	601	600	40	40	593
T6421B	601	200	40	30	459
T6421D	601	400	40	30	459
T6421E	601	500	40	30	459
T6421F	601	50	40	30	459
T6421M	601	600	40	30	459
T6426B	607	200	40	40	406
T6426D	607	400	40	40	406
T6426M	607	600	40	40	406
T6427B	607	200	40	30	406
T6427D	607	400	40	30	406
T6427M	607	600	40	30	406

Silicon Controlled Rectifier Product Classification Chart

Type No.	Page No.	V_{DROM} (Max.) V	P_{GM} W	$I_{T(RMS)}$ (Max.) A	File No.
2N681	656	25	5	25	96
2N682*	656	50	5	25	96
2N683*	656	100	5	25	96
2N684*	656	150	5	25	96
2N685*	656	200	5	25	96
2N686*	656	250	5	25	96
2N687*	656	300	5	25	96
2N688*	656	400	5	25	96
2N689	656	500	5	25	96
2N690*	656	600	5	25	96
2N3228	619	200^{Δ}	13	5.0	114
2N3525	619	400^{Δ}	13	5.0	114
2N3650	663	100	40	35	408
2N3651	663	200	40	35	408
2N3652	663	300	40	35	408
2N3653	663	400	40	35	408
2N3654	663	50	40	35	724
2N3655	663	100	40	35	724
2N3656	663	200	40	35	724
2N3657	663	300	40	35	724
2N3658	663	400	40	35	724
2N3668	639	100^{Δ}	40	12.5	116
2N3669	639	200	40	12.5	116
2N3670	639	400	40	12.5	116
2N3870	653	100	40	35	578
2N3871	653	200	40	35	578
2N3872	653	400	40	35	578
2N3873	653	600	40	35	578
2N3896	653	100	40	35	578
2N3897	653	200	40	35	578
2N3898	653	400	40	35	578
2N3899	653	600	40	35	578
2N4101	619	600	13	5.0	114
2N4103	639	600	40	12.5	116
2N6394	646	50	16	12	891
2N6395	646	100	16	12	891
2N6396	646	200	16	12	891
2N6397	646	400	16	12	891
2N6398	646	600	16	12	891
2N6400	646	50	16	16	892
2N6401	646	100	16	16	892
2N6402	646	200	16	16	892
2N6403	646	400	16	16	892
2N6404	646	600	16	16	892
C106A	610	100^{+}	0.5	3.5	1005
C106B	610	200^{+}	0.5	3.5	1005
C106C	610	300^{+}	0.5	3.5	1005
C106D	610	400^{+}	0.5	3.5	1005
C106E	610	500^{+}	0.5	3.5	1005
C106F	610	50^{+}	0.5	3.5	1005
C106M	610	600^{+}	0.5	3.5	1005
C122A	622	100	16	8	1173
C122B	622	200	16	8	1173
C122C	622	300	16	8	1173
C122D	622	400	16	8	1173
C122E	622	500	16	8	1173
C122F	622	50	16	8	1173
C122M	622	600	16	8	1173
S2060A	613	100^{+}	0.5	4	654
S2060B	613	200^{+}	0.5	4	654
S2060C	613	300^{+}	0.5	4	654
S2060D	613	400^{+}	0.5	4	654
S2060E	613	500^{+}	0.5	4	654
S2060F	613	50^{+}	0.5	4	654
S2060M	613	600^{+}	0.5	4	654
S2060Q	613	15^{+}	0.5	4	654
S2060Y	613	30^{+}	0.5	4	654
S2061A	613	100^{+}	0.5	4	654
S2061B	613	200^{+}	0.5	4	654
S2061C	613	300^{+}	0.5	4	654
S2061D	613	400^{+}	0.5	4	654
S2061E	613	500^{+}	0.5	4	654
S2061F	613	50^{+}	0.5	4	654
S2061M	613	600^{+}	0.5	4	654
S2061Q	613	15^{+}	0.5	4	654
S2061Y	613	30^{+}	0.5	4	654
S2062A	613	100^{+}	0.5	4	654
S2062B	613	200^{+}	0.5	4	654
S2062C	613	300^{+}	0.5	4	654
S2062D	613	400^{+}	0.5	4	654
S2062E	613	500^{+}	0.5	4	654
S2062F	613	50^{+}	0.5	4	654
S2062M	613	600^{+}	0.5	4	654
S2062Q	613	15^{+}	0.5	4	654
S2062Y	613	30^{+}	0.5	4	654
S2600B	616	200	40	7	496
S2600D	616	400	40	7	496
S2600M	616	600	40	7	496
S2610B	616	200	40	7	496
S2610D	616	400	40	7	496
S2610M	616	600	40	7	496
S2620B	616	200	40	7	496
S2620D	616	400	40	7	496
S2620M	616	600	40	7	496
S2710B	619	200^{Δ}	13	5.0‡	266
S2710D	619	400^{Δ}	13	5.0‡	266
S2710M	619	600^{Δ}	13	5.0‡	266
S2800A	625	100	16	10	890
S2800B	625	200	16	10	890
S2800C	625	300	16	10	890
S2800D	625	400	16	10	890
S2800E	625	500	16	10	890
S2800F	625	50	16	10	890
S2800M	625	600	16	10	890
S2800S	625	700	16	10	890
S3060A	627	100^{+}	0.5	3	1307
S3060B	627	200^{+}	0.5	3	1307
S3060D	627	400^{+}	0.5	3	1307
S3060F	627	50^{+}	0.5	3	1307
S3060M	627	600^{+}	0.5	3	1307
S3700B	630	200	13	5	306
S3700D	630	400	13	5	306
S3700M	630	600	13	5	306
S3701M	632	600	25	5	476
S3702S	633	700	25	5	1315
S3703SF	633	750	25	5	1315
S3705M	633	600	25	5	1315
S3706E	633	500	25	5	1315
S3900E†	636	500	25	8	938
S3900MF†	636	650	25	8	938
S3900S†	636	700	25	8	938
S3900SF†	636	750	25	8	938

***JAN-type versions also available ‡I_{FRMS} $^{+}V_{DRXM}$ $^{\Delta}V_{FBOM}$**

†ITR - Integrated Thyristor/Rectifier

Silicon Controlled Rectifier Product Classification Chart

Type No.	Page No.	V_{DROM} (Max.) V	P_{GM} W	$I_{T(RMS)}$ (Max.) A	File No.
S3901M†	636	600	25	8	938
S3901MF†	636	650	25	8	938
S3901S†	636	700	25	8	938
S4060A	642	100$^+$	0.5	10	1306
S4060B	642	200$^+$	0.5	10	1306
S4060C	642	300$^+$	0.5	10	1306
S4060D	642	400$^+$	0.5	10	1306
S4060E	642	500$^+$	0.5	10	1306
S4060F	642	50$^+$	0.5	10	1306
S4060M	642	600$^+$	0.5	10	1306
S4060N	642	800$^+$	0.5	10	1306
S4060S	642	700$^+$	0.5	10	1306
S4060U	642	25$^+$	0.5	10	1306
S5800B	644	200	13	5	1051
S5800C	644	300	13	5	1051
S5800D	644	400	13	5	1051
S5800E	644	500	13	5	1051
S5800M	644	600	13	5	1051
S6200A	650	100	40	20	418
S6200B	650	200	40	20	418
S6200D	650	400	40	20	418
S6200M	650	600	40	20	418
S6210A	650	100	40	20	418
S6210B	650	200	40	20	418
S6210D	650	400	40	20	418
S6210M	650	600	40	20	418
S6220A	650	100	40	20	418
S6220B	650	200	40	20	418
S6220D	650	400	40	20	418
S6220M	650	600	40	20	418
S6420A	653	100	40	35	578
S6420B	653	200	40	35	578
S6420D	653	400	40	35	578
S6420M	653	600	40	35	578
S6493M	658	600	40	35	247
S7310B	660	200	40	40	975
S7310C	660	300	40	40	975
S7310D	660	400	40	40	975
S7310E	660	500	40	40	975
S7310M	660	600	40	40	975
S7310N	660	800	40	40	975
S7410M	663	600	40	35	408
S7412M	663	600	40	35	724

†ITR - Integrated Thyristor/Rectifier $^+V_{DRXM}$

Guide to Product Selection

Power Transistors Product Matrix

Hometaxial-Base (Single-Diffused) N-P-N Types

$I_C$max. = 1.5 A $f_T$typ. = 1.5 MHz TO-205MD/TO-39	$I_C$max. = 4 A $f_T$typ. = 1 MHz TO-213MA/TO-66	$I_C$max. = 4 A $f_T$typ. = 1 MHz TO-220	$I_C$max. = 3 A $f_T$typ. = 0.8 MHz TO-213MA/TO-66	$I_C$max. = 3 A $f_T$typ. = 0.8 MHz TO-220	$I_C$max. = 7 A $f_T$typ. = 1 MHz TO-220
2N1482 Family	**2N3054** Family	**2N5298** Family	**2N3441** Family	**2N6478** Family	**2N5496** Family
2N1479 V_{CEO} = 40 V h_{FE} = 20-60 @ 0.2 A P_T = 5 W	**BDX24** **40250** V_{CEO} = 40 V h_{FE} = 25-100 @ 1.5 A P_T = 29 W	**2N5296** V_{CEO} = 40 V h_{FE} = 30-120 @ 1 A P_T = 36 W	**2N6263** V_{CEO} = 120 V h_{FE} = 20-100 @ 0.5 A P_T = 20 W	**RCA3441** V_{CEO} = 120 V h_{FE} = 20-150 @ 0.5 A P_T = 36 W	**2N5490** V_{CEO} = 40 V h_{FE} = 20-100 @ 2 A P_T = 50 W
2N1482 V_{CEO} = 55 V h_{FE} = 35-100 @ 0.2 A P_T = 5 W	**2N3054** V_{CEO} = 55 V h_{FE} = 25-150 @ 0.5 A P_T = 25 W	**2N5298** V_{CEO} = 60 V h_{FE} = 20-80 @ 1.5 A P_T = 36 W	**2N3441** V_{CEO} = 140 V h_{FE} = 25-100 @ 0.5 A P_T = 25 W	**2N6477** V_{CEO} = 120 V h_{FE} = 25-150 @ 1 A P_T = 50 W	**2N5492** V_{CEO} = 55 V h_{FE} = 20-100 @ 2.5 A P_T = 50 W
40348 V_{CEO} = 65 V h_{FE} = 30-125 @ 0.3 A P_T = 8.75 W	**2N6261** V_{CEO} = 80 V h_{FE} = 25-100 @ 1.5 A P_T = 50 W	**2N5294** V_{CEO} = 70 V h_{FE} = 30-120 @ 0.5 A P_T = 36 W	**2N6264** V_{CEO} = 150 V h_{FE} = 20-60 @ 1 A P_T = 50 W	**2N6478** V_{CEO} = 140 V h_{FE} = 25-150 @ 1 A P_T = 50 W	**2N5496** V_{CEO} = 70 V h_{FE} = 20-100 @ 3.5 A P_T = 50 W

$I_C$max. = 15 A $f_T$typ. = 1.5 MHz TO-204MA/TO-3	$I_C$max. = 16 A $f_T$typ. = 1.5 MHz TO-220	$I_C$max. = 10 A $f_T$typ. = 0.4 MHz TO-204MA/TO-3	$I_C$max. = 30 A $f_T$typ. = 1.5 MHz TO-204MA/TO-3	$I_C$max. = 16 A $f_T$typ. = 0.7 MHz TO-204MA/TO-3
2N3055 Family	**2N6103** Family	**2N3442** Family	**2N3772** Family	**2N3773** Family
2N6371 V_{CEO} = 40 V h_{FE} = 15-60 @ 8 A P_T = 117 W	**2N6103** V_{CEO} = 40 V h_{FE} = 15-60 @ 8 A P_T = 75 W	**2N4347** V_{CEO} = 120 V h_{FE} = 15-60 @ 2 A P_T = 100 W	**2N3771** V_{CEO} = 40 V h_{FE} = 15-60 @ 15 A P_T = 150 W	**2N4348** V_{CEO} = 120 V h_{FE} = 15-60 @ 5 A P_T = 120 W
BD182 **2N3055** V_{CEO} = 60 V h_{FE} = 20-70 @ 4 A P_T = 115 W	**2N6099** V_{CEO} = 60 V h_{FE} = 20-80 @ 4 A P_T = 75 W	**2N3442** V_{CEO} = 140 V h_{FE} = 20-70 @ 3 A P_T = 117 W	**2N3772** V_{CEO} = 60 V h_{FE} = 15-60 @ 10 A P_T = 150 W	**BDY37** **2N3773** V_{CEO} = 140 V h_{FE} = 15-60 @ 8 A P_T = 150 W
2N6254 V_{CEO} = 80 V h_{FE} = 20-70 @ 5 A P_T = 150 W	**2N6101** V_{CEO} = 70 V h_{FE} = 20-80 @ 5 A P_T = 75 W	**2N6262** V_{CEO} = 150 V h_{FE} = 20-70 @ 3 A P_T = 150 W	**RCS258** V_{CEO} = 60 V h_{FE} = 15-60 @ 10 A P_T = 250 W	**2N6259** V_{CEO} = 150 V h_{FE} = 15-60 @ 8 A P_T = 250 W

Power Transistors Product Matrix

Epitaxial-Base N-P-N and P-N-P Types

$I_C$max. = -3.5 A $f_T$typ. = 20 MHz TO-205MD/TO-39	$I_C$max. = 6 A $f_T$typ. = 8 MHz TO-213MA/TO-66	$I_C$max. = -6 A $f_T$typ. = 10 MHz TO-213MA/TO-66	$I_C$max. = 7 A $f_T$typ. = 8 MHz TO-220	$I_C$max. = -7 A $f_T$typ. = 10 MHz TO-220	$I_C$max. = 15 A $f_T$typ. = 6 MHz TO-204MA/TO-3	$I_C$max. = 15 A $f_T$typ. = 8 MHz TO-204MA/TO-3
2N5783 Family P-N-P	**2N6374** Family N-P-N	**2N5954** Family P-N-P	**2N6292** Family N-P-N	**2N6107** Family P-N-P	**2N3716** Family N-P-N	**2N6472** Family N-P-N
2N5783 V_{CEO} = -40 V h_{FE} = 20-100 @ -1.6 A P_T = 10 W	**2N6374** V_{CEO} = 40 V h_{FE} = 20-100 @ 3 A P_T = 40 W	**2N5956** V_{CEO} = -40 V h_{FE} = 20-100 @ -3 A P_T = 40 W	**2N6669** V_{CEO} = 30 V h_{FE} = 20-100 @ 5 A P_T = 40 W	**2N6111** V_{CEO} = -30 V h_{FE} = 30-150 @ -3 A P_T = 40 W	**2N6569** V_{CEO} = 40 V h_{FE} = 15-120 @ 4 A P_T = 100 W	**2N6470** V_{CEO} = 40 V h_{FE} = 20-150 @ 5 A P_T = 125 W
2N5782 V_{CEO} = -50 V h_{FE} = 20-100 @ -1.2 A P_T = 10 W	**2N6372** V_{CEO} = 80 V h_{FE} = 20-100 @ 2 A P_T = 40 W	**2N5954** V_{CEO} = -80 V h_{FE} = 20-100 @ -2 A P_T = 40 W	**2N6292** V_{CEO} = 70 V h_{FE} = 30-150 @ 2 A P_T = 40 W	**2N6107** V_{CEO} = -70 V h_{FE} = 30-150 @ -2 A P_T = 40 W	**2N3055** V_{CEO} = 60 V h_{FE} = 20-70 @ 4 A P_T = 115 W	**2N6471** V_{CEO} = 60 V h_{FE} = 20-150 @ 5 A P_T = 125 W
2N5781 V_{CEO} = -65 V h_{FE} = 20-100 @ -1 A P_T = 10 W	**2N6465** V_{CEO} = 80 V h_{FE} = 15-150 @ 1.5 A P_T = 40 W	**2N6467** V_{CEO} = -100 V h_{FE} = 15-150 @ -1.5 A P_T = 40 W	**2N6473** V_{CEO} = 100 V h_{FE} = 15-150 @ 1.5 A P_T = 40 W	**2N6475** V_{CEO} = -100 V h_{FE} = 15-150 @ -1.5 A P_T = 40 W	**2N3716** V_{CEO} = 80 V h_{FE} = 30 @ 3 A P_T = 150 W	**2N6472** V_{CEO} = 80 V h_{FE} = 20-150 @ 5 A P_T = 125 W
	2N6466 V_{CEO} = 120 V h_{FE} = 15-150 @ 1.5 A P_T = 40 W	**2N6468** V_{CEO} = -120 V h_{FE} = 15-150 @ -1.5 A P_T = 40 W	**2N6474** V_{CEO} = 120 V h_{FE} = 15-150 @ 1.5 A P_T = 40 W	**2N6476** V_{CEO} = -120 V h_{FE} = 15-150 @ -1.5 A P_T = 40 W	**2N5878** V_{CEO} = 80 V h_{FE} = 20-100 @ 4 A P_T = 150 W	

$I_C$max. = -15 A $f_T$typ. = 16 MHz TO-204MA/TO-3	$I_C$max. = 15 A $f_T$typ. = 8 MHz TO-220	$I_C$max. = -15 A $f_T$typ. = 8 MHz TO-220	$I_C$max. = 30 A $f_T$typ. = 8 MHz TO-204MA/TO-3	$I_C$max. = 20 A $f_T$typ. = 4 MHz TO-204MA/TO-3	$I_C$max. = -20 A $f_T$typ. = 4 MHz TO-204MA/TO-3
2N6247 Family P-N-P	**2N6488** Family N-P-N	**2N6491** Family P-N-P	**2N5303** Family N-P-N	**RCA8638** Family N-P-N	**RCA9116** Family P-N-P
2N6594 V_{CEO} = -40 V h_{FE} = 15-200 @ -4 A P_T = 100 W	**2N6486** V_{CEO} = 40 V h_{FE} = 20-150 @ 5 A P_T = 75 W	**2N6489** V_{CEO} = -40 V h_{FE} = 20-150 @ -5 A P_T = 75 W	**2N5301** V_{CEO} = 40 V h_{FE} = 15-60 @ 15 A P_T = 200 W	**RCA8638E** V_{CEO} = 100 V h_{FE} = 10-100 @ 7.5 A P_T = 200 W	**RCA9116E** V_{CEO} = -100 V h_{FE} = 10-100 @ -7.5 A P_T = 200 W
2N5875 V_{CEO} = -60 V h_{FE} = 20-100 @ -4 A P_T = 150 W	**2N6487** V_{CEO} = 60 V h_{FE} = 20-150 @ 5 A P_T = 75 W	**2N6490** V_{CEO} = -60 V h_{FE} = 20-150 @ -5 A P_T = 75 W	**2N5302** V_{CEO} = 60 V h_{FE} = 15-60 @ 15 A P_T = 200 W	**RCA3773** V_{CEO} = 140 V h_{FE} = 15-60 @ 8 A P_T = 150 W	**2N6609** V_{CEO} = -140 V h_{FE} = 15-60 @ -8 A P_T = 150 W
2N5880 V_{CEO} = -80 V h_{FE} = 20-100 @ -6 A P_T = 160 W	**2N6488** V_{CEO} = 80 V h_{FE} = 20-150 @ 5 A P_T = 75 W	**2N6491** V_{CEO} = -80 V h_{FE} = 20-150 @ -5 A P_T = 75 W	**2N5303** V_{CEO} = 80 V h_{FE} = 15-60 @ 10 A P_T = 200 W	**RCA8638C** V_{CEO} = 140 V h_{FE} = 25-150 @ 5 A P_T = 200 W	**RCA9116C** V_{CEO} = -140 V h_{FE} = 25-150 @ -5 A P_T = 200 W
2N6248 V_{CEO} = -100 V h_{FE} = 20-100 @ -5 A P_T = 125 W				**MJ15003** V_{CEO} = 140 V h_{FE} = 25-150 @ 5 A P_T = 250 W	**MJ15004** V_{CEO} = -140 V h_{FE} = 25-150 @ -5 A P_T = 250 W

Power Transistors Product Matrix

High-Speed-Switching N-P-N and P-N-P Types

$I_C$max. = 1 A $f_T$typ. = 100 MHz TO-205MD/TO-39	$I_C$max. = -1 A $f_T$typ. = 100 MHz TO-205MD/TO-39	$I_C$max. = 2 A $f_T$typ. = 75 MHz TO-205MD/TO-39	$I_C$max. = -2 A $f_T$typ. = 75 MHz TO-205MD/TO-39	$I_C$max. = 7 A $f_T$typ. = 100 MHz TO-213MA/TO-66
2N2102 Family N-P-N	**2N4036** Family P-N-P	**2N5320** Family N-P-N	**2N5322** Family P-N-P	**2N3879** Family N-P-N
2N3053 V_{CEO} = 40 V h_{FE} = 50-250 @ 0.15 A P_T = 5 W	**2N4037** V_{CEO} = -40 V h_{FE} = 50-250 @ -0.15 A P_T = 7 W	**2N5321** V_{CEO} = 50 V h_{FE} = 40-250 @ 0.5 A P_T = 10 W	**2N5323** V_{CEO} = -50 V h_{FE} = 40-250 @ -0.5 A P_T = 10 W	**2N5202** V_{CEO} = 50 V h_{FE} = 10-100 @ 4 A P_T = 35 W
2N2270 V_{CEO} = 45 V h_{FE} = 50-200 @ 0.15 A P_T = 5 W	**2N4036** V_{CEO} = -65 V h_{FE} = 40-140 @ -0.15 A P_T = 7 W	**2N5320** V_{CEO} = 75 V h_{FE} = 30-130 @ 0.5 A P_T = 10 W	**2N5322** V_{CEO} = -75 V h_{FE} = 30-130 @ -0.5 A P_T = 10 W	**2N3878** V_{CEO} = 50 V h_{FE} = 20 min. @ 4 A P_T = 35 W
2N2102 V_{CEO} = 65 V h_{FE} = 40-120 @ 0.15 A P_T = 5 W	**2N4314** V_{CEO} = -65 V h_{FE} = 50-250 @ -0.15 A P_T = 7 W			**2N3879** V_{CEO} = 75 V h_{FE} = 20-80 @ 4 A P_T = 35 W
2N2405 V_{CEO} = 90 V h_{FE} = 60-200 @ 0.15 A P_T = 5 W				**2N6500** V_{CEO} = 90 V h_{FE} = 15-60 @ 3 A P_T = 35 W

$I_C$max. = 7 A $f_T$typ. = 100 MHz TO-220	$I_C$max. = 12 A $f_T$typ. = 150 MHz Radial Pkg.	$I_C$max. = 20 A $f_T$typ. = 90 MHz TO-204MA/TO-3	$I_C$max. = 30 A $f_T$typ. = 100 MHz TO-204MA/TO-3	$I_C$max. = 25 A $f_T$typ. = 50 MHz TO-204MA/TO-3	$I_C$max. = 50 A $f_T$typ. = 100 MHz Modified TO-3
2N6704 Family N-P-N	**2N6480** Family N-P-N	**2N5038** Family N-P-N	**2N5671** Family N-P-N	**2N6688** Family N-P-N	**2N6033** Family N-P-N
BUW64A **2N6702** V_{CEO} = 90 V h_{FE} = 20 min. @ 5 A P_T = 50 W	**2N6479** V_{CEO} = 60 V h_{FE} = 20-300 @ 12 A P_T = 87 W	**2N5039** V_{CEO} = 75 V h_{FE} = 20-100 @ 10 A P_T = 140 W	**2N5671** V_{CEO} = 120 V h_{FE} = 20 min. @ 20 A P_T = 140 W	**2N6686** V_{CEO} = 160 V h_{FE} = 15 min. @ 25 A P_T = 200 W	**2N6032** V_{CEO} = 90 V h_{FE} = 10-50 @ 50 A P_T = 140 W
BUW64B **2N6703** V_{CEO} = 110 V h_{FE} = 20 min. @ 5 A P_T = 50 W	**2N6480** V_{CEO} = 80 V h_{FE} = 20-300 @ 12 A P_T = 87 W	**2N5038** V_{CEO} = 90 V h_{FE} = 20-100 @ 12 A P_T = 140 W	**2N5672** V_{CEO} = 90 V h_{FE} = 20 min. @ 20 A P_T = 140 W	**2N6687** V_{CEO} = 180 V h_{FE} = 15 min. @ 25 A P_T = 200 W	**2N6033** V_{CEO} = 120 V h_{FE} = 10-50 @ 40 A P_T = 140 W
BUW64C **2N6704** V_{CEO} = 130 V h_{FE} = 20 min. @ 5 A P_T = 50 W		**2N6354** V_{CEO} = 120 V h_{FE} = 10-100 @ 10 A P_T = 140 W		**2N6688** V_{CEO} = 200 V h_{FE} = 15 min. @ 25 A P_T = 200 W	

Power Transistors Product Matrix

High-Voltage N-P-N and P-N-P Types

$I_C$max. = 1A **$f_T$typ. = 25 MHz** **TO-205MD/TO-39**	**$I_C$max. = -1 A** **$f_T$typ. = 35 MHz** **TO-205MD/TO-39**	**$I_C$max. = 5 A** **$f_T$typ. = 25 MHz** **TO-213MA/TO-66**	**$I_C$max. = -5 A** **$f_T$typ. = 30 MHz** **TO-213MA/TO-66**	**$I_C$max. = 7 A** **$f_T$typ. = 7 MHz** **TO-213MA/TO-66**	**$I_C$max. = 5 A** **$f_T$typ. = 5 MHz** **TO-204MA/TO-3**
2N3439 Family N-P-N	**2N5415** Family P-N-P	**2N3585** Family N-P-N	**2N6213** Family P-N-P	**2N6079** Family N-P-N	**2N5240** Family N-P-N
40346 V_{CER} = 175 V h_{FE} = 25 @ 10 mA P_T = 10 W	**RCA1A16** V_{CEO} = -100 V h_{FE} = 40-250 @ -10 mA P_T = 10 W	**2N3583** V_{CEO} = 175 V h_{FE} = 40-200 @ 0.75 A P_T = 35 W	**2N6211** V_{CEO} = -225 V h_{FE} = 10-100 @ -1 A P_T = 35 W	**2N6078** V_{CEO} = 250 V h_{FE} = 12-70 @ 1.2 A P_T = 45 W	**2N5239** V_{CEO} = 225 V h_{FE} = 20-80 @ 2 A P_T = 100 W
2N3440 V_{CEO} = 250 V h_{FE} = 40-160 @ 20 mA P_T = 10 W	**2N5415** V_{CEO} = -200 V h_{FE} = 35-150 @ -50 mA P_T = 10 W	**2N3584** V_{CEO} = 250 V h_{FE} = 25-100 @ 1 A P_T = 35 W	**2N6213** V_{CEO} = -350 V h_{FE} = 10-100 @ -1 A P_T = 35 W	**2N6077** V_{CEO} = 275 V h_{FE} = 12-70 @ 2 A P_T = 45 W	**2N5240** V_{CEO} = 300 V h_{FE} = 20-80 @ 2 A P_T = 100 W
2N3439 V_{CEO} = 350 V h_{FE} = 40-160 @ 20 mA P_T = 10 W	**2N5416** V_{CEO} = -300 V h_{FE} = 30-120 @ -50 mA P_T = 10 W	**2N3585** V_{CEO} = 300 V h_{FE} = 25-100 @ 1 A P_T = 35 W	**2N6214** V_{CEO} = -400 V h_{FE} = 10-100 @ -1 A P_T = 35 W	**2N6079** V_{CEO} = 350 V h_{FE} = 12-50 @ 1.2 A P_T = 45 W	**2N5840** V_{CEO} = 350 V h_{FE} = 10-50 @ 2 A P_T = 100 W

$I_C$max. = 10 A **$f_T$typ. = 6 MHz** **TO-204MA/TO-3**	**$I_C$max. = 8 A** **$f_T$typ. = 15 MHz** **TO-204MA/TO-3**	**$I_C$max. = 7 A** **$f_T$typ. = 2 MHz** **TO-204MA/TO-3**	**$I_C$max. = 10 A** **$f_T$typ. = 20 MHz** **TO-204MA/TO-3**	**$I_C$max. = 8 A** **$f_T$typ. = 20 MHz** **TO-204MA/TO-3**	**$I_C$max. = 15** **$f_T$typ. = 20 MHz** **TO-204MA/TO-3**	**$I_C$max. = 15 A** **$f_T$typ. = 20 MHz** **TO-211MA/TO-61**
2N6251 Family N-P-N	**2N6308** Family N-P-N	**2N6510** Family N-P-N	**RCA8766** Family N-P-N	**2N6673** Family N-P-N	**2N6678** Family N-P-N	**2N6693** Family N-P-N
2N6249 V_{CEO} = 200 V h_{FE} = 10-50 @ 10 A P_T = 175 W	**2N6306** V_{CEO} = 250 V h_{FE} = 15-75 @ 3 A P_T = 125 W	**2N6510** V_{CEO} = 200 V h_{FE} = 10-50 @ 3 A P_T = 120 W	**RCA8766** V_{CEO} = 350 V h_{FE} = 100 @ 6 A P_T = 150 W	**2N6671■** V_{CEO} = 300 V h_{FE} = 10-40 @ 5 A P_T = 100 W	**2N6674■** V_{CEO} = 300 V h_{FE} = 8-20 @ 10 A P_T = 175 W	**2N6689■** V_{CEO} = 300 V h_{FE} = 8-20 @ 10 A P_T = 175 W
2N6250 V_{CEO} = 275 V h_{FE} = 8-50 @ 10 A P_T = 175 W	**2N6307** V_{CEO} = 300 V h_{FE} = 15-75 @ 3 A P_T = 125 W	**2N6514** V_{CEO} = 300 V h_{FE} = 10-50 @ 5 A P_T = 120 W	**RCA8766B** V_{CEO} = 400 V h_{FE} = 100 @ 6 A P_T = 150 W	**2N6672■** V_{CEO} = 350 V h_{FE} = 10-40 @ 5 A P_T = 150 W	**2N6676■** V_{CEO} = 300 V h_{FE} = 8 @ 15 A P_T = 175 W	**2N6690■** V_{CEO} = 400 V h_{FE} = 8-20 @ 10 A P_T = 175 W
2N6251 V_{CEO} = 350 V h_{FE} = 6-50 @ 10 A P_T = 175 W	**2N6308** V_{CEO} = 350 V h_{FE} = 12-60 @ 3 A P_T = 125 W	**2N6513** V_{CEO} = 350 V h_{FE} = 10-50 @ 4 A P_T = 120 W	**RCA8766D** V_{CEO} = 450 V h_{FE} = 100 @ 6 A P_T = 150 W	**2N6673■** V_{CEO} = 400 V h_{FE} = 10-40 @ 5 A P_T = 150 W	**2N6678■** V_{CEO} = 400 V h_{FE} = 8 @ 15 A P_T = 175 W	**2N6693■** V_{CEO} = 400 V h_{FE} = 8 @ 15 A P_T = 175 W

■ SwitchMax transistor.

Power Transistors Product Matrix

Monolithic Darlington N-P-N and P-N-P Types

$I_C$max. = -10 A $f_T$typ. = 40 MHz TO-220	$I_C$max. = 10 A $f_T$typ. = 60 MHz TO-220	$I_C$max. = 10 A $f_T$typ. = 60 MHz TO-204MA/TO-3	$I_C$max. = -10 A $f_T$typ. = 40 MHz TO-204MA/TO-3	$I_C$max. = 20 A $f_T$typ. = 15 MHz TO-204MA/TO-3	$I_C$max. = -20 A $f_T$typ. = 50 MHz TO-204MA/TO-3	$I_C$max. = 8 A $f_T$typ. = 60 MHz TO-213MA/TO-66	$I_C$max. = 10 A $f_T$typ. = 20 MHz TO-204MA/TO-3
2N6668 Family P-N-P	**2N6388** Family N-P-N	**2N6385** Family N-P-N	**2N6650** Family P-N-P	**2N6284** Family N-P-N	**2N6287** Family P-N-P	**2N6537** Family N-P-N	**RCA8766** Family N-P-N
2N6666 V_{CEO} = -40 V h_{FE} = 1k-20k @ -3 A P_T = 65 W	**2N6386** V_{CEO} = 40 V h_{FE} = 1k-20k @ 3 A P_T = 65 W	**2N6055** V_{CEO} = 60 V h_{FE} = 0.75k-18k @ 4 A P_T = 100 W	**2N6648** V_{CEO} = -40 V h_{FE} = 1k-20k @ -5 A P_T = 70 W	**2N6282** V_{CEO} = 60 V h_{FE} = 0.75k-18k @ 10 A P_T = 160 W	**2N6285** V_{CEO} = -60 V h_{FE} = 0.75k-18k @ -10 A P_T = 160 W	**2N6534** V_{CEO} = 80 V h_{FE} = 1k-10k @ 5 A P_T = 36 W	**RCA8766** V_{CEO} = 350 V h_{FE} = 100 @ 6 A P_T = 150 W
2N6667 V_{CEO} = -60 V h_{FE} = 1k-20k @ -5 A P_T = 65 W	**2N6387** V_{CEO} = 60 V h_{FE} = 1k-20k @ 5 A P_T = 65 W	**2N6383** V_{CEO} = 40 V h_{FE} = 1k-20k @ 5 A P_T = 100 W	**2N6649** V_{CEO} = -60 V h_{FE} = 1k-20k @ -5 A P_T = 70 W	**2N6283** V_{CEO} = 80 V h_{FE} = 0.75k-18k @ 10 A P_T = 160 W	**2N6286** V_{CEO} = -80 V h_{FE} = 0.75k-18k @ -10 A P_T = 160 W	**2N6535** V_{CEO} = 100 V h_{FE} = 0.5k-10k @ 3 A P_T = 36 W	**RCA8766B** V_{CEO} = 400 V h_{FE} = 100 @ 6 A P_T = 150 W
2N6668 V_{CEO} = -80 V h_{FE} = 1k-20k @ -5 A P_T = 65 W	**2N6388** V_{CEO} = 80 V h_{FE} = 1k-20k @ 5 A P_T = 65 W	**2N6385** V_{CEO} = 80 V h_{FE} = 1k-20k @ 5 A P_T = 100 W	**2N6650** V_{CEO} = -80 V h_{FE} = 1k-20k @ -5 A P_T = 70 W	**2N6284** V_{CEO} = 100 V h_{FE} = 0.75k-18k @ 10 A P_T = 160 W	**2N6287** V_{CEO} = -100 V h_{FE} = 0.75k-18k @ -10 A P_T = 160 W	**2N6536** V_{CEO} = 100 V h_{FE} = 1k-10k @ 5 A P_T = 36 W	**RCA8766D** V_{CEO} = 450 V h_{FE} = 100 @ 6 A P_T = 150 W
	2N6533 V_{CEO} = 120 V h_{FE} = 1k-20k @ 3 A P_T = 65 W	**2N6578** V_{CEO} = 120 V h_{FE} = 2k-20k @ 4 A P_T = 120 W				**2N6537** V_{CEO} = 120 V h_{FE} = 1k-10k @ 3 A P_T = 36 W	

Transistors for Audio-Amplifier Applications

Full Complementary Output Darlington Pairs

RCA Types	NPN or PNP	Package	H_{FE}	I_C/V_{CE}	V_{CER}	P_T
2N6385	NPN	TO-3	1000	5A/3V	80V	100W
2N6650	PNP	TO-3	1000	−5A/3V	−80V	70W
BDX33	NPN	TO-220	750	4A/3V	100V	70W
BDX34	PNP	TO-220	750	−4A/−3V	−100V	70W
2N6284	PNP	TO-3	750	−10A/−3V	−100V	160W
2N6287	NPN	TO-3	750	10A/3V	100V	160W

Full Complementary Output Transistor Pairs

RCA Types	NPN or PNP	Package	H_{FE}	I_C/V_{CE}	V_{CER}	P_T
2N3055	NPN	TO-3	20	4A/4V	70V	115W
BDX18	PNP	TO-3	20	−4A/−4V	−70V	115W
2N6292	NPN	TO-220	30	3A/4V	80V	40W
2N6107	PNP	TO-220	30	−3A/−4V	−80V	40W
2N6488	NPN	TO-220	20	5A/4V	85	75W
2N6491	PNP	TO-220	20	−5A/−4V	−85V	75W
BD239-243	NPN	TO-220	15	3A/4V	100V	70W
BD240-244	PNP	TO-220	15	−3A/−4V	−100V	70W
RCA1A05	PNP	TO-39	50	−0.15A/−4V	−75V	7W
RCA1A06	NPN	TO-39	50	0.15A/4V	75V	5W
RCA1C05	NPN	TO-220AB	20	3A/4V	50V	40W
RCA1C06	PNP	TO-220AB	20	−3A/−4V	−50V	40W
BD750	**PNP**	**TO-204MA**	**15**	**−7.5A/−2V**	**−100V**	**200W**
BD751	**NPN**	**TO-204MA**	**15**	**7.5A/2V**	**100V**	**200W**
BD750C	**PNP**	**TO-204MA**	**25**	**−5A/−2V**	**−140V**	**250W**
BD751C	**NPN**	**TO-204MA**	**25**	**5A/2V**	**140V**	**250W**
BD500	**PNP**	**TO-220AB**	**15**	**−5A/−4V**	**−55V**	**75W**
BD500B	**PNP**	**TO-220AB**	**20**	**−3.5A/−4V**	**−85V**	**75W**
BD501B	**NPN**	**TO-220AB**	**20**	**3.5A/4V**	**85V**	**75W**
RCA1C10	**NPN**	**TO-220**	**50**	**1.5A/4V**	**40V**	**40W**
RCA1C11	**PNP**	**TO-220**	**50**	**−1.5A/−4V**	**−40V**	**40W**
RCA8638C	**NPN**	**TO-3**	**15**	**8A/4V**	**140V**	**200W**
RCA9116C	**PNP**	**TO-3**	**15**	**−8A/4V**	**−140V**	**200W**
RCA8638C	NPN	TO-3	15	8A/4V	140V	200W
RCA9116C	PNP	TO-3	15	−8A/4V	−140V	200W

Quasi Complementary Output Transistors

RCA Types	NPN or PNP	Package	H_{FE}	I_C/V_{CE}	V_{CER}	P_T
2N3055	NPN	TO-3	20	4A/4V	70V	115W
2N3055 (Hometaxial)	NPN	TO-3	20	5A/4V	80V	150W
2N3442	NPN	TO-3	20	3A/2V	150V	150W
2N3772	NPN	TO-3	15	10A/4V	70V	250W
2N3773	NPN	TO-3	15	8A/4V	160V	250W
2N5298	NPN	TO-220	20	5A/4V	75V	75W
2N5496	NPN	TO-220	20	3,5A/4V	70V	36W
2N6103	NPN	TO-3	20	5A/4V	75V	75W
2N6292	NPN	TO-220	30	2.5A/4V	80V	40W
2N6488	NPN	TO-220	20	5A/4V	90V	75W
2N6510	NPN	TO-3	10	4A/3V	300V	120W
BD550	**NPN**	**TO-204MA**	**15**	**4A/4V**	**130V**	**150W**

Quasi Complementary Output Transistors (Cont'd)

RCA Types	NPN or PNP	Package	H_{FE}	I_C/V_{CE}	V_{CER}	P_T
BD550B	**NPN**	**TO-204MA**	**10**	**2A/4V**	**275V**	**150W**
BUX18	**NPN**	**TO-3**	**10**	**4A/3V**	**375V**	**120W**
RCA1A03	NPN	TO-39	70	0.3A/4V	95V	10W
RCA1A04	PNP	TO-39	70	−0.3A/−4V	−95V	10W
RCA1A05	PNP	TO-39	50	−0.15A/−4V	−75V	7W
RCA1A06	NPN	TO-39	50	0.15A/4V	75V	5W
RCA1B01	NPN	TO-3	20	4A/4V	95V	115W
RCA1B04	NPN	TO-3	15	2A/5V	200V	150W
RCA1B05	NPN	TO-3	15	2A/5V	250V	150W
RCA1B06	NPN	TO-3	10	4A/4V	100V	150W
RCA1B09	NPN	TO-3	40	2A/5V	250V	150W
RCA1C03	NPN	TO-220	50	1A/4V	100V	40W
RCA1C04	PNP	TO-220	50	−1A/−4V	−100V	40W
RCA1C09	NPN	TO-220	20	4A/4V	65V	75W
RCA1C12	NPN	TO-220	40	1A/2V	120V	40W
RCA1C13	PNP	TO-220	40	−1A/2V	−120V	40W

Complementary Driver Pairs/Predrivers

RCA Types	NPN or PNP	Package	H_{FE}	I_C/V_{CE}	V_{CER}	P_T
2N2102	NPN	TO-39	25	0.1A/5V	100V	5W
2N3440	NPN	TO-39	40	20 mA/10V	400V	10W
2N4036	PNP	TO-39	50	0.15A/10V	65V	7W
2N5320	NPN	TO-39	40	0.5A/4V	90V	10W
2N5322	PNP	TO-39	40	−0.5A/−4V	−90V	10W
2N5415	PNP	TO-39	20	−50mA/−10V	−300V	10W
BD239-243	NPN	TO-220	15	3A/4V	100V	70W
BD240-244	PNP	TO-220	15	−3A/−4V	−100V	70W
RCA1A01	NPN	TO-39	40	0.01A/4V	70V	5W
RCA1A09	NPN	TO-39	20	0.01A/10V	175V	10W
RCA1A10	PNP	TO-39	40	−0.01A/−10V	−175V	10W
RCA1A15	NPN	TO-39	20	0.01A/10V	100V	10W
RCA1A16	PNP	TO-39	40	−0.01A/−10V	−100V	10W
RCA1E02	NPN	TO-66	30	0.3A/2V	175V	35W
RCA1E03	PNP	TO-66	30	−0.3A/−2V	−175V	35W

Protection Circuit Types

RCA Types	NPN or PNP	Package	H_{FE}	I_C/V_{CE}	V_{CER}	P_T
RCA1A18	NPN	TO-39	40	0.01A/4V	10V	5W
RCA1A19	PNP	TO-39	40	−0.01A/−4V	−10V	7W

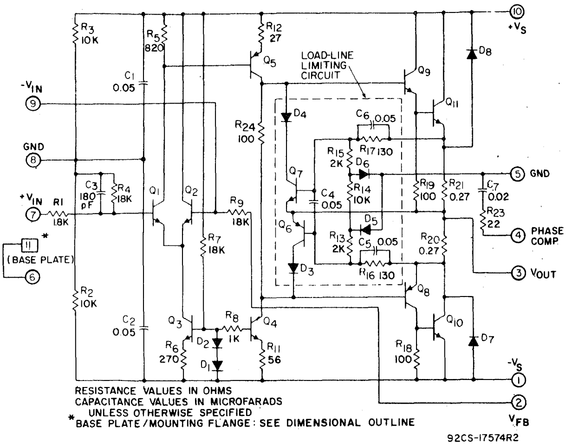
Input Device Types

RCA Types	NPN or PNP	Package	H_{FE}	I_C/V_{CE}	V_{CER}	P_T
RCA1A02	PNP	TO-39	30	−0.1A/−10V	−50V	7W
RCA1A11	NPN	TO-39	40	0.01A/10V	175V	10W

Power Hybrid Comparison Chart

Multi-Purpose High-Power Operational Amplifiers

HC2000H



RESISTANCE VALUES IN OHMS
CAPACITANCE VALUES IN MICROFARADS
UNLESS OTHERWISE SPECIFIED
*BASE PLATE/MOUNTING FLANGE: SEE DIMENSIONAL OUTLINE

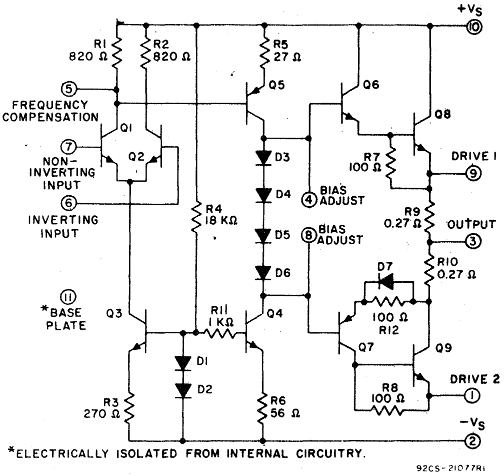
92CS-17574R2

Schematic diagram of type HC2000H operational amplifier.

HC2000H – Applications

Motor control, magnetic-deflection amplifiers, solenoid driver, low-frequency oscillator amplifier, voltage regulators, constant current source, inverting and non-inverting unity-gain amplifier.

HC2500



*ELECTRICALLY ISOLATED FROM INTERNAL CIRCUITRY.

92CS-21077R1

Schematic diagram of type HC2500 operational amplifier.

HC2500 – Applications

Low-distortion, high-power amplifiers for audio and other end uses where internal overload protection is not required.

Ratings and Features for HC2000H and HC2500

Ratings:

SUPPLY VOLTAGE:
Between leads 1 and 10 .... 75 V
OUTPUT CURRENT (peak) .... 7 A
OPERATING TEMPERATURE RANGE . . . -55 to +150°C

Features:

Bandwidth: 30 kHz at 60 W
High power output: up to 100 W (rms)
Single or split power supply:
30 to 75 V single, ±15 to ±37.5 V split

COMPARISON CHART

TYPE	IM DIST. @ 200 mW	OUTPUT PROTECTION NETWORK	OPERATING MODE	FREQUENCY COMPENSATION	COMMUTATING DIODES
HC2000H	0.6%	YES	CLASS B	LC FILTER ON OUTPUT	YES
HC2500	0.06%	NO	CLASS AB	CAPACITOR ON SIGNAL TERMINALS	NO

Socket for both types: RCA part DG-293A, or
Electronic Essentials, 210 Elizabeth St., New York, N.Y. 10012, Part No. MS5-1000

Triac Product Matrix

RCA Triacs			TO-205MA/TO-5 Modified				Mod. TO-205MA/TO-5 With Heat Radiator				TO-202AB VERSATAB	
Standard	$I_{T(RMS)}$		2.5A	2.5A	2.5A	2.5A	2.5A	2.5A	2.5A	2.5A	2.5A	2.5A
	I_{TSM}(60 Hz)		25A	25A	25A	25A	25A	25A	25A	25A	25A	25A
	V_{DROM}(V)	50	T2300F	T2301F	T2302F	T2303F	T2310F	T2311F	T2312F	T2313F	T2320F	T2327F
		100	T2300A	T2301A	T2302A	2N5754	T2310A	T2311A	T2312A	T2313A	T2320A	T2327A
		200	T2300B	T2301B	T2302B	2N5755	T2310B	T2311B	T2312B	T2313B	T2320B	T2327B
		300									T2320C	T2327C
		400	T2300D	T2301D	T2302D	2N5756	T2310D	T2311D	T2312D	T2313D	T2320D	T2327D
		500									T2320E	T2327E
		600				2N5757				T2313M		
	I_{GT}(mA)	I^+, III^-	3	4	10	25	3	4	10	25	3	5
		I^-, III^+	3	4	10	40	3	4	10	40	3	5
	V_{GT}(V)	All Modes	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Zero Voltage Switch	V_{DROM}(V)	100				T2306A				T2316A		
		200				T2306B				T2316B		
		400				T2306D				T2316D		
	I_{GT}(mA)	I^+, III^+				45				45		
	V_{GT}(V)	I^+, III^+				1.5				1.5		
400-Hz Operation	$I_{T(RMS)}$				0.5A	0.5A						
	V_{DROM}(V)	200			T2304B	T2305B						
		400			T2304D	T2305D						
	I_{GT}(mA)	I^+, III^-			10	25						
		I^-, III^+			10	40						
	V_{GT}(V)	All Modes			2.2	2.2						

RCA Triacs			TO-202AB VERSATAB		TO-213MA/ TO-66		TO-213MA/ TO-66 With Heat Radiator	TO-220AB VERSAWATT				
Standard	$I_{T(RMS)}$		2.5A	2.5A	6A	15A	6A	6A	6A	8A	8A	ISOWATT* 8A
	I_{TSM}(60 Hz)		25A	25A	100A	100A	100A	60A	80A	100A	100A	100A
	V_{DROM}(V)	50	T2322F	T2323F					T2801F	T2800F	T2802F	T2850F
		100	T2322A	T2323A					T2801A	T2800A	T2802A	T2850A
		200	T2322B	T2323B	T2700B	T4700B	T2710B	T2500B	T2801B	T2800B	T2802B	T2850B
		300	T2322C	T2323C					T2801C	T2800C	T2802C	
		400	T2322D	T2323D	T2700D	T4700D	T2710D	T2500D	T2801D	T2800D	T2802D	T2850D
		500	T2322E	T2323E					T2801E	T2800E	T2802E	T2850E
		600							T2801M	T2800M	T2802M	T2850M
	I_{GT}(mA)	I^+, III^-	10	25	25	30	25	25	80	25	50	25
		I^-, III^+	10	40	40	80	40	60	–	60	–	60
	V_{GT}(V)	All Modes	2.2	2.2	2.2	2.5	2.2	2.5	4.0▲	2.5	2.5▲	2.5
Zero Voltage Switch	V_{DROM}(V)	100										
		200			T2706B	T4706B	T2716B	T2506B			T2806B	T2856B
		400			T2706D	T4706D	T2716D	T2506D			T2806D	T2856D
	I_{GT}(mA)	I^+, III^+			45	45	45	45			45	45
	V_{GT}(V)	I^+, III^+			1.5	1.5	1.5	1.5			1.5	1.5

*ISOWATT — Mounting tab electrically isolated from electrodes

▲I^+, III^- only

Triac Product Matrix

RCA Triacs			TO-220AB VERSAWATT							
Standard	$I_{T(RMS)}$		6A	10A	6A	8A	10A	12A	12A	12A
	I_{TSM}(60 Hz)		80A	120A	80A	100A	110A	115A	120A	120A
	V_{DROM}(V)	50								
		100								
		200	SC141B	SC146B			BTA22B	BTA23B	2N6342A	2N6346A
		300			BTA20C	BTA21C	BTA22C	BTA23C		
		400	SC141D	SC146D	BTA20D	BTA21D	BTA22D	BTA23D	2N6343A	2N6347A
		500	SC141E	SC146E	BTA20E	BTA21E	BTA22E	BTA23E		
		600	SC141M	SC146M			BTA22M	BTA23M	2N6344A	2N6348A
	I_{GT}(mA)	I^+, III^-	50	50	80	35	25	25	50	50
		I^-, III^+	50 •	50 •	–	–	60	60	–	75
	V_{GT}(V)	All Modes	2.5	2.5	4	2.5	2.5	2.5	2	2.5

• I^- only

RCA Triacs			Press-Fit (TO-203AA)			Stud			Isolated Stud		TO-220AB VERSAWATT	
Standard	$I_{T(RMS)}$			10A	15A		10	15	10A	15A	15A	15A
	I_{TSM}(60 Hz)			100A	100A		100A	100A	100A	100A	150A	150A
	V_{DROM}(V)	50		T4101F	T4100F		T4111F	T4110F	T4121F	T4120F		
		100										
		200		2N5567	2N5571		2N5569	2N5573	T4121B	T4120B	MAC15-4	MAC15A-4
		300							T4121D	T4120D	MAC15-6	MAC15A-6
		400		2N5568	2N5572		2N5570	2N5574	T4121E	T4120E		
		500		T4101E	T4100E		T4111E	T4110E	T4121M	T4120M	MAC15-8	MAC15A-8
		600		T4101M	T4100M		T4111M	T4110M				
	I_{GT}(mA)	I^+, III^-		25	50		25	50	25	50	50	50
		I^-, III^+		40	80		40	80	40	80	–	75
	V_{GT}(V)	All Modes		2.5	2.5		2.5	2.5	2.5	2.5	2	2.5
Zero Voltage Switch	V_{DROM}(V)	200			T4106B		T4117B	T4116B		T4126B		
		400			T4106D		T4117D	T4116D		T4126D		
		600			T4106M					T4126M		
	I_{GT}(mA)	I^+, III^+			45		45	45		45		
	V_{GT}(V)	All Modes			1.5		1.5	1.5		1.5		
400-Hz Operation	$I_{T(RMS)}$					6A	10A	15A				
	V_{DROM}(V)	200				T4115B	T4114B	T4113B				
		400				T4115D	T4114D	T4113D				
	I_{GT}(mA)	I^+, III^-				50	50	50				
		I^-, III^+				80	80	80				
	V_{GT}(V)	All Modes				2.5	2.5	2.5				

Triac Product Matrix

RCA Triacs			TO-220AB VERSAWATT		TO-238AA Quick-Connect		Press-Fit		Stud			Isolated Stud	
Standard	$I_{T(RMS)}$		16A	16A	25A	25A	30A	30A	30A		40A	30A	40A
	I_{TSM}(60 Hz)		150A	150A	300A	300A	300A	300A	300A		300A	300A	300A
	V_{DROM}(V)	50	T6000F	T6001F			T6401F		T6411F			T6421F	T6420F
		100											
		200	T6000B	T6001B	T6260B	T6261B	T6401B	2N5441	T6411B		2N5444	T6421B	T6420B
		300	T6000C	T6001C	T6260C	T6261C							
		400	T6000D	T6001D	T6260D	T6261D	T6401D	2N5442	T6411D		2N5445	T6421D	T6420D
		500	T6000E	T6001E	T6260E	T6261E	T6401E		T6411E			T6421E	T6420E
		600	T6000M	T6001M	T6260M	T6261M	T6401M	2N5443	T6411M		2N5446	T6421M	T6420M
	I_{GT}(mA)	I^+, III^-	50	80	50	80	50	50	50		50	50	50
		I^-, III^+	80	–	80	–	80	80	80		80	80	80
	V_{GT}(V)	All Modes	2.5	3	2.5	3	2.5	2.5	2.5		2.5	2.5	2.5
Zero Voltage Switch	V_{DROM}(V)	200	T6006B				T6407B	T6406B	T6417B		T6416B	T6427B	T6426B
		300	T6006C										
		400	T6006D				T6407D	T6406D	T6417D		T6416D	T6427D	T6426D
		500	T6006E										
		600	T6006M				T6407M	T6406M	T6417M		T6416M	T6427M	T6426M
	I_{GT}(mA)	I^+, III^+	45				45	45	45		45	45	45
	V_{GT}(V)	All Modes	1.5				1.5	1.5	1.5		1.5	1.5	1.5
400-Hz Operation	$I_{T(RMS)}$						25A	40A	25A	25A	40A		
	V_{DROM}(V)	200					T6405B	T6404B	T6415B	2N5806	T6414B		
		400					T6405D	T6404D	T6415D	2N5807	T6414D		
		500								2N5808			
		600								2N5809			
	I_{GT}(mA)	I^+, III^-					80	80	80	80	80		
		I^-, III^+					120	120	120	150■	120		
	V_{GT}(V)	All Modes					3	3	3	2.5▲	3		

▲4V for III^+ mode

■80 mA for I^- mode

SCR Product Matrix

RCA SCR's		TO-8	TO-202AB VERSATAB		TO-220AB VERSAWATT			TO-213MA/TO-66			
$I_{T(RMS)}$		2A	FTO* 3A	4A	4A	4A	4A	5A	FTO* 5A	FTO* 5A	FTO* 5A
I_{TSM}(60 Hz)		60A	20A	20A	35A	35A	35A	60A	80A	80A	75A (Ipm)
V_{DROM}	15				S2060Q	S2061Q	S2062Q				
	30				S2060Y	S2061Y	S2062Y				
	50		S3060F	C106F	S2060F	S2061F	S2062F				
	100		S3060A	C106A	S2060A	S2061A	S2062A				
	200	2N3528	S3060B	C106B	S2060B	S2061B	S2062B	2N3228		S3700B	
	300				S2060C	S2061C	S2062C				
	400	2N3529	S3060D	C106D	S2060D	S2061D	S2062D	2N3525		S3700D	
	500			C106E	S2060E	S2061E	S2062E		S3706E		
	600	2N4102	S3060M	C106M	S2060M	S2061M	S2062M	2N4101	S3705M	S3700M	S3701M
I_{GT}(mA)		15	2	0.2	0.2	0.5	2	15	30	40	35
V_{GT}(V)		2	1.5	0.8	0.8	0.8	0.8	2	4	3.5	4

RCA SCR's		TO-213MA/TO-66		TO-213MA/ TO-66 With Heat Rad.	TO-220AB VERSAWATT	Low-Profile Mod. TO-205MA/ TO-5	TO-205MA/ TO-5 With Heat Rad.	TO-205MA/ TO-5 With Heat Spreader
$I_{T(RMS)}$		FTO* 5A	FTO* 5A	5A	FTO* 5A	7A	3.3A	7A
I_{TSM}(60 Hz)		80A	80A	80A	80A	100A	100A	100A
V_{DROM} V_{RROM}(V)	100							
	200			S2710B	S5800B	S2600B	S2610B	S2620B
	300				S5800C			
	400			S2710D	S5800D	S2600D	S2610D	S2620D
	500				S5800E			
	600			S2710M	S5800M	S2600M	S2610M	S2620M
	700	S3702S						
	750		S3703SF					
I_{GT}(mA)		45	40	15	50	15	15	15
V_{GT}(V)		4	4	2	2.5	1.5	1.5	1.5

RCA SCR's		TO-220AB VERSAWATT					TO-204MA/ TO-3	Press-Fit TO-203AA		Stud	
$I_{T(RMS)}$		8A	10A	10A	12A	16A	12.5A	20A	35A	20A	35A
I_{TSM}(60 Hz)		100A	100A	120A	125	160	200A	200A	350A	200A	350A
V_{DROM} V_{RROM}(V)	25			S4060U							
	50	C122F	S2800F	S4060F	2N6394	2N6400					
	100	C122A	S2800A	S4060A	2N6395	2N6401	2N3668	S6200A	2N3870	S6210A	2N3896
	150										
	200	C122B	S2800B	S4060B	2N6396	2N6402	2N3669	S6200B	2N3871	S6210B	2N3897
	300	C122C	S2800C	S4060C							
	400	C122D	S2800D	S4060D	2N6397	2N6403	2N3670	S6200D	2N3872	S6210D	2N3898
	500	C122E	S2800E	S4060E							
	600	C122M	S2800M	S4060M	2N6398	2N6406	2N4103	S6200M	2N3873	S6210M	2N3899
	700		S2800S	S4060S							
	800			S4060N							
I_{GT}(mA)		25	15	0.2	30	30	40	15	40	15	40
V_{GT}(V)		1.5	1.5	1.5	1.5	1.5	2	2	2	2	2

*FTO – Fast Turn-Off.

SCR Product Matrix

RCA SCR's		Isolated Stud		TO-208MA/TO-48				
					Pulse Modulator	FTO*	FTO*	FTO*
$I_{T(RMS)}$		20A	35A	25A	35A	35A	35A	40A■
I_{TSM}(60 Hz)		200A	350A	150A	150A	180A	180A	400A
V_{DROM} V_{RROM}(V)	25			2N681				
	50			2N682			2N3654	
	100	S6220A	S6420A	2N683		2N3650	2N3655	
	150			2N684				
	200	S6220B	S6420B	2N685		2N3651	2N3656	S7310B
	250			2N686				
	300			2N687		2N3652	2N3657	S7310C
	400	S6220D	S6420D	2N688		2N3653	2N3658	S7310D
	500			2N689				S7310E
	600	S6220M	S6420M	2N690	S6493M	S7410M	S7412M	S7310M
	800							S7310N
I_{GT}(mA)		15	40	25	80	180	180	80
V_{GT}(V)		2	2	3	2	3	2	3

*FTO – Fast Turn-Off

■ASCR (Asymmetrical Silicon Controlled Rectifiers)

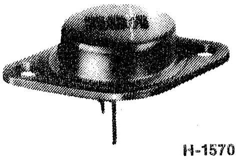
ITR Product Matrix

For Horizontal-Deflection Circuits

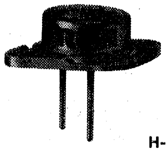
RCA ITR's*		TO-220AB VERSAWATT	
		Trace	Commutating (Retrace)
$I_{T(RMS)}$		8A	8A
I_{TSM}(60 Hz)		90A	90A
V_{DROM}(V)	300		
	400		
	450		
	500	S3900E	
	550		
	600		S3901M
	650	S3900MF	S3901MF
	700	S3900S	S3901S
	750	S3900SF	
I_{GT}(mA)		30	45
V_{GT}(V)		4	4

*Integrated Thyristor/Rectifiers

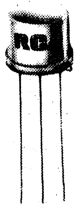
Packages


H-1570

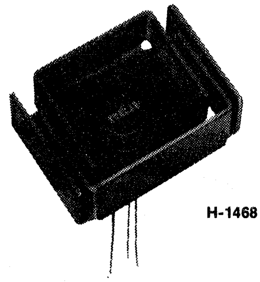
JEDEC TO-3/
TO-204MA


H-1811

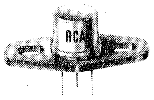
2N6032 2N6033
Modified TO-3
(0.060-In.Dia.Pins)


H-1380

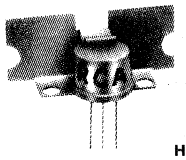
JEDEC TO-5/
TO-205MA


H-1468

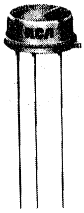
TO-39/TO-5
With Heat Radiator


H-1375

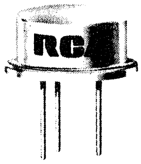
TO-39/TO-5
With Flange


H-1539

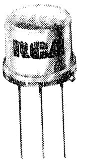
TO-5
With Heat Spreader


H-1599

TO-5
Low-Profile


H-1015

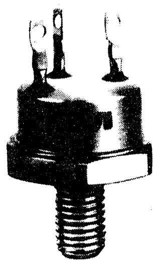
JEDEC TO-8


H-1381

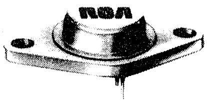
JEDEC TO-39/
TO-205MD


H-1612

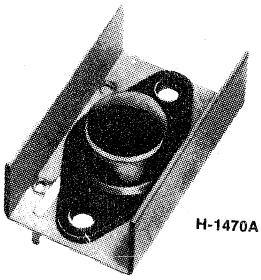
JEDEC TO-48/
TO-208MA


H-1896

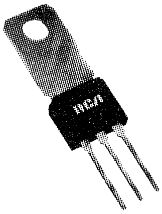
JEDEC TO-61/
TO-211MA


H-1340

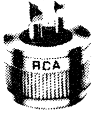
JEDEC TO-66/
TO-213MA


H-1470A

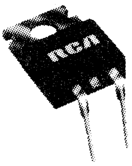
TO-66
With Heat Radiator


H-1824

VERSATAB
JEDEC TO-202AB

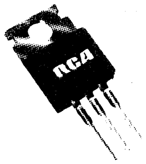

H-1611

Press-Fit
JEDEC
TO-203AA

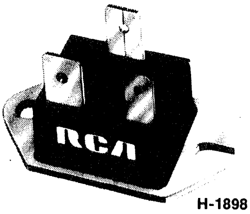

H-1534R1

VERSAWATT
JEDEC TO-220AA

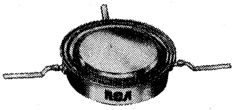
Packages



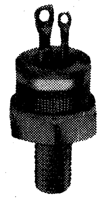
VERSAWATT
JEDEC TO-220AB



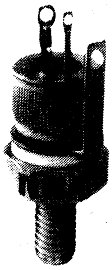
Quick Connect
JEDEC TO-238



Radial

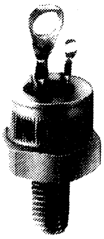


Stud

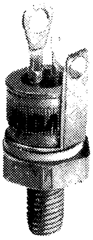


Isolated Stud
6-20 A Thyristors
35 A SCR's

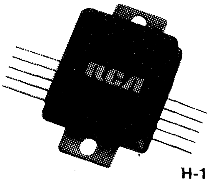
Press-Fit



Stud
25-40 A Triacs



Isolated Stud
25-40 A Triacs



Power Hybrid
Circuit

Power Devices Cross-Reference Guide
(Industry Type to Equivalent RCA Type)

This guide provides a quick reference to more than 2800 industry power devices (power transistors, silicon controlled rectifiers, and triacs) and their nearest RCA replacements. The nearest RCA device is determined on the basic of electrical similarity as well as package similarity.

Industry Type	RCA Replacement Type
2N656	2N2102
2N1132	2N4037
2N1132A	2N4037
2N1420	2N1711
2N1507	2N1711
2N1565	RCA1A01
2N1565A	RCA1A01
2N1573	40409
2N1574	40409
2N1613S	2N1613
2N1711S	2N1711
12N1714	2N1480
2N1889	2N699
2N1893S	2N1893
2N1974	RCA1A01
2N1975	RCA1A01
2N1984	RCA1A01
2N1985	RCA1A01
2N1986	2N3053
2N1987	2N697
2N1990	BF257
2N2034	2N5784
2N2049	2N1711
2N2102S	2N2102
2N2192	2N1711
2N2193	2N1613
2N2194	2N699
2N2195	2N697
2N2195A	2N697
2N2217	2N697
2N2218	2N697
2N2243	2N1893
2N2243A	2N1893
2N2270S	2N2270
2N2297	2N1613
2N2297S	2N1613
2N2303	40315
2N2410	2N3053
2N2537	RCA1A06
2N2538	2N1711
2N2800	40406
2N2846	2N697
2N2848	2N697
2N2863	2N5321
2N2864	2N3053
2N2868	2N3053
2N2958	2N697
2N2959	2N1711
2N3020	2N1893
2N3024	2N4904
2N3025	2N4905
2N3026	2N4905
2N3036	2N5320
2N3108	2N2102
2N3109	2N1711
2N3110	2N3053
2N3114	BF257
2N3122	2N5321
2N3133	RCA1A05
2N3134	2N4037
2N3171	2N6254
2N3172	2N6246
2N3173	2N6247
2N3174	2N6248
2N3183	2N6246
2N3184	2N6246
2N3185	2N6247
2N3186	2N6248
2N3195	2N6246
2N3196	2N6246
2N3197	2N6247
2N3198	2N6248
2N3202	2N5783
2N3203	2N5781
2N3208	2N5783
2N3224	2N5415
2N3225	2N5415
2N3226	2N6253
2N3233	2N3442
2N3234	2N3055,2N6262
2N3235	2N3055
2N3236	2N6254
2N3237	2N5302
2N3238	2N5882
2N3239	2N5882
2N3240	2N5882
2N3244	2N5323
2N3245	2N5323
2N3292	2N697
2N3300	2N1711
2N3418	2N5320
2N3444	2N5321
2N3445	2N6471
2N3446	2N6472
2N3447	2N6471
2N3448	2N6472
2N3464	2N3053
2N3665	2N1893
2N3672	2N699
2N3712	2N3440,BF257
2N3713	2N3715
2N3714	2N3716
2N3719	2N5323
2N3720	2N5322
2N3738	2N3584
2N3739	2N3585
2N3740	2N5955
2N3741	2N5954
2N3742	2N3439,BF259
2N3743	2N5416,BFT19B
2N3766	2N3879,2N6373
2N3767	2N6372
2N3774	2N5783
2N3775	2N5781
2N3778	2N5783
2N3779	2N5781
2N3782	2N5783
2N3788	2N5840
2N3789	2N3791
2N3790	2N3792
2N3795	2N5415
2N3863	2N3055
2N3864	2N3442
2N3865	2N6262
2N3902	2N6308,BUX18C
2N3945	2N2102,2N2270
2N4000	2N5320
2N4030	2N4036
2N4070	2N6306
2N4071	2N6306
2N4111	2N4914
2N4113	2N4915
2N4130	2N3055
2N4231	2N4231A
2N4232	2N4232A
2N4233	2N4233A
2N4234	2N5783
2N4235	2N5782
2N4236	2N5781
2N4237	2N5786
2N4238	2N5785
2N4239	2N5784
2N4387	2N5956
2N4388	2N5955
2N4404	2N1893
2N4405	2N2405
2N4438	2N3439
2N4890	2N4037
2N4907	2N6246
2N4908	2N6246
2N4909	2N6247
2N4910	2N6260,2N6374
2N4911	2N3054,2N6373
2N4912	2N6261,2N6372
2N4926	2N3440,BF258
2N4927	2N3440,BF258
2N4928	BFT28
2N4929	BFT28A
2N4930	2N5415,BFT28B
2N4931	2N5416,BFT28C
2N5058	2N3439,BF259
2N5059	2N3440,BF258
2N5091	2N5416
2N5092	2N3439
2N5110	2N5783

Power Devices Cross-Reference Guide
(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type	Industry Type	RCA Replacement Type	Industry Type	RCA Replacement Type
2N5157	2N5840	2N5979	2N6488	2N6424	2N6211
2N5241	2N6513,BUX18C	2N5980	2N6489	2N6425	2N6212
2N5264	2N6510	2N5981	2N6490	2N6461	2N3439
2N5279	2N3439	2N5982	2N6491	2N6543	2N6673
2N5280	2N4036	2N5983	2N6486	2N6545	2N6673
2N5281	2N5415	2N5984	2N6487	2N6563	2N6689
2N5282	2N5416	2N5985	2N6488	2N6585	2N6692
2N5294	2N5294	2N5986	2N6489	2N6586	2N6690
2N5296	2N5298	2N5987	2N6490	2N6588	2N6692
2N5298	2N5298	2N5988	2N6491	2N6589	2N6690
2N5305	BDY29	2N5989	2N6486	2SA489	2N6107
2N5344	2N6211	2N5990	2N6487	2SA490	2N6109
2N5345	2N6212	2N5991	2N6488	2SA503	2N4314
2N5427	2N6372	2N6029	RCA9116E	2SA504	2N4037
2N5429	2N6465	2N6030	RCA9116D	2SA512	2N4314
2N5466	2N6671	2N6031	2N6609	2SA560	2N4314
2N5467	2N6671	2N6054	2N6650	2SA597	2N4037
2N5598	2N5202	2N6139	2N5569	2SA814	2N6476
2N5600	2N6500	2N6140	2N5570	2SA815	2N6475
2N5602	2N3879	2N6141	T4111M	2SB502A	2N5954
2N5604	2N6500	2N6142	2N5569	2SB503A	2N5955
2N5606	2N3879	2N6143	2N5570	2SB530	2N6248
2N5608	2N3879	2N6144	T4111M	2SB531	2N6247
2N5610	2N6500	2N6145	T4120B	2SB558	2N6248
2N5612	2N6500	2N6146	T4120D	2SB595	2N6475
2N5614	2N5039	2N6147	T4120M	2SB596	2N6107
2N5616	2N5038	2N6151	T2800B	2SC481	2N699
2N5618	2N5038	2N6152	T2800D	2SC482	2N1613
2N5620	2N6496	2N6153	T2800M	2SC485	2N1893
2N5622	2N5039	2N6154	T2802B	2SC504	2N1711
2N5624	2N5038	2N6155	T2802D	2SC512	2N699
2N5626	2N5038	2N6156	T2802M	2SC558	BUX17A
2N5628	2N6496	2N6157	T6401B	2SC560	2N2405
2N5660	2N6077	2N6158	T6401D	2SC779	2N3584
2N5661	2N6079	2N6159	T6401M	2SC782	2N3585
2N5664	2N6077	2N6160	T6411B	2SC782A	2N3585
2N5665	2N6079	2N6161	T6411D	2SC783	2N3583
2N5687	40412	2N6162	T6111M	2SC789	2N6292
2N5732	2N5671	2N6163	T6421B	2SC790	2N6290
2N5734	2N5671	2N6164	T6421D	2SC792	BUX16B
2N5737	2N6246	2N6165	T6421M	2SC1173	2N6288
2N5738	2N6248	2N6226	2N6248	2SC1195	BUX16
2N5739	2N5878	2N6229	RCA9116E	2SC1576	BUX16
2N5758	2N3442,2N6262	2N6230	RCA9116D	2SD102	2N6261
2N5759	2N3442,2N6262	2N6231	MJ15004	2SD129	2N6372
2N5760	2N3442,2N6262	2N6233	2N3583,2N6077	2SD130	2N3054
2N5861	2N5321	2N6234	2N3584,2N6077	2SD234	RCA3054
2N5864	RCA1A05	2N6235	2N3585,2N6079	2SD235	RCA3054
2N5865	RCA1A05	2N6270	2N5671	2SD369	2N3055
2N5867	2N6246	2N6271	2N5672	2SD371	2N6254
2N5888	2N6247	2N6296	2N6649	2SD404C	2N6288
2N5929	2N5671	2N6297	2N6650	2SD424	2N6262
2N5930	2N5672	2N6298	2N6649	2SD425	2N3442
2N5932	2N5671	2N6299	2N6650	2SD427	2N4347
2N5933	2N5672	2N6302	RCA3773	2SD428	2N4348
2N5935	2N6032	2N6338	2N5672	2SD523	2N6384
2N5936	2N6033	2N6339	2N5672	2SD524	2N6385
2N5970	2N6472	2N6342	T2802B,2N6342A	2SD526	2N6292
2N5971	2N6472	2N6343	T2802D,2N6343A	2SD552	BUX17A
2N5972	2N6472	2N6344	T2802M,2N6344A	6T06	T2700B
2N5974	2N6489	2N6346	T2800B,2N6346A	6T08	T4700B
2N5975	2N6490	2N6347	T2800D,2N6347A	6T16	T2700B
2N5976	2N6491	2N6348	T2800M,2N6348A	6T18	T4700B
2N5977	2N6486	2N6359	2N4348	6T26	T2700B
2N5978	2N6487	2N6360	2N4348	6T28	T4700B

Power Devices Cross-Reference Guide
(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type
6T36	T2700D
6T38	T4700D
6T46	T2700D
6T48	T4700D
10RC10AS24	2N3650
10RC20AS24	2N3650
10RC30AS24	2N3651
10RC40AS24	2N3652
10RC50AS24	S7410M
10RC60AS24	S7410M
16RC10A	2N683
16RC10AS24	2N3650
16RC20A	2N685
16RC20AS24	2N3651
16RC30A	2N687
16RC30AS24	2N3652
16RC40A	2N688
16RC40AS24	2N3653
16RC50A	2N689
16RC50AS24	S7410M
16RC60A	2N690
16RC60AS24	S7410M
73T2	40392
100T2	2N4347
104T2	2N6253
108T2	2N5039
109T2	2N6354
182T2A	BUX16
182T2B	BUX16
182T2C	BUX16
183T2A	BUX16
183T2B	BUX16
183T2C	BUX16
184T2A	BUX16
184T2B	BUX16
184T2C	BUX16
185T2A	BUX16A
185T2B	BUX16A
185T2C	BUX16A
40216	S6493M
40250	2N3054
40251	2N3055
40360	RCA1A01
40429	T2700B
40430	T2700D
40502	T2710B
40503	T2710D
40504	S2710B
40505	S2710D
40506	S2710M
40525	T2300A
40526	T2300B
40527	T2300D
40528	T2302A
40529	T2302B
40530	T2302D
40531	T2310A
40532	T2310B
40533	T2310D
40534	T2312A
40535	T2312B
40536	T2312D
40553	S3700B
40554	S3700D
40555	S3700M
40575	T4700B
40576	T4700D
40594	RCA1A03
40595	RCA1A04
40634	RCA1A05
40635	RCA1A06
40636	RCA1B01
40654	S2600B
40655	S2600D
40656	S2620B
40657	S2620D
40658	S2610B
40659	S2610D
40660	T6401B
40661	T6401D
40662	T6411B
40663	T6411D
40668	T2800B
40669	T2800D
40670	T2800M
40671	T6401M
40672	T6411M
40684	T2313A
40685	T2313B
40686	T2313D
40687	T2313M
40688	T6420B
40689	T6420D
40690	T6420M
40691	T2301B
40692	T2301D
40693	T2316A
40694	T2316B
40695	T2316D
40696	T2306A
40697	T2306B
40698	T2306D
40699	T6406B
40700	T6406D
40701	T6406M
40702	T6416B
40703	T6416D
40704	T6416M
40705	T6407M
40706	T6407D
40709	T6407M
40711	T4106B
40712	T4106D
40713	T4116B
40714	T4116D
40715	T4706B
40716	T4706D
40719	T4117B
40720	T4117D
40721	T2806B
40722	T2806D
40727	T2706B
40728	T2706D
40729	T2716B
40730	T2716D
40735	S7410M
40749	S6200M
40750	S6200B
40751	S6200D
40752	S6200M
40753	S6210A
40754	S6210B
40755	S6210D
40756	S6210M
40757	S6220A
40758	S6220B
40759	S6220D
40760	S6220M
40761	T2311B
40762	T2311D
40766	T2301A
40767	T2311A
40769	T2304B
40770	T2304D
40771	T2305B
40772	T2305D
40777	T4115B
40778	T4115D
40781	T4114B
40782	T4114D
40785	T4113B
40786	T4113D
40787	T6405B
40788	T6405D
40789	T6415B
40790	T6415D
40791	T6404D
40793	T6414B
40794	T6414D
40795	T4101M
40796	T4111M
40797	T4100M
40798	T4110M
40799	T4121B
40800	T4121D
40801	T4121M
40802	T4120B
40803	T4120D
40804	T4120M
40805	T6421B
40806	T6421D
40807	T6421M
40833	S2600M
40834	S2620M
40835	S2610M
40867	S2800A
40868	S2800B
40869	S2800D
40871	RCA1C03
40872	RCA1C04
40900	T2850A
40901	T2850B
40902	T2850D
40927	T6420N
40979	RCA1C10
40980	RCA1C11
41014	T2500B
41015	T2500D
BC119	2N697
BC120	2N697
BC139	40406
BC140	2N5321
BC141	2N5320
BC142	RCA1A01
BC143	RCA1A04

Power Devices Cross-Reference Guide

(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type
BC144	RCA1A03
BC160	2N5323
BC161	2N5322
BC185	2N3053
BC286	2N2102
BC287	2N4036
BC300	2N1893
BC301	2N699
BC302	2N2270
BC303	2N4314
BC304	2N4037
BC310	2N1893
BC311	2N4314
BC323	2N5320
BC324	2N5320
BC340	2N3053
BC341	2N3053A
BC342	2N2102
BC343	2N4036
BC344	2N2405
BC345	2N4036
BC360	40319
BC361	2N4036
BC441	2N5320
BC460	2N5323
BC461	2N5322
BCW44	RCA1A01
BCW45	40362
BCW77-16	2N1711
BCW78-16	2N1711
BCW79-16	2N4037
BCW80-16	2N4037
BCY40	2N4037
BCY54	2N4036
BD115	BF258
BD116	2N3055
BD141	2N4347
BD144	BUX18C
BD148	BDY71
BD149	BDY71
BD160	2N6510
BD162	40250
BD163	2N6260
BD165	BD239
BD166	BD240
BD167	BD239A
BD168	BD240A
BD169	BD239B
BD170	BD240B
BD175	BD239
BD176	BD240
BD177	BD239A
BD178	BD240A
BD179	BD239B
BD180	BD240B
BD185	BD239
BD186	BD240
BD187	BD239
BD188	BD240
BD189	BD239A
BD190	BD240A
BD191	2N3054
BD192	2N6260
BD195	BD243
BD196	BD244
BD197	BD243A
BD198	BD244A
BD199	BD243B
BD200	BD244B
BD201	BD243
BD202	BD244
BD203	BD243A
BD204	BD244A
BD205	2N6486
BD206	2N6489
BD207	2N6487
BD208	2N6490
BD213-45	2N6486
BD213-60	2N6487
BD213-80	2N6488
BD214-45	2N6489
BD214-60	2N6490
BD214-80	2N6491
BD215	2N3584
BD216	2N3585
BD244A	BD244A
BD244B	BD244B
BD244C	BD244C
BD245	2N6486
BD245A	2N6487
BD245B	2N6488
BD246	2N6489
BD246A	2N6490
BD246B	2N6491
BD253	BUX31
BD253A	BUX31
BD253B	BUX31
BD253C	BUX31A
BD260	2N3584
BD261	2N3584
BD264	2N6667
BD264A	2N6668
BD264B	BDX34C
BD265	2N6387
BD265A	2N6388
BD265B	BDX33C
BD266	BDX34A
BD266A	BDX34B
BD266B	BDX34C
BD267	BDX33A
BD267A	BDX33B
BD267B	BDX33C
BD268	BDX34A
BD268A	BDX34B
BD269	BDX33A
BD269A	BDX33B
BD271	BD241
BD272	BD242
BD273	BD241A
BD274	BD242A
BD275	BD241B
BD276	BD242B
BD301	BD243
BD302	BD244
BD303	BD243A
BD304	BD244A
BD311	2N6471
BD312	2N6246
BD313	2N6472
BD314	2N6247
BD315	2N6472
BD316	2N6247
BD317	2N6472
BD318	2N6248
BD342	2N6569
BD343	2N6594
BD350A	BDX18
BD351A	2N3055
BD401	BUW64A
BD403	BUW64B
BD539	BD241
BD539A	BD241A
BD539B	BD241B
BD539C	BD241C
BD540	BD242
BD540A	BD242A
BD540B	BD242B
BD540C	BD242C
BD543	2N6486
BD543A	2N6487
BD543B	2N6488
BD544	2N6489
BD544A	2N6490
BD544B	2N6491
BD545	2N6486
BD545A	2N6487
BD545B	2N6488
BD546	2N6489
BD546A	2N6490
BD546B	2N6491
BD566	2N6667
BD566A	2N6668
BD567	2N6387
BD567A	2N6388
BD575	BD241
BD576	BD242
BD577	BD241A
BD578	BD242A
BD579	BD241B
BD580	BD242B
BD581	BD241C
BD582	BD242C
BD585	BD241
BD586	BD242
BD587	BD241A
BD588	BD242A
BD589	BD241B
BD590	BD242B
BD591	BD241C
BD592	BD242C
BD595	BD243
BD596	BD244
BD597	BD243A
BD598	BD244A
BD599	BD243B
BD600	BD244B
BD601	BD243C
BD602	BD244C
BD605	2N6486
BD606	2N6489
BD607	2N6487
BD608	2N6490
BD609	2N6488
BD610	2N6491
BD633	RCA1C10

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(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type
BD634	RCA1C11
BD635	RCA1C03
BD636	RCA1C04
BD637	RCA1C03
BD638	RCA1C04
BD644	BDX34
BD646	BDX34A
BD648	BDX34B
BD661	2N6486
BD661K	BD243
BD662	2N6489
BD662K	BD244
BD663	BD278E
BD663B	2N6486
BD664	2N6489
BD675	BDX33
BD676	BDX34
BD677	BDX33A
BD678	BDX34A
BD679	BDX33B
BD680	BDX34B
BD695A	BDX33
BD696A	BDX34
BD697	BDX33A
BD697A	BDX33A
BD698	BDX34A
BD698A	BDX34A
BD699	BDX33B
BD699A	BDX33B
BD700	BDX34B
BD700A	BDX34B
BD701	BDX33C
BD702	BDX34C
BD705	2N6486
BD706	2N6489
BD707	2N6487
BD708	2N6490
BD709	2N6488
BD710	2N6491
BD795	BD243
BD796	BD244
BD797	BD243A
BD798	BD244A
BD799	BD243B
BD800	BD244B
BD801	BD243C
BD802	BD244C
BD805	2N6486
BD806	2N6489
BD807	2N6487
BD808	2N6490
BD809	2N6488
BD810	2N6491
BD895	BD895
BD895A	BD895A
BD896	BD896
BD896A	BD896A
BD897	BD897
BD897A	BD897A
BD898	BD898
BD898A	BD898A
BD899	BD899
BD899A	BD899A
BD900	BD900
BD900A	BD900A
BD901	BD901
BD902	BD902
BD905	2N6486
BD906	2N6489
BD907	2N6487
BD908	2N6490
BD909	2N6488
BD910	2N6491
BD933	BD239
BD934	BD240
BD935	BD239A
BD936	BD240A
BD937	BD239B
BD938	BD240B
BD939	BD239C
BD940	BD240C
BD941	2N6474
BD942	2N6476
BD943	2N6288
BD944	2N6111
BD945	2N6288
BD946	2N6111
BD947	2N6290
BD948	2N6109
BD949	BD241A
BD950	BD242A
BD951	BD241B
BD952	BD242B
BD953	BD241C
BD954	BD242C
BD955	2N6474
BD956	2N6476
BDT62	BDX34A
BDT62A	BDX34B
BDT62B	BDX34C
BDT63	BDX33A
BDT63A	BDX33B
BDT63B	BDX33C
BDT63C	BDX33D
BDT91	2N6487
BDT92	2N6490
BDT93	2N6488
BDT94	2N6491
BDW21	2N6569
BDW21A	2N3055
BDW22	2N6469
BDW22A	2N6246
BDW22B	2N6247
BDW22C	2N6248
BDW23	BDX33
BDW23A	BDX33A
BDW23B	BDX33B
BDW23C	BDX33C
BDW25-4	2N6466
BDW25-6	2N6466
BDW25-10	2N6466
BDW51	2N6470
BDW51A	2N6471
BDW51B	2N6472
BDW52	2N6469
BDW52A	2N6246
BDW52B	2N6247
BDW52C	2N6248
BDW73	BDX33
BDW74	BDX34
BDW93	BDX33
BDW93A	BDX33A
BDW93B	BDX33B
BDW93C	BDX33C
BDW94	BDX34
BDW94A	BDX34A
BDW94B	BDX34B
BDW94C	BDX34C
BDX14	2N5954
BDX16	BUX66
BDX27	2N3879
BDX28	2N3879
BDX30	2N6500
BDX54	BDX34
BDX54A	BDX34A
BDX54B	BDX34B
BDX54C	BDX34C
BDX60	2N6254
BDX61	2N3055
BDX62	2N6649
BDX62A	2N6650
BDX63	2N6384
BDX63A	2N6385
BDX64	BDX84A
BDX64A	BDX84B
BDX64B	BDX84C
BDX65	BDX83A
BDX65A	BDX83B
BDX65B	BDX83C
BDX66	2N6285
BDX66A	2N6286
BDX66B	2N6287
BDX67	2N6282
BDX67A	2N6283
BDX67B	2N6284
BDX77	BD243B
BDX78	BD244B
BDX85	2N6383
BDX85A	2N6055
BDX85B	2N6056
BDX87	BDX83
BDX87A	BDX83A
BDX87B	BDX83B
BDX87C	BDX83C
BDX91	2N4914
BDX92	2N4905
BDX93	2N4915
BDX94	2N4906
BDY10	2N6253
BDY11	2N3055
BDY12	BUX16
BDY13	BUX16
BDY15	BUX16
BDY17	BUX16
BDY20	BUX16
BDY23	2N4914
BDY24	2N4915
BDY25A	BUX16
BDY25B	BUX16
BDY25C	BUX16
BDY26A	BUX16
BDY26B	BUX16
BDY26C	BUX16
BDY27A	BUX16
BDY27B	BUX16

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Industry Type	RCA Replacement Type
BDY27C	BUX16
BDY28A	BUX16A
BDY28B	BUX16A
BDY28C	BUX16A
BDY34	BD241
BDY38	2N6253
BDY39	2N3055
BDY42	BUX18A
BDY43	BUX18B
BDY44	BUX18C
BDY45	BUX17A
BDY46	BUX17B
BDY55	BDY55
BDY55	2N5039
BDY56	2N5038
BDY56	BDY56
BDY57	BDY57A
BDY57	41012
BDY58	BDY58R
BDY58	41013
BDY73	2N3055
BDY74	2N4347
BDY76	2N3772
BDY77	2N3773
BDY78	2N6373
BDY79	2N3583
BDY80A	2N5296
BDY81A	2N5298
BDY82A	2N6111
BDY83A	2N6109
BDY91	2N5038
BDY92	2N5039
BDY93	BU126
BDY94	BU126
BDY95	BU126
BDY96	2N6513
BDY97	2N6512
BDY98	2N6511
BDY99	2N6511
BF111	2N3440
BF137	BF257
BF157	BF257
BF174	BF257
BF177	40360
BF178	40412
BF179	BF257
BF179A	BF257
BF179B	BF258
BF179C	BF258
BF305	BF257
BF322	40317
BF323	40319
BF336	BF258
BF337	BF258
BF338	BF258
BF355	2N3440
BF390	BF259
BFR19	2N1613
BFR20	2N1711
BFR21	2N1893
BFR22	2N2102
BFR23	2N4036
BFR24	2N4037
BFR56	2N5321
BFR57	BF257
BFR58	BF258
BFR59	BF259
BFR77	2N1893
BFR78	2N2405
BFS91A	2N4036
BFS92	2N4036
BFS93	2N4314
BFS94	2N4037
BFS95	2N4037
BFT32	RCA1A06
BFT33	40409
BFT34	2N2405
BFT35	2N4314
BFT36	40410
BFT39	40409
BFT40	40628
BFT41	40628
BFT44	BF259
BFT45	BF258
BFT60	2N4037
BFT61	2N4037
BFW24	2N2102
BFW25	2N1711
BFW26	2N697
BFW33	2N1893
BFW44	BFT19
BFW45	BF257
BFX17	2N3053
BFX29	2N4036
BFX30	2N4036
BFX39	2N4036
BFX68	2N1711
BFX68A	2N1711
BFX69	2N697
BFX69A	2N1613
BFX74	2N4037
BFX74A	2N4314
BFX85	2N2405
BFX86	2N1711
BFX87	2N4038
BFX88	2N4037
BFX91	BFT28B
BFX98	BF257
BFY17	40317
BFY33	2N697
BFY34	2N697
BFY40	40320
BFY43	BF257
BFY44	2N2102
BFY45	40408
BFY46	2N1711
BFY50	2N697
BFY51	2N697
BFY52	2N3053
BFY55	2N697
BFY56	2N699
BFY57	BF257
BFY67	2N3053
BFY67A	2N1613
BFY68	2N1711
BFY70	2N3053
BFY94	RCA1A03
BRY41-100	2N5754
BRY41-200	2N5755
BRY41-300	2N5756
BRY41-400	2N5757
BRY41-500	2N5757
BRY45-100	2N5754
BRY45-200	2N5755
BRY45-300	2N5756
BRY45-400	2N5757
BRY45-500	2N5757
BSS15	2N5320
BSS16	2N5321
BSS17	2N5322
BSS18	2N5323
BSS30	2N2102
BSS32	2N2405
BSS45	2N5320
BSS46	2N5322
BSS48	2N3440
BSS49	2N3439
BSV15	2N4037
BSV15-6	2N4037
BSV15-10	2N4037
BSV16	2N4314
BSV16-6	2N4314
BSV16-10	2N4314
BSV17	2N5322
BSV69	2N5321
BSV77	2N5321
BSV84	2N1893
BSW23	2N4037
BSW39	2N1893
BSX22	2N5321
BSX23	2N5320
BSX40	2N4037
BSX45	2N3053
BSX46	2N2102
BSX47	2N1893
BSX59	2N5321
BSX60	2N5321
BSX61	2N5321
BSX72	2N3053
BSX95	2N1613
BSX96	2N1711
BSY25	2N697
BSY44	2N699
BSY45	2N1893
BSY46	2N699
BSY51	2N697
BSY52	2N1711
BSY53	2N697
BSY54	2N1711
BSY55	2N1893
BSY68	2N2405
BSY71	2N1711
BSY81	2N697
BSY82	2N1711
BSY83	2N697
BSY84	2N1711
BSY85	2N1893
BSY87	2N2102
BSY91	2N697
BSY92	2N1711
BT102-300R	S2800C
BT102-500R	S2800E
BT137-500	T2800E
BT137-600	T2800M
BT138-500	2N6348A

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(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type
BT138-600	2N6348A
BT139-500	MAC15A8
BT139-600	MAC15A8
BTR0205	T2700B
BTR0210	T2700B
BTR0220	T2700B
BTR0230	T2700D
BTR0240	T2700D
BTR0305	T2700B
BTR0310	T2700B
BTR0320	T2700B
BTR0330	T2700D
BTR0340	T2700D
BTR0405	T4700B
BTR0410	T4700B
BTR0420	T4700B
BTR0430	T4700D
BTR0440	T4700D
BTS0305	2N5567
BTS0310	2N5567
BTS0320	2N5567
BTS0330	2N5568
BTS0340	2N5568
BTS0350	T4101M
BTS0360	T4101M
BTS0405	2N5567
BTS0410	2N5567
BTS0420	2N5567
BTS0430	2N5568
BTS0440	2N5568
BTS0450	T4101M
BTS0460	T4101M
BTS0505	2N5571
BTS0510	2N5571
BTS0520	2N5571
BTS0530	2N5572
BTS0540	2N5572
BTS0550	T4100M
BTS0560	T4100M
BTS0605	2N5441
BTS0610	2N5441
BTS0620	2N5441
BTS0630	2N5442
BTS0640	2N5442
BTS0650	2N5443
BTS0660	2N5443
BTU0305	2N5569
BTU0310	2N5569
BTU0320	2N5569
BTU0330	2N5570
BTU0340	2N5570
BTU0350	T4111M
BTU0360	T4111M
BTU0405	2N5569
BTU0410	2N5569
BTU0420	2N5569
BTU0430	2N5570
BTU0440	2N5570
BTU0450	T4111M
BTU0460	T4111M
BTU0505	2N5573
BTU0510	2N5573
BTU0520	2N5573
BTU0530	2N5574
BTU0540	2N5574
BTU0550	T4110M
BTU0560	T4110M
BTU0605	T6411B
BTU0610	T6411B
BTU0620	T6411B
BTU0630	T6411D
BTU0640	T6411D
BTU0650	T6411M
BTU0660	T6411M
BTV0405	T4121B
BTV0410	T4121B
BTV0420	T4121B
BTV0430	T4121D
BTV0440	T4121D
BTV0450	T4121M
BTV0460	T4121M
BTW10-100	T2700B
BTW10-200	T2700B
BTW10-300	T2700D
BTW10-400	T2700D
BTW11-100	T2700B
BTW11-200	T2700B
BTW11-300	T2700D
BTW11-400	T2700D
BTW12-100	2N5567
BTW12-200	2N5567
BTW12-300	2N5568
BTW12-400	2N5568
BTW12-500	T4101M
BTW13-100	2N5569
BTW13-200	2N5569
BTW13-300	2N5570
BTW13-400	2N5570
BTW13-500	T4111M
BTW14-100	T4700B
BTW14-200	T4700B
BTW14-300	T4700D
BTW14-400	T4700D
BTW15-100	2N5567
BTW15-200	2N5567
BTW15-300	2N5568
BTW15-400	2N5568
BTW15-500	T4101M
BTW16-100	2N5569
BTW16-200	2N5569
BTW16-300	2N5570
BTW16-400	2N5570
BTW16-500	T4111M
BTW18-100	2N5571
BTW18-200	2N5571
BTW18-300	2N5572
BTW18-400	2N5572
BTW18-500	T4101M
BTW19-100	2N5571
BTW19-200	2N5571
BTW19-300	2N5572
BTW19-400	2N5572
BTW19-500	T4101M
BTW20-100	T6411B
BTW20-200	T6411B
BTW20-300	T6411D
BTW20-400	T6411D
BTW20-500	T6411M
BTW30-300	2N3657
BTW30-400	2N3658
BTW31-300	2N3657
BTW31-400	2N3658
BTW31-400	2N3658
BTW31-500	S7412M
BTW31-600	S7412M
BTX0505	T4120B
BTX0510	T4120B
BTX0520	T4120B
BTX0530	T4120D
BTX0540	T4120D
BTX0550	T4120M
BTX0560	T4120M
BTX0605	T6421B
BTX0610	T6421B
BTX0620	T6421B
BTX0630	T6421D
BTX0640	T6421D
BTX0650	T6421M
BTX0660	T6421M
BTX31-100	S7310A
BTX31-200	S7310B
BTX31-400	S7310D
BTX31-500	S7310M
BTX31-600	S7310M
BTX32-100	S7310B
BTX32-400	S7310D
BTX32-500	S7310M
BTX32-600	S7310M
BTX33-100	S6210A
BTX33-200	S6210B
BTX33-400	S6210D
BTX33-500	S6210M
BTX33-600	S6210M
BTX70-100	S6210A
BTX70-200	S6210B
BTX70-400	S6210D
BTX70-500	S6210M
BTX70-600	S6210M
BTX71-100	S7310B
BTX71-200	S7310B
BTX71-400	S7310D
BTX71-500	S7310M
BTX71-600	S7310M
BTX72-100	S7310M
BTX72-200	S7310M
BTX72-400	S7310M
BTX72-500	S7310M
BTX72-600	S7310M
BTX73-100	2N683
BTX73-200	2N685
BTX73-400	2N688
BTX73-500	2N689
BTX73-600	2N690
BTX74-100	S6210A
BTX74-200	S6210B
BTX74-400	S6210D
BTX74-500	S6210M
BTX74-600	S6210M
BTX94-400	T6411D
BTX94-500	T6411M
BTX94-600	T6411M
BU102	BUX18B
BU104	2N6671
BU104DP	RCA6671
BU109	2N6671

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Industry Type	RCA Replacement Type	Industry Type	RCA Replacement Type	Industry Type	RCA Replacement Type
BU109DP	RCA6671	BUX37	BUX37A	C22U	S6200A
BU111	2N6512	BUX39	BUX39	C30A	2N3896
BU112	2N6672	BUX40	BUX40A	C30B	2N3897
BU114	2N6510	BUX41	BUX41	C30C	2N3898
BU116	2N6671	BUX41N	BUX41N	C30D	2N3898
BU121	BUX18	BUX42	BUX42	C30P	2N3896
BU129	BUX18C	BUX43	BUX43	C30U	2N3896
BU134	2N6672	BUX44	BUX44	C31A	2N3896
BU135	2N6510	BUX45	BUX45	C31B	2N3897
BU136	2N6510	BUX46	BUX31A	C31C	2N3898
BU137	2N6754	BUX47A	BUX32A	C31D	2N3898
BU218	2N5039	BUX48A	2N6752	C31P	2N3896
BU222	2N6513	BUX63	2N6079	C31U	2N3896
BU222A	2N6513	BUX80	BUX32	C32A	2N3870
BU310	BUX17	BUX81	BUX32B	C32B	2N3871
BU311	BUX17	BUX82	BUX31	C32C	2N3872
BU312	BUX17	BUX83	BUX31B	C32D	2N3872
BU322	RCA8766E	BUX97	BUX31	C32F	2N3870
BU322A	RCA8766E	BUX97A	BUX31	C32U	2N3870
BU323	RCA8766D	BUX97B	BUX31A	C33A	2N3870
BU323A	RCA8766D	BUY18S	2N6671	C33B	2N3871
BU406	RCA6671	BUY20	2N6671	C33C	2N3872
BU406H	RCA6671	BUY21	2N6671	C33D	2N3872
BU407	RCA6671	BUY21A	2N6671	C33F	2N3870
BU407H	RCA6671	BUY22	2N6673	C33U	2N3870
BU408	RCA6671	BUY23	2N6673	C34A2	2N3650
BU409	RCA6671	BUY23A	2N6673	C34B2	2N3651
BU606	2N6671	BUY35	2N6511	C34C2	2N3652
BU607	2N6671	BUY43	BDY71	C34D2	2N3653
BU608	2N6671	BUY46	2N3054	C34E2	S7410M
BUS11	BUX31A	BUY51A	2N5039	C34F2	2N3650
BUS11A	BUX31B	BUY52A	2N5671	C35A	2N683,2N3896
BUS12	BUX32A	BUY53A	2N5038	C35B	2N685,2N3897
BUS12A	BUX32B	BUY54A	2N5672	C35C	2N687,2N3898
BUV10	2N5672	BUY55	2N5239	C35D	2N688,2N3898
BUV11N	2N6686	BUY56	2N5239	C35E	2N689,2N3899
BUV21	BUV21	BUY66	BU126	C35F	2N682,2N3896
BUV23	2N6677	BUY67	BU126	C35G	2N684,2N3897
BUV24	2N6678	BUY69A	BUX31B	C35H	2N686,2N3898
BUW24	2N6542	BUY69B	BUX31	C35M	2N690,2N3899
BUW34	BUX32	BUY69C	BUX31	C35U	2N681,2N3896
BUW35	BUX32	BUY70A	BUX31B	C38A	2N683
BUW36	BUX32A	BUY70B	BUX31	C38B	2N685
BUW44	2N6678	BUY70C	BUX31	C38C	2N687
BUW57	2N5672	BUY72	2N5239	C38D	2N688
BUW58	2N6686	BUY74	BUX18A	C38E	2N689
BUW66	RCA8766B	BUY75	BUX18C	C38F	2N682
BUW67	RCA8766	BUY76	BU126	C38G	2N684
BUW73	2N6676	BUY77	BUX18A	C38M	2N686
BUW74	2N6674	BUY78	BUX18C	C38U	2N681
BUW75	2N6674	BUY79	BUX126	C40A	2N3650
BUW76	BUX32	BUY94	BUX31	C40B	2N3651
BUW77	BUX32	BUY95	BUX31	C40C	2N3652
BUX10	BUX10A	BUY96	BUX31	C40D	2N3653
BUX11	BUX11	C20A	S6210A	C40E	S7410M
BUX11N	BUX11N	C20B	S6210B	C40F	2N3650
BUX12	BUX12	C20C	S6210C	C40G	2N3654
BUX13	BUX13	C20D	S6210D	C40H	2N3652
BUX14	BUX14	C20F	S6210A	C40U	2N3650
BUX15	BUX15	C20U	S6210A	C106A	C106A
BUX20	BUX20A	C22A	S6200A	C106B	C106B
BUX26	2N6510	C22B	S6200B	C106C	C106C
BUX27	BUX18C	C22C	S6200C	C106D	C106D
BUX28	RCA8766A	C22D	S6200D	C106E	C106E
BUX29	RCA8766C	C22F	S6200A	C106F	C106F

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Industry Type	RCA Replacement Type
C122A	C122A
C122B	C122B
C122C	C122C
C122D	C122D
C122E	C122E
C122F	C122F
C122M	C122M
C140A	2N3650
C140B	2N3651
C140C	2N3652
C140D	2N3653
C140F	2N3654
C141A	2N3655
C141B	2N3656
C141C	2N3657
C141D	2N3658
C141F	2N3654
C220A	S6210A
C220A2	S6220A
C220B	S6210B
C220B2	S6220B
C220C	S6210C
C220C2	S6220C
C220D	S6210D
C220D2	S6220D
C220E	S6210M
C220E2	S6220M
C220F	S6210A
C220F2	S6220A
C220U	S6210A
C220U2	S6220A
C222A	S6200A
C222B	S6200D
C222C	S6200D
C222D	S6200D
C222E	S6200M
C222F	S6200A
C222U	S6200A
CS302D02	S2062B
CS304D02	S2062D
CS305D02	S2062E
CS306D02	S2062M
CS5-2T	2N3228
CS5-4T	2N3525
CS5-5-5T	2N4101
CS10-02M	S6200A
CS10-02N	S6210A
CS10-05M	S6200A
CS10-05N	S6210A
CS10-1M	S6200A
CS10-1N	S6210A
CS10-2M	S6200B
CS10-2N	S6210B
CS10-4M	S6200D
CS10-4N	S6210D
CS10-6M	S6200M
CS10-6N	S6210D
CS20-05M	S6200A
CS20-05N	S6210A
CS20-1M	S6200A
CS20-1N	S6210A
CS20-2M	S6200B
CS20-2N	S6210B
CS20-4M	S6200D
CS20-4N	S6210D
CS20-6M	S6200M
CS20-6N	S6210M
CS35-02M	2N3870
CS35-02N	2N3896
CS35-05M	2N3870
CS35-05N	2N3896
CS35-1M	2N3870
CS35-1N	2N3896
CS35-2M	2N3871
CS35-2N	2N3897
CS35-4M	2N3872
CS35-4N	2N3898
CS35-6M	2N3873
CS35-6N	2N3899
D42C1	2N6288
D42C2	2N6288
D42C3	2N6288
D42C4	2N6290
D42C5	2N6290
D42C6	2N6290
D42C7	2N6292
D42C8	2N6292
D42C9	2N6292
D42C10	2N6292
D42C11	2N6292
D42C12	2N6292
D43C1	2N6111
D43C2	2N6111
D43C3	2N6111
D43C4	2N6109
D43C5	2N6109
D43C6	2N6109
D43C7	2N6107
D43C8	2N6107
D43C9	2N6107
D43C10	2N6107
D43C11	2N6107
D43C12	2N6107
D44C1	2N6288,BD239
D44C2	2N6288,BD239
D44C3	2N6288,BD239
D44C4	2N6290,BD239
D44C5	2N6290,BD239
D44C6	2N6290,BD239
D44C7	2N6292,BD239A
D44C8	2N6292,BD239A
D44C9	2N6292,BD239A
D44C10	2N6292,BD239B
D44C11	2N6292,BD239B
D44C12	BD239B
D44E1	2N6386
D44E2	2N6387
D44E3	2N6388
D44H1	2N6288
D44H2	2N6288
D44H4	2N6290
D44H5	2N6290
D44H7	2N6292
D44H8	2N6292
D44H10	2N6292
D44H11	2N6292
D45C1	2N6111,BD240
D45C2	2N6111.BD240
D45C3	2N6111,BD240
D45C4	2N6109,BD240
D45C5	2N6109,BD240
D45C6	2N6109,BD240
D45C7	2N6107,BD240A
D45C8	2N6107,BD240A
D45C9	2N6107,BD240A
D45C10	2N6107,BD240B
D45C11	2N6107,BD240B
D45C12	BD240B
D45E1	2N6666
D45E2	2N6667
D45E3	2N6668
D45H1	2N6111
D45H2	2N6111
D45H4	2N6109
D45H5	2N6109
D45H7	2N6107
D45H8	2N6107
D45H10	2N6107
D45H11	2N6107
D64VE3	2N6671
D64VE4	2N6672
D64VE5	2N6673
DTS410	RCA410
DTS411	RCA411
DTS413	RCA413
DTS423	RCA423
DTS431	RCA431
EC106A1	C106A
EC106B1	C106B
EC106M1	C106M
ESM16	2N6671
ESM16A	2N6672
ESM16B	2N6673
ESM113	2N6384
ESM114	2N6385
ESM159	2N6649
ESM160	2N6650
ESM191	2N6673
ESM213	2N6387
ESM214	2N6388
ESM217	2N6387
ESM218	2N6388
ESM259	2N6667
ESM260	2N6668
ESM261	2N6667
ESM262	2N6668
FT410	RCA410
FT411	RCA411
FT413	RCA413
FT423	RCA423
FT431	RCA431
H103SC	T2301F
H103SD	T2301A
H103SG	T2302F
H103SH	T2303F
H103SS	T2300F
H113SC	T2301A
H113SD	T2301A
H113SG	T2302A
H113SH	2N5754
H113SS	T2300A
H123SC	T2301B
H123SD	T2301B
H123SH	2N5755
H123SS	T2300B

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Industry Type	RCA Replacement Type
H133SC	T2301D
H133SD	T2301D
H133SG	T2302D
H133SH	2N5756
H133SS	T2300D
H143SC	T2301D
H143SD	T2301D
H143SG	T2302D
H143SH	2N5756
H143SS	T2300D
H153SH	2N5757
H163SH	2N5757
HB26	2N5755
HB46	2N5756
IR140A	2N3650
IR140B	2N3651
IR140C	2N3652
IR140D	2N3653
IR140F	2N3654
IR141A	2N3655
IR141B	2N3656
IR141C	2N3657
IR141D	2N3658
IR141F	2N3654
IT06	T2850A
IT08	T2850A
IT16	T2850A
IT18	T2850A
IT26	T2850B
IT28	T2850B
IT36	T2850D
IT38	T2850D
IT46	T2850D
IT48	T2850D
L2001M3	T2300B
L2001M4	T2300B
L2001M5	T2301B
L2001M7	T2302B
L2001M9	2N5755
L4001M3	T2300D
L4001M4	T2300D
L4001M5	T2310D
L4001M7	T2302D
L4001M9	2N5756
MAC-5-1	2N5569
MAC-5-2	2N5569
MAC-5-3	2N5569
MAC-5-4	2N5569
MAC-5-5	2N5570
MAC-5-6	2N5570
MAC-5-7	T4111M
MAC-5-8	T4111M
MAC-15-4	MAC-15-4
MAC-15-6	MAC-15-6
MAC-15-8	MAC-15-8
MAC-15A-4	MAC-15A-4
MAC-15A-6	MAC-15A-6
MAC-15A-8	MAC-15A-8
MAC-35-1	T6401B
MAC-35-2	T6401B
MAC-35-3	T6401B
MAC-35-4	T6401B
MAC-35-5	T6401D
MAC-35-6	T6401D
MAC-35-7	T6401M
MAC-36-1	T6411B
MAC-36-2	T6411B
MAC-36-3	T6411B
MAC-36-4	T6411B
MAC-36-5	T6411D
MAC-36-6	T6411D
MAC-36-7	T6411M
MAC-37-1	T6401B
MAC-37-2	T6401B
MAC-37-3	T6401B
MAC-37-4	T6401B
MAC-37-5	T6401D
MAC-37-6	T6401D
MAC-37-7	T6401M
MAC-38-1	T6411B
MAC-38-2	T6411B
MAC-38-3	T6411B
MAC-38-4	T6411B
MAC-38-5	T6411D
MAC-38-6	T6411D
MAC-38-7	T6411M
MAC40688	T6420B
MAC40689	T6420D
MAC40690	T6420M
MAC40797	T4100M
MAC40798	T4110M
MCR1718-5	2N3653
MCR1718-6	2N3653
MCR1718-7	S7410M
MCR1718-8	S7410M
MCR3818-1	S6200A
MCR3818-3	S6200A
MCR3818-5	S6200D
MCR3818-7	S6200M
MCR3835-1	2N3870
MCR3835-2	2N3870
MCR3835-3	2N3870
MCR3835-4	2N3871
MCR3835-5	2N3872
MCR3835-6	2N3872
MCR3835-7	2N3873
MCR3835-8	2N3873
MCR3918-1	S6210A
MCR3918-3	S6210A
MCR3918-5	S6210D
MCR3918-7	S6210M
MCR3935-1	2N3896
MCR3936-2	2N3896
MCR3935-3	2N3896
MCR3935-4	2N3897
MCR3935-5	2N3898
MCR3935-6	2N3898
MCR3935-7	2N3899
MCR3935-8	2N3899
MD21SC14	MWS5114
MJ400	2N3585
MJ410	RCA410
MJ411	RCA411
MJ413	RCA413
MJ423	RCA423
MJ424	BUX16C
MJ425	BUX18C
MJ431	RCA431
MJ450	2N6246,2N6469
MJ480	2N6470
MJ481	2N6471
MJ490	2N6246,2N6469
MJ491	2N6246
MJ802	RCS258
MJ900	2N6649
MJ901	2N6650
MJ920	2N6649
MJ921	2N6650
MJ1000	RCA1000
MJ1001	RCA1001
MJ1200	2N6384
MJ1201	2N6385
MJ1800	2N5838,BUX16C
MJ2249	2N3879
MJ2250	2N3879
MJ2251	2N3584,BUX67B
MJ2252	2N3585,BUX67C
MJ2253	2N5955
MJ2254	2N5954
MJ2267	2N6246,2N6469
MJ2268	2N6246
MJ2500	2N6050
MJ2501	2N6051
MJ2801	2N6371
MJ2840	2N3055,2N6471
MJ2841	2N6254,2N6472
MJ2901	2N6246,2N6249
MJ2940	2N6246,BDX18
MJ2941	2N6247
MJ2955	MJ2955
MJ3000	2N6057
MJ3001	2N6058
MJ3010	BUX16B
MJ3011	BUX16B
MJ3026	2N5839
MJ3027	2N5840,BU126
MJ3028	2N5840,BU126
MJ3029	BUX16A
MJ3030	BUX16C
MJ3101	2N3878
MJ3201	BUX67A
MJ3202	2N3585,BUX67B
MJ3430	2N5840,BUX18B
MJ3583	2N6211
MJ3584	2N6212
MJ3585	2N6212
MJ3701	2N5956
MJ3760	BU126
MJ3761	BU126
MJ3771	2N3771
MJ3772	2N3772
MJ3773	2N3773
MJ4000	2N6384,RCA1000
MJ4001	2N6385,RCA1001
MJ4010	2N6649
MJ4011	2N6650
MJ4030	2N6285
MJ4031	2N6286
MJ4032	2N6287
MJ4033	2N6282
MJ4034	2N6283
MJ4035	2N6284
MJ4240	2N6212
MJ4502	RCA9116E
MJ5415	2N5415

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Industry Type	RCA Replacement Type
MJ5416	2N5416
MJ5600	2N3772
MJ5601	2N6258
MJ5602	2N3773
MJ5603	2N3773
MJ6000	2N3772
MJ6002	2N3773
MJ6302	2N3773
MJ15001	MJ15001
MJ15002	MJ15002
MJ15003	MJ15003
MJ15004	MJ15004
MM3005	RCA1A06
MM4000	BFT28
MM4001	BFT28A
MM4002	BFT28B
MM4003	BFT28C
MM5005	RCA1A05
NL-C35A	2N683
NL-C35B	2N685
NL-C35C	2N687
NL-C35D	2N688
NL-C35E	2N689
NL-C35G	2N684
NL-C35H	2N686
NL-C35M	2N689
NL-C40A	2N3650
NL-C40B	2N3651
NL-C40C	2N3652
NL-C40D	2N3654
NL-C40E	S7410M
NL-C40G	2N3651
NL-C40H	2N3652
NL570M	2N690
PMD10K60	2N6057
PMD10K80	2N6058
PMD10K100	2N6059
PMD11K60	2N6050
PMD11K80	2N6051
PMD11K100	2N6052
PMD12K40	2N6383
PMD12K60	2N6384
PMD12K80	2N6385
PMD13K40	2N6648
PMD13K60	2N6649
PMD13K80	2N6650
PMD1601K	2N6282
PMD1602K	2N6283
PMD1603K	2N6284
PMD1701K	2N6285
PMD1702K	2N6286
PMD1703K	2N6287
PS08	S6200A
PS020	S6200A
PS035	2N3870
PS18	S6200A
PS28	S6200B
PS38	S6200D
PS48	S6200D
PS58	S6200M
PS68	S6200M
PS120	S6200M
PS135	2N3870
PS220	S6200B
PS235	2N3871
PS320	S6200D
PS335	2N3872
PS420	S6200D
PS435	2N3872
PS520	S6200M
PS535	2N3873
PS620	S6200M
PS635	2N3873
PT06	2N5567
PT08	2N5567
PT10	2N5567
PT15	2N5567
PT16	2N5567
PT18	2N5567
PT025	T6401B
PT026	2N5867
PT028	2N6567
PT030	T6401B
PT036	2N5568
PT038	2N5568
PT040	2N5441
PT046	2N5568
PT048	2N5568
PT056	T4101M
PT058	T4101M
PT066	T4101M
PT068	T4101M
PT110	2N5567
PT115	2N5571
PT125	T6401B
PT130	T6401B
PT140	2N5441
PT210	2N5567
PT215	2N5571
PT225	T6401B
PT230	T6401B
PT240	2N5441
PT310	2N5568
PT315	2N5572
PT325	T6401D
PT330	T6401D
PT340	2N5442
PT410	2N5568
PT415	2N5572
PT425	T6401D
PT430	T6401D
PT440	2N5442
PT510	T4101M
PT515	T4100M
PT525	T6401M
PT530	T6401M
PT540	2N5443
PT610	T4101M
PT615	T4100M
PT625	T6401M
PT630	T6401M
Q2001MS2	T2302B
Q2001M2	2N5755
Q2003P	T2800B
Q2004	T4120B
Q2006L4	T2850B
Q2008	T4121B
Q2010	T4121B
Q2015	T4120B
Q2025	T6421B
Q2040	T6420B
Q4001MS2	T2302D
Q4001M2	2N5756
Q4003L4	T2850D
Q4004	T4121D
Q4004L4	T2850D
Q4006	T4121D
Q4006L4	T2850D
Q4008	T4121D
Q4010	T4121D
Q4015	T4120D
Q4025	T6421D
Q4040	T6420D
Q5006L4	T2850D
Q5008	T4121M
Q5010	T4121M
Q5015	T4120M
Q5025	T6421M
Q5040	T6420M
Q6008	T4121M
Q6010	T4121M
Q6015	T4120M
Q6025	T6421M
Q6040	T6420M
Q8025	T6420N
Q8040	T6420N
RCA106A	S2060A
RCA106B	S2060B
RCA106D	S2060D
RCA106E	S2060E
RCA106F	S2060F
RCA106Q	S2060Q
RCA106M	S2060M
RCA106Y	S2060Y
RCA107A	S2061A
RCA107B	S2061B
RCA107C	S2061C
RCA107D	S2061D
RCA107E	S2061E
RCA107F	S2061F
RCA107Q	S2061Q
RCA107M	S2061M
RCA107Y	S2061Y
RCA108A	S2062A
RCA108B	S2062B
RCA108C	S2062C
RCA108D	S2062D
RCA108E	S2062E
RCA108F	S2062F
RCA108Q	S2062Q
RCA108M	S2062M
RCA108Y	S2062Y
RM555T	CA555T
RM723T	CA723T
RM741DC	CA741G
RM741DE	CA741G
RM741T	CA741T
RM747DC	CA747G
RM747T	CA747T
RM1558DE	CA1558G
RM1558T	CA1558T
RTS0202	S6200A
RTS0205	S6200A
RTS0210	S6200A
RTS0220	S6200B

Power Devices Cross-Reference Guide

(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type
RTS0230	S6200D
RTS0240	S6200D
RTS0250	S6200M
RTS0260	S6200M
RTS0502	S6200A
RTS0505	S6200A
RTS0510	S6200A
RTS0520	S6200B
RTS0530	S6200D
RTS0540	S6200D
RTS0550	S6200M
RTS0602	S6200A
RTS0605	S6200A
RTS0610	S6200A
RTS0620	S6200B
RTS0630	S6200D
RTS0640	S6200D
RTS0650	S6200M
RTS0660	S6200M
RTU0102	S6210A
RTU0105	S6210A
RTU0110	S6210A
RTU0120	S6210B
RTU0130	S6210D
RTU0140	S6210D
RTU0150	S6210M
RTU0160	S6210M
RTU0202	2N3896
RTU0205	2N3896
RTU0210	2N3896
RTU0220	2N3897
RTU0230	2N3898
RTU0240	2N3898
RTU0602	2N3896
RTU0605	2N3896
RTU0610	2N3896
RTU0620	2N3897
RTU0630	2N3898
RTU0640	2N3898
RTU0650	2N3899
RTU0660	2N3899
RTU0705	2N3896
RTU0710	2N3896
RTU0720	2N3897
RTU0730	2N3898
RTU0740	2N3898
RTU0750	2N3899
RTU0760	2N3899
S0525G	2N3870
S1003RS2	S2060A
S1003RS3	S2061A
S1006B	S6220A
S1006G	S6200A
S1006H	S6210A
S1008B	S6220A
S1008G	S6200A
S1008H	S6210A
S1010B	S6220A
S1010G	S6200A
S1010H	S6210A
S1016B	S6220A
S1016G	S6200A
S1016H	S6210A
S1025H	2N3870
S1025H	2N3896
S1035G	2N3870
S1035H	2N3896
S2003RS2	S2060B
S2003RS3	S2061B
S2006B	S6220B
S2006G	S6200B
S2006H	S6210B
S2008B	S6220B
S2008G	S6200B
S2008H	S6210B
S2010B	S6220B
S2010G	S6200B
S2010H	S6210B
S2016B	S6220B
S2016G	S6200B
S2016H	S6210B
S2025G	2N3871
S2025H	2N3897
S2035G	2N3871
S2035H	2N3897
S4006B	S6220D
S4006G	S6200D
S4006H	S6210D
S4010B	S6220D
S4010G	S6200D
S4010H	S6210D
S4016B	S6220D
S4016G	S6200D
S4016H	S6210D
S4025G	2N3872
S4025H	2N3898
S4035G	2N3872
S4035H	2N3898
S6003RS2	S2060M
S6003RS3	S2061M
S6006B	S6220M
S6006G	S6200M
S6006H	S6210M
S6008G	S6200M
S6008H	S6210M
S6010B	S6220M
S6010G	S6200M
S6010H	S6210M
S6016B	S6220M
S6016G	S6200M
S6016H	S6210M
S6025G	2N3873
S6025H	2N3899
S6035G	2N3873
S6035H	2N3899
SC35A	2N5569
SC35B	2N5569
SC35D	2N5570
SC35F	2N5569
SC36A	2N5567
SC36B	2N5567
SC36D	2N5568
SC36F	2N5567
SC40A	2N5569
SC40B	2N5569
SC40B2	T4121B
SC40D	2N5570
SC40D2	T4121D
SC40E	T4111M
SC40E2	T4121M
SC40F	2N5569
SC41A	2N5567
SC41B	2N5567
SC41D	2N5568
SC41E	T4101M
SC41F	2N5567
SC45A	2N5569
SC45B	2N5569
SC45B2	T4121B
SC45D	2N5570
SC45D2	T4121D
SC45E	T4111M
SC45E2	T4121M
SC45F	2N5569
SC46A	2N5567
SC46B	2N5567
SC46D	2N5568
SC46E	T4101M
SC46F	2N5567
SC50A	2N5573
SC50B	2N5573
SC50B2	T4120B
SC50D	2N5574
SC50D2	T4120D
SC50E	2N5573,T4110M
SC50E2	T4120M
SC50F	2N5573
SC51A	2N5571
SC51B	2N5571
SC51D	2N5572
SC51E	T4100M
SC51F	2N5571
SC60B	T6411B
SC60B2	T6421B
SC60B12	T6411B
SC60B13	T6411B
SC60B14	T6414B
SC60B22	T6421B
SC60B23	T6421B
SC60D	T6411D
SC60D2	T6421D
SC60D12	T6411D
SC60D13	T6411D
SC60D14	T6414D
SC60D22	T6421D
SC60D23	T6421D
SC60E	T6411M
SC60E2	T6421M
SC60E12	T6411M
SC60E13	T6411M
SC60E22	T6421M
SC60E23	T6421M
SC61B	T6401B
SC61B12	T6401B
SC61B13	T6401B
SC61B14	T6404B
SC61D	T6401D
SC61D12	T6401D
SC61D13	T6401D
SC61D14	T6404D
SC61E	T6401M
SC61E12	T6401M
SC61E13	T6401M
SC136A	T2322A
SC136B	T2322B

Power Devices Cross-Reference Guide
(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type	Industry Type	RCA Replacement Type	Industry Type	RCA Replacement Type
SC136D	T2322D	SC246E13	T4101M	SDT9704	2N6254
SC141B	SC141B	SC250B	2N5573	SDT9705	2N4348
SC141D	SC141D	SC250B2	T4120B	SDT9706	2N4348
SC141E	SC141E	SC250B12	2N5573	SDT9707	2N3055
SC141M	SC141M	SC250B13	2N5573	SDT9801	2N6254
SC146B	SC146B	SC250B14	T4113B	SDT9802	2N6254
SC146D	SC146D	SC250B22	T4120B	SDT9803	2N6254
SC146E	SC146E	SC250D	2N5574	SDT9804	2N3773
SC146M	SC146M	SC250D2	T4120D	SDT12203	2N6689
SC240B	2N5569	SC250D12	2N5574	SDT13201	2N6689
SC240B2	T4121B	SC250D13	2N5574	SDT13202	2N6692
SC240B12	2N5569	SC250D14	T4113D	SDT13203	2N6690
SC240B13	2N5569	SC250D22	T4120D	SE555L	CA555T
SC240B22	T4121B	SC250E	T4110M	SE555N	CA555E
SC240B23	T4121B	SC250E2	T4120M	SE555P	CA555E
SC240D	2N5570	SC250E12	T4110M	SE555T	CA555T
SC240D2	T4121D	SC250E13	T4110M	SE9300	TIP120
SC240D12	2N5570	SC250E22	T4120M	SE9301	TIP121
SC240D13	2N5570	SC251B	2N5571	SE9302	TIP122
SC240D22	T4121D	SC251B12	2N5571	SE9303	2N6384
SC240D23	T4121D	SC251B13	2N5571	SE9304	2N6385
SC240E	T4111M	SC251B14	T4103B	SPC410	RCA410
SC240E2	T4121M	SC251D	2N5572	SPC411	RCA411
SC240E12	T4111M	SC251D12	2N5572	SPC413	RCA413
SC240E13	T4111M	SC251D13	2N5572	SPC423	RCA423
SC240E22	T4121M	SC251E	T4100M	SPC431	RCA431
SC240E23	T4121M	SC251E12	T4100M	SPS08	S6210A
SC241B	2N5567	SC251E13	T4100M	SPS18	S6210A
SC241B12	2N5567	SDT410	RCA410	SPS020	S6210A
SC242B13	2N5567	SDT411	RCA411	SPS28	S6210B
SC241D	2N5568	SDT413	RCA413	SPS38	S6210D
SC242D12	2N5568	SDT423	RCA423	SPS48	S6210D
SC241D13	2N5568	SDT431	RCA431	SPS58	S6210M
SC241E	T4101M	SDT6901	2N6078	SPS68	S6210M
SC241E12	T4101M	SDT6902	2N6078	SPS120	S6210A
SC241E13	T4101M	SDT6903	2N6078	SPS220	S6210B
SC245B	2N5569	SDT6904	2N6078	SPS320	S6210D
SC245B2	T4121B	SDT6905	2N6078	SPS420	S6210D
SC245B12	2N5569	SDT6906	2N6078	SPS520	S6210M
SC245B13	2N5569	SDT6907	2N6078	SPS620	S6210M
SC245B14	T4115B	SDT6908	2N6078	SPT06	2N5569
SC245B22	T4121B	SDT7601	2N5039	SPT08	2N5569
SC245B23	T4121B	SDT7602	2N5039	SPT10	2N5569
SC245D	2N5570	SDT7603	2N5038	SPT15	2N5573
SC245D2	T4121D	SDT7604	2N6496	SPT16	2N5569
SC245D12	2N5570	SDT7605	2N6249	SPT18	2N5569
SC245D13	2N5570	SDT7607	2N5039	SPT025	T6411B
SC245D14	T4115D	SDT7608	2N5039	SPT030	T6411B
SC245D22	T4121D	SDT7609	2N5038	SPT26	2N5569
SC245D23	T4121D	SDT7610	2N6354	SPT28	2N5569
SC245E	T4111M	SDT7731	2N6470	SPT36	2N5570
SC245E2	T4121M	SDT7732	2N6471	SPT38	2N5570
SC245E12	T4111M	SDT7733	2N6472	SPT40	2N5444
SC245E13	T4111M	SDT9201	2N3055	SPT46	2N5570
SC245E22	T4121M	SDT9202	2N6254	SPT48	2N5570
SC245E23	T4121M	SDT9203	2N4348	SPT56	T4111M
SC246B	2N5567	SDT9204	2N4348	SPT58	T4111M
SC246B12	2N5567	SDT9205	2N3055	SPT68	T4111M
SC246B13	2N5567	SDT9206	2N3055	SPT110	2N5569
SC246B14	T4105B	SDT9207	2N6254	SPT115	2N5573
SC246D	2N5568	SDT9208	2N4348	SPT125	T6411B
SC246D12	2N5568	SDT9209	2N4348	SPT130	T6411B
SC246D13	2N5568	SDT9210	2N6253	SPT140	2N5444
SC246E	T4101M	SDT9702	2N4348	SPT210	2N5569
SC246E12	T4101M	SDT9703	2N4348	SPT215	2N5573

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(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type
SPT225	T6411B
SPT230	T6411B
SPT240	2N5444
SPT310	2N5570
SPT315	2N5574
SPT325	T6411D
SPT330	T6411D
SPT340	2N5445
SPT410	2N5570
SPT415	2N5574
SPT425	T6411D
SPT430	T6411D
SPT440	2N5445
SPT510	T4111M
SPT515	T4110M
SPT525	T6411M
SPT530	T6411M
SPT540	2N5446
SPT610	T4111M
SPT615	T4110M
SPT625	T6411M
SPT630	T6411M
SPT640	2N5446
STS410	RCA410
STS411	RCA411
STS413	RCA413
STS423	RCA423
STS431	RCA431
SVT300-5B	2N6689
SVT300-10B	2N6689
T1482	40311
T1484	2N697
T1492	40407
T1493	2N1613
TAG136	T2322D
TAG-6-100	2N3668
TAG-6-200	2N3669
TAG-6-400	2N3670
TAG-6-500	2N4103
TAG-6-600	2N4103
TAG-7-100	S5210B
TAG-7-200	S5210B
TAG-7-400	S5210D
TAG-7-500	S5210M
TAG-7-600	S5210M
TAG-10-100	S7310B
TAG-10-200	S7310B
TAG-10-400	S7310D
TAG-10-500	S7310M
TAG-10-600	S7310M
TAG-15-100	S6210A
TAG-15-200	S6210B
TAG-15-400	S6210D
TAG-15-500	S6210M
TAG-15-600	S6210M
TAG-20-100	S6210A
TAG-20-200	S6210B
TAG-20-400	S6210D
TAG-20-500	S6210M
TAG-20-600	S6210M
TAG-35-100	S6410A
TAG-35-200	S6410B
TAG-35-400	S6410D
TAG-35-500	S6410M
TAG-35-600	S6410M
TAG-200-100	T2302A
TAG-201-100	T2303A
TAG-200-200	T2302B
TAG-201-200	T2303B
TAG-200-400	T2302D
TAG-201-400	T2303D
TAG-202-100	T2302A
TAG-202A-100	T2302A
TAG-202-200	T2302B
TAG-202A-200	T2302B
TAG-202-400	T2302D
TAG-202A-400	T2302D
TAG-203-100	T2301A
TAG-203A-100	T2301A
TAG-203-200	T2301B
TAG-203A-200	T2301B
TAG-203-400	T2301D
TAG-203A-400	T2301D
TAG-204-100	T2300A
TAG-204A-100	T2300A
TAG-204-200	T2300B
TAG-204A-200	T2300B
TAG-204-400	T2300D
TAG-204A-400	T2300D
TAG-205-100	T2303A
TAG-205-200	T2303B
TAG-205-400	T2303D
TAG-206-100	T2302A
TAG-206-200	T2302B
TAG-206-400	T2302D
TAG-220-200	T2500B
TAG-220-400	T2500D
TAG-224-200	T2800B
TAG-224-400	T2802D
TAG-224-600	T2802M
TAG-225-200	T2800B
TAG-225-400	T2800D
TAG-225-600	T2800M
TAG-240-200	T2850B
TAG-240-400	T2850D
TAG-241-200	T2850D
TAG-245-200	T2850B
TAG-245-400	T2850D
TAG-246-200	T2850B
TAG-246-400	T2850D
TAG-255-200	T6000B
TAG-255-400	T6000D
TAG-255-600	T6000M
TAG-255A-200	T6000B
TAG-255A-200	T6000D
TAG-255A-200	T6000M
TAG-260-200	T2700B
TAG-260-400	T2700D
TAG-261-200	T2700B
TAG-261-400	T2700D
TAG-265-200	T4700B
TAG-265-400	T4700D
TAG-266-200	T4700B
TAG-266-400	T4700D
TAG-280-200	T6000B
TAG-280-400	T6000D
TAG-280-600	T6000M
TDAL113A	2N5754
TDAL113B	T2302B
TDAL113S	T2300B
TDAL223A	2N5756
TIC20	2N5567
TIC21	2N5568
TIC22	2N5569
TIC23	2N5570
TIC106A	S2060A
TIC106B	S2060B
TIC106C	S2060C
TIC106D	S2060D
TIC106F	S2060F
TIC106Y	S2060Y
TIC116A	C122A
TIC116B	C122B
TIC116C	C122C
TIC116D	C122D
TIC116E	C122E
TIC116F	C122F
TIC116M	C122M
TIC126A	2N6395
TIC126B	2N6396
TIC126D	2N6397
TIC126F	2N6349A
TIC126M	2N6398
TIC226B	T2800B
TIC226D	T2800D
TIC250B	T6401B
TIC250D	T6401D
TIC250E	T6401M
TIC250M	T6401M
TIC252B	T6411B
TIC252D	T6411D
TIC252E	T6411M
TIC252M	T6411M
TIC260B	T6401B
TIC260D	T6401D
TIC260E	T6401M
TIC260M	T6401M
TIC262B	T6411B
TIC262D	T6411D
TIC262E	T6411M
TIC262M	T6411M
TIC270B	2N5441
TIC270D	2N5442
TIC270E	2N5443
TIC270M	2N5443
TIC272B	2N5444
TIC272D	2N5445
TIC272E	2N5446
TIC272M	2N5446
TIP29	BD239,TIP29
TIP29A	BD239A,TIP29A
TIP29B	BD239B,TIP29B
TIP29C	BD239C,TIP29C
TIP30	BD240,TIP30
TIP30A	BD240A,TIP30A
TIP30B	BD240B,TIP30B
TIP30C	BD240C,TIP30C
TIP31	BD241,TIP31
TIP31A	BD241A,TIP31A
TIP31B	BD241B,TIP31B
TIP31C	BD241C,TIP31C
TIP32	BD242,TIP32
TIP32A	BD242A,TIP32A
TIP32B	BD242B,TIP32B
TIP32C	BD242C,TIP32C

Power Devices Cross-Reference Guide

(Industry Type to Equivalent RCA Type)

Industry Type	RCA Replacement Type
TIP41	BD243,TIP41
TIP41A	BD243A,TIP41A
TIP41B	BD243B,TIP41B
TIP41C	BD243C,TIP41C
TIP42	BD244,TIP42
TIP42A	BD244A,TIP42A
TIP42B	BD244B,TIP42B
TIP42C	BD244C,TIP42C
TIP100	TIP100
TIP101	TIP101
TIP102	TIP102
TIP110	BDX33A
TIP111	BDX33B
TIP112	BDX33C
TIP115	BDX34A
TIP116	BDX34B
TIP117	BDX34C
TIP120	BDX33A,TIP120
TIP121	BDX33B,TIP121
TIP122	BDX33C,TIP122
TIP125	BDX34A,TIP125
TIP126	BDX34B,TIP126
TIP127	BDX34C,TIP127
TIP130	BDX33A
TIP131	BDX33B
TIP132	BDX33C
TIP135	BDX34A
TIP136	BDX34B
TIP137	BDX34C
TIP140	2N6387
TIP141	2N6530
TIP142	2N6531
TIP145	2N6666
TIP146	2N6667
TIP147	2N6668
TIP525	2N6671
TIP527	2N6674
TIP531	2N6250
TIP532	2N6675
TIP535	BUX17A
TIP536	2N6674
TIP537	2N6675
TIP538	2N6250
TIP539	2N6250
TIP544	2N6248
TIP546	2N6469
TIP554	2N6671
TIP555	2N6672
TIP556	2N6673
TIP562	TIP562
TIP563	TIP563
TIP620	2N6383
TIP621	2N6384
TIP622	2N6385
TIP640	2N6384
TIP641	2N6385
TIP642	2N6385
TIP645	2N6666
TIP646	2N6667
TIP647	2N6668
TIP3054	RCA3054
TRAL1110D	2N5569
TRAL1115D	2N5573
TRAL1125D	T6411B
TRAL1130D	T6421B
TRAL1140D	T6420B
TRAL2210D	2N5570
TRAL2215D	2N5574
TRAL2225D	T6411D
TRAL2230D	T6421D
TRAL2240D	T6420D
TS2218	2N1613
TS2219	2N1711
TS2904	40406
TX01A10	T2700A
TXC01A20	T2700B
TXC01A40	T2700D
TXC01B10	T2700A
TXC01B20	T2700B
TXC01B40	T2700D
TXC01C10	T2700A
TXC01C20	T2700B
TXC01C40	T2700D
TXC01D10	T2700A
TXC01D20	T2700B
TXC01D40	T2700D
TXC01E10	T2700A
TXC01E20	T2700B
TXC01E40	T2700D
TXC01F10	T2700A
TXC01F20	T2700B
TXC01F40	T2700D
TXD98A20	2N5573
TXD98A40	2N5574
TXD98A50	T4110M
TXD99A20	2N5569
TXD99A40	2N5570
TXD99A50	T4111M
TXE99A20	T6411B
TXE99A40	T6411D
TXE99A50	T6411M
TY504	S2062A
TY1004	S2062A
TY2004	S2062B
TY3004	S2062C
TY4004	S2062D
TY5004	S2062E
TY6004	S2062M
TY507	C122A
TY1007	C122A
TY2007	C122B
TY3007	C122C
TY4007	C122D
TY5007	C122E
TY6007	C122M
TY510	S2800F
TY1010	S2800A
TY2010	S2800B
TY3010	S2800C
TY4010	S2800D
TY5010	S2800E
TY6010	S2800M
TYAL113B	T2500B
TYAL113C	T2500B
TYAL113M	T2801B
TYAL116B	T2500B
TYAL116C	T2500B
TYAL116M	T2801B
TYAL118B	T2800B
TYAL118C	T2800B
TYAL118M	T2802B
TYAL223B	T2500D
TYAL223C	T2500D
TYAL223M	T2801D
TYAL226B	T2500D
TYAL226C	T2500D
TYAL226M	T2801D
TYAL228B	T2800D
TYAL228C	T2800D
TYAL228M	T2802D
TYAL1110B	T2800B
TYAL1110C	T2800B
TYAL1110M	T2802B
TYAL2210B	T2800D
TYAL2210C	T2800D
TYAL2210M	T2802D

Operating Considerations

Solid state devices are being designed into an increasing variety of electronic equipment because of their high standards of reliability and performance. However, it is essential that equipment designers be mindful of good engineering practices in the use of these devices to achieve the desired performance.

This Note summarizes important operating recommendations and precautions which should be followed in the interest of maintaining the high standards of performance of solid state devices.

The ratings included in RCA Solid State Devices data bulletins are based on the Absolute Maximum Rating System, which is defined by the following Industry Standard (JEDEC) statement:

Absolute-Maximum Ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

It is recommended that equipment manufacturers consult RCA whenever device applications involve unusual electrical, mechanical or environmental operating conditions.

GENERAL CONSIDERATIONS

The design flexibility provided by these devices makes possible their use in a broad range of applications and under many different operating conditions. When incorporating these devices in equipment, therefore, designers should anticipate the rare possibility of device failure and make certain that no safety hazard would result from such an occurrence.

The small size of most solid state products provides obvious advantages to the designers of electronic equipment. However, it should be recognized that these compact devices usually provide only relatively small insulation area between adjacent leads and the metal envelope. When these devices are used in moist or contaminated atmospheres, therefore, supplemental protection must be provided to prevent the development of electrical conductive paths across the relatively small insulating surfaces. For specific information on voltage creepage, the user should consult references such as the JEDEC Standard No. 7 "Suggested Standard on Thyristors," and JEDEC Standard RS282 "Standards for Silicon Rectifier Diodes and Stacks".

The metal shells of some solid state devices operate at the collector voltage and for some rectifiers and thyristors at the anode voltage. Therefore, consideration should be given to the possibility of shock hazard if the shells are to operate at voltages appreciably above or below ground potential. In general, in any application in which devices are operated at voltages which may be dangerous to personnel, suitable precautionary measures should be taken to prevent direct contact with these devices.

Devices should not be connected into or disconnected from circuits with the power on because high transient voltages may cause permanent damage to the devices.

TESTING PRECAUTIONS

In common with many electronic components, solid-state devices should be operated and tested in circuits which have reasonable values of current limiting resistance, or other forms of effective current overload protection. Failure to observe these precautions can cause excessive internal heating of the device resulting in destruction and/or possible shattering of the enclosure.

TRANSISTORS AND THYRISTORS WITH FLEXIBLE LEADS

Flexible leads are usually soldered to the circuit elements. It is desirable in all soldering operatings to provide some slack or an expansion elbow in each lead to prevent excessive tension on the leads. It is important during the soldering operation to avoid excessive heat in order to prevent possible damage to the devices. Some of the heat can be absorbed if the flexible lead of the device is grasped between the case and the soldering point with a pair of pliers.

TRANSISTORS AND THYRISTORS WITH MOUNTING FLANGES

The mounting flanges of JEDEC-type packages such as the TO-3 or TO-66 often serve as the collector or anode terminal. In such cases, it is essential that the mounting flange be securely fastened to the heat sink, which may be the equipment chassis. Under no circumstances, however, should the mounting flange of a transistor be soldered directly to the heat sink or chassis because the heat of the soldering operation could permanently damage the device. Soldering is the preferred method for mounting thyristors; see "Rectifiers and Thyristors," below. Devices which cannot be soldered can be installed in commercially available sockets. Electrical connections may also be made by soldering directly to the terminal pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals; otherwise the heat of the soldering operation could crack the pin seals and damage the device.

Operating Considerations

During operation, the mounting-flange temperature is higher than the ambient temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capacity to assure that the heat dissipated in the heat sink itself does not raise the device mounting-flange temperature above the rated value. The heat sink or chassis may be connected to either the positive or negative supply.

In many applications the chassis is connected to the voltage-supply terminal. If the recommended mounting hardware shown in the data bulletin for the specific solid-state device is not available, it is necessary to use either an anodized aluminum insulator having high thermal conductivity or a mica insulator between the mounting-flange and the chassis. If an insulating aluminum washer is required, it should be drilled or punched to provide the two mounting holes for the terminal pins. The burrs should then be removed from the washer and the washer anodized. To insure that the anodized insulating layer is not destroyed during mounting, it is necessary to remove the burrs from the holes in the chassis.

It is also important that an insulating bushing, such as glass-filled nylon, be used between each mounting bolt and the chassis to prevent a short circuit. However, the insulating bushing should not exhibit shrinkage or softening under the operating temperatures encountered. Otherwise the thermal resistance at the interface between device and heat sink may increase as a result of decreasing pressure.

PLASTIC POWER TRANSISTORS AND THYRISTORS

RCA power transistors and thyristors (SCR's and triacs) in molded-silicone-plastic packages are available in a wide range of power-dissipation ratings and a variety of package configurations. The following paragraphs provide guidelines for handling and mounting of these plastic-package devices, recommend forming of leads to meet specific mounting requirements, and describe various mounting arrangements, thermal considerations, and cleaning methods. This information is intended to augment the data on electrical characteristics, safe operating area, and performance capabilities in the technical bulletin for each type of plastic-package transistor or thyristor.

Lead-Forming Techniques

The leads of the RCA VERSAWATT in-line plastic packages can be formed to a custom shape, provided they are not indiscriminately twisted or bent. Although these leads can be formed, they are not flexible in the general sense, nor are they sufficiently rigid for unrestrained wire wrapping

Before an attempt is made to form the leads of an in-line package to meet the requirements of a specific application, the desired lead configuration should be determined, and a lead-bending fixture should be designed and constructed. The use of a properly designed fixture for this operation eliminates the need for repeated lead bending. When the use of a special bending fixture is not practical, a pair of long-nosed pliers may be used. The pliers should hold the lead firmly between the bending point and the case, but should not touch the case.

When the leads of an in-line plastic package are to be formed, whether by use of long-nosed pliers or a special bending fixture, the following precautions must be observed to avoid internal damage to the device:

1. Restrain the lead between the bending point and the plastic case to prevent relative movement between the lead and the case.
2. When the bend is made in the plane of the lead (spreading), bend only the narrow part of the lead.
3. When the bend is made in the plane perpendicular to that of the leads, make the bend at least 1/8 inch from the plastic case.
4. Do not use a lead-bend radius of less than 1/16 inch.
5. Avoid repeated bending of leads.

The leads of the TO-220AB VERSAWATT in-line package are not designed to withstand excessive axial pull. Force in this direction greater than 4 pounds may result in permanent damage to the device. If the mounting arrangement tends to impose axial stress on the leads, some method of strain relief should be devised.

Wire wrapping of the leads is permissible, provided that the lead is restrained between the plastic case and the point of the wrapping. Soldering to the leads is also allowed. The maximum soldering temperature, however, must not exceed 275°C and must be applied for not more than 5 seconds at a distance not less than 1/8 inch from the plastic case. When wires are used for connections, care should be exercised to assure that movement of the wire does not cause movement of the lead at the lead-to-plastic junctions.

The leads of RCA molded-plastic high-power packages are not designed to be reshaped. However, simple bending of the leads is permitted to change them from a standard vertical to a standard horizontal configuration, or conversely. Bending of the leads in this manner is restricted to three 90-degree bends; repeated bendings should be avoided.

Mounting

Recommended mounting arrangements and suggested hardward for the VERSAWATT package are given in the data bulletins for specific devices and in RCA Application Note AN-4142.* When the package is fastened to a heat sink, a rectangular washer (RCA Part No. NR231A) is recommended to minimize distortion of the mounting flange. Excessive distortion of the flange could cause damage to the package. The washer is particularly important when the size of the mounting hole exceeds 0.140 inch (6-32 clearance). Larger holes are needed to accommodate insulating bushings; however, the holes should not be larger than necessary to provide hardware clearance and, in any case, should not exceed a diameter of 0.250 inch.

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*This Note is included in the Appendix to this DATABOOK.

Operating Considerations

Flange distortion is also possible if excessive torque is used during mounting. A maximum torque of 8 inch-pounds is specified. Care should be exercised to assure that the tool used to drive the mounting screw never comes in contact with the plastic body during the driving operation. Such contact can result in damage to the plastic body and internal device connections. An excellent method of avoiding this problem is to use a spacer or combination spacer-isolating bushing which raises the screw head or nut above the top surface of the plastic body. The material used for such a spacer or spacer-isolating bushing should, of course, be carefully selected to avoid "cold flow" and consequent reduction in mounting force. Suggested materials for these bushings are diallphtalate, fiberglass-filled nylon, or fiberglass-filled polycarbonate. Unfilled nylon should be avoided.

Modification of the flange can also result in flange distortion and should not be attempted. The package should not be soldered to the heat sink by use of lead-tin solder because the heat required with this type of solder will cause the junction temperature of the device to become excessively high.

The TO-220AA plastic package can be mounted in commercially available TO-66 sockets, such as UID Electronics Corp. Socket No. PTS-4 or equivalent. For testing purposes, the TO-220AB in-line package can be mounted in a Jetron Socket No. DC74-104 or equivalent. Regardless of the mounting method, the following precautions should be taken:

1. Use appropriate hardware.
2. Always fasten the package to the heat sink before the leads are soldered to fixed terminals.
3. Never allow the mounting tool to come in contact with the plastic case.
4. Never exceed a torque of 8 inch-pounds.
5. Avoid oversize mounting holes.
6. Provide strain relief if there is any probability that axial stress will be applied to the leads.
7. Use insulating bushings to prevent hot-creep problems. Such bushings should be made of diallphthalate, fiberglass-filled nylon, or fiberglass-filled polycarbonate.

The maximum allowable power dissipation in a solid state device is limited by the junction temperature. An important factor in assuring that the junction temperature remains below the specified maximum value is the ability of the associated thermal circuit to conduct heat away from the device.

When a solid state device is operated in free air, without a heat sink, the steady-state thermal circuit is defined by the junction-to-free-air thermal resistance given in the published data for the device. Thermal considerations require that a free flow of air around the device is always present and that the power dissipation be maintained below the level which would cause the junction temperature to rise above the maximum rating. However, when the device is mounted on a heat sink, care must be taken to assure that all portions of the thermal circuit are considered.

To assure efficient heat transfer from case to heat sink when mounting RCA molded-plastic solid state power devices, the following special precautions should be observed:

1. Mounting torque should be between 4 and 8 inch-pounds.
2. The mounting holes should be kept as small as possible.
3. Holes should be drilled or punched clean with no burrs or ridges, and chamfered to a maximum radius of 0.010 inch.
4. The mounting surface should be flat within 0.002 inch/inch.
5. Thermal grease (Dow Corning 340 or equivalent) should always be used on both sides of the insulating washer if one is employed. The bleed rate of the thermal-grease compound should be such that it does not exceed 0.5 per cent after 24 hours at 200°C.
6. Thin insulating washers should be used. (Thickness of factory-supplied mica washers range from 2 to 4 mils).
7. A lock washer or torque washer, made of material having sufficient creep strength, should be used to prevent degradation of heat sink efficiency during life.

A wide variety of solvents is available for degreasing and flux removal. The usual practice is to submerge components in a solvent bath for a specified time. However, from a reliability stand point it is extremely important that the solvent, together with other chemicals in the solder-cleaning system (such as flux and solder covers), do not adversely affect the life of the component. This consideration applies to all non-hermetic and molded-plastic components.

It is, of course, impractical to evaluate the effect on long-term device life of all cleaning solvents, which are marketed with numerous additives under a variety of brand names. These solvents can, however, be classified with respect to their component parts as either acceptable or unacceptable. Chlorinated solvents tend to dissolve the outer package and, therefore, make operation in a humid atmosphere unreliable. Gasoline and other hydrocarbons cause the inner encapsulant to swell and damage the transistor. Alcohol is an acceptable solvent. Examples of specific, acceptable alcohols are isopropanol, methanol, and special denatured alcohols, such as SDA1, SDA30, SDA34, and SDA44.

Under certain conditions, dimethyl silicone fluids may react chemically with the encapsulant of plastic devices and cause damage to the package. These fluids do not cause damage when they are contained in materials such as thermal compounds. These fluids, however, are unacceptable for use

Operating Considerations

as baths or encapsulants for plastic-package devices. In addition, plastic-package devices should not be used or stored in environments that contain significant amounts of dimethyl silicone fluid.

Care must also be used in the selection of fluxes for lead soldering. Rosin or activated rosin fluxes are recommended, while organic or acid fluxes are not. Examples of acceptable fluxes are:

1. Alpha Reliaros No. 320-33
2. Alpha Reliaros No. 346
3. Alpha Reliaros No. 711
4. Alpha Reliafoam No. 807
5. Alpha Reliafoam No. 809
6. Alpha Reliafoam No. 811-13
7. Alpha Reliafoam No. 815-35
8. Kester No. 44

If the completed assembly is to be encapsulated, the effect on the molded-plastic transistor must be studied from both a chemical and a physical standpoint.

THYRISTORS

A surge-limiting impedance should always be used in series with thyristors. The impedance value must be sufficient to limit the surge current to the value specified under the maximum ratings. This impedance may be provided by the power transformer winding, or by an external resistor or choke.

A very efficient method for mounting thyristors utilizing the "modified TO-5" package is to provide intimate contact between the heat sink and at least one half of the base of the device opposite the leads. This package can be mounted to the heat sink mechanically with glue or an expoxy adhesive, or by soldering, the most efficient method.

The use of a "self-jigging" arrangement and a solder preform is recommended. If each unit is soldered individually, the heat source should be held on the heat sink and the solder on the unit. Heat should be applied only long enough to permit solder to flow freely. For more detailed thyristor mounting considerations, refer to Application Note AN3822, "Thermal Considerations in Mounting of RCA Thyristors".

SOLID STATE CHIPS

Solid state chips, unlike packaged devices, are non-hermetic devices, normally fragile and small in physical size, and therefore, require special handling considerations as follows:

1. Chips must be stored under proper conditions to insure that they are not subjected to a moist and/or contaminated atmosphere that could alter their electrical, physical, or mechanical characteristics. After the shipping container is opened, the chip must be stored under the following conditions:
   A. Storage temperature, 40°C max.
   B. Relative humidity, 50% max.
   C. Clean, dust-free environment.
2. The user must exercise proper care when handling chips to prevent even the slightest physical damage to the chip.
3. During mounting and lead bonding of chips the user must use proper assembly techniques to obtain proper electrical, thermal, and mechanical performance.
4. After the chip has been mounted and bonded, any necessary procedure must be followed by the user to insure that these non-hermetic chips are not subjected to moist or contaminated atmosphere which might cause the development of electrical conductive paths across the relatively small insulating surfaces. In addition, proper consideration must be given to the protection of these devices from other harmful environments which could conceivably adversely affect their proper performance.

Terms and Symbols

General

AQL	acceptance quality level
CM	cross modulation
IMD	intermodulation distortion
K	post-radiation neutron-damage constant
LTPD	lot tolerance per cent defective
MTBF	mean time between failures
MTTF	mean time to failure
NF	noise factor (or noise figure)
P_D	device dissipation
pps	pulses per second
P_{rr}	pulse repetition rate
prt	pulse recurrence time
PW	pulse width
RMS	root mean square
$R_{\theta JA}$	thermal resistance, junction-to-ambient
$R_{\theta JC}$	thermal resistance, junction-to-case
$R_{\theta JF}$	thermal resistance, junction-to-flange
$R_{\theta JFA}$	thermal resistance, junction-to-free air
$R_{\theta JHS}$	thermal resistance, junction-to-heat sink
T_A	ambient temperature
T_C	case temperature
THD	total harmonic distortion
T_J	operating (junction) temperature
T_L	lead temperature during soldering
t_p	pulse duration
T_{stg}	storage temperature
η	efficiency
θ	conduction angle
ϕ	phase angle
ϕL	lead radius (for bending)
τ	torque
τ_s	device stud torque

Power Transistors

(C)	collector-to-base charge-generation constant (during gamma exposure)
$C_{b'c}$	feedback capacitance
C_c	collector-to-case capacitance
C_{cb}	collector-to-base feedback capacitance
C_{ib}	common-base input capacitance
C_{ob}	common-base output capacitance
C_{obo}	open-circuit common-base output capacitance
$E_{S/b}$	reverse-bias second-breakdown energy
f_{ab}	base (alpha) cutoff frequency
f_{ae}	emitter (beta) cutoff frequency
h_{FE}	dc forward-current transfer ratio
h_{fe}	common-emitter, small-signal, short-circuit, forward-current transfer ratio
$\|h_{fe}\|$	magnitude of common-emitter, small-signal, short-circuit, forward-current transfer ratio
f_{hfe}	common-emitter, small-signal, short-circuit forward-current transfer ratio cutoff frequency
f_T	gain-bandwidth product (unity-gain frequency for devices in which gain roll off has a −1 slope)
G_c	conversion gain
G_{pb}	small-signal, common-base power gain
G_{PB}	large-signal, common-base power gain
G_{pe}	small-signal, common-emitter power gain
G_{PE}	large-signal, common-emitter power gain
G_{VE}	wide-band voltage gain
h_{ib}	common-base, small-signal, short-circuit input impedance
h_{ie}	common-emitter, small-signal, short-circuit input impedance
h_{ob}	common-base, small-signal, open circuit output admittance
h_{rb}	common-base, small-signal, open-circuit reverse-voltage transfer ratio
I_B	continuous base current
I_{BEV}	base-cutoff current with specified voltage between collector and emitter
I_{BM}	peak base current
I_C	continuous collector current
I_{CBO}	collector-cutoff current, emitter open
I_{CEO}	collector-cutoff current, base open
I_{CER}	collector-cutoff current with specified resistance between base and emitter
I_{CES}	collector-cutoff current with base-emitter junction short-circuited
I_{CEV}	collector-cutoff current with specified voltage between base and emitter
I_{CEX}	collector-cutoff current with specified circuit between base and emitter
I_{CM}	peak collector current
$I_C(sat)$	collector current at which h_{FE}, $V_{BE}(sat)$, $V_{CE}(sat)$, and switching speeds are measured
I_E	continuous emitter current
I_{EBO}	emitter-cutoff current, collector open
I_{EM}	peak emitter current
$I_{S/b}$	forward-bias, second-breakdown collector current
P_G	power gain
PRT	power rating test
P_T	transistor dissipation at specified temperature
$r_{bb'}$	base spreading resistance
R_{BB}	base bias resistor
$r_b'C_c$	collector-to-base time constant
R_{BE}	external base-to-emitter resistance
R_C	collector resistor
$r_{CE}(sat)$	dc collector-to-emitter saturation resistance
$Re(h_{ie})$	real part of common-emitter, small-signal, short-circuit input impedance
R_s	collector-to-emitter saturation resistance
t_c	clamped turn-off switching time of an inductive load
t_d	delay time
t_f	fall time
t_{OFF}	turn-off time (storage time + fall time)
t_{ON}	turn-on time (delay time + rise time)
t_r	rise time
t_s	storage time

Terms and Symbols

Power Transistors (Cont'd)

T_{VI}	clamped inductive turn-off time
V_{BB}	base supply voltage
V_{BE}	base-to-emitter voltage
$V_{BE}(sat)$	base-to-emitter saturation voltage
$V_{(BR)CBO}$	collector-to-base breakdown voltage, emitter open
$V_{(BR)CEO}$	collector-to-emitter breakdown voltage, base open
$V_{(BR)CEV}$	collector-to-emitter breakdown voltage with specified voltage between base and emitter
$V_{(BR)CEX}$	collector-to-emitter breakdown voltage with specified circuit between base and emitter
$V_{(BR)EBO}$	emitter-to-base breakdown voltage, collector open
V_{CB}	collector-to-base voltage
V_{CBO}	collector-to-base voltage, emitter open
V_{CC}	collector supply voltage
V_{CE}	collector-to-emitter voltage
V_{CEO}	collector-to-emitter voltage, base open
$V_{CE}(sat)$	collector-to-emitter saturation voltage
$V_{CEO}(sus)$	collector-to-emitter sustaining voltage, base open
V_{CER}	collector-to-emitter voltage with specified resistance between base and emitter
$V_{CER}(sus)$	collector-to-emitter sustaining voltage with specified resistance between base and emitter
V_{CES}	collector-to-emitter voltage with base-emitter junction short-circuited
V_{CEV}	collector-to-emitter voltage with specified voltage between base and emitter
$V_{CEV}(sus)$	collector-to-emitter sustaining voltage with specified voltage between base and emitter
V_{CEX}	collector-to-emitter voltage with specified circuit between base and emitter
$V_{CEX}(sus)$	collector-to-emitter sustaining voltage with specified circuit between base and emitter
V_{EB}	emitter-to-base voltage
V_{EBO}	emitter-to-base voltage, collector open
V_F	diode forward-voltage drop
V_{RT}	collector-to-emitter reach-through (or punch through) voltage
α	common-base current gain (alpha)
β	collector-emitter current gain (beta)
η_C	collector efficiency
τ_I	thermal time constant

Power Hybrid Operational Amplifiers

A	voltage gain
A_{CL}	closed-loop voltage gain
A_{OL}	open-loop voltage gain
CMRR	common-mode rejection ratio
f_H	closed-loop bandwidth
I_i	idling current
I_{IB}	input bias current
I_{IO}	input offset current
I_o	quiescent current
I_{om}	maximum peak quiescent current
I_S	short-circuit current
P_T	total power dissipation for each output transistor
R_{em}	common-mode input impedance
S/N	signal-to-noise ratio
SR	slew rate
V_{ICR}	common-mode input voltage range
V_{IN}	input signal voltage swing
V_{IO}	input offset voltage
V_{offset}	offset voltage
V_{OUT}	output voltage swing
V_{OUT}/V_{IN}	voltage gain
V_{RR}	supply-voltage ripple rejection ratio
V_S	supply voltage
Z_{IN}	input impedance
ΔI_i	idling-current drift

Thyristors (Triacs, SCR's and ITR's)

di/dt	rate of change of on-state current
di_F/dt	rate of change of forward current (rectifier unit of ITR)
dv/dt	critical rate of rise of off-state voltage
i_D	instantaneous off-state current
i_{DO}	instantaneous off-state current, gate open
I_{DOM}	maximum (peak) off-state current, gate open
I_{DROM}	maximum peak (repetitive) off-state current, gate open
I_{DRX}	dc off-state current, specified circuit between gate and cathode
I_{DRXM}	maximum (peak) repetitive dc off-state current with specified circuit between gate and cathode
I_{DXM}	maximum (peak) off-state current, specified circuit between gate and cathode
i_F	instantaneous forward current
I_{FM}	peak forward current
I_{FRM}	peak repetitive forward current
I_{FSM}	peak surge forward current (nonrepetitive)
I_G	dc gate current
I_g	pulsed gate trigger current (gate drive current)
I_{GM}	maximum (peak) gate current
$I_{GR(BR)}$	reverse gate breakdown current
I_{GRRM}	maximum (peak) reverse gate current
I_{GT}	dc gate trigger current
i_{HO}	instantaneous holding current, gate open
I_{HO}	dc holding current, gate open
i_L	instantaneous latching current
I_L	dc latching current
I_o	average dc forward current
I_R	dc reverse current
i_R	instantaneous reverse current
i_{RO}	instantaneous reverse current, gate open
I_{RM}	maximum (peak) reverse current
I_{RROM}	maximum (peak) reverse current, gate open
I_{RRX}	dc reverse current, specified circuit between gate and cathode
I_{RRXM}	maximum (peak) reverse current, specified circuit between gate and cathode
I^2t	amperes squared-seconds (fusing current for device protection)

Terms and Symbols

Thyristors (Triacs, SCR's and ITR's) (Cont'd)

i_T	instantaneous on-state current
I_T	dc on-state current
$I_{T(AV)}$	average on-state current
I_{TM}	maximum (peak) on-state current
$I_{TM(pulse)}$	maximum (peak) pulse on-state current
$I_{T(RMS)}$	rms on-state current
I_{TRXM}	maximum (peak) (repetitive) on-state current, specified operating circuit
I_{TSM}	maximum (peak) surge (non-repetitive) on-state current
I_{TXM}	maximum (peak) on-state current, specified operating circuit
P_D	device dissipation
$P_{D(AV)}$	average device dissipation
$P_{G(AV)}$	average gate power dissipation
P_{GM}	maximum (peak) gate power dissipation
P_{GRM}	maximum (peak) reverse gate power
P_T	on-state power dissipation
$P_{T(AV)}$	average on-state power dissipation
t_d	delay time
t_f	fall time
$t_{g(rec)}$	gate recovery time
t_{gt}	gate controlled turn-on time ($t_d + t_r$)
t_q	circuit commutated turn-off time ($t_{rr} + t_{g(rec)}$)
t_r	rise time
t_{rr}	reverse recovery time
t_s	storage time
$V_{(BO)}$	breakover voltage
$v_{(BO)O}$	instantaneous breakover voltage, gate open
V_D	dc off-state voltage
v_D	instantaneous off-state voltage
V_{DM}	maximum (peak) dc off-state voltage
V_{DROM}	maximum (peak) (repetitive) off-state voltage, gate open
V_{DRXM}	maximum (peak) (repetitive) off-state voltage, specified circuit between gate and cathode
V_{DSOM}	maximum (peak) (nonrepetitive) off-state voltage, gate open
V_{DSXM}	maximum (peak) (nonrepetitive) off-state voltage, specified circuit between gate and cathode
v_{DX}	instantaneous off-state voltage, specified circuit between gate and cathode
V_{DX}	dc off-state voltage, specified circuit between gate and cathode
v_F	instantaneous forward voltage drop
V_{FM}	maximum (peak) forward voltage
V_G	dc gate voltage
V_{GK}	dc gate-to-cathode voltage
V_{GR}	dc reverse gate voltage
$V_{GR(BR)}$	reverse gate breakdown voltage
V_{GRM}	maximum (peak) gate reverse voltage
V_{GRRM}	Maximum (peak) repetitive reverse gate voltage
V_{GT}	dc gate trigger voltage
V_R	dc reverse voltage
V_{RROM}	maximum (peak) (repetitive) reverse voltage, gate open
V_{RRXM}	maximum (peak) (repetitive) voltage, specified circuit between gate and cathode
V_{RSOM}	maximum (peak) (nonrepetitive)reverse voltage, gate open
V_{RSXM}	maximum (peak) (nonrepetitive) reverse voltage, specified circuit between gate and cathode
V_{RX}	dc reverse voltage, specified circuit between gate and cathode
V_{RXM}	maximum (peak) reverse voltage, specified circuit between gate and cathode
v_T	instantaneous on-state voltage
V_T	dc on-state voltage
$v_{T(I)}$	initial on-state voltage
V_{TM}	maximum (peak) dc on-state voltage
Z_{GS}	gate source impedance

Power Transistors - JEDEC Types

Technical Data

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 2N3053A, 40366, 40389, 40392

Low-Power Silicon N-P-N Planar Transistors

For Small-Signal Applications In Industrial and Commercial Equipment

These RCA types are silicon n-p-n planar transistors intended for a variety of small-signal and medium-power applications. They feature exceptionally high collector-to-emitter sustaining voltages, low leakage characteristics, high switching speeds, and high pulse beta (h_{FE}). RCA-2N2102 is a direct replacement for the 2N1613. RCA-2N2405 is a direct replacement for the 2N1893. All of these devices except the 40389 and 40392 are supplied in the JEDEC TO-39 hermetic package. The 40389 is a 2N3053 with a factory-attached heat radiator and the 40392 is a 2N3053 with a factory-attached diamond-shaped mounting flange.

Features:

- **Planar construction for low noise and low leakage**
- **Low output capacitance**
- **Low saturation voltages**

Additional Features for 40366:

- **High reliability assured by five preconditioning steps**
- **Group A test data included in data sheet.**

								2N3053		
			2N2102	2N1613				40389		
	2N697	2N699	40366	2N1711	2N1893	2N2270	2N2405	40392	2N3053A	
V_{CBO}	60	120	120	75	120	60	120	60	80	V
V_{CER}(sus) RBE ≤ 10 Ω		80	80	50	100	60	140	50	70	V
V_{CEV}(sus)	–	–	–	–	120	–	120	60	80	V
V_{CEO}(sus)	–	–	65	–	80	45	90	40	60	V
V_{EBO}	5	5	7	7	7	7	7	5	5	V
I_C	0.5	1	1	1	0.5	1	1	0.7	0.7	A
P_T										
TC ≤ 25° C	2	2	5	3	3	5	5	5●	5	W
free-air ≤ 25° C	0.6	0.6	1	0.8	0.8	1	1	1■	1	W
TC>25° C	Derate linearly to maximum temperature									
T_{stg}, T_J	−65 to +175	−65 to 200								°C
T_L	255	230	300	300	255	230	255	235	235	°C

At distance from seating plane for 10 s max. ≥1/16 in. (1.58 mm) . . . .

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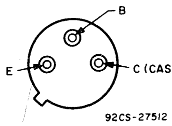
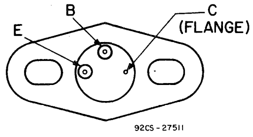
* 2N-Series types in accordance with JEDEC registration data

●7 for 40392. ■3.5 for 40389

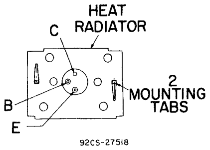
TERMINAL DESIGNATIONS



JEDEC TO-39
(See dimensional outline "C".)



JEDEC TO-39 with Flange
40392
(See dimensional outline "E".)



JEDEC TO-39 with Heat Radiator
40389
(See dimensional outline "D".)

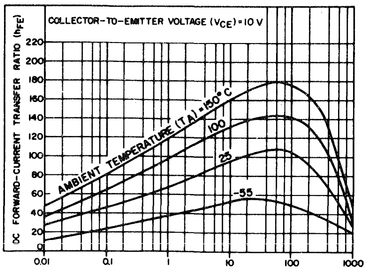


Fig. 1 - Typical dc beta characteristics for 2N699, 2N1613, 2N2102, 2N2270.

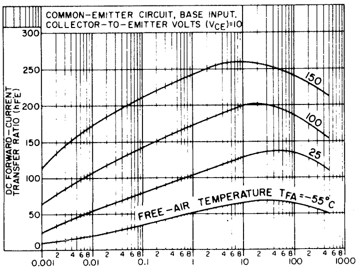


Fig. 2 - Typical dc beta characteristics for 2N1711.

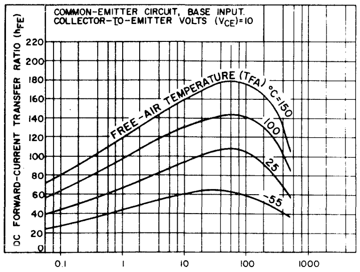


Fig. 3 - Typical dc beta characteristics for 2N1893, 2N2405.

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 2N3053A, 40366, 40389, 40392

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS											UNITS
		VOLTAGE V dc		CURRENT mA dc		2N697			2N699		2N1613		2N2102 40366		2N1711		
		V_{CB}	V_{CE}	I_C	I_B	MIN.	TYP.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* Collector Cutoff Current:		30				–	0.01	1	–	–	–	–	–	–	–	–	
With emitter open	I_{CBO}	60				–	–	–	–	0.05	–	0.01	–	0.002	–	0.01	μA
At T_C = 150°C		60				–	–	–	–	–	–	10	–	2	–	10	
* Emitter Cutoff Current: V_{EB} = 5 V	I_{EBO}			0		–	–	–	–	0.05	–	0.01	–	0.002	–	0.005	μA
			10	0.01		–	–	–	–	–	–	–	10	–	20	–	
			10	0.1		–	–	–	–	–	20	–	20	–	35	–	
* DC Forward-Current Transfer Ratio	h_{FE}		10	10^a		–	–	–	–	–	35	–	35	–	75	–	
			10	150^a		40	–	120	40	120	40	120	40	120	100	300	
			10	500^a		–	–	–	–	–	20	–	25	–	40	–	
At T_C = –55°C			10	10^a		–	–	–	–	–	20	–	20	–	35	–	
* Collector-to-Emitter Reachthrough Voltage: V_{EB} = 1.5 V, I_E = 0	V_{RT}					–	–	–	–	–	–	–	120	–	75	–	V
* Collector-to-Base Breakdown Voltage: With emitter open	$V_{(BR)CBO}$			0.1		60	75	–	120	–	75	–	120	–	75	–	V
* Emitter-to-Base Breakdown Voltage: I_E = 0.1 mA	$V_{(BR)EBO}$			0		5	7.5	–	–	–	7	–	7	–	7	–	V
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			100^a	0	–	–	–	–	–	–	–	65	–	–	–	V
With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$			100^a		40	60	–	80	–	50	–	80	–	50	–	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			150^a	15	–	1	1.3	–	1.3	–	1.3	–	1.1	–	1.3	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			150^a	15	–	0.7	1.5	–	5	–	1.5	–	0.5	–	1.5	V
* Common-Emitter, Small-Signal, Forward-Current Transfer Ratio	h_{fe}		5	1		–	–	–	35	100	30	100	30	100	50	200	
(f = 1 kHz)			10	5		–	–	–	45	–	35	150	35	150	70	300	
Magnitude of Common-Emitter, Small-Signal, Forward Current Transfer Ratio (f = 20 MHz)	$\|h_{fe}\|$		10	50		2.5	5	–	2.5	–	3	–	3	–	3.5	–	
* Input Resistance:	h_{ib}	5		1		–	–	–	20	30	24	34	24	34	24	34	Ω
f = 1 kHz		10		5		–	–	–	–	10	4	8	4	8	4	8	
* Small-Signal Reverse Voltage		5		1		–	–	–	–	3×10^{-4}	–	3×10^{-4}	–	3×10^{-4}	–	5×10^{-4}	
Transfer (Feedback) Ratio:	h_{rb}	10		1		–	–	–	–	–	–	3×10^{-4}	–	–	–	–	
f = 1 kHz		10		5		–	–	–	–	3×10^{-4}	–	–	–	3×10^{-4}	–	5×10^{-4}	
* Output Conductance:	h_{ob}	5		1		–	–	–	0.05	0.5	0.05	0.5	0.01	0.5	0.05	0.5	μmho
f = 1 kHz		10		5		–	–	–	–	1	0.05	0.5	0.01	1	0.05	0.5	
* Output Capacitance: I_E = 0	C_{ob}	10				–	20	35	–	20	–	25	–	15	–	25	pF
* Input Capacitance: V_{EB} = 0.5 V	C_{ib}			0		–	–	–	–	–	–	80	–	80	–	80	pF
Gain-Bandwidth Product	f_T					50	100	–	50	–	60	–	60	–	70	–	MHz
* Noise Figure: Circuit Bandwidth (BW) = 1 Hz Reference signal freq. = 1 kHz Generator resistance (R_G) =	NF	10		0.3													dB
510 Ω (2N1613, 2N1711)						–	–	–	–	–	–	12	–	–	–	8	
1 KΩ (2N2102)						–	–	–	–	–	–	–	–	6	–	–	
* Saturated Switching Time	$t_d+t_r+t_f$					–	–	–	–	–	–	30	–	30	–	–	ηs
Thermal Resistance: Junction-to-case	$R\theta_{JC}$					–	–	75	–	75*	–	58.3*	–	35*	–	58.3*	°C/W
Junction-to-ambient	$R\theta_{JA}$					–	–	250	–	250*	–	219*	–	175*	–	219*	

*2N-Series types in accordance with JEDEC registration data

[a] Pulsed, pulse duration = 300 μs, duty factor = 2% (1.8% for 2N2102 only).

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 2N3053A, 40366, 40389, 40392

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified.*

SYMBOL	TEST CONDITIONS				LIMITS										UNITS
	VOLTAGE V dc		CURRENT mA dc		2N1893		2N2405		2N2270		2N3053 40389 40392		2N3053A		
	V_{CB}	V_{CE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CBO}	15				–	–	–	–	–	–	–	–	–	–	µA
	30				–	–	–	–	–	–	–	0.25	–	–	
	60				–	–	–	–		0.05	–	–	–	–	
	90				–	0.01	–	0.01	–	–	–	–	–	–	
Tc=150° C	60				–	–	–	–	–	50	–	–	–	–	
	90				–	15	–	10	–	–	–	–	–	–	
* I_{EBO} VEB=5V●			0		–	0.01	–	0.01	–	0.1	–	0.25	–	**0.25**	µA
* h_{FE}		10	0.1		–	–	20	–	--	–	–	–	–	–	
		10	1		–	–	–	–	30	–	–	–	–	–	
		10	10^a		35	–	35	–	–	–	–	–	–	–	
		10	150^a		40	120	60	200	50	200	50	250	**50**	**250**	
Tc=55° C		10	10^a		20	–	20	–	–	–	–	–	–	–	
* $V_{(BR)CBO}$			0.1		120	–	120	–	60	–	60	–	**80**	–	V
* $V_{(BR)EBO}$ I_E=0.1mA			0		7	–	7	–	7	–	5	–	**5**	–	V
* $V_{CEO}(sus)$			100^a	0	–	–	90	–	45	–	40	–	60	–	V
			30^a	0	80	–	90	–	–	–	–	–	–	–	
* $V_{CER}(sus)$ RBE=10 Ω			100^a		100	–	140	–	60	–	50	–	70	–	V
=500 Ω			100^a		–	–	120	–	–	–	–	–	–	–	
* $V_{BE}(sat)$			150^a	15	–	**1.3**	–	**1.1**	–	**1.2**	–	**1.7**	**0.6**	**1**	V
			50^a	5	–	**0.9**	–	**0.9**	–	–	–	–	–	–	
* $V_{CE}(sat)$			150^a	15	–	**5**	–	**0.5**	–	**0.9**	–	1.4	–	**0.3**	V
			50^a	5	–	**1.3**	–	**0.2**	--	–	–	–	–	–	
V_{BE}		**2.5**	**150**		–	–	–	–	–	–	–	**1.7**	–	**1**	V
		10	150^a		–	–	–	–	–	–	–	–	–	–	
* h_{fe} * f = 1 kHz		5	1		30	100	–	–	–	–	–	–	–	–	
* = 1 kHz		5	5		–	–	50	275	5	–	–	–	–	–	
* = 1 kHz		10	5		45	–	–	--	5	275	–	–	–	–	
* = 20 MHz		10	50		2.5*	–	6	–	5*	–	5*	–	**5**	–	
* h_{ib} f=1 kHz	5		1		20	30	24	34	–	–	–	–	–	–	Ω
	10		5		4	8	4	8	–	–	–	–	–	–	

*2N-Series type in accordance with JEDEC registration data.
aPulsed; pulse duration = 300 µs, duty factor ≤ 2%.
●V_{EB}=4V for 2N3053, 2N3053A

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 2N3053A, 40366, 40389, 40392

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified.* (cont'd)

SYMBOL	TEST CONDITIONS				LIMITS										UNITS
	VOLTAGE V dc		CURRENT mA dc		2N1893		2N2405		2N2270		2N3053 40389 40392		2N3053A		
	V_{CB}	V_{CE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* h_{rb} f=1kHz	5		1		–	1.25 x 10^{-4}	–	3 x 10^{-4}	–	–	–	–	–	–	
	10		5		–	1.25 x 10^{-4}	–	3 x 10^{-4}	–	–	–	–	–	–	
* h_{ob} f=1kHz	5		1		–	0.5	–	0.5	–	–	–	–	–	–	µmho
	10		5		–	0.5	–	0.5	–	–	–	–	–	–	
* C_{ob} $I_{E=O}$	10				–	15	–	15	–	15	–	15	–	**15**	pF
* C_{ib} V_{EB}=0.5V			0		–	85	–	85	–	80	–	80	–	**80**	pF
f_T					50	–	120	–	100	–	100	–	**100**	–	MHz
NF▲	10		0.3		–	–	–	6	–	10*	–	–	–	–	dB
* $t_d+t_r+t_f$					–	–	–	–	–	30	–	–	–	–	ηs
$R\theta_{JC}$					–	58.3	–	35	–	35	–	35●	–	**35**	°C/W
$R\theta_{JA}$					–	219	–	175	–	175	–	175■	–	**175**	

*2N-Series types in accordance with JEDEC registration data. aPulsed; pulse duration=300 µs, duty factor≤ 2%.
▲BW=1Hz, reference signal freq.=1kHz, R_G=500 Ω (2N2405) and R_G=1 kΩ (2N2270).
●25 max. for 40392. ■ 50 max. for 40389.

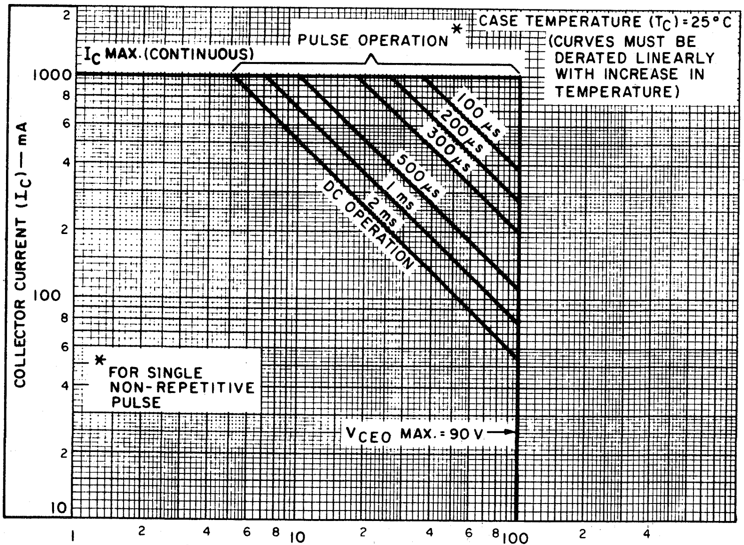


Fig. 4 - Maximum operating areas for 2N2405.

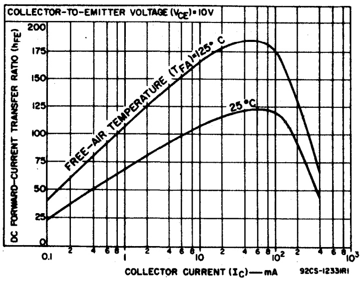


Fig. 5 — Typical dc beta characteristics for 2N3053, 2N3053A, 40389, 40392.

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 2N3053A, 40366, 40389, 40392

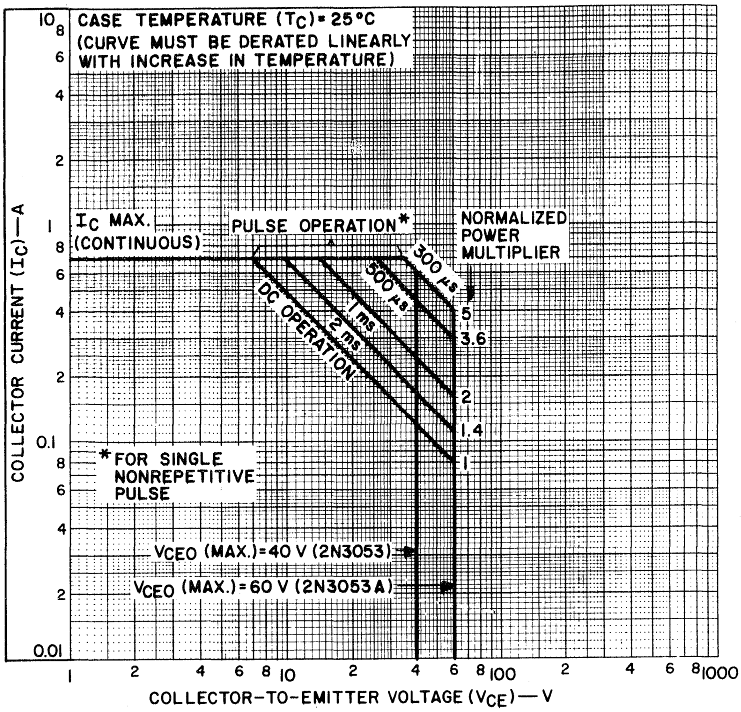


Fig. 6 — Maximum operating areas for 2N3053 and 2N3053A.

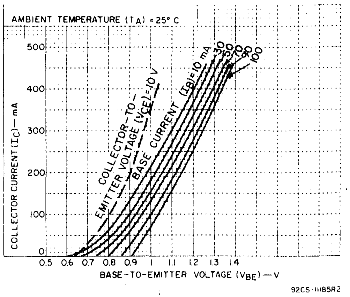


Fig. 7 - Typical transfer characteristics for 2N1613, 2N1711, 2N1893, 2N2102, 2N2405.

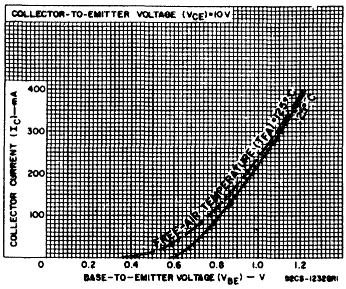


Fig. 8 - Typical transfer characteristics for 2N3053, 2N3053A, 40389, 40392.

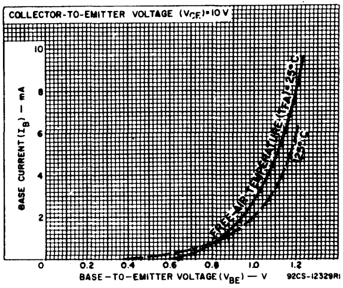


Fig. 9 - Typical input characteristics for 2N3053, 2N3053A, 40389, 40392.

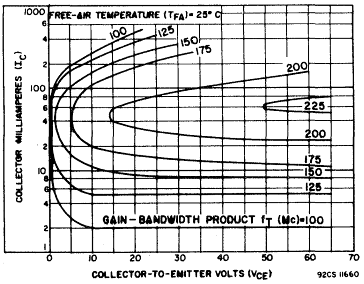


Fig. 10 - Typical gain bandwidth product (f_T) for 2N1711, 2N1893,2N2405.

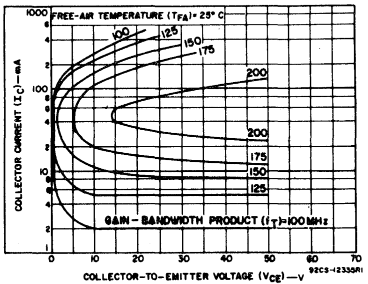


Fig. 11 - Typical gain bandwidth product (f_T) for 2N699, 2N1613, 2N2102, 2N2270, 2N3053, 2N3053A, 40389, 40392.

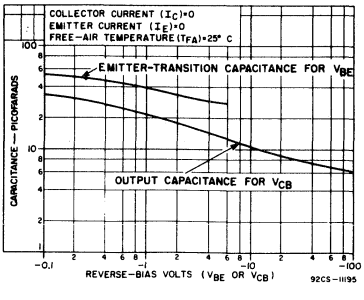


Fig. 12 - Typical capacitance characteristics for all types.

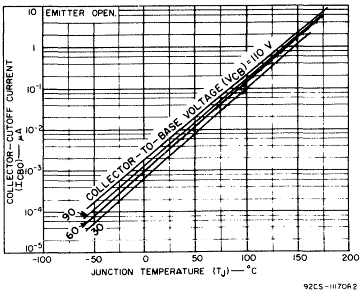


Fig. 13 - Typical collector-cutoff current characteristics for 2N699, 2N1893, 2N2405.

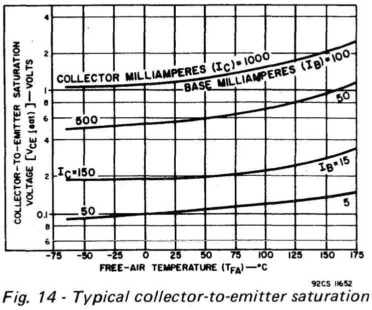


Fig. 14 - Typical collector-to-emitter saturation characteristics for 2N1893, 2N2405.

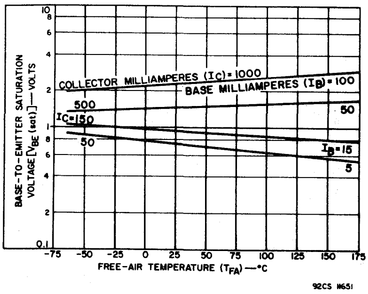


Fig. 15 - Typical base-to-emitter saturation characteristics for 2N1893, 2N2405.

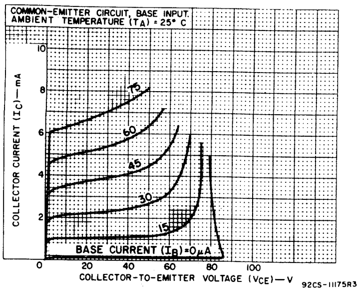


Fig. 16 - Typical low-current output characteristics for 2N699, 2N1613, 2N2102, 2N2270.

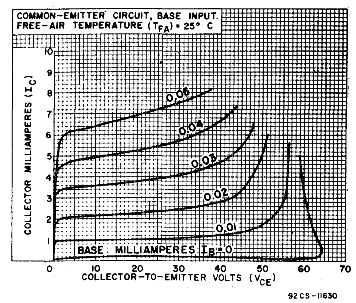


Fig. 17 - Typical low-current output characteristics for 2N1711.

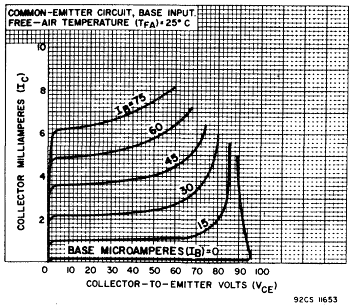


Fig. 18 - Typical low-current output characteristics for 2N1893.

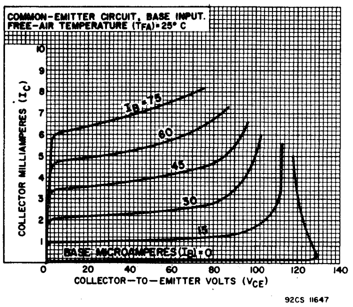


Fig. 19 - Typical low-current output characteristics for 2N2405.

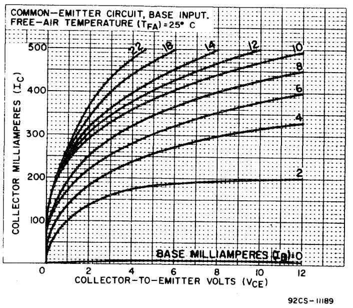


Fig. 20 - Typical high-current output characteristics for 2N699, 2N2270.

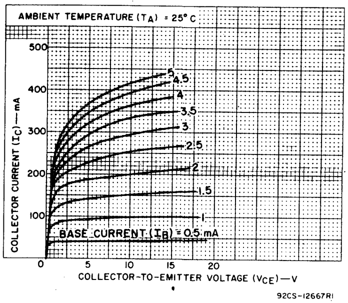


Fig. 21 - Typical high-current output characteristics for 2N1613, 2N2102.

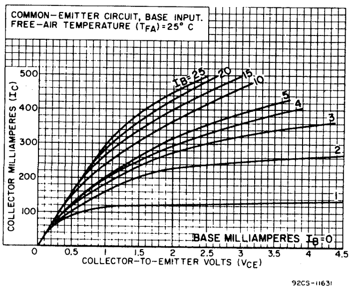


Fig. 22 - Typical high-current output characteristics for 2N1711.

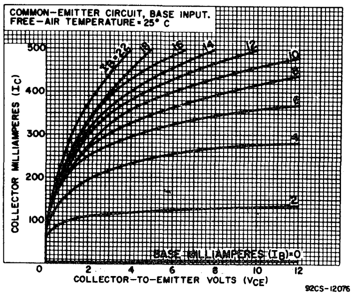


Fig. 23 - Typical high-current output characteristics for 2N1893.

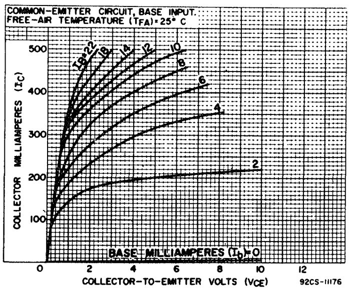


Fig. 24 - Typical high-current output characteristics for 2N2405.

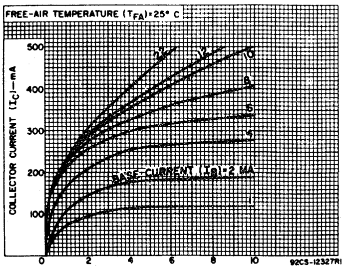


Fig. 25 - Typical high-current output characteristics for 2N3053, 2N3053A,

2N1479-2N1482, 2N1700, 40347, 40348, 40367

Hometaxial-Base Silicon N-P-N Power Transistors

General-Purpose Types for Low-Power Applications

These RCA types are hometaxial-base, silicon n-p-n power transistors intended for a wide variety of applications in industrial and military equipment. They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay controls; in oscillator, regulator, and pulse-amplifier circuits; and as class A and class B push-pull audio and servo amplifiers.

The 2N1700 and 40367 are supplied in the hermetic JEDEC TO-39 package or TO-39 with factory-attached heat radiator.

Features:

- High-temperature characterization
- High dc beta at 200 mA
- Full switching-time characterization at 200 mA

Additional features for 40367:

- High realiability assured by five preconditioning steps
- Group A test data in data bulletin

Maximum Ratings, *Absolute-Maximum Values:*		**2N1479** **2N1481**	**2N1480** **2N1482**	**2N1700**	**40347** **40347V1**	**40348** **40348V1**	**40367**
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	100	60	60	90	100 V
* COLLECTOR-TO-EMITTER VOLTAGE:							
With base open, sustaining	$V_{CEO}(sus)$	40	55	40	40	65	55 V
With emitter-to-base reverse biased (V_{EB} = 1.5 volts)	V_{CEV}	60	100	60	60	90	100 V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	12	12	6	7	7	12 V
* COLLECTOR CURRENT	I_C	1.5	1.5	1	1.5	1.5	1.5 A
PEAK COLLECTOR CURRENT	I_{CM}	–	–	–	3.0	3.0	– A
* EMITTER CURRENT	I_E	−1.75	−1.75	–	–	–	– A
* BASE CURRENT	I_B	1	1	0.75	0.5	0.5	1 A
* TRANSISTOR DISSIPATION:	P_T						
At case temperature of 25°C		5	5	5	8.75 (40347)	8.75 (40348)	5 W
At ambient temperature up to 25°C		–	–	–	1.0 (40347) 4.4 (40347V1)	1.0 (40348) 4.4 (40348V1)	1 W
* TEMPERATURE RANGE:							
Operating and Storage	T_C, T_{stg}	←			−65 to 200		→ °C
* LEAD TEMPERATURE (During soldering):							
At distances ⩾ 1/32 in (0.8 mm) from seating plane for 10 s max.	T_L	–	–	255	230	230	255°C

*2N-Series types in accordance with JEDEC registration data

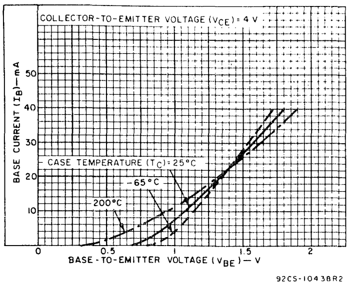


Fig. 1 — Typical input characteristics for 2N1479–2N1482.

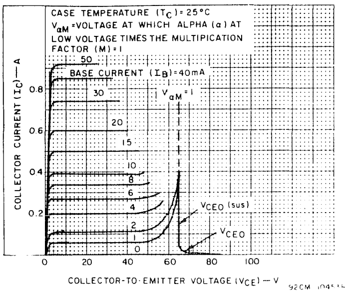
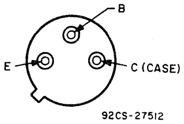
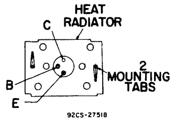


Fig. 2 — Typical output characteristics for 2N1479–2N1482.

TERMINAL DESIGNATIONS



JEDEC TO-39
2N1479-2N1482,2N1700,
40347-40348,40367
(See dimensional outline "C".)



JEDEC TO-39 with Heat Radiator
40347V1,40348V1
(See dimensional outline "D".)

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

SYMBOL	TEST CONDITIONS						LIMITS												UNITS
	VOLTAGE V dc			CURRENT mA dc			2N1479		2N1480		2N1481		2N1482		2N1700		40367		
	V_{CB}	V_{CE}	V_{EB}	I_C	I_B	I_E	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CBO}	30					0	–	10	–	10	–	10	–	10	–	75	–	4	μA
T_C = 150°C	30					0	–	500	–	500	–	500	–	500	–	1000	–	–	
* I_{EBO}			12	0			–	10	–	10	–	10	–	10	–	–	–	2	μA
			6	0			–	–	–	–	–	–	–	–	–	25	–	–	
* V_{CEV}			1.5	0.25			60	–	100	–	60	–	100	–	–	–	100	–	V
			1.5	0.5			–	–	–	–	–	–	–	–	60	–	–	–	
V_{CEO}(sus)				50	0		40	–	55	–	40	–	55	–	–	–	55	–	
* V_{BE}		4		200			–	3	–	3	–	3	–	3	–	–	–	3	V
		4		100			–	–	–	–	–	–	–	–	–	2	–	–	
V_{CE}(sat)				200	10		–	–	–	–	–	–	–	–	–	–	–	1.4	V
* h_{FE}		4		200			20	60	20	60	35	100	35	100	–	–	35	100	
		4		100			–	–	–	–	–	–	–	–	20	80	–	–	
h_{fe}		4		5			50 Typ.*		50 typ.*		50 Typ.*		50 Typ.*		40 Typ.		–	–	
* r_{CE}(sat)				200	20		–	7	–	7	–	–	–	–	–	–	–	–	Ω
				200	10	–	–	–	–	–	–	7	–	7	–	–	–	–	
				100	10	–	–	–	–	–	–	–	–	–	–	10	–	–	
C_{ob}	40						150 Typ.*		150 Typ.*		150 Typ.*		150 Typ.*		150 Typ.		–	–	pF
τ_1							10 Typ.*		10 Typ.*		10 Typ.*		10 Typ.*		10 Typ.		–	–	ms
$f_{\alpha b}$	28			5			1.5 Typ.*		1.5 Typ.*		1.5 Typ.*		1.5 Typ.*		1.5 Typ.		–	–	MHz
t_d●							0.2 Typ.*		0.2 Typ.*		0.2 Typ.*		0.2 Typ.*		0.2 Typ.		–	–	
t_r●							1 Typ.*		1 Typ.*		1 Typ.*		1 Typ.*		1 Typ.		–	–	
t_s●							0.6 Typ.*		0.6 Typ.*		0.6 Typ.*		0.6 Typ.*		0.6 Typ.		–	–	
t_f●							1 Typ.*		1 Typ.*		1 Typ.*		1 Typ.*		1 Typ.		–	–	
* $R\theta_{JC}$								35		35		35		35		35	–	35	
$R\theta_{JFA}$								200		200		200		200		200	–	–	

*2N-Series types in accordance with JEDEC registration data.

● I_C = 200 mA, I_{B_1} = 20 mA, I_{B_2} = −85. rnA

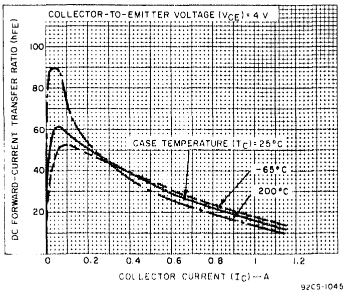


Fig. 3– Typical dc beta characteristics for 2N1479–2N1482.

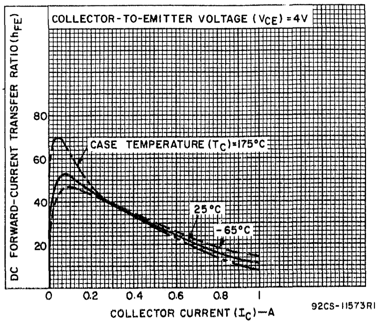


Fig.4–Typical dc beta characteristics for 2N1700.

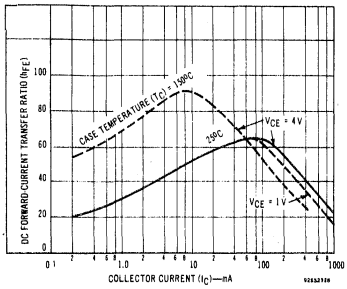


Fig.5–Typical dc beta characteristics for 40347.

2N1479-2N1482, 2N1700, 40347, 40348, 40367

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		40347		40348		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 1 kΩ	I_{CER}	30				–	1	–	–	μA
		60				–	–	–	1	
		90				–	–	–	–	
With R_{BE} = 1 kΩ and T_C = 150°C	I_{CER}	30				–	1	–	–	mA
		60				–	–	–	1	
		90				–	–	–	–	
Emitter-Cutoff Current	I_{EBO}		–7			–	10	–	10	μA
DC Forward-Current Transfer Ratio	h_{FE}	4		0.15		–	–	–	–	
		4		0.30		–	–	30	125	
		4		0.45		25	100	–	–	
		4		1.00		–	–	10	–	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse biased	$V_{CEV}(sus)$		–1.5	0.050		60	–	90	–	V
With base open	$V_{CEO}(sus)$			0.050		40	–	65	–	V
Base-to-Emitter Voltage	V_{BE}	4		0.15		–	–	–	–	V
		4		0.30		–	–	–	1.3	
		4		0.45		–	1.5	–	–	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			0.15	15 mA	–	–	–	–	V
				0.30	30 mA	–	–	–	0.75	
				0.45	45 mA	–	1	–	–	
Forward-Bias Second Breakdown Collector Current (1-s non-repetitive pulse)	$I_{S/b}$	38				345	–	–	–	mA
		63				–	–	208	–	
		138				–	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					20(max.) 40347		20(max.) 40348		°C/W
Thermal Resistance: Junction-to-Ambient	$R_{\theta JA}$					40(max.) 40347V1		40(max.) 40348V1		°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ≤2%.

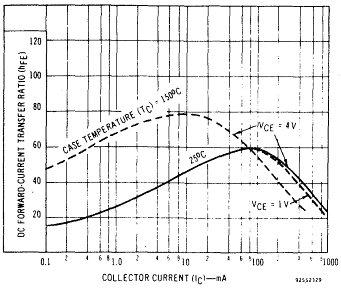


Fig.6—Typical dc beta characteristics for 40348.

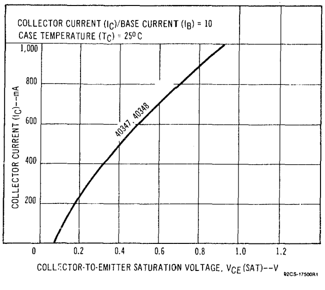


Fig. 7-Typical saturation characteristics for 40347 and 40348.

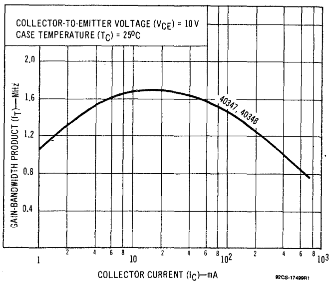


Fig.8—Typical gain-bandwidth product vs. collector current for 40347 and 40348.

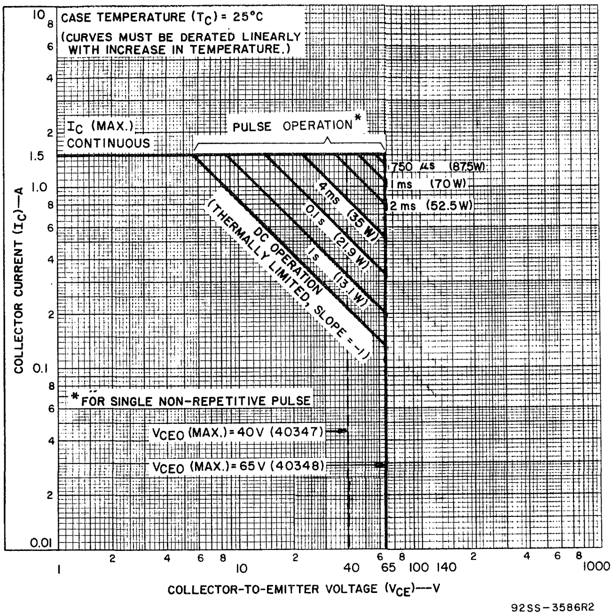


Fig.9—Maximum operating areas for 40347 and 40348.

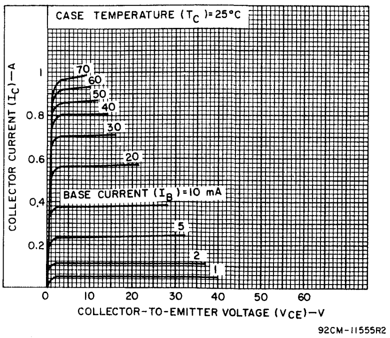


Fig.10—Typical output characteristics for 2N1700.

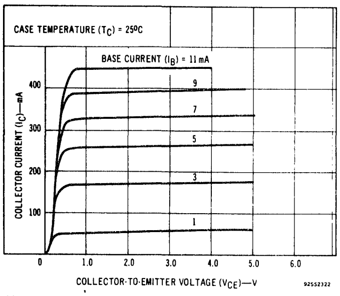


Fig.11—Typical output characteristics for 40347.

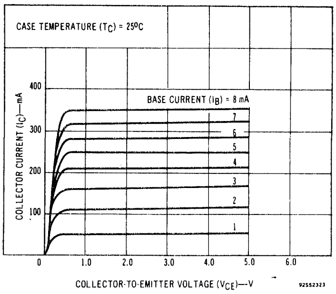


Fig.12—Typical output characteristics for 40348.

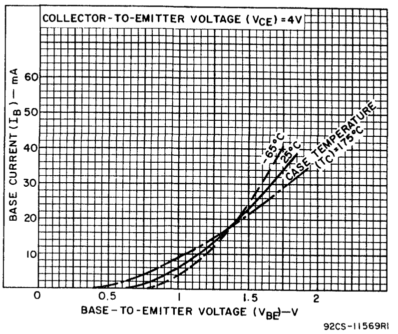


Fig. 13 — Typical input characteristics for 2N1700.

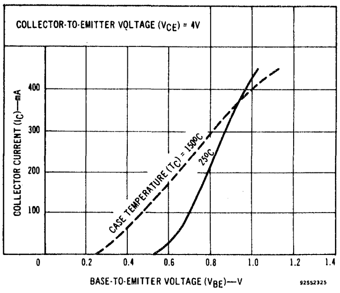


Fig.14—Typical transfer characteristics for 40347.

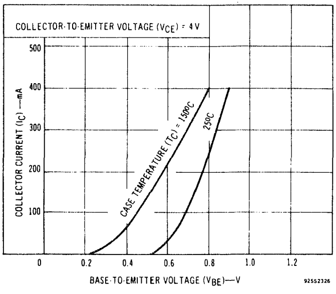


Fig.15—Typical transfer characteristics for 40348.

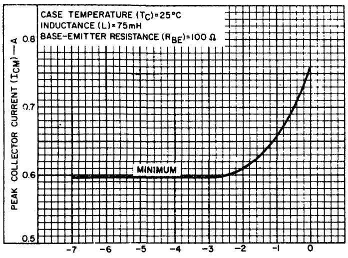


Fig. 16 —Reverse-bias second-breakdown characteristics for 40347 and 40348.

2N1479-2N1482, 2N1700, 40347, 40348, 40367

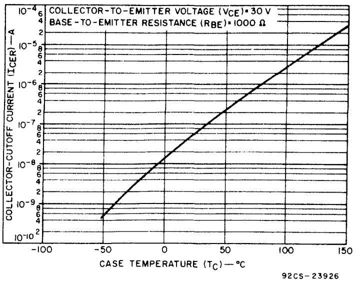


Fig. 17—Collector-cutoff-current characteristic for 40347.

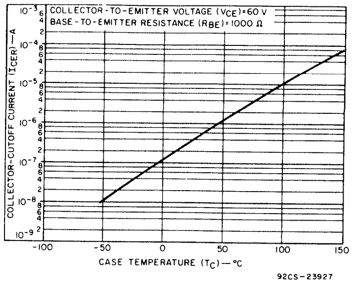


Fig. 18—Collector-cutoff-current characteristic for 40348.

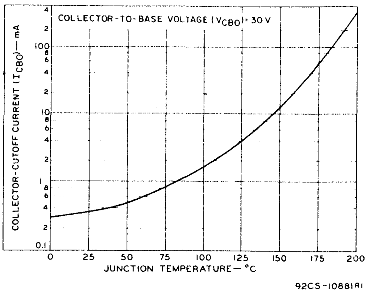


Fig. 19 — Typical leakage characteristics for 2N1479—2N1482.

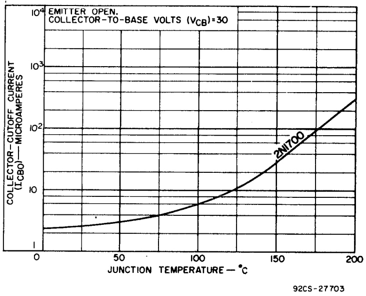


Fig. 20 — Typical leakage characteristics for 2N1700.

2N1487-2N1490, 2N1702

Hometaxial-Base Silicon N-P-N Power Transistors

General-Purpose Types for High-Power Applications

These RCA types are hometaxial-base power transistors of the silicon n-p-n type intended for a wide variety of applications in industrial and military equipment. They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay controls; in oscillator, regulator, and pulse-amplifier circuits; and as class-A and class-B push-pull audio and servo amplifiers.

These transistors feature high power-dissipation ratings, high beta at high current, and excellent high-temperature performance. They are supplied in the JEDEC TO-3 hermetic package.

Features:

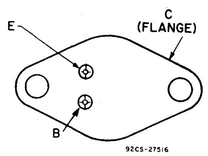
- High-temperature characterization
- High dc beta at 1.5A
- Full switching-time characterization at 1.5A

Maximum Ratings, *Absolute-Maximum Values:*

		2N1487 2N1489	2N1488 2N1490	2N1702	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	100	60	V
* COLLECTOR-TO-EMITTER VOLTAGE:					
With base open (sustaining voltage)	$V_{CEO}(sus)$	40	55	40	V
With emitter-to-base reverse biased (V_{EB}) = 1.5 volts)	V_{CEV}	60	100	60	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	10	10	6	V
* COLLECTOR CURRENT	I_C	6	6	5	A
* EMITTER CURRENT	I_E	−8	−8	–	A
* BASE CURRENT	I_B	3	3	2.5	A
* TRANSISTOR DISSIPATION:	P_T				
At mounting-flange temperature of 25°C		75	75	75	W
At mounting-flange temperature of 100°C		43	43		W
* TEMPERATURE RANGE:					
Operating and Storage	T_C, T_{stg}	-65 to 200			°C
PIN TEMPERATURE (During soldering):					
At distance ≥ 1/32 in. (0.79 mm) from seating plane for 10 s max.	T_L	235			°C

*2N-Series types in accordance with JEDEC registration data

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

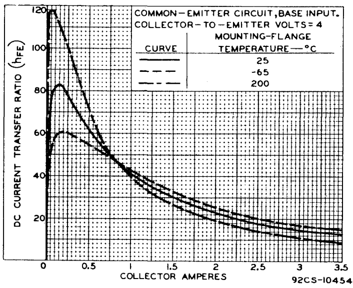


Fig. 1 – Typical dc beta characteristics for 2N1487–2N1490.

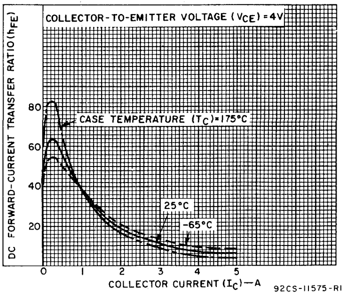


Fig. 2 – Typical dc beta characteristics for 2N1702.

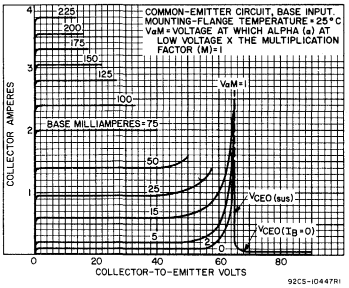


Fig. 3 – Typical output characteristics for 2N1487–2N1490.

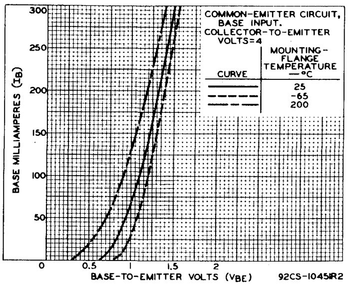


Fig. 4 – Typical input characteristics for 2N1487–2N1490.

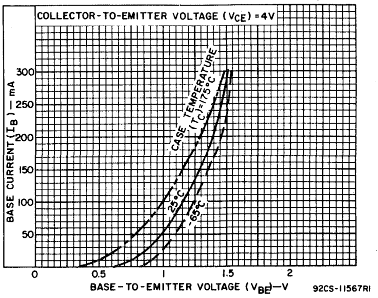


Fig. 5 – Typical input characteristics for 2N1702.

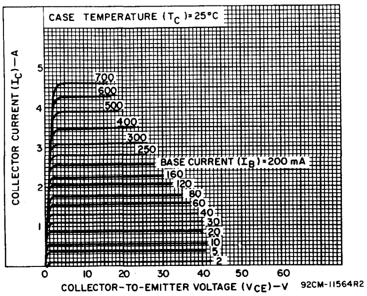


Fig. 6 – Typical output characteristics for 2N1702.

2N1487-2N1490, 2N1702

ELECTRICAL CHARACTERISTICS *Mounting-flange temperature = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS					LIMITS										UNITS
	DC COLLECTOR VOLTAGE (VOLTS)		DC EMITTER VOLTAGE (VOLTS)	DC COLLECTOR CURRENT (mA)	DC BASE CURRENT (mA)	TYPE 2N1487		TYPE 2N1488		TYPE 2N1489		TYPE 2N1490		TYPE 2N1702		
	V_{CB}	V_{CE}	V_{EB}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CBO}	30					–	25	–	25	–	25	–	25	–	200	μA
	60					–	–	–	–	–	–	–	–	–	1000	
At $T_C = 150°C$	30					–	1000	–	1000	–	1000	–	1000	–	2000	μA
* I_{EBO}			6	0		–	–	–	–	–	–	–	–	–	100	μA
I_{EBO}			10	0		–	25	–	25	–	25	–	25	–	–	μA
* V_{CEX}			1.5	0.25		–	–	–	–	–	–	–	–	–	–	V
			1.5	0.5		60	–	100	–	60	–	100	–	–	–	
			1.5	1		–	–	–	–	–	–	–	–	60^b	–	
* $V_{CEO}(sus)$				100	0	40	–	55	–	40	–	55	–	40^b	–	V
* h_{FE}		4		1500		15	45	15	45	25	75	25	75	–	–	
		4		800		–	–	–	–	–	–	–	–	15	60	
		20		5000		–	–	–	–	–	–	–	–	3.5	–	
* $r_{CE}(sat)$				1500	300	–	2	–	2	–	–	–	–	–	–	Ω
				1500	100	–	–	–	–	–	0.67	–	0.67	–	–	
				800	80	–	–	–	–	–	–	–	–	–	4	
* V_{BE}		4		1500		–	3.5	–	3.5	–	2.5	–	2.5	–	–	V
		4		250		–	–	–	–	–	–	–	–	–	4	
		20		300		–	–	–	–	–	–	–	–	–	20.5	
* $V_{CE}(sat)$				5000	2000	–	–	–	–	–	–	–	–	–	20	V
* C_{ob}	40					200(typ.)		200(typ.)		200(typ.)		200(typ.)		200 (typ.)		pF
* τ_l						12 (typ.)		12 (typ.)		12 (typ.)		12 (typ.)		12 (typ.)		ms
* $f_{\alpha b}$	12			100		1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		–	–	MHz
* f_{hfb}	6				100	–	–	–	–	–	–	–	–	300	–	kHz
	28			0.5		–	–	–	–	–	–	–	–	1 (typ.)		MHz
t_d■						0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		μs
t_r■						1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		
t_s■						1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		
t_f■						1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		
* $R_{\theta JC}$						–	2.33	–	2.33	–	2.33	–	2.33	–	2.33	°C/W

* 2N-Series types in accordance with JEDEC registration data.

■ $I_C = 1.5$ A, $I_{B_1} = 300$ mA, $I_{B_2} = -150$ mA

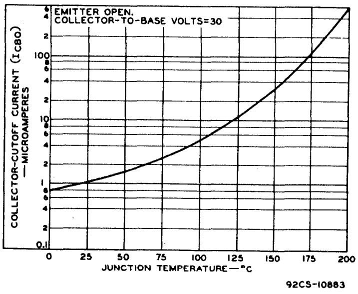


Fig. 7 — Typical collector-cutoff current characteristic for 2N1487–2N1490.

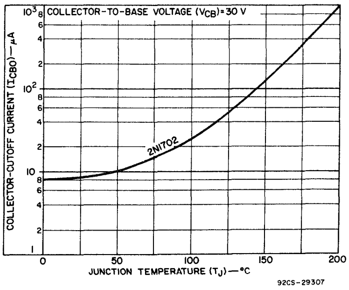


Fig. 8 — Typical collector-cutoff current characteristics for 2N1702.

2N3054, 2N6260, 2N6261, 40250, 40372

Hometaxial-Base, Medium-Power Silicon N-P-N Transistors

Rugged Devices for Intermediate-Power Applications in Industrial and Commercial Equipment

These RCA types are hometaxial-base silicon n-p-n transistors intended for a wide variety of medium- to high-power applications. Types 2N3054, 2N6260, 2N6261, and 40250 are supplied in the JEDEC TO-66 hermetic package.

Types 40250V1 and 40372 are the 40250 and 2N3054 with factory-attached heat radiators intended for printed-circuit-board applications.

Features:

- f_T = 800 kHz at 0.2A (2N3054, 40372)
- Maximum safe-area-of-operation curves for dc and pulse operation
- V_{CEV}(sus) = 90 V min (2N3054, 2N6261)
- Low saturation voltage: V_{CE}(sat) = 1.0 V at I_C = 0.5 A (2N3054)

Applications:

- Power switching circuits
- Series- and shunt-regulator driver and output stages
- High-fidelity amplifiers
- Solenoid drivers.

Maximum Ratings, *Absolute-Maximum Values:*

		40250 40250V1	2N6260	2N3054 40372	2N6261	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	50	90	90	V
COLLECTOR-TO-EMITTER VOLTAGE:						
* With base open	V_{CEO}	40	40	55	80	V
* With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}(sus)	–	45	60	85	V
With base reverse-biased (V_{BE} = -1.5 V)	V_{CEV}(sus)	50	50	90	90	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	7	7	V
* CONTINUOUS COLLECTOR CURRENT	I_C	4	3	4	4	A
* CONTINUOUS BASE CURRENT	I_B	2	2	2	2	A
* TRANSISTOR DISSIPATION:	P_T					
* At case temperature up to 25°C		29 (40250)	29 (2N6260)	25 (2N3054)	50 (2N6261)	W
At ambient temperatures up to 25°C		5.8 (40250V1)		5.8 (40372)		W
* At temperatures above 25°C		Derate linearly to 200 °C				
* TEMPERATURE RANGE:						
Storage & Operating (Junction)		-65 to 200				°C
PIN TEMPERATURE (During soldering):						
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235				°C

*In accordance with JEDEC registration data format JS-9 RDF-10 (2N3054), JS-6 RDF-2 (2N6260, 2N6261)

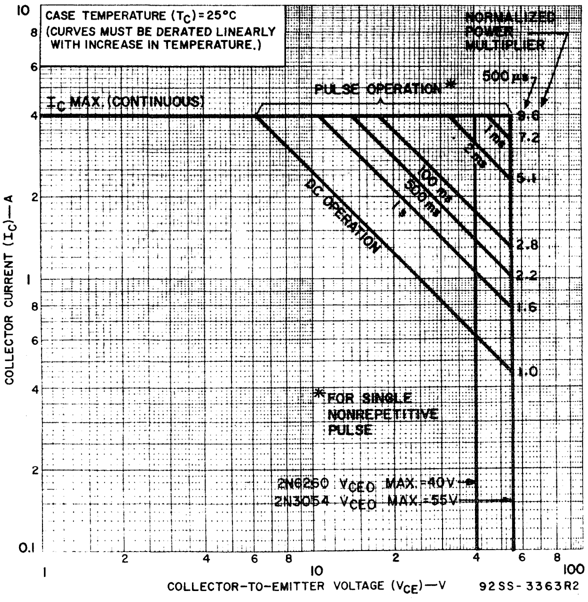
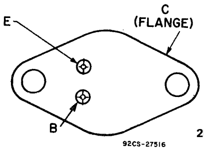


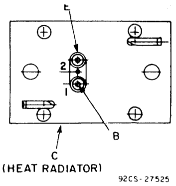
Fig. 1—Maximum operating areas for 2N3054 and 2N6260.

TERMINAL DESIGNATIONS



JEDEC TO-66
2N3054, 2N6260, 2N6261, 40250

(See dimensional outline "N".)



JEDEC TO-66 with Heat Radiator
40250V1, 40372

(See dimensional outline "O".)

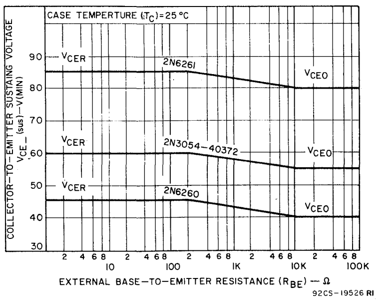


Fig. 2 — Sustaining voltage vs. base-to-emitter resistance for 2N3054, 2N6260, 2N6261, and 40372.

2N3054, 2N6260, 2N6261, 40250, 40372

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		2N6260		2N3054 40372		2N6261		40250 40250V1		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
*Collector-Cutoff Current: With base open	I_{CBO}	V_{CB} = 30		I_E = 0		–	–	–	–	–	–	–	1	mA
	I_{CEO}	30			0	–	1	–	0.5	–	–	–	–	
		60			0	–	–	–	–	–	0.5	–	–	
With base-emitter junction reverse-biased	I_{CEV}	40	−1.5			–	5	–	–	–	–	–	–	
		80	−1.5			–	–	–	–	–	0.5	–	–	
		90	−1.5			–	–	–	1.0	–	–	–	–	
At T_C = 150°C	I_{CBO}	VCB = 30		I_E = 0		–	–	–	–	–	–	–	5	
	I_{CEV}	40	−1.5			–	25	–	–	–	–	–	–	
		80	−1.5			–	–	–	–	–	1.0	–	–	
		90	−1.5			–	–	–	6.0	–	–	–	–	
*Emitter-Cutoff Current	I_{EBO}		−5		0	–	5	–	–	–	–	–	5	mA
			−7		0	–	–	–	1.0	–	0.2	–	–	
Collector-to-Base Breakdown Votlage	$V_{(BR)CBO}$			0.05		–	–	–	–	–	–	50	–	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEV}$		−1.5	0.05		–	–	–	–	–	–	50	–	V
Collector-to-Emitter Sustaining Voltage: With base open	V_{CEO}(sus)			0.1[a]	0	40	–	55	–	80	–	40	–	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}(sus)			0.1[a]		45	–	60	–	85	–	–	–	
Emitter-to-Base Breakdown Voltage I_E = 0.005 A	$V_{(BR)EBO}$					–	–	–	–	–	–	5	–	V
*DC Forward-Current Transfer Ratio	h_{FE}	2		4[a]		3	–	–	–	5	–	–	–	
		2		1.5[a]		–	–	–	–	25	100	–	–	
		4		3[a]		–	–	5	–	–	–	–	–	
		4		0.5[a]		–	–	25	150	–	–	–	–	
		4		1.5[a]		20	100	–	–	–	–	25	100	
*Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			0.5[a]	0.05[a]	–	–	–	1.0	–	–	–	–	
				1.5[a]	0.15[a]	–	1.5	–	–	–	0.5	–	1.5	V
				3[a]	1[a]	–	–	–	6.0	–	–	–	–	
*Base-to-Emitter Voltage	V_{BE}	2		1.5		–	–	–	–	–	1.5	–	–	
		4		1.5		–	2.2	–	–	–	–	–	2.2	V
		4		0.5		–	–	–	1.7	–	–	–	–	
*Common-Emitter Small-Signal Short-Circuit, Forward Current Transfer Ratio Cutoff Frequency	f_{hfe}	4		0.1		0.03	–	0.03	–	0.03	–	–	–	MHz

[a] **Pulsed: Pulse duration = 300 μs duty factor = 1.8%.**

***In accordance with JEDEC registration data format JS-9 RDF-10 (2N3054) JS-6 RDF-2 (2N6260-61)**

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T$_C$) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		2N6260		2N3054 40372		2N6261		40250 40250V1		
		V$_{CE}$	V$_{BE}$	I$_C$	I$_B$	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 0.4 MHz)	$\|h_{fe}\|$	4		0.1		2	–	–	–	2	–	–	–	
* Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		0.1		25		25	–	25	–	–	–	
Forward-Bias Second Breakdown Collector Current (t - 1 s)	$I_{S/b}$	40 80 55				0.725 – –	– – –	– – 0.455	– – –	– 0.625 –	– – –	– – –	– – –	A
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					6 (max.) 2N6260		7 (max.) 2N3054		3.5 (max.) 2N6261		6 (max.) 40250		°C/W
Junction-to-Ambient	$R_{\theta JA}$							30 (max.) 40372				30 (max.) 40250V1		

^{a}Pulsed: Pulse duration = 1.8%.
*In accordance with JEDEC registration data format JS-9 RDF-10 (2N3054) JS-6 RDF-2 (2N6260-61)

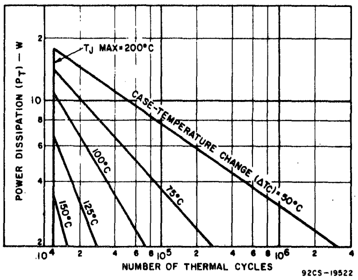


Fig. 3 - Thermal-cycling rating chart for 2N3054.

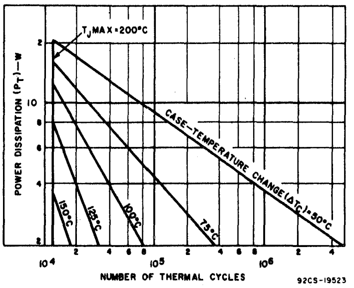


Fig. 4 - Thermal-cycling rating chart for 2N6260.

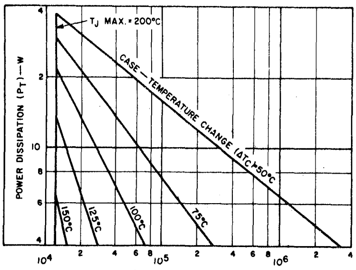


Fig. 5 - Thermal-cycling rating chart for 2N6261.

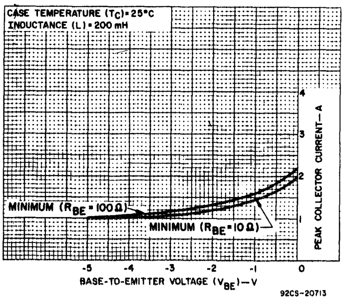


Fig. 6 - Reverse-bias second-breakdown characteristics for all types.

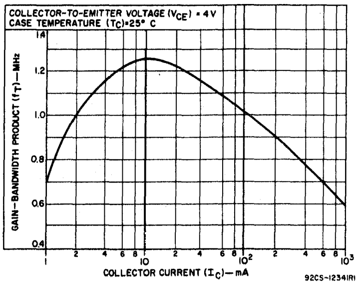


Fig. 7 - Typical gain-bandwidth product for all types.

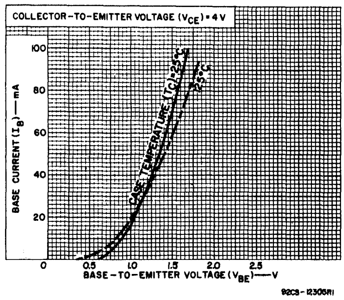


Fig. 8 - Typical input characteristics for 2N3054, 2N6260, 40250, 40250VI, and 40372.

2N3054, 2N6260, 2N6261, 40250, 40372

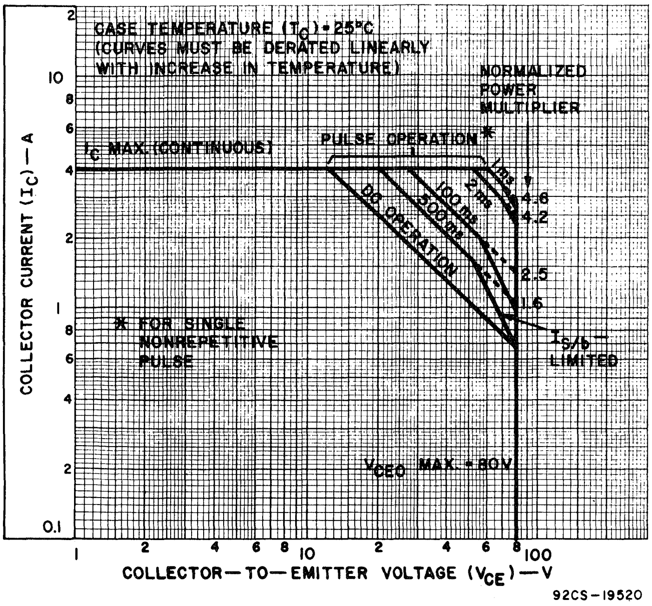


Fig. 9 - Maximum operating areas for 2N6261.

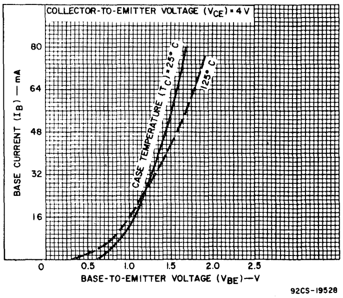


Fig. 10 - Typical input characteristics for 2N6261.

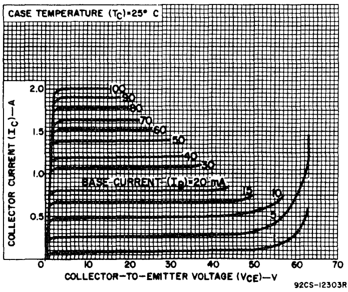


Fig. 11 — Typical output characteristics for 2N3054 and 40372.

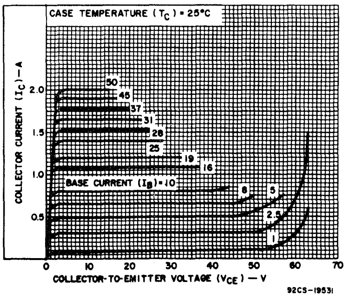


Fig. 12 — Typical output characteristics for 2N6260.

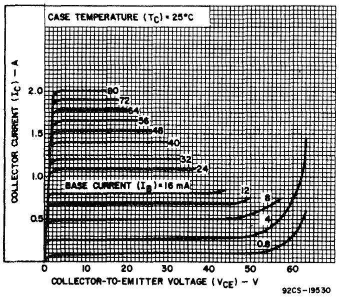


Fig. 13 — Typical output characteristics for 2N6261.

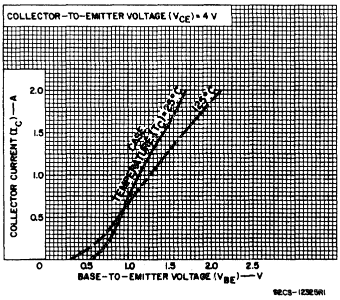


Fig. 14 — Typical transfer characteristics for 2N3054, 2N6260, 40250, 40250V1, and 40372

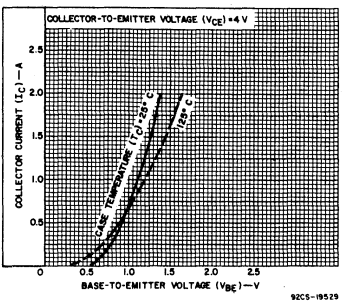


Fig. 15 - Typical transfer characteristics for 2N6261.

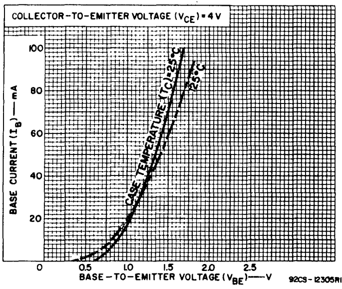


Fig. 16 — Typical input characteristics for 2N6260, 40250, 40250V1, and 40372.

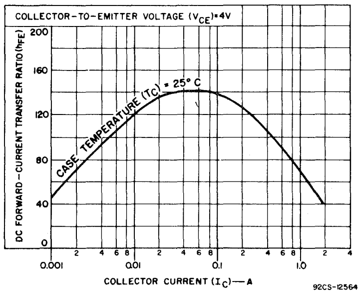


Fig. 17 — Typical dc beta characteristics for 2N6260 40250, and 40250V1.

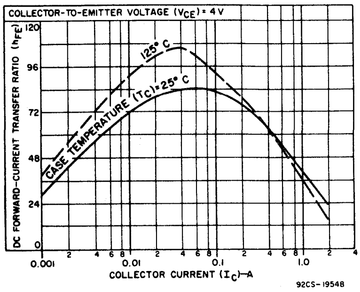


Fig. 18 - Typical dc beta characteristics for 2N6261.

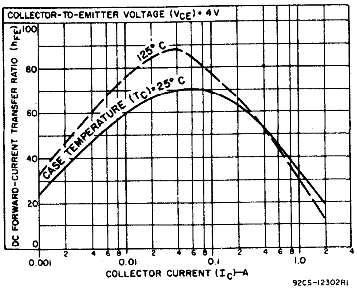


Fig. 19 — Typical dc beta characteristics for 2N3054 and 40372.

2N3055, 2N6569, BDX18, 2N6594, MJ2955

Silicon N-P-N and P-N-P Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-2N6594, BDX18 and MJ2955 are epitaxial-base silicon p-n-p transistors featuring gain at high current. The RCA-2N6569 and 2N3055 are epitaxial-base silicon n-p-n transistors. They may be used as complements to the 2N6594 and BDX18 or MJ2955, respectively. These devices have a dissipation capability of 100 watts (2N6569 and 2N6594), 115 watts (2N3055, BDX18) and 150 watts (MJ2955) at case temperatures up to 25° C.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204MA hermetic package.

The 2N3055 is also available in a hometaxial-base version. To obtain the hometaxial-base type order the 2N3055 (Hometaxial).

Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**
- **Hermetically sealed JEDEC TO-204MA package**
- **High gain at high current**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

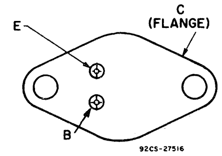
MAXIMUM RATINGS, *Absolute-Maximum Values:*

	N-P-N	2N6569	2N3055	
	P-N-P	2N6594◆	BDX18◆ MJ2955◆	
* V_{CBO}		45	100	V
$V_{CER}(sus)$				
R_{BE} = 100 Ω		45	70*	V
* $V_{CEO}(sus)$		40	60	V
* V_{EBO}		5	7	V
* I_C		12	15	A
I_{CM}		24	–	A
* I_B		5	7	A
* I_E		17	–	A
* P_T				
At $T_C \leqslant 25^oC$		100	150 (MJ2955) 115 (Others)	W
At $T_C > 25^oC$ . . . . Derate linearly		0.572	0.86 (MJ2955) 0.66 (Others)	W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235		°C

* 2N-types in accordance with JEDEC registration data.

◆ For p-n-p devices, voltage and current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

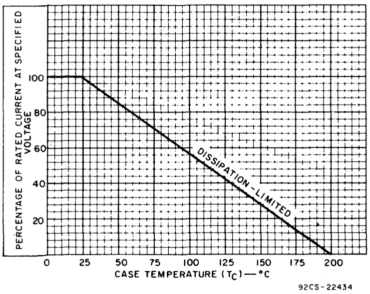


Fig. 1 — Derating curve.

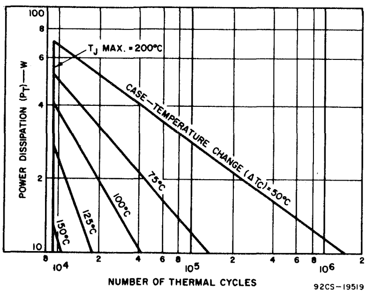


Fig. 2 — Thermal cycling rating chart for 2N6569 and 2N6594.

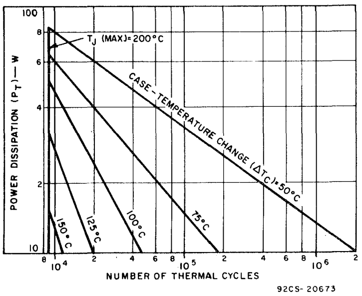


Fig. 3 — Thermal-cycling rating chart for 2N3055 and BDX18.

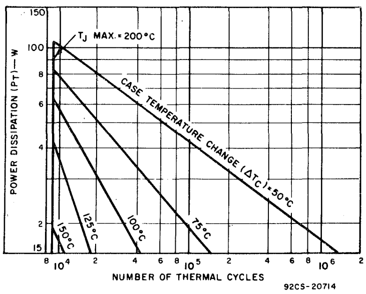


Fig. 4 — Thermal cycling rating chart for MJ2955.

◆For p-n-p devices, voltage and current values are negative.

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6569 2N6594◆		2N3055 BDX18◆ MJ2955◆		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
* I_{CEX}	45	−1.5			–	1	–	–	
2N3055, BDX18	100	−1.5			–	–	–	5	
MJ2955	100	−1.5			–	–	–	1	mA
* I_{CEX}, T_C = 100°C	45	−1.5			–	10	–	–	mA
* I_{CEX}, MJ2955	100	−1.5			–	–	–	5	
T_C = 150°C 2N3055	100	−1.5			–	–	–	30	mA
BDX18	60	−1.5			–	–	–	10	
I_{CEO}	30			0	–	0.7	–	0.7*	mA
* I_{EBO}		5	0		–	5	–	–	
2N3055, BDX18		7	0		–	–	–	5	mA
MJ2955		7	0		–	–	–	5	
* $V_{CEO}(sus)$			0.2	0	40^b	-	60^b		V
$V_{CER}(sus)$ R_{BE} = 100Ω			0.2	0	45^b	-	70^{b}*	–	V
* h_{FE}	3		4^a		15	200	–	–	
	4		4^a		-	–	20	70	
Except BDX18	4		10^a		-	-	5	-	
	4		12^a		5	100			
V_{BE}	4		4^a			1.8*		1.8*	V
* $V_{BE}(sat)$			4	0.55	-	2	-	-	V
					-	2	-	-	
* $V_{CE}(sat)$			4^a	0.4	-	1.5	-	1.1	
			4^a	0.55	-	1.5	-	-	V
2N3055 only			10^a	3.3			-	8	
MJ2955 only			10^a	3.3		-	-	3	
			12^a	2.4	-	4	–	-	
* f_T 2N6569	4		1		1.5	-		–	MHz
f = 0.5 MHz 2N6594	4		1		2.5	–	–	–	
* f_{hfe} 2N3055	4		1			-	20	–	kHz
f = 10 kHz MJ2955	4		1		-	–	10	–	
$\|h_{fe}\|$ f = 1 MHz	4		1		–	–	2.5	–	
MJ2955 (only)	4		0.5		-	–	4	–	
h_{fe} f = 1 kHz	4		1		15	–	15*	120*	
$I_{S/b}$ t_p = 1 s nonrep.	40				2.5	–	2.87	–	A
* C_{obo} V_{CB} = 10 V, f = 1 MHz					75	750	–	–	pF
* t_d V_{CC} = 30 V			2	0.2	–	0.4	–	–	µs
* t_r I_{B1} = I_{B2}			2	0.2	–	1.5	–	–	
* t_s			2	0.2	–	5	–	–	
* t_f			2	0.2	–	1.5	–	–	
$R_{\theta JC}$ 2N3055, BDX18					–	1.75*	–	1.5	°C/W
MJ2955					–		–	1.17	

◆ For p-n-p devices, voltage and current values are negative.

* 2N types in accordance with JEDEC registration data.

[a] Pulsed; pulse duration = 300 µs, duty factor = 1.8%.

[b] **CAUTION:** Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ *MUST NOT* be measured on a curve tracer.

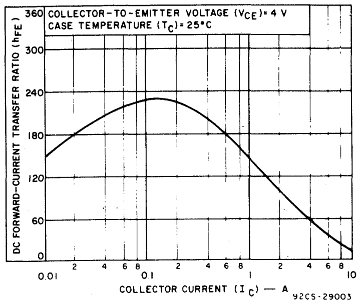


Fig. 5 — Typical dc beta characteristics.◆

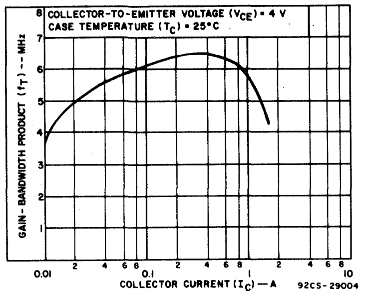


Fig. 6 — Typical gain-bandwidth product.◆

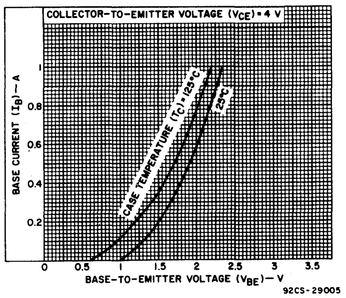


Fig. 7 — Typical input characteristics.◆

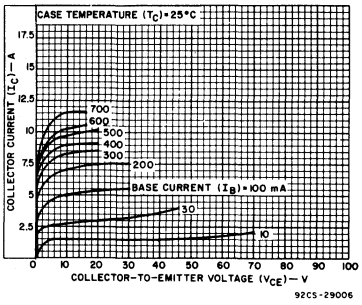


Fig. 8 — Typical output characteristics.◆

◆For p-n-p devices, voltage and current values are negative.

2N3055, 2N6569, BDX18, 2N6594, MJ2955

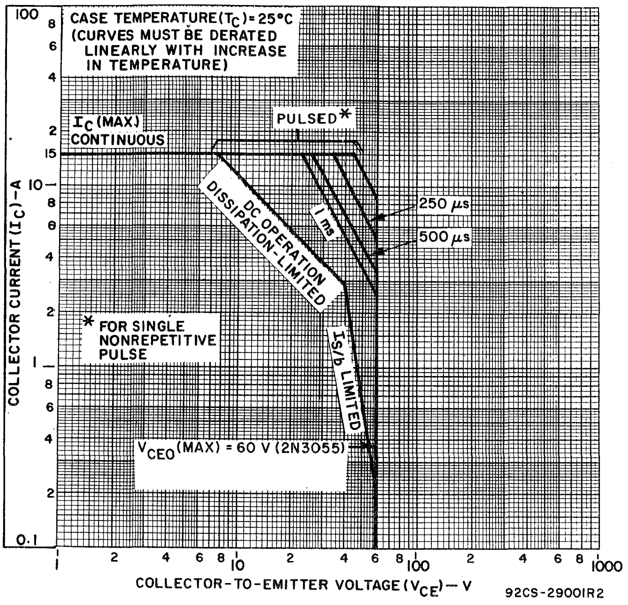


Fig. 9 — Maximum operating areas for 2N3055.

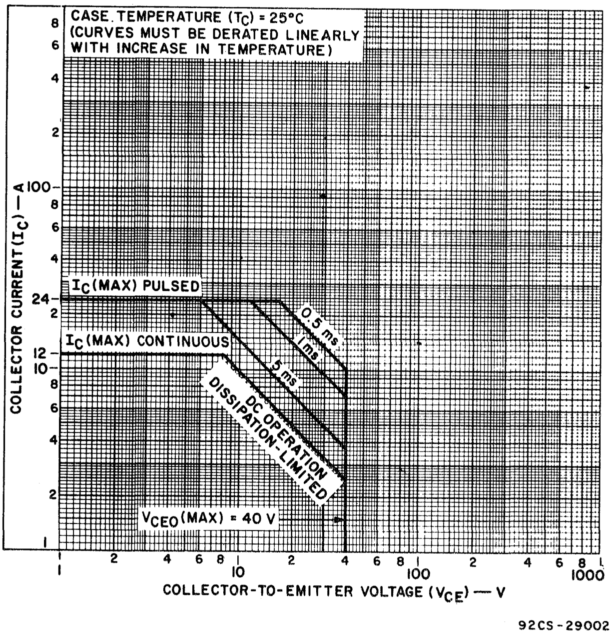


Fig. 10 — Maximum operating areas for 2N6569 and 2N6594.◆

◆ For p-n-p devices, voltage and current values are negative.

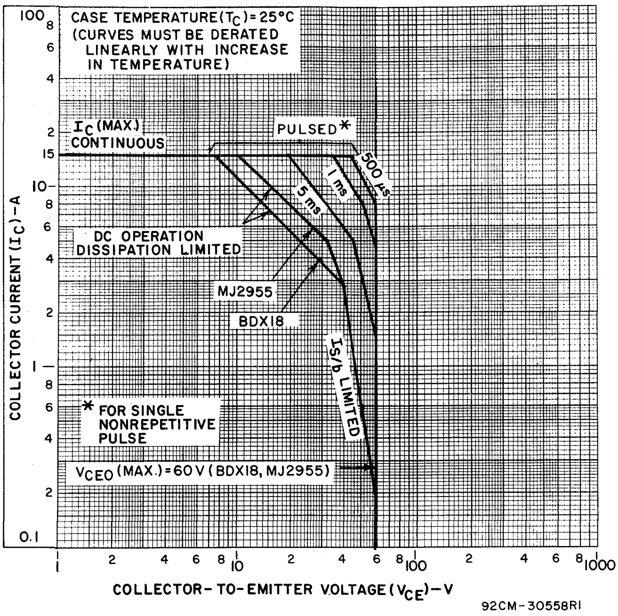


Fig. 11 — Maximum operating areas for BDX18 and MJ2955.

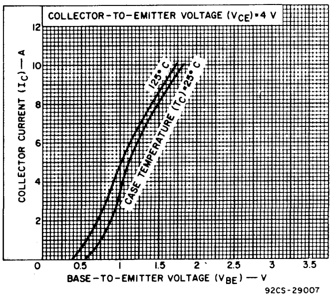


Fig. 12 — Typical transfer characteristics.◆

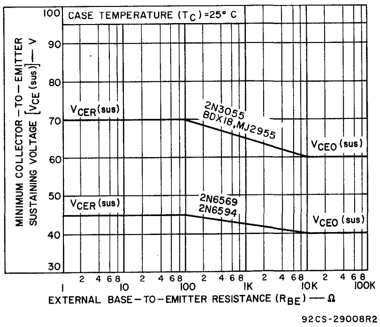


Fig. 13 — Sustaining voltage vs. base-to-emitter resistance.◆

◆For p-n-p devices, voltage and current values are negative.

2N3055 (Hometaxial), 2N6253, 2N6254, 2N6371, 40251

Hometaxial-Base High-Power Silicon N-P-N Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-2N3055 (Hometaxial)*, 2N6253, 2N6254 and 2N6371 are silicon n-p-n transistors intended for a wide variety of high-power applications. The hometaxial-base construction of these devices renders them highly resistant to second breakdown over a wide range of operating conditions.

These devices differ in maximum ratings for voltage and power dissipation. All are supplied in JEDEC TO-204MA hermetic steel packages.

The 2N3055 is also available in an epitaxial-base version. To obtain the hometaxial-base type described in this data sheet, order the 2N3055 (Hometaxial).

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*Formerly 2N3055H.

Features:

- 2N6254: premium type from 2N3055 (Hometaxial) family
- Maximum safe-area-of-operation curves
- Low saturation voltages
- High dissipation capability
- Thermal-cycling rating curves

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers
- Low-frequency inverters

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N3055 (Hometaxial)	2N6253	2N6254	2N6371	40251	
* V_{CBO}	100	55	100	50	50	V
* $V_{CER}(sus)$						
$R_{BE} = 100\ \Omega$	70	55	85	45	—	V
* $V_{CEO}(sus)$	60	45	80	40	40	V
$V_{CEV}(sus)$						
$V_{BE} = -1.5$ V	90	55	90	50	50	V
* V_{EBO}	7	5	7	5	5	V
* I_C	15	15	15	15	15	A
* I_B	7	7	7	7	7	A
* P_T:						
$\leqslant 25^\circ$C	115	115	150	117	117	W
$>25^\circ$C	Derate linearly to 200°C					
* T_J, T_{stg}	−65 to +200					°C
* T_L: During soldering, at distances 1/32 in. (0.8 mm) from seating plane for 10 s max.	235					°C

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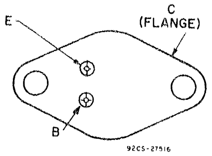
*In accordance with JEDEC registration data formats JS-9 RDF-10; 2N3055 (Hometaxial) JS-6 RDF-2; 2N6253, 2N6254, 2N6371.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

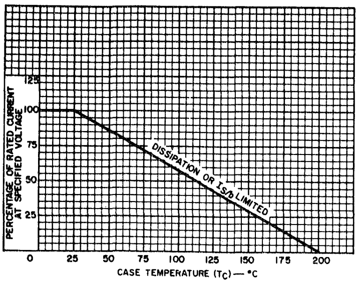


Fig. 1 — Current derating curve for all types.

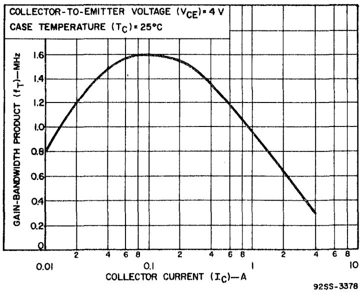


Fig. 2 — Typical gain-bandwidth product for all types.

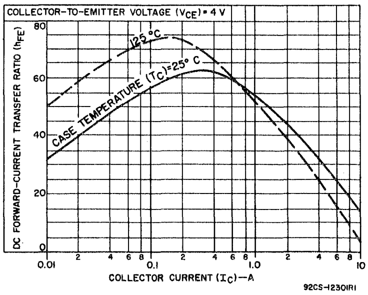


Fig. 3 — Typical dc-beta characteristics for 2N3055 (Hometaxial) and 2N6371.

2N3055 (Hometaxial), 2N6253, 2N6254, 2N6371, 40251

ELECTRICAL CHARACTERISTICS, *T_C = 25°C Unless Otherwise Specified.*

CHARACTERISTIC	TEST CONDITIONS				LIMITS										UNITS
	VOLTAGE V dc		CURRENT A dc		2N3055 (Hometaxial)		2N6253		2N6254		2N6371		40251		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	25			0	–	–	–	1.5	–	–	–	1.5	–	–	mA
	30			0	–	0.7	–	–	–	–	–	–	–	–	
	60			0	–	–	–	–	–	1	–	–	–	–	
* I_{CEX}	40	−1.5			–	–	–	–	–	–	–	–	–	2	mA
	45	−1.5			–	–	–	–	–	–	–	2	–	–	
	55	−1.5			–	–	–	2	–	–	–	–	–	–	
	100	−1.5			–	5	–	–	–	0.5	–	–	–	–	
* T_C = 150°C	40	−1.5			–	–	–	–	–	–	–	10	–	10	
	50	−1.5			–	–	–	10	–	–	–	–	–	–	
	100	−1.5			–	30	–	–	–	5	–	–	–	–	
* I_{EBO}		−5			–	–	–	10	–	–	–	10	–	10	mA
		−7			–	5	–	–	–	0.5	–	–	–	–	
$V_{(BR)CBO}$			0.1		–	–	–	–	–	–	–	–	50	–	V
$V_{(BR)CEV}$		−1.5	0.1		–	–	–		–	–	–	–	50	–	V
$V_{(BR)EBO}$ I_E = 0.01 A			0		–	–	–	–	–	–	–	–	5	–	V
* $V_{CEO(sus)}$			0.2^a	0	60	–	45	–	80	–	40	–	40	–	V
* $V_{CER(sus)}$ R_{BE} = 100 Ω			0.2^a		70	–	55		85	–	45	–	–	–	
$V_{CEV(sus)}$		−1.5	0.1^a		90	–	55	–	90	–	50	–	–	–	
* h_{FE}	4		3^a		–	–	20	70	–	–	–	–	–	–	
	4		4^a		20	70	–	–	–	–	–	–	–	–	
	2		5^a		–	–	–	–	20	70	–	–	–	–	
	4		8^a		–	–	–	–	–	–	15	60	15	60	
	4		10^a		5	–	–	–	–	–	–	–	–	–	
	4		15^a		–	–	3	–	5	–	–	–	–	–	
	4		16^a		–	–	–	–	–	–	4	–	–	–	
* V_{BE}	4		3^a		–	–	–	1.7	–	–	–	–	–	–	V
	4		4^a		–	1.8	–	–	–	–	–	–	–	–	
	2		5^a		–	–	–	–	–	1.5	–	–	–	–	
	4		8^a		–	–	–	–	–	–	–	–	–	2.2	
	4		16^a		–	–	–	–	–	–	–	4	–	–	
* $V_{CE(sat)}$			3^a	0.3^a	–	–	–	1	–	–	–	–	–	–	V
			4^a	0.4^a	–	1.1	–	–	–	–	–	–	–	–	
			5^a	0.5^a	–	–	–	–	–	0.5	–	–	–	–	
			8^a	0.8^a	–	–	–	–	–	–	–	1.5	–	1.5	
			10^a	3.3^a	–	8	–	–	–	–	–	–	–	–	
			15^a	3^a	–	–	–	–	–	4	–	–	–	–	
			15^a	5^a	–	–	–	4	–	–	–	–	–	–	
			16^a	4^a	–	–	–	–	–	–	–	4	–	–	

* In accordance with JEDEC registration data formats JS-9 RDF-10: 2N3055H; JS-6 RDF-2: 2N6253, 2N6254, 2N6371.

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

2N3055 (Hometaxial), 2N6253, 2N6254, 2N6371, 40251

ELECTRICAL CHARACTERISTICS, T_C = *25°C Unless Otherwise Specified.*

CHARACTERISTIC	TEST CONDITIONS				LIMITS										UNITS
	VOLTAGE V dc		CURRENT A dc		2N3055 (Hometaxial)		2N6253		2N6254		2N6371		40251		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* h_{fe} f = 1 kHz	4		1		15	120	10	–	10	–	10	–	–	–	
f_T	4		1		800	–	–	–	–	–	800	–	–	–	kHz
* $\|h_{fe}\|$ f = 0.4 MHz	4		1		–	–	2	–	2	–	2	–	–	–	
* f_{hfe}	4		1		10	–	10	–	10	–	–	–	–	–	kHz
$I_{S/b}$ t_p = 1 s nonrep.	39				–	–	–	–	–	–	–	–	3	–	A
	40				2.9	–	–	–	–	–	2.9	–	–	–	
	45				–	–	2.55	–	–	–	–	–	–	–	
	60				1.95	–	–	–	–	–	–	–	–	–	
	80				–	–	–	–	1.87	–	–	–	–	–	
$R\theta_{JC}$					–	1.5	–	1.5	–	1.17	–	1.5	–	1.5	°C/W

*In accordance with JEDEC registration data formats JS-9 RDF-10: 2N3055H; JS-6 RDF-2: 2N6253, 2N6254, 2N6371.

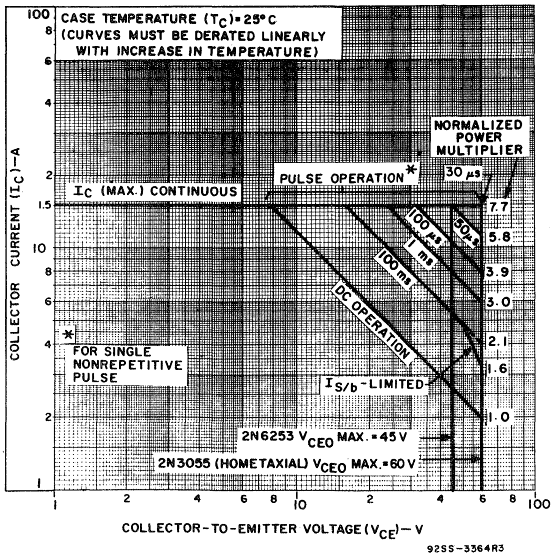


Fig. 4 — Maximum operating areas for 2N6253 and 2N3055 (Hometaxial).

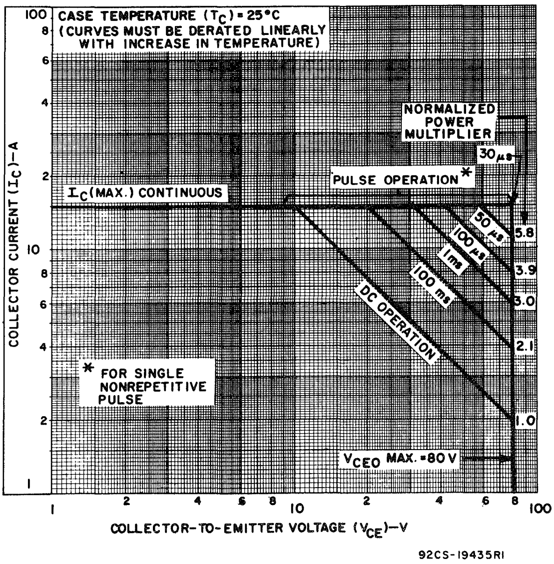


Fig. 5 — Maximum operating areas for 2N6254.

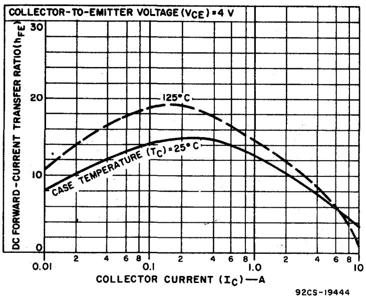


Fig. 6 – Typical dc-beta characteristics for 2N6253.

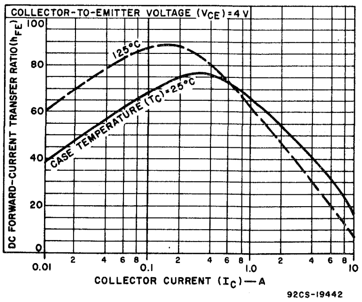


Fig. 7 – Typical dc-beta characteristics for 2N6254.

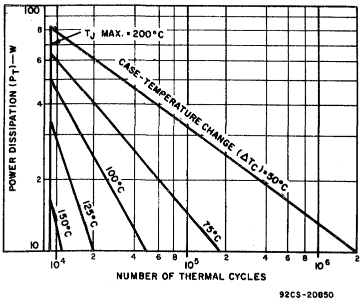


Fig. 8 – Thermal-cycling rating chart for 2N3055 (Hometaxial), 2N6253 and 2N6371.

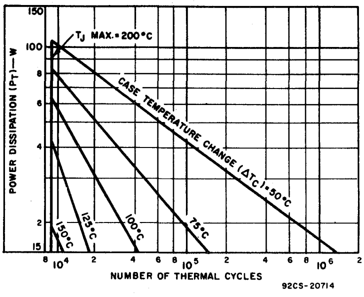


Fig. 9 – Thermal-cycling rating chart for 2N6254.

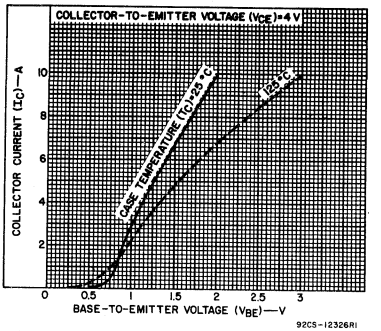


Fig. 10 – Typical transfer characteristics for 2N6253, 2N3055 (Hometaxial), 2N6371 and 40251.

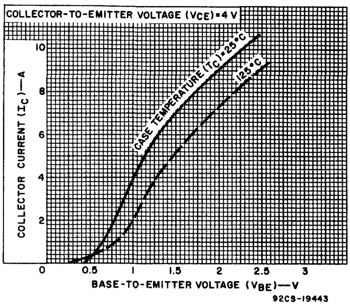


Fig. 11 – Typical transfer characteristics for 2N6254.

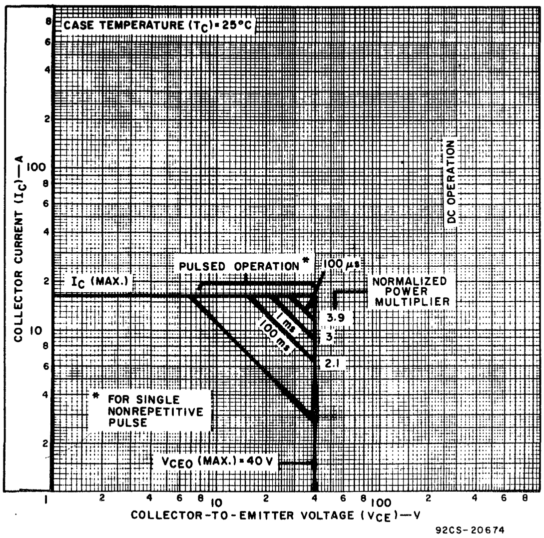


Fig. 12 – Maximum safe-area-of-operation at case temperature of 25⁰ C for 2N6371.

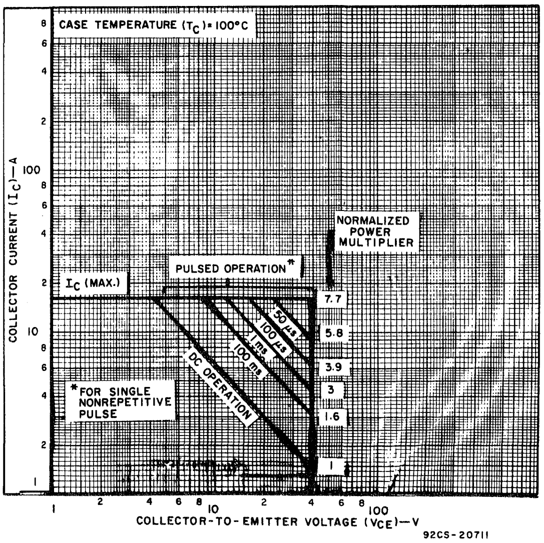


Fig. 13 – Maximum safe-area-of-operation at case temperature of 100⁰ C for 2N6371.

2N3055 (Hometaxial), 2N6253, 2N6254, 2N6371, 40251

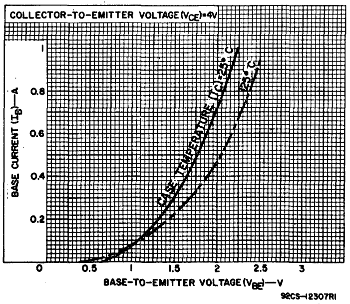


Fig. 14 – Typical input characteristics for 2N3055 (Hometaxial), 2N6371 and 40251.

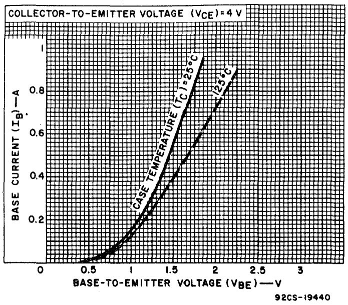


Fig. 15 – Typical input characteristics for 2N6253.

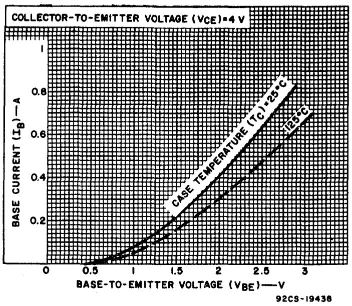


Fig. 16 – Typical input characteristics for 2N6254.

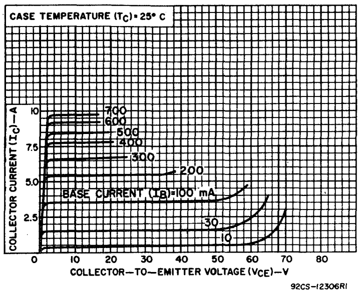


Fig. 17 – Typical output characteristics for 2N3055 (Hometaxial) and 2N6371.

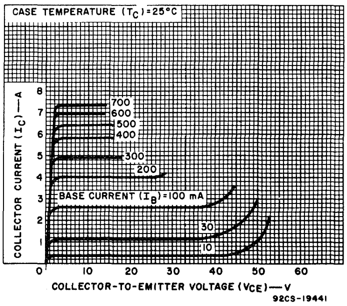


Fig. 18 – Typical output characteristics for 2N6253.

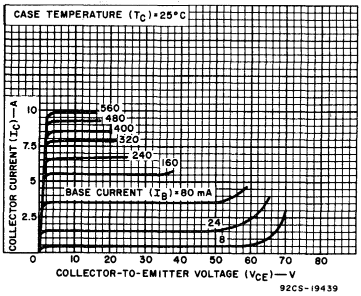


Fig. 19 – Typical output characteristics for 2N6254.

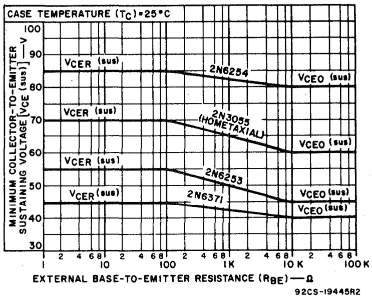


Fig. 20 – Sustaining voltage vs. base-to-emitter resistance for all types.

2N3439, 2N3440, 2N4063, 2N4064, 40385, 40346, V1, V2, 40390, 40412, V1

High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

These RCA types are epitaxial-base silicon n-p-n transistors with high breakdown voltages, high-frequency response, and fast switching speeds. These transistors are intended for industrial, commercial, and military equipment. Typical applications include high-voltage differential and operational amplifiers, high-voltage inverters, and high-voltage, low-current switching and series regulators.

Types 40346, 40346V1, and 40346V2 are especially useful in such devices as neon indicator and NIXIE● driver circuits and in differential and operational amplifiers. Types 40412, and 40412V1, are especially suited for class-A ac/dc audio-amplifier service.

These transistors are supplied in JEDEC TO-39 hermetic packages or in the TO-39 package with factory-attached mounting flange or heat radiator.

●Nixie is a Registered Trademark of Burroughs Corporation, Electronic Components Division, Plainfield, N.J.

Features:

- **High voltage ratings:**
  V_{CBO} = 450 V max. (2N3439, 2N4063)
  = 300 V max. (2N3440, 2N4064)
  V_{CEO}(sus) = 350 V max. (2N3439, 2N4063)
  = 250 V max. (2N3440, 2N4064)
- **Maximum-area-of-operation curves**
- **Low saturation voltages**
- **Planar construction for low noise and low leakage**

Additional Features for 40385:

- **High reliability assured by five preconditioning steps**
- **Group A test data in data File 215**

MAXIMUM RATINGS, *Absolute-Maximum Values:*		**2N3439 2N4063 40385**	**2N3440 2N4064 40390**	**40346 40346V1 40346V2**	**40412 40412V1**	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	450	300	–	–	V
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance						
(R_{BE}) = 1,000 Ω	V_{CER}(sus)	–	–	175	–	V
= 10,000 Ω	V_{CER}(sus)	–	–	–	250	V
* With base open	V_{CEO}(sus)	350	250	–	–	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	–	–	V
*CONTINUOUS COLLECTOR CURRENT	I_C	1	1	1	1	A
*CONTINUOUS BASE CURRENT	I_B	0.5	0.5	0.5	0.5	A
TRANSISTOR DISSIPATION:	P_T					
At case temperature up to 25°C		10	10(2N3440) 10(2N4064)	10(40346) 10(40346V2)	10(40412)	W
At free-air temperatures up to 25°C		1(40385)	3.5(40390)	4(40346V1)	4(40412V1)	W
At free-air temperatures up to 50°C		1(2N3439)	1(2N3440)	1(40346)	1(40412)	W
At free-air temperatures above 25°C or 50°C		Derate linearly to 200°C				°C
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		–65 to 200				°C
*LEAD TEMPERATURE (During soldering):						
At distances ⩾ 1/32 in (0.79 mm) from seating plane for 10 s max.		255				°C

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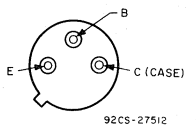
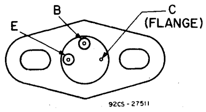
*2N-Series types in accordance with JEDEC registration data

NOTE: P_T value of 10 W at T_C = 25°C and lead temperature of 255°C are registered data for 2N4063 and 2N4064 only.

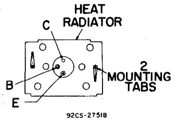
TERMINAL DESIGNATIONS



JEDEC TO-39
2N3439,2N3440,40346
40385,40412
(See dimensional outline "C".)



JEDEC TO-39 with Flange
2N4063,2N4064,40346V2
(See dimensional outline "E".)



JEDEC TO-39 with Heat Radiator
40390,40346V1,40412V1
(See dimensional outline "D".)

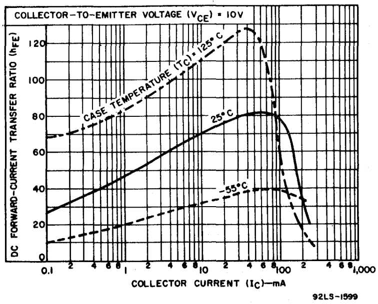


Fig. 1 — Typical dc-beta characteristics for 2N3439, 2N3440, 2N4063, 2N4064 and 40390.

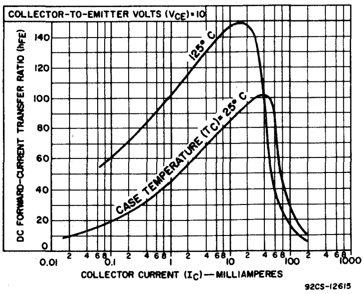


Fig. 2 — Typical dc-beta characteristics for 40346, 40346V1, 40346V2, 40412, and 40412V1.

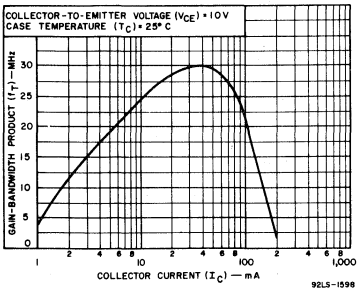


Fig.3—Typical gain-bandwidth product for all types.

2N3439, 2N3440, 2N4063, 2N4064, 40385, 40346, V1, V2, 40390, 40412, V1

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

CHARACTERISTICS	SYMBOL	VOLTAGE V dc		CURRENT mA dc	LIMITS								UNITS
					2N3439 2N4063 40385		2N3440 2N4064 40390		40346 40346V1 40346V2		40412 40412V1		
		V_{CE}	V_{BE}	I_C	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector-Cutoff Current: With base open	I_{CEO}	100	–		–	–	–	–	–	5	–	–	μA
		200			–	–	–	50	–	–	–	–	
		300			–	20	–	–	–	–	–	–	
With base reverse-biased:	I_{CEV}	200	− 1.5		–	–	–	–	–	10	–	–	
		300	− 1.5		–	–	–	500	–	–	–	–	
		450	− 1.5		–	500	–	–	–	–	–	–	
At T_C = 150°C		150	− 1.5		–	–	–	–	–	–	–	2	mA
		200	− 1.5		–	–	–	–	–	1	–	–	
With R = 10,000 ohms	I_{CER}	100			–	–	–	–	–	—	–	1	mA
* Collector-Cutoff Current	I_{CBO}	250	–		–	–	–	20^c	–	–	–	–	μA
		360	–		–	20^c	–	–	–	–	–	–	
* Emitter-Cutoff Current	I_{EBO}		− 3		–	–	–	–	–	–	–	100	μA
			− 4		–	–	–	–	–	5	–	–	
			− 6		–	20	–	20	–	–	–	–	
DC Forward-Current Transfer Ratio	h_{FE}	10		2	30	–	–	–	–	–	–	–	
		10		10	–	–	–	–	25	–	–	–	
		10		20	40	160	40	160	–	–	–	–	
		20		30	–	–	–	–	–	–	40	–	
Collector-to-Emitter Sustaining Voltage: With base open	V_{CEO}(sus)			50	350^a	–	250^a	–	–	–	–	–	V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance R_{BE}= 1,000 ohms	V_{CER}(sus)			50	–	–	–	–	175^a	–	–	–	
R_{BE}= 10,000 ohms	V_{CER}(sus)			50	–	–	–	–	–	–	250^a	–	
Base-to-Emitter Voltage	V_{BE}	10		10	–	–	–	–	–	1	–	–	V
* Base-to-Emitter Saturation Voltage I_B = 4 mA	V_{BE}(sat)			50	–	1.3	–	1.3	–	–	–	–	V
Collector-to-Emitter Saturation Voltage I_B = 1 mA	V_{CE}(sat)			10	–	–	–	–	–	0.5	–	0.5	V
* I_B = 4 mA				50	–	0.5	–	0.5	–	–	–	–	
* Small-Signal Forward-Current Transfer Ratio: f= 5 MHz	h_{fe}	10		10	3	–	3	–	2	–	2	–	
* Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{ob}				–	10	–	10	–	10	–	10	pF
Second-Breakdown Current t_p = 0.4 s	$I_{S/b}$	200			–	50^b	–	50^b	–	–	50	– –	mA
Thermal Resistance: Junction-to-case	$R_{\theta JC}$				–	17.5	–	17.5	15 max. (40346) (40346V2)		15 max. (40412)		°C/W
Junction-to-free air	$R_{\theta JFA}$				–	–	–	–	45 max. (40346V1)		45 max. (40412V1)		

[a] CAUTION: The sustaining voltages, V_{CEO}(sus) and V_{CER}(sus), MUST NOT be measured on a curve tracer. [b] 2N-Series types.

[c] 2N3439 and 2N3440 only. *2N-Series types in accordance with JEDEC registration data.

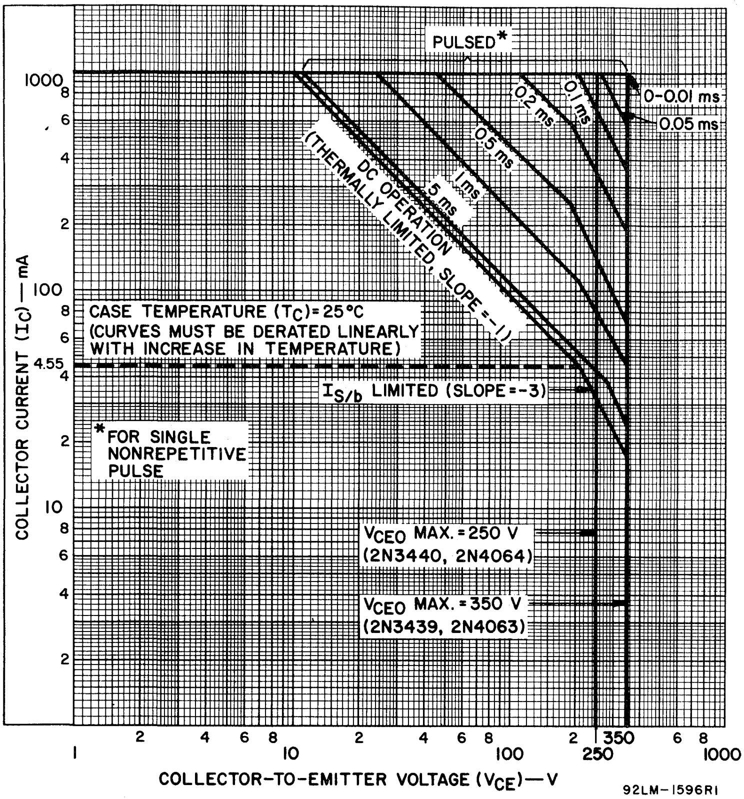


Fig.4—Maximum operating areas for 2N3439,2N3440,2N4063 and 2N4064.

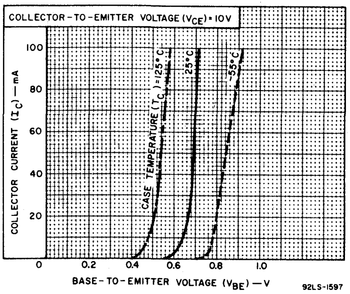


Fig. 5 — Typical transfer characteristics for 2N3439, 2N3440, 2N4063, 2N4064 and 40390.

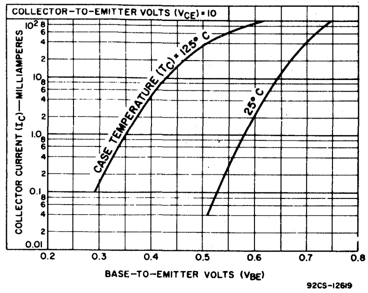


Fig. 6 — Typical transfer characteristics for 40346, 40346V1, 40346V2, 40412 and 40412V1

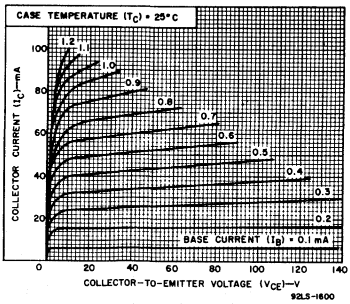


Fig. 7 — Typical output characteristics for 2N3439, 2N3440, 2N4063, 2N4064 and 40390

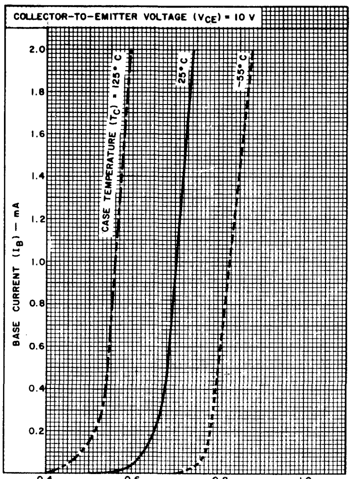


Fig. 8 — Typical input characteristics for 2N3439, 2N3440, 2N4063, 2N4064 and 40390.

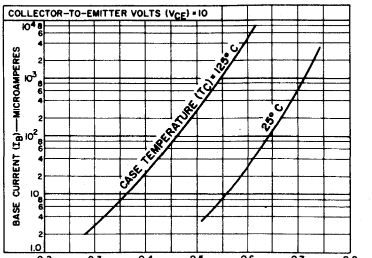


Fig. 9 — Typical input characteristics for 40346, 40346V1, 40346V2, 40412, and 40412V1.

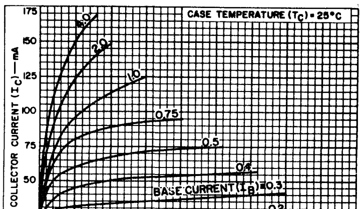


Fig. 10 — Typical output characteristics for 40346, 40346V1, 40346V2, 40412, and 40412V1.

2N3441, 2N6263, 2N6264, 40373, 40913

Hometaxial-Base, Medium-Power Silicon N-P-N Transistors

Rugged Devices for Intermediate, Power Applications
in Industrial and Commercial Equipment

RCA 2N3441, 2N6263, and 2N6264 are hometaxial-base silicon n-p-n transistors intended for a wide variety of medium to-high power, high-voltage applications. These types are supplied in the JEDEC TO-66 hermetic package.

Types 40373 and 40913 are the 2N3441 and 2N6264 with factory-attached heat-radiators intended for printed-circuit-board applications.

Features:

- **2N6264: premium type from 2N3441 family**
- **Maximum safe-area-of-operation curves for dc and pulse operation**
- **High voltage ratings**
- **Low saturation voltages**
- **Thermal-cycling rating curves**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power switching circuits**
- **Solenoid drivers**

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

		2N6263	2N3441 40373	2N6264 40913	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	170	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
* With base open	$V_{CEO}(sus)$	120	140	150	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$	130	150	160	V
With base reverse-biased (V_{BE} = -1.5 V)	$V_{CEV}(sus)$	140	160	170	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	3	3	3	A
PEAK COLLECTOR CURRENT		4	4	4	A
*CONTINUOUS BASE CURRENT	I_B	2	2	2	A
TRANSISTOR DISSIPATION:	P_T				
* At case temperature up to 25°C		20 (2N6263)	25 (2N3441)	50 (2N6264)	W
At ambient temperatures up to 25°C			5.8 (40373)	5.8 (40913)	W
* At temperatures above 25°C		Derate linearly to 200°C			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		-65 to 200			°C
*PIN TEMPERATURE (During Soldering):					
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235			°C

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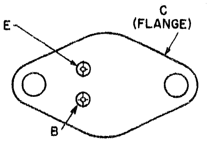
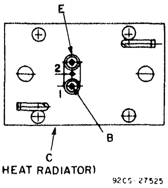
*In accordance with JEDEC registration data format JS-6 RDF-2

TERMINAL DESIGNATIONS



JEDEC TO-66
2N3441,2N6263,2N6264

(See dimensional outline "N".)



JEDEC TO-66 with Heat Radiator
40373, 40913

(See dimensional outline "O".)

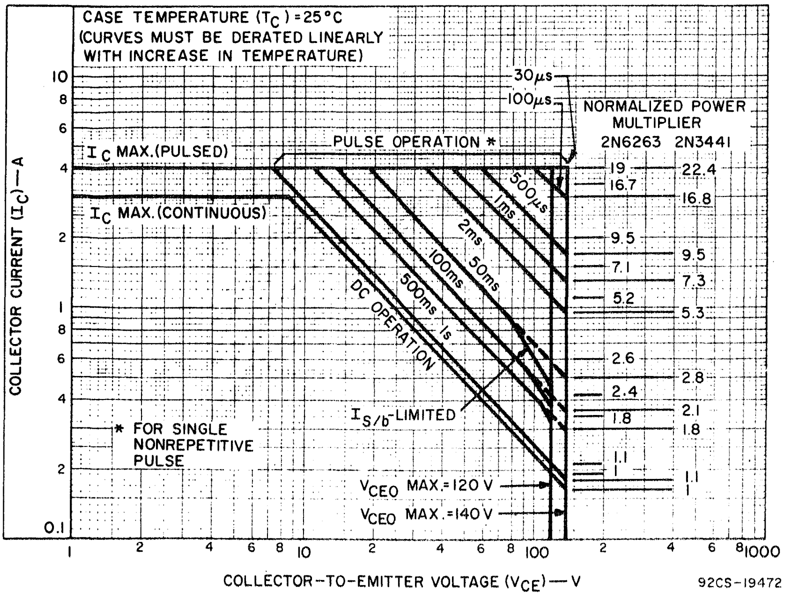


Fig. 1—Maximum operating areas for 2N3441 and 2N6263.

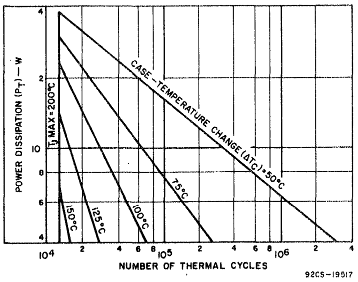


Fig. 2—Thermal-cycle rating chart for 2N6264.

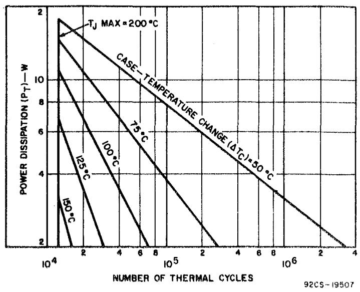


Fig. 3—Thermal-cycle rating chart for 2N3441.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS						UNITS
		VOLTAGE V dc			CURRENT A dc		2N6263		2N3441 40373		2N6264 40913		
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: * With base open	I_{CEO}	100				0	–	5	–	–	–	–	mA
		130				0	–	–	–	–	–	1	
		140				0	–	–	–	100	–	–	
Collector-Cutoff Current: With base-emitter junction reversed biased	I_{CEX}	120		−1.5			–	2*	–	–	–	–	mA
		140		−1.5			–	–	–	5*	–	–	
		140		−1.5			–	–	–	1	–	–	
		150		−1.5			–	–	–	–	–	0.05*	
	I_{CEX} (T_C = 150°C)	120		−1.5			–	10*	–	–	–	–	
		140		−1.5			–	–	–	6*	–	–	
		140		−1.5			–	–	–	5	–	–	
		150		−1.5			–	–	–	–	–	1*	
* Emitter-Cutoff Current	I_{EBO}		5				–	2	–	–	–	–	mA
			7				–	–	–	1	–	0.2	
Collector-to-Emitter Sustaining Voltage:[a] * With base open	V_{CEO}(sus)				0.1	0	120	–	140	–	150	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)				0.1		130	–	150	–	160	–	
With base-emitter junction reversed biased	V_{CEV}(sus)			−1.5	0.1		140	–	160	–	170	–	
* DC Forward-Current Transfer Ratio	h_{FE}	2			1		–	–	–	–	20	60	
		2			3		3	–	–	–	5	–	
		4			0.5		20	100	25	100	–	–	
		4			2.7		–	–	5	–	–	–	
Collector-to-Emitter Saturating Voltage	V_{CE}(sat)				0.5	0.05	–	1.2*	–	1	–	–	V
					1	0.1	–	–	–	–	–	0.5*	
					2.7	0.9	–	–	–	6*	–	–	
Base-to-Emitter Voltage	V_{BE}	2			1		–	–	–	–	–	1.5*	V
		4			0.5		–	2*	–	1.7	–	–	
		4			2.7		–	–	–	6*	–	–	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 40 kHz)	$\|h_{fe}\|$	4			0.5		5	–	5	–	5	–	
Gain-Bandwidth Product	f_T	4			0.2		200	–	200	–	200	–	kHz
* Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4			0.1		25	–	–	–	25	–	
		4			0.5		–	–	15	75	–	–	
Forward-Bias Second Breakdown Collector Current, Pulse Duration (non-repetitive) = 1 s	$I_{S/b}$	120					0.167	–	–	–	–	–	A
		120					–	–	–	–	0.417	–	
		120					–	–	0.21	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						8.75 (max.) 2N6263		7 (max.) 2N3441		3.5 (max.) 2N6264		°C/W
Junction-to-Free Air	$R_{\theta JA}$								30 (max.) 40373		30 (max.) 40913		

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*In accordance with JEDEC registration data format (JS-6 RDF-2).

[a] **CAUTION:** The sustaining voltage V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 23.

2N3441, 2N6263, 2N6264, 40373, 40913

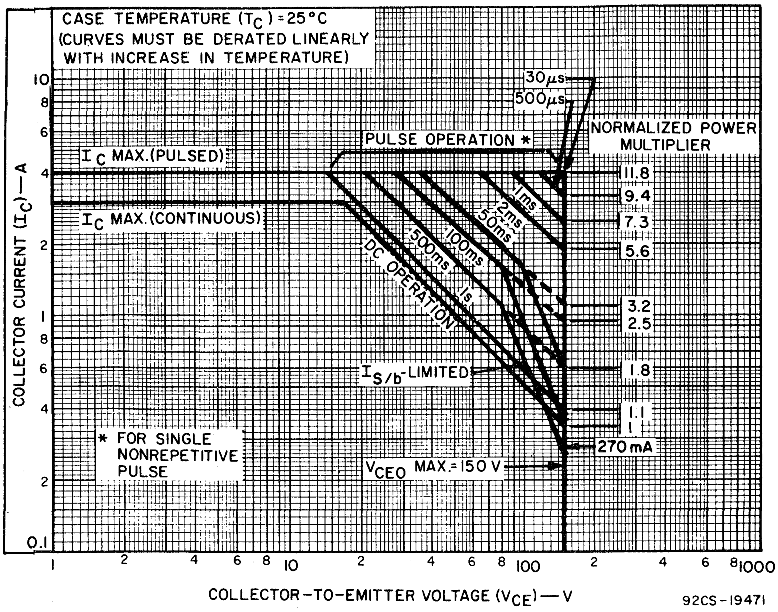

Fig. 4 — Maximum operating areas for 2N6264.

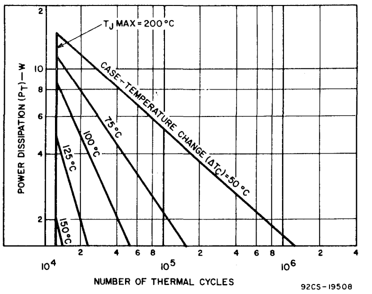

Fig. 5—Thermal-cycle rating chart for 2N6263.

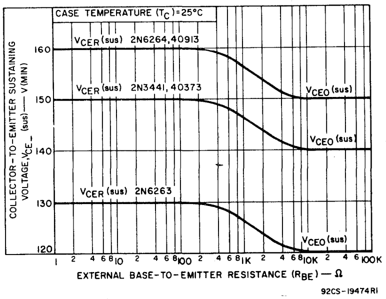

Fig. 6—Sustaining voltage vs. base-to-emitter resistance for all types.

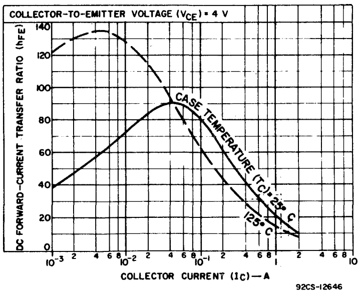

Fig. 7—Typical dc-beta characteristics for 2N3441 and 40373.

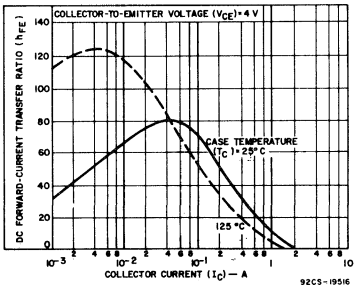

Fig. 8—Typical dc-beta characteristics for 2N6263.

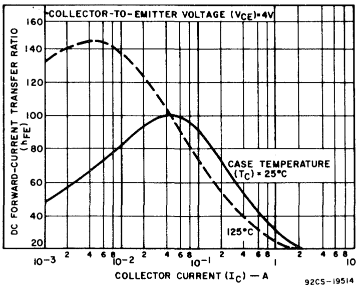

Fig. 9—Typical dc-beta characteristics for 2N6264 and 40913.

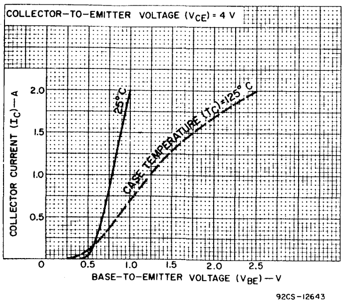

Fig. 10—Typical transfer characteristics for 2N3441 and 40373.

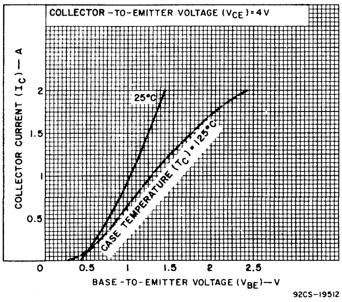

Fig. 11—Typical transfer characteristics for 2N6263.

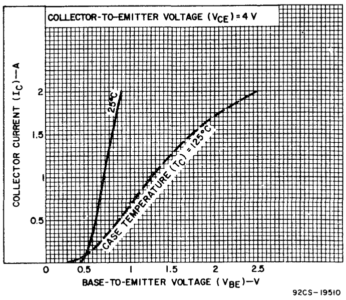

Fig. 12—Typical transfer characteristics for 2N6264 and 40913.

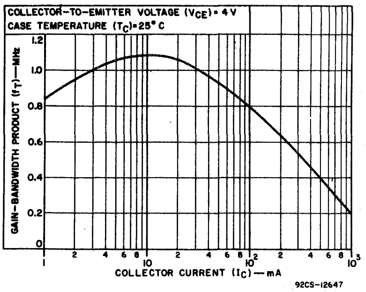

Fig. 13— Typical gain-bandwidth product for all types.

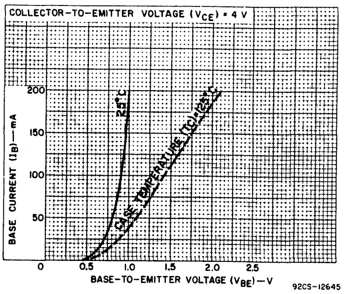

Fig. 14— Typical input characteristics for 2N3441 and 40373.

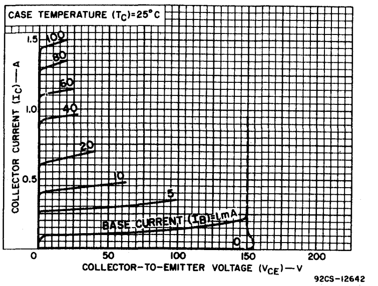

Fig. 15— Typical output characteristics for 2N3441 and 40373.

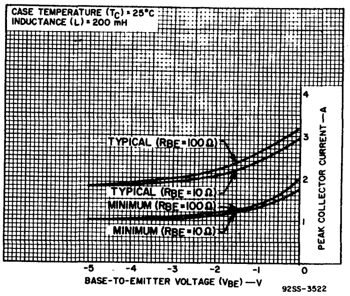

Fig. 16— Reverse-bias second-breakdown characteristics for all types.

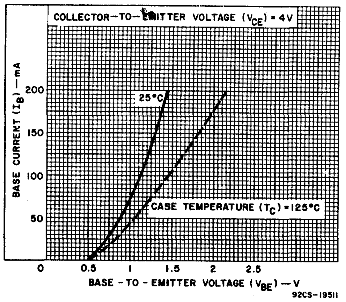

Fig. 17— Typical input characteristics for 2N6263.

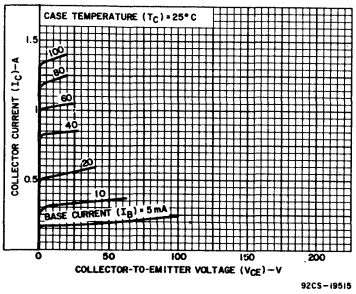

Fig. 18— Typical output characteristics for 2N6263.

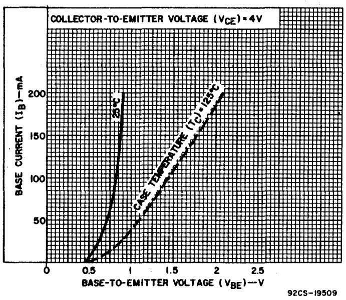

Fig. 19— Typical input characteristics for 2N6264 and 40913.

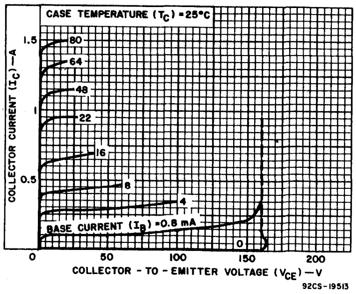

Fig. 20— Typical output characteristics for 2N6264 and 40913.

2N3442, 2N4347, 2N6262

Hometaxial-Base High-Voltage Silicon N-P-N Transistors

Rugged High-Power Devices for Applications in Industrial and Commercial Equipment

RCA 2N3442, 2N4347, and 2N6262 are hometaxial-base, silicon n-p-n transistors intended for a wide variety of high-power, high-voltage applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

These devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage, current, and power.

Features:

- Low saturation voltages
- Thermal-cycle rating charts
- High dissipation capability – 100 W (2N4347)
  – 117 W (2N3442)
  – 150 W (2N6262)
- Maximum area-of-operation curves for dc and pulse operation.

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits

MAXIMUM RATINGS, *Absolute-Maximum Values:*		2N4347	2N3442	2N6262	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	170	V
COLLECTOR-TO-EMITTER VOLTAGE:					
* With base open	V_{CEO}	120	140	150	V
With reverse bias (V_{BE}) of –1.5 V	V_{CEV}	140*	160	170	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
*COLLECTOR CURRENT:	I_C				
Continuous		5	10	10	A
Peak		10*	15	15	A
*BASE CURRENT:	I_B				
Continuous		3	7	7	A
Peak		8*	–	–	A
*TRANSISTOR DISSIPATION:	P_T				
At case temperature up to 25°C		100	117	150	W
At case temperatures above 25°C		Derate linearly to 200°C			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		← –65 to +200 →			°C
*PIN TEMPERATURE (During Soldering):					
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		235	235	235	°C

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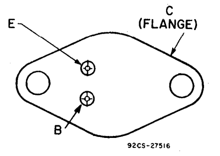
*In accordance with JEDEC registration data format (JS-6, RDF-2).

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A.")

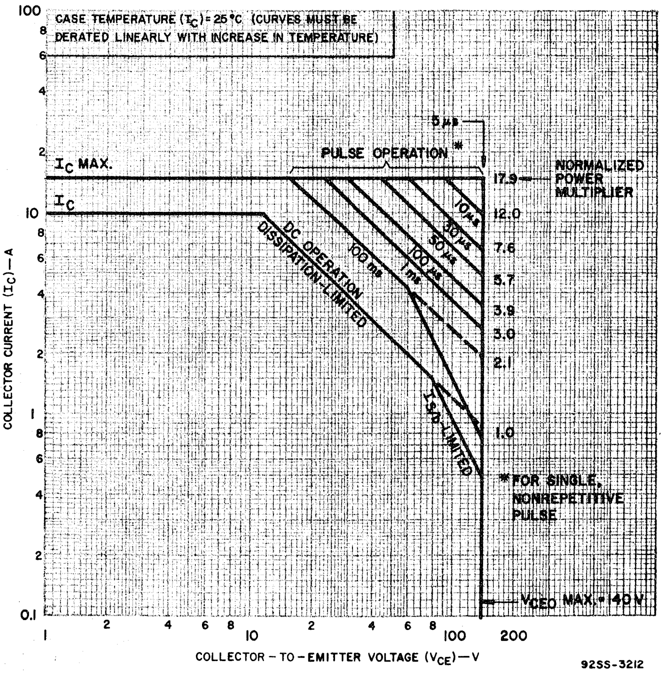


Fig. 1—Maximum operating areas for 2N3442.

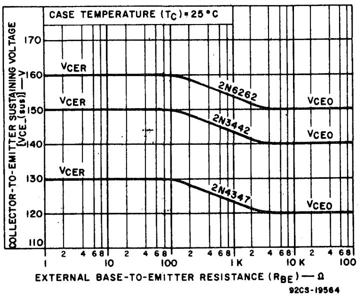


Fig.2—Sustaining voltage vs. base-to-emitter resistance for all types.

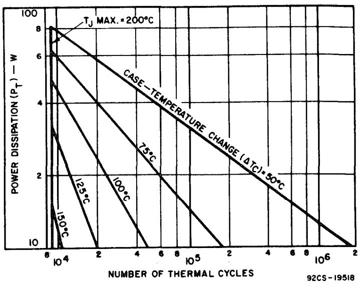


Fig.3—Thermal-cycle rating chart for 2N3442.

2N3442, 2N4347, 2N6262

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N4347		2N3442		2N6262		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With emitter open (V_{CB} = 140 V)	I_{CBO}					–	–	–	1*	–	1	mA
* With base-emitter junction reverse-biased	I_{CEX}	120	-1.5			–	2	–	–	–	–	mA
		140	-1.5			–	–	–	5	–	–	
		140	-1.5			–	–	–	1	–	–	
		150	-1.5			–	–	–	–	–	0.1	
* With base-emitter junction reverse-biased and T_C = 150°C	I_{CEX}	125	–1.5			–	10	–	–	–	–	mA
		140	–1.5			–	–	–	30	–	–	
		140	-1.5			–	–	–	10	–	–	
		150	-1.5			–	–	–	–	–	2	
* With base open	I_{CEO}	100				–	200	–	–	–	–	mA
		110				–	–	–	–	–	1	
		140				–	–	–	200	–	–	
* Emitter Cutoff Current	I_{EBO}		–7	0		–	5	–	5	–	0.2	mA
* DC Forward Current Transfer Ratio	h_{FE}	2		3^a		–	–	–	–	20	70	
		2		10^a		–	–	–	–	5	–	
		4		2^a		15	60	–	–	–	–	
		4		3^a		–	–	20	70	–	–	
		4		5^a		10	–	–	–	–	–	
		4		10^a		–	–	7.5	–	–	–	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased	$V_{CEV}(sus)$		–1.5	0.1		140	–	160	–	–	–	V
			–1.5	0.2		–	–	–	–	170	–	
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$			0.1		130	–	–	–	–	–	V
				0.2		–	–	150	–	160	–	
* With base open	$V_{CEO}(sus)$			0.2^a	0	120	–	140	–	–	–	V
				0.2^a	0	–	–	–	–	150	–	
* Base-to-Emitter Voltage	V_{BE}	2		3^a		–	–	–	–	–	1	V
		4		3^a		–	–	–	1.7	–	–	
		4		2^a		–	2	–	-	–	–	
		4		5^a		–	3	–	–	–	–	
		4		10^a		–	–	–	5.7	–	–	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			2^a	0.2	–	1	–	–	–	–	V
				3^a	0.3	–	–	–	1	–	0.5	
				5^a	0.63	–	2	–	–	–	–	
				10^a	2	–	–	–	5	–	–	
Power Rating Test	PRT	67		1.5		1	–	–	–	–	–	s
		78		1.5		–	–	1	–	–	–	
		100		1.5		–	–	–	–	1	–	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 50 kHz	$\lvert h_{fe} \rvert$	4		0.5		4	–	–	–	–	–	
f = 40 kHz	$\lvert h_{fe} \rvert$	4		1		–	–	–	–	2	–	
		4		2		–	–	2	–	–	–	
* Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		0.5		40	–	–	–	–	–	
		4		1		–	–	–	–	10	–	
		4		2		–	–	12	72	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.75	–	1.5	–	1.17	°C/W

***In accordance with JEDEC registration data format JS-6 RDF-2**

[a] Pulse test; pulse duration = 300 μs,rep. rate = 60 Hz

2N3442, 2N4347, 2N6262

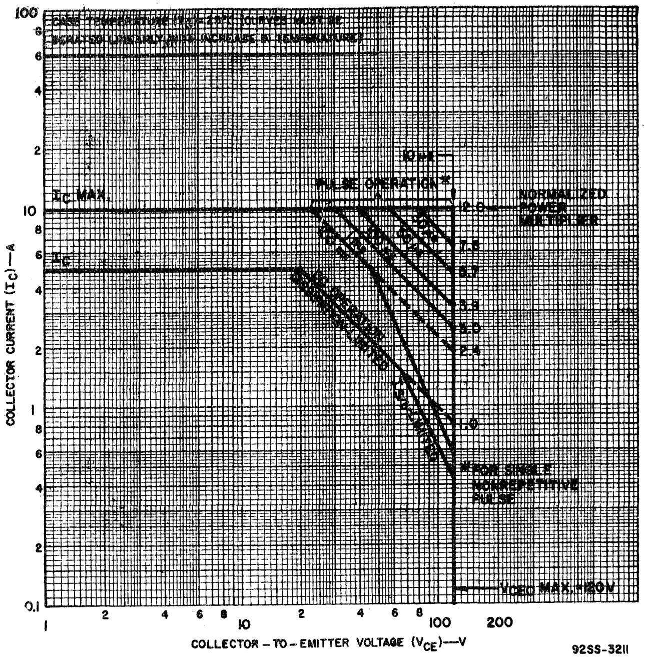


Fig. 4 – Maximum operating areas for 2N4347.

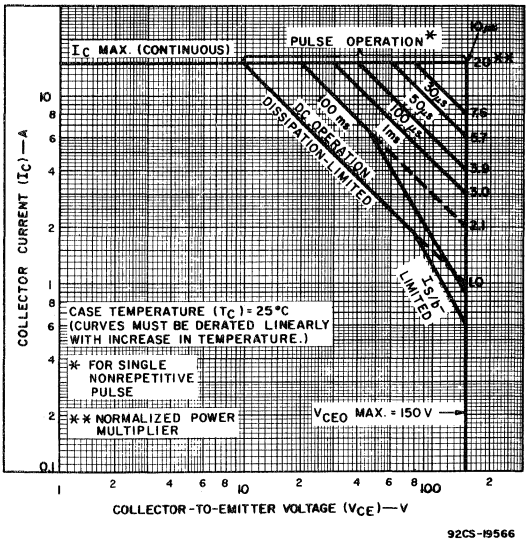


Fig. 5 – Maximum operating areas for 2N6262.

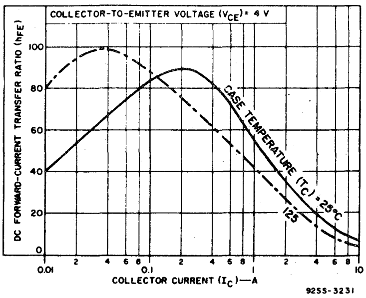


Fig. 6 – Typical dc beta characteristics for 2N3442.

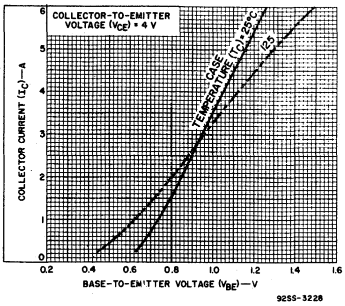


Fig. 7 – Typical transfer characteristics for 2N3442 and 2N4347.

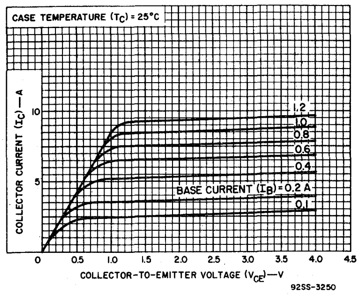


Fig.8–Typical small-signal output characteristics for 2N3442.

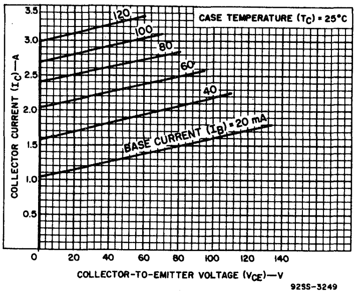


Fig. 9 –Typical large-signal output characteristics for 2N3442.

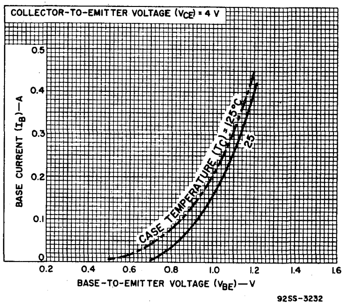


Fig. 10 –Typical input characteristics for 2N3442.

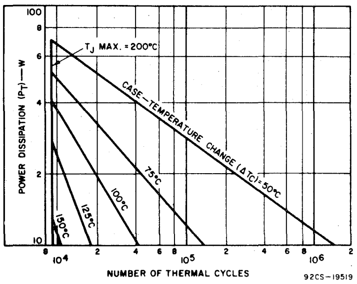


Fig. 11 –Thermal-cycle rating chart for 2N4347.

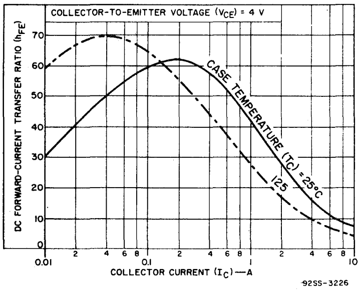


Fig. 12 –Typical dc beta characteristics for 2N4347.

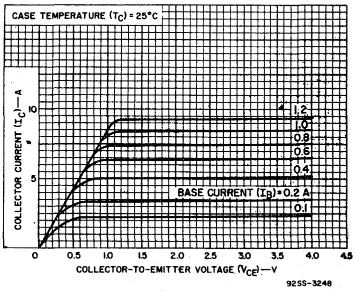


Fig. 13 –Typical small-signal output characteristics for 2N4347.

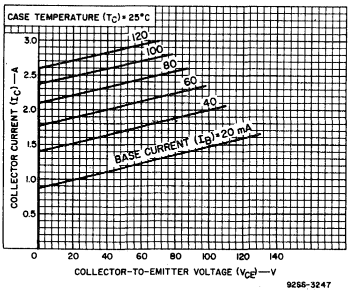


Fig. 14 –Typical large-signal output characteristics for 2N4347.

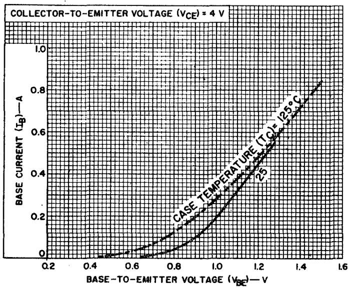


Fig. 15 –Typical input characteristics for 2N4347.

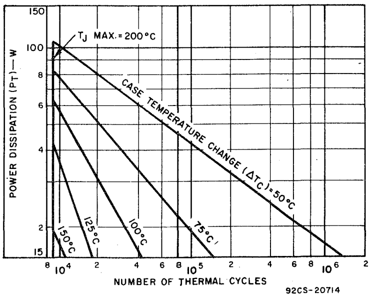


Fig. 16 –Thermal-cycle rating chart for 2N6262.

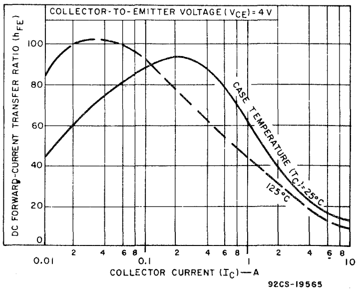


Fig. 17 –Typical dc beta characteristics for 2N6262.

2N3442, 2N4347, 2N6262

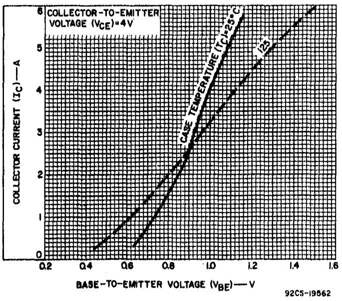


Fig. 18 – Typical transfer characteristics for 2N6262.

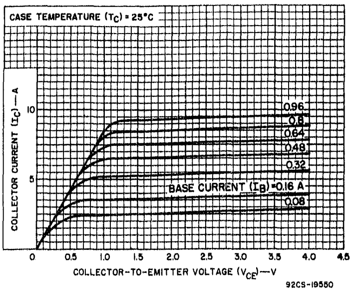


Fig. 19 – Typical small-signal output characteristics for 2N6262.

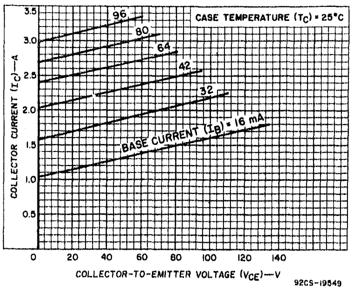


Fig. 20 – Typical large-signal output characteristics for 2N6262.

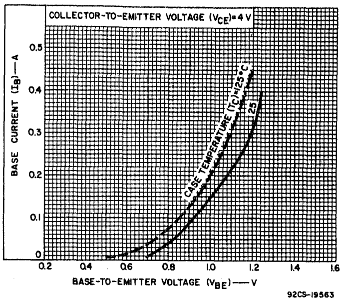


Fig. 21 – Typical input characteristics for 2N6262.

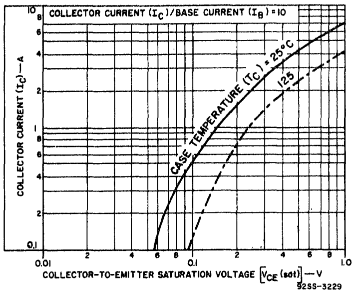


Fig. 22 – Typical saturation-voltage characteristics for all types.

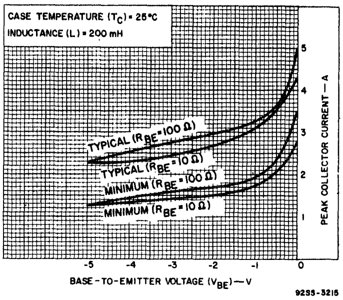


Fig. 23 – Reverse-bias, second-breakdown characteristics for all types.

2N3583-2N3585, 2N4240, 40374

High Voltage Silicon N-P-N Transistor

For High-Speed Switching, Linear-Amplifier Applications, and Off-Line Switching-Regulator Type Power-Supply Applications

These RCA types are silicon n-p-n transistors with high breakdown voltages and fast switching speeds.

Typical applications for these transistors include high-voltage operational amplifiers, high-voltage switches, switching regulators, converters, inverters, deflection- and hi-fi amplifiers.

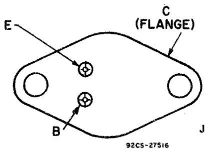
These transistors are also intended for a wide variety of applications in ac/dc commercial equipment.

Types 2N3583, 2N3584, 2N3585, and 2N4240 are supplied in hermetic JEDEC TO-66 packages. Type 40374 is a 2N3583 with a factory-attached heat radiator.

Features for JEDEC Types:

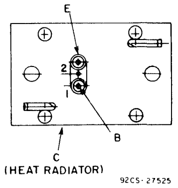
- **100-percent tested to assure freedom from second breakdown in both forward- and reverse-bias conditions when operated within specified limits**
- **Economy types for ac/dc circuits**
- **Fast turn-on time at high collector current**

TERMINAL DESIGNATIONS



JEDEC TO-66 2N3583, 2N3584, 2N3585, 2N4240, 40850

(See dimensional outline "N.")



JEDEC TO-66 with Heat Radiator 40374

(See dimensional outline "O.")

MAXIMUM RATINGS, *Absolute-Maximum Values:*		**2N3583**	**2N3584**	**2N3585 2N4240**	**40374**	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	375	500	250	V
*COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With base open	$V_{CEO}(sus)$	175	250	300	175	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
*CONTINUOUS COLLECTOR CURRENT	I_C	1	2	2	2	A
*PEAK COLLECTOR CURRENT	I_{CM}	5	5	5	5	A
*CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
*TRANSISTOR DISSIPATION	P_T					
At case temperature (T_C) = 25°C		35	35	35	–	W
At ambient temperature (T_A) = 25°C		–	–	–	5.8	W
At case temperatures above 25°C		Derate linearly at 0.2 W/°C				
For other conditions		Derate linearly to 200°C				
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		--65 to 200				°C
*PIN TEMPERATURE:						
1/16 in. (1.58 mm) from seating plane for 10 s max.		235	235	235	235	°C

*In accordance with JEDEC registration data format JS-6 RDF-2 (2N3583), JS-6 RDF-1 (2N3584, 2N3585, 2N4240).

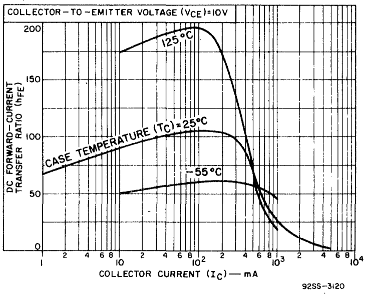


Fig.1—Typical dc beta vs. collector current for 2N3583, 2N4240 and 40374.

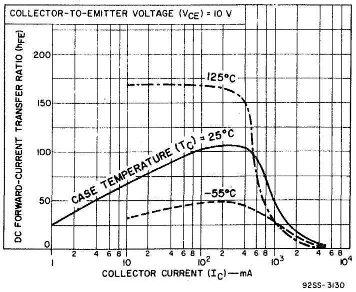


Fig.2—Typical dc beta vs. collector current for 2N3584 and 2N3585.

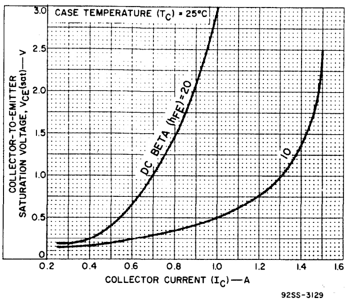


Fig.3—Typical collector-to-emitter saturation voltage vs. current for 2N3584 and 2N3585.

2N3583-2N3585, 2N4240, 40374

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTICS	SYMBOL	TEST CONDITIONS					LIMITS								UNITS
		VOLTAGE V dc		CURRENT mA dc			2N3583 40374		2N3584		2N3585		2N4240		
		V_{CE}	V_{BE}	I_C	I_E	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* Collector-Cutoff Current	I_{CEO}	150				0	–	10	–	5	–	5	–	5	mA
* Collector-Cutoff Current	I_{CEV}	225 340 450	−1.5 −1.5 −1.5				– – –	1.0 – –	– – –	– 1.0 –	– – –	– – 1.0	– – –	– – 2.0	mA
At T_C = 150°C	I_{CEV}	225 300	−1.5 −1.5				– –	3 –	– –	– 3	– –	– 3	– –	– 5.0	mA
* Emitter-Cutoff Current	I_{EBO}		−6	0			–	5.0	–	0.5	–	0.5	–	0.5	mA
* DC Forward-Current Transfer Ratio	h_{FE}	2 2 10 10 10 10		750^a 1A^a 100^a 750^a 750^a 1A			– – 40 40 – 10	– – – 200 – –	– 8 40 – – 25	– 80 – – – 100	– 8 40 – – 25	– 80 – – – 100	10 – 40 – 30 –	100 – – – 150 –	
Collector-to-Emitter Sustaining Voltage: With base open	V_{CEO}(sus)			200		0	175●	–	250●	–	300●	–	300●	–	V
With external base-to-emitter resistance (R_{BE})=50 Ω	I_{CER}	250 300 450		200			– – –	1.0 – –	– – –	– 1.0 –	– – –	– – 1.0	– – –	– – 1.0	mA
* Base-to-Emitter Saturation Voltage	V_{BE}(sat)			750^a 1A^a		75 100	– –	– 1.4	– –	– 1.4	– –	– 1.4	– –	1.8 –	V
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			750^a 1A^a		75 125	– –	– 5	– –	– 0.75	– –	– 0.75	– –	1.0 –	V
Small-Signal Forward Current Transfer Ratio f = 5 MHz * f = 1 kHz	h_{fe}	10 30		200 100			3 25	– 350	3 –	– –	3 –	– –	3 –	– –	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio f = 5 MHz	$\|h_{fe}\|$	10		200			2	–	2		2		3	–	
Output Capacitance: V_{CB}=10 V, f = 1 MHz	C_{obo}				0		–	120	–	120		120	–	120	pF
Second-Breakdown Collector Current With base forward-biased**	$I_{S/b}$	100					350	–	350	–	350	–	350		mA
Second-Breakdown Energy with base reverse-biased R_{BE} = 20Ω, L = 100 μH	$E_{S/b}$		−4	1A pk			50	–	–	–	–	–	50	–	μJ
R_{BE} = 20Ω; L = 100 μH			−4	2A pk			–	–	200	–	200	–	–	–	
* Saturated Switching Time (V_{CC}=200 V): Rise Time (See Figs. 13 & 16)	t_r			1A 750		100 75	– –	– –	– –	3 –	– –	3 –	– –	– 0.5	μs
* Storage Time (See Figs. 14 & 16)	t_s			1A 750		100 75	– –	– –	– –	4 –	– –	4 –	– –	– 6	
Fall Time (See Figs. 15 & 16)	t_f			750 1A		75 100	– –	– –	– –	– 3	– –	– 3	– –	3 –	
* Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						5 (Max.) 2N3583		–	5	–	5	–	5	°C/W
Junction-to-Ambient	$R_{\theta JA}$						70 (Max.) 2N3583 30 (Max.) 40374		– –	70 –	– –	70 –	– –	70 –	

* In accordance with JEDEC registration data formal JS-6 RDF-2 (2N3583), JS-6 RDF-1 (2N3584, 2N3585, 2N4240)

● **CAUTION:** The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) **MUST NOT** be measured on a curve tracer.

** Specified value of $I_{S/b}$ for given value of V_{CE} as base voltage is increased from zero in a positive direction.

^{a} Pulsed, pulse duration = 300 μs; duty factor ⩽ 2%.

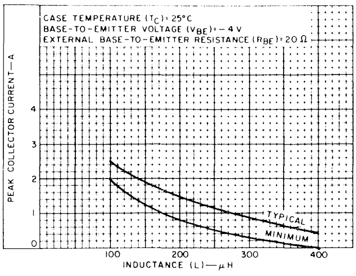


Fig.4—Reverse-bias second breakdown characteristics for 2N3584 and 2N3585.

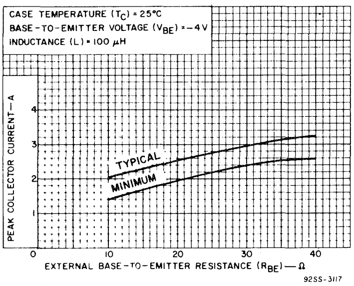


Fig.5—Reverse-bias second breakdown characteristics for 2N3584 and 2N3585.

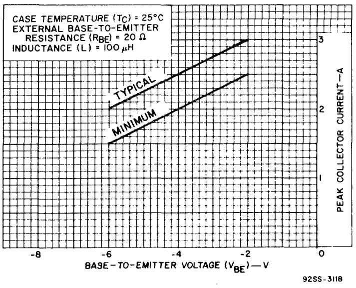


Fig.6—Reverse-bias second breakdown characteristics for 2N3584 and 2N3585.

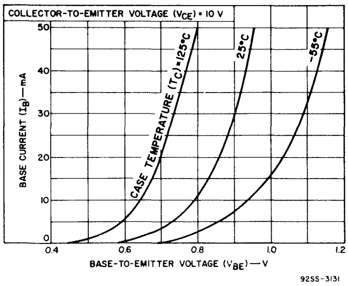


Fig.7—Typical input characteristics for all types.

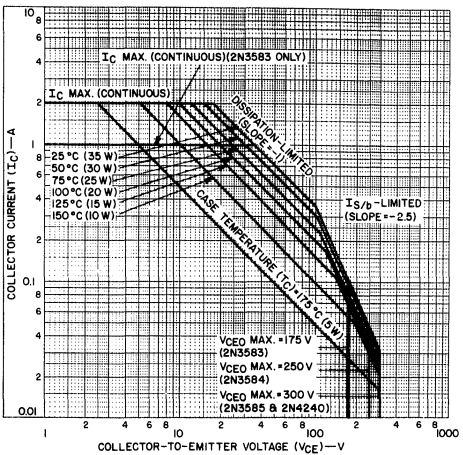


Fig.8—Maximum operating areas for 2N3583, 2N3584, 2N3585, and 2N4240 (pulse conditions).

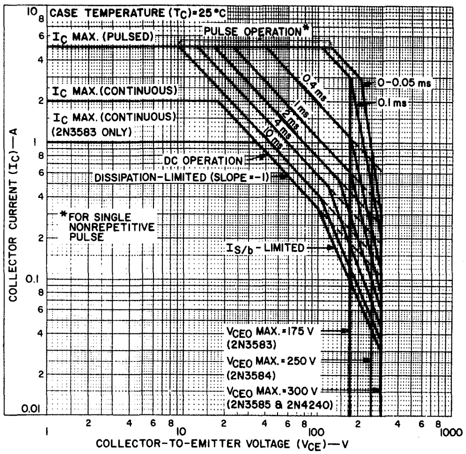


Fig.9—Maximum operating areas for 2N3583, 2N3584, 2N3585, and 2N4240 (dc conditions).

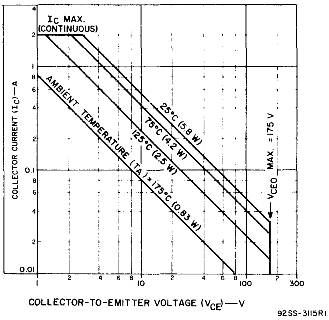


Fig.10—Maximum operating areas for 40374.

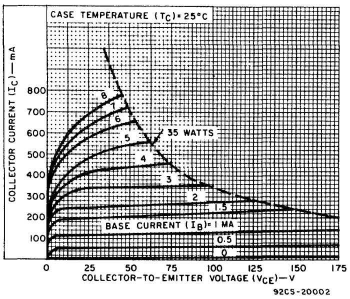


Fig.11—Typical output characteristics for 2N3583 and 40374.

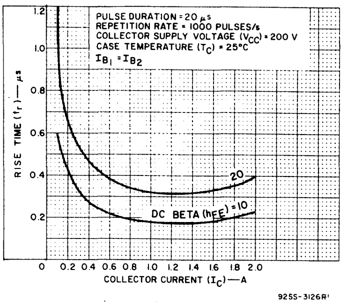


Fig.12—Typical rise time vs. collector current for 2N3584 and 2N3585.

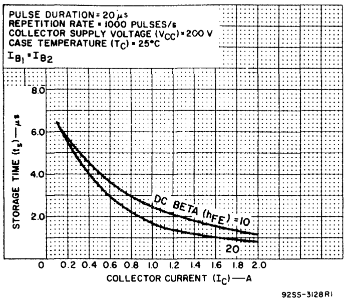


Fig.13—Typical storage time vs. collector current for 2N3584 and 2N3585.

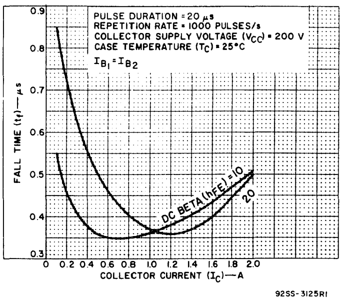


Fig.14—Typical fall time vs. collector current for 2N3584 and 2N3585.

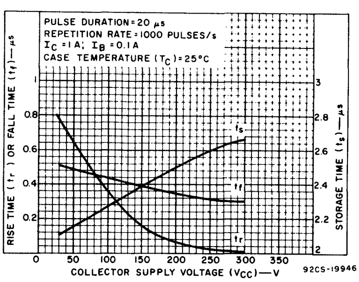


Fig.15—Typical rise time, fall time, and storage time vs. collector supply voltage for 2N3584 and 2N3585.

2N3715, 2N3716

Silicon N-P-N Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-2N3715 and 2N3716 are epitaxial-base silicon n-p-n transistors featuring high gain and high current. They may be used as complements to the RCA-2N3791 and 2N3792 respectively. These devices have a dissipation capability of 150 watts at case temperature up to 25°C. They differ in voltage ratings and in the currents at which the parameters are controlled. Both are supplied in the steel JEDEC TO-204MA hermetic package.

Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**
- **Hermetically sealed JEDEC TO-3/TO-204MA package**
- **High gain at high current**
- **Thermal-cycling rating curve**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3715	2N3716	
* V_{CBO}		80	100	V
* $V_{CEO}(sus)$		60	80	V
* V_{EBO}		7	7	V
* I_C		10	10	A
* I_B		4	4	A
* P_T				
At $T_C \leqslant 25°C$		150	150	W
At $T_C > 25°C$	Derate linearly	0.86		W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235		°C

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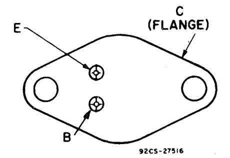
* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

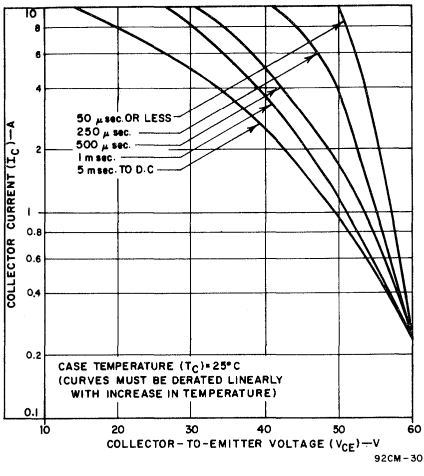


Fig. 1 — Maximum operating areas for 2N3715.

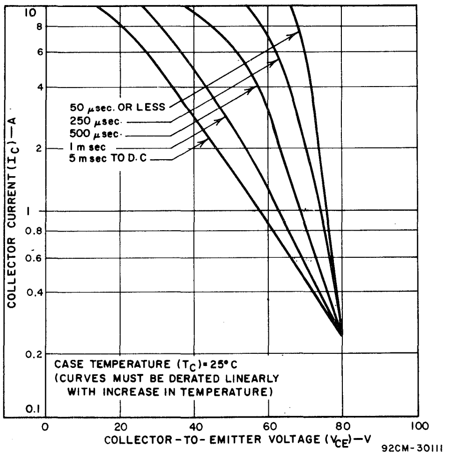


Fig. 2 — Maximum operating areas for 2N3716.

ELECTRICAL CHARACTERISTICS,
at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N3715		2N3716		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
* I_{CEX}	80 100	−1.5 −1.5			– –	1 –	– –	– 1	mA
* I_{CEX}, T_C = 150°C	60 80	−1.5 −1.5			– –	10 –	– –	– 10	mA
* I_{CEO}	30 40			0 0	– –	0.7 –	– –	– 0.7	mA
* I_{EBO}		−7	0		–	1.0	–	1.0	mA
* $V_{CEO}(sus)$[b]			0.2	0	60	–	80	–	V
* h_{FE}	2 2 4		1[a] 3[a] 10		50 30 5	150 – –	50 30 5	150 – –	
* V_{BE}[a]	2		3		–	1.5	–	1.5	V
$V_{BE}(sat)$[a]			5	0.5	–	1.5	–	1.5	V
* $V_{CE}(sat)$[a]			5 10	0.5 2.0	– –	0.8 4	– –	0.8 4	V
* $\|h_{fe}\|$ f = 1 MHz	10		0.5		5	–	5	–	
* f_{hfe}	10		0.5		30	–	30	–	KHz
* h_{fe} f = 1 KHz	10		0.5		25	250	25	250	
* C_{ob} V_{CB} = 10 V f = 1 MHz			0		–	250	–	250	pF
$I_{S/b}$ tp = 1s	40				2.7	–	2.95	–	A
$R_{\theta JC}$					–	1.17	–	1.17	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed; pulse duration = 200 μs, duty factor = 1.5%.

[b] **CAUTION**: Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ *MUST NOT* be measured on a curve tracer.

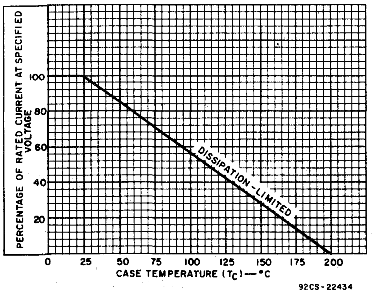


Fig. 3 – Derating curve.

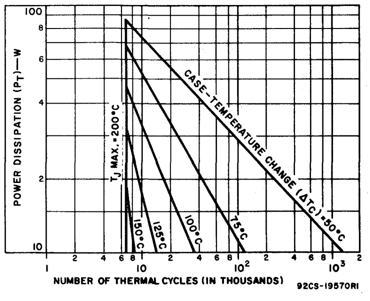


Fig. 4 – Thermal-cycling rating chart.

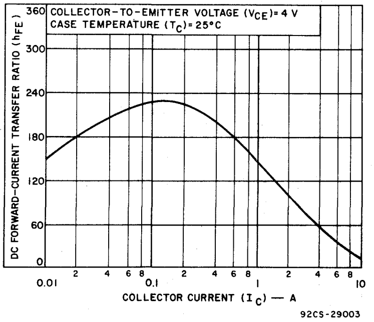


Fig. 5 – Typical dc beta characteristics for both types.

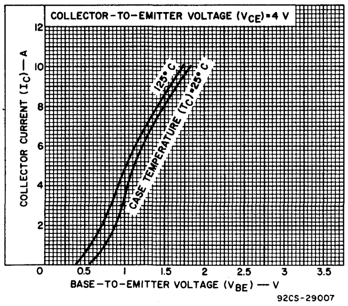


Fig. 6 – Typical transfer characteristics for both types.

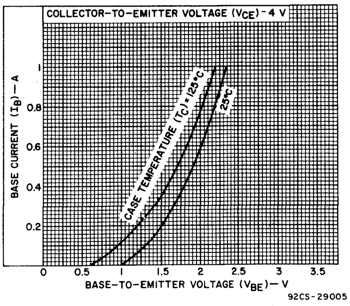


Fig. 7 – Typical input characteristics for both types.

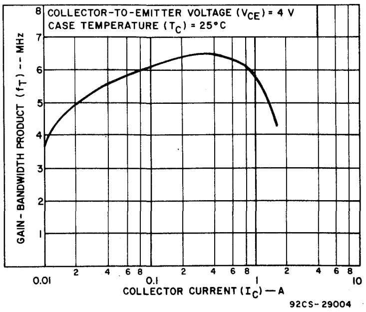


Fig. 8 – Typical gain-bandwidth product for both types.

2N3771, 2N3772, RCS258

Hometaxial-Base, High-Power N-P-N Transistors

Rugged Silicon N-P-N Devices for Applications in Industrial and Commercial Equipment

These RCA types are hometaxial base, silicon n-p-n transistors intended for a wide variety of high-power, high-current applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

All devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage, current, and power.

Features:

- **High dissipation capability**
- **V_{CEX}(sus) at 3 A = 50 V min. (2N3771) = 90 V min. (2N3772)**
- **15-A specification for: h_{FE}, V_{BE}, & V_{CE}(sat) (2N3771)**
- **10-A specification for: h_{FE}, V_{BE}, & V_{CE}(sat) (2N3772, RCS258)**
- **Low saturation voltage with high beta**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3771	2N3772	RCS258	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	100	100	V
*COLLECTOR-TO-EMITTER VOLTAGE:					
With −1.5 V (V_{BE}) & R_{BE} = 100Ω	V_{CEX}	50	80	80	V
With base open	V_{CEO}	40	60	60	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	7	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	30	20	20	A
*PEAK COLLECTOR CURRENT	I_{CM}	30	30	30	A
*CONTINUOUS BASE CURRENT	I_B	7.5	5	5	A
*PEAK BASE CURRENT	I_{BM}	15	15	15	A
*TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		150	150	250	W
At case temperatures above 25°C		Derate linearly to 200°C			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		−65 to 200			°C
*PIN TEMPERATURE (During soldering):					
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230			

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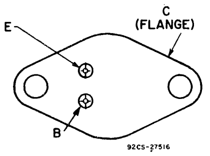
*In accordance with JEDEC registration data format JS-6 RDF-2.

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

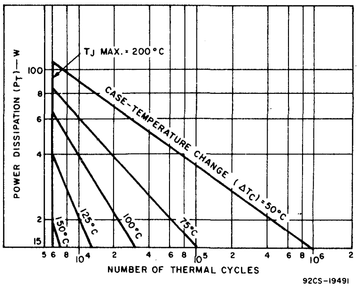


Fig. 1—Thermal-cycle rating chart for 2N3771, 2N3772.

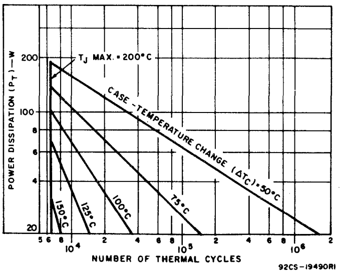


Fig. 2 — Thermal-cycle rating chart for RCS258.

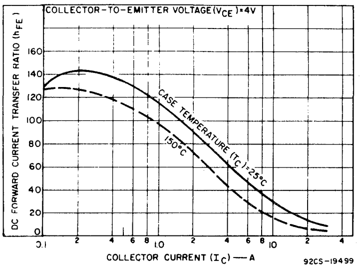


Fig. 3—Typical dc beta characteristics for 2N3771.

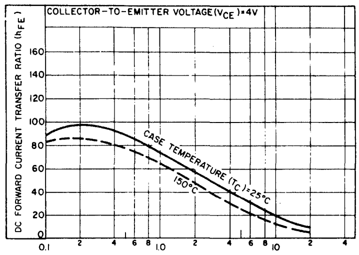


Fig. 4 — Typical dc beta characteristics for 2N3772 and RCS258.

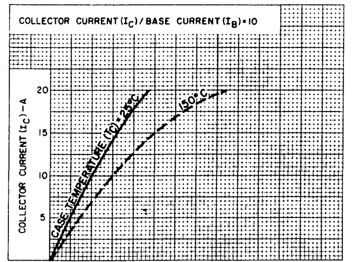


Fig. 5—Typical saturation-voltage characteristics for 2N3771.

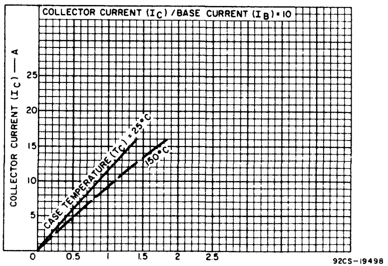


Fig. 6 — Typical saturation-voltage characteristics for 2N3772 and RCS258.

2N3771, 2N3772, RCS258

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

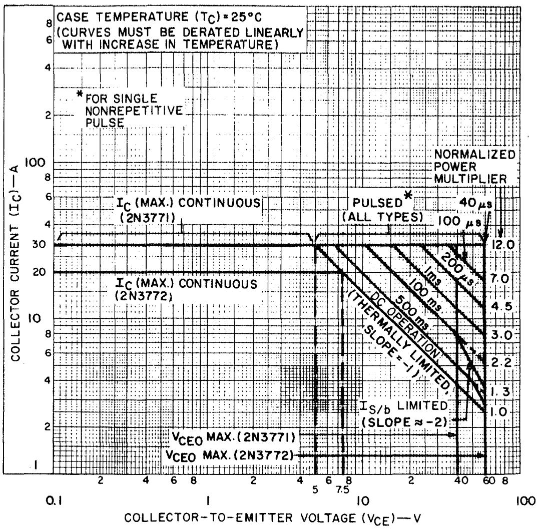
CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N3771		2N3772		RCS258		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	50[a]				–	2*	–	–	–	–	mA
	100[a]				–	–	–	5*	–	5	
I_{CEX}	45	−1.5			–	–	–	–	–	–	mA
	50	−1.5			–	2	–	–	–	–	
	100	−1.5			–	–	–	5	–	5	
I_{CEX} T_C = 150°C	30	−1.5			–	10	–	10	–	–	mA
	45	−1.5			–	–	–	–	–	–	
	100	−1.5			–	–	–	–	–	10	
I_{CEO}	25			0	–	–	–	–	–	–	mA
	30			0	–	10	–	–	–	–	
	50			0	–	–	–	10	–	10	
* I_{EBO}		−5	0		–	5	–	–	–	–	mA
		−7	0		–	–	–	5	–	5	
* h_{FE}	4		30●		5	–	–	–	–	–	
	4		20●		–	–	5	–	5	–	
	4		15●		15	60	–	–	–	–	
	4		10●		–	–	15	60	15	60	
	4		8●		–	–	–	–	–	–	
$V_{CEX(sus)}$ R_{BE} = 100Ω		−1.5	0.2●		50	–	80	–	80	–	V
$V_{CER(sus)}$ R_{BE} = 100Ω			0.2●		45	–	70	–	70	–	V
* $V_{CEO(sus)}$			0.2●	0	40	–	60	–	60	–	V
* V_{BE}	4		15●		–	2.7	–	–	–	–	V
	4		10●		–	–	–	2.2	–	2.2	
	4		8●		–	–	–	–	–	–	
* $V_{CE(sat)}$			30●	6	–	4	–	–	–	–	V
			20●	4	–	–	–	4	–	4	
			15●	1.5	–	2	–	–	–	–	
			10●	1	–	–	–	1.4	–	1.4	
			8●	0.8	–	–	–	–	–	–	
$I_{S/b}$ t_p = 1 s nonrep.	60				–	–	2.5	–	4.2	–	A
	40				3.75	–	–	–	–	–	
$E_{S/b}$ L=40mH R_{BE} = 100Ω		−1.5	5		500	–	500	–	500	–	mJ
$\|h_{fe}\|$ f = 0.05 MHz	4		1		4*	16 (Typ)	4*	16 (Typ)	4	16 (Typ)	
* h_{fe} f=1 kHz	4		1		40	–	40	–	40	–	
$R_{\theta JC}$					–	1.17	–	1.17	–	0.7	°C/W

* 2N-types in accordance with JEDEC registration data format JS-6 RDF-2.

● Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz, duty factor ≤2%.

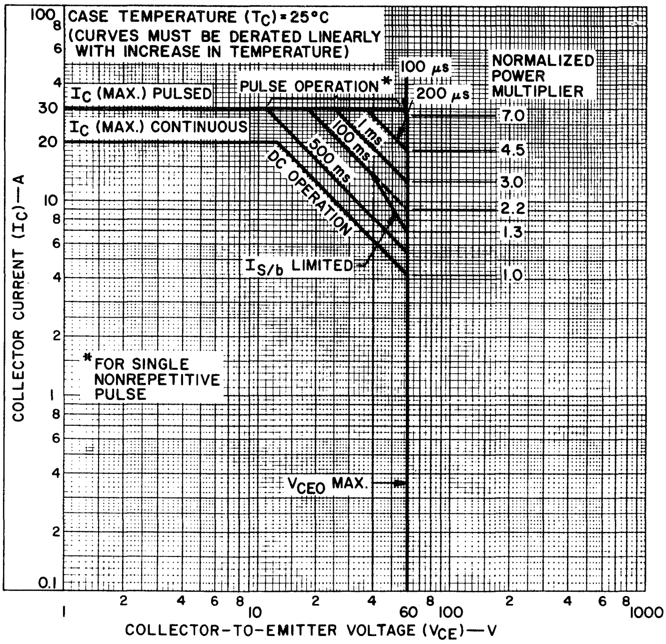
[a] V_{CB}

2N3771, 2N3772, RCS258



92CS-28551R1

Fig. 7— Maximum operating areas for 2N3771 and 2N3772.



92CS-26449

Fig. 8— Maximum operating areas for RCS258.

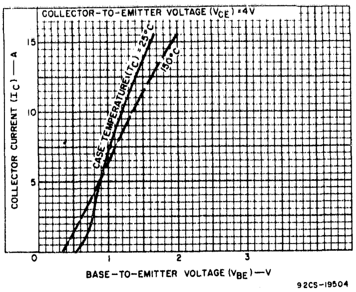


Fig. 9— Typical transfer characteristics for 2N3771.

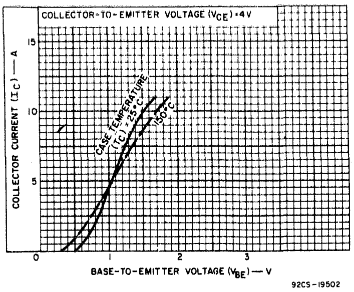


Fig. 10— Typical transfer characteristics for 2N3772 and RCS258.

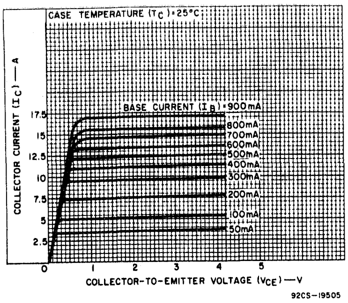


Fig. 11— Typical output characteristics for 2N3771.

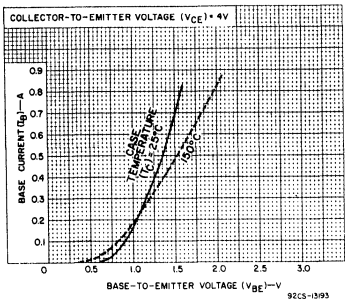


Fig. 12— Typical input characteristics for 2N3771.

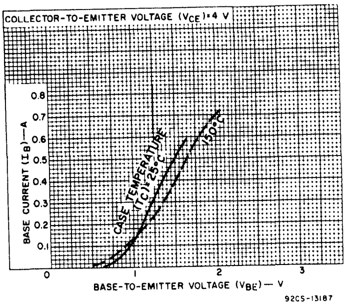


Fig. 13— Typical input characteristics for 2N3772 and RCS258.

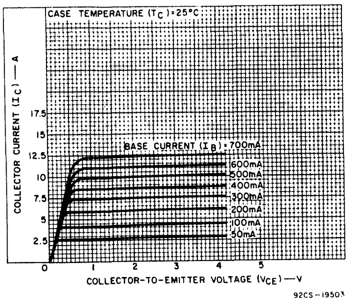


Fig. 14— Typical output characteristics for 2N3772 and RCS258.

2N3773, 2N4348, 2N6259

Hometaxial-Base, High Current Silicon N-P-N Transistors

Rugged High-Voltage Devices for Applications
in Industrial and Commercial Equipment

These RCA types are hometaxial-base silicon n-p-n transistors intended for a wide variety of high-voltage high-current applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

These devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage, current, and power.

Features:

- **High dissipation capability – 120 W (2N4348), 150 W (2N3773), 250 W (2N6259)**
- **5-A specification for h_{FE}, V_{BE}, & V_{CE}(sat) (2N4348)**
- **8-A specification for h_{FE}, V_{BE}, & V_{CE}(sat) (2N3773, 2N6259)**
- **V_{CEX}– 140 V min (2N4348), 160 V min (2N3773) 170 V min (2N6259)**
- **Low saturation voltage with high beta**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N4348	2N3773	2N6259	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	170	V
COLLECTOR-TO-EMITTER VOLTAGE:					
* With base open	V_{CEO}	120	140	150	V
With reverse bias (V_{BE}) of −1.5 V	V_{CEX}	140	160	170	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
*COLLECTOR CURRENT:	I_C				
Continuous		10	16	16	A
Peak		30	30	30	A
*BASE CURRENT:	I_B				
Continuous		4	4	4	A
Peak		15	15	15	A
*TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		120	150	250	W
At case temperatures above 25°C		Derate linearly to 200°C			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		← −65 to +200 →			°C
*PIN TEMPERATURE (During Soldering):					
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		← 230 →			°C

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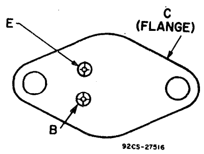
* In accordance with JEDEC registration data format (JS-6, RDF-2).

TERMINAL DESIGNATIONS



JEDEC TO-3
(See dimensional outline "A".)

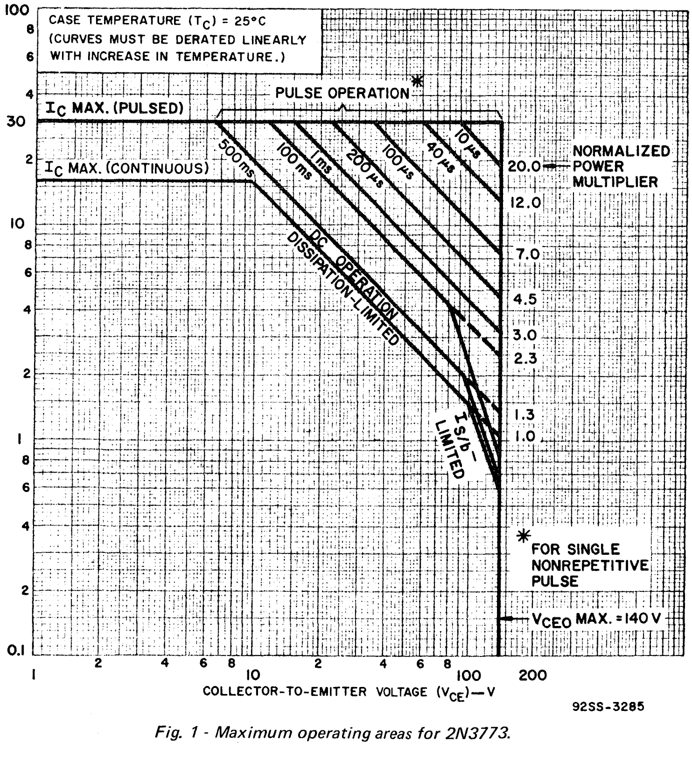


Fig. 1 - Maximum operating areas for 2N3773.

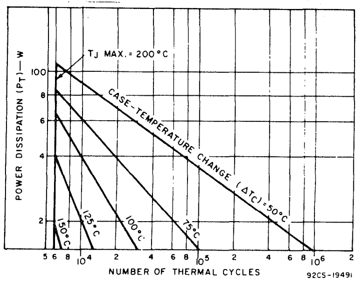


Fig. 2 - Thermal-cycle rating chart for 2N3773.

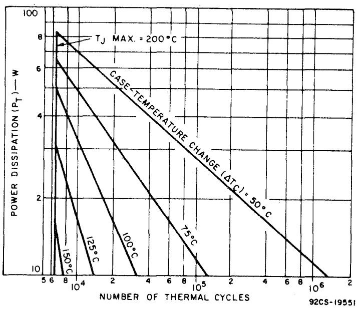


Fig. 3 - Thermal-cycle rating chart for 2N4348.

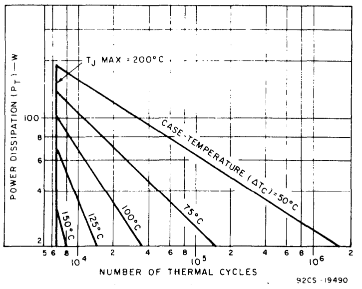


Fig. 4 - Thermal-cycle rating chart for 2N6259.

2N3773, 2N4348, 2N6259

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N4348		2N3773		2N6259		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* Collector-Cutoff Current: With emitter open, V_{CB}=140 V	I_{CBO}					–	–	–	2	–	–	mA
With base-emitter junction reverse-biased	I_{CEX}	120	−1.5			–	2	–	–	–	–	mA
		140	−1.5			–	–	–	2	–	–	
		150	−1.5			–	–	–	–	–	0.2	
With base-emitter junction reverse-biased and T_C = 150°C	I_{CEX}	120	−1.5			–	10	–	–	–	–	mA
		140	−1.5			–	–	–	10	–	–	
		150	−1.5			–	–	–	–	–	4	
With base open	I_{CEO}	100				–	200	–	–	–	–	mA
		120				–	–	–	10	–	2	
* Emitter-Cutoff Current	I_{EBO}		−7	0		–	5	–	5	–	2	mA
* DC Forward Current Transfer Ratio	h_{FE}	4		5^a		15	60	–	–	–	–	
		4		8^a			–	15	60	–	–	
		2		8^a				–	–	15	60	
		4		10^a		10		–	–		–	
		4		16^a				5		10		
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased (R_{BE} = 100Ω)	$V_{CEX(sus)}$		1.5	0.1		140		160		170		V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER(sus)}$			0.2^a		140		,150		160		V
* With base open	$V_{CEO(sus)}$			0.2^a	0	120		140		150		V
* Base-to-Emitter Voltage	V_{BE}	4		5^a			2					V
		4		8^a					2.2			
		2		8^a		–	–	–			2	
		4		10^a			3		–	–		
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			5^a	0.5		1					V
				8^a	0.8				1.4		1	
				10^a	1.25	–	2					
				16^a	3.2		–		4		2.5	
Second-Breakdown Collector Current With base forward-biased and 1-s nonrepetitive pulse	$I_{S/b}{}^b$	80				1.5						A
		100					–	1.5	–	2.5		
Second-Breakdown Energy With base reverse-biased and L = 40 mH, R_{BE} = 100Ω	$E_{S/b}{}^c$		−1.5	2.5		0.125		0.125		0.125		J
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 50 kHz)	$\lvert h_{fe} \rvert$	4		1		4	–	4	–	4	–	
* Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		1		40	–	40	–	40		
Thermal Resistance Junction-to-Case	$R_{\theta JC}$					–	1.46	–	1.17	–	0.7	°C/W

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[*] In accordance with JEDEC registration data format JS 6 RDF-2.

[a] Pulsed; pulse duration 300μs, rep. rate = 60 Hz.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter base junction forwar transistor operation in the active region.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b}$ 1/2LI^2 where L is a leakage inductance and I is the peak collector current.

2N3773, 2N4348, 2N6259

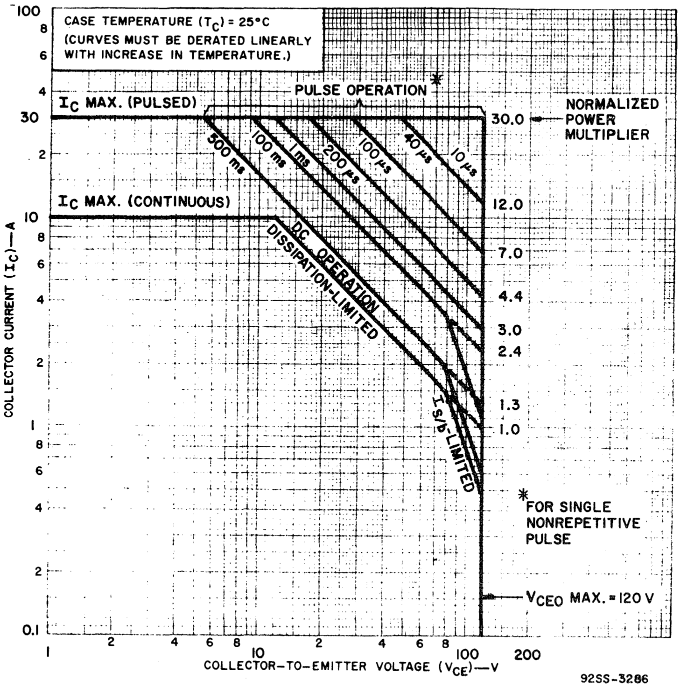


Fig. 5 — Maximum operating areas for 2N4348.

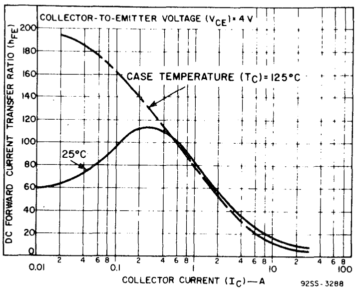


Fig. 7 — Typical dc beta characteristics for 2N3773.

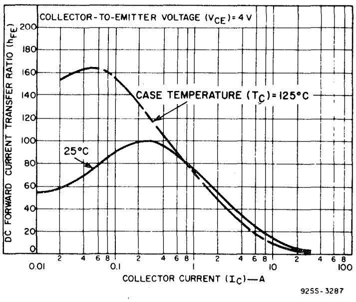


Fig. 8 — Typical dc beta characteristics for 2N4348.

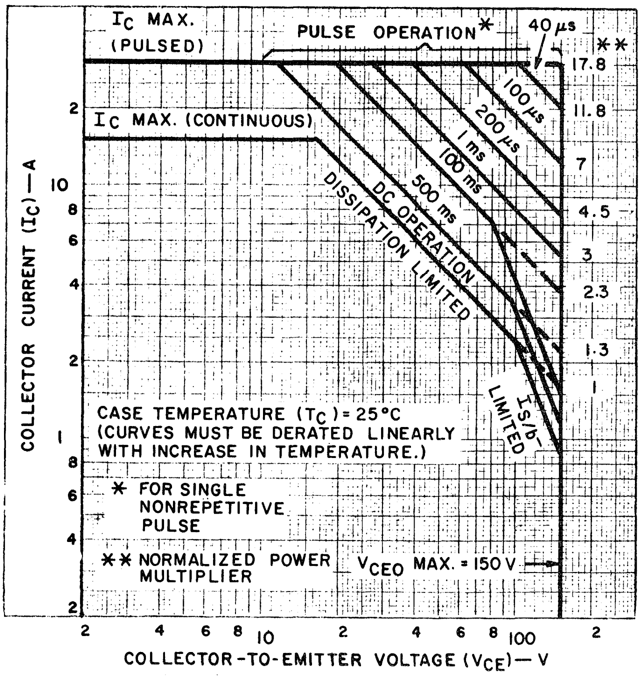


Fig. 6 — Maximum operating areas for 2N6259.

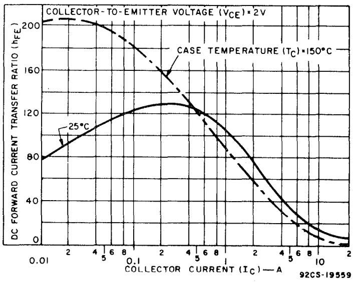


Fig. 9 — Typical dc beta characteristics for 2N6259.

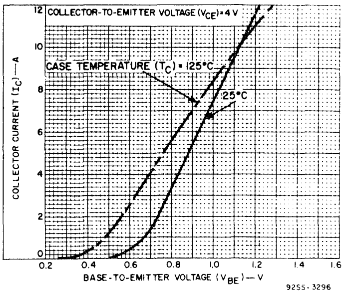


Fig. 10 — Typical transfer characteristics for 2N3773.

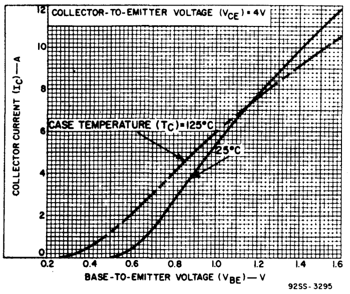


Fig. 11 — Typical transfer characteristics for 2N4348.

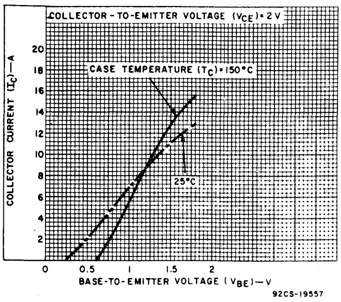


Fig. 12 — Typical transfer characteristics for 2N6259.

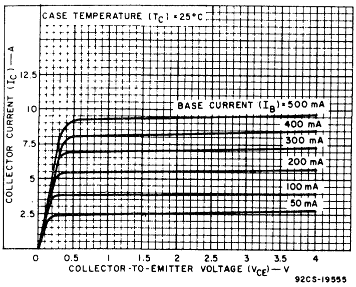


Fig. 13 — Typical output characteristics for 2N3773.

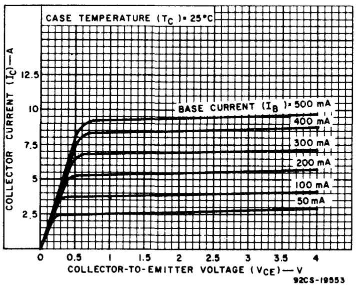


Fig. 14 — Typical output characteristics for 2N4348.

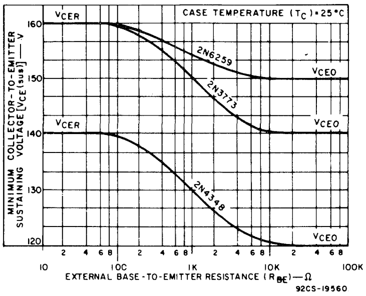


Fig. 15 — Sustaining voltage as a function of base-to-emitter resistance for all types.

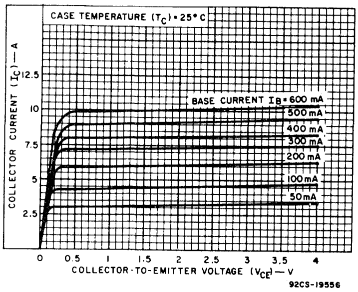


Fig. 16 — Typical output characteristics for 2N6259.

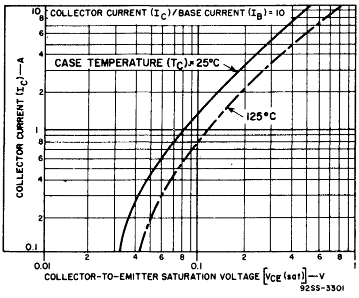


Fig. 17 - Typical saturation-voltage characteristics for 2N3773.

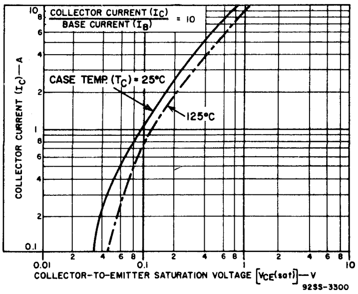


Fig. 18 - Typical saturation-voltage characteristics for 2N4348.

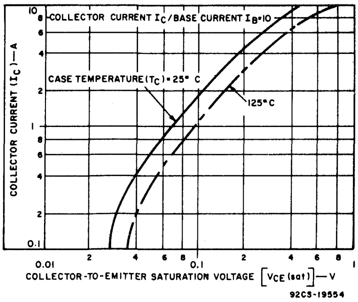


Fig. 19 - Typical saturation-voltage characteristics for 2N6259.

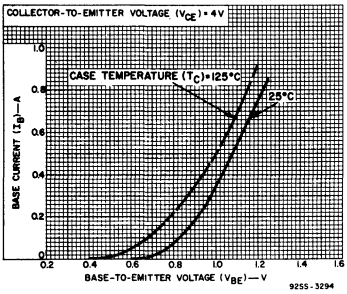


Fig. 20 - Typical input characteristics for 2N3773.

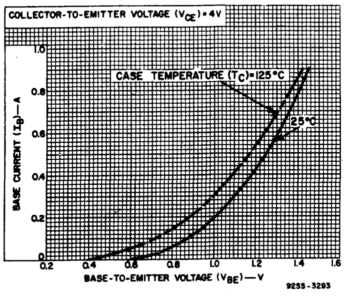


Fig. 21 - Typical input characteristics for 2N4348.

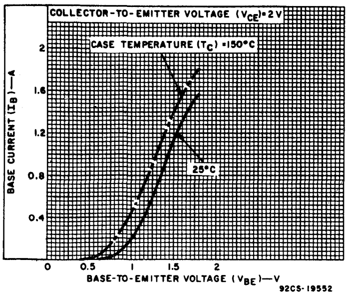


Fig. 22 - Typical input characteristics for 2N6259.

2N3791, 2N3792

Silicon P-N-P Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-2N3791 and 2N3792 are epitaxial-base silicon p-n-p transistors featuring high-gain at high current. They may be used as complements to the n-p-n types 2N3715 and 2N3716, respectively. These devices are intended for medium-speed switching and amplifier applications and feature a dissipation capability of 150 watts at case temperatures up to 25°C

They differ in voltage ratings and in the currents at which the parameters are controlled. Both are supplied in the steel JEDEC TO-204MA hermetic package.

Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-areas-of-operation curves**
- **Hermetically sealed JEDEC TO-204MA package**
- **High gain at high current**
- **Thermal-cycling rating curve**

APPLICATIONS:

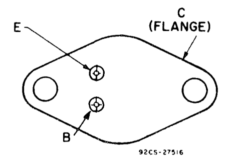
- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

Maximum Ratings, *Absolute-Maximum Values:*

	2N3791	2N3792	
* V_{CBO}	−60	−80	V
* V_{CEO}	−60	−80	V
* V_{EBO}	−7	−7	V
* I_C	−10	−10	A
* I_{CM}	−10	−10	A
* I_B	−4	−4	A
* P_T			
$T_C \leqslant 25°C$	150	150	W
$T_C > 25°C$ derate linearly	0.86		W/°C
* T_J, T_{stg}	−65 to 200		°C

* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

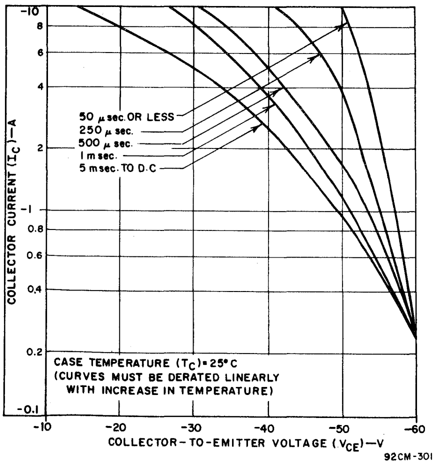


Fig. 1 — Maximum operating areas for 2N3791.

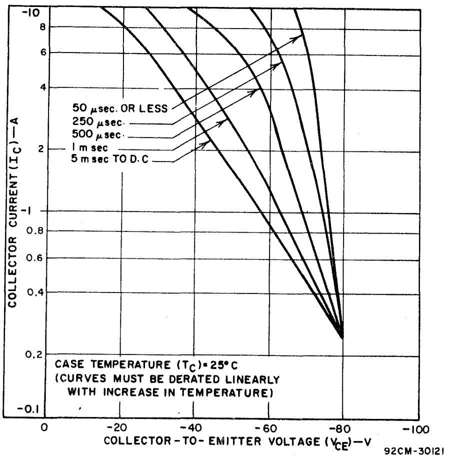


Fig. 2 — Maximum operating areas for 2N3792.

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C Unless Otherwise Specified

	CHARACTERISTICS	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N3791		2N3792		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
*	I_{CEX}	–60 –80	1.5 1.5	– –	– –	– –	–1 –	– –	– –1	mA
	T_C = 150°C	–60 –80	1.5 1.5	– –	– –	– –	–5 –	– –	– –5	
*	I_{CEO}	–30 –40		– –	– –	– –	–10 –10	– –	–10 –10	mA
*	I_{EBO}		7	–	–	–	–5	–	–5	mA
*	$V_{CEO}(sus)^b$			–0.2	0	–60	–	–80	–	V
*	$h_{FE}{}^a$	–2 –2 –4		–1 –3 –10	– – –	50 30 4	150 – –	50 30 4	150 – –	
*	V_{BE}	–2 –4		–5 –10	– –	– –	–1.8 –4.0	– –	–1.8 –4.0	V
*	$V_{BE}(sat)^a$			–5	–0.5	–	–1.5	–	–1.5	V
*	$V_{CE}(sat)^a$			–5 –10	–0.5 –2.0	– –	–1 –4	– –	–1 –4	V
*	f_{hfe}	–10		–0.5	–	30	–	30	–	KHz
*	h_{fe} f = 1 KHz	–10		–0.5	–	25	250	25	250	
*	$\|h_{fe}\|$ f = 1 MHz	–10		–0.5	–	4	–	4	–	
	$I_{S/b}$ tp = 1s	40				2.7	–	2.95	–	A
*	C_{ob} V_{CB} = 10 V f = 1 MHz			0		–	500	–	500	pF
*	$R_{\theta JC}$					–	1.17	–	1.17	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed; pulse duration = 200 µs, duty factor = 1.5%.

[b] **CAUTION:** Sustaining voltage, $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer.

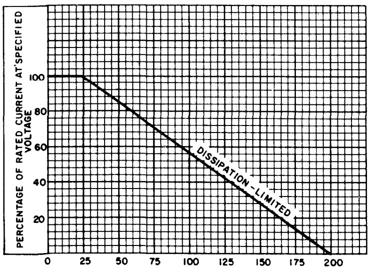


Fig. 3 — Derating curve.

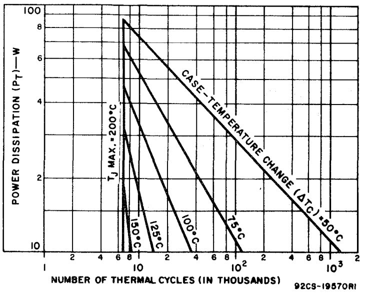


Fig. 4 — Thermal-cycling rating chart.

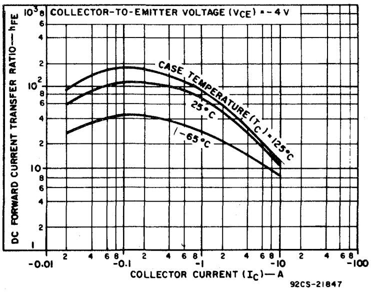


Fig. 5 — Typical dc beta characteristics for both types.

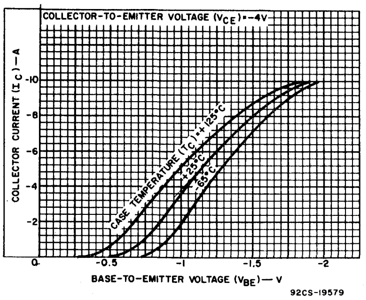


Fig. 6 — Typical transfer characteristics for both types.

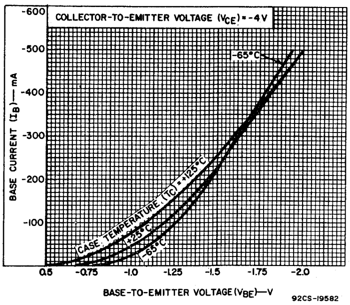


Fig. 7 — Typical input characteristics for both types.

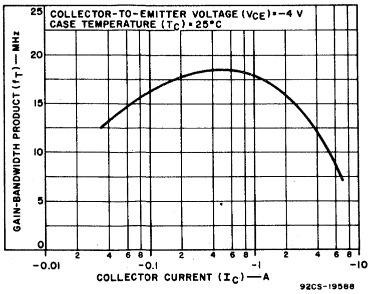


Fig. 8 — Typical gain-bandwidth product for both types.

2N3878, 2N3879, 2N5202, 2N6500, 40375

High-Speed, Epitaxial-Collector Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:

- Maximum-area-of-operation curves for dc and pulse operation
- Rated for safe operation in both forward- and reverse-bias conditions
- High sustaining voltage
- Total saturated transition time less than 1 μs for 2N3879, 2N5202, and 2N6500

RCA-2N3878, 2N3879, 2N5202, and 2N6500● are epitaxial silicon n-p-n transistors. The 2N3878 is an amplifier type intended for audio-, ultrasonic-, and radio-frequency circuits. Types 2N3879, 2N5202, and 2N6500 are switching transistors intended for use in high-current, high-speed switching circuits.

Type 40375 is a 2N3878 with a factory-attached heat radiator; it is intended for printed circuit-board applications.

Typical applications for these transistors include: low-distortion power amplifiers, oscillators, switching regulators, series regulators, converters, and inverters.

● Formerly RCA Dev. Type Nos. TA2509, TA2509A, TA7285, and TA8932, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3878 40375	2N3879	2N5202	2N6500	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	120	100	120	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 50 Ω	V_{CER}(sus)	65	90	75*	110*	V
With base open	V_{CEO}(sus)	50*	75*	50	90*	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	6	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	4	7	4	4	A
PEAK COLLECTOR CURRENT	I_{CM}	10	10	5	5	A
*CONTINUOUS BASE CURRENT	I_B	4	5	2	3	A
*TRANSISTOR DISSIPATION	P_T					
At case temperature (T_C) = 25°C		35 (2N3878)	35	35	35	W
At case temperatures above 25°C		Derate linearly at 0.2 W/°C				
At ambient temperature (T_A) = 25°C		5.8 (40375)	–	–	–	W
For other conditions		See Figs. 1,2,3, and 5				
*TEMPERATURE RANGE:						
Storage & operating (Junction)		-65 to 200				°C
*PIN TEMPERATURE:						
1/32 in. (0.8 mm) from seating plane for 10 s max.		235	235	235	235	°C

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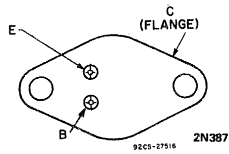
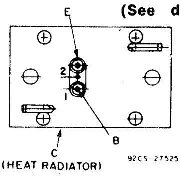
* In accordance with JEDEC registration data format JS-6 RDF-2 (2N3878); JS-6 RDF-1 (2N3879, 2N5202, 2N6500).

TERMINAL DESIGNATIONS



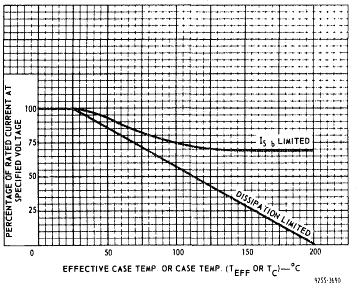
JEDEC TO-66
2N3878, 2N3879, 2N5202, 2N6500

(See dimensional outline "N".)



JEDEC TO-66 with Heat Radiator
40375

(See dimensional outline "O".)



Note: Use ambient temperature for derating 40375.

Fig. 2 - Dissipation derating for all types.

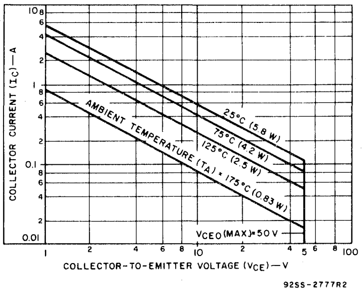


Fig. 3 - Maximum operating areas for 40375.

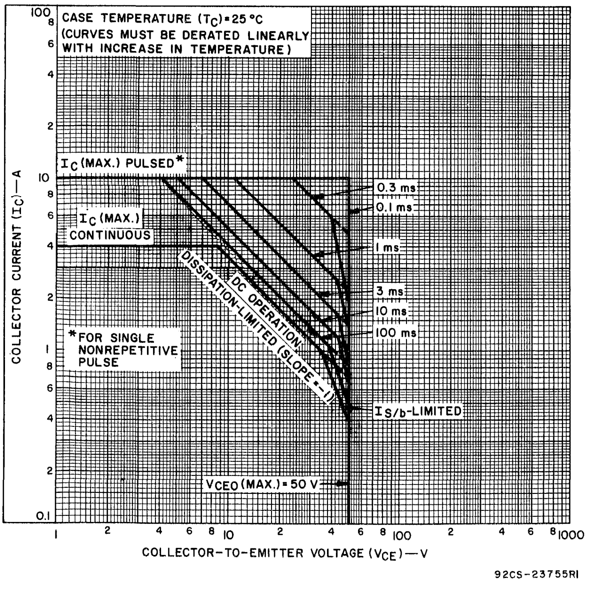


Fig. 1 - Maximum operating areas for 2N3878.

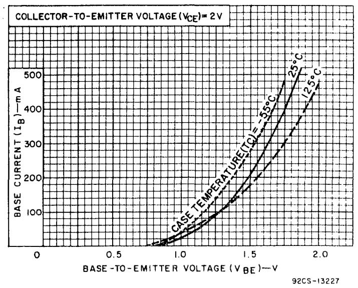


Fig. 4 - Typical input characteristics for all types.

2N3878, 2N3879, 2N5202, 2N6500, 40375

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25^{o}C unless otherwise specified:*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		2N3878 40375		2N3879		2N5202		2N6500		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current:														
* With base-emitter junction reverse-biased	I_{CEV}	100	−1.5			–	–	–	–	–	10	–	–	mA
		110	0			–	–	–	–	–	–	–	5	
		120	−1.5			–	25	–	25	–	–	–	–	
* With base-emitter junction reverse-biased and T_C = 150^{o}C		100	−1.5			–	4	–	4	–	10	–	–	
		110	0			–	–	–	–	–	–	–	10	
With base open	I_{CEO}	40			0	–	5*	–	5	–	–	–	–	mA
		70			0	–	–	–	–	–	–	–	5	
* Emitter Cutoff Current	I_{EBO}		−6			–	–	–	–	–	10	–	–	mA
			−7			–	10	–	10	–	–	–	25	
Collector-to-Emitter Sustaining Voltage With base open	V_{CEO}(sus)			0.2	0	50^{a}*		75^{a}*		50^{a}		90^{a}*		V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	V_{CER}(sus)			0.2	0	65^{a}		90^{a}		75^{a}		110^{a}		
DC Forward-Current Transfer Ratio	h_{FE}	1.2		4^{b}						10*	100*			
		2		0.5^{b}		40*	200*							
		2		3^{b}								15*	60*	
		2		4^{b}		8*		12*	100*					
		5		4^{b}		20*		20	80					
		5		0.5^{b}		50*	200*	40						
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			3^{b}	0.3								1.5	V
				4^{b}	0.4		2		1.2		1.2			
* Base-to-Emitter Voltage	V_{BE}	2		4^{b}			2.5							V
* Base-to-Emitter Saturation Voltage	V_{BE}(sat)			3^{b}	0.3								2.5	V
				4^{b}	0.4				2		2			
Collector-to-Base Output Capacitance : (f = 1 MHz, V_{CB} = 10 V)	C_{ob}						175		175		175		175	pF
Second Breakdown Collector Current With base forward-biased and 1-s nonrepetitive pulse	$I_{S/b}$	40				750		500		400		400		mA
Second-Breakdown Energy With base reverse-biased and R_{BE} = 50 Ω, V_{BB} = −4 V At L = 50 μH	$E_{S/b}$^{c}									0.4				mJ
At L = 125 μH						1		1				0.5		
* Magnitude of Common Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio:(f = 10 MHz)	$\|h_{fe}\|$	10		0.5		4		4		6		6		
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio:(f = 1 kHz)	h_{fe}	30		0.1		40								
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					2N3878	5		5		5		5	^{o}C/W
Junction-to-ambient	$R_{\theta JA}$					40375	30							

* In accordance with JEDEC registration data format JS-6 RDF-2 (2N3878); JS-6 RDF-1 (2N3879, 2N5202, 2N6500).

[a] CAUTION: Sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer.

[b] Pulsed, pulse duration = 300 μs, duty factor ≤ 2 %.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = 1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

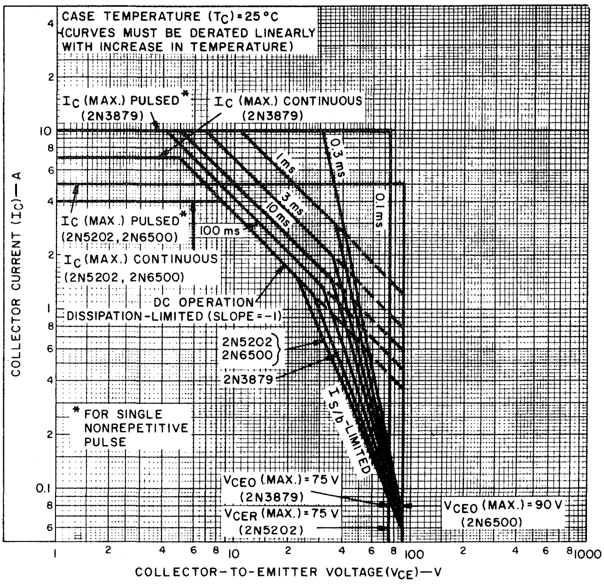
2N3878, 2N3879, 2N5202, 2N6500, 40375

TRANSITION AND STORAGE-TIME CHARACTERISTICS FOR SWITCHING TYPES, *At Case Temperature (T_C) = 25^{o}C:*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS						UNITS
		VOLTAGE V dc	CURRENT A dc		2N3879		2N5202		2N6500		
		V_{CC}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Saturated Switching Time Delay time	t_d	30 30 30	3 4 4	0.3^a 0.4^a 0.8^a	– – –	– 40 –	– – –	– – 40	– – –	40 – –	ns
* Rise time	t_r	30 30 30	3 4 4	0.3^a 0.4^a 0.8^a	– – –	– 400 –	– – –	– – 400	– – –	400 – –	
* Storage time	t_s	30 30 30	3 4 4	0.3^a 0.4^a 0.8^a	– – –	– 800 –	– – –	– – 1200	– – –	1000 – –	
* Fall time	t_f	30 30 30	3 4 4	0.3^a 0.4^a 0.8^a	– – –	– 400 –	– – –	– – 400	– – –	500 – –	

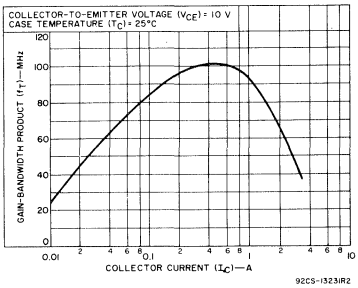
* In accordance with JEDEC registration data format (JS-6, RDF-1)

^{a} $I_{B_1} = I_{B_2}$



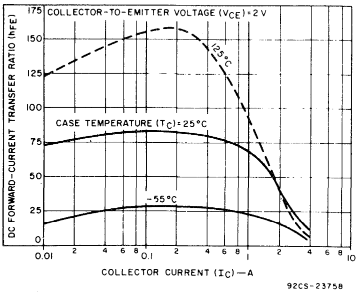
92CS-23756

Fig. 5 - Maximum operating areas for 2N3879, 2N5202, and 2N6500.



92CS-13231R2

Fig. 6 - Typical gain-bandwidth product for all types.



92CS-23758

Fig. 7 - Typical dc beta characteristics for 2N6500.

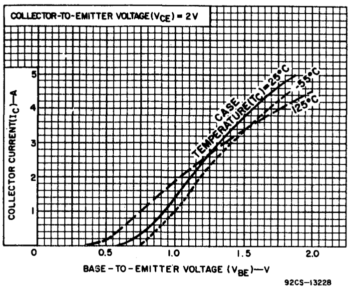


Fig. 8 - Typical transfer characteristics for all types.

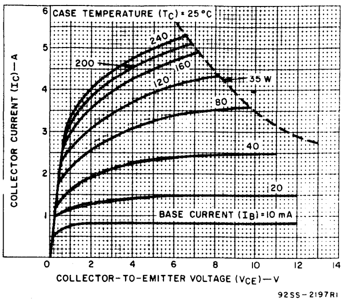


Fig. 9 - Typical output characteristics for 2N3878, 2N3879, 2N5202 and 40375.

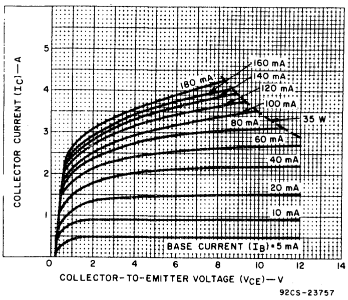


Fig. 10 - Typical output characteristics for 2N6500.

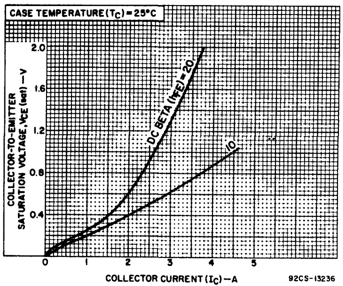


Fig. 11 - Typical saturation-voltage characteristics for 2N3878, and 2N3879.

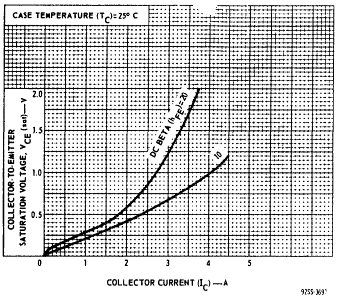


Fig. 12 - Typical saturation-voltage characteristics for 2N5202.

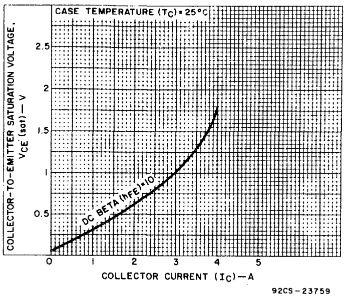


Fig. 13 - Typical saturation-voltage characteristics for 2N6500.

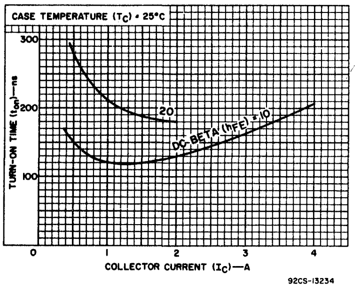


Fig. 14 - Typical turn-on time for 2N3879, 2N5202, and 2N6500.

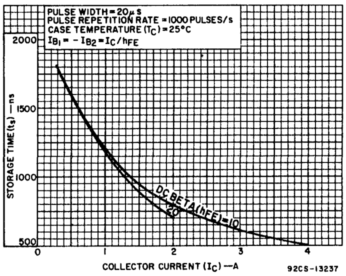


Fig. 15 - Typical storage time for 2N3879, 2N5202, and 2N6500.

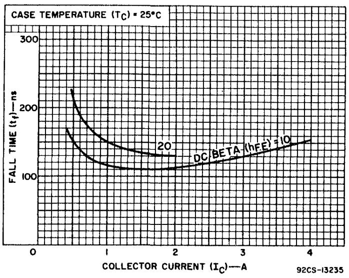


Fig. 16 - Typical fall time for 2N3879, 2N5202, and 2N6500.

2N4036, 2N4037, 2N4314, 40391, 40394

Medium-Power Silicon P-N-P Planar Transistors

General-Purpose Types for Industrial and Commercial Applications

These RCA types are double-diffused, epitaxial-planar, silicon p-n-p transistors; they differ in breakdown-voltage ratings, leakage-current, and saturation characteristics.

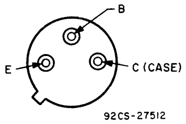
The 2N4036, 2N4037, 2N4314, 40391, and 40394 transistors are intended for a wide variety of small-signal medium-power applications. With a minimum gain-bandwidth product (f_T) of 60 MHz, these devices provide useful gain at high frequencies. In addition, the 2N4036 is useful in high-speed saturated switching applications.

Types 2N4036, 2N4037, 2N4314, and 41503 are supplied in the JEDEC TO-39 hermetic package. The 40391 is a 2N4037 with a factory attached heat radiator, intended for printed-circuit-board applications. Type 40394 is a 2N4037 with a factory-attached diamond-shaped mounting flange.

Features:

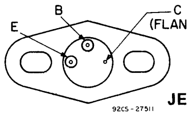
- **2N4036, 2N4037 are p-n-p complements of 2N2102, 2N3053**
- **Gain-bandwidth product (f_T) = 60 MHz min.**
- **High breakdown voltages**
- **Maximum-area-of-operation curves**
- **Planar construction provides low noise and low leakage**
- **Low saturation voltages**
- **High pulsed beta at high collector current**
- **Fast switching (2N4036)**

TERMINAL DESIGNATIONS



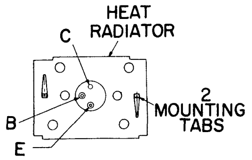
JEDEC TO-39
2N4036, 2N4037
2N4314

(See dimensional outline "C".)



JEDEC TO-39 with Flange
40394

(See dimensional outline "E".)



JEDEC TO-39 with Heat Radiator
40391

(See dimensional outline "D".)

MAXIMUM RATINGS, *Absolute Maximum Values:*		**2N4036**	**2N4037 40391, 40394**	**2N4314**	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−90	−60	−90	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With 1.5 volts (V_{BE}) of reverse bias	V_{CEV}(sus)	−85	−60	−85	V
With external base-to-emitter resistance (R_{BE}) ≤ 200Ω	V_{CER}(sus)	−85	−60	−85	V
* With base open	V_{CEO}(sus)	−65	−40	−65	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	−7	−7	−7	V
*COLLECTOR CURRENT	I_C	−1.0	−1.0	−1.0	A
*BASE CURRENT	I_B	−0.5	−0.5	−0.5	
*TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		7	7(2N4037)	7	W
		–	7(40394)	–	W
At free-air temperatures up to 25°C		1	3.5(40391)	1	W
		–	1(2N4037, 40394)	–	W
At temperatures above 25°C		Derate linearly to 200°C			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		−65 to 200			°C
*LEAD TEMPERATURE (During soldering):					
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		230			°C

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* In accordance with JEDEC registration data format (JS-6 RDF-1 2N4036; JS-9 RDF-2 2N4037, 2N4314).

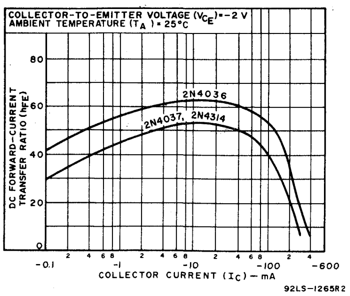


Fig.1—Typical dc-beta characteristics for 2N4036, 2N4037 and 2N4314.

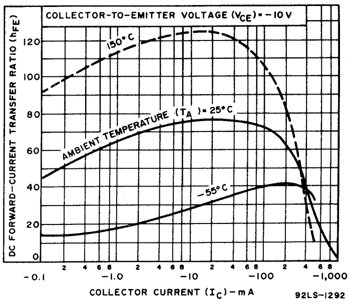


Fig.2—Typical dc beta characteristics for 2N4037 and 2N4314.

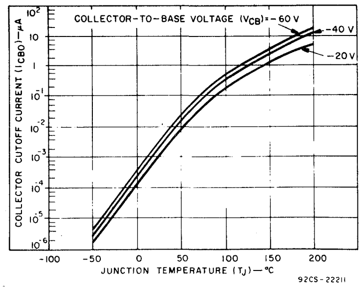


Fig.3 —Typical collector-cutoff current vs. junction temperature for 2N4036.

2N4036, 2N4037, 2N4314, 40391, 40394

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc			CUR-RENT mA dc	2N4036		2N4037 40391 40394		2N4314		
		V_{CB}	V_{CE}	V_{BE}	I_C	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With emitter open	I_{CBO}	–15 –90 –60				– –	– -0.1● -0.02	– – –	– – -0.25●	– – –	– – -0.25●	μA mA μA
With base open	I_{CEO}		–30			–	-0.5●	–	-5●	–	-5●	μA
With base-emitter junction reverse biased	I_{CEX}		–85	1.5		–	-100●	–	–	–	–	mA
T_C = 150°C			–30	1.5		–	-0.1●	–	–	–	–	
Emitter Cutoff Current	I_{EBO}			7 5	0 0	– –	-0.1● -0.02	– –	– -1●	– –	– -1●	mA μA
Collector-to-Base Breakdown Voltage (I_E = 0)	$V_{(BR)CBO}$				-0.1	-90	–	-60●	–	-90●	–	V
Emitter-to-Base Breakdown Voltage (I_E = -0.1 mA)	$V_{(BR)EBO}$				0	-7	–	-7	–	-7	–	V
Collector-to-Emitter Sustaining Voltage:												
With base-emitter junction reverse biased	V_{CEV}(sus)			1.5	-100	-85^a	–	-60^a	–	-85^a	–	V
With external base-to-emitter resistance (R_{BE}) ≤ 200Ω	V_{CER}(sus)				-100	-85^a	–	-60^a	–	-85^a	–	V
● With base open	V_{CEO}(sus)				-30 -100	– -65^a	– –	– -40^a	– –	– -65^a	– –	V
● Collector-to-Emitter Voltage (I_B = –15 mA)	V_{CE}(sat)				-150	–	-0.65	–	-1.4	–	-1.4	V
Base-to-Emitter Voltage	V_{BE}		-10		-150	–	-1.1	–	-1.5●	–	-1.5●	V
● Base-to-Emitter Voltage (I_B = –15 mA)	V_{BE}(sat)				-150	–	-1.4	–	–	–	–	V
● DC Forward-Current Transfer Ratio	h_{FE}		-2 -10 -10 -10 -10		-150 -0.1 -1.0 -150^b -500^b	20 20 – 40 20	200 – – 140 –	– – 15 50 –	– – – 250 –	– – 15 50 –	– – – 250 –	
Common-Emitter, Small-Signal Short-Circuit, Forward-Current Transfer Ratio (at f = 20 MHz)	h_{fe}		-10		-50	3	–	3	–	3	–	
● Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (at f = 20 MHz)	$\|h_{fe}\|$		-10		-50	3	–	3	10	3	10	
Collector-Base Capacitance (at f = 1 MHz, I_E = 0)	C_{cb}	-10				–	30	–	30●	–	30●	pF
Input Capacitance	C_{ib}			0.5	0	–	90	–	90	–	90	pF
● Sat. Switching Time^c												
Rise time	t_r		-30		-150	–	70	–	–	–	–	ηs
Storage time	t_s		-30		-150	–	600	–	–	–	–	
Fall time	t_f		-30		-150	–	100	–	–	–	–	
Turn-on time	t_{on}		-30		-150	–	110	–	–	–	–	
Turn-off time	t_{off}		-30		-150	–	700	–	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					– –	25● –	25 (max.) 2N4037 & 40394		– –	25 –	°C/W
Junction-to-Ambient	$R_{\theta JA}$					– –	165 –	165 (max.) 2N4037 40394 50 (max.) 40391		– –	165 –	

^{a}CAUTION: The sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) MUST NOT be measured on a curve tracer.

^{b} Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

●In accordance with JEDEC registration data format (JS-6 RDF-1 2N4036; JS-9 RDF-2 2N4037, 2N4314).

$^c I_{B1} = I_{B2}$ = 15 mA

2N4036, 2N4037, 2N4314, 40391, 40394

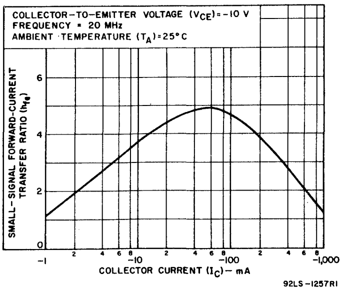


Fig.4—Typical small-signal beta characteristics for all types.

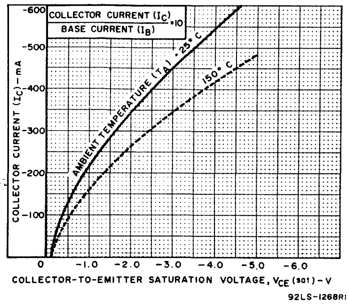


Fig. 5—Typical saturation-voltage characteristics for 2N4036.

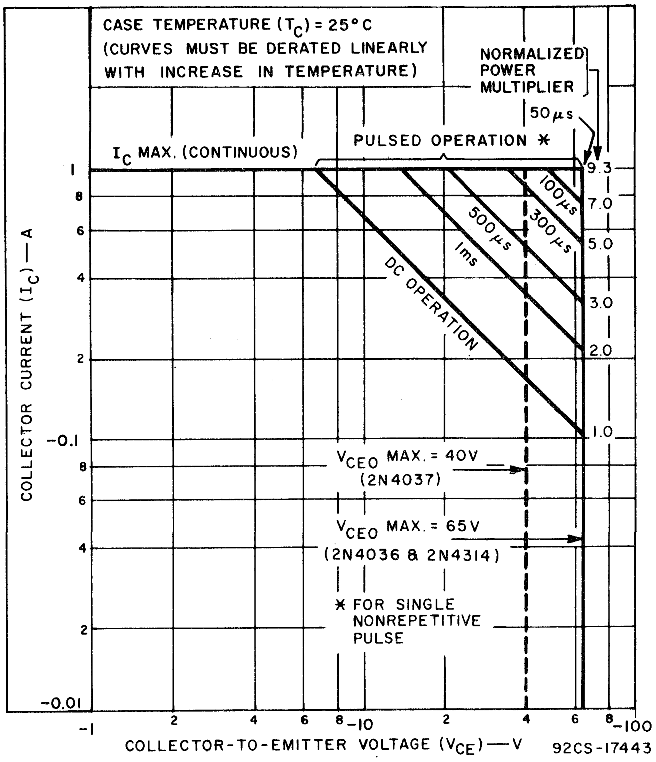


Fig. 6—Maximum operating areas for 2N4036, 2N4037, and 2N4314.

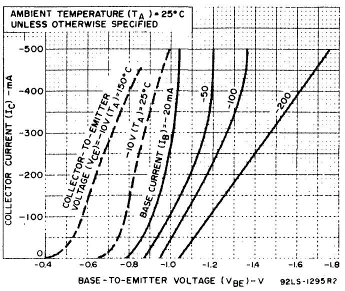


Fig.7—Typical transfer characteristics for 2N4037 and 2N4314.

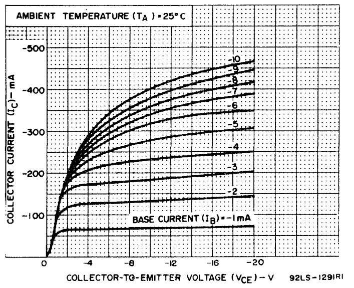


Fig.8—Typical large-signal output characteristics for 2N4037, 2N4314, 40391, and 40394.

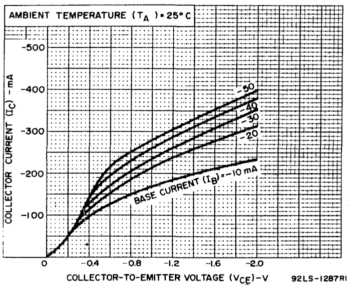


Fig.9—Typical small-signal output characteristics for 2N4037, 2N4314, 40391, and 40394.

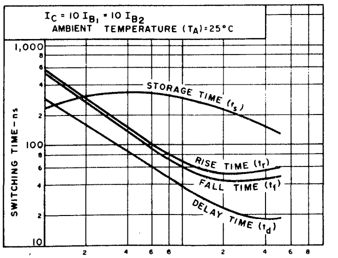


Fig.10—Typical saturated switching times for 2N4036.

2N4231A, 2N4232A, 2N4233A, 2N6312, 2N6313, 2N6314

Silicon N-P-N and P-N-P Medium-Power Transistors

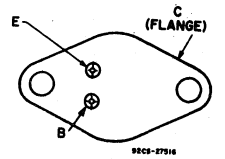
General-Purpose Types for Switching Applications

RCA-2N4231A, 2N4232A, and 2N4233A are multiple-epitaxial n-p-n transistors. The RCA-2N6312, 2N6313, and 2N6314 are multiple-epitaxial p-n-p transistors. They are complements to 2N4231A, 2N4232A, and 2N4233A. These types are supplied in steel JEDEC TO-213MA hermetic packages.

Features:

- **2N4231A–2N4233A complements of 2N6312–2N6314**
- **Low saturation voltages**
- **Maximum-safe-area-of-operation curves**
- **Thermal-cycle ratings**
- **High gain at high current**

TERMINAL DESIGNATIONS



JEDEC TO-213MA
(See dimensional outline "N".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	N-P-N 2N4231A	2N4232A	2N4233A	
	P-N-P 2N6312◆	2N6313◆	2N6314◆	
* V_{CBO}	40	60	80	V
V_{CEO}(sus)	40	60	80	V
* V_{EBO}	5	5	5	V
* I_C (2N4231A, 2N4232A, 2N4233A)		3		A
(2N6312, 2N6313, 2N6314)		5		A
* I_{CM} (Registered for 2N6312, 13, 14 only)		10		A
* I_B (2N4231A, 2N4233A, 2N4233A)		1		A
(2N6312, 2N6313, 2N6314)		2		A
* P_T $T_C \leqslant 25°C$		75		W
$T_C > 25°C$ derate linearly		0.43		W/°C
* T_J, T_{stg} (2N4231A, 2N4232A, 2N4233A)		–55 to 200		°C
(2N6312, 2N6313, 2N6314)		–65 to 200		°C
* T_L (2N6312, 2N6313, 2N6314 only) At distances ⩾1/32 in. (0.8 mm) from seating plane for 10 s max.		235		°C

* In accordance with JEDEC registration data.

◆ For p-n-p devices, voltage and current values are negative.

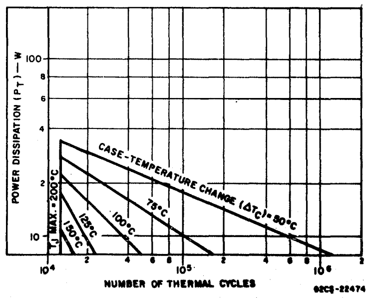


Fig. 2 — Thermal-cycling rating chart for all types.

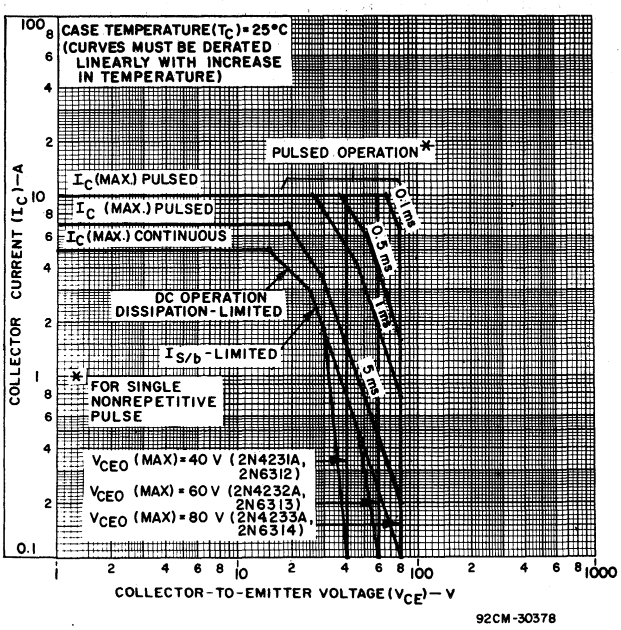


Fig. 1 — Maximum operating areas for all types.◆

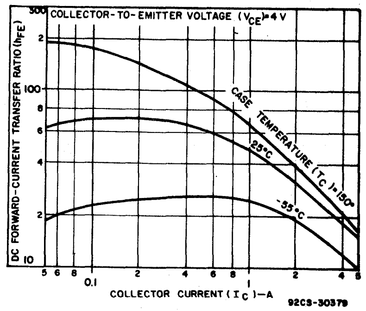


Fig. 3 — Typical dc beta characteristics for 2N4231A, 2N4232A, and 2N4233A.

◆ For p-n-p devices, voltage and current values are negative.

2N4231A, 2N4232A, 2N4233A, 2N6312, 2N6313, 2N6314

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

	CHARACTERISTIC	TEST CONDITIONS♦				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N4231A 2N6312♦		2N4232A 2N6313♦		2N4233A 2N6314♦		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
*	I_{CBO}	40^a				–	50	–	–	–	–	µA
		60^a				–	–	–	50	–	–	
		80^a				–	–	–	–	–	50	
*	I_{CEX}	40	–1.5			–	100	–	–	–	–	
	R_{BE} = 100 Ω	60	–1.5			–	–	–	100	–	–	
		80	–1.5			–	–	–	–	–	100	
*	R_{BE} = 100 Ω,	40	–1.5			–	1	–	–	–	–	mA
	T_C = 150°C	60	–1.5			–	–	–	1	–	–	
		80	–1.5			–	–	–	–	–	1	
*	I_{CEO}	30			0	–	1	–	–	–	–	
		50			0	–	–	–	1	–	–	
		70			0	–	–	–	–	–	1	
*	I_{EBO}		–5			–	0.5	–	0.5	–	0.5	
*	h_{FE}	2		3^c		10	–	10	–	10	–	
	2N4231A, 2N4232A,	2		1.5^c		25	100	25	100	25	100	
	2N4233A	2		0.5^c		40	–	40	–	40	–	
		4		5^c		4	–	4	–	4	–	
	2N6312, 2N6313,	4		3^c		10	–	10	–	10	–	
	2N6314	4		1.5^c		25	100	25	100	25	100	
		4		0.5^c		40	–	40	–	40	–	
*	V_{BE} 2N4231A, 2N4232A, 2N4233A	2		1.5^c		–	1.4	–	1.4	–	1.4	
	2N6312, 2N6313, 2N6314	4		1.5^c		–	1.4	–	1.4	–	1.4	
*	V_{CE}(sat) 2N4231A, 2N4232A,			3^c	0.3	–	2	–	2	–	2	V
	2N4233A			1.5^c	0.15	–	0.7	–	0.7	–	0.7	
				5^c	1.25	–	4	–	4	–	4	
	2N6312, 2N6313, 2N6314			3^c	0.3	–	2	–	2	–	2	
				1.5^c	0.15	–	0.7	–	0.7	–	0.7	
*	$V_{CEO}(sus)^b$			0.1^c	0	40	–	60	–	80	–	
*	$\lvert h_{fe} \rvert$ f=1 MHz	10		0.5		4	–	4	–	4	–	
*	h_{fe} f=1 kHz	10		0.5		20	–	20	–	20	–	
	f_T	10		0.5		4	–	4	–	4	–	MHz
*	C_{obo} f = 0.1 MHz 2N4231A, 2N4233A, 2N4233A	10^a				–	200	–	200	–	200	pF
	2N6312, 2N6313, 2N6314	10^a				–	300	–	300	–	300	
	$R_{\theta JC}$					–	2.3	–	2.3	–	2.3	°C/W

* In accordance with JEDEC registration data format.

♦ For p-n-p devices, voltage and current values are negative.

[a] V_{CB} value.

[b] **CAUTION:** Sustaining voltages V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

[c] Pulsed, pulse duration = 300 µs, duty factor = 1.8%.

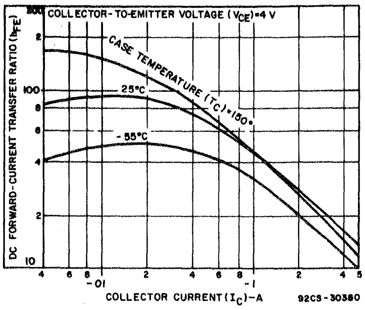


Fig. 4 — Typical dc beta characteristics for 2N6312, 2N6313, and 2N6314.

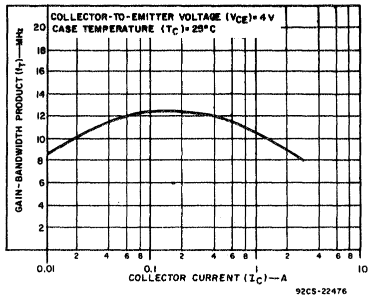


Fig. 5 — Typical gain-bandwidth product for all types.♦

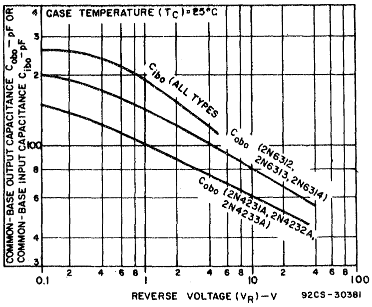


Fig. 6 — Typical common-base input or output capacitance characteristics as a function of reverse voltage for all types.♦

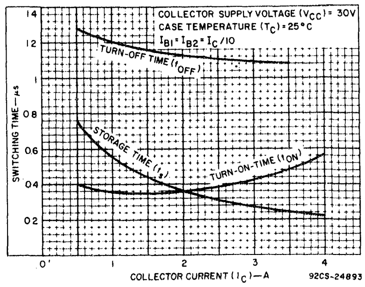


Fig. 7 — Typical saturated switching characteristics for 2N4231A, 2N4232A, and 2N4233A.

♦For p-n-p devices, voltage and current values are negative.

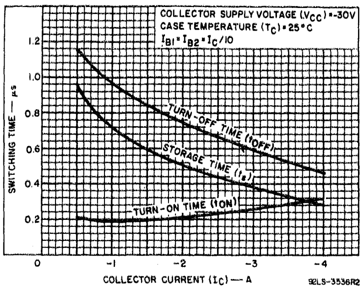


Fig. 8 — Typical saturated switching characteristics for 2N6312, 2N6313, and 2N6314.

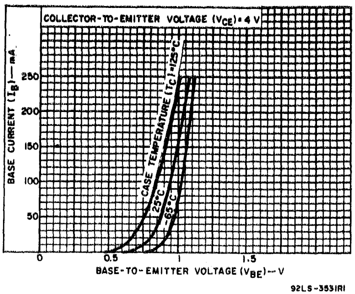


Fig. 9 — Typical input characteristics for all types.♦

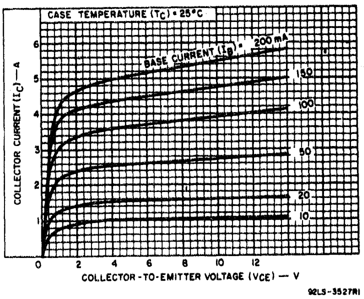


Fig. 10 — Typical output characteristics for all types.♦

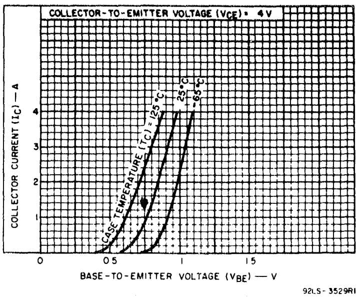


Fig. 11 — Typical transfer characteristics for all types.♦

♦For p-n-p devices, voltage and current values are negative.

2N4898, 2N4899, 2N4900

Silicon P-N-P Medium-Power Transistors

General-Purpose Types for Switching Applications

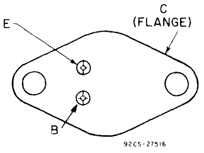
The RCA-2N4898, -2N4899, and -2N4900 are multiple-epitaxial p-n-p transistors. All are supplied in the JEDEC TO-213MA package.

All these transistors are intended for a wide variety of medium-power switching and amplifier applications, such as series and output stages of high-fidelity amplifiers.

Features:

- Low saturation voltages
- Maximum-safe-area-of-operation curves
- Hermetically-sealed JEDEC TO-213MA package

TERMINAL DESIGNATIONS



JEDEC TO-213MA

(See dimensional outline "N".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N4898	2N4899	2N4900	
* V_{CBO}	40	60	80	V
* $V_{CEX}(sus)$				
$V_{BE} = -1.5$ V, $R_{BE} = 100\ \Omega$	40	60	80	V
$V_{CEO}(sus)$	40	60	80	V
* V_{EBO}	5	5	5	V
* I_C	1	1	1	A
I_{CM}	4	4	4	A
* I_B	1	1	1	A
* P_T				
At T_C up to 25°C	25	25	25	W
At T_C above 25°C	See Figs. 1, 3			
* T_J, T_{stg}	−65 to +200			°C
* T_L				
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	+235			°C

* In accordance with JEDEC registration data.

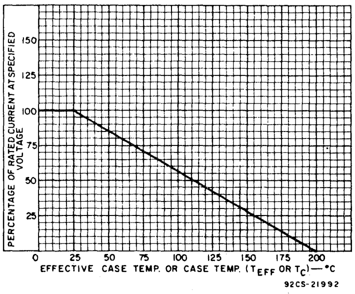


Fig. 2 — Current derating chart for all types.

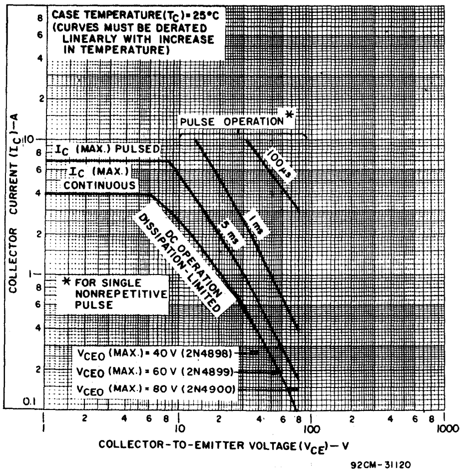


Fig. 1 — Maximum operating areas for all types. (T_C = 25°C).

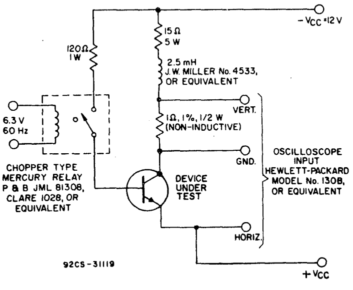


Fig. 3 — Circuit used to measure sustaining voltage, $V_{CEO}(sus)$.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

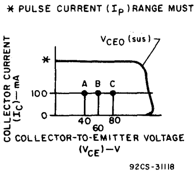
CHARACTERISTICS	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N4898		2N4899		2N4900		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CBO}	40[a]				–	100	–	–	–	–	μA
	60[a]				–	–	–	100	–	–	
	80[a]				–	–	–	–	–	100	
* I_{CEX} R_{BE} = 100 Ω	40	−1.5			–	100	–	–	–	–	μA
	60	−1.5			–	–	–	100	–	–	
	80	−1.5			–	–	–	–	–	100	
* R_{BE} = 100 Ω T_C = 150°C	40	−1.5			–	1	–	–	–	–	mA
	60	−1.5			–	–	–	1	–	–	
	80	−1.5			–	–	–	–	–	1	
* I_{CEO}	20				–	0.5	–	–	–	–	mA
	30				–	–	–	0.5	–	–	
	40				–	–	–	–	–	0.5	
* I_{EBO}		−5			–	1	–	1	–	1	mA
* h_{FE}	1		0.5[b]		20	100	20	100	20	100	
	1		0.05[b]		40	–	40	–	40	–	
	1		1[b]		10	–	10	–	10	–	
* V_{CEO}(sus)[c]			0.1[b]		40	–	60	–	80	–	V
V_{BE}(sat)			1[b]	0.1	–	1.3	–	1.3	–	1.3	V
* V_{BE}	1		1[b]		–	1.3	–	1.3	–	1.3	V
* V_{CE}(sat)			1[b]	0.1	–	0.6	–	0.6	–	0.6	V
* h_{fe} f = 1 kHz	10		0.25		25	–	25	–	25	–	
* f_T f = 1 MHz	10		0.25		3	–	3	–	3	–	MHz
C_{obo}	10[a]				–	100	–	100	–	100	pF
$R_{\theta JC}$					–	7	–	7	–	7	°C/W

* In accordance with JEDEC registration data.

[a] V_{CB} value.

[b] Pulsed, pulse duration = 300 μs, duty factor = 1.8%.

[c] **CAUTION:** Sustaining voltage, V_{CEO}(sus), *MUST NOT* be measured on a curve tracer. (See Figs. 2 and 4.)



The sustaining voltage, V_{CEO}(sus), is acceptable when the trace falls to the right of point "A" for type 2N4898; point "B" for type 2N4899; and point "C" for type 2N4900.

Fig. 4 — Oscilloscope display for measurement of sustaining voltages.

2N4904, 2N4905, 2N4906

Silicon P-N-P Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-2N4904, 2N4905 and 2N4906 are epitaxial-base silicon p-n-p transistors featuring high-gain at high current. They may be used as complements to the 2N4913, 2N4914 and 2N4915 n-p-n types, respectively. These devices are intended for medium-speed switching and amplifier applications and feature a dissipation capability of 87.5 watts at case temperatures up to 25°C.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204MA hermetic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N4904	2N4905	2N4906	
* V_{CEO}	−40	−60	−80	V
* V_{CBO}	−40	−60	−80	V
* V_{EBO}	−5	−5	−5	V
* I_C	−5	−5	−5	A
* I_B	−1	−1	−1	A
* P_T				
At $T_C \leqslant 25^{\circ}C$	87.5	87.5	87.5	W
At $T_C > 25^{\circ}C$ derate linearly		0.5		W/°C
* T_J, T_{stg}		−65 to 200		°C
* T_L at 1/16 ± 1/32 in. (1.58 ± 0.8 mm) from case for 10 s		235		°C

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* In accordance with JEDEC registration data.

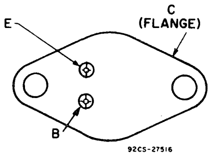
Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**
- **Hermetically sealed JEDEC TO-3/TO-204MA package**
- **High gain at high current**
- **Thermal-cycling rating curve**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

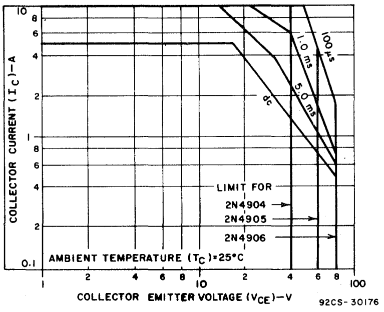


Fig. 1 — Maximum operating areas for all types.

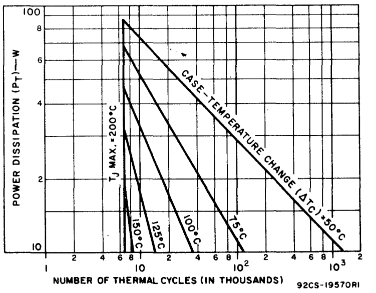


Fig. 2 — Thermal-cycling rating chart.

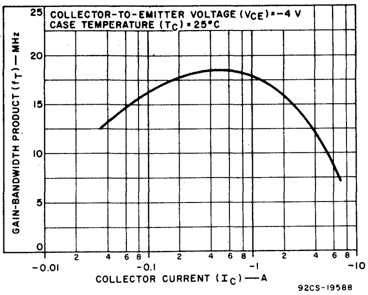


Fig. 3 — Typical gain-bandwidth product for all types.

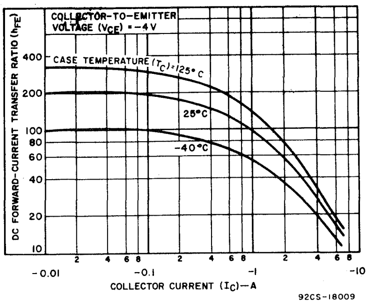


Fig. 4 — Typical dc beta characteristics for all types.

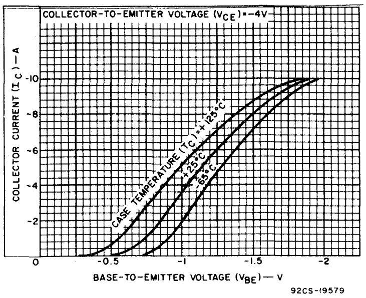


Fig. 5 — Typical transfer characteristics for all types.

2N4904, 2N4905, 2N4906

ELECTRICAL CHARACTERISTICS, At Case Temperature $T_C = 25^oC$ Unless Otherwise Specified

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		2N4904		2N4905		2N4906		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEX}	–40	1.5	–	–	–	–0.1	–	–	–	–	mA
	–60	1.5	–	–	–	–	–	–0.1	–	–	
	–80	1.5	–	–	–	–	–	–	–	–0.1	
T_C=150°C	–40	1.5	–	–	–	–2	–	–	–	–	
	–60	1.5	–	–	–	–	–	–2	–	–	
	–80	1.5	–	–	–	–	–	–	–	–2	
* I_{CEO}	–40	–	–	0	–	–1	–	–	–	–	mA
	–60	–	–	0	–	–	–	–1	–	–	
	–80	–	–	0	–	–	–	–	–	–1	
I_{CBO}	40^c	–	–	–	–	–0.1	–	–	–	–	mA
$I_E = 0$	60^c	–	–	–	–	–	–	–0.1	–	–	
	80^c	–	–	–	–	–	–	–	–	–0.1	
* I_{EBO}	–	5	0	–	–	–1	–	–1	–	–1	mA
* $V_{CEO}(sus)^b$	–	–	–0.2	0	–40	–	–60	–	–80	–	V
* h_{FE}^a	–2	–	–2.5	–	25	100	25	100	25	100	
	–2	–	–5	–	7	–	7	–	7	–	
* V_{BE}^a	–2	–	–2.5	–	–	–1.4	–	–1.4	–	–1.4	V
* $V_{CE}(sat)^a$	–	–	–2.5	–0.25	–	–1	–	–1	–	–1	V
	–	–	–5	–1	–	–1.5	–	–1.5	–	–1.5	
* f_T f=1 MHz	–10	–	–1	–	4	–	4	–	4	–	MHz
* h_{fe} f=1 kHz	–10	–	–0.5	–	40	–	40	–	40	–	
* $R_{\theta JC}$	–	–	–	–	–	2	–	2	–	2	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed; pulse duration = 300 μs, duty factor = 2%.

[b] *CAUTION:* Sustaining voltage, $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer.

[c] V_{CB}.

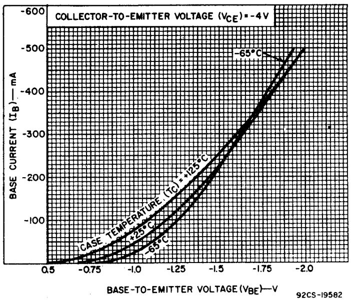


Fig. 6 — Typical input characteristics for all types.

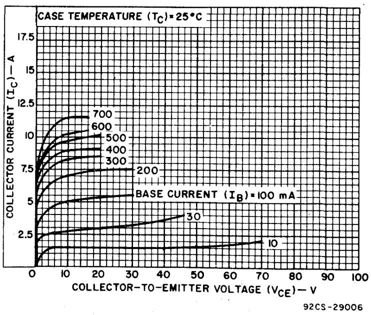


Fig. 7 — Typical output characteristics for all types.

2N4913, 2N4914, 2N4915

Silicon N-P-N Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-2N4913, 2N4914, and 2N4915 are epitaxial-base silicon n-p-n transistors featuring high-gain at high current. They may be used as complements to the 2N4904, 2N4905, and 2N4906 p-n-p types respectively. These devices are intended for medium-speed switching and feature a dissipation capability of 87.5 watts at case temperature up to 25°C.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204MA hermetic package.

Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-areas-of-operation curves**
- **Hermetically sealed JEDEC TO-3/TO-204MA package**
- **High gain at high current**
- **Thermal-cycling rating curve**

Applications:

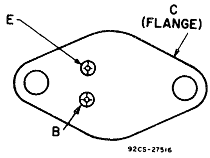
- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N4913	2N4914	2N4915	
* V_{CEO}	40	60	80	V
* V_{CBO}	40	60	80	V
* V_{EBO}	5	5	5	V
* I_C	5	5	5	A
* I_B	1	1	1	A
* P_T				
At $T_C \leqslant 25^\circ C$	87.5	87.5	87.5	W
At $T_C > 25^\circ C$ derate linearly		0.5		W/°C
* T_L				
At 1/16 in. ± 1/32 in. (1.58 mm 0.8 mm) from case for 10 s		235		°C
* T_J, T_{stg}		−65 to 200		°C

* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

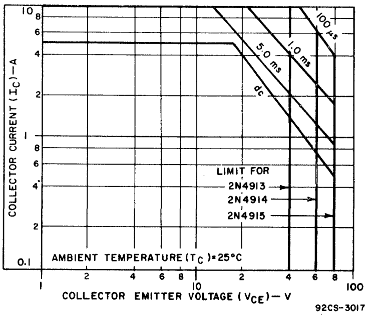


Fig. 1 — Maximum operating areas for all types.

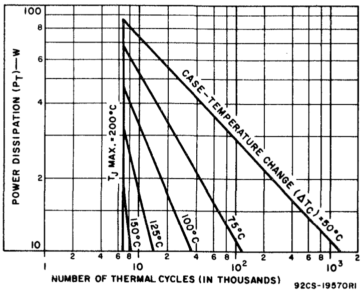


Fig. 2 — Thermal-cycling rating chart.

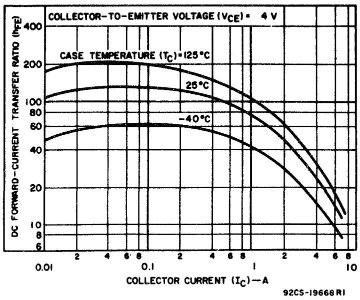


Fig. 3 — Typical dc beta characteristics for all types.

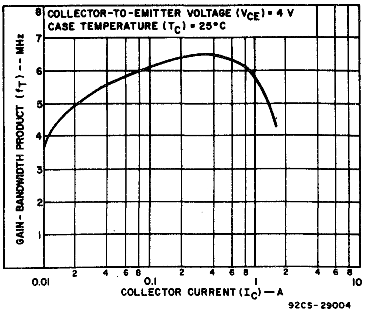


Fig. 4 — Typical gain bandwidth product for all types.

2N4913, 2N4914, 2N4915

ELECTRICAL CHARACTERISTICS, at Case Temperature T_C = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N4913		2N4914		2N4915		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEX}	40 60 80	−1.5 −1.5 −1.5	– – –	– – –	– – –	0.1 – –	– – –	– 0.1 –	– – –	– – 0.1	mA
T_C = 150°C	40 60 80	−1.5 −1.5 −1.5	– – –	– – –	– – –	2 – –	– – –	– 2 –	– – –	– – 2	
* I_{CEO}	40 60 80	– – –	– – –	0 0 0	– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
I_{CBO}	40^c 60^c 80^c	– – –	– – –	– – –	– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
* I_{EBO}	–	5	–	–	–	1	–	1	–	1	mA
* $V_{CEO}(sus)^b$	–	–	0.2	0	40	–	60	–	80	–	V
* $h_{FE}{}^a$	2 2	– –	2.5 5	– –	25 7	100 –	25 7	100 –	25 7	100 –	
* $V_{BE}{}^a$	2	–	2.5	–	–	1.4	–	1.4	–	1.4	V
* $V_{CE}(sat)^a$	– –	– –	2.5 5	0.25 1	– –	0.75 1.5	– –	0.75 1.5	– –	0.75 1.5	V
* f_T f = 1 MHz	10	–	1	–	4	–	4	–	4	–	MHz
* h_{fe} f = 1 kHz	10	–	0.5	–	20	–	20	–	20	–	
$R_{\theta JC}$	–	–	–	–	–	2	–	2	–	2	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed; pulse duration = 300 μs, Duty factor = 2%.

[b] **CAUTION:** Sustaining voltage, $BV_{CEO}(sus)$, *MUST NOT BE* measured on a curve tracer.

[c] V_{CB}

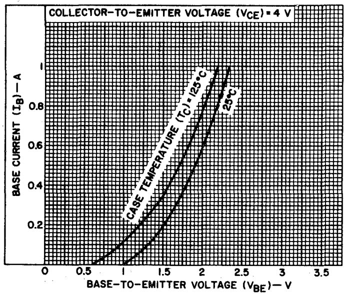


Fig. 5 — Typical input characteristics for all types.

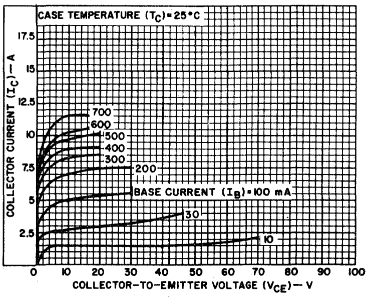


Fig. 6 — Typical output characteristics for all types.

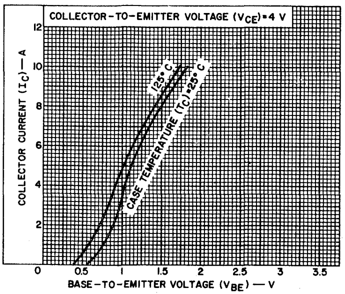


Fig. 7 — Typical transfer characteristics for all types.

2N5038, 2N5039, 2N6354, 2N6496

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistors

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

RCA-2N5038, 2N5039, 2N6354, and 2N6496 are epitaxial silicon n-p-n power transistors. They differ in breakdown-voltage ratings, leakage-current, and dc-beta values

The high current-handling capability of these transistors in conjunction with fast switching speeds make these devices especially sutted for switching-control amplifiers, power gates, switching regulators, converters, and inverters. Other recommended applications include dc-rf amplifiers and power oscillators. These transistors are supplied in the JEDEC TO-3 package.

Features:

- **Maximum operating area curves for dc and pulse operation**
- **$I_{S/b}$-limit line beginning at 28 V**
- **High collector current ratings**
- **High-dissipation capability**
- **Fast switching speeds —**
  Measured at: 5 A, 8 A, 10 A, 12 A levels

MAXIMUM RATINGS, *Absolute Maximum Values:*

		2N5038	2N5039	2N6354	2N6496	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	150	120	150	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With −1.5 volts (V_{BE}) of reverse bias and external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CEX}(sus)	150	120	–	–	V
* With external base-to-emitter resistance (R_{BE}) = 500Ω, L = 7mH	V_{CEX}	–	–	130	–	V
With $R_{BE} \leqslant 50\Omega$	V_{CER}(sus)	110	95	–	130	V
With base open	V_{CEO}(sus)	90	75	120	110	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	6.5	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	20	20	10	15	A
*PEAK COLLECTOR CURRENT	I_{CM}	30	30	12	–	A
*CONTINUOUS BASE CURRENT	I_B	5	5	5	5	A
*TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C and V_{CE} up to 28 V		140	140	140	140	W
At case temperature of 100°C and V_{CB} of 20 V		80	80	80	80	W
At case temperatures above 25°C		Derate linearly to 200°C				
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to 200				°C
PIN TEMPERATURE (During soldering) At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230				

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* In accordance with JEDEC registration data format (JS-6, RDF-1)

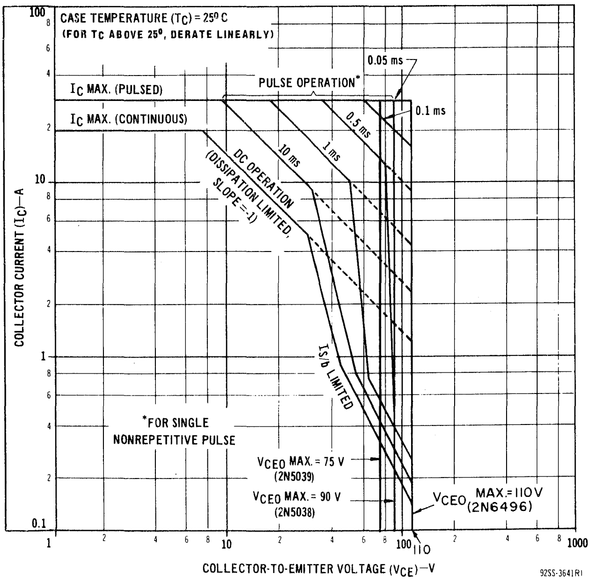
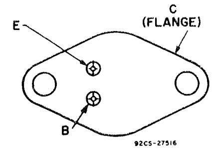


Fig. 1 — Maximum operating areas for 2N5038, 2N5039, 2N6496.

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

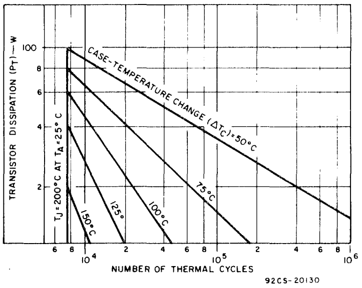


Fig. 2 — Thermal-cycling rating chart for all types.

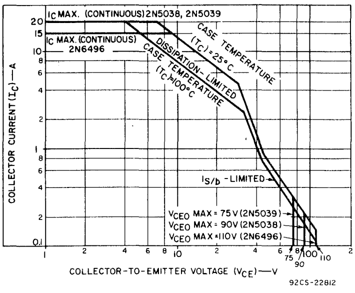


Fig. 3 — Maximum operating areas for 2N5038, 2N5039, 2N6496.

2N5038, 2N5039, 2N6354, 2N6496

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		2N5038		2N5039		2N6354		2N6496		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
*	I_{CBO} V_{CB} = 150 V					–	–	–	–	–	5	–	–	mA
	I_{CEO}	55			0	–	–	–	20	–	–	–	–	mA
		70			0	–	20	–	–	–	–	–	–	
		100				–	–	–	–	–	20	–	–	
	I_{CEV}	110	-1.5			–	–	–	50	–	–	–	–	mA
*		130	0			–	–	–	–	–	–	–	20	
		140	-1.5			–	50	–	–	–	–	–	–	
		140	0			–	–	–	–	–	10	–	–	
	T_C = 150°C	85	-1.5			–	–	–	10	–	–	–	–	
*		100	-1.5			–	10	–	–	–	–	–	–	
		130	0			–	–	–	–	–	–	–	25	
*	T_C = 125°C	140	0			–	–	–	–	–	20	–	–	
	I_{EBO}		-5	0		–	5	–	15	–	–	–	–	mA
*			-6.5	0		–	–	–	–	–	5	–	–	
			-7	0		–	50	–	50	–	–	–	50	
*	h_{FE}	2		5^a		–	–	–	–	20	150	–	–	
*		2		8^a		–	–	–	–	–	–	12	100	
*		2		10^a		–	–	–	–	10	100	–	–	
		5		2^a		50	250	30	250	–	–	–	–	
*		5		10^a		–	–	20	100	–	–	–	–	
*		5		12^a		20	100	–	–	–	–	–	–	
*	$\lvert h_{fe} \rvert$													
	f = 5 MHz	10		2		12	–	12	–	–	–	12	–	
	f = 10 MHz	10		1		–	–	–	–	8	–	–	–	
	V_{CEO}(sus)			0.2^a	0	90^b	–	75^b	–	120^b	–	100^b	–	
	V_{CEX}(sus) (R_{BE}) = 100Ω		-1.5	0.2	0	150^b	–	120^b	–	–	–	–	–	V
	V_{CER} R_{BE} ⩽ 50Ω			0.2	0	110^b	–	95^b	–	–	–	130^b	–	
	⩽ 100Ω			0.2		–	–	–	–	130^b	–	–	–	
	V_{EBO} I_E = 0.05 A			0		7	–	7	–	–	–	7	–	V
*	= 0.005 A			0		–	–	–	–	6.5	–	–	–	
	V_{BE}	2		8^a		–	–	–	–	–	–	–	1.6	V
		5		10^a		–	–	–	1.8	–	–	–	–	
		5		12^a		–	1.8	–	–	–	–	–	–	
*	V_{CE}(sat)			8^a	0.8	–	–	–	–	–	–	–	1.0	V
*				5^a	0.5	–	–	–	–	–	0.5	–	–	
				10^a	1.0	–	–	–	1.0	–	1	–	–	
				12^a	1.2	–	1.0	–	–	–	–	–	–	
*				20^a	5	–	2.5	–	2.5	–	–	–	–	
*	V_{BE}(sat)			5^a	0.5	–	–	–	–	–	1.3	–	–	V
				8^a	0.8	–	–	–	–	–	–	–	2.0	
*				10^a	1	–	–	–	–	–	2	–	–	
*				20^a	5	–	3.3	–	3.3	–	–	–	–	
	C_{ob} V_{CB} = 10V, f = 1 MHz					–	400	–	400	–	400	–	400	pF

* In accordance with JEDEC registration data format (JS-6, RDF-1).

[a] Pulsed; pulse duration ⩽ 350 μs, duty factor = 2%.

[b] CAUTION: The sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) MUST NOT be measured on a curve tracer.

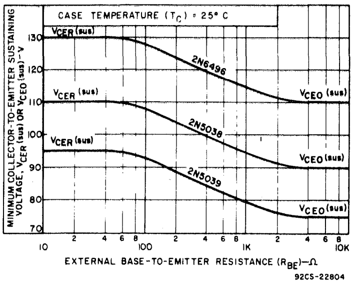


Fig. 4 — Collector-to-emitter sustaining voltage characteristics for 2N5038, 2N5039 and 2N6496.

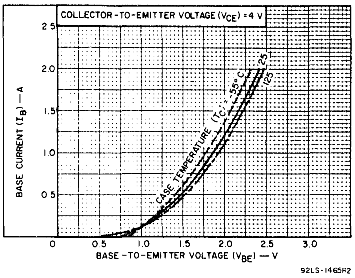


Fig. 5 — Typical input characteristics for 2N5038 and 2N5039.

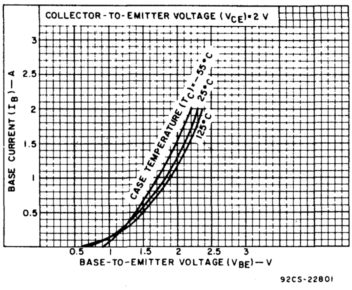


Fig. 6 — Typical input characteristic for 2N6496.

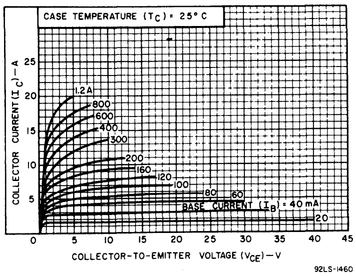


Fig. 7 — Typical output characteristics for 2N5038.

2N5038, 2N5039, 2N6354, 2N6496

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified (Cont.)*

SYMBOL	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		2N5038		2N5039		2N6354		2N6496		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
$I_{S/b}$	25				–	–	–	–	5.5	–	–	–	A
t = 1s,	28				5.0	–	5.0	–	–	–	5.0	–	
nonrepetitive	45				0.9	–	0.9	–	–	–	0.9	–	
$E_{S/b}$ R_{BE} = 51Ω, L = 25µH		-1	5		–	–	–	–	0.3	–	–	–	mJ
R_B = 20Ω,		-4	12		13	–	13	–	–	–	–	–	
L = 180µH		-4	8		–	–	–	–	–	–	5.7	–	
* t_r (V_{CC} = 30 V, $I_{B_1} = I_{B_2}$): Rise Time			5	0.5	–	–	–	–	–	0.3	–	–	µs
			8	0.8	–	–	–	–	–	–	–	0.5	
			10	1.0	–	–	–	0.5	–	1	–	–	
			12	1.2	–	0.5	–	–	–	–	–	–	
* t_{s_1}			5	0.5	–	–	–	–	–	1	–	–	
			8	0.8	–	–	–	–	–	–	–	1.5	
			10	1.0	–	–	–	1.5	–	–	–	–	
			12	1.2	–	1.5	–	–	–	–	–	–	
t_{s_2} (No Load)			0.5	0.5	–	–	–	–	–	2	–	–	
* t_f			5	0.5	–	–	–	–	–	0.2	–	–	
			8	0.8	–	–	–	–	–	–	–	0.5	
			10	1.0	–	–	–	0.5	–	–	–	–	
			12	1.2	–	0.5	–	–	–	–	–	–	
$R_{\theta JC}$	10		10		–	1.25	–	1.25	–	–	–	1.25	°C/W
	20		1		–	–	–	–	–	1.25	–	–	

* In accordance with JEDEC registration data format (JS-6, RDF-1).

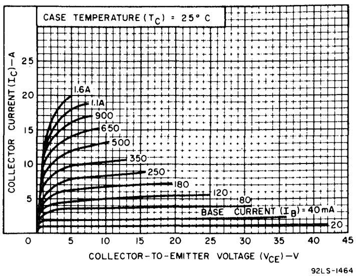


Fig. 8 — Typical output characteristics for 2N5039.

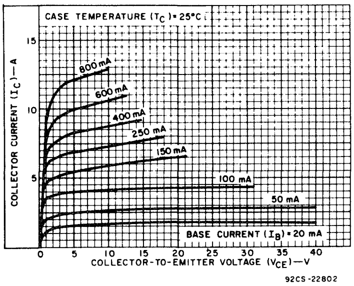


Fig. 9 — Typical output characteristics for 2N6496.

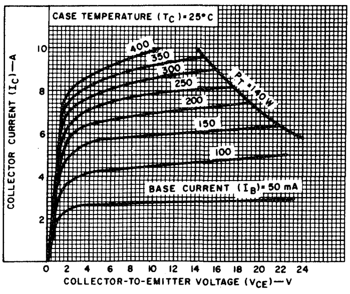


Fig. 10 — Typical output characteristics for 2N6354.

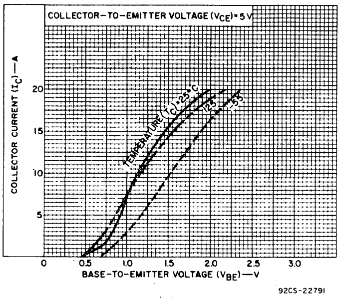


Fig. 11 — Typical transfer characteristics for 2N5038.

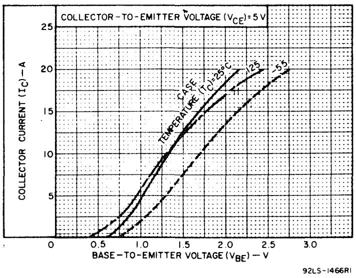


Fig. 12 — Typical transfer characteristics for 2N5039.

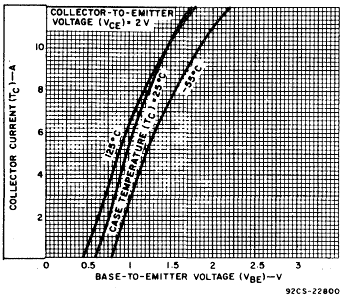


Fig. 13 — Typical transfer characteristics for 2N6496.

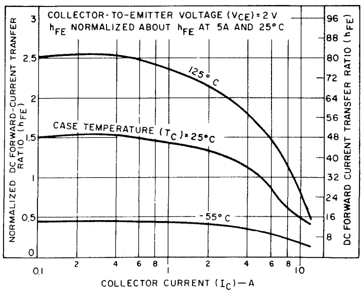


Fig. 14 - Typical normalized dc beta characteristics for 2N6354.

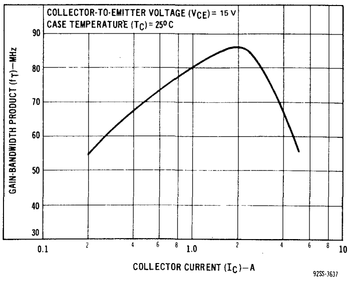


Fig. 15 - Typical gain-bandwidth product for 2N5038, 2N5039, and 2N6496.

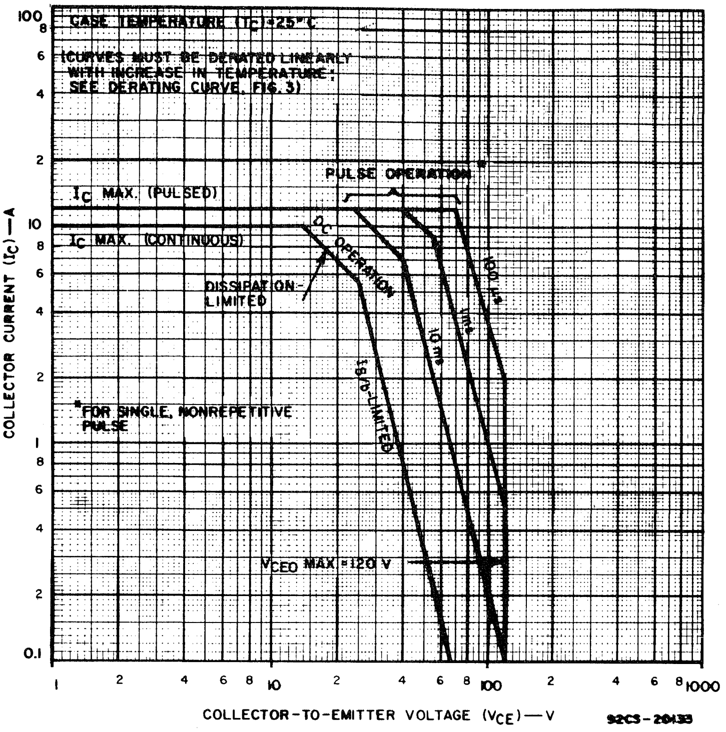


Fig. 16 — Maximum operating areas for 2N6354.

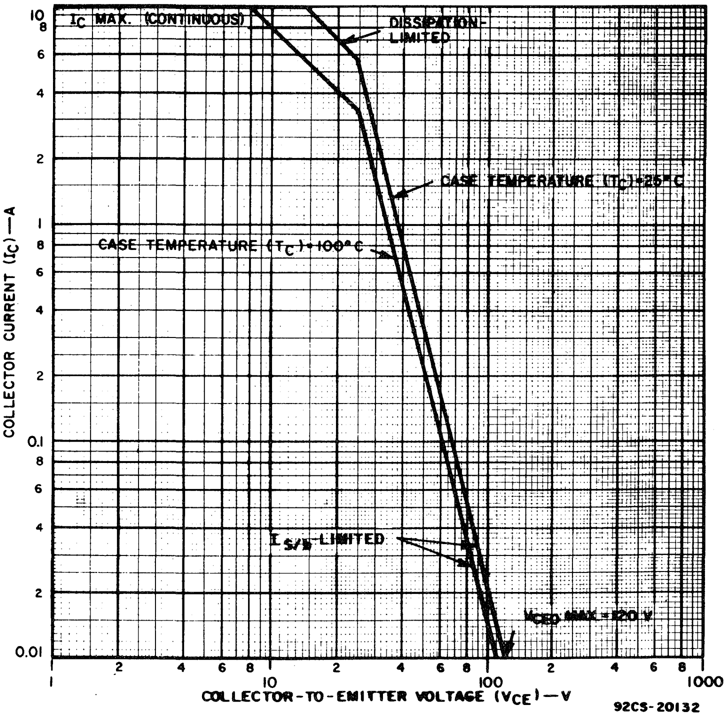


Fig. 17 — Maximum operating areas for 2N6354.

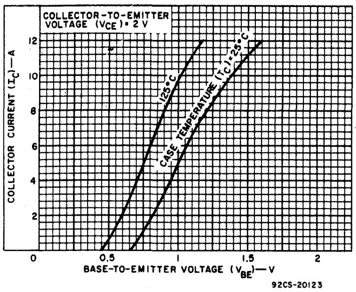


Fig. 18 — Typical transfer characteristics for 2N6354.

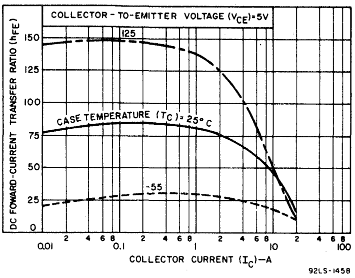


Fig. 19 — Typical dc beta characteristics for 2N5038.

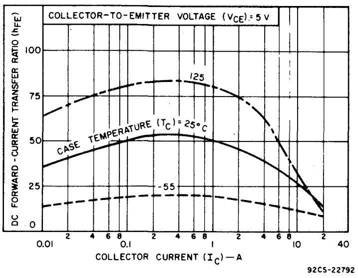


Fig. 20 — Typical dc beta characteristics for 2N5039.

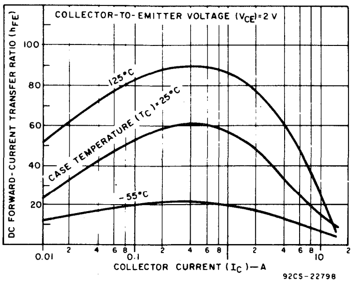


Fig. 21 — Typical dc beta characteristics for 2N6496.

2N5038, 2N5039, 2N6354, 2N6496

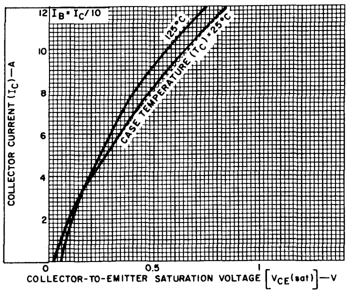


Fig. 22 — Typical saturation voltage characteristics for 2N6354.

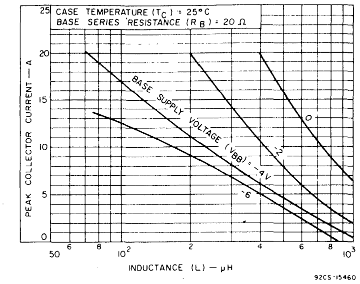


Fig. 23 — Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

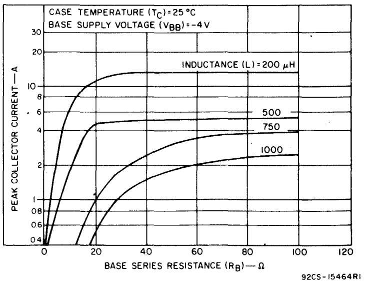


Fig. 24 — Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

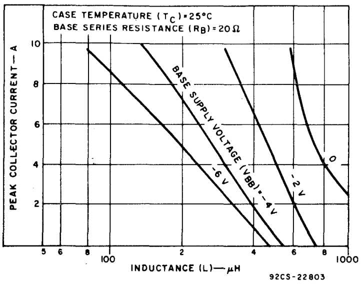


Fig. 25 — Maximum reverse-bias, second-breakdown characteristics for 2N6496.

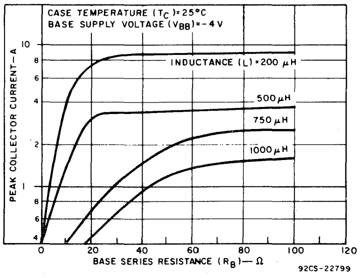


Fig. 26 — Maximum reverse-bias, second-breakdown characteristics for 2N6496.

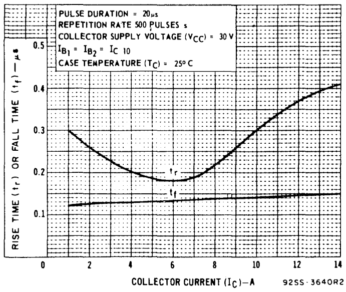


Fig. 27 — Typical rise-time and fall-time characteristics for 2N5038, 2N5039, 2N6496.

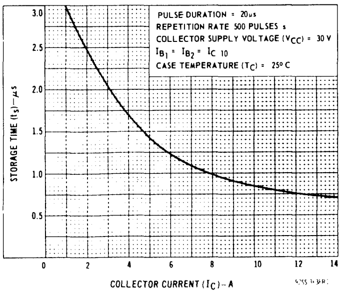


Fig. 28 — Typical storage time characteristics for 2N5038, 2N5039, 2N6496.

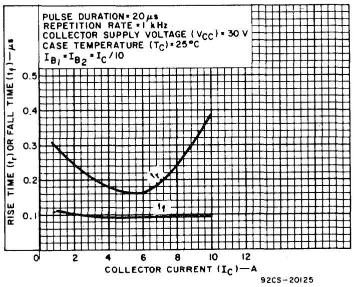


Fig. 29 — Typical rise- and fall-time characteristics for 2N6354.

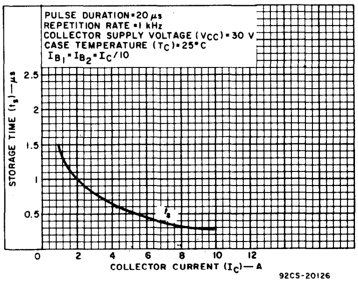


Fig. 30 — Typical storage-time characteristics for 2N6354.

2N5050, 2N5051, 2N5052

High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:

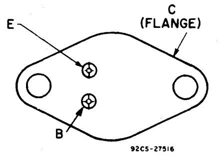
- **Economy types for ac/dc circuits**
- **Fast turn-on time at high collector current**

The RCA-2N5050, 2N5051, and 2N5052 are silicon n-p-n transistors with high breakdown voltages and fast switching speeds.

Typical applications for these transistors include high-voltage operational amplifiers, high-voltage switches, switching regulators, converters, inverters, deflection- and hi-fi amplifiers.

The 2N5050, 2N5051, and 2N5052 transistors are supplied in steel JEDEC TO-213MA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-213MA

(See dimensional outline "N".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5050	2N5051	2N5052	
* V_{CBO}	125	150	200	V
* V_{CEO}	125	150	200	V
* V_{EBO}	6			V
* I_C	2			A
I_{CM}	4			A
* I_B	1			A
* P_T				
T_C up to 25°C	40			W
T_C above 25°C, derate linearly	0.266			W/°C
* T_{stg}	−65 to 200			°C
* T_C	−65 to 175			°C
* T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235			°C

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* In accordance with JEDEC registration data.

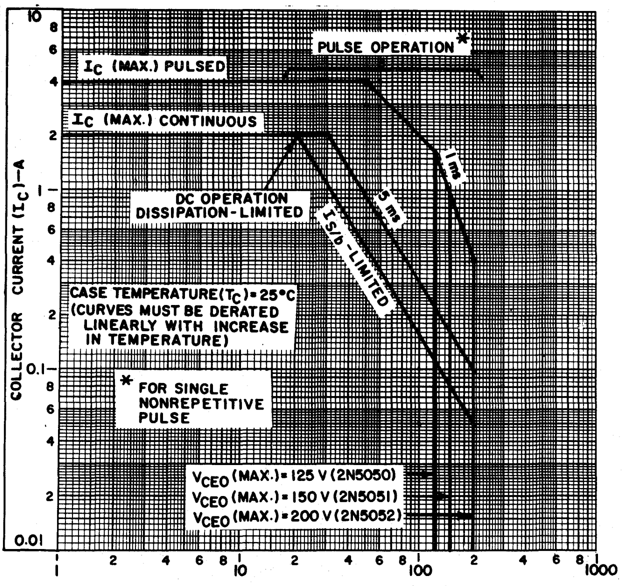


Fig. 1 — Maximum operating areas for all types.

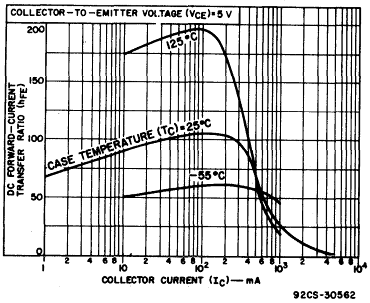


Fig. 2 — Typical dc beta characteristics for all types.

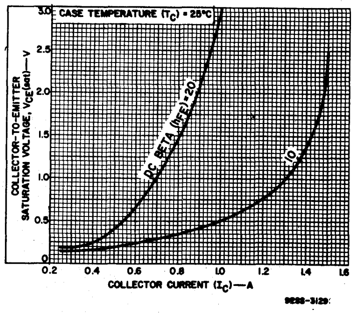


Fig. 3 — Typical collector-to-emitter saturation voltage as a function of collector current.

2N5050, 2N5051, 2N5052

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS						Units
	VOLTAGE V dc		CURRENT A dc		2N5050		2N5051		2N5052		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEX}	125 150 200	−1.5 −1.5 −1.5			– – –	0.5 – –	– – –	– 0.5 –	– – –	– – 0.5	mA
At T_C = 150°C	125 150 200	−1.5 −1.5 −1.5			– – –	5 – –	– – –	– 5 –	– – –	– – 5	
* I_{CEO}	62.5 75 100				– – –	0.1 – –	– – –	– 0.1 –	– – –	– – 0.1	
* I_{EBO}		−6	0		–	0.1	–	0.1	–	0.1	
* V_{CEO}(sus)[b]			0.2[a]	0	125	–	150	–	200	–	V
* h_{FE}	5 5 5		0.75[a] 1[a] 2[a]		25 25 5	100 – –	25 25 5	100 – –	25 25 5	100 – –	
* V_{BE}	5		0.75[a]		–	1.2	–	1.2	–	1.2	
* V_{CE}(sat)			0.75[a] 2[a]	0.1 0.4	– –	1 5	– –	1 5	– –	1 5	V
$I_{S/b}$	100				0.15	–	0.15	–	0.15	–	mA
* $\|h_{fe}\|$ f = 5 MHz	10		0.25		2	–	2	–	2	–	
* h_{fe} f = 1 kHz	10		0.25		25	–	25	–	25	–	
* C_{obo} f = 1 MHz	10[c]		0		–	250	–	250	–	250	pF
* t_r	120[d]		0.75	0.1	–	0.3	–	0.3	–	0.3	µs
* t_s	120[d]		0.75	0.1	–	3.5	–	3.5	–	3.5	
* t_f	120[d]		0.75	0.1	–	1.2	–	1.2	–	1.2	
$R_{\theta JC}$					–	3.7	–	3.7	–	3.7	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 µs, duty factor ≤2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer. See circuit, Fig. 9, or equivalent, to measure V_{CEO}(sus).

[c] V_{CB} value

[d] V_{CC} value

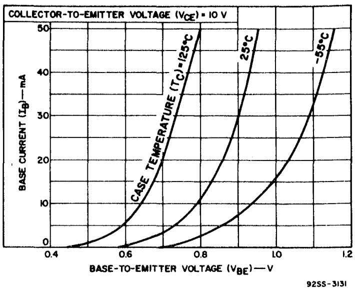


Fig. 4 – Typical input characteristics for all types.

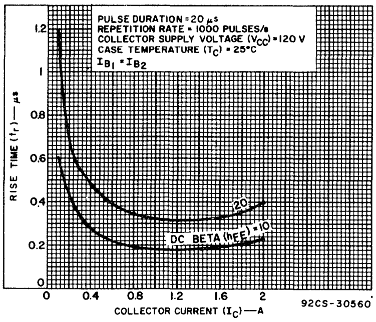


Fig. 5 – Typical rise time as a function of collector current.

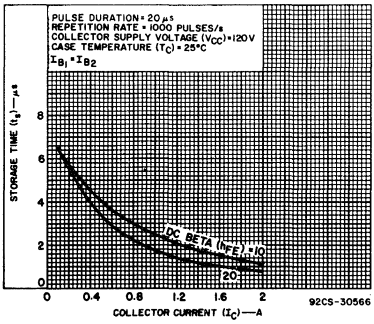


Fig. 6 – Typical storage time as a function of collector current.

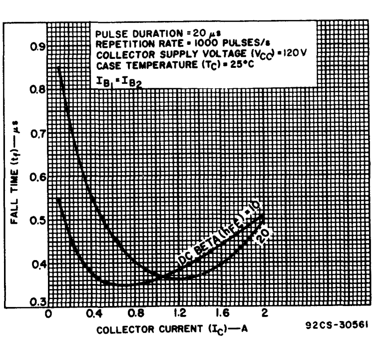


Fig. 7 – Typical fall time as a function of collector current.

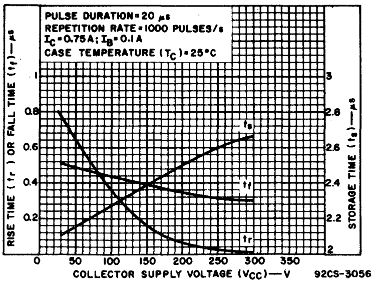


Fig. 8 – Typical rise, fall, and storage time as a function of collector supply voltage.

2N5239, 2N5240

High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications in Industrial and Commercial Service

The RCA-2N5239 and 2N5240• are multiple epitaxial silicon n-p-n power transistors employing a new overlay construction with several emitter sites.

The high breakdown voltage ratings and exceptional second-breakdown capabilities of these transistors make them especially suitable for use in series regulators, power amplifiers, inverters, deflection circuits, switching regulators, and high-voltage bridge amplifiers.

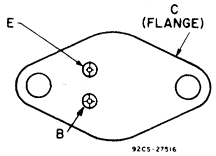
These types differ in breakdown voltage and leakage current values. The 2N5239 and 2N5240 are supplied in steel JEDEC TO-204MA hermetic packages.

•RCA Dev. Nos. TA2765 and TA2765A, respectively.

Features:

- **High voltage ratings: V_{CER}(sus)**
  = 350 V, $R_{BE} \leqslant 50\ \Omega$ (2N5240)
  = 250 V, $R_{BE} \leqslant 50\ \Omega$ (2N5239)
- **High power dissipation rating:**
  P_T = 100 W at V_{CE} = 150 V,
  T_C = 25°C
- **For switching applications where circuit values and operating conditions require a transistor with a high second breakdown rating ($I_{S/b}$) (limit line begins at 150 V)**
- **Exceptional second-breakdown:**
  0.67A at V_{CE} = 150 V
- **Maximum area-of-operation curves for dc and pulse operation**

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values*

	2N5239	2N5240	
* V_{CBO}	300	375	V
V_{CER}(sus)			
$R_{BE} \leqslant 50\Omega$	250	350	V
* V_{CEO}(sus)	225	300	V
* V_{EBO}	6		V
* I_C	5		A
* I_B	2		A
* P_T			
$T_C \leqslant 25\ °C$ and $V_{CE} \leqslant 150$ V	100		W
$T_C \leqslant 25\ °C$ and $V_{CE} > 150$ V	See Fig. 1		
$T_C > 25\ °C$ and $V_{CE} > 150$ V	See Fig. 1 and 2		
* T_{stg}, T_J	− 65 to 100		°C
T_L			
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		°C

*In accordance with JEDEC registration data

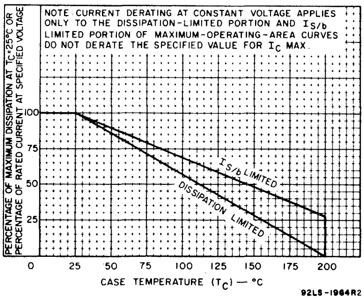


Fig. 1 -Derating curves for both types.

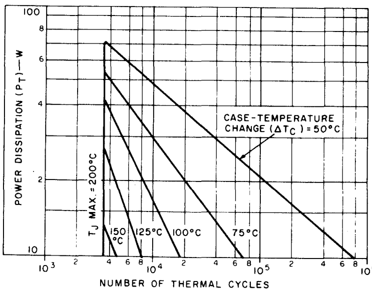


Fig. 2 -Thermal-cycling rating chart for both types.

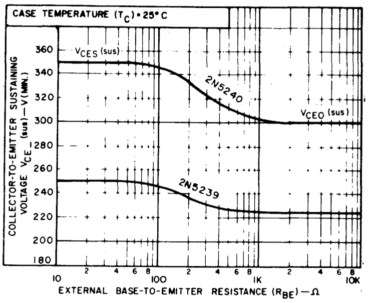


Fig. 3 -Sustaining voltages as a function of base-to-emitter resistance for both types.

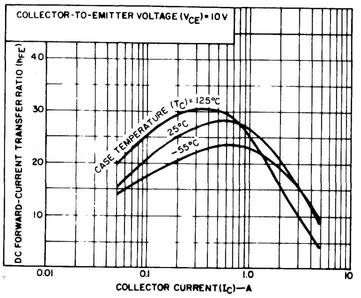


Fig. 4 - Typical dc beta characteristics for both types.

2N5239, 2N5240

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

	CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N5239		2N5240		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
*	I_{CEO}	200			0	—	5	—	2	mA
*	I_{CEV}	300 375	−1.5 −1.5			— —	4 —	— —	— 2	
	(T_C = 150°C)	300	−1.5			—	5	—	3	
 *	I_{EBO} (V_{EB} = 5 V) (V_{EB} = 6 V)			0 0		— —	5 20	— —	1 20	
	V_{EBO}				0.02	6	—	6	—	V
*	$V_{CEO}(sus)^a$			0.2^b		225	—	300	—	
	$V_{CER}(sus)^a$ (R_{BE} ≤ 50 Ω)			0.2^b		250	—	350	—	
 * *	h_{FE}	10 10 10		0.4^b 2^b 4.5^b		20 20 5	80 80 —	20 20 5	80 80 —	
*	V_{BE}	10		2^b		—	3	—	3	V
 *	$V_{CE}(sat)$			2^b 4.5^b	0.25 1.125	— —	2.5 5	— —	2.5 5	
*	$I_{S/b}$ (t = 1 s)	150				0.67	—	0.67	—	A
	$E_{S/b}$ (R_{BE} = 50 Ω, L = 0.2 mH, V_{EB} = 4 V)			4		1.6	—	1.6	—	mJ
*	$\|h_{fe}\|$ (f = 1 MHz)	10		0.2		2	—	2	—	
*	h_{fe} (f = 1 kHz)	10		4		20	—	20	—	
	f_T	10		0.2		2	—	2	—	MHz
	C_{obo} (f = 1 MHz)	10^c		0		—	150	—	150	pF
	$R_{\theta JC}$					—	1.75	—	1.75	°C/W

* In accordance with JEDEC registration data.

[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig.14

[b] Pulsed; pulse duration ≤ 350 μs, duty factor ≤ 2%.

[c] V_{CB} value

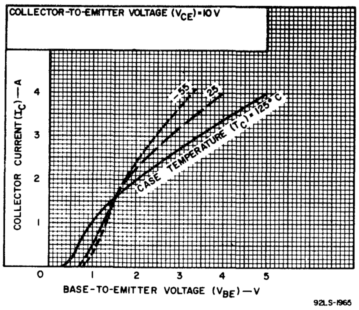


Fig. 5 - Typical transfer characteristics for both types.

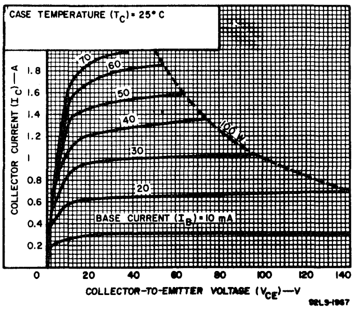


Fig. 6 - Typical output characteristics for both types.

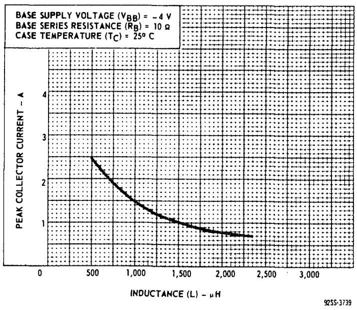


Fig. 7 - Typical reverse-bias, second-breakdown characteristic for both types.

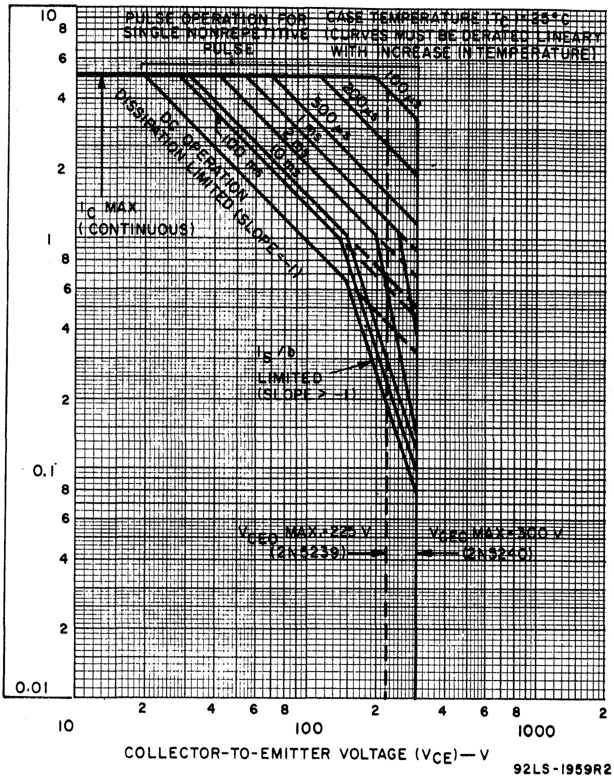


Fig. 8 - Maximum operating areas for both types.

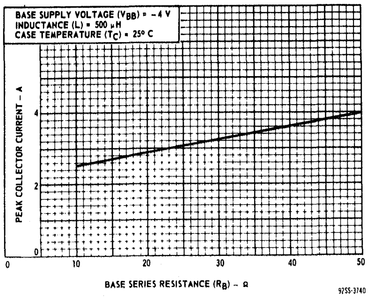


Fig. 9 - Typical reverse-bias, second-breakdown characteristic for both types.

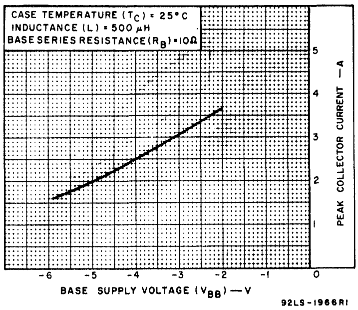


Fig. 10 - Typical reverse-bias, second-breakdown characteristic for both types.

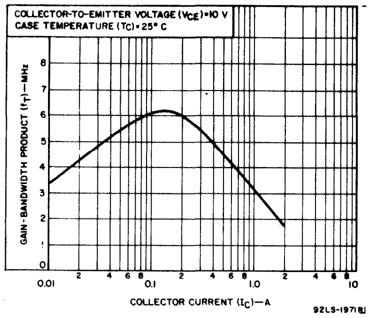


Fig. 11 - Typical gain-bandwidth product as a function of collector current for both types.

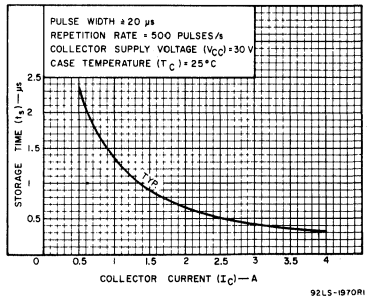


Fig. 12 - Typical saturated-switching time (storage) as a function of collector current for both types.

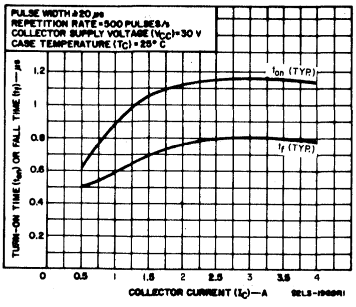


Fig. 13 - Typical saturated-time (turn-on or fall) as a function of collector current for both types.

2N5293-2N5298, RCA3054

Hometaxial-Base, Silicon N-P-N VERSAWATT Transistors

General-Purpose Types for Medium-Power Switching and Amplifier Applications in Military, Industrial, and Commercial Equipment

RCA-2N5293, 2N5294, 2N5295, 2N5296, 2N5297, 2N5298, and RCA3054 are hometaxial-base silicon n-p-n transistors. They are intended for a wide variety of medium-power switching and amplifier applications such as series and shunt regulators, and in driver and output stages of high-fidelity amplifiers. Types 2N5293, 2N5295, and 2N5297 have formed emitter and base leads for easy insertion into TO-66 sockets. Types 2N5294, 2N5296, and 2N5298 are electrically identical to the 2N5293, 2N5295, and 2N5297, respectively, but have straight leads. The RCA3054 is supplied with straight leads.

These plastic power transistors differ in voltage ratings and in the currents at which the parameters are controlled.

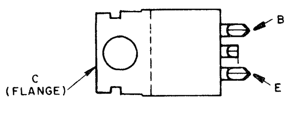
Features:

- **Low saturation voltage—**
  V_{CE}(sat) = 1 V max. at I_C = 0.5 A (2N5293, 2N5294)
  = 1 V max. at I_C = 1 A (2N5295, 2N5296)
  = 1 V max. at I_C = 1.5 A (2N5297, 2N5298)
- **VERSAWATT package (molded-silicone plastic)**
- **Maximum safe-area-of-operation curves**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5293 2N5294	2N5295 2N5296	2N5297 2N5298	RCA3054	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	80	60	80	90	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With −1.5 volts (V_{BE}) of reverse bias	V_{CEV}(sus)	80	60	80	90	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)	75	50	70	60	V
With base open	V_{CEO}(sus)	70	40	60	55	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	5	5	7	V
COLLECTOR CURRENT	I_C	4	4	4	4	A
BASE CURRENT	I_B	2	2	2	2	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		36	36	36	36	W
At case temperatures above 25°C		Derate linearly at 0.288				W/°C
At ambient temperatures up to 25°C		1.8	1.8	1.8	1.8	W
At ambient temperatures above 25°C		Derate linearly at 0.0144				W/°C
TEMPERATURE RANGE:						
Storage and Operating (Junction)		−65 to +150				°C
LEAD TEMPERATURE (During soldering):						
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.		235				°C

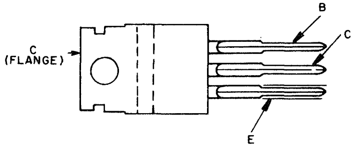
TERMINAL DESIGNATIONS



92CS-27520

BOTTOM VIEW

JEDEC TO-220AA
2N5293, 2N5295, 2N5297
(See dimensional outline "R".)



92CS-27519

BOTTOM VIEW

JEDEC TO-220AB
2N5294, 2N5296, 2N5298, RCA3054
(See dimensional outline "S".)

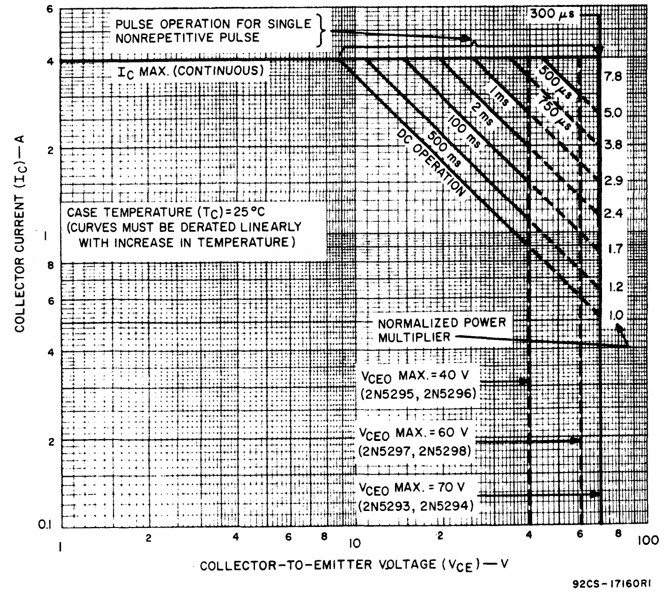


Fig. 1 — Maximum operating areas for 2N5293—2N5298.

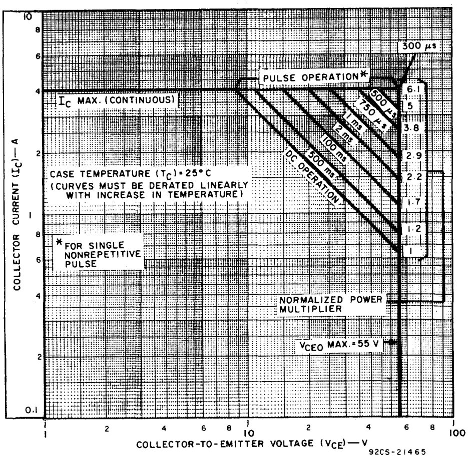


Fig. 2 — Maximum operating areas for RCA3054.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, unless otherwise specified.*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		2N5293 2N5294		2N5295 2N5296		2N5297 2N5298		**RCA3054**		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX	MIN.	MAX.	
I_{CEV} •	90	-1.5			–	–	–	–	–	–	–	1	mA
	65	-1.5			–	0.5	–	–	–	0.5	–	–	
	35	-1.5			–	–	–	2	–	–	–	–	
I_{CEV} • (T_C = 150°C)	90	-1.5			–	–	–	–	–	–	–	6	
	65	-1.5			–	3	–	–	–	3	–	–	
	35	-1.5					–	5	–	–	–	–	
I_{CER} (R_{BE} = 100 Ω)	50					0.5	–	–	–	0.5	–	–	mA
	20					–	–	–	–	–	–	–	
I_{CER} (T_C = 150°C)	50					2			–	2	–	–	mA
I_{EBO}		-7	0			1	–	–	–	–	–	1	mA
		-5	0		–		–	1	–	1	–	–	
		-4	0				–	–	–	–	–	–	
h_{FE}[c]	4		0.5		30	120	–	–	–	–	25	100	
	4		1				30	120	–	–	–	–	
	4		1.5						20	80	–	–	
$V_{CEO(sus)}$[c]			0.1	0	70	–	–		–		55	–	V
			0.1	0	–	–	40			–	–	–	
			0.1	0	–	–	–		60	–	–	–	
$V_{CER(sus)}$[c] (R_{BE} - 100 Ω)			0.1		75	–	–	–	–	–	–	–	V
			0.1		–	–	50	–	–	–	–	–	
			0.1		–	–	–	–	70	–	60	–	
$V_{CEV(sus)}$[c]		-1.5	0.1		80	–	–	–		–	–	–	V
		-1.5	0.1		–	–	60		–	–	–	–	
		-1.5	0.1		–	–	–	–	80	–	90	–	
V_{BE}[c]	4		0.5		–	1.1	–	–	–	–	–	1.7	V
	4		1		–	–	–	1.3	–	–	–	–	
	4		1.5		–	–	–	–	–	1.5	–	–	
$V_{CE(sat)}$[c]			0.5	0.05	–	1	–	–	–	–	–	1	V
			1	0.05		–		–	–	–	–	–	
			1	0.1		–		1	–	–	–	–	
			1.5	0.15		–	–	–	–	1	–	–	
f_T	4		0.2		0.8	–	0.8	–	0.8	–	0.8	–	MHz
t_{ON}	V_{CC} = 30		0.5	0.05[a]		5	–	–	–	–	–	–	μs
			1	0.1[a]	–	–	–	5	–	–	–	–	
			1.5	0.15[a]	–	–	–	–	–	5	–	–	
t_{OFF}	V_{CC} = 30		0.5	-0.5[a]	–	15	–	–	–	–	–	–	μs
			1	-0.1[b]	–	–	–	15	–	–	–	–	
			1.5	-0.15[b]	–	–	–	–	–	15	–	–	
$R_{\theta JC}$					–	3.5	–	3.5	–	3.5	–	3.5	°C/W
$R_{\theta JA}$					–	70	–	70	–	70	–	70	°C/W

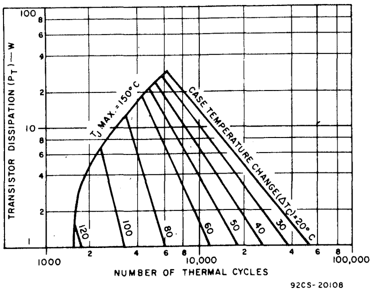


Fig. 3 – Thermal-cycling rating chart for all types.

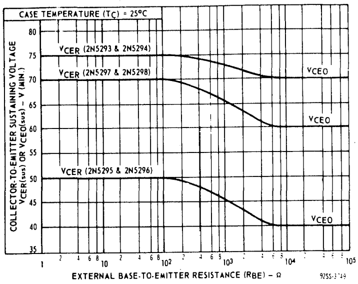


Fig. 4 – Sustaining voltage vs. base-to-emitter resistance for 2N5293–2N5298.

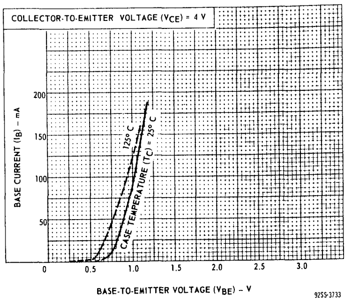


Fig. 5 – Typical input characteristics for 2N5293, 2N5294, and RCA3054.

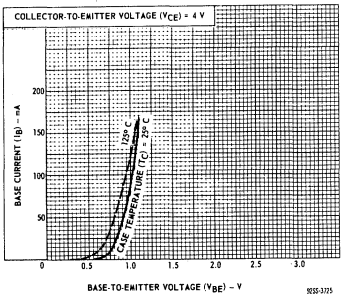


Fig. 6 – Typical input characteristics for 2N5295 and 2N5296.

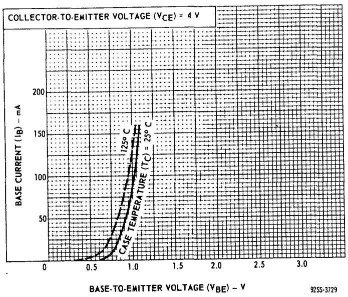


Fig. 7 – Typical input characteristics for types 2N5297 and 2N5298.

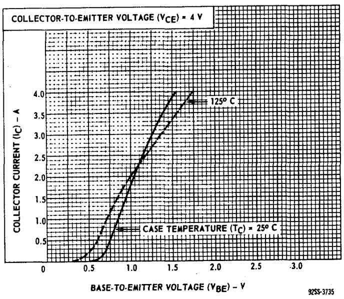


Fig. 8 – Typical transfer characteristics for 2N5293, 2N5294, and RCA3054.

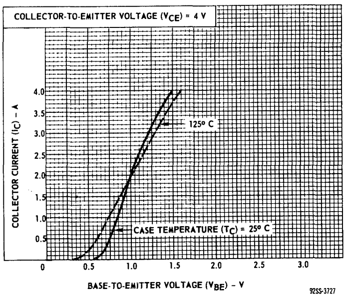


Fig. 9 – Typical transfer characteristics for 2N5295 and 2N5296.

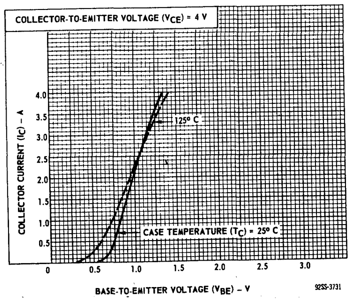


Fig. 10 – Typical transfer characteristics for 2N5297 and 2N5298.

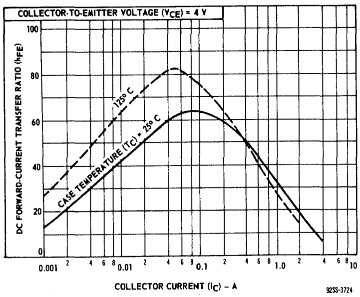


Fig. 11 – Typical dc beta for 2N5293, 2N5294, and RCA3054.

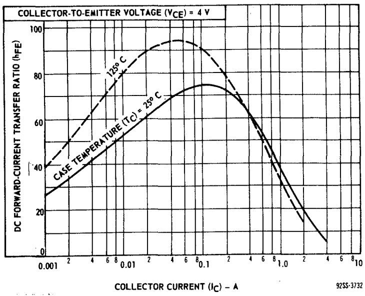


Fig. 12 – Typical dc beta for 2N5295, and 2N5296.

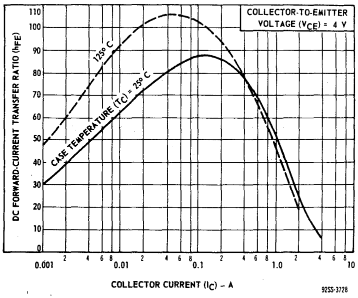


Fig. 13—Typical dc beta for 2N5297 and 2N5298.

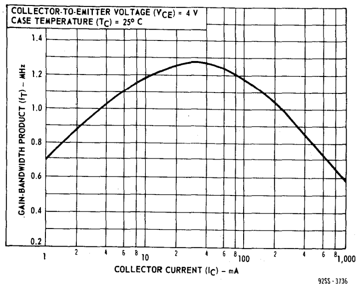


Fig. 14—Typical gain-bandwidth product for 2N5293, 2N5294, and RCA3054.

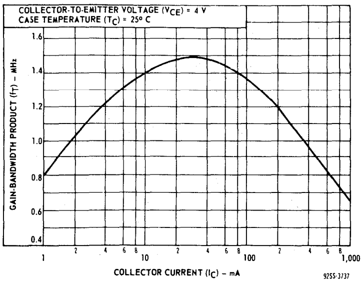


Fig. 15—Typical gain-bandwidth product for 2N5295 and 2N5296.

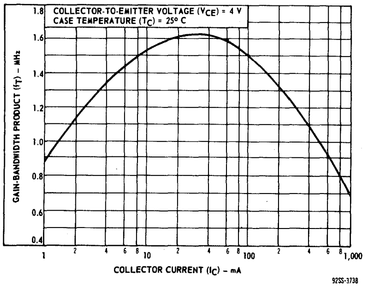


Fig. 16—Typical gain-bandwidth product for 2N5297 and 2N5298.

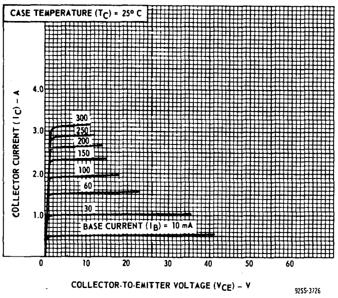


Fig. 17—Typical output characteristics for 2N5293, 2N5294, and RCA3054.

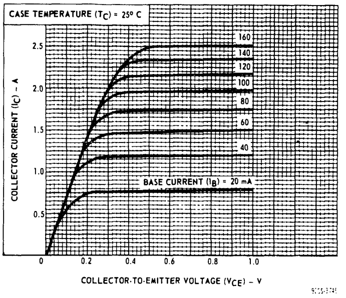


Fig. 18—Typical output characteristics for 2N5295 and 2N5296.

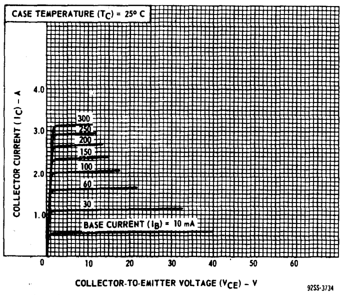


Fig. 19—Typical output characteristics for 2N5295 and 2N5296.

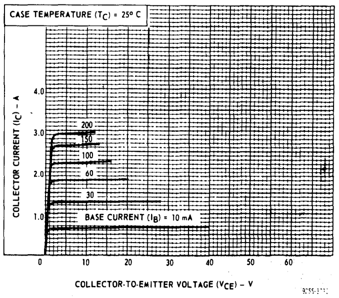


Fig. 20—Typical output characteristics for 2N5297 and 2N5298.

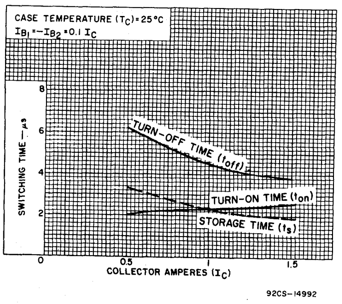


Fig. 21—Typical saturated switching characteristics for 2N5295, 2N5296, and RCA3054.

2N5301, 2N5302, 2N5303

High-Current High-Power High-Speed N-P-N Power Transistors

The RCA-2N5301, 2N5302 and 2N5303 are epitaxial-base silicon n-p-n transistors intended for a wide variety of high-power, high-current applications, such as power-switching circuits, driver and output stages for series and shunt regulstors, dc-to-dc converters, inverters, and solenoid (hammer) /relay drivers.

These devices differ in maximum voltage ratings and V_{CE}(sat), V_{BE}(sat), and V_{BE} characteristics. All are supplied in JEDEC TO-204MA hermetic steel packages.

Features:

- **Specification for h_{FE} and V_{CE}(sat) up to 30A**
- **Current gain-bandwidth product f_T = 2 MHz min. at 1A**
- **Low saturation voltage with high beta**
- **High dissipation capability**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5301	2N5302	2N5303	
* V_{CBO}		40	60	80	V
* V_{CEO}(sus)		40	60	80	V
* V_{EBO}		5			V
* I_C		30			A
* I_{CM}		50			A
* I_B		7.5			A
I_{BM}		15			A
* P_T					
At $T_C \leqslant 25^\circ C$		200			W
At $T_C > 25^\circ C$	Derate linearly	1.15 *See Fig. 1 and 2*			W/°C
* T_{stg}, T_J		−65 to 200			°C
T_L At distance ≥1/32 in. (0.8 mm) from seating plane for 10 s max.		230			°C

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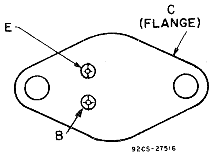
* In accordance with JEDEC registration data format JS-6 RDF-2.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

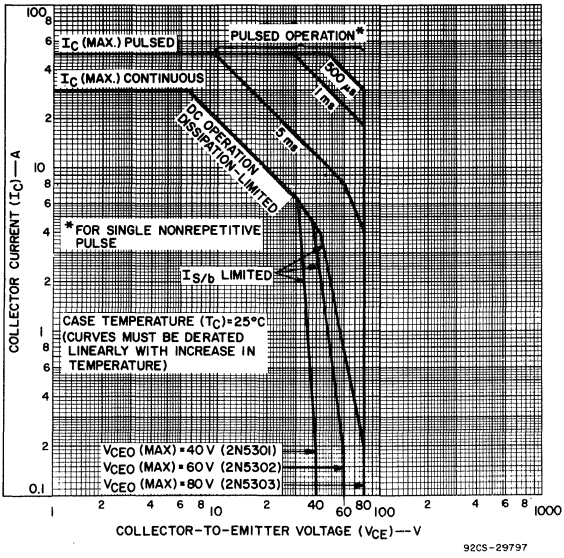


Fig. 1 – Maximum operating areas for 2N5301, 2N5302, and 2N5303.

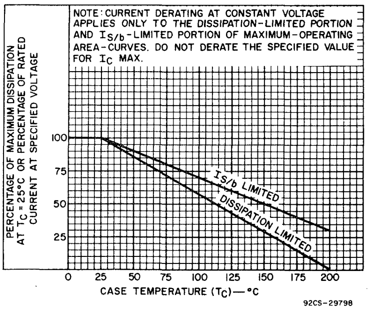


Fig. 2 – Derating curves for 2N5301, 2N5302, and 2N5303.

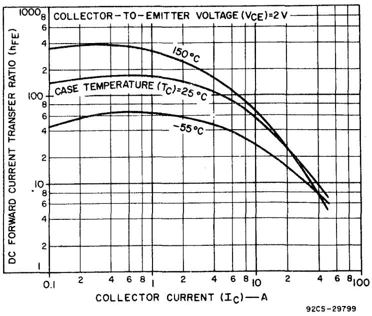


Fig. 3 – Typical dc beta characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

2N5301, 2N5302, 2N5303

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

	CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N5301		2N5302		2N5303		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
*	I_{CBO}	40^a				–	1	–	–	–	–	mA
		60^a				–	–	–	1	–	–	
		80^a				–	–	–	–	–	1	
*	I_{CEX}	40	−1.5			–	1	–	–	–	–	
		60	−1.5			–	–	–	1	–	–	
		80	−1.5			–	–	–	–	–	1	
*	I_{CEX} T_C = 150°C	40	−1.5			–	10	–	–	–	–	
		60	−1.5			–	–	–	10	–	–	
		80	−1.5			–	–	–	–	–	10	
*	I_{CEO}	40				–	5	–	–	–	–	
		60				–	–	–	5	–	–	
		80				–	–	–	–	–	5	
*	I_{EBO}		−5			–	5	–	5	–	5	
*	h_{FE}	2		1^b		40	–	40	–	40	–	
		2		10^b		–	–	–	–	15	60	
		3		15^b		15	60	15	60	–	–	
		2		20^b		–	–	–	–	5	–	
		3		30^b		5	–	5	–	–	–	
*	V_{CEO}(sus)			0.2		40	–	60	–	80	–	V
*	V_{BE}	2		10^b		–	–	–	–	–	1.5	
		2		15^b		–	1.7	–	1.7	–	–	
		4		20^b		–	–	–	–	–	2.5	
		4		30^b		–	3	–	3	–	–	
*	V_{BE}(sat)			10^b	1	–	1.7	–	1.7	–	1.7	
				15^b	1.5	–	1.8	–	1.8	–	2	
				20^b	2	–	2.5	–	2.5	–	–	
				20^b	4	–	–	–	–	–	2.5	
*	V_{CE}(sat)			10^b	1	–	0.75	–	0.75	–	1	
				15^b	1.5	–	–	–	–	–	1.5	
				20^b	2	–	2	–	2	–	–	
				20^b	4	–	–	–	–	–	2	
				30^b	6	–	3	–	3	–	–	
	$I_{S/b}$ tp = 1 s nonrep.	20				10	–	10	–	10	–	A
	$E_{S/b}$ L = 125 µH, R_{BE} = 51 Ω		−1.5	10	–	6.25	–	6.25	–	6.25	–	mJ
*	$\|h_{fe}\|$ f = 1 MHz	10		1	–	2	–	2	–	2	–	
*	h_{fe} f = 1 kHz	10		1	–	40	–	40	–	40	–	
*	t_r (See Fig.8)	V_{CC} =		10	1	–	1	–	1	–	1	µs
*	t_s	30		10	1^c	–	2	–	2	–	2	
*	t_f			10	1^c	–	1	–	1	–	1	
	$R_{\theta JC}$	20		5	–	–	0.875	–	0.875	–	0.875	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-1.

[a] V_{CB}

[b] Pulsed; pulse duration = 300 µs, duty factor = 1.8%

[c] $I_{B_1} = -I_{B_2}$

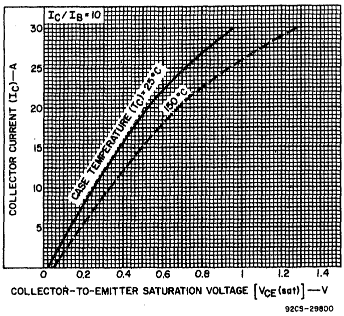


Fig. 4 — Typical saturation voltage characteristics for 2N5301, 2N5302, and 2N5303.

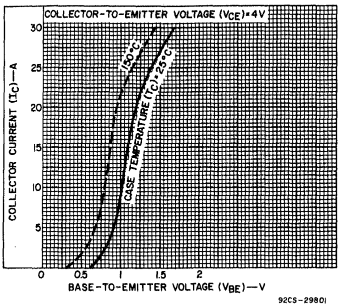


Fig. 5 — Typical transfer characreristics for 2N5301, 2N5302, and 2N5303.

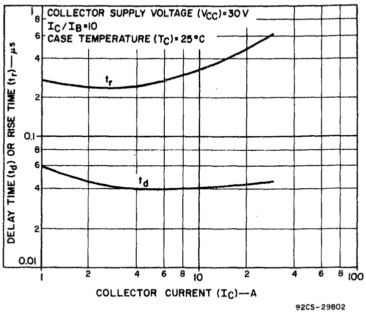


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

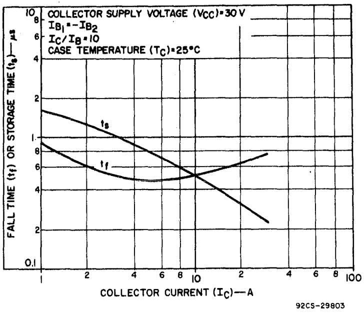


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

Complementary N-P-N & P-N-P Silicon Power Transistors

General-Purpose Types for Small-Signal, Medium-Power Applications

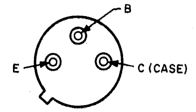
RCA-2N5320, 2N5321, 2N5322 and 2N5323 are double-diffused epitaxial-planar silicon power transistors intended for small-signal medium-power applications. The 2N5320 and 2N5321 n-p-n types are actually high-current, high-dissipation versions of the 2N2102 with all of the salinet features of that device. The 2N5322 and 2N5323, p-n-p complements of the 2N5320 and 2N5321, are actually high-current, high-power versions of the 2N4036 with all of its additional outstanding features. (Technical data on the 2N2102 and 2N4036 are shown on pages 29 and 71, respectively).

The devices are supplied in the JEDEC TO-39 hermetic package.

Features:

- 2N5322 } P–N–P { 2N5320
  2N5323 } Complements of: { 2N5321
- Maximum safe-area-of-operation curves
- Planar construction for low-noise and low-leakage characteristics
- Low saturation voltage
- High beta at high collector current

TERMINAL DESIGNATIONS



92CS-27512

JEDEC TO-39
(See dimensional ouline "C".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5321	2N5323●	2N5320	2N5322●	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	75	-75	100	-100	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With 1.5 volts (V_{BE}) of reverse bias	$V_{CEV}(sus)$	75	-75	100	-100	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	65	-65	90	-90	V
* With base open	$V_{CEO}(sus)$	50	-50	75	-75	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	-5	7	-7	V
* COLLECTOR CURRENT	I_C	2	-2	2	-2	A
* BASE CURRENT	I_B	1	-1	1	-1	A
* TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25° C		10	10	10	10	W
At case temperatures above 25° C		Figs. 2 & 5 Derate linearly at 0.057 W/°C				
* TEMPERATURE RANGE:						
Storage and operating (Junction)		← -65 to + 200 →				°C
* LEAD TEMPERATURE (During soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max		← 230 →				°C

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* In accordance with JEDEC registration data format (JS-6-RDF-1)

● For p-n-p devices, voltage and current values are negative.

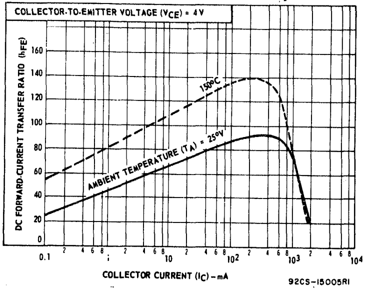


Fig. 1 - Typical static beta characteristics for types 2N5320 and 2N5321.

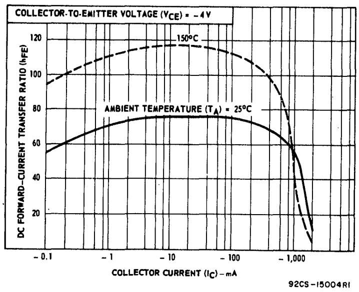


Fig. 3 - Typical static beta characteristics for 2N5322 and 2N5223.

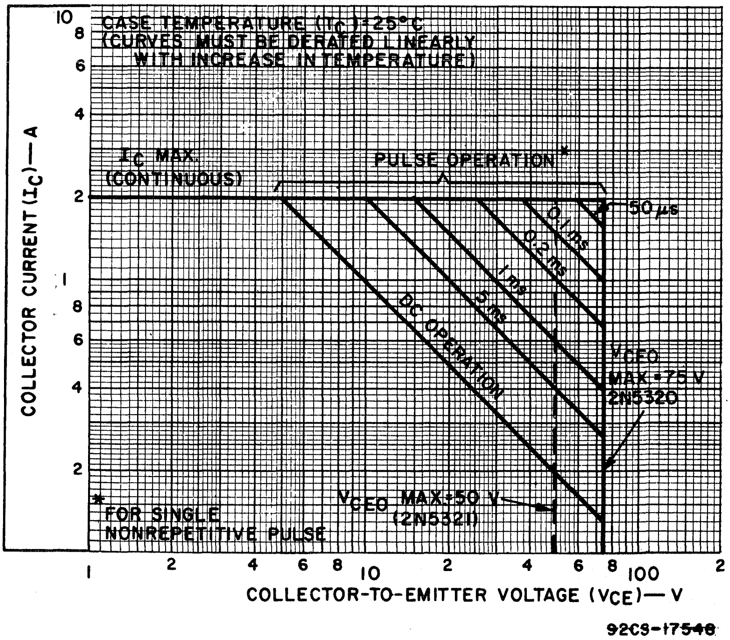


Fig. 2 - Maximum operating areas for 2N5320 and 2N5321.

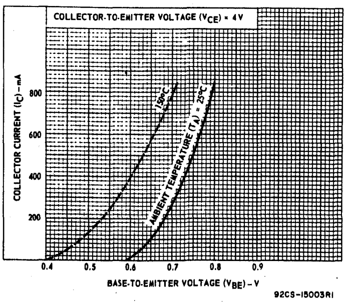


Fig. 4 - Typical transfer characteristics for 2N5320 and 2N5321.

2N5320-2N5323

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C, unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT mA dc		2N5320		2N5321		2N5322		2N5323		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CBO}	80▲				–	0.5	–	–	–	–	–	–	μA
	60▲				–	–	–	5	–	–	–	–	
	−80▲				–	–	–	–	–	−0.5	–	–	
	−60▲				–	–	–	–	–	–	–	−5	
* I_{CEX}	100	−1.5			–	0.1	–	–	–	–	–	–	mA
	75	−1.5			–	–	–	0.1	–	–	–	–	
	−100	1.5			–	–	–	–	–	−0.1	–	–	
	−75	1.5			–	–	–	–	–	–	–	−0.1	
T_C = 150°C	70	−1.5			–	5	–	–	–	–	–	–	mA
	45	−1.5			–	–	–	5	–	–	–	–	
	−70	1.5			–	–	–	–	–	−5	–	–	
	−45	1.5			–	–	–	–	–	–	–	−5	
* I_{EBO}		−7	0		–	0.1	–	–	–	–	–	–	mA
		−5	0		–	–	–	0.1	–	–	–	–	
		7	0		–	–	–	–	–	−0.1	–	–	
		5	0		–	–	–	–	–	–	–	−0.1	
		−5	0		–	0.1	–	–	–	–	–	–	μA
		−4	0		–	–	–	0.5	–	–	–	–	
		5	0		–	–	–	–	–	−0.1	–	–	
		4	0		–	–	–	–	–	–	–	−0.5	
$V_{(BR)CEV}$		−1.5	0.1		100	–	75	–	–	–	–	–	V
		1.5	−0.1		–	–	–	–	−100	–	−75	–	
$V_{CER}(sus)^{a}$ R_{BE} = 100Ω			100^{b}		90	–	65	–	–	–	–	–	V
			-100^{b}		–	–	–	–	−90	–	−65	–	
* $V_{CEO}(sus)^{a}$			100^{b}	0	75	–	50	–	–	–	–	–	V
			-100^{b}	0	–	–	–	–	−75	–	−50	–	
* $V_{CE}(sat)$			500^{b}	50	–	0.5	–	0.8	–	–	–	–	V
			-500^{b}	−50	–	–	–	–	–	−0.7	–	−1.2	
* V_{BE}	4		500^{b}		–	1.1	–	1.4	–	–	–	–	V
	−4		-500^{b}		–	–	–	–	–	−1.1	–	−1.4	
* h_{FE}	4		500^{b}		30	130	40	250	–	–	–	–	
	−4		-500^{b}		–	–	–	–	30	130	40	250	
	2		1000^{b}		10	–	–	–	–	–	–	–	
	−2		-1000^{b}		–	–	–	–	10	–	–	–	
* $\lvert h_{fe} \rvert$ f = 10 MHz	4		50		5	–	5	–	–	–	–	–	
	−4		−50		–	–	–	–	5	–	5	–	
$I_{S/b}{}^{d}$	50				200	–	200	–	–	–	–	–	mA
	−35				–	–	–	–	−285	–	−285	–	
* t_{ON}	30		500	50	–	80	–	80	–	–	–	–	ns
	−30		−500	−50	–	–	–	–	–	100	–	100	
* t_{OFF}	30		500	50	–	800	–	800	–	–	–	–	ns
	−30		−500	−50	–	–	–	–	–	1000	–	1000	
* $R_{\theta JC}$					–	17.5	–	17.5	–	17.5	–	17.5	°C/W
$R_{\theta JA}$					–	150	–	150	–	150	–	150	°C/W

▲ V_{CB}

* In accordance with JEDEC registration data format (JS-6 RDF-1)

[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

[b] Pulsed; pulse duration $< 300\ \mu s$, duty factor < 0.02.

[d] Pulsed; 0.4 s non-repetitive pulse.

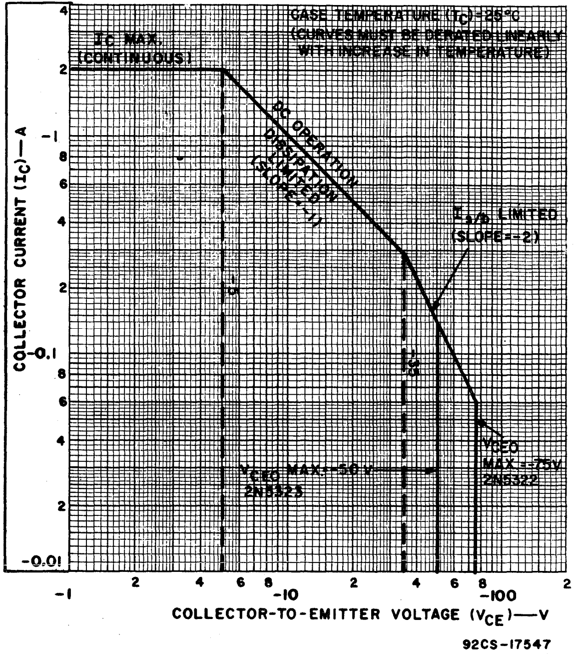


Fig. 5 — Maximum operating areas for 2N5322 and 2N5323.

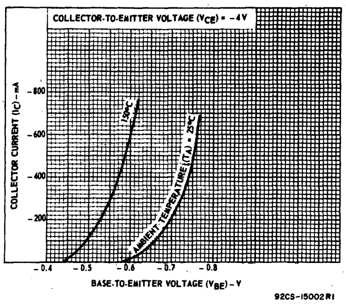


Fig. 6 — Typical transfer characteristics for 2N5322 and 2N5323.

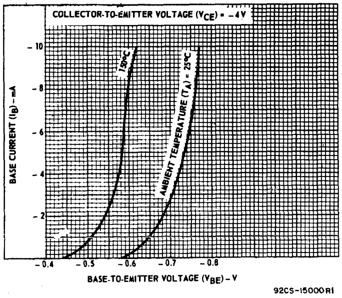


Fig. 7 — Typical input characterisitcs for 2N5322 and 2N5323.

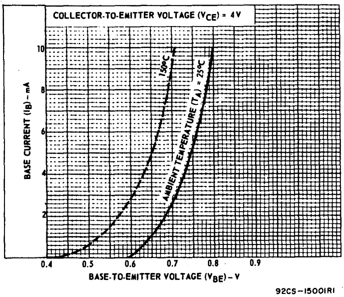


Fig. 8 — Typical input characteristics for 2N5320 and 2N5321.

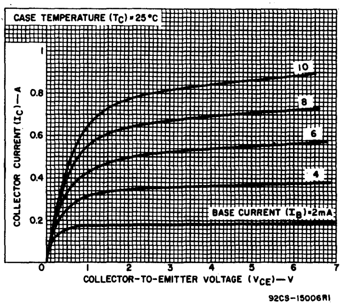


Fig. 9 — Typical output characteristics for 2N5320 and 2N5321.

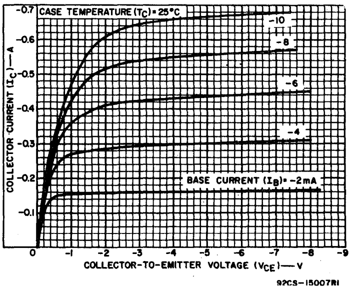


Fig. 10 — Typical output characteristics for 2N5322 and 2N5323.

2N5415, 2N5416

Silicon P-N-P High-Voltage Transistors

For High-Speed Switching and Linear-Amplifier
Applications in Military, Industrial and Commercial Equipment

The RCA-2N5415 and 2N5416♦ are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds.

These transistors differ primarily in their voltage ratings. Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters; and high-voltage, low-current switching and series regulators.

The 2N5415 and 2N5416 are supplied in the JEDEC TO-39 package.

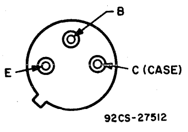
♦Formerly RCA Dev. Types TA2819 and TA2819A.

●Data on types 2N3439 and 2N3440 are given in RCA data bulletin File No. 64.

Features:

- 2N5415: p-n-p complement of 2N3440●
  2N5416: p-n-p complement of 2N3439●
- Maximum safe-area-of-operation curves
- High voltage ratings:
  V_{CBO} = −350 V max. (2N5416)
  V_{CEO} = −300 V max. (2N5416)
  −200 V max. (2N5415)

TERMINAL DESIGNATIONS



(See dimensional outline "C".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5415	2N5416	
* V_{CBO}	−200	−350	V
V_{CER}			
R_{BE} = 50 Ω	–	−350	V
* V_{CEO}	−200	−300	V
* V_{EBO}	−4	−6	V
* I_C	−1	−1	A
* I_B	−0.5	−0.5	A
* P_T			
$T_C \leqslant 25°C$	10	10	W
$T_C > 25°C$	See Figs. 1 and 2		
$T_C \leqslant 50°C$	1	1	W
$T_C > 50°C$ Derate linearly at	6.7	6.7	mW/°C
* T_{stg}, T_J	−65 to +200		°C
* T_L			
At distance ≥1/32 in. (0.8 mm) from seating plane for 10 s max.	255		°C

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*In accordance with JEDEC registration data format (JS-9 RDF-8).

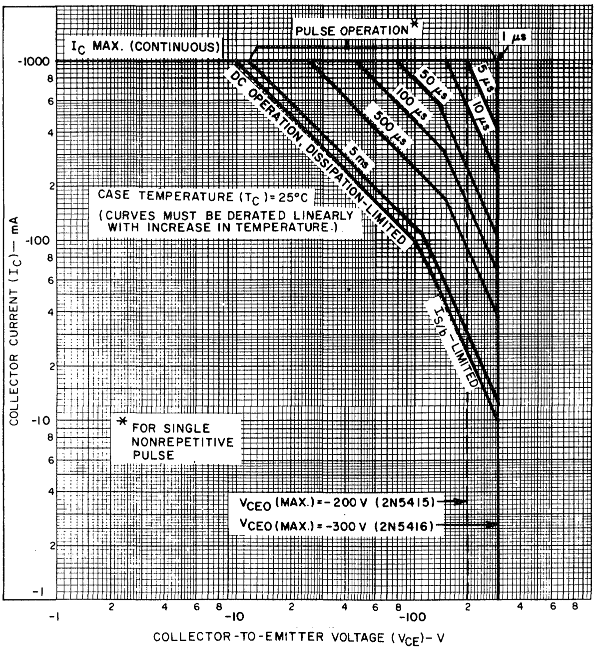

Fig. 1 — Maximum safe operating areas.

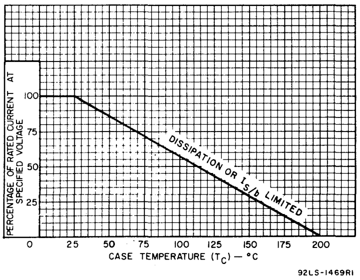

Fig. 2 — Dissipation derating curve.

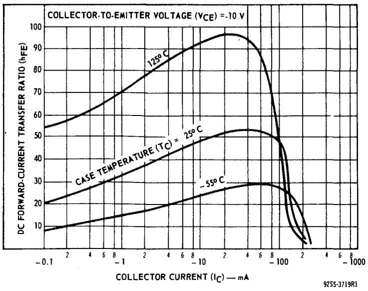

Fig. 3 — Typical dc beta characteristics for both types.

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT mA dc		2N5415		2N5416		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
I_{CEO}		−250 −150 −100			0 0 0	– – –	– −50 –	– – –	−50 – –	μA
* I_{CBO} $I_E = 0$	−280 −175					– –	– −50	– –	−50 –	μA
I_{CEV}		−300 −200 −150	1.5 1.5 1.5			– – –	– −50 –	– – –	−50 – –	μA
* I_{EBO}			6 4	0 0		– –	– −20	– –	−20 –	μA
* h_{FE}		−10 −10 −10		−50[b] −50[b] −35[b]		– 30 –	– 150 –	30 – –	120 – –	
V_{CEO}(sus)				−50	0	−200[a]	–	−300[a]	–	V
V_{CER}(sus) R_{BE} = 50 Ω				−50		–	–	−350[a]	–	V
V_{BE}		−10		−50[b]		–	−1.5	–	−1.5	V
V_{CE}(sat)				−50[b]	−5	–	−2.5	–	−2	V
* h_{fe} f = 1 kHz		−10		−5		25	–	25	–	
* $\|h_{fe}\|$ f = 5 MHz		−10		−10		3	–	3	–	
* Re(h_{ie}) f = 1 MHz		−10		−5		–	300	–	300	Ω
* C_{ib} f = 1 MHz			5	0		–	75	–	75	pF
* C_{ob} f = 1 MHz	−10					–	15	–	15	pF
$I_{S/b}$ t_p = 0.4 s nonrep.		−100 −75				−100 –	– –	−100 –	– –	mA
$R_{\theta JC}$						–	17.5	–	17.5	°C/W

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* In accordance with JEDEC registration data format (JS-9 RDF-8).

[a] CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in Fig. 12.

[b] Pulsed: Pulse = 300 μs; duty factor ≤2%.

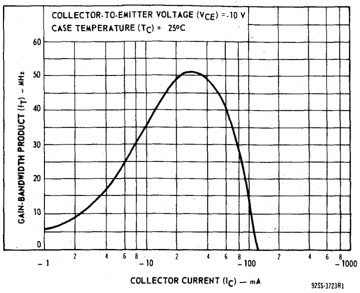


Fig. 4 — Typical gain-bandwidth product for both types.

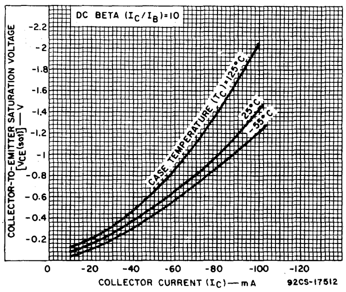


Fig. 5 — Typical collector-to-emitter saturation voltage for both types.

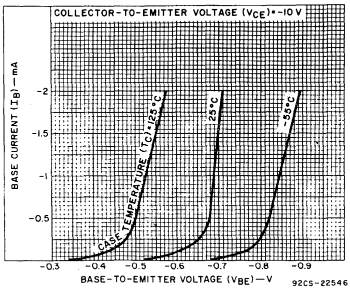


Fig. 6 — Typical input characteristics for both types.

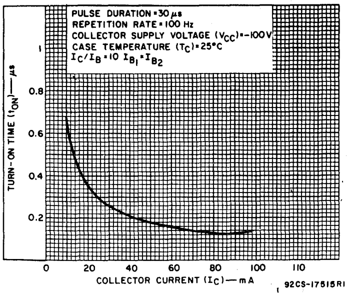


Fig. 7 — Typical turn-on time characteristic for both types.

2N5415, 2N5416

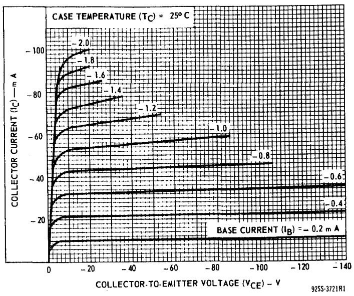


Fig. 8 – Typical output characteristics for both types.

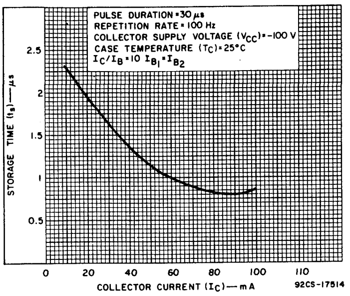


Fig. 9 – Typical storage-time characteristic for both types.

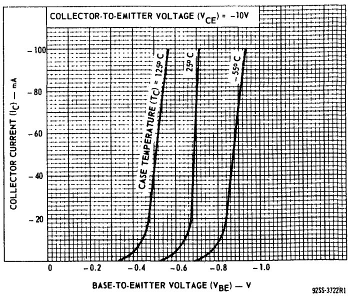


Fig. 10 – Typical transfer characteristics for both types.

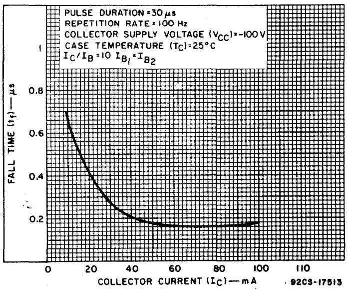


Fig. 11 – Typical fall-time characteristic for both types.

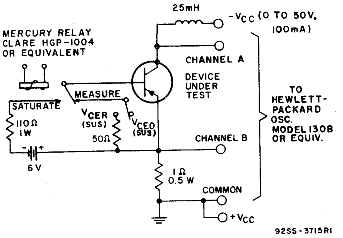
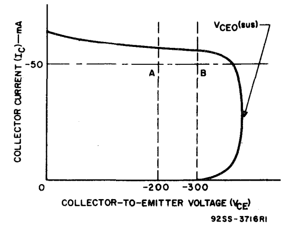


Fig. 12 – Circuit used to measure sustaining voltages, $V_{CEO}(sus)$ and $V_{CER}(sus)$ for both types.



The sustaining voltage V_{CEO}(sus) is acceptable when the trace falls to the right and above point "A" for type 2N5415. The trace must fall to the right and above point "B" for type 2N5416.

Fig. 13 – Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 12).

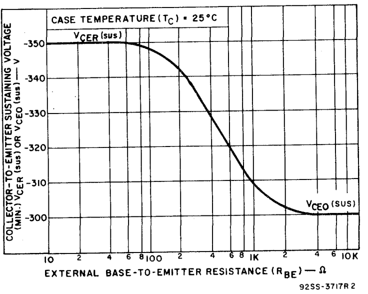


Fig. 14 – Sustaining voltage vs. base-to-emitter resistance for type 2N5416.

2N5490-2N5497

Hometaxial-Base, Silicon N-P-N VERSAWATT Transistors

General-Purpose Types for Medium-Power Switching and Amplifier Applications in Military, Industrial, and Commercial Equipment

RCA-2N5490, 2N5491, 2N5492, 2N5493, 2N5494, 2N5495, 2N5496 and 2N5497* are hometaxial-base silicon n-p-n transistors. They are intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

Types 2N5491, 2N5493, 2N5495, and 2N5497 have formed emitter and base leads for insertion into TO-66 sockets. Types 2N5490, 2N5492, 2N5494, and 2N5496 are electrically identical to the 2N5491, 2N5493, 2N5495, and 2N5497 but have straight leads.

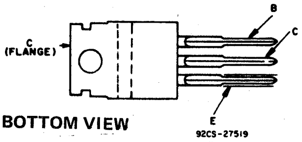
These plastic-package power transistors differ in voltage ratings and in the currents at which the parameters are controlled.

*Formerly RCA Dev. Nos. TA7317, TA7318, TA7315, TA7316, TA7313, TA7314, TA7311, TA7312, respectively.

FEATURES

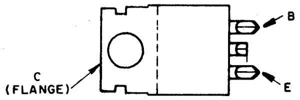
- Low saturation voltage—
  $V_{CE}(sat)$ = 1 V max. at I_C = 2 A (2N5490, 2N5491)
  = 1 V max. at I_C = 2.5 A (2N5492, 2N5493)
  = 1 V max. at I_C = 3 A (2N5494, 2N5495)
  = 1 V max. at I_C = 3.5 A (2N5496, 2N5497)
- VERSAWATT package (molded silicone plastic)
- Maximum safe-area-of-operation curves specified for DC and pulse operation

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB
2N5490 2N5494
2N5492 2N5496
(See dimensional outline "S".)



BOTTOM VIEW

JEDEC TO-220AA
2N5491 2N5495
2N5493 2N5497
(See dimensional outline "R".)

Maximum Ratings, *Absolute-Maximum Values:*

		2N5490 2N5491 2N5494 2N5495	2N5492 2N5493	2N5496 2N5497	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	75	90	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With -1.5 volts (V_{BE}) of reverse bias	$V_{CEV}(sus)$	60	75	90	V
With external base-to-emitter resistance (R_{BE}) 100	$V_{CER}(sus)$	50	65	80	V
With base open	$V_{CEO}(sus)$	40	55	70	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	V
COLLECTOR CURRENT	I_C	7	7	7	A
BASE CURRENT	I_B	3	3	3	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		50	50	50	W
At ambient temperatures up to 25°C		1.8	1.8	1.8	W
At case temperatures above 25°C		Derate linearly at 0.4 W °C or see Figs. 1 & 2			
At ambient temperatures above 25°C		Derate linearly at 0.0144 W °C			
TEMPERATURE RANGE:					
Storage & Operating (Junction)		← -65 to 150 →			°C
LEAD TEMPERATURE (During Soldering):					
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max		← 235 →			°C

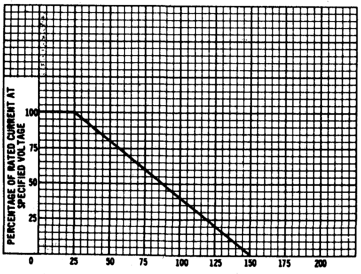


Fig. 1 — Derating curve for types 2N5490 through 2N5497 inclusive.

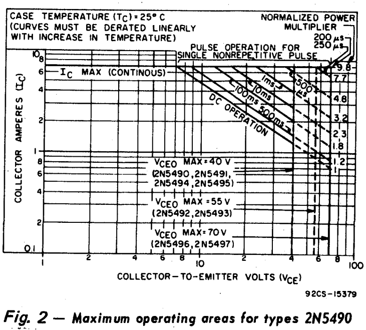


Fig. 2 — Maximum operating areas for types 2N5490 through 2N5497 inclusive.

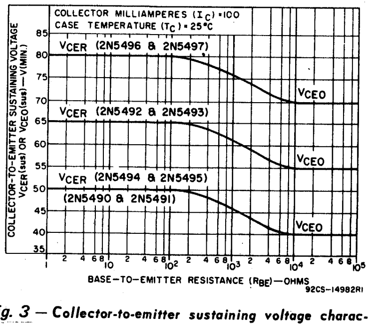


Fig. 3 — Collector-to-emitter sustaining voltage characteristics for types 2N5490 through 2N5497 inclusive.

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

Characteristic	Symbol	TEST CONDITIONS				LIMITS								Units
		DC Voltage (V)		DC Current (A)		Types 2N5496 2N5497		Types 2N5494 2N5495		Types 2N5492 2N5493		Types 2N5490 2N5491		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current With base-emitter junction reverse biased	I_{CEV}	85	-1.5			-	1	-	-	-	-	-	-	mA
		55	-1.5			-	-	-	1	-	-	-	-	
		70	-1.5			-	-	-	-	-	1	-	-	
	I_{CEV} (T_C = 150°C)	85	-1.5			-	5	-	-	-	-	-	-	mA
		55	-1.5			-	-	-	5	-	-	-	-	
		70	-1.5			-	-	-	-	-	5	-	-	
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	70				-	0.5	-	-	-	-	-	-	mA
		40				-	-	-	0.5	-	-	-	2	
		55				-	-	-	-	-	0.5	-	-	
	I_{CER} (T_C = 150°C)	70				-	3.5	-	-	-	-	-	-	mA
		40				-	-	-	3.5	-	-	-	5	
		55				-	-	-	-	-	3.5	-	-	
Emitter-Cutoff Current	I_{EBO}		-5			-	1	-	1	-	1	-	1	mA
DC Forward-Current Transfer Ratio	h_{FE}[c]	4		3.5		20	100	-	-	-	-	-	-	
		4		3		-	-	20	100	-	-	-	-	
		4		2.5		-	-	-	-	20	100	-	-	
		4		2		-	-	-	-	-	-	20	100	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$[c]			0.1	0	70	-	40	-	55	-	40	-	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$[c]			0.1		80	-	50	-	65	-	50	-	V
With base-emitter junction reverse biased	$V_{CEV}(sus)$[c]		-1.5	0.1		90	-	60	-	75	-	60	-	V
Base-to-Emitter Voltage	V_{BE}[c]	4		3.5		-	1.7	-	-	-	-	-	-	V
		4		3		-	-	-	1.5	-	-	-	-	
		4		2.5		-	-	-	-	-	1.3	-	-	
		4		2		-	-	-	-	-	-	-	1.1	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$[c]			3.5	0.35	-	1	-	-	-	-	-	-	V
				3	0.3	-	-	-	1	-	-	-	-	
				2.5	0.25	-	-	-	-	-	1	-	-	
				2	0.2	-	-	-	-	-	-	-	1	
Gain-Bandwidth Product	f_T	4		0.5		0.8	-	0.8	-	0.8	-	0.8	-	MHz
Sat. Switching Time: Turn-On	t_{on}	V_{CC} = 30		3.5	0.35[a]	-	5	-	-	-	-	-	-	µs
				3	0.3[a]	-	-	-	5	-	-	-	-	
				2.5	0.25[a]	-	-	-	-	-	5	-	-	
				2	0.2	-	-	-	-	-	-	-	5	
Turn-Off	t_{off}	V_{CC} = 30		3.5	0.35[b]	-	15	-	-	-	-	-	-	µs
				3	0.3[b]	-	-	-	15	-	-	-	-	
				2.5	0.25[b]	-	-	-	-	-	15	-	-	
				2	0.2	-	-	-	-	-	-	-	15	
Thermal Resistance: Junction-to-Case	$\theta_{J\text{-}C}$					-	2.5	-	2.5	-	2.5	-	2.5	°C/W
Junction-to-Ambient	$\theta_{J\text{-}A}$					-	70	-	70	-	70	-	70	°C/W

[a] I_{B1} value (turn-on base current). [b] I_{B2} value (turn-off base current). [c] Pulsed, pulse duration = 300 µs, duty factor = .018.

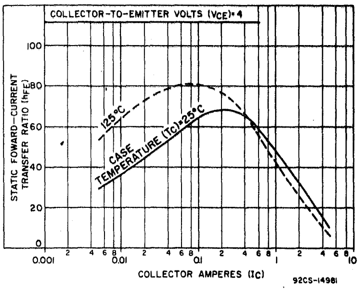


Fig.4 - Typical static beta characteristics for types 2N5490 through 2N5493 inclusive.

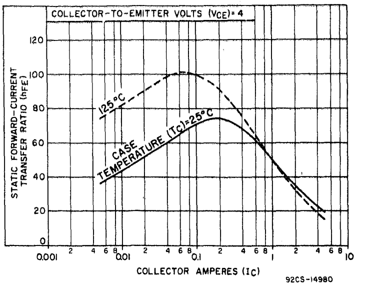


Fig.5 - Typical static beta characteristics for types 2N5494 and 2N5495.

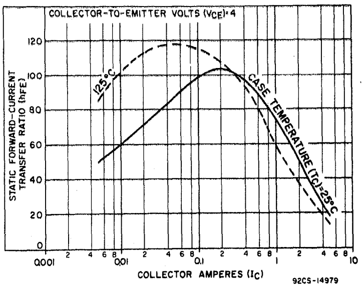


Fig.6 - Typical static beta characteristics for types 2N5496 and 2N5497.

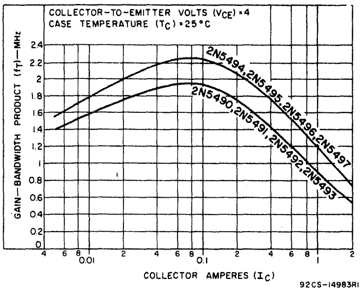


Fig.7 - Typical gain-bandwidth product for types 2N5490 through 2N5497 inclusive.

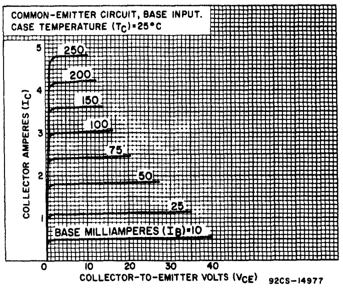


Fig.8 - Typical output characteristics for types 2N5494 through 2N5497 inclusive.

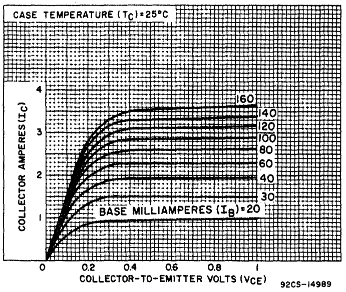


Fig.9 - Typical output characteristics for types 2N5494 and 2N5495.

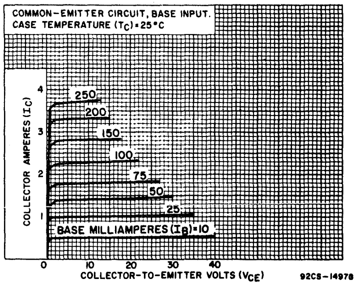


Fig.10 - Typical output characteristics for types 2N5490 through 2N5493 inclusive.

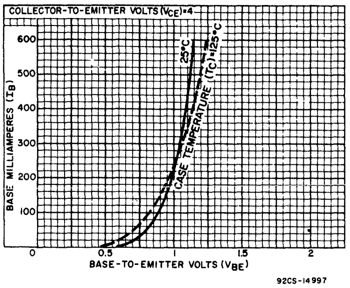


Fig.11 - Typical input characteristics for types 2N5494 through 2N5497 inclusive.

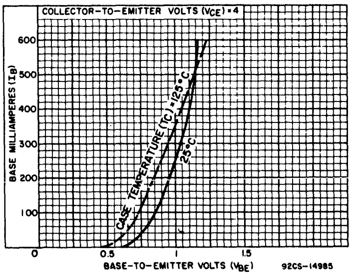


Fig.12 - Typical input characteristics for types 2N5490 through 2N5493 inclusive.

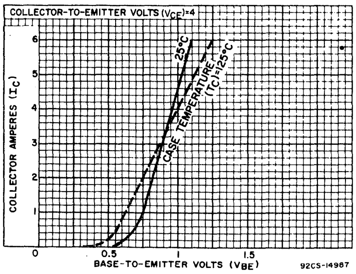


Fig.13 - Typical transfer characteristics for types 2N5494 through 2N5497 inclusive.

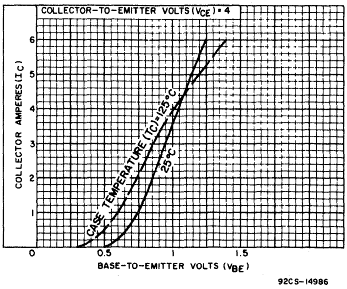


Fig.14 - Typical transfer characteristics for types 2N5490 through 2N5493 inclusive.

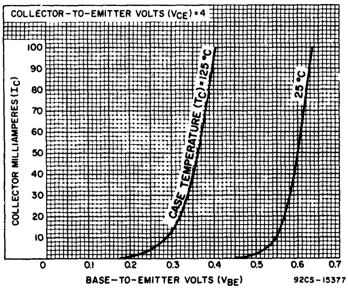


Fig.15 - Typical transfer characteristics for types 2N5490 through 2N5497 inclusive.

2N5629-2N5631

Silicon N-P-N Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-2N5629, 2N5630 and 2N5631 are epitaxial-base silicon n-p-n transistors intended for a wide variety of high-power, high-current applications, such as power-switching circuits, driver and output stages for series and shunt regulators, dc-to-dc converters, inverters, and solenoid (hammer)/relay drivers.

These devices differ in maximum voltage ratings. They are supplied in JEDEC TO-204MA hermetic steel packages.

Features:

- High dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- Hermetically sealed JEDEC TO-204MA package
- High gain at high current

Applications:

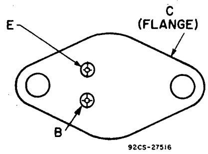
- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5629	2N5630	2N5631	
* V_{CEO}	100	120	140	V
* V_{CBO}	100	120	140	V
* V_{EBO}	7			V
* I_C	16			A
* I_{CM}	20			A
* I_B	5			A
* P_T				
At $T_C \leq 25^\circ C$	200			W
At $T_C > 25^\circ C$ derate linearly	1.14			W/$^\circ$C
* T_J, T_{stg}	–65 to 200			$^\circ$C
* T_L at 1/16 ± 1/32 in. (1.58 ± 0.8 mm) from case for 10 s	235			$^\circ$C

* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

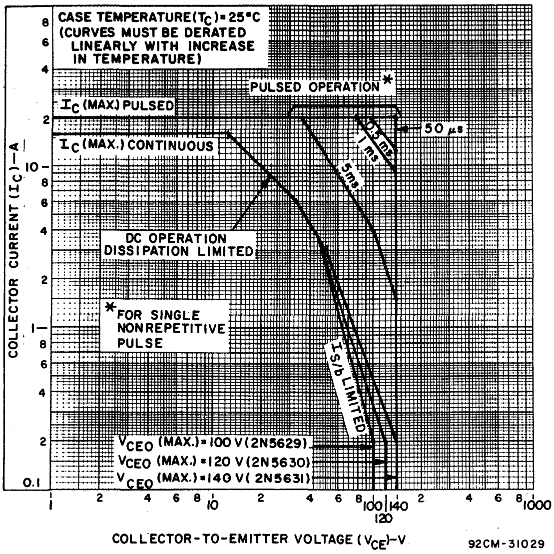


Fig. 1 – Maximum operating areas for all types (T_C = 25°C).

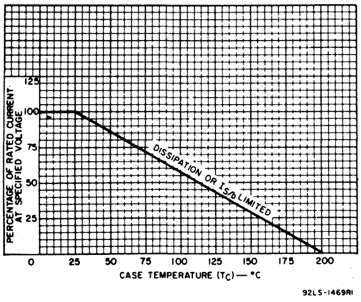


Fig. 2 — Current derating curve for all types.

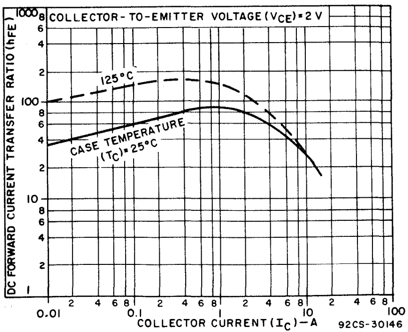


Fig. 3 — Typical dc beta characteristics as a function of collector current for all types.

ELECTRICAL CHARACTERISTICS, At Case Temperature T_C = 25°C Unless Otherwise Specified

	CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N5629		2N5630		3N5631		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
*	I_{CEX}	100	−1.5	–	–	–	1	–	–	–	–	mA
		120	−1.5	–	–	–	–	–	1	–	–	
		140	−1.5	–	–	–	–	–	–	–	1	
	T_C = 150°C	100	−1.5	–	–	–	5	–	–	–	–	
		120	−1.5	–	–	–	–	–	5	–	–	
		140	−1.5	–	–	–	–	–	–	–	5	
*	I_{CEO}	50	–	–	0	–	1	–	–	–	–	mA
		60	–	–	0	–	–	–	1	–	–	
		70	–	–	0	–	–	–	–	–	1	
	I_{CBO} $I_E = 0$	100[a]	–	–	–	–	1	–	–	–	–	mA
		120[a]	–	–	–	–	–	–	1	–	–	
		140[a]	–	–	–	–	–	–	–	–	1	
*	I_{EBO}	–	7	0	–	–	1	–	1	–	1	mA
*	$V_{CEO}(sus)$[b]	–	–	0.2[c]	0	100	–	120	–	140	–	V
*	h_{FE}[a]	2	–	8[c]	–	25	100	20	80	15	60	
		2	–	16[c]	–	4	–	4	–	4	–	
*	V_{BE}[a]	2	–	8[c]	–	–	1.5	–	1.5	–	1.5	V
*	$V_{BE}(sat)$[a]	–	–	10[c]	1	–	1.8	–	1.8	–	1.8	V
*	C_{obo} f = 0.1 MHz $I_E = 0$	10[a]	–	–	–	–	500	–	500	–	500	pF
*	$V_{CE}(sat)$[a]	–	–	10[c]	1	–	1	–	1	–	1	V
		–	–	16[c]	4	–	2	–	2	–	2	
*	f_T f=0.5 MHz	20	–	1	–	1	–	1	–	1	–	MHz
*	h_{fe} f = 1 kHz	10	–	4	–	15	–	15	–	15	–	
	$I_{S/b}$ t_p = 1 s nonrep.	30	–	–	–	6.67	–	6.67	–	6.67	–	A
	$R_{\theta JC}$	10	–	10	–	–	0.875	–	0.875	–	0.875	°C/W

* In accordance with JEDEC registration data.

[a] V_{CB} value.

[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$ MUST NOT BE measured on a curve tracer.

[c] Pulsed; pulse duration ⩽300 μs. Duty factor ⩽2%.

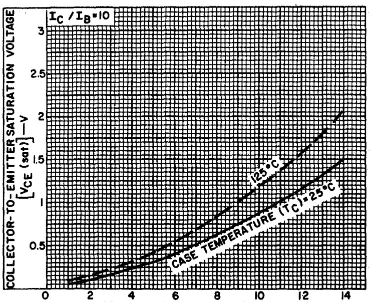


Fig. 4 — Typical saturation voltage characteristics for all types.

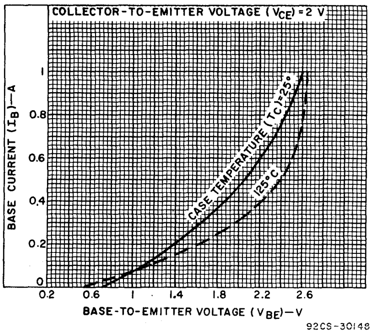


Fig. 5 — Typical input characteristics for all types.

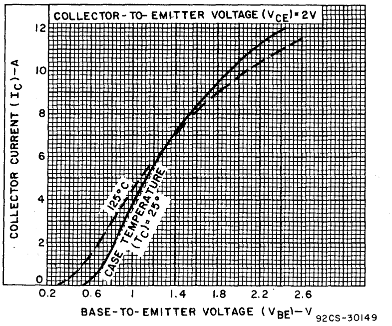


Fig. 6 — Typical transfer characteristics for all types.

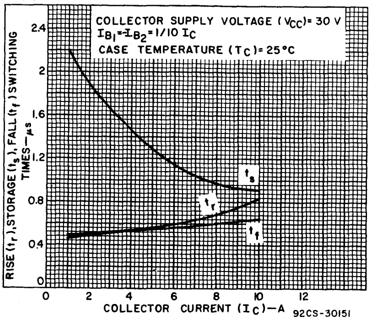


Fig. 7 — Typical saturated-switching times for all types.

2N5632, 2N5633, 2N5634

Silicon N-P-N Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-2N5632, 2N5633 and 2N5634 are epitaxial-base silicon n-p-n transistors intended for a wide variety of high-power, high-current applications, such as power-switching circuits, driver and output stages for series and shunt regulators, dc-to-dc converters, inverters, and solenoid (hammer)/relay drivers.

These devices differ in maximum voltage ratings. They are supplied in JEDEC TO-204MA hermetic steel packages.

Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**
- **Hermetically sealed JEDEC TO-3/TO-204MA package**
- **High gain at high current**

Applications:

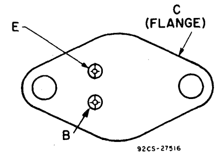
- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5632	2N5633	2N5634	
* V_{CEO}	100	120	140	V
* V_{CBO}	100	120	140	V
* V_{EBO}		7		V
* I_C		10		A
* I_{CM}		15		A
* I_B		5		A
* P_T				
At $T_C \leqslant 25^oC$		150		W
At $T_C > 25^oC$ derate linearly		0.857		W/°C
* T_J, T_{stg}		−65 to 200		°C
* T_L at 1/16 ± 1/32 in. (1.58 ± 0.8 mm) from case for 10 s		235		°C

* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

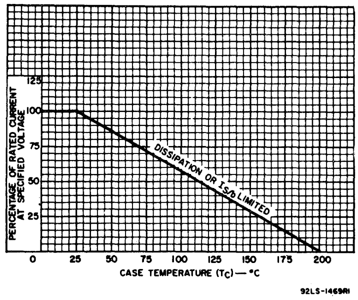


Fig. 2 — Current derating curve for all types.

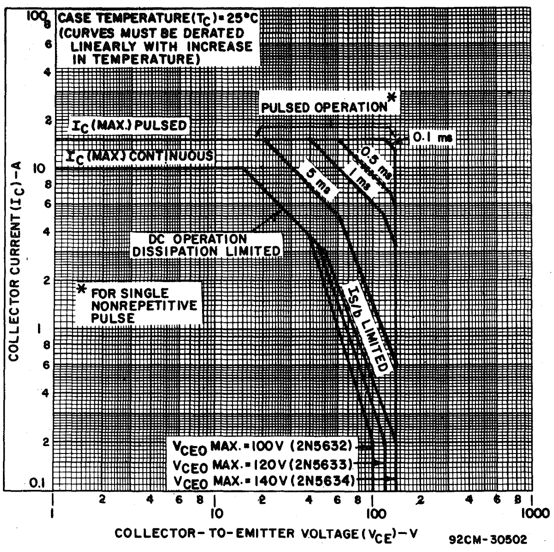


Fig. 1 — Maximum operating areas for all types.

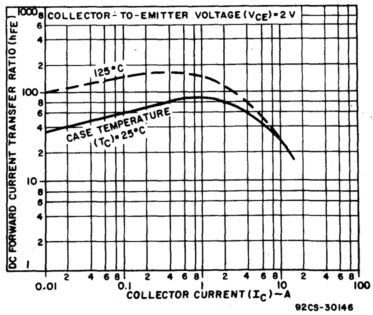


Fig. 3 — Typical dc beta characteristics as a function of collector current for all types.

ELECTRICAL CHARACTERISTICS, At Case Temperature $T_C = 25^oC$
Unless Otherwise Specified

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N5632		2N5633		2N5634		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEX}	100	−1.5	–	–	–	1.0	–	–	–	–	mA
	120	−1.5	–	–	–	–	–	1.0	–	–	
	140	−1.5	–	–	–	–	–	–	–	1.0	
$T_C \doteq 150^oC$	100	−1.5	–	–	–	5.0	–	–	–	–	
	120	−1.5	–	–	–	–	–	5.0	–	–	
	140	−1.5	–	–	–	–	–	–	–	5.0	
* I_{CEO}	50	–	–	0	–	1.0	–	–	–	–	mA
	60	–	–	0	–	–	–	1.0	–	–	
	70	–	–	0	–	–	–	–	–	1.0	
I_{CBO} $I_E = 0$ V_{CB}=Rated V_{CB}	100	–	–	–	–	1.0	–	–	–	–	mA
	120	–	–	–	–	–	–	1.0	–	–	
	140	–	–	–	–	–	–	–	–	1.0	
* I_{EBO}	–	7	–	–	–	1.0	–	1.0	–	1.0	mA
* $V_{CEO}(sus)^b$	–	–	0.2	0	100	–	120	–	140	–	V
* h_{FE}^a	2	–	5	–	25	100	20	80	15	60	
	2	–	10	–	5	–	5	–	5	–	
* V_{BE}^a	2	–	5	–	–	1.5	–	1.5	–	1.5	V
* $V_{CE}(sat)^a$	–	–	7.5	0.75	–	1.0	–	1.0	–	1.0	V
	–	–	10	2.0	–	2.0	–	2.0	–	2.0	
* f_T f = 0.5 MHz	20	–	1	–	1	–	1	–	1	–	MHz
* h_{fe} f = 1 kHz	10	–	2.0	–	15	–	15	–	15	–	
* $V_{BE}(sat)$			7.5	0.75	–	2.0	–	2.0	–	2.0	V
* C_{obo} f = 0.1 MHz $I_E = 0$	10^c				–	300	–	300	–	300	pF
$I_{S/b}$ t_p = 1 s nonrep.	50				3.0	–	–	–	–	–	A
	45				–	–	3.33	–	–	–	
	40				–	–	–	–	3.75	–	
$R_{\theta JC}$	–	–	–	–	–	1.17	–	1.17	–	1.17	$^oC/W$

* In accordance with JEDEC registration data.

[a] Pulsed; pulse duration ⩽ 300 µs. Duty factor ⩽ 2%.

[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$ MUST NOT BE measured on a curve tracer.

[c] V_{CB}.

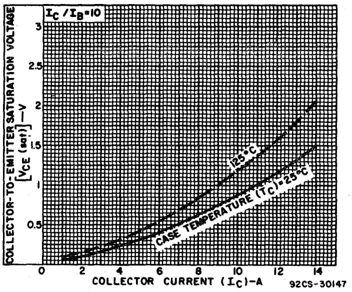


Fig. 4 — Typical saturation voltage characteristics for all types.

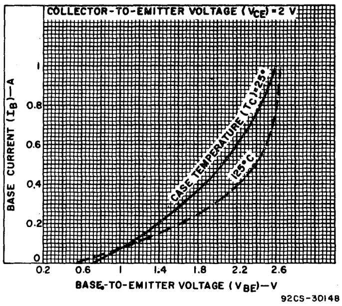


Fig. 5 — Typical input characteristics for all types.

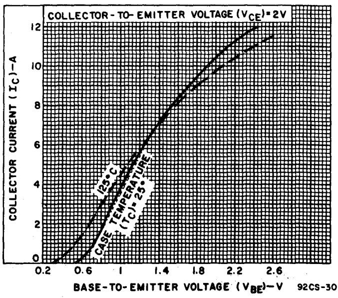


Fig. 6 — Typical transfer characteristics for all types.

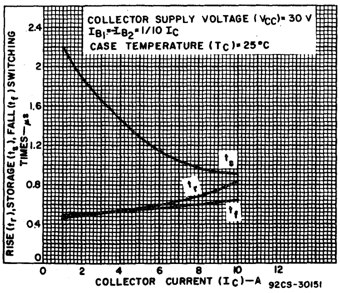


Fig. 7 — Typical saturated-switching times for all types.

2N5671, 2N5672

Silicon N-P-N Power Transistors

High-Current, High-Speed, High-Power Types for Switching and Amplifier Applications

RCA Types 2N5671 and 2N5672▲ are epitaxial silicon n-p-n transistors having high current and high power handling capability and fast switching speed. The 2N5672 is similar to the 2N5671 except that it has higher voltage ratings and lower leakage currents. These devices are especially suitable for switching-control amplifiers, power gates, switching regulators, power-switching circuits, converters, inverters, control circuits. Other recommended applications included DC-RF amplifiers and power oscillators.

They are supplied in the JEDEC TO-3 hermetic steel package.

▲Formerly Dev. Types TA7323 and TA7323A, respectively

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

	2N5671	2N5672	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open, V_{CEO}(sus)	90	120	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω, V_{CER}(sus)	110	140	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω & V_{BE} = -1.5, V_{CEX}(sus)	120	150	V
*EMITTER-TO-BASE VOLTAGE, V_{EBO}	7	7	V
*COLLECTOR CURRENT, I_C	30	30	A
*BASE CURRENT, I_B	10	10	A
*TRANSISTOR DISSIPATION, P_T:			
At case temperatures up to 25° C and V_{CE} up to 24 V	140	140	W
At case temperatures up to 25° C and V_{CE} above 24 V	See Fig. 1		
At case temperatures above 25° C and V_{CE} above 24 V	See Figs. 1&2.		
*TEMPERATURE RANGE:			
Storage & Operating (Junction)	–65 to +200		°C
*PIN TEMPERATURE (During Soldering)			
At distances ≥ 1/32 in. from seating plane for 10 s max	230		°C

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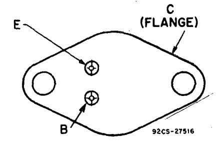
*In accordance with JEDEC registration data format (JS-6, RFD-1)

Features:

- **Maximum Safe-Area-of-Operation Curves . . .** **$I_{S/b}$ limit line beginning at 24 V**
- **Fast Turn-On Time . . . t_{on} = 0.5μs max. at I_C = 15 A**
- **High-Current Capability . . .** **h_{FE}, V_{CE}(sat), V_{BE}(sat), & V_{BE} measured at I_C = 15 A**
- **Low V_{CE}(sat) = 0.75 V max.**
- **High P_T = 140 W max. at T_C = 25° C**

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

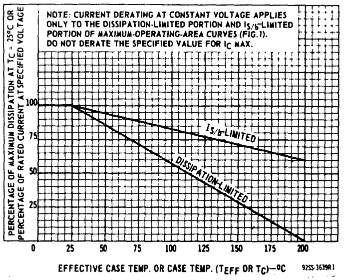


Fig. 2 - Dissipation derating curves for types 2N5671 and 2N5672.

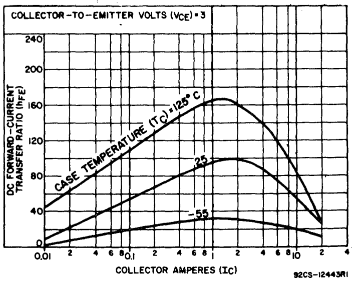


Fig. 3 - Typical dc beta characteristics for types 2N5671 and 2N5672.

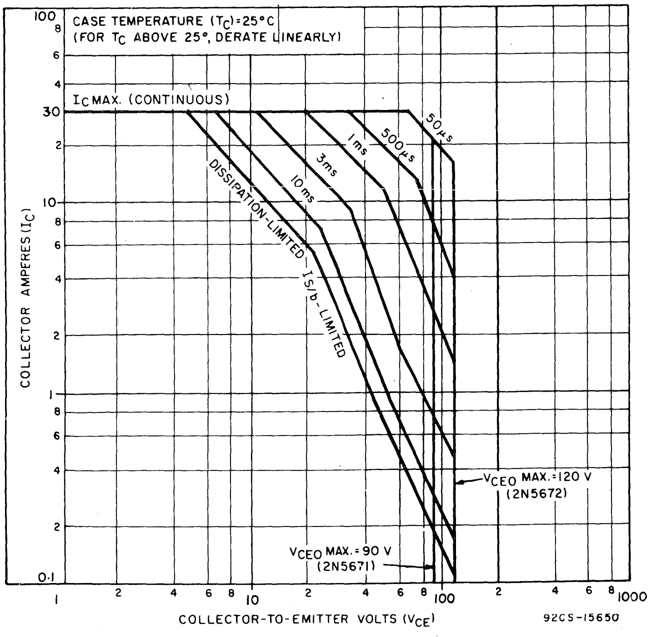


Fig. 1 - Maximum operating areas for types 2N5671 and 2N5672.

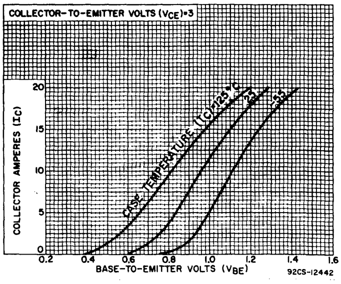


Fig. 4 - Typical transfer characteristics for types 2N5671 and 2N5672.

2N5671, 2N5672

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS					LIMITS				UNITS
	DC Voltage (V)			DC Current (A)		Type 2N5671		Type 2N5672		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	-	80	-	-	0	-	10	-	10	mA
* I_{CEV}	-	110	-1.5	-	-	-	12	-	-	mA
* I_{CEV}		135	-1.5	-	-	-	-	-	10	mA
(T_C=150° C)	-	100	-1.5	-	-	-	15	-	10	mA
* I_{EBO}	-	-	-7	0	-	-	10	-	10	mA
V_{CEO}(sus)	-	-	-	0.2	0	90[a]	-	120[a]	-	V
V_{CER}(sus) (R_{BE}) ≤50 Ω	-	-	-	0.2	0	110[a]	-	140[a]	-	V
V_{CEX}(sus) & R_{BE} ≤ 50 Ω	-	-	-1.5	0.2	-	120[a]	-	150[a]	-	V
* V_{BE}(sat)	-	-	-	15	1.2	-	1.5	-	1.5	V
V_{BE}	-	5	-	15	-	-	1.6	-	1.6	V
* V_{CE}(sat)	-	-	-	15	1.2	-	0.75	-	0.75	V
* h_{FE}	- -	2 5	- -	15 20	- -	20 20	100 -	20 20	100 -	
$I_{S/b}$[b]	- -	24 45	- -	- -	- -	5.8[c] 0.9[c]	- -	5.8[c] 0.9[c]	- -	A A
$E_{S/b}$[d] R_{BE} = 20 Ω, L = 180 μH	-	-	-4	15	-	20	-	20	-	mJ
f_T	-	10	-	2	-	50	-	50	-	MHz
C_{ob} (At 1 MHz, I_E= 0)	10	-	-	-	-	-	900	-	900	pF
* t_{on}	V_{CC}= 30 V	-	-	15	I_{B1}= I_{B2}= 1.2	-	0.5	-	0.5	μs
* t_s	V_{CC}= 30 V	-	-	15	I_{B1}= I_{B2}= 1.2	-	1.5	-	1.5	μs
* t_f	V_{CC}= 30 V	-	-	15	I_{B1}= I_{B2}= 1.2	-	0.5	-	0.5	μs
$R_{\theta JC}$	-	10	-	5	-	-	1.25	-	1.25	°C/W

[a] Pulsed; pulse duration ≤ 350 μs, duty factor=0.02.

[b] CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CEX}(sus) MUST NOT be measured on a curve tracer.

[c] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.

[d] Pulsed; 1-s, non-repetitive pulse.

[e] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b}=1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

*In accordance with JEDEC registration data format JS-6 RDF-1.

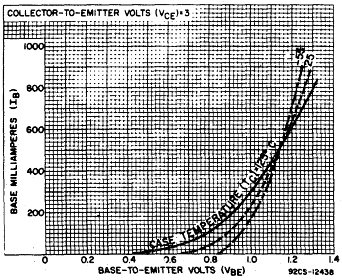


Fig. 5 - Typical input characteristics for types 2N5671 and 2N5672.

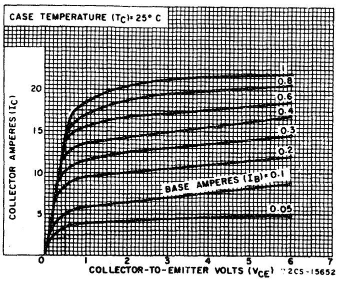


Fig. 6 - Typical output characteristics for types 2N5671 and 2N5672.

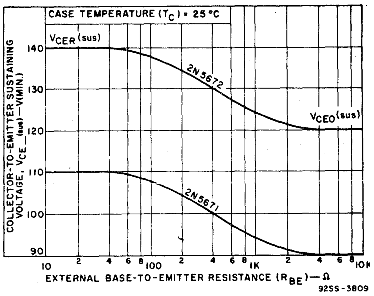


Fig. 7 - Collector-to-emitter sustaining voltage characteristics for types 2N5671 and 2N5672.

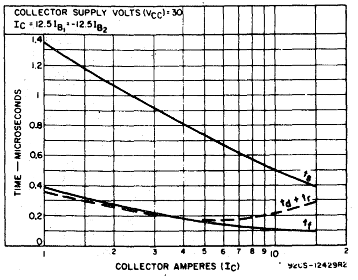


Fig. 8 - Typical saturated switching characteristics for types 2N5671 and 2N5672.

2N5781-2N5786

Silicon N-P-N and P-N-P Epitaxial-Base Complementary-Symmetry Transistors

General-Purpose Types for Switching and Linear-Amplifier Applications

RCA-2N5781, 2N5782, and 2N5783 are epitaxial-base silicon p-n-p transistors - - complements of the hometaxial-base silicon n-p-n types 2N5784, 2N5785, and 2N5786,● respectively.

The three types in each family differ primarily in voltage ratings and saturation characteristics.

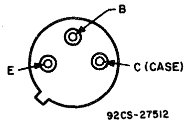
These transistors are intended for medium-power switching and complementary-symmetry audio amplifier applications.

● Formerly RCA Dev. Types TA7270, TA7271, TA7272, TA7289, TA7290, and TA7291 respectively.

Features:

- Low saturation voltages
- Maximum safe-area-of-operation curves
- Hermetically sealed package
- High gain at high current
- High breakdown voltages

TERMINAL DESIGNATIONS



JEDEC TO-39

(See dimensional outline "C".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		P-N-P	2N5781◆	2N5782◆	2N5783◆	
		N-P-N	2N5784	2N5785	2N5786	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}		80	65	45	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
* With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$		80	65	45	V
With base open	$V_{CEO}(sus)$		65	50	40	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}		5	5	3.5	V
*CONTINUOUS COLLECTOR CURRENT	I_C		3.5	3.5	3.5	A
*CONTINUOUS BASE CURRENT	I_B		1	1	1	A
*TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C			10	10	10	W
At ambient temperatures up to 25°C			1	1	1	W
At case temperatures above 25°C .... Derate linearly			0.057 W/°C, or see Fig. 1			
At ambient temperatures above 25°C .... Derate linearly			0.0057			W/°C
*TEMPERATURE RANGE:						
Storage and operating (Junction)			−65 to +200			°C
*LEAD TEMPERATURE (During soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.			230			°C

*In accordance with JEDEC registration data format JS-6 RDF-2.

◆For p-n-p devices, voltage and current values are negative.

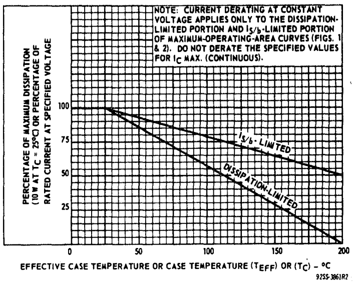


Fig. 1 - Dissipation derating curve for all types.

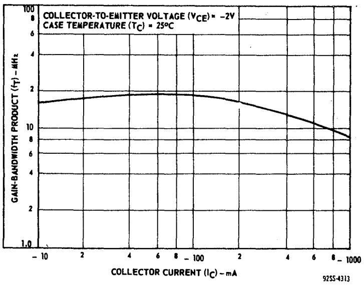


Fig. 2 - Typical gain-bandwidth product for 2N5781, 2N5782, & 2N5783.

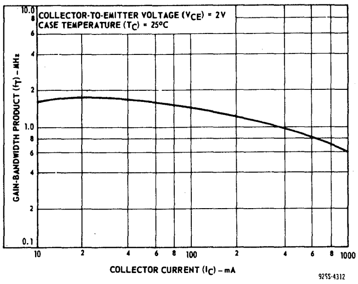


Fig. 3 - Typical gain-bandwidth product for 2N5784, 2N5785, & 2N5786.

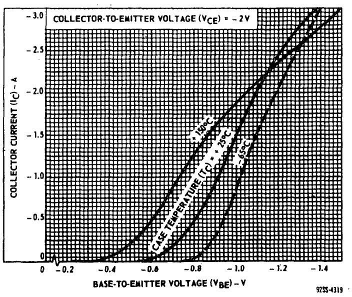


Fig. 4 - Typical transfer characteristics for types 2N5781, 2N5782, 2N5783.

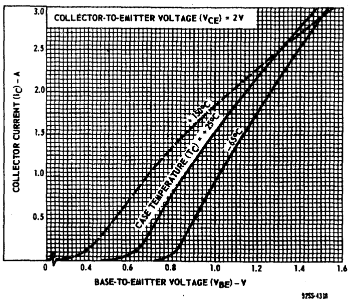


Fig. 5 - Typical transfer characteristics for types 2N5784, 2N5785, 2N5786.

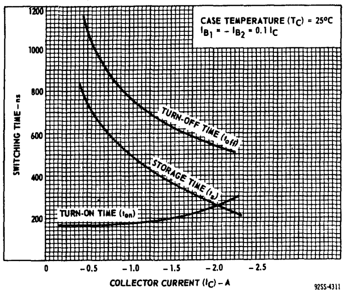


Fig. 6 - Typical saturated switching characteristics for types 2N5781, 2N5782, 2N5783.

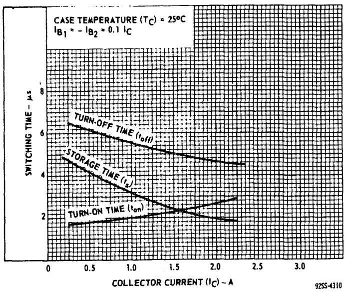


Fig. 7 - Typical saturated switching characteristics for types 2N5784, 2N5785, & 2N5786.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N5781 p-n-p		2N5784 n-p-n		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	65				–	–10	–	10	μA
At T_C = 150°C		65				–	–1	–	1	mA
* With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CEX}	–75 75	1.5 –1.5			– –	–10 –	– –	– 10	μA
* At T_C = 150°C		–75 75	1.5 –1.5			– –	–1 –	– –	– 1	mA
* With base open	I_{CEO}	60			0	–	–100	–	100	μA
* Emitter Cutoff Current	I_{EBO}		–5	0		–	–10	–	10	μA
* DC Forward-Current Transfer Ratio	h_{FE}	2 2		1^a 3.2^a		20 4	100 –	20 4	100 –	
* Collector-to-Emitter Sustaining Voltage (see Figs, 2 and 3): With base open	$V_{CEO}(sus)$			0.1^a	0	-65^b	–	65^b	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1^a		-80^b	–	80^b	–	
* Base-to-Emitter Voltage	V_{BE}	2		1^a		–	–1.5	–	1.5	V
* Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case)^c	$V_{CE}(sat)$			1^a	0.1	–	–0.5	–	0.5	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio^d f = 4 MHz	$\|h_{fe}\|$	–2		–0.1		2	15	–	–	
f = 200 kHz		2		0.1				5	20	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	2		0.1		25	–	25	–	
Saturated Switching Time (V_{CC} = 30 V, I_{B1} = I_{B2}): Turn-on ($t_d + t_r$)	t_{ON}			–1 1	–0.1 0.1	– –	0.5 –	– –	– 5	μs
Turn-off ($t_s + t_f$)	t_{OFF}			–1 1	–0.1 0.1	– –	2.5 –	– –	– 15	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	

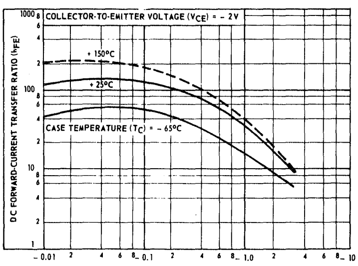


Fig. 8 - Typical dc-beta characteristics for type 2N5781.

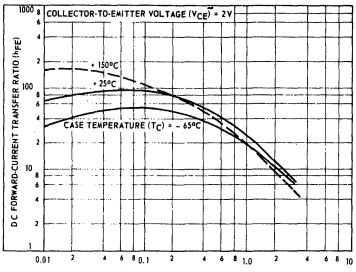


Fig. 9 - Typical dc-beta characteristics for type 2N5784.

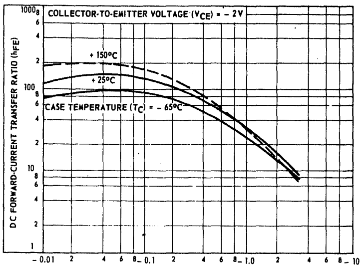


Fig. 10 - Typical dc-beta characteristics for type 2N5782.

2N5781-2N5786

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS◆				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N5782 p-n-p		2N5785 n-p-n		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	50				–	–10	–	10	μA
At T_C = 150°C		50				–	–1	–	1	mA
* With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CEX}	–60 60	1.5 –1.5			– –	–10 –	– –	– 10	μA
* At T_C = 150°C		–60 60	1.5 –1.5			– –	–1 –	– –	– 1	mA
* With base open	I_{CEO}	35			0	–	–100	–	100	μA
* Emitter Cutoff Current	I_{EBO}		–5	0		–	–10	–	10	μA
* DC Forward-Current Transfer Ratio	h_{FE}	2 2		1.2[a] 3.2[a]		20 4	100 –	20 4	100 –	
* Collector-to-Emitter Sustaining Voltage (see Figs. 2 and 3): With base open	$V_{CEO}(sus)$			0.1[a]	0	–50[b]	–	50[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1[a]		–65[b]	–	65[b]	–	
* Base-to-Emitter Voltage	V_{BE}	2		1.2[a]		–	–1.5	–	1.5	V
* Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case)[c]	$V_{CE}(sat)$			1.2[a] 3.2[a]	0.12 0.8	– –	–0.75 –2	– –	0.75 2	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio[d] f = 4 MHz	$\|h_{fe}\|$	–2		–0.1		2	15	–	–	
f = 200 kHz		2		0.1		–	–	5	20	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	2		0.1		25	–	25	–	
Saturated Switching Time (V_{CC} = 30 V, I_{B1} = I_{B2}): Turn-on ($t_d + t_r$)	t_{ON}			–1 1	–0.1 0.1	– –	0.5 –	– –	– 5	μs
Turn-off ($t_s + t_f$)	t_{OFF}			–1 1	–0.1 0.1	– –	2.5 –	– –	– 15	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	

* In accordance with JEDEC registration data format JS-6 RDF-2.

[a] Pulsed, pulse duration = 300 μs, duty factor = 1.8%.

[b] *CAUTION: Sustaining voltages $V_{CEO}(sus)$, and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.*

◆ For p-n-p devices, voltage and current values are negative.

[c] Lead resistance is critical in this test.

[d] Measured at a frequency where $|h_{fe}|$ is decreasing at approximately 6 dB per octave.

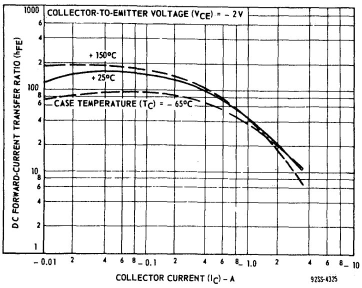


Fig. 11 - Typical dc-beta characteristics for type 2N5783.

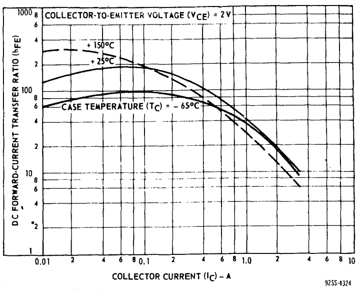


Fig. 12 - Typical dc-beta characteristics for type 2N5786.

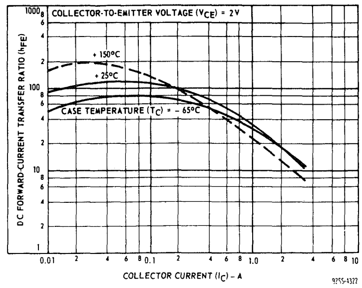


Fig. 13 - Typical dc-beta characteristics for type 2N5785.

ELECTRICAL CHARACTERISTICS, *At Case Temperature, (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS◆				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N5783 p-n-p		2N5786 n-p-n		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	40				–	–10	–	10	μA
At T_C = 150°C		40.				–	–1	–	1	mA
* With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CEX}	–45 45	1.5 –1.5			– –	–10 –	– –	– 10	μA
* At T_C = 150°C		–45 45	1.5 –1.5			– –	–1 –	– –	– 1	mA
* With base open	I_{CEO}	25			0	–	–100	–	100	μA
* Emitter Cutoff Current	I_{EBO}		–3.5	0		–	–10	–	10	μA
* DC Forward-Current Transfer Ratio	h_{FE}	2 2		1.6[a] 3.2[a]		20 4	100 –	20 4	100 –	
* Collector-to-Emitter Sustaining Voltage (see Figs. 2 and 3): With base open	V_{CEO}(sus)			0.1[a]	0	–40[b]	–	40[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)			0.1[a]		–45[b]	–	45[b]	–	
* Base-to-Emitter Voltage	V_{BE}	2		1.6[a]		–	–1.5	–	1.5	V
* Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case)[c]	V_{CE}(sat)			1.6[a] 3.2[a]	0.16 0.8	– –	–1 –2	– –	1 2	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio[d] f = 4 MHz	$\|h_{fe}\|$	–2		–0.1		2	15	–	–	
f = 200 kHz		2		0.1		–	–	5	20	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	2		0.1		25	–	25	–	
Saturated Switching Time (V_{CC} = 30 V, $I_{B1} = I_{B2}$): Turn-on ($t_d + t_r$)	t_{ON}			–1 1	–0.1 0.1	– –	0.5 –	– –	– 5	μs
Turn-off ($t_s + t_f$)	t_{OFF}			–1 1	–0.1 0.1	– –	2.5 –	– –	– 15	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	

* In accordance with JEDEC registration data format JS-6 RDF-2.

◆ For p-n-p devices, voltage and current values are negative.

[a] Pulsed, pulse duration = 300 μs, duty factor = 1.8%.

[b] *CAUTION: Sustaining voltages V_{CEO}(sus), and V_{CER}(sus) MUST NOT be measured on a curve tracer.*

[c] Lead resistance is critical in this test.

[d] Measured at a frequency where $|h_{fe}|$ is decreasing at approximately 6 dB per octave.

2N5781-2N5786

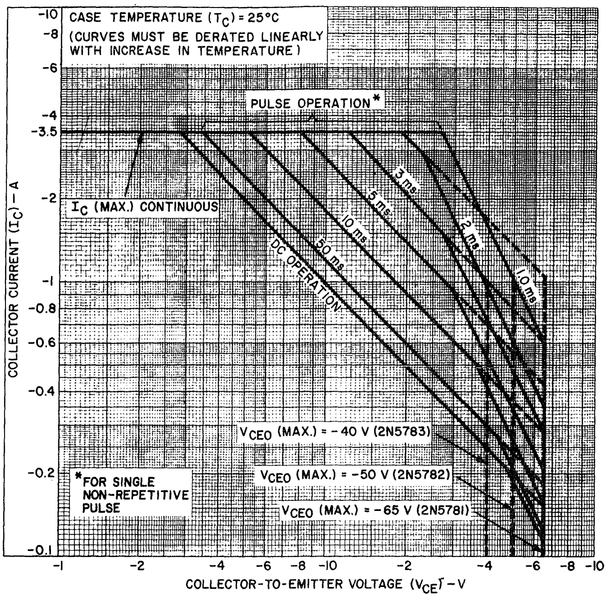


Fig. 14 - Maximum operating areas for types 2N5781, 2N5782, and 2N5783.

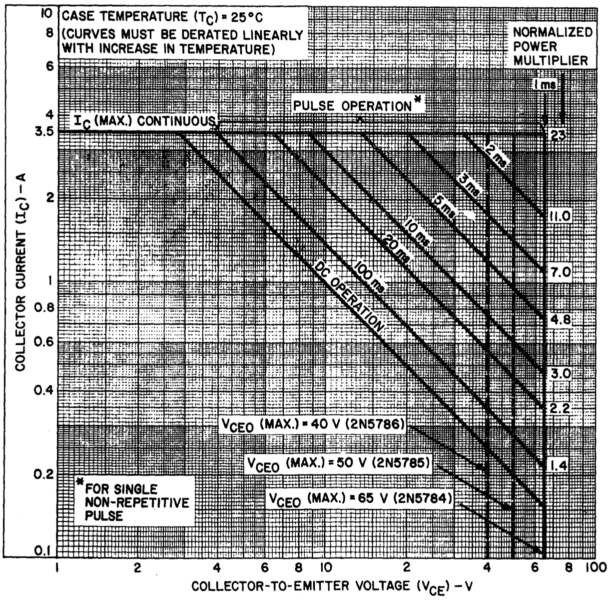


Fig. 15 - Maximum operating areas for types 2N5784, 2N5785, and 2N5786.

2N5838-2N5840

High-Voltage, High-Power Silicon N-P-N Power Transistor

For Switching and Linear Applications in Military, Industrial and Commercial Equipment

RCA 2N5838, 2N5839 and 2N5840** are epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. These devices employ the popular JEDEC TO-3 package; they differ mainly in voltage, current-gain, and V_{CE}(sat) ratings.

Featuring high breakdown voltage ratings and low-saturation voltage values, the 2N5838, 2N5839 and 2N5840 are especially suitable for use in inverters, deflection circuits, switching regulators, high-voltage bridge amplifiers, ignition circuits, and other high-voltage switching applications.

** Formerly RCA Dev. types TA7513, TA7530, and TA7420 respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5838	2N5839	2N5840	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	275	300	375	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With base open, V_{CEO}(sus)	250	275	350	V
* With reverse bias (V_{BE}) of -1.5 V, V_{CEV}(sus)▲	275	300	375	V
With external base-to-emitter resistance (R_{BE}) $\leq$ 50 Ω, V_{CER}(sus)	275	300	375	V
*EMITTER-TO-BASE VOLTAGE, V_{EBO}	6	6	6	V
*COLLECTOR CURRENT, I_C				
Continuous	3	3	3	A
Peak	5	5	5	A
*CONTINUOUS BASE CURRENT, I_B	1.5	1.5	1.5	A
*TRANSISTOR DISSIPATION, P_T:				
At case temperature up to 25° C and V_{CE} up to 40 V	100	100	100	W
At case temperatures up to 25° C and V_{CE} above 40 V	See Fig. 5			
At case temperatures above 25° C and V_{CE} above 40 V	See Figs. 1 & 5			
*TEMPERATURE RANGE:				
Storage & Operating (Junction)	-65 to +200			°C
*PIN TEMPERATURE (During Soldering):				
At distances $\geq$ 1/32 in. (0.8 mm) from case for 10 s max	230			°C

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* In accordance with JEDEC registration data format (JS-6, RDF-1).

▲ Shown as V_{CEX}(sus) in JEDEC Registration Data.

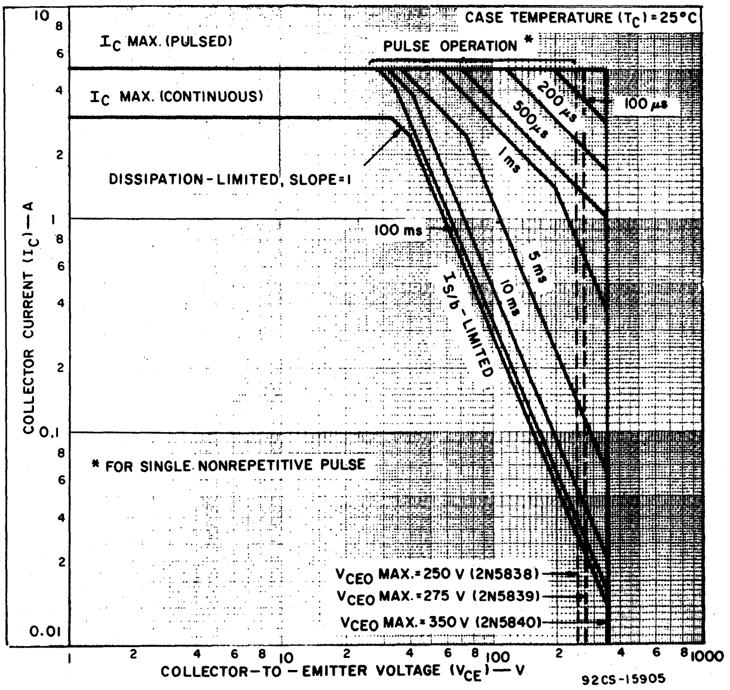
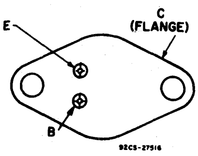


Fig. 1 - Maximum operating areas for all types.

Features:

- **Maximum safe-area-of-operation curves**
- **Low saturation voltages**
- **High voltage ratings**
  V_{CER}(sus) = 375 V (2N5840)
  300 V (2N5839)
  275 V (2N5838)
- **High dissipation rating**
  P_T = 100 W

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

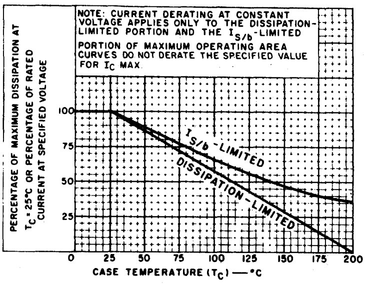


Fig. 2 - Derating curves for all types.

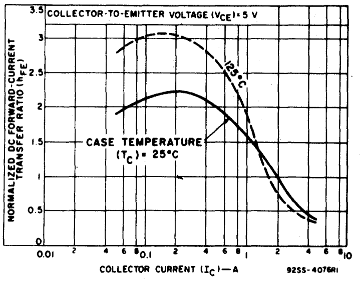


Fig. 3 - Typical normalized dc beta characteristics for all types.

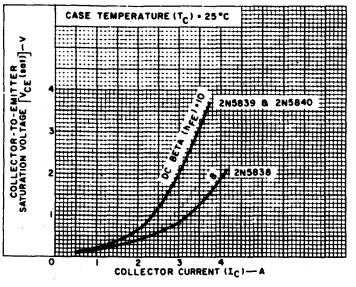


Fig. 4 - Typical saturation voltage characteristics for all types.

2N5838-2N5840

ELECTRICAL CHARACTERISTICS, *Case Temperature* (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N5838		2N5839		2N5840		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	200 250				- -	2	-	- 2	- -	- 2	mA
* With base-emitter junction reverse biased	I_{CEV}	265 290 360	-1.5 -1.5 -1.5			- - -	5 -	- -	- 2 -	- - -	- - 2	mA
* With base-emitter junction reverse biased, T_C=100°C	I_{CEV} T_C 100 °C	265 290 360	-1.5 -1.5 -1.5			- - -	8 -	-	- 5	-	- - 5	mA
* Emitter-Cutoff Current	I_{EBO}		-6			-	1	-	1	-	1	mA
* Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)^a$			0.2[a]		250[b]	-	275[b]	-	350[b]	-	V
* With base-emitter junction reverse biased	$V_{CEX}(sus)^a$		-1.5	0.1[a]		275[b]	-	300[b]	-	375[b]	-	
With external base-to-emitter resistance (R_{BE}) - 50 Ω	$V_{CER}(sus)^a$			0.2[a]		275[b]	-	300[b]	-	375[b]	-	
* Emitter-to-Base Voltage I_E = 0.02 A	V_{EBO}					6	-	6	-	6	-	V
* DC Forward-Current * Transfer Ratio	h_{FE}	5 3 2		0.5[a] 2[a] 3[a]		20 - 8	- - 40	20 10 -	- 50 -	20 10 -	- 50 -	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			2[a] 3[a]	0.2 0.375	- -	2	-	2	-	2	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			2[a] 3[a]	0.2 0.375	-	1	-	1.5	-	1.5	V
Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{obo}					-	150		150		150	pF
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f - 1 MHz)	$\lvert h_{fe} \rvert$	10		0.2		5		5		5	-	
Forward-Bias, Second-Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$	40				2.5		2.5		2.5	-	A
Second Breakdown[c] Energy (With base reverse biased) R_B = 50 Ω, L = 100 μH	$E_{S/b}$		4			0.45	-	0.45	-	0.45	-	mJ
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$	10		5			1.75	-	1.75	-	1.75	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-1)

a Pulsed; pulse duration = 350 μs, Duty factor ≤ 2%.

b CAUTION: The sustaining voltages $V_{CEO}(sus)$, $V_{CEX}(sus)$ and $V_{CER}(sus)$, MUST NOT be measured on a curve tracer.

SWITCHING-TIME CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS						UNITS
		VOLTAGE V dc	CURRENT A dc		2N5838		2N5839		2N5840		
		V_{CC}	I_C	I_B●	Max.	Typ.	Max.	Typ.	Max.	Typ.	
Switching Times: Delay	t_d	200	2	0.2	-	-	-	0.07	-	0.07	μs
			3	0.375	-	0.06	-		-	-	
* Rise	t_r	200	2	0.2	-	-	1.5	0.6	1.75	0.6	
			3	0.375	1.5	0.8	-	-	-	-	
* Storage	t_s	200	2	0.2	-	-	3.75	1.75	3.0	1.75	
			3	0.375	3.0	1.0	-		-	-	
* Fall	t_f	200	2	0.2	-	-	1.5	0.35	1.5	0.35	
			3	0.375	1.5	0.4	-	-	-	-	

* In accordance with JEDEC registration data format (JS-6 RDF-1). ● $I_{B1} = I_{B2}$ = value shown.

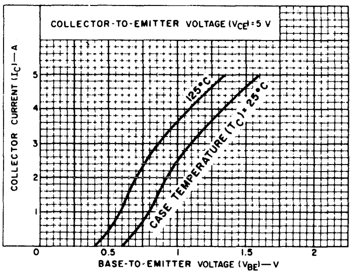


Fig. 5 - Typical transfer characteristics for all types.

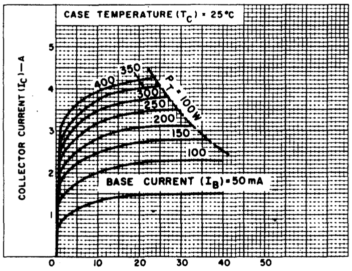


Fig. 6 - Typical output characteristics for all types.

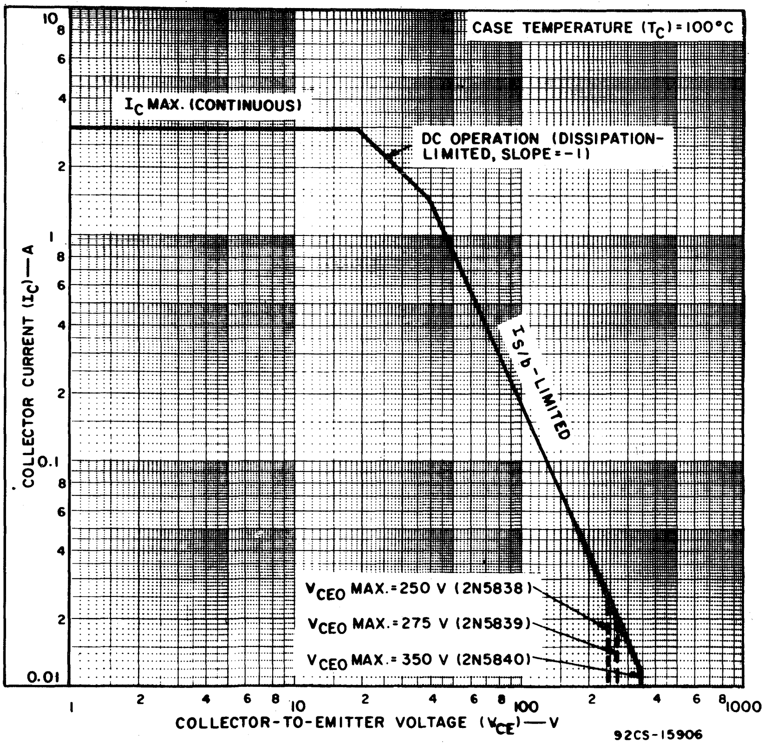


Fig. 7 - Maximum operating areas for all types.

2N5838-2N5840

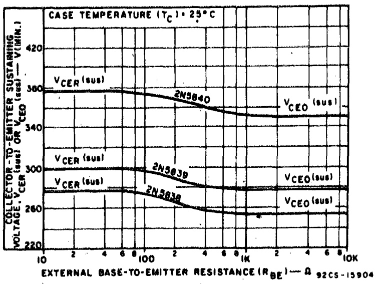


Fig. 8 - Collector-to-emitter sustaining voltage characteristics for all types.

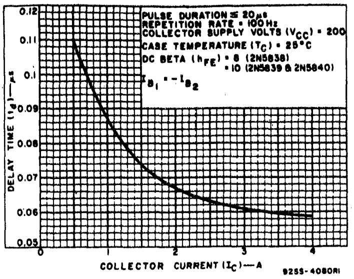


Fig. 9 - Typical delay-time characteristic for all types.

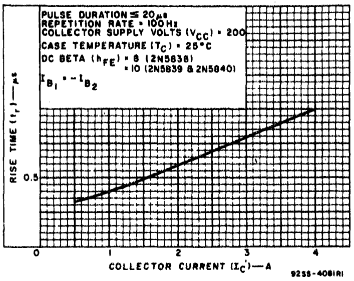


Fig. 10 - Typical rise-time characteristic for all types.

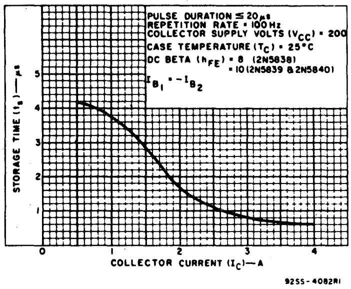


Fig. 11 - Typical storage-time characteristic for all types.

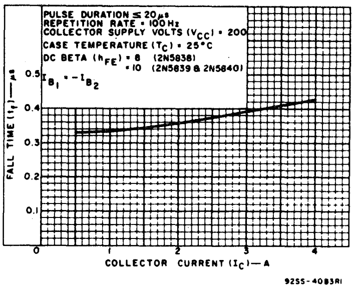


Fig. 12 - Typical fall-time characteristic for all types.

2N5871, 2N5872, 2N5873, 2N5874

Silicon N-P-N and P-N-P Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable
For Industrial and Commercial Use

The RCA-2N5871 and 2N5872 are epitaxial-base silicon p-n-p transistors featuring high gain at high current. The RCA-2N5873 and 2N5874 are epitaxial-base silicon n-p-n transistors. They may be used as complements to 2N5871 and 2N5872, respectively. These devices have a dissipation capability of 115 watts at case temperature up to 25°C.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204MA hermetic package.

Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-areas-of-operation curves**
- **Hermetically sealed JEDEC TO-3/ TO-204MA package**
- **High gain at high current**
- **Thermal-cycling rating curve**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

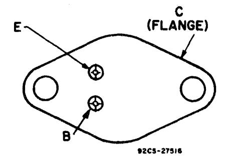
MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5871• 2N5873	2N5872• 2N5874	
* V_{CEO}	60	80	V
* V_{CBO}	60	80	V
* V_{EBO}	5	5	V
* I_C	7	7	A
* I_{CM}	15	15	A
* I_B	2	2	A
* P_T			
At $T_C \leqslant 25^\circ C$	115	115	W
At $T_C > 25^\circ C$ derate linearly	0.658		W/°C
* T_L			
At distance 1/16 in. (1.58 mm) from case for 10 s	250		°C
* T_J, T_{stg}	–65 to 200		°C

* In accordance with JEDEC registration data.

• For p-n-p devices, voltage and current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

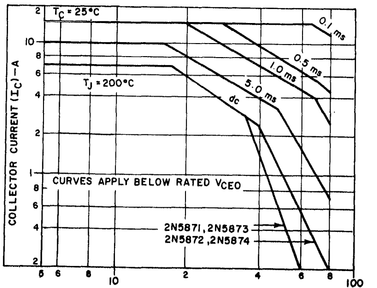


Fig. 1 – Maximum operating areas for all types.

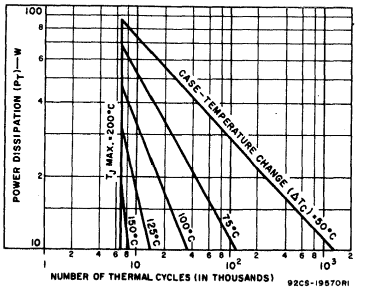


Fig. 2 – Thermal-cycling rating chart.

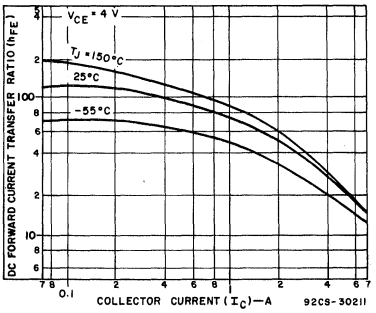


Fig. 3 – Typical dc beta characteristics for 2N5871 and 2N5872.

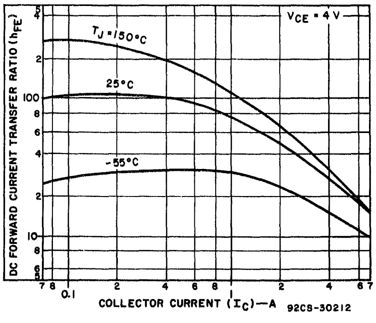


Fig. 4 – Typical dc beta characteristics for 2N5873 and 2N5874.

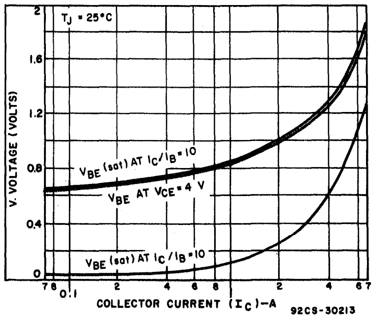


Fig. 5 – Typical voltage characteristics for 2N5871 and 2N5872.

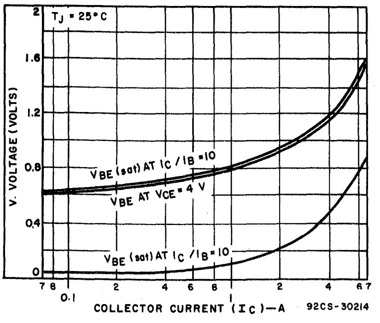


Fig. 6 – Typical voltage characteristics for 2N5873 and 2N5874.

2N5871, 2N5872, 2N5873, 2N5874

ELECTRICAL CHARACTERISTICS, at Case Temperature T_C = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNIT
	VOLTAGE V dc		CURRENT A dc		2N5871• 2N5873		2N5872• 2N5874		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
* I_{CEX}	60	1.5	–	–	–	0.25	–	–	mA
	80	1.5	–	–	–	–	–	0.25	
T_C = 150°C	60	1.5	–	–	–	2	–	–	
	80	1.5	–	–	–	–	–	2	
* I_{CEO}	30	–	–	0	–	0.5	–	–	mA
	40	–	–	0	–	–	–	0.5	
* I_{CBO}	60c	–	–	–	–	0.25	–	–	mA
I_E = 0	80c	–	–	–	–	–	–	0.25	
* I_{EBO}	–	−5	0	–	–	1	–	1	mA
* $V_{CEO}(sus)^b$	–	–	0.1	0	60	–	80	–	V
* h_{FE}^a	4	–	0.5	–	35	–	35	–	
	4	–	2.5	–	20	100	20	100	
	4	–	7.0	–	4	–	4	–	
* V_{BE}^a	4	–	2.5	–	–	1.5	–	1.5	V
* $V_{BE}(sat)^a$	–	–	7	1.75	–	2.5	–	2.5	V
* $V_{CE}(sat)^a$	–	–	4	0.4	–	1	–	1	V
	–	–	7	1.75	–	2	–	2	
* f_T f = 1 MHz	10	–	0.25	–	4	–	4	–	MHz
* h_{fe} f = 1.0 kHz	4	–	0.5	–	20	–	20	–	
* C_{ob} 2N5871-72	10c	–	–	–	–	300	–	300	pF
f = 1 MHz 2N5873-74						250	–	250	
* t_r	–	–	2.5	0.25d	–	0.7	–	0.7	µs
* t_s V_{CC} = 30 V	–	–	2.5	0.25d	–	1	–	1	µs
* t_f	–	–	2.5	0.25d	–	0.8	–	0.8	µs
$R_{\theta JC}$	–	–	–	–	–	1.52	–	1.52	°C/W

• For p-n-p devices, voltage and current values are negative.

* In accordance with JEDEC registration data.

[a] Pulsed; pulse width ⩽300 µs, duty factor ⩽2%.

[b] **CAUTION:** Sustaining voltage, $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer.

[c] V_{CB} [d] $I_{B1} = -I_{B2}$

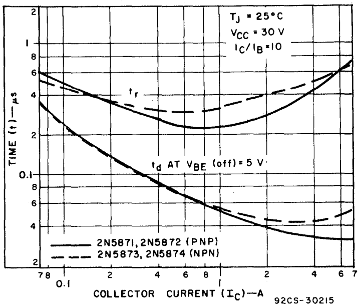


Fig. 7 — Typical turn-on-time for all types.

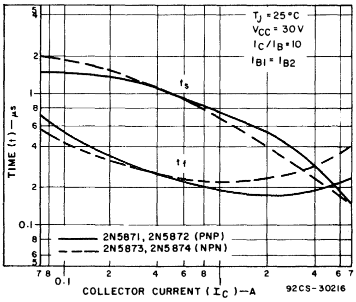


Fig. 8 — Typical turn-off-time for all types.

2N5875, 2N5876, 2N5877, 2N5878

Silicon N-P-N and P-N-P Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable
For Industrial and Commercial Use

The RCA-2N5875 and 2N5876 are epitaxial-base silicon p-n-p transistors featuring high gain at high current. The RCA-2N5877 and 2N5878 are epitaxial-base silicon n-p-n transistors. They may be used as complements to 2N5875 and 2N5876, respectively. These devices have a compability of 150 watts at case temperatures up to 25°C.

They differ in voltage ratings and in currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204MA hermetic package.

Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-areas-of-operation curves**
- **Hermetically sealed JEDEC TO-3/TO-204MA package**
- **High gain at high current**
- **Thermal-cycling rating curve**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

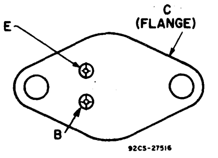
MAXIMUM RATINGS, *Absolute Values:*

	2N5875• 2N5877	2N5876• 2N5878	
* V_{CEO}	60	80	V
* V_{CBO}	60	80	V
* V_{EBO}	5	5	V
* I_C	10	10	A
* I_{CM}	20	20	A
* I_B	4	4	A
* P_T			
At $T_C \leqslant 25°C$	150	150	W
At $T_C > 25°C$ derate linearly	0.857		W/°C
* T_J, T_{stg}	−65 to 200		°C
* T_L			
At 1/16 in. (1.58 mm) from case for 10 s	250		°C

*In accordance with JEDEC registration data.

•For p-n-p devices, voltage & current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

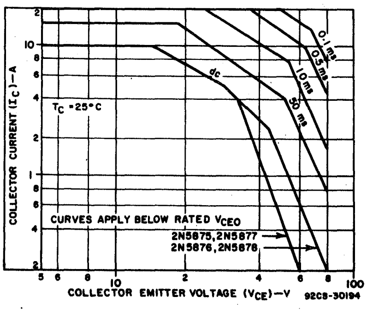


Fig. 1 — Collector-emitter voltage (V_{CE})-V

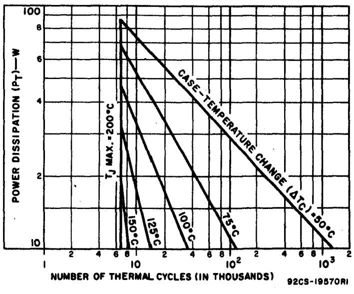


Fig. 2 — Thermal-cycling rating chart.

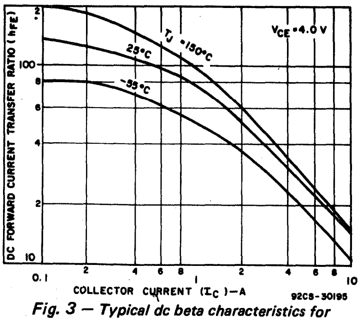


Fig. 3 — Typical dc beta characteristics for 2N5875 and 2N5876.

2N5875, 2N5876, 2N5877, 2N5878

ELECTRICAL CHARACTERISTICS, at Case Temperature $T_C = 25°C$ Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N5875● 2N5877		2N5876● 2N5878		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
* I_{CEX}	60	1.5	–	–	–	0.5	–	–	mA
	80	1.5	–	–	–	–	–	0.5	
$T_C = 150°C$	60	1.5	–	–	–	5	–	–	
	80	1.5	–	–	–	–	–	5	
* I_{CEO}	30	–	–	0	–	1	–	–	mA
	40	–	–	0	–	–	–	1	
* I_{CBO} $I_E = 0$	60^c	–	–	–	–	0.5	–	–	mA
	80^c	–	–	–	–	–	–	0.5	
* I_{EBO} $I_E = 0$	–	–5	–	–	–	1	–	1	mA
* $V_{CEO}(sus)^b$	–	–	0.2	0	60	–	80	–	V
* $h_{FE}{}^a$	4	–	1	–	35	–	35	–	
	4	–	4	–	20	100	20	100	
	4	–	10	–	4	–	4	–	
* $V_{BE}{}^a$	4	–	4	–	–	1.5	–	1.5	V
* $V_{BE}(sat)^a$	–	–	10	2.5	–	2.5	–	2.5	V
* $V_{CE}(sat)^a$	–	–	5	0.5	–	1	–	1	V
	–	–	10	2.5	–	3	–	3	
* $f_T{}^c$ f = 1 MHz	10	–	0.5	–	4	–	4	–	MHz
* h_{fe} f = 1 kHz	4	–	1	–	20	–	20	–	
* C_{ob} V_{CB} = 10 V 2N5875-76	–	–	–	–	–	500	–	500	pF
f = 1 MHz 2N5877-78	–	–	–	–	–	300	–	300	
* t_r V_{CC} = 30 V	–	–	4	0.4^d	–	0.7	–	0.7	μs
* t_s V_{CC} = 30 V	–	–	4	0.4^d	–	1.0	–	1.0	μs
* t_f V_{CC} = 30 V	–	–	4	0.4^d	–	0.8	–	0.8	μs
$R_{\theta JC}$	–	–	–	–	–	1.17	–	1.17	°C/W

* In accordance with JEDEC registration data.

a Pulsed; pulse width ⩽300 μs, duty cycle ⩽2%.

c V_{CB}

● For p-n-p devices, voltages and current values are negative.

b **CAUTION:** Sustaining voltage, $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer.

d $I_{B1} = -I_{B2}$

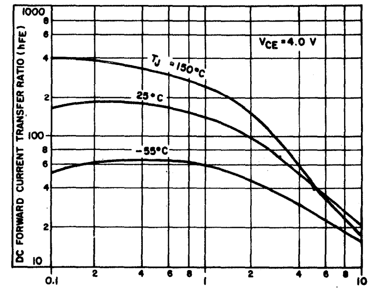


Fig. 4 — Typical dc beta characteristics for 2N5877 and 2N5878.

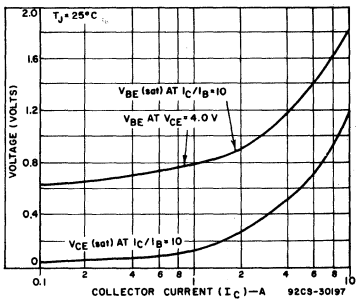


Fig. 5 — Typical voltages for 2N5875 and 2N5876.

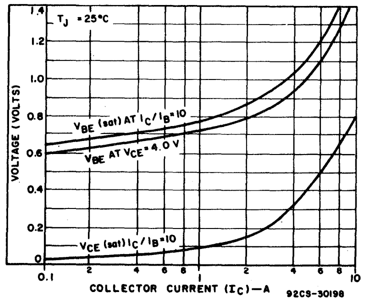


Fig. 6 — Typical voltages for 2N5877 and 2N5878.

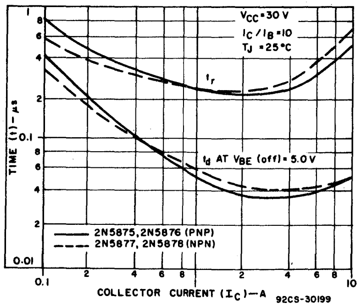


Fig. 7 — Typical turn-on-time for all types.

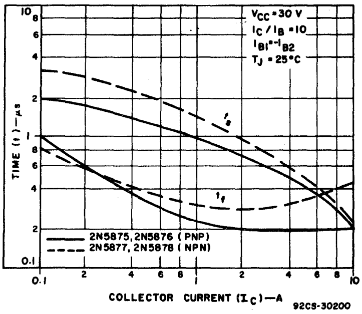


Fig. 8 — Typical turn-off-time for all types.

2N5879, 2N5880, 2N5881, 2N5882

Silicon N-P-N and P-N-P Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commercial Use

The RCA-2N5879 and 2N5880 are epitaxial-base silicon p-n-p transistors featuring high gain at high current. The RCA-2N5881 and 2N5882 are epitaxial-base silicon n-p-n transistors. They may be used as complements to 2N5879 and 2N5880, respectively. These devices have a dissipation capability of 160 watts at case temperatures up to 25°C. They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204MA hermetic package.

Features:

- **High dissipation capability**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**
- **Hermetically sealed JEDEC TO-3/ TO-204MA package**
- **High gain at high current**
- **Thermal-cycling rating curve**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

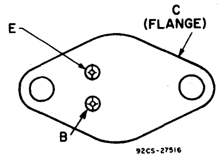
MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5879• 2N5881	2N5880• 2N5882	
* V_{CEO}	60	80	V
* V_{CBO}	60	80	V
* V_{EBO}	5	5	V
* I_C	15	15	A
* I_{CM}	30	30	A
* I_B	5	5	A
* P_T			
At $T_C \leqslant 25^oC$	160	160	W
At $T_C > 25^oC$ ...... derate linearly	0.915		W/°C
* T_J, T_{stg}	−65 to 200		°C
* T_L At 1/16 in. (1.58 mm) from case for 10 s	250		°C

* In accordance with JEDEC registration data.

• For p-n-p devices, voltage and current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

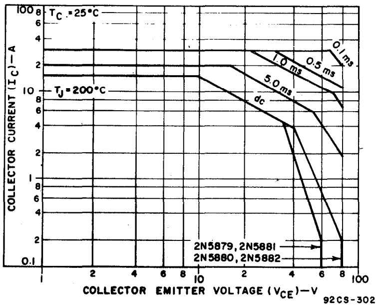


Fig. 1 — Maximum operating areas for all types.

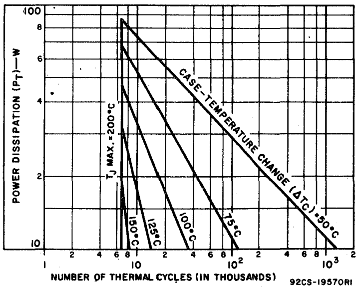


Fig. 2 — Thermal-cycling rating chart.

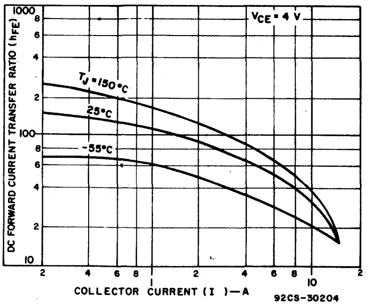


Fig. 3 — Typical dc beta characteristics for 2N5879 and 2N5880.

2N5879, 2N5880, 2N5881, 2N5882

ELECTRICAL CHARACTERISTICS, At Case Temperature T_C = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N5879● 2N5881		2N5880● 2N5882		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
* I_{CEX}	60	1.5	–	–	–	0.5	–	–	mA
	80	1.5	–	–	–	–	–	0.5	
T_C = 150°C	60	1.5	–	–	–	5	–	–	
	80	1.5	–	–	–	–	–	5	
* I_{CEO}	30	–	–	0	–	1	–	–	mA
	40	–	–	0	–	–	–	1	
* I_{CBO}	60^c	–	–	–	–	0.5	–	–	mA
$I_E = 0$	80^c	–	–	–	–	–	–	0.5	
* I_{EBO}	–	–5	0	–	–	1	–	1	mA
* $V_{CEO}(sus)^b$	–	–	0.2	0	60	–	80	–	V
* $h_{FE}{}^a$	4	–	2	–	35	–	35	–	
	4	–	6	–	20	100	20	100	
	4	–	15	–	4	–	4	–	
* $V_{BE}{}^a$	4	–	6	–	–	1.5	–	1.5	V
* $V_{BE}(sat)^a$	–	–	15	3.75	–	2.5	–	2.5	V
* $V_{CE}(sat)^a$	–	–	7	0.7	–	1	–	1	V
	–	–	15	3.75	–	4	–	4	
* f_T, f = 1 MHz	10	–	1	–	4	–	4	–	MHz
* h_{fe}, f = 1 kHz	4	–	2	–	20	–	20	–	
* C_{ob}, f = 1 MHz									pF
2N5879-80	10^c	–	–	–	–	600	–	600	
2N5881-82	10^c	–	–	–	–	400	–	400	
* t_r V_{CC} = 30 V	–	–	6	0.6^d	–	0.7	–	0.7	μs
* t_s	–	–	6	0.6^d	–	1	–	1	μs
* t_f	–	–	6	0.6^d	–	0.8	–	0.8	μs
$R_{\theta JC}$	–	–	–	–	–	1.1	–	1.1	°C/W

*In accordance with JEDEC registration data.

●For p-n-p devices, voltage and current values are negative.

[a] Pulsed; pulse duration ⩽ 300 μs, duty factor = 2%.

[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.

[c] V_{CB}.

[d] $I_{B1} = I_{B2}$.

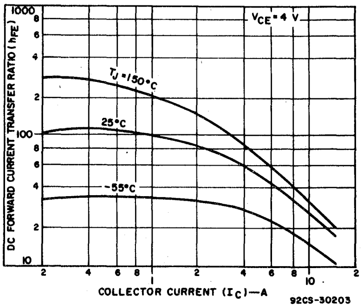


Fig. 4 — Typical dc beta characteristics for 2N5881 and 2N5882.

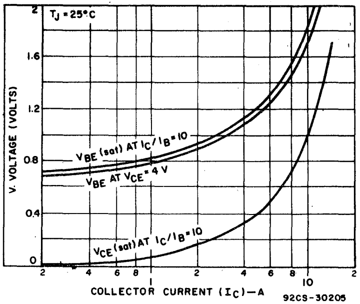


Fig. 5 — Typical voltage characteristics for 2N5879 and 2N5880.

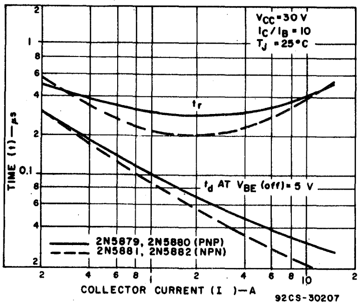


Fig. 6 — Typical turn-on time for all types.

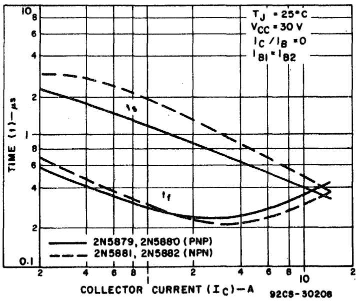


Fig. 7 — Typical turn-off time for all types.

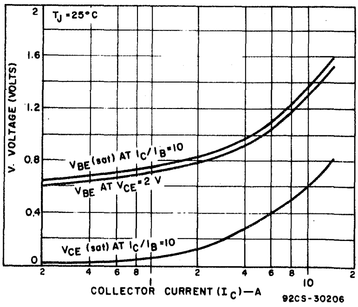


Fig. 8 — Typical voltage characteristics for 2N5881 and 2N5882.

2N5885, 2N5886

High-Current, High-Power, High-Speed N-P-N Power Transistors

The RCA-2N5885 and 2N5886 are epitaxial-base silicon n-p-n transistors intended for a wide variety of high-power, high-current applications, such as power-switching circuits, driver and output stages for series and shunt regulators, dc-to-dc converters, inverters, and solenoid (hammer)/relay drivers.

These devices differ in maximum voltage ratings. They are supplied in JEDEC TO-204MA hermetic steel packages.

Features:

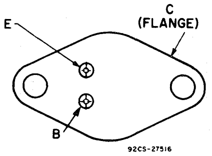
- **Specification for h_{FE} and V_{CE}(sat) up to 25 A**
- **Current gain bandwidth product f_T = 4 MHz (min.) at 1 A**
- **Low saturation voltage with high beta**
- **High dissipation capability**
- **90 mJ $E_{S/b}$ characteristic**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5885	2N5886	
*V_{CBO}	60	80	V
*V_{CEO}(sus)	60	80	V
*V_{EBO}	5		V
*I_C	25		A
*I_{CM}	50		A
*I_B	7.5		A
I_{BM}	15		A
*P_T			
At T_C ≤ 25°C	200		W
At T_C > 25°C Derate linearly	1.15		W/°C
	See Figs. 1 and 2		
*T_{stg}, T_J	−65 to 200		°C
T_L			
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		°C

* In accordance with JEDEC registration data format JS-6 RDF-1.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

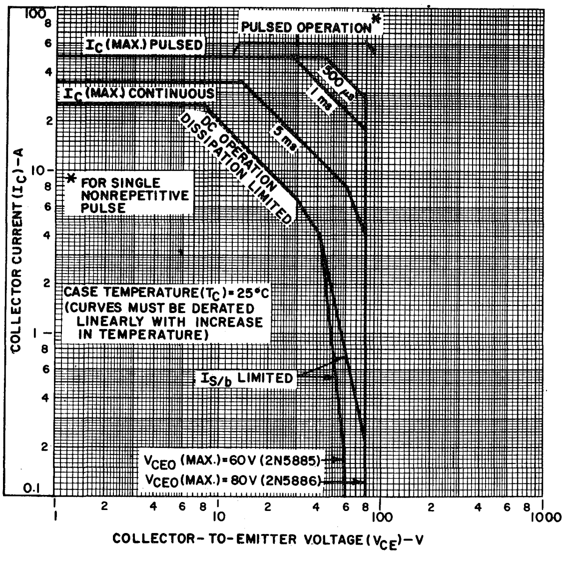


Fig. 1 — Maximum operating areas for 2N5885 and 2N5886.

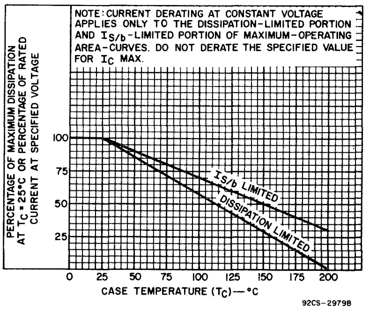


Fig. 2 — Derating curves for 2N5885 and 2N5886.

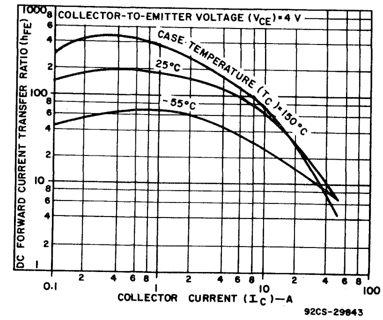


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5885 and 2N5886.

2N5885, 2N5886

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N5885		2N5886		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
* I_{CBO}	60^a 80^a				– –	1 –	– –	– 1	mA
* I_{CEX}	60 80	−1.5 −1.5			– –	1 –	– –	– 1	
* I_{CEX} T_C = 150°C	60 80	−1.5 −1.5			– –	10 –	– –	– 10	
* I_{CEO}	30 40				– –	2 –	– –	– 2	
* I_{EBO}		−5			–	1	–	1	
* h_{FE}	4 4 4		3^b 10^b 25^b		35 20 4	– 100 –	35 20 4	– 100 –	
* $V_{CEO}(sus)$			0.2		60	–	80	–	V
* V_{BE}	4		10		–	1.5	–	1.5	
* $V_{BE}(sat)$			25^b	6.25	–	2.5	–	2.5	
* $V_{CE}(sat)$			15^b 25^b	1.5 6.25	– –	1 4	– –	1 4	
$I_{S/b}$ t_p = 1 s nonrep.	20				10	–	10	–	A
$E_{S/b}$ L = 125 µH, R_{BE} = 51 Ω		−1.5	10		6.25	–	6.25	–	mJ
L = 20 mH, R_{BE} = 100 Ω		0	3		90	–	90	–	
* $\|h_{fe}\|$ f = 1 MHz	10		1		4	–	4	–	
* h_{fe} f = 1 kHz	4		3		20	–	20	–	
* C_{obo} f = 1 MHz	10^a				–	500	–	500	pF
* t_r * t_s * t_f	V_{CC} = 30		10 10 10	1 1^c 1^c	– – –	0.7 1 0.8	– – –	0.7 1 0.8	µs
$R_{\theta JC}$	20		5		–	0.875	–	0.875	°C/W

*In accordance with JEDEC registration data format JS-6 RDF-1.

[a] V_{CB}.

[b] Pulsed; pulse duration = 300 µs, duty factor = 1.8%.

[c] $I_{B_1} = -I_{B_2}$.

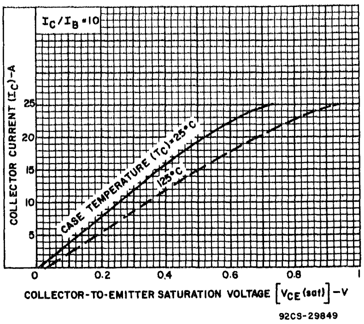


Fig. 4 — Typical saturation voltage characteristics for 2N5885 and 2N5886.

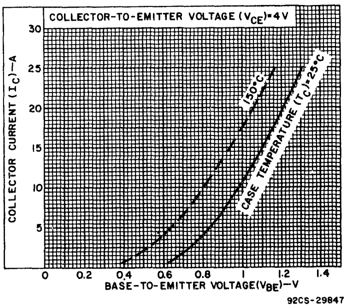


Fig. 5 — Typical transfer characteristics for 2N5885 and 2N5886.

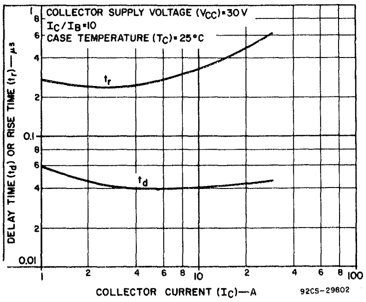


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5885 and 2N5886.

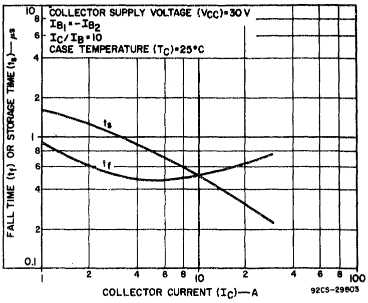


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5885 and 2N5886.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829, 40831

Silicon N-P-N and P-N-P Medium-Power Transistors

General-Purpose Types for Switching Applications

RCA-2N5954, -2N5955, and -2N5956 are multiple-epitaxial p-n-p transistors. RCA-2N6372, -2N6373, and -2N6374 are multiple-epitaxial n-p-n transistors. They are complements to 2N5954, 2N5955, and 2N5956.

The RCA-2N6465 and 2N6466 are multiple-epitaxial n-p-n transistors. They are complements to the 2N6467, and 2N6468, multiple-epitaxial p-n-p transistors. These devices differ in voltage ratings and in the currents at which the parameters are controlled.

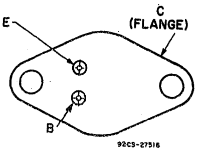
All are supplied in the JEDEC TO-66 package.

Types 2N5954 and 2N5956 are available with factory-attached heat radiators as RCA types 40829 and 40831, respectively. The other devices may be obtained with heat radiators on special order. Radiator versions are intended for printed-circuit-board applications, and differ electrically from their basic counterparts only in device dissipation (5.8 W up to 25° C ambient) and thermal resistance (30° C/W max. at T_A=25° C).

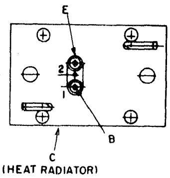
Features:

- 2N5954-2N5956 complements to 2N6372-2N6374
- 2N6465, 2N6466 complements to 2N6467, 2N646
- Low saturation voltages
- Maximum-safe-area-of-operation curves
- Thermal-cycle ratings
- Hermetically-sealed JEDEC TO-66 package

TERMINAL DESIGNATIONS



JEDEC TO-66
2N5954-2N5956 2N6372-2N6374, 2N6465-2N6468
(See dimensional outline "N".)



JEDEC TO-66 with Heat Raidator
40829, 40831
(See dimensional outline "O".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	N-P-N 2N6374	2N6373	2N6372	2N6465	2N6466	
	P-N-P 2N5956◆ 40831◆	2N5955◆	2N5954◆ 40829◆	2N6467◆	2N6468◆	
*V_{CBO}	50	70	90	110	130	V
*V_{CEX}(sus) V_{BE} = −1.5 V, R_{BE} = 100 Ω	50	70	90	110	130	V
V_{CER}(sus) R_{BE} = 100 Ω	45	65	85	105	125	V
V_{CEO}(sus)	40	60	80	100	120	V
*V_{EBO}	5	5	5	5	5	V
*I_C	6	6	6	4	4	A
*I_B	2	2	2	2	2	A
*P_T						
At T_C up to 25°C	40 (2N6374) (2N5956)	40 (2N6373) (2N5955)	40 (2N6372) (2N5954)	40	40	W
At T_A up to 25°C	5.8 (40831)		5.8 (40829)	–	–	W
At T_C above 25°C	Derate linearly to 200°C					
*T_J, T_{stg}	−65 to +200					°C
*T_L At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	+235					°C

*JEDEC types in accordance with JEDEC registration data format JS-6-RDF-2.

◆For p-n-p devices, voltage and current values are negative.

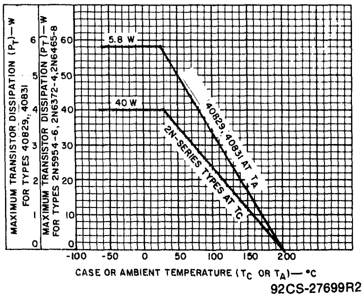


Fig. 1 - Dissipation derating chart for all types.

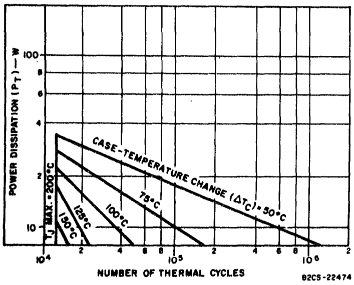


Fig. 2 - Thermal-cycling rating chart for all types.

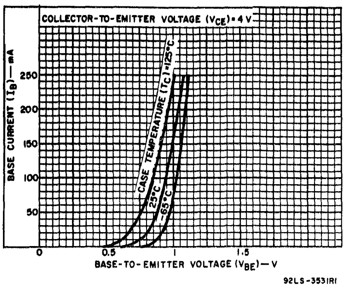


Fig. 3 - Typical input characteristics for 2N5954-56, 2N6372-74, 40829, and 40831.◆

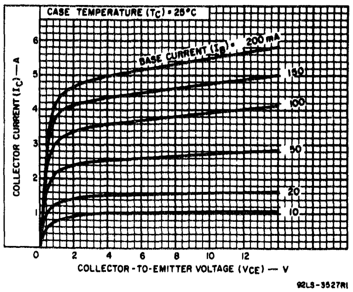


Fig. 4 - Typical output characteristics for 2N5954-56, 2N6372-74, 40829 and 40831.◆

◆For p-n-p devices, voltage and current values are negative.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829, 40831

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS◆ VOLTAGE V dc		CURRENT A dc		LIMITS 2N6374 2N5956◆ 40831◆		2N6373 2N5955◆		2N6372 2N5954◆ 40829◆		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CER} R_{BE}=100 Ω	35				–	100	–	–	–	–	μA
	55				–	–	–	100	–	–	
	75				–	–	–	–	–	100	
* I_{CEX} R_{BE}=100 Ω	45	–1.5			–	100	–	–	–	–	μA
	65	–1.5			–	–	–	100	–	–	
	85	–1.5			–	–	–	–	–	100	
* R_{BE}=100 Ω, T_C=150°C	45	–1.5			–	2	–	–	–	–	mA
	65	–1.5			–	–	–	2	–	–	
	85	–1.5			–	–	–	–	–	2	
* I_{CEO}	25				–	1	–	–	–	–	mA
	45				–	–	–	1	–	–	
	65				–	–	–	–	–	1	
* I_{EBO}		–5			–	0.1	–	0.1	–	0.1	mA
* h_{FE}	4		3^a		20	100	–	–	–	–	
	4		2.5^a		–	–	20	100	–	–	
	4		2^a		–	–	–	–	20	100	
	4		6^a		5	–	5	–	5	–	
* V_{CEO}(sus)			0.1^a		40^b	–	60^b	–	80^b	–	V
V_{CER}(sus) R_{BE}=100 Ω			0.1^a		45^b	–	65^b	–	85^b	–	
V_{CEX}(sus) R_{BE}=100 Ω		–1.5	0.1^a		50^b	–	70^b	–	90^b	–	
* V_{BE} All types	4		3^a		–	2	–	–	–	–	V
All types	4		2.5^a		–	–	–	2	–	–	
All types	4		2^a		–	–	–	–	–	2	
2N6372-2N6374	4		6^a		–	3	–	3	–	3	
* V_{CE}(sat)			3^a	0.3	–	1	–	–	–	–	V
			2.5^a	0.25	–	–	–	1	–	–	
			2^a	0.2	–	–	–	–	–	1	
2N5954–2N5956			6	1.2	–	2	–	2	–	2	
* $\|h_{fe}\|$ f=1 MHz 2N6372-2N6374	4		1		4	–	4	–	4	–	
2N5954-56, 40829, 31	–4		–1		5	–	5	–	5	–	
* h_{fe} f=1 kHz	4		0.5		25	–	25	–	25	–	
$R_{\theta JC}$ 2N5954-56, 2N6372-74					–	4.3	–	4.3	–	4.3	°C/W
$R_{\theta JA}$ 40829, 40831					–	30	–	30	–	30	

* In accordance with JEDEC registration data format JS-6 RDF-2 for JEDEC (2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829, 40831) types.

◆ For p-n-p devices, voltage and current values are negative.

[a] Pulsed, pulse duration = 300 μs, duty factor = 1.8%.

[b] *CAUTION: Sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) MUST NOT be measured on a curve tracer.*

◆For p-n-p devices, voltage and current values are negative.

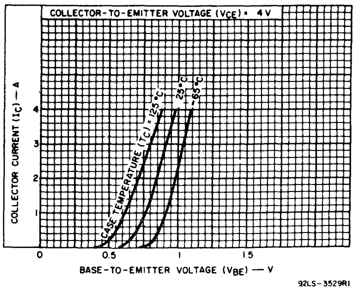


Fig. 5 - Typical transfer characteristics for 2N5954-56, 2N6372-74 and 40829 and 40831.◆

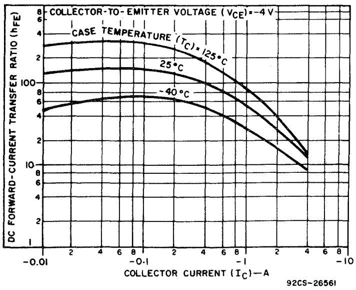


Fig. 6 - Typical dc beta characteristics for 2N6467 and 2N6468.

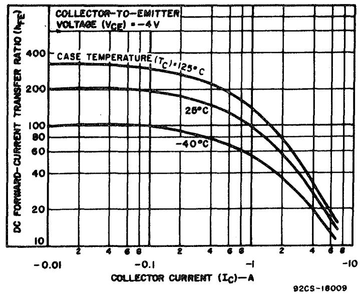


Fig. 7 - Typical dc beta characteristics for 2N5954-2N5956, 40829 and 40831.

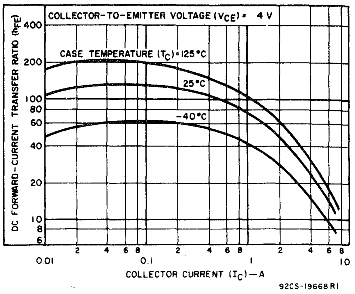


Fig. 8 - Typical dc beta characteristics for 2N6372-2N6374.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829, 40831

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6465 2N6467◆		2N6466 2N6468◆		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER}	95				–	100	–	–	µA
R_{BE} = 100 Ω	100				–	–	–	100	
* I_{CEX}	100	−1.5			–	100	–	–	µA
R_{BE} = 100 Ω	120	−1.5			–	–	–	100	
R_{BE} = 100 Ω,	100	−1.5			–	2	–	–	mA
T_C = 150°C	120	−1.5			–	–	–	2	
* I_{CEO}	50				–	1	–	–	mA
	60				–	–	–	1	
* I_{EBO}		−5			–	0.1	–	0.1	mA
* h_{FE}	4		1.5[a]		15	150	15	150	
	4		4[a]		5	–	5	–	
* $V_{CEO}(sus)$			0.1[a]		100[b]	–	120[b]	–	V
$V_{CER}(sus)$ R_{BE} = 100 Ω			0.1[a]		105[b]	–	125[b]	–	
* $V_{CEX}(sus)$ R_{BE} = 100 Ω		−1.5	0.1[a]		110[b]	–	130[b]	–	
* V_{BE}	4		1.5[a]		–	2	–	2	V
	4		4[a]		–	3.5	–	3.5	
$V_{CE}(sat)$ All types			1.5[a]	0.15	–	1.2	–	1.2	V
2N6465–2N6466			4[a]	0.8		3*	–	3*	
2N6467–2N6468			−4[a]	−0.8	–	−4*	–	−4*	
* $\|h_{fe}\|$ f = 1 MHz	4		1		5	–	5	–	
* h_{fe} f = 1 kHz	4		0.5		25	–	25	–	
$R_{\theta JC}$					–	4.3	–	4.3	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2.

◆ For p-n-p devices, voltage and current values are negative.

[a] Pulsed, pulse duration = 300 µs, duty factor = 1.8%

[b] *CAUTION: Sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer.*

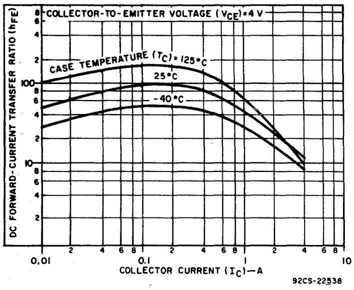


Fig. 9 - Typical dc beta characteristics for 2N6465 and 2N6466.

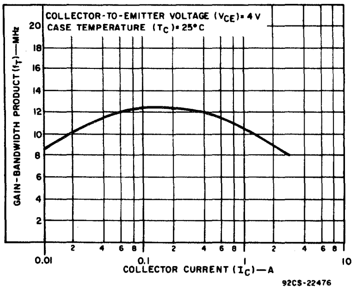


Fig. 10 - Typical gain-bandwidth product for 2N5954-56, 2N6372-74, 2N6467-68, 40829, and 40831. (For p-n-p devices voltage and current values are negative.)

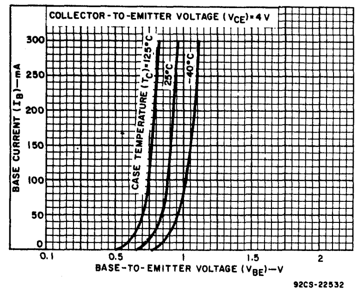


Fig. 11 - Typical input characteristics for 2N6465 and 2N6466.

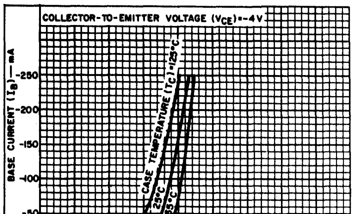


Fig. 12 - Typical input characteristics for 2N6467 and 2N6468.

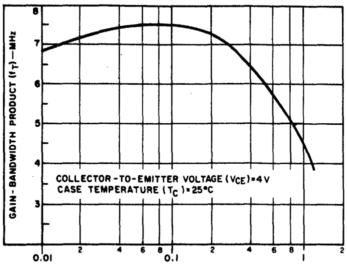


Fig. 13 - Typical gain-bandwidth product for 2N6465 and 2N6466.

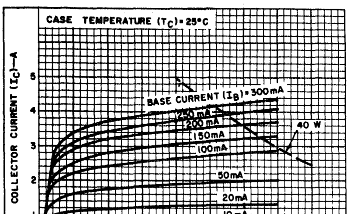
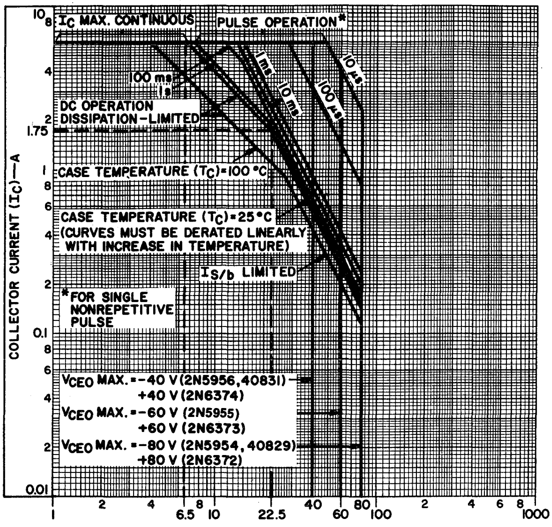


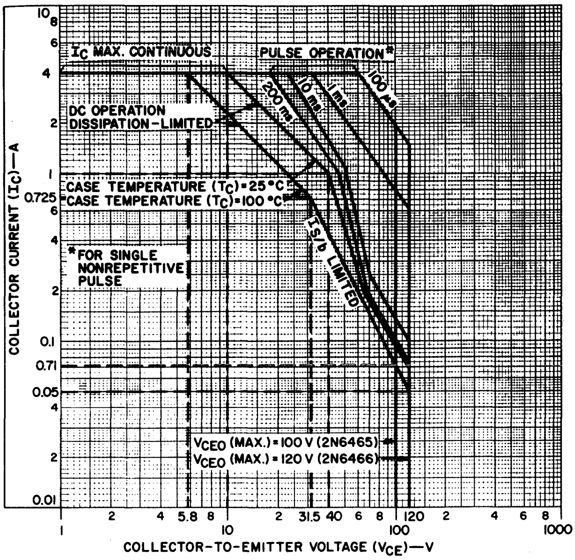
Fig. 14 - Typical output characteristics for 2N6465 and 2N6466.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829, 40831



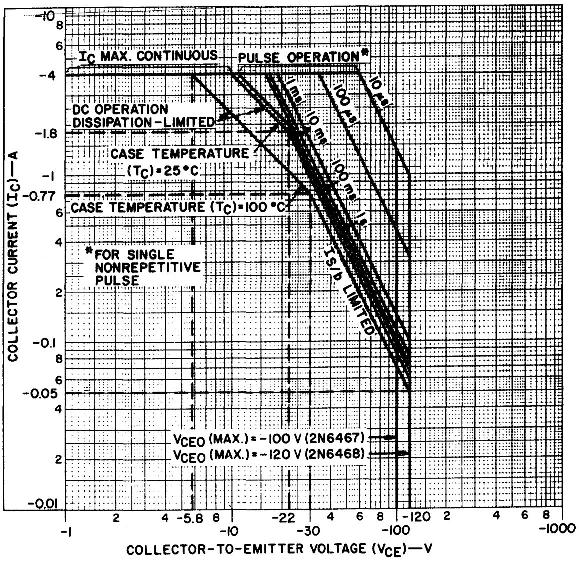
92CS-26543R1

Fig. 15 - Maximum operating areas for 2N5954-56, 2N6372-74, 40829, and 40831.◆



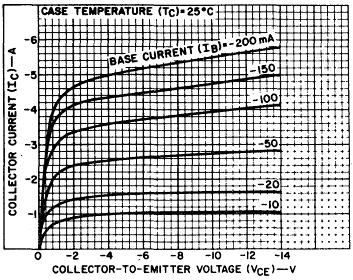
92CS-26558

Fig. 16 - Maximum operating areas for 2N6465 and 2N6466.



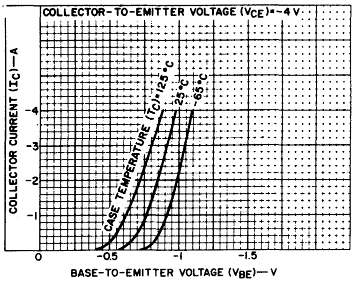
92CS-26560

Fig. 17 - Maximum operating areas for 2N6467 and 2N6468.



92CS-26565

Fig. 18 - Typical output characteristics for 2N6467 and 2N6468.



92CS-26566

Fig. 19 - Typical transfer characteristics for 2N6467 and 2N6468.

◆For p-n-p devices, voltage and current values are negative.

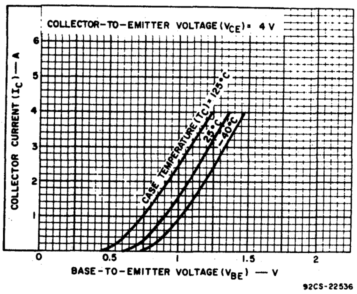


Fig. 20 - Typical transfer characteristics for 2N6465 and 2N6466.

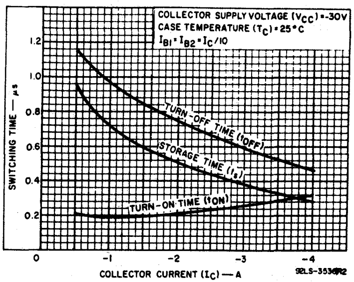


Fig. 21 - Typical saturated switching characteristics for 2N5954-56, 40829, and 40831.

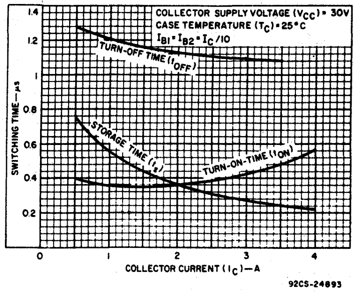


Fig. 22 - Typical saturated switching characteristics for 2N6372-2N6374.

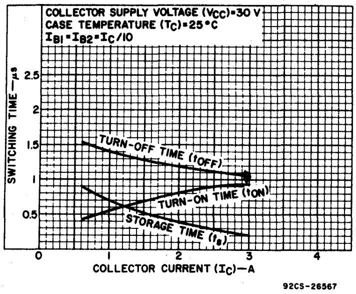


Fig. 23 - Typical saturated switching characteristics for 2N6465 and 2N6466.

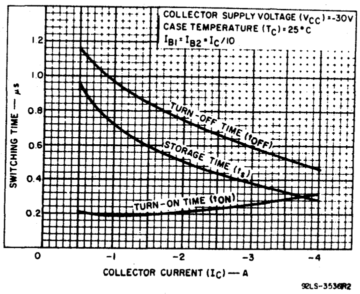


Fig. 24 - Typical saturated switching characteristics for 2N6467 and 2N6468.

2N6032, 2N6033

High-Current, High-Speed, High-Power Transistors

Silicon N-P-N Types

For Switching and Amplifier Applications
in Military, Industrial, and Commercial Equipment

RCA Types 2N6032 and 2N6033* are epitaxial silicon n-p-n transistors having high-current and high-power handling capability and fast switching speed. The 2N6033 is similar to the 2N6032; they differ in maximum values for continuous collector current and sustaining voltage.

They are supplied in modified TO-3 hermetic steel packages with 0.60-in. diameter pins.

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*Formerly RCA Dev. Types TA7337 and TA7337A, respectively.

Applications:

- **Switching-control amplifiers**
- **Power gates**
- **Switching regulators**
- **Power-switching circuits**
- **Power oscillators**
- **DC-RF amplifiers**
- **Converters**
- **Inverters**
- **Control circuits**

Features:

- **Low V_{CE}(sat) = 1.0 V max. at 40 A, 1.3 V max. at 50 A**
- **Maximum Safe-Area-of-Operation Curve. . . $I_{S/b}$ limit line beginning at 24 V**
- **Fast Storage Time . . . t_s = 1.5 μs max at I_C = 40 A (2N6033) 50A (2N6032)**
- **High-Current Capability . . . V_{CE}(sat) & V_{BE} measured at I_C = 40 A (2N6033)**
  = 50 A (2N6032)
- **High P_T (140 W max. at T_C = 25°C)**

MAXIMUM RATINGS, *Absolute Maximum Values:*

		2N6032	2N6033	
* COLLECTOR-TO-BASE VOLTAGE . . .	V_{CBO}	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With base open	$V_{CEO}(sus)$	90	120	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω	$V_{CER}(sus)$	110	140	V
* With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω & V_{BE} = -1.5 V	$V_{CEX}(sus)$	120	150	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
* CONTINUOUS COLLECTOR CURRENT	I_C	50	40	A
* BASE CURRENT	I_B	10	10	A
* EMITTER CURRENT	I_E	50	40	A
* TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C and V_{CE} up to 24 V		140	140	W
At case temperatures above 25°C		Derate linearly to 200°C		
* TEMPERATURE RANGE:				
Storage & Operating (Junction)		-65 to +200		°C
* PIN TEMPERATURE (During Soldering):				
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max		230		°C

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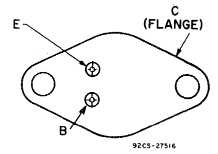
*In accordance with JEDEC registration data format JS-6 RDF-1.

TERMINAL DESIGNATIONS



Modified JEDEC TO-3

(See dimensional outline "B".)

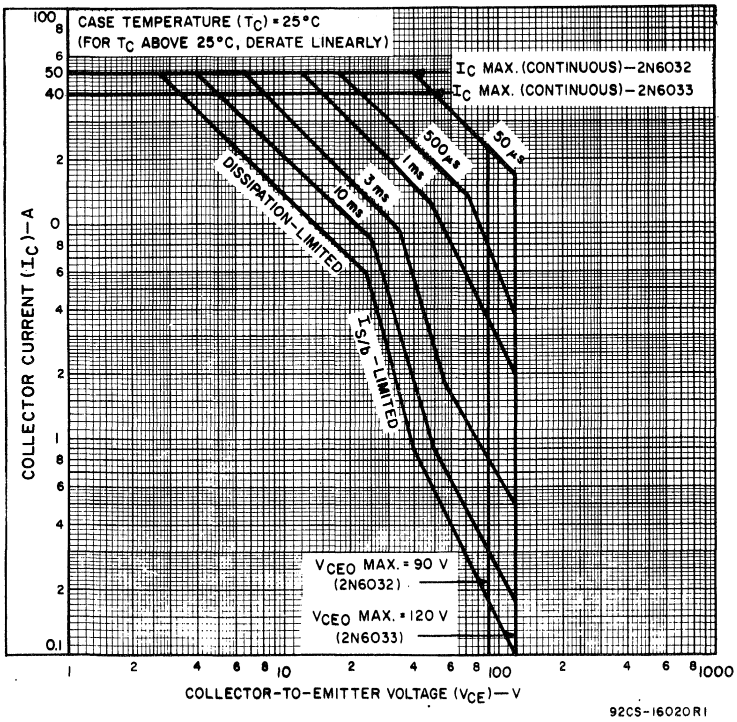


Fig. 1 - Maximum operating areas for both types.

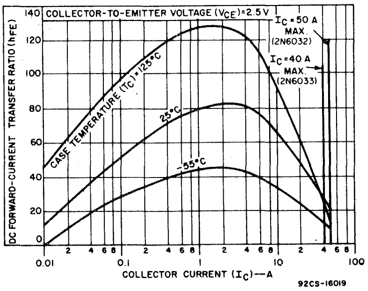


Fig. 2 - Typical dc-beta characteristics for both types.

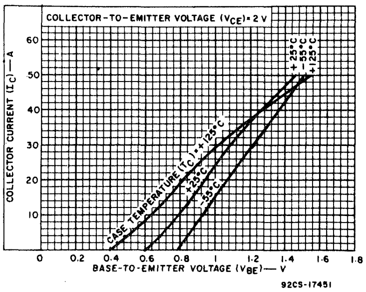


Fig. 3 - Typical transfer characteristics for both types.

2N6032, 2N6033

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N6032		2N6033		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	80	–	–	0	–	10	–	10	mA
* With base-emitter junction reverse biased	I_{CEV}	110 135	-1.5 -1.5	– –	– –	– –	12	– –	– 10	mA
T_C = 150°C		100	-1.5	–	–	–	15	–	10	mA
* Emitter-Cutoff Current	I_{EBO}	–	–7	0	–	–	10	–	10	mA
Collector-to-Emitter Sustaining Voltage: *(See Figs. 12 & 13)* * With base open	$V_{CEO}(sus)$		–	0.2^b	0	90^a	–	120^a	–	V
With external base to emitter resistance (R_{BE}) ≤ 50 Ω	$V_{CER}(sus)$			0.2^b	0	110^a	–	140^a	–	
With base-emitter junction reverse biased & R_{BE} ≤ 50 Ω	$V_{CEX}(sus)$		-1.5	0.2^b	0	120^a	–	150^a	–	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	–	– –	50^b 40^b	5 4	– –	2 –	– –	– 2	V
Base-to-Emitter Voltage	V_{BE}	2 2	– –	50^b 40^b	– –	– –	2 –	– –	– 2	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	– –	 –	50^b 40^b	5 4	– –	1.3 –	– –	– 1	V
* DC Forward-Current Transfer Ratio	h_{FE}	2.6 2	– –	50^b 40^b	– –	10 –	50 –	– 10	– 50	
Second-Breakdown Collector Current With base forward biased, t = 1 s nonrepetitive	$I_{S/b}$	24 40	– –	– –	– –	5.8^c 0.9^c	– –	5.8^c 0.9^c	– –	A
Second-Breakdown Energy With base reverse biased (L = 310 μH, R_{BE} = 5 Ω)	$E_{S/b}$	-	-4	20	–	62	–	62	–	mJ
* Magnitude of common-emitter small-signal, short-circuit, forward-current transfer ratio f = 5 MHz	$\lvert h_{fe}\rvert$	10		2		10	–	10	–	
* Gain-Bandwidth Product f = 5 MHz	f_T	10	–	2	–	50	–	50	–	MHz
Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{obo}	–	–	–	–	–	800	–	800	pF
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$	10	–	10	–	–	1.25	–	1.25	°C/W

*In accordance with JEDEC registration format JS-6 RDF-1.

[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer.

[b] Pulsed: Pulse duration 300 μs; duty factor ≤ 2%.

SWITCHING TIME CHARACTERISTICS, *Case Temperature* (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N6032		2N6033		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Saturated Switching Time: (V_{CC}=30 V, I_{B1} = I_{B2}):										
* Rise Time	t_r	– –	– –	50 40	5 4	– –	1 —	– –	– 1	μs
* Storage Time	t_s	– –	– –	50 40	5 4	– –	1.5 –	– –	– 1.5	μs
* Fall Time	t_f	– –	– –	50 40	5 4	– –	0.5 –	– –	– 0.5	μs

2N6032, 2N6033

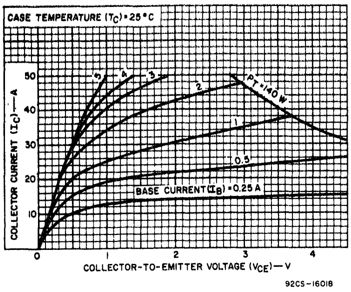


Fig. 4 - Typical output characteristics for both types.

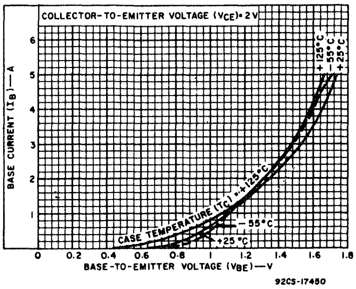


Fig. 5 - Typical input characteristics for both types.

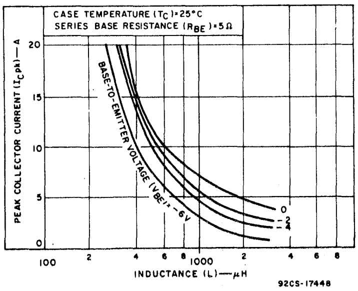


Fig. 6 - Maximum reverse-bias second-breakdown characteristics for both types.

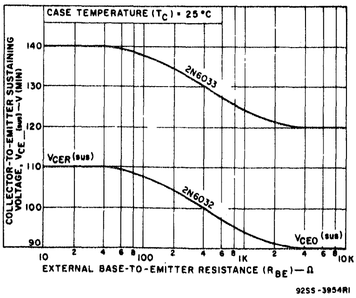


Fig. 7 - Collector-to-emitter sustaining voltage characteristics for both types.

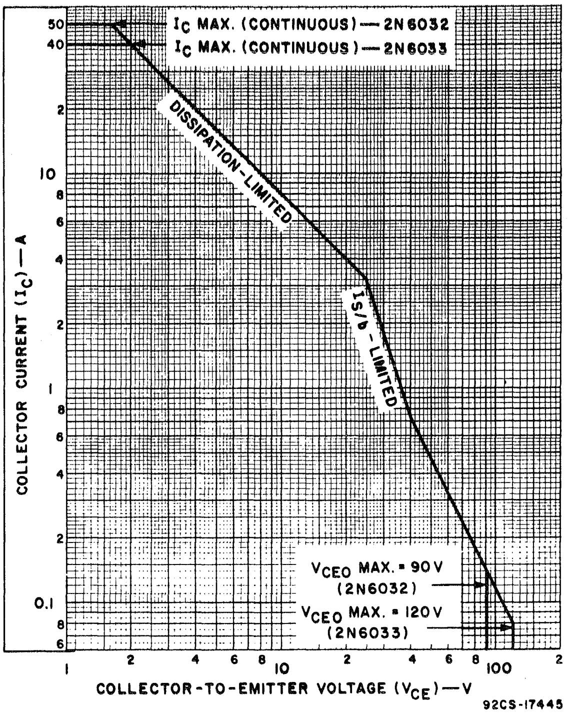


Fig. 8 - Maximum operating areas for both types at case temperature $(T_C) = 100^{\circ}C$.

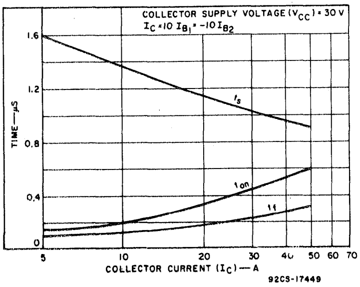


Fig. 9 - Typical saturated switching characteristics for both types.

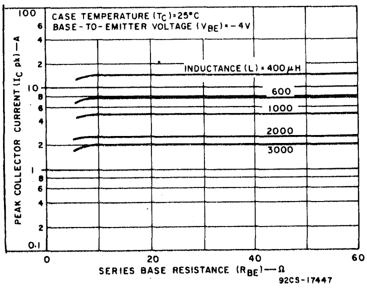


Fig. 10 - Maximum reverse-bias second-breakdown characteristics for both types.

2N6043, 2N6044, 2N6045

8-Ampere N-P-N Darlington Power Transistors

60-, 80-, 100-Volts, 75 Watts
Gain of 1000 at 4 A (2N6043, 2N6044)
Gain of 1000 at 3 A (2N6045)

The 2N6043, 2N6044, and 2N6045 are monolithic silicon n-p-n Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. These devices are supplied in the JEDEC TO-220AB straight-lead version of the VERSAWATT package.

Features:

- **Operates from IC without predriver**
- **High reverse second-breakdown capability**

Applications:

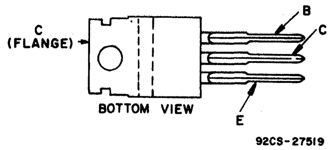
- **Power switching**
- **Hammer drivers**
- **Audio amplifiers**
- **Series and shunt regulators**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6043	2N6044	2N6045	
* V_{CBO}	60	80	100	V
V_{CEO}(sus)	60	80	100	V
* V_{EBO}	5			V
* I_C	8			A
I_{CM}	16			A
* I_B	0.12			A
* P_T:				
$T_C \geqslant 25^oC$	75			W
$T_C > 25^oC$	See Fig. 2			
* T_{stg}, T_J	−65 to 150			^oC
* T_L				
At distances ≥1/8 in. (3.17 mm) from case for 10 s max.	235			^oC

* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S")

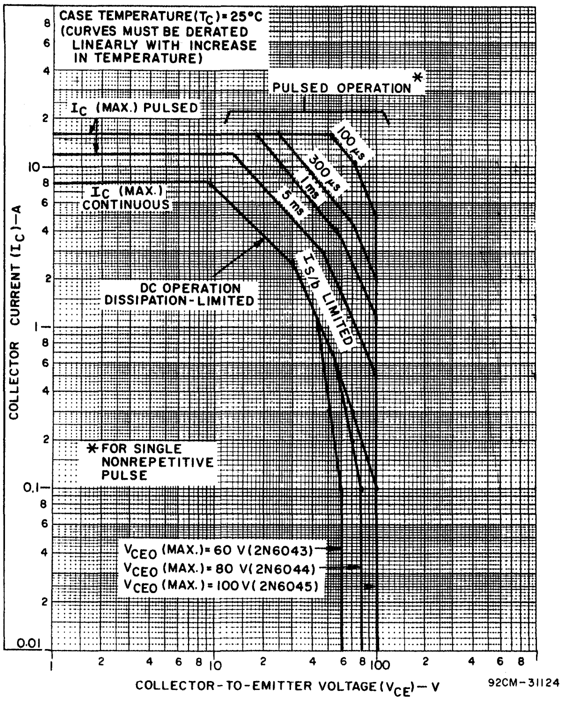


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

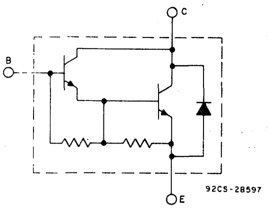


Fig. 2 — Schematic diagram for all types.

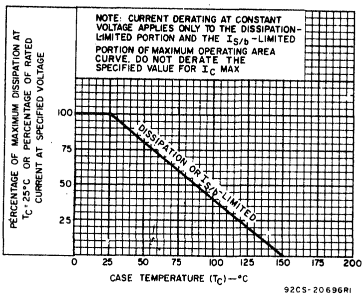


Fig. 3 — Derating curve for all types.

2N6043, 2N6044, 2N6045

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25^{o}C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6043		2N6044		2N6045		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	100			0	–	–	–	–	–	20	μA
	80			0	–	–	–	20	–	–	
	60			0	–	20	–	–	–	–	
* I_{CEV}	100	−1.5			–	–	–	–	–	20	
	80	−1.5			–	–	–	20	–	–	
	60	−1.5			–	20	–	–	–	–	
T_C=125^{o}C	100	−1.5			–	–	–	–	–	200	
	80	−1.5			–	–	–	200	–	–	
	60	−1.5			–	200	–	–	–	–	
* I_{EBO}		5		0	–	2	–	2	–	2	mA
* V_{CEO}(sus)			0.1^a	0	60	–	80	–	100	–	V
I_{CBO}	100^b				–	–	–	–	–	20	μA
	80^b				–	–	–	20	–	–	
	60^b				–	20	–	–	–	–	
* h_{FE}	4		4		1000	20,000	1000	20,000	–	–	
	4		3		–	–	–	–	1000	20,000	
	4		8		100	–	100	–	100	–	
* V_{BE}	4		4		–	2.8	–	2.8	–	–	V
	4		3		–	–	–	–	–	2.8	
* V_{BE}(sat)			8	0.08	–	4.5	–	4.5	–	4.5	
* V_{CE}(sat)			4	0.016	–	2	–	2	–	–	V
			3	0.012	–	–	–	–	–	2	
			8	0.08	–	4	–	4	–	4	
V_F			−8^a		–	4	–	4	–	4	V
* h_{fe} f=1 kHz	4		3		300	–	300	–	300	–	
* $\|h_{fe}\|$ f=1 MHz	4		3		4	–	4	–	4	–	
* C_{obo} f=1 MHz	10^b				–	200	–	200	–	200	pF
$I_{S/b}$ t=1 s, nonrep.	30				2.5	–	2.5	–	2.5	–	A
$R_{\theta JC}$					–	1.67	–	1.67	–	1.67	^{o}C/W

* In accordance with JEDEC registration data.

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[b] V_{CB} value.

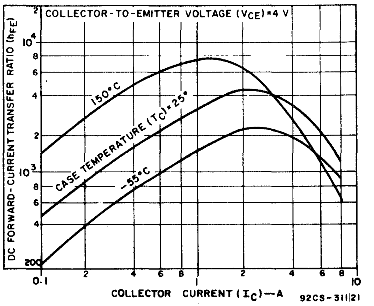


Fig. 4 — Typical dc beta characteristics for all types.

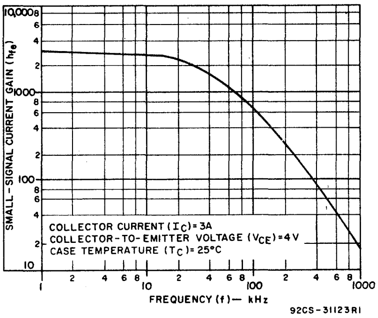


Fig. 5 — Typical small-signal gain for all types.

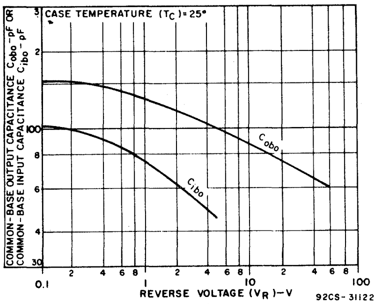


Fig. 6 — Typical common-base input or output capacitance characteristics as a function of reverse voltage for all types.

12-Ampere Complementary P-N-P and N-P-N Monolithic Darlington Power Transistors

60-80-100 Volts, 150 Watts
Gain of 7000 (Typ.) at 5 A (2N6050, 2N6051, 2N6052)
Gain of 4000 (Typ.) at 5 A (2N6057, 2N6058, 2N6059)

The RCA-2N6050, 2N6051, and 2N6052 p-n-p types and the 2N6057, 2N6058, and 2N6059 n-p-n types are complementary monolithic silicon Darlington transistors designed for general-purpose amplifier and low-speed switching applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. These devices are supplied in the JEDEC TO-204MA hermetic steel package.

Features:

- Operates from IC without predriver
- High reverse second-breakdown capability
- Monolithic construction
- High voltage ratings:

$V_{CEO}(sus)$ = 60 V Min. – 2N6050•, 2N6057
= 80 V Min. – 2N6051•, 2N6058
= 100 V Min. – 2N6052•, 2N6059

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6050• 2N6057	2N6051• 2N6058	2N6052• 2N6059	
* V_{CBO}	60	80	100	V
* $V_{CEO}(sus)$	60	80	100	V
* V_{EBO}		5		V
* I_C		12		A
* I_{CM}		20		A
* I_B		0.2		A
* P_T				
$T_C \leqslant 25°C$		150		W
$T_C > 25°C$ . . . Derate linearly		0.857		W/°C
* T_{stg}, T_J		–65 to 200		°C
* T_L				
At distances ⩾1/16 in. (1.58 mm) from case for 10 s max.		235		°C

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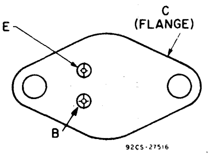
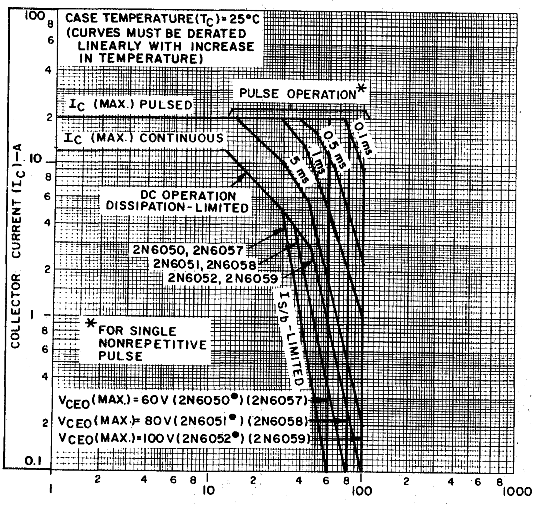
* In accordance with JEDEC registration data. • For p-n-p devices, voltage and current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)



•FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

Fig. 1 – Maximum operating areas for all types.

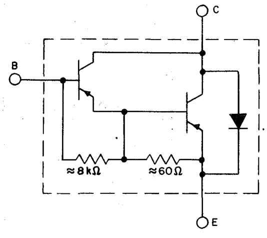


Fig. 2 – Schematic diagram for 2N6050, 2N6051, and 2N6052.

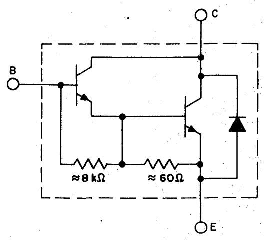


Fig. 3 – Schematic diagram for 2N6057, 2N6058, and 2N6059.

2N6050-2N6052, 2N6057-2N6059

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6050● 2N6057		2N6051● 2N6058		2N6052● 2N6059		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	30			0	–	1	–	–	–	–	mA
	40			0	–	–	–	1	–	–	
	50			0	–	–	–	–	–	1	
* I_{CEX}	60	−1.5			–	0.5	–	–	–	–	
	80	−1.5			–	–	–	0.5	–	–	
	100	−1.5			–	–	–	–	–	0.5	
T_C = 150°C	60	−1.5			–	5	–	–	–	–	
	80	−1.5			–	–	–	5	–	–	
	100	−1.5			–	–	–	–	–	5	
* I_{EBO}		−5	0		–	2	–	2	–	2	mA
* $V_{CEO}(sus)$			0.1^a	0	60	–	80	–	100	–	V
* h_{FE}	3		12^a		100	–	100	–	100	–	
	3		6^a		750	18,000	750	18,000	750	18,000	
* $V_{CE}(sat)$			12^a	0.12	–	3	–	3	–	3	V
			6^a	0.024	–	2	–	2	–	2	
* V_{BE}	3		6^a		–	2.8	–	2.8	–	2.8	V
* $V_{BE}(sat)$			12^a	0.12	–	4	–	4	–	4	V
* h_{fe} f = 1 kHz	3		5		300	–	300	–	300	–	
* $\|h_{fe}\|$ f = 1 MHz	3		5		4	–	4	–	4	–	
* C_{ob} V_{CB} = 10 V, I_E 0, f = 0.1 MHz 2N6050-52					–	500	–	500	–	500	pF
2N6057-59					–	300	–	300	–	300	
$I_{S/b}$ t = 1 s, nonrep.	30				5	–	5	–	5	–	A
$R_{\theta JC}$						1.17	–	1.17	–	1.17	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

* In accordance with JEDEC registration data.

● For p-n-p devices, voltage and current values are negative.

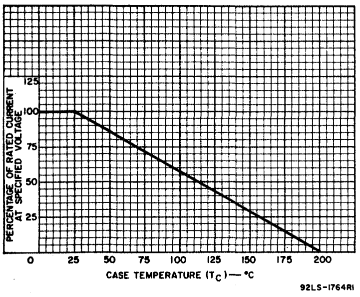


Fig. 4 — Current derating curve for all types.

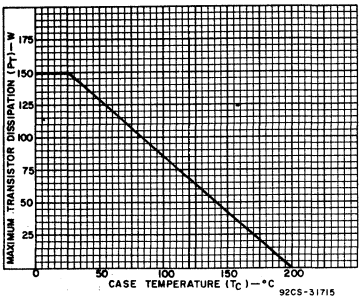


Fig. 5 — Power derating curve for all types.

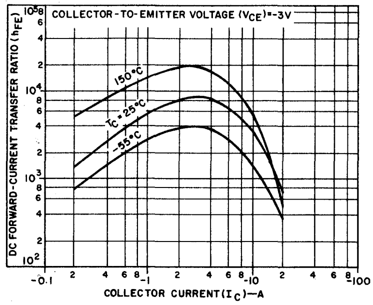
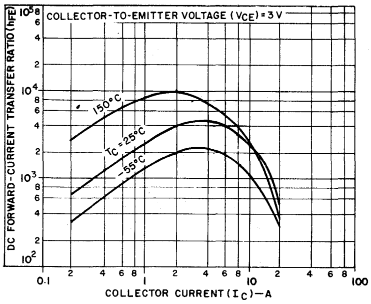
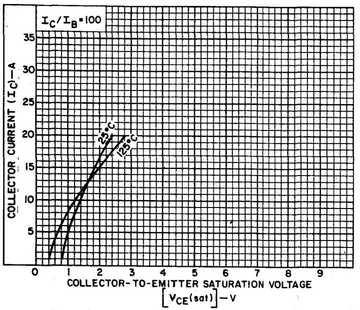


Fig. 6 — Typical dc beta characteristics for 2N6050, 2N6051, and 2N6052.



92CS-29132

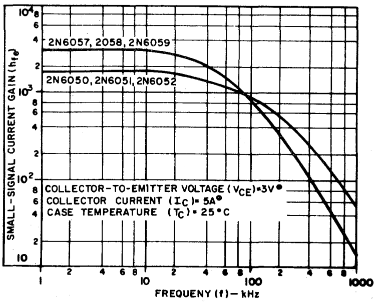
Fig. 7 — Typical dc beta characteristics for 2N6057, 2N6058, and 2N6059.



FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

92CS-31712

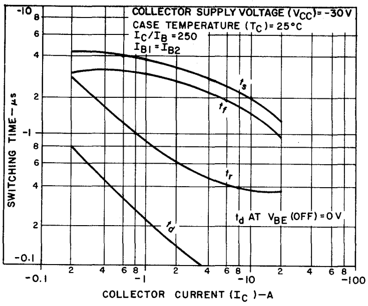
Fig. 8 — Typical saturation characteristics for all types.



*FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

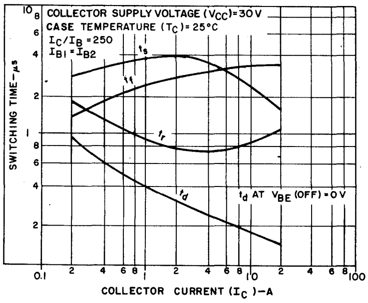
92CS-31713

Fig. 9 — Typical small-signal current gain for all types.



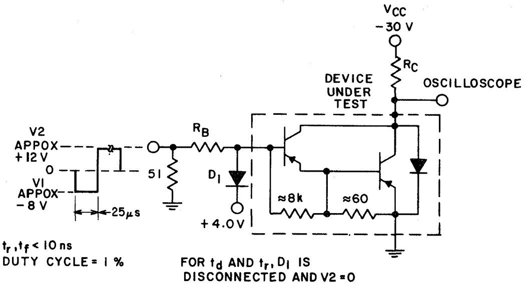
92CS-29137

Fig. 10 — Typical switching times for 2N6050, 2N6051, and 2N6052.



92CS-29136

Fig. 11 — Typical switching times for 2N6057, 2N6058, and 2N6059.



R_B & R_C VARIED TO OBTAIN DESIRED CURRENT LEVELS

D_1 MUST BE FAST RECOVERY TYPE

FOR n-p-n TEST CIRCUIT REVERSE DIODE AND VOLTAGE POLARITIES

92CS-29138

Fig. 12 — Switching times test circuit.

2N6077-2N6079

High-Voltage, High-Power Silicon N-P-N Transistors

For Switching and Linear Applications

RCA 2N6077, 2N6078 and 2N6079 are multiple epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. Multiple-epitaxial construction maximizes the volt-ampere characteristic of the device and provides fast switching speeds. Multiple-emitter-site design ensures uniform current flow throughout the structure, which produces a high $I_{S/b}$ and a large safe-operation area.

These devices use the popular JEDEC TO-66 package; they differ mainly in voltage ratings, leakage-current limits, and V_{CE}(sat) ratings.

The 2N6077 is characterized for switching applications with load lines in the active region. These applications include sweep circuits and all circuits using the transistor as an active voltage clamp.

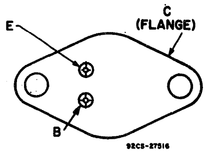
Type 2N6078 is characterized for switching applications with the load line extending into the reverse-bias region. Its voltage ratings make this device useful for switching regulators operating directly from a rectified 110-V or 220-V power line. The unit is rated to take surge currents up to 5 A and maintain saturation.

The 2N6079 is characterized for use in inverters operating directly from a rectified 110-V power line. The leakage current is specified at 450 volts; therefore the device can also be used in a series bridge configuration on a 220-V line. The V_{EBO} rating of 9 volts eases requirements on the drive transformer in inverter applications. Storage time, an important factor in the frequency stability of an inverter, is specified in Fig. 11, which shows variation in storage time with variation in load current from zero to maximum (4 A).

Features:

- **Maximum safe-area-of-operation curves**
- **Low saturation voltages**
- **High voltage ratings:**
  V_{CER}(sus) = 300 V (2N6077)
  275 V (2N6078)
  375 V (2N6079)
- **High dissipation rating: P_T = 45 W**

TERMINAL DESIGNATIONS



JEDEC TO-66

(See dimensional outline "N".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*		**2N6077**	**2N6078**	**2N6079**	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	300	275	375	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With base open	V_{CEO}(sus)	275	250	350	V
* With reverse bias (V_{BE}) of −1.5 V	V_{CEX}(sus)	300	275	375	V
With external base-to-emitter resistance (R_{BE}) ⩽ 500 Ω	V_{CER}(sus)	300	275	375	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	9	V
*COLLECTOR CURRENT:	I_C				
Continuous		7	7	7	A
Peak		10	10	10	A
*CONTINUOUS BASE CURRENT	I_B	4	4	4	A
*TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		45	45	45	W
At case temperatures above 25°C		Derate linearly to 200°C			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		−65 to +200			°C
*PIN TEMPERATURE (During Soldering):					
At distances ⩾ 1/32 in. (0.8 mm) from case for 10 s max.		230			°C

* 2N-Series types in accordance with JEDEC registration data format (JS-6, RDF-1).

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS									UNITS
	VOLTAGE V dc		CURRENT A dc		2N6077			2N6078			2N6079			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
I_{CEO}	250			0	–	–	2	–	–	–	–	–	–	mA
* I_{CEV}	250	−1.5			–	–	5	–	–	0.05	–	–	–	mA
	450	−1.5			–	–	–	–	–	–	–	–	0.5	
(T_C = 125°C)	250	−1.5			–	–	8	–	–	0.2	–	–	–	mA
	450	−1.5			–	–	–	–	–	–	–	–	5	
* I_{EBO}		−6	0		–	–	1	–	–	1	–	–	–	mA
		−9	0		–	–	–	–	–	–	–	–	1	
* V_{CEO}(sus)			0.2[a]		275[b]	–	–	250[b]	–	–	350[b]	–	–	V
V_{CER}(sus) (R_{BE} = 500 Ω)			0.2[a]		300[b]	–	–	275[b]	–	–	375[b]	–	–	
* V V_{EBO} (I_E = 1 mA)			0		6	–	–	6	–	–	9	–	–	V
* h_{FE}	1		1.2[a]		12	28	70	12	28	70	12	28	50	
* V_{BE}(sat)			1.2[a]	0.2	–	1.0	1.6	–	1.0	1.6	–	1.0	1.6	V
			3[a]	0.6	–	1.2	1.9	–	–	–	–	–	–	
			4[a]	0.8	–	–	–	–	–	–	–	1.3	2	
			5[a]	1	–	–	–	–	1.5	2	–	–	–	
* V_{CE}(sat)			1.2[a]	0.2	–	0.15	0.5	–	0.15	0.5	–	0.15	0.5	V
			3[a]	0.6	–	0.25	1	–	–	–	–	–	–	
			4[a]	0.8	–	–	–	–	–	–	–	0.5	3	
			5[a]	1	–	–	–	–	0.8	3	–	–	–	
C_{obo} (V_{CB} = 10 V, f = 1 MHz)					–	–	150	–	–	150	–	–	150	pF
* $\|h_{fe}\|$ (f = 1 MHz)	10		0.2		1	7	–	1	7	–	1	7	–	
$I_{S/b}$ (Pulse duration (non-repetitive) = 1 s)	50				0.9	–	–	0.9	–	–	0.9	–	–	A
$E_{S/b}$ (R_B = 50Ω, L=100µH)		−4	3		0.45	–	–	0.45	–	–	0.45	–	–	mj
t_d[c]			1.2	0.2	–	0.02	–	–	0.02	–	–	0.02	–	µs
* t_r[c]			1.2	0.2	–	0.3	0.75	–	0.3	0.75	–	0.3	0.75	
* t_s[c]			1.2	0.2	–	2.8	5	–	2.8	5	–	2.8	5	
* t_f[c]			1.2	0.2	–	0.3	0.75	–	0.3	0.75	–	0.3	0.75	
$R_{\theta JC}$	20		2.25		–	–	3.9	–	–	3.9	–	–	3.9	°C/W

*2N-series types in accordance with JEDEC registration data format (JS-6, RDF-1).

[a] Pulsed; pulse duration ⩽ 350 µs, Duty factor = 2%.

[b] CAUTION: The sustaining voltages V_{CEO}(sus), and V_{CER}(sus), MUST NOT be measured on a curve tracer.

[c] V_{CC} = 250 V, I_{B1} = I_{B2}.

2N6077-2N6079

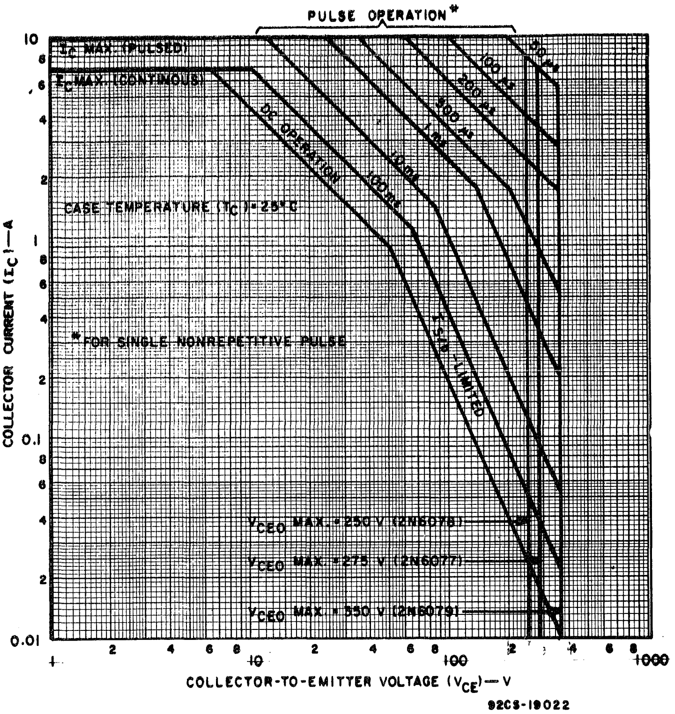


Fig. 1 - Maximum operating areas for all types.

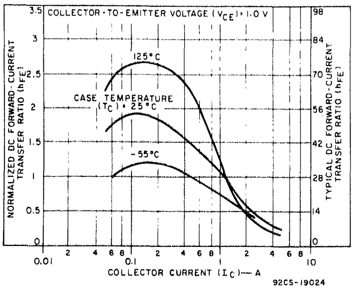


Fig. 2 - Typical normalized dc beta characteristics for all types.

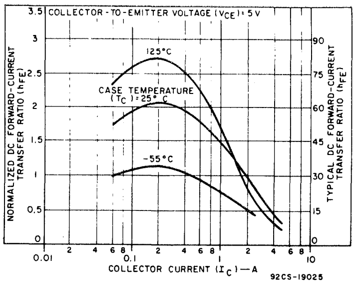


Fig. 3 - Typical normalized dc beta characteristics for all types.

Note (Figs. 2 & 3): To estimate min., max. h_{FE} at any current and temperature, read normalized dc forward-current transfer ratio and multiply by min., max. specifications given in Electrical Characteristics Chart.

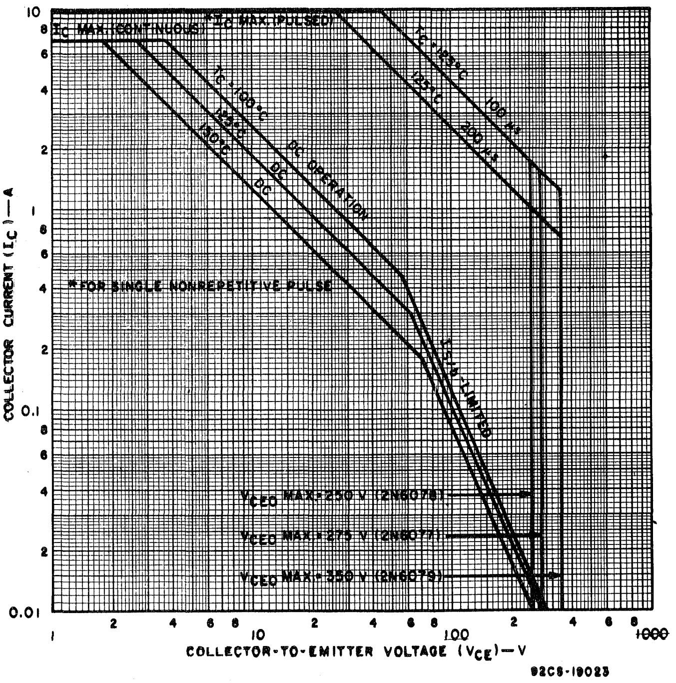


Fig. 4 - Maximum operating areas for all types.

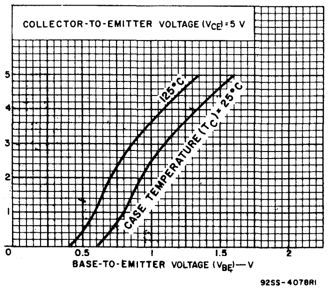


Fig. 5 - Typical transfer characteristics for all types.

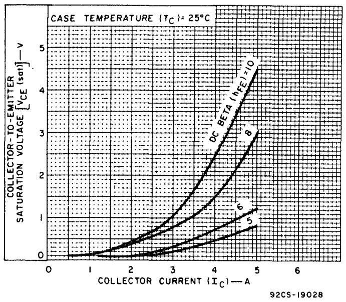


Fig. 6 - Typical saturation voltage characteristics for all types.

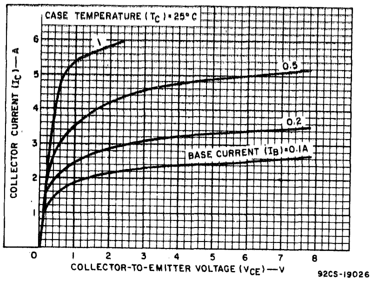


Fig. 7 - Typical output characteristics for all types.

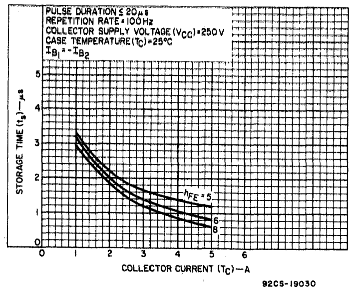


Fig. 8 - Typical storage-time characteristics for all types (with constant forced gain).

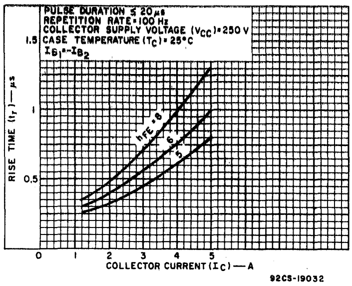


Fig. 9 - Typical rise-time characteristic for all types.

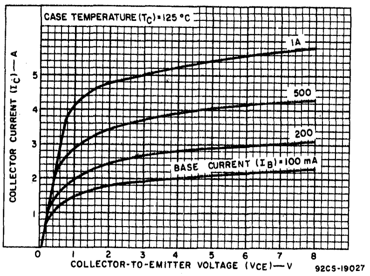


Fig. 10 - Typical output characteristics for all types.

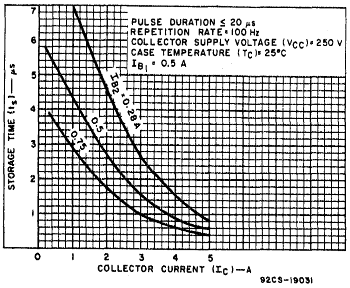


Fig. 11 - Typical storage-time characteristics for all types (with constant-base drives).

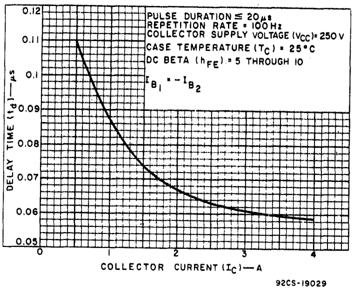


Fig. 12 - Typical delay-time characteristic for all types.

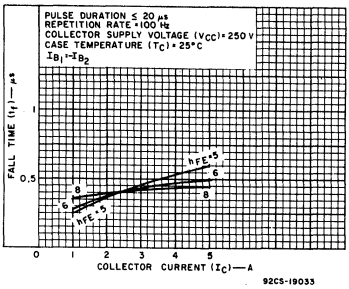


Fig. 13 - Typical fall-time characteristic for all types.

2N6098-2N6103, RCA3055

High-Current Silicon N-P-N VERSAWATT Transistor

Designed for Medium-Power Linear and Switching Service
in Consumer, Automotive, and Industrial Applications

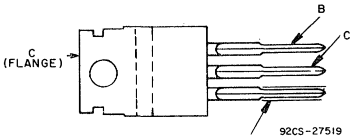
These RCA types are hometaxial-base silicon n-p-n transistors. Types 2N6098, 2N6100, and 2N6102 have formed emitter and base leads for easy insertion into TO-66 sockets. Types 2N6099, 2N6101, and 2N6103 are electrically identical to the 2N6098, 2N6100, and 2N6102, respectively.

These new VERSAWATT package transistors differ in voltage ratings and in the currents at which the parameters are controlled. They are intended for a wide variety of medium-power switching and linear applications, such as series and shunt regulators, solenoid drivers, motor-speed controls, inverters, and driver and output stages of high-fidelity amplifiers.

Features:

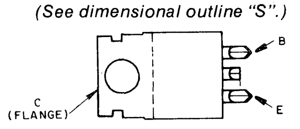
- **Low saturation voltage –**
  V_{CE}(sat) = 1 V max. at I_C = 4 A (2N6098, 2N6099)
  = 1 V max. at I_C = 5 A (2N6100, 2N6101)
  = 1 V max. at I_C = 8 A (2N6102, 2N6103)
- VERSAWATT **Package**
- **Maximum safe-area-of-operation curves**
- **Thermal-cycle rating curve**

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB
2N6099, 2N6101, 2N6103
(See dimensional outline "S".)



BOTTOM VIEW

JEDEC TO-220AA
2N6098, 2N6100, 2N6102
(See dimensional outline "R".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6102 2N6103	2N6098 2N6099	2N6100 2N6101	RCA3055	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	45	70	80	100	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}(sus)	45	65	75	70	V
* With base open	V_{CEO}(sus)	40	60	70	60	V
With base reverse-biased V_{BE} = −1.5 V	V_{CEV}(sus)	–	–	–	90	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	8	8	7	V
*COLLECTOR CURRENT (Continuous)	I_C	16	10	10	15	A
*BASE CURRENT	I_B	4	4	4	4	A
TRANSISTOR DISSIPATION:	P_T					
* At case temperatures up to 25°C		75	75	75	75	W
At ambient temperatures up to 25°C		1.8	1.8	1.8	1.8	W
* At case temperatures above 25°C, derate linearly		0.6				W/°C
At ambient temperatures above 25°C, derate linearly		0.0144				W/°C
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to 150				°C
*LEAD TEMPERATURE (During Soldering):						
At distance ⩾ 1.8 in. (3.17 mm) from case of 10 s max.		235				°C

* 2N-Series types in accordance with JEDEC registration data format JS-6 RDF-2.

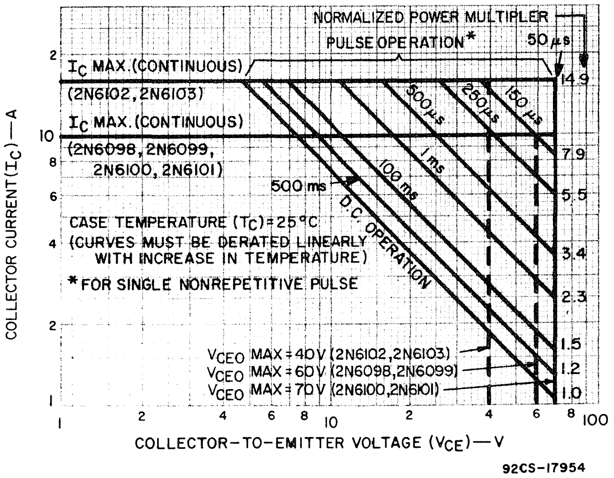


Fig. 1 – Maximum safe operating areas for 2N6098-2N6103, inclusive.

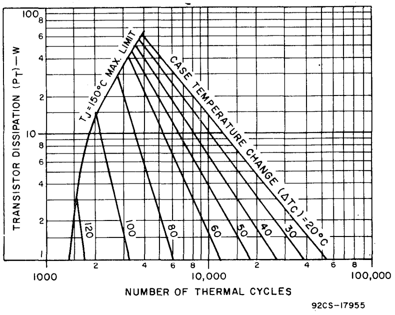


Fig. 2 – Thermal-cycling rating for all types.

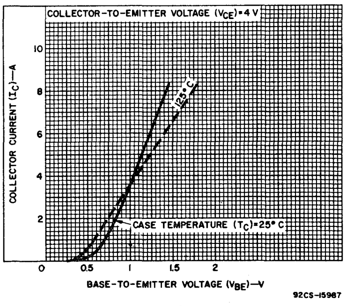


Fig. 3 – Typical transfer characteristics for all types.

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		2N6102 2N6103		2N6098 2N6099		2N6100 2N6101		RCA3055		
	V_{CE}	V_{EB}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEX}	40	1.5			–	2	–	–	–	–	–	–	mA
	65	1.5			–	–	–	2	–	–	–	–	
	75	1.5			–	–	–	–	–	2	–	–	
	100	1.5			–	–	–	–	–	–	–	5	
* $I_{CEX'}$ (T_C = 150°C)	40	1.5			–	10	–	–	–	–	–	–	
	65	1.5			–	–	–	10	–	–	–	–	
	75	1.5			–	–	–	–	–	10	–	–	
	100	1.5			–	–	–	–	–	–	–	30	
* I_{CEO}	30			0	–	2	–	–	–	–	–	0.7	mA
	50			0	–	–	–	2	–	–	–	–	
	60			0	–	–	–	–	–	2	–	–	
* I_{EBO}		5	0		–	1	–	–	–	–	–	–	mA
		7	0		–	–	–	–	–	–	–	5	
		8	0		–	–	–	1	–	1	–	–	
$V_{CER}(sus)$ R_{BE} = 100Ω[a]			0.2		45	–	65	–	75	–	70	–	V
* $V_{CEO}(sus)$[a]			0.2	0	40	–	60	–	70	–	60	–	
$V_{CEV}(sus)$[a]		1.5	0.1		–	–	–	–	–	–	90	–	
* h_{FE}[a]	4		4		–	–	20	80	–	–	20	70	
	4		5		–	–	–	–	20	80	–	–	
	4		8		15	60	–	–	–	–	–	–	
	4		10		–	–	5	–	5	–	5	–	
	4		16		5	–	–	–	–	–	–	–	
* V_{BE}[a]	4		4		–	–	–	1.7	–	–	–	1.8	V
	4		5		–	–	–	–	–	1.7	–	–	
	4		8		–	1.7	–	–	–	–	–	–	
* $V_{CE}(sat)$[a]			4	0.4	–	–	–	–	–	–	–	1.1	V
			10	2	–	–	–	2.5	–	2.5	–	–	
			16	3.2	–	2.5	–	–	–	–	–	–	
$I_{S/b}$[b] (t ≥ 1 s)	60				–	–	–	–	–	–	1.2	–	A
f_{hfe}	4		1		–	–	–	–	–	–	10	–	kHz
* h_{fe}	4	f=1kHz	0.5		15	–	15	–	15	–	15	120	
* $\|h_{fe}\|$	4	f= 0.1MHz	0.5		8	28	8	28	8	28	8	–	
$R_{\theta JC}$					–	1.67	–	1.67	–	1.67	–	1.67	°C/W
$R_{\theta JA}$					–	70	–	70	–	70	–	70	

*2N-series types in accordance with JEDEC registration data format (JS-6, RDF-2)

[a] Pulsed, pulse duration = 300 μs, duty factor = 0.018

2N6098-2N6103, RCA3055

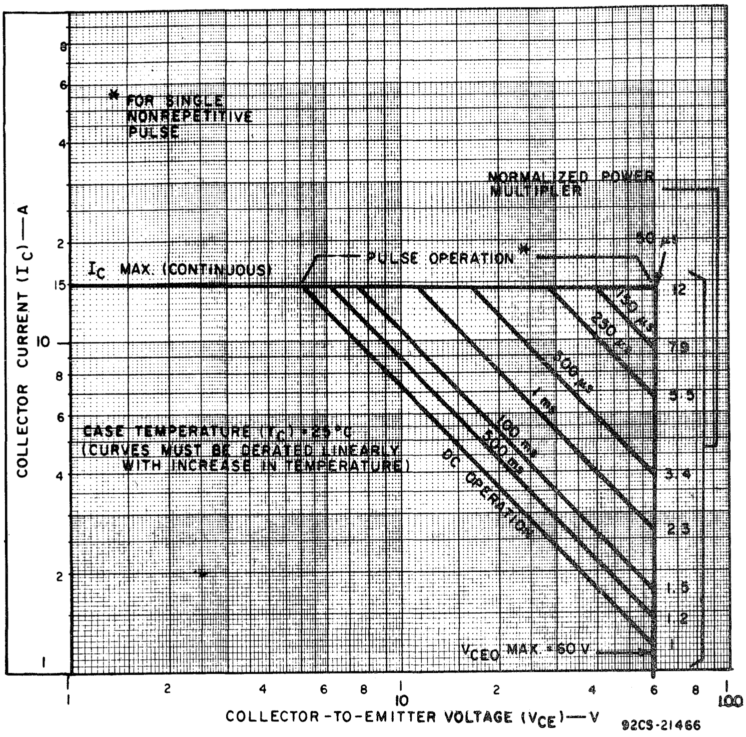


Fig. 4 — Maximum operating areas for RCA3055.

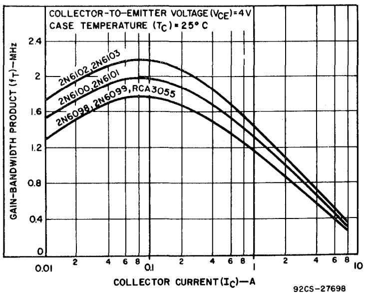


Fig. 5 — Typical gain-bandwidth product for all types.

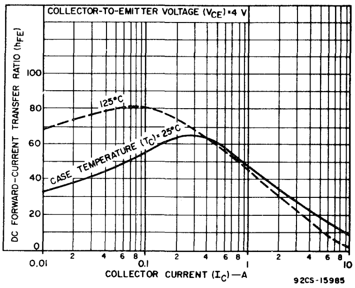


Fig. 6 — Typical dc beta characteristics for 2N6098, 2N6099, and RCA3055.

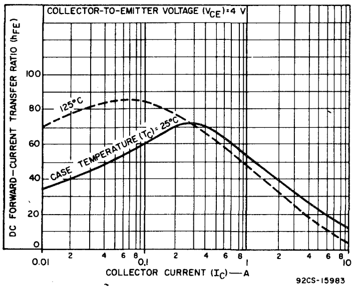


Fig. 7 — Typical dc beta characteristics for 2N6100 and 2N6101.

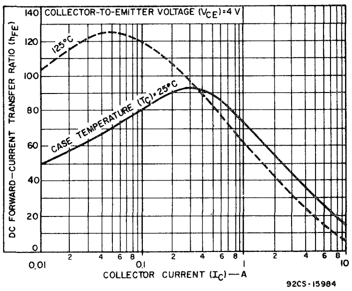


Fig. 8 - Typical dc beta characteristics for 2N6102 and 2N6103.

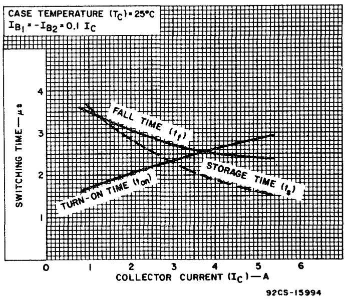


Fig. 9 - Typical saturated switching characteristics for all types.

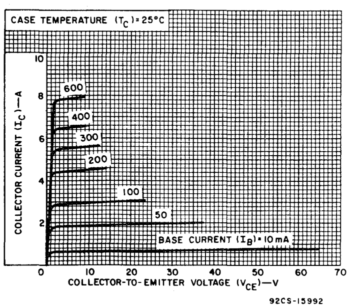


Fig. 10 - Typical output characteristics for 2N6098, 2N6099, and RCA3055.

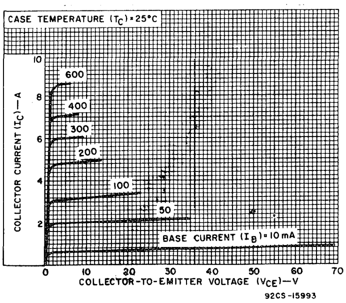


Fig. 11 - Typical output characteristics for 2N6100 and 2N6101.

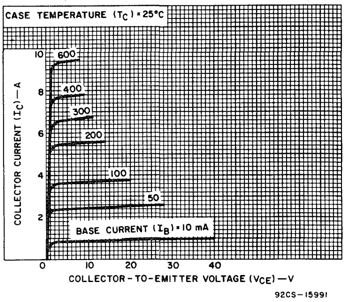


Fig. 12 - Typical output characteristics for 2N6102 and 2N6103.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

Epitaxial-Base, Silicon N-P-N andP-N-P VERSAWATT Transistors

General-Purpose Medium-Power Types for Switching and Amplifier Applications

RCA 2N6106-2N6111, 2N6288-2N6293, and 2N6473-2N6476, 41500 and 41501 are epitaxial-base silicon transistors supplied in a VERSAWATT package. The 2N6288-2N6293, 2N6473, 2N6474, and 41500 are n-p-n complements of p-n-p types 2N6106-2N6111, 2N6475, 2N6476, and 41501, respectively. All these transistors are intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

The 2N6289, 2N6291, and 2N6293 n-p-n types and 2N6106, 2N6108, and 2N6110 p-n-p devices fit into TO-66 sockets. The remaining types are supplied in the JEDEC TO-220AB straight-lead VERSAWATT package.

Features:

- **Low saturation voltages**
- **VERSAWATT package**
- **Complementary n-p-n and p-n-p types**
- **Thermal-cycling ratings**
- **Maximum safe-area-of-operation curves specified for dc operation**

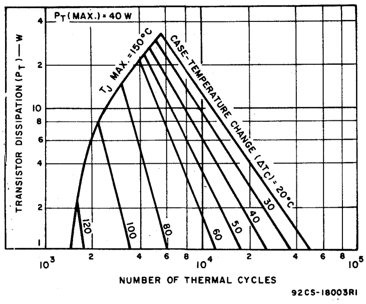
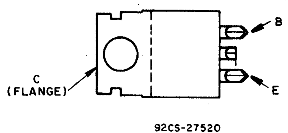


Fig. 1 - Thermal-cycling ratings for all types.

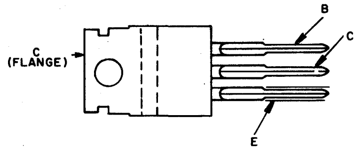
TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AA
2N6106, 2N6108, 2N6110
2N6289, 2N6291, 2N6293

(See dimensional outline "R".)



BOTTOM VIEW

JEDEC TO-220AB
2N6107, 2N6109, 2N6111,
2N6288, 2N6290, 2N6292,
2N6473, 2N6474, 2N6475,
2N6476, 41500, 41501

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*	N-P-N	2N6288 2N6289	2N6290 2N6291	2N6292 2N6293	2N6473	2N6474	41500	
	P-N-P	2N6110♦ 2N6111♦	2N6108♦ 2N6109♦	2N6106♦ 2N6107♦	2N6475♦	2N6476♦	41501♦	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	60	80	110	130	35	V
*COLLECTOR-TO-EMITTER VOLTAGE:								
With external base-supply resistance (R_{BB}) = 100Ω, and base supply voltage (V_{BB}) = 0	V_{CEX}	40	60	80	110	130	35	V
With base open = 0 V	V_{CEO}	30	50	70	100	120	25	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	5	3	V
*COLLECTOR CURRENT (Continuous) At case temperature ⩽ 106°C	I_C	7	7	7	4	4	7	A
*BASE CURRENT (Continuous) At case temperature ⩽ 130°C	I_B	3	3	3	2	2	3	A
TRANSISTOR DISSIPATION:	P_T							
At case temperatures up to 25°C		40	40	40	40	40	40	W
* At case temperatures up to 100°C		16	16	16	16	16	16	W
At ambient temperatures up to 25°C		1.8	1.8	1.8	1.8	1.8	1.8	W
At case temperatures above 25°C		Derate linearly at 0.32 W/°C						
* At case temperatures above 100°C		Derate lineraly at 0.32 W/°C						
At ambient temperatures above 25°C		Derate linearly at 0.0144 W/°C						
*TEMPERATURE RANGE: Storage and Operating (Junction)		−65 to 150						°C
*LEAD TEMPERATURE (During Soldering): At distance ⩾ 1/8 in. (3.17 mm) from case for 10 s max.		235						°C

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* 2N-Series types in accordance with JEDEC registration data format (JS-6, RDF-2)

♦ For p-n-p devices, voltage and current values are negative

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS♦				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6292 2N6293 2N6106♦ 2N6107♦		2N6290 2N6291 2N6108♦ 2N6109♦		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
I_{CER} (R_{BE} = 100Ω)	75				–	0.1	–	–	mA
	55				–	–	–	0.1	
(T_C = 150°C)	70				–	2	–	–	
	50				–	–	–	2	
* I_{CEX}	75	−1.5			–	0.1	–	–	mA
	56	−1.5			–	–	–	0.1	
* (T_C = 150°C)	70	−1.5			–	2	–	–	
	50	−1.5			–	–	–	2	
* I_{CEO}	40			0	–	–	–	1	mA
	60			0	–	1	–	–	
* I_{EBO}		−5	0		–	1	–	1	mA
* V_{CEO}(sus)			0.1[a]	0	70	–	50	–	V
V_{CER}(sus) (R_{BE} = 100Ω)			0.1		80	–	60	–	V
* h_{FE}	4		2[a]		30	150	–	–	
	4		2.5[a]		–	–	30	150	
	4		7[a]		2.3	–	2.3	–	
* V_{BE} 2N6292, 2N6293	4		2[a]		–	1.5	–	–	V
2N6290, 2N6291	4		2.5[a]		–	–	–	1.5	
All Types	4		7[a]		–	3	–	3	
* V_{CE}(sat)			2[a]	0.2	–	1	–	–	V
			2.5[a]	0.25	–	–	–	1	
			7[a]	3[a]	–	3.5	–	3.5	
* h_{fe} (f = 50 kHz)	4		0.5		20	–	20	–	
f_T 2N6290 - 2N6293	4		0.5		4	–	4	–	MHz
2N6106 - 2N6109	−4		-0.5		10	–	10	–	
* $\|h_{fe}\|$ (f = 1 MHz) 2N6290 - 2N6293	4		0.5		4	–	4	–	
2N6106 - 2N6109	−4		-0.5		10	–	10	–	
* C_{obo} (f = 1 MHz, V_{CB} = 10 V)			0		–	250	–	250	pF
$R_{\theta JC}$					–	3.125	–	3.125	°C/W
$R_{\theta JA}$					–	70	–	70	

[a] Pulsed; pulse duration = 300 μs, duty factor = 0.018.

♦For p-n-p devices, voltage and current values are negative

* In accordance with JEDEC registration data format (JS-6 RDF-2).

CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS◆				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6474 2N6476◆		2N6473 2N6475◆		41500 41501◆		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CER} (R_{BE} = 100Ω)	30				–	–	–	–	–	0.25	mA
	120				–	0.1	–	–	–	–	
	100				–	–	–	0.1	–	–	
(T_C = 100°C)	120				–	2	–	–	–	–	
	100				–	–	–	2	–	–	
* I_{CEX}	120	−1.5			–	0.1	–	–	–	–	mA
	100	−1.5			–	–	–	0.1	–	–	
* (T_C = 100°C)	120	−1.5			–	2	–	–	–	–	
	100	−1.5			–	–	–	2	–	–	
* I_{CEO}	60			0	–	1	–	–	–	–	mA
	50			0	–	–	–	1	–	–	
* I_{EBO}		−5	0		–	1	–	1	–	–	mA
		−3	0		–	–	–	–	–	1	
* V_{CEO}(sus)			0.1^a	0	120	–	100	–	25	–	V
V_{CER}(sus) (R_{BE} = 100Ω)			0.1		130	–	110	–	35	–	V
* h_{FE}	4		1^a		–	–	–	–	25	–	
	4		1.5^a		15	150	15	150	–	–	
	2.5		4^a		2	–	2	–	–	–	
* V_{BE}	4		1^a		–	–	–	–	–	1.5	V
	4		1.5^a		–	2	–	2	–	–	
	2.5		4^a		–	3.5	–	3.5	–	–	
* V_{CE}(sat)			1^a	0.1	–	–	–	–	–	1	V
			1.5^a	0.15	–	1.2	–	1.2	–	–	
			4^a	2	–	2.5	–	2.5	–	–	
* h_{fe} (f = 50 kHz)	4		0.5		20	–	20	–	20	–	
f_T 41500, 2N6473, 2N6474	4		0.5		4	–	4	–	4	–	MHz
2N6475, 2N6476	−4		−0.5		5	–	5	–	–	–	
* $\|h_{fe}\|$ (f = 1 MHz) 41500, 2N6473, 2N6474	4		0.5		4	–	4	–	4	–	
2N6475, 2N6476	−4		−0.5		5	–	5	–	–	–	
* C_{obo} (f = 1 MHz, V_{CB} = 10 V)			0		–	250	–	250	–	250	pF
$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	°C/W
$R_{\theta JA}$					–	70	–	70	–	70	

^{a}Pulsed; pulse duration = 300 μs, duty factor = 0.018. ◆For p-n-p devices, voltage and current values are negative.

*2N-series types in accordance with JEDEC registration data format (JS-6 RDF-2).

CAUTION: The sustaining voltage V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS◆				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N6288 2N6289		2N6110◆ 2N6111◆		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
Collector-Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	35				–	0.1	–	–0.1	mA
With (R_{BE}) = 100 Ω and T_C = 150°C		30				–	2	–	–2	
* With base-emitter junction reverse-biased	I_{CEX}	37.5	–1.5			–	0.1	–	–0.1	mA
* With base-emitter junction reverse-biased and T_C = 150°C		30	–1.5			–	2	–	–2	
* With base open	I_{CEO}	20			0	–	1	–	–1	mA
* Emitter-Cutoff Current	I_{EBO}		5	0		–	1	–	–1	mA
Collector-to-Emitter Sustaining Voltage: * With base open	$V_{CEO}(sus)$			0.1^a	0	30	–	–30	–	V
With external base-to emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1		40	–	–40	–	V
* DC Forward Current Transfer Ratio	h_{FE}	4 4		3^a 7^a		30 2.3	150 –	30 2.3	150 –	
* Base-to-Emitter Voltage: 2N6288, 2N6289 All Types	V_{BE}	4 4		3^a 7^a		– –	1.5 3	– –	– 3	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			3^a 7^a	0.3 3	– –	1 3.5	– –	–1 –3.5	V
* Common-Emitter, Small-Signal, Forward-Current Transfer Ratio: f = 50 kHz	h_{fe}	4		0.5		20	–	20	–	
Gain-Bandwidth Product: 2N6288-2N6289 2N6110-2N6111	f_T	4 –4		0.5 –0.5		4 –	– –	– 10	– –	MHz
* Magnitude of Common-Emitter, Small-Signal, Forward-Current Transfer Ratio: f = 1 MHz 2N6288-2N6289 2N6110-2N6111	$\lvert h_{fe} \rvert$	4 –4		0.5 –0.5		4 –	– –	4 10	– –	
* Collector-to-Base Capacitance: f = 1 MHz, V_{CB} = 10 V	C_{obo}			0		–	250	–	250	pF
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	3.125	–	3.125	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	70	–	70	

[a] Pulsed: Pulse duration = 300 μs, duty factor = 0.018.

◆For p-n-p devices, voltage and current values are negative.

*In accordance with JEDEC registration data format (JS-6 RDF-2).

CAUTION: The sustaining voltage $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

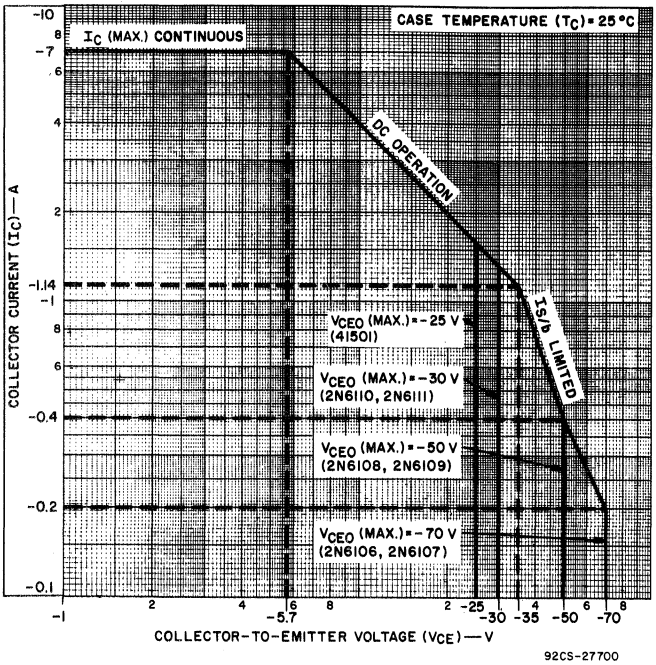


Fig. 2 - Maximum operating areas for 2N6106–2N6111 and 41501.

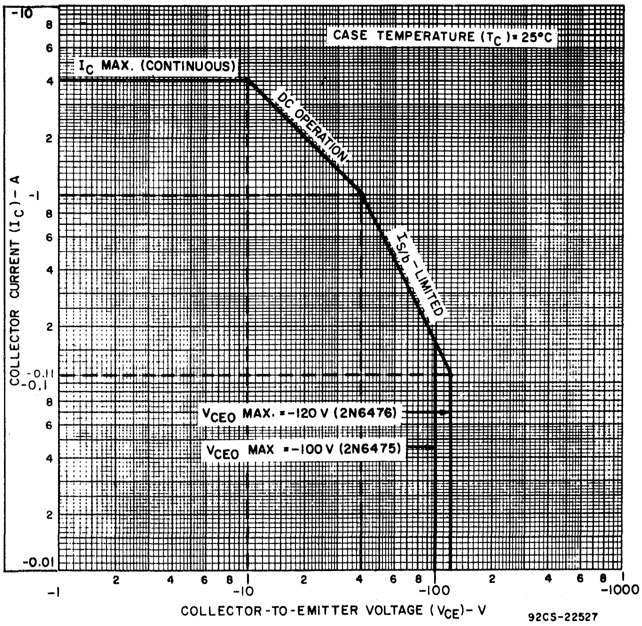


Fig. 3 - Maximum operating areas for 2N6475–2N6476.

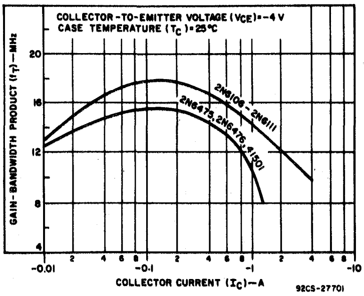


Fig. 4 - Typical gain-bandwidth product for 2N6106–2N6111, 2N6475, 2N6476, and 41501.

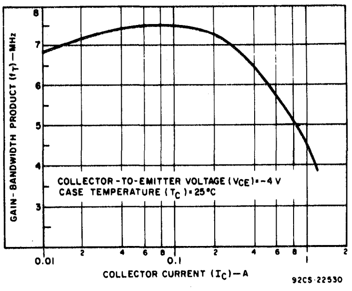


Fig. 5 - Typical gain-bandwidth product for 2N6473 and 2N6474.

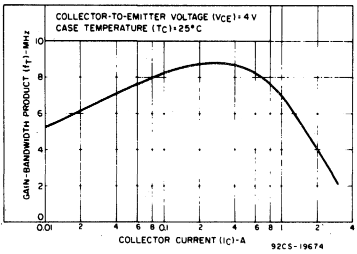


Fig. 6 - Typical gain-bandwidth product for 2N6288–2N6293, and 41500.

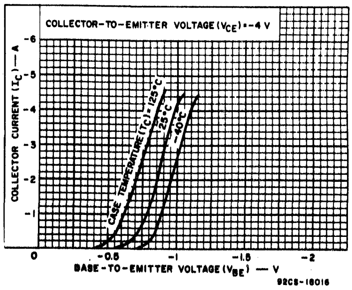


Fig. 7 - Typical transfer characteristics for 2N6106–2N6111.

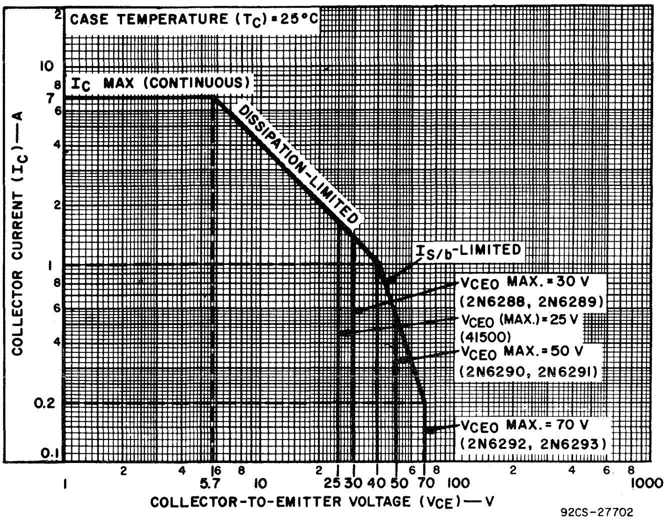


Fig. 8 - Maximum operating areas for 2N6288—2N6293 and 41500.

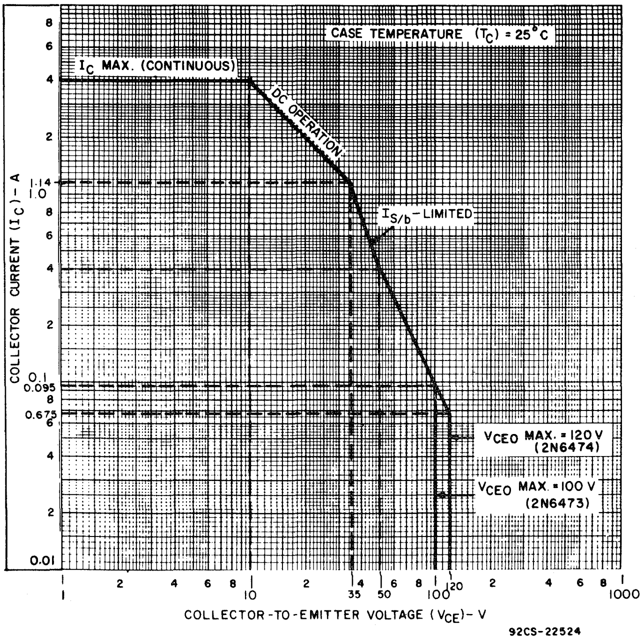


Fig. 9 - Maximum operating areas for 2N6473 and 2N6474.

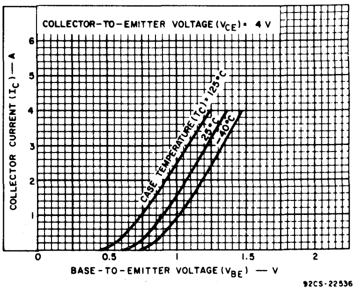


Fig. 10 - Typical transfer characteristics for 2N6473 and 2N6474.

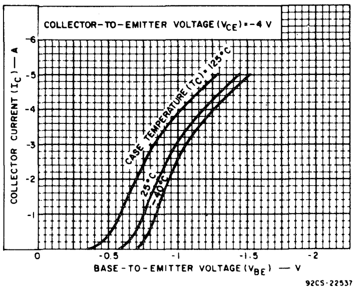


Fig. 11 - Typical transfer characteristics for 2N6475 and 2N6476.

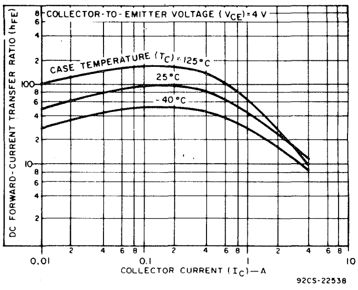


Fig. 12 - Typical dc beta characteristics for 2N6473 and 2N6474.

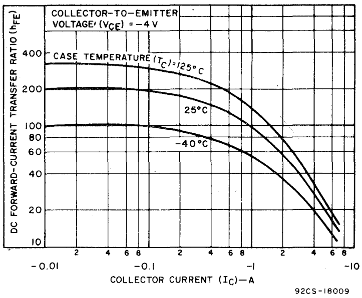


Fig. 13 - Typical dc beta characteristics for 2N6106—2N6111.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

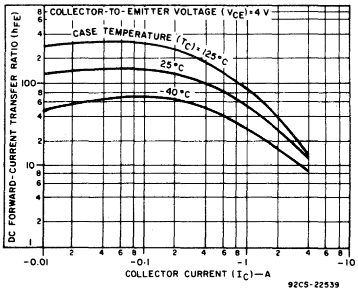


Fig. 14 - Typical dc beta characteristics for 2N6475 and 2N6476.

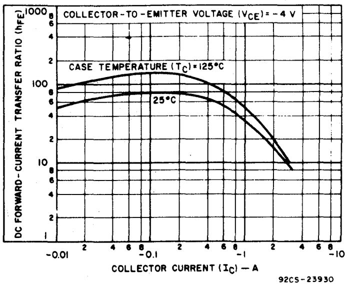


Fig. 15 - Typical dc beta characteristics for 41501.

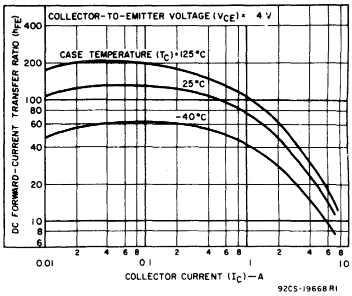


Fig. 16 - Typical dc beta characteristics for 2N6288—2N6293, and 41500.

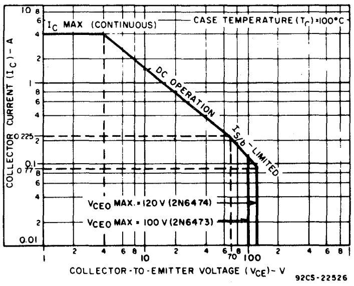


Fig. 17 - Maximum operating areas for 2N6473—2N6474.

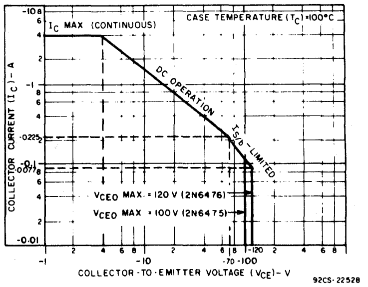


Fig. 18 - Maximum operating areas for 2N6475 and 2N6476.

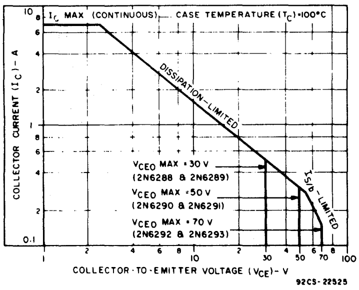


Fig. 19 - Maximum operating areas for 2N6288—2N6293.

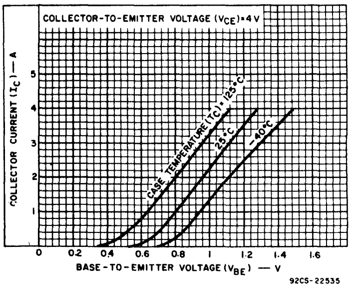


Fig. 20 - Typical transfer characteristics for 2N6288—2N6293, and 41500.

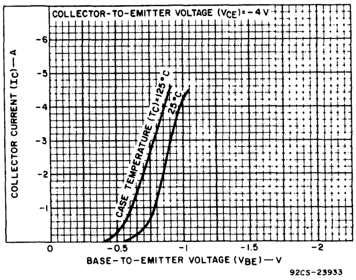


Fig. 21 - Typical transfer characteristics for 41501.

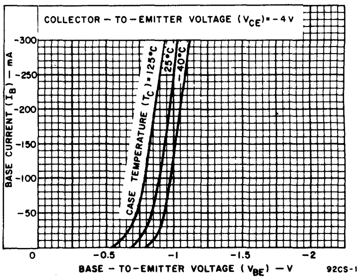


Fig. 22 - Typical input characteristics for 2N6106—2N6111, 2N6475, and 2N6476.

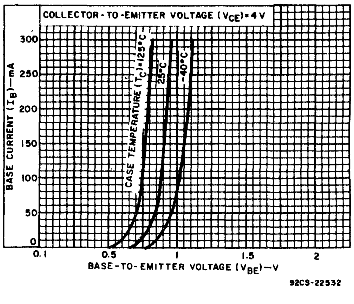


Fig 23 - Typical input characteristics for 2N6473 and 2N6474.

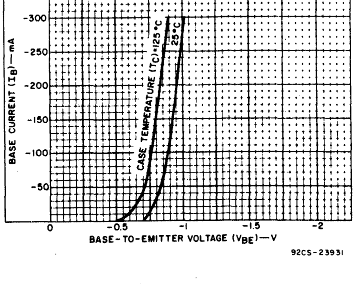


Fig. 24 - Typical input characteristics for 41501.

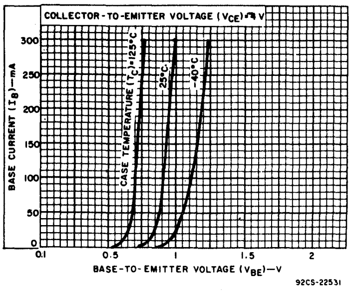


Fig. 25 - Typical input characteristics for 2N6288—2N6293.

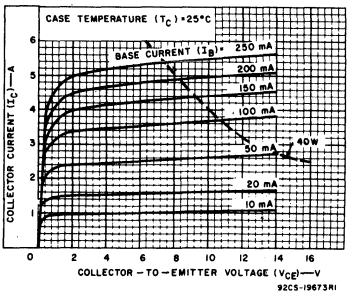


Fig. 26 - Typical output characteristics for 2N6288–2N6293, and 41500.

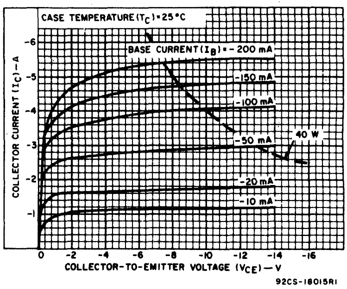


Fig. 27 - Typical output characteristics for 2N6106–2N6111.

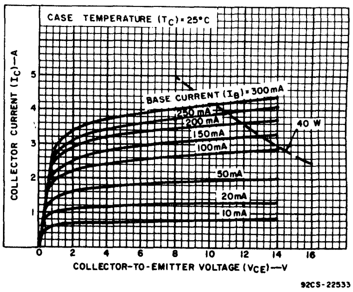


Fig. 28 - Typical output characteristics for 2N6473 and 2N6474.

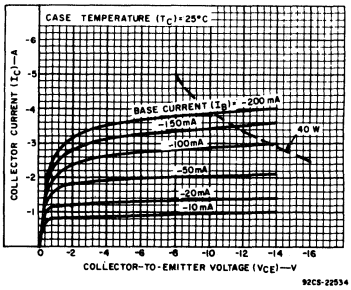


Fig. 29 - Typical output characteristics for 2N6475 and 2N6476.

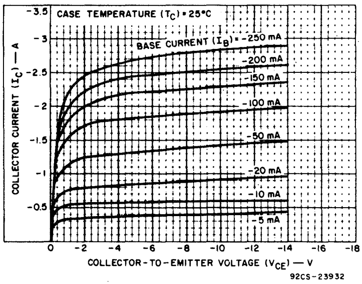


Fig. 30 - Typical output characteristics for 41501.

2N6121-2N6123, 2N6124-2N6126

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

General-Purpose Medium-Power Types for Switching and Amplifier Applications

Features:

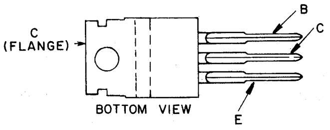
- **Low saturation voltages**
- **VERSAWATT package**
- **Complementary n-p-n and p-n-p types**
- **Thermal-cycling ratings**
- **Maximum safe-area-of-operation curves specified for dc operation**

The RCA-2N6121, 2N6122, and 2N6123 are epitaxial-base n-p-n transistors. The 2N6124, 2N6125, and 2N6126 are epitaxial-base p-n-p transistors. They are complements to 2N6121, 2N6122, and 2N6123, respectively.

All types utilize the JEDEC TO-220AB (RCA VERSAWATT) plastic package.

All these transistors are intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

N-P-N	2N6121	2N6122	2N6123	
P-N-P	2N6124◆	2N6125◆	2N6126◆	
* V_{CBO}	45	60	80	V
* $V_{CEO}(sus)$	45	60	80	V
* V_{EBO}	5			V
* I_C	4			A
* I_B	1			A
P_T				
* $T_C \geqslant 25^oC$	40			W
$T_C > 25^oC \leqslant 100^oC$	16			W
$T_C > 25^oC$	Derate linearly 0.32			W/°C
$T_A \leqslant 25^oC$	1.8			W
$T_A > 25^oC$	Derate linearly 0.0144			W/°C
* T_{stg}, T_J	−65 to 150			°C
* T_L				
At distances ⩾1/8 in. (3.17 mm) from case for 10 s max.	235			°C

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* In accordance with JEDEC registration data. ◆For p-n-p devices, voltage and current values are negative.

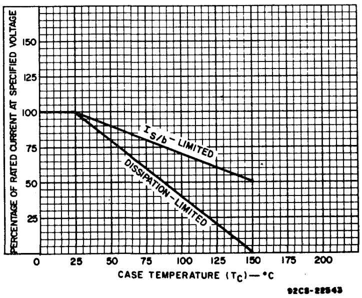


Fig. 2 – Current derating curves for all types.

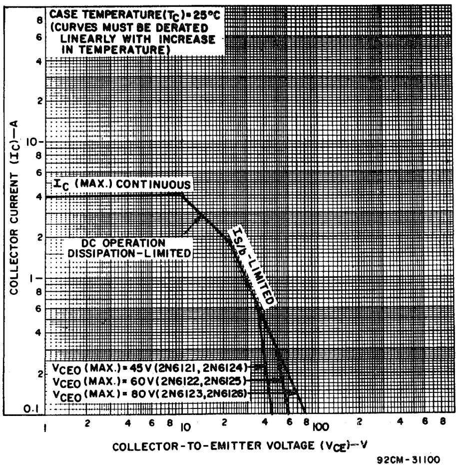


Fig. 1 – Maximum operating areas for all types.

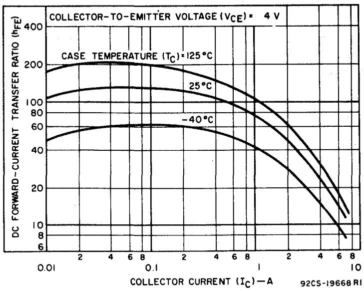


Fig. 3 – Typical dc beta characteristics for all types.

2N6121-2N6123, 2N6124-2N6126

ELECTRICAL CHARACTERISTICS *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS♦				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6121 2N6124♦		2N6122 2N6125♦		2N6123 2N6126♦		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CBO}	45^a				–	0.1	–	–	–	–	mA
	60^a				–	–	–	0.1	–	–	
	80^a				–	–	–	–	–	0.1	
* I_{CEX}	45	−1.5			–	0.1	–	–	–	–	
	60	−1.5			–	–	–	0.1	–	–	
	80	−1.5			–	–	–	–	–	0.1	
T_C = 125°C	45	−1.5			–	2	–	–	–	–	
	60	−1.5			–	–	–	2	–	–	
	80	−1.5			–	–	–	–	–	2	
* I_{CEO}	45			0	–	1	–	–	–	–	
	60			0	–	–	–	1	–	–	
	80			0	–	–	–	–	–	1	
* I_{EBO}		−5	0		–	1	–	1	–	1	
* V_{CEO} (sus)^b			0.1^c	0	45	–	60	–	80	–	V
* h_{FE}	2		1.5^c		25	100	25	100	20	80	
	2		4^c		10	–	10	–	7	–	
* V_{BE}	2		1.5^c		–	1.2	–	1.2	–	1.2	V
V_{CE}(sat)			1.5^c	0.15	–	0.6	–	0.6	–	0.6	
			4^c	1	–	1.4	–	1.4	–	1.4	
* $\|h_{fe}\|$ (f=1 MHz)	4		1		2.5	–	2.5	–	2.5	–	
* h_{fe} (f=1 kHz)	2		0.1		25	–	25	–	25	–	
$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	°C/W

* In accordance with JEDEC registration data.

^{b} **CAUTION**: The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

^{a} V_{CB} value.

^{c} Pulsed: Pulse duration = 300 μs, duty factor = 0.018.

♦For p-n-p devices, voltage and current values are negative.

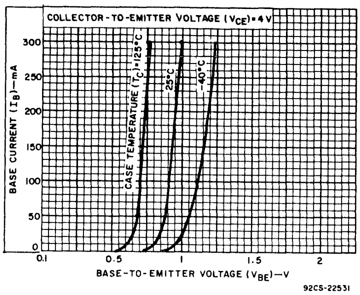


Fig. 4 — Typical input characteristics for all types.

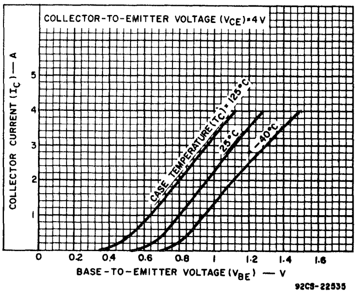


Fig. 5 — Typical transfer characteristics for all types.

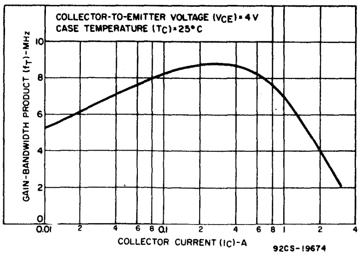
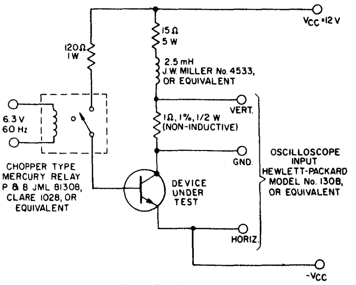


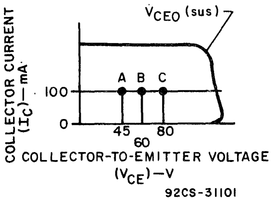
Fig. 6 — Typical gain-bandwidth product.



NOTE: FOR p-n-p TYPES, REVERSE POLARITY OF VCC·

92CS-31102

Fig. 7 — Circuit used to measure sustaining voltage V_{CEO}(sus) for all types.



Note:
Curve will be inverted and polarity reversed. The sustaining voltage, V_{CEO}(sus), is acceptable when the traces fall to the right and above the designated points:
Point A: 2N6121, 2N6124
Point B: 2N6122, 2N6125
Point C: 2N6123, 2N6126

Fig. 8 - Oscilloscope display for measurement of sustaining voltage (test circuit shown in Fig. 7).

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

General-Purpose Medium-Power Types for Switching and Amplifier Applications

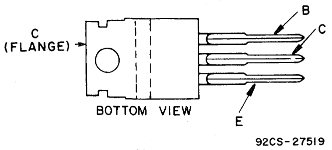
Features:

- ■ **Low saturation voltages**
- ■ **VERSAWATT package**
- ■ **Complementary n-p-n and p-n-p types**
- ■ **Maximum safe-area-of-operation curves**

The RCA-2N6129, 2N6130, and 2N6131 n-p-n transistors and their complementary p-n-p types, 2N6132, 2N6133, and 2N6134, respectively, are epitaxial-base transistors intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers.

All types utilize the JEDEC TO-220AB (RCA VERSAWATT) plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6129	2N6130	2N6131	
N-P-N P-N-P	2N6129 2N6132■	2N6130 2N6133■	2N6131 2N6134■	
* V_{CBO}	40	60	80	V
* $V_{CEO}(sus)$	40	60	80	V
* V_{EBO}		5		V
* I_C		7		A
* I_B		3		A
* P_T				
* $T_C = 25°C$		50		W
* $T_C = 100°C$		20		W
* $T_C > 25°C$		Derate linearly 0.4		W/°C
* T_{stg}, T_J		−65 to +150		°C
* T_L At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max		235		°C

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* In accordance with JEDEC registration data.

■ For p-n-p devices, voltage and current values are negative.

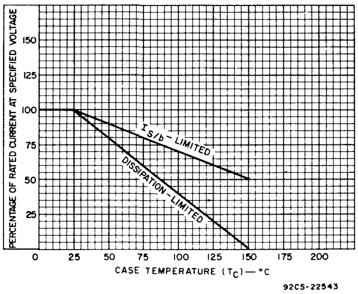


Fig. 2—Current derating curves for all types.

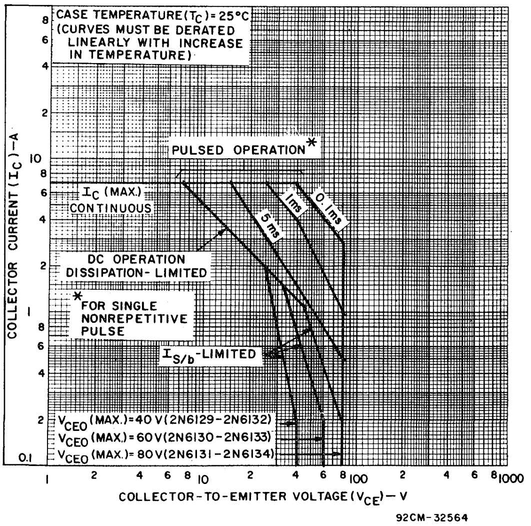


Fig. 1—Maximum operating areas for all types.

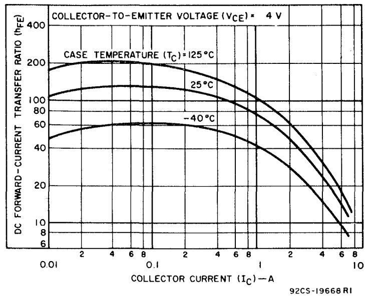


Fig. 3—Typical dc beta characteristics for all types.

2N6129-2N6131, 2N6132-2N6134

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

Charac-teristic	Test Conditions■				Limits						Units
	Voltage V dc		Current A dc		2N6129 2N6132■		2N6130 2N6133■		2N6131 2N6134■		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	40[a]				—	0.1	—	—	—	—	mA
	60[a]				—	—	—	0.1	—	—	
	80[a]				—	—	—	—	—	0.1	
* I_{CEX}	40	—1.5			—	0.2	—	—	—	—	
	60	—1.5			—	—	—	0.2	—	—	
	80	—1.5			—	—	—	—	—	0.2	
* $T_C = 125°C$	40	—1.5			—	2	—	—	—	—	
	60	—1.5			—	—	—	2	—	—	
	80	—1.5			—	—	—	—	—	2	
* I_{CEO}	40			0	—	2	—	—	—	—	
	60			0	—	—	—	2	—	—	
	80			0	—	—	—	—	—	2	
* I_{EBO}		—5	0		—	1	—	1	—	1	
* V_{CEO}(sus)**b**			0.1[c]	0	40	—	60	—	80	—	V
* h_{FE}	4		2.5[c]		20	100	20	100	20	100	
	4		7[c]		7	—	7	—	5	—	
* V_{BE}	4		2.5[c]		—	2.0	—	2.0	—	2.0	V
V_{CE}(sat)			7[c]	3	—	1.4	—	1.4	—	1.8	
* $\|h_{fe}\|$ (f = 1 MHz)	4		1		2.5	—	2.5	—	2.5	—	
* h_{fe} (f = 1 kHz)	4		0.1		25	—	25	—	25	—	
$R_{\theta JC}$					—	2.5	—	2.5	—	2.5	°C/W

* In accordance with JEDEC registration data.

[b] **CAUTION:** The sustaining voltage **V_{CEO}(sus)** *MUST NOT* be measured on a curve tracer.

[a] V_{CB} value.

[c] Pulsed: Pulse duration = 300 μs, duty factor = 0.018.

■ For p-n-p devices, voltage and current values are negative.

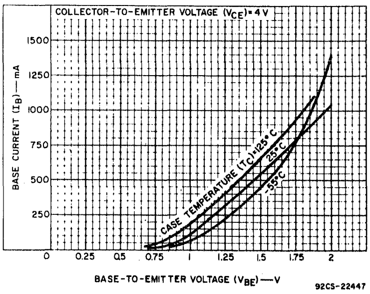


Fig. 4—Typical input characteristics for all types.

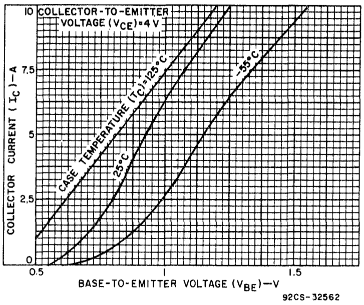


Fig. 5—Typical transfer characteristics for all types.

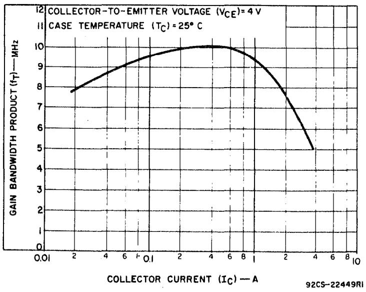


Fig. 6—Typical gain-bandwidth product.

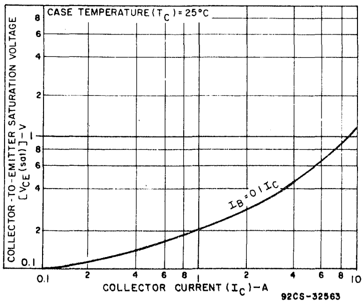


Fig. 7—Typical collector-to-emitter saturation voltage for all types.

2N6211-2N6214

High-Voltage, Medium-Power Silicon P-N-P Transistors

For Switching and Amplifier Applications
In Military, Industrial, and Commercial Equipment

Features:

- **High voltage ratings:**
  $V_{CEO}(sus)$ = −400 V max. (2N6214)
  = −350 V max. (2N6213)
  = −300 V max. (2N6212)
  = −225 V max. (2N6211)
- **Large safe-operating area**
- **Complements to 2N3585 transistor family**
- **Thermal-cycling rating**

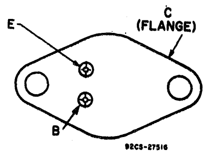
RCA types 2N6211, 2N6212, 2N6213, and 2N6214● are epitaxial silicon p-n-p transistors with high breakdown-voltage ratings and fast switching speeds. They are supplied in the popular JEDEC TO-66 package; they differ in breakdown-voltage ratings and leakage-current values.

● Formerly RCA Dev. Nos. TA7719, TA7410, TA8330, and TA8331, respectively.

Applications:

- **Power-Switching Circuits**
- **Switching Regulators**
- **Converters**
- **Inverters**
- **High-Fidelity Amplifiers**

TERMINAL DESIGNATIONS



JEDEC TO-66

(See dimensional outline "N".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6211	2N6212	2N6213	2N6214	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−275	−350	−400	−450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With base open	$V_{CEO}(sus)$	−225	−300	−350	−400	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$	−250	−325	−375	−425	V
* With base-emitter junction reverse-biased (V_{BE} = 1.5 V)	$V_{CEX}(sus)$	−275	−350	−400	−450	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	−6	−6	−6	−6	V
*COLLECTOR CURRENT (Continuous)	I_C	−2	−2	−2	−2	A
*BASE CURRENT (Continuous)	I_B	−1	−1	−1	−1	A
TRANSISTOR DISSIPATION:	P_T					
* At case temperatures up to 100°C and V_{CE} up to 50 V		20	20	20	20	W
At case temperatures up to 25°C and V_{CE} up to 40 V		35	35	35	35	W
At case temperatures up to 25°C and V_{CE} above 40 V		See Fig. 1				
At case temperatures above 25°C		Derate linearly to 200°C				
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to 200 →				°C
*LEAD TEMPERATURE (During Soldering):						
At distance ≥ 1/32 in. (0.8 mm) from case for 10s max.		← 230 →				°C

*In accordance with JEDEC registration data format (JS-6 RDF-1)

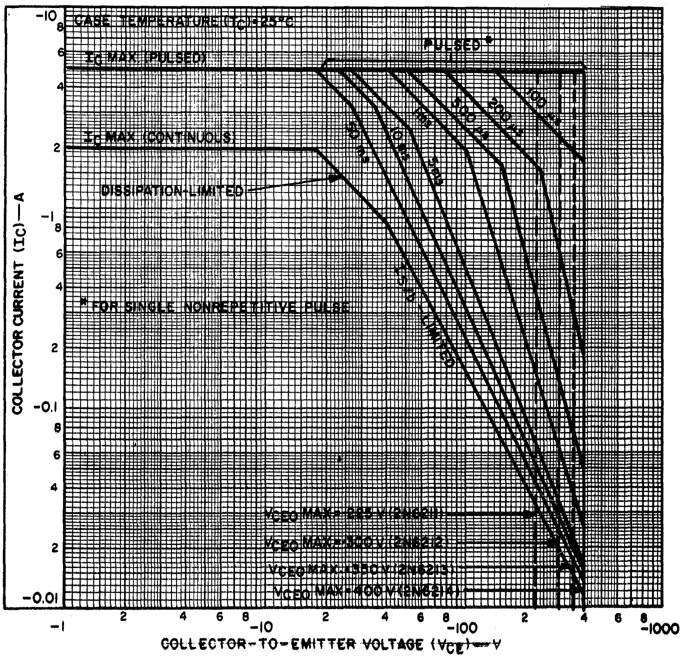


Fig. 1 - Maximum operating areas for all types.

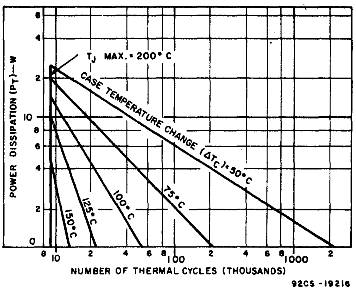


Fig. 2 - Thermal-cycling rating chart for all types.

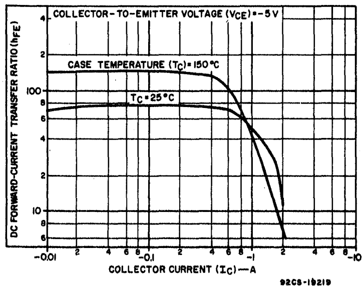


Fig. 3 - Typical dc beta characteristic for all types.

2N6211-2N6214

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		Voltage V dc		Current A dc		2N6211		2N6212		2N6213		2N6214		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	-150			0	–	-5	–	-5	–	-5	–	-5	mA
• With base-emitter junction reverse-biased	I_{CEV}	-250 -315 -360 -410	1.5 1.5 1.5 1.5			– – – –	-0.5 – – –	– – – –	– -0.5 – –	– – – –	– – -0.5 –	– – – –	– – – -1	mA
• With base-emitter junction reverse biased and T_C = 100°C	I_{CEV}	-250 -315 -360 -410	1.5 1.5 1.5 1.5			– – – –	-5 – – –	– – – –	– -5 – –	– – – –	– – -5 –	– – – –	– – – -10	mA
• Emitter-Cutoff Current	I_{EBO}		6	0		–	1	-	-0.5	–	-0.5	-	-0.5	mA
• DC Forward-Current Transfer Ratio	h_{FE}	-2.8 -3.2 -4 -5		-1^a -1^a -1^a -1^a		10 – - -	100 – –	– 10 – -	– 100 -	– – 10 –	– – 100 –	– – – 10	– - - 100	
• Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			-0.2^a	0	-225	–	-300	-	-350	–	-400		V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$			-0.2^a		250		-325	-	-375	–	-425		V
With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) 50 Ω	$V_{CEX}(sus)$		1 5	-0.2^a		275		350		400	–	-450		V
• Emitter-to-Base Voltage	V_{EBO}				0.5 mA 1 mA	 6		-6		-6	–	-6	– –	V
• Emitter-to-Base Saturation Voltage	$V_{BE}(sat)$			-1^a	0 125		1 4		-1.4	-	-1.4	-	-1.4	V
• Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			-1^a	0.125		1.4		1.6	–	-2	-	-2.5	V
Output Capacitance (f = 1 MHz)	C_{obo}	-10 (V_{CB})					220	-	220	–	220		220	pF
Second-Breakdown Collector Current (Base forward-biased)	$I_{S/b}$	-40				-0.875		-0.875	-	-0.875	–	-0.875	–	A
• Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 5 MHz)	$\|h_{fe}\|$	-10		-0.2		4	–	4	–	4	–	4	–	
• Saturated Switching Times: Rise time	t_r	V_{CC} = -200 V		-1	I_{B1} & I_{B2} -0.125	-	0.6	–	0.6	–	0.6	–	0.6	μs
Storage time	t_s	V_{CC} = -200 V	-	-1	I_{B1} & I_{B2} -0.125	–	2.5	–	2.5	–	2.5	–	2.5	μs
Fall time	t_f	V_{CC} = -200 V		-1	I_{B1} & I_{B2} -0.125	–	0.6	–	0.6	–	0.6	–	0.6	μs
Thermal Resistance (Junction-to-case)	$R_{\theta JC}$	-10		-1		–	5	–	5	–	5	–	5	°C/W

• In accordance with JEDEC registration data format JS-6 RDF-1.

[a] Pulsed, pulse duration = 300 μs; duty factor ≤ 2%.

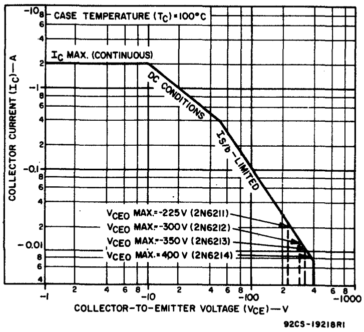


Fig. 4 - Maximum operating areas for all types.

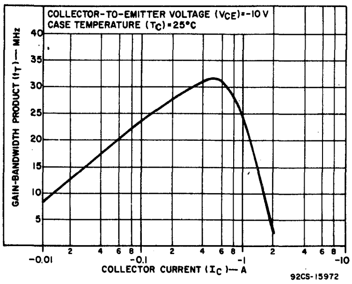


Fig. 5 - Typical gain-bandwidth product for all types.

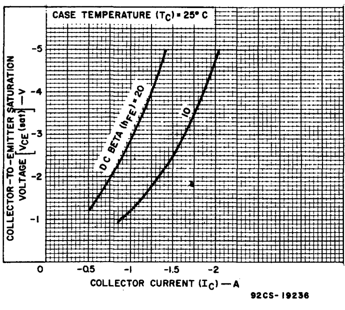


Fig. 6 - Typical saturation-voltage characteristics for all types.

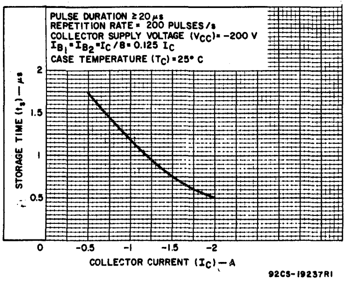


Fig. 7 - Typical storage-time characteristic for all types.

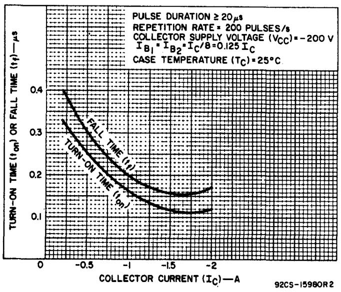


Fig. 8 - Typical turn-on time and fall-time characteristics for all types.

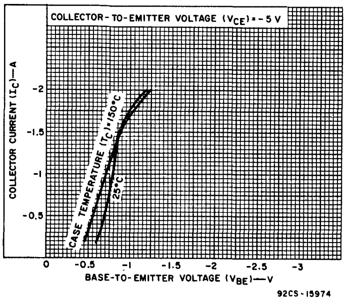


Fig. 9 - Typical transfer characteristics for all types.

2N6246, 2N6247, 2N6248, 2N6469, 2N6470, 2N6471, 2N6472

Silicon N-P-N and P-N-P Epitaxial-Base High-Power Transistors

General-Purpose Types for Switching and Linear-Amplifier Applications

RCA-2N6246, 2N6247, 2N6248, and 2N6469▲ are epitaxial-base silicon p-n-p transistors featuring high gain at high current. RCA-2N6470, 2N6471, and 2N6472● are epitaxial-base silicon n-p-n transistors. They may be used as complements to the 2N6469, 2N6246, and 2N6247, respectively. All of these devices have a dissipation capability of 125 watts at case temperatures up to 25°C. They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the JEDEC TO-3 package.

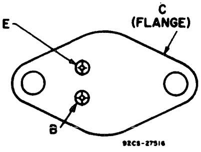
▲ Formerly RCA Dev. Nos. TA7281, TA7280, TA7279, and TA8724, respectively.

● Formerly RCA Dev. Nos. TA8726, TA8443, and TA8442, respectively.

Features:

- **High dissipation capability: 125 W at 25°C**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**
- **Hermetically sealed JEDEC TO-3 package**
- **High gain at high current**
- **Thermal-cycling rating curve**

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

Maximum Ratings, *Absolute-Maximum Values:*

		N-P-N	2N6470	2N6471	2N6472		
		P-N-P	**2N6469◆**	**2N6246◆**	**2N6247◆**	**2N6248◆**	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}		50	70	90	110	V
COLLECTOR-TO-EMITTER VOLTAGE:							
* With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}		50	70	90	110	V
With base open	V_{CEO}		40	60	80	100	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}		5	5	5	5	V
*CONTINUOUS COLLECTOR CURRENT	I_C		15	15	15	10	A
*CONTINUOUS BASE CURRENT	I_B		5	5	5	5	A
*TRANSISTOR DISSIPATION:	P_T						
At case temperatures up to 25°C			125	125	125	125	W
At case temperatures above 25°C			← Derate linearly 200°C →				
*TEMPERATURE RANGE:							
Storage & Operating (Junction)			← −65 to +200 →				°C
*PIN TEMPERATURE (During Soldering):							
At distances ≥ 1/32" (0.8 mm) from seating plane for 10 s max.			← +235 →				°C

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* In accordance with JEDEC registration data format (JS-6 RDF-2).

◆ **For p-n-p devices, voltage and current values are negative.**

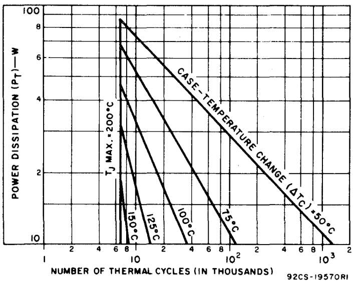


Fig. 1 - Thermal-cycling rating chart for all types.

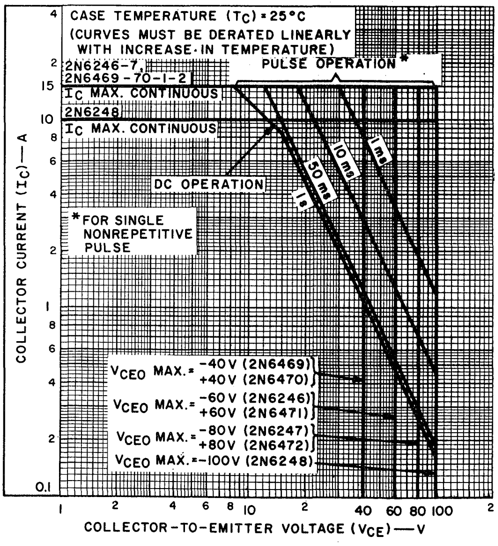


Fig. 2 — Maximum operating areas for all types.◆

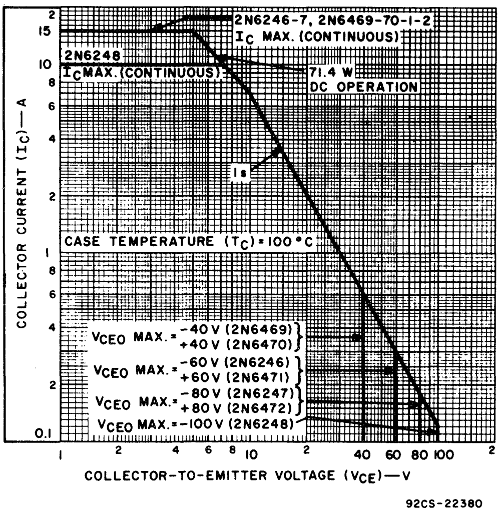


Fig. 3 - Maximum operating areas for all types.◆

◆For p-n-p devices, voltage and current values are negative.

2N6246, 2N6247, 2N6248, 2N6469, 2N6470, 2N6471, 2N6472

ELECTRICAL CHARACTERISTICS FOR N-P-N TYPES, *At case temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	CURRENT A dc I_C	I_B	LIMITS 2N6470 Min.	Max.	2N6471 Min.	Max.	2N6472 Min.	Max.	UNITS
Collector-Cutoff Current: With external base-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	35 55 75			– – –	500 – –	– – –	– 500 –	– – –	– – 500	μA
* With base-emitter junction reverse-biased V_{BE} = −1.5 V	I_{CEX}	45 65 85			– – –	500 – –	– – –	– 500 –	– – –	– – 500	μA
* With reverse bias, V_{BE} = −1.5 V, and T_C = 150°C		40 60 80			– – –	5 – –	– – –	– 5 –	– – –	– – 5	mA
* With base open	I_{CEO}	20 30 40		0 0 0	– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
* Emitter-Cutoff Current: V_{BE} = −5 V	I_{EBO}		0		–	1	–	1	–	1	mA
* DC Forward-Current Transfer Ratio	h_{FE}	4 4	5[a] 15[a]		20 5	150 –	20 5	150 –	20 5	150 –	
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$		0.2	0	40[b]	–	60[b]	–	80[b]	–	V
With external base-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$		0.2		50[b]	–	70[b]	–	90[b]	–	
* Base-to-Emitter Voltage	V_{BE}	4 4	5[a] 15[a]		– –	1.3 3.5	– –	1.3 3.5	– –	1.3 3.5	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$		5[a] 15[a]	0.5 5	– –	1.3 3.5	– –	1.3 3.5	– –	1.3 3.5	V
* Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio: f = 1 MHz	$\|h_{fe}\|$	4	1		5	–	5	–	5	–	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 kHz	h_{fe}	4	1		25	–	25	–	25	–	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$				–	1.4	–	1.4	–	1.4	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-2).

[a] Pulsed; pulse duration ≐ 300 μs, duty factor = 1.8%.

[b] *CAUTION: Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.*

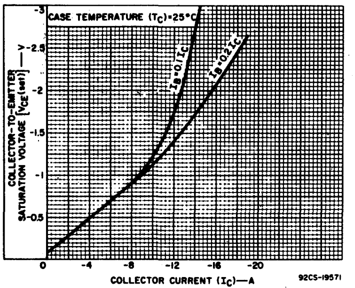


Fig. 4 — Typical collector-to-emitter saturation-voltage characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

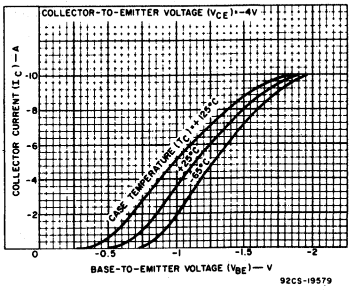


Fig. 5 — Typical transfer characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

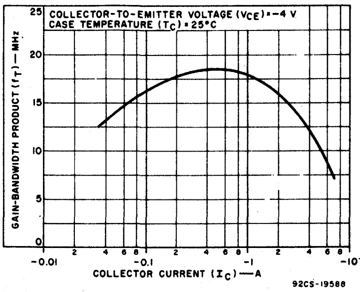


Fig. 6 — Typical gain-bandwidth product as a function of collector current for 2N6246, 2N6247, 2N6248, and 2N6469.

2N6246, 2N6247, 2N6248, 2N6469, 2N6470, 2N6471, 2N6472

ELECTRICAL CHARACTERISTICS FOR P-N-P TYPES, *At case temperature (T_C) = 25°C unless otherwise specified*

SYMBOL	TEST CONDITIONS				LIMITS				TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6469		2N6246		VOLTAGE V dc		CURRENT A dc		2N6247		2N6248		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER} (R_{BE}) = 100 Ω	-35 -55				– –	-200 –	– –	– -200	-75 -95				– –	-200 –	– –	– -200	µA
* I_{CEX}	-45 -65	1.5 1.5			– –	-200 –	– –	– -200	-85 -100	1.5 1.5			– –	-200 –	– –	– -200	µA
* T_C = 150°C	-45 -55	1.5 1.5			– –	-5 –	– –	– -5	-70 -90	1.5 1.5			– –	-5 –	– –	– -5	mA
* I_{CEO}	-20 -30			0 0	– –	-1 –	– –	– -1	-40 -50			0 0	– –	-1 –	– –	– -1	mA
* I_{EBO}		5		0	–	-5	–	-5		5		0	–	-1	–	-1	mA
* h_{FE}	-4 -4 -4		-5^a -7^a -15^a		20 5	150 – –	– 20 5	– 100 –	-4 -4 -4 -4		-5^a -6^a -10^a -15^a		– 20 – 5	– 100 – –	20 – 5 –	100 – – –	
* $V_{CEO}(sus)$			-0.2	0	40^b	–	-60^b	–			-0.2	0	-80^b	–	-100^b	–	V
$V_{CER}(sus)$			-0.2		-50^b	–	-70^b	–			-0.2		-90^b	–	-110^b	–	
* V_{BE}	-4 -4		-15^a -7^a		– 	-3.5 	– –	– -2	-4 -4		-6^a -5^a		– –	-1.8 –	– –	– -1.8	V
* $V_{CE}(sat)$			-5^a -7^a -15^a -15^a	-0.5 -0.7 -5 -3	– – – 	-1.3 – -3.5 –	– – – –	– -1.3 – -2.5			-5^a -6^a -15^a -10^a	-0.5 -0.6 -4 -2	– – – –	– -1.3 -3.5 –	– – – –	-1.3 – – -3.5	V
* $\|h_{fe}\|$ f = 2 MHz	-4		-1		5	–	5	–	-4		-1		5	–	5	–	
* h_{fe} f = 1 kHz	-4		-1		25	–	25	–	-4		-1		25	–	25	–	
$R_{\theta JC}$					–	1.4	–	1.4					–	1.4	–	1.4	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-2).

[a] Pulsed; pulse duration = 300 µs, duty factor = 1.8%.

[b] *CAUTION: CAUTION: **Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.***

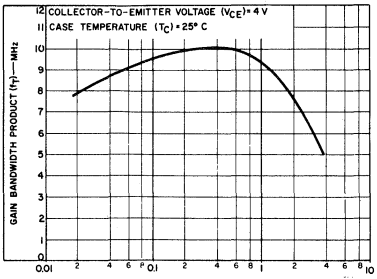


Fig. 7 - Typical gain-bandwidth product as a function of collector current for 2N6470, 2N6471, and 2N6472.

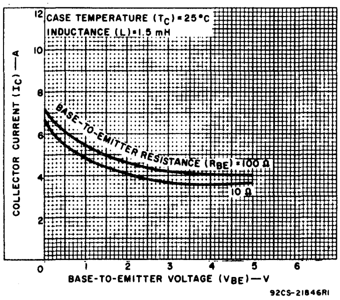


Fig. 8 - Minimum reverse-bias second-breakdown characteristics for all types. (Values for p-n-p types are negative).

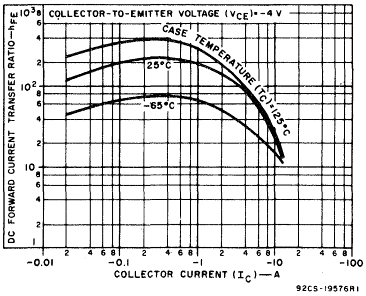


Fig. 9 - Typical dc beta characteristics for 2N6246, 2N6247, and 2N6469.

2N6246, 2N6247, 2N6248, 2N6469, 2N6470, 2N6471, 2N6472

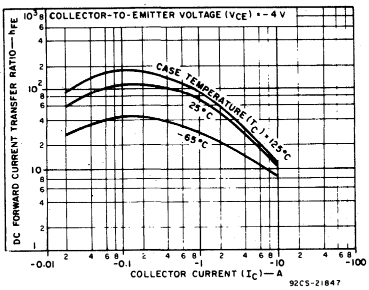


Fig. 10 — Typical dc beta characteristics for 2N6248.

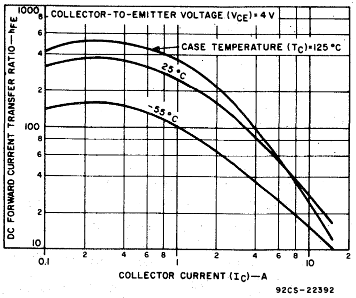


Fig. 11 — Typical dc beta characteristics for 2N6470, 2N6471, and 2N6472.

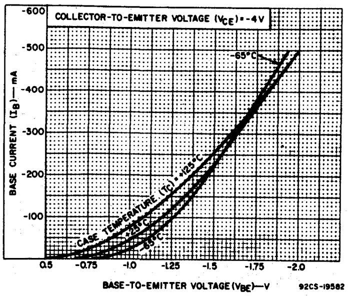


Fig. 12 — Typical input characteristics for 2N6246, 2N6247, and 2N6449.

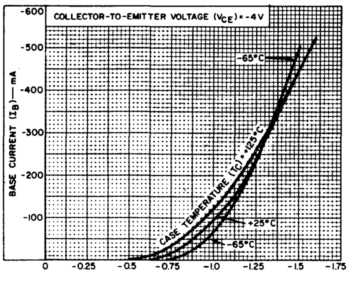


Fig. 13 — Typical input characteristics for 2N6248.

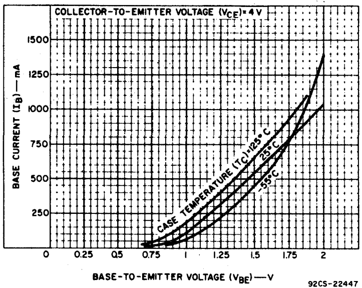


Fig. 14 — Typical input characteristics for 2N6470, 2N6471, and 2N6472.

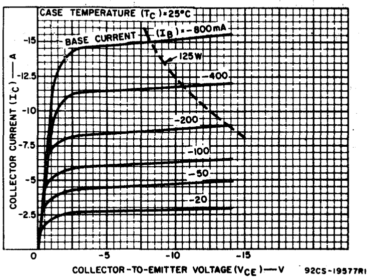


Fig. 15 — Typical output characteristics for 2N6246, 2N6247, and 2N6469.

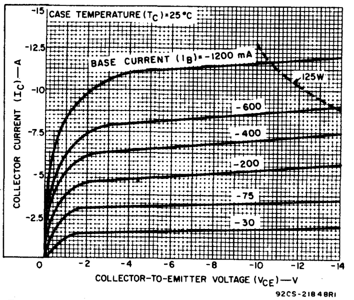


Fig. 16 — Typical output characteristics for 2N6248.

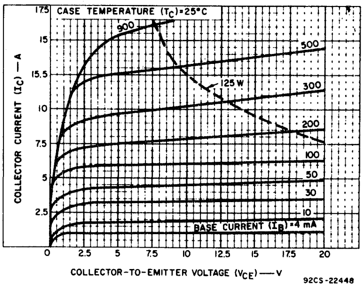


Fig. 17 — Typical output characteristics for 2N6470, 2N6471, and 2N6472.

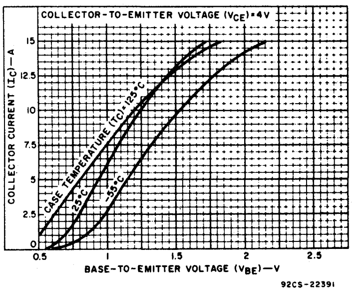


Fig. 18 - Typical transfer characteristics for 2N6470, 2N6471, and 2N6472.

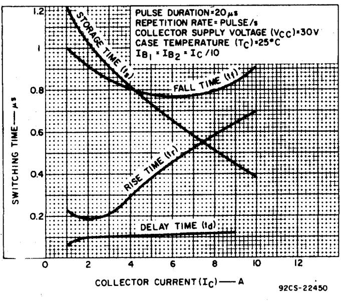


Fig. 19 - Typical saturated switching characteristics for 2N6470, 2N6471, and 2N6472.

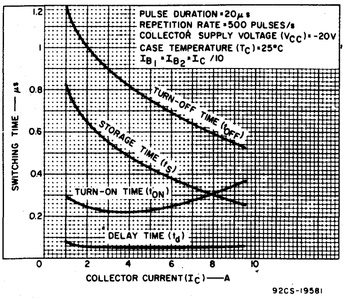


Fig. 20 - Typical saturated switching characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

2N6249, 2N6250, 2N6251

450-V, 30-A, 175-W Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

RCA-2N6269, 2N6250 and 2N6251 are multiple epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. Multiple-epitaxial construction maximizes the volt-ampere characteristic of the device and provides fast switching speeds. Multiple-emitter-site design assures uniform current flow throughout the structure, which produces a high $I_{S/b}$ and a large safe-operation area.

These devices use the popular JEDEC TO-3/TO-204MA package; they differ mainly in voltage ratings, leakage-current limits, and V_{CE}(sat) ratings.

The exceptional second-breakdown capabilities and high voltage-breakdown ratings make these transistors especially suitable for off-line inverters, switching regulators motor controls, and deflection circuit applications.

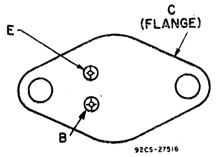
The high gain and high $E_{S/b}$ energy-handling capability of the 2N6249 make it an excellent choice for motor-control applications in which large winding inductances are encountered and high surge currents are required to start the motor.

The high breakdown voltages, low saturation voltages, and fast-switching capability of the 2N6250 and 2N6251 make them especially suitable for inverter circuits operating directly off the rectified 115-V power line or a bridge configuration operating from the rectified 220-V line.

Features:

- **High voltage ratings:**
  V_{CBO} = 450 V (2N6251)
  375 V (2N6250)
  300 V (2N6249)
- **High dissipation rating:**
  P_T = 175 W
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**

TERMINAL DESIGNATIONS



JEDEC TO3/TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*	**2N6249**	**2N6250**	**2N6251**	
* V_{CBO}	300	375	450	V
V_{CEO}(sus)	200	275	350	V
* V_{CEX}(sus) (V_{BE} = 0 V)	225	300	375	V
V_{CER}(sus) (R_{BE}) $\leqslant 50\ \Omega$	225	300	375	V
* V_{EBO}	6	6	6	V
* I_C	10	10	10	A
I_{CM}	30	30	30	A
* I_B	10	10	10	A
* P_T				
At T_C up to 25°C and V_{CE} up to 30 V	175	175	175	W
At T_C up to 25°C and V_{CE} above 30 V	Derate linearly at 1			°C/W
* $T_J + T_{stg}$	–65 to +200			°C
* T_L				
At distances $\geqslant$ 1/32 in. (0.8 mm) from case for 10 s max.	230			°C

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* 2N-Series types in accordance with JEDEC registration data format (JS-6, RDF-1).

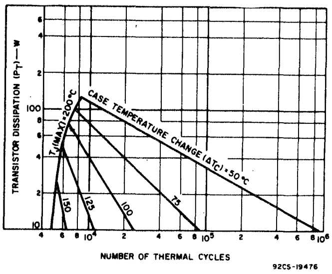

Fig. 1 — Thermal-cycle rating chart for all types.

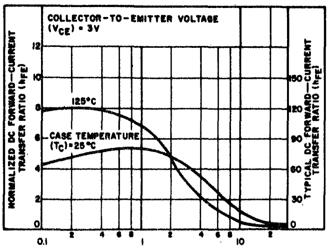

Fig. 2 — Typical normalized dc beta characteristics for all types.

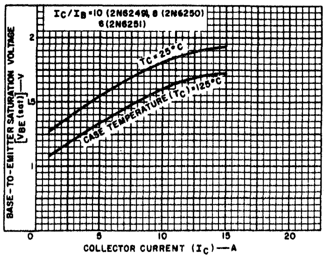

Fig. 3 — Typical base-to-emitter saturation voltage characteristics for all types.

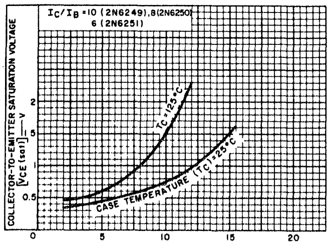

Fig. 4 — Typical collector-to-emitter saturation voltage characteristics for all types.

2N6249, 2N6250, 2N6251

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS			LIMITS									UNITS
	DC VOLTAGE (V)	DC CURRENT (A)		2N6249			2N6250			2N6251			
	V_{CE}	I_C	I_B	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
I_{CEO}	150		0	–	–	5	–	–	–	–	–	–	mA
	225		0	–	–	–	–	–	5	–	–	–	
	300		0	–	–	–	–	–	–	–	–	5	
* I_{CEV} $V_{BE} = -1.5$	225			–	–	5	–	–	–	–	–	–	
	300			–	–	–	–	–	5	–	–	–	
	375			–	–	–	–	–	–	–	–	5	
* I_{CEV} $V_{BE} = -1.5$ $T_C = 125°C$	225			–	–	10	–	–	–	–	–	–	
	300			–	–	–	–	–	10	–	–	–	
	375			–	–	–	–	–	–	–	–	10	
* I_{EBO} $V_{BE} = -6$				–	–	1	–	–	1	–	–	1	mA
* $V_{CEO}(sus)$		0.2		200[b]	–	–	275[b]	–	–	350[b]	–	–	V
$V_{CER}(sus)$ $R_{BE} = 50\ \Omega$		0.2		225[b]	–	–	300[b]	–	–	375[b]	–	–	V
* V_{EBO} $I_E = 1$ mA				6	–	–	6	–	–	6	–	–	V
* h_{FE}	3	10[a]		10	–	50	–	–	–	–	–	–	
	3	10[a]		–	–	–	8	–	50	–	–	–	
	3	10[a]		–	–	–	–	–	–	6	–	50	
* $V_{BE}(sat)$		10[a]	1	–	–	2.25	–	–	–	–	–	–	V
		10[a]	1.25	–	–	–	–	–	2.25	–	–	–	
		10[a]	1.67	–	–	–	–	–	–	–	–	2.25	
* $V_{CE}(sat)$		10[a]	1	–	–	1.5	–	–	–	–	–	–	V
		10[a]	1.25	–	–	–	–	–	1.5	–	–	–	
		10[a]	1.67	–	–	–	–	–	–	–	–	1.5	
* $\lvert h_{fe} \rvert$ f = 1 MHz	10	1		2.5	8	–	2.5	8	–	2.5	8	–	
* $I_{S/b}$ t_p = 1s nonrep.	30			5.8	–	–	5.8	–	–	5.8	–	–	A
* $E_{S/b}$ $V_{BE} = -4$ $R_B = 50\ \Omega$, $L = 50\ \mu H$		10[c]		2.5	–	–	2.5	–	–	2.5	–	–	mJ
* t_r $V_{CC} = 200$ V, $I_{B1} = -I_{B2}$		10	1	–	0.8	2	–	–	–	–	–	–	μs
		10	1.25	–	–	–	–	0.8	2	–	–	–	
		10	1.67	–	–	–	–	–	–	–	0.8	2	
* t_s $V_{CC} = 200$ V, $I_{B1} = -I_{B2}$		10	1	–	1.8	3.5	–	–	–	–	–	–	
		10	1.25	–	–	–	–	1.8	3.5	–	–	–	
		10	1.67	–	–	–	–	–	–	–	1.8	3.5	
* t_f $V_{CC} = 200$ V, $I_{B1} = -I_{B2}$		10	1	–	0.5	1	–	–	–	–	–	–	
		10	1.25	–	–	–	–	0.5	1	–	–	–	
		10	1.67	–	–	–	–	–	–	–	0.5	1	
$R_{\theta JC}$	10	5		–	–	1	–	–	1	–	–	1	°C/W

* 2N-Series types in accordance with JEDEC registration data format (JS-6 RDF-1).

[a] Pulsed; pulse duration ≤300 μs, duty factor = 2%.

[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

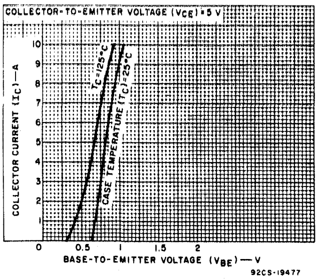

Fig. 5 — Typical transfer characteristics for all types.

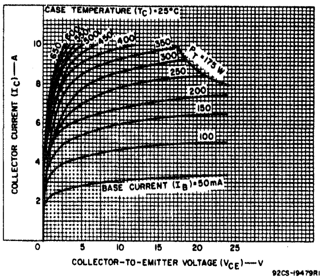

Fig. 6 — Typical output characteristics for all types.

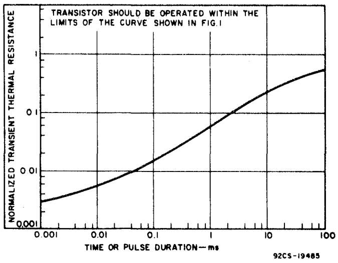

Fig. 7 — Typical thermal response characteristics for all types.

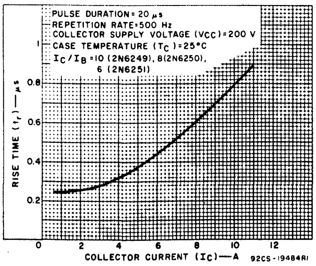

Fig. 8 — Typical rise-time characteristics for all types.

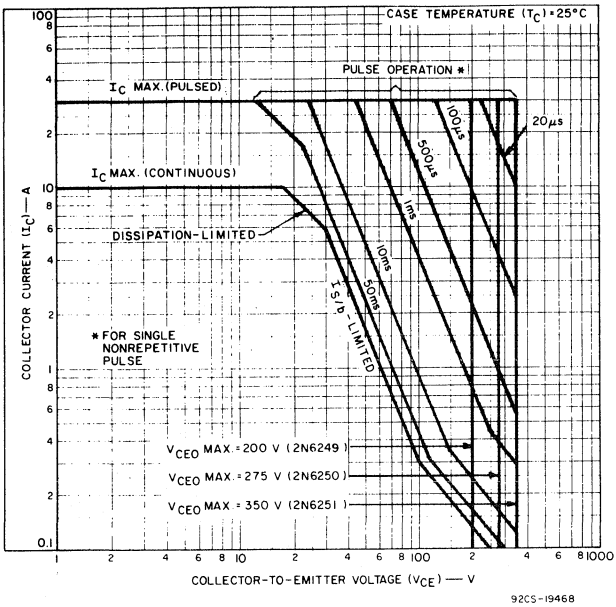

Fig. 9 — Maximum operating areas for all types at $T_C = 25^\circ C$.

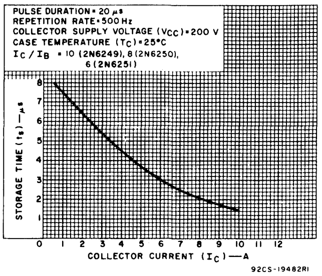

Fig. 11 — Typical storage-time characteristics for all types (with constant forced gain).

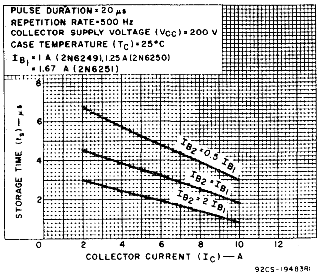

Fig. 12 — Typical storage-time characteristics for all types (with constant base drive).

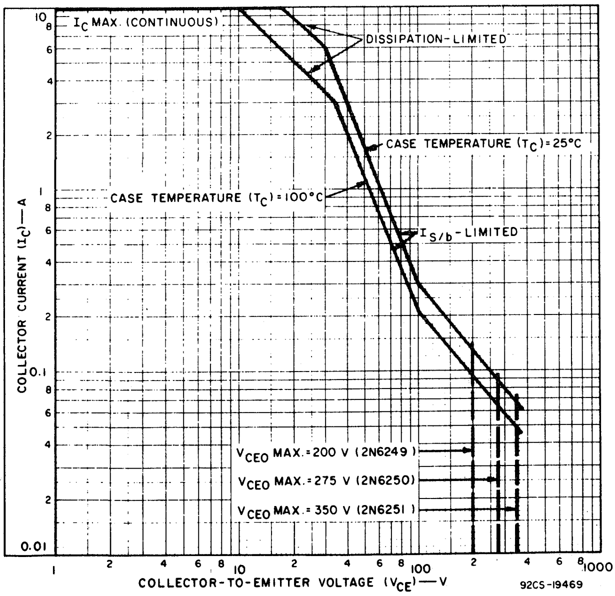

Fig. 10 — Maximum operating areas for all types at $T_C = 100^\circ C$.

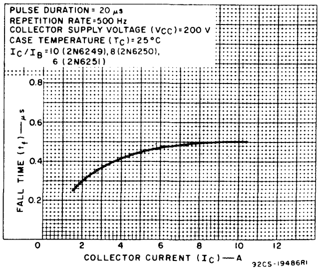

Fig. 13 — Typical fall-time characteristic for all types.

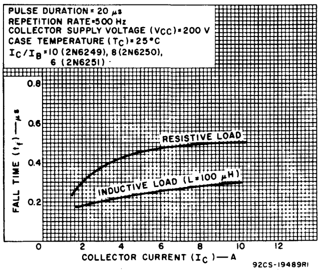

Fig. 14 — Typical inductive- and resistive-load fall-time characteristics for all types.

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287

20-Ampere Complementary N-P-N and P-N-P Monolithic Darlington Power Transistors

60-80-100 Volts, 160 Watts
Gain of 2400 (Typ.) at 10 A (2N6282, 2N6283, 2N6284)
Gain of 3500 (Typ.) at 10 A (2N6285, 2N6286, 2N6287)

The RCA-2N6282, 2N6283, and 2N6284 and the 2N6285, 2N6286, and 2N6287 are complementary n-p-n and p-n-p monolithic silicon Darlington transistors designed for general-purpose amplifier and low-speed switching applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. These devices are supplied in the JEDEC TO-3 hermetic steel package.

Features:

- **Operates from IC without predriver**
- **High reverse second-breakdown capability**
- **Monolithic construction**
- **High voltage ratings:**
  $V_{CEO}(sus)$ = 60 V Min. – 2N6282, 2N6285•
  = 80 V Min. – 2N6283, 2N6286•
  = 100 V Min. – 2N6284, 2N6287•

Applications:

- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6282 2N6285•	2N6283 2N6286•	2N6284 2N6287•	
*	V_{CBO}	60	80	100	V
*	$V_{CEO}(sus)$	60	80	100	V
*	V_{EBO}	5	5	5	V
*	I_C	20	20	20	A
*	I_{CM}	40	40	40	A
*	I_B	0.5	0.5	0.5	A
*	P_T				
	$T_C \leqslant 25^\circ C$	160	160	160	W
	$T_C > 25^\circ C$ . . . Derate linearly		0.915		W/°C
*	Tstg, TJ		−65 to 200		°C
*	T_L				
	At distances ⩾1/16 in. (1.58 mm) from case for 10 s max.		235		°C

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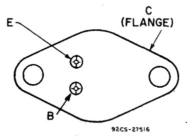
* In accordance with JEDEC registration data.
• For p-n-p devices, voltage and current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A")

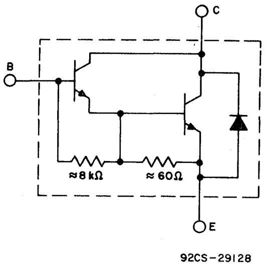


Fig. 1 – Schematic diagram for 2N6282, 2N6283, and 2N6284.

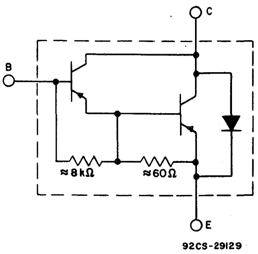


Fig. 2 – Schematic diagram for 2N6285, 2N6286, and 2N6287.

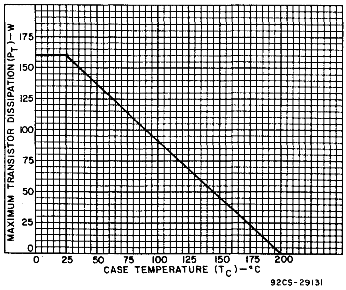


Fig. 3 – Power derating curve for all types.

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6282 2N6285•		2N6283 2N6286•		2N6284 2N6287•		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	30			0	–	1	–	–	–	–	mA
	40			0	–	–	–	1	–	–	
	50			0	–	–	–	–	–	1	
* I_{CEX}	60	−1.5			–	0.5	–	–	–	–	
	80	−1.5			–	–	–	0.5	–	–	
	100	−1.5			–	–	–	–	–	0.5	
T_C = 150°C	60	−1.5			–	5	–	–	–	–	
	80	−1.5			–	–	–	5	–	–	
	100	−1.5			–	–	–	–	–	5	
* I_{EBO}		−5	0		–	2	–	2	–	2	mA
* V_{CEO}(sus)			0.1^a	0	60	–	80	–	100	–	V
* h_{FE}	3		20^a		100	–	100	–	100	–	
	3		10^a		750	18,000	750	18,000	750	18,000	
* V_{CE}(sat)			20^a	0.2	–	3	–	3	–	3	V
			10^a	0.04	–	2	–	2	–	2	
* V_{BE}	3		10^a		–	2.8	–	2.8	–	2.8	V
* V_{BE}(sat)			20^a	0.2	–	4	–	4	–	4	V
* h_{fe} f = 1 kHz	3		10		300	–	300	–	300	–	
* $\|h_{fe}\|$ f = 1 MHz	3		10		4	–	4	–	4	–	
* C_{ob} V_{CB} = 10 V, I_E 0, f = 0.1 MHz											
2N6282-84					–	400	–	400	–	400	pF
2N6285-87					–	600	–	600	–	600	
$I_{S/b}$ t = 1 s, nonrep.	30				5.3	–	5.3	–	5.3	–	A
$R_{\theta JC}$						1.09	–	1.09	–	1.09	°C/W

^{a} Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

* In accordance with JEDEC registration data.

• For p-n-p devices, voltage and current values are negative.

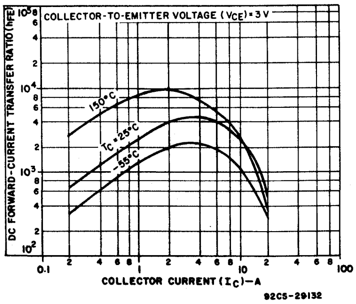


Fig. 4 – Typical dc beta characteristics for 2N6282, 2N6283, and 2N6284.

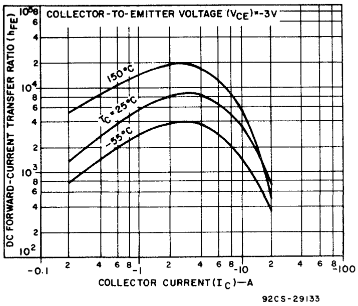
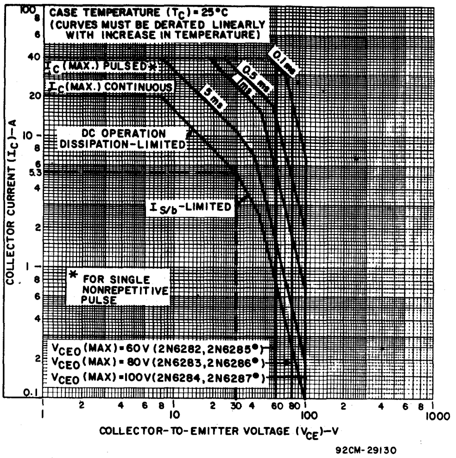


Fig. 5 – Typical dc beta characteristics for 2N6285, 2N6286, and 2N6287.

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287



• FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

Fig. 6 — Maximum operating areas for all types.

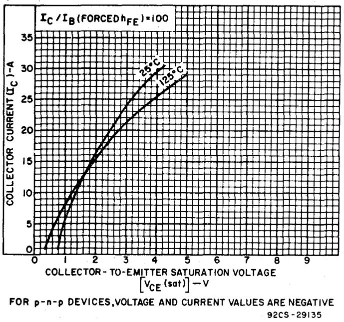


Fig. 7 — Typical saturation characteristics for all types.

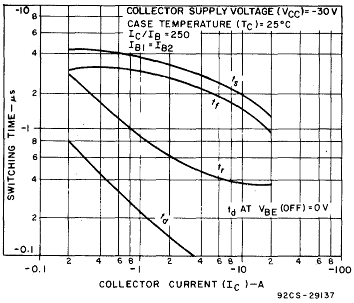


Fig. 8 — Typical switching times for 2N6285, 2N6286, and 2N6287.

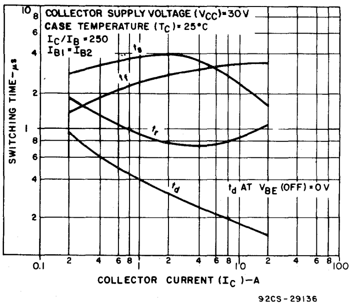


Fig. 9 — Typical switching times for 2N6282, 2N6283, and 2N6284.

2N6306-2N6308, RCS579

High-Voltage, High-Current Silicon N-P-N Power-Switching Transistors

For Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6306, 2N6307, 2N6308, and RCS579 are epitaxial silicon n-p-n power transistors with pi-nu construction. They are hermetically sealed in a steel JEDEC TO-3 package, and differ mainly in voltage ratings, saturation voltage, and beta characteristics. The exceptional second-breakdown and high voltage ratings, together with the high gain, low saturation voltage and fast-switching capability of this series of devices, make them particularly suitable for inverter circuits operating directly off the rectified 120-volt power line or in a bridge configuration operating from the rectified 240-volt line.

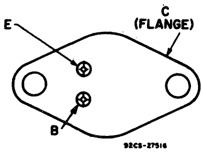
Features:

- **Fast Switching Speed**
- **High Voltage Ratings: V_{CER} = 350 V to 450 V**
- **High Gain at I_C = 3 A**
- **Thermal-Cycling Rating Chart**

Applications:

- **Off-Line Power Supplies**
- **High-Voltage Inverters**
- **Switching Regulators**
- **Motor Controls**

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCS579	2N6306	2N6307	2N6308	
* V_{CBO}	500	500	600	700	V
$V_{CER(sus)}$					
R_{BE} = 50 Ω	400	350	400	450	V
* $V_{CEO(sus)}$	250	250	300	350	V
* V_{EBO}	6	8	8	8	V
* I_C	8	8	8	8	A
* I_{CM}	16	16	16	16	A
* I_B	4	4	4	4	A
* P_T					
T_C up to 25°C	125	125	125	125	W
T_C above 25°C	Derate linearly to 200°C				
* T_{stg}, T_J	–65 to +200				°C
* T_L					
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235				°C

*2N-Series types in accordance with JEDEC registration data format (JS-6 RDF-1)

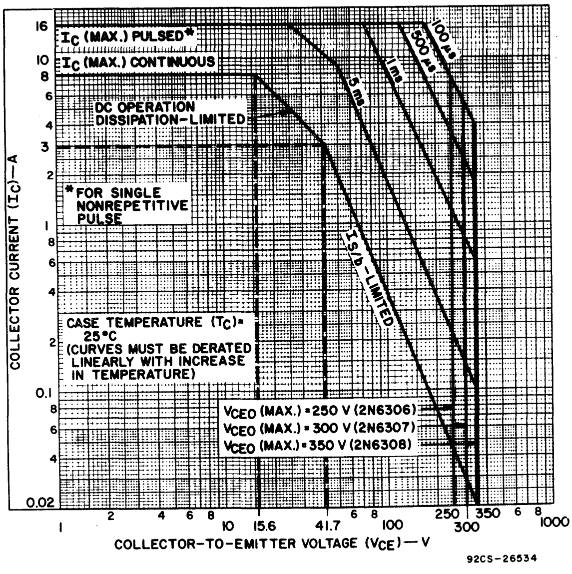


Fig. 1 - Maximum operating areas for 2N6306–2N6308.

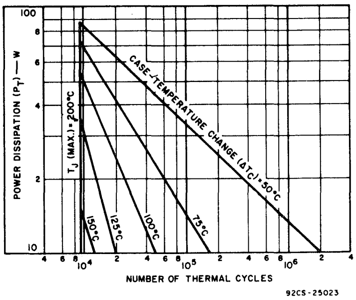


Fig. 2 - Thermal-cycling rating chart for all types.

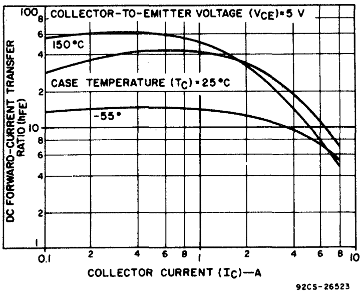


Fig. 3 - Typical dc beta characteristics for all types.

2N6306-2N6308, RCS579

ELECTRICAL CHARACTERISTICS, *T_C - 25°C Unless Otherwise Specified.*

CHARACTERISITC	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		2N6306		2N6307		2N6308		RCS579		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	250			0	–	0.5	–	–	–	–	–	0.5	mA
	300			0	–	–	–	0.5	–	–	–	–	
	350			0	–	–	–	–	–	0.5	–	–	
* I_{CEV}	500	−1.5			–	0.5	–	–	–	–	–	0.5	
	600	−1.5			–	–	–	0.5	–	–	–	–	
	700	−1.5			–	–	–	–	–	0.5	–	–	
* T_C = 150°C	450	−1.5			–	2.5	–	–	–	–	–	2.5	
	550	−1.5			–	–	–	2.5	–	–	–	–	
	650	−1.5			–	–	–	–	–	2.5	–	–	
* I_{EBO}		−6	0		–	–	–	–	–	–	–	2	mA
		−8	0		–	1	–	1	–	1	–	–	
* V_{CEO}(sus)			0.1[a]	0	250	–	300	–	350	–	250	–	V
V_{CER}(sus) R_{BR} = 50 Ω			0.1[b]		350	–	400	–	450	–	400	–	V
V_{EBO} I_E = 1 mA			0		–	–	–	–	–	–	6	–	V
* h_{FE}	5		3[a]		15	75	15	75	12	60	12	–	
	5		8[a]		4	–	4	–	3	–	3	–	
* V_{BE}	5		3[a]		–	1.3	–	1.3	–	1.5	–	1.5	V
* V_{BE}(sat)			8[a]	2	–	2.3	–	2.3	–	–	–	–	V
			8[a]	2.67	–	–	–	–	–	2.5	–	2.5	
* V_{CE}(sat)			3[a]	0.6	–	0.8	–	1	–	1.5	–	1.5	V
			8[a]	2	–	5	–	5	–	–	–	–	
			8[a]	2.67	–	–	–	–	–	5	–	5	
* $\|h_{fe}\|$ * f = 1 MHz	10		0.3		5	–	5	–	5	–	5	–	
* $E_{S/b}$ L = 40 mH R_{BB} = 3kΩ		−1.5	3		180	–	180	–	180	–	180	–	mJ
$I_{S/b}$ t_p = 1 s, nonrep.	40				3.15	–	3.15	–	3.15	–	3.15	–	A
* C_{obo} V_{CB} = 10 V, f = 0.1 MHz					–	250	–	250	–	250	–	250	pF
* t_r V_{CC} = 125 V			3	0.6	–	0.6	–	0.6	–	0.6	–	0.6	µs
* t_s V_{CC} = 125 V t_p = 25 µs			3	+0.6 −1.5	–	1.6	–	1.6	–	1.6	–	2	
t_p = 5 µs			3	+0.6 −1.5	–	0.8	–	0.8	–	0.8	–	–	
* t_f V_{CC} = 125 V			3	+0.6 −1.5	–	0.4	–	0.4	–	0.4	–	0.4	
$R_{\theta JC}$					–	1.4	–	1.4	–	1.4	–	1.4	°C/W

* 2N-Series types in accordance with JEDEC registration data fomat (JS-6, RDF-1).

[a] Pulsed; pulse duration = 300 µs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltage V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer. V_{CEO}(sus) should be measured by the pulse method (Note "a").

2N6306-2N6308, RCS579

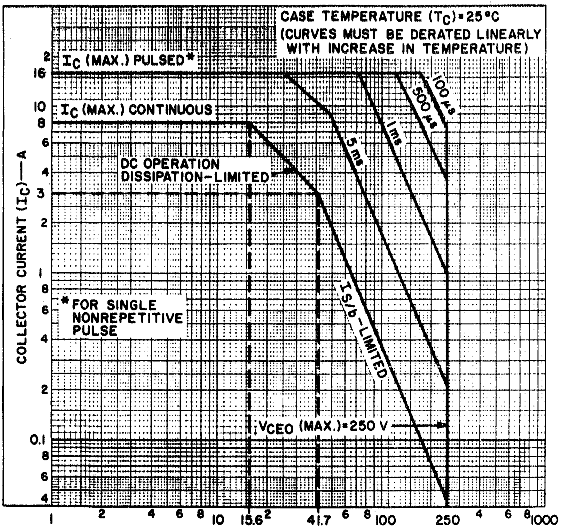


Fig. 4 - Maximum operating areas for RCS579.

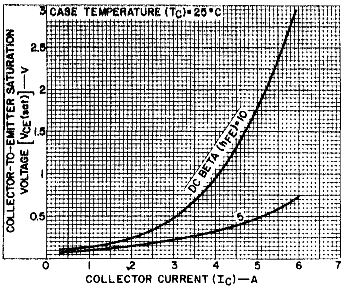


Fig. 5 - Typical collector-to-emitter saturation-voltage characteristics for all types.

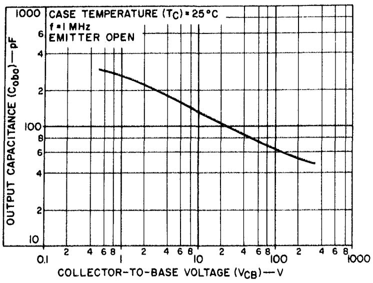


Fig. 6 - Typical output capacitance for all types.

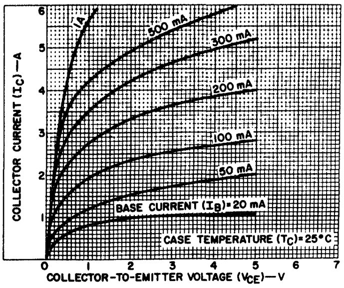


Fig. 7 - Typical output characteristics for all types.

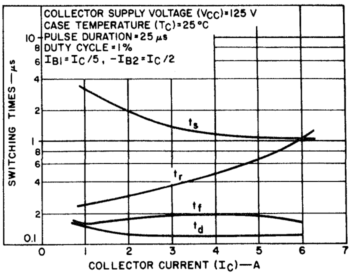


Fig. 8 - Typical saturated-switching-time characteristics for all types.

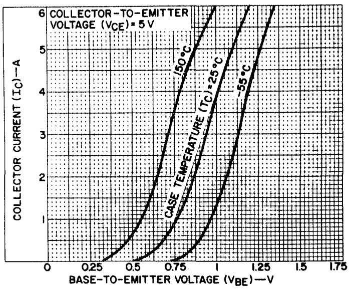


Fig. 9 - Typical transfer characteristics for all types.

2N6326, 2N6327

High-Current, High-Power, High-Speed N-P-N Power Transistors

The RCA-2N6326 and 2N6327 are epitaxial-base silicon n-p-n transistors intended for a wide variety of high-power, high-current applications, such as power-switching circuits, driver and output stages for series and shunt regulators, dc-to-dc converters, inverters, and solenoid (hammer)/relay drivers.

These devices differ in maximum voltage ratings. They are supplied in JEDEC TO-204MA hermetic steel packages.

Features:

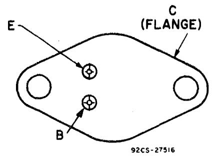
- **Specification for h_{FE} and V_{CE}(sat) up to 30 A**
- **Current gain bandwidth product f_T = 3 MHz (min.) at 1 A**
- **Low saturation voltage with high beta**
- **High dissipation capability**
- **200 mJ $E_{S/b}$ characteristic**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6326	2N6327	
* V_{CBO}	60	80	V
* V_{CEO}(sus)	60	80	V
* V_{EBO}	5		V
* I_C	30		A
* I_{CM}	40		A
* I_B	10		A
I_{BM}	15		A
* P_T			
At $T_C \leqslant 25^oC$	200		W
At $T_C > 25^oC$ . . . . Derate linearly	1.15		W/°C
	See Figs. 1 and 2		
* T_{stg}, T_J	−65 to 200		°C
T_L			
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		°C

* In accordance with JEDEC registration data format JS-6 RDF-2.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

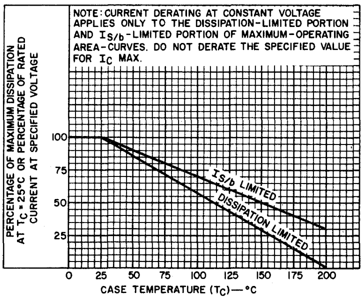


Fig. 2 — Derating curves for 2N6326 and 2N6327.

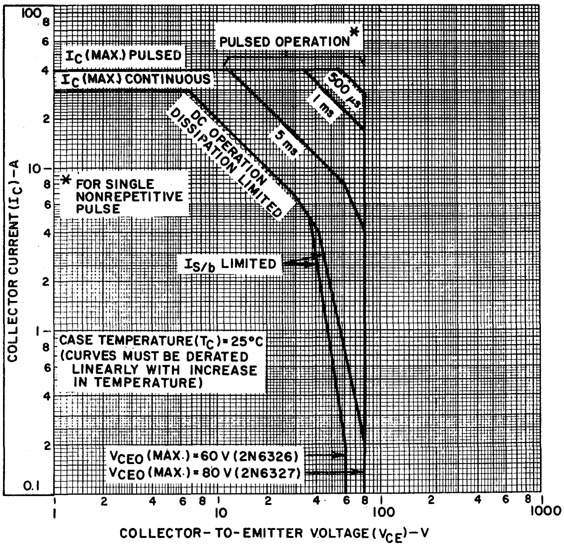


Fig. 1 — Maximum operating areas for 2N6326 and 2N6327.

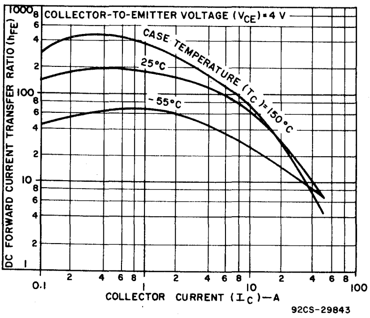


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N6326 and 2N6327.

2N6326, 2N6327

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6326		2N6327		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
* I_{CES}	60				–	0.5	–	–	mA
	80				–	–	–	0.5	
* I_{CES} T_C = 150°C	30				–	5	–	–	
	40				–	–	–	5	
* I_{CEO}	30				–	1	–	–	
	40				–	–	–	1	
* I_{EBO}		–5			–	0.5	–	0.5	
* h_{FE}	4		5^a		25	–	25	–	
	4		15^a		12	–	12	–	
	4		30^a		6	30	6	30	
* V_{CEO}(sus)			0.03		60	–	80	–	V
* V_{BE}	4		15^a		–	2	–	2	
	4		30^a		–	4	–	4	
* V_{CE}(sat)			15^a	2	–	1.5	–	1.5	
			30^a	7.5	–	3	–	3	
$I_{S/b}$ t_p = 1 s nonrep.	20				10	–	10	–	A
$E_{S/b}$ L = 125 µH, R_{BE} = 51 Ω		–1.5	10		6.25	–	6.25	–	mJ
L = 20 mH, R_{BE} = 100 Ω		0	4.47		200	–	200	–	
* $\|h_{fe}\|$ f = 1 MHz	10		1		3	–	3	–	
* h_{fe} f = 1 kHz	10		1		30	–	30	–	
t_{on} t_{off}	V_{CC} = 30		15 15	2 2^b	0.45 (Typ.) 0.9 (Typ.)		0.45 (Typ.) 0.9 (Typ.)		µs
$R_{\theta JC}$	20		5		–	0.875	–	0.875	°C/W

*In accordance with JEDEC registration data format JS-6 RDF-2.

[a] Pulsed; pulse duration = 300 µs, duty factor = 1.8%.

[b] $I_{B_1} = -I_{B_2}$.

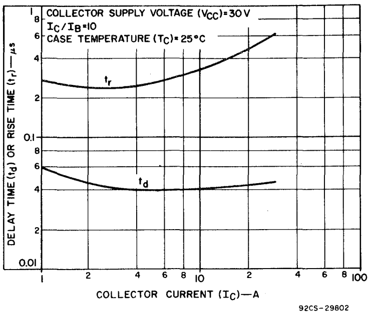


Fig. 4 — Typical delay-time and rise-time characteristics as a function of collector current for 2N6326 and 2N6327.

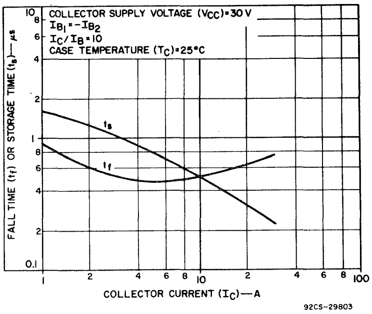


Fig. 5 — Typical storage-time and fall-time characteristics as a function of collector current for 2N6326 and 2N6327.

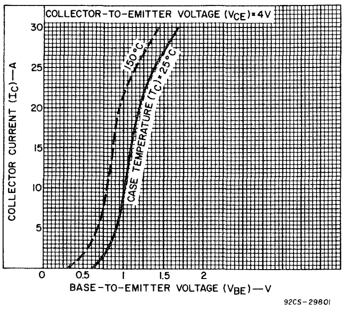


Fig. 6 — Typical transfer characteristics for 2N6326 and 2N6327.

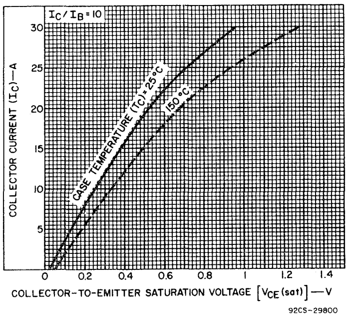


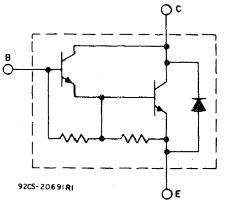
Fig. 7 — Typical saturation voltage characteristics for for 2N6326 and 2N6327.

2N6383-2N6385, 2N6055, 2N6056, RCA1000, RCA1001

8- and 10-Ampere N-P-N Darlington Power Transistors

For Use as Output Devices in Switching and Amplifier Applications
40-60-80 Volts, 90-100 Watts

The RCA devices are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The double epitaxial construction of these devices provides good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.



Schematic diagram for all types.

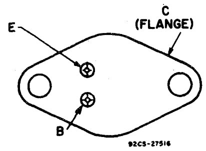
Features:

- **Operation from IC without predriver**
- **Low leakage at high temperature**
- **High reverse-second-breakdown capability**

Applications:

- **Power switching**
- **Audio amplifiers**
- **Series and shunt regulators**
- **Hammer drivers**

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6385	2N6384	2N6383	2N6055	2N6056	RCA1000	RCA1001	
$^*V_{CBO}$	80	60	40	60	80	60	80	V
$V_{CER}(sus)$								
$R_{BE} = 100\ \Omega$	80	60	40	60	80	–	–	V
$^*V_{CEO}(sus)$	80	60	40	60	80	60	80	V
$V_{CEV}(sus)$								
$V_{BE} = -1.5$ V	–	–	–	60	80	–	–	V
$^*V_{CEX}$								
$V_{BE} = -1.5$ V, $R_{BB} = 100\ \Omega$	80	60	40	–	–	–	–	V
$^*V_{EBO}$	5	5	5	5	5	5	5	V
$^*I_C$	10	10	10	8	8	8	8	A
I_{CM}	15	15	15	16	16	15	15	A
$^*I_B$	0.25	0.25	0.25	0.12	0.12	0.1	0.1	A
$^*P_T$								
$T_C \leqslant 25°C$	100	100	100	100	100	90	90	W
$T_C > 25°C$	Derate linearly to 200°C							
$^*T_{stg}, T_J$	–65 to +200							°C
$^*T_L$								
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235							°C

*2N-Series types in accordance with JEDEC registration data format JS-6 RDF-2.

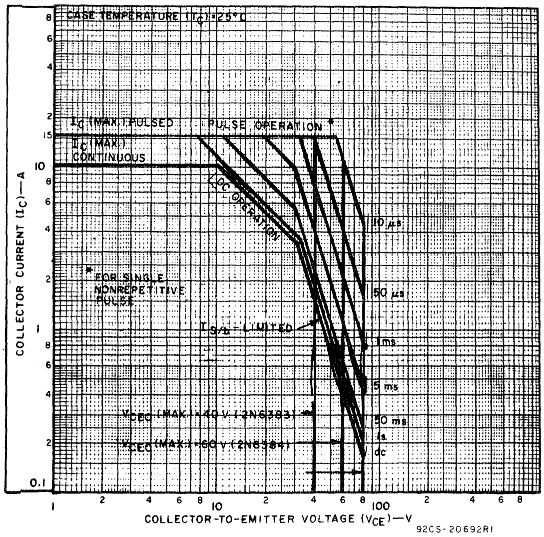


Fig. 1 – Maximum operating area for 2N6383–2N6385.

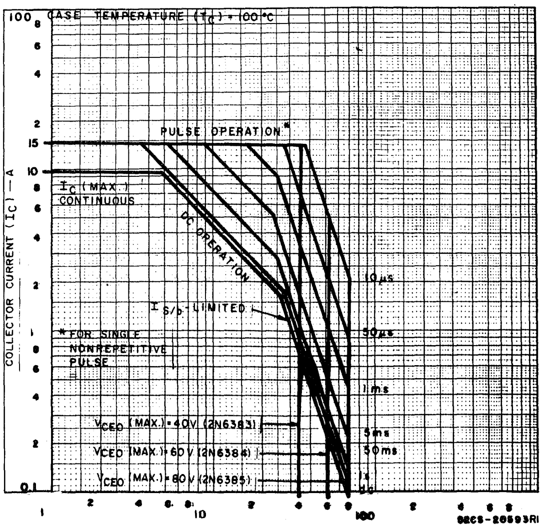


Fig. 2 – Maximum operating area for 2N6383 – 2N6385 at T_C = 100°C.

2N6383-2N6385, 2N6055, 2N6056, RCA1000, RCA1001

ELECTRICAL CHARACTERISTICS, *At Case Temperature, T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS					LIMITS						UNITS
	VOLTAGE V dc			CURRENT A dc		2N6385		2N6384		2N6383		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	80				0	–	1	–	–	–	–	
	60				0	–	–	–	1	–	–	
	40				0	–	–	–	–	–	1	
* I_{CEV}	80		−1.5			–	0.3	–	–	–	–	mA
	60		−1.5			–	–	–	0.3	–	–	
	40		−1.5			–	–	–	–	–	0.3	
T_C = 150°C	80		−1.5			–	3	–	–	–	–	
	60		−1.5			–	–	–	3	–	–	
	40		−1.5			–	–	–	–	–	3	
* I_{EBO}		5		0		–	5	–	5	–	5	mA
* $V_{CEO}(sus)$				0.2[a]	0	80	–	60	–	40	–	
* $V_{CER}(sus)$ R_{BE} = 100 Ω				0.2[a]		80	–	60	–	40	–	V
$V_{CEV}(sus)$			−1.5	0.2[a]		80	–	60	–	40	–	
* h_{FE}	3			5[a]		1000	20,000	1000	20,000	1000	20,000	
	3			10[a]		100	–	100	–	100	–	
* V_{BE}	3			5[a]		–	2.8	–	2.8	–	2.8	V
	3			10[a]		–	4.5	–	4.5	–	4.5	
* $V_{CE}(sat)$				5[a]	0.01[a]	–	2	–	2	–	2	V
				10[a]	0.1[a]	–	3	–	3	–	3	
V_F				−10		–	4	–	4	–	4	
* h_{fe} f = 1 kHz	5			1		1000	–	1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	5			1		20	–	20	–	20	–	
* C_{obo} f = 1 MHz	V_{CB} = 10				I_E=0	–	200	–	200	–	200	pF
$I_{S/b}$ t = 1 s, non rep.	75					0.22	–	–	–	–	–	
	55					–	–	0.55	–	–	–	A
	30					3.33	–	3.33	–	3.33	–	
$R_{\theta JC}$						–	1.75	–	1.75	–	1.75	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

* 2N-Series types in accordance with JEDEC registration data format JS-6 RDF-2.

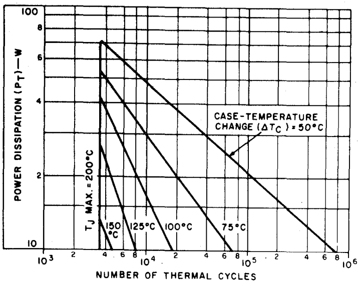


Fig. 3 - Thermal-cycling rating chart for 2N6055–2N6056, 2N6383–2N6385.

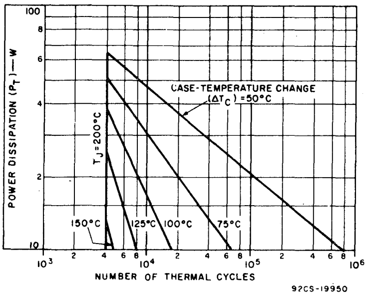


Fig. 4 - Thermal-cycling rating chart for RCA1000, RCA1001.

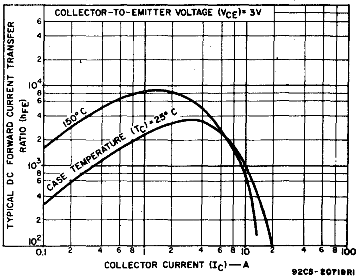


Fig. 5 - Typical dc beta characteristics for all types.

2N6383-2N6385, 2N6055, 2N6056, RCA1000, RCA1001

ELECTRICAL CHARACTERISTICS, *At Case Temperature, T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS DC VOLTAGE V			TEST CONDITIONS DC CURRENT A			LIMITS 2N6055		LIMITS 2N6056		LIMITS RCA1000		LIMITS RCA1001		UNITS
	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	30					0	–	0.5	–	–	–	0.5	–	–	mA
	40					0	–	–	–	0.5	–	–	–	0.5	
I_{CER}	60						–	–	–	–	–	1	–	–	mA
R_{BE} = 1 kΩ	80						–	–	–	–	–	–	–	1	
I_{CER}	60						–	–	–	–	–	5	–	–	
R_{BE} = 1 kΩ	80						–	–	–	–	–	–	–	5	
T_C = 150°C															
I_{CEX}	60		−1.5				–	0.5	–	–	–	–	–	–	mA
	80		−1.5				–	–	–	0.5	–	–	–	–	
I_{CEX}	60		−1.5				–	5	–	–	–	–	–	–	
T_C = 150°C	80		−1.5				–	–	–	5	–	–	–	–	
* I_{EBO}		5		0			–	2	–	2	–	2	–	2	mA
* h_{FE}	3			8^a			100	–	100	–	–	–	–	–	
	3			4^a			750	18,000	750	18,000	750	–	750	–	
	3			3^a			–	–	–	–	1000	–	1000	–	
$V_{(BR)CEO}$				0.1^a	0		–	–	–	–	60	–	80	–	V
$V_{CEO}(sus)$				0.1^a			60^a	–	80^a	–	–	–	–	–	V
$V_{CER}(sus)$ R_{BE} = 100 Ω				0.1^a			60^a	–	80^a	–	–	–	–	–	
$V_{CEX}(sus)$			−1.5	0.1^a			60^a	–	80^a	–	–	–	–	–	
* $V_{CE}(sat)$				3^a		0.012	–	–	–	–	–	2	–	2	V
				4^a		0.016	–	2	–	2	–	–	–	–	
				8^a		0.04	–	–	–	–	–	4	–	4	
				8^a		0.08	–	3	–	3	–	–	–	–	
* V_{BE}	3			3^a			–	–	–	–	–	2.5	–	2.5	V
	3			4^a			–	2.8	–	2.8	–	–	–	–	
$V_{BE}(sat)$				8^a		0.08	–	4	–	4	–	–	–	–	
* $\vert h_{fe}\vert$ f = 1 MHz	3			3			4	–	4	–	–	–	–	–	
* C_{obo} f = 0.1 MHz, V_{CB} = 10 V					0		–	200	–	200	–	–	–	–	pF
* h_{fe} f = 1 kHz	3			3			300	–	300	–	–	–	–	–	
$I_{S/b}$ t = 1 s, non rep.	33.3						3	–	3	–	–	–	–	–	A
	40						–	–	2	–	–	–	–	–	
$R\theta JC$							–	1.75	–	1.75	–	1.94	–	1.94	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2. ^{a} Pulsed: Pulse duration = 300 μs, duty factor = 2%

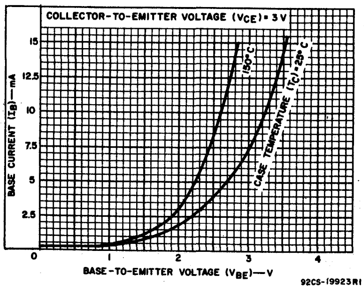


Fig. 6 - Typical input characteristics for 2N6383–2N6385, 2N6055, 2N6056.

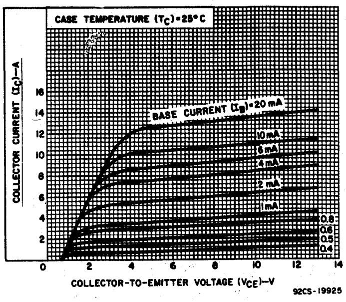


Fig. 7 - Typical output characteristics for 2N6383–2N6385, 2N6055, 2N6056.

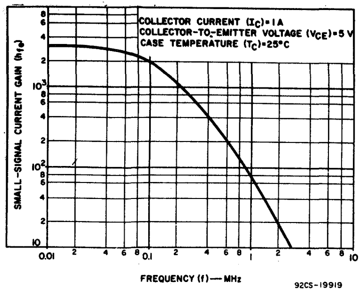


Fig. 8 - Typical small-signal gain for all types.

2N6383-2N6385, 2N6055, 2N6056, RCA1000, RCA1001

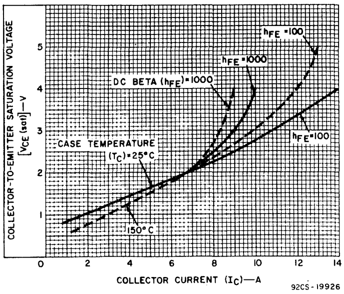


Fig. 9 - Typical saturation characteristics for 2N6055, 2N6056, RCA1000, RCA1001.

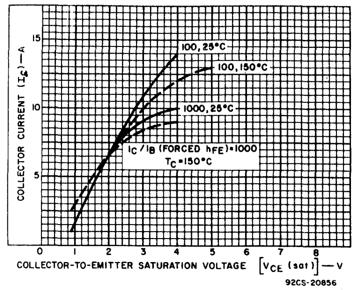


Fig. 10 - Typical saturation characteristics for 2N6383–2N6385.

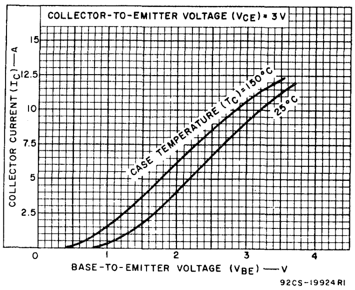


Fig. 11 - Typical transfer characteristics for 2N6383–2N6385, 2N6055, 2N6056.

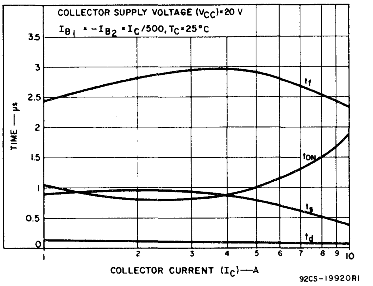


Fig. 12 - Typical saturated switching-time characteristics for 2N6383–2N6385, 2N6055, 2N6056.

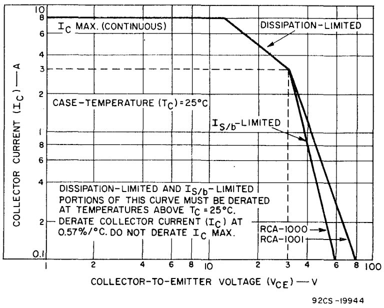


Fig. 13 - DC safe-area-of-operation for RCA1000 and RCA1001.

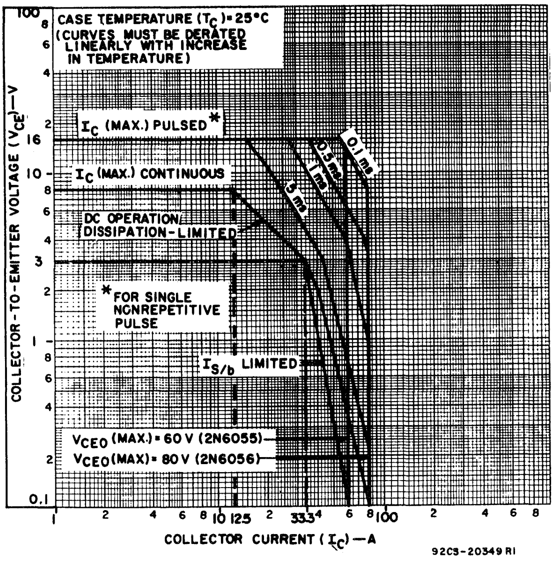


Fig. 14— Maximum operating areas for 2N6055 and 2N6056.

2N6386, 2N6387, 2N6388

8- and 10-Ampere N-P-N Darlington Power Transistors

60-80-100 Volts, 65 Watts

These RCA devices are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The double epitaxial construction of these transistors provides good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB VERSAWATT package.

The 2N6386 is complementary to the RCA8203 and the 2N6666, the 2N6387 is complementary to the RCA8203A and the 2N6667, and the 2N6388 is complementary to the RCA8203B and the 2N6668.

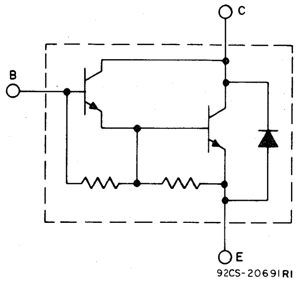


Fig. 1 - Schematic diagram for all types.

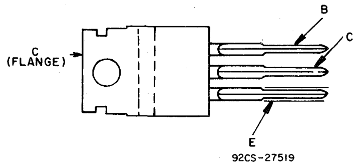
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

Applications:

- **Power switching**
- **Hammer drives**
- **Series and shunt regulators**
- **Audio amplifiers**

TERMINAL DESIGNATIONS



BOTTOM VIEW
JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6386	2N6387	2N6388	
* V_{CBO}	40	60	80	V
V_{CER}(sus)				
$R_{BE} = 100\ \Omega$	40	60	80	V
V_{CEO}(sus)	40	60	80	V
* V_{CEV}(sus)				
$V_{BE} = -1.5$ V	40	60	80	V
* V_{EBO}	5	5	5	V
* I_C	8	10	10	A
I_{CM}	15	15	15	A
* I_B	0.25	0.25	0.25	A
* P_T				
$T_C \leq 25°C$	65	65	65	W
$T_C > 25°C$	Derate linearly to 150°C			
* T_{stg}, T_J	−65 to +150			°C
* T_L At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235			°C

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* 2N- Series types in accordance with JEDEC registration data format JS-6 RDF-2.

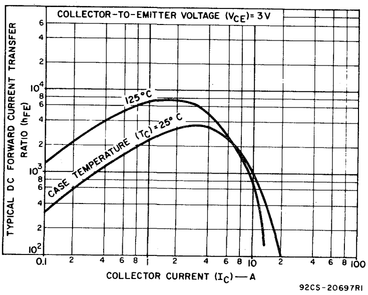

Fig. 2 — Typical dc beta characteristics for 2N6386, 2N6387, and 2N6388.

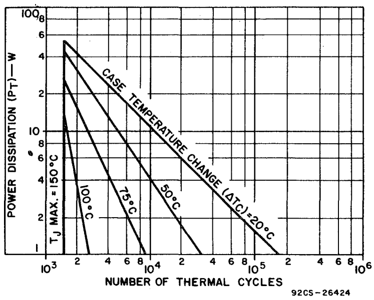

Fig. 3 — Thermal-cycling rating chart for 2N6386, 2N6387, and 2N6388.

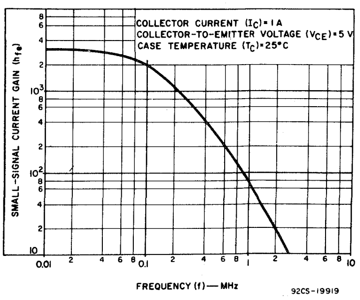

Fig. 4 — Typical small-signal gain for all types.

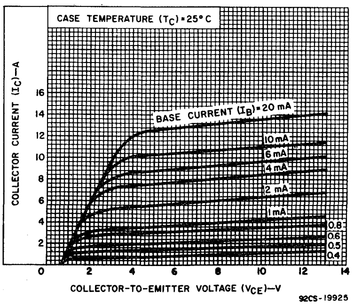

Fig. 5 — Typical output characteristics for 2N6386, 2N6387, and 2N6388.

2N6386, 2N6387, 2N6388

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6386		2N6387		2N6388		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	80			0	–	–	–	–	–	1	mA
	60			0	–	–	–	1	–	–	
	40			0	–	1	–	–	–	–	
* I_{CEV}	80	−1.5			–	–	–	–	–	0.3	
	60	−1.5			–	–	–	0.3	–	–	
	40	−1.5			–	0.3	–	–	–	–	
T_C = 125°C	80	−1.5			–	–	–	–	–	3	
	60	−1.5			–	–	–	3	–	–	
	40	−1.5			–	3	–	–	–	–	
* I_{EBO}		5	0		–	5	–	5	–	5	mA
* V_{CEO}(sus)			0.2[a]	0	40	–	60	–	80	–	V
V_{CER}(sus) R_{BE} = 100 Ω			0.2[a]		40	–	60	–	80	–	
V_{CEV}(sus)		−1.5	0.2[a]		40	–	60	–	80	–	
* h_{FE}	3		3[a]		1000	20,000	–	–	–	–	
	3		5[a]		–	–	1000	20,000	1000	20,000	
	3		8[a]		100	–	–	–	–	–	
	3		10[a]		–	–	100	–	100	–	
* V_{BE}	3		3[a]		–	2.8	–	–	–	–	V
	3		5[a]		–	–	–	2.8	–	2.8	
	3		8[a]		–	4.5	–	–	–	–	
	3		10[a]		–	–	–	4.5	–	4.5	
* V_{CE}(sat)			3[a]	0.006[a]	–	2	–	–	–	–	V
			5[a]	0.01[a]	–	–	–	2	–	2	
			8[a]	0.08[a]	–	3	–	–	–	–	
			10[a]	0.1[a]	–	–	–	3	–	3	
V_F			−8[a]		–	4	–	–	–	–	V
			−10[a]		–	–	–	4	–	4	
* h_{fe} f = 1 kHz	5		1		1000	–	1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	20	–	
* C_{ob} V_{CB} = 10 V, f = 1 MHz					–	200	–	200	–	200	pF
$I_{S/b}$ t = 1 s, nonrep.	25				2.6	–	2.6	–	2.6	–	A
$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

* In accordance with JEDEC registration data format JS-6 RDF-2.

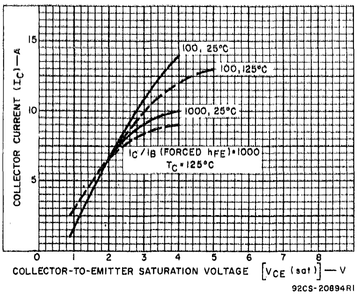

Fig. 6 — Typical saturation characteristics for 2N6386, 2N6387, and 2N6388.

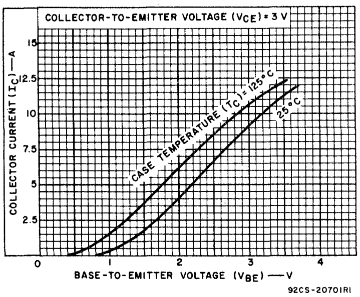

Fig. 7 — Typical transfer characteristics for 2N6386, 2N6387, and 2N6388.

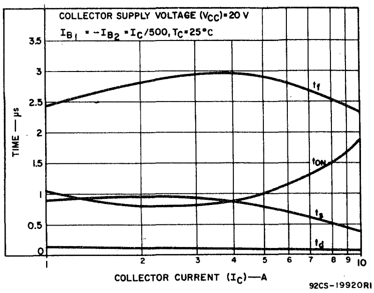

Fig. 8 — Typical saturated switching-time characteristics for 2N6386, 2N6387, and 2N6388.

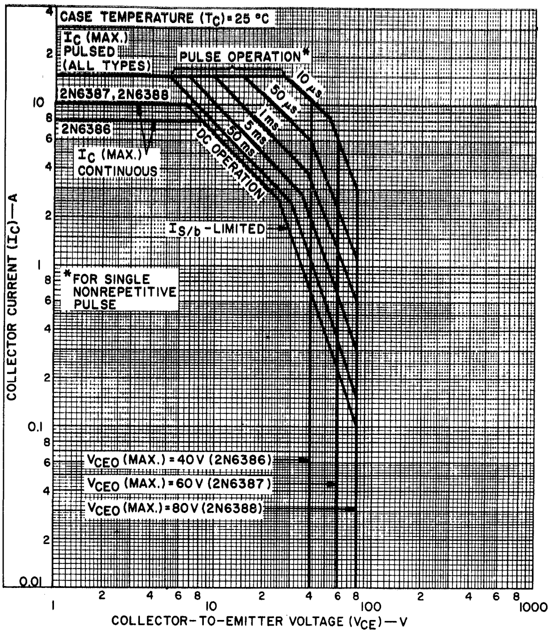

Fig. 9 — Maximum operating areas for 2N6386, 2N6387, and 2N6388 at $T_C = 25°C$.

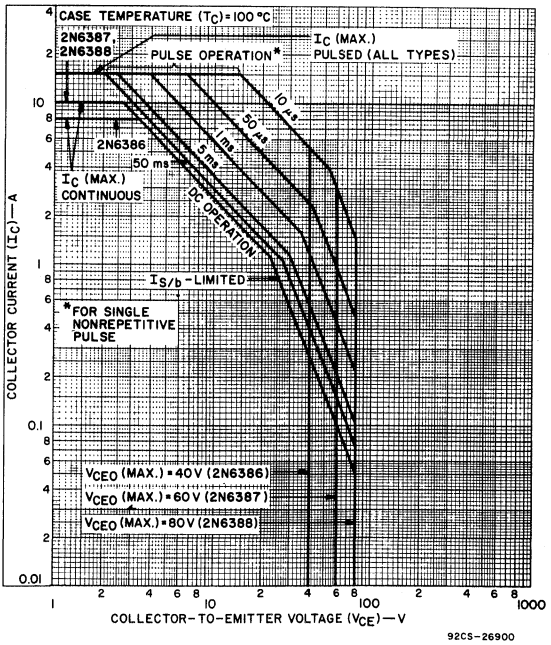

Fig. 10 — Maximum operating areas for 2N6386, 2N6387, and 2N6388 at $T_C = 100°C$.

2N6420, 2N6421, 2N6422, 2N6423

High-Voltage Medium-Power Silicon P-N-P Transistors

For High-Speed Switching and Linear-Amplifier Applications

The RCA-2N6420, 2N6421, 2N6422, and 2N6423 are epitaxial silicon p-n-p power transistors with high-voltage ratings and fast switching speeds. Typical applications for these transistors include high-voltage operational amplifiers, switching regulators, converters, inverters, deflection stages and high-fidelity amplifiers.

These types are supplied in steel JEDEC TO-213MA hermetic packages.

Features:

- **High voltage ratings:**
  V_{CEO}(sus) = −175 V max. (2N6420)
  = −250 V max. (2N6421)
  = −300 V max. (2N6422)
  = −300 V max. (2N6423)
- **Large safe-operating area**
- **Thermal-cycling rating**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6420	2N6421	2N6422	2N6423	
* V_{CBO}	−250	−375	−500	−500	V
V_{CEO}(sus)	−175	−250	−300	−300	V
* V_{EBO}	−6				V
* I_C	−1	−2			A
* I_{CM}	−5				A
* I_B	−1				A
P_T					
$T_C \leqslant 100^\circ C$, $V_{CE} \leqslant 50$ V	20				W
* $T_C \leqslant 25^\circ C$, $V_{CE} \leqslant 40$ V	35				W
$T_C \leqslant 25^\circ C$, $V_{CE} > 40$ V	*See Fig. 1*				
$T_C > 25^\circ C$, $V_{CE} > 40$ V	*See Figs. 1 & 3*				
* T_{stg}, * T_J	−65 to +200				°C
* T_L At distances ⩾1/32 in. (0.8 mm) from case for 10 s max.	235				°C

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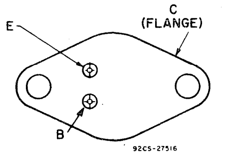
* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-213MA

(See dimensional outline "N".)

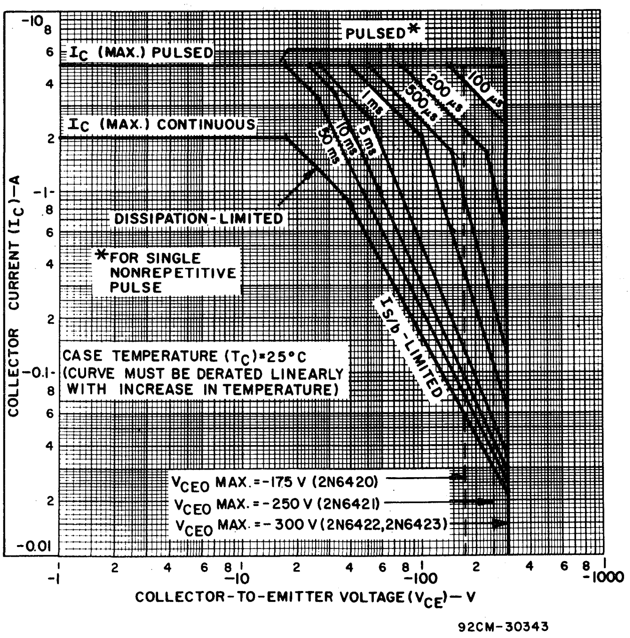


Fig. 1 — Maximum operating areas for all types at $T_C = 25^\circ C$.

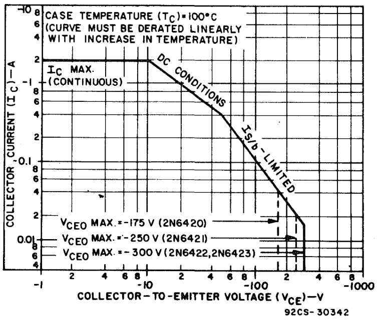


Fig. 2 — Maximum operating areas for all types, at $T_C = 100^\circ C$.

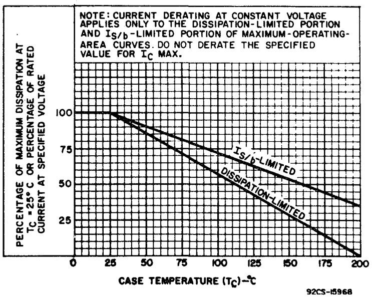


Fig. 3 — Derating curves for all types.

2N6420, 2N6421, 2N6422, 2N6423

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						Units
	VOLTAGE V dc		CURRENT A dc		2N6420		2N6421 2N6422		2N6423		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEO}	−150				–	−10	–	−5	–	−5	mA
* I_{CEX}	−225	1.5			–	−1	–	–	–	–	
2N6421	−340	1.5			–	–	–	−1	–	–	
2N6422	−450	1.5			–	–	–	−1	–	–	
	−450	1.5			–	–	–	–	–	−2	
* ICEX	−225	1.5			–	−3	–	–	–	–	
T_C=150°C	−300	1.5			–	–	–	−3	–	−5	
* I_{EBO}		6	0		–	−5	–	−0.5	–	−0.5	
h_{FE}	−10		−0.1[a]		40	–	40	–	40	–	
	−10		−0.5[a]		40	200	–	–	–	–	
*	−2		−0.75[a]		–	–	–	–	10	100	
	−10		−0.75[a]		–	–	–	–	30	150	
*	−2		−1[a]		–	–	8	80	–	–	
*	−10		−1[a]		10	–	25	100	–	–	
V_{BE}	−10		−1[a]		–	−1.4	–	−1.4	–	−1.4	V
* V_{BE}(sat)			−0.75[a]	−0.075	–	–	–	–	−1.8	–	
			−1[a]	−0.1	–	−1.4	–	−1.4	–	–	
V_{CE}(sat)			−0.75[a]	−0.075	–	–	–	–	–	−1	
			−1[a]	−0.125	–	−5	–	−0.75	–	–	
* V_{CEO}(sus)[b]			−0.05[a]	0	−175	–	–	–	−300	–	
2N6421			−0.05[a]	0	–	–	−250	–	–	–	
2N6422			−0.05[a]	0	–	–	−300	–	–	–	
$I_{S/b}$	−100				−0.15	–	−0.15	–	−0.15	–	A
* $\|h_{fe}\|$											
f = 5MHz	−10		−0.2		2	–	2	–	3	–	
* f = 1 kHz	−30		−0.1		25	350	–	–	–	–	
C_{obo} V_{CB}=10V f = 1 MHz			0		–	180	–	180	–	180	pF
* t_r[c]			−0.75	−0.075[d]	–	–	–	–	–	0.5	µs
			−1	−0.1[d]	–	–	–	3	–	–	
* t_s[c]			−0.75	−0.075[d]	–	–	–	–	–	6	
			−1	−0.1[d]	–	–	–	4	–	–	
* t_f[c]			−0.75	−0.075[d]	–	–	–	–	–	3	
			−1	−0.1[d]	–	–	–	3	–	–	
$R_{\theta JC}$	−10		−1		–	5	–	5	–	5	°C/W

* In accordance with JEDEC registration data.

[a] **Pulsed:** pulse duration = 300 µs, duty factor ≤2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

[c] V_{CC} = −200 V, t_p = 20 µs

[d] $-I_{B_1} = I_{B_2}$

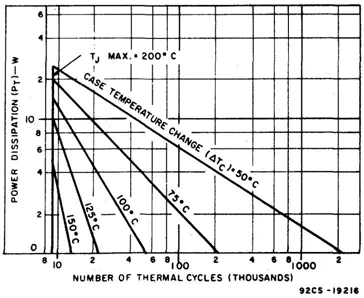


Fig. 4 — Thermal-cycling rating chart for all types.

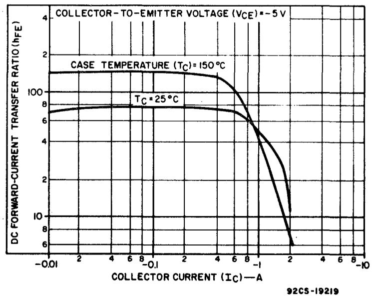


Fig. 5 — Typical dc beta characteristics for all types.

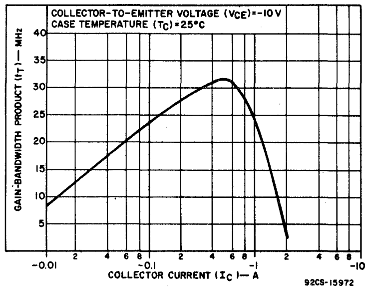


Fig. 6 — Typical gain-bandwidth product for all types.

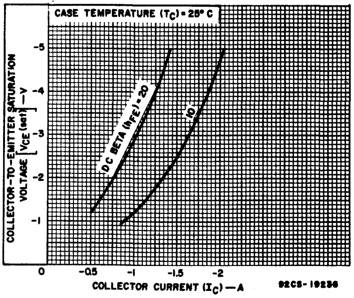


Fig. 7 — Typical saturation-voltage characteristics for all types.

2N6420, 2N6421, 2N6422, 2N6423

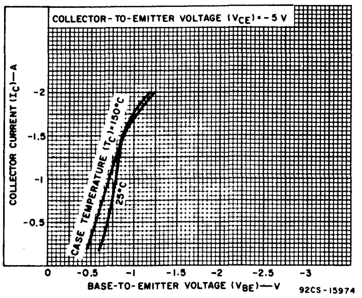


Fig. 8 — Typical transfer characteristics for all types.

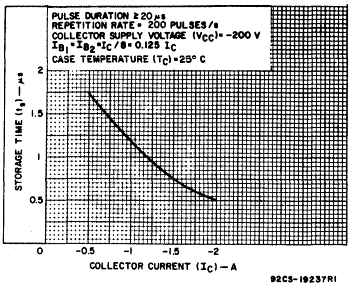


Fig. 9 — Typical storage time characteristic for all types.

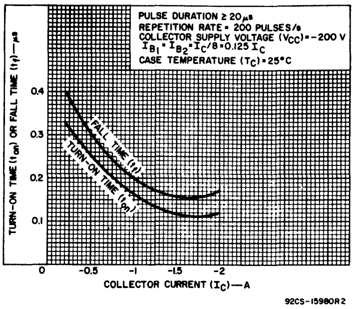


Fig. 10 — Typical turn-on time and fall-time characteristics for all types.

2N6477, 2N6478, RCA3441

Hometaxial-Base, Medium-Power Silicon N-P-N Transistors

Designed for Medium-Power Linear and Switching Service in Consumer, Automotive, and Industrial Applications

RCA 2N6477 and 2N6478 are hometaxial-base silicon n-p-n transistors intended for a wide variety of medium-to-high power, high-voltage applications. These devices, which are voltage extensions of the 2N5298 family, are especially useful in vertical output stages in color and black-and-white TV. The units differ in voltage ratings and in the currents at which parameters are controlled.

RCA3441 is a silicon n-p-n transistor intended for a wide variety of high-current applications. The hometaxial-base construction of this device renders it highly resistant to second breakdown over a wide range of operating conditions. The VERSAWATT case has a proven thermal-cycling capability. This capability is assured by real-time quality controls in our manufacturing locations. All these types are supplied in the JEDEC TO-220AB straight-lead version of the package. They are also available on special order in a variety of lead-form configurations. Two popular variations have leads formed to fit TO-66 sockets (specify formed lead No. 6201) or printed-circuit boards (specify formed lead No. 6207). Detailed information on these and other VERSAWATT outlines may be obtained from your RCA Sales Office.

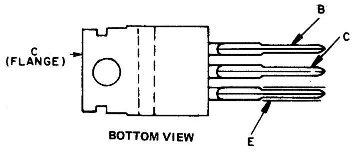
Features:

- **Maximum safe-area-of-operation curves**
- **Low saturation voltages**
- **High dissipation ratings**
- **Thermal-cycling rating curves**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power switching circuits**
- **Solenoid drivers**
- **Vertical output stages in color and B/W TV**

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6477	2N6478	RCA3441	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	160	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)	120	140	140	V
With base open	V_{CEO}(sus)	130	150	150	V
With base reverse-biased V_{BE} = −1.5 V	V_{CEV}(sus)	140	160	160	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	2.5	2.5	3	A
PEAK COLLECTOR CURRENT		4	4	4	A
CONTINUOUS BASE CURRENT	I_B	1	1	2	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		50	50	36	W
		Derate linearly to 150°C			
At case temperatures above 25°C		1.8	1.8	—	W
		Derate linearly at 0.0144		—	W/°C
TEMPERATURE RANGE:					
Storage and Operating (Junction)			−65 to 150 °C		
PIN TEMPERATURE (During Soldering):					
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.			235		°C

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* 2N- Series types in accordance with JEDEC registration data format JS-6 RDF-2.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N6477		2N6478		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
* Collector-Cutoff Current: With base open	I_{CEO}	80 100			0 0	– –	2 –	– –	– 2	mA
With base-emitter junction reverse-biased	I_{CEV}	130 150	−1.5 −1.5			– –	2 –	– –	– 2	
At T_C = 150°C	I_{CEV}	120 140	−1.5 −1.5			– –	10 –	– –	– 10	
* Emitter-Cutoff Current	I_{EBO}		−5	0		–	2	–	2	mA
* Collector-to-Emitter Sustaining Voltage: With base open	V_{CEO}(sus)			0.1ᵃ	0	120	–	140	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)			0.1ᵃ		130	–	150	–	
With base-emitter junction reverse-biased	V_{CEV}(sus)		−1.5	0.1ᵃ		140	–	160	–	
* DC Forward-Current Transfer Ratio	h_{FE}	4 4		1ᵃ 2.5ᵃ		25 5	150 –	25 5	150 –	
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			1ᵃ 2.5ᵃ	0.1 0.5	– –	1 2	– –	1 2	V
* Base-to-Emitter Voltage	V_{BE}	4 4		1ᵃ 2.5ᵃ		– –	1.8 3	– –	1.8 3	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: f = 40 kHz	$\lvert h_{fe} \rvert$	4		0.5		5	–	5	–	
Gain-Bandwidth Product	f_T	4		0.5		200	–	200	–	kHz
* Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: f = 1 kHz	h_{fe}	4		0.1		25	–	25	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	2.5	–	2.5	°C/W
Junction-to-Ambient	$R_{\theta JC}$					–	70	–	70	

* In accordance with JEDEC registration data format (JS-6 RDF-2).

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

CAUTION: The sustaining voltage V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) MUST NOT be measured on a curve tracer.

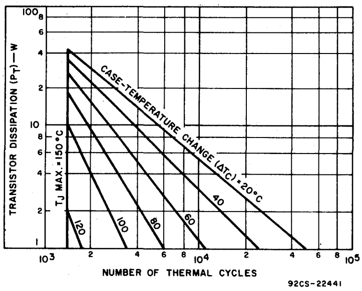


Fig. 1 - Thermal-cycling rating chart for 2N6477, 2N6478.

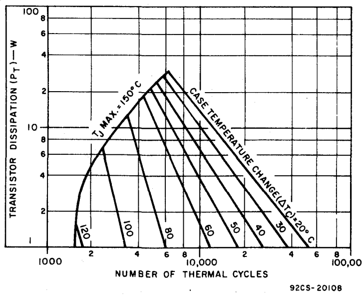


Fig. 2 - Thermal-cycling rating chart for RCA3441.

2N6477, 2N6478, RCA3441

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS		UNITS
		VOLTAGE V dc			CURRENT A dc		RCA3441		
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	
Collector-Cutoff Current: With base open	I_{CEO}	100 120				0 0	– –	– 5	mA
With base-emitter junction reverse-biased	I_{CEX}	120 140		−1.5 −1.5			– –	– 5	
At T_C = 150°C	I_{CEX}	120 140		−1.5 −1.5			– –	– 10	
Emitter-Cutoff Current	I_{EBO}		5		0		–	2	mA
Collector-to-Emitter Sustaining Voltage: With base open	V_{CEO}(sus)				0.1^a	0	140	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)				0.1^a		150	–	
With base-emitter junction reverse-biased	V_{CEV}(sus)			−1.5	0.1^a		160	–	
DC Forward-Current Transfer Ratio	h_{FE}	4			0.5^a		20	150	
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)				0.5^a	0.05^a	–	1.2	V
Base-to-Emitter Voltage	V_{BE}	4			0.5^a		–	2	V
Gain-Bandwidth Product	f_T	4			0.2		200	–	kHz
Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	4			0.1		25	–	
Forward-Bias Second Breakdown Collector Current^b (t ≥ 1 s)	$I_{S/b}$	120					0.3	–	A
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	3.5	°C/W
Junction-to-Ambient	$R_{\theta JA}$						–	70	

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[b] Pulsed: 1-second non-repetitive pulse.

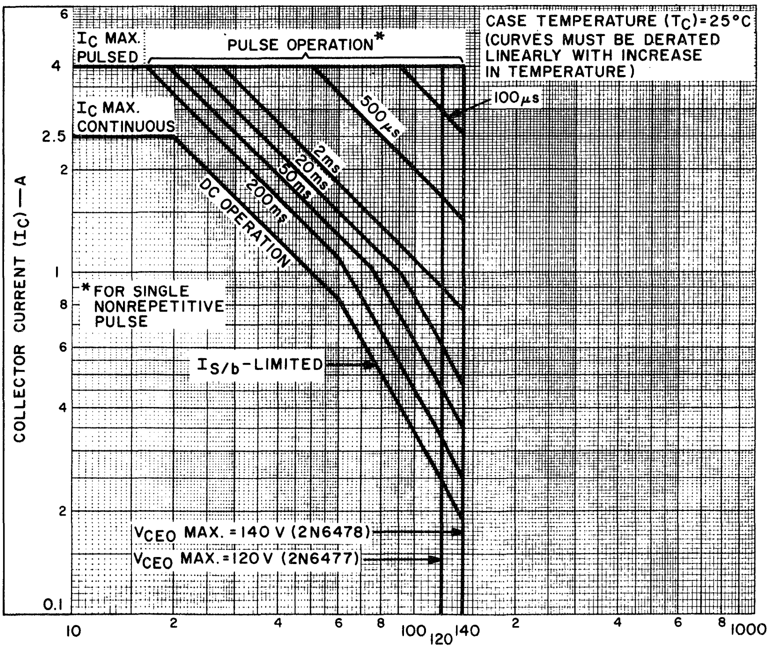


Fig. 6 - Maximum operating areas for 2N6477 and 2N6478.

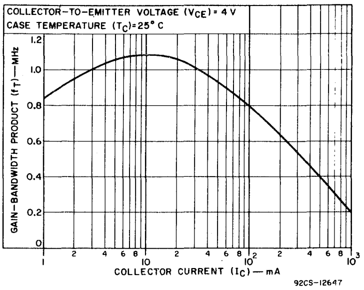


Fig. 3 - Typical gain-bandwidth product for all types.

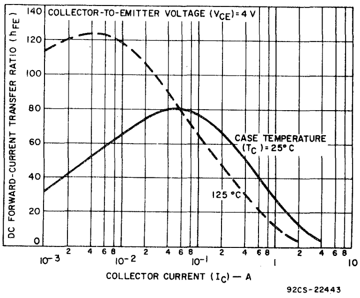


Fig. 4 - Typical dc beta characteristics for 2N6477.

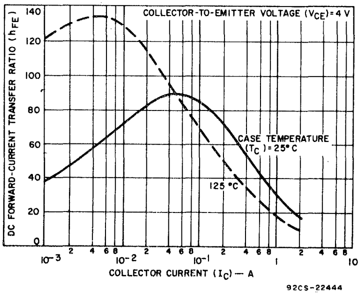


Fig. 5 - Typical dc beta characteristics for 2N6478.

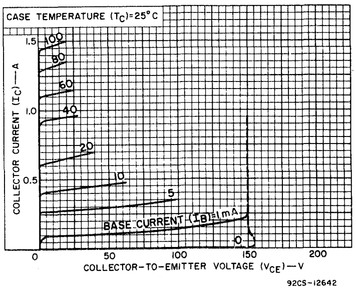


Fig. 7 - Typical output characteristics for 2N6478 and RCA3441.

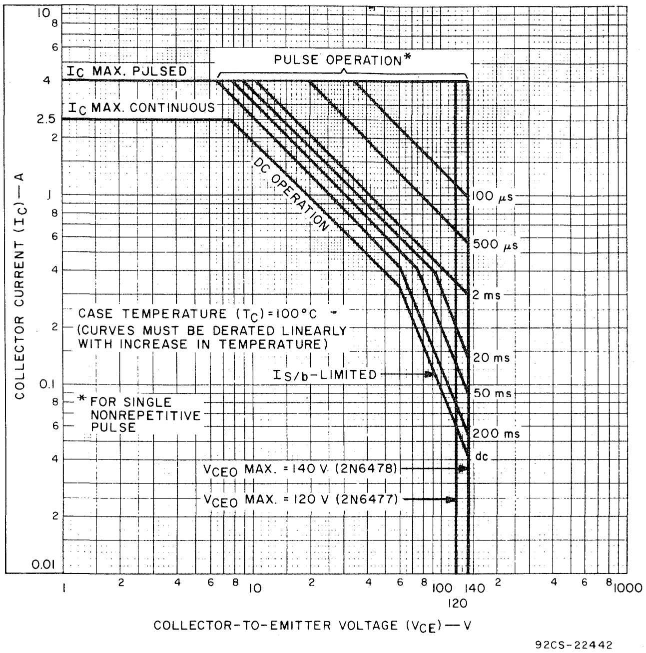


Fig. 8 - Maximum operating areas for 2N6477 and 2N6478.

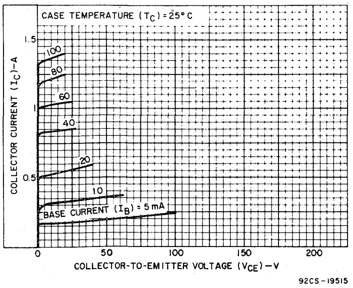


Fig. 9 - Typical output characteristics for 2N6477.

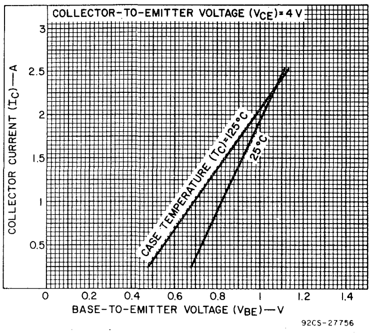


Fig. 10 - Typical transfer characteristics for 2N6477 and 2N6478.

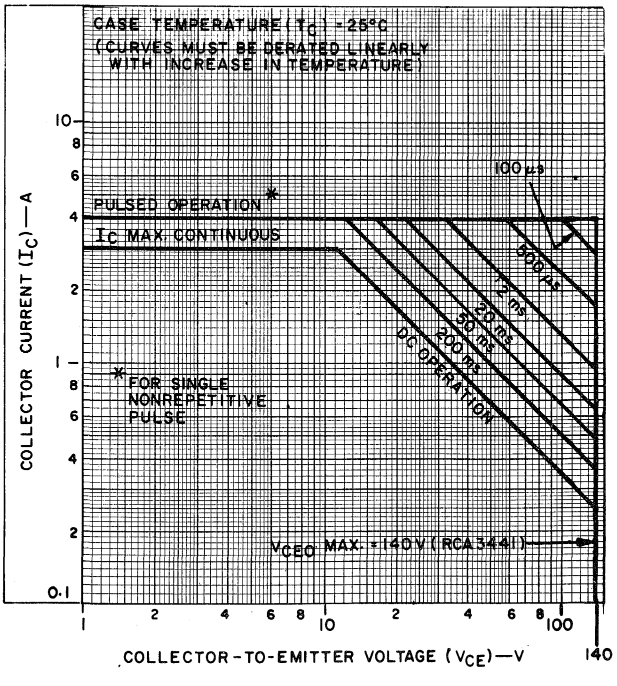


Fig. 11 - Maximum operating areas for RCA3441.

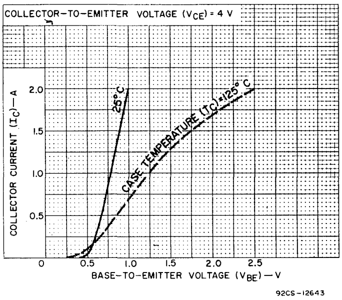


Fig. 12 - Typical transfer characteristics for RCA3441.

2N6479, 2N6480

Radiation-Hardened Silicon N-P-N Power Transistors

Epitaxial-Planar Types for Aerospace and Military Applications

Rated for Operation in Radiation Environments with Cumulative Neutron Fluence Levels to 1 x 10^{14} Neutrons/cm^2 and Gamma Intensity to 1 x 10^8 Rad(Si)/s

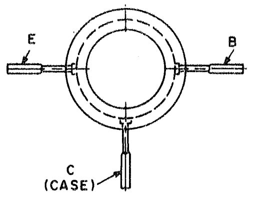
The RCA-2N6479 and 2N6480• are epitaxial silicon n-p-n planar power-switching transistors. They are designed for aerospace applications in which they might be subjected to extreme neutron and gamma-ray exposure.

The 2N6479 and 2N6480 are intended for use in 5-to-10 ampere high-frequency power inverter service.

They are supplied in hermetic flat 3/4-inch (19.05 mm) diameter packages with radial leads.

•Formerly RCA Dev. Nos. TA8007 and TA8007B, respectively.

TERMINAL DESIGNATIONS



92CS-27523

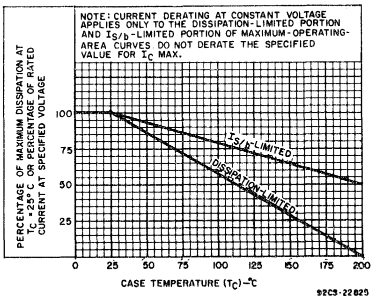
(RADIAL)

(See dimensional outline "T".)

MAXIMUM RATINGS, *Absolute-Maximum Values*

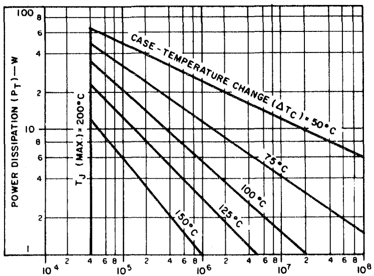
	2N6479	2N6480	
* V_{CBO}	100	100	V
$V_{CER}(sus)$ $R_{BE} \leq 100\ \Omega$	80	100	V
* V_{CEX}	60	80	V
* $V_{CEO}(sus)$	60	80	V
* V_{EBO}	6		V
* I_C	12		A
I_{CM}	25		A
* I_B	5		A
* P_T:			
$T_C \leq 25\ °C$	87		W
$T_C < 25\ °C$	See Fig. 1 and 5		
* $T_C = 100\ °C$	50		W
* T_J, T_{stg}	−65 to 200		°C
* T_L:			
During soldering, at distances 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		°C

*In accordance with JEDEC registration data



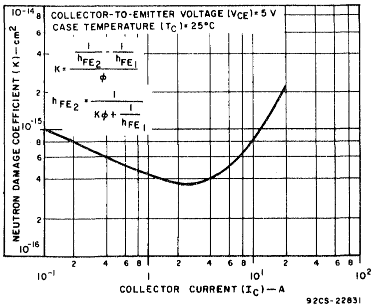
92CS-22825

Fig. 1 - Derating curves for both types.



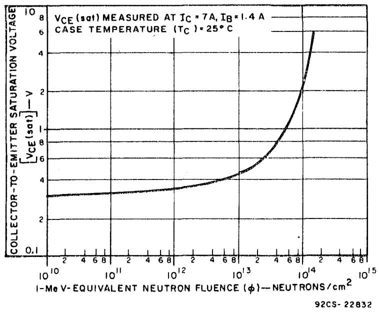
92CS-22827

Fig. 2 - Thermal-cycling rating chart for both types.



92CS-22831

Fig. 3 - Typical 1-Me V-equivalent neutron damage coefficient as a function of collector current for both types.



92CS-22832

Fig. 4 - Typical collector-to-emitter saturation voltage as a function of 1-Me V-equivalent neutron fluence for both types.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C* PRE-RADIATION

CHARACTERISTIC	TEST CONDITIONS				LIMITS		UNITS
	VOLTAGE V dc		CURRENT A dc		2N6479 2N6480		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
I_{CBO}	100[a]				—	1	mA
I_{CES}	60				—	200	μA
* I_{CEV}	100	0			—	1	mA
(T_C = 100°C)	60	0			—	1	
* I_{EBO}		−6			—	2	
V_{EBO} (I_E = 2 mA)					6	—	V
* $V_{CEO}(sus)$[b] 2N6479 2N6480			0.2[c] 0.2[c]		60 80	— —	
$V_{CER}(sus)$[b] (R_{BE} = 100 Ω) 2N6479 2N6480			0.2[c] 0.2[c]		80 100	— —	
* h_{FE}	2		12[c]		20	300	
* $V_{BE}(sat)$			12[c]	1.2	—	1.5	V
* $V_{CE}(sat)$			12[c]	1.2	—	0.75	
$I_{S/b}$ (t = 1 s)	12				7.3	—	A
$E_{S/b}$ (R_{BE} = 100 Ω, L = 100μH)			5		1.25	—	mJ
* $\|h_{fe}\|$ (f = 10 MHz)	5		1		10	—	
f_T	5		1		100	—	MHz
C_{obo} (f = 1 MHz)	10[a]				—	400	pF
* t_r	30[d]		12	1.2	—	400	ns
* t_s	30[d]		12	1.2[e]	—	800	
* t_f	30[d]		12	1.2[e]	—	200	
$R_{\theta JC}$	10			5	—	2	°C/W

*In accordance with JEDEC registration data.

[a] V_{CB} value.

[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 10.

[c] Pulsed; pulse duration ⩽ 350 μs, duty factor ⩽ 2%.

[d] V_{CC} value.

[e] $I_{B_1} = -I_{B_2}$.

TYPICAL CHARACTERISTIC DURING GAMMA EXPOSURE FOR DOSE RATES OF LESS THAN 1 x 10^8 RAD(Si)/sec

CHARACTERISTIC	TEST CONDITIONS		LIMITS	UNITS
	VOLTAGE — V dc		For both Types	
	V_{CB}	V_{BE}	TYPICAL	
Collector-to-Base Charge Generation Constant (C)	20	0	5×10^{-8}	Coulomb Rad

The charge generated in the depletion region of a transistor is proportional to the volume of the depletion region, the total dose, and the energy of the gamma radiation.

The primary base-collector photo current $[1_{pp(base)}] = (C)\dot{\gamma}$, where $\dot{\gamma}$ is the gamma dose rate in Rad(Si)/s.

2N6479, 2N6480

POST-NEUTRON-RADIATION ELECTRICAL CHARACTERISTICS AFTER EXPOSURE TO 5 x 10^{13} NEUTRONS/cm^2 (1 MeV equiv.), *At Case Temperature (T_C = 25°C*

	CHARACTERISTIC	TEST CONDITIONS				LIMITS		UNITS
		VOLTAGE V dc		CURRENT A dc		2N6479 2N6480		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
*	I_{CEV}	100	0			—	1.2	mA
*	I_{EBO}		−5			—	2.2	
*	$V_{CEO}(sus)^b$ 2N6479 2N6480			0.2^c 0.2^c		60 80	— —	V
*	h_{FE}	5		7^c		12	—	
*	$V_{BE}(sat)$			7^c	1.4	—	1.5	V
*	$V_{CE}(sat)$			7^c	1.4	—	1.5	
*	$\|h_{fe}\|$ (f = 10 MHz)	5		1		10		
*	K▲					—	$9x10^{-16}$	

*In accordance with JEDEC registration data.

[b] CAUTION: The sustaining voltage $V_{CEO}(sus)$ MUST NOT be measured on a curve tracer. This sustaining voltage should be measured by means of test circuit shown in Fig. 10.

[c] Pulsed; pulse duration ⩽ 350 μs, duty factor ⩽ 2%.

▲Damage constant $K = \dfrac{\dfrac{1}{h_{FE_2}} - \dfrac{1}{h_{FE_1}}}{\phi}$

Where h_{FE_1} = Beta prior to exposure

h_{FE_2} = Beta after exposure

θ = Neutron fluence (1 MeV equiv.)

Knowing K, h_{FE_2} may be calculated for other fluences using the relationship:

$$h_{FE_2} = \frac{1}{K\phi + \dfrac{1}{h_{FE_1}}}$$

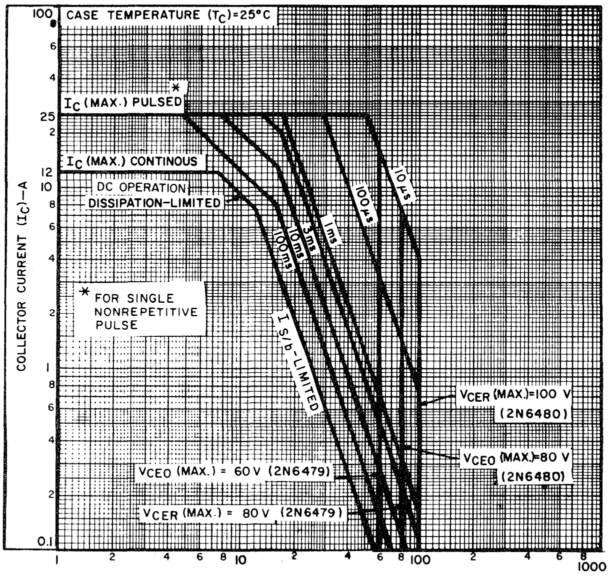


Fig. 5 - Maximum operating areas for both types (T_C = 25°C).

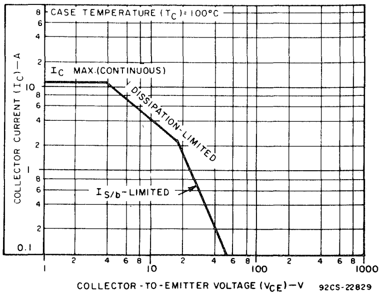


Fig. 6 - Maximum operating area for both types (T_C = 100°C).

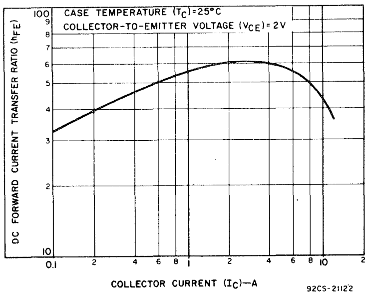


Fig. 7 - Typical dc beta characteristic for both types.

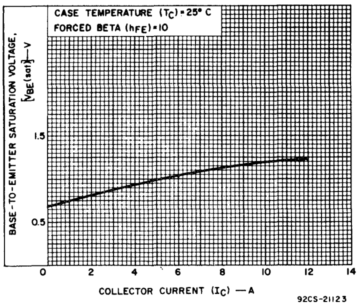


Fig. 8 - Typical base-to-emitter saturation voltage characteristic as a function of collector current for both types.

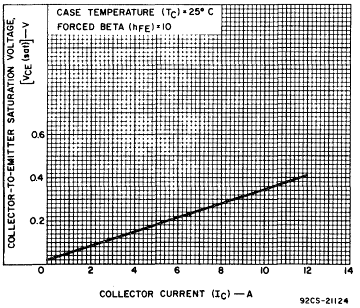


Fig. 9 - Typical collector-to-emitter saturation voltage characteristic as a function of collector current for both types.

15-A, 75-W, Silicon N-P-N and P-N-P Epitaxial-Base VERSAWATT Transistors

Complementary Pairs for General-Purpose Switching and Amplifier Applications

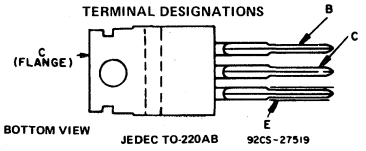
RCA-2N6486—2N6491•, inclusive, are epitaxial-base silicon transistors. The 2N6486, 2N6487, and 2N6488 are n-p-n complements of p-n-p types 2N6489, 2N6490, and 2N6491, respectively. All these devices are intended for a wide variety of medium-power switching and amplifier applications, and are particularly useful in high-fidelity amplifiers utilizing complementary-symmetry circuits.

These devices are supplied in the RCA VERSAWATT package in color-coded molded-silicone plastic; the 2N6489—2N6491 (p-n-p) devices are green, and the 2N6486—2N6488 (n-p-n) devices are gray. All are regularly supplied in the JEDEC TO-220AB.

Features:

- **Thermal-cycling ratings**
- **Maximum safe-area-of-operation curves**
- **Color-coded packages of molded-silicone plastic:**
  - Green – p-n-p (2N6489, 2N6490, 2N6491)
  - Gray – n-p-n (2N6486, 2N6487, 2N6488)

TERMINAL DESIGNATIONS



(See dimensional outline "S".)

• Formerly RCA Dev. Nos. TA8325, TA8324, TA8323, TA8328, TA8327, and TA8326 respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		N-P-N P-N-P	2N6486 2N6489◆	2N6487 2N6490◆	2N6488 2N6491◆	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}		50	70	90	V
COLLECTOR-TO-EMITTER VOLTAGE:						
* With 1.5 volts (V_{BE}) of reverse bias, and external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CEX}		50	70	90	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}		45	65	85	V
With base open	V_{CEO}		40	60	80	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}		5	5	5	V
* CONTINUOUS COLLECTOR CURRENT	I_C		15	15	15	A
* CONTINUOUS BASE CURRENT	I_B		5	5	5	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C			75	75	75	W
At ambient temperatures up to 25°C			1.8	1.8	1.8	W
At case temperatures above 25°C			Derate linearly 0.6			W/°C
At ambient temperatures above 25°C			Derate linearly 0.0144			W/°C
* TEMPERATURE RANGE:						
Storage and operating (Junction)			–65 to +150			°C
* LEAD TEMPERATURE (During soldering): At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.			235			°C

* In accordance with JEDEC registration data format JS-6 RDF-2.

◆ For p-n-p devices, voltage and current values are negative.

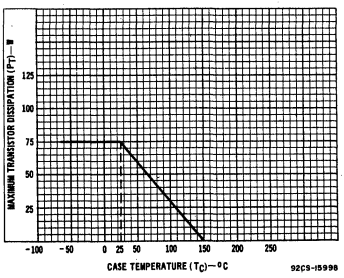


Fig. 1 - Derating chart for all types.

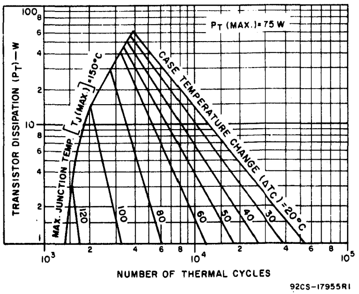


Fig. 2 - Thermal-cycling rating chart for all types.

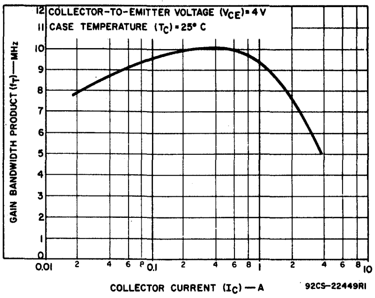


Fig. 3 - Typical gain-bandwidth product as a function of collector current for all types.◆

◆ For p-n-p devices, voltage and current values are negative.

2N6486-2N6491

ELECTRICAL CHARACTERISTICS, *At case temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS						UNITS
		VOLTAGE V dc		CURR. A dc	2N6486 2N6489◆		2N6487 2N6490◆		2N6488 2N6491◆		
		V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With external base-emitter resistance (R_{BE}) = 100Ω	I_{CER}	35 55 75			– – –	500 – –	– – –	– 500 –	– – –	– – 500	µA
* With base-emitter junction reverse biased and external base-to-emitter resistance (R_{BE}) = 100Ω	I_{CEX}	45 65 85	−1.5 −1.5 −1.5		– – –	500 – –	– – –	– 500 –	– – –	– – 500	µA
* At T_C = 150°C		40 60 80	−1.5 −1.5 −1.5		– – –	5 – –	– – –	– 5 –	– – –	– – 5	mA
* With base open	I_{CEO}	20 30 40			– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
* Emitter-Cutoff Current	I_{EBO}		−5	0	–	1	–	1	–	1	mA
* DC Forward-Current Transfer Ratio	h_{FE}	4 4		5^a 15^a	20 5	150	20 5	150	20 5	150	
* Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$			0.2	40^b		60^b		80^b		V
With external base-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$			0.2	45^b		65^b		85^b		
With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CEX}(sus)$		-1.5	0.2	50^b		70^b		90^b		
* Base-to-Emitter Voltage	V_{BE}	4 4		5^a 15^a		1.3 3.5	-	1.3 3.5	– –	1.3 3.5	V
* Collector-to-Emitter Saturation Voltage [I_B = 0.5 A I_B = 5 A	$V_{CE}(sat)$			5^a 15^a		1.3 3.5		1.3 3.5	– –	1.3 3.5	V
* Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio: f = 1 MHz	$\|h_{fe}\|$	4		1	5		5	-	5	-	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		1	25	–	25	–	25	–	
Thermal Resistance Junction-to-case	$R_{\theta JC}$				–	1.67	–	1.67	–	1.67	°C/W
Junction-to-ambient	$R_{\theta JA}$				–		–	70	–	70	

* In accordance with JEDEC registration data format (JS-6 RDF-2).

[a] Pulsed; pulse duration = 300 µs, duty factor = 1.8%

[b] *CAUTION: Sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer. (See Fig. 19)*

◆ For p-n-p devices, voltage and current values are negative.

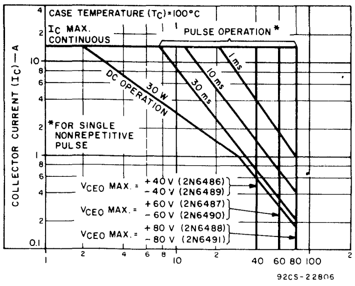


Fig. 4 - Maximum operating areas for all types.◆

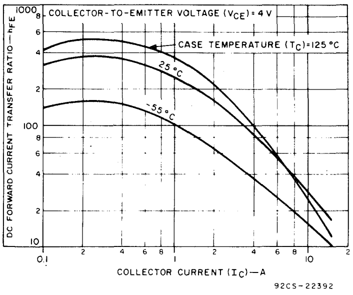


Fig. 5 - Typical dc beta characteristics for 2N6486, 2N6487, and 2N6488.

◆ For p-n-p devices, voltage and current values are negative.

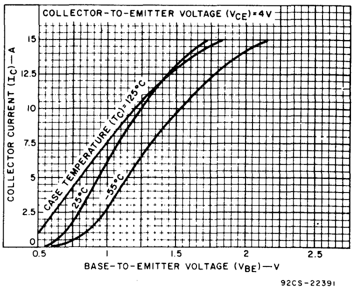


Fig. 6 - Typical transfer characteristics for all types.◆

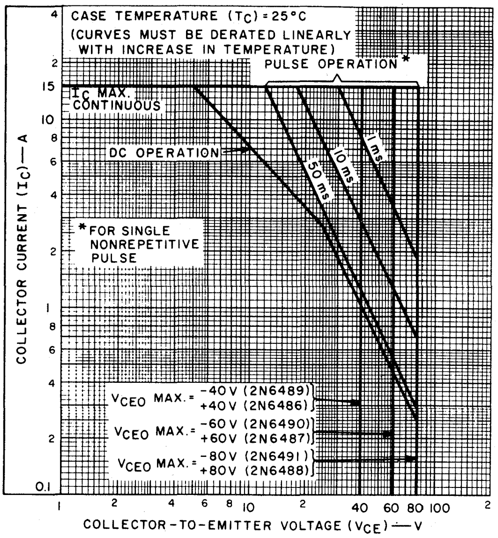


Fig. 7 - Maximum operating areas for all types.◆

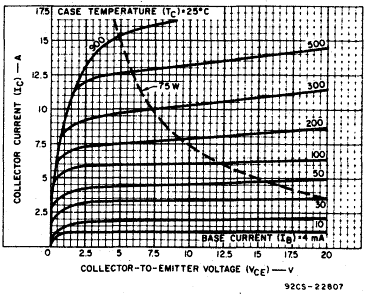


Fig. 8 - Typical output characteristics for all types.◆

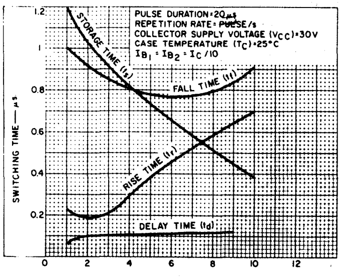


Fig. 9 - Typical saturated switching characteristics for 2N6486, 2N6487, and 2N6488.

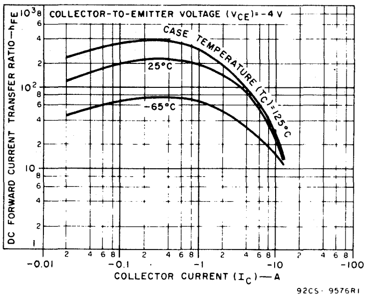


Fig. 10 - Typical dc beta characteristics for 2N6489, 2N6490, 2N6491.

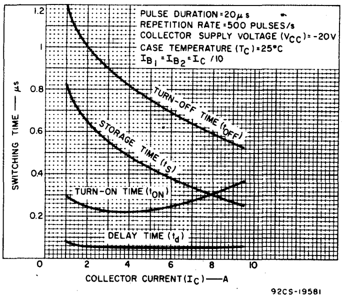


Fig. 11 - Typical saturated switching characteristics for 2N6489, 2N6490, and 2N6491.

◆ For p-n-p devices, voltage and current values are negative.

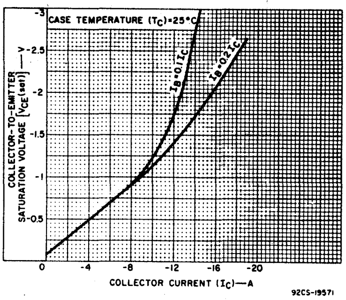


Fig. 12 - Typical collector-to-emitter saturation-voltage characteristics for all types.

2N6510-2N6514

High-Voltage, High-Current, Silicon N-P-N Power Switching Transistors

For Switching Applications in Industrial
Commercial and Military Equipment

Features:

- Fast switching speed
- Epitaxial pi-nu construction
- Hermetic steel package—JEDEC TO-3
- Maximum-safe-area-of-operation curves
- Thermal-cycling rating chart

The RCA-2N6510, -2N6511, -2N6512, -2N6513, and -2N6514● are epitaxial silicon n-p-n power transistors with pi-nu construction. They are especially designed for use in electronic ignition circuits and other applications requiring high-voltage, high-energy, and fast-switching-speed capability.

These devices are hermetically sealed in a steel JEDEC TO-3 package. They differ from each other in breakdown-voltage ratings, leakage, and beta characteristics.

●Formerly RCA Dev. Nos. TA8847D, TA8847A, TA8847B, TA8847C, and TA8847E, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6510	2N6511	2N6512	2N6513	2N6514	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	300	350	400	350	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:							
With external base-to-emitter resistance R_{BE} = 50 Ω	$V_{CER}(sus)$	250	300	350	400	350	V
* With base open	$V_{CEO}(sus)$	200	250	300	350	300	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	6	V
*CONTINUOUS COLLECTOR CURRENT	I_C	7	7	7	7	7	A
*CONTINUOUS BASE CURRENT	I_B	3	3	3	3	3	A
*EMITTER CURRENT	I_E	10	10	10	10	10	A
*TRANSISTOR DISSIPATION:	P_T						
At case temperatures up to 25°C		120	120	120	120	120	W
At case temperatures above 25°C		See Figs. 1 and 2.					
*TEMPERATURE RANGE:							
Storage and Operating (Junction)		−65 to +200					°C
*PIN TEMPERATURE (During Soldering):							
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230					°C

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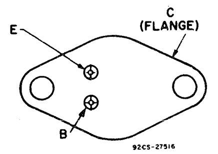
*In accordance with JEDEC registration data format JC-25 RDF-1.

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

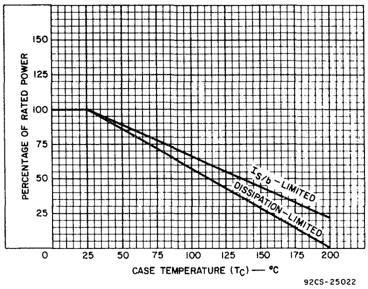


Fig. 2 - Derating curve for all types.

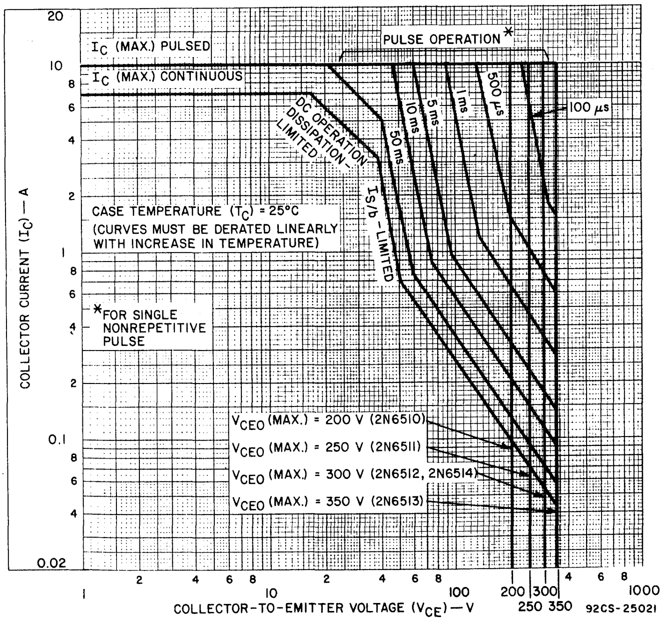


Fig. 1 - Maximum operating areas for all types.

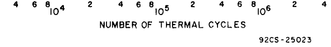


Fig. 3 - Thermal-cycling rating chart for all types.

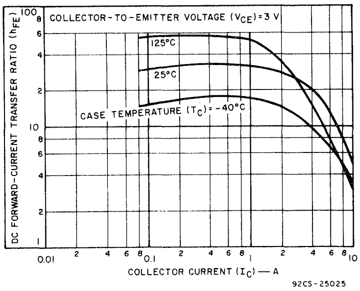


Fig. 4 - Typical dc beta characteristic for all types.

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6512 2N6514			2N6513			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	
I_{CEO}	250				–	–	5	–	–	–	mA
	300				–	–	–	–	–	5	
* I_{CEV}	350	−1.5			–	–	5	–	–	–	mA
	400	−1.5			–	–	–	–	–	5	
* T_C = 100°C	350	−1.5			–	–	10	–	–	–	
	400	−1.5			–	–	–	–	–	10	
* I_{EBO}		−6			–	–	3	–	–	3	mA
* $V_{CEO}(sus)$			0.2		300[b]	–	–	350[b]	–	–	V
$V_{CER}(sus)$ R_{BE} = 50 Ω			0.2		350[b]	–	–	400[b]	–	–	
* V_{EBO} I_E = 3 mA					6	–	–	6	–	–	V
* h_{FE}											
2N6512, 2N6513,	3		4[a]		10	–	50	10	–	50	
2N6514	3		5[a]		10	–	50	–	–	–	
* $V_{BE}(sat)$											
2N6512, 2N6513,			4[a]	0.8	–	–	1.7	–	–	1.7	V
2N6514			5[a]	1	–	–	1.7	–	–	–	
* $V_{CE}(sat)$											
2N6512, 2N6513,			4[a]	0.8	–	–	1.5	–	–	1.5	V
2N6514			5	1	–	–	1.5	–	–	–	
All types			7	3	–	1.5	2.5	–	1.5	2.5	
* C_{obo} V_{CB} = 10 V, f = 1 MHz					50	–	200	50	–	200	pF
* $\|h_{fe}\|$ f = 1 MHz	10		1		1	–	9	1	–	9	MHz
* $I_{S/b}$	38				3.16	–	–	3.16	–	–	A
t = 1 s, nonrepetitive	200				0.1	–	–	0.1	–	–	
* t_d[c]											
2N6512, 2N6513,			4	0.8	–	0.1	0.2	–	0.1	0.2	
2N6514			5	1	–	0.1	0.2	–	–	–	
* t_r[c]											
2N6512, 2N6513,			4	0.8	–	0.7	1.5	–	0.7	1.5	
2N6514			5	1	–	0.7	1.5	–	–	–	μs
* t_s[c]											
2N6512, 2N6513,			4	0.8	–	3	5	–	3	5	
2N6514			5	1	–	3	5	–	–	–	
* t_f[c]											
2N6512, 2N6513,			4	0.8	–	0.5	1.5	–	0.5	1.5	
2N6514			5	1	–	0.5	1.5	–	–	–	
* $R_{\theta JC}$	20		5		–	–	1.46	–	–	1.46	°C/W

* Minimum and maximum values and test conditions in accordance with JEDEC registration data format JC-25 RDF-1.

[a] Pulsed; pulse duration = 300 μs, duty factor ⩽2%.

[b] **CAUTION:** The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 12.

[c] V_{CC} = 200 V, I_{B1} = I_{B2}.

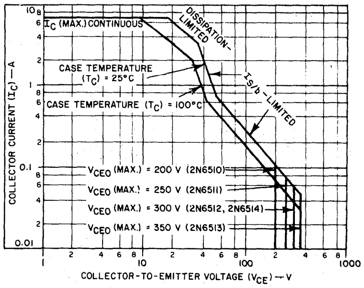


Fig. 5 - Maximum operating areas for all types at 25°C and 100°C.

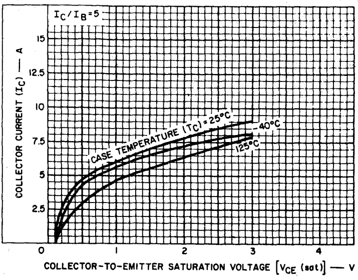


Fig. 6 - Typical collector-to-emitter saturation-voltage characteristics for all types.

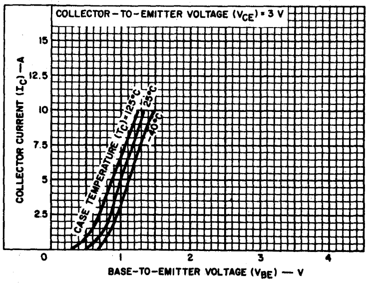


Fig. 7 - Typical transfer characteristics for all types.

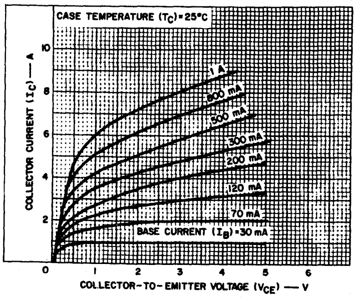


Fig. 8 - Typical output characteristics for all types.

2N6510-2N6514

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6510			2N6511			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	
I_{CEO}	150				–	–	5	–	–	–	mA
	200				–	–	–	–	–	5	
* I_{CEV}	250	−1.5			–	–	5	–	–	–	mA
	300	−1.5			–	–	–	–	–	5	
* T_C = 100°C	250	−1.5			–	–	10	–	–	–	
	300	−1.5			–	–	–	–	–	10	
* I_{EBO}		−6			–	–	3	–	–	3	mA
* V_{CEO}(sus)			0.2		200[b]	–	–	250[b]	–	–	V
V_{CER}(sus) R_{BE} = 50 Ω			0.2		250[b]	–	–	300[b]	–	–	
* V_{EBO} I_E = 3 mA					6	–	–	6	–	–	V
* h_{FE}	3		3[a]		10	–	50	–	–	–	
	3		4[a]		–	–	–	10	–	50	
* V_{BE}(sat)			3[a]	0.6	–	–	1.7	–	–	–	V
			4[a]	0.8	–	–	–	–	–	1.7	
* V_{CE}(sat)			3[a]	0.6	–	–	1.5	–	–	–	V
			4[a]	0.8	–	–	–	–	–	1.5	
			7[a]	3	–	1.5	2.5	–	1.5	2.5	
* C_{obo} V_{CB} = 10 V, f = 1 MHz					50	–	200	50	–	200	pF
* $\|h_{fe}\|$ f = 1 MHz	10		1		1	–	9	1	–	9	MHz
* $I_{S/b}$ t = 1s, nonrepetitive	38				3.16	–	–	3.16	–	–	A
	200				0.1	–	–	0.1	–	–	
* t_d[c]			3	0.6	–	0.1	0.2	–	–	–	µs
			4	0.8	–	–	–	–	0.1	0.2	
t_r[c]			3	0.6	–	0.7	1.5	–	–	–	
			4	0.8	–	–	–	–	0.7	1.5	
t_s[c]			3	0.6	–	3	5	–	–	–	
			4	0.8	–	–	–	–	3	5	
t_f[c]			3	0.6	–	0.5	1.5	–	–	–	
			4	0.8	–	–	–	–	0.5	1.5	
* $R_{\theta JC}$	20		5		–	–	1.46	–	–	1.46	°C/W

* Minimum and maximum values and test conditions in accordance with JEDEC registration data format JC-25 RDF-1.

[a] Pulsed; pulse duration = 300 µs, duty factor ≤2%.

[b] **CAUTION:** The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 12.

[c] V_{CC} = 200 V, I_{B1} = I_{B2}.

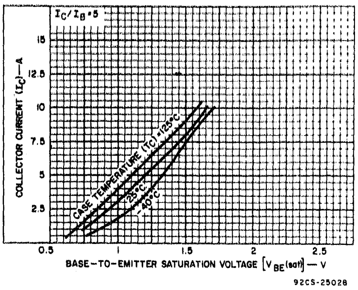


Fig. 9 - Typical base-to-emitter saturation-voltage characteristics for all types.

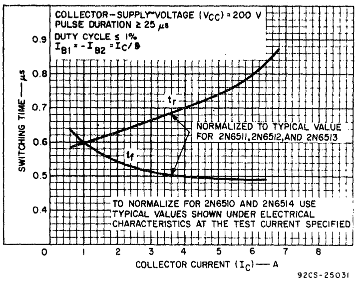


Fig. 10 - Typical rise- and fall-time characteristics for all types.

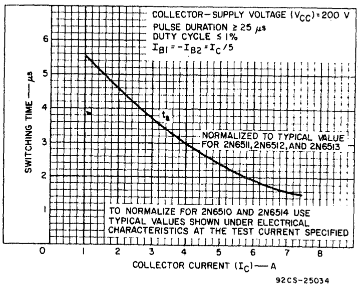


Fig. 11 - Typical storage-time characteristic for all types.

8-Ampere N-P-N Darlington Power Transistors

80, 100, 120 Volts, 60 Watts
Gain of 1000 at 5 A (2N6530, 2N6532)

Gain of 1000 at 3 A (2N6533)
Gain of 500 at 3 A (2N6531)

The RCA-2N6530, 2N6531, 2N6532, and 2N6533● are monolithic n-p-n silicon Darlington transistors designed for power applications at low and medium frequencies. The double epitaxial construction of these devices provides good forward and reverse second-breakdown characteristics. Their high gain allows them to be driven directly from integrated circuits.

● Formerly RCA Dev. Nos. TA8904C, TA8904D, TA8904B, and TA8904A, respectively.

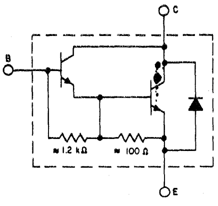
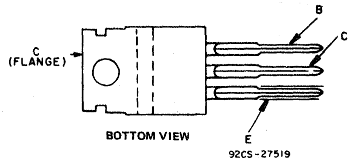


Fig. 1 - Schematic diagram for all types.

Features:
- **Operate from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

Applications:
- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6530	2N6531	2N6532	2N6533	
$^*V_{CBO}$	80	100	100	120	V
$V_{CER}(sus)$					
$R_{BE} = 100\ \Omega$	80	100	100	120	V
$V_{CEO}(sus)$	80	100	100	120	V
$^*V_{CEV}(sus)$					
$V_{BE} = -1.5$ V	80	100	100	120	V
$^*V_{EBO}$	5	5	5	5	V
$^*I_C$	8	8	8	8	A
I_{CM}	15	15	15	15	A
$^*I_B$	0.25	0.25	0.25	0.25	A
$^*P_T$					
Up to 25°C	65	65	65	65	W
Above 25°C	See Fig. 2				
$^*T_J$, T_{stg}	−65 to +150				°C
$^*T_L$					
At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

* In accordance with JEDEC registration data format JS-6, RDF-4.

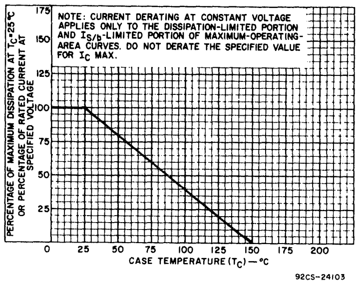


Fig. 2 - Dissipation derating curve for all types.

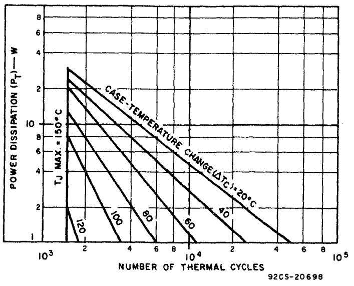


Fig. 3 - Thermal-cycling rating chart for all types.

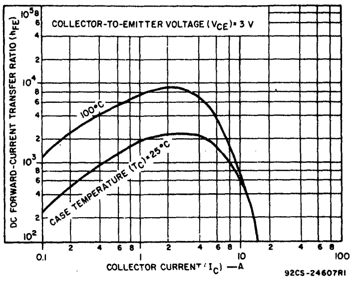


Fig. 4 - Typical dc beta characteristics for all types.

2N6530-2N6533

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6530		2N6531		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	80			0	–	1	–	–	mA
	100			0	–	–	–	1	
* I_{CEV}	80	−1.5			–	0.5	–	–	
	100	−1.5			–	–	–	0.5	
* T_C = 125°C	80	−1.5			–	5	–	–	
	100	−1.5			–	–	–	5	
I_{EBO}		−5	0		–	5	–	5	mA
* h_{FE}	3		5^a		1,000	10,000	–	–	
	3		3^a		–	–	500	10,000	
	3		8^a		100	5,000	100	5,000	
V_{CEO}(sus)			0.2	0	80^b	–	100^b	–	V
V_{CER}(sus) R_{BE} = 100 Ω			0.2		80^b	–	100^b	–	
* V_{CEV}(sus)		−1.5	0.2		80^b	–	100^b	–	
V_{BE}	3		5^a		–	2.8	–	–	V
	3		3^a		–	–	–	2.8	
	3		8^a		–	4.5*	–	4.5*	
V_{CE}(sat)			3^a	0.006	–	–	–	3	V
			5^a	0.01	–	2	–	–	
			8^a	0.08	–	3*	–	3*	
V_F			5^a		–	–	–	4	V
			8^a		–	5	–	–	
h_{fe} f = 1 kHz	5		1		1,000	–	1,000	–	
* $\lvert h_{fe} \rvert$ f = 1 MHz	5		1		20	–	20	–	
C_{obo} V_{CB} = 10 V f = 1 MHz					–	200	–	200	pF
* $I_{S/b}$ t = 0.5 s, nonrep.	24				2.7	–	2.7	–	A
$E_{S/b}$ L = 12 mH R_{BE} = 100 Ω		−1.5	4.5		120	–	120	–	mJ
$R_{\theta JC}$					–	1.92	–	1.92	°C/W

* In accordance with JEDEC registration data format JS-6, RDF-4.

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

[b] *CAUTION:* Sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) *MUST NOT* be measured on a curve tracer.

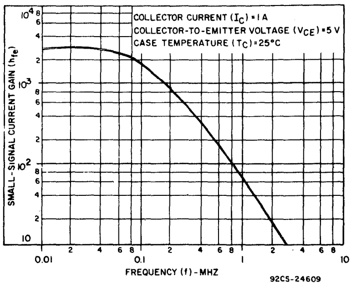


Fig. 5 - Typical small-signal current gain for all types.

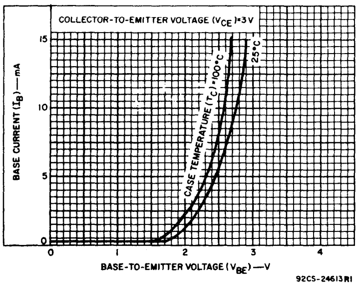


Fig. 6 - Typical input characteristics for all types.

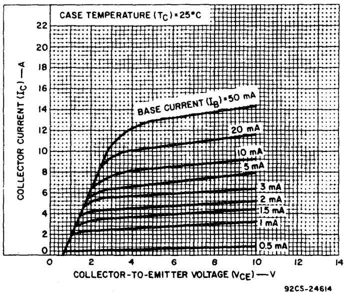


Fig. 7 - Typical output characteristics for all types.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6532		2N6533		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	120			0	–	–	–	1	mA
	100			0	–	1	–	–	
* I_{CEV}	120	−1.5			–	–	–	0.5	
	100	−1.5			–	0.5	–	–	
* T_C = 125°C	120	−1.5			–	–	–	5	
	100	−1.5			–	5	–	–	
I_{EBO}		−5	0		–	5	–	5	mA
* h_{FE}	3		3^a		–	–	1,000	10,000	
	3		5^a		1,000	10,000	–	–	
	3		8^a		100	5,000	100	5,000	
$V_{CEO}(sus)$			0.2	0	100^b	–	120^b	–	V
$V_{CER}(sus)$ R_{BE} = 100 Ω			0.2		100^b	–	120^b	–	
* $V_{CEV}(sus)$		−1.5	0.2		100^b	–	120^b	–	
V_{BE}	3		3^a		–	–	–	2.8	V
	3		5^a		–	2.8	–	–	
	3		8^a		–	4.5*	–	4.5*	
$V_{CE}(sat)$			3^a	0.006	–	–	–	2	V
			5^a	0.01	–	2	–	–	
			8^a	0.08	–	3*	–	3*	
V_F			5^a		–	–	–	4	V
			8^a		–	5	–	–	
h_{fe} f = 1 kHz	5		1		1,000	–	1,000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	
C_{obo} V_{CB} = 10 V f = 1 MHz					–	200	–	200	pF
* $I_{S/b}$ t = 0.5 s, nonrep.	24				2.7	–	2.7	–	A
$E_{S/b}$ L = 12 mH R_{BE} = 100 Ω		−1.5	4.5		120	–	120	–	mJ
$R_{\theta JC}$					–	1.92	–	1.92	°C/W

* In accordance with JEDEC registration data format JS-6, RDF-4.

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

[b] *CAUTION:* Sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ *MUST NOT* be measured on a curve tracer.

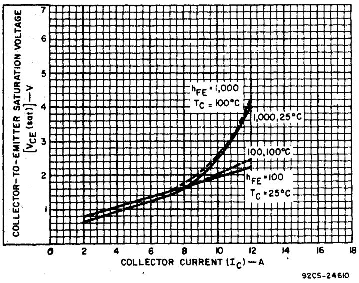


Fig. 8 - Typical saturation characteristics for all types.

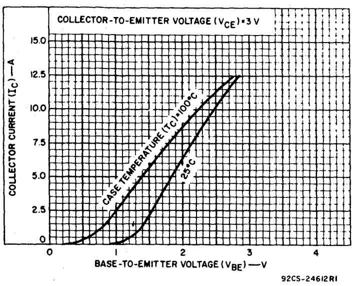


Fig. 9 - Typical transfer characteristics for all types.

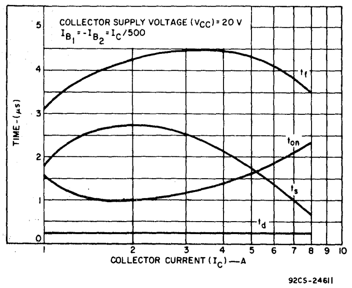


Fig. 10 - Typical saturated switching-time characteristics for all types.

2N6530-2N6533

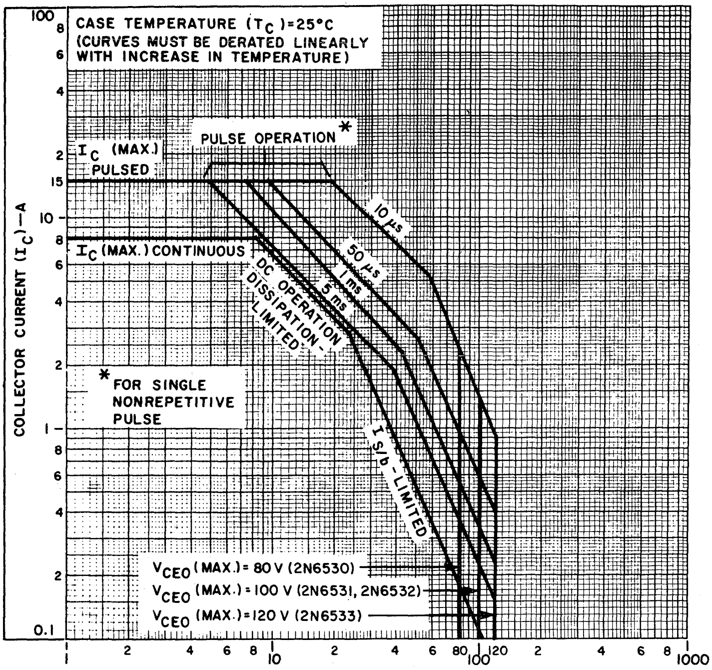


Fig. 11 - Maximum operating areas for all types at case temperature of 25°C.

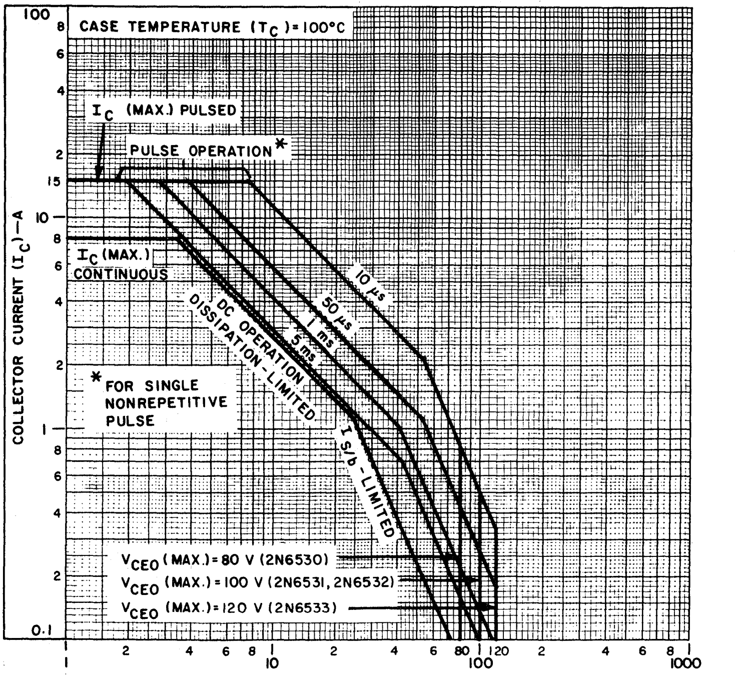


Fig. 12 - Maximum operating areas for all types at case temperature of 100°C.

2N6542, 2N6544, 2N6546

3-, 5-, and 10-A Power-Switching Transistors

High-Voltage N-P-N Types for Off- Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6542, 2N6544, and 2N6546 series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are eassential to the design to high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are characterized at 100°C; as well as at 25°C, to provide information necessary for worst-case design.

The 2N6542, 2N6544 and 2N6546 transistors are supplied in steel JEDEC TO-204MA hermetic packages.

Features:

- **100% High Temperature Tested for 100°C Parameters**
- **Fast Switching Speed**
- **High Voltage Rating:** **V_{CEX} = 350 V**
- **Low V_{CE}(sat) at I_C = 3-, 5-, and 10-A**
- **Steel Hermetic TO-204MA Package**

Applications:

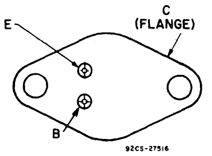
- **Off-Line Power Supplies**
- **High Voltage Inverters**
- **Switching Regulators**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6542	2N6544	2N6546	
* V_{CBO}		650		V
* V_{CEV}				
V_{BE} = −1.5 V		650		V
* V_{CEX}(Clamped)				
V_{BE} = −1.5 V		350		V
* V_{CEO}		300		V
* V_{EBO}		8		V
I_C(sat)	3	5	10	A
* I_C	5	8	15	A
I_{CM}	10	16	30	A
* I_B	5	8	10	A
* P_T				
T_C up to 25°C	100	125	175	W
T_C above 25°C, derate linearly	0.57	0.714	1	W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distance ≥1/8 in. (3.17 mm) from seating plane for 5 s max.		275		°C

* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

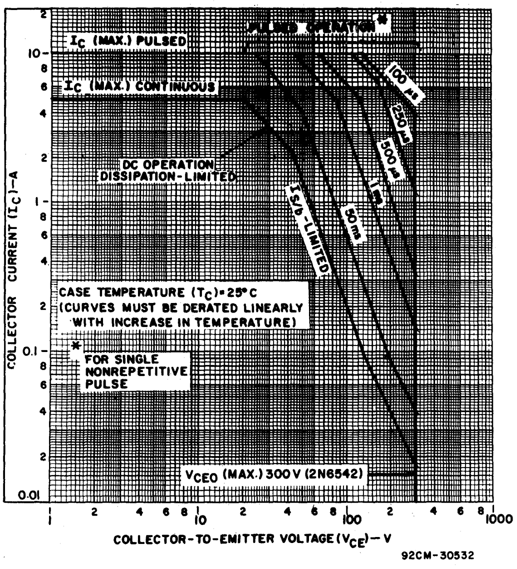


Fig. 1 — Maximum operating areas for type 2N6542 (T_C = 25°C).

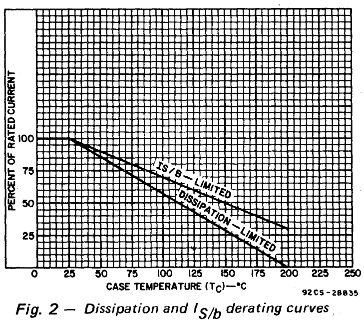


Fig. 2 — Dissipation and $I_{S/b}$ derating curves for all types.

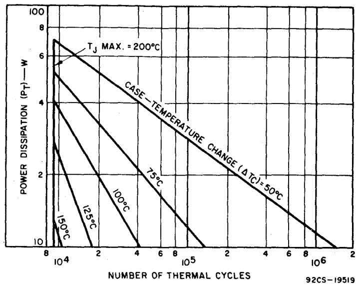


Fig. 3 — Thermal-cycling chart for type 2N6542.

2N6542, 2N6544, 2N6546

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						Units
	VOLTAGE V dc		CURRENT A dc		2N6542		2N6544		2N6546		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
$T_C = 25°C$											
* I_{CEV}	650	−1.5			–	0.5	–	0.5	–	1	mA
* I_{EBO}		−8	0		–	1	–	1	–	1	
* $V_{CEO}(sus)^b$			0.1^a		300	–	300	–	300	–	V
* h_{FE}	2		3^a		7	35	–	–	–	–	
	2		1.5^a		12	60	–	–	–	–	
	3		5^a		–	–	7	35	–	–	
	3		2.5^a		–	–	12	60	–	–	
	2		10^a		–	–	–	–	6	30	
	2		5^a		–	–	–	–	12	60	
* $V_{BE}(sat)$			3^a	0.6	–	1.4	–	–	–	–	
			5^a	1	–	–	–	1.6	–	–	
			10^a	2	–	–	–	–	–	1.6	
* $V_{CE}(sat)$			3^a	0.6	–	1	–	–	–	–	V
			5^a	1	–	5	–	1.5	–	–	
			8^a	2	–	–	–	5	–	–	
			10^a	2	–	–	–	–	–	1.5	
			15^a	3	–	–	–	–	–	5	
* $I_{S/b}$ t = 1 s	100				0.2	–	0.2	–	0.2	–	A
* f_T f = 1 MHz	10		0.2		6	28	–	–	–	–	MHz
	10		0.3		–	–	6	28	–	–	
	10		0.5		–	–	–	–	6	28	
* C_{obo} f = 1 MHz	10^d				50	200	75	300	125	500	pF
* t_d^e			3	0.6	–	0.05	–	–	–	–	μs
			5	1	–	–	–	0.05	–	–	
			10	2	–	–	–	–	–	0.05	
* t_r^e			3	0.6	–	0.7	–	–	–		
			5	1	–	–	–	1	–	–	
			10	2	–	–	–	–	–	1	
* t_s^e			3	0.6	–	4	–	–	–	–	
			5	1	–	–	–	4	–	–	
			10	2	–	–	–	–	–	4	
* t_f^e			3	0.6	–	0.8	–	–	–	–	
			5	1	–	–	–	1	–	–	
			10	2	–	–	–	–	–	0.7	

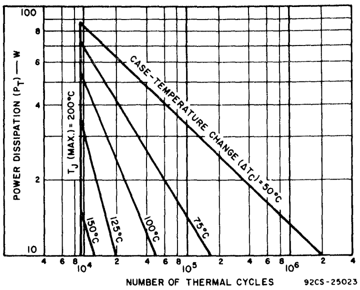


Fig. 4 — Thermal-cycling chart for type 2N6544.

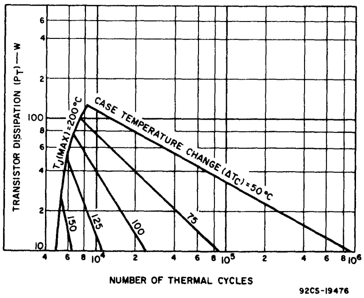


Fig. 5 — Thermal-cycle rating chart for type 2N6546.

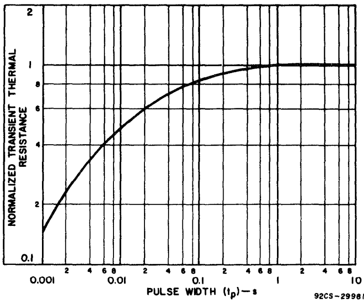


Fig. 6 — Typical thermal-response characteristic for types 2N6542 and 2N6544.

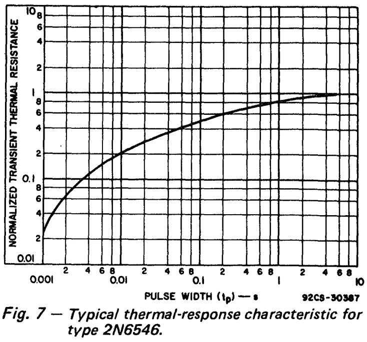


Fig. 7 — Typical thermal-response characteristic for type 2N6546.

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						Units
	VOLTAGE V dc		CURRENT A dc		2N6542		2N6544		2N6546		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
$T_C = 100°C$											
* I_{CEV}	650	−1.5			–	2.5	–	2.5	–	4	mA
* I_{CER} $R_{BE} = 50\,\Omega$	650				–	3	–	3	–	5	
* $V_{CEX}(sus)^{b,c}$ $V_{CC} = 20$ V			2.6^a		350	–	–	–	–	–	V
L=180 μH, $R_C = 0.05\Omega$			4.5^a		–	–	350	–	–	–	
V_{clamp} = Rated V_{CEX}			8^a		–	–	–	–	350	–	
V_{clamp} = Rated V_{CEO} −100 V			5^a		200	–	–	–	–	–	
			8^a		–	–	200	–	–	–	
			15^a		–	–	–	–	200	–	
* $V_{BE}(sat)$			3^a	0.6	–	1.4	–	–	–	–	V
			5^a	1	–	–	–	1.6	–	–	
			10^a	2	–	–	–	–	–	1.6	
* $V_{CE}(sat)$			3^a	0.6	–	2	–	–	–	–	
			5^a	1	–	–	–	2.5	–	–	
			10^a	2	–	–	–	–	–	2.5	
* $t_s{}^f$		−5	3	0.6	–	4	–	–	–	–	μs
		−5	5	1	–	–	–	4	–	–	
		−5	10	2	–	–	–	–	–	5	
* $t_f{}^f$		−5	3	0.6	–	0.8	–	–	–	–	
		−5	5	1	–	–	–	0.9	–	–	
		−5	10	2	–	–	–	–	–	1.5	
* $R_{\theta JC}$					–	1.75	–	1.4	–	1	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 μs, duty factor ⩽2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ and $V_{CEX}(sus)$ *MUST NOT* be measured on a curve tracer.

[c] $V_{CC} = 20$ V, L = 180 μH, $R_C = 0.05\ \Omega$

[d] V_{CB} value

[e] Resistive load, $V_{CC} = 250$ V, $t_p = 100$ μs, $I_{B_1} = -I_{B_2}$

[f] Inductive load, V_{clamp} = Rated $V_{CEX}(sus)$, $I_{B_1} = -I_C/5$, L = 180 μH, $R_C = 0.05\ \Omega$, $V_{CC} = 20$ V

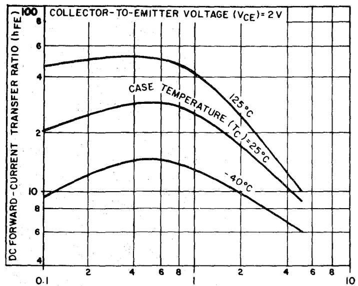


Fig. 8 — Typical dc beta characteristics for type 2N6542.

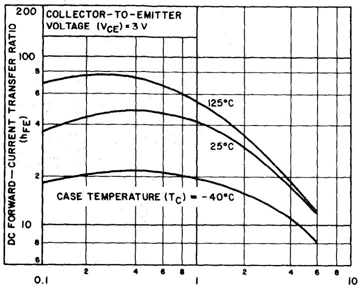


Fig. 9 — Typical dc beta characteristics for type 2N6544.

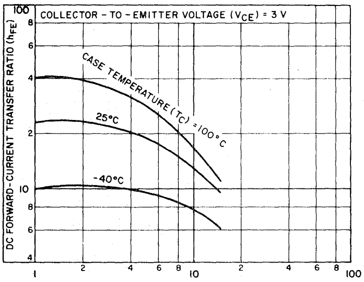


Fig. 10 — Typical dc beta characteristics for type 2N6546.

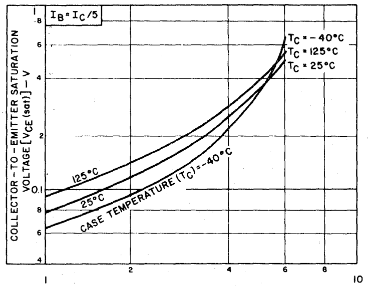


Fig. 11 — Typical collector-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

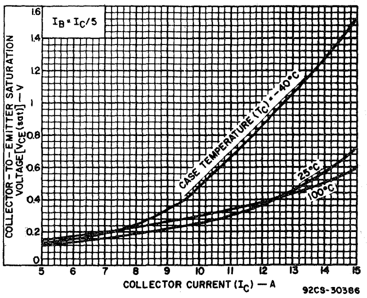


Fig. 12 — Typical collector-to-emitter saturation voltage characteristics for type 2N6546.

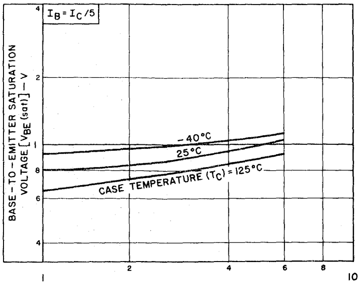


Fig. 13 — Typical base-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

2N6542, 2N6544, 2N6546

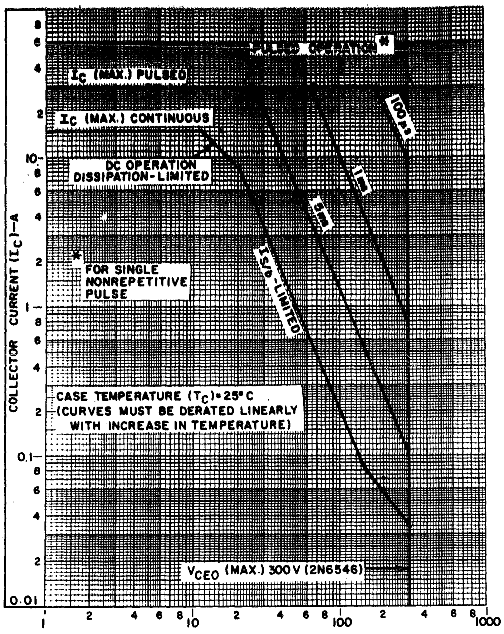


Fig. 14 – Maximum operating areas for type 2N6546 (T_C = 25°C).

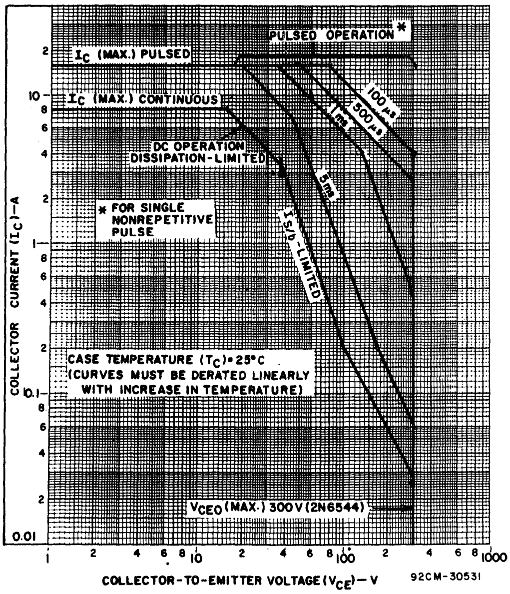


Fig. 15 – Maximum operating areas for type 2N6544 (T_C = 25°C).

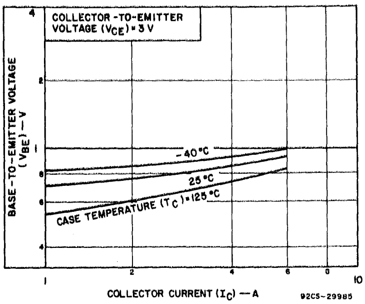


Fig. 16 – Typical base-to-emitter voltage as a function of collector current for types 2N6542 and 2N6544.

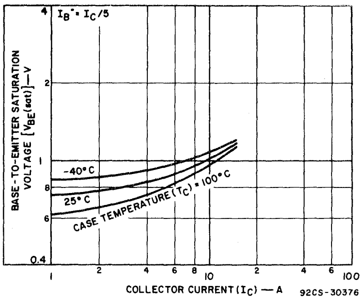


Fig. 17 – Typical base-to-emitter saturation voltage characteristics for type 2N6546.

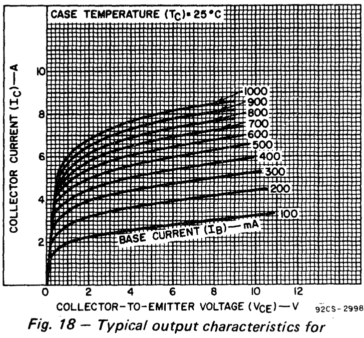


Fig. 18 – Typical output characteristics for types 2N6542 and 2N6544.

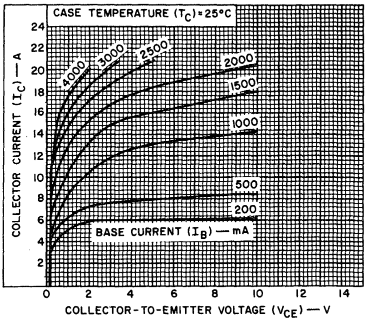


Fig. 19 – Typical output characteristics for type 2N6546.

2N6576, 2N6577, 2N6578

15-Ampere N-P-N Darlington Power Transistors

60, 90, 120 Volts, 120 Watts
Gain of 2000 at 4 A

The 2N6576, 2N6577, and 2N6578 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The double epitaxial construction of these devices provides good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

All types utilize the steel JEDEC TO-204MA/ TO-3 hermetic package.

Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

Applications:

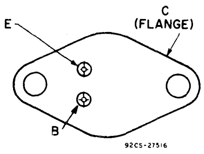
- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6576	2N6577	2N6578	
* V_{CBO}	60	90	120	V
* $V_{CEO}(sus)$	60	90	120	V
* V_{EBO}		7		V
* I_C		15		A
I_{CM}		30		A
* I_B		0.25		A
* P_T				
$T_C \leqslant 25^oC$		120		W
$T_C > 25^oC$		See Fig. 2		
* T_{stg}, T_J		−65 to 200		^oC
* T_L				
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235		^oC

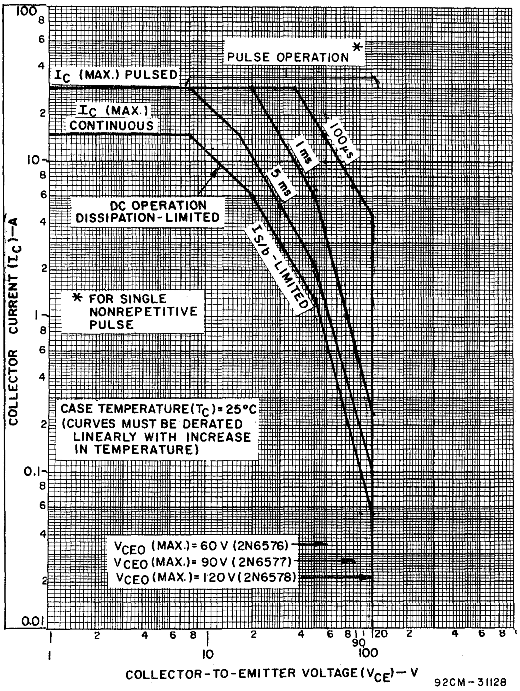
* In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)



1 — Maximum operating areas for all types.

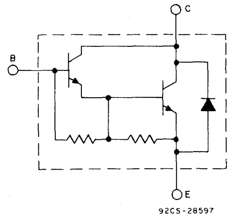


Fig. 2 — Schematic diagram for all types.

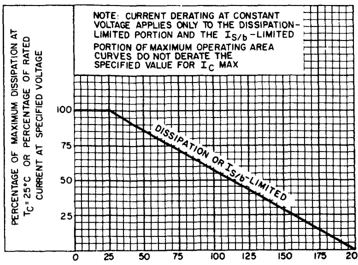


Fig. 3 — Derating curves for all types.

2N6576, 2N6577, 2N6578

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS					LIMITS						UNITS
	VOLTAGE V dc			CURRENT A dc		2N6576		2N6577		2N6578		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CBO}	60[a]					–	0.5	–	–	–	–	mA
	90[a]					–	–	–	0.5	–	–	
	120[a]					–	–	–	–	–	0.5	
* I_{CEO}	60				0	–	1	–	–	–	–	
	90				0	–	–	–	1	–	–	
	120				0	–	–	–	–	–	1	
I_{CER}	60					–	5	–	–	–	–	
R_{BE} = 10K	90					–	–	–	5	–	–	
* T_C=150°C	120					–	–	–	–	–	5	
I_{CEX}	60		−1.5			–	5	–	–	–	–	
T_C=175°C	90		−1.5			–	–	–	5	–	–	
	120		−1.5			–	–	–	–	–	5	
* I_{EBO}		7		0		–	7.5	–	7.5	–	7.5	mA
* V_{CEO}(sus)				0.2[b]	0	60	–	90	–	120	–	V
* h_{FE}	3			0.4[b]		200	–	200	–	200	–	
	3			4[b]		2000	20000	2000	20000	2000	20000	
	3			10[b]		500	5000	500	5000	500	5000	
	4			15[b]		100	–	100	–	100	–	
* V_{BE}(sat)			10	0.1[b]		–	3.5	–	3.5	–	3.5	V
			15	0.15[b]		–	4.5	–	4.5	–	4.5	
* V_{CE}(sat)				10[b]	0.1	–	2.8	–	2.8	–	2.8	V
				15[b]	0.15	–	4	–	4	–	4	
V_F				−15		–	4.5	–	4.5	–	4.5	
* h_{fe} f=1 MHz	3			3		4	40	4	40	4	40	
* t_d[c]				10	0.1	–	0.15	–	0.15	–	0.15	μs
* t_r[c]				10	0.1	–	1	–	1	–	1	
* t_s[c]				10	0.1[d]	–	2	–	2	–	2	
* t_f[c]				10	0.1[d]	–	7	–	7	–	7	
$I_{S/b}$ t=1 s, non rep.	20					6	–	6	–	6	–	A
$R_{\theta JC}$						–	1.46	–	1.46	–	1.46	°C/W

* In accordance with JEDEC registration data.

[a] V_{CB} value.

[b] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[c] V_{CC} = 30 V, t_p = 300 μs, duty cycle = 2%.

[d] $I_{B_1} = -I_{B_2}$.

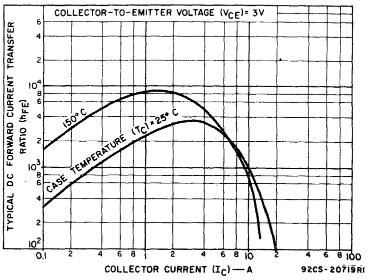


Fig. 4 – Typical dc-beta characteristics for all types.

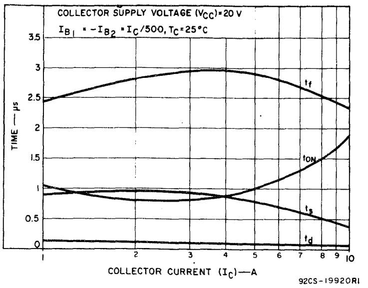


Fig. 5 – Typical saturated switching time characteristics for all types.

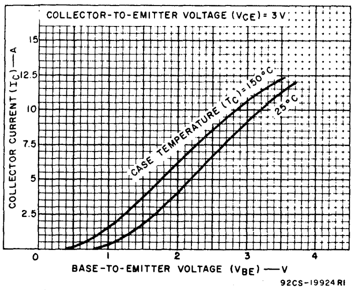


Fig. 6 – Typical transfer characteristics for all types.

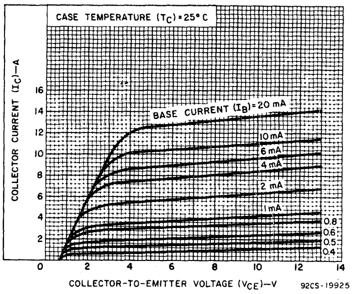


Fig. 7 – Typical output characteristics for all types.

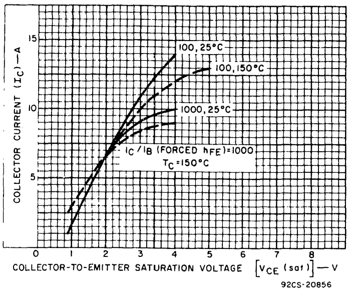


Fig. 8 – Typical saturation characteristics for all types.

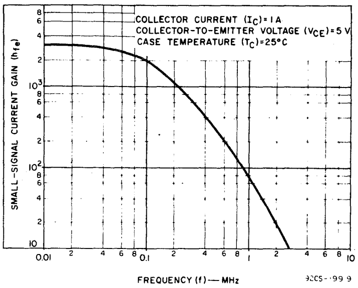


Fig. 9 – Typical small-signal gain for all types.

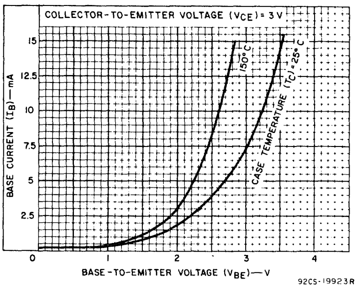


Fig. 10 – Typical input characteristics for all types.

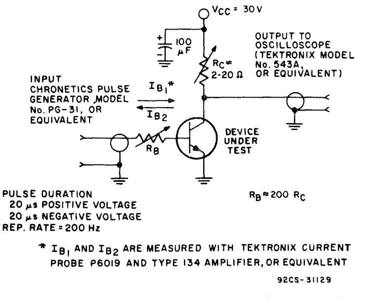


Fig. 11 – Circuit used to measure saturated-switching times.

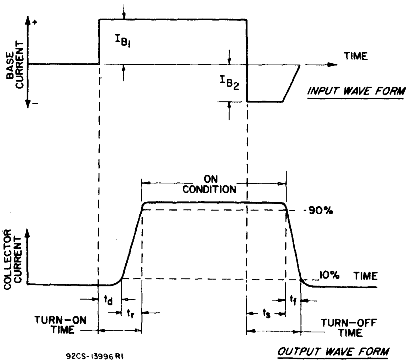


Fig. 12 – Phase relationship between input current and output current showing reference points for specification of switching times (test circuit shown in Fig. 11).

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

Silicon P-N-P Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable
For Industrial and Commercial Use

The RCA-2N6609, MJ15004, RCA9116C, RCA9116D, and RCA9116E are ballasted epitaxial-base silicon p-n-p transistors featuring high gain at high current. They may be used as complements to the n-p-n types RCA3773, MJ15003, RCA8638C, RCA 8638D, and RCA8638E, respectively.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204MA packages.

Features:

- High-dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- f_T = 2 MHz
- High gain at high current

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6609	MJ15004	RCA9116C	RCA9116D	RCA9116E	
* V_{CBO}	−160	−140	−140	−120	−100	V
V_{CEX}(sus)						
V_{BE} = −1.5 V; R_{BE} = 100 Ω	−160	–	–	–	–	V
V_{CER}(sus)						
R_{BE} = 100 Ω	−150	−150	−150	−130	−110	V
* V_{CEO}(sus)	−140	−140	−140	−120	−100	V
* V_{EBO}	−7	−5				V
* I_C	−16	−20				A
* I_B	−4	−5				A
* P_T						
At $T_C \geqslant 25^\circ C$	150	250	200	200	200	W
At $T_C > 25^\circ C$ Derate linearly	0.857	1.43	1.14			W/°C
* T_{stg}, T_J	−65 to 200					°C
* T_L						
At distance ⩾1/32 in. (0.8 mm) from seating plane for 10 s max.	265	230				°C

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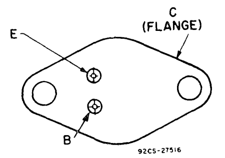
* 2N-type in accordance with JEDEC registration data format JS25RDF1, Issue 1.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

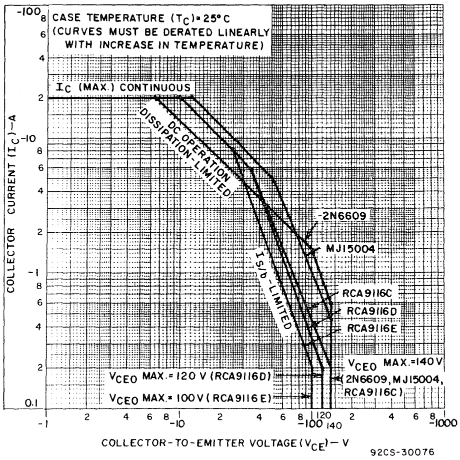


Fig. 1 — Maximum operating areas for all types.

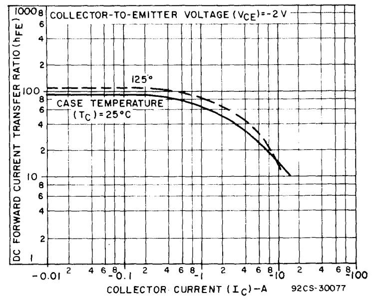


Fig. 2 — Typical dc beta characteristics as a function of collector current for all types.

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

	CHARACTERISTIC	TEST CONDITIONS			LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc	2N6609		MJ15004		
		V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
 *	I_{CBO}	−160[a] −140[a]			– –	−4 −2	– –	– −1	mA
	I_{CEX}	−140	1.5		–	–	–	−0.1	
	I_{CEX} T_C = 150°C	−140	1.5		–	–	–	−2	
*	I_{CEV}	−140	1.5		–	−2	–	–	
*	I_{CEV} T_C = 150°C	−140	1.5		–	−10	–	–	
 *	I_{CEO} I_B = 0	−140 −120			– –	– −10	– –	−0.25 –	
*	I_{EBO}	−7 −5			– –	−5 –	– –	– −0.1	
* *	h_{FE}	−4 −4 −2 −2		−8[c] −16[c] −5[c] −10[c]	15 5 – –	60 – – –	– – 25 10	– – 150 –	
	$V_{CEX}(sus)$[b] R_{BE} = 100Ω		1.5	−0.2	−160	–	–	–	V
	$V_{CER}(sus)$[b] R_{BE} ⩽ 100Ω			−0.2	−150	–	−150	–	
*	$V_{CEO}(sus)$[b]			−0.2	−140	–	−140	–	
	V_{EBO} I_E = −1 mA			0	−7	–	−5[d]	–	
	V_{BE}	−4 −2		−8[c] −5[c]	– –	−2.2 –	– –	– −2	
 * *	$V_{CE}(sat)$ I_B = −3.2A = −0.8A = −0.5A			 −16[c] −8[c] −5[c]	 – – –	 −4 −1.4 –	 – – –	 – – −1	
	$I_{S/b}$ t_p = 1 s nonrep.	−100 −50			−1.5 –	– –	−1 −5	– –	A
 *	$\|h_{fe}\|$ f = 0.05 = 0.5 MHz	 −4 −10		 −1 −0.5	 4 4	 – –	 – 4	 – –	
	f_T				2	–	2	–	MHz
*	h_{fe} f = 1 kHz	−4		−1	40	–	–	–	
	C_{ob} f = 0.1 MHz	−10[a]			–	1000	–	1000	pF
	$R_{\theta JC}$	−10		−10	–	1.17	–	0.7	°C/W

See page 252 for footnotes.

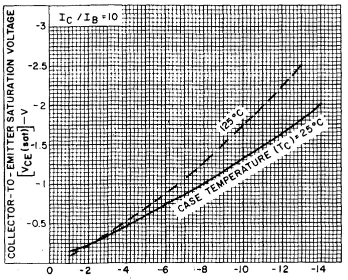


Fig. 3 — Typical saturation voltage characteristics for all types.

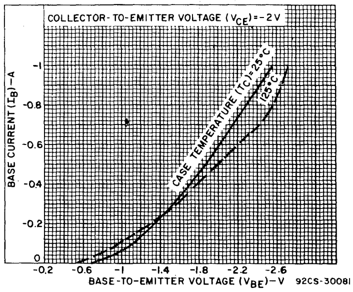


Fig. 4 — Typical input characteristics for all types.

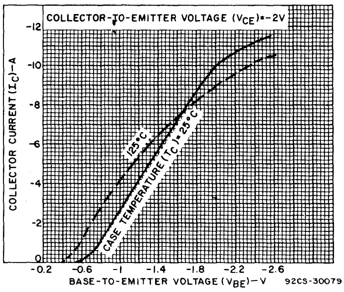


Fig. 5 — Typical transfer characteristics for all types.

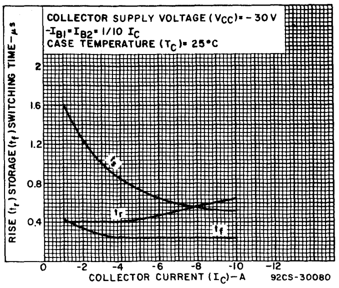


Fig. 6 — Typical saturated-switching times for all types.

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified (Cont'd)*

CHARAC-TERISTIC	TEST CONDITIONS			LIMITS						UNITS
	VOLTAGE V dc		CUR-RENT A dc	RCA9116C		RCA9116D		RCA9116E		
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	−140[a]			–	−1	–	–	–	–	mA
	−120[a]			–	–	–	−1	–	–	
	−100[a]			–	–	–	–	–	−1	
I_{CEX}	−140	1.5		–	−1	–	–	–	–	
	−120	1.5		–	–	–	−1	–	–	
I_{CEX} T_C = 150°C	−140	1.5		–	−5	–	–	–	–	
	−120	1.5		–	–	–	−5	–	–	
I_{CEO} I_B = 0	−70			–	−1	–	–	–	–	
	−60			–	–	–	−1	–	–	
I_{EBO}	−5			–	−1	–	−1	–	−1	
h_{FE}	−2		−5[c]	25	150	25	150	–	–	
	−2		−7.5[c]	–	–	–	–	10	100	
	−2		−10[c]	10	–	10	–	–	–	
V_{CER}(sus)[b] $R_{BE} \leqslant 100\Omega$			−0.2	−150	–	−130	–	−110	–	V
V_{CEO}(sus)[b]			−0.2	−140	–	−120	–	−100	–	
V_{EBO} I_E = −1 mA			0	−5	–	−5	–	−5	–	
V_{BE}	−2		−7.5[c]	–	–	–	–	–	−3	
	−2		−5[c]	–	−2	–	−2	–	–	
V_{CE}(sat) I_B = −0.75A			−7.5[c]	–	–	–	–	–	−1.5	
= −0.5A			−5[c]	–	−1	–	−1	–	–	
$I_{S/b}$ t_p = 1 s nonrep.	−35			−5.71	–	−5.71	–	–	–	A
	−25			–	–	–	–	−8	–	
$\|h_{fe}\|$ f = 0.5 MHz	−10		−0.5	4	–	4	–	4	–	
f_T				2	–	2	–	2	–	MHz
C_{ob} f = 0.1 MHz	−10[a]			–	1000	–	1000	–	1000	pF
$R_{\theta JC}$	−10		−10	–	0.875	–	0.875	–	0.875	°C/W

* 2N-types in accordance with JEDEC registration data format JS25 RDF1, Issue 1.

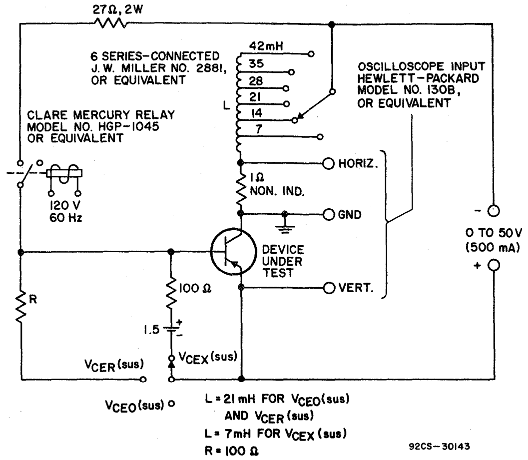
[a] V_{CB}

[b] **CAUTION:** Sustaining voltages V_{CEX}(sus), V_{CER}(sus), and V_{CEO}(sus) *MUST NOT* be measured on a curve tracer. **See Figs. 7 and 8.**

[c] Pulsed; pulse duration = 300 μs, duty factor = 1.8%.

[d] Measured at I_E = −0.1 mA.

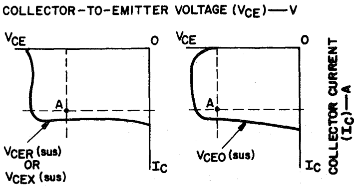
2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E



L = 21 mH FOR V_{CEO}(sus) AND V_{CER}(sus)
L = 7mH FOR V_{CEX}(sus)
R = 100 Ω

92CS-30143

Fig. 7 - Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) for all types.



NOTE: The sustaining Voltages V_{CEO}(sus), V_{CER}(sus) or, V_{CEX}(sus) are acceptable when the trace falls to the left and below point "A". (For values of current and voltage, see Electrical Characteristics.

92CS-30144

Fig. 8 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 7).

2N6648, 2N6649, 2N6650

10-Ampere P-N-P Darlington Power Transistors

40-60-80 Volts, 70 Watts
Gain of 1000 at 5 A

The 2N6648, 2N6649 and 2N6650 are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The 2N6648, 2N6649 and 2N6650 are complementary to the 2N6383, 2N6384, and 2N6385 respectively.

They are all supplied in hermetic steel JEDEC TO-204MA packages.

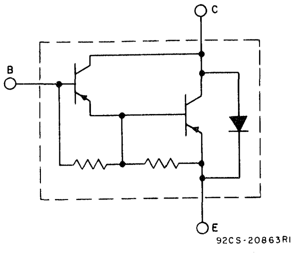


Fig. 1 – Schematic diagram for all types.

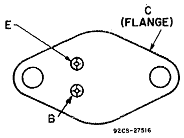
Features:

- **Operates from IC without predriver**
- **High reverse second-breakdown capability**

Applications:

- **Power switching** ■ **Audio amplifiers**
- **Hammer drivers**
- **Series and shunt regulators**

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*	2N6648	2N6649	2N6650	
* V_{CBO}	–40	–60	–80	V
V_{CER}(sus) R_{BE} = 100 Ω	–40	–60	–80	V
* V_{CEO}(sus)	–40	–60	–80	V
V_{CEV}(sus) V_{BE} = –1.5 V	–40	–60	–80	V
* V_{EBO}	–5	–5	–5	V
* I_C	–10	–10	–10	A
I_{CM}	–15	–15	–15	A
* I_B	–0.25	–0.25	–0.25	A
* P_T $T_C \leqslant 25°C$	70	70	70	W
$T_C > 25°C$ Derate linearly	0.56			W/°C
* T_{stg}, T_J	–65 to +150			°C
* T_L At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235			°C

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* In accordance with JEDEC registration data format (JS-6 RDF-4)

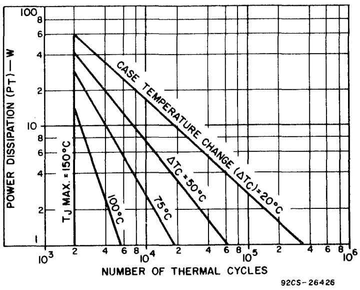


Fig. 2 – Thermal-cycling rating chart for all types.

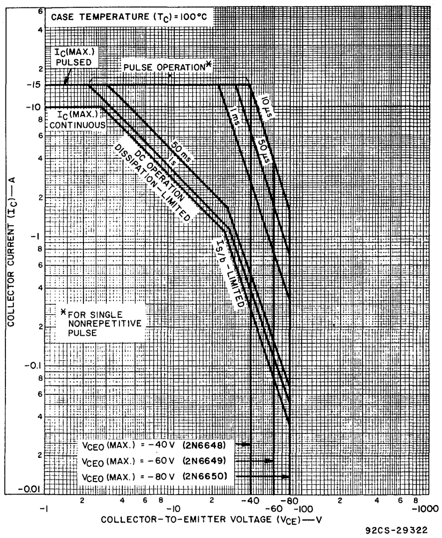


Fig. 3 – Maximum operating areas for all types.

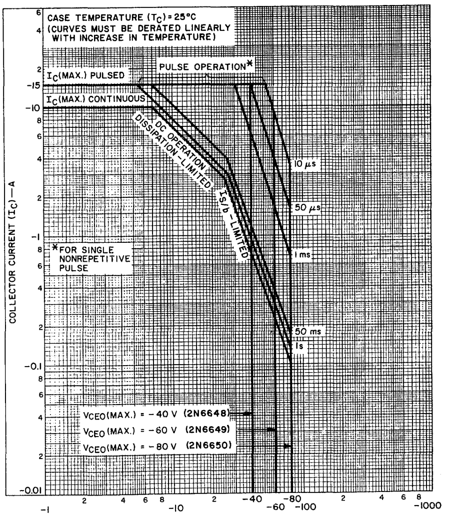


Fig. 4 – Maximum operating areas for all types at T_C = 100°C.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6648		2N6649		2N6650		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}	−40 −60 −80			0 0 0	– – –	−1 – –	– – –	– −1 –	– – –	– – −1	mA
* I_{CEV}	−40 −60 −80	1.5 1.5 1.5			– – –	−0.3 – –	– – –	– −0.3 –	– – –	– – −0.3	
T_C = 150°C	−40 −60 −80	1.5 1.5 1.5			– – –	−3 – –	– – –	– −3 –	– – –	– – −3	
* I_{EBO}		5	0		–	−10	–	−10	–	−10	mA
* V_{CEO}(sus)			-0.2^a	0	−40	–	−60	–	−80	–	V
V_{CER}(sus) R_{BE} = 100 Ω			-0.2^a		−40	–	−60	–	−80	–	
V_{CEV}(sus)		1.5	-0.2^a		−40	–	−60	–	−80	–	
* h_{FE}	−3 −3		-5^a -10^a		1000 100	20,000 –	1000 100	20,000 –	1000 100	20,000 –	
V_{BE}	−3 −3		-5^a -10^a		– –	−2.8 −4.5*	– –	−2.8 −4.5*	– –	−2.8 −4.5*	V
V_{CE}(sat)			-5^a -10^a	-0.01^a -0.1^a	– –	−2 −3*	– –	−2 −3*	– –	−2 −3*	V
V_F			10^a		–	4	–	4	–	4	V
h_{fe} f = 1 kHz	−5		−1		1000	–	1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	−5		−1		20	–	20	–	20	–	
$E_{S/b}$ L = 3 mH, R_{BE} = 100 Ω		1.5	−4.5		30	–	30	–	30	–	mJ
$I_{S/b}$ t = 1 s, nonrep.	−35 −25				−1 −2.8	– –	−1 −2.8	– –	−1 −2.8	– –	A
$R_{\theta JC}$					–	1.75	–	1.75	–	1.75	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-4).

a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

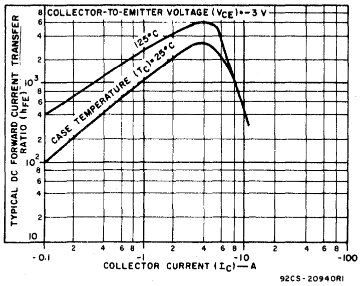


Fig. 5 — Typical dc beta characteristics for for all types.

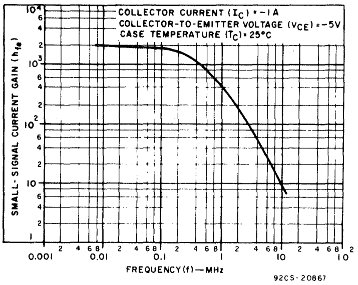


Fig. 6 — Typical small-signal gain for all types

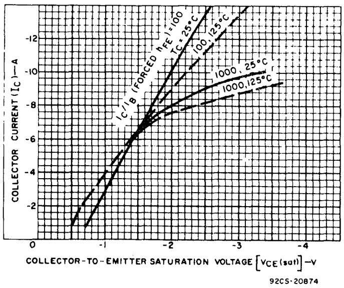


Fig. 7 — Typical saturation characteristics for all types.

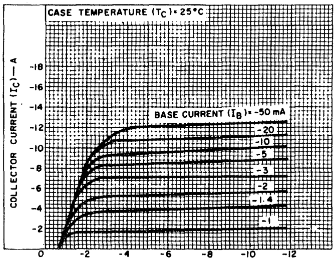


Fig. 8 — Typical output characteristics for all types.

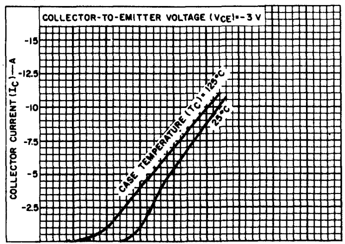


Fig. 9 — Typical transfer characteristics for all types.

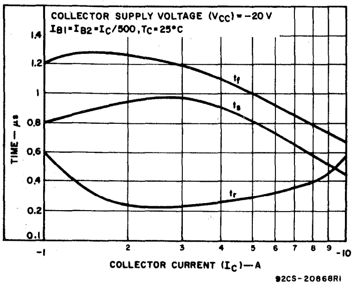


Fig. 10 — Typical saturated switching-time characteristics for all types.

2N6666, 2N6667, 2N6668

10-Ampere P-N-P Darlington Power Transistors

40-60-80 Volts, 65 Watts
Gain of 1000 at 3 A (2N6666)
Gain of 1000 at 5 A (2N6667, 2N6668)

Features:

- Operates from IC without predriver
- High reverse second-breakdown capability

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators

The 2N6666, 2N6667, and 2N6668 are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The 2N6666, 2N6667, and 2N6668 are complementary to the 2N6386, 2N6387, and 2N6388, respectively.▲

These devices are supplied in the JEDEC TO-220AB VERSAWATT package.

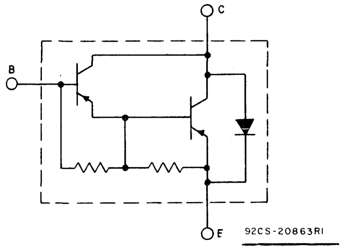
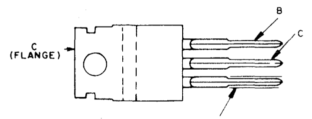


Fig. 1 – Schematic diagram for all types.

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S".)

▲Technical data for 2N6386-2N6388 are given in RCA Bulletin File No. 610.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6666	2N6667	2N6668	
*	V_{CBO}	−40	−60	−80	V
	V_{CER}(sus)				
	R_{BE} = 100 Ω	−40	−60	−80	V
	V_{CEO}(sus)	−40	−60	−80	V
	V_{CEV}(sus)				
	V_{BE} = −1.5 V	−40	−60	−80	V
*	V_{EBO}	−5	−5	−5	V
*	I_C	−8	−10	−10	A
	I_{CM}	−15	−15	−15	A
*	I_B	−0.25	−0.25	−0.25	A
*	P_T				
	$T_C \leqslant 25^oC$	65	65	65	W
	$T_C > 25^oC$ derate linearly		0.52		W/°C
*	T_{stg}, T_J		−65 to +150		°C
*	T_L				
	At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.		235		°C

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*In accordance with JEDEC registration data format (JS-6 RDF-4).

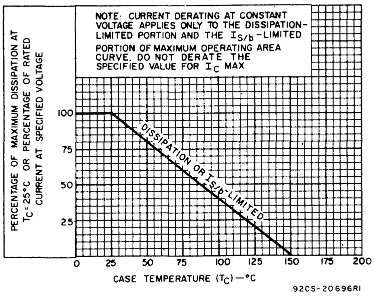


Fig. 2 – Derating curve for all types.

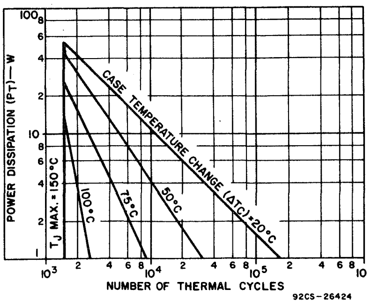


Fig. 3 – Thermal-cycling rating chart for all types.

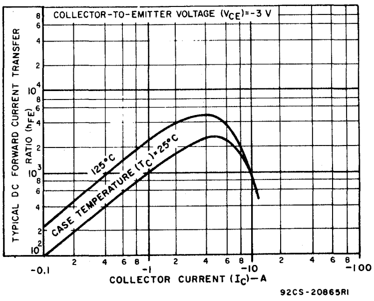


Fig. 4 – Typical dc beta characteristics for all types.

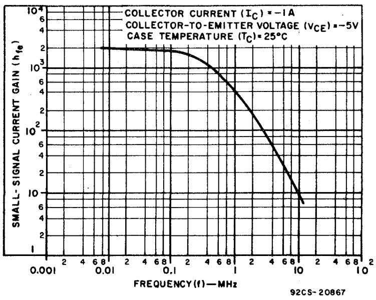


Fig. 5 – Typical small-signal gain for all types.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6666		2N6667		2N6668		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}	–80 –60 –40			0 0 0	– – –	– – –1	– – –	– –1 –	– – –	–1 – –	mA
* I_{CEV}	–80 –60 –40	1.5 1.5 1.5			– – –	– – –0.3	– – –	– –0.3 –	– – –	–0.3 – –	
T_C = 125°C	–80 –60 –40	1.5 1.5 1.5			– – –	– – –3	– – –	– –3 –	– – –	–3 – –	
I_{EBO}		5	0		–	–10	–	–10	–	–10	mA
* V_{CEO}(sus)			–0.2[a]	0	–40	–	–60	–	–80	–	V
V_{CER}(sus) R_{BE} = 100 Ω			–0.2[a]		–40	–	–60	–	–80	–	
V_{CEV}(sus)		1.5	–0.2[a]		–40	–	–60	–	–80	–	
* h_{FE}	–3 –3 –3 –3		–3[a] –5[a] –8[a] –10[a]		1000 – 100 –	20,000 – – –	– 1000 – 100	– 20,000 – –	– 1000 – 100	– 20,000 – –	
V_{BE}	–3 –3 –3 –3		–3[a] –5[a] –8[a] 10[a]		–	2.8 – 4.5 –	– – –	– –2.8 – –4.5	– – – –	– –2.8 – –4.5	V
* $V_{CE(sat)}$			–3[a] –5[a] –8[a] 10[a]	–0.006[a] –0.01[a] –0.08[a] –0.1[a]	– – – –	2 3	– – –	– –2 – 3	– – – –	– –2 – –3	V
V_F			8[a] 10[a]			4 –	–	– 4	– –	4	V
h_{fe} f = 1 kHz	–5		1		1000		1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20		20	–	20	–	
$E_{s/b}$ L = 3 mH, R_{BE} = 100 Ω		1.5	4.5		30		30	–	30	–	mJ
$I_{S/b}$ t = 1 s, nonrep.	–20				3.2		–3.2	–	–3.2	–	A
$R_{\theta JC}$						1.92	–	1.92	–	1.92	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 2%.

*In accordance with JEDEC registration data format (JS-6 RDF-4).

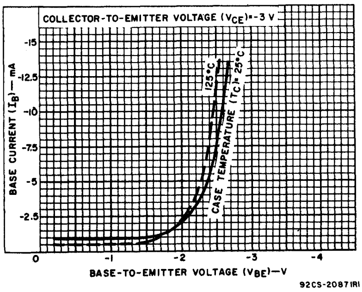


Fig. 6 — Typical input characteristics for all types.

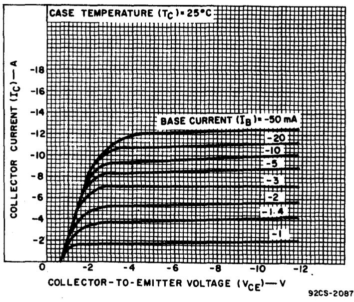


Fig. 7 — Typical output characteristics for all types.

2N6666, 2N6667, 2N6668

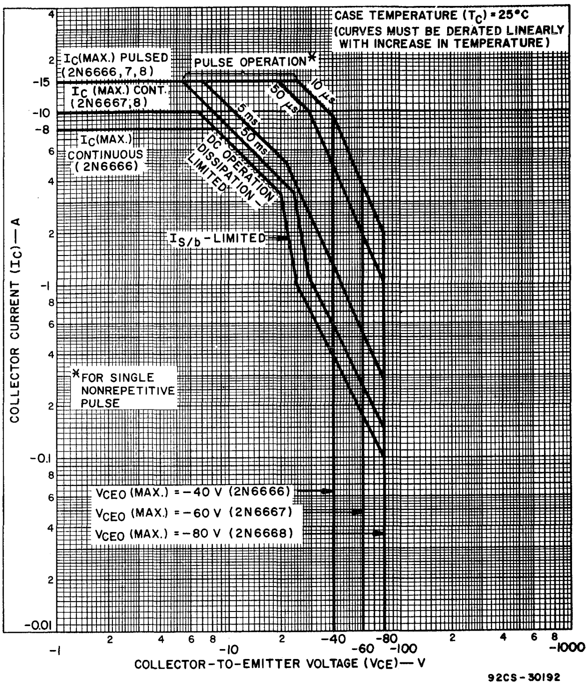


Fig. 8 — Maximum operating areas for all types of $T_C = 25^\circ C$.

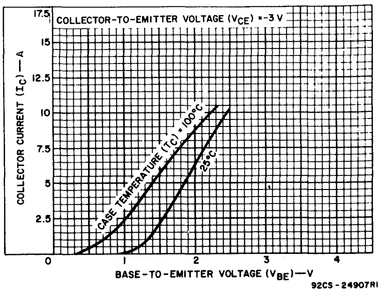


Fig. 9 — Typical transfer characteristics for all types.

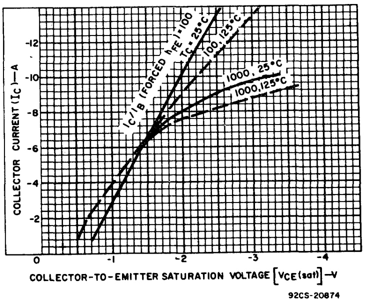


Fig. 10 — Typical saturation characteristics for all types.

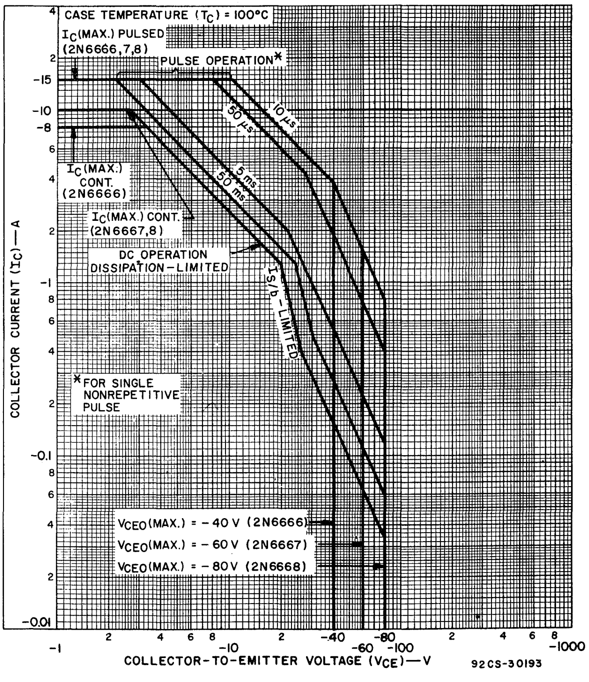


Fig. 11 — Maximum operating areas for all types at $T_C = 100^\circ C$.

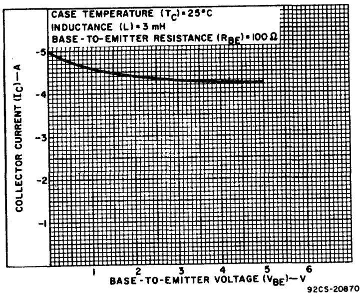


Fig. 12 — Minimum values of reverse-bias second breakdown characteristic ($E_{S/b}$) for all types.

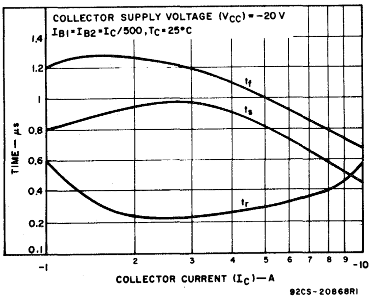


Fig. 13 — Typical saturated switching-time characteristics for all types.

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistor

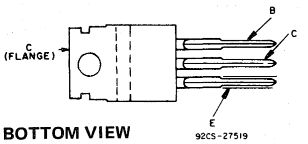
General-Purpose, Medium-Power Type for Switching and Amplifier Applications

Features:
- Low saturation voltages
- Switching speed

The RCA-2N6669● is an epitaxial-base silicon n-p-n transistor supplied in the VERSAWATT package. This transistor is intended for a wide variety of medium-power switching and amplifier applications such as series and shunt regulators, automotive voltage regulators, and driver stages for high-fidelity amplifiers.

●Formerly RCA Dev. No. TA9105.

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB
(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*	2N6669	
* V_{CBO}	40	V
* V_{CEO}	30	V
* V_{EBO}	5	V
* I_C	10	A
* I_B	4	A
* I_E	14	A
* P_T:		
At $T_C = 25°C$	40	W
At $T_C = 100°C$	16	W
At $T_C \geqslant 25°C$ Derate linearly	0.32	W/°C
* T_{stg}, T_J	−65 to 150	°C
* T_L (During soldering): At distance 0.125 in. (3.17 mm) from case for 10 s max.	235	°C

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* In accordance with JEDEC registration data format (JC-25 RDF-1).

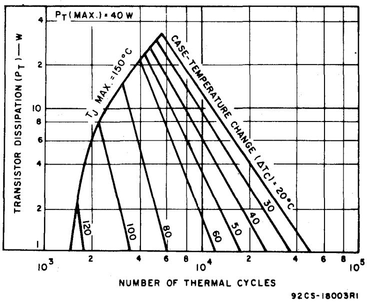


Fig. 1 – Thermal-cycling rating chart.

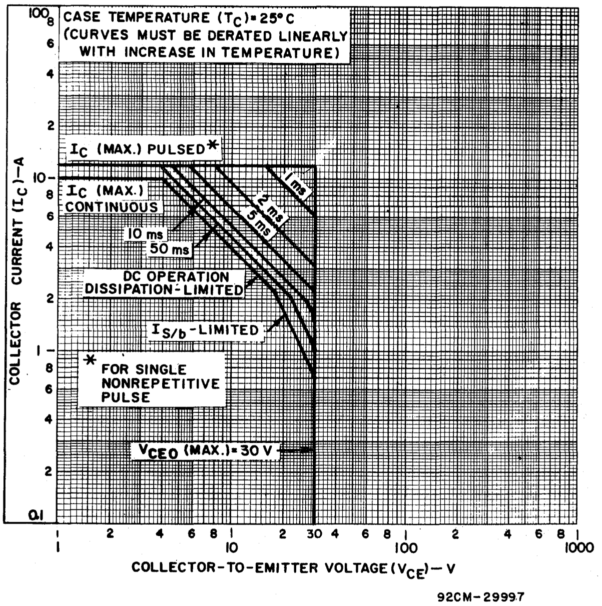


Fig. 2 — Maximum operating areas at $T_C = 25°C$.

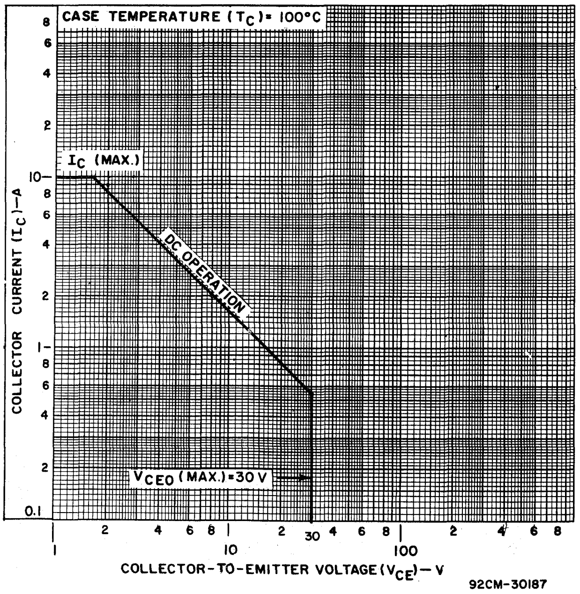


Fig. 3 — Maximum operating areas at $T_C = 100°C$.

2N6669

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

	CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	TEST CONDITIONS VOLTAGE V dc V_{BE}	TEST CONDITIONS CURRENT A dc I_C	TEST CONDITIONS CURRENT A dc I_B	LIMITS 2N6669 Min.	LIMITS 2N6669 Typ.	LIMITS 2N6669 Max.	UNITS
	I_{CEO}	20				–	–	0.1	mA
*	I_{CEV}	40	−1.5			–	–	0.1	mA
	T_C = 100°C	20	−1.5			–	–	5.0	
*	I_{EBO}		5.0			–	–	1.0	mA
*	$V_{CEO}(sus)$ [b]			0.2[a]		30	–	–	V
	$V_{CER}(sus)$ [b] R_{BE} = 50 Ω			0.2[a]		40	–	–	
*	h_{FE}	2		5[a]		20	–	100	
*	$V_{BE}(sat)$			5[a]	0.5	–	–	2.0	V
*	$V_{CE}(sat)$			5[a] 10[a]	0.5 1.0	– –	– –	1.0 2.5	V
*	C_{obo} V_{CB} = 10 V, f = 1 MHz					50	–	150	pF
*	$\lvert h_{fe} \rvert$ f = 1 MHz	2		0.5		10	–	70	
	$I_{S/b}$ t = 0.5 s, nonrepetitive	25 10				1.0 4.0	– –	– –	A
*	t_d [c]			5.0	0.5	–	0.03	0.05	μs
*	t_r [c]			5.0	0.5	–	0.2	0.3	
*	t_s [c]			5.0	0.5	–	0.3	0.5	
*	t_f [c]			5.0	0.5	–	0.3	0.5	
*	$R_{\theta JC}$	10		4		–	–	3.125	°C/W

*Minimum and maximum values and test conditions in accordance with JEDEC registration data format JC-25 RDF-1.

[a] Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

[c] V_{CC} = 30V, I_{B1} = $-I_{B2}$

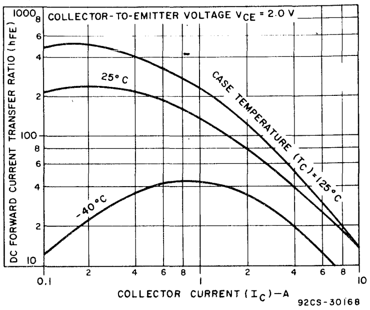


Fig. 4 – Typical dc beta characteristics.

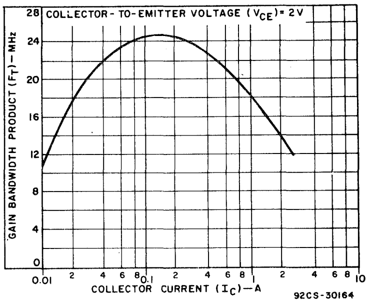


Fig. 5 – Typical gain-bandwidth product.

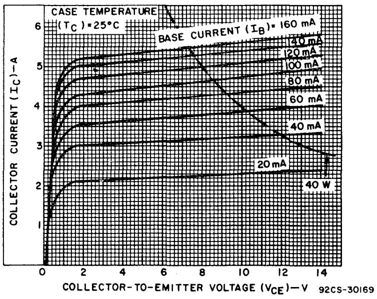


Fig. 6 – Typical output characteristics.

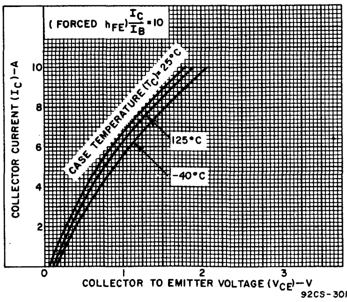


Fig. 7 – Typical saturation characteristics.

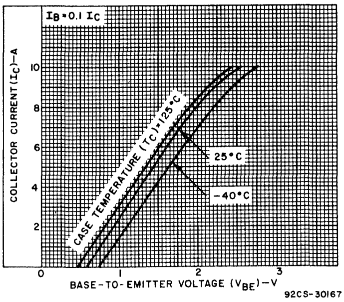


Fig. 8 – Typical base-to-emitter saturation characteristics.

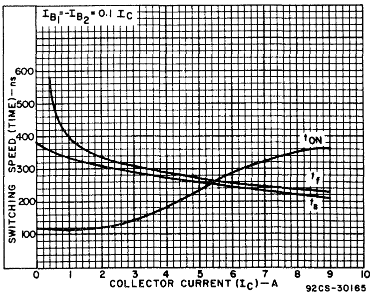


Fig. 9 – Typical saturated switching characteristics.

2N6671, 2N6672, 2N6673

5-A ***SwitchMax*** Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6671, 2N6672, and 2N6673● SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 125°C, as well as at 25°C, to provide information necessary for worst-case design.

The RCA-2N6671, 2N6672, and 2N6673 series transistors are supplied in steel JEDEC TO-204MA hermetic packages.

●Formerly RCA8767, RCA8767A, and RCA8767B, respectively.

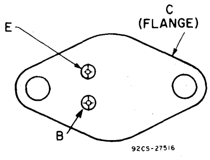
Features:

- **100% High-Temperature Tested for 125°C Parameters**
- **Fast Switching Speed**
- **High Voltage Ratings:**
  V_{CEX} = 350 V to 450 V
- **Low V_{CE}(sat) at I_C = 5 A**
- **Steel Hermetic TO-204MA Package**

Applications:

- **Off-Line Power Supplies**
- **High-Voltage Inverters**
- **Switching Regulators**

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6671	2N6672	2N6673	
* V_{CEV}				
V_{BE} = −1.5 V	450	550	650	V
* V_{CEX} (Clamped)				
V_{BE} = −1.5 V	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}		8		V
I_C(sat)		5		A
* I_C		8		A
I_{CM}		10		A
* I_B		4		A
* P_T				
T_C up to 25°C		150		W
T_C above 25°C, derate linearly		0.86		W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distance ⩾ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

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* In accordance with JEDEC registration data.

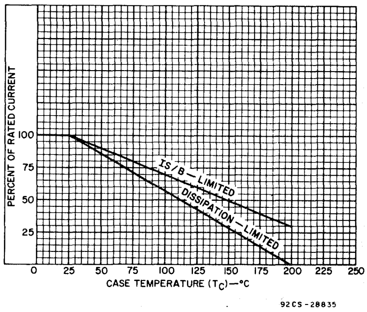

Fig. 1 — Dissipation and $I_{S/b}$ derating curves for all types.

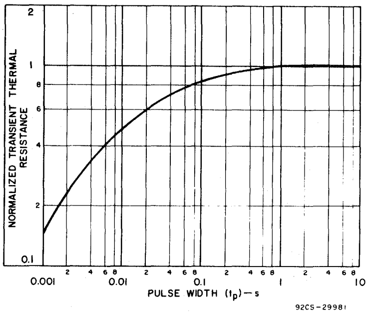

Fig. 2 — Typical thermal-response characteristic for all types.

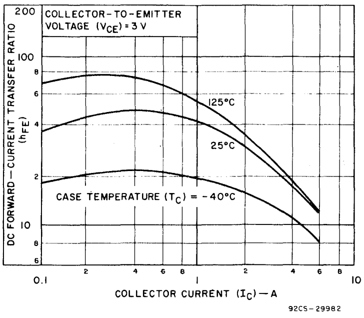

Fig. 3 — Typical dc beta characteristics for all types.

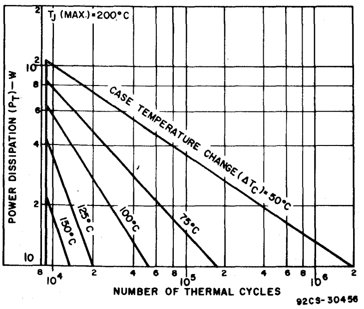

Fig. 4 — Thermal-cycling chart for all types.

2N6671, 2N6672, 2N6673

ELECTRICAL CHARACTERISTICS

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6671		2N6672		2N6673		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
$T_C = 25^oC$											
* I_{CEV}	450 550 650	−1.5 −1.5 −1.5			– – –	0.1 – –	– – –	– 0.1 –	– – –	– – 0.1	mA
* I_{EBO}		−8	0		–	2	–	2	–	2	
* $V_{CEO}(sus)^b$			0.2^a	0	300	–	350	–	400	–	V
* h_{FE}	3		5^a		10	40	10	40	10	40	
* $V_{BE}(sat)$			5^a	1	–	1.6	–	1.6	–	1.6	V
* $V_{CE}(sat)$			5^a 8^a	1 4	– –	1 2	– –	1 2	– –	1 2	
* V_{CEX}^b (Clamped $E_{S/b}$) L=170 μH, R_{BB}=5 Ω		−5 −5	5 8	1^e 3^e	350 200	– –	400 250	– –	450 300	– –	
* $I_{S/b}$	25		6		1	–	1	–	1	–	s
* $\|h_{fe}\|$ f=5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
* C_{obo} f=0.1 MHz	10^c				50	300	50	300	50	300	pF
* t_d^d			5	1	–	0.1	–	0.1	–	0.1	μs
* t_r^d			5	1	–	0.5	–	0.5	–	0.5	
* t_s^d			5	1^e	–	2.5	–	2.5	–	2.5	
* t_f^d			5	1^e	–	0.4	–	0.4	–	0.4	
* t_c V_{CC}=125 V, L=170 μH, R_C=25 Ω Collector clamped to V_{CEX}			5	1^e	–	0.4	–	0.4	–	0.4	
$T_C = 125^oC$											
* I_{CEV}	450 550 650	−1.5 −1.5 −1.5			– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
* $V_{CE}(sat)$			5^a	1	–	2	–	2	–	2	V
* t_r^d			5	1	–	0.8	–	0.8	–	0.8	μs
* t_s^d			5	1^e	–	4	–	4	–	4	
* t_f^d			5	1^e	–	0.8	–	0.8	–	0.8	
* t_c V_{CC}=125 V, L=170 μH, R_C=25 Ω Collector clamped to V_{CEX}			5	1^e	–	0.8	–	0.8	–	0.8	
* $R_{\theta JC}$					–	1.17	–	1.17	–	1.17	$^oC/W$

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 μs, duty factor ⩽ 2%.

[b] CAUTION: The sustaining voltage $V_{CEO}(sus)$ and V_{CEX} MUST NOT be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 125 V, t_p = 20 μs.

[e] $I_{B_1} = -I_{B_2}$.

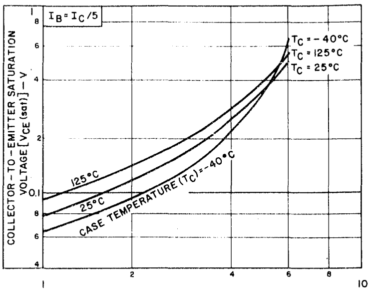

Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

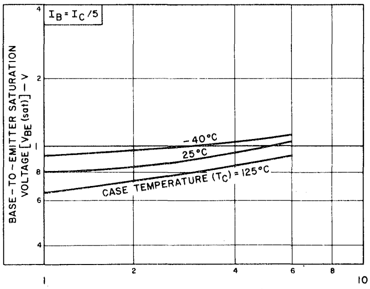

Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

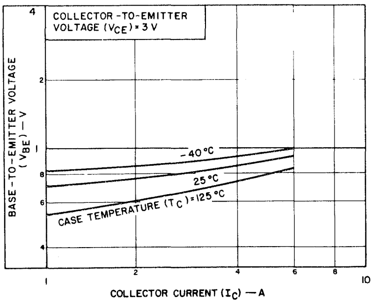

Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

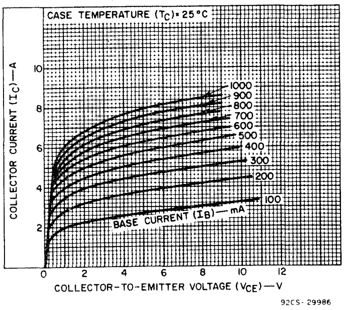

Fig. 8 — Typical output characteristics for all types.

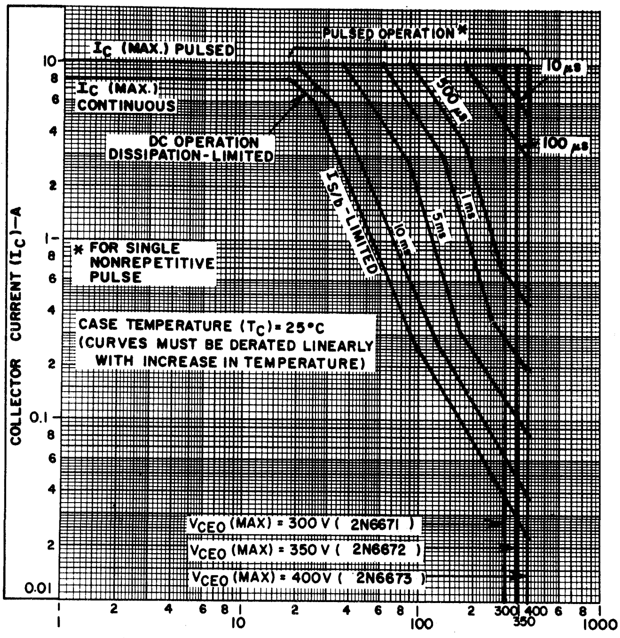

Fig. 9 — Maximum operating areas for all types ($T_C = 25^\circ C$).

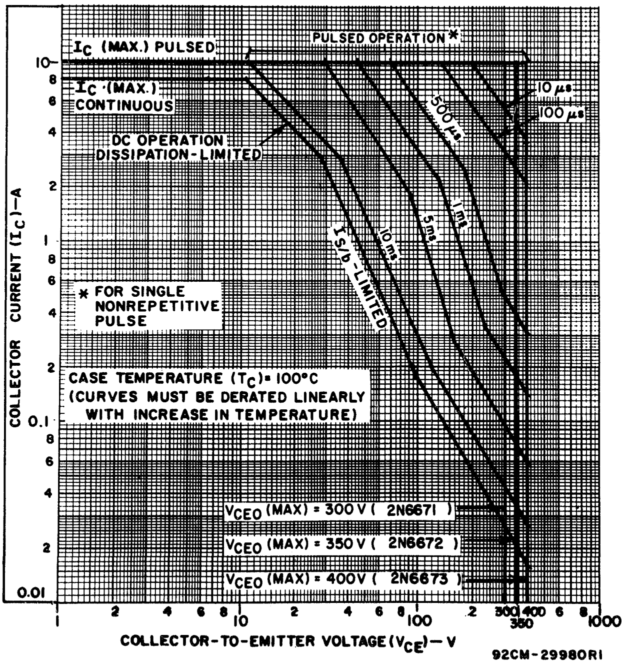

Fig. 10 — Maximum operating areas for all types ($T_C = 100^\circ C$).

2N6671, 2N6672, 2N6673

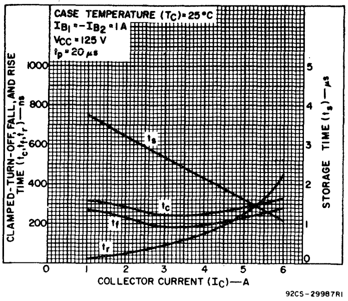

Fig. 11 – Typical saturated switching time characteristics for all types.

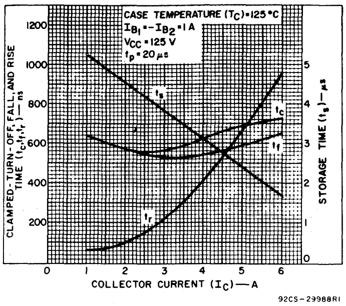

Fig. 12 – Typical saturated switching time characteristics for all types.

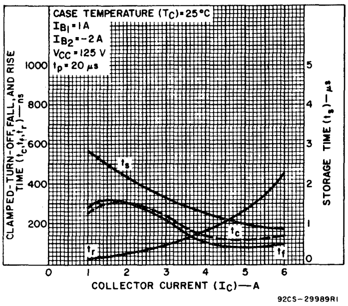

Fig. 13 – Typical saturated switching time characteristics for all types.

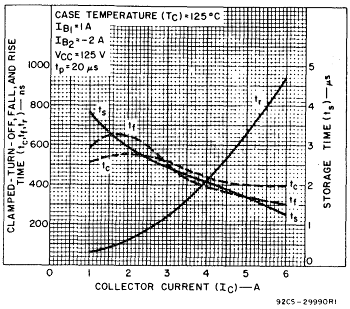

Fig. 14 – Typical saturated switching time characteristics for all types.

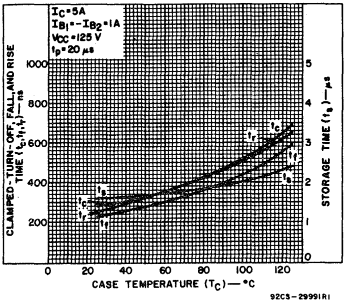

Fig. 15 – Typical saturated switching time characteristics as a function of case temperature for all types.

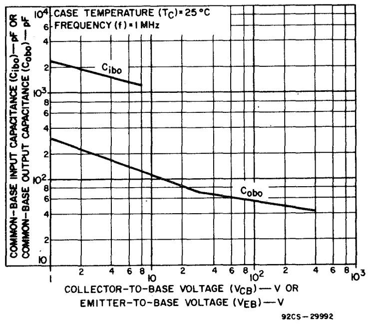

Fig. 16 – Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

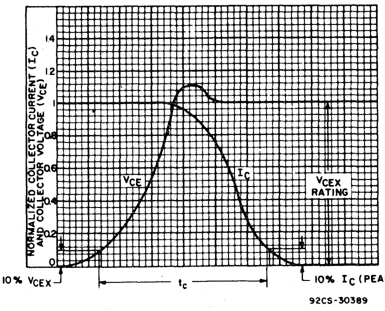

Fig. 17 – Oscilloscope display for measurement of clamped induction switching time (t_c).

2N6674, 2N6675, 2N6689, 2N6690

10-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6674, 2N6675, 2N6689 and 2N6690● SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 100°C, as well as at 25°C, to provide information necessary for worst-case design.

The 2N6674 and 2N6675 transistors are supplied in steel JEDEC TO-204MA hermetic packages. The 2N6689 and 2N6690 transistors are supplied in JEDEC TO-211MA hermetic packages with all terminals electrically isolated from case.

● Formerly RCA Dev. Type Nos. TA9114D and TA9114E; TA9146D and TA9146E, respectively.

Features:

- **100% High-Temperature Tested for 100°C Parameters**
- **Fast Switching Speed**
- **High Voltage Ratings:** **V_{CEX} = 350 V to 450 V**
- **Low V_{CE}(sat) at I_C = 10 A**
- **Steel Hermetic TO-204MA Package (2N6674, 2N6675)**
- **TO-211MA Package— steel hermetic shell, solid copper header/stud for low-thermal resistance. All terminals isolated from case (2N6689, 2N6690)**

Applications:

- **Off-Line Power Supplies**
- **High-Voltage Inverters**
- **Switching Regulators**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6674 2N6689	2N6675 2N6690	
* V_{CEV}			
V_{BE} = −1.5 V	450	650	V
* V_{CEX}(Clamped)			
V_{BE} = −1.5 V	350	450	V
* V_{CEO}	300	400	V
* V_{EBO}	7		V
I_C(sat)	10		A
* I_C	15		A
I_{CM}	20		A
* I_B	5		A
* P_T			
T_C up to 25°C	175		W
T_C above 25°C, derate linearly	1		W/°C
* T_{stg}, T_J	−65 to 200		°C
* T_L			
At distance ⩾ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235		°C

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* In accordance with JEDEC registration data.

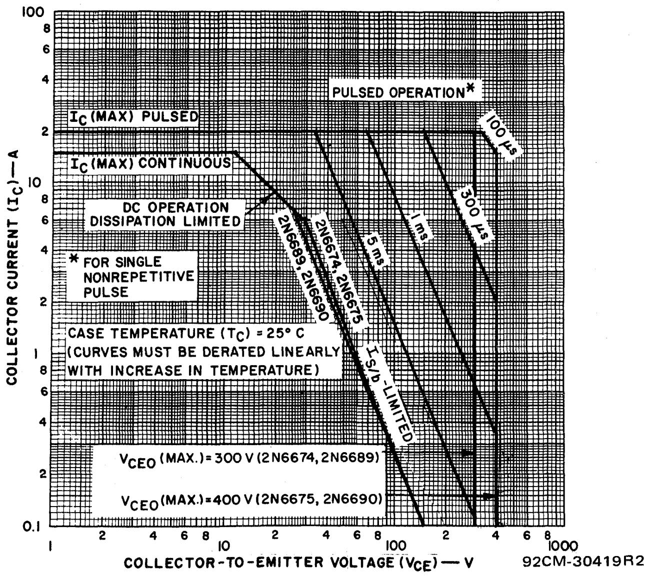
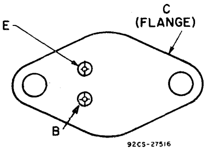


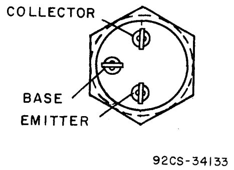
Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)



JEDEC TO-211MA

(See dimensional outline "M".)

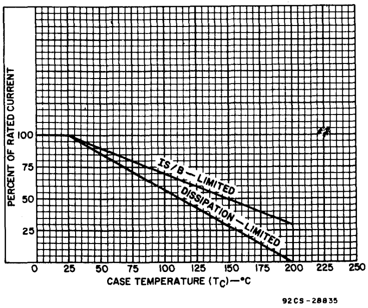


Fig. 2 — Dissipation and $I_{S/b}$ derating curves for all types.

2N6674, 2N6675, 2N6689, 2N6690

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6674 2N6689		2N6675 2N6690		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
$T_C = 25^oC$									
* I_{CEV}	450 650	−1.5 −1.5			– –	0.1 –	– –	– 0.1	mA
* I_{EBO}		−7	0		–	2	–	2	
* $V_{CEO}(sus)^b$			0.2^a	0	300	–	400	–	V
* h_{FE}	2		10^a		8	20	8	20	
* $V_{BE}(sat)$			10^a	2	–	1.5	–	1.5	V
* $V_{CE}(sat)$			10^a 15^a	2 5	– –	1 5	– –	1 5	
V_{CEX}^b (Clamped $E_{S/b}$) L=50 µH, R_{BB}=2 Ω		−4	10	2	350	–	450	–	
$I_{S/b}$ 2N6689,90	25		7		1	–	1	–	s
$I_{S/b}$ 2N6674,75	30		5.9		1	–	1	–	
$I_{S/b}$ For All Types	100		0.25		1	–	1	–	
* $\|h_{fe}\|$ f = 5 MHz	10		1		3	10	3	10	
f_T	10		1		15	50	15	50	MHz
* C_{obo} f = 0.1 MHz	10^c				150	500	150	500	pF
* t_d^d		−6	10	2	–	0.1	–	0.1	µs
* t_r^d		−6	10	2	–	0.6	–	0.6	
* t_s^d		−6	10	2^e	–	2.5	–	2.5	
* t_f^d		−6	10	2^e	–	0.5	–	0.5	
* t_c V_{CC} = 135 V, L=50 µH, $R_C \leqslant$ 13.5 Ω, Collector clamped to V_{CEX}		−6	10	2^e	–	0.5	–	0.5	
$T_C = 100\ ^oC$									
* I_{CEV}	450 650	−1.5 −1.5			– –	1 –	– –	– 1	mA
* $V_{CE}(sat)$			10^a	2	–	2	–	2	V
* t_r^d		−6	10	2	–	1	–	1	µs
* t_s^d		−6	10	2^e	–	4	–	4	
* t_f^d		−6	10	2^e	–	1	–	1	
* t_c V_{CC} = 135 V, L=50 µH, $R_C \leqslant$ 13.5 Ω, Collector clamped to V_{CEX}		−6	10	2^e	–	0.8	–	0.8	
* $R_{\theta JC}$	10		5		–	1	–	1	°C/W

[a] Pulsed: pulse duration = 300 µs, duty factor ⩽2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ and V_{CEX} MUST NOT be measured on a curve tracer.

[*] In accordance with JEDEC registration data.

[c] V_{CB} value.

[d] V_{CC} = 135 V, t_p = 20 µs.

[e] $I_{B1} = -I_{B2}$.

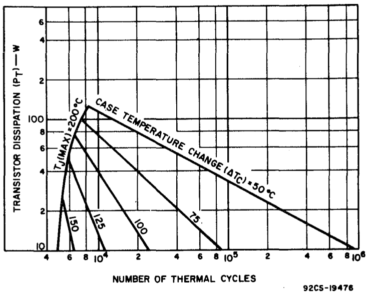


Fig. 3 — Thermal-cycling for all types.

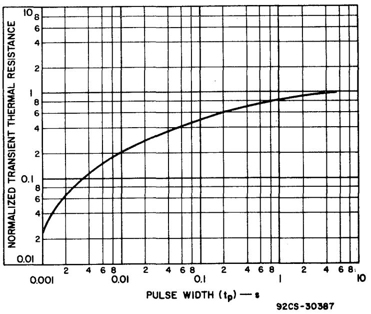


Fig. 4 — Typical thermal-response characteristic for all types.

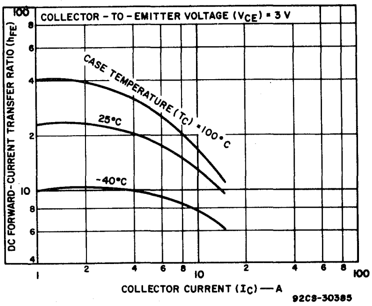


Fig. 5 — Typical dc beta characteristics for all types.

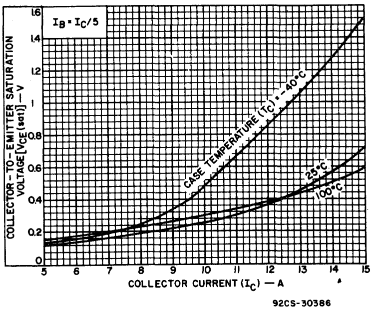


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics for all types.

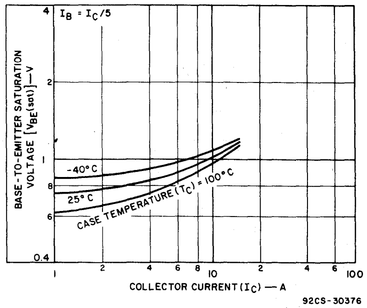


Fig. 7 – Typical base-to-emitter saturation voltage characteristics for all types.

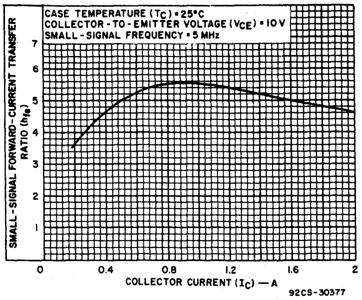


Fig. 8 – Typical small-signal forward current transfer ratio characteristic for all types (f = 5 MHz).

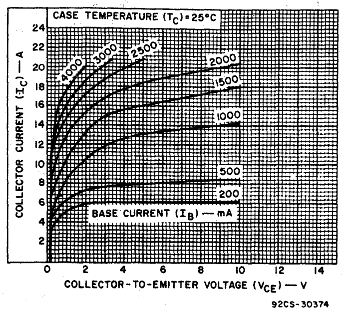


Fig. 9 – Typical output characteristics for all types.

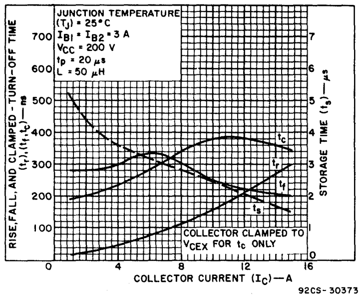


Fig. 10 – Typical saturated-switching-time characteristics at T_J = 25°C as a function of collector current for all types.

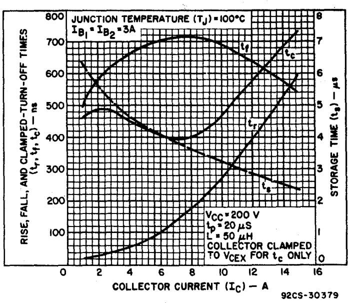


Fig. 11 – Typical saturated-switching-time characteristics at T_J = 100°C as a function of collector current for all types.

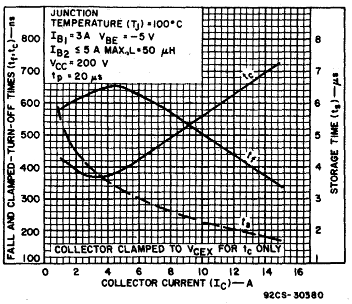


Fig. 12 – Typical saturated-switching-time characteristics at T_J = 100°C as a function of collector current for all types.

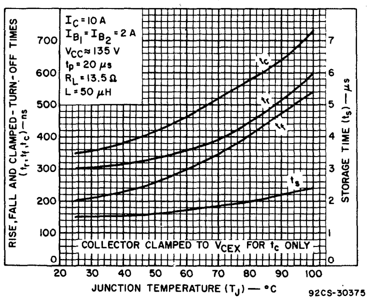


Fig. 13 – Typical saturated-switching-time characteristics as a function of junction temperature for all types.

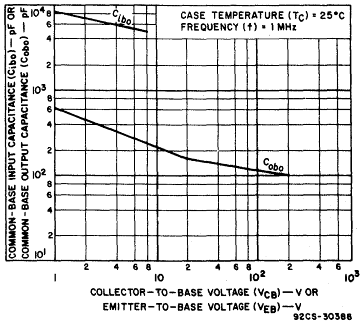


Fig. 14 – Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

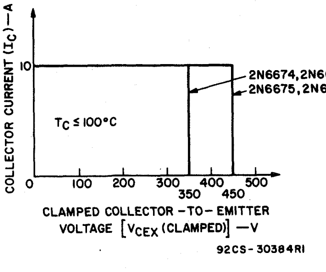


Fig. 15 – Maximum operating conditions for switching between saturation and cutoff for all types.

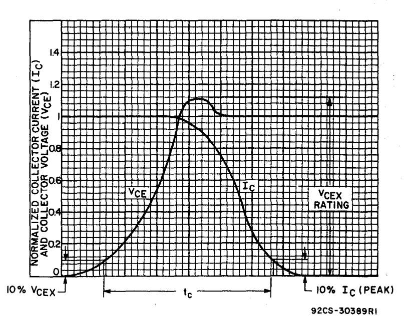


Fig. 16 – Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

2N6676, 2N6677, 2N6678, 2N6691, 2N6692, 2N6693

15-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

RCA-2N6676, 2N6677, 2N6678, 2N6691, 2N6692, and 2N6693• SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits. Switching time, including inductive turn-off time, and saturation voltages are tested at 100°C, as well as at 25°C, to provide information necessary for worst-case design.

The 2N6676, 2N6677, and 2N6678 transistors are supplied in steel JEDEC TO-204MA hermetic packages. The 2N6691, 2N6692, 2N6693 transistors are supplied in JEDEC TO-211MA hermetic packages with all terminals electrically isolated from case.

• Formerly RCA Dev. Types Nos. TA9114A, TA9114B, TA9114C, TA9146A, TA9146B, and TA9146C, respectively.

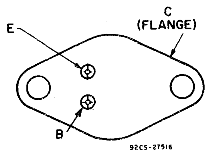
Features:

- **100% High-Temperature Tested for 100°C Parameters**
- **Fast Switching Speed**
- **High Voltage Ratings: V_{CEX} = 350 V to 450 V**
- **Low $V_{CE}(sat)$ at I_C = 15 A**
- **Steel Hermetic TO-204MA Package (2N6676,77,78)**
- **TO-211MA Package— steel hermetic shell, solid copper header/stud for low-thermal resistance. All terminals isolated from case (2N6691, 2N6692, 2N6693)**

Applications:

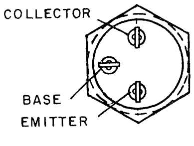
- **Off-Line Power Supplies**
- **High-Voltage Inverters**
- **Switching Regulators**

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)



92CS-34133

JEDEC TO-211MA

(See dimensional outline "M".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6676 2N6691	2N6677 2N6692	2N6678 2N6693	
* V_{CEV}				
V_{BE} = −1.5 V	450	550	650	V
* V_{CEX} (Clamped)				
V_{BE} = −1.5 V	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}	8			V
I_C(sat)	15			A
* I_C	15			A
I_{CM}	20			A
* I_B	5			A
* P_T				
T_C up to 25°C	175			W
T_C above 25°C, derate linearly	1			W/°C
* T_{stg}, T_J	−65 to 200			°C
* T_L				
At distance ⩾ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235			°C

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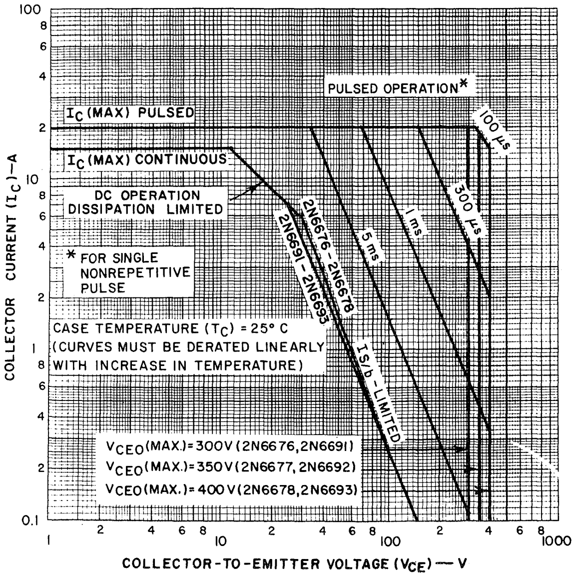
* In accordance with JEDEC registration data.



92CM-30390R2

Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

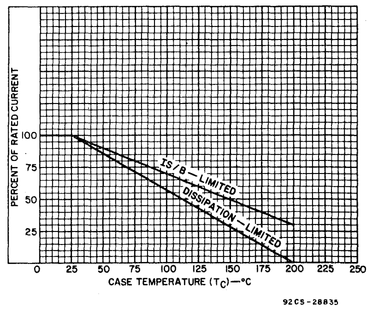


Fig. 2 — Dissipation and $I_{S/b}$ derating curves for all types.

2N6676, 2N6677, 2N6678, 2N6691, 2N6692, 2N6693

ELECTRICAL CHARACTERISTICS

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6676 2N6691		2N6677 2N6692		2N6678 2N6693		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
$T_C = 25^oC$											
* I_{CEV}	450 550 650	−1.5 −1.5 −1.5			– – –	0.1 – –	– – –	– 0.1 –	– – –	– – 0.1	mA
* I_{EBO}		−8	0		–	2	–	2	–	2	
* $V_{CEO}(sus)^b$			0.2^a	0	300	–	350	–	400	–	V
* h_{FE}	3		15^a		8	–	8	–	8	–	
* $V_{BE}(sat)$			15^a	3	–	1.5	–	1.5	–	1.5	V
* $V_{CE}(sat)$			15^a 15^a	3 3	– –	1 1.5	– –	1 1.5	– –	1 1.5	
* V_{CEX}^b (Clamped $E_{S/b}$) L=50 μH, R_{BB}=2 Ω		−6	15	3	350	–	400	–	450	–	
$I_{S/b}$ 2N6691,92,93	25		7		1	–	1	–	1	–	s
$I_{S/b}$ 2N6676,77,78	30		5.9		1	–	1	–	1	–	
$I_{S/b}$ For All Types	100		0.25		1	–	1	–	1	–	
* $\|h_{fe}\|$ f=5 MHz	10		1		3	10	3	10	3	10	
f_T	10		1		15	50	15	50	15	50	MHz
* C_{obo} f=0.1 MHz	10^c				150	500	150	500	150	500	pF
* t_d^d		−6	15	3	–	0.1	–	0.1	–	0.1	μs
* t_r^d		−6	15	3	–	0.6	–	0.6	–	0.6	
* t_s^d		−6	15	3^e	–	2.5	–	2.5	–	2.5	
* t_f^d		−6	15	3^e	–	0.5	–	0.5	–	0.5	
* t_c^f V_{CC}=200 V L=50 μH, $R_C \leqslant 13.5\ \Omega$		−6	15	3^e	–	0.5	–	0.5	–	0.5	
$T_C = 100^oC$											
* I_{CEV}	450 550 650	−1.5 −1.5 −1.5			– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
* $V_{CE}(sat)$			15^a	3	–	2	–	2	–	2	V
* t_r^d		−6	15	3	–	1	–	1	–	1	μs
* t_s^d		−6	15	3^e	–	4	–	4	–	4	
* t_f^d		−6	15	3^e	–	1	–	1	–	1	
* t_c^f V_{CC}=200 V, L=50 μH, $R_C \leqslant 13.5\ \Omega$		−6	15	3^e	–	0.8	–	0.8	–	0.8	
* $R_{\theta JC}$	10		5		–	1	–	1	–	1	°C/W

[a] Pulsed: pulse duration = 300 μs, duty factor ⩽2%.

[b] **CAUTION**: The sustaining voltage $V_{CEO}(sus)$ and V_{CEX} MUST NOT be measured on a curve tracer.

*In accordance with JEDEC registration data.

[c] V_{CB} value.

[d] V_{CC} = 200 V, t_p = 20 μs.

[e] $I_{B1} = -I_{B2}$.

[f] Collector clamped to V_{CEX}.

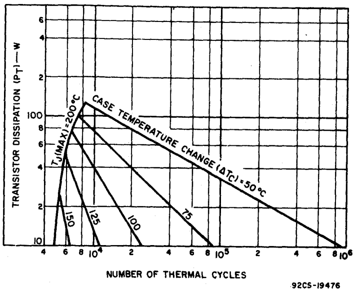


Fig. 3 – Thermal-cycling chart for all types.

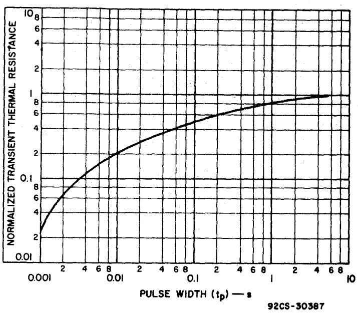


Fig. 4 – Typical thermal-response characteristic for all types.

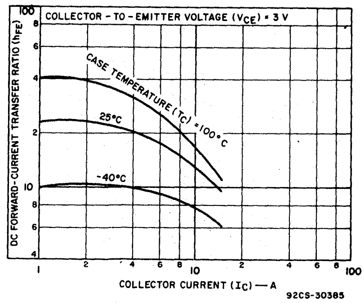


Fig. 5 – Typical dc beta characteristics for all types.

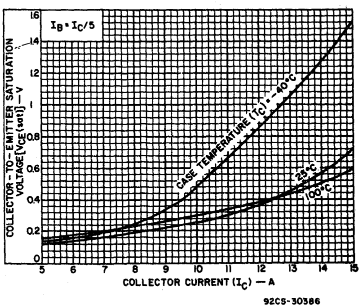


Fig. 6 – Typical collector-to-emitter saturation voltage characteristics for all types.

2N6676, 2N6677, 2N6678, 2N6691, 2N6692, 2N6693

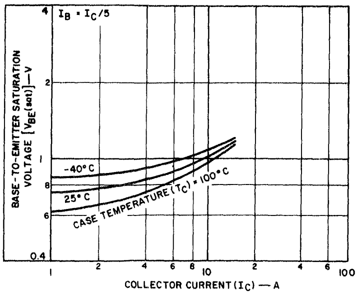


Fig. 7 – Typical base-to-emitter saturation voltage characteristics for all types.

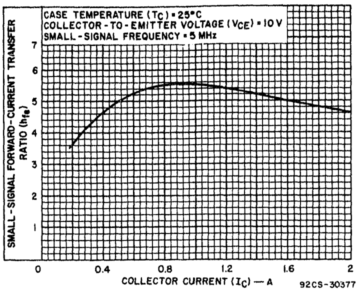


Fig. 8 – Typical small-signal forward current transfer ratio characteristic for all types (f = 5 MHz).

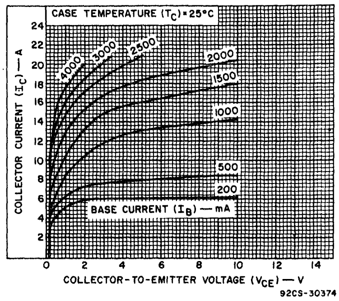


Fig. 9 – Typical output characteristics for all types.

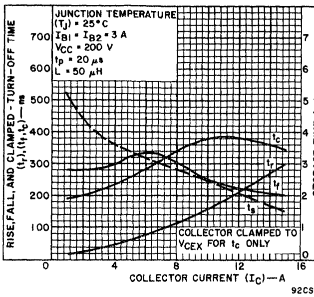


Fig. 10 – Typical saturated-switching-time characteristics at $T_J = 25^oC$ as a function of collector current for all types.

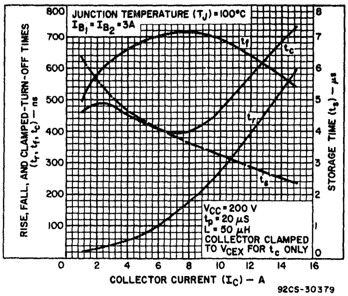


Fig. 11 – Typical saturated-switching-time characteristics at $T_J = 100^oC$ as a function of collector current for all types.

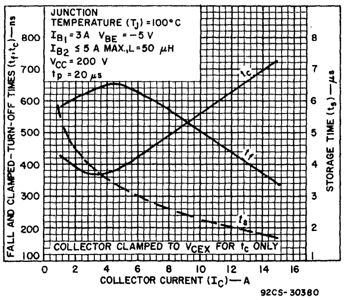


Fig. 12 – Typical saturated-switching-time characteristics at $T_J = 100^oC$ as a function of collector current for all types.

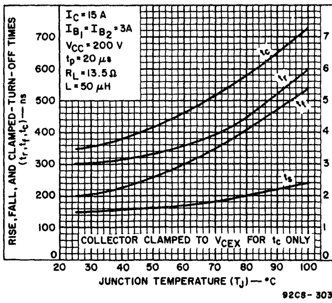


Fig. 13 – Typical saturated-switching-time characteristics as a function of junction temperature for all types.

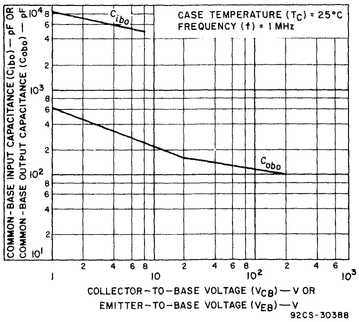


Fig. 14 – Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

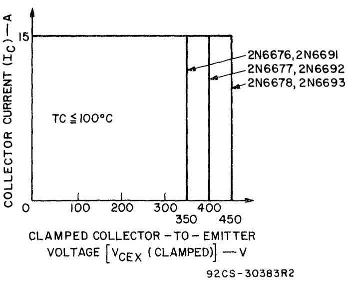


Fig. 15 – Maximum operating conditions for switching between saturation and cutoff for all types.

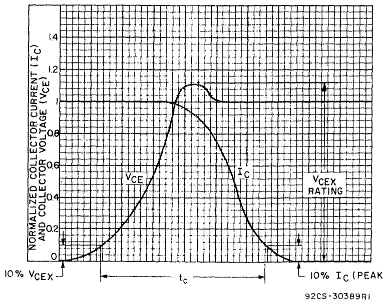


Fig. 16 – Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

2N6686, 2N6687, 2N6688

25-A *SwitchMax* Power Transistors

N-P-N Types for Power Supplies and Other High Voltage Switching Applications

RCA-2N6686, 2N6687, and 2N6688● SwitchMax series of silicon n-p-n power transistors feature fast switching speeds, low saturation voltages, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits. These high-current, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits.

Switching time, including inductive turn-off time, and saturation voltages are tested at 125°C, as well as at 25°C, to provide information necessary for worst-case design.

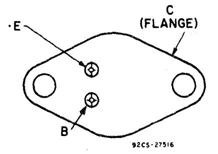
The 2N6686, 2N6687, and 2N6688 transistors are supplied in steel JEDEC TO-204MA hermetic packages.

● Formerly RCA Dev. Type Nos. TA9119A, TA9119B, TA9119C, respectively.

Features:

- **100% High-Temperature Tested for 125°C Parameters**
- **Fast Switching Speed**
- **Low V_{CE}(sat)**
- **Steel Hermetic TO-204MA Package**

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6686	2N6687	2N6688	
* V_{CEV}				
$V_{BE} = -1.5$ V	260	280	300	V
* V_{CEX}(Clamped)				
$V_{BE} = -1.5$ V	210	230	250	V
* V_{CEO}	160	180	200	V
* V_{EBO}		8		V
I_C(sat)	25	25	20	A
* I_C	25	25	20	A
I_{CM}		50		A
* I_B		8		A
* P_T				
T_C up to 25 °C		200		W
T_C above 25 °C, derate linearly		1.14		W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

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* In accordance with JEDEC registration data.

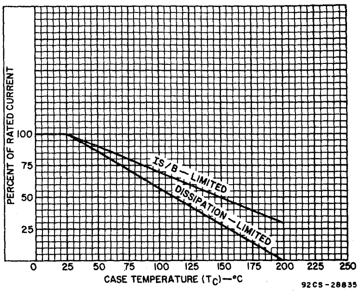


Fig. 1-Dissipation and $I_{S/b}$ derating curves for all types.

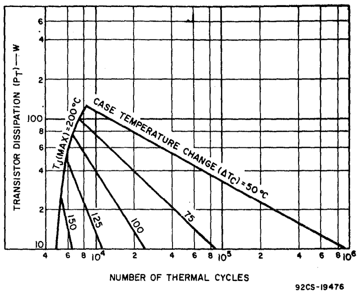


Fig. 2-Thermal-cycling chart for all types.

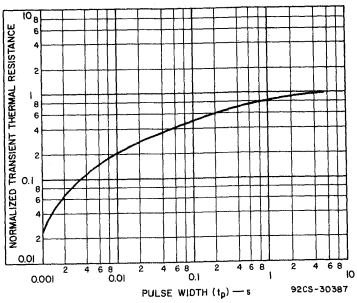


Fig. 3-Typical thermal-response characteristic for all types.

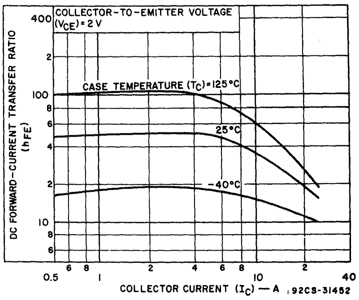


Fig. 4-Typical dc beta characteristics for all types.

2N6686, 2N6687, 2N6688

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6686		2N6687		2N6688		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
$T_C = 25°C$											
* I_{CEV}	260	−1.5			–	50	–	–	–	–	μA
	280	−1.5			–	–	–	50	–	–	
	300	−1.5			–	–	–	–	–	50	
* I_{EBO}		−8	0		–	100	–	100	–	100	
* $V_{CEO}(sus)^b$			0.2^a	0	160	–	180	–	200	–	V
* h_{FE}	2		1^a		30	–	30	–	25	–	
	2		10^a		25	100	25	100	20	80	
	2		20^a		–	–	–	–	15	–	
	2		25^a		15	–	15	–	–	–	
* $V_{BE}(sat)$			20^a	2	–	–	–	–	–	1.8	V
			25^a	2.5	–	1.8	–	1.8	–	–	
* $V_{CE}(sat)$			20^a	2	–	–	–	–	–	1.5	
			25^a	2.5	–	1.5	–	1.5	–	–	
* V_{CEX}^b (Clamped $E_{S/b}$) L=25 μH, R_{BB}=10 Ω		−4	25	3	210	–	230	–	250	–	
$I_{S/b}$	18		11.1		1	–	1	–	1	–	s
* $\lvert h_{fe} \rvert$ f=5 MHz	10		1		4	20	4	20	4	20	
f_T	10		1		20	100	20	100	20	100	MHz
* C_{obo} f=0.1 MHz	10^c				300	650	300	650	300	650	pF
* t_d^d		−4	20	2	–	–	–	–	–	0.1	μs
			25	2.5	–	0.1	–	0.1	–	–	
* t_r^d		−4	20	2	–	–	–	–	–	0.35	
			25	2.5	–	0.35	–	0.35	–	–	
* t_s^d		−4	20	2^e	–	–	–	–	–	1	
			25	2.5^e	–	1	–	1	–	–	
* t_f^d		−4	20	2^e	–	–	–	–	–	0.25	
			25	2.5^e	–	0.25	–	0.25	–	–	
* t_c V_{CC}=80 V, L=25 μH, $R_C \leqslant 4\ \Omega$, Collector clamped to V_{CEX}		−4	20	3^e	–	–	–	–	–	0.5	
		−4	25	3^e	–	0.5	–	0.5	–	–	

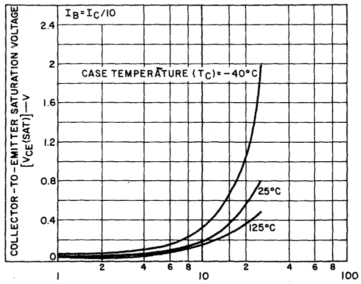


Fig. 5- Typical collector-to-emitter saturation voltage characteristics for all types.

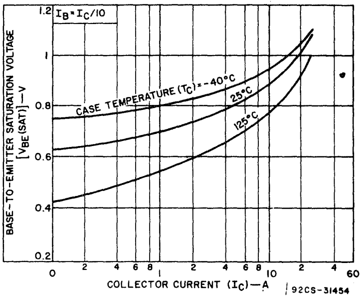


Fig. 6- Typical base-to-emitter saturation voltage characteristic for all types.

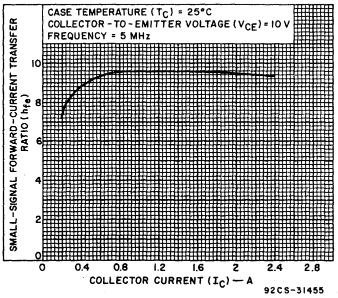


Fig. 7-Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

2N6686, 2N6687, 2N6688

ELECTRICAL CHARACTERISTICS (cont'd)

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6686		2N6687		2N6688		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
$T_C = 125°C$											
* I_{CEV}	260 280 300	−1.5 −1.5 −1.5			– – –	0.5 – –	– – –	– 0.5 –	– – –	– – 0.5	mA
* V_{CE}(sat)			20[a] 25[a]	2 2.5	– –	– 1.5	– –	– 1.5	– –	1.5 –	V
* t_r[d]		−4	20 25	2 2.5	– –	– 0.6	– –	– 0.6	– –	0.6 –	μs
* t_s[d]		−4	20 25	2 2.5[e]	– –	– 2.5	– –	– 2.5	– –	2.5 –	
* t_f[d]		−4	20 25	2 2.5[e]	– –	– 0.8	– –	– 0.8	– –	0.8 –	
* t_c V_{CC}=80 V, L=25 μH, $R_C \leq 4\,\Omega$, Collector Clamped to V_{CEX}		−4 −4	20 25	3[e] 3[e]	– –	– 0.8	– –	– 0.8	– –	0.8 –	
* $R_{\theta JC}$	10		5		–	0.875	–	0.875	–	0.875	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 μs, duty factor ⩽2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) and V_{CEX} **MUST NOT** be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 80 V, t_p = 20 μs

[e] $I_{B_1} = -I_{B_2}$

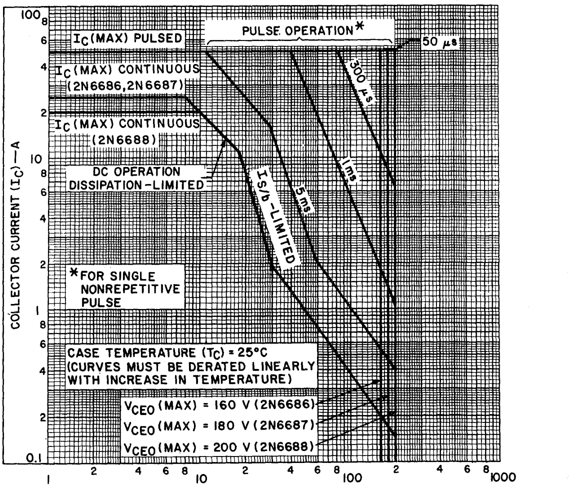


Fig. 8- Maximum operating areas for all types (T_C = 25°C).

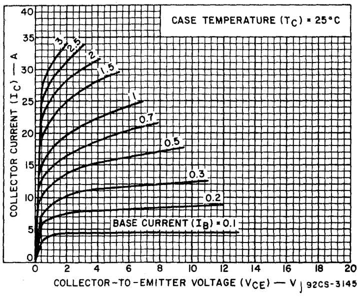


Fig. 9-Typical output characteristics for all types.

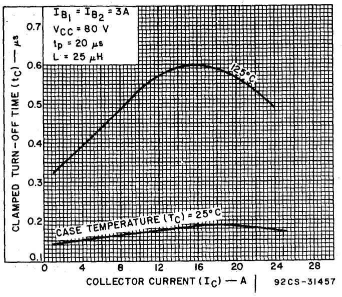


Fig. 10-Typical clamped turn-off time characteristics for all types.

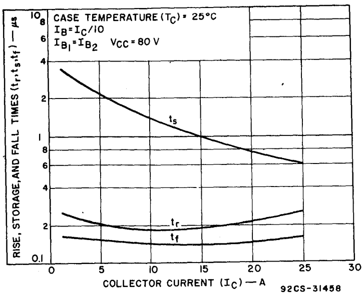


Fig. 11-Typical saturated-switching-time characteristics as a function of collector current for all types.

2N6686, 2N6687, 2N6688

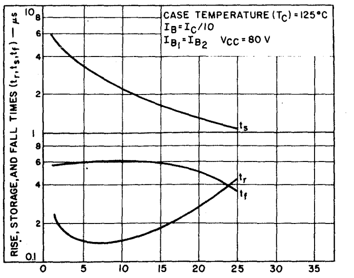


Fig. 12-Typical saturated-switching-time characteristics at T_C = 125°C as a function of collector current for all for all types.

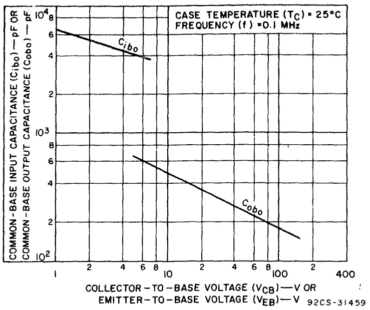


Fig. 13-Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

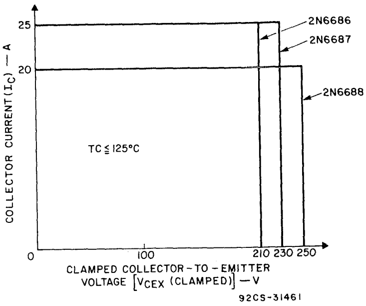


Fig. 14-Maximum operating conditions for switching between saturation and cutoff for all types.

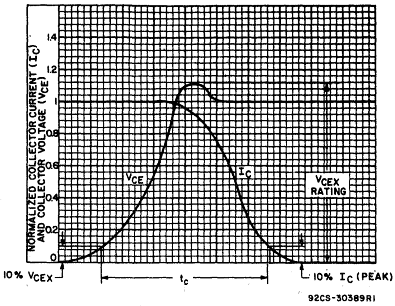


Fig. 15-Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

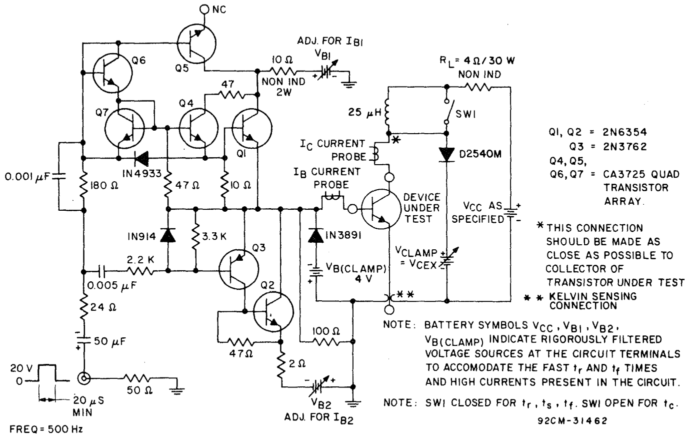
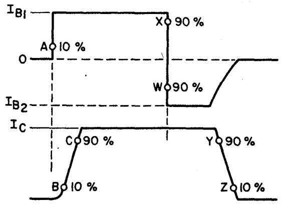


Fig. 16-Circuit for measuring switching times.



t_d = A–B t_s = X–Y
t_r = B–C t_f = Y–Z
$t_{transition}$ = X–W

NOTE: TRANSITION TIME FROM 90% I_{B_1} TO 90% I_{B_2} MUST BE LESS THAN 0.5 µs.

Fig. 17-Phase relationship between input and output currents showing reference points for specification of switching times.

2N6702, 2N6703, 2N6704

High-Current, Silicon N-P-N VERSAWATT Transistors

Switching Applications

RCA-2N6702, 2N6703, and 2N6704• epitaxial-base silicon n-p-n power transistors which feature fast switching speeds, low saturation voltages, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits.

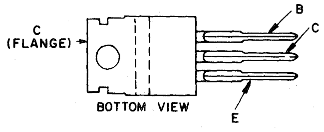
The 2N6702, 2N6703, and 2N6704 transistors are supplied in the JEDEC TO-220AB (RCA VERSAWATT) plastic packages.

•Formerly RCA Dev. Type Nos. TA9164A, TA9164B, TA9164C, respectively.

Features:

- Fast switching speed at temperatures up to 125°C
- Low V_{CE}(sat)
- VERSAWATT plastic package

TERMINAL DESIGNATIONS



92CS-27519

JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6702	2N6703	2N6704	
* V_{CEV}				
V_{BE} = −1.5 V	140	160	180	V
* V_{CEO}	90	110	130	V
* V_{EBO}		7		V
I_C(sat)	5	5	4	A
* I_C		7		A
I_{CM}		10		A
* I_B		5		A
* P_T				
T_C up to 25°C		50		W
T_C above 25°C, derate linearly		0.4		W/°C
* T_{stg}, T_J		−65 to 150		°C
* T_L				
At distance ⩾1/8 in. (3.16 mm) from seating plane for 10 s max.		235		°C

* In accordance with JEDEC registration data.

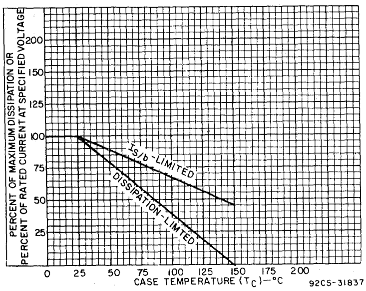


Fig. 1 — Dissipation and $I_{S/b}$ derating curves for all types.

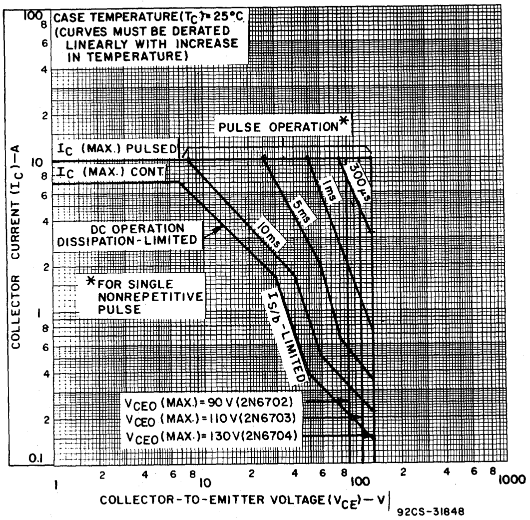


Fig. 2 — Maximum operating areas for all types (T_C = 25°C).

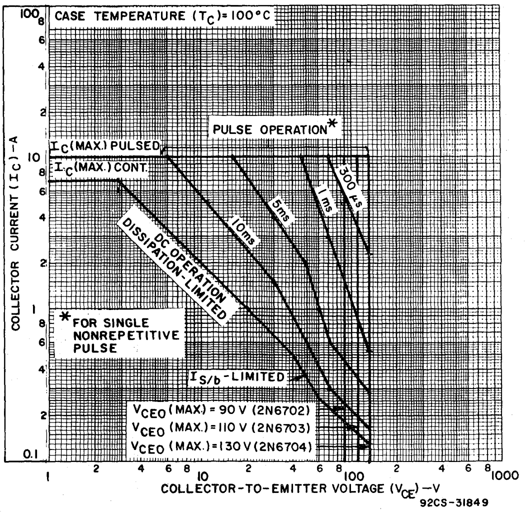


Fig. 3 — Maximum operating areas for all types (T_C = 100°C).

2N6702, 2N6703, 2N6704

ELECTRICAL CHARACTERISTICS, at Case Temperature T_C = 25°C Unless Otherwise Specified

	CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N6702		2N6703		2N6704		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
*	I_{CEV}	140	−1.5			–	100	–	–	–	–	µA
		160	−1.5			–	–	–	100	–	–	
		180	−1.5			–	–	–	–	–	100	
	T_C = 125°C	140	−1.5			–	1	–	–	–	–	mA
		160	−1.5			–	–	–	1	–	–	
		180	−1.5			–	–	–	–	–	1	
*	I_{EBO}		−7	0		–	100	–	100	–	100	µA
*	$V_{CEO}(sus)^b$			0.01^a	0	90	–	110	–	130	–	V
*	h_{FE}	2		0.2^a		30	–	30	–	30	–	
		2		4^a		–	–	–	–	20	–	
		2		5^a		20	–	20	–	–	–	
*	$V_{BE}(sat)$			4^a	0.4	–	–	–	–	–	1.4	V
				5^a	0.5	–	1.5	–	1.5	–	–	
*	$V_{CE}(sat)$			4^a	0.4	–	–	–	–	–	0.7	
				5^a	0.5	–	0.8	–	0.8	–	–	
				7^a	0.7	–	1.5	–	1.5	–	1.5	
	$I_{S/b}$	20		2.5		1	–	1	–	1	–	s
*	$\lvert h_{fe}\rvert$ f = 5 MHz	10		0.5		10	40	10	40	10	40	
	f_T	10		0.5		50	200	50	200	50	200	MHz
*	C_{obo} f = 0.1 MHz	10^c				50	150	50	150	50	150	pF
*	$t_d{}^d$		−4	4	0.4	–	–	–	–	–	0.1	µs
				5	0.5	–	0.1	–	0.1	–	–	
*	$t_r{}^d$		−4	4	0.4	–	–	–	–	–	0.25	
				5	0.5	–	0.25	–	0.25	–	–	
*	$t_s{}^d$		−4	4	0.4^e	–	–	–	–	–	1	
				5	0.5^e	–	1	–	1	–	–	
*	$t_f{}^d$		−4	4	0.4^e	–	–	–	–	–	0.5	
				5	0.5^e	–	0.5	–	0.5	–	–	
*	$R_{\theta JC}$	4		5		–	2.5	–	2.5	–	2.5	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 µs, duty factor $\leqslant$2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 70 V, t_p = 20 µs

[e] $I_{B_1} = -I_{B_2}$.

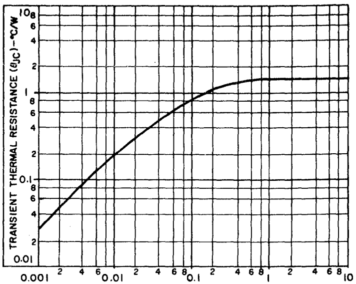


Fig. 4 — Typical thermal-response characteristic for all types.

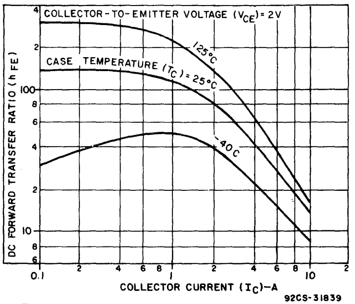


Fig. 5 — Typical dc beta characteristics for all types.

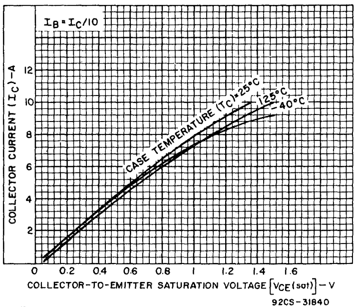


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics for all types.

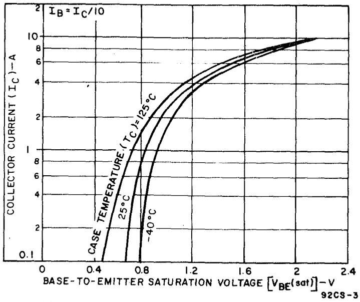


Fig. 7 — Typical base-to-emitter saturation voltage characteristic for all types.

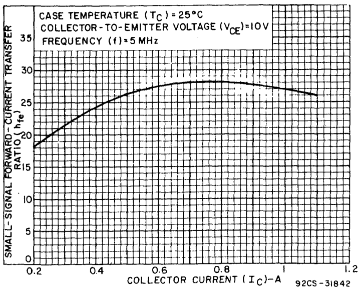


Fig. 8 — Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

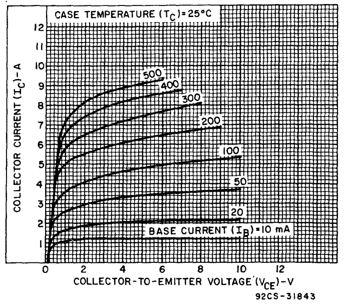


Fig. 9 — Typical output characteristics for all types.

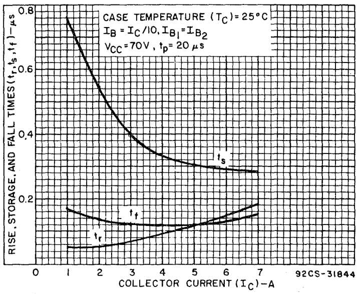


Fig. 10 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 25°C).

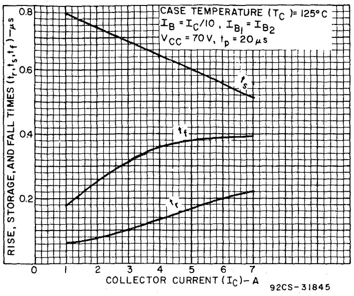


Fig. 11 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 125°C).

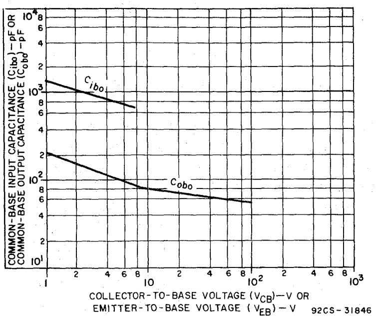


Fig. 12 – Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

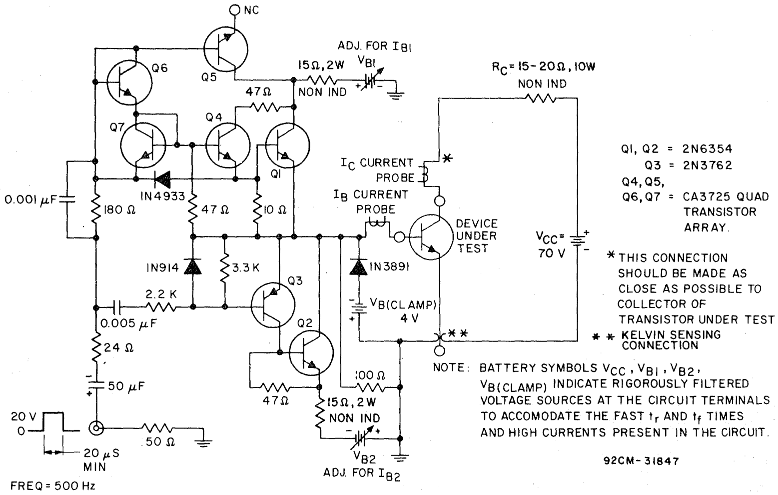


Fig. 13 – Circuit for measuring switching times.

2N6738, 2N6739, 2N6740

5-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6738, 2N6739, and 2N6740• SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-percent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 125°C, as well as at 25°C, to provide information necessary for worst-case design.

The RCA-2N6738, 2N6739, and 2N6740 series transistors are supplied in the JEDEC TO-220AB package.

•Formerly RCA Dev. Type Nos. TA9141A, TA9141B, and TA9141C, respectively.

Features:
- *100% High-Temperature Tested for 125° C Parameters*
- *Fast Switching Speed*
- *High Voltage Ratings:* V_{CEX}*=350 V to 450 V*
- *Low* $V_{CE}(sat)$ *at* I_C*=5 A*
- *VERSAWATT package*

Applications:
- *Off-Line Power Supplies*
- *High-Voltage Inverters*
- *Switching Regulators*

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6738	2N6739	2N6740	
* V_{CEV}				
V_{BE}=−1.5 V	450	550	650	V
* V_{CEX}(Clamped)				
V_{BE}=−1.5 V	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}	8			V
I_C(sat)	5			A
* I_C	8			A
I_{CM}	10			A
* I_B	4			A
* P_T				
T_C up to 25°C	100			W
T_C above 25°C, derate linearly	0.8			W/°C
* T_{stg}, T_J	−65 to 150			°C
* T_L				
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max.	235			°C

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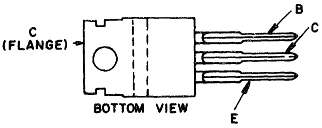
*In accordance with JEDEC registration data.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

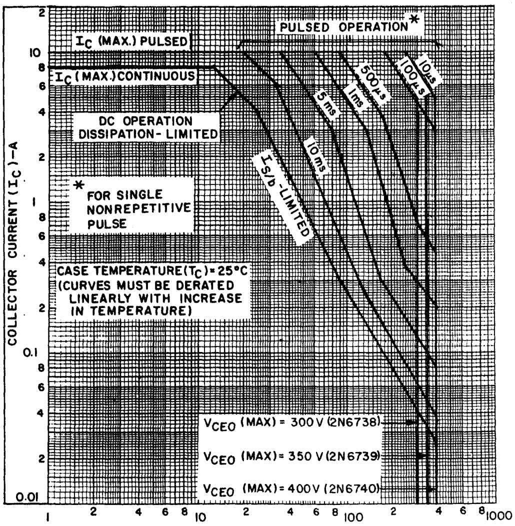


Fig. 1 - Maximum operating areas for all types (T_C=25° C).

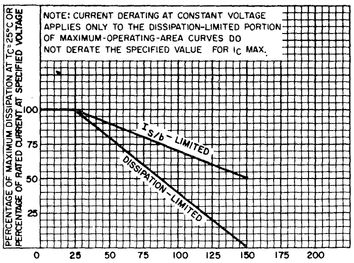


Fig. 2 - Dissipation and derating curve for all types.

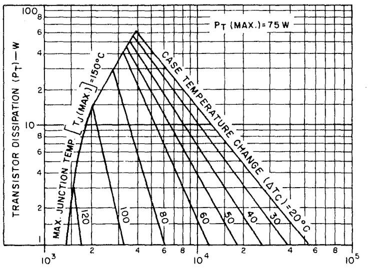


Fig. 3 - Thermal-cycling rating chart for all types.

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6738		2N6739		2N6740		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C=25° C											
* I_{CEV}	450	−1.5			—	0.1	—	—	—	—	mA
	550	−1.5			—	—	—	0.1	—	—	
	650	−1.5			—	—	—	—	—	0.1	
* I_{EBO}		−8	0		—	2	—	2	—	2	
* $V_{CEO}(sus)^b$			0.2^a	0	300	—	350	—	400	—	V
* h_{FE}	3		5^a		10	40	10	40	10	40	
* $V_{BE}(sat)$			5^a	1	—	1.6	—	1.6	—	1.6	V
* $V_{CE}(sat)$			5^a	1	—	1	—	1	—	1	
			8^a	4	—	2	—	2	—	2	
* V_{CEX}^b (Clamped $E_{S/b}$) L=170 μH, R_{BB}=5 Ω		−5	5	1^e	350	—	400	—	450	—	
		−5	8	3^e	200	—	250	—	300	—	
* $I_{S/b}$	25		4		0.5	—	0.5	—	0.5	—	s
* $\|h_{fe}\|$ f=5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
* C_{obo} f=0.1 MHz	10^c				50	300	50	300	50	300	pF
* $t_d{}^d$			5	1	—	0.1	—	0.1	—	0.1	μs
* $t_r{}^d$			5	1	—	0.5	—	0.5	—	0.5	
* $t_s{}^d$			5	1^e	—	2.5	—	2.5	—	2.5	
* $t_f{}^d$			5	1^e	—	0.4	—	0.4	—	0.4	
* t_c V_{CC}=125 V, L=170 μH, R_C=25 Ω Collector clamped to V_{CEX}			5	1^e	—	0.4	—	0.4	—	0.4	
T_C=125° C											
* I_{CEV}	450	−1.5			—	1	—	—	—	—	mA
	550	−1.5			—	—	—	1	—	—	
	650	−1.5			—	—	—	—	—	1	
* $V_{CE}(sat)$			5^a	1	—	2	—	2	—	2	V
* $t_r{}^d$			5	1	—	0.8	—	0.8	—	0.8	μs
* $t_s{}^d$			5	1^e	—	4	—	4	—	4	
* $t_f{}^d$			5	1^e	—	0.8	—	0.8	—	0.8	
* t_c V_{CC}=125 V, L=170 μH, R_C=25 Ω Collector clamped to V_{CEX}			5	1^e	—	0.8	—	0.8	—	0.8	
* $R_{\theta JC}$	10		5		—	1.25	—	1.25	—	1.25	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

*In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltage $V_{CEO}(sus)$ and V_{CEX} MUST NOT be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 125 V, t_p = 20 μs.

[e] $I_{B_1} = -I_{B_2}$.

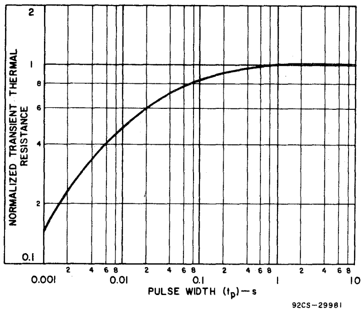


Fig. 4 - Typical thermal-response characteristic for all types.

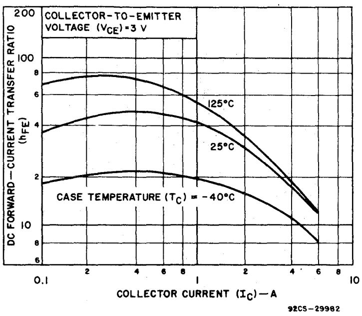


Fig. 5 - Typical dc beta characteristics for all types.

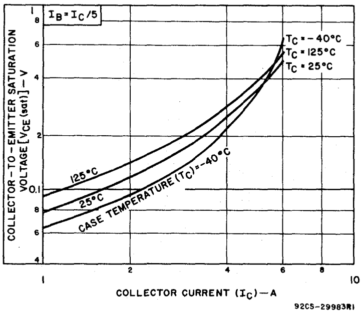


Fig. 6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

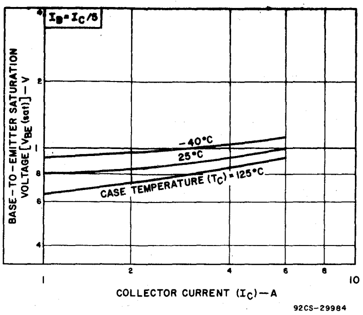


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current for all types.

2N6738, 2N6739, 2N6740

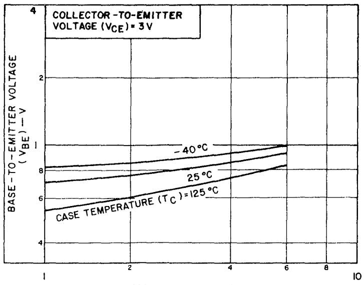


Fig. 8 - Typical base-to-emitter voltage as a function of collector current for all types.

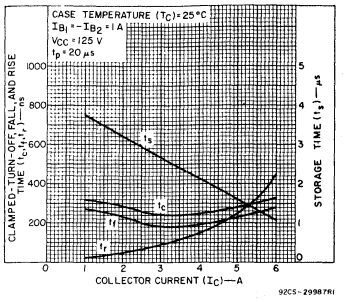


Fig. 9 - Typical saturated switching time characteristics for all types.

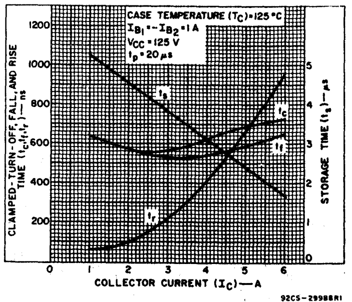


Fig. 10 - Typical saturated switching time characteristics for all types.

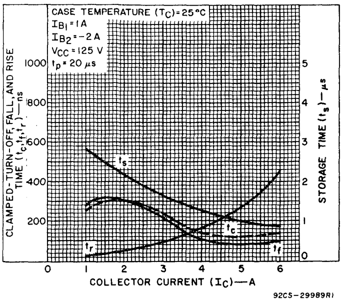


Fig. 11 - Typical saturated switching time characteristics for all types.

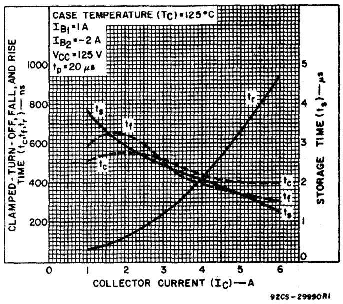


Fig. 12 - Typical saturated switching time characteristics for all types.

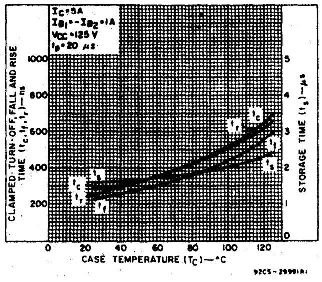


Fig. 13 - Typical saturated switching time characteristics as a function of case temperature for all types.

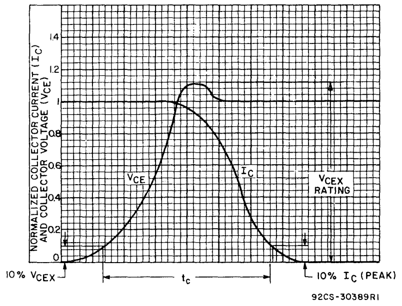
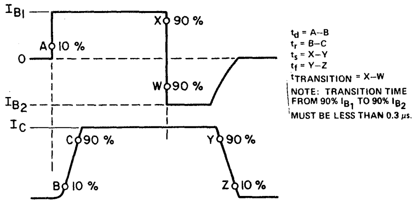


Fig. 14 - Oscilloscope display for measurement of clamped induction switching time (t_C).

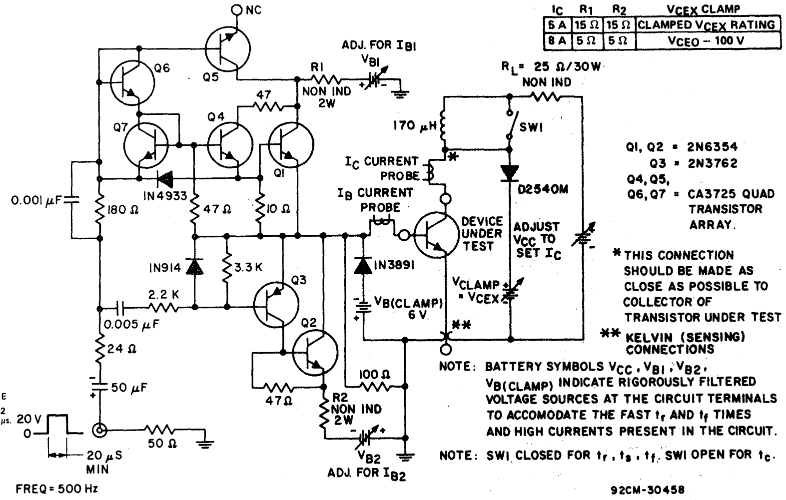


t_d = A–B
t_r = B–C
t_s = X–Y
t_f = Y–Z
$t_{TRANSITION}$ = X–W

NOTE: TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} MUST BE LESS THAN 0.3 µs.

92CS-30458

Fig. 15 - Phase relationship between input and output currents showing reference points for specification of switching times.



I_C	R_1	R_2	V_{CEX} CLAMP
5 A	15 Ω	15 Ω	CLAMPED V_{CEX} RATING
8 A	5 Ω	5 Ω	V_{CEO} – 100 V

Q1, Q2 = 2N6354
Q3 = 2N3762
Q4, Q5,
Q6, Q7 = CA3725 QUAD TRANSISTOR ARRAY.

* THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

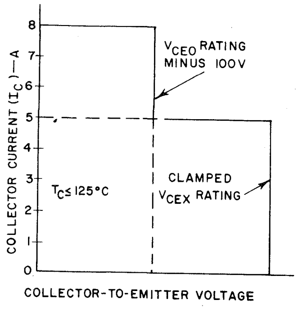
** KELVIN (SENSING) CONNECTIONS

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

NOTE: SWI CLOSED FOR t_r, t_s, t_f. SWI OPEN FOR t_c.

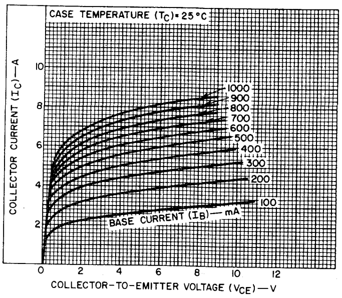
92CM-30458

Fig. 16 - Circuit for measuring switching times.



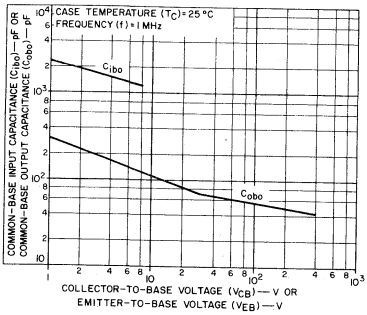
92CS-30455

Fig. 17 - Maximum operating conditions for switching between saturation and cutoff.



92CS-29986

Fig. 18 - Typical output characteristics for all types.



92CS-29992

Fig. 19 - Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

2N6751, 2N6752, 2N6753, 2N6754

5-A SwitchMax Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6751, 2N6752, 2N6753, and 2N6754 SwitchMax series● of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 100°C, as well as at 25°C, to provide information necessary for worst-case design.

The 2N6751, 2N6752, 2N6753, and 2N6754 series transistors are supplied in steel JEDEC TO-204MA hermetic packages.

● Formerly TA9153, TA9153A, TA9153B,

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6751	2N6752	2N6753	2N6754	
* V_{CEV}					
$V_{BE} = -1.5$ V	800	850	900	1000	V
* V_{CEX}(Clamped)					
$V_{BE} = -1.5$ V	450	500	550	550	V
* V_{CEO}	400	450	500	500	V
* V_{EBO}	8				V
I_C(sat)	5				A
* I_C	10				A
I_{CM}	10				A
* I_B	5				A
* P_T					
$T_C \leq 25$°C	150				W
$T_C \geq 25$°C, derate linearly	1				W/°C
* T_J	−65 to 175				°C
* T_{stg}	−65 to 200				°C
* T_L					
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max	235				°C

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* In accordance with JEDEC registration data.

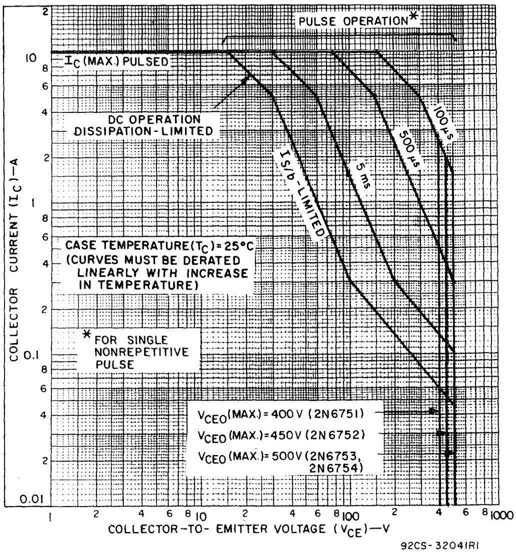


Fig. 1—Maximum operating areas for all types (T_C).

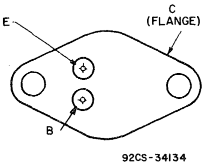
Features:

- *100% high-temperature tested for 100°C parameters*
- *Fast switching speed*
- *High voltage ratings: V_{CEX} = 450 —550V*
- *Low V_{CE}(sat) at I_C = 5 A*
- *Steel hermetic TO-204MA package*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "CC".)

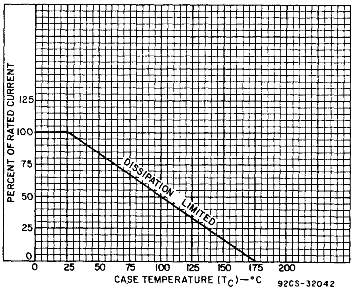


Fig. 2—Dissipation derating curve for all types.

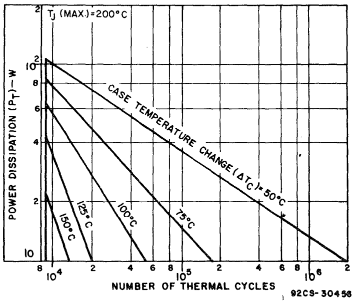


Fig. 3—Thermal-cycling chart for all types.

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6751		2N6752		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
T_C = 25°C									
* I_{CEV}	800 850	−1.5 −1.5			— —	0.1 —	— —	— 0.1	mA
* I_{EBO}		−8	0		—	2	—	2	
* V_{CEO}(sus)^b			0.2^a	0	400	—	450	—	V
* h_{FE}	3		5^a		8	40	8	40	
* V_{BE}(sat)			5^a	1	—	1.3	—	1.3	V
* V_{CE}(sat)			5^a 10^a	1 3	— —	1 3	— —	1 3	
V_{CEX}^{b} (Clamped $E_{S/b}$) L = 170 µH		−6	5	1^c	450	—	500	—	
$I_{S/b}$	30		5		1	—	1	—	s
* $\lvert h_{fe} \rvert$ f = 5 MHz	10		0.2		3	12	3	12	
f_T	10		0.2		15	60	15	60	MHz
* C_{obo} f = 0.1 MHz	10^d				50	250	50	250	pF
* t_d^{e}		−6	5	1	—	0.1	—	0.1	µs
* t_r^{e}		−6	5	1	—	0.4	—	0.4	
* t_s^{e}		−6	5	1^c	—	3	—	3	
* t_f^{e}		−6	5	1^c	—	0.4	—	0.4	
* t_c V_{CC} = 250 V, L = 170 µH, R_C = 50 Ω, Collector clamped to V_{CEX}		−6	5	1^c	—	0.4	—	0.4	
T_C = 100°C									
* I_{CEV}	800 850	−1.5 −1.5			— —	1 —	— —	— 1	mA
* V_{CE}(sat)			5^a	1	—	1.5	—	1.5	V
* t_r^{e}		−6	5	1	—	0.6	—	0.6	µs
* t_s^{e}		−6	5	1^c	—	5	—	5	
* t_f^{e}		−6	5	1^c	—	0.7	—	0.7	
* t_c V_{CC} = 250 V, L = 170 µH, R_C = 50 Ω, Collector clamped to V_{CEX}		−6	5	1^c	—	0.7	—	0.7	
* $R_{\theta JC}$	10		5		—	1	—	1	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed duration = 300 µs, duty factor ≤ 2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) and V_{CEX} *MUST NOT* be measured on a curve tracer.

[c] $I_{B_1} = -I_{B_2}$ [d] V_{CB} value [e] V_{CC} = 250 V, tp = 20 µs

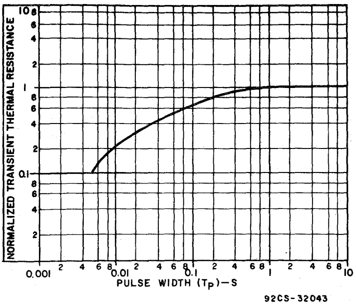


Fig. 4—Typical thermal-response characteristic for all types.

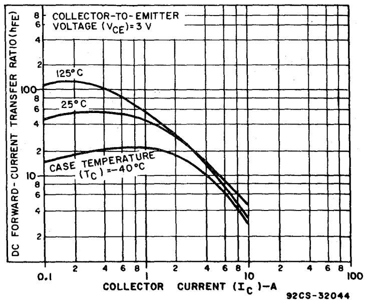


Fig. 5—Typical dc beta characteristics for all types.

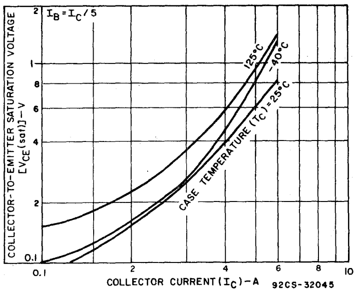


Fig. 6—Typical collector-to-emitter saturation voltage as a function of collector current for all types.

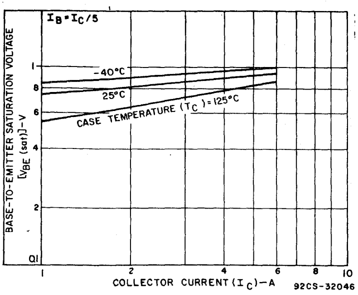


Fig. 7—Typical base-to-emitter saturation voltage as a function of collector current for all types.

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6753		2N6754		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
T_C = 25°C									
* I_{CEV}	900	−1.5			—	0.1	—	—	mA
	1000	−1.5			—	—	—	0.1	
* I_{EBO}		−8	0		—	2	—	2	
* $V_{CEO}(sus)^b$			0.2^a	0	500	—	500	—	V
* h_{FE}	3		5^a		8	40	8	40	
* $V_{BE}(sat)$			5^a	1	—	1.3	—	1.3	V
* $V_{CE}(sat)$			5^a	1	—	1	—	1	
			10^a	3	—	3	—	3	
$V_{CEX}{}^b$ (Clamped $E_{S/b}$) L = 170 µH		−6	5	1^c	550	—	550	—	
$I_{S/b}$	30		5		1	—	1	—	s
* $\lvert h_{fe} \rvert$ f = 5 MHz	10		0.2		3	12	3	12	
f_T	10		0.2		15	60	15	60	MHz
* C_{obo} f = 0.1 MHz	10^d				50	250	50	250	pF
* $t_d{}^e$		−6	5	1	—	0.1	—	0.1	µs
* $t_r{}^e$		−6	5	1	—	0.4	—	0.4	
* $t_s{}^e$		−6	5	1^c	—	3	—	3	
* $t_f{}^e$		−6	5	1^c	—	0.4	—	0.4	
* t_c V_{CC} = 250 V, L = 170 µH, R_C = 50 Ω, Collector clamped to V_{CEX}		−6	5	1^c	—	0.4	—	0.4	
T_C = 100°C									
* I_{CEV}	900	−1.5			—	1	—	—	mA
	1000	−1.5			—	—	—	1	
* $V_{CE}(sat)$			5^a	1	—	1.5	—	'1.5	V
* $t_r{}^e$		−6	5	1	—	0.6	—	0.6	µs
* $t_s{}^e$		−6	5	1^c	—	5	—	5	
* $t_f{}^e$		−6	5	1^c	—	0.7	—	0.7	
* t_c V_{CC} = 250 V, L = 170 µH, R_C = 50 Ω, Collector clamped to V_{CEX} *		−6	5	1^c	—	0.7	—	0.7	
* $R_{\theta JC}$	10		5		—	1	—	1	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed duration = 300 µs, duty factor ⩽ 2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) and V_{CEX} *MUST NOT* be measured on a curve tracer.

[c] $I_{B_1} = -I_{B_2}$ [d] V_{CB} value [e] V_{CC} = 250 V, t_p = 20 µs

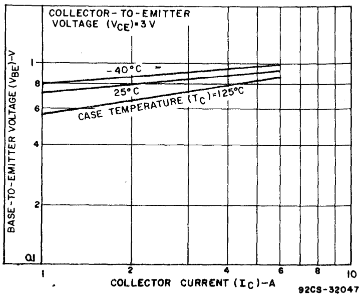


Fig. 8—Typical base-to-emitter voltage as a function of collector current for all types.

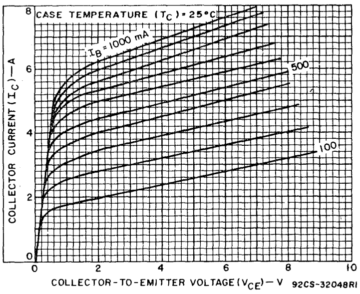


Fig. 9—Typical output characteristics for all types.

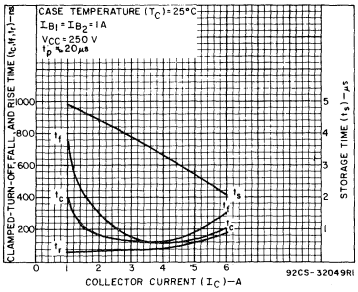


Fig. 10—Typical saturated switching time characteristics for all types.

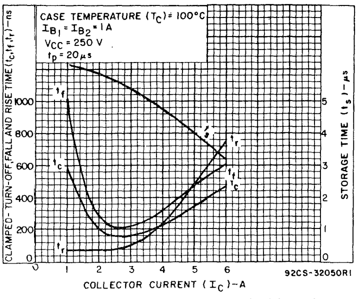


Fig. 11—Typical saturated switching time characteristics for all types.

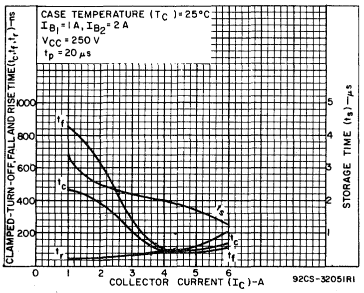


Fig. 12—Typical saturated switching time characteristics for all types.

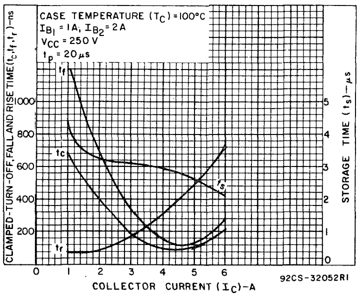


Fig. 13—Typical saturated switching time characteristics for all types.

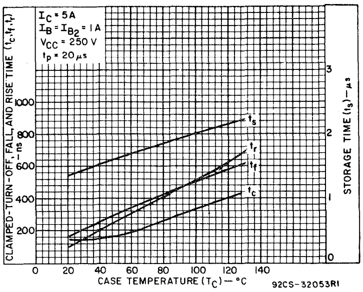


Fig. 14—Typical saturated switching time characteristics as a function of case temperature for all types.

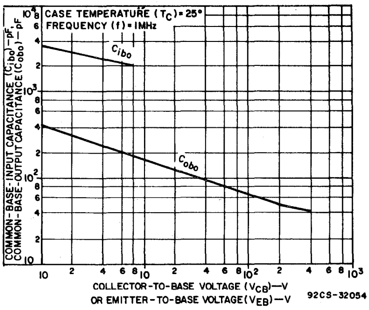


Fig. 15—Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

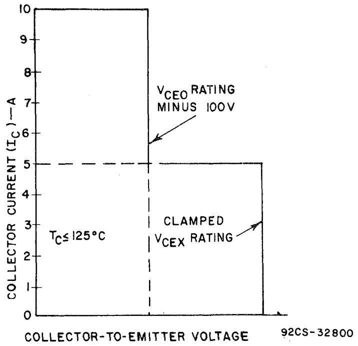


Fig. 16—Maximum operating conditions for switching between saturation and cutoff.

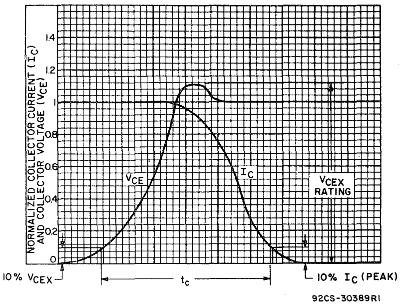
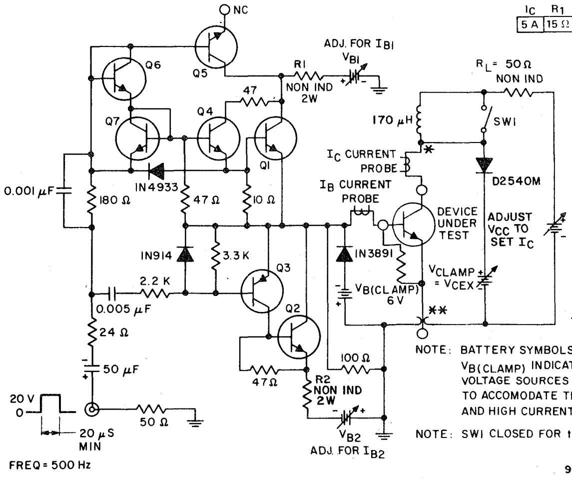


Fig. 17—Oscilloscope display for measurement of clamped induction switching time (tc).



IC	R1	R2	VCEX CLAMP
5 A	15 Ω	15 Ω	CLAMPED VCEX RATING

Q1, Q2 = 2N6354
Q3 = 2N3762
Q4, Q5, Q6, Q7 = CA3725 QUAD TRANSISTOR ARRAY

* THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

** KELVIN (SENSING) CONNECTIONS

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT

NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

92CM-32103

Fig. 18—Circuit for measuring switching times.

2N6771, 2N6772, 2N6773

1-A SwitchMax VERSAWATT Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6771, 2N6772, and 2N6773• SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 125° C, as well as at 25° C, to provide information necessary for worst-case design.

The RCA-2N6771, 2N6772, and 2N6773 series transistors are supplied in the JEDEC TO-220AB VERSAWATT plastic package.

Features:

- *100% High-Temperature Tested for 125° C Parameters*
- *Fast Switching Speed*
- *High Voltage Ratings:* *V_{CEX}=350 V to 450 V*
- *Low $V_{CE}(sat)$ at I_C=1 A*
- *VERSAWATT package*

Applications:

- *Off-Line Power Supplies*
- *High-Voltage Inverters*
- *Switching Regulators*

•Formerly RCA8863A, RCA8863B, and RCA8863C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6771	2N6772	2N6773	
* V_{CEV}				
V_{BE}=−1.5 V	450	550	650	V
* V_{CEX}(Clamped)				
V_{BE}=−1.5 V	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}		8		V
I_C(sat)		1		A
* I_C		1		A
I_{CM}		2		A
* I_B		0.6		A
* P_T				
T_C up to 25°C		40		W
T_C above 25°C, derate linearly		0.32		W/°C
* T_{stg}, T_J		−65 to 150		°C
* T_L				
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max.		235		°C

*In accordance with JEDEC registration data.

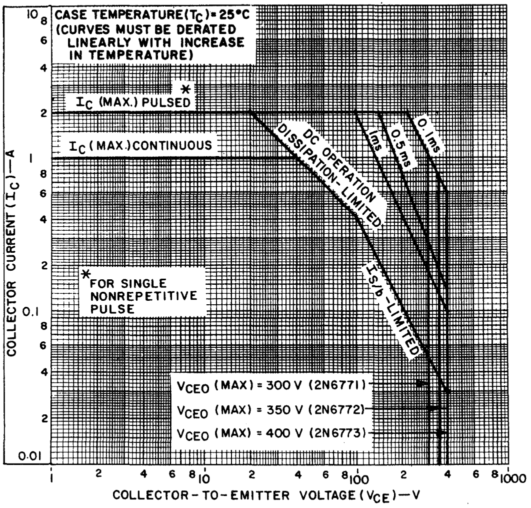
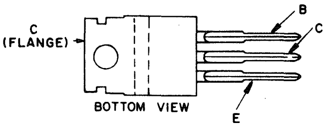


Fig. 1 - Maximum operating areas for all types.

TERMINAL DESIGNATIONS



(See dimensional outline "S".)

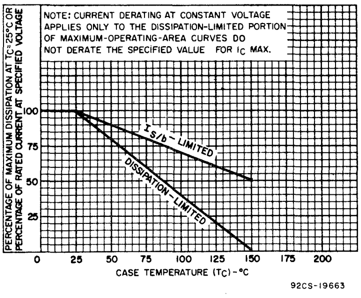


Fig. 2 - Derating curve for all types.

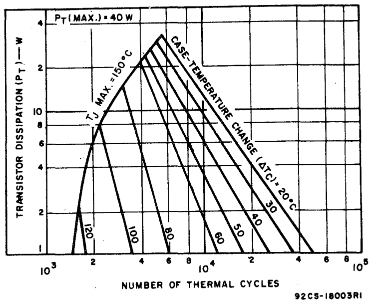


Fig. 3 - Thermal-cycling rating chart for all types.

ELECTRICAL CHARACTERISTICS

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6771		2N6772		2N6773		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C=25° C											
* I_{CEV}	450	−1.5			—	0.1	—	—	—	—	mA
	550	−1.5			—	—	—	0.1	—	—	
	650	−1.5			—	—	—	—	—	0.1	
* I_{EBO}		−8	0		—	2	—	2	—	2	
* V_{CEO}(sus)[b]			0.2[a]	0	300	—	350	—	400	—	V
* V_{CE}(sat)			1[a]	0.2	—	1.0	—	1.0	—	1.0	
* V_{BE}(sat)			1[a]	0.2	—	1.2	—	1.2	—	1.2	
* h_{FE}	3		0.3[a]		20	100	20	100	20	100	
	3		1[a]		10	50	10	50	10	50	
* V_{CEX}[b] (Clamped $E_{S/b}$) L=450 μH, R_{BB}=50 Ω		−5	1	0.1[e]	350	—	400	—	450	—	V
* $I_{S/b}$	100		0.4		0.5	—	0.5	—	0.5	—	s
* $\|h_{fe}\|$ f=1 MHz	10		0.2		10	50	10	50	10	50	
f_T	10		0.2		10	50	10	50	10	50	MHz
* C_{obo} f=0.1 MHz	10[c]				20	60	20	60	20	60	pF
* t_d[d]			1	0.2	—	0.05	—	0.05	—	0.05	μs
* t_r[d]			1	0.2	—	0.2	—	0.2	—	0.2	
* t_s[d]			1	0.2[e]	—	2.5	—	2.5	—	2.5	
* t_f[d]			1	0.2[e]	—	0.4	—	0.4	—	0.4	
* t_c V_{CC}=200 V, L=450 μH, R_C=200 Ω Collector clamped to V_{CEX}			1	0.2[e]	—	0.4	—	0.4	—	0.4	
T_C=125° C											
* I_{CEV}	450	−1.5			—	1	—	—	—	—	mA
	550	−1.5			—	—	—	1	—	—	
	650	−1.5			—	—	—	—	—	1	
* V_{CE}(sat)			1[a]	0.2	—	2	—	2	—	2	V
* t_r[d]			1	0.2	—	0.5	—	0.5	—	0.5	μs
* t_s[d]			1	0.2[e]	—	4.5	—	4.5	—	4.5	
* t_f[d]			1	0.2[e]	—	1.3	—	1.3	—	1.3	
* t_c V_{CC}=200 V, L=450 μH, R_C=200 Ω Collector clamped to V_{CEX}			1	0.2[e]	—	1.3	—	1.3	—	1.3	
* $R_{\theta JC}$	20		1		—	3.12	—	3.12	—	3.12	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

*In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltage V_{CEO}(sus) and V_{CEX} MUST NOT be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 200 V, t_p = 20 μs.

[e] $I_{B1} = -I_{B2}$.

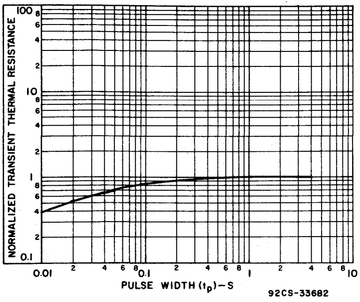


Fig. 4 - Typical thermal-response characteristics for all types.

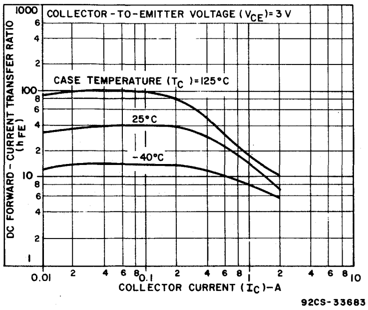


Fig. 5 - Typical dc beta characteristics for all types.

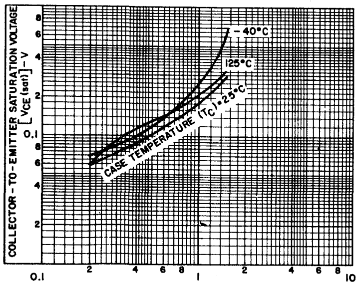


Fig. 6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

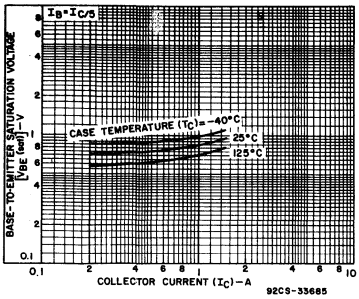


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current for all types.

2N6771, 2N6772, 2N6773

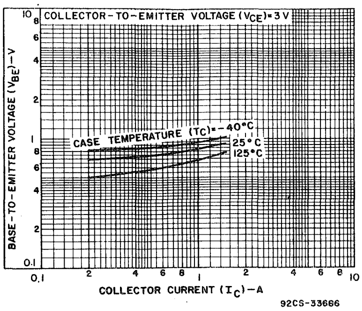


Fig. 8 - Typical base-to-emitter voltage as a function of collector current for all types.

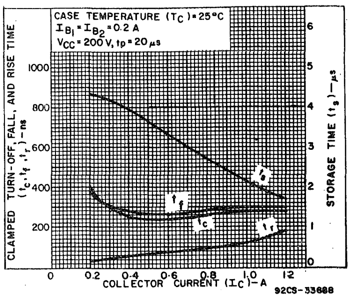


Fig. 9 - Typical saturated-switching-time characteristics for all types.

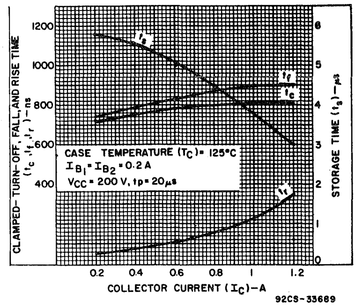


Fig. 10 - Typical saturated-switching-time characteristics as a function of collector current for all types.

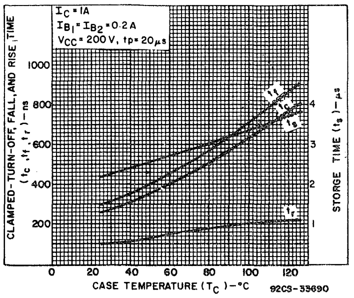


Fig. 11 - Typical saturated-switching-time characteristics as a function of case temperature for all types.

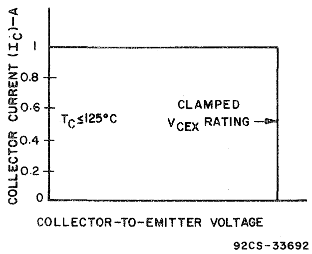


Fig. 12 Maximum operating conditions for switching between saturation and cutoff.

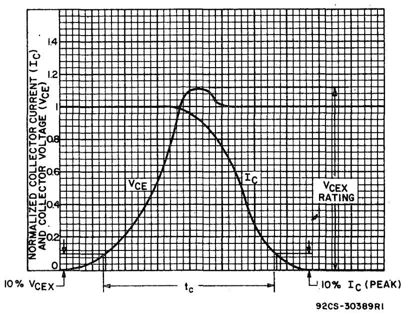
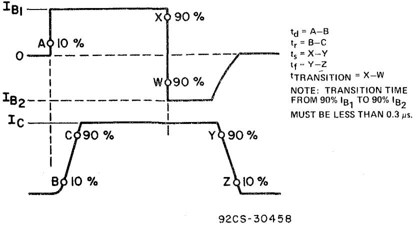


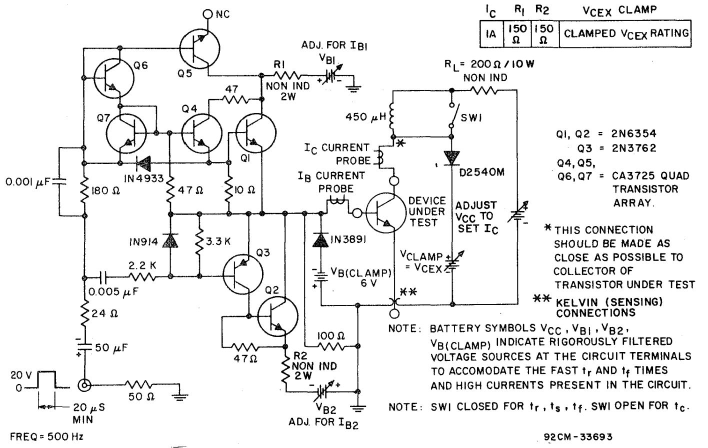
Fig. 13 - Oscilloscope display for measurement of clamped induction switching time (t_C).



t_d = A–B
t_r = B–C
t_s = X–Y
t_f = Y–Z
$t_{TRANSITION}$ = X–W

NOTE: TRANSITION TIME FROM 90% I_{B_1} TO 90% I_{B_2} MUST BE LESS THAN 0.3 μs.

Fig. 14 - Phase relationship between input and output currents showing reference points for specification of switching times.



IC	R1	R2	VCEX CLAMP
1A	150 Ω	150 Ω	CLAMPED VCEX RATING

Q1, Q2 = 2N6354
Q3 = 2N3762
Q4, Q5,
Q6, Q7 = CA3725 QUAD TRANSISTOR ARRAY.

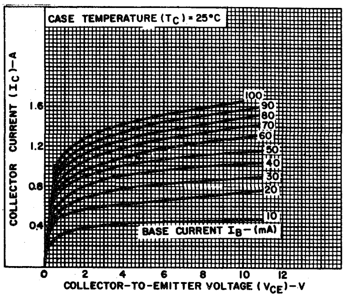
* THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

** KELVIN (SENSING) CONNECTIONS

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

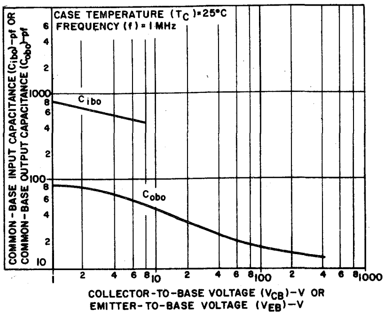
NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

Fig. 15 - Circuit for measuring switching times.



92CS-33687

Fig. 16 - Typical output characteristics for all types.



92CS-33691

Fig. 17 - Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

2N6774, 2N6775, 2N6776

15-A SwitchMax Power Transistors with Integral Antiparallel Diodes

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6774, 2N6775, and 2N6776* series of SwitchMax transistors feature electrical performance similar to the popular 2N6676, 2N6677, 2N6678 devices plus the added features of an integrated antiparallel diode and base-emitter resistor. The use of these transistors can often eliminate the need for some of the discrete base-resistors and high-voltage diodes in high-power designs such as half-bridge and bridge converters, variable-frequency motor drivers, and ultrasonic power generators. They are specially suited for systems in which several devices are paralleled for high-current switching, because each provides a distributed base-emitter resistance and antiparallel diode without the corresponding wiring congestion. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits. Switching time, including inductive turn-off time, and saturation voltages are tested at 100° C, as well as at 25° C, to provide information necessary for worst-case design.

The 2N6774, 2N6775, and 2N6776 transistors are supplied in steel JEDEC TO-204MA hermetic packages.

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*Formerly RCA Dev. Types Nos. TA9177A, TA9177B, and TA9177C, respectively.

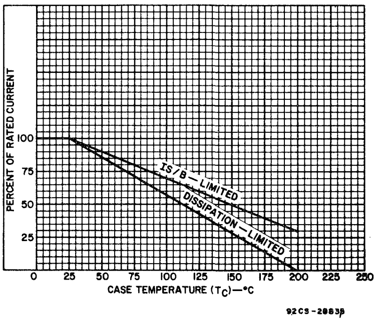


Fig. 1 - Dissipation and $I_{S/b}$ derating curves for all types.

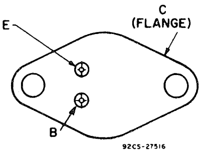
Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

Features:

- *100% High-temperature tested for 100° C parameters*
- *Fast switching speed*
- *High voltage ratings:* V_{CEX} = *350 V to 450 V*
- *Low* V_{CE} ***(sat) at*** I_C *= 15 A*
- *Steel hermetic TO-204MA package*
- *Fully integrated antiparallel diode [*V_F *(*V_{ECO}*) < 2 V @ 15A]*
- *Fully integrated base-emitter resistor (Typ. 100 ohms)*

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

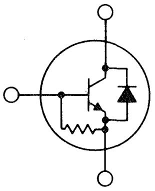


Fig. 2 - Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6774	2N6775	2N6776	
*V_{CEV}				
V_{BE} = −1.5 V	450	550	650	V
*V_{CEX} (Clamped)				
V_{BE} = −1.5 V	350	400	450	V
*V_{CEO}	300	350	400	V
*V_{EBO}	8			V
I_C (sat)	15			A
*I_C	15			A
I_{CM}	20			A
*I_B	5			A
*P_T				
T_C up to 25°C	175			W
T_C above 25°C, derate linearly	1			W/°C
*T_{stg}, T_J	−65 to 200			°C
*T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235			°C

*In accordance with JEDEC registration data.

ELECTRICAL CHARACTERISTICS

	CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N6774		2N6775		2N6776		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
	$T_C = 25° C$											
*	I_{CEV}	450	−1.5			—	0.1	—	—	—	—	mA
		550	−1.5			—	—	—	0.1	—	—	
		650	−1.5			—	—	—	—	—	0.1	
*	I_{EBO}		−8	0		40	200	40	200	40	200	
*	V_{CEO} (sus) [b,f]			0.2[a]	0	300	—	350	—	400	—	V
*	h_{FE}	3		15[a]		8	—	8	—	8	—	
*	V_{BE} (sat)			15[a]	3	—	1.5	—	1.5	—	1.5	V
*	V_{CE} (sat)			15[a]	3	—	1	—	1	—	1	
				15[a]	3	—	1.5	—	1.5	—	1.5	
*	V_F (VECO)			15		—	2	—	2	—	2	
*	V_F (VECO)			100		3.5 (Typ.)		3.5 (Typ.)		3.5 (Typ.)		
*	V_{CEX} [b,f] (clamped $E_{s/b}$) L = 50μH, RBB = 2Ω		−6	15	3	350	—	400	—	450	—	
	$I_{S/b}$	30		5.9		1	—	1	—	1	—	s
		100		0.25		1	—	1	—	1	—	
*	$\|h_{fe}\|$ f = 5 MHz	10		1		3	10	3	10	3	10	
	f_T	10		1		15	50	15	50	15	50	MHz
*	C_{obo} f = 0.1 MHz	10[c]				150	500	150	500	150	500	pF
*	t_d[d]		−6	15	3	—	0.1	—	0.1	—	0.1	μs
*	t_r[d]		−6	15	3	—	0.6	—	0.6	—	0.6	
*	t_s[d]		−6	15	3[e]	—	2.5	—	2.5	—	2.5	
*	t_f[d]		−6	15	3[e]	—	0.5	—	0.5	—	0.5	
*	trr diode			15		—	3.0	—	3.0	—	3.0	
*	t_c[f] V_{CC} = 200 V, L = 50 μH, $R_C \leq 13.5\ \Omega$		−6	15	3[e]	—	0.5	—	0.5	—	0.5	
	$T_C = 100° C$											
*	I_{CEV}	450	−1.5			—	1	—	—	—	—	mA
		550	−1.5			—	—	—	1	—	—	
		650	−1.5			—	—	—	—	—	1	
*	V_{CE} (sat)			15[a]	3	—	2	—	2	—	2	V
*	t_r[d]		−6	15	3	—	1	—	1	—	1	μs
*	t_s[d]		−6	15	3[e]	—	4	—	4	—	4	
*	t_f[d]		−6	15	3[e]	—	1	—	1	—	1	
*	t_c[f] V_{CC} = 200V, L = 50 μH, $R_C \leq 13.5\ \Omega$		−6	15	3[e]	—	0.8	—	0.8	—	0.8	
*	$R_{\theta JC}$	10		5		—	1	—	1	—	1	°C/W

[a] Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltage V_{CEO} (sus) and V_{CEX} MUST NOT be measured on a curve tracer.

*In accordance with JEDEC registration data.

[c] V_{CB} value.

[d] V_{CC} = 200 V, t_p = 20 μs.

[e] $I_{B1} = -I_{B2}$

[f] Collector clamped to V_{CEX}.

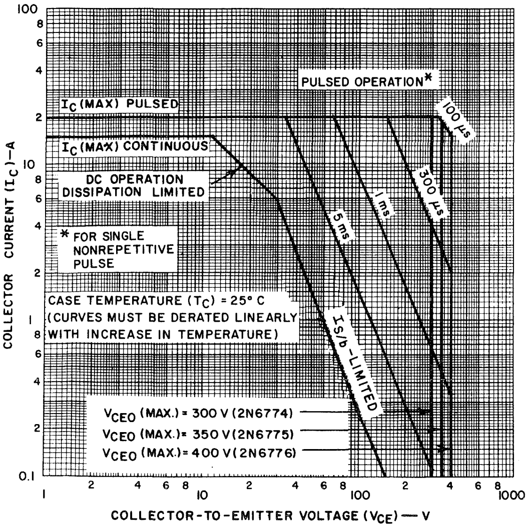


Fig. 3 - Maximum operating areas for all types (T_C = 25° C).

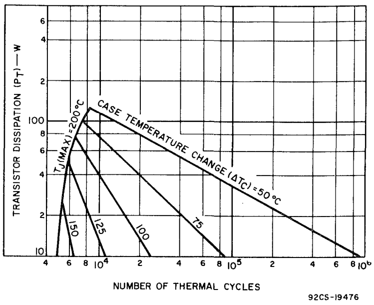


Fig. 4 - Thermal-cycling chart for all types.

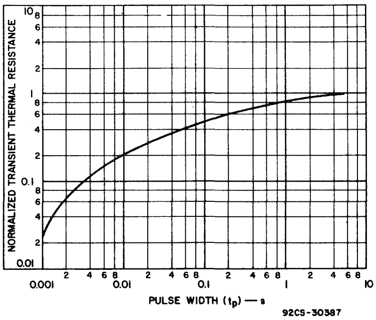


Fig. 5 - Typical thermal-response characteristic for all types.

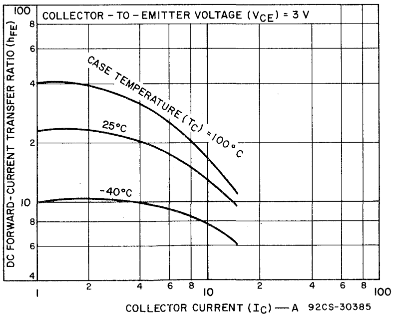


Fig. 6 - Typical dc beta characteristics for all types.

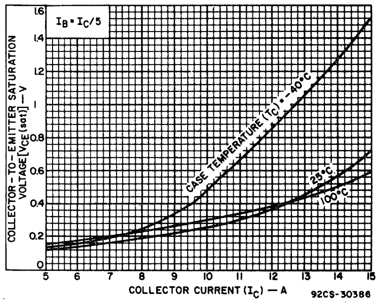


Fig. 7 - Typical collector-to-emitter saturation voltage characteristics for all types.

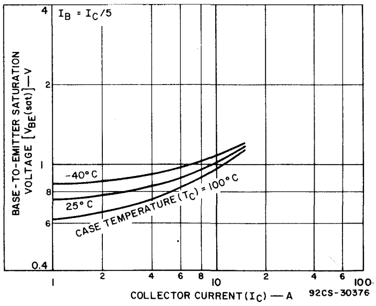


Fig. 8 - Typical base-to-emitter saturation voltage characteristics for all types.

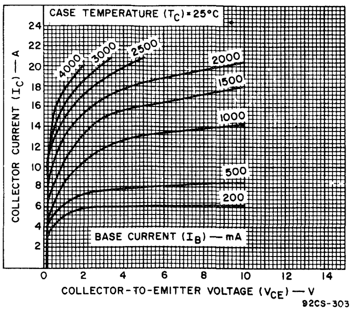


Fig. 9 - Typical output characteristics for all types.

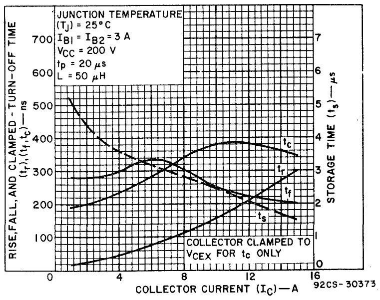


Fig. 10 - Typical saturated-switching-time characteristics at T_J = 25° C as a function of collector current for all types.

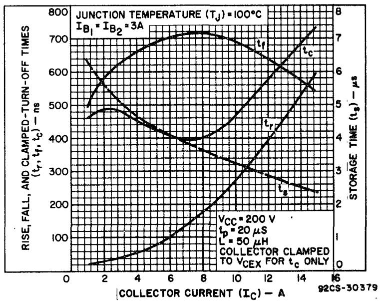


Fig. 11 - Typical saturated-switching-time characteristics at T_J = 100° C as a function of collector current for all types.

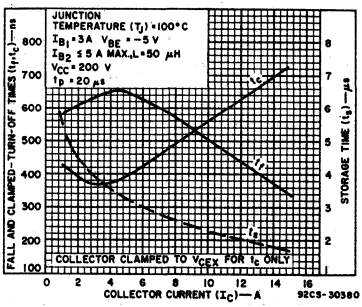


Fig. 12 - Typical saturated-switching-time characteristics at $T_J = 100°C$ as a function of collector current for all types.

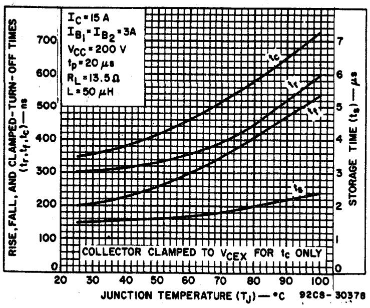


Fig. 13 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

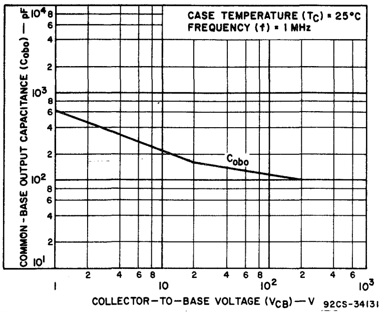


Fig. 14 - Typical common-base output (C_{obo}) capacitance characteristics for all types.

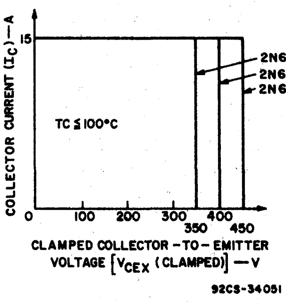


Fig. 15 - Maximum operating conditions for switching between saturation and cutoff for all types.

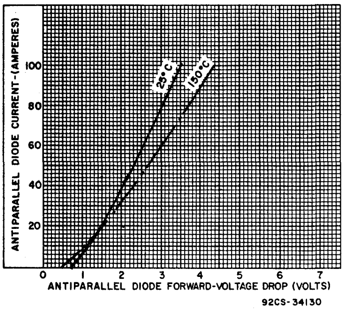


Fig. 16 - Typical antiparallel diode forward voltage drop characteristics.

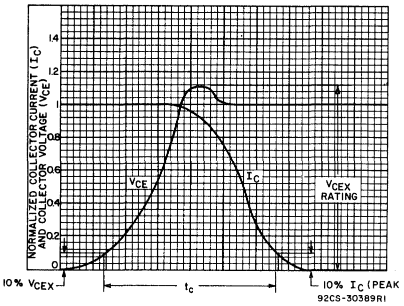
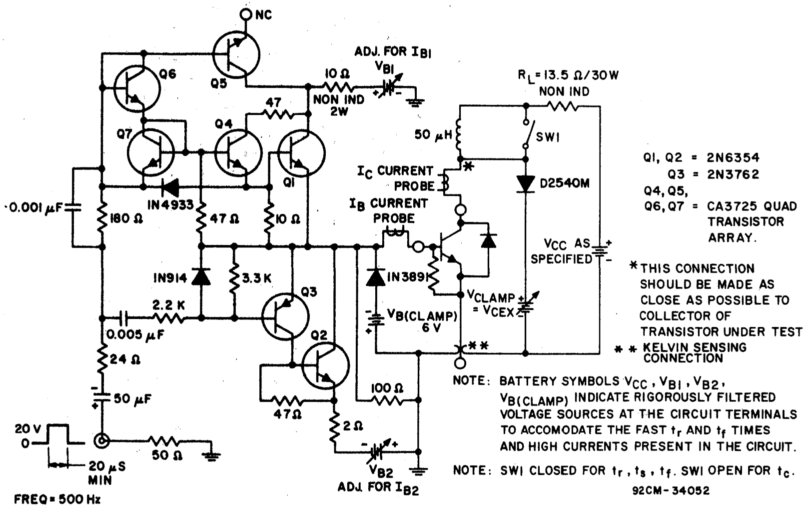


Fig. 17 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).



Q1, Q2 = 2N6354
Q3 = 2N3762
Q4, Q5, Q6, Q7 = CA3725 QUAD TRANSISTOR ARRAY.

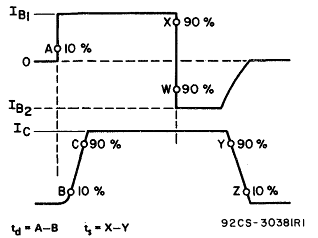
*THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

** KELVIN SENSING CONNECTION

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

Fig. 18 - Circuit for measuring switching times.



t_d = A–B t_s = X–Y
t_r = B–C t_f = Y–Z
$t_{transition}$ = X–W
NOTE: TRANSITION TIME FROM 90% I_{B_1} TO 90% I_{B_2} MUST BE LESS THAN 0.5 μs.

Fig. 19 - Phase relationship between input and output currents showing reference points for specification of switching times.

Power Transistors
Pro Electron Types
Technical Data

BD142

Hometaxial-Base, High-Power Silicon N-P-N Transistor

Rugged General-Purpose Device For Commercial Use

The RCA-BD142 is a hometaxial-base diffused-junction silicon n-p-n transistor intended for a wide variety of intermediate-power and high-power applications. It is especially suited for use in audio and inverter circuits at 12 volts.

The BD142 is supplied in a JEDEC TO-3 hermetic steel package.

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers
- 12-V audio and inverter circuits

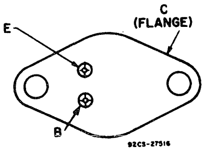
Features:

- Maximum-safe-area-of-operation curves
- Low saturation voltage
- High dissipation rating
- Thermal-cycling rating curve

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open	$V_{CEO}(sus)$	45	V
With base reverse bias V_{BE} = −1.5 V	$V_{CEV}(sus)$	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	15	A
CONTINUOUS BASE CURRENT	I_B	7	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		117	W
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235	°C

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

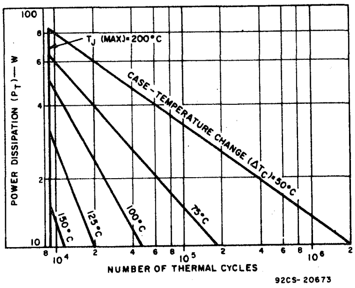


Fig. 1 — Thermal-cycling rating chart.

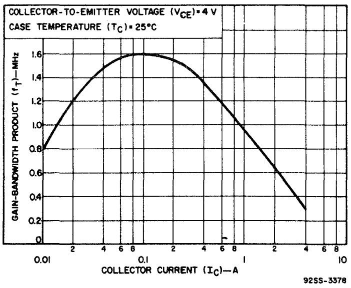


Fig. 2 — Typical gain-bandwidth product.

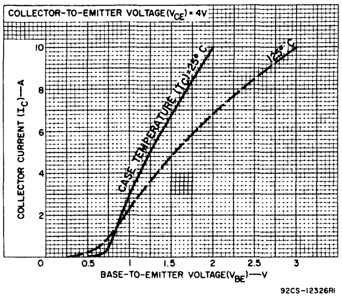


Fig. 3 — Typical transfer characteristics.

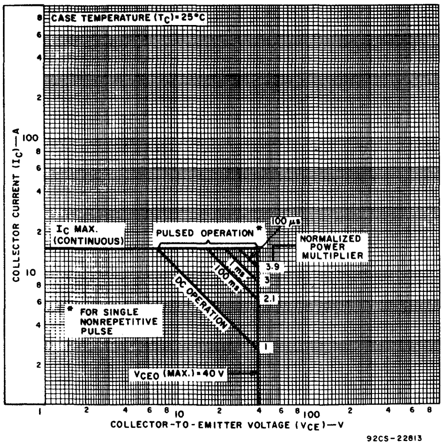


Fig. 4 — Maximum safe area of operation.

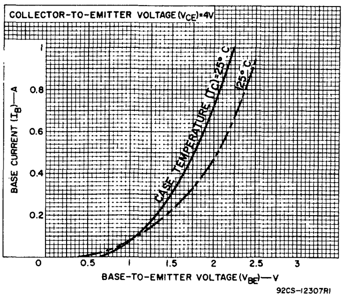


Fig. 5 — Typical input characteristics.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified.*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS		UNITS
		VOLTAGE V dc			CURRENT A dc				
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	
Collector Cutoff Current: With base-emitter junction reverse-biased	I_{CEV}	40		−1.5			–	2	mA
Emitter Cutoff Current	I_{EBO}		7				–	1	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$				0.2	0	45	–	V
With base-emitter junction reverse-biased	$V_{CEV}(sus)$			−1.5	0.1		50	–	
DC Forward Current Transfer Ratio	h_{FE}	4			4^a		12.5	160	
Base-to-Emitter Voltage	V_{BE}	4			4^a		–	1.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				4^a	0.4	–	1.1	V
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4			1		10	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 0.4 MHz)	$\|h_{fe}\|$	4			1		2	–	
Gain-Bandwidth Product	f_T				1		800	–	kHz
Forward-Bias Second-Breakdown Collector Current (t ≥ 1 s)	$I_{S/b}$	39					3	–	A
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	1.5	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 2%.

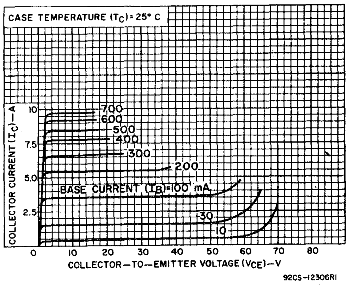


Fig. 6 – Typical output characteristics.

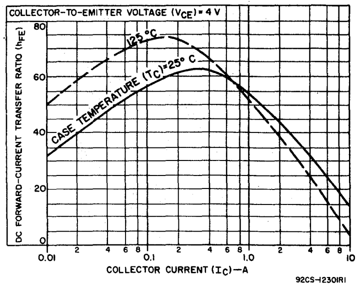


Fig. 7 – Typical dc beta characteristics.

BD181, BD182, BD183

Hometaxial-Base, High Power Silicon N-P-N Transistors

Rugged, Broadly Applicable Devices For Commercial Use

RCA-BD181, BD182 and BD183 are silicon n-p-n transistors intended for a wide variety of high-power applications. The hometaxial-base construction of these devices renders them highly resistant to second breakdown over a wide range of operating conditions.

These transistors are supplied in a JEDEC TO-3 hermetic steel package.

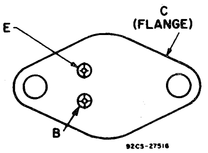
Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

Features:

- Maximum safe-area-of-operation curves
- Low saturation voltages
- High dissipation ratings
- Thermal-cycling rating curves

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD181	BD182	BD183	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	70	85	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	55	70	85	V
With base open	$V_{CEO}(sus)$	45	60	80	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	15	15	15	A
CONTINUOUS BASE CURRENT	I_B	7	7	7	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		117	117	117	W
At case temperatures above 25°C		← See Fig. 2 →			
TEMPERATURE RANGE:					
Storage and Operating (Junction)		← −65 to +200 →			°C
PIN TEMPERATURE (During Soldering):					
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		← 235 →			°C

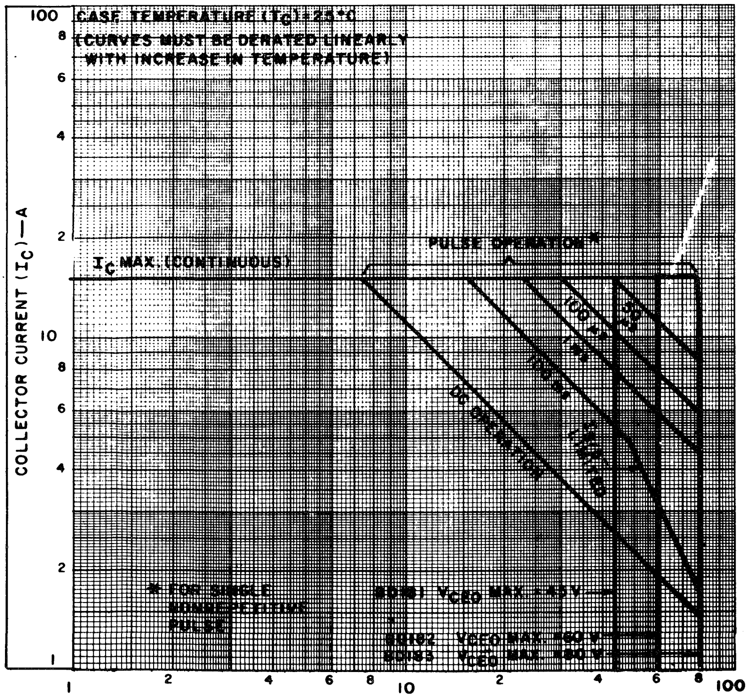


Fig. 1 — Maximum operating areas for all types.

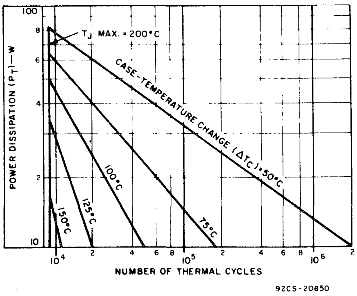


Fig. 2 — Thermal cycling rating chart for all types.

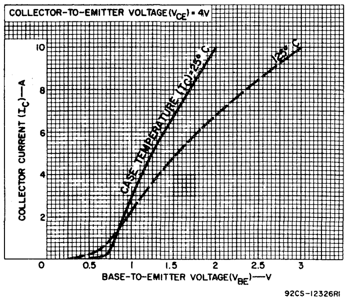


Fig. 3 — Typical transfer characteristics for all types.

BD181, BD182, BD183

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS						UNITS
		VOLTAGE V dc				CUR-RENT A dc		BD181		BD182		BD183		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector-Cutoff Current: With emitter open and T_C = 200°C	I_{CBO}	45					0	–	2	–	–	–	–	mA
		60					0	–	–	–	5	–	–	
		80					0	–	–	–	–	–	5	
With base-emitter junction reverse-biased	I_{CEX}		45		−1.5				1	–	–	–	–	
			60		−1.5			–	–	–	1	–	–	
			80		−1.5			–	–	–	–	–	1	
Emitter-Cutoff Current	I_{EBO}			7				–	5	–	5	–	5	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$					0.2^a	0	45	–	60	–	80	–	V
With external base-to-emitter resistance (R_{BE})=100 Ω	$V_{CER}(sus)$					0.2^a		55	–	70	–	85	–	
DC Forward Current Transfer Ratio	h_{FE}		4			4^a		–	–	20	70	–	–	
			4			3^a		20	70	–	–	20	70	
Base-to-Emitter Voltage	V_{BE}		4			3^a		–	1.5	–	–	–	1.5	V
			4			4^a		–	–	–	1.5	–	–	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					4^a	0.4^a	–	–	–	1	–	–	V
						3^a	0.3^a	–	1	–	–	–	1	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 0.4 MHz)	$\|h_{fe}\|$		4			1		2	–	2	–	2	–	
Gain-Bandwidth Product	f_T					1		800	–	800	–	800	–	kHz
Common-Emitter, Short-Circuit, Small-Signal, Forward Current Transfer Ratio Cutoff Frequency	f_{hfe}		4			0.3		15	–	15	–	15	–	kHz
Forward-Bias Second Breakdown Collector Current (t ⩾ 1 s)	$I_{S/b}$		30					3.95	–	3.95	–	3.95	–	A
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$							–	1.5	–	1.5	–	1.5	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

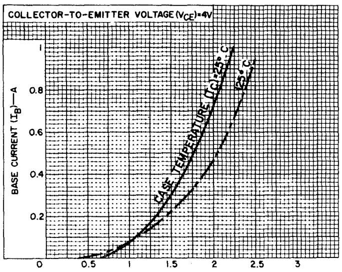


Fig. 4 – Typical input characteristics for BD182.

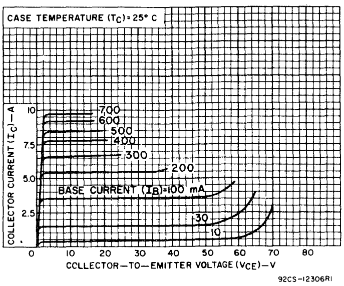


Fig. 5 – Typical output characteristics for BD182.

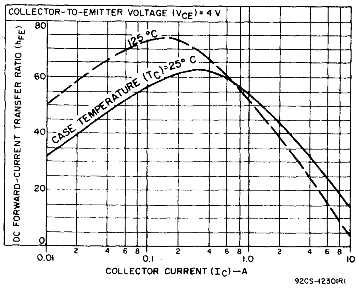


Fig. 6 – Typical dc-beta characteristics for BD182.

BD181, BD182, BD183

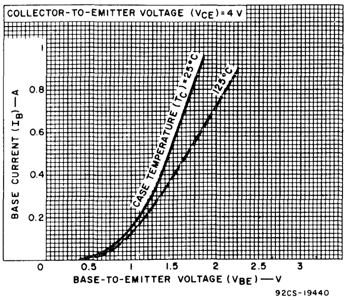


Fig. 7 – Typical input characteristics for BD181 and BD183.

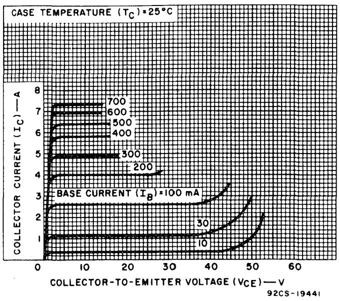


Fig. 8 – Typical output characteristics for BD181 and BD183.

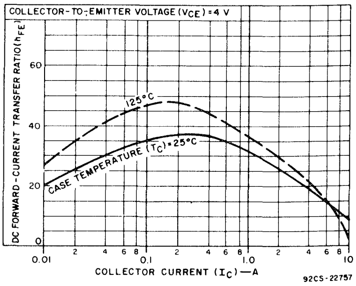


Fig. 9 – Typical dc-beta characteristics for BD181 and BD183.

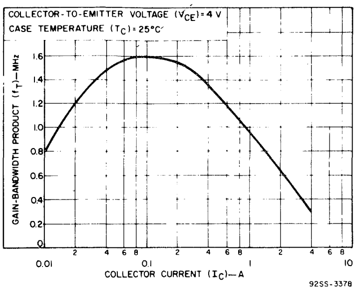


Fig. 10 – Typical gain-bandwidth product for all types.

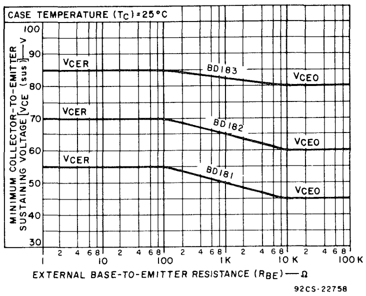


Fig. 11 – Sustaining voltage vs. base-to-emitter resistance for all types.

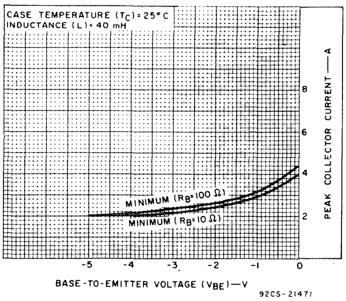


Fig. 12 – Minimum reverse-bias second-breakdown characteristics for all types.

BD201, BD202, BD203, BD204

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

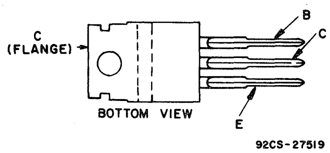
General-Purpose Medium-Power Types for Switching and Amplifier Applications

Features:
- *Low saturation voltages*
- *VERSAWATT package*
- *Complementary n-p-n and p-n-p types*
- *Maximum safe-area-of-operation curves*

The RCA-BD201 and BD203 n-p-n transistors and their complementary p-n-p types, BD202 and BD204 respectively, are epitaxial-base transistors intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators, and driver and output stages of high-fidelity amplifier.

All types utilize the JEDEC TO-220AB (RCA VERSAWATT) plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

N-P-N	**BD201**	**BD203**	
P-N-P	**BD202**■	**BD204**■	
V_{CBO}	60	60	V
$V_{CEO}(sus)$	45	60	V
V_{EBO}	5		V
I_C	8		A
I_B	3		A
P_T			
$T_C \leq 25°C$	60		W
$T_C > 25°C$	Derate linearly 0.48		W/°C
T_{stg}, T_J	-65 to 150		°C
T_L			
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235		°C

■For p-n-p devices, voltage and current values are negative.

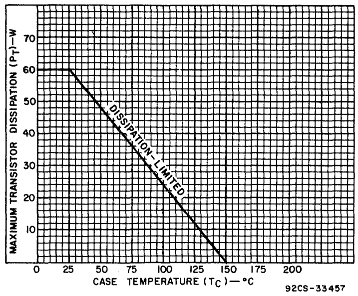


Fig. 2 - Derating curve for all types.

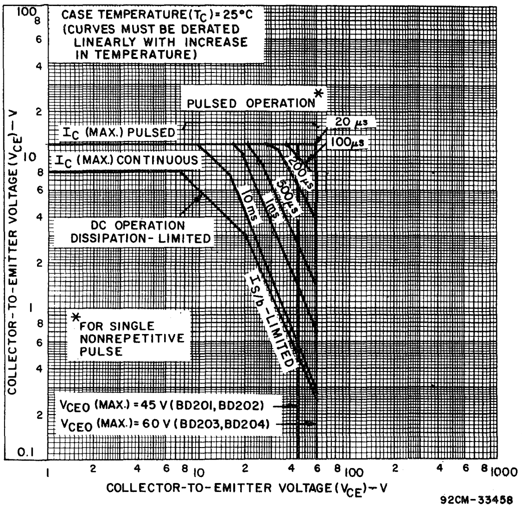


Fig. 1 - Maximum operating areas for all types (T_C=25° C).

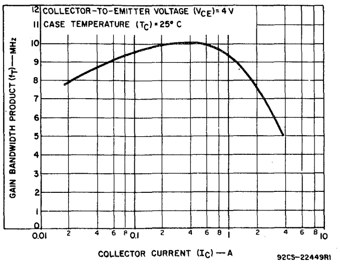


Fig. 3 - Typical gain-bandwidth product vs. collector current for all types.

BD201, BD202, BD203, BD204

ELECTRICAL CHARACTERISTICS, *at Case Temperature* (T_C)=25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS■					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD201 BD202■		BD203 BD204■		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO}	40					—	1	—	1	mA
T_J=150°C	40					—	1	—	1	
I_{CEO}		30				—	1	—	1	
I_{EBO}			-5			—	5	—	5	
V_{CEO}(sus)[a]				0.2[b]		45	—	60	—	V
h_{FE}		2		1[b]		30	—	30	—	
		2		2[b]		—	—	30	—	
		2		3[b]		30	—	—	—	
V_{BE}		2		3[b]		—	1.5	—	1.5	V
V_{CE}(sat)				3[b]	0.3	—	1	—	1	
$I_{S/b}$		20		3		0.5	—	0.5	—	s
$\|h_{fe}\|$ (f=1 kHz)		3		0.3		3	—	3	—	
h_{fe} (f=1 kHz)		3		0.3		25	—	25	—	
$R_{\theta JC}$						—	2.08	—	2.08	°C/W
$R_{\theta JA}$						—	70	—	70	

[a] CAUTION: The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

[b] Pulsed: pulse duration = 300 μs, duty factor = 0.018.

■For p-n-p devices, voltage and current values are negative.

BD239, BD239A, BD239B, BD239C, BD240, BD240A, BD240B, BD240C

Epitaxial-Base Silicon N-P-N and P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

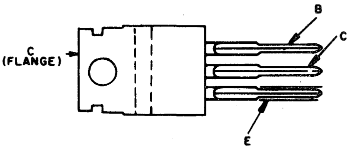
These RCA devices are epitaxial-base silicon n-p-n and p-n-p transistors; they differ only in their voltage ratings. These transistors are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD240-series p-n-p power transistors are complements of the n-p-n devices in the BD239 series.

All these transistors are supplied in the JEDEC TO-220AB VERSAWATT package.

Features:

- **30 W at 25°C case temperature**
- **4-A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 200 mA**

TERMINAL DESIGNATIONS



BOTTOM VIEW
JEDEC TO-220 AB
(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD239 BD240◆	BD239A BD240A◆	BD239B BD240B◆	BD239C BD240C◆	
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	4	4	4	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		30	30	30	30	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C		Derate linearly to 150°C				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

◆ For p-n-p devices, voltage and current values are negative.

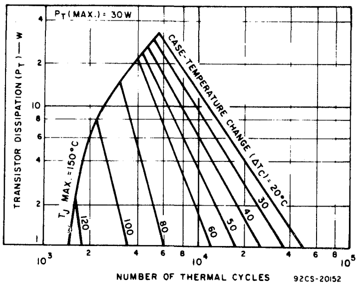


Fig. 1 — Thermal-cycling ratings for all types.

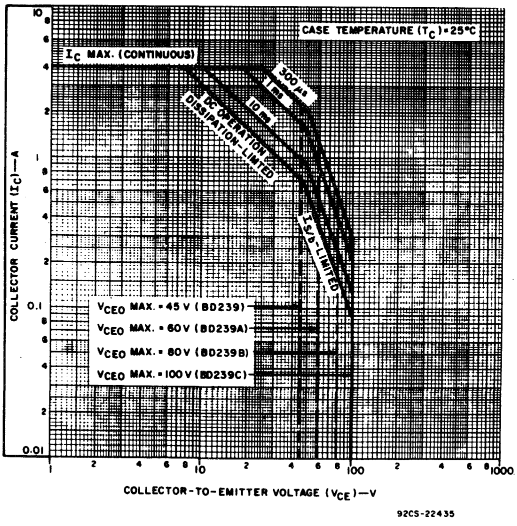


Fig. 2 — Maximum safe operating areas for BD239-series types.

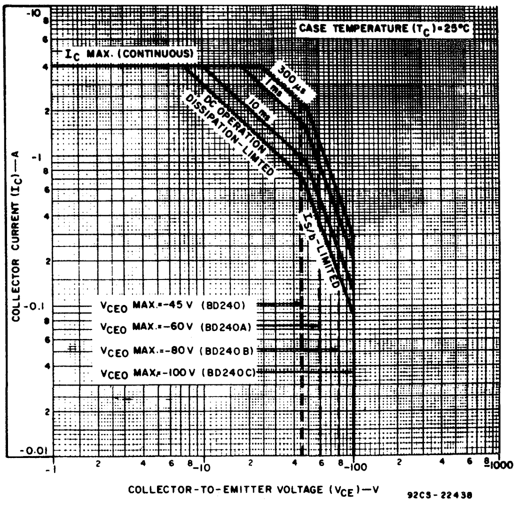


Fig. 3 — Maximum safe operating areas for BD240-series types.

BD239, BD239A, BD239B, BD239C, BD240, BD240A, BD240B, BD240C

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS◆				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD239 BD240◆		BD239A BD240A◆		BD239B BD240B◆		BD239C BD240C◆		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	−30			0	–	−0.3	–	−0.3	–	–	–	–	mA
		−60			0	–	–	–	–	–	−0.3	–	−0.3	
With base-to-emitter junction short-circuited	I_{CES}	−45	0			–	−0.2	–	–	–	–	–	–	
		−60	0			–	–	–	−0.2	–	–	–	–	
		−80	0			–	–	–	–	–	−0.2	–	–	
		−100	0			–	–	–	–	–	–	–	−0.2	
Emitter Cutoff Current	I_{EBO}		5	0		–	−1	–	−1	–	−1	–	−1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			−0.03[a]	0	−45	–	−60	–	−80	–	−100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	−4		−0.2[a]		40	–	40	–	40	–	40	–	
		−4		−1[a]		15	–	15	–	15	–	15	–	
Base-to-Emitter Voltage	V_{BE}	−4		−1[a]		–	−1.3	–	−1.3	–	−1.3	–	−1.3	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			−1[a]	−0.2	–	−0.7	–	−0.7	–	−0.7	–	−0.7	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	−10		0.2		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	−10		0.2		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	4.17	–	4.17	–	4.17	–	4.17	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

◆ For p-n-p devices, voltage and current values are negative.

[a] Pulsed: Pulse duration = 300 µs, duty factor = 2%.

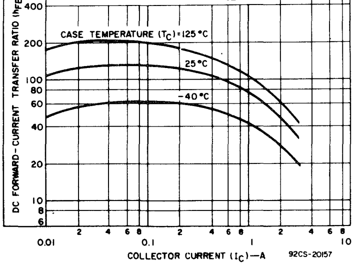


Fig. 4 – Typical dc beta characteristics for BD239-series types.

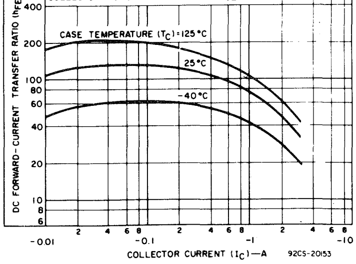


Fig. 5 – Typical dc beta characteristics for BD240-series types.

BD241, BD241A, BD241B, BD241C, BD242, BD242A, BD242B, BD242C

Epitaxial-Base Silicon N-P-N and P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

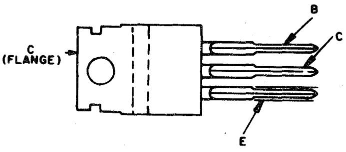
These RCA devices are epitaxial-base silicon n-p-n and p-n-p transistors; they differ only in their voltage ratings. These transistors are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD242-series p-n-p power transistors are complements of the n-p-n devices in the BD241 series.

All these transistors are supplied in the JEDEC TO-220AB VERSAWATT package.

Features:

- **40 W at 25°C case temperature**
- **5-A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 500 mA**

TERMINAL DESIGNATIONS



BOTTOM VIEW
JEDEC TO-220 AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD241 BD242◆	BD241A BD242A◆	BD241B BD242B◆	BD241C BD242C◆	
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	5	5	5	5	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		40	40	40	40	W
At ambient temperatures up to 25°C .		2	2	2	2	W
At case temperatures above 25°C		Derate linearly to 150°C				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

◆ For p-n-p devices, voltage and current values are negative.

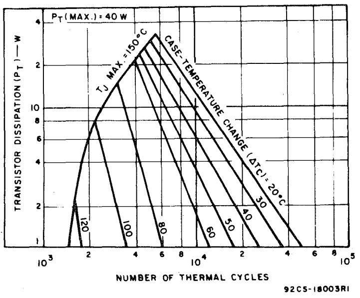


Fig. 1 — Thermal-cycling ratings for all types.

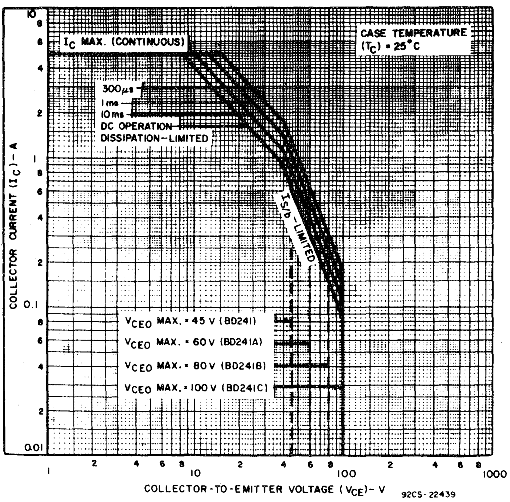


Fig. 2 — Maximum safe operating areas for BD241-series types.

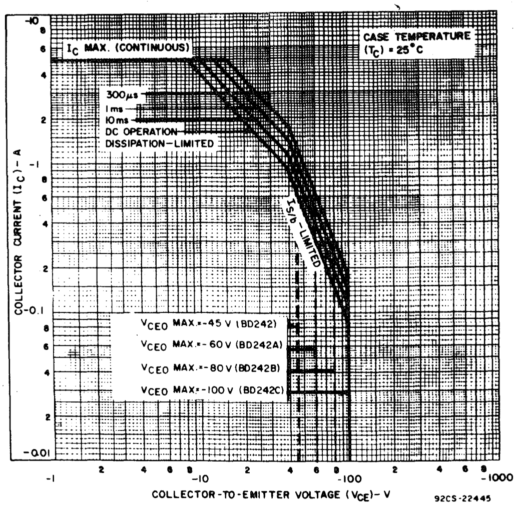


Fig. 3 — Maximum safe operating areas for BD242-series types.

BD241, BD241A, BD241B, BD241C, BD242, BD242A, BD242B, BD242C

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS◆				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD241 BD242◆		BD241A BD242A◆		BD241B BD242B◆		BD241C BD242C◆		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	30			0	–	0.3	–	0.3	–	–	–	–	mA
		60			0	–	–	–	–	–	0.3	–	0.3	
With base-to-emitter junction short-circuited	I_{CES}	45	0			–	0.2	–	–	–	–	–	–	
		60	0			–	–	–	0.2	–	–	–	–	
		80	0			–	–	–	–	–	0.2	–	–	
		100	0			–	–	–	–	–	–	–	0.2	
Emitter Cutoff Current	I_{EBO}		–5	0		–	1	–	1	–	1	–	1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			0.03^a	0	45	–	60	–	80	–	100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4		1^a		25	–	25	–	25	–	25	–	
		4		3^a		10	–	10	–	10	–	10	–	
Base-to-Emitter Voltage	V_{BE}	4		3^a		–	1.8	–	1.8	–	1.8	–	1.8	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			3^a	0.6	–	1.2	–	1.2	–	1.2	–	1.2	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	10		0.5		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	10		0.5		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	–	3.125	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

[a] Pulsed: Pulse duration = 300 μs, duty factor = 2%.

◆ For p-n-p devices, voltage and current values are negative.

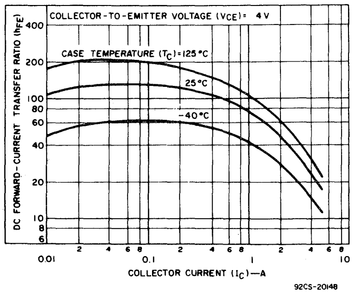


Fig. 4 — Typical dc beta characteristics for BD241-series types.

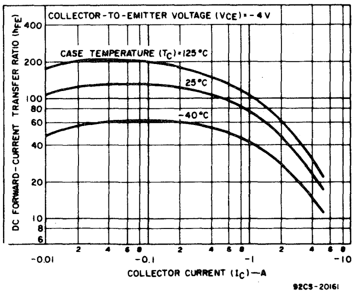


Fig. 5 — Typical dc beta characteristics for BD242-series types.

BD243, BD243A, BD243B, BD243C, BD244, BD244A, BD244B, BD244C

Epitaxial-Base Silicon N-P-N and P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

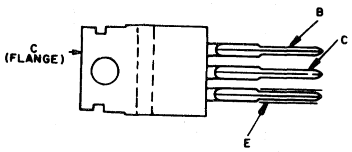
These RCA devices are epitaxial-base silicon n-p-n and p-n-p transistors; they differ only in their voltage ratings. These transistors are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high fidelity amplifiers. The BD244-series p-n-p power transistors are complements of the n-p-n devices in the BD243 series.

All these transistors are supplied in the JEDEC TO-220AB VERSAWATT package.

Features:

- **65 W at 25° C case temperature**
- **7-A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 500 mA**

TERMINAL DESIGNATIONS



92CS-27519

BOTTOM VIEW

JEDEC TO-220 AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD243 BD244◆	BD243A BD244A◆	BD243B BD244B◆	BD243C BD244C◆	
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	6.5	6.5	6.5	6.5	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		65	65	65	65	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C		Derate linearly to 150°C				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

◆ For p-n-p devices, voltage and current values are negative.

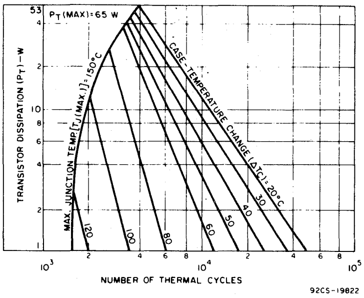


Fig. 1 — Thermal-cycling ratings for all types.

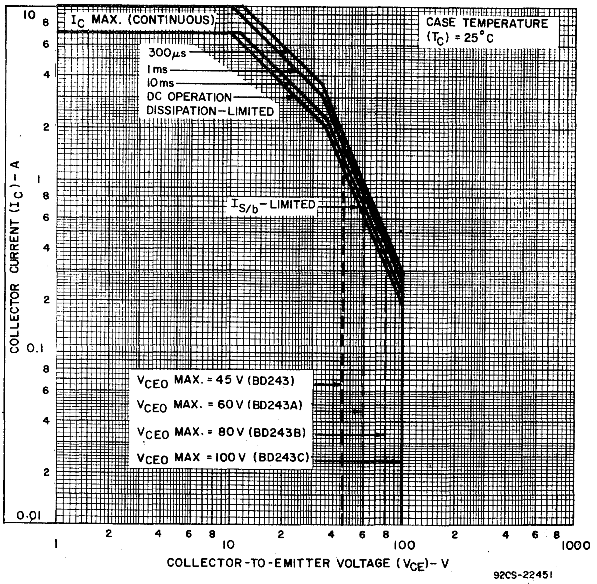


Fig. 2 — Maximum safe operating areas for BD243-series types.

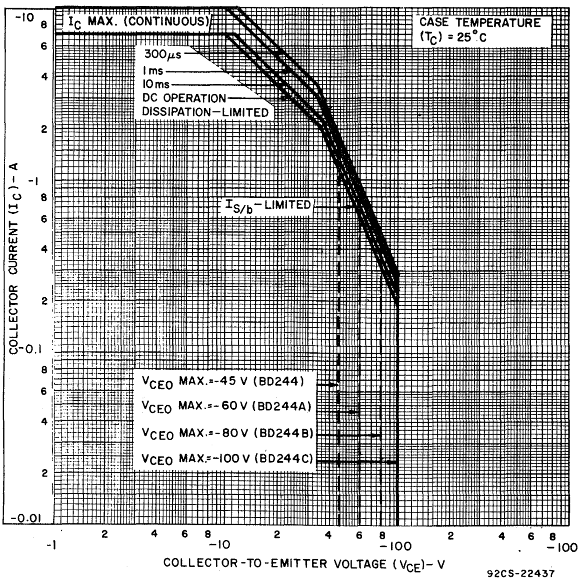


Fig. 3 — Maximum safe operating areas for BD244-series types.

BD243, BD243A, BD243B, BD243C, BD244, BD244A, BD244B, BD244C

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS◆				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD243 BD244◆		BD243A BD244A◆		BD243B BD244B◆		BD243C BD244C◆		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	30			0	–	0.7	–	0.7	–	–	–	–	mA
		60			0	–	–	–	–	–	0.7	–	0.7	
With base-to-emitter junction short-circuited	I_{CES}	45	0			–	0.4	–	–	–	–	–	–	
		60	0			–	–	–	0.4	–	–	–	–	
		80	0			–	–	–	–	–	0.4	–	–	
		100	0			–	–	–	–	–	–	–	0.4	
Emitter Cutoff Current	I_{EBO}		–5	0		–	1	–	1	–	1	–	1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			0.03^a	0	45	–	60	–	80	–	100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4		0.3^a		30	–	30	–	30	–	30	–	
		4		3^a		15	–	15	–	15	–	15	–	
Base-to-Emitter Voltage	V_{BE}	4		6^a		–	2	–	2	–	2	–	2	V
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			6^a	1	–	1.5	–	1.5	–	1.5	–	1.5	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	10		0.5		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	10		0.5		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	–	1.92	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

^{a}Pulsed: Pulse duration = 300 μs, duty factor = 2%.

◆ For p-n-p devices, voltage and current values are negative.

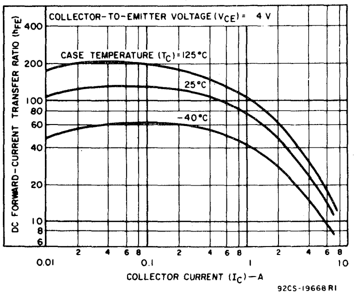


Fig. 4 — Typical dc beta characteristics for BD243-series types.

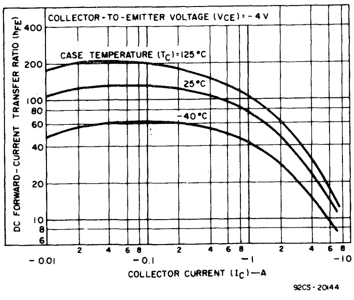


Fig. 5 — Typical dc beta characteristics for BD244-series types.

7-A, 70-W, Epitaxial-Base, Silicon P-N-P VERSAWATT Transistor

For Applications in Series and Shunt Regulators

Features:

- **Thermal-cycling ratings**
- **Maximum-safe-area-of -operation curve**
- **Low saturation voltage**
- **VERSAWATT package**
- **High power-dissipation capability**

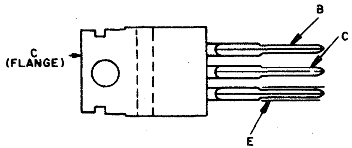
Type BD277 is an epitaxial-base silicon p-n-p transistor supplied in the JEDEC TO-220AB straight-lead VERSAWATT package. It is also available in the TO-220AA package (leads formed to fit a TO-66 socket) to order this version, specify formed lead No. 6201.

The BD277 is useful in series regulators and shunt regulators because of its low saturation voltage and high power-dissipation capability. It is also useful as a replacement for germanium p-n-p transistors in many applications.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	–45	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	–45	V
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EBO}	–4	V
COLLECTOR CURRENT (Continuous)	I_C	–7	A
BASE CURRENT (Continuous)	I_B	–3	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		70	W
At case temperatures above 25°C		Derate linearly at 0.56 W/°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		–65 to 150	°C
LEAD TEMPERATURE (During Soldering):			
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.		235	°C

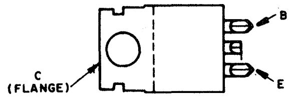
TERMINAL DESIGNATIONS



BOTTOM VIEW 92CS-27519

JEDEC TO-220AB

(See dimensional outline "S".)



BOTTOM VIEW 92CS-27520

JEDEC TO-220AA

(See dimensional outline "R".)

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless specified otherwise*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS		UNITS
		VOLTAGE V dc			CURRENT A dc					
		V_{CE}	V_{CB}	V_{EB}	I_C	I_B	I_E	MIN.	MAX.	
Collector Cutoff Current: With emitter open	I_{CBO}		–45				0	–	–0.1	mA
With emitter open and T_C = 150°C			–40				0	–	–2.0	
With base open	I_{CEO}	–30				0		–	–1.0	
Emitter Cutoff Current: With collector open	I_{EBO}			–4	0			–	–1.0	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				–0.1*	0		–45	–	V
Base-to-Emitter Voltage	V_{BE}	–2			–1.75*			–	1.2	V
DC Forward-Current Transfer Ratio	h_{FE}	–2			–1.75*			30	150	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				–1.75*	–0.1		–	–0.5	V
Gain-Bandwidth Product	f_T	–4			–0.5			10	–	MHz
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$							–	1.78	°C/W
Junction-to-Ambient	$R_{\theta JA}$							–	70	

* Pulsed: Pulse duration = 300 μs, duty factor ≤ 2%.

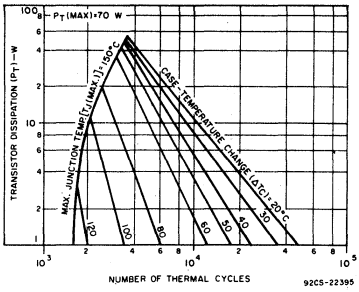


Fig. 1 — Thermal-cycling ratings.

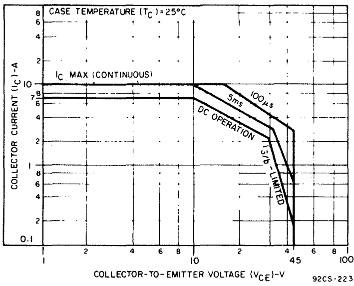


Fig. 2 — Maximum operating area.

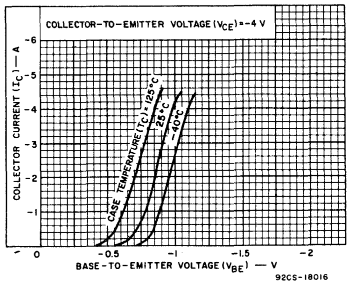


Fig. 3 — Typical transfer characteristics.

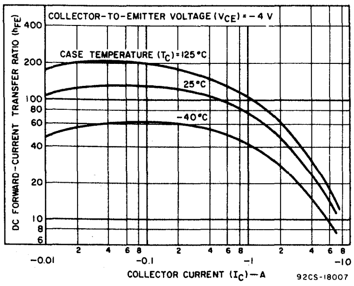


Fig. 4 — Typical dc beta characteristics.

BD278, BD278A

High-Current Silicon N-P-N VERSAWATT Transistors

For Medium-Power Linear and Switching Service in Consumer, Automotive, and Industrial Applications

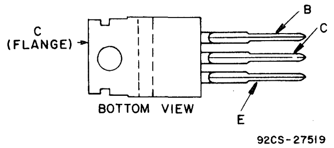
Features:

- **Low saturation voltage:** $V_{CE(sat)}$ = 1 V max. at I_C = 4 A
- **VERSAWATT package**
- **Maximum-safe-area-of-operation curve**
- **Thermal-cycling rating curve**

The RCA-BD278 and BD278A are hometaxial-base silicon n-p-n transistors supplied in the JEDEC TO-220AB straight-lead VERSAWATT package.

These transistors are intended for a wide variety of medium-power switching and linear applications such as series regulators, shunt regulators, solenoid drivers, motor-speed controls, inverters, output stages for high-fidelity amplifiers, and power-supply and vertical-deflection circuits for monochrome and color TV.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD278	BD278A	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	55	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER(sus)}$	55	55	V
With base open	$V_{CEO(sus)}$	45	45	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	V
COLLECTOR CURRENT (Continuous)	I_C	10	10	A
BASE CURRENT	I_B	4	4	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C		75	75	W
At ambient temperatures up to 25°C		1.8	1.8	W
At case temperatures above 25°C, derate linearly		0.6		W/°C
At ambient temperatures above 25°C, derate linearly		0.0144		W/°C
TEMPERATURE RANGE:				
Storage & Operating (Junction)		−65 to 150		°C
LEAD TEMPERATURE (During Soldering):				
At distance ⩾ 1/8 in. (3.17 mm) from case for 10 s max.		235		°C

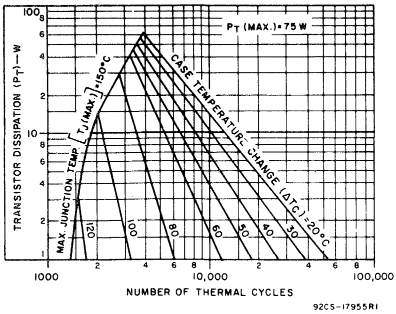


Fig.1 – Thermal-cycling ratings.

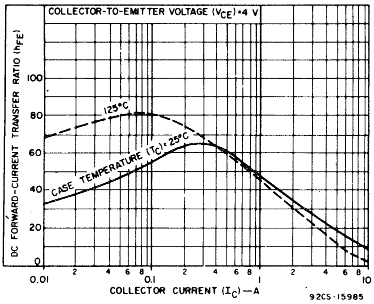


Fig.2 – Typical dc beta characteristics.

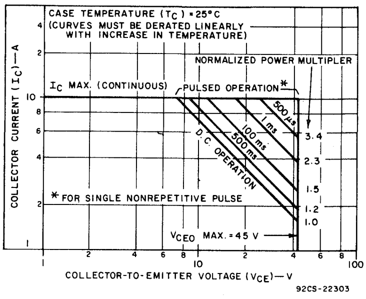


Fig.3 – Maximum safe operating area.

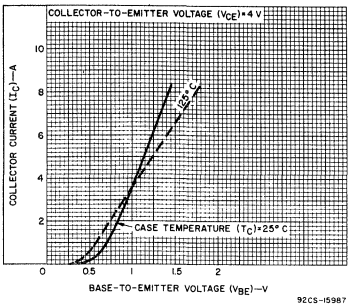


Fig.4 – Typical transfer characteristics.

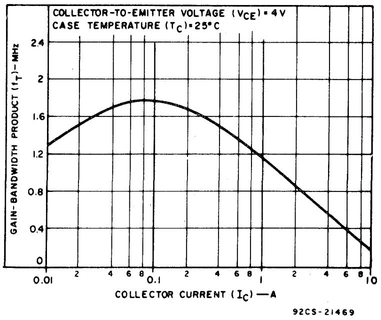


Fig.5 – Typical gain-bandwidth product.

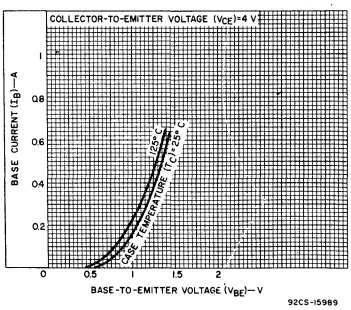


Fig.6 – Typical input characteristics.

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BD278		BD278A		
	V_{CE}	V_{EB}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
I_{CEX}	55	1.5			–	2	–	2	mA
$T_C = 150°C$	50	1.5			–	10	–	10	
I_{CEO}	30			0	–	2	–	2	
I_{EBO}		5			–	5	–	5	mA
$V_{CER}(sus)$ $R_{BE} = 100\Omega$			0.2[a]		55	–	55	–	V
$V_{CEO}(sus)$			0.2[a]	0	45	–	45	–	
h_{FE}	4 3		4[a] 2[a]		15 —	75 —	15 30	75 —	
V_{BE}	4		4[a]		--	1.8	–	1.8	V
$V_{CE}(sat)$			4[a]	0.4	–	1	–	1	V
h_{fe} (f = 1 kHz)	4		0.5		15	–	15	–	
h_{fe} (f = 0.1 MHz)	4		0.5		8	28	8	28	
$I_{S/b}$ (t = 0.5 s)	40				1.87	–	1.87	–	A
$R_{\theta JC}$					–	1.67	–	1.67	°C/W
$R_{\theta JA}$					–	70	–	70	

[a] Pulsed, pulse duration = 300μs, duty factor = 0.018

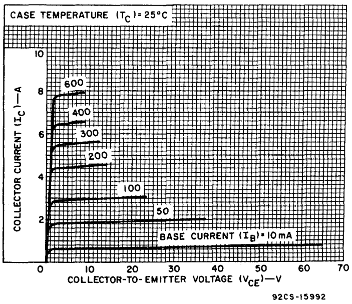


Fig.7 — Typical output characteristics.

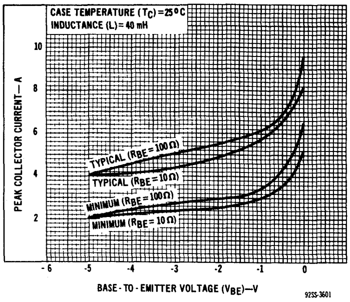


Fig.8 — Reverse-bias second-breakdown characteristics.

BD311, BD312, BD313, BD314

Silicon N-P-N and P-N-P Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-BD311 and BD313 types and their p-n-p complements, BD312 and BD314, respectively, are epitaxial-base silicon transistors featuring high gain and high current. All these devices have a dissipation capability of 150 watts at case temperature up to 25°C and are supplied in the JEDEC TO-204MA steel hermetic package.

Features:
- *High dissipation capability*
- *Low saturation voltages*
- *Maximum safe-area-of-operation curves*
- *Hermetically sealed JEDEC TO-204MA package*
- *High gain at high current*
- *Thermal-cycling rating curve*

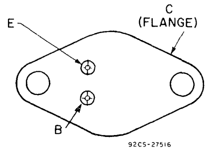
Applications:
- *Series and shunt regulators*
- *High-fidelity amplifiers*
- *Power-switching circuits*
- *Solenoid drivers*

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BD311 ● BD312	BD313 ● BD314	n-p-n p-n-p
V_{CBO}	60	80	V
$V_{CEO}(sus)$	60	80	V
V_{EBO}	7	7	V
I_C	10	10	A
I_B	4	4	A
P_T			
At $T_C \leq 25$°C	150	150	W
At $T_C > 25$°C . . . Derate linearly	0.86		W/°C
T_{stg}, T_J	−65 to 200		°C
T_L			
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235		°C

● For p-n-p devices, voltage and current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

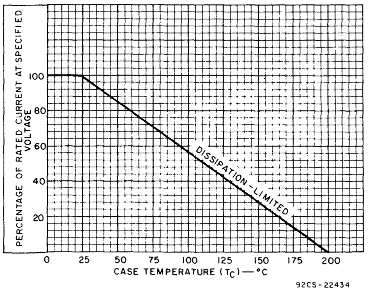


Fig. 2 - Derating curve for all types.

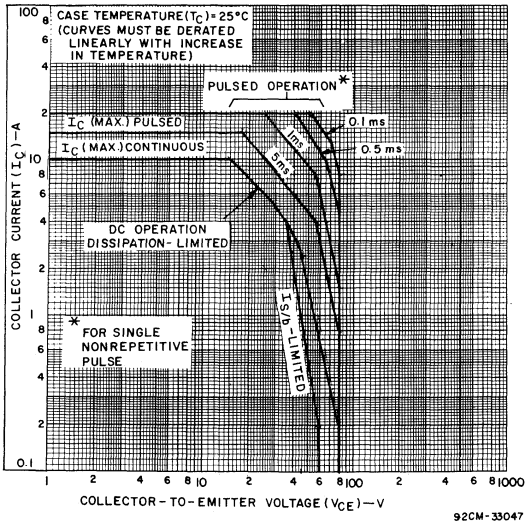


Fig. 1 - Maximum safe operating areas for all types.

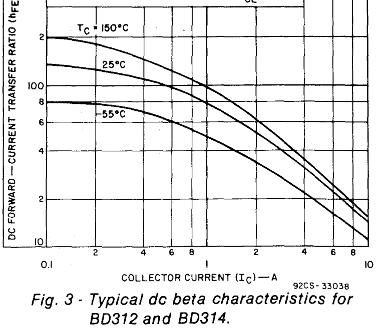


Fig. 3 - Typical dc beta characteristics for BD312 and BD314.

BD311, BD312, BD313, BD314

ELECTRICAL CHARACTERISTICS, *at case temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BD311 ● BD312		BD313 ● BD314		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO} $V_{CB} = 60$ V					—	1.0	—	—	mA
$V_{CB} = 80$ V					—	—	—	1.0	
I_{EBO}		−7	0		—	1.0	—	1.0	mA
$V_{CEO}(sus)^b$			0.2	0	60	—	80	—	V
h_{FE}	4		4a		—	—	25	—	
	4		5a		25	—	—	—	
	4		10a		5	—	5	—	
$V_{BE}a$	4		5		—	1.5	—	1.5	V
$V_{BE}(sat)^a$			5	0.5	—	1.8	—	1.8	V
$V_{CE}(sat)^a$			5	0.5	—	1.0	—	1.0	V
			—	—	—	—	—	—	
$\|h_{fe}\|$ f = 1 MHz	10		0.5		4	—	4	—	
$R_{\theta JC}$					—	1.17	—	1.17	°C/W

[a] Pulsed; pulse duration = 200 μs, duty factor = 1.5%.

[b] CAUTION: Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ *MUST NOT* be measured on a curve tracer.

● For p-n-p devices, voltage and current values are negative.

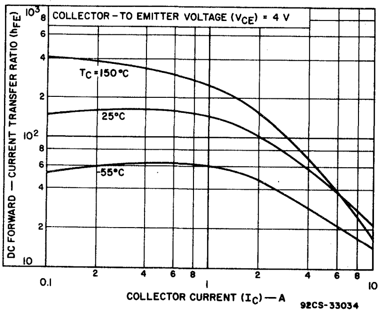


Fig. 4 - Typical dc beta characteristics for BD311 and BD313.

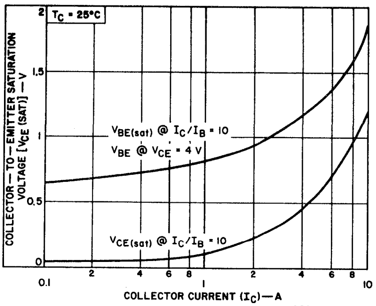


Fig. 5 - Typical saturation-voltage characteristics for BD312 and BD314.

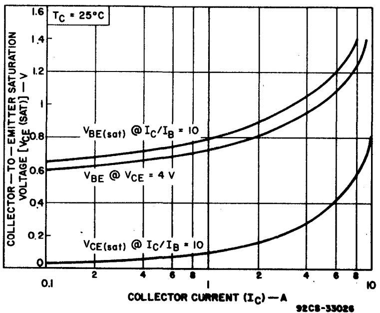


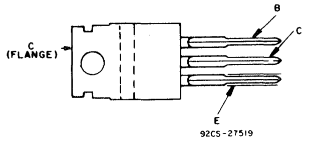
Fig. 6 - Typical saturation-voltage characteristics for BD311 and BD313.

BD500, BD501 Series

Silicon Transistors for 40-Watt Full-Complementary- Symmetry Audio Amplifiers

The BD500-Series and BD501-Series types are p-n-p and n-p-n epitaxial-base silicon transistors, respectively, especially suitable for audio-output applications. The 40-watt amplifier shown in Figs. 1 and 5 uses the BD500B and BD501B in conjunction with seven TO-39 transistors, ten diodes, and a 64-volt split power supply. The amplifier output is directly coupled to an 8-ohm speaker. The BD500A and BD501A are intended for similar 40-watt audio amplifiers except for a 4-ohm speaker and a split 46-volt power supply. The BD500 and BD501 are intended for 25-watt audio amplifiers of similar circuitry except for a 4-ohm speaker and a split 40-volt power supply.

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BD501 BD500•	BD501A BD500A•	BD501B BD500B•	N-P-N P-N-P
V_{CBO}	60	70	90	V
V_{CEO}	50	60	80	V
$V_{CER}(R_{BE} = 100\ \Omega)$	55	65	85	V
V_{EBO}		5		V
I_C		10		A
I_B		4		A
P_T:				
At $T_C \leqslant 25\ °C$		75		W
At $T_C > 25\ °C$		See Figs. 2 and 4		
T_{stg}, T_J		− 65 to 150		°C
T_L:				
At distances ⩾ 1/32 in. (0.8 mm) from case for 10 s max.		230		°C

•For p-n-p devices, voltage and current values are negative.

TYPICAL PERFORMANCE DATA
For 40-Watt Audio Amplifier

Measured at a line voltage of 220 V, T_A = 25°C, and a frequency of 1 kHz, unless otherwise specified.

Power:
- Rated power (8-Ω load, at rated distortion) . . . 40 W
- Typical power (4-Ω load) . . . 75 W■
- Typical power (16-Ω load) . . . 22 W

Total Harmonic Distortion:
- Rated distortion . . . 1.0%
- Typical at 20 W . . . 0.05%

IM Distortion:
- 10 dB below continuous power output at 60 Hz and 7 kHz (4:1) . . . 0.1%

IHF Power Bandwidth:
- 3 dB below rated continuous power at rated distortion . . . 80 kHz

Sensitivity:
- At continuous power-output rating . . . 600 mV

Hum and Noise:
- Below continuous power output:
  - Input shorted . . . 80 dB
  - Input open . . . 75 dB

Input Resistance . . . 20 kΩ

■Typical power (4Ω load) with 46-volt split power supply and BD500A, BD501A output . . . 40 W
Typical power (4Ω load) with 40-volt split power supply and BD500, BD501 output . . . 25W

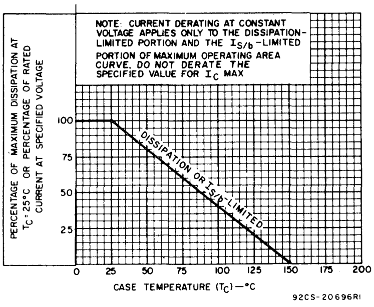


Fig. 2 - Derating curve for all types.

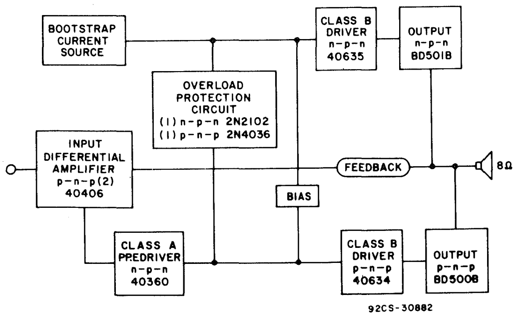


Fig. 1 - Block diagram and transistor complement for 40-watt full-complementary-symmetry audio amplifier.

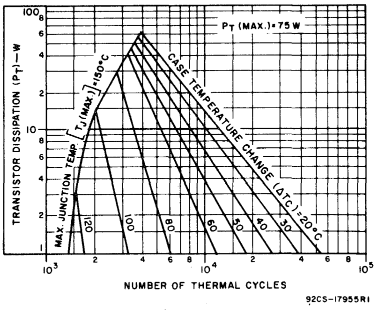


Fig. 3 - Thermal-cycling ratings.

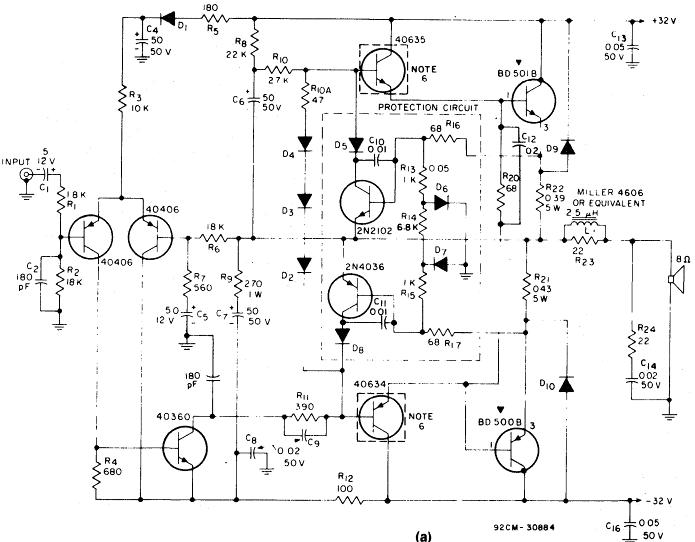
BD500, BD501 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARAC-TERISTICS	TEST CONDITIONS	LIMITS▲						UNITS
		BD500• BD501		BD500A• BD501A		BD500B• BD501B		
		Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER} R_{BE} = 100 Ω	V_{CE} = 45 V	—	1	—	—	—	—	mA
	V_{CE} = 55V	—	—	—	1	—	—	
	V_{CE} = 75 V	—	—	—	—	—	1	
I_{EBO}	V_{EB} = 5 V	—	1	—	1	—	1	mA
V_{CEO}	I_C = 0.1 A	50	—	60	—	80	—	V
V_{CER}	I_C = 0.1 A; R_{BE} = 100 Ω	55	—	65	—	85	—	V
f_T	I_C = 0.5 A; V_{CE} = 4 V	5	—	5	—	5	—	MHz
h_{FE}	I_C = 5 A; V_{CE} = 4 V	15	90	15	90	—	—	—
	I_C = 3.5 A; V_{CE} = 4 V	—	—	—	—	20	120	
V_{CE}(sat)	I_C = 5 A; I_B = 0.5 A	—	1.2	—	1.2	—	—	V
	I_C = 3.5 A; I_B = 0.35A	—	—	—	—	—	1	
V_{BE}	I_C = 5 A; V_{CE} = 4 V	—	1.8	—	1.8	—	—	V
	I_C = 3.5 A; V_{CE} = 4 V	—	—	—	—	—	1.5	
$I_{S/b}$	V_{CE} = 20 V; t = 0.55 s	3.75	—	—	—	—	—	A
	V_{CE} = 25 V; t = 0.55 s	—	—	3	—	—	—	
	V_{CE} = 30 V; t = 0.55 s	—	—	—	—	2.5	—	

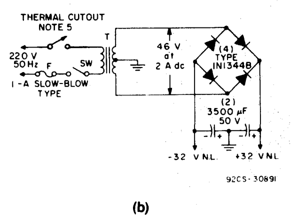
▲For characteristics curves and test conditions, refer to published data for prototypes (File 678): 2N6487 (BD501, BD501A); 2N6488 (BD501B); 2N6490 (BD500, BD500A); 2N6491 (BD500B).

•For p-n-p devices, voltage and current values are negative.



(a)

NOTES *(for Fig. 5)*:
1. D1-D10—D1201A.
2. Resistors are ½-watt, ± 10%, unless otherwise specified; values are in ohms.
3. Non-inductive resistors.
4. Capacitances are in μF unless otherwise specified.
5. 55°C thermal cutout attached to heat sink of output devices.
6. TO-39 case devices with heat radiator attached.
7. Provide heat sink of approx. 1.2°C/W per output device with a contact thermal resistance of 1.3°C/W max. and T_A = 40°C max.



(b)

Fig. 5 - 40-watt amplifier circuit featuring full-complementary-symmetry output using load line limiting: (a) basic amplifier circuit, (b) power-supply circuit.

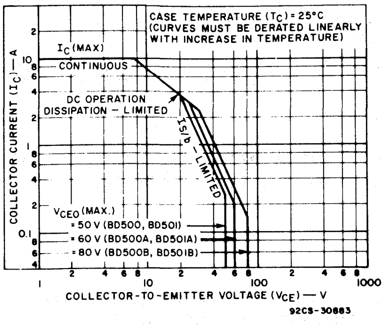


Fig. 4 - Maximum operating areas for all types.

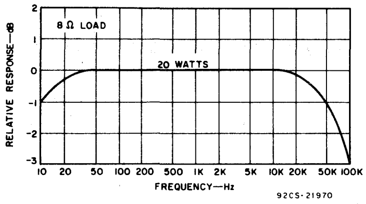


Fig. 6 - Typical frequency response.

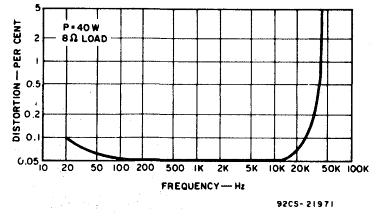


Fig. 7 - Typical total harmonic distortion as a function of frequency.

BD533, BD534, BD535, BD536, BD537, BD538

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

Features:

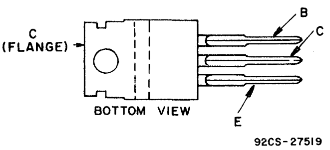
- _Low saturation voltages_
- _VERSAWATT package_
- _Complementary n-p-n and p-n-p types_
- _Maximum safe-area-of-operation curves_

General-Purpose Medium-Power Types for Switching and Amplifier Applications

The RCA-BD533-BD538 are epitaxial-base silicon transistors intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. The BD533, BD535, and BD537 are n-p-n complements of p-n-p types BD534, BD536, and BD538, respectively.

All types are supplied in the JEDEC TO-220AB VERSAWATT package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, _Absolute-Maximum Values:_

N-P-N	BD533	BD535	BD537	
P-N-P	BD534■	BD536■	BD538■	
V_{CBO}	45	60	80	V
V_{CES}(sus)	45	60	80	V
V_{CEO}(sus)	45	60	80	V
V_{EBO}	5			V
I_C	8			A
I_B	1			A
P_T:				
$T_C \le 25°C$	50			W
$T_C > 25°C$, derate linearly	0.4			W/°C
T_{stg}, T_J	−65 to 150			°C
T_L				
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235			°C

■ For p-n-p devices, voltage and current values are negative.

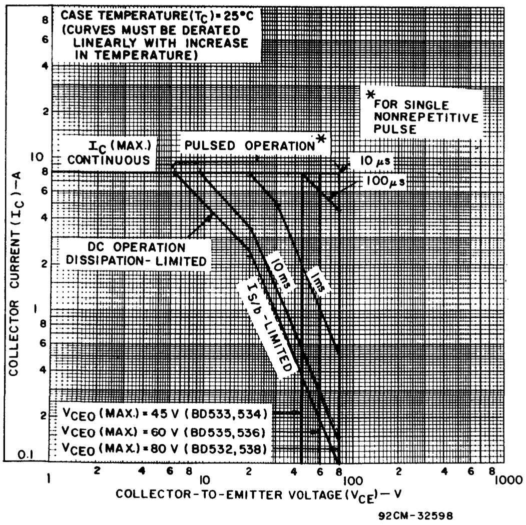


Fig. 1—Maximum safe-operating areas for all types.

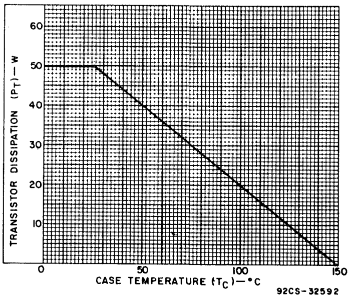


Fig. 2—Derating curve for all types.

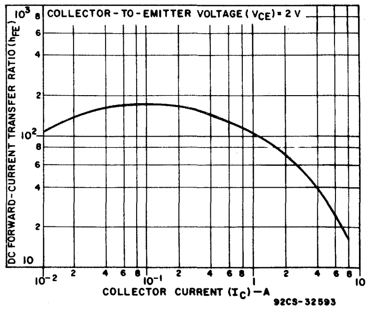


Fig. 3—Typical dc beta characteristic for **BD533, BD535, and BD537 types.**

BD533, BD534, BD535, BD536, BD537, BD538

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS▲				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		BD533 BD534▲		BD535 BD536▲		BD537 BD538▲		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN	MAX.	MIN.	MAX.	
I_{CBO}	45⊕				—	100	—	—	—	—	µA
	60⊕				—	—	—	100	—	—	
	80⊕				—	—	—	—	—	100	
I_{CES}	45				—	100	—	—	—	—	
	60				—	—	—	100	—	—	
	80				—	—	—	—	—	100	
I_{EBO}		5			—	1	—	1	—	1	mA
V_{CEO}(sus)■			0.1*	0	45	—	60	—	80	—	V
h_{FE}	5		0.01*		20	—	20	—	15	—	
	2		0.5*		40	—	40	—	40	—	
	2		2*		25	—	25	—	15	—	
h_{FE} Groups J	2		2*		30	75	30	75	30	75	
	2		3*		15	—	15	—	15	—	
K	2		2*		40	100	40	100	40	100	
	2		3*		20	—	20	—	20	—	
L (For BD533, BD534 only)	2		2*		60	150	—	—	—	—	
	2		3*		30	—	—	—	—	—	
V_{BE}	2		2*		—	1.5	—	1.5	—	1.5	
V_{CE}(sat)			2*	0.2	—	0.8	—	0.8	—	0.8	V
			6*	0.6	0.8●	—	0.8●	—	0.8●	—	
f_T	1		0.5		3	12●	3	12●	3	12●	MHz
$R_{\theta JC}$					—	2.5	—	2.5	—	2.5	°C/W

▲ For p-n-p devices, voltage and current values are negative.
⊕ V_{CB} value
■ **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.
* Pulsed: Pulse duration = 300 µs, duty factor = 1.5%.
● Typical values.

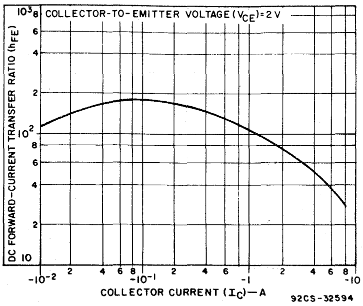


Fig. 4—Typical dc beta characteristic for BD534, BD536, and BD538 types.

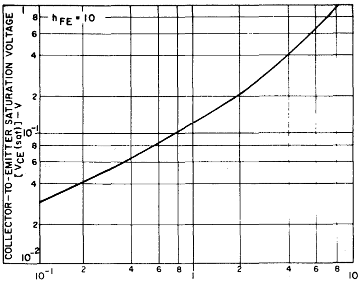


Fig. 5—Typical collector to-emitter saturation voltage characteristic for BD533, BD535, and BD537 types.

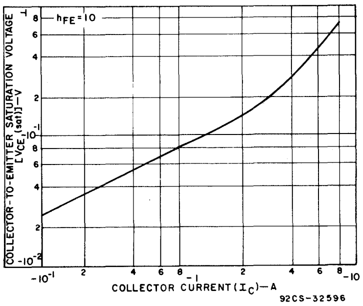


Fig. 6—Typical collector-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

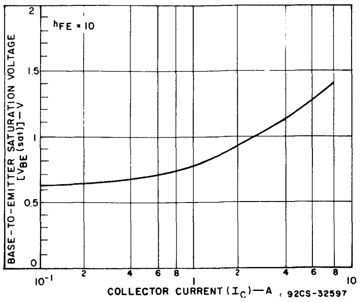


Fig. 7—Typical base-to-emitter saturation voltage characteristic for BD533 BD535, and BD537 types.

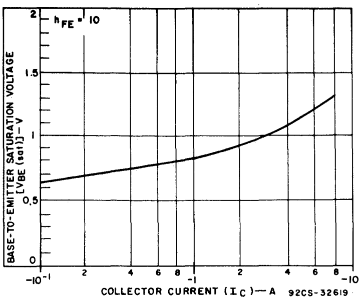


Fig. 8—Typical base-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

BD533, BD534, BD535, BD536, BD537, BD538

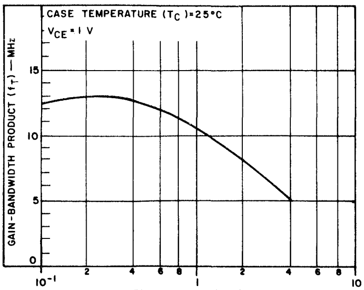


Fig. 9—Typical gain-bandwidth product characteristic for BD533, BD535, and BD537 types.

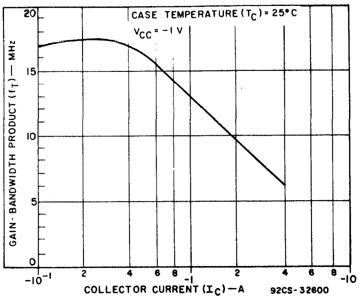


Fig. 10—Typical gain-bandwidth product characteristic for BD534, BD536, and BD538 types.

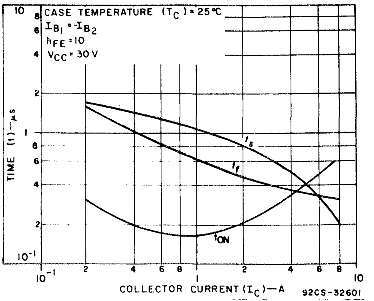


Fig. 11—Typical saturated-switching time characteristics for BD533, BD535, and BD537 types.

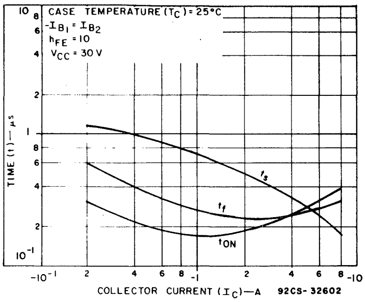


Fig. 12—Typical saturated switching time characteristics for BD534, BD536, and BD538 types.

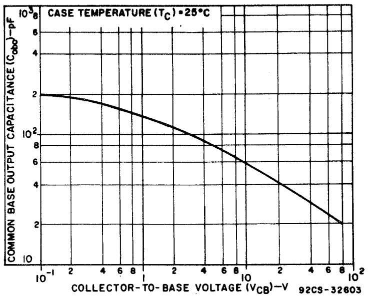


Fig. 13—Typical common-base output capacitance characteristic for BD533, BD535, and BD537 types.

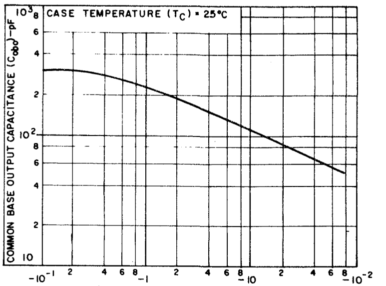


Fig. 14—Typical common-base output capacitance characteristic for BD534, BD536, and BD538 types.

BD550 Series

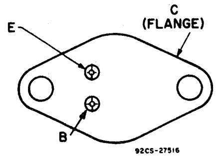
Silicon Transistors for 70-, 120-, 200-, and 300-W Quasi-Complementary-Symmetry Audio Amplifiers

The RCA-BD550, BD550A, and BD550B are silicon n-p-n transistors especially suitable for applications in audio-amplifier circuits, in which they may be used as either driver or output unit.

These devices, together with a variety of other transistors that serve as input devices, V_{BE} amplifiers for biasing, current sources, load-line limiters (for overload protection), and predrivers, may be used to develop several hundred watts of audio output power in quasi-complementary-symmetry audio amplifier configurations that employ parallel output transistors. Circuit examples, a recommended complement of transistors, and performance data are shown for 70-, 120-, 200-, and 300-W amplifiers.

The BD-550-series is supplied in the JEDEC TO-204MA hermetic steel case.

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

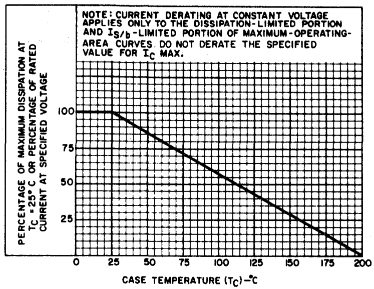
	BD550	BD550A	BD550B	
V_{CBO}	130	200	275	V
V_{CEO}	110	175	250	V
$V_{CER}(R_{BE} = 100\ \Omega)$	130	200	275	V
V_{EBO}		5		V
I_C		7		A
I_B		2		A
P_T				
At $T_C \leqslant 25°C$		150		W
At $T_C > 25°C$		See Fig. 1		
T_{stg}, T_J		−65 to 200		°C
T_L				
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230		°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS	LIMITS						UNITS
		BD550▲		BD550A●		BD550B●		
		Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER} R_{BE} = 100 Ω	V_{CE} = 110 V	–	1	–	–	–	–	mA
	V_{CE} = 175 V	–	–	–	1	–	–	
	V_{CE} = 250 V	–	–	–	–	–	1	
I_{CEO}	V_{CE} = 95 V	–	5	–	–	–	–	mA
	V_{CE} = 150 V	–	–	–	5	–	–	
	V_{CE} = 200 V	–	–	–	–	–	5	
I_{EBO}	V_{EB} = 5 V	–	1	–	1	–	1	mA
V_{CEO}	I_C = 0.2 A	110	–	175	–	250	–	V
V_{CER}	I_C = 0.2 A; R_{BE} = 100 Ω	130	–	200	–	275	–	V
f_T	I_C = 0.2 A; V_{CE} = 10 V	5 typ.		5 typ.		5 typ.		MHz
h_{FE}	I_C = 4 A; V_{CE} = 4 V	15	75	–	–	–	–	
	I_C = 2 A; V_{CE} = 4 V	–	–	15	75	10	50	
$V_{CE}(sat)$	I_C = 4 A; I_B = 0.5 A	–	2	–	–	–	–	V
	I_C = 2 A; I_B = 0.25 A	–	–	–	2	–	2	
V_{BE}	I_C = 4 A; V_{CE} = 4 V	0.75	1.75	–	–	–	–	V
	I_C = 2 A; V_{CE} = 4 V	–	–	1	2	1	2	
$I_{S/b}$	V_{CE} = 80 V; t = 1 S	1.87	–	–	–	–	–	A
	V_{CE} = 100 V; t = 1 S	–	–	1.5	–	–	–	
	V_{CE} = 140 V; t - 1 S	–	–	–	–	1.07	–	

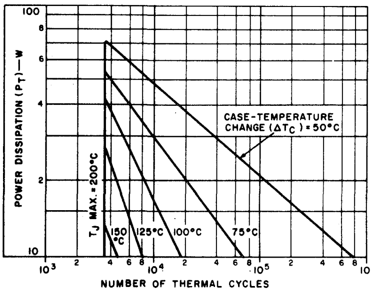
▲ For characteristics curbes and test conditions, refer to published data for prototype RCA8638D (File 1060).

● For characteristics curves and test conditions, refer to published data for prototype 2N5240 (File 321).



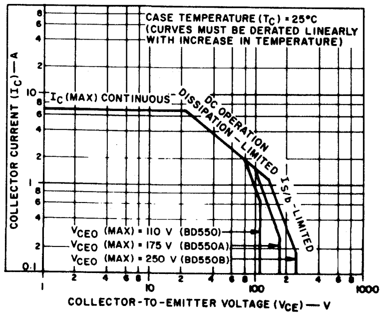
92CS-19943

Fig. 1 — Derating curve for all types.



92CS-19922

Fig. 2 — Thermal-cycling ratings for all types.



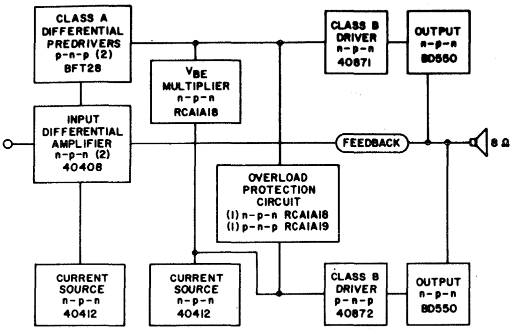
92CS-30886

Fig. 3 — Maximum operating areas for all types.

BD550 Series

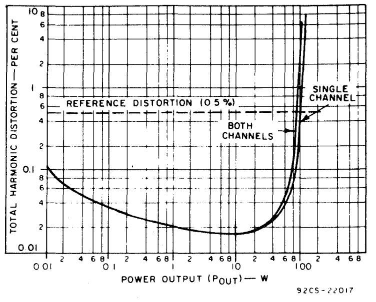
70-Watt Amplifier

The 70-watt amplifier shown in Figs. 4 and 5 uses two BD550 transistors as output devices, and operates on a 90-volt split power supply. It is designed for direct coupling to an 8 ohm load. Figs. 6 and 7 show typical distortion characteristics for the amplifier.



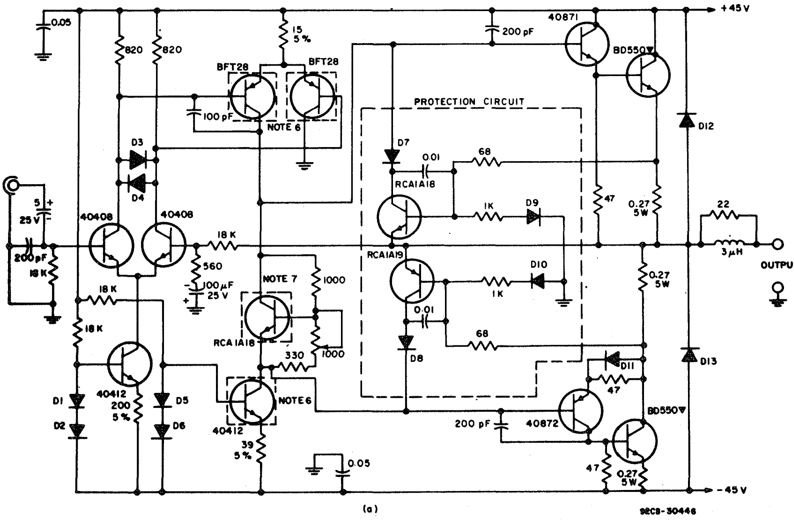
92CS-30887

Fig. 4 – Block diagram and transistor complement for 70-watt quasi-complementary-symmetry audio amplifier with epitaxial-base output transistors.

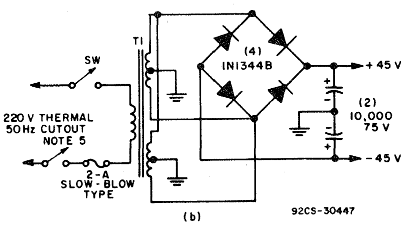


92CS-22017

Fig. 6 – Typical total harmonic distortion as a function of power output at 1 kHz, for the 70-watt amplifier.



92CS-30446



92CS-30447

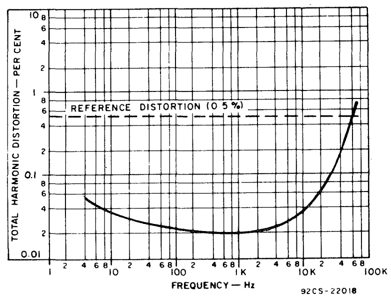
NOTES:

1. D1-D8,D11-1N5391, D9,D10,D12,D13-1N5393
2. Resistors are 1/2-watt, ±10%, unless otherwise specified; values are in ohms.
3. Non-inductive resistors.
4. Capacitances are in µF unless otherwise specified
5. 80°C thermal cutout attached to heat sink of output devices.
6. Mount each device on TO-39 heat sink.
7. Attach TO-39 heat sink cap to device and mount on same heat sink with the output devices.

▼8. Provide heat sink of approx. 1°C/W per output device with a contact thermal resistance of 0.5°C/W max. and T_A = 45°C max.

92CM-30446

Fig. 5 – 70-watt amplifier circuit featuring quasi-complementary-symmetry output employing epitaxial-base construction output transistors: (a) basic amplifier circuit, (b) power-supply circuit.



92CS-22018

Fig. 7 – Typical total harmonic distortion as a function of frequency at 35 W, for the 70-watt amplifier.

Typical Performance Data for 70-W Audio Amplifier

Measured at a line voltage of 220 V, T_A = 25°C, and a frequency of 1 kHz, unless otherwise specified.

Power:	
Rated power (8-Ω load, at rated distortion)	70 W
Typical power (16-Ω load)	40 W
Total Harmonic Distortion:	
Rated distortion	0.5 %
IM Distortion:	
10 dB below continuous power output at 60 Hz and 7 kHz (4:1)	<0.2%
IHF Power Bandwidth:	
3 dB below rated continuous power at rated distortion	5 Hz to 50 kHz
Bandwidth at 1 W	5 Hz to 100 kHz
Sensitivity:	
At continuous power-output rating	600 mV
Hum and Noise:	
Below continuous power output:	
Input shorted	100 dB
Input open	85 dB
With 2 kΩ resistance on 20-ft. cable on input	97 dB
Input Resistance	18 kΩ

BD550 Series

120-Watt Amplifier

The 120-watt amplifier shown in Figs. 8 and 9 uses four BD550A transistors as parallel units in the amplifier output stages, and operates on a 130-volt split power supply. It is intended for direct coupling to an 8 ohm load, but may be used on 4 ohm or 16 ohm loads as shown in the Typical Performance Data; Figs. 10 and 11 show typical distortion characteristics for the amplifier.

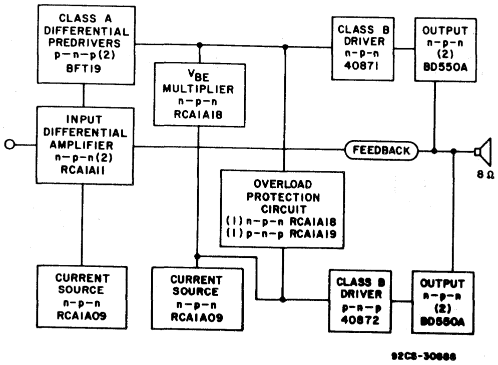
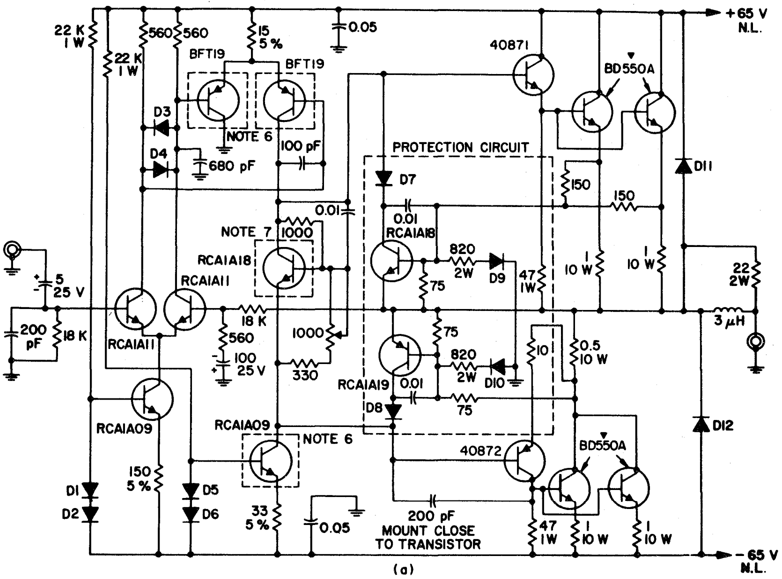


Fig. 8 – Block diagram and transistor complement for 120-W quasi-complementary-symmetry audio amplifier with parallel output transistors.



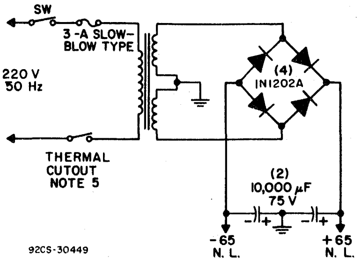
(a)

92CM-30448

NOTES:

1. D1-D8 – 1N5391; D9,D10 – 1N914B; D11, D12 – 1N5393
2. Resistors are 1/2-watt, ±10%, unless otherwise specified; values are in ohms.
3. Non-inductive resistors.
4. Capacitances are in µF unless otherwise specified.
5. 95 C thermal cutout attached to heat sink of output devices.
6. Mount each device on TO-39 heat sink.
7. Attach TO-39 heat sink cap to device and mount on same heat sink with the otuput devices.
▼8. Provide heat sink of approx. 1 C/W per output device with a contact thermal resistance of 0.5 C/W max. and T_A = 45 C max.

92CM-30448



(b)

Fig. 9 – 120-watt amplifier circuit featuring quasi-complementary-symmetry output circuit with parallel output transistors: (a) basic amplifier circuit, (b) power-supply circuit.

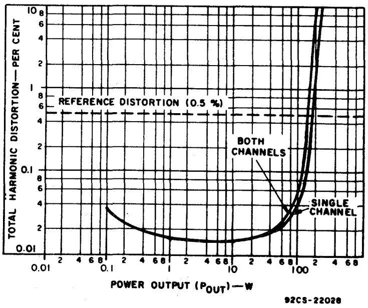


Fig. 10 – Typical total harmonic distortion as a function of power output for single channel (8Ω) and both channels driven at 1 kHz for 120-W amplifier.

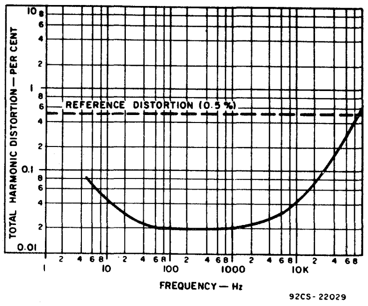


Fig. 11 – Typical total harmonic distortion as a function of frequency for 60-W output for 120-W amplifier.

Typical Performance Data for 120-W Audio Amplifier

Measured at a line voltage of 220 V, T_A = 25°C, and a frequency of 1 kHz, unless otherwise specified.

Power:	
Rated power (8-Ω load, at rated distortion)	120 W
Typical power (4-Ω load)	120 W●
Typical power (16-Ω load)	70 W
Total Harmonic Distortion:	
Rated Distortion	0.5%
IM Distortion:	
10 dB below continuous power output at 60 Hz and 7 kHz (4:1)	0.2%
Sensitivity:	
At continuous power output rating	.900 mV
Input Resistance	18 kΩ
IHF Power Bandwidth:	
3 dB below rated continuous power at rated distortion	5 Hz to 50 kHz
Hum and Noise:	
Below continuous power output:	
Input shorted	104 dB
Input open	88 dB
With 1 kΩ resistance on 20-ft cable on input	104 dB

●With a 90 V split power supply and 4-BD550 substituted for 4-BD550A.

BD550 Series

200-Watt Amplifier

The 200-watt amplifier shown in Figs. 12 and 13 uses eight BD550B transistors, two as drivers and six as parallel units in the amplifier output stages, and operates on a 160-volt split power supply. It is intended for direct coupling to an 8 ohm load, but may be used on 4-ohm or 16-ohm loads as shown in the Typical Performance Data. Figs. 14 and 15 show the typical distortion characteristics for the amplifier.

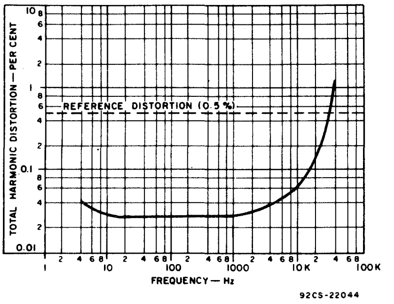


Fig. 14 – Typical total harmonic distortion as a function of frequency at 100-W output for 200-W amplifier.

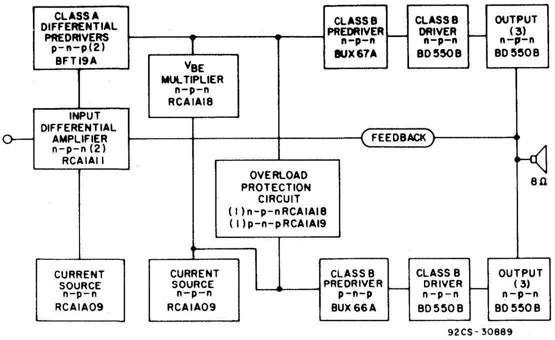


Fig. 12 – Block diagram and transistor complement for 200-W quasi-complementary-symmetry audio amplifier with parallel output transistors.

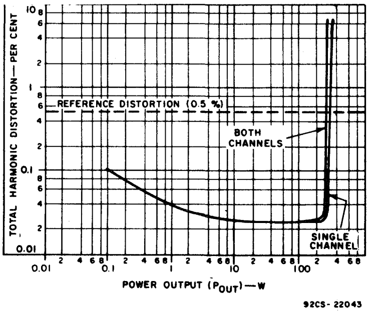
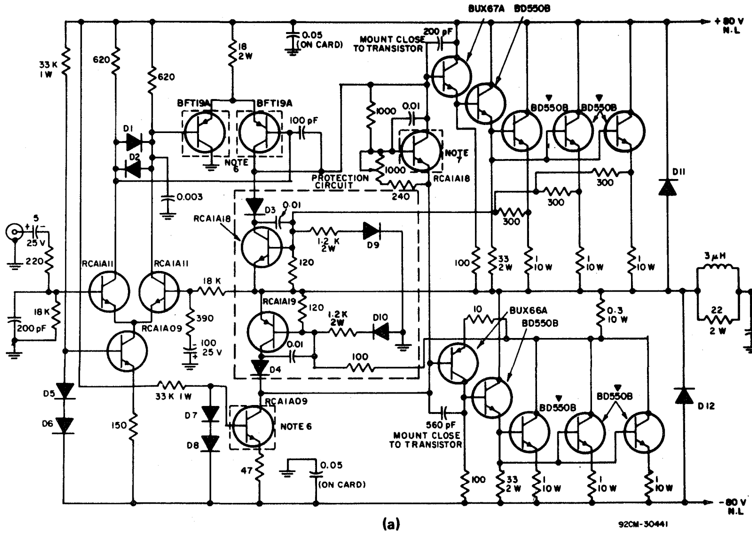


Fig. 15 – Typical total harmonic distortion as a function of power output for single channel and both channels driven at 1 kHz for 200-W amplifier.



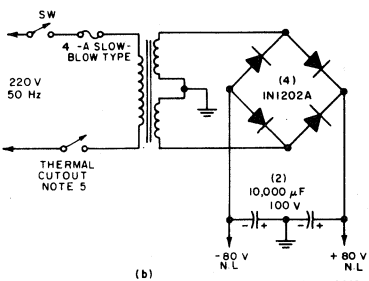
(a)

NOTES:

1. D1-D8 – 1N5391; D9,D10 – 1N5316; D11, D12 – 1N5393
2. Resistors are 1/2-watt, ±10%, unless otherwise specified; values are in ohms.
3. Non-inductive resistors.
4. Capacitances are in µF unless otherwise specified.
5. 80°C thermal cutout attached to heat sink of output devices.
6. Mount each device on TO-39 heat sink.
7. Attach TO-39 heat sink cap to device and mount on same heat sink with the output devices.

▼8. Provide heat sink of approx. 1°C/W per output device with a contact thermal resistance of 0.5°C/W max. and T_A = 45°C max.

92CM-30441



(b)

Fig. 13 – 200-watt amplifier circuit featuring quasi-complementary-symmetry output circuit with parallel output transistors: (a) basic amplifier circuit, (b) power-supply circuit.

Typical Performance Data for 200-W Audio Amplifier

Measured at a line voltage of 220 V, T_A = 25°C, and a frequency of 1 kHz, unless otherwise specified.

Power:	
Rated power (8-Ω load, at rated distortion)	200 W
Typical power (4-Ω load)	200 W●
Typical power (16-Ω load)	120 W
Total Harmonic Distortion:	
Rated distortion	0.5%
IM Distortion:	
10 dB below continuous power output at 60 Hz and 7 kHz (4:1)	0.2%
Sensitivity:	
At continuous power output rating	900 mV
Input Resistance	18 kΩ
IHF Power Bandwidth:	
3 dB below rated continuous power at rated distortion	5 Hz to 35 kHz
Hum and Noise:	
Below continuous power output:	
Input shorted	96 dB
Input open	84 dB
With 2 kΩ resistance on 20-ft cable on input	94 dB

● With a 110-V split power supply and 8-BD550A substituted for 8-BD550B.

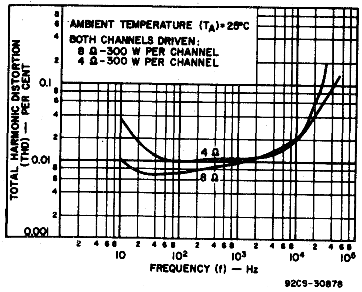


Fig. 17 – Typical total harmonic distortion as a function of frequency for 300-W amplifier.

300-Watt Amplifier

The 300-watt amplifier shown in Figs. 16 and 19 uses two BD550B transistors as drivers and sixteen BD550B transistors as parallel units in the amplifier output stages, and operates on a 172-volt split power supply. It is intended for direct coupling to an 8 ohm load, but may be used on 4 ohm or 16 ohm loads as shown in the typical performance data (Figs. 17, 18, 20, and 21).

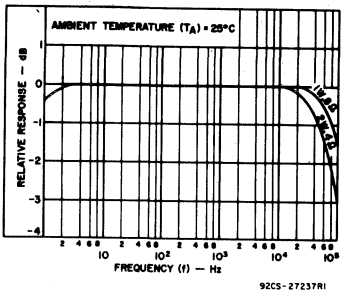
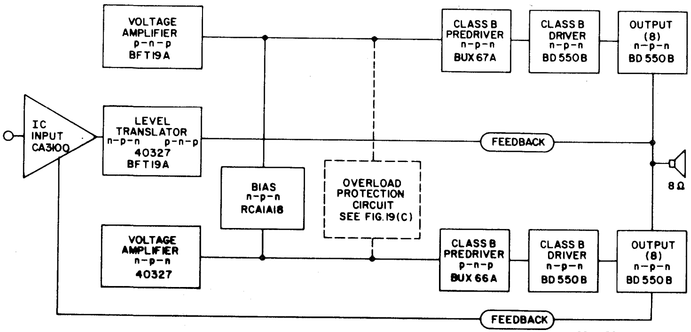


Fig. 18 – Typical frequency response for 300-W amplifier.



Ratings and characteristics of type CA3100 are given in RCA data bulletin File No. 625.

Fig. 16 – Block diagram and transistor complement for 300-W quasi-complementary-symmetry audio amplifier with parallel output transistors.

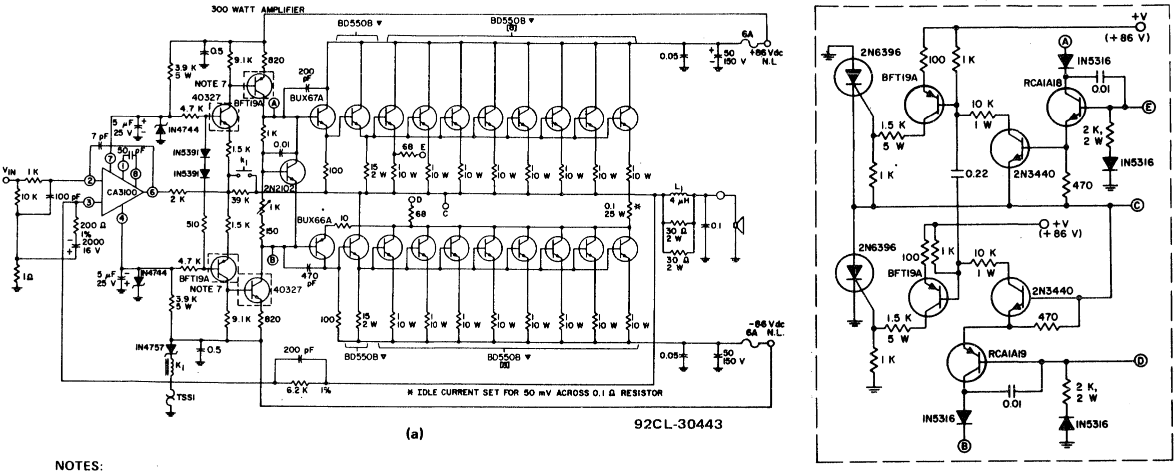
Typical Performance Data for 300-W Audio Amplifier

Measured at a line voltage of 220 V, T_A = 25°C, and a frequency of 1 kHz, unless otherwise specified.

Rated Power (8-Ω load at rated distortion)	300 W
Typical power (4-Ω load)	300 W■
Typical power (16-Ω load	160 W
Total Harmonic Distortion (THD)	See Figs. 17 and 21
Intermodulation Distortion (IMD)	See Fig. 20
Sensitivity	1.6 V for 300 W
Input Impedance	10 kΩ
Hum and Noise:	
Below rated power output:	
Open input	104 dB
Shorted input	112 dB
Phase Shift	+1° at 20 Hz, –13° at 20 kHz
Slew Rate	35 V/μs
Rise Time	2.5 μs
Damping Factor	200

■With 120 V split power supply and 18-BD550A substituted for 18-BD550B.

BD550 Series



(a)

92CL-30443

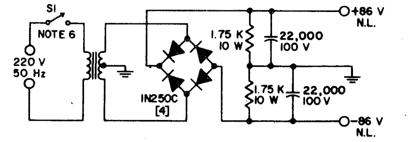
(c)

92CS-30879

NOTES:

1. Resistors are 1/2-watt, ±5% carbon, unless otherwise specified; values are in ohms.
2. Non-inductive resistors.
3. Capacitances are in μF unless otherwise specified.
4. K1 – Relay, single-pole, single-throw, normally closed, with 24-V, 3 mA coil.
5. TSS1 – 70 C thermal cutout attached to heat sink for output devices.
6. S1 – 10-A circuit breaker.
7. Common heat sink – 175 cm^2 minimum.
▼8. Provide heat sink of approx. 1 C/W per output device with a contact thermal resistance of 0.5°C/W max. and T_A = 45 C max.

92CL-30443



(b)

92CS-30880

Fig. 19 – 300-W audio amplifier circuit featuring quasi-complementary symmetry with parallel output transistors: (a) basic amplifier circuit, (b) power-supply circuit, and (c) protection circuit.

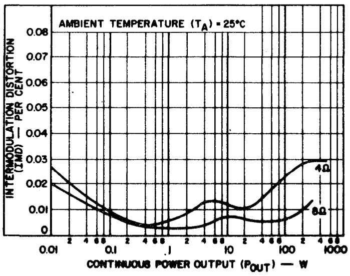


Fig. 20 – Typical intermodulation distortion as a function of power at 60 Hz and 7 kHz with both channels driven for 300-W amplifier.

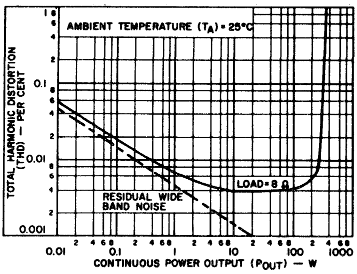


Fig. 21 – Typical total harmonic distortion as a function of power at 1 kHz, both channels driven, for 300-W amplifier.

BD643, BD645, BD647, BD649

8-Ampere N-P-N Darlington Power Transistors

45-60-80 Volts, 70 Watts
Gain of 750 at 3A

The RCA-BD643, BD645, BD647, and BD649 are monolithic silicon n-p-n Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

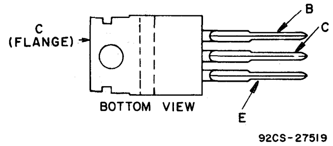
Applications:

- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BD643	BD645	BD647	BD649	
V_{CBO}	45	60	80	100	V
$V_{CEO}(sus)$	45	60	80	100	V
V_{EBO}	5				V
I_C	8				A
I_{CM}	12				A
I_B	0.15				A
P_T					
$T_C \leq 25°C$	62.5				W
$T_C > 25°C$	Derate linearly 0.5				W/°C
T_{stg}, T_J	−55 to 150				°C
T_L					
At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc			CUR-RENT A dc	BD643		BD645		
	V_{CB}	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CEO}		20 30			— —	0.5 —	— —	— 0.5	mA
I_{CBO}	45 60				— —	0.2 —	— —	— 0.2	
T_C = 100°C	45 60				— —	2 —	— —	— 2	
I_{EBO}			−5	0	—	2	—	2	
$V_{(BR)CEO}$				0.1[a]	45	—	60	—	V
$V_{(BR)CBO}$				0.005	45	—	60	—	
$V_{(BR)EBO}$ I_E = 2 mA					5	—	5	—	
h_{FE}		3 3 3		0.5[a] 3[a] 6[a]	1500[b] 750 750[b]	— — —	1500[b] 750 750[b]	— — —	
V_{BE}		3		3[a]	—	2.5	—	2.5	V
$V_{CE}(sat)$ I_B = 12 mA				3[a]	—	2	—	2	
f_T f = 1 MHz		3 3		3 3	1 10[b]	— —	1 10[b]	— —	MHz
$R_{\theta JC}$					—	2	—	2	°C/W

[a] Pulsed; pulse duration = 200 μs, duty factor = 1%.

[b] Typical value.

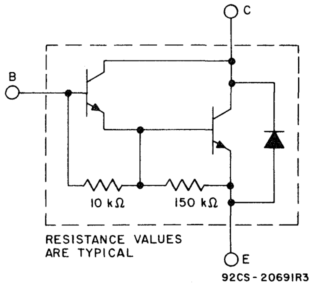


Fig. 1—Schematic diagram for all types.

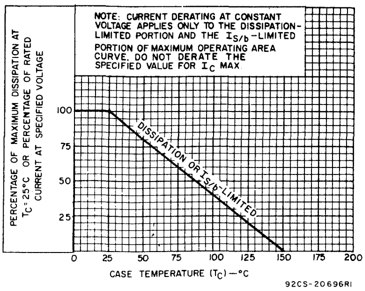


Fig. 2—Derating curve for all types.

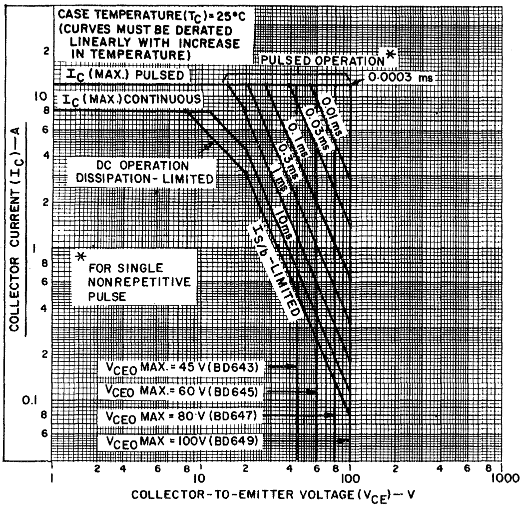
BD643, BD645, BD647, BD649

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc	BD647		BD649		
	V_{CB}	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CEO}		40			—	0.5	—	—	mA
		50			—	—	—	0.5	
I_{CBO}	80				—	0.2	—	—	
	100				—	—	—	0.2	
T_C = 100°C	80				—	2	—	—	
	100				—	—	—	2	
I_{EBO}			−5	0	—	2	—	2	
$V_{(BR)CEO}$				0.1[a]	80	—	100	—	V
$V_{(BR)CBO}$				0.005	80	—	100	—	
$V_{(BR)EBO}$ I_E = 2 mA					5	—	5	—	
h_{FE}		3		0.5[a]	1500[b]	—	1500[b]	—	
		3		3[a]	750	—	750	—	
		3		6[a]	750[b]	—	750[b]	—	
V_{BE}		3		3[a]	—	2.5	—	2.5	V
$V_{CE}(sat)$ I_B = 12 mA				3[a]	—	2	—	2	
f_T f = 1 MHz		3		3	1	—	1	—	MHz
		3		3	10[b]	—	10[b]	—	
$R_{\theta JC}$					—	2	—	2	°C/W

[a] Pulsed; pulse duration = 200 μs, duty factor = 1%.

[b] Typical value.



92CM-32695

Fig. 3—Maximum operating area for all types.

BD750, BD751 Series

Silicon Transistors for 80- and 100-Watt Full-Complementary-Symmetry Audio Amplifiers

Features:

- *High-dissipation capability*
- *Low saturation voltages*
- *Maximum safe-area-of-operation curves*
- *f_T=4 MHz min.*
- *High gain at high current*

The RCA-BD750 Series and BD751 Series types are p-n-p and n-p-n ballasted epitaxial-base silicon transistors, respectively. The corresponding types in these series form complementary p-n-p/n-p-n pairs that are especially suited for audio-output applications.

These transistors are supplied in the JEDEC TO-204MA steel hermetic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	•BD750 BD751	•BD750A BD751A	•BD750B BD751B	•BD750C BD751C	P-N-P N-P-N
V_{CBO}	100	130	110	140	V
V_{CEO}	90	120	100	130	V
V_{CER} (R_{BE}=100 Ω)	100	130	110	140	V
V_{EBO}	5				V
I_C	20				A
I_B	5				A
P_T:					
At $T_C \leq 25°C$	200	200	250	250	W
At $T_C > 25°C$	See Figs. 1 and 2				
T_{stg}, T_J	-65 to +200				°C
T_L:					
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.	230				°C

•For p-n-p devices, voltage and current values are negative.

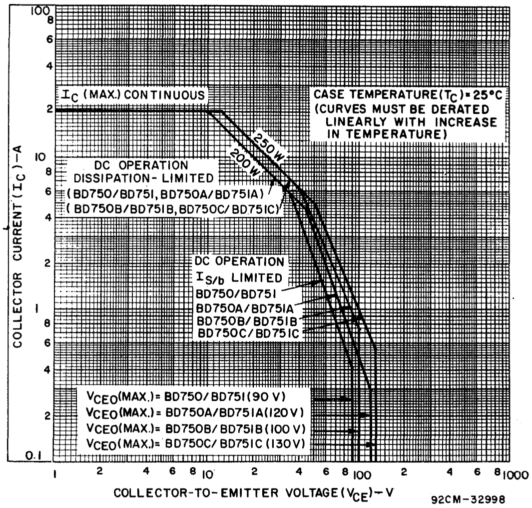
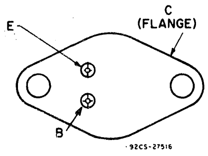


Fig. 1 — Maximum operating areas for all types.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

Typical Performance Data for 100-W Audio Amplifiers (4 Ohms and 8 Ohms)

Measured at a line voltage of 220 V, T_A=25° C, and a frequency of 1 kHz, unless otherwise specified.

Rated Power	100 W	100 W
Load Impedance	4 Ω	8 Ω
Sensitivity	530 mV	750 mV
Input Impedance	10 KΩ	10 KΩ
Slew Rate	25 V/μs	25 V/μs
Frequency Response	See Fig. 3	
Square Wave Response	See Fig. 5	
Total Harmonic Distortion	See Fig. 4	

Table I - Main Modifications For an 80-W Amplifier

	4 Ω	8 Ω	Units
V_S	70	94	V
Q_{10}	BD751	BD751A	
Q_{11}	BD750	BD750B	
R_{26}-R_{27}	56	75	Ω
Q_8, Q_9, Q_{10}, Q_{11} Heatsink	1.5	1.5	°C/W
T_{cutout}	95	95	°C

Load and Power Output vs. Types

Load	P_{out}=80 W	P_{out}=100 W
4 Ω	BD750/751	BD750B/751B
8 Ω	BD750A/751A	BD750C/751C

BD750, BD751 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C)=25° C*

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS‡								UNITS
		BD750• BD751		BD750A• BD751A		BD750B• BD751B		BD750C• BD751C		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER}	V_{CE}=V_{CEO} max., R_{BE}=100Ω	—	1	—	1	—	1	—	1	mA
I_{CEO}	V_{CE}=V_{CEO} max.-20 V	—	1	—	1	—	1	—	1	
I_{EBO}	V_{EB}=5 V	—	1	—	1	—	1	—	1	
V_{CEO}	I_C=0.2 A	90	—	120	—	100	—	130	—	V
V_{CER}	I_C=0.2 A;R_{BE}=100 Ω	100	—	130	—	110	—	140	—	
f_T	I_C=1 A; V_{CE}=10 V	4	—	4	—	4	—	4	—	MHz
h_{FE}	I_C=5 A; V_{CE}=2 V	—	—	25	100	—	—	25	100	
	I_C=7.5 A; V_{CE}=2 V	15	60	—	—	15	60	—	—	
V_{CE}(sat)	I_C=5 A; I_B=0.5 A	—	—	—	1	—	—	—	1	V
	I_C=7.5 A; I_B=0.75 A	—	1.5	—	—	—	1.5	—	—	
V_{BE}(sat)	I_C=5 A; I_B=0.5 A	—	—	—	2	—	—	—	2	
	I_C=7.5 A; I_B=0.75 A	—	2.5	—	—	—	2.5	—	—	
$I_{S/b}$ t=1 sec.	V_{CE}=35 V	5.71	—	—	—	—	—	—	—	A
	V_{CE}=40 V	—	—	—	—	6.25	—	—	—	
	V_{CE}=45 V	—	—	4.44	—	—	—	—	—	
	V_{CE}=50 V	—	—	—	—	—	—	5	—	

‡For characteristic curves and test conditions, refer to published data for prototypes (RCA Data Bulletin File Nos. 1060 and 1061): RCA 8638 series for BD751 series and RCA 9116 series for BD750 series.

•For p-n-p devices, voltage and current values are negative.

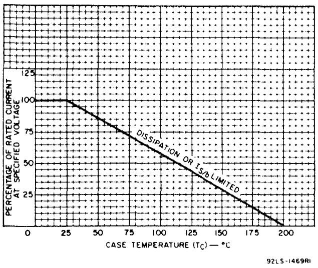


Fig. 2 — Current derating curve for all types.

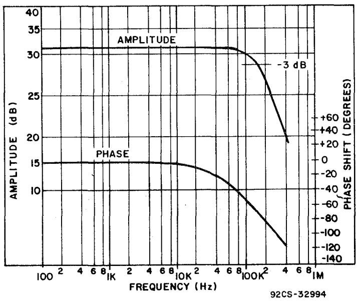


Fig. 3 — Complete amplifier typical frequency response.

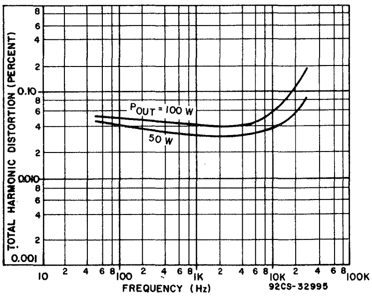


Fig. 4 — Total harmonic distortion as a function of frequency.

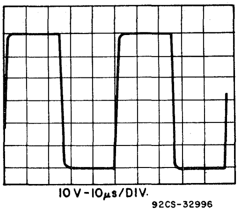
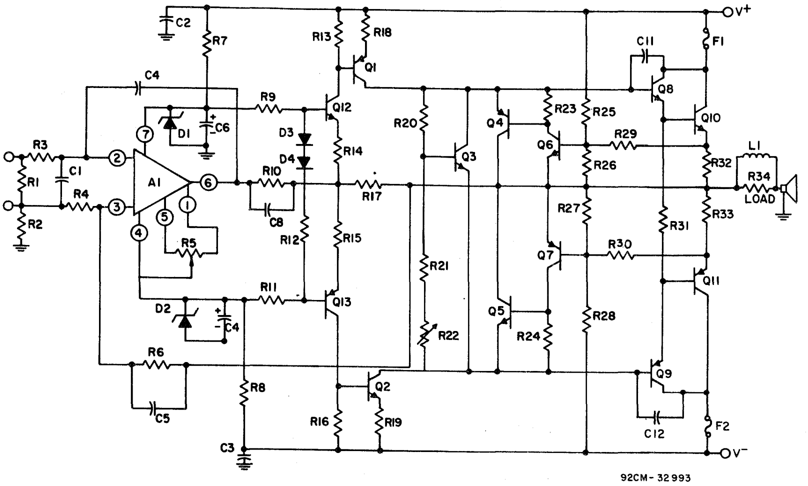


Fig. 5 — 20-kHz square wave output waveform.



PARTS LIST

(4-ohm and 8-ohm loads)

Parts	4-Ohm Load	8-Ohm Load
R1	10 K	10 K
R2	1	1
R3	1 K	1 K
R4	220	220
R5 (note 6)	Potentiometer, 10 K	Potentiometer, 10 K
R6	8 K 2	8 K 2
R7	1 K - 1W	1 K 8 - 1W
R8	1 K - 1W	1 K 8 - 1W
R9	1 K 8	1 K 8
R10	2 K 2	2 K 2
R11	1 K 8	1 K 8
R12	220	220
R13	4 K 7	1 K 8
R14	820	820
R15	820	820
R16	4 K 7	1 K 8
R17	39 K	39 K
R18	47	47
R19	47	47
R20	390	1 K
R21	56	56
R22 (note 5)	Potentiometer, 1 K	Potentiometer, 1 K
R23	100	100
R24	100	100
R25	3 K 9 - 1W	8 K 2 - 1W
R26	50	68
R27	50	68
R28	3 K 9 - 1W	8 K 2 - 1W
R29	180	470
R30	180	470
R31	100	100
R32	0.27 - 7W	0.68 - 7W
R33	0.27 - 7W	0.68 - 7W
R34	4.7 - 1W	10 - 1W
C1	100 pF	100 pF
C2	0.47 μF - 50V	0.47 μF - 50V
C3	0.47 μF - 50V	0.47 μF - 50V
C4	12 pF	12 pF
C5	100 pF	100 pF
C6	22 μF - 25V	22 μF - 25V
C7	22 μF - 25V	22 μF - 25V
C8	10 nF	10 nF
C11	3.9 nF	3.9 nF
C12	3.9 nF	3.9 nF
D1	Zener 15V	Zener 15V
D2	Zener 15V	Zener 15V
D3	1N4148	1N4148
D4	1N4148	1N4148
Q1 (note 2)	RCA1A10	RCA1A10
Q2 (note 2)	RCA1A11	RCA1A11
Q3 (note 3)	RCA1A18	RCA1A18
Q4	2N5323	2N5323
Q5	2N5321	2N5321
Q6	RCA1A18	RCA1A18
Q7	RCA1A19	RCA1A19
Q8 (note 4)	RCA1C03	RCA1C12
Q9 (note 4)	RCA1C04	RCA1C13
Q10 (note 4)	BD751B	BD751C
Q11 (note 4)	BD750B	BD750C
Q12 (note 2)	RCA1A11	RCA1A11
Q13 (note 2)	RCA1A10	RCA1A10
A1	CA3100	CA3100
F1	4 A	3 A
F2	4 A	3 A
L1	2 μH	4 μH
V	39 V	52 V

NOTES:

1. All resistors are non-inductive.
2. Mount each device on heat sink of 30 cm^2 min. area.
3. Mount on same heat sink as driver and output devices Q_8, Q_9, Q_{10}, and Q_{11}.
4. Provide heat sink of approx. 1.2°C/W per output device with a contact thermal resistance of 0.4°C/W and T_A=45°C max. 95°C thermal cutout attached to heat sink of output devices.
5. Adjust to get a quiescent current of 200 mA.
6. Adjust to get 0-V output with 0-V input signal.

Fig. 6 — 100-W audio amplifier (dc coupled).

BD795, BD796, BD797, BD798, BD799, BD800, BD801, BD802

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

General-Purpose Medium-Power Types for Switching and Amplifier Applications

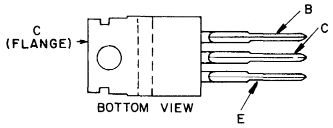
Features:

- *Low saturation voltages*
- *VERSAWATT package*
- *Complementary n-p-n and p-n-p types*
- *Thermal-cycling ratings*
- *Maximum safe-area-of-operation curves specified for dc operation*

The RCA-BD795, BD797, BD799, and BD801 n-p-n transistors and their p-n-p complements BD796, BD798, BD800, and BD802, respectively, are epitaxial-base silicon types intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

These transistors are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

TERMINAL DESIGNATIONS



92CS-27519

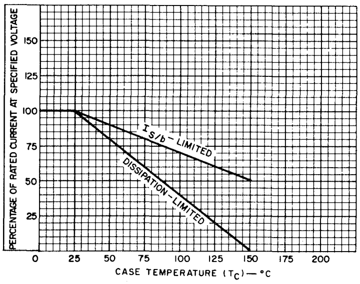
JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

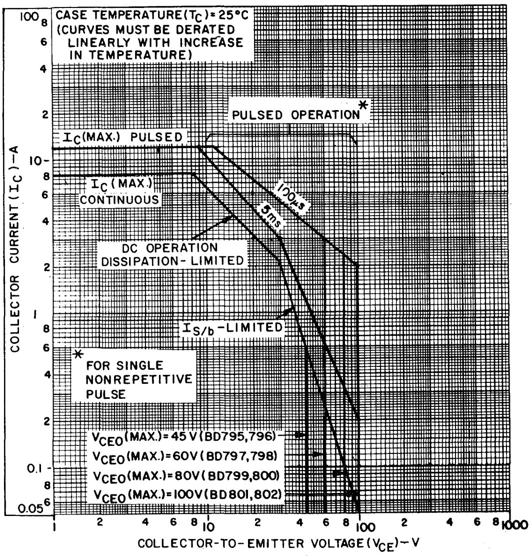
	N-P-N	**BD795**	**BD797**	**BD799**	**BD801**	
	P-N-P	**BD796●**	**BD798●**	**BD800●**	**BD802●**	
V_{CBO}		45	60	80	100	V
$V_{CEO}(sus)$		45	60	80	100	V
V_{EBO}		5				V
I_C		8				A
I_B		3				A
P_T						
$T_C \leq 25°C$		65				W
$T_C > 25°C$		Derate Linearly 0.522				W/°C
T_{stg}, T_J		-55 to 150				°C
T_L						
At distances ≥1/8 in. (3.17 mm) from case for 10 s max.		235				°C

● For p-n-p devices, voltage and current values are negative.



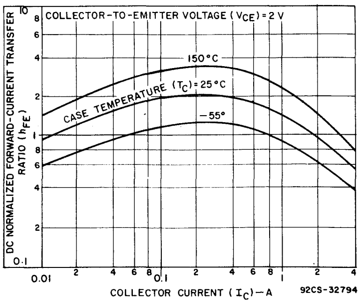
92CS-22543

Fig. 2—Current derating curves for all types.



92CM-32796

Fig. 1—Maximum operating areas for all types.



92CS-32794

Fig. 3—Normalized dc-beta characteristics for all types.

BD795, BD796, BD797, BD798, BD799, BD800, BD801, BD802

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD799 BD800 ●		BD801 BD802 ●		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO}	80					—	0.1	—	—	mA
	100					—	—	—	0.1	
I_{EBO}			−5	0		—	1	—	1	
V_{CEO}[b]				0.1[a]	0	80	—	100	—	V
h_{FE}		2		1[a]		30	—	30	—	
		2		3[a]		15	—	15	—	
V_{BE}(ON)		2		3[a]		—	1.6	—	1.6	V
V_{CE}(sat)				3[a]	0.3	—	1	—	1	
f_T f = 1 MHz		10		0.25		3	—	3	—	MHz
$R_{\theta JC}$						—	1.92	—	1.92	°C/W

[a] Pulsed; Pulse duration = 300 μs, duty factor = 1.8%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

● For p-n-p devices, voltage and current values are negative.

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD795 BD796 ●		BD797 BD798 ●		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO}	45					—	0.1	—	—	mA
	60					—	—	—	0.1	
I_{EBO}			−5	0		—	1	—	1	
V_{CEO}[b]				0.1[a]	0	45	—	60	—	V
h_{FE}		2		1[a]		40	—	40	—	
		2		3[a]		25	—	25	—	
V_{BE}(ON)		2		3[a]		—	1.6	—	1.6	V
V_{CE}(sat)				3[a]	0.3	—	1	—	1	
f_T f = 1 MHz		10		0.25		3	—	3	—	MHz
$R_{\theta JC}$						—	1.92	—	1.92	°C/W

[a] Pulsed; Pulse duration = 300 μs, duty factor = 1.8%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

● For p-n-p devices, voltage and current values are negative.

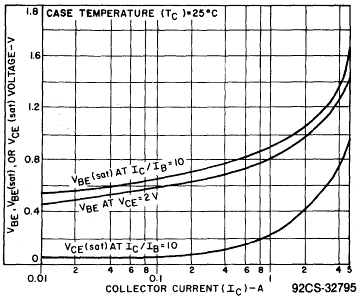


Fig. 4—Typical "on" voltage characteristics for all types.

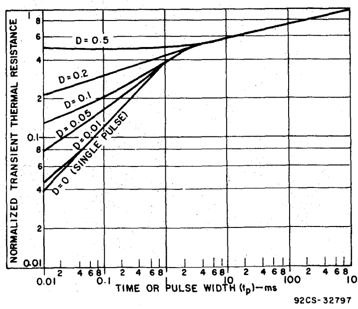


Fig. 5—Typical thermal-response characteristics for all types.

BD895, BD895A, BD897, BD897A BD899, BD899A, BD901

8-Ampere N-P-N Darlington Power Transistors

45-60-80-100-Volts, 70 Watts

Gain of 750 at 4 A
(BD895A, BD897A, BD899A)
Gain of 750 at 3 A
(BD895, BD897, BD899, BD901)

The RCA-BD895, BD895A, BD897, BD897A, BD899, BD899A, and BD901 are monolithic silicon n-p-n Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

Features:

- **Operated from IC without predriver**
- **Low Leakage at high temperature**
- **High reverse second-breakdown capability**

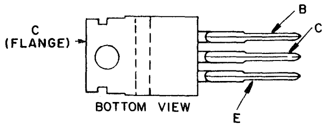
Applications:

- **Power Switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BD895 BD895A	BD897 BD897A	BD899 BD899A	BD901 —	
V_{CBO}	45	60	80	100	V
$V_{CEO}(sus)$	45	60	80	100	V
V_{EBO}	5				V
I_C	8				A
I_B	0.1				A
P_T					
$T_C \leq 25°C$	70				W
$T_C > 25°C$	Derate linearly 0.56				W/°C
T_{stg}, T_J	−65 to 150				°C
T_L					
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max	235				°C

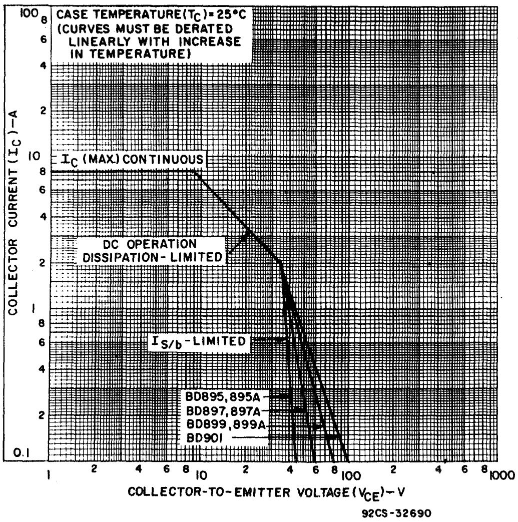
TERMINAL DESIGNATIONS



92CS-27519

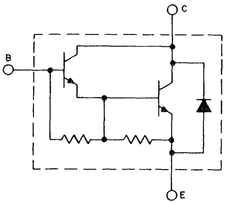
JEDEC TO-220AB

(See dimensional outline "S".)



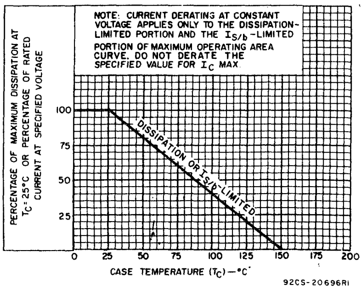
92CS-32690

Fig. 1—Maximum operating areas for all types.



92CS-20691R2

Fig. 2—Schematic diagram for all types.



92CS-20696R1

Fig. 3—Derating curve for all types.

BD895, BD895A, BD897, BD897A BD899, BD899A, BD901

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD895 BD895A		BD897 BD897A		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		20 30			0 0	— —	500 —	— —	— 500	μA
I_{CBO}	45 60					— —	0.2 —	— —	— 0.2	mA
T_C = 100°C	45 60					— —	2 —	— —	— 2	
I_{EBO}			−5	0		—	2	—	2	
V_{CEO}(sus)				0.1[a]	0	45	—	60	—	V
h_{FE} BD895,BD897		3		3[a]		750	—	750	—	
BD895A,BD897A		3		4[a]		750	—	750	—	
V_{BE} BD895,BD897		3		3[a]		—	2.5	—	2.5	V
BD895A,BD897A		3		4[a]		—	2.5	—	2.5	
V_{CE}(sat) BD895 BD897				3[a]	0.012	—	2.5	—	2.5	
BD895A,BD897A				4[a]	0.016	—	2.8	—	2.8	
h_{fe} f = 1 MHz		3		3		1	—	1	—	
$R_{\theta JC}$						—	1.78	—	1.78	°C/W

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD899 BD899A		BD901		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		40 50			0 0	— —	500 —	— —	— 500	μA
I_{CBO}	80 100					— —	0.2 —	— —	— 0.2	mA
T_C = 100°C	80 100					— —	2 —	— —	— 2	
I_{EBO}			−5	0		—	2	—	2	
V_{CEO}(sus)				0.1[a]	0	80	—	100	—	V
h_{FE} BD899,BD901		3		3[a]		750	—	750	—	
BD899A only		3		4[a]		750	—	—	—	
V_{BE} BD899,BD901		3		3[a]		—	2.5	—	2.5	V
BD899A only		3		4[a]		—	2.5	—	—	
V_{CE}(sat) BD899 BD901				3[a]	0.012	—	2.5	—	2.5	
BD899A only				4[a]	0.016	—	2.8	—	—	
h_{fe} f = 1 MHz		3		3[a]		1	—	1	—	
$R_{\theta JC}$						—	1.78	—	1.78	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

BDX10, BDX13, BDX23

Hometaxial-Base, High-Power Silicon N-P-N Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

The RCA-BDX10, BDX13, and BDX23 are silicon n-p-n transistors intended for a wide variety of high-power applications. The hometaxial-base construction of these devices renders them highly resistant to second breakdown; for example, the BDX10 can withstand an $I_{S/b}$ current of 1.95 amperes (min.) at a V_{CEO} of up to 60 volts.

All these transistors are supplied in the steel JEDEC TO-204MA hermetic package.

Features:

- *Maximum safe-area-of-operation curves*
- *Low saturation voltages*
- *High dissipation capability*
- *Thermal-cycling rating curves*

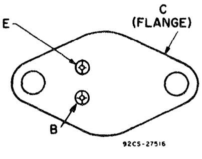
Applications:

- *Series and shunt regulators*
- *High-fidelity amplifiers*
- *Power-switching circuits*
- *Solenoid drivers*
- *Low-frequency inverters*

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX10	BDX13	BDX23	
V_{CBO}	100	50	—	V
V_{CER}(sus) R_{BE}=100 Ω	70	—	95	V
V_{CEO}(sus)	60	40	—	V
V_{CEV} V_{BE}=-1.5 V	90	50	—	V
V_{EBO}	7	5	7	V
I_C	15	15	15	A
I_B	7	7	7	A
P_T ≤ 25°C	117	117	117	W
> 25°C	Derate linearly to 200			°C
T_J, T_{stg}	-65 to +200			°C
T_L: During soldering, at distances 1/32 in. (0.8 mm) from seating plane for 10 s max.	235			°C

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

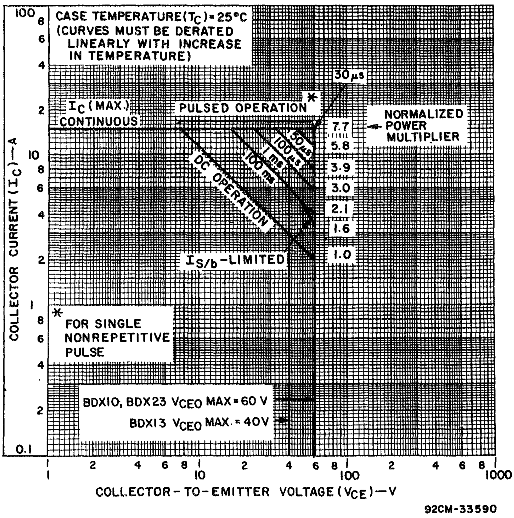


Fig. 1 - Maximum operating areas for BDX10.

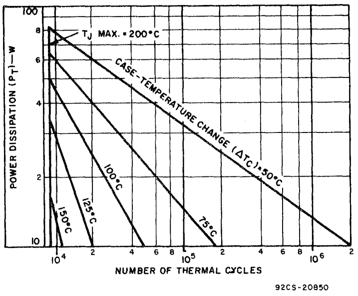


Fig. 2 - Thermal-cycling rating chart for BDX10.

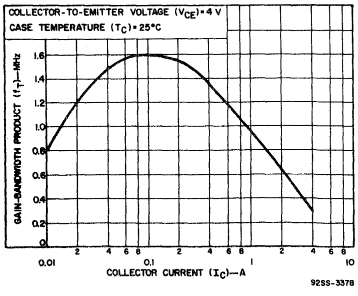


Fig. 3 - Typical gain-bandwidth product for all types.

ELECTRICAL CHARACTERISTICS, *T_C=25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		BDX10		BDX13		BDX23		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	30			0	—	0.7	—	—	—	—	mA
I_{CEX}	40	-1.5			—	—	—	2	—	—	
	100	-1.5			—	5	—	—	—	—	
I_{CER} (100 Ω)	85				—	—	—	—	—	0.5	
I_{CEX}	40	-1.5			—	—	—	10	—	—	
T_C=150°C	100	-1.5			—	30	—	—	—	—	
I_{EBO}		-5			—	—	—	10	—	—	
		-4			—	—	—	—	—	1.0	
		-7			1.0	—	—	—	—	—	
$V_{(BR)CBO}$			0.1		—	—	50	—	—	—	V
$V_{(BR)CEV}$		-1.5	0.1		—	—	50	—	—	—	
$V_{(BR)EBO}$ I_E=0.01 A			0		—	—	5	—	—	—	
V_{CEO}(sus)			0.2^a	0	60	—	40	—	—	—	
V_{CER}(sus) R_{BE}=100 Ω			0.2^a		70	—	—	—	95	—	
V_{CEV}(sus)		-1.5	0.1^a		90	—	—	—	—	—	
h_{FE}‡	4		4^a		20	70	—	—	20	70	
	4		8^a		—	—	15	60	—	—	
	4		10^a		5	—	—	—	—	—	
V_{BE}	4		4^a		—	1.5	—	—	—	1.5	V
	4		8^a		—	—	—	2.2	—	—	
V_{CE}(sat)			4^a	4^a	—	1.0	—	—	—	1.0	
			8^a	0.8^a	—	—	—	1.5	—	—	
			10^a	3.3^a	—	3	—	—	—	—	
h_{fe} f=1 kHz	4		1		15	120	—	—	—	—	
f_T	4		1		800	—	—	—	—	—	kHz
f_{hfe}	4		1		10	—	—	—	—	—	
$I_{S/b}$ t_p=1 s	39				—	—	3	—	—	—	A
nonrep.	60				1.95	—	—	—	1.95	—	
$R_{\theta JC}$					—	1.5	—	1.5	—	1.5	°C/W

^{a}Pulsed: Pulse duration=300 μs, duty factor=1.8%.

‡These types can be supplied in four different beta groups in the range h_{FE}=20-250 at V_{CE}=4 V and I_C=0.5 A^a. Please contact your local RCA Sales Representative for details.

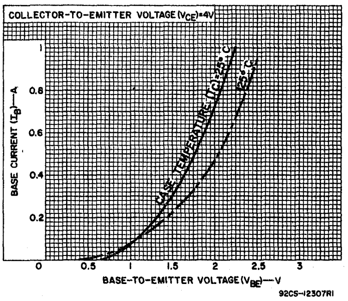


Fig. 4 - Typical input characteristics for BDX10 and BDX13.

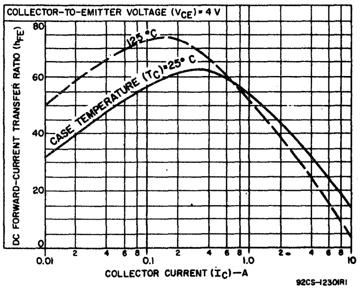


Fig. 5 - Typical dc-beta characteristics for BDX10.

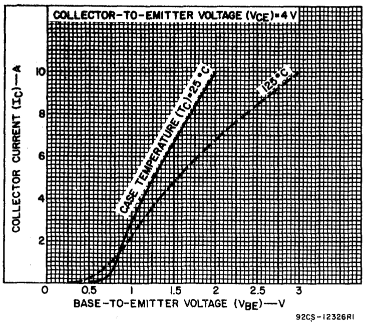


Fig. 6 - Typical transfer characteristics for BDX10 and BDX13.

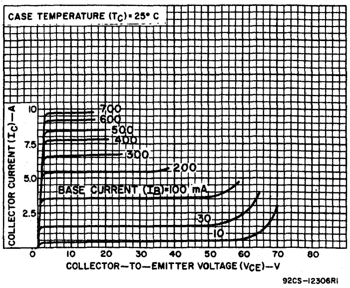


Fig. 7 - Typical output characteristics for BDX10.

BDX24

Hometaxial-Base, Medium-Power Silicon N-P-N Transistor

Rugged Devices for Intermediate-Power Applications in Industrial and Commercial Equipment

The RCA-BDX24 is a hometaxial-base silicon n-p-n transistor intended for a wide variety of medium- to high-power applications. The BDX24 is supplied in a steel JEDEC TO-213MA hermetic package.

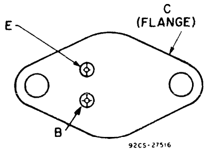
Applications:

- *Power-switching circuits*
- *Series- and shunt-regulator driver and output stages*
- *High-fidelity amplifiers*
- *Solenoid drivers*

Features:

- *Maximum safe-area-of-operation curves for dc and pulse operation*
- *$V_{CEV}(sus)$ = 50 V min*
- *Low saturation voltage: $V_{CE}(sat)$ = 1.5 V at I_C = 1.5 A*

TERMINAL DESIGNATIONS



JEDEC TO-213MA

(See dimensional outline "N".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX24	
V_{CBO}	50	V
V_{CEO}	40	V
$V_{CEV}(sus)$		
V_{BE} = —1.5 V	50	V
V_{EBO}	5	V
I_C	4	A
I_B	2	A
P_T:		
$T_C \leq 25°C$	29	W
$T_C > 25°C$	derate linearly to 200°C	
T_{stg}, T_J	—65 to +200	°C
T_L		
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

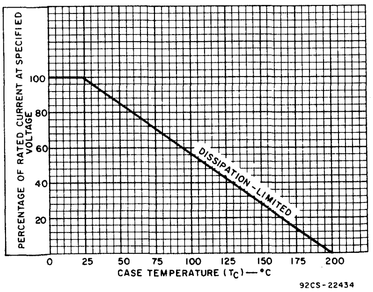


Fig.2 - Derating curve.

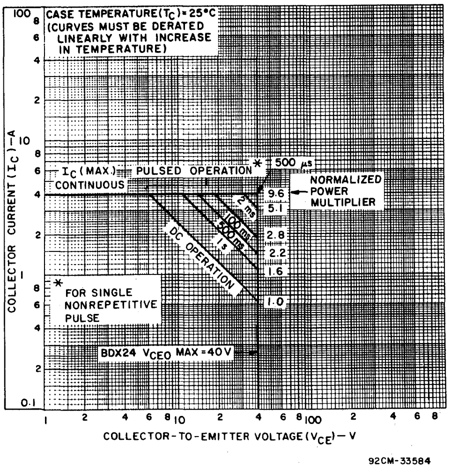


Fig.1 - Maximum operating area.

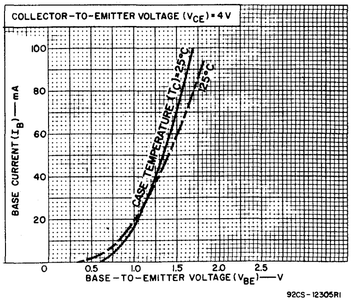


Fig.3 - Typical input characteristics.

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25° C*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		Min.	Max.	
I_{CBO} ($I_E = 0$)	$V_{CB} = 30$ V $V_{CB} = 30$ V, $T_C = 150$°C	— —	1 5	mA
I_{EBO} ($I_C = 0$)	$V_{EB} = 5$ V	—	5	mA
V_{CBO} ($I_E = 0$)	$I_C = 50$ mA	50	—	V
V_{CEO}(sus) ($I_B = 0$)	$I_C = 0.1 \div 2$ A	40	—	V
V_{CEO}(sus) ($V_{BE} = -1.5$ V)	$I_C = 0.05 \div 1$ A	50	—	V
V_{CE}(sat)	$I_C = 1.5$ A, $I_B = 0.15$ A	—	1.5	V
V_{BE}•	$I_C = 1.5$ A, $V_{CE} = 4$ V	—	2.2	V
h_{FE}#	$I_C = 1.5$ A, $V_{CE} = 4$ V	25	100	
h_{FE1}/h_{FE2}	$I_C = 100$ mA, $V_{CE} = 4$ V	—	1.6	
$I_{S/b}$	$V_{CE} = 40$ V, $I_C = 725$ mA	1	—	s

•Pulsed: pulse duration = 300 μs, duty factor = 1.5%.

#The BDX24 can be supplied in four different beta groups as follows:
GR. 4—h_{FE} = 20—50 at I_C = 100 mA, V_{CE} = 4 V
GR. 5—h_{FE} = 35—75 at I_C = 100 mA, V_{CE} = 4 V
GR. 6—h_{FE} = 60—145 at I_C = 100 mA, V_{CE} = 4 V
GR. 7-h_{FE} = 120—250 at I_C = 100 mA, V_{CE} = 4 V
Please contact your local RCA Sales Representative for details.

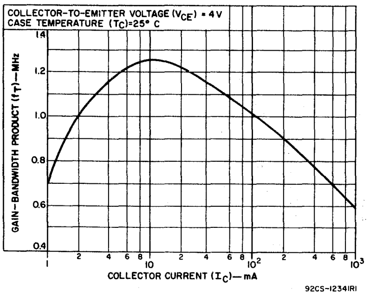


Fig.4 - Typical gain-bandwidth product.

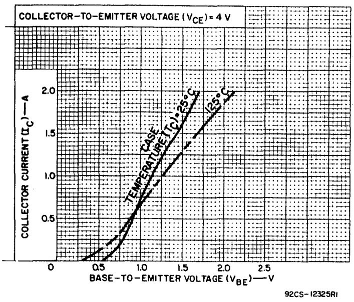


Fig.5 - Typical transfer characteristics.

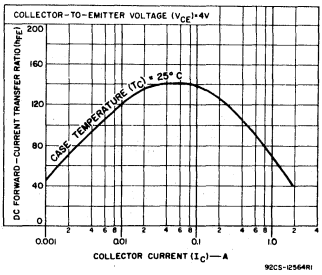


Fig.6 - Typical dc beta characteristics.

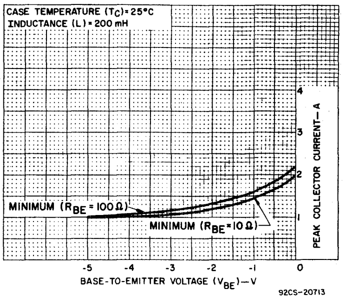


Fig.7 - Reverse-bias second-breakdown characteristics.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D, BDX34, BDX34A, BDX34B, BDX34C

10-Ampere N-P-N and P-N-P Darlington Power Transistors

40-60-80-100-120 Volts, 70 Watts

Gain of 750 at 4 A (BDX33, BDX33A, BDX34, BDX34A)

Gain of 750 at 3 A (BDX33B, BDX33C, BDX33D, BDX34B, BDX34C)

Features:

- Operates from IC without predriver
- Low leakage at high temperature
- High reverse second-breakdown capability

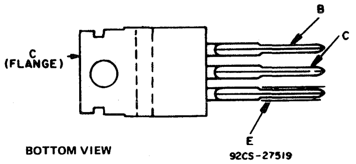
Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

These RCA devices are monolithic silicon n-p-n and p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The BDX33, BDX33A, BDX33B, and BDX33C n-p-n transistors are complementary to the BDX34, BDX34A, BDX34B, and BDX34C p-n-p devices.

All these transistors are supplied in the JEDEC TO-220AB package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BDX33 BDX34	BDX33A BDX34A	BDX33B BDX34B	BDX33C BDX34C*	BDX33D	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	45	60	80	100	120	V
COLLECTOR-TO-EMITTER VOLTAGE:							
With external base-to-emitter resistance (R_{BE}) = 100Ω, sustaining	$V_{CER}(sus)$	45	60	80	100	120	V
With base open, sustaining	$V_{CEO}(sus)$	45	60	80	100	120	V
With base reverse-biased $V_{BE} = -1.5$ V	$V_{CEX}(sus)$	45	60	80	100	120	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	10	10	10	10	10	A
CONTINUOUS BASE CURRENT	I_B	0.25	0.25	0.25	0.25	0.25	A
TRANSISTOR DISSIPATION:	P_T						
At case temperatures up to 25°C		70	70	70	70	70	W
At case temperatures above 25°C				Derate linearly 0.56			W/°C
TEMPERATURE RANGE:							
Storage and Operating (Junction)				−65 to + 150			°C
LEAD TEMPERATURE (During Soldering):							
At distances ≥1/8 in. (3.17 mm) from case for 10 s max.				235			°C

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* For p n p devices, voltage and current values are negative.

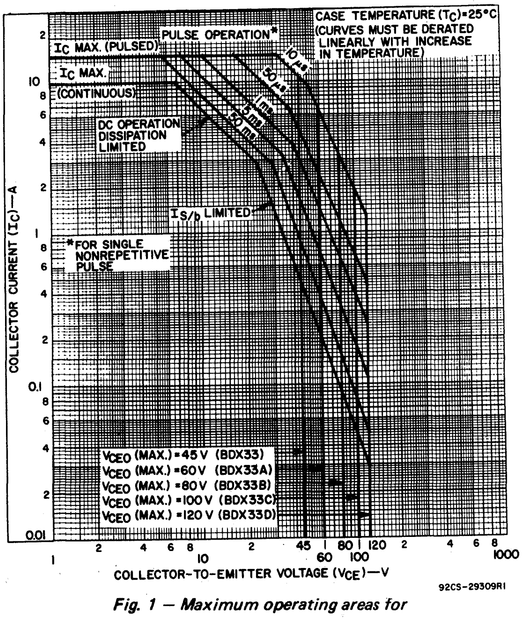


Fig. 1 — Maximum operating areas for BDX33-series types.

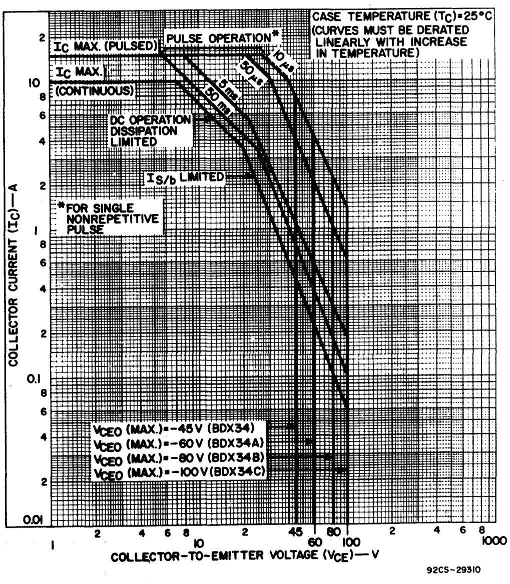


Fig. 2 — Maximum operating areas for BDX34-series types.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D, BDX34, BDX34A, BDX34B, BDX34C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS◆					LIMITS										UNITS
	VOLTAGE V dc			CURRENT A dc		BDX33 BDX34◆		BDX33A BDX34A◆		BDX33B BDX34B◆		BDX33C BDX34C◆		BDX33D		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} With base open		60			0	–	–	–	–	–	–	–	–	–	0.5	mA
		50			0	–	–	–	–	–	–	–	0.5	–	–	
		40			0	–	–	–	–	–	0.5	–	–	–	–	
		30			0	–	–	–	0.5	–	–	–	–	–	–	
		20			0	–	0.5	–	–	–	–	–	–	–	–	
I_{CEO} T_C = 100°C		60			0	–	–	–	–	–	–	–	–	–	10	
		50			0	–	–	–	–	–	–	–	10	–	–	
		40			0	–	–	–	–	–	10	–	–	–	–	
		30			0	–	–	–	10	–	–	–	–	–	–	
		20			0	–	10	–	–	–	–	–	–	–	–	
I_{CBO}	120					–	–	–	–	–	–	–	–	–	1	
	100					–	–	–	–	–	–	–	1	–	–	
	80					–	–	–	–	–	1	–	–	–	–	
	60					–	–	–	1	–	–	–	–	–	–	
	45					–	1	–	–	–	–	–	–	–	–	
I_{CBO} T_C = 100°C	120					–	–	–	–	–	–	–	–	–	5	
	100					–	–	–	–	–	–	–	5	–	–	
	80					–	–	–	–	–	5	–	–	–	–	
	60					–	–	–	5	–	–	–	–	–	–	
	45					–	5	–	–	–	–	–	–	–	–	
I_{EBO}			–5	0		–	10	–	10	–	10	–	10	–	10	mA
V_{CEO}(sus)				0.1[a]	0	–	–	–	–	–	–	–	–	120	–	V
				0.1[a]	0	–	–	–	–	–	–	100	–	–	–	
				0.1[a]	0	45	–	60	–	80	–	–	–	–	–	
V_{CER}(sus) (R_{BE}) = 100Ω				0.1[a]		–	–	–	–	–	–	–	–	120	–	
				0.1[a]		–	–	–	–	–	–	100	–	–	–	
				0.1[a]		45	–	60	–	80	–	–	–	–	–	
V_{CEV}(sus)			–1.5	0.1[a]		–	–	–	–	–	–	–	–	120	–	
			–1.5	0.1[a]		–	–	–	–	–	–	100	–	–	–	
			–1.5	0.1[a]		45	–	60	–	80	–	–	–	–	–	
h_{FE}		3		3[a]		–	–	–	–	750	–	750	–	750	–	
		3		4[a]		750	–	750	–	–	–	–	–	–	–	
V_{BE}		3		3[a]		–	–	–	–	–	2.5	–	2.5	–	2.5	V
		3		4[a]		–	2.5	–	2.5	–	–	–	–	–	–	
V_{CE}(sat)				3[a]	0.006	–	–	–	–	–	2.5	–	2.5	–	2.5	V
				4[a]	0.008	–	2.5	–	2.5	–	–	–	–	–	–	
V_F				8		–	4	–	4	–	4	–	4	–	4	V
h_{fe} f = 1 kHz		5		1		1000	–	1000	–	1000	–	1000	–	1000	–	
h_{fe} f = 1.0 MHz		5		1		20	–	20	–	20	–	20	–	20	–	
$E_{S/b}$[b] R_{BE} = 100Ω L = 12 mH, types BDX33 types			1.5	4.5		120	–	120	–	120	–	120	–	120	–	mJ
L = 3 mH, BDX34 types			1.5	4.5		30	–	30	–	30	–	30	–	30	–	
$I_{S/b}$ tp = 0.5 s nonrep. BDX33 types		25				2.8	–	2.8	–	2.8	–	2.8	–	2.8	–	A
		36				1	–	1	–	1	–	1	–	1	–	
BDX34 types		–20				–3.5	–	–3.5	–	–3.5	–	–3.5	–	–3.5	–	
		–33				–1	–	–1	–	–1	–	–1	–	–1	–	
$R_{\theta JC}$						–	1.78	–	1.78	–	1.78	–	1.78	–	1.78	°C/W

◆ For p-n-p devices, voltage and current values are negative.

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%

[b] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D, BDX34, BDX34A, BDX34B, BDX34C

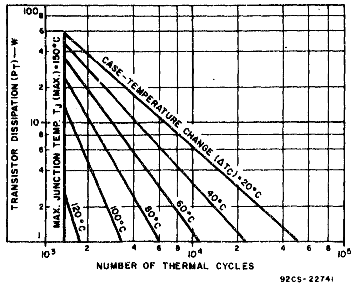


Fig. 3 – Thermal-cycling rating chart for all types.

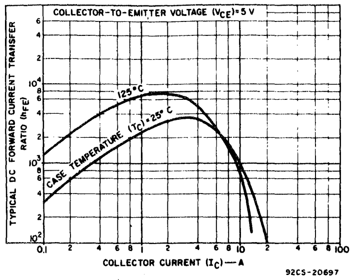


Fig. 4 – Typical dc-beta characteristics for BDX33-series types.

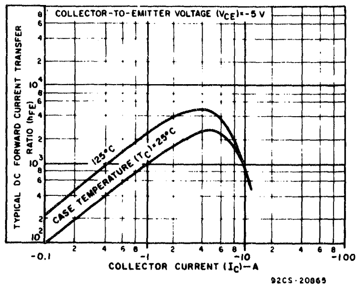


Fig. 5 – Typical dc-beta characteristics for BDX34-series types.

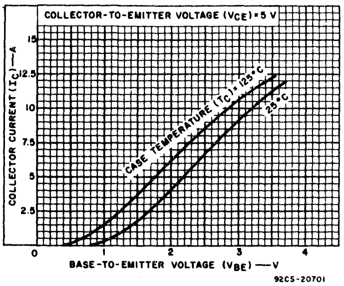


Fig. 6 – Typical transfer characteristics for BDX33-series types.

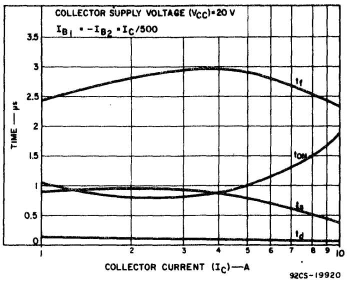


Fig. 7 – Typical saturated switching-time characteristics for BDX33-series types.

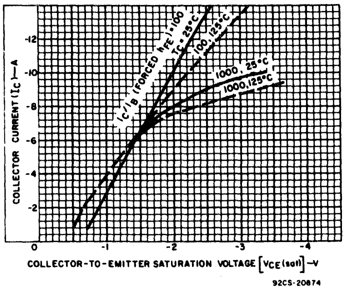


Fig. 8 – Typical saturation characteristics for BDX34-series types.

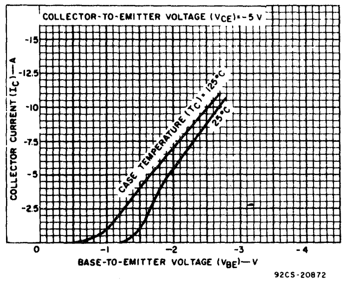


Fig. 9 – Typical transfer characteristics for BDX34-series types.

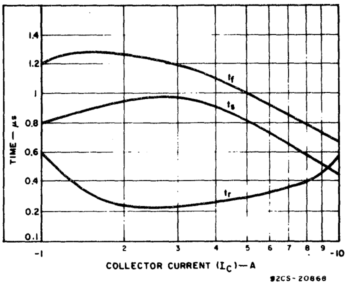


Fig. 10 – Typical saturated switching-time characteristics for BDX34-series types.

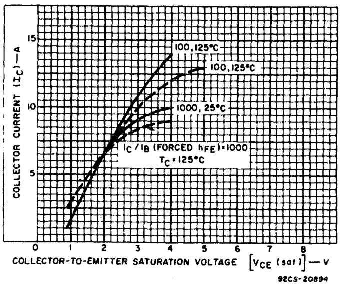


Fig. 11 – Typical saturation characteristics for BDX33-series types.

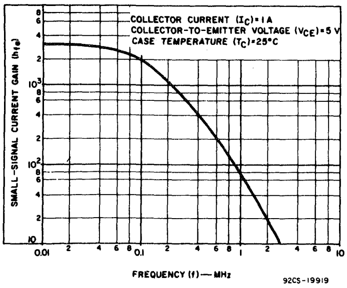


Fig. 12 – Typical small-signal gain for BDX33-series types.

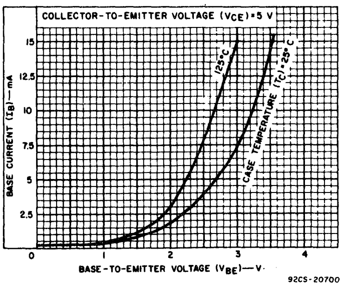


Fig. 13 – Typical input characteristics for BDX33-series types.

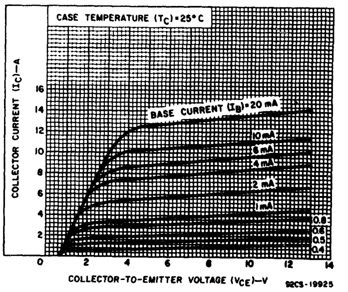


Fig. 14 – Typical output characteristics for BDX33-series types.

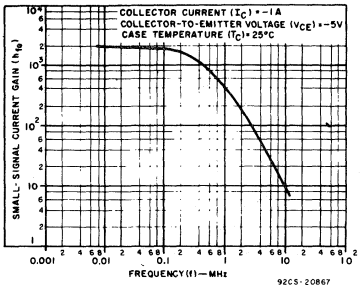


Fig. 15 — Typical small-signal gain for BDX34-series types.

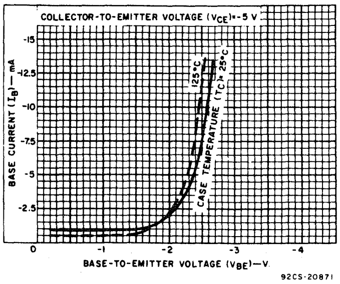


Fig. 16 — Typical input characteristics for BDX34-series types.

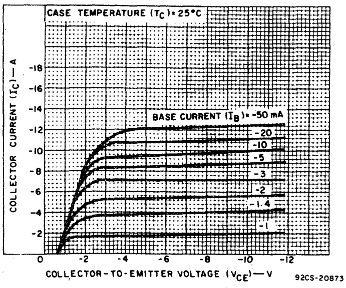


Fig. 17 — Typical output characteristics for BDX34-series types.

BDX53, BDX53A, BDX53B, BDX53C

8-Ampere N-P-N Darlington Power Transistors

45-60-80-100 Volts, 60 Watts
Gain of 750 at 3 A

Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

Applications:

- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**

The RCA-BDX53, BDX53A, BDX53B, and BDX53C monolithic silicon Darlington transistors are designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

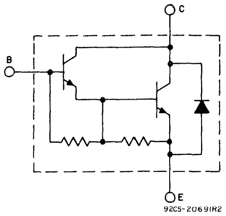
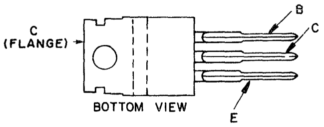


Fig. 1—Schematic diagram for all types.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX53	BDX53A	BDX53B	BDX53C	
V_{CBO}	45	60	80	100	V
$V_{CEO}(sus)$	45	60	80	100	V
V_{EBO}		5			V
I_C		8			A
I_B		0.2			A
P_T					
$T_C \leq 25°C$		60			W
$T_C > 25°C$		Derate linearly 0.48			W/°C
T_{stg}, T_J		—65 to +150			°C
T_L					
At distances ≥1/18 in. (3.17 mm) from case for 10 s max		235			°C

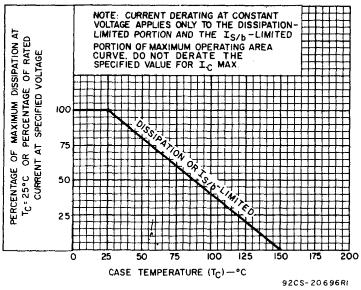


Fig. 3—Derating curve for all types.

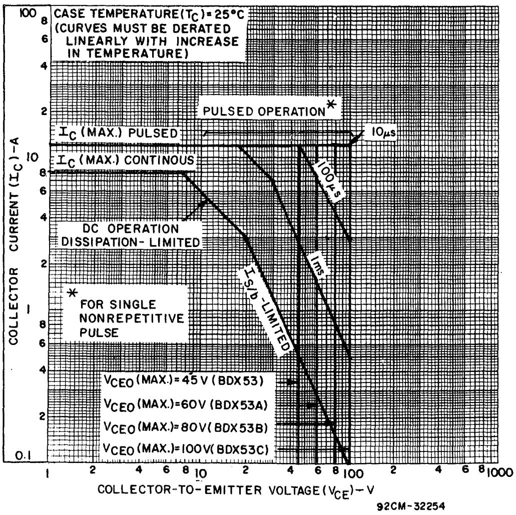


Fig. 2—Maximum operating areas for all types.

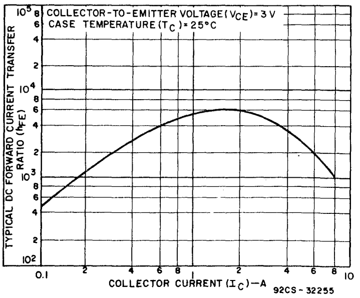


Fig. 4—Typical dc-beta characteristics for all types.

BDX53, BDX53A, BDX53B, BDX53C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX53		BDX53A		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		22			0	—	500	—	—	μA
		30			0	—	—	—	500	
I_{CBO}	45					—	200	—	—	
	60					—	—	—	200	
I_{EBO}			−5	0		—	2	—	2	mA
$V_{CEO}(sus)$				0.1^a	0	45	—	60	—	V
h_{FE}		3		3^a		750	—	750	—	
$V_{BE}(sat)$				3^a	0.012	—	2.5	—	2.5	V
$V_{CE}(sat)$				3^a	0.012	—	2	—	2	
V_F				3^b		—	1.8	—	1.8	
				8^b		2.5^c	—	2.5^c	—	
$R_{\theta JC}$						—	2.08	—	2.08	°C/W

^{a} Pulsed: Pulse duration = 300 μs, duty factor = 1.5%. ^{b} I_F value. ^{c} Typical value.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX53B		BDX53C		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		40			0	—	500	—	—	μA
		50			0	—	—	—	500	
I_{CBO}	80					—	200	—	—	
	100					—	—	—	200	
I_{EBO}			−5	0		—	2	—	2	mA
$V_{CEO}(sus)$				0.1^a	0	80	—	100	—	V
h_{FE}		3		3^a		750	—	750	—	
$V_{BE}(sat)$				3^a	0.012	—	2.5	—	2.5	V
$V_{CE}(sat)$				3^a	0.012	—	2	—	2	
V_F				3^b		—	1.8	—	1.8	
				8^b		2.5^c	—	2.5^c	—	
$R_{\theta JC}$						—	2.08	—	2.08	°C/W

^{a} Pulsed: Pulse duration = 300 μs, duty factor = 1.5%. ^{b} I_F value. ^{c} Typical value.

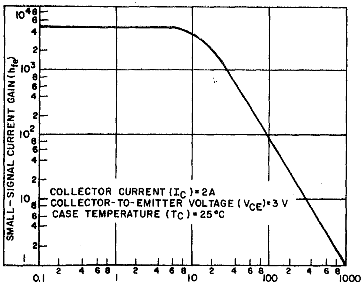


Fig. 5—Typical small-signal gain for all types.

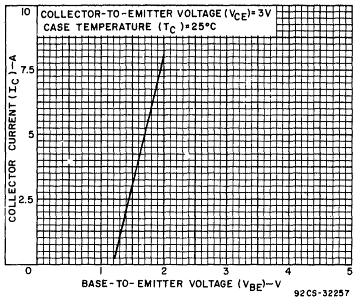


Fig. 6—Typical transfer characteristics for all types.

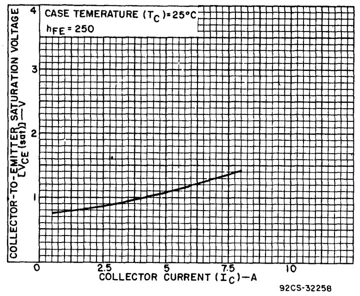


Fig. 7—Typical saturation characteristics for all types.

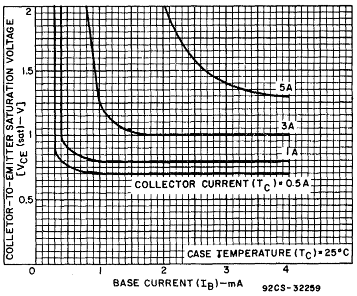


Fig. 8—Typical saturation characteristics for all types.

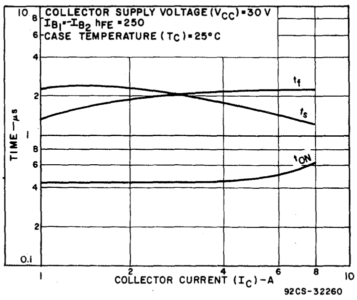


Fig. 9—Typical saturated switching-time characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C

15-Ampere N-P-N Darlington Power Transistors

40-60-80-100 Volts, 125 Watts   Gain of 1000 at 5 Amperes

The RCA-BDX83, BDX83A, BDX83B, and BDX83C are monolithic silicon Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The BDX83-series types are supplied in the JEDEC TO-3 hermetic steel package.

Features:

- Operates from IC without predriver
- Low leakage at high temperature
- High reverse second-breakdown capability

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

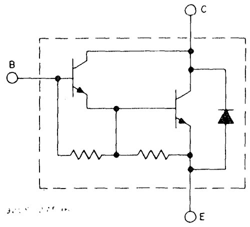
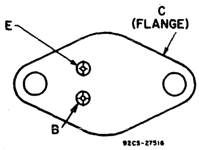


Fig. 1 – Schematic diagram for all types.

TERMINAL DESIGNATIONS



JEDEC TO-3
(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX83	BDX83A	BDX83B	BDX83C	
V_{CBC}	45	60	80	100	V
$V_{CEO}(sus)$	45	60	80	100	V
V_{EBO}	5	5	5	5	V
I_C	10	10	10	10	A
I_{CM}	15	15	15	15	A
I_B	0.25	0.25	0.25	0.25	A
P_T					
$T_C \leqslant 25^oC$	125	125	125	125	W
$T_C > 25^oC$	Derate linearly at 0.714 W/^{o}C				
T_{stg}, T_J	–65 to +200				^{o}C
T_L					
At distances $\geqslant$ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235				^{o}C

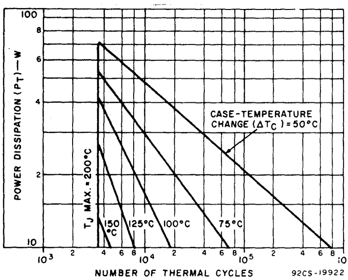
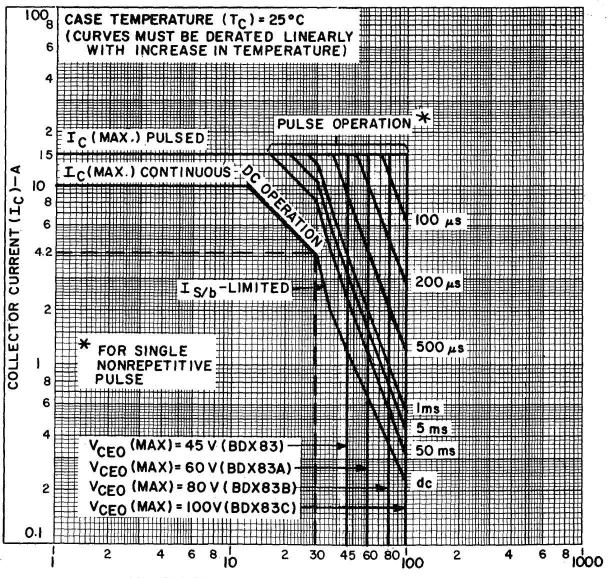


Fig. 3 – Thermal-cycling rating chart for all types.



92CM-29144

Fig. 2 – Maximum operating area for all types.

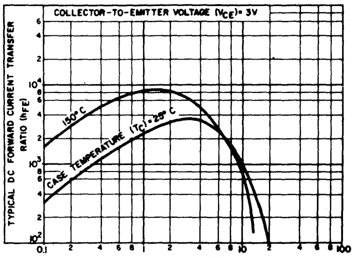


Fig. 4 – Typical dc-beta characteristics for all types.

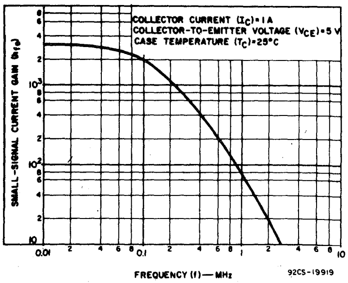


Fig. 5 – Typical small-signal gain for all types.

BDX83, BDX83A, BDX83B, BDX83C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX83		BDX83A		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	20				0	–	1	–	–	mA
	30				0	–	–	–	1	
I_{CEV}	45		–1.5			–	0.5	–	–	
	60		–1.5			–	–	–	0.5	
T_C = 150°C	45		–1.5			–	3	–	–	
	60		–1.5			–	–	–	3	
I_{EBO}		5		0		–	5	–	5	mA
V_{CEO}(sus)				0.1[a]	0	45	–	60	–	V
h_{FE}	3			1[a]		750	–	750	–	
	3			5[a]		1000	–	1000	–	
	3			10[a]		250	–	250	–	
V_{BE}	3			5[a]		–	2.8	–	2.8	V
	3			10[a]		–	4.5	–	4.5	
V_{CE}(sat)				5[a]	0.01[a]	–	2	–	2	V
V_F				–10		–	4	–	4	
h_{fe} f = 1 kHz	5			1		1000	–	1000	–	
$\lvert h_{fe}\rvert$ f = 1 MHz	5			1		20	–	20	–	
$E_{S/b}$[b] L = 12 mH, R_{BE} = 100 Ω			–1.5	4.5		120	–	120	–	mJ
$I_{S/b}$ t = 1 s, non rep.	35					2.2	–	–	–	A
	50					–	–	0.9	–	
	30					4.16	–	4.16	–	
$R_{\theta JC}$						–	1.4	–	1.4	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[b] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = ½LI^2$ where L is a series load or leakage inductance, and I is the peak collector current.

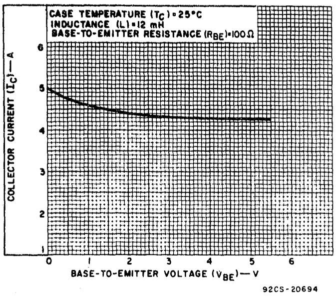


Fig. 6 – Minimum values of reverse-bias second-breakdown characteristic ($E_{S/b}$) for all types.

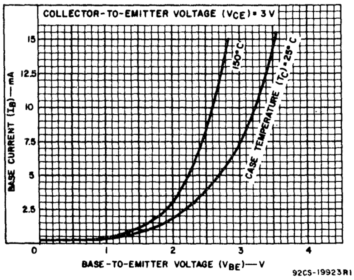


Fig. 7 – Typical input characteristics for all types.

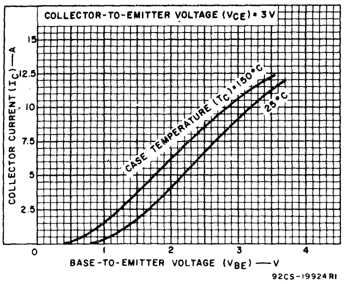


Fig. 8 – Typical transfer characteristics for all types.

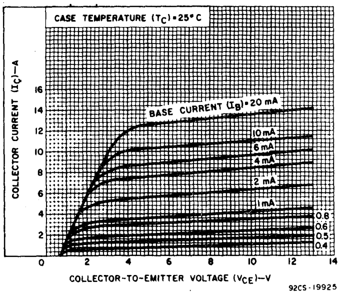


Fig. 9 – Typical output characteristics for all types.

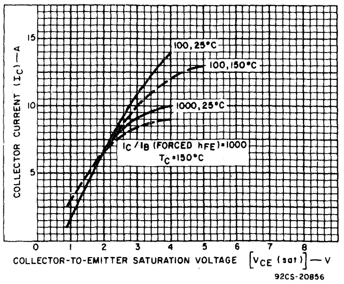


Fig. 10 – Typical saturation characteristics for all types.

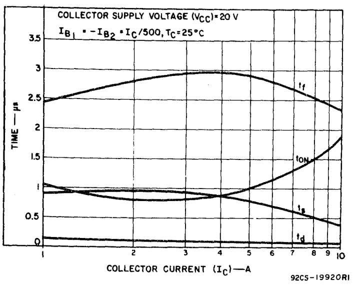


Fig. 11 – Typical saturated switching time characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX83B		BDX83C		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	40				0	–	1	–	–	mA
	50				0	–	–	–	1	
I_{CEV}	80		−1.5			–	0.5	–	–	
	100		−1.5			–	–	–	0.5	
T_C = 150°C	80		−1.5			–	3	–	–	
	100		−1.5			–	–	–	3	
I_{EBO}		5		0		–	5	–	5	mA
V_{CEO}(sus)				0.1[a]	0	80	–	100	–	V
h_{FE}	3			1[a]		750	–	750	–	
	3			5[a]		1000	–	1000	–	
	3			10[a]		250	–	250	–	
V_{BE}	3			5[a]		–	2.8	–	2.8	V
	3			10[a]		–	4.5	–	4.5	
V_{CE}(sat)				5[a]	0.01[a]	–	2	–	2	V
V_F				−10		–	4	–	4	
h_{fe} f = 1 kHz	5			1		1000	–	1000	–	
$\lvert h_{fe} \rvert$ f = 1 MHz	5			1		20	–	20	–	
$E_{S/b}$[b] L = 12 mH, R_{BE} = 100 Ω			−1.5	4.5		120	–	120	–	mJ
$I_{S/b}$ t = 1 s, non rep.	70					0.37	–	–	–	A
	85					–	–	0.25	–	
	30					4.16	–	4.16	–	
$R_{\theta JC}$						–	1.4	–	1.4	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[b] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = \frac{1}{2}LI^2$ where L is a series load or leakage inductance, and I is the peak collector current.

BDY29

Hometaxial-Base High-Current Silicon N-P-N Transistor

Rugged Silicon N-P-N Devices for Applications in Industrial and Commercial Equipment

The RCA-BDY29 is a hometaxial-base silicon n-p-n transistor intended for a wide variety of high-power high-current applications. Typical applications for the BDY29 include power-switching circuits, audio amplifiers, series- and shunt-regulators, driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

The device is supplied in the popular JEDEC TO-3 package.

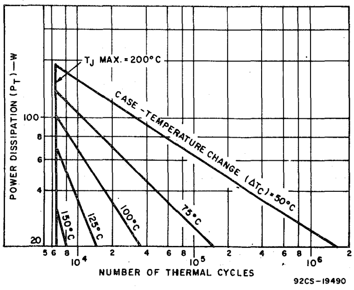


Fig. 1 — Thermal-cycling rating chart.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	100	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With −1.5 V (V_{BE}) & R_{BE} = 100 Ω	V_{CEX}	90	V
With base open	V_{CEO}	75	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	30	A
PEAK COLLECTOR CURRENT	I_{CM}	30	A
CONTINUOUS BASE CURRENT	I_B	7.5	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		220	W
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
PIN TEMPERATURE (During soldering):			
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230	°C

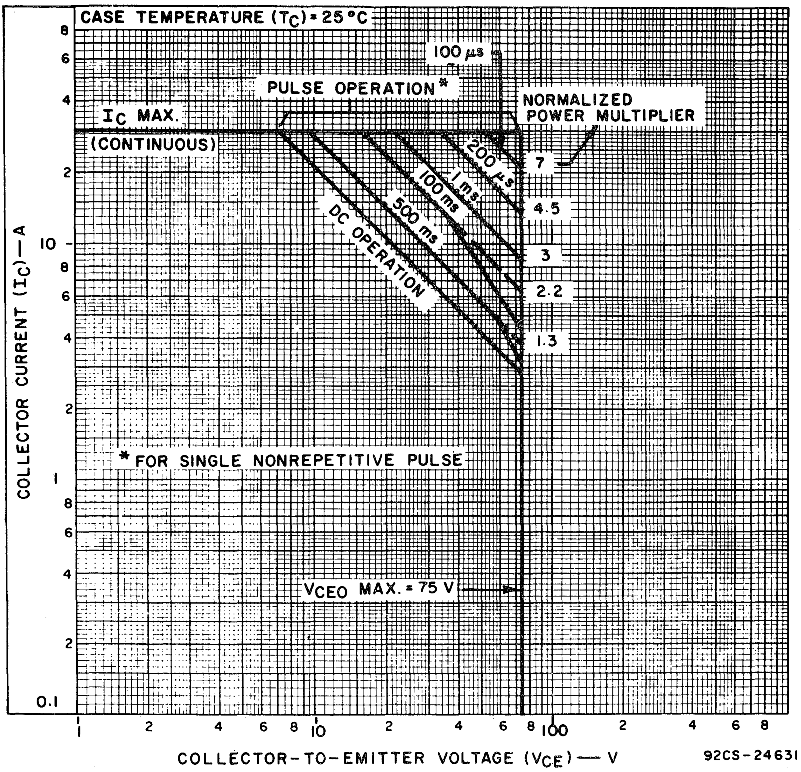
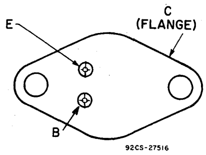


Fig. 2 — Maximum operating areas.

Features:

- **High dissipation capability**
- **High V_{CEX} ratings**
- **15-A specification for h_{FE} and V_{CE}(sat)**
- **Low saturation voltage with high beta**

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

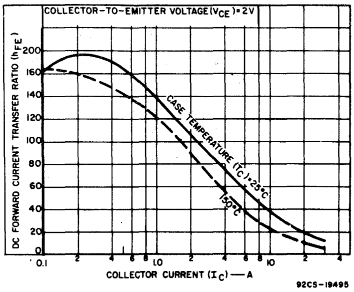


Fig. 3 — Typical dc beta characteristics.

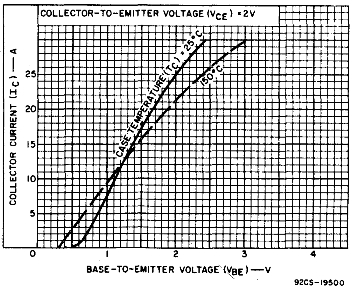


Fig. 4 — Typical transfer characteristics.

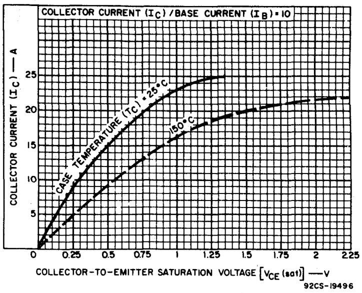


Fig. 5 — Typical saturation-voltage characteristics.

BDY29

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS		UNITS
		VOLTAGE V dc			CURRENT A dc		BDY29		
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
Collector Cutoff Current: With emitter open	I_{CBO}	100					–	1	mA
With base-emitter junction reverse-biased	I_{CEX}		100	−1.5			–	1	mA
With base-emitter junction reverse-biased & T_C = 150°C	I_{CEX}		100	−1.5			–	10	mA
With base open	I_{CEO}		60			0	–	2	mA
Emitter Cutoff Current	I_{EBO}			−7	0		–	2	mA
DC Forward Current Transfer Ratio	h_{FE}		2		15[a]		15	60	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased (R_{BE})= 100 Ω	$V_{CEX}(sus)$			−1.5	0.2		90	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				0.2		85	–	V
With base open	$V_{CEO}(sus)$				0.2	0	75	–	V
Base-to-Emitter Voltage	V_{BE}		4		30[a]		–	3.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				15[a]	1.5	–	1.2	V
Second-Breakdown Collector Current: With base forward-biased and 1-s, nonrepetitive pulse	$I_{S/b}$[b]		60				3.66	–	A
Second-Breakdown Engergy: With base reverse-biased and L = 40 mH, R_{BE} = 100 Ω	$E_{S/b}$[c]			−1.5	5		500	–	mJ
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 0.05 MHz	$\lvert h_{fe} \rvert$		4		1		4	16 (Typ.)	
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 1 kHz	h_{fe}		4		1		40	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	0.8	°C/W

[a] Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz; duty factor ≤ 2%.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = 1/2LI^2$, where L is a series load or leakage inductance and I is the peak collector current.

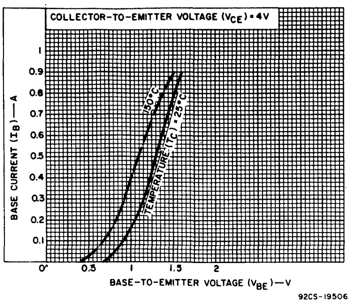


Fig. 6 — Typical input characteristics.

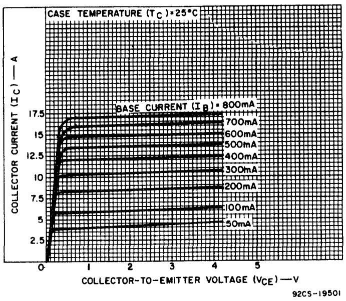


Fig. 7 — Typical output characteristics.

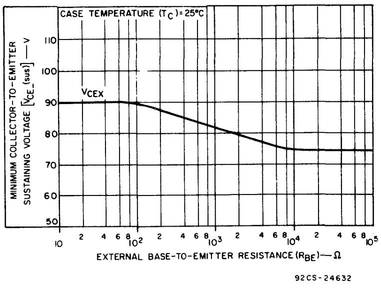


Fig. 8 — Sustaining voltage vs. base-to-emitter resistance.

BDY37

Hometaxial-Base, High-Current Silicon N-P-N Transistor

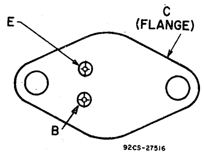
Features:

- High dissipation capability – 150 W
- 8-A specification for h_{FE}, V_{BE}, and $V_{CE}(sat)$
- V_{CEX} – 160 V min.
- Low saturation voltage with high beta

Rugged High-Voltage Device for Applications in Industrial and Commercial Equipment

The RCA-BDY 37 is a hometaxial-base silicon n-p-n transistor intended for a wide variety of high-voltage high-current applications. Typical applications include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service. The BDY 37 employs the popular JEDEC TO-3 package.

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	160	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	140	V
With reverse bias (V_{BE}) of –1.5 V	V_{CEX}	160	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
COLLECTOR CURRENT:			
Continuous	I_C	16	A
Peak	I_{CM}	30	A
BASE CURRENT:			
Continuous	I_B	4	A
Peak	I_{BM}	15	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		150	W
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		–65 to +200	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		230	°C

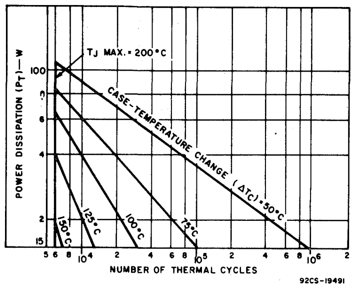


Fig. 2 – Thermal-cycling rating chart.

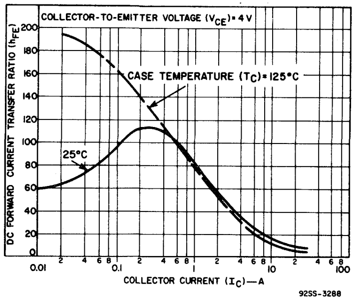


Fig. 3 – Typical dc beta characteristics.

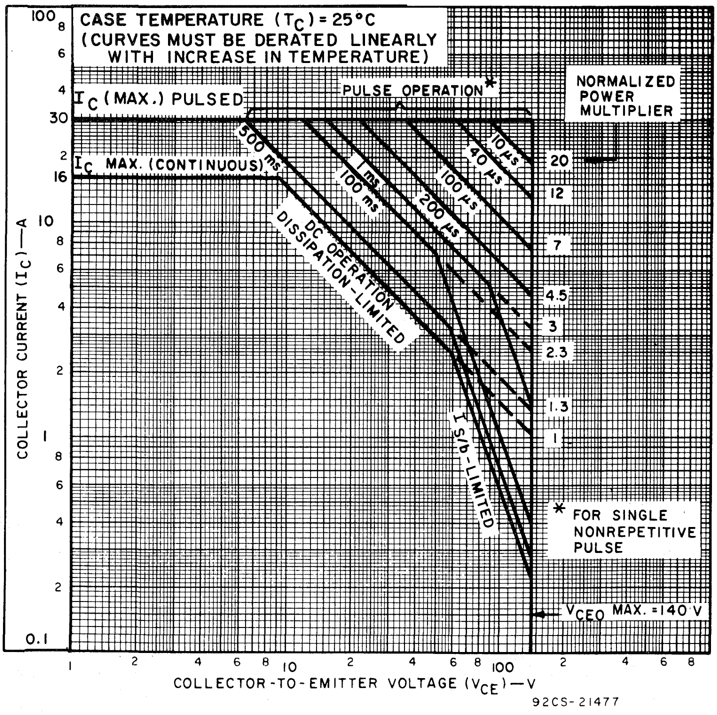


Fig. 1 – Maximum operating areas.

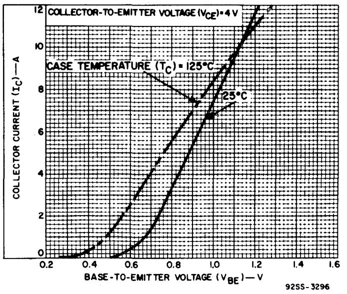


Fig. 4 – Typical transfer characteristics.

BDY37

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS							LIMITS		UNITS
		VOLTAGE V dc				CURRENT A dc			BDY37		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	
Collector-Cutoff Current: With emitter open	I_{CBO}	140					0		–	2	mA
With base-emitter junction reverse-biased	I_{CEX}		140		−1.5				–	2	mA
With base-emitter junction reverse-biased and T_C = 150°C	I_{CEX}		140		−1.5				–	10	mA
With base open	I_{CEO}		120					0	–	10	mA
Emitter-Cutoff Current	I_{EBO}			7		0			–	5	mA
DC Forward-Current Transfer Ratio	h_{FE}		4			8[a]			15	60	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased (R_{BE} = 100 Ω)	$V_{CEX}(sus)$				−1.5	0.1			160	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$					0.2[a]			150	–	V
With base open	$V_{CEO}(sus)$					0.2[a]		0	140	–	V
Base-to-Emitter Voltage	V_{BE}		4			8[a]			–	2.2	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					8[a]		0.8	– –	1.4	V
Second-Breakdown Collector Current: With base forward-biased and 1-s nonrepetitive pulse	$I_{S/b}$[b]		60						2.5	–	A
Second-Breakdown Energy: With base reverse-biased and L = 40 mH, R_{BE} = 100 Ω	$E_{S/b}$[c]				−1.5	2.5			0.125	–	J
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 50 kHz)	$\lvert h_{fe} \rvert$		4			1			4	–	
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}		4			1			40	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$								–	1.17	°C/W

[a] Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz, duty factor ≤ 2%.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = 1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

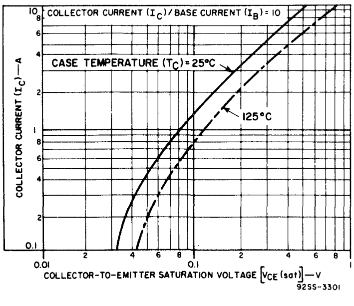


Fig. 5 — Typical staturation-voltage characteristics.

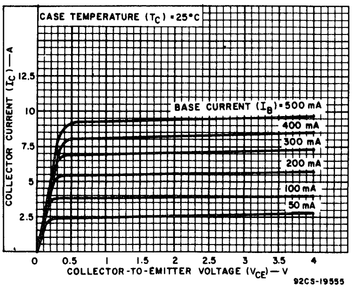


Fig. 6 — Typical output characteristics.

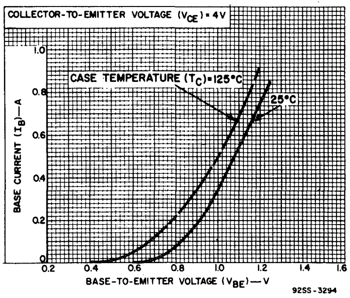


Fig. 7 — Typical input characteristics.

BDY37A

Hometaxial-Base, High-Current Silicon N-P-N Transistor

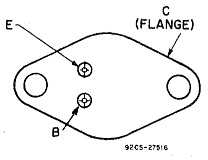
Rugged High-Voltage Devices for Applications in Industrial and Commercial Equipment

Features

- *High dissipation capability—250 W*
- *8-A specification for h_{FE}, V_{BE}, & $V_{CE}(sat)$*
- *V_{CEX}—160 V min.*
- *Low saturation voltage with high beta*

RCA-BDY37A is a hometaxial-base silicon transistor intended for a wide variety of high-voltage, high-current applications. Typical applications include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service. The BDY37A employs the popular JEDEC TO-204MA steel hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	160	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	140	V
With reverse bias (V_{BE}) of − 1.5 V	V_{CEX}	160	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
COLLECTOR CURRENT:			
Continuous	I_C	16	A
Peak	I_{CM}	30	A
BASE CURRENT:			
Continuous	I_B	4	A
Peak	I_{BM}	15	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25 °C		250	W
At case temperatures above 25 °C		Derate linearly to 200 °C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		− 65 to + 200	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		230	°C

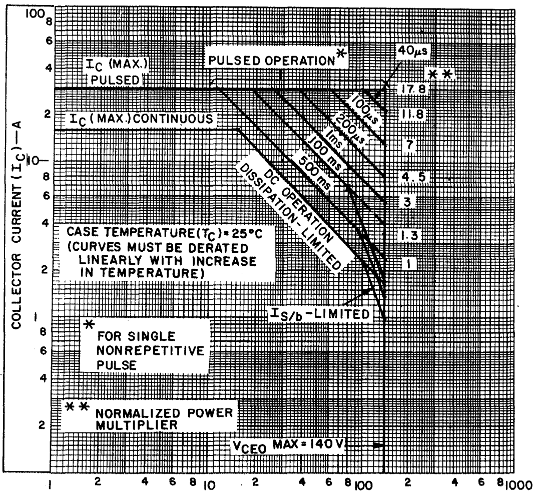


Fig. 1 - Maximum operating areas.

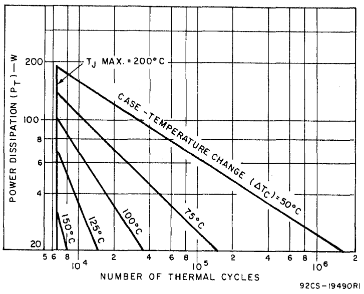


Fig. 2 - Thermal-cycling rating chart.

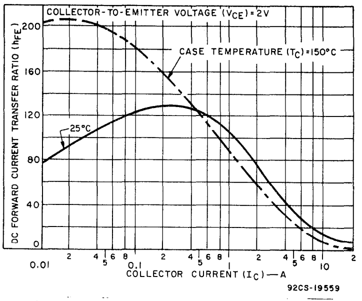


Fig. 3 - Typical dc beta characteristics.

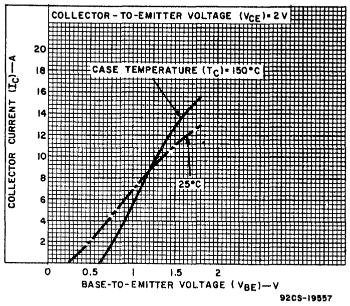


Fig. 4 - Typical transfer characteristics.

BDY37A

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25 °C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS							LIMITS		UNITS
	VOLTAGE V dc				CURRENT A dc			BDY37A		
	V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	
I_{CBO}	140					0		—	2	mA
I_{CEX}		140		−1.5				—	2	mA
I_{CEX} $T_C = 150\,°C$		140		−1.5				—	10	mA
I_{CEO}		120					0	—	10	mA
I_{EBO}			7		0			—	2	mA
h_{FE}		2 4			8[a] 16[a]			15 7	60 —	
$V_{CEX}(sus)$ $R_{BE} = 100\ \Omega$				−1.5	0.1			160	—	V
$V_{CER}(sus)$ $R_{BE} = 100\ \Omega$					0.2[a]			150	—	V
$V_{CEO}(sus)$					0.2[a]		0	140	—	V
V_{BE}		2			8[a]			—	2.2	V
$V_{CE}(sat)$					8[a] 16[a]		0.8 3.2	— —	1 2.5	V
$I_{S/b}$[b] 1-s nonrepetitive pulse		100						2.5	—	A
$E_{S/b}$[c] $L = 40$ mH, $R_{BE} = 100\ \Omega$				−1.5	2.5			0.125	—	J
$\lvert h_{fe}\rvert$ f = 50 kHz		4			1			4	—	
h_{fe} f = 1 kHz		4			1			40	—	
$R_{\theta JC}$								—	0.7	°C/W

[a] Pulsed, pulse duration = 300 μs, rep. rate = 60 Hz, duty factor ⩽ 2%.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = \frac{1}{2} LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

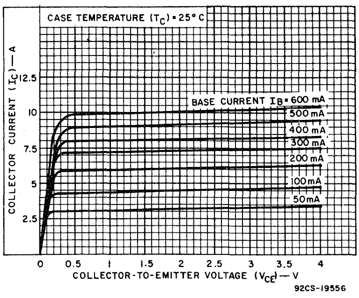


Fig. 5 - Typical output characteristics.

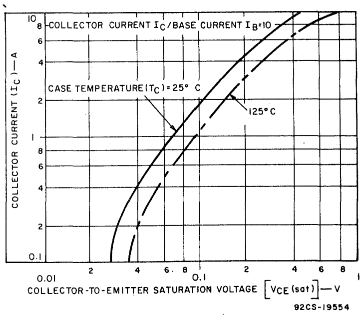


Fig. 6 - Typical saturation-voltage characteristics.

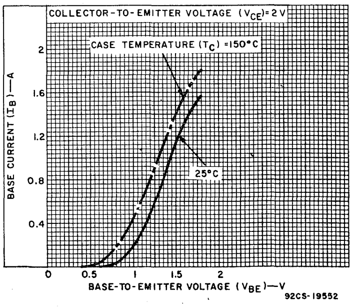


Fig. 7 - Typical input characteristics.

BDY55, BDY56

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistors

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

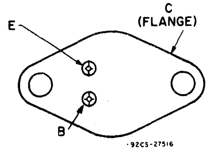
The RCA-BDY55 and BDY56 are epitaxial silicon n-p-n power transistors. They differ in voltage ratings and leakage-current.

The high current-handling capability of these transistors in conjunction with fast switching speeds make them especially suited for switching-control amplifiers, power gates, switching regulators, converters, and inverters. Other recommended applications include dc-rf amplifiers and power oscillators. These transistors are supplied in the steel JEDEC TO-204MA hermetic package.

Features:

- **Maximum operating area curves for dc and pulse operation**
- **Large-signal power amplification**
- **High-current fast switching**

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDY55	BDY56	
V_{CBO}	100	150	V
V_{CEO}	60	120	V
V_{EBO}	7		V
I_C	15		A
I_B	7		A
P_T			
T_C = 25°C	117		W
T_{stg}, T_J	−65 to +200		°C
T_L			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10s max.	230		°C

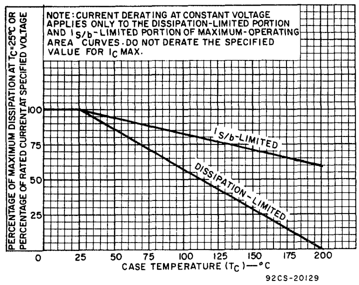


Fig. 2—Dissipation derating curves for both types.

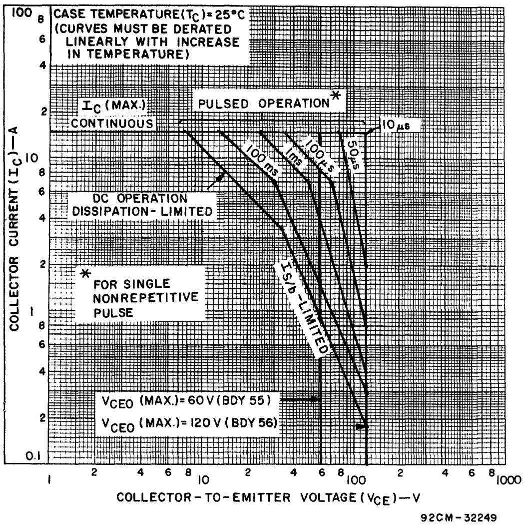


Fig. 1—Maximum operating areas for BDY55 and BDY56.

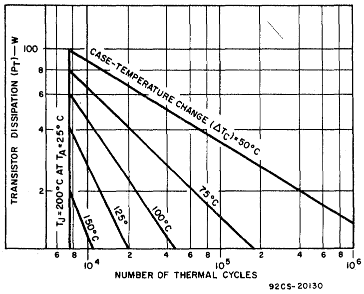


Fig. 3—Thermal-cycling rating chart for both types.

BDY55, BDY56

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDY55		BDY56		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	30				0	—	0.7	—	—	mA
	60				0	—	—	—	0.5	
I_{CEV}	100		−1.5			—	5	—	—	
	150		−1.5			—	—	—	3	
At T_C = 150°C	100		−1.5			—	30	—	—	
	150		−1.5			—	—	—	30	
I_{EBO}		7		0		—	5	—	3	mA
h_{FE}	4			4a		20	70	20	70	
	4			10a		10	—	10	—	
f_T	4			1		10	—	10	—	MHz
$V_{CEO}(sus)$b				0.2	0	60	—	120	—	V
V_{BE}	4			4		—	1.8	—	1.8	
$V_{CE}(sat)$				4	4	—	1.1	—	1.1	
				10	3.3	—	2.5	—	2.5	
t_{ON} V_{CC} = 50 V				5	1.0	—	05	—	0.5	μs
t_{OFF} V_{CC} = 50 V				5	I_{B1} = 1A I_{B2} = −0.5A	—	2	—	2	
$R_{\theta JC}$	10			10		—	1.5	—	1.5	°C/W

a Pulsed; pulse duration ⩽ 350 μs, duty factor = 2%.

b **CAUTION:** The sustaining voltages $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit.

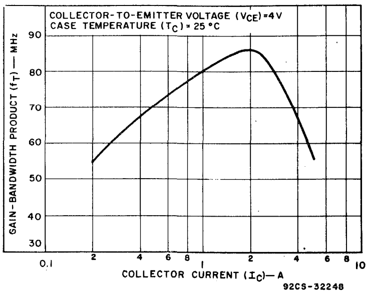


Fig. 4—Typical gain-bandwidth product for both types.

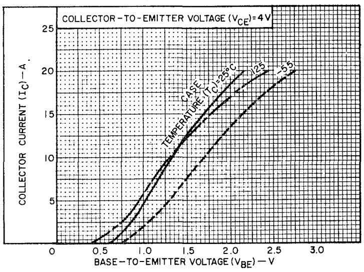


Fig. 5—Typical transfer characteristics for both types.

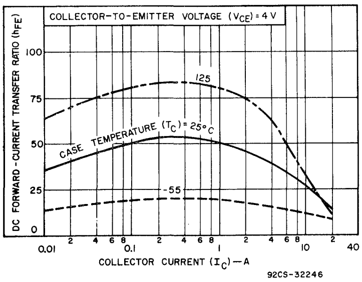


Fig. 6—Typical dc beta characteristics for both types.

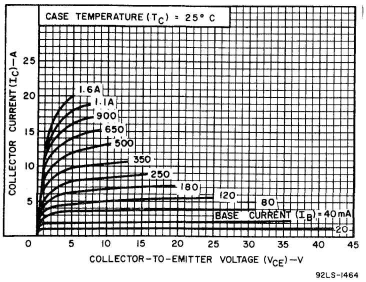


Fig. 7—Typical output characteristics for both types.

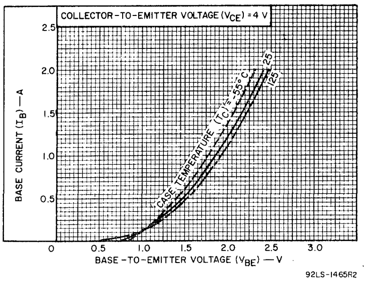


Fig. 8—Typical input characteristics for both types.

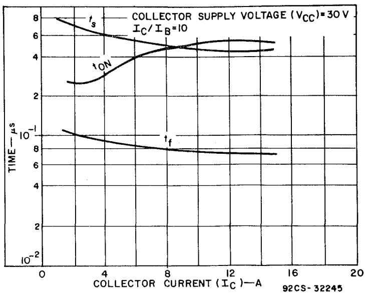


Fig. 9 — Switching-time characteristics as a function of collector current for both types.

High-Current, High-Speed High-Power Silicon N-P-N Transistor

For Switching and Amplifier Applications in Industrial and Commercial Service

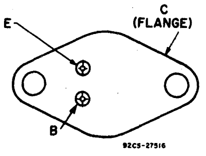
The RCA-BDY57A epitaxial silicon n-p-n power transistor has high current and high power handling capability and fast switching speed. It is especially suitable for switching-control amplifiers, power gates, switching regulators, power-switching circuits converters, inverters, control circuits. Other recommended applications include dc-rf amplifiers, and power oscillators.

The BDY57A is supplied in a steel JEDEC TO-204MA hermetic package.

Features:

- **Maximum area-of-operation curves for dc and pulse operation—$I_{S/b}$ limit begins at 25 V**
- **Fast turn-on time—1 μs at I_C = 15 A**
- **High-current capability— h_{FE}, $V_{CE}(sat)$ measured at I_C = 10 A**

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values*

V_{CBO}	120	V
$V_{CEO}(sus)$	80	V
V_{EBO}	9	V
I_C	25	A
I_B	6	A
P_T		
$T_C \leqslant$ 25°C	175	W
$T_C \geqslant$ 25°C, derate linearly	1	W/°C
T_{stg}, T_J	−65 to 200	°C
T_L		
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230	°C

THERMAL FATIGUE INSPECTION

Pulsed Test:

20,000 cycles
"on": 2 minutes at 56 watts P_T
"off": 1 minute at 56 watts P_T
T_C = 125°C max.
ΔT_C = 50°C max.
T_J 175°C max.

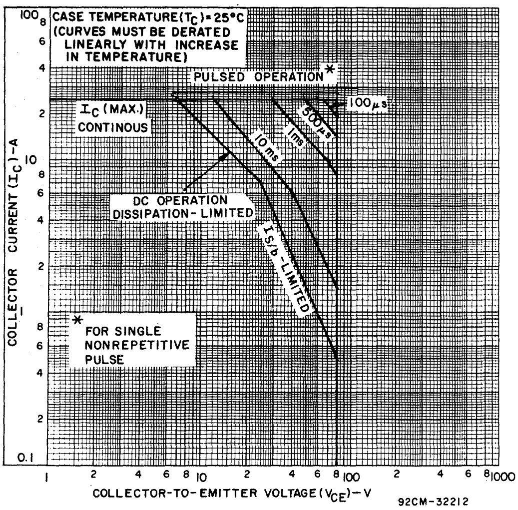


Fig. 1—Maximum operating areas. (T_C = 25°C).

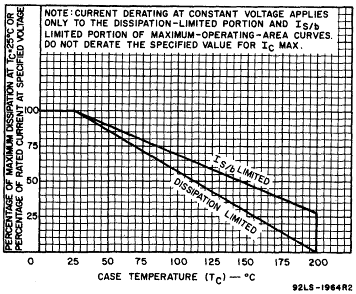


Fig. 2 — Derating Curves.

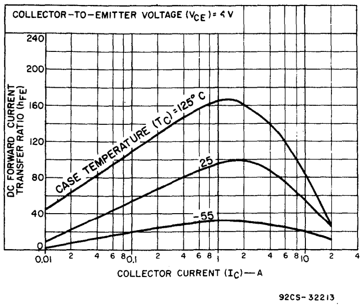


Fig. 3—Typical dc beta characteristics.

BDY57A

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc					
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CBO}	120●				–	0.5	1	mA
I_{CER} R_{BE} = 10 Ω, T_C = 100°C	80				–	–	10	
I_{EBO}		-9	0		–	–	2	
$V_{(BR)CBO}$			5*		120	–	–	V
V_{CEO}(sus)■			0.1*	0	80	–	–	
$V_{(BR)EBO}$ I_E = 5 mA			0		9	–	–	
h_{FE}	4 4		10* 20*		20 –	– 15	60 –	
T_C = –30°C	4		10*		10	–	–	
V_{BE}(sat)			10*	1	–	0.5	1.4	V
V_{CE}(sat)			10*	1	–	1.4	2	
f_T f = 10 MHz	15		1		10	30	–	MHz
t_{ON} $t_d + t_r$	V_{CC} = 75 V		15	1.5	–	0.25	1	µs
t_{OFF} $t_s + t_f$			15	1.5	–	1	2	
$R_{\theta JC}$					–	–	1	°C/W

● V_{CB} value. * Pulsed; pulse duration ⩽300 µs, duty factor ⩽2%.

■ **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

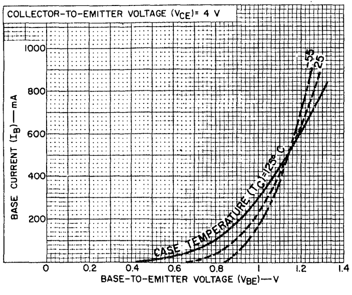


Fig. 4—Typical input characteristics

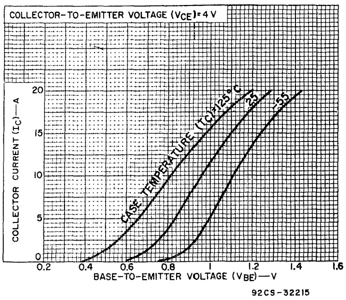


Fig. 5—Typical transfer characteristics.

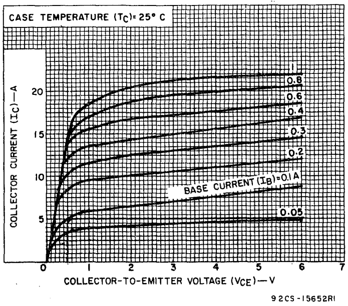


Fig. 6—Typical output characteristics.

Silicon N-P-N Switching Transistor

For Switching Applications in Industrial and Commercial Equipment

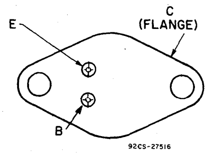
Features:

- V_{CEO} - *160 V*
- I_C - *25 A*
- P_T - *175 W*

RCA-BDY58R is a silicon n-p-n power transistor featuring fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. It is specially designed for converters, inverters, pulse-width-modulated regulators, and a variety of power switching circuits.

The RCA-BDY58R transistor is supplied in a steel JEDEC TO-204MA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDY58R
V_{CBO}	250 V
V_{CEO}	160 V
V_{CEX}	
$V_{BE} = -1.5$ V	250 V
V_{EBO}	8 V
I_C	25 A
I_{CM}	50 A
I_B	8 A
P_T:	
At T_C up to 25°	175 W
T_J, T_{stg}	−65 to +200 °C
T_L:	
At distances ⩾ 1/16 in. (1.58 mm) from case for 10 s max.	235 °C

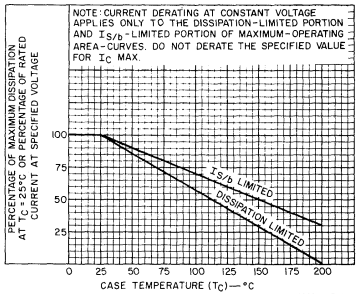


Fig. 2 - Dissipation and $I_{S/b}$ derating curve.

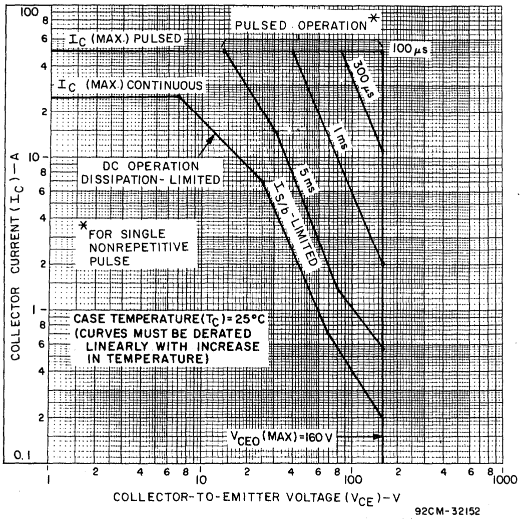


Fig. 1 - Maximum safe-operating areas (T_C = 25°C).

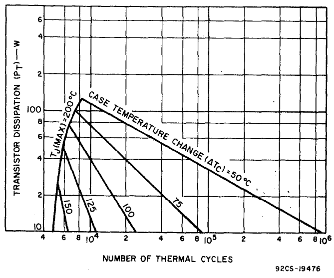


Fig. 3 - Thermal-cycling rating chart.

BDY58R

ELECTRICAL CHARACTERISTICS, *at Case Temperature* $(T_C) = 25°C$ *unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BDY58R			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CBO}	V_{CB} = 200	—	—	0	—	0.1	1	mA
I_{CER} $R_{BE} = 10\ \Omega$, $T_C = 100°C$	180	—	—	—	—	—	10	
I_{EBO}	—	−5	0	—	—	0.1	0.5	
$V_{CEO}(sus)^b$	—	—	0.2[a]	—	160[a]	—	—	V
$V_{(BR)EBO}$ $I_E = 0.05$ A	—	—	0	—	8	—	—	
$V_{BE}(sat)$	—	—	10[a]	1	—	0.9	2	
$V_{CE}(sat)$	—	—	10[a]	1	—	0.2	1.4	
h_{FE}	4	—	10[a]	—	20	—	60	
	4	—	20[a]	—	—	20	—	
$T_C = -30°C$	4	—	10[a]	—	10	—	—	
f_T	15	—	1	—	10	48	—	MHz
t_{on}	V_{CC} = 75 V	—	15	1.5	—	0.3	1	µs
t_{off} $(I_{B1} = I_{B2})$		—	15	1.5	—	1.2	2	
$R_{\theta JC}$	—	—	—	—	—	—	1	°C/W

[a] Pulsed, pulse duration = 300 µs, duty factor ⩽ 2%.

[b] **CAUTION:** Sustaining Voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

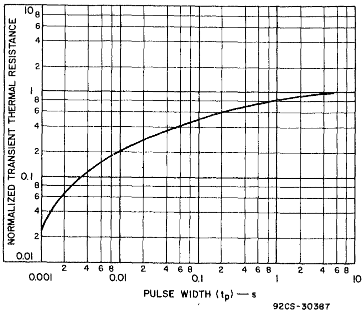


Fig. 4 - Typical thermal-response characteristic.

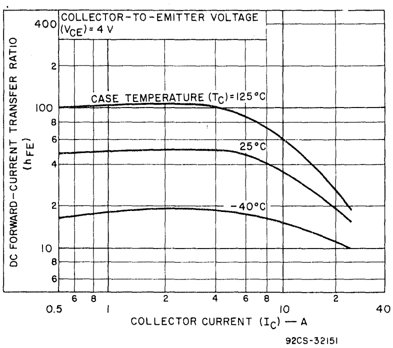


Fig. 5 - Typical dc beta characteristics.

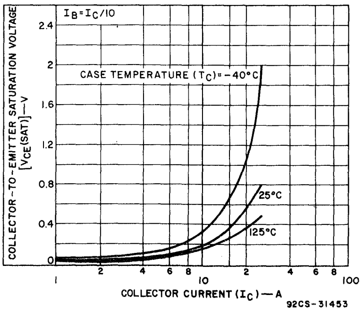


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics.

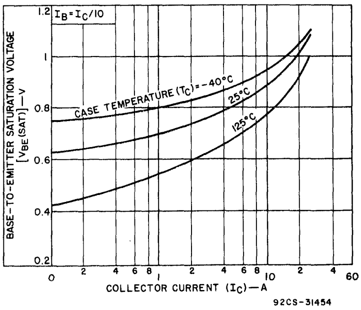


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current.

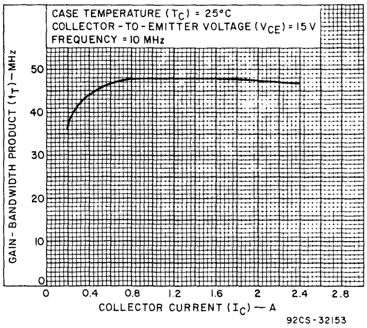


Fig. 8 - Typical gain-bandwidth product.

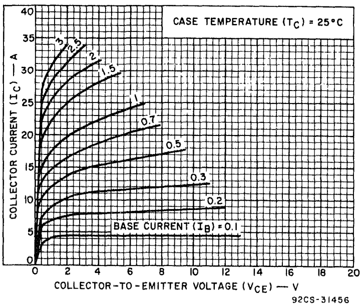


Fig. 9 - Typical output characteristics.

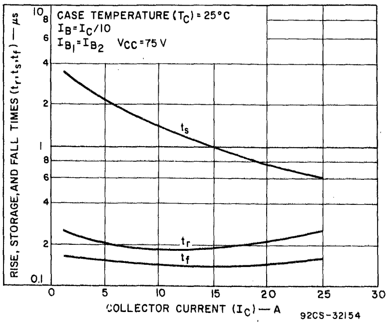


Fig. 10 - Typical saturated-switching-time characteristics as a function of collector current.

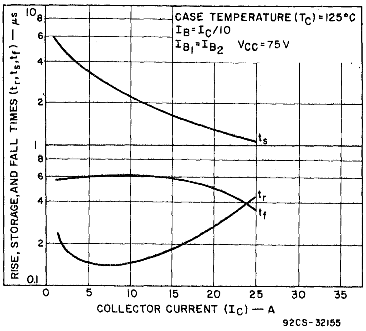


Fig. 11 - Typical switching-time characteristics at T_C = 125°C as a function of collector current.

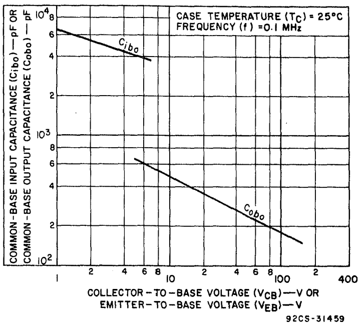


Fig. 12 - Typical common-base input (C_{ibo}) of output (C_{obo}) capacitance characteristics.

BDY71

Hometaxial-Base, Medium-Power Silicon N-P-N Transistor

For Intermediate-Power Applications in Industrial and Commercial Equipment

The RCA-BDY71 is a hometaxial-base silicon n-p-n transistor intended for a wide variety of medium- to high-power applications. It is supplied in the JEDEC TO-66 hermetic package.

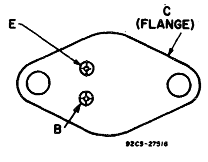
Applications:

- **Power switching circuits**
- **Series- and shunt-regulator driver and output stages**
- **High-fidelity amplifiers**
- **Solenoid drivers**

Features:

- **Maximum safe-area-of-operation curves for dc and pulse operation**
- **$V_{CEV}(sus)$ = 90 V min**
- **Low saturation voltage: $V_{CE}(sat)$ = 1.0 V at I_C = 0.5 A**

TERMINAL DESIGNATIONS



JEDEC TO-66

(See dimensional outline "N".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BDY71	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	90	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	55	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$	60	V
With base reverse-biased (V_{BE} = -1.5 V)	$V_{CEV}(sus)$	90	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	A
CONTINUOUS BASE CURRENT	I_B	2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperature up to 25°C		29	W
At temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
PIN TEMPERATURE (During Soldering):			
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235	°C

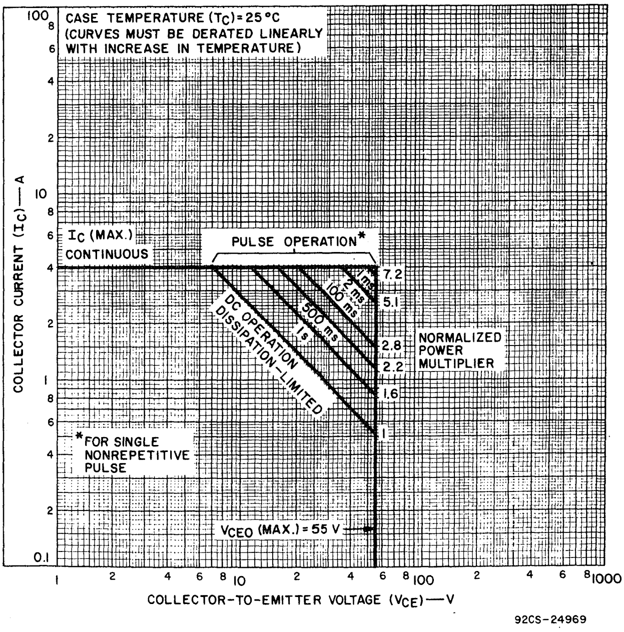


Fig. 1 – Maximum operating areas for BDY71.

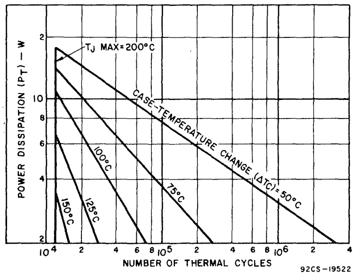


Fig. 2 – Thermal-cycling rating chart.

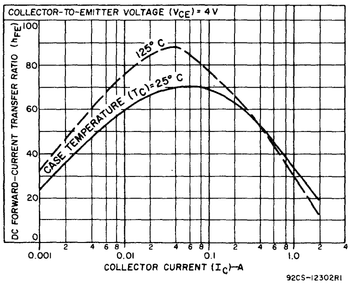


Fig. 3 – Typical dc beta characteristics.

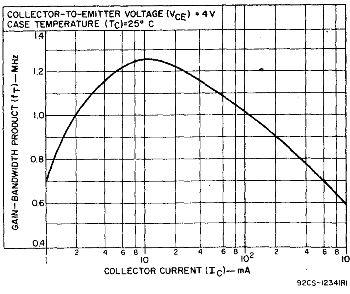


Fig. 4 – Typical gain-bandwidth product.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS		UNITS
		VOLTAGE V dc		CURRENT A dc		BDY71		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	30			0	–	0.5	mA
With base-emitter junction reverse-biased	I_{CEX}	90	−1.5			–	1	mA
at T_C = 150°C	I_{CEX}	90	−1.5			–	6	mA
Emitter-Cutoff Current	I_{EBO}		−7		0	–	1	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.1[a]	0	55	–	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$			0.1[a]		60	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4 4		3[a] 0.5[a]		5 80	– 200	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			0.5[a] 3[a]	0.05[a] 1[a]	– –	1 6	V
Base-to-Emitter Voltage	V_{BE}	4		0.5		–	1.7	V
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio Cutoff Frequency	f_{hfe}	4		0.1		0.03	–	MHz
Gain-Bandwidth Product: f = 0.4 MHz	f_T			0.2		800	–	kHz
Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio: f = 1 kHz	h_{fe}	4		0.1		25	–	
Forward-Bias Second Breakdown Collector Current: t = 1-s nonrepetitive	$I_{S/b}$	55				525	–	mA
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					6.3	–	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

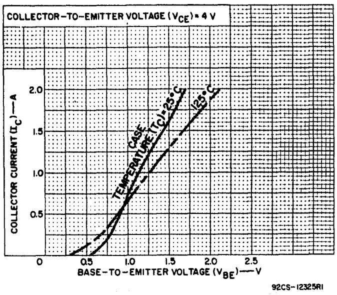


Fig. 5 — Typical transfer characteristics.

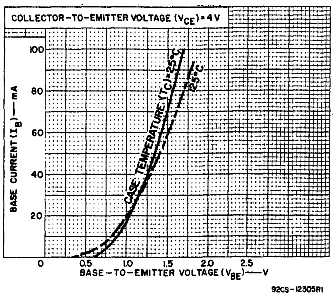


Fig. 6 — Typical input characteristics.

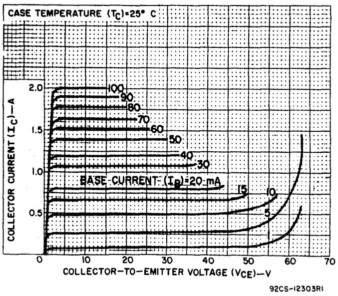


Fig. 7 — Typical output characteristics.

BDY90, BDY91, BDY92

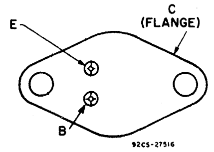
High-Speed Silicon N-P-N Power Transistors

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

Features

- *Maximum operating area curves for dc and pulse operation*

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

The RCA-BDY90, BDY91, and BDY92 are epitaxial silicon n-p-n power transistors. They differ in breakdown-voltage ratings, leakage-current, and dc-beta values.

The high current-handling capability of these transistors in conjunction with fast switching speeds make them especially suited for switching-control amplifiers, power gates, switching regulators, converters, and inverters. Other recommended applications include dc-rf amplifiers and power oscillators. These transistors are supplied in the steel JEDEC TO-204MA hermetic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDY90	BDY91	BDY92	
V_{CBO}	120	100	80	V
$V_{CEX}(sus)$				
$V_{BE} = -1.5$ V	120	100	80	V
$V_{CEO}(sus)$	100	80	60	V
V_{EBO}		6		V
I_C		10		A
I_{CM}		15		A
I_B		2		A
P_T				
$T_C \leq 75°C$		40		W
$T_C \leq 25°C, V_{CE} > 28$ V		See Fig. 2		
$T_C > 25°C, V_{CE} > 28$ V		See Figs. 1 & 2		
T_J, T_{stg}		−65 to 175		°C
T_L				
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		175		°C

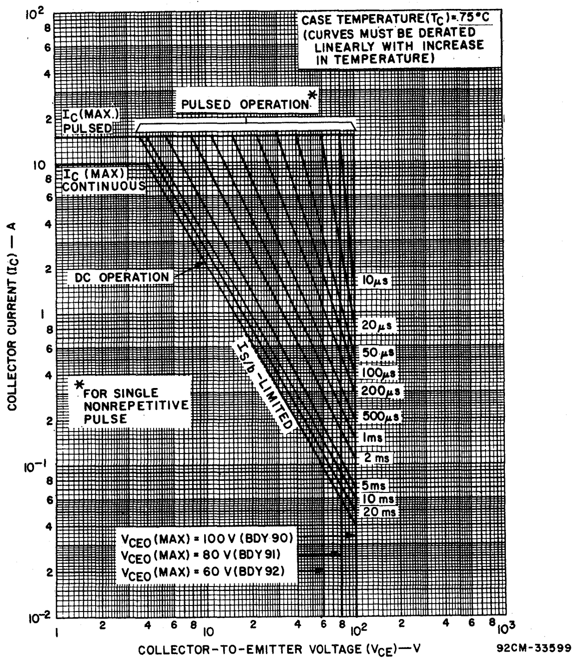


Fig. 1 — Maximum operating areas for all types.

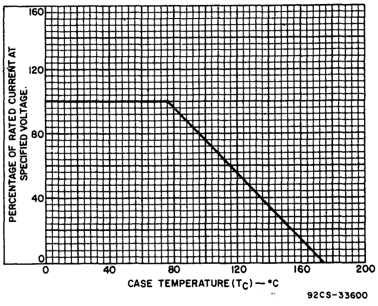


Fig. 2 — Dissipation derating curves for all types.

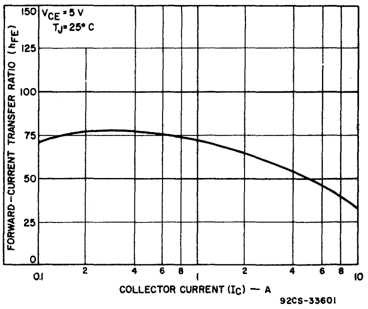


Fig. 3 — Typical dc beta characteristics for all types.

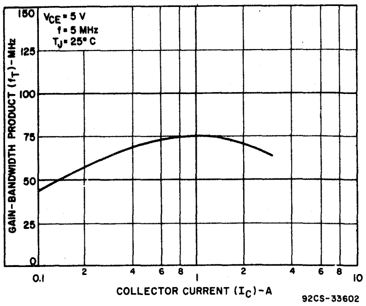


Fig. 4 — Typical gain-bandwidth product for all types.

BDY90, BDY91, BDY92

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) =25° C Unless Otherwise Specified*

Charac-teristic	Test Conditions				Limits						Units
	Voltage V dc		Current A dc		BDY90		BDY91		BDY92		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEX} T_C = 150° C	120	—1.5			—	3	—	—	—	—	mA
	100	—1.5			—	—	—	3	—	—	
	80	—1.5			—	—	—	—	—	3	
h_{FE}	2		1[a]		35	—	35	—	35	—	
	5		5[a]		30	120	30	120	30	120	
	5		10[a]		20	—	20	—	20	—	
$\|h_{fe}\|$ f=5 MHz	5		0.5		14 Typ.	—	14 Typ.	—	14 Typ.	—	
$V_{CEO}(sus)$[b]			0.2	0	100	—	80	—	60	—	V
$V_{CEX}(sus)$[b]		—1.5	0.2	0	120	—	100	—	80	—	
V_{EBO} I_E=0.05A			0		6	—	6	—	6	—	
$V_{CE}(sat)$			5[a]	0.5	—	0.5	—	0.5	—	0.5	V
			10[a]	1	—	1.5	—	1.5	—	1.0	
$V_{BE}(sat)$			5[a]	0.5	—	1.2	—	1.2	—	1.2	V
			10[a]	1	—	1.5	—	1.5	—	1.5	
t_{ON} V_{CC}=30 V			5	0.5[c]	—	0.35	—	0.35	—	0.35	µs
t_s V_{CC}=30 V			5	0.5[c]	—	1.3	—	1.3	—	1.3	
t_f V_{CC}=30 V			5	0.5[c]	—	0.2	—	0.2	—	0.2	
$R_{\theta JC}$	10		10		—	2.5	—	2.5	—	2.5	°C/W

[a] Pulsed: pulse duration = 300 µs, duty factor ≤ 2%. [c] $I_{B_1} = -I_{B_2}$

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ and V_{CEX} *MUST NOT* be measured on a curve tracer.

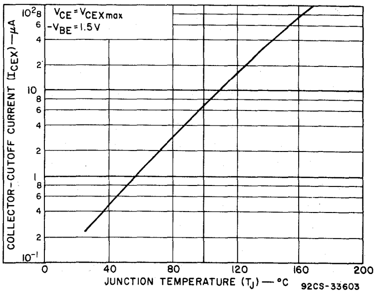


Fig.5 - Typical collector leakage current vs. junction temperature for all types.

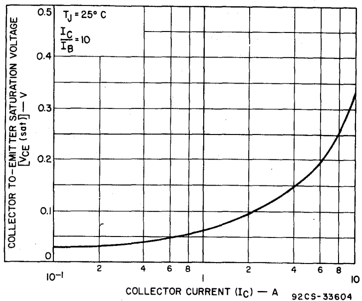


Fig.6 - Typical collector-to-emitter saturation voltage characteristics as a function of collector current for all types.

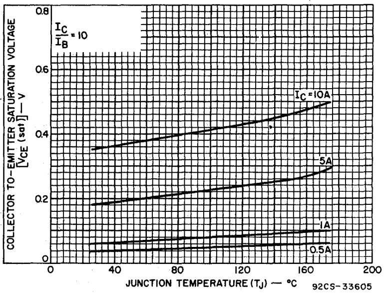


Fig.7 - Typical collector-to-emitter saturation voltage characteristics as a function of junction temperature for all types.

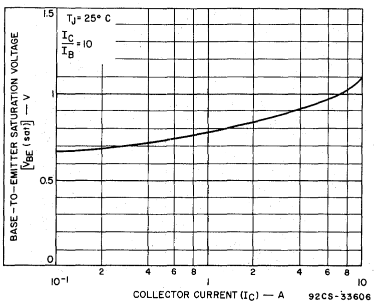


Fig.8 - Typical base-to-emitter saturation voltage characteristics as a function of collector current for all types.

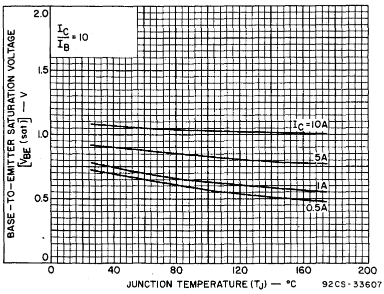


Fig.9 - Typical base-to-emitter saturation voltage characteristics as a function of junction temperature.

BFT19, BFT19A, BFT19B

High-Voltage Silicon P-N-P Transistors

For High-Speed Switching and Linear-Amplifier
Applications in Military, Industrial and Commercial Equipment

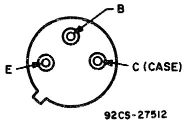
Features:

- **Maximum safe-area-of-operation curves**
- **High voltage ratings:**
  V_{CBO} = −400 V max. (BFT19B); −300 V max. (BFT19A); −200 V max. (BFT19)
  $V_{CEO}(sus)$ = −350 V max. (BFT19B); −250 V max. (BFT19A); −150 V max. (BFT19)

RCA-BFT19, BFT19A, and BFT19B are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds. These transistors differ in their voltage ratings. They are supplied in the JEDEC TO-39 hermetic package.

Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters, and high-voltage, low-current switching and series regulators.

TERMINAL DESIGNATIONS



JEDEC TO-39

(See dimensional outline "C".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BFT19	BFT19A	BFT19B	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−200	−300	−400	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With base open	$V_{CEO}(sus)$	−150	−250	−350	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	−200	−300	−400	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	−5	−5	−5	V
COLLECTOR CURRENT (Continuous)	I_C	−1	−1	−1	A
BASE CURRENT (Continuous)	I_B	−0.5	−0.5	−0.5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		5	5	5	W
At case temperatures above 25°C		Derate linearly to 200°C			
At ambient temperatures up to 25°C		1	1	1	W
At ambient temperatures above 25°C		Derate linearly at 5.7 mW/°C			
TEMPERATURE RANGE:					
Storage and Operating (Junction)		← −65 to 200 →			°C
PIN TEMPERATURE (During Soldering):					
At distance ≥ 1/32 in. (0.8 mm) from case for 10 s max.		← 255 →			°C

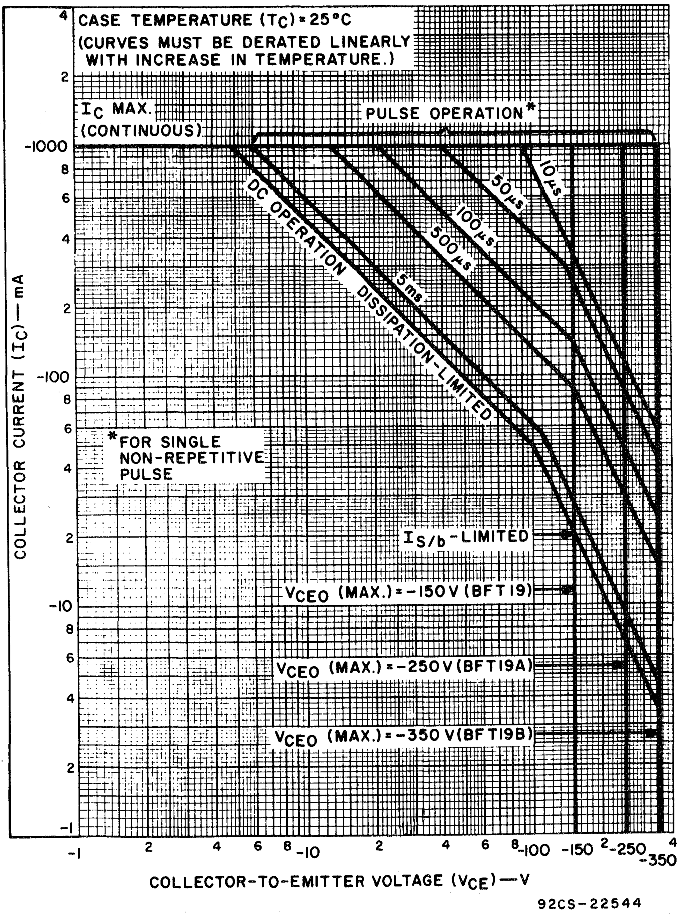


Fig. 1 — Maximum operating areas for all types.

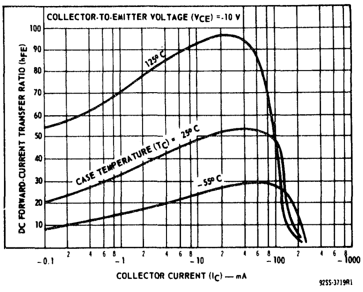


Fig. 2 — Typical dc beta characteristics.

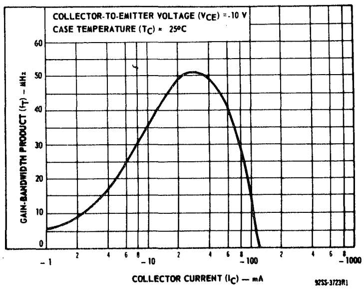


Fig. 3 — Typical gain-bandwidth product.

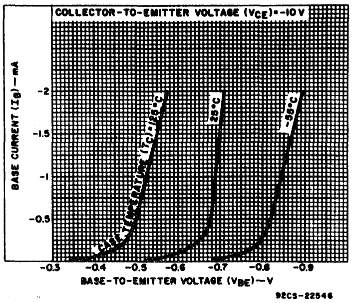


Fig. 4 — Typical input characteristics.

BFT19, BFT19A, BFT19B

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS						UNITS
		VOLTAGE V dc			CURRENT mA			BFT19		BFT19A		BFT19B		
		V_{CB}	V_{CE}	V_{EB}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With emitter open	I_{CBO}	−100 −200 −300					0 0 0	– – –	−100 – –	– – –	– −100 –	– – –	– – −100	µA
Emitter-Cutoff Current	I_{EBO}			−5	0			–	−100	–	−100	–	−100	µA
DC Forward-Current Transfer Ratio	h_{FE}		−10 −10 −10		−10 −30 −50			20 25 20	– – –	20 25 20	– – –	20 25 20	– – –	
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$				−10		0	−150[a]	–	−250[a]	–	−350[a]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				−10			−200[a]	–	−300[a]	–	−400[a]	–	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$				−30		−3	–	−1.8	–	−1.8	–	−1.8	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				−10 −30		−1 −3	– –	−1 −2.5	– –	−1 −2.5	– –	−1 −2.5	V
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (at 1 kHz)	h_{fe}		−10		−5			25	–	25	–	25	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio (at 5 MHz)	$\lvert h_{fe} \rvert$		−10		−30			5	–	5	–	5	–	
Common-Base, Short-Circuit, Input Capacitance (at 1 MHz)	C_{ib}			−5	0			–	75	–	75	–	75	pF
Output Capacitance (at 1 MHz)	C_{ob}	−10				0		–	15	–	15	–	15	pF
Second-Breakdown Collector Current: With base forward biased	$I_{S/b}$	−100						−50	–	−50	–	−50	–	mA
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$							–	35	–	35	–	35	°C/W

[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

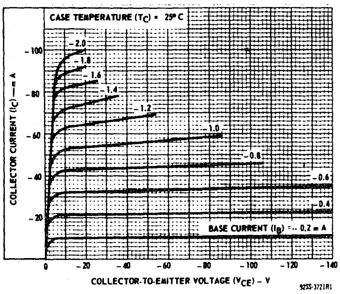


Fig. 5 – Typical output characteristics.

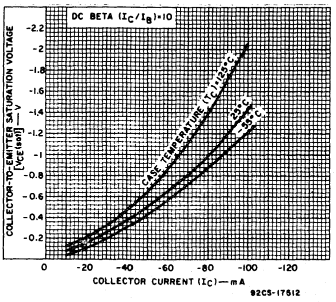


Fig. 6 – Typical collector-to-emitter saturation voltage.

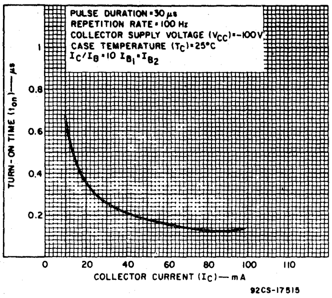


Fig. 7 – Typical turn-on time characteristics.

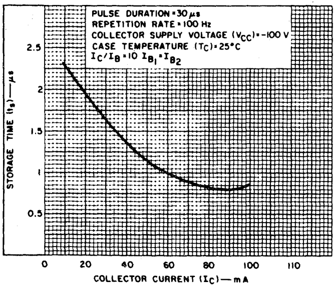


Fig. 8 – Typical storage-time characteristic.

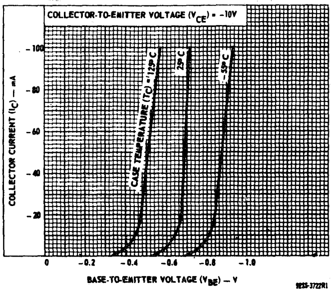


Fig. 9 – Typical transfer characteristics.

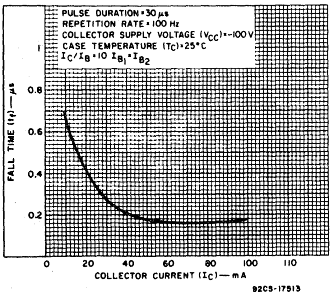


Fig. 10 – Typical fall-time characteristic.

BFT28, BFT28A, BFT28B, BFT28C

High-Voltage Silicon P-N-P Transistors

For High-Speed Switching and Linear-Amplifier
Applications in Military, Industrial and Commercial Equipment

The RCA-BFT28, BFT28A, BFT28B and BFT28C are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds. They are supplied in the JEDEC TO-39 hermetic package.

These transistors differ primarily in their voltage ratings. Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters; and high-voltage, low-current switching and series regulators.

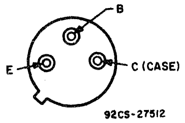
Features:

- **Maximum safe-area-of-operation curves**
- **High voltage ratings:**
  V_{CBO} = –150 V max. (BFT 28); –200 V max. (BFT28A);
  –250 V max. (BFT 28 B); –300 V max. (BFT28C)
  V_{CEO}(sus) = –100 V max. (BFT 28); –150 V max. (BFT28A);
  –200 V max. (BFT28B); –250 V max. (BFT28C)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BFT28	BFT28A	BFT28B	BFT28C	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	–150	–200	–250	–300	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)	–150	–200	–250	–300	V
With base open	V_{CEO}(sus)	–100	–150	–200	–250	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	–4	–4	–4	–4	V
COLLECTOR CURRENT	I_C	–1	–1	–1	–1	A
BASE CURRENT	I_B	–0.5	–0.5	–0.5	–0.5	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C		5	5	5	5	W
At case temperatures above 25°C		Derate linearly to 200°C				
At ambient temperatures up to 50°C		1	1	1	1	W
At ambient temperatures above 50°C ..... Derate linearly at		5.7	5.7	5.7	5.7	mW/°C
TEMPERATURE RANGE:						
Storage and Operating (Junction)		–65 to +200				°C
LEAD TEMPERATURE (During soldering):						
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		255				°C

TERMINAL DESIGNATIONS



JEDEC TO-39

(See dimensional outline "C".)

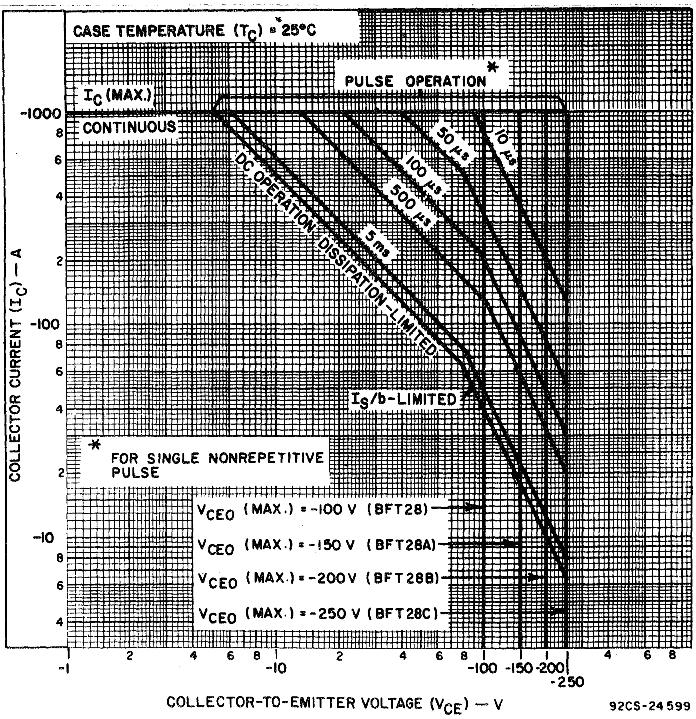


Fig. 1 — Maximum safe operating areas.

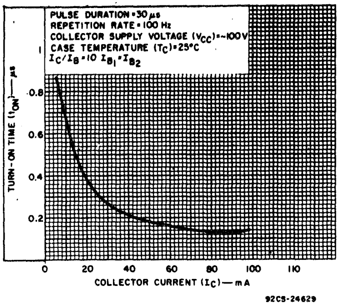


Fig. 2 — Typical turn-on time characteristic for all types.

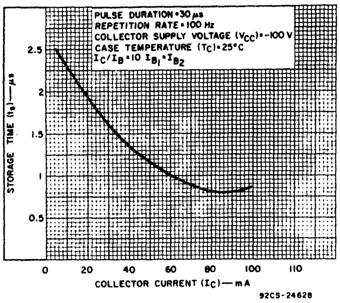


Fig. 3 — Typical storage-time characteristic for all types.

BFT28, BFT28A, BFT28B, BFT28C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS								UNITS
		VOLTAGE V dc			CURRENT mA dc		BFT28		BFT28A		BFT28B		BFT28C		
		V_{CB}	V_{CE}	V_{EB}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With emitter open	I_{CBO}	−50 −75 −150					– – –	−1 – –	– – –	– −1 –	– – –	– – −5	– – –	– – −5	μA
Emitter-Cutoff Current	I_{EBO}			−4	0		–	−100	–	−100	–	−100	–	−100	μA
DC Forward-Current Transfer Ratio	h_{FE}		−10		-10^c		20	–	20	–	20	–	20	–	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$				−10	0	-100^a	–	-150^a	–	-200^a	–	-250^a	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				−10		-150^a	–	-200^a	–	-250^a	–	-300^a	–	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$				-30^c	−3	–	−1.5	–	−1.5	–	−1.5	–	−1.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				-10^c	−1	–	−0.6	–	−0.6	–	−5	–	−5	V
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 kHz	h_{fe}		−10		−5		25	–	25	–	25	–	25	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: f = 5 MHz	$\lvert h_{fe} \rvert$		−10		−30		5	–	5	–	5	–	5	–	
Common-Base, Short-Circuit, Input Capacitance: f = 1 MHz	C_{ib}			−5	0		–	75	–	75	–	75	–	75	pF
Output Capacitance: f = 1 MHz	C_{ob}	−10					–	15	–	15	–	15	–	15	pF
Forward-Bias, Second-Breakdown Collector Current: 0.4-s non-repetitive pulse	$I_{S/b}{}^b$		−80				−62.5	–	−62.5	–	−62.5	–	−62.5	–	mA
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	35	–	35	–	35	–	35	°C/W

[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.

[c] Pulsed, pulse duration = 300 μs; duty factor ≤ 2%.

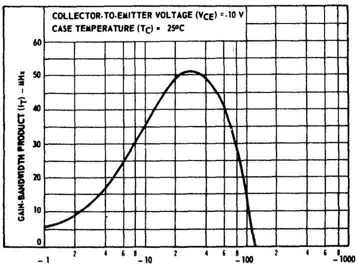


Fig. 4 — Typical gain-bandwidth product for all types.

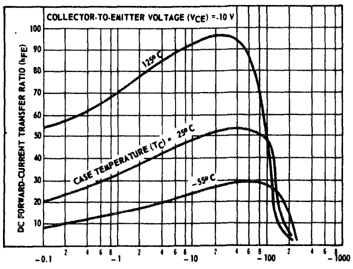


Fig. 5 — Typical dc beta characteristics for all types.

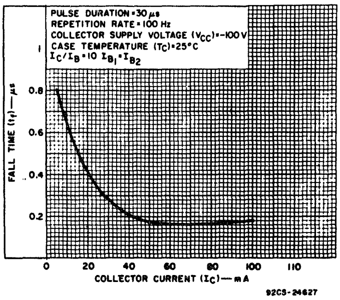


Fig. 6 — Typical fall-time characteristic for all types.

BFT28, BFT28A, BFT28B, BFT28C

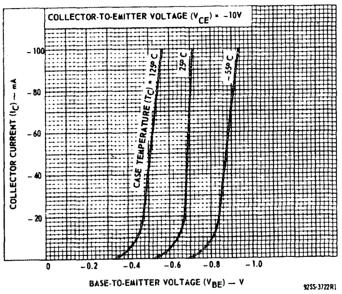


Fig. 7 – Typical transfer characteristics for all types.

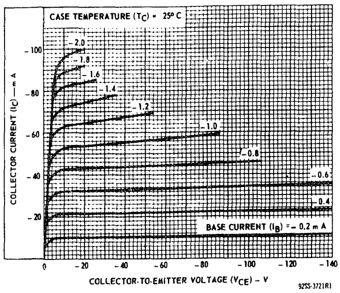


Fig. 8 – Typical output characteristics for all types.

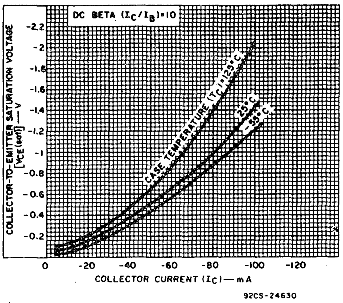


Fig. 9 – Typical collector-to-emitter saturation voltage for all types.

BU126, BU133

High-Voltage, Power-Switching Silicon N-P-N Transistors

Features:

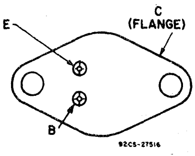
- **Fast switching speed**
- **Hermetic steel package – JEDEC TO-3**
- **Epitaxial pi-nu construction**

TV Colour/Monochrome Receiver Power Supplies –90° and 110° Deflection Angles

The RCA-BU126 and BU133 are silicon epitaxial-collector n-p-n power switching transistors intended for use in switched-mode power supplies of 90° and 110° colour and black-and-white TV receivers.

These devices are hermetically sealed in a steel JEDEC TO-3 package.

TERMINAL DESIGNATIONS



JEDEC TO-3
(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BU126	BU133	
V_{CES}	750	750	V
V_{CEV}			
$V_{BE} = -1.5$ V	750	750	V
$V_{CEO}(sus)$	300	250	V
V_{EBO}	6	6	V
I_C	3	3	A
I_{CM}	6	6	A
I_B	2	2	A
P_T			
Up to 25°C	80	80	W
Above 25°C	Derate linearly to 200°C		
T_J, T_{stg}	–65 to 200		°C
T_L			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235		°C

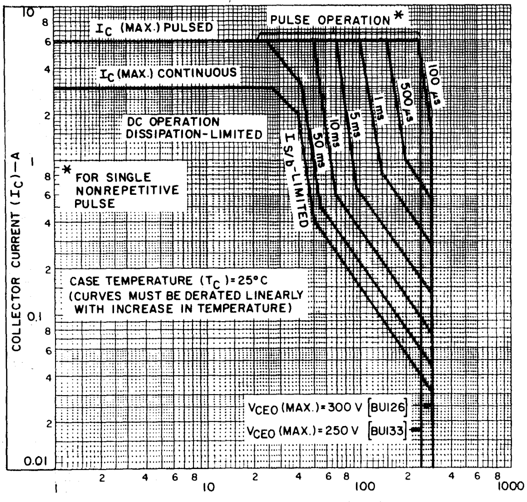


Fig. 1 – Maximum operating areas for BU126, BU133.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BU126		BU133		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CES}	750	0			–	500	–	500	µA
$T_C = 125°C$	750	0			–	2	–	2	mA
I_{EBO}		–6			–	5	–	5	mA
h_{FE}	5		1a		15	60	15	80	
$V_{CEO}(sus)$			0.1[a]	0	300[b]	–	250[b]	–	V
$V_{BE}(sat)$			4[a]	1	–	1.5	–	1.5	V
$V_{CE}(sat)$			2.5[a] 4[a]	0.25 1	– –	10 5	– –	10 5	V
$I_{S/b}$ t = 1 s nonrep.	40 200				2 50	– –	2 50	– –	V mA
f_T	10		0.2		3.5 typ.		3.5 typ.		MHz
t_s $V_{CC} = 50$ V			2.5	0.25[c]	1.5 typ.	2.4	1.5 typ.	2.4	µs
t_f $V_{CC} = 50$ V[d]			2.5	0.25[c]	0.5 typ.	0.9	0.5 typ.	0.9	µs
$R_{\theta JC}$					–	2.18	–	2.18	°C/W

[a] Pulsed: pulse duration = 300 µs, rep. rate = 50 Hz, duty factor = 2%

[b] CAUTION: The sustaining voltage $V_{CEO}(sus)$ MUST NOT be measured on a curve tracer.

[c] $I_{B_1} = I_{B_2}$

[d] Fall-time characteristics measured in a typical switched-mode power supply show an average value of 0.16 µs.

BU323, BU323A

10-Ampere N-P-N Monolithic Darlington Power Transistors

350, 400 Volts, 175 Watts
Gain of 150 at 6 A

The BU323 and BU323A are monolithic n-p-n silicon Darlington transistors designed for automotive electronic power applications..

These devices provide good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

The BU323 and BU323A are supplied in the JEDEC TO-204MA hermetic steel package.

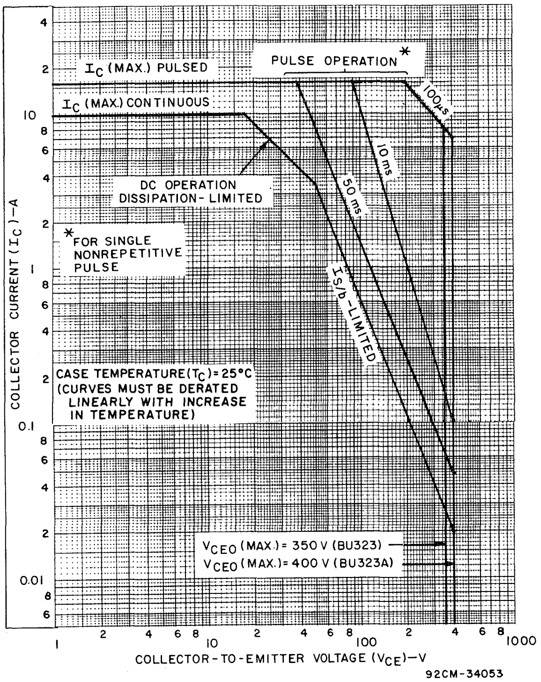


Fig. 1 — Maximum operating areas for both types.

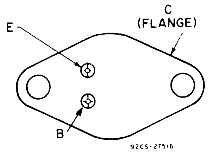
Features:

- *Operates from IC without predriver*
- *High voltage breakdown*
- *High reverse second-breakdown capability*

Applications:

- *Power switching*
- *Solenoid drivers*
- *Automotive ignition*
- *Series and shunt regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BU323	BU323A	
V_{CBO}	500	600	V
V_{CER}(sus)			
R_{BE}=100 Ω	400	475	V
V_{CEO}(sus)	350	400	V
V_{EBO}	8	8	V
I_C	10	10	A
I_{CM}	16	16	A
I_B	3	3	A
P_T			
$T_C \leq 25°C$	175	175	W
$T_C > 25°C$	See Fig. 3		
T_{stg}, T_J	-65 to +200		°C
T_L			
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235		°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) 25° C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BU323		BU323A		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER}	400				—	1	—	—	mA
R_{BE}=100 Ω	475				—	—	—	1	
I_{EBO}		-6	0		—	40	—	40	
I_{CBO}	500^b				—	1	—	—	
	600^b				—	—	—	1	
$V_{CER}(sus)$ R_{BE}=100 Ω L=500 µH			4		400	—	475	—	V
$V_{CEO}(sus)$			0.2^a	0	350	—	400	—	
h_{FE}	6		3^a		300	—	300	—	
	6		6^a		150	2000	150	2000	
	6		10^a		50	—	50	—	
$V_{CE}(sat)$			3^a	0.06^a	—	1.5	—	1.5	V
			6^a	0.12^a	—	1.7	—	1.7	
			10^a	0.30^a	—	2.7	—	2.7	
T_C=-40° C			6^a	0.12^a	—	2.0	—	2.0	
$V_{BE}(sat)$			6^a	0.12	—	2.2	—	2.2	V
			10^a	0.30	—	3	—	3	
T_C=-40° C			6^a	0.12	—	2.4	—	2.4	
$V_{BE}(On)$	6		10^a		—	2.5	—	2.5	
V_F			10^a		—	3.5	—	3.5	
C_{ob} f=100 kHz	10^b				—	350	—	350	pF
$I_C^2L/2$ (See Fig. 10)					550	—	550	—	mJ
t_s $I_{B1}=I_{B2}$	12^c		6	0.3	—	15	—	15	µs
t_f $I_{B1}=I_{B2}$	12^c		6	0.3	—	15	—	15	
$\lvert h_{fe}\rvert$ f=1 MHz	5		1		10	—	10	—	
$I_{S/b}$ t=1 s, nonrep.	50				3.5	—	3.5	—	A
$R_{\theta JC}$					—	1	—	1	°C/W

[a] Pulsed: Pulse duration=300 µs, duty factor=1.8%.
[b] V_{CB} value.
[c] V_{CC} value.

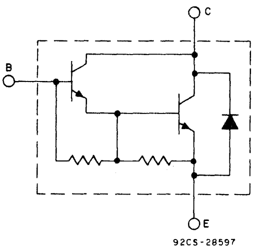


Fig. 2-Schematic diagram for both types.

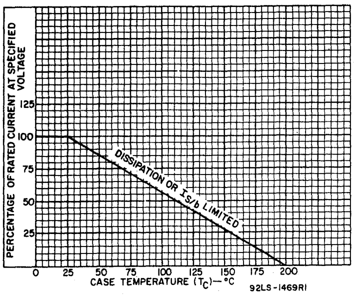


Fig. 3-Dissipation derating curve for both types.

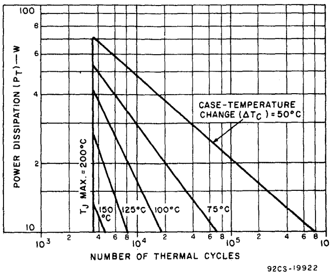


Fig. 4-Thermal-cycling rating chart for both types.

BU323, BU323A

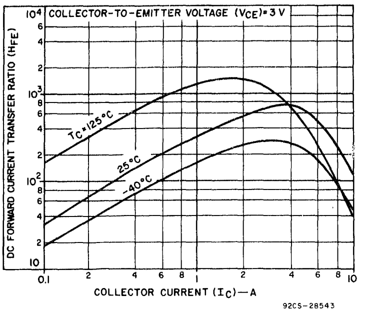


Fig. 5-Typical DC beta characteristics for both types.

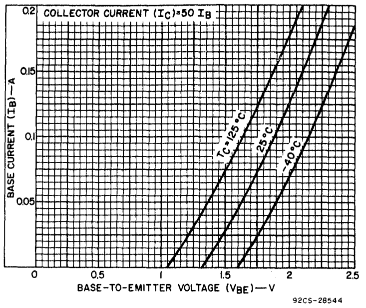


Fig. 6-Typical input characteristics for both types.

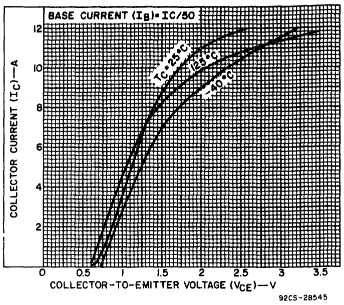


Fig. 7-Typical output characteristics for both types.

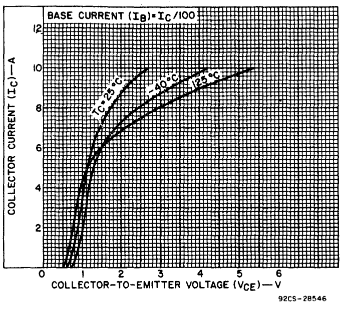
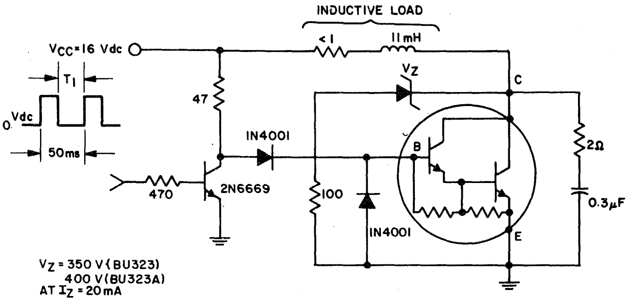


Fig. 8-Typical output characteristics for both types.



T1 TO BE SELECTED SUCH THAT IC REACHES 10 Adc BEFORE SWITCH-OFF

NOTE FIGURE 10 SPECIFIES ENERGY HANDLING CAPABILITIES FOR AN AUTOMOTIVE IGNITION CIRCUIT.

92CM-34054

Fig. 10-Ignition test circuit.

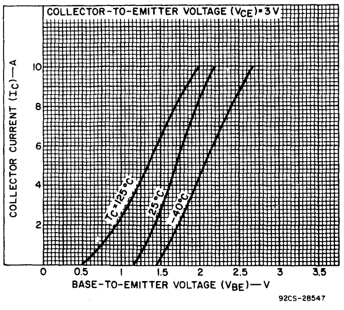


Fig. 9-Typical transfer characteristics for both types.

BUW40, BUW40A, BUW40B

1-A *SwitchMax* VERSAWATT Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-BUW40, BUW40A, and BUW40B SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

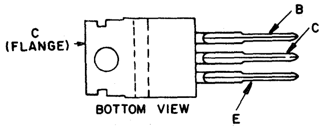
These high-voltage, high-speed transistors are 100-percent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 125° C, as well as at 25° C, to provide information necessary for worst-case design.

The RCA-BUW40, BUW40A, and BUW40B series transistors are supplied in the JEDEC TO-220AB VERSAWATT plastic package.

Features:
- *100% High-Temperature Tested for 125° C Parameters*
- *Fast Switching Speed*
- *High Voltage Ratings:* *V_{CEX}=350 V to 450 V*
- *Low V_{CE}(sat) at I_C=1 A*
- *VERSAWATT package*

Applications:
- *Off-Line Power Supplies*
- *High-Voltage Inverters*
- *Switching Regulators*

TERMINAL DESIGNATIONS

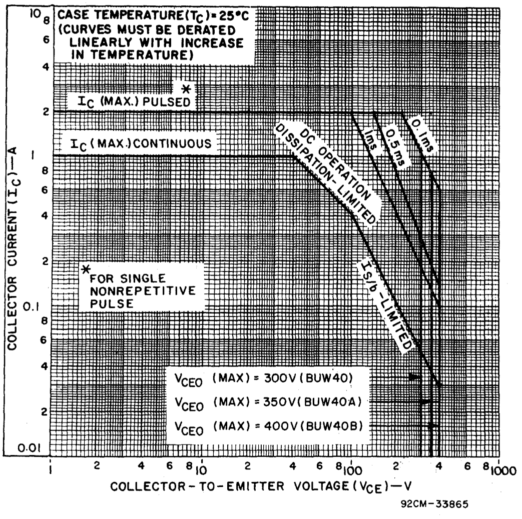


92CS-27519

(See dimensional outline "S".)

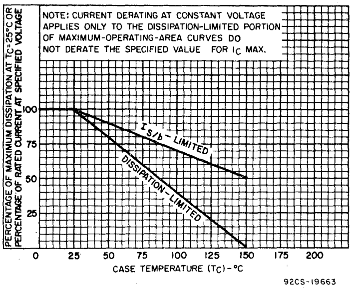
MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUW40	BUW40A	BUW40B	
V_{CER}, R_{BE}=100 Ω	350	400	450	V
V_{CEV}				
V_{BE}=−1.5 V	450	550	650	V
V_{CEX}(Clamped)				
V_{BE}=−1.5 V	350	400	450	V
V_{CEO}	300	350	400	V
V_{EBO}		8		V
I_C(sat)		1		A
I_C		1		A
I_{CM}		2		A
I_B		0.6		A
P_T				
T_C up to 25°C		40		W
T_C above 25°C, derate linearly		0.32		W/°C
T_{stg}, T_J		−65 to 150		°C
T_L				
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max.		235		°C



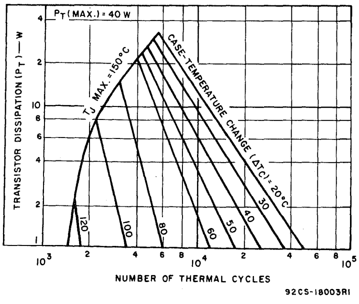
92CM-33865

Fig. 1 - Maximum operating areas for all types.



92CS-19663

Fig. 2 - Derating curve for all types.



92CS-18003R1

Fig. 3 - Thermal-cycling rating chart for all types.

BUW40, BUW40A, BUW40B

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		BUW40		BUW40A		BUW40B		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C=25° C											
I_{CEV}	450	−1.5			—	0.1	—	—	—	—	mA
	550	−1.5			—	—	—	0.1	—	—	
	650	−1.5			—	—	—	—	—	0.1	
I_{EBO}		−8	0		—	2	—	2	—	2	
V_{CEO}(sus)[b]			0.2[a]	0	300	—	350	—	400	—	V
V_{CE}(sat)			1[a]	0.2	—	1.0	—	1.0	—	1.0	
V_{BE}(sat)			1[a]	0.2	—	1.2	—	1.2	—	1.2	
h_{FE}	3		0.3[a]		20	100	20	100	20	100	
	3		1[a]		10	50	10	50	10	50	
V_{CEX}[b] (Clamped $E_{S/b}$) L=450 µH, R_{BB}=50 Ω		−5	1	0.1[e]	350	—	400	—	450	—	V
$I_{S/b}$	100		0.4		0.5	—	0.5	—	0.5	—	s
$\|h_{fe}\|$ f=1 MHz	10		0.2		10	50	10	50	10	50	
f_T	10		0.2		10	50	10	50	10	50	MHz
C_{obo} f=0.1 MHz	10[c]				20	60	20	60	20	60	pF
t_d[d]			1	0.2	—	0.05	—	0.05	—	0.05	µs
t_r[d]			1	0.2	—	0.2	—	0.2	—	0.2	
t_s[d]			1	0.2[e]	—	2.5	—	2.5	—	2.5	
t_f[d]			1	0.2[e]	—	0.4	—	0.4	—	0.4	
t_c V_{CC}=200 V, L=450 µH, R_C=200 Ω Collector clamped to V_{CEX}			1	0.2[e]	—	0.4	—	0.4	—	0.4	
T_C=125° C											
I_{CEV}	450	−1.5			—	1	—	—	—	—	mA
	550	−1.5			—	—	—	1	—	—	
	650	−1.5			—	—	—	—	—	1	
V_{CE}(sat)			1[a]	0.2	—	2	—	2	—	2	V
t_r[d]			1	0.2	—	0.5	—	0.5	—	0.5	µs
t_s[d]			1	0.2[e]	—	4.5	—	4.5	—	4.5	
t_f[d]			1	0.2[e]	—	1.3	—	1.3	—	1.3	
t_c V_{CC}=200 V, L=450 µH, R_C=200 Ω Collector clamped to V_{CEX}			1	0.2[e]	—	1.3	—	1.3	—	1.3	
$R_{\theta JC}$	20		1		—	3.12	—	3.12	—	3.12	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

[a] Pulsed: pulse duration = 300 µs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltage V_{CEO}(sus) and V_{CEX} MUST NOT be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 200 V, t_p = 20 µs.

[e] $I_{B1} = -I_{B2}$.

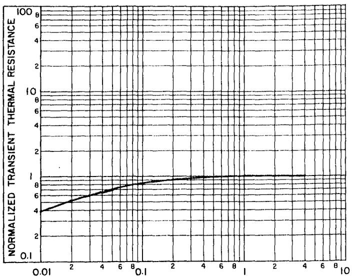


Fig. 4 - Typical thermal-response characteristics for all types.

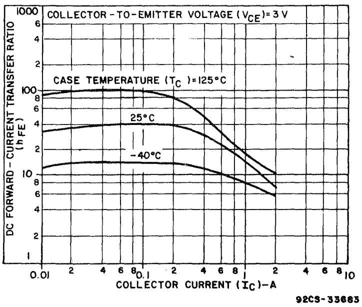


Fig. 5 - Typical dc beta characteristics for all types.

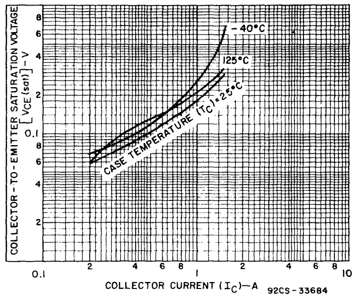


Fig. 6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

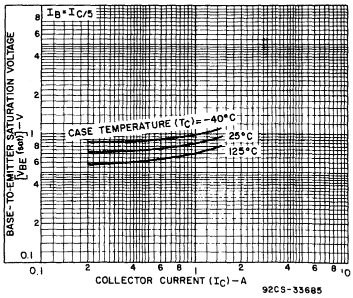


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current for all types.

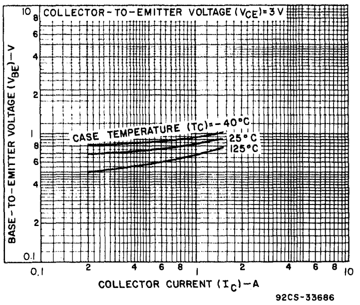


Fig. 8 - *Typical base-to-emitter voltage as a function of collector current for all types.*

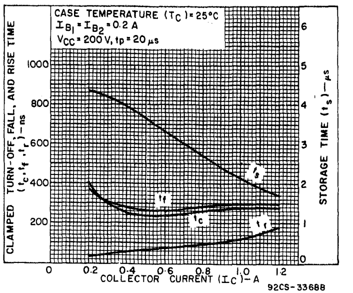


Fig. 9 - *Typical saturated switching time characteristics for all types.*

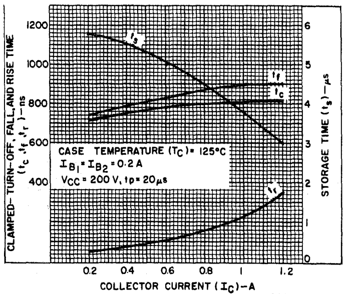


Fig. 10 - *Typical saturated-switching-time characteristics as a function of collector current for all types.*

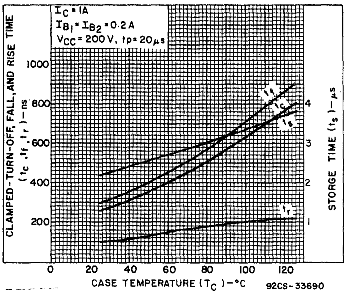


Fig. 11 - *Typical saturated-switching-time characteristics as a function of case temperature for all types.*

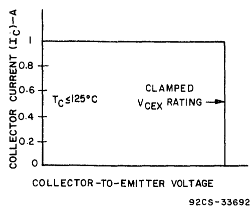


Fig. 12 - *Maximum operating conditions for switching between saturation and cutoff.*

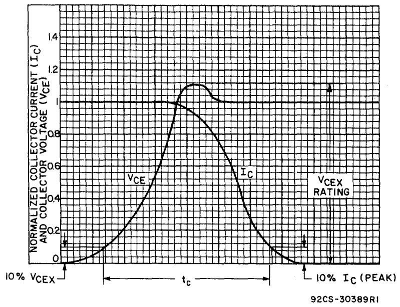
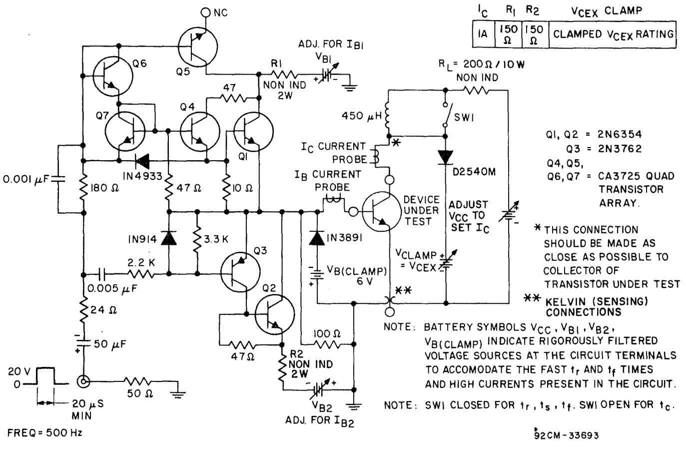


Fig. 13 - *Oscilloscope display for measurement of clamped induction switching time (t_c).*



I_C	R_1	R_2	V_{CEX} CLAMP
1A	150 Ω	150 Ω	CLAMPED V_{CEX} RATING

Q1, Q2 = 2N6354
Q3 = 2N3762
Q4, Q5, Q6, Q7 = CA3725 QUAD TRANSISTOR ARRAY.

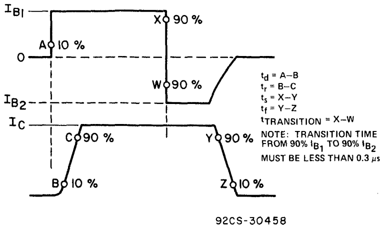
* THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

** KELVIN (SENSING) CONNECTIONS

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

Fig. 14 - *Circuit for measuring switching times.*

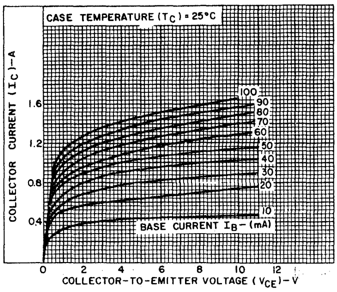


t_d = A–B
t_r = B–C
t_s = X–Y
t_f = Y–Z
$t_{TRANSITION}$ = X–W

NOTE: TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} MUST BE LESS THAN 0.3 μs

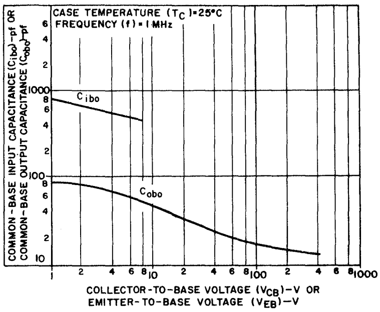
Fig. 15 - *Phase relationship between input and output currents showing reference points for specification of switching times.*

BUW40, BUW40A, BUW40B



92CS-33687

Fig. 16 - Typical output characteristics for all types.



92CS-33691

Fig. 17 - Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

BUW41, BUW41A, BUW41B

5-A SwitchMax Power Transistors

High Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-BUW41, BUW41A and BUW41B SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 125° C, as well as at 25° C, to provide information necessary for worst-case design.

The BUW41, BUW41A and BUW41B series transistors are supplied in JEDEC TO-220AB (RCA VERSAWATT) plastic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUW41	BUW41A	BUW41B	
V_{CER}, R_{BE} = 100Ω	350	400	450	V
V_{CEV}				
V_{BE} = −1.5 V	450	550	650	V
V_{CEX} (clamped)				
V_{BE} = −1.5 V	350	400	450	V
V_{CEO}	300	350	400	V
V_{EBO}		8		V
I_C(sat)		5		A
I_C		8		A
I_{CM}		10		A
I_B		4		A
P_T				
T_C up to 25°C		100		W
T_C above 25°C, derate linearly		0.8		W/°C
T_{stg}, T_J		-65 to 150		°C
T_L				
At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.		235		°C

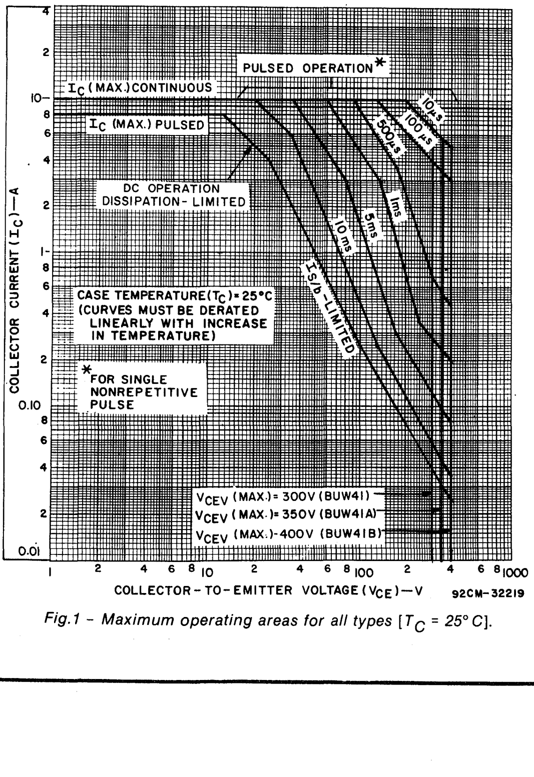


Fig.1 - Maximum operating areas for all types [T_C = 25° C].

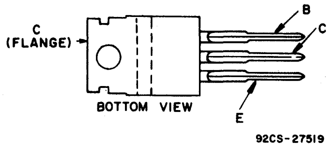
Features:

- *100% High-Temperature Tested for 125° C Parameters*
- *Fast Switching Speed*
- *High Voltage Ratings: V_{CEX} = 350 V to 450 V*
- *Low V_{CE}[sat] at I_C = 5 A*
- *VERSAWATT PACKAGE*

Applications

- *Off-Line Power Supplies*
- *High-Voltage Inverters*
- *Switching Regulators*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

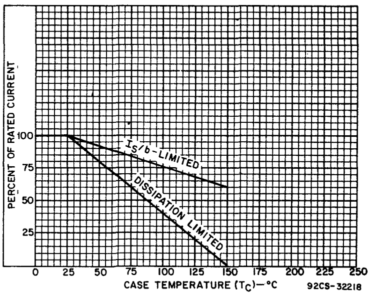


Fig.2 - Dissipation and $I_{S/b}$ derating curves for all types.

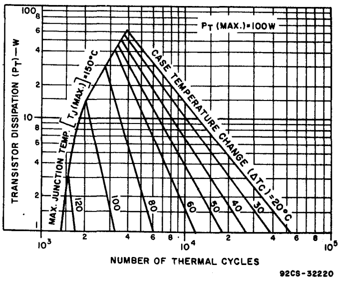


Fig.3 - Thermal-cycling chart for all types.

BUW41, BUW41A, BUW41B

ELECTRICAL CHARACTERISTICS

T_C = 25° C

Characteristic	Test Conditions Voltage V dc V_{CE}	 V_{BE}	Current A dc I_C	 I_B	Limits BUW41 Min.	 Max.	 BUW41A Min.	 Max.	 BUW41B Min.	 Max.	Units
I_{CEV}	450 550 650	—1.5 —1.5 —.5			— — —	0.1 — —	— — —	— 0.1 —	— — —	— — 0.1	mA
I_{IEBO}		—8	0		—	2	—	2	—	2	
$V_{CEO}(sus)^b$			0.2ᵃ	0'	300	—	350	—	400	—	V
h_{FE}	3		5ᵃ		10	40	10	40	10	40	
$V_{BE}(sat)$			5ᵃ	1	—	1.6	—	1.6	—	1.6	V
$V_{CE}(sat)$			5ᵃ 8ᵃ	1 4	— —	1 2	— —	1 2	— —	1 2	
V_{CEX}^b (Clamped $E_{S/b}$) L = 170 μH		—5	5	1ᵉ	350	—	400	—	450	—	
R_{BB} = 5 Ω		—5	8	3ᵉ	200	—	250	—	300	—	
$I_{S/b}$	25		4		0.5	—	0.5	—	0.5	—	s
$\|h_{fe}\|$ f=5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
C_{obo} f=0.1 MHz	10ᶜ				50	300	50	300	50	300	pF
t_d^d			5	1	—	0.1	—	0.1	—	0.1	
t_r^d			5	1	—	0.5	—	0.5	—	0.5	
t_s^d			5	1ᵉ	—	2.5	—	2.5	—	2.5	
t_f^d			5	1ᵉ		0.4	—	0.4	—	0.4	
t_c V_{CC}= 125 V, L=170 μH, R_C = 25 Ω Collector clamped to V_{CEX}			5	1ᵉ	—	0.4	—	0.4	—	0.4	μs

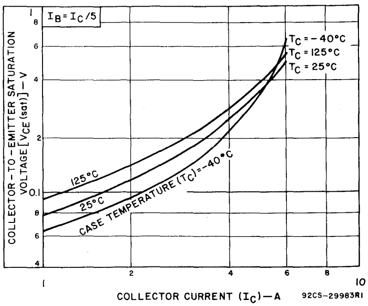


Fig.6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

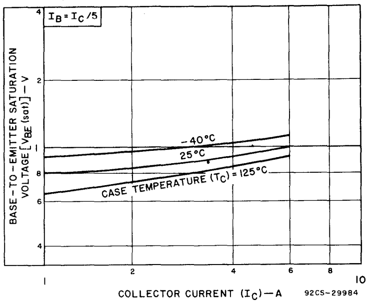


Fig.7 - Typical base-to-emitter saturation voltage as a function of collector current for all types.

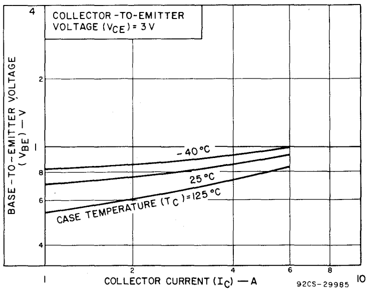


Fig.8 - Typical base-to-emitter voltage as a function of collector current for all types.

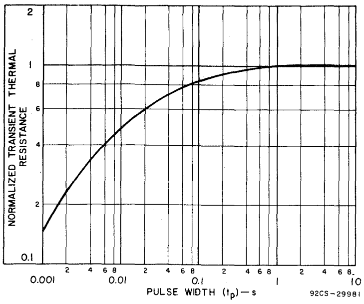


Fig.4 - Typical thermal-response characteristic for all types.

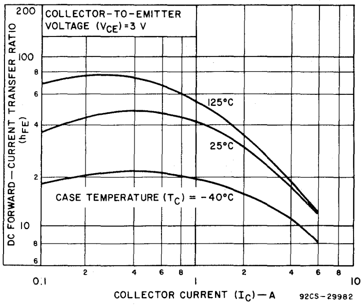


Fig.5 - Typical dc beta characteristics for all types.

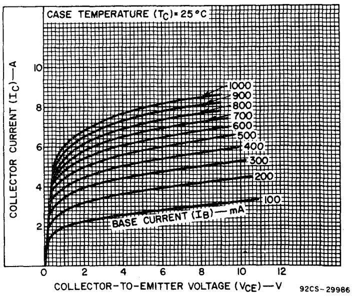


Fig.9 - Typical output characteristics for all types.

BUW41, BUW41A, BUW41B

ELECTRICAL CHARACTERISTICS Continued

Characteristic	Test Conditions				Limits						Units
	Voltage V dc		Current A dc		BUW41		BUW41A		BUW41B		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C = 125° C											
I_{CEV}	450	−1.5			—	1	—	—	—	—	mA
	550	−1.5			—	—	—	1	—	—	
	650	−1.5			—	—	—	—	—	1	
V_{CE}(sat)			5^a	1	—	2	—	2	—	2	V
$t_r{}^d$			5	1	—	0.8	—	0.8	—	0.8	μs
$t_s{}^d$			5	1^e	—	4	—	4	—	4	
$t_f{}^d$			5	1^e	—	0.8	—	0.8	—	0.8	
t_c V_{CC}= 125 V, L=170 μH, R_C = 25 Ω Collector clamped to V_{CEX}			5	1^e	—	0.8	—	0.8	—	0.8	

$R_{\theta JC}$					—	1.25	—	1.25	—	1.25	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

[a] Pulsed: pulse duration = 300 μs, duty factor ≤2%.

[b] CAUTION: The sustaining voltage V_{CEO}(sus) and V_{CEX} MUST NOT be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC}=125 V, t_p=20 μs.

[e] I_{B1}= $-I_{B2}$.

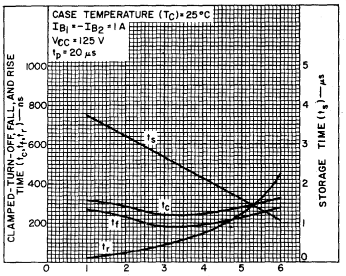


Fig.10 - Typical saturated switching time characteristics for all types.

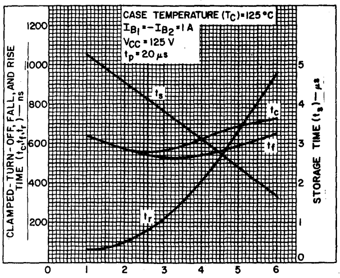


Fig.11 - Typical saturated switching time characteristics for all types.

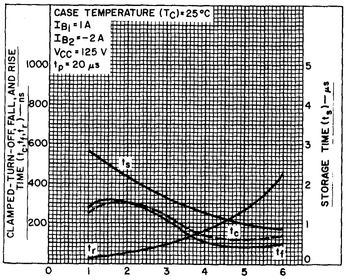


Fig.12 - Typical saturated switching time characteristics for all types.

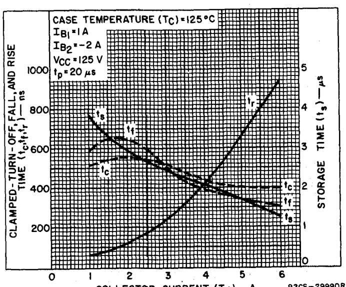


Fig.13 - Typical saturated switching time characteristics for all types.

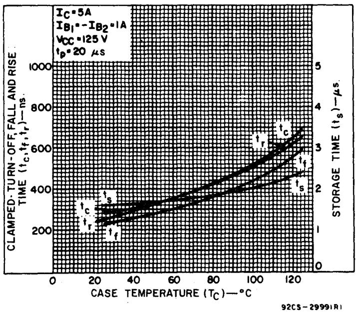


Fig.14 - Typical saturated switching time characteristics as a function of case temperature for all types.

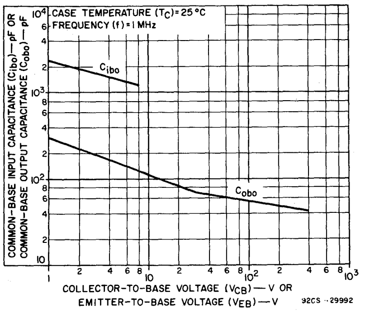


Fig.15 - Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

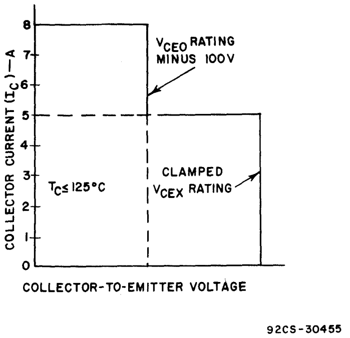


Fig.16 - Maximum operating conditions for switching between saturation and cutoff.

BUW41, BUW41A, BUW41B

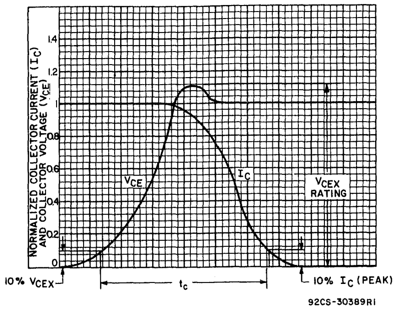


Fig.17 - Oscilloscope display for measurement of clamped induction switching time [t_c].

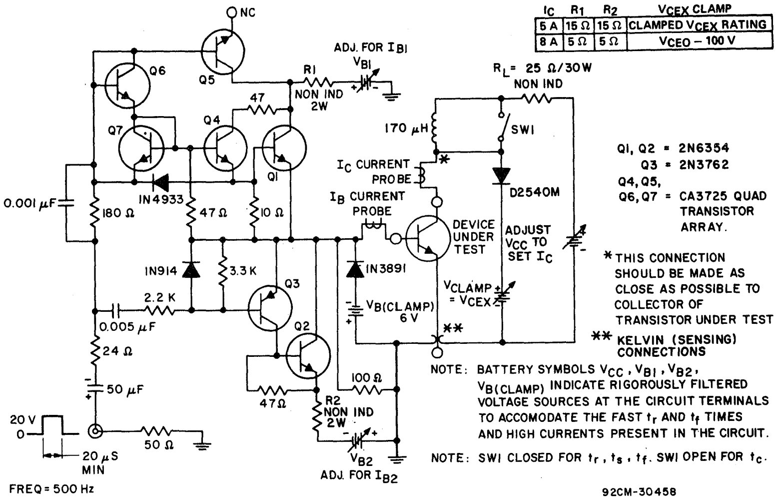


Fig.18 - Circuit for measuring switching times.

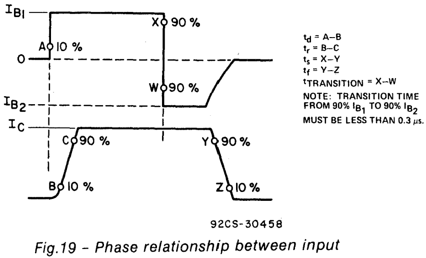


Fig.19 - Phase relationship between input and output currents showing reference points for specification of switching times.

BUW64A, BUW64B, BUW64C

High-Current, Silicon N-P-N VERSAWATT Transistors

Switching Applications

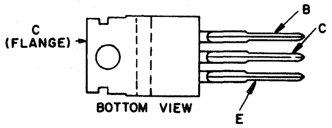
RCA-BUW64A, BUW64B, and BUW64C epitaxial-base silicon n-p-n power transistors feature fast switching speeds, low saturation voltages, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits.

The BUW64A, BUW64B and BUW64C transistors are supplied in the JEDEC TO-220AB (RCA VERSAWATT) plastic packages.

Features:

- Fast switching speed at temperatures up to 125°C
- Low V_{CE}(sat)
- VERSAWATT plastic package

TERMINAL DESIGNATIONS



JEDEC TO-220AB 92CS-27519

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUW64A	BUW64B	BUW64C	
V_{CEV}				
$V_{BE} = -1.5$ V	140	160	180	V
V_{CEO}	90	110	130	V
V_{EBO}		7		V
I_C(sat)	5	5	4	A
I_C		7		A
I_{CM}		10		A
I_B		5		A
P_T				
T_C up to 25°C		50		W
T_C above 25°C, derate linearly		0.4		W/°C
T_{stg}, T_J		−65 to 150		°C
T_L				
At distance ⩾ 1/8 in. (3.16 mm) from seating plane for 10 s max.		235		°C

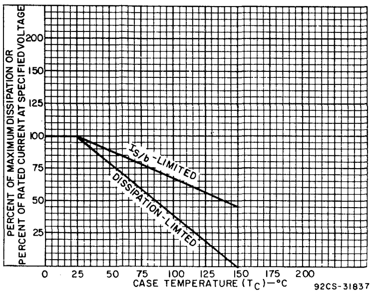


Fig. 1 — Dissipation and $I_{S/b}$ derating curves for all types.

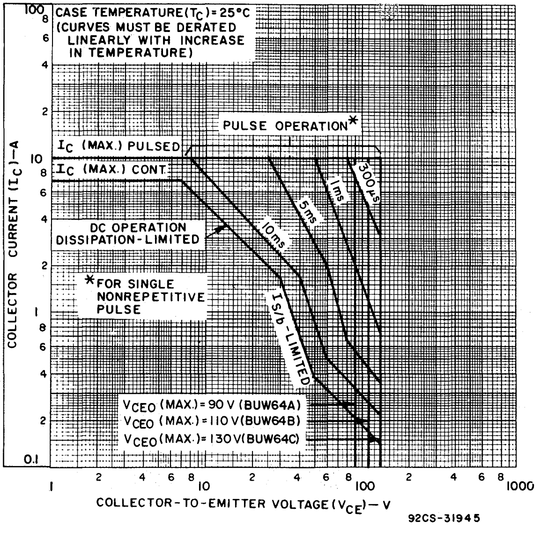


Fig. 2 — Maximum operating areas for all types ($T_C = 25°C$).

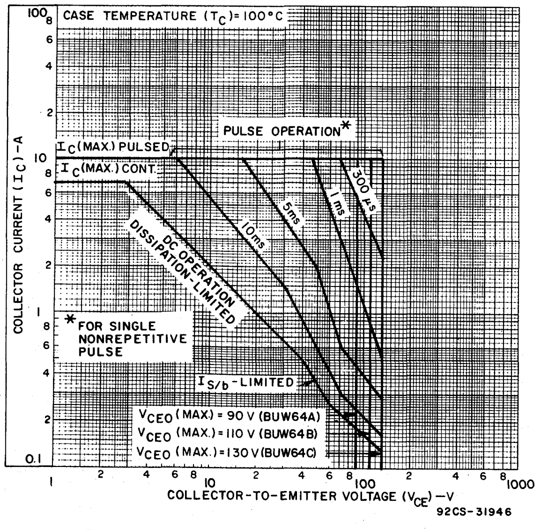


Fig. 3 — Maximum operating areas for all types ($T_C = 100°C$).

BUW64A, BUW64B, BUW64C

ELECTRICAL CHARACTERISTICS, at Case Temperature T_C = 25°C Unless Otherwise Specified

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		BUW64A		BUW64B		BUW64C		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEV}	140	−1.5			–	100	–	–	–	–	μA
	160	−1.5			–	–	–	100	–	–	
	180	−1.5			–	–	–	–	–	100	
T_C = 125°C	140	−1.5			–	1	–	–	–	–	mA
	160	−1.5			–	–	–	1	–	–	
	180	−1.5			–	–	–	–	–	1	
I_{EBO}		−7	0		–	100	–	100	–	100	μA
$V_{CEO}(sus)$[b]			0.01[a]	0	90	–	110	–	130	–	V
h_{FE}	2		0.2[a]		30	–	30	–	30	–	
	2		4[a]		–	–	–	–	20	–	
	2		5[a]		20	–	20	–	–	–	
$V_{BE}(sat)$			4[a]	0.4	–	–	–	–	–	1.4	V
			5[a]	0.5	–	1.5	–	1.5	–	–	
$V_{CE}(sat)$			4[a]	0.4	–	–	–	–	–	0.7	
			5[a]	0.5	–	0.8	–	0.8	–	–	
			7[a]	0.7	–	1.5	–	1.5	–	1.5	
$I_{S/b}$	20		2.5		1	–	1	–	1	–	s
$\|h_{fe}\|$ f = 5 MHz	10		0.5		10	40	10	40	10	40	
f_T	10		0.5		50	200	50	200	50	200	MHz
C_{obo} f = 0.1 MHz	10[c]				50	150	50	150	50	150	pF
t_d[d]		−4	4	0.4	–	–	–	–	–	0.1	μs
			5	0.5	–	0.1	–	0.1	–	–	
t_r[d]		−4	4	0.4	–	–	–	–	–	0.25	
			5	0.5	–	0.25	–	0.25	–	–	
t_s[d]		−4	4	0.4[e]	–	–	–	–	–	1	
			5	0.5[e]	–	1	–	1	–	–	
t_f[d]		−4	4	0.4[e]	–	–	–	–	–	0.5	
			5	0.5[e]	–	0.5	–	0.5	–	–	
$R_{\theta JC}$	4		5		–	2.5	–	2.5	–	2.5	°C/W

[a] Pulsed: pulse duration = 300 μs, duty factor ⩽2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 70 V, t_p = 20 μs

[e] $I_{B_1} = -I_{B_2}$.

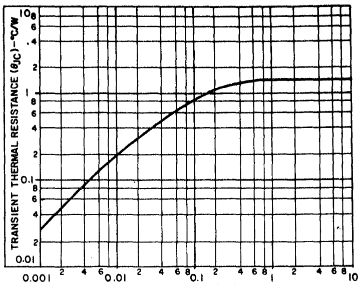


Fig. 4 – Typical thermal-response characteristic for all types.

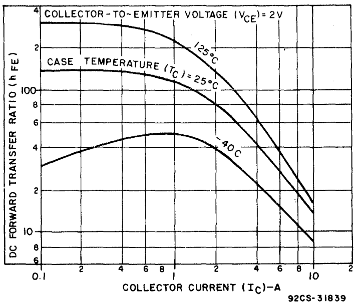


Fig. 5 – Typical dc beta characteristics for all types.

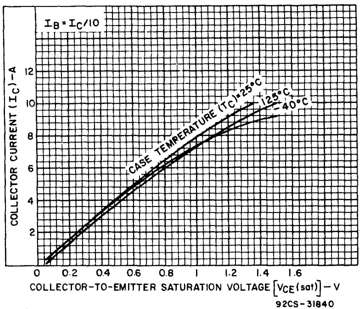


Fig. 6 – Typical collector-to-emitter saturation voltage characteristics for all types.

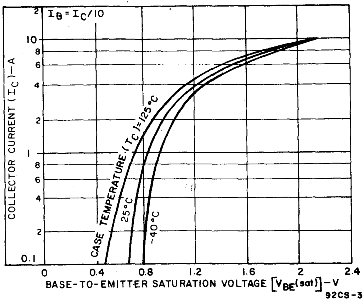


Fig. 7 – Typical base-to-emitter saturation voltage characteristic for all types.

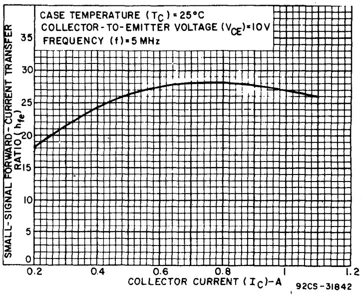


Fig. 8 – Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

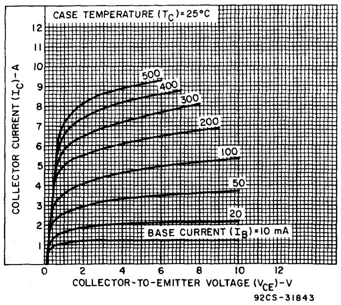


Fig. 9 – Typical output characteristics for all types.

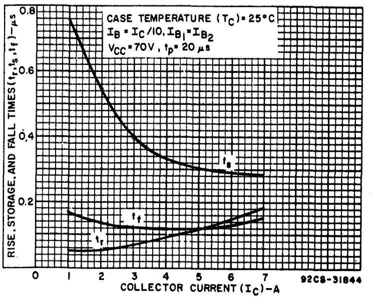


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 25°C).

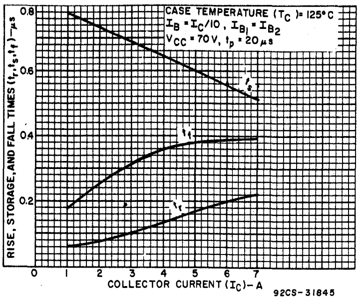


Fig. 11 — Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 125°C).

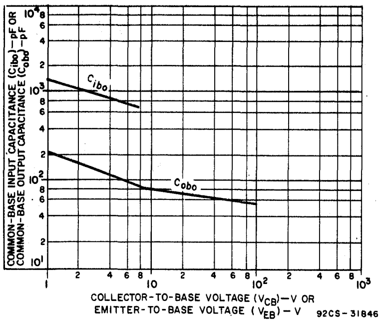


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

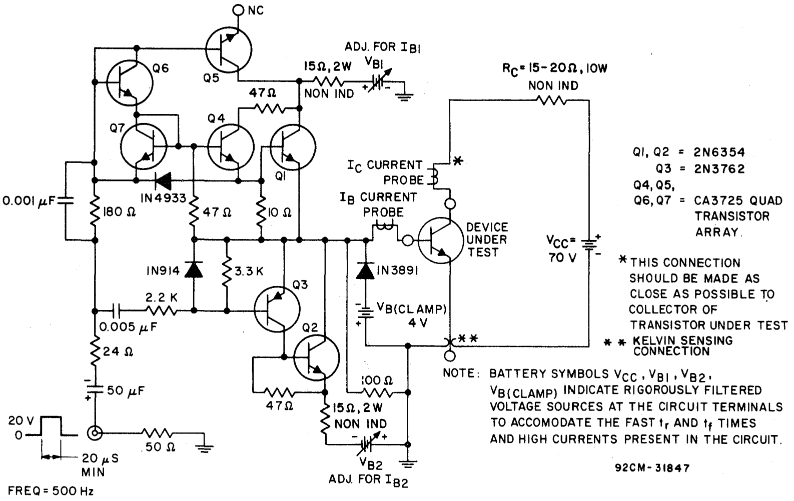


Fig. 13 — Circuit for measuing switching times.

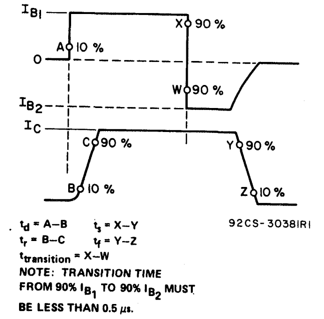


Fig. 14 — Phase relationship between input and output currents showing reference points for specification of switching times.

BUX10A

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistor

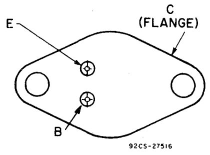
Features:

V_{CEO} — — 125 V
IC — — 25 A
P_T — —150 W

The RCA-BUX10A is an epitaxial silicon n-p-n transistor having high-voltage and high-current capabilities and featuring fast-switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers.

The RCA-BUX10A is supplied in a steel JEDEC TO-204MA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

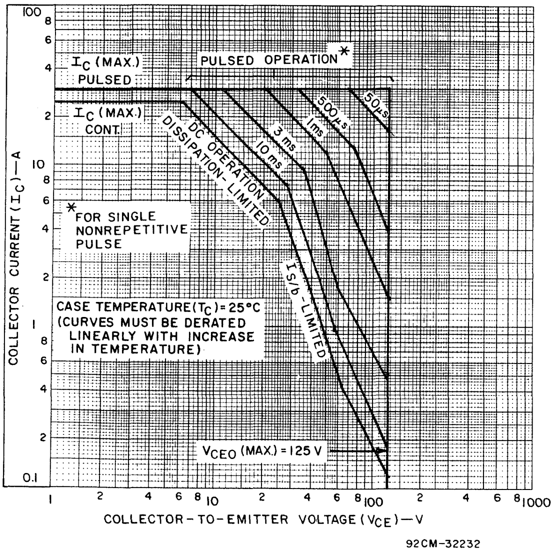
(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX10A	
V_{CBO}	170	V
V_{CER} $R_{BE} = 100\,\Omega$	160	V
V_{CEO}	125	V
V_{CEX} $V_{BE} = -1.5$ V	170	V
V_{EBO}	7	V
I_C	25	A
I_{CM}	30	A
I_B	5	A
P_T $T_C \leq 25°C$	150	W
$T_C > 25°C$ derate linearly	0.86	W/°C
T_{stg}, T_J	−65 to +200	°C
T_J At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max	235	°C

THERMAL FATIGUE INSPECTION

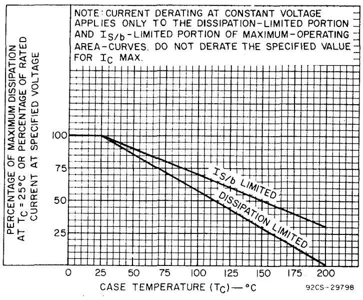
Pulsed test:
20,000 cycles
"on": 2 minutes at 56 Watts P_T
"off": 1 minute at 0 Watts P_T
T_C = 125°C max.
ΔT_C = 50°C max.
T_J = 175°C max.



*FOR SINGLE NONREPETITIVE PULSE

CASE TEMPERATURE (T_C) = 25°C (CURVES MUST BE DERATED LINEARLY WITH INCREASE IN TEMPERATURE)

Fig. 1—Maximum safe-operating areas (T_C = 25°C).



NOTE: CURRENT DERATING AT CONSTANT VOLTAGE APPLIES ONLY TO THE DISSIPATION-LIMITED PORTION AND $I_{S/b}$-LIMITED PORTION OF MAXIMUM-OPERATING AREA-CURVES. DO NOT DERATE THE SPECIFIED VALUE FOR I_C MAX.

Fig. 2—Derating curves for $I_{S/b}$ and dissipation.

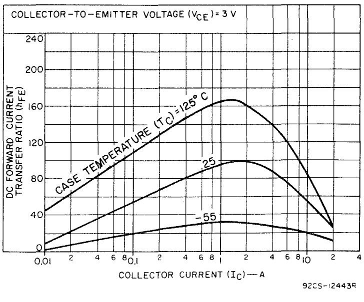


Fig. 3—Typical dc beta characteristics.

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C*
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX10A			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	125			0	—	—	5	mA
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	—	V
I_{EBO}		−5	0		—	—	1	mA
$V_{CEO}(sus)^b$			0.2[a]	0	125	—	—	V
$V_{CER}(sus)^b$ R_{BE} = 100 Ω			0.2[a]		160	—	—	
h_{FE}	2 4		10 20		20 10	— —	70 —	
$V_{BE}(sat)$			20[a]	2	—	1.5	2	V
$V_{CE}(sat)$			10[a] 20[a]	1 2	— —	0.3 0.7	0.6 1.5	
f_T f = 10 MHz	10		2		50	—	—	MHz
$I_{S/b}$ t = 1s, nonrepetitive	25				6	—	—	A
t_{ON}	V_{CE} = 30 V		20	2	—	1	1.5	μs
t_s $I_{B1} = I_{B2}$			20	2	—	0.6	1.2	
t_f $I_{B1} = I_{B2}$			20	2	—	0.15	0.2	
$R_{\theta JC}$					—	—	1.17	°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

[b] **CAUTION:** The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ *MUST NOT* be measured on a curve tracer.

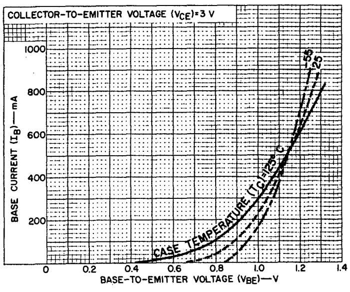


Fig. 4—Typical input characteristics.

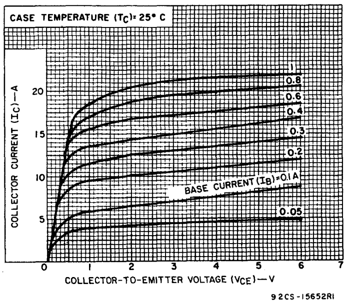


Fig. 5—Typical output characteristics.

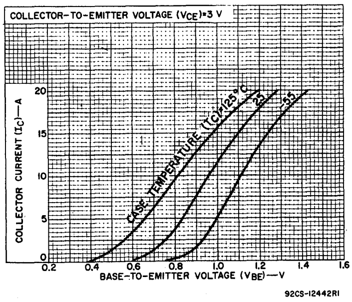


Fig. 6—Typical transfer characteristics.

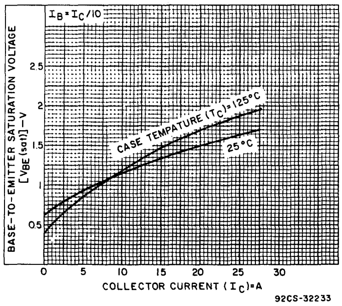


Fig. 7—Typical base-to-emitter saturation voltage characteristics.

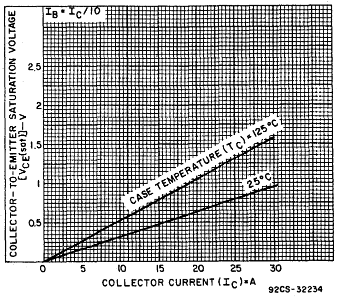


Fig. 8—Typical collector-to-emitter saturation voltage characteristics.

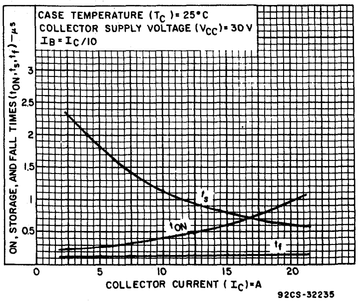


Fig. 9—Typical switching time characteristics.

BUX11, BUX11N

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistors

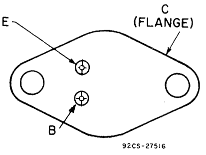
The RCA-BUX11 and -BUX11N are epitaxial-base silicon n-p-n transistors having high-voltage and high-current capabilities and featuring fast switching speed at low saturation voltage. They are especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers.

The RCA-BUX11 and -BUX11N are supplied in a steel JEDEC TO-204MA hermetic package.

Features:

	BUX11	BUX11N
V_{CEO} ——	*200 V*	*160 V*
I_C ——	*20 A*	*20 A*
P_T ——	*150 W*	*150 W*

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX11	BUX11N	
V_{CBO}	250	220	V
V_{CER}			
R_{BE} = 100 Ω	240	200	V
V_{CEO}	200	160	V
V_{CEX}			
V_{BE} = −1.5 V	250	220	V
V_{EBO}	7	7	V
I_C	20	20	A
I_{CM}	25	25	A
I_B	4	5	A
P_T			
$T_C \leq 25°C$	150	150	W
$T_C > 25°C$ derate linearly	0.86	0.86	W/°C
T_{stg}, T_J	−65 to +200	−65 to +200	°C
T_L			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	235	°C

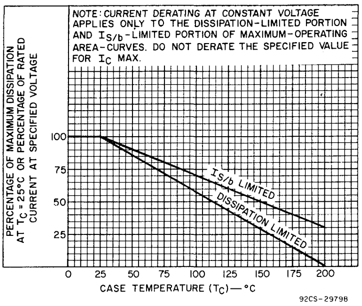


Fig. 1—Derating curves for $I_{S/b}$ and dissipation.

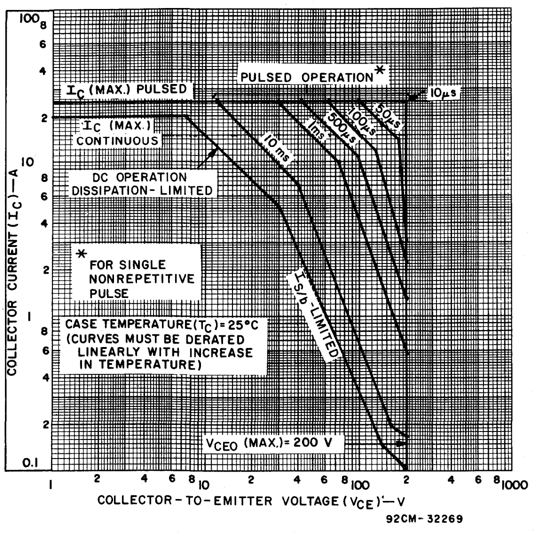


Fig. 2—Maximum safe-operating areas for BUX11 (T_C = 25°C).

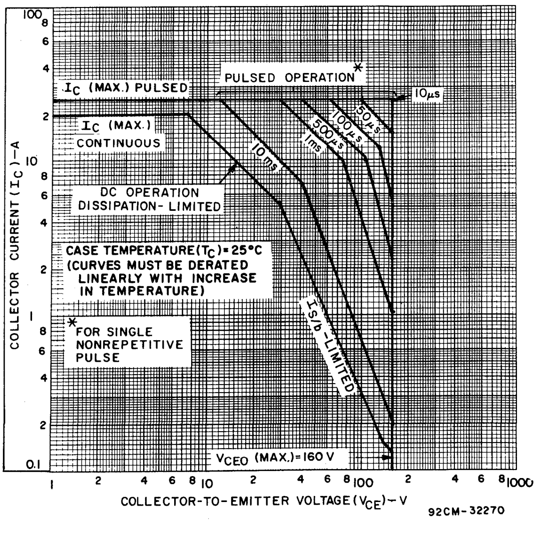


Fig. 3—Maximum safe-operating areas for BUX11N (T_C = 25°C).

BUX11, BUX11N

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BUX11		BUX11N		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	160 130			0 0	— —	1.5 —	— —	— 1.5	mA
I_{CEX}	250 220	−1.5 −1.5			— —	1.5 —	— —	— 1.5	
I_{CEX} T_C = 125°C	250 220	−1.5 −1.5			— —	6 —	— —	— 6	
I_{EBO}		−5			—	1	—	1	
$V_{CEO}(sus)^a$			0.2^b		200	—	160	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	7	—	
h_{FE}	2 4 2 4		6^b 12^b 8^b 15^b		20 10 — —	60 — — —	— — 20 10	— — 60 —	
$V_{BE}(sat)$			12^b 15^b	1.5 1.88	— —	1.5 —	— —	— 1.8	V
$V_{CE}(sat)$			6^b 12^b 8^b 15^b	0.6 1.5 0.8 1.88	— — — —	0.6 1.5 — —	— — — —	— — 0.6 1.5	
$I_{S/b}$ tp = 1s nonrep.	140 30				0.15 5	— —	0.15 5	— —	A
f_T	15		1	—	8	—	8	—	MHz
t_{ON}	150^c 30^c		12 15	1.5 1.88	— —	1 —	— —	— 1.5	μs
t_s $I_{B1} = I_{B2}$	150^c 30^c		12 15	1.5 1.88	— —	1.8 —	— —	— 1.5	
t_f $I_{B1} = I_{B2}$	150^c 30^c		12 15	1.5 1.88	— —	0.4 —	— —	— 0.5	
$R_{\theta JC}$					—	1.17	—	1.17	°C/W

[a] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

[b] Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

[c] V_{CC}.

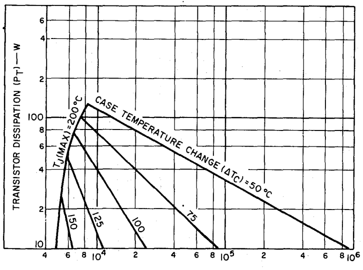


Fig. 4—Thermal-cycling chart for both types.

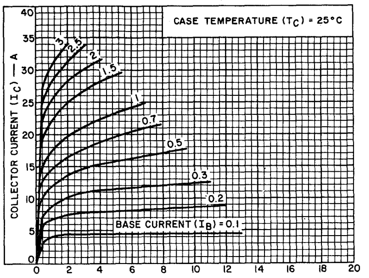


Fig. 5—Typical output characteristics for both types.

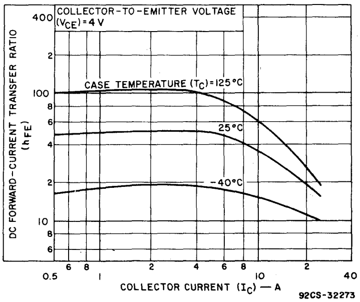


Fig. 6—Typical dc beta characteristics for both types.

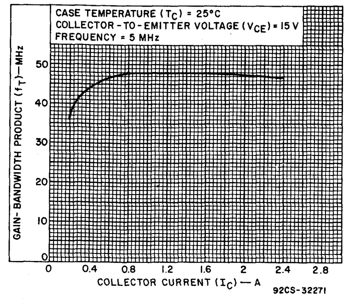


Fig. 7—Typical gain-bandwidth product for both types.

BUX11, BUX11N

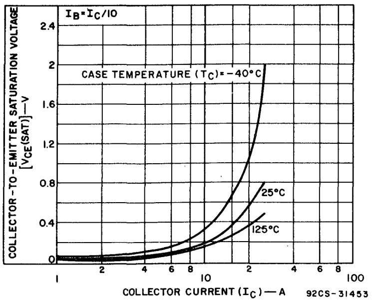


Fig. 8—Typical collector-to-emitter saturation voltage characteristics for both types.

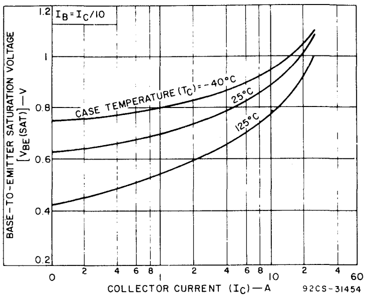


Fig. 9—Typical base-to-emitter saturation voltage characteristics for both types.

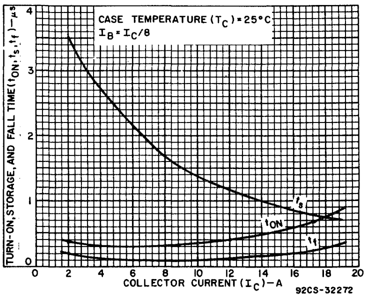


Fig. 10—Typical saturated-switching times as a function of collector current for both types.

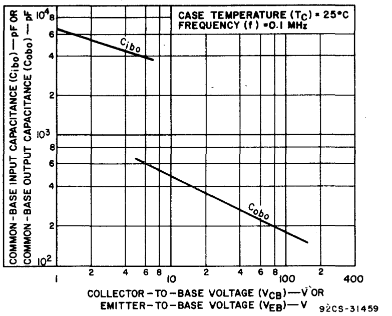


Fig. 11—Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for both types.

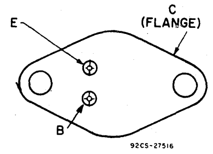
BUX12

High-Voltage, High-Current, Silicon N-P-N Power-Switching Transistor

Features:

V_{CEO} — 250V
I_C — 20 A
P_T — 150 W

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

The RCA-BUX12 is an epitaxial-base silicon n-p-n transistor having high-voltage and high-current capabilities and featuring fast-switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers. The RCA-BUX12 is supplied in a steel JEDEC TO-204MA hermetic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX12	
V_{CBO}	300	V
V_{CER} R_{BE} = 100Ω	290	V
V_{CEO}	250	V
V_{CEX} V_{BE} = −1.5 V	300	V
V_{EBO}	7	V
I_C	20	A
I_{CM}	25	A
I_B	4	A
P_T		
$T_C \leqslant 25°C$	150	W
$T_C > 25°C$ derate linearly	0.86	W/°C
T_{stg}, T_J	−65 to +200	°C
T_L		
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

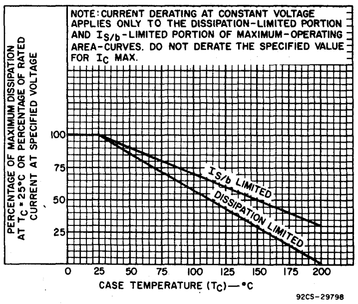


Fig. 2—Derating curves for $I_{S/b}$ and dissipation.

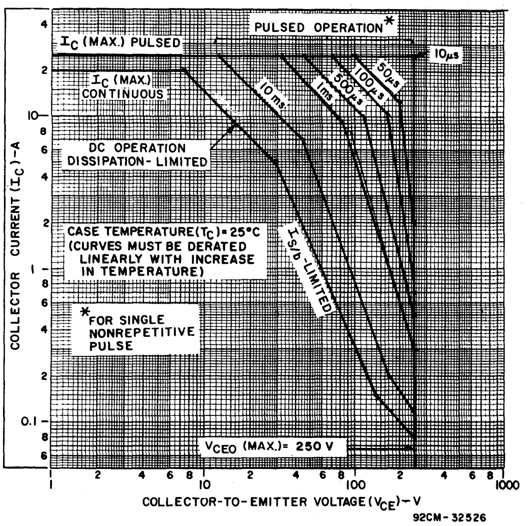


Fig. 1—Maximum safe-operating areas for BUX12 (T_C = 25°C).

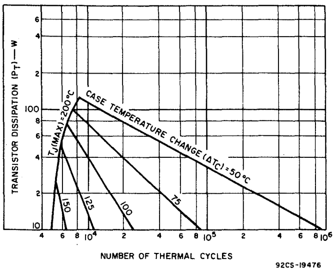


Fig. 3—Thermal-cycling chart.

BUX12

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX12			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	200	—	—	0	—	—	1.5	mA
I_{CEX}	300	—1.5	—	—	—	—	1.5	
T_C = 125°C	300	—1.5	—	—	—	—	6	
I_{EBO}	—	—5	0	—	—	—	1	
$V_{CEO}(sus)$[b]	—	—	0.2[a]	0	250[a]	—	—	V
$V_{(BR)EBO}$ I_E = 0.05 A	—	—	0	—	7	—	—	V
$V_{BE}(sat)$	—	—	10[a]	1.25	—	1	1.5	
$V_{CE}(sat)$	—	—	5[a]	0.5	—	0.2	1	
	—	—	10[a]	1.25	—	0.3	1.5	
h_{FE}	4	—	5[a]	—	20	—	60	
	4	—	10[a]	—	10	—	—	
$I_{S/b}$	140	—	—	—	0.15	—	—	A
t = 1 s, nonrepetitive	30	—	—	—	5	—	—	
f_T	15	—	1	—	8	—	—	MHz
t_{ON}	V_{CC} = 150 V	—	10	1.25	—	0.5	1	μs
t_s		—	10	1.25[c]	—	1.5	2	
t_f		—	10	1.25[c]	—	0.2	0.5	
$R_{\theta JC}$	—	—	—	—	—	—	1.17	°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ⩽ 2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

[c] $I_{B_1} = I_{B_2}$.

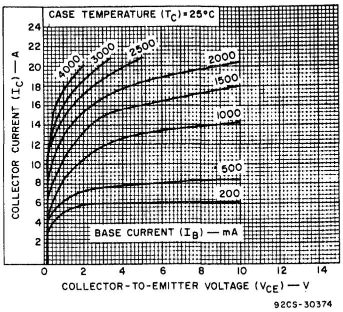


Fig. 4—Typical output characteristics.

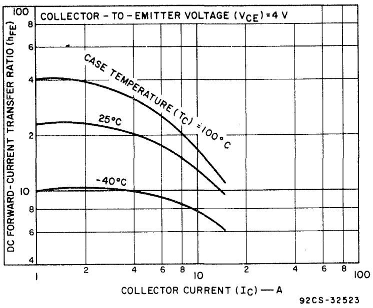


Fig. 5—Typical dc beta characteristics.

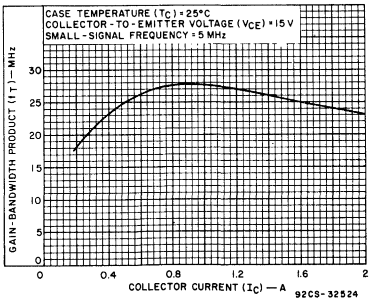


Fig. 6—Typical gain-bandwidth product characteristic.

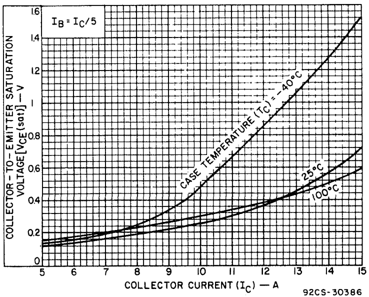


Fig. 7—Typical collector-to-emitter saturation voltage characteristics.

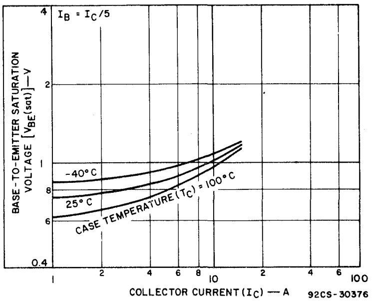


Fig. 8—Typical base-to-emitter saturation voltage characteristics.

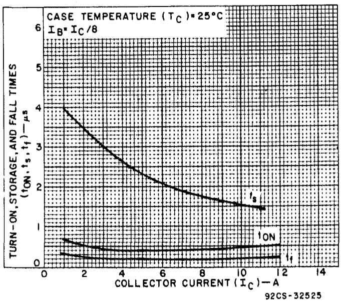


Fig. 9—Typical saturated-switching times as a function of collector current.

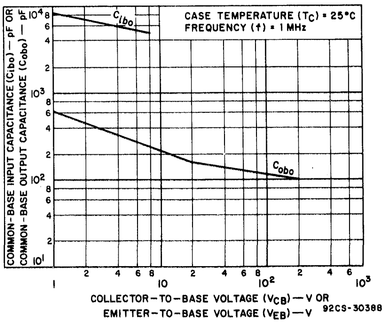


Fig. 10—Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics.

BUX13

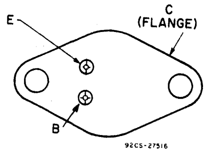
High-Voltage, High-Current Silicon N-P-N Power-Switching Transistor

Features:

- *V_{CEO} —— 325V*
- *I_C —— 15 A*
- *P_T —— 150 W*

The RCA-BUX13 is an epitaxial-base silicon n-p-n transistor having high-voltage and high-current capabilities and featuring fast-switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers. The RCA-BUX13 is supplied in a steel JEDEC TO-204MA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX13	
V_{CBO}	400	V
V_{CER}		
$R_{BE} = 100\,\Omega$	390	V
V_{CEO}	325	V
V_{CEX}		
$V_{BE} = -1.5\,V$	400	V
V_{EBO}	7	V
I_C	15	A
I_{CM}	20	A
I_B	3	A
P_T		
$T_C \leqslant 25°C$	150	W
$T_C > 25°C$ derate linearly	0.86	W/°C
T_{stg}, T_J	−65 to +200	°C
T_L		
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

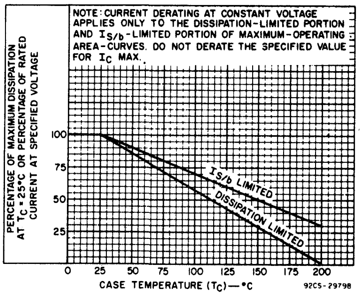


Fig. 2—Derating curves for $I_{S/b}$ and dissipation.

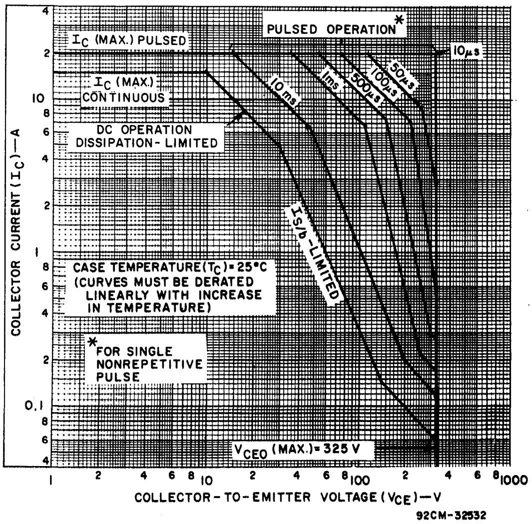


Fig. 1—Maximum safe-operating areas for BUX13 (T_C = 25°C).

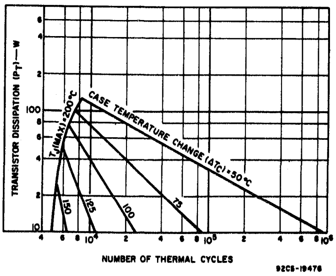


Fig. 3—Thermal-cycling chart.

BUX13

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX13			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	260	—	—	0	—	—	1.5	mA
I_{CEX}	400	−1.5	—	—	—	—	1.5	
T_C = 125°C	400	−1.5	—	—	—	—	6	
I_{EBO}	—	−5	0	—	—	—	1	
$V_{CEO}(sus)$[b]	—	—	0.2[a]	0	325[a]	—	—	V
$V_{(BE)EBO}$ I_E = 0.05 A	—	—	0	—	7	—	—	V
$V_{BE}(sat)$	—	—	8[a]	1.6	—	1	1.5	
$V_{CE}(sat)$	—	—	4[a]	0.8	—	0.1	0.8	
	—	—	8[a]	1.6	—	0.2	1.5	
h_{FE}	4	—	4[a]	—	15	—	60	
	4	—	8[a]	—	8	—	—	
$I_{S/b}$	140	—	—	—	0.15	—	—	A
t = 1 s, nonrepetitive	30	—	—	—	5	—	—	
f_T	15	—	1	—	8	—	—	MHz
t_{ON}	V_{CC} = 160 V	—	8	1.6	—	0.5	1.2	µs
t_s		—	8	1.6[c]	—	1.7	2.5	
t_f		—	8	1.6[c]	—	0.3	1	
$R_{\theta JC}$	—	—	—	—	—	—	1.17	°C/W

[a] Pulsed, pulse duration = 300 µs, duty factor ⩽ 2%.

[b] **CAUTION:** Sustaining Voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

[c] $I_{B_1} = I_{B_2}$.

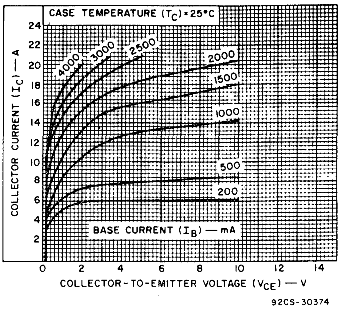


Fig. 4—Typical output characteristics.

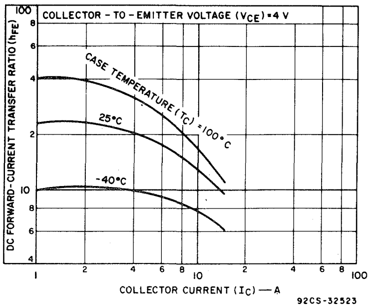


Fig. 5—Typical dc beta characteristics.

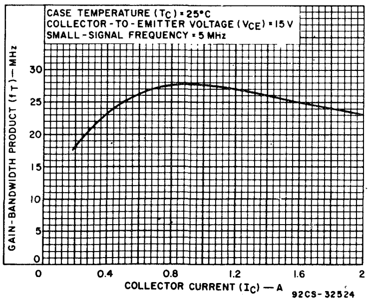


Fig. 6—Typical gain-bandwidth product characteristic.

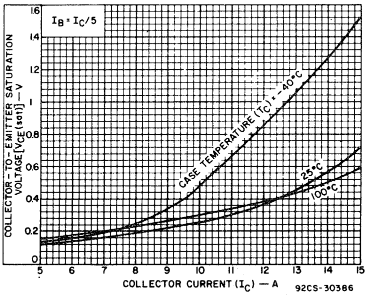


Fig. 7—Typical collector-to-emitter saturation voltage characteristics.

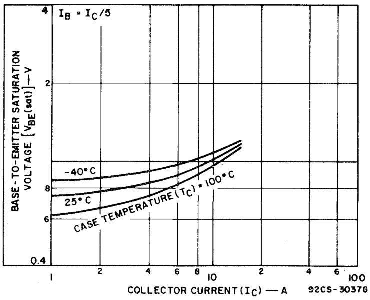


Fig. 8—Typical base-to-emitter saturation voltage characteristics.

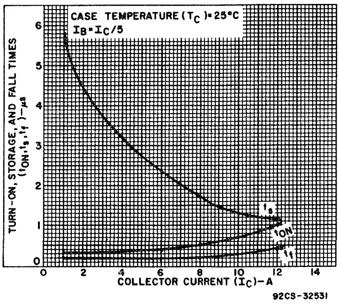


Fig. 9—Typical saturated-switching times as a function of collector current.

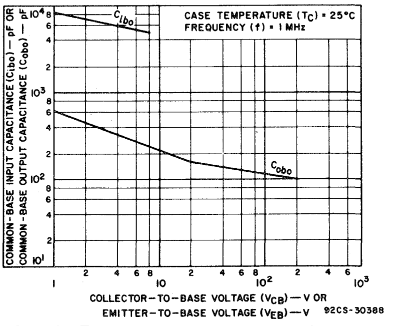


Fig. 10—Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics.

BUX14

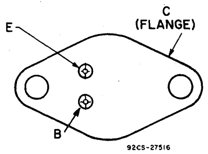
Silicon N-P-N Switching Transistor

For High-Voltage Switching and Amplifier Applications in Industrial and Commercial Equipment

Features:

- V_{CEO} - 400 V
- I_C - 10 A
- P_T - 150 W

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

RCA-BUX14 is a silicon n-p-n power transistor featuring fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. It is especially designed for use in off-line power supplies and is also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUX14 transistor is supplied in a steel JEDEC TO-204MA hermetic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX14
V_{CBO}	450 V
V_{CEO}	400 V
V_{CEX}	
$V_{BE} = -1.5$ V	450 V
V_{CER}	
$R_{BE} = 100\,\Omega$	440 V
V_{EBO}	7 V
I_C	10 A
I_{CM}	15 A
I_B	2 A
P_T:	
At T_C up to 25°	150 W
T_J, T_{stg}	−65 to +200 °C
T_L:	
At distances ≥ 1/16 in. (1.58 mm) from case for 10 s max.	235 °C

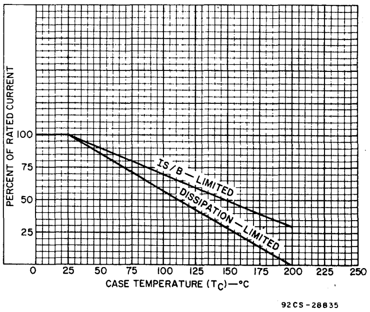


Fig. 2 - Dissipation and $I_{S/b}$ derating curves.

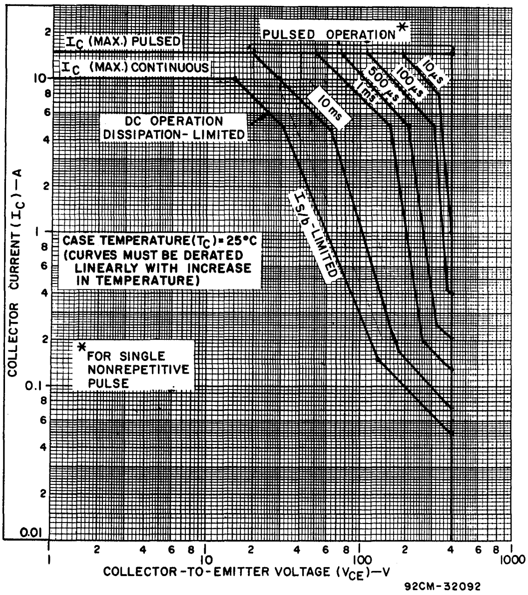


Fig. 1 - Maximum safe-operating areas ($T_C = 25°C$).

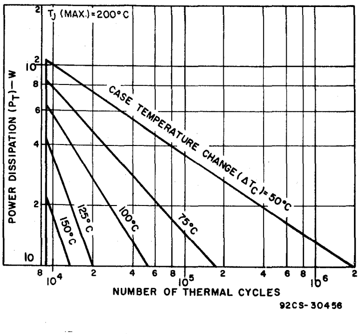


Fig. 3 - Thermal-cycling chart.

BUX14

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX14			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	320	—	—	0	—	—	1.5	mA
I_{CEX}	450	−1.5	—	—	—	—	1.5	
T_C = 125°C	450	−1.5	—	—	—	—	6	
I_{EBO}	—	−5	0	—	—	—	1	
$V_{CEO}(sus)^b$	—	—	0.2ª	0	400ª	—	—	V
$V_{(BR)EBO}$ I_E = 0.05 A	—	—	0	—	7	—	—	V
$V_{BE}(sat)$	—	—	6ª	1.2	—	1	1.5	
$V_{CE}(sat)$	—	—	3ª	0.6	—	0.2	0.6	
	—	—	6ª	1.2	—	0.5	1.5	
h_{FE}	4	—	3ª	—	15	—	60	
	4	—	6ª	—	8	—	—	
$I_{S/b}$	140	—	—	—	0.15	—	—	A
t = 1 s, nonrepetitive	30	—	—	—	5	—	—	
f_T	15	—	1	—	8	—	—	MHz
t_{on}	V_{CC} = 30 V	—	6	1.2	—	0.5	1.4	µs
t_s		—	6	1.2ᶜ	—	1	3	
t_f		—	6	1.2ᶜ	—	0.3	1.2	
$R_{\theta JC}$	—	—	—	—	—	—	1.17	°C/W

ªPulsed, pulse duration = 300 µs, duty factor ≤ 2%.

ᵇ**CAUTION:** Sustaining Voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

ᶜ$I_{B1} = I_{B2}$.

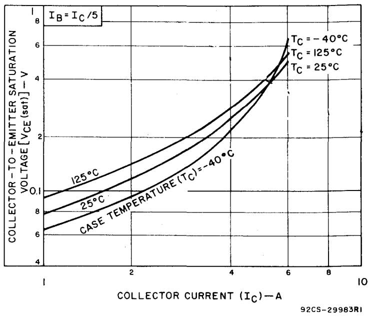


Fig. 8 - Typical collector-to-emitter saturation voltage as a function of collector current.

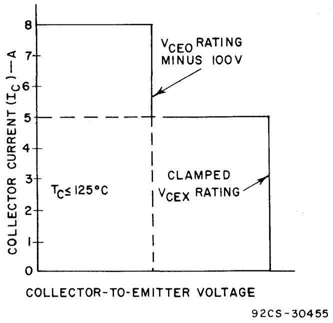


Fig. 9 - Maximum operating conditions for switching between saturation and cutoff.

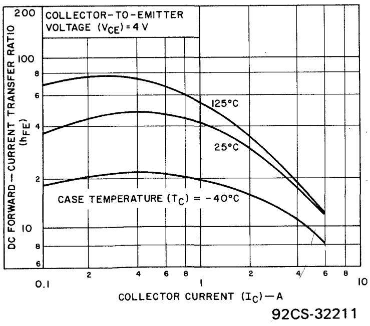


Fig. 4 - Typical dc beta characteristics.

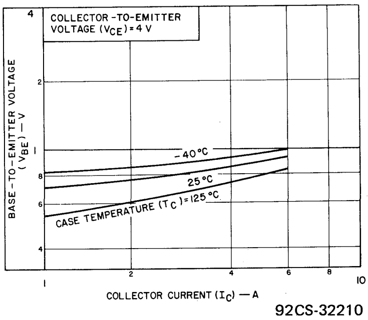


Fig. 5 - Typical base-to-emitter voltage as a function of collector current.

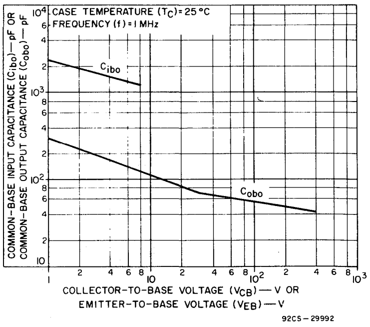


Fig. 10 - Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

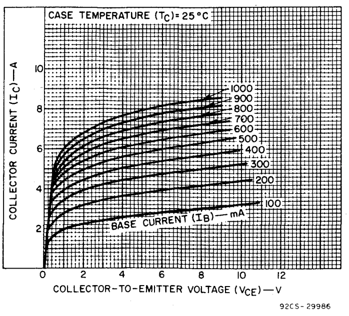


Fig. 6 - Typical output characteristics.

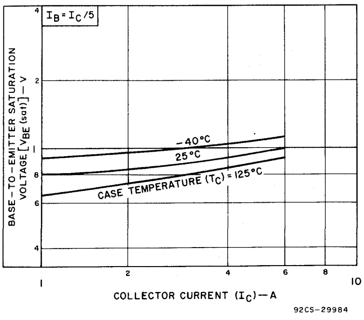


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current.

BUX15

High-Voltage, High-Power, Silicon N-P-N Power-Switching Transistor

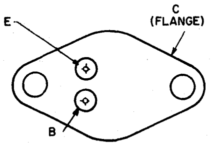
Features:

- V_{CEO} — — 500V
- I_C — — 8 A
- P_T — — 150 W

The RCA-BUX15 is an epitaxial-base silicon n-p-n transistor having high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. It is specially designed for use in off-line power supplies and is also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUX15 is supplied in a steel JEDEC TO-204MA hermetic package.

TERMINAL DESIGNATIONS



92CS-34134

JEDEC TO-204MA

(See dimensional outline "CC".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX15	
V_{CBO}	500	V
V_{CER} R_{BE} = 100Ω	500	V
V_{CEO}	500	V
V_{CEX} V_{BE} = −1.5 V	500	V
V_{EBO}	7	V
I_C	8	A
I_{CM}	10	A
I_B	2	A
P_T $T_C \leq 25°C$	150	W
$T_C > 25°C$ derate linearly	0.86	W/°C
T_{stg}, T_J	−65 to +200	°C
T_L At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

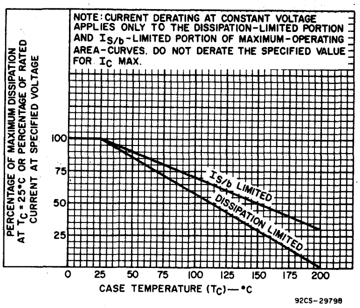


Fig. 2—Derating curves for $I_{S/b}$ and dissipation.

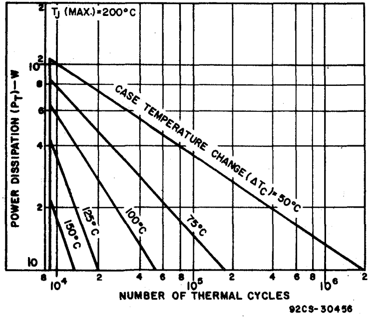


Fig. 3—Thermal-cycling chart.

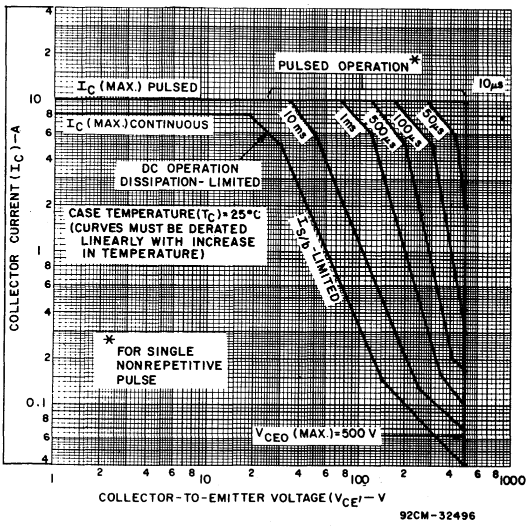


Fig. 1—Maximum safe-operating areas (T_C = 25°C).

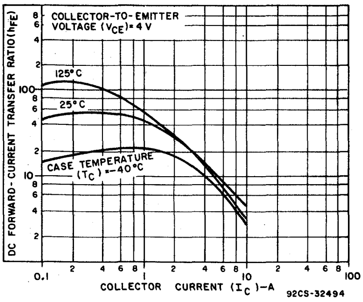


Fig. 4—Typical dc beta characteristics.

BUX15

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX15			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	400			0	—	—	1.5	mA
I_{CEX}	500	—1.5			—	—	1.5	
T_C = 125°C	500	—1.5			—	—	6	
I_{EBO}		—5	0		—	—	1	
$V_{CEO}(sus)$[b]			0.2[a]	0	500	—	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	—	
h_{FE}	4		2[a]		15	—	60	
	4		4[a]		8	—	—	
$V_{BE}(sat)$			4[a]	0.8	—	0.9	1.5	V
$V_{CE}(sat)$			2[a]	0.4	—	0.15	0.6	
			4[a]	0.8	—	0.4	1	
f_T	15		1		8	—	—	MHz
$I_{S/b}$	140				0.15	—	—	A
t = 1 s, nonrepetitive	30				5	—	—	
t_{ON}	V_{CC}		4	0.8	—	0.5	1.6	μs
t_s I_{B1} = I_{B2}	=		4	0.8	—	2.7	5	
t_f I_{B1} = I_{B2}	150 V		4	0.8	—	0.7	1.4	
$R_{\theta JC}$					—	—	1.17	°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

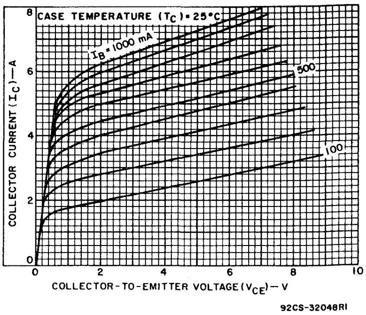


Fig. 5—Typical output characteristics.

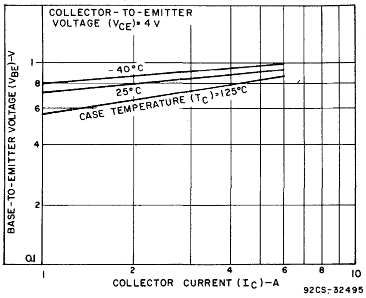


Fig. 6—Typical base-to-emitter voltage as a function of collector current.

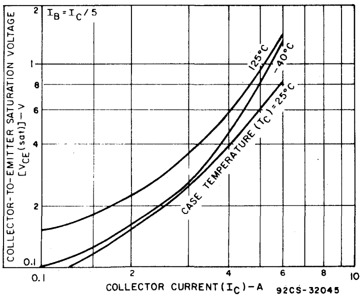


Fig. 7—Typical collector-to-emitter saturation voltage as a function of collector current.

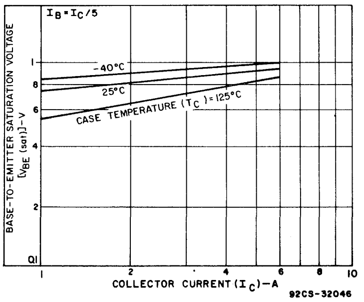


Fig. 8—Typical base-to-emitter saturation voltage as a function of collector current.

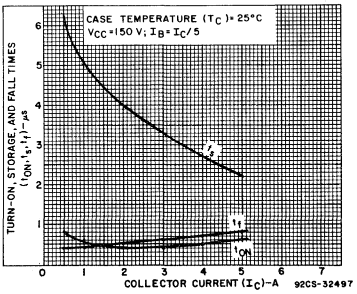


Fig. 9—Typical saturated-switching times as a function of collector current.

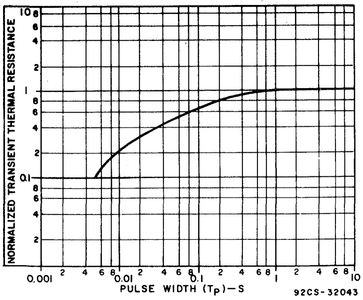


Fig. 10—Typical thermal-response characteristic.

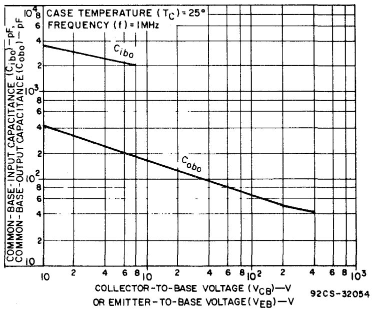


Fig. 11—Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

BUX16, BUX16A, BUX16B, BUX16C

High-Voltage, High-Power Silicon N-P-N Power Transistors

For Switching and Linear Applications in Industrial, and Commercial Equipment

The RCA BUX16-series devices are multiple epitaxial silicon n-p-n power transistors employing a new overlay construction with several emitter sites. All devices employ the popular JEDEC TO-3 package; they differ in breakdown-voltage, leakage-current, and current-gain values.

The high breakdown-voltage ratings and exceptional second-breakdown capabilities of these transistors make them especially suitable for use in series regulators, power amplifiers, inverters, deflection circuits, switching regulators, and high-voltage bridge amplifiers.

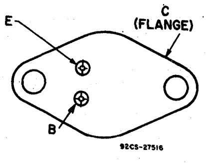
MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BUX16	BUX16A	BUX16B	BUX16C	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	325	375	425	V
COLLECTOR-TO-EMITTER VOLTAGE:						
With base reverse-biased (V_{BE}) = −1.5 V	V_{CEV}	250	325	375	425	V
With external base-to-emitter resistance (R_{BE}) ⩽50 Ω	V_{CER}(sus)	225	300	350	400	V
With base open	V_{CEO}(sus)	200	250	300	350	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
CONTINUOUS COLLECTOR CURRENT	I_C	5	5	5	5	A
CONTINUOUS BASE CURRENT	I_B	2	2	2	2	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C and V_{CE} up to 135 V		100	100	100	100	W
At case temperatures up to 25°C and V_{CE} above 135 V		See Fig. 1				
At case temperatures above 25°C		Derate linearly to 200°C				
TEMPERATURE RANGE:						
Storage and operating (Junction)		−65 to 200				°C
PIN TEMPERATURE (During soldering):						
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	230				°C

Features:

- **High voltage ratings: V_{CER}(sus) up to 400 V, R_{BE} ⩽ 50 Ω**
  V_{CEO}(sus) up to 350 V
- **High power dissipation rating: P_T = 100 W at V_{CE} = 135 V, T_C = 25°C**
- **For switching applications where circuit values and operating conditions require a transistor with a high second breakdown rating ($I_{S/b}$) (limit line begins at 135 V)**
- **Maximum area-of-operation curves for dc and pulse operation**

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

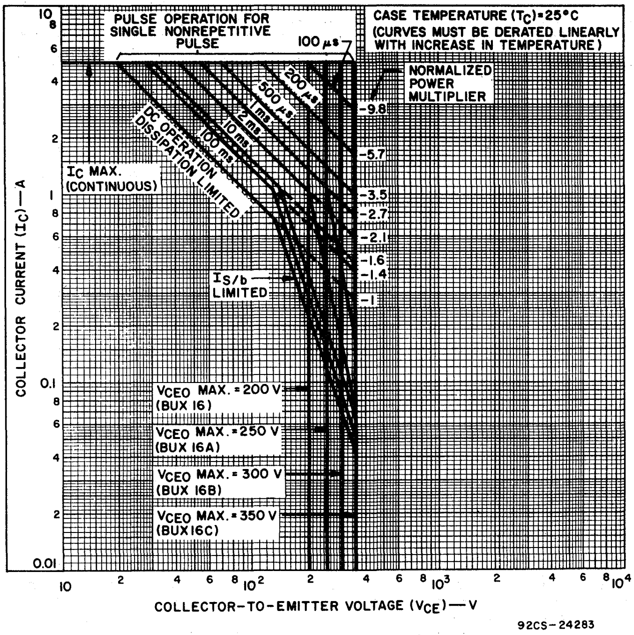


Fig. 1 — Maximum operating areas for all types.

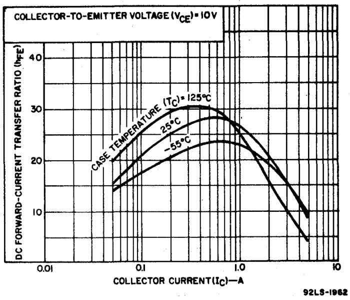


Fig. 2 — Typical dc beta vs. collector current for all types.

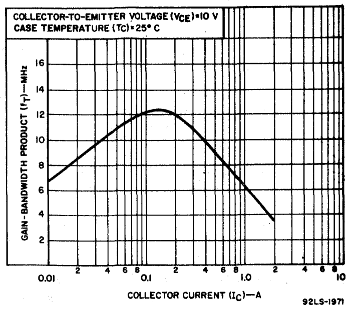


Fig. 3 — Typical gain-bandwidth product vs. collector current for all types.

BUX16, BUX16A, BUX16B, BUX16C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BUX16		BUX16A		BUX16B		BUX16C		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With base reverse-biased	I_{CEV}	250	−1.5	–	–	–	5	–	–	–	–	–	–	mA
		325	−1.5	–	–	–	–	–	5	–	–	–	–	
		375	−1.5	–	–	–	–	–	–	–	2	–	–	
		425	−1.5	–	–	–	–	–	–	–	–	–	2	
With base reverse-biased T_C = 150°C	I_{CEV}	250	−1.5	–	–	–	8	–	8	–	3	–	3	
With base open	I_{CEO}	175	–	–	0	–	5	–	2	–	–	–	–	
		250	–	–	0	–	–	–	–	–	5	–	2	
Emitter Cutoff Current: V_{EB} = 5 V	I_{EBO}	–	–	0	–	–	5	–	5	–	2	–	2	mA
Collector-to-Emitter Sustaining Voltage[a] With base open	V_{CEO}(sus)	–	–	0.2	0	200	–	250	–	300	–	350	–	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω	V_{CER}(sus)	–	–	0.2	–	225	–	300	–	350	–	400	–	
Emitter-to-Base Voltage	V_{EBO}	–	–	0	0.02	6	–	6	–	6	–	6	–	V
DC Forward-Current Transfer Ratio	h_{FE}	10	–	0.4^b	–	15	130	15	130	15	130	15	130	
		10	–	2^b	–	15	–	15	–	12	–	12	–	
		10	–	4.5^b	–	5	–	5	–	5	–	5	–	
Base-to-Emitter Voltage	V_{BE}	10	–	2^b	–	–	3	–	3	–	3	–	3	V
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)	–	–	2^b	0.25	–	2.5	–	2.5	–	2.5	–	2.5	V
		–	–	4.5^b	1.125	–	5	–	5	–	5	–	5	
Gain-Bandwidth Product	f_T	10	–	0.2	–	5	–	5	–	5	–	5	–	MHz
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio[c] (at 1 MHz)	$\lvert h_{fe} \rvert$	10	–	0.2	–	5	–	5	–	5	–	5	–	
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (at 1 kHz)	h_{fe}	10	–	4	–	20	–	20	–	20	–	20	–	
Output Capacitance (at 1 MHz): V_{CB} = 10 V, I_E = 0	C_{obo}	–	–	–	–	–	150	–	150	–	150	–	150	pF
Second-Breakdown Collector Current[d]: (With base forward-biased) Pulse duration (nonrepetitive) = 1 s	$I_{S/b}$	135	–	–	–	0.75	–	0.75	–	0.75	–	0.75	–	A
Second-Breakdown Energy[e]: (With base reverse-biased) L = 150 μH, R_{BE} = 50 Ω	$E_{S/b}$	–	−4	4	–	1.2	–	1.2	–	1.2	–	1.2	–	mJ
Thermal Resistance: Junction-to-case	$R_{\theta JC}$	–	–	–	–	–	1.75	–	1.75	–	1.75	–	1.75	°C/W

[a] *CAUTION:* Sustaining voltages V_{CEO}(sus) and V_{CER}(sus) *MUST NOT* be measured on a curve tracer.

[b] Pulsed, pulse duration ≤ 350 μs, duty factor = 2%.

[c] Measured at a frequency where $|h_{fe}|$ is decreasing at approximately 6 dB per octave.

[d] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

[e] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias connections. $E_{S/b} = \frac{1}{2} LI^2$ where L is a series load or leakage inductance, and I is the peak collector current.

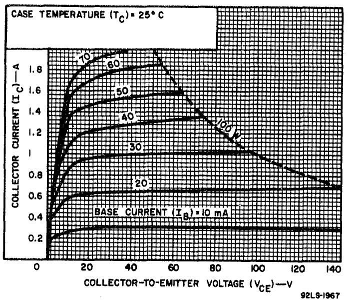


Fig. 4 — Typical output characteristics for all types.

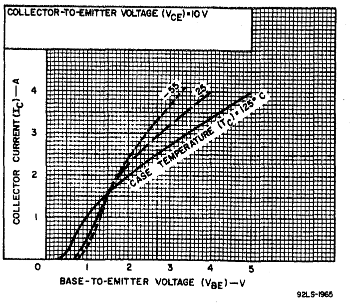


Fig. 5 — Typical transfer characteristics for all types.

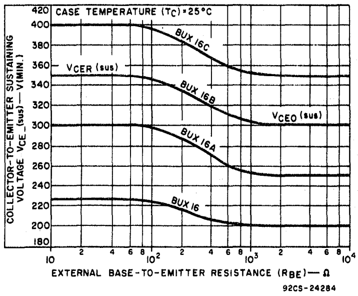


Fig. 6 — Sustaining voltage vs base-to-emitter resistance for all types.

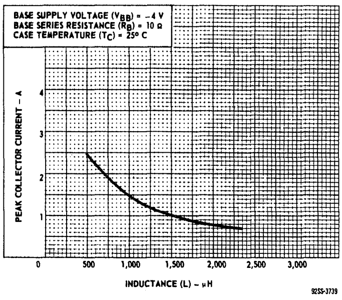


Fig. 7 — Typical reverse-bias, second-breakdown characteristic for all types.

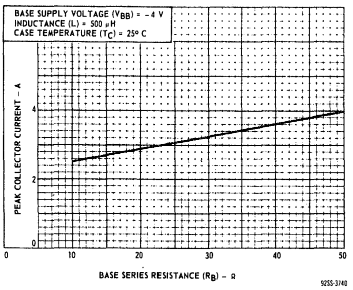


Fig. 8 — Typical reverse-bias, second-breakdown characteristic for all types.

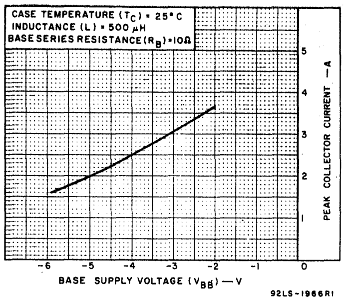


Fig. 9 — Typical reverse-bias, second-breakdown characteristic for all types.

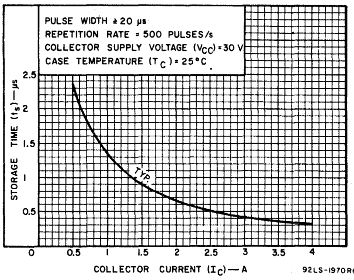


Fig. 10 — Saturated switching time (storage) vs. collector current for all types.

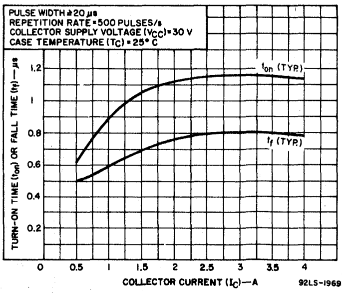


Fig. 11 — Saturated switching times (turn-on and fall) vs. collector current for all types.

BUX17, BUX17A, BUX17B, BUX17C

Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

The RCA-BUX17, BUX17A, BUX17B, and BUX17C are multiple epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. Multiple-epitaxial construction maximizes the volt-ampere characteristic of the device and provides fast switching speeds. Multiple-emitter-site design assures uniform current flow throughout the structure, which produces a high $I_{S/b}$ and a large safe-operation area.

These devices use the popular JEDEC TO-3 package; they differ mainly in voltage ratings and leakage-current limits.

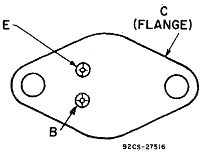
The exceptional second-breakdown capabilities and high voltage-breakdown ratings make these transistors especially suitable for off-line inverters, switching regulators, motor controls, and deflection-circuit applications.

The high breakdown voltages, low saturation voltages, and fast-switching capability of these devices make them especially suitable for inverter circuits operating directly off the rectified 115-V power line or in a bridge configuration operating from the rectified 220-V line.

Features:

- **High voltage ratings:**
  - **V_{CBO} = 250 V (BUX17)**
  - **= 350 V (BUX17A)**
  - **= 400 V (BUX17B)**
  - **= 450 V (BUX17C)**
- **High dissipation rating: P_T = 150 W**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BUX17	BUX17A	BUX17B	BUX17C	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	350	400	450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With base open	$V_{CEO}(sus)$	150	250	300	350	V
With reverse bias (V_{BE}) = 0 V (with base-emitter shorted)	$V_{CEX}(sus)$	250	350	400	450	V
With external base-to-emitter resistance (R_{BE}) $\leqslant$ 50 Ω	$V_{CER}(sus)$	175	275	325	375	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
COLLECTOR CURRENT:						
Continuous	I_C	10	10	10	10	A
Peak	I_{CM}	30	30	30	30	A
CONTINUOUS BASE CURRENT	I_B	10	10	10	10	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C and V_{CE} up to 30 V		150	150	150	150	W
At case temperatures up to 25°C and V_{CE} above 30 V		See Fig. 1				
At case temperatures above 25°C		Derate linearly to 200°C				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to +200				°C
PIN TEMPERATURE (During soldering):						
At distances $\geqslant$ 1/32 in. (0.8 mm) from case for 10 s max.		230				°C

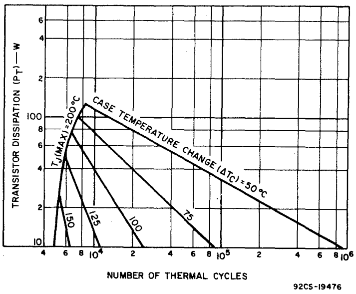


Fig. 2 — Thermal-cycling rating chart for all types.

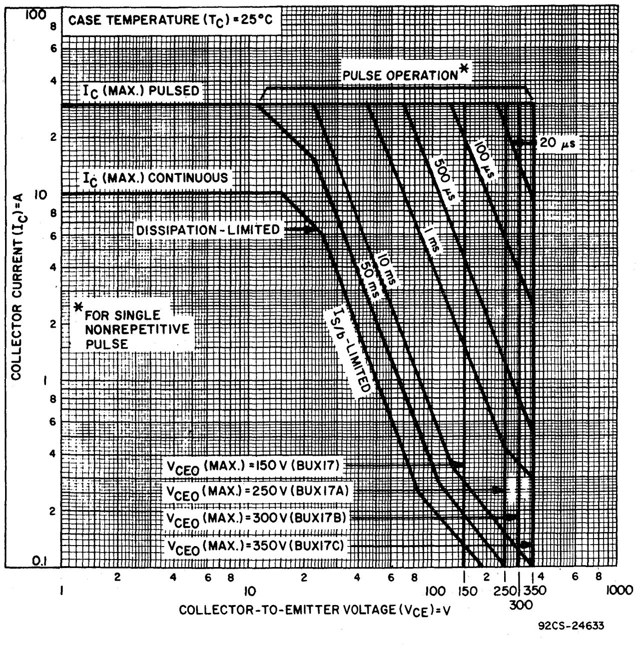


Fig. 1 — Maximum operating areas for all types.

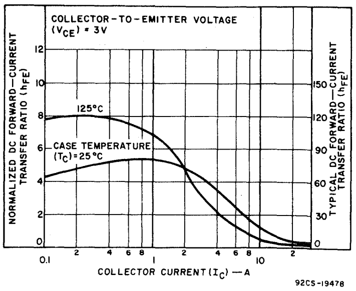


Fig. 3 — Typical normalized dc beta characteristics for all types.

BUX17, BUX17A, BUX17B, BUX17C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BUX17		BUX17A		BUX17B		BUX17C		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 50 Ω	I_{CER}	175				–	10	–	–	–	–	–	–	mA
		275				–	–	–	10	–	–	–	–	
		325				–	–	–	–	–	10	–	–	
		375				–	–	–	–	–	–	–	10	
With base-emitter junction reverse-biased	I_{CEV}	250	−1.5			–	10	–	–	–	–	–	–	
		350	−1.5			–	–	–	10	–	–	–	–	
		400	−1.5			–	–	–	–	–	5	–	–	
		450	−1.5			–	–	–	–	–	–	–	5	
At T_C = 125°C		250	−1.5			–	20	–	–	–	–	–	–	
		350	−1.5			–	–	–	20	–	–	–	–	
		400	−1.5			–	–	–	–	–	10	–	–	
		450	−1.5			–	–	–	–	–	–	–	10	
Emitter Cutoff Current	I_{EBO}		−6	0		–	2	–	2	–	2	–	2	mA
DC Forward-Current Transfer Ratio	h_{FE}	3		4^a		20	–	20	–	15	–	15	–	
		3		8		–	–	–	–	7	–	7	–	
		3		10^a		7	–	7	–	–	–	–	–	
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$			0.2^a		150^b	–	250^b	–	300^b	–	350^b	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$			0.2^a		175^b	–	275^b	–	325^b	–	375^b	–	
Base-to-Emitter Voltage	V_{BE}	3		8^a			–	–	–	–	3.5	–	3.5	V
		3		10^a		–	4	–	4	–	–	–	–	
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			8^a	1.5	–	–	–	–	–	2	–	2	V
				10^a	2	–	3	–	3	–	–	–	–	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			8^a	1.5		–	–	–	–	3	–	3	V
				10^a	2	–	2	–	2	–	–	–	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 MHz	$\lvert h_{fe}\rvert$	10		1		2.5	8	2.5	8	2	8	2.5	8	
Forward-bias Second Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$	25				6	–	6	–	6	–	6	–	A
Second-Breakdown Energy: With base reverse-biased, and R_{BE} = 50 Ω, L = 40 μH	$E_{S/b}$		−4	10		2	–	2	–	2	–	2	–	mJ
Saturated Switching Time (V_{CC}= 200 V, I_{B1} = I_{B2}): Turn-on (t_d + t_r)	t_{ON}			8	1.5	–	–	–	–	–	2	–	2	μs
				10	2	–	2	–	2	–	–	–	–	
Storage	t_s			8	1.5	–	–	–	–	–	3.5	–	3.5	
				10	2	–	3.5	–	3.5	–	–	–	–	
Fall	t_f			8	1.5	–	–	–	–	–	1	–	1	
				10	2	–	1	–	1					
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.17	–	1.17	–	1.17	–	1.17	°C/W

[a] Pulsed; pulse duration ⩽ 350 μs, duty factor = 2%.

[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

BUX17, BUX17A, BUX17B, BUX17C

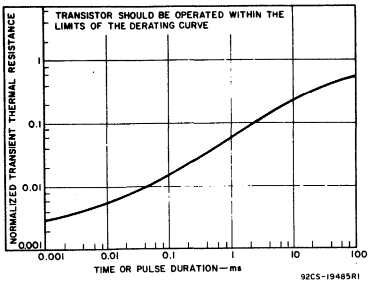


Fig. 4 – Typical thermal response characteristics for all types.

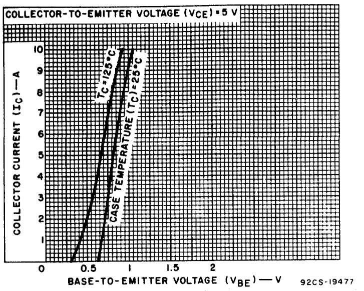


Fig. 5 – Typical transfer characteristics for all types.

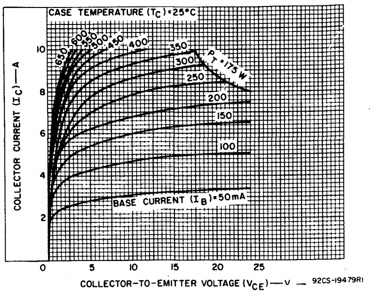


Fig. 6 – Typical output characteristics for all types.

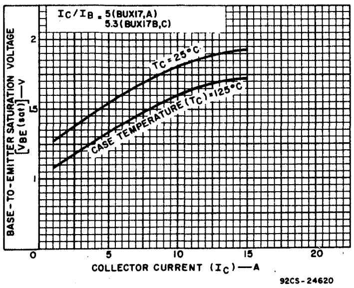


Fig. 7 – Typical base-to-emitter saturation-voltage characteristics for all types.

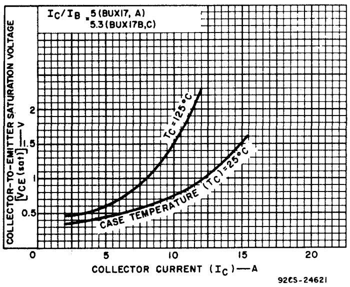


Fig. 8 – Typical collector-to-emitter saturation-voltage characteristics for all types.

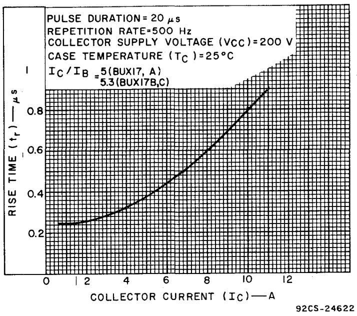


Fig. 9 – Typical rise-time characteristics for all types.

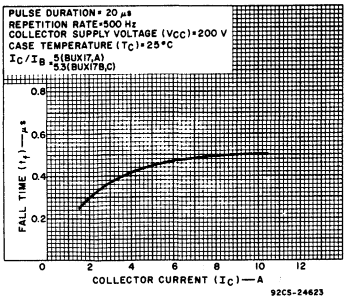


Fig. 10 – Typical fall-time characteristic for all types.

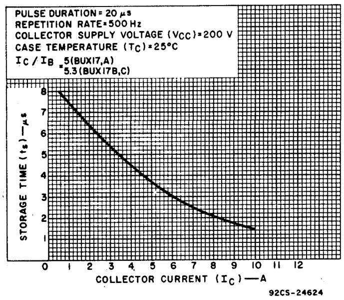


Fig. 11 – Typical storage-time characteristics for all types (with constant forced gain).

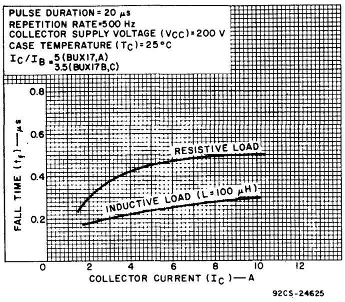


Fig. 12 – Typical inductive- and resistive-load fall-time characteristics for all types.

BUX18, BUX18A, BUX18B, BUX18C

High-Voltage, High-Current Silicon N-P-N Power-Switching Transistors

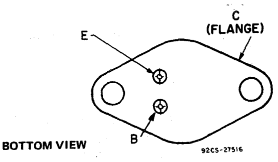
For Off-Line Switching Applications

The RCA-BUX18, BUX18A, BUX18B, and BUX18C are epitaxial silicon n-p-n power-switching transistors with pi-nu construction. They are intended for use in off-line power supplies and for other applications in which a combination of high-current-handling capability, ruggedness, and fast switching speed is required. The devices are hermetically sealed in a steel JEDEC TO-3 package, and differ from each other in collector voltage ratings.

Features:

- **Fast switching speed**
- **Hermetic steel package—JEDEC TO-3**
- **Epitaxial pi-nu construction**

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BUX18	BUX18A	BUX18B	BUX18C	
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGES:						
With reverse bias, V_{BE} = −1.5 V	$V_{CEV}(sus)$	300	450	600	750	
With external base-to-emitter resistance (R_{BE} = 100Ω)	$V_{CER}(sus)$	250	325	375	425	V
With base open	$V_{CEO}(sus)$	200	275	325	375	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
CONTINUOUS COLLECTOR CURRENT	I_C	8	8	8	8	A
PEAK COLLECTOR CURRENT	I_{CM}	12	12	12	12	A
CONTINUOUS BASE CURRENT	I_B	2	2	2	2	A
PEAK BASE CURRENT	I_{BM}	3	3	3	3	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		120	120	120	120	W
At case temperatures above 25°C		Derate linearly at 0.68 W/°C				
TEMPERATURE RANGE:						°C
Storage and Operating (Junction)		−65 to +200				°C
LEAD TEMPERATURE (During Soldering):						
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		235				°C

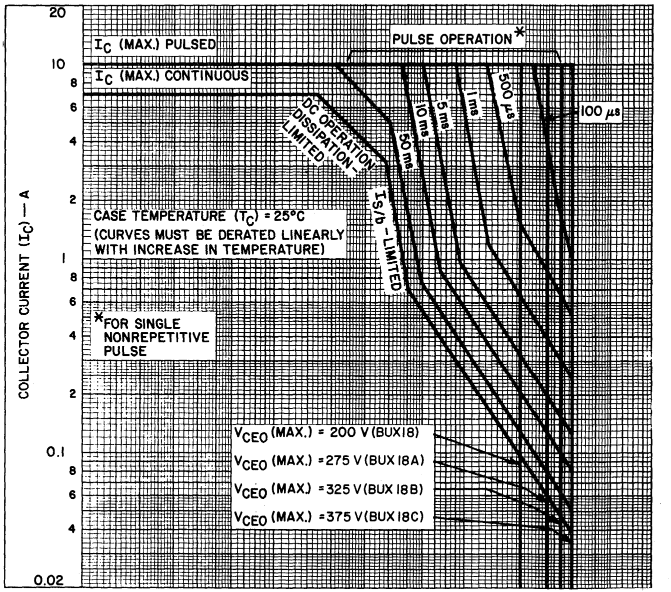


Fig. 1 — Maximum operating areas for all types.

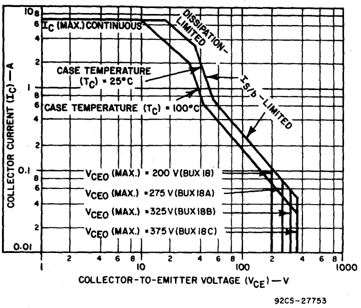


Fig. 2 — Maximum operating areas for all types at 25°C and 100°C.

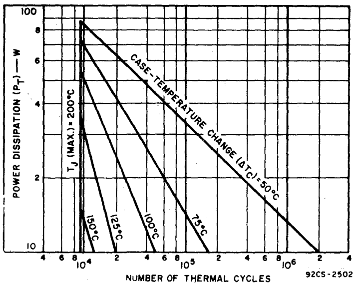


Fig. 3 — Thermal-cycling rating chart for all types.

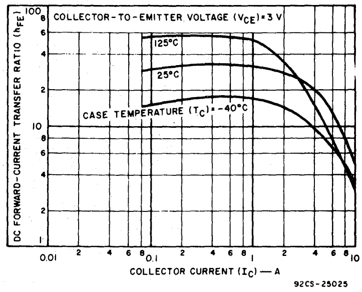


Fig. 4 — Typical dc beta characteristic for all types.

BUX18, BUX18A, BUX18B, BUX18C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified.*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BUX18		BUX18A		BUX18B		BUX18C		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current:														mA
With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	200				–	3	–	–	–	–	–	–	
		275				–	–	–	3	–	–	–	–	
		325				–	–	–	–	–	3	–	–	
		400				–	–	–	–	–	–	–	3	
With base-to-emitter junction reverse-biased	I_{CEV}	300	−1.5			–	0.5	–	–	–	–	–	–	
		450	−1.5			–	–	–	0.5	–	–	–	–	
		600	−1.5			–	–	–	–	–	0.5	–	–	
		750	−1.5			–	–	–	–	–	–	–	0.5	
With base-to-emitter junction reverse-biased, and T_C = 100°C		300	−1.5			–	10	–	–	–	–	–	–	
		450	−1.5			–	–	–	10	–	–	–	–	
		600	−1.5			–	–	–	–	–	10	–	–	
		750	−1.5			–	–	–	–	–	–	–	10	
Emitter Cutoff Current	I_{EBO}		−6	0		–	3	–	3	–	3	–	3	mA
Emitter Cutoff Voltage	V_{EBO}			0	0.003	6	–	6	–	6	–	6	–	V
DC Forward-Current Transfer Ratio	h_{FE}	3		4[a]		–	–	–	–	10	–	10	–	
		3		5[a]		–	–	7	–	–	–	–	–	
		3		6[a]		7	–	–	–	–	–	–	–	
		5		1[a]		15	100	15	100	15	100	15	100	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.2	0	200[b]	–	275[b]	–	325[b]	–	375[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.2		250[b]	–	325[b]	–	375[b]	–	425[b]	–	
Forward-Biased Second-Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$	38				3.16	–	3.16	–	3.16	–	3.16	–	A
		200				0.1	–	0.1	–	0.1	–	0.1	–	
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			6[a]	1.2	–	2.5	–	–	–	–	–	–	V
				5[a]	1	–	–	–	2.5	–	–	–	–	
				4[a]	0.8	–	–	–	–	–	2.5	–	2.5	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			6[a]	1.2	–	1.5	–	–	–	–	–	–	V
				5[a]	1	–	–	–	1.5	–	–	–	–	
				4[a]	0.8	–	–	–	–	–	1.5	–	1.5	
Reverse-Bias Second-Breakdown Energy: R_{BE} = 3 kΩ, L = 40 μH	$E_{S/b}$		−1.5	3		180	–	180	–	180	—	180	–	mJ
Saturated Switching Time (I_{B1} = I_{B2}): Storage	t_s	V_{CC}= 200 V		4	0.8	–	2	–	2	–	2	–	2	μs
Fall	t_f	V_{CC} = 200 V		4	0.8	–	0.6	–	0.6	–	0.6	–	0.6	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.46	–	1.46	–	1.46	–	1.46	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ≤2%.

[b] CAUTION: Sustaining Voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$, MUST NOT be measured on a curve tracer.

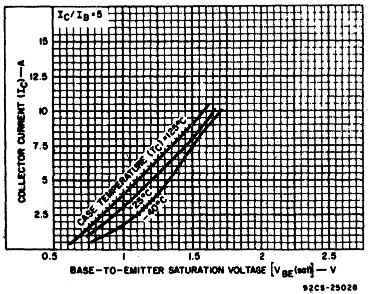


Fig. 5 — Typical collector-to-emitter saturation-voltage characteristics for all types.

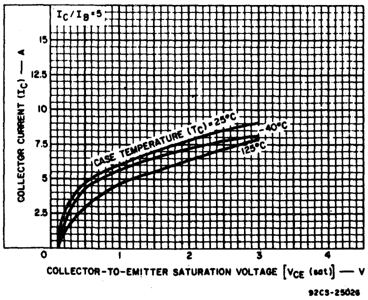


Fig. 6 — Typical base-to-emitter saturation-voltage characteristics for all types.

BUX20A

Silicon N-P-N Switching Transistor

For Switching Applications in Industrial and Commercial Equipment

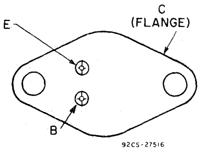
Features:

V_{CEO} — 125 V
I_C — 40 A
P_T — 140 W

The RCA-BUX20A is a silicon n-p-n power transistor featuring fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. It is specially designed for converters, inverters, pulse-width-modulated regulators, and a variety of power switching circuits.

The RCA-BUX20A transistor is supplied in a steel JEDEC TO-204MA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX20A	
V_{CBO}	160	V
$V_{CER}(sus)$		
$R_{BE} = 50\,\Omega$	140	V
$V_{CEO}(sus)$	125	V
$V_{CEX}(sus)$		
$V_{BE} = -1.5$ V	160	V
V_{EBO}	7	V
I_C	40	A
I_{CM}	50	A
I_B	10	A
P_T		
$T_C \leqslant 25$ °C and V_{CE} up to 24 V	140	W
T_{stg}, T_J	−65 to +200	°C
T_L		
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230	°C

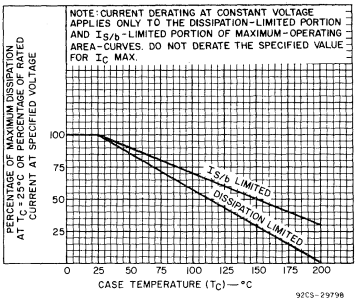


Fig. 2 - Derating curves for $I_{S/b}$ and dissipation.

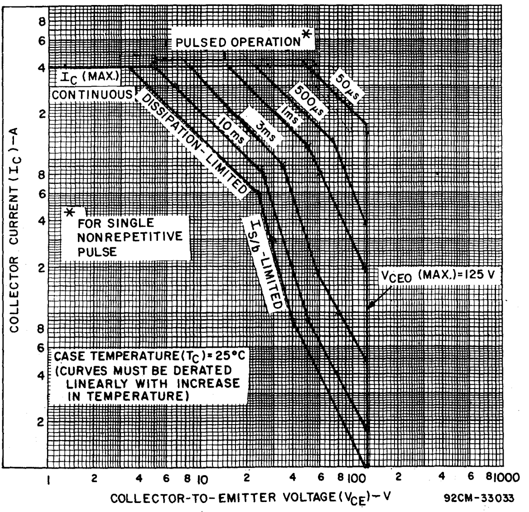


Fig. 1 - Maximum safe operating area.

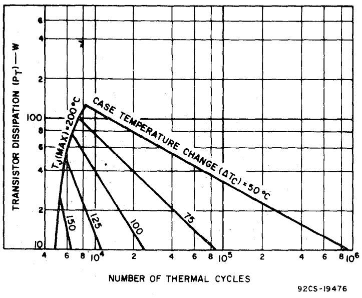


Fig. 3 - Thermal-cycling chart.

BUX20A

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX20A			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	100	—	—	0	—	—	3	mA
I_{CEV}	160	−1.5	—	—	—	—	5	
T_C = 125°C	160	−1.5	—	—	—	—	12	
I_{EBO}	—	−7	0	—	—	—	10	
$V_{CEO}(sus)^b$	—	—	0.2^a	—	125	—	—	V
$V_{CEX}(sus)^b$ R_B = 50 Ω L = 2 mH	—	−1.5	0.2^a	—	160	—	—	V
$V_{BE}(sat)^a$	—	—	20	2	—	1.3	1.5	
	—	—	40	4	—	2.0	2.2	
$V_{CE}(sat)^a$	—	—	20	2	—	0.6	0.8	
	—	—	40	4	—	1.8	2.5	
h_{FE}^a	2	—	20	—	20	—	60	
	4	—	40	—	10	—	—	
$I_{S/b}$	24	—	—	—	5.8	—	—	A
t = 1 s, nonrepetitive	45	—	—	—	0.9	—	—	
f_T	10	—	2	—	50	—	—	MHz
t_{ON}	V_{CC} = 30 V	—	20	2	—	0.45	0.7	μs
t_s^c		—	20	2	—	0.6	1.5	
t_f^c		—	20	2	—	0.15	0.5	
$R_{\theta JC}$	10	—	10	—	—	—	1.25	°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

[b] **CAUTION:** The sustaining voltages $V_{CEO}(sus)$ and $V_{CEX}(sus)$ *MUST NOT* be measured on a curve tracer.

[c] $I_{B_1} = -I_{B_2}$.

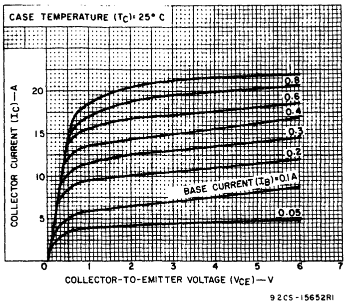


Fig. 4 - Typical output characteristics.

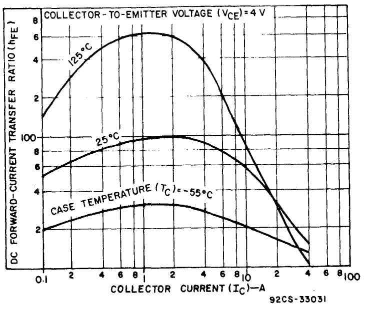


Fig. 5 - Typical dc beta characteristics.

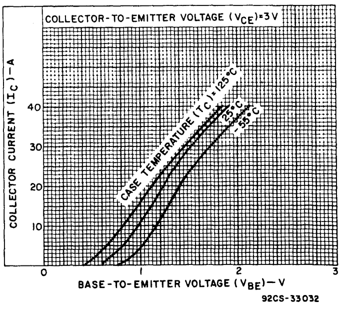


Fig. 6 - Typical transfer characteristics.

Silicon N-P-N Switching Transistor

For Switching Applications in
Industrial and Commercial Equipment

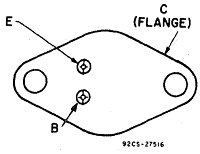
RCA-BUX21 is a silicon n-p-n power transistor featuring fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. It is specially designed for converters, inverters, pulse-width-modulated regulators, and a variety of power switching circuits.

The RCA-BUX21 transistor is supplied in a steel JEDEC TO-204MA hermetic package.

Features:

V_{CEO} – 200 V
I_C – 40 A
P_T – 250 W

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A")

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX21	
V_{CBO}	250	V
V_{CEO}	200	V
V_{CEX}		
$V_{BE} = -1.5$ V	250	V
V_{CER}		
$R_{BE} = 100\ \Omega$	240	V
V_{EBO}	7	V
I_C	40	A
I_{CM}	50	A
I_B	8	A
P_T:		
At T_C up to 25° and V_{CE} up to 20 V	250	W
T_J, T_{stg}	–65 to +200	°C
T_L		
At distances ≥1/16 in. (1.58 mm) from case for 10 s max.	200	°C

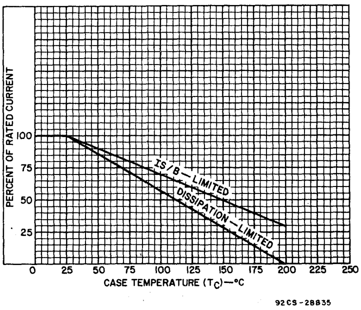


Fig. 2 – Dissipation and $I_{S/b}$ derating curve.

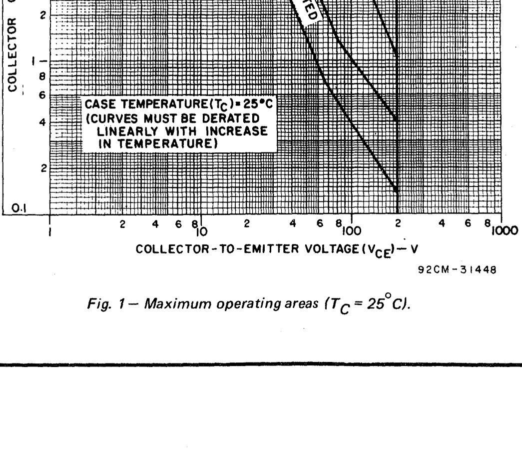


Fig. 1 – Maximum operating areas (T_C = 25°C).

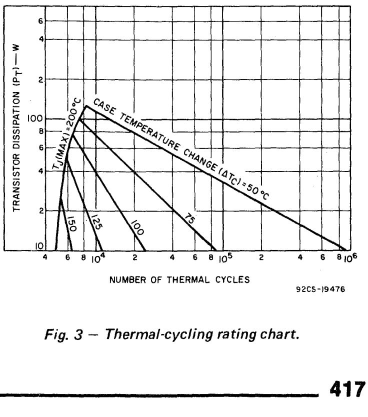


Fig. 3 – Thermal-cycling rating chart.

BUX21

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX21			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	160	–	–	0	–	–	3	mA
I_{CEV}	250	–1.5	–	–	–	–	3	
T_C = 125°C	250	–1.5	–	–	–	–	12	
I_{EBO}	–	–5	0	–	–	–	1	
$V_{CEO}(sus)$[b]	–	–	0.2[a]	–	200[a]	–	–	V
$V_{(BR)EBO}$ I_E = 0.05 A	–	–	0	–	7	–	–	V
$V_{BE}(sat)$	–	–	25[a]	3	–	1.2	1.5	
$V_{CE}(sat)$	– –	– –	12[a] 25[a]	1.2 3	– –	0.2 0.7	0.6 1.5	
h_{FE}	2 4	– –	12[a] 25[a]	– –	20 10	– –	60 –	
$I_{S/b}$ t = 1s, nonrepetitive	140 20	– –	– –	– –	0.15 12.5	– –	– –	A
f_T f = 10 MHz	15	–	2	–	8	–	–	MHz
t_{on}	V_{CC} = 100 V	–	25	3	–	0.3	1.2	µs
t_s ($I_{B_1} = I_{B_2}$)	V_{CC} = 100 V	–	25	3	–	1.0	1.8	
t_f ($I_{B_1} = I_{B_2}$)	V_{CC} = 100 V	–	25	3	–	0.2	0.4	
$R_{\theta JC}$	–	–	–	–	–	–	0.7	°C/W

[a] Pulsed, pulse duration = 300 µs, duty factor ≤2%.

[b] **CAUTION:** Sustaining Voltages $V_{CEO}(sus)$ *MUST NOT* be measured on a curver tracer.

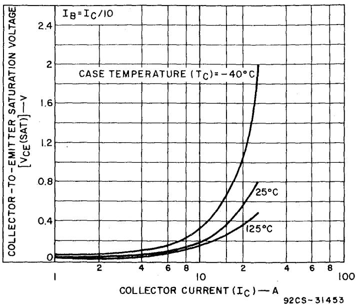


Fig. 6 – Typical collector-to-emitter saturation voltage characteristics.

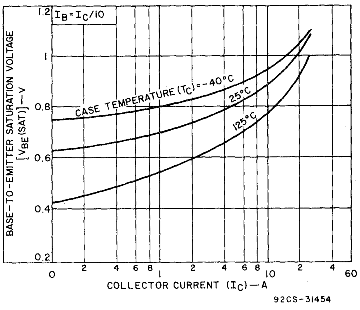


Fig. 7 – Typical base-to-emitter saturation voltage characteristics.

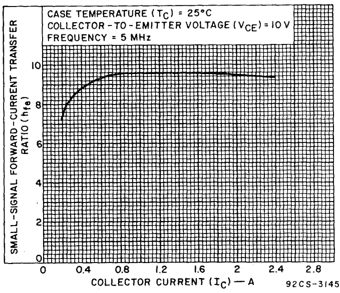


Fig. 8 – Typical small-signal forward-current transfer ratio characteristics.

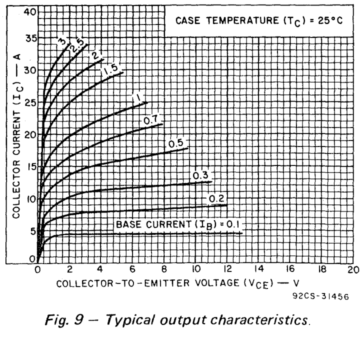


Fig. 9 – Typical output characteristics.

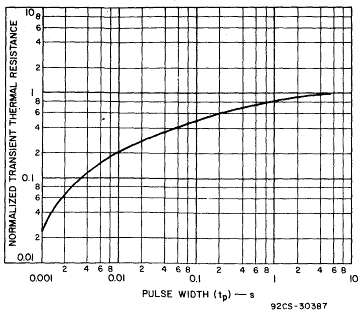


Fig. 4 – Typical thermal-response characteristic.

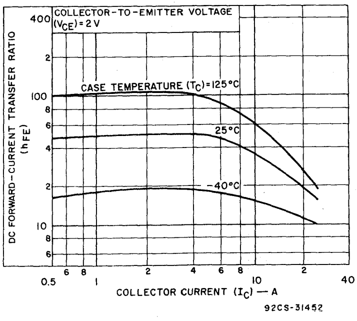


Fig. 5 – Typical dc beta characteristics.

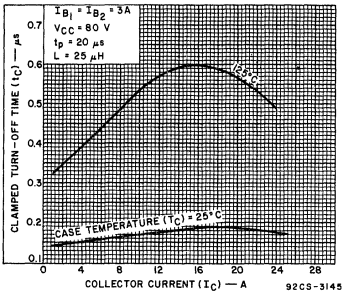


Fig. 10 – Typical clamped turn-off time characteristics.

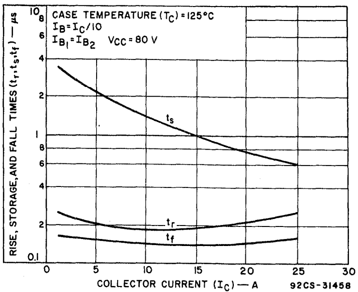


Fig. 11 – Typical saturated-switching-time characteristics as a function of collector current.

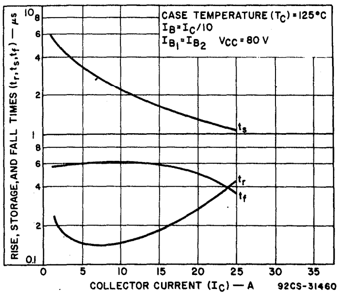


Fig. 12 – Typical-switching-time characteristics at $T_C = 125°C$ as a function of collector current.

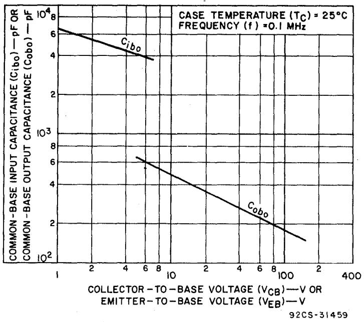


Fig. 13 – Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics.

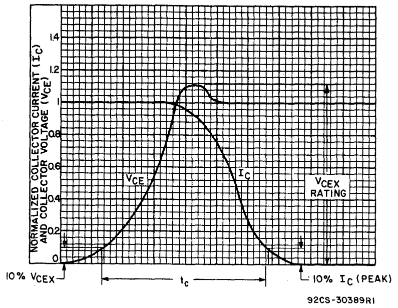
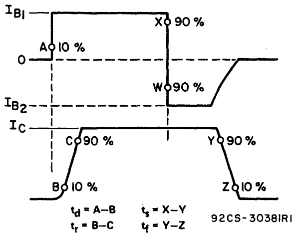
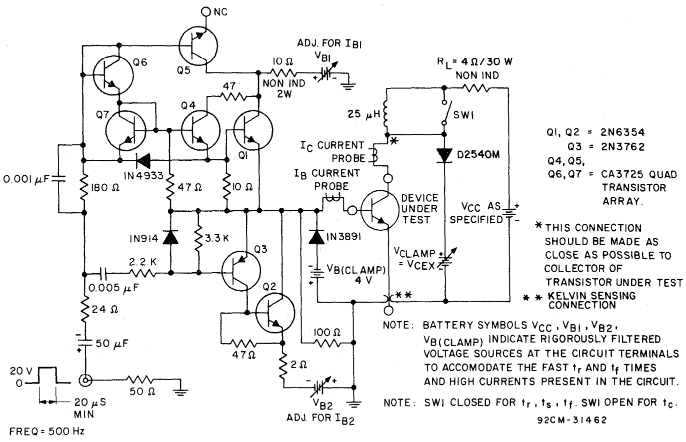


Fig. 14 – Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).



NOTE: TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} MUST BE LESS THAN 0.5 µs.

Fig. 15 – Phase relationship between input and output currents showing reference points for specification of switching times.



Q1, Q2 = 2N6354
Q3 = 2N3762
Q4, Q5, Q6, Q7 = CA3725 QUAD TRANSISTOR ARRAY.

* THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

** KELVIN SENSING CONNECTION

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

Fig. 16 – Circuit for measuring switching times.

BUX31, BUX31A, BUX31B

4-A SwitchMax Power Transistors

High Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-BUX31 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 100°C, as well as at 25°C, to provide information necessary for worst-case design.

The BUX31-series transistors are supplied in steel JEDEC TO-204MA hermetic packages.

Features:

- *100% High-Temperature Tested for 100° C Parameters*
- *Fast Switching Speed*
- *High Voltage Ratings:* *V_{CEX} = 450 - 550 V*
- *Low V_{CE}(sat) at I_C = 4 A*
- *Steel Hermetic TO-204MA Package*

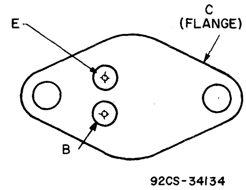
Applications

- *Off-Line Power Supplies*
- *High-Voltage Inverters*
- *Switching Regulators*

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX31	BUX31A	BUX31B	
V_{CEV}				
V_{BE} = −1.5 V	800	900	1000	V
V_{CER}				
$R_{BE} \leq 10\ \Omega$	800	900	1000	V
V_{CEX} (Clamped)				
V_{BE} = −1.5 V	450	500	550	V
V_{CEO}	400	450	500	V
V_{EBO}	8			V
I_C(sat)	4			A
I_C	8			A
I_{CM}	10			A
I_B	4			A
P_T				
T_C up to 25°C	150			W
T_C above 25°C, derate linearly	1.0			W/°C
T_J	−65 to 175			°C
T_{stg}	−65 to 200			°C
T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235			°C

TERMINAL DESIGNATIONS



(See dimensional outline "CC")

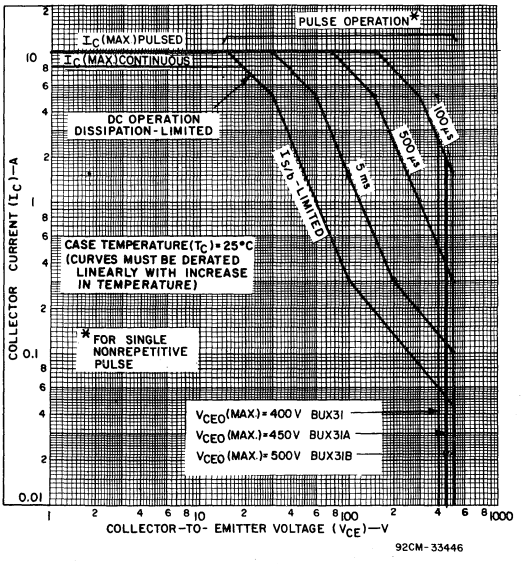


Fig.1 - Maximum operating areas for all types [T_C].

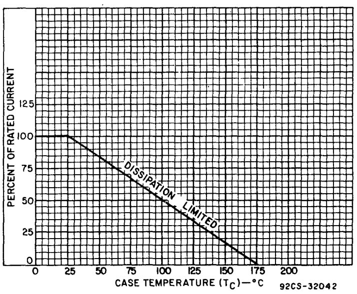


Fig.2 - Dissipation derating curve for all types.

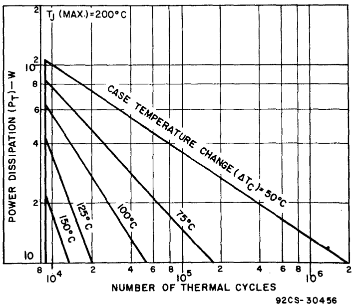


Fig.3 - Thermal-cycling chart for all types.

ELECTRICAL CHARACTERISTICS

Characteristic	Test Conditions				Limits						Units
	Voltage V dc		Current A dc		BUX31		BUX31A		BUX31B		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C = 25° C											
I_{CEV}	800	—1.5			—	0.1	—	—	—	—	mA
	900	—1.5			—	—	—	0.1	—	—	
	1000	—1.5			—	—	—	—	—	0.1	
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	0.2	—	—	—	—	
	900				—	—	—	0.2	—	—	
	1000				—	—	—	—	—	0.2	
I_{EBO}		—8	0		—	2	—	2	—	2	
$V_{CEO}(sus)^b$			0.2^a	0	400	—	450	—	500	—	V
h_{FE}	3		4		8	40	8	40	8	40	
$V_{BE}(sat)$			4	0.8	—	1.3	—	1.3	—	1.3	V
$V_{CE}(sat)$			4	0.8	—	1	—	1	—	1	
			8	2	—	2	—	2	—	2	
V_{CEX}^b (Clamped $E_{S/b}$) L = 170 μH		—5	4	0.8^e	450	—	500	—	550	—	
$I_{S/b}$	30		5		1	—	1	—	1	—	s
$\lvert h_{fe}\rvert$ f=5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
C_{obo} f=0.1 MHz	10^c				50	250	50	250	50	250	pF
t_d^d			4	0.8	—	0.1	—	0.1	—	0.1	μs
t_r^d			4	0.8	—	0.45	—	0.45	—	0.45	
t_s^d			4	0.8^e	—	3.0	—	3.0	—	3.0	
t_f^d			4	0.8^e		0.4	—	0.4	—	0.4	
t_c V_{CC}=250V, L=170 μH, R_C = 50Ω Collector clamped to V_{CEX}			4	0.8^e	—	0.4	—	0.4	—	0.4	

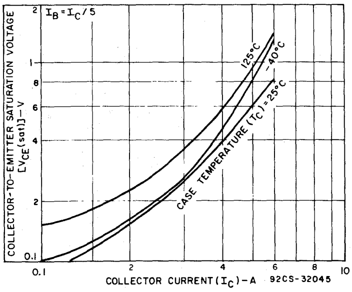


Fig.6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

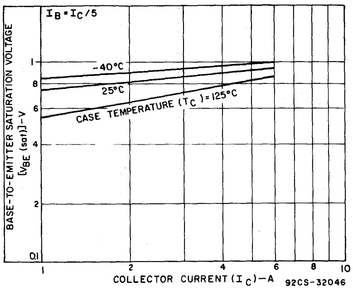


Fig.7 - Typical base-to-emitter saturation voltage as a function of collector current for all types.

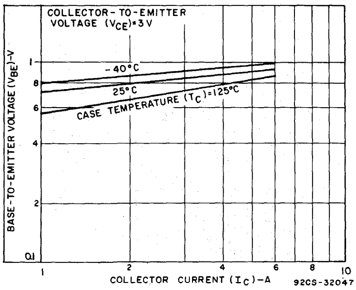


Fig.8 - Typical base-to-emitter voltage as a function of collector current for all types.

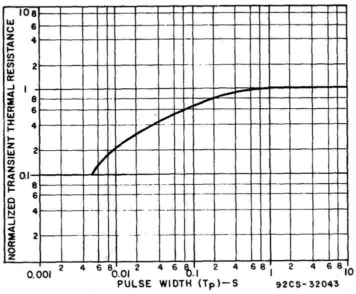


Fig.4 - Typical thermal-response characteristic for all types.

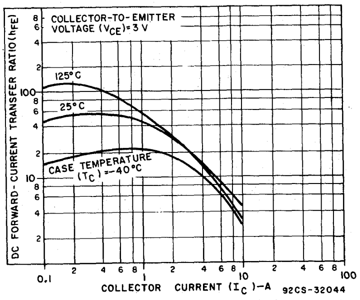


Fig.5 - Typical dc beta characteristics for all types.

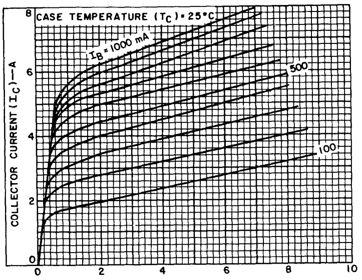


Fig.9 - Typical output characteristics for all types.

BUX31, BUX31A, BUX31B

ELECTRICAL CHARACTERISTICS (Continued)

Characteristic	Test Conditions				Limits						Units
	Voltage V dc		Current A dc		BUX31		BUX31A		BUX31B		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
$T_C = 100°C$											
I_{CEV}	800	—1.5			—	1	—	—	—	—	mA
	900	—1.5			—	—	—	1	—	—	
	1000	—1.5			—	—	—	—	—	1	
I_{CER} $R_{BE} \leq 10Ω$	800				—	3	—	—	—	—	
	900				—	—	—	3	—	—	
	1000				—	—	—	—	—	3	
$V_{CE}(sat)$			4	0.8	—	1.5	—	1.5	—	1.5	V
t_r[d]			4	0.8	—	0.6	—	0.6	—	0.6	µs
t_s[d]			4	0.8[e]	—	4	—	4	—	4	
t_f[d]			4	0.8[e]	—	0.7	—	0.7	—	0.7	
t_c V_{CC}=250V, L=170 µH, R_C = 50Ω Collector clamped to V_{CEX}			4	0.8[e]	—	0.8	—	0.8	—	0.8	
$R_{\theta JC}$	10	5			—	1.0	—	1.0	—	1.0	°C/W

[a] Pulsed: pulse duration = 300 µs, duty factor ≤2%.

[b] CAUTION: The sustaining voltage V_{CEO}(sus) and V_{CEX} MUST NOT be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC}=250 V, t_p=20 µs.

[e] I_{B_1}= —I_{B_2}.

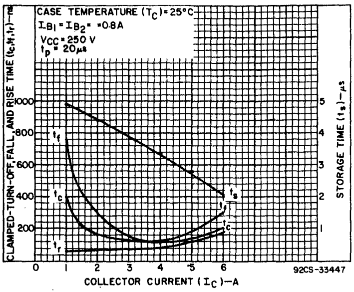


Fig.10 - Typical saturated switching time characteristics for all types.

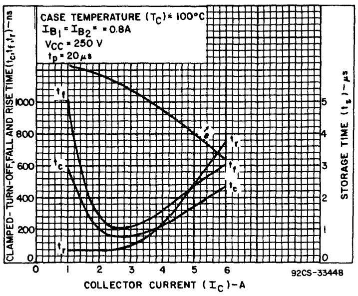


Fig.11 - Typical saturated switching time characteristics for all types.

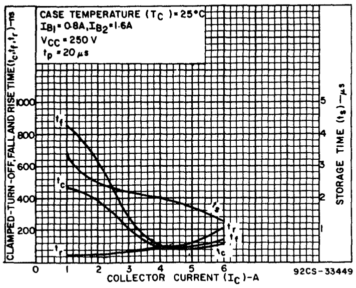


Fig.12 - Typical saturated switching time characteristics for all types.

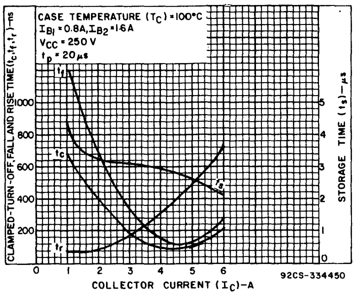


Fig.13 - Typical saturated switching time characteristics for all types.

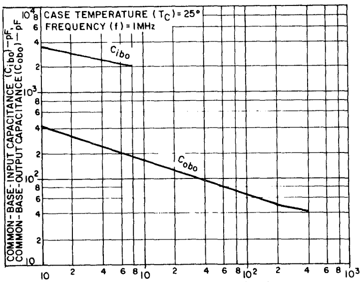


Fig.14 - Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

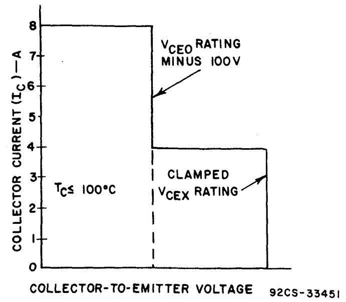


Fig.15 - Maximum operating conditions for switching between saturation and cutoff.

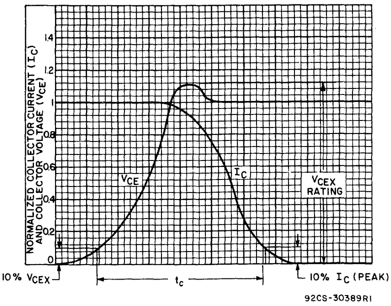


Fig.16 - Oscilloscope display for measurement of clamped induction switching time[t_C].

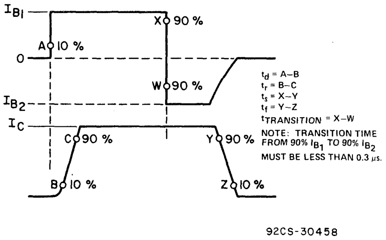
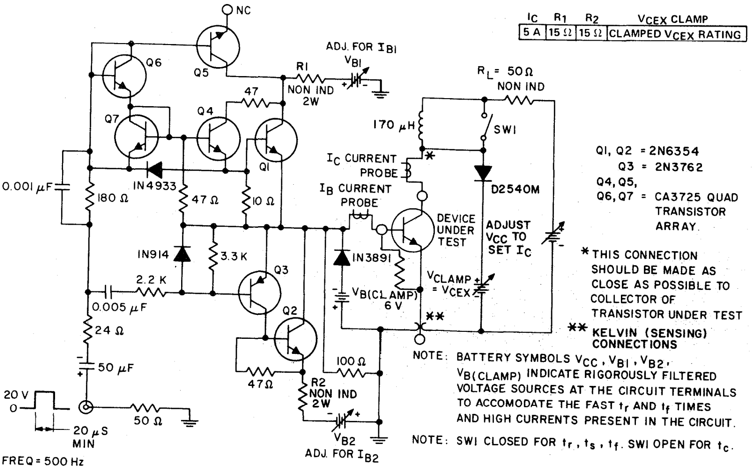


Fig.17 - Phase relationship between input and output currents showing reference points for specification of switching times.



I_C	R_1	R_2	V_{CEX} CLAMP
5 A	15 Ω	15 Ω	CLAMPED V_{CEX} RATING

Q1, Q2 = 2N6354
Q3 = 2N3762
Q4, Q5,
Q6, Q7 = CA3725 QUAD TRANSISTOR ARRAY.

* THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

** KELVIN (SENSING) CONNECTIONS

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

92CM-32103

Fig.18 - Circuit for measuring switching times.

BUX32, BUX32A, BUX32B

6-A SwitchMax Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

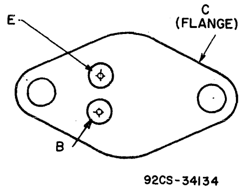
The BUX32 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are tested at 100°C, as well as at 25°C, to provide information necessary for worst-case design.

The BUX32-series transistors are supplied in steel JEDEC TO-204MA hermetic packages.

Features:
- *100% high-temperature tested for 100°C parameters*
- *Fast switching speed*
- *High voltage ratings: V_{CEX}=450-550 V*
- *Low $V_{CE}(sat)$ at I_C=6 A*
- *Steel hermetic TO-204MA package*

Applications:
- *Off-Line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "CC".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX32	BUX32A	BUX32B	
V_{CEV}				
V_{BE}=-1.5 V	800	900	1000	V
V_{CER} $R_{BE} \leq 10\ \Omega$	800	900	1000	V
V_{CEX} (Clamped)				
V_{BE}=-1.5 V	450	500	550	V
V_{CEO}	400	450	500	V
V_{EBO}	8			V
$I_C(sat)$	6			A
I_C	8			A
I_{CM}	10			A
I_B	4			A
P_T				
T_C up to 25°C	150			W
T_C above 25°C, derate linearly	1.0			W/°C
T_J	-65 to 175			°C
T_{stg}	-65 to 200			°C
T_L				
At distance ≧ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235			°C

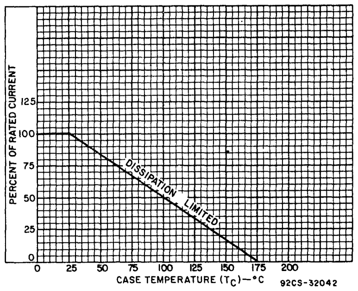


Fig. 2 - Dissipation derating curve for all types.

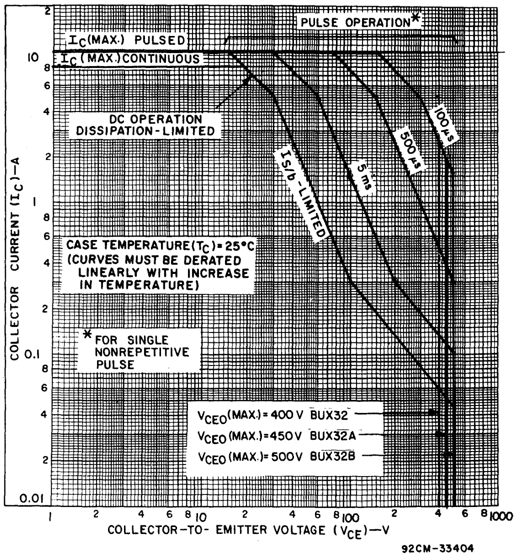


Fig. 1 - Maximum operating areas for all types (T_C).

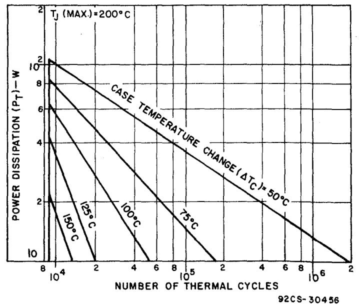


Fig. 3 - Thermal-cycling chart for all types.

BUX32, BUX32A, BUX32B

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BUX32 Min.	Max.	BUX32A Min.	Max.	BUX32B Min.	Max.	UNITS
T_C=25° C											
I_{CEV}	800	-1.5			—	0.1	—	—	—	—	mA
	900	-1.5			—	—	—	0.1	—	—	
	1000	-1.5			—	—	—	—	—	0.1	
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	0.2	—	—	—	—	
	900				—	—	—	0.2	—	—	
	1000				—	—	—	—	—	0.2	
I_{EBO}		-8	0		—	2	—	2	—	2	
$V_{CEO}(sus)^b$			0.2^a	0	400	—	450	—	500	—	V
h_{FE}	3		6		8	40	8	40	8	40	
$V_{BE}(sat)$			6	1.2	—	1.3	—	1.3	—	1.3	V
$V_{CE}(sat)$			6	1.2	—	1	—	1	—	1	
			8	2	—	2	—	2	—	2	
V_{CEX}^b (Clamped $E_{S/b}$) L=170 µH		-5	6	1.2^e	450	—	500	—	550	—	
$I_{S/b}$	30		5		1	—	1	—	1	—	s
$\|h_{fe}\|$ f=5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
C_{obo} f=0.1 MHz	10^c				50	250	50	250	50	250	pF
t_d^d			6	1.2	—	0.1	—	0.1	—	0.1	µs
t_r^d			6	1.2	—	0.45	—	0.45	—	0.45	
t_s^d			6	1.2^e	—	3.0	—	3.0	—	3.0	
t_f^d			6	1.2^e	—	0.4	—	0.4	—	0.4	
t_c V_{CC}=250 V, L=170 µH, R_C=50 Ω Collector clamped to V_{CEX}			6	1.2^e	—	0.4	—	0.4	—	0.4	
T_C=100° C											
I_{CEV}	800	-1.5			—	1	—	—	—	—	mA
	900	-1.5			—	—	—	1	—	—	
	1000	-1.5			—	—	—	—	—	1	
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	3	—	—	—	—	
	900				—	—	—	3	—	—	
	1000				—	—	—	—	—	3	
$V_{CE}(sat)$			6	1.2	—	1.5	—	1.5	—	1.5	V
t_i^d			6	1.2	—	0.6	—	0.6	—	0.6	µs
t_s^d			6	1.2^e	—	4	—	4	—	4	
t_f^d			6	1.2^e	—	0.7	—	0.7	—	0.7	
t_c V_{CC}=250 V, L=170 µH, R_C=50 Ω Collector clamped to V_{CEX}			6	1.2^e	—	0.8	—	0.8	—	0.8	
$R_{\theta JC}$	10	5			—	1.0	—	1.0	—	1.0	°C/W

[a] Pulsed; pulse duration=300 µs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltage $V_{CEO}(sus)$ and V_{CEX} MUST NOT be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC}=250 V, t_p=20 µs.

[e] $I_{B1}=-I_{B2}$.

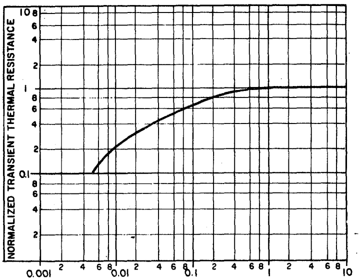


Fig. 4 - Typical thermal-response characteristic for all types.

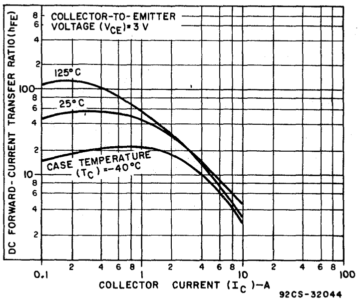


Fig. 5 - Typical dc beta characteristics for all types.

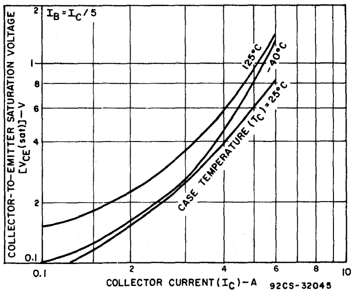


Fig. 6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

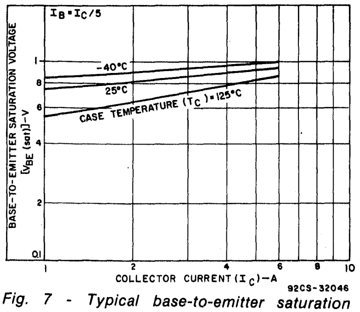


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current for all types.

BUX32, BUX32A, BUX32B

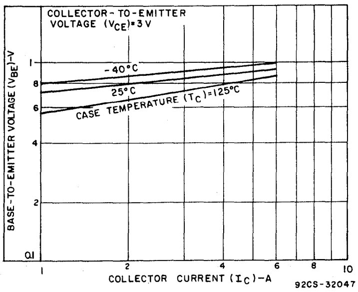


Fig. 8 - Typical base-to-emitter voltage as a function of collector current for all types.

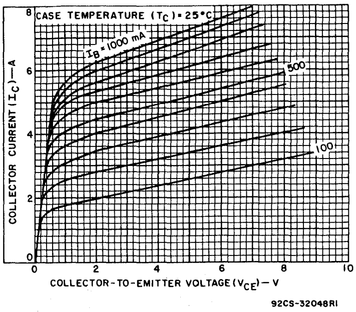


Fig. 9 - Typical output characteristics for all types.

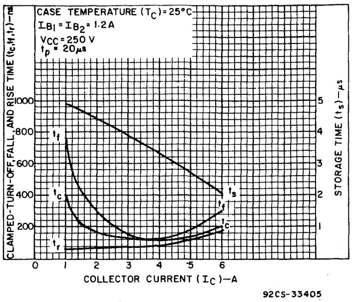


Fig. 10 - Typical saturated switching time characteristics for all types.

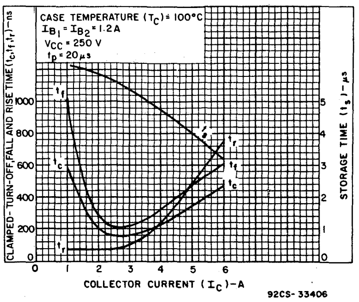


Fig. 11 - Typical saturated switching time characteristics for all types.

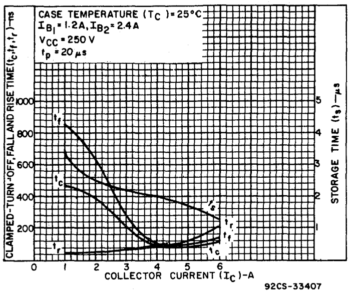


Fig. 12 - Typical saturated switching time characteristics for all types.

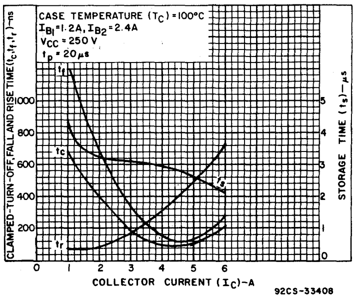


Fig. 13 - Typical saturated switching time characteristics for all types.

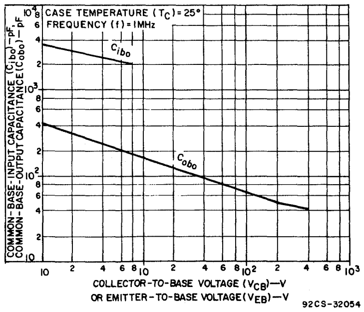


Fig. 14 - Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

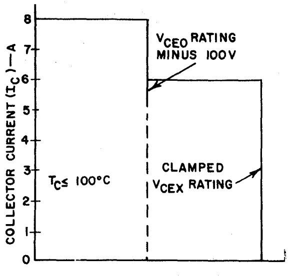
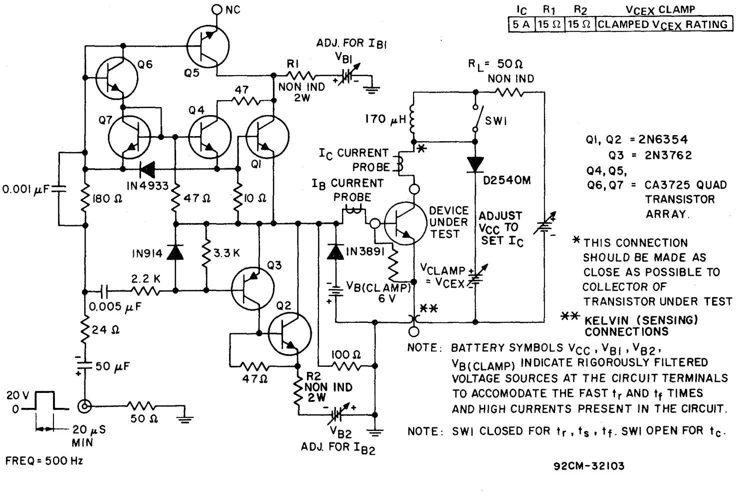


Fig. 15 - Maximum operating conditions for switching between saturation and cutoff.



I_C	R_1	R_2	V_{CEX} CLAMP
5 A	15 Ω	15 Ω	CLAMPED V_{CEX} RATING

Q1, Q2 = 2N6354
Q3 = 2N3762
Q4,Q5, Q6,Q7 = CA3725 QUAD TRANSISTOR ARRAY.

* THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

** KELVIN (SENSING) CONNECTIONS

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

Fig. 16 - Circuit for measuring switching times.

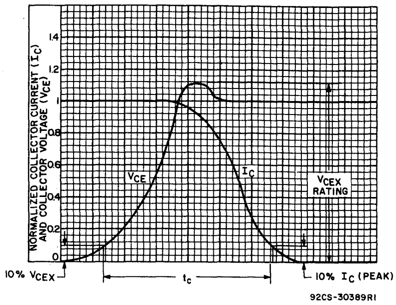


Fig. 17 - Oscilloscope display for measurement of clamped induction switching time (t_C).

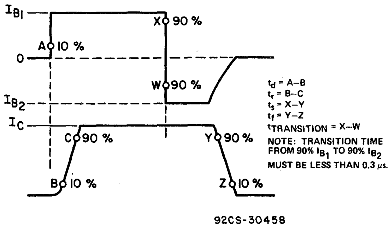


Fig. 18 - Phase relationship between input and output current showing reference points for specification of switching times.

BUX37

15-Ampere N-P-N Monolithic Darlington Power Transistor

400 V , 35 W
Gain of 20 at 15A

The RCA-BUX37 is a monolithic n-p-n silicon Darlington transistor designed for automotive electronic power applications. The pi-nu construction of this device provides good forward and reverse second-breakdown capability.

The RCA-BUX37 is supplied in the steel JEDEC TO-204MA hermetic package.

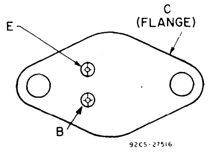
Features:

- *High reverse second-breakdown capability*

Applications:

- *Power switching*
- *Solenoid drivers*
- *Automotive Ignition*
- *Series and shunt regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

$V_{CEO}(sus)$	400	V
V_{EBO}	7	V
I_C	15	A
I_B	4	A
P_T		
$T_C \leq 100°C$	35	W
$T_C > 100°C$	Derate Linearly 0.7	W/°C
T_{stg}, T_J	−65 to 150	°C
T_L		
At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.	235	°C

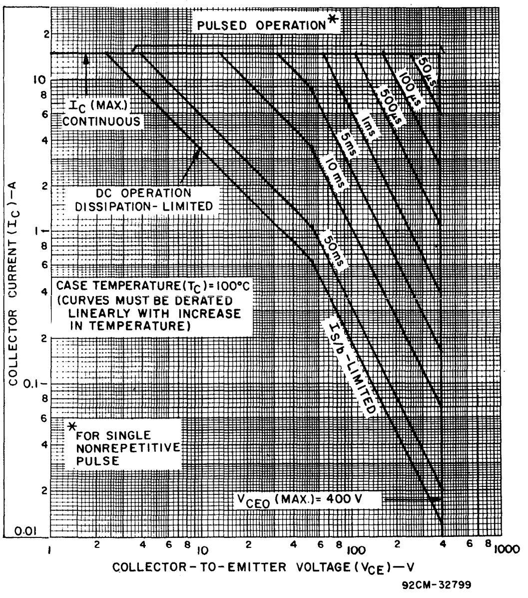


Fig. 1—Maximum operating areas (T_C= 100°C).

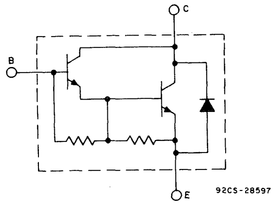


Fig. 2—Schematic diagram for all types.

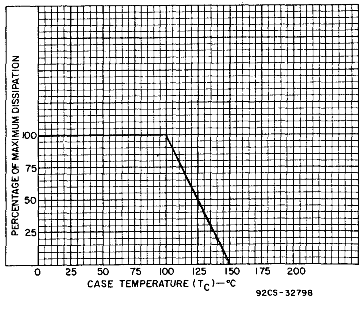


Fig. 3—Derating curve.

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS		UNITS
	VOLTAGE V dc		CURRENT A dc		BUX37		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
I_{CEO}	400			0	—	0.25	mA
$V_{CEO}(sus)^b$ L = 1.5 mH			5ᵃ	0	400	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	
h_{FE}	5		15ᵃ		20	—	
$V_{BE}(sat)$			10ᵃ	0.15	—	2.7	V
T_C = −40°C			10ᵃ	0.15	—	3.5	
$V_{CE}(sat)$			7ᵃ 10ᵃ	0.07 0.15	— —	1.5 2	
T_C = −40°C			10ᵃ	0.15	—	2.9	
$R_{\theta JC}$					—	1.5	°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ≤2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

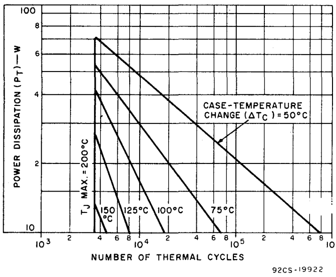


Fig. 4—Thermal-cycling rating chart.

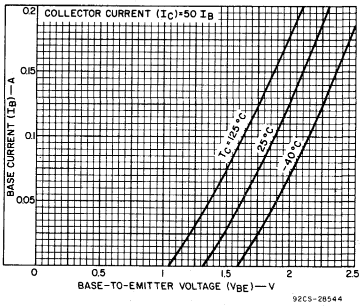


Fig. 5—Typical input characteristics.

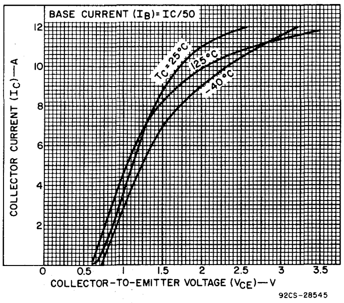


Fig. 6—Typical output characteristics.

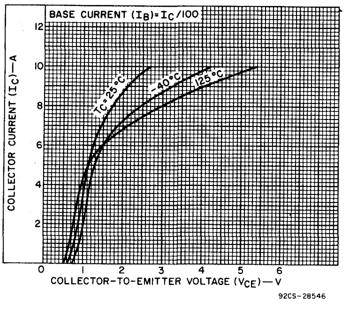


Fig. 7—Typical output characteristics.

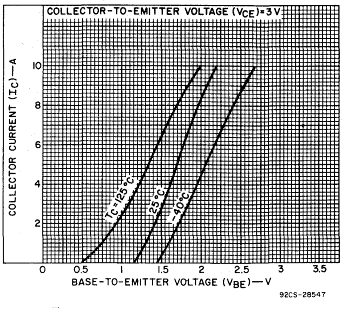


Fig. 8—Typical transfer characteristics.

BUX39

High-Current, High-Speed High-Power Silicon N-P-N Transistor

For Switching and Amplifier Applications in Industrial and Commercial Service

The RCABUX39 is an epitaxial silicon n-p-n power transistor that has high current and high power handling capability and fast switching speed.

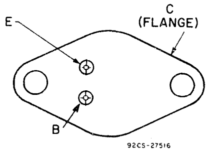
This device is especially suitable for switching-control amplifiers, power gates, switching regulators, power-switching circuits converters, inverters, control circuits. Other recommended applications include dc-rf amplifiers, and power oscillators.

The BUX39 is supplied in a steel JEDEC TO-204MA hermetic package.

Features:

- **Maximum area-of-operation curves for dc and pulse operation—$I_{S/b}$ limit begins at 25 V**
- **Fast turn-on- time — 1 μs at I_C = 15 A**
- **High-current capability—**
  h_{FE}, V_{CE}(sat), V_{BE}(sat) measured at I_C = 10 A

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{CBO}	120	V
V_{CEX}		
V_{BE} = —1.5 V	120	V
V_{CER}		
R_{BE} = 100 Ω	110	V
V_{CEO}(sus)	90	V
V_{EBO}	7	V
I_C	30	A
I_{CM}	40	A
I_B	6	A
P_T		
T_C ≤25°C	120	W
T_C ≥25°C, derate linearly	0.68	W/°C
T_{stg}, T_J	—65 to 100	°C
T_L		
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230	°C

THERMAL FATIGUE INSPECTION

Pulsed Test:

"on": 2 minutes at 56 watts P_T
"off": 1 minute at 56 watts P_T
T_C = 125°C max.
ΔT_C = 50°C max.
T_J = 175°C max.

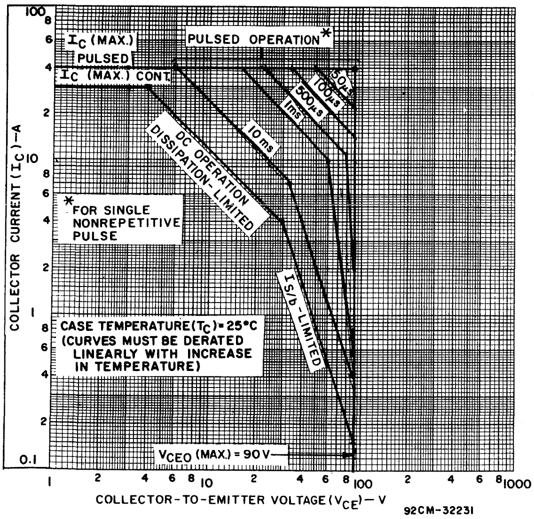


Fig. 1—Maximum operating areas.

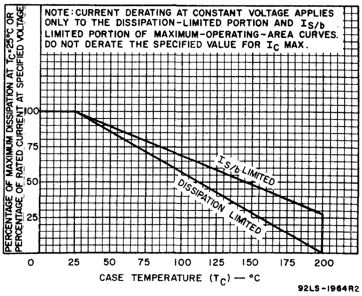


Fig. 2—Derating curves.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc					
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	70				—	—	1	mA
I_{CEX}	120	-1.5			—	—	1	
T_C = 125°C	120	-1.5			—	—	5	
I_{EBO}		-5	0		—	—	1	
$V_{CEO}(sus)^a$ · L = 25 mH			0.2b	0	90	—	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0'		7	—	—	
h_{FE}	4		12b		15	—	45	
	4		20b		8	—	—	
$V_{BE}(sat)$			20b	2.5	—	2.1	2.5	V
$V_{CE}(sat)$			12b 20b	1.2 2.5	— —	0.7 1.25	1.2 1.6	
$I_{S/b}$ t = 1 s	45 30				1 4	— —	— —	A
f_T	15		1		8	—	—	MHz
t_{ON} $t_d + t_r$	V_{CC} = 30 V		20	2.5	—	0.8	1.5	μs
t_s			20	2.5c	—	0.55	1	
t_f			20	2.5c		0.15	0.3	
$R_{\theta JC}$					—	—	1.46	°C/W

a **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

b Pulsed; pulse duration ≤ 300 μs, duty factor ≤ 2%.

c $I_{B_1} = -I_{B_2}$.

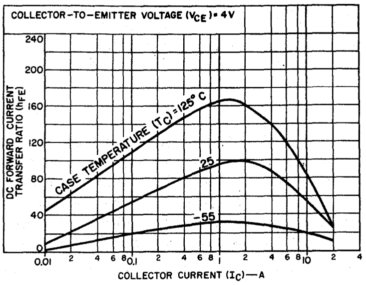


Fig. 3—Typical DC beta characteristics.

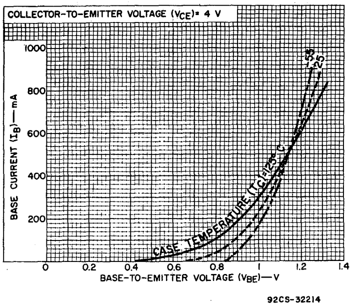


Fig. 4—Typical input characteristics.

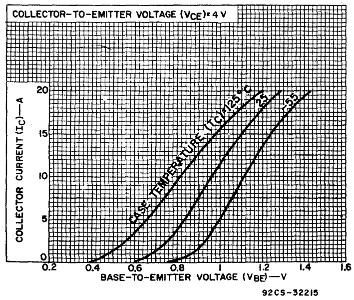


Fig. 5—Typical transfer characteristics.

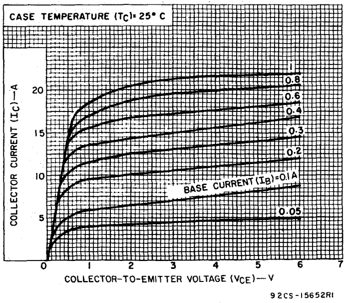


Fig. 6—Typical output characteristics.

BUX40A

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistor

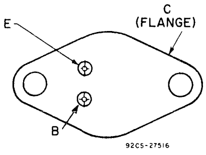
Features:

V_{CEO} —— 125 V
I_C —— 20 A
P_T —— 120 W

The RCA-BUX40A is an epitaxial silicon n-p-n transistor having high-voltage and high-current capabilities and featuring fast-switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers.

The RCA-BUX40A is supplied in a steel JEDEC TO-204MA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX40A	
V_{CBO}	160	V
V_{CER} R_{BE} = 100 Ω	150	V
V_{CEO}	125	V
V_{CEX} V_{BE} = −1.5 V	160	V
V_{EBO}	7	V
I_C	20	A
I_{CM}	28	A
I_B	4	A
P_T:		
At $T_C \leq 25°C$	120	W
At $T_C > 25°C$ derate linearly	0.69	W/°C
T_{stg}, T_J	−65 to +200	°C
T_L At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

THERMAL FATIGUE INSPECTION

Pulsed test:

20,000 cycles
"on": 2 minutes at 56 Watts P_T
"off": 1 minute at 0 Watts P_T
T_C = 125°C max.
$\triangle T_C$ = 50°C max.
T_J = 175°C max.

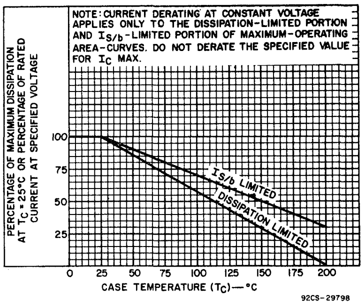


Fig. 2— Derating curves for $I_{S/b}$ and dissipation.

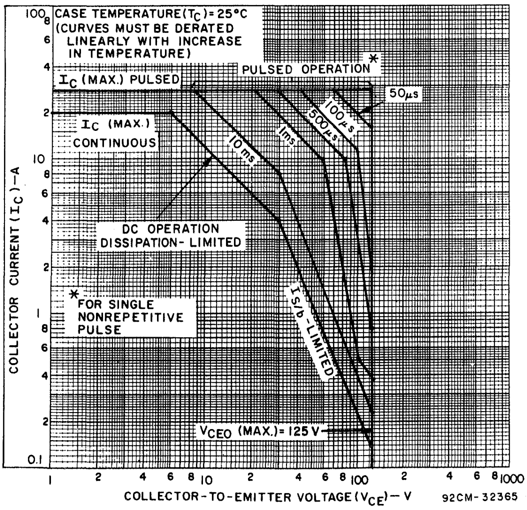


Fig. 1— Maximum safe-operating areas (T_C = 25°C).

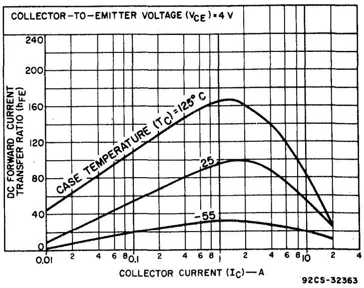


Fig. 3—Typical dc beta characteristics.

BUX40A

ELECTRICAL CHARACTERISTICS, *AT Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX40A			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	100			0	—	—	1	mA
I_{CEX}	160	−1.5			—	—	1	
T_C = 125°C		−1.5			—	—	5	
I_{EBO}		−5	0		—	—	1	
$V_{CEO}(sus)^b$			0.2ª	0	125	—	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	—	
h_{FE}	4 4		10ª 15ª		15 8	— —	80 —	
$V_{BE}(sat)$			15ª	1.88	—	1.3	2	V
$V_{CE}(sat)$			10ª 15ª	1 1.88	— —	0.3 0.5	1.2 1.6	
f_T	15		1		8	—	—	MHz
$I_{S/b}$ t = 1 s, nonrepetitive	50 30				1 4	— —	— —	A
t_{ON}	V_{CC} = 30 V		15	1.88	—	0.6	1.2	μs
t_s I_{B1} = I_{B2}			15	1.88	—	0.8	1	
t_f I_{B1} = I_{B2}			15	1.88	—	0.15	0.4	
$R_{\theta JC}$					—	—	1.46	°C/W

ª Pulsed; pulse duration = 300 μs, duty factor ≤ 2 %.

ᵇ **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

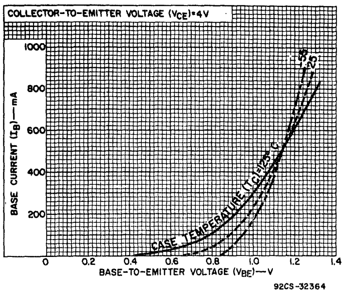


Fig. 4—Typical input characteristics.

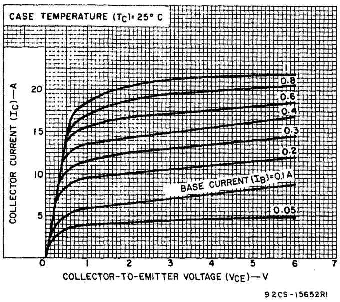


Fig. 5—Typical output characteristics.

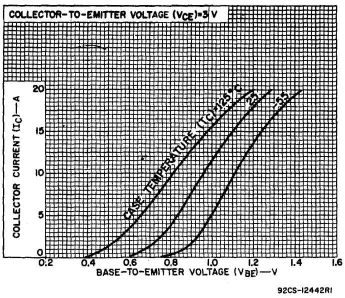


Fig. 6—Typical transfer characteristics.

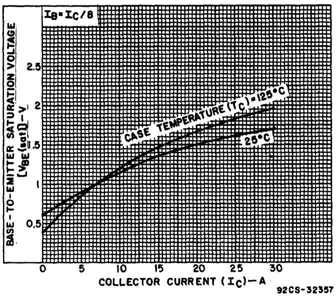


Fig. 7—Typical base-to-emitter saturation voltage characteristics.

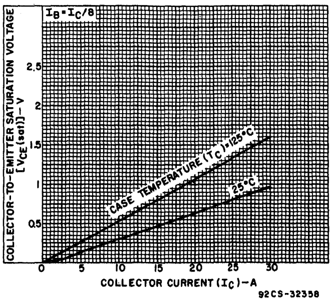


Fig. 8—Typical collector-to-emitter saturation voltage characteristics.

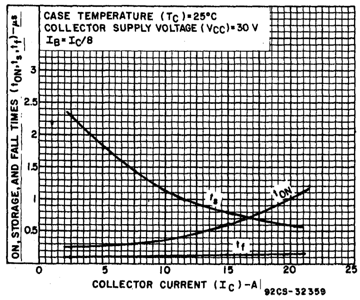


Fig. 9—Typical switching time characteristics.

BUX41, BUX41N

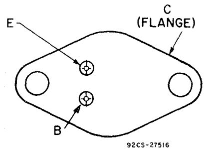
High-Current, High-Power, High-Speed Silicon N-P-N Power Transistors

The RCA-BUX41 and-BUX41N are epitaxial-base silicon n-p-n transistors having high-voltage and high-current capabilities and featuring fast-switching speed at low saturation voltage. They are especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers. The RCA-BUX41 and-BUX41N are supplied in a steel JEDEC TO-204MA hermetic package.

Features:

	BUX41	BUX41N
V_{CEO} ——	*200 V*	*160 V*
I_C ——	*15 A*	*18 A*
P_T ——	*120W*	*120 W*

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX41	BUX41N	
V_{CBO}	250	220	V
V_{CER} R_{BE} = 100 Ω	240	200	V
V_{CEO}	200	160	V
V_{CEX} V_{BE} = −1.5 V	250	220	V
V_{EBO}	7	7	V
I_C	15	18	A
I_{CM}	20	25	A
I_B	3	3.6	A
P_T $T_C \leq 25°C$	120	120	W
$T_C > 25°C$ derate linearly	0.69	0.69	W/°C
T_{stg}, T_J	−65 to +200	−65 to +200	°C
T_L At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max	235	235	°C

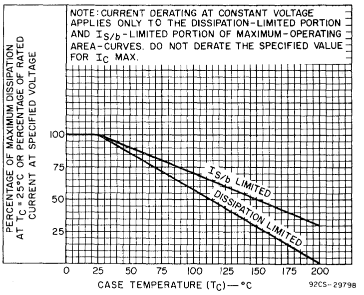


Fig. 1—Derating curves for $I_{S/B}$ and dissipation.

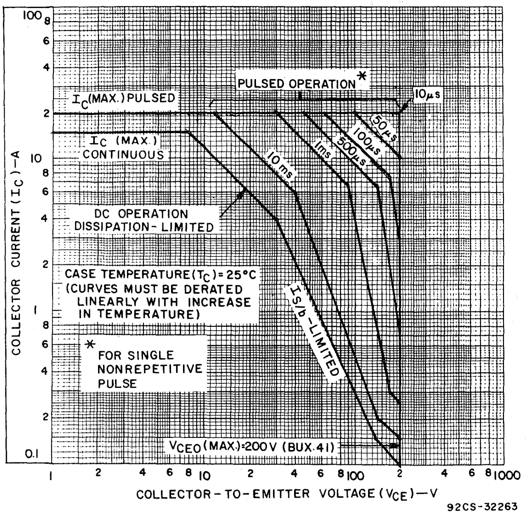


Fig. 2— Maximum safe-operating areas for BUX41 (T_C = 25°C).

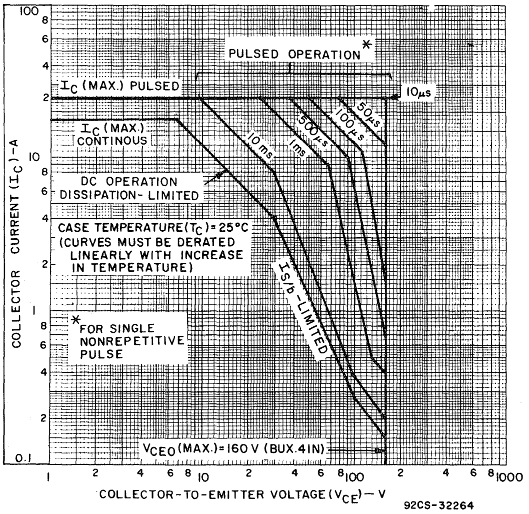


Fig. 3—Maximum safe-operating areas for BUX41N (T_C = 25°C).

BUX41, BUX41N

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C)* = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BUX41		BUX41N		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	160 130			0 0	— —	1 —	— —	— 1	mA
I_{CEX}	250 220	−1.5 −1.5			— —	1 —	— —	— 1	
I_{CEX} T_C = 125°C	250 220	−1.5 −1.5			— —	5 —	— —	— 5	
I_{EBO}		−5			—	1	—	1	
V_{CEO}(sus)[a]			0.2[b]		200	—	160	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	7	—	
h_{FE}	4 4 4		5[b] 8[b] 12[b]		15 8 —	45 — —	— 15 8	— 45 —	
V_{BE}(sat)			8[b] 12[b]	1 1.5	— —	2 —	— —	— 2	V
V_{CE}(sat)			5[b] 8[b] 8[b] 12[b]	0.5 1 0.8 1.5	— — — —	1.2 1.6 — —	— — — —	— — 1.2 1.6	
$I_{S/b}$ t_p = 1s nonrep.	135 100 30				0.15 — 4	— — —	— 0.27 4	— — —	A
f_T	15		1	—	8	—	8	—	MHz
t_{ON}	150[c] 30[c]		8 12	1 1.5	— —	1 —	— —	— 1.3	µs
t_s I_{B1} = I_{B2}	150[c] 30[c]		8 12	1 1.5	— —	1.7 —	— —	— 1.5	
t_f I_{B1} = I_{B2}	150[c] 30[c]		8 12	1 1.5	— —	0.8 —	— —	— 0.8	
$R_{\theta JC}$					—	1.46	—	1.46	°C/W

[a] **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

[b] Pulsed; pulse duration = 300 µs, duty factor ⩽ 2%.

[c] V_{CC}.

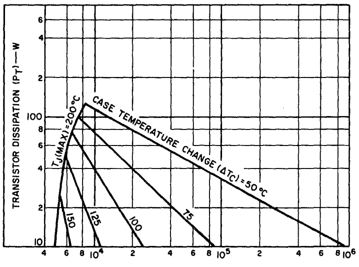


Fig. 4—Thermal-cycling rating chart for both types.

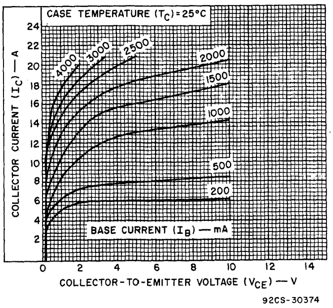


Fig. 5—Typical output characteristics for both types.

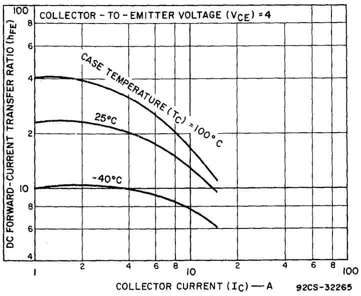


Fig. 6—Typical dc beta characteristics for both types.

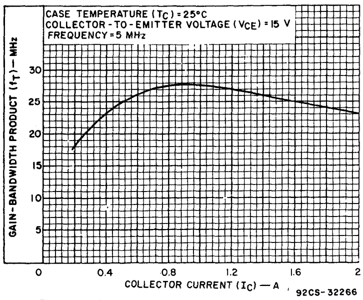


Fig. 7—Typical gain-bandwidth product characteristic for both types.

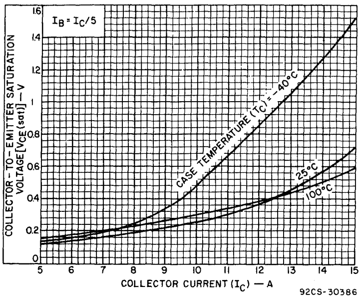


Fig. 8—Typical collector-to-emitter saturation voltage characteristics for both types.

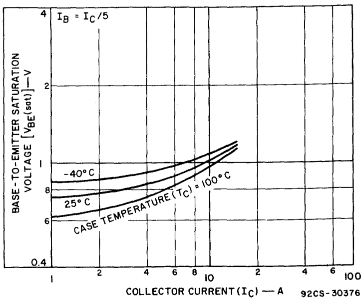


Fig. 9—Typical base-to-emitter saturation voltage characteristics for both types.

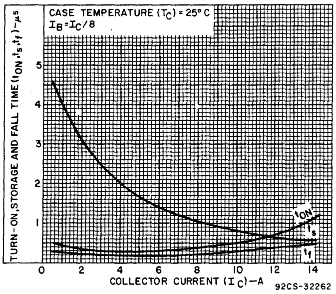


Fig. 10—Typical saturated-switching times as function of collector current for both types.

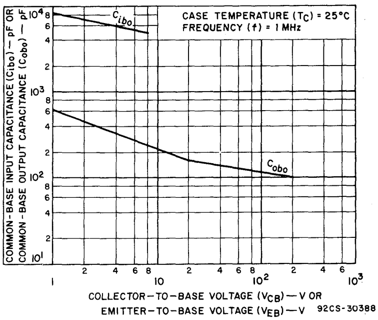


Fig. 11—Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for both types.

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistor

Features:

V_{CEO} — 250 V
I_C — 12 A
P_T — 120 W

The RCA-BUX42 is an epitaxial-base silicon n-p-n transistor having high-voltage and high-current capabilities and featuring fast switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-contrtol amplifiers.

The RCA-BUX42 is supplied in a steel JEDCEC TO-204MA hermetic package.

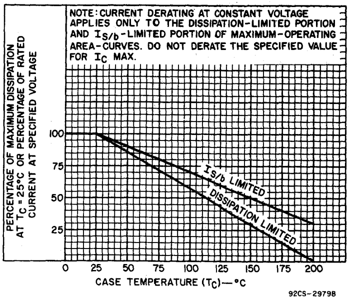
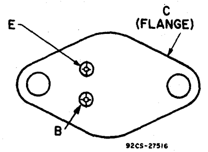


Fig. 1—Derating curves for $I_{S/b}$ and dissipation.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX42	
V_{CBO}	300	V
V_{CER} R_{BE} = 100Ω	290	V
V_{CEO}	250	V
V_{CEX} V_{BE} = —1.5V	300	V
V_{EBO}	7	V
I_C	12	A
CM	15	A
I_B	2.4	A
P_T		
T_C ≤25°C	120	W
T_C >25°C	0.69	W/°C
T_{stg}, T_J	—65 to +200	°C
T_L At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

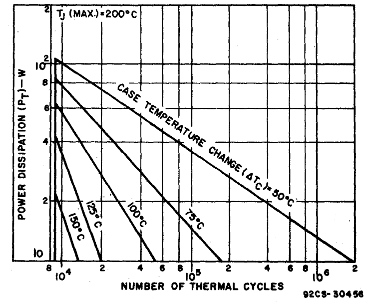


Fig. 2 — Thermal-cycling chart.

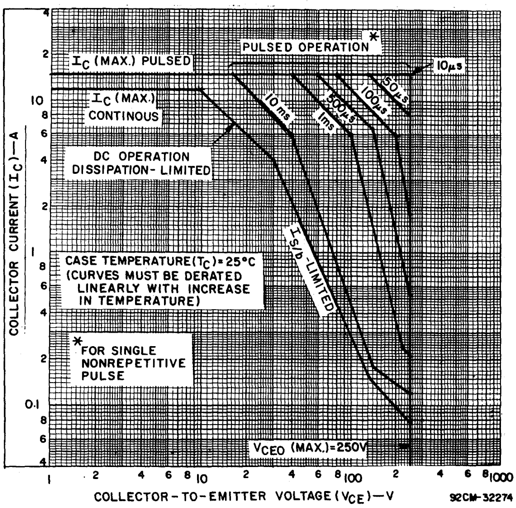


Fig. 3— Maximum safe-operating areas (T_C = 25°C).

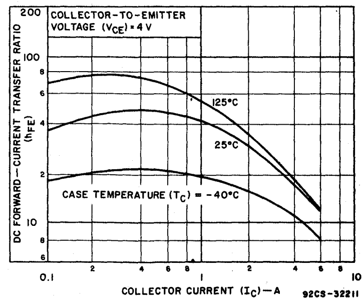


Fig. 4—Typical dc beta characteristics.

BUX42

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX42			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	200			0	—	—	1	mA
I_{CEX}	300	−1.5			—	—	1	
T_C = 125°C	300	−1.5			—	—	5	
I_{EBO}		−5	0		—	—	1	
$V_{CEO}(sus)^b$			0.2ᵃ	0	250	—	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	—	
h_{FE}	4 4		4ᵃ 6ᵃ		15 8	— —	45 —	
$V_{BE}(sat)$			6ᵃ	0.75	—	1	2	V
$V_{CE}(sat)$			4ᵃ 6ᵃ	0.4 0.75	— —	0.3 0.5	1.2 1.6	
f_T	15		1		8	—	—	MHz
$I_{S/b}$ t = 1 s, nonrepetitive	135 30				0.15 4	— —	— —	A
t_{ON}	V_{CC} = 150 V		6	0.75		0.45	1	μs
t_s $I_{B1} = I_{B2}$			6	0.75	—	1.35	2	
t_f $I_{B1} = I_{B2}$			6	0.75	—	0.7	1.2	
$R_{\theta JC}$					—	—	1.46	°C/W

ᵃ Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

ᵇ **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

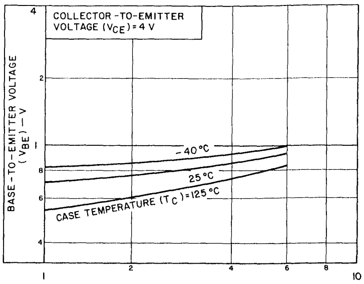


Fig. 5—Typical base-to-emitter voltage as a function of collector current.

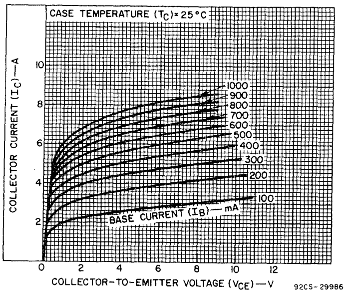


Fig. 6—Typical output characteristics.

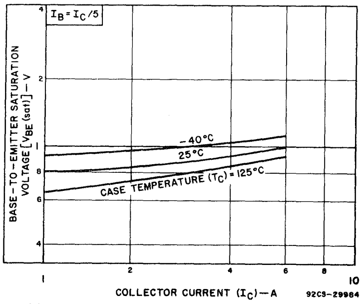


Fig. 7—Typical base-to-emitter saturation voltage as a function of collector current.

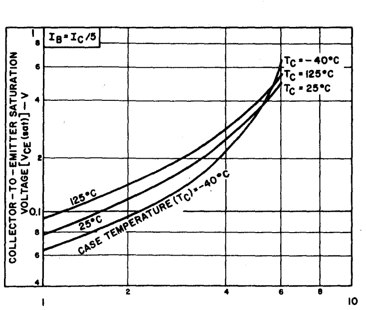


Fig. 8—Typical collector-to-emitter saturation voltage as a function of collector current.

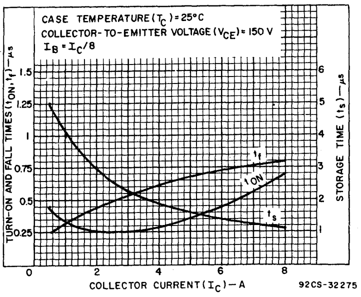


Fig. 9—Typical saturated switching times as a function of collector current.

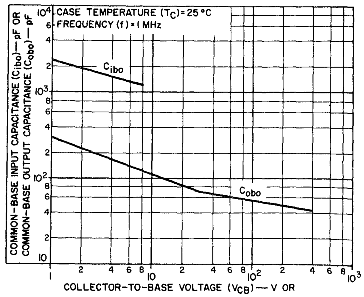


Fig. 10—Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

High-Voltage Power Transistor

For Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-BUX43 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. It is specially designed for use in off-line power supplies and is also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUX43 is supplied in a steel JEDEC TO-204MA hermetic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{CBO}	400	V
V_{CEX}		
$V_{BE} = -1.5$ V	400	V
V_{CER}		
$R_{BE} = 100\,\Omega$	360	V
V_{CEO}	325	V
V_{EBO}	7	V
I_C	10	A
I_{CM}	12	A
I_B	2	A
P_T		
T_C up to 25°C	120	W
T_C above 25°C, derate linearly	0.69	W/°C
T_{stg}, T_J	−65 to 200	°C
T_L		
At distance ⩾ 1/16 in. (1.58 mm) from seating plane for 10 s max	235	°C

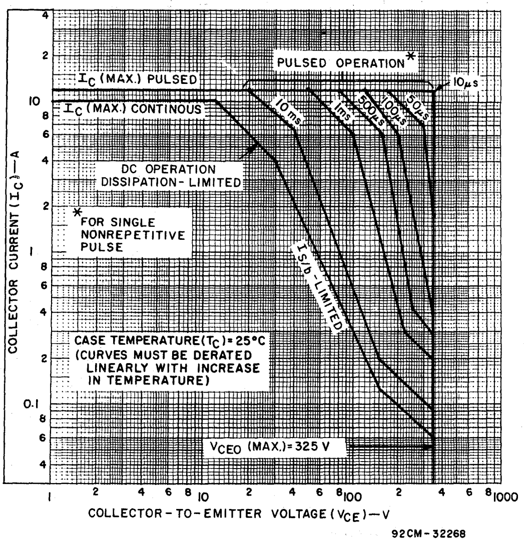


Fig. 1— Maximum operating areas.

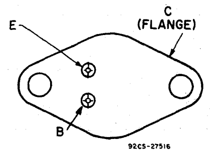
Features:

- **Fast Switching Speed**
- **High Voltage Rating:**
  V_{CEX} = 400 V
- **Low V_{CE}(sat) at I_C = 5 A**
- **Steel Hermetic TO-204MA Package**

Applications:

- **Off-Line Power Supplies**
- **High-Voltage Inverters**
- **Switching Regulators**

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

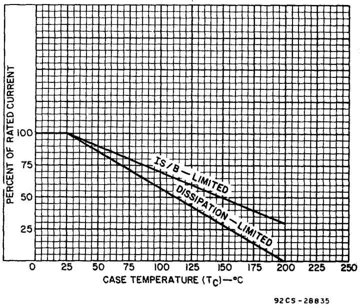


Fig. 2— Dissipation and $I_{S/b}$ derating curves.

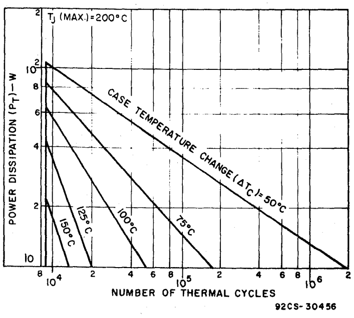


Fig. 3— Thermal-cycling chart.

BUX43

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc					
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	260				—	—	1	mA
I_{CEX}	400	−1.5			—	—	1	
T_C = 125°C	400				—	—	5	
I_{EBO}		−5	0		—	—	1	
$V_{CEO}(sus)^a$ L = 25 mH			0.2^b	0	325	—	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	—	
h_{FE}	4 4		3^b 5^b		15 8	— —	60 —	
$V_{BE}(sat)$			5^b	1	—	1.2	2	V
$V_{CE}(sat)$			3^b 5^b	0.375 1	— —	0.3 0.5	1 1.6	
$I_{S/b}$ t = 1s	135 30				0.15 4	— —	— —	A
f_T	15		1		8	—	—	MHz
t_{ON} $t_d + t_r$	V_{CC} = 150 V		5	1	—	0.45	1	μs
t_s			5	1^c	—	1.5	2.2	
t_f			5	1^c	—	0.6	1.2	
$R_{\theta JC}$					—	—	1.46	°C/W

[a] **CAUTION:** sustaining $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

[b] Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

[c] $I_{B_1} = -I_{B_2}$.

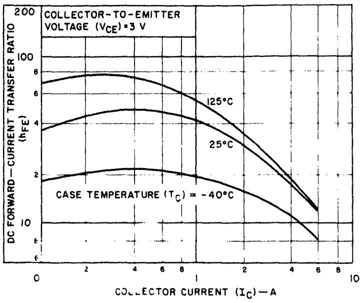


Fig. 4— Typical dc beta characteristics.

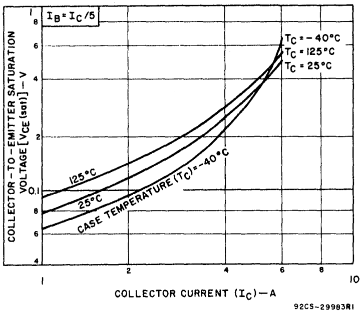


Fig. 5—Typical collector-to-emitter saturation voltage as a function of collector current.

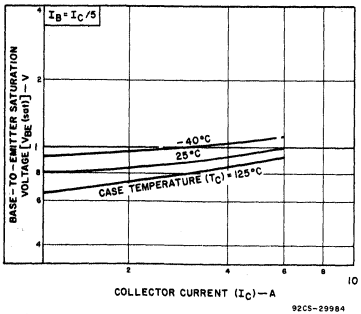


Fig. 6—Typical base-to-emitter saturation voltage as a function of collector current.

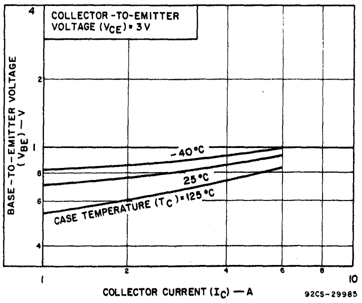


Fig. 7—Typical base-to-emitter voltage as a function of collector current.

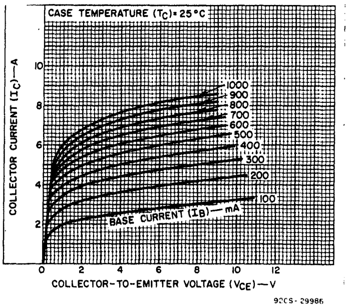


Fig. 8—Typical output characteristics.

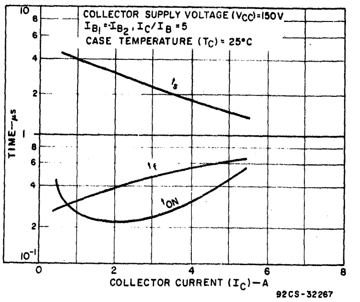


Fig. 9—Typical saturated switching time characteristics.

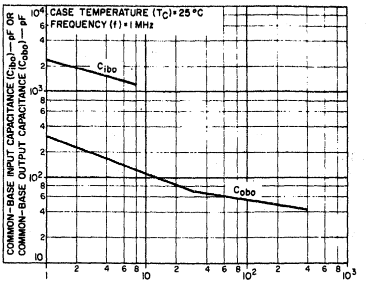


Fig. 10—Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

BUX44

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistor

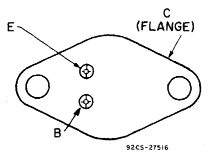
The RCA-BUX44 is an epitaxial-base silicon n-p-n transistor having high-voltage and high-current capabilities and featuring fast-switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers.

The RCA-BUX44 is supplied in a steel JEDEC TO-204MA hermetic package.

Features:

V_{CEO} — — 400 V
I_C — — 8 A
P_T — — 120 W

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX44	
V_{CBO}	450	V
V_{CER}		
R_{BE} = 100Ω	440	V
V_{CEO}	400	V
V_{CEX}		
V_{BE} = −1.5 V	450	V
V_{EBO}	7	V
I_C	8	A
I_{CM}	10	A
I_B	1.6	A
P_T		
$T_C \leq$ 25°C	120	W
$T_C >$ 25°C derate linearly	0.69	W/°C
T_{stg}, T_J	−65 to +200	°C
T_L		
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max	235	°C

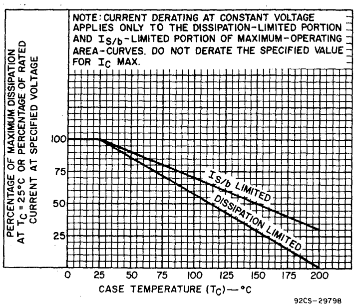


Fig. 2— Derating curves for $I_{S/b}$ and dissipation.

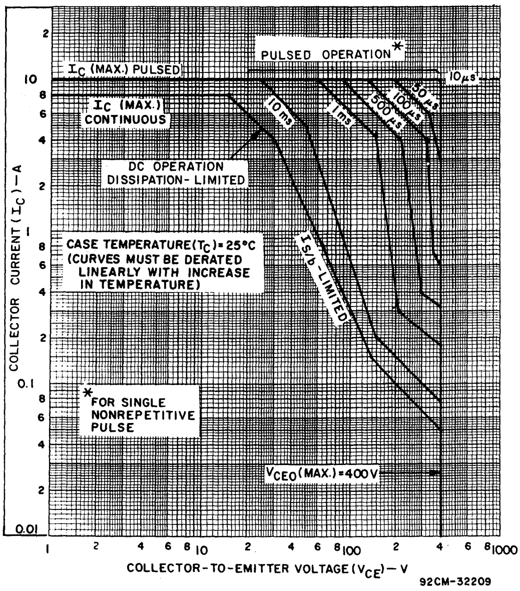


Fig. 1— Maximum safe-operating areas (T_C = 25°C).

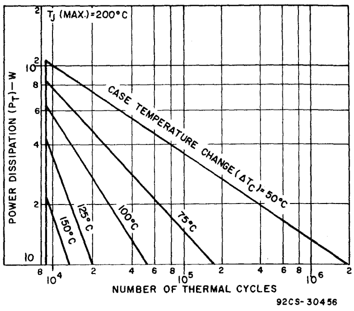


Fig. 3— Thermal-cycling chart.

BUX44

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C*
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX44			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	320			0	–	–	1	mA
I_{CEX}	450	−1.5			–	–	1	
$T_C = 125°C$	450	−1.5			–	–	5	
I_{EBO}		−5	0		–	–	1	
$V_{CEO}(sus)$[b]			0.2[a]	0	400	–	–	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	–	–	
h_{FE}	4 4		2[a] 4[a]		15 8	– –	45 –	
$V_{BE}(sat)$			4[a]	0.8	–	1	2	V
$V_{CE}(sat)$			2[a] 4[a]	0.25 0.8	– –	0.15 0.25	1 2	
f_T	15		1		8	–	–	MHz
$I_{S/b}$ t = 1 s, nonrepetitive	135 30				0.15 4	– –	– –	A
t_{ON}	V_{CC} = 150 V		4	0.8	–	0.4	1	μs
t_s $I_{B1} = I_{B2}$			4	0.8	–	1.7	2.5	
t_f $I_{B1} = I_{B2}$			4	0.8	–	0.65	1.2	
$R_{\theta JC}$					–	–	1.46	°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ≤2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

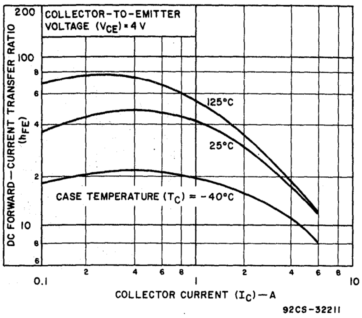


Fig. 4—Typical dc beta characteristics.

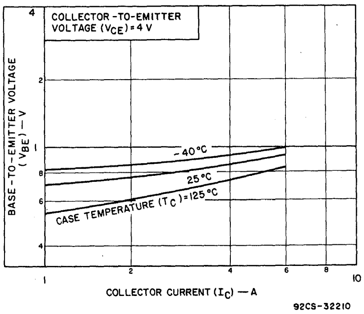


Fig. 5—Typical base-to-emitter voltage as a function of collector current.

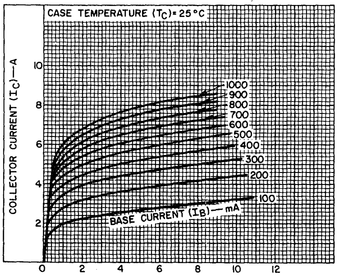


Fig. 6—Typical output characteristics.

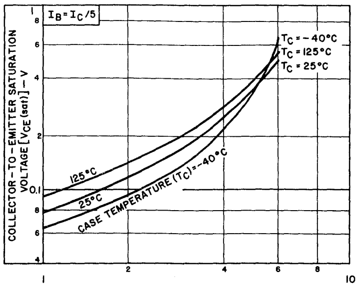


Fig. 7—Typical collector-to-emitter saturation voltage as a function of collector current.

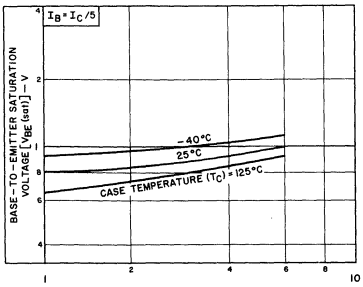


Fig. 8—Typical base-to-emitter saturation voltage as a function of collector current.

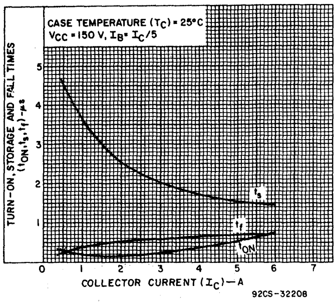


Fig. 9—Typical saturated switching time characteristics.

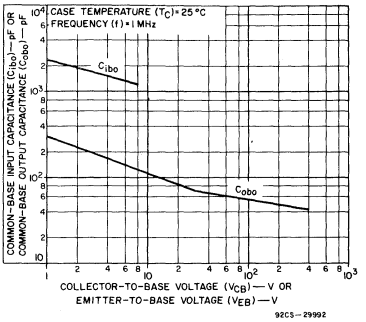


Fig. 10—Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

High-Voltage, High-Power, Silicon N-P-N Power-Switching Transistor

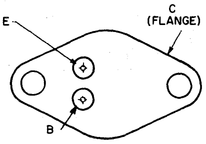
Features:

V_{CEO} — — 500 V
I_C — — 5A
P_T — — 120 W

The RCA-BUX45 is an epitaxial-base silicon n-p-n transistor having high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. It is specially designed for use in off-line power supplies and is also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUX45 is supplied in a steel JEDEC TO-204MA hermetic package.

TERMINAL DESIGNATIONS



92CS-34134

JEDEC TO-204MA

(See dimensional outline "CC".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX45	
V_{CBO}	500	V
V_{CER}		
R_{BE} = 100Ω	500	V
V_{CEO}	500	V
V_{CEX}		
V_{BE} = —1.5 V	500	V
V_{EBO}	7	V
I_C	5	A
I_{CM}	7	A
I_B	1	A
P_T		
$T_C \leqslant$ 25°C	120	W
$T_C >$ 25°C derate linearly	0.69	W/°C
T_{stg}, T_J	—65 to +200	°C
T_L		
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

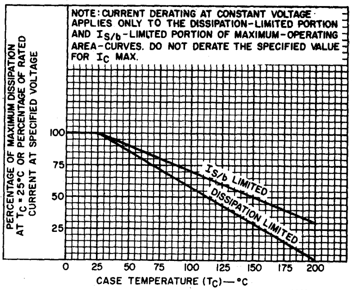


Fig. 2—Derating curves for $I_{S/b}$ and dissipation.

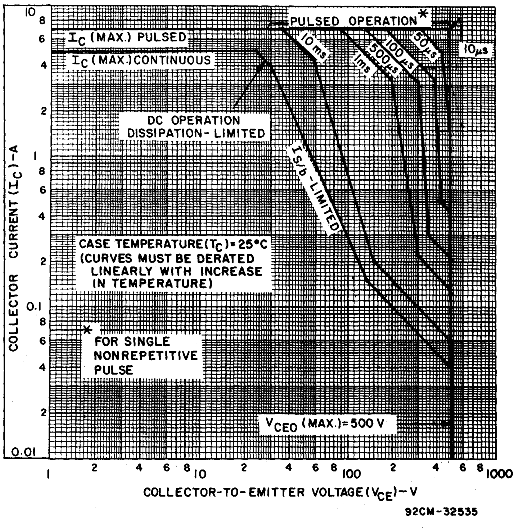


Fig. 1—Maximum safe-operating areas (T_C = 25°C).

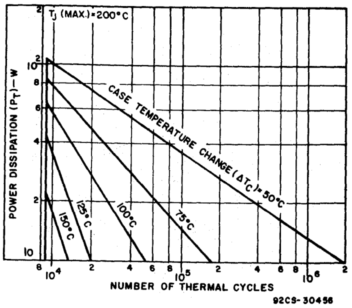


Fig. 3—Thermal-cycling chart.

BUX45

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX45			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	400			0	—	—	1	mA
I_{CEX}	500	—1.5			—	—	1	
T_C = 125°C	500	—1.5			—	—	5	
I_{EBO}		—5	0		—	—	1	
$V_{CEO}(sus)^b$			0.2^a	0	500	—	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	—	
h_{FE}	4		1^a		15	—	45	
	4		2^a		8	—	—	
$V_{BE}(sat)$			2^a	0.4	—	0.8	2	V
$V_{CE}(sat)$			1^a	0.125	—	0.15	1	
			2^a	0.4	—	0.15	2	
f_T	15		1		8	—	—	MHz
$I_{S/b}$	135				0.15	—	—	A
t = 1s, nonrepetitive	30				4	—	—	
t_{ON}	V_{CC} = 100 V		2	0.4	—	0.4	1	µs
t_s $I_{B1} = I_{B2}$			2	0.4	—	3.5	5	
t_f $I_{B1} = I_{B2}$			2	0.4	—	0.6	1.2	
$R_{\theta JC}$					—	—	1.46	°C/W

[a] Pulsed; pulse duration = 300 µs, duty factor ≤ 2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

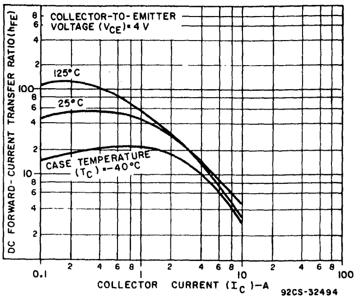


Fig. 4—Typical dc beta characteristics.

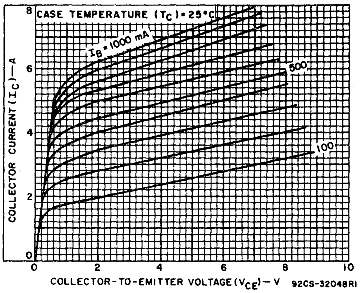


Fig. 5—Typical output characteristics.

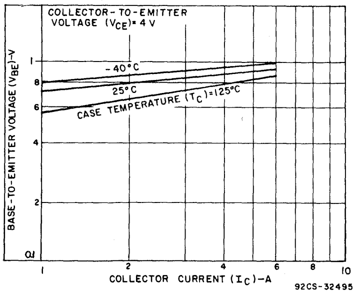


Fig. 6—Typical base-to-emitter voltage as a function of collector current.

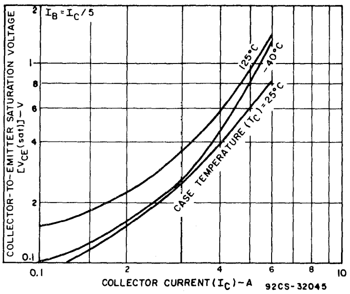


Fig 7—Typical collector-to-emitter saturation voltage as a function of collector current.

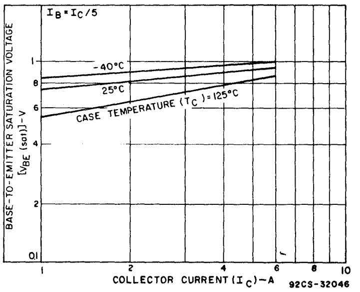


Fig. 8—Typical base-to-emitter saturation voltage as a function of collector current.

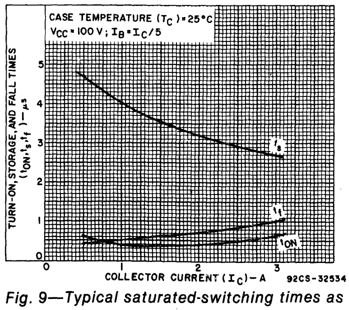


Fig. 9—Typical saturated-switching times as a function of collector current.

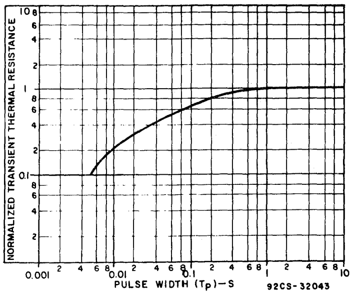


Fig. 10—Typical thermal-response characteristic.

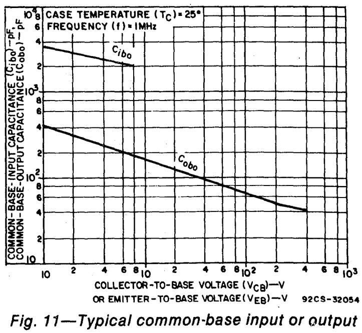


Fig. 11—Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

High-Voltage, High-Power, Silicon N-P-N Power-Switching Transistors

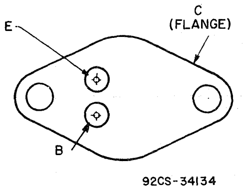
The RCA-BUX47 is an epitaxial-base silicon n-p-n transistor having high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. It is specially designed for use in off-line power supplies and is also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUX47 is supplied in a steel JEDEC TO-204MA hermetic package.

Features:

- V_{CER} -- 850 V
- V_{CEO} -- 400 V
- $I_C(sat)$ -- 6 A
- I_{CM} -- 12 A
- t_f -- 0.8 μs max.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "CC".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{CER}		
R_{BE} = 10 Ω	850	V
V_{CEO}	400	V
V_{CEX}		
V_{BE} = −2.5 V	850	V
I_C	8.5	A
I_{CM}	12	A
I_B	3	A
P_T		
$T_C \leq 25°C$	107	W
$T_C > 25°C$	0.7	W/°C
T_{stg}, T_J	−65 to 175	°C
T_L		
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

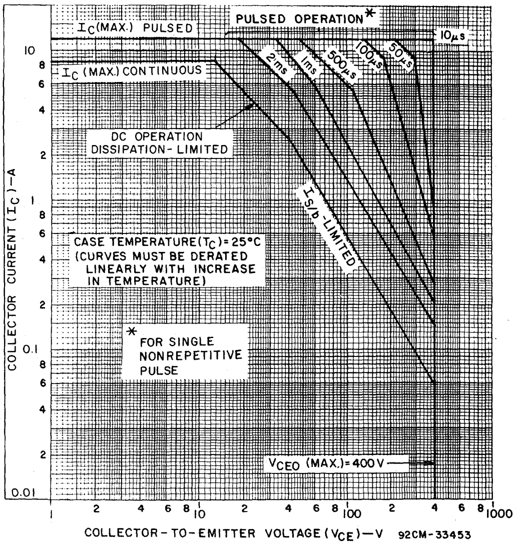


Fig.1 - Maximum safe-operating areas (T_C = 25° C).

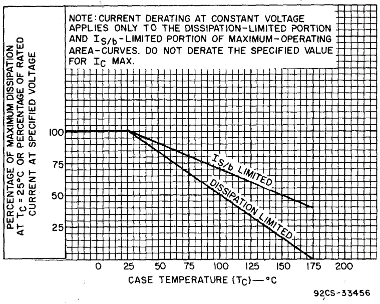


Fig.2 - Derating curves for $I_{S/b}$ and dissipation.

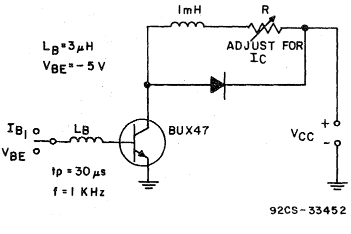


Fig.3 - Switching times test circuit - inductive load.

BUX47

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25° C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX47			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CER} R_{BE} = 10 Ω	850			0	—	—	0.4	mA
T_C = 125°C	850			0	—	—	3	
I_{CEX}	850	−2.5			—	—	0.15	
T_C = 125°C	850	−2.5			—	—	1.5	
I_{EBO}		−5	0		—	—	1	
$V_{CEO}(sus)^b$ L = 25 mH			0.2^a	0	400	—	—	V
$V_{(BR)EBO}$ I_E = 500 mA^a			0		—	—	30	
$V_{BE}(sat)^a$			6	1.2	—	—	1.6	
$V_{CE}(sat)^a$			6	1.2	—	0.6	1.5	
			9	3	—	—	3	
$I_{S/b}$ t = 1s, nonrepetitive	100				0.5	—	—	A
t_{ON}	V_{CC} = 150 V		6	1.2	—	0.5	1	μs
t_s I_{B1} = I_{B2}			6	1.2	—	1.5	3	
t_f I_{B1} = I_{B2}			6	1.2	—	0.5	0.8	
t_f Inductive Load	V_{CC} = 300 V		6	1.2	—	0.2	—	
$R_{\theta JC}$					—	—	1.4	°C/W

[a] Pulsed; pulse duration = 300 μs, factor ≤ 2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

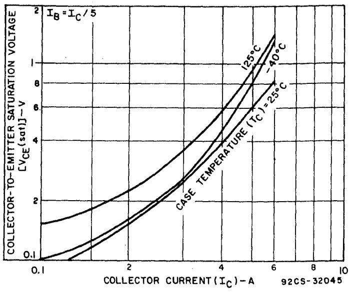


Fig.8 - Typical collector-to-emitter saturation voltage as a function of collector current.

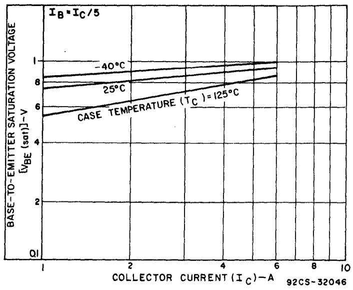


Fig.9 - Typical base-to-emitter saturation voltage as a function of collector current.

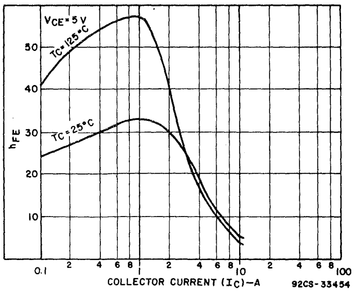


Fig.4 - Static forward current transfer ratio vs. collector current.

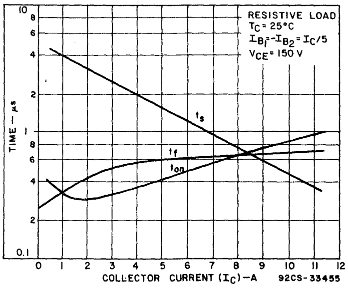


Fig.5 - Switching times vs. collector current.

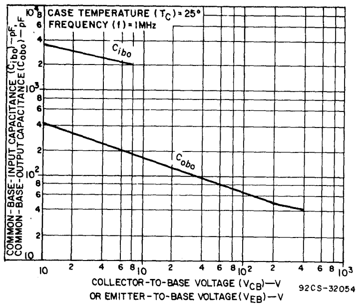


Fig.10 - Typical commonm-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

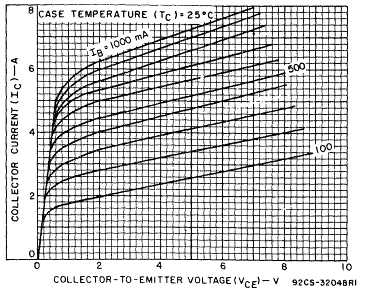


Fig.6 - Typical output characteristics.

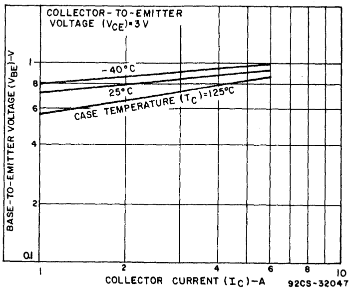


Fig.7 - Typical base-to-emitter voltage as a function of collector current.

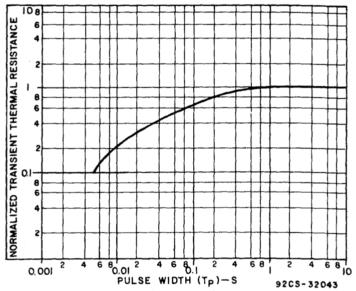


Fig.11- Typical thermal-response characteristic.

BUX66, BUX66A, BUX66B, BUX66C, BUX67, BUX67A, BUX67B, BUX67C

High-Voltage Silicon N-P-N and P-N-P Transistors

For High-Speed Switching and Linear-Amplifier Applications

The RCA-BUX66-series types are silicon p-n-p transistors; the RCA-BUX67-series types are silicon n-p-n transistors. All of these devices feature high breakdown voltage and fast switching speeds. They are intended for a wide variety of applications in ac/dc commercial equipment.

Typical applications include high-voltage operational and linear amplifiers, high-voltage switches, switching regulators, converters, and inverters.

The BUX66,BUX66A,BUX66B,and BUX66C are p-n-p complements to the n-p-n types BUX67, BUX67A, BUX67B, and BUX67C. All are supplied in the JEDEC TO-66 hermetic package.

Features:

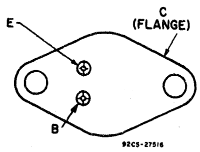
- **High voltage ratings:**
- **Large safe-operating area**
- **Thermal-cycling rating**
- **100-percent tested to assure freedom from second breakdown in both forward- and reverse-bias conditions when operated within specified limits**
- **Economy types for ac/dc circuits**
- **Fast turn-on time at high collector current**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX66◆	BUX66A◆	BUX66B◆	BUX66C◆	
	BUX67	BUX67A	BUX67B	BUX67C	
V_{CBO}	200	300	350	400	V
$V_{CEV}(sus)$					
$V_{BE} = -1.5$ V	200	300	350	400	V
$V_{CER}(sus)$					
$R_{BE} = 100\ \Omega$	175	275	325	375	V
$V_{CEO}(sus)$	150	250	300	350	V
V_{EBO}	6	6	6	6	V
I_C	2	2	2	2	A
I_{CM}	5	5	5	5	A
I_B	1	1	1	1	A
P_T					
Up to 25°C	35	35	35	35	W
Above 25°C, Derate linearly	0.2	0.2	0.2	0.2	W/°C
T_J, T_{stg}	−65 to 200				°C
T_L At distance 1/16 in. (1.58 mm) from seating plane for 10 s max.	235	235	235	235	°C

◆For p-n-p devices, voltage and current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-66
(See dimensional outline "N".)

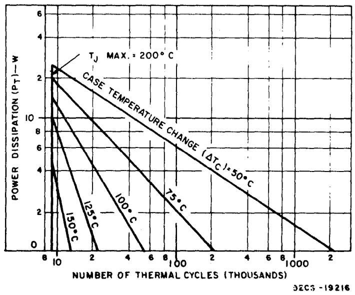


Fig. 1 – Thermal-cycling rating chart for BUX66-series types.

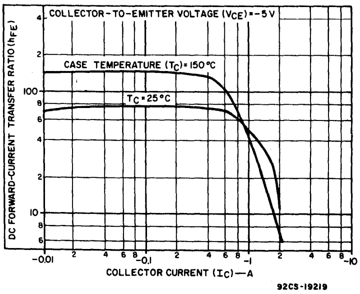


Fig. 2 – Typical dc beta characteristics for BUX66-series types.

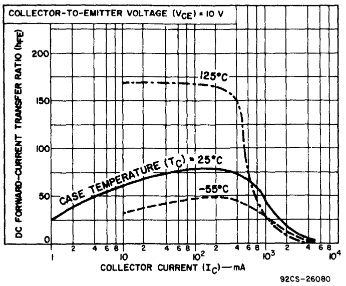


Fig. 3 – Typical dc beta characteristics for BUX67-series types.

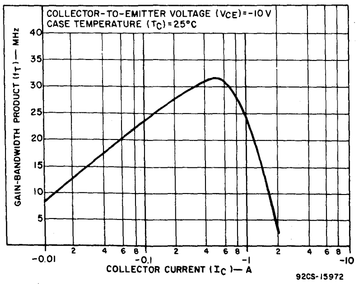


Fig. 4 – Typical gain-bandwidth product for BUX66-series types.

BUX66, BUX66A, BUX66B, BUX66C, BUX67, BUX67A, BUX67B, BUX67C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS♦				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		BUX66♦ BUX67		BUX66A♦ BUX67A		BUX66B♦ BUX67B		BUX66C♦ BUX67C		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	150			0	–	10	–	10	–	–5	–	–5	mA
I_{CEX}	200	–1.5			–	8	–	–	–	–	–	–	
	300	–1.5			–	–	–	8	–	–	–	–	
	350	–1.5			–	–	–	–	–	–8	–	–	
	400	–1.5			–	–	–	–	–	–	–	–8	
T_C = 100°C	200	–1.5			–	10	–	–					
	300	–1.5			–	–	–	10					
	350	–1.5			–	10	–	–	–	–10	–	–	
	400	–1.5			–	–	–	10	–	–	–	–10	
I_{EBO}		–6	0		–	1	–	1	–	1	–	1	mA
h_{FE}	5		1[a]		10	150	10	150	10	150	10	150	
$V_{CEO(sus)}$			0.2[a]	0	150[c]	–	250[c]	–	–300[c]	–	–350[c]	–	V
$V_{CER(sus)}$ R_{BE} = 50 Ω			0.2		175[c]	–	275[c]	–	–325[c]	–	–375[c]	–	
$V_{BE(sat)}$			1[a]	0.15	–	1.5	–	1.5	–	–1.5	–	–1.5	V
$V_{CE(sat)}$			1[a]	0.15	–	2.5	–	2.5	–	–2.5	–	–2.5	V
C_{obo} V_{CB} = 10 V f = 1 MHz													pF
BUX67 Types			0		–	120	–	120	–	220	–	220	
BUX66 Types			0		–	200	–	200	–	220	–	220	
$I_{S/b}$ t = 1 s, nonrep.	40				875	–	875	–	–875	–	–875	–	mA
$E_{S/b}$ L = 100 µH R_{BE} = 20 Ω		–4			50	–	200	–	200	–	50	–	µJ
$\|h_{fe}\|$ f = 5 MHz													
BUX67 Types	10		0.2		2	–	2	–	2	–	2	–	
BUX66 Types	–10		–0.2		4	–	4	–	4	–	4	–	
t_r V_{CC} = 200 V													µs
BUX67 Types			1	0.1[b]	–	3	–	3	–	3	–	3	
BUX66 Types			–1	–0.10[b]	–	0.6	–	0.6	–	0.6	–	0.6	
t_s V_{CC} = 200 V													
BUX67 Types			1	0.1[b]	–	4	–	4	–	4	–	4	
BUX66 Types			–1	–0.10[b]	–	2.5	–	2.5	–	2.5	–	2.5	
t_f V_{CC} = 200 V													
BUX67 Types			1	0.1[b]	–	3	–	3	–	3	–	3	
BUX66 Types			–1	–0.10[b]	–	0.6	–	0.6	–	0.6	–	0.6	
$R_{\theta JC}$						5	–	5	–	5	–	5	°C/W

[a] Pulsed: Pulse duration = 300 µs; duty factor ≤ 2%. [b] $I_{B1} = I_{B2}$ ♦For p-n-p devices, voltage and current values are negative.

[c] Sustaining voltages, $V_{CEO(sus)}$ and $V_{CER(sus)}$ MUST NOT be measured on a curve tracer.

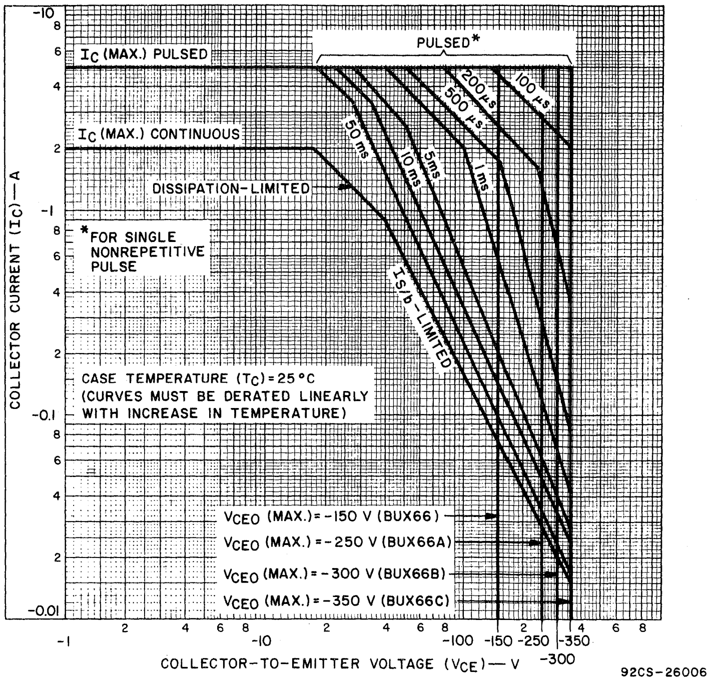


Fig. 5 – Maximum operating areas for BUX66-se, ies types.

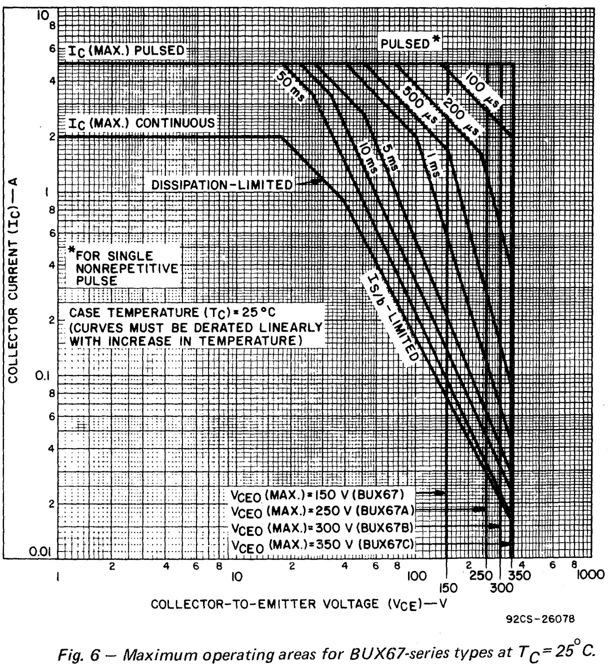


Fig. 6 – Maximum operating areas for BUX67-series types at $T_C = 25^\circ C$.

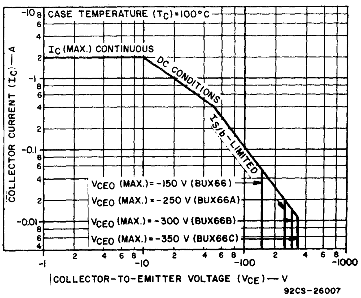


Fig. 7 – Maximum operating areas for BUX66-series at $T_C = 100^\circ C$.

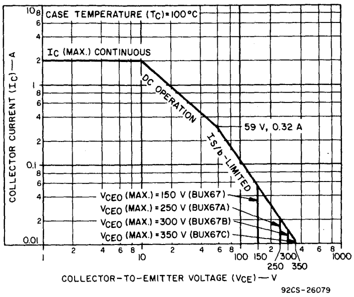


Fig. 8 – Maximum operating areas for BUX67-series at $T_C = 100^\circ C$.

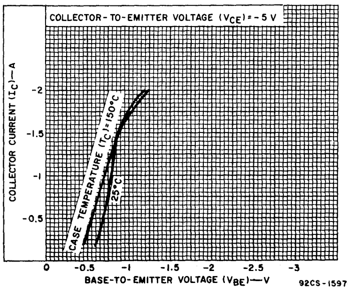


Fig. 9 – Typical transfer characteristics for BUX66-series types.

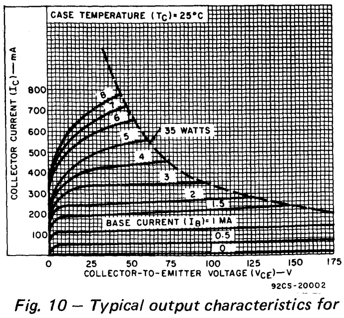


Fig. 10 – Typical output characteristics for BUX67-series types.

BUX66, BUX66A, BUX66B, BUX66C, BUX67, BUX67A, BUX67B, BUX67C

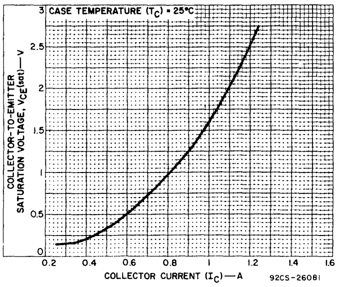


Fig. 11 – Typical saturation-voltage characteristic for BUX67-series types.

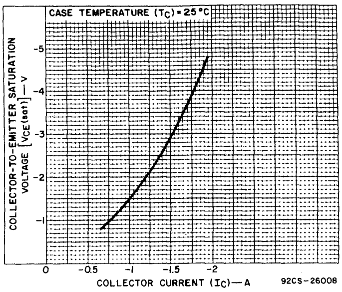


Fig. 12 – Typical saturation-voltage characteristic for BUX66-series types.

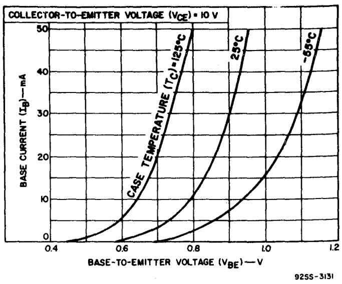


Fig. 13 – Typical input characteristics for BUX67-series types.

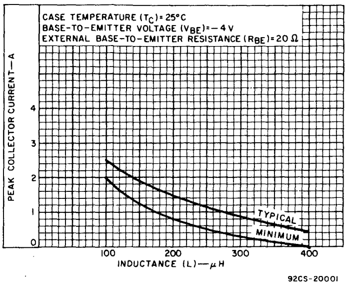


Fig. 14 – Reverse-bias second-breakdown characteristics for BUX67-series types.

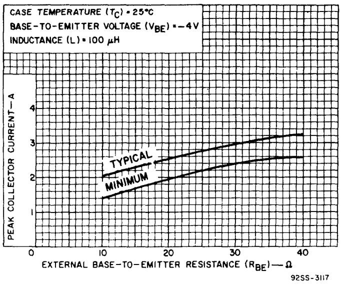


Fig. 15 – Reverse-bias second-breakdown characteristics for BUX67-series types.

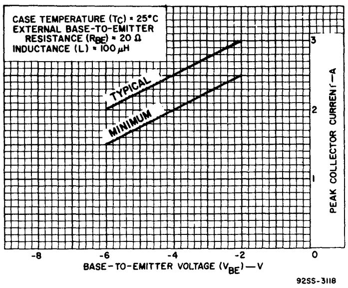


Fig. 16 – Reverse-bias second-breakdown characteristics for BUX67-series types.

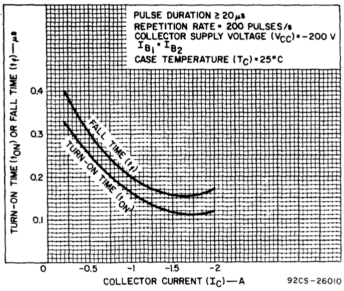


Fig. 17 – Typical turn-on time and fall-time characteristics for BUX66-series types.

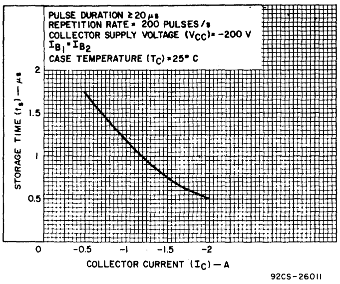


Fig. 18 – Typical storage-time characteristic for BUX66-series types.

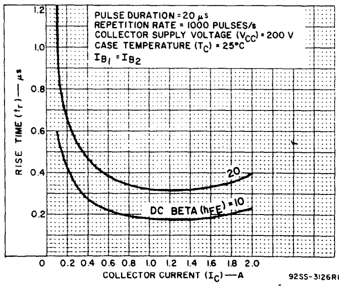


Fig. 19 – Typical rise time vs. collector current for BUX67-series types.

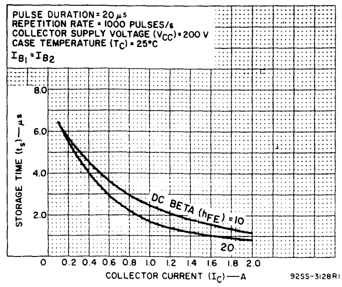


Fig. 20 – Typical storage time vs. collector current for BUX67-series types.

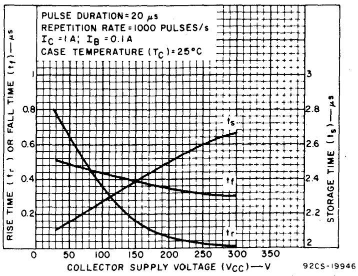


Fig. 21 – Typical rise time, fall time, and storage time vs. collector supply voltage for BUX67-series types.

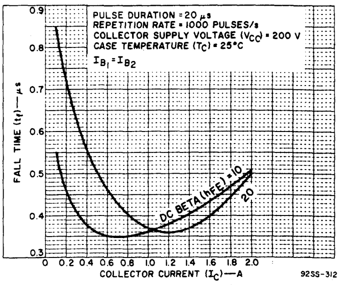


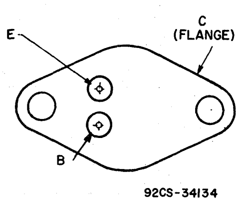
Fig. 22 – Typical fall time vs. collector current for BUX67-series types.

High Voltage, High-Power, Silicon N-P-N Power-Switching Transistors

The RCA-BUX97 series are epitaxial-base silicon n-p-n transistors having high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA)ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The BUX97-series transistors are supplied in steel JEDEC TO-204MA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "CC".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX97	BUX97A	BUX97B	
V_{CES}	750	800	800	V
V_{CEO}	350	400	450	V
V_{EBO}	7			V
I_C	6			A
I_{CM} (t_p = 500 μs)	8			A
I_B	3			A
P_T				
T_C = 75°C	60			W
T_J	175			°C
T_{stg}	−65 to 175			°C
T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235			°C

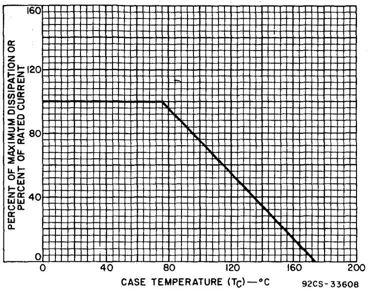


Fig.2 - Dissipation derating curves for all types.

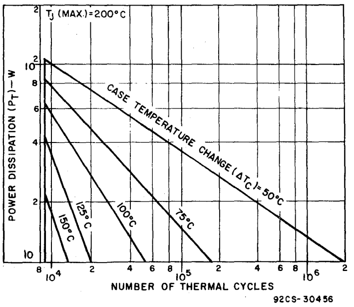


Fig.3 - Thermal-cycling chart for all types.

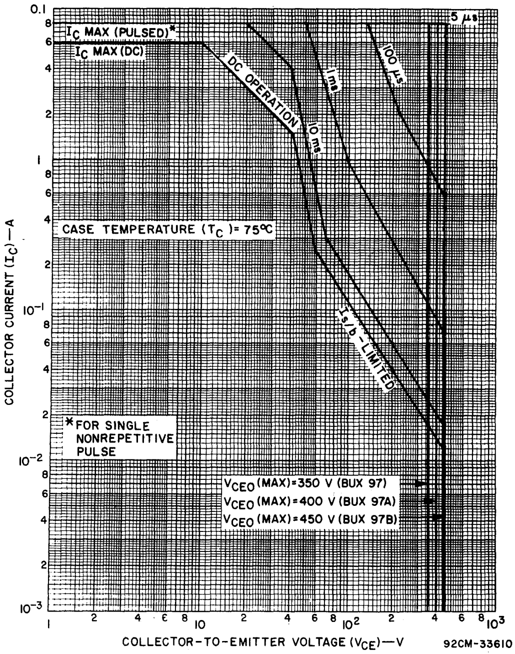


Fig.1 -Maximum safe-operating areas for all types.

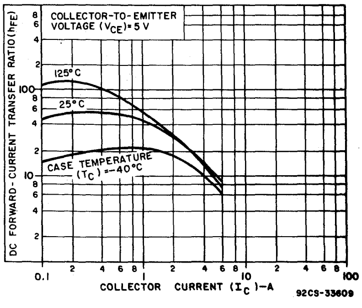


Fig.4 - Typical dc beta characteristics for all types.

BUX97, BUX97A, BUX97B

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) =25° C*
Unless Otherwise Specified

Charac-teristic	Test Conditions				Limits						Units
	Voltage V dc		Current A dc		BUX97		BUX97A		BUX97B		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CES}	750[d]	0			—	1	—	—	—	—	mA
	800[d]	0			—	—	—	1	—	1	
I_{CES} T_C=150° C	750[d]	0			—	3	—	—	—	—	
	800[d]	0			—	—	—	3	—	3	
I_{EBO}		−7	0		—	1	—	1	—	1	mA
V_{CEO}(sus)[b]			0.1[a]	0	350	—	400	—	450	—	V
h_{FE}	5		1.0[a]		10	70	10	70	10	70	
V_{BE}(sat)			1[a]	0.2	—	1.3	—	1.3	—	1.3	V
			4[a]	1.25	—	1.8	—	1.8	—	1.8	
V_{CE} (sat)			1[a]	0.2	—	1	—	1	—	1	V
			4[a]	1.25	—	3	—	3	—	3	
f_T	10		0.5		20 (Typ.)		20 (Typ.)		20 (Typ.)		MHz
t_{ON} V_{CC}=100V			4	1.25[c]	0.6 (Typ.)		0.6 (Typ.)		0.6 (Typ.)		µs
t_s V_{CC}=100 V			4	1.25[c]	3.5 (Typ.)		3.5 (Typ.)		3.5 (Typ.)		
t_f V_{CC}=100 V			4	1.25[c]	0.5 (Typ.)		0.5 (Typ.)		0.5 (Typ.)		
$R_{\theta JC}$	10		5		—	1.67	—	1.67	—	1.67	°C/W

[a] Pulsed: pulse duration = 300 µs, duty factor = 1.8%

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

[c] $I_{B1} = -I_{B2}$

[d] $V_{CE} = V_{CES}$ max.

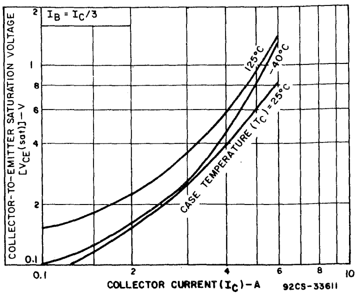


Fig.5 - Typical collector to-emitter saturation voltage as a function of collector current for all types.

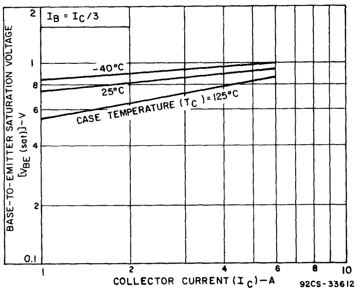


Fig.6 - Typical base-to-emitter saturation voltage as a function of collector current for all types.

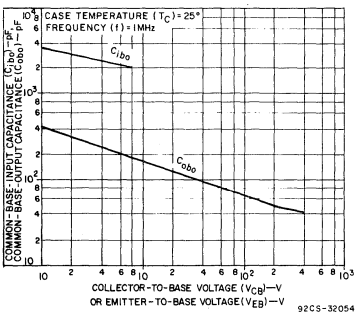


Fig.7 - Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

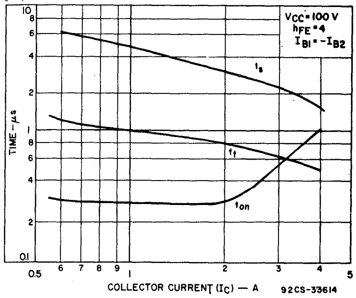


Fig.8 - Typical switching-time characteristics as a function of collector current for all types.

BUY69A, BUY69B, BUY69C

High Voltage Silicon N-P-N Power Transistors

For Horizontal-Deflection Circuits and Other High-Voltage Switching Applications

The RCA-BUY69 series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, together with high safe-operating-area (SOA) ratings.

They are intended for horizontal-deflection circuit application in black and white television, CRT's, off-line power supplies and a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUY69 series transistors are supplied in steel JEDEC TO-204MA hermetic packages.

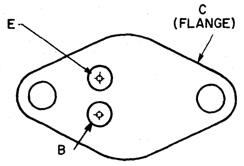
Features:

- *Fast Switching Speed*
- *High Voltage Ratings: V_{CEX} = 500-1000*

Applications:

- *Off-Line Power Supplies*
- *High-Voltage Inverters*
- *Switching Regulators*

TERMINAL DESIGNATIONS



92CS-34134

JEDEC TO-204MA

(See dimensional outline "CC".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUY69A	BUY69B	BUY69C	
V_{CBO}	1000	800	500	V
V_{CEO}	400	325	200	V
V_{CEX}				
V_{BE} = −2 V	1000	800	500	V
V_{EBO}		8		V
I_C		10		A
I_{CM} (tp = 500 μs)		15		A
I_B		3		A
P_T				
T_C = 25°C		100		W
T_J		200		°C
T_{stg}		−65 to 200		°C
T_L				
At distance ⩾ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

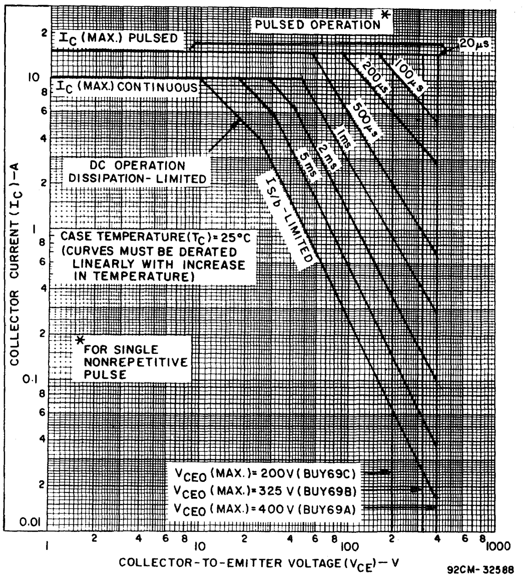


Fig. 1—Maximum operating areas for all types (T_C = 25°C).

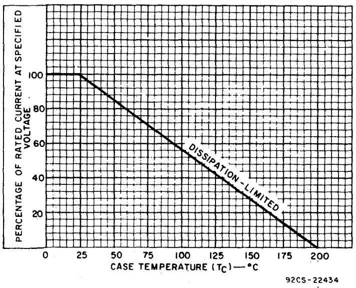


Fig. 2—Dissipation derating curve for all types.

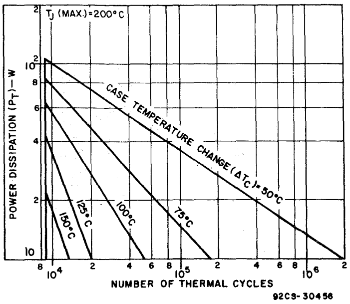


Fig. 3— Thermal-cycling chart for all types.

BUY69A, BUY69B, BUY69C

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		BUY69A		BUY69B		BUY69C		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEX}	1000	−2			—	0.1	—	—	—	—	mA
	800	−2			—	—	—	0.1	—	—	
	500	−2			—	—	—	—	—	0.1	
I_{EBO}		−5	0		—	1	—	1	—	1	
$V_{CEO}(sus)$[b]			0.2[a]	0	400	—	325	—	200	—	V
h_{FE}	10		2.5[a]		15	—	15	—	15	—	
$V_{BE}(sat)$			8[a]	2.5	—	2.2	—	2.2	—	2.2	V
$V_{CE}(sat)$			8[a]	2.5	—	3.3	—	3.3	—	3.3	
$V_{(BR)CBO}$			0.1		1000	—	800	—	500	—	
$V_{(BR)EBO}$ $I_E = 10$ mA					8	—	8	—	8	—	
$I_{S/b}$ t = 1s	25				4	—	4	—	4	—	A
f_T f = 10 MHz	10		0.5		6 (typ.)		6 (typ.)		6 (typ.)		MHz
t_f	V_{CC} = 40		8	2.5[c]	—	1	—	1	—	1	μs
$R_{\theta JC}$					—	1.75	—	1.75	—	1.75	°C/W

[a] Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

[c] $I_{B1} = -I_{B2}$

[b] **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ and V_{CEX} *MUST NOT* be measured on a curve tracer.

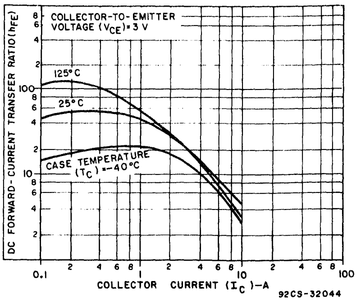


Fig. 4—Typical dc beta characteristics for all types.

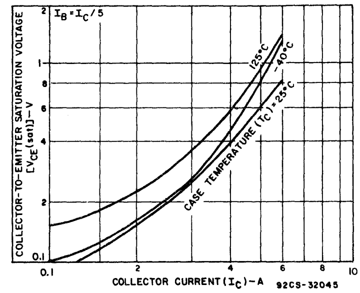


Fig. 5—Typical collector-to-emitter saturation voltage as a function of collector current for all types.

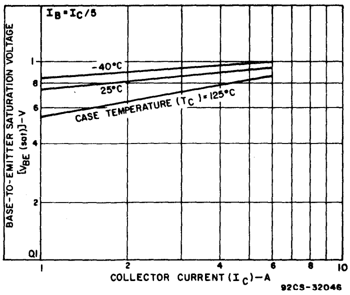


Fig. 6—Typical base-to-emitter saturation voltage as a function of collector current for all types.

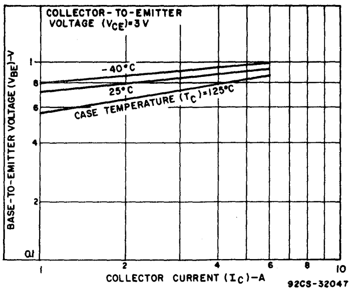


Fig. 7—Typical base-to-emitter voltage as a function of collector current for all types.

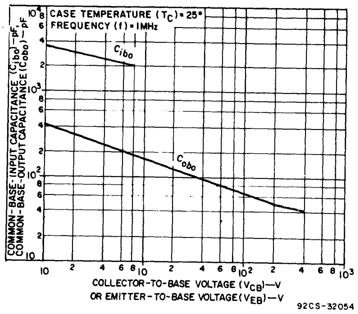
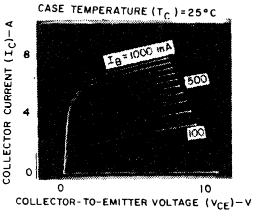


Fig. 8—Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.



92CS-32048

Fig. 9—Typical output characteristics for all types.

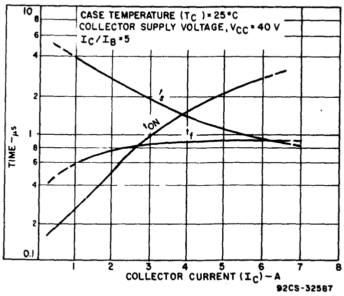


Fig. 10—Typical switching-time characteristics as a function of collector current.

Power Transistors - Industry Types

Technical Data

40310-40314, 40316-40319, 40321-40325, 40327, 40362, 40363, 40537, 40538

Silicon Transistors for Audio-Frequency Linear-Amplifier Applications

These RCA transistors are diffused-junction silicon n-p-n and p-n-p types intended for specific applications in audio amplifiers. They provide high-quality economical performance in applications from low-level input stages to driver and power-output stages of 5 to 50 watts. Supply voltages range from the nominal 12-volt vehicular type to 117-volt ac-dc type.

The use of all-silicon devices permits more flexibility in the mechanical and electrical design of amplifiers since the output heat sinks can be held to a minimum.

Features:

- Hermetically-sealed packages
- Pellet bonded to header –
  - for greater power-handling capability
  - for greater shock resistance
- Freedom from second breakdown
- **40319 is the p-n-p complement of 40317**

N-P-N TYPES IN TO-66 PACKAGE

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	40310	40312	40313	40316	40318	40322	40324	
V_{CEO}(sus)	35		–	–	–	–	35	V
V_{CER}(sus)	–	60	300	40	300	300	–	V
At R_{BE}	–	500	500	500	500	500	–	Ω
V_{EBO}	2.5	2.5	2.5	5	6	6	2.5	V
I_C	4	4	2	4	2	2	4	A
I_B	2	2	1	2	1	1	2	A
P_T:								
$T_C \leqslant 25^oC$	29	29	35	29	35	35	29	W
$T_C > 25^oC$, derate linearly	0.17	0.17	0.2	0.17	0.2	0.2	0.17	W/°C
$T_C = 175^oC$	–	–	5	–	5	5	–	W
T_{stg}, T_J	–65 to 200							°C
T_L (During soldering):								
At distances ⩾ 1/16 in.(1.58 mm) from case for 10 s max.	235							°C

N-P-N TYPES IN TO-39 PACKAGE

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	40311	40314	40317	40321	40323	40327	
V_{CEO}(sus)	30	40	40	–	18	–	V
V_{CER}(sus)	–	–	–	300	–	300	V
At R_{BE}	–	–	–	500	–	1000	Ω
V_{EBO}	2.5	2.5	2.5	5	2.5	5	V
I_C	0.7	0.7	0.7	1	0.7	1	A
I_B	0.2	0.2	0.2	0.5	0.2	0.5	A
P_T:							
$T_C \leqslant 25^oC$	5	5	5	5	5	5	W
$T_C > 25^oC$, derate linearly	0.029						W/°C
$T_A \leqslant 25^oC$	1	1	1	1	1	1	W
T_{stg}, T_J	–65 to 200						°C
T_L (During soldering):							
At distances ⩾ 1/16 in.(1.58 mm) from case for 10 s max.	300	300	300	255	300	255	°C

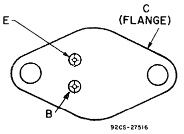
P-N-P TYPES IN TO-39 PACKAGE

N-P-N TYPES IN TO-3 PACKAGE

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	40319	40362	40537	40538	40325	40363	
V_{CBO}	–	–	–	–	35	–	V
V_{CEO}(sus)	–40	–	–	–	35	–	V
V_{CER}(sus)	–	–70	–55	–55	–	70	V
At R_{BE}	–	200	500	500	–	200	Ω
V_{CEV}(sus)							
At V_{BE} = –1.5 V	–	–	–	–	35	–	V
V_{EBO}	–2.5	–4	–5	–5	5	4	V
I_C	–0.7	–0.7	–0.7	–0.7	15	15	A
I_B	–0.2	–0.2	–0.2	–0.2	7	7	A
P_T:							
$T_C \leqslant 25^oC$	5	5	5	5	117	115	W
$T_C > 25^oC$, derate linearly	0.029	0.029	0.029	0.029	0.67	0.66	W/°C
$T_A \leqslant 25^oC$	1	1	1	1	–	–	W
T_{stg}, T_J	–65 to 200				–65 to 200		°C
T_L (During soldering):							
At distances ⩾ 1/16 in.(1.58 mm) from case for 10 s max.	230				235		°C

TERMINAL DESIGNATIONS

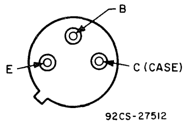


JEDEC TO-3

n-p-n

40325
40363

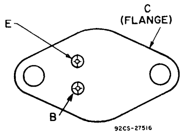
(See dimensional outline "A")



JEDEC TO-39

n-p-n	p-n-p
40311	40319
40314	40362
40317	40537
40321	40538
40323	
40327	

(See dimensional outline "C")



JEDEC TO-66

n-p-n

40310 40316
40312 40318
40313 40322
40324

(See dimensional outline "N")

Types: 40321, 40323, 40327, n-p-n
Package: JEDEC TO-39
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C)= 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS 40321 Min.	40321 Max.	40323 Min.	40323 Max.	40327 Min.	40327 Max.	UNITS
I_{CBO}	V_{CB}=15 V,I_E=0,T_C=25°C	–	–	–	0.25	–	–	μA
	V_{CB}=150 V,I_E=0,T_C=150°C	–	0.1	–	1	–	0.1	mA
I_{CER}	V_{CE}=150 V,R_{BE}=1000 Ω	–	5	–	–	–	5	μA
I_{EBO}	V_{BE}=–2.5 V (40323)	–	–	–	1	–	–	mA
	V_{BE}=–5 V (40321,40327)	–	0.1	–	–	–	0.1	
V_{CEO}(sus)	I_C=100 mA*	–	–	18	–	–	–	V
V_{CER}(sus)	I_C=50 mA*,R_{BE}=1000 Ω	300	–	–	–	300	–	V
V_{BE}	V_{CB}=4 V,I_C=50 mA*(40323)	–	–	–	1	–	–	V
	V_{CB}=10 V,I_C=50 mA* (40321,40327)	–	2	–	–	–	2	
h_{FE}	V_{CE}=4 V,I_C=50 mA*(40323)	–	–	70	350	–	–	
	V_{CE}=10 V,I_C=20 mA* (40321,40327)	25	200	–	–	40	250	
f_T	V_{CE}=10 V,I_C=50 mA	–	–	100 typ.		–	–	MHz
$R_{\theta JC}$		–	35	–	35	–	30	°C/W
$R_{\theta JA}$		–	–	–	175	–	–	

* Pulsed: Pulse duration = 300 μs, duty factor ⩽ 2%.
For characteristics curves and test conditions, refer to published data for prototype.

Audio Type	Prototype
40321	2N3439
40323	2N2102
40327	2N3439

Types: 40311, 40314, 40317, n-p-n 40319, p-n-p
Package: JEDEC TO-39
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS▲	LIMITS 40311 Min.	40311 Max.	40314 Min.	40314 Max.	40317 40319▲ Min.	40317 40319▲ Max.	UNITS
I_{CBO}	V_{CB}=15 V, I_E=0 T_C=25°C	–	0.25	–	0.25	–	0.25	μA
	T_C=150°C	–	1	–	1	–	1	mA
I_{EBO}	V_{BE}=–2.5 V	–	1	–	1	–	1	mA
V_{CEO}(sus)	I_C=100 mA*	30	–	40	–	40	–	V
V_{BE}	V_{CE}=4 V I_C=10 mA*(40317);I_C=50 mA (40311,40314,40319)	–	1	–	1	–	1	V
V_{CE}(sat)	I_C=150 mA*, I_B=15 mA	–	–	–	1.4	–	–1.4●	V
h_{FE}	V_{CE}=4 V I_C=10 mA*(40317);I_C=					40	200	
	50 mA*(40311,40314,40319)	70	350	70	350	35●	200●	
f_T	V_{CE}=10 V(40311);V_{CE}=4 V (40314,40319),I_C=50 mA	100 typ.		100 typ.		100 typ.●		MHz
$R_{\theta JC}$		–	35	–	35	–	35	°C/W
$R_{\theta JA}$		–	175	–	175	–	175	

▲ For p-n-p devices, voltage and current are negative.
● 40319 *Pulsed: Pulse duration = 300 μs, duty factor ⩽ 2%.
For characteristics curves and test conditions, refer to published data for prototype.

Audio Type	Prototype
40311	2N2102
40314	2N2102
40317	2N2102
40319	2N4036

40310-40314, 40316-40319, 40321-40325, 40327, 40362, 40363, 40537, 40538

Types: 40362, 40537, 40538, p-n-p
Package: JEDEC TO-39
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS						UNITS
		40362		40537		40538		
		Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER}	V_{CE}=−45 V,R_{BE}=500 Ω, T_C=25°C	–	–	–	−10	–	−10	μA
	V_{CE}=−65 V,R_{BE}=1000 Ω, T_C=25°C	–	−1	–	–	–	–	
	V_{CE}=−60 V,R_{BE}=1000 Ω, T_C=150°C	–	−100	–	–	–	–	
I_{EBO}	V_{BE}=4 V	–	−1	–	–	–	–	mA
	V_{BE}=5 V	–	–	–	−1	–	−1	
V_{CER}(sus)	I_C=−100 mA*,R_{BE}=500 Ω	–	–	−55	–	−55	–	V
	I_C=−100 mA*,R_{BE}=1000 Ω	−70	–	–	–	–	–	
V_{BE}	V_{CE}=−4 V,I_C=−50 mA*	–	−1	–	−1.8	–	–	V
	V_{CE}=−4 V,I_C=−500 mA*	–	–	–	–	–	−2.7	
V_{CE}(sat)	I_C=−50 mA*,I_B=−5 mA	–	–	–	−1.1	–	–	V
	I_C=−150 mA*, I_B=−15 mA	–	−1.4	–	–	–	–	
	I_C=−500 mA*,I_B=−50 mA	–	–	–	–	–	−2	
h_{FE}	V_{CE}=−4 V,I_C=−50 mA*	35	200	50	300	–	–	
	V_{CE}=−4 V,I_C=−500 mA*	–	–	–	–	15	90	
f_T	V_{CE}=−4 V,I_C=−50 mA	100 typ.		100 typ.		100 typ.		MHz
$R_{\theta JC}$		–	35	–	–	–	–	°C/W
$R_{\theta JA}$		–	175	–	175	–	175	

Audio Type	Prototype
40362	2N4036
40537	2N4036
40538	2N5322 2N5320

*Pulsed: Pulse duration = 300 μs, duty factor ⩽ 2%.

For characteristics curves and test conditions, refer to published data for prototype.

Types: 40310, 40312, 40316, 40324, n-p-n
Package: JEDEC TO-66
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS						UNITS
		40310 40312		40316		40324		
		Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	V_{CB}=15 V,I_E=0							
	T_C=25°C	–	10	–	10	–	10	μA
	T_C=150°C	–	5	–	5	–	5	mA
I_{EBO}	V_{BE}=−2.5 V	–	5	–	–	–	5	mA
	V_{BE}=−5 V	–	–	–	5	–	–	
V_{CEO}(sus)	I_C=100 mA*	35●	–	–	–	35	–	V
V_{CER}(sus)	I_C=100 mA*,R_{BE}=500 Ω	60#	–	40	–	–	–	V
V_{BE}	V_{CE}=2 V,I_C=1 A*	–	1.4	–	1.4	–	1.4	V
h_{FE}	V_{CE}=2 V,I_C=1 A*	20	120	20	120	20	120	
f_T	V_{CE}=4 V,I_C=500 mA	750 typ.		750 typ.		750 typ.		kHz
$R_{\theta JC}$		–	6	–	6	–	6	°C/W

● 40310 # 40312 *Pulsed: Pulse duration = 300 μs, duty factor ⩽ 2%.

For characteristics curves and test conditions, refer to published data for prototype.

Audio Type	Prototype
40310	2N3054
40312	2N3054
40316	2N3054
40324	2N3054

Types: 40313, 40318, 40322, n-p-n
Package: JEDEC TO-66
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS						UNITS
		40313		40318		40322		
		Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	V_{CE}=150 V,I_B=0	–	5	–	5	–	–	mA
I_{CEV}	V_{CE}=150 V (40318),V_{CE}= 300 V (40313), V_{BE}= −1.5 V, T_C=25°C	–	10	–	5	–	–	mA
	T_C=150°C	–	10	–	10	–	–	
I_{EBO}	V_{BE}=−2.5 V	–	5	–	–	–	–	mA
	V_{BE}=−6 V	–	–	–	5	–	5	
V_{CER}(sus)	I_C=200 mA*,R_{BE}=200 Ω, L=500 mH	300	–	300	–	300	–	V
V_{BE}	V_{CE}=10 V, I_C=100 mA*	–	1.5	–	–	–	–	V
	I_C=500 mA*	–	–	–	1.5	–	–	
h_{FE}	V_{CE}=10 V, I_C=500 mA*	40	–	50	–	75	–	
	I_C=100 mA*	40	250	–	–	–	–	
	I_C=20 mA*	–	–	40	–	40	–	
$I_{S/b}$	V_{CE}=150 V	150	–	100	–	100	–	mA
$E_{S/b}$	V_{BE}=−4 V	–	–	50	–	50	–	μJ
$R_{\theta JC}$		–	5	–	5	–	5	°C/W

*Pulsed: Pulse duration = 300 μs, duty factor ≤ 2%.

For characteristics curves and test conditions, refer to published data for prototype.

Audio Type	Prototype
40313	2N3585
40318	2N3585
40322	2N3585

Types: 40325, 40363, n-p-n
Package: JEDEC TO-3
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS				UNITS
		40325		40363		
		Min.	Max.	Min.	Max.	
I_{CBO}	V_{CB}=30 V, T_C=25°C	–	5	–	–	mA
	T_C=150°C	–	10	–	–	
I_{CER}	V_{CE}=60 V,R_{BE}=200 Ω, T_C=25°C	–	–	–	1	mA
	T_C=150°C	–	–	–	10	
I_{EBO}	V_{BE}=−5 V	–	10	–	–	mA
	V_{BE}=−4 V	–	–	–	5	
V_{CEO}(sus)	I_C=200 mA*	35	–	–	–	V
V_{CER}(sus)	I_C=200 mA*,R_{BE}=200 Ω	–	–	70	–	V
V_{CBO}	I_C=100 mA,I_E=0	35	–	–	–	V
V_{BE}	V_{CE}=4 V, I_C=8 A*	–	2	–	–	V
	I_C=4 A*	–	–	–	1.8	
V_{CE}(sat)	I_C=8 A*, I_B=800 mA	–	1.5	–	–	V
	I_C=4 A*,I_B=400 mA	–	–	–	1.1	
h_{FE}	V_{CE}=4 V, I_C=8 A*	12	60	–	–	
	I_C=4 A*	–	–	20	70	
f_T	V_{CE}=4 V,I_C=3 A	–	–	700 typ.		kHz
$R_{\theta JC}$		–	1.5	–	1.5	°C/W

*Pulsed: Pulse duration = 300 μs, duty factor ≤ 2%.

For characteristics curves and test conditions, refer to published data for prototype.

Audio Type	Prototype
40325	2N3055
40363	2N3055

40406, 40408, 40410, 40407, 40409, 40411

Silicon N-P-N and P-N-P Power Transistors

For Audio-Amplifier Applications

RCA-40406-40411, inclusive, are diffused-junction silicon n-p-n and p-n-p transistors intended for use in audio amplifiers. Giving high-quality performance economically, these six devices have power dissipation ratings of 1 to 150 W. Types 40406, 40407, and 40408 are supplied in JEDEC TO-39 hermetic packages; types 40409 and 40410 are in TO-39 packages mounted on integral heat radiators. The 40411 unit, intended for use in audio output stages, is in a steel JEDEC TO-3 hermetic package.

	40406	40407	40408	40409	40410	40411	
V_{CEO}(sus)	-50	50	90	–	–	–	V
V_{CER}(sus) R_{BE} = 100 Ω	–	–	–	90	-90	90	V
V_{EBO}	-4	4	4	4	-4	4	V
I_C	-0.7	0.7	0.7	0.7	-0.7	30	A
I_B	-0.2	0.2	0.2	0.2	-0.2	15	A
P_T:							
$T_A \leq 25°C$	1	1	1	–	–	–	W
$T_A \leq 50°C$	–	–	–	3	3	–	W
$T_C \leq 25°C$	–	–	–	–	–	150	W
T_J	-65 to +200						°C

Features:

40406 & 40407

- V_{CEO}(sus) = -50 V **min. (40406)**
- V_{CEO}(sus) = 50 V **min. (40407)**
- **40406 is p-n-p complement of 40407**
- **1 W dissipation rating**

40408

- V_{CEO}(sus) = 90 V **min.**
- **1 W dissipation rating**

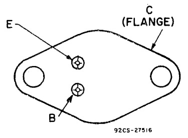
40409 & 40410

- V_{CER}(sus) = 90 V **min. (40409)**
- V_{CER}(sus) = -90 V **min. (40410)**
- **40410 is p-n-p complement of 40409**
- **3 W free-air dissipation rating**

40411

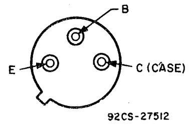
- V_{CER}(sus) = 90 **min.**
- **Hometaxial-base construction**
- **150 W dissipation rating**

TERMINAL DESIGNATIONS



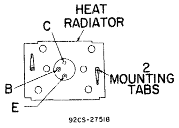
JEDEC TO-3

(See dimensional outline "A".)



JEDEC TO-39

(See dimensional outline "C".)



JEDEC TO-39 with Heat Radiator

(See dimensional outline "D".)

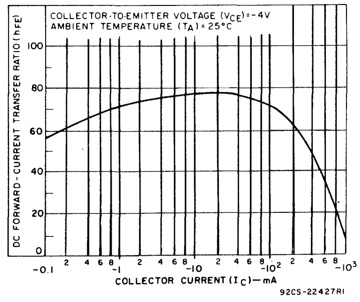


Fig. 1 – Typical dc beta characteristic for 40406 and 40410.

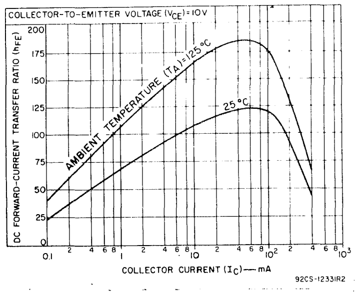


Fig. 2 – Typical dc beta characteristics for 40407, 40408, and 40409.

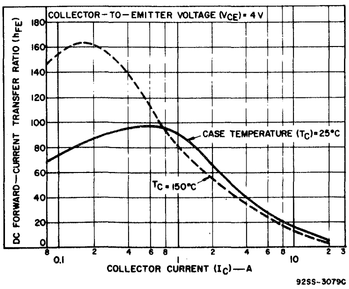


Fig. 3 – Typical dc beta characteristics for 40411.

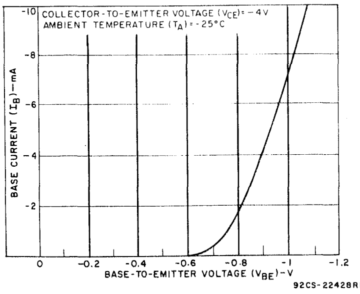


Fig. 4 – Typical input characteristic for 40406 and 40410.

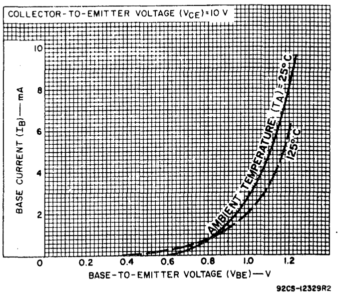


Fig. 5 – Typical input characteristics for 40407, 40408, and 40409.

40406, 40408, 40410, 40407, 40409, 40411

ELECTRICAL CHARACTERISTICS, *T_C = 25° Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc	TEST CONDITIONS CURRENT A dc		LIMITS 40406# 40407		40408		40409 40410#		40411		UNITS
	V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} $I_E = 0$	10●			–	0.25♠	–	–	–	–	–	–	μA
I_{CEO}	40			–	1	–	–	–	–	–	–	μA
	80			–	–	–	1	–	–	–	–	
T_C = 150° C												mA
40406	40			–	0.01	–	–	–	–	–	–	
40407	40			–	0.1	–	–	–	–	–	–	
40408	80			–	–	–	0.25	–	–	–	–	
I_{CER} R_{BE} = 100 Ω	80			–	–	–	–	–	1	–	500	μA
T_C = 150° C	80			–	–	–	–	–	0.1	–	2	mA
I_{EBO} V_{BE} = -4 V		0		–	100	–	100	–	100	–	500	μA
V_{CEO}(sus)		0.1[a]	0	50[b]	–	90[b]	–	–	–	–	–	V
V_{CER}(sus) R_{BE} = 100 Ω		0.1			–	–	–	90	–	–	–	V
		0.2			–	–	–	–	–	90	–	
V_{BE}	10	0.001[a]		–	0.8[c]	–	–	–	–	–	–	V
	4	0.01[a]		–	–	–	1	–	–	–	–	
	4	0.15[a]		–	–	–	–	–	1	–	–	
	4	4[a]		–	–	–	–	–	–	–	1.2	
V_{CE}(sat)		0.15[a]	0.015	–	–	–	1.4	–	1.4	–	–	V
		4[a]	0.4	–	–	–	–	–	–	–	0.8	
h_{FE} 40406	10	0.1 mA[a]		30	200	–	–	–	–	–	–	
40407	10	0.001[a]		40	200	–	–	–	–	–	–	
40408	4	0.01[a]		–	–	40	200	–	–	–	–	
40409-10	4	0.15[a]		–	–	–	–	50	250	–	–	
40411	4	4[a]		–	–	–	–	–	–	35	100	
h_{fe} f = 20 MHz	10	0.05		6♠	–	–	–	–	–	–	–	
f_T	4	0.05		100 (typ.)		100 (typ.)		100 (typ.)		–	–	MHz
	4	4		–	–	–	–	–	–	800 (typ.)		kHz
C_{obo} $I_E = 0$ f = 1 MHz	10●			15♠	–	–	–	–	–	–	–	pF
$I_{S/b}$ t = 1s nonrep	30			–	–	–	–	–	–	5	–	A
$R_{\theta JC}$				–	35	–	35	–	–	–	1.17	°C/W
$R_{\theta JA}$				–	175	–	175	–	50	–	–	

\# For p-n-p devices, voltage and current values are negative

● V_{CB} ♠ 40407 only

[a] Pulsed; pulse duration = 300 μs, duty factor ⩽2%

[b] CAUTION: The sustaining voltage V_{CEO}(sus) MUST NOT be measured on a curve tracer. V_{CEO}(sus) should be measured by the pulse method (Note 'a').

[c] 40406 tested at I_C = –0.1 mA

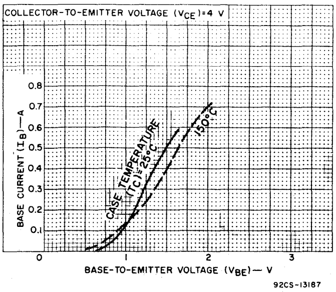


Fig. 6 — Typical input characteristics for 40411.

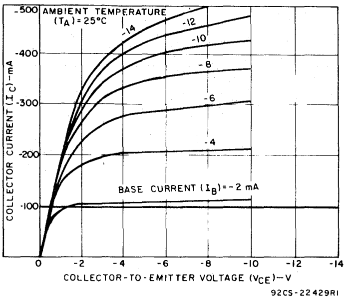


Fig. 7 — Typical output characteristics for 40406 and 40410.

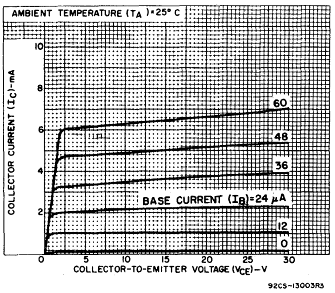


Fig. 8 — Typical output characteristics for 40407, 40408, and 40409.

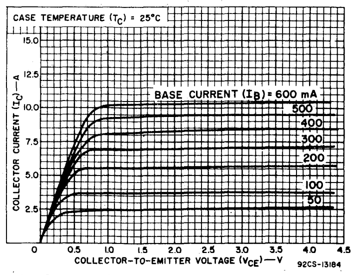


Fig. 9 — Typical output characteristics for 404ll.

40631

Hometaxial-Base Silicon N-P-N VERSAWATT Transistors

Designed for Medium-Power
Linear and Switching Applications

Features:

- **Low saturation voltages**
- **High dissipation ratings**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

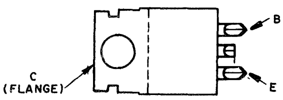
The RCA-40631 is a hometaxial base silicon n-p-n transistor intended for a wide variety of medium-power applications. The hometaxial-base construction of this device renders it highly resistant to second breakdown over a wide range of operating conditions. The 40631 is intended especially for use in driver and output stages in high-fidelity audio-amplifier circuits.

The 40631 is supplied in the JEDEC TO-220AA formed-lead version of the VERSAWATT flame retardant plastic package for use with TO-66 sockets.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	40631	
$V_{CER}(sus)$		
R_{BE} = 100 Ω	45	V
V_{EBO}	5	V
I_C	4	A
I_B	2	A
P_T:		
At $T_C \leqslant 25^oC$	36	W
At $T_C > 25^oC$ Derate linearly	0.288	W/^{o}C
At $T_A \leqslant 25^oC$	1.8	W
T_J, T_{stg}	−65 to +150	^{o}C
T_L		
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	^{o}C

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AA

(See dimensional outline "R".)

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25^{o}C*

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS		UNITS
	VOLTAGE V dc		CURRENT A dc		40631		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
I_{CER} R_{BE} = 100 Ω	20 40				– –	– 0.5	mA
I_{EBO}		−4 −5	0 0		– –	– 1	mA
$V_{CER}(sus)$ R_{BE} = 100 Ω			0.1[a] 0.2[a]		– 45	– –	V
h_{FE}	4 4		1[a] 2[a]		– 20	– 70	
$V_{CE}(sat)$			1[a] 2[a]	0.05 0.2	– –	– 1	V
V_{BE}	4 4		1[a] 2[a]		– –	– 1.5	V
$\|h_{fe}\|$ f = 0.4 MHz	4		0.2		2	–	
$R_{\theta JC}$					–	3.5	^{o}C/W
$R_{\theta JA}$					–	70	

[a] Pulsed: Pulse duration = 300 μs, duty factor ⩽ 2%.

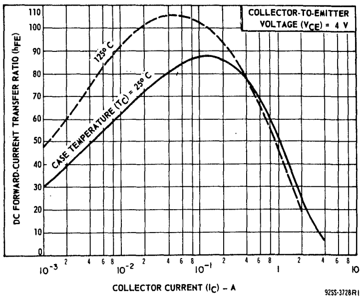


Fig. 1 — Typical dc beta characteristics for 40631.

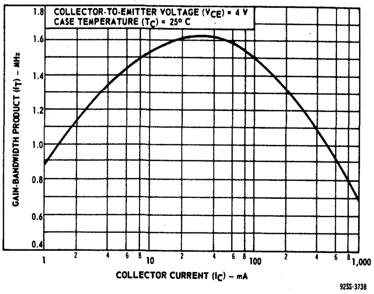


Fig. 2— Typical gain-bandwidth product for 40631.

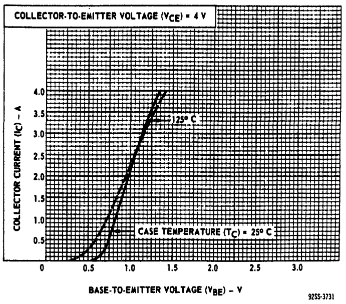


Fig. 3— Typical transfer characteristics for 40631.

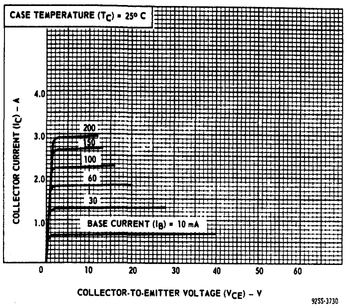


Fig. 4— Typical output characteristics for 40631.

40850, 40851, 40852, 40854

450-V Silicon N-P-N Power Transistors

For Off-Line Switching-Regulator Type Power-Supply Applications

The RCA-40850, 40851, 40852, and 40854 are n-p-n types selected from RCA's line of silicon power transistors for power-supply applications. Their high-voltage ratings permit operation directly off the power line thereby eliminating the heavy and bulky 60-Hz power transformer; their fast switching speeds permit operation above the audio-frequency range (20 to 30 KHz) for quiet performance and permit the use of small ferrite-core transformers for changing voltage levels.

These devices have sufficient voltage capability to be used as push-pull inverters or pulse-width-modulated inverters operating directly off the 120-V power line; they can operate as switching regulators off a 240-V line; for 120-V lines, the prototypes can be used.

Features:

- **High-voltage ratings for operation from power lines without a step-down transformer**
- **Popular JEDEC TO-3 and TO-66 hermetic packages**

Applications:

- **For use in switching-regulator supplies which feature:**
  - **–A substantial reduction in size and weight due to elimination of the 60-Hz power transformer.**
  - **–Operation with a substantial reduction of heat**
- **5-V, off-line supplies with current ratings of 25, 50, 100, or 200 A**
- **30-V, off-line supplies with current ratings of 5, 10, 20, or 40 A**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	40850	40851	40852	40854	
V_{CBO}	450	450	450	450	V
$V_{CEO}(sus)$	300	350	350	300	V
$V_{CER}(sus)$ $R_{BE} \leqslant 50\ \Omega$	400	375	375	325	V
V_{EBO}	6	9	9	6	V
I_C	2	7	7	15	A
I_{CM} (For 10 ms max.)	5	10	10	30	A
I_B	1	4	4	10	A
P_T:* $T_C \leqslant 25^oC$	35	45	100	175	W
$T_C > 25^oC$	Derate linearly to 200°C				
T_J, T_{stg}	–65 to +200				°C
T_L (During soldering): At distances ⩾ 1/32 in. (0.8 mm) from case for 10 s max.	230				°C

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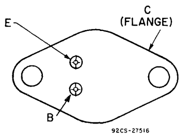
* Safe-operating-area curves for prototype devices should be extended to the maximum values of collector current for these devices.

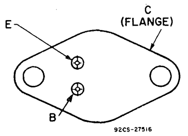
TERMINAL DESIGNATIONS



JEDEC TO-3

40852
40853

(See dimensional outline "A".)



JEDEC TO-66

40850
40851

(See dimensional outline "N".)

Type 40850 (For 5-V, 25-A & 30-V, 5-A Power Supplies)
Package: JEDEC TO-66
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEV}	V_{CE} = 450 V, V_{BE} = -1.5 V	–	0.2	mA
I_{CEV}	V_{CE} = 450 V, V_{BE} = -1.5 V, T_C = 125°C	–	2	mA
$V_{CEO}(sus)^a$	I_C = 0.2 A, I_B = 0	300	–	V
$V_{CER}(sus)^a$	I_C = 0.2 A, R_{BE} = 50 Ω	400	–	V
V_{EBO}	I_E = 5 mA, I_C = 0	6	–	V
h_{FE}	I_C = 0.75 A, V_{CE} = 10 V	25	–	
$V_{CE}(sat)$	I_C = 2 A, I_B = 0.4 A	–	2.0	V
$V_{BE}(sat)$	I_C = 2 A, I_B = 0.4 A	–	2.0	V
$I_{S/b}^a$	V_{CE} = 100 V	0.35	–	A
$E_{S/b}^a$	L = 100 μH, I_C(PEAK) = 2 A, R_{BE} = 20 Ω V_{BE} = -4 V	0.2	–	mJ

[a] For characteristics curves and test conditions, refer to published data for prototype 2N3585

Type 40851 (For 5-V, 50-A & 30-V, 10-A Power Supplies)
Package: JEDEC TO-66
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEV}	V_{CE} = 450 V, V_{BE} = -1.5 V	–	0.5	mA
I_{CEV}	V_{CE} = 450 V, V_{BE} = -1.5 V, T_C = 125°C	–	5	mA
V_{CEO}(sus)[a]	I_C = 0.2 A, I_B = 0	350	–	V
V_{CER}(sus)[a]	I_C = 0.2 A, R_{BE} = 50 Ω	375	--	V
V_{EBO}	I_E = 1 mA, I_C = 0	9	–	V
h_{FE}	I_C = 1.2 A, V_{CE} = 1.0 V	12	–	
V_{CE}(sat)	I_C = 4 A, I_B = 0.8 A	–	3	V
V_{BE}(sat)	I_C = 4 A, I_B = 0.8 A	–	2	V
$I_{S/b}$[a]	V_{CE} = 50 V	0.9	–	A
$E_{S/b}$[a]	L = 100 μH, I_C(PEAK) = 3 A, R_{BE} = 50 Ω V_{BE} = -4 V	0.45	–	mJ

[a] For characteristics curves and test conditions, refer to published data for prototype 2N6079

Type 40852 (For 5-V, 50-A & 30-V, 10-A Power Supplies
Package: JEDEC TO-3
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEV}	V_{CE} = 450 V, V_{BE} = -1.5 V	–	0.5	mA
I_{CEV}	V_{CE} = 450 V, V_{BE} = -1.5 V, T_C = 125°C	–	5	mA
V_{CEO}(sus)[a]	I_C = 0.2 A, I_B = 0	350	–	V
V_{CER}(sus)[a]	I_C = 0.2 A, R_{BE} = 50 Ω	375	–	V
V_{EBO}	I_E = 1 mA, I_C = 0	9	–	V
h_{FE}	I_C = 1.2 A, V_{CE} = 1.0 V	12	–	
V_{CE}(sat)	I_C = 4 A, I_B = 0.8 A	–	3.0	V
V_{BE}(sat)	I_C = 4 A, I_B = 0.8 A	–	2.0	V
$I_{S/b}$[a]	V_{CE} = 40 V	2.5	–	A
$E_{S/b}$[a]	L = 100 μH, I_C(PEAK) = 3 A, R_{BE} = 50 Ω V_{BE} = -4 V	0.45	–	mJ

[a] For characteristics curves and test conditions, refer to published data for prototype 2N5240

40850, 40851, 40852, 40854

Type 40854 (For 5-V, 200-A & 30-V, 40-A Power Supplies)
Package: JEDEC TO-3
ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEV}	V_{CE} = 450 V, V_{BE} = -1.5 V	–	1.0	mA
I_{CEV}	V_{CE} = 450 V, V_{BE} = -1.5 V, T_C = 125°C	–	10	mA
$V_{CEO}(sus)$[a]	I_C = 0.2 A, I_B = 0	300	–	V
$V_{CER}(sus)$[a]	I_C = 0.2 A, R_{BE} = 50 Ω	325	–	V
V_{EBO}	I_E = 5 mA, I_C = 0	6	–	V
h_{FE}	I_C = 10 A, V_{CE} = 4 V	8	–	
$V_{CE}(sat)$	I_C = 16 A, I_B = 3.2 A	–	3	V
$V_{BE}(sat)$	I_C = 16 A, I_B = 3.2 A	–	3	V
$I_{S/b}$[a]	V_{CE} = 30 V	5.8	–	A
$E_{S/b}$[a]	L = 50 μH, I_C(PEAK) = 10 A, R_{BE} = 50 Ω V_{BE} = -4 V	2.5	–	mJ

[a] For characteristics curves and test conditions, refer to published data for prototype 2N6251

MJ15001, MJ15002

Complementary N-P-N/P-N-P Silicon Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commercial Use

The RCA-MJ15001 and MJ15002 are ballasted epitaxial-base silicon transistors featuring high gain at high current. The MJ15001 n-p-n transistor complements the MJ15002 p-n-p transistor. These types are supplied in the JEDEC TO-204MA packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MJ15001	MJ15002	
V_{CBO}	140	−140	V
V_{CEO}	140	−140	V
V_{EBO}	5	−5	V
I_C	15	−15	A
I_B	5	−5	A
I_E	20	−20	A
P_T			
At $T_C \geqslant 25^\circ$	200	−200	W
At $T_C > 25^\circ C$	1.14		W/°C
T_{stg}, T_J	−65 to 200		°C
T_L			
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		°C

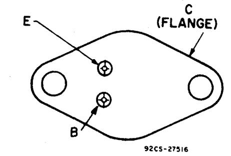
Features:

- High-dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- f_T = 2 MHz
- High gain at high current

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTICS	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		MJ15001		MJ15002		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEX}	140	1.5			–	1	–	−1	mA
T_C = 150°C	140	1.5			–	2	–	−2	
I_{CEO}	140			0	–	2.5	–	−2.5	mA
I_{EBO}		5	0		–	1	–	−1	mA
$V_{CEO}(sus)^a$			0.2	0	140	–	−140	–	V
h_{FE}^a	2		4		25	150	25	150	
V_{BE}	2		4		–	2	–	−2	V
$V_{CE}(sat)$			4	0.4	–	1	–	−1	V
f_T f = 0.5 MHz	10		0.5		2	–	2	–	MHz
$I_{S/b}$ tp - 1s	40 100				5 0.5	– –	−5 −0.5	– –	A
C_{ob} V_{CB} = 10 V f = 1 MHz					–	1000	–	1000	pF
$R_{\theta JC}$					–	0.875	–	0.875	°C/W

[a] CAUTION: Sustaining voltage, $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer.

MJ15001, MJ15002

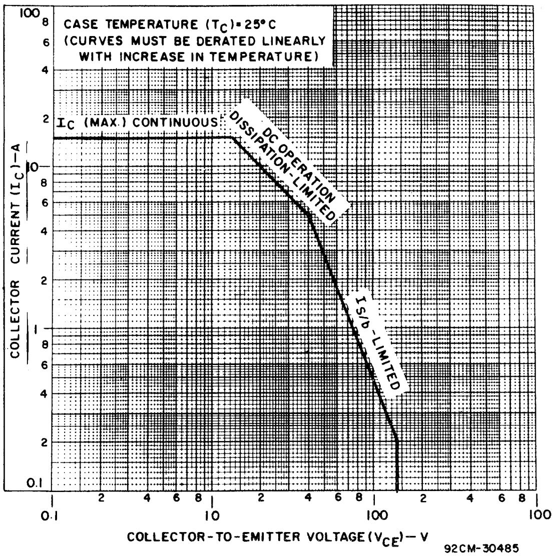


Fig. 1 – Maximum operating area for both types.

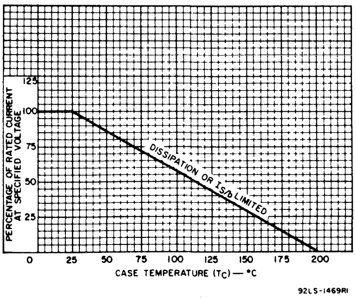


Fig. 2 – Current derating curve for both types.

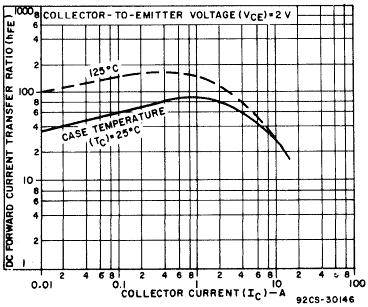


Fig. 3 – Typical dc beta characteristics as a function of collector current for MJ15001.

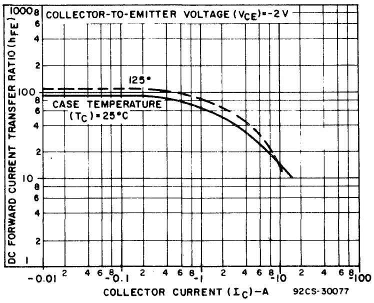


Fig. 4 – Typical dc beta characteristics as a function of collector current for MJ15002.

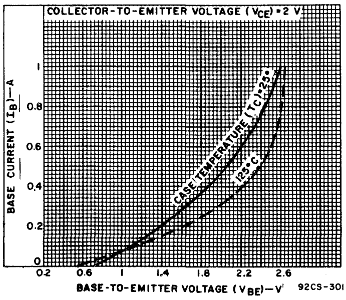


Fig. 5 – Typical input characteristics for MJ15001.

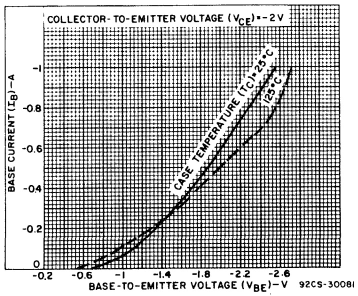


Fig. 6 – Typical input characteristics for MJ15002.

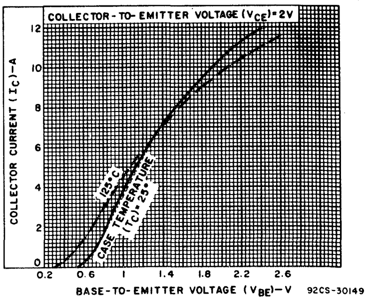


Fig. 7 – Typical transfer characteristics for MJ15001.

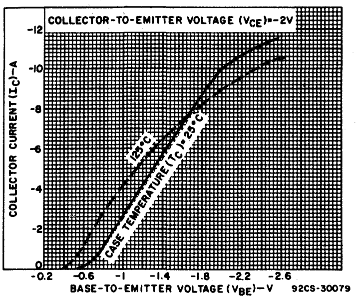


Fig. 8 – Typical transfer characteristics for MJ15002.

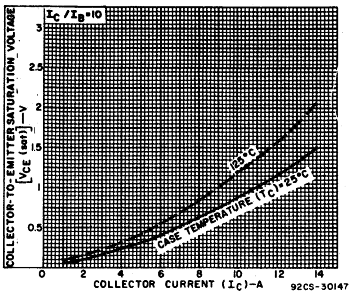


Fig. 9 – Typical saturation voltage characteristics for MJ15001.

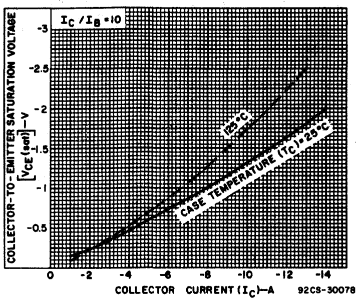


Fig. 10 – Typical saturation voltage characteristics for MJ15002.

MJ15003, RCA3773, RCA8638C, RCA8638D, RCA8638E

Silicon N-P-N Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commercial Use

The RCA3773, MJ15003, RCA8638C, RCA-8638D, and RCA8638E are ballasted epitaxial-base silicon n-p-n transistors featuring high gain at high current. They may be used as complements to the p-n-p types 2N6609, MJ15004, RCA9116C, RCA9116D, and RCA-9116E, respectively.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204MA packages.

Features:

- High-dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- f_T = 2 MHz
- High gain at high current

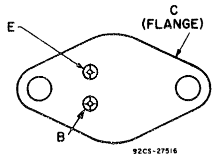
Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA3773	MJ15003	RCA8638C	RCA8638D	RCA8638E	
V_{CBO}	160	140	140	120	100	V
$V_{CEX}(sus)$						
V_{BE} = −1.5 V; R_{BE} = 100 Ω	160	–	–	–	–	V
$V_{CER}(sus)$						
R_{BE} = 100 Ω	150	150	150	130	110	V
$V_{CEO}(sus)$	140	140	140	120	100	V
V_{EBO}	7	5				V
I_C	20					A
I_B	5					A
P_T						
At $T_C \leq 25°C$	150	250	200	200	200	W
At $T_C > 25°C$ Derate linearly	0.857	1.43	1.14			W/°C
T_{stg}, T_J	−65 to 200					°C
T_L						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230					°C

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

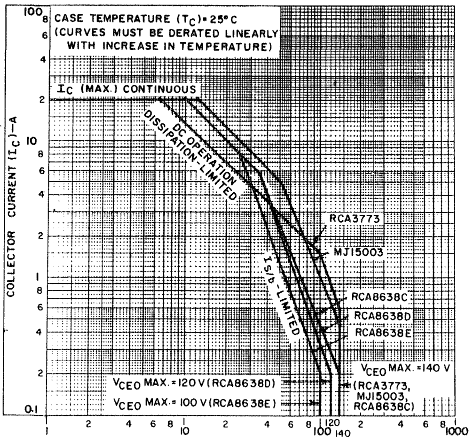


Fig. 1 – Maximum operating areas for all types.

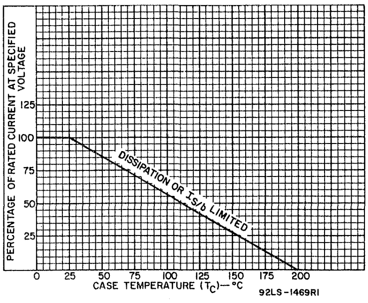


Fig. 2 – Current derating curve for all types.

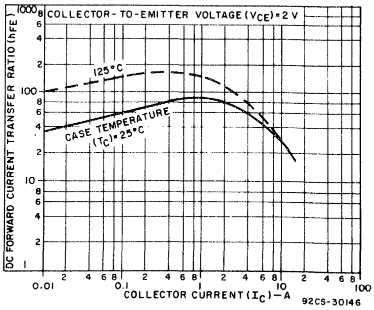


Fig. 3 – Typical dc beta characteristics as a function of collector current for all types.

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified (Cont'd)*

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc	RCA8638C		RCA8638D		RCA8638E		
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	140[a]			–	1	–	–	–	–	mA
	120[a]			–	–	–	1	–	–	
	100[a]			–	–	–	–	–	1	
I_{CEX}	140	1.5		–	1	–	–	–	–	
	120	1.5		–	–	–	1	–	–	
I_{CEX} T_C = 150°C	140	1.5		–	5	–	–	–	–	
	120	1.5		–	–	–	5	–	–	
I_{CEO} $I_B = 0$	70			–	1	–	–	–	–	
	60			–	–	–	1	–	–	
I_{EBO}	5			–	1	–	1	–	1	
h_{FE}	2		5[c]	25	150	25	150	–	–	
	2		7.5[c]	–	–	–	–	10	100	
	2		10[c]	10	–	10	–	–	–	
$V_{CER}(sus)$[b] $R_{BE} \leqslant 100\Omega$			0.2	150	–	130	–	110	–	V
$V_{CEO}(sus)$[b]			0.2	140	–	120	–	100	–	
V_{EBO} I_E = 1 mA			0	5	–	5	–	5	–	
V_{BE}	2		7.5[c]	–	–	–	–	–	3	
	2		5[c]	–	2	–	2	–	–	
$V_{CE}(sat)$										
I_B = 0.75A			7.5[c]	–	–	–	–	–	1.5	
= 0.5A			5[c]	–	1	–	1	–	–	
$I_{S/b}$ t_p = 1 s nonrep.	35			5.71	–	5.71	–	–	–	A
	25			–	–	–	–	8	–	
$\|h_{fe}\|$ f = 0.5 MHz	10		0.5	4	–	4	–	4	–	
f_T				2	–	2	–	2	–	MHz
C_{ob} f = 0.1 MHz	10[a]			–	500	–	500	–	500	pF
$R_{\theta JC}$	10		10	–	0.875	–	0.875	–	0.875	°C/W

[a] V_{CB}

[b] **CAUTION**: Sustaining voltages $V_{CEX}(sus)$, $V_{CER}(sus)$, and $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

[c] Pulsed; pulse duration = 300 μs, duty factor = 1.8%.

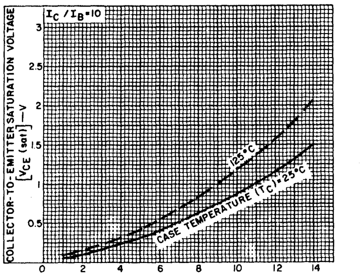


Fig. 4 — Typical saturation voltage characteristics for all types.

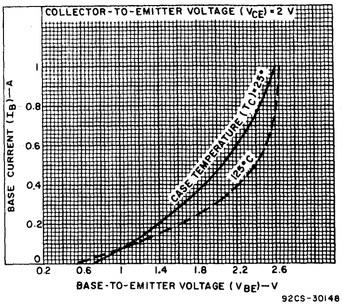


Fig. 5 — Typical input characteristics for all types.

MJ15003, RCA3773, RCA8638C, RCA8638D, RCA8638E

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS			LIMITS				UNITS
	VOLTAGE V dc		CUR-RENT A dc	RCA3773		MJ15003		
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CBO}	160[a]			–	4	–	–	mA
	140[a]			–	2	–	1	
I_{CEX}	140	-1.5		–	1	–	0.1	
I_{CEX} T_C = 150°C	140	-1.5		–	5	–	2	
I_{CEO} I_B = 0	140			–	–	–	0.25	
	120			–	1	–	–	
I_{EBO}	7			–	1	–	–	
	5			–	–	–	0.1	
h_{FE}	4		8[c]	15	60	–	–	
	4		16[c]	5	–	–	–	
	2		5[c]	–	–	25	150	
	2		10[c]	–	–	10	–	
V_{CEX}(sus)[b] R_{BE} = 100Ω		-1.5	0.2	160	–	–	–	V
V_{CER}(sus)[b] R_{BE} ≤ 100Ω			0.2	150	–	150	–	
V_{CEO}(sus)[b]			0.2	140	–	140	–	
V_{EBO} I_E = 1 mA			0	7	–	5[d]	–	
V_{BE}	4		8[c]	–	2.2	–	–	
	2		5[c]	–	–	–	2	
V_{CE}(sat) I_B = 3.2A			16[c]	–	4	–	–	
= 0.8A			8[c]	–	1.4	–	–	
= 0.5A			5[c]	–	–	–	1	
$I_{S/b}$ t_p = 1 s nonrep.	100			1.5	–	1	–	A
	50			–	–	5	–	
$\|h_{fe}\|$ f = 0.5 MHz	10		0.5	4	–	4	–	
f_T				2	–	2	–	MHz
h_{fe} f = 1 kHz	4		1	40	–	–	–	
C_{ob} f = 0.1 MHz	10[a]			–	500	–	500	pF
$R_{\theta JC}$	10		10	–	1.17	–	0.7	°C/W

[a] V_{CB}

[b] **CAUTION**: Sustaining voltages V_{CEX}(sus), V_{CER}(sus), and V_{CEO}(sus) *MUST NOT* be measured on a curve tracer. *See figs. 8 & 9.*

[c] Pulsed; pulse duration = 300 µs, duty factor = 1.8%.

[d] Measured at I_E = –0.1 mA.

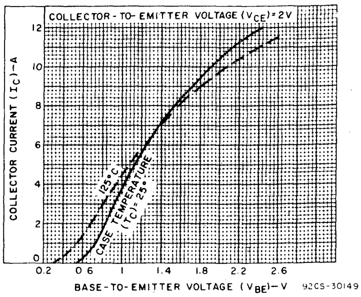


Fig. 6 — Typical transfer characteristics for all types.

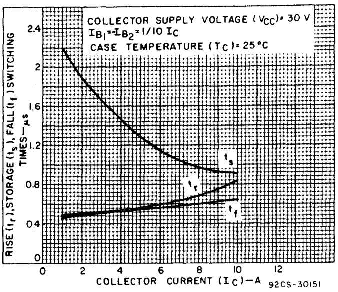


Fig. 7 — Typical saturated-switching times for all types.

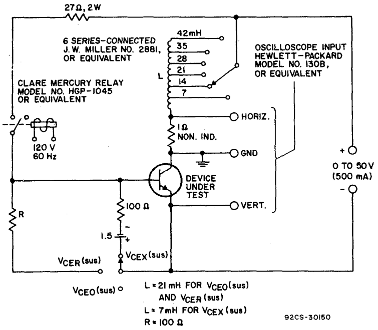
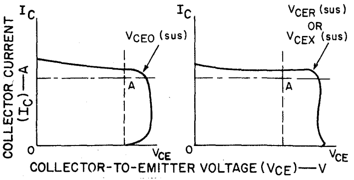


Fig. 8 - Circuit used to measure sustaining voltages V_{CEO}[sus], V_{CER}[sus], and V_{CEX} for all types.



NOTE: The sustaining Voltages V_{CEO}(sus), V_{CER}(sus) or, V_{CEX}(sus) are acceptable when the trace falls to the right and above point "A". (For values of current and voltage, see Electrical Characteristics.

92CS-15224RI

Fig. 9 - Oscilloscope display for measurement of sustaining voltages. [Test circuit shown in Fig. 8].

RCA1A01-RCA1A06, RCA1A09-RCA1A11, RCA1A15, RCA1A16, RCA1A18, RCA1A19

Silicon Transistors for Audio-Frequency Linear-Amplifier Applications

"RCA1A-Series" n-p-n and p-n-p silicon transistors are especially characterized for audio-amplifier applications. They are particularly useful as input devices, V_{BE} multipliers for biasing, current sources, load-line-limiting (protection) circuits, predrivers, and in some instances as complementary drivers. Other applications for these devices include audio power amplifiers, linear modulators, servo amplifiers, and operational amplifiers. The units are supplied in the JEDEC TO-39 package.

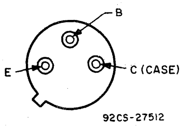
N-P-N TYPES

RCA1A01	RCA1A11
RCA1A03	RCA1A15
RCA1A06	RCA1A18
RCA1A09	

P-N-P TYPES

RCA1A02	RCA1A10
RCA1A04	RCA1A16
RCA1A05	RCA1A19

TERMINAL DESIGNATIONS



JEDEC TO-39

(See dimensional outline "C".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*		**RCA1A01**	**RCA1A02**	**RCA1A03**	**RCA1A04**	**RCA1A05**	**RCA1A06**	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	–	–	95	–95	–75	75	V
COLLECTOR-TO-EMITTER VOLTAGE:								
With base open	V_{CEO}	70	–50	–	–	–	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	–	–	95	–95	–75	75	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	–4	4	–4	–4	4	V
COLLECTOR CURRENT	I_C	1	–1	2	–2	–1	1	A
BASE CURRENT	I_B	0.5	–0.5	1	–1	–0.5	0.5	A
TRANSISTOR DISSIPATION:	P_T							
At case temperatures up to 25°C		5	7	10	10	5	5	W
At case temperatures above 25°C		← See Fig. 1 →						
TEMPERATURE RANGE:								
Storage & Operating (Junction)		← –65 to +200 →						°C
PIN TEMPERATURE (During Soldering): At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		← 230 →						°C

•R_{BE} = 10 Ω ▲R_{BE} = 300 Ω

MAXIMUM RATINGS, *Absolute-Maximum Values:*		**RCA1A09**	**RCA1A10**	**RCA1A11**	**RCA1A15**	**RCA1A16**	**RCA1A18**	**RCA1A19**	
COLLECTOR-TO-EMITTER VOLTAGE:									
With base open	V_{CEO}	175	–175	175	100	–100	10	–10	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	–6	6	5	–5	4	–4	V
COLLECTOR CURRENT	I_C	1	–1	1	1	–1	1	–1	A
BASE CURRENT	I_B	0.5	–0.5	0.5	0.5	–0.1	0.5	–0.5	A
TRANSISTOR DISSIPATION:	P_T								
At case temperatures up to 25°C		10	10	10	10	10	7	7	W
At case temperatures above 25°C		← See Fig. 1 →							
TEMPERATURE RANGE:									
Storage & Operating (Junction)		← –65 to +200 →							°C
PIN TEMPERATURE (During Soldering): At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		← 230 →							°C

Type RCA1A01
Package: JEDEC TO-39
Construction: Silicon n-p-n, planar

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = 60 V, I_B = 0	–	1	μA
I_{EBO}	V_{EB} = 4 V, I_C = 0	–	1	mA
V_{CEO}	I_C = 100 mA	70	–	V
f_T	V_{CE} = 4 V, I_C = 50 mA	120	–	MHz
h_{FE}	I_C = 10 mA, V_{CE} = 4 V	40	200	
V_{CE}(sat)	I_C = 150 mA, I_B = 15 mA	–	1.4	V
V_{BE}	I_C = 10 mA, V_{CE} = 4 V	–	1	V

For characteristics curves and test conditions, refer to published data for prototype 2N2102

Type RCA1A02
Package: JEDEC TO-39
Construction: Silicon p-n-p, epitaxial planar

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = –40 V, I_B = 0	–	–1	μA
I_{EBO}	V_{EB} = –4 V, I_C = 0	–	–1	mA
V_{CEO}	I_C = –0.1 A	–50	–	V
f_T	V_{CE} = –4 V, I_C = –50 mA	60	–	MHz
h_{FE}	I_C = –0.1 mA, V_{CE} = –10 V	30	200	
V_{BE}	I_C = –0.1 mA, V_{CE} = –10 V	–	–0.8	V

For characteristics curves and test conditions, refer to published data for prototype 2N4036

RCA1A01-RCA1A06, RCA1A09-RCA1A11
RCA1A15, RCA1A16, RCA1A18, RCA1A19

Type RCA1A03
Package: JEDEC TO-39
Construction: Silicon n-p-n, planar

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 85 V, R_{BE} = 100Ω	–	10	µA
I_{EBO}	V_{EB} = 4 V, I_C = 0	–	0.1	mA
V_{CER}	I_C = 0.1 A, R_{BE} = 100Ω	95	–	V
f_T	I_C = 0.1 A, V_{CE} = 4 V	50	–	MHz
h_{FE}	I_C = 300 mA, V_{CE} = 4 V	70	300	
V_{CE}(sat)	I_C = 300 mA, I_B = 30 mA	–	0.8	V
V_{BE}	I_C = 300 mA, V_{CE} = 4 V	–	1.4	V
$I_{S/b}$	V_{CE} = 50 V, t = 0.4 s	0.2	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N5320

Type RCA1A04
Package: JEDEC TO-39
Construction: Silicon p-n-p, epitaxial-planar

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = –85 V, R_{BE} = 100Ω	–	–10	µA
I_{EBO}	V_{EB} = 4 V, I_C = 0	–	–0.1	mA
V_{CER}	I_C = –0.1 A, R_{BE} = 100Ω	–95	–	V
f_T	I_C = –0.1 A, V_{CE} = –4 V	50	–	MHz
h_{FE}	I_C = –300 mA, V_{CE} = –4 V	70	300	
V_{CE}(sat)	I_C = –300 mA, I_B = –30 mA	–	–0.8	V
V_{BE}	I_C = –300 mA, V_{CE} = –4 V	–	–1.4	V
$I_{S/b}$	V_{CE} = –35 V, t = 0.4 s	–0.285	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N5322

Type RCA1A05
Package: JEDEC TO-39
Construction: Silicon p-n-p epitaxial planar

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = –65 V, R_{BE} = 100Ω	–	–10	µA
I_{EBO}	V_{EB} = –4 V, I_C = 0	–	–0.1	mA
V_{CER}	I_C = –0.1 A, R_{BE} = 100Ω	–75	–	V
f_T	I_C = –50 mA, V_{CE} = –4 V	60		MHz
h_{FE}	I_C = –150 mA, V_{CE} = –4 V	50	250	
V_{CE}(sat)	I_C = –150 mA, I_B = –15 mA	–	–0.8	V
V_{BE}	I_C = –150 mA, V_{CE} = –4 V	–	–1.4	V
$I_{S/b}$	V_{CE} = –65 V, t = 0.4 s	–0.1	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N4036

Type RCA1A06
Package: JEDEC TO-39
Construction: Silicon n-p-n, planar

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 65V, R_{BE} = 100Ω	–	10	µA
I_{EBO}	V_{EB} = 4V, I_C = 0	–	0.1	mA
V_{CER}	I_C = 100 mA, R_{BE} = 100Ω	75	–	V
f_T	I_C = 50 mA, V_{CE} = 4 V	120	–	MHz
h_{FE}	I_C = 150 mA, V_{CE} = 4V	50	250	
V_{CE}(sat)	I_C = 150 mA, I_B = 15 mA	–	0.8	V
V_{BE}	I_C = 150 mA, V_{CE} = 4V	–	1.4	V
$I_{S/b}$	V_{CE} = 65V, t = 0.4 s	0.077	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N2102

Type RCA1A09
Package: JEDEC TO-39
Construction: Silicon n-p-n, epitaxial

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = 90 V, I_B = 0	–	10	µA
I_{EBO}	V_{EB} = 6 V, I_C = 0	–	100	µA
V_{CEO}	I_C = 10 mA, I_B = 0	175	–	V
f_T	I_C = 10 mA, V_{CE} = 10 V	15	–	MHz
h_{FE}	I_C = 10 mA, V_{CE} = 10 V	20	100	
V_{CE}(sat)	I_C = 50 mA, I_B = 4 mA	–	0.5	V
V_{BE}	I_C = 10 mA, V_{CE} = 10 V	–	0.9	V
$I_{S/b}$	V_{CE} = 150 V, t = 1 s	0.065	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N3439

Type RCA1A10
Package: JEDEC TO-39
Construction: Silicon p-n-p

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = –120 V, I_B = 0	–	–10	µA
I_{EBO}	V_{EB} = –6 V, I_C = 0	–	–100	µA
V_{CEO}	I_C = –10 mA, I_B = 0	–175	–	V
f_T	I_C = –10 mA, V_{CE} = –10 V	15	–	MHz
h_{FE}	I_C = –10 mA, V_{CE} = –10 V	40	250	
V_{CE}(sat)	I_C = –10 mA, I_B = –1 mA	–	–2	V
V_{BE}	I_C = –10 mA, V_{CE} = –10 V	–	–0.8	V
$I_{S/b}$	V_{CE} = –150 V, t = 1 s	–0.04	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N5415

Type RCA1A11
Package: JEDEC TO-39
Construction: Silicon n-p-n, epitaxial

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = 90 V, I_B = 0	–	10	μA
I_{EBO}	V_{EB} = 6 V, I_C = 0	–	100	μA
V_{CEO}	I_C = 10 mA, I_B = 0	175	–	V
f_T	I_C = 10 mA, V_{CE} = 10 V	15	–	MHz
h_{FE}	I_C = 1 mA, V_{CE} = 10 V	40	250	
V_{BE}	I_C = 1 mA, V_{CE} = 10 V	0.5	0.7	V

For characteristics curves and test conditions, refer to published data for prototype 2N3439

Type RCA1A15
Package: JEDEC TO-39
Construction: Silicon n-p-n, epitaxial

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = 90 V	–	10	μA
I_{EBO}	V_{EB} = 5 V, I_C = 0	–	1	mA
V_{CEO}	I_C = 10 mA, I_B = 0	100	–	V
f_T	V_{CE} = 10 V, I_C = 10 mA	15	–	MHz
h_{FE}	I_C = 10 mA, V_{CE} = 10 V	20	100	
V_{CE}(sat)	I_C = 10 mA, I_B = 1 mA	–	1	V
V_{BE}	I_C = 10 mA, V_{CE} = 10 V	–	1	V
$I_{S/b}$	V_{CE} = 50 V, t = 0.4 s	0.2	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N3440

Type RCA1A16
Package: JEDEC TO-39
Construction: Silicon p-n-p, epitaxial

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = –90 V	–	–10	μA
I_{EBO}	V_{EB} = –5 V, I_C = 0	–	–1	mA
V_{CEO}	I_C = –10 mA, I_B = 0	–100	–	V
f_T	V_{CE} = –10 V, I_C = –10 mA	15	–	MHz
h_{FE}	I_C = –10 mA, V_{CE} = –10 V	40	250	
V_{CE}(sat)	I_C = –10 mA, I_B = –1 mA	–	–1	V
V_{BE}	I_C = –10 mA, V_{CE} = –10 V	–	–1	V
$I_{S/b}$	V_{CE} = –50 V, t = 0.4 s	–0.2	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N5416

Type RCA1A18
Package: JEDEC TO-39
Construction: Silicon n-p-n, planar

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = 5 V, I_B = 0	–	10	μA
I_{EBO}	V_{EB} = 4 V, I_C = 0	–	1	mA
V_{CEO}	I_C = 10 mA, I_B = 0	10	–	V
f_T	I_C = 50 mA, V_{CE} = 4 V	120	–	MHz
h_{FE}	I_C = 10 mA, V_{CE} = 4 V	40	250	
V_{CE}(sat)	I_C = 10 mA, I_B = 0.5 mA	–	1	V
V_{BE}	I_C = 10 mA, V_{CE} = 4 V	–	0.78	V

For characteristics curves and test conditions, refer to published data for prototype 2N2102

Type RCA1A19
Package: JEDEC TO-39
Construction: Silicon p-n-p, epitaxial planar

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CEO}	V_{CE} = –5 V, I_B = 0	–	–10	μA
I_{EBO}	V_{EB} = –4 V, I_C = 0	–	–1	mA
V_{CEO}	I_C = –10 mA, I_B = 0	–10	–	V
f_T	I_C = –50 mA, V_{CE} = –4 V	60	–	MHz
h_{FE}	I_C = –10 mA, V_{CE} = –4 V	40	250	
V_{CE}(sat)	I_C = –10 mA, I_B = –0.5 mA	–	–1	V
V_{BE}	I_C = –10 mA, V_{CE} = –4 V	–	–0.78	V

For characteristics curves and test conditions, refer to published data for prototype 2N4036

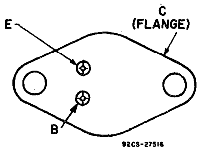
RCA1B01

Silicon Transistor for 70-Watt Quasi-Complementary-Symmetry Audio Amplifiers with Hometaxial-Base Output Transistors

RCA1B01 is an n-p-n hometaxial-base silicon transistor in a JEDEC TO-3 package. This device is particularly suitable for audio-output use, and can be driven by either the RCA1A03 n-p-n or RCA1A04 p-n-p transistor.

The 70-watt amplifier shown in Fig. 4 uses the RCA1B01 in conjunction with seven TO-39 transistors, eleven diodes, and an 84-volt split power supply. The amplifier output is directly coupled to an 8-ohm speaker. This amplifier is most useful for instrumentation applications where ruggedness and raw power are essential.

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

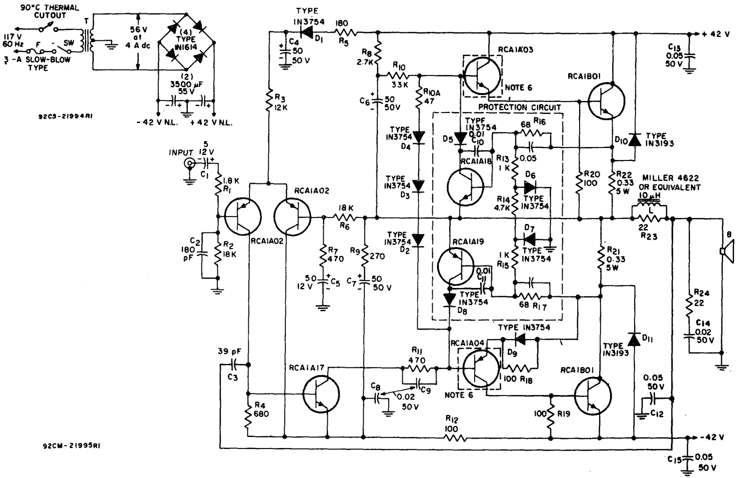
		RCA1B01	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	95	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}	95	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
COLLECTOR CURRENT	I_C	15	A
BASE CURRENT	I_B	7	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		115	W
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max		230	°C

Type RCA1B01
Package: JEDEC TO-3
Construction: Silicon n-p-n, hometaxial base

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 85 V, R_{BE} = 100Ω	–	0.5	mA
I_{EBO}	V_{EB} = 4 V, I_C = 0	–	1	mA
V_{CER}	I_C = 0.2A, R_{BE} = 100Ω	95	–	V
f_T	V_{CE} = 4 V, I_C = 1 A	0.8	–	MHz
h_{FE}	I_C = 4 A, V_{CE} = 4 V	20	70	
V_{CE}(sat)	I_C = 4 A, I_B = 0.4 A	–	1	V
V_{BE}	I_C = 4 A, V_{CE} = 4 V	–	1.4	V
$I_{S/b}$	V_{CE} = 60 V, t = 1 s	1.95	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N3055 (**Hometaxial**).



NOTES:

1. T: Signal 56-4•, Signal Transformer Co., 1 Junius St., Brooklyn, N.Y. 11212
. Resistors are 1/2-watt unless otherwise specified; values are in ohms.
3. Capacitances are in μF unless otherwise specified.
4. Non-inductive resistors.

• Or equivalent.

Fig. 1 – 70-Watt amplifier circuit featuring quasi-complementary-symmetry output employing hometaxial-base output transistors.

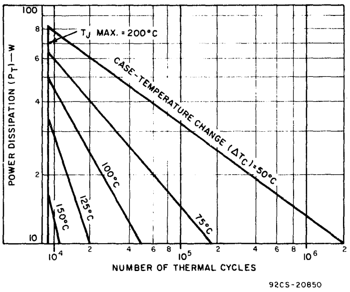


Fig. 2 – Thermal-cycling ratings for RCA1B01.

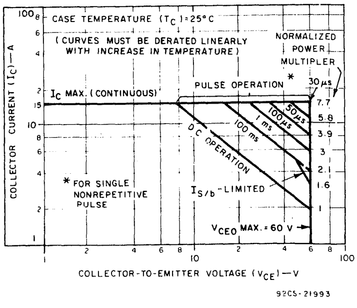
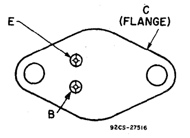


Fig. 3 – Maximum operating areas for RCA1B01.

RCA1B04, RCA1B05, RCA1B09

Silicon Transistors for 100-,120-, 200-, and 300-W Quasi-Complementary-Symmetry Audio Amplifiers with Parallel Output Transistors

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

The RCA1B04, RCA1B05, and RCA1B09 are silicon n-p-n pi-nu transistors in a JEDEC TO-3 package. They are especially suitable for applications in audio-amplifier circuits, in which they may be used as either driver or output unit.

These devices, together with a variety of other transistors that serve as input devices, V_{BE} amplifiers for biasing, current sources, load-line limiters (for overload protection), and predrivers, may be used to develop several hundred watts of audio output power in quasi-complementary-symmetry audio-amplifier configurations that employ parallel output transistors. Circuit examples, data are shown for 100-, 120-, 200-, and 300-W amplifiers.

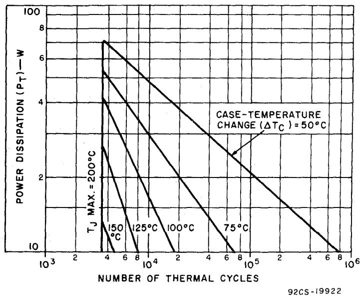


Fig. 1 — Thermal-cycling ratings for RCA1B04 and RCA1B05.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA1B04	RCA1B05 RCA1B09	
V_{CBO}	225	275	V
V_{CEO}	200	250	V
V_{CER} R_{BE} = 100 Ω	225	275	V
V_{EBO}	5		V
I_C	7		A
I_B	2		A
P_T			
At $T_C \leqslant 25^oC$	150		W
At $T_C > 25^oC$	**Derate linearly to 200°C**		
T_{stg}, T_J	−65 to 200		^oC
T_L			
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		^oC

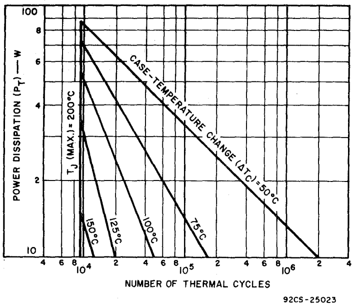


Fig. 2 — Thermal-cycling rating chart for RCA1B09.

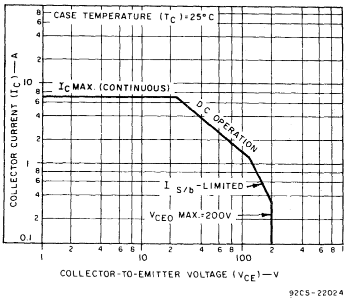


Fig. 3 — Maximum operating areas for RCA1B04.

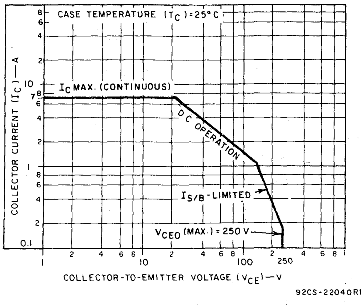


Fig. 4 — Maximum operating areas for RCA1B05.

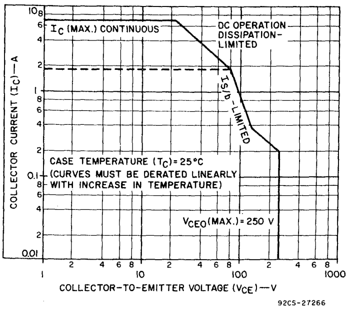


Fig. 5 — Maximum operating areas for RCA1B09.

RCA1B04, RCA1B05, RCA1B09

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS						UNITS
		RCA1B04▲		RCA1B05*		RCA1B09**		
		Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER}	V_{CE} = 120 V, R_{BE} = 100 Ω	–	1	–	–	–	–	mA
	V_{CE} = 200 V, R_{BE} = 100 Ω	–	–	–	1	–	1	
I_{EBO}	V_{EB} = 5 V, I_C = 0	–	1	–	1	–	1	mA
V_{CEO}	I_C = 0.2 A, I_B = 0	200	–	250	–	250	–	V
V_{CER}	I_C = 0.2 A, R_{BE} = 100 Ω	225	–	275	–	275	–	V
f_T	I_C = 0.2 A, V_{CE} = 10 V	5	–	5	–	–	–	MHz
	I_C = 1 A, V_{CE} = 15 V	–	–	–	–	5	–	
h_{FE}	I_C = 2 A, V_{CE} = 5 V	15	75	15	75	40	–	
$V_{CE}(sat)$	I_C = 2 A, I_B = 0.255 A	–	2	–	2	–	–	V
	I_C = 2 A, I_B = 0.2 A	–	–	–	–	–	1	
V_{BE}	I_C = 2 A, V_{CE} = 5 V	0.75	1.75	0.75	1.75	–	1	V
$I_{S/b}$	V_{CE} = 120 V, t = 1 s	1.25	–	–	–	–	–	A
	V_{CE} = 140 V, t = 1 s	–	–	1.07	–	–	–	
	V_{CE} = 80 V, t = 1 s	–	–	–	–	1.875	–	

▲ For characteristics curves and test conditions, refer to published data for prototype 2N5239

* For characteristics curves and test conditons, refer to published data for prototype 2N5240

** For characteristics curves and test conditions, refer to published data for prototype 2N6510

100-W Amplifier

The 100-W amplifier shown in Figs. 6 and 7 uses two RCA1B09 transistors as drivers and four RCA1B05 transistors as parallel units in the amplifier output stages, and operates on a 104-V split power supply.

This 100-W amplifier [DC-Coupled (Fig.6) or AC-Coupled (Fig.7)] is conservatively designed to provide excellent high-power performance into an 8-Ω load. With the exception of the RCA-CA3100 Linear Integrated Circuit for front end, this amplifier is entirely push-pull for improved high-frequency distortion and slew rate. Additional circuit features include new thermal overload protection and instant turn-on with no undesirable transients.

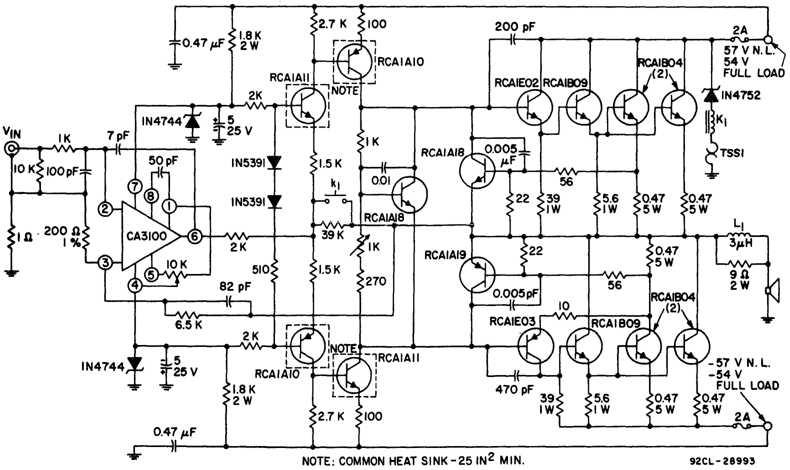
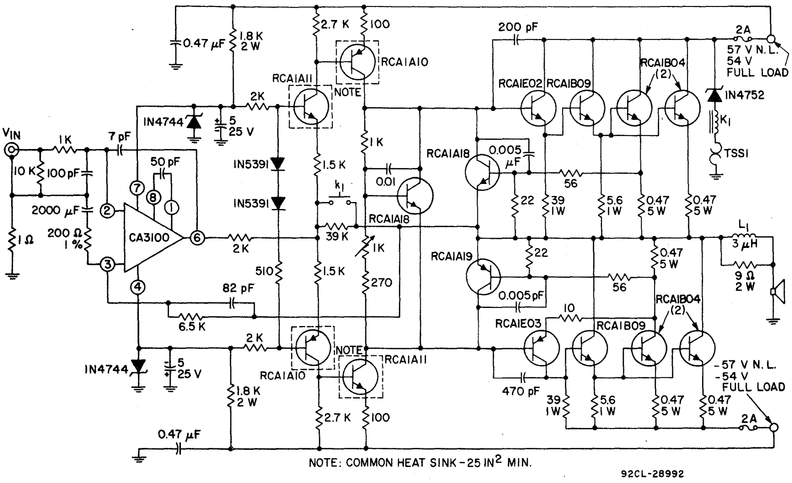


Fig. 6 – 100-W dc-coupled audio amplifier circuit featuring parallel output transistors.



OUTPUT HEAT SINK – 1°C/W PER OUTPUT TRANSISTOR

SET IDLING CURRENT FOR 150 – 200 mA THROUGH 2-A FUSE.

NOTES:

1. All resistors 1/2 W, 5% carbon unless specified.
2. All capacitances in µF unless specified.
3. All resistors are non-inductive.
4. K-1 Relay, single-pole, single-throw, normally closed, with 24 V, 3 mA coil.
5. TSS1 - 70°C thermal cutout, Elmwood Sensor Part No. 3450-157-37, or equivalent.

Fig. 7 — 100-W ac-coupled audio amplifier circuit featuring parallel output transistors.

NOTE:

Power Transformer: Signal BO-8 (Signal Transformer Co., 1 Junius St., Brooklyn, N.Y. 11212), or equivalent.

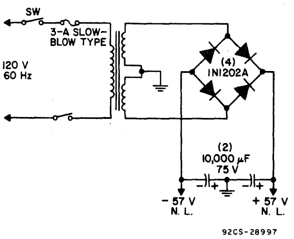


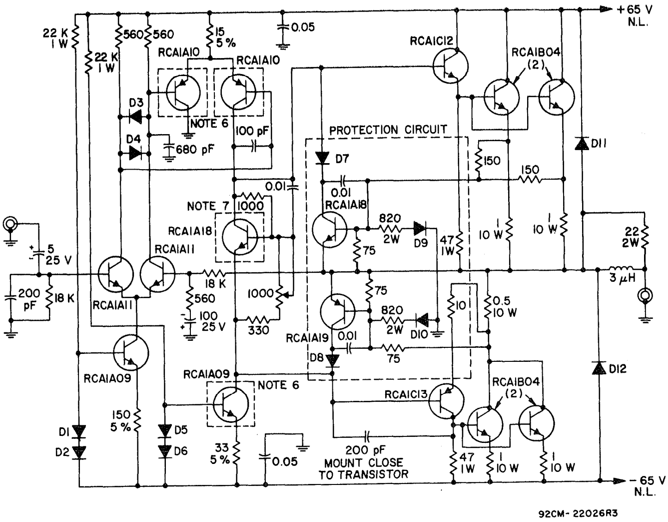
Fig. 8 — Power supply for 100-W audio amplifiers shown in Figs. 6 and 7.

120-W Amplifier

The 120-W amplifier shown in Fig. 9 uses four RCA1B04 transistors as parallel units in the amplifier output stages, and operates on a 130-V split power supply.

This 120-W amplifier is especially designed for top-of-the line quadrasonic use in applications requiring 1/2 kW of quadrasonic sound with excellent tonal quality. The amplifier output is directly coupled to an 8-Ω speaker.

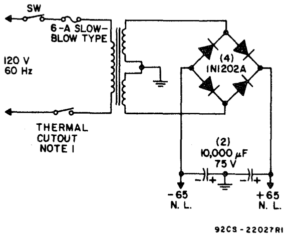
RCA1B04, RCA1B05, RCA1B09



NOTES:

1. D1-D8 – 1N5391; D9,D10 – 1N914B; D11, D12 – 1N5393
2. Resistors are 1/2 W ± 10% unless otherwise specified; values are in ohms
3. Capacitances are in μF unless otherwise specified.
4. Non-inductive resistors
5. Provide approx. 1°C/W heat sinking per output device based on mounting with mica washer and ZnO thermal compound (Dow Corning No.340, or equivalent) with T_A = 45°C max.
6. Mount on heat sink, Wakefield No. 209-AB, or equivalent. (Alternatively, this type may be obtained with a factory-attached integral heat sink).
7. Attach heat sink cap (Wakefield No.260-6SH5E, or equivalent) on device and mount on same heat sink with output transistor.

Fig. 9 – 120-W audio-amplifier circuit featuring parallel output transistors.



NOTES:

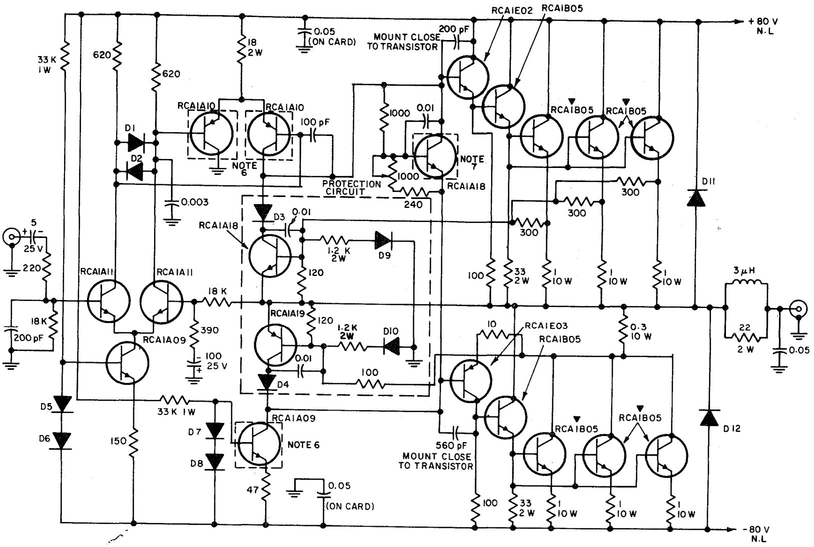
1. 93°C thermal cutout (attached to heat sink for output transistors (Elmwood Sensor part No. 2455-88-4), or equivalent.
2. Power transformer: Signal 88-6, Signal Transformer Co., 1 Junius St., Brooklyn, N.Y. 11212, or equivalent.
   Use 125-V primary tap.

Fig. 10 – Power supply for 120-W audio amplifier circuit shown in Fig. 9.

200-W Amplifier

The 200-W amplifier shown in Fig. 11 uses eight RCA 1B05 transistors, two as drivers and six as parallel units in the amplifier output stages, and operates on a 160-V split power supply.

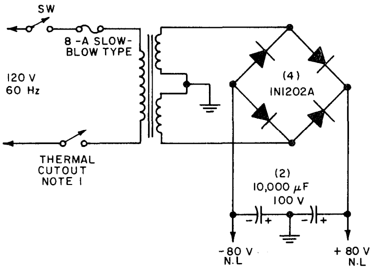
This 200-W amplifier is especially designed to feature ruggedness in combination with high power output and excellent high fidelity performance. The amplifier output is directly coupled to an 8-Ω speaker.



NOTES:

1. D1-D8 – 1N5391; D9, D10 – 1N5316; D11, D12 – 1N5393.
2. Resistors are 1/2W ± 10% unless otherwise specified, values are in ohms.
3. Capacitances are in μF unless otherwise specified.
4. Non-inductive resistors.
5. ▼ Provide approx. 1°C/W heat sinking per output device based on mounting with mica washer and ZnO thermal compound (Dow Corning No. 340, or equivalent) with T_A = 45°C max.
6. Mount on heat sink, Wakefield No. 209-AB, or equivalent. (Alternately, this type may be obtained with a factory-attached integral heat sink.)
7. Attach heat sink cap (Wakefield No. 260-6SHSE, or equivalent) on device and mount on same heat sink with output transistor.

Fig. 11 – 200-W audio amplifier circuit featuring paralle output transistors.



NOTES:

1. 90°C thermal cutout attached to heat sink for output transistors.
2. Power transformer: Signal 120-8 (Signal Tranformer Co., 1 Junius St., Brooklyn, N.Y. 11212), or equivalent. Use 125-V primary tap.

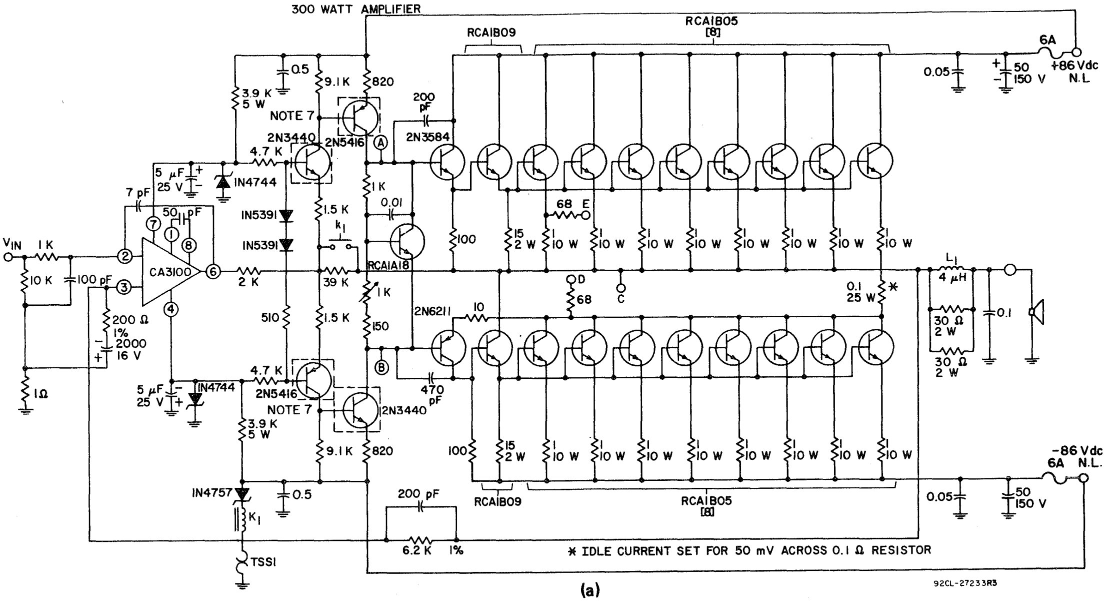
Fig. 12 – Power supply for 200-W audio amplifier circuit shown in Fig. 11.

300-W Amplifier

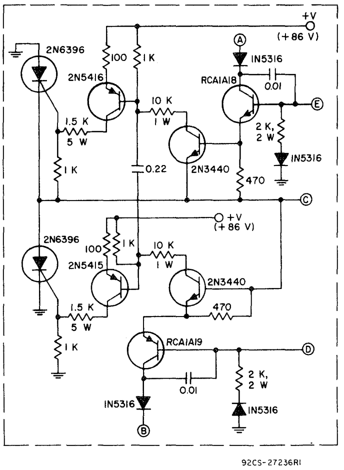
The 300-W amplifier shown in Fig. 13 uses two RCA1B09 transistors as drivers and sixteen RCA1B05 transistors as parallel units in the amplifier output stages, and operates on a 172-V split power supply.

This 300-W amplifier is conservatively designed to provide excellent high-power performance into either 8-Ω or 4-Ω loads. With the exception of the RCA-CA3100 linear integrated circuit for the front end, this amplifier is entirely push-pull for improved high-frequency distortion and slew rate. Additional circuit features include new thermal overload and reactive overload protection and instant turn-on with no undesirable transients.

RCA1B04, RCA1B05, RCA1B09



(a)

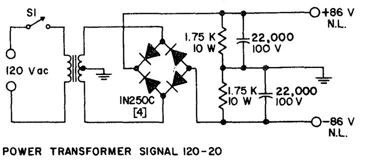


(b)

NOTES:

1. All resistors 1/2 W, 5% carbon unless specified.
2. All capacitances in microfarads unless specified.
3. All resistors are non-inductive.
4. K1-Relay, single-pole, single-throw, normally closed, with 24-V, 3 mA coil.
5. TSS1-70°C thermal cutout, Elmwood Sensor Part No. 3450-157-37, or equivalent.
6. For dc-coupled version, delete 2,000-μF capacitor, add 10-kΩ potentiometer – see 100-W amplifier circuit Fig.9 (a).
7. Common heat sink – 25 in.^{2} minimum.

Fig. 13 – 300-W audio amplifier circuit featuring parallel output transistors: (a) basic amplifier circuit, (b) protection circuit.



POWER TRANSFORMER SIGNAL 120-20 (SIGNAL TRANSFORMER CO., JANIUS ST., BROOKLYN, N.Y. 11212), OR EQUIVALENT SI-20-A CIRCUIT BREAKER

92CS-27234R2

Fig. 14 – Power supply for 300-W audio-amplifier circuit shown in Fig. 13.

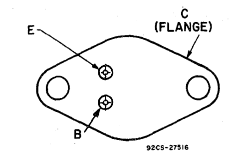
RCA1B06

Silicon Transistor for 70-Watt Quasi-Complementary-Symmetry Audio Amplifiers with Pi-Nu Output Transistors

RCA1B06 is an n-p-n pi-nu silicon transistor in a JEDEC TO-3 package. This device is especially characterized for audio-amplifier applications, and can be driven by either RCA1C03 or RCA1C04, n-p-n and p-n-p types, respectively.

The 70-watt amplifier shown in Fig. 1 uses the RCA1B06 output device in conjunction with eleven other discrete transistors, thirteen diodes, and a 90-volt split power supply. The amplifier output is directly coupled in an 8-ohm speaker. The high-frequency RCA1B06 output transistors used in the amplifier circuit produce excellent transient response at a high power level.

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		RCA1B06	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	100	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}	120	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	V
COLLECTOR CURRENT	I_C	7	A
BASE CURRENT	I_B	2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		150	W
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		230	°C

Type RCA1B06
Package: JEDEC TO-3
Construction: Silicon n-p-n, epitaxial, multiple-emitter-site, pi-nu

ELECTRICAL CHARACTERISTICS. *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 90 V, R_{BE} = 100Ω	–	1	mA
V_{CEO}	I_C = 0.2 A, I_B = 0	100	–	V
f_T	I_C = 0.2 A, V_{CE} = 10 V	5	–	MHz
h_{FE}	I_C = 4 A, V_{CE} = 4 V	10	50	
V_{CE}(sat)	I_C = 4 A, I_B = 0.8 A	–	2	V
V_{BE}	I_C = 4 A, V_{CE} = 4 V	–	2	V
$I_{S/b}$	V_{CE} = 80 V, t = 1 s	1.87	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N5840

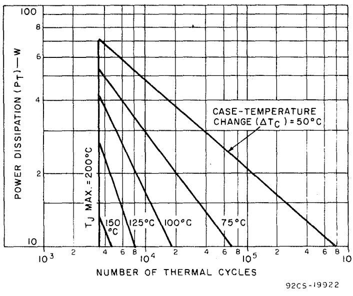


Fig. 2 — Thermal-cycling ratings for RCA1B06.

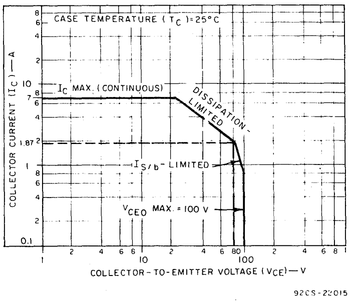
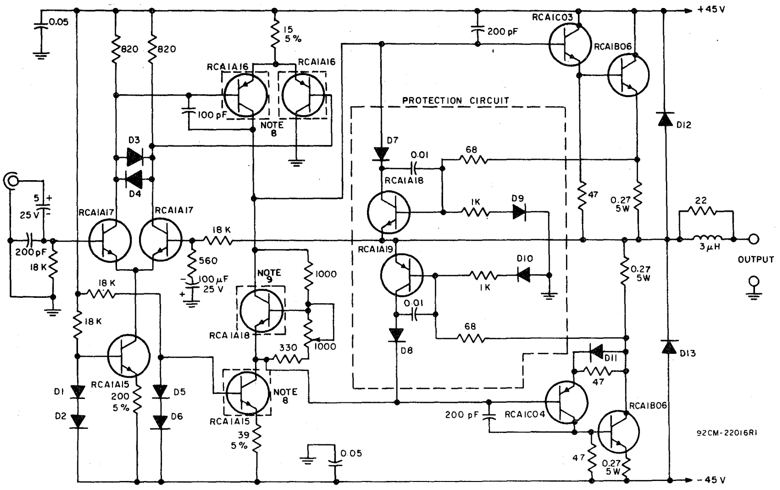


Fig. 3 — Maximum operating areas for RCA1B06.



NOTES:

1. 100°C thermal cutout attached to heat sink for output transistors (Elmwood Sensor part No. 2455-88-4).●
2. Power transformer: Signal 120-2 (parallel secondary),● Signal Transformer Co., 1 Junius St., Brooklyn, N.Y. 11212.
3. Resistors are 1/2-watt unless otherwise specified; values are in ohms.
4. Capacitances are in μF unless otherwise specified.
5. Non-inductive resistors.
6. D1-D8, D11-1N5391
   D9, D10, D12, D13-1N5393

● Or equivalent.

Fig. 1 — 70-Watt amplifier circuit featuring quasi-complementary-symmetry output employing pi-nu construction output transistors.

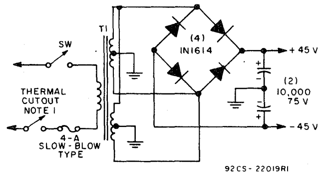


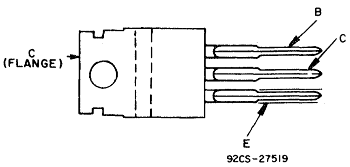
Fig. 4 — Power supply for 70-watt audio-amplifier shown in Fig. 3.

RCA1C03, RCA1C04, RCA1C012, RCA1C013

Silicon Transistors for Audio-Frequency Linear-Amplifier Applications

RCA1C03, RCA1C04, RCA1C12, and RCA1C13 are complementary silicon n-p-n and p-n-p transistors especially characterized for audio-amplifier applications. These devices, singly or in pairs in complementary- or quasi-complementary-symmetry circuits, are particularly useful as drivers or pre-drivers. They may also be used in audio power amplifiers, linear modulators, servo amplifiers, and operational amplifiers. The units are supplied in the JEDEC TO-220AB version of the plastic VERSAWATT package.

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S")

N-P-N Types	P-N-P Types
RCA1C03	RCA1C04
RCA1C12	RCA1C13

MAXIMUM RATINGS, *Absolute-Maximum Values:*		RCA1C03	RCA1C04	RCA1C12	RCA1C13	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	−120	140	−140	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With base open	V_{CEO}	100	−100	120	−120	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	120	−120	140	−140	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	−5	5	−5	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	−4	4	−4	A
CONTINUOUS BASE CURRENT	I_B	2	−2	2	−2	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		40	40	40	40	W
At case temperatures above 25°C		← Derate linearly to 150°C →				
TEMPERATURE RANGE:						
Storage and Operating (Junction)		← −65 to +150 →				°C
PIN TEMPERATURE (During Soldering):						
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		← 230 →				°C

Type RCA1C03
Package: JEDEC TO-220AB
Construction: Silicon n-p-n, epitaxial

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 110 V, R_{BE} = 100Ω	–	1	mA
I_{EBO}	V_{EB} = 5 V, I_C = 0	–	1	mA
V_{CEO}	I_C = 0.1 A, I_B = 0	100	–	V
f_T	I_C = 0.5 A, V_{CE} = 4 V	4	–	MHz
h_{FE}	I_C = 1 A, V_{CE} = 4 V	50	250	
$V_{CE(sat)}$	I_C = 1 A, I_B = 0.1 A	–	1	V
V_{BE}	I_C = 1 A, V_{CE} = 4 V	–	1.5	V
$I_{S/b}$	V_{CE} = 40 V, t = 0.4 s	1	–	A

For charachersistics curves and test conditions, refer to published data for prototype 2N6293.

Type RCA1C04
Package: JEDEC TO-220AB
Construction: Silicon p-n-p, epitaxial

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = −110 V, R_{BE} = 100Ω	–	−1	mA
I_{EBO}	V_{EB} = −5 V, I_C = 0	–	−1	mA
V_{CEO}	I_C = −0.1 A, I_B = 0	−100	–	V
f_T	I_C = −0.5 A, V_{CE} = −4 V	5	–	MHz
h_{FE}	I_C = −1 A, V_{CE} = −4 V	50	250	
$V_{CE(sat)}$	I_C = −1 A, I_B = −0.1 A	–	−1	V
V_{BE}	I_C = −1 A, V_{CE} = −4 V	–	−1.5	V
$I_{S/b}$	V_{CE} = −40 V, t = 0.4 s	−1	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6476.

Type RCA1C12
Package: JEDEC TO-220AB
Construction: Silicon n-p-n, epitaxial

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 90 V, R_{BE} = 100 Ω	–	100	μA
I_{EBO}	V_{EB} = 5 V, I_C = 0	–	1	mA
V_{CEO}	I_C = 0.1 A, I_B = 0	120	–	V
V_{CER}	I_C = 0.1 A, R_{BE} = 100 Ω	140	–	V
f_T	I_C = 0.5 A, V_{CE} = 4 V	4	–	MHz
h_{FE}	I_C = 1 A, V_{CE} = 2 V	40	250	
V_{BE}	I_C = 1 A, V_{CE} = 2 V	–	1.2	V
$I_{S/b}$	V_{CE} = 60 V, t = 0.4 s	0.66	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6474.

Type RCA1C13
Package: JEDEC TO-220AB
Construction: Silicon p-n-p, epitaxial

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = −90 V, R_{BE} = 100 Ω	–	−100	μA
I_{EBO}	V_{EB} = −5 V, I_C = 0	–	−1	mA
V_{CEO}	I_C = −0.1 A, I_B = 0	−120	–	V
V_{CER}	I_C = −0.1 A, R_{BE} = 100 Ω	−140	–	V
f_T	I_C = −0.5 A, V_{CE} = −4 V	5	–	MHz
h_{FE}	I_C = −1 A, V_{CE} = −2 V	40	250	
V_{BE}	I_C = −1 A, V_{CE} = −2 V	–	−1.2	V
$I_{S/b}$	V_{CE} = −60 V, t = 0.4 s	−0.66	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6476.

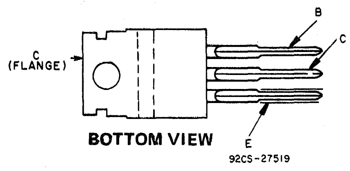
RCA1C05, RCA1C06

Silicon Transistors for 25-Watt Full-Complementary-Symmetry Audio Amplifiers

RCA1C05 and RCA1C06 are n-p-n and p-n-p epitaxial-base silicon power transistors, respectively. These complementary output devices for audio applications are provided in the JEDEC TO-220AB plastic package.

The 25-watt audio-amplifier circuit shown in Fig. 4 uses RCA1C05 and RCA1C06 as output devices in conjunction with seven TO-39 discrete transistors, ten diodes, and a 52-volt split power supply. The amplifier output is directly coupled to an 8-ohm speaker. The full-complementary-symmetry output stage provides excellent high-frequency performance at moderate cost.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		RCA1C05	RCA1C06	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	–60	V
COLLECTOR-TO- EMITTER VOLTAGE:				
With base open	V_{CEO}	50	–50	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}	60	–60	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	–5	V
COLLECTOR CURRENT	I_C	7	–7	A
BASE CURRENT	I_B	3	–3	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C		40	40	W
At case temperatures above 25°C		Derate linearly to 150°C		
TEMPERATURE RANGE:				
Storage & Operating (Junction)		–65 to +150		°C
PIN TEMPERATURE (During Soldering):				
At distances ≥1/32 in. (0.8 mm) from case of 10 s max.		230		°C

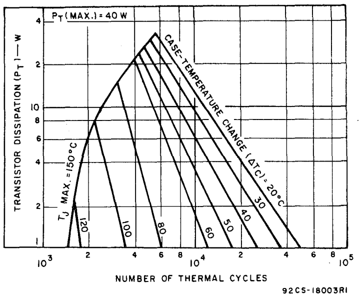


Fig. 1 — Thermal-cycling ratings for RCA1C05 and RCA1C06.

Type RCA1C05
Package: JEDEC TO-220AB
Construction: Silicon n-p-n, epitaxial base

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 50 V, R_{BE} = 100Ω	–	1	mA
I_{EBO}	V_{BE} = 5 V, I_C = 0	–	1	mA
V_{CER}	I_C = 0.1 A, R_{BE} = 100Ω	60	–	V
f_T	I_C = 0.1 A, V_{CE} = 4 V	4	–	MHz
h_{FE}	I_C = 3 A, V_{CE} = 4 V	20	120	
V_{CE}(sat)	I_C = 3 A, I_B = 0.3 A	–	1	V
V_{BE}	I_C = 3 A, V_{CE} = 4 V	–	1.5	V
$I_{S/b}$	V_{CE} = 20 V, t = 0.5 s	2	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6292

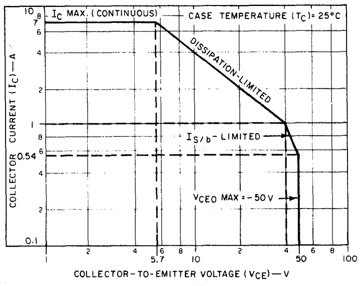


Fig. 2 — Maximum operating areas for RCA1C05.

Type RCA1C06
Package: JEDEC TO-220AB
Construction: Silicon p-n-p, epitaxial base

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = –50 V, R_{BE} = 100Ω	–	–1	mA
I_{EBO}	V_{EB} = –5 V, I_C = 0	–	–1	mA
V_{CER}	I_C = –0.1 A, R_{BE} = 100Ω	–60	–	V
f_T	I_C = –0.1 A, V_{CE} = –4 V	10	–	MHz
h_{FE}	I_C = –3 A, V_{CE} = –4 V	20	120	
V_{CE}(sat)	I_C = –3 A, I_B = –0.3 A	–	–1	V
V_{BE}	I_C = –3 A, V_{CE} = –4 V	–	–1.5	V
$I_{S/b}$	V_{CE} = –20 V, t = 0.5 s	–2	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6107 (File 488).

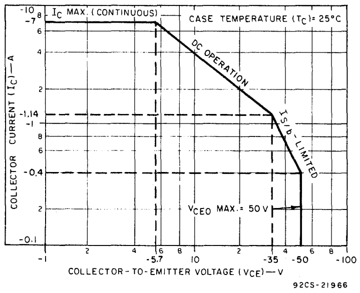
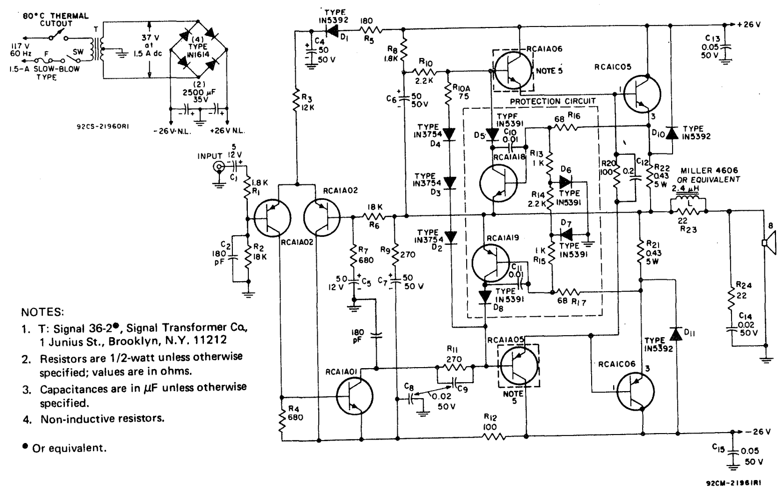


Fig. 3 — Maximum operating areas for RCA1C06.

RCA1C05, RCA1C06



NOTES:

1. T: Signal 36-2•, Signal Transformer Co., 1 Junius St., Brooklyn, N.Y. 11212
2. Resistors are 1/2-watt unless otherwise specified; values are in ohms.
3. Capacitances are in μF unless otherwise specified.
4. Non-inductive resistors.

• Or equivalent.

Fig. 4 – 25-watt amplifier circuit featuring true-complementary-symmetry output with load line limiting.

RCA1C07, RCA1C08

Silicon Transistors for 40-Watt Full-Complementary-Symmetry Audio Amplifiers

RCA1C07 and RCA1C08 are n-p-n and p-n-p epitaxial-base silicon power transistors, respectively, especially suitable for audio-output applications. These devices are provided in the economical JEDEC TO-220AB version of the VERSAWATT package.

The 40-watt amplifier shown in Fig. 3 uses the RCA1C07 and RCA1C08 in conjunction with seven TO-39 transistors, ten diodes, and a 64-volt split power supply. The amplifier output is directly coupled to an 8-ohm speaker. The high-frequency performance of this 40-watt amplifier will provide excellent reproduction for the most critical listener.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		RCA1C07	RCA1C08	
COLLECTOR-TO-BASE-VOLTAGE	V_{CBO}	75	−75	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open	V_{CEO}	65	−65	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}	75	−75	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	−5	V
COLLECTOR CURRENT	I_C	10	−10	A
BASE CURRENT	I_B	4	−4	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C		75	75	W
At case temperatures above 25°C		Derate linearly to 150°C		
TEMPERATURE RANGE:				
Storage & Operating (Junction)		← −65 to 150 →		°C
PIN TEMPERATURE (During Soldering):				
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		← 230 →		°C

Type RCA1C07
Package: JEDEC TO-220AB
Construction: Silicon n-p-n, epitaxial base

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 65V, R_{BE} = 100Ω	–	1	mA
I_{EBO}	V_{BE} = 5V, I_C = 0	–	1	mA
V_{CER}	I_C = 0.1A, R_{BE} = 100Ω	75	–	V
f_T	I_C = 1 A, V_{CE} = 4V	5	–	MHz
h_{FE}	I_C = 4A, V_{CE} = 4V	20	120	
V_{CE}(sat)	I_C = 4A, I_B = 0.4 A	–	1	V
V_{BE}	I_C = 4A, V_{CE} = 4V	–	1.5	V
$I_{S/b}$	V_{CE} = 30V, t = 0.5 s	2.5	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6292

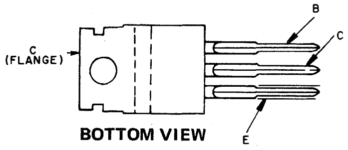
Type RCA1C08
Package: JEDEC TO-220AB
Construction: Silicon p-n-p, epitaxial base

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = −65V, R_{BE} = 100Ω	–	−1	mA
I_{EBO}	V_{EB} = −5V, I_C = 0	–	−1	mA
V_{CER}	I_C = −0.1A, R_{BE} = 100Ω	−75	–	V
f_T	I_C = −1 A, V_{CE} = −4V	5	–	MHz
h_{FE}	I_C = −4A, V_{CE} = −4V	20	120	
V_{CE}(sat)	I_C = −4A, I_B = −0.4A	–	−1	V
V_{BE}	I_C = −4A, V_{CE} = −4V	–	−1.5	V
$I_{S/b}$	V_{CE} = −30V, t = 0.5 s	−2.5	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6107 (File 488).

TERMINAL DESIGNATIONS



BOTTOM VIEW

92CS-27519

JEDEC TO-220AB
(See dimensional outline "S".)

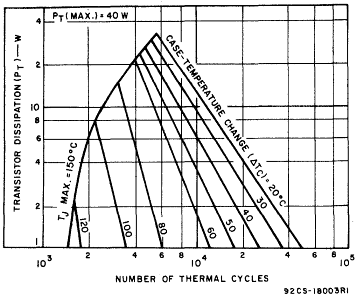
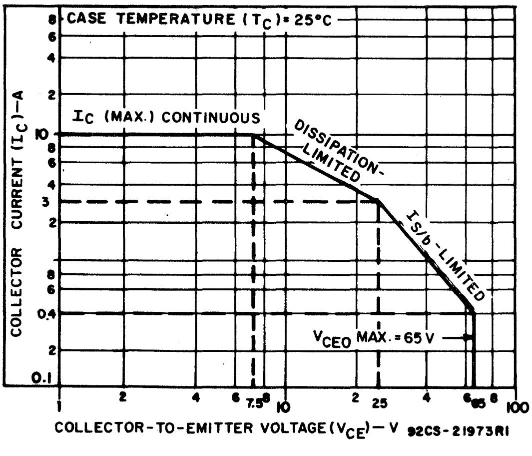


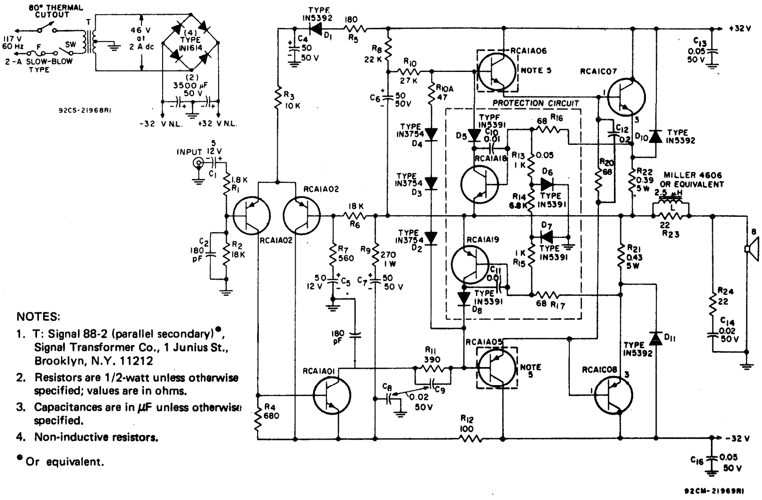
Fig. 1 — Thermal-cycling ratings for RCA1C07 and RCA1C08.



♦ For p-n-p device, voltage and current are negative.

Fig. 2 — Maximum operating areas for RCA1C07 and RCA1C08.

RCA1C07, RCA1C08



NOTES:

1. T: Signal 88-2 (parallel secondary)●, Signal Transformer Co., 1 Junius St., Brooklyn, N.Y. 11212
2. Resistors are 1/2-watt unless otherwise specified; values are in ohms.
3. Capacitances are in μF unless otherwise specified.
4. Non-inductive resistors.

● Or equivalent.

Fig. 3 — 40-Watt amplifier circuit featuring full-complementary-symmetry output using load line limiting.

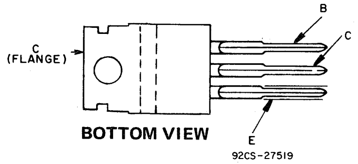
RCA1C09

Silicon Transistor for 40-Watt Quasi-Complementary-Symmetry Audio Amplifiers

RCA1C09 is an n-p-n, hometaxial-base silicon transistor packaged in the JEDEC TO-220AB (VERSAWATT) case. Two of these devices, driven in the class-B mode by the RCA1A06 and RCA1A05 silicon n-p-n and p-n-p transistors, can be used as output devices in audio-amplifier applications.

The 40-watt amplifier shown in Fig. 3 uses two RCA1C09 transistors as output units in conjunction with seven TO-39 transistors, 11 diodes, and a 64-volt split power supply. The amplifier output is directly coupled to an 8-ohm speaker. This 40-watt amplifier features ruggedness and economy in the mid-power range.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

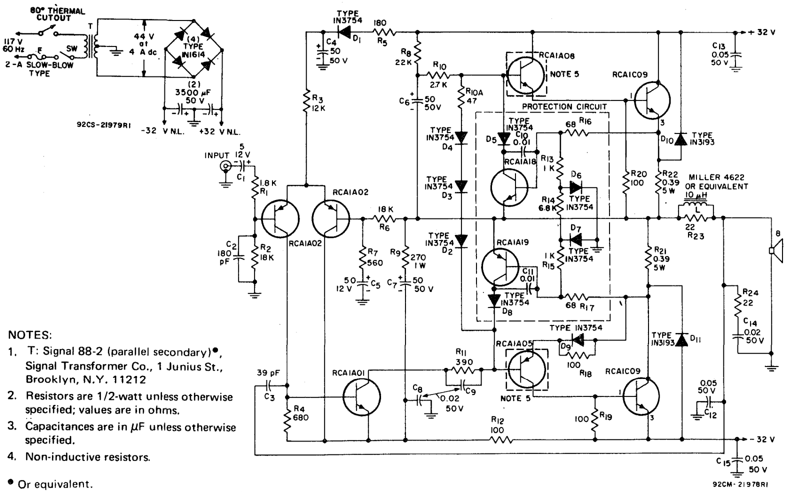
MAXIMUM RATINGS, *Absolute-Maximum Values:*		RCA1C09	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	75	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	65	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}	75	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	V
COLLECTOR CURRENT	I_C	10	A
BASE CURRENT	I_B	4	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		75	W
At case temperatures above 25°C		Derate linearly to 150°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 150	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		230	°C

Type RCA1C09
Package: JEDEC TO-220AB
Construction: Silicon n-p-n, hometaxial base

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 65 V, R_{BE} = 100Ω	–	1	mA
I_{EBO}	V_{EB} = 5 V, I_C = 0	–	1	mA
V_{CER}	I_C = 0.2 A, R_{BE} = 100Ω	75	–	V
f_T	I_C = 0.5 A, V_{CE} = 4 V	0.8	–	MHz
h_{FE}	I_C = 4 A, V_{CE} = 4 V	20	120	
V_{CE}(sat)	I_C = 4 A, I_B = 0.4 A	–	1	V
V_{BE}	I_C = 4 A, V_{CE} = 4 V	–	1.5	V
$I_{S/b}$	V_{CE} = 40 V, t = 0.5 s	1.87	–	A

For characteristics curves and test conditions, refer to published



NOTES:

1. T: Signal 88-2 (parallel secondary)•, Signal Transformer Co., 1 Junius St., Brooklyn, N.Y. 11212
2. Resistors are 1/2-watt unless otherwise specified; values are in ohms.
3. Capacitances are in µF unless otherwise specified.
4. Non-inductive resistors.

• Or equivalent.

Fig. 1 – 40-Watt amplifier circuit featuring quasi-complementary-symmetry output.

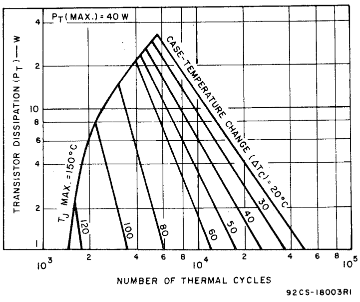


Fig. 2 – Thermal-cycling ratings for RCA1C09.

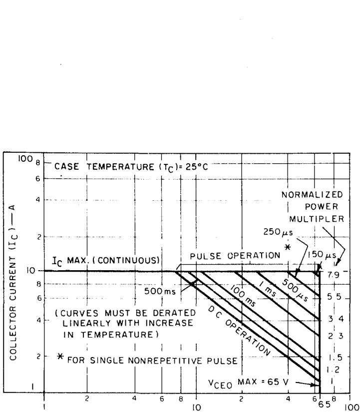


Fig. 3 – Maximum operating areas for RCA1C09.

RCA1C10, RCA1C11

Silicon Transistors for 12-Watt True-Complementary-Symmetry Audio Amplifers

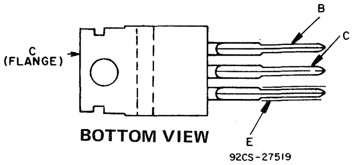
RCA1C10 and RCA1C11 are n-p-n and p-n-p epitaxial-base silicon power transistors, respectively, especially characterized for audio-output service. To enhance circuit economics, they are provided in the JEDEC TO-220AB version of the VERSAWATT plastic package.

The 12-watt audio amplifier circuit shown in Fig. 4 uses RCA1C10 and RCA1C11 as output devices in conjunction with three discrete transistors, two diodes, and a single 36-volt power supply; the amplifier output is capacitively coupled to an 8-ohm speaker. The choice of a true-complementary-symmetry output stage provides excellent fidelity for a low-cost system.

The 12-watt amplifier circuit shown in Fig. 5 uses RCA1C10 and RCA1C11 discrete transistors, an integrated circuit, one diode, and a 36-volt split power supply; the amplifier output is directly coupled to an 8-ohm speaker. The integrated circuit-true-complementary-symmetry combination provides a high-quality, low-cost amplifier.

The RCA CA3094AT integrated circuit provides sufficient drive current for the complementary-symmetry output stage. Tone controls, bass and treble, with functions of "boost" and "cut" are incorporated into the feedback loop of the amplifier, resulting in excellent signal-to-noise ratio and freedom from distortion. Ratings and characteristics of type CA3094AT are given in RCA data bulletin File 598.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		RCA1C10	RCA1C11	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	−40	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open	V_{CEO}	40	−40	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}	50	−50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	−5	V
COLLECTOR CURRENT	I_C	7	−7	A
BASE CURRENT	I_B	3	−3	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C		40	40	W
At case temperatures above 25°C		Derate linearly to 150°C		
TEMPERATURE RANGE:				
Storage & Operating (Junction)		← −65 to 150 →		°C
PIN TEMPERATURE (During Soldering):				
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		← 230 →		°C

Type RCA1C10
Package: JEDEC TO-220AB
Construction: Silicon n-p-n, epitaxial-base

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 35 V, R_{BE} = 100Ω	–	10	μA
I_{EBO}	V_{EB} = 5 V	–	1	mA
V_{CEO}	I_C = 0.1 A, I_B = 0	40	–	V
V_{CER}	I_C = 0.1 A, R_{BE} = 100Ω	50	–	V
f_T	V_{CE} = 4 V, I_C = 0.5 A	4	–	MHz
h_{FE}	I_C = 1.5 A, V_{CE} = 4 V	50	250	
$V_{CE}(sat)$	I_C = 1.5 A, I_B = 0.075 A	–	1	V
V_{BE}	I_C = 1.5 A, V_{CE} = 4 V	–	1.5	V
$I_{S/b}$	V_{CE} = 20 V, t = 0.4 s	2	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6292

Type RCA1C11
Package: JEDEC TO-220AB
Construction: Silicon p-n-p, epitaxial base

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = −35 V, R_{BE} = 100Ω	–	−10	μA
I_{EBO}	V_{EB} = −5 V	–	−1	mA
V_{CEO}	I_C = −0.1 A, I_B = 0	−40	–	V
V_{CER}	I_C = −0.1 A, R_{BE} = 100Ω	−50	–	V
f_T	V_{CE} = −4 V, I_C = −0.5 A	10	–	MHz
h_{FE}	I_C = −1.5 A, V_{CE} = −4 V	50	250	
$V_{CE}(sat)$	I_C = −1.5 A, I_B = −0.075 A	–	−1	V
V_{BE}	I_C = −1.5 A, V_{CE} = −4 V	–	−1.5	V
$I_{S/b}$	V_{CE} = −20 V, t = 0.4 s	−2	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6107

RCA1C10, RCA1C11

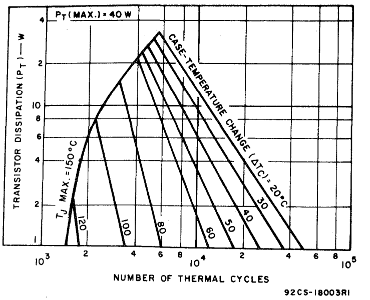


Fig. 1 – Thermal-cycling ratings for RCA1C10 and RCA1C11.

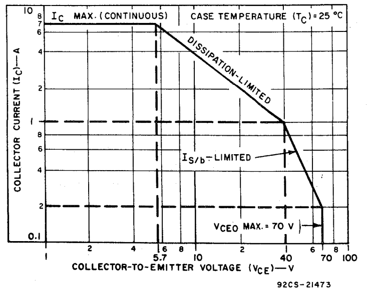


Fig. 2 – Maximum operating areas for RCA1C10.

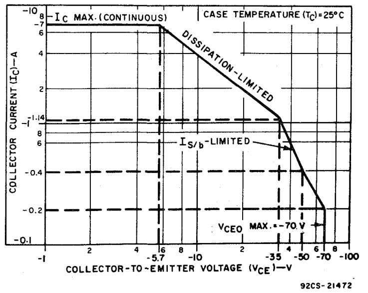
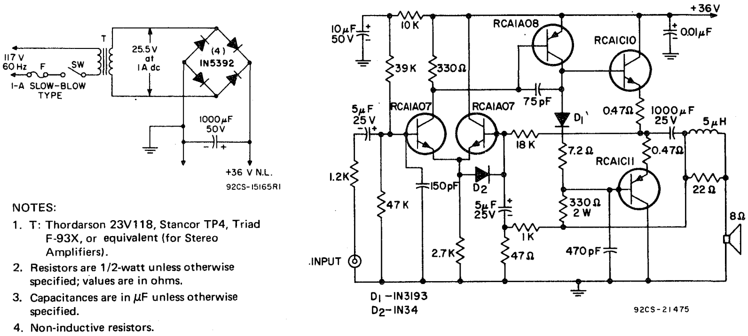


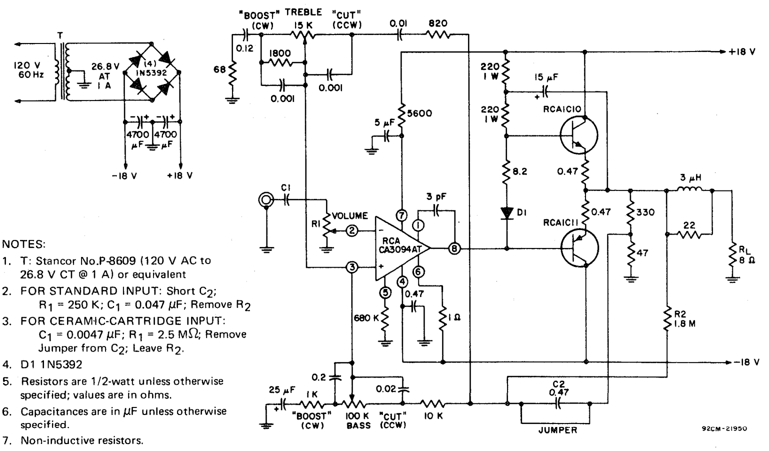
Fig. 3 – Maximum operating areas for RCA1C11.



NOTES:

1. T: Thordarson 23V118, Stancor TP4, Triad F-93X, or equivalent (for Stereo Amplifiers).
2. Resistors are 1/2-watt unless otherwise specified; values are in ohms.
3. Capacitances are in μF unless otherwise specified.
4. Non-inductive resistors.

Fig. 4 – 12-watt amplifier circuit featuring complementary-symmetry output.



NOTES:

1. T: Stancor No.P-8609 (120 V AC to 26.8 V CT @ 1 A) or equivalent
2. FOR STANDARD INPUT: Short C_2; R_1 = 250 K; C_1 = 0.047 μF; Remove R_2
3. FOR CERAMIC-CARTRIDGE INPUT: C_1 = 0.0047 μF; R_1 = 2.5 MΩ; Remove Jumper from C_2; Leave R_2.
4. D1 1N5392
5. Resistors are 1/2-watt unless otherwise specified; values are in ohms.
6. Capacitances are in μF unless otherwise specified.
7. Non-inductive resistors.

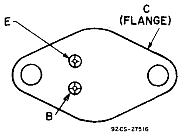
Fig. 5 – 12-watt amplifier circuit featuring an integrated-circuit driver and a true-complementary-symmetry output stage.

RCA1E02, RCA1E03

Silicon Transistors for Audio-Frequency Linear-Amplifier Applications

RCA1E02 and RCA1E03 are silicon n-p-n and p-n-p transistors, respectively. These complementary devices are especially characterized for audio-amplifier applications. They may be used singly or as a complementary pair in complementary- or quasi-complementary-symmetry circuits, and are particularly useful as drivers or predrivers. They may also be used in audio power amplifiers, linear modulators, servo amplifiers, and operational amplifiers. The units are supplied in the JEDEC TO-66 package.

TERMINAL DESIGNATIONS



JEDEC TO-66

(See dimensional outline "N.")

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		RCA1E02	RCA1E03	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	200	−200	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open	V_{CEO}	175	−175	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	200	−200	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	−5	V
COLLECTOR CURRENT	I_C	2	−2	A
BASE CURRENT	I_B	1	−1	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C		35	35	W
At case temperatures above 25°C		Derate linearly to 200°C		
TEMPERATURE RANGE:				
Storage and Operating (Junction)		←— −65 to +200 —→		°C
PIN TEMPERATURE (During Soldering):				
At distances ⩾ 1/32 in. (0.8 mm) from case for 10 s max.		←— 230 —→		°C

Type RCA1E02
Package: JEDEC TO-66
Construction: Silicon n-p-n

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = 120 V, R_{BE} = 100 Ω	–	100	μA
I_{EBO}	V_{EB} = 5 V, I_C = 0	–	1	mA
V_{CEO}	I_C = 0.1 A, I_B = 0	175	–	V
V_{CER}	I_C = 0.1 A, R_{BE} = 100 Ω	200	–	V
h_{FE}	I_C = 0.3 A, V_{CE} = 2 V	30	150	
V_{BE}	I_C = 0.3 A, V_{CE} = 2 V	–	1	V
$I_{S/b}$	V_{CE} = 80 V, t = 0.4 s	0.4	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N3583

Type RCA1E03
Package: JEDEC TO-66
Construction: Silicon p-n-p

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
		MIN.	MAX.	
I_{CER}	V_{CE} = −120 V, R_{BE} = 100 Ω	–	−100	μA
I_{EBO}	V_{EB} = −5 V, I_C = 0	–	−1	mA
V_{CEO}	I_C = −0.1 A, I_B = 0	−175	–	V
V_{CER}	I_C = −0.1 A, R_{BE} = 100 Ω	−200	–	V
h_{FE}	I_C = −0.3 A, V_{CE} = −2 V	30	150	
V_{BE}	I_C = −0.3 A, V_{CE} = −2 V	–	−1	V
$I_{S/b}$	V_{CE} = −80 V, t = 0.4 s	−0.25	–	A

For characteristics curves and test conditions, refer to published data for prototype 2N6211

High-Voltage, High-Power Silicon N-P-N Transistors

For Switching and Linear Applications in
Military, Industrial, and Commercial Equipment

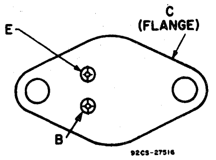
RCA-410 is an epitaxial silicon n-p-n power transistor utilizing a multiple-emitter-site structure. This device employs the popular JEDEC TO-3 package.

Featuring high breakdown-voltage ratings and low saturation-voltage values, the RCA-410 is especially suitable for use in inverters, deflection circuits, switching regulators, high-voltage bridge amplifiers, ignition circuits, and other high-voltage switching applications.

Features:

- **Maximum safe-area-of-operation curves**
- **Low saturation voltage: V_{CE}(sat) = 0.8 V (max.)**
- **High voltage rating: V_{CEO}(sus) = 200 V**
- **High dissipation rating: P_T = 125 W**

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	200	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE		
With base open, V_{CEO}(sus)	200	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5	V
COLLECTOR CURRENT:		
Continuous, I_C	7	A
Peak	10	A
BASE CURRENT (Continuous), I_B	2	A
TRANSISTOR DISSIPATION, P_T:		
At case temperatures up to 25°C and V_{CE} up to 75 V	125	W
At case temperatures up to 25°C and V_{CE} above 75 V	See Fig. 2.	
At case temperatures above 25°C and V_{CE} above 75 V	See Figs. 1 & 2.	
TEMPERATURE RANGE:		
Storage & Operating (Junction)	−65 to +200	°C
PIN TEMPERATURE (During Soldering):		
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.	230	°C

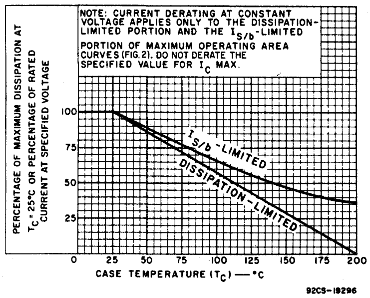


Fig.1—Dissipation and current derating curves.

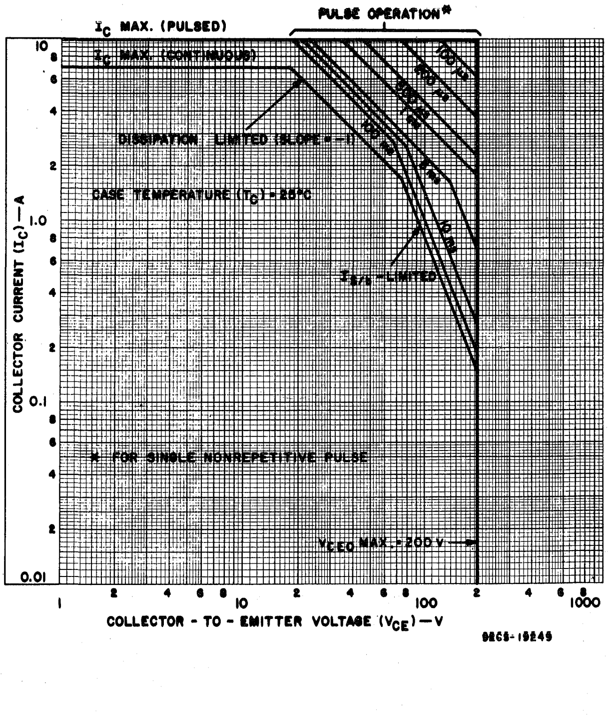


Fig.2—Maximum operating areas.

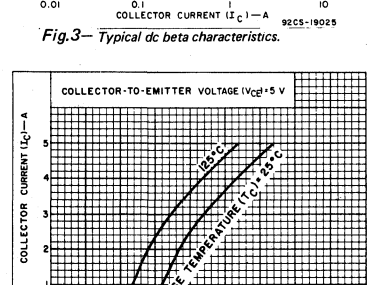


Fig.3— Typical dc beta characteristics.

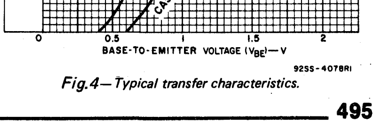


Fig.4— Typical transfer characteristics.

RCA410

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified

Characteristic	Symbol	Test Conditions					Limits			Units
		DC Collector Voltage (V)	DC Emitter or Base Voltage (V)		DC Current (A)					
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	200					–	–	0.25	mA
With base-emitter junction reverse-biased & T_C = 125°C	I_{CEV}	200		−1.5			–	–	0.5	
Emitter-Cutoff Current	I_{EBO}		5				–	–	5.0	mA
DC Forward-Current Transfer Ratio	h_{FE}	5 5			1.0[a] 2.5[a]		30 10	– –	90 –	
Collector-to-Emitter Sustaining Voltage: With base open (See Figs. 3 & 4.)	$V_{CEO}(sus)$[b]				0.1		200[b]	–	–	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$				1.0[a]	0.1	–	0.9	1.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				1.0[a]	0.1	–	0.2	0.8	V
Second-Breakdown Collector Current: (With base forward-biased) Pulse duration (non-repetitive) = 1 s	$I_{S/b}$[c]	150					0.3	–	–	A
Gain-Bandwidth Product	f_T	10			0.2		–	4.0	–	MHz
Switching Time: Rise (See Figs. 10, 12, & 13.)	t_s				1.0	0.1 (I_{B1}) −0.5 (I_{B2})	–	0.35	–	µs
Storage (See Figs. 11, 12, & 13.)	I_S				1.0	0.1 (I_{B1}) −0.5 (I_{B2})	–	1.4	–	
Fall (See Figs. 9, 12, & 13.)	t_f				1.0	0.1 (I_{B1}) −0.5 (I_{B2})	–	0.15	–	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$	10			5		–	–	1.4	°C/W

[a] Pulsed; pulse duration $\leq$350 µs, duty factor = 2%

[b] CAUTION: The sustaining voltage $V_{CEO}(sus)$ MUST NOT be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in Fig. 3.

[c] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.

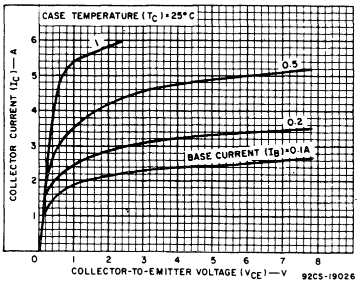


Fig.5— Typical output characteristics.

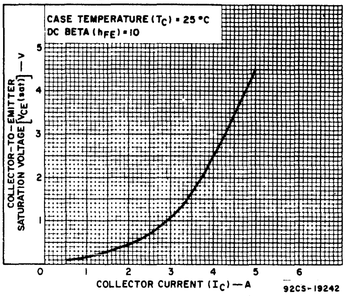


Fig.6—Typical saturation voltage characteristic.

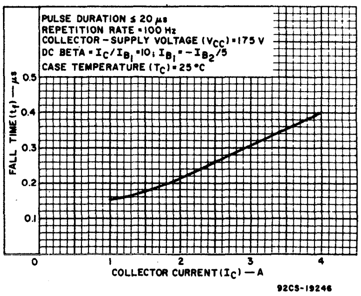


Fig.7— Typical fall time vs. collector current.

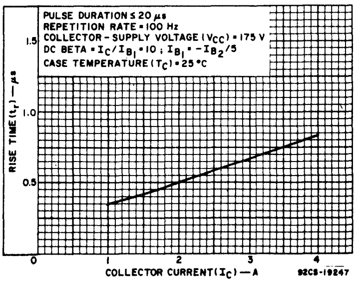


Fig.8—Typical rise time vs. collector current.

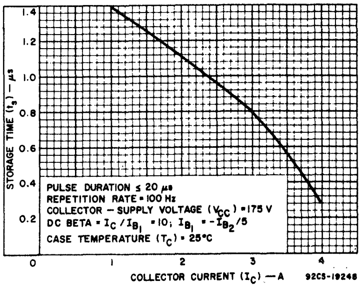


Fig.9— Typical storage time vs. collector current.

RCA411

High-Voltage, High-Power Silicon N-P-N Power Transistor

For Switching and Linear Applications in
Military, Industrial, and Commercial Equipment

RCA-411 is an epitaxial silicon n-p-n power transistor utilizing a multiple-emitter-site structure. This device employs the popular JEDEC TO-3 package.

Featuring high breakdown-voltage ratings and low saturation-voltage values, the RCA-411 is especially suitable for use in inverters, deflection circuits, switching regulators, high-voltage bridge amplifiers, ignition circuits, and other high-voltage switching applications.

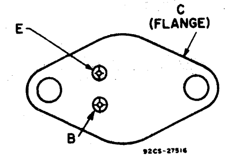
Features:

- **Maximum safe-area-of-operation curves**
- **Low saturation voltage: V_{CE}(sat) = 0.8 V (max.)**
- **High voltage rating: V_{CEO}(sus) = 300 V**
- **High dissipation rating: P_T = 125 W**

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	300	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:		
With base open, V_{CEO}(sus)	300	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5	V
COLLECTOR CURRENT:		
Continuous, I_C	7	A
Peak	10	A
BASE CURRENT (Continuous), I_B	2	A
TRANSISTOR DISSIPATION, P_T:		
At case temperatures up to 25°C and V_{CE} up to 75 V	125	W
At case temperatures up to 25°C and V_{CE} above 75 V	See Fig. 2.	
At case temperatures above 25°C and V_{CE} above 75 V	See Figs. 1 & 2.	
TEMPERATURE RANGE:		
Storage & Operating (Junction)	−65 to +200	°C
PIN TEMPERATURE (During Soldering):		
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.	230	°C

TERMINAL DESIGNATIONS



JEDEC TO-3
(See dimensional outline "A".)

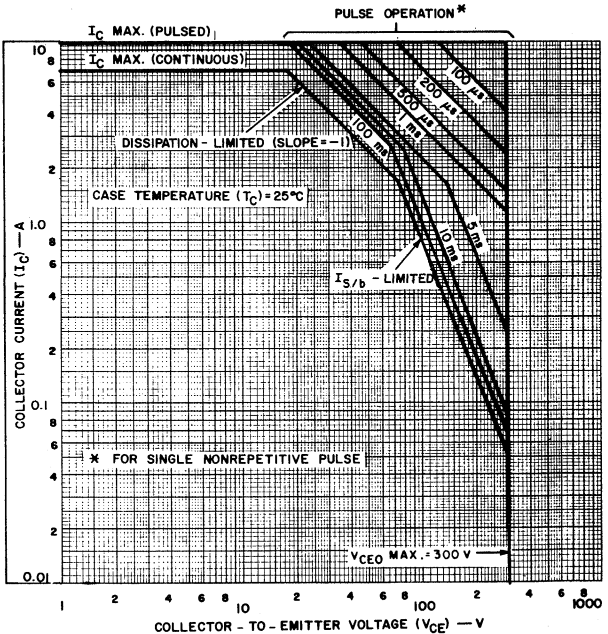


Fig.2—Maximum operating areas.

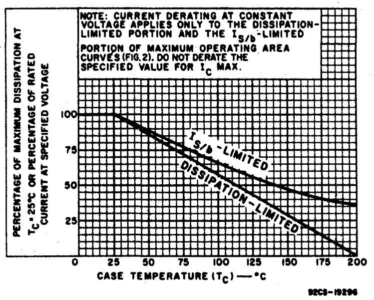


Fig.1—Dissipation and current derating curves.

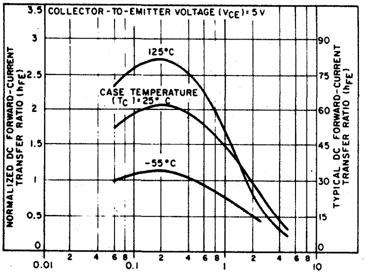


Fig.3— Typical dc beta characteristics.

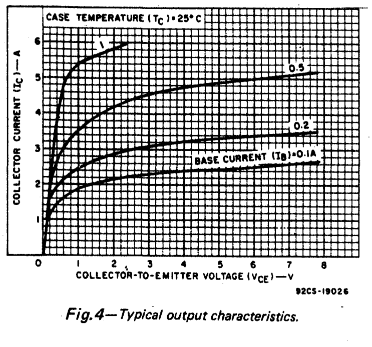


Fig.4—Typical output characteristics.

RCA411

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified

Characteristic	Symbol	Test Conditions: DC Collector Voltage (V)	Test Conditions: DC Emitter or Base Voltage (V)		Test Conditions: DC Current (A)		Limits			Units
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
Collector-Cutoff Current With base open	I_{CEO}	300					–		0.25	mA
With base-emitter junction reverse-biased	I_{CEV}	300		1.5			–		0.25	
With base-emitter junction reverse-biased & T_C 125°C	I_{CEV}	300		-1.5			–	–	0.5	
Emitter-Cutoff Current	I_{EBO}		5				-		5.0	mA
DC Forward-Current Transfer Ratio	h_{FE}	5 5			1.0[a] 2.5[a]		30 10		90	
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$[b]				0.1		300[b]			V
Base to Emitter Saturation Voltage	$V_{BE}(sat)$				1.0[a]	0.1	-	0.9	1.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				1.0[a]	0.1		0.2	0.8	V
Second-Breakdown Collector Current (With base forward-biased) Pulse duration (non-repetitive) 1 s	$I_{S/b}$[c]	150					0.3			A
Gain-Bandwidth Product	f_T	10			0.2		–	2.5		MHz
Switching Time Rise	t_r				1.0	0.1 (I_{B1}) -0.5 (I_{B2})		0.35	-	µs
Storage	t_s				1.0	0.1 (I_{B1}) -0.5 (I_{B2})	–	1.4	-	
Fall	t_f				1.0	0.1 (I_{B1}) -0.5 (I_{B2})		0.15		
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$	10			5			-	1.4	°C/W

[a] Pulsed; pulse duration ≤ 350 µs, duty factor = 2%. [b] CAUTION The sustaining voltage $V_{CEO}(sus)$ MUST NOT be measured on a curve tracer.

[c] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.

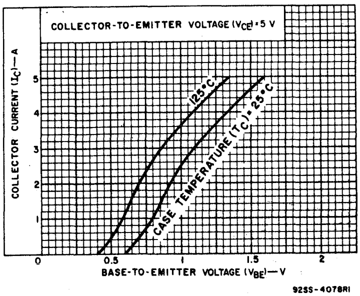


Fig.5— Typical transfer characteristics.

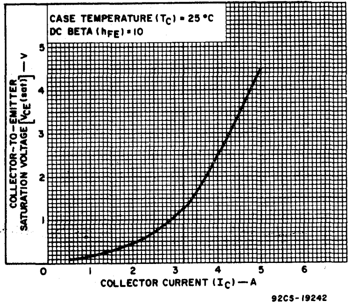


Fig.6— Typical saturation voltage characteristic.

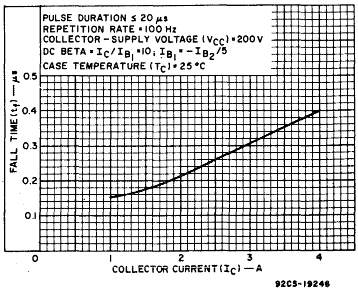


Fig.7— Typical fall time vs. collector current.

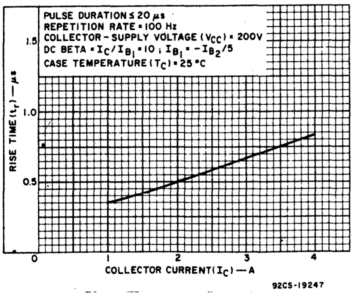


Fig.8— Typical rise time vs. collector current.

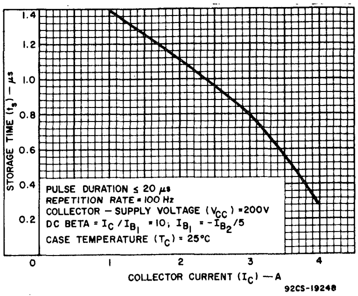


Fig.9— Typical storage time vs. collector current.

RCA413, RCA423, RCA431

High-Voltage, High-Power Silicon N-P-N Power Transistors

For Switching and Linear Applications in Military, Industrial, and Commercial Equipment

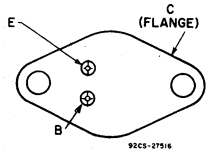
Features:
- *Maximum safe-area-of-operation curves*
- *Low saturation voltage:*
  $V_{CE}(sat)$=0.8 V (max.)
  - RCA413, RCA423
  $V_{CE}(sat)$=0.7 V (max.)
  - RCA431
- *High voltage rating: $V_{CEO}(sus)$=325 V*
- *High dissipation rating: P_T=125 W*

The RCA413, RCA423, and RCA431 are epitaxial silicon n-p-n transistors utilizing a multiple-emitter-site structure.

The transistors feature high breakdown-voltage ratings and low saturation-voltage values, making them especially suitable for use in inverters, deflection circuits, switching regulators, high-voltage bridge amplifiers, ignition circuits, and other high-voltage switching applications.

The RCA413, RCA423, and RCA431 transistors are supplied in steel JEDEC TO-204MA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{CBO}	400 V
$V_{CEO}(sus)$	325 V
V_{EBO}	5 V
I_C	7 A
I_{CM}	10 A
I_B	2 A
P_T	
T_C up to 25°C	125 W
T_C above 25°C, derate linearly	0.714 W/°C
T_{stg}, T_J	-65 to +200°C
T_L	
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230°C

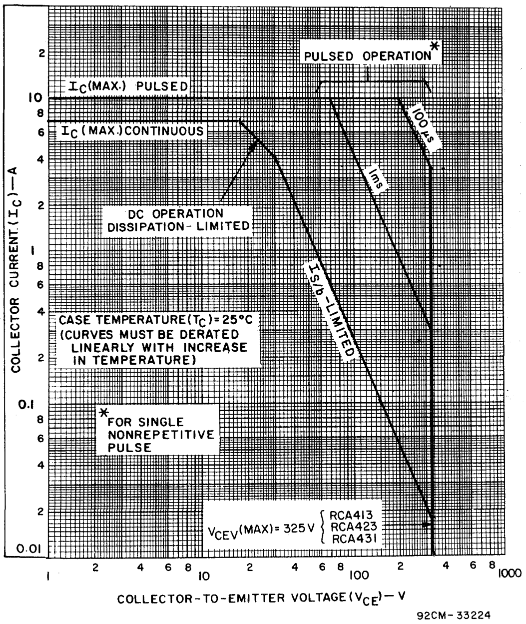


Fig. 1 — Maximum operating areas.

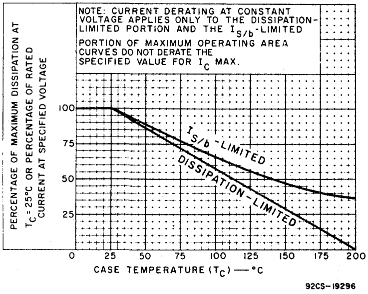


Fig. 2 — Dissipation and current derating curves.

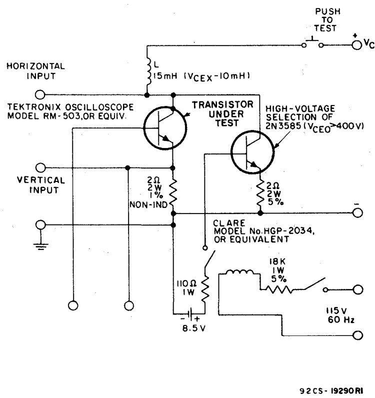


Fig. 3 - Circuit used to measure sustaining voltage, $V_{CEO}(sus)$.

RCA413, RCA423, RCA431

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C)=25°C Unless Otherwise Specified

Characteristic Symbol	Test Conditions				Limits									Units
	Voltage (V)		DC Current (A)		RCA413			RCA423			RCA431			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
I_{CEO}	300				—	—	0.25	—	—	0.25	—	—	2.5	mA
I_{CEV}	400	-1.5			—	—	0.25	—	—	0.25	—	—	2.5	
I_{CEV} (T_C=125°C)	400	-1.5			—	—	0.5	—	—	0.5	—	—	5	
I_{EBO}		-5			—	—	5	—	—	5	—	—	2	
h_{FE}	5		0.5[a]		20	—	80	—	—	—	—	—	—	
	5		1[a]		15	—	—	30	—	90	—	—	—	
	5		2.5[a]		—	—	—	10	—	—	15	—	35	
	5		3.5[a]		—	—	—	—	—	—	10	—	—	
V_{CEO}(sus)[b] (Figs. 3 & 4)			0.1		325[b]	—	—	325[b]	—	—	325[b]	—	—	V
V_{BE}(sat)			0.5[a]	0.05	—	0.8	1.5	—	—	—	—	—	—	
			1[a]	0.1	—	—	—	—	0.9	1.5	—	—	—	
			2.5[a]	0.5	—	—	—	—	—	—	—	1.1	1.5	
V_{CE}(sat)			0.5[a]	0.05	—	0.15	0.8	—	—	—	—	—	—	
			1[a]	0.1	—	—	—	—	0.2	0.8	—	—	—	
			2.5[a]	0.5	—	—	—	—	—	—	—	0.25	0.7	
$I_{S/b}$[c] Pulse duration (non-repetitive)=1 s	150				0.1	—	—	0.1	—	—	0.1	—	—	A
f_T	10		0.2		—	4	—	—	4	—	—	4	—	MHz
t_r (Figs. 12, 13, 16, 17)			1	0.1 (I_{B1})	—	0.35	—	—	0.35	—	—	—	—	μs
			2.5	0.5 (I_{B1})	—	—	—	—	—	—	—	0.35	—	
t_s (Figs. 14, 15, 16, 17)			1	0.1 (I_{B1}) -0.5 (I_{B2})	—	1.4	—	—	1.4	—	—	—	—	
			2.5	0.5 (I_{B1})[d]	—	—	—	—	—	—	—	1.8	—	
t_f (Figs. 10, 11, 16, 17)			1	0.1 (I_{B1}) -0.5 (I_{B2})	—	0.15	—	—	0.15	—	—	—	—	
			2.5	0.5 (I_{B1})[d]	—	—	—	—	—	—	—	0.4	—	
$R_{\theta JC}$	10		5		—	—	1.4	—	—	1.4	—	—	1.4	°C/W

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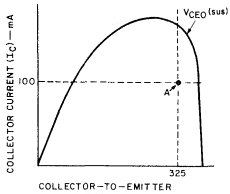
[a] Pulsed; pulse duration ≤ 350 μs, duty factor = 2%.

[b] CAUTION: The sustaining voltage V_{CEO}(sus) MUST NOT be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in Fig. 3.

[c] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.

[d] I_{B1} = $-I_{B2}$ = value shown.



THE SUSTAINING VOLTAGE V_{CEO}(sus) IS ACCEPTABLE WHEN THE TRACE FALLS TO THE RIGHT AND ABOVE POINT "A"

92CS-19278'

Fig. 4 - Oscilloscope display for measurement of sustaining voltage (test circuit shown in Fig. 3).

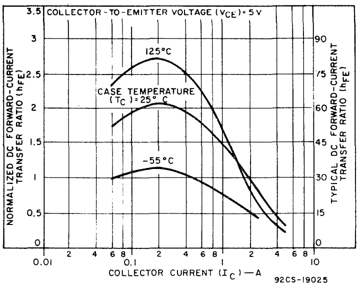


Fig. 5 - Typical dc beta characteristics. for all types.

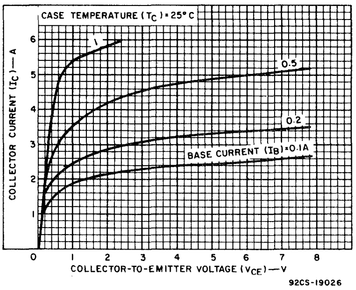


Fig. 6 - Typical output characteristics. for all types.

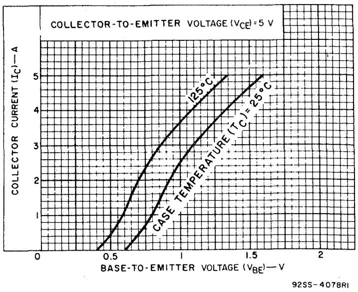


Fig. 7 - Typical transfer characteristics. for all types.

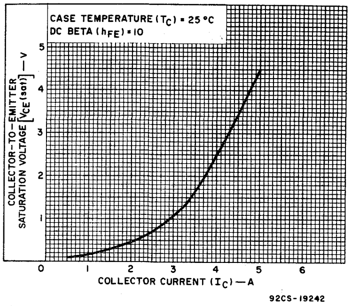


Fig. 8 - Typical saturation voltage vs. collector current for RCA413 and RCA423.

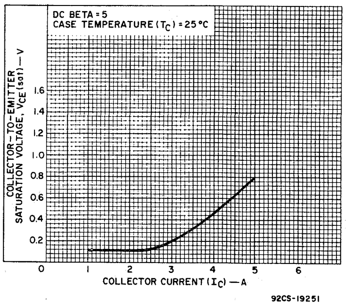


Fig. 9 - Typical saturation voltage vs. collector current for RCA431.

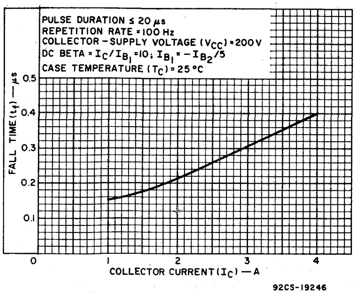


Fig. 10 - Typical fall time vs. collector current for RCA413 and RCA423.

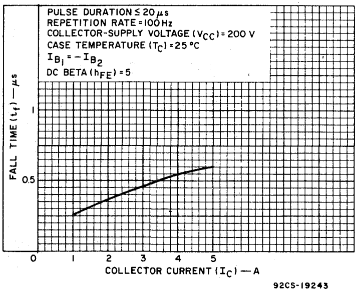


Fig. 11 - Typical fall-time vs. collector current for RCA431.

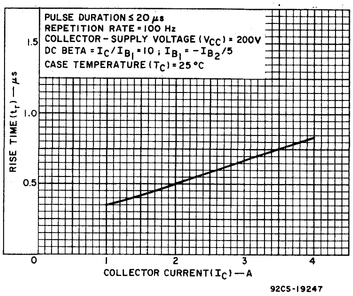


Fig. 12 - Typical rise time vs. collector current for RCA413 and RCA423.

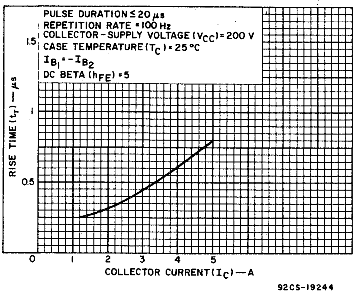


Fig. 13 - Typical rise time vs. collector current for RCA431.

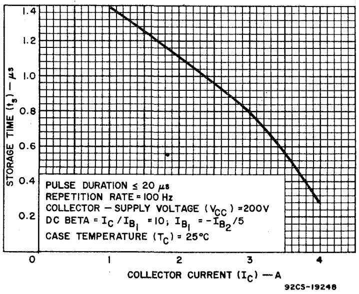


Fig. 14 - Typical storage time vs. collector current for RCA413 and RCA423.

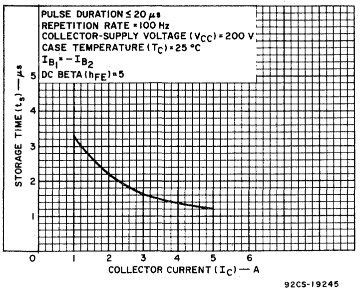


Fig. 15 - Typical storage time vs. collector current for RCA431.

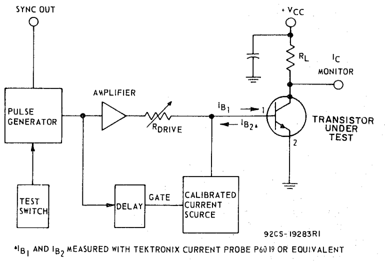


Fig. 16 - Circuit used to measure switching times.

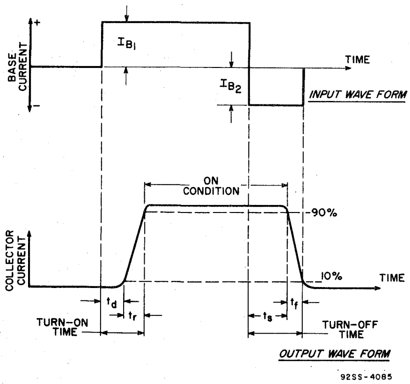


Fig. 17 - Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 16).

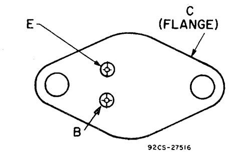
RCA6340, RCA6341

25-A Silicon N-P-N Power Transistors

N-P-N Types for
Power Supplies and Other High Voltage
Switching Applications

Features:
- **Fast Switching Speed**
- **Low V_{CE}(sat)**
- **Steel Hermetic TO-204MA Package**

TERMINAL DESIGNATIONS



JEDEC TO-204MA
(See dimensional outline "A".)

RCA6340 and RCA6341 silicon n-p-n power transistors which feature fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits.

These high-current, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits.

The RCA6340 and RCA6341 transistors are supplied in steel JEDEC TO-204MA hermetic packages.

These types are similar to the 2N6340 and 2N6341 except for the C_{obo}, h_{FE} measured at I_C of 0.5A, and I_{B1}, I_{B2} conditions for switching times.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA6340	**RCA6341**	
V_{CBO}	160	180	V
V_{CEO}	140	150	V
V_{EBO}	6		V
I_C	25		A
I_{CM}	50		A
I_B	10		A
P_T			
T_C up to 25°C	200		W
T_C above 25°C, derate linearly	1.143		W/°C
T_{stg}, T_J	−65 to 200		°C
T_L			
At distance ⩾ 1/16 in. (1.58mm) from seating plane for 10 s max	235		°C

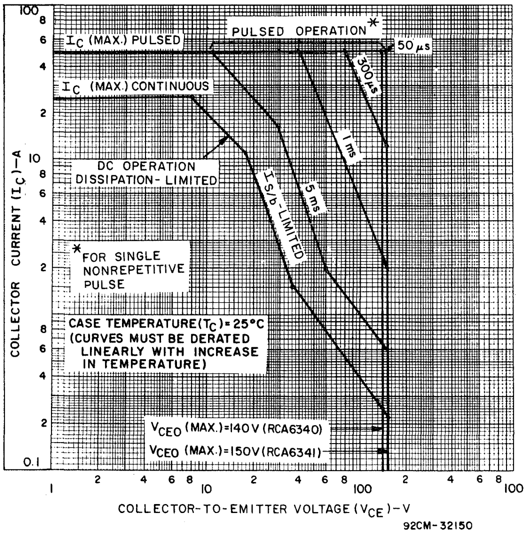


Fig. 1—Maximum operating areas for both types.

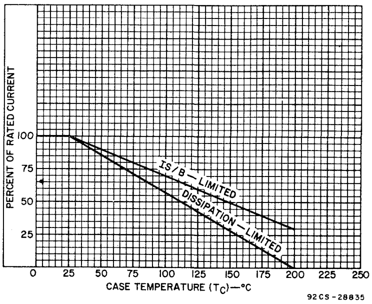


Fig. 2—Dissipation and $I_{S/b}$ derating curves for both types.

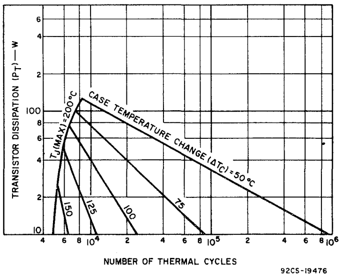


Fig. 3—Thermal-cycling chart for both types.

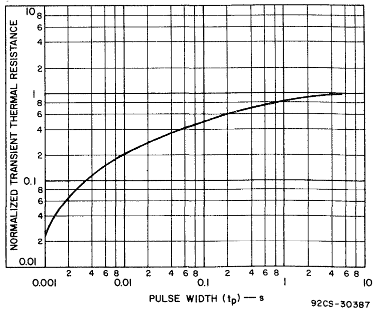


Fig. 4—Typical thermal-response characteristic for both types.

RCA6340, RCA6341

ELECTRICAL CHARACTERISTICS, at Case Temperature T_C = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		RCA6340		RCA6341		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEV}	150	−1.5			–	10	–	–	µA
	150	−1.5			–	–	–	10	
T_C = 150°C	140	−1.5			–	1	–	–	mA
	150	−1.5			–	–	–	1	
I_{CBO}	160[c]				–	10	–	–	µA
	180[c]				–	–	–	10	
I_{EBO}		−6	0		–	100	–	100	
V_{CEO}(sus)[b]			0.05[a]	0	140	–	150	–	V
h_{FE}	2		0.5[a]		30	–	30	–	
	2		10[a]		30	120	30	120	
	2		25[a]		12	–	12	–	
V_{BE}	2		10[a]		–	1.8	–	1.8	V
V_{BE}(sat)			10[a]	1	–	1.8	–	1.8	
			25[a]	2.5	–	2.5	–	2.5	
V_{CE}(sat)			10[a]	1	–	1	–	1	
			25[a]	2.5	–	1.8	–	1.8	
$I_{S/b}$	18		11.1		1	–	1	–	s
$\|h_{fe}\|$ f = 5 MHz	10		1		8	–	8	–	
f_T	10		1		40	–	40	–	MHz
C_{obo} f = 0.1 MHz	10[c]				–	600	–	600	pF
t_r[d]		−6	10	0.5	–	0.3	–	0.3	µs
t_s[d]		−6	10	0.5[e]	–	1	–	1	
t_f[d]		−6	10	0.5[e]	–	0.25	–	0.25	
$R_{\theta JC}$	10		5		–	0.875	–	0.875	°C/W

[a] Pulsed: pulse duration = 300 µs, duty factor ≤2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 80 V, t_p = 10 µs

[e] $I_{B_1} = -I_{B_2}$

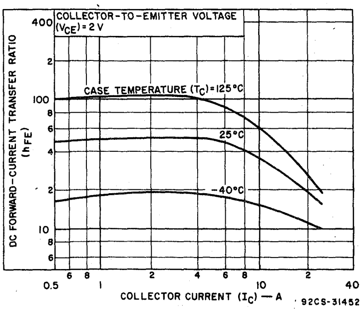


Fig. 5—Typical dc beta characteristics for both types.

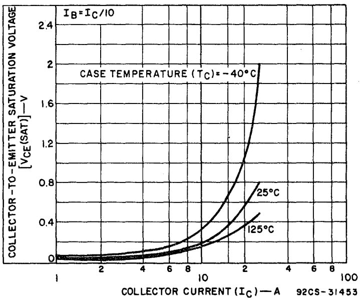


Fig. 6—Typical collector-to-emitter saturation voltage characteristics for both types.

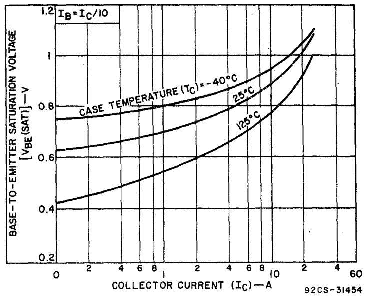


Fig. 7—Typical base-to-emitter saturation voltage characteristic for both types.

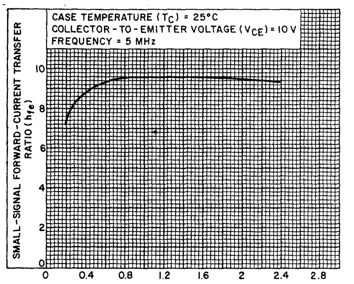


Fig. 8—Typical small-signal forward-current transfer ratio characteristic for both types (f = 5 MHz).

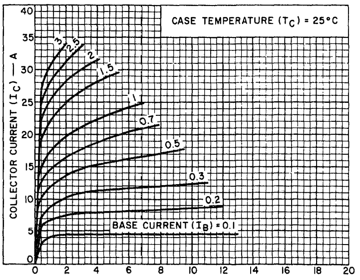


Fig. 9—Typical output characteristics for both types.

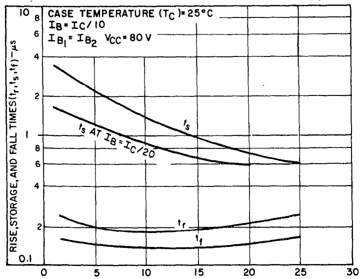


Fig. 10—Typical saturated-switching-time characteristics as a function of collector current for both types.

RCA6340, RCA6341

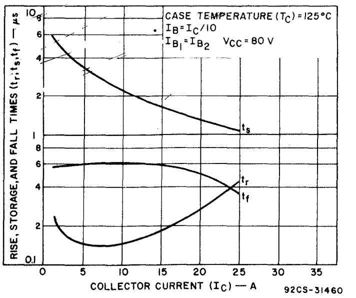


Fig. 11—Typical saturated-switching-time characteristics at T_C = 125°C as a function of collector current for both types.

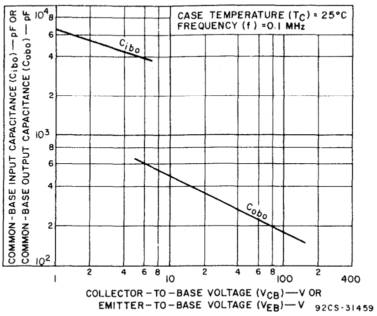


Fig. 12—Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for both types.

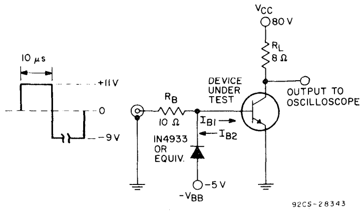


Fig. 13—Switching-time test circuit.

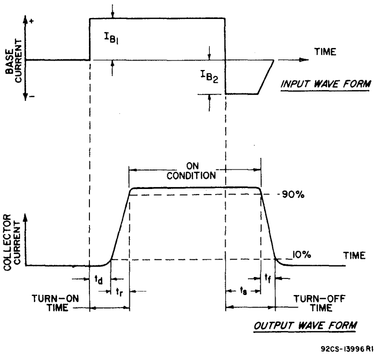


Fig. 14—Phase relationship between input current and output current showing reference points for specification of switching times.

RCA8766 Series

10-Ampere N-P-N Monolithic Darlington Power Transistors

350, 400, 450 Volts, 150 Watts
Gain of 100 at 4, 6A

The RCA-8766 Series● are monolithic n-p-n silicon Darlington transistors designed for automotive electronic power applications. The pi-nu construction of these devices provides good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

The devices in the series differ primarily in voltage ratings and in the current at which the dc gain is specified.

The RCA-8766 Series are supplied in the JEDEC TO-3 hermetic steel package.

● Formerly RCA Dev. Nos. TA8766 Series.

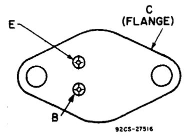
Features:
- **Operates from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

Applications:
- **Power switching**
- **Solenoid drivers**
- **Automotive Ignition**
- **Series and shunt regulators**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA8766 RCA8766A	RCA8766B RCA8766C	RCA8766D RCA8766E	
V_{CBO}	350	400	450	V
$V_{CER}(sus)$				
R_{BE} = 50 Ω	350	400	450	V
$V_{CEO}(sus)$	350	400	450	V
V_{EBO}	5	5	5	V
I_C	10	10	10	A
I_{CM}	15	15	15	A
I_B	1	1	1	A
P_T				
$T_C \leqslant 25°C$	150	150	150	W
$T_C > 25°C$	derate linearly 1			°C/W
T_{stg}, T_J	−65 to +175			°C
T_L				
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235			°C

TERMINAL DESIGNATIONS



JEDEC TO-3
(See dimensional outline "A".)

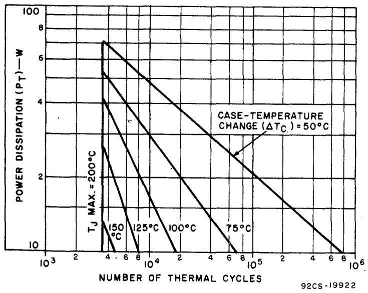


Fig. 1 — Thermal-cycling rating chart for all types.

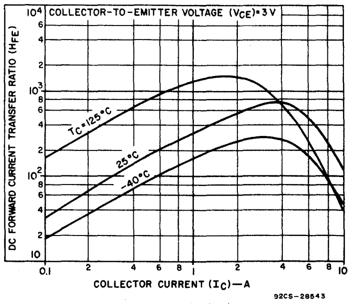


Fig. 2 — Typical DC beta characteristics for all types.

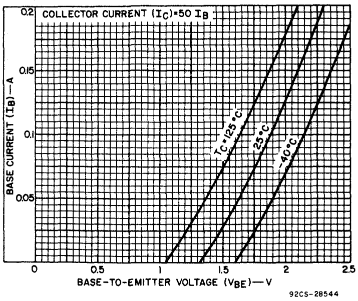


Fig. 3 — Typical input characteristics for all types.

RCA8766 Series

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	VOLTAGE V dc	CURRENT A dc		RCA8766 RCA8766A		RCA8766B RCA8766C		RCA8766D RCA8766E		
	V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER} R_{BE} = 50 Ω	350			–	1	–	–	–	–	mA
	400			–	–	–	1	–	–	
	450			–	–	–	–	–	1	
T_C = 150°C	350			–	10	–	–	–	–	
	400			–	–	–	10	–	–	
	450			–	–	–	–	–	10	
I_{EBO} V_{BE} = −5 V		0		–	60	–	60	–	60	mA
V_{CEO}(sus)		0.2^a	0	350	–	400	–	450	–	V
h_{FE} RCA8766	3	6^a		100	–	–	–	–	–	
RCA8766A	3	4^a		100	–	–	–	–	–	
RCA8766B	3	6^a		–	–	100	–	–	–	
RCA8766C	3	4^a		–	–	100	–	–	–	
RCA8766D	3	6^a		–	–	–	–	100	–	
RCA8766E	3	4^a		–	–	–	–	100	–	
V_{BE} RCA8766	3	6^a		–	2.5	–	–	–	–	V
RCA8766A	3	4^a		–	2.5	–	–	–	–	
RCA8766B	3	6^a		–	–	–	2.5	–	–	
RCA8766C	3	4^a		–	–	–	2.5	–	–	
RCA8766D	3	6^a		–	–	–	–	–	2.5	
RCA8766E	3	4^a		–	–	–	–	–	2.5	
V_{CE}(sat) RCA8766		6^a	0.2^a	–	1.5	–	–	–		V
RCA8766A		4^a	0.133^a	–	1.5	–	–	–		
RCA8766B		6^a	0.2^a	–	–	–	1.5	–		
RCA8766C		4^a	0.133^a	–	–	–	1.5	–	–	
RCA8766D		6^a	0.2^a	–	–	–	–	–	1.5	
RCA8766E		4^a	0.133^a	–	–	–	–	–	1.5	
All Types		8^a	0.5^a	–	2.5	–	2.5	–	2.5	
V_F		7^a		–	2	–	2	–	2	V
$\|h_{fe}\|$ f = 1 MHz	5	1		10	–	10	–	10	–	
$I_{S/b}$ t = 1 s, nonrep.	30			5	–	5	–	5	–	A
$R_{\theta JC}$				–	1	–	1	–	1	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

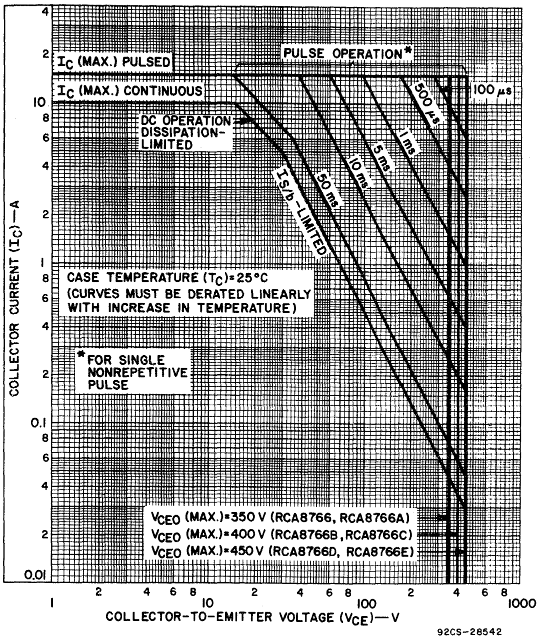


Fig. 4 — Maximum operating areas for all types.

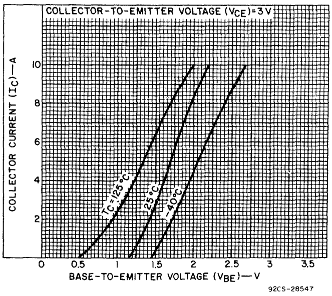


Fig. 5 — Typical transfer characteristics for all types.

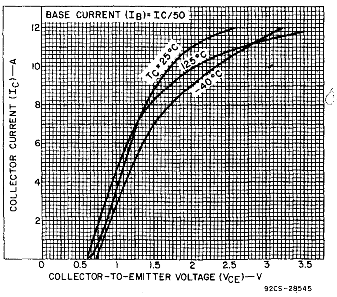


Fig. 6 — Typical output characteristics for all types.

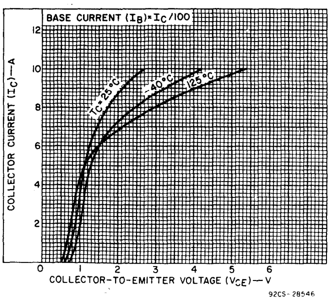


Fig. 7 — Typical output characteristics for all types.

RCA9166A, RCA9166B, MJ15022, MJ15024

Silicon N-P-N Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable
For Industrial and Commercial Use

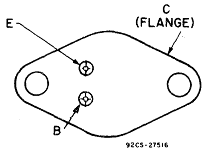
Features:
- *High dissipation capability*
- *Maximum safe-area-of-operation curves*
- *High voltage*
- *High gain at high current*

Applications:
- *High-fidelity amplifiers*
- *Series and shunt regulators*
- *Linear/power amplifiers*

The RCA9166A•, RCA9166B•, MJ15022, and MJ15024 are ballasted epitaxial-base silicon n-p-n transistors featuring high gain at high current and high voltage. They differ from each other in voltage ratings, safe-operating-area (SOA) ratings, and the currents at which the parameters are controlled.

All these types are supplied in the JEDEC TO-204MA steel hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA9166A	RCA9166B	MJ15024	MJ15022	
V_{CBO}	—	—	400	350	V
$V_{CER}(sus)$ R_{BE}=100 Ω	275	225	275	225	V
$V_{CEO}(sus)$	250	200	250	200	V
V_{EBO}	5				V
I_C	16				A
I_{CM}	30				A
I_B	5				A
P_T					
At $T_C \leq 25°C$	250				W
At $T_C > 25°C$ Derate linearly	1.43				W/°C
T_{stg}, T_J	−65 to 200				°C
T_L					
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230				°C

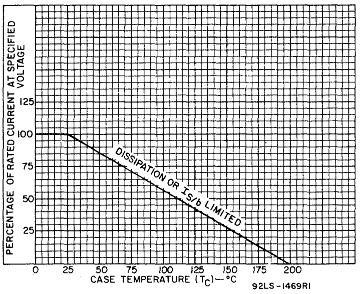


Fig. 2 - Current derating curve for all types.

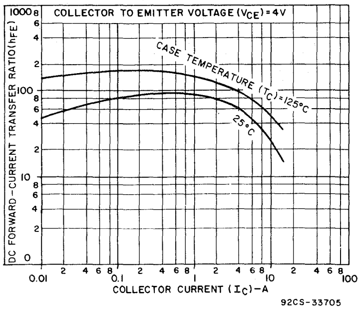


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

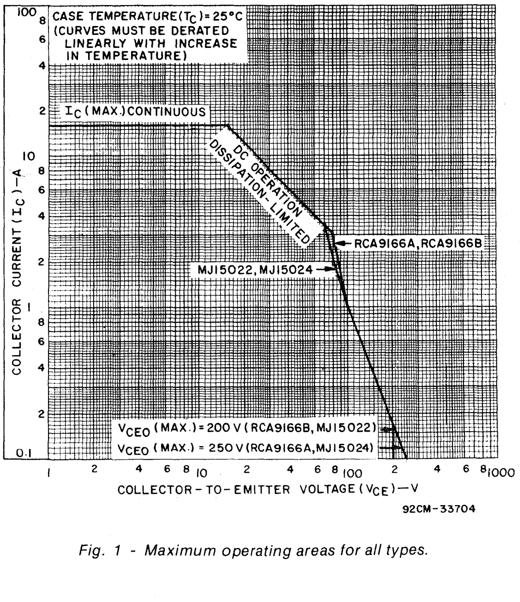


Fig. 1 - Maximum operating areas for all types.

•Formerly RCA Dev. Type Nos. TA9166A and TA9166B, respectively.

RCA9166A, RCA9166B, MJ15022, MJ15024

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C)=25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CUR-RENT A dc	LIMITS								UNITS
				RCA9166A		RCA9166B		MJ15024		MJ15022		
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	400ᵃ			—	—	—	—	—	1	—	—	mA
	350ᵃ			—	—	—	—	—	—	—	1	
I_{CEO}	200			—	1	—	—	—	0.5	—	—	
	150			—	—	—	1	—	—	—	0.5	
I_{CEX}	400	−1.5		—	—	—	—	—	0.5	—	0.5	
	250	−1.5		—	—	—	—	—	0.25	—	—	
	200	−1.5		—	—	—	—	—	—	—	0.25	
I_{CER} R_{BE}=100 Ω, T_C=150°C	200			—	4	—	—	—	4	—	—	
	150			—	—	—	4	—	—	—	4	
h_{FE}	4		3ᶜ	30	—	30	—	—	—	—	—	
	4		5ᶜ	20	—	20	—	—	—	—	—	
	4		8ᶜ	—	—	—	—	15	60	15	60	
	4		16ᶜ	3.2	—	3.2	—	5	—	5	—	
V_{CEO}(sus)ᵇ			0.1	250	—	200	—	250	—	200	—	V
V_{CER}(sus)ᵇ R_{BE}=100 Ω			0.1	275	—	225	—	275	—	225	—	
V_{EBO} I_E=1 mA				5	—	5	—	—	—	—	—	
I_E=0.5 mA				—	—	—	—	5	—	5	—	
V_{BE}	4		3ᶜ	—	2	—	2	—	—	—	—	
	4		8ᶜ	—	—	—	—	—	2.2	—	2.2	
V_{CE}(sat) I_B=0.3 A			3ᶜ	—	1.0	—	1.0	—	—	—	—	
I_B=0.8 A			8ᶜ	—	—	—	—	—	1.4	—	1.4	
I_B=3.2 A			16ᶜ	—	—	—	—	—	4	—	4	
$I_{S/b}$ t_p=0.5 s	80			3	—	3	—	2	—	2	—	A
nonrep.	50			—	—	—	—	5	—	5	—	
$\|h_{fe}\|$ f=1 MHz	10		1	4	20	4	20	4	20	4	20	
f_T	10		1	4	20	4	20	4	20	4	20	MHz
C_{ob}	10ᵃ			—	500	—	500	—	500	—	500	pF
$R_{\theta JC}$	10		10	—	0.7	—	0.7	—	0.7	—	0.7	°C/W

[a] V_{CB}.

[b] *CAUTION:* Sustaining voltages V_{CER}(sus) and V_{CEO}(sus) *MUST NOT* be measured on a curve tracer. See Figs. 9 and 10.

[c] Pulsed; pulse duration=300 μs, duty factor=1.8%.

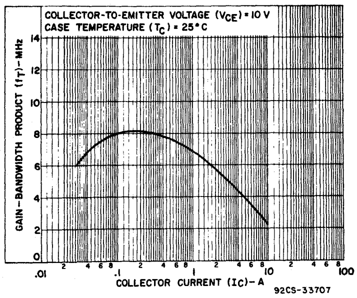


Fig. 4 - Typical gain-bandwidth product for all types.

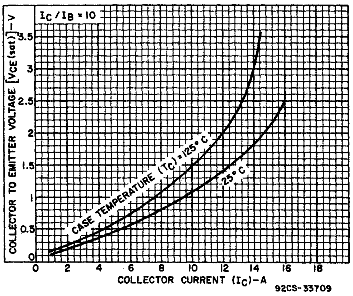


Fig. 5 - Typical saturation voltage characteristics for all types.

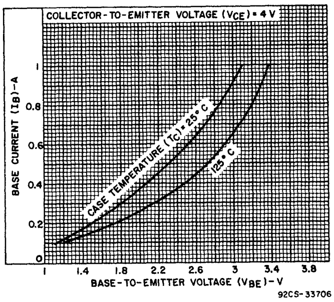


Fig. 6 - Typical input characteristics for all types.

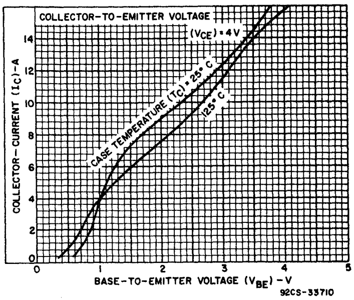
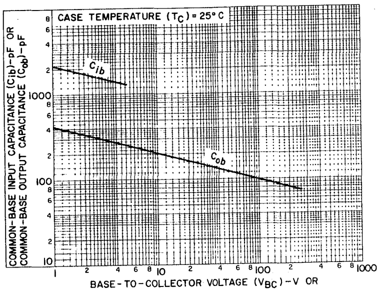


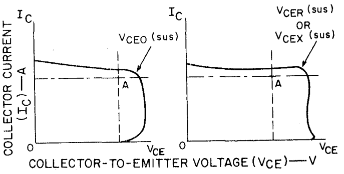
Fig. 7 - Typical transfer characteristics.

RCA9166A, RCA9166B, MJ15022, MJ15024



92CS-33708

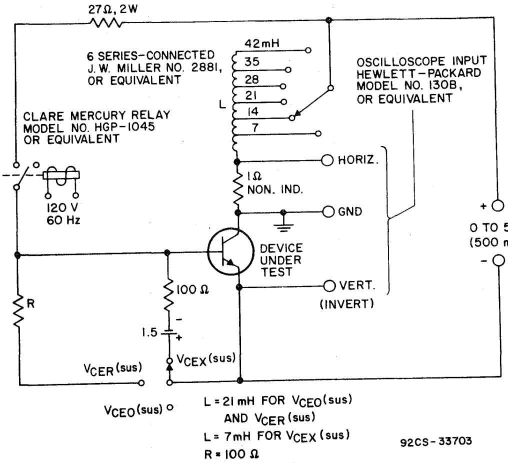
Fig. 8 - Typical common-base input or output capacitance characteristics as a function of reverse voltages for all types.



NOTE: The sustaining Voltages V_{CEO}(sus), V_{CER}(sus) or, V_{CEX}(sus) are acceptable when the trace falls to the right and above point "A". (For values of current and voltage, see Electrical Characteristics.

92CS-15224R1

Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 10).



92CS-33703

Fig. 10 - Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) for all types.

TIP29 Series

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

The RCA-TIP29-series are epitaxial-base, silicon n-p-n transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP30-series.

They differ from each other in voltage ratings.

The TIP29-series are supplied in the JEDEC TO-220AB VERSAWATT package.

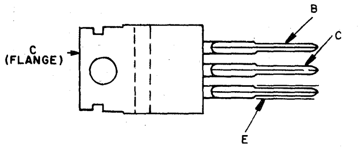
Features:

- **30 W at 25°C case temperature**
- **3 A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 200 mA**
- **Designed for complementary use with TIP30-series p-n-p types**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

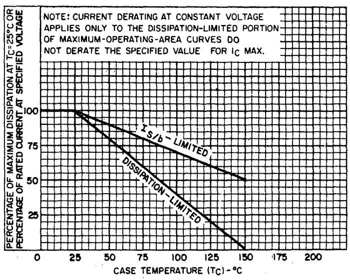
	TIP29	TIP29A	TIP29B	TIP29C	
V_{CBO}	40	60	80	100	V
V_{CEO}	40	60	80	100	V
V_{EBO}	5	5	5	5	V
I_C	5	5	5	5	A
I_B	1	1	1	1	A
P_T:					
At $T_C \leqslant 25°C$	30	30	30	30	W
At $T_A \leqslant 25°C$	2	2	2	2	W
At $T_C > 25°C$ Derate linearly		0.24			W/°C
T_{stg}, T_J		−65 to 150			°C
T_L (During soldering): At distance 1/8 in. (3.17 mm) from case for 10s max.		235			°C

TERMINAL CONNECTIONS



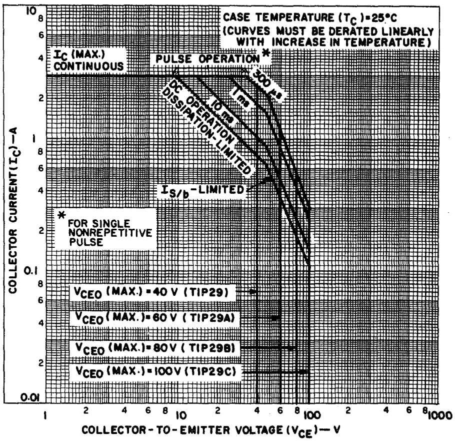
92CS-27519

BOTTOM VIEW
JEDEC TO-220AB
(See dimensional outline "S".)



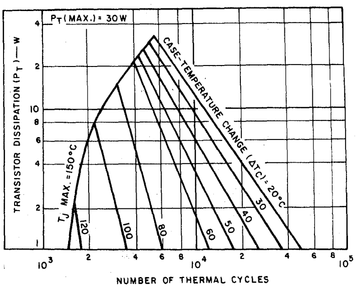
92CS-19663

Fig. 2 – Derating curve for TIP29-series.



92CS-28810

Fig. 1 – Maximum operating areas for TIP29-series.



92CS-20152

Fig. 3 – Thermal-cycling ratings for TIP29-series.

TIP29 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARAC-TERISTIC	TEST COND. VOLT-AGE V dc	TEST COND. CUR-RENT A dc	LIMITS TIP29		LIMITS TIP29A		LIMITS TIP29B		LIMITS TIP29C		Units
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} I_B=0	30		–	0.3	–	0.3	–	–	–	–	mA
	60		–	–	–	–	–	0.3	–	0.3	
I_{CES} V_{EB}=0	40		–	0.2	–	–	–	–	–	–	mA
	60		–	–	–	0.2	–	–	–	–	
	80		–	–	–	–	–	0.2	–	–	
	100		–	–	–	–	–	–	–	0.2	
I_{EBO} V_{BE}=–5V		0	–	1	–	1	–	1	–	1	mA
V_{CEO}(sus) I_B=0		0.03[a]	40[b]	–	60[b]	–	80[b]	–	100[b]	–	V
h_{FE}	4	0.2[a]	40	–	40	–	40	–	40	–	
	4	1[a]	15	150	15	150	15	150	15	150	
V_{BE}	4	1[a]	–	1.3	–	1.3	–	1.3	–	1.3	V
V_{CE}(sat) I_B= 0.125A		1[a]	–	0.7	–	0.7	–	0.7	–	0.7	V
h_{fe} f=1 kHz	10	0.2	20	–	20	–	20	–	20	–	
$\|h_{fe}\|$ f=1 MHz	10	0.2	3	–	3	–	3	–	3	–	
t_{ON} (t_d+t_r) V_{CC}= 30V R_L=30Ω I_{B1}=I_{B2} =0.1A		1	0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		µs
t_{OFF} (t_s+t_f) V_{CC}= 30V R_L=30Ω I_{B1}=–I_{B2} =0.1A		1	1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		
$R_{\theta JC}$	TIP29-series		–	4.17	–	4.17	–	4.17	–	4.17	°C/W
$R_{\theta JA}$	TIP29-series		–	62.5	–	62.5	–	62.5	–	62.5	

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[a] Pulsed, pulse duration = 300 µs, duty factor ⩽ 2%.

[b] *CAUTION:* Sustaining voltage, V_{CEO}(sus), *MUST NOT* be measured on a curve tracer.

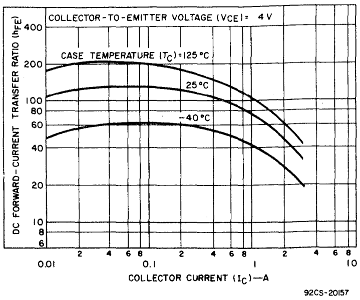


Fig. 4 — Typical dc beta characteristics for TIP29, TIP29A, TIP29B.

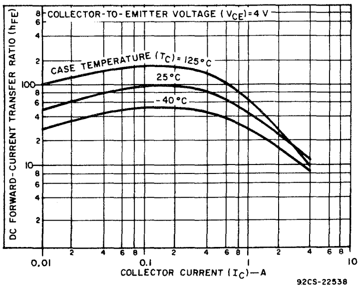


Fig. 5 — Typical dc beta characteristics for TIP29C.

TIP30 Series

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

The RCA-TIP30-series are epitaxial-base, silicon p-n-p transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP29-series.

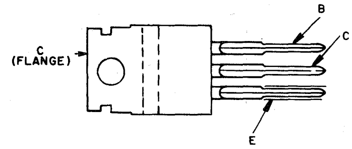
They differ from each other in voltage ratings.

The TIP30-series are supplied in the JEDEC TO-220AB VERSAWATT package.

Features:

- **30 W at 25°C case temperature**
- **3 A rated collector current**
- **Min. f_T of 3 MHz at −10 V, −200 mA**
- **Designed for complementary use with TIP29-series n-p-n types**

TERMINAL DESIGNATIONS



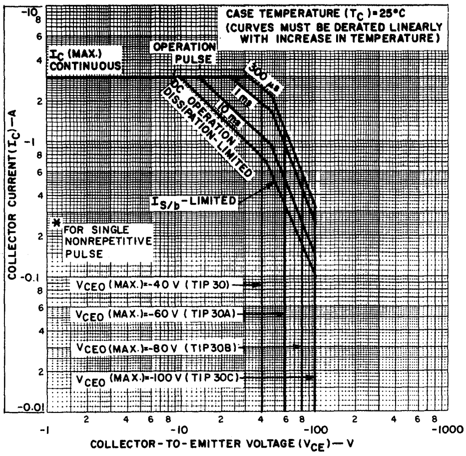
92CS-27519

BOTTOM VIEW
JEDEC TO-220AB

(See dimensional outline "S".)

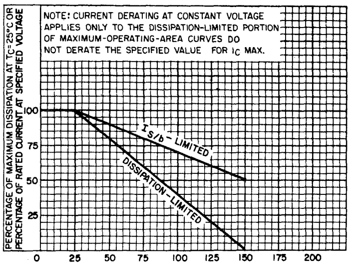
MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP30	TIP30A	TIP30B	TIP30C	
V_{CBO}	−40	−60	−80	−100	V
V_{CEO}	−40	−60	−80	−100	V
V_{EBO}	−5	−5	−5	−5	V
I_C	−5	−5	−5	−5	A
I_B	−1	−1	−1	−1	A
P_T:					
At $T_C \leq 25^\circ C$	30	30	30	30	W
At $T_A \leq 25^\circ C$	2	2	2	2	W
At $T_C > 25^\circ C$ Derate linearly		0.24			W/°C
T_{stg}, T_J		−65 to 150			°C
T_L (During soldering):					
At distance 1/8 in. (3.17 mm) from case for 10s max.		235			°C



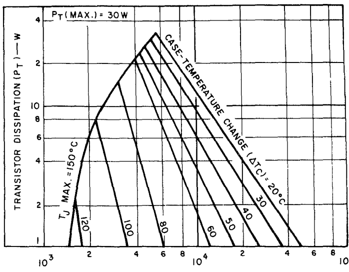
92CS-28824

Fig. 1 — Maximum operating areas for TIP30-series.



92CS-19663

Fig. 2 — Derating curve to TIP30 -series.



92CS-20152

Fig. 3 — Thermal-cycling ratings for TIP30 -series.

TIP30 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARAC-TERISTIC	TEST COND.		LIMITS								Units
	VOLT-AGE V dc	CUR-RENT A dc	TIP30		TIP30A		TIP30B		TIP30C		
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} $I_B=0$	−30		–	−0.3	–	−0.3	–	–	–	–	mA
	−60		–	–	–	–	–	−0.3	–	−0.3	
I_{CES} $V_{EB}=0$	−40		–	−0.2	–	–	–	–	–	–	mA
	−60		–	–	–	−0.2	–	–	–	–	
	−80		–	–	–	–	–	−0.2	–	–	
	−100		–	–	–	–	–	–	–	−0.2	
I_{EBO} $V_{BE}=5V$		0	–	−1	–	−1	–	−1	–	−1	mA
$V_{CEO}(sus)$ $I_B=0$		−0.03[a]	−40[b]	–	−60[b]	–	−80[b]	–	−100[b]	–	V
h_{FE}	−4	−0.2[a]	40	–	40	–	40	–	40	–	
	−4	−1[a]	15	150	15	150	15	150	15	150	
V_{BE}	−4	−1[a]	–	−1.3	–	−1.3	–	−1.3	–	−1.3	V
$V_{CE}(sat)$ $I_B=$ $-0.125A$		−1[a]	–	−0.7	–	−0.7	–	−0.7	–	−0.7	V
h_{fe} f=1 kHz	−10	−0.2	20	–	20	–	20	–	20	--	
$\|h_{fe}\|$ f=1 MHz	−10	−0.2	3	–	3	–	3	–	3	–	
t_{ON} (t_d+t_r) $V_{CC}=$ $-30V$ $R_L=30\Omega$ $I_{B1}=-I_{B2}$ $=-0.1A$		−1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		µs
t_{OFF} (t_s+t_f) $V_{CC}=$ $-30V$ $R_L=30\Omega$ $I_{B1}=I_{B2}$ $=-0.1A$		−1	1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		
$R_{\theta JC}$	TIP 30 series		—	4.17	–	4.17	–	4.17	–	4.17	°C/W
$R_{\theta JA}$	TIP 30 series		—	62.5	–	62.5	–	62.5	–	62.5	

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[a] Pulsed, pulse duration = 300 µs, duty factor ⩽ 2%.

[b] *CAUTION:* Sustaining voltage, $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer.

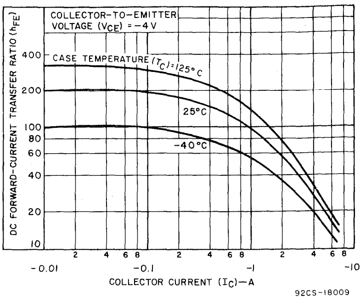


Fig. 4 — Typical dc beta characteristics for TIP30, TIP30A, TIP30B.

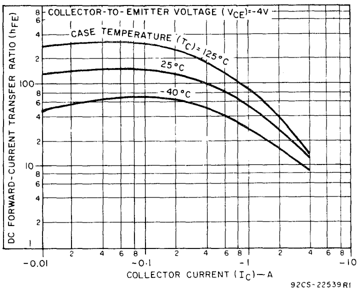


Fig. 5 — Typical dc beta characteristics for TIP30C.

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

The RCA-TIP31-series are epitaxial-base, silicon n-p-n transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP32-series.

They differ from each other in voltage ratings.

The TIP31-series are supplied in the JEDEC TO-220AB VERSAWATT package.

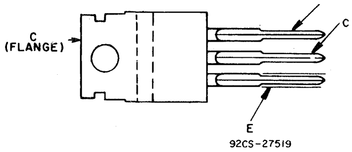
Features:

- **40 W at 25°C case temperature**
- **5 A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 500 mA**
- **Designed for complementary use with TIP32-series p-n-p types**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP31	TIP31A	TIP31B	TIP31C	
V_{CBO}	40	60	80	100	V
V_{CEO}	40	60	80	100	V
V_{EBO}	5	5	5	5	V
I_C	5	5	5	5	A
I_B	1	1	1	1	A
P_T:					
At $T_C \leq 25°C$	40	40	40	40	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$: Derate linearly		0.32			W/°C
T_{stg}, T_J		−65 to 150			°C
T_L (During soldering): At distance 1/8 in. (3.17 mm) from case for 10s max.		235			°C

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S".)

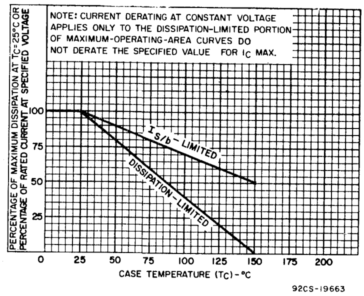


Fig. 2 – Derating curve for TIP31-series.

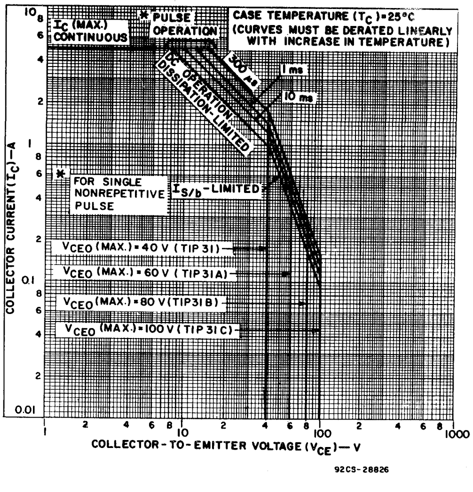


Fig. 1 – Maximum operating areas for TIP31-series.

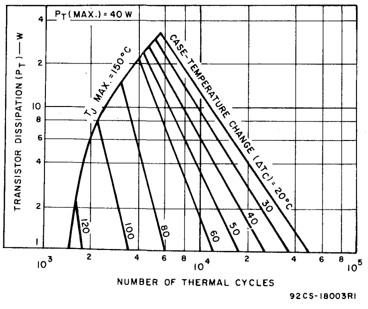


Fig. 3 – Thermal-cycling ratings for TIP31-series.

TIP31 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

	TEST COND.		LIMITS								
CHARACTERISTIC	VOLTAGE V dc	CURRENT A dc	TIP31		TIP31A		TIP31B		TIP31C		Units
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} I_B=0	30		–	0.3	–	0.3	–	–	–	–	mA
	60		–	–	–	–	–	0.3	–	0.3	
I_{CES} V_{EB}=0	40		–	0.2	–	–	–	–	–	–	mA
	60		–	–	–	0.2	–	–	–	–	
	80		–	–	–	–	–	0.2	–	–	
	100		–	–	–	–	–	–	–	0.2	
I_{EBO} V_{BE}=−5V		0	–	1	–	1	–	1	–	1	mA
$V_{CEO}(sus)$ I_B=0		0.03[a]	40[b]	–	60[b]	–	80[b]	–	100[b]	–	V
h_{FE}	4	1[a]	25	–	25	–	25	–	25	–	
	4	3[a]	10	50	10	50	10	50	10	50	
V_{BE}	4	3[a]	–	1.8	–	1.8	–	1.8	–	1.8	V
$V_{CE}(sat)$ I_B= 0.375A		3[a]	–	1.2	–	1.2	–	1.2	–	1.2	V
h_{fe} f=1 kHz	10	0.5	20	–	20	–	20	–	20	--	
$\|h_{fe}\|$ f=1 MHz	10	0.5	3	–	3	–	3	–	3	–	
t_{ON} (t_d+t_r) V_{CC}= 30V R_L=30Ω I_{B1}=I_{B2} =0.1A		1	0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		µs
t_{OFF} (t_s+t_f) V_{CC}= 30V R_L=30Ω I_{B1}=−I_{B2} =0.1A		1	1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		
$R_{\theta JC}$			—	3.125	–	3.125	–	3.125	–	3.125	°C/W
$R_{\theta JA}$			—	62.5	–	62.5	–	62.5	–	62.5	

[a] Pulsed, pulse duration = 300 µs, duty factor ⩽ 2%.

[b] *CAUTION:* Sustaining voltage, $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer.

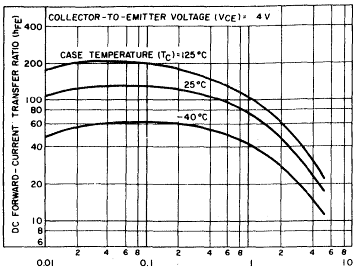


Fig. 4 — Typical dc beta characteristics for TIP31, TIP31A, TIP31B.

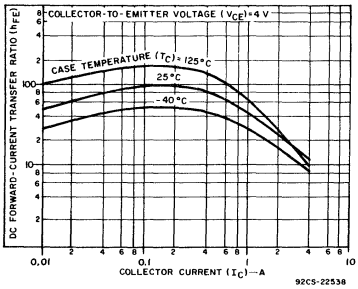


Fig. 5 — Typical dc beta characteristics for TIP31C.

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

The RCA-TIP32-series are epitaxial-base, silicon p-n-p transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP31-series.

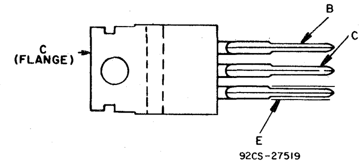
They differ from each other in voltage ratings.

The TIP32-series are supplied in the JEDEC TO-220AB VERSAWATT package.

Features:

- **40 W at 25°C case temperature**
- **5 A rated collector current**
- **Min. f_T of 3 MHz at −10 V, −500 mA**
- **Designed for complementary use with TIP31-series n-p-n types**

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP32	TIP32A	TIP32B	TIP32C	
V_{CBO}	−40	−60	−80	−100	V
V_{CEO}	−40	−60	−80	−100	V
V_{EBO}	−5	−5	−5	−5	V
I_C	−5	−5	−5	−5	A
I_B	−1	−1	−1	−1	A
P_T:					
At $T_C \leqslant 25^\circ C$	40	40	40	40	W
At $T_A \leqslant 25^\circ C$	2	2	2	2	W
At $T_C > 25^\circ C$ Derate linearly		0.32			W/°C
T_{stg}, T_J		−65 to 150			°C
T_L (During soldering): At distance 1/8 in. (3.17 mm) from case for 10s max.		235			°C

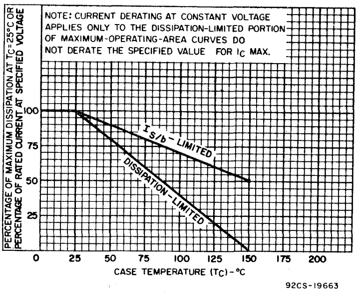


Fig. 2 — Derating curve.

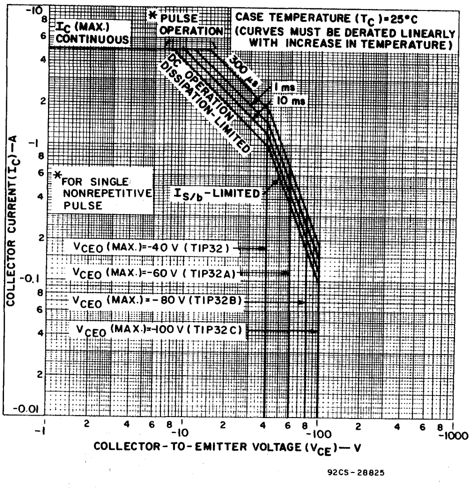


Fig. 1 — Maximum operating areas.

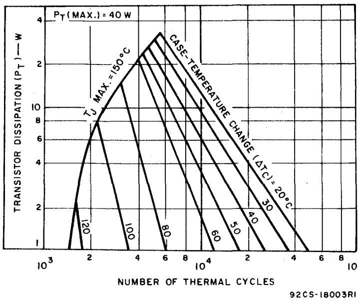


Fig. 3 — Thermal-cycling ratings.

TIP32 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST COND. VOLTAGE V dc	TEST COND. CURRENT A dc	LIMITS TIP32		LIMITS TIP32A		LIMITS TIP32B		LIMITS TIP32C		Units
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} I_B=0	−30		–	−0.3	–	−0.3	–	–	–	–	mA
	−60		–	–	–	–	–	−0.3	–	−0.3	
I_{CES} V_{EB}=0	−40		–	−0.2	–	–	–	–	–	–	mA
	−60		–	–	–	−0.2	–	–	–	–	
	−80		–	–	–	–	–	−0.2	–	–	
	−100		–	–	–	–	–	–	–	−0.2	
I_{EBO} V_{BE}=5V		0	–	−1	–	−1	–	−1	–	−1	mA
V_{CEO}(sus) I_B=0		−0.03[a]	−40[b]	–	−60[b]	–	−80[b]	–	−100[b]	–	V
h_{FE}	−4	−1[a]	25	–	25	–	25	–	25	–	
	−4	−3[a]	10	50	10	50	10	50	10	50	
V_{BE}	−4	−3[a]	–	−1.8	–	−1.8	–	−1.8	–	−1.8	V
V_{CE}(sat) I_B= −0.375A		−3[a]	–	−1.2	–	−1.2	–	−1.2	–	−1.2	V
h_{fe} f=1 kHz	−10	−0.5	20	–	20	–	20	–	20	–	
$\|h_{fe}\|$ f=1 MHz	−10	−0.5	3	–	3	-	3	–	3	–	
t_{ON} (t_d+t_r) V_{CC}= −30V R_L=30Ω I_{B1}=I_{B2} =−0.1A		−1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		µs
t_{OFF} (t_s+t_f) V_{CC}= −30V R_L=30Ω I_{B1}=−I_{B2} =−0.1A		−1	1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		
$R_{\theta JC}$	TIP32-series		—	3.125	–	3.125	–	3.125	–	3.125	°C/W
$R_{\theta JA}$	TIP32-series		—	62.5	–	62.5	–	62.5	–	62.5	

[a] Pulsed, pulse duration = 300 µs, duty factor ⩽ 2%.

[b] *CAUTION:* Sustaining voltage, V_{CEO}(sus), *MUST NOT* be measured on a curve tracer.

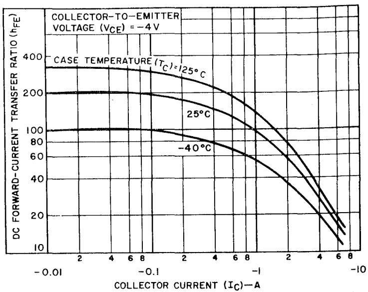


Fig. 4 — Typical dc beta characteristics for TIP32, TIP32A, TIP32B.

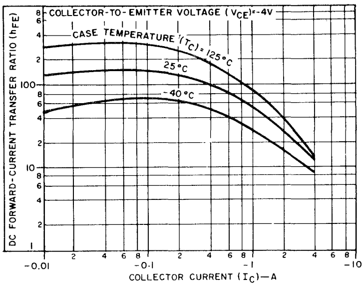


Fig. 5 — Typical dc beta characteristics for TIP32C.

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

The RCA-TIP41 series are epitaxial-base, silicon n-p-n transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP42 series. They differ from each other in voltage ratings. They are supplied in the JEDEC TO-220AB VERSAWATT package.

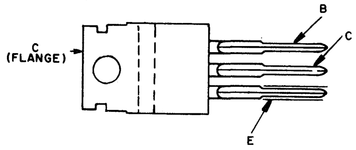
Features:

- **65 W at 25°C case temperature**
- **7-A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 500 mA**
- **Designed for complementary use with TIP42-series p-n-p types**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP41	TIP41A	TIP41B	TIP41C	
V_{CBO}	40	60	80	100	V
V_{CEO}	40	60	80	100	V
V_{EBO}	5	5	5	5	V
I_C	7	7	7	7	A
I_{CM}	10	10	10	10	A
I_B	3	3	3	3	A
P_T:					
At $T_C \leqslant 25°C$	65	65	65	65	W
At $T_A \leqslant 25°C$	2	2	2	2	W
At $T_C > 25°C$ .... Derate linearly at	0.52				W/°C
T_{stg}, T_J	−65 to 150				°C
T_L (During soldering): At distance 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

TERMINAL DESIGNATIONS

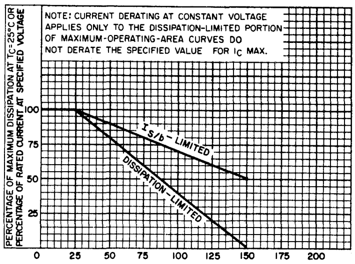


92CS-27519

BOTTOM VIEW

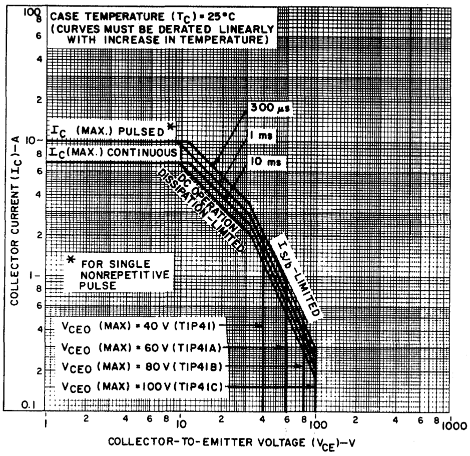
JEDEC TO-220AB

(See dimensional outline "S".)



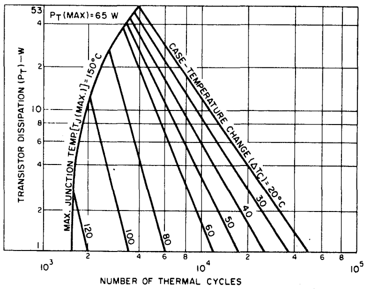
92CS-19663

Fig. 2 — Derating curves for all types.



92CS-28975

Fig. 1 — Maximum operating areas for all types.



92CS-19822

Fig. 3 — Thermal-cycling ratings for all types.

TIP41 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS Voltage V dc V_{CE}	TEST CONDITIONS Current A dc I_C	LIMITS TIP41 Min.	LIMITS TIP41 Max.	LIMITS TIP41A Min.	LIMITS TIP41A Max.	LIMITS TIP41B Min.	LIMITS TIP41B Max.	LIMITS TIP41C Min.	LIMITS TIP41C Max.	Units
I_{CEO} I_B=0	30 60		– –	0.7 –	– –	0.7 –	– –	– 0.7	– –	– 0.7	mA
I_{CES} V_{BE}=0	40 60 80 100		– – – –	0.4 – – –	– – – –	– 0.4 – –	– – – –	– – 0.4 –	– – – –	– – – 0.4	mA
I_{EBO} V_{BE}=–5 V		0	–	1	–	1	–	1	–	1	mA
V_{CEO}(sus) I_B=0		0.03[a]	40[b]	–	60[b]	–	80[b]	–	100[b]	–	V
h_{FE}	4 4	0.3[a] 3[a]	30 15	– 150	30 15	– 150	30 15	– 150	30 15	– 150	
V_{BE}	4	6[a]	–	2.2	–	2.2	–	2.2	–	2.2	V
V_{CE}(sat) I_B=0.6 A		6[a]	–	2	–	2	–	2	–	2	V
h_{fe} f=1 kHz	10	0.5	20	–	20	–	20	–	20	–	
$\|h_{fe}\|$ f=1 MHz	10	0.5	3	–	3	–	3	–	3	–	
t_{ON} ($t_d + t_r$) V_{CC}=30 V, R_L=5 Ω, I_{B1}=I_{B2}=0.6 A		6	0.6 (typ.)		0.6 (typ.)		0.6 (typ.)		0.6 (typ.)		µs
t_{OFF} ($t_s + t_f$) V_{CC}=30 V, R_L=5 Ω, I_{B1}=I_{B2}=0.6 A		6	1.4 (typ.)		1.4 (typ.)		1.4 (typ.)		1.4 (typ.)		
$R_{\theta JC}$ $R_{\theta JA}$			– –	1.92 62.5	– –	1.92 62.5	– –	1.92 62.5	– –	1.92 62.5	°C/W

[a] Pulsed, pulse duration = 300 µs, duty factor ⩽ 2%.

[b] *CAUTION: Sustaining voltage, V_{CEO}(sus), MUST NOT be measured on a curve tracer.*

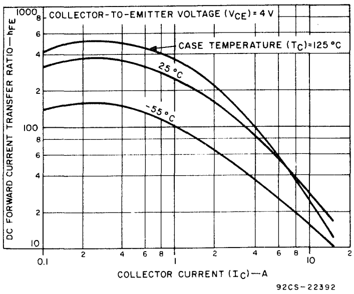


Fig. 4 — Typical dc beta characteristics for all types.

TIP42 Series

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

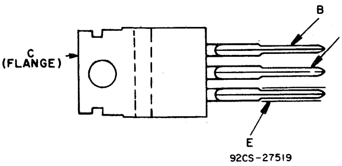
The RCA-TIP42 series are epitaxial-base silicon p-n-p transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP41 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB VERSAWATT package.

Features:

- **65 W at 25°C case temperature**
- **7 A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 500 mA**
- **Designed for complementary use with TIP41 -series n-p-n types**

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP42	TIP42A	TIP42B	TIP42C	
V_{CBO}	-40	-60	-80	-100	V
V_{CEO}	-40	-60	-80	-100	V
V_{EBO}	- 5	- 5	- 5	- 5	V
I_C	- 7	- 7	- 7	- 7	A
I_{CM}	-10	-10	-10	- 10	A
I_B	- 3	- 3	- 3	- 3	A
P_T:					
At $T_C \leq 25°C$	65	65	65	65	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ .... Derate linearly at	0.52				W/°C
T_{stg}, T_J	-65 to 150				°C
T_L (During soldering):					
At distance 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

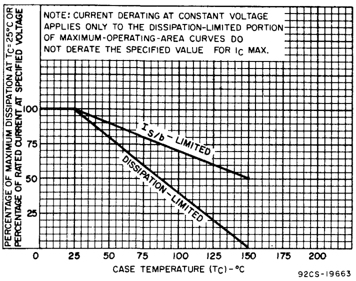


Fig. 2 – Derating curve for all types.

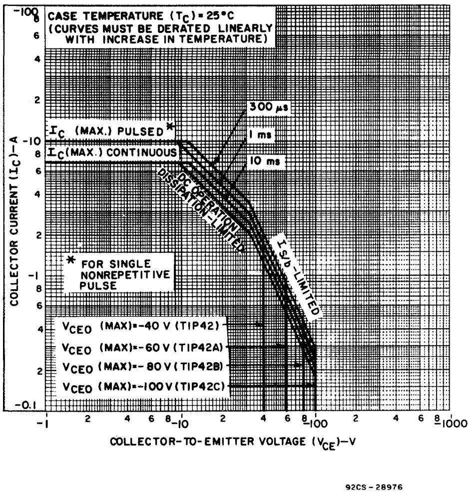


Fig. 1 – Maximum operating areas for all types.

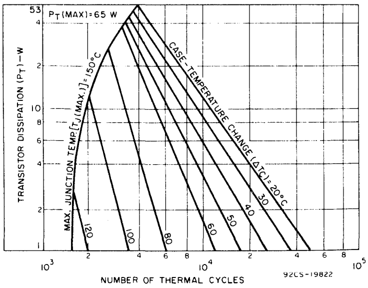


Fig. 3 – Thermal-cycling ratings for all types.

TIP42 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTICS	TEST COND.		LIMITS								UNITS
	VOLTAGE V dc	CURRENT A dc	TIP42		TIP42A		TIP42B		TIP42C		
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} $I_B = 0$	- 30		–	-0.7	–	-0.7	–	–	–	–	mA
	- 60		–	–	–	–	–	-0.7	–	-0.7	
I_{CES} $V_{EB} = 0$	- 40		–	-0.4	–	–	–	–	–	–	mA
	- 60		–	–	–	-0.4	–	–	–	–	
	- 80		–	–	–	–	–	-0.4	–	–	
	-100		–	–	–	–	–	–	–	-0.4	
I_{EBO} $V_{BE} = -5$ V		0	–	-1	–	-1	–	-1	–	-1	mA
$V_{CEO}(sus)$ $I_B = 0$		-0.03^{a}	-40^{b}	–	-60^{b}	–	-80^{b}	–	-100^{b}	–	V
h_{FE}	- -4	-0.3^{a}	30	–	30	–	30	–	30	–	
	-4	-3^{a}	15	150	15	150	15	150	15	150	
V_{BE}	-4	-6^{a}	–	-2.2	–	-2.2	–	-2.2	–	-2.2	V
$V_{CE}(sat)$ $I_B = -0.6$ A		-6^{a}	–	-2	–	-2	–	-2	–	-2	V
h_{fe} f = 1 kHz	-10	-0.5	20	–	20	–	20	–	20	–	
$\|h_{fe}\|$ f = 1 MHz	-10	-0.5	3	–	3	–	3	–	3	–	
t_{ON} $(t_d + t_r)$ $V_{CC} = -30$ V $R_L = 5\ \Omega$ $I_{B1} = I_{B2} = -0.6$ A		-6	0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		µs
t_{OFF} $(t_s + t_f)$ $V_{CC} = -30$ V $R_L = 5\ \Omega$ $I_{B1} = I_{B2} = -0.6$ A		-6	0.7 (typ.)		0.7 (typ.)		0.7 (typ.)		0.7 (typ.)		
$R_{\theta JC}$			–	1.92	–	1.92	–	1.92	–	1.92	°C/W
$R_{\theta JA}$			–	62.5	–	62.5	–	62.5	–	62.5	

^{a} Pulsed, pulse duration = 300 µs, duty factor $\leqslant$ 2%.

^{b} *CAUTION:* Sustaining voltage, $V_{CEO}(sus)$, *MUST NOT* be measured on a curve tracer.

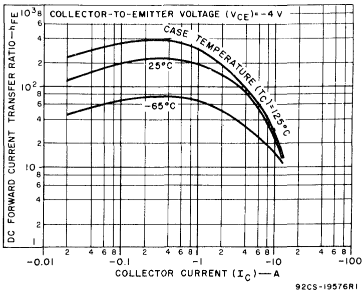


Fig. 4 — Typical dc beta characteristics for TIP42, TIP42A, TIP42B.

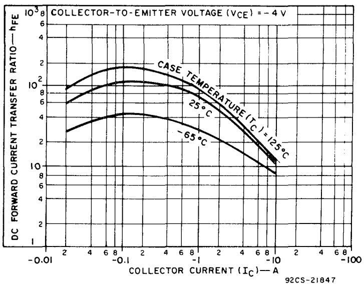


Fig. 5 — Typical dc beta characteristics for TIP42C.

TIP47, TIP48, TIP49, TIP50

High-Voltage Silicon N-P-N VERSAWATT Transistors

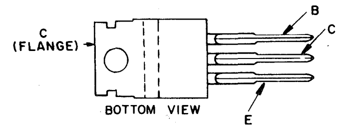
For High-Speed Switching
and Linear-Amplifier Applications

Features:

- Glass passivated chip
- VERSAWATT package
- Thermal-cycling ratings
- Maximum safe-area-of-operation curves

The RCA-TIP47, TIP48, TIP49, and TIP50 are silicon n-p-n transistors. Typical applications for these transistors include high-voltage switches and switching regulators. TV horizontal-deflection circuits, power supplies, and TV audio-output circuits. They are supplied in the JEDEC TO-220AB VERSAWATT plastic package.

TERMINAL DESIGNATIONS

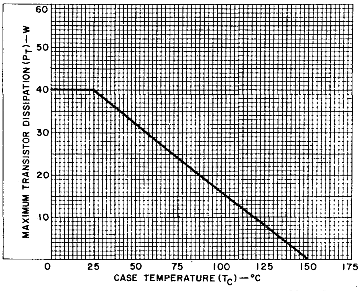


92CS-27519

(See dimensional outline "S".)

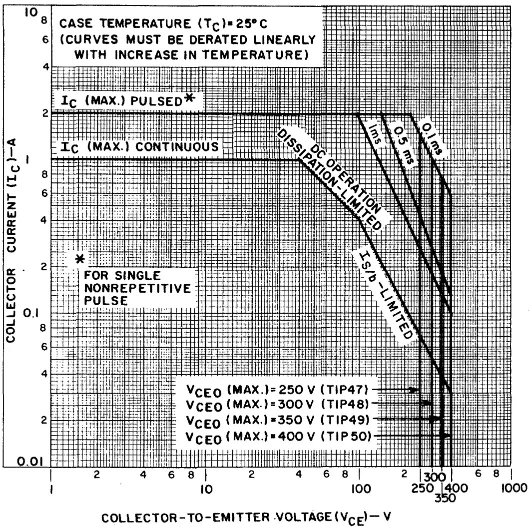
MAXIMUM RATINGS, *Absolute-Maximum Values:*

		TIP47	TIP48	TIP49	TIP50	
V_{CBO}		350	400	450	500	V
$V_{CEO}(sus)$		250	300	350	400	V
V_{EBO}		5	5	5	5	V
I_C		1	1	1	1	A
I_{CM}		2	2	2	2	A
I_B		0.6	0.6	0.6	0.6	A
P_T:						
T_C up to 25°C		40	40	40	40	W
T_C above 25°C	Derate linearly	0.32				W/°C
T_A up to 25°C		1.8				W
T_{stg}, T_J		−65 to 150				°C
T_L:						
At distance ⩾ 1/8 in. (3.17 mm) from seating plane for 10 s max.		235				°C



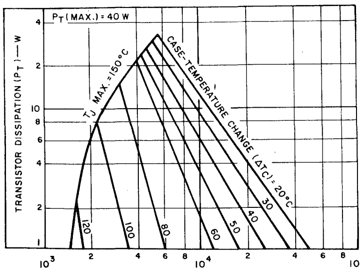
92CS-24114

Fig.2 — Derating curve for all types.



92CS-28656RI

Fig.1 — Maximum operating areas for all types.



92CS-18003RI

Fig.3 — Thermal-cycling rating chart for all types.

TIP47, TIP48, TIP49, TIP50

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST COND.		LIMITS								UNITS
	VOLTAGE V dc	CURRENT A dc	TIP47		TIP48		TIP49		TIP50		
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} $I_B = 0$	150		–	1	–	–	–	–	–	–	mA
	200		–	–	–	1	–	–	–	–	
	250		–	–	–	–	–	1	–	–	
	300		–	–	–	–	–	–	–	1	
I_{CES} $V_{EB} = 0$	350		–	1	–	–	–	–	–	–	mA
	400		–	–	–	1	–	–	–	–	
	450		–	–	–	–	–	1	–	–	
	500		–	–	–	–	–	–	–	1	
I_{EBO} $V_{BE} = -5$ V		0	–	1	–	1	–	1	–	1	mA
h_{FE}	10	1[a]	10	–	10	–	10	–	10	–	
	10	0.3[a]	30	150	30	150	30	150	30	150	
$V_{CEO}(sus)$ $I_B = 0$		0.3[a]	250[b]	–	300[b]	–	350[b]	–	400[b]	–	V
V_{BE}	10	1[a]	–	1.5	–	1.5	–	1.5	–	1.5	V
$V_{CE}(sat)$ $I_B = 0.2$ A		1[a]	–	1	–	1	–	1	–	1	V
$\|h_{fe}\|$ f = 1 MHz	10	0.2	10	–	10	–	10	–	10	–	
f_T f = 1 MHz	10	0.2	10	–	10	–	10	–	10	–	MHz
h_{fe} f = 1 kHz	10	0.2	25	–	25	–	25	–	25	–	
$I_{S/b}$ t = 0.5 s	100	–	0.4	–	0.4	–	0.4	–	0.4	–	A
t_{ON} $(t_d + t_r)$[c,d] $V_{CC} = 200$ V		1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		µs
t_s[c,d] $V_{CC} = 200$ V		1	2 (typ.)		2 (typ.)		2 (typ.)		2 (typ.)		
t_f[c,d] $V_{CC} = 200$ V		1	0.5 (typ.)		0.5 (typ.)		0.5 (typ.)		0.5 (typ.)		
$R_{\theta JC}$			–	3.12	–	3.12	–	3.12	–	3.12	°C/W
$R_{\theta JA}$			–	70	–		–	70	–	70	

[a] Pulsed, pulse duration = 300 µs, duty factor ⩽ 2%..

[b] *CAUTION: Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.*

[c] See Fig. 9.

[d] $I_{B1} = I_{B2} = 0.1$ A.

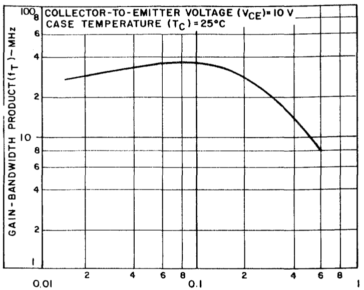


Fig.4 — Typical gain-bandwidth characteristics for all types.

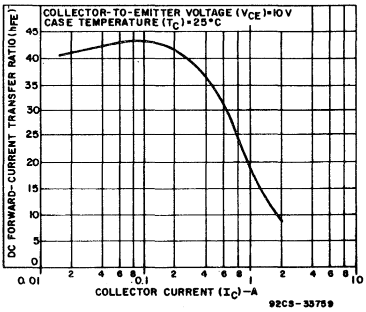


Fig.5 — Typical dc beta characteristics for all types.

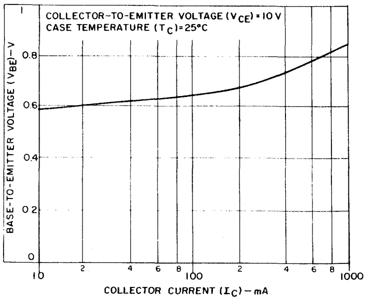


Fig.6 — Typical base-to-emitter voltage vs. collector current.

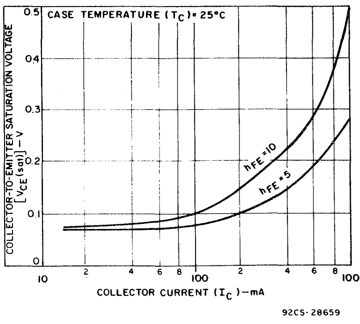
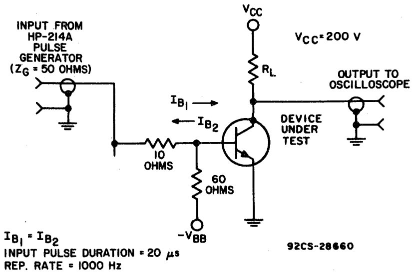


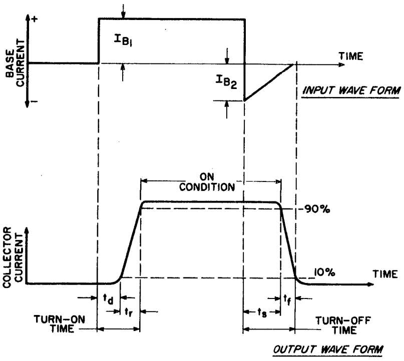
Fig.7 — Typical saturation-voltage characteristics for all types.



$I_{B1} = I_{B2}$
INPUT PULSE DURATION = 20 μs
REP. RATE = 1000 Hz

92CS-28660

Fig.8 – Circuit used to measure saturated switching times.



92CS-12874

Fig.9 – Phase relationship between input and output currents, showing reference points for specification of switching times.

TIP100, TIP101, TIP102

8-Ampere N-P-N Darlington Power Transistors

60, 80, and 100 Volts, 80 Watts
Gain of 1000 at 3 A

The RCA-TIP100, TIP101 and TIP102 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The double epitaxial construction of these devices provides good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220 AB (RCA VERSAWATT) plastic package.

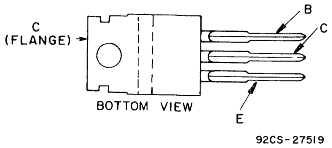
Applications:

- **Power switching**
- **Hammer drivers**
- **Audio amplifiers**
- **Series and shunt regulators**

Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP100	TIP101	TIP102	
V_{CBO}	60	80	100	V
$V_{CEO}(sus)$	60	80	100	V
V_{EBO}		5		V
I_C		8		A
I_{CM}		15		A
I_B		1		A
P_T:				
T_C up to 25°C		80		W
T_C above 25°C . . . Derate linearly at		0.64		W/°C
T_{stg}, T_J		−65 to 150		°C
T_L				
At distance ⩾ 1/8 in. (3.17 mm) from case for 10 s max.		235		°C

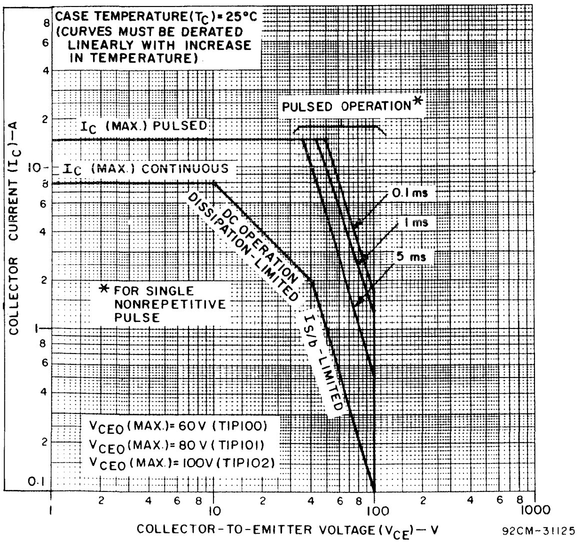


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

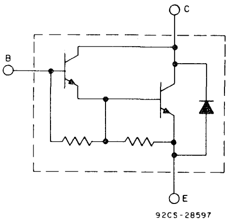


Fig. 2 — Schematic diagram for all types.

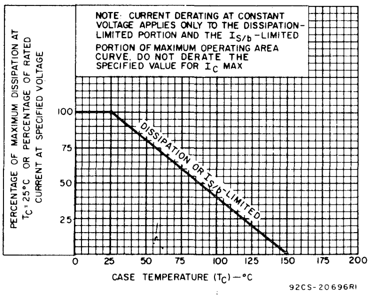


Fig. 3 — Derating curve for all types.

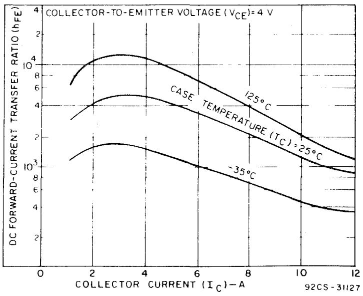


Fig. 4 — Typical dc-beta characteristics for all types.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		TIP100		TIP101		TIP102		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} $I_E = 0$	60 80 100				– – –	50 – –	– – –	– 50 –	– – –	– – 50	µA
I_{CEO}	30 40 50			0 0 0	– – –	50 – –	– – –	– 50 –	– – –	– – 50	
I_{EBO}		–5	0		–	8	–	8	–	8	mA
$V_{CEO}(sus)$			0.03^b	0	60	–	80	–	100	–	V
h_{FE}	4 4		3^b 8^b		1000 200	20,000 –	1000 200	20,000 –	1000 200	20,000 –	
V_{BE}	4		8^b		–	2.8	–	2.8	–	2.8	V
$V_{CE}(sat)$			3^b 8^b	0.006 0.08	– –	2 2.5	– –	2 2.5	– –	2 2.5	
V_F			–10		–	2.8	–	2.8	–	2.8	
$t_d{}^c$ $t_r{}^c$ $t_s{}^c$ $t_f{}^c$			8 8 8 8	0.08 0.08 0.08^d 0.08^d	0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		µs
$I_{S/b}$ t=0.15 s non-rep. pulse	40				2	–	2	–	2	–	A
$R_{\theta JC}$					–	1.56	–	1.56	–	1.56	°C/W

^{a} V_{CB} value. ^{b} Pulsed: Pulse duration = 300 µs, duty factor ⩽2%. ^{c} V_{CC} = 40 V ^{d} $I_{B_1} = -I_{B_2}$.

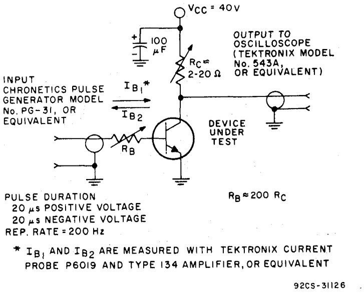


Fig. 5 – Circuit used to measure saturated switching times.

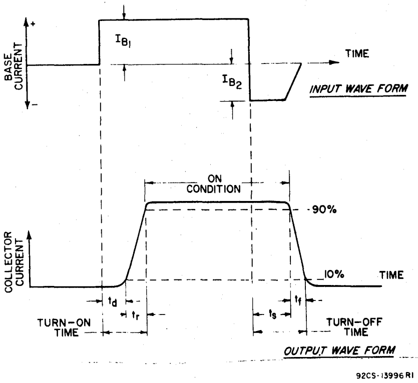


Fig. 6 – Phase relationship between input current and output current showing reference points for specification of switching times.

TIP120, TIP121, TIP122

8-Ampere N-P-N Darlington Power Transistors

60, 80, and 100 Volts, 65 Watts
Gain of 1000 at 0.5 A
Gain of 1000 at 3 A

The RCA-TIP120, TIP121, and TIP122 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The double epitaxial construction of these devices provides good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB VERSAWATT package.

The TIP120, TIP121 and TIP122 are n-p-n complements of the TIP125, TIP126 and TIP127.

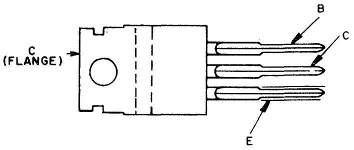
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

Applications:

- **Power switching**
- **Audio amplifiers**
- **Hammer drivers**
- **Series and shunt regulators**

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP120	TIP121	TIP122	
V_{CBO}	60	80	100	V
$V_{CER}(sus)$				
$R_{BE} = 100\ \Omega$	60	80	100	V
$V_{CEO}(sus)$	60	80	100	V
$V_{CEV}(sus)$				
$V_{BE} = -1.5$ V	60	80	100	V
V_{EBO}	5	5	5	V
I_C	8	8	8	A
I_{CM}	10	10	10	A
I_B	0.25	0.25	0.25	A
P_T:				
T_C up to 25°C	65	65	65	W
T_C above 25°C . . . Derate linearly at		0.52		W/°C
T_{stg}, T_J		−65 to 150		°C
T_L				
At distance ⩾ 1/8 in. (3.17 mm) from case for 10 s max.		235		°C

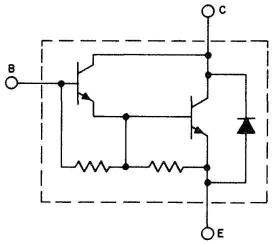


Fig. 1 — Schematic diagram for all types.

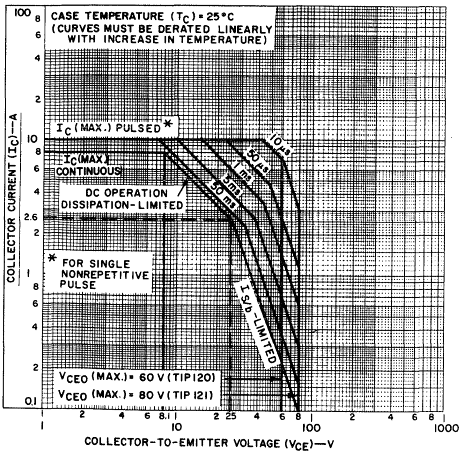


Fig. 2 — Maximum operating areas for TIP120 and TIP121.

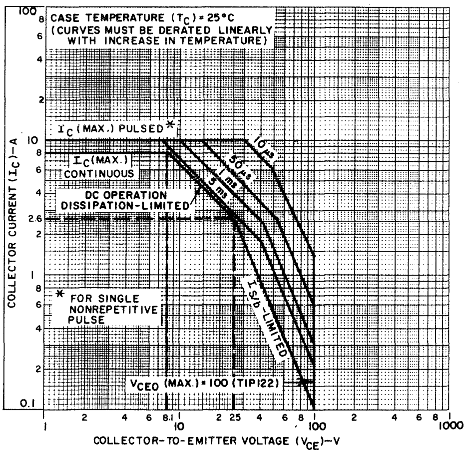


Fig. 3 — Maximum operating areas for TIP122.

TIP120, TIP121, TIP122

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		TIP120		TIP121		TIP122		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} I_E=0	60				–	0.2	–	–	–	–	mA
	80				–	–	–	0.2	–	–	
	100				–	–	–	–	–	0.2	
I_{CEO}	30			0	–	0.5	–	–	–	–	
	40			0	–	–	–	0.5	–	–	
	50			0	–	–	–	–	–	0.5	
I_{EBO}		–5	0		–	2	–	2	–	2	mA
V_{CEO}(sus)			0.2[a]	0	60	–	80	–	100	–	V
h_{FE}	3		3[a]		1000	–	1000	–	1000	–	
	3		0.5[a]		1000	–	1000	–	1000	–	
V_{BE}	3		3[a]		–	2.5	–	2.5	–	2.5	V
V_{CE}(sat)			3[a]	0.012	–	2	–	2	–	2	V
			5[a]	0.02	–	3	–	3	–	3	
h_{fe} f=1 kHz	5		1		1000	–	1000	–	1000	–	
$\|h_{fe}\|$ f=1 MHz	5		1		20	–	20	–	20	–	
C_{obo} V_{CB}=10 V f=1 MHz					–	200	–	200	–	200	pF
$E_{S/b}$ L=12 mH, R_{BE}=100 Ω		–1.5	4.5		120	–	120	–	120	–	mJ
$I_{S/b}$ t=0.5 s non-rep. pulse	25				2.6	–	2.6	–	2.6	–	A
$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

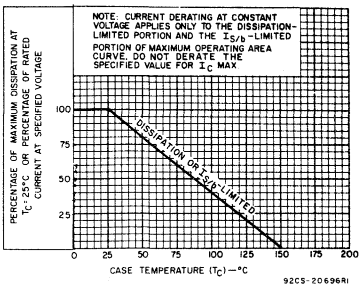


Fig. 4 — Derating curve for all types.

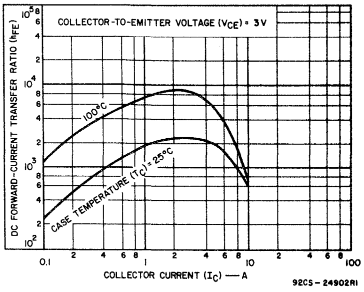


Fig. 5 — Typical dc beta characteristics for all types.

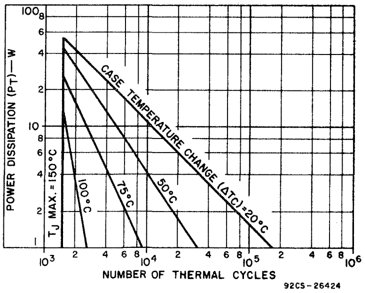


Fig. 6 — Thermal-cycling rating chart for all types.

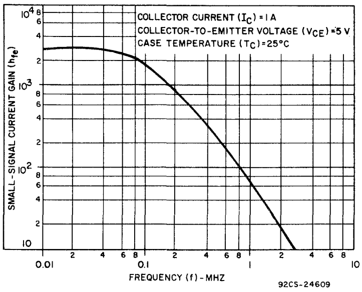


Fig. 7 — Typical small-signal current gain for all types.

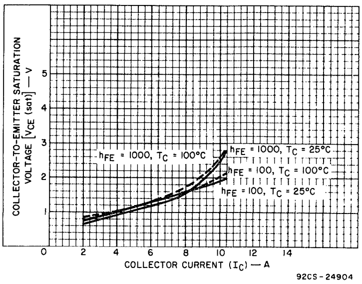


Fig. 8 — Typical saturation characteristics for all types.

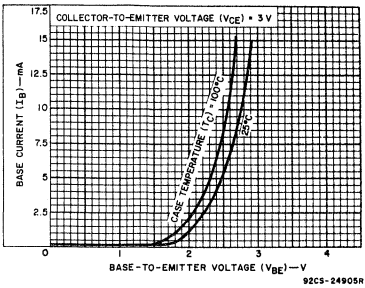


Fig. 9 — Typical input characteristics for all types.

TIP120, TIP121, TIP122

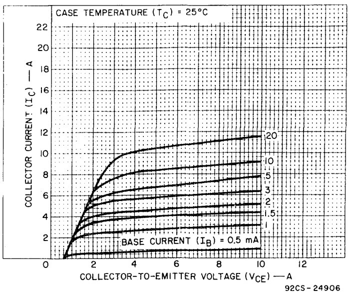


Fig. 10 — Typical output characteristics for all types.

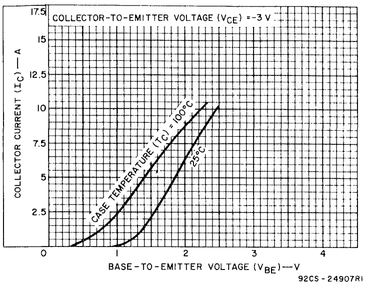


Fig. 11 — Typical transfer characteristics for all types.

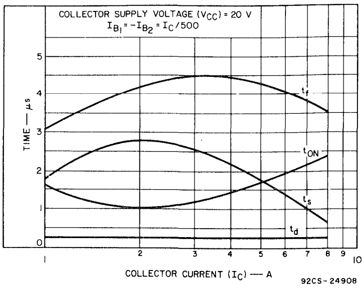


Fig. 12 — Typical saturated switching characteristics for all types.

TIP125, TIP126, TIP127

8-Ampere P-N-P Darlington Power Transistors

−60, −80, and −100 Volts, 65 Watts
Gain of 1000 at −3 A
Gain of 500 at −0.75 A

Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

Applications:

- **Power switching**
- **Audio amplifiers**
- **Hammer drivers**
- **Series and shunt regulators**

The RCA-TIP125, TIP126, and TIP127 are monolithic silicon p-n-p Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB VERSAWATT package.

The TIP125, TIP126 and TIP127 are p-n-p complements of the TIP120, TIP121 and TIP122.

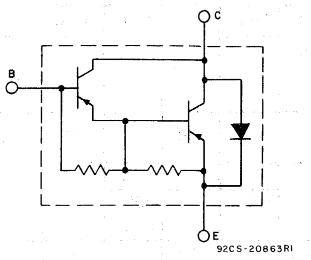
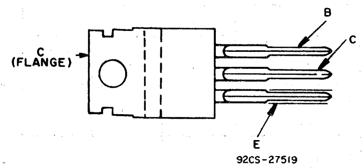


Fig. 1 – Schematic diagram for all types.

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP125	TIP126	TIP127	
V_{CBO}	−60	−80	−100	V
V_{CEO}(sus)	−60	−80	−100	V
V_{EBO}	−5	−5	−5	V
I_C	−8	−8	−8	A
I_{CM}	−15	−15	−15	A
I_B	−0.25	−0.25	−0.25	A
P_T:				
$T_C \leqslant 25^\circ C$	65	65	65	W
$T_C > 25^\circ C$ . . TIP125, TIP126, TIP127 Derate linearly at		0.52		W/°C
T_{stg}, T_J		−65 to 150		°C
T_L				
At distance 1/18 in. (3.17 mm) from case for 10s max		235		°C

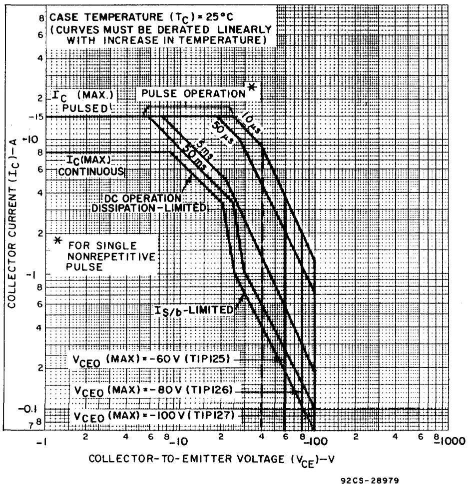


Fig. 2 – Maximum operating areas for all types.

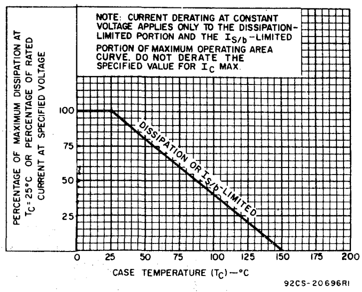


Fig. 3 – Dissipation derating curve for all types.

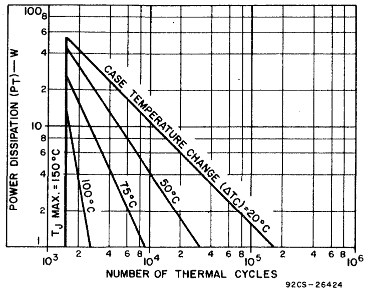


Fig. 4 – Thermal-cycling rating chart for all types.

TIP125, TIP126, TIP127

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARAC-TERISTIC	TEST CONDITIONS			LIMITS						UNITS
	Voltage V dc	Current A dc		TIP125		TIP126		TIP127		
	V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	–30 –40 –50		0 0 0	– – –	–0.5 – –	– – –	– –0.5 –	– – –	– – –0.5	mA
I_{EBO} V_{BE}=5 V		0		–	–10	–	–10	–	–10	mA
V_{CEO}(sus)		–0.03[a]	0	–60	–	–80	–	–100	–	V
h_{FE}	–3 –3	–0.75[a] –3[a]		500 1000	– –	500 1000	– –	500 1000	– –	
V_{BE}	–3	–3[a]		–	–2.5	–	–2.5	–	–2.5	V
V_{CE}(sat)		–3[a] –5[a]	–0.012 –0.02	– –	–2 –4	– –	–2 –4	– –	–2 –4	V
h_{fe} f=1 kHz	–5	–1		1000	–	1000	–	1000	–	
$\|h_{fe}\|$ f=1 MHz	–5	–1		20	–	20	–	20	–	
$I_{S/b}$ t=1-s nonrep. pulse	–20			–3.2	–	–3.2	–	–3.2	–	A
$R_{\theta JC}$				–	1.92	–	1.92	–	1.92	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor ⩽ 2%.

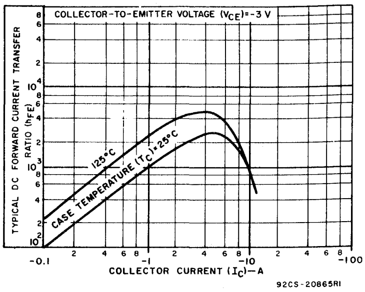


Fig. 5 — Typical dc beta characteristics for all types.

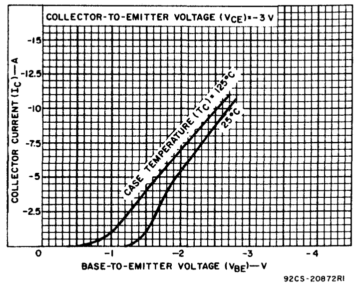


Fig. 6 — Typical transfer characteristics for all types.

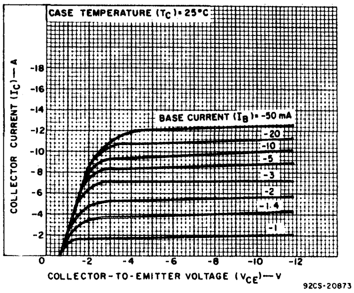


Fig. 7 — Typical output characteristics for all types.

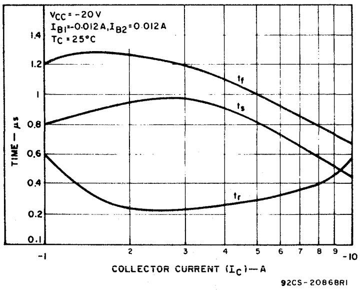


Fig. 8 — Typical saturated switching-time characteristics for all types.

Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

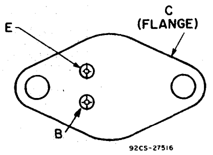
Features:

- V_{CEO} — *300 V and 400 V*
- I_C — *10 A*
- P_T — *100 W*

The RCA-TIP562 and TIP563 silicon n-p-n power transistors feature fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators, and a variety of power-switching circuits.

The RCA-TIP562 and TIP563 transistors are supplied in steel JEDEC TO-204MA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-204MA

(See dimensional outline "A".)

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

	TIP562	TIP563	
V_{CBO}	300	400	V
$V_{CEO}(sus)$	300	400	V
V_{EBO}	8		V
I_C	10		A
I_{CM}	15		A
I_B	2		A
P_T:			
At T_C up to 100°	100		W
T_J, T_{stg}	−65 to +200		°C
T_L:			
At distances ⩾ 1/16 in. (1.58 mm) from case for 10 s max.	200		°C

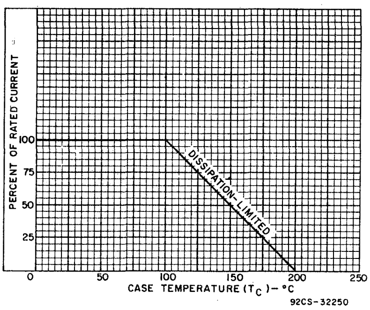


Fig. 2 - Dissipation derating curve.

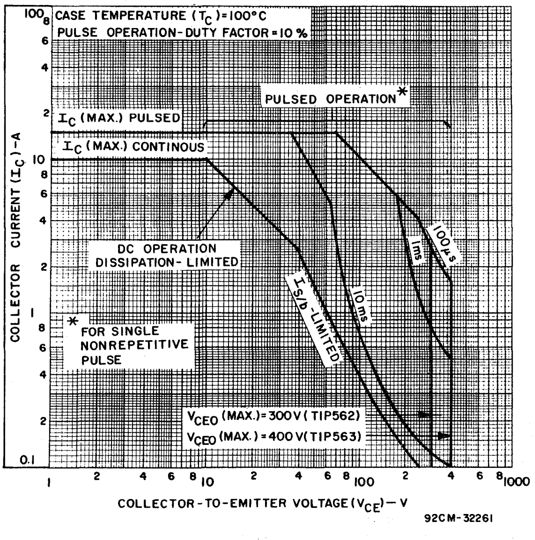


Fig. 1 - Maximum operating areas (T_C = 100°C).

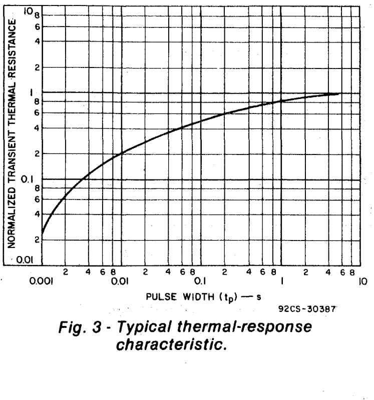


Fig. 3 - Typical thermal-response characteristic.

TIP562, TIP563

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		TIP562			TIP563			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	
I_{CEO}	270	—	—	0	—	—	1	—	—	—	mA
	360	—	—	0	—	—	—	—	—	1	
I_{CBO}, $I_E = 0$	300^b	—	—	—	—	—	100	—	—	—	μA
	400^b	—	—	—	—	—	—	—	—	100	
I_{EBO}	—	8	0	—	—	—	5	—	—	5	mA
$V_{CEO}(sus)^a$	—	—	0.1	—	300	—	—	400	—	—	V
$V_{BE}(sat)^a$	—	—	10	1.66	—	—	1.4	—	—	1.4	
$V_{CE}(sat)^2$	—	—	10	1.66	—	—	1.2	—	—	1.2	
	—	—	15	5	—	—	2.0	—	—	2.0	
h_{FE}^a	4	—	1.0	—	20	—	—	20	—	—	
	4	—	10	—	8	—	—	8	—	—	
$I_{S/b}$, t_p = 1 s, non-repetitive	40	—	—	—	2.5	—	—	2.5	—	—	A
t_d	V_{CC} = 180 V	−5.2	10	2	—	.05	—	—	.05	—	μs
t_r	V_{CC} = 180 V	−5.2	10	2	—	0.5	—	—	0.5	—	
t_s ($I_{B1} = I_{B2}$)	V_{CC} = 180 V	−5.2	10	2	—	1.2	—	—	1.2	—	
t_f ($I_{B1} = I_{B2}$)	V_{CC} = 180 V	−5.2	10	2	—	0.3	—	—	0.3	—	
t_c V_{CC} = 135 V L = 50 μH R_C = 13.5 Ω	—	−6	10	2	—	—	700	—	—	700	ns
$R_{\theta JC}$	—	—	—	—	—	—	1.0	—	—	1.0	°C/W

^{a}Pulsed, pulse duration = 300 μs, duty factor ≤2%. $^b V_{CB}$ value.

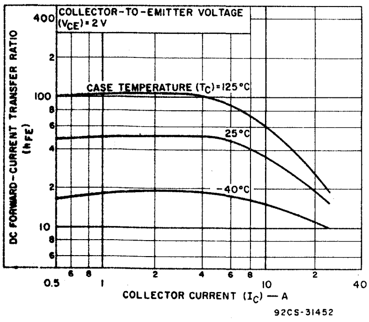


Fig. 4 - Typical dc beta characteristics for both types.

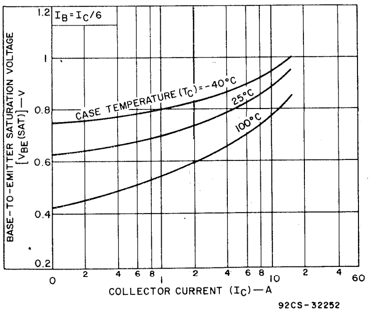


Fig. 5 - Typical base-to-emitter saturation voltage characteristics for both types.

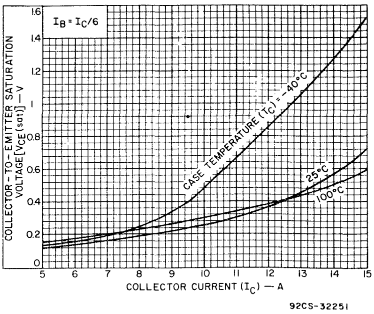


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for both types.

Power Hybrid Circuits

Technical Data

HC2000H, HC2500
Multi-Purpose 7-Ampere Operational Amplifiers

Linear Amplifiers for Applications in Industrial and Commercial Equipment

The RCA-HC2000H and HC2500 hybrid-circuit operational amplifiers are designed for operation from either single or split power supplies at output currents up to 7 amperes and power outputs up to 100 watts. These versatile amplifiers are recommended for servoamplifiers, audio power amplifiers, driven inverters, power operational amplifiers, deflection amplifiers, solenoid drivers, voltage regulators, and similar linear-amplifier power applications. They are supplied in a metal hermetic package.

The HC2000H and HC2500 employ a quasi-complementary-symmetry output stage with hometaxial-base output transistors. They feature low distortion, with a maximum total harmonic distortion of 0.5 per cent over a bandwidth of 30 kHz at a power output of 60 watts and a typical intermodulation distortion of less than 1 per cent at rms power outputs from 0.2 to 70 watts. At an rms output of 50 milliwatts, the HC2500 has an exceptionally low typical intermodulation distortion of only 0.06 per cent.

The HC2000H includes a load-line limiting network that provides protection against short-circuit loads and against high-energy transients when the amplifier is used to drive inductive loads. Both circuits also feature adjustable idling current and direct coupling to the load.

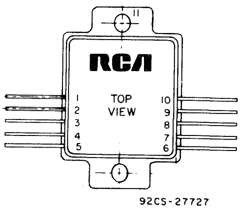
Features:

- **Bandwidth: 30 kHz at 60 W**
- **High power output: up to 100 W(rms)**
- **High output current: 7A (peak)**
- **Low IMD and THD**
- **Adjustable idling current**
- **Stability with resistive or reactive loads**
- **Single or split power supply (30 to 75 V, single, ± 15 to ±37.5, split)**
- **Class AB output stage (HC2500)**
  Class B output state (HC2000H)
- **Direct coupling to load**
- **Built-in load-line-limiting circuit to protect amplifiers from accidentally short-circuited output terminals (HC2000H)**
- **Reactive-load fault protection (HC2000H)**
- **Socket available**
- **Rugged package with heavy leads**
- **Light weight: 100 grams**

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

	HC2000H HC2500
V_S:	
Between leads 1 & 10	75 V
I_{OM}	7 A
P_T:	
Per Output Device	See Figs. 3 & 4
T_{stg}	−55 to +125°C
T_J	−55 to +150°C
T_L (During Soldering):	
At distance ≥1/8 in. (3.17 mm) from case for 10 s max.	235°C
ϕL (Min):	
At distance ≥0.075 (1.91 mm) from case	0.04 in. (1.02 mm)

TERMINAL DESIGNATION



HC2000H, HC2500

(See dimensional outline "AA".)

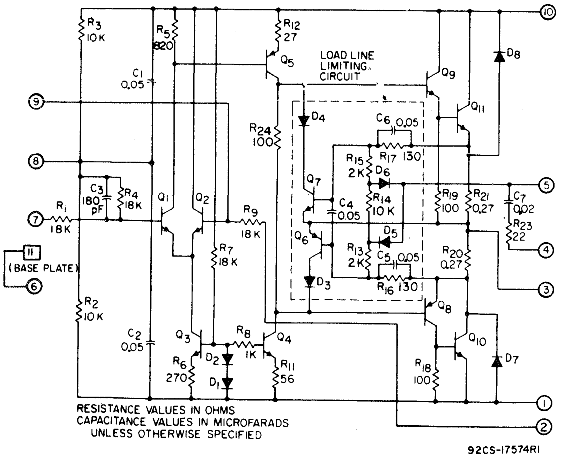


Fig. 1 — Schematic diagram of type HC2000H operational amplifier.

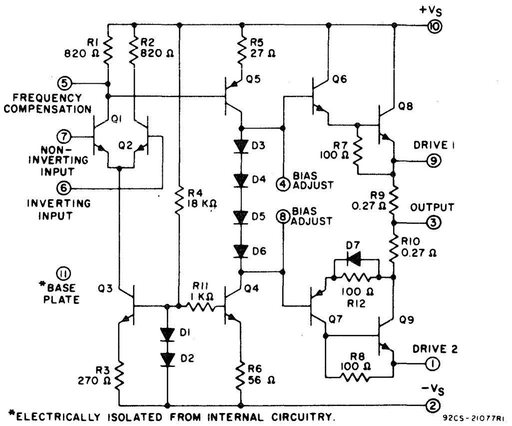


Fig. 2 — Schematic diagram of type HC2500 operational amplifier.

HC2000H, HC2500

COMPARISON CHART

TYPE	IM DIST.	OUTPUT PROTECTION NETWORK	OPERATING MODE	FREQUENCY COMPENSATION	COMMUTATING DIODES
HC2500	0.06% @ 50 mW	NO	CLASS AB	CAPACITOR ON SIGNAL TERMINALS	NO
HC2000H	0.6% @ 200 mW	YES	CLASS B	LC FILTER ON OUTPUT	YES

HC2000H

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	V_S –V	f –kHz	P_O –W	R_L –Ω	MIN.	TYP.	MAX.	
$\frac{V_{OUT}}{V_{IN}}$ Open-Loop	±37.5	1	25	4	–	2000	–	
Closed-Loop	±37.5	1	1	4	26	30	–	
Z_{IN} Measured between leads 7 & 8	–	–	–	–	15.9	18	–	kΩ
I_o	±37.5	–	–	–	15	–	30	mA
V_{IO} Measured between leads 4 & 5	±37.5	–	–	4	0	±30	±250	mV
V_{OUT}	±37.5	1	100	4	28	32	–	V
f_H (See Fig.9)	±37.5	–	1	4	43	–	–	kHz
THD (See Fig. 10)	±37.5	1	60	4	–	0.4	0.5	%
I_S (See Fig. 12)	±37.5	1	–	0	±2	–	±3.85	A
S/N Z_G = 600 Ω	±37.5	–	–	–	–	78	–	dB
SR (Unity gain, I_{OM} = 4A)	±37.5	1	100	4	4.5	–	–	V/µs
$R_{\theta JC}$ Per Output Device (See Figs. 3 & 4)	–	–	–	–	–	–	2	°C/W

HC2500

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C and Supply Voltage (V_S) = ±37.5 V*

CHARACTERISTIC	REFERENCE FIG. NO.	TEST CONDITIONS				LIMITS			UNITS
		SPECIAL NOTES	FREQ. (f)–kHz	OUTPUT POWER (P_O)–W	LOAD RESIST. (R_L)–Ω	MIN.	TYP.	MAX.	
V_{offset}		Measured Pin 3 to Gnd	–	–	4	–	–	±250	mV
I_o		Idling Current < 1 mA	–	–	Open	–	–	±30	mA
V_{OUT}		Peak dc voltage	0	200	4	28	–	–	V
f_H			–	1	4	43	–	–	kHz
THD	21		1	60	4	–	0.3	0.5	%
A_{CL}			1	1	4	31	32	–	
$R_{\theta JC}$	3, 4				-	–	–	2	C/W

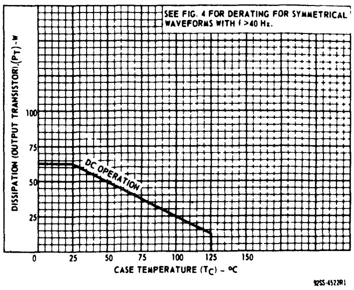


Fig. 3 — Dissipation (dc) derating curve for each output transistor for both types.

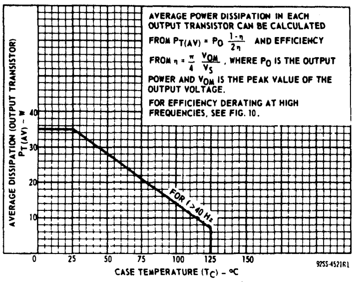


Fig. 4 — Dissipation (average) derating curve for each output transistor (for symmetrical wave-forms with f >40 Hz) for both types.

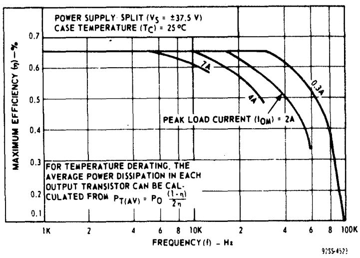


Fig. 5 — Maximum efficiency vs. frequency for several values of peak load current for both types.

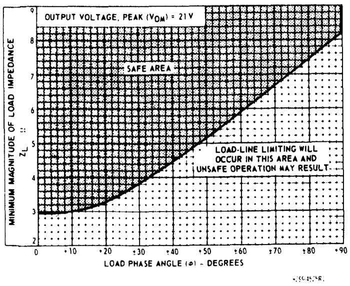


Fig. 6 — Minimum load impedance vs. load phase angle and safe area of operation for both types.

HC2000H, HC2500

HC2500

ELECTRICAL CHARACTERISTICS (Cont'd)

Typical Values (for Design Guidance), *At Case Temperature (T_C) = 25°C and Supply Voltage (V_S) = ±37.5*

CHARACTERISTIC	REFERENCE FIG. NO.	TEST CONDITIONS				LIMITS			UNITS
		SPECIAL NOTES	FREQ. (f)–kHz	OUTPUT POWER (P_O)–W	LOAD RESIST. (R_L)–Ω	MIN.	TYP.	MAX.	
A_{OL}	16	Idling current = 50 mA	1	25	4	–	70	–	dB
V_{IO}			–	0	Open	–	±10	–	mV
I_{IO}			–	0	Open	–	7	–	μA
I_{IB}			–	0	Open	–	20	–	μA
R_{CM}			0.005	0	Open	–	1	–	MΩ
V_{ICR}			0.5	100	4	–	32	–	V
CMRR			0.005	0	Open	–	50	–	dB
V_{RR}			0.06	0	4	–	30	–	dB
IMD	20	Idling current = 50 mA	–	0.05	4	–	0.06	–	%
SR	24	A_{CL} = 2 C_c = 100 pF	0.5 Square Wave	–	4	–	4.3	–	V/μs
ΔI_i	23	25°C to 100°C	–	–	4	–	1	–	mA/°C

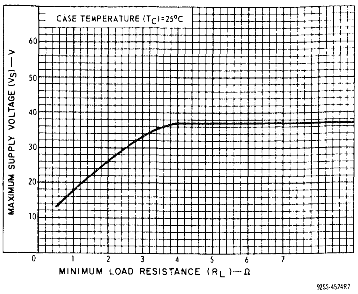


Fig. 7 — Maximum allowable supply voltage vs. load resistance for HC2000H.

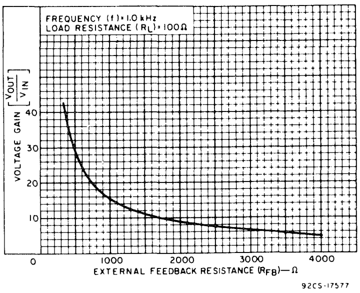


Fig. 8 — Closed-loop voltage gain vs. external feedback resistance for HC2000H.

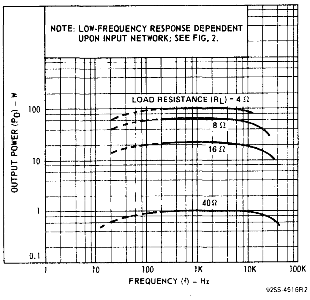


Fig. 9 — Output power vs. frequency for HC2000H.

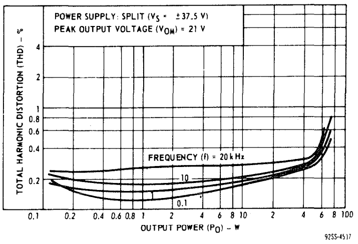


Fig. 10 — Total harmonic distortion with split power supply for HC2000H.

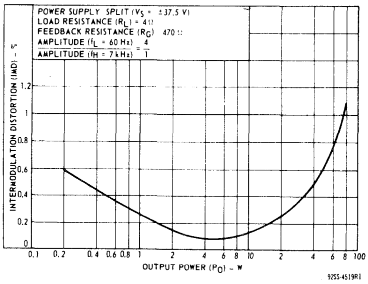


Fig. 11 — Intermodulation distortion with split supply and 4-ohm load for HC2000H.

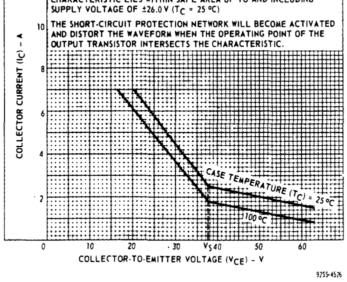


Fig. 12 — Characteristics of built-in load-line-limiting circuit for HC2000H.

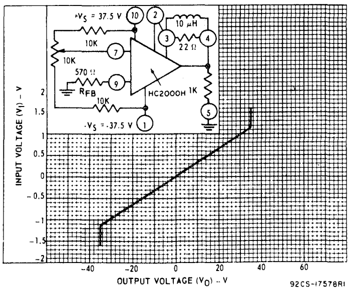


Fig. 13 — Gain linearity characteristics for HC2000H.

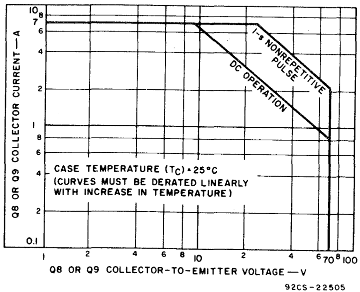


Fig. 14 – Maximum operating area for HC2500.

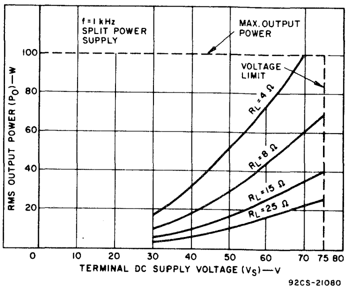


Fig. 15 – Output power as a function of supply voltage, with various values of load resistance, for symmetrical sine-wave operation for HC2500.

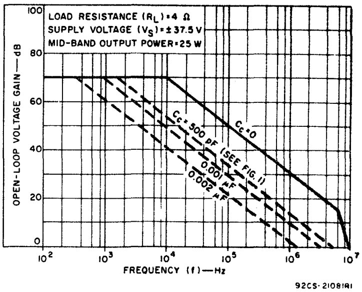


Fig. 16 – Typical open-loop voltage gain vs. frequency for HC2500.

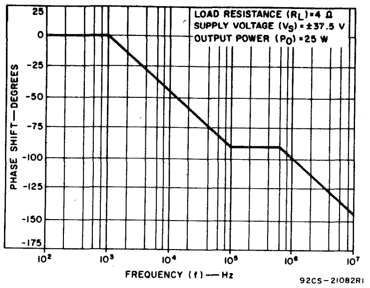


Fig. 17 – Typical open-loop phase shift vs. frequency for HC2500.

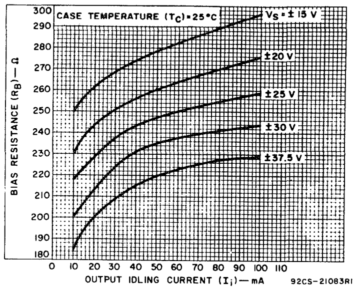


Fig. 18 – Bias resistor value vs. output idling current (I_i) for HC2500.

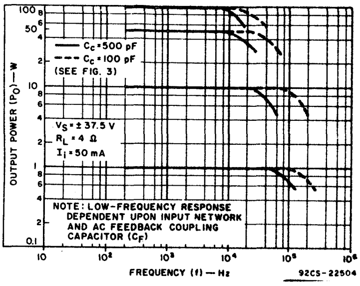


Fig. 19 – Output power vs. frequency for HC2500.

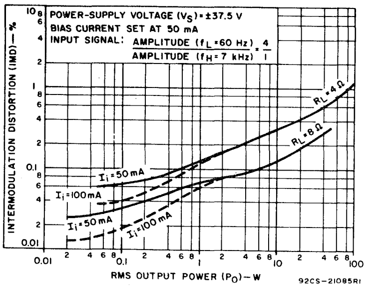


Fig. 20 – Typical intermodulation distortion vs. rms output power for HC2500.

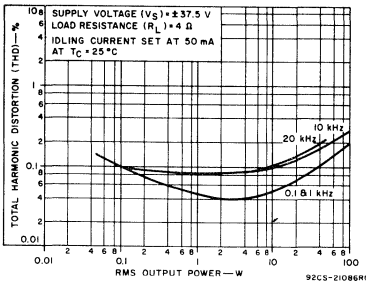


Fig. 21 – Typical harmonic distortion vs. rms output power for HC2500.

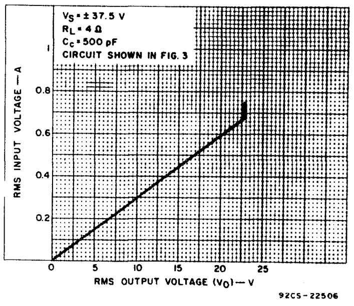


Fig. 22 – Input sensitivity for HC2500.

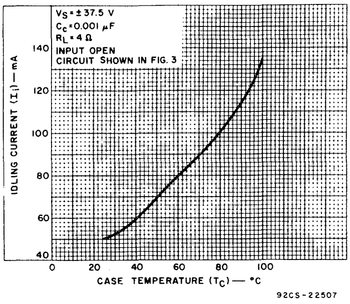


Fig. 23 – Typical idling-current drift for HC2500.

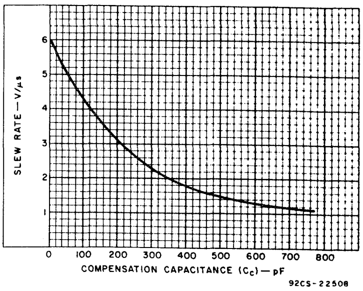


Fig. 24 – Typical slew rate vs. value of compensation capacitor C_C for HC2500.

Triacs
Technical Data

T2300, T2301, T2302, T2310, T2311, T2312 Series

2.5-A Sensitive-Gate Silicon Triacs

Mod. TO-5 and Mod. TO-5 with Heat Radiator Packages For AC Power Switching

The RCA-T2300, T2301, T2302, T2310, T2311, T2312 series triacs are gate-controlled full-wave silicon ac switches that are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

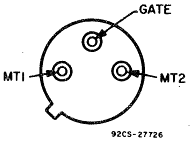
The T2310, T2311, and T2312 series are the same as the T2300, T2301, and T2302 series, respectively, but have factory-attached heat radiators and are intended for printed-circuit-board applications.

The gate sensitivity of these triacs permits the use of economical transistorized control circuits and enhances their use in low-power phase-control and load-switching applications.

Features:

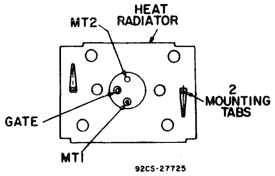
- ■ Very high gate sensitivity—3, 4, and 10 mA
- ■ di/dt capability—100 A/μs
- ■ Shorted-emitter, center-gate design
- ■ Low switching losses
- ■ Low on-state voltage at high current levels

TERMINAL CONNECTIONS



T2300
T2301
T2302
Series

Modified TO-5
(See dimensional outline "F".)



T2310
T2311
T2312
Series

Mod. TO-5 with Heat Radiator
(See dimensional outline "G".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies Up to 50/60 Hz and with Resistive or Inductive Load

3 mA Gate	**T2300F**	**T2300A**	**T2300B**	**T2300D**	
4 mA Gate	**T2301F**	**T2301A**	**T2301B**	**T2301D**	
10 mA Gate	**T2302F**	**T2302A**	**T2302B**	**T2302D**	
3 mA Gate	**T2310F**	**T2310A**	**T2310B**	**T2310D**	
4 mA Gate	**T2311F**	**T2311A**	**T2311B**	**T2311D**	
10 mA Gate	**T2312F**	**T2312A**	**T2312B**	**T2312D**	
V_{DROM}▲					
Gate open, T_J=−40 to 100°C	50	100	200	400	V
$I_{T(RMS)}$ (θ = 360°):					
T_C = 70°C **(T2300 Series)**	2.5				A
T_A = 25°C **(T2310 Series)**	1.9				A
For other conditions	See Figs. 2,3,4,5				
I_{TSM}:					
For one cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$:					
60 Hz (sinusoidal)	25				A
50 Hz (sinusoidal)	21				A
For more than one cycle of applied principal voltage	See Figs. 6,7				
di/dt:					
$V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 μs	100				A/μs
I^2t [At T_C shown for $I_{T(RMS)}$]:					
t = 20 ms	4.3				A^2s
= 2.5 ms	2				A^2s
= 0.5 ms	1				A^2s
For other time values	See Fig. 7				
I_{GTM}●:					
For 1 μs max.	1				A
P_{GM}:					
Peak (For 1 μs max., $I_{GTM} \leqslant$ 1 A(peak)	10				W
$P_{G(AV)}$:					
T_C = 60°C	0.15				W
T_A = 25°C	0.05				W
T_{stg}■	−40 to 150				°C
T_C■	−40 to 100				°C
T_T■:					
During soldering for 10 s maximum at distance ⩾ 1/16 in. (1.58 mm) from seating plane	225				°C

▲ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

● For either polarity of gate voltage (V_G) with reference to main terminal 1.

■ For temperature measurement reference point, see Dimensional Outlines.

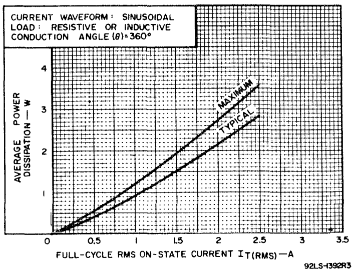


Fig. 1—Power dissipation vs. on-state current.

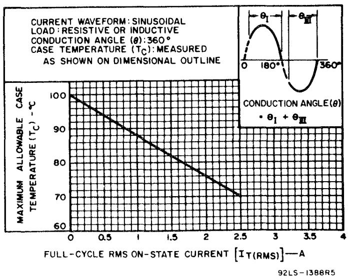


Fig. 2—Maximum allowable case temperature vs. on-state current.

T2300, T2301, T2302, T2310, T2311, T2312 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}▲: Gate open, T_J=100°C, V_{DROM}=Max.rated value	–	0.2	0.75	mA
V_{TM}▲: i_T=10 A(peak), T_C=25°C	–	1.7	2.2	V
I_{HO}▲: *(See Figs. 9 & 10)* Gate open, Initial principal current=150 mA (dc), v_D=12 V, T_C=25°C				mA
(T2300, T2301, T2310, T2311 series)	–	2	5	
(T2302, T2312 series)	–	7	15	
dv/dt (Commutating)▲: v_D=V_{DROM}, $I_{T(RMS)}$=2.5 A, commutating di/dt=1.33 A/ms, gate unenergized, T_C=70°C	0.5	–	–	V/µs
dv/dt (Off-state)▲: v_D=V_{DROM}, exponential voltage rise, gate open,				V/µs
T_C= 90°C (T2300, T2301, T2310, T2311 series)	3	5	–	
T_C=100°C (T2302, T2312 series)	6	10	–	
I_{GT}▲●: *(See Figs. 13 & 14)* v_D=12 V dc, R_L=30 Ω, T_C=25°C				mA
Mode V_{MT2} V_G				
I^+ positive positive				
T2300, T2310 series	–	1	3	
T2301, T2311 series	–	1	4	
T2302, T2312 series	–	3.5	10	
III^- negative negative				
T2300, T2310 series	–	1	3	
T2301, T2311 series	–	1	4	
T2302, T2312 series	–	3.5	10	
I^- positive negative				
T2300, T2310 series	–	2	3	
T2301, T2311 series	–	2	4	
T2302, T2312 series	–	7	10	
III^+ negative positive				
T2300, T2310 series	–	2	3	
T2301, T2311 series	–	2	4	
T2302, T2312 series	–	7	10	
V_{GT}▲●: *(See Fig. 15)*				V
v_D=12 V dc, R_L=30 Ω, T_C=25°C	–	1	2.2	
v_D=V_{DROM}, R_L= 3 kΩ , T_C=100°C	0.15	–	–	
t_{gt}: v_D=V_{DROM}, I_{GT}=60 mA, t_r=0.1 µs, i_T=10 A(peak), T_C=25°C	–	1.8	2.5	µs
$R_{\theta JC}$: Steady-state	–	–	8.5	°C/W
$R_{\theta JA}$:				
(T2300 Series)	–	–	150	
(T2310 Series)	–	–	30	

▲For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

●For either polarity of gate voltage (V_G) with reference to main terminal 1.

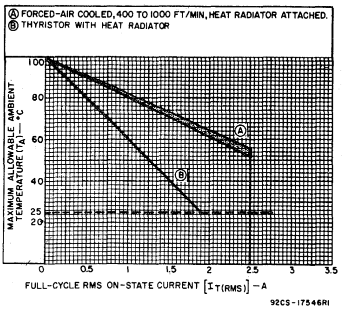


Fig. 3—Maximum allowable ambient temperature vs. on-state current for T2310, T2311, T2312 series.

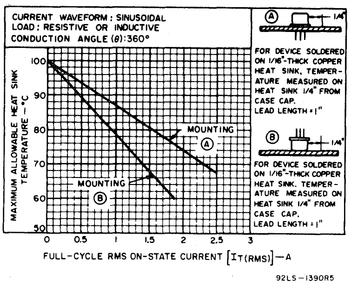


Fig. 4—Maximum allowable heat-sink temperature vs. on-state current for T2300, T2301, T2302 series.

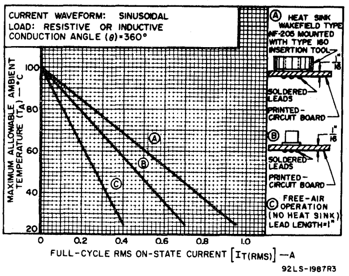


Fig. 5—Maximum allowable ambient temperature vs. on-state current for T2302 series.

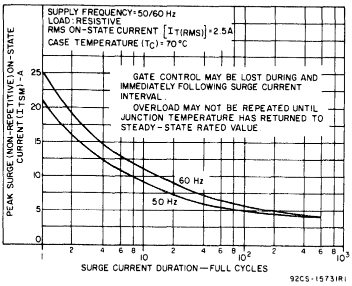


Fig. 6—Peak surge on-state current vs. surge-current duration.

T2300, T2301, T2302, T2310, T2311, T2312 Series

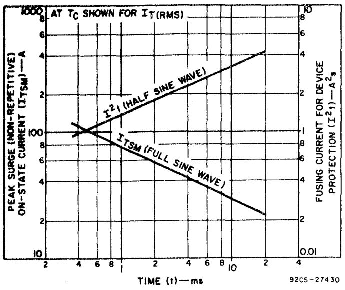


Fig. 7—Peak surge on-state current and fusing current vs. time.

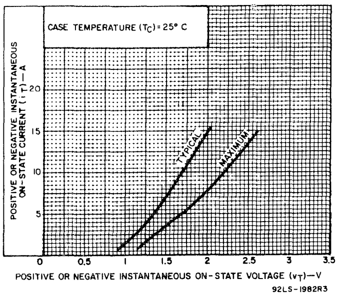


Fig. 8—On-state current vs. on-state voltage for all standard series.

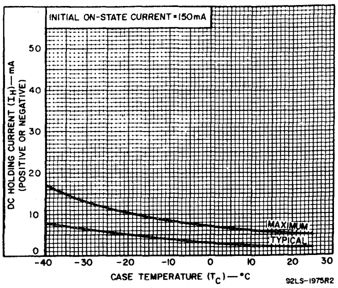


Fig. 9—DC holding current (positive or negative) vs. case temperature for T2300, T2301, T2310, T2311 series.

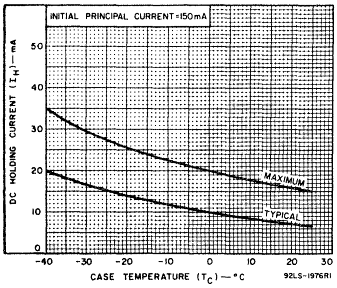


Fig. 10—DC holding current (positive or negative) vs. case temperature for T2302, T2312 series.

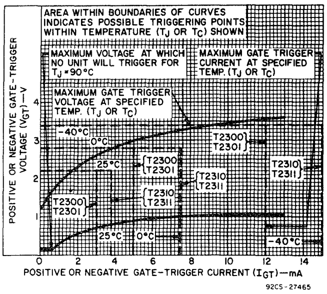


Fig. 11—Gate-trigger voltage vs. gate-trigger current for T2300, T2301, T2310, T2311 series.

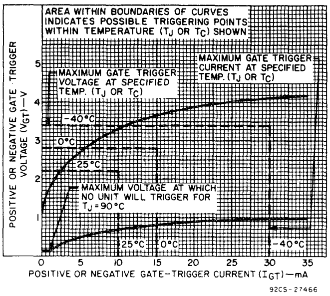


Fig. 12—Gate-trigger voltage vs. gate-trigger current for T2302, T2312 series.

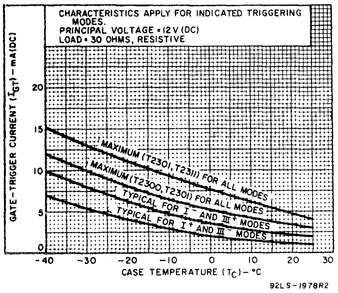


Fig. 13—Gate-trigger current vs. case temperature for T2300, T2301.

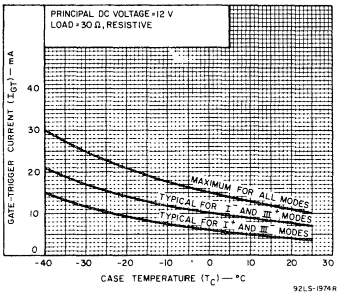


Fig. 14—Gate-trigger current vs. case temperature for T2302, T2312 series.

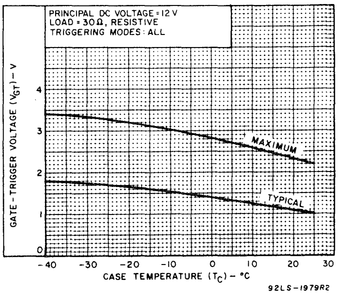


Fig. 15—Gate-trigger voltage vs. case temperature.

T2303 (2N5754-2N5757), T2313 Series

2.5-A Silicon Triacs

Modified TO-5 and Modified TO-5 with Heat Radiator Packages For AC power Switching Applications

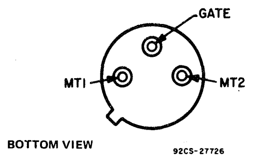
The RCA-T2303 and T2313 series triacs are gate-controlled full-wave silicon ac switches that are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages.

The T2303 (2N5754-57) series types employ a hermetic modified TO-5 package. The T2313 series types employ a hermetic modified TO-5 with a factory-attached heat radiator package.

Features:

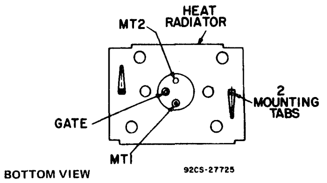
- Gate sensitivity –25 mA
- di/dt capability –100 A/μs
- Shorted-emitter, center-gate design
- Low switching losses
- Low-on-state voltage at high current levels

TERMINAL CONNECTIONS



T2303 (2N5754–57) Series

(See dimensional outline "F".)



T2313 Series

(See dimensional outline "G".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

For operation with sinusoidal supply voltage at frequencies up to 50/60 Hz and with resistive or inductive load

	T2303F T2313F	2N5754 T2313A	2N5755 T2313B	2N5756 T2313D	2N5757 T2313M	
*V_{DROM}▲:						
Gate open, T_J = –65 to 100°C	50	100	200	400	600	V
$I_{T(RMS)}$(θ = 360°C):						
* T_C = 70°C (T2303 series)			2.5			A
T_A = 25°C (T2313 series)			1.9			A
For other conditions			See Figs. 2,3,4			
I_{TSM}:						
For one cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$:						
* 60 Hz (sinusoidal)			25			A
50 Hz (sinusoidal)			21			A
For more than one cycle of applied principal voltage			See Figs. 5,6			
di/dt:						
$V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 μs			100			A/μs
I^2t [At T_C shown for $I_{T(RMS)}$]:						
t = 20 ms			4.3			A^2s
t = 2.5 ms			2			A^2s
t = 0.5 ms			1			A^2s
For other time values			See Fig. 6			
*I_{GTM}●:						
For 1 μs max. (See Fig. 9)			1			A
P_{GM}:						
Peak (For 1 μs max., $I_{GTM} \leqslant 1$ A (peak), (See Fig. 9)			10			W
*$P_{G(AV)}$ – T_C = 70°C			0.15			W
T_A = 25°C			0.05			W
*T_{stg}■			–65 to 150			°C
*T_C■			–65 to 100			°C
T_T■:						
During soldering for 10 s maximum at distance ⩾ 1/16 in. (1.58 mm) from seating plane			225			°C

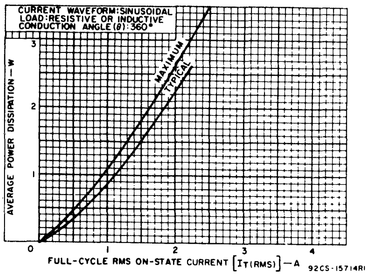


Fig. 1 – Power dissipation vs. on-state current.

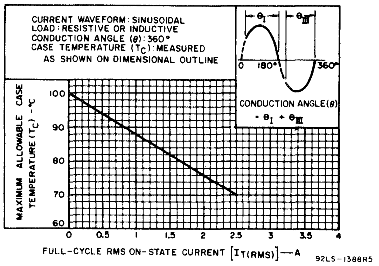


Fig. 2 – Maximum allowable case temperature vs. on-state current.

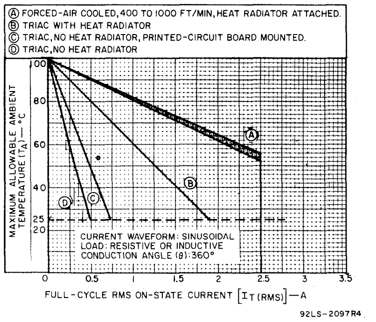


Fig. 3 – Maximum allowable ambient temperature vs. on-state current.

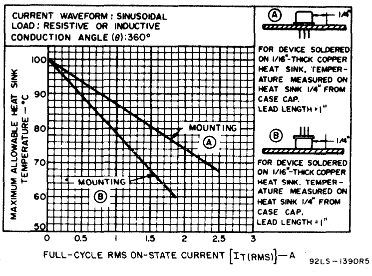


Fig. 4 – Maximum allowable heat-sink temperature vs. on-state current.

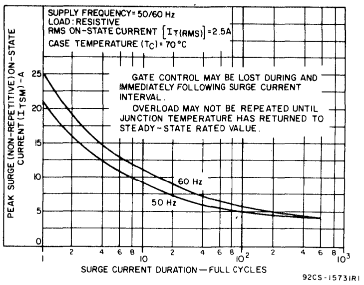


Fig. 5 – Peak surge on-state current vs. surge-current duration.

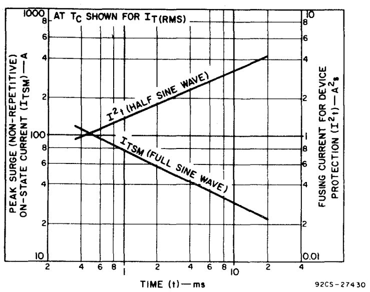


Fig. 6 – Peak surge on-state current and fusing current vs. time.

T2303 (2N5754-2N5757) T2313 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTICS	LIMITS			UNITS
	For All Types Except as Specified			
	MIN.	TYP.	MAX.	
* I_{DROM}▲: Gate open, T_J = 100°C, V_{DROM} = Max. rated value	—	0.2	0.75	mA
V_{TM}▲: *(See Fig. 7)*				V
i_T = 10 A (peak), T_C = 25°C	–	2.2	2.6	
* i_T = 3.5 A (peak), T_C = 25°C	–	–	1.8	
I_{HO}▲: *(See Fig. 8)* Gate open, Initial principal current = 150 mA (dc), v_D = 12 V				mA
T_C = 25°C	–	6	35	
= –65°C	–	20	82*	
dv/dt (Commutating)▲: v_D = V_{DROM}, $I_{T(RMS)}$ = 2.5 A commutating di/dt = 1.33 A/ms, gate unenergized, T_C = 70°C	0.5	–	–	V/μs
* dv/dt (Off-State)▲: v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C:	10	100	–	V/μs
I_{GT}▲●: (See Fig. 10)				mA
v_D = 12 V dc, R_L = 30Ω, T_C = 25°C				
Mode V_{MT2} V_G				
I^+ positive positive	–	5	25	
III^- negative negative	–	5	25	
I^- positive negative	–	10	40	
III^+ negative positive	—	10	40	
v_D = 12 V dc, R_L = 30Ω, T_C = –65°C				
Mode V_{MT2} V_G				
I^+ positive positive	–	30	60*	
III^- negative negative	–	30	60*	
I^- positive negative	–	40	100*	
III^+ negative positive	–	40	100*	
V_{GT}▲●: (See Fig. 11)				V
v_D = 12 V dc, R_L = 30Ω, T_C = 25°C	–	0.9	2.2	
= –65°C	–	1.5	3*	
v_D = V_{DROM}, R_L = 125Ω, T_C = 100°C	0.2	–	–	
t_{gt}: v_D = V_{DROM}, I_{GT} = 60 mA, t_r = 0.1 μs, i_T = 10 A (peak) T_C = 25°C	–	1.8	2.5	μs
* $R_{\theta JC}$: Steady-State	–	–	8.5	°C/W
$R_{\theta JA}$: Steady-State T2303 Series	–	–	150	
T2313 Series	—	—	30	

* In accordance with JEDEC registration data format (JS-14, RDF-2– filed for the JEDEC (2N-Series) types.

▲ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

● For either polarity of gate voltage (V_G) with reference to main terminal 1.

T2303 (2N5754-2N5757), T2313 Series

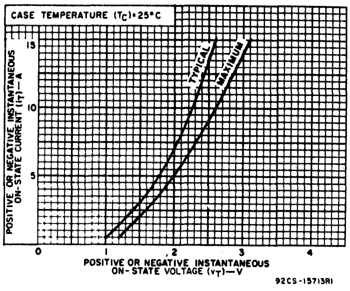


Fig. 7 — On-state current vs. on-state voltage.

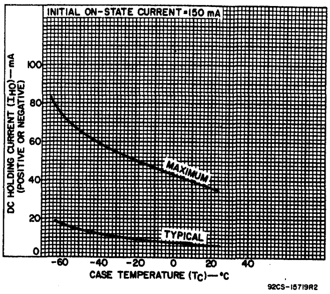


Fig. 8 — DC holding current (positive or negative) vs. case temperature.

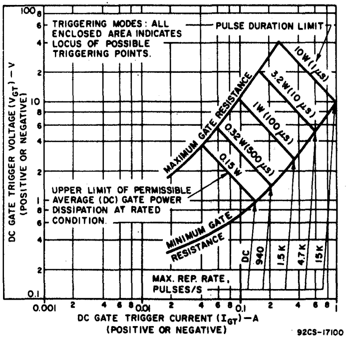


Fig. 9 — Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

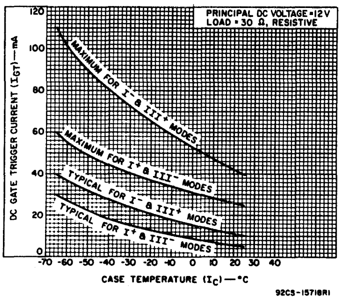


Fig. 10 — DC gate-trigger current vs. case temperature.

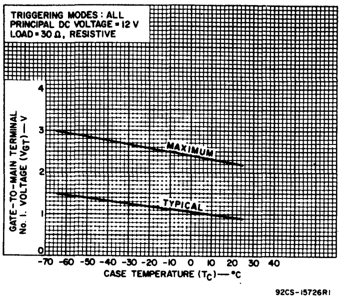


Fig. 11 — DC gate-trigger voltage vs. case temperature.

T2304, T2305 Series

400-Hz, 0.5-A Sensitive-Gate Silicon Triacs

For Control-Systems Application in Airborne and Ground-Support Type Equipment

RCA T2304- and T2305-series triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

These triacs are intended for operation up to 400 Hz with resistive or inductive loads and nominal line voltages of 115 and 208 V RMS sine wave and repetitive peak off-stage voltages of 200 V and 400 V.

The high gate sensitivity of these triacs permits the use of economical transistorized or integrated control circuits and enhances their use in low-power phase control and load-switching applications.

Features:

- **High gate sensitivity, I_{GT} = 10/40 mA max.**
- **di/dt capability = 100 A/μs**
- **Commutating dv/dt capability characterized at 400 Hz**
- **Shorted-Emitter Design**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

For Operation with Sinusoidal Supply Voltage at Frequencies up to 400 Hz and with Resistive or Inductive Load.

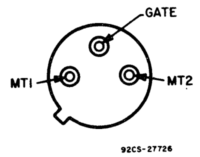
		T2304B T2305B	T2304D T2305D	
REPETITIVE PEAK OFF-STATE VOLTAGE:*				
Gate open, T_J = -50 to 100°C	V_{DROM}	200	400	V
RMS ON-STATE CURRENT (Conduction angle = 360°):	$I_{T(RMS)}$			
Case temperature (T_C) = 90°C		0.5		A
Ambient temperature (T_A) = 25°C, without heat sink		0.4		A
For other conditions		*See Figs. 2 & 3*		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}			
For one cycle of applied principal voltage, T_C = 90°C				
400 Hz (sinusoidal)		50		A
60 Hz (sinusoidal)		25		A
50 Hz (sinusoidal)		21		A
For more than one cycle of applied principal voltage		*See Fig. 4*		
RATE-OF-CHANGE OF ON-STATE CURRENT:	di/dt			
V_{DM} = V_{DROM}, I_{GT} = 60 mA, t_r = 0.1 μs		100		A/μs
FUSING CURRENT (for triac protection):				
T_J = -50 to 100°C, t = 1.25 to 10 ms	I^2t	2		A^2s
PEAK GATE-TRIGGER CURRENT:■	I_{GTM}			
For 1 μs (max.) *(See Fig. 10)*		1		A
GATE POWER DISSIPATION:				
PEAK (For 1 μs max., *(See Fig. 10)*	P_{GM}	10		W
AVERAGE (At T_C = 60°C)	$P_{G(AV)}$	0.15		W
(At T_A = 25°C, without heat sink)	$P_{G(AV)}$	0.05		W
TEMPERATURE RANGE:▲				
Storage	T_{stg}	-50 to 150		°C
Operating (Case)	T_C	-50 to 100		°C
LEAD TEMPERATURE (During soldering):				
At distances ≥ 1/16 in. (1.58 mm) from the case for 10 s max.	T_L	225		°C

* For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

▲ For temperature measurement reference point, see Dimensional Outline.

TERMINAL CONNECTIONS



Modified JEDEC TO-5

(See dimensional outline "F.")

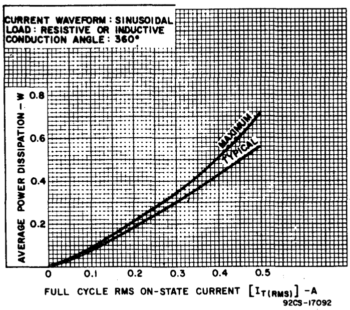


Fig. 1—Power dissipation vs. on-state current.

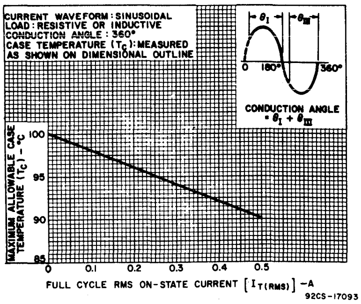


Fig. 2—Maximum allowable case temperature vs. on-state current.

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS						UNITS
		T2304 Series			T2305 Series			
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Off-State Current:♠ Gate open, T_J = 100°C, V_{DROM} = Max. rated value	I_{DROM}	-	0.2	0.75	-	0.2	0.75	mA
Maximum On-State Voltage:♠ For i_T = 10 A (peak), T_C = 25°C	V_{TM}	-	1.7	2.2	-	1.7	2.2	V
DC Holding Current:♠ Gate open, Initial principal current = 150 mA (DC), v_D = 12 V, T_C = 25°C	I_{HO}	-	7	15	-	15	30	mA
For other case temperatures		← See Figs. 8 & 9 →						
Critical Rate-of-Rise of Commutation Voltage:♠ For v_D = V_{DROM}, $I_{T(RMS)}$ = 0.5 A, commutating di/dt = 1.8 A/ms, gate unenergized, T_C = 90°C	dv/dt	1	4	-	1	4	-	V/μs
Critical Rate-of-Rise of Off-Stage Voltage:♠ For v_D = V_{DROM}, exponentail voltage rise, gate open, T_C = 100°C	dv/dt	10	100	-	10	100	-	V/μs
DC Gate-Trigger Current:♠ Mode | V_{MT2} | V_G	I_{GT}							mA
For v_D = 12 V (DC), R_L = 30 Ω, T_C = 25°C I$^+$ | positive | positive		-	3.5	10	-	5	25	
III$^-$ | negative | negative		-	3.5	10	-	5	25	
I$^-$ | positive | negative		-	7	10	-	10	40	
III$^+$ | negative | positive		-	7	10	-	10	40	
For other case temperatures		← See Figs. 11 & 12 →						
DC Gate-Trigger Voltage:♠† For v_D = 12 V (DC), R_L = 30Ω, T_C = 25°C	V_{GT}	-	1	2.2	-	1	2.2	V
For other case temperatures		← See Fig. 13 →						
For v_D = V_{DROM}, R_L = 125Ω, T_C = 100°C		0.15	-	-	0.15	-	-	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For v_D = V_{DROM}, I_{GT} = 60 mA, t_r = 0.1 μs, i_T = 10 A (peak), T_C = 25°C (See Fig. 16)	t_{gt}	-	1.8	-	2.5	1.8	2.5	μs
Thermal Resistance, Junction-to-Case:	$\theta_{J\text{-}C}$	-	-	8.5	-	-	8.5	°C/W

♠ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

† For either polarity of gate voltage (V_G) with reference to main terminal 1.

T2304, T2305 Series

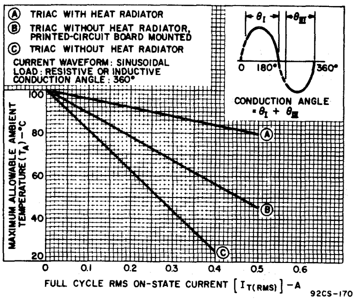


Fig. 3—Maximum allowable ambient temperature vs. on-state current for the package/mounting options of these triacs.

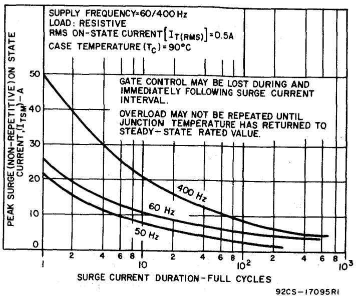


Fig. 4—Peak surge on-state current vs. surge-current duration.

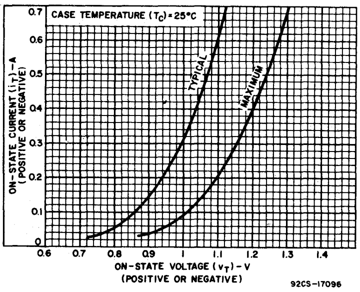


Fig. 5—On-state current vs. on-state voltage (steady-state condition).

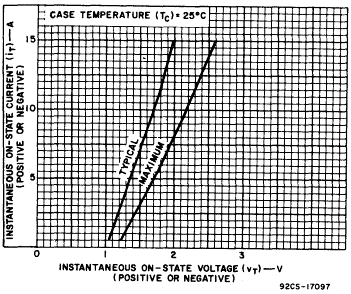


Fig. 6—On-state current vs. on-state voltage (surge condition).

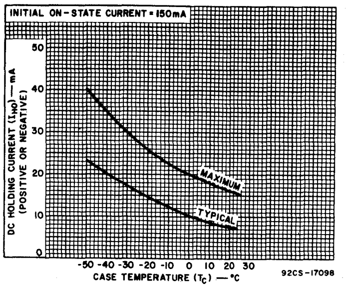


Fig. 7—DC holding current vs. case temperature for T2304 series.

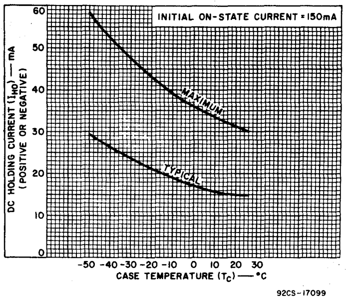


Fig. 8—DC holding current vs. case temperature for T2305 series.

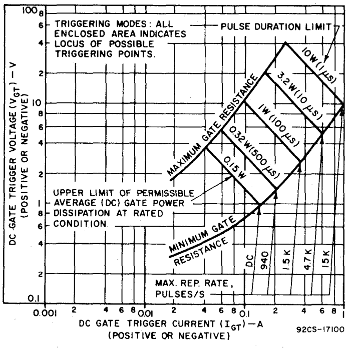


Fig. 9—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

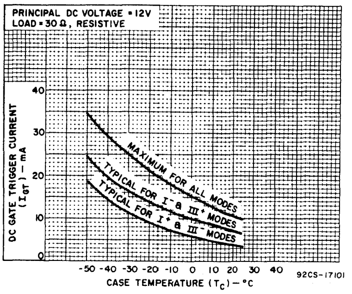


Fig. 10—DC gate-trigger current vs. case temperature for T2304 series.

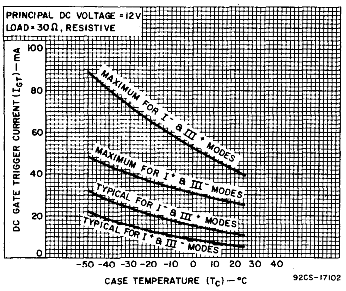


Fig. 11—DC gate-trigger current vs. case temperature for T2305 series.

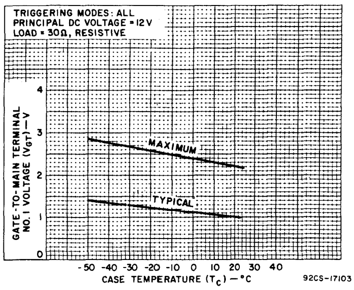


Fig. 12—DC gate-trigger voltage vs. case temperature.

T2320, T2322, T2323, T2327 Series

2.5-A Sensitive-Gate Silicon Triacs

For AC Power Switching

The RCA-T2320, T2322, T2323 and T2327, series triacs are gate- controlled full-wave silicon ac switches that are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

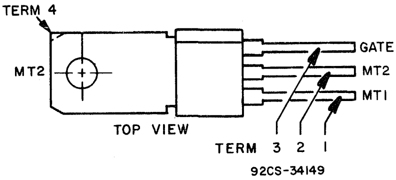
The gate sensitivity of these triacs permits the use of economical transistorized or integrated circuit control circuits and enhances their use in low-power phase-control and load-switching applications.

All types in each series utilize the JEDEC-TO-202AB (RCA VERSATAB) plastic package.

Features:

- **Very high gate sensitivity—3,5 and 10 mA**
- **di/dt capability—100 A/μs**
- **Shorted-emitter, center-gate design**
- **Low switching losses**
- **Low on-state voltage at high current levels**
- **Glass-passivated chip for stability**
- **Package and formed-lead options available**

TERMINAL CONNECTIONS



JEDEC TO-202AB
(Type 1 Package)
(See dimensional outline "P".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies Up to 50/60 Hz and with Resistive or Inductive Load

3 mA Gate	**T2320F**	**T2320A**	**T2320B**	**T2320C**	**T2320D**	**T2320E**	
10 mA Gate	**T2322F**	**T2322A**	**T2322B**	**T2322C**	**T2322D**	**T2322E**	
25 mA Gate	**T2323F**	**T2323A**	**T2323B**	**T2323C**	**T2323D**	**T2323E**	
5 mA Gate	**T2327F**	**T2327A**	**T2327B**	**T2327C**	**T2327D**	**T2327E**	
V_{DROM}▲							
Gate open, T_J=–40 to 100°C	50	100	200	300	400	500	V
$I_{T(RMS)}$ (θ= 360°):							
T_C = 70°C	2.5						A
T_A = 25°C	0.8						A
For other conditions	See Figs. 3 and 4						
I_{TSM}:							
For one full cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$:							
60 Hz (sinusoidal)	25						A
50 Hz (sinusoidal)	23.5						A
For more than one cycle of applied principal voltage	See Fig.5						
di/dt:							
$V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 μs (See Fig. 10)	100						A/μs
I^2t [At T_C shown for $I_{T(RMS)}$] (Half-sine wave):							
t = 20 ms	3.4						A^2s
= 2.5 ms	1.7						A^2s
0.5 ms	1						A^2s
For other time values	See Fig.6						
I_{GTM}●:							
For 1 μs max.	1						A
P_{GM}:							
Peak (For 1 μs max., $I_{GTM} \leqslant 1$ A(peak)	10						W
$P_{G(AV)}$:							
T_C = 60°C	0.1						W
T_A = 25°C	0.05						W
T_{stg}■	–40 to 150						°C
T_C■	–40 to 100						°C
T_T■:							
During soldering for 10 s maximum at distance $\geqslant$1/16 in. (1.58 mm) from seating plane	225						°C

▲ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
● For either polarity of gate voltage (V_G) with reference to main terminal 1.
■ For termperature measurement reference point, *see Dimensional Outlines.*

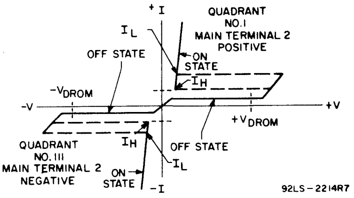


Fig. 1 — Principal voltage-current characteristic.

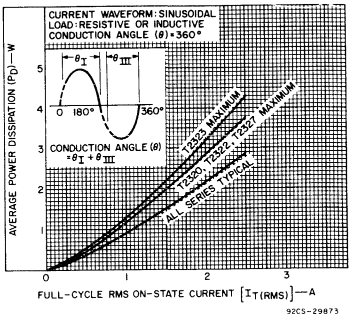


Fig. 2 — Power dissipation as a function of on-state current.

T2320, T2322, T2323, T2327 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified Min.	 Typ.	 Max.	UNITS
I_{DROM}▲: Gate open, T_J = 100°C, V_{DROM} = Max. rated value	–	0.2	0.75	mA
V_{TM}▲:				V
i_T = 10 A(peak), T_C = 25°C T2320, T2322, T2327 series	–	1.7	2.2	
i_T = 10 A(peak), T_C = 25°C T2323 series	–	1.7	2.6	
I_{HO}▲: Gate open, Initial principal current = 150 mA (dc), v_D = 12 V, T_C = 25°C	–	15	30	mA
dv/dt (Commutating)▲: v_D = V_{DROM}, $I_{T(RMS)}$ = 2.5 A, commutating di/dt = 1.33 A/ms, gate unenergized, T_C = 90°C	1	4	–	V/µs
dv/dt (Off-state)▲: v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C	10	100	–	
I_{GT}▲●: *(See Fig. 8)* v_D = 12 V dc, R_L = 30 Ω, T_C = 25°C				mA
Mode V_{MT2} V_G				
I^+ positive positive				
T2320 series	–	–	3	
T2322 series	–	–	10	
T2323 series	–	–	25	
T2327 series	–	–	5	
III^- negative negative				
T2320 series	–	–	3	
T2322 series	–	–	10	
T2323 series	–	–	25	
T2327 series	–	–	5	
I^- positive negative				
T2320 series	–	–	3	
T2322 series	–	–	10	
T2323 series	–	–	40	
T2327 series	–	–	5	
III^+ negative positive				
T2320 series	–	–	3	
T2322 series	–	–	10	
T2323 series	–	–	40	
T2327 series	–	–	5	
V_{GT}▲●: *(See Fig. 9)*				V
v_D = 12 V dc, R_L = 30 Ω, T_C = 25°C	–	1	2.2	
v_D = V_{DROM}, R_L = 125 Ω, T_C = 100°C	0.15	–	–	
t_{gt}: v_D = V_{DROM}, I_{GT} = 60 mA, t_r = 0.1 µs, i_T = 10 A(peak), T_C = 25°C	–	1.8	2.5	µs
$R_{\theta JC}$ (Package Types 1, 11, 12, 3, 32)	–	–	8	°C/W
$R_{\theta JA}$ (Package Types 1, 11, 12, 3, 32)	–	–	80	
$R_{\theta JL}$ (Package Types 2, 21)	–	–	50	
$R_{\theta JA}$ (Package Types 2, 21)	–	–	100	

▲ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

● For either polarity of gate voltage (V_G) with reference to main terminal 1.

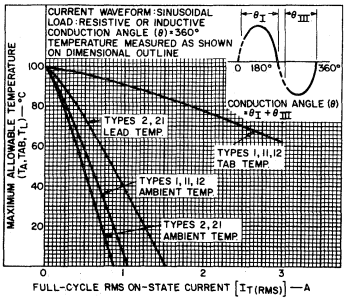


Fig. 3 — Maximum allowable temperature as a a function of on-state current for T2320, T2322, and T2327.

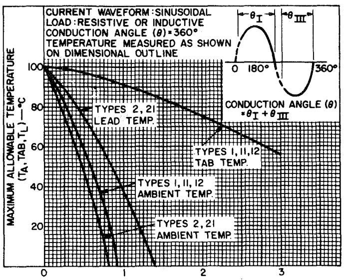


Fig. 4 — Maximum allowable temperature as a function of on-state current for T2323.

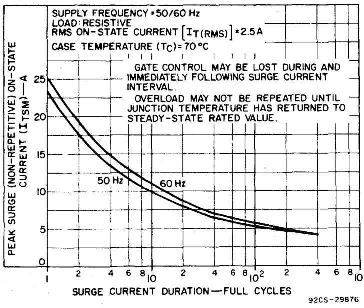


Fig. 5 — Peak surge on-state current as a function of surge-current duration.

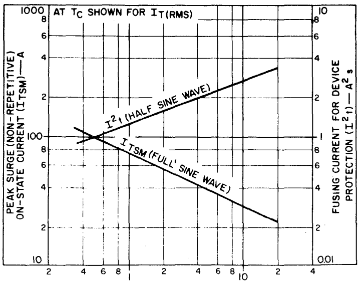


Fig. 6 — Peak surge on-state current and fusing current as a function of time.

T2320, T2322, T2323, T2327 Series

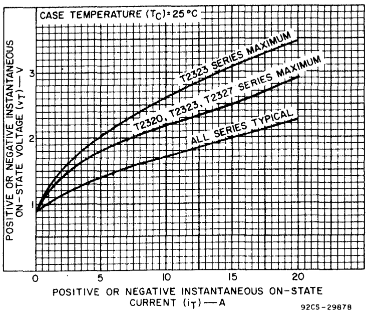


Fig. 7 – On-state current as a function of on-state voltage.

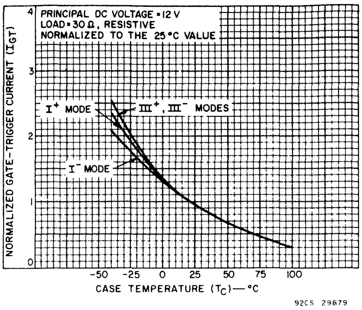


Fig. 8 – Gate-trigger current as a function of case temperature.

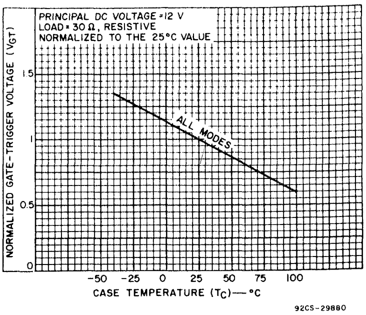


Fig. 9 – Gate trigger voltage as a function of case temperature.

T2500 Series

6-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

Types T2500B and T2500D* are gate-controlled full-wave silicon triacs utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, heating controls, relay replacement, solenoid drivers, static switching, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 6 amperes at a T_C of 80°C and repetitive off-state voltage ratings of 200 volts and 400 volts, respectively.

These triacs employ the plastic JEDEC TO-220-AB package.

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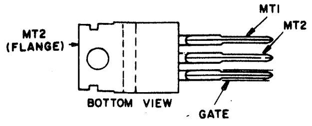
*Formerly RCA Dev. Nos. TA8504 and TA8505.

Features:

- 60-A Peak Surge Full-Cycle Current Ratings
- Shorted-Emitter, Center-Gate Design
- Package Design Facilitates Mounting on a Printed-Circuit Board
- Low Switching Losses
- Low Thermal Resistance

TERMINAL CONNECTIONS



BOTTOM VIEW
JEDEC TO-220AB
(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

		T2500B	T2500D	
REPETITIVE PEAK OFF-STATE VOLTAGE:●				
Gate open, T_J = −65 to 100°C	V_{DROM}	200	400	V
RMS ON-STATE CURRENT (Conduction angle = 360°):				
Case temperature	$I_{T(RMS)}$			
T_C = 80°C		6		A
For other conditions		See Fig. 2		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:				
For one cycle of applied principal voltage, T_C = 80°C	I_{TSM}			
60 Hz (sinusoidal)		60		A
50 Hz (sinusoidal)		50		A
For more than one cycle of applied principal voltage		See Fig. 3		
RATE OF CHANGE OF ON-STATE CURRENT:				
V_{DM} = V_{DROM}, I_{GT} = 200 mA, tr = 0.1 μs	di/dt	70		A/μs
FUSING CURRENT (for Triac Protection):				
T_C = −65 to 100°C, t = 1.25 to 10 ms	I^2t	18		A^2s
PEAK GATE-TRIGGER CURRENT:■				
For 10 μs max; see *Fig. 10*	I_{GTM}	4		A
GATE POWER DISSIPATION:				
Peak (For 1 μs max., $I_{GTM} \leq 4$ A; see *Fig. 6*)	P_{GM}	16		W
AVERAGE	$P_{G(AV)}$	0.2		W
TEMPERATURE RANGE:▲				
Storage	T_{stg}	−65 to 150		°C
Operating (Case)	T_C	−65 to 100		°C
TERMINAL TEMPERATURE (During soldering):				
For 10 s max. (terminals and case)	T_T	225		°C

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see *Dimensional Outline*.

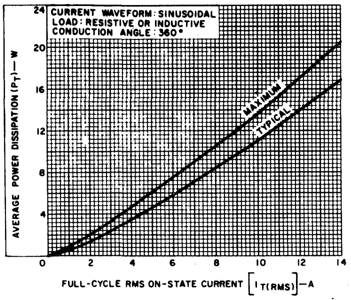


Fig. 1—Power dissipation vs. on-state current.

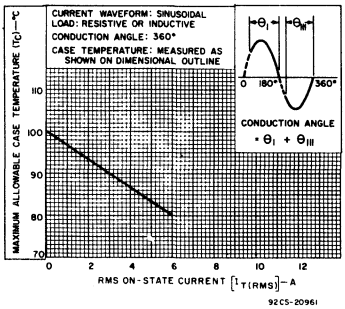


Fig. 2—Allowable case temperature vs. on-state current.

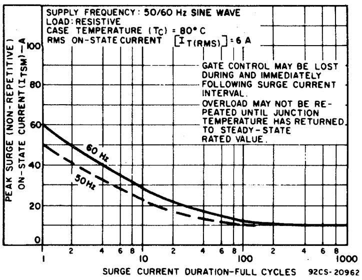


Fig. 3—Peak surge on-state current vs. surge-current duration.

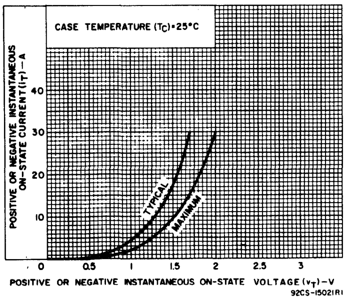


Fig. 4—On-state current vs. on-state voltage.

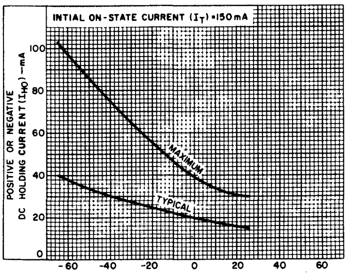


Fig. 5—DC holding current for either direction of on-state current vs. case temperature.

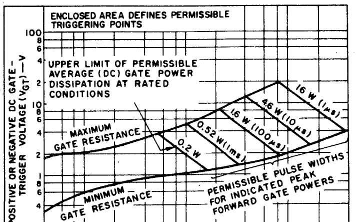


Fig. 6—Gate-pulse characteristics for all triggering modes.

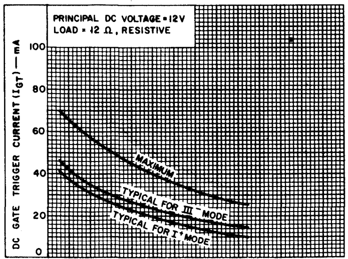


Fig. 7—DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

T2500 Series

ELECTRICAL CHARACTERISTICS at Maximum Ratings unless otherwise specified, and at indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS						UNITS
		T2500B			T2500D			
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Peak Off-State Current:* Gate Open, V_{DROM} = Max. rated value At T_J = 100°C	I_{DROM}	-	0.1	2	-	0.1	2	mA
Maximum On-State Voltage:* For i_T = 30 A (peak) and T_C = 25 °C	V_{TM}	-	1.7	2	-	1.7	2	V
DC Holding Current:* Gate Open Initial principal current = 150 mA (dc) At T_C = 25 °C	I_{HO}	-	15	30	-	15	30	mA
For other case temperatures		See Fig. 5.						
Critical Rate of Rise of Commutation Voltage:*♦ For v_D = V_{DROM}, $I_{T(RMS)}$ = 6 A, Commutating di/dt = 3.2 A/ms, and gate unenergized At T_C = 80°C	dv/dt	4	10	-	4	10	-	V/μs
Critical Rate of Rise of Off-State Voltage:* For v_D = V_{DROM}, exponential voltage rise, and gate open At T_C = 100°C	dv/dt	100	300	-	75	250	-	V/μs
For other case temperatures		See Fig.9						
DC Gate-Trigger Current:*† For v_D = 12 V (dc), R_L = 12 Ω T_C = 25 °C, and specified triggering mode:								
I^+ Mode (V_{MT2} positive, V_G positive)	I_{GT}	-	10	25	-	10	25	mA
III^- Mode (V_{MT2} negative, V_G negative)		-	15	25	-	15	25	
I^- Mode (V_{MT2} positive, V_G negative)		-	20	60	-	20	60	
III^+ Mode (V_{MT2} negative, V_G positive)		-	30	60	-	30	60	
For other case temperatures		See Figs. 7 and 8.						
DC Gate-Trigger Voltage:*† For v_D = 12 V (dc) and R_L = 12 Ω At T_C = 25 °C	V_{GT}	-	1.25	2.5	-	1.25	2.5	V
For other case temperatures		See Fig.9						
For v_D = V_{DROM} and R_L = 125 Ω At T_C = 100 °C		0.2	-	-	0.2	-	-	
Gate-Controlled Turn-On Time (Delay Time + Rise Time): For v_D = V_{DROM}, I_{GT} = 160 mA, rise time = 0.1 μs, and i_T = 10 A (peak) See *Fig. 11* At T_C = 25°C	t_{gt}	-	1.6	2.5	-	1.6	2.5	μs
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	-	-	2.7	-	-	2.7	°C/W
Junction-to-Ambient	$R_{\theta JA}$	-	-	60	-	-	60	°C/W

*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

†For either polarity of gate voltage (V_G) with reference to main terminal 1.

♦Variants of these devices having dv/dt characteristics selected specifically for inductive loads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.

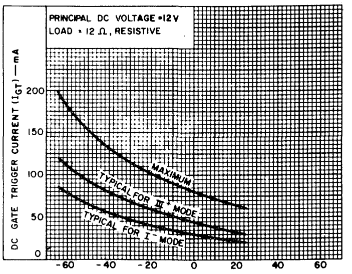


Fig. 8—DC gate-trigger current (for I^- and III^+ triggering modes) vs. temperature.

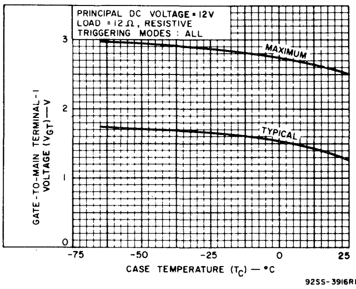


Fig. 9—DC gate-trigger voltage vs. case temperature.

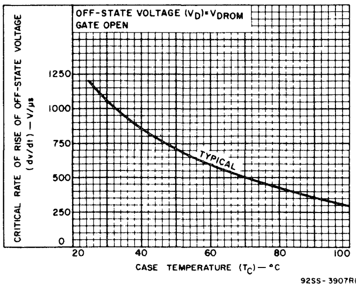


Fig. 10—Critical rate of rise of off-state voltage vs. case temperature.

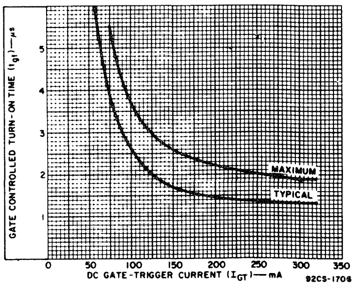


Fig. 11—Typical turn-on time vs. gate-trigger current.

T2700, T2710 Series

6-A Silicon Triacs

For Power-Control and Power-Switching Applications

RCA T2700- and T2710-series devices are gate-controlled full-wave silicon triacs. They are intended for the control of ac loads in applications such as heating controls, motor controls, light dimmers, and power switching systems.

These triacs are designed to switch from an off-state to an on-state condition for either polarity of applied voltage with positive or negative triggering voltages to the gate.

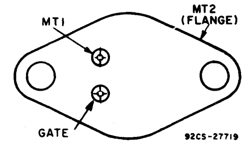
T2700B and T2700D are hermetically sealed types having an on-state current rating of 6 amperes at a case temperature of +75° C and repetitive off-state voltage ratings of 200 volts and 400 volts, respectively.

The T2700 series types employ the hermetic JEDEC TO-66 package. The T2710 series employ the hermetic TO-66 with a factory attached heat-radiator package.

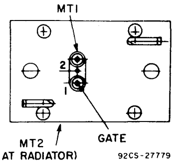
Features:

- **Shorted-emitter construction . . . contains an internally diffused resistor between gate and Main Terminal 1**
- **Center gate construction . . . provides rapid uniform gate-current spreading for faster turn-on with substantially reduced heating effects**

TERMINAL CONNECTIONS



JEDEC TO-66
(See dimensional outline "N".)



JEDEC TO-66 With Heat Radiator
(See dimensional outline "O".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies of 50/60 Hz, and with Resistive or Inductive Load

		T2700B T2710B	T2700D T2710D	
REPETITIVE PEAK OFF-STATE VOLTAGE• Gate Open, For T_J = -65 to 100°	V_{DROM}:	200	400	V
RMS ON-STATE CURRENT. For case temperature (TC) of +75° C and a conduction angle of 360°	$I_{t(rms)}$:	6	6	A
For ambient temperature (T_A) up to +100° C and a conduction angle of 360°			See Fig. 3.	
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT For one cycle of applied principal voltage, T_C = 75° C	I_{TSM}:			
60Hz (sinusoidal)		100	100	A
50HZ (sinusoidal)		85	85	A
For more than one full cycle of applied voltage			See Fig. 4.	
RATE OF CHANGE OF ON-STATE CURRENT: V_{DM} = V_{DROM} I_{GT} = 200mA, tr = 0.iµs di/dt			100	A/ s
FUSING CURRENT (for triac protection) T_J = -65 to 100° C, t = 1.25 to 10 ms	I^2t:	50	50	A^2s
PEAK GATE-TRIGGER CURRENT ■ For 1 µs max.	I_{GTM}:	4	4	A
GATE POWER DISSIPATION: ■ Peak For 1 µs max. and $I_{GTM} \leq 4$ A (peak)	P_{GM}	16	16	W
Average	$P_{G(AV)}$	.02	0.2	W
TEMPERATURE RANGE ⋆ Storage	T_J		-65 to +150	°C
Operating (case)	T_{stg}		-65 to +100	°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■For either polarity of gate Voltage (V_{GT}) with reference to main terminal 1.

⋆For information on the reference point of temperature measurement, see *Dimensional Outline.*

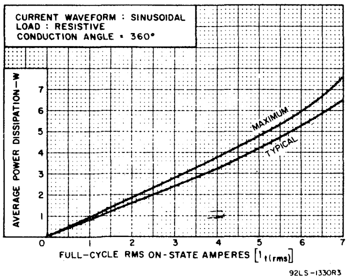


Fig. 1—Power dissipation vs. on-state current.

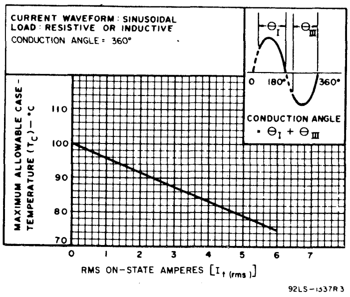


Fig. 2—Allowable case temperature vs. on-state current.

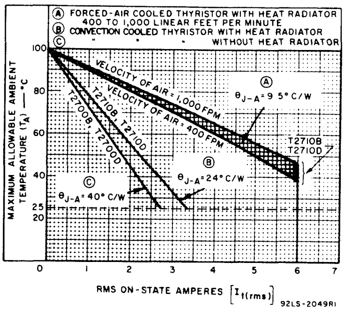


Fig. 3—Maximum allowable ambient temperature vs. on-state current.

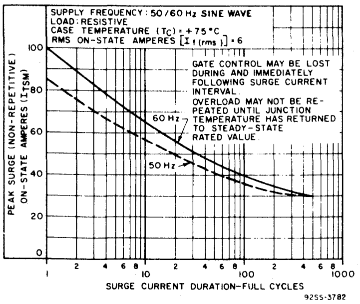


Fig. 4—Peak surge on-state current vs. surge-current duration.

T2700, T2710 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS												UNITS
		T2700B			T2710B			T2700D			T2710D			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Off-State Current:* Gate Open At T_J = + 100 °C and V_{DROM} = Max. rated value	I_{DROM}	-	0.1	4	-	0.1	1.2	-	0.2	4	-	0.2	1.2	mA
Maximum On-State Voltage:* For i_T = 30A (peak) and T_C = +25 °C	V_{TM}	-	1.8	2.25	-	1.8	2.25	-	1.8	2.25	-	1.8	2.25	V
DC Holding Current:* Gate Open Initial principal current = 150 mA (DC) At T_C = +25 °C	I_{HO}	-	15	30	-	15	30	-	15	30	-	15	30	mA
For other case temperatures		See Fig. 6.												
Critical Rate of Rise of Commutation Voltage:*♦ For V_D = V_{DROM}, $I_{t(rms)}$ = 6 A, commutating di/dt = 3.2 A/ms, and gate unenergized At T_C = +75 °C	dv/dt	3	10	-	-	-	-	3	10	-	-	-	-	V/µs
$I_{t(rms)}$ and T_A specified by curve A of Fig. 3		-	-	-	3	10	-	-	-	-	3	10	-	
$I_{t(rms)}$ and T_A specified by curve B of Fig. 3		-	-	-	4	12	-	-	-	-	4	12	-	
Critical Rate of Rise of Off-State Voltage:* For V_D = V_{DROM}, exponential voltage rise, and gate open At T_C = + 100 °C	dv/dt	30	150	-	30	150	-	20	100	-	20	100	-	V/µs
DC Gate-Trigger Current:*† For V_D = 12 volts (DC), R_L = 12 Ω T_C = +25 °C, and specified triggering mode: I+ Mode: positive V_{MT2}, positive V_{GT}	I_{GT}	-	15	25	-	15	25	-	15	25	-	15	25	mA
III- Mode: negative V_{MT2}, negative V_{GT}		-	15	25	-	15	25	-	15	25	-	15	25	
I- Mode: positive V_{MT2}, negative V_{GT}		-	25	40	-	25	40	-	25	40	-	25	40	
III+ Mode: negative V_{MT2}, positive V_{GT}		-	25	40	-	25	40	-	25	40	-	25	40	
For other case temperatures		See Fig. 8 & 9.												
DC Gate-Trigger Voltage:*† For V_D = 12 volts (DC) and R_L = 12 Ω At T_C = +25 °C	V_{GT}	-	1	2.2	-	1	2.2	-	1	2.2	-	1	2.2	V
For other case temperatures		See Fig. 10.												
For V_D = V_{DROM} and R_L = 125 Ω At T_C = + 100 °C		0.2	-	-	0.2	-	-	0.2	-	-	0.2	-	-	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For V_D = V_{DROM} and I_{GT} = 80 mA, 0.1 µs rise time, and i_T = 10 A (peak) At T_C = +25 °C	t_{gt}	-	2.2	-	-	2.2	-	-	2.2	-	-	2.2	-	µs
Thermal Resistance: Junction-to-Case (Steady-State)	$\theta_{J\text{-}C}$	-	-	4	-	-	-	-	-	4	-	-	-	°C/W
Junction-to-Case (Transient)		See Fig. 11.												
Junction-to-Ambient	$\theta_{J\text{-}A}$	-	-	-	See Fig. 3.			-	-	-	See Fig. 3.			

*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

†For either polarity of gate voltage (V_{GT}) with reference to main terminal 1.

♦Variants of these devices having dv/dt characteristics selected specifically for inductive loads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.

T2700, T2710 Series

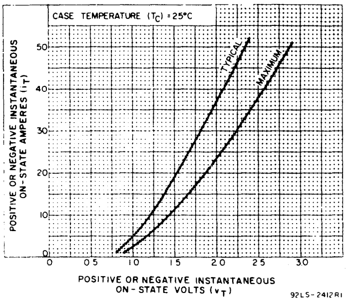


Fig. 5—On-state current vs. on-state voltage.

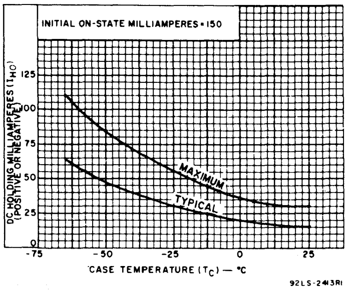


Fig. 6—DC holding current for either direction of on-state current vs. case temperature.

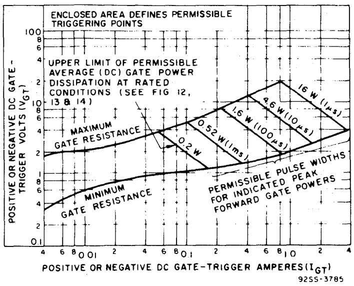


Fig. 7—Gate-pulse characteristics for all triggering modes.

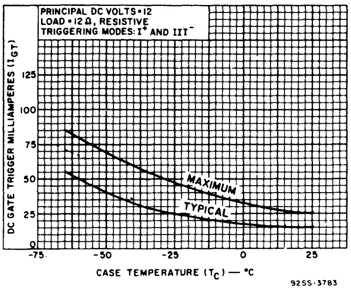


Fig. 8—DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

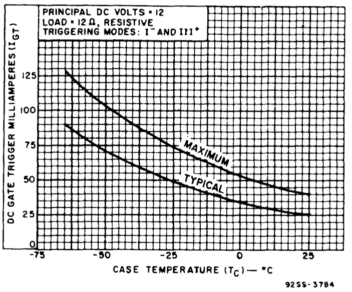


Fig. 9—DC gate-trigger current (for I^- and III^+ triggering modes) vs. case temperature.

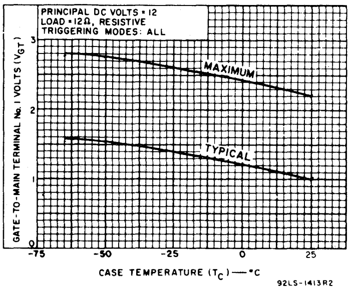


Fig. 10—DC gate-trigger voltage vs. case temperature.

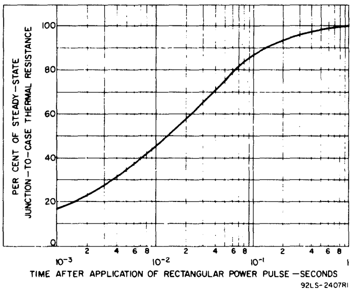


Fig. 11—Transient thermal resistance (junction-to-case vs. time).

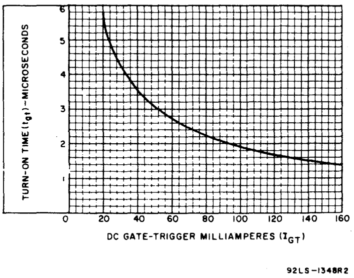
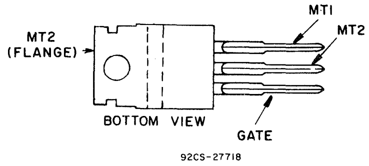


Fig. 12—Typical turn-on time vs. gate-trigger current.

T2800, T2801, T2802 Series

6-A and 8-A Silicon Triacs

Three-Lead Plastic Types for
Power-Control and Power-Switching Applications



BOTTOM VIEW

JEDEC TO-220AB

(See dimensional outline "S".)

Features:

- *100-A peak surge full-cycle current ratings*
- *Shorted-emitter center-gate design*
- *Low switching losses*
- *Low thermal resistance*
- *Package design facilitates mounting on a printed-circuit board*

These RCA triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

The T2801 and T2802 series triacs are characterized for I^+, III^- gate triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

All series employ the plastic JEDEC TO-220AB package. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal-Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

	T2800F	**T2800A**	**T2800B**	**T2800C**	**T2800D**	**T2800E**	**T2800M**	**—**	
	T2801F	**T2801A**	**T2801B**	**T2801C**	**T2801D**	**T2801E**	**T2801M**	**—**	
	T2802F	**T2802A**	**T2802B**	**T2802C**	**T2802D**	**T2802E**	**T2802M**	**T2802S**	
V_{DROM}*									
Gate Open, $T_J = -65$ to 100° C	50	100	200	300	400	500	600	700	V
$I_{T(RMS)}$									
(Conduction angle = 360°):									
T_C = 80° C (T2800, T2802 series)		8							A
= 80° C (T2801 series only)		6							A
For other conditions		See Fig. 4							
I_{TSM}									
For one cycle of applied principal voltage									
60 Hz (sinusoidal), T_C = 80° C (T2800, T2802 series)		100							A
50 Hz (sinusoidal), T_C = 80° C (T2800, T2802 series)		85							A
60 Hz (sinusoidal), T_C = 80° C (T2801 series only)		80							A
50 Hz (sinusoidal), T_C = 80° C (T2801 series only)		65							A
For more than one cycle of applied principal voltage		See Figs. 5,6							
di/dt									
$V_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs		70							A/μs
I^2t									
At T_C shown for $I_{T(RMS)}$									
t = 20 ms									
T2800, T2802		55							A^2s
T2801		35							A^2s
= 2.5 ms									
T2800, T2802		28							A^2s
T2801		18							A^2s
= 0.5 ms									
T2800, T2802		16							A^2s
T2801		10							A^2s
I_{GTM}†									
For 1 μs max. See Fig. 11		4							A
P_{GM}									
Peak (for 1 μs max., $I_{GTM} \leq 4$ A, See Fig. 11		16							W
$P_{G(AV)}$		0.35							W
T_{stg}‡		−65 to 150							°C
T_C‡		−65 to 100							°C
T_T (During soldering):									
For 10 s max. (terminals and case)		225							°C

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*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

†For either polarity of gate voltage (V_G) with reference to main terminal 1.

‡For temperature measurement reference point, see Dimensional Outline.

T2800, T2801, T2802 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTICS	Symbol	Limits For All Types Except as Specified			Units
		Min.	Typ.	Max.	
Peak Off-State Current:*					
Gate open, T_J = 100° C, V_{DROM} = Max. rated value	I_{DROM}	—	0.1	2	mA
Maximum On-State Voltage:* (See Figs. 9,10)					
For i_T = 30 A (peak), T_C = 25° C (T2800, T2802 series)	v_{TM}	—	1.7	2	V
(T2801 series)		—	2	3	
DC Holding Current:*					
Gate open, Initial principal current = 150 mA (dc)					
v_D = 12 V, T_C = 25° C, T2800 series		—	15	30	
T2801 series	I_{HO}	—	100	—	mA
T2802 series		—	20	60	
For other case temperatures		See Figs. 7, 8			
Critical Rate-of-Rise of Commutation Voltage*†					
For V_D = V_{DROM}, $I_{T(RMS)}$ = 8 A, commutating di/dt = 4.3 A/ms, gate unenergized, T_C = 80° C (T2800, T2802 series)	dv/dt	4	10	—	V/μs
For v_D = V_{DROM}, $I_{T(RMS)}$ = 6 A, commutating di/dt = 3.2 A/ms, gate unenergized, T_C = 80° C (T2801 series)		2	10	—	
Critical Rate-of-Rise of Off-State Voltage:*					
For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100° C					
T2800B, T2802B		100	300	—	
T2800C, T2802C	dv/dt	85	275	—	V/μs
T2800D, T2802D		75	250	—	
T2800E, T2802E		65	225	—	
T2800M, T2802M		60	200	—	
T2801B		50	300		
T2801C	dv/dt	40	275		V/μs
T2801D		30	250	—	
T2801E		20	225	—	
DC Gate-Trigger Current:*‡					
For v_D = 12 V (dc), R_L = 12 Ω, T_C = 25° C					
Mode V_{MT2} V_G					
I^+ positive positive T2800 series		—	10	25	
T2801 series		—	25	80	
T2802 series	I_{GT}	—	25	50	mA
III^- negative negative T2800 series		—	15	25	
T2801 series		—	25	80	
T2802 series		—	25	50	
I^- positive negative T2800 series only		—	20	60	
III^+ negative positive T2800 series only		—	30	60	
For other case temperatures		See Figs. 11, 12, 13			
DC Gate-Trigger Voltage:*‡					
For v_D = 12 V (dc), R_L = 12Ω, T_C = 25° C					
T2800, T2802 series	V_{GT}	—	1.25	2.5	V
T2801 series		—	1.5	4	
For other case temperatures		See Figs. 14, 15, 16			
For v_D = V_{DROM}, R_L = 125Ω, T_C = 100° C		0.2	—	—	
Gate-Controlled Turn-On Time:					
For v_D = V_{DROM}, I_{GT} = 80 mA, t_r = 0.1 μs					
i_T = 10 A (peak), T_C = 25° C (T2800, T2802 series)	t_{gt}	—	1.6	2.5	μs
(T2801 series)		—	2.2	—	
Thermal Resistance:					
Junction-to-Case	$R_{\theta JC}$	—	—	2.2	°C/W
Junction-to-Ambient	$R_{\theta JA}$	—	—	60	

*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

‡For either polarity of gate voltage (V_G) with refrence to main terminal 1.

†Variants of these devices having dv/dt characteristics selected specifically for inductive leads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.

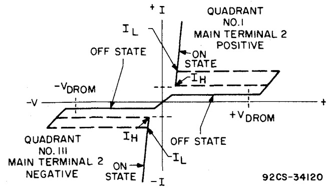


Fig. 1 - Principal voltage-current characteristics.

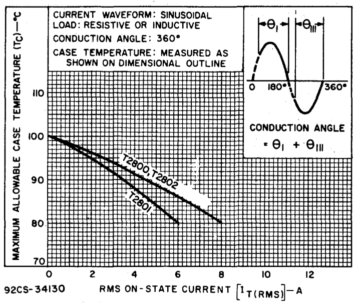


Fig. 2 - Maximum allowable case temperature vs. on-state current.

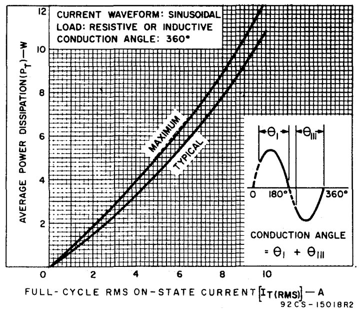


Fig. 3 - Power dissipation vs. on-state current for T2800, T2802 series.

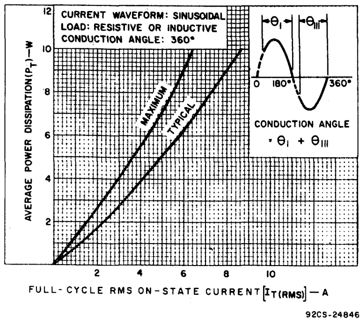


Fig. 4 - Power dissipation vs. on-state current for T2801 series.

T2800, T2801, T2802 Series

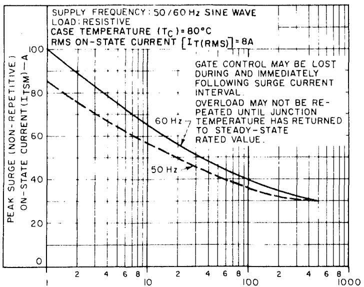


Fig. 5 - Peak surge on-state current vs. surge current duration for T2800, T2802 series.

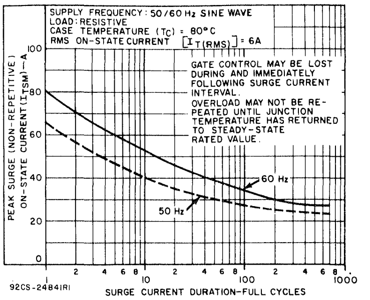


Fig. 6 - Peak surge on-state current vs. surge current duration for T2801 series.

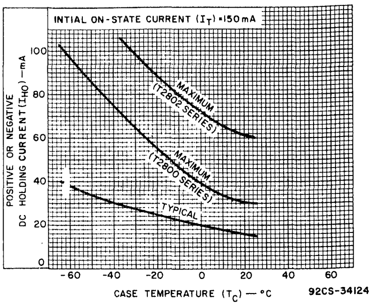


Fig. 7 - DC holding current vs. case temperature for T2800, T2802.

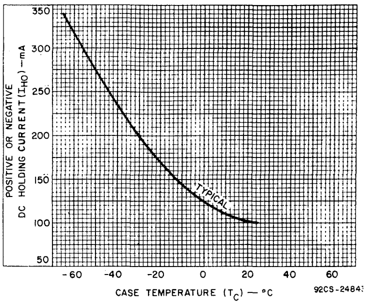


Fig. 8 - DC holding current vs. case temperature for T2801 series.

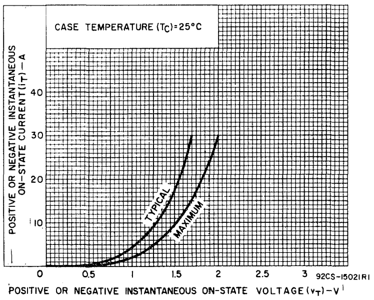


Fig. 9 - On-state current vs. on-state voltage for T2800, T2802 series.

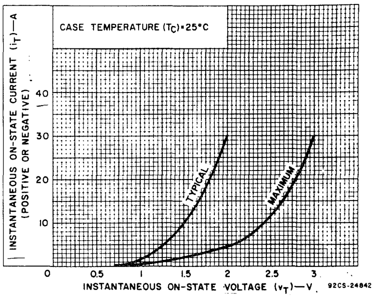


Fig. 10 - On-state current vs. on-state voltage for T2801 series.

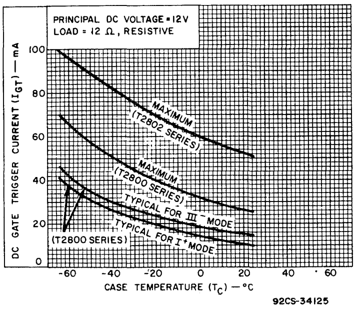


Fig. 11 - DC gate-trigger current (for 1^+ and III^- triggering modes) vs. case temperature for T2800, T2802 series.

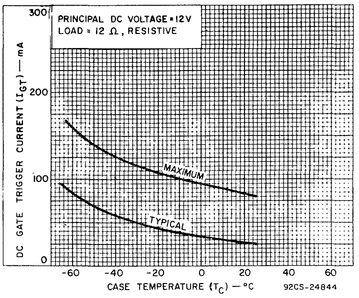


Fig. 12 - DC gate-trigger current (for 1^+ and III^- triggering modes) vs. case temperature for T2801 series.

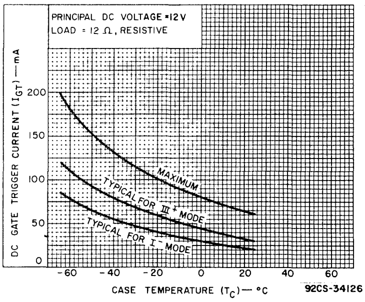


Fig. 13 - DC gate-trigger current (for 1^- and III^+ triggering modes) vs. case temperature for T2800, T2802 series.

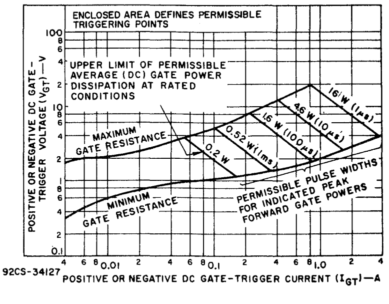


Fig. 14 - Gate pulse characteristics for all triggering modes for all series.

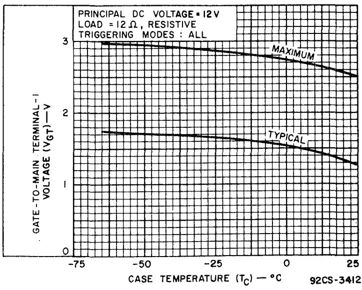


Fig. 15 - DC gate-trigger voltage vs. case temperature for T2800, T2802 series.

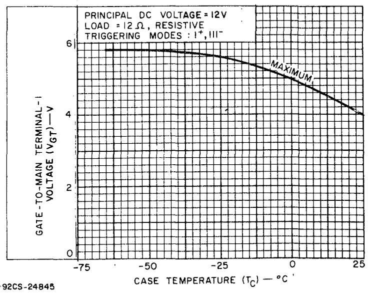


Fig. 16 - DC gate-trigger voltage vs. case temperature for T2801 series.

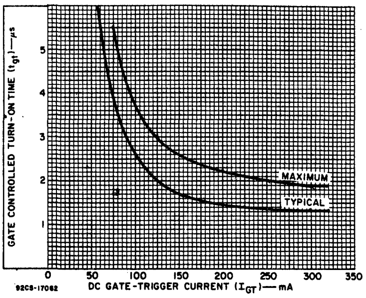


Fig. 17 - Turn-on time vs. gate-trigger current for T2800, T2802 series.

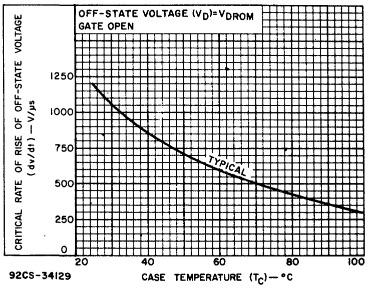
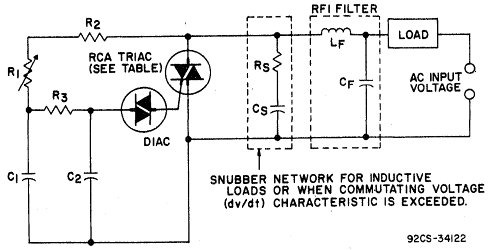


Fig. 18 - Typical critical rate-of-rise of off-state voltage vs. case temperature for all series.



AC Input Voltage		**120 V 60 Hz**	**240 V 60 Hz**	**240 V 50 Hz**
C_1		0.1 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
C_2		0.1 µF 100 V	0.1 µF 100 V	0.1 µF 100 V
R_1		100 kΩ 1/2 W 1/2 W	200 kΩ 1/2 W 1 W	250 kΩ 1/2 W 1 W
R_2		2.2 kΩ 1/2 W	3.3 kΩ 1/2 W	3.3 kΩ 1/2 W
R_3		15 kΩ 1/2 W	15 kΩ 1/2 W	15 kΩ 1/2 W
SNUBBER NETWORK For 6 A and 8 A (RMS) INDUCTIVE LOAD	C_S	0.068 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
	R_S	1.2 kΩ 1/2 W	1 kΩ 1/2 W	1 kΩ 1/2 W
RFI FILTER	C_F*	0.1 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
	L_F*	100 µH	200 µH	200 µH
RCA TRIAC		T2800B T2800C T2801B T2801C T2802B T2802C	T2800D T2801D T2801E T2802D	T2800D T2801D T2801E T2802D

*Typical values for Lamp dimming circuits.

Fig. 19 - Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

BTA20 (T2800) Series

6-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

Features
- *80-A peak surge full-cycle current ratings*
- *Shorted-emitter center-gate design*
- *Low switching losses*
- *Low thermal resistance*
- *Package design facilitates mounting on a printed-circuit board*

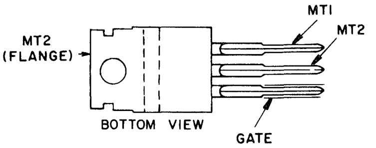
The RCA BTA20-series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 6 amperes at a T_C of 80° C and repetitive off-state voltage ratings of 300, 400, and 500 volts.

These devices are characterized for I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

All these types are supplied in the JEDEC TO-220AB VERSAWATT plastic package. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

TERMINAL DESIGNATIONS



92CS-27718

JEDEC TO-220AB

(See dimensional outline "S".)

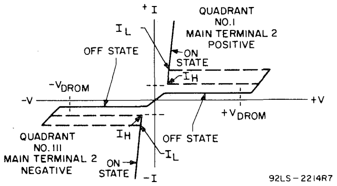


Fig. 1 - Principal voltage-current characteristic.

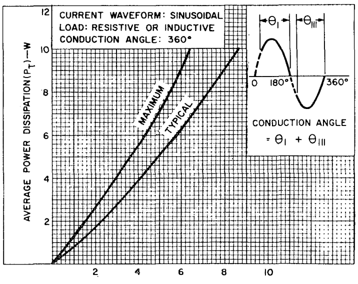
MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

	BTA20C	BTA20D	BTA20E	
V_{DROM}•, Gate open, T_J=−65 to 100°C	300	400	500	V
$I_{T(RMS)}$, T_C=80° C, θ=360°		6		A
For other conditions		See Fig. 3		
I_{TSM}				
For one cycle of applied principal voltage				
60 Hz (sinusoidal), T_C=80° C		80		A
50 Hz (sinusoidal), T_C=80° C		75		A
For more than one cycle of applied principal voltage		See Fig. 4		
di/dt				
V_D=V_{DROM}, I_{GT}=200 mA, t_r=0.1 μs		70		A/μs
I^2t (See Fig. 10)				
t=20 ms		40		A^2s
t=16.67 ms		38		A^2s
t=2.5 ms		20		A^2s
t=0.5 ms		11		A^2s
I_{GTM}■				
For 1 μs max., See Fig. 5		4		A
P_{GM} (For 1 μs max., I_{GTM} ≤ 4 A, See Fig. 5		16		W
$P_{G(AV)}$		0.35		W
T_{stg}‡		−65 to 150		°C
T_C‡		−65 to 100		°C
T_T (During Soldering):				
For 10 s max. (terminals and case)		225		°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

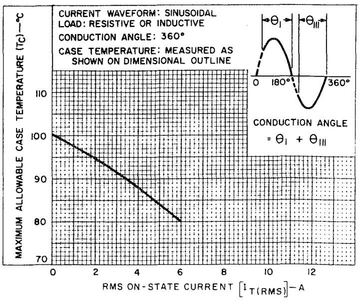
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

‡For temperature measurement reference point, see Dimensional Outline.



92CS-24846

Fig. 2 - Power dissipation vs. on-state current.



92CS-24840

Fig. 3 - Allowable case temperature vs. on-state current.

BTA20 (T2800) Series

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	MIN.	TYP.	MAX.	
I_{DROM}•				
Gate open, T_J=100°C, V_{DROM}=Max. rated value..	—	0.1	2	mA
V_{TM}•				
i_T=30 A (peak), T_C=25°C (See Fig. 6)	—	2	3	V
I_{HO}•				
Gate open, Initial principal current=150 mA (dc) v_D=12 V, T_C=25°C	—	100	—	mA
For other case temperatures		See Fig. 7		
dv/dt (Commutating)•				
v_D=V_{DROM}, $I_{T(RMS)}$=6 A, commutating di/dt=3.2 A/ms, gate unenergized, T_C=80°C	2	10	—	V/μs
dv/dt•				
v_D=V_{DROM}, exponential voltage rise, gate open, T_C=100°C:				
BTA20C	40	275	—	
BTA20D	30	250	—	V/μs
BTA20E	20	225	—	
I_{GT}•■ Mode V_{MT2} V_G				
v_D=12 V (dc) I+ positive positive...	—	25	80	
R_L=12 Ω				mA
T_C=25°C III− negative negative...	—	25	80	
For other case temperatures		See Fig. 9		
V_{GT}•■				
v_D=12 V (dc), R_L=12 Ω, T_C=25°C	—	1.5	4	
For other case temperatures		See Fig. 11		V
v_D=V_{DROM}, R_L=125 Ω, T_C=100°C..............	0.2	—	—	
t_{gt}				
For v_D=V_{DROM}, I_{GT}=80 mA, t_r=0.1 μs, i_T=10 A (peak), T_C=25°C	—	2.2	—	μs
$R_{\theta JC}$	—	—	2.2	°C/W
$R_{\theta JA}$	—	—	60	

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

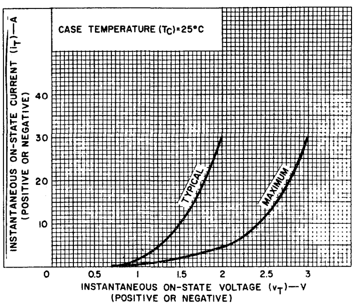


Fig. 6 - On-state current vs. on-state voltage.

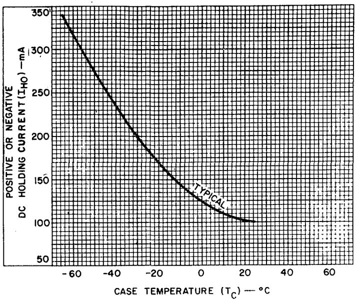


Fig. 7 - DC holding current vs. case temperature.

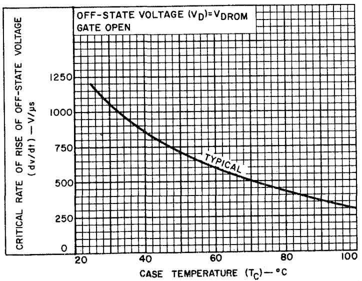


Fig. 8 - Critical rate-of-rise of off-state voltage vs. case temperature.

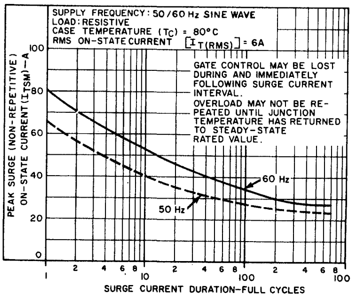


Fig. 4 - Peak surge on-state current vs. surge current duration.

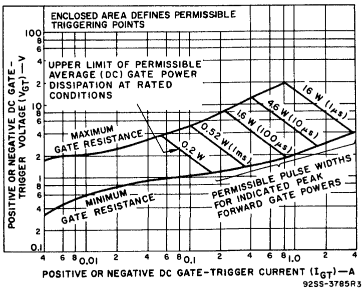


Fig. 5 - Gate pulse characteristics for all triggering modes.

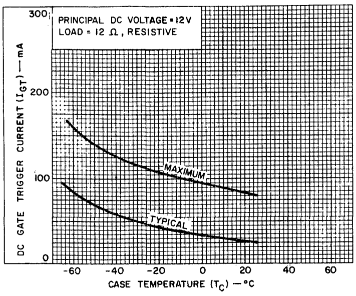


Fig. 9 - DC gate-trigger current (for I+ and III− triggering modes) vs. case temperature.

BTA20 (T2800) Series

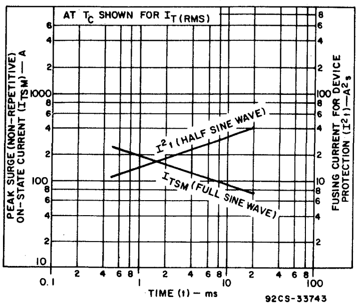


Fig. 10 - Peak surge on-state current and fusing current vs. time.

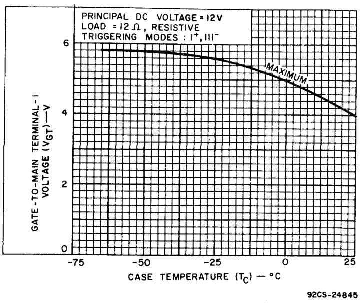
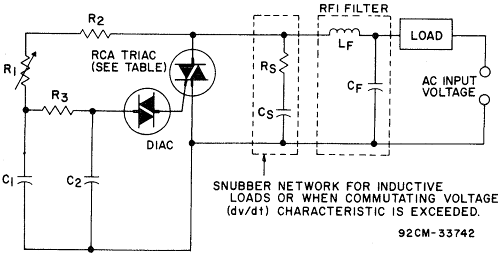


Fig. 11 - DC gate-trigger voltage vs. case temperature.



SNUBBER NETWORK FOR INDUCTIVE LOADS OR WHEN COMMUTATING VOLTAGE (dv/dt) CHARACTERISTIC IS EXCEEDED.

92CM-33742

AC INPUT VOLTAGE		120 V 60 Hz	240 V 60 Hz	240 V 50 Hz
C_1		0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
C_2		0.1 μF 100 V	0.1 μF 100 V	0.1 μF 100 V
R_1		100 kΩ ½ W	200 kΩ ½ W	250 kΩ ½ W
R_2		2.2 kΩ ½ W	3.3 kΩ ½ W	3.3 kΩ ½ W
R_3		15 kΩ ½ W	15 kΩ ½ W	15 kΩ ½ W
SNUBBER NETWORK FOR 6 A (RMS)* INDUCTIVE LOAD	C_S	0.068 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	R_S	1.2 kΩ ½ W	1 kΩ ½ W	1 kΩ ½ W
RFI FILTER	C_F*	0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	L_F*	100 μH	200 μH	200 μH
RCA TRIACS		BTA20C	BTA20D BTA20E	BTA20D BTA20E

*For other RMS current values refer to RCA Application Note AN-4745.

*Typical values for lamp dimming circuits.

Fig. 12 - Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

8-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

The RCA BTA21-series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 8 amperes at a T_C of 80° C and repetitive off-state voltage ratings of 300, 400, and 500 volts.

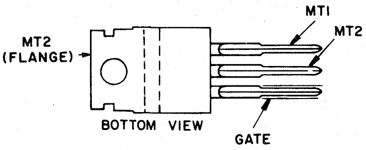
The BTA21-series triacs are characterized for I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

All these types are supplied in the JEDEC TO-220AB VERSAWATT plastic package. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

Features

- *100-A peak surge full-cycle current ratings*
- *Shorted-emitter center-gate design*
- *Low switching losses*
- *Low thermal resistance*
- *Package design facilitates mounting on a printed-circuit board*

TERMINAL DESIGNATIONS



92CS-27718

JEDEC TO-220AB
(See dimensional outline "S".)

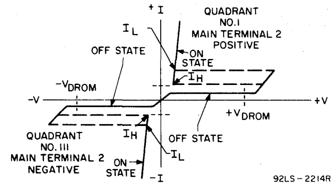


Fig. 1 - Principal voltage-current characteristic.

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

	BTA21C	BTA21D	BTA21E	
V_{DROM}•, Gate open, T_J=−65 to 100°C	300	400	500	V
$I_{T(RMS)}$, T_C=80° C, θ=360°	8			A
For other conditions	See Fig. 3			
I_{TSM}				
For one cycle of applied principal voltage				
60 Hz (sinusoidal), T_C=80° C	100			A
50 Hz (sinusoidal), T_C=80° C	94			A
For more than one cycle of applied principal voltage	See Fig. 4			
di/dt				
V_D=V_{DROM}, I_{GT}=200 mA, t_r=0.1 μs	70			A/μs
I^2t (See Fig. 9)				
t=20 ms	55			A^2S
t=2.5 ms	27			A^2S
t=0.5 ms	16			A^2S
I_{GTM}■				
For 1 μs max., See Fig. 5	4			A
P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A, See Fig. 5	16			W
$P_{G(AV)}$	0.35			W
T_{stg}‡	−65 to 150			°C
T_C‡	−65 to 100			°C
T_T (During Soldering):				
For 10 s max. (terminals and case)	225			°C

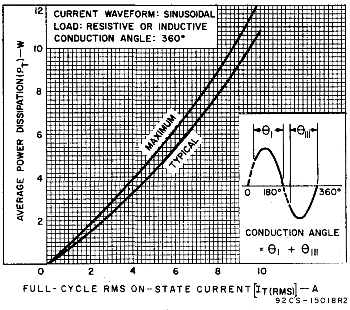


Fig. 2 - Power dissipation vs. on-state current.

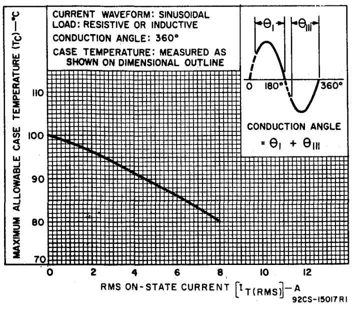


Fig. 3 - Maximum allowable case temperature vs. on-state current.

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■For either polarity of gate voltage (V_G) with reference to main terminal 1.

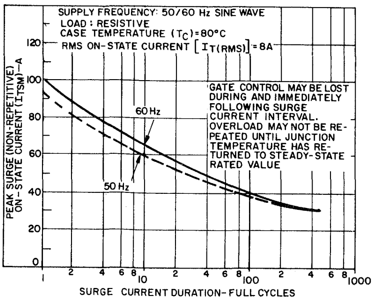
‡For temperature measurement reference point, see Dimensional Outline.

BTA21 (T2800) Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

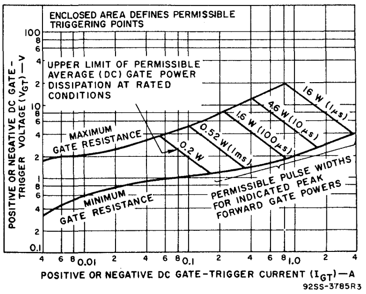
CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	MIN.	TYP.	MAX.	
I_{DROM}• Gate open, T_J=100°C, V_{DROM}=Max. rated value..	—	0.1	2	mA
V_{TM}• i_T=30 A (peak), T_C=25°C	—	1.7	2	V
I_{HO}• Gate open, Initial principal current=150 mA (dc) v_D=12 V, T_C=25°C	—	100	—	mA
For other case temperatures		See Fig. 6		
dv/dt (Commutating)• v_D=V_{DROM}, $I_{T(RMS)}$=8 A, commutating di/dt=4.3 A/ms, gate unenergized, T_C=80°C	2	10	—	V/µs
dv/dt• v_D=V_{DROM}, exponential voltage rise, gate open, T_C=100°C:				V/µs
BTA21C	40	275	—	
BTA21D	30	250	—	
BTA21E	20	225	—	
I_{GT}•■ Mode V_{MT2} V_G v_D=12 V (dc) I^+ positive positive...	—	—	35	mA
R_L=12 Ω T_C=25°C III^- negative negative...	—	—	35	
For other case temperatures		See Fig. 8		
V_{GT}•■ v_D=12 V (dc), R_L=12 Ω, Modes I^+, III^- T_C=25°C	—	1.25	2.5	V
For other case temperatures		See Fig. 10		
v_D=V_{DROM}, R_L=125 Ω, T_C=100°C	0.2	—	—	
t_{gt} For v_D=V_{DROM}, I_{GT}=80 mA, t_r=0.1 µs, i_T=10 A (peak), T_C=25°C	—	2.2	—	µs
$R_{\theta JC}$	—	—	2.2	°C/W
$R_{\theta JA}$	—	—	60	

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.



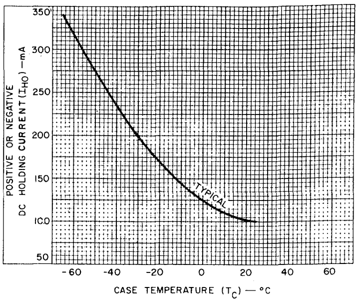
92CS-33756

Fig. 4 - Peak surge on-state current vs. surge current duration.



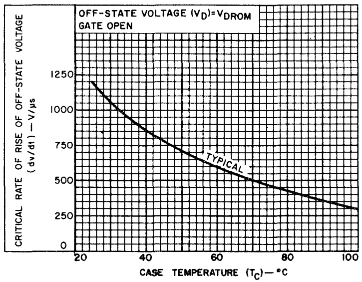
92SS-3785R3

Fig. 5 - Gate pulse characteristics for all triggering modes.



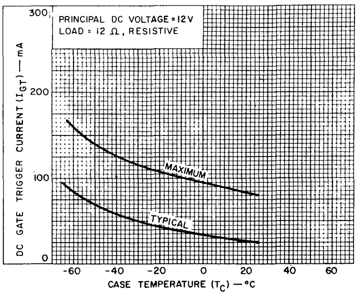
92CS-24843RI

Fig. 6 - DC holding current vs. case temperature.



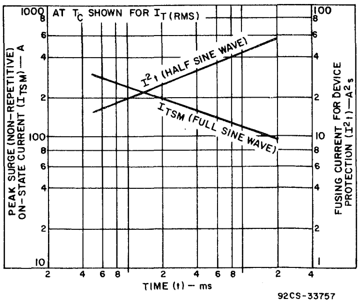
92SS-3907RI

Fig. 7 - Critical rate-of-rise of off-state voltage vs. case temperature.



92CS-24844

Fig. 8 - DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.



92CS-33757

Fig. 9 - Peak surge on-state current and fusing current as a function of time.

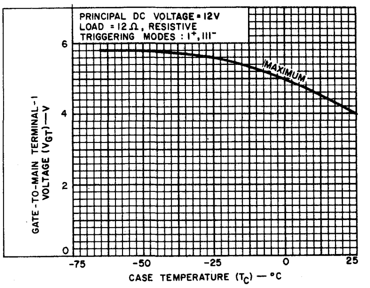
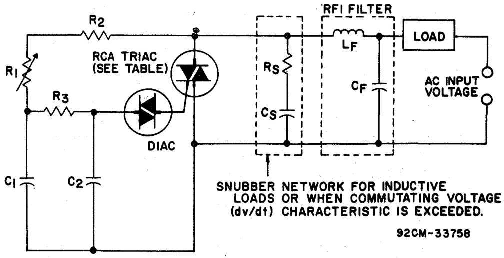


Fig. 10 - DC gate-trigger voltage vs. case temperature.



AC INPUT VOLTAGE		120 V 60 Hz	240 V 60 Hz	240 V 50 Hz
C1		0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
C2		0.1 μF 100 V	0.1 μF 100 V	0.1 μF 100 V
R1		100 kΩ ½ W	200 kΩ ½ W	250 kΩ ½ W
R2		2.2 kΩ ½ W	3.3 kΩ ½ W	3.3 kΩ ½ W
R3		15 kΩ ½ W	15 kΩ ½ W	15 kΩ ½ W
SNUBBER NETWORK FOR 8 A (RMS)• INDUCTIVE LOAD	CS	0.068 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	RS	1.2 kΩ ½ W	1 kΩ ½ W	1 kΩ ½ W
RFI FILTER	CF•	0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	LF•	100 μH	200 μH	200 μH
RCA TRIACS		BTA21C	BTA21D BTA21E	BTA21D BTA21E

•For other RMS current values refer to RCA Application Note AN-4745.

•Typical values for lamp dimming circuits.

Fig. 11 - Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

BTA22 (T2800) Series

10-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

The RCA BTA22-series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

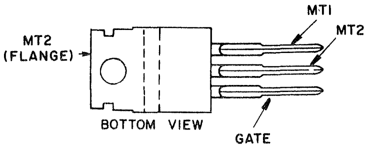
These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 10 amperes at a T_C of 75° C and repetitive off-state voltage ratings of 200, 300, 400, 500 and 600 volts.

These devices are characterized for I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

All these types are supplied in the JEDEC TO-220AB VERSAWATT plastic package. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

Features
- *110-A peak surge full-cycle current ratings*
- *Shorted-emitter center-gate design*
- *Low switching losses*
- *Low thermal resistance*
- *Package design facilitates mounting on a printed-circuit board*

TERMINAL DESIGNATIONS



92CS-27718

JEDEC TO-220AB

(See dimensional outline "S".)

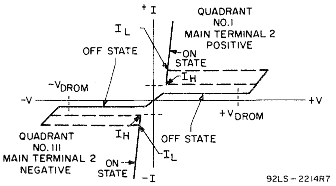


Fig. 1 - Principal voltage-current characteristic.

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

	BTA22B	BTA22C	BTA22D	BTA22E	BTA22M	
V_{DROM}●, Gate open, T_J=−65 to 100°C	200	300	400	500	600	V
$I_{T(RMS)}$, T_C=75° C, θ=360°	10					A
For other conditions	See Fig. 3					
I_{TSM}						
For one cycle of applied principal voltage (Fig. 11)						
60 Hz (sinusoidal) T_C=80° C	110					A
50 Hz (sinusoidal) T_C=80° C	103					A
For more than one cycle of applied principal voltage	See Fig. 4					
di/dt						
V_D=V_{DROM}, I_{GT}=200 mA, t_r=0.1 μs	70					A/μs
I^2t (See Fig. 11)						
t=20 ms	66					A^2s
t=2.5 ms	33					A^2s
t=0.5 ms	19					A^2s
I_{GTM}■						
For 1 μs max., See Fig. 5	4					A
P_{GM} (For 1 μs max., I_{GTM} ≤ 4 A, See Fig. 5	16					W
$P_{G(AV)}$	0.35					W
T_{stg}‡	−65 to 150					°C
T_C‡	−65 to 100					°C
T_T (During Soldering):						
For 10 s max. (terminals and case)	225					°C

●For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.
‡For temperature measurement reference point, see Dimensional Outline.

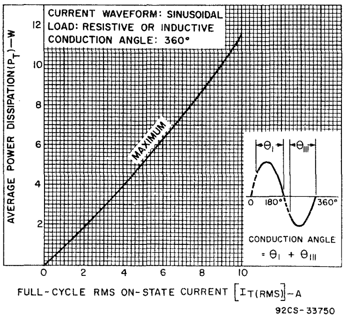


Fig. 2 - Power dissipation vs. on-state current.

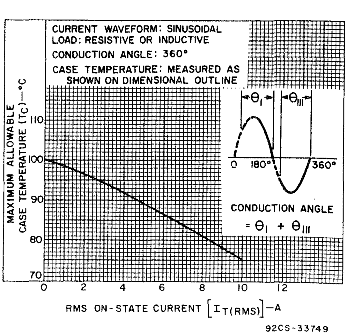


Fig. 3 - Maximum allowable case temperature vs. on-state current.

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	MIN.	TYP.	MAX.	
I_{DROM}• Gate open, T_J=100°C, V_{DROM}=Max. rated value	—	0.1	2	mA
V_{TM}• i_T=30 A (peak), T_C=25°C (See Fig. 6)	—	—	1.7	V
I_{HO}• Gate open, Initial principal current=150 mA (dc) v_D=12 V, T_C=25°C	—	15	30	mA
For other case temperatures		See Fig. 7		
dv/dt (Commutating)• v_D=V_{DROM}, $I_{T(RMS)}$=10 A, commutating di/dt=4.44 A/ms, gate unenergized, T_C=75°C	4	10	—	V/μs
dv/dt• v_D=V_{DROM}, exponential voltage rise, gate open, T_C=100°C:				
BTA22B	100	300	—	V/μs
BTA22C	85	275	—	
BTA22D	75	250	—	
BTA22E	65	225	—	
BTA22M	60	200	—	
I_{GT}•■ Mode V_{MT2} V_G v_D=12 V (dc) I+ positive positive... R_L=12 Ω	—	10	25	mA
T_C=25°C III− negative negative... For other case temperatures	—	15	25	
I− positive negative...	—	20	60	
III+ negative positive...	—	30	60	
For other case temperatures		See Figs. 9 & 10		
V_{GT}•■ v_D=12 V (dc), R_L=12 Ω, T_C=25°C	—	1.25	2.5	V
For other case temperatures		See Fig. 12		
v_D=V_{DROM}, R_L=125 Ω, T_C=100°C	0.2	—	—	
t_{gt} For v_D=V_{DROM}, I_{GT}=80 mA, t_r=0.1 μs, i_T=10 A (peak), T_C=25°C (See Fig. 13)	—	1.6	2.5	μs
$R_{\theta JC}$	—	—	2.2	°C/W
$R_{\theta JA}$	—	—	60	

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■For either polarity of gate voltage (V_G) with reference to main terminal 1.

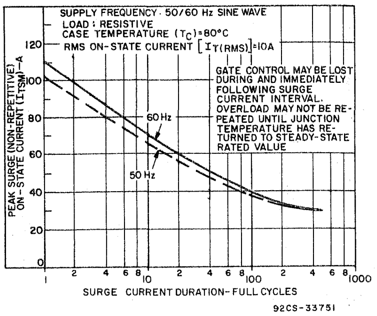


Fig. 4 - Peak surge on-state current vs. surge current duration.

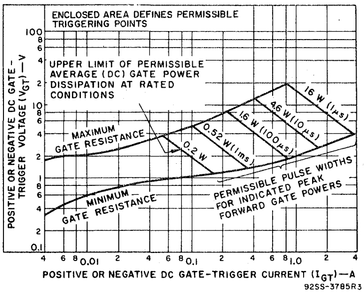


Fig. 5 - Gate pulse characteristics for all triggering modes.

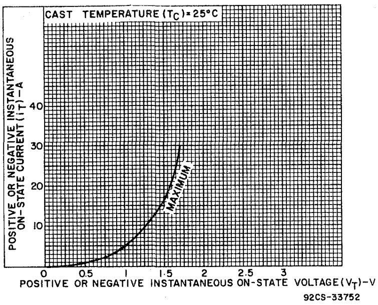


Fig. 6 - On-state current vs. on-state voltage.

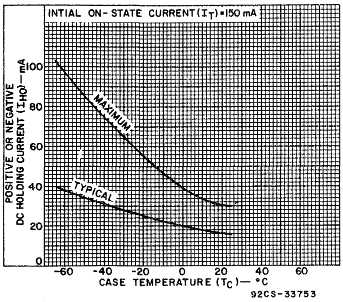


Fig. 7 - DC holding current vs. case temperature.

BTA22 (T2800) Series

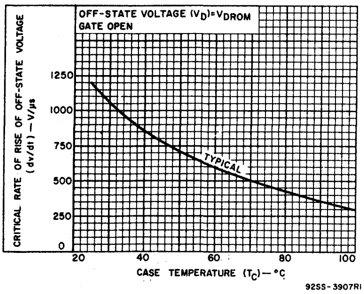


Fig. 8 - Critical rate-of-rise of off-state voltage vs. case temperature.

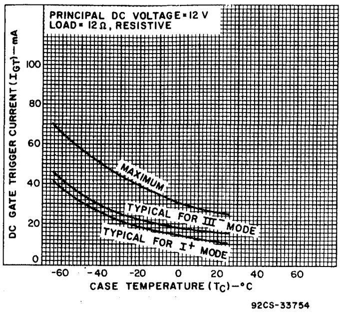


Fig. 9 - DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

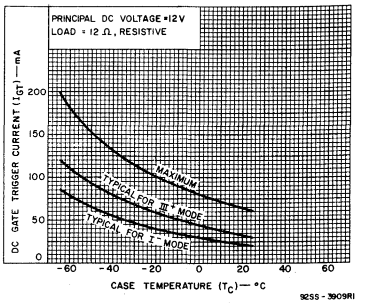


Fig. 10 - DC gate-trigger current (for I^- and III^+ triggering modes) vs. case temperature.

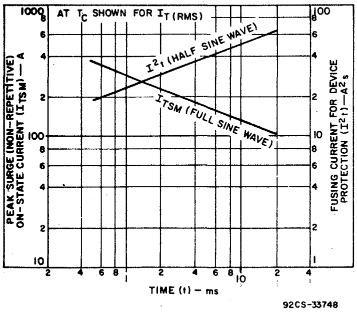


Fig. 11 - Peak surge on-state current and fusing current as a function of time.

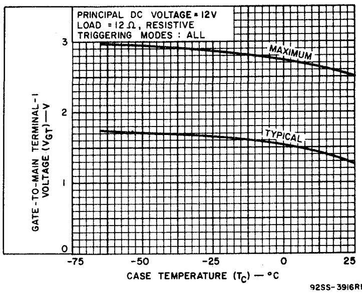


Fig. 12 - DC gate-trigger voltage vs. case temperature.

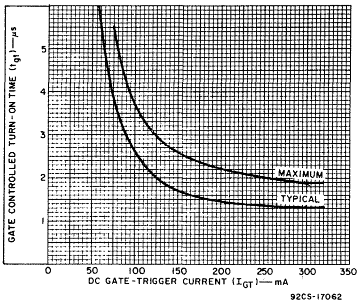
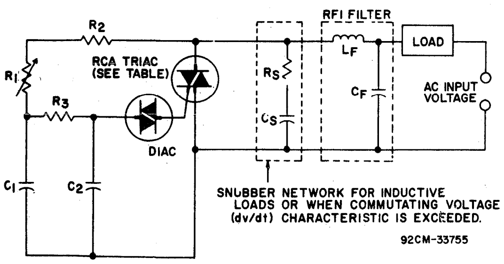


Fig. 13 - Turn-on time vs. gate-trigger current.



AC INPUT VOLTAGE		120 V 60 Hz	240 V 60 Hz	240 V 50 Hz
C_1		0.1 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
C_2		0.1 µF 100 V	0.1 µF 100 V	0.1 µF 100 V
R_1		100 kΩ ½ W	200 kΩ ½ W	250 kΩ ½ W
R_2		2.2 kΩ ½ W	3.3 kΩ ½ W	3.3 kΩ ½ W
R_3		15 kΩ ½ W	15 kΩ ½ W	15 kΩ ½ W
SNUBBER NETWORK FOR 10 A (RMS)• INDUCTIVE LOAD	C_S	0.068 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
	R_S	1.2 kΩ ½ W	1 kΩ ½ W	1 kΩ ½ W
RFI FILTER	C_F•	0.1 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
	L_F•	100 µH	200 µH	200 µH
RCA TRIACS		BTA22B BTA22C	BTA22D BTA22E	BTA22D BTA22E

•For other RMS current values refer to RCA Application Note AN-4745.

•Typical values for lamp dimming circuits.

Fig. 14 - Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

12-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

Features
- *115-A peak surge full-cycle current ratings*
- *Shorted-emitter center-gate design*
- *Low switching losses*
- *Low thermal resistance*
- *Package design facilitates mounting on a printed-circuit board*

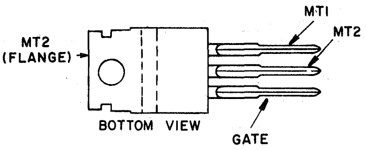
The RCA BTA23-series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 12 amperes at a T_C of 70° C and repetitive off-state voltage ratings of 200, 300, 400, 500 and 600 volts.

These devices are characterized for I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

All these types are supplied in the JEDEC TO-220AB VERSAWATT plastic package. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

(See dimensional outline "S".)

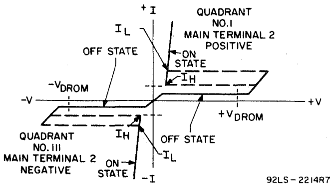


Fig. 1 - Principal voltage-current characteristic.

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

	BTA23B	BTA23C	BTA23D	BTA23E	BTA23M	
V_{DROM}•, Gate open, T_J=−65 to 100°C	200	300	400	500	600	V
$I_{T(RMS)}$, T_C=70° C, θ=360°	12					A
For other conditions	See Fig. 3					
I_{TSM} (See Fig.13)						
For one cycle of applied principal voltage						
60 Hz (sinusoidal)	115					A
50 Hz (sinusoidal)	108					A
For more than one cycle of applied principal voltage	See Fig. 4					
di/dt						
V_D=V_{DROM}, I_{GT}=200 mA, t_r=0.1 μs	70					A/μs
I^2t (See Fig.13)						
t=20 ms	73					A^2s
t=2.5 ms	36					A^2s
t=0.5 ms	20					A^2s
I_{GTM}■						
For 10 μs max., See Fig. 8	4					A
P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A, See Fig. 8)	16					W
$P_{G(AV)}$	0.2					W
T_{stg}‡	−65 to 150					°G
T_C‡	−65 to 100					°C
T_T (During Soldering):						
For 10 s max. (terminals and case)	225					°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal I.

■For either polarity of gate voltage (V_G) with reference to main terminal 1.

‡For temperature measurement reference point, *see Dimensional Outline.*

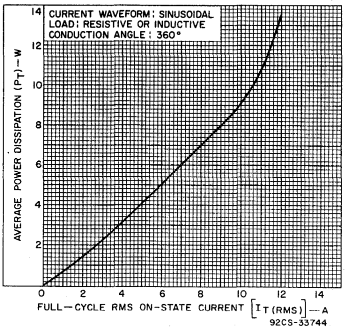


Fig. 2 - Power dissipation as a function of on-state current.

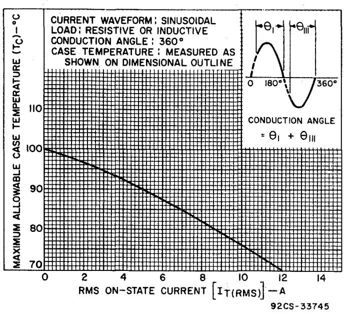
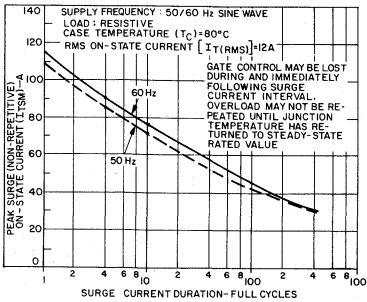


Fig. 3 - Allowable case temperature as a function of on-state current.

BTA23 (T2800) Series

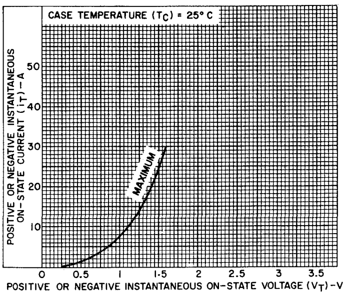
ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	MIN.	TYP.	MAX.	
I_{DROM}• Gate open, T_J=100°C, V_{DROM}=Max. rated value..	—	0.1	2	mA
V_{TM}• i_T=30 A (peak), T_C=25°C	—	—	1.6	V
I_{HO}• Gate open, Initial principal current=150 mA (dc) v_D=12 V, T_C=25°C	—	15	30	mA
dv/dt (Commutating)• v_D=V_{DROM}, $I_{T(RMS)}$=12 A, commutating di/dt=5.33 A/ms, gate unenergized, T_C=70°C	4	10	—	V/μs
dv/dt• v_D=V_{DROM}, exponential voltage rise, gate open, T_C=100°C:				
BTA23B	100	300	—	
BTA23C	85	275	—	
BTA23D	75	250	—	V/μs
BTA23E	65	225	—	
BTA23M	60	200	—	
I_{GT}•■ Mode V_{MT2} V_G v_D=12 V (dc) I+ positive positive... R_L=12 Ω	—	10	25	
T_C=25°C III− negative negative...	—	15	25	mA
I− positive negative...	—	20	60	
III+ negative positive...	—	30	60	
V_{GT}•■ v_D=12 V (dc), R_L=12 Ω, T_C=25°C	—	1.25	2.5	V
v_D=V_{DROM}, R_L=125 Ω, T_C=100°C..............	0.2	—	—	
t_{gt} For v_D=V_{DROM}, I_{GT}=80 mA, t_r=0.1 μs, i_T=10 A (peak), T_C=25°C (See Fig. 12)	—	1.6	2.5	μs
$R_{\theta JC}$	—	—	2.2	°C/W
$R_{\theta JA}$	—	—	60	



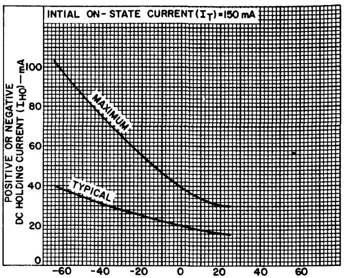
92CS-33746

Fig. 4 - Peak surge on-state current as a function of surge current duration.



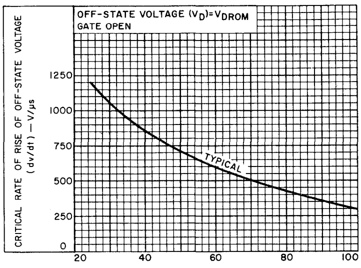
92CS-33747

Fig. 5 - On-state current vs. on-state voltage.



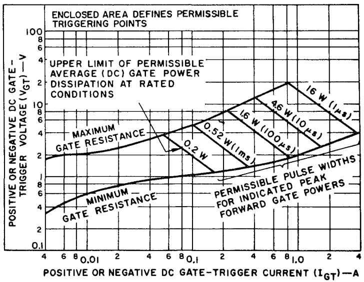
92CS-33753

Fig. 6 - DC holding current for either direction of on-state current vs. case temperature.



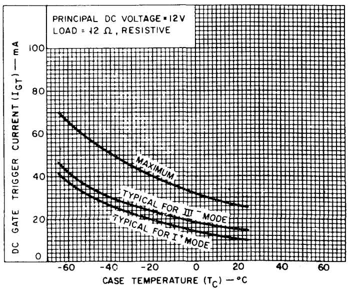
92SS-3907RI

Fig. 7 - Critical rate-of-rise of off-state voltage as a function of case temperature.



92SS-3785R3

Fig. 8 - Gate-pulse characteristics for all triggering modes.



92SS-3908RI

Fig. 9 - DC gate-trigger current (for I+ and III− triggering modes) vs. case temperature.

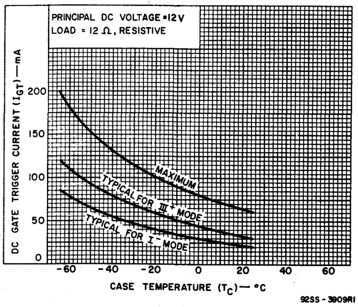


Fig. 10 - DC gate-trigger current (for I⁻ and III+ triggering modes) vs. case temperature.

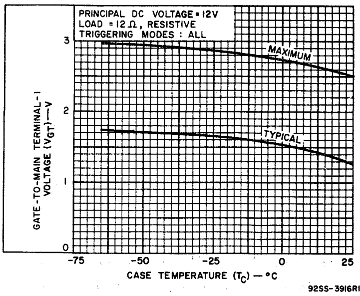


Fig. 11 — DC gate-trigger voltage vs. case temperature.

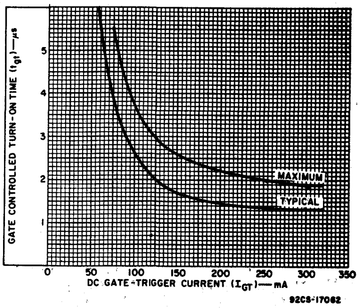


Fig. 12 — Turn-on time vs. gate-trigger current.

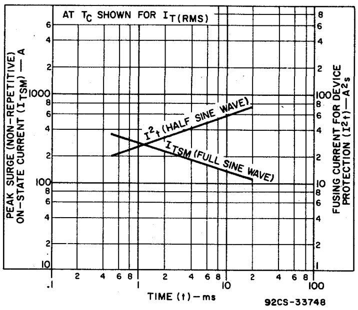
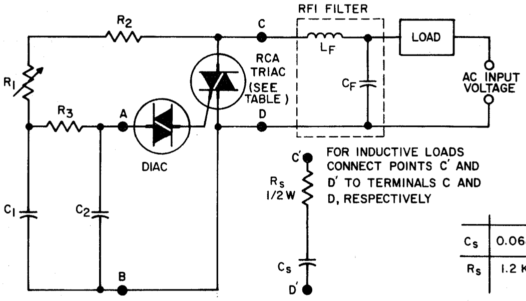


Fig. 13 - Peak surge on-state current and fusing current as a function of time.



	120V	240 V
C_S	0.068 μF/200V	0.1μF/400V
R_S	1.2 KΩ	1 KΩ

AC INPUT VOLTAGE	C_1	C_2	R_1	R_2	R_3	RFI FILTER		RCA TYPES
						L_F* (typ.)	C_F* (typ.)	
120 V 60 Hz	0.1 μF 200 V	0.1 μF 100 V	100 KΩ ½ W	2.2 KΩ ½ W	15 KΩ ½ W	100 μH	0.1 μF 200V	BTA23B,C
240 V 50 Hz	0.1 μF 400 V	0.1 μF 100 V	250 KΩ 1 W	3.3 KΩ ½ W	15 KΩ ½ W	200 μH	0.1 μF 400 V	BTA23D,E
240 V 60 Hz	0.1 μF 400 V	0.1 μF 100 V	200 KΩ 1 W	3.3 KΩ ½ W	15 KΩ ½ W	200 μH	0.1 μF 400 V	BTA23D,E

*Typical values for lamp-dimming circuits.

92CS-33761

Fig. 14 - Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

SC141, SC146 (T2800) Series

6-A and 10-A Silicon Triacs

Three-Lead Plastic Types for Power-Control
and Power-Switching Applications

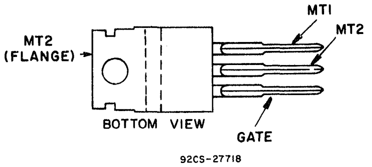
The RCA-SC141 and SC146 series triacs are gate-controlled full-wave silicon switches utilizing the RCA VERSAWATT plastic package (JEDEC TO-220AB) with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 6-A at T_C = 75°C (SC141 series) and 10-A at T_C = 80°C (SC146 series) and repetitive off-state voltage ratings, of 200, 400, 500, and 600 volts. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

Features:

- **80 and 120-A peak surge full-cycle current ratings**
- **Shorted-emitter center-gate design**
- **Low switching losses**
- **Low thermal resistance**
- **Glass-passivated chip for stability**
- **Package design facilitates mounting on a printed-circuit board**

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	SC141B SC146B	SC141D SC146D	SC141E SC146E	SC141M SC146M	
V_{DROM}● T_J= −40 to 100°C	200	400	500	600	V
$I_{T(RMS)}$ θ = 360°:					
For SC141 series, T_C = 75°C	6				A
For SC146 series, T_C = 80°C	10				A
For other conditions	See Fig. 4				
I_{TSM}:					
For one full cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$:	SC141 Series		SC146 Series		
60 Hz (sinusoidal)	80		120		A
50 Hz (sinusoidal)	75		110		A
For more than one cycle of applied principal voltage	See Fig. 5				
di/dt					
$v_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs	70				A/μs
I^2t [At T_C shown for $I_{T(RMS)}$, half-sine wave]:	SC141 Series		SC146 Series		
t = 10 ms	25		70		A^2s
2.5 ms	17		45		A^2s
0.5 ms	10		25		A^2s
I_{GTM}■					
For 1 μs max.	4				A
P_{GM} (For 1 μs max., $I_{GTM} \leqslant 4$ A)	10				W
$P_{G(AV)}$	0.5				W
T_{stg}	−40 to 125				°C
T_C	−40 to 100				°C
T_T (During soldering for 10 s max.)	230				°C

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

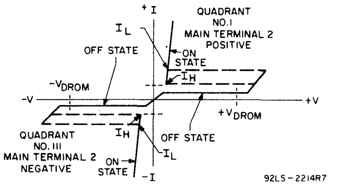


Fig. 1 — Principal voltage-current characteristic.

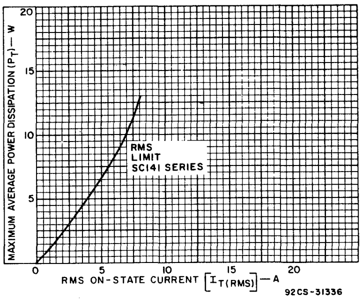


Fig. 2 — Power dissipation as a function of on-state current for SC141 series.

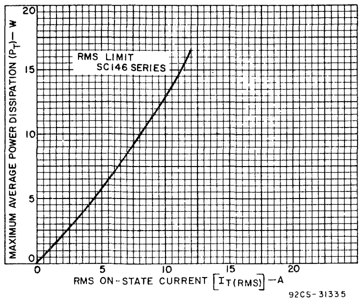


Fig. 3 — Power dissipation as a function of on-state current for SC146 series.

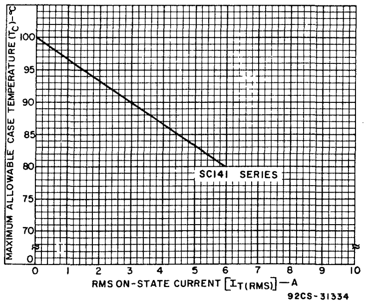


Fig. 4 — Maximum allowable case-temperature as a function of on-state current for SC141 series.

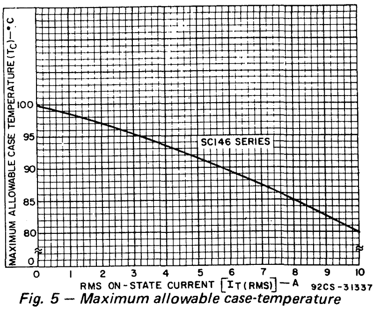


Fig. 5 — Maximum allowable case-temperature as a function of on-state current for SC146 series.

SC141, SC146 (T2800) Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC					LIMITS For All Types Except as Specified			UNITS
					Min.	Typ.	Max.	
I_{DROM}●								
V_{DROM} = Max. rated value, T_C = 25°C					–	–	0.1	mA
= 100°C					–	–	0.5	
v_{TM}●								
T_C = 25°C, i_T = 8.5 A (peak SC141 series					–	–	1.83	V
= 14 A (peak) SC146 series					–	–	1.65	
I_{HO}●								
Gate open, initial principal current = 500 mA (dc)								
v_D = 12 V, T_C = 25°C					–	–	50	mA
= −40°C					–	–	100	
I_L●								
R_{GK} = 100 Ω, t_W = 50 μs, t_r = t_f = 5 μs, f = 1 kHz,								
T_C = 25°C		Mode	V_{MT2}	V_G				
		1+	+	+	–	–	100	
		111−	–	–	–	–	100	
		1−	+	–	–	–	200	
T_C = −40°C		1+	+	+	–	–	200	
		111−	–	–	–	–	200	
		1−	+	–	–	–	400	
dv/dt● (Commutating)								
v_D = V_{DROM}, $I_{T(RMS)}$ = Max. rated value,								
di/dt = 3.2 A/ms, T_C = 80°C SC141 series					4	–	–	V/μs
di/dt = 5.4 A/ms, T_C = 80°C SC146 series					4	–	–	
dv/dt● (Off-State)								
v_D = V_{DROM}, T_C = 100°C, Exponential voltage rise								
SC141 series					30	100	–	
SC146 series					100	250	–	
I_{GT}●■ v_D = 12 V (dc)								
T_C = 25°C	R_L–Ω	Mode	V_{MT2}	V_G				
	100	1+	+	+	–	–	50	mA
	100	111−	–	–	–	–	50	
	50	1−	+	–	–	–	50	
T_C = −40°C	50	1+	+	+	–	–	80	
	50	111−	–	–	–	–	80	
	25	1−	+	–	–	–	80	
V_{GT}●■ v_D = 12 V (dc)								
T_C = 25°C	R_L–Ω	Mode	V_{MT2}	V_G				
	100	1+	+	+	–	–	2.5	V
	100	111−	–	–	–	–	2.5	
	50	1−	+	–	–	–	2.5	
T_C = −40°C	50	1+	+	+	–	–	3.5	
	50	111−	–	–	–	–	3.5	
	25	1−	+	–	–	–	3.5	

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

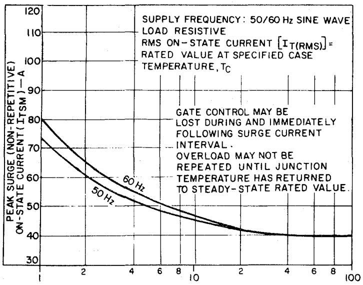


Fig. 6 — Peak surge on-state current as a function of surge current duration for SC141 series.

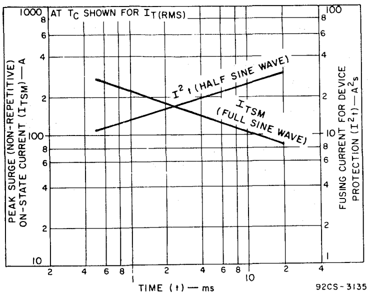


Fig. 7 — Peak surge on-state current and fusing current as a function of time for SC141 series.

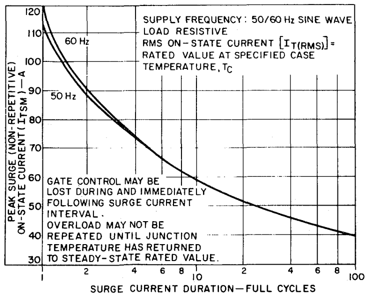


Fig. 8 — Peak surge on-state current as a function of surge current duration for SC146 series.

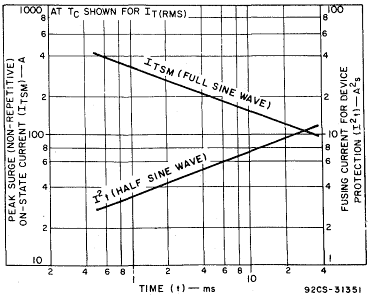


Fig. 9 — Peak surge on-state current and fusing current as a function of time for SC146 series.

SC141, SC146 (T2800) Series

ELECTRICAL CHARACTERISTICS (Cont'd)

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
V_{GD}● $v_D = V_{DROM}$, $R_L = 1k\Omega$, $T_C = 100°C$ (For all triggering modes)	0.2	–	–	V
t_{gt} $v_D = V_{DROM}$, $I_{GT} = 80$ mA, $t_r = 0.1$ μs, $i_T = 25$ A (peak), $T_C = 25°C$	–	1.6	2.5	μs

Thermal Characteristics

$R_{\theta JC}$ SC141 series SC146 series	–	–	3.0 2.2	°C/W
$R_{\theta JA}$	–	–	75	
$R_{\theta JC(ac)}$* During ac current conduction SC141 series SC146 series	– –	– –	2.22 1.5	

- ● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
- ■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
- * This characteristic is useful in the calculation of junction-temperature rise above T_C for ac current conduction and applies for a 50 or 60 Hz full sine wave of current. It can be calculated with the following formula:

$$\text{Apparent thermal resistance} = \frac{T_{J(max.)} - T_C}{P_{T(AV)}}$$

where:
$T_{J(max.)}$ = maximum junction temperature
T_C = case temperature
$P_{T(AV)}$ = average on-state power

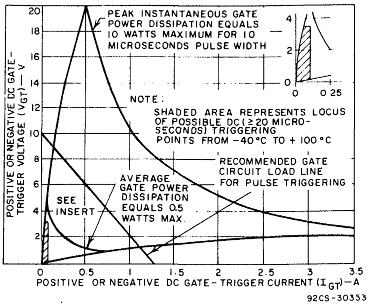


Fig. 10 – Gate pulse characteristics for all triggering modes.

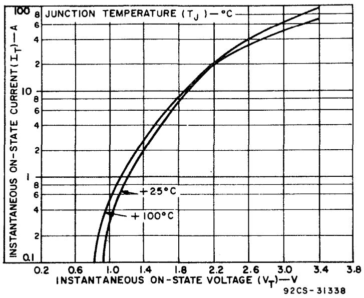


Fig. 11 – On-state current as a function of on-state voltage for SC141 series.

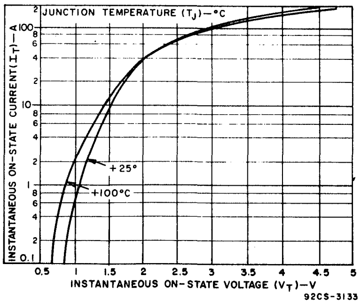


Fig. 12 – On-state current as a function of on-state voltage for SC146 series.

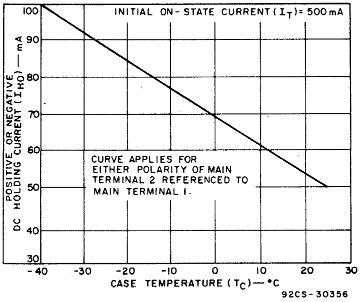


Fig. 13 – DC holding current as a function of case temperature.

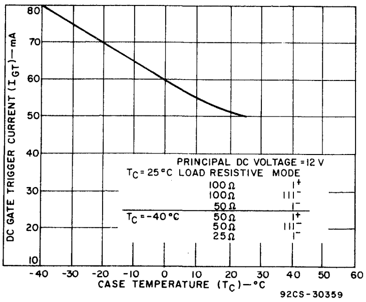


Fig. 14 – DC gate trigger current as a function of case temperature.

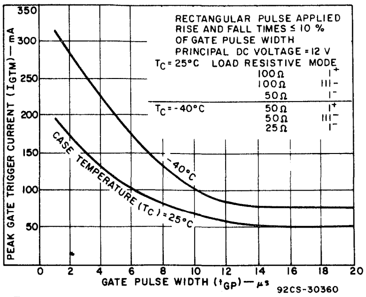


Fig. 15 – Peak gate trigger current as a function of gate pulse width.

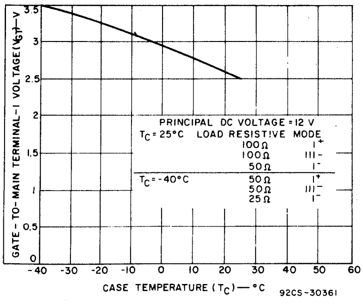


Fig. 16 – DC gate-trigger voltage as a function of case temperature.

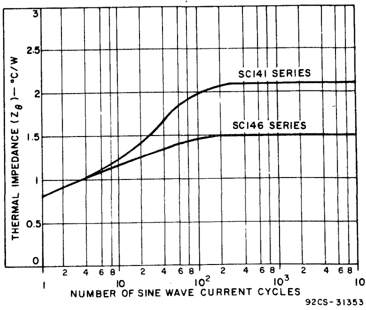


Fig. 17 – Thermal impedance as a function of sine-wave current cycles.

8-A Isolated-Tab Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

The RCA-T2850 series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

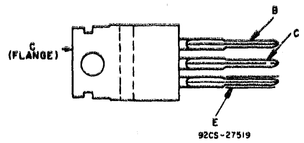
These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 8 amperes at a T_C of 75°C and repetitive off-state voltage ratings of 100, 200, 400, 500 and 600 volts.

The T2850-series types employ an ISOWATT package, a plastic case with three leads that are electrically isolated from the mounting flange. Because of this internal isolation, the triac can be mounted directly on a heat sink, without any insulating hardware; therefore heat transfer is improved and heat-sink size can be reduced.

Features:

- Internal isolation
- 100-A peak surge full-cycle current ratings
- Shorted-emitter, center-gate design
- Low switching losses
- Low thermal resistance
- Package suitable for direct mounting on heat sink
- Glass-passivated junctions

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

	T2850A	T2850B	T2850D	T2850E	T2850M	
V_{DROM}• T_J = −65 to 100°C	100	200	400	500	600	V
$I_{T(RMS)}$ T_C = 75°C, θ = 360°	8					A
For other conditions	See Fig. 3					
I_{TSM}						
For one cycle of applied principal voltage						
60 Hz (sinusoidal), T_C = 75°C	100					A
50 Hz (sinusoidal), T_C = 75°C	85					A
For more than one cycle of applied principal voltage	See Fig. 4					
di/dt						
v_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs	70					A/μs
I^2t [At T_C shown for $I_{T(RMS)}$, half-sine wave]: See Fig. 5						
t = 20 ms	55					A^2s
= 2.5 ms	28					A^2s
= 0.5 ms	16					A^2s
I_{GTM}■						
For 1 μs max., See Fig. 6	4					A
P_{GM} (For 1 μs max., I_{GTM} ≤ 4 A), See Fig. 6	16					W
$P_{G(AV)}$	0.2					W
T_{stg}	−65 to 150					°C
T_C	−65 to 100					°C
T_T (During soldering for 10 s max.)	225					°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■For either polarity of gate voltage (V_G) with reference to main terminal 1.

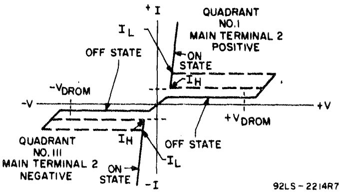


Fig. 1 – Principal voltage-current characteristic.

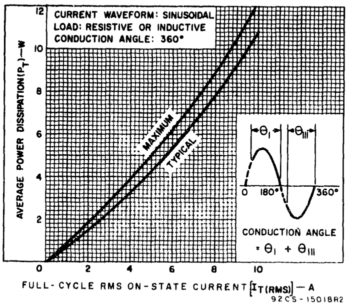


Fig. 2 – Power dissipation as a function of on-state current.

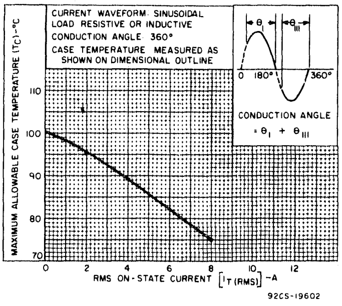


Fig. 3 – Allowable case temperature as a function of on-state current.

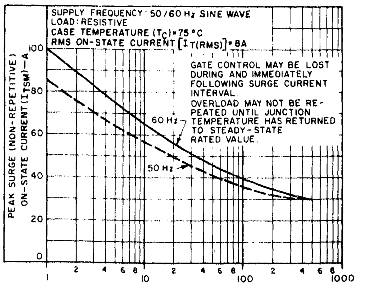


Fig. 4 – Peak surge on-state current as a function of surge current duration.

T2850 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}● T_J = 100°C, V_{DROM} = Max. rated value	–	0.1	2	mA
v_{TM}● i_T = 30 A (peak), T_C = 25°C, See Fig. 7	–	1.7	2	V
I_{HO}● v_D = 12 V, T_C = 25°C	–	15	30	mA
For other case temperatures	See *Fig. 7*			
dv/dt (Commutating)●* v_D = V_{DROM}, $I_{T(RMS)}$ = 8A, di/dt = 4.3 A/ms, gate unenergized, T_C = 75°C	4	10	–	V/µs
dv/dt (Off-State)● v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C				V/µs
T2850A	125	350	–	
T2850B	100	300	–	
T2850D	75	250	–	
T2850E	100	300	–	
T2850M	75	250	–	
I_{GT}● v_D = 12 V dc R_L = 12 Ω T_C = 25°C Mode V_{MT2} V_G				mA
I+ Positive Positive	–	20	25	
III− Negative1 Negative	–	15	25	
I− Positive Negative	–	20	60	
III+ Negative Positive	–	30	60	
For other case temperatures	See Figs. 10 & 11			
V_{GT}●■ v_D = 12 V dc, R_L = 12 Ω, T_C = 25°C	–	1.25	2.5	V
v_D = V_{DROM}, R_L = 125 Ω, T_C = 100°C	0.2	–	–	
For other case temperatures	See Figs. 12			
t_{gt} v_D = V_{DROM}, I_{GT} = 160 mA, t_r = 0.1 µs, i_T = 10 A (peak), T_C = 25°C	–	1.6	2.5	µs
$R_{\theta JC}$	–	–	3.1	°C/W
$R_{\theta JA}$	–	–	60	°C/W

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

* Variants of these devices having dv/dt characteristics selected specifically for inductive loads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.

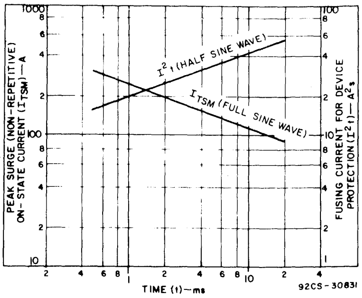


Fig. 5 — Peak surge on-state current and fusing current as a function of time.

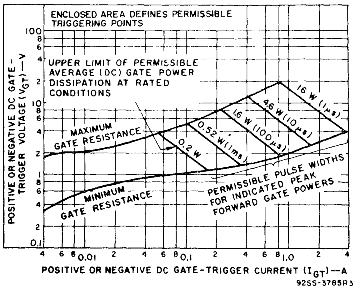


Fig. 6 — Gate-pulse characteristics for all triggering modes.

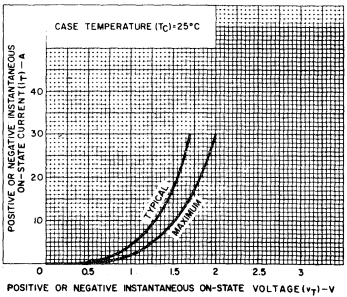


Fig. 7 — On state current as a function of on-state voltage.

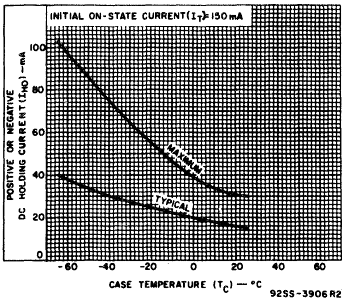


Fig. 8 — DC holding current vs. case temperature.

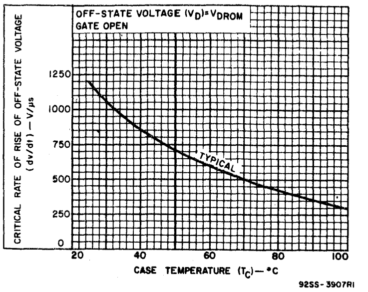


Fig. 9 — Typical critical rate-of-rise of offstate voltage as a function of case temperature.

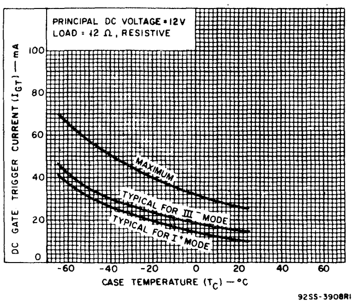


Fig. 10 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

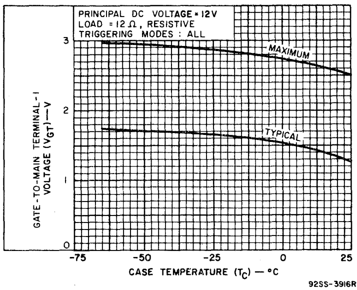


Fig. 11 — DC gate-trigger voltage vs. case temperature.

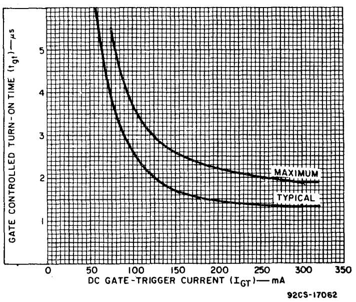
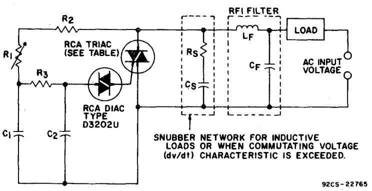


Fig. 12 — Turn-on time vs. gate-trigger current.



AC INPUT VOLTAGE		120 V 60 Hz	240 V 60 Hz	240 V 50 Hz
C_1		0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
C_2		0.1 μF 100 V	0.1 μF 100 V	0.1 μF 100 V
R_1		100 kΩ 1/2 W 1/2 W	200 kΩ 1/2 W 1 W	250 kΩ 1/2 W 1 W
R_2		2.2 kΩ 1/2 W	3.3 kΩ 1/2 W	3.3 kΩ 1/2 W
R_3		15 kΩ 1/2 W	15 kΩ 1/2 W	15 kΩ 1/2 W
SNUBBER NETWORK FOR 8 A (RMS) INDUCTIVE LOAD	C_S	0.068 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	R_S	1.2 kΩ 1/2 W	1 kΩ 1/2 W	1 kΩ 1/2 W
RFI FILTER	C_F●	0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	L_F●	100 μH	200 μH	200 μH
RCA TRIAC		T2850B	T2850D T2850E T2850M	T2850D

● Typical values for Lamp dimming circuits.

Fig. 13 — Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

T4100, T4101, T4110, T4111, T4120, T4121 Series
(Includes 2N5567-2N5574)

10-A and 15-A Silicon Triacs

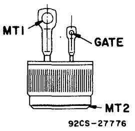
For General Purpose AC Power Switching

These RCA triacs are gate-controlled, fullwave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

These triacs are intended for control of ac loads in applications such as heating controls, motor controls, arc-welding equipment, light dimmers, and power switching systems.

Features:
- **di/dt Capability = 150 A/μs**
- **Shorted-Emitter, Center-Gate Design**
- **Low Switching Losses**
- **Low On-State Voltage at High Current Levels**
- **Low Thermal Resistance**

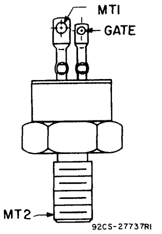
TERMINAL CONNECTIONS



2N5667	**T4100F**	**T4101E**
2N5568	**T4100E**	**T4101F**
2N5571	**T4100M**	**T4101M**
2N5572		

Pres-Fit Types

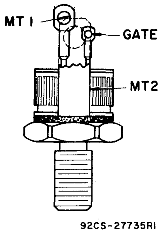
(See dimensional outline "Q")



2N5669	**T4110F**	**T4111F**
2N5570	**T4110E**	**T4111F**
2N5573	**T4110M**	**T4111M**
2N5574		

Stud Types

(See dimensional outline "W")



T4120B	**T4121B**
T4120D	**T4121D**
T4120E	**T4121E**
T4120F	**T4121F**
T4120M	**T4121M**

Isolated-Stud Types

(See dimensional outline "Z")

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

		T4100F T4101F T4110F T4111F T4120F T4121F	2N5567 2N5569 2N5571 2N5573 T4120B T4121B	2N5568 2N5570 2N5572 2N5574 T4120D T4121D	T4100E T4101E T4110E T4111E T4120E T4121E	T4100M T4101M T4110M T4111M T4120M T4121M	
*REPETITIVE PEAK OFF-STATE VOLTAGE:●							
Gate open, T_J = −65 to 100°C	V_{DROM}	50	200	400	500	600	V
*RMS ON-STATE CURRENT (Conduction angle = 360°):							
Case temperature	$I_{T(RMS)}$						
T_C = 85°C (2N5567, 68, 69, 70, T4101M, T4111M, T4121B, D, M)		10					A
= 80°C (2N5571, 72, 73, 74, T4100M, T4110M Press-fit & stud types)		15					A
= 75°C (T4120B, D, M – Isolated-stud types)		15					A
For other conditions		See Fig. 3, 4					
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}						
For one cycle of applied principal voltage, T_C as above							
60 Hz (sinusoidal)		100					A
50 Hz (sinusoidal)		85					A
For more than one cycle of applied principal voltage		See Fig. 5, 6					
RATE-OF-CHANGE OF ON-STATE CURRENT:							
$V_{DM} = V_{DROM}$, I_{GT} = 160 mA, t_r = 0.1 μs	di/dt	150					A/μs
FUSING CURRENT (for Triac Protection):							
At T_C shown for $I_{T(RMS)}$	I^2t						
t = 20 ms		55					A^2s
= 2.5 ms		28					A^2s
= 0.5 ms		16					A^2s
PEAK GATE-TRIGGER CURRENT:■							
For 1 μs max., See Fig. 11	I_{GTM}	4					A
*GATE POWER DISSIPATION:							
PEAK (For 1 μs max., $I_{GTM} \leqslant 4$ A, See Fig. 11	P_{GM}	16					W
AVERAGE	$P_{G(AV)}$	0.5					W
*TEMPERATURE RANGE:▲							
Storage	T_{stg}	−65 to 150					°C
Operating (Case)	T_C	−65 to 100					°C
*TERMINAL TEMPERATURE (During soldering):							
For 10 s max. (terminals and case)	T_T	225					°C
STUD TORQUE:	τ_s						
Recommended		35					in-lb
Maximum (DO NOT EXCEED)		50					in-lb

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* In accordance with JEDEC registration data format (JS-14, RDF 2) filed for the JEDEC (2N-Series) types.

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

▲ For temperature measurement reference point, see Dimensional Outline.

T4100, T4101, T4110, T4111, T4120, T4121 Series
(Includes 2N5567-2N5574)

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Indicated*

CHARACTERISTICS	SYMBOL	LIMITS			UNITS
		MIN.	TYP.	MAX.	
Peak Off-State Current:♠ Gate open, T_J = 100°C, V_{DROM} = Max. rated value	I_{DROM}	–	0.1	2*	mA
Maximum On-State Voltage:♠ For i_T = 14 A (peak), T_C = 25°C (2N5567, 68, 69, 70, T4101M, T4111M, T4121 series)	V_{TM}	–	1.35	1.65*	V
= 21 A (peak), T_C = 25°C (2N5571, 72, 73, 74, T4100M, T4110M, T4120 series)		–	1.4	1.8*	
DC Holding Current:♠ Gate open, Initial principal current = 500 mA (DC), v_D = 12 V: 2N5567, 68, 69, 70, T4101M, T4111M, T4121 series: T_C = 25°C	I_{HO}	–	15	30	mA
T_C = −65°C		–	75	200*	
2N5571, 72, 73, 74, T4100M, T4110M, T4120 series: T_C = 25°C		–	20	75	
T_C = −65°C		–	75	300*	
For other case temperature		See Fig. 9 & 10			
Critical Rate-of-Rise of Commutation Voltage:♠ For v_D = V_{DROM}, $I_{T(RMS)}$ = 10 A, commutating di/dt = 5.4 A/ms, gate unenergized, T_C = 85°C 2N5567, 68, 69, 70, T4101M, T4111M, T4121 series	dv/dt	2*	5	–	V/μs
For v_D = V_{DROM}, $I_{T(RMS)}$ = 15 A, commutating di%dt = 8 A/ms, gate unenergized, T_C = 80°C (2N5571, 72, 73, 74, T4110M – Press-fit & stud types)		2*	10	–	
= 75°C (T4120B, D, M – Isolated-stud)		2	10	–	
Critical Rate-of-Rise of Off-State Voltage:♠ For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C: 2N5567, 2N5569, T4121, 2N5571, 2N5573, T4120B.	dv/dt	30*	150	–	V/μs
2N5568, 2N5570, T4121D, 2N5572, 2N5574, T4120D. . . .		20*	100	–	
T4101M, T4111M, T4121M, T4100M, T4110M, T4120M. . .		10	75	–	
DC Gate-Trigger Current:♠♦ For v_D = 12 V (DC), R_L = 30 Ω, T_C = 25°C Mode V_{MT2} V_G I^+ positive positive All 10-A triacs	I_{GT}	–	10	25	mA
All 15-A triacs		–	20	50	
III^- negative negative All 10-A triacs		–	10	25	
All 15-A triacs		–	20	50	
I^- positive negative All 10-A triacs		–	20	40	
All 15-A triacs		–	35	80	
III^+ negative positive All 10-A triacs		–	20	40	
All 15-A triacs		–	35	80	
For v_D = 12 V (DC), R_L = 30Ω, T_C = −65°C Mode V_{MT2} V_G I^+ positive positive All 10-A triacs		–	45	100*	
All 15-A triacs		–	75	150*	
III^- negative negative All 10-A triacs		–	45	100*	
All 15-A triacs		–	75	150*	
I^- positive negative All 10-A triacs		–	80	150*	
All 15-A triacs		–	100	200*	
III^+ negative positive All 10-A triacs		–	80	150*	
All 15-A triacs		–	100	200*	
For other case temperatures		See Fig. 12, 13, 14, & 15			
DC Gate-Trigger Voltage:♠♦ For v_D = 12 V(DC), R_L = 30Ω T_C = 25°C	V_{GT}	–	1	2.5	V
T_C = −65°C		–	2	4*	
For other case temperatures		See Fig. 16 & 17			
For v_D = V_{DROM}, R_L = 125Ω, T_C = 100°C		0.2	–	–	

* In accordance with JEDEC registration data format (JS-14, RDF-2) filed for the JEDEC (2N-Series) types.

♠ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

♦ For either polarity of gate voltage (V_G) with reference to main terminal 1.

T4100, T4101, T4110, T4111, T4120, T4121 Series
(Includes 2N5567-2N5574)

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Indicated*

CHARACTERISTICS	SYMBOL	LIMITS			UNITS
		MIN.	TYP.	MAX.	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For $v_D = V_{DROM}$, I_{GT} = 160 mA, t_r = 0.1 μs, i_T = 15 A (peak) All 10-A triacs, i_T = 25 A (peak) All 15-A triacs, T_C = 25°C	t_{gt}	–	1.6	2.5	μs
Thermal Resistance: Junction-to-Case: Steady-State Transient	$\theta_{J\text{-}C}$	– 	– (See Fig. 19)	1* 	°C/W
Junction-to-Isolated Hex (Stud, see Dim. Outline): Steady-State	$\theta_{J\text{-}IH}$	–	–	1.1	

* In accordance with JEDEC registration data format (JS-14, RDF 2) filed for the JEDEC (2N-Series) types.

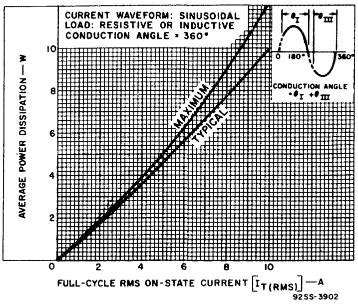


Fig. 1 — Power dissipation vs. on-state current for all 10-A triacs.

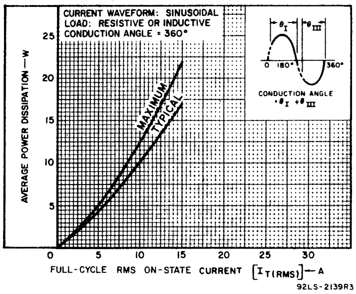


Fig. 2 — Power dissipation vs. on-state current for all 15-A triacs.

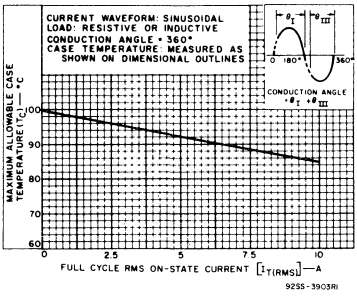


Fig. 3 — Maximum allowable case temperature vs. on-state current for all 10-A triacs.

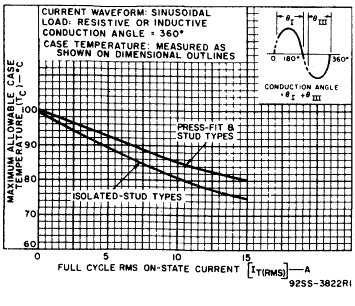


Fig. 4 — Maximum allowable case temperature vs. on-state current for all 15-A triacs.

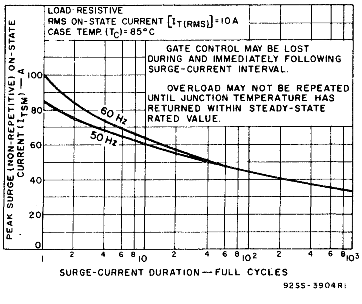


Fig. 5 — Peak surge on-state current vs. surge current duration for all 10-A triacs.

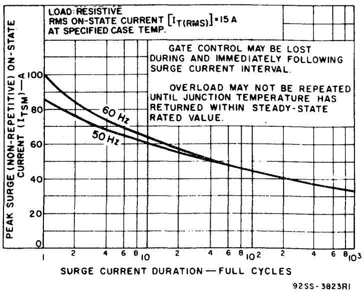


Fig. 6 — Peak surge on-state current vs. surge current duration for all 15-A triacs.

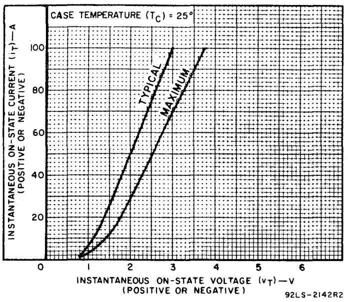


Fig. 7 — On-state current vs. on-state voltage for all 10-A triacs.

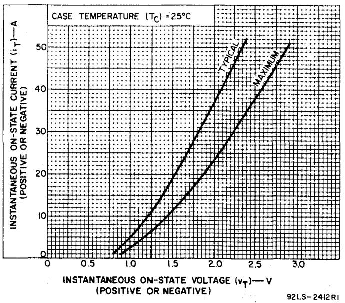


Fig. 8 — On-state current vs. on-state voltage for all 15-A triacs.

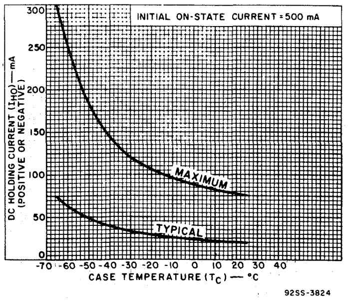


Fig. 9 — DC holding current vs. case temperature for all 10-A triacs.

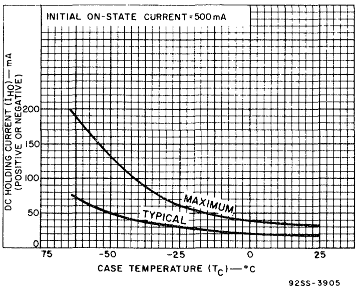


Fig. 10 — DC holding current vs. case temperature for all 15-A triacs.

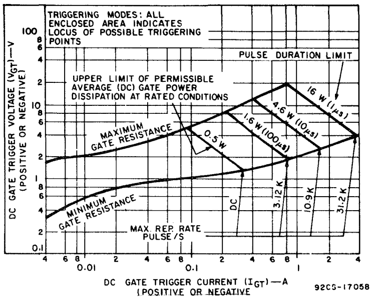


Fig. 11 — Gate trigger characteristics and limiting conditions for determination of permissible gate trigger pulses for all triacs.

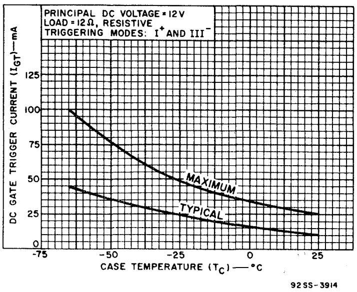


Fig. 12 — DC gate-trigger current vs. case temperature (I$^+$ & III$^-$ modes) for all 10-A triacs.

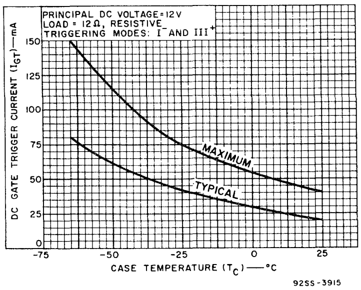


Fig. 13 — DC gate-trigger current vs. case temperature (I$^-$ & III$^+$ modes) for all 10-A triacs.

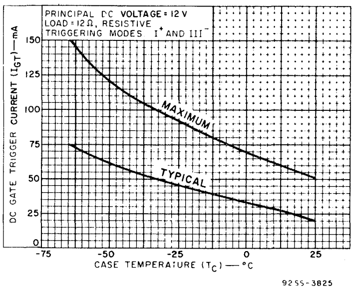


Fig. 14 — DC gate-trigger current vs. case temperature (I$^+$ & III$^-$ modes) for all 15-A triacs.

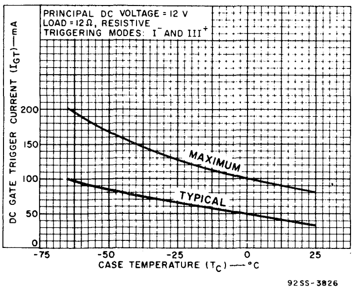


Fig. 15 — DC gate-trigger current vs. case temperature (I$^-$ & III$^+$ modes) for all 15-A triacs.

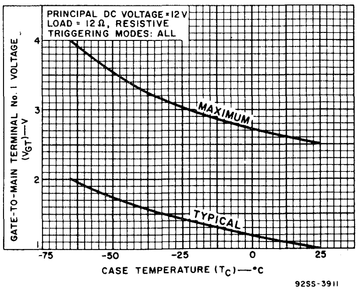


Fig. 16 — DC gate-trigger voltage vs. case temperature for all 10-A triacs.

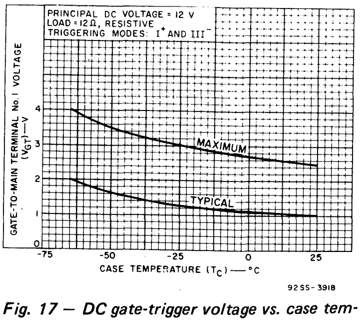


Fig. 17 — DC gate-trigger voltage vs. case temperature for all 15-A triacs.

T4100, T4101, T4110, T4111, T4120, T4121 Series (Includes 2N5567-2N5574)

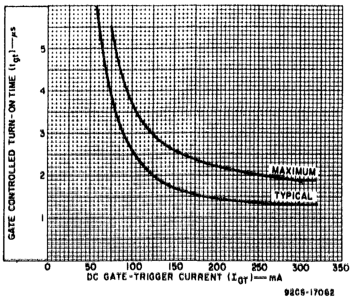


Fig. 18 — Turn-on time vs. gate trigger current for all types.

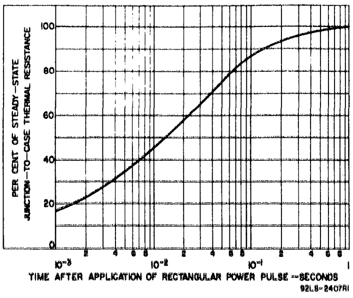


Fig. 19 — Transient junction-to-case thermal resistance vs. time for all triacs.

WARNING:
The RCA isolated-stud package thyristors should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient. Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

T4113-T4115 Series

400-Hz, 6, 10, & 15-A Silicon Triacs

For Control-Systems Application in Airborne and Ground-Support Type Equipment

These RCA triacs are gate-controlled full-wave silicon ac switches.

The devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages.

They are intended for operation up to 400 Hz with resistive or inductive loads and nominal line voltages of 115 and 208 V RMS sine Wave and repetitive peak off-state voltages of 200 V and 400 V.

These triacs exhibit commutating voltage (dv/dt) capability at high commutating current (di/dt). They can also be used in 60-Hz applications where high commutating capability is required.

Features:

- **di/dt capability = 150 A/μs**
- **Shorted-emitter center-gate design**
- **Commutating dv/dt capability characterized at 400 Hz**

MAXIMUM RATINGS, Absolute-Maximum Values:
For Operation with Sinusoidal Supply Voltage at Frequencies up to 400 Hz and with Resistive or Inductive Load.

		T4113B T4114B T4115B	T4113D T4114D T4115D	T4113E T4114E T4115E	T4113M T4114M T4115M	
REPETITIVE PEAK OFF-STATE VOLTAGE:*	V_{DROM}					
Gate open, T_J = 50 to 100° C		200	400	500	600	V
RMS ON-STATE CURRENT (Conduction angle = 360°):	$I_{T(RMS)}$					
Case Temperature						
T_C = 90° C (T4115B, T4115D)		6				A
= 85° C (T4114B, T4114D)		10				A
= 80° C (T4113B, T4113D)		15				A
For other conditions		*See fig. 2*				
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT	I_{TSM}					
For one cycle of applied principal voltage						
400 Hz (sinusoidal)		200				A
60 Hz (sinusoidal)		100				A
50 Hz (sinusoidal)		85				A
For more than one cycle of applied principal voltage		See fig. 3				
RATE-OF-CHANGE OF ON-STATE CURRENT:	di/dt					
$V_{DM} = V_{DROM}$, I_{GT} = 160mA, t_r = 0.1 μs		150				A/μs
FUSING CURRENT (for triac protection):						
T_J = -50 to 100° C, t = 1.25 to 10 ms	I^2t	30				A^2s
PEAK GATE-TRIGGER CURRENT:■	I_{GTM}					
For 1 μs max.		4				A
GATE POWER DISSIPATION:						
PEAK (For 1 μs max., $I_{GTM} \leq$ 4 A. See fig. 6)	P_{GM}	16				W
AVERAGE	$P_{G(AV)}$	0.2				W
TEMPERATURE RANGE:						
Storage	T_{stg}	-50 to 150				°C
Operating (Case)	T_C	-50 to 100				°C
TERMINAL TEMPERATURE (During soldering):						
For 10 s max., (terminals and case)	T_T	225				°C
STUD TORQUE: τ_s						
Recommended		35				in-lb
Maximum (DO NOT EXCEED)		50				in-lb

* For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see Dimensional Outline.

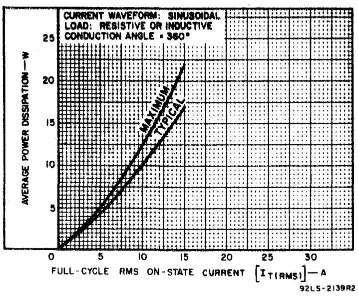


Fig. 1—Power dissipation vs. on-state current.

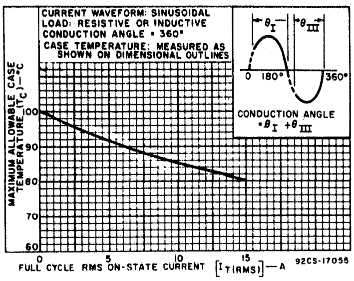
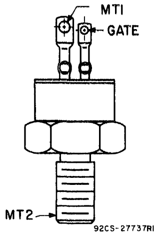


Fig. 2—Maximum allowable case temperature vs. on-state current.



T4113 Series
T4114 Series
T4115 Series▲

Stud

(See dimensional outline "W".)

T4113-T4115 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC				SYMBOL	LIMITS ALL TYPES			UNITS
					Min.	Typ.	Max.	
Peak Off-State Current:♦								
Gate open, T_J = 100°C , V_{DROM} = Max. rated value				I_{DROM}	-	0.1	2	mA
Maximum On-State Voltage:♦								
For i_T = 21 A (peak), T_C = 25 °C.				V_{TM}	-	1.4	1.8	V
DC Holding Current:♦								
Gate open, Initial principal current = 500 mA (DC), v_D = 12 V, T_C = 25° C.				I_{HO}	-	20	75	mA
For other case temperatures					See Fig. 5			
Critical Rate-of-Rise of Commutation Voltage:♦								
For v_D = V_{DROM}, $I_{T(RMS)}$ = rated value, gate unenergized								
Commutating di/dt = 21.4 A/ms, T_C = 90° C								
T4105B, T4105D, T4115B, T4115D					5	10	-	
Commutating di/dt = 36 A/ms, T_C = 85° C				dv/dt				V/μs
T4104B, T4104D, T4114B, T4114D					5	10	-	
Commutating di/dt = 53.3 A/ms, T_C = 80° C								
T4103B, T4103D, T4113B, T4113D					5	10	-	
Critical Rate-of-Rise of Off-State Voltage:♦								
For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100° C.				dv/dt	30	150	-	V/μs
DC Gate-Trigger Current:♦†	Mode	V_{MT2}	V_G					
For v_D = 12 V (DC),	I⁺	positive	positive			20	50	
R_L = 30 Ω, and	III⁻	negative	negative	I_{GT}		20	50	mA
T_C = 25 °C	I⁻	positive	negative			35	80	
	III⁺	negative	positive		-	35	80	
For other case temperatures.					See Figs. 7 & 8			
DC Gate-Trigger Voltage:♦†								
For v_D = 12 V(DC), R_L = 30Ω, T_C = 25°C.				V_{GT}	-	1	2.5	V
For other case temperatures.					See Fig. 9			
For v_D = V_{DROM}, R_L = 125Ω, T_C = 100°C					0.2	-	-	
Gate-Controlled Turn-On Time:								
(Delay Time + Rise Time)								
For v_D = V_{DROM}, I_{GT} = 160mA, t_r = 0.1 μs, i_T = 25A (peak), T_C = 25°C				t_{gt}	-	1.6	2.5	μs
Thermal Resistance								
Steady-State (Junction-to-Case)				$\theta_{J\text{-}C}$	-	-	1	°C/W
Transient (Junction-to-Case).					See Fig. 11			
Steady-State (Junction-to-Ambient).				$\theta_{J\text{-}A}$	-	-	33	°C/W

♦ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

† For either polarity of gate voltage (V_G) with reference to main terminal 1.

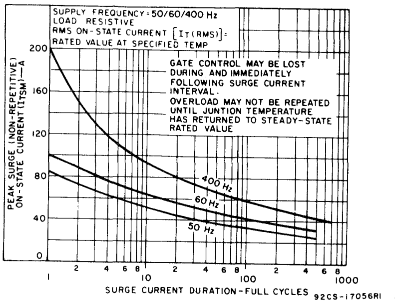


Fig. 3—Peak surge on-state current vs. surge-current duration.

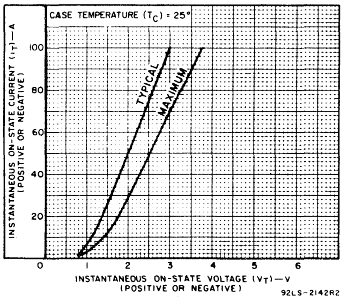


Fig. 4—On-state current vs. on-state voltage.

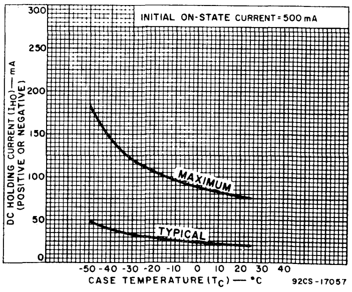


Fig. 5—DC holding current vs. case temperature.

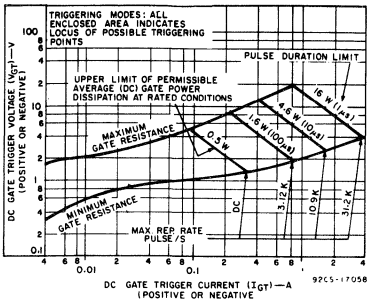


Fig. 6—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

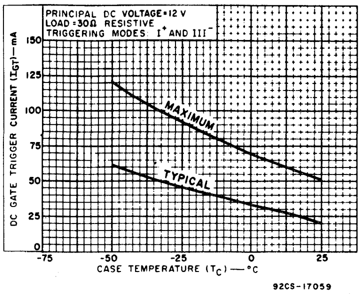


Fig. 7—DC gate-trigger current vs. case temperature. (I^+ and III^- modes).

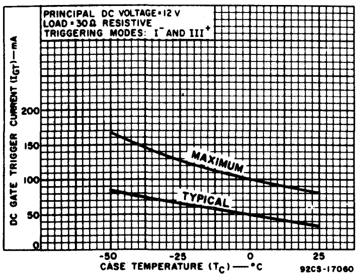


Fig. 8—DC gate-trigger current vs. case temperature. (I^- and III^+ modes).

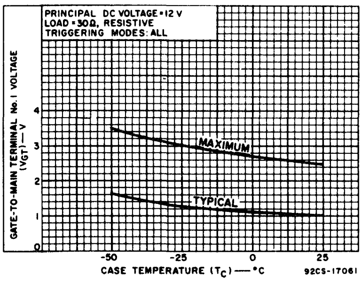


Fig. 9—DC gate-trigger voltage vs. case temperature.

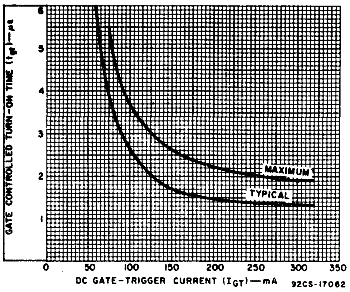


Fig. 10—Turn-on time vs. gate-trigger current.

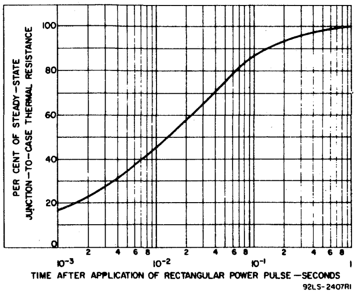


Fig. 11—Transient thermal resistance vs. time (junction-to-case).

T4700 Series

15-A Silicon Triacs

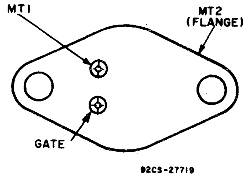
For Low-Power Phase-Control and Load-Switching Applications

RCA T4700 series are gate-controlled full-wave ac silicon switches. They are designed to switch from an off-state to a conducting state for either polarity of applied voltage with positive or negative gate triggering.

These devices are intended for the control of ac loads in applications such as space heater, oven and furnace controls, motor controls, and lamp loads.

Features:
- di/dt Capability = 150 A/μs
- Shorted-Emitter, Center-Gate Design
- Low Switching Losses
- Low On-State Voltage at High Current Levels
- Low Thermal Resistance

TERMINAL CONNECTIONS



BOTTOM VIEW

JEDEC TO-66

(See dimensional outline "N".)

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

For Operation with 50/60-Hz, Sinusoidal Supply Voltage and Resistive or Inductive Load		**T4700F**	**T4700B**	**T4700D**	**T4700E**	
REPETITIVE PEAK OFF-STATE VOLTAGE:■						
Gate Open	V_{DROM}	50	200	400	500	V
RMS ON-STATE CURRENT:						
T_C = 70°C, conduction angle = 360°	$I_{T(RMS)}$	15				A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}					
For one full cycle of applied principal voltage 60 Hz (sinusoidal), T_C = 70°C		100				A
For one full cycle of applied principal voltage (50-Hz, sinusoidal), T_C = 70°C		85				A
For more than one full cycle of applied voltage		See Fig. 3				
PEAK GATE-TRIGGER CURRENT:						
For 1 μs max.	I_{GTM}	4				A
RATE OF CHANGE OF ON-STATE CURRENT:						
$V_D = V_{DROM}$, I_{GT} = 200 mA, tr = 0.1 μs	di/dt	150				A/μs
FUSING CURRENT (for triac protection):						
T_J = −40 to 100°C, t = 1.25 to 10 ms	I^2t	50				A^2s
GATE POWER DISSIPATION:						
Peak● (for 1 μs max. and I_{GTM} = ≤ 4 A)	P_{GM}	16				W
Average (averaging time = 10 ms max.)	$P_{G(AV)}$	0.45				W
TEMPERATURE RANGE:▲						
Storage	T_{stg}	−40 to 150				°C
Operating (Case)	T_C	−40 to 100				°C
PIN TEMPERATURE (During soldering):						
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	225				°C

■ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
● For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, *see Dimensional Outline.*

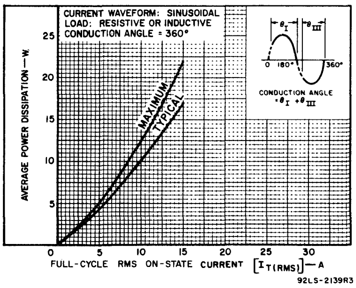


Fig. 1—Power dissipation curve.

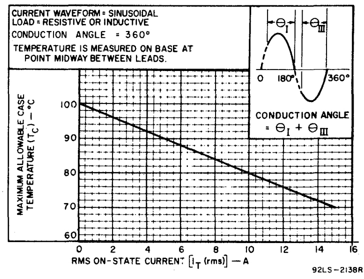


Fig. 2—Conduction rating chart (case temperature).

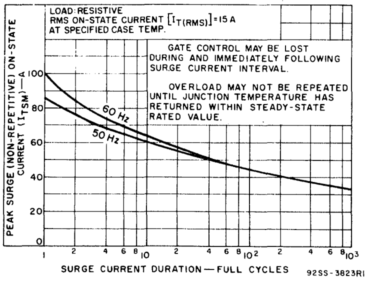


Fig. 3—Surge current rating chart.

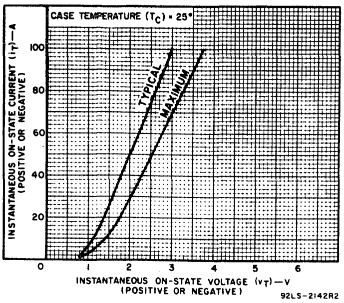


Fig. 4—On-state characteristics for either direction of principal current.

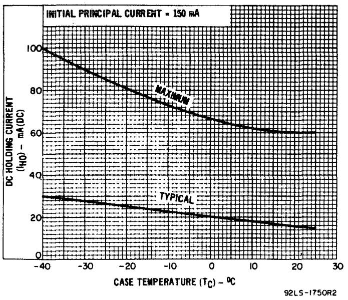


Fig. 5—DC holding current characteristics for either direction of principal current.

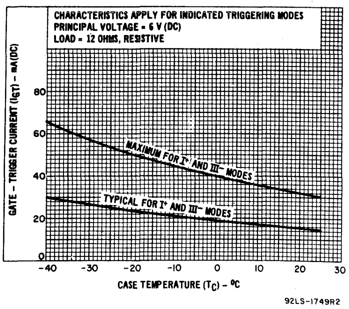


Fig. 6—DC gate-trigger current characteristics for I^+ and III^- modes.

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTICS	TRIAC TYPES						UNITS
	T4700B			T4700D			
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Off-State Current♠, I_{DROM}							
Gate open							
At T_j = +100° C and V_{DROM} = Max. rated value	–	0.2	4	–	0.2	4	mA
Instantaneous On-State Voltage♠, v_T							
For i_T = 30 A (peak) and T_C = +25° C.	–	1.6	2.0	–	1.6	2.0	V(peak)
DC Holding Current♠, I_{HO}:							
Gate Open							
Initial principal current = 150 mA (dc)							
At T_C = +25° C.	–	15	60	–	15	60	mA(dc)
For other case temperatures.		See Fig. 5			See Fig.5		
Critical Rate of Applied Commutating Voltage♠,							
Commutating dv/dt:							
For v_D = V_{DROM}, $I_{T(RMS)}$ = 15 A, commutating di/dt = 8 A/ms, and gate unenergized							
At T_C = +70° C.	2	10	–	2	10	–	V/μs
Critical Rate of Rise of Off-State Voltage♠,							
Critical dv/dt:							
For v_D = V_{DROM}, exponential voltage rise, gate open							
At T_C = +100° C.	30	150	–	20	100	–	V/μs
DC Gate-Trigger Current♠ ■, I_{GT}							
For v_D = 6 volts (dc), R_L = 12 ohms, T_C = +25° C, and Specified Triggering Mode:							
I^+ Mode: V_{T2} is positive, V_G is positive. . .	–	15	30	–	15	30	mA(dc)
I^- Mode: V_{T2} is positive, V_G is negative. . .	–	35	80	–	35	80	mA(dc)
III^+ Mode: V_{T2} is negative, V_G is positive. . .	–	35	80	–	35	80	mA(dc)
III^- Mode: V_{T2} is negative, V_G is negative. . .	–	15	30	–	15	30	mA(dc)
For other case temperatures.		See Figs. 6 & 7			See Figs. 6 & 7		
DC Gate-Trigger Voltage♠ ■, V_{GT}:							
For v_D = 6 volts (dc) and R_L = 12 ohms							
At T_C = +25° C.	–	1	2.5	–	1	2.5	V(dc)
For other case temperatures.		See Fig. 8			See Fig. 8		
For v_D = V_{DROM} and R_L = 125 ohms							
At T_C = +100° C.	0.2	–	–	0.2	–	–	V(dc)
Gate-Controlled Turn-On Time, t_{gt}							
(Delay Time + Rise Time)							
For v_D = V_{DROM}, I_{GT} = 160 mA, 0.1 μs rise time, and i_T = 25 A (peak)							
At T_C = +25° C.	–	1.6	2.5	–	1.6	2.5	μs
Thermal Resistance, Junction to case,							
$R_{\theta JC}$	–	–	1.3	–	–	1.3	°C/W

♠For either polarity of main terminal 2 voltage (V_{T2}) with reference to main terminal 1.

■For either polarity of gate voltage (V_G) with reference to main terminal 1.

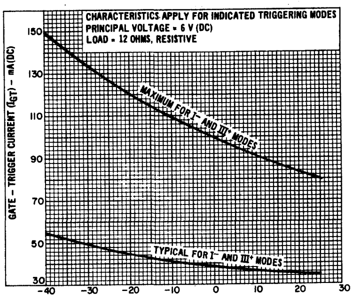


Fig. 7—DC gate-trigger current characteristics for I^- and III^+ modes.

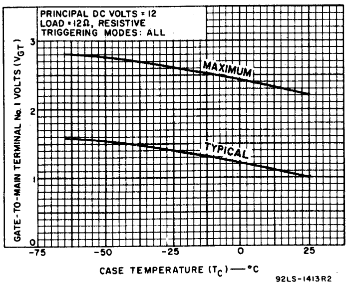


Fig. 8—DC gate-trigger voltage characteristics.

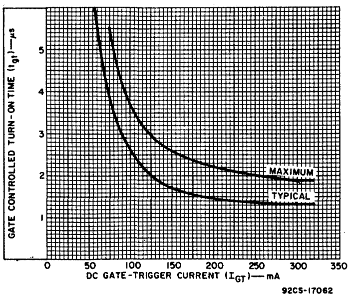


Fig. 9—Turn-on time vs. gate-trigger current.

T6000, T6001, T6006 Series

16-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

The RCA-T6000, T6001 and T6006 series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 16 amperes at a T_C of 80°C and repetitive off-state voltage ratings of 50 to 600 volts.

The T6001-series triacs are characterized for I^+ III^- gate triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

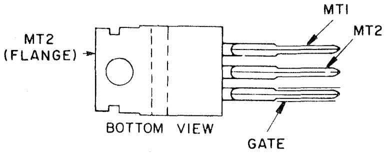
The T6006-series triacs are characterized for I^+ and III^+ gate-triggering modes only. They are intended for power-control applications in which integrated-circuit zero-crossing switches, such as the RCA-CA3059 series, are used as the triac-triggering circuits. The T6006-series triacs have gate characteristics which assure that a CA3059-series integrated circuit can supply sufficient gate current to trigger them over their full operating temperature range.

The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

Features:

- **150-A peak surge full-cycle current ratings**
- **Shorted-emitter center-gate design**
- **Low switching losses**
- **Low thermal resistance**
- **Package design facilitates mounting on a printed-circuit board**

TERMINAL DESIGNATIONS



92CS-27718

JEDEC TO-220AB

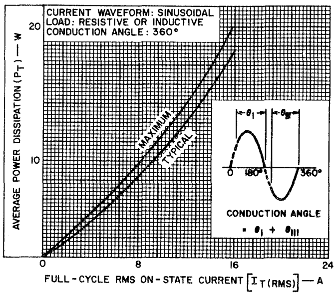
(See dimensional outline "S".)

Maximum Ratings, *Absolute-Maximum Values:*

<table>
<tr><th></th><th>T6000F
T6001F
—</th><th>T6000B
T6001B
T6006B</th><th>T6000C
T6001C
T6006C</th><th>T6000D
T6001D
T6006D</th><th>T6000E
T6001E
T6006E</th><th>T6000M
T6001M
T6606M</th><th></th></tr>
<tr><td>V_{DROM}● T_J = –65 to 110°C</td><td>50</td><td>200</td><td>300</td><td>400</td><td>500</td><td>600</td><td>V</td></tr>
<tr><td>I_{T(RMS)} T_C = 80°C, θ = 360°)</td><td colspan="6">16</td><td>A</td></tr>
<tr><td>For other conditions</td><td colspan="6">See Fig. 2</td><td></td></tr>
<tr><td>I_{TSM}</td><td colspan="6"></td><td></td></tr>
<tr><td>For one cycle of applied principal voltage</td><td colspan="6"></td><td></td></tr>
<tr><td>60 Hz (sinusoidal), T_C = 80°C.</td><td colspan="6">150</td><td>A</td></tr>
<tr><td>50 Hz (sinusoidal), T_C = 80°C.</td><td colspan="6">140</td><td>A</td></tr>
<tr><td>For more than one cycle of applied principal voltage</td><td colspan="6">See Fig. 3</td><td></td></tr>
<tr><td>di/dt</td><td colspan="6"></td><td></td></tr>
<tr><td>v_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs</td><td colspan="6">100</td><td>A/μs</td></tr>
<tr><td>I²t [At T_C shown for I_{T(RMS)}]:</td><td colspan="6"></td><td></td></tr>
<tr><td>t = 10 ms</td><td colspan="6">100</td><td>A²s</td></tr>
<tr><td>= 4.25 ms</td><td colspan="6">49</td><td>A²s</td></tr>
<tr><td>I_{GTM}■</td><td colspan="6"></td><td></td></tr>
<tr><td>For 1 μs max.</td><td colspan="6">4</td><td>A</td></tr>
<tr><td>P_{GM} (For 1 μs max., I_{GTM} ≤4 A)</td><td colspan="6">16</td><td>W</td></tr>
<tr><td>P_{G(AV)}</td><td colspan="6">0.5</td><td>W</td></tr>
<tr><td>T_{stg}</td><td colspan="6">–65 to 150</td><td>°C</td></tr>
<tr><td>T_C</td><td colspan="6">–65 to 110</td><td>°C</td></tr>
<tr><td>T_T (During soldering for 10 s max.)</td><td colspan="6">225</td><td>°C</td></tr>
</table>

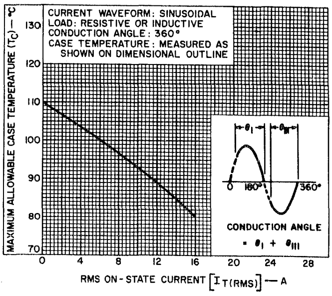
● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.



92CS-29277

Fig. 1 — Power dissipation vs on-state current.



92CS-29278

Fig. 2 — Maximum allowable case-temperature vs on-state current.

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}●				
$T_J = 110°C$, V_{DROM} = Max. rated value	–	0.1	1.2	mA
v_{TM}● T6000, T6006 Series	–	1.4	1.75	V
i_T = 30 A (peak), $T_C = 25°C$ T6001 Series	–	1.8	2.0	
I_{HO}●				
$v_D = 12$ V, $T_C = 25°C$ T6000 Series	–	15	35	mA
T6001 Series	–	20	50	
For other case temperatures	See Fig. 7			
dv/dt●▲ $v_D = V_{DROM}$, $I_{T(RMS)}$ = 16 A, di/dt = 8.5A/ms, $T_C = 80°C$	4	10	–	V/μs
dv/dt● $v_D = V_{DROM}$, $T_C = 100°C$				
T6000B, T6001B, T6006B	100	300	–	
T6000C, T6001C, T6006C	85	275	–	
T6000D, T6001D, T6006D	75	250	–	V/μs
T6000E, T6001E, T6006E	65	225		
T6000M, T6001M, T6006M	60	200	–	
I_{GT}●■ Mode V_{MT2} V_G				
v_D = 12 V (dc) I+ positive positive T6000 series	–	25	50	
$R_L = 30\ \Omega$ T6001 series	–	–	80	
$T_C = 25°C$ T6006 series	–	–	45	mA
III− negative negative T6000 series	–	25	50	
T6001 series	–	–	80	
I− positive negative T6000 series only	–	45	80	
III+ negative positive T6000 series only	–	45	80	mA
T6006	–	–	45	
For other case temperatures.	See Figs. 9 and 10			
V_{GT}●▲				
T6001 I+ III−	–	1.25	3.0	
v_D = 12 V (dc), $R_L = 30\ \Omega$, $T_C = 25°C$. T6006 I+ III+	–	1.25	1.5	V
T6000 all modes	–	1.25	2.5	
$v_D = V_{DROM}$, $R_L = 125\ \Omega$, $T_C = 100°C$	0.2	–	–	
For other case temperatures.	See Fig. 11			
t_{gt} $v_D = V_{DROM}$, I_{GT} = 80 mA, t_r = 0.1 μs, i_T = 25 A (peak), $T_C = 25°C$	–	1.6	2.5	μs
$R_{\theta JC}$	–	–	1.5	°C/W
$R_{\theta JA}$	–	–	50	°C/W

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

▲ Variants of these devices having dv/dt characteristics selected specifically for inductive loads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.

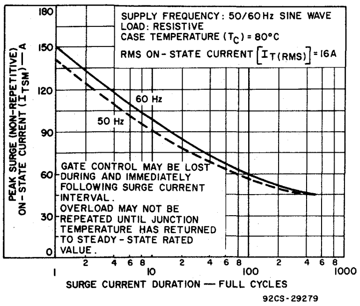


Fig. 3 — Peak surge on-state current vs surge current duration.

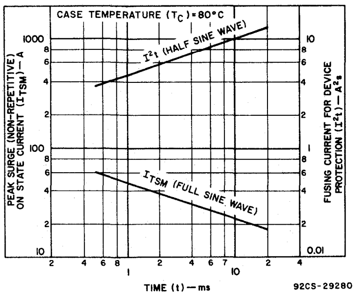


Fig. 4 — Peak surge on-state current and fusing-current vs time.

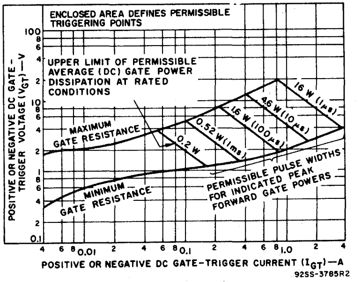


Fig. 5 — Gate pulse characteristics for all triggering modes.

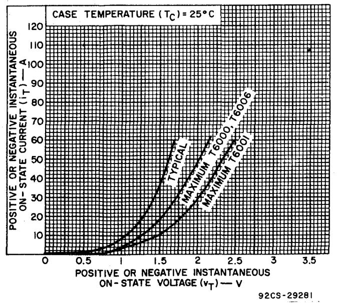


Fig. 6 — On-state current vs on-state voltage.

T6000, T6001, T6006 Series

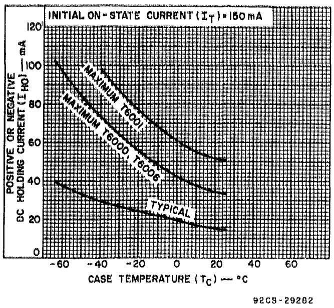


Fig. 7 — DC holding current vs case temperature.

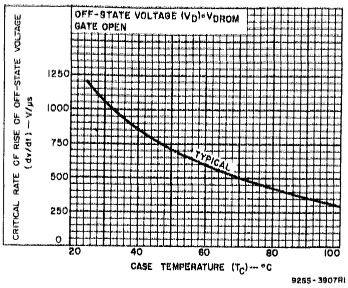


Fig. 8 — Typical critical rate-of-rise of off-state voltage vs case temperature.

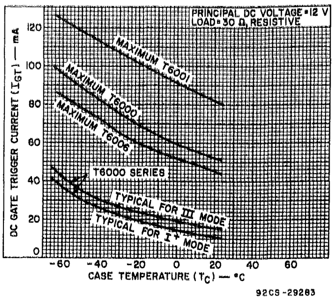


Fig. 9 — DC gate-trigger current (for I^+ and III^- triggering modes) vs case temperature.

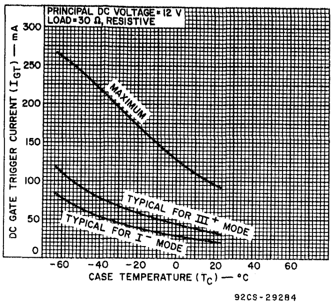


Fig. 10 — DC gate-trigger current (for I^- and III^+ triggering modes) vs case temperature for T6000-series only.

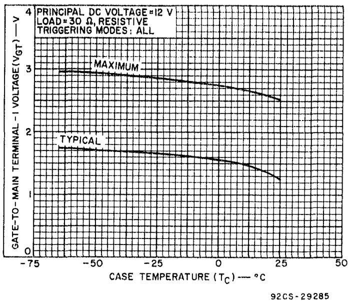


Fig. 11 — DC gate-trigger voltage vs case temperature for T6000 series only.

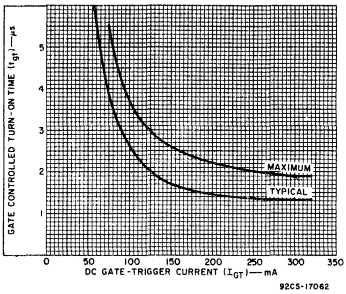


Fig. 12 — Turn-on time vs gate-trigger current.

2N6342A-2N6344A, 2N6346A-2N6348A (T6000) Series

12-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

The 2N6342A–44A, and 2N6346A–48A series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 12 amperes at a T_C of 80°C and repetitive off-state voltage ratings of 200, 400, and 600 volts. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

Features:

- **120-A peak surge full-cycle current ratings**
- **Shorted-emitter center-gate design**
- **Low switching losses**
- **Low thermal resistance**
- **Glass-passivated chip for stability**
- **Package design facilitates mounting on a printed-circuit board**

Maximum Ratings, ***Absolute-Maximum Values:***

<table>
<tr><th></th><th></th><th>2N6342A
2N6346A</th><th>2N6343A
2N6347A</th><th>2N6344A
2N6348A</th><th></th></tr>
<tr><td>*</td><td>V_{DROM}● $T_J = -40$ to 110°C</td><td>200</td><td>400</td><td>600</td><td>V</td></tr>
<tr><td>*</td><td>$I_{T(RMS)}$ $T_C = 80°C, \theta = 360°$</td><td colspan="3">12</td><td>A</td></tr>
<tr><td></td><td>For other conditions</td><td colspan="3">See Fig. 5</td><td></td></tr>
<tr><td></td><td>I_{TSM}</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>For one full cycle of applied principal voltage</td><td></td><td></td><td></td><td></td></tr>
<tr><td>*</td><td>60 Hz (sinusoidal), $T_C = 80°C$</td><td colspan="3">120</td><td>A</td></tr>
<tr><td></td><td>50 Hz (sinusoidal), $T_C = 80°C$</td><td colspan="3">113</td><td>A</td></tr>
<tr><td></td><td>For more than one cycle of applied principal voltage</td><td colspan="3">See Fig. 6</td><td></td></tr>
<tr><td></td><td>di/dt</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>$v_D = V_{DROM}, I_{GT} = 200$ mA, $t_r = 0.1$ μs</td><td colspan="3">100</td><td>A/μs</td></tr>
<tr><td></td><td>I^2t [At T_C shown for $I_{T(RMS)}$, half-sine wave]:</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>t = 10 ms</td><td colspan="3">64</td><td>A^2s</td></tr>
<tr><td></td><td>= 2.5 ms</td><td colspan="3">40</td><td>A^2s</td></tr>
<tr><td></td><td>= 0.5 ms</td><td colspan="3">23</td><td>A^2s</td></tr>
<tr><td>*</td><td>= 1 to 8.3 ms</td><td colspan="3">40</td><td>A^2s</td></tr>
<tr><td>*</td><td>I_{GTM}■</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>For 1 μs max.</td><td colspan="3">4</td><td>A</td></tr>
<tr><td>*</td><td>P_{GM} (For 1 μs max., $I_{GTM} \leqslant 4$ A)</td><td colspan="3">20</td><td>W</td></tr>
<tr><td>*</td><td>$P_{G(AV)}$</td><td colspan="3">0.5</td><td>W</td></tr>
<tr><td>*</td><td>T_{stg}</td><td colspan="3">−40 to 150</td><td>°C</td></tr>
<tr><td>*</td><td>T_C</td><td colspan="3">−40 to 110</td><td>°C</td></tr>
<tr><td>*</td><td>T_T (During soldering for 10 s max.)</td><td colspan="3">230</td><td>°C</td></tr>
</table>

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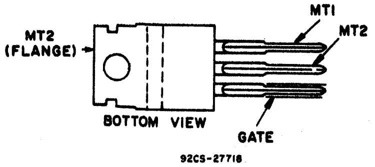
* In accordance with JEDEC registration data format JC-22 RDF-2.

● For either polarity to main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity to gate voltage (V_G) with reference to main terminal 1.

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S.")

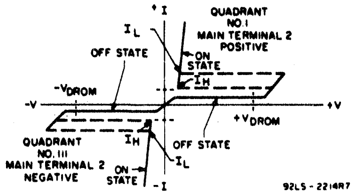


Fig. 1 – Principal voltage-current characteristic.

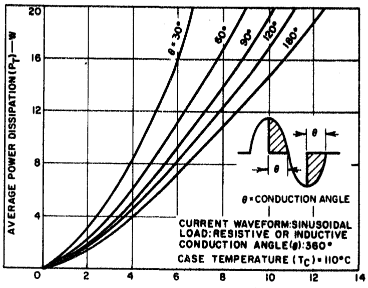


Fig. 2 – Power dissipation as a function of average on-state current.

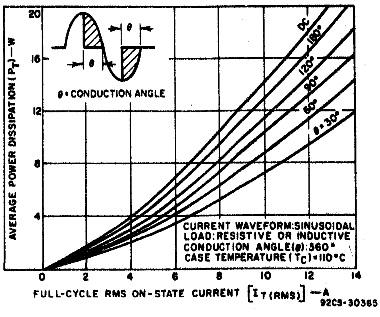


Fig. 3 – Power dissipation as a function of rms on-state current.

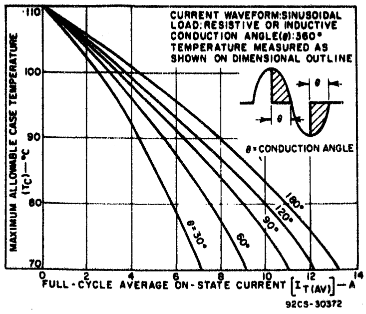


Fig. 4 – Maximum allowable case-temperature as a function of average on-state current.

2N6342A-2N6344A, 2N6346A-2N6348A (T6000) Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Uness Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified Min.	Typ.	Max.	UNITS
* I_{DROM}● T_J = 110°C, V_{DROM} = Max. rated value	–	–	2	mA
* V_{TM}● i_T = 17A (peak), T_C = 25°C	–	1.3	1.75	V
I_{HO}● Gate open, Initial principal current = 200 mA v_D = 12V, T_C = 25°C	–	6	40	mA
* = −40°C	–	–	75	
dv/dt● (Commutating) v_D = V_{DROM}, I_{TM} = 17A, di/dt = 6.5A/ms, T_C = 80°C	–	5	–	V/μs
dv/dt● (Off-State) v_D = V_{DROM}, T_C = 100°C				
2N6342A, 2N6346A	100	300	–	
2N6343A, 2N6347A	75	250	–	
2N6344A, 2N6348A	60	200	–	
I_{GT}●■ v_D = 12V (dc), R_L = 100Ω Mode V_{MT2} V_G				
T_C = 25°C 1+ + +	–	6	50	
III− − −	–	10	50	
1− + − (2N6346A-48A only)	–	6	75	
III+ − + (2N6346A-48A only)	–	25	75	mA
* T_C = −40°C 1+ + +	–	–	100	
* III− − −	–	–	100	
* 1− + − (2N6346A-48A only)	–	–	125	
* III+ − + (2N6346A-48A only)	–	–	125	
V_{GT}●■ v_D = 12V (dc), R_L = 100Ω Mode V_{MT2} V_G				
T_C = 25°C 1+ + +	–	0.9	2	
III− − −	–	1.1	2	
1− + − (2N6346A-48A only)	–	0.9	2.5	
III+ − + (2N6346A-48A only)	–	1.4	2.5	
* T_C = −40°C 1+ + +	–	–	2.5	
* III− − −	–	–	2.5	
* 1− + − (2N6346A-48A only)	–	–	3	V
* III+ − + (2N6346A-48A only)	–	–	3	
v_D = V_{DROM}, R_L = 10 kΩ T_J = 110°C 1+ + +	0.2	–	–	
III− − −	0.2	–	–	
1− + − (2N6346A-48A only)	0.2	–	–	
III+ − + (2N6346A-48A only)	0.2	–	–	
* t_{gt} v_D = V_{DROM}, I_{GT} = 120 mA, t_r = 0.1 μs, i_T = 17A (peak), T_C = 25°C	–	1.5	2	μs
* $R_{\theta JC}$	–	–	2	°C/W

* In accordance with JEDEC registration data format JC-22 RDF2.

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

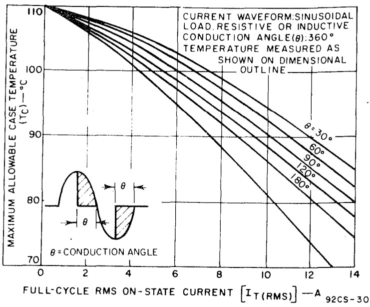


Fig. 5 — Maximum allowable case-temperature as a function of rms on-state current.

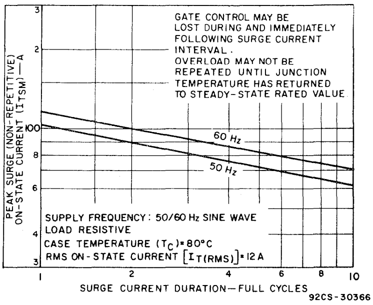


Fig. 6 — Peak surge on-state current as a function of surge current duration.

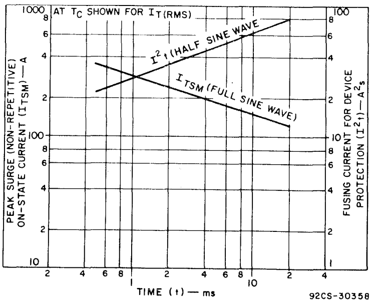


Fig. 7 — Peak surge on-state current and fusing current as a function of time.

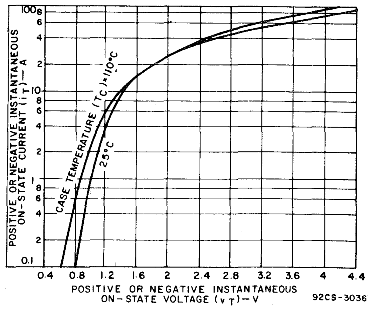


Fig. 8 — On-state current as a function of on-state voltage.

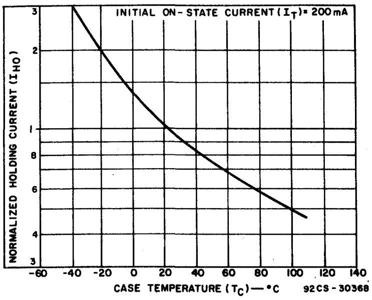


Fig. 9 – Normalized holding current as a function of case temperature.

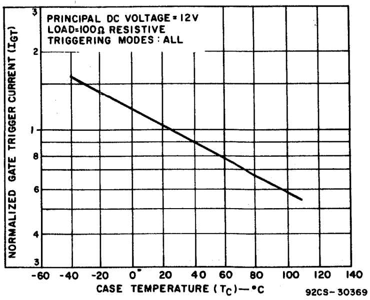


Fig. 10 – Normalized gate trigger current as a function of case temperature.

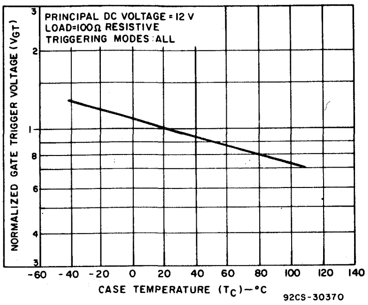


Fig. 11 – Normalized gate trigger voltage as a function of case temperature.

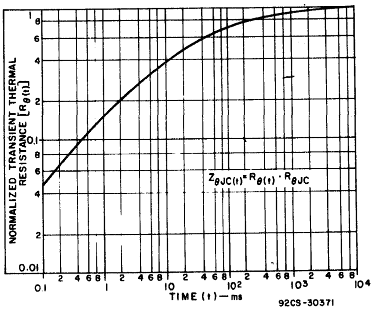


Fig. 12 – Normalized transient thermal resistance as a function of time.

MAC15, MAC15A (T6000) Series

15-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

The RCA-MAC15 and MAC15A series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

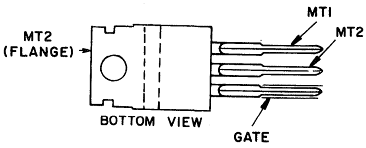
These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 12-A at T_C = 95°C and 15-A at T_C = 80°C and repetitive off-state voltage ratings, of 200, 400, and 600 volts.

The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

Features:

- 150-A peak surge full-cycle current ratings
- Shorted-emitter center-gate design
- Low switching losses
- Low thermal resistance
- Glass-passivated chip for stability
- Package design facilitates mounting on a printed-circuit board

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S".)

Maximum Ratings, *Absolute-Maximum Values:*

	MAC15-4 MAC15A-4	MAC15-6 MAC15A-6	MAC15-8 MAC15A-8	
V_{DROM}• T_J = –40 to 125°C	200	400	600	V
$I_{T(RMS)}$ θ = 360°:				
T_C = 95°C		12		A
= 80°C		15		A
For other conditions		See Fig. 3		
I_{TSM}:				
For one full cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$				
60 Hz (sinusoidal)		150		A
50 Hz (sinusoidal)		140		A
For more than one cycle of applied principal voltage		See Fig. 4		
di/dt				
$v_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs		100		A/μs
I_{GTM}■				
For 1 μs max.		2		A
P_{GM} (For 1 μs max., $I_{GTM} \leqslant 4$ A)		20		W
$P_{G(AV)}$		0.5		W
T_{stg}		–40 to 150		°C
T_C		–40 to 125		°C
T_T (During soldering for 10 s max.)		230		°C

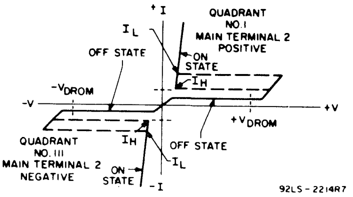


Fig. 1 – Principal voltage-current characteristic.

• For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

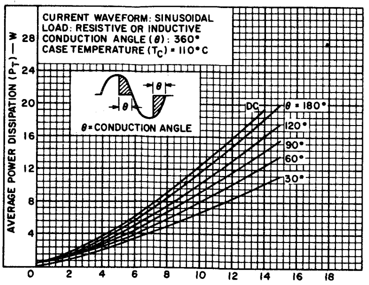


Fig. 2 – Power dissipation as a function of on-state current.

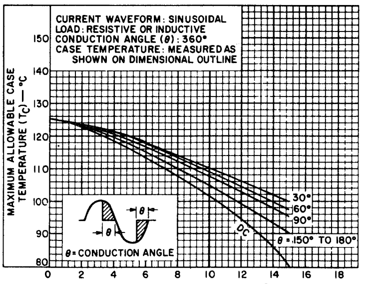


Fig. 3 – Maximum allowable case-temperature as a function of on-state current.

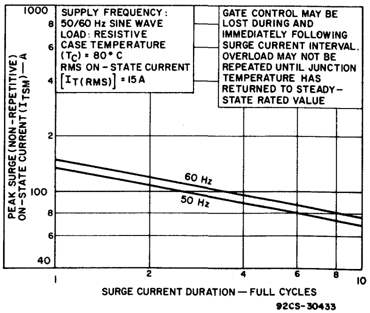


Fig. 4 – Peak surge on-state current as a function of surge current duration.

MAC15, MAC15A (T6000) Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}● V_{DROM} = Max. rated value, T_C = 125°C	–	–	2	mA
v_{TM}● T_C = 25°C, i_T = 21A (peak)	–	1.3	1.6	V
I_{HO}● Gate open, Initial principal current = 200 mA (dc) v_D = 12 V, T_C = 25°C	–	6	40	mA
dv/dt● (Commutating) v_D = V_{DROM}, i_T = 21A (peak) di/dt = 8 A/ms, T_C = 80°C	–	5	–	V/μs
I_{GT}●■ v_D = 12 V (dc), R_L = 100 Ω T_C = 25°C Mode V_{MT2} V_G I+ + +	–	–	50	mA
III– – –	–	–	50	
I– + – MAC15A series only	–	–	75	
III+ – + MAC15A series only	–	–	75	
V_{GT}●■ v_D = 12 V (dc), R_L = 100 Ω T_C = 25°C Mode V_{MT2} VG I+ + +	–	0.9	2	V
III– – –	–	1.1	2	
I– + – MAC15A series only	–	0.9	2.5	
III+ – + MAC15A series only	–	1.4	2.5	
T_C = 110°C v_D = V_{DROM}, R_L = 10 kΩ I+ + +	0.2	–	–	
III– – –	0.2	–	–	
I– + – MAC15A series only	0.2	–	–	
III+ – + MAC15A series only	0.2	–	–	
t_{gt} v_D = V_{DROM}, I_{GT} = 120 mA, t_r = 0.1 μs, i_T = 17A (peak), T_C = 25°C	–	1.5	2	μs
$R_{\theta JC}$	–	–	2	°C/W

- ● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
- ■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

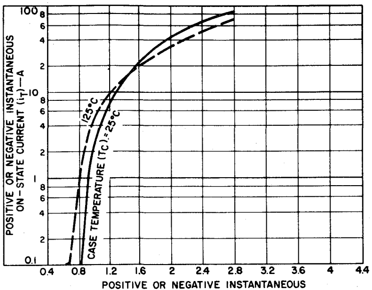


Fig. 5 – On-state current as a function of on-state voltage.

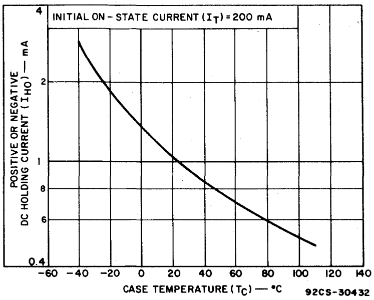


Fig. 6 – DC holding current as a function of case temperature.

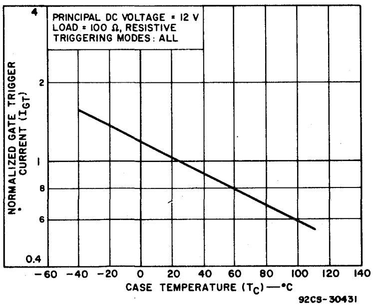


Fig. 7 – Normalized gate trigger current as a function of case temperature.

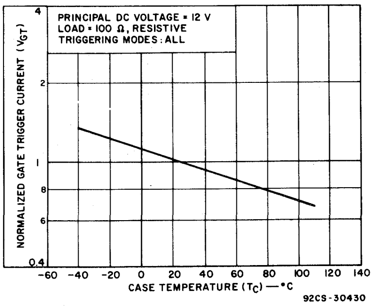


Fig. 8 – Normalized gate trigger voltage as a function of case temperature.

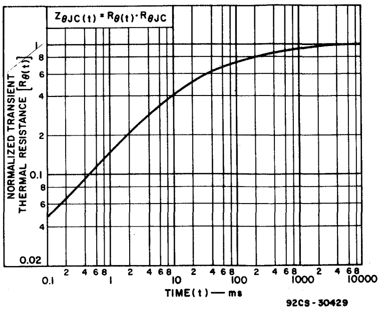


Fig. 9 – Normalized transient thermal resistance as a function of time.

T6260, T6261 Series

25-A Silicon Triacs

Isolated Flange, Quick-Connect Terminals – Compatible TO-3 Mounting

For General Purpose AC Power Switching Applications

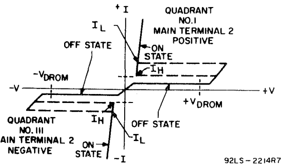


Fig. 1 – Principal voltage-current characteristic for both series.

Features:

- **di/dt Capacity = 100 A/μs**
- **Shorted-Emitter, Center- Gate Design**
- **Low Switching Losses**
- **Low On-State Voltage at High Current Levels**
- **Low Thermal Resistance**
- **2.5 kV RMS Isolation**
- **Recognized under the component program of Underwriters Laboratories, Inc. (File No. E76004)**

The RCA T6260 series and T6261 series triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off state to an on state for either polarity of applied voltage with positive or negative gate-triggering voltages.

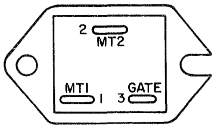
The types in these series utilize an RCA designed package JEDEC TO-238AA that features an isolated flange for ease of mounting and with good thermal conductivity; and rugged, quick-connect type terminals.

These triacs are intended for control of ac loads in applications such as microwave-oven controls, heating controls, motor controls, arc-welding equipment, light dimmers, and power-switching systems. They can also be used in air-conditioning and photocopying equipment.

The T6260 series triacs are characterized for all four triggering modes, I^+, III^-, I^-, and III^+.

The T6261 series triacs are characterized for I^+ and III^- gate triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

TERMINAL DESIGNATIONS



92CS-34148

TOP VIEW

JEDEC TO-238AA

(See dimensional outline "V".)

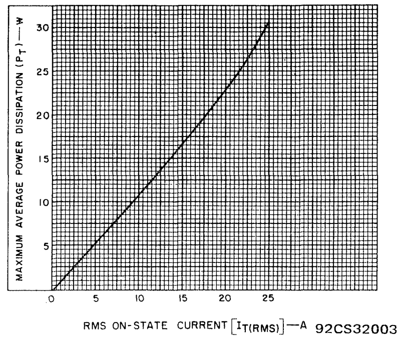


Fig. 2 – Power dissipation as a function of on-state current for both series.

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies Up to 50/60 Hz and with Resistive or Inductive Load.

	T6260B T6261B	T6260C T6261C	T6260D T6261D	T6260E T6261E	T6260M T6261M	
V_{DROM} :●						
Gate open, T_J = –40 to 110°C	200	300	400	500	600	V
$I_{T(RMS)}$ (θ = 360°):						
T_C = 75°C	25					A
For other conditions	See Fig. 3					
i_{TSM}:						
For one cycle of applied principal voltage						
60 Hz (sinusoidal), $I_{T(RMS)}$ and T_C as above	300					A
50 Hz (sinusoidal), $I_{T(RMS)}$ and T_C as above	280					A
For more than one cycle of applied principal voltage	See Fig. 4					
di/dt:						
$V_{DM} = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs (See Fig. 14)	100					A/μs
I^2t [At T_C shown for $I_{T(RMS)}$, half-sine wave]:						
t = 20 ms	500					A^2s
8.3 ms	370					A^2s
0.5 ms	145					A^2s
I_{GTM} :■						
For 1 μs max. (See Fig. 8)	12					A
P_{GM}:						
Peak (For 10 μs max., $I_{GTM} \leq$ 4A (peak), (See Fig. 8)	40					W
$P_{G(AV)}$	0.75					W
T_{stg}▲	-40 to 125					°C
T_C▲	-40 to 110					°C
T_T▲						
During soldering for 10 s maximum	225					°C
Isolation Voltage (Terminals to flange)	2500					V_{RMS}

●For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲For temperature measurement reference point, see Dimensional Outline.

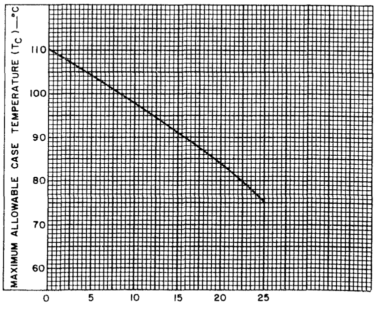


Fig. 3 – Maximum allowable case-temperature as a function of on-state current for both series.

T6260, T6261 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}• V_{DROM} = Max. rated value, gate open, T_C = 110°C	–	0.2	4	mA
V_{TM}• T_C = 25°C, i_T = 100A (peak),	–	1.5	2	V
= 56A (peak)	–	1.35	1.85	
I_{HO}• Gate open, initial principal current = 500 mA (dc) V_D = 12 V, T_C = 25°C	–	25	60	mA
For other case temperatures	See Fig. 7			
dv/dt• (Commutating) (See Fig. 15) V_D = V_{DROM}, $I_{T(RMS)}$ = Max. rated value, di/dt = 13 A/ms, gate unenergized, T_C = 75°C	5	30	–	V/µs
dv/dt• (Off-State) V_D = V_{DROM}, exponential voltage rise, gate open, T_C = 110°C — V_D = 200 V	50	200	–	
300, 400 V	30	150	–	
500, 600 V	20	100	–	
I_{GT}•■ V_D = 12 V (dc), R_L = 30Ω, T_C = 25°C Mode V_{MT2} V_G				mA
T6260 I+ + +	–	15	50	
T6260 III– – –	–	20	50	
T6260 I– + –	–	30	80	
T6260 III+ – +	–	40	80	
T6261 I+ + +	–	–	80	
T6261 III– – –	–	–	80	
For other case temperatures	See Fig. 9, 10			
V_{GT}•■ V_D = 12 V (dc), R_L = 30Ω, T_C = 25°C (See Fig. 11) T6260	–	1.1	2.5	V
T6261	–	1.5	3	
t_{gt} (See Fig. 12, 16) V_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 µs, i_T = 60A (peak), T_C = 25°C	–	1.7	–	µs
$R_{\theta JC}$	–	–	1.1	°C/W

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■For either polarity of gate voltage (V_G) with reference to main terminal 1.

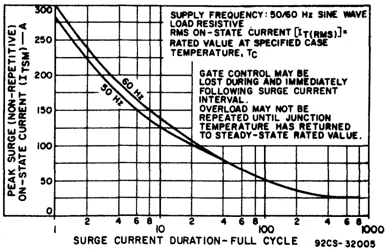


Fig. 4 – Peak surge on-state current as a function of surge current duration for both series.

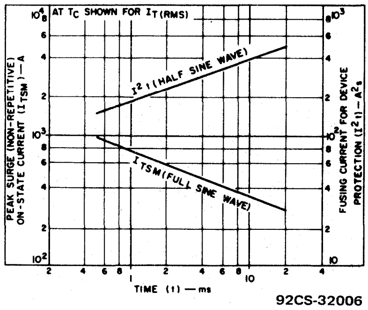


Fig. 5 – Peak surge on-state current and fusing current as a function of time for both series.

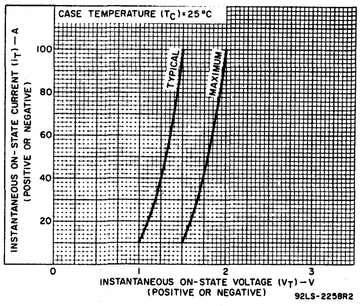


Fig. 6 – On-state current as a function of on-state voltage for both series.

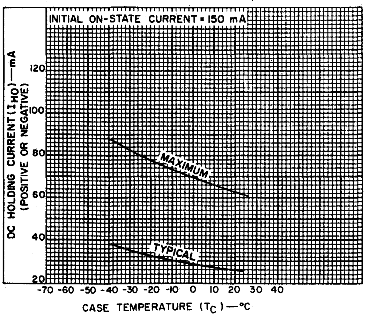


Fig. 7 – DC holding current as a function of case temperature for both series.

T6260, T6261 Series

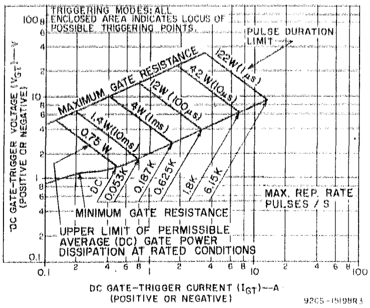


Fig. 8 — Gate-trigger characteristics and limiting conditions for determination of permissable gate-trigger pulses for both series.

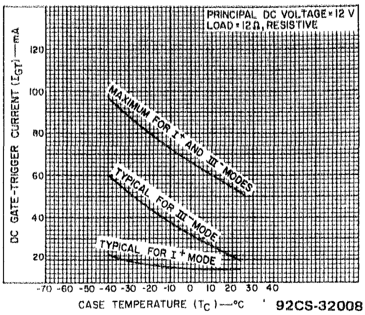


Fig. 9 — DC gate-trigger current vs. case temperature (I^+ & III^- modes) for both series.

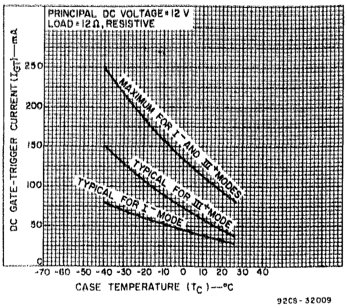


Fig. 10 — DC gate-trigger current vs. case temperature (I^- & III^+ modes) for both series.

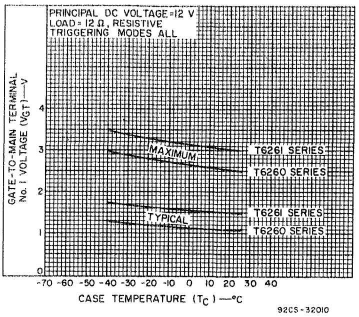


Fig. 11 — DC gate-trigger voltage vs. case temperature for both series.

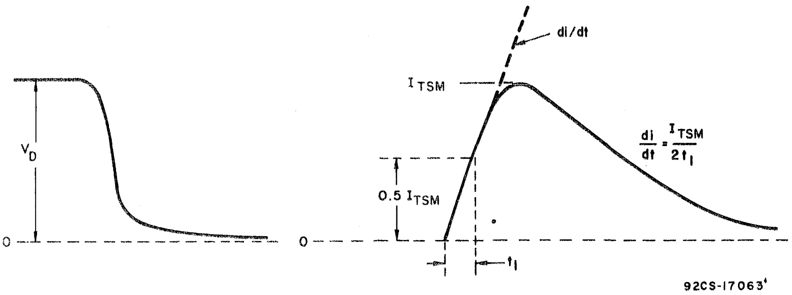


Fig. 14 — Rate-of-change of on-state current with time (defining di/dt) for both series.

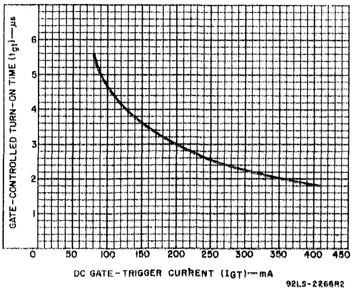


Fig. 12 — Turn-on time vs. gate-trigger current.

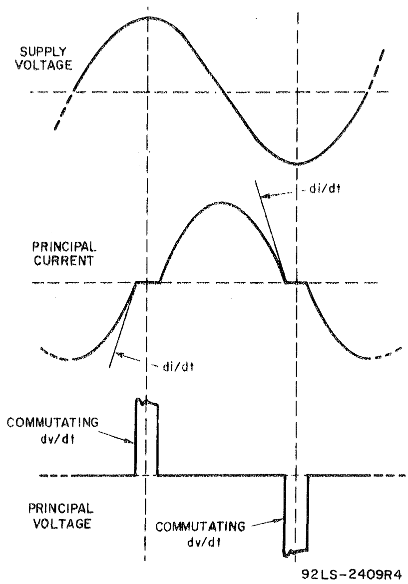


Fig. 15 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

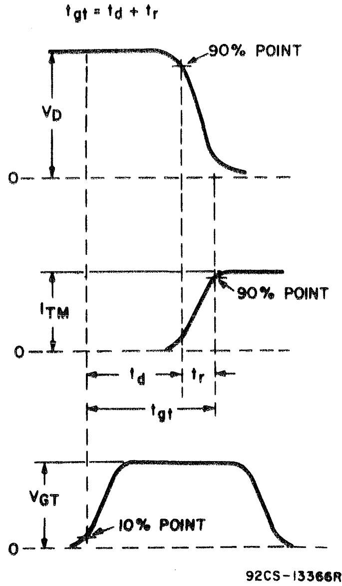


Fig. 16 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

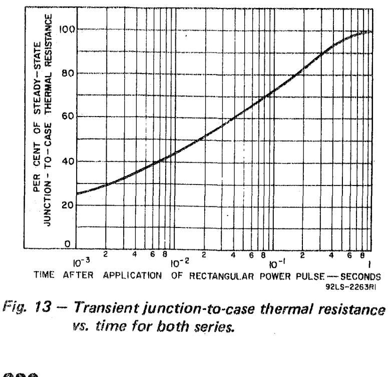


Fig. 13 — Transient junction-to-case thermal resistance vs. time for both series.

T6400, T6401, T6410, T6411, T6420, T6421 Series
(Includes 2N5441-2N5446, 2N5806-2N5809)

25-A, 30-A and40-A Silicon Triacs

For General Purpose AC Power Switching Application
All 30-A and 40-A Triacs

For Control-Systems Application in Airborne and Ground Support Type Equipment
25-A, 400-Hz Triacs (2N5806-2N5809)

Features:

- di/dt Capability = 100 A/μs
- Shorted-Emitter, Center-Gate Design
- Low Switching Losses
- Low On-State Voltage at High Current Levels
- Low Thermal Resistance

Additional Features for the 2N5806-2N5809:

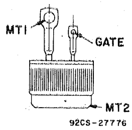
- Available in JAN
- Commutating dv/dt capability Characterized at 400 Hz

These RCA triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

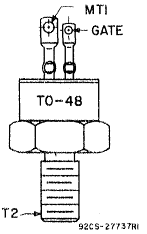
These triacs are intended for control of ac loads in applications such as heating controls, motor controls, arc-welding equipment, light dimmers, and power switching systems. They can also be used in air-conditioning and photocopying equipment.

Types 2N5441-43 and T6401 series employ a press-fit package. Types 2N5444-46, 2N5806-09, and T6411 series employ a stud package. T6421 series and T6421 series employ an isolated-stud package.

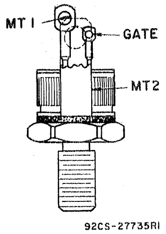
TERMINAL CONNECTIONS



2N5441-43 T6401 series
Press-Fit Types
(See dimensional outline "U.")



2N5444-46,
2N5806-09, T6411 series
Stud Types
(See dimensional outline "Y.")



T6420 series,
T6421 series
Isolated-Stud Types

(See dimensional outline "X.")

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/400 Hz and with Resistive or Inductive Load.

		40-A	–	2N5441	2N5442	–	2N5443	
			–	2N5444	2N5445	–	2N5446	
			T6420F	T6420B	T6420D	T6420E	T6420M	
		30-A	T6401F	T6401B	T6401D	T6401E	T6401M	
			T6411F	T6411B	T6411D	T6411E	T6411M	
			T6421F	T6421B	T6421D	T6421E	T6421E	
		25-A	–	2N5806	2N5807	2N5808	2N5809	
*REPETITIVE PEAK OFF-STATE VOLTAGE:●	V_{DROM}							
Gate open, T_J = −65 to 110°C			50	200	400	500	600	V
RMS ON-STATE CURRENT (Conduction angle = 360°):	$I_{T(RMS)}$							
Case temperature								
T_C = 70°C (2N5441;43, –Press-fit types)			40					A
= 65°C (2N5444-46, –Stud types)			40					A
= 60°C (T6420 series – Isolated-stud types)			40					A
= 65°C (T6401 series – Press-fit types)			30					A
= 60°C (T6411 series – Stud types)			30					A
= 55°C (T6421 series – Isolated-stud types)			30					A
= 80°C (2N5806-2N5809 – Stud types)			25					A
For other conditions			See Figs. 4, 5, 6					
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}							
For one cycle of applied principal voltage, T_C as above								
* 60 Hz (sinusoidal - 30-A & 40-A types)			300					A
50 Hz (sinusoidal - 30-A & 40-A types)			265					A
400 Hz (sinusoidal - 25-A types)			370					A
* 60 Hz (sinusoidal - 25-A types)			200					A
50 Hz (sinusoidal - 25-A types)			170					A
For more than once cycle of applied principal voltage			See Figs. 7, 8, 9					
RATE OF CHANGE OF ON-STATE CURRENT:	di/dt							
$V_{DM} = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs			100					A/μs
FUSING CURRENT (For Triac Protection):	I^2t							
[At T_C shown for $I_{T(RMS)}$]:								
t = 20 ms (30-A & 40-A types)			500					A^2s
= 2.5 ms (30-A & 40-A types)			250					A^2s
= 0.5 ms (30-A & 40-A types)			145					A^2s
= 20 ms (25-A types)			240					A^2s
= 2.5 ms (25-A types)			110					A^2s
=0.5 ms (25-A types)			65					A^2s
*PEAK GATE-TRIGGER CURRENT:■	I_{GTM}							
For 1 μs max., See Fig. 15 (30-A and 40-A types only)			12					A
*GATE POWER DISSIPATION:								
PEAK (For 10 μs max., $I_{GTM} \leqslant 4$ A, –30-A & 40-A types)	P_{GM}		40					W
– 25-A types)	P_{GM}		10					W
AVERAGE (30-A & 40-A types)	$P_{G(AV)}$		0.75					W
(25-A types, t = 16.6 ms)	$P_{G(AV)}$		0.5					W
*TEMPERATURE RANGE:▲								
Storage (20-A & 40-A types)	T_{stg}		−65 to 150					°C
(25-A types)	T_{stg}		−55 to 125					°C
Operating (Case) – 40-A types	T_C		−65 to 110					°C
– 30-A types	T_C		−65 to 100					°C
– 25-A types	T_C		−40 to 115					°C
*TERMINAL TEMPERATURE:	T_T							
During soldering for 10 s max. (terminals and case)								
30-A & 40-A types			225					°C
25-A types			260					°C
STUD TORQUE:	τ_s							
Recommended			35					in-lb
			0.4					kgf-m
Maximum (DO NOT EXCEED)			50					in-lb
			0.57					kgf-m

WARNING: The ceramic of the isolated stud package contains beryllium oxide. Do not crush, grind, or abrade this part because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

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* In accordance with JEDEC registration data format (JS-14, RDF 2) filed for the JEDEC (2N-Series) types.
● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see Dimensional Outline.

T6400, T6401, T6410, T6411, T6420, T6421 Series (Includes 2N5441-2N5446,2N5806-2N5809)

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTICS	SYMBOL	LIMITS MIN.	LIMITS TYP.	LIMITS MAX.	UNITS
Peak Off-State Current:♠ Gate open, V_{DROM} = Max. rated value					
T_J = 110°C, (40-A types)	I_{DROM}	–	0.2	4*	mA
= 100°C, (30-A types)		–	0.2	4	
= 115°C, (25-A types)		–	0.2	2*	
Maximum On-State Voltage:♠					
For i_T = 100 A (peak), T_C = 25°C, (40-A types)	V_{TM}	–	1.7	2	V
For i_T = 56 A (peak), T_C = 25°C, (40-A types)		–	1.5	1.85*	
For i_T = 100 A (peak), T_C = 25°C, (30-A types)		–	2.1	2.5	
= 35 A (peak), pulse width ≤ 1 ms, duty cycle ≤ 2%, I_G = 150 mA, T_C = 25°C (25-A types)		–	1.3	1.6*	
DC Holding Current:♠ Gate open, Initial principal current = 500 mA (dc), v_D = 12V:					
T_C = 25°C (30-A & 40-A types)	I_{HO}	–	25	60	mA
= 25°C (25-A types)		–	30	75	
= −65°C (40-A types)		–	–	100*	
= −40°C (25-A types)		–	45	100*	
For other case temperatures		See Figs. 13 & 14			
Critical Rate of Rise of Commutation Voltage:♠ v_D = V_{DROM}, $I_{T(RMS)}$ = 40 A, commutating di/dt = 22 A/ms, gate unenergized,					
T_C = 70°C (40-A, Press-fit types)	dv/dt	5*	30	–	V/µs
= 65°C (40-A, Stud-types)		5*	30	–	
= 60°C (40-A, Isolated-stud types)		5*	30	–	
v_D = V_{DROM}, $I_{T(RMS)}$ = 30 A, commutating di/dt = 16 A/ms, gate unenergized,					
T_C = 65°C (30-A, Press-fit types)		3	20	–	
= 60°C (30-A, Stud types)		3	20	–	
= 55°C, (30-A, Isolated-stud types)		3	20	–	
v_D = V_{DROM}, $I_{T(RMS)}$ = 25 A, commutating di/dt = 88 A/ms, gate unenergized					
T_C = 80°C (25-A, Stud types)		5	–	–	
Critical Rate-of-Rise of Off-State Voltage:♠ For v_D = V_{DROM}, exponential voltage rise, gate open T_C = 110°C (40-A types):					
2N5441, 2N5444, T6420B	dv/dt	50*	200	–	V/µs
2N5442, 2N5445, T6420D		30*	150	–	
2N5443, 2N5446, T6420M		20*	100	–	
T_C = 100°C (30-A types):					
T6401B, T6411B, T6421B		40	200	–	
T6401D, T6411D, T6421D		25	150	–	
T6401M, T6411M, T6421M		20	100	–	
T_C = 115°C (25-A types)		20	100	–	
DC Gate-Trigger Current:♠♦ v_D = 12 V (dc) R_L = 30Ω T_C = 25°C Mode V_{MT2} V_G					
I⁺ positive positive (40-A & 30-A types)	I_{GT}	–	15	50	mA
(25-A types)		–	20	80	
III⁻ negative negative (40-A & 30-A types)		–	20	50	
(25-A types)		–	50	80	
I⁻ positive negative (40-A & 30-A types)		–	30	80	
(25-A types)		–	80	80	
III⁺ negative positive (40-A & 30-A types)		–	40	80	
(25-A types)		–	100	150	
v_D = 12 V (dc) R_L = 30Ω T_C = −65°C Mode V_{MT2} V_G					
I⁺ positive positive (40-A types only)		–	–	125*	
III⁻ negative negative (40-A types only)		–	–	125*	
I⁻ positive negative (40-A types only)		–	–	240*	
III⁺ negative positive (40-A types only)		–	–	240*	
v_D = 12 V (dc) R_L = 25Ω T_C = 40°C Mode V_{MT2} V_G					
I⁺ positive positive (25-A types only)		–	32	120	
III⁻ negative negative (25-A types only)		–	98	120	
I⁻ positive negative (25-A types only)		–	–	170	
III⁺ negative positive (25-A types only)		–	–	–	
DC Gate-Trigger Voltage:♠♦ v_D = 12 V (dc), R_L = 30Ω,					
T_C = 25°C (30-A & 40-A types)	V_{GT}	–	1.35	2.5	V
= −65°C (40-A types only)		–	1.8	3.4*	
For other case temperatures		See Fig. 20			
v_D = V_{DROM}, R_L = 125Ω, T_C = 110°C (40-A types)		0.2	–	–	
= 100°C (30-A types)		0.2	–	–	

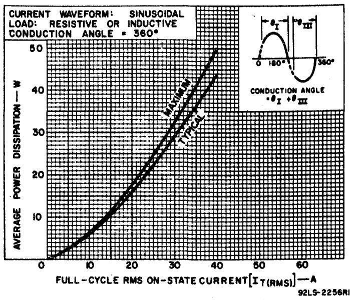

Fig. 1 — Power dissipation vs. on-state current for 2N5441-46, and T6420 series.

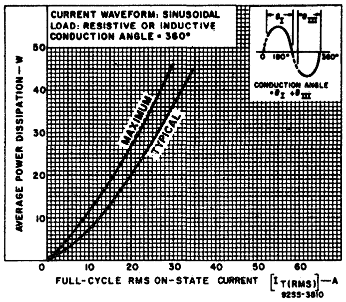

Fig. 2 — Power dissipation vs. on-state current for T6401, T6411, T6421 series.

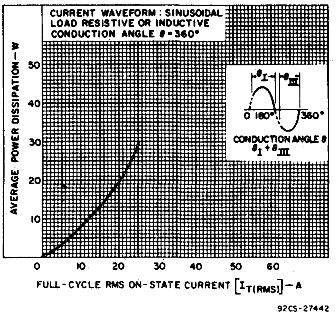

Fig. 3 — Power dissipation vs. on-state current for 2N5806-2N5809.

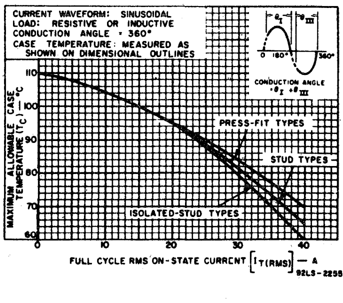

Fig. 4 — Maximum allowable case temperature vs. on-state current for 2N5441-46, and 6420 series.

T6400, T6401, T6410, T6411, T6420, T6421 Series (Includes 2N5441-2N5446, 2N5806-2N5809)

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTICS	SYMBOL	LIMITS			UNITS
		MIN.	TYP.	MAX.	
DC Gate-Trigger Voltage: ♠♦					
v_D = 12 V (dc), R_L = 25Ω					
Triggering Modes I^+, III^-, I^- (25-A types), T_C = 25°C	V_{GT}	–	2	2.5	V
= −40°C		–	2.6	4*	
Triggering Modes III^+ (25-A types), T_C = 25°C		–	3	4	
v_D = 12 V (dc), R_L = 1 kΩ,					
Triggering Modes I^+, III^-, I^- (25-A types): T_C = 115°C		0.15	–	–	
Gate-Controlled Turn-On Time:					
(Delay Time + Rise Time)					
$v_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs, i_T = 60 A (peak), T_C = 25°C (40-A types)	t_{gt}	–	1.7	3	μs
$v_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs, i_T = 45 A (peak), T_C = 25°C (30-A types)		–	1.7	3	
$v_D = V_{DROM}$, I_{GT} = 150 mA, t_r = 0.1 μs, i_T = 60 A (peak), T_C = 25°C (25-A types)		–	1.6	–	
Thermal Resistance, Junction-to-Case:					
Steady-State					
Press-fit types	$R_{\theta JC}$	–	–	0.8*	°C/W
Stud types		–	–	0.9*	
Stud types (25-A types only)		–	1	1.23*	
Isolated-stud types		–	–	1	
Transient (Press-fit & stud types)		See Fig. 24			
Thermal Resistance, Junction-to-Ambient					
Steady-State (25-A types only)	$R_{\theta JA}$	–	–	50*	

* In accordance with JEDEC registration data format (JS-14, RDF 2) field for the JEDEC (2N-Series) types.

♠ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

♦ For either polarity of gate voltage (V_G) with reference to main terminal 1.

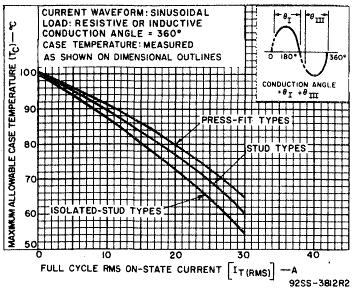

Fig. 5 – Maximum allowable case temperature vs. on-state current for T6401, T6411, T6421 series.

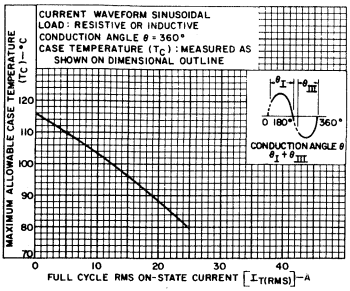

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Fig. 6 – Maximum allowable case temperature vs. on-state current for 2N5806-2N5809.

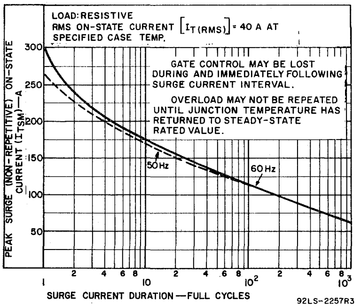


Fig. 7 – Peak surge on-state current vs. surge current duration for 2N5441-46, and T6420 series.

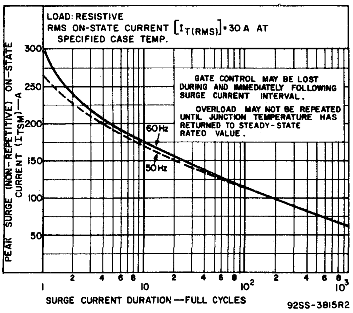


Fig. 8 – Peak surge on-state current vs. surge current duration for T6401, T6411, T6421 series.

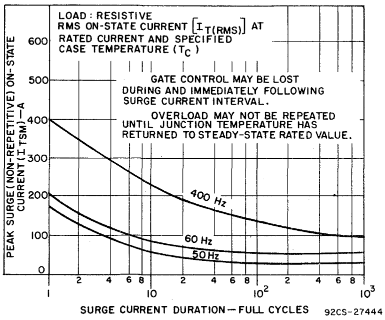


Fig. 9 – Peak surge on-state current vs. surge current duration for 2N5806-2N5809.

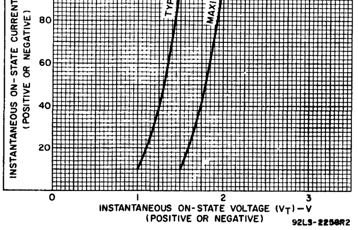


Fig. 10 – On-state current vs. on-state voltage for 2N5441-46, and T6420 series.

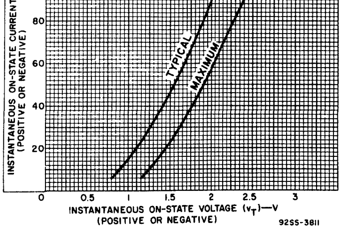


Fig. 11 – On-state current vs. on-state voltage for T6401, T6411, T6421 series.

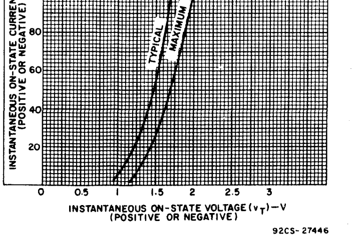


Fig. 12 – On-state current vs. on-state voltage for 2N5806-2N5809.

T6400, T6401, T6410, T6411, T6420, T6421 Series (Includes 2N5441-2N5446, 2N5806-2N5809)

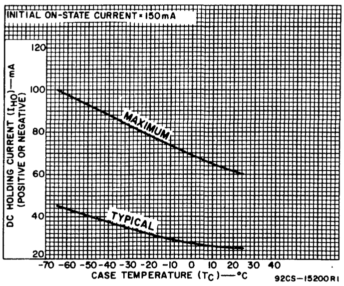


Fig. 13 — DC holding current vs. case temperature for 2N5441-46, T6420, T6401, T6411, T6421 series.

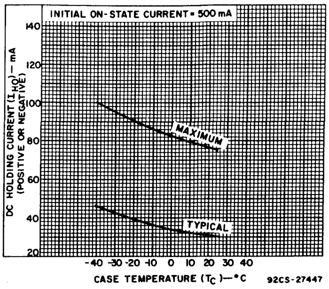


Fig. 14 — DC holding current vs. case temperature for 2N5806-2N5809 series.

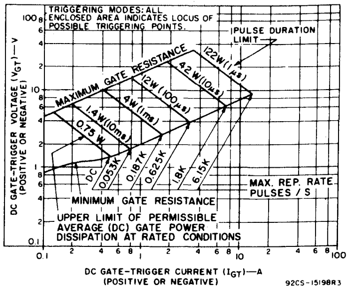


Fig. 15 — Gate-trigger characteristics and limiting conditions for determination of permissable gate-trigger pulses for 2N5441-46, T6420, T6401, T6411, T6421 series.

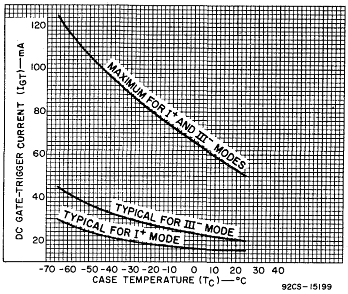


Fig. 16 — DC gate-trigger current vs. case temperature (1^+ & III^- modes) for 2N5441-46, T6420, T6401, T6411, T6421 series.

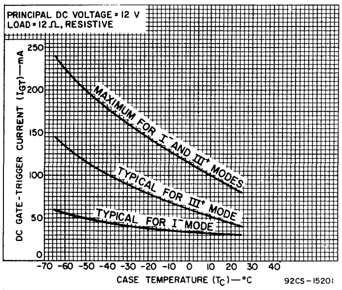


Fig. 17 — DC gate-trigger current vs. case temperature (I^- & III^+ modes) for 2N5441-46, T6420, T6401, T6411, T6421 series.

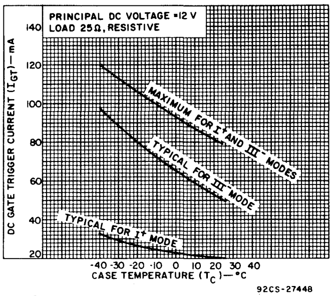


Fig. 18 — DC gate-trigger current vs. case temperature (1^+ & III^- modes) for 2N5806-2N5809.

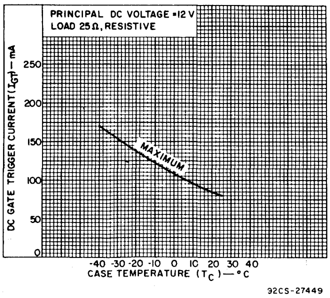


Fig. 19 — DC gate-trigger current vs. case temperature (1^- mode) for 2N5806-2N5809.

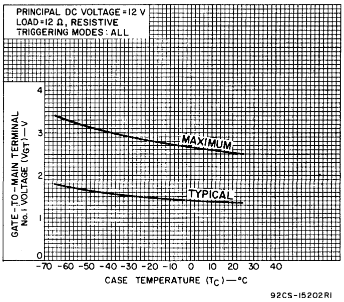


Fig. 20 — DC gate-trigger voltage vs. case temperature for 2N5441-46, T6420, T6401, T6411, T6421 series.

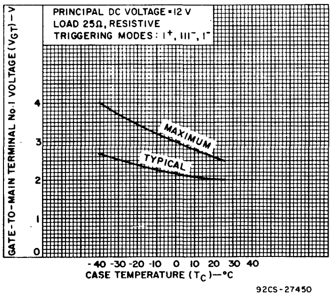


Fig. 21 — DC gate-trigger voltage vs. case temperature for 2N5806-2N5809.

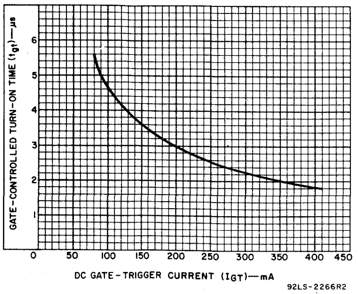


Fig. 22 — Turn-on time vs. gate-trigger current for 2N5441-46, T6420, T6401, T6411, T6421 series.

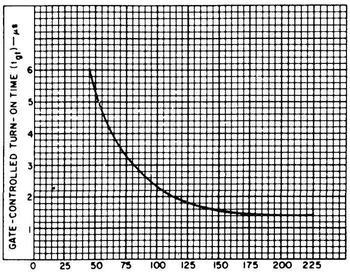


Fig. 23 — Typical turn-on time vs. gate-trigger current for 2N5806-2N5809.

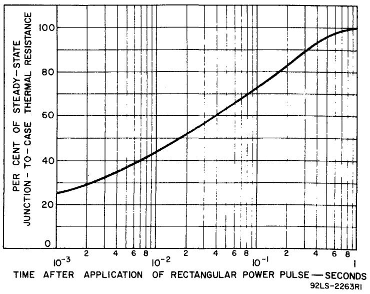


Fig. 24 — Transient junction-to-case thermal resistance vs. time for press-fit and stud types.

T6404, T6405, T6414, T6415 Series

400-Hz, 25 & 40-A Silicon Triacs

For Control-Systems Application in Airborne and Ground-Support Type Equipment

These RCA triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

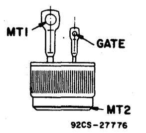
They are intended for operation at 400 Hz with resistive or inductive loads and nominal line voltages of 115 and 208 V RMS sine wave and repetitive peak off-state voltages of 200 V and 400 V.

These triacs exhibit commutating voltage (dv/dt) capability at high commutating current (di/dt). They can also be used in 60-Hz applications where high commutating capability is required.

Features:

- **RMS On-State Current –**
  $I_{T(RMS)}$ = 25A: T6405 and T6415 Series
  = 40A: T6404 and T6414 Series
- **Commutating dv/dt Capability Characterized at 400 Hz**
- **Shorted-Emitter Center-Gate Design**
- **di/dt Capability = 100 A/µs**

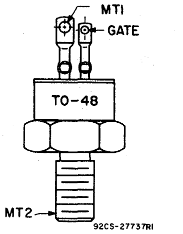
TERMINAL CONNECTIONS



T6404 Series
T6405 Series

Press-fit

(See dimensional outline "U".)



T6414 Series
T6415 Series

Stud

(See dimensional outline "Y".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at 400 Hz and with Resistive or Inductive Load.

		T6404B T6405B T6414B T6415B	T6404D T6405D T6414D T6415D	T6404E T6405E – –	
REPETITIVE PEAK OFF-STATE VOLTAGE:*					
Gate open, T_J = –50 to 110° C	V_{DROM}	200	400	500	V
RMS ON-STATE CURRENT (Conduction Angle = 360°):	$I_{T(RMS)}$				
Case temperature					
T_C = 85° C (T6405 Series)		25			A
80° C (T6415 Series)		25			A
70° C (T6404 Series)		40			A
65° C (T6414 Series)		40			A
For other conditions		*See Fig. 2*			
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}				
For one cycle of applied principal voltage, T_C as above					
400 Hz (sinusoidal)		600			A
60 Hz (sinusoidal)		300			A
50 Hz (sinusoidal)		265			A
For more than one cycle of applied principal voltage		See *Fig. 3*			
RATE-OF-CHANGE OF ON-STATE CURRENT:	di/dt				
V_{DM} = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 µs		100			A/µs
FUSING CURRENT (for Triac Protection):	I^2t				
T_J = –50 to 110° C, t = 1.25 to 10 ms		270			A^2s
PEAK GATE-TRIGGER CURRENT:■	I_{GTM}				
For 1 µs max. *(See Fig. 7)*		12			A
GATE POWER DISSIPATION:					
Peak (For 10 µs max., I_{GTM} ≤4 A (peak), *(See Fig. 7)*	P_{GM}	42			W
Average	$P_{G(AV)}$	0.75			W
TEMPERATURE RANGE:▲					
Storage	T_{stg}	–50 to 150			°C
Operating (Case)	T_C	–50 to 110			°C
TERMINAL TEMPERATURE (During soldering):	T_T				
For 10 s max. (terminals and case)		225			°C
STUD TORQUE:					
Recommended	τ_s	35			in.-lb
Maximum (DO NOT EXCEED)		50			in.-lb

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* For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see Dimensional Outline.

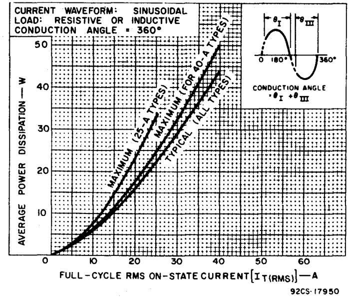


Fig. 1—Power dissipation vs. on-state current.

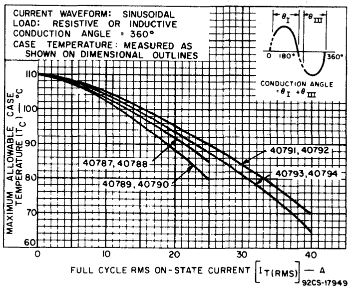


Fig. 2—Maximum allowable case temperature vs. on-state current.

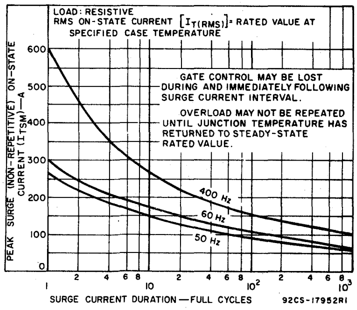


Fig. 3—Peak surge on-state current vs. surge current duration.

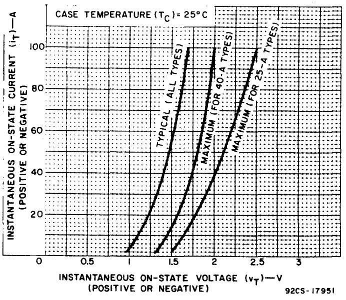


Fig. 4—On-state current vs. on-state voltage.

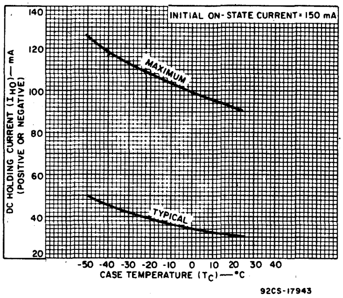


Fig. 5—DC holding current vs. case temperature.

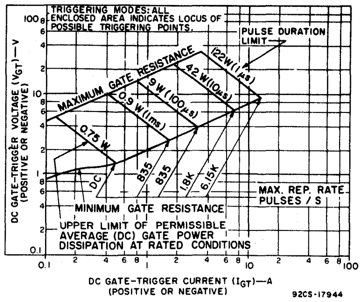


Fig. 6—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

T6404, T6405, T6414, T6415 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS			UNITS
		Min.	Typ.	Max.	
Peak Off-State Current:♠					
Gate open, T_J = 110° C, V_{DROM} = Max. rated value	I_{DROM}	–	0.2	4	mA
Maximum On-State Voltage:♠					
For i_T = 100 A (peak), T_C = 25° C:	V_{TM}				V
T6405 & T6415 Series		–	1.7	2.5	
T6404 & T6414 Series		–	1.7	2	
DC Holding Current:♠					
Gate open, Initial principal current = 500 mA (DC), v_D = 12 V, T_C = 25° C	I_{HO}	–	30	90	mA
For other case temperatures		See Fig. 5			
Critical Rate-of-Rise of Commutation Voltage:♠					
For v_D = V_{DROM}, $I_{T(RMS)}$ = rated value, gate unenergized,					
Commutating di/dt = 88 A/ms					
T_C = 85° C (T6405 Series)	dv/dt	2	–	–	V/µs
= 80° C (T6415 Series)		2	–	–	
Commutating di/dt = 141 A/ms					
T_C = 70° C (T6404 Series)		2	–	–	
= 65° C (T6414 Series)		2	–	–	
Critical Rate-of-Rise of Off-State Voltage:♠					
For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 110° C:	dv/dt				V/µs
T6405 & T6415 Series		30	150	–	
T6404 & T6414 Series		50	200	–	
DC Gate-Trigger Current:♠† Mode / V_{MT2} / V_G					
For v_D = 12 V (DC), I$^+$ positive positive	I_{GT}	–	20	80	mA
R_L = 30 Ω, III$^-$ negative negative		–	50	80	
T_C = 25° C I$^-$ positive negative		--	80	120	
III$^+$ negative positive		–	80	120	
For other case temperatures		See Figs. 7& 8			
DC Gate-Trigger Voltage:♠†					
For v_D = 12 V(DC), R_L = 30 Ω, T_C = 25° C	V_{GT}	–	2	3	V
For other case temperatures		See Fig. 9			
For v_D = V_{DROM}, R_L = 125 Ω, T_C = 110° C		0.2	–	–	
Gate-Controlled Turn-On Time:					
(Delay Time + Rise Time)					
For v_D = V_{DROM}, I_{GT} = 150 mA, t_r = 0.1 µs, i_T = 60 A (peak), T_C = 25° C (See Fig. 10)	t_{gt}	–	1.6	2.5	µs
Thermal Resistance, Junction-to-Case:					
Steady-State					
Press-fit types	$θ_{J-C}$	–	–	0.8	°C/W
Stud		–	–	0.9	
Transient (Press-fit & stud types)		See Fig. 12			

♠ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

† For either polarity of gate voltage (V_G) with reference to main terminal 1.

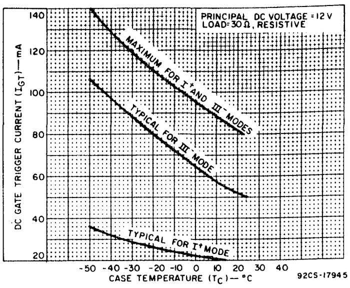


Fig. 7—DC gate-trigger current vs. case temperature (I$^+$ and III$^-$ modes).

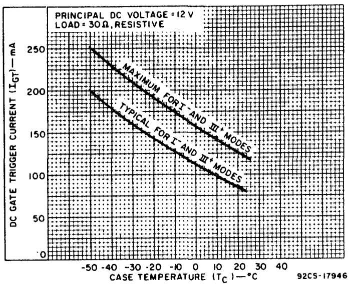


Fig. 8—DC gate-trigger current vs. case temperature (I$^-$ and III$^+$ modes).

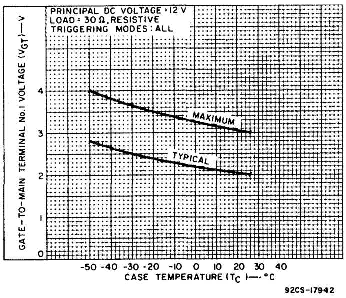


Fig. 9—DC gate-trigger voltage vs. case temperature.

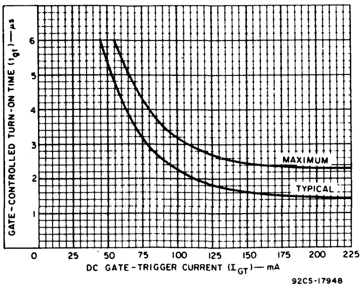


Fig. 10—Turn-on time vs. gate-trigger current.

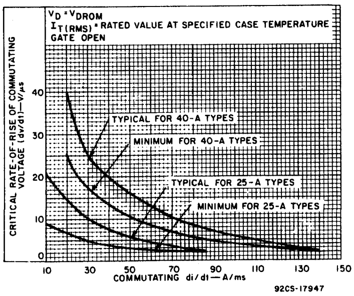


Fig. 11—Commutating voltage vs. commutating current.

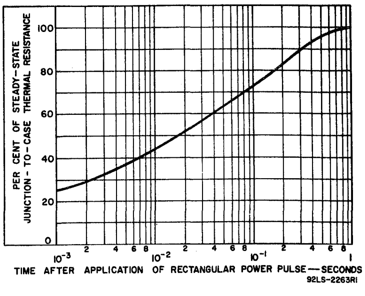


Fig. 12—Transient junction-to-case thermal resistance vs. time.

2.5-40 A, 100-600 V Silicon Triacs for Use With IC Zero-Voltage Switches

For Power-Control and Switching Applications at 50-60 Hz with RCA-CA3058, CA3059, or CA3079 IC as Trigger Circuits

The triacs listed below are gate-controlled full-wave ac switches intended for load-control applications. They are especially useful in ac circuits for heating controls (proportional or on-off), lamp switching, motor switching, and a wide variety of other power-control applications.

These devices have gate characteristics which assure that an RCA-CA3058, CA3059, or CA3079 integrated circuit can supply sufficient drive current to trigger them over their full operating-temperature range (−40°C to +85°C).

The RCA-CA3058, CA3059, and CA3079 are monolithic silicon integrated-circuit zero-voltage switches which can operate directly from the ac line. They are designed to drive the triac gate directly and provide the gating signal at zero-voltage crossings for minimum radio-frequency interference.

These triacs have rms on-state current ratings that range from 2.5 to 40 amperes, and repetitive off-state voltage ratings from 100 to 600 volts. They are supplied in a variety of packages.

Technical information on RCA-CA3058, CA3059, and CA3079 is contained in bulletin File No. 490. For detailed application information, see Application Note ICAN-6182, "Features and Application of RCA Integrated-Circuit Zero-Voltage Switches".

WARNING: The ceramic of the isolated stud package contains beryllium oxide. Do not crush, grind, or abrade this part because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

RATINGS AND CHARACTERISTICS

All types, at case temperature (T_C) = 25°C, I^+ and III^+ triggering modes,▲ I_{GT} = 45 mA max., V_{GT} = 1.5 V max.

Type No.	Rep. Peak Off-State Voltage V_{DROM} (V)	RMS On-State Current $I_{T(RMS)}$ at Case Temp. (A)	(°C)	Typ. DC Holding Current at 25°C, I_{HO} (mA)	Package	For additional data, see Basic Family Types*
T2306A	100	2.5	70	6	Mod. TO-5	T2300
T2306B	200	2.5	70	6		
T2306D	400	2.5	70	6		
T2316A	100	2.5	70	6	Mod. TO-5 on Heat Radiator	T2310
T2316B	200	2.5	70	6		
T2316D	400	2.5	70	6		
T2506B	200	6	80	15	TO-220AB	T2500
T2506D	400	6	80	15		
T2706B	200	6	75	15	TO-66	T2700
T2706D	400	6	75	15		
T2716B	200	6	75	15	TO-66 with Heat Radiator	T2710
T2716D	400	6	75	15		
T2806B	200	8	80	15	TO-220AB	T2800
T2806C	300	8	80	15		
T2806D	400	8	80	15		
T2806M	600	8	80	15		
T2856B	200	8	75	15	Isolated-Tab TO-220AB	T2850
T2856C	300	8	75	15		
T2856D	400	8	75	15		
T4106B	200	15	80	20	Press-fit	T4100
T4106D	400	15	80	20		
T4106M	600	15	80	20		
T4116B	200	15	80	20	Stud	T4110
T4116D	400	15	80	20		
T4116M	600	15	80	20		
T4117B	200	10	85	15	Stud	T4111
T4117D	400	10	85	15		
T4117M	600	10	85	15		
T4126B	200	15	75	20	Isolated Stud	T4120
T4126D	400	15	75	20		
T4126M	600	15	75	20		
T6406B	200	40	70	45	Press-fit	T6404
T6406D	400	40	70	45		
T6406E	500	40	70	45		
T6406M	600	40	70	45		
T6407B	200	30	65	25	Press-fit	T6401
T6407D	400	30	65	25		
T6407E	500	30	65	25		
T6407M	600	30	65	25		
T6416B	200	40	65	25	Stud	T6410
T6416D	400	40	65	25		
T6416M	600	40	65	25		
T6417B	200	30	60	25	Stud	T6410
T6417D	400	30	60	25		
T6417M	600	30	60	25		
T6426B	200	40	60	25	Isolated Stud	T6420
T6426D	400	40	60	25		
T6426M	600	40	60	25		
T6427B	200	30	55	25	Isolated Stud	T6420
T6427D	400	30	55	25		
T6427M	600	30	55	25		

▲ A triac driven directly from the output terminal of the CA3058, CA3059, or CA3079 should be characterized for operation in the I^+ or III^+ triggering mode, i.e., with positive gate current (current flows into the gate for both polarities of the applied ac voltage).

* Except for gate characteristics, data for basic family types also apply to the types listed in this chart.

Silicon Controlled Rectifiers (SCR's)

Technical Data

C106 Series

4-A Sensitive-Gate Silicon Controlled Rectifiers

For Power-Switching and Control Applications

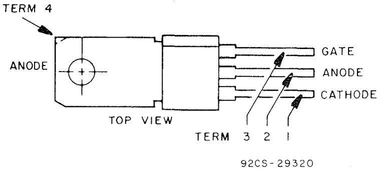
The RCA-C106 series of sensitive-gate silicon controlled rectifiers are designed for switching ac and dc currents. The types within the series differ in their voltage ratings; the voltage ratings are identified by suffix letters in the type designations.

These SCR's have microampere gate-current requirements which permit operation with low-level logic circuits. They can be used for lighting, power-switching, and motor-speed controls, and for gate-current amplification for driving larger SCR's.

All types in the series utilize the JEDEC-TO-202AB (RCA VERSATAB) plastic package.

Features:

- **Microampere gate sensitivity**
- **600-V capability**
- **3.5-A(rms) on-state current ratings**
- **20-A peak surge capability**
- **Glass-passivated chip for stability**
- **Low thermal resistances**
- **Surge capability curve**
- **Package and formed-lead options available**



JEDEC TO-202AB

(See dimensional outline "P".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

C106A C106C C106E

C106F **C107F** **C108F**	**C106B** **C107B** **C108B**	**C106D** **C107D** **C108D**	**C106M** **C107M** **C108M**

V_{RSXM}: R_{GK} = 1000 Ω, T_C = −40 to 110°C V_{DSXM}: R_{GK} = 1000 Ω, T_C = −40 to 110°C	75 125 250 400 500 600 700	V
V_{RRXM}: R_{GK} = 1000 Ω, T_C = −40 to 110°C V_{DRXM}: R_{GK} = 1000 Ω, T_C = −40 to 110°C	30 50 100 200 300 400 500 600	V
$I_{T(AV)}$ (T_C = 45°C, θ = 180°)	2.2	A
$I_{T(RMS)}$ (T_C = 45°C, θ = 180°)	3.5	A
$I_{T(DC)}$ (T_C = 70°C)	2.6	A
I_{TSM}:		
For one cycle of applied principal voltage, T_C = 45°C		
60 Hz (sinusoidal)	20	A
50 Hz (sinusoidal)	18.5	A
For more than one cycle of applied principal voltage	See Fig. 11	
I_{GM} (t = 10 μs)	0.2	A
V_{GRM}	6	V
di/dt:		
$V_{DM}=V_{DROM}$, I_{GT} = 1 mA, t_r = 0.5 μs, T_C = 110°C	100	A/μs
I^2t [At T_C shown for $I_{T(RMS)}$]:		
t = 10 ms	1.77	A^2s
8.33 ms	1.67	A^2s
1 ms	0.82	A^2s
P_{GM} (For 10 μs max.)	0.5	W
$P_{G(AV)}$ (Averaging time = 10 ms max.)	0.1	W
T_{stg}	−40 to +150	°C
T_C	−40 to +110	°C
T_T (During soldering for 10 s max.	250	°C

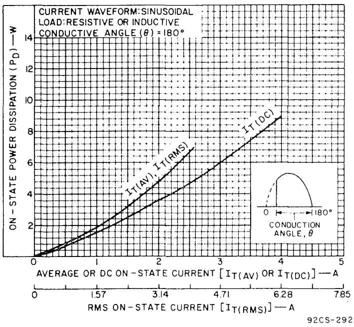


Fig. 1 — Power dissipation as a function of average dc, or rms on-state current.

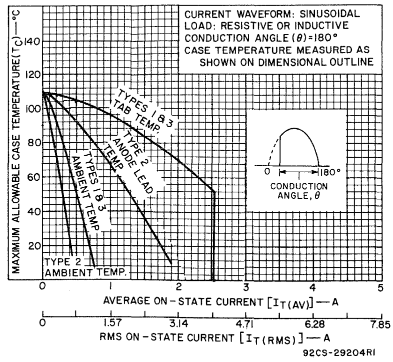


Fig. 2 — Maximum allowable case temperature as a function of average or rms on-state current.

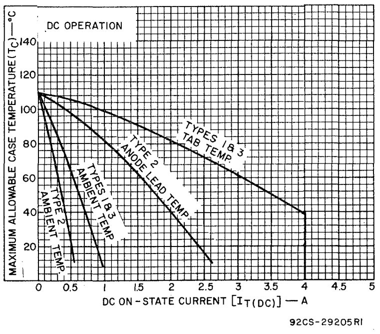


Fig. 3 — Maximum allowable case temperature as a function of dc on-state current for C106 series.

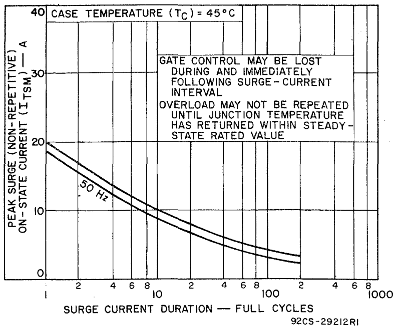


Fig. 4 — Peak surge on-state current as a function of surge current duration.

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED			UNITS
	Min.	Typ.	Max.	
I_{DRXM} or I_{RRXM}: $V_D = V_{DRXM}$ or $V_R = V_{RRXM}$, $R_{GK} = 1000\ \Omega$ $T_C = 25^oC$ . . . . $T_C = 110^oC$	– –	0.1 10	10 100	μA
v_T: For i_T = 4 A and $T_C = 25^oC$ (See Fig. 7) For i_T = 5 A and $T_C = 25^oC$ (See Fig. 7)	–	1.25	2.2	V
i_{HX}: R_{GK}=1000 Ω, V_D=12 V, $I_{T(INITIAL)}$=50 mA, T_C=25^{o}C:	–	1.7	3	mA
I_{LX}: R_{GK} = 1000 Ω, V_D = 12 V, T_C = 25^{o}C: (I_{GT} = 200 μA)	–	1.8	4	mA
dv/dt: V_D=V_{DRXM}, R_{GK}=1000 Ω, Exponential rise, T_C=110^{o}C	–	8	–	V/μs
I_{GT}: V_D=12 V dc, R_L=30 Ω, T_C=25^{o}C:	–	30	200	μA
For other case temperatures.		(See Fig. 12)		
V_{GT}: V_D = 12 V dc, R_L = 30 Ω, T_C = 25^{o}C . . . . For other case temperatures.	–	0.5 (See Fig. 13)	0.8	V
t_{gt}: V_D = V_{DRXM}, i_T = 1 A, R_{GK} = 1000 Ω, I_{GT} = 1 mA, Rise Time = 0.1 μs, T_C = 25^{o}C.	–	1.7	2.5	μs
t_q: V_D = V_{DRXM}, i_T = 1 A, R_{GK} = 1000 Ω, Pulse Duration = 50 μs, dv/dt = 5 V/μs, di/dt = –10 A/μs, I_{GT} = 1 mA at turn-on, T_C = 110^{o}C . .	–	30	100	μs
$R_{\theta JC}$ . . . . $R_{\theta JA}$	– –	– –	8 60	^{o}C/W

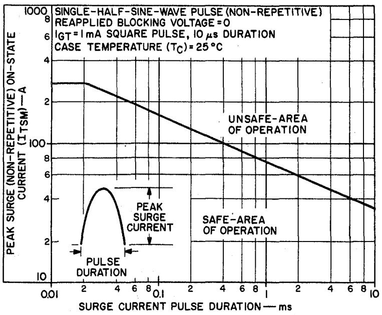


Fig. 5 — Surge capability without reapplied blocking voltage for all series.

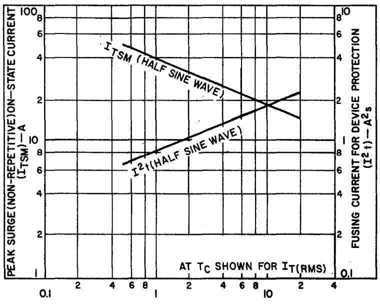


Fig. 6 — Peak surge on-state current and fusing current as a function of time.

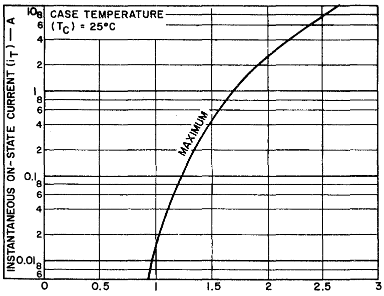


Fig. 7 — Maximum instantaneous on-state current as a function of on-state voltage.

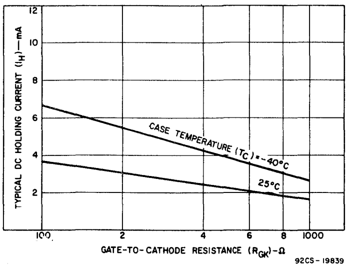


Fig. 8 — DC holding current as a function of gate-cathode resistance for the C106 series.

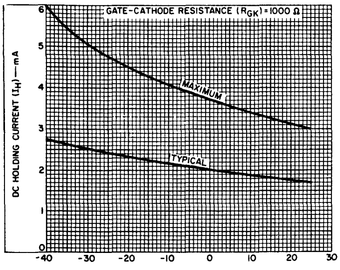


Fig. 9 — DC holding current as a function of case temperature.

C106 Series

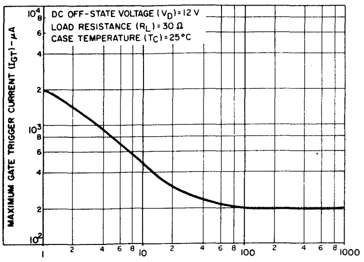


Fig. 10 – Maximum gate trigger current as a function of pulse duration for types in the C106 series.

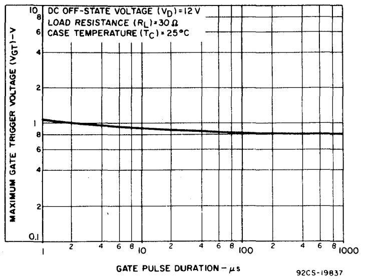


Fig. 11 – Maximum gate trigger voltage as a function of gate pulse duration for types in the C106 series.

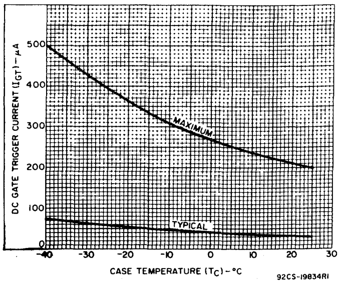


Fig. 12 – DC gate trigger current as a function of case temperature for C106 series.

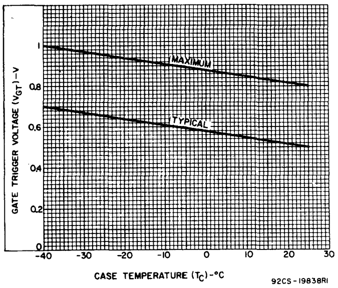


Fig. 13 – Gate trigger voltage as a function of case temperature.

4-A Sensitive-Gate Silicon Controlled Rectifiers

For Power Switching and Control Applications

The S2060, S2061, and S2062 series• are sensitive-gate silicon controlled rectifiers designed for switching ac and dc currents. These SCR's are divided into the three different series according to gate sensitivity. The types within each series differ in their voltage ratings; the voltage ratings are identified by suffix letters in the type designations.

These thyristors have microampere gate-current requirements which permit operation with low-level logic circuits. They can be used for lighting, power-switching, and motor-speed controls, and for gate-current amplification for driving larger SCR's.

All types in each series utilize the JEDEC TO-220AB package.

Features:

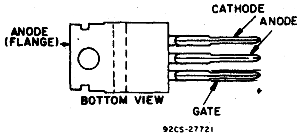
- **Microampere gate sensitivity**
- **Minimum gate current specified for the S2062 series**
- **600-V capability**
- **4-A (rms) on-state current ratings**
- **35-A peak surge capability**
- **Glass-passivated chip for stability**
- **Low thermal resistances**
- **Surge capability curve**

•Formerly the RCA106, RCA 107, and RCA 108 series

MAXIMUM RATINGS, *Absolute-Maximum Values:*		Suffix Letter									
		Q	Y	F	A	B	C	D	E	M	
NON-REPETITIVE PEAK REVERSE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 110°C	V_{RSXM}	25	50	75	125	250	400	500	600	700	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 110°C	V_{DSXM}										
REPETITIVE PEAK REVERSE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 110°C	V_{RRXM}	15	30	50	100	200	300	400	500	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 110°C	V_{DRXM}										
ON-STATE CURRENT:											
Conduction angle = 180°, T_C = 85°C											
Average ac value	$I_{T(AV)}$	2.5									A
RMS value	$I_{T(RMS)}$	4									A
DC operation	$I_{T(DC)}$	2.75									A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}										
For one cycle of applied principal voltage, T_C = 85°C											
60 Hz (sinusoidal)		35									A
50 Hz (sinusoidal)		28									A
60 Hz (sinusoidal)	I_{TSM}	35									A
For more than one cycle of applied principal voltage		See Fig. 5									
PEAK GATE CURRENT (t = 10 μsec)	I_{GM}	0.2									A
PEAK GATE REVERSE VOLTAGE	V_{RGM}	6									V
RATE OF CHANGE OF ON-STATE CURRENT: V_{DM} = V_{DROM}, I_{GT} = 1 mA, t_r = 0.5 μs, T_C = 110°C	di/dt	100									A/μs
FUSING CURRENT (for SCR protection): T_J = −40 to 110°C, t = 1 to 8.3 ms	I^2t	2.6									A^2s
GATE POWER DISSIPATION:											
PEAK FORWARD (for 10 μs max.)	P_{GM}	0.5									W
AVERAGE (averaging time = 10 ms max.)	$P_{G(AV)}$	0.1									W
TEMPERATURE RANGE:											
Storage	T_{stg}	-40 to +150									°C
Operating (case)*	T_C	-40 to +110									°C
TERMINAL TEMPERATURE (During soldering): For 10 s max.	T_T	250									°C

*Temperature measuring point is shown in the dimensional outline.

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S".)

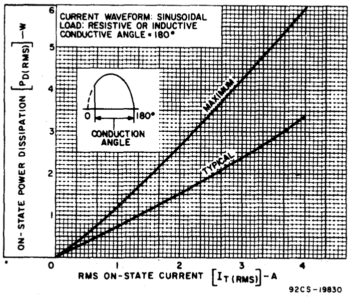


Fig. 1—Power dissipation vs. rms-on-state current for all series.

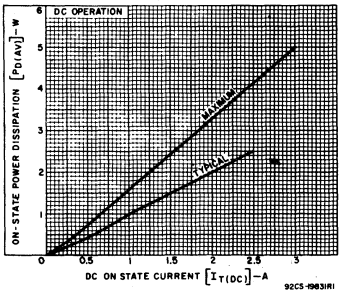


Fig. 2—Power dissipation vs. dc on-state current for all series.

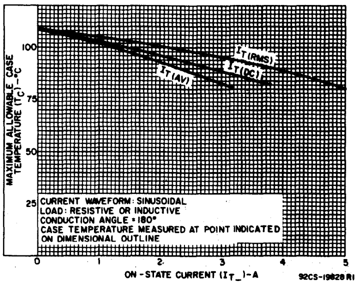


Fig. 3—Maximum allowable case temperature vs. on-state current for all series.

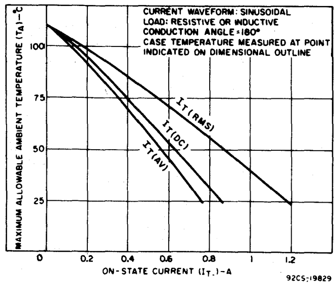


Fig. 4—Maximum allowable ambient temperature vs. on-state current for all series.

S2060, S2061, S2062 Series

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED			UNITS
		MIN.	TYP.	MAX.	
PEAK OFF-STATE CURRENT:					
Forward, $V_D = V_{DRXM}$, $R_{GK} = 1000\ \Omega$	I_{DRXM}				μA
$T_C = 25^\circ C$		–	0.1	10	
$T_C = 110^\circ C$		–	10	100	
Reverse, $V_R = V_{RRXM}$, $R_{GK} = 1000\ \Omega$	I_{RRXM}				
$T_C = 25^\circ C$		–	0.1	10	
$T_C = 100^\circ C$		–	10	100	
INSTANTANEOUS ON-STATE VOLTAGE:					
For $i_T = 4$ A and $T_C = 25^\circ C$ (See Fig. 7)	v_T	–	1.25	2.2	V
DC GATE TRIGGER CURRENT:					
$V_D = 12$ V (dc), $R_L = 30\ \Omega$, $T_C = 25^\circ C$:	I_{GT}				μA
S2060 Series		–	–	200	
S2061 Series		–	–	500	
S2062 Series		100	–	2000	
For other case temperatures		See Figs. 10,11,12			
DC GATE TRIGGER VOLTAGE:					
$V_D = 12$ V (dc), $R_L = 30\ \Omega$, $T_C = 25^\circ C$	V_{GT}	–	0.5	0.8	V
For other case temperatures		See Fig. 14			
INSTANTANEOUS HOLDING CURRENT:					
$R_{GK} = 1000\ \Omega$, $V_D = 12$ V, $I_{T\ (INITIAL)} = 50$ mA, $T_C = 25^\circ C$:	i_H				mA
S2060 Series		–	1.7	3	
S2061 Series		–	3.9	6	
S2062 Series		–	6	10	
LATCHING CURRENT:					
$R_{GK} = 1000\ \Omega$, $V_D = 12$ V, $T_C = 25^\circ C$:	i_L				mA
S2060 Series ($I_{GT} = 200\ \mu A$)		–	1.8	4	
S2061 Series ($I_{GT} = 500\ \mu A$)		–	2.5	8	
S2062 Series ($I_{GT} = 2000\ \mu A$)		–	8	12	
CRITICAL RATE OF RISE OF OFF-STATE VOLTAGE:					
$V_D = V_{DRXM}$, $R_{GK} = 1000\ \Omega$, Exponential rise, $T_C = 110^\circ C$	dv/dt	5	8	–	V/μs
GATE-CONTROLLED TURN-ON TIME:					
$V_D = V_{DRXM}$, $i_T = 1$ A, $R_{GK} = 1000\ \Omega$, $I_{GT} = 1$ mA, rise time = 0.1 μs, $T_C = 25^\circ C$	t_{gt}	–	1.7	2.5	μs
CIRCUIT COMMUTATED TURN-OFF TIME:					
$V_D = V_{DRXM}$, $i_T = 1$ A, $R_{GK} = 1000\ \Omega$, Pulse Duration = 50 μs, dv/dt = 5 V/μs, di/dt = –10 A/μs, $I_{GT} = 1$ mA at turn on, $T_C = 110^\circ C$	t_q	–	30	100	μs
THERMAL RESISTANCE:					
Junction-to-Case*	$R_{\theta JC}$	–	–	3.5	°C/W
Junction-to-Ambient	$R_{\theta JA}$	–	–	60	

* Temperature measuring point is shown in the dimensional outline,

S2060, S2061, S2062 Series

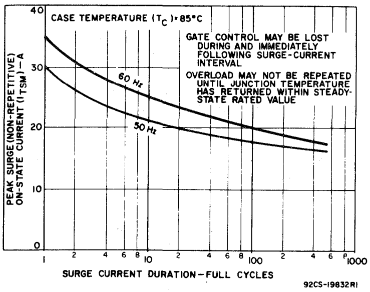


Fig. 5—Peak surge on-state current vs. surge-current duration for all series.

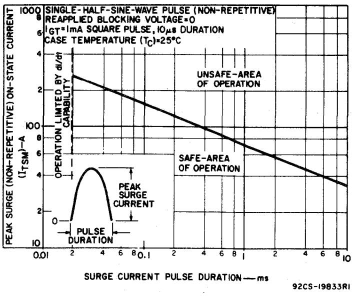


Fig. 6—Surge capability without reapplied blocking voltage for all series.

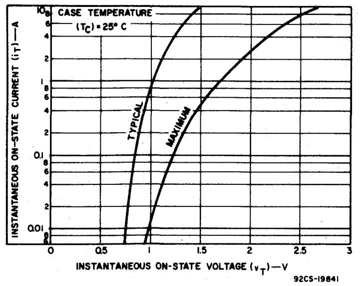


Fig. 7—Instantaneous on-state current vs. on-state voltage for all series.

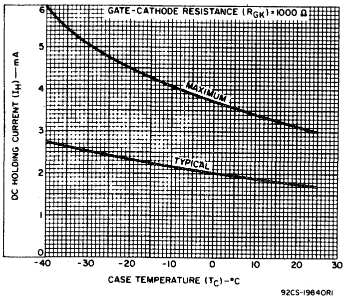


Fig. 8—DC holding current vs. case temperature for the S2060 series.

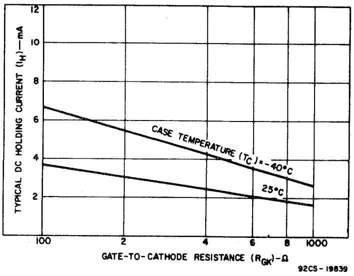


Fig. 9—DC holding current vs. gate-cathode resistance for the S2060 series.

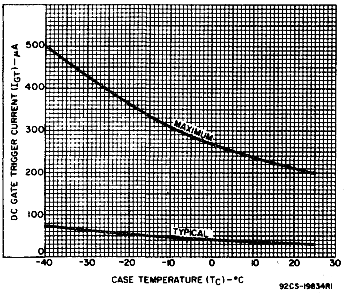


Fig. 10—DC gate-trigger current vs. case temperature for S2060 series.

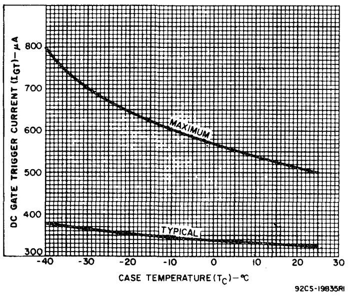


Fig. 11—DC gate-trigger current vs. case temperature for S2061 series.

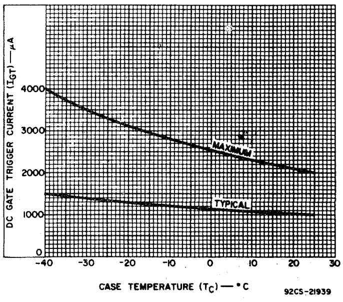


Fig. 12—DC gate-trigger current vs. case temperature for S2062 series.

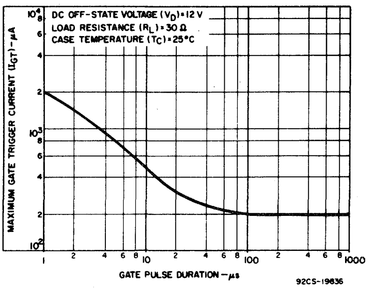


Fig. 13—Maximum gate-trigger current vs. gate-pulse duration for types in the S2060 series.

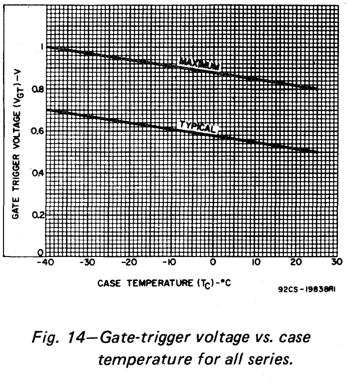


Fig. 14—Gate-trigger voltage vs. case temperature for all series.

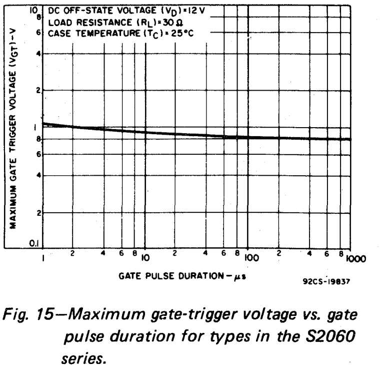


Fig. 15—Maximum gate-trigger voltage vs. gate pulse duration for types in the S2060 series.

S2600, S2610, S2620 Series

7-A "Low-Profile" Silicon Controlled Rectifiers

For Power Switching, Power Control, Power Crowbar, and Ignition Applications

The S2600, S2610, and S2620 series are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) for capacitor-discharge ignition systems, high-voltage generators, and power-switching and control applications. They may be used in capacitor-discharge ignition systems (battery or magneto types) for internal combustion engines, electronic igniters, and high- voltage generators. Other uses are power-control and power- switching circuits.

The S2600B, S2600D, and S2600M have a three-lead low-profile package (similar to the JEDEC TO-5). TheS2610B, S2610D, and S2610M have integral heat radiators. The S2620B, S2620D, and S2620M have integral heat spreaders.

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

		S2600B **S2610B** **S2620B**	**S2600D** **S2610D** **S2620D**	**S2600M** **S2610M** **S2620M**	
NON-REPETITIVE PEAK REVERSE VOLTAGE•					
Gate open	V_{RSOM}	250	500	700	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE:•					
Gate open	V_{DSOM}	250	500	700	V
REPETITIVE PEAK REVERSE VOLTAGE•					
Gate open	V_{RROM}	200	400	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE•					
Gate open	V_{DROM}	200	400	600	V
RMS ON-STATE CURRENT (Conduction angle = 180°)	$I_{T(RMS)}$		See Figs. 2-6		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}				
For one cycle of applied principal voltage					
60 Hz (sinusoidal)		100	100	100	A
50 Hz (sinusoidal)		85	85	85	A
For more than one cycle of applied principal voltage			See Fig. 7		
PEAK REPETITIVE ON-STATE CURRENT† (See Fig. 16):	I_{TRM}				
Duty factor = 0.1%, T_C = 75°C Pulse duration = 5 μs (min.), 20 μs (max.)		100	100	100	A
RATE OF CHANGE OF ON-STATE CURRENT:					
$V_{DM} = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.5 μs	di/dt		200		A/μs
FUSING CURRENT (for SCR protection):					
T_J = −65 to 100°C, t = 1 to 8.3 ms	I^2t		40		A^2s
NON-REPETITIVE SUB-CYCLE SURGE CURRENT:					
T_C = 25°C, single pulse, I_{GT} = 50 mA, 10 μs square pulse			See Fig. 20		
GATE POWER DISSIPATION▲:					
PEAK FORWARD (for 1 μs max.)	P_{GM}	40	40	40	W
PEAK REVERSE	P_{RGM}		See Fig. 14		
AVERAGE (averaging time = 10 ms, max.)	$P_{G(AV)}$	0.5	0.5	0.5	W
TEMPERATURE RANGE♦:					
Storage	T_{stg}		-65 to +150		°C
Operating (case)	T_C		-65 to +100		°C
LEAD TEMPERATURE (During soldering)■:					
For 10 s max. for case or leads			225		°C

---

† When rms current exceeds 4 amperes (maximum rating for the anode lead), connection must be made to the case.

•These values do not apply if there is a positive gate signal. Gate must be open, terminated, or have negative bias.

▲Any values of peak gate current or peak gate voltage that yield the maximum gate power are permissible.

♦*For information on the reference point of temperature measurement, see dimensional outlines.*

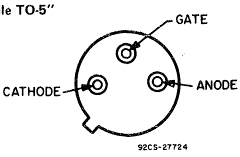
■When these devices are soldered directly to the heat sink, a 60/40 solder should be used. Case heating time should be a minimum . . . sufficient to allow the solder to flow freely.

Features:

- **Forward and reverse gate ratings**
- **All-diffused center gate construction**
- **Low leakage currents, both forward and reverse**
- **Low forward voltage drop at high current levels**
- **High pulse-current capability for capacitor-discharge ignition circuits**
- **High dv/dt capability**
- **Low switching losses**
- **Low thermal resistance**
- **Sub-cycle surge capability curve**

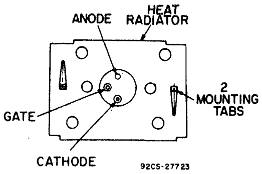
TERMINAL CONNECTIONS

"Low-Profile TO-5"



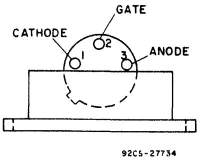
BOTTOM VIEW
S2600 Series
(See dimensional outline "H".)

"Low-Profile TO-5" with Heat Radiator



BOTTOM VIEW
S2610 Series
(See dimensional outline "I".)

"Low-Profile TO-5" with Heat Spreader



S2620 Series
(See dimensional outline "J".)

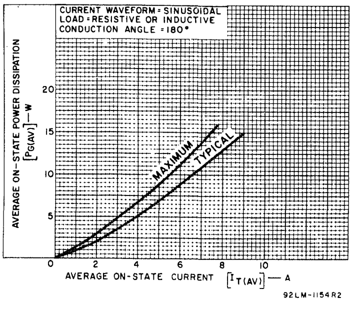


Fig. 1—Power dissipation vs. on-state current.

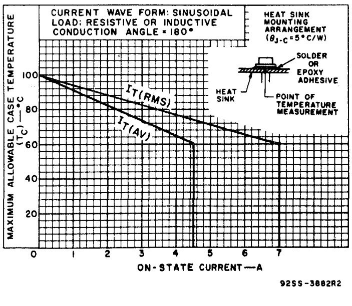


Fig. 2—Maximum allowable case temperature vs. on-state current for S2600 series.

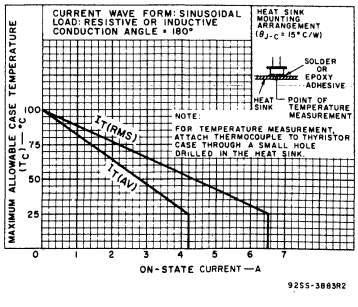
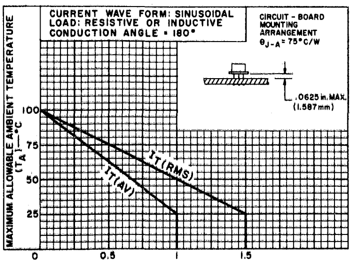


Fig. 3—Maximum allowable case temperature vs. on-state current for S2600 series.

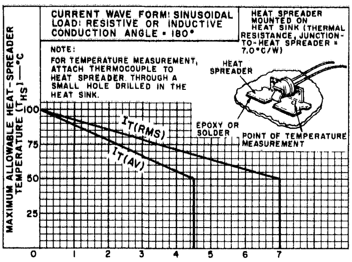
ELECTRICAL CHARACTERISTICS, *At maximum ratings and at indicated case temperature (T_C) unless otherwise specified*

CHARACTERISTIC	SYMBOL	LIMITS						UNITS
		S2600 Series			S2610 Series S2620 Series			
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
PEAK OFF-STATE CURRENT: (Gate Open, T_C = +100°C) FORWARD, $V_D = V_{DROM}$	I_{DOM}	–	0.1	0.5	–	0.2	1.5	mA
REVERSE, $V_{R_1} = V_{RROM}$	I_{ROM}	–	0.05	0.5	–	0.1	1.5	
INSTANTANEOUS ON-STATE VOLTAGE: For i_T = 30 A and T_C = +25°C	v_T	–	1.9	2.6	–	1.9	2.6	V
DC GATE TRIGGER CURRENT: V_D = 12 V (DC) R_L = 30 Ω T_C = +25°C	I_{GT}	–	6	15	–	6	15	mA
For other case temperatures		See Fig. 12						
DC GATE TRIGGER VOLTAGE: V_D = 12 V (DC) R_L = 30 Ω T_C = +25°C	V_{GT}	–	0.65	1.5	–	0.65	1.5	V
For other case temperatures		See Fig. 13						
INSTANTANEOUS HOLDING CURRENT: Gate Open and T_C = +25°C	i_{HO}	–	9	20	–	9	20	mA
For other case temperatures		See Fig. 10						
CRITICAL RATE-OF-RISE OF OFF-STATE VOLTAGE: $V_D = V_{DROM}$ Exponential rise, T_C = +100°C	dv/dt	20	200	–	20	200	–	V/μs
GATE CONTROLLED TURN-ON TIME: $V_D = V_{DROM}$, i_T = 4.5 A I_{GT} = 200 mA, 0.1 μs rise time T_C = +25°C (See Fig. 15)	t_{gt}	–	1	2	1	2	–	μs
CIRCUIT COMMUTATED TURN-OFF TIME: $V_D = V_{DROM}$, i_T = 2 A Pulse Duration = 50 μs dv/dt = 20V/μs, di/dt = -30A/μs I_{GT} = 200 mA at turn on, T_C = +75°C	t_q	–	15	50	–	15	50	μs
THERMAL RESISTANCE: Junction-to-Case	$R_{\theta JC}$	–	–	5	–	–	5	°C/W
Junction-to-Ambient (See dimensional outlines)	$R_{\theta JA}$	–	–	120	–	–	30 (S2610 Series)	
Junction-to-Heat Spreader (See dimensional outline)	$R_{\theta JHS}$	–	–	–	–	–	7 (S2620 Series)	



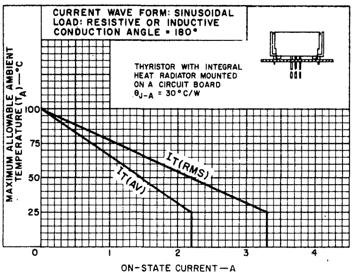
92SS-3884R2

Fig. 4—Maximum allowable ambient temperature vs. on-state current for S2600 series.



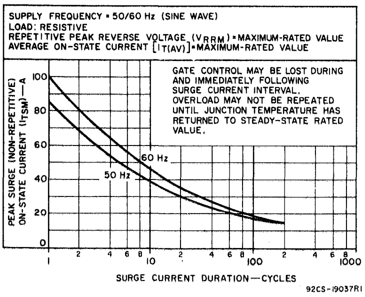
92SS-3885R2

Fig. 5—Maximum allowable heat-spreader temperature vs. on-state current for S2620 series.



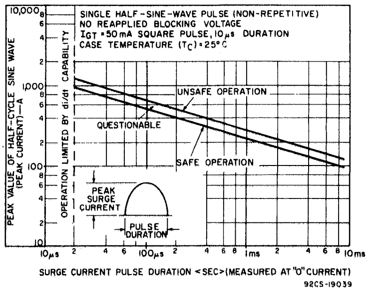
92SS-3886R2

Fig. 6—Maximum allowable ambient temperature vs. on-state current for S2610 series.



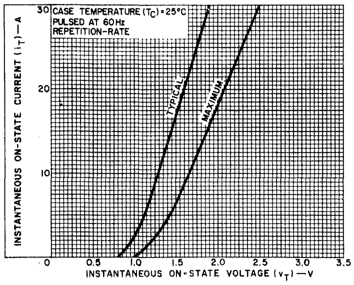
92CS-19037R1

Fig. 7—Peak surge on-state current vs. surge-current duration for all types.



92CS-19039

Fig. 8—Sub-cycle surge capability.



92LS-1150R1

Fig. 9—Instantaneous on-state current vs. on-state voltage for all types.

S2600, S2610, S2620 Series

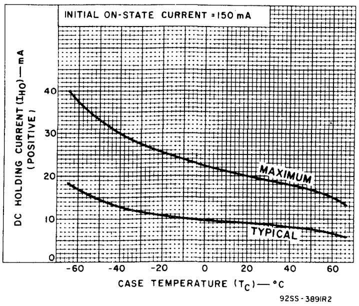


Fig. 10—DC holding current (positive) vs. case temperature.

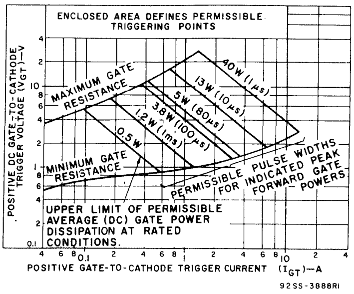


Fig. 11—Gate-pulse characteristics for forward-triggering mode.

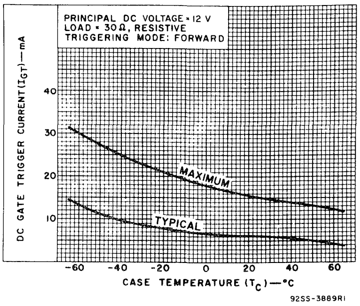


Fig. 12—DC gate-trigger current (forward) vs. case temperature.

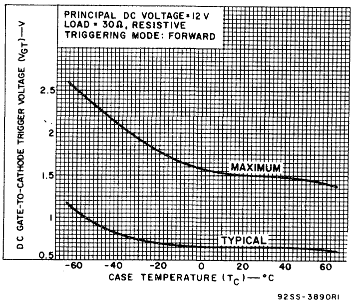


Fig. 13—DC gate-trigger voltage vs. case temperature.

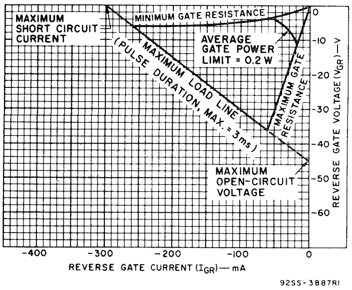


Fig. 14—Reverse-gate voltage vs. reverse-gate current.

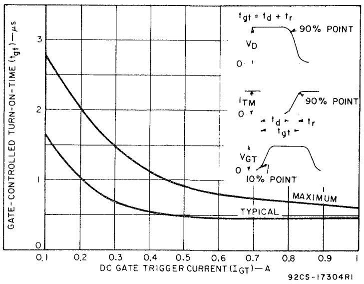


Fig. 15—Gate controlled turn-on time (t_{gt}) vs. gate-trigger current.

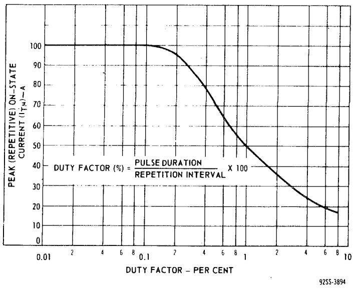


Fig. 16—Derating curve for peak pulse current (repetitive) vs. duty factor for the ignition circuit.

S2700(2N3228, 2N3525, 2N4101), S2710 Series

5-A Silicon Controlled Rectifiers

For Low-Cost Power-Control and Power-Switching Applications

RCA 2N3228*, 2N3525*, and 2N4101* are all-diffused, three-junction, silicon controlled rectifiers (SCR's) intended for use in power-control and power-switching applications.

Types 2N3228, 2N3525, and 2N4101 use the JEDEC TO-66 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 5 amperes (rms value) at a case temperature of 75° C.

S2710B, S2710D, and S2710M are all-diffused, three-junction silicon controlled rectifiers having integral heat radiators. They are variants of the 2N3228, 2N3525, and 2N4101, respectively.*

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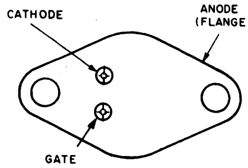
*Formerly Dev. Types TA1222, TA1225, and TA2773, respectively.

FEATURES

- **Designed especially for high-volume systems**
- **Readily adaptable for printed-circuit boards and metal heat sinks**
- **Low switching losses**
- **High di/dt and dv/dt capabilities**
- **Shorted emitter gate-cathode construction**
- **Forward and reverse gate dissipation ratings**
- **All-diffused construction – assures exceptional uniformity and stability of characteristics**
- **Direct-soldered internal construction – assures exceptional resistance to fatigue**
- **Symmetrical gate-cathode construction – provides uniform current density, rapid electrical conduction, and efficient heat dissipation**
- **All-welded construction and hermetic sealing**
- **Low leakage currents, both forward and reverse**
- **Low forward voltage drop at high current levels**
- **Low thermal resistance**

TERMINAL CONNECTIONS

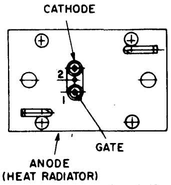


92CS-27720

BOTTOM VIEW

JEDEC TO-66

(See dimensional outline "N".)



92CS-27725

BOTTOM VIEW

TO-66 with Heat Radiator

(See dimensional outline "O".)

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load

RATINGS	**CONTROLLED-RECTIFIER TYPES**			**UNITS**
	2N3228 S2710B	**2N3525** S2710D	**2N4101** S2710M	
Transient Peak Reverse Voltage (Non-Repetitive), v_{RM}(non-rep)	330	660	700	volts
Peak Reverse Voltage (Repetitive), v_{RM}(rep)	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), v_{FBOM}(rep)	200	400	600	volts
Forward Current:				
For case temperature (T_C) of + 75°C, and unit mounted on heat sink–				
Average DC value at a conduction angle of 180°, I_{FAV}	3.2	3.2	3.2	amperes
RMS value, I_{FRMS}	5.0	5.0	5.0	amperes
For other conditions, See Fig. 2				
For free-air temperature (T_{FA}) of 25°C, and with no heat sink employed–				
Average DC value at a conduction angle of 180°, I_{FAV}	1.7	1.7	1.7	amperes
RMS value, I_{FRMS}	—	—	—	amperes
For other conditions, See *Figs. 3 & 4*				
Peak Surge Current, i_{FM}(surge):				
For one cylce of applied principal voltage.				
60 Hz (sinusoidal), T_C = 75°C	60			amperes
50 Hz (sinusoidal), T_C = 75°C	50			amperes
For more than one cycle of applied voltage	See Fig. 5			
Fusing Current (for SCR protection): T_J = −40 to 100°C, t = 1 to 8.3 ns, I^2t	15			ampere² second
Rate of Change of Forward Current, di/dt V_{FB} = v_{BOO}(min. value) I_{GT} = 200mA, 0.5 μs rise time	200			amperes/ microsecond
Gate Power*:				
Peak, Forward or Reverse, for 10 μs duration, P_{GM} (See Figs. 7 and 9)	13			watts
Average, P_{GAV}	0.5			watt
Temperature:				
Storage, T_{stg}	−40 to +125			°C
Operating (Case), T_C	−40 to +100			°C

*Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

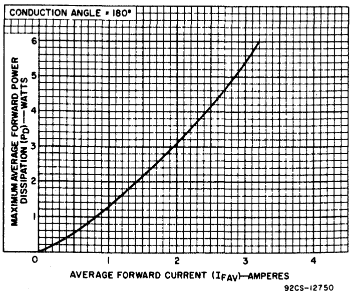


Fig. 1—Power dissipation chart for all types.

S2700 (2N3228, 2N3525, 2N4101), S2710 Series

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES									UNITS
	2N3228, S2710B			2N3525, S2710D			2N4101, S2710M			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Breakover Voltage, v_{BOO}: At T_C = +100°C	200	—	—	400	—	—	600	—	—	volts
Peak Blocking Current, at T_C = +100°C:										
Forward, I_{FBOM} $v_{FBO}^p = v_{BOO}$(min. value)	—	0.10	1.5	—	0.20	3.0	—	0.40	4.0	mA
Reverse, I_{RBOM} $v_{RBO}^p = v_{RM}$(rep) value	—	0.05	0.75	—	0.10	1.5	—	0.20	2.0	mA
Forward Voltage Drop, v_F At a Forward Current of 30 amperes and a T_C = +25°C	—	2.15	2.8	—	2.15	2.8	—	2.15	2.8	volts
DC Gate-Trigger Current, I_{GT} At T_C = +25°C (See Fig. 9)	—	8	15	—	8	15	—	8	15	mA(dc)
Gate-Trigger Voltage, V_{GT} At T_C = +25°C (See Fig. 9)	—	1.2	2.0	—	1.2	2.0	—	1.2	2.0	volts(dc)
Holding Current, i_{HOO} At T_C = +25°C	—	10	20	—	10	20	—	10	20	mA
Critical Rate of Applied Forward Voltage, Critical dv/dt $v_{FB} = v_{BOO}$(min. value), exponential rise, T_C = +100°C	10	200	—	10	200	—	10	200	—	volts/ microsecond
Turn-On Time, t_{on}, (Delay Time + Rise Time) $v_{FB} = v_{BOO}$(min. value), i_F = 4.5amperes, I_{GT} = 200mA, 0.1μs rise time, T_C = +25°C	0.75	1.5	—	0.75	1.5	—	0.75	1.5	—	microseconds
Turn-Off Time, t_{off} i_F = 2 amperes, 50μs pulse width, dv_{FB}/dt = 20v/μs, di_r/dt = 30A/μs, I_{GT} = 200mA, T_C = +75°C	—	15	50	—	15	50	—	15	50	microseconds
Thermal Resistance: Junction-to-case (2N3228, 2N3525, 2N4101)	—	—	4	—	—	4	—	—	4	
Junction-to-ambient (2N3228, 2N3525, 2N4101)	—	—	40	—	—	40	—	—	40	°C/W
S2710 Series	—	—	28	—	—	28	—	—	28	

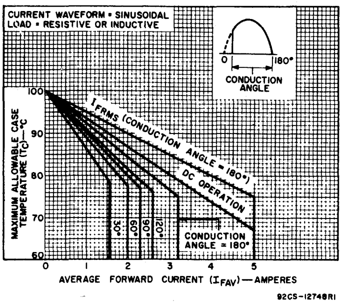


Fig. 2—Rating chart (case temperature) for types 2N3228, 2N3525, and 2N4101.

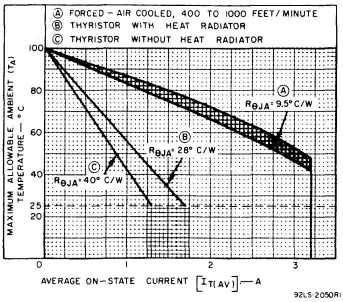


Fig.3—Maximum allowable ambient temperature vs. on-state current for S2710 series only.

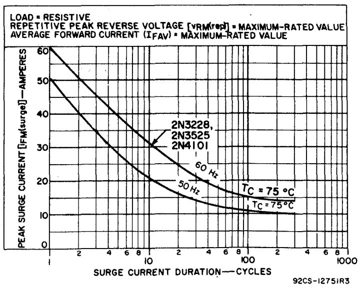


Fig. 4—Surge-current rating chart.

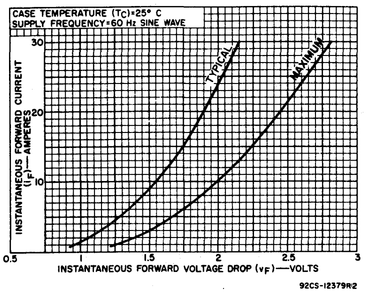


Fig. 5—Forward characteristics for all types.

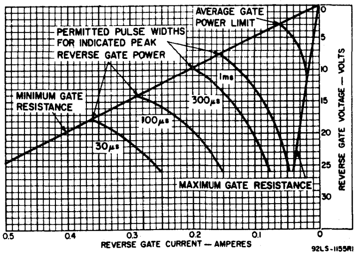


Fig. 6—Reverse gate characteristics.

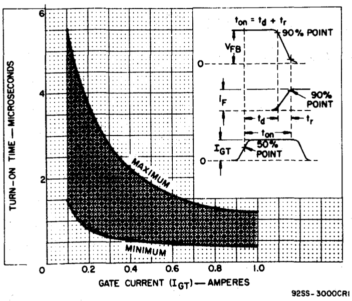


Fig. 7—Turn-on time characteristics.

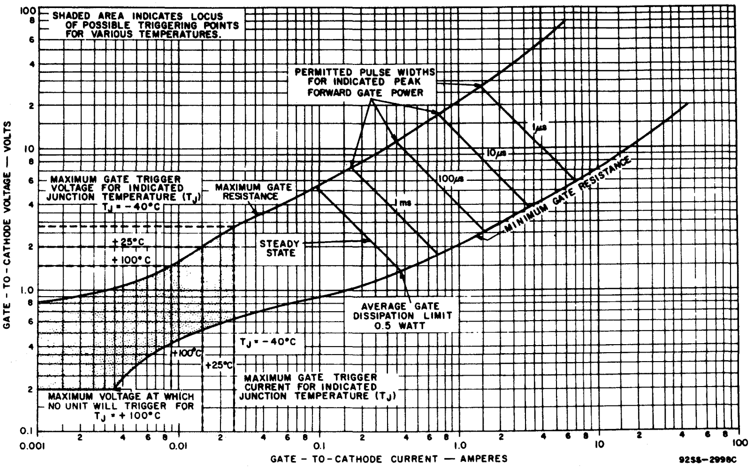


Fig. 8—Forward gate characteristics.

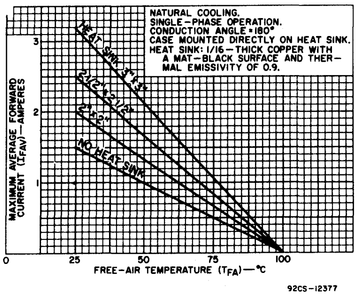


Fig. 9—Operation guidance chart for types 2N3228, 2N3525, and 2N4101.

C122 Series

8-A Silicon Controlled Rectifiers

For Power Switching, Power Control, and Ignition Applications

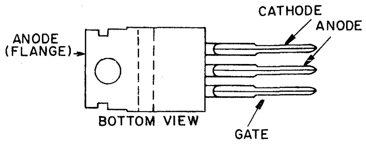
Features:

- High dv/dt capability
- Glass-passivated chip
- Low on-state voltage at high current levels
- Shorted-emitter gate-cathode construction
- Low thermal resistance
- Center-gate construction

The RCA-C122 series types are medium-power silicon controlled rectifiers (reverse-blocking triode thyristors) designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state regardless of gate-voltage polarity.

The TO-220AB package provides easy package mounting and low thermal resistance, allowing operation at high case temperatures and permitting reduced heat-sink size. These SCR's can be used in lighting and motor-speed controls, capacitor-discharge ignition circuits, high-voltage generators, automotive applications, and power-switching systems.

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	C122F	C122A	C122B	C122C	C122D	C122E	C122M	
V_{RSOM}▲, V_{DSOM}▲	75	125	250	375	500	600	700	V
V_{RROM}▲, V_{DROM}▲	50	100	200	300	400	500	600	V
$I_{T(RMS)}$ (T_C = 75°C, θ = 180°)	8							A
I_{TSM}								
For one full cycle of applied principal voltage 400-Hz	200							A
60-Hz	100							A
50-Hz	85							A
For more than one full cycle of applied principal voltage	See Fig. 4							
di/dt								
$V_D = V_{DROM}$, I_{GT} = 80 mA, t_r = 0.5 μs (See Fig.14)	100							A/μs
I^2t								
T_J = −65 to 100°C, t = 1 to 8.3 ms	40							A^2s
P_{GM}● (for 10 μs max.)	16							W
P_{RGM}●	See Fig. 8							
$P_{G(AV)}$● (averaging time = 10 ms max.)	0.5							W

	C122F	C122A	C122B	C122C	C122D	C122E	C122M	
T_{stg}■	−65 to +150							°C
T_C■	−65 to +100							°C
T_T								
During soldering for 10 s maximum (terminal and case)	250							°C

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any values of peak gate current or peak gate voltage which result in an equal or lower power are permissible.

■ For information on the reference point of temperature measurement, see Dimensional Outline.

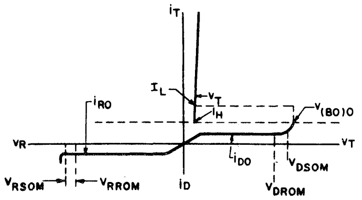


Fig. 1 – Principal voltage-current characteristic.

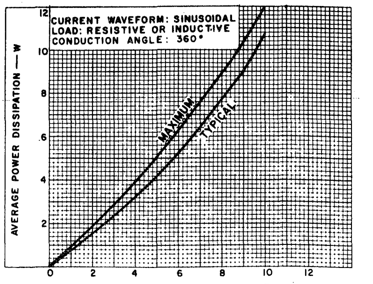


Fig. 2 – Power dissipation vs. on-state current.

C122 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified Min.	 Typ.	 Max.	UNITS
I_{DOM} or I_{ROM} $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = +100°C$	–	0.1	0.5	mA
v_T $i_T = 16$ A, $T_C = +25°C$ For other values of i_T	– ◄	1.45 See Fig. 6	1.83 ►	V
I_{GT} $V_D = 12$ V (DC), $R_L = 30\ \Omega$ $T_C = +25°C$ .... For other case temperatures	– ◄	18 See Fig. 9	25 ►	mA
V_{GT} $V_D = 12$ V (DC), $R_L = 30\ \Omega$ $T_C = +25°C$ .... For other case temperatures	– ◄	0.9 See Fig. 10	1.5 ►	V
I_{HO} $T_C = +25°C$ .... For other case temperatures	– ◄	20 See Fig. 11	30 ►	mA
dv/dt $V_D = V_{DROM}$ Exponential voltage rise $T_C = +100°C$ (See Fig. 15)	10	100	–	V/µs
t_{gt} $V_D = V_{DROM}$, $i_T = 4.5$ A, $i_T = 2$ A $I_{GT} = 80$ mA, 0.1 µs rise time $T_C = +25°C$ (See Fig. 13)	–	1.6	2.5	µs
t_q $V_D = V_{DROM}$, $i_T = 2$ A, $t_p = 50$ µs dv/dt = 200 V/µs, di/dt = −10 A/µs $I_{GT} = 200$ mA at t_{ON}, $T_C = +75°C$ (See Fig. 16)	–	10	35	µs
$R_{\theta JC}$	–	–	1.8	°C/W
$R_{\theta JA}$	–	–	75	

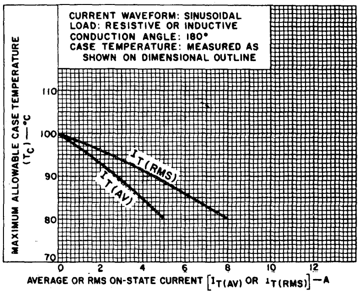


Fig. 3 – Maximum allowable case temperature vs. on-state current.

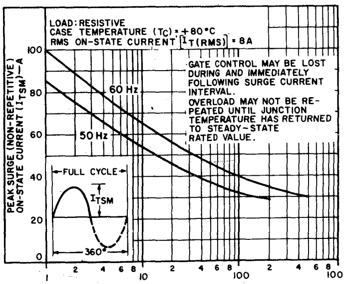


Fig. 4 – Allowable peak surge on-state current vs. surge duration.

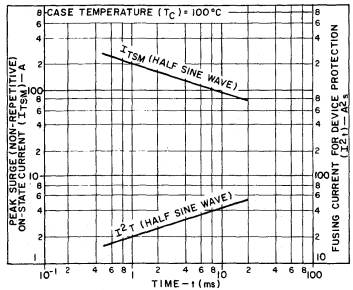


Fig. 5 – Peak surge on-state current and fusing current as a function of time.

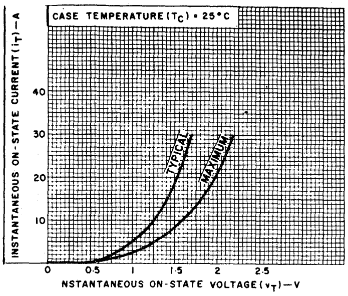


Fig. 6 – Instantaneous on-state current vs. on-state voltage.

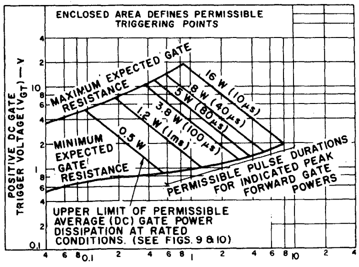


Fig. 7 – Typical forward-biased gate characteristics.

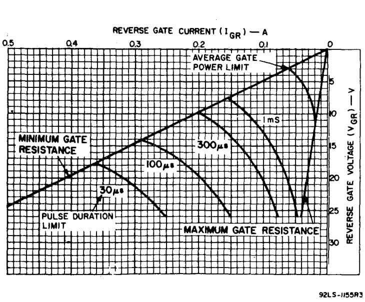


Fig. 8 – Reverse gate voltage vs. reverse gate current.

C122 Series

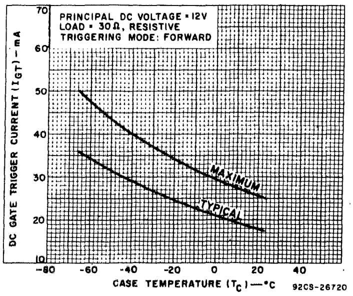


Fig. 9 – DC gate-trigger current vs. case temperature.

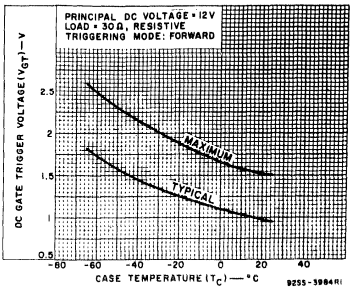


Fig. 10 – DC gate-trigger voltage vs. case temperature.

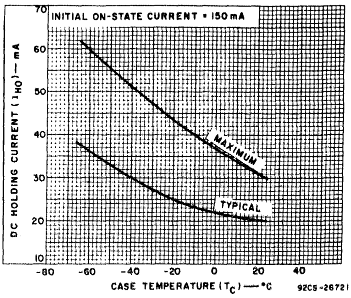


Fig. 11 – Holding current vs. case temperature.

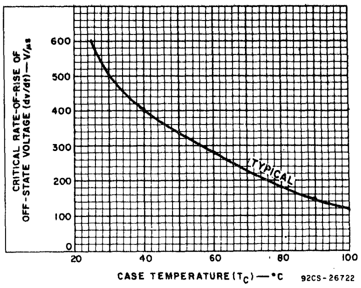


Fig. 12 – Critical rate of rise of off-state voltage vs. case temperature.

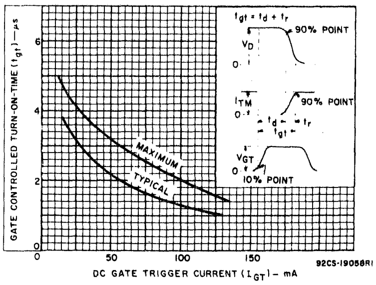


Fig. 13 – Gate-controlled turn-on time vs. gate trigger current.

10-A Silicon Controlled Rectifiers

For Power Switching, Power Control, and Ignition Applications

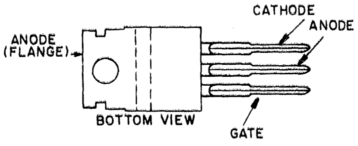
The RCA-S2800 series types are medium-power silicon controlled rectifiers (reverse-blocking triode thyristors) designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state regardless of gate-voltage polarity.

The TO-220AB package provides easy package mounting and low thermal resistance, allowing operation at high case temperatures and permitting reduced heat-sink size. These SCR's can be used in lighting and motor-speed controls, capacitor-discharge ignition circuits, high-voltage generators, automotive applications, and power-switching systems.

Features:

- **High dv/dt capability**
- **Glass-passivated chip**
- **Low on-state voltage at high current levels**
- **Shorted-emitter gate-cathode construction**
- **Low thermal resistance**
- **Center-gate construction**

TERMINAL DESIGNATIONS



92CS-27721

JEDEC TO-220AB
(See dimensional outline "S".)

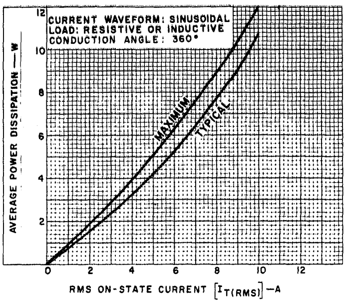
MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S2800F	S2800A	S2800B	S2800C	S2800D	S2800E	S2800M	S2800S	
V_{RSOM}▲, V_{DSOM}▲	75	125	250	375	500	600	700	800	V
V_{RROM}▲, V_{DROM}▲	50	100	200	300	400	500	600	700	V
$I_{T(RMS)}$ (T_C = 75°C, θ = 180°)	10								A
I_{TSM}									
For one full cycle of applied principal voltage 400-Hz	200								A
60-Hz	100								A
50-Hz	85								A
For more than one full cycle of applied principal voltage	See Fig. 3								
di/dt									
$V_D = V_{DROM}$, I_{GT} = 80 mA, t_r = 0.5 μs (See Fig.13)	100								A/μs
I^2t									
T_J = −65 to 100°C, t = 1 to 8.3 ms	40								A^2s
P_{GM}● (for 10 μs max.)	16								W
P_{RGM}●	See Fig. 6								
$P_{G(AV)}$● (averaging time = 10 ms max.)	0.5								W
T_{stg}■	−65 to +150								°C
T_C■	−65 to +100								°C
T_T									
During soldering for 10 s maximum (terminal and case)	250								°C

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

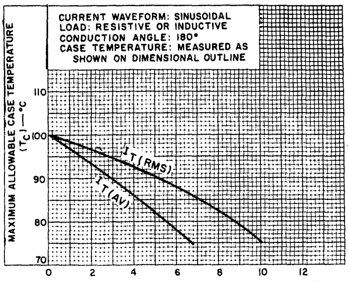
● Any values of peak gate current or peak gate voltage which result in an equal or lower power are permissible.

■ For information on the reference point of temperature measurement, see Dimensional Outline.



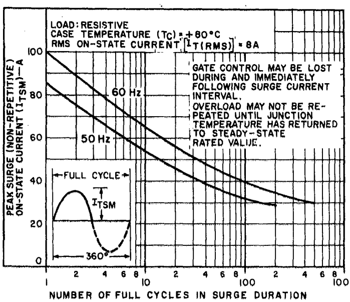
92SS-4163RI

Fig. 1— Power dissipation vs. on-state current.



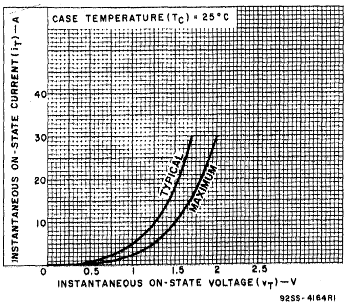
92CS-26725

Fig. 2— Maximum allowable case temperature vs. on-state current.



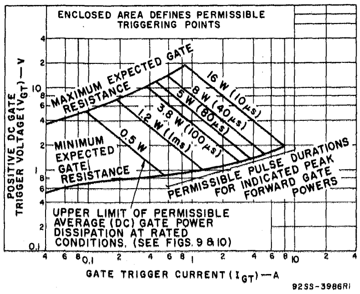
92LS-1351R5

Fig. 3— Allowable peak surge on-state current vs. surge duration.



92SS-4164RI

Fig. 4— Instantaneous on-state current vs. on-state voltage.



92SS-3986RI

Fig. 5— Typical forward-biased gate characteristics.

S2800 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DOM} or I_{ROM} $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = +100^{\circ}C$	–	0.1	2	mA
V_T $i_T = 30$ A, $T_C = +25^{\circ}C$	–	1.7	2	V
For other values of i_T		See Fig. 4		
I_{GT} $V_D = 12$ V (DC), $R_L = 30\ \Omega$ $T_C = +25^{\circ}C$	–	8	15	mA
For other case temperatures		See Fig. 7		
V_{GT} $V_D = 12$ V (DC), $R_L = 30\ \Omega$ $T_C = +25^{\circ}C$	–	0.9	1.5	V
For other case temperatures		See Fig. 8		
I_{HO} $T_C = +25^{\circ}C$	–	10	20	mA
For other case temperatures		See Fig. 9		
dv/dt $V_D = V_{DROM}$ Exponential voltage rise $T_C = +100^{\circ}C$ (See Fig. 14)				
S2800F	100	–	–	V/µs
S2800A	75	–	–	
S2800B	50	–	–	
S2800C	40	–	–	
S2800D	30	–	–	
S2800E	25	–	–	
S2800M	20	–	–	
S2800S	15	–	–	
t_{gt} $V_D = V_{DROM}$, $i_T = 4.5$ A, $i_T = 2$ A $I_{GT} = 80$ mA, 0.1 µs rise time $T_C = +25^{\circ}C$ (See Fig. 11)	–	1.6	2.5	µs
t_q $V_D = V_{DROM}$, $i_T = 2$ A, $t_p = 50$ µs dv/dt = 200 V/µs, di/dt = –10 A/µs $I_{GT} = 200$ mA at t_{ON}, $T_C = +75^{\circ}C$ (See Fig. 11)	–	10	35	µs
$R_{\theta JC}$	–	–	2	°C/W
$R_{\theta JA}$	–	–	60	

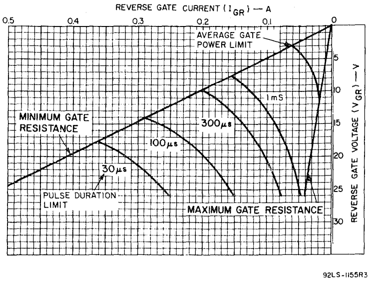


Fig. 6— Reverse gate voltage vs. reverse gate current.

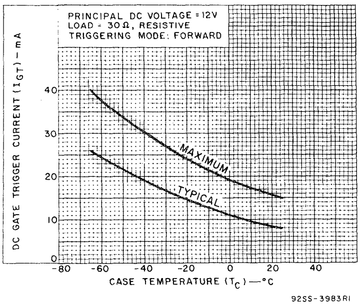


Fig. 7— DC gate-trigger current vs. case temperature.

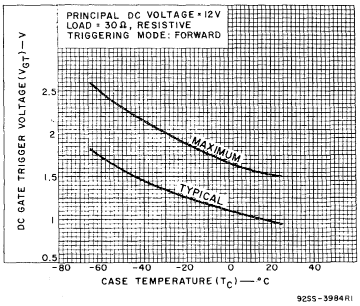


Fig. 8— DC gate-trigger voltage vs. case temperature.

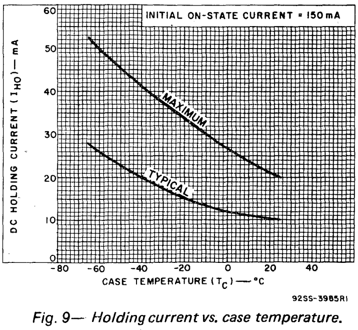


Fig. 9— Holding current vs. case temperature.

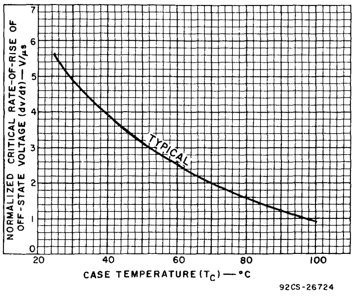


Fig. 10— Normalized critical rate of rise of off-state voltage vs. case temperature.

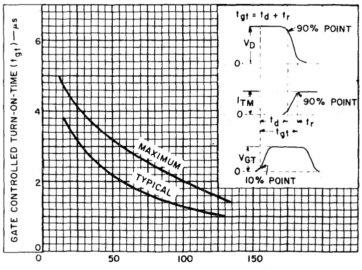


Fig. 11— Gate-controlled turn-on time vs. gate trigger current.

S3060 Series

3-A High-Speed Sensitive-Gate Silicon Controlled Rectifiers

For Power Switching and Control Applications

The S3060 series of sensitive-gate silicon controlled rectifiers are intended for high-speed switching applications such as low-power inverters, switching regulators for television and industrial applications, as well as current amplifiers for driving larger devices.

These thyristors feature fast turn-off and can be operated at frequencies of up to 20 kHz. They have low gate-current requirements which permit operation with low-level logic circuits.

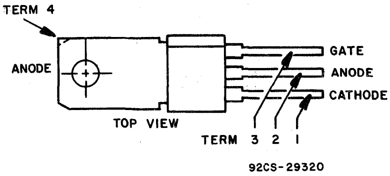
All types in this series utilize the JEDEC TO-202AB (RCA VERSATAB) plastic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S3060F	S3060A	S3060B	S3060D	S3060M	
V_{RSXM} $R_{GK} = 1000\ \Omega$, $T_C = -40$ to $100°C$ ...... V_{DSXM} $R_{GK} = 1000\ \Omega$, $T_C = -40$ to $100°C$	75	125	225	425	625	V
V_{RRXM} $R_{GK} = 1000\ \Omega$, $T_C = -40$ to $100°C$ ...... V_{DRXM} $R_{GK} = 1000\ \Omega$, $T_C = -40$ to $100°C$	50	100	200	400	600	V
$I_{T(AV)}$ ($T_C = 60°C$, $\theta = 180°$)	1.8					A
$I_{T(RMS)}$ ($T_C = 60°C$, $\theta = 180°$)	3					A
$I_{T(DC)}$ ($T_C = 60°C$)	2.0					A
I_{TSM}:						
For one cycle of applied principal voltage, $T_C = 60°C$						
60 Hz (sinusoidal)	20					A
50 Hz (sinusoidal)	17					A
For more than one cycle of applied principal voltage	See Fig. 6					
I_{GM} ($t = 10\ \mu s$)	0.2					A
V_{GRM}	6					V
di/dt:						
$V_{DM} = V_{DROM}$, $I_{GT} = 1$ mA, $t_r = 0.5\ \mu s$, $T_C = 100°C$	100					A/μs
I^2t [At T_C shown for $I_{T(RMS)}$]:						
t = 10 ms	1.7					A^2s
1 ms	0.8					A^2s
P_{GM} (For 10 μs max.)	0.5					W
$P_{G(AV)}$ (Averaging time = 10 ms max.)..	0.1					W
T_{stg}	−40 to +150					°C
T_C	−40 to +100					°C
T_T (During soldering for 10 s max.)....	225					°C

Features:
- *Fast turn-off time (tq) = 6 μs Typ.*
- *High gate sensitivity (I_{GT}) = 1.2 mA Typ.*
- *600-V capability*
- *3-A (rms) on-state current ratings*
- *20-A peak surge capability*
- *Glass-passivated chip for stability*
- *Low thermal resistances*
- *Surge capability curve*

TERMINAL DESIGNATIONS



JEDEC TO-202AB

(See dimensional outline "P".)

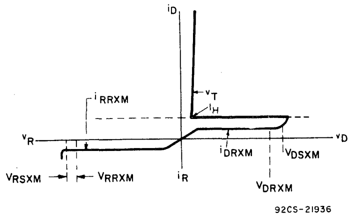


Fig. 1 - Typical volt-ampere characteristics for all series.

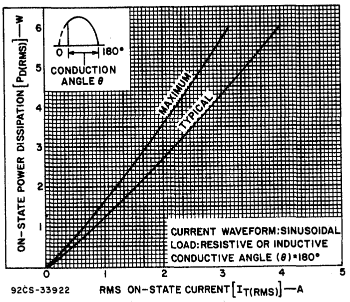


Fig. 2 - Power dissipation vs. rms-on-state current.

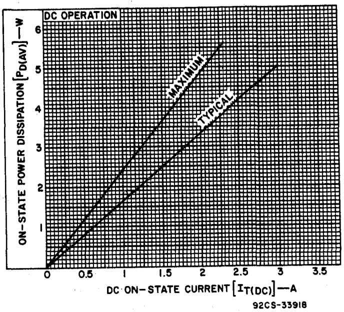


Fig. 3 - Power dissipation vs. dc on-state current.

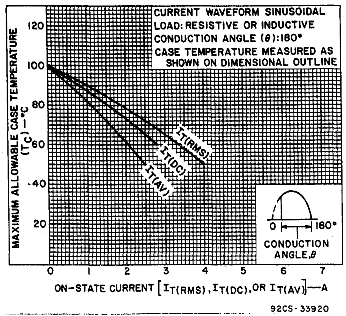


Fig. 4 - Maximum allowable case temperature vs. on-state current.

S3060 Series

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED			UNITS
	MIN.	TYP.	MAX.	
I_{DRXM} or I_{RRXM} $V_D = V_{DRXM}$ or $V_R = V_{RRXM}$, $R_{GK} = 1000\Omega$ $T_C = 25°C$	—	10	200	µA
$T_C = 100°C$	—	100	2000	
v_T For $i_T = 10$ A and $T_C = 25°C$, pulsed 300µs (See Fig. 8)	—	2.3	3.5	V
i_{HX} $R_{GK} = 1000\ \Omega$, $V_D = 12$ V, $I_{T(INITIAL)} = 250$ mA, $T_C = 25°C$	—	10	16	mA
i_{LX} $R_{GK} = 1000\ \Omega$, $V_D = 12$ V, $T_C = 25°C$, $I_G = 4$mA	—	18	40	mA
dv/dt $V_D = V_{DRXM}$, $R_{GK} = 1000\ \Omega$, Exponential rise, $T_C = 100°C$	—	20	—	V/µs
I_{GT} $V_D = 12$ V dc, $R_L = 30\ \Omega$, $T_C = 25°C$: For other case temperatures	—	1.2 See Fig. 11	2.0	mA
V_{GT} $V_D = 12$ V dc, $R_L = 30\ \Omega$, $T_C = 25°C$ For other case temperatures	—	0.75 See Fig. 12	1.5	V
t_{gt} $V_D = V_{DRXM}$, $i_T = 1$ A, $R_{GK} = 1000\ \Omega$, $I_{GT} = 4$ mA, Rise Time = 0.1 µs, $T_C = 25°C$	—	1.7	2.5	µs
t_q $V_D = V_{DRXM}$, $i_T = 1$ A, $R_{GK} = 1000\ \Omega$, Pulse Duration = 50 µs, dv/dt = 20 V/µs, di/dt = — 10 A/µs, $I_{GT} = 4$ mA at turn-on, $T_C = 100°C$	—	6.0	12	µs
$R_{\theta JC}$	—	—	8	°C/W
$R_{\theta JA}$	—	—	60	

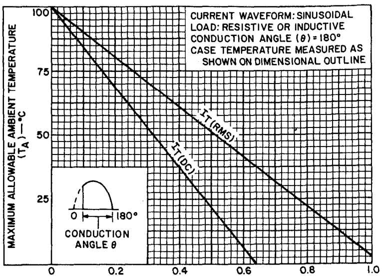


Fig. 5 - Maximum allowable ambient temperature vs. on-state current.

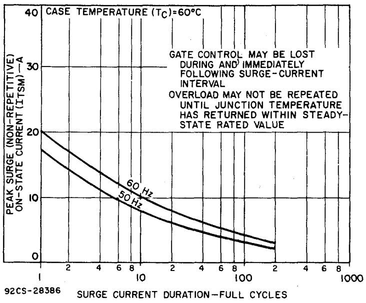


Fig. 6 - Peak surge on-state current as a function of surge-current duration.

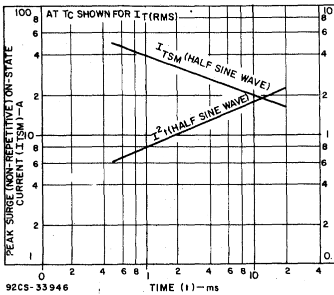


Fig. 7 - Peak surge on-state current and fusing current vs. time.

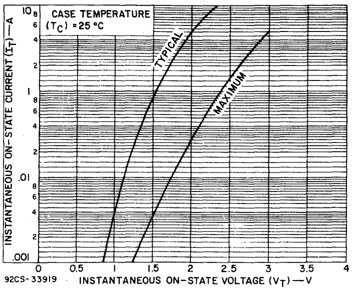


Fig. 8 - Instantaneous on-state current vs. on-state voltage.

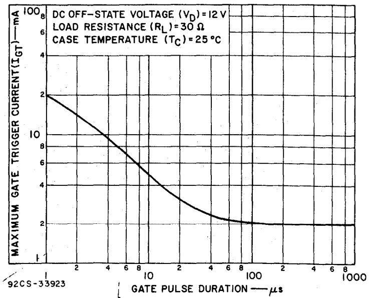


Fig. 9 - Maximum gate trigger current as a function of gate pulse duration.

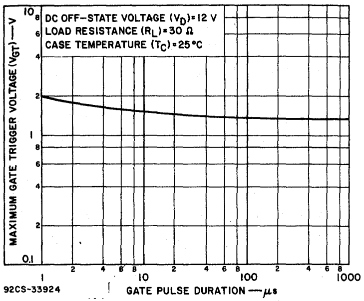


Fig. 10 - Maximum gate trigger voltage vs. gate pulse duration.

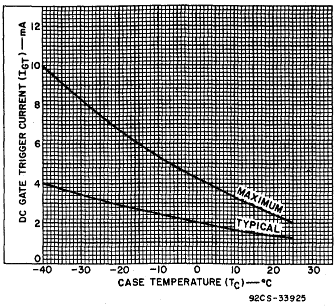


Fig. 11 - DC gate trigger current vs. case temperature.

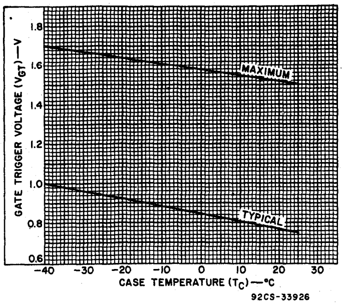


Fig. 12 - Gate trigger voltage vs. case temperature.

S3700 Series

5-A Silicon Controlled Rectifiers

For Inverter Applications

The RCA-S3700-series types are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) designed for inverter applications such as ultrasonics, choppers, regulated power supplies; induction heaters, cycloconverters, and fluorescent lighting. These types may be used at frequencies up to 25 kHz.

The S3700 series employ a hermetic JEDEC TO-66 package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		S3700B	S3700D	S3700M	
NON-REPETITIVE PEAK REVERSE VOLTAGE:■					
Gate Open	V_{RSOM}	300	500	700	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE:■					
Gate Open	V_{DSOM}	300	500	700	V
REPETITIVE PEAK REVERSE VOLTAGE:■					
Gate Open	V_{RROM}	200	400	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE:■					
Gate Open	V_{DROM}	200	400	600	V
ON-STATE CURRENT:					
$T_C = 60°C$, conduction angle = 180°:					
RMS	$I_{T(RMS)}$	5			A
Average	$I_{T(AV)}$	3.2			A
For other conditions		See Figs. 3, 4			
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}				
For one full cycle of applied principal voltage, $T_C = 60°C$					
60 Hz (sinusoidal)		80			A
50 Hz (sinusoidal)		65			A
For more than one full cycle of applied principal voltage		See Fig. 5			
RATE OF CHANGE OF ON-STATE CURRENT					
$V_D = V_{DROM}$, $I_{GT} = 50$ mA, $t_r = 0.1$ μs	di/dt	200			A/μs
FUSING CURRENT (for SCR protection):					
$T_J = -40$ to 100°C, t = 1 to 8.3 ms	I^2t	25			A
GATE POWER DISSIPATION:●					
Peak Forward (for 10 μs max., See Fig. 7)	P_{GM}	13			W
Peak Reverse (for 10 μs max., See Fig. 8)	P_{RGM}	13			W
Average (averaging time = 10 ms max.)	$P_{G(AV)}$	0.5			W
TEMPERATURE RANGE:▲					
Storage	T_{stg}	−40 to 150			°C
Operating (Case)	T_C	−40 to 100			°C
PIN TEMPERATURE (During soldering):					
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	225			°C

■ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

▲ For temperature measurement reference point, *see Dimensional Outline*.

ELECTRICAL CHARACTERISTICS

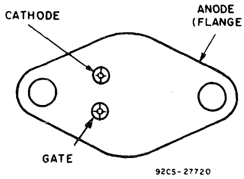
At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS			UNITS
		FOR ALL TYPES Except as Specified			
		MIN.	TYP.	MAX.	
Peak Off-State Current: (Gate open, $T_C = 100°C$) Forward Current (I_{DOM}) at $V_D = V_{DROM}$ Reverse Current (I_{ROM}) at $V_R = V_{RROM}$	I_{DOM} I_{ROM}	– –	0.5 0.3	3 1.5	mA
Instantaneous On-State Voltage: $i_T = 30$ A (peak), $T_C = 25°C$ For other conditions	v_T	–	2.2	3 See Fig. 6	V
Instantaneous Holding Current: Gate open, $T_C = 25°C$	i_{HO}	–	20	50	mA
Critical Rate of Rise of Off-State Voltage: $V_D = V_{DROM}$, exponential voltage rise, Gate open, $T_C = 80°C$	dv/dt	100	250	–	V/μs
DC Gate Trigger Current: $V_D = 12$ V (dc), $R_L = 30\ \Omega$, $T_C = 25°C$ For other conditions	I_{GT}	–	15	40 See Fig. 7	mA
DC Gate Trigger Voltage: $V_D = 12$ V (dc), $R_L = 30\ \Omega$, $T_C = 25°C$ For other conditions	V_{GT}	–	1.8	3.5 See Fig. 7	V
Gate Controlled Turn-On Time: (Delay Time + Rise Time) For $V_{DX} = V_{DROM}$, $I_{GT} = 300$ mA, $t_r = 0.1$ μs, $I_T = 2$ A (peak), $T_C = 25°C$ (See Fig. 10)	t_{gt}	–	0.7	–	μs
Circuit Commutated Turn-Off Time: $V_{DX} = V_{DROM}$, $i_T = 2$ A, pulse duration = 50 μs, dv/dt = 100 V/μs, −di/dt = −10 A/μs, $I_{GT} = 100$ mA, $V_{GT} = 0$ V (at turn-off), $T_C = 80°C$ (See Fig. 13)	t_q	–	4	6	μs
Thermal Resistance: Junction-to-Case Junction-to-Ambient	$R\theta JC$ $R\theta JA$	– –	4 –	8 40	°C/W °C/W

Features

- **Fast turn-off time 8 μs max.**
- **High di/dt and dv/dt capabilities**
- **Shorted-emitter gate-cathode construction . . . contains an internally diffused resistor between gate and cathode**
- **Center gate construction.... provides rapid uniform gate-current spreading for faster turn-on with substantially reduced heating effects**

TERMINAL DESIGNATIONS



BOTTOM VIEW

JEDEC TO-66

(See dimensional outline "O".)

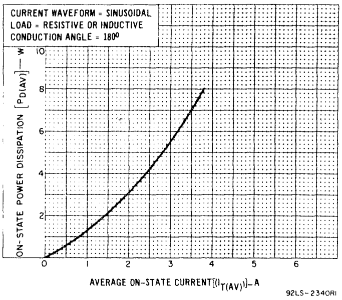


Fig. 1—Power dissipation vs. average on-state current.

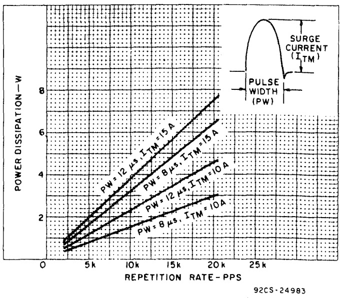


Fig. 2—Dissipation vs. repetition rate.

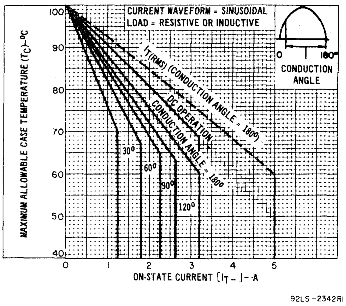


Fig. 3—Maximum allowable case temperature vs. on-state current.

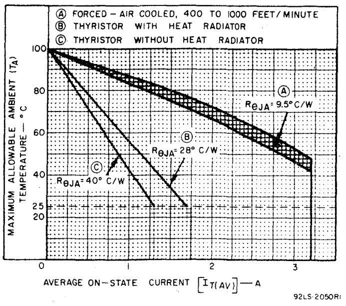


Fig. 4—Maximum allowable ambient temperature vs. average on-state current.

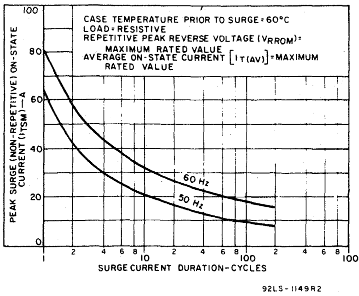


Fig. 5—Peak surge on-state current vs. surge-current duration.

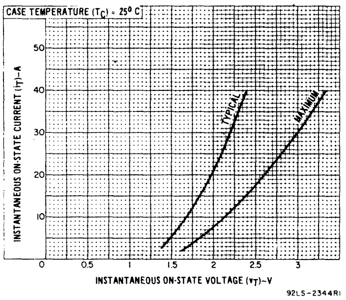


Fig. 6—Instantaneous on-state current vs. on-state voltage.

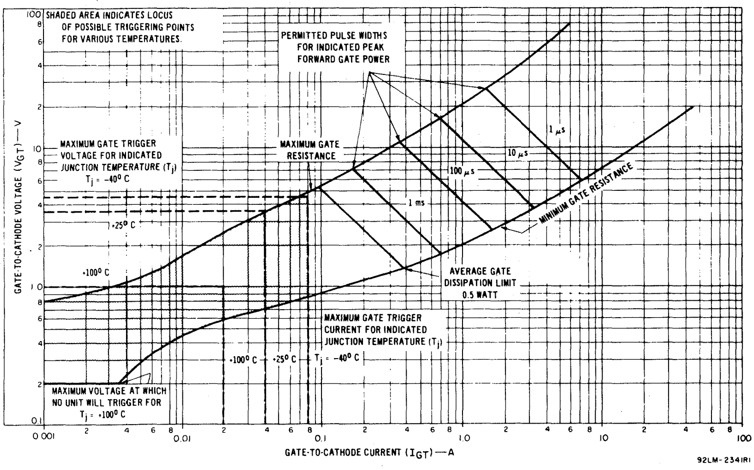


Fig. 7—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

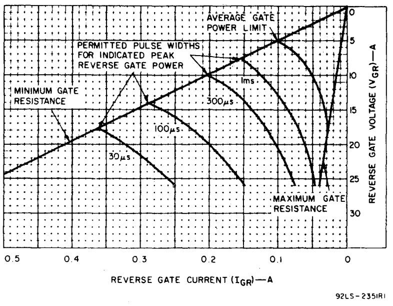


Fig. 8—Reverse-gate voltage vs. reverse-gate current.

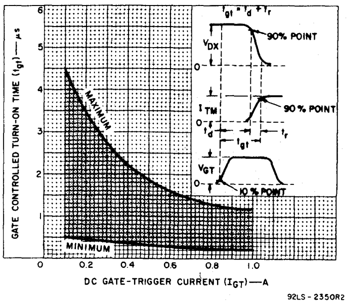


Fig. 9—Turn-on time vs. gate-trigger current.

S3701M

5-A Silicon Controlled Rectifier

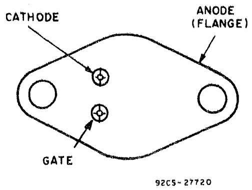
For Applications in Pulse Power Supplies To Drive GaAs Laser Diodes

Type S3701M is a silicon controlled rectifier intended for use in circuits which generate pulses to drive injection laser diodes.

The S3701M SCR is designed for the good current-spreading and delay-time characteristics necessary to provide high-peak-current pulses to drive the laser diode. An additional significant characteristic of this device is its well controlled holding current, which assures operation only at currents sufficiently high to meet the circuit requirements.

The S3701M SCR employs a hermetic JEDEC TO-66 package.

TERMINAL CONNECTIONS



BOTTOM VIEW

JEDEC TO-66

(See dimensional outline "N".)

Features:

- **High peak-current capability**
- **Good current-spreading attributes**
- **Symmetrical gate-cathode construction for uniform current density, rapid electrical conduction, and efficient heat dissipation**
- **Controlled minimum holding current**
- **Hermetic construction**
- **Low thermal resistance**

MAXIMUM RATINGS, *Absolute-Maximum Values:*
Case temperature (T_C) = 25°C, unless otherwise specified

REPETITIVE PEAK OFF-STATE VOLTAGE:			
Gate open	V_{DROM}	600	V
RMS ON-STATE CURRENT (Conduction angle = 180°)	$I_{T(RMS)}$	5	A
REPETITIVE PEAK ON-STATE CURRENT (0.2 μs Pulse Width):	I_{PM}		
Free-air cooling, f = 500 Hz		75	A
Free-air cooling, f = 5000 Hz		40	A
Infinite heat sink, f = 10,000 Hz		40	A
Infinite heat sink, f = 1,000 Hz		75	A
GATE POWER DISSIPATION:			
PEAK (For 10 μs pulse)	P_{GM}	25	W
TEMPERATURE RANGE:			
Storage	T_{stg}	-40 to 125°C	
Operating (Case)	T_C	-40 to 100°C	
TERMINAL TEMPERATURE (During soldering):	T_T		
For 10 s max. (terminals and case)		225	°C

ELECTRICAL CHARACTERISTICS
At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS		UNITS
		Min.	Max.	
Peak Off-State Current: Gate open, v_D = V_{DROM}, T_C = 25°C	I_{DROM}	–	0.65	mA
T_C = 75°C		–	1.2	
DC Gate-Trigger Current: T_C = 25°C	I_{GT}	–	35	mA
DC Gate-Trigger Voltage: T_C = 25°C	V_{GT}	–	4	V
DC Holding Current: Gate open, T_C = 25°C	I_{HO}	15	–	mA
T_C = 75°C		10	–	
Critical Rate-of-Rise of Off-State Voltage: For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 75°C	dv/dt	200	–	V/μs
Source Voltage for Functional Test (See Fig. 2): I_p = 75A, C = 0.022μF, R_s = 2Ω, f = 60Hz, pulse duration = 0.2μs, T_C = 25°C	V_s	–	550	V
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	–	7	°C/W
Junction-to-Ambient	$R_{\theta JA}$	–	40	

S3702S, S3703F, S3705M, S3706E

SCR'S for Horizontal-Deflection Circuits

For Large-Screen Color TV

Features:

- *Operation from supply voltages between 150 and 270 V [nominal]*
- *Ability to handle high beam current; average 1.6 mA dc*
- *Ability to supply as much as 5 mJ to 8 mJ of stored energy to the deflection yoke, which is sufficient for 29-mm-neck picture tubes operated at 29 kV or 31 kV [nominal value]*

The RCA-S3702S, S3702SF, S3705M, and S3706E silicon controlled rectifiers are designed for use in horizontal output circuits.

The S3703SF and S3705M silicon controlled rectifiers are designed to act as bipolar switches that control horizontal yoke current during e beam trace interval. The S3702S and S3706E silicon controlled rectifiers act as the commutating switches to initiate trace-retrace switching and control yoke current during retrace.

These SCR's employ a hermetic JEDEC TO-66 package.

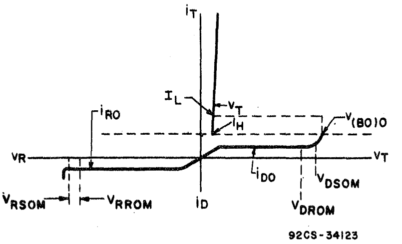
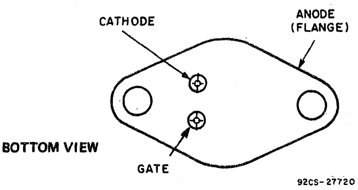


Fig. 1 - Principal voltage-current characteristic for all types.

TERMINAL DESIGNATIONS



JEDEC TO-66

(See dimensional outline "N".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*	**S3703SF**	**S3705M**	**S3702S**	**S3706E**	
	TRACE SCR		**COMMUTATING SCR**		
V_{DSOM}‡	800†	700†	750†	600†	V
V_{RROM}‡	25	25	25	25	V
V_{DROM}‡	750	600	700	500	V
$I_{T(RMS)}$ $T_c = 60°C$, 60 Hz sine wave, conduction angle = 180°	5	5	5	5	A
$I_{T(AV)}$ $T_c = 60°C$, 60 Hz sine wave, conduction angle = 180°	3.2	3.2	3.2	3.2	A
I_{TSM}					
For one full cycle of applied principal voltage					
60 Hz (sinusoidal), $T_c = 60°C$	80	80	80	80	A
50 Hz (sinusoidal), $T_c = 60°C$	65	65	65	65	A
For one-half sine wave, 3 ms pulse width	130	150	130	150	A
di/dt					
$V_D=V_{DROM}$, I_{GT} 50 mA, t, 0.1 μs	200				A/μs
I^2t					
T_J=40 to 80°C, t=1 to 10 ms	20				A^2s
P_{GM}★					
Peak (forward or reverse) for 10 μs duration, max.					
negative gate bias = −35 V (S3703SF, S3705M)	25				W
= −10 V (S3702S, S3706E)	25				W
T_{stg}*	−40 to 150				°C
T_c*	−40 to 80				°C
T_p					
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max	225				°C

† Protection against transients above these'values induced by arcing or other causes must be provided.

‡ These values do not apply if there is a positive gate signal, Gate must be open or negatively biased.

★ Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted, provided that the maximum reverse gate bias (as specified) is not exceeded.

* For temperature measurement reference point, see Dimension Outline.

S3702S, S3703F, S3705M, S3706E

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified and at Indicated Case* ***Temperature*** **(*T_C*)**

	LIMITS				UNITS
	S3703SF S3705M TRACE SCR		S3702S S3706E COMMUT. SCR		
CHARACTERISTIC	**TYP.**	**MAX.**	**TYP.**	**MAX.**	
I_{DOM} Gate open, $V_D = V_{DROM}$, $T_C = 85°C$	0.5	1.5	0.5	1.5	mA
V_T $i_T = 30$ A (peak), $T_C = 25°C$	2.2	3	2.2	3	V
dv/dt $V_D = V_{DROM}$, exponential voltage rise, Gate open, $T_C = 70°C$ S3702S	—	—	700 (min.) $(dv/dt)_3$		V/μs
S3706E	175 (min.)		1000 (min.) $(dv/dt)_2$		
I_{GT} $V_D = 12$ V (dc), $R_L = 30\Omega$, $T_C = 25°C$.	15	32	15	45	mA
V_{GT} $V_D = 12$ V (dc), $R_L = 30\Omega$, $T_C = 25°C$.	1.8	4	1.8	4	V
Tq†† $T_C = 70°C$, minimum negative gate bias during turn-off time = −20 V (S3703SF, S3705M) and −2.5 V (S3702S, S3706E, rate of reapplied voltage (dv/dt) = 175 V/μs S3703S	—	2.4	—	—	μs
S3705M	—	2.5	—	—	
= 400 V/μs S3702S	—	—	—	4.2	
S3706E	—	—	—	4.5	
$R_{\theta JC}$	—	4	—	4	°C/W

††This parameter, the sum of reverse recovery time and gate recovery time, is measured from the zero crossing of current to the start of the reapplied voltage. Knowledge of the current, the reapplied voltage, and the case temperature is necessary when measuring t_q. In the worst conditions (high line, zero-beam, off-frequency, minimum auxiliary load, etc.), turn-off time must not fall below the given values. Turn-off time increases with temperature, therfore, case temperature must not exceed 70°C.

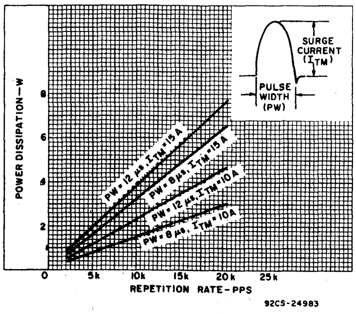


Fig. 2 - Dissipation vs. repetition rate for all types.

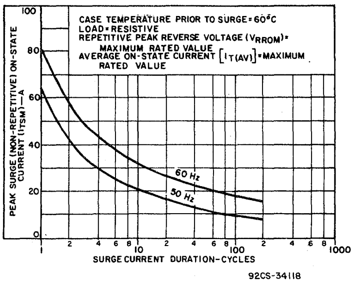


Fig. 3 - Peak surge on-state current vs. surge current duration for all types.

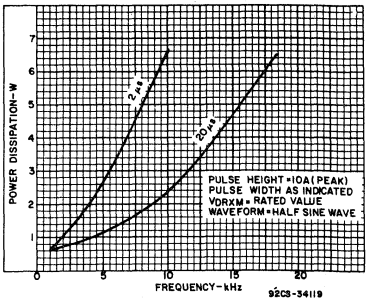


Fig. 4 - Dissipation vs. frequency for S3702S and S3703SF.

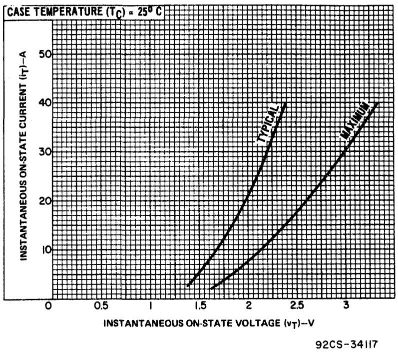
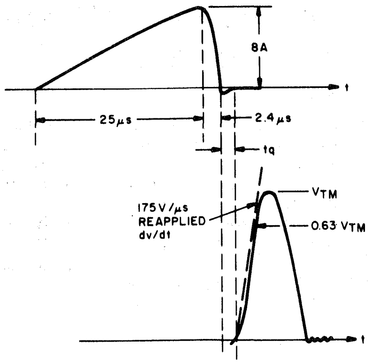
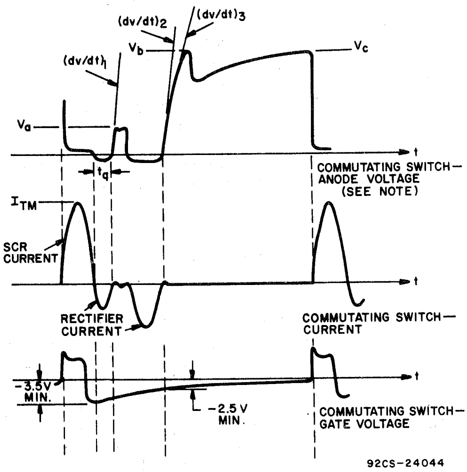


Fig. 5 - Instantaneous on-state current vs. on-state voltage for all types.



I_{TM} = 8 A, V_{TM} = V_{DROM}, reapplied dv/dt = 175 V/μs (measured from 0 to 0.63 of V_{TM}), negative gate voltage source = –24 V, source impedance = 15 Ω.

Fig. 6 - Oscilloscope display of trace switching [S3705M, S3703SF] showing circuit-commutating turn-off time [tq].

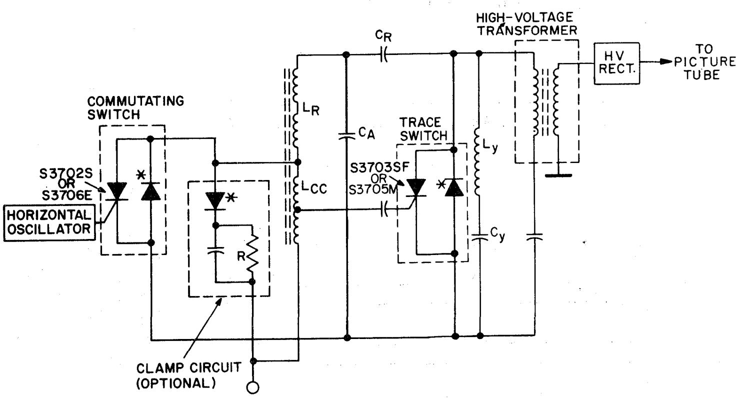


NOTE: "Commutating Switch-Anode Voltage" oscilloscope display has been modified graphically to show the measurement points of dv/dt more effectively.

I_{TM} = 15 A, V_a = 180 V max., V_b = 500 V max., V_c = V_{DROM}. Gate voltage = 12 V positive from 15 V supply. Gate current should rise to 100 mA within 0.2 μs. Minimum duration of gate current pulse = 3 μs. Minimum amplitude of gate current pulse = 200 mA. Negative gate bias at turn-off = –3.5 V minimum, negative gate bias at 2nd reapplied voltage $(dv/dt)_2$ = –2.5 V minimum.

$(dv/dt)_1$ = 400 V/μs (measured tangent to waveform at 0.8 of V_a)
$(dv/dt)_2$ = 1000 V/μs (measured tangent to waveform at 0.3 of V_b)
$(dv/dt)_3$ = 700 V/μs (measured tangent to waveform at 0.8 of V_b)

Fig. 7 - Oscilloscope display of commutating switching [S3702S, S3706E] showing circuit-commutated turn-off time [tq].



* TELEFUNKEN TYPE DIS700P OR EQUIVALENT

Fig. 8 - Simplified schematic diagram of horizontal output circuit.

S3900, S3901 Series

Monolithic Integrated Thyristor/Rectifiers (ITR's) for TV Horizontal-Deflection Circuits

Color and Monochrome

The RCA-S3900- and S3901-series integrated thyristor/rectifiers are all-diffused power monolithic circuits that incorporate a silicon controlled rectifier and a silicon rectifier on a common pellet. The S3900-series types are used as bipolar switches to control horizontal yoke current during the beam trace interval; the S3901-series types are used as commutating switches to initiate trace-retrace switching.

The S3900 and S3901-series ITR's are designed for use in color TV circuits. Devices in the S3900 series are capable of supplying 8 mJ of stored energy to the deflection yoke; this is sufficient for 29-mm-neck and 35-mm-neck color picture tubes operated at a nominal value of 31 kV.

All types in these series are supplied in the JEDEC TO—220AB package. The plastic used in this package is a flame-retardant material.

Features:

- Operation from nominal supply voltages between 140V and 270V
- Ability to handle high beam current: 1.6 mA dc (avg.)
- Ability to supply stored energy to the deflection yoke, as much as: 8mJ for 31 kV (nom.) color TV tubes- S3900 Series
- Highly reliable circuit which can also be used as a low-voltage power supply

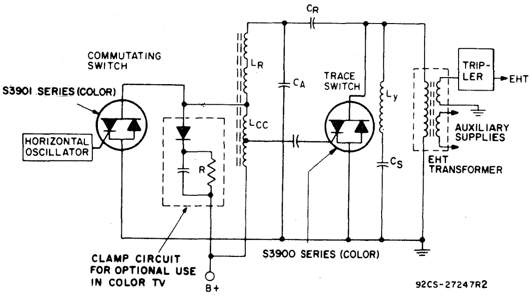
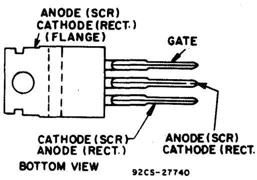


Fig. 1 — Simplified schematic diagram of horizontal output circuit.

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S".)

ITR's FOR COLOR TELEVISION

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TRACE				COMMUTATING			
	S3900E	S3900MF	S3900S	S3900SF	S3901M	S3901MF	S3901S	
V_{DSOM}:*● T_C = 85°C	550	700	750	800	650	700	750	V
V_{RROM}:● T_C = 85°C	4	4	4	4	4	4	4	V
V_{DROM}:● T_C = 85°C	500	650	700	750	600	650	700	V
CURRENT:								
T_C = 60°C, 50 Hz sine wave, θ = 180°:								
Rectifier Unit:								
I_o	3							A
$I_{F(RMS)}$	4.5							A
SCR Unit:								
$I_{T(AV)}$	5							A
$I_{T(RMS)}$	8							A
I_{TSM}:								
For one full cycle of applied principal voltage:								
60 Hz (sinusoidal), T_C=85°C:								
Rectifier Unit, I_{FSM}	80							A
SCR Unit, I_{TSM}	80							A
50 Hz (sinusoidal), T_C=85°C:								
Rectifier Unit, I_{FSM}	70							A
SCR Unit, I_{TSM}	70							A
For more than one full cycle of applied principal voltage	See Figs. 6 and 7							
For one-half sine wave, t_p=3 ms:								
Rectifier Unit, I_{FSM}	150							A
SCR Unit, I_{TSM}	150							A

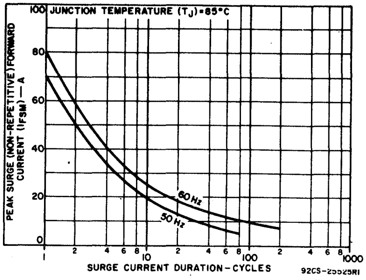


Fig. 2 — Peak surge forward current vs. surge-current duration for rectifier unit of ITR (all types).

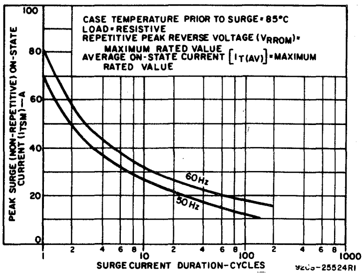


Fig. 3 — Peak surge on-state current vs. surge-current duration for SCR unit of ITR (all types).

ITR's FOR COLOR TELEVISION

MAXIMUM RATINGS, *Absolute-Maximum Values:* **(Cont'd)**

	TRACE			COMMUTATING			
	S3900MF	S3900S	S3900SF	S3901M	S3901MF	S3901S	
di/dt: $V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 µs	200						A/µs
I^2t (For ITR protection): T_J = −40 to 85°C, t = 1 to 10 ms	30						A^2s
P_{GM}:■ Forward or reverse for 10 µs duration, max. negative gate bias = −10 V	25						W
T_{stg}:▲	−40 to 150						°C
T_C:▲	−40 to 85						°C
T_T (During soldering): At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.	225						°C

*Protection against transients above these values induced by arcing or other causes must be provided.

•These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

■Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted, provided that the maximum reverse gate bias (as specified) is not exceeded.

▲For temperature measurement reference point, see Dimensional Outline.

ELECTRICAL CHARACTERISTICS FOR ITR's FOR COLOR-TELEVISION CIRCUITS

At Maximum Ratings and at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	LIMITS				UNITS
	S3900 Series TRACE ITR		S3901 Series COMMUTATING ITR		
	TYP.	MAX.	TYP.	MAX.	
I_{DOM}: $V_D = V_{DROM}$, T_C = 85°C	0.5	1.5	0.5	1.5	mA
V_T: SCR Unit: i_T = 30 A (See Fig. 4)	1.75	3	1.75	3	V
V_F: Rectifier Unit: i_F = 10 A (See Fig. 5)	1.35	1.7	1.35	2	V
dv/dt: $V_D = V_{DROM}$, T_C = 85°C V_G = −2.5 V min. (S3901 Series)	175 (min.)		1000 (min.) $(dv/dt)_2$		V/µs
I_{GT}: V_D = 12 V dc, R_L = 30 Ω	15	40	15	45	mA
V_{GT}: V_D = 12 V dc, R_L = 30 Ω	1.8	4	1.8	4	V
t_q: ♦ T_C = 80°C Minimum negative gate bias = −20 V (S3900 Series) = −2.5 V (S3901 Series) dv/dt = 175 V/µs (S3900 Series)	–	2.4	–	–	µs
dv/dt = 400 V/µs (S3901 Series)	–	–	–	4.2	

♦ Turn-off time increases with temperature; therefore, case temperature must not exceed the level indicated.

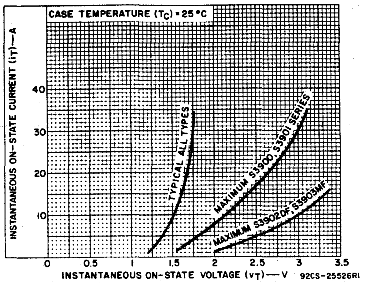


Fig. 4 — Instantaneous on-state current vs. on-state voltage for SCR unit of ITR (all types).

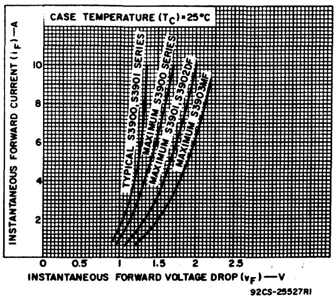


Fig. 5 — Instantaneous forward current vs. forward voltage drop for rectifier unit of ITR (all types).

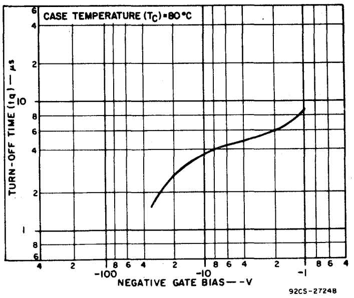


Fig. 6 — Typical turn-off time vs. gate bias for S3900-series types.

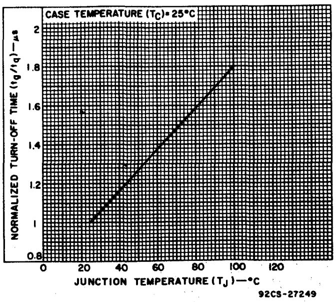


Fig. 7 — Normalized turn-off time vs. junction temperature for S3900- and S3901-series types.

S3900, S3901 Series

ELECTRICAL CHARACTERISTICS FOR ITR's FOR COLOR-TELEVISION CIRCUITS (Cont'd)
At Maximum Ratings and at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	LIMITS				UNITS
	S3900 Series TRACE ITR		S3901 Series COMMUTATING ITR		
	TYP.	MAX.	TYP.	MAX.	
t_{rr}: Rectifier Unit: I_{FM} = 10 A, $-di_F/dt$ = −10 A/μs, t_p = 3 μs	0.5	0.7	0.5	0.7	μs
V_{FM} (At t_g): Rectifier Unit: I_{FM} = 1 A	8	13	–	–	V
$R_{\theta JC}$▲	–	2.5	–	2.5	°C/W

▲ Measured at point indicated on Dimensional Outline.

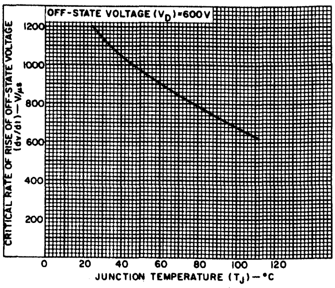


Fig. 8 — Typical dv/dt vs. junction temperature for S3900- and S3901-series types.

S4000(2N3668-2N3670,2N4103) Series

12.5-A Silicon Controlled Rectifiers

For Low-Cost Power-Control and Power-Switching Applications

RCA 2N3668*, 2N3669*, 2N3670*, and 2N4103* are all-diffused, three-junction, silicon controlled-rectifiers (SCR's). They are intended for use in power-control and power-switching applications requiring a blocking voltage capability of up to 600 volts and a forward-current capability of 12.5 amperes (rms value) or 8 amperes (average value) at a case temperature of 80°C.

The 2N3668 is designed for low-voltage power supplies, the 2N3669 for direct operation from 120-volt line supplies, the 2N3670 for direct operation from 240-volt line supplies, and the 2N4103 for high-voltage power supplies.

The 2N3668, 2N3669, 2N3670 and 2N4103 SCR's employ the hermetic JEDEC TO-3 package.

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*Formerly Dev. Types TA2621, TA2598, TA2618, and TA2775, respectively.

Features:

- Low switching losses
- High di/dt and dv/dt capabilities
- Shorted emitter gate-cathode construction
- Forward and reverse gate dissipation ratings
- Designed especially for high-volume systems
- All-diffused construction – assures exceptional uniformity and stability of characteristics
- Direct-soldered internal construction – assures exceptional resistance to fatigue
- Symmetrical gate-cathode construction – provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- All-welded construction and hermetic sealing
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- Low thermal resistance

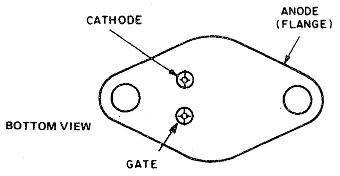
Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load

RATINGS	CONTROLLED-RECTIFIER TYPES				UNITS
	2N3668	2N3669	2N3670	2N4103	
Transient Peak Reverse Voltage (Non-Repetitive), v_{RM}(non-rep)	150	330	660	700	volts
Peak Reverse Voltage (Repetitive), v_{RM}(rep)	100	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), v_{FBOM}(rep)	100	200	400	600	volts
Forward Current:					
For case temperature (T_C) of +80° C					
Average DC value at a conduction angle of 180°, I_{FAV}	8	8	8	8	amperes
RMS value, I_{FRMS}	12.5	12.5	12.5	12.5	amperes
For other conditions, (See Fig. 4)					
Peak Surge Current, i_{FM}(surge):					
For one cycle of applied voltage	200	200	200	200	amperes
For one cycle of applied principal voltage					
60 Hz (sinusoidal), T_C = 80°C	200	200	200	200	amperes
50 Hz (sinusoidal), T_C = 80°C	170	170	170	170	amperes
For more than one cycle of applied voltage	See Fig. 2	See Fig. 2	See Fig. 2	See Fig. 2	
Fusing Current (for SCR protection):					
T_J = −40 to 100°C, t = 1 to 8.3 ms, I^2t	170	170	170	170	ampere^2 second
Rate of Change of Forward Current, di/dt V_{FB} = v_{BOO}(min. value) I_{GT} = 200mA, 0.5 .. s rise time	200	200	200	200	amperes/microsecond
Gate Power*:					
Peak, Forward or Reverse, for 10 .. s duration, P_{GM} (See Figs. 5 and 6)	40	40	40	40	watts
Average, P_{GAV}	0.5	0.5	0.5	0.5	watt
Temperature:					
Storage, T_{stg}●	-40 to +125	-40 to +125	-40 to +125	-40 to +125	°C
Operating (Case), T_C	-40 to +100	-40 to +100	-40 to +100	-40 to +100	°C

* Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

● Temperature reference point is within 1/8 in. (3.17 mm) of the center of the underside of unit.

TERMINAL DESIGNATIONS



JEDEC TO-3

(See dimensional outline "A".)

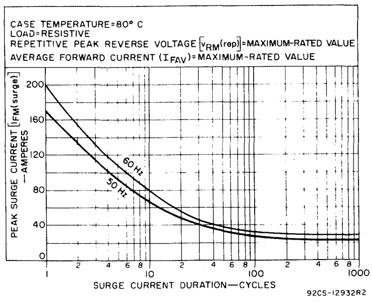


Fig. 1 — Peak surge current vs. surge current duration.

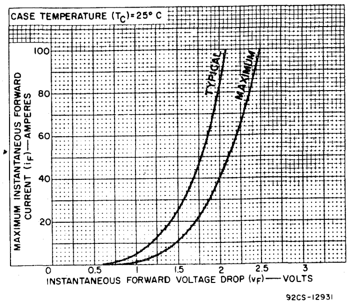


Fig. 2 — Instantaneous forward current vs. instantaneous forward voltage drop.

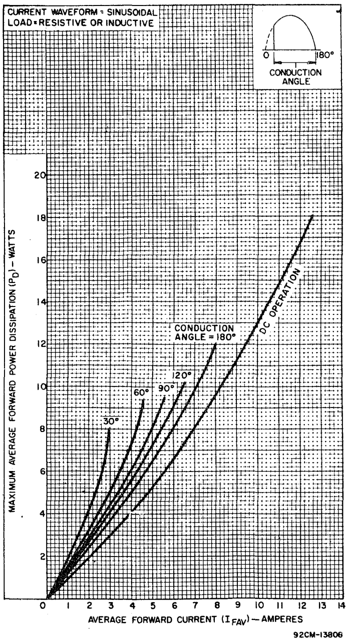


Fig. 3 — Power dissipation vs. forward current.

S4000(2N3668-2N3670,2N4103) Series

ELECTRICAL CHARACTERISTICS

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES												UNITS
	2N3668			2N3669			2N3670			2N4103			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Repetitive Blocking Voltage, V_{DROM} At T_C = +100°C	100	–	–	200	–	–	400	–	–	600	–	–	volts
Peak Blocking Current, at T_C = +100°C:													
Forward, I_{DOM} $V_D = V_{DROM}$	–	0.2	2	–	0.25	2.5	–	0.3	3	–	0.35	4	mA
Reverse, I_{ROM} $V_R = V_{RROM}$	–	0.05	1	–	0.1	1.25	–	0.2	1.5	–	0.3	3	mA
Forward Voltage Drop, v_F At a Forward Current of 25 amperes and a T_C = +25°C (See Fig. 2)	–	1.5	1.8	–	1.5	1.8	–	1.5	1.8	–	1.5	1.8	volts
DC Gate-Trigger Current, I_{GT}: At T_C = +25°C (See Fig. 5)	1	20	40	1	20	40	1	20	40	1	20	40	mA(dc)
Gate-Trigger Voltage, V_{GT}: At T_C = +25°C (See Fig. 5)	–	1.5	2	–	1.5	2	–	1.5	2	–	1.5	2	volts (dc)
Holding Current, i_{HOO}: At T_C = +25°C	0.5	25	50	0.5	25	50	0.5	25	50	0.5	25	50	mA
Critical Rate of Applied Forward Voltage, Critical dv/dt $V_{FB} = v_{BOO}$(min.value), exponential rise, T_C = +100°C	10	100	–	10	100	–	10	100	–	10	100	–	volts/ microsecond
Turn-On Time, t_{on}, (Delay Time + Rise Time) $V_{FB} = v_{BOO}$(min. value), i_F = 8 amperes, I_{GT} = 200mA, 0.1 μs rise time, T_C = +25°C (See waveshapes of Fig. 3)	0.75	1.25	–	0.75	1.25	–	0.75	1.25	–	0.75	1.25	–	microseconds
Turn-Off Time, t_{off}, (Reverse Recovery Time + Gate Recovery Time) i_F = 8 amperes, 50 μs pulse width, dv_{FB}/dt = 20 v/μs, di_f/dt = 30 A/μs, I_{GT} = 200mA, T_C = +80°C	–	20	50	–	20	50	–	20	50	–	20	50	microseconds
Thermal Resistance, Junction-to-Case	–	–	1.7	–	–	1.7	–	–	1.7	–	–	1.7	°C/W

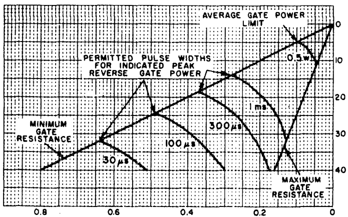


Fig. 4 — Reverse gate characteristics.

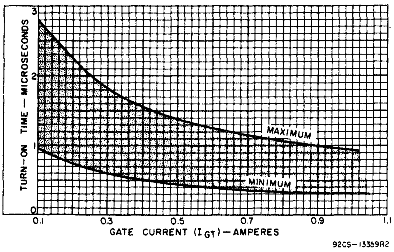


Fig. 5 — Turn-on time vs. gate current.

S4000(2N3668-2N3670, 2N4103) Series

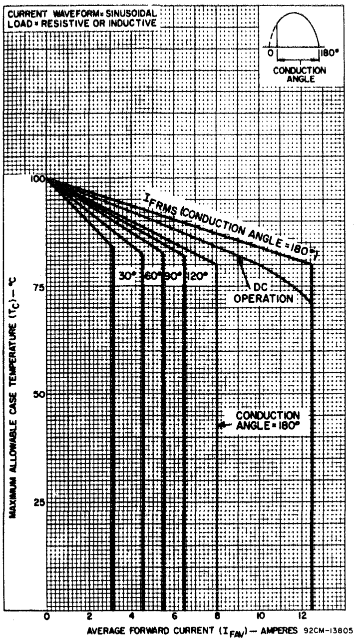


Fig. 6 — Maximum allowable case temperature vs. average forward current.

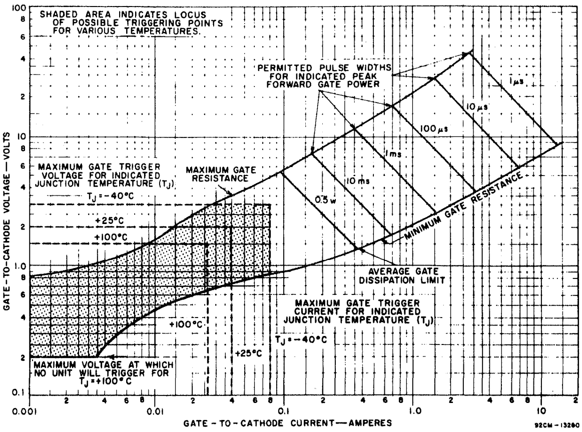


Fig. 7 — Forward gate characteristics.

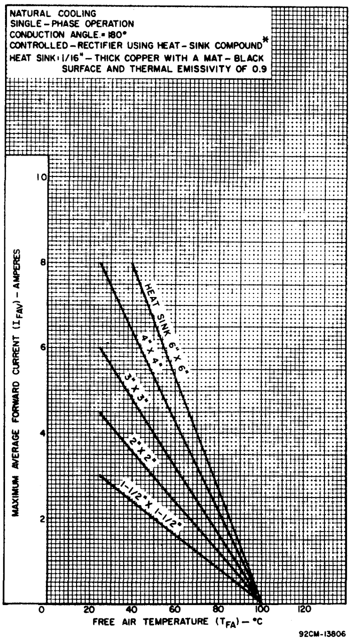


Fig. 8 — Natural-cooling operation guidance chart.

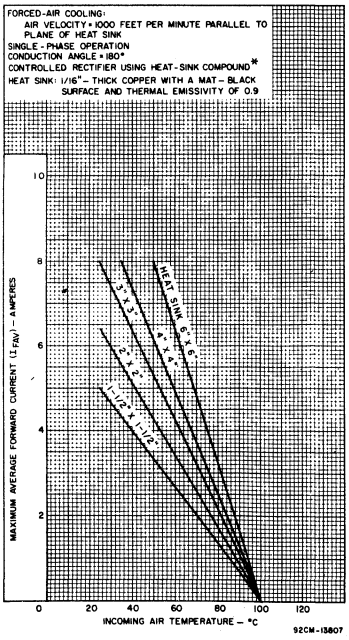


Fig. 9 — Forced-air cooling operation guidance chart.

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*Dow Corning 340 Silicon Heat Sink Compound, or Equivalent.

S4060 Series

10-Ampere Sensitive-Gate Silicon Controlled Rectifiers

For Power Switching and Control Applications

The S4060 series* are sensitive-gate silicon controlled rectifiers designed for switching ac and dc currents. The types within the series differ in their voltage ratings; the voltage ratings are identified by suffix letters in the type designations.

All types utilize the JEDEC TO-220AB package.

These thyristors have microampere gate-current requirements which permit operation with low-level logic circuits. They can be used for lighting, power-switching, and motor-speed controls, and for gate-current amplification for driving larger SCR's.

*Formerly the RCA Dev. No. TAS4060 series.

MAXIMUM RATINGS,

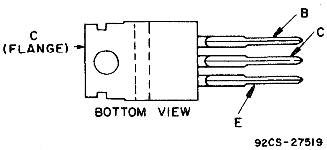
Absolute-Maximum Values:

	S4060U	S4060F	S4060A	S4060B	S4060C	S4060D	S4060E	S4060M	S4060S	S4060N	
V_{RRXM} R_{GK}=1000 Ω, T_C=−40 to 110°C .. V_{DRXM} R_{GK}=1000 Ω, T_C=−40 to 110°C...	25	50	100	200	300	400	500	600	700	800	V
$I_{T(RMS)}$ Conduction angle=180°, T_C=88°C	10										A
I_{TSM} For one cycle of applied principal voltage 60 Hz (sinusoidal)	120										A
For more than one cycle of applied principal voltage	See Figs. 5,6										
I_{GFM} (t=10 μsec)	0.2										A
V_{GRM}	6										V
di/dt V_{DM}=V_{DROM}, I_{GT}=1 mA, t_r=0.5 μs, T_C=110°C	100										A/μs
P_{GM} (for 10 μs max.)	0.5										W
$P_{G(AV)}$ (averaging time=10 ms max.)	0.1										W
T_{stg}	−40 to +150										°C
T_C	−40 to +110										°C
T_T For 10 s max.	250										°C

Features:

- *Microampere gate sensitivity*
- *800-V capability*
- *10-A (rms) on-state current ratings*
- *120-A peak surge capability*
- *Glass-passivated chip for stability*
- *Low thermal resistances*
- *Surge capability curve*

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S")

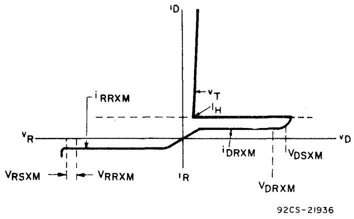


Fig. 1 - Typical volt-ampere characteristics.

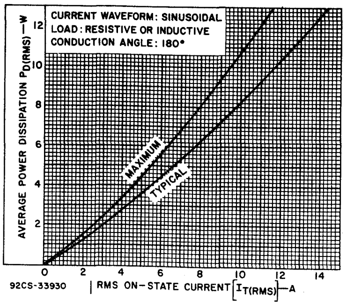


Fig. 2 - Power dissipation vs. RMS on-state current.

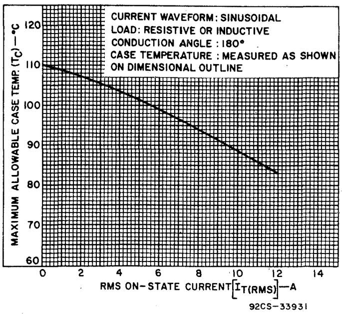


Fig. 3 - Maximum allowable case temp. vs. RMS on-state current.

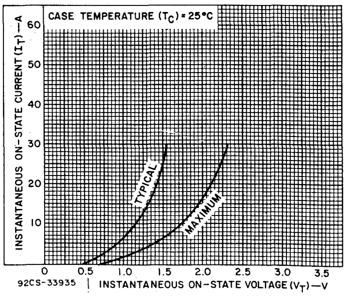


Fig. 4 - Instantaneous on-state current vs. on-state voltage.

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED			UNITS
	MIN.	TYP.	MAX.	
I_{DRXM}, $V_D = V_{DRXM}$, R_{GK} = 1000 Ω T_C = 25° C T_C = 110° C	 — —	 0.4 50	 50 500	μA
I_{RRXM}, $V_R = V_{RRXM}$, R_{GK} = 1000 Ω T_C = 25° C T_C = 110° C	 — —	 0.4 50	 50 500	
V_T For i_T = 30 A and T_C = 25° C (See Fig. 4)	—	1.55	2.3	V
I_{GT} V_D = 12 V (dc), R_L = 30 Ω, T_C = 25° C: For other case temperatures	— 	— See Fig. 8	200	μA
V_{GT} V_D = 12 V (dc), R_L = 30 Ω, T_C = 25° C For other case temperatures	—	0.58 See Fig. 7	1.5	V
i_H R_{GK} = 1000 Ω, V_D = 12 V, $I_{T\,(INITIAL)}$ = 150 mA, T_C = 25° C: (See Fig. 9)	—	3.45	6.0	mA
i_L R_{GK} = 1000 Ω, V_D = 12 V, T_C = 25° C: (I_{GT} = 200 μA)	—	1.8	4	mA
dv/dt $V_D = V_{DRXM}$, R_{GK} = 1000 Ω, Exponential rise, T_C = 110° C (See Fig. 10)	2.0	4.0	—	V/μs
t_{gt} $V_D = V_{DRXM}$, i_T = 1 A, R_{GK} = 1000 Ω, I_{GT} = 1 mA, rise time = 0.1 μs, T_C = 25° C	—	1.7	2.5	μs
t_q $V_D = V_{DRXM}$, i_T = 1 A, R_{GK} = 1000 Ω, Pulse Duration = 50 μs, dv/dt = 2 V/μs, di/dt = — 10 A/μs, I_{GT} = 1 mA at turn on, T_C = 110° C	—	50	110	μs
$R_{\theta JC}$	—	—	2.0	°C/W
$R_{\theta JA}$	—	—	60	

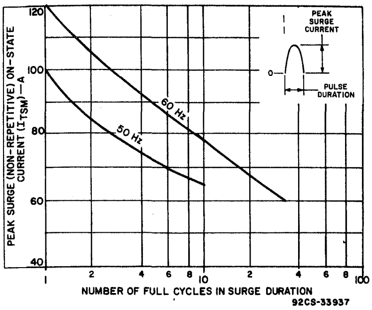


Fig. 5 - Allowable peak surge on-state current vs. surge duration.

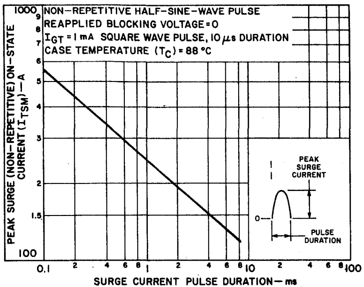


Fig. 6 - Surge capability without reapplied blocking voltage.

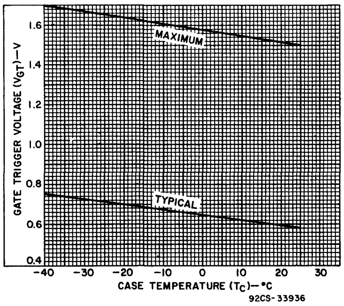


Fig. 7 - Gate trigger voltage vs. case temperature.

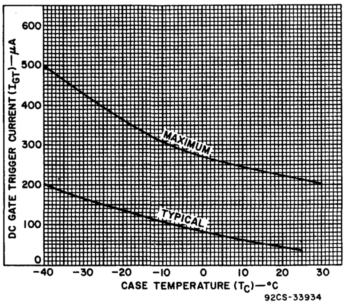


Fig. 8 - DC trigger current vs. case temperature.

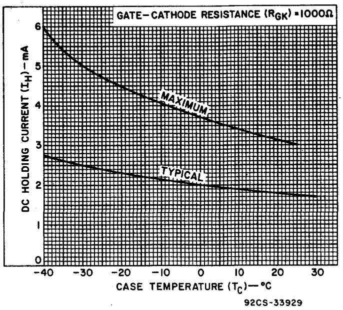


Fig. 9 - DC holding current vs. case temperature.

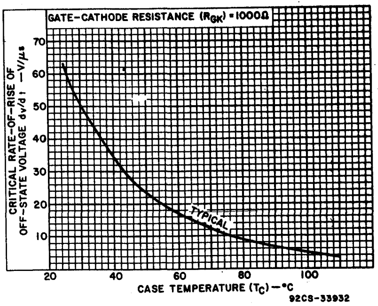


Fig. 10 - Critical rate-of-rise of off-state voltage vs. case temperature.

S5800 Series

5-A Silicon Controlled Rectifiers

For Inverter/Regulator Applications

The RCA-S5800 series are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors)intended for high-speed switching applications such as power inverters, switching regulators, and high-current pulse applications. They feature fast turn-off, high dv/dt, and high di/dt characteristics and may be used at frequencies up to 25 kHz.

All types in the series utilize the JEDEC-TO-220AB (RCA VERSAWATT) plastic package.

Features:

- Fast turn-off time (tq) = 6 μs max.
- High di/dt and dv/dt capabilities
- Shorted-emitter gate-cathode construction. . .contains an internally diffused resistor between gate and cathode
- Low thermal resistance
- Center-gate construction . . .provides rapid uniform gate-current spreading for faster turn-on with substantially reduced heating effects

MAXIMUM RATINGS,
Absolute-Maximum Values:

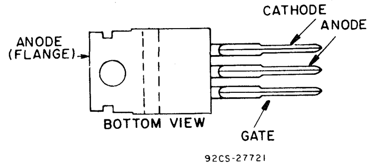
	S5800B	S5800C	S5800D	S5800E	S5800M	
V_{RSOM}▲ V_{DSOM}▲	250	350	450	550	650	V
V_{RROM}▲ V_{DROM}▲	200	300	400	500	600	V
$I_{T(RMS)}$ (T_C = 60°C, t_1/t_2 = 0.5)			5			A
$I_{T(AV)}$ (T_C = 60°C, t_1/t_2 = 0.5)			3.2			A
I_{TSM}:						
For one full cycle of applied principal voltage						
60-Hz (sinusoidal)			80			A
50-Hz (sinusoidal)			75			A
For more than one cycle of applied principal voltage			See Fig. 4			
di/dt:						
$V_{DM} = V_{DROM}$, I_{GT} = 500 mA, t_r = 0.5 μs			200			A/μs
I^2T [At T_C shown for $I_{T(RMS)}$]:						
t = 10 ms			28			A^2s
8.3 ms			26			A^2s
1 ms			13			A^2s
For other time values			See Fig. 5			
P_{GM}●:						
Peak forward for 10 μs max.			13			W
P_{RGM}●:						
Peak reverse for 10 μs max.			13			W
$P_{G(AV)}$●:						
Averaging time = 10 ms max			0.5			W
T_{stg}■			−40 to 150			°C
T_C■			−40 to 100			°C
T_T■ (During soldering for 10 s maximum, terminals and case)			225			°C

■ For temperature measurement reference point, see Dimensional Outline.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S".)

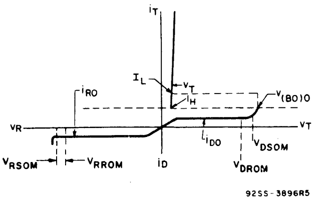


Fig. 1 — Principal voltage-current characteristic.

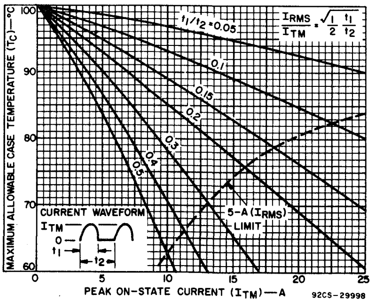


Fig. 2 — Maximum allowable case temperature as a function of peak on-state current.

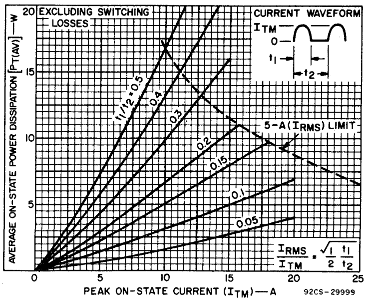


Fig. 3 — Average on-state power dissipation as a function of peak on-state current.

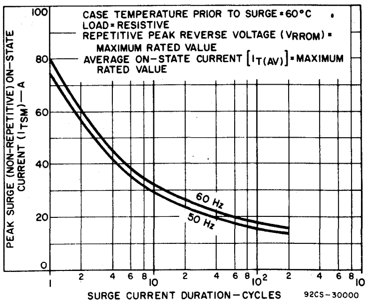


Fig. 4 — Peak surge on-state current as a function of surge duration.

S5800 Series

ELECTRICAL CHARACTERISTICS

As Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Min.	 Typ.	 Max.	UNITS
I_{DROM}: $V_D = V_{DROM}$, $T_C = 100°C$	–	0.5	3	mA
I_{RROM}: $V_R = V_{RROM}$, $T_C = 100°C$	–	0.3	1.5	
V_T: $I_{TM} = 30$ A (peak), $T_C = 25°C$: (See Fig. 6) S5800 series	–	2.34	4	V
i_{HO}: $T_C = 25°C$	–	20	50	mA
dv/dt: (Linear) $V_D = V_{DROM}$, $T_C = 80°C$	100	250	–	V/µs
I_{GT}: $V_D = 12$ V dc, $R_L = 30\ \Omega$, $T_C = 25°C$	–	–	50	mA
V_{GT}: $V_D = 12$ V dc, $R_L = 30\ \Omega$, $T_C = 25°C$	–	1.2	2.5	V
t_{gt}: $V_D = V_{DROM}$, $i_T = 8$ A (peak), $I_{GT} = 300$ mA, $t_r = 0.1$ µs, $T_C = 25°C$	–	0.7	–	µs
t_q: (See Fig. 8) ½ Sine Wave $V_D = V_{DROM}$, pulse duration = 50 µs, dv/dt = 100 V/µs, –di/dt = –10 A/µs, I_{GT} = 100 mA at turn on, V_{GK} = 0 V at turn off, $T_C = 75°C$: i_T = 4A S5800 series	–	4.4	–	µs
i_T = 8A S5800 series	–	4.7	6	
$R_{\theta JC}$	–	–	2.2	°C/W

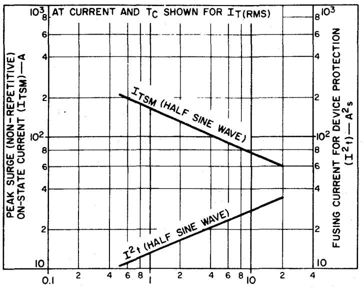


Fig. 5 – Peak surge on-state current and fusing current as a function of time.

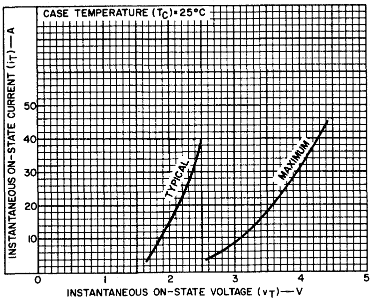


Fig. 6 – Instantaneous on-state current as a function of instantaneous on-state voltage.

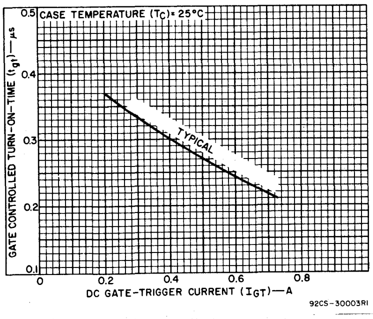


Fig. 7 – Gate-controlled turn-on-time as a function of gate current.

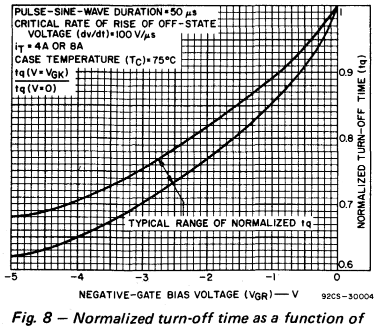


Fig. 8 – Normalized turn-off time as a function of negative-gate bias voltage.

S6000 (2N6394-2N6398)
S6100 (2N6400-2N6404) Series

12-A and 16-A Silicon Controlled Rectifiers

For Power Switching, Power Control, and Ignition Applications

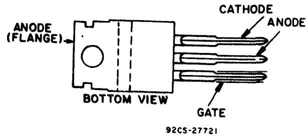
The RCA-2N6394 to 2N6398, inclusive, and 2N6400 to 2N6404, inclusive, are all-diffused silicon controlled rectifiers (reverse--blocking triode thyristors) designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state.

The TO-220AB package provides easy package mounting and low thermal resistance, allowing operation at high case temperatures and permitting reduced heat-sink size. These SCR's can be used in lighting and motor-speed control, capacitor-discharge ignition circuits, high-voltage generators, automotive applications, and power-switching systems.

Features:

- **High dv/dt capability**
- **Low thermal resistance**
- **Shorted-emitter center gate design**
- **Low on-state voltage at high current levels**
- **Glass passivated junctions**

TERMINAL CONNECTIONS



JEDEC TO-220AB

(See dimensional outline "S".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6394 2N6400	2N6395 2N6401	2N6396 2N6402	2N6397 2N6403	2N6398 2N6404	
*V_{RSOM}▲	75	125	250	450	650	V
V_{DSOM}▲	75	125	250	450	650	V
*V_{RROM}▲	50	100	200	400	600	V
*V_{DROM}▲	50	100	200	400	600	V
$I_{T(RMS)}$ $\theta = 180^\circ C$						
$T_C = 90^\circ C$ – 2N6394-98			12			A
$T_C = 100^\circ C$ - 2N6400-04			16			A
I_{TSM}:						
Foı one full cycle of applied principal voltage						
* 60-Hz† – 12-A types			125♦			A
16-A types			160			A
50-Hz† – 12-A types			105			A
– 16-A types			135			A
For more than one full cycle of applied principal voltage			See Fig. 7, 8			
di/dt						
$V_D = V_{DROM}$, $I_{GT} = 80$ mA, $t_r = 0.1\,\mu s$			100			A/µs
I^2t:						
$T_J = -40$ to $125^\circ C$,						
t = 1 to 8.3 ms – 12-A types			65			A^2s
16-A types			100			A^2s
P_{GM}●:						
Peak forward for 10 µs max.			16♠			W
Peak reverse			See Fig. 13			
*$P_{G(AV)}$●:						
Averaging time = 8 ms maximum			0.5			W
I_{GM}: (forward)			2			A
*T_{stg}■			–40 to 150			°C
*T_C■			–40 to 125			°C
T_T:						
During soldering for 10 s maximum (terminal and case)			250			°C

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* In accordance with JEDEC registration data format (JS-22, RDF-1) filed for the JEDEC (2N series) types.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

† At maximum rated $I_{T(RMS)}$.

♦ JEDEC registered value is 100 A at $T_C = 90^\circ C$.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

♠ JEDEC registered value is 10 W.

■ For temperature measurement reference point, see Dimensional Outline.

S6000 (2N6394-2N6398)
S6100 (2N6400-2N6404) Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTIC	LIMITS			UNITS
	For All Types			
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, T_C = 125°C	–	0.1	2*	mA
v_T: (See Fig. 9, 10) i_T = 24 A (peak), T_C = 25°C (12-A types)	–	1.7	2.2*	V
= 32 A (peak), T_C = 25°C (16-A types)	–	1.4	1.7*	
i_{HO}: (See Fig. 11) T_C = 25°C	–	10	35	mA
T_C = –40°C	–	–	60*	
dv/dt: $V_D = V_{DROM}$, exponential voltage rise, T_C = 125°	50	–	–	V/μs
I_{GT} (See Fig. 14) V_D = 12 V (dc), R_L = 50Ω, T_C = 25°C	–	8	30	mA
V_D = 12 V (dc), R_L = 50Ω, T_C = –40°C	–	–	60*	
V_{GT}: (See Fig. 15) V_D = 12 V (dc), R_L = 50Ω, T_C = 25°C	–	0.7	1.5	V
V_D = 12 V (dc), R_L = 50Ω, T_C = –40°C	–	–	2.5*	
V_{GRD}: $V_D = V_{DROM}$, T_C = 125°C	0.2	–	–	V
t_{gt}: $V_D = V_{DROM}$, i_T = 24 A (peak), I_{GT} = 200 mA, t_r = 0.02 μs, T_C = 25°C	–	–	2*	μs
t_q: Rectangular Pulse $V_D = V_{DROM}$, $i_T = I_{T(RMS)}$, pulse duration = 50 μs, dv/dt = 50 V/μs, –di/dt = –10 A/μs, I_{GT} = 80 mA at turn-on, V_R = 20 V minimum, V_{GK} = 0 V at turn-off, T_C = 75°C	–	35	75	μs
$R_{\theta JC}$	–	–	2*	°C/W
$R_{\theta JA}$	–	–	50*	

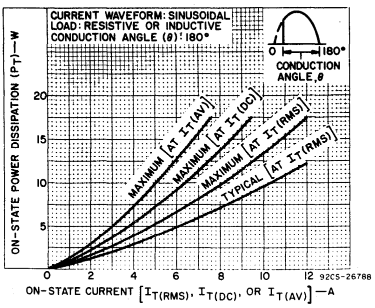


Fig. 1 — On-state power dissipation vs. on-state current for 2N6394–2N6398.

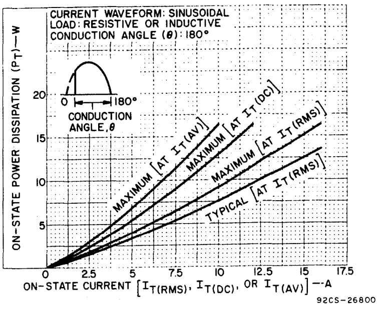


Fig. 2 — On-state power dissipation vs. on-state current for 2N6400-2N6404.

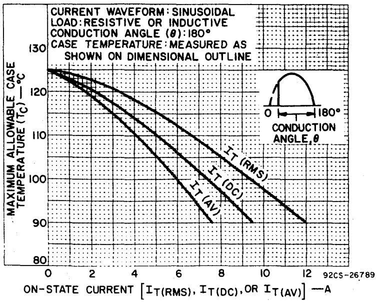


Fig. 3 — Maximum allowable case temperature vs. on-state current for 2N6394- 2N6398.

S6000 (2N6394-2N6398)
S6100 (2N6400-2N6404) Series

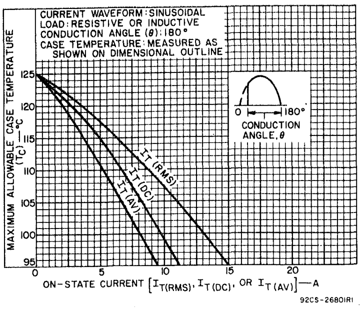


Fig. 4 – Maximum allowable case temperature vs. on-state current for 2N6400-2N6404.

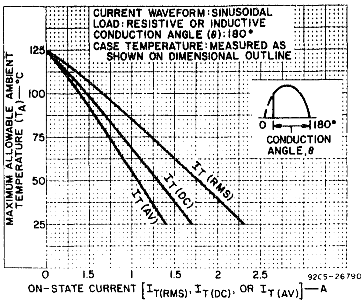


Fig. 5 – Maximum allowable ambient temperature vs. on-state current – no heat sinking for 2N6394-2N6398.

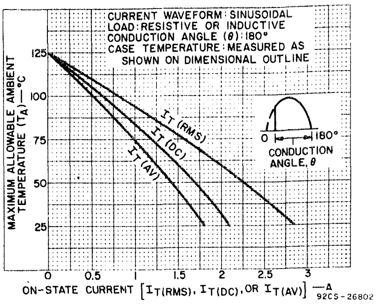


Fig. 6 – Maximum allowable ambient temperature vs. on-state current – no heat sinking for 2N6400-2N6404.

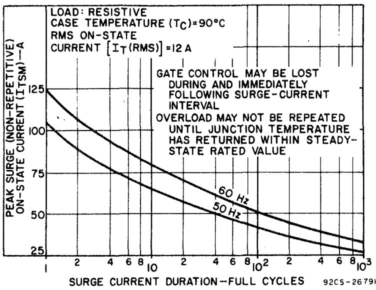


Fig. 7 – Allowable peak surge on-state current vs. surge duration for 2N6394-2N6398.

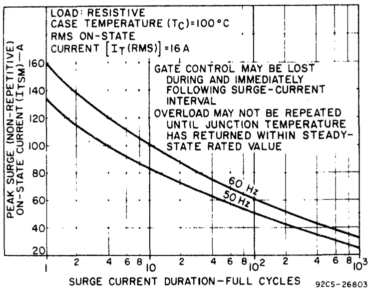


Fig. 8 – Allowable peak surge on-state current vs. surge duration for 2N6400-2N6404.

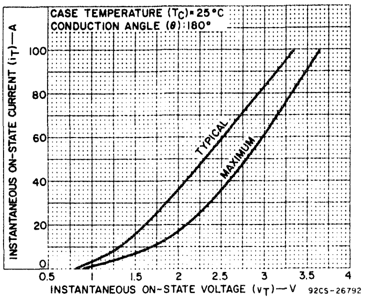


Fig. 9 – Instantaneous on-stage current vs. instantaneous on-state voltage for 2N6394–2N6398.

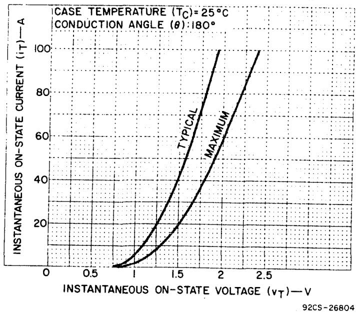


Fig. 10 – Instantaneous on-state current vs. instantaneous on-state voltage for 2N6400–2N6404.

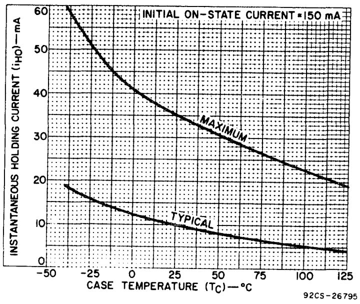


Fig. 11 – Instantaneous holding current vs. case temperature for all types.

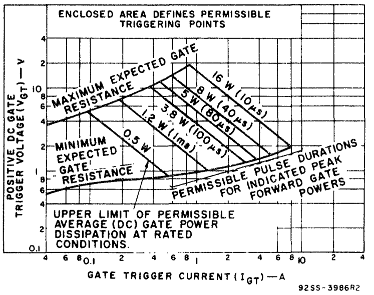


Fig. 12 – Gate trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses for all types.

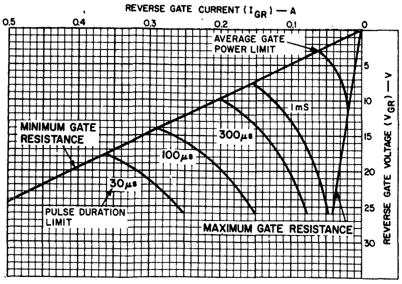


Fig. 13 – Reverse gate characteristics for all types.

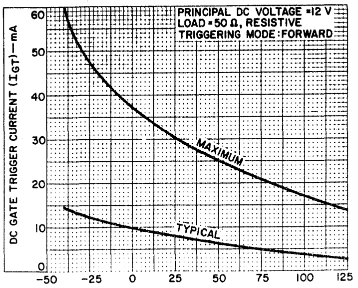


Fig. 14 – DC gate trigger current vs. case temperature for all types.

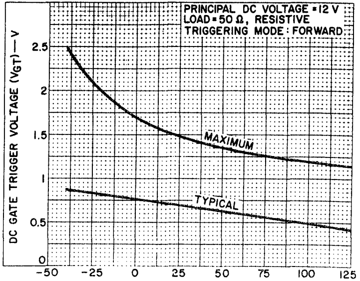


Fig. 15 – DC gate trigger voltage vs. case temperature for all types.

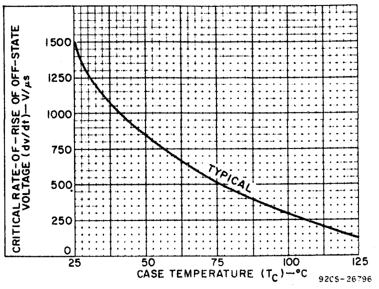


Fig. 16 — Critical rate of rise of off-state voltage vs. case temperature for all types.

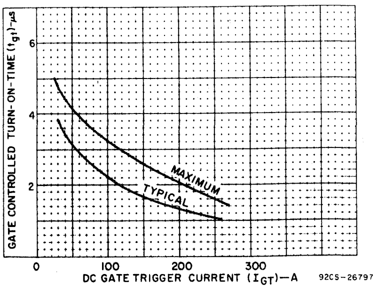


Fig. 17 — Typical gate-controlled turn-on time vs. gate trigger current for all types.

S6200, S6210, S6220 Series

20-A Silicon Controlled Rectifiers

Press-Fit, Stud, and Isolated-Stud Packages

These RCA types are all-difussed, silicon controlled rectifiers (reverse-blocking triode thryistors) designed for power switching and voltage regulator applications and for heating, lighting and motor speed-control circuits.

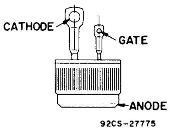
These SCRs have an RMS on-state current rating (I_T[RMS]) of 20A and have voltage ratings (V_{DROM}) of 100, 200, 400 and 600 volts.

The S6200 SCR series employs a hermetic press-fit package, the S6210 series employs a hermetic stud package, and the S6220 series employs a hermetic isolated-stud package.

Features:

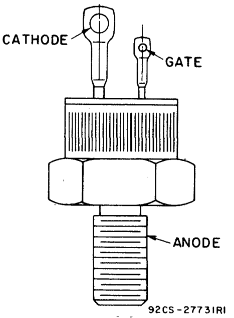
- **Low switching losses**
- **High di/dt and dv/dt capabilities**
- **Shorted-emitter gate-cathode construction**
- **Forward and reverse gate dissipation ratings**
- **All diffused construction–assures exceptional uniformity and stability of characteristics**
- **Symmetrical gate-cathode construction–provides uniform current density, rapid electrical conduction, and efficient heat dissipation**
- **Low leakage currents, both forward and reverse**
- **Low forward voltage drop at high current levels**
- **Low thermal resistance**

TERMINAL CONNECTIONS

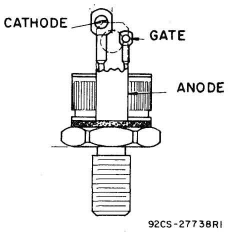


Press-Fit Types

(See dimensional outline "Q".)



(See dimensional outline "W".)



(See dimensional outline "Z".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		S6200A S6210A S6220A	S6200B S6210B S6220B	S6200D S6210D S6220D	S6200M S6210M S6220M	
NON-REPETITIVE PEAK REVERSE VOLTAGE						
Gate Open	V_{RSOM}	150	250	500	700	V
NON-REPETITIVE PEAK FORWARD VOLTAGE						
Gate Open	V_{DSOM}	150	250	500	700	V
REPETITIVE PEAK REVERSE VOLTAGE						
Gate Open	V_{RROM}	100	200	400	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE						
Gate Open	V_{DROM}	100	200	400	600	V
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:						
For one cycle of applied principal voltage $T_C = 75^oC$	I_{TSM}					
50-Hz, (sinusoidal)		170				A
60-Hz, (sinusoidal)		200				A
For more than one full cycle of applied principal voltage		See Fig. 3				
ON-STATE CURRENT:						
For case temperature (T_C) = 75° C, conduction angle of 180°						
Average DC value	$I_{T(AV)}$	12.5				A
RMS value	$I_{T(RMS)}$	20				A
RATE-OF-CHANGE OF ON-STATE CURRENT:						
$V_{DM} = V_{(BO)O}, I_{GT} = 200$ mA, $t_r = 0.5\ \mu s$	di/dt	200				A/µs
FUSING CURRENT (for SCR protection):						
$T_J = -65$ to 100^oC, t = 1 to 8.3 ms	I^2t	170				A^2s
GATE POWER DISSIPATION:						
PEAK FORWARD (for 10 µs max.)	P_{GM}	40				W
AVERAGE (averaging time = 10 ms, max.)	$P_{G(AV)}$	0.5				W
PEAK REVERSE	P_{RGM}	See Fig. 10				
TEMPERATURE RANGE:						
Storage		-65 to 150				^oC
Operating (Case)		-65 to 100				^oC
Soldering (10 s max. for terminals)		225				^oC

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS - ALL TYPES			UNITS
		Min.	Typ.	Max.	
Instantaneous Forward Breakover Voltage: (Gate open, T_C = 100 °C)	$V_{(BO)O}$				V
S6200A, S6210A, S6220A		100	-	-	
S6200B, S6210B, S6220B		200		-	
S6200D, S6210D, S6220D		400	-	-	
S6200M, S6210M, S6220M		600	-	-	
Peak Off-State Current: (Gate open, T_C = 100 °C)					mA
Forward, $V_{DO} = V_{DROM}$	I_{DOM}	--	0.2	3	
Reverse, $V_{RO} = V_{RROM}$	I_{RROM}	-	0.1	2	
Instantaneous On-State Voltage: For i_T = 100 A, T_C = 25 °C	v_T		1.9	2.4	V
DC Gate Trigger Current: V_D = 12 V (DC), R_L = 30 Ω, T_C = 25 °C	I_{GT}		8	15	mA
At other case temperatures			See Fig. 8		
DC Gate Trigger Voltage: V_D = 12 V (DC), R_L = 30 Ω, T_C = 25 °C	V_{GT}		1.1	2	V
At other case temperatures			See Fig. 9		
Instantaneous Holding Current: Gate open, T_C = 25 °C	I_{HO}		9	20	mA
At other case temperatures			See Fig. 6		
Critical Rate-of-Rise of Off-State Voltage: (V_{DO} = $V_{(BO)O}$ Min. value, Exponential rise, T_C = 100°C)	dv/dt				V/μs
S6200A, S6200D, S6210A, S6210D, S6220A, S6220D		10	100	-	
S6200B, S6210B, S6220B		10	150	-	
S6200M, S6210M, S6220M		10	75	-	
Gate Controlled Turn-On Time: V_D = $V_{(BO)O}$ Min. value, i_T = 30 A, I_{GT} = 200 mA, 0.1 μs rise time, T_C = 25°C See Fig. 11	t_{gt}	-	2	-	μs
Circuit Commutated Turn-Off Time: V_D = $V_{F(BO)O}$ Min. value, i_T = 18 A, Pulse Duration = 50 μs, **dv/dt = 20 V/μs, di/dt = −30 A/μs, T_C = 75°C**	t_q	–	20	40	μs
Thermal Resistance: Junction-to-Case **(press-fit, stud packages)**	$R_{\theta JC}$	-	-	1.2	°C/W
Junction-to-Isolated Stud **(Isolated-stud package)**	$R_{\theta JIS}$	-	-	1.4	

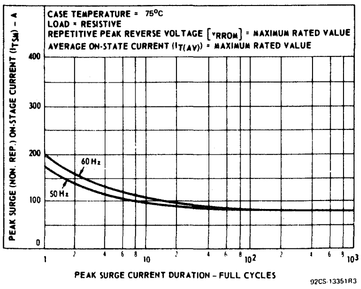


Fig. 1 — Peak surge on-state current vs. surge current duration.

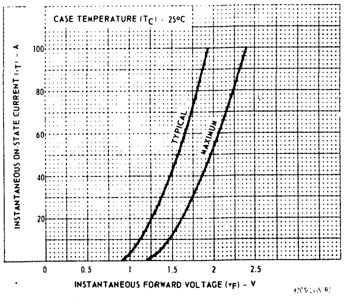


Fig. 2 — Instantaneous on-state current vs. on-state voltage.

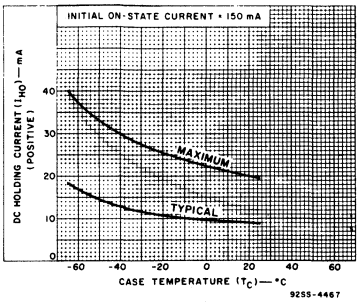


Fig. 3 — DC holding current vs. case temperature.

S6200, S6210, S6220 Series

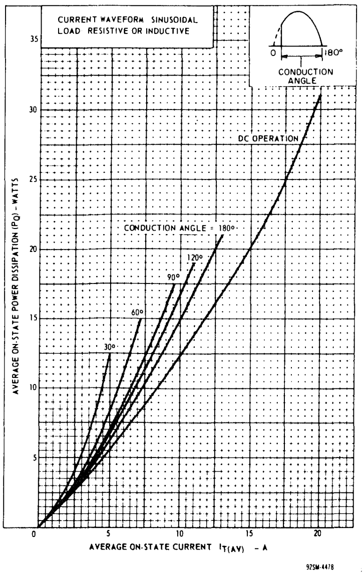


Fig. 4 — Power dissipation vs. on-state current.

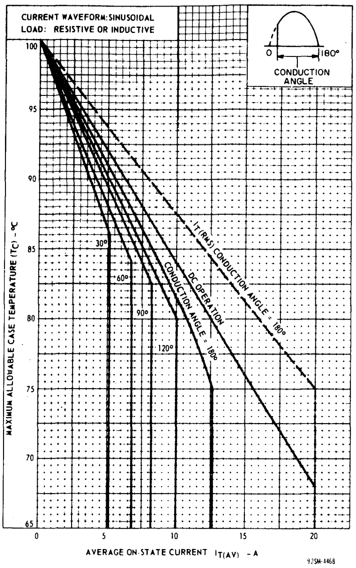


Fig. 5 — Maximum allowable case temperature vs. average forward current for stud and press-fit.

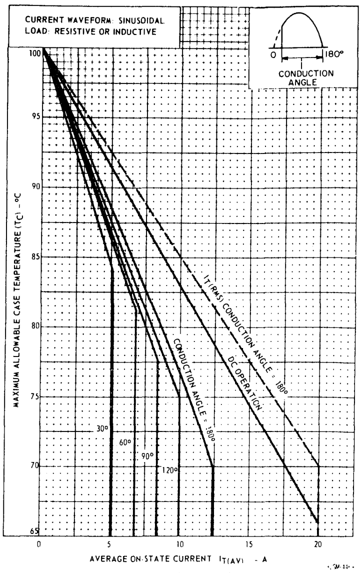


Fig. 6 — Maximum allowable case temperature vs. average forward current for isolated stud.

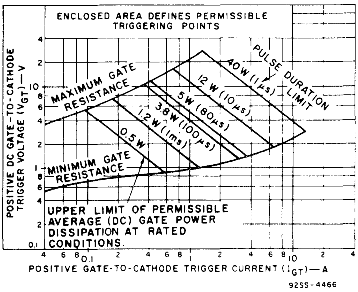


Fig. 7 - Typical forward-biased gate-trigger characteristics.

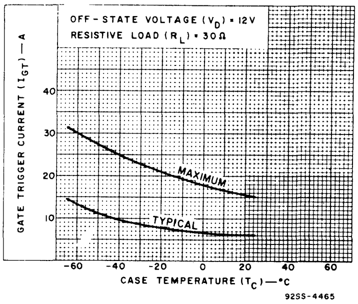


Fig. 8 — DC gate-trigger current (forward) vs. case temperature.

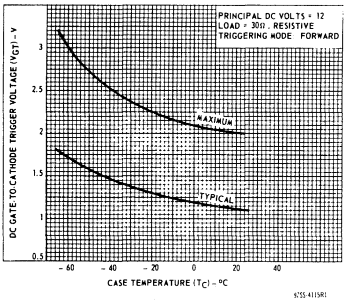


Fig. 9 — DC gate-trigger voltage vs. case temperature.

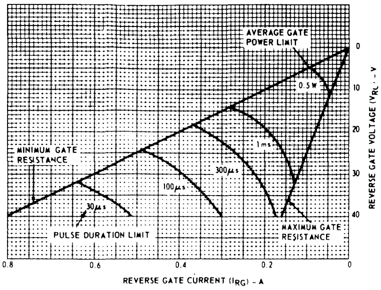


Fig. 10 — Reverse gate voltage vs. reverse gate current.

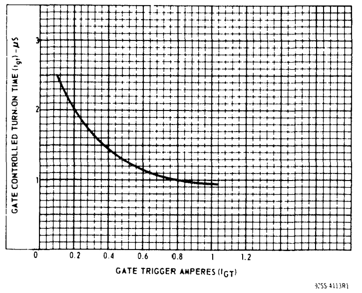


Fig. 11 — Gate controlled turn-on time (t_{gt}) vs. gate-trigger current.

WARNING: The ceramic of the isolated stud package contains beryllium oxide. Do not crush, grind, or abrade this part because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

S6400 (2N3870-2N3873) S6410 (2N3896-2N3899)
S6420 Series

35-A Silicon Controlled Rectifiers

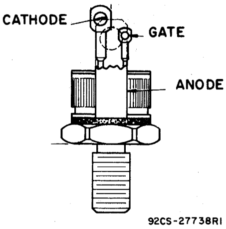
These RCA types are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) designed for power switching, power control, and voltage regulator applications and for heating, lighting, and motor speed-control circuits.

The 2N3870-73 and S6400N employ a hermetic press-fit package.

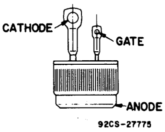
The 2N3896-99 and S6410 employ a hermetic stud package. The S6420 series employ a hermetic isolated-stud package.

Features:
- **High di/dt and dv/dt capabilities**
- **Low on-state voltage at high current levels**
- **Low thermal resistance**
- **Shorted-emitter center-gate construction**

TERMINAL CONNECTIONS

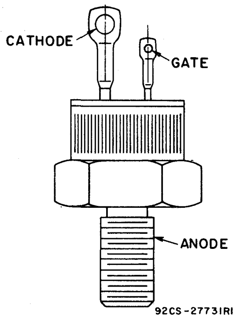


Isolated-Stud Types
(See dimensional outline "Z")



Press-Fit Types

(See dimensional outline "Q")



Stud Types
(See dimensional outline "W".)

WARNING: The ceramic of the isolated stud package contains beryllium oxide. Do not crush, grind, or abrade this part because the dust resulting from such action may be hazardous if inhaled, Disposal should be by burial.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3870 2N3896 S6420A	2N3871 2N3897 S6420B	2N3872 2N3898 S6420D	2N3873 2N3899 S6420M	
***NON-REPETITIVE PEAK REVERSE VOLTAGE▲**						
Gate Open	V_{RSOM}	150	330	660	700	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE▲						
Gate Open	V_{DSOM}	150	330	660	700	V
***REPETITIVE PEAK REVERSE VOLTAGE▲**						
Gate Open	V_{RROM}	100	200	400	600	V
***REPETITIVE PEAK OFF-STATE VOLTAGE▲**						
Gate Open	V_{DROM}	100	200	400	600	V
ON-STATE CURRENT:						
T_C = 65°C♦, conduction angle = 180°:						
RMS	$I_{T(RMS)}$	35				A
* Average	$I_{T(AV)}$	22				A
For other conditions		See Figs. 2 & 4				
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}					
For one full cycle of applied principal voltage, T_C = 65°C						
* 60 Hz (sinusoidal)		350				A
50 Hz (sinusoidal)		300				A
For more than one full cycle of applied principal voltage		See Fig. 3				
RATE OF CHANGE OF ON-STATE CURRENT						
$V_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.5 μs	di/dt	200				A/μs
FUSING CURRENT (for SCR protection):						
T_J = -40 to 100°C, t = 1 to 8.3 ms	I^2t	300				A^2s
GATE POWER DISSIPATION●:						
Peak Forward (for 10 μs max., See Fig. 7)	P_{GM}	40				W
Peak Reverse	P_{RGM}	See Fig. 8				
Average (averaging time = 10 ms max.)	$P_{G(AV)}$	0.5				W
***TEMPERATURE RANGE■:**						
Storage	T_{stg}	-40 to 125				°C
Operating (Case)	T_C	-40 to 100				°C
TERMINAL TEMPERATURE (During soldering):	T_T					
For 10 s max. (terminals and case)		225				°C

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* In accordance with JEDEC registration data filed for the JEDEC (2N-series) types.
▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
♦ T_C = 60° for isolated-stud package types.
● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
■ Temperature measurement point is shown on the DIMENSIONAL OUTLINE.

S6400 (2N3870-2N3873) S6410 (2N3896-2N3899) S6420 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS			UNITS
		FOR ALL TYPES Unless Otherwise Specified			
		MIN.	TYP.	MAX.	
Peak Off-State Current: (Gate open, T_C = 100°C) Forward Current (I_{DOM}) at V_D = V_{DROM} Reverse Current (I_{ROM}) at V_R = V_{RROM}	I_{DOM} or I_{ROM}				
2N3870, 2N3896, S6420A		–	0.2	2*	mA
2N3871, 2N3897, S6420B		–	0.25	2.5*	mA
2N3872, 2N3898, S6420D		–	0.3	3*	mA
2N3873, 2N3899, S6420M					
Instantaneous On-State Voltage: i_T = 69 A (peak), T_C = 25°C	v_T	–	–	1.85*	V
i_T = 100 A (peak), T_C = 25°C		–	1.7	2.1	
DC Gate Trigger Voltage: V_D = 12 V (dc), R_L = 30 Ω, T_C = -40°C	V_{GT}	–	1.5	.3*	V
V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C		–	1.1	2	
For other case temperatures			See Fig. 10		
DC Gate Trigger Current: V_D = 12 V (dc), R_L = 30 Ω, T_C = -40°C	I_{GT}	–	46	80*	mA
V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C		1	25	40	
For other case temperatures			See Fig. 9		
Instantaneous Holding Current: Gate open, T_C = 25°C	i_{HO}	0.5	30	70	mA
For other case temperatures			See Fig. 6		
Gate Controlled Turn-On Time: (Delay Time + Rise Time) For V_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs, I_T = 30 A (peak), T_C = 25°C	t_{gt}	–	1.25	2	μs
Circuit Commutated Turn-Off Time: V_D = V_{DROM}, i_T = 18 A, pulse duration = 50 μs, dv/dt = 20 V/μs, -di/dt = -30 A/μs, I_{GT} = 200 mA, T_C = 80°C	t_q	–	20	40	μs
Critical Rate of Rise of Off-State Voltage: V_D= V_{DROM}, exponential voltage rise, Gate open, T_C = 100°C	dv/dt	10	100	–	V/μs
Thermal Resistance, Junction-to-Case: Steady-State Press-fit & stud types	$R_{\theta JC}$	–	–	0.9*	°C/W
Isolated-stud types		–	–	1	

*In accordance with JEDEC registration data filed for the JEDEC (2N-series) types.

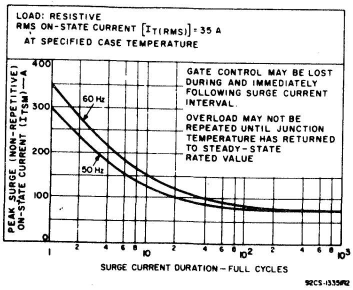


Fig.1 — Peak surge on-state current vs. surge current duration.

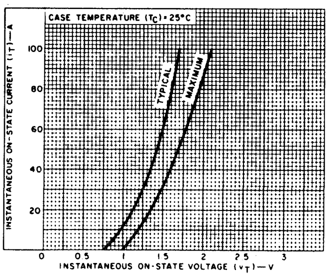


Fig.2 — Instantaneous on-state current vs. on-state voltage.

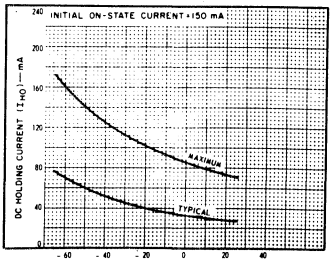


Fig.3 — DC holding current vs. case temperature.

S6400 (2N3870-2N3873), S6410 (2N3896-2N3899), S6420 Series

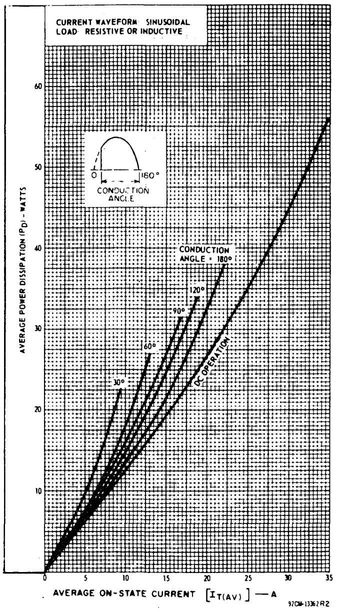


Fig. 4 — Power dissipation vs. on-state current.

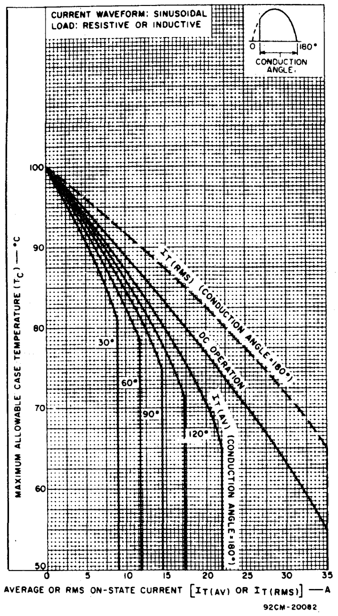


Fig. 5 — Maximum allowable case temperature vs. on-state current for press-fit and stud types.

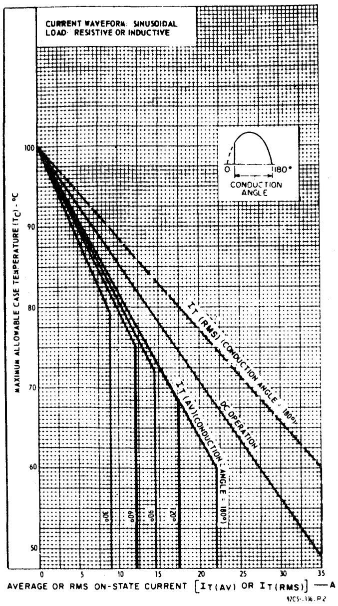


Fig. 6 — Maximum allowable case temperature vs. on-state current for isolated-stud types.

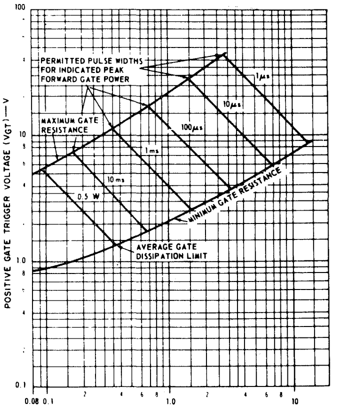


Fig.7 — Gate pulse characteristics for forward triggering mode.

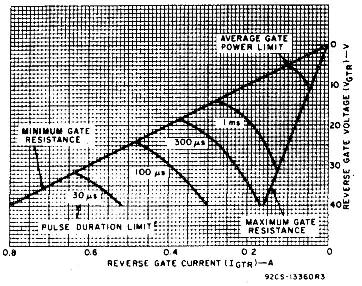


Fig.8 — Reverse gate voltage vs. reverse gate current.

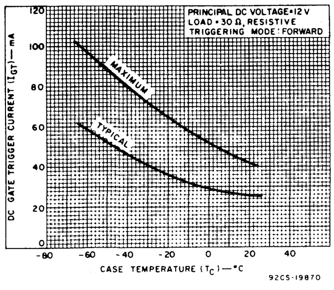


Fig.9 — DC gate trigger current (forward) vs. case temperature.

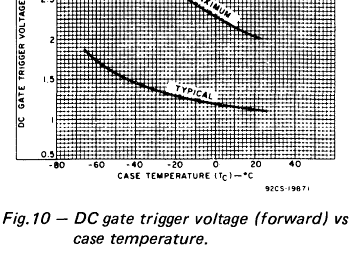


Fig.10 — DC gate trigger voltage (forward) vs. case temperature.

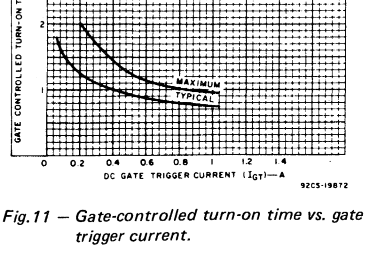


Fig.11 — Gate-controlled turn-on time vs. gate trigger current.

S6491 (2N681-2N690) Series

16-A and 25-A Silicon Controlled Rectifiers

For Power-Control and Power-Switching Applications

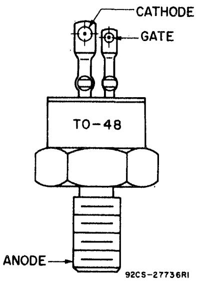
The RCA2N681-2N690 are all-diffused silicon controlled rectifiers (reverse-blocking triode thrysistors) designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state.

These SCR's employ a hermetic JEDEC TO-48 package.

Features:

- High di/dt capability
- Low on-state voltage at high current levels
- Low thermal resistance
- Shorted-emitter center-gate construction

TERMINAL CONNECTIONS



JEDEC TO-48

(See dimensional outline "L".)

MAXIMUM RATINGS,

Absolute-Maximum Values:	2N681	2N682	2N683	2N684	2N685	2N686	2N687	2N688	2N689	2N690	
$^{*}V_{RSOM}$▲	35	75	150	225	300	350	400	500	600	700	V
$^{*}V_{RROM}$▲	25	50	100	150	200	250	300	400	500	600	V
$^{*}V_{DROM}$▲	25	50	100	150	200	250	300	400	500	600	V
$I_{T(RMS)}$ ($\theta = 180^\circ$): $T_C = 65^\circ C$	25										A
$^{*}I_{T(AV)}$ ($\theta = 180^\circ$): $T_C = 65^\circ C$	16										A
I_{STM}: For one full cycle of applied principal voltage 60Hz♦	150										A
50Hz♦	140										A
For more than one full cycle of applied principal voltage	See Figs. 3, 4										
di/dt: $V_D = V_{DROM}$, $I_{GT} = 200$ mA, $t_r = 0.5\ \mu s$	200										A/μs
I^2t [at T_C shown for $I_{T(RMS)}$]: t = 10 ms	100										A^2s
= 1 ms	46										A^2s
$^{*}P_{GM}$●:	5										W
$^{*}P_{G(AV)}$●:	0.5										W
$^{*}I_{GM}$	2										A
$^{*}V_{GM}$	10										V
$^{*}V_{GRM}$	5										V
$^{*}T_{stg}$■	−65 to 150										°C
$^{*}T_C$■	−65 to 125										°C
T_T: During soldering for 10 s maximum (terminal and case)	225										°C
τ_s: Recommended	35										in-lb
	0.4										kgf-m
Maximum (DO NOT EXCEED)	50										in-lb
	0.57										kgf-m

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* In accordance with JEDEC registration data.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

♦ At $I_{T(RMS)} = 25$ A and $T_C = 65^\circ C$

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

■ For temperature measurement reference point, see Dimensional Outline.

S6491 (2N681-2N690) Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTIC	LIMITS 2N681-2N690			UNITS
	MIN.	TYP.	MAX.	
* I_{DROM} or I_{RROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, T_C = 125°C:				
2N681, 2N682, 2N683, 2N684	–	–	6.5	mA
2N685	–	–	6	
2N686	–	–	5.5	
2N687	–	–	5	
2N688	–	–	4	
2N689	–	–	3	
2N690	–	–	2.5	
* v_T: i_T = 50 A (peak), T_C = 25°C	–	–	2	V
v_T(AV): $I_T = I_T$(RMS) = T_C = 65°C	–	–	0.86	V
I_{HO}: T_C = 125°C	–	15	–	mA
I_{GT}: T_C = 125°C	–	–	25	mA
V_D = 12 V (dc), R_L = 50Ω, T_C = -65° C	–	–	80●	
* V_{GT}: V_D = 12 V (dc), R_L = 50Ω, T_C = –65 to 125°C	–	–	3	V
= 125°C	0.25	–	–	
$R_{\theta JC}$	–	–	2	°C/W

* In accordance with JEDEC registration data.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

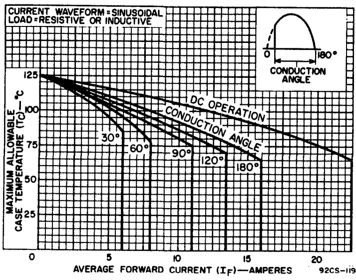


Fig. 1 — Maximum allowable case temperature vs. on-state current for 2N681 - 2N690.

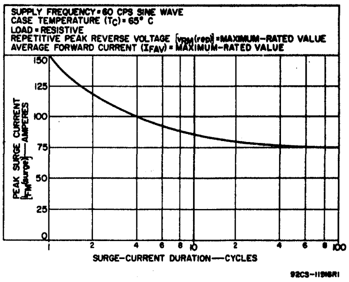


Fig. 2 — Peak surge on-state current vs. surge duration for 2N681-2N690.

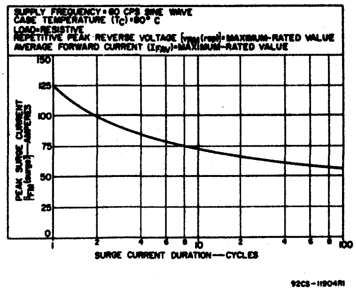


Fig. 3 — Peak surge on-state current vs. surge duration for 2N681-2N690.

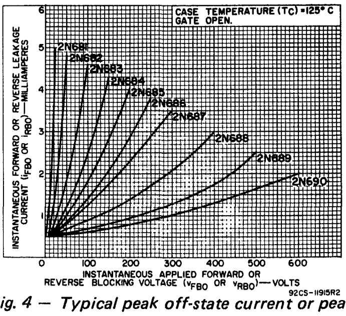


Fig. 4 — Typical peak off-state current or peak reverse current vs. off-state or reverse voltage for 2N681-2N690.

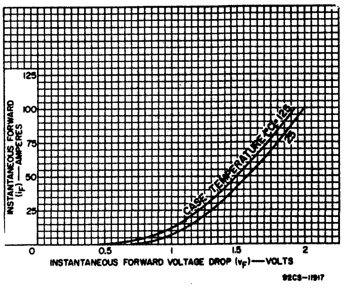


Fig. 5 — Typical on-state current vs. instantaneous on-state voltage for 2N681—2N690.

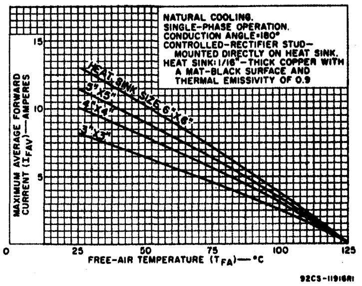


Fig. 6 — Average on-state forward current vs. ambient temperature for 2N681—2N690.

S6493M

Silicon Controlled Rectifier for High-Current Pulse Applications

The RCA-S6493M* is an all-diffused silicon controlled rectifier (reverse-blocking triode thyristor) designed especially for use in radar pulse modulators, inverters, switching regulators, and other applications requiring a large ratio of peak to average current.

It is especially constructed for rapid spread of forward current over the full junction area to achieve a high rate of change of forward current (di/dt) capability and low switching dissipation.

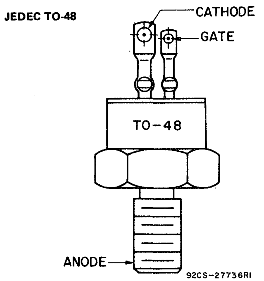
The S6493M employs a hermetic JEDEC TO-48 package.

*Formerly RCA Type No. S6431M.

Features:

- Up to 900 A peak pulse on-state current
- 30 W maximum average dissipation
- On-state current of 35 A (rms value)
- Shorted-emitter center-gate design

TERMINAL CONNECTIONS



(See dimensional outline "L".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{RSOM}▲	700	V
V_{DSOM}▲	700	V
V_{RROM}▲	600	V
V_{DROM}▲	600	V
$I_{T(RMS)}$ (T_C = 65°C, θ = 180°)	35	A
$I_{TM(pulse)}$:		
T_C = 65°C, See Figs. 1 and 2	900	A
I^2t:		
T_J = −65 to 125°C, t = 1 to 8.3 ms	2000	A^2s
$P_{D(AV)}$ (T_C = 65°C, See Fig. 3)	30	W
P_{GM}●:		
Peak (forward or reverse) for 10 µs maximum, See Fig. 4	40	W
$P_{G(AV)}$●:		
Averaging time = 10 ms maximum	1	W
T_{stg}■	−65 to 150	°C
T_C■	−65 to 125	°C
T_T:		
During soldering for 10 s maximum (terminals and case)	225	°C
τ_s:		
Recommended	35 0.4	in-lbf kgf-m
Maximum (DO NOT EXCEED)	50 0.57	in-lbf kgf-m

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

■ For temperature measurement reference point, *see Dimensional Outline.*

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS			UNITS
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, T_C = 125°C	–	2	10	mA
$v_{T(I)}$ $I_{TM(pulse)}$ = 600 A, t = 2 µs, T_C = 65°C (See Fig. 7)	–	–	19	V
i_{HO}: T_C = 25°C	0.5	20	70	mA
dv/dt: $V_D = V_{DROM}$, exponential voltage rise, T_C = 125°C	20	50	–	V/µs
I_{GT} (T_C = 25°C), See Fig.4	1	25	80	mA
V_{GT} (T_C = 25°C), See Fig.4	–	1.1	2	V
t_{gt}: $V_D = V_{DROM}$, i_T = 30 A (peak), I_{GT} = 200 mA, t_r = 0.1 µs, T_C = 25°C	–	1.25	–	µs
t_q: Rectangular Pulse $V_{DX} = V_{DROM}$, i_T 18 A, pulse duration = 50 µs, dv/dt = 20 V/µs, – di/dt = −30 A/µs, I_{GT} = 200 mA at turn-on, T_C = 80°C	15	20	40	µs
$R_{\theta JC}$	–	–	2	°C/W

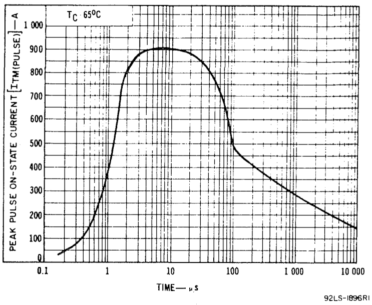


Fig.1 — Peak pulse on-state current vs. time.

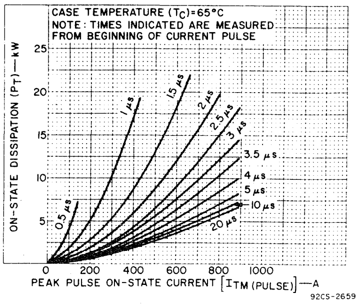


Fig.2 — On-state dissipation vs. peak pulse on-state current and time.

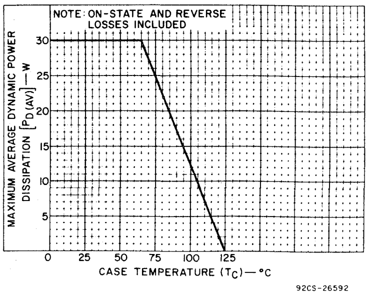


Fig.3 — Dissipation derating curve.

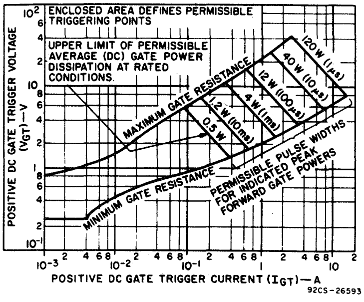


Fig.4 — Forward-bias gate-trigger characteristics and limiting conditions for determination of premissible gate-trigger pulses.

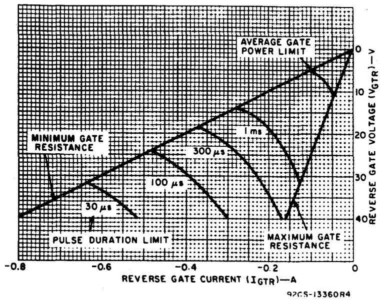


Fig.5 — Reverse bias gate-trigger characteristics.

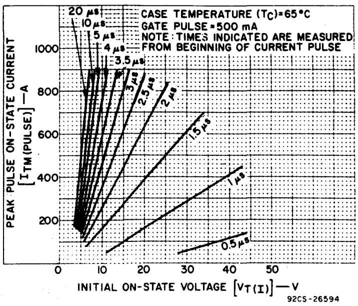


Fig.6 — Initial on-state voltage characteristics.

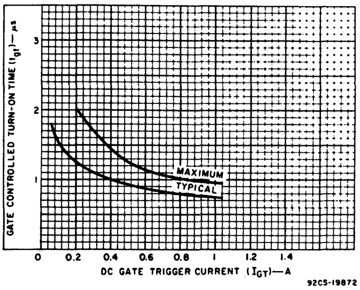


Fig.7 — Gate-controlled turn-on time vs. gate trigger current.

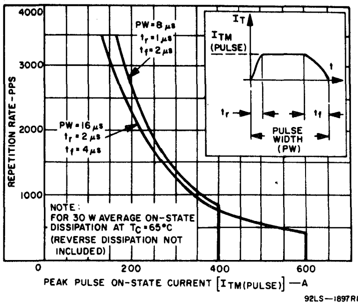


Fig.8 — Peak pulse on-state current as a function of repetition rate, rectangular pulse.

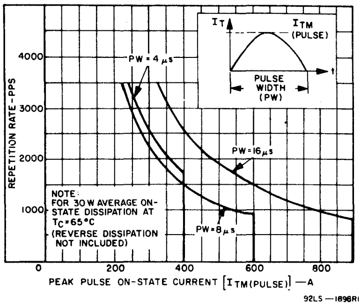


Fig.9 — Peak pulse on-state current as a function of repetition rate, half sine wave pulse.

S7310 Series

40-A Asymmetrical Silicon Controlled Rectifiers (ASCR)

For Induction Cooking Appliances, Pulse Modulators,
High-Frequency Inverters, Electronic Welders, and
Other Switching Applications Up to 40 kHz

The RCA-S7310-series types are asymmetrical silicon controlled rectifiers designed for high-frequency power-switching applications such as induction-cooking-appliance controls, inverters, electronic welders, switching regulators, and high-current pulse modulators. These types may be used at frequencies up to 40 kHz. They are supplied in the JEDEC TO-48 package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S7310B	S7310C	S7310D	S7310E	S7310M	S7310N	
V_{RROM}▲	7						V
V_{DROM}▲	200	300	400	500	600	800	V
$I_{T(RMS)}$ (T_C = 75°C, θ = 180°)	40						A
$I_{T(AV)}$ (T_C = 75°C, θ = 180°)	25						A
I_{TSM}:							
For one full cycle of applied principal voltage							
60-Hz (sinusoidal)	400						A
50-Hz (sinusoidal)	370						A
For more than one cycle of applied principal voltage	*See Fig. 5*						
di/dt:							
V_{DM} = V_{DROM}, I_{GT} = 500 mA, t_r = 0.5 μs	2000						A/μs
I^2T (at T_C = 75°C):							
t = 10 ms	700						A^2s
t = 1 ms	325						A^2s
P_{GM}●:							
Peak forward for 10 μs max.	40						W
$P_{G(AV)}$●:							
Averaging time = 10 ms maximum	2						W
T_{stg}■	−40 to 150						°C
T_C■	−40 to 125						°C
T_T:							
During soldering for 10 s maximum (terminal and case)	225						°C
τ_s:							
Recommended	35						in-lbf
	0.4						kgf-m
Maximum (DO NOT EXCEED)	50						in-lbf
	0.57						kgf-m

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

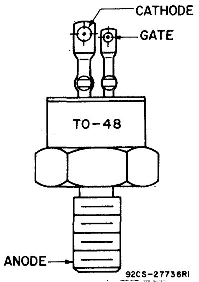
● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

■ For temperature measurement reference point, see Dimensional Outline.

Features:

- **Fast turn-off-time-4μs max.**
- **High di/dt and dv/dt capabilities**
- **Shorted-emitter gate-cathode construction. . .contains an internally diffused resistor between gate and cathode**
- **Low thermal resistance**
- **Center-gate construction . . .provides rapid uniform gate-current spreading for faster turn-on with substantially reduced heating effects**

TERMINAL DESIGNATIONS



JEDEC TO-48
(See dimensional outline "L".)

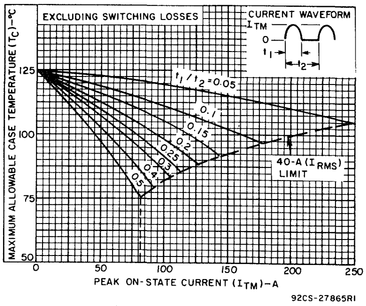


Fig. 1 — Maximum allowable case temperature vs. peak on-state current.

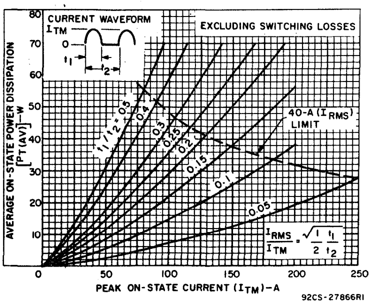


Fig. 2 — Average on-state power dissipation vs. peak on-state current.

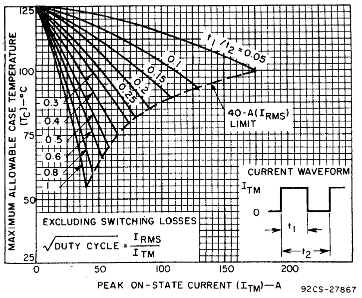


Fig. 3 — Maximum allowable case temperature vs. peak on-state current.

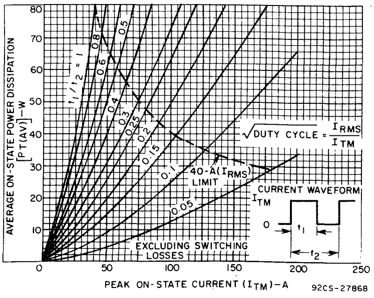


Fig. 4 — Average on-state power dissipation vs. peak on-state current.

S7310 Series

ELECTRICAL CHARACTERISTICS

As Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES			UNITS
	Min.	Typ.	Max.	
I_{DROM}: $V_D = V_{DROM}$, $T_C = 125^oC$	–	–	4	mA
I_{RROM}: $V_R = V_{RROM}$, $T_C = 125^oC$	–	–	5	
V_T: I_{TM} = 100 A (peak), $T_C = 25^oC$	–	1.7	2.5	V
$V_{T(I)}$: I_{TM} = 100 A (peak), I_{GT} = 0.5 A, t_r = 0.1 μs, $T_C = 25^oC$ (measured 0.5 μs after 10% of I_{TM})	–	14	22	V
i_{HO}: $T_C = 25^oC$	10	35	110	mA
dv/dt: (Linear) $V_D = V_{DROM}$, $T_C = 125^oC$	250	550	–	V/μs
I_{GT}: V_D = 12 V dc, R_L = 30 Ω, $T_C = 25^oC$	–	50	80	mA
V_{GT}: V_D = 12 V dc, R_L = 30 Ω, $T_C = 25^oC$	–	1	3	V
t_{gt}: $V_D = V_{DROM}$, i_T = 100 A (peak), I_{GT} = 500 mA, t_r = 0.1 μs, T_C = 25°C, t_{gt} t_r t_d	– – –	250 90 160	290 110 180	ns
t_q: 1/2 Sine Wave $V_D = V_{DROM}$, i_T = 100 A, pulse duration = 2 μs, dv/dt = 200 V/μs, I_{GT} = 500 mA at turn-on, V_{GK} = –10 V at turn-off, $T_C = 115^oC$	–	2.8	4	μs
R_{GK} (Reverse)	–	40	75	Ω
$R\theta_{JS}$	–	–	0.9	°C/W

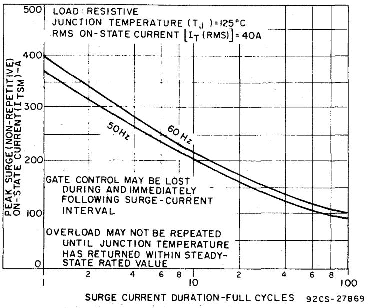


Fig. 5 — Peak surge on-state vs. surge duration.

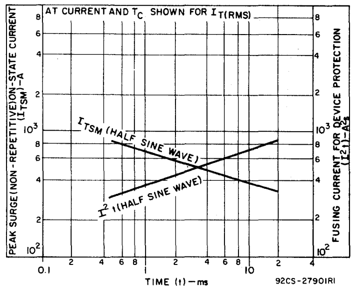


Fig. 6 — Peak surge on-state and fusing current vs. time.

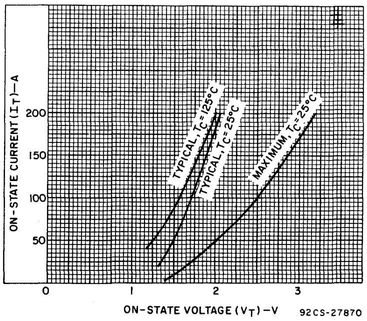


Fig. 7 — On-state current vs. on-state voltage.

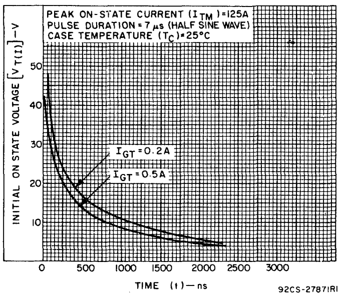


Fig. 8 — Typical initial on-state voltage vs. time. [Zero time is the time at which the initial on-state current is equal to 0.10I_{TM}

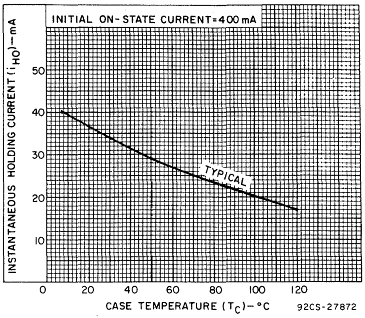


Fig. 9 — Typical instantaneous holding current vs. case temperature.

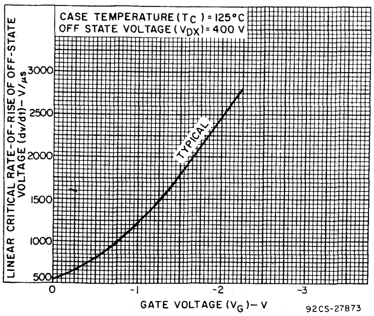


Fig. 10 — Typical linear critical rate of rise of off-state voltage vs. gate voltage.

S7310 Series

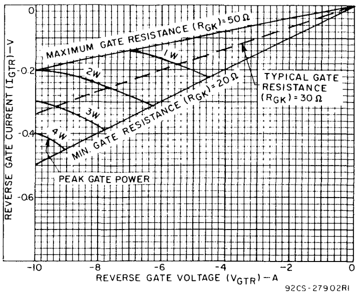


Fig. 11 — Reverse gate-trigger characteristics.

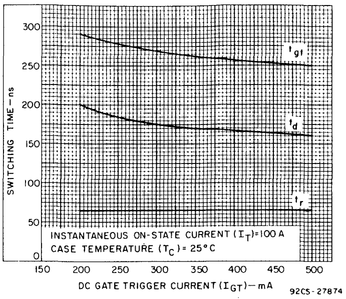


Fig. 12 — Typical switching time (t_{gt}, t_d, t_r) vs. gate-trigger current.

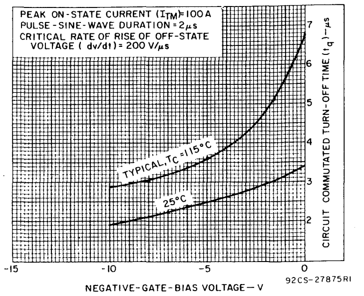


Fig. 13 — Typical circuit commutated turn-off time vs. gate-trigger voltage.

S7410 (2N3650-2N3653; S7410) S7412
(2N3654-2N3658; S7412M) Series

35-A Silicon Controlled Rectifiers

For Inverter Applications

RCA-2N3650 to 2N3658, inclusive, and the S7410M* and S7412M● are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) intended for high-speed switching applications such as power inverters, switching regulators, and high-current pulse applications. They feature fast turn-off, high dv/dt, and high di/dt characteristics and may be used at frequencies up to 25 kHz.

This SCR series has forward and reverse off-state voltage ratings of 50, 100, 200, 300, and 400 volts. Types S7410M and S7412M has a forward and reverse off-state voltage rating of 600 volts.

These SCR's employ a hermetic JEDEC TO-48 package.

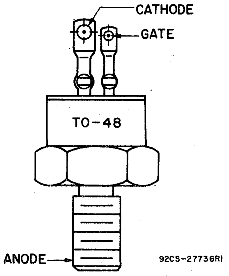
● Formerly RCA Type No. S7432M.

* Formerly RCA Type No. S7430M.

Features

- **Fast turn-off time — 10 μs to 15 μs max.**
- **High di/dt and dv/dt capabilities**
- **Shorted-emitter center gate design**
- **Low thermal resistance**

TERMINAL CONNECTIONS



JEDEC TO-48
(See dimensional outline "L".)

MAXIMUM RATINGS, *Absolute-Maximum Values:*		**2N3650**	**2N3651**	**2N3652**	**2N3653**	**S7410M**	
	2N3654	**2N3655**	**2N3656**	**2N3657**	**2N3658**	**S7412M**	
* V_{RSOM}▲	75	150	300	400	500	700	V
V_{DSOM}▲	75	150	300	400	500	700	V
* V_{RROM}▲	50	100	200	300	400	600	V
* V_{DROM}▲	50	100	200	300	400	600	V
$I_{T(RMS)}$ (T_C = 40°C, θ = 180°)	35						A
* $I_{T(AV)}$ (T_C = 40°C, θ = 180°)	25						A
* I_{TSM}: **Peak rectangular pulse,** t_p = 5 ms, t_r = 50 μs max., T_C = 40° C.	180						A
* di/dt: $V_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs	400						A/μs
I^2t: T_J = –65 to 120°C, t = 1 to 8.3 ms	165						A^2s
* P_{GM}●: Peak (forward or reverse) for 10 μs maximum, See Fig. 6)	40						W
* $P_{G(AV)}$●: Averaging time = 10 ms maximum	1						W
* T_{stg}■	–65 to 150						°C
* T_C■	–65 to 120						°C
T_T: During soldering for 10 s maximum (terminal and case)	225						°C
τ_s: Recommended	35						in-lbf
	0.4						kgf-m
Maximum (DO NOT EXCEED)	50						in-lbf
	0.57						kgf-m

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* In accordance with JEDEC registration data format (JS-14, RDF-1) filed for the JEDEC (2N series) types.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

■ For temperature measurement reference point, see Dimensional Outline.

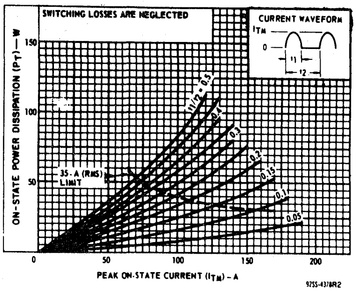


Fig. 1 — Power dissipation vs. peak on-state current

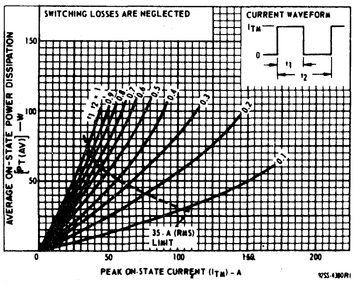


Fig. 2 — Power dissipation vs. peak on-state current

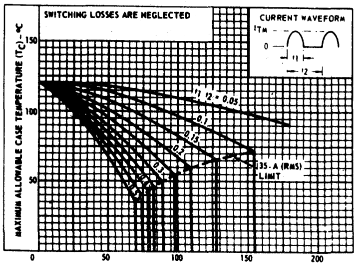


Fig. 3 — Maximum allowable case-temperature vs. peak on-state current.

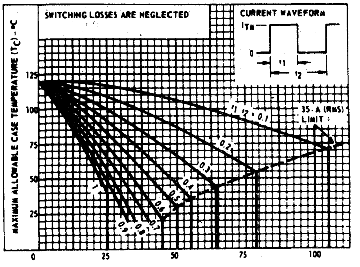


Fig. 4 — Maximum allowable case-temperature vs. peak on-state current.

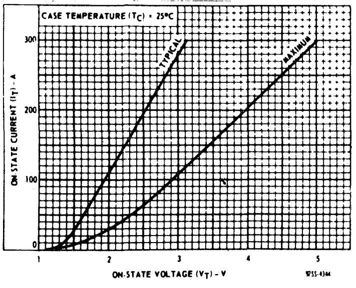


Fig. 5 — Variation of on-state with on-state voltage.

S7410 (2N3650-2N3653; S7410) S7412 (2N3654-2N3658; S7412M) Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = 120°C$				
2N3650, 51, 54, 55, 56, S7412M	–	2	6*	mA
2N3652, 2N3657	–	2	5.5*	
2N3653, 2N3658	–	2	4*	
S7410M	—	—	3	
V_T: i_T = 25 A (peak), $T_C = 25°C$	–	1.5	2.05*	V
I_{HO}: $T_C = 25°C$	–	75	150	mA
$T_C = -65°C$	–	150	350*	
* dv/dt: $V_D = V_{DROM}$, exponential voltage rise, $T_C = 120°C$	200	—	—	V/µs
I_{GT}: V_D = 6 V (dc), $R_L = 4\ \Omega$, $T_C = 25°C$	–	80	180	mA
V_D = 6 V (dc), $R_L = 2\ \Omega$, $T_C = -65°C$	–	150	500*	
V_{GT}: V_D = 6 V (dc), $R_L = 4\ \Omega$, $T_C = 25°C$	–	1.5	3	V
* V_D = 6 V (dc), $R_L = 200\ \Omega$, $T_C = 120°C$	0.25	–	–	
V_D = 6 V (dc), $R_L = 2\ \Omega$, $T_C = -65°C$	–	2	4.5*	
* tq: Rectangular Pulse $V_{DX} = V_{DROM}$, i_T = 10 A, pulse duration = 50 µs, dv/dt = 200 V/µs, –di/dt = 5 A/µs, I_{GT} = 200 mA at turn-on, V_{RX} = 15 V minimum, V_{GK} = 0 V at turn-off, $T_C = 120°C$				
2N3650 - 53; S7410M	–	–	15	µs
2N3654 - 58; S7412M	–	–	10	
Sinusoidal Pulse $V_{DX} = V_{DROM}$, i_T = 100 A, pulse duration = 2 µs, dv/dt = 200 V/µs, V_{RX} = 30 V minimum, V_{GK} = 0 at turn-off, $T_C = 115°C$				
2N3650 - 53; S7410M	–	–	15	
2N3654 - 58; S7412M	–	–	10	
$R_{\theta JC}$	–	0.85	1.7*	°C/W

* In accordance with JEDEC registration data format (JS-14, RDF-1) filed for the JEDEC (2N series) types.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

■ For temperature measurement reference point, see Dimensional Outline.

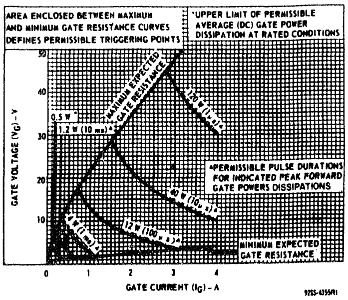


Fig.6 — Typical forward-biased gate characteristics.

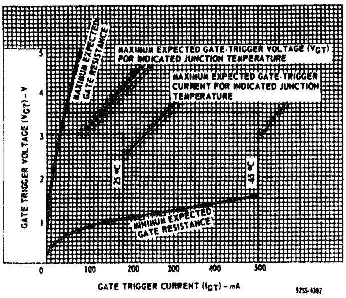


Fig.7 — Typical gate-trigger characteristics.

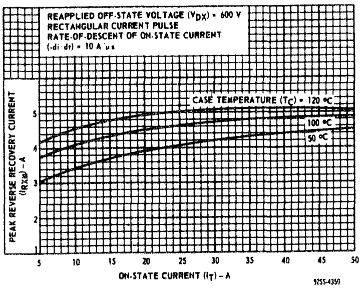


Fig.8 — Typical variation of peak reverse-recovery current with on-state current (rectangular pulse).

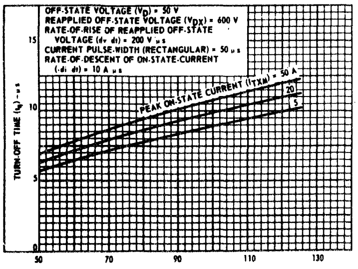


Fig.9 — Typical variation of turn-off time with junction temperature (rectangular pulse).

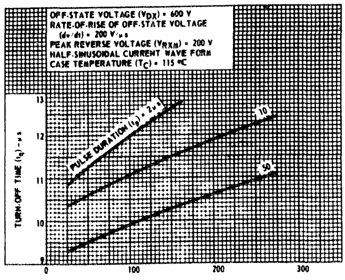


Fig.10 — Typical variation of turn-off time with peak on-state current (half-sine-wave pulse).

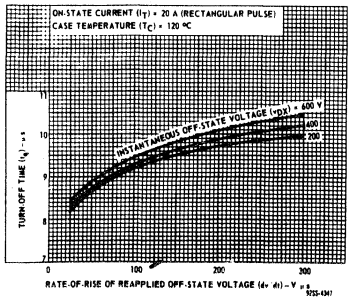


Fig.11 — Typical variation of turn-off time with rate-of-rise of reapplied off-state voltage (rectangular pulse).

High-Reliability Power Devices

Preconditioning and Screening

High-Reliability Power Devices

Solid-state devices classified as high-reliability types have come to be primarily associated with military and aerospace applications. In many ways, this association is misleading because the commercial equipment market is probably the largest user of high-reliability products, but not necessarily by that label. Military and aerospace agencies, however, have been largely responsible for establishment of comprehensive published reliability specifications and standards which have been accepted by the solid-state industry. MIL standards dominate the procedures used to specify high-reliability solid-state devices and represent a common reference point frequently used by commercial users to define their requirements.

Military and aerospace requirements for high-reliability solid-state devices are extremely large and diverse, not only in terms of performance, operating conditions, and reliability, but also in terms of logistics and procurement. As a result of these requirements, the military services have jointly developed specifications and standards under which most military end-use solid-state devices are procured. To simplify procurement, logistics, and the development of reliability data, MIL specs are not issued for the full spectrum of devices manufactured; rather, they are restricted to those devices for which significant need is demonstrated and are specified so that the device can have as wide applicability as possible. Although the limits for operating conditions may exceed those required for some applications, they simplify procurement and assure a supply of devices for the majority of military equipment. These standards also cover a wide range of requirements for the manufacturer on such things as:

(a) The procedure and requirements for a manufacturer to become certified to manufacture MIL-spec parts.

(b) The requirements for qualifying parts.

(c) Product-assurance provisions in such areas as quality control, inspection procedures, personnel training, cleanliness, failure analysis, and documentation.

(d) Test methods and procedures.

(e) Marking and identification of product.

(f) Preservation and packing.

JAN, JANTX, SOLID-STATE DEVICES

The major military specification used for the procurement of standard solid-state devices by the military is MIL-S-19500, which covers devices such as discrete transistors, thyristors, and diodes.

MIL-S-19500 is the specification for the familiar "JAN"-type solid-state device. Detailed electrical specifications are prepared as needed by the three military services and coordinated by the Defense Electronic Supply Center. At present, approximately five hundred detailed electrical specifications are included in the MIL-S-19500 system.

Levels of reliability are defined by MIL-S-19500. Devices designated as JAN types receive lot screening only and are the least expensive. Devices designated as JANTX receive some 100-per-cent screening (primarily burn-in) and a tight lot-sampling plan. Not all detailed specifications include JANTX requirements.

Fig. 1 shows the processing requirements specified by MIL-S-19500 for JAN and JANTX solid-state power devices.

The Defense Electronic Supply Center maintains a "Qualified Products List" of all vendors qualified to produce devices

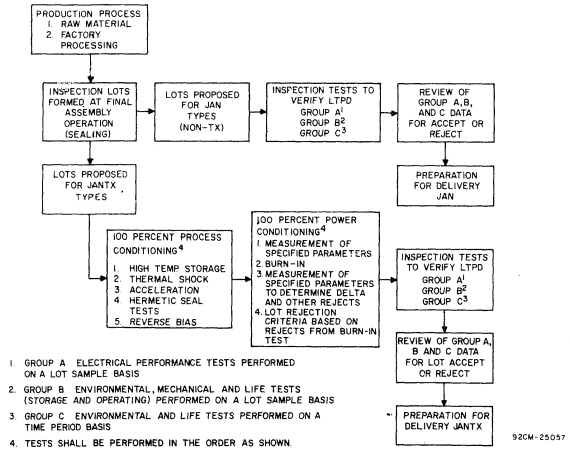


Fig. 1 — Order of procedure diagram for JAN and JANTX solid-state devices.

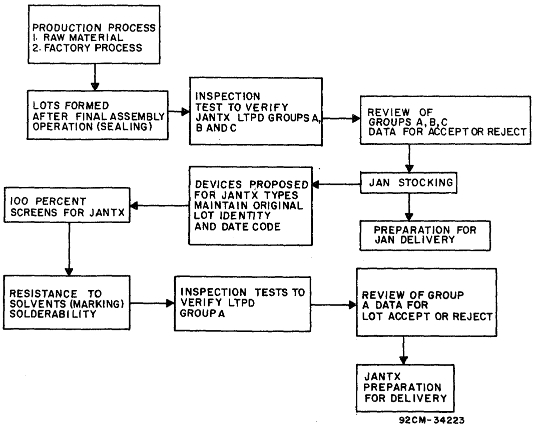


Fig. 2 — Alternate order of procedure diagram for JAN and JANTX device types.

in accordance with MIL-S-19500. This list, QPL-19500-77, is published periodically and is available to manufacturers of military equipment.

RCA offers a number of solid-state power devices that have been qualified as JAN and JANTX devices in accordance with MIL-S-19500. These devices, which include power transistors and silicon controlled rectifiers (SCR's), are processed in accordance with the MIL-S-19500 general specifications. MIL-STD-750 test methods are used as required by the individual military detail specification.

RCA NON-JAN TYPE SOLID-STATE DEVICES

Many solid-state devices not yet covered by military specifications, because they are too new, offer the most recent technological advances or have special performance characteristics which offer advantages to the designer of high-reliability equipment. RCA co-operates with the users of such devices in establishment of high-reliability specifications patterned after MIL standards, which allow these designs to be approved for use in military and aerospace systems, as well as commercial equipment.

Most procurements of solid-state devices for military systems are made by the equipment contractor from the MIL-STD parts list as awards are received for electronic equipment. Some military and aerospace programs, because of their size, duration, or special requirements (Minuteman and Apollo are two examples), require that special specifications and process methods, or even special production lines, be established and tailored to the particular functional, reliability, and economic needs of the program. RCA Solid State Division has frequently used the resources of its laboratories, production facilities, and expert technical staff to contribute to the success of such programs.

All RCA high-reliability solid-state power devices are processed in accordance with the provisions of MIL-S-19500. These provisions include the following items:

1. A clearly defined procedure for the conversion of a customer specification into an RCA internal specification with built-in safeguards to assure the customer that the delivered parts meet or exceed his specification requirements.
2. A formalized personnel training and testing program which assures that each operation is performed correctly.
3. A complete inspection of incoming materials, utilities, and work in process using on-site facilities such as scanning-electron-microscope and X-ray equipment.
4. Maintenance of cleanliness in work areas.
5. Rigorous control over changes in design, materials, and processes with documentation kept in active files for a minimum of three years.
6. Tool and test equipment maintenance and calibration in strict accordance with MIL-C-45662, "Calibration System Requirements."
7. A quality-assurance program in accordance with MIL-Q-9858, "Quality Program Requirements."

Power Transistors

In addition to JAN and JANTX types, high-reliability selections of all RCA power transistors can be obtained on a custom basis. Such power transistors are subjected to high-reliability preconditioning and screening in accordance with the Group A, B, and C Sampling Tests as specified in MIL-STD-750 or special customer requirements.

Thyristors (Triacs and SCR's)

RCA high-reliability thyristors that are subjected to high-reliability preconditioning and screening in accordance with the Group A, B, and C Sampling Tests as specified in MIL-STD-750 or special customer requirements can be obtained on a custom basis.

RADIATION-RESISTANT POWER TRANSISTORS

RCA offers a variety of bipolar silicon power transistors in which special design and processing techniques are used to assure continued functional performance after exposure to specified dosages of neutron and gamma radiation.

Neutron-Radiation Compensation

In RCA radiation-resistant power transistors, the base width is made as narrow as possible (consistent with other design objectives) to achieve a minimum base transit time so that a maximum number of minority carriers can complete the journey through the base. The narrower base width thus compensates for the major cause of failure in transistors exposed to neutron radiation, the reduction in minority-carrier lifetime and the corresponding decrease in transistor current gain. The voltage-supporting region in the collector is also made as narrow as feasible and is heavily doped. In this way, the series-resistance path is made as low as possible to compensate for the rise in collector series resistance and the resulting higher saturation voltage caused by exposure of the transistor to neutron radiation.

The problem of increased leakage currents is solved by use of epitaxial-planar transistors. The initial leakage in these transistors is so small that even the higher levels caused by neutron bombardment are unlikely to cause failure.

Because the narrower base width and reduced collector resistivity used to improve transistor radiation resistance are contradictory to the design requirement for high-voltage, high-energy transistors, designers should adjust circuits to require the minimum possible emitter-to-collector voltage-breakdown capability. In addition, ratings for transistors should be specified in accordance with the way in which the devices are to be used (i.e., V_{CER} or V_{CEV}, and never V_{CEO}). The circuit design should also provide high-energy protection for the transistor.

Gamma-Radiation Compensation

The gamma dose rate at which the onset of secondary photocurrent occurs depends strongly on the geometry of the transistor emitter. The secondary photocurrent is initiated when a portion of the emitter-base junction becomes forward-biased because of the voltage drop across the lateral base resistance under the emitter. In RCA radiation-resistant transistors, the distance from the base contact to the farthest point of the base under the emitter is reduced to the minimum possible value to achieve a substantial increase in the gamma threshold level at which the secondary photocurrent starts.

Design Example

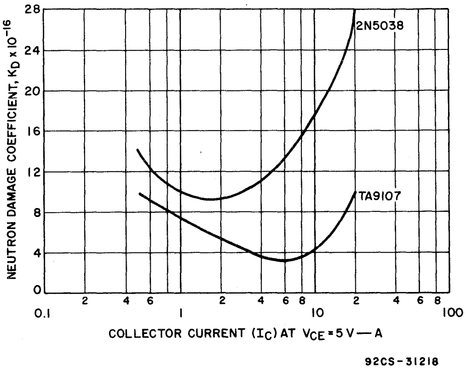
The RCA developmental transistor TA9107 is an excellent example of the radiation-resistance capability that can be achieved through the use of effective design techniques. This transistor can operate satisfactorily after exposure to neutron fluence levels of 1 x 10^{14} neutrons/cm^2 and can withstand a gamma dose rate of 1 x 10^8 rads(Si)/second before the onset of secondary photocurrent.

The TA9107 has a collector-to-emitter voltage rating V_{CER} of 100 volts and a post-radiation current capability of 10 amperes. The width of the collector-to-base depletion region is only 0.7 mil, the doping concentration in the collector is 1 x 10^{15} atoms/cm^2, and the width of the base is only about 8000 angstroms. The TA9107 employs a unique emitter design in which 32 emitter sites are interconnected by an expanded metallization system so that the maximum distance from the base contact to the center of the emitter is only 2 mils.

Aluminum metallization 50,000 angstroms thick is used in the TA9107 to assure uniform current distribution in the emitter. A gold eutectic bond is used for collector mounting.

Radiation-Resistant Bipolar Power Transistors

Type	Polarity	Package	I_C/V_{CER}
Characterized to 5 x 10^{13} neutrons 1 x 10^7 rads (Si)/second			
2N5320	NPN	TO-39	1A/80V
2N5322	PNP	TO-39	1A/80V
2N3879	NPN	TO-66	3A/8V
2N6248	PNP	TO-3	5A/8V
2N5038	NPN	TO-3	10A/80V
2N6480	NPN	RADIAL	12A/80V
2N5671	NPN	TO-3	15A/100V
2N6688	NPN	TO-3	5A/200V
2N6673	NPN	TO-3	2A/350V
Characterized to 1 x 10^{14} neutrons 1 x 10^8 rad (Si)/second			
TA9107	NPN	RADIAL	10A/80V



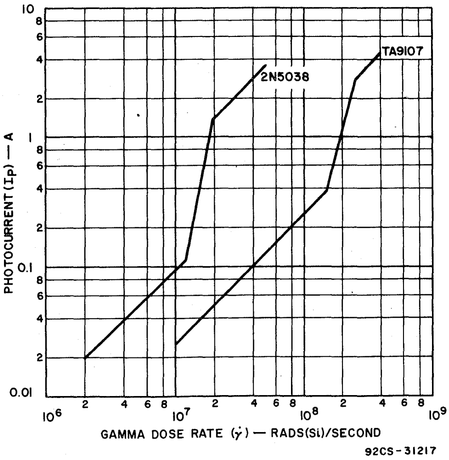
Neutron damage coefficient (at 1 mev) as a function of collector current for the TA9107 and 2N5038 radiation-hardened power transistors.

TA9107 Capability

Characteristic	Pre-Radiation	Post-Radiation (5 x 10^{13} N/cm^2)
V_{CEO}	80 V	80 V
V_{CBO}	100 V	100 V
V_{EBO}	5.5 V	5.5 V
h_{FE} at I_C = 5A, V_{CE} = 2V	80	10
V_{CE}(sat) at I_C = 8A, h_{FE} = 5	0.5 V	2.0 V
V_{BE}(sat) at I_C = 8A, h_{FE} = 5	1.35 V	1.5 V
$I_{S/b}$ at 75V for 100 μs	60 W	60 W
$E_{S/b}$ L P 125 μH	0.3 mj	0.3 mj

Primary Photocurrent = 250 mA typ. at 1 x 10^8 rad (Si)/second

Onset of Secondary Photocurrent occurs typically at 1.5 x 10^8 rad(Si)/second



Photocurrent as a function of gamma dose rate for the TA9107 and 2N5038 radiation-hardened power tansistors.

Appendix

General Characteristics, Test Circuits, and Waveforms

POWER TRANSISTORS

Dissipation Derating Chart

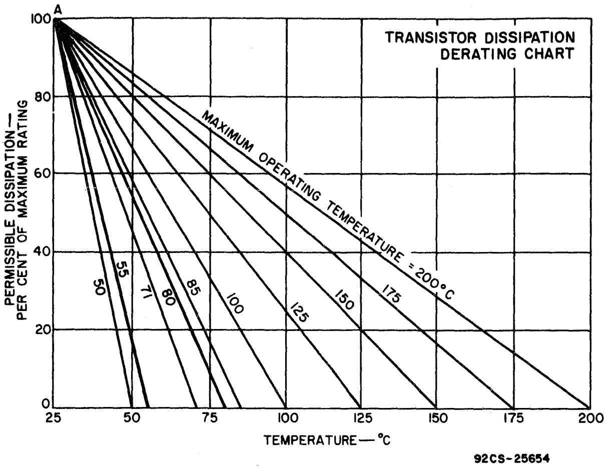


Fig.1 – Dissipation derating chart for silicon power transistors operated at temperatures above 25°C.

For many transistors, the maximum value of dissipation is specified for ambient, case, or mounting-flange temperatures up to 25°C, and must be reduced linearly for higher temperatures. For such types, the chart above can be used to determine maximum permissible dissipation values at particular temperature conditions above 25°C. (This chart cannot be assumed to apply to types other than those for which it is specified that the maximum allowable dissipation is derated linearly to zero at the maximum allowable operating temperature, T_J (max.).) The curves show the permissible percentage of the maximum dissipation ratings as a function of ambient or case temperature. Individual curves are plotted for maximum operating temperatures of 50, 55, 75, 80, 85, 100, 125, 150, 175, and 200°C. If the maximum operating temperature of a transistor is some other value, a new curve can be drawn from point A in the figure to the desired temperature value on the abscissa.

To use the chart, it is necessary to know the maximum dissipation rating and the maximum operating temperature for a given transistor. The calculation involves only two steps:

1. A vertical line is drawn at the desired operating temperature value on the abscissa to intersect the curve representing the maximum operating temperature for the transistor.

2. A horizontal line drawn from this intersection point to the ordinate establishes the permissible percentage of the maximum dissipation at the given temperature.

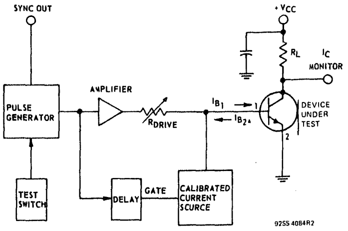
The following example illustrates the calculation of the maximum permissible dissipation for transistor type 2N1487 at a case temperature of 100°C. This type has a maximum dissipation rating of 75 watts at a case temperature of 25°C, and a maximum permissible case-temperature rating of 200°C.

1. A perpendicular line is drawn from the 100-degree point on the abscissa to the 200-degree curve.

2. Projection of this point to the ordinate shows a percentage of 57.5.

Therefore, the maximum permissible dissipation for the 2N1487 at a case temperature of 100°C is 0.575 times 75, or approximately 43 watts.

Switching-Time Measurements



*I_{B_1} AND I_{B_2} MEASURED WITH TEKTRONIX CURRENT PROBE P6019 OR EQUIVALENT

* For p-n-p types, direction of currents and polarities of voltages are reversed.

Fig.2 – Circuit used to measure switching times.

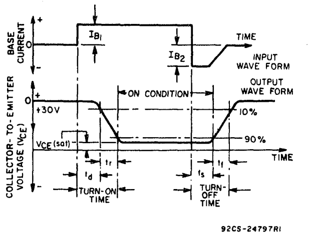


Fig.3 – Oscilloscope display for measurement of switching times.

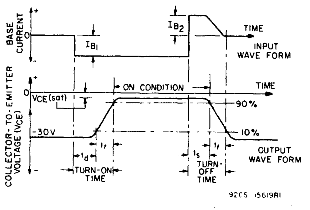
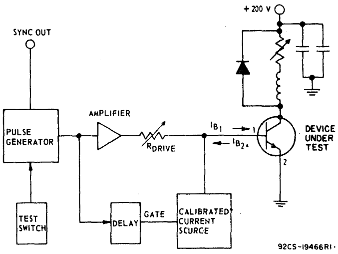


Fig.4 – Oscilloscope display for measurement of switching times for p-n-p types.



*I_{B_1} AND I_{B_2} MEASURED WITH TEKTRONIX CURRENT PROBE P6019 OR EQUIVALENT

* For p-n-p types, direction of currents and polarities of voltages are reversed.

Fig.5 – Circuit used to measure inductive-load switching times.

General Characteristics, Test Circuits, and Waveforms

POWER TRANSISTORS (Cont'd)

Breakdown (Sustaining) Voltage Tests

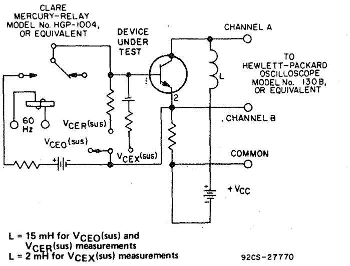


Fig.6 — Basic configuration used to measure sustaining voltage V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) for n-p-n power transistors.

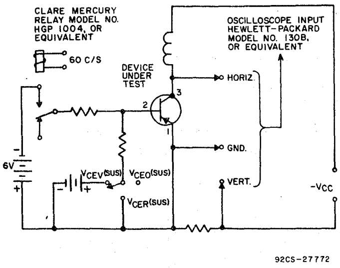
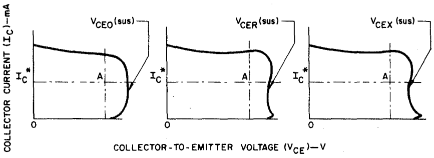


Fig.8 — Basic circuit configuration used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) for p-n-p power transistors.

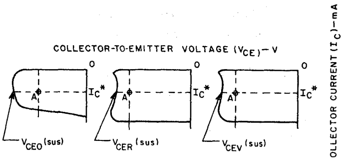


The sustaining voltages (V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) are acceptable when the traces fall to the right of point "A", where "A" is the rated value of V_{CEO}(sus), V_{CER}(sus), or V_{CEV}(sus).

*I_C = value specified in technical data for transistor under test (usually forced-beta current)

92CS-27771

Fig.7 — Oscilloscope display for measurement of sustaining voltages of n-p-n power transistors.

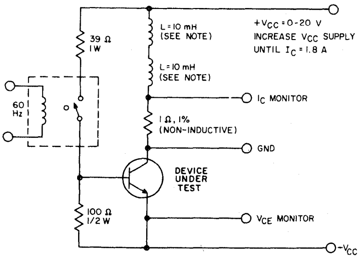


The sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) are acceptable when the traces fall to the left and below point "A" where "A" is the rated value for V_{CEO}(sus), V_{CER}(sus), or V_{CEV}(sus).

*I_C = value specified in technical data for transistor under test (usually forced-beta current)

Fig.9 — Oscilloscope display for measurement of sustaining voltages of p-n-p power transistors.

Inductive Load-Switching Measurements



NOTE: TWO 10 mH, 0.11 Ω CHICAGO STANDARD TRANSFORMER CORP. NO. C-2688, OR EQUIVALENT.

92CS-20156R1

Fig.10 — Circuit for measuring inductive-load switching for all types.

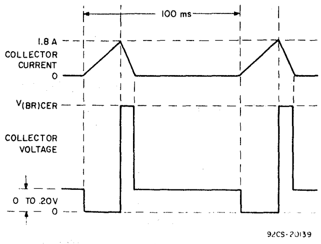


Fig.11 — Inductive-load switching voltage and current waveforms .

General Characteristics, Test Circuits, and Waveforms

HC2000H POWER HYBRID OPERATIONAL AMPLIFIER TEST CIRCUITS

PROCEDURE FOR MEASUREMENT OF COMMON-MODE INPUT IMPEDANCE

a) Insert unit
b) Apply ±37.5 V
c) Close S1
d) Adjust signal generator for 1 V on voltmeter V1
e) Open S1
f) Read voltmeter V1
g) Input impedance = $(10\text{ k})\text{x}\ \frac{V1}{1-V1}$

Note: Circuit under test must have a heat sink so that $T_C \approx 25^{\circ}C$, unless otherwise noted.

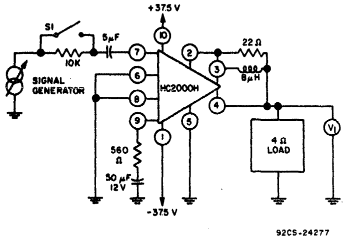


Fig. 12 – Circuit for measurement of common-mode input impedance.

PROCEDURE FOR MEASUREMENT OF OFFSET VOLTAGE AND QUIESCENT CURRENT

A = DC ammeter 100 mA range
V = DC voltmeter ± 250 mV range
a) Close S1
b) Insert unit
c) Apply ± 37.5 V
d) Read offset voltage on voltmeter. Change polarity if required.
e) Open S1
f) Read positive and negative quiescent current on ammeter.

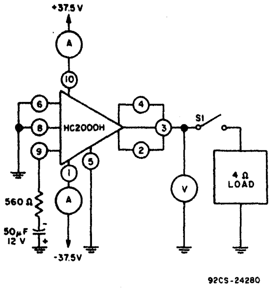


Fig. 13 – Circuit for measurement of offset voltage and quiescent current.

HC2000H

TERMINAL CONNECTIONS

Pin No.	Connection	
1	$-V_S$	Negative supply voltage
2	V_{FB}	Feedback voltage
3	V_{OUT}	Output voltage
4	PC	Phase compensation
5	GND	Ground
6	BP	Base plate (internal connection)
7	$+V_{IN}$	Non-inverting input
8	GND	Ground
9	$-V_{IN}$	Inverting input
10	$+V_S$	Positive supply voltage

PROCEDURE FOR MEASUREMENT OF OPEN-LOOP GAIN

a) Insert unit
b) Apply ± 37.5 V
c) Set generator at 1 kHz and adjust until V1 = 10 V rms
d) Read V2
e) Open-loop gain = V1/V2

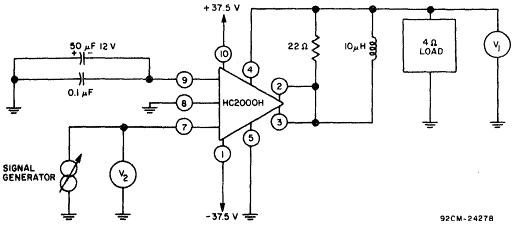


Fig. 14 – Circuit for measurement of open-loop gain.

PROCEDURE FOR MEASUREMENT OF CLOSED-LOOP VOLTAGE GAIN

a) Insert unit
b) Adjust signal generator to 1 kHz, V2 = 0
c) Apply ± 37.5 V
d) Adjust signal generator for 2 V rms on voltmeter V1
e) Read voltmeter V2
f) Voltage gain = $\frac{V1}{V2}$

PROCEDURE FOR MEASUREMENT OF TOTAL HARMONIC DISTORTION

a) Adjust signal generator for 15.5 V rms on V1
b) Adjust distortion analyzer. Record the meter reading as Total Harmonic Distortion (THD).

PROCEDURE FOR MEASUREMENT OF MAXIMUM VOLTAGE SWING AND MAXIMUM POWER

a) Adjust signal generator for maximum output on scope No. 1 with no clipping. Read peak voltage as maximum voltage swing.
b) Read V1
c) Maximum power = $\frac{V1^2}{4}$

PROCEDURE FOR MEASUREMENT OF SHORT-CIRCUIT CURRENT

a) Lower power supply to ± 26 V
b) Momentarily replace 4-ohm load with 0.5-ohm load
c) Scope No. 1 must show symmetrical square wave of less than ± 1.75 V

PROCEDURE FOR MEASUREMENT OF BANDWIDTH

a) Raise power supply to ± 37.5 V
b) Adjust signal generator at 43 kHz to 2 V rms on V1
c) Adjust distortion analyzer and verify that THD < 0.5%

PROCEDURE FOR MEASUREMENT OF SLEW RATE

a) Replace signal generator with square-wave generator.
b) Adjust generator for 500 Hz and V1 = 40 V peak-to-peak.
c) Read time required for swing from peak to peak.
d) Slew rate = $\frac{40\text{ V}}{\text{Measured time}}$

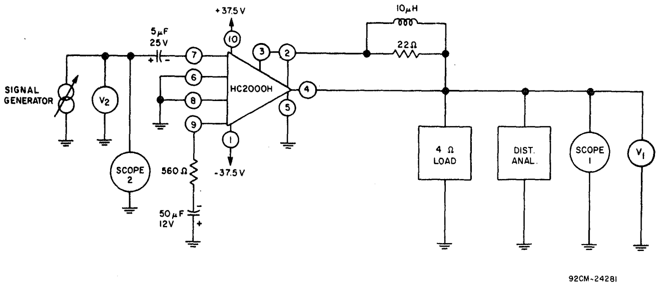


Fig. 15 – Circuit for measurement of closed-loop voltage gain, total harmonic distortion, maximum voltage swing, maximum power, short-circuit current, bandwidth, and slew-rate.

General Characteristics, Test Circuits, and Waveforms

HC2500 POWER HYBRID OPERATIONAL AMPLIFIER TEST CIRCUITS (Cont'd)

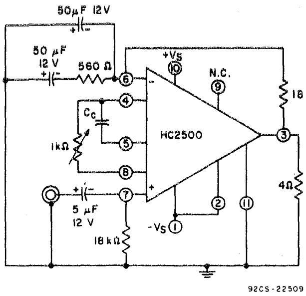
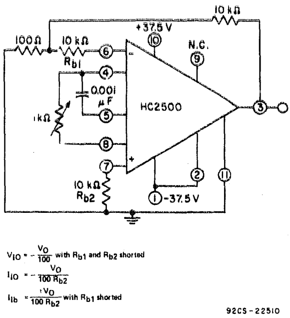


Fig.16 – Test circuit for open-loop gain and phase response.



$V_{IO} = -\frac{V_O}{100}$ with R_{b1} and R_{b2} shorted

$I_{IO} = -\frac{V_O}{100\,R_{b2}}$

$I_{Ib} = \frac{\pm V_O}{100\,R_{b2}}$ with R_{b1} shorted

Fig.17 – Test circuit for input offset voltage and current test.

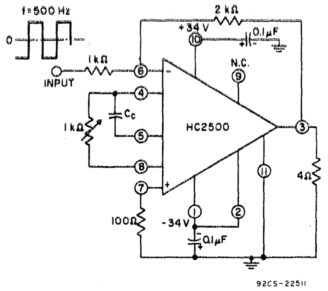
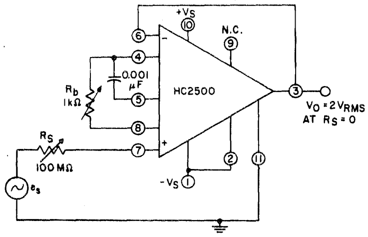


Fig.18 – Circuit used to test slew rate.



$R_{CM} = 9\,R_S$ with series resistance (R_S) increased from zero until output voltage (V_O) is reduced by 10%.

Fig.19 – Test circuit for measuring common-mode input resistance.

HC2500

TERMINAL CONNECTIONS

Pin No.		Connection
1		Drive 2
2	$-V_S$	Negative supply voltage
3	V_{OUT}	Output Voltage
4		Bias adjust
5		Frequency compensation
6	$-V_{IN}$	Inverting input
7	$+V_{IN}$	Noninverting input
8		Bias adjust
9		Drive 1
10	$+V_S$	Positive supply voltage
11	BP	Base plate (electrically isolated from internal circuitry)

THYRISTORS

Voltage-Current Characteristics

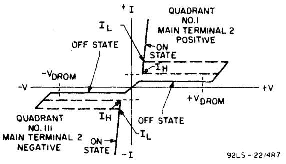


Fig.20 – Principal voltage-current characteristic for a triac.

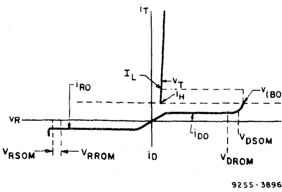


Fig.21 – Principal voltage-current characteristic for a conventional SCR.

General Characteristics, Test Circuits, and Waveforms

THYRISTORS (Cont'd)

Critical Rate of Rise of On-State Current (di/dt)

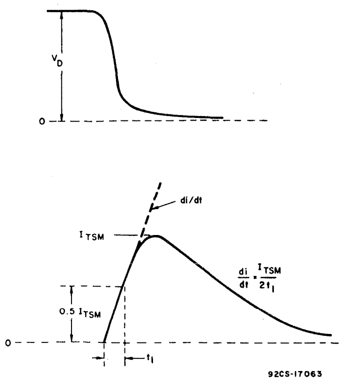


Fig. 22 – Rate of change of on-state current with time (defining di/dt) for a triac.

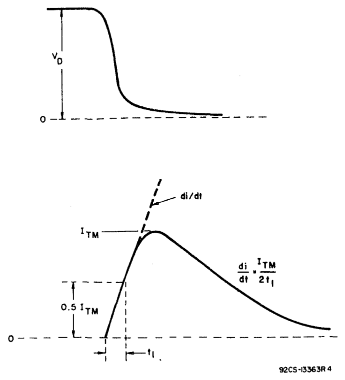
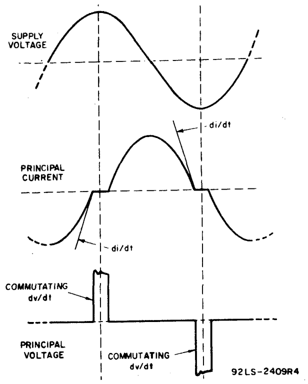


Fig. 23 – Rate of change of on-state current with time (defining di/dt) for an SCR.

Critical Rate of Rise of Off-State Voltage (Static and Commutating dv/dt)



NOTES

1. Curve defines temperature rise of either junction above case temperature for equal-amplitude symmetrical sine wave current at 50 and 80 Hz.
2. Curve considers junction temperature measured immediately after the final cycle of current.
3. Gate will regain control if temperature is maintained below rated value and load current is reduced or maintained at RMS value.
4. For more than 100 cycles of current the case temperature rise must be observed and used in calculating the total junction temperature.
5. Junction temperature rise above case is defined as apparent transient thermal impedance times average conduction power dissipated during full cycle conduction.
6. Apparent steady-state value is not the same as JEDEC value listed as steady-state in characteristics table.

Fig. 24 – Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt) for a triac.

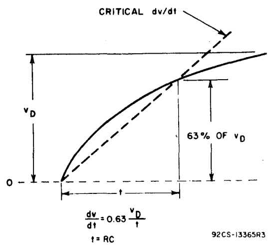


Fig. 25 – Rate of rise of off-state voltage with time (defining critical dv/dt) for general-purpose SCR's, gate-turn-off SCR's, and triacs.

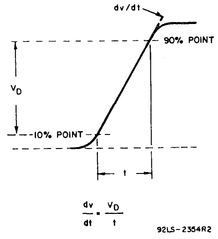


Fig. 26 – Rate of rise of off-state voltage with time (defining dv/dt) for an inverter SCR.

Subcycle Surge-Current Test for SCR's

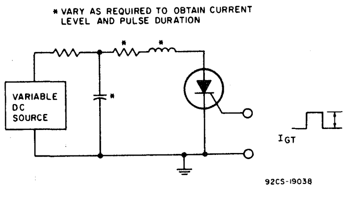


Fig. 27 – Sub-cycle surge capability test circuit.

Turn-On-Time Waveforms

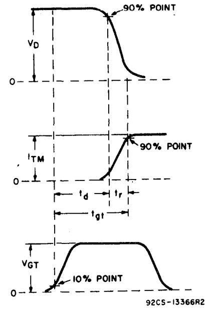


Fig. 28 – Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}) for triacs and SCR's.

General Characteristics, Test Circuits, and Waveforms

THYRISTORS (Cont'd)

Turn-Off-Time Test Circuits and Waveforms for SCR's

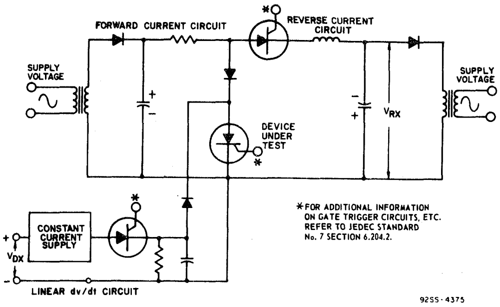


Fig. 29 - Circuit used to measure turn-off time (t_q) rectangular pulse.

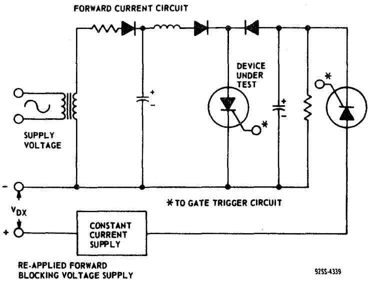


Fig.30 — Circuit used to measure turn-off time (t_q) half-sine wave pulse.

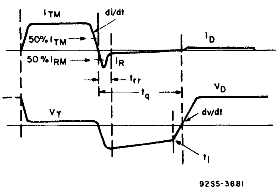


Fig.31 — Relationship between instantaneous on-state current and voltage showing reference points for definition of circuit commutated turn-off time (t_q) for general-purpose SCR's (rectangular pulse).

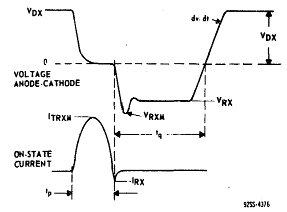


Fig. 32 — Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points for specification of turn-off time (t_q) for an inverter SCR (half-sine-wave pulse).

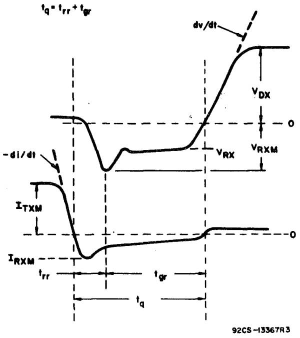
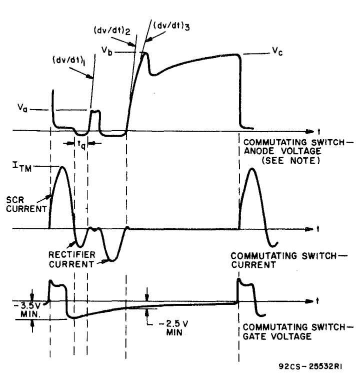


Fig.33 — Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points defining turn-off time (t_q) for inverter SCR's (rectangular pulse).

Switching Waveforms for Deflection-Circuit ITR's



NOTE: "Commutating Switch-Anode Voltage" oscilloscope display has been modified graphically to show the measurement points of dv/dt more effectively.

Fig.34 — Oscilloscope display of commutating switching ITR's showing circuit-commutated turn-off time (t_q).

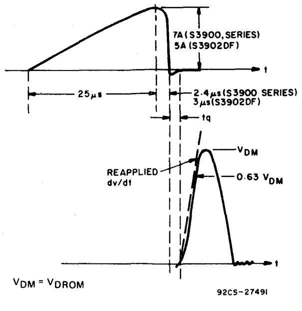


Fig.35 — Oscilloscope display of trace switching ITR's (S3900 Series, S3902DF) showing circuit-commutated turn-off time (t_q).

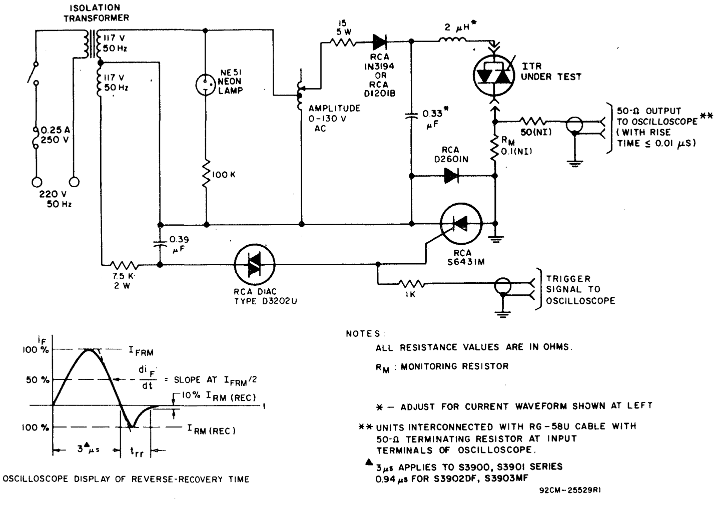
Notes for Figs. 34 and 35

Circuit-commutated turn-off time (t_q), the sum of reverse recovery time and gate recovery time, is measured from the zero crossing of current to the start of the reapplied voltage. Knowledge of the current, the reapplied voltage, and the case temperature is necessary when measuring t_q. In the worst conditions (high line, zero beam, off-frequency, minimum auxiliary load, etc), turn-off time must not fall below the given values. Turn-off time increases with temperature, therefore, case temperature must not exceed 75°C for all types.

General Characteristics, Test Circuits, and Waveforms

THYRISTORS (Cont'd)

Reverse-Recovery-Time Measurements for Rectifier Unit of ITR



NOTES:

ALL RESISTANCE VALUES ARE IN OHMS.

R_M : MONITORING RESISTOR

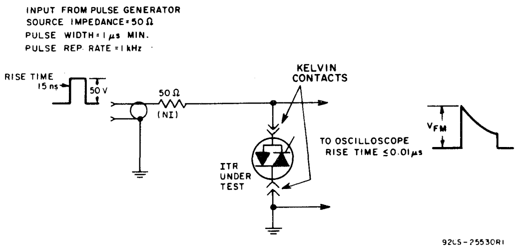
* – ADJUST FOR CURRENT WAVEFORM SHOWN AT LEFT

** UNITS INTERCONNECTED WITH RG-58U CABLE WITH 50-Ω TERMINATING RESISTOR AT INPUT TERMINALS OF OSCILLOSCOPE.

▲ 3μs APPLIES TO S3900, S3901 SERIES
0.94μs FOR S3902DF, S3903MF

Fig.36 – Test circuit (pulsed sine wave) oscilloscope display for measurement of reverse-recovery time for rectifier unit of ITR.

Peak Forward-Voltage Measurements for Rectifier Unit of ITR

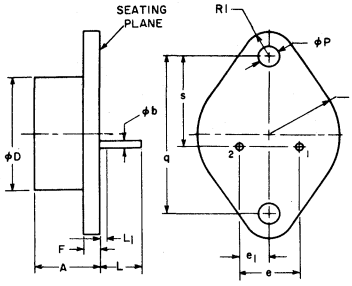


INPUT FROM PULSE GENERATOR
SOURCE IMPEDANCE = 50 Ω
PULSE WIDTH = 1 μs MIN.
PULSE REP. RATE = 1 kHz

Fig.37 – Test circuit for measurement of peak forward voltage drop at turn-on for rectifier unit of ITR.

Dimensional Outlines

TO-204MA/TO-3 A



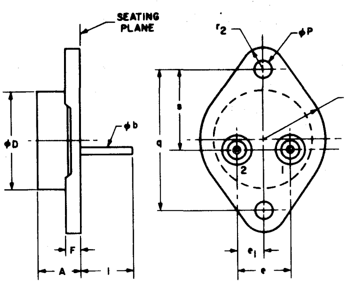
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.35	11.35	
ϕb	0.038	0.043	0.96	1.092	1
ϕD	–	0.875	–	22.22	
e	0.420	0.440	10.67	11.17	2
e_1	0.205	0.225	5.21	5.71	2
F	0.060	0.135	1.53	3.42	
L	0.312	0.500	7.93	12.70	
L_1	–	0.050	–	1.27	1
ϕP	0.151	0.161	3.836	4.089	
q	1.177	1.197	29.90	30.40	
R	0.495	0.525	12.58	13.33	
R_1	0.131	0.188	3.33	4.77	
s	0.655	0.675	16.64	17.14	

Notes:

1: ϕb applies between L_1 and L. Diameter is uncontrolled in L_1.

2: These dimensions should be measured at points 0.050 in. (1.270 mm) to 0.055 in. (1.397 mm) below seating plane. When gage is not used, measurement will be made at seating plane.

Modified TO-3 (2N6032, 2N6033) B



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.300	0.350	7.62	8.89	
ϕb	0.059	0.064	1.499	1.626	2
ϕD		0.800		20.32	
e	0.420	0.440	10.67	11.18	
e_1	0.205	0.225	5.21	5.72	
F		0.114		2.90	
l	0.440	0.470	11.18	11.94	2
ϕp	0.151	0.161	3.84	4.09	
q	1.177	1.197	29.90	30.40	
r_1		0.525		13.34	
r_2		0.188		4.78	
s	0.655	0.675	16.64	17.15	1

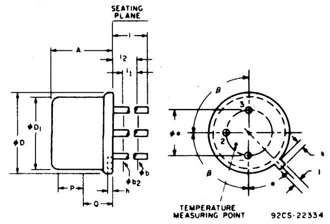
NOTES

1 THESE DIMENSIONS SHOULD BE MEASURED AT POINTS 0.050" (1.27 mm) TO 0.055" (1.40 mm) BELOW SEATING PLANE. WHEN GAGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

2 TWO LEADS

92CS 17432R1

TO-205MA/TO-5 TO-205MD/TO-39 C



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕa	0.190	0.210	4.83	5.33	
A	0.240	0.260	6.10	6.60	
ϕb	0.016	0.021	0.406	0.533	2
$ϕb_2$	0.016	0.019	0.406	0.483	2
ϕD	0.350	0.370	8.89	9.40	
$ϕD_1$	0.305	0.335	8.00	8.51	
h	0.009	0.041	0.229	1.04	
j	0.028	0.034	0.711	0.864	
k	0.029	0.040	0.737	1.02	3
L TO-5	1.500		38.10		2
L TO-39	0.500		12.70		2
l_1		0.050		1.27	2
l_2	0.250		6.35		2
P	0 100		2.54		1
Q					4
α	45° NOMINAL				
β	90° NOMINAL				

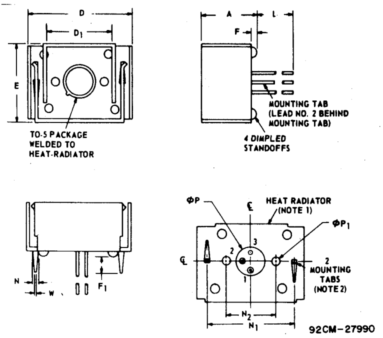
Note 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed 0.010 in. (0.254 mm).

Note 2: (Three leads)ϕb_2 applies between l_1 and l_2. ϕb applies between l_2 and l. Diameter is uncontrolled in l_1.

Note 3: Measured from maximum diameter of the actual device.

Note 4: Details of outline in this zone optional.

TO-205MA/TO-5 TO-205MD/TO-39 WITH HEAT RADIATOR D

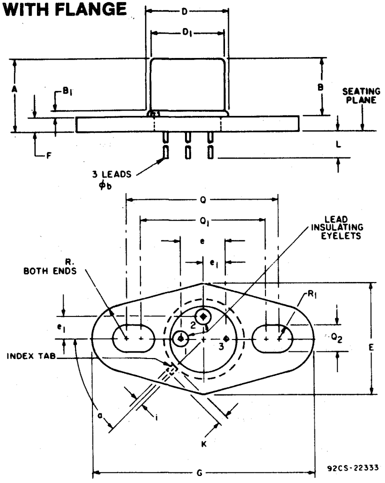


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.630	–	16.00	
D	1.205	1.235	30.61	31.37	
D_1	0.775	0.785	19.69	19.93	
E	0.875	0.905	22.22	22.99	
F	0.040	0.055	1.02	1.40	
F_1	0.160	0.195	4.06	4.95	
L	0.410	–	10.41	–	
ϕP	0.295	0.305	7.493	7.747	
$ϕP_1$	0.093	0.095	2.362	2.413	
N	0.048	0.062	1.21	1.57	
N_1	0.998	1.002	25.349	25.450	3
W	0.048	0.052	1.219	1.320	

NOTES:

1. 0.035 C.R.S., finish – electroless nickel plate.
2. Recommended hole size for printed-circuit board is 0.070 in. (1.78 mm) dia.
3. Measured at bottom of heat-radiator.

TO-205MA/TO-5 TO-205MD/TO-39 WITH FLANGE E

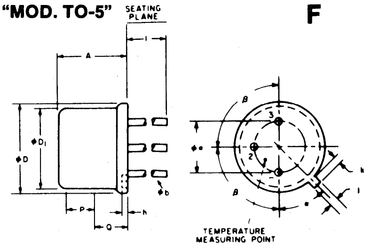


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.328	–	8.33	
B	0.240	0.260	6.10	6.60	
B_1	0.009	0.125	0.229	3.18	
ϕb	0.016	0.019	0.406	0.483	
D	0.335	0.370	8.51	9.40	
D_1	0.305	0.335	7.75	8.51	
E	0.495	0.505	12.57	12.83	
e	0.200 T.P.		5.08 T.P.		1
e_1	0.100 T.P.		2.54 T.P.		1
F	0.062	0.068	1.57	1.74	
G	0.995	1.005	25.27	25.53	
i	0.028	0.034	0.711	0.864	
k	0.029	0.045	0.737	1.14	
L long lead	1.430		36 32		
L short lead	0.430	–	10 92		
Q	0.685	0.691	17.40	17.55	
Q_1	0.559	0.565	14.20	14.35	
Q_2	0.128	0.132	3.25	3.35	
R	0.156 T.P.		3.96 T.P.		1
R_1	0.064	0.066	1.63	1.67	
α	45° T.P.				1, 2

NOTES:

1. True position.
2. Tab centerline.

"MOD. TO-5" F



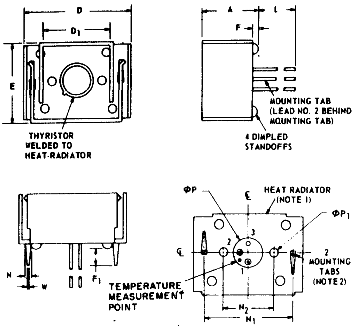
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕa	.190	.210	4.83	5.33	
A	.240	.260	6.10	6.60	
ϕb	.017	.021	.44	.53	
ϕ	.335	.366	8.51	9.30	
$ϕD_1$		.330	8.13	8.38	
h	.015	.035	.38	.89	
i	.028	.035	.71	.89	
k	.029	.045	.74	1.14	
l	.975	1.025	24.76	26.03	
P	.100	–	2.54	–	
Q	–	–	–	–	1
α	45° NOMINAL				
β	50° NOMINAL				

Note 1: Details of outline in this zone optional. 92LM-2048R2

Dimensional Outlines

"MOD. TO-5" WITH HEAT RADIATOR

G



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	–	.630	–	16.00	
D	1.205	1.235	30.61	31.37	
D_1	.745	.755	18.923	19.177	
E	.875	.905	22.22	22.99	
F	.040	.055	1.02	1.40	
F_1	.170	.225	4.32	5.72	
L	.920	–	23.37	–	
ΦP	.295	.305	7.493	7.747	
$ΦP_1$	.093	.095	2.362	2.413	
N	.048	.062	1.21	1.57	
N_1	.998	1.002	25.349	25.450	3
N_2	.687	.689	17.45	17.50	3
W	.048	.052	1.219	1.320	

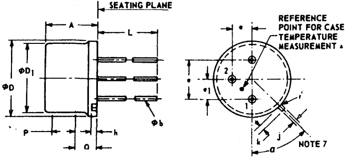
92LM-2109R1

NOTES:

1. 0.035 C.R.S., finish: electroless nickel plate
2. Recommended hole size for printed-circuit board is 0.070 in. (1.78 mm) dia.
3. Measured at bottom of heat radiator

"LOW-PROFILE TO-5"

H



92CS-34150

NOTES:

1. This zone is controlled for automatic handling. The variation in actual diameter within the zone shall not exceed .012 in. (.279 mm).
2. (Three Leads) ϕ b applies between seating plane and 1.015 in. (25.78 mm).
3. Measured from maximum diameter of the actual device.
4. Leads having maximum diameter .021 in. (.533 mm) measured at the seating plane of the device shall be within .007 in. (.178 mm) of their true positions relative to the maximum-width tab.
5. The device may be measured by direct methods or by the gage and gaging procedure described on gage drawing GS-1 of JEDEC publication 12E, May 1964.
6. Details of outline in this zone optional.
7. Tab centerline.

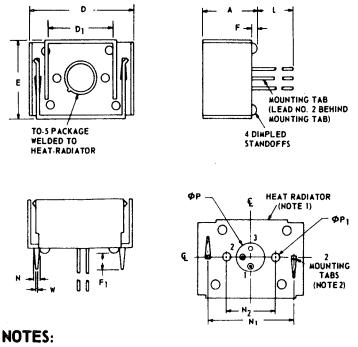
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.160	.180	4.06	4.57	
Φb	.017	.021	.432	.533	2
ΦD	.355	.366	9.017	9.296	
$ΦD_1$	.323	.335	8.204	8.51	
e	.190	.210	4.83	5.33	
e_1	.100 TRUE POSITION		2.54 TRUE POSITION		4,5
h	.015	.035	.381	.889	
j	.028	.035	.711	.889	5
k	.029	.045	.737	1.14	3,5
L	.985	1.015	25.02	25.78	2
P	.100		2.54		1
Q					6
r		.007		.179	
α	42°	48°			5,7

▲CASE TEMPERATURE MEASUREMENT

The specified temperature-reference point should be used when making temperature measurements. A low-mass temperature probe or thermocouple having wire no larger than AWG No. 26 should be attached at the temperature reference point.

"LOW-PROFILE TO-5" WITH HEAT RADIATOR

I



NOTES:

1. 0.035 C.R.S., finish: electroless nickel plate

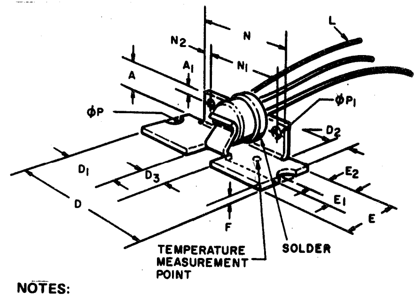
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	–	.630	–	16.00	
D	1.205	1.235	30.61	31.37	
D_1	.745	.755	18.923	19.177	
E	.875	.905	22.22	22.99	
F	.040	.055	1.02	1.40	
F_1	.170	.225	4.32	5.72	
L	.885	–	22.48	–	
ΦP	.295	.305	7.493	7.747	
$ΦP_1$	.093	.095	2.362	2.413	
N	.048	.062	1.21	1.57	
N_1	.998	1.002	25.349	25.450	3
N_2	.687	.689	17.45	17.50	3
W	.048	.052	1.219	1.320	

92CM-34152

2. Recommended hole size for printed-circuit board is 0.070 in. (1.78 mm) dia.
3. Measured at bottom of heat-radiator

"LOW-PROFILE TO-5" WITH HEAT SPREADER

J



NOTES:

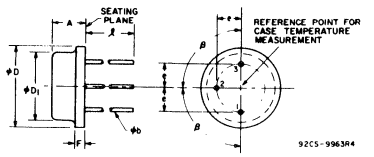
1. Min. length, 3 leads.
2. Two holes.

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	0.22		5.58		
A_1	0.75		19.05		
D	1.0		25.4		
D_1	0.406		10.31		
D_2	0.14	0.16	3.55	4.06	
D_3	0.188		4.77		
E	0.40		10.16		
E_1	0.32		8.12		
E_2	0.156		3.96		
F	0.02		0.05		
L	0.95	—	24.13	–	1
N	0.69	0.71	17.52	18.03	
N_1	0.55		13.97		
N_2	0.75		19.05		
ϕ P	0.072 Rad.		1.83 Rad.		
$ϕ P_1$	0.094 Dia.		2.39 Dia.		2

92CS-34151

TO-8

K



92CS-9963R4

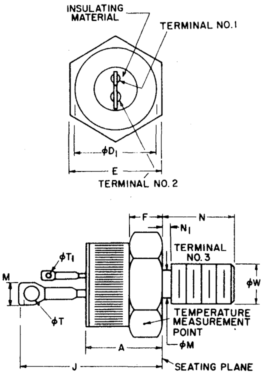
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	0.270	0.330	6.86	8.38	–
ϕb	0.027	0.033	0.686	0.838	1
ϕD	0.550	0.650	13.97	16.51	–
$ϕD_1$	0.444	0.524	11.28	13.31	–
e	0.136	0.146	3.45	3.71	–
F	–	0.115	–	2.92	–
ℓ	0.360	0.440	9.14	11.18	1
β	90 NOMINAL				

NOTE:

1. Three leads.

TO-208MA/TO-48

L



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	0.330	0.505	9.4	12.8	—
ϕD1	—	0.544	—	13.81	—
E	0.544	0.562	13.82	14.28	—
F	0.113	0.200	2.87	5.08	—
J	0.950	1.100	24.13	27.94	—
ϕM	0.220	0.249	5.59	6.32	—
M	0.215	0.225	5.46	5.71	—
N	0.422	0.453	10.72	11.50	—
N1	—	0.090	—	2.28	—
ϕT1	0.058	0.068	1.47	1.73	—
ϕT	0.138	0.148	3.50	3.75	—
ϕW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

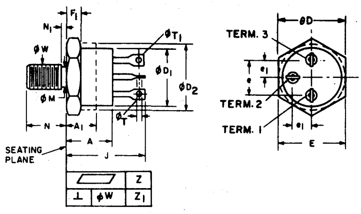
92CS-15208R5

NOTE

1. ϕW is pitch diameter of coated threads.
   REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I. Recommended Torque: 35 in.lbf (0.4 kg f-m).
   Maximum Torque: 50 in-lbf (0.57 kgf-m)

Dimensional Outlines

TO-211MA/TO-61 **M**



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.325	0.460	8.26	11.68	
A_1	–	0.270	–	6.85	1
ϕD	–	0.794	–	20.16	
ϕD_1	0.570	0.610	14.48	15.49	
ϕD_2	0.610	0.687	15.50	17.44	1
E	0.669	0.688	17.00	17.47	
e	0.340	0.415	8.64	10.54	2
e_1	0.170	0.213	4.32	5.41	2
F_1	0.090	0.150	2.29	3.81	3
J	0.640	0.875	16.26	22.22	
ϕM	0.220	0.249	5.59	6.32	
N	0.422	0.455	10.72	11.55	
N_1	–	0.090	–	2.28	
ϕT	0.047	0.072	1.20	1.82	
ϕT_1	0.046	0.077	1.17	1.95	4
ϕW	1/4-28 UNF-2A		1/4-28 UNF-2A		5
Z	–	0.002	–	0.050	
Z_1	–	0.006	–	0.152	

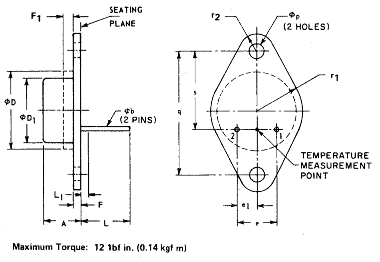
NOTES:

1. The device contour with the exception of the hexagon is optional within cylinder defined by ϕD_2 and A_1, ϕD_2 not to exceed actual E.
2. Angular orientation of terminals with respect to hexagon is optional.
3. Chamfer or undercut on one or both ends of hexagonal portion is optional.
4. Termianl 3 can be flattened and pierced or hook type.
5. ϕW is pitch diameter of coated threads. Ref: Screw Thread Standards for Federal Services, Handbook H28, Part I. Recommended torque: 35 in-lbf (0.4 kgf m) Maximum torque: 50 in-lbf (0.58 kgf m)

92CM-31275

WARNING: The isolating material (ceramic) used in this package contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

TO-213MA/TO-66 **N**



Maximum Torque: 12 lbf in. (0.14 kgf m)

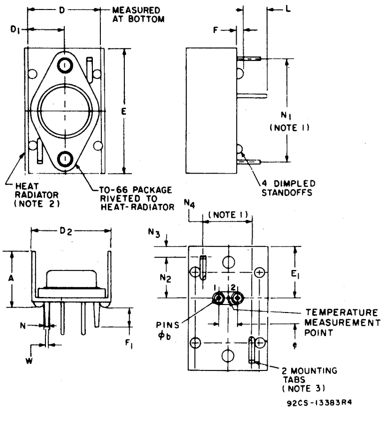
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.340	6.35	8.63	
ϕb	0.028	0.034	0.712	0.863	
ϕD	–	0.620	–	15.74	1
ϕD_1	0.470	0.500	11.94	12.70	
e	0.190	0.210	4.83	5.33	2
e_1	0.093	0.107	2.37	2.71	2
F	0.050	0.075	1.27	1.90	
F_1	–	0.050	–	1.27	1
L	0.360	0.500	9.15	12.70	
L_1	–	0.050	–	1.27	3
ϕp	0.142	0.152	3.607	3.860	
q	0.958	0.962	24.334	24.434	
R	–	0.350	–	8.89	
R_1	0.115	0.145	2.93	3.68	
s	0.570	0.590	14.48	14.98	

92CM-34147

Notes:

1. Body contour is optional within zone defined by ϕD and F_1.
2. These dimensions should be measured at points 0.050 in. (1.27 mm) to 0.055 in. (1.40 mm) below seating plane. When gage is not used, measurements will be made at seating plane.
3. ϕb applies between L_1 and L. Diameter is uncontrolled in L_1.
4. The seating plane of header shall be flat within 0.001 in. (0.025 mm) concave to 0.004 in. (0.10 mm) convex inside a 0.520 in. (13.21 mm) diameter circle on the center of the header and flat within 0.001 in (0.025 mm) concave to 0.006 in. (0.15 mm) convex overall.

TO-66 WITH HEAT RADIATOR **O**

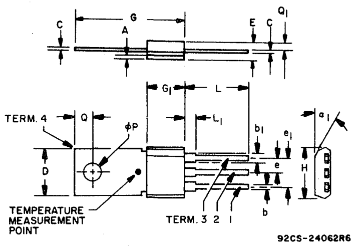


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.620	–	15.75	
ϕb	0.028	0.034	0.711	0.864	
D	0.750	0.760	19.05	19.30	
D_1	0.370	0.385	9.40	9.78	
D_2	0.820	0.920	20.83	23.37	
E	1.297	1.327	32.94	33.70	
E_1	0.546	0.566	13.87	14.37	
e	0.190	0.210	4.83	5.33	
F	0.30	0.55	7.62	13.97	
F_1	0.175	0.210	4.44	5.33	
L	0.270	–	6.86	–	
N	0.052	0.065	1.32	1.65	
N_1	1.098	1.102	27.89	27.99	1
N_2	0.448	0.452	11.38	11.47	
N_3	0.099	0.113	0.25	0.29	
N_4	0.498	0.502	12.65	12.75	
W	0.048	0.060	1.22	1.52	

NOTES:

1. Measured at bottom of heat radiator
2. 0.035 in (0.889) C.R.S., tin plated.
3. Recommended hole size for printed-circuit board is 0.070 in. (1.778) dia

TO-202AB VERSATAB **P**



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.05	–	1.270	1
b	0.023	0.029	0.584	0.736	
b_1	0.045	0.055	1.143	1.397	1
c	0.018	0.026	0.457	0.660	
D	0.305	0.325	7.747	8.255	
E	0.130	0.150	3.302	3.810	
e	0.095	0.105	2.413	2.667	
e_1	0.190	0.210	4.826	5.334	
G	0.760	0.840	19.31	21.33	
G_1	0.230	0.250	5.842	6.350	
H	0.330	0.370	8.382	9.398	
L	0.400	0.450	10.16	11.43	
L_1	0.050	0.100	1.27	2.54	1,2
ϕP	0.123	0.127	3.124	3.225	
Q	0.120	0.130	3.048	3.302	
Q_1	0.039	0.050	0.990	1.270	
α_1	–	50°	–	50°	1

TEMPERATURE MEASUREMENT:

1/16 in. (1.58 mm) from plastic encapsulation on either mounting flange (terminal No. 4) or anode lead (terminal No. 2).

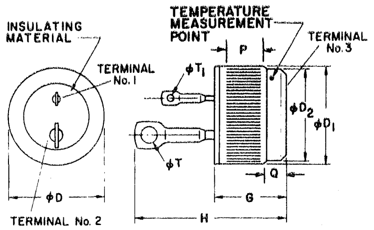
NOTES:

1. **Package contour optional within dimensions specified.**
2. **Lead dimensions uncontrolled in this zone.**
3. **Controlling dimensions: inch.**

Dimensional Outlines

TO-203AA PRESS-FIT 6-, 10-, AND 15-A TRIACS; 20- AND 35-A SCR's

Q



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕD	–	0.510	–	12.95	1
ϕD_1	0.501	0.505	12.726	12.827	2
ϕD_2	0.465	0.475	11.82	12.06	
G	0.330	0.380	8.39	9.65	
H	–	0.800	–	20.32	
P	0.100	–	2.54	–	2
Q	0.080	0.097	–	–	
ϕT	0.065	0.090	1.66	2.28	3,4
ϕT_1	0.035	0.068	0.89	1.72	

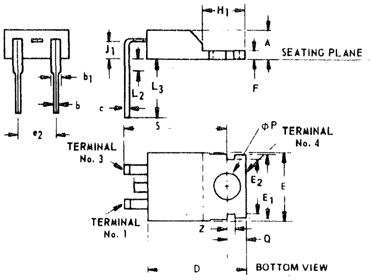
NOTES:

1. Outline contour is optional within zone defined by ϕD and G min. and H max.
2. Straight knurl surface.
3. Elongated hole in terminal is optional.
4. Contour and orientation of terminal 1 and terminal 2 are not defined.
5. Terminal 1 to be shorter than terminal 2 for identification.

92CS-23134R1

TO-220AA VERSAWATT

R



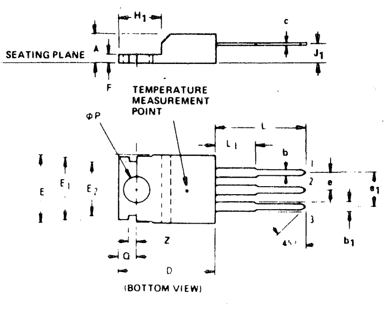
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	–
b	0.020	0.045	0.51	1.14	–
b_1	0.045	0.070	1.14	1.77	–
c	0.015	0.025	0.38	0.63	–
D	0.560	0.625	14.23	15.87	–
E	0.380	0.420	9.66	10.66	1
E_1	0.365	0.385	9.28	9.77	–
E_2	0.300	0.320	7.62	8.12	–
e_2	0.190	0.210	4.83	5.33	2
F	0.045	0.055	1.14	1.39	–
H_1	0.230	0.270	5.85	6.85	1
J_1	0.080	0.115	2.04	2.92	–
L_2	–	0.050	–	1.27	–
L_3	0.360	0.422	9.15	10.71	–
ϕP	0.139	0.147	3.531	3.733	–
Q	0.100	0.120	2.54	3.04	–
S	0.580	0.610	14.74	15.49	–
Z	0.040	0.060	1.02	1.52	–

NOTES: 92CS-17990R2

1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.050 – 0.055 in. (1.270 – 1.397 mm) below seating plane.

TO-220AB VERSAWATT

S



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	–
b	0.020	0.045	0.51	1.14	–
b_1	0.045	0.070	1.14	1.77	–
c	0.015	0.025	0.38	0.63	–
D	0.560	0.625	14.23	15.87	–
E	0.380	0.420	9.66	10.66	i
E_1	0.365	0.385	9.28	9.77	–
E_2	0.300	0.320	7.62	8.12	–
e	0.090	0.110	2.29	2.79	2
e_1	0.190	0.210	4.83	5.33	2
F	0.045	0.055	1.14	1.39	–
H_1	0.230	0.270	5.85	6.85	1
J_1	0.080	0.115	2.04	2.92	–
L	0.500	0.562	12.70	14.27	–
L_1	–	0.250	–	6.35	–
ϕP	0.139	0.147	3.531	3.733	–
Q	0.100	0.120	2.54	3.04	–
Z	0.040	0.060	1.02	1.52	–

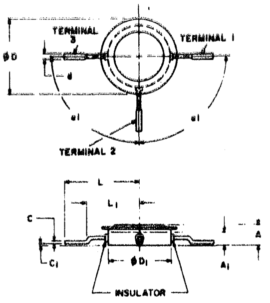
92SS-17991R2

NOTES:

1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.250 – 0.255 in. (6.350 – 6.477 mm) from case.

RADIAL PACKAGE

T



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	–	0.200	–	5.08	
A_1	–	0.125	–	3.17	1
C	0.015	0.019	0.38	0.48	
C_1	–	0.015	–	0.38	
ϕD	–	0.710	–	18.03	
ϕD_1	0.616	0.690	15.62	17.52	1
d	0.042	0.046	1.06	1.16	
L	–	0.706	–	17.90	
L_1	–	0.510	–	12.95	
α_1	90° ± 2°		90° ± 2°		

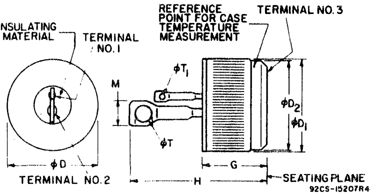
92CS-20224

NOTE

1. CONTROLLED AREA OF THE DIAMETER DOES NOT INCLUDE THE BRAZED AREA AROUND THE CERAMIC AND TERMINAL 2

PRESS-FIT 25-, 30-, AND 40-A TRIACS

U



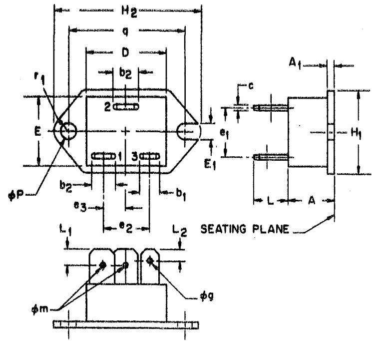
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
G	–	0.380	–	9.65	–
ϕD	0.501	0.510	12.73	12.95	–
ϕD_1	–	0.505	–	12.83	1
ϕD_2	0.465	0.475	11.81	12.07	–
H	0.825	1.000	20.95	25.40	–
M	0.215	0.225	5.46	5.71	–
ϕT_1	0.058	0.068	1.47	1.73	–
ϕT	0.138	0.148	3.51	3.75	–

NOTE:

1. Outer diameter of knurled surface.

Dimensional Outlines

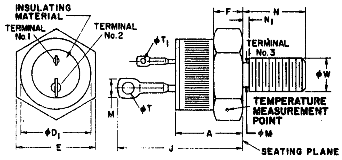
TO-238AA (Quick-Connect Package) V



SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.375	0.525	9.53	13.33
A1	0.040	0.130	1.02	3.30
b1	0.182	0.190	4.67	4.83
b2	0.247	0.253	6.27	6.43
c	0.031	0.033	0.788	0.838
D	0.802	0.822	20.37	20.88
E	0.677	0.697	17.20	17.70
E1	0.152	0.162	3.87	4.11
e1	0.490	0.510	12.45	12.95
e2	0.469	0.479	11.92	12.16
e3	0.215	0.225	5.47	5.71
H1	0.685	0.860	17.40	21.84
H2	1.480	1.520	37.60	38.60
L	0.352	0.410	8.94	10.41
φP	0.152	0.162	3.87	4.11
q	1.177	1.197	29.90	30.40
r1	—	0.185	—	4.699
L1	0.173	0.183	0.39	4.65
L2	0.120	0.130	3.05	3.30
φg	0.052 NOM		1.32 NOM	
φm	0.072 NOM		1.83 NOM	

92CS-32011R1

STUD W
6-, 10-, AND 15-A TRIACS; 20- and 35-A SCR's

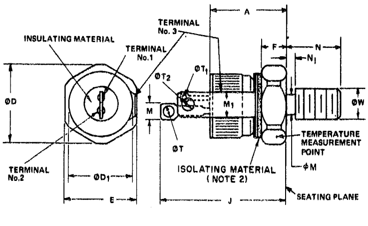


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.330	0.505	8.40	12.80	—
φD1	—	0.544	—	13.81	—
E	0.544	0.562	13.82	14.28	—
F	0.113	0.200	2.87	5.08	—
J	—	0.950	—	24.13	—
φM	0.220	0.249	5.59	6.32	—
M	—	0.155	—	3.94	—
N	0.422	0.453	10.72	11.50	—
N1	—	0.090	—	2.28	—
φT1	0.058	0.068	1.47	1.73	—
φT	0.080	0.090	2.03	2.29	—
φW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

92CS-23135R2

NOTE
1. φW is pitch diameter of coated threads.
   REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I.
   Recommended Torque: 35 in.lbf (0.4 kg f-m).
   Maximum Torque: 50 in-lbf (0.57 kgf-m)

ISOLATED-STUD X
25-, 30-, AND 40-A TRIACS

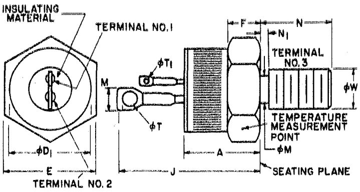


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.673	—	17.09	—
φD	0.604	0.614	15.34	15.59	—
φD1	0.501	0.505	12.72	12.82	—
E	0.551	0.557	13.99	14.14	—
F	0.100	0.185	2.50	4.69	—
J	—	1.298	—	32.96	—
φM	0.220	0.249	5.59	6.32	—
M	0.210	0.230	5.33	5.84	—
M1	0.200	0.210	5.08	5.33	—
N	0.422	0.452	10.72	11.48	—
N1	—	0.090	—	2.28	—
φT1	0.058	0.068	1.47	1.73	—
φT	0.138	0.148	3.50	3.75	—
φT2	0.138	0.148	3.50	3.75	—
φW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

92CS-29311R3

NOTE
1. φW is pitch diameter of coated threads.
   REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I.
   Recommended Torque: 35 in.lbf (0.4 kg f-m).
   Maximum Torque: 50 in-lbf (0.57 kgf-m)
2. Isolating material (ceramic) between hex (stud) and terminal No. 3 is beryllium oxide. Minimum isolation breakdown voltage is 2100 V rms for 1 minute duration.

STUD Y
25-, 30-, AND 40-A TRIACS

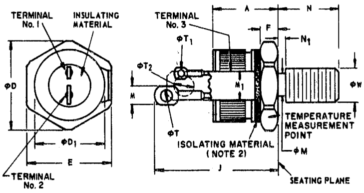


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.330	0.505	9.4	12.8	—
φD1	—	0.544	—	13.81	—
E	0.544	0.562	13.82	14.28	—
F	0.113	0.200	2.87	5.08	—
J	0.950	1.100	24.13	27.94	—
φM	0.220	0.249	5.59	6.32	—
M	0.215	0.225	5.46	5.71	—
N	0.422	0.453	10.72	11.50	—
N1	—	0.090	—	2.28	—
φT1	0.058	0.068	1.47	1.73	—
φT	0.138	0.148	3.50	3.75	—
φW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

92CS-15208R5

NOTE
1. φW is pitch diameter of coated threads.
   REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I. Recommended Torque: 35 in.lbf (0.4 kg f-m).
   Maximum Torque: 50 in-lbf (0.57 kgf-m)

ISOLATED-STUD Z
6-, 10-, AND 15-A TRIACS; 20- AND 35-A SCR's



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.673	—	17.09	—
φD	0.604	0.614	15.34	15.59	—
φD1	0.501	0.505	12.72	12.82	—
E	0.551	0.557	13.99	14.14	—
F	0.100	0.185	2.50	4.69	—
J	—	1.055	—	26.79	—
φM	0.220	0.249	5.59	6.32	—
M	—	0.155	—	3.94	—
M1	0.200	0.210	5.08	5.33	—
N	0.422	0.452	10.72	11.48	—
N1	—	0.090	—	2.28	—
φT1	0.058	0.068	1.47	1.73	—
φT	0.080	0.090	2.03	2.29	—
φT2	0.138	0.148	3.50	3.75	—
φW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

92CS-23133R4

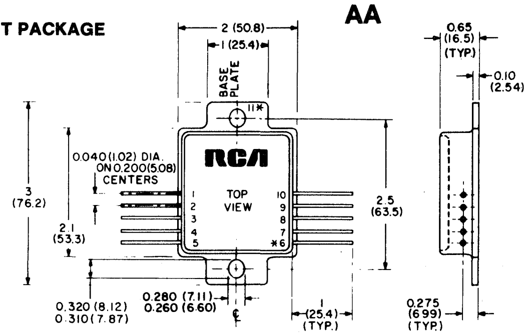
NOTE
1. φW is pitch diameter of coated threads.
   REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I.
   Recommended Torque: 35 in.lbf (0.4 kg f-m).
   Maximum Torque: 50 in-lbf (0.57 kgf-m)
2. Isolating material (ceramic) between hex (stud) and terminal No. 3 is beryllium oxide. Minimum isolation *breakdown voltage is 2100 V rms for 1 minute duration.*

WARNING: The ceramic used in these packages contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

Dimensional Outlines

HYBRID-CIRCUIT PACKAGE

AA



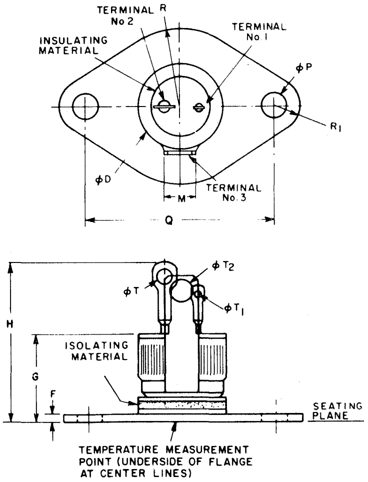
DIMENSIONS IN INCHES AND MILLIMETERS (VALUES IN PARENTHESES)

92CS-27779

*For HC2000H, Terminal 11 is internally connected to Terminal 6. For HC2500, Terminal 11 is electrically isolated from internal circuitry.

PRESS-FIT, ISOLATED ON TO-3 FLANGE FOR SCR's AND TRIACS FOR 25-A, 30-A, AND 40-A TRIACS; SEE NOTES 1 AND 2

BB



92CM-26377R2

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
G	–	0.635	–	16.13	
ϕD	–	0.510	–	12.95	
F	0.060	0.065	1.52	1.65	
H	–	1.015	–	25.78	
M	0.200	0.210	5.08	5.33	
Q	1.184	1.190	30.07	30.22	
ϕP	0.152	0.159	3.86	4.04	
R	0.497	0.503	12.62	12.77	
R_1	0.169	0.176	4.29	4.47	
ϕT	0.065	0.090	1.66	2.28	1
ϕT_1	0.035	0.068	0.89	1.72	2
ϕT_2	0.138	0.148	3.50	3.76	

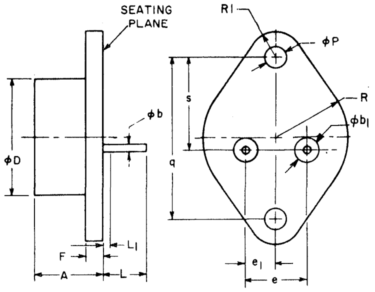
NOTES:

1. For 25-A, 30-A, and 40-A triacs, ϕT = 0.138–0.148 in. (3.50–3.75 mm)
2. For 25-A, 30-A, and 40-A triacs, ϕT_1 = 0.058–0.068 in. (1.47 – 1.73 mm)

WARNING: The ceramic used in these packages contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

TO-204MA (FORMERLY JEDEC TO-3) WITH 200-MIL DIAMETER PIN ISOLATION

CC



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.35	11.35	
ϕb	0.038	0.043	0.96	1.092	1
ϕb_1	0.200 NOM.		5.08 NOM.		
ϕD	–	0.875	–	22.22	
e	0.420	0.440	10.67	11.17	2
e_1	0.205	0.225	5.21	5.71	2
F	0.060	0.135	1.53	3.42	
L	0.312	0.500	7.93	12.70	
L_1	–	0.050	–	1.27	1
ϕP	0.151	0.161	3.836	4.089	
q	1.177	1.197	29.90	30.40	
R	0.495	0.525	12.58	13.33	
R_1	0.131	0.188	3.33	4.77	
s	0.655	0.675	16.64	17.14	

92CS-32102

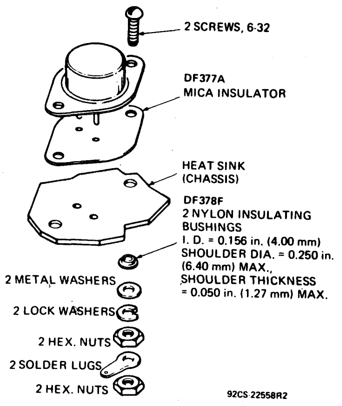
Notes:

1: ϕb applies between L_1 and L. Diameter is uncontrolled in L_1.

2: These dimensions should be measured at points 0.050 in. (1.270 mm) to 0.055 in. (1.397 mm) below seating plane. When gage is not used, measurement will be made at seating plane.

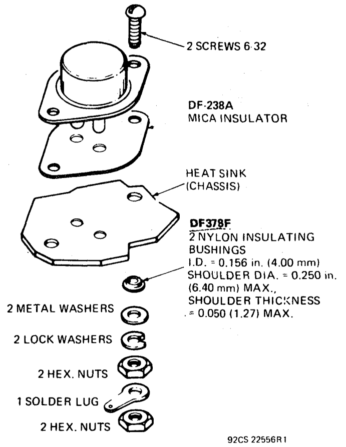
Suggested Hardware and Mounting Arrangements

TO-204MA/TO-3

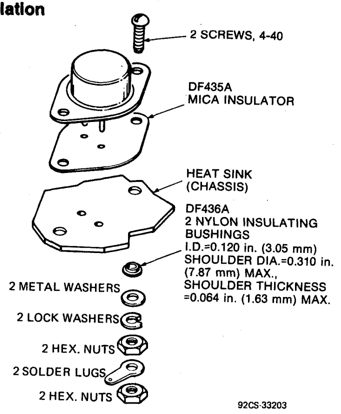


NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 12 in. lbs. (0.14 kgf m).

MODIFIED TO-3

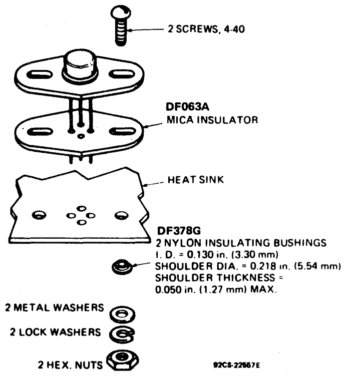


TO-204MA/TO-3
With 200-mil diameter pin isolation



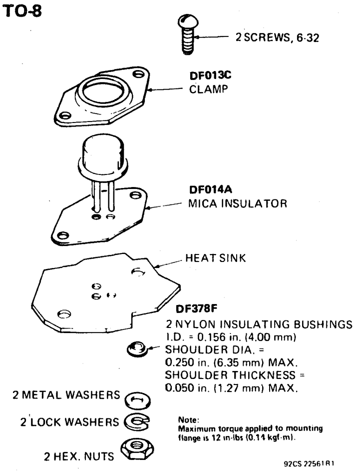
NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in.-lbs. (0.09 kgf m).

TO-205MA/TO-5
TO-205MD/TO-39
With Flange



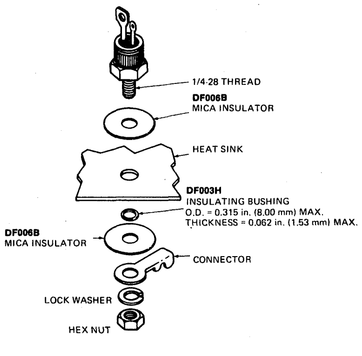
Note: Maximum torque applied to mounting flange is 8 in-lb (0.09 kgf-m).

TO-8



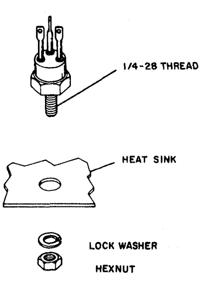
Note:
Maximum torque applied to mounting flange is 12 in-lbs (0.14 kgf-m).

TO-208MA/TO-48



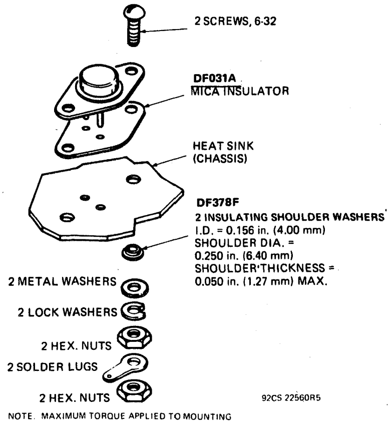
Maximum torque: 50 in.-lb (0.58 kgf-m)

TO-211MA/TO-61



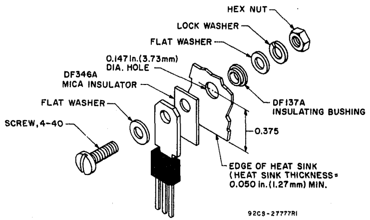
MAXIMUM TORQUE
50in lb (0.58 kgf m)

TO-213MA/TO-66



NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 12 in. lb (0.14 kgf m)

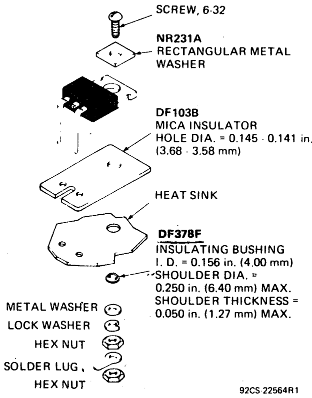
TO-202AB



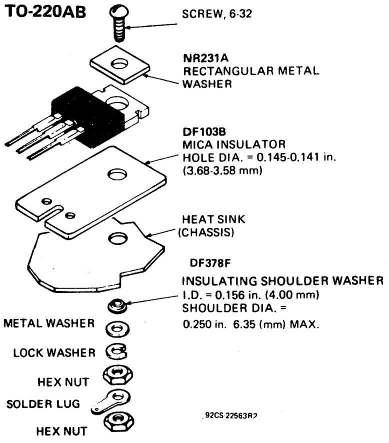
NOTE: Maximum torque applied to mounting flange is 8 in.-lb (0.09 kgf-m)

Suggested Hardware and Mounting Arrangements

TO-220AA

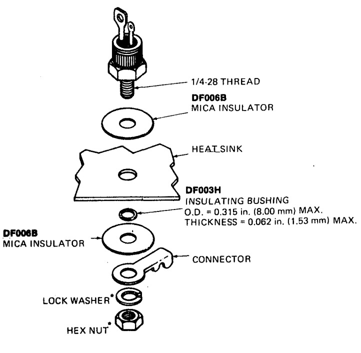


TO-220AB



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in.-lb. (0.09 kgf·m)

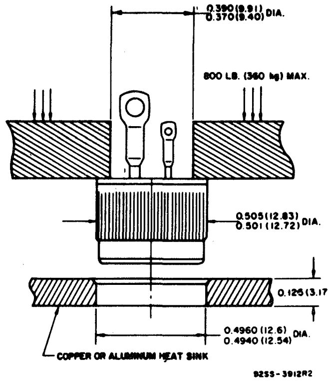
Stud and Isolated-Stud Triacs and SCR's except 60- and 80-A Triacs



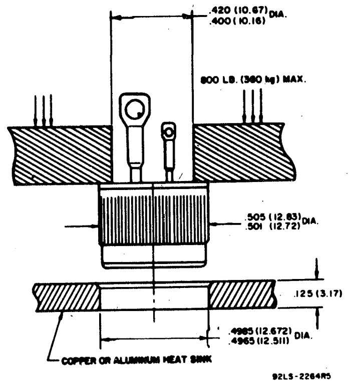
Maximum torque: 50 in.-lb (0.58 kgf-m) 92CS-22566R1

***Only hardware required for Isolated-Stud package**

TO-203AA
6-, 10-, and 15-A Triacs, 20- and 35-A SCR's

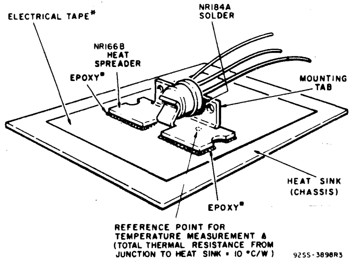


Press-Fit
25-, 30-, and 40-A Triacs



NOTE: Dimensions in parentheses are in millimeters.

"LOW - Profile TO-5" with Heat Spreader



- * Scotch brand electrical tape No.27 (thermo setting one side), Minnesota Mining & Mfg. Co., St Paul, Minnesota, or equivalent.
- ■ An epoxy such as Hysol Epoxy Patch Kit 6C, Hysol Corporation, Olean, N. Y. 14761, or equivalent.
- ▲ For heat-sink temperature measurement, the thermocouple (wire no larger than AWG No. 26) should be inserted in a small, shallow hole drilled in (but not through) the heat sink at the indicated temperature reference point.

Press-Fit
Triacs and SCR's

MOUNTING CONSIDERATIONS

Mounting of press-fit package types depends upon an interference fit between the thyristor case and the heat sink. As the thyristor is forced into the heat-sink hole, metal from the heat sink flows into the knurl voids of the thyristor case. The resulting close contact between the heat sink and the thyristor case assures low thermal and electrical resistances.

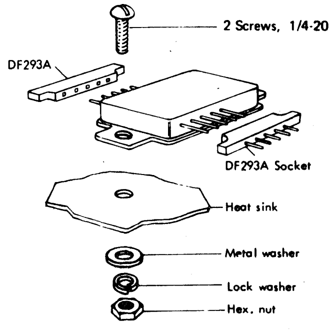
A recommended mounting method, Press-Fit (TO-203AA) or Press-Fit (25-, 30-, and 40-A triacs) - shows press-fit knurl and heat-sink hole dimensions. If these dimensions are maintained, a "worst-case" condition of 0.0085 in. (0.2159 mm) interference fit will allow press-fit insertion below the maximum allowable insertion force of 800 pounds. A slight chamfer in the heat-sink hole will help center and guide the press-fit package properly into the heat sink. The insertion tool should be a hollow shaft having an inner diameter of 0.380 ± 0.010 in. (9.65 ± 0.254 mm) for PF-1 package, and 0.410 ± 0.010 in. (10.41 ± 0.254 mm) for PF-2 package and an outer diameter of 0.500 in (12.70 mm). These dimensions provide sufficient clearance for the leads and assure that no direct force will be applied to the glass seal of the thyristor.

The press-fit package is not restricted to a single mounting arrangement; direct soldering and the use of epoxy adhesives have been successfully employed. The press-fit case is tin-plated to facilitate direct soldering to the heat sink. A 60-40 solder should be used and heat should be applied only long enough to allow the solder to flow freely.

Case-to-Heat Sink Thermal Resistance for Different Mounting Arrangements– Triacs and SCR's

Package	Type of Mounting Employed	Thermal Resistance-°C/W
Stud & Isolated-Stud	Directly mounted on heat sink with or without the use of heat-sink compound.	0.6
Stud	Mounted on heat sink with a 0.004 to 0.006 in. (0.102 to 0.152 mm) thick mica insulating washer used between unit and heat sink.	
	Without heat sink compound	2.5
	With heat sink compound	1.5
Press-Fit	Press-fitted into heat sink. Minimum required thickness of heat sink = 1/8 in. (3.17 mm).	0.5
	Soldered directly to heat sink. (60-40 solder which has a melting point of 188°C should be used. Heating time should be sufficient to cause solder to flow freely).	0.1 to 0.35

Power Hybrid Circuit Package



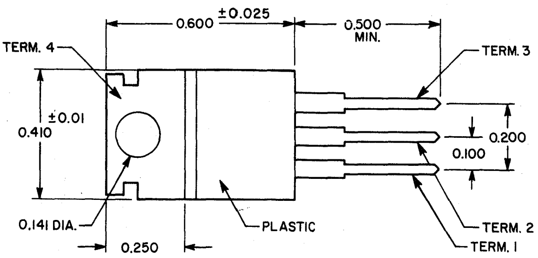
Note: Maximum torque applied to mounting flange is 24 in-lb (0.3 kgf-m).

DF293A is a socket to enable simple connection of this module

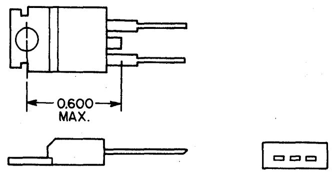
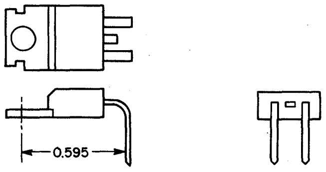
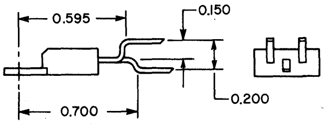
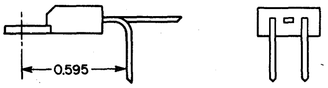
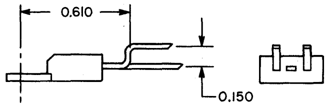
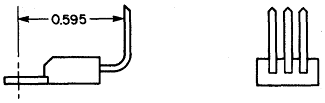
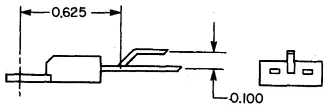
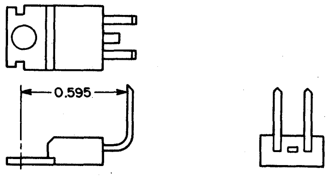
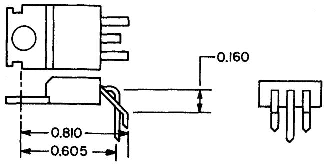
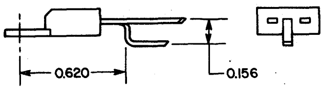
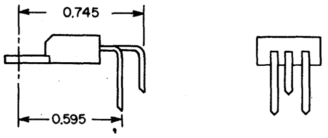
92CS-27782

Lead Forms for RCA Plastic Power Packages

TO-220 (VERSAWATT)



Top View

Lead Form No.	Outline	Lead Form No.	Outline
6200		6206	
6201		6207	
6202		6209	
6203		6210	
6204		6211	
6205		6212	

Lead Forms for RCA Plastic Power Packages

TO-220 (VERSAWATT) [cont'd]

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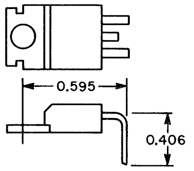
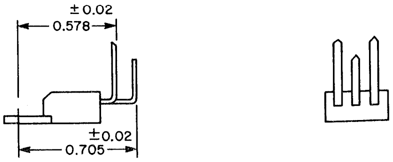
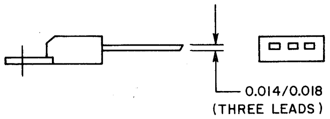
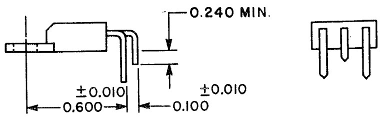
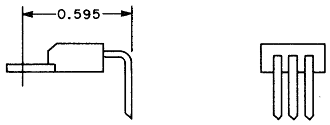
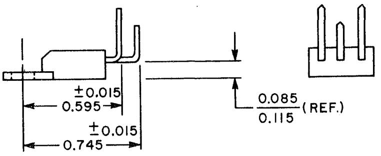
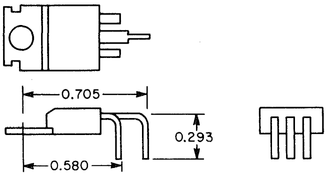
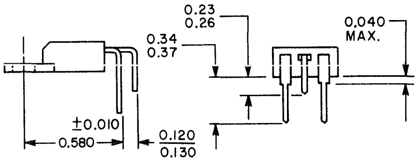
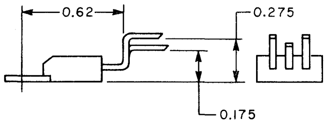
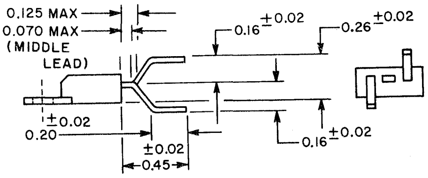
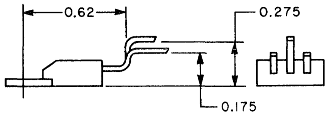
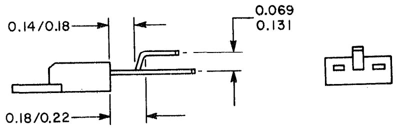
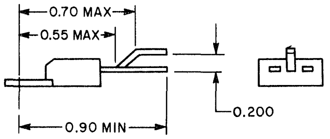
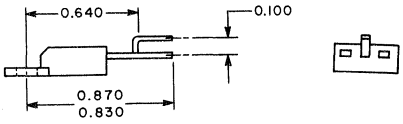
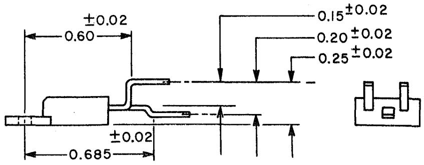
6216		**6227**	
6217		**6231**	
6220		**6233**	
6221		**6234**	
6223		**6235**	
6224		**6237**	
6226		**6242**	
		6245	

TO-220 (VERSAWATT) [cont'd]

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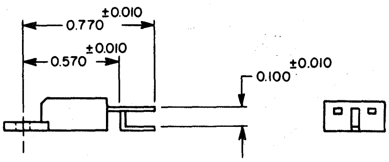
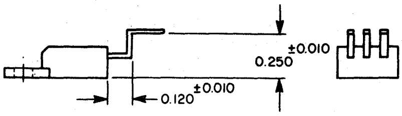
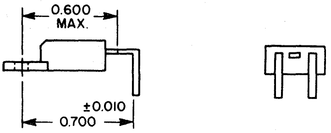
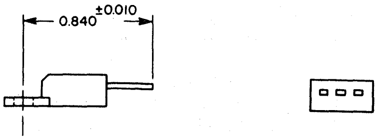
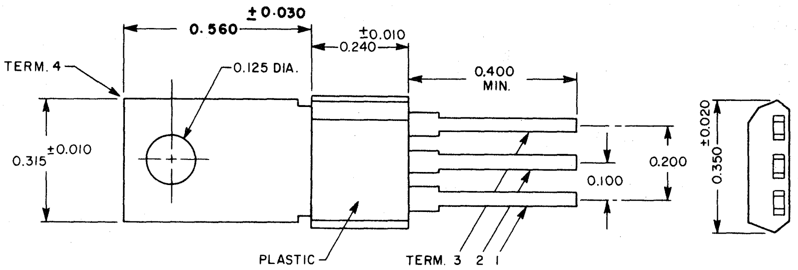
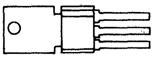
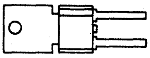
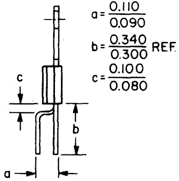
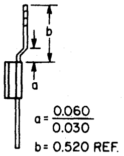
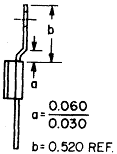
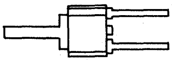
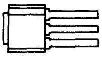
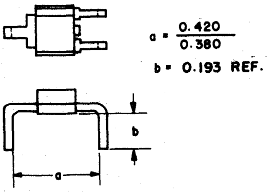
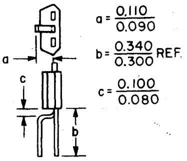
6246		**6248**	
6247		**6249**	

TO-202 (VERSATAB)



Top View

Lead Form No.	Outline	Lead Form No.	Outline
Type 1		Type 3	
Type 11		Type 32	
Type 12		Type 4	
Type 2		Type 41	
Type 21			

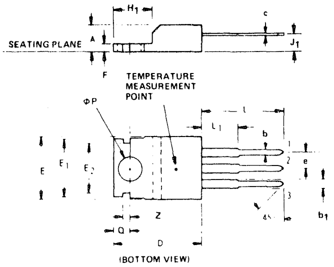
Handling and Mounting of RCA Molded-Plastic Transistors and Thyristors

AN-4124

RCA power transistors and thyristors (SCR's and triacs) in VERSAWATT molded-silicone-plastic packages are specially designed for ease of use in a wide range of medium-power applications. This Note provides detailed guidelines for handling and mounting of these plastic-package devices, and shows different package options and suggested mounting hardware to accommodate various mounting arrangements. Recommendations are made for handling of the packages during the forming of leads to meet specific mounting requirements. Various mounting arrangements, thermal considerations, and cleaning methods are described. This information is intended to augment the data on electrical characteristics, safe operating area, and performance capabilities in the technical data bulletin for each type of plastic-package transistor or thyristor.

Package Options

Figs. 1 through 3 show the options currently available for devices in RCA VERSAWATT (JEDEC TO-220) packages. The JEDEC Type TO-220AB in-line-lead version, shown in Fig. 1. represents the basic style. This configuration features leads that can be formed to meet a variety of specific mounting requirements. Fig. 2 shows a package configuration that allows a VERSAWATT package to be mounted on a printed-circuit board with a 0.100-inch grid and a minimum lead spacing of 0.200 inch. Fig. 3 shows a JEDEC Type TO-220AA version of the VERSAWATT package. The dimensions of this type of transistor package are such that it can replace the JEDEC TO-66 transistor package in a commercial socket or printed-circuit board without retooling.



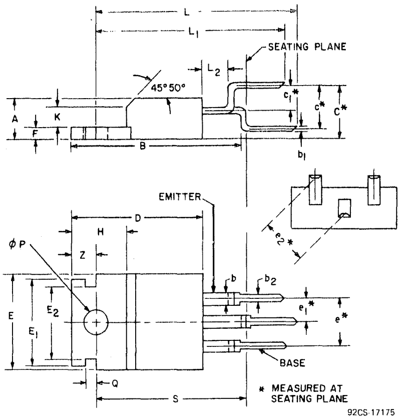
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	–
b	0.020	0.045	0.51	1.14	–
b_1	0.045	0.070	1.14	1.77	–
c	0.015	0.025	0.38	0.63	–
D	0.560	0.625	14.23	15.87	–
E	0.380	0.420	9.66	10.66	1
E_1	0.365	0.385	9.28	9.77	–
E_2	0.300	0.320	7.62	8.12	–
e	0.090	0.110	2.29	2.79	2
e_1	0.190	0.210	4.83	5.33	2
F	0.045	0.055	1.14	1.39	–
H_1	0.230	0.270	5.85	6.85	1
J_1	0.080	0.115	2.04	2.92	–
L	0.500	0.562	12.70	14.27	–
L_1	–	0.250	–	6.35	–
φP	0.139	0.147	3.531	3.733	–
Q	0.100	0.120	2.54	3.04	–
Z	0.040	0.060	1.02	1.52	–

92CS-17991R2

NOTES:

1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.250 – 0.255 in. (6.350 – 6.477 mm) from case.

Fig. 1 - Dimensional outline of the JEDEC TO-220AB in-line-lead VERSAWATT package.



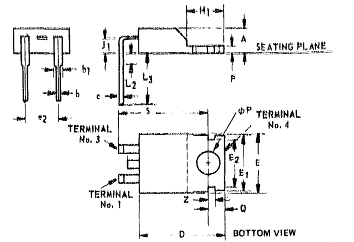
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	–
B		0.850	–	21.59	–
b	0.045	0.070	1.15	1.17	–
b_1	0.015	0.030	0.382	0.762	–
b_2	0.020	0.038	0.508	0.965	–
C	0.230	0.270	5.85	6.85	–
c	0.180	0.220	4.58	5.58	–
c_1	0.130	0.170	3.31	4.31	–
D	0.560	0.625	14.23	15.87	–
E	0.380	0.420	9.66	10.66	1
E_1	0.365	0.385	9.28	9.77	–
E_2	0.300	0.320	7.62	8.12	–
e	0.190	0.210	4.83	5.33	–
e_1	0.090	0.110	2.29	2.79	–
e_2	0.203	0.243	5.16	6.17	–
F	0.045	0.055	1.15	1.39	–
H	0.230	0.270	5.85	6.85	1
K	0.080	0.085	2.032	2.159	–
L	0.993	1.033	25.22	26.23	–
L_1	0.895	0.935	22.73	23.74	–
L_2	0.070	0.090	1.78	2.28	–
φP	0.139	0.147	3.531	3.734	–
Q	0.040	0.060	1.02	1.52	–
S	0.655	0.685	16.64	17.39	–
Z	0.100	0.120	2.54	3.04	–

Note:

92CS-17175

1. Tab contour optional within H and E.

Fig. 2 - Dimensional outline of VERSAWATT package designed for mounting on printed-circuit boards.



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	–
b	0.020	0.045	0.51	1.14	–
b_1	0.045	0.070	1.14	1.77	–
c	0.015	0.025	0.38	0.63	–
D	0.560	0.625	14.23	15.87	–
E	0.380	0.420	9.66	10.66	1
E_1	0.365	0.385	9.28	9.77	–
E_2	0.300	0.320	7.62	8.12	–
e_2	0.190	0.210	4.83	5.33	2
F	0.045	0.055	1.14	1.39	–
H_1	0.230	0.270	5.85	6.85	1
J_1	0.080	0.115	2.04	2.92	–
L_2	–	0.050	–	1.27	–
L_3	0.360	0.422	9.15	10.71	–
φP	0.139	0.147	3.531	3.733	–
Q	0.100	0.120	2.54	3.04	–
S	0.580	0.610	14.74	15.49	–
Z	0.040	0.060	1.02	1.52	–

92CS-17990R2

NOTES:

1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.050 – 0.055 in. (1.270 – 1.397 mm) below seating plane.

Fig. 3 - JEDEC TO-220AA VERSAWATT package designed for direct replacement of the JEDEC TO-66 package.

The pin-connection arrangement of thyristors supplied in TO-220AA packages, however, differs from that of thyristors supplied in conventional TO-66 packages so that some hardware changes are required to effect a replacement.

Lead-Forming Techniques

RCA VERSAWATT plastic packages are both rugged and versatile within the confines of commonly accepted standards for such devices. Although these versatile packages lend themselves to numerous arrangements, provision of a wide variety of lead configurations to conform to the specific requirements of many different mounting arrangements is highly impractical. However, the leads of the VERSAWATT in-line package can be formed to a custom shape, provided that they are not indiscriminately twisted or bent. Although these leads can be formed, they are not flexible in the general sense, nor are they sufficiently rigid for unrestrained wire wrapping.

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Handling and Mounting of RCA Molded-Plastic Transistors and Thyristors

Before an attempt is made to form the leads of an in-line package to meet the requirements of a specific application, the desired lead configuration should be determined, and a lead-bending fixture should be designed and constructed. The use of a properly designed fixture for this operation eliminates the need for repeated lead bending. When the use of a special-bending fixture is not practical, a pair of long-nosed pliers may be used. The pliers should hold the lead firmly between the bending point and the case, but should not touch the case. Fig. 4 illustrates the use of long-nosed pliers for lead bending. Fig. 4(a) shows techniques that should be avoided; Fig. 4(b) shows the correct method.

When the leads of an in-line plastic package are to be formed, whether by use of long-nosed pliers or a special bending fixture, the following precautions must be observed to avoid internal damage to the device:

1. Restrain the lead between the bending point and the plastic case to prevent relative movement between the lead and the case.
2. When the bend is made in the plane of the lead (spreading), bend only the narrow part of the lead.
3. When the bend is made in the plane perpendicular to that of the leads, make the bend at least 1/8 inch from the plastic case.
4. Do not use a lead-bend radius of less than 1/16 inch.
5. Avoid repeated bending of leads.

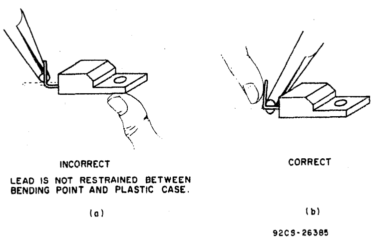
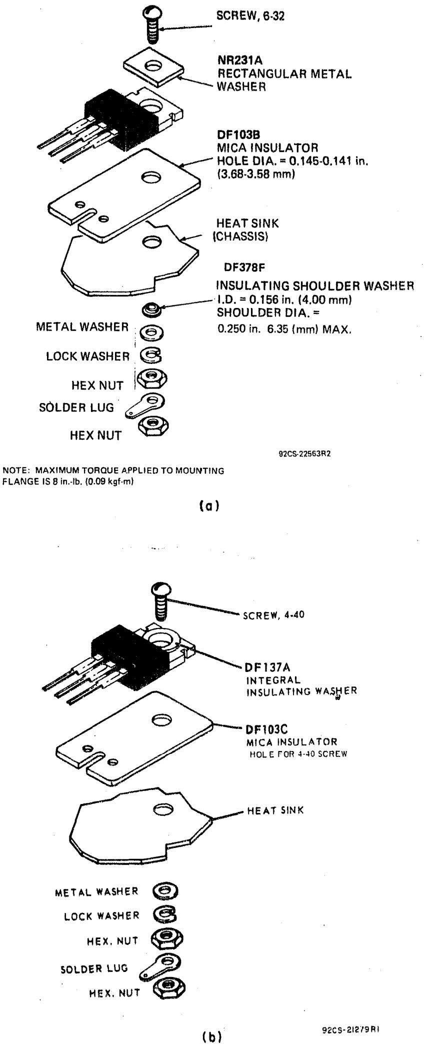


Fig. 4 - Use of long-nosed pliers for lead bending: (a) incorrect method; (b) correct method.

The leads of the TO-220AB VERSAWATT in-line package are not designed to withstand excessive axial pull. Force in this direction greater than 4 pounds may result in permanent damage to the device. If the mounting arrangement tends to impose axial stress on the leads, some method of strain relief should be devised. Fig. 2 illustrates an acceptable lead-forming method that provides this relief.

Wire wrapping of the leads is permissible, provided that the lead is restrained between the plastic case and the point of the wrapping. Soldering to the leads is also allowed; the maximum soldering temperature, however, must not exceed 235°C and must be applied for not more than 10 seconds at a distance greater than 1/8 inch from the plastic case. When wires are used for connections, care should be exercised to assure that movement of the wire does not cause movement of the lead at the lead-to-plastic junctions.



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in.-lb. (0.09 kgf-m)

(a)

(b)

Fig. 5 - Methods of mounting JEDEC TO-220AB in-line-lead version of RCA VERSAWATT transistors and thyristors.

Mounting

Figs. 5 through 8 show recommended mounting arrangements and suggested hardware for the VERSAWATT transistors. The rectangular washer (NR231A) shown in Fig. 5(a) is designed to minimize distortion of the mounting flange when the transistor is fastened to a heat sink. Excessive distortion of the flange could cause damage to the transistor. The washer is particularly important when the size of the mounting hold exceeds 0.140 inch (6-32 clearance). Larger holds are needed to accommodate insulating bushings; however, the holds should not be larger than necessary to provide hardware clearance and, in any case, should not exceed a diameter of 0.250 inch. Flange distortion is also possible if excessive torque is used during mounting. A maximum torque of 8 inch-pounds is specified. Care should be exercised to assure that the tool used to drive the mounting screw never comes in contact with the plastic body during the driving operation. Such contact can result in damage to the plastic body and internal device connections. An excellent method of avoiding this problem is to use a spacer or combination spacer-isolating bushing which raises the screw head or nut above the top surface of the plastic body, as shown in Fig. 8. The material used for such a spacer or spacer-isolating bushing should, of course, be carefully selected to avoid "cold flow" and consequent reduction in mounting force. Suggested materials for these bushings are diallphthalate, fiberglass-filled nylon, or fiberglass-filled polycarbonate. Unfilled nylon should be avoided.

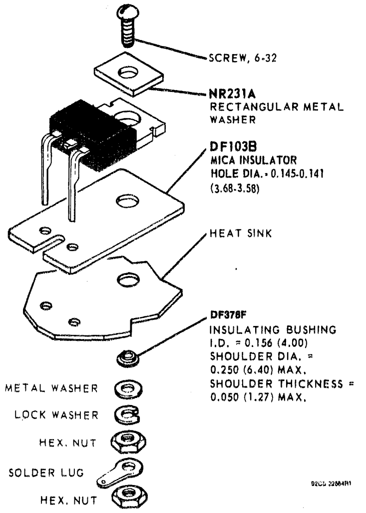


Fig. 6 - Chassis mounting of JEDEC TO-220AA version of RCA VERSAWATT devices.

Handling and Mounting of RCA Molded-Plastic Transistors and Thyristors

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Modification of the flange can also result in flange distortion and should not be attempted. The package should not be soldered to the heat sink by use of lead-tin solder because the heat required with this type of solder will cause the junction temperature of the package to become excessive.

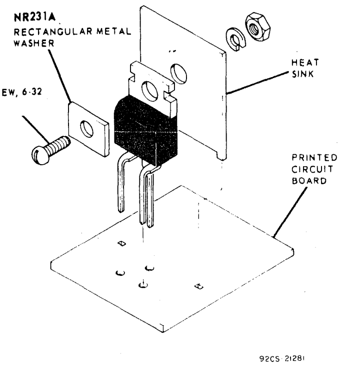


Fig. 7 - Method of mounting RCA VERSAWATT packages on printed-circuit boards.

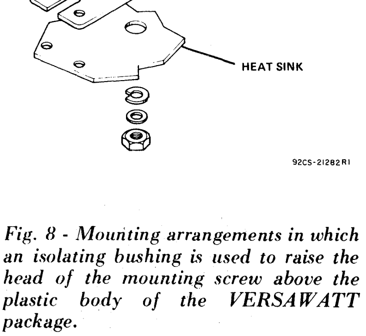


Fig. 8 - Mounting arrangements in which an isolating bushing is used to raise the head of the mounting screw above the plastic body of the VERSAWATT package.

The TO-220AA plastic package can be mounted in commercially available TO-66 sockets, such as UID Electronics Corp. Socket No. PTD-4 or equivalent. For testing purposes, the TO-220AB in-line package can be mounted in a Jetron Socket No. CD74-104 or equivalent. Regardless of the mounting method, the following precautions should be taken:

1. Use appropriate hardware.
2. Always fasten the transistor to the heat sink before the leads are soldered to fixed terminals.
3. Never allow the mounting tool to come in contact with the plastic case.
4. Never exceed a torque of 8 inch-pounds.
5. Avoid oversize mounting holes.
6. Provide strain relief if there is any probability that axial stress will be applied to the leads.
7. Use insulating bushings to prevent hot-creep problems. Such bushings should be made of diallphthalate, fiberglass-filled nylon, or fiberglass-filled polycarbonate.

Thermal-Resistance Considerations

The maximum allowable power dissipation in a solid-state device is limited by its junction temperature. An important factor to assure that the junction temperature remains below the specified maximum value is the ability of the associated thermal circuit to conduct heat away from the device.

When a solid-state device is operated in free air, without a heat sink, the steady-state thermal circuit is defined by the junction-to-free-air thermal resistance given in the published data on the device. Thermal considerations require that there by a free flow of air around the device and that the power dissipation be maintained below that which would cause the junction temperature to rise above the maximum rating. When the device is mounted on a heat sink, however, care must be taken to assure that all portions of the thermal circuit are considered.

Fig. 9 shows the thermal circuit for a heat-sink-mounted transistor. This figure shows that the junction-to-ambient thermal circuit includes three series thermal-resistance components, i.e., junction-to-case, $R_{\theta\ JC}$; case-to-heat-sink, $R_{\theta\ CS}$; and heat-sink-to-ambient, $R_{\theta\ SA}$. The junction-to-case thermal resistance of the various device types is given in the individual technical bulletins on specific types. The heat-sink-to-ambient thermal resistance can be determined from the technical data provided by the heat-sink manufacturer, or from published heat-sink nomographs. The case-to-heat-sink thermal resistance depends on several factors, which include the condition of the heat-sink surface, the type of material and thickness of the insulator, the type of thermal compound, the mounting torque, and the diameter of the mounting hold in the heat-sink.

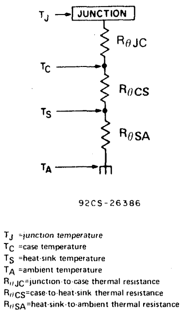


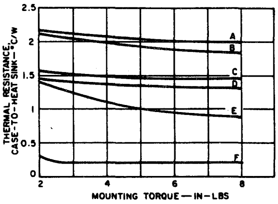
Fig. 9 - Thermal equivalent circuit for a transistor mounted on a heat sink.

Fig. 10 shows a set of curves of typical case-to-heat-sink thermal resistance of the VERSAWATT package as a function of mounting torque for several mounting arrangements. Curves A through D show typical case-to-heat-sink thermal resistance for the mounting arrangements shown in Fig. 5. Curves E and F are representative of a VERSAWATT package mounted over a heat-sink mounting hold that has a diameter of 0.140 inch (No. 6 screw clearance). Curve E shows the wide variation in thermal resistance with torque when the transistor is mounted dry. Curve F shows the effect on contact thermal resistance of a thin layer of Dow Corning No. 340 silicone grease applied between transistor and heat sink. For torques within the recommended range of 4 to 8 inch-pounds, contact thermal resistance is reduced to between 18 and 25 per cent of the dry values.

Operation of the transistor with heat-sink temperatures of 100°C or greater results in some shrinkage of the insulating bushing normally used to mount power transistors and thyristors. The degradation of contact thermal resistance (refer to Fig. 10) is usually less than 25 per cent if a good thermal compound is used.

AN-4124

Handling and Mounting of RCA Molded-Plastic Transistors and Thyristors



CURVE	MOUNTING ARRANGEMENT FIGURE	HEAT SINK HOLE DIA. (IN.)	MICA THICKNESS (MILS)	THERMAL COMPOUND
A	5 (a)	.250	4	Dow Corning No.340
B	5 (b)	.113	4	Dow Corning No.340
C	5 (a)	.250	2	Dow Corning No.340
D	5 (b)	.113	2	Dow Corning No.340
E	—	.140	None	None
F	—	.140	None	Dow Corning No.340

Fig. 10 — Typical case-to-heat-sink thermal resistance as a function of mounting torque for an RCA VERSAWATT package.

During the mounting of RCA molded-plastic solid-state power devices, the following special precautions should be taken to assure efficient heat transfer from case to heat sink:

1. Mounting torque should be between 4 and 8 inch-pounds.
2. The mounting holes should be kept as small as possible.
3. Holes should be drilled or punched clean with no burrs or ridges, and chamfered to a maximum radius of 0.010 inch.
4. The mounting surface should be flat within 0.002 inch/inch.
5. Thermal grease (Dow Corning 340 or equivalent) should always be used (on both sides on the insulating washer if one is employed).
6. Thin insulating washers should be used (thickness of factory-supplied mica washers ranges from 2 to 4 mils).
7. A lock washer or torque washer should be used, together with materials that have sufficient creep strength to prevent degradation of heat-sink efficiency during life.

Cleaning After Mounting

A wide variety of solvents is available for degreasing and flux removal. The usual practice is to submerge components in a solvent bath for a specified time. From a reliability standpoint, however, it is extremely important that the solvent, together with other chemicals in the solder-cleaning system (such as flux and solder covers), not adversely affect the life of the component. This consideration applies to all non-hermetic and molded-plastic components.

It is, of course, impractical to evaluate the effect on long-term transistor life of all cleaning solvents, which are marketed under a variety of brand names with numerous additives. These solvents can, however, be classified with respect to their component parts, as either acceptable or unacceptable. Chlorinated solvents tend to dissolve the outer package and, therefore, make operation in a humid atmosphere unreliable. Gasoline and other hydrocarbons cause the inner encapsulant to swell and damage the package. Alcohols are acceptable solvents and are recommended for flux removal whenever possible. Examples of suitable alcohols are methanol, isopropanol, and special denatured ethyl alcohols, such as SDA1, SDA30, SDA34, and SDA44.

When considerations such as solvent flammability are of concern, selected freon-alcohol blends are usable when exposure is limited. Solvent such as the following should be safe for normal flux-removal operations, but care should be taken to assure their suitability in the cleaning procedure:

Freon TE
Freon TE-35
Freon TP-35 (Freon PC)

The solvents may be used for a maximum of 4 hours at 25°C or for a maximum of 1 hour at 50°C.

Care must also be used in the selection of fluxes in the soldering of leads. Rosin or activated rosin fluxes are recommended, while organic or acid fluxes are not. Examples of acceptable fluxes are:

Alpha Reliaros No. 320-33
Alpha Reliaros No. 346
Alpha Reliaros No. 711
Alpha Reliafoam No. 807
Alpha Reliafoam No. 809
Alpha Reliafoam No. 811-13
Alpha Reliafoam No. 815-35
Kester No. 44

If the completed assembly is to be encapsulated, the effect on the molded-plastic transistor must be studies from both a chemical and a physical standpoint.

Note:
Silicone-oil fluids that come into direct physical contact with the molded-plastic packages may react chemically with and cause damage to the packages. Such fluids, therefore, are unacceptable as baths for degreasing and flux removal. Silicone oils contained in thermal compounds or other materials used in mounting the molded-plastic packages, however, do not cause damage to the packages provided the bleed rate of such materials is not excessive. For example, in mounting arrangements that employ an insulating washer, a thermal-grease heat-sink compound, such as Dow Corning No. 340 or equivalent, for which the bleed rate does not exceed 0.5 per cent after 24 hours at 200°C is recommended for use on both sides of the insulating washer.

Application Note Abstracts

Power Transistors

AN-3565 ....4 pages
A 100-Watt, 18-kHz Inverter Using RCA-2N5202 Silicon Power Transistors
A two-transistor, two transformer inverter that demonstrates the excellent switching capabilities of the RCA-2N5202 power transistor is described.

AN-4124 ....8 pages
Handling and Mounting of RCA Molded-Plastic Transistors and Thyristors
Detailed guidelines for handling and mounting plastic-packaged RCA power transistors and thyristors are given. Types of packages and suggested mounting hardware to accommodate various mounting arrangements are described. Recommendations are made for handling packages during the forming of leads. Various mounting arrangements. thermal considerations, and cleaning methods are described. This information is intended to supplement the data on electrical characteristics, safe operating area, and performance capabilities in the technical bulletin for each type of plastic-packaged transistor or thyristor.

AN-4509 ....8 pages
Compact 5-Volt Power Supplies Using High-Voltage Power Transistors
The use of low-cost, industrial-type, high voltage power transistors and fast-recovery rectifiers to achieve size and weight reductions and efficiency improvements in 5-volt dc power supplies with output currents of 50 amperes or more are discussed. The supplies described, like those used in high-reliability aerospace applications, use switching rather than dissipating regulators to eliminate the need for a 60-Hz power transformer and heat sinks for the transistors. A complete switching-regulator power supply is described in detail.

AN-4558 ....12 pages
A regulated constant-voltage power supply that uses integrated circuits and a rugged hometaxial-base transistor to attain high output-power capability is described. A 20-volt, 3-ampere supply that uses a single RCA-2N3055 pass transistor is described in detail; the discussion includes circuit descriptions, operating characteristics, component specifications, and suggestions for layout and construction. Thermal-fatigue effects and safe operating conditions for power transistors are considered. Guidance is provided for those who may want to develop a similar circuit.

AN-4573 ....6 pages
Testing for Forward-Bias Second Breakdown in Power Transistors
The design of a non-destructive forward-bias second-breakdown test facility that determines the forward-bias second-breakdown safe-operating locus for power transistors is described. Detailed schematic diagrams of test circuits that can be used to test devices with collector-current ratings up to 2.5 amperes and sustaining collector-to-emitter voltage [V_{CEO}(sus)] ratings up to 300 volts, or with ratings to 5 amperes and 100 volts, are given.

AN-4612 ....4 pages
Thermal-Cycling Rating System for Silicon Power Transistors
The basic causes of thermal fatigue in silicon power transistors are analyzed, and a rating chart that makes it possible for a circuit designer to avoid such failures during the operating life of his equipment is described. Examples are provided on the use of this chart to determine the transistor operating conditions required to assure a desired thermal-cycling capability and to determine whether the thermal-cycling capability is adequate for the requirements of a given application.

AN-4673 ....6 pages
A 750-Watt Three-Phase Frequency Converter
A frequency converter with an output frequency ranging from 380 Hz to 1250 Hz that delivers up to 750 watts of three-phase power at 120 or 208 volts rms is described. The circuit, useful in military equipment that uses three phase, 400-Hz power, and industrial plants and laboratories that require power at a variety of low frequencies, makes use of a three-phase bridge inverter supplied from a rectified line; the input can be single-phase or three-phase, 120 volts or 208 volts, at any frequency from 47 Hz to 1250 Hz. The RCA-2N5805 power transistor is used in the circuit.

AN-4783 ....8 pages
Thermal-Cycling Ratings of Power Transistors
A testing program used to determine the capability of the design of an RCA-2N3055 power transistor to withstand thermal cycling over a wide range of operating conditions is described. A sufficient number of tests were performed to verify a rating chart that can be applied by an equipment designer to any practical operating condition. The discussion covers a brief description of thermal fatigue, a method of "scaling the environment" to determine the proper test conditions, specialized test equipment and techniques that assure that the proper stresses were applied to the transistor, and the test results and predicted-capability chart for the transistor.

AN-6145 ....8 pages
A Test Set for Nondestructive Safe-Area Measurements Under High-Voltage, High-Current Conditions
The determination of the safe-operating area of power transistors at high volt/ampere products under pulsed and repetitive-pulsed conditions, nondestructively, is made possible by the test set described in this Note. System philosophy, design, construction, and operation are detailed.

AN-6163 ....12 pages
Quantitative Measurement of Thermal-Cycling Capability of Silicon Power Transistors
This Note discusses the methods used to test the thermal-cycling capability of power transistors. A brief description of thermal fatigue, application requirements, and rating charts is given. A detailed discussion of the practical design and construction of thermal-cycling racks is also included along with actual test conditions for various power transistor types. Acceleration factors, failure indicators, failure mechanisms, and real-time control of thermal-cycling capability of factory products are discussed. Some information is also given on hermetic versus plastic-package thermal-cycling reliability.

AN-6195 ....8 pages
A Switching Regulator Using An RCA p-n-p Power Darlington Transistor
A 20-kHz switching regulator that employs an RCA 8350B, a p-n-p Darlington transistor, and that operates from a 28-volt supply is described. The regulator has a regulated output between 4 and 16 volts dc and features overload protection that limits the current to about 11 amperes. The regulator does not operate at a fixed clock frequency, but is free-running.

AN-6215 ....6 pages
Interpretation of Voltage Ratings for Transistors
The basic voltage-breakdown mechanisms of power transistors and the relationship of these mechanisms to external circuits are described—transistor voltage breakdown is a function of both individual device characteristics and associated circuits. The mechanisms described are used to explain the various types of voltage ratings used by transistor manufacturers.

AN-6249 ....6 pages
Real-Time Controls of Silicon Power-Transistor Reliability
This Note compares the traditional, classical approach to the reliability-assurance testing of power transistors with a newer classification of testing: Real-Time Control, RTC. The classical approach is commonly referred to as Group B, and involves a series of mechanical, environmental, and life stress tests. RTC involves a continuous, systematic evaluation and control in "real time" of basic, potential failure mechanisms. It is an important supplement to a total program of reliability assurance.

AN-6272 ....6 pages
Characteristics of RCA Monolithic Power Darlingtons
The design and application of RCA monolithic power Darlington transistors is described. The Darlington circuit has been in use for some time in applications where high beta is needed, but has only recently been available as a monolithic device. The RCA Power Darlington series 2N6385 consists of n-p-n circuits that can be driven directly from an integrated circuit and that operate at currents up to 10 amperes and voltages ranging from 40 to 80 volts.

AN-6281 ....6 pages
Accurate Measurement of Sustaining Voltage of Power Transistors — A Pulsed-Breakdown Test Set
Several techniques for the measurement of the primary (sustaining) breakdown voltage of power transistors are in common use today. The characteristics and limitations of these test methods frequently make rapid and accurate sustaining-voltage readings on power transistors difficult or impossible. The test set described in this Note fills the need for accurate, laboratory-type, sustaining-voltage measuring equipment, although circuitry used in the test set design may be adapted to high-speed testing equipment as well. A complete parts list and calibration sequence are given.

AN-6297 ....2 pages
Biasing Circuit for the Output Stage of a Power Amplifier — The V_{BE} Multiplier
A biasing circuit, the V_{BE} multiplier, for the output stage of a power amplifier is described. The V_{BE} multiplier provides proper bias for the output transistors of the amplifier under all operating conditions.

Application Note Abstracts

AN-6320 .... 8 pages

Radiation-Hardness Capability of RCA Silicon Power Transistors

The types of radiation damage that might be experienced by a power device and the tests used to determine the design most effective in preventing these types of damage are described.

AN-6330 .... 12 pages

A Safe-Area Rating System for Power Inverters Handling Capacitive and Inductive Loads

Although transistor power inverters have classically been evaluated with resistive loads, the reliability of practical inverters often depends on inductive and capacitive loads and associated starting transient considerations. This Note describes a safe-area rating system for transistors and relates this system to self-excited single-transformer, self-excited double transformer, and driven inverters operating into resistive, capacitive, and inductive loads under both steady-state and starting conditions.

AN-6400 .... 16 pages

Operating Conditions Experienced by Transistors in TV Horizontal-Deflection Circuits

This Note is a compilation of equations used to calculate the operating conditions experienced by the output transistor in various types of deflection circuits, circuits that provide horizontal (line) deflection of the electron beam in TV picture tubes employing magnetic deflection yokes. The circuits treated include direct-drive circuits and those in which taps and auxiliary windings on the flyback transformer are employed to provide impedance transformation and yoke voltage reduction. Derivations of the various equations, the simplified as well as the rigorous forms, are provided in Appendixes. Relationships for calculating the "worst case" voltage conditions are given. Operating conditions as measured in experimental circuits are compared with those calculated by means of the equations provided in this Note.

AN-6423 .... 8 pages

Thirty-Watt (RMS) True Complementary — Symmetry Audio Amplifier Using BDX33 and BDX34 Darlington Transistors

Monolithic-silicon Darlington transistors designed for low- and medium-frequency power applications are especially suitable for audio-output applications. This Note describes the design and performance of an audio amplifier that incorporates such devices.

AN-6425 .... 8 pages

Automatic Analyzer for Determining Safe Operating Area of Power Transistors

The safe operating area is one of the most important ratings of a power transistor, yet only a few methods exist to evaluate it. The method presented in this Note allows description of the safe operating area for both dc and pulse operation without subjecting the transistor to breakdown. Botn n-p-n and p-n-p transistors in hermetic or plastic packages can be evaluated, and the complete safe-area curve can be automatically described in a short time.

AN-6432 .... 8 pages

2-Kilowatt Stepped Sine-Wave Inverter

Recent advances in high-power semiconductor technology, complemented by the capabilities of existing digital integrated circuits, have made possible the economical design of a stepped sine-wave inverter in the multikilowatt range. This Note describes the use of the 2N5578 power transistor in a 2-kilowatt, 60-Hz, stepped sine-wave inverter.

AN-6605 .... 16 pages

Application of RCA Power Devices in Off-Line, High-Frequency Inverter/Converter Circuits

The current trend in power inverter/converter design is to use high-frequency switching techniques and direct operation off the available utility lines (i.e., 110 or 220 volts). The use of higher operating frequencies reduce the magnetic materials required and the size of the filter capacitors. This Note discusses the use of RCA power transistors and SCR's in selected high-frequency inverter/converter applications.

AN-6624 .... 16 pages

Voltage Limitations of Power Transistors

This Note summarizes the primary factors that determine the voltage limitations of power transistors used in common-emitter circuits with typical base-to-emitter circuit terminations. The material presented defines terms and the various operating regions of the transistor as shown in typical volt-ampere characteristics, develops the analytic relations defining operation in each of the regions, and relates each of the operating regions to the physical actions taking place within the transistor structure.

AN-6679 .... 32 pages

Theoretical Relationships in Capacitive-Discharge Ignition Systems

There has been both confusion and exaggeration concerning the electrical performance of capacitive-discharge, or CD, ignition systems. The theoretical relationships developed in this Note allow the analysis of the fundamentals of this type of ignition system and an evaluation of the maximum performance levels attainable. Three types of systems, the diode-clamped system, the free-ringing system (no diode clamp) and the free-ringing single-cycle system are analyzed and compared.

AN-6688 .... 20 pages

A Practical Approach to an Audio-Amplifier Design

This Note discusses general considerations, design requirements, and performance for a 20-watt, hi-fi amplifier.

AN-6741 .... 8 pages

RCA 15-Ampere SwitchMax Power Transistors in a 340-Watt 20kHz Flyback Converter

This Note describes the use of the RCA 2N6676, a 15-ampere SwitchMax power transistor, as a driven pulse-width-modulated fly-back-converter stage, the final power-output stage, in a 20-kHZ off-line power converter that provides 340 watts of output power. Adjunct circuitry, such as the driver stage, reverse-bias amplifier, and overvoltage and overcurrent protection circuits, are also discussed.

AN-6743 .... 16 pages

900-Watt, Off-the-Line, Half-Bridge Converter Using Only Two 15-Ampere 'SwitchMax' High-Voltage Power Transistors

To examine and demonstrate the capabilities of RCA's new series of 'SwitchMax' power transistors in a typical switching application, a 900-watt half-bridge converter was constructed and studied. The circuit switches at a 20-kilohertz rate and with minimal alterations can operate from either 120 or 240 volts. It was built using conventional circuitry but in a non-compact modular format so that it would be easily accessible for instrumentation connections and component or design alteration. The power switches used are the RCA-2N6678 'SwitchMax' 15-ampere [$I_{CE(sat)}$] 450-volt (V_{CEX}) high-speed transistors.

AN-6744 .... 6 pages

Low-Cost High-Power Audio Amplifiers Using the RCA 8638 and RCA 9116 Transistor Families

This Note discusses the basic considerations and requirements for design of the output stage for class AB audio amplifiers using devices selected from the RCA 8638 and RCA9116 families, depending on the output desired. Operation with load impedances other than eight ohms is also discussed for the various power categories.

AN-6760 .... 12 pages

A 230-Watt, 40-kHz, Off-Line Forward Converter Using One SwitchMax Transistor

The increased availability of reliable high-current, high-voltage, fast switches, such as RCA's SwitchMax series devices, and the development of functional pulse-width-modulating integrated circuits have greatly reduced the cost of the off-line medium-power, high-frequency forward converters used in the production of precisely conditioned low-voltage power. This Note describes the possibilities of the forward-converter circuit and demonstrates the performance of the RCA 2N6673 SwitchMax transistor in a 230-watt 15-volt 15-ampere off-line converter operating at 40 kHz from a 120-volt 60-cycle line.

AN-6800 .... 6 pages

A Test Set for Measuring h_{fe} and f_T as a Function of Collector Current

This Application Note describes a technique and test circuit, the Swept-I_C Test Set, that measures the h_{fe} characteristic of a power transistor at a fixed test frequency while the collector current, I_C, is "swept," or varied, repetitively, at a linear rate, from zero to a predetermined maximum.

AN-6819 .... 8 pages

The SwitchMax Transistor

The SwitchMax transistor families, designed for high-frequency off-line switching power supplies, converters, switching regulators and pulse-widthmodulated amplifiers, are rated for 5, 10, 15, and 25-ampere operating currents. They have high safe-operating-area (SOA) ratings in both the forward-bias and inductive turn-off (clamped $E_{S/b}$) modes. These capabilities are combined with V_{CEO} ratings of up to 500 volts, and V_{CEV} ratings to 1000 volts.

AN-6820 .... 8 pages

Typical Switching Speed Versus Temperature Data for SwitchMax Transistors Under Non-JEDEC Conditions

Since the introduction of the SwitchMax power-transistor line in 1978, a great amount of study of device behavior in special situations has resulted in the accumulation of a large volume of switching-speed data on hundreds of devices. This Note distills the data into a qualitative picture of SwitchMax-device performance at other than JEDEC-registered switching-test conditions.

Application Note Abstracts

AN-6827 .... 4 pages

40-Watt Automotive Audio-Power Booster

In recent years, there has been a growing demand for higher power-output capability in automotive tape and audio systems. One of the factors limiting output capability is the 12-volt automotive-system voltage. This Note describes the combination of a dc-to-dc regulated up-converter and a simple and economical output amplifier that will deliver 40 watts into a 4-ohm load.

AN-6828 .... 4 pages

In-Socket, High-Temperature, Dynamic Testing of Power Transistors

The measurement, at elevated temperatures, of dynamic parameters such as switching time, is a problem in in-chamber facilities because of the critical nature of lead length and dress. A solution to this problem, the approach described in this Note, involves the location of a source of heat at the socket of the device under test. This "hot-socket" method, in which controlled amounts of power are supplied to the socket heaters, is adaptable to curve-tracer measurements where IR drops are critical at high current. Kelvin connections are used at the collector and emitter terminals, mandating a five-terminal socket.

AN-6857 .... 4 pages

20-Ampere Monolithic-Darlington Power Transistors in a Sine-Wave-Inverter Output Stage

This Note describes the use of the type 2N6284 power transistor, a 20-ampere, n-p-n, monolithic darlington, and its complement, the type 2N6287 (p-n-p), as low-cost high-output-power single-ended power inverters. Either transistor can be used with equivalent performance results; the choice of type is dependent only upon the polarity of the dc voltage supply available.

An-6866 .... 6 pages

Practical Aspects of Voltage-Breakdown Testing of Power Transistors and Darlingtons

In specifying voltage-breakdown requirements for power transistors and power darlingtons, a customer will choose a limit which he feels will protect his application. However, during the testing of the product to verify this limit, either the manufacturer or the customer may damage the device. This Note reviews the common methods of measurement of avalanche breakdown voltage. It points out why damage occurs to power transistors as a result of these measurements and suggests methods that may reduce the incidence of damage. The Note also points out that avalanche breakdown testing is performed at voltages beyond the maximum ratings of the device and that such testing should only be undertaken after all necessary precautions have been taken, and with a complete understanding of the risks.

AN-6896 .... 8 pages

Safe Operating Area and the Design of Reliable Audio Power Amplifiers

The reilability of an audio power amplifier can depend on the designer's understanding of the Safe Operating Area, SOA, of the transistors employed, and his freedom to implement safeguards against the failure of those devices. The designer can overcome the limits placed by economics and other factors on this freedom, while assuring optimum reliability and performance from his designs, by working within the constraints imposed by the SOA ratings. This Note discusses the use of these ratings through example, and the protection circuits required in a proper design.

AN-6904 .... 12 pages

One-Hundred-Watt True-Complementary-Symmetry Audio Amplifier Using BD750 and BD751 Silicon Transistors

The BD750 and BD751 series of power transistors are complementary p-n-p and n-p-n series, respectively, selected from the ballasted epitaxial-base silicon transistor families, RCA8638 and RCA9116. They feature high-dissipation capability, low saturation voltage, maximum safe-operating area, a gain-bandwidth product (f_T) higher than 4 MHz, and high gain at high current levels. The transistors are especially suitable for use in the output stage of true-complementary high power audio amplifiers.

Power Hybrid Circuits

AN-4483 .... 6 pages

General Application Considerations for the RCA-HC2000H Hybrid Linear Power Amplifier

This Note briefly describes the RCA HC-2000H hybrid linear amplifier and discusses such operating considerations as dc and ac power dissipation, efficiency as a function of frequency, protection against excessive load variations and reactive loads, and heat-sink requirements.

AN-4782 .... 6 pages

General Application Considerations for the RCA-HC2000H Power Hybrid Operational Amplifier

The RCA-HC2000H is a power hybrid operational amplifier that can deliver 100 watts rms to a 4-ohm load at a maximum peak current of 7 amperes. It operates from a maximum power-supply voltage of 75 volts (single ended) or ±37.5 volts (split). The low-profile package is light in weight and can be used with either printed-circuit-board connections or commercially available 0.110-inch quick-disconnect push-on terminals. This Note briefly describes the HC2000H and discusses some general application considerations for this amplifier.

Thyristors (SCR's and Triacs)

AN-3551 .... 6 pages

Circuit Factor Charts for RCA Thyristor Applications

In the design of circuits using thyristors, it is often necessary to determine the specific values of peak, average, and rms current flowing through the device. This Note contains charts that show several current ratios as functions of conduction and firing angles for some SCR and triac circuits. Examples are given of the use of these charts in the design of half-wave, full-wave ac, full-wave dc, and three-phase half-wave circuits using RCA thyristors. Current and voltage waveforms for the various circuits are included, as are curves of per-cent ripple in load current and voltage.

AN-3659 .... 6 pages

Application of RCA Silicon Rectifiers to Capacitive Loads

This Note describes a simplified rating system that allows designers to calculate the characteristics of capacitive-load rectifier circuits quickly and accurately. The effect of the addition of a series limiting resistance to such circuits and the importance of the ratio of the limiting resistance to capacitive reactance are described; curves of rectifier current ratios are presented as functions of the effective ratio. Typical design examples are given, and output-ripple considerations are discussed.

AN-3697 .... 8 pages

Triac Power-Control Applications

This Note describes triac operating characteristics and provides guidance in the use of triacs in specific applications: incandescent lamp controls, light-activated controls, motor controls, heat controls, and a proportional integral-cycle control.

AN-3822 .... 6 pages

Thermal Considerations in Mounting of RCA Thyristors

Three simple rules to aid the designer in determining heat-sink specifications for a given application are provided. Power dissipation and heat-sink area, the mounting of thyristors on heat-sinks, typical heat-sink configurations, and chassis-mounted heat-sinks are discussed.

AN-4124 .... 8 pages

Handling and Mounting of RCA Molded-Plastic Transistors and Thyristors

Detailed guidelines for handling and mounting plastic-packaged RCA power transistors and thyristors are given. Types of packages and suggested mounting hardware to accommodate various mounting arrangements are described. Recommendations are made for handling packages during the forming of leads. Various mounting arrangements, thermal considerations, and cleaning methods are described. This information is intended to supplement the data on electrical characteristics, safe operating area, and performance capabilities in the technical bulletin for each type of plastic-packaged transistor or thyristor.

AN-4242 .... 16 pages

A Review of Thyristor Characteristics and Applications

This Note describes the operation, ratings, characteristics and typical applications of thyristors. The basic operation of a thyristor is explained by use of a two-transistor analogy. The significance of voltage and temperature ratings is pointed out. Thyristor gate characteristics, switching behavior, and triggering techniques are described. Use of thyristors in typical power-control applications is discussed.

AN-4537 .... 8 pages

Thyristor Control of Incandescent Traffic-Signal Lamps

This Note discusses the use of thyristors in the control of traffic signals. The thyristor most applicable to this application is the triac, which can carry the electrical power required for incandescent traffic-light bulbs, yet can be gated by the low-power signals from electronic control timers or monitoring computers. In addition, the triac is able to handle the large transient currents that result from cold filament turn-on (inrush) and filament rupture (flashover). Triac operation, stresses on triacs in operation with incandescent lamps, and a number of triac circuits for control of incandescent lamps in traffic signal applications are discussed.

Application Note Abstracts

AN-4745 ....6 pages
Analysis and Design of Snubber Networks for dv/dt Suppression in Thyristor Circuits

When a triac is used to control an inductive load, voltages with high rates of change (dv/dt) can be generated that can cause a non-gated turn-on of the triac. The result is a loss of control of power to the load. The simplest method of suppressing this dv/dt stress is to place a series RC network across the main terminals of the triac. The design of this network, commonly called a snubber network, must take into account the peak voltage that can be allowed in the circuit and the maximum dv/dt stress that the device can withstand. This Note analyzes the RC network design and contains graphs that allow a designer to select a snubber to fit a given application.

AN-6054 ....6 pages
Triac Power Controls for Three-Phase Systems

The growing demand for solid-state switching of ac power in heating controls and other industrial applications has resulted in the increasing use of triac circuits in the control of three-phase power. This Note explains a basic approach to the design of triac control circuits for use in the switching of three-phase power. The basic design rules employed in this approach are outlined, an integrated-circuit zero-voltage switch specifically intended for use in triac triggering is briefly described, and the necessity for, and methods of isolation of, the dc logic circuitry in power controls for three-phase systems are pointed out. Recommended configurations are then shown for power-control circuits intended for use with both inductive and resistive balanced three-phase loads, and the specific design requirements for each type of loading condition are discussed.

AN-6096 ....8 pages
Solid-State Approaches to Cooking-Range Control

As a result of decreasing semiconductor costs, advanced system-cost analysis by appliance manufacturers, and increased consumer consciousness, various solid-state range-control designs can be applied in today's appliance market. This Note presents various solid-state design approaches available to the range-control designer.

AN-6141 ....6 pages
Power Switching Using Solid-State Relays

Solid-state relays make use of a semiconductor device for control of ac or dc power. Since, in most ac applications, the semiconductor element chosen for power control is the triac, this Note describes the triac as a power-switching element. Advantages and disadvantages of the active element over the electromechanical relay are discussed in general terms. Basic parameters, such as surge in-rush capability, transient-voltage ratings, suppression network, turn-off consideration and the different modes of triac gating are also discussed. AC power control is covered by various circuit designs for ON/OFF control, zero-voltage switching, and line-voltage isolation.

ICAN-6182 ....28 pages
Features and Applications of RCA Integrated-Circuit Zero - Voltage Switches (CA3058, CA3059 and CA3079)

RCA-CA3058, CA3059 and CA3079 zero-voltage switches are monolithic integrated circuits designed primarily for use as trigger circuits for thyristors in ac power-control and power-switching applications. These integrated-circuit switches operate from ac input voltages of 24, 120, 208 to 230, or 277 volts at 50, 60, or 400 Hz. Zero-voltage switches trigger the thyristors at zero-voltage points in the supply-voltage cycle. Consequently, transient load-current surges and radio-frequency interference are substantially reduced. Zero-voltage switches also reduce the rate of change of on-state current (di/dt) in the thyristor being triggered and can be adapted for use in a variety of control functions by use of an internal differential comparator to detect the difference between two externally developed voltages.

AN-6286 ....8 pages
Latching, Gate-Trigger Circuits Using Thyristors for Machine Control Applications

This Note describes a variety of approaches to the development of a solid-state, latching gate drive for the control of ac loads; the solid-state device used is the thyristor. The solid-state circuits described have fewer undesirable characteristics than electro-mechanical devices and are smaller and lighter.

AN-6288 ....2 pages
Thyristors in Capacitive Discharge (CD) Ignition Systems

This Note describes the requirements of small-engine ignition systems (those deriving electrical energy from a flywheel alternator system), automotive or battery-powered systems, and the ac line-operated igniters. The merits of both capacitive and inductive systems are compared. Both systems are described in terms of performance and limitations. Practical circuits are shown.

AN-6438 ....24 pages
Surge Capability of SCR's, Triacs, and Rectifiers

This Note provides the designer with an easy way to derive, from the published sinusoidal capability of any semiconductor, its triangular surge capability for stress durations between 0.5 and 20 milliseconds, and thereby helps him select the most suitable fuse to protect the semiconductor of interest.

AN-6452 ....16 pages
A New Practical Fuse-Thyristor Coordination Method

This Note describes the possibilities of protecting a semiconductor by fusing—when and how a fuse can be used and how much protection is afforded. Cases for which fuse protection is not possible, or for which only partial protection is feasible are also discussed. Fuse selection methods are described.

AN-6456 ....12 pages
Characteristics and Applications of RCA Fast-Switching ASCR's

Silicon controlled rectifiers (SCR's) used in applications such as inverters, choppers, and radar pulse modulators at switching frequencies up to 30 kHz require high di/dt and dv/dt capabilities and very short turn-on and turn-off times. This Note explains SCR characteristics required for fast-switching applications, describes a new type of fast-switching SCR, the asymmetrical silicon controlled rectifier (ASCR), and discusses the application of this new type of SCR in induction cooking ranges.

AN-6605 ....16 pages
Application of RCA Power Devices in Off-Line, High-Frequency Inverter/Converter Circuits

The current trend in power inverter/converter design is to use high-frequency switching techniques and direct operation off the available utility lines (i.e., 110 or 220 volts). The use of higher operating frequencies reduce the magnetic materials required and the size of the filter capacitors. This Note discusses the use of RCA power transistors and SCR's in selected high-frequency inverter/converter applications.

AN-6628 ....8 pages
Design and Application of High-Power Ultrasonic Converters Using ASCR's

Asymmetrical SCR's with maximum turn-off times of 4 microseconds make possible high-power ultrasonic converters operating at 10 kilowatts at a very competitive price. This Note describes the ASCR structure, explains the basic design principles of an ASCR converter, and discusses the application of this converter to electronic arc-welding equipment and industrial power supplies.

AN-6687 ....6 pages
Latching Voltage and Current in Thyristors

Triacs are normally used for the switching of ac load current in on-off applications and for phase control of power to a load. Their design permits gating signals of positive or negative polarity with respect to main terminal one to initiate turn-on of load currents of either polarity. However, the gate triggering sensitivity and turn-on requirements in each of the four modes are normally not equal, and there may be preferred modes of operation

The purpose of this Note is to describe the sensitivity levels of each mode relative to turn on, and to relate preferred modes of operation of RCA triacs to circuit applications.

AN-6689 ....12 pages
Circuit-Commutated Turn-Off Time of Thyristors

Thyristor turn-off is one of the most difficult semiconductor parameters to determine because of its strong dependency on many variables, such as junction temperature, gate bias, and anode-voltage and anode-current waveforms. Because of this strong dependency, it makes no sense to specify the turn-off time of a thyristor without specifying precisely the conditions under which that time was determined. But it is impossible to choose a set of conditions that will match the interests of all present or potential purchasers of the device. Therefore, the need for a new concept for measuring the circuit commutated turn-off time of thyristors.

The turn-off-time measurement method described in this Note is very different from the conventional, complex turn-off-time specification mentioned above; it is a very basic method intended to measure the turn-off time as a simple parameter under conditions that are not critical for measurement precision and that can be easily reproduced by any thyristor user. Data are provided to assure correct interpretation of the new measurement, inherent turn-off-time. T_{Qi}

AN-6745 ....12 pages
Operating Characteristics of Self-Commutated Sinewave SCR Inverters

This Application Note is a guide for developing typical SCR inverters, empirically, through the use of waveform analysis, not only to characterize device operation, but also to detect potential failure modes. Both single-ended and double-ended inverters are discussed.

Application Note Abstracts

AN-6783 .... 12 pages

ASCR's in Welding-Equipment Inverters

Present state-of-the-art SCR inverters for welding equipment are forced to operate at audible frequencies of 15 kHz or lower because of the slow (20 μs) turn-off capability of the high-current SCR's. This low frequency is also required as a means of minimizing the switching dissipation that results from the slow turn-on of conventional gold-doped SCR's. With the development of the ASCR by RCA, this frequency barrier has been raised significantly in that resonant inverters, using the S7310 ASCR, are now capable of delivering 4 to 5 kilowatts at frequencies as high as 30 kHz. By combining the output of several such systems, the power capability can be increased to tens of kilowatts. A discussion of the developments that have made these improvements possible follows a review of the characteristics required of an SCR in a high-frequency inverter.

AN-6856 .... 12 pages

Regulating the SCR Inverter Power Supply

The development of the ASCR (asymmetrical silicon controlled rectifier) has significantly raised the power and frequency capability of SCR inverters. Power outputs of more than 1,500 watts have been achieved at 50 kHz with an efficiency of 75 percent. At 20 kHz, 4,500 watts was produced at 88 percent efficiency. These levels have been reached with sinusoidal inverters using the S7310M ASCR.

As a result of this newly developed frequency capability, inverter power supplies using SCR's can now be regulated as simply as those using transistors. For example, a 1,200-watt power supply was maintained at a constant 60-volt output while the line voltage was varied from 100 volts to 136 volts and the load current from 3 to 20 amperes. These variations were made by modulating the trigger frequency of a sinusoidal ASCR inverter that had a pulse length of approximately 8 microseconds. The repetition rate was varied from 50 kHz to 16.7 kHz. This Note explains some of the properties of the ASCR that contribute to these circuit capabilities and illustrates, in a general way, the requirements for regulating the SCR inverter.

AN-6865 .... 8 pages

50-kHz High-Voltage Deflection System

The reproduction of a transmitted picture on the face of a TV receiver or of a page of computer information on the screen of a video-display terminal is the result of the scanning of the internal surface of the cathode-ray tube by an electron beam. The number of horizontal scans made for each vertical frame determines the resolution of the display. All commercial monochromatic TV receivers in the U.S. operate at a horizontal scan rate of 15,750 cycles per second. At this rate, the electron beam scans the face of the picture tube horizontally 262.5 times for each vertical frame. Video display systems generally require far better resolution than commercial TV sets and, for this reason, most deflection circuits used in video-display systems operate at horizontal scan frequencies of 30,000 Hz or higher. Currently, in order to achieve a display of even greater resolution, many system designers are working on deflection circuits capable of scanning the beam at rates of 50,000 cycles per second. This Note briefly describes the principles of operation of a horizontal deflection system and discusses two examples of high-scan-rate systems.

AN-6936 .... 8 pages

Triac Gate Characteristics and Drive Considerations

This Note provides information concerning more reliable pulsed triggering of RCA triacs. It describes triac gate triggering and employs equivalent circuits to illustrate the gate trigger process. Gate characteristics of the triac are discussed and the critical turn-on period is defined. Data is presented showing the time dependence of gate drive, the relationship between gate sensitivity and main-terminal voltage, and the dependence of latching current on gate drive current. Finally, recommendations are given for safe, reliable pulse firing.

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