DISCRETE SEMICONDUCTORS

Low-frequency Power transistors and Hybrid IC Power Modules

BOOK SC05 1989

Philips Components

PHILIPS

LOW-FREQUENCY POWER TRANSISTORS AND HYBRID IC POWER MODULES

page

NOTE: For information on high-voltage and switching power transistors see Book SC06.

SELECTION GUIDE

ACCESSORIES

CLIP MOUNTING

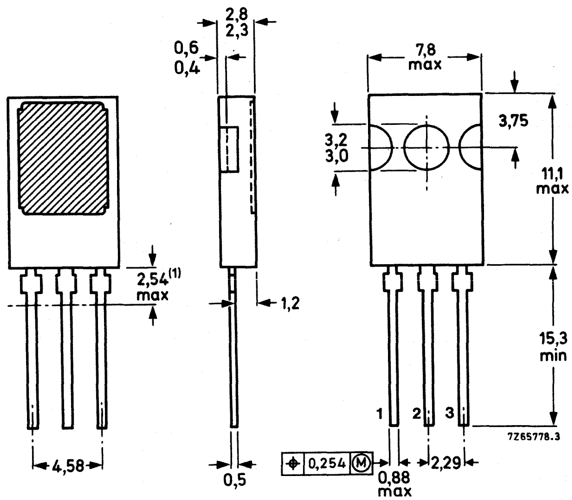
envelope	direct mounting		insulated mounting		
	clip		mica	alumina	clip
TO-126 (SOT32)	56353		56354		56353
SOT82	56353		56354		56353
TO-220 (SOT78)	56363		56369	56367	56364
SOT186	56363				
SOT93	56379		56378		56379
SOT199	56379				

SCREW MOUNTING

envelope	direct mounting		insulated mounting			
	metal washer	mounting size	mica washer	insulated bush	metal washer	mounting size
TO-126 (SOT32)	56326	M3				
up to 300 V			56387a	56387b	56326	M2,5
TO-220 (SOT78)	56360a	M3				
up to 800 V			56359b	56359c	56360a	M3
up to 1000 V			56359b	56359d	56360a	M3
SOT186	56360a	M3				
SOT93	–	M4	56368a	56368b		M3
SOT199	–	M				
TO-3 (SOT3)	–	M4				
up to 500 V			56201d	56201j or 56261a		M3
up to 2000 V			56339	56352		M3

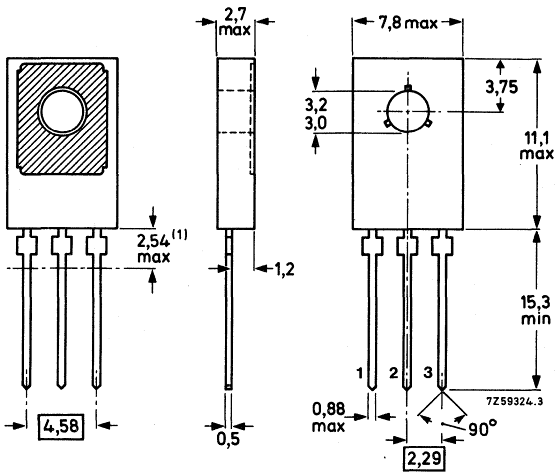
The accessories included in this section can be supplied on request. Details of their use can be found in the Mounting Instructions section.

SOT82



type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BD331	npn	6	60	60	60	215
BD332	pnp	6	60	60	60	225
BD333	npn	6	80	80	60	215
BD334	pnp	6	80	80	60	225
BD335	npn	6	100	100	60	215
BD336	pnp	6	100	100	60	225
BD337	npn	6	120	120	60	215
BD338	pnp	6	120	120	60	225

TO-126

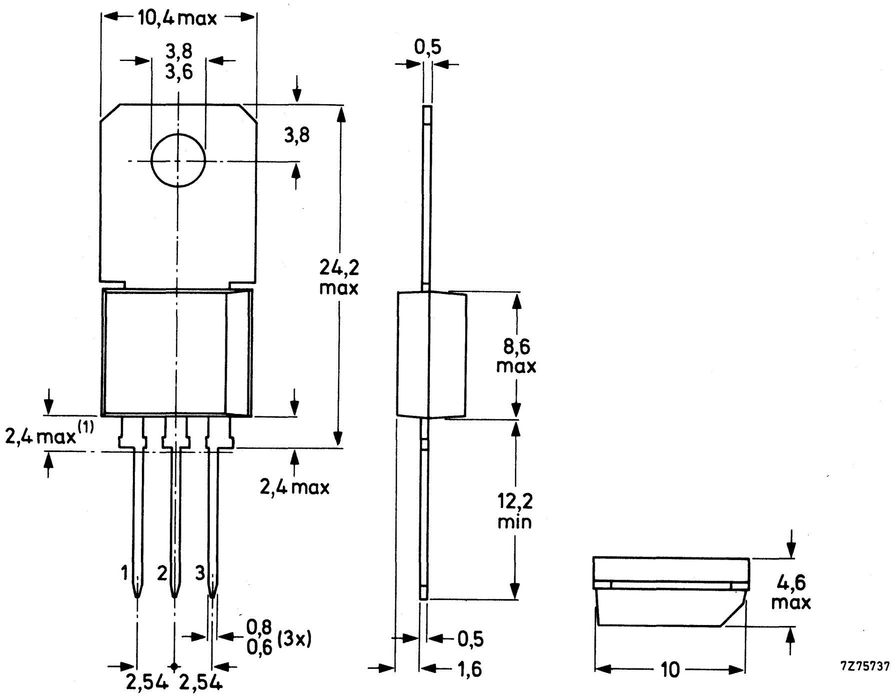


type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BDX42	npn	1	45*	60	1.25	705
BDX45	pnp	1	45*	60	1.25	713
BDX43	npn	1	60*	80	1.25	705
BDX46	pnp	1	60*	80	1.25	713
BDX44	npn	1	80*	90	1.25	705
BDX47	pnp	1	80*	90	1.25	713
BD135	npn	1.5	45	45	8	65
BD136	pnp	1.5	45	45	8	75
BD226	npn	1.5	45	45	12.5	121
BD227	pnp	1.5	45	45	12.5	131
BD137	npn	1.5	60	60	8	65
BD138	pnp	1.5	60	60	8	75
BD228	npn	1.5	60	60	12.5	121
BD229	pnp	1.5	60	60	12.5	131
BD139	npn	1.5	80	100	8	65
BD140	pnp	1.5	80	100	8	75
BD230	npn	1.5	80	100	12.5	121
BD231	pnp	1.5	80	100	12.5	131
BD233	npn	2	45	45	25	141
BD234	pnp	2	45	45	25	149
BD235	npn	2	60	60	25	141
BD236	pnp	2	60	60	25	149
BD237	npn	2	80	100	25	141
BD238	pnp	2	80	100	25	149
BD329	npn	3	20	32	15	199

* V_{CER}.

TO-126 (continued)

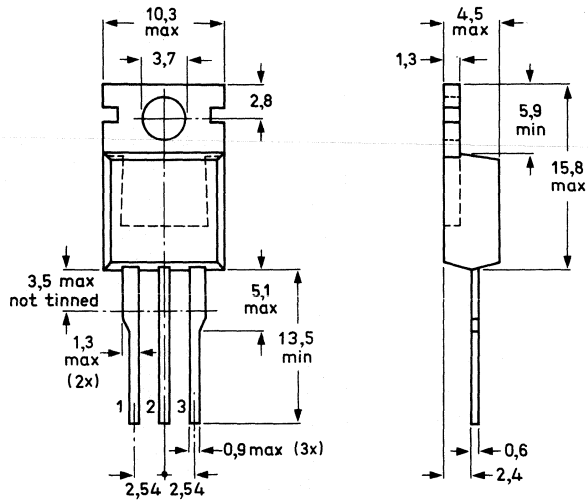
type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BD330	pnp	3	20	32	15	207
BD131	npn	3	45	70	15	47
BD132	pnp	3	45	45	15	57
BD433	npn	4	22	22	36	235
BD434	pnp	4	22	22	36	243
BD435	npn	4	32	32	36	235
BD436	pnp	4	32	32	36	243
BD437	npn	4	45	45	36	235
BD438	pnp	4	45	45	36	243
BD675	npn	4	45	60	40	287
BD676	pnp	4	45	45	40	297
BD677	npn	4	60	80	40	287
BD678	pnp	4	60	60	40	297
BD719	npn	4	60	60	36	305
BD720	pnp	4	60	60	36	313
BD679	npn	4	80	100	40	287
BD680	pnp	4	80	80	40	297
BD721	npn	4	80	80	36	305
BD722	pnp	4	80	80	36	313
BD681	npn	4	100	120	40	287
BD682	pnp	4	100	100	40	297
BD723	npn	4	100	100	36	305
BD724	pnp	4	100	100	36	313
BD683	npn	4	120	140	40	287
BD684	pnp	4	120	120	40	297
BD725	npn	4	120	120	36	305
BD726	pnp	4	120	120	36	313
BDX35	npn	5	60	100	15	697
BDX36	npn	5	60	120	15	697
BDX37	npn	5	80	120	15	697



TO-202

type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BD825	npn	1	45	45	8	321
BD826	pnp	1	45	45	8	329
BD827	npn	1	60	60	8	321
BD828	pnp	1	60	60	8	329
BD829	npn	1	80	100	8	321
BD830	pnp	1	80	100	8	329
BD839	npn	1.5	45	45	10	337
BD840	pnp	1.5	45	45	10	345
BD841	npn	1.5	60	60	10	337
BD842	pnp	1.5	60	60	10	345
BD843	npn	1.5	80	100	10	337
BD844	pnp	1.5	80	100	10	345

TO-220



type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BDT29	npn	1	40	80	30	427
BDT30	pnp	1	40	80	30	441
TIP29	npn	1	40	80	30	819
TIP30	pnp	1	40	80	30	821
BDT29A	npn	1	60	100	30	427
BDT30A	pnp	1	60	100	30	441
TIP29A	npn	1	60	100	30	819
TIP30A	pnp	1	60	100	30	821
BDT29B	npn	1	80	120	30	427
BDT30B	pnp	1	80	120	30	441
TIP29B	npn	1	80	120	30	819
TIP30B	pnp	1	80	120	30	821
BDT29C	npn	1	100	140	30	427
BDT30C	pnp	1	100	140	30	441
TIP29C	npn	1	100	140	30	819
TIP30C	pnp	1	100	140	30	821
BDT31	npn	3	40	80	40	455
BDT32	pnp	3	40	80	40	471
TIP31	npn	3	40	80	40	823
TIP32	pnp	3	40	80	40	825
BD239	npn	3	45	45	30	157
BD240	pnp	3	45	45	30	163
BD933	npn	3	45	45	30	353
BD934	pnp	3	45	45	30	367
BD239A	npn	3	60	60	30	157

TO-220 (continued)

type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BD240A	pnp	3	60	60	30	163
BD935	npn	3	60	60	30	353
BD936	pnp	3	60	60	30	367
BDT31A	npn	3	60	100	40	455
BDT32A	pnp	3	60	100	40	471
TIP31A	npn	3	60	100	40	823
TIP32A	pnp	3	60	100	40	825
BD239B	npn	3	80	80	30	157
BD240B	pnp	3	80	80	30	163
BD937	npn	3	80	100	30	353
BD938	pnp	3	80	100	30	367
BDT31B	npn	3	80	120	40	455
BDT32B	pnp	3	80	120	40	471
TIP31B	npn	3	80	120	40	823
TIP32B	pnp	3	80	120	40	825
BD239C	npn	3	100	100	30	157
BD240C	pnp	3	100	100	30	163
BD939	npn	3	100	120	30	353
BD940	pnp	3	100	120	30	367
BDT31C	npn	3	100	140	40	455
BDT32C	pnp	3	100	140	40	471
TIP31C	npn	3	100	140	40	823
TIP32C	pnp	3	100	140	40	825
BD941	npn	3	120	140	30	353
BD942	pnp	3	120	140	30	367
BDT60	pnp	4	60	60	50	519
BDT61	npn	4	60	60	50	535
TIP110	npn	4	60	60	50	843
TIP115	pnp	4	60	60	50	849
BDT60A	pnp	4	80	80	50	519
BDT61A	npn	4	80	80	50	535
TIP111	npn	4	80	80	50	843
TIP116	pnp	4	80	80	50	849
BDT60B	pnp	4	100	100	50	519
BDT61B	npn	4	100	100	50	535
TIP112	npn	4	100	100	50	843
TIP117	pnp	4	100	100	50	849
BDT60C	pnp	4	120	120	50	519
BDT61C	npn	4	120	120	50	535
BD943	npn	5	22	22	40	379
BD944	pnp	5	22	22	40	393
BD945	npn	5	32	32	40	379
BD946	pnp	5	32	32	40	393
BD241	npn	5	45	45	40	169
BD242	pnp	5	45	45	40	179

TO-220 (continued)

typ	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BD947	npn	5	45	45	40	379
BD948	pnp	5	45	45	40	393
BD241A	npn	5	60	60	40	169
BD242A	pnp	5	60	60	40	179
BD949	npn	5	60	60	40	407
BD950	pnp	5	60	60	40	417
TIP120	npn	5	60	60	65	855
TIP125	pnp	5	60	60	65	861
BD241B	npn	5	80	80	40	169
BD242B	pnp	5	80	80	40	179
BD951	npn	5	80	80	40	407
BD952	pnp	5	80	80	40	417
TIP121	npn	5	80	80	65	855
TIP126	pnp	5	80	80	65	861
BD241C	npn	5	100	100	40	169
BD242C	pnp	5	100	100	40	179
BD953	npn	5	100	100	40	407
BD954	pnp	5	100	100	40	417
TIP122	npn	5	100	100	65	855
TIP127	pnp	5	100	100	65	861
BD955	npn	5	120	120	40	407
BD956	pnp	5	120	120	40	417
BDT41	npn	6	40	40	65	487
BDT42	pnp	6	40	80	65	503
TIP41	npn	6	40	80	65	839
TIP42	pnp	6	40	80	65	841
BDT41A	npn	6	60	60	65	487
BDT42A	pnp	6	60	100	65	503
TIP41A	npn	6	60	100	65	839
TIP42A	pnp	6	60	100	65	841
BDT41B	npn	6	80	80	65	487
BDT42B	pnp	6	80	120	65	503
TIP41B	npn	6	80	120	65	839
TIP42B	pnp	6	80	120	65	841
BDT41C	npn	6	100	100	65	487
BDT42C	pnp	6	100	140	65	503
TIP41C	npn	6	100	140	65	839
TIP42C	pnp	6	100	140	65	841
BD201	npn	8	45	60	60	85
BD202	pnp	8	45	60	60	103
BD243	npn	8	45	45	65	187
BD244	pnp	8	45	45	65	193
BD643	npn	8	45	60	62.5	251
BD644	pnp	8	45	45	62.5	269
BD203	npn	8	60	60	60	85

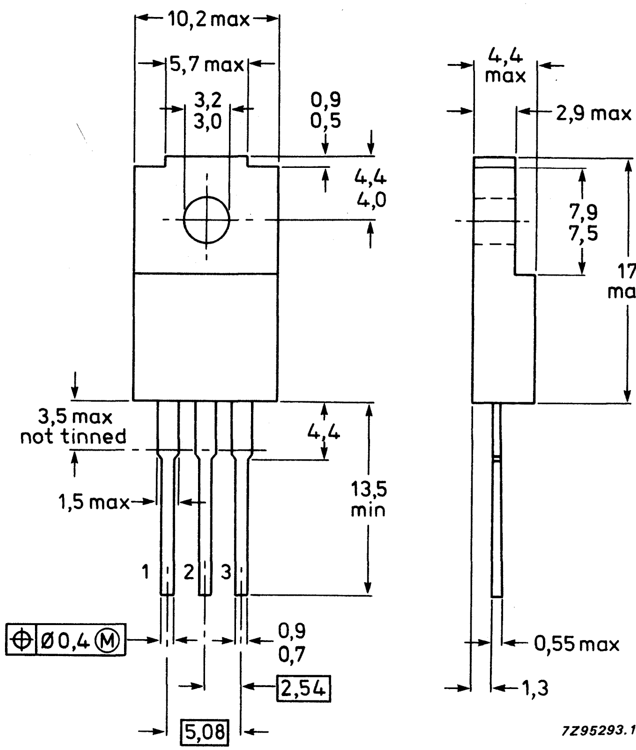
TO-220 (continued)

type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BD204	pnp	8	60	60	60	103
BD243A	npn	8	60	60	65	187
BD244A	pnp	8	60	60	65	193
BD645	npn	8	60	80	62.5	251
BD646	pnp	8	60	60	62.5	269
TIP130	npn	8	60	60	70	867
TIP135	pnp	8	60	60	70	873
BD243B	npn	8	80	80	65	187
BD244B	pnp	8	80	80	65	193
BD647	npn	8	80	100	62.5	251
BD648	pnp	8	80	80	62.5	269
BDX77	npn	8	80	100	60	85
BDX78	pnp	8	80	100	60	103
TIP131	npn	8	80	80	70	867
TIP136	pnp	8	80	80	70	873
BD243C	npn	8	100	100	65	187
BD244C	pnp	8	100	100	65	193
BD649	npn	8	100	120	62.5	251
BD650	pnp	8	100	100	62.5	269
TIP132	npn	8	100	100	70	867
TIP137	pnp	8	100	100	70	873
BD651	npn	8	120	140	62.5	251
BD652	pnp	8	120	120	62.5	269
BDT62	pnp	10	60	60	90	553
BDT63	npn	10	60	60	90	571
BDT91	npn	10	60	60	90	637
BDT92	pnp	10	60	60	90	647
TIP2955T	pnp	10	60	70	75	897
TIP3055T	npn	10	60	70	75	907
BDT62A	pnp	10	80	80	90	553
BDT63A	npn	10	80	80	90	571
BDT93	npn	10	80	80	90	637
BDT94	pnp	10	80	80	90	647
BDT62B	pnp	10	100	100	90	553
BDT63B	npn	10	100	100	90	571
BDT95	npn	10	100	100	90	637
BDT96	pnp	10	100	100	90	647
BDT62C	pnp	10	120	120	90	553
BDT63C	npn	10	120	120	90	571
BDT64	pnp	12	60	60	125	589
BDT65	npn	12	60	60	125	605
BDT64A	pnp	12	80	80	125	589
BDT65A	npn	12	80	80	125	605

TO-220 (continued)

type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BDT64B	pnp	12	100	100	125	589
BDT65B	npn	12	100	100	125	605
BDT64C	pnp	12	120	120	125	589
BDT65C	npn	12	120	120	125	605
BDT81	npn	15	60	60	125	621
BDT82	pnp	15	60	60	125	629
BDT83	npn	15	80	80	125	621
BDT84	pnp	15	80	80	125	629
BDT85	npn	15	100	100	125	621
BDT86	pnp	15	100	100	125	629
BDT87	npn	15	120	120	125	621
BDT88	pnp	15	120	120	125	629

SOT186



type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BDT29F	npn	3	40	80	19	433
BDT30F	pnp	3	40	80	19	447
BDT31F	npn	3	40	80	22	463
BDT32F	pnp	3	40	80	22	479
BD933F	npn	3	45	45	19	361
BD934F	pnp	3	45	45	19	373
BD935F	npn	3	60	60	19	361
BD936F	pnp	3	60	60	19	373
BDT29AF	npn	3	60	100	19	433
BDT30AF	pnp	3	60	100	19	447
BDT31AF	npn	3	60	100	22	463
BDT32AF	pnp	3	60	100	22	479
BD937F	npn	3	80	100	19	361
BD938F	pnp	3	80	100	19	373
BDT29BF	npn	3	80	120	19	433
BDT30BF	pnp	3	80	120	19	447
BDT31BF	npn	3	80	120	22	463
BDT32BF	pnp	3	80	120	22	479
BD939F	npn	3	100	120	19	361
BD940F	pnp	3	100	120	19	373

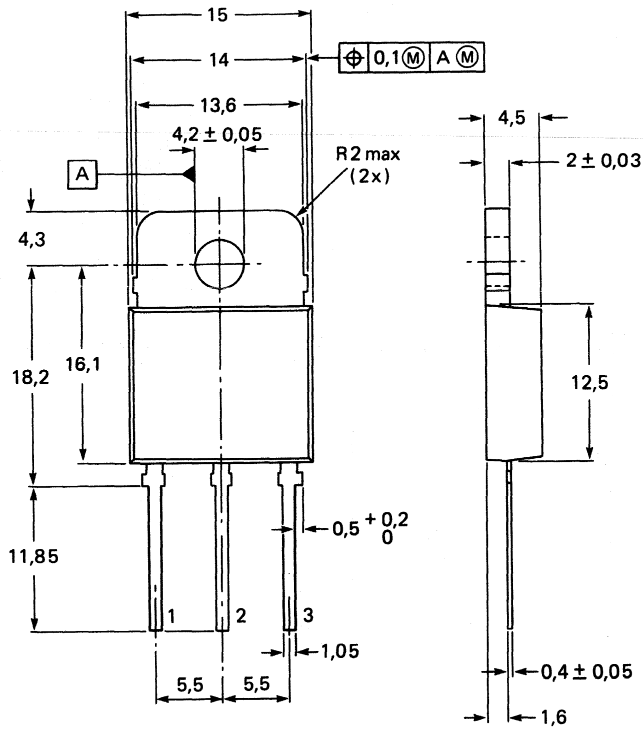
SOT186 (continued)

type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BDT29CF	npn	3	100	140	19	433
BDT30CF	pnp	3	100	140	19	447
BDT31CF	npn	3	100	140	22	463
BDT32CF	pnp	3	100	140	22	479
BDT29DF	npn	3	120	160	19	433
BD941F	npn	3	120	140	19	361
BD942F	pnp	3	120	140	19	373
BDT30DF	pnp	3	120	160	19	447
BDT31DF	npn	3	120	160	22	463
BDT32DF	pnp	3	120	160	22	479
BDT60F	pnp	4	60	60	25	527
BDT61F	npn	4	60	60	25	545
BDT60AF	pnp	4	80	80	25	527
BDT61AF	npn	4	80	80	25	545
BDT60BF	pnp	4	100	100	25	527
BDT61BF	npn	4	100	100	25	545
BDT60CF	pnp	4	120	120	25	527
BDT61CF	npn	4	120	120	25	545
BD943F	npn	5	22	22	22	387
BD944F	pnp	5	22	22	22	401
BD945F	npn	5	32	32	22	387
BD946F	pnp	5	32	32	22	401
BD947F	npn	5	45	45	22	387
BD948F	pnp	5	45	45	22	401
BD949F	npn	5	60	60	22	415
BD950F	pnp	5	60	60	22	425
BD951F	npn	5	80	80	22	415
BD952F	pnp	5	80	80	22	425
BD953F	npn	5	100	100	22	415
BD954F	pnp	5	100	100	22	425
BD955F	npn	5	120	120	22	415
BD956F	pnp	5	120	120	22	425
BDT41F	npn	6	40	80	32	495
BDT42F	pnp	6	40	80	32	511
BDT41AF	npn	6	60	100	32	495
BDT42AF	pnp	6	60	100	32	511
BDT41BF	npn	6	80	120	32	495
BDT42BF	pnp	6	80	120	32	511
BDT41CF	npn	6	100	140	32	495
BDT42CF	pnp	6	100	140	32	511
BD201F	npn	8	45	60	32	95
BD202F	pnp	8	45	60	32	113
BD644F	pnp	8	45	45	20	279
BD203F	npn	8	60	60	32	95
BD204F	pnp	8	60	60	32	113

SOT186 (continued)

type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BD643F	npn	8	45	60	20	261
BD645F	npn	8	60	80	20	261
BD646F	pnp	8	60	60	20	279
BD647F	npn	8	80	100	20	261
BD648F	pnp	8	80	80	20	279
BDX77F	npn	8	80	100	32	95
BDX78F	pnp	8	80	100	32	113
BD649F	npn	8	100	120	20	261
BD650F	pnp	8	100	100	20	279
BD651F	npn	8	120	140	20	261
BD652F	pnp	8	120	120	20	279
BDT62F	pnp	10	60	60	36	563
BDT63F	npn	10	60	60	36	581
BDT91F	npn	10	60	60	32	645
BDT92F	pnp	10	60	60	32	655
BDT62AF	pnp	10	80	80	36	563
BDT63AF	npn	10	80	80	36	581
BDT93F	npn	10	80	80	32	645
BDT94F	pnp	10	80	80	32	655
BDT62BF	pnp	10	100	100	36	563
BDT63BF	npn	10	100	100	36	581
BDT95F	npn	10	100	100	32	645
BDT96F	pnp	10	100	100	32	655
BDT62CF	pnp	10	120	120	36	563
BDT63CF	npn	10	120	120	36	581
BDT64F	pnp	12	60	60	39	597
BDT65F	npn	12	60	60	39	613
BDT64AF	pnp	12	80	80	39	597
BDT65AF	npn	12	80	80	39	613
BDT64BF	pnp	12	100	100	39	597
BDT65BF	npn	12	100	100	39	613
BDT64CF	pnp	12	120	120	39	597
BDT65CF	npn	12	120	120	39	613
BDT81F	npn	15	60	60	36	627
BDT82F	pnp	15	60	60	36	635
BDT83F	npn	15	80	80	36	627
BDT84F	pnp	15	80	80	36	635
BDT85F	npn	15	100	100	36	627
BDT86F	pnp	15	100	100	36	635
BDT87F	npn	15	120	120	36	627
BDT88F	pnp	15	120	120	36	635

SOT93

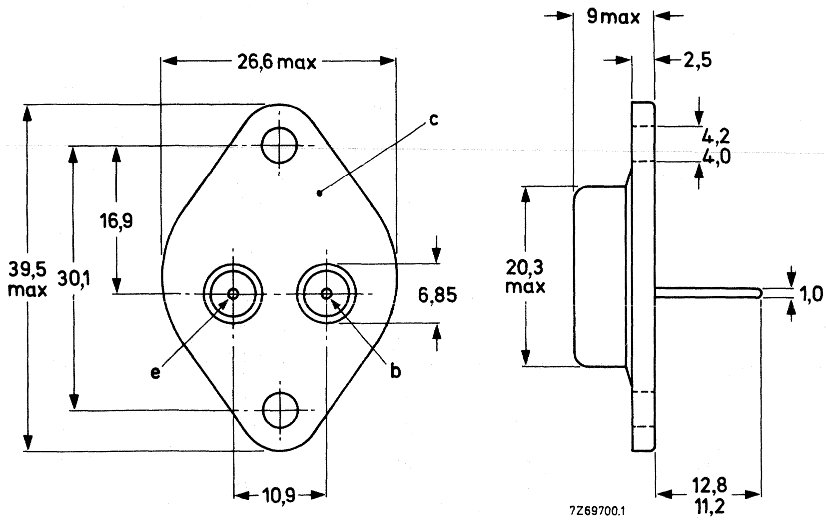


type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
TIP33	npn	10	40	80	80	827
TIP34	pnp	10	40	80	80	833
BDV91	npn	10	60	60	100	685
BDV92	pnp	10	60	60	100	691
TIP140	npn	10	60	60	125	879
TIP145	pnp	10	60	60	125	885
TIP33A	npn	10	60	100	80	827
TIP34A	pnp	10	60	100	80	833
BDV93	npn	10	80	80	100	685
BDV94	pnp	10	80	80	100	691
TIP141	npn	10	80	80	125	879
TIP146	pnp	10	80	80	125	885
TIP33B	npn	10	80	120	80	827
TIP34B	pnp	10	80	120	80	833
BDV95	npn	10	100	100	100	685
BDV96	pnp	10	100	100	100	691
TIP142	npn	10	100	100	125	879
TIP147	pnp	10	100	100	125	885
TIP33C	npn	10	100	140	80	827

SOT93 (continued)

type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
TIP34C	pnp	10	100	140	80	833
BDV64	pnp	12	60	60	125	657
BDV65	npn	12	60	60	125	665
BDV64A	pnp	12	80	80	125	657
BDV65A	npn	12	80	80	125	665
BDV64B	pnp	12	100	100	125	657
BDV65B	npn	12	100	100	125	665
BDV64C	pnp	12	120	120	125	657
BDV65C	npn	12	120	120	125	665
TIP2955	pnp	15	60	100	100	891
TIP3055	npn	15	60	100	100	901
BDV66A	pnp	16	80	100	175	673
BDV67A	npn	16	80	100	200	679
BDV66B	pnp	16	100	120	175	673
BDV67B	npn	16	100	120	200	679
BDV66C	pnp	16	120	140	175	673
BDV67C	npn	16	120	140	200	679
BDV66D	pnp	16	150	160	175	673
BDV67D	npn	16	150	160	200	679

TO-3



type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BDX62	pnp	8	60	60	90	721
BDX63	npn	8	60	80	90	731
BDX62A	pnp	8	80	80	90	721
BDX63A	npn	8	80	100	90	731
BDX62B	pnp	8	100	100	90	721
BDX63B	npn	8	100	120	90	731
BDX62C	pnp	8	120	120	90	721
BDX63C	npn	8	120	140	90	731
BDX91	npn	10	60	60	90	795
BDX92	pnp	10	60	60	90	803
BDY92	npn	10	60	80	40	811
BDX93	npn	10	80	80	90	795
BDX94	pnp	10	80	80	90	803
BDY91	npn	10	80	100	40	811
BDX95	npn	10	100	100	90	795
BDX96	pnp	10	100	100	90	803
BDY90	npn	10	100	120	40	811
BDX64	pnp	12	60	60	117	741
BDX65	npn	12	60	80	117	751
BDX64A	pnp	12	80	80	117	741
BDX65A	npn	12	80	100	117	751
BDX64B	pnp	12	100	100	117	741
BDX65B	npn	12	100	120	117	751
BDX64C	pnp	12	120	120	117	741
BDX65C	npn	12	120	140	117	751

TO-3 (continued)

type	polarity	I_C (A)	V_{CEO} (V)	V_{CBO} (V)	P_{tot} (W)	page
BDX66	pnp	16	60	60	150	761
BDX67	npn	16	60	80	150	771
BDX66A	pnp	16	80	80	150	761
BDX67A	npn	16	80	100	150	771
BDX66B	pnp	16	100	100	150	761
BDX67B	npn	16	100	120	150	771
BDX66C	pnp	16	120	120	150	761
BDX67C	npn	16	120	140	150	771
BDX68	pnp	25	60	60	200	783
BDX69	npn	25	60	80	200	787
BDX68A	pnp	25	80	80	200	783
BDX69A	npn	25	80	100	200	787
BDX68B	pnp	25	100	100	200	783
BDX69B	npn	25	100	120	200	787
BDX68C	pnp	25	120	120	200	783
BDX69C	npn	25	120	140	200	787

TYPE NUMBER SURVEY

TYPE NUMBER SURVEY ACCESSORIES

type number	description	envelope
56201d	mica washer (up to 500 V)	TO-3
56201j	insulating bushes (up to 500 V)	TO-3
56261a	insulating bushes (up to 500 V)	TO-3
56326	metal washer	TO-126
56339	mica washer (500 to 2000 V)	TO-3
56352	insulating mounting support	TO-3
56353	spring clip	TO-126/SOT82
56354	mica insulator	TO-126/SOT82
56359b	mica washer (up to 1000 V)	TO-220
56359c	insulating bush (up to 800 V)	TO-220
56359d	rectangular insulating bush (up to 1000 V)	TO-220
56360a	rectangular washer (brass)	TO-220
56363	spring clip (direct mounting)	TO-220
56364	spring clip (insulated mounting)	TO-220
56367	alumina insulator (up to 2000 V)	TO-220
56368a	mica insulator (up to 800 V)	SOT93
56368b	insulating bush (up to 800 V)	SOT93
56369	mica insulator (up to 2 kV)	TO-220
56378	mica insulator (up to 1500 V)	SOT93
56379	spring clip	SOT93
56387a	mica insulator (up to 300 V)	TO-126
56387b	insulating bush (up to 300 V)	TO-126

GENERAL

TRANSISTOR RATINGS

The ratings are presented as voltage, current, power and temperature ratings. The list of these ratings and their definitions is given as follows:

Transistor voltage ratings

Collector to base voltage ratings

V_{CBmax} — The maximum permissible instantaneous voltage between collector and base terminals. The collector voltage is negative with respect to base in pnp transistors and positive with respect to base in npn types.

V_{CBmax} (IE = 0) — The maximum permissible instantaneous voltage between collector and base terminals, when the emitter terminal is open-circuited.

Emitter to base voltage ratings

V_{EBmax} — The maximum permissible instantaneous reverse voltage between emitter and base terminal. The emitter voltage is negative with respect to base for pnp transistor and positive with respect to base for npn types.

V_{EBmax} ($I_C = 0$) — The maximum permissible instantaneous reverse voltage between emitter and base terminals when the collector terminal is open-circuited.

Collector to emitter voltage ratings

V_{CEmax} — The maximum permissible instantaneous voltage between collector and emitter terminals. The collector voltage is negative with respect to emitter in pnp transistors and positive with respect to emitter in npn types. This rating is very dependent on circuit conditions and collector current and it is necessary to refer to the curve of V_{CE} versus I_C for the appropriate circuit condition in order to obtain the correct rating.

V_{CEmax} (Cut-off) — The maximum permissible instantaneous voltage between collector and emitter terminals when the emitter current is reduced to zero by means of a reverse emitter base voltage, i.e. the base voltage is normally positive with respect to emitter for pnp transistor and negative with respect to emitter for npn types.

NOTE: The term "cut-off" is sometimes replaced by $V_{BE} > x$ volts, or $\frac{R_B}{R_E}$, $\leqslant y$ which are equivalent conditions under which the device may be cut-off.

V_{CEmax} ($I_C = x$ mA) — The maximum permissible instantaneous voltage between collector and emitter terminals when the collector current is at a high value, often the max. rated value.

V_{CEmax} ($I_B = 0$) — The maximum permissible instantaneous voltage between collector and emitter terminals when the base terminal is open circuited or when a very high resistance is in series with the base terminal. Special care must be taken to ensure that thermal runaway due to excessive collector leakage current does not occur in this condition.

Due to the current dependency of V_{CE} it is usual to present this information as a voltage rating chart which is a curve of collector as a function of collector to emitter voltage (see Fig. 1).

Fig. 1 is divided into two areas:

The permissible area of operation under all conditions of base drive provided the dissipation rating is not exceeded (area 1) and the area where operation is allowable under certain specified conditions (area 2). To assist in determining the rating in this second area, further curves are provided relating the voltage rating to external circuit conditions, for example:

$$\frac{R_B}{R_E},\ R_B,\ Z_{Bg},\ V_{BE},\ I_B \text{ or } \frac{V_{BB}}{R_B}.$$

An example of this type of curve is given in Fig. 2 as V_{CE} as a function of $\frac{R_B}{R_E}$ for two different values of collector current.

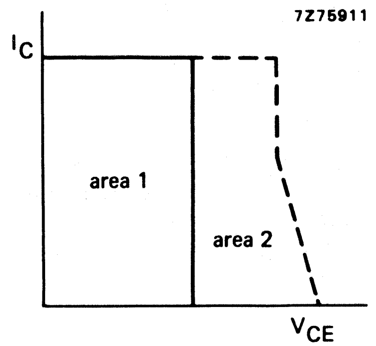


Fig. 1 Permissible operation areas.

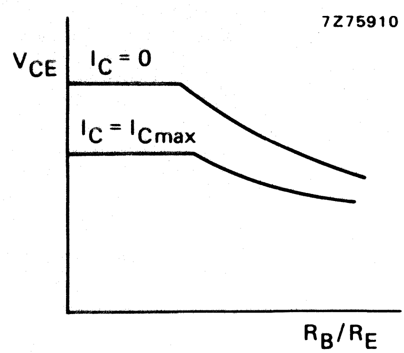


Fig. 2 Effect of collector current on permissible operation areas.

It should be noted that when R_E is shunted by a capacitor, the collector voltage V_{CE}, during switching, must be restricted to a value which does not rely on the effect of R_E.
In the case of an inductive load, when an energy rating is given, it may be permissible to operate outside the rated area provided the specified energy rating is not exceeded.

Transistor current ratings

Collector current ratings

I_{Cmax}	The maximum permissible collector current. Without further qualification, the DC value is implied.
$I_{C(AV)max}$	The maximum permissible average value of the total collector current
I_{CM}	The maximum permissible instantaneous value of the total collector current.

Emitter current ratings

I_{Emax}	The maximum permissible emitter current. Without further qualification, the DC value is implied.
$I_{E(AV)max}$	The maximum permissible average value of the total emitter current.
$I_{ER(AV)max}$	The maximum permissible average value of the total emitter current when operating in the reverse emitter-base breakdown region.
I_{EM}	The maximum permissible instantaneous value of the total emitter current.
I_{ERM}	The maximum permissible instantaneous value of the total reverse emitter current allowable in the reverse breakdown region.

Base current ratings

I_{Bmax}	The maximum permissible base current. Without further qualification, the DC value is implied.
$I_{B(AV)max}$	The maximum permissible average value of the total base current.
$I_{BR(AV)max}$	The maximum permissible average value of the total reverse base current allowable in the reverse breakdown region.
I_{BM}	The maximum permissible instantaneous value of the total base current. The rating also includes the switch off current.
I_{BRM}	The maximum permissible instantaneous value of the total reverse current allowable in the reverse breakdown region.

Transistor power ratings

P_{tot} max: The total maximum permissible continuous power dissipation in the transistor, which includes both the collector-base dissipation and the emitter-base dissipation. Under steady state conditions the total power is given as:

$$P_{tot} = V_{CE} \times I_C + V_{BE} \times I_B.$$

In order to distinguish between "steady state" and "pulse" conditions the terms "steady state power (P_S)" and "pulse power (P_P)" are often used. The permissible total power dissipation is dependent upon temperature and its relationship is shown in Fig. 3.

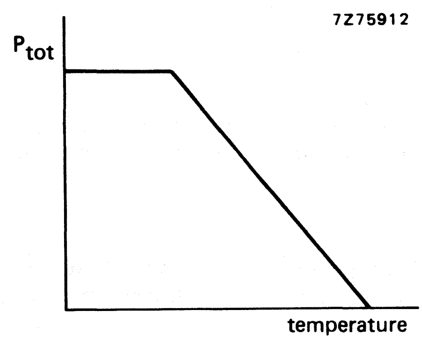


Fig. 3 Permissible total power dissipation.

The temperature may be the ambient, case or mounting base temperature. Where a colling clip or a heatsink is attached to the device, the allowable power dissipation is also dependent on the efficiency of the heatsink.

The efficiency of this clip or heatsink is measured in terms of its thermal resistance ($R_{th\ h}$) normally expressed in degrees kelvin per watt (K/W). For mounting base rated devices, the added effect of the contact resistance ($R_{th\ i}$) must be taken into account.

The effect of heatsinks of various thermal resistance and contact resistance is often included in Fig. 3.

The relationship between maximum permissible power dissipation, ambient temperature and thermal heatsink resistance is given as:

$$P_{tot} = \frac{T_j - T_{amb}}{R_{th\ j\text{-}a}}$$

where $R_{th\ j\text{-}a}$ is the thermal resistance from the transistor junction to the ambient. For case rated or mounting base rated devices, the thermal resistance $R_{th\ j\text{-}a}$ is made up of the thermal resistance junction to case or mounting base ($R_{th\ j\text{-}mb}$), the contact thermal resistance ($R_{th\ i}$) and the heatsink thermal resistance ($R_{th\ h}$).

For the calculation of pulse power operation P_P, the maximum pulse power is obtained using Fig. 4.

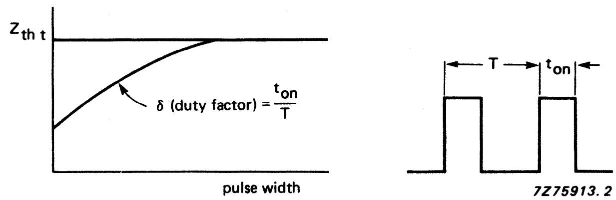


Fig. 4 Pulse power operation.

The general expression from which the maximum pulse power dissipation can be calculated is:

$$P_P = \frac{T_j - T_{amb} - P_S \times R_{th\ j\text{-}a}}{Z_{th\ t} + \delta\,(R_{th\ c\text{-}a})}$$

where $Z_{th\ t}$ and d are given in Fig. 4 and $R_{th\ c\text{-}a}$ is the thermal resistance between case and ambient for case rated device. For mounting base rated device, it is equal to $R_{th\ h} + R_{th\ i}$ and is zero for free air rated device because the effect of the temperature rise of the case over the ambient for a pulse train is already included in $Z_{th\ t}$.

Temperature ratings

T_{jmax}	The maximum permissible junction temperature which is used as the basis for the calculation of power ratings. Unless otherwise stated, the continuous value is implied.
T_{jmax} (continuous operation)	The maximum permissible continuous value.
T_{jmax} (intermittent operation)	The maximum permissible instantaneous junction temperature usually allowed for a total duration of 200 hours.
T_{mb}	The temperature of the surface making contact with a heatsink. This is confined to devices where a flange or stud for fixing onto a heatsink forms an integral part of the envelope.
T_{case}	The temperature of the envelope. This is confined to devices to which may be attached a clip-on cooling fin.

RATING SYSTEMS

The rating systems described are those recommended by the International Electrotechnical Commission (IEC) in its Publication 134.

DEFINITIONS OF TERMS USED

Electronic device. An electronic tube or valve, transistor or other semiconductor device.

Note
This definition excludes inductors, capacitors, resistors and similar components.

Characteristic. A characteristic is an inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electro-magnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form.

Bogey electronic device. An electronic device whose characteristics have the published nominal values for the type. A bogey electronic device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

Rating. A value which establishes either a limiting capability or a limiting condition for an electronic device. It is determined for specified values of environment and operation, and may be stated in any suitable terms.

Note
Limiting conditions may be either maxima or minima.

Rating system. The set of principles upon which ratings are established and which determine their interpretation.

Note
The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

ABSOLUTE MAXIMUM RATING SYSTEM

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

These values are chosen by the device manufacturer 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 the characteristics of the device under consideration and of all other electronic devices in the equipment.

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 variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

DESIGN MAXIMUM RATING SYSTEM

Design maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

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

DESIGN CENTRE RATING SYSTEM

Design centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply voltage.

LETTER SYMBOLS FOR TRANSISTORS AND SIGNAL DIODES

based on IEC Publication 148

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

Basic letters

The basic letters to be used are:

I, i = current
V, v = voltage
P, p = power.

Lower-case basic letters shall be used for the representation of instantaneous values which vary with time.
In all other instances upper-case basic letters shall be used.

Subscripts

A, a	Anode terminal
(AV), (av)	Average value
B, b	Base terminal, for MOS devices: Substrate
(BR)	Breakdown
C, c	Collector terminal
D, d	Drain terminal
E, e	Emitter terminal
F, f	Forward
G, g	Gate terminal
K, k	Cathode terminal
M, m	Peak value
O, o	As third subscript: The terminal not mentioned is open circuited
R, r	As first subscript: Reverse. As second subscript: Repetitive. As third subscript: With a specified resistance between the terminal not mentioned and the reference terminal.
(RMS), (rms)	Root-mean-square value
S, s	As first or second subscript: Source terminal (for FETS only) As second subscript: Non-repetitive (not for FETS) As third subscript: Short circuit between the terminal not mentioned and the reference terminal
X, x	Specified circuit
Z, z	Replaces R to indicate the actual working voltage, current or power of voltage reference and voltage regulator diodes.

Note: No additional subscript is used for DC values.

Upper-case subscripts shall be used for the indication of:

a) continuous (DC) values (without signal)

Example I_B

b) instantaneous total values

Example i_B

c) average total values

Example $I_{B(AV)}$

d) peak total values

Example I_{BM}

e) root-mean-square total values

Example $I_{B(RMS)}$

Lower-case subscripts shall be used for the indication of values applying to the varying component alone:

a) instantaneous values

Example i_b

b) root-mean-square values

Example $I_{b(rms)}$

c) peak values

Example I_{bm}

d) average values

Example $I_{b(av)}$

Note: If more than one subscript is used, subscript for which both styles exist shall either be all upper-case or all lower-case.

Additional rules for subscripts

Subscripts for currents

Transistors: If it is necessary to indicate the terminal carrying the current, this should be done by the first subscript (conventional current flow from the external circuit into the terminal is positive).

Examples: I_B, i_B, i_b, I_{bm}

Diodes: To indicate a forward current (conventional current flow into the anode terminal) the subscript F or f should be used; for a reverse current (conventional current flow out of the anode terminal) the subscript R or r should be used.

Examples: I_F, I_R, i_F, $I_{f(rms)}$

Subscripts for voltages

Transistors: If it is necessary to indicate the points between which a voltage is measured, this should be done by the first two subscripts. The first subscript indicates the terminal at which the voltage is measured and the second the reference terminal or the circuit node. Where there is no possibility of confusion, the second subscript may be omitted.

Examples: V_{BE}, v_{BE}, v_{be}, V_{bem}

Diodes: To indicate a forward voltage (anode positive with respect to cathode), the subscript F or f should be used; for a reverse voltage (anode negative with respect to cathode) the subscript R or r should be used.

Examples: V_F, V_R, v_F, V_{rm}

Subscripts for supply voltages or supply currents

Supply voltages or supply currents shall be indicated by repeating the appropriate terminal subscript.

Examples: V_{CC}, I_{EE}

Note: If it is necessary to indicate a reference terminal, this should be done by a third subscript

Example : V_{CCE}

Subscripts for devices having more than one terminal of the same kind

If a device has more than one terminal of the same kind, the subscript is formed by the appropriate letter for the terminal followed by a number; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

Examples: I_{B2} = continuous (DC) current flowing into the second base terminal

V_{B2-E} = continuous (DC) voltage between the terminals of second base and emitter

Subscripts for multiple devices

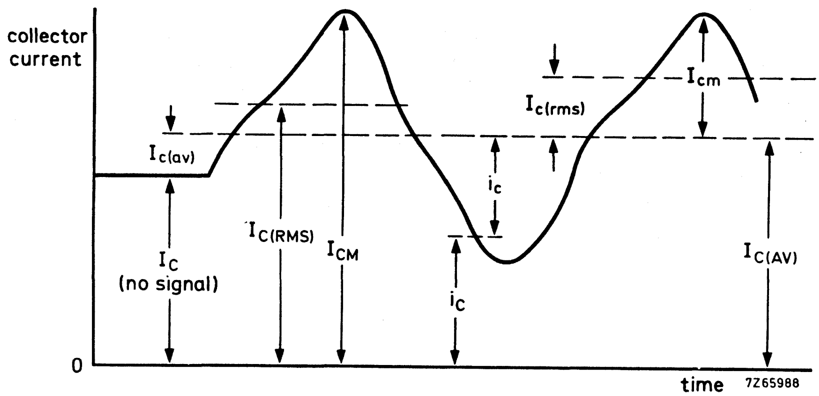
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

Examples: I_{2C} = continuous (DC) current flowing into the collector terminal of the second unit

V_{1C-2C} = continuous (DC) voltage between the collector terminals of the first and the second unit.

Application of the rules

The figure below represents a transistor collector current as a function of time. It consists of a continuous (DC) current and a varying component.



LETTER SYMBOLS FOR ELECTRICAL PARAMETERS

Defenition

For the purpose of this Publication, the term "electrical parameter" applies to four-pole matrix parameters, elements of electrical equivalent circuits, electrical impedances and admittances, inductances and capacitances.

Basic letters

The following is a list of the most important basic letters used for electrical parameters of semiconductor devices.

B, b = susceptance; imaginary part of an admittance

C = capacitance

G, g = conductance; real part of an admittance

H, h = hybrid parameter

L = inductance

R, r = resistance; real part of an impedance

X, x = reactance; imaginary part of an impedance

Y, y = admittance;

Z, z = impedance;

Upper-case letters shall be used for the representation of:

a) electrical parameters of external circuits and of circuits in which the device forms only a part;

b) all inductances and capacitances.

Lower-case letters shall be used for the representation of electrical parameters inherent in the device (with the exception of inductances and capacitances).

Subscripts

General subscripts

The following is a list of the most important general subscripts used for electrical parameters of semiconductor devices:

F, f = forward; forward transfer
I, i (or 1) = input
L, l = load
O, o (or 2) = output
R, r = reverse; reverse transfer
S, s = source

Examples: Z_S, h_f, h_F

The upper-case variant of a subscript shall be used for the designation of static (d.c.) values.

Examples : h_{FE} = static value of forward current transfer ratio in common-emitter configuration (DC current gain)

R_E = DC value of the external emitter resistance

Note: The static value is the slope of the line from the origin to the operating point on the appropriate characteristic curve, i.e. the quotient of the appropriate electrical quantities at the operating point.

The lower-case variant of a subscript shall be used for the designation of small-signal values.

Examples: h_{fe} = small-signal value of the short-circuit forward current transfer ratio in common-emitter configuration

$Z_e = R_e + jX_e$ = small-signal value of the external impedance

Note: If more than one subscript is used, subscripts for which both styles exist shall either be all upper-case or all lower-case

Examples: h_{FE}, y_{RE}, h_{fe}

Subscripts for four-pole matrix parameters

The first letter subscript (or double numeric subscript) indicates input, output, forward transfer or reverse transfer

Examples: h_i (or h_{11})
h_o (or h_{22})
h_f (or h_{21})
h_r (or h_{12})

A further subscript is used for the identification of the circuit configuration. When no confusion is possible, this further subscript may be omitted.

Examples: h_{fe} (or h_{21e}), h_{FE} (or h_{21E})

Distinction between real and imaginary parts

If it is necessary to distinguish between real and imaginary parts of electrical parameters, no additional subscripts should be used. If basic symbols for the real and imaginary parts exist, these may be used.

Examples: $Z_i = R_i + jX_i$
$y_{fe} = g_{fe} + jb_{fe}$

If such symbols do not exist or if they are not suitable, the following notation shall be used:

Examples: Re (h_{ib}) etc. for the real part of h_{ib}
Im (h_{ib}) etc. for the imaginary part of h_{ib}

TRANSISTOR SAFE OPERATING AREA (SOAR)

There are two main limiting factors which affect the power handling ability of a transistor; the average junction temperature and the second-breakdown.

To indicate these limitations, the data sheets contain safe operating area curves specific to the type and, for reliable operation of the transistor, the I_C/V_{CE} limits shown by these curves must never be exceeded.

The purpose of this chapter is to enable design engineers to make optimum use of the information.

Average junction temperature

Heat dissipation in the collector-base junction flows through the thermal resistance $R_{th\ j\text{-}mb}$ between junction and mounting base, see Fig. 1.

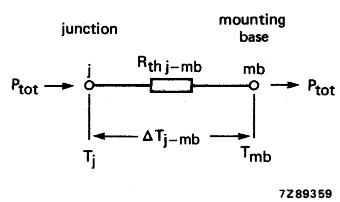


Fig. 1 Heat transport in a transistor with power dissipation constant with respect to time.

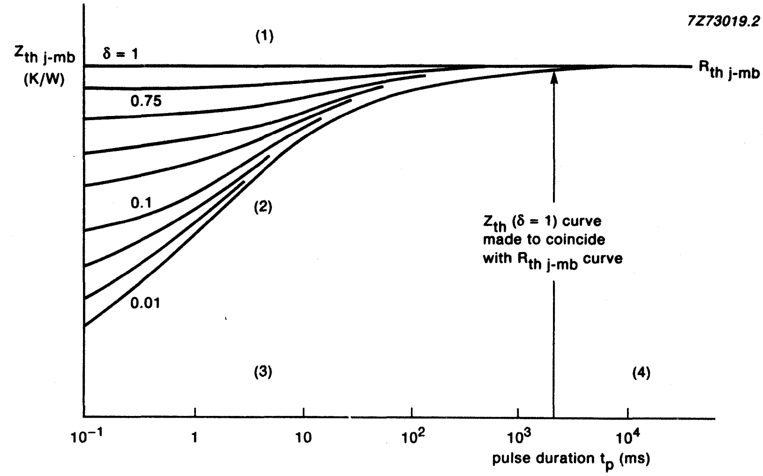
For steady-state (DC) operation the junction temperature will increase to:

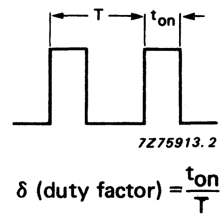
$$T_j = T_{mb} + P_{tot} \times R_{th\ j\text{-}mb}$$

For pulse operation the junction temperature will be:

$$T_j = T_{mb} + P_{tot} \times Z_{th\ j\text{-}mb}$$

During pulsed operation the junction has no time to be fully heated and will wholly or partly cool during the interval between pulses. For this reason a higher heat dissipation is permitted, see Fig. 2.





(1) DC line.
(2) Single pulse line.
(3) Pulse conditions.
(4) Steady-state conditions.

Fig. 2 A typical family of $Z_{th\ j\text{-}mb}$ curves for a power transistor.

This curve may be presented with either absolute figures ($Z_{th\ j\text{-}mb}$) or as normalized thermal impedance (NTI), where:

$$NTI = \frac{Z_{th\ j\text{-}mb}}{R_{th\ j\text{-}mb}}$$

Maximum allowable dissipation

Total power dissipation in a transistor is given by:

$$P_{tot} = I_C \times V_{CE} + I_B \times V_{BE}$$

The second term can usually be disregarded so $P_{tot} \approx I_C \times V_{CE}$.

The maximum allowable power dissipation is limited by the maximum allowable junction temperature for the constant power curves (P_{tot}) and by second breakdown for the second-breakdown curves, see Fig. 3.

Constant power curves

P_{tot} can be calculated as follows:

For steady-state conditions (DC);

$$P_{tot} = \frac{T_{j\ max} - T_{mb}}{R_{th\ j\text{-}mb}}$$

For pulsed conditions;

$$P_{tot} = \frac{T_{j\ max} - T_{mb}}{Z_{th\ j\text{-}mb}}$$

In most cases the maximum power dissipation ($P_{tot\ max}$ DC) specified in a data sheet is for a given mounting base temperature. This is usually T_{mb} = 25 °C but may be much higher.

For transistors in fully isolated envelopes (SOT186 and SOT199, ISOTOP), the maximum dissipation can not be referenced to the mounting base, therefore, the data sheets specify a given heatsink temperature (T_h) which may be calculated as follows:

For steady-state conditions (DC)

$$P_{tot} = \frac{T_{j\ max} - T_h}{R_{th\ j\text{-}mb}}$$

For pulsed conditions

$$P_{tot} = \frac{T_{j\ max} - T_h}{Z_{th\ j\text{-}mb}}$$

Again the temperature specified in a data sheet is usually T_h = 25 °C but may be much higher. The total thermal resistance/impedance includes the transfer resistance from the case to heatsink under specific mounting conditions.

Second breakdown curves

In the forward biased condition second-breakdown is a thermally triggered avalanche effect which once started will destroy the transistor. The mechanism can be understood by considering the device as a large number of elemental transistors in parallel, some of which will have a lower forward voltage drop than others. Current will tend to gather in these, raising their temperature and further lowering their forward voltage drop. Current will concentrate still further, leading to local overheating and eventually a short circuit between emitter and collector.

This effect can occur under various conditions:

Forward Biased up to V_{CEOmax}
Forward Biased with $V_{CE} > V_{CEO\ max}$
Reverse Biased up to V_{CESmax}

In the data sheets, safe operating area curves for the first condition are given for every power transistor; curves showing extensions for the safe operating area for the last two conditions are only specified for power switching transistors.

FORWARD BIASED SAFE OPERATION AREA UP TO V_{CEOmax}

Four operating limits form the boundaries of the forward biased safe operating area up to V_{CEOmax}:

Maximum collector current I_C or I_{CM}
Maximum collector-emitter voltage V_{CEOmax}
Maximum power dissipation P_{tot}
Second-breakdown limit S/B sat

To cover the widest range of applications FB-SOAR curves are specified for both DC and pulse operation.

At steady state conditions (DC)

Fig. 3 shows a DC FB-SOAR curve plotted on a log-log grid. The right-hand boundary is formed by V_{CEOmax} which extends up to a collector current of 300 V, above this point as I_{CE} is increased V_{CE} must be reduced to prevent second-breakdown.

The upper boundary is formed by I_{Cmax}, which extends to where the product of I_{Cmax} and V_{CE} equals the maximum power dissipation, from this point I_C must be reduced with increasing V_{CE} forming the constant power curve of the maximum power dissipation boundary.

This maximum power dissipation boundary will normally intersect the second breakdown boundary at some point.

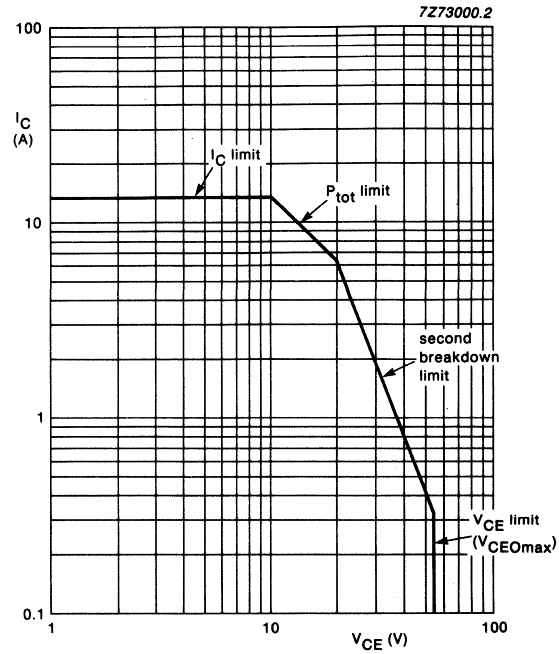
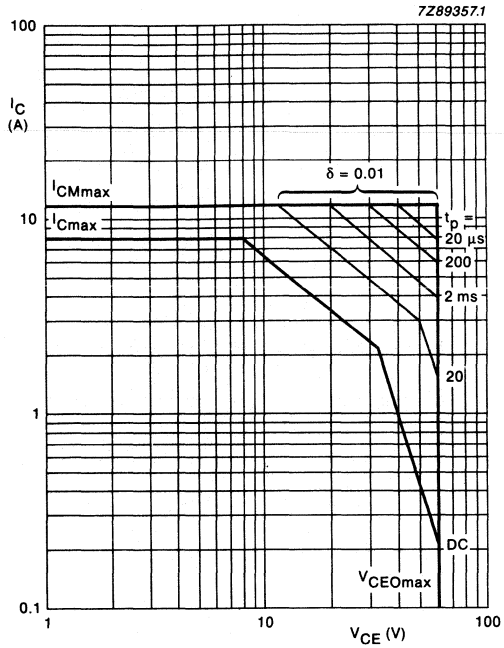


Fig. 3 A typical DC SOAR graph with boundaries defined.

At pulsed conditions

With the exception of DC FB-SOAR data sheets for power transistors contain a set of curves that apply under specific pulse conditions, that are normally at a duty factor of $\delta = 0.01$ and a pulse length of 20 ms or less.

An example of the FB-SOAR extension for single-shot and repetitive pulsed operation is shown in Fig. 4.



These curves for pulsed conditions are derived from the DC curve with the aid of the thermal impedance curves shown in Fig. 2.

All curves apply to the stated temperature (T_{mb} or T_h) above which derating must be applied.
A power derating curve of the form shown in Fig. 5 is given in the data sheets from which maximum allowable power dissipation for P_{tot} and S/B sat can be calculated for any T_{mb} or T_h up to $T_{j\ max}$.

Fig. 4 Maximum collector current and collector-emitter voltage for DC and pulsed conditions.

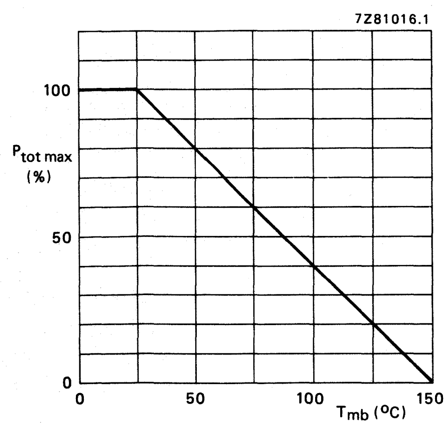
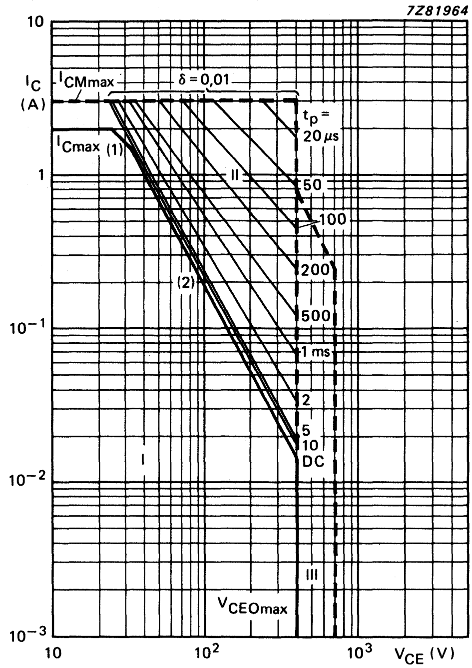


Fig. 5 Power derating curve, maximum permissible dissipation as a function of mounting base temperature.

FORWARD BIASED SAFE OPERATING AREA WITH $V_{CE} > V_{CEOmax}$



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.
III Area of permissible operation during turn-on in single transistor converters, providing $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 6.0\ \mu s$.

Fig. 6 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

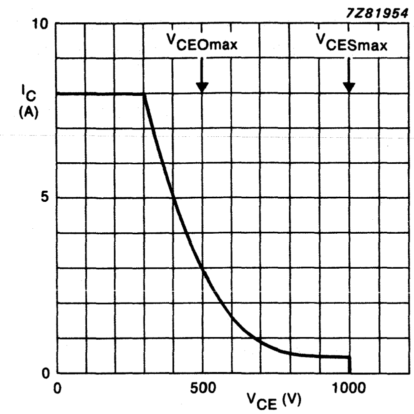
For switching power transistors in inductive load applications such as flyback converters, the collector-emitter voltage normally exceeds the rated V_{CEOmax} limit in the non-inductive stage. The collector current will rise steeply at turn on while the collector-emitter voltage is still greater than V_{CEOmax}. Under these conditions the collector current must be held to a safe level by means of load line shaping etc.

Fig. 6 shows FB-SOAR with an extension for turn-on (area III), (this is not temperature dependent and therefore derating at higher temperatures is not necessary).

REVERSE BIASED SAFE OPERATING AREA UP TO V_{CESmax} (RB-SOAR)

At turn-off of inductive loaded transistors, where in most cases the base to emitter junction is reverse biased, the collector to emitter voltage will rise steeply to a high level while the collector is still conducting. Under these conditions the collector voltage must be held to a safe level by means of clamping, snubbing etc.

The safe level of operation is contained in the data sheets in the form shown in Fig. 7.



This turn-off extension is not temperature dependent and so derating at higher temperatures is not necessary.

Fig. 7 Reverse biased area of permissible operation during turn-off, providing that $T_{mb} \leqslant 100\ ^oC$; $V_{BE\ off} = 5$ V; $I_C/I_B \geqslant 5$.

HOW TO USE THE SOAR INFORMATION FROM THE DATA SHEETS

When the intended function of the power transistor and its application is decided, a suitable device can be selected using the following ratings from the quick reference data:

Collector current	I_C or I_{CM}
Collector voltage	V_{CEO} or V_{CES}
Maximum allowable dissipation	P_{tot}
Maximum allowable junction temperature	T_j
Required gain	h_{FE}
Required speed	t_f or f_T

Now determine the following parameters for the intended application.

Duty factor	d
Maximum operational ambient temperature	T_{amb}
Maximum operational worse case average dissipation	P_{wc}

The next step is to calculate the required thermal resistance of the heatsink ($R_{th\ h\text{-}a}$) as follows:

For direct mounted devices:

$$R_{th\ h\text{-}a} = \frac{T_j - T_{mb}}{P_{wc}} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h})$$

For fully isolated devices:

$$R_{th\ h\text{-}a} = \frac{T_j - T_{mb}}{P_{wc}} - R_{th\ j\text{-}h}$$

Also calculate the mounting base temperature (T_{mb} or T_h) as follows:

For direct mounted devices:

$$T_{mb} = T_{amb} + P_{wc}\,(R_{th\ h\text{-}a} + R_{th\ mb\text{-}h})$$

For fully isolated devices:

$$T_h = T_{amb} + P_{wc} \times R_{th\ h\text{-}a}$$

The SOAR data sheet curves, thermal impedance and derating may now be used to construct a safe operating area for the device, (this is adaptable to the conditions for the application e.g. T_{mb} , pulse time and duty factor).

The last step is to measure the I_C/V_{CE} locus in your application and check that it does not exceed the previously constructed SOAR graph. In switching applications check also the extensions for turn-on and turn-off.

If the SOAR of the prefered transistor does not fit, select the nearest suitable device or modify the circuitry.

TRANSISTOR DATA

SILICON PLANAR EPITAXIAL POWER TRANSISTOR

N-P-N transistor in a SOT-32 plastic envelope for general purpose, medium power applications. P-N-P complement is BD132.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	70	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector current (d.c.)	I_C	max.	3	A
Collector current (peak value)	I_{CM}	max.	6	A
Total power dissipation up to T_{mb} = 60 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 0,5 A; V_{CE} = 12 V	h_{FE}	>	40	
Transition frequency at f = 35 MHz I_C = 0,25 A; V_{CE} = 5 V	f_T	>	60	MHz

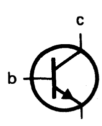
MECHANICAL DATA

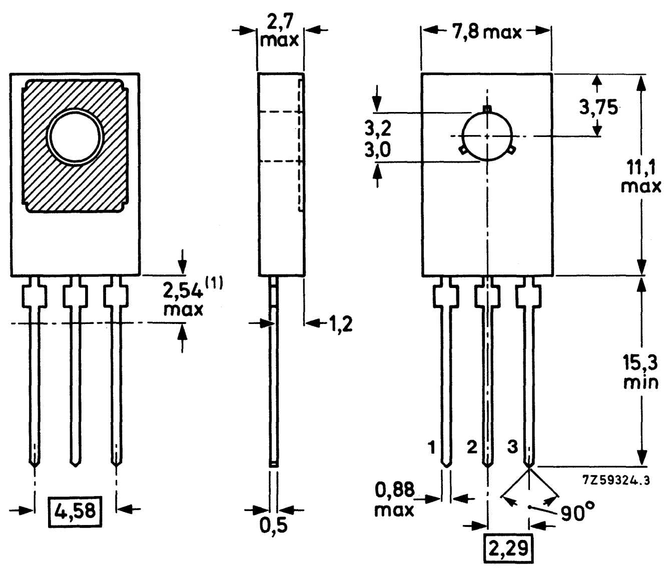
Dimensions in mm

Fig. 1 TO-126 (SOT-32).

Collector connected to metal part of mounting surface.

Pinning
1 = emitter
2 = collector
3 = base





See also chapters Mounting instructions and Accessories.

(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	V_{CBO}	max.	70	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V
Collector current (d.c.)	I_C	max.	3	A
Collector current (peak value)	I_{CM}	max.	6	A
Base current (peak value)	I_{BM}	max.	0,5	A
Reverse base current (peak value)	$-I_{BM}$	max.	0,5	A
Total power dissipation up to T_{mb} = 60 °C	P_{tot}	max.	15	W
Storage temperature	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	6	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
I_E = 0; V_{CB} = 50 V	I_{CBO}	<	5 μA
I_E = 0; V_{CB} = 50 V; T_j = 150 °C	I_{CBO}	<	500 μA
Emitter cut-off current			
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	5 μA
Saturation voltages			
I_C = 0,5 A; I_B = 50 mA	V_{CEsat}	<	0,3 V
	V_{BEsat}	<	1,2 V
I_C = 2 A; I_B = 200 mA	V_{CEsat}	<	0,7 V
	V_{BEsat}	<	1,5 V
D.C. current gain			
I_C = 0,5 A; V_{CE} = 12 V	h_{FE}	>	40
I_C = 2 A; V_{CE} = 1 V	h_{FE}	>	20
Collector capacitance at f = 1 MHz			
I_E = I_e = 0; V_{CB} = 5 V	C_c	<	60 pF
Transition frequency at f = 35 MHz			
I_C = 0,25 A; V_{CE} = 5 V; T_{amb} = 25 °C	f_T	>	60 MHz
D.C. current gain ratio of the complementary pairs			
I_C = 0,5 A; V_{CE} = 12 V	h_{FE1}/h_{FE2}	<	1,2

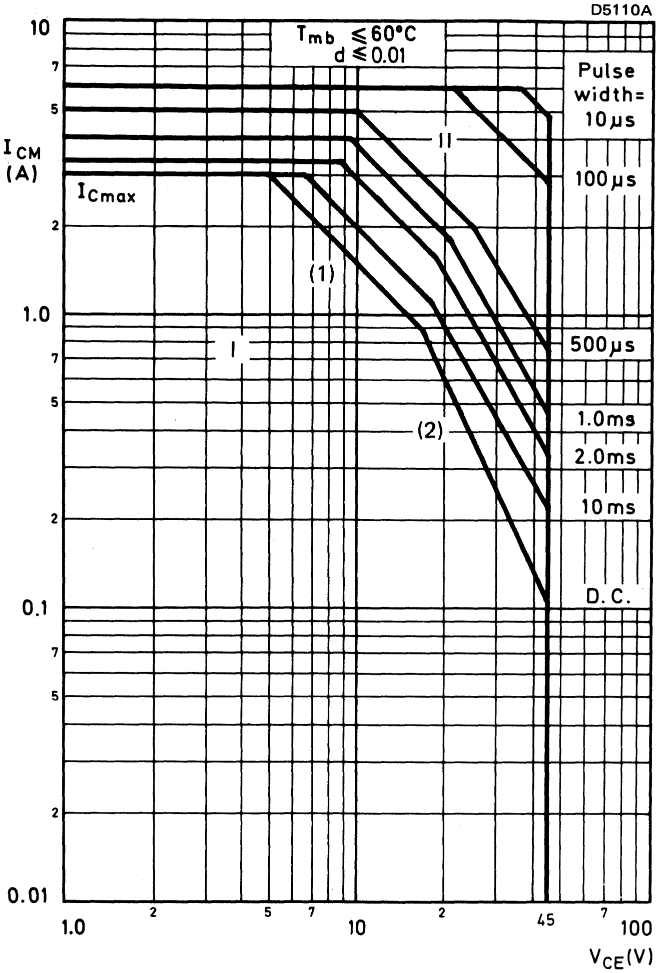


Fig. 2 Safe Operating ARea with the transistor forward biased.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second breakdown limits.

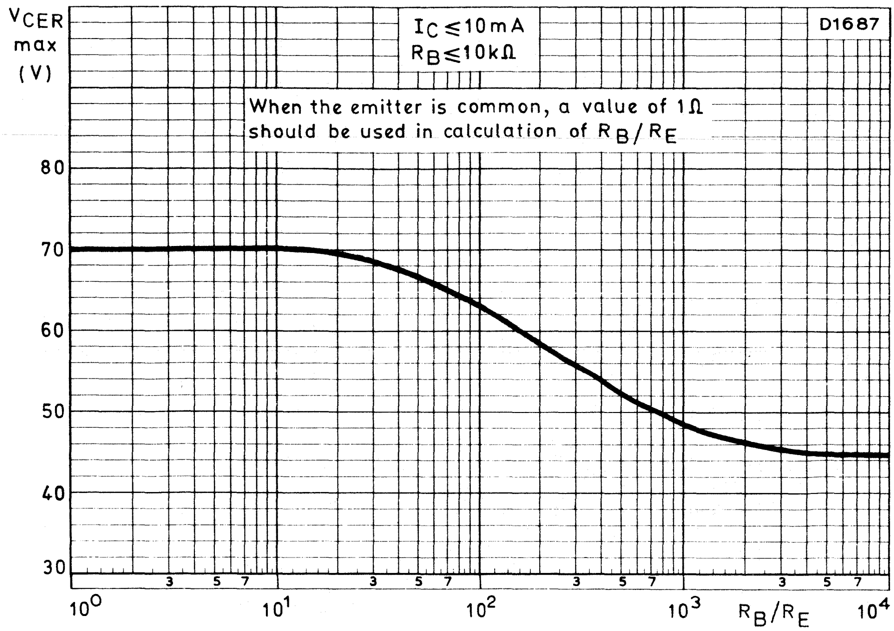


Fig. 3 Maximum allowable collector-emitter voltage as a function of base-emitter resistance.

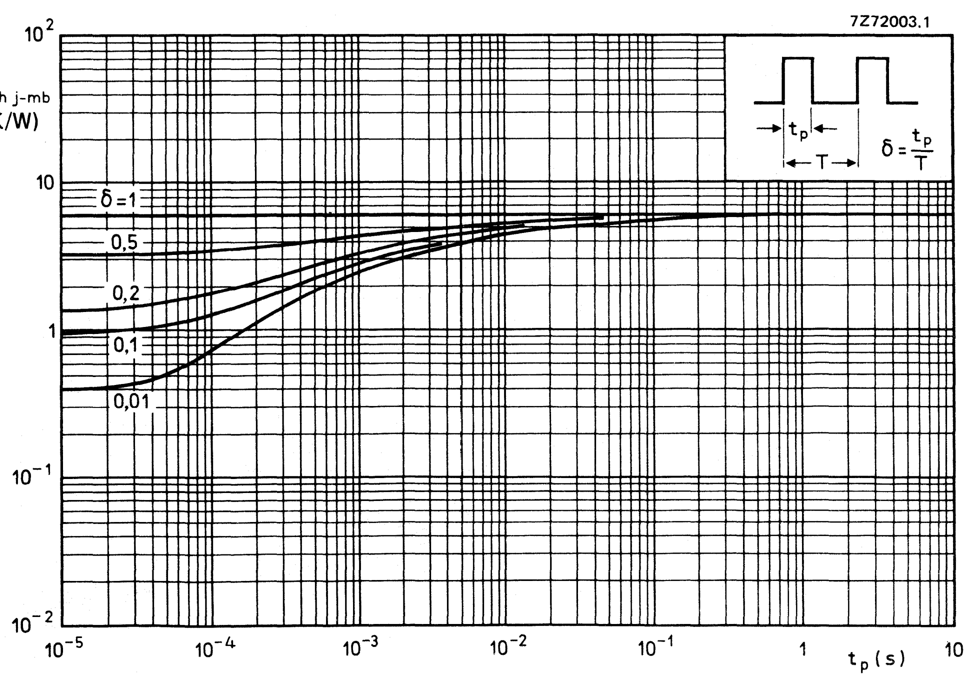


Fig. 4 Pulse power rating chart.

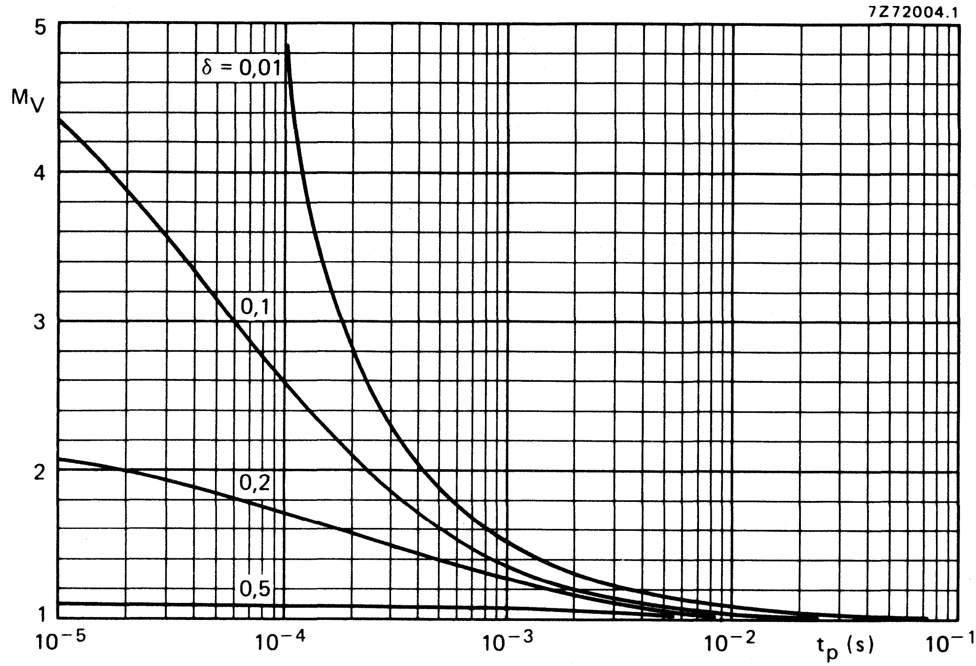


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

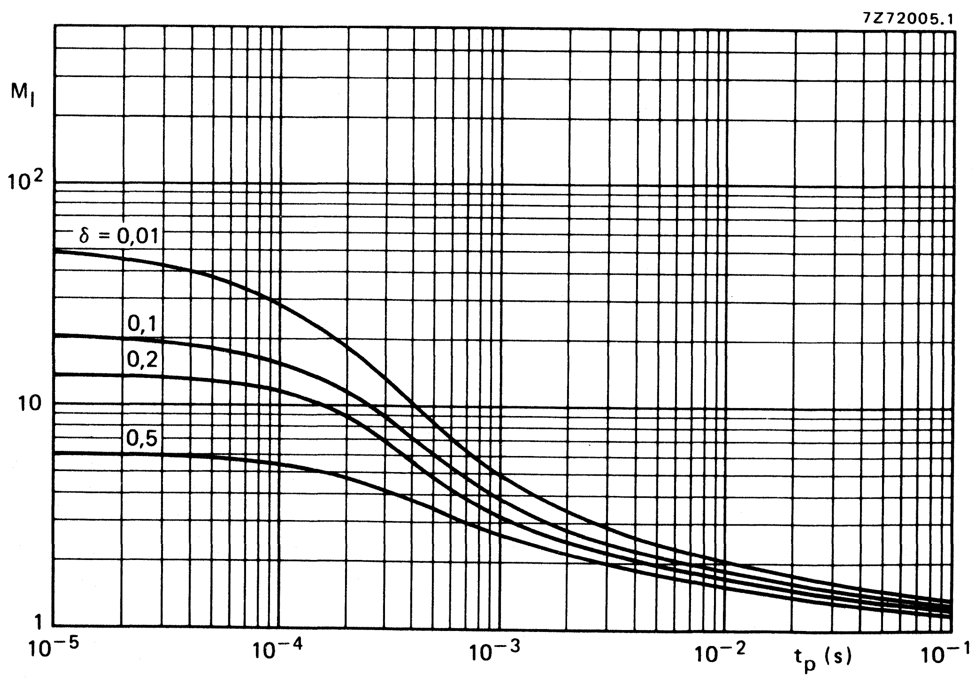


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level.

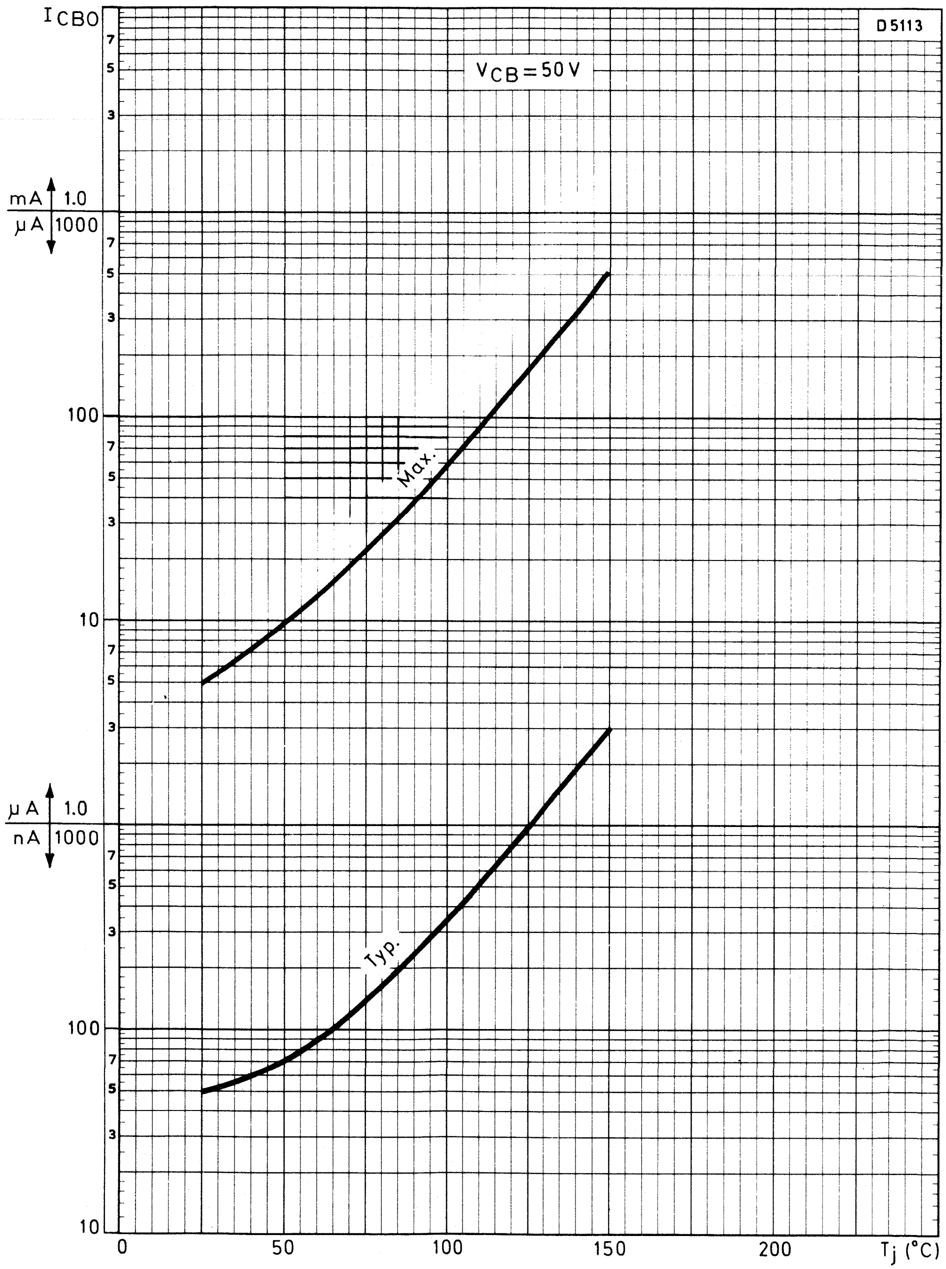


Fig. 7 Collector-base current (open emitter) as a function of the junction temperature.

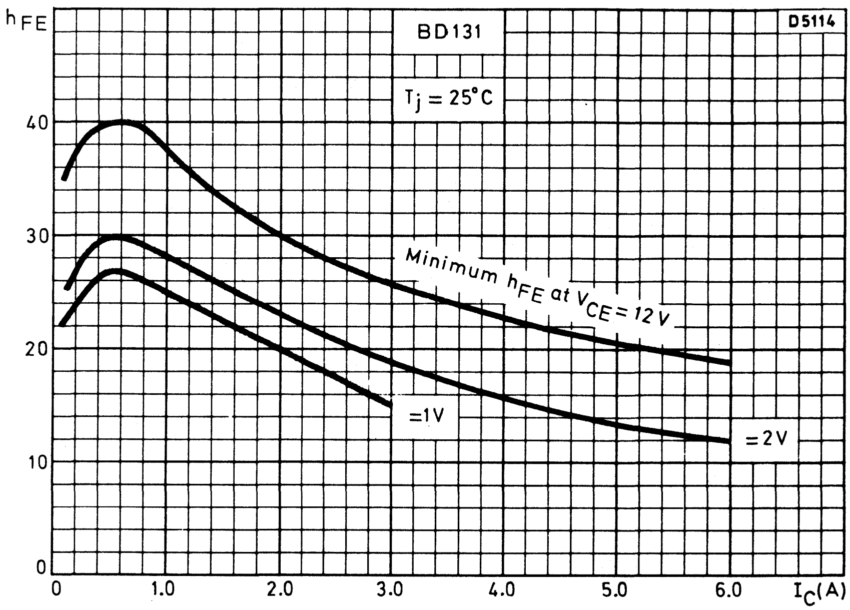

hFE
BD131
D5114
Tj = 25°C
40
30
20
10
0
Minimum hFE at VCE = 12 V
=1V
=2V
0
1.0
2.0
3.0
4.0
5.0
6.0
IC(A)

Fig. 8.

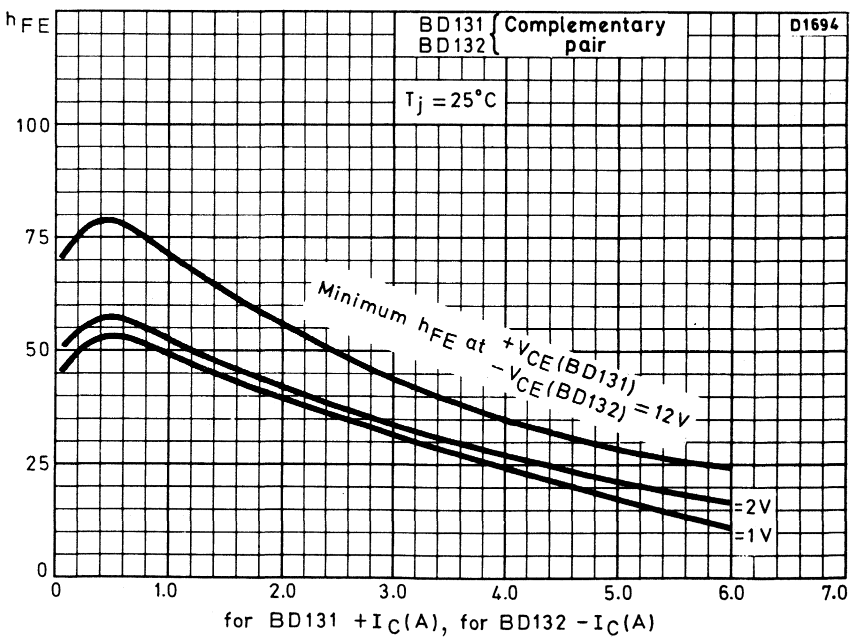

hFE
BD131 BD132 Complementary pair
D1694
Tj = 25°C
100
75
50
25
0
Minimum hFE at +VCE (BD131) −VCE (BD132) = 12 V
=2V
=1V
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
for BD131 +IC(A), for BD132 −IC(A)

Fig. 9.

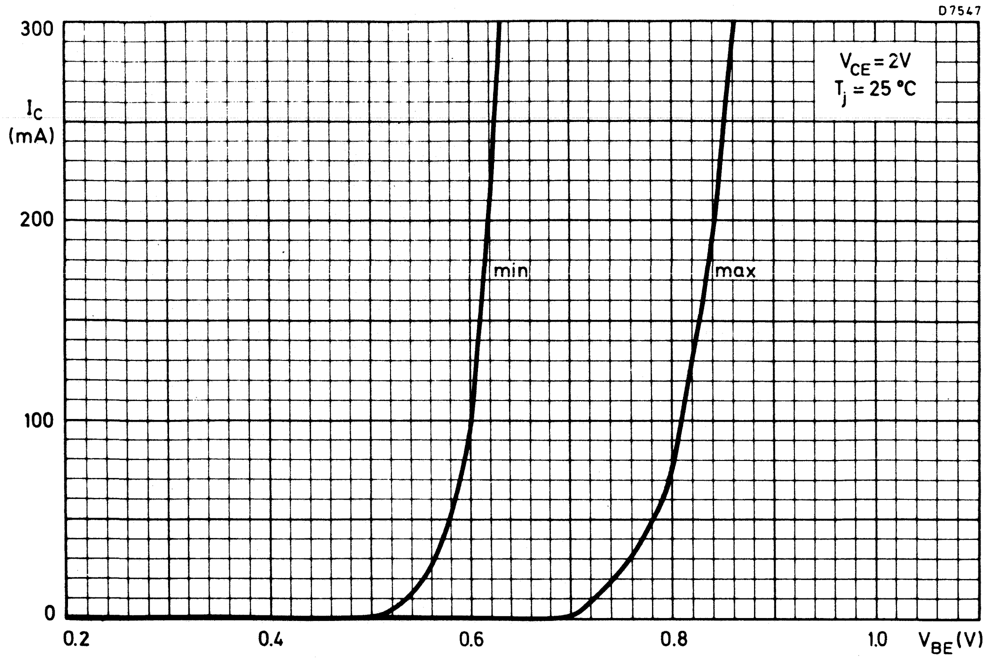

D7547
300
200
100
0
I_C
(mA)
0.2
0.4
0.6
0.8
1.0
V_{BE}(V)
min
max
V_{CE} = 2V
T_j = 25 °C

Fig. 10.

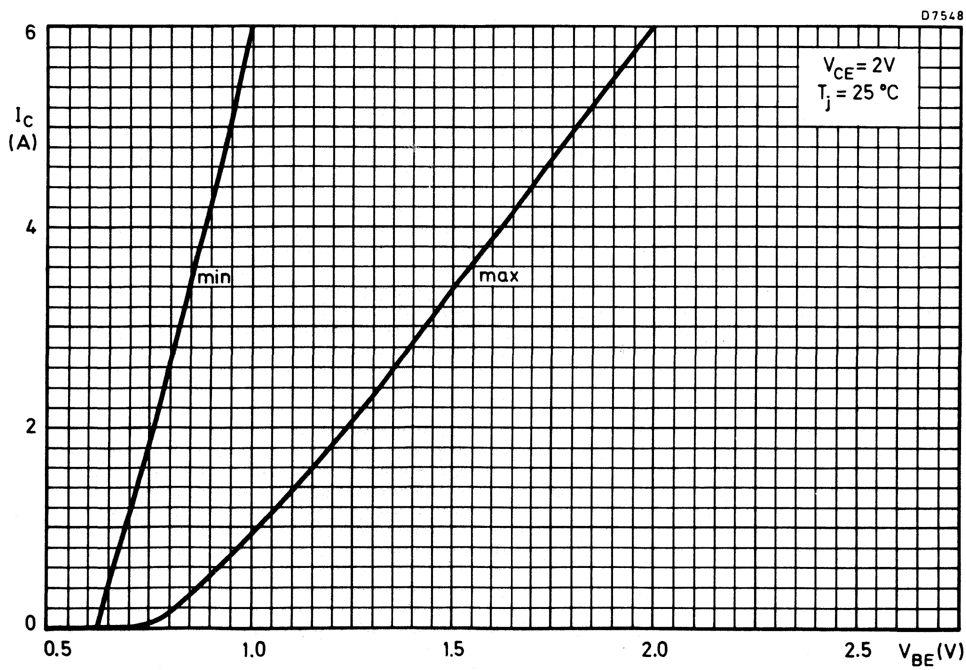

D7548
6
4
2
0
I_C
(A)
0.5
1.0
1.5
2.0
2.5
V_{BE}(V)
min
max
V_{CE} = 2V
T_j = 25 °C

Fig. 11.

SILICON PLANAR EPITAXIAL POWER TRANSISTOR

P-N-P transistor in a SOT-32 plastic envelope for general purpose, medium power applications. N-P-N complement is BD131.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	V
Collector current (d.c.)	$-I_C$	max.	3	A
Collector current (peak value)	$-I_{CM}$	max.	6	A
Total power dissipation up to T_{mb} = 60 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	150	°C
D.C. current gain $-I_C$ = 0,5 A; $-V_{CE}$ = 12 V	h_{FE}	>	40	
Transition frequency at f = 35 MHz $-I_C$ = 0,25 A; $-V_{CE}$ = 5 V	f_T	>	60	MHz

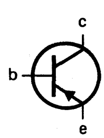
MECHANICAL DATA

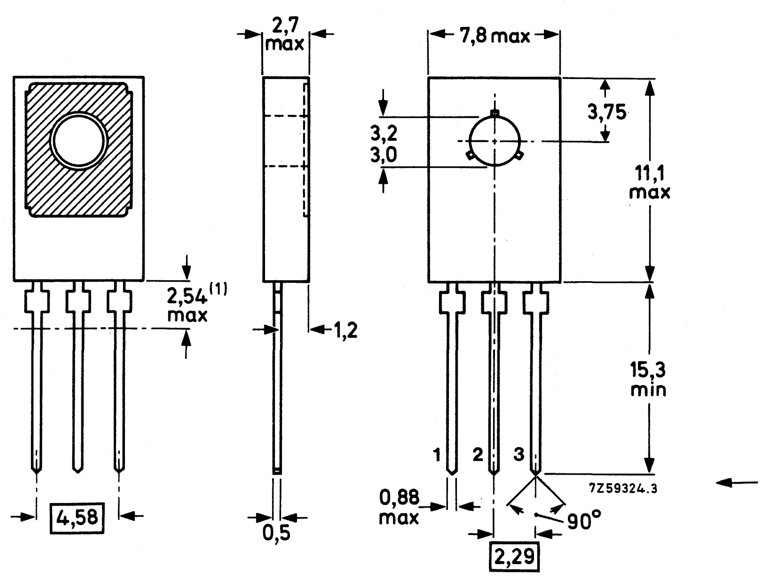
Dimensions in mm

Fig. 1 TO-126 (SOT-32)

Collector connected to metal part of mounting surface.

Pinning
1 = emitter
2 = collector
3 = base





See also chapters Mounting instructions and Accessories.

(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4	V
Collector current (d.c.)	$-I_C$	max.	3	A
Collector current (peak value)	$-I_{CM}$	max.	6	A
Base current (peak value)	$-I_{BM}$	max.	0,5	A
Reverse base current (peak value)	$+I_{BM}$	max.	0,5	A
Total power dissipation up to T_{mb} = 60 °C	P_{tot}	max.	15	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	6	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB}$ = 40 V	$-I_{CBO}$	<	5	μA
$I_E = 0$; $-V_{CB}$ = 40 V; T_j = 150 °C	$-I_{CBO}$	<	500	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB}$ = 3 V	$-I_{EBO}$	<	5	μA
Saturation voltages				
$-I_C$ = 0,5 A; $-I_B$ = 50 mA	$-V_{CEsat}$	<	0,3	V
	$-V_{BEsat}$	<	1,2	V
$-I_C$ = 2 A; $-I_B$ = 200 mA	$-V_{CEsat}$	<	0,7	V
	$-V_{BEsat}$	<	1,5	V
D.C. current gain				
$-I_C$ = 0,5 A; $-V_{CE}$ = 12 V	h_{FE}	>	40	
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	>	20	
Transition frequency at f = 35 MHz				
$-I_C$ = 0,25 A; $-V_{CE}$ = 5 V; T_{amb} = 25 °C	f_T	>	60	MHz
D.C. current gain ratio of the complementary pairs				
$-I_C$ = 500 mA; $-V_{CE}$ = 12 V	h_{FE1}/h_{FE2}	<	1,2	

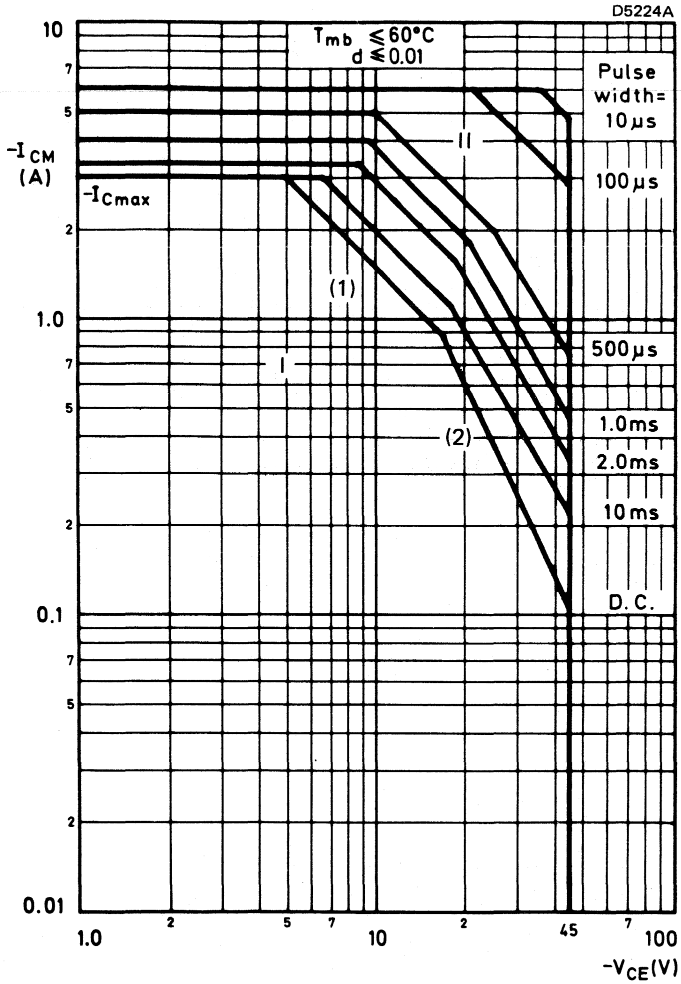


Fig. 2 Safe Operating ARea with the transistor forward biased.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second breakdown limits.

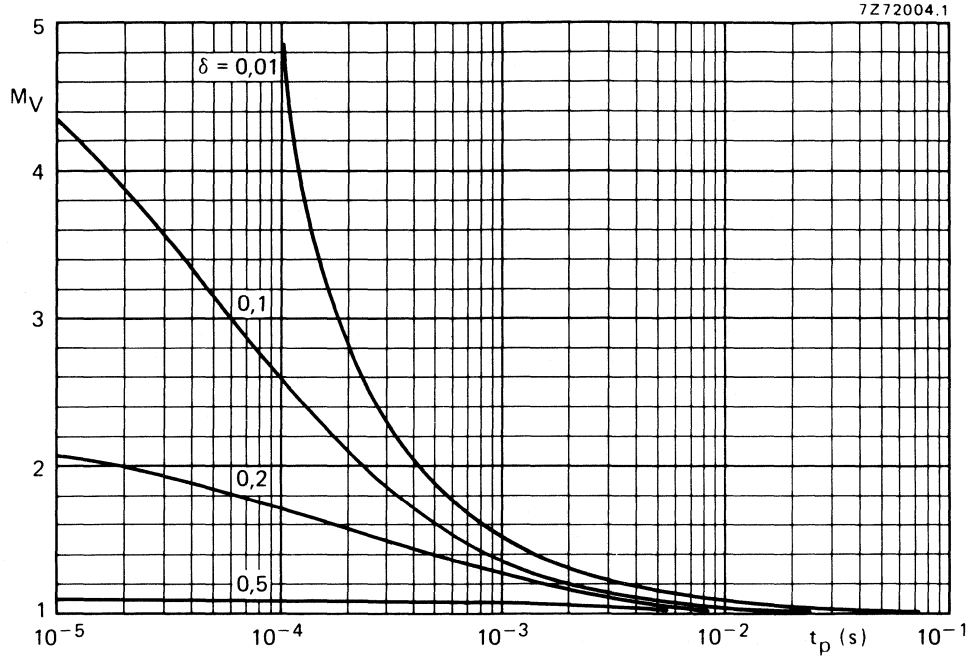


Fig. 3 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

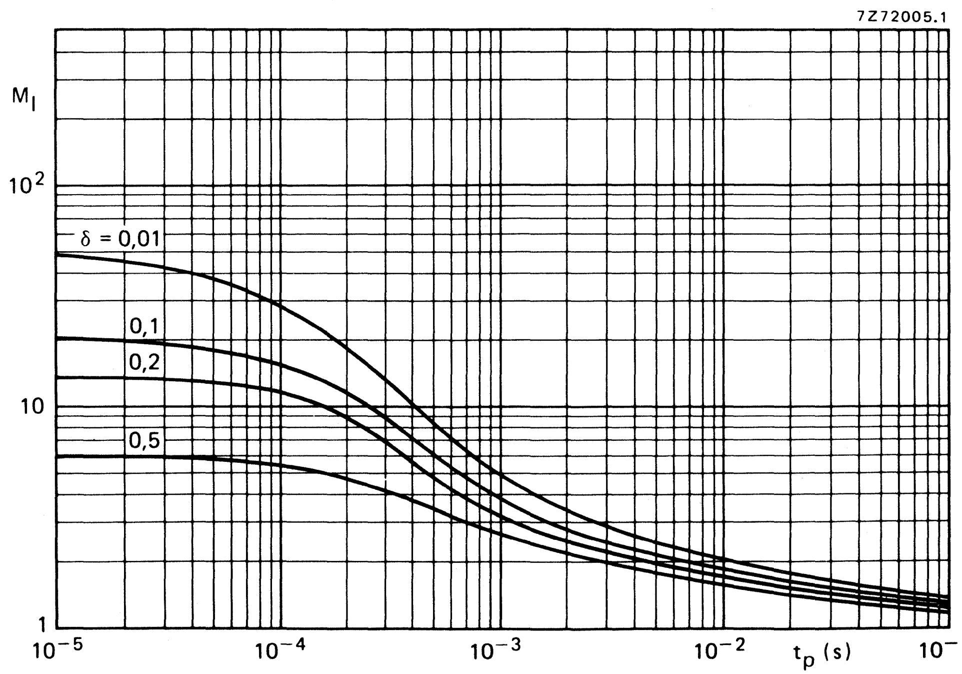


Fig. 4 S.B. current multiplying factor at the $-V_{CEOmax}$ level.

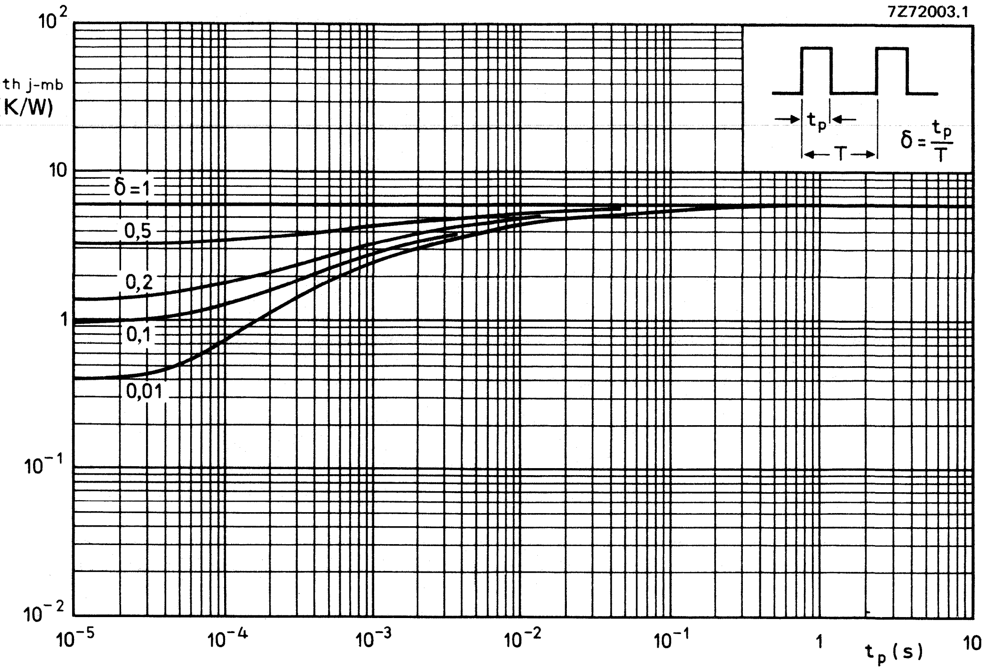


Fig. 5 Pulse power rating chart.

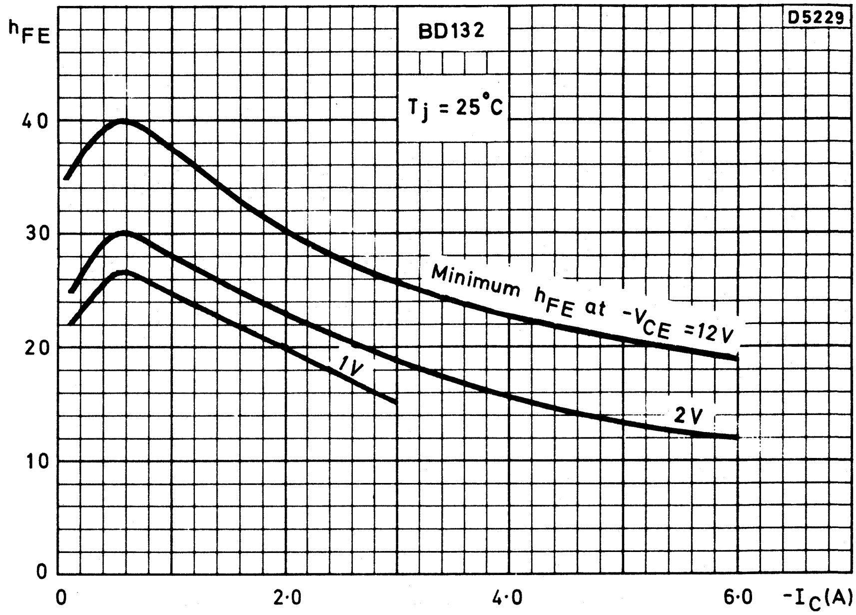


Fig. 6 D.C. current gain.

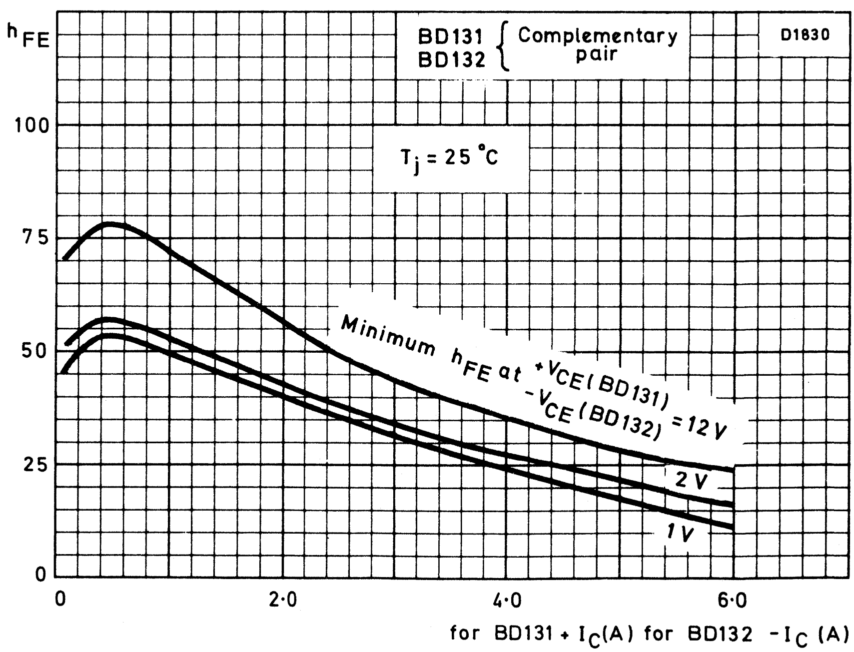


Fig. 7 D.C. current gain ratio.

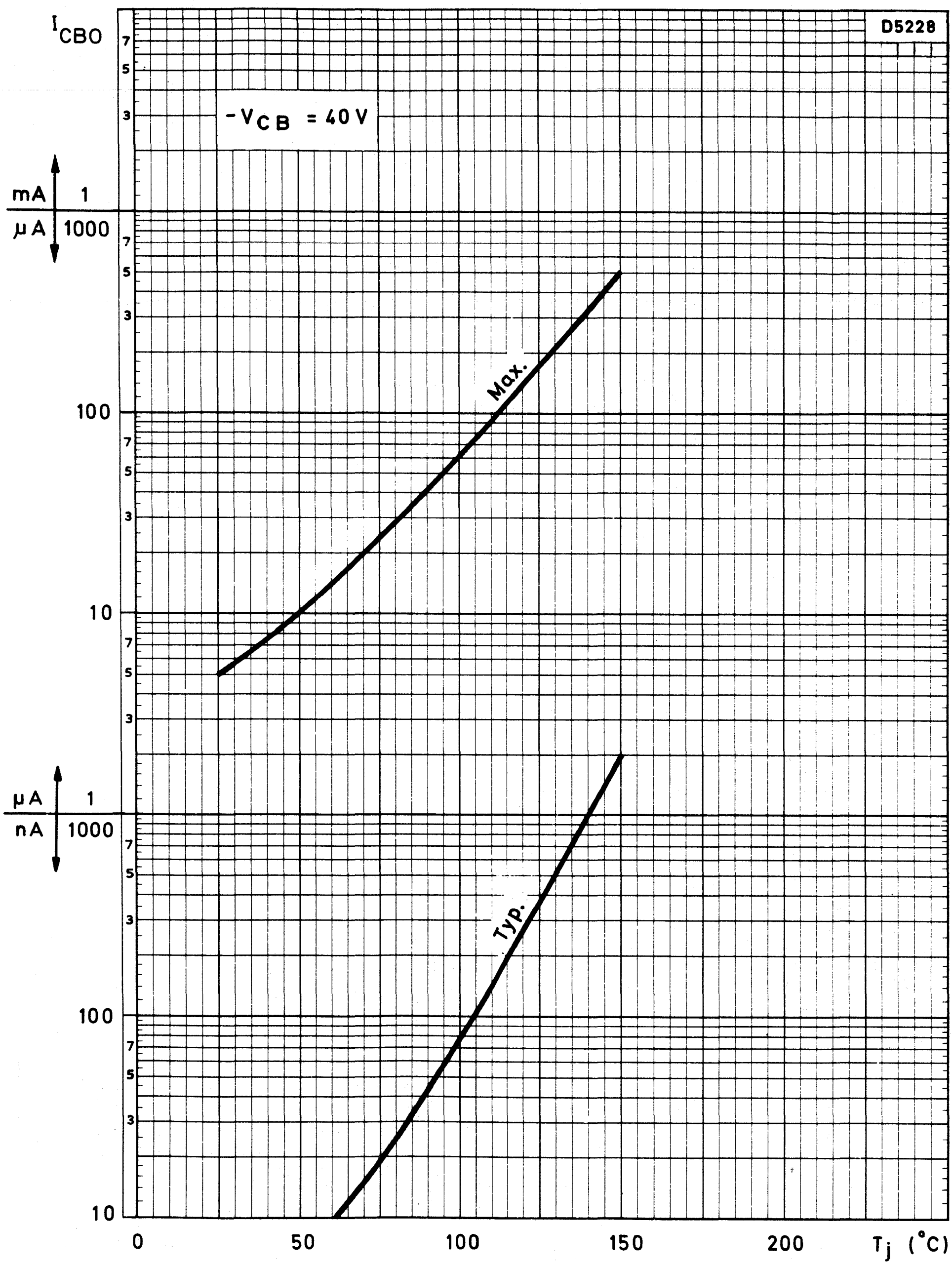


Fig. 8 Collector-base current (open emitter) as a function of the junction temperature.

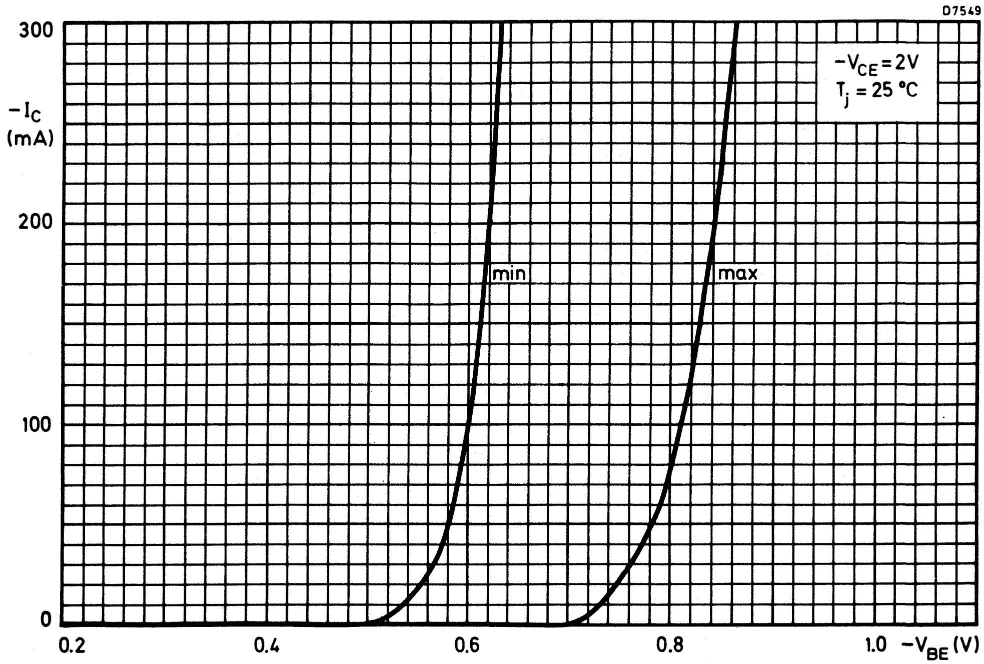

D7549
300
200
100
0
$-I_C$ (mA)
0.2
0.4
0.6
0.8
1.0
$-V_{BE}$ (V)
$-V_{CE} = 2V$
$T_j = 25\ °C$
min
max

Fig. 9.

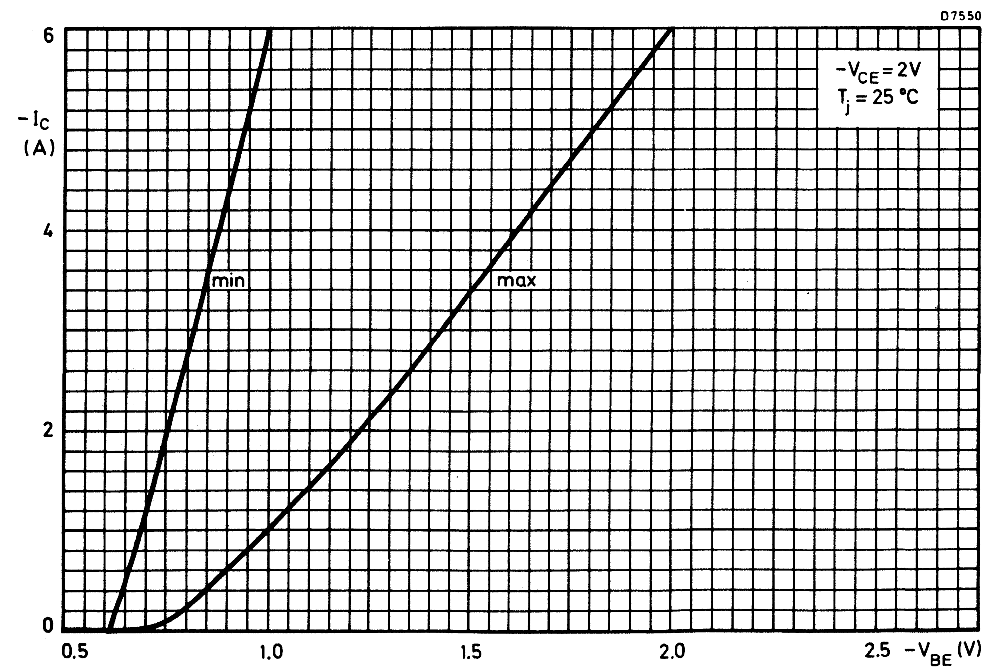

D7550
6
4
2
0
$-I_C$ (A)
0.5
1.0
1.5
2.0
2.5
$-V_{BE}$ (V)
$-V_{CE} = 2V$
$T_j = 25\ °C$
min
max

Fig. 10.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose n-p-n transistors in SOT-32 plastic envelope, recommended for driver stages in hi-fi amplifiers and television circuits.
The BD136, BD138 and BD140 are complementary to the BD135, BD137 and BD139 respectively.

QUICK REFERENCE DATA

			BD135	BD137	BD139	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (d.c.)	I_C	max.	1,5	1,5	1,5	A
Collector current (peak value)	I_{CM}	max.	2,0	2,0	2,0	A
Total power dissipation up to T_{mb} = 70 °C	P_{tot}	max.	8	8	8	W
Junction temperature	T_j	max.	150	150	150	°C
D.C. current gain I_C = 150 mA; V_{CE} = 2 V	h_{FE}	>	40	40	40	
		<	250	250	250	
Transition frequency I_C = 50 mA; V_{CE} = 5 V	f_T	typ.	250	250	250	MHz

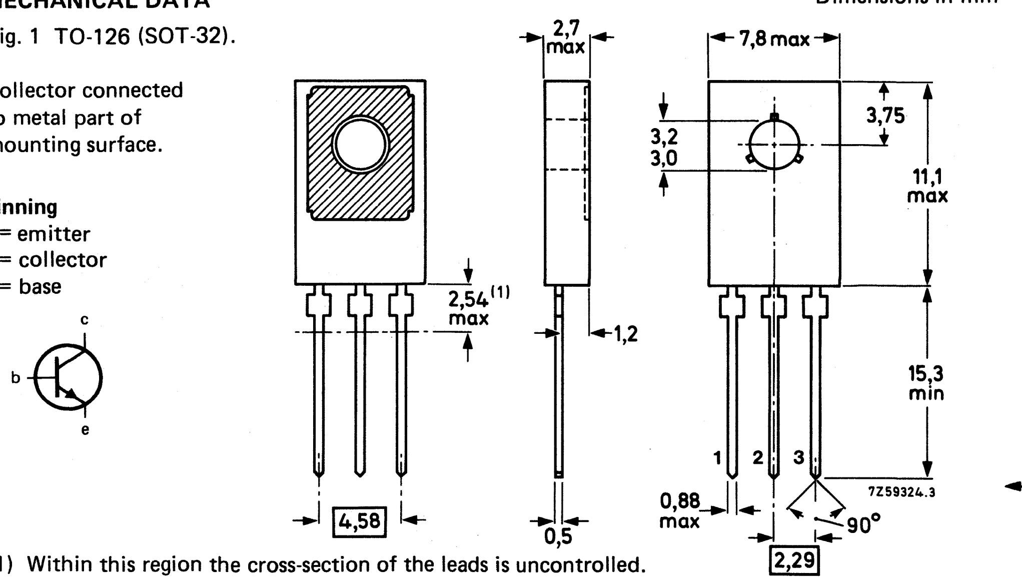
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126 (SOT-32).

Collector connected to metal part of mounting surface.

Pinning
1 = emitter
2 = collector
3 = base



(1) Within this region the cross-section of the leads is uncontrolled.

See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD135	BD137	BD139	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
Collector current (d.c.)	I_C	max.	1,5	1,5	1,5	A
Collector current (peak value)	I_{CM}	max.	2,0	2,0	2,0	A
Total power dissipation up to T_{mb} = 70 °C	P_{tot}	max.		8		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	10	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 125$ °C	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	μA
Base-emitter voltage				
$I_C = 500$ mA; $V_{CE} = 2$ V	V_{BE}	<	1	V
Saturation voltage				
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	0,5	V
D.C. current gain				
$I_C = 5$ mA; $V_{CE} = 2$ V	h_{FE}	>	25	
$I_C = 150$ mA; $V_{CE} = 2$ V				
BDxxx	h_{FE}		40 to 250	
BDxxx-6	h_{FE}		40 to 100	
BDxxx-10	h_{FE}		63 to 160	
BDxxx-16	h_{FE}		100 to 250	
$I_C = 500$ mA; $V_{CE} = 2$ V	h_{FE}	>	25	
Transition frequency at f = 35 MHz				
$I_C = 50$ mA; $V_{CE} = 5$ V	f_T	typ.	250	MHz
D.C. current gain ratio of matched pairs				
BD135/BD136; BD137/BD138; BD139/BD140				
$\lvert I_C \rvert = 150$ mA; $\lvert V_{CE} \rvert = 2$ V	h_{FE1}/h_{FE2}	typ. <	1,3 1,6	

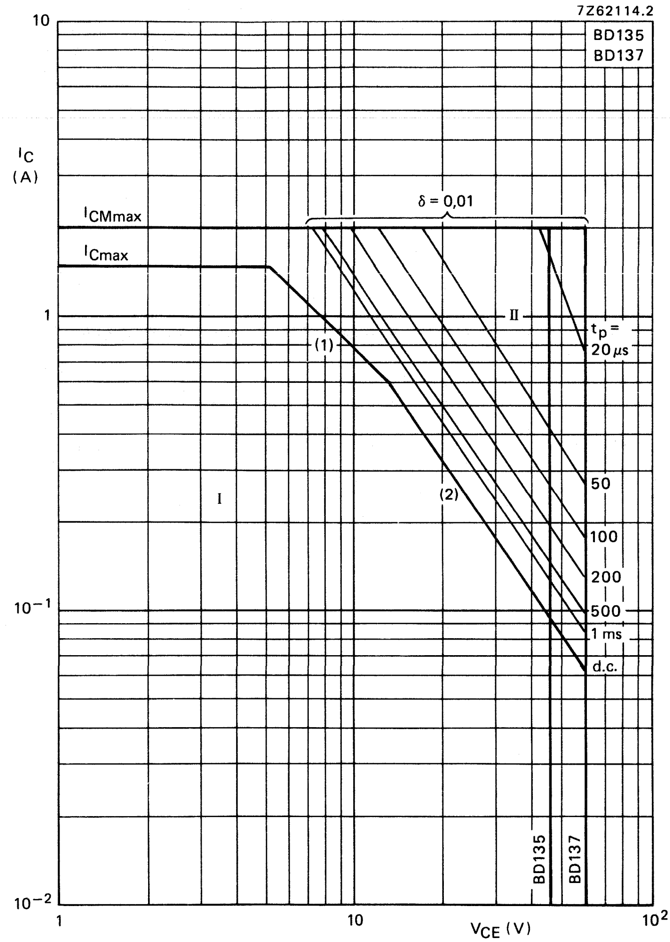


Fig. 2 Safe Operating Area with the transistor forward biased.

I Region of permissible d.c. operation
II Permissible extension for repetitive pulse operation

(1) $P_{tot\,max}$ line
(2) Second breakdown limits.

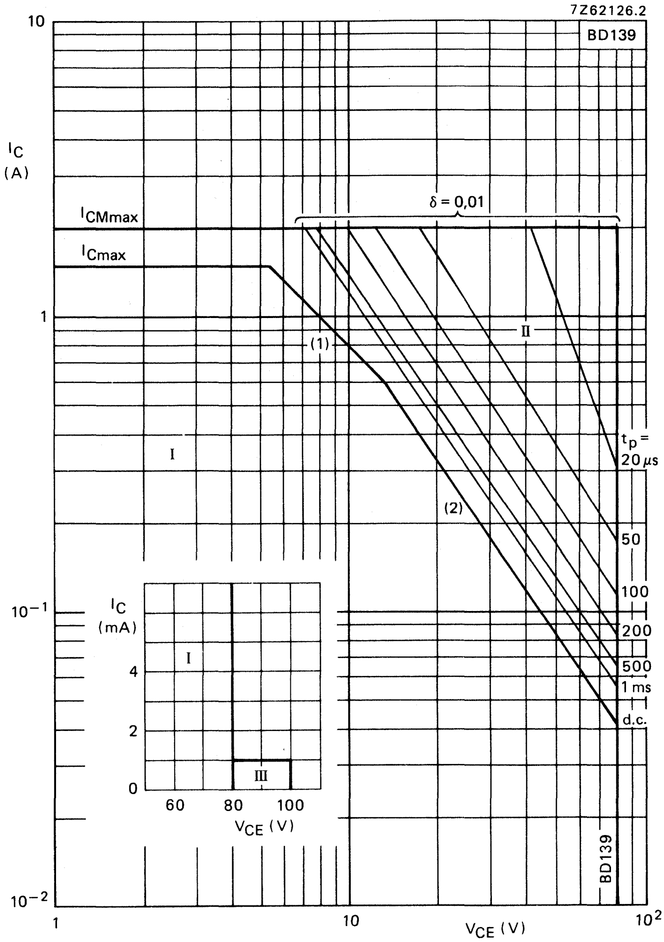


Fig. 3 Safe Operating Area with the transistor forward biased.

I Region of permissible d.c. operation
II Permissible extension for repetitive pulsed operation
III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leqslant 1\ k\Omega$

(1) $P_{tot\ max}$ line
(2) Second breakdown limit

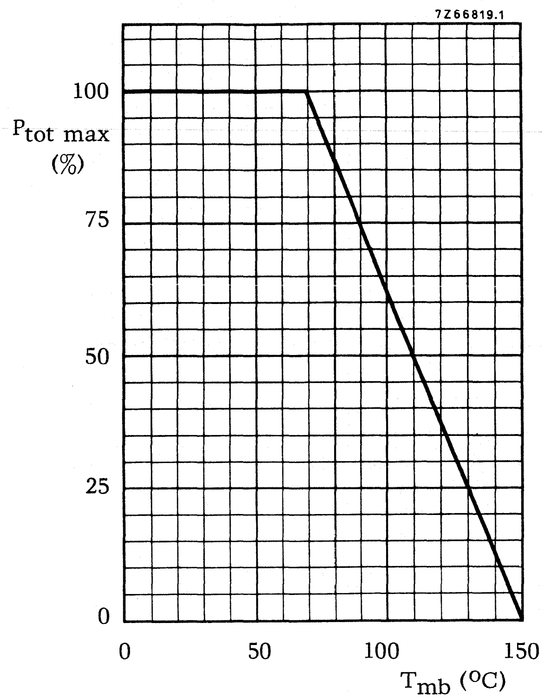

7Z66819.1
100
$P_{tot\ max}$
(%)
75
50
25
0
0
50
100
150
T_{mb} (°C)

Fig. 4.

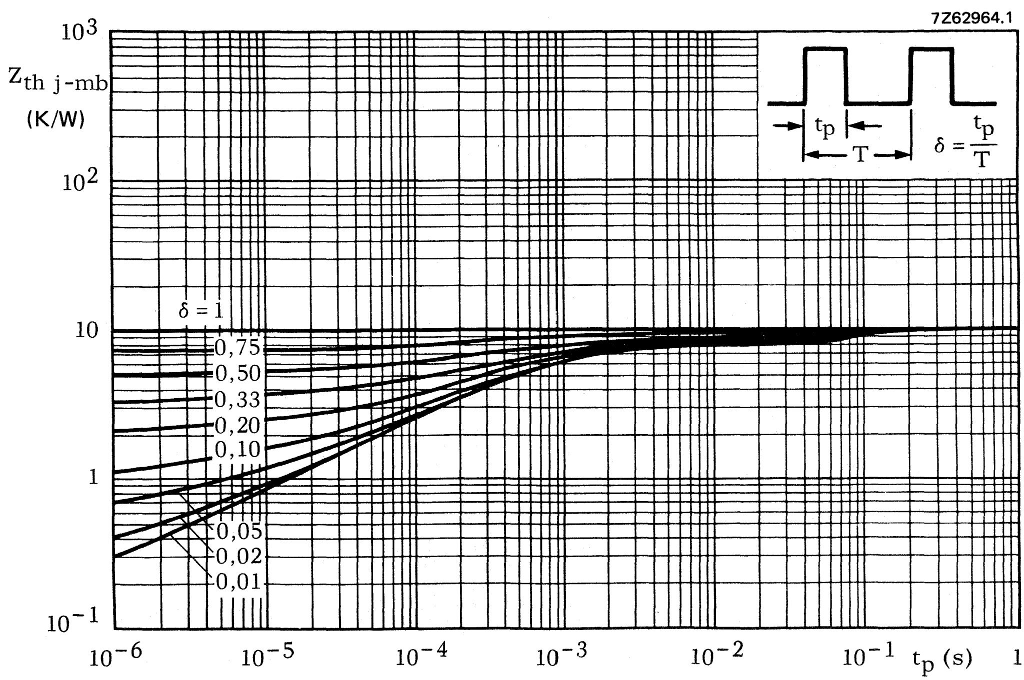

7Z62964.1
10^3
$Z_{th\ j\text{-}mb}$
(K/W)
10^2
10
1
10^{-1}
δ = 1
0,75
0,50
0,33
0,20
0,10
0,05
0,02
0,01
t_p
T
$\delta = \frac{t_p}{T}$
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
t_p (s)
1

Fig. 5.

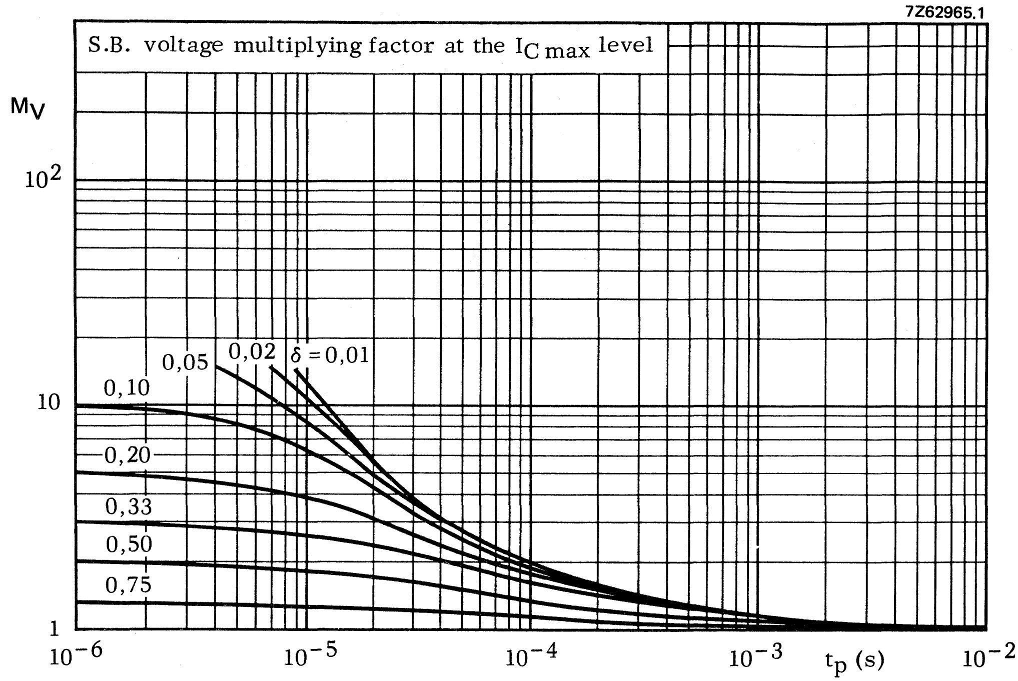

7Z62965.1
S.B. voltage multiplying factor at the $I_{C\,max}$ level
M_V
10^2
10
1
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}
0,05
0,02
$\delta = 0,01$
0,10
0,20
0,33
0,50
0,75

Fig. 6.

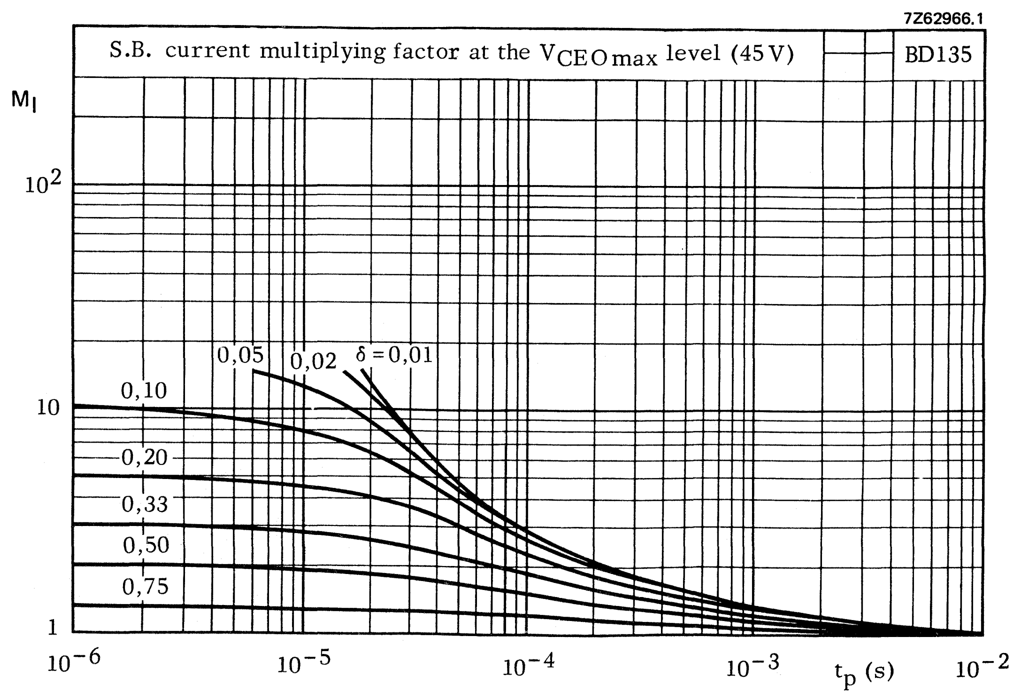

7Z62966.1
S.B. current multiplying factor at the $V_{CEO\,max}$ level (45 V)
BD135
M_I
10^2
10
1
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}
0,05
0,02
$\delta = 0,01$
0,10
0,20
0,33
0,50
0,75

Fig. 7.

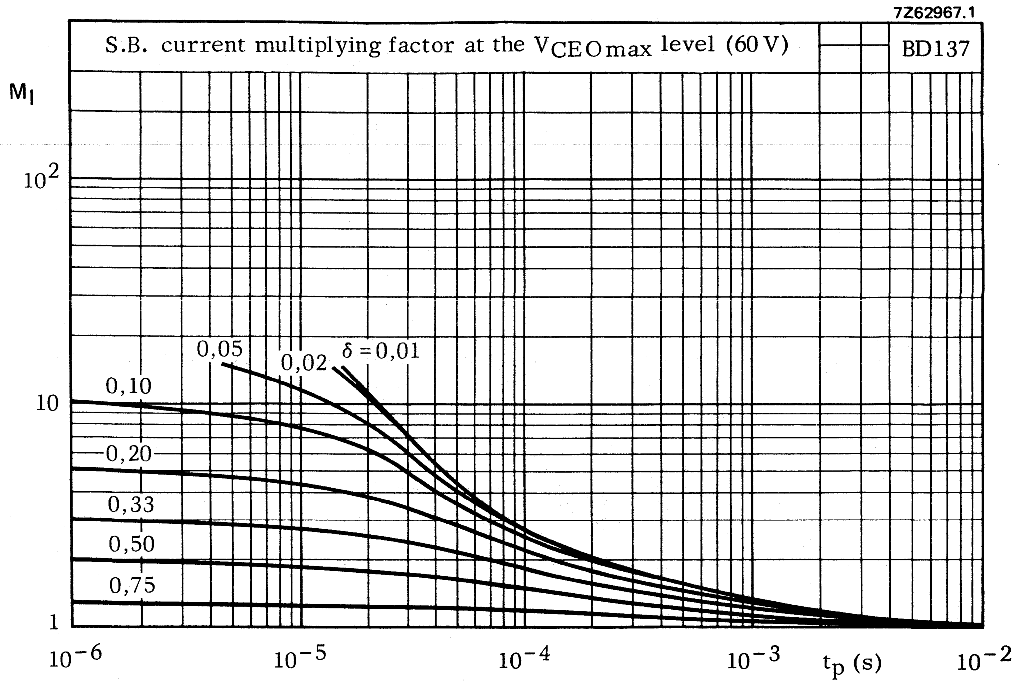

7Z62967.1
S.B. current multiplying factor at the $V_{CEO max}$ level (60 V)
BD137
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 8.

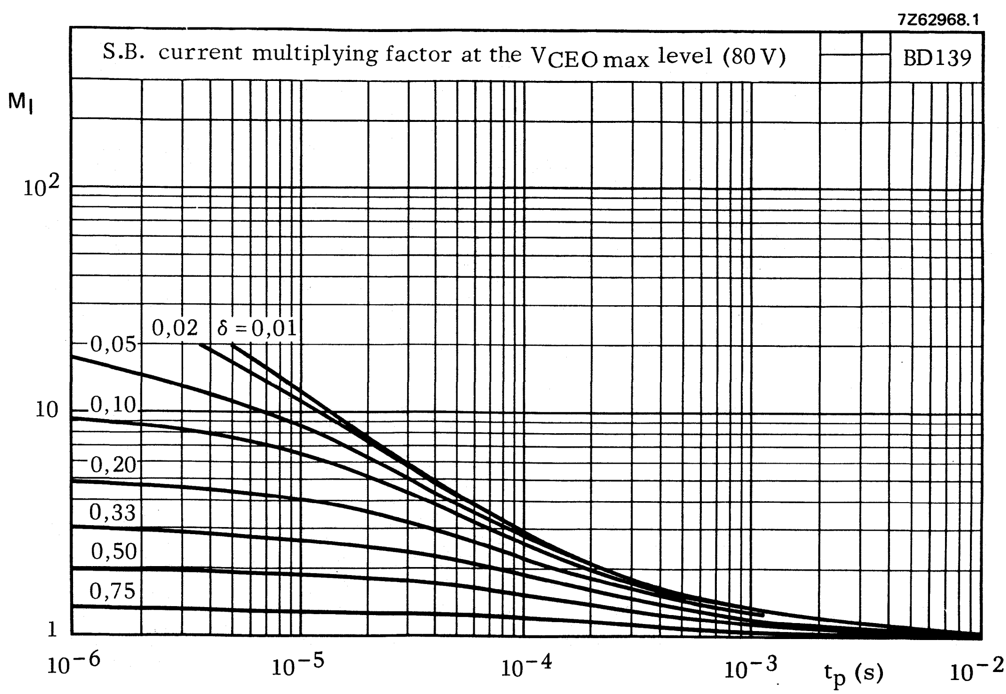

7Z62968.1
S.B. current multiplying factor at the $V_{CEO max}$ level (80 V)
BD139
M_I
10^2
10
1
0,02
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 9.

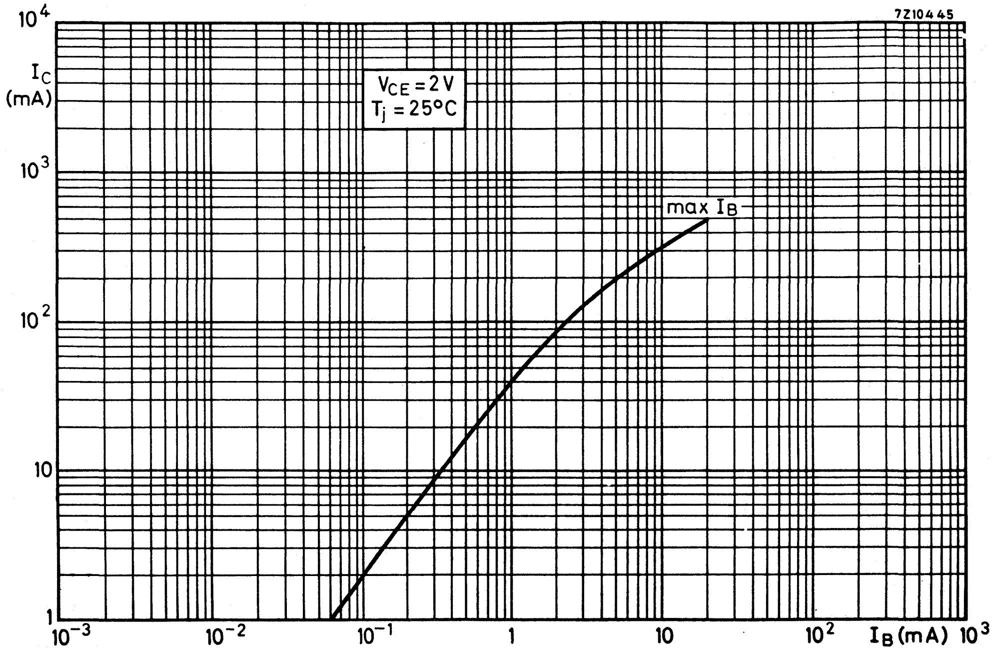

7Z10445
I_C (mA)
V_{CE} = 2 V
T_j = 25 °C
max I_B
10^4
10^3
10^2
10
1
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
I_B (mA)
10^3

Fig. 10.

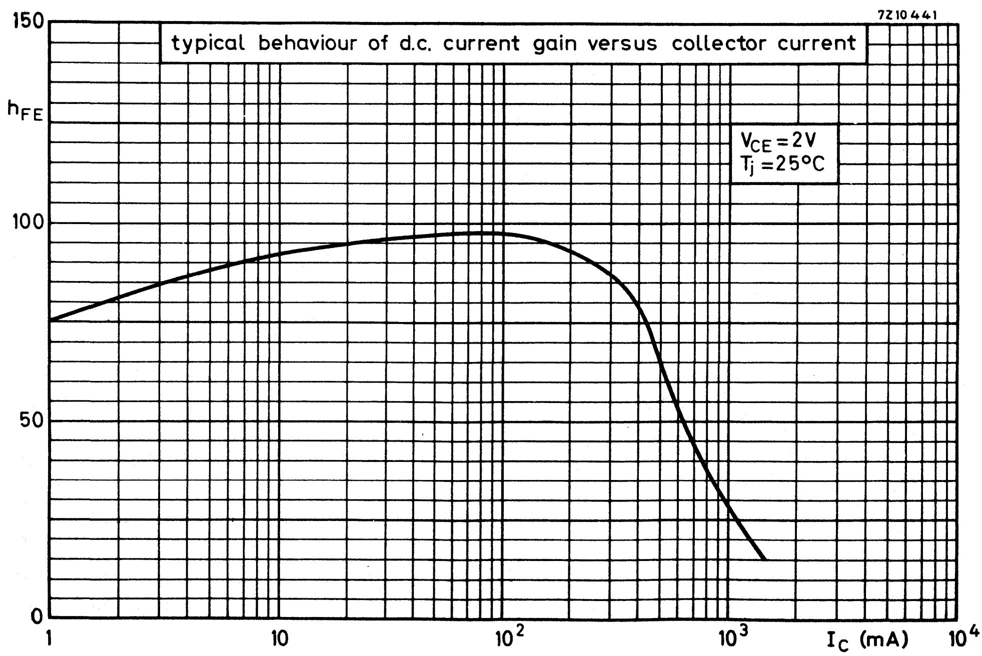

7Z10441
typical behaviour of d.c. current gain versus collector current
h_{FE}
V_{CE} = 2 V
T_j = 25 °C
150
100
50
0
1
10
10^2
10^3
I_C (mA)
10^4

Fig. 11.

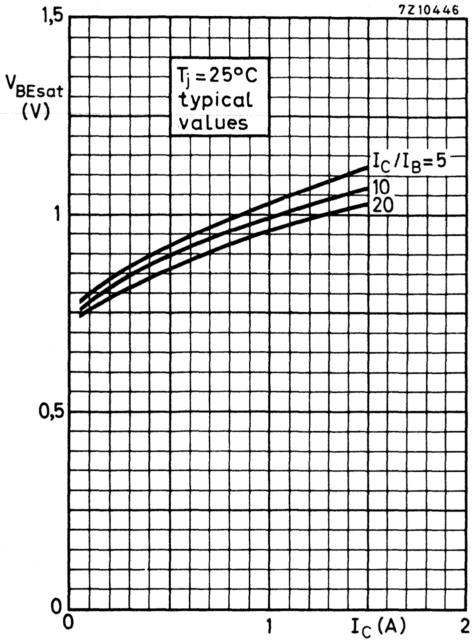


Fig. 12.

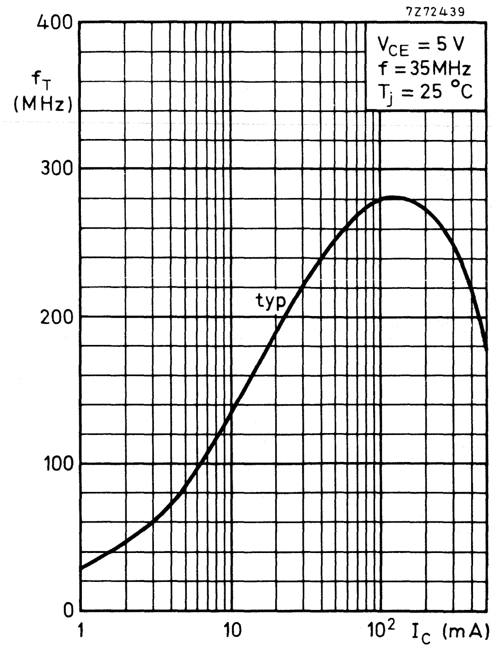


Fig. 13.

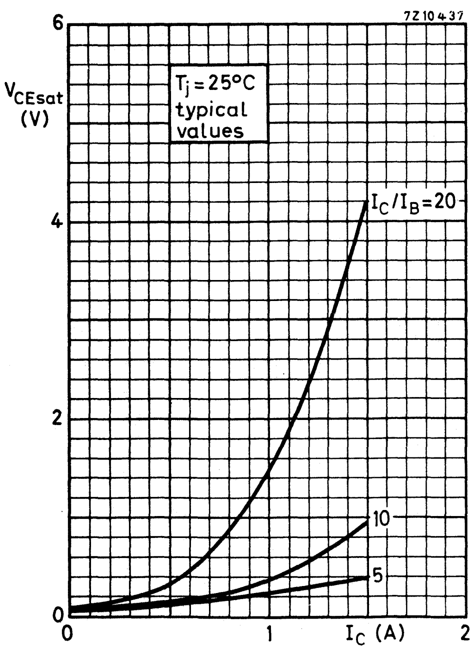


Fig. 14.

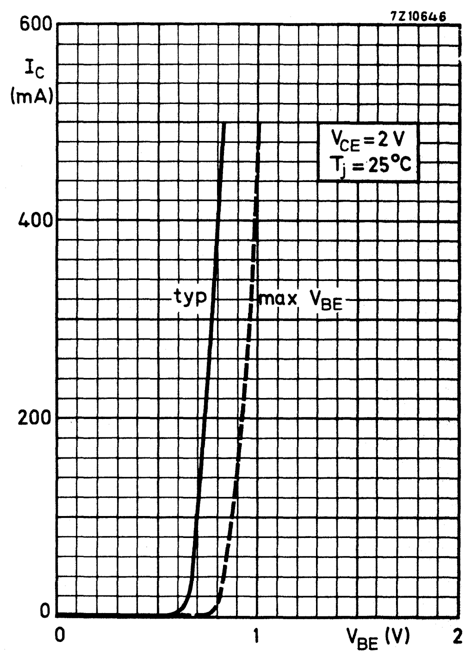


Fig. 15.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose p-n-p transistors in SOT-32 plastic envelope, recommended for driver stages in hi-fi amplifiers and television circuits.
The BD135, BD137 and BD139 are complementary to the BD136, BD138 and BD140 respectively.

QUICK REFERENCE DATA

			BD136	BD138	BD140	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector current (d.c.)	$-I_C$	max.	1,5	1,5	1,5	A
Collector current (peak value)	$-I_{CM}$	max.	2,0	2,0	2,0	A
Total power dissipation up to T_{mb} = 70 °C	P_{tot}	max.	8	8	8	W
Junction temperature	T_j	max.	150	150	150	°C
D.C. current gain $-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}	> <	40 250	40 250	40 250	
Transition frequency $-I_C$ = 50 mA; $-V_{CE}$ = 5 V	f_T	typ.	75	75	75	MHz

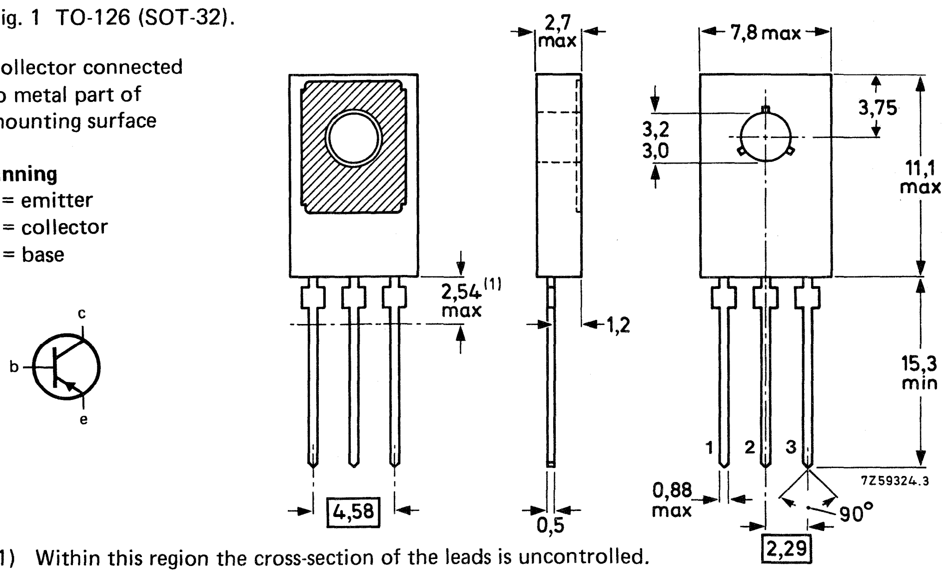
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126 (SOT-32).

Collector connected to metal part of mounting surface

Pinning
1 = emitter
2 = collector
3 = base



(1) Within this region the cross-section of the leads is uncontrolled.

See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD136	BD138	BD140	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (d.c.)	$-I_C$	max.	1,5	1,5	1,5	A
Collector current (peak value)	$-I_{CM}$	max.	2,0	2,0	2,0	A
Total power dissipation up to T_{mb} = 70 °C	P_{tot}	max.		8		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	10	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB}$ = 30 V	$-I_{CBO}$	<	100	nA
$I_E = 0$; $-V_{CB}$ = 30 V; T_j = 125 °C	$-I_{CBO}$	<	10	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	10	μA
Base-emitter voltage				
$-I_C$ = 500 mA; $-V_{CE}$ = 2 V	$-V_{EB}$	<	1	V
Saturation voltage				
$-I_C$ = 500 mA; $-I_B$ = 50 mA	$-V_{CEsat}$	<	0,5	V
D.C. current gain				
$-I_C$ = 5 mA; $-V_{CE}$ = 2 V	h_{FE}	>	25	
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V				
BDxxx	h_{FE}		40 to 250	
BDxxx-06	h_{FE}		40 to 100	
BDxxx-10	h_{FE}		63 to 160	
BDxxx-16	h_{FE}		100 to 250	
$-I_C$ = 500 mA; $-V_{CE}$ = 2 V	h_{FE}	>	25	
Transition frequency at f = 35 MHz				
$-I_C$ = 50 mA; $-V_{CE}$ = 5 V	f_T	typ.	75	MHz
D.C. current gain ratio of matched pairs				
BD135/BD136; BD137/BD138; BD139/BD140				
$\lvert I_C \rvert$ = 150 mA; $\lvert V_{CE} \rvert$ = 2 V	h_{FE1}/h_{FE2}	typ.	1,3	
		<	1,6	

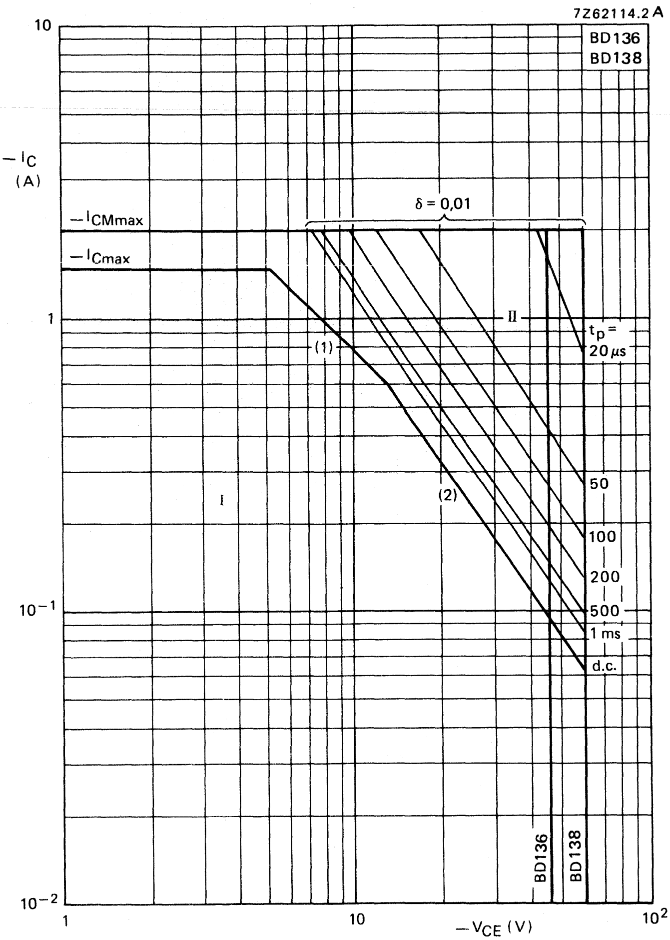


Fig. 2 Safe Operating Area with the transistor forward biased.

I Region of permissible d.c. operation
II Permissible extension for repetitive pulse operation

(1) $P_{tot\ max}$ line
(2) Second breakdown limits.

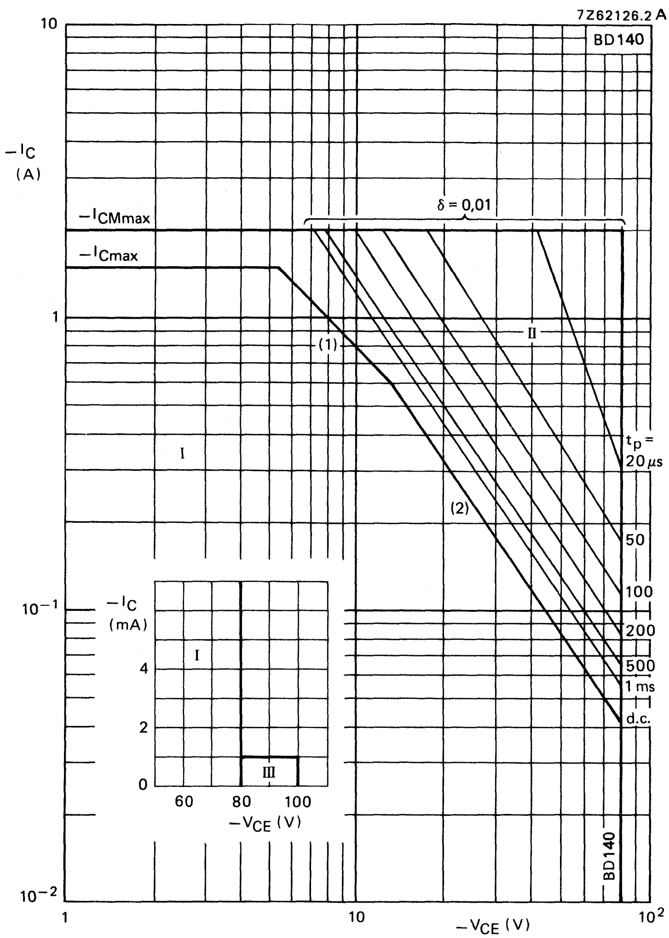


Fig. 3 Safe Operating Area with the transistor forward biased.

I Region of permissible d.c. operation
II Permissible extension for repetitive pulse operation
III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leqslant 1\ k\Omega$

(1) $P_{tot\ max}$ line
(2) Second breakdown limits.

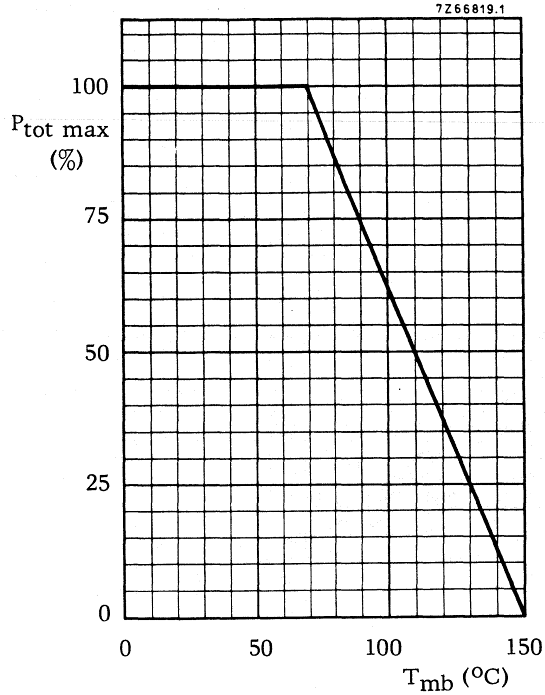

7Z66819.1
100
$P_{tot\ max}$
(%)
75
50
25
0
0
50
100
150
T_{mb} (°C)

Fig. 4.

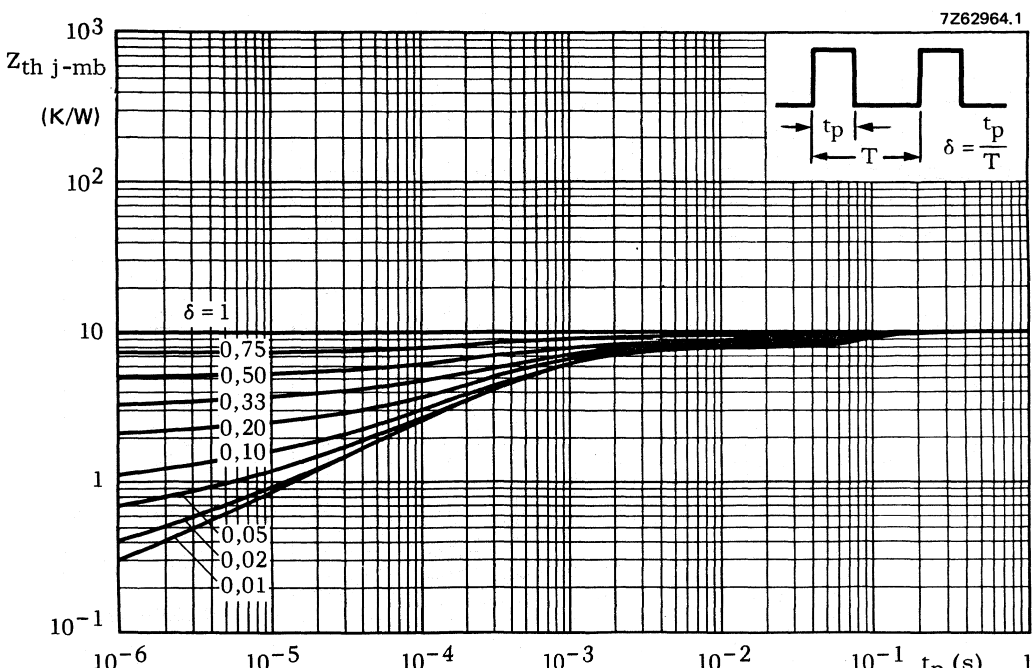

7Z62964.1
10^3
$Z_{th\ j\text{-}mb}$
(K/W)
10^2
10
1
10^{-1}
δ = 1
0,75
0,50
0,33
0,20
0,10
0,05
0,02
0,01
t_p
T
$\delta = \frac{t_p}{T}$
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
t_p (s)
1

Fig. 5.

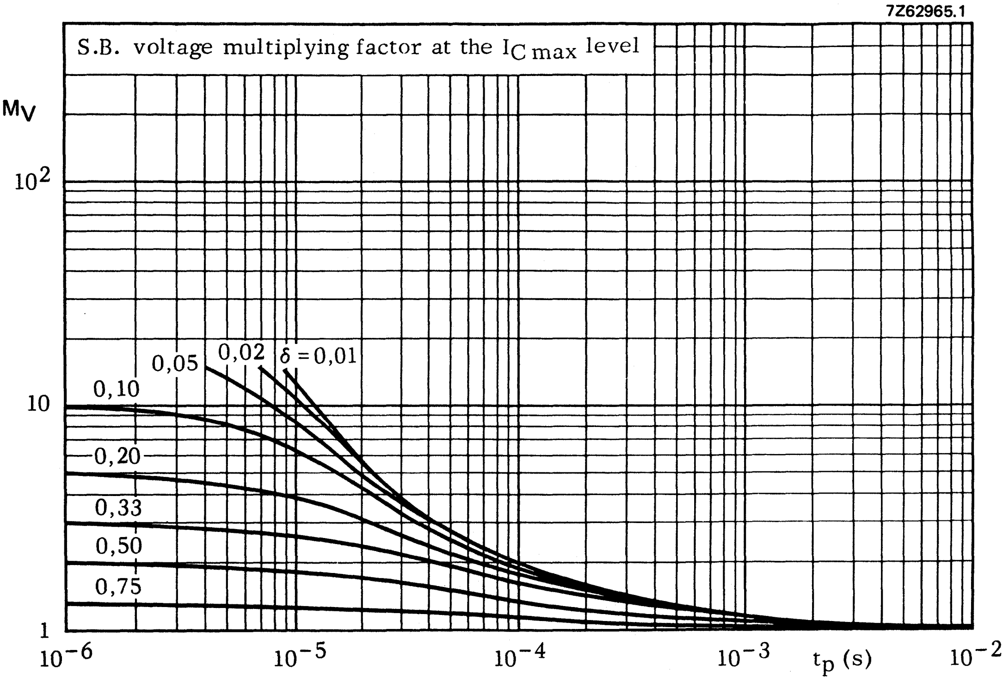

7Z62965.1
S.B. voltage multiplying factor at the $I_{C max}$ level
M_V
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 6.

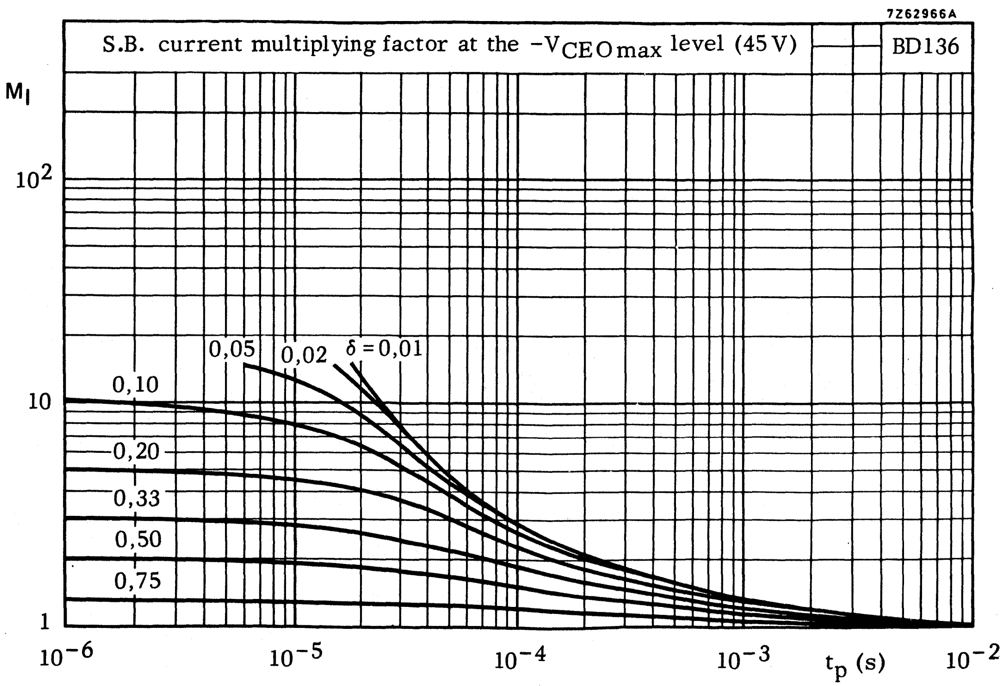

7Z62966A
S.B. current multiplying factor at the $-V_{CEO max}$ level (45 V)
BD136
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 7.

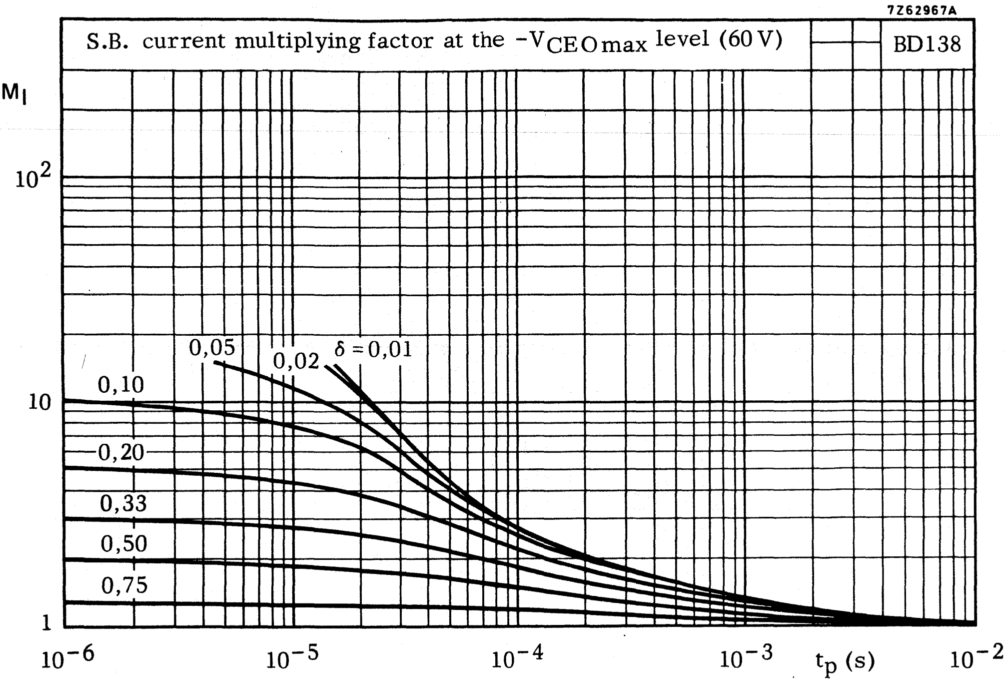

7Z62967A
S.B. current multiplying factor at the $-V_{CEOmax}$ level (60 V)
BD138
M_I
10^2
10
1
0,05
0,02
$\delta = 0,01$
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 8.

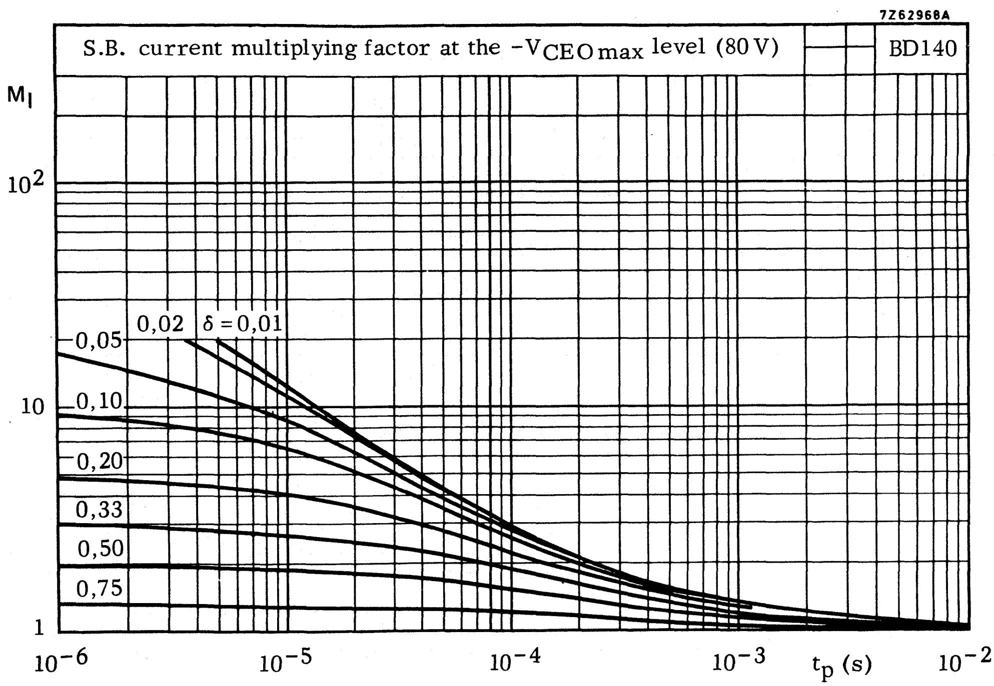

7Z62968A
S.B. current multiplying factor at the $-V_{CEOmax}$ level (80 V)
BD140
M_I
10^2
10
1
0,02
$\delta = 0,01$
0,05
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 9.

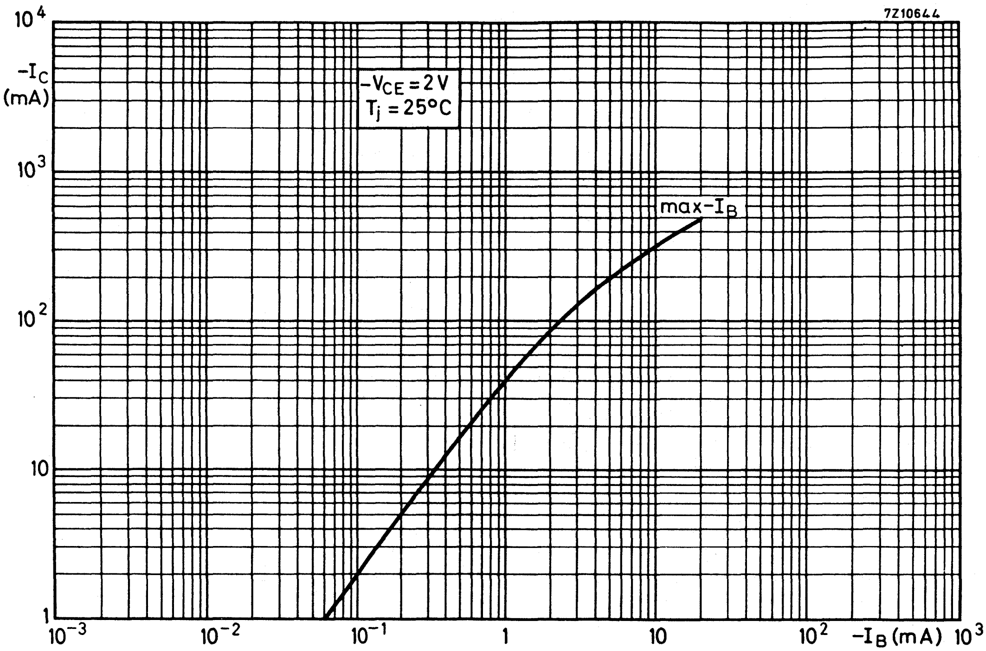

7Z10644
10^4
$-I_C$ (mA)
$-V_{CE} = 2$ V
$T_j = 25$ °C
10^3
max-I_B
10^2
10
1
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
$-I_B$ (mA)
10^3

Fig. 10.

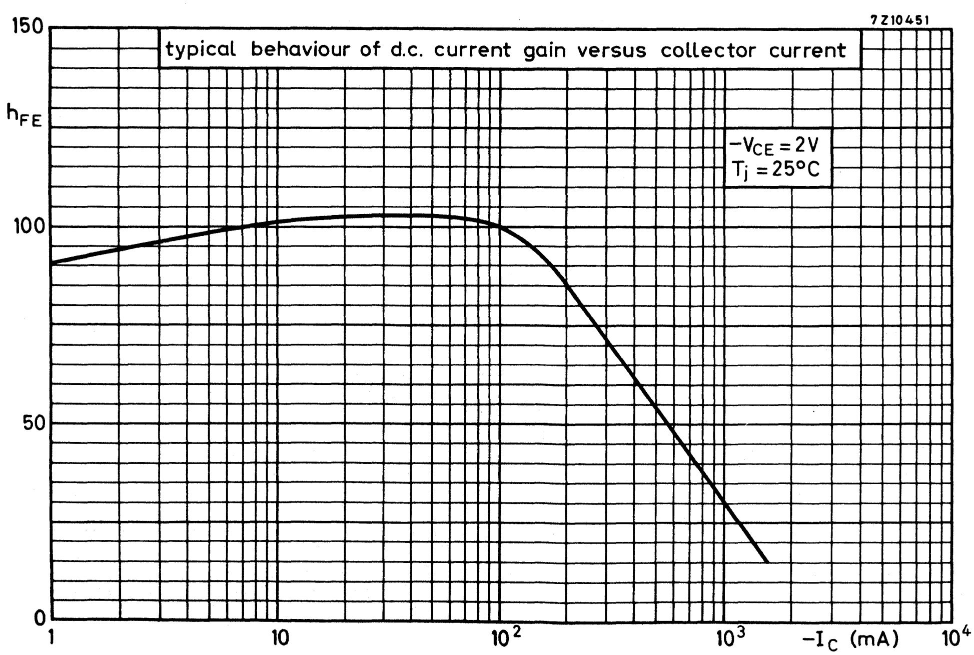

7Z10451
typical behaviour of d.c. current gain versus collector current
150
h_{FE}
$-V_{CE} = 2$ V
$T_j = 25$ °C
100
50
0
1
10
10^2
10^3
$-I_C$ (mA)
10^4

Fig. 11.

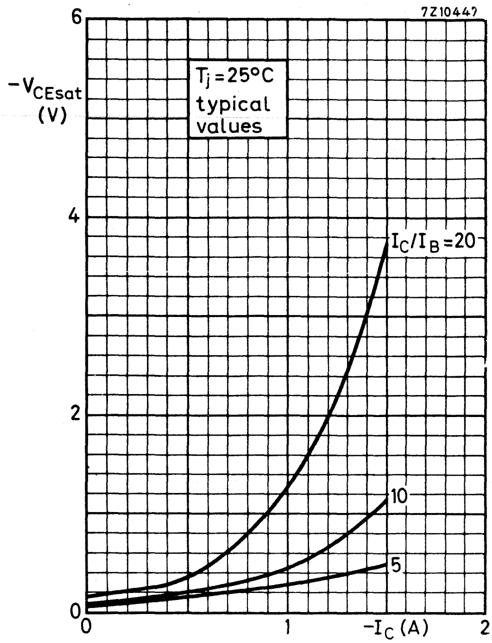


Fig. 12.

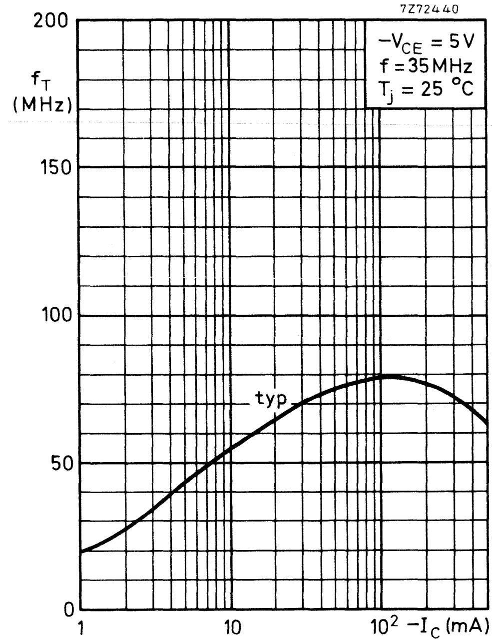


Fig. 13.

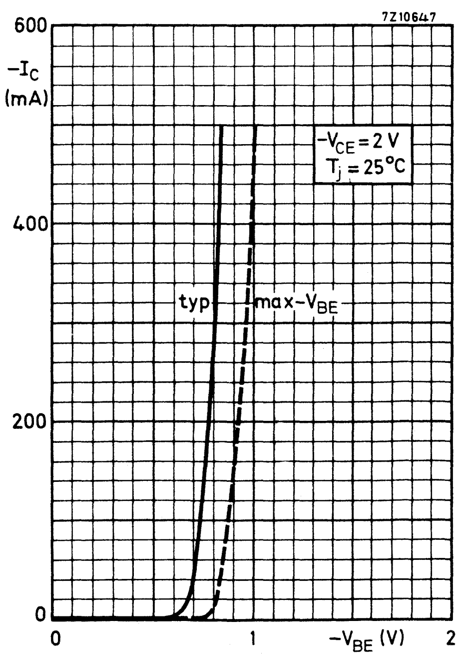


Fig. 14.

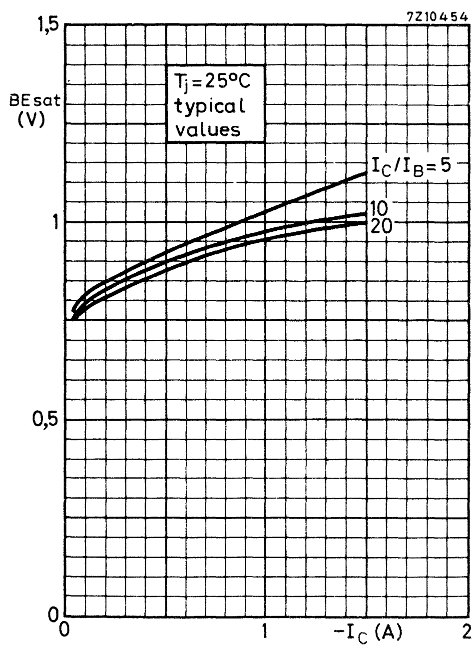


Fig. 15.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

N-P-N transistors in a plastic envelope. With their p-n-p complements BD202, BD204 and BDX78 they are primarily intended for use in hi-fi equipment delivering an output of 15 to 25 W into a 4 Ω or 8 Ω load.

QUICK REFERENCE DATA

			BD201	BD203	BDX77	
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector current (DC)	I_C	max.		8		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		60		W
Cut-off frequency I_C = 0,3 A; V_{CE} = 3 V	f_{hfe}	>		25		kHz

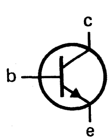
MECHANICAL DATA

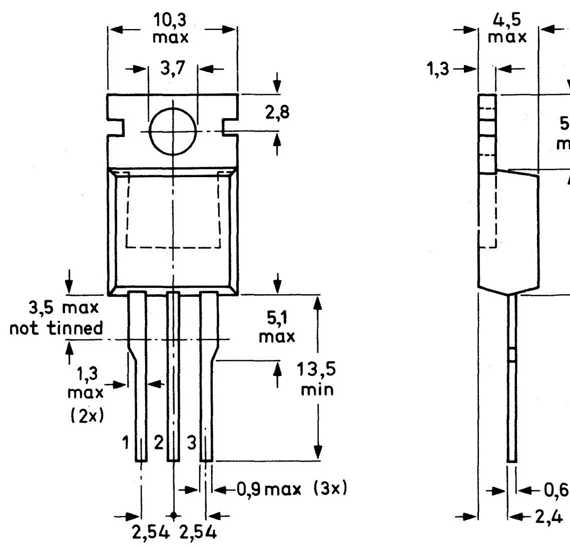
Dimensions in mm

Fig. 1 TO-220.

Collector connected to mounting base.

Pinning
1 = base
2 = collector
3 = emitter





See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD201	BD203	BDX77	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V

Collector current (DC)	I_C	max.	8	A
Collector current (peak value, $t_p \leqslant 10$ ms)	I_{CM}	max.	12	A
Collector current (non-repetitive peak value, $t_p \leqslant 2$ ms)	I_{CSM}	max.	25	A
Base current (DC)	I_B	max.	3	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	60	W
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,08	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	0,2	mA
$I_E = 0$; $V_{CB} = 40$ V; $T_j = 150$ °C	I_{CBO}	<	1	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	0,5	mA
Base-emitter voltage*				
$I_C = 3$ A; $V_{CE} = 2$ V	V_{BE}	<	1,5	V
Knee voltage*				
$I_C = 3$ A; I_B = value for which $I_C = 3{,}3$ A at $V_{CE} = 2$ V	V_{CEK}	typ.	1	V
Saturation voltage*				
$I_C = 3$ A; $I_B = 0{,}3$ A	V_{CEsat}	<	1	V
$I_C = 6$ A; $I_B = 0{,}6$ A	V_{CEsat}	<	1,5	V
	V_{BEsat}	<	2	V
D.C. current gain*				
BD201; $I_C = 3$ A; $V_{CE} = 2$ V	h_{FE}	>	30	
BD203; $I_C = 2$ A; $V_{CE} = 2$ V	h_{FE}	>	30	
$I_C = 1$ A; $V_{CE} = 2$ V	h_{FE}	>	30	
Cut-off frequency				
$I_C = 0{,}3$ A; $V_{CE} = 3$ V	f_{hfe}	>	25	kHz

* Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.

Transition frequency at f = 1 MHz			
I_C = 0,3 A; V_{CE} = 3 V	f_T	>	7 MHz
D.C. current gain ratio of matched complementary pairs			
I_C = 1 A; V_{CE} = 2 V	h_{FE1}/h_{FE2}	<	2,5
Forward bias second breakdown collector current			
V_{CE} = 40 V; t_p = 0,1 s; T_{amb} = 25 °C	$I_{(SB)}$	>	1,5 A
Switching times			
I_{Con} = 2 A; I_{Bon} = $-I_{Boff}$ = 0,2 A			
Turn-on time	t_{on}	<	1 μs
Turn-off time	t_{off}	<	4 μs

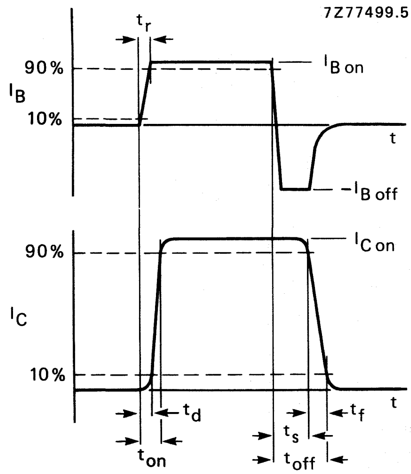


Fig. 2 Switching time waveforms.

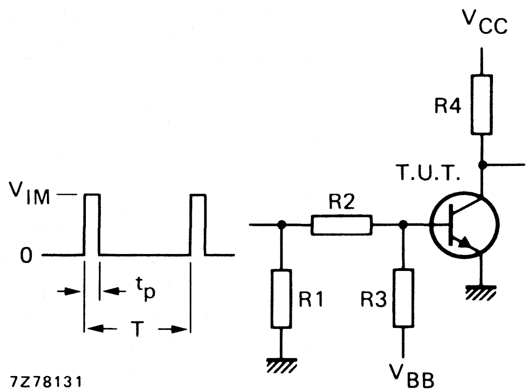


Fig. 3 Switching times test circuit.

V_{IM} = 15 V		R3	= 22 Ω
V_{CC} = 20 V		R4	= 10 Ω
V_{BB} = −4 V		$t_r = t_f$	⩽ 15 ns
R1 = —		t_p	= 20 μs
R2 = 33 Ω		T	= 500 μs

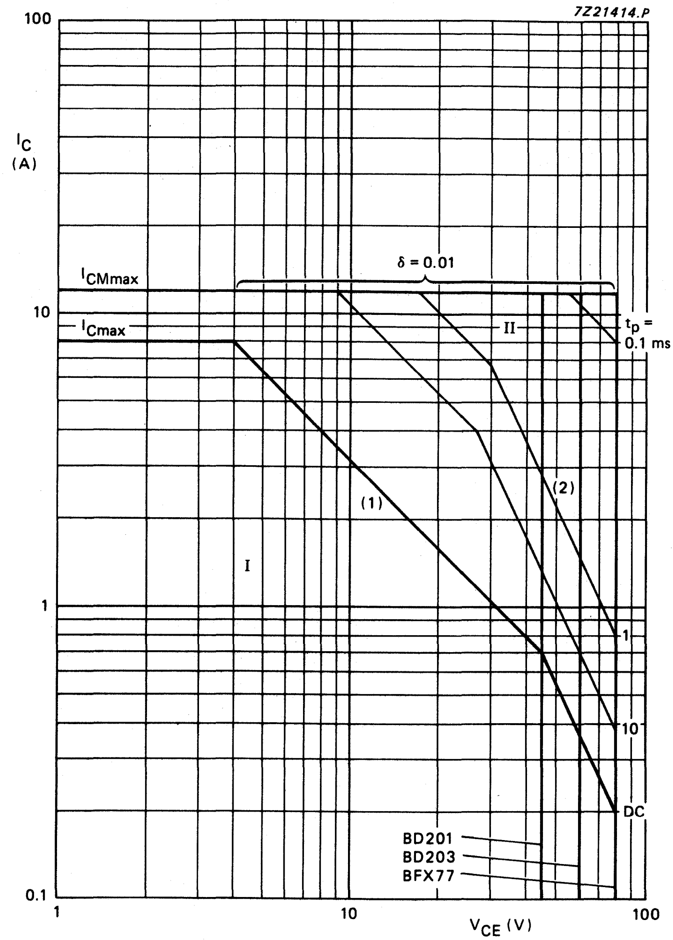


Fig. 4 Safe Operating ARea, $T_{mb} \leq 25$ °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

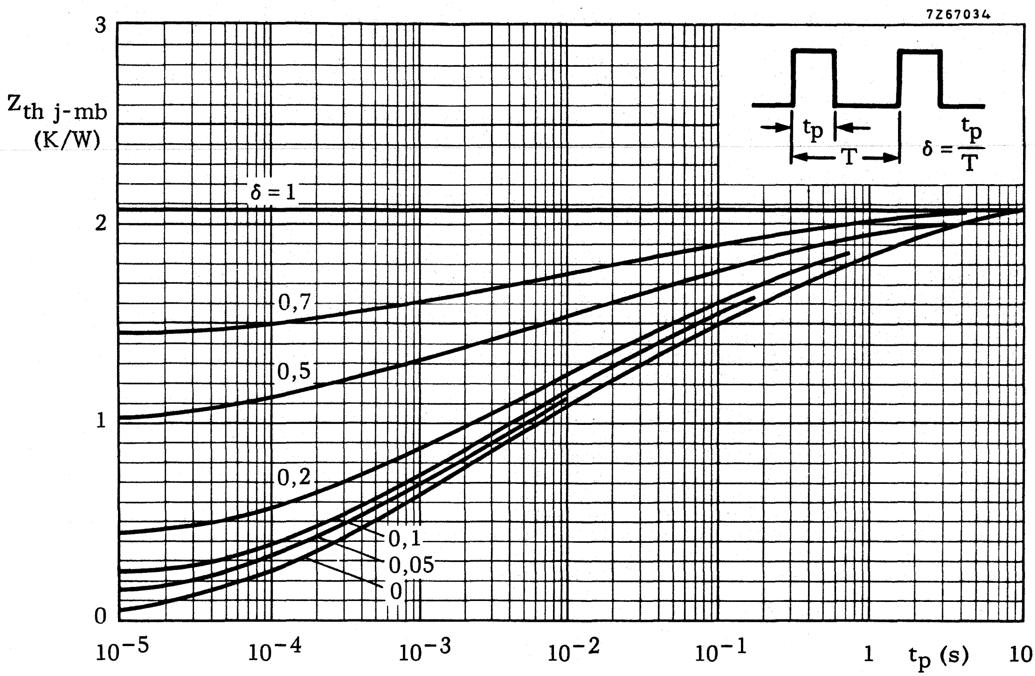


Fig. 5 Pulse power rating chart.

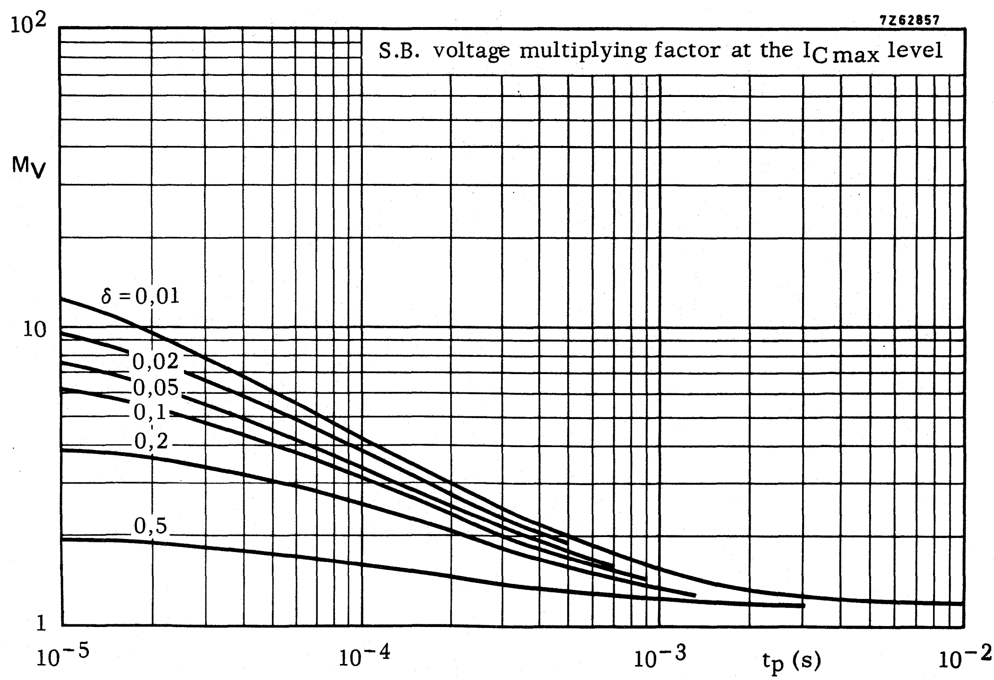


Fig. 6 S.B. voltage multiplying factor at the I_{Cmax} level.

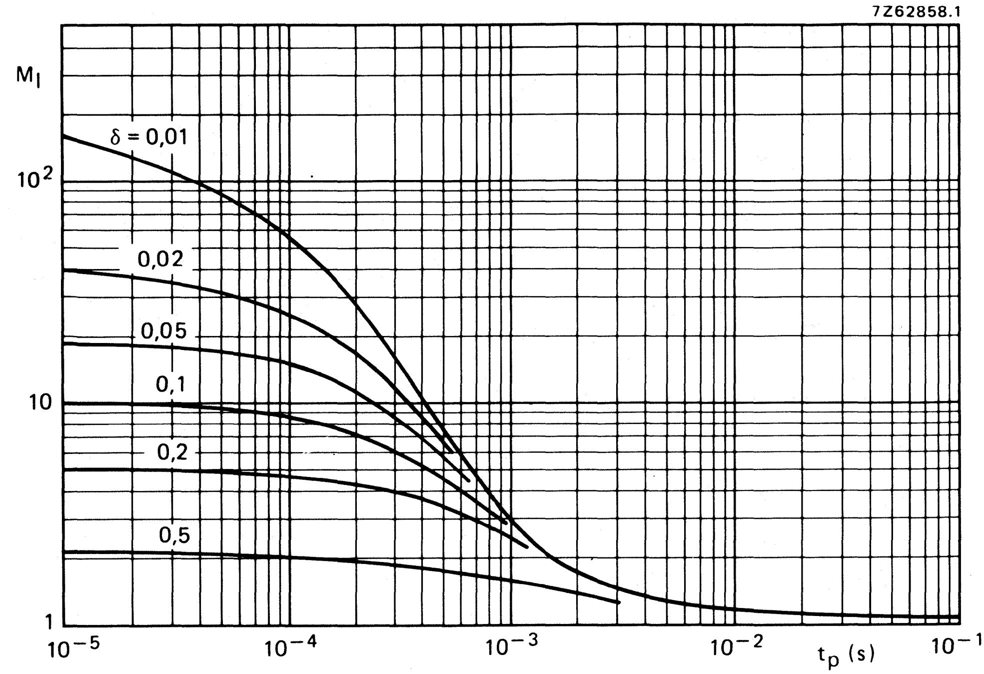


Fig. 7 S.B. current multiplying factor at the $V_{CEO\,max}$ level.

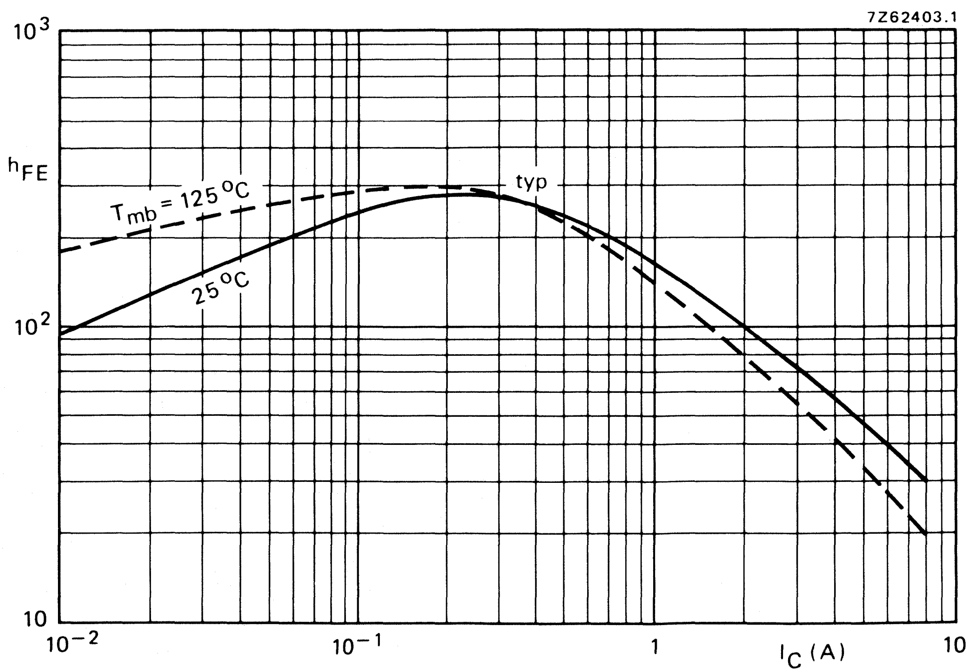


Fig. 8 D.C. current gain. V_{CE} = 2 V.

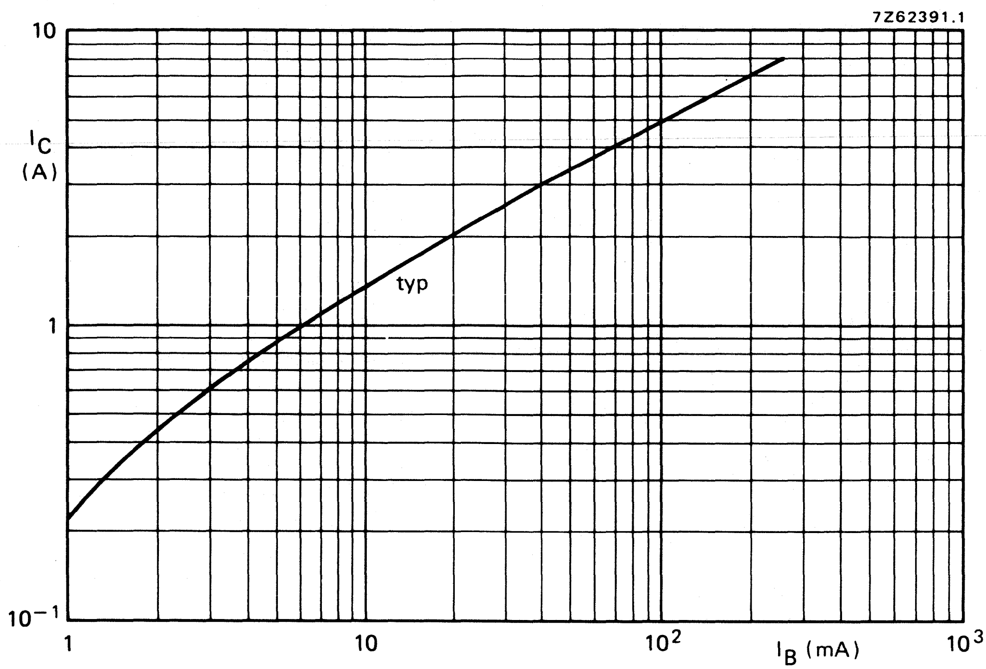


Fig. 9 Collector current as a function of base current. V_{CE} = 2 V; T_j = 25 °C.

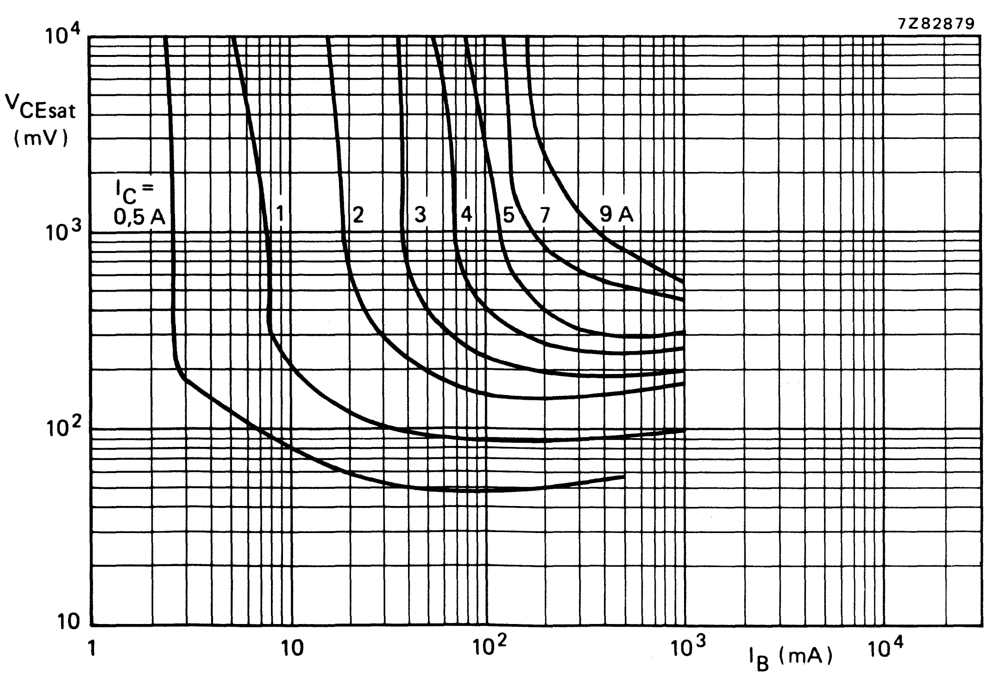


Fig. 10 Typical collector-emitter saturation voltage. T_j = 25 °C.

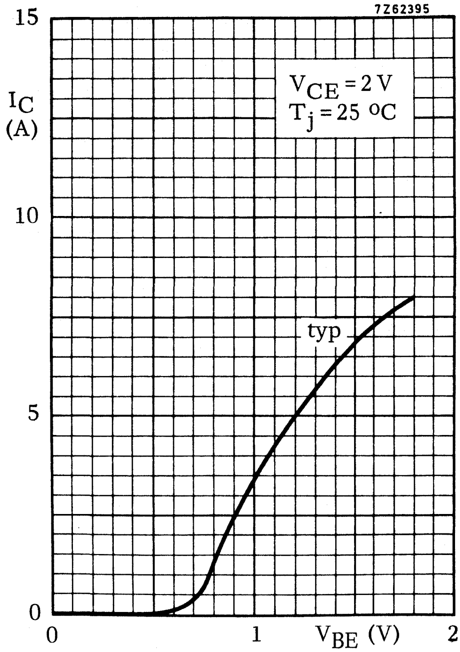


Fig. 11.

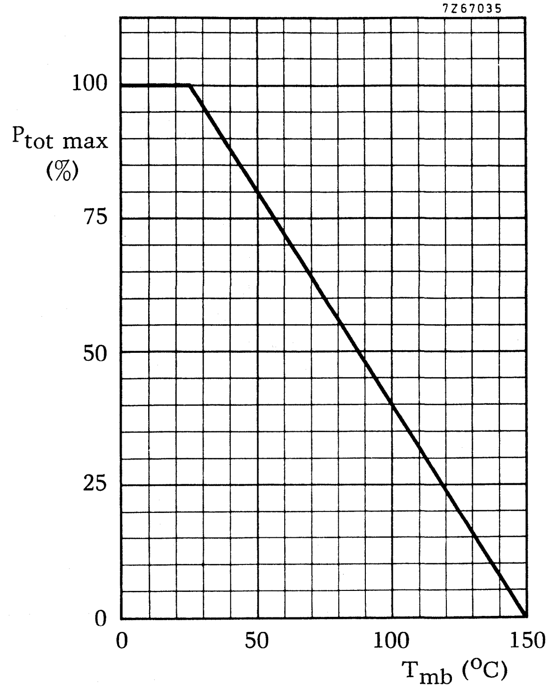


Fig. 12.

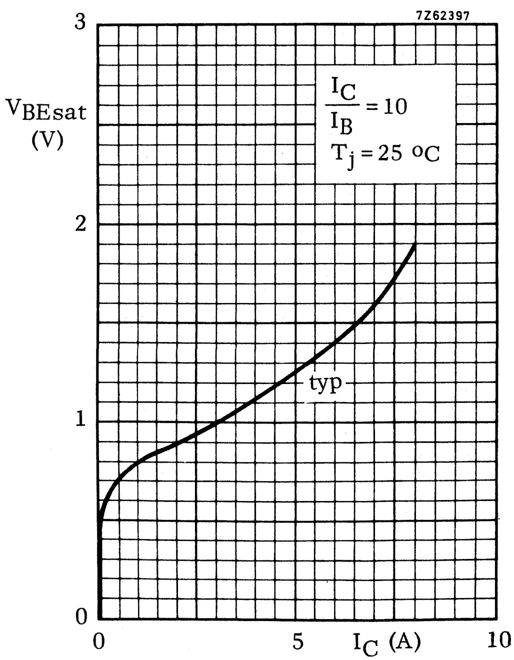


Fig. 13.

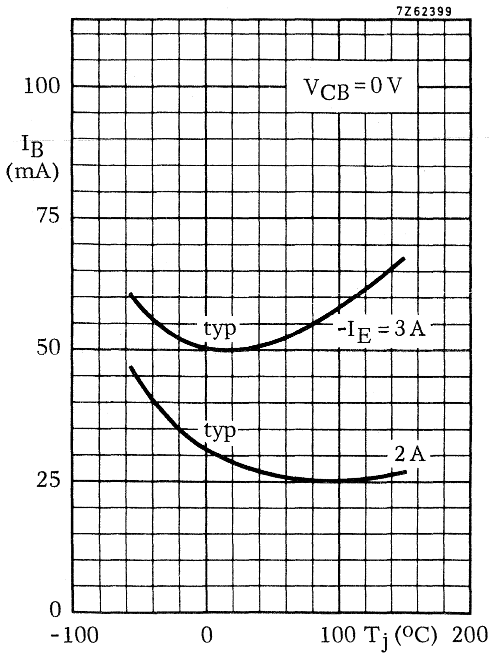


Fig. 14.

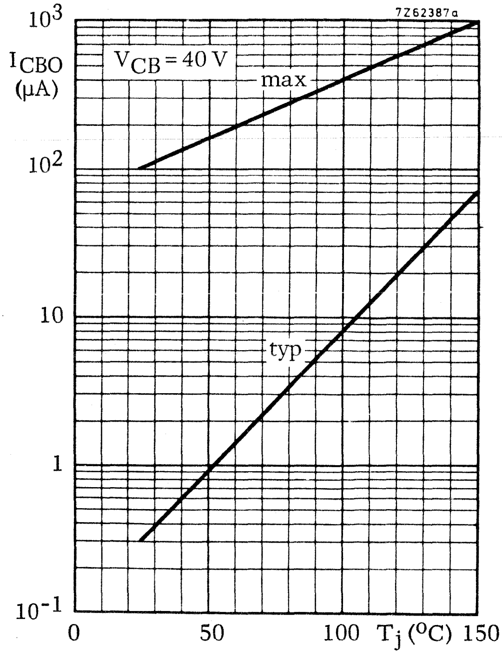


Fig. 15.

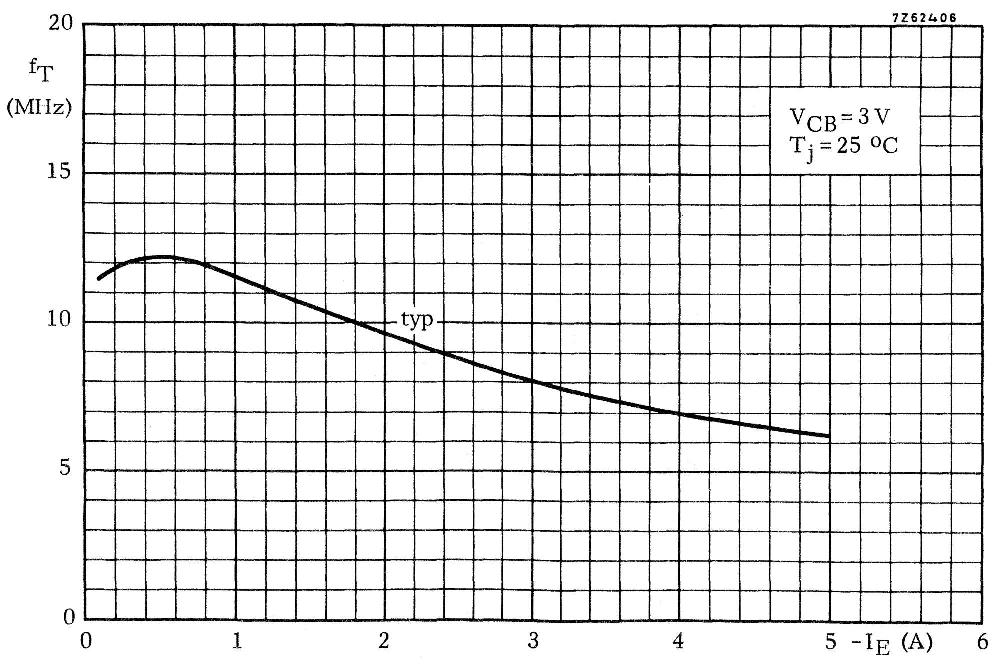


Fig. 16.

SILICON EPITAXIAL POWER TRANSISTORS

NPN Silicon power transistors in a SOT186 envelope with an electrically insulated mounting base.
PNP complements are BD202F, BD204F and BDX78F.

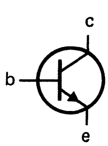
QUICK REFERENCE DATA

			BD201F	BD203F	BDX77F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current DC	I_C	max.		8		A
Collector current peak value	I_{CM}	max.		12		A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.		32		W

MECHANICAL DATA

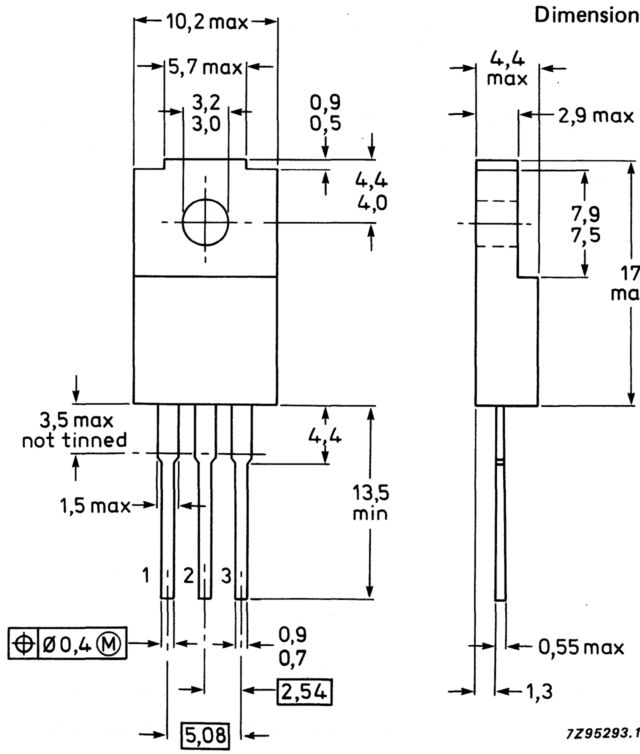
Dimensions in mm

Fig. 1 SOT186.



Pinning

1 = Base
2 = Collector
3 = Emitter



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD201F	BD203F	BDX77F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current						
DC	I_C	max.		8		A
peak value	I_{CM}	max.		12		A
Base current (DC)	I_B	max.		3		A
Total power dissipation						
up to T_h = 25 °C (note 1)	P_{tot}	max.		20		W
up to T_h = 25 °C (note 2)	P_{tot}	max.		32		W
Storage temperature	T_{stg}			−65 to 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.6	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.3	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V
Isolation capacitance from collector to external heatsink	C_{th}	typ.	12	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

CHARACTERISTICS

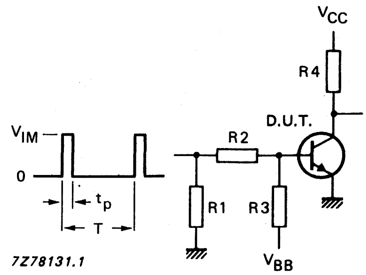
T_j = 25 °C unless otherwise specified

			BD201F	BD203F	BDX77F	
Collector cut-off current						
I_B = 0; V_{CE} = 30 V	I_{CEO}	max.	0.2	0.2	0.2	mA
I_E = 0; V_{CB} = V_{CBO}	I_{CBO}	max.	0.1	0.1	0.1	mA
I_E = 0; V_{CB} = ½V_{CBO}; T_j = 150 °C	I_{CBO}	max.	1.0	1.0	1.0	mA
Emitter cut-off current						
I_C = 0; V_{EB} = 5 V	I_{EBO}	max.	0.5	0.5	0.5	mA
Collector-emitter breakdown voltage (note 1)						
I_C = 0.2 A; I_B = 0	$V_{(BR)CEO}$	min.	45	60	80	V
DC current gain (note 1)						
I_C = 3 A; V_{CE} = 2 V	h_{FE}	min.	30	—	—	
I_C = 2 A; V_{CE} = 2 V	h_{FE}	min.	—	30	30	
I_C = 1 A; V_{CE} = 2 V	h_{FE}	min.	30	30	—	
Collector-emitter saturation voltage (note 1)						
I_C = 3 A; I_B = 0.3 A	V_{CEsat}	max.	1.0	1.0	1.0	V
I_C = 2 A; I_B = 0.2 A	V_{CEsat}	max.	—	—	0.6	V
I_C = 6 A; I_B = 0.6 A	V_{CEsat}	max.	1.5	1.5	1.5	V
Knee voltage (note 1)						
I_C = 3 A; I_B = value at which I_C = 3.3 A at V_{CE} = 2 V	V_{CEK}	typ.		1.0		V
Base-emitter voltage (note 1)						
I_C = 3 A; V_{CE} = 2 V	V_{BE}	max.		1.5		V
Base-emitter saturation voltage (note 1)						
I_C = 6 A; I_B = 0.6 A	V_{BEsat}	max.		2.0		V
Cut-off frequency						
I_C = 0.3 A; V_{CE} = 3 V	f_{HFE}	min.		25		kHz
Transition frequency at f = 1 MHz						
I_E = 0.3 A; V_{CB} = 3 V	f_T	min.		7.0		MHz
Forward bias second breakdown collector current						
V_{CE} = 40 V; t_p = 0.1 s	I_{SB}	min.		0.8		A
Switching times						
$I_{C\,on}$ = 2 A; $I_{B\,on}$ = $I_{B\,off}$ = 0.2 A						
turn-on time	t_{on}	max.		1.0		μs
turn-off time	t_{off}	max.		4.0		μs

(Values from knee voltage downward apply to all three types.)

Note

1. To be measured under pulsed conditions. Pulse time 300 μs, duty cycle 2%.



V_{IM}	= 15 V
V_{CC}	= 20 V
$-V_{BB}$	= 4 V
R1	= 56 Ω
R2	= 33 Ω
R3	= 22 Ω
R4	= 10 Ω
t_r	= t_f = 15 ns
t_p	= 20 μs
T	= 500 μs

Fig. 2 Switching times test circuit.

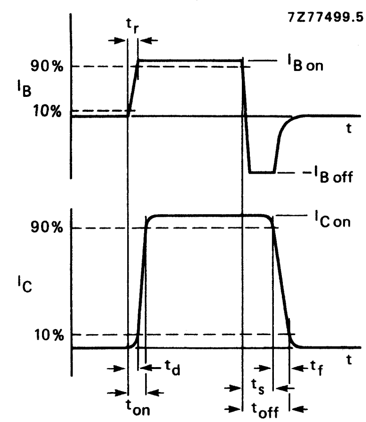
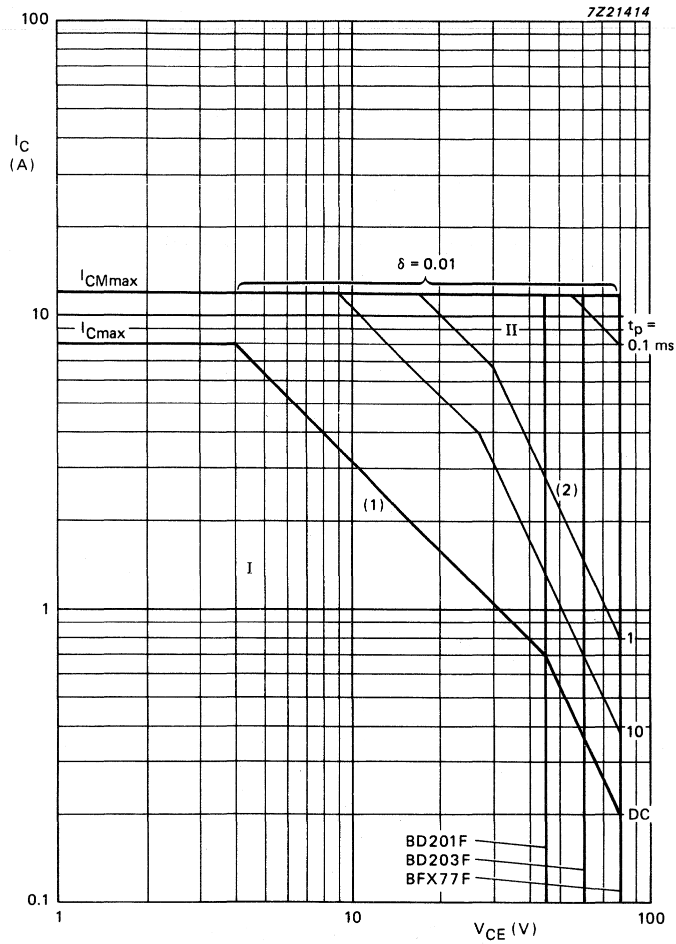


Fig. 3 Switching times waveforms.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) P_{tot} max and P_{peak} max lines.
(2) Second-breakdown limits.

Note: Mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

Fig.4 Safe operating area; T_{amb} = 25 °C.

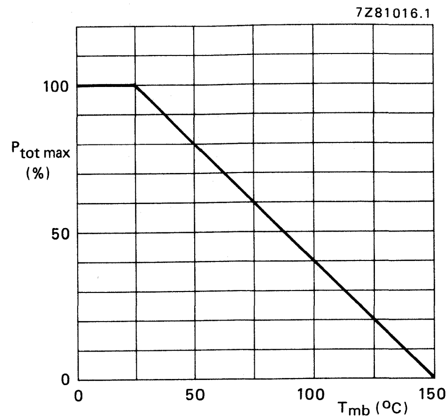


Fig. 5 Maximum power dissipation as a function of temperature.

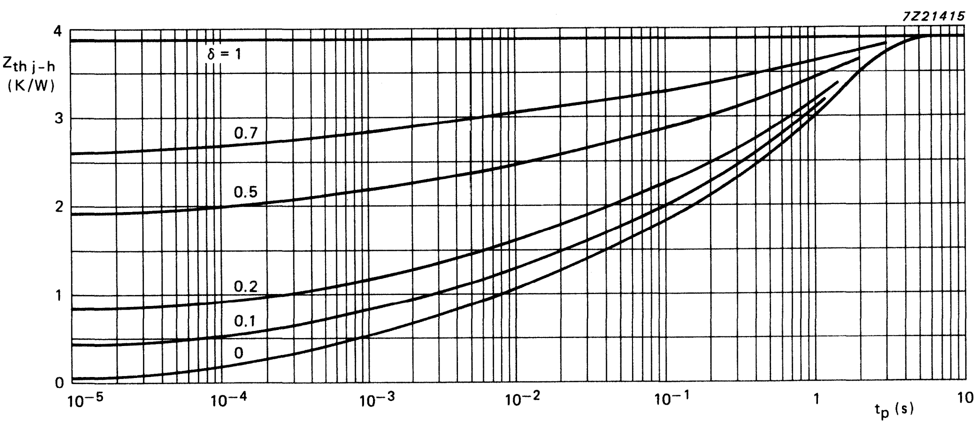


Fig. 6 Pulse power rating chart.

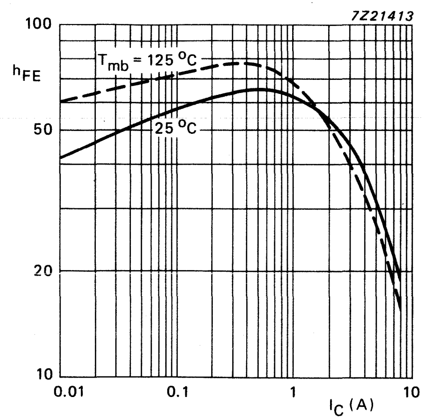


Fig. 7 Typical DC current gain curves at V_{CE} = 2 V.

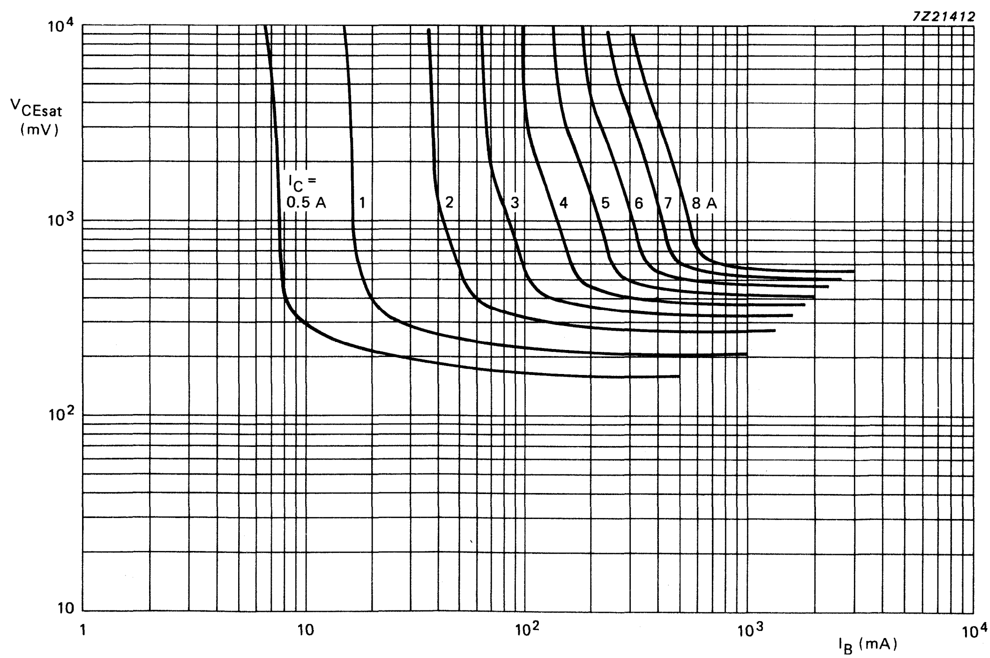


Fig. 8 Collector-emitter saturation voltage as a function of base current; typical values; T_j = 25 °C.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

PNP transistors in a plastic envelope. With their npn complements BD201, BD203, and BDX77, they are primarily intended for use in hi-fi equipment delivering an output of 15 to 25 W into a 4 Ω or 8 Ω load.

QUICK REFERENCE DATA

			BD202	BD204	BDX78	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector current (DC)	$-I_C$	max.		8		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		60		W
Cut-off frequency $-I_C$ = 0.3 A; $-V_{CE}$ = 3 V	f_{hfe}	min.		25		kHz

MECHANICAL DATA

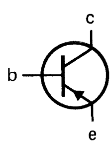
Dimensions in mm

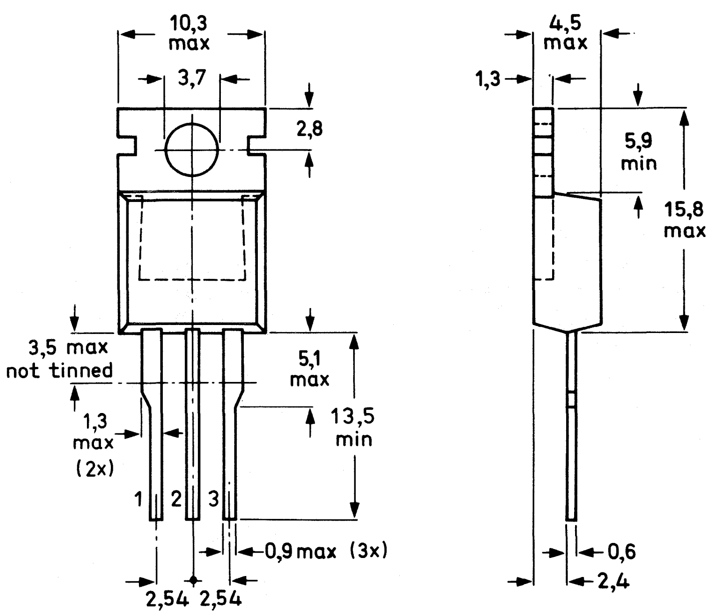
Fig.1 TO-220.

Collector connected to mounting base.

Pinning

1 = base
2 = collector
3 = emitter





See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD202	BD204	BDX78	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (DC)	$-I_C$	max.		8		A
Collector current (peak value; t_p max. 10 ms)	$-I_{CM}$	max.		12		A
Collector current (non-repetitive peak value, t_p max. 2 ms)	$-I_{CSM}$	max.		25		A
Base current (DC)	$-I_B$	max.		3		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		60		W
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.08	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	max.	0.2	mA
$I_E = 0$; $-V_{CB} = 40$ V; $T_j = 150$ °C	$-I_{CBO}$	max.	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	max.	0.5	mA
Collector-emitter breakdown voltage				
$I_C = 0.2$ A; $I_B = 0$ BD202	$-V_{(BR)CEO}$	min.	45	V
$I_C = 0.2$ A; $I_B = 0$ BD204	$-V_{(BR)CEO}$	min.	60	V
$I_C = 0.2$ A; $I_B = 0$ BDX78	$-V_{(BR)CEO}$	min.	80	V
Base-emitter voltage (note 1)				
$-I_C = 3$ A; $-V_{CE} = 2$ V	$-V_{BE}$	max.	1.5	V
Knee voltage (note 1)				
$-I_C = 3$ A; $-I_B$ = value at which $-I_C = 3.3$ A at $-V_{CE} = 2$ V	$-V_{CEK}$	typ.	1	V
Saturation voltages (note 1)				
$-I_C = 3$ A; $-I_B = 0.3$ A	$-V_{CEsat}$	max.	1	V
$-I_C = 6$ A; $-I_B = 0.6$ A	$-V_{CEsat}$	max.	1.5	V
	$-V_{BEsat}$	max.	2	V
DC current gain (note 1)				
$-I_C = 3$ A; $-V_{CE} = 2$ V BD202	h_{FE}	min.	30	
$-I_C = 2$ A; $-V_{CE} = 2$ V BD204	h_{FE}	min.	30	
$-I_C = 1$ A; $-V_{CE} = 2$ V BDX78	h_{FE}	min.	30	

Note

1. Measured under pulse conditions: $t_p < 300\ \mu s$; $\delta < 2\%$.

Cut-off frequency		
$-I_C = 0.3$ A; $-V_{CE} = 3$ V	f_{hfe}	min. 25 kHz
Transition frequency at f = 1 MHz		
$-I_C = 0.3$ A; $-V_{CE} = 3$ V	f_T	min. 7 MHz
DC current gain ratio of matched complementary pairs		
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE1}/h_{FE2}	max. 2.5
Forward bias second breakdown collector current		
$V_{CE} = 40$ V; $t_p = 0.1$ s	I_{SB}	min. 1.5 A
Switching times		
$-I_{Con} = 2$ A; $-I_{Bon} = I_{Boff} = 0.2$ A		
turn-on time	t_{on}	max. 1 μs
turn-off time	t_{off}	max. 2 μs

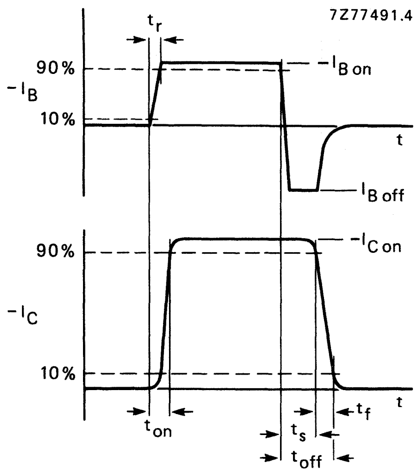


Fig. 2 Switching times waveforms.

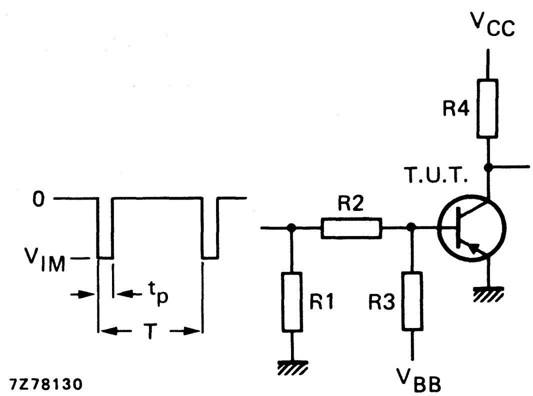
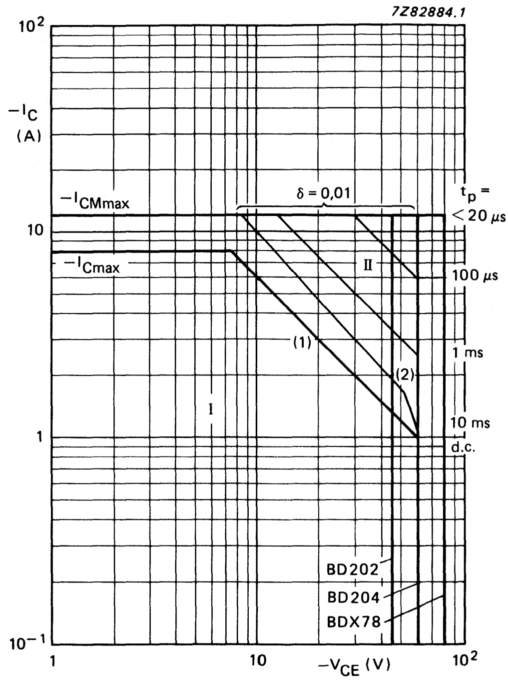


Fig. 3 Switching times test circuit.

$-V_{IM}$	= 15 V	R3	= 22 Ω
$-V_{CC}$	= 20 V	R4	= 10 Ω
$+V_{BB}$	= 4 V	$t_r = t_f$	= 15 ns
R1	= 56 Ω	t_p	= 10 μs
R2	= 33 Ω	T	= 500 μs



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

Fig.4 Safe operating area; T_{mb} = 25 °C.

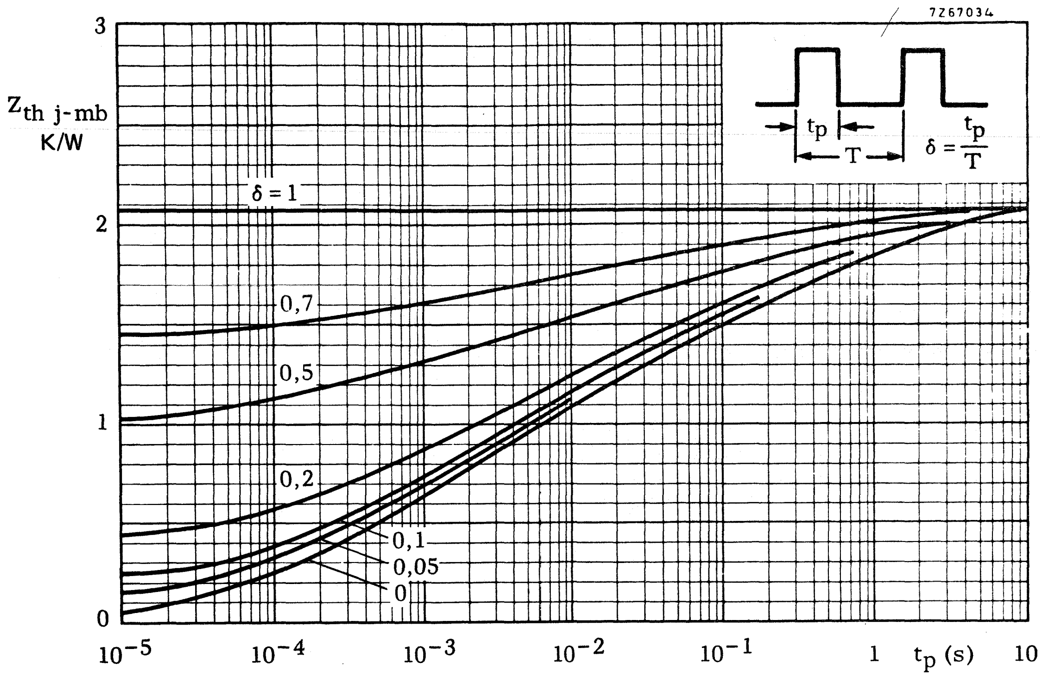


Fig. 5 Pulse power rating chart.

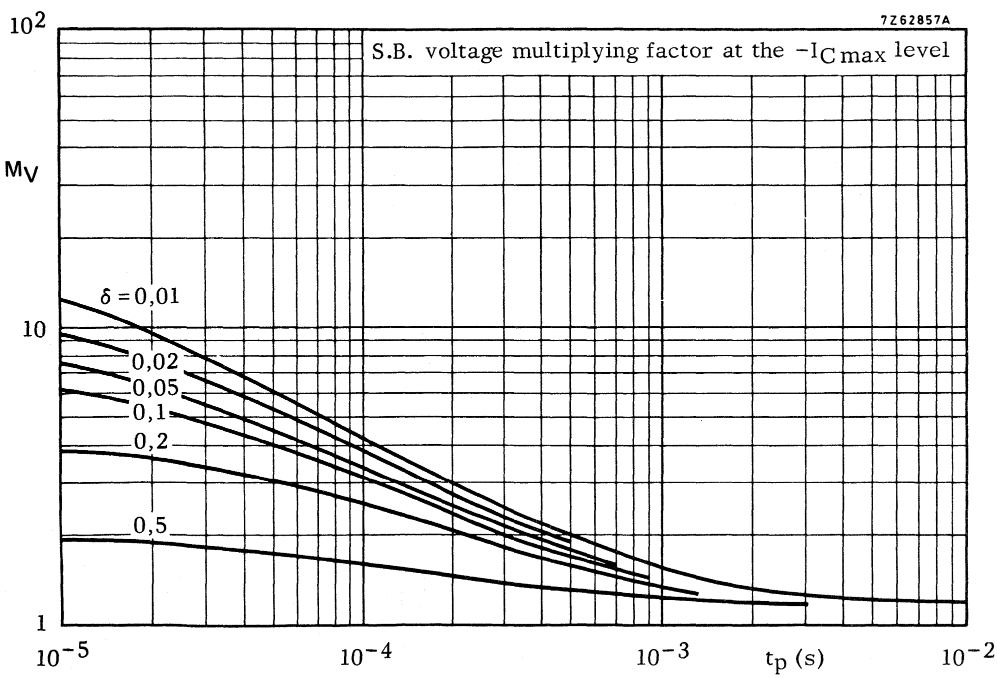


Fig. 6 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

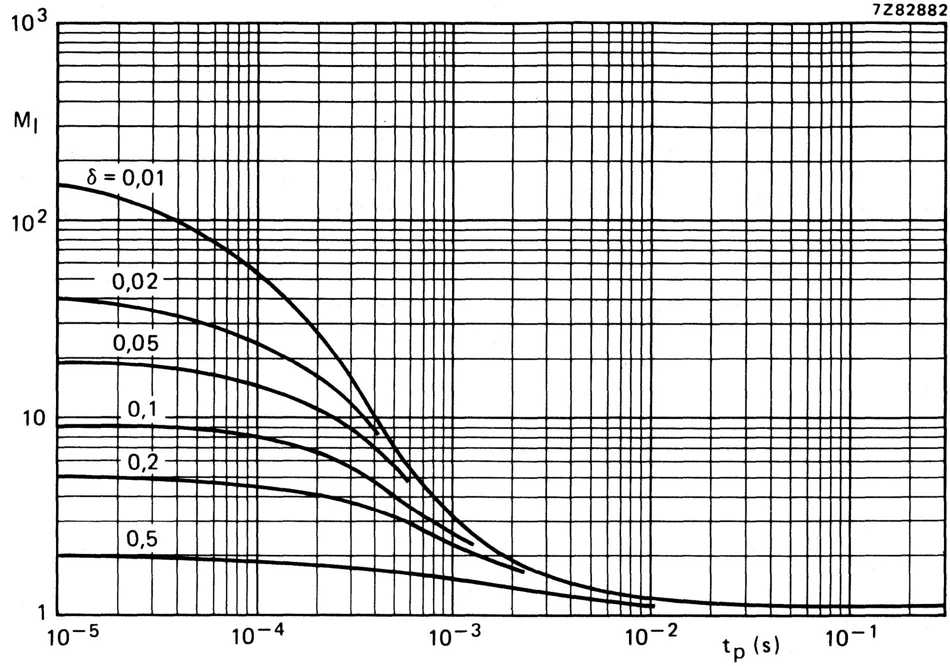


Fig. 7 S.B. current multiplying factor at the $-V_{CEOmax}$ level.

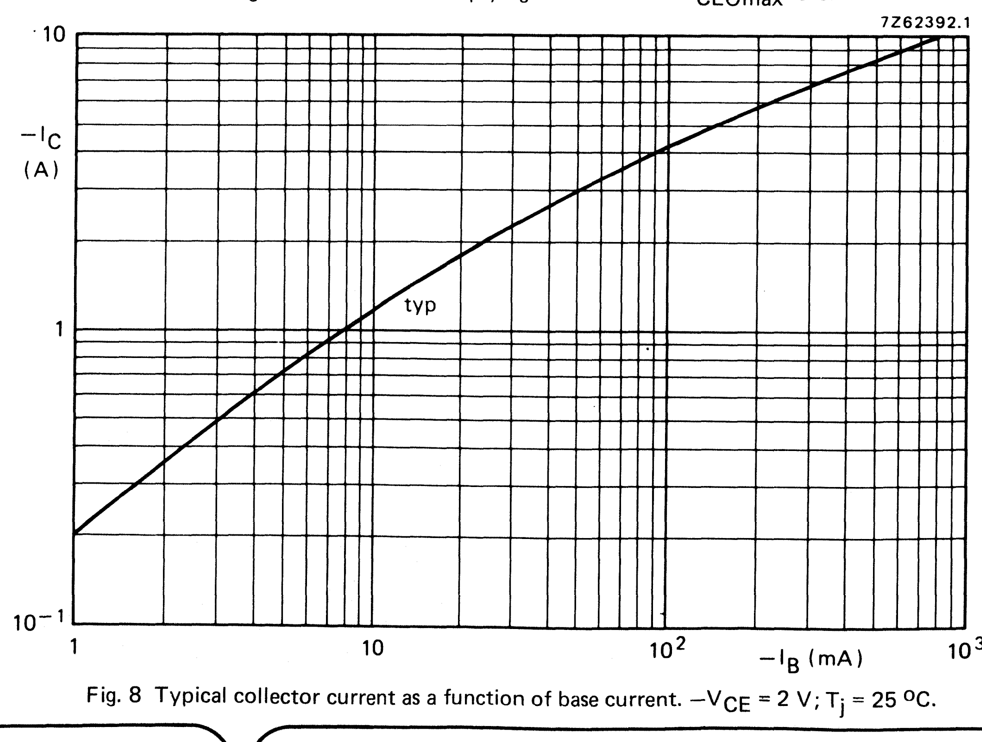


Fig. 8 Typical collector current as a function of base current. $-V_{CE}$ = 2 V; T_j = 25 °C.

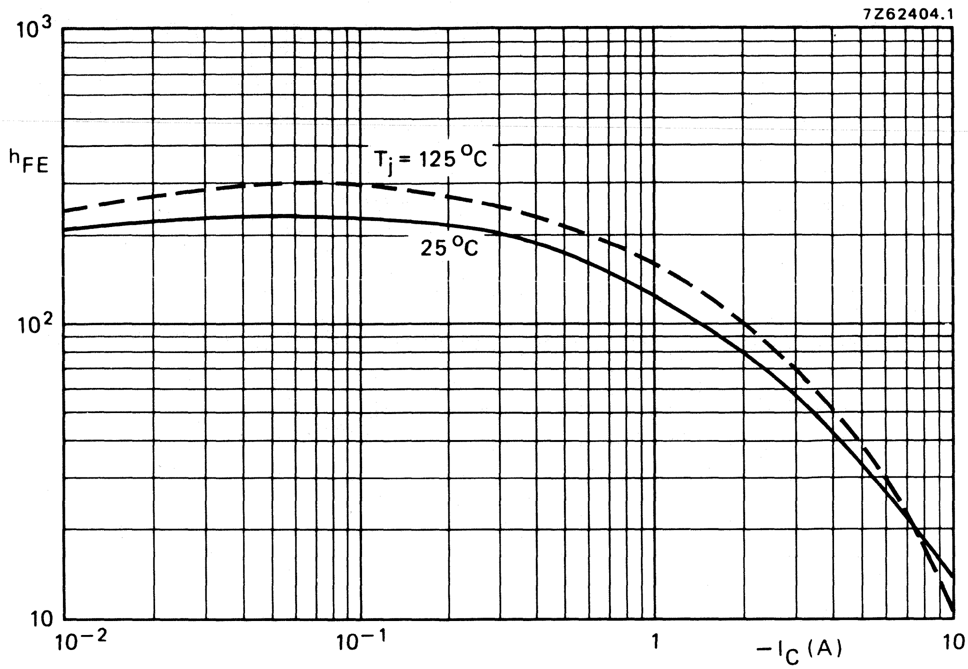


Fig. 9 Typical forward current transfer ratio at $-V_{CE} = 2$ V.

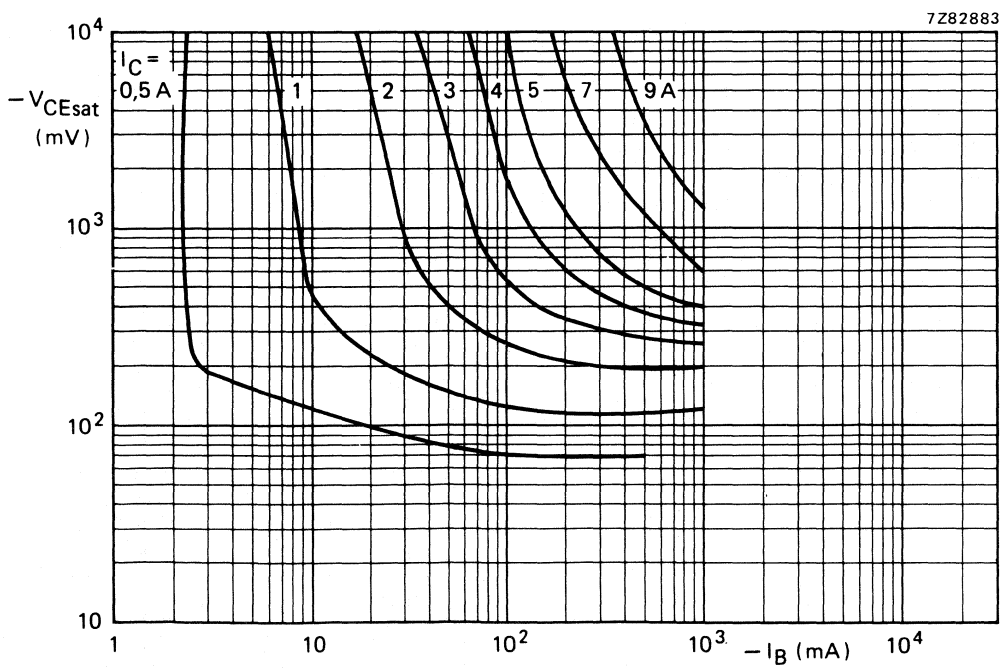


Fig. 10 Typical collector-emitter saturation voltage. $T_j = 25\ ^oC$.

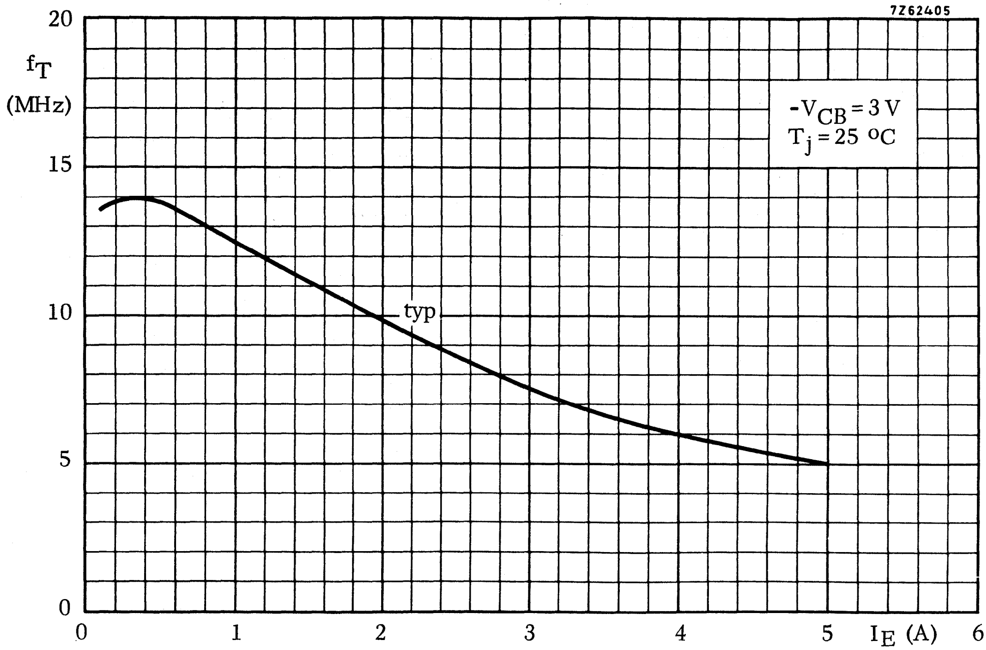


Fig. 11 Typical transition frequency.

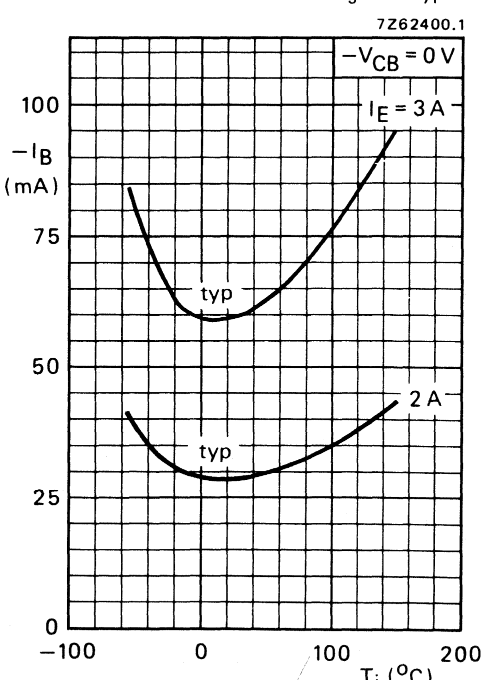


Fig. 12 Typical base current.

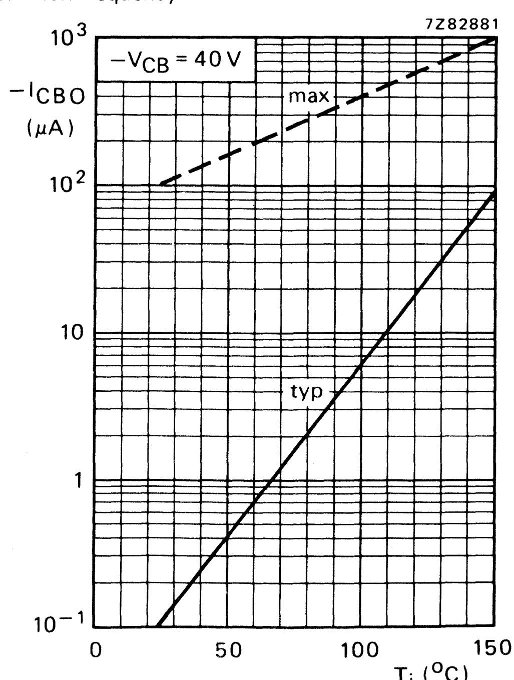


Fig. 13 Collector-base cut-off current.

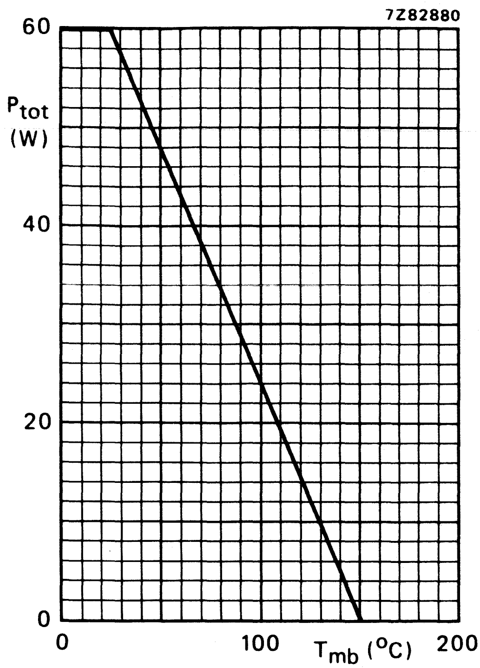


Fig. 14 Total power dissipation.

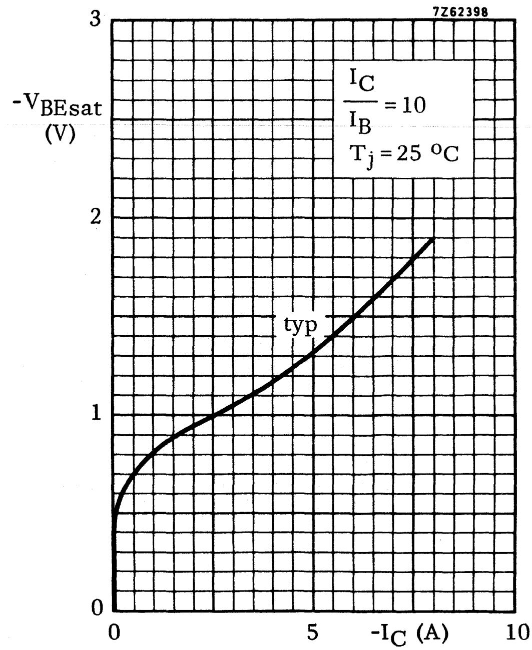


Fig. 15 Base-emitter saturation voltage.

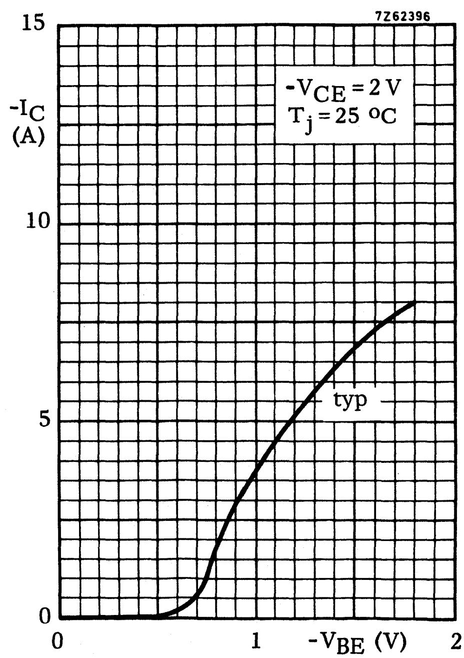


Fig. 16 Typical collector current.

SILICON EPITAXIAL POWER TRANSISTORS

PNP silicon power transistors in SOT186 envelopes with an electrically insulated mounting base.
NPN complements are BD201F, BD203F and BDX77F respectively.

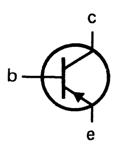
QUICK REFERENCE DATA

			BD202F	BD204F	BDX78F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current DC	$-I_C$	max.		8		A
peak value	$-I_{CM}$	max.		12		A
Total power dissipation up to $T_h = 25\ ^oC$	P_{tot}	max.		32		W

MECHANICAL DATA

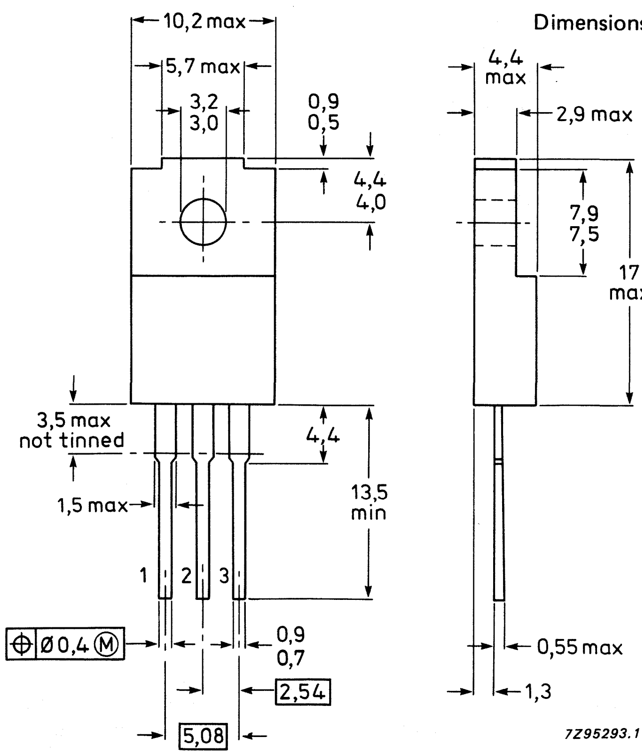
Dimensions in mm

Fig. 1 SOT186.



Pinning

1 = Base
2 = Collector
3 = Emitter



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD202F	BD204F	BDX78F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current						
DC	$-I_C$	max.		8		A
peak value	$-I_{CM}$	max.		12		A
Base current (DC)	$-I_B$	max.		3		A
Total power dissipation						
up to T_h = 25 °C (note 1)	P_{tot}	max.		20		W
up to T_h = 25 °C (note 2)	P_{tot}	max.		32		W
Storage temperature range	T_{stg}			−65 to 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.6	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.3	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V
Isolation capacitance from collector to external heatsink	C_{th}	typ.	12	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

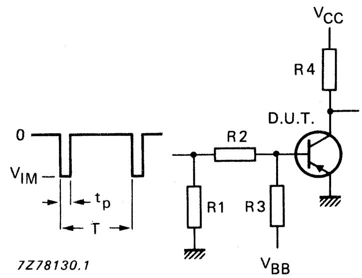
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD202F	BD204F	BDX78F	
Collector cut-off current						
$I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	max.	0.2	0.2	0.2	mA
$I_E = 0$; $-V_{CB} = V_{CBO}$	$-I_{CBO}$	max.	0.1	0.1	0.1	mA
$I_E = 0$; $-V_{CB} = ½ V_{CBO}$; $T_j = 150$ °C	$-I_{CBO}$	max.	1.0	1.0	1.0	mA
Emitter cut-off current						
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	max.	0.5	0.5	0.5	mA
Collector-emitter breakdown voltage (note 1)						
$-I_C = 0.2$ A; $I_B = 0$	$-V_{(BR)CEO}$	min.	45	60	80	V
DC current gain (note 1)						
$-I_C = 3$ A; $-V_{CE} = 2$ V	h_{FE}	min.	30	—	—	
$-I_C = 2$ A; $-V_{CE} = 2$ V	h_{FE}	min.	—	30	30	
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	min.	30	30	—	
Collector-emitter saturation voltage (note 1)						
$-I_C = 3$ A; $-I_B = 0.3$ A	$-V_{CEsat}$	max.	1.0	1.0	1.0	V
$-I_C = 2$ A; $-I_B = 0.2$ A	$-V_{CEsat}$	max.	—	—	0.6	V
$-I_C = 6$ A; $-I_B = 0.6$ A	$-V_{CEsat}$	max.	1.5	1.5	1.5	V
Knee voltage (note 1)						
$-I_C = 3$ A; $-I_B$ = value at which $-I_C = 3.3$ A at $-V_{CE} = 2$ V	$-V_{CEK}$	typ.		1.0		V
Base-emitter voltage (note 1)						
$-I_C = 3$ A; $-V_{CE} = 2$ V	$-V_{BE}$	max.		1.5		V
Base-emitter saturation voltage (note 1)						
$-I_C = 6$ A; $-I_B = 0.6$ A	$-V_{BEsat}$	max.		2.0		V
Cut-off frequency						
$-I_C = 0.3$ A; $-V_{CE} = 3$ V	f_{HFE}	min.		25		kHz
Transition frequency at f = 1 MHz						
$-I_E = 0.3$ A; $-V_{CB} = 3$ V	f_T	min.		7.0		MHz
Forward bias second breakdown collector current						
$-V_{CE} = 40$ V; $t_p = 0.1$ s	$-I_{SB}$	min.		0.8		A
Switching times						
$-I_{C\,on} = 2$ A; $-I_{B\,on} = I_{B\,off} = 0.2$ A						
turn-on time	t_{on}	max.		1.0		μs
turn-off time	t_{off}	max.		2.0		μs

Note

1. To be measured under pulsed conditions. Pulse time 300 μs, duty cycle 2%.



$-V_{IM}$ = 15 V
$-V_{CC}$ = 20 V
$+V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 33 Ω
R3 = 22 Ω
R4 = 10 Ω
t_r = t_f = 15 ns
t_p = 20 μs
T = 500 μs

Fig. 2 Switching times test circuit.

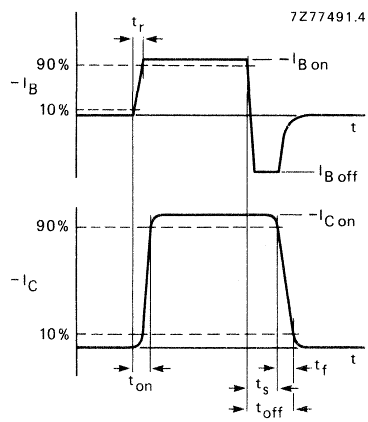
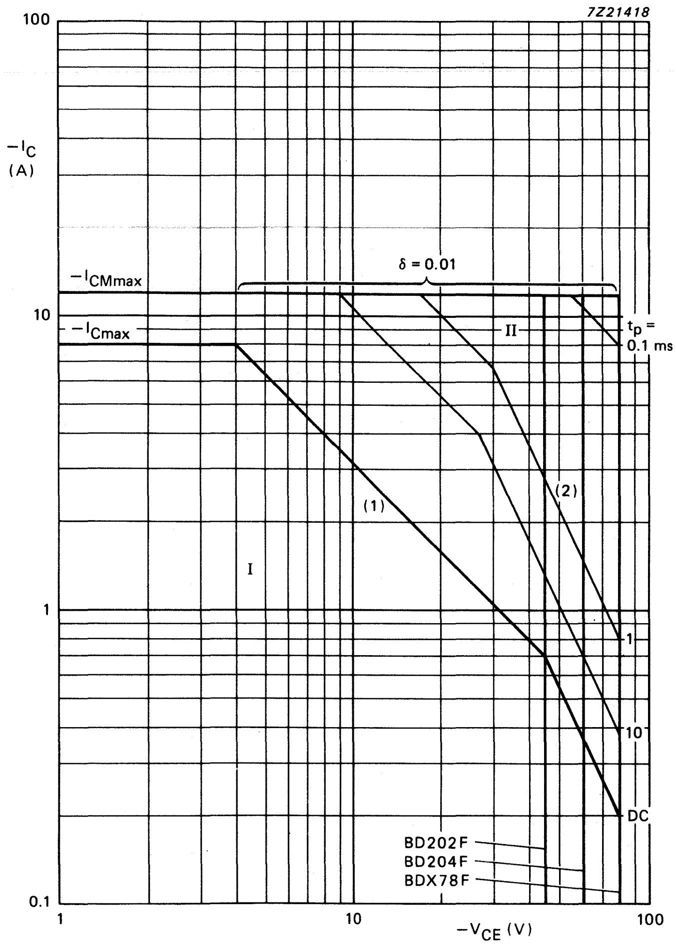


Fig. 3 Switching times waveforms.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) P_{tot} max and P_{peak} max lines.
(2) Second-breakdown limits.

Note: Mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

Fig. 4 Safe Operating Area; T_{amb} = 25 °C.

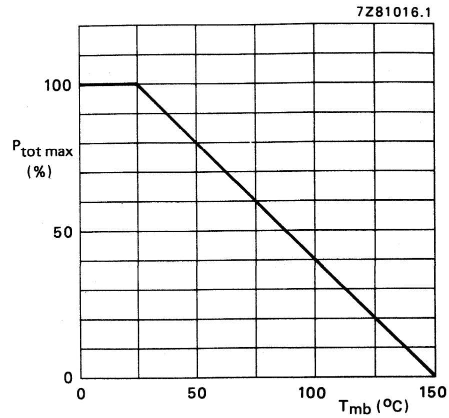


Fig. 5 Maximum power dissipation as a function of temperature.

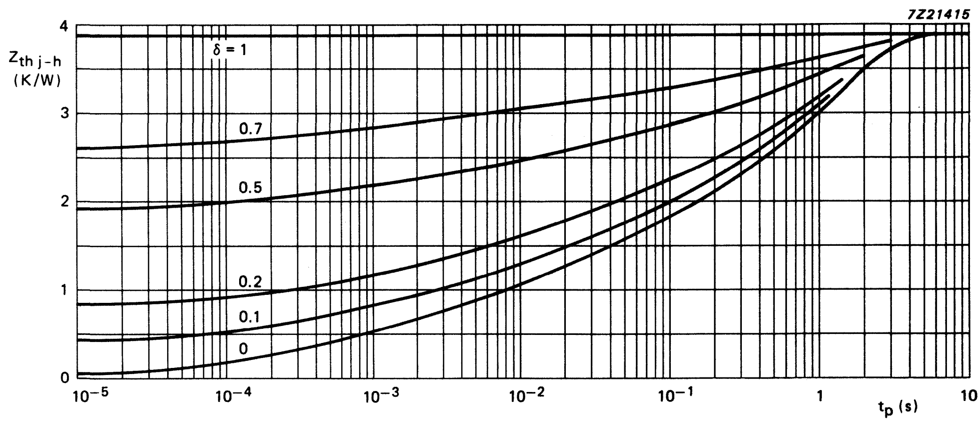


Fig. 6 Pulse power rating chart.

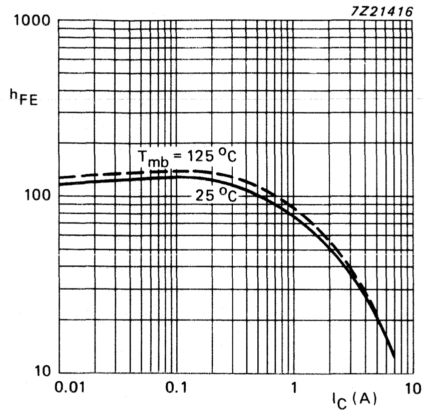


Fig. 7 Typical DC current gain curves at $-V_{CE}$ = 2 V.

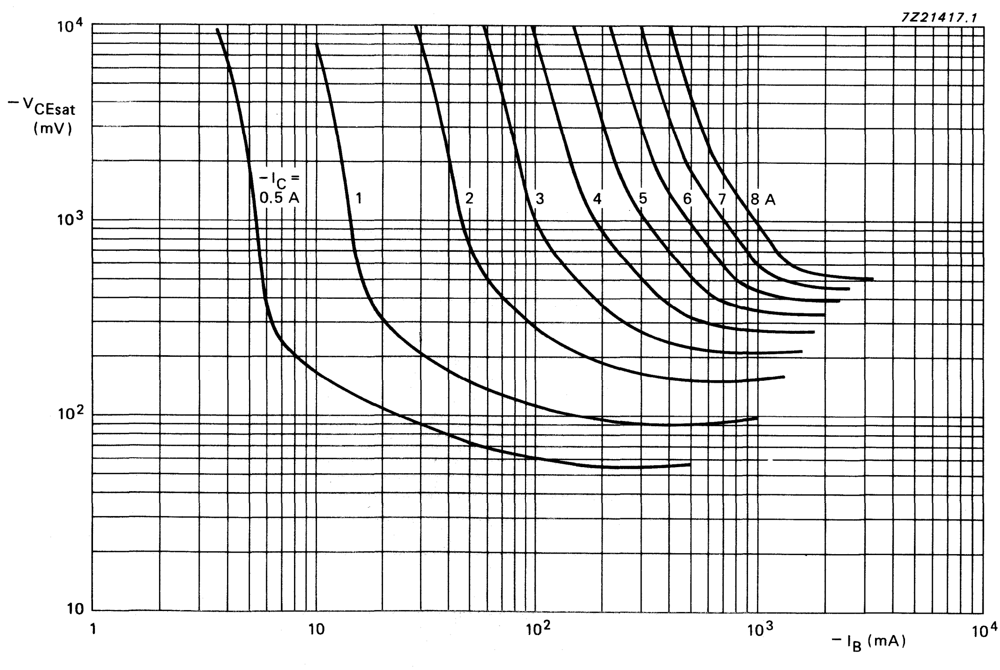


Fig. 8 Collector-emitter saturation voltage as a function of base current; typical values; T_j = 25 °C.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose n-p-n transistors in a SOT-32 plastic envelope especially recommended for television circuits. Their complements are BD227, BD229 and BD231.

QUICK REFERENCE DATA

			BD226	BD228	BD230	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.	3	3	3	A
Total power dissipation up to T_{mb} = 62 °C	P_{tot}	max.	12,5	12,5	12,5	W
Junction temperature	T_j	max.	150	150	150	°C
D.C. current gain						
I_C = 150 mA; V_{CE} = 2 V	h_{FE}			40 to 250		
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>		25		
Transition frequency						
I_C = 50 mA; V_{CE} = 5 V	f_T	typ.		125		MHz

MECHANICAL DATA

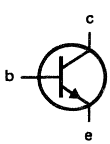
Dimensions in mm

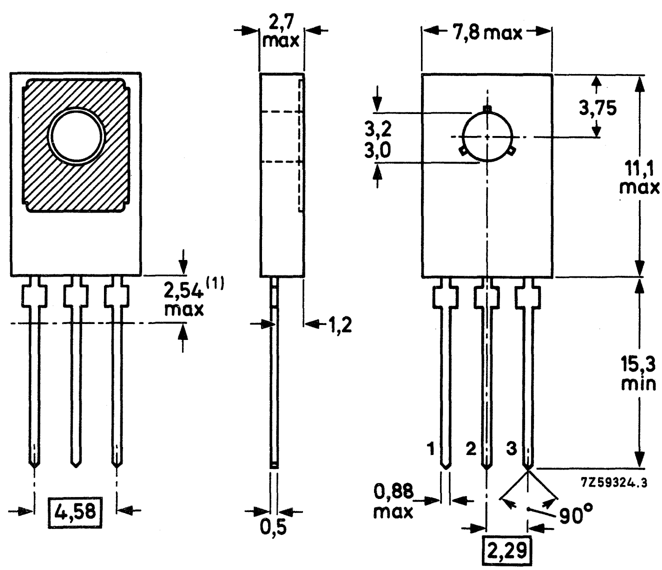
TO-126 (SOT-32)

Collector connected to metal part of mounting surface

Pinning

1 = emitter
2 = collector
3 = base





See chapters Mounting Instructions and Accessories.

1) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD226	BD228	BD230	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V

Collector current (d.c.)	I_C	max.	1,5	A
Collector current (peak value)	I_{CM}	max.	3	A
Total power dissipation up to T_{mb} = 62 °C	P_{tot}	max.	12,5	W
Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

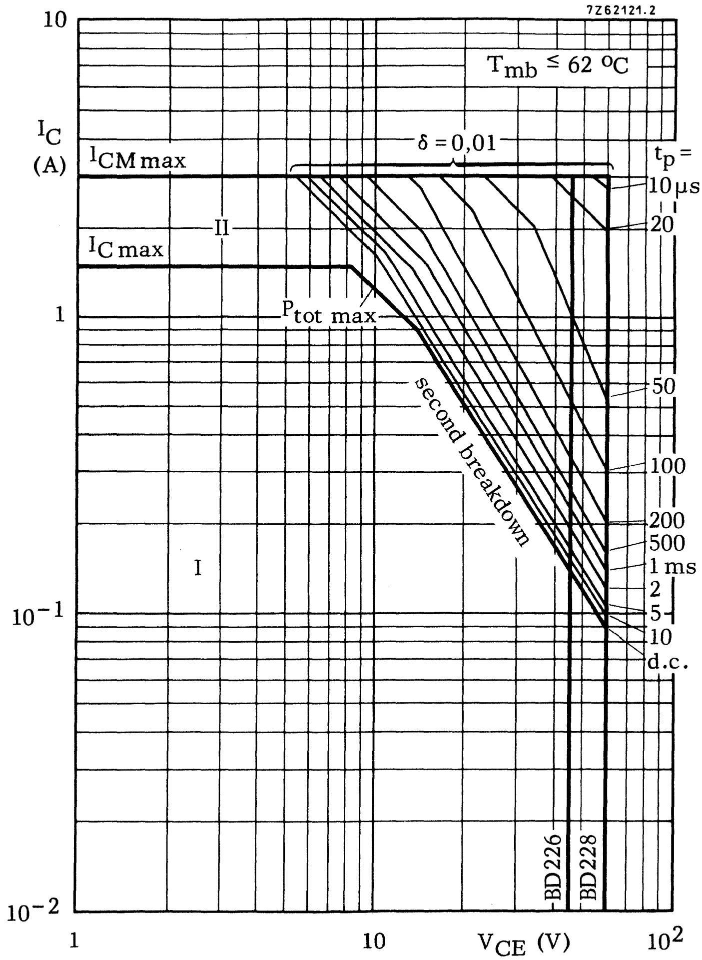
From junction to ambient in free air	$R_{th\ j-a}$	=	100	K/W
From junction to mounting base	$R_{th\ j-mb}$	=	7	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; V_{CB} = 30 V	I_{CBO}	<	100	nA
$I_E = 0$; V_{CB} = 30 V; T_j = 125 °C	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	10	μA
Base-emitter voltage [1]				
I_C = 1 A; V_{CE} = 2 V	V_{BE}	<	1,3	V
Saturation voltage				
I_C = 1 A; I_B = 0.1 A	V_{CEsat}	<	0,8	V
D.C. current gain				
I_C = 5 mA; V_{CE} = 2 V	h_{FE}	>	25	
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 to 250	
I_C = 1 A ; V_{CE} = 2 V	h_{FE}	>	25	
Transition frequency at f = 35 MHz				
I_C = 50 mA; V_{CE} = 5 V	f_T	typ.	125	MHz
D.C. current gain ratio of matched pairs				
BD226/BD227; BD228/BD229;				
BD230/BD231				
$\|I_C\|$ = 150 mA; $\|V_{CE}\|$ = 2 V	h_{FE1}/h_{FE2}	typ. <	1,3 1,6	

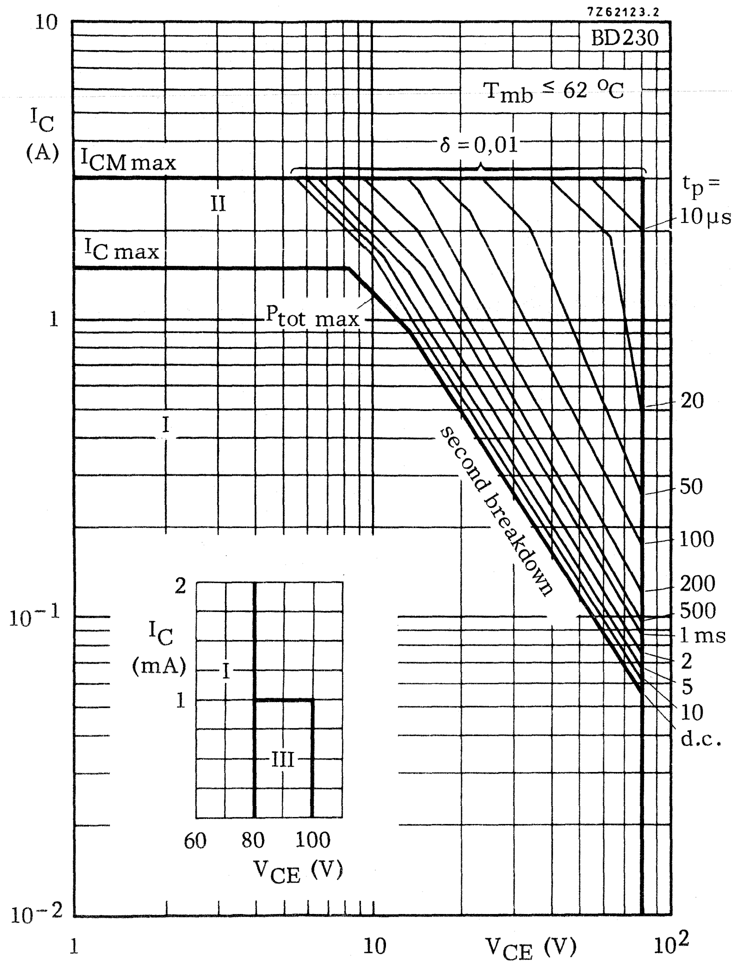
[1]) V_{BE} decreases by about 2,3 mV/K with increasing temperature.



Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

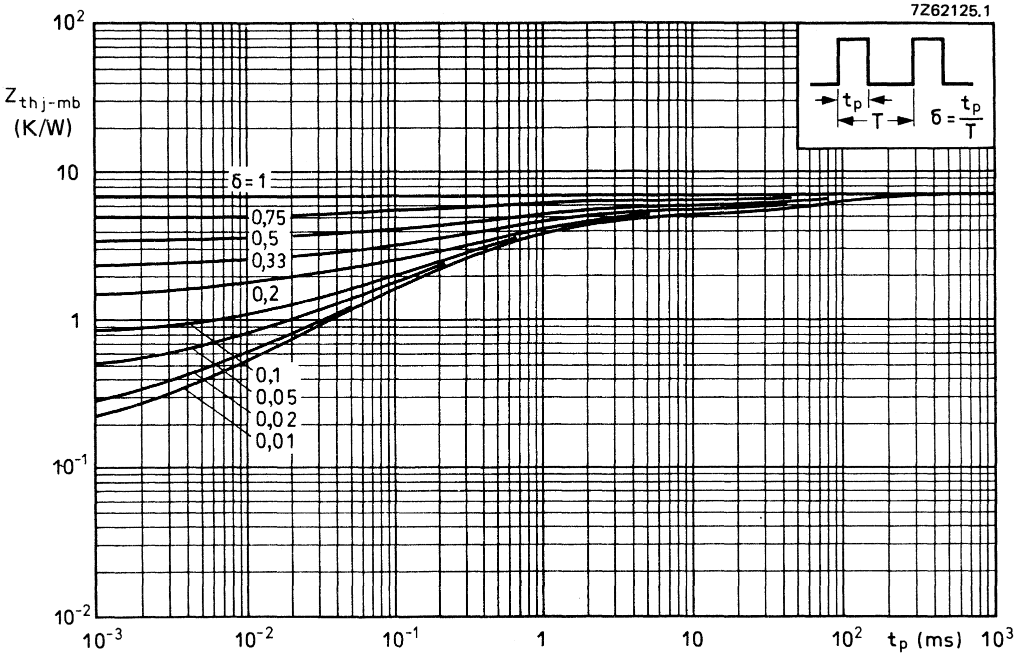


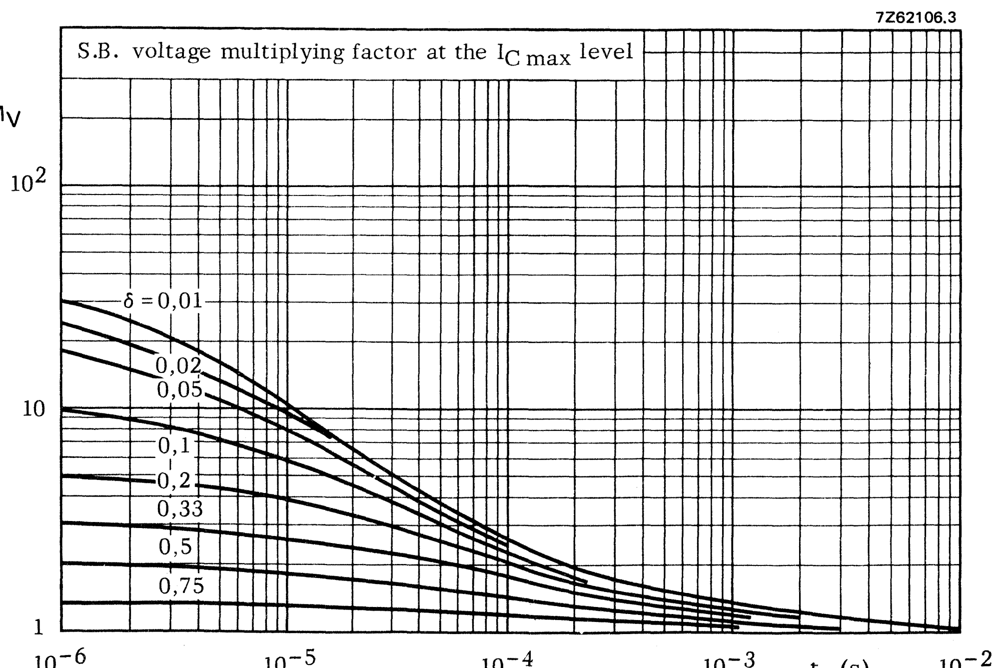
Safe Operating Area with the transistor forward biased

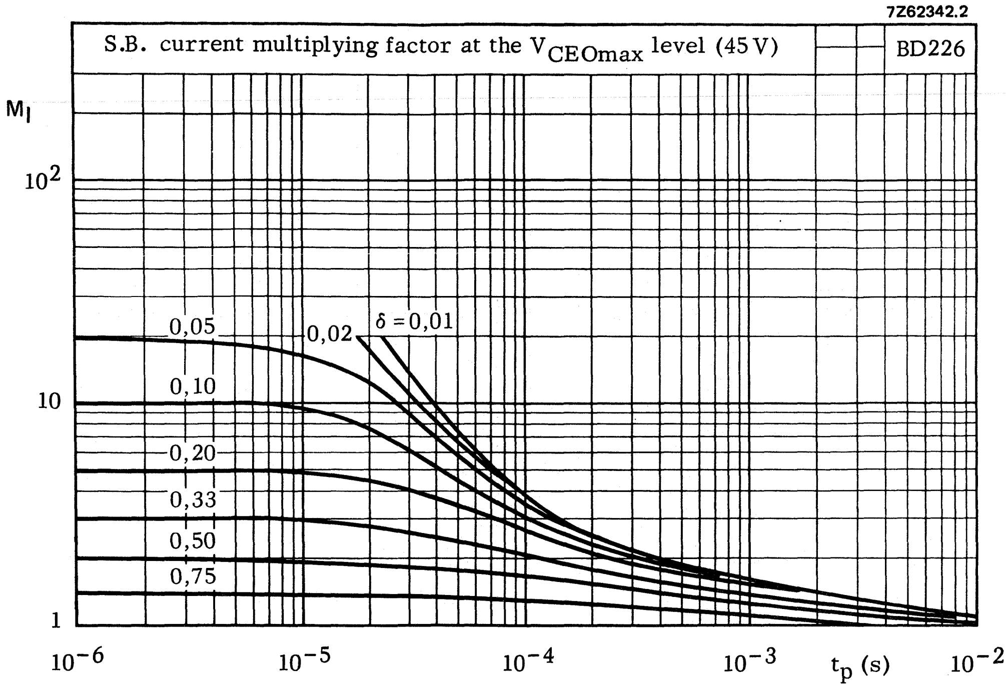
I Region of permissible d.c. operation

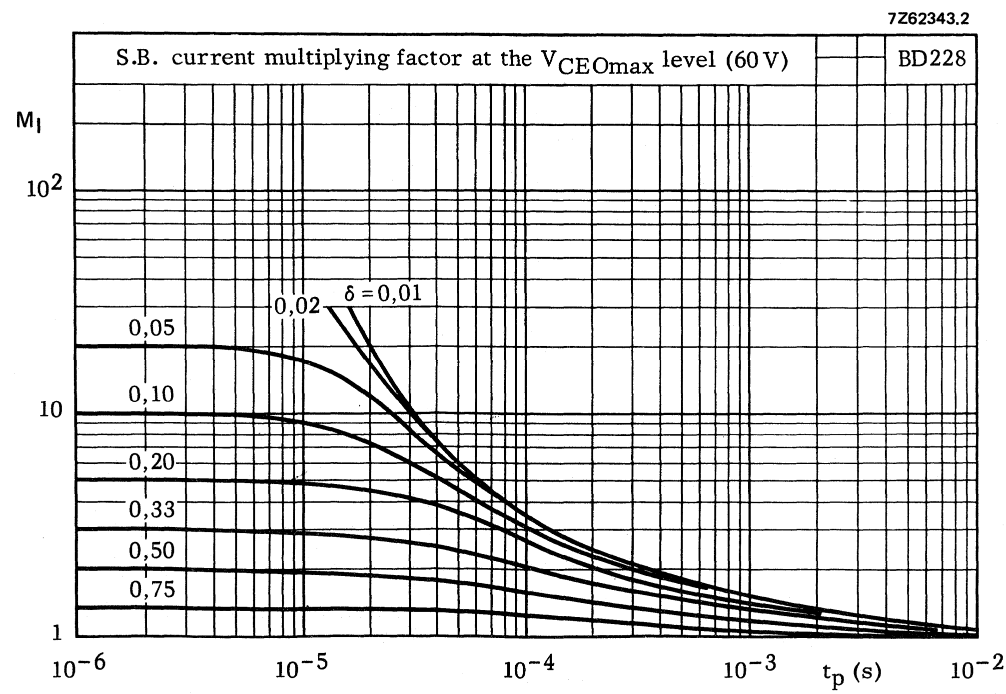
II Permissible extension for repetitive pulse operation

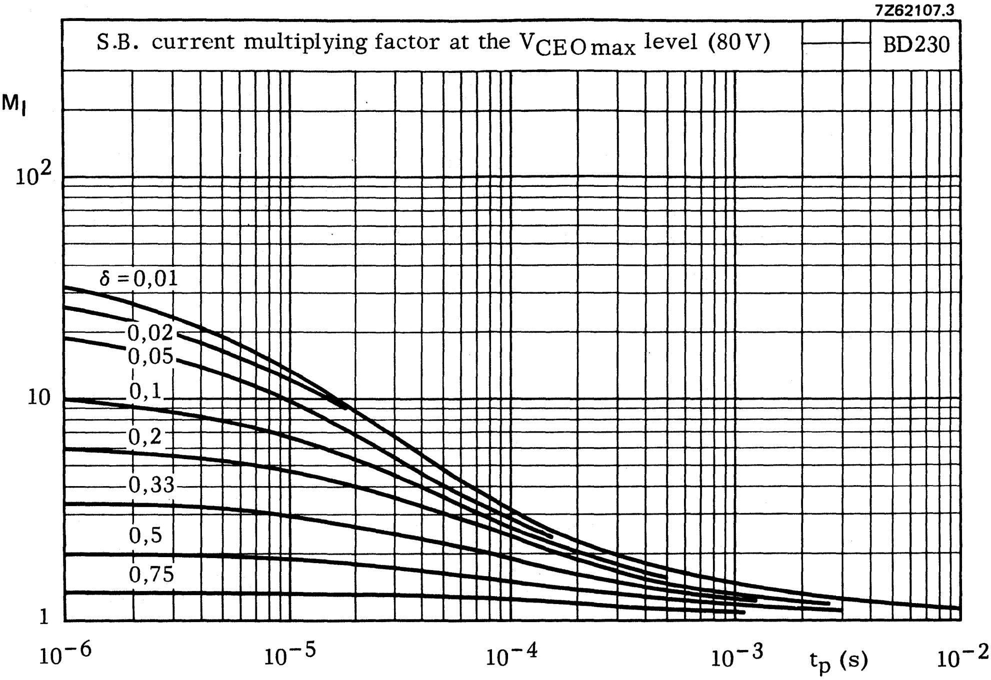
III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1$ kΩ

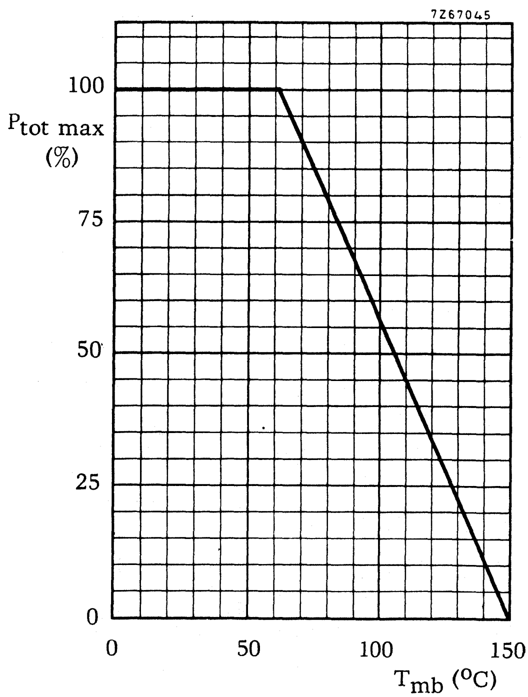

7Z62125.1
$Z_{th\,j\text{-}mb}$ (K/W)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (ms)
10^3
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
t_p
T
$\delta = \frac{t_p}{T}$

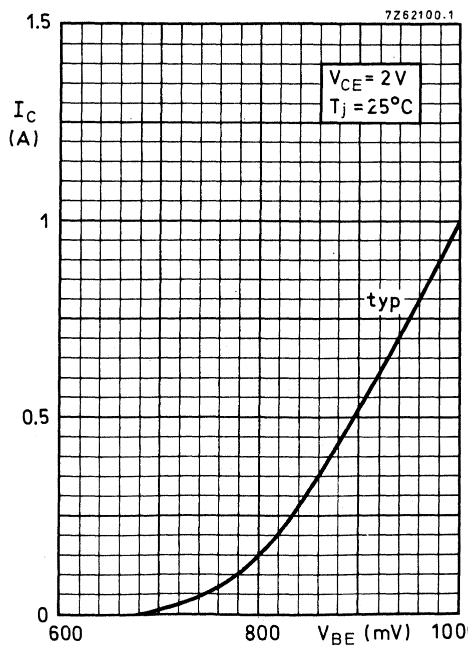

7Z62106.3
S.B. voltage multiplying factor at the $I_{C\,max}$ level
M_V
10^2
10
1
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75

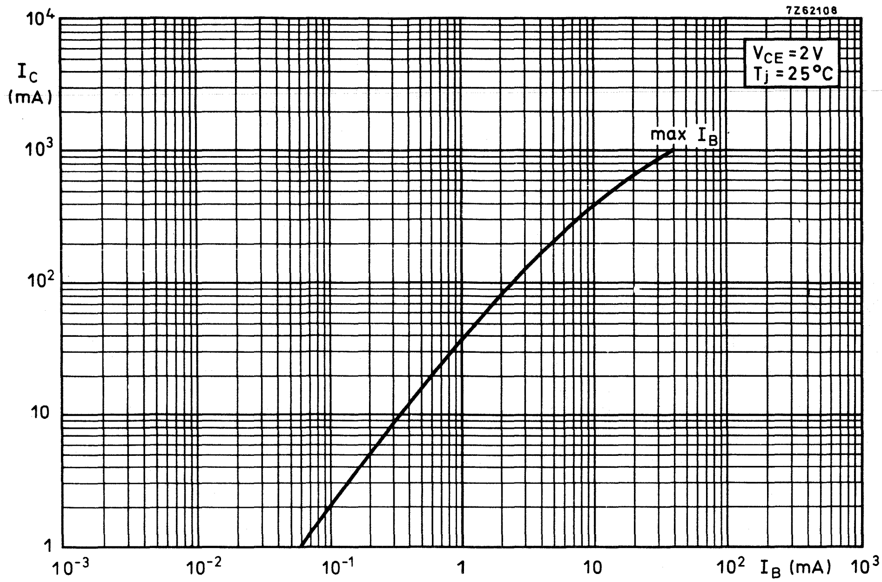

7Z62342.2
S.B. current multiplying factor at the V_{CEOmax} level (45 V)
BD226
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

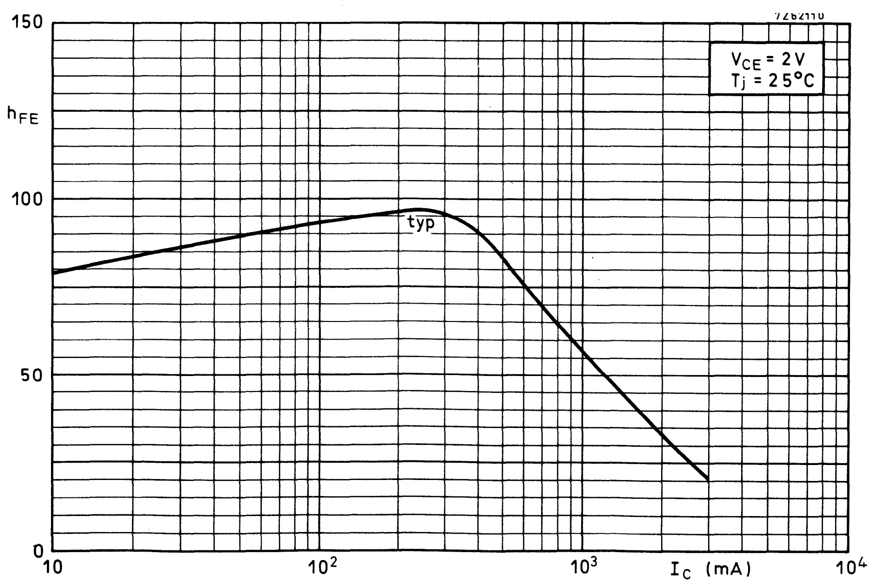

7Z62343.2
S.B. current multiplying factor at the V_{CEOmax} level (60 V)
BD228
M_I
10^2
10
1
0,02
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

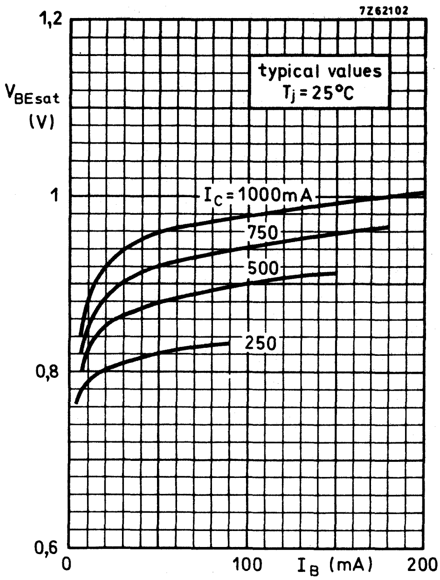

7Z62107.3
S.B. current multiplying factor at the VCEO max level (80 V)
BD230
MI
10²
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
tp (s)
10⁻²

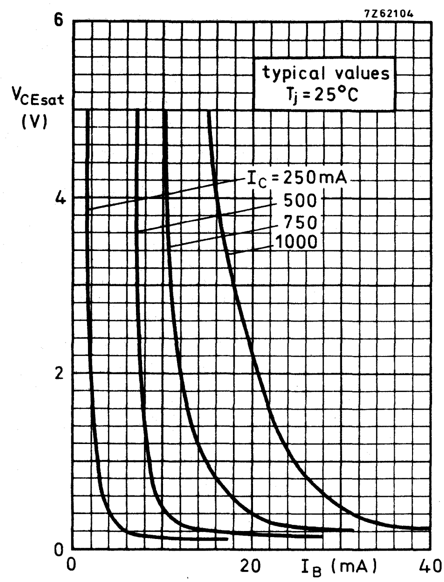

7Z67045
100
Ptot max
(%)
75
50
25
0
0
50
100
150
Tmb (°C)

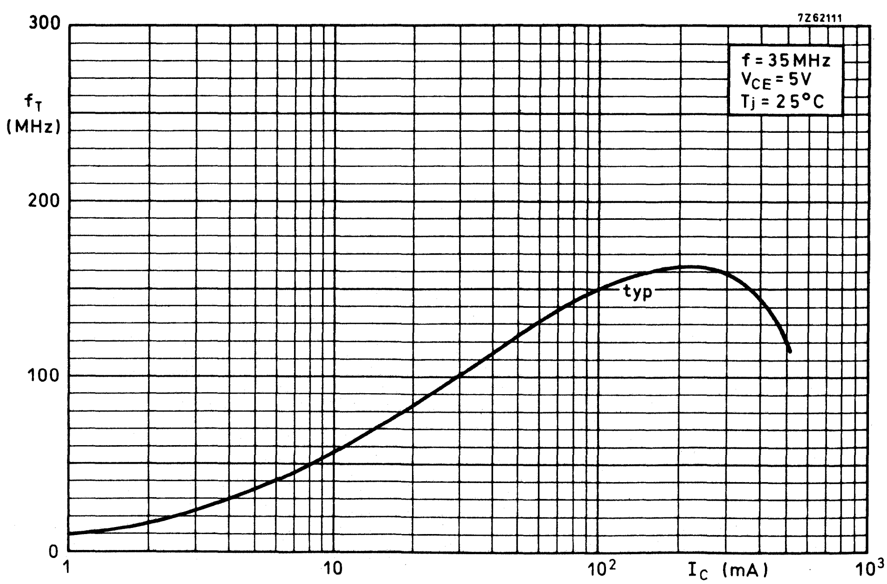

7Z62100.1
1.5
IC
(A)
1
0.5
0
VCE = 2 V
Tj = 25°C
typ
600
800
VBE (mV)
1000


7Z62108
V_{CE} = 2 V
T_j = 25 °C
I_C (mA)
10^4
10^3
10^2
10
1
max I_B
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
I_B (mA)
10^3


7Z62110
V_{CE} = 2 V
T_j = 25 °C
h_{FE}
150
100
50
0
typ
10
10^2
10^3
I_C (mA)
10^4


7Z62102
typical values
$T_j = 25°C$
V_{BEsat} (V)
$I_C = 1000mA$
750
500
250
1,2
1
0,8
0,6
0
100
200
I_B (mA)


7Z62104
typical values
$T_j = 25°C$
V_{CEsat} (V)
$I_C = 250mA$
500
750
1000
6
4
2
0
0
20
40
I_B (mA)


7Z62111
f = 35 MHz
$V_{CE} = 5V$
$T_j = 25°C$
f_T (MHz)
typ
300
200
100
0
1
10
10^2
10^3
I_C (mA)

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose pnp transistors in a SOT-32 plastic envelope especially recommended for television circuits. Their complements are BD226, BD228 and BD230.

QUICK REFERENCE DATA

			BD227	BD229	BD231	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.	3	3	3	A
Total power dissipation up to T_{mb} = 62 °C	P_{tot}	max.	12.5	12.5	12.5	W
Junction temperature	T_j	max.	150	150	150	°C
DC current gain						
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}			40 to 250		
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>		25		
Transition frequency						
$-I_C$ = 50 mA; $-V_{CE}$ = 5 V	f_T	typ.		50		MHz

MECHANICAL DATA

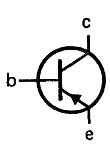
Dimensions in mm

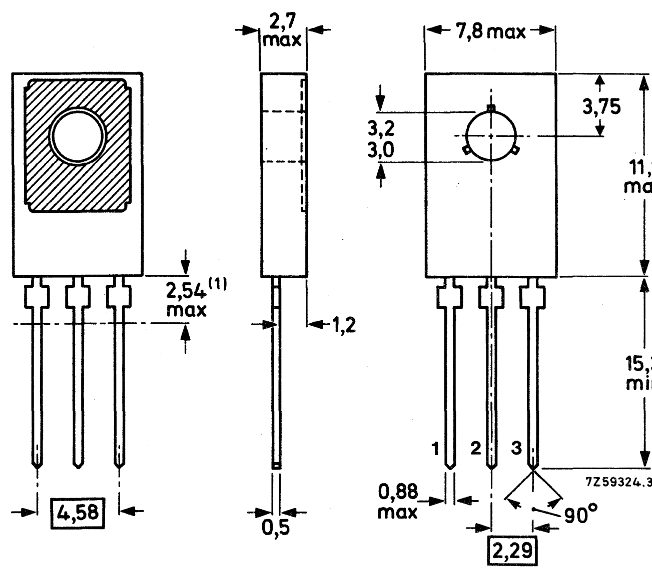
Fig. 1 TO-126 (SOT-32)

Collector connected to metal part of mounting surface.

Pinning:

1 = emitter
2 = collector
3 = base





See Mounting Instructions and Accessories

1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD227	BD229	BD231	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (DC)	$-I_C$	max.		1.5		A
Collector current (peak value)	$-I_{CM}$	max.		3		A
Total power dissipation up to T_{mb} = 62 °C	P_{tot}	max.		12.5		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	7	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = 30$ V	$-I_{CBO}$	<	100	nA
$I_E = 0; -V_{CB} = 30$ V; $T_j = 125$ °C	$-I_{CBO}$	<	10	μA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	10	μA
Base-emitter voltage *				
$-I_C = 1$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1.3	V
Saturation voltage				
$-I_C = 1$ A; $-I_B = 0.1$ A	$-V_{CEsat}$	<	0.8	V
DC current gain				
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25	
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}	<	40 to 250	
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	25	
Transition frequency at f = 35 MHz				
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	typ.	50	MHz
DC current gain ratio of matched pairs BD226/BD227; BD228/BD229; BD230/BD231				
$\|I_C\| = 150$ mA; $\|V_{CE}\| = 2$ V	h_{FE1}/h_{FE2}	typ.	1.3	
		<	1.6	

* $-V_{BE}$ decreases by about 2.3 mV/K with increasing temperature.

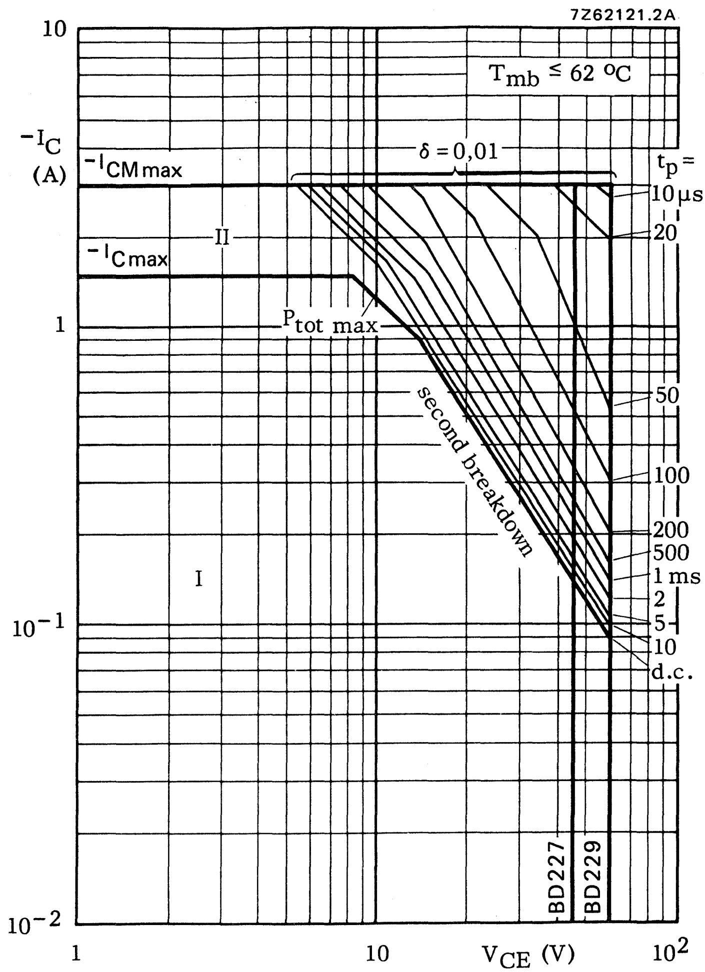


Fig. 2 Safe operating area with the transistor forward biased.

I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

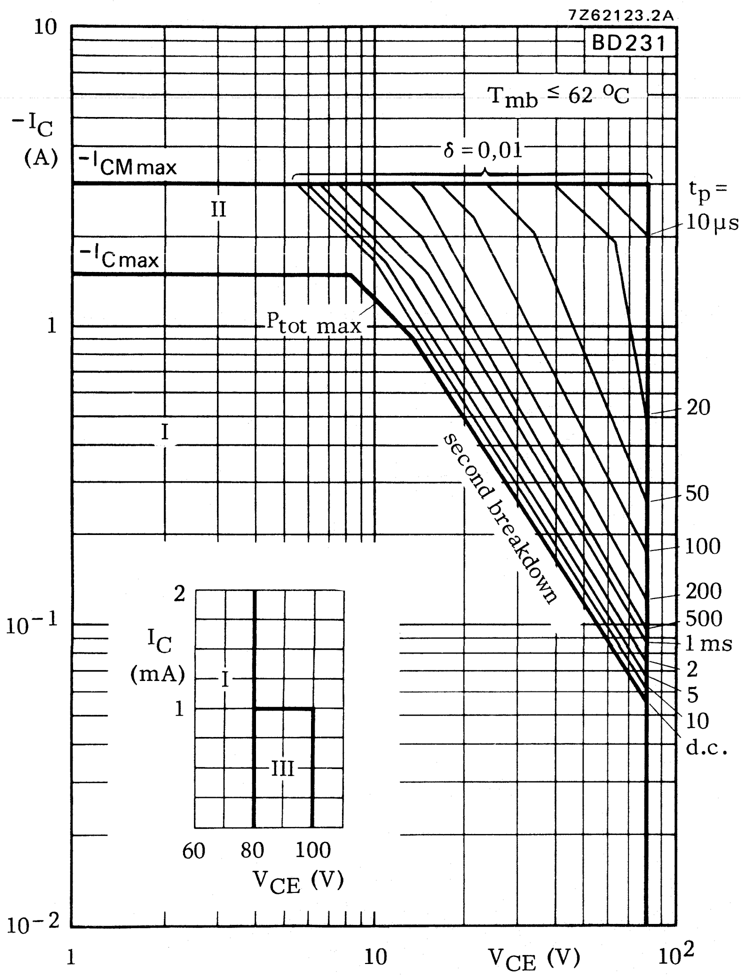


Fig. 3 Safe operating area with the transistor forward biased.

I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.
III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leqslant 1$ kΩ.

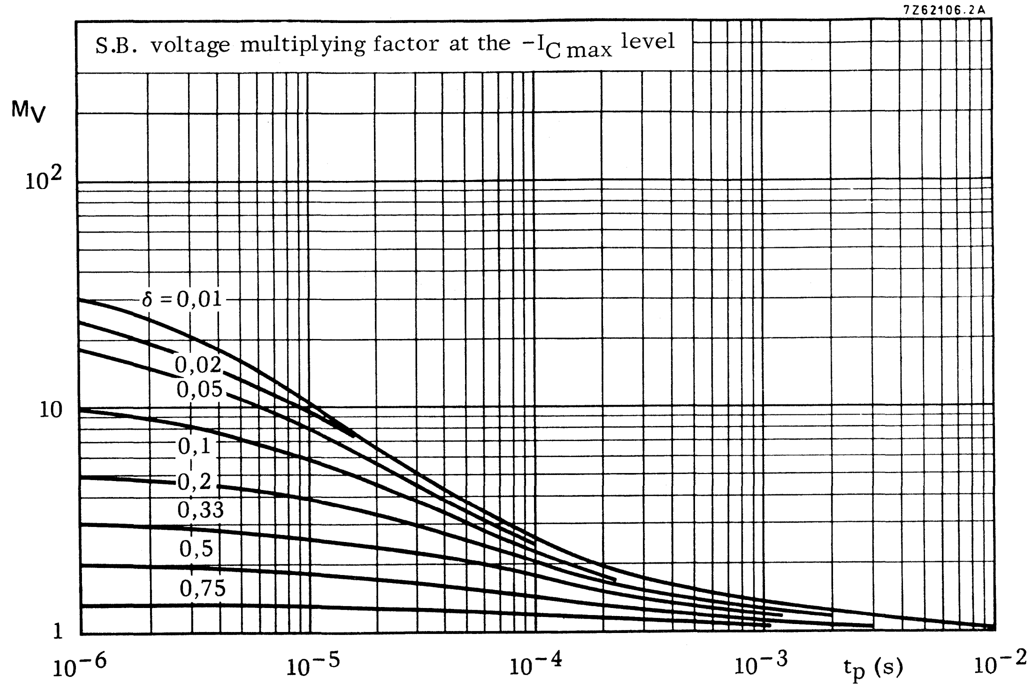

7Z62106.2A
S.B. voltage multiplying factor at the $-I_{C\,max}$ level
M_V
10^2
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 4.

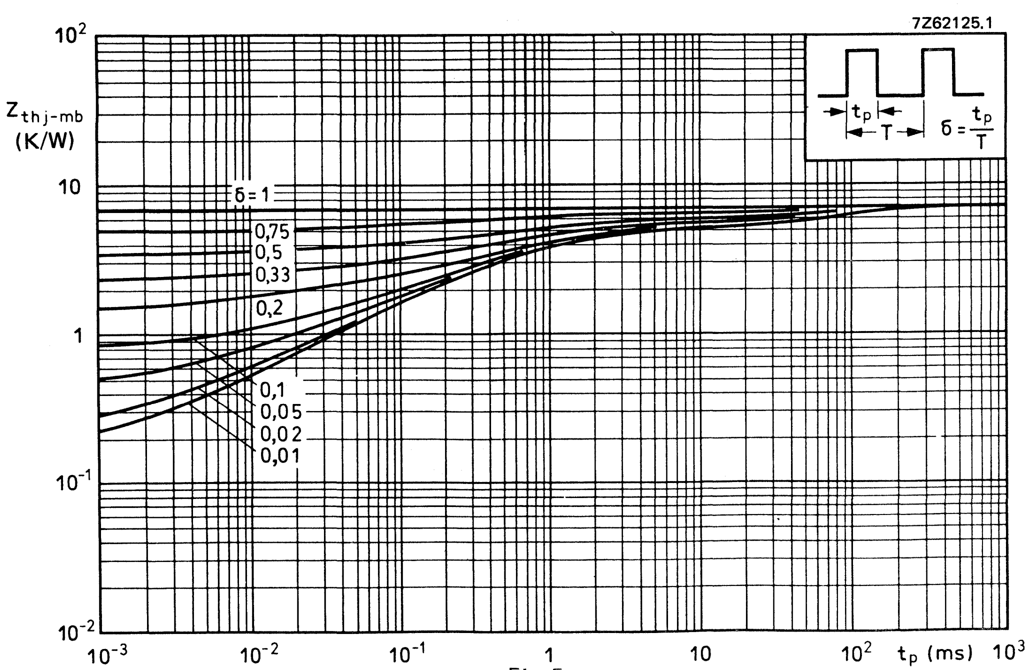

7Z62125.1
10^2
$Z_{th\,j\text{-}mb}$
(K/W)
10
1
10^{-1}
10^{-2}
t_p
T
$\delta = \frac{t_p}{T}$
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (ms)
10^3

Fig. 5.

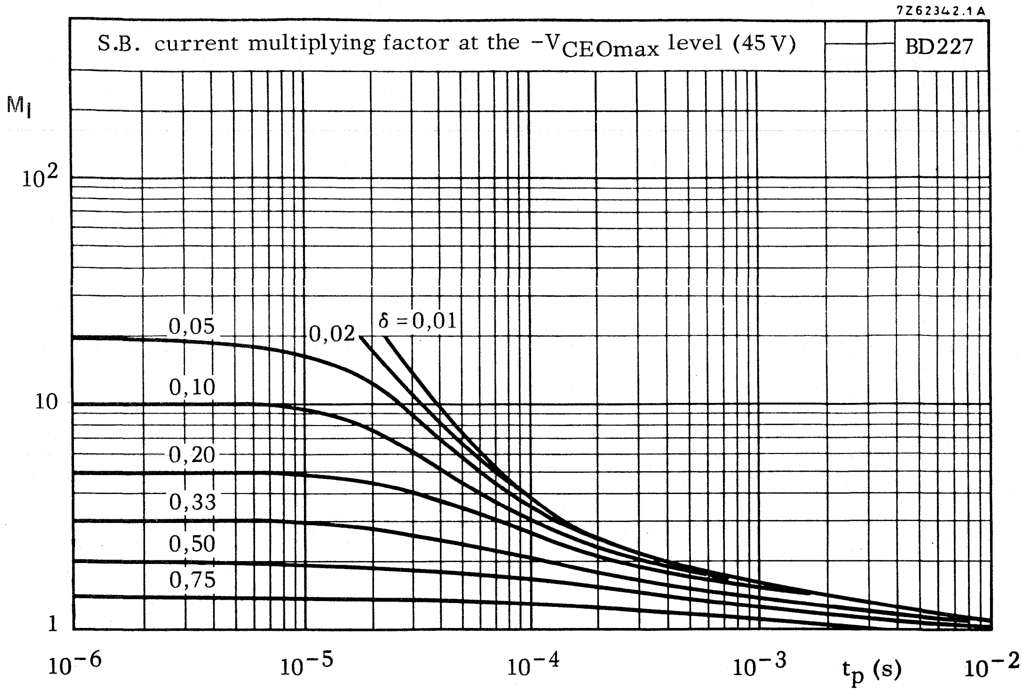

7Z62342.1A
S.B. current multiplying factor at the $-V_{CEOmax}$ level (45 V)
BD227
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 6.

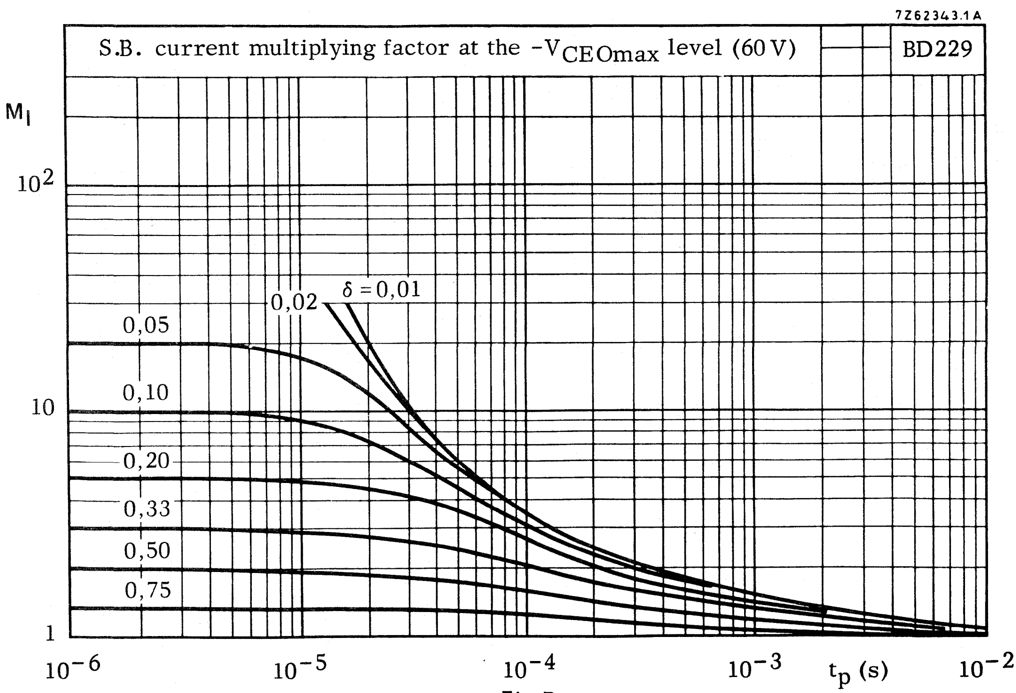

7Z62343.1A
S.B. current multiplying factor at the $-V_{CEOmax}$ level (60 V)
BD229
M_I
10^2
10
1
0,02
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 7.

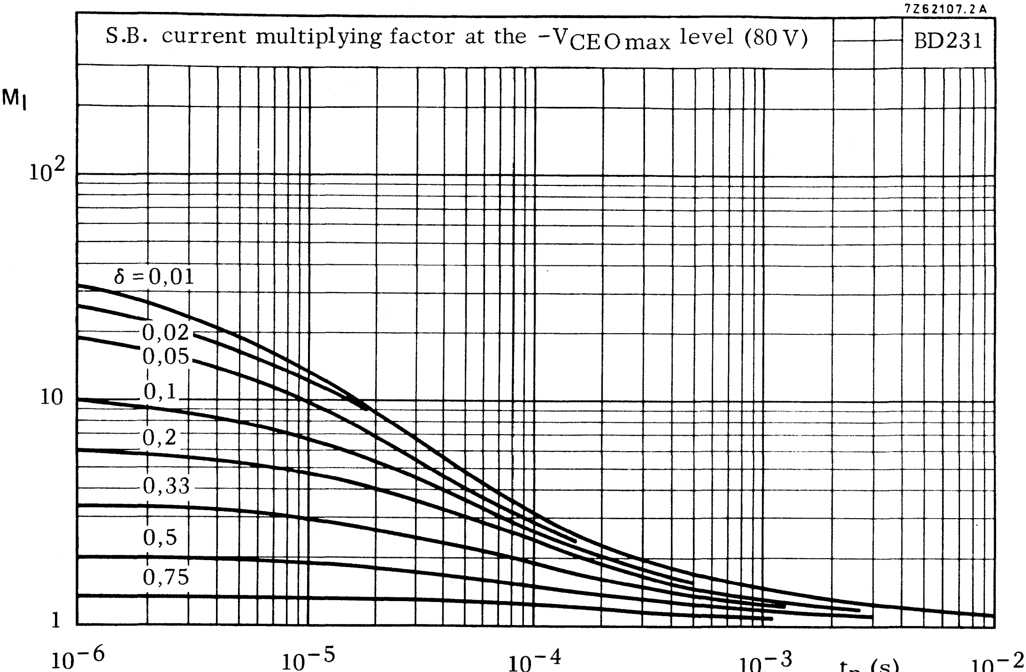


Fig. 8.

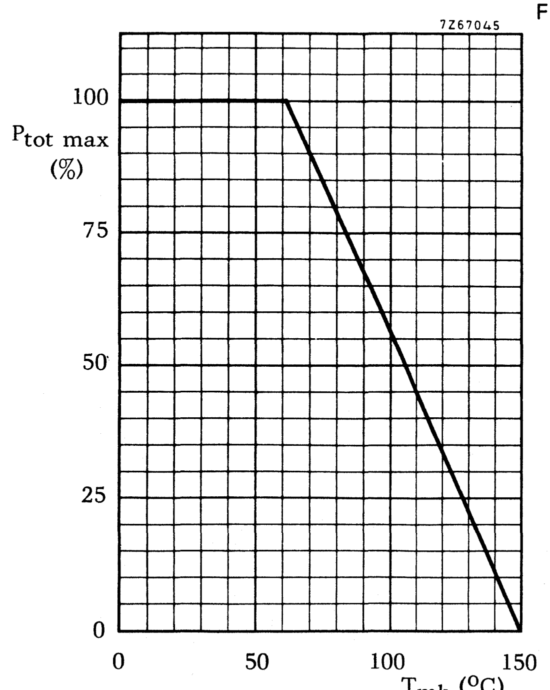


Fig. 9.

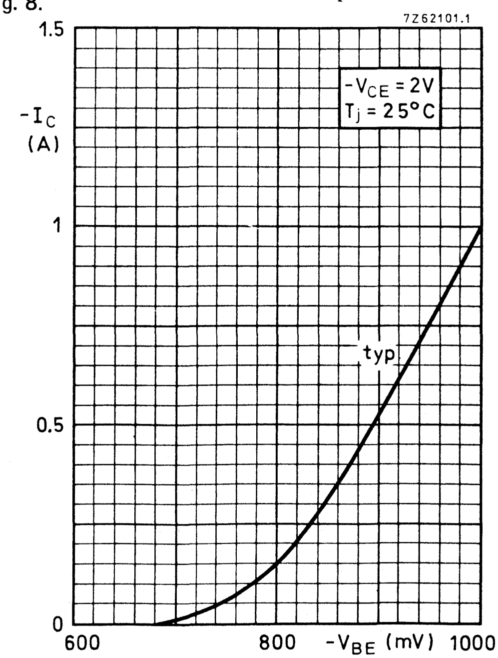


Fig. 10.

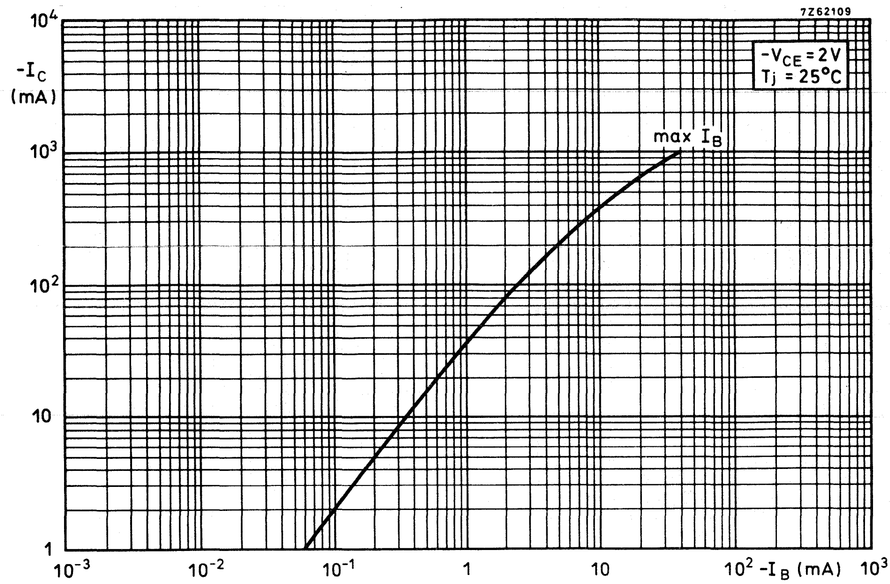

7Z62109
$-V_{CE} = 2\,V$
$T_j = 25\,°C$
$-I_C$ (mA)
10^4
10^3
10^2
10
1
max I_B
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
$-I_B$ (mA)
10^3

Fig. 11.

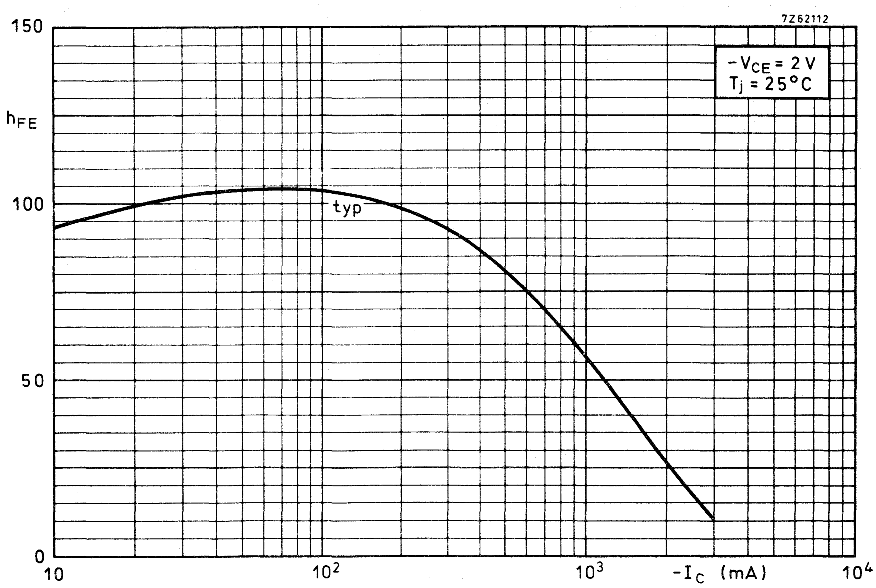

7Z62112
$-V_{CE} = 2\,V$
$T_j = 25\,°C$
h_{FE}
150
100
50
0
typ
10
10^2
10^3
$-I_C$ (mA)
10^4

Fig. 12.

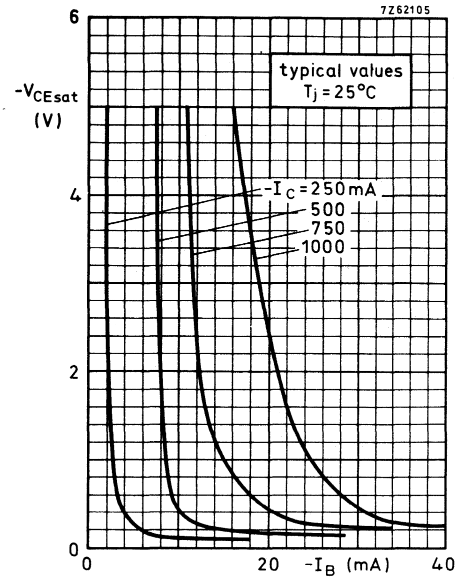


Fig. 13.

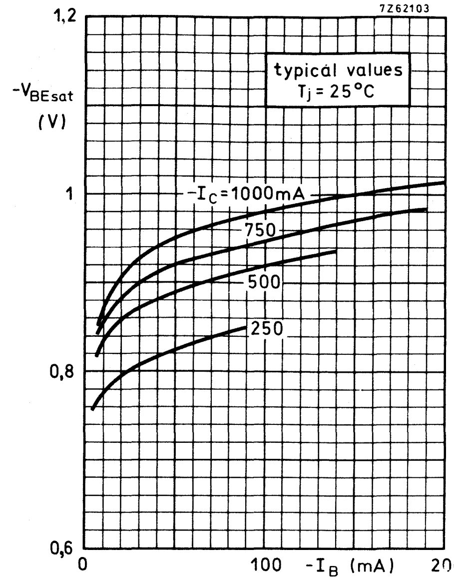


Fig. 14.

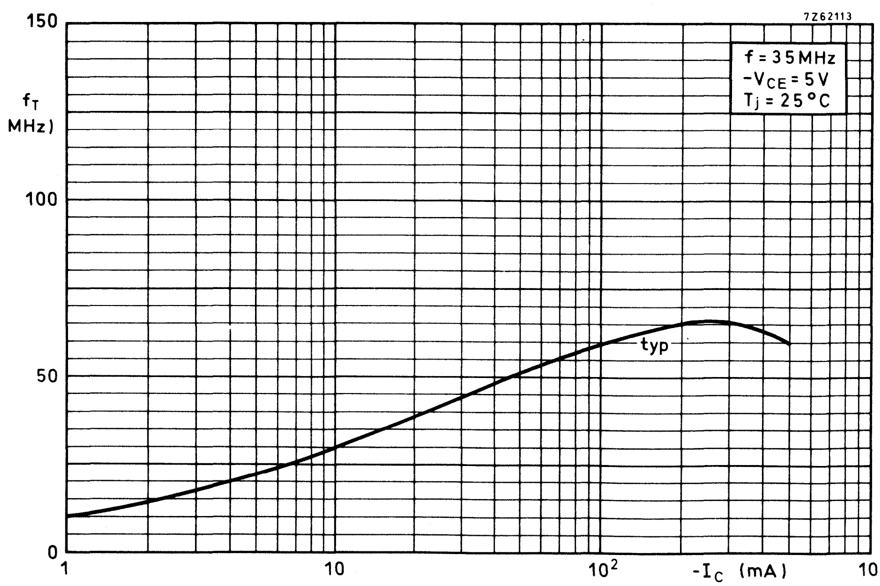


Fig. 15.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

N-P-N transistors in a SOT-32 plastic envelope intended for use in television and audio amplifier circuits where high peak powers can occur. P-N-P complements are BD234, BD236 and BD238. Matched pairs can be supplied.

QUICK REFERENCE DATA

			BD233	BD235	BD237	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.		6		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		25		W
Junction temperature	T_j	max.		150		°C
D.C. current gain I_C = 1 A; V_{CE} = 2 V	h_{FE}	>		25		
Transition frequency I_C = 250 mA; V_{CE} = 10 V	f_T	>		3		MHz

MECHANICAL DATA

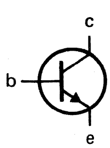
Dimensions in mm

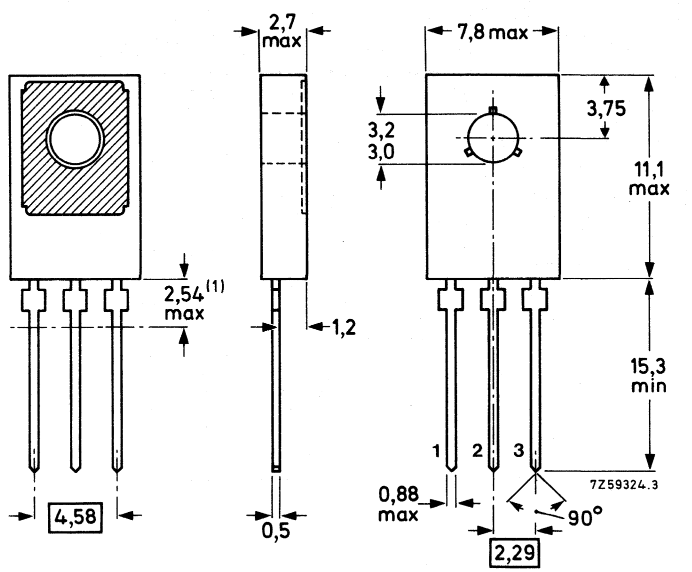
Fig. 1 TO-126 (SOT-32).

Collector connected to metal part of mounting surface

Pinning

1 = emitter
2 = collector
3 = base





(1) Within this region the cross-section of the leads is uncontrolled.

See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD233	BD235	BD237	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
Collector current (d.c.)	I_C	max.		2		A
Collector current (peak value)	I_{CM}	max.		6		A
Base current (d.c.)	I_B	max.		0,5		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		25		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	50	μA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	1	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	0,2	mA
Second-breakdown collector current				
V_{CE} = 40 V; t_p = 20 ms	$I_{(SB)C}$	<	0,5	A
Base-emitter voltage*				
I_C = 1 A; V_{CE} = 2 V	V_{BE}	<	1,3	V
Saturation voltage*				
I_C = 1 A; I_B = 0,1 A	V_{CEsat}	<	0,6	V
D.C. current gain*				
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 to 250	
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>	25	
Transition frequency at f = 1 MHz				
I_C = 250 mA; V_{CE} = 10 V	f_T	>	3	MHz

* Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified.

D.C. current gain ratio of matched complementary pairs* $|I_C|$ = 150 mA; $|V_{CE}|$ = 2 V	h_{FE1}/h_{FE2}	<	1,6
Switching times I_{Con} = 1 A; $I_{Bon} = -I_{Boff}$ = 0,1 A			
turn-on time	t_{on}	typ.	0,4 μs
		<	1 μs
turn-off time	t_{off}	typ.	1,5 μs
		<	3 μs

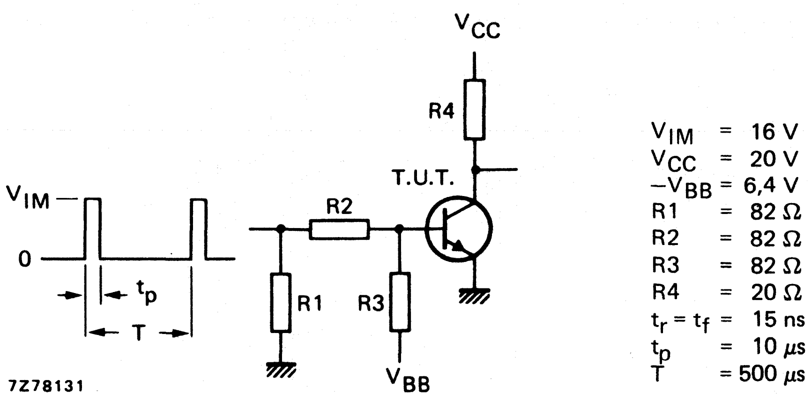


Fig. 2 Test circuit.

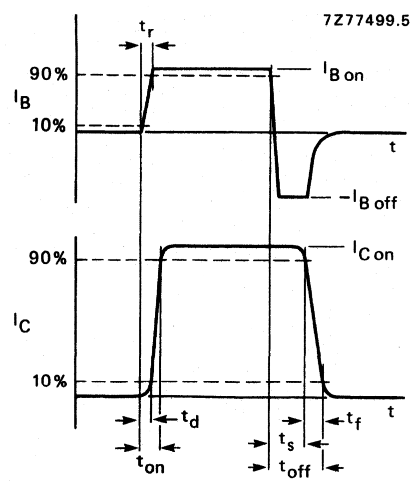


Fig. 3 Switching times waveforms.

* Measured under pulse conditions; $t_p < 300\ \mu s$, $\delta < 2\%$.

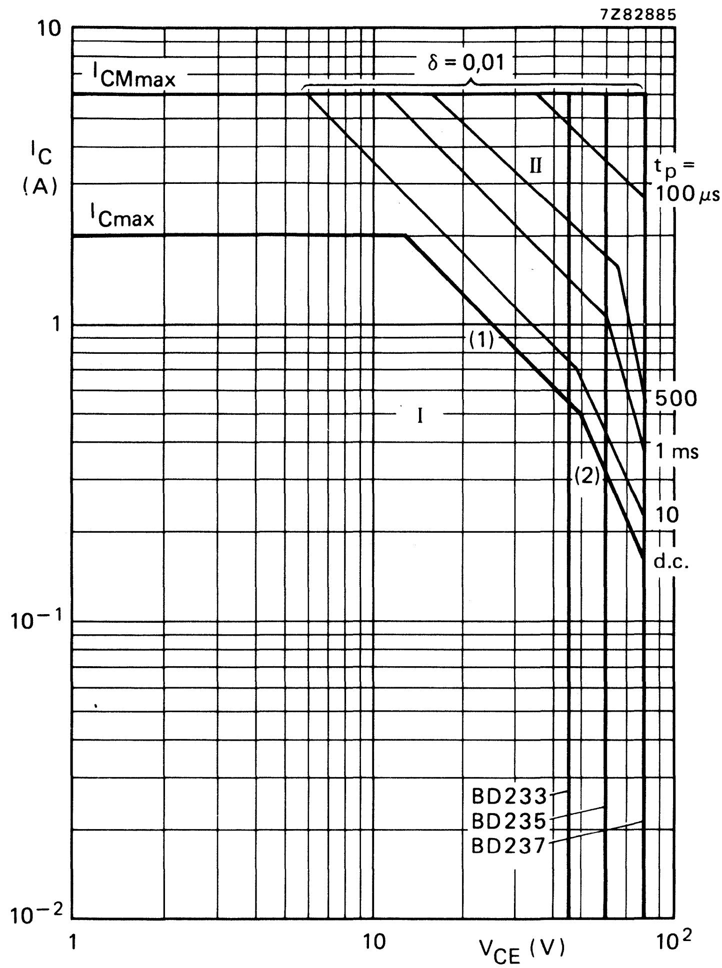


Fig. 4 Safe Operating Area with the transistor forward biased, $T_{mb} \leq 25\ ^{o}C$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second breakdown limits.

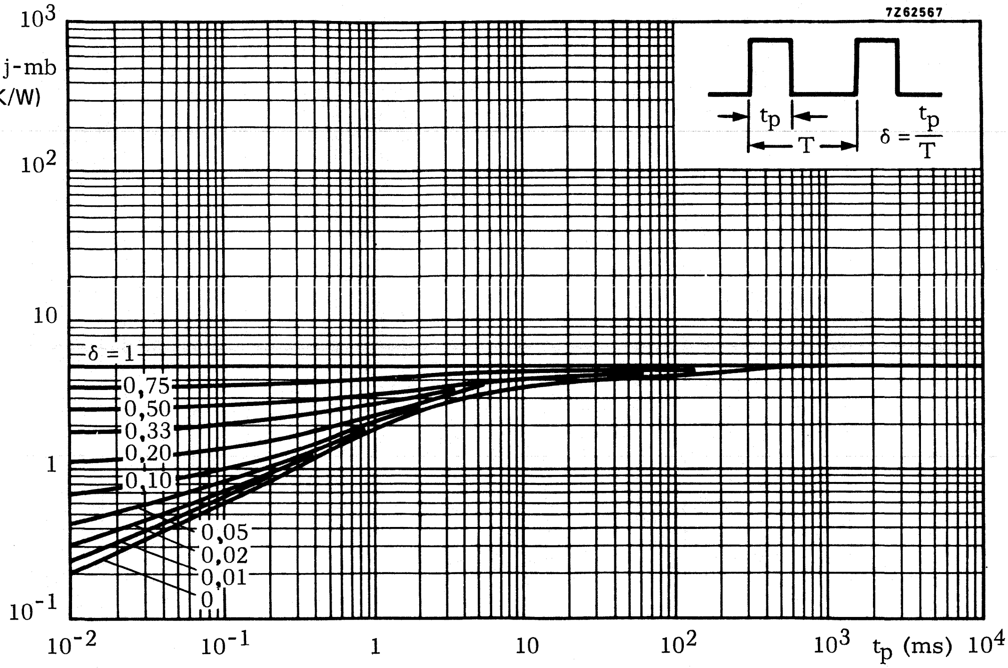
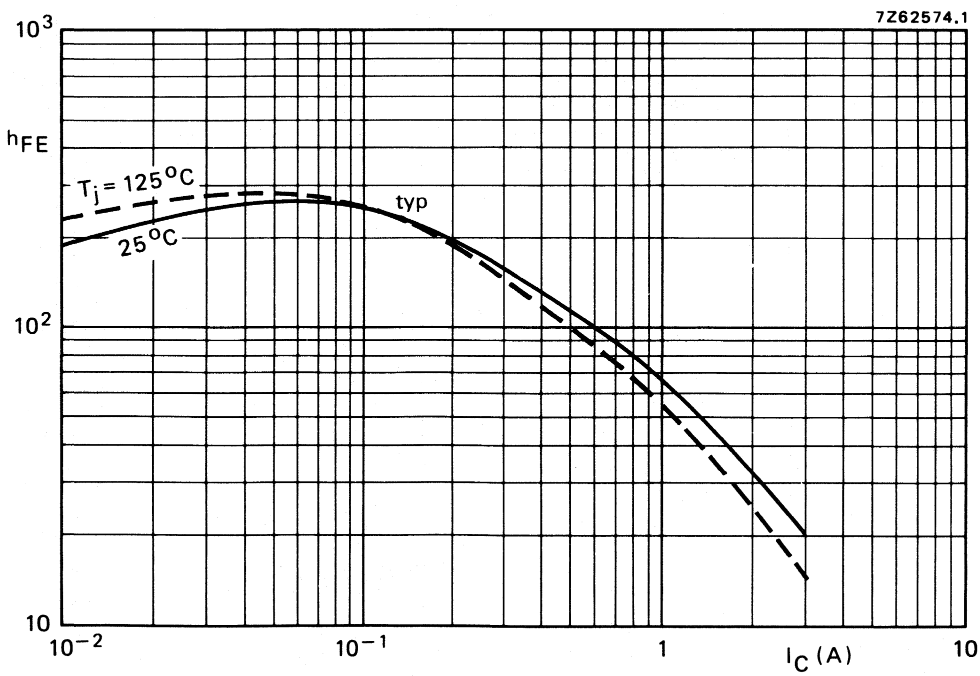


Fig. 5 Pulse power rating chart.



D.C. current gain; $V_{CE} = 2$ V.

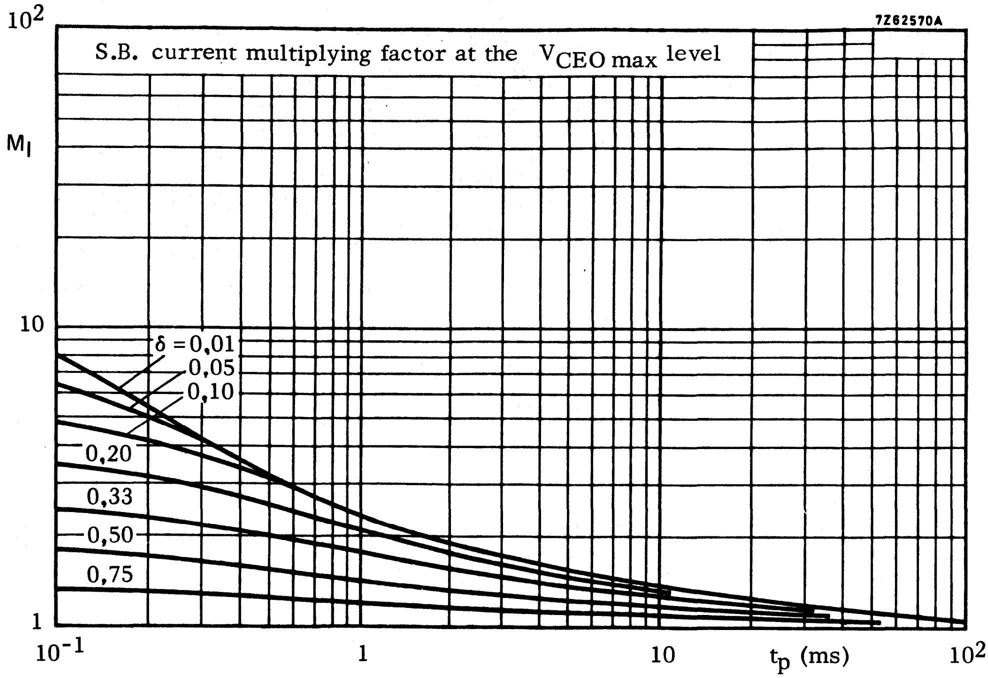


Fig. 7 S.B. current multiplying factor at the V_{CEOmax} level.

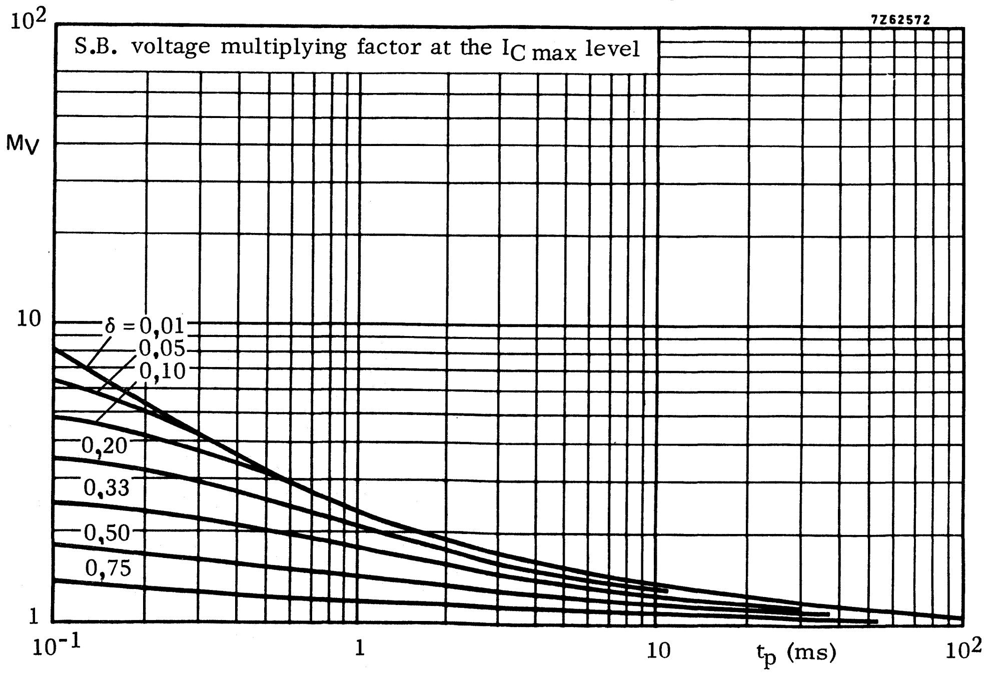


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

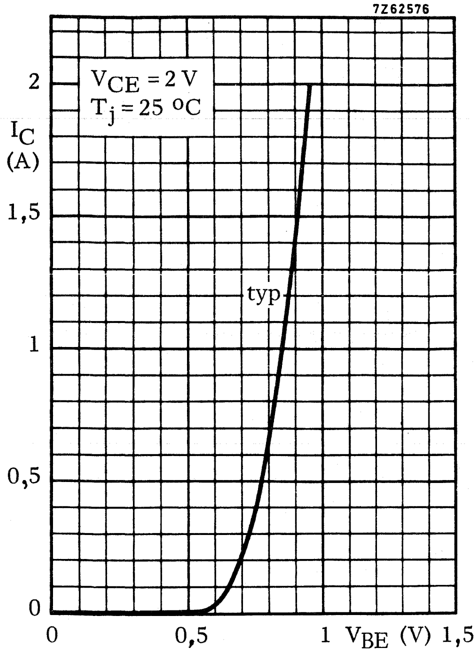

7Z62576
V_{CE} = 2 V
T_j = 25 °C
I_C (A)
2
1,5
1
0,5
0
typ
0
0,5
1
V_{BE} (V)
1,5

Fig. 9.

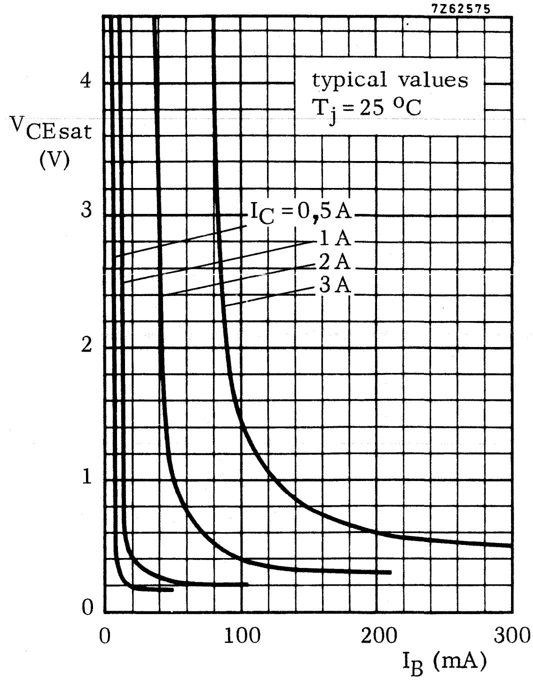

7Z62575
typical values
T_j = 25 °C
V_{CEsat} (V)
4
3
2
1
0
I_C = 0,5 A
1 A
2 A
3 A
0
100
200
300
I_B (mA)

Fig. 10.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

P-N-P transistors in a SOT-32 plastic envelope intended for use in television and audio amplifier circuits where high peak powers can occur. N-P-N complements are BD233, BD235 and BD237. Matched pairs can be supplied.

QUICK REFERENCE DATA

			BD234	BD236	BD238	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector current (d.c.)	$-I_C$	max.		2		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		25		W
Junction temperature	T_j	max.		150		°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>		25		
Transition frequency $-I_C$ = 250 mA; $-V_{CE}$ = 10 V	f_T	>		3		MHz

MECHANICAL DATA

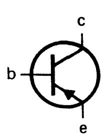
Dimensions in mm

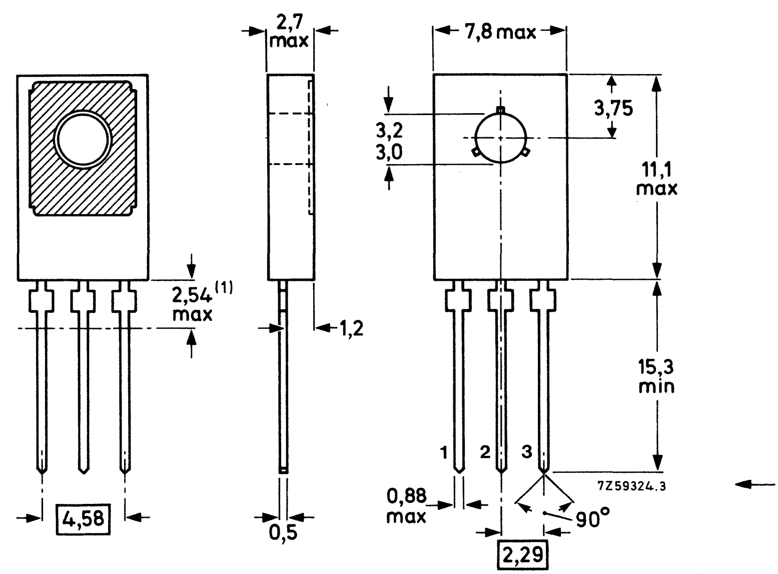
Fig. 1 TO-126 (SOT-32)

Collector connected to metal part of mounting surface

Pinning

1 = emitter
2 = collector
3 = base





1) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD234	BD236	BD238	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	2	A
Collector current (peak value)	$-I_{CM}$	max.	6	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	25	W
Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	K/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

→ $I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	**50**	μA
→ $I_E = 0$; $-V_{CB} = -V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<	**1**	mA

Emitter cut-off current

→ $I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	**0,2**	mA

CHARACTERISTICS (continued)

$T_j = 25\ ^oC$

Base-emitter voltage			
$-I_C = 1$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1,3 V
Saturation voltage			
$-I_C = 1$ A; $-I_B = 0,1$ A	$-V_{CEsat}$	<	0,6 V
D.C. current gain			
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}		40 to 250
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	25
Transition frequency at f = 1 MHz			
$-I_C = 250$ mA; $-V_{CE} = 10$ V	f_T	>	3 MHz
D.C. current gain ratio of matched pairs BD233/BD234; BD235/BD236; BD237/BD238			
$\lvert I_C \rvert = 150$ mA; $\lvert V_{CE} \rvert = 2$ V	h_{FE1}/h_{FE2}	<	1,6
Switching times			
$-I_{Con} = 1$ A; $-I_{Bon} = I_{Boff} = 0,1$ A			
turn-on time	t_{on}	typ	0,3 μs
turn-off time	t_{off}	typ	0,7 μs

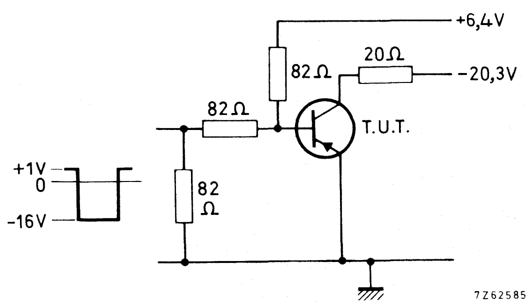


Fig. 2 Switching times test circuit

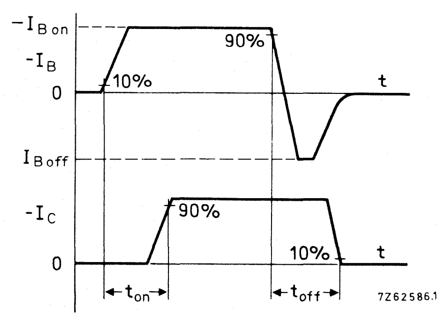


Fig. 3 Switching times waveforms.

Input pulse:
$t_r = t_f = 15$ ns
$t_p = 10$ μs
$T = 500$ μs

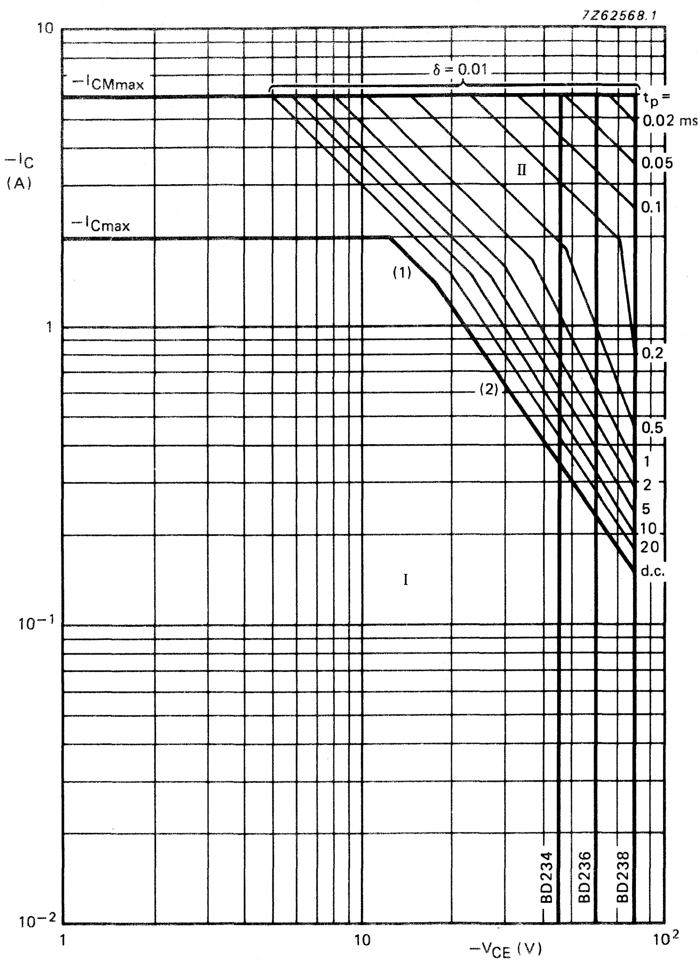


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second breakdown limits.

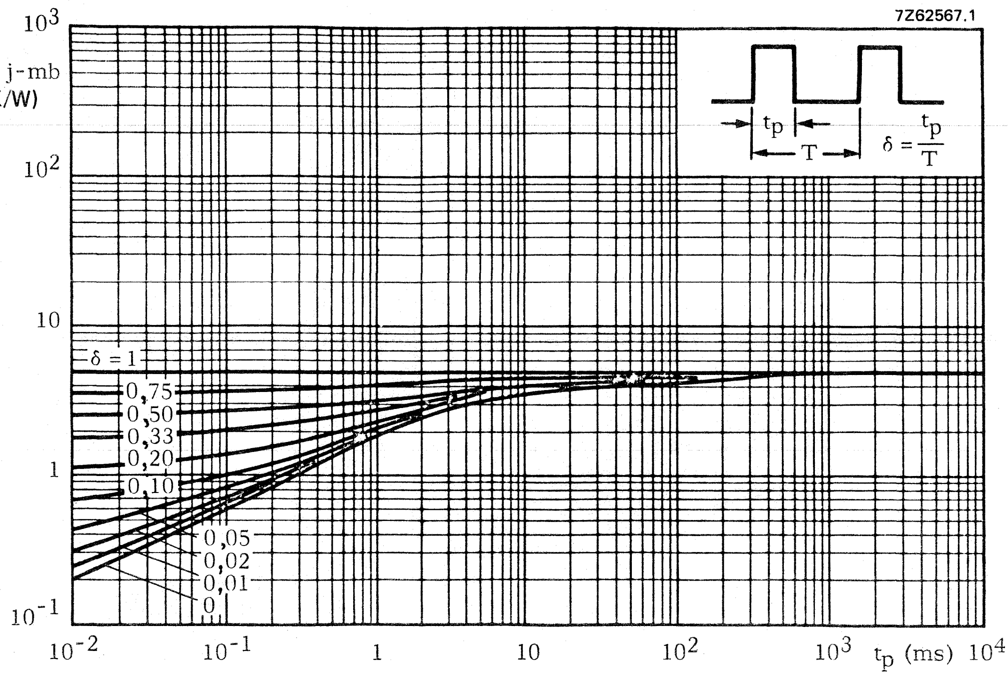

7Z62567.1
10^3
$Z_{th\ j\text{-}mb}$ (K/W)
10^2
10
1
10^{-1}
t_p
T
$\delta = \frac{t_p}{T}$
δ = 1
0,75
0,50
0,33
0,20
0,10
0,05
0,02
0,01
0
10^{-2}
10^{-1}
1
10
10^2
10^3
t_p (ms)
10^4

Fig. 5

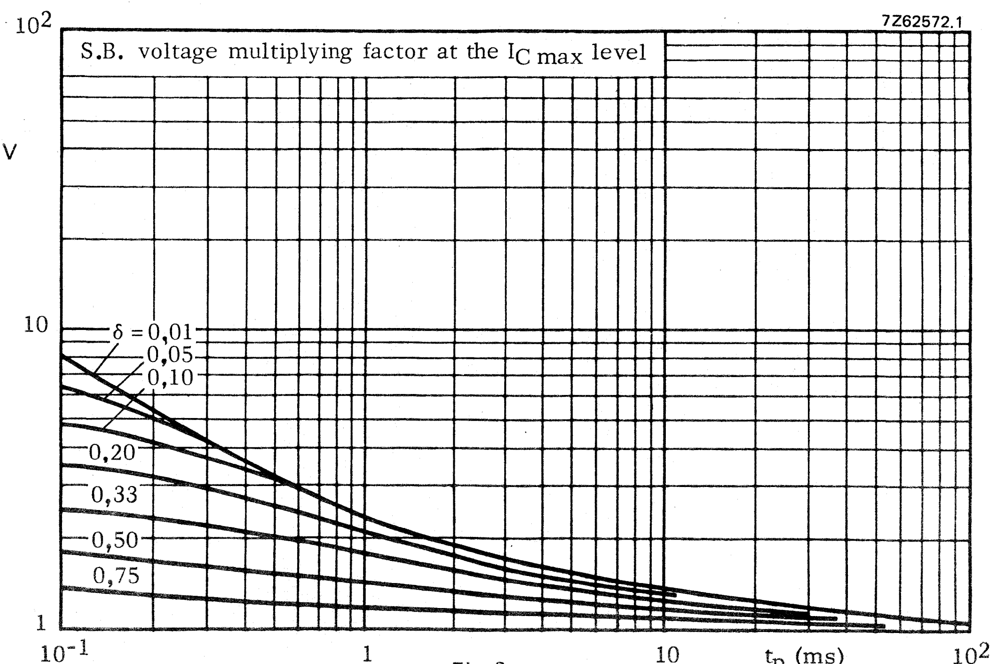

7Z62572.1
10^2
S.B. voltage multiplying factor at the $I_{C\ max}$ level
M_V
10
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
1
10^{-1}
1
10
t_p (ms)
10^2

Fig. 6

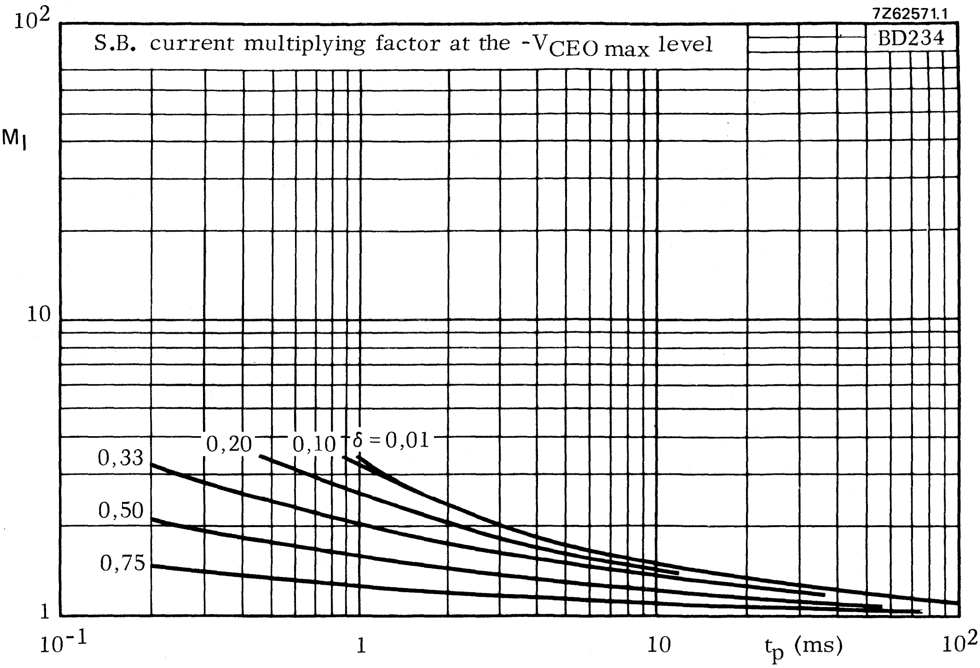

7Z62571.1
S.B. current multiplying factor at the $-V_{CEO\,max}$ level
BD234
10^2
M_I
10
1
0,33
0,20
0,10
$\delta = 0,01$
0,50
0,75
10^{-1}
1
10
t_p (ms)
10^2

Fig. 7

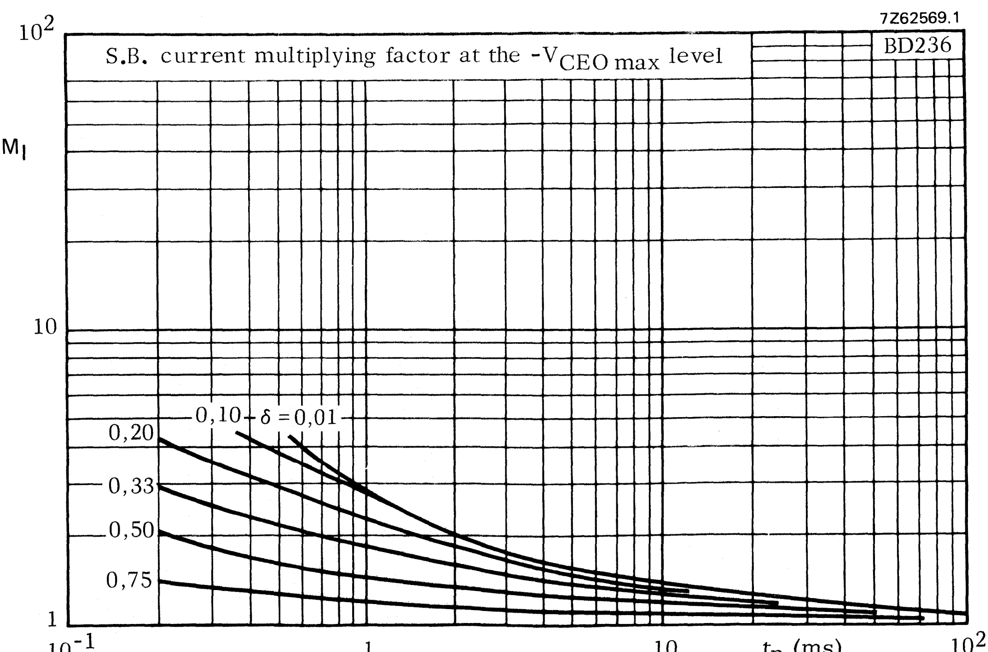

7Z62569.1
S.B. current multiplying factor at the $-V_{CEO\,max}$ level
BD236
10^2
M_I
10
1
0,10
$\delta = 0,01$
0,20
0,33
0,50
0,75
10^{-1}
1
10
t_p (ms)
10^2

Fig. 8

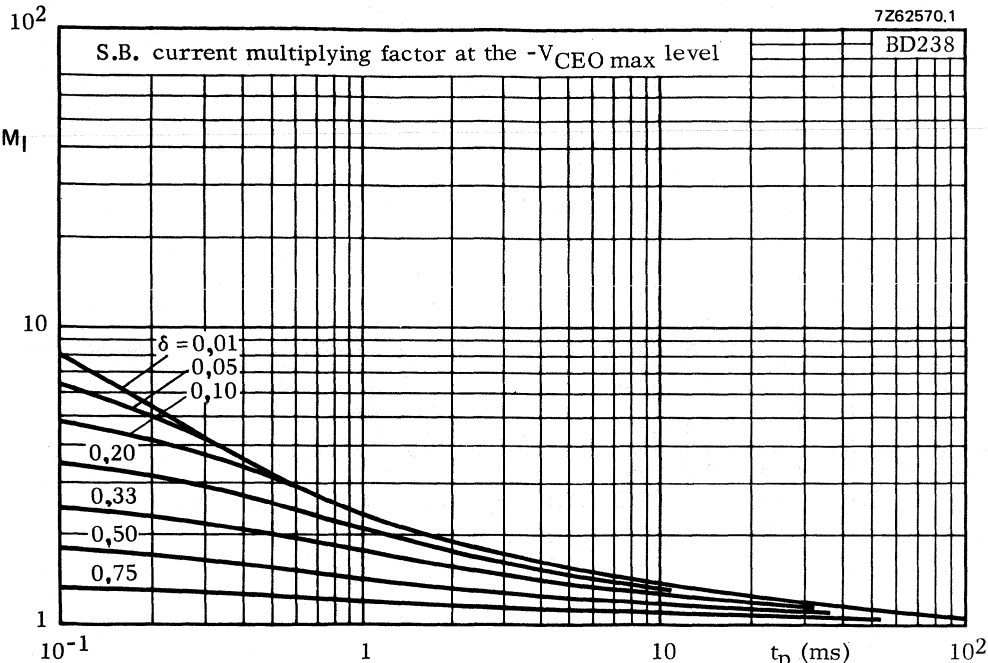


Fig. 9

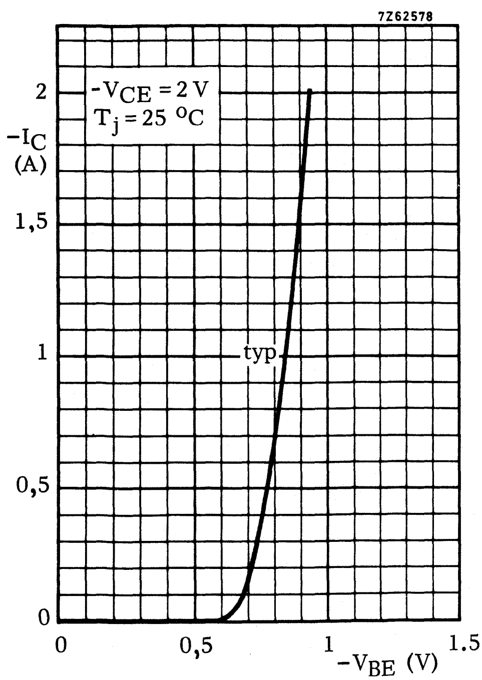


Fig. 10

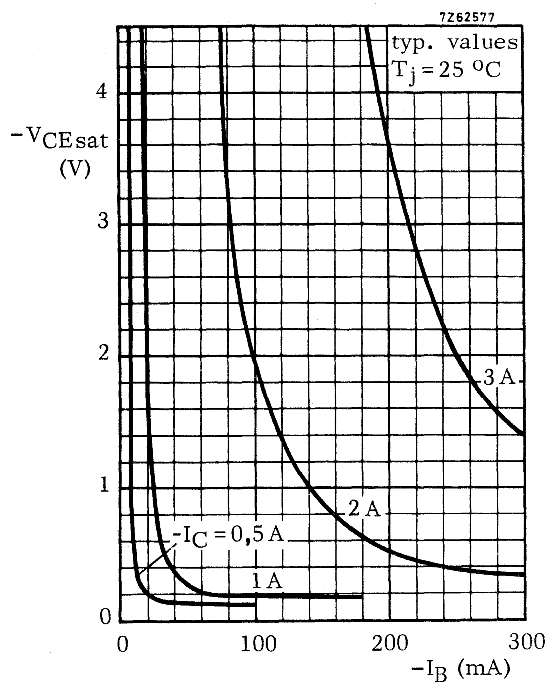


Fig. 11

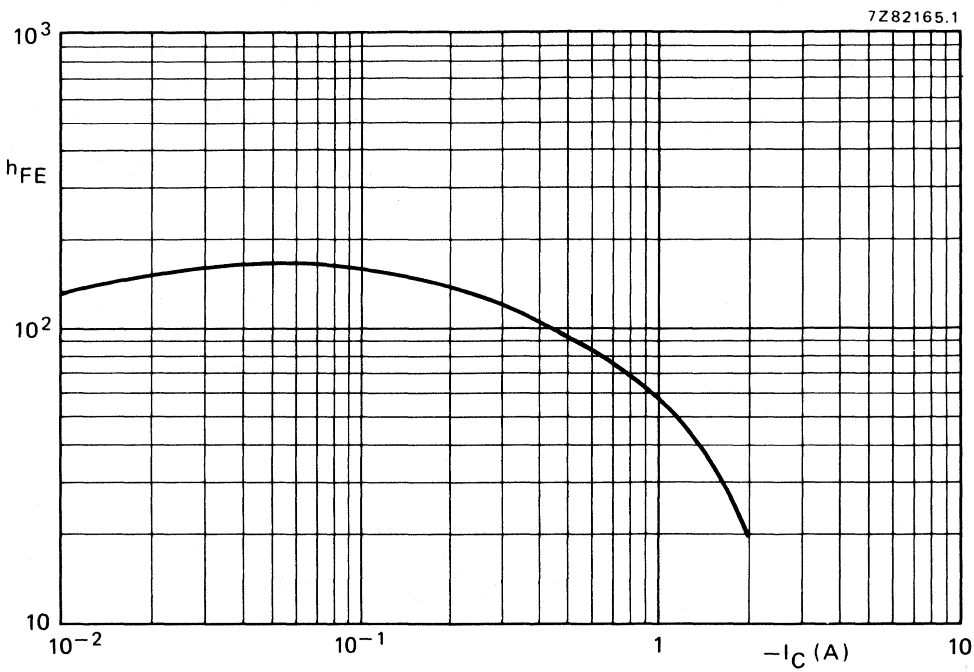


Fig. 12 Typical static forward current transfer ratio as a function of the collector current.
$-V_{CE}$ = 2 V; $T_j \leqslant 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in audio output stages, general amplifier and high-speed switching applications. P-N-P complements are BD240; 240A; 240B and BD240C.

QUICK REFERENCE DATA

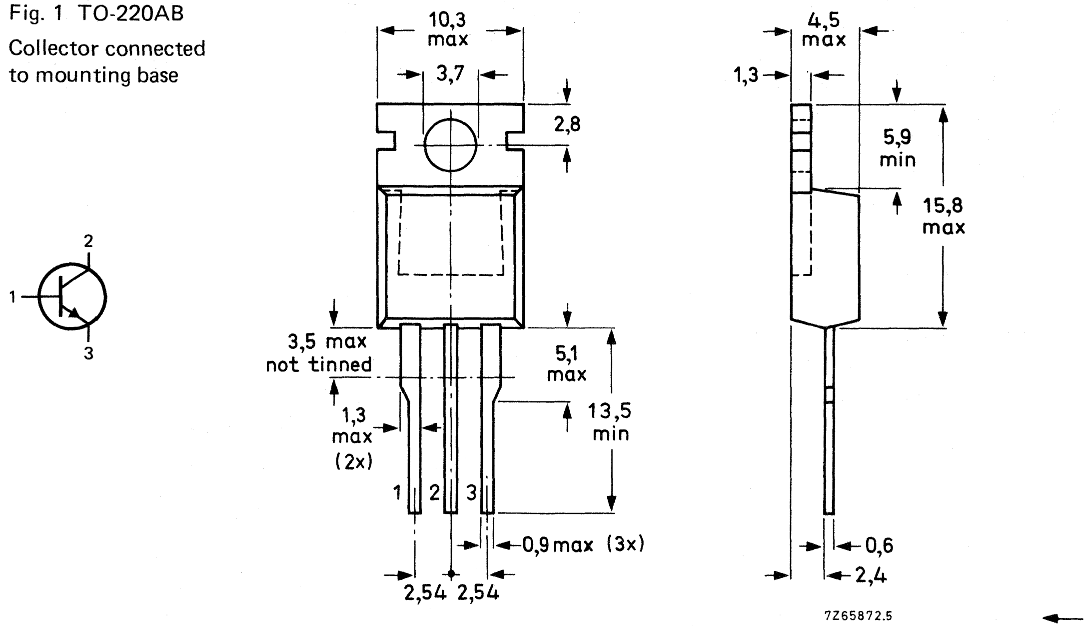
			BD239	A	B	C	
Collector-base voltage	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	V
Collector current (d.c.)	I_C	max.	3				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Junction temperature	T_j	max.	150				°C
D.C. current gain I_C = 1 A, V_{CE} = 4 V	h_{FE}	>	15				
Transition frequency at f = 1 MHz I_C = 200 mA, V_{CE} = 10 V	f_T	>	3				MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB

Collector connected to mounting base



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD239	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	V
Collector-emitter voltage (R_{BE} = 100 Ω)	V_{CER}	max.	55	70	90	115	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	3				A
Collector current (peak value)	I_{CM}	max.	7				A
Base current (d.c.)	I_B	max.	0,5				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Storage temperature	T_{stg}		−65 to +150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$T_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD239; A	BD239B; C	
→ Collector cut-off current					
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	0,1	–	mA
$I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	<	–	0,1	mA
$V_{BE} = 0$; $V_{CE} = V_{CEOmax}$	I_{CES}	<	0,2		mA
→ Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	0,2		mA
D.C. current gain*					
$I_C = 200$ mA; $V_{CE} = 4$ V	h_{FE}	>	40		
$I_C = 1$ A; $V_{CE} = 4$ V	h_{FE}	>	15		
Base-emitter voltage**					
$I_C = 1$ A; $V_{CE} = 4$ V	V_{BE}	<	1,3		V
Collector-emitter saturation voltage*					
$I_C = 1$ A; $I_B = 0,2$ A	V_{CEsat}	<	0,6		V
Turn-off breakdown energy					
L = 20 mH; $I_{CC} = 1,8$ A	$E_{(BR)}$	>	32		mJ

* Measured under pulse conditions; $t_p \leqslant 300\ \mu s$, $\delta \leqslant 0,02$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Transition frequency at f = 1 MHz			
I_C = 0,2 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times (between 10% and 90% levels)			
I_{Con} = 0,2 A; I_{Bon} = $-I_{Boff}$ = 20 mA			
Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	0,8 μs

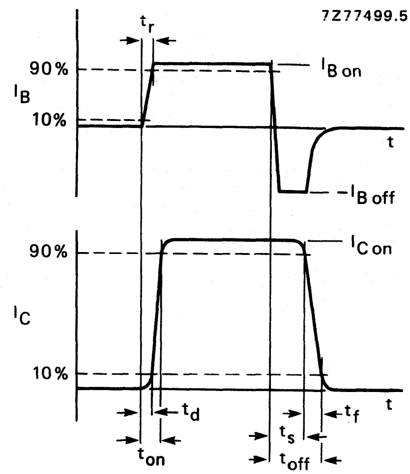
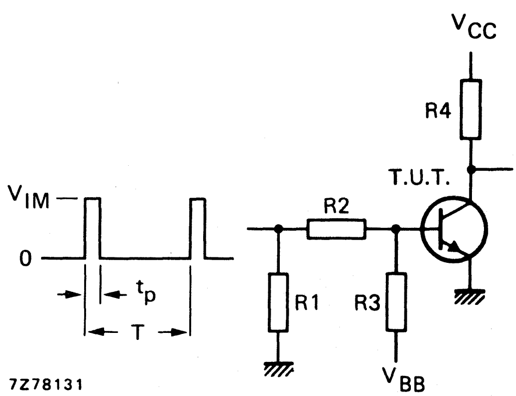


Fig. 2 Switching times waveforms.



V_{IM}	=	40 V
V_{CC}	=	30 V
$-V_{BB}$	=	4,4 V
R1	=	51 Ω
R2	=	1000 Ω
R3	=	300 Ω
R4	=	150 Ω
$t_r = t_f$	⩽	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

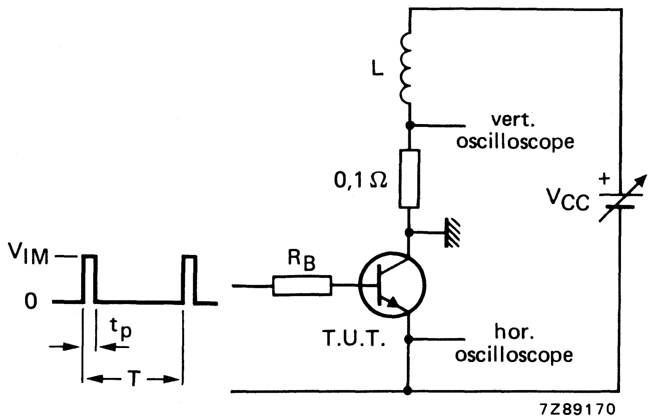


Fig. 4 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 1,8 A; t_p = 1 ms; δ = 0,01.

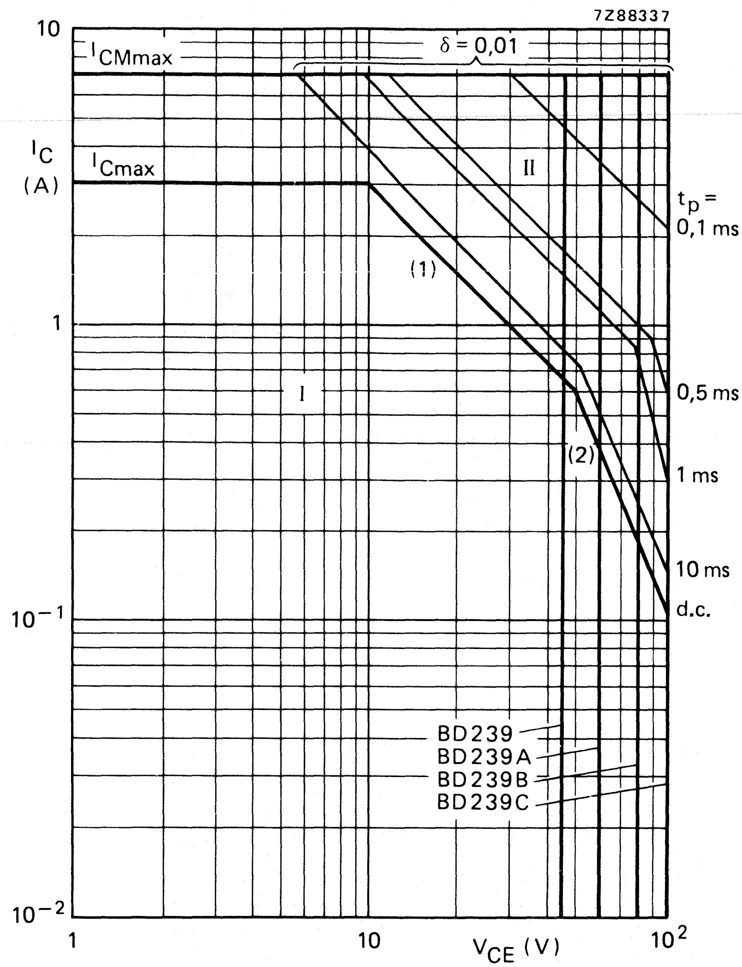


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second breakdown limits.

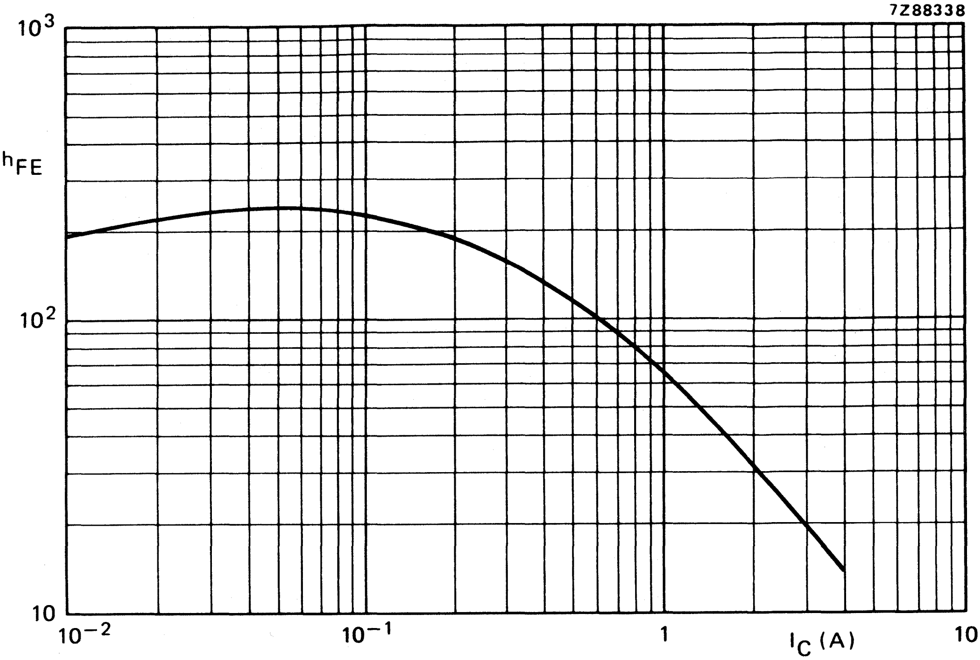


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. V_{CE} = 4 V, T_j = 25 °C.

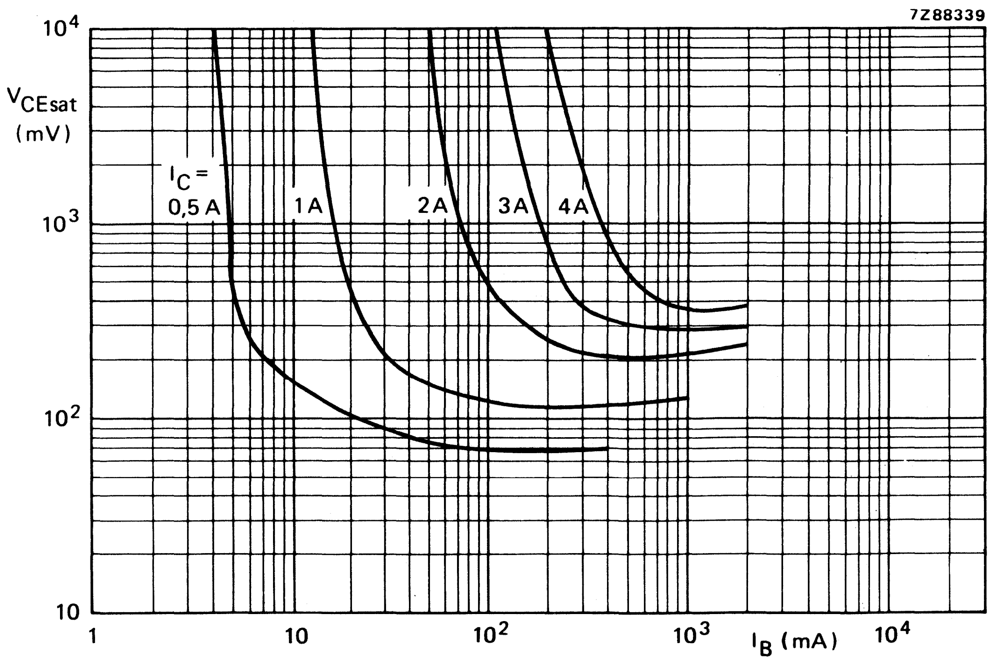


Fig. 7 Typical values collector-emitter saturation voltage at T_j = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur. N-P-N complements are BD239; 239A; 239B; and BD239C.

QUICK REFERENCE DATA

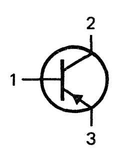
			BD240	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	3				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	>	15				
Transistion frequency $-I_C$ = 200 mA; $-V_{CE}$ = 10 V	f_T	>	3				MHz

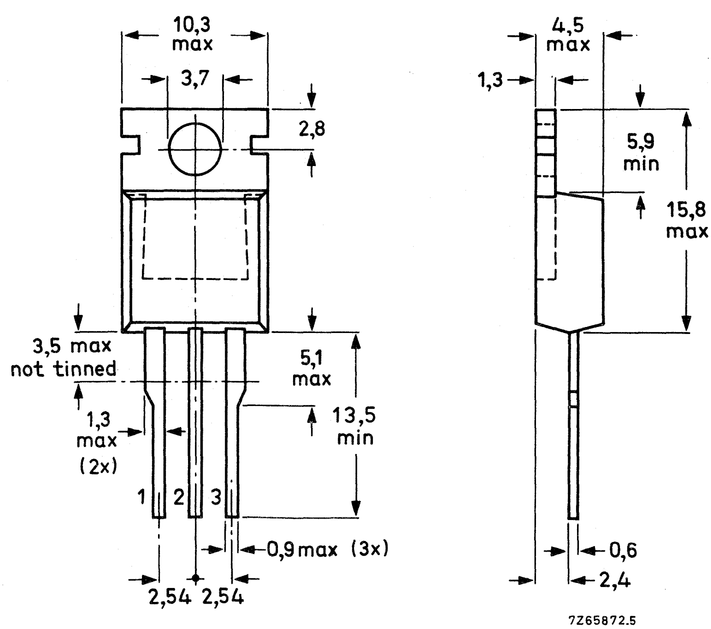
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD240	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	V
Collector-emitter voltage (R_{BE} = 100 Ω)	$-V_{CER}$	max.	55	70	90	115	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
Collector current (d.c.)	$-I_C$	max.	3				A
Collector current (peak value)	$-I_{CM}$	max.	7				A
Base current (d.c.)	$-I_B$	max.	0,5				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD240A	BD240B; C	
→ Collector cut-off current					
$-I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	<	0,1	–	mA
$-I_B = 0$; $-V_{CE} = 60$ V	$-I_{CEO}$	<	–	0,1	mA
$-V_{BE} = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,2		mA
→ Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	0,2		mA
D.C. current gain *					
$-I_C = 200$ mA; $-V_{CE} = 4$ V	h_{FE}	>	40		
$-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}	>	15		
Base-emitter voltage *					
$-I_C = 1$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,3		V
Collector-emitter saturation voltage *					
$-I_C = 1$ A; $-I_B = 0,2$ A	$-V_{CEsat}$	<	0,6		V
Turn off breakdown energy					
$L = 20$ mH; $-I_{CC} = 1,22$ A	$E_{(BR)}$	>	15		mJ

* Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta < 0,02$.

Transition frequency at f = 1 MHz			
$-I_C$ = 200 mA; $-V_{CE}$ = 10 V	f_T	>	3 MHz
Switching times			
$-I_{Con}$ = 0,2 A; $-I_{Bon}$ = I_{Boff} = 20 mA			
turn-on time	t_{on}	typ.	0,2 μs
turn-off time	t_{off}	typ.	0,4 μs

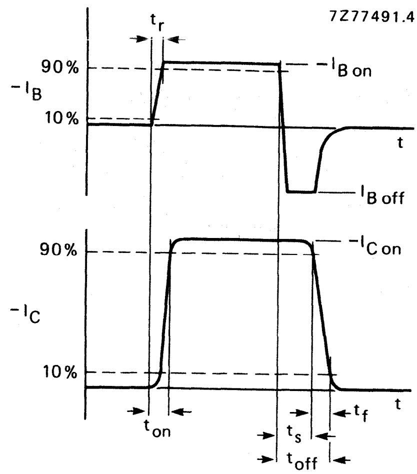
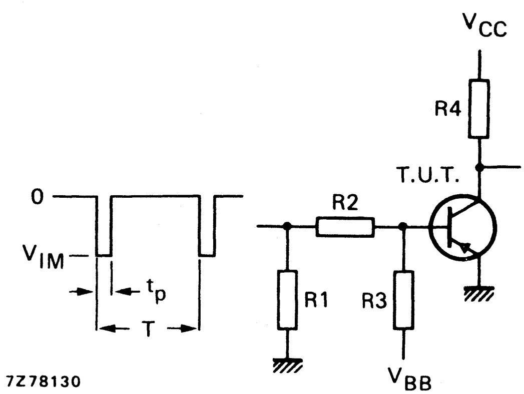


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	40 V
$-V_{CC}$	=	30 V
$+V_{BB}$	=	4,4 V
R1	=	51 Ω
R2	=	1000 Ω
R3	=	300 Ω
R4	=	150 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

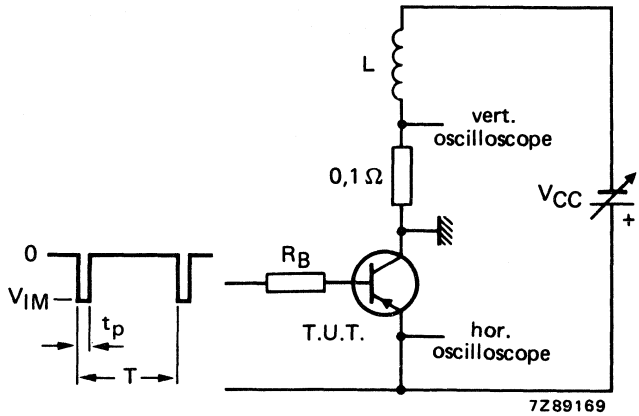


Fig. 4 Test circuit for turn-off breakdown energy.
V_{IM} = −12 V; R_B = 270 Ω; $-I_{CC}$ = 1,22 A; t_p = 1 ms; δ = 0,01.

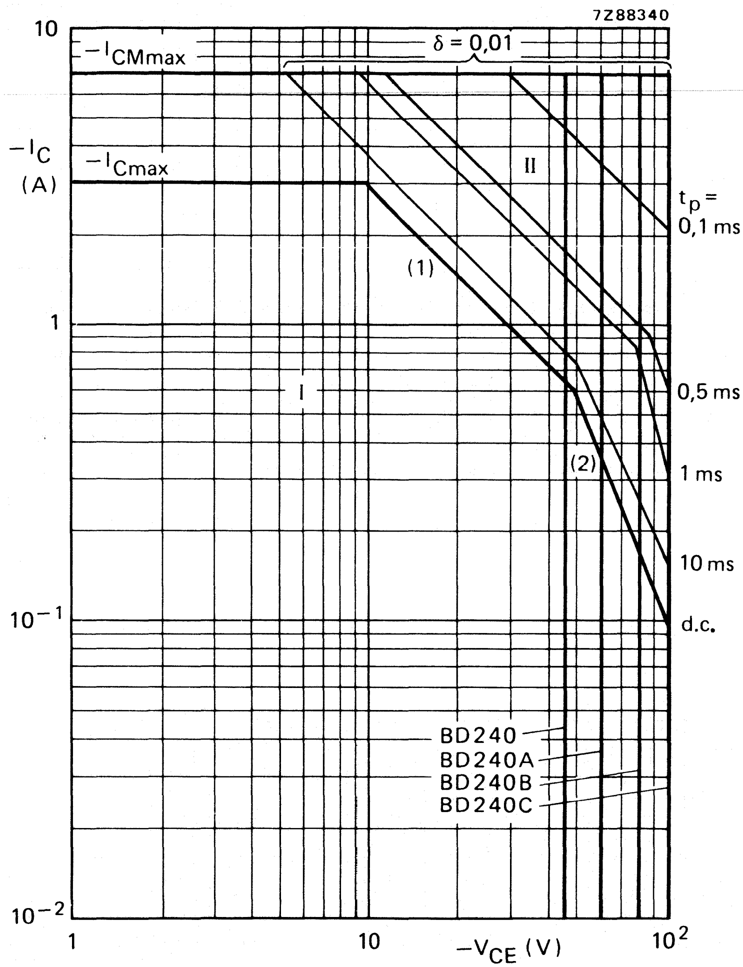


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second breakdown limits.

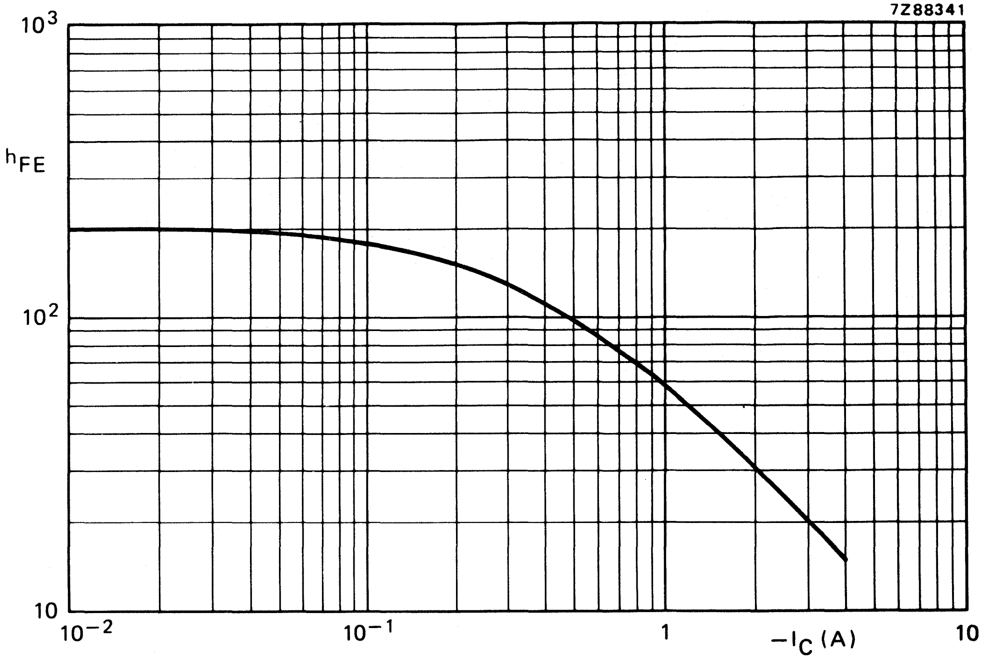


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V, $T_j = 25$ °C.

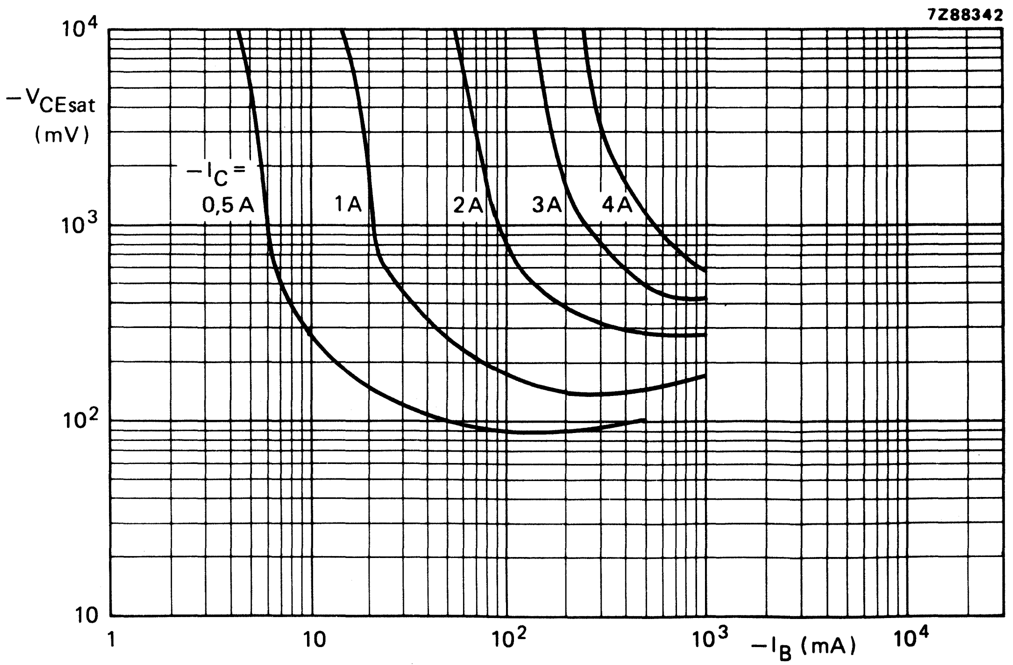


Fig. 7 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in audio output stages, general amplifier and high-speed switching applications. P-N-P complements are BD242; 242A; 242B; and 242C.

QUICK REFERENCE DATA

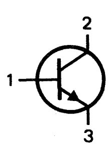
			BD241	A	B	C	
Collector-base voltage	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	V
Collector current (d.c.)	I_C	max.			5		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			40		W
Junction temperature	T_j	max.			150		°C
D.C. current gain I_C = 1 A; V_{CE} = 4 V	h_{FE}	>			25		
Transition frequency at f = 1 MHz I_C = 500 mA; V_{CE} = 10 V	f_T	>			3		MHz

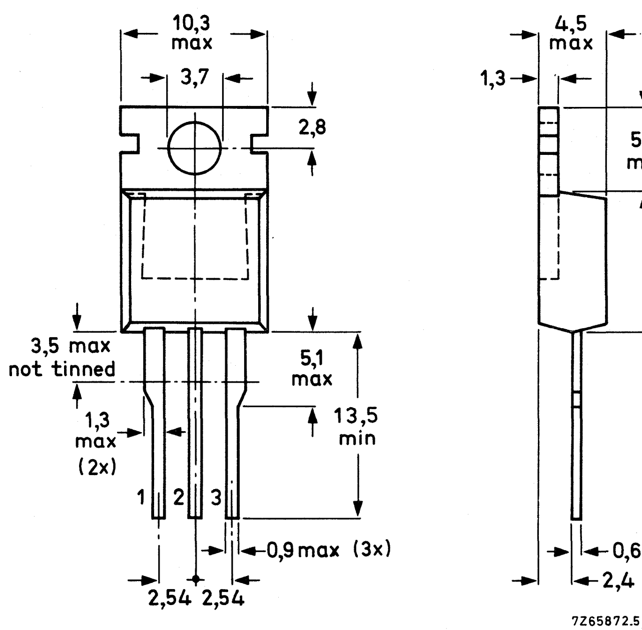
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD241	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	V
Collector-emitter voltage (R_{BE} = 100 Ω)	V_{CER}	max.	55	70	90	115	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	5	A
Collector current (peak value)	I_{CM}	max.	8	A
Base current (d.c.)	I_B	max.	1	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40	W
Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	3, 12	K/W
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD241; A	BD241B; C	
→ Collector cut-off current					
I_B = 0; V_{CE} = 30 V	I_{CEO}	<	0,1	–	mA
I_B = 0; V_{CE} = 60 V	I_{CEO}	<	–	0,1	mA
V_{BE} = 0; V_{CE} = V_{CEOmax}	I_{CES}	<	0,2		mA
→ Emitter cut-off current					
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	1		mA
D.C. current gain*					
I_C = 1 A; V_{CE} = 4 V	h_{FE}	>	25		
I_C = 3 A; V_{CE} = 4 V	h_{FE}	>	10		
Base-emitter voltage**					
I_C = 3 A; V_{CE} = 4 V	V_{BE}	<	1,8		V
Collector-emitter saturation voltage*					
I_C = 3 A; I_B = 0,6 A	V_{CEsat}	<	1,2		V
Small-signal current gain					
I_C = 0,5 A; V_{CE} = 10 V; f = 1 kHz	$\|h_{fe}\|$	>	20		
Turn off breakdown energy					
L = 20 mH; I_{CC} = 1,8 A	$E_{(BR)}$	>	32		mJ

* Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta < 0{,}02$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Transition frequency at f = 1 MHz			
I_C = 0,5 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times			
(between 10% and 90% levels)			
I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A			
Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	1 μs

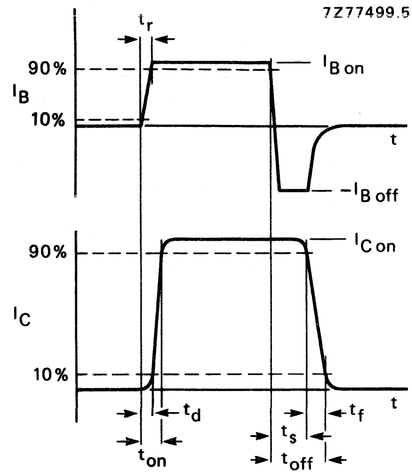
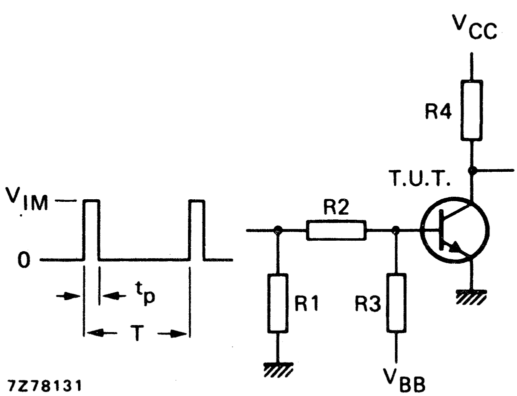


Fig. 2 Switching times waveforms.



V_{IM}	=	16 V
V_{CC}	=	20 V
$-V_{BB}$	=	6,4 V
R1	=	82 Ω
R2	=	82 Ω
R3	=	82 Ω
R4	=	20 Ω
$t_r = t_f$	⩽	20 ns
t_p	=	20 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

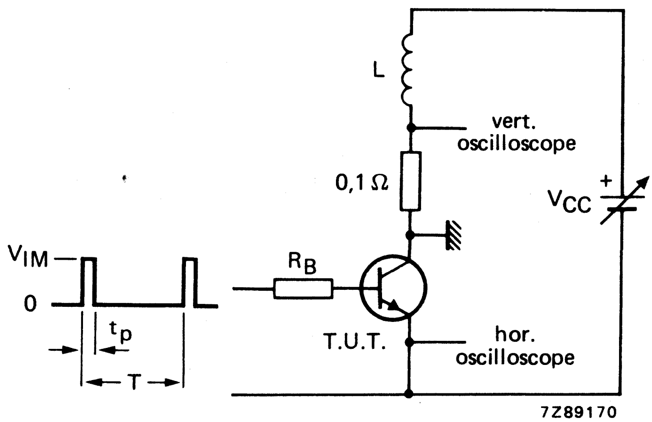


Fig. 4 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 1,8 A; t_p = 1 ms; δ = 0,01.

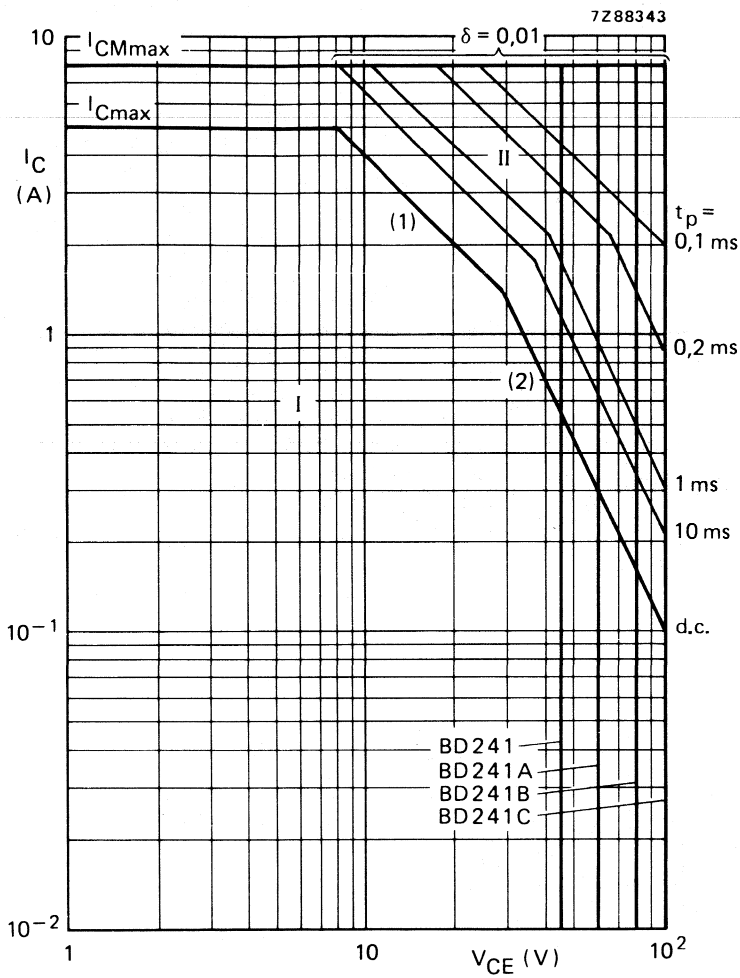


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second breakdown limits.

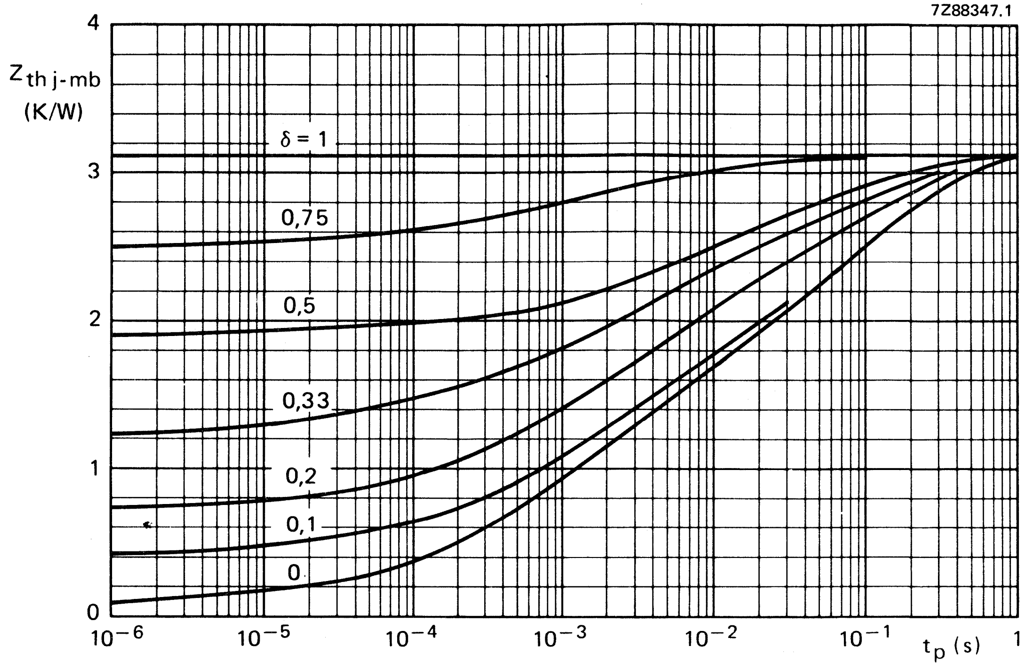


Fig. 6 Power pulse rating chart.

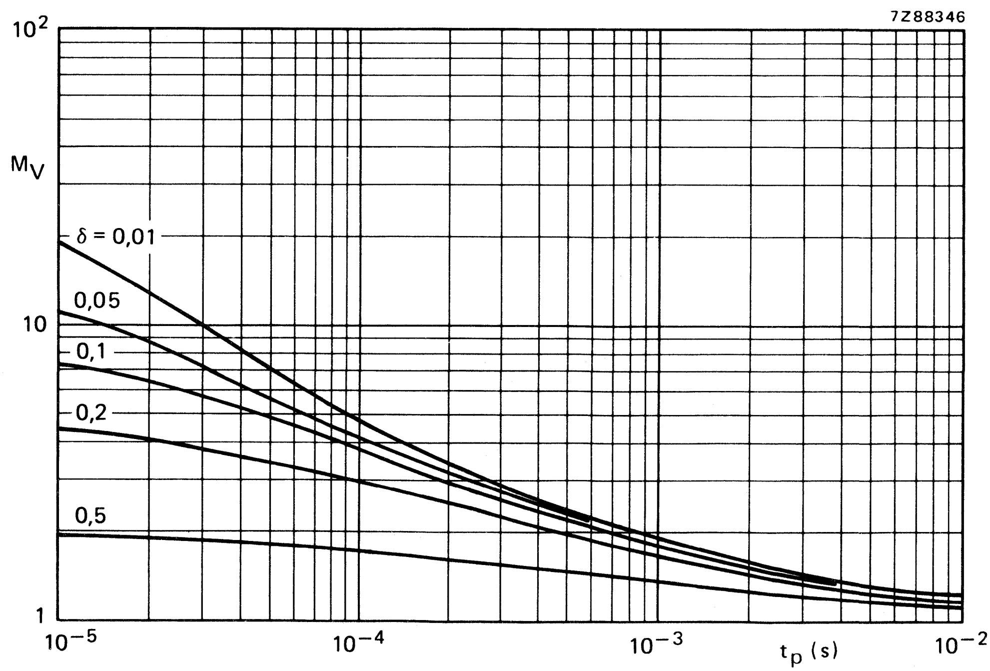


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

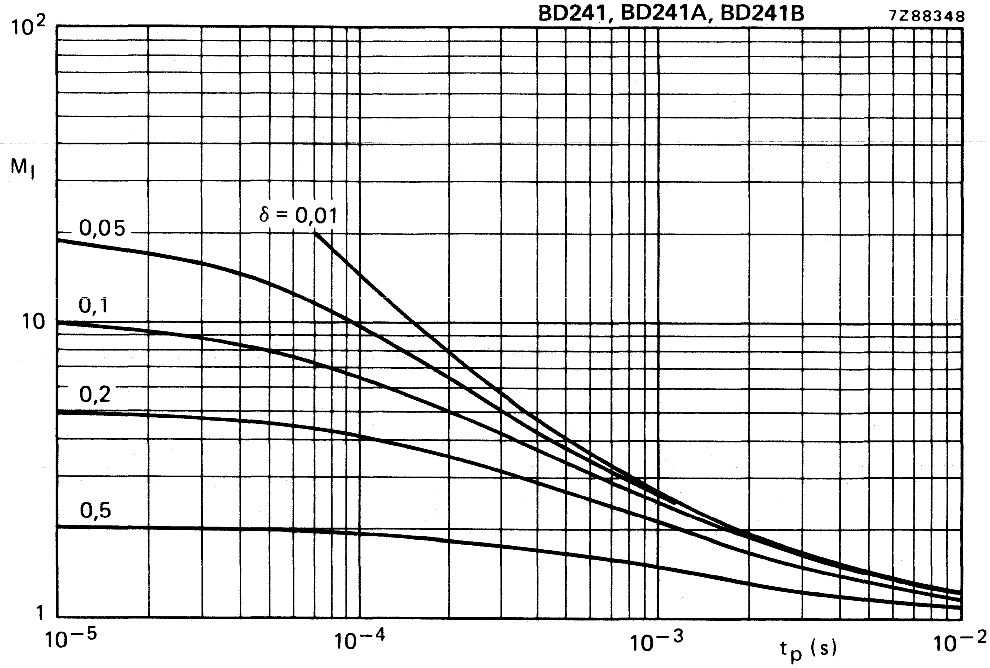


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

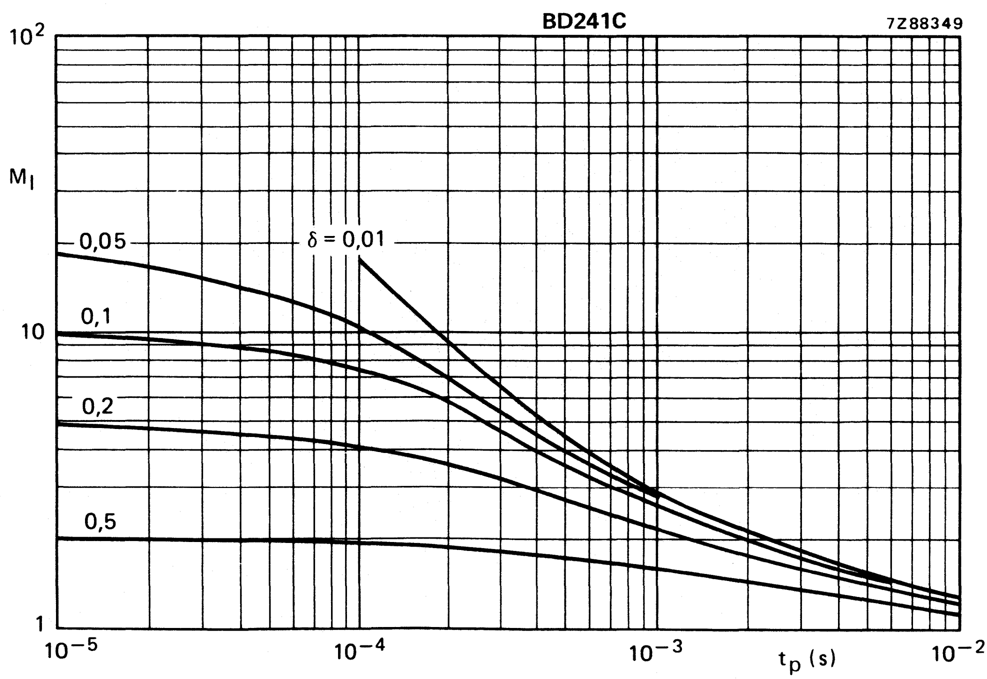


Fig. 9 S.B. current multiplying factor at the V_{CEOmax} level.

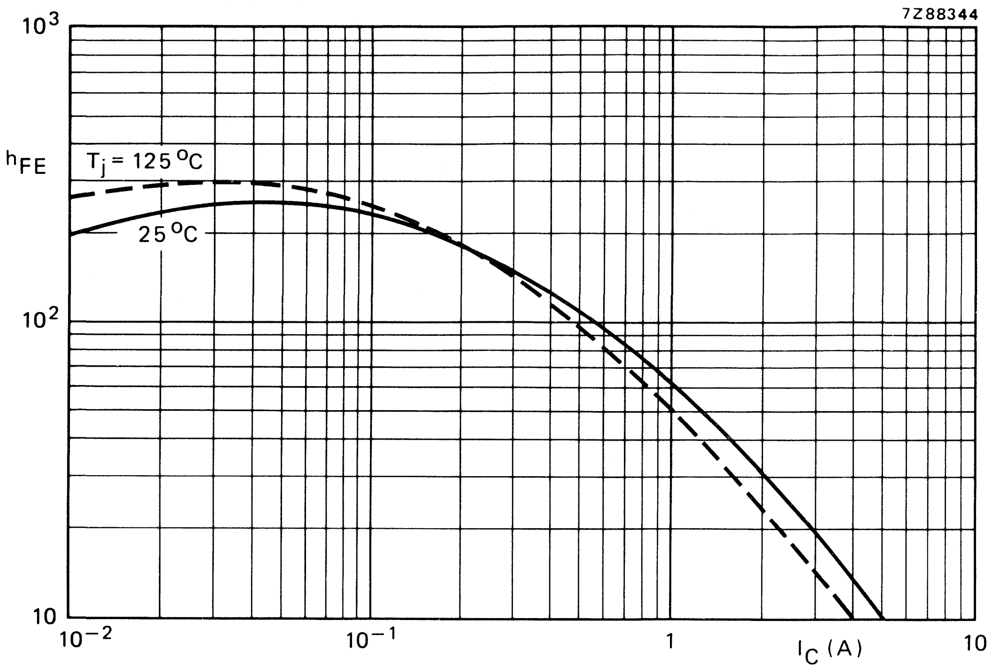


Fig. 10 Typical static forward current transfer ratio as a function of the collector current. V_{CE} = 4 V.

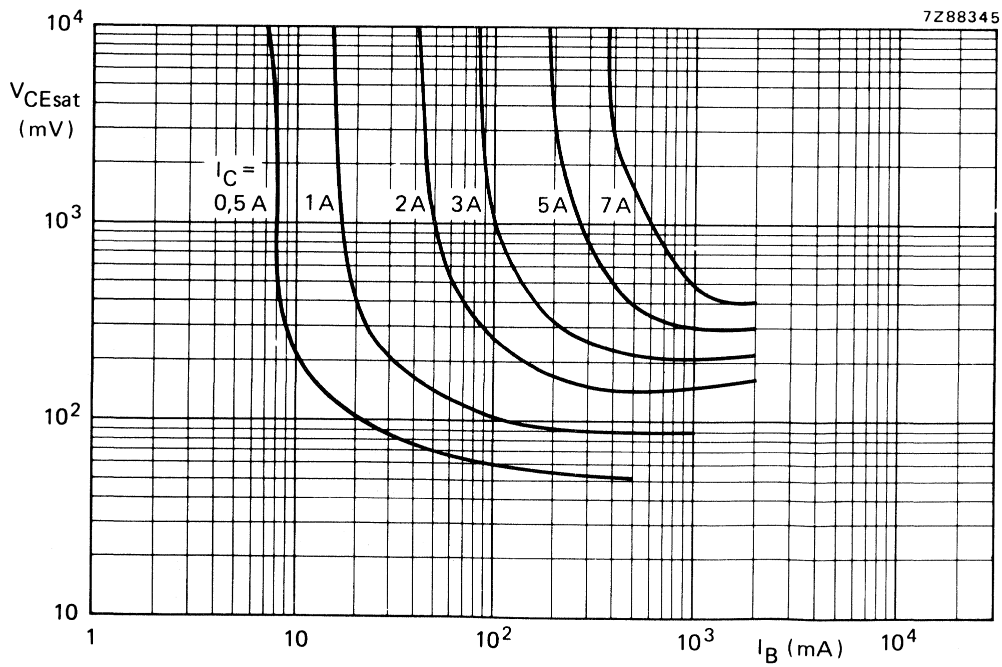


Fig. 11 Typical values collector-emitter saturation voltage at T_j = 25 °C.

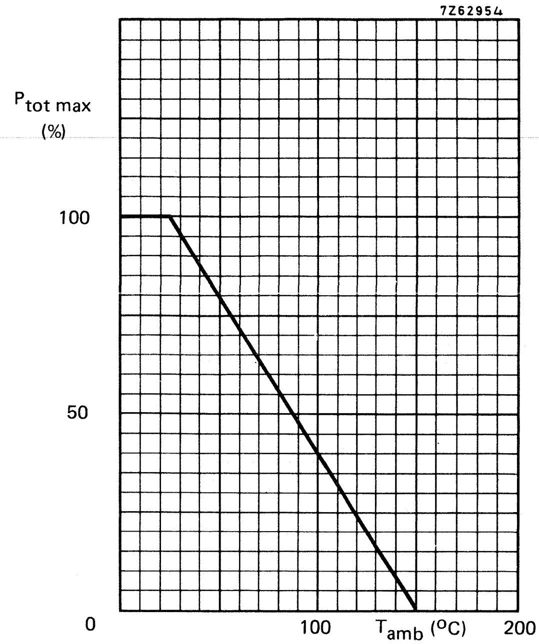


Fig. 12 Power derating curve.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in audio output stages, general amplifier and high-speed switching applications. N-P-N complements are BD241; 241A; 241B and BD241C.

QUICK REFERENCE DATA

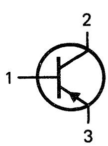
			BD242	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	5				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	>	25				
Transition frequency $-I_C$ = 500 mA; $-V_{CE}$ = 10 V	f_T	>	3				MHz

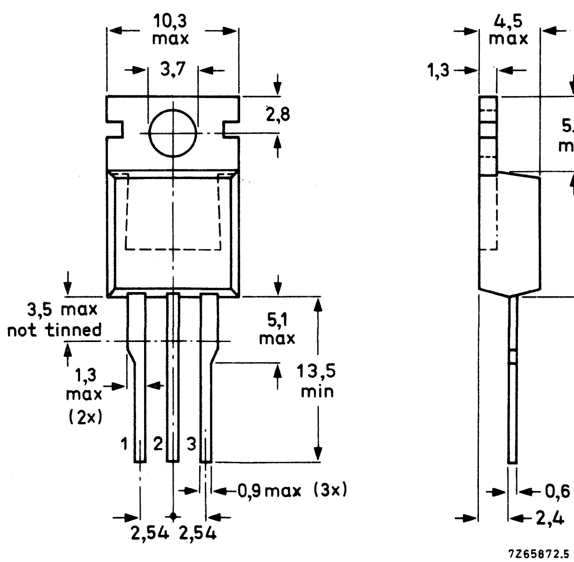
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD242	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	V
Collector-emitter voltage (R_{BE} = 100 Ω)	$-V_{CER}$	max.	55	70	90	115	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
Collector current (d.c.)	$-I_C$	max.	5				A
Collector current (peak value)	$-I_{CM}$	max.	8				A
Base current (d.c.)	$-I_B$	max.	1				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD242; A	BD242B; C	
→ Collector cut-off current					
$-I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	<	0,1	–	mA
$-I_B = 0$; $-V_{CE} = 60$ V	$-I_{CEO}$	<	–	0,1	mA
$-V_{BE} = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,2		mA
→ Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	0,2		mA
D.C. current gain *					
$-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}	>	25		
$-I_C = 3$ A; $-V_{CE} = 4$ V	h_{FE}	>	10		
Base-emitter voltage *					
$-I_C = 3$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,8		V
Collector-emitter saturation voltage *					
$-I_C = 3$ A; $-I_B = 0{,}6$ A	$-V_{CEsat}$	<	1,2		V
Small-signal current gain					
$-I_C = 0{,}5$ A; $-V_{CE} = 10$ V; f = 1 kHz	$\lvert h_{fe} \rvert$	>	20		
Turn off breakdown energy					
L = 20 mH; $-I_{CC} = 1{,}22$ A	$E_{(BR)}$	>	15		mJ

* Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta < 0{,}02$.

Transition frequency at f = 1 MHz		
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	f_T >	3 MHz
Switching times		
$-I_{Con}$ = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A		
turn-on time	t_{on} typ.	0,3 μs
turn-off time	t_{off} typ.	1 μs

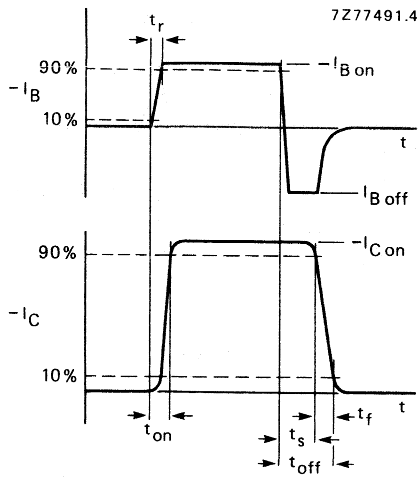


Fig. 2 Switching times waveforms.

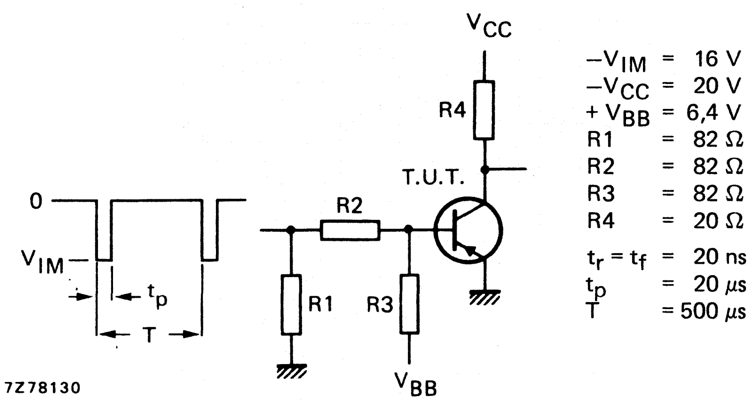


Fig. 3 Switching times test circuit.

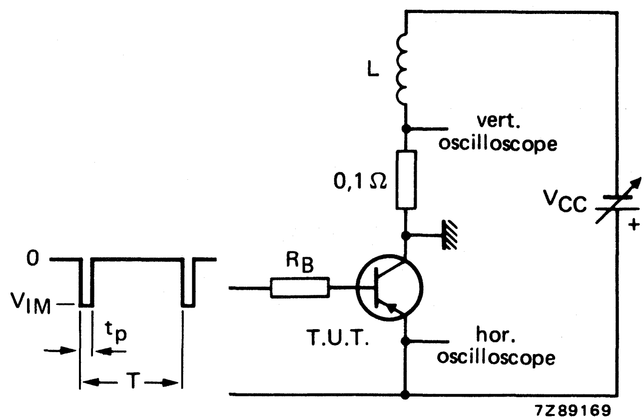


Fig. 4 Test circuit for turn-off breakdown energy.
$V_{IM} = -12$ V; $R_B = 270\ \Omega$; $-I_{CC} = 1,22$ A; $t_p = 1$ ms; $\delta = 0,01$.

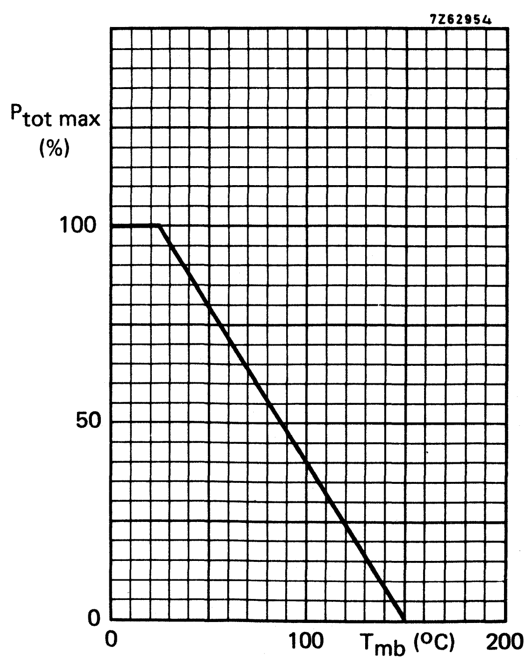


Fig. 4a Power derating curve.

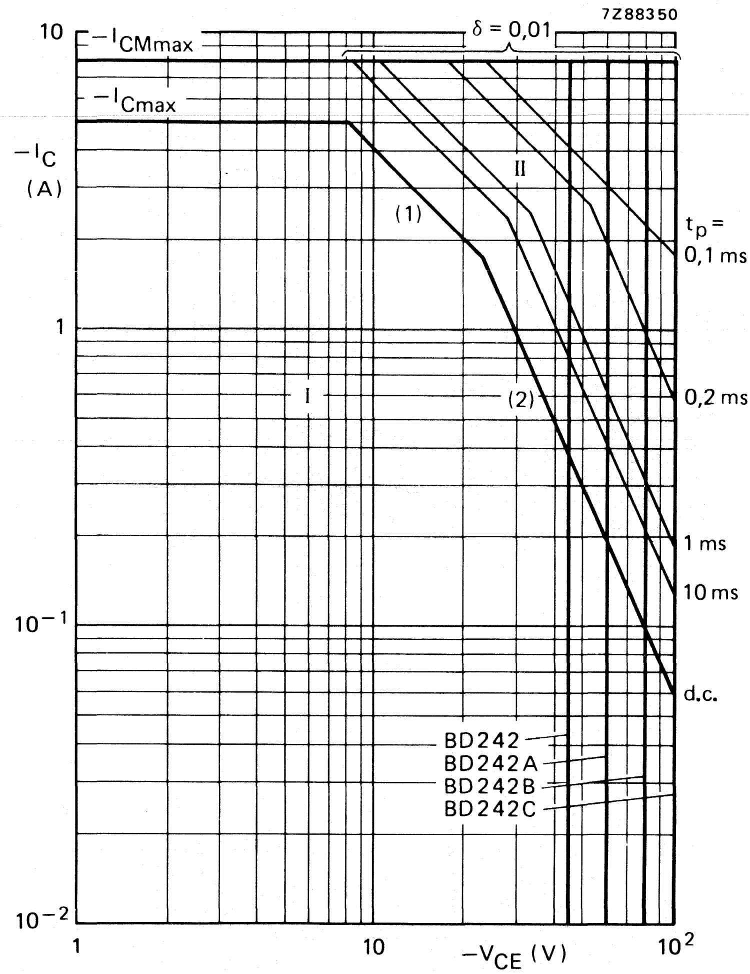


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second breakdown limits.

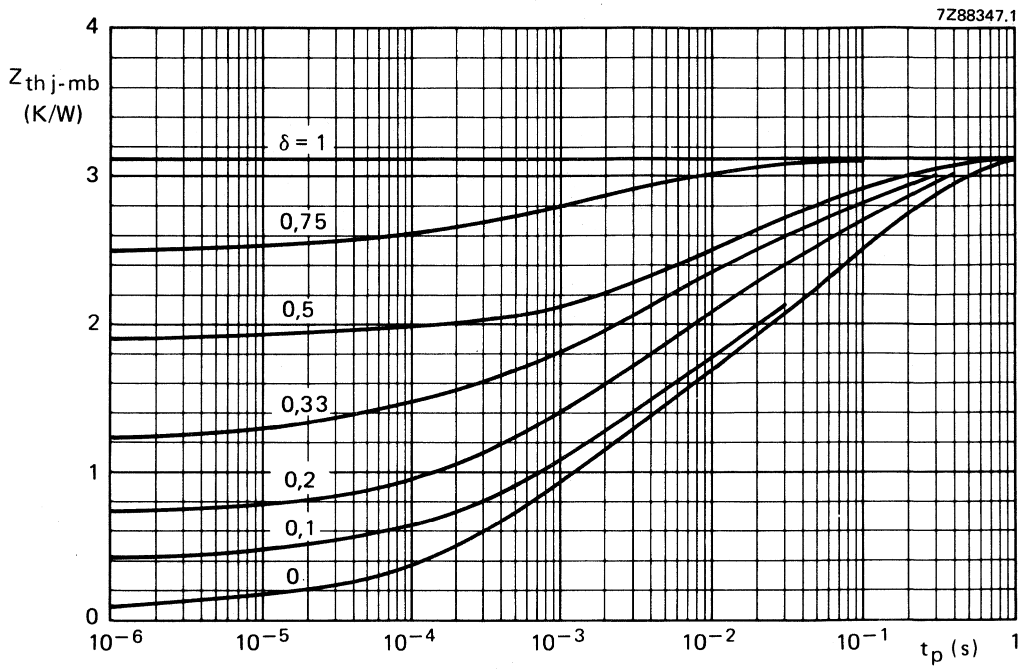


Fig. 6 Power pulse rating chart.

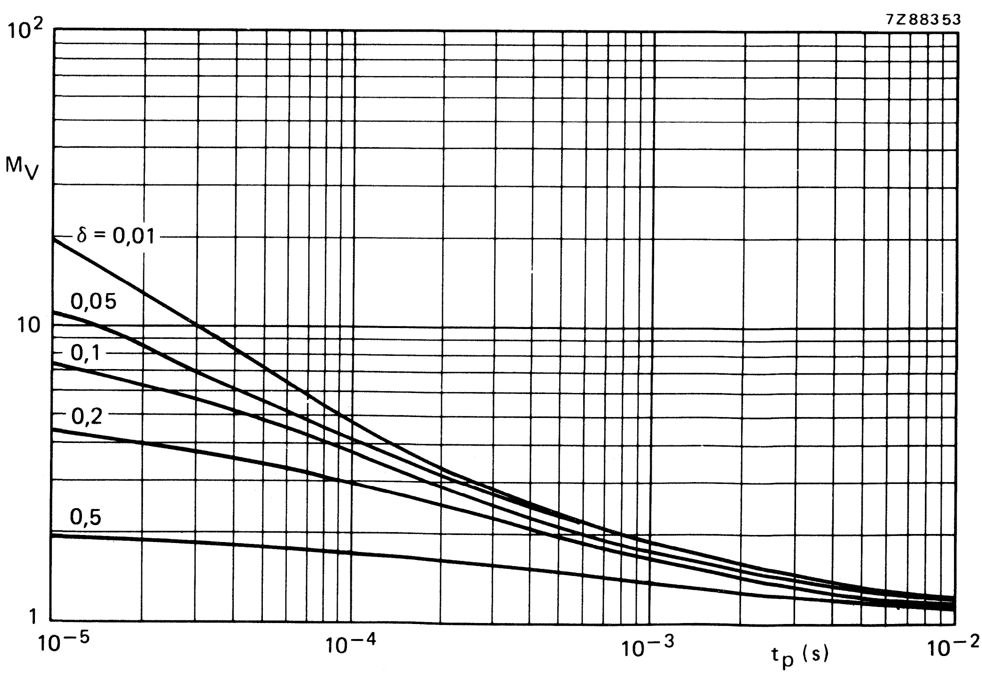


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

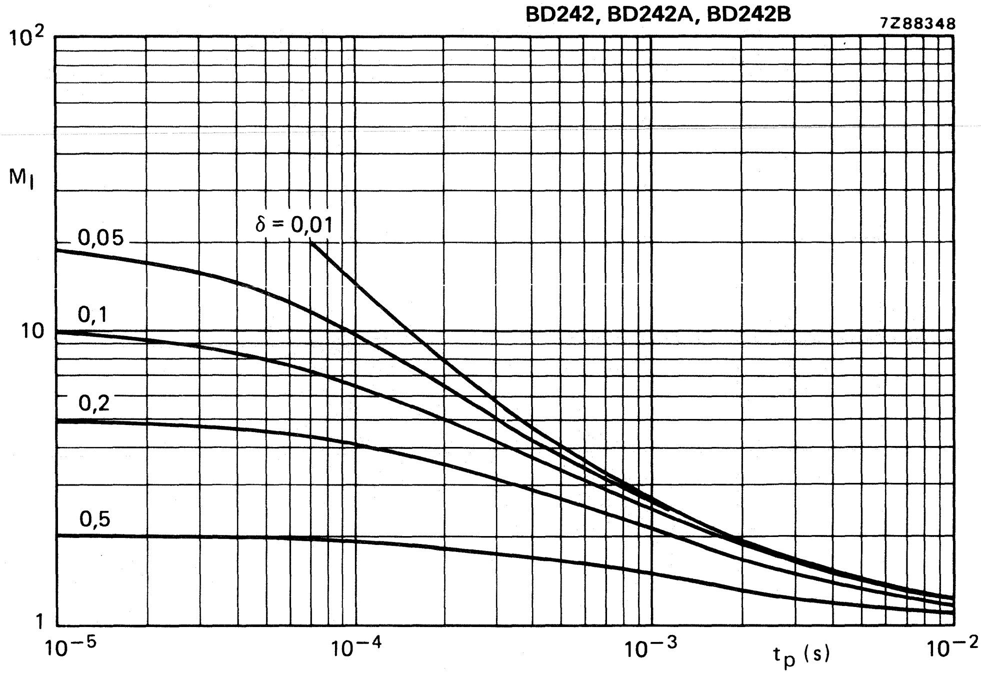


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

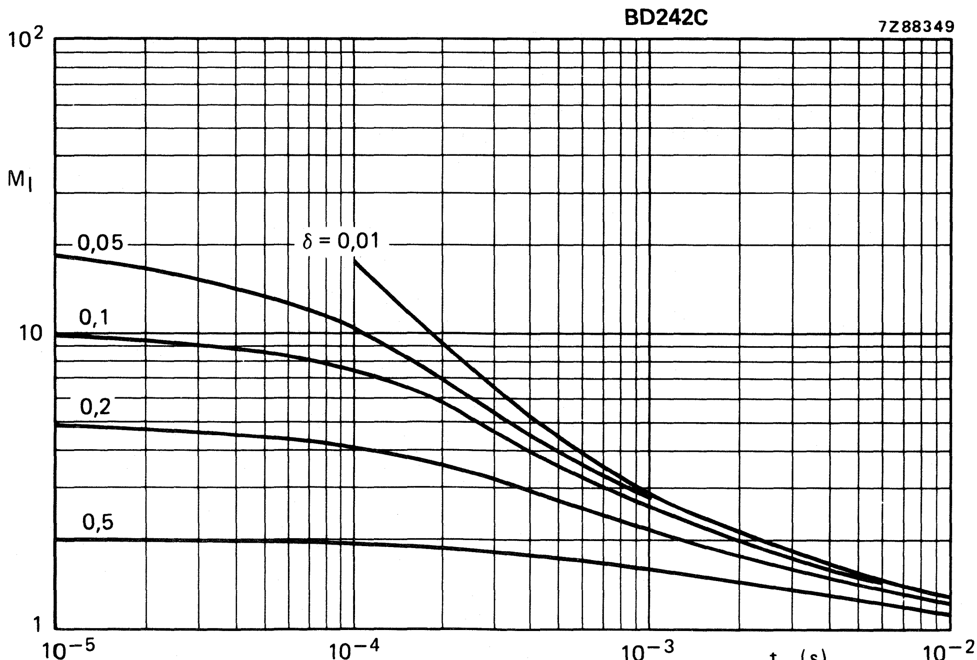


Fig. 9 S.B. current multiplying factor at the V_{CEOmax} level.

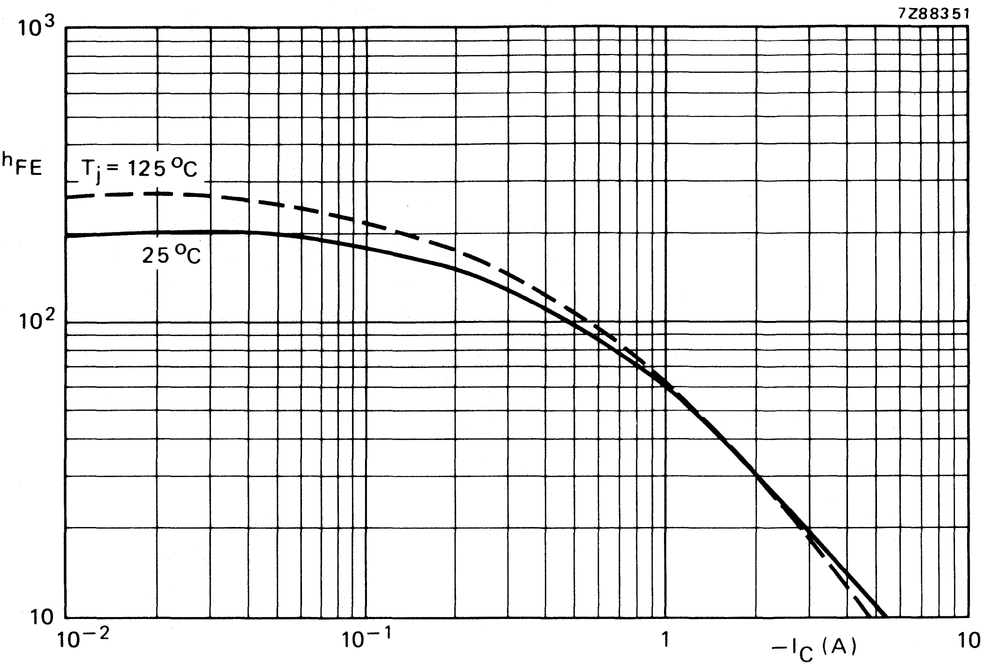


Fig. 10 Typical static forward current transfer ratio as a function of the collector current; $-V_{CE}$ = 4 V.

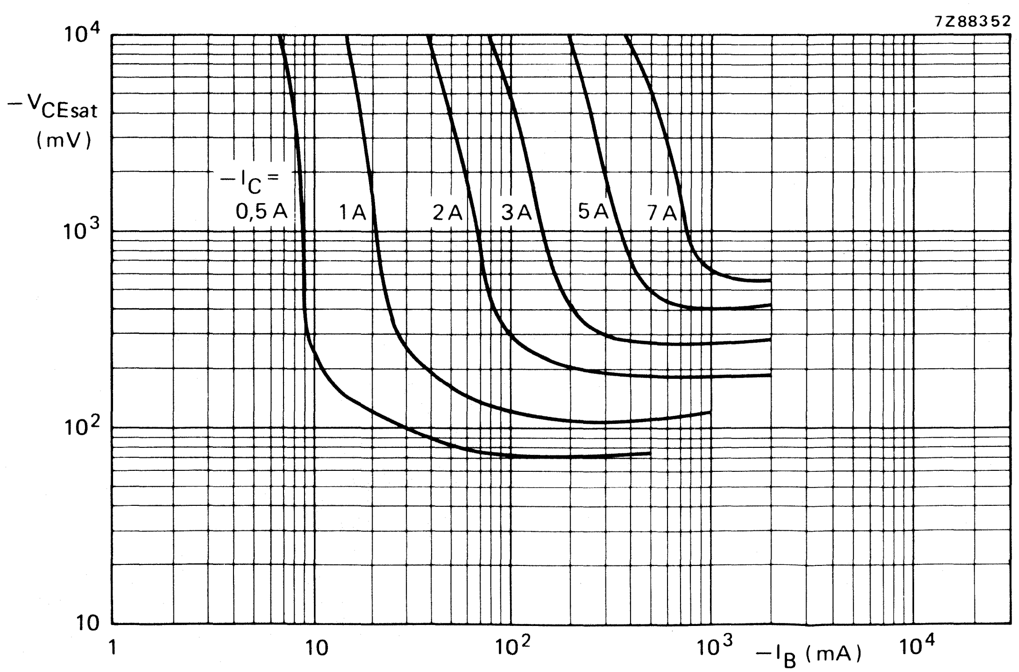


Fig. 11 Typical values collector-emitter saturation voltage at T_j = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in general amplifier and switching applications. P-N-P complements are BD244; 244A; 244B; and BD244C.

QUICK REFERENCE DATA

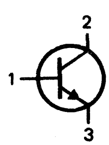
			BD243	A	B	C	
Collector-base voltage	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	V
Collector current (d.c.)	I_C	max.		8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		65			W
Junction temperature	T_j	max.		150			°C
D.C. current gain I_C = 3 A; V_{CE} = 4 V	h_{FE}	>		15			
Transition frequency at f = 1 MHz I_C = 500 mA; V_{CE} = 10 V	f_T	>		3			MHz

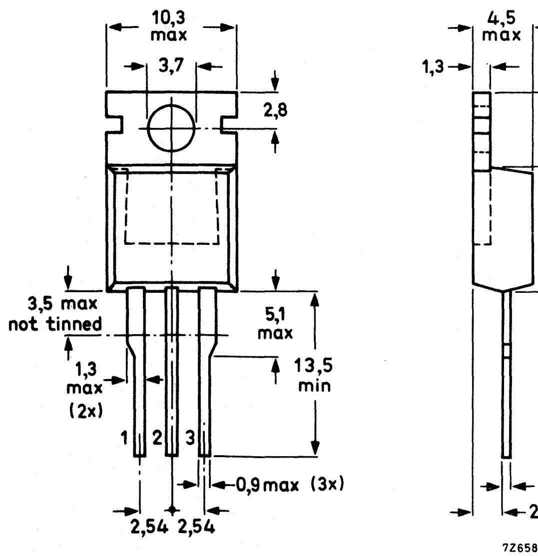
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD243	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	V
Collector-emitter voltage (R_{BE} = 100 Ω)	V_{CER}	max.	55	70	90	115	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	8				A
Collector current (peak value)	I_{CM}	max.	12				A
Base-current (d.c.)	I_B	max.	3				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Storage temperature	T_{stg}		−65 to +150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD243; A	BD243B; C	
→ Collector cut-off current					
$I_B = 0$; V_{CE} = 30 V	I_{CEO}	<	0,2	–	mA
$I_B = 0$; V_{CE} = 60 V	I_{CEO}	<	–	0,2	mA
$V_{BE} = 0$; $V_{CE} = V_{CEOmax}$	I_{CES}	<	0,4		mA
→ Emitter cut-off current					
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	0,5		mA
D.C. current gain*					
I_C = 300 mA; V_{CE} = 4 V	h_{FE}	>	30		
I_C = 3 A; V_{CE} = 4 V	h_{FE}	>	15		
Base-emitter voltage**					
I_C = 6 A; V_{CE} = 4 V	V_{BE}	<	2		V
Collector-emitter saturation voltage*					
I_C = 6 A; I_B = 1 A	V_{CEsat}	<	1,5		V
Turn off breakdown energy					
L = 20 mH; I_{CC} = 2,5 A	$E_{(BR)}$	>	62,5		mJ

* Measured under pulse conditions: $t_p \leq 300\,\mu s$; $\delta < 0,02$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Transition frequency at f = 1 MHz			
I_C = 0,5 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times (between 10% and 90% levels)			
I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A			
Turn-on time	t_{on}	typ.	0,6 μs
Turn-off time	t_{off}	typ.	2 μs

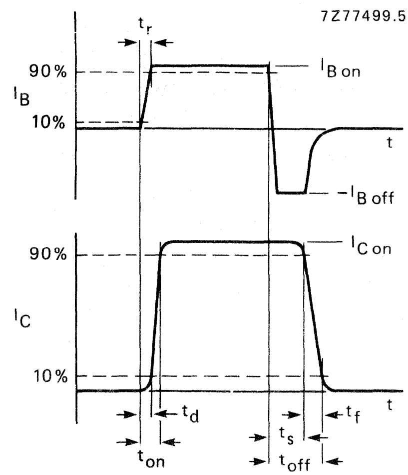
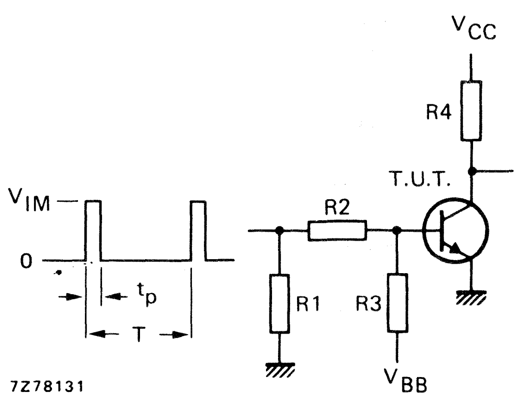


Fig. 2 Switching times waveforms.



V_{IM}	=	30 V
V_{CC}	=	20 V
$-V_{BB}$	=	3,5 V
R1	=	82 Ω
R2	=	150 Ω
R3	=	39 Ω
R4	=	20 Ω
$t_r = t_f$	⩽	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

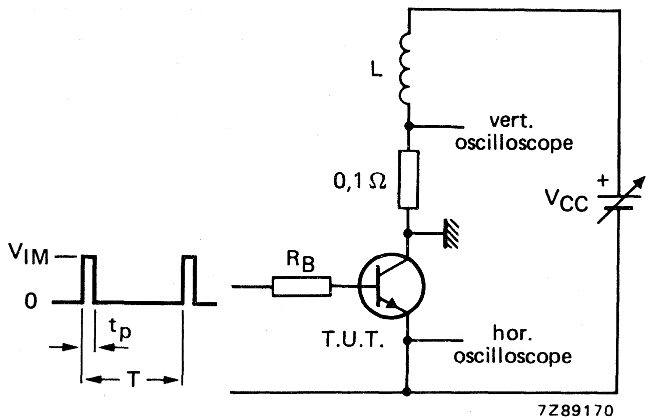


Fig. 4 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 2,5 A; t_p = 1 ms; δ = 0,01.

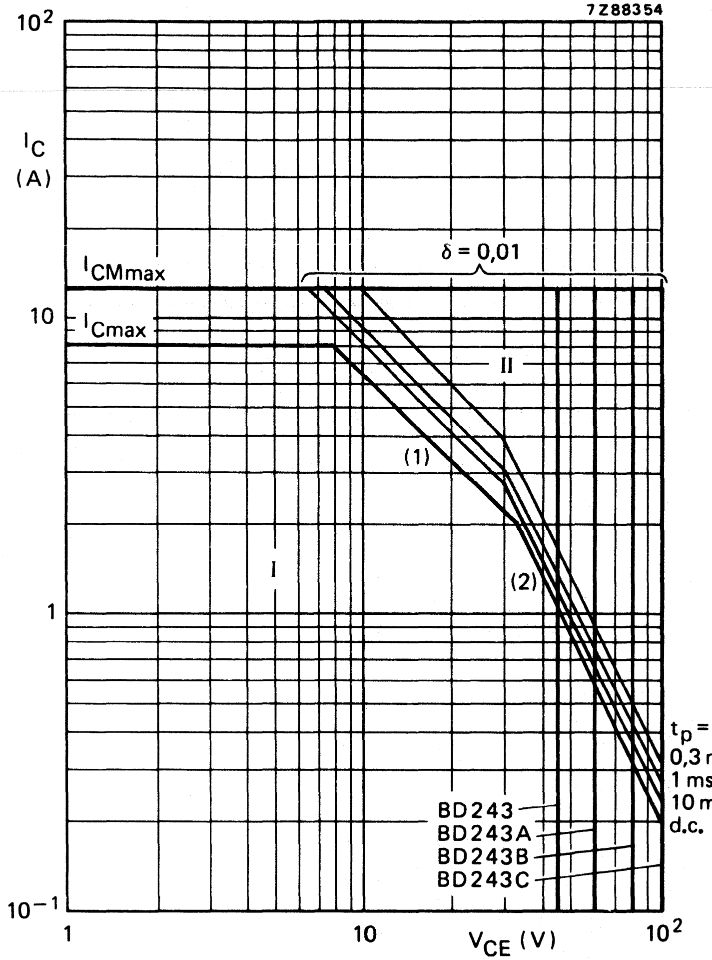


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second breakdown limits.

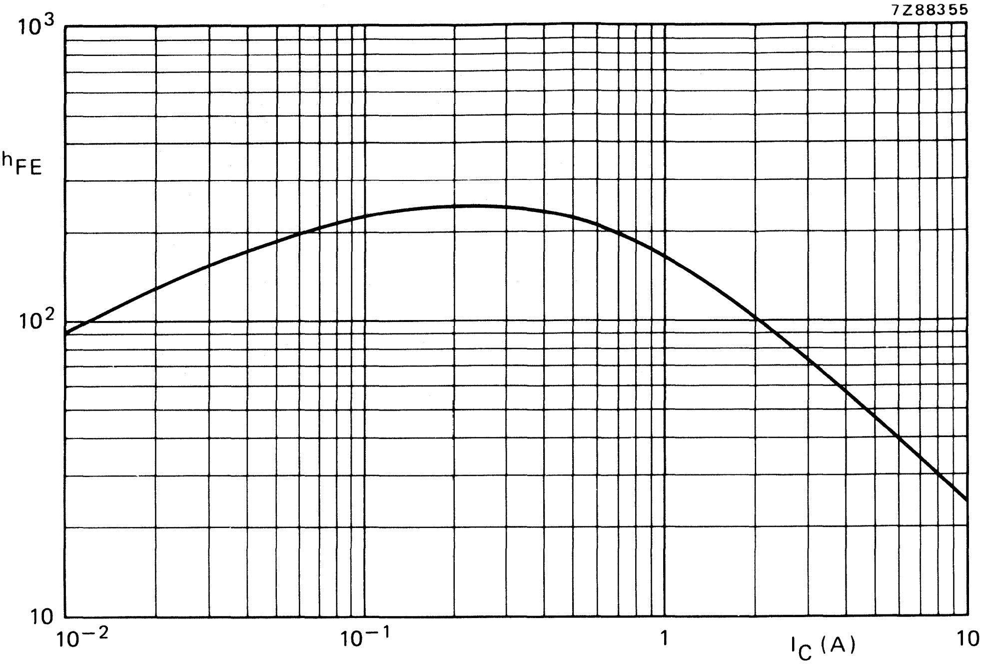


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. V_{CE} = 4 V, T_j = 25 °C.

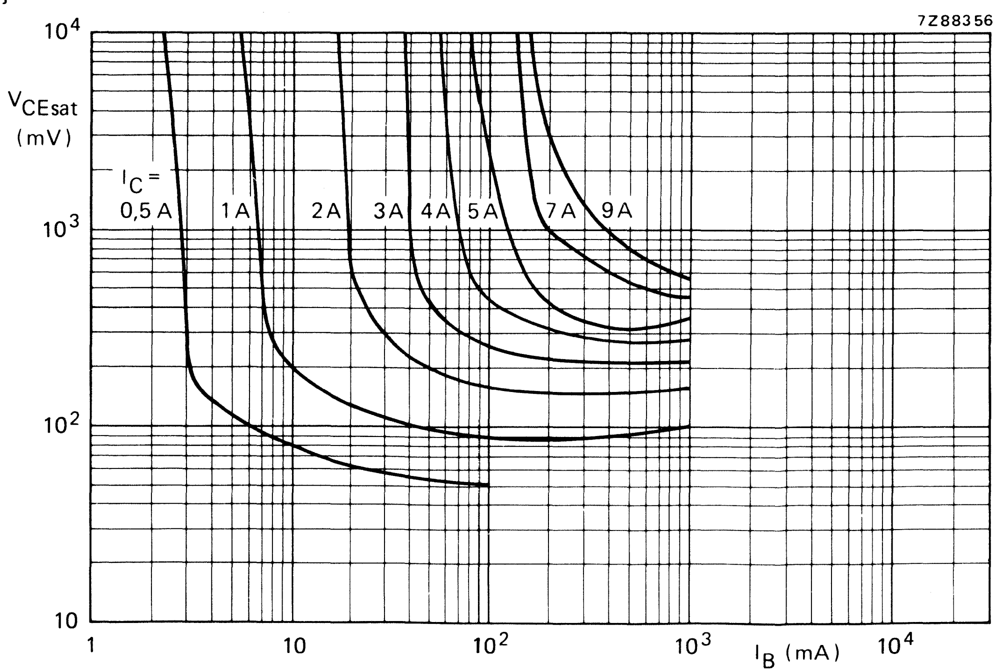


Fig. 7 Typical values collector-emitter saturation voltage at T_j = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in general amplifier and switching applications. N-P-N complements are BD243; 243A; 243B; and BD243C.

QUICK REFERENCE DATA

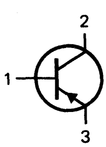
			BD244	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	8				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	>	15				
Transition frequency $-I_C$ = 500 mA; $-V_{CE}$ = 10 V	f_T	>	3				MHz

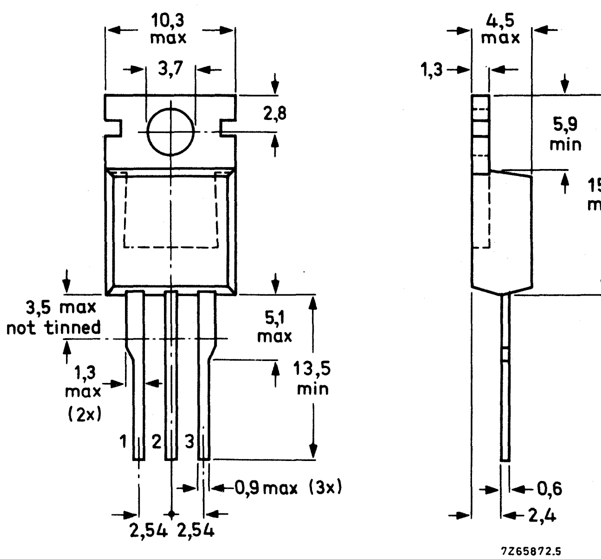
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD244	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	V
Collector-emitter voltage (R_{BE} = 100 Ω)	$-V_{CER}$	max.	55	70	90	115	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
Collector current (d.c.)	$-I_C$	max.	8				A
Collector current (peak value)	$-I_{CM}$	max.	12				A
Base current (d.c.)	$-I_B$	max.	3				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD244; A	BD244B; C	
→ Collector cut-off current					
$-I_B = 0$; $-V_{CE}$ = 30 V	$-I_{CEO}$	<	0,2	–	mA
$-I_B = 0$; $-V_{CE}$ = 60 V	$-I_{CEO}$	<	–	0,2	mA
$-V_{BE} = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,4		mA
→ Emitter cut-off current					
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	0,5		mA
D.C. current gain *					
$-I_C$ = 300 mA; $-V_{CE}$ = 4 V	h_{FE}	>	30		
$-I_C$ = 3 A; $-V_{CE}$ = 4 V	h_{FE}	>	15		
Base-emitter voltage *					
$-I_C$ = 6 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	2		V
Collector-emitter saturation voltage *					
$-I_C$ = 6 A; $-I_B$ = 1 A	$-V_{CEsat}$	<	1,5		V
Turn off breakdown energy					
L = 20 mH; $-I_{CC}$ = 2,5 A	$E_{(BR)}$	>	62,5		mJ

* Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta < 2\%$.

Transition frequency at f = 1 MHz	
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	f_T > 3 MHz
Switching times	
$-I_{Con}$ = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A	
turn-on time	t_{on} typ. 0,4 μs
turn-off time	t_{off} typ. 0,7 μs

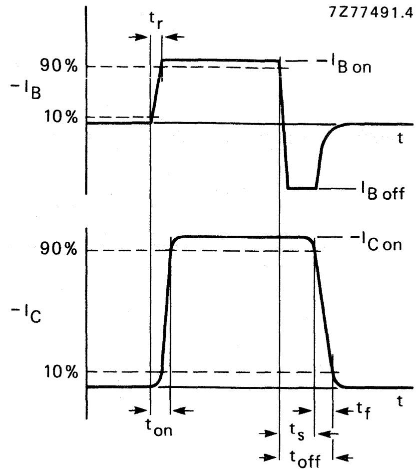


Fig. 2 Switching times waveforms.

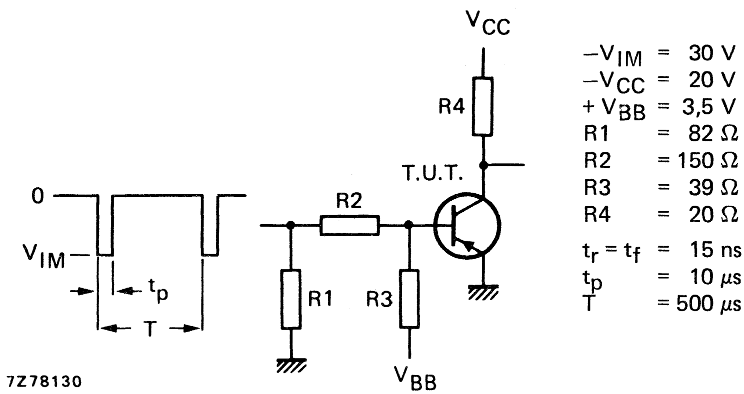


Fig. 3 Switching times test circuit.

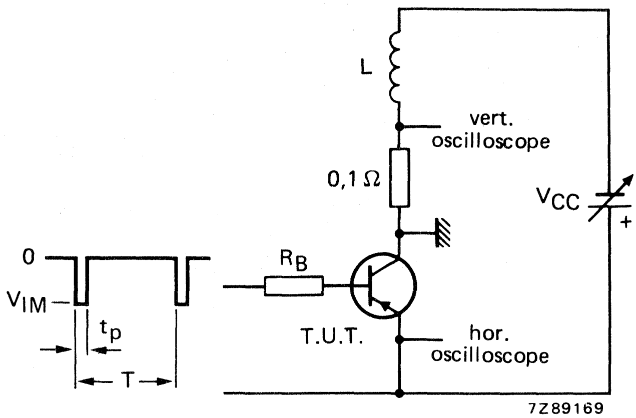


Fig. 4 Test circuit for turn-off breakdown energy.
$V_{IM} = -12$ V; $R_B = 270\ \Omega$; $-I_{CC} = 2{,}5$ A; $t_p = 1$ ms; $\delta = 0{,}01$.

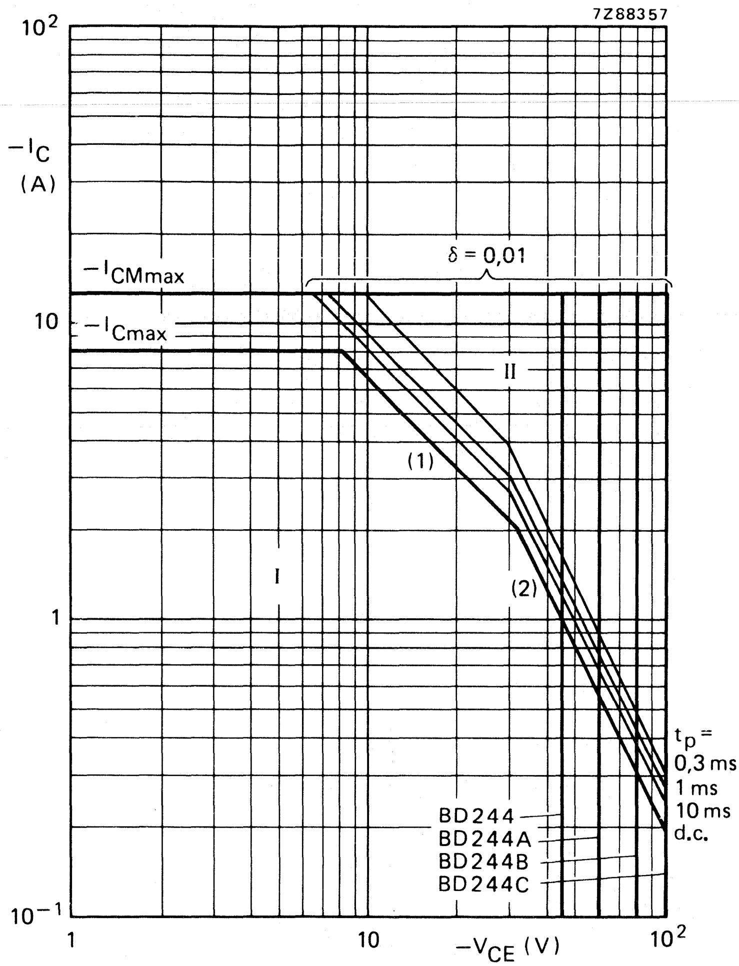


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second breakdown limits.

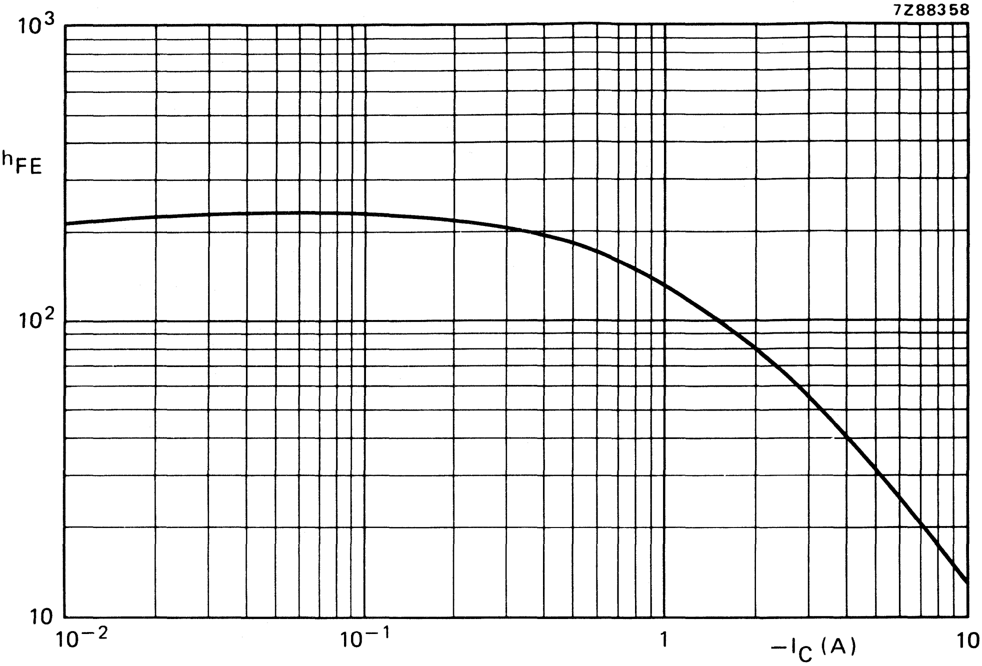


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V, $T_j = 25$ °C.

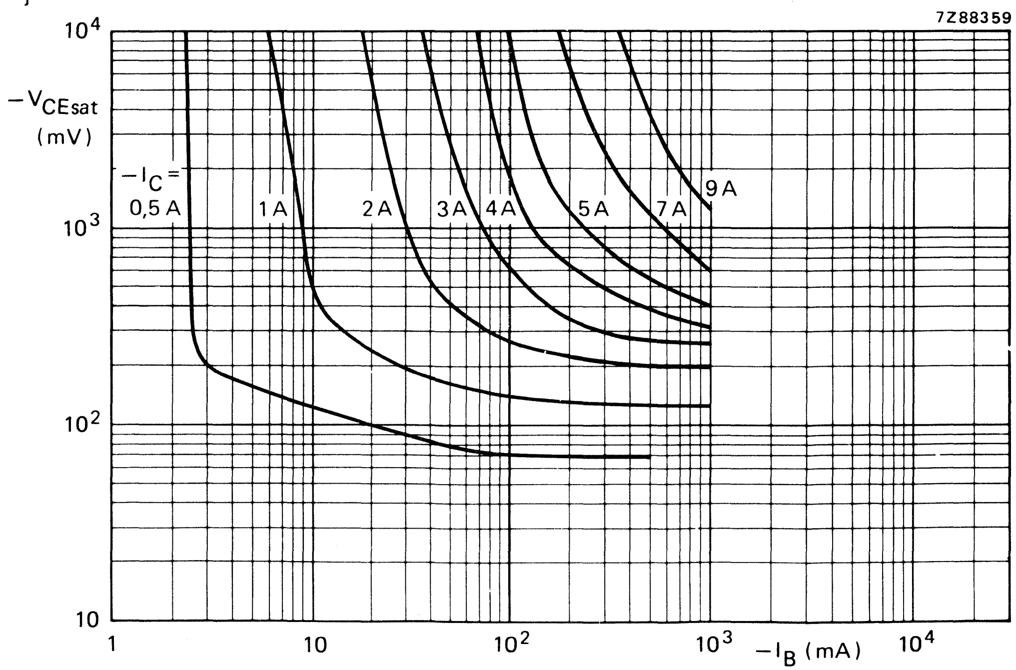


Fig. 7 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

SILICON PLANAR EPITAXIAL POWER TRANSISTOR

N-P-N transistor in a SOT-32 plastic envelope intended for car-radio output stages.
P-N-P complement is BD330. Matched pairs can be supplied.

QUICK REFERENCE DATA

Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (peak value)	I_{CM}	max.	3	A
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 0,5 A; V_{CE} = 1 V	h_{FE}		85 to 375	
Transition frequency I_C = 50 mA; V_{CE} = 5 V	f_T	typ.	130	MHz

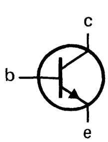
MECHANICAL DATA

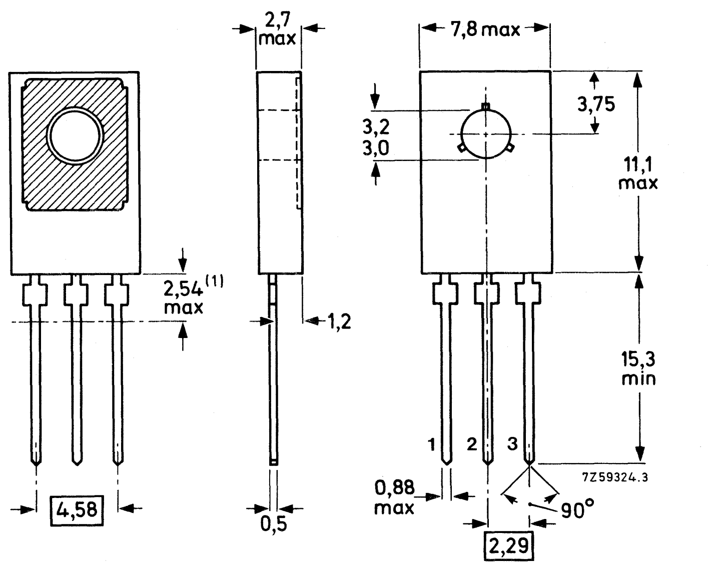
Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface

Pinning
1 = emitter
2 = collector
3 = base





See chapters Mounting Instructions and Accessories.

1) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	3	A
Collector current (peak value)	I_{CM}	max.	3	A
Base current (d.c.)	I_B	max.	1	A
Emitter current (d.c.)	$-I_E$	max.	3	A
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	15	W
Storage temperature	T_{stg}		− 65 to +150	°C
Junction temperature	T_j	max.	150	°C

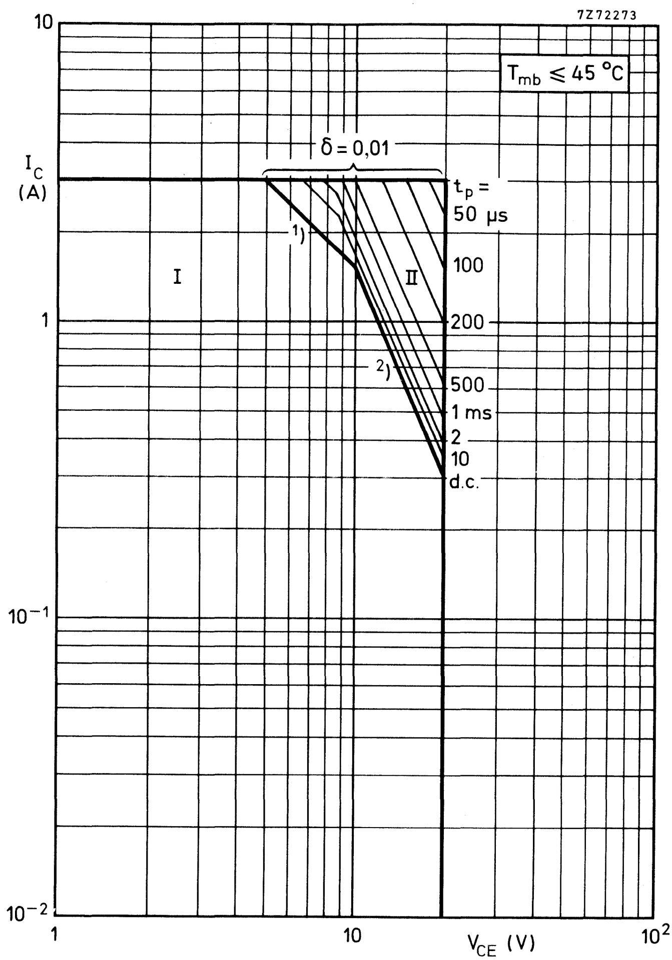
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	7	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	100	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

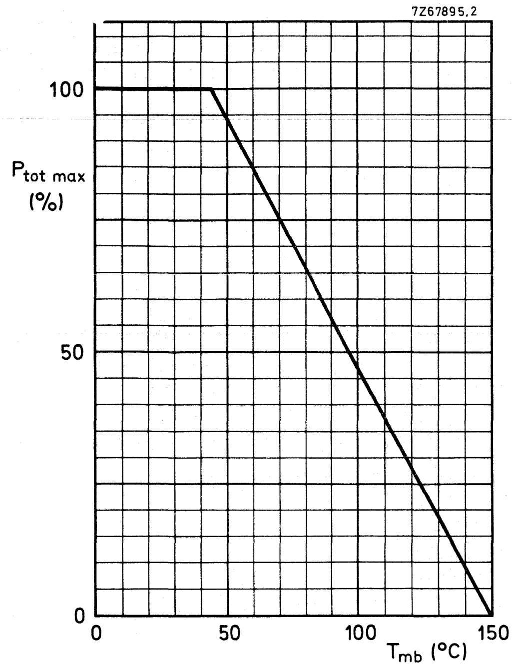
Collector cut-off current				
$I_E = 0$; $V_{CB} = 32$ V	I_{CBO}	<	10	µA
$I_E = 0$; $V_{CB} = 32$ V; $T_j = 150$ °C	I_{CBO}	<	1	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	µA
Base-emitter voltage				
$I_C = 5$ mA; $V_{CE} = 10$ V	V_{BE}	typ.	0,6	V
$I_C = 2$ A; $V_{CE} = 1$ V	V_{BE}	<	1,2	V
Collector-emitter saturation voltage				
$I_C = 2$ A; $I_B = 0,2$ A	V_{CEsat}	<	0,5	V
D.C. current gain				
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{FE}	>	50	
$I_C = 0,5$ A; $V_{CE} = 1$ V	h_{FE}		85 to 375	
$I_C = 2$ A; $V_{CE} = 1$ V	h_{FE}	>	40	
Transition frequency at f = 35 MHz				
$I_C = 50$ mA; $V_{CE} = 5$ V	f_T	typ.	130	MHz
D.C. current gain ratio of matched pairs				
BD329/BD330				
$\lvert I_C \rvert = 0,5$ A; $\lvert V_{CE} \rvert = 1$ V	h_{FE1}/h_{FE2}	<	1,6	

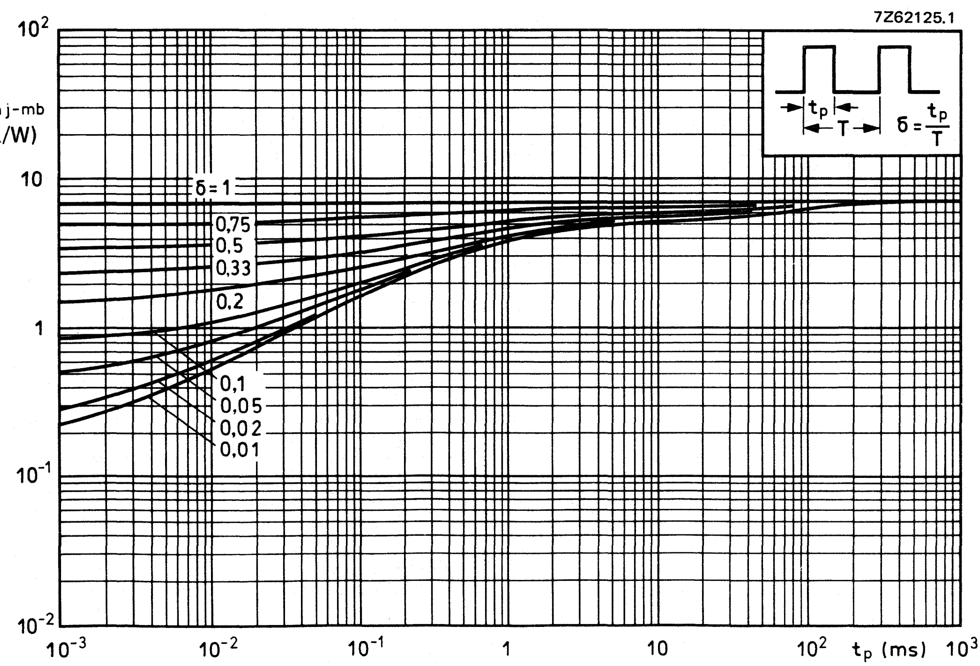


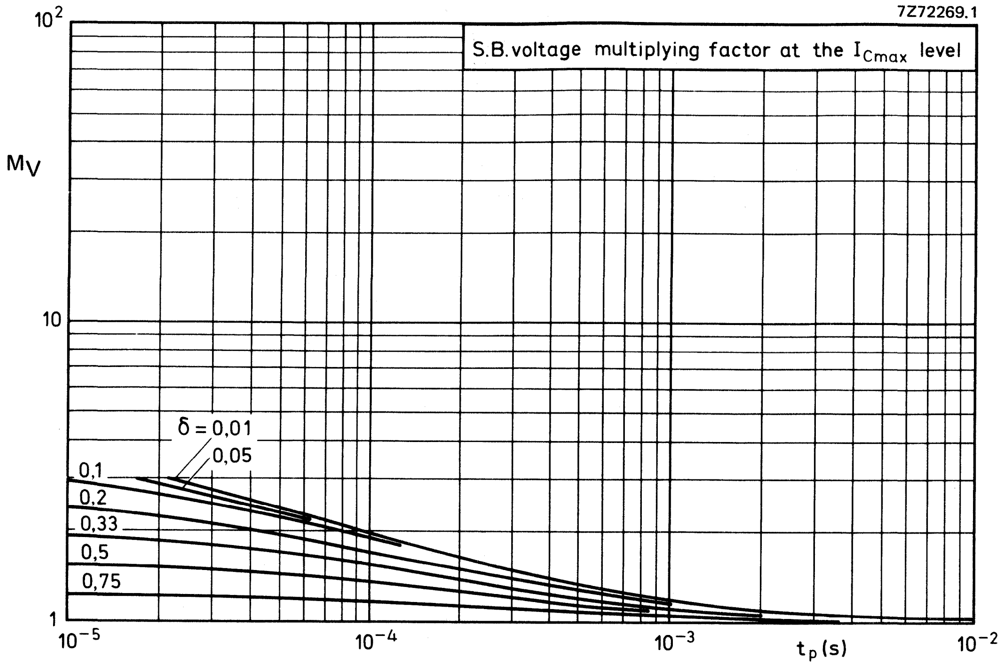
Safe Operating ARea with the transistor forward biased

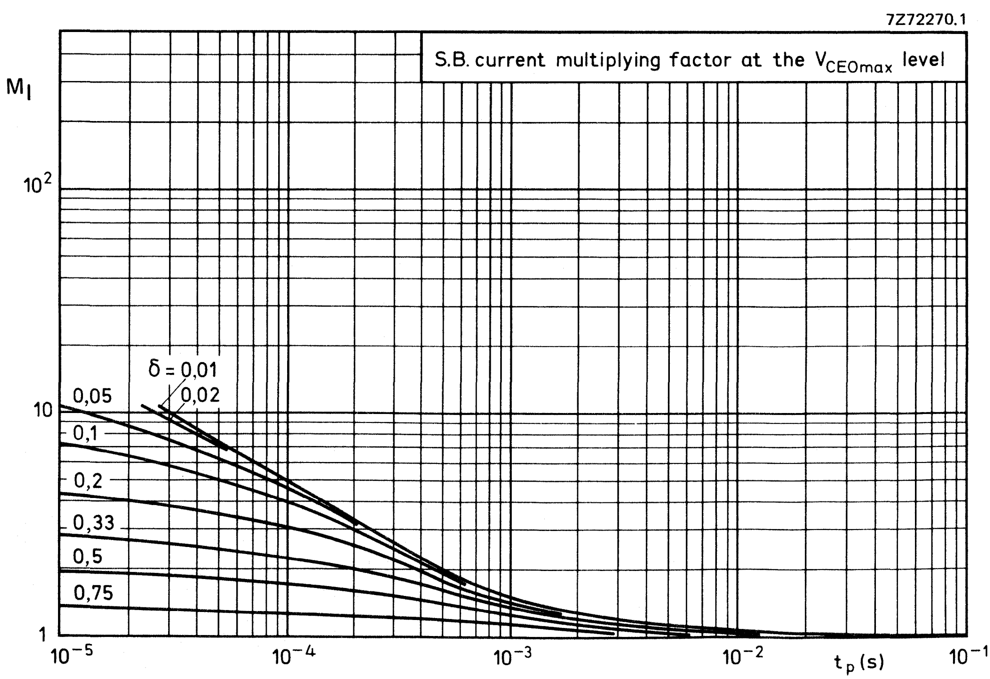
I Region of permissible d.c. operation
II Permissible extension for repetive pulse operation

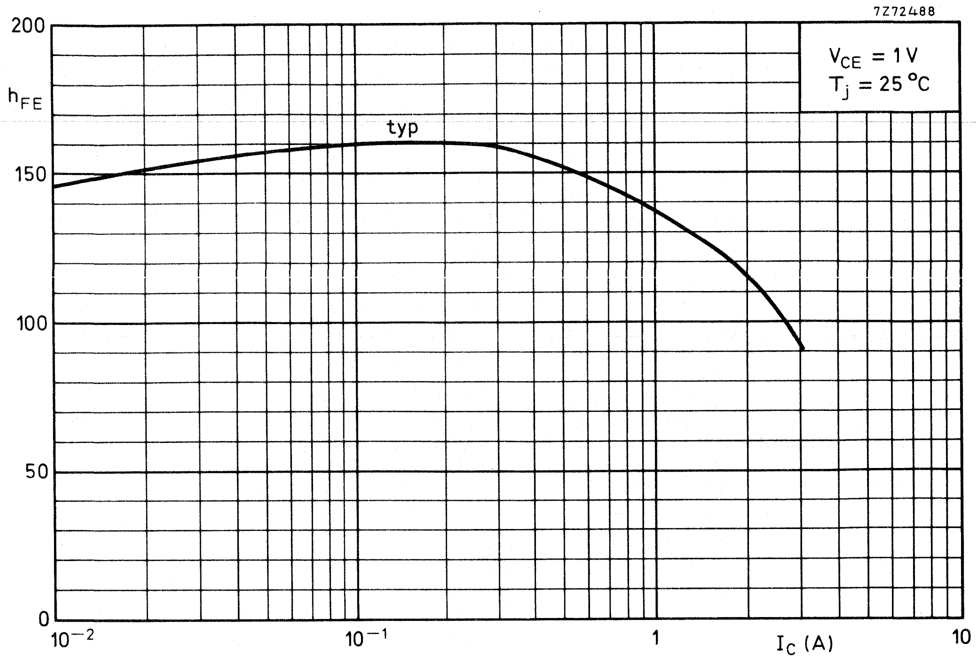
1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
2) Second-breakdown limits

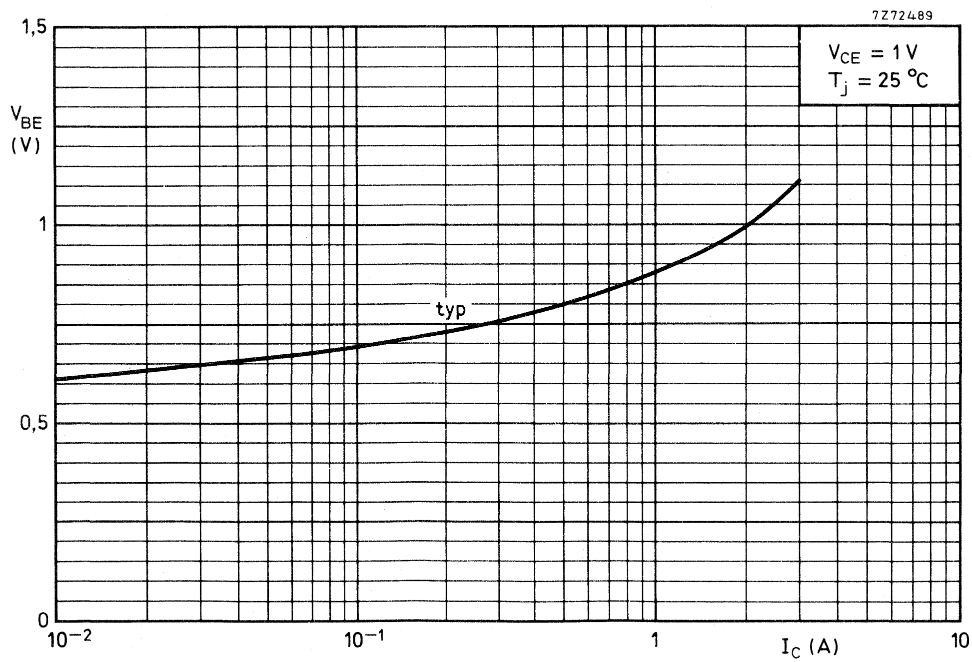

7Z67895.2
100
$P_{tot\ max}$
(%)
50
0
0
50
100
150
T_{mb} (°C)

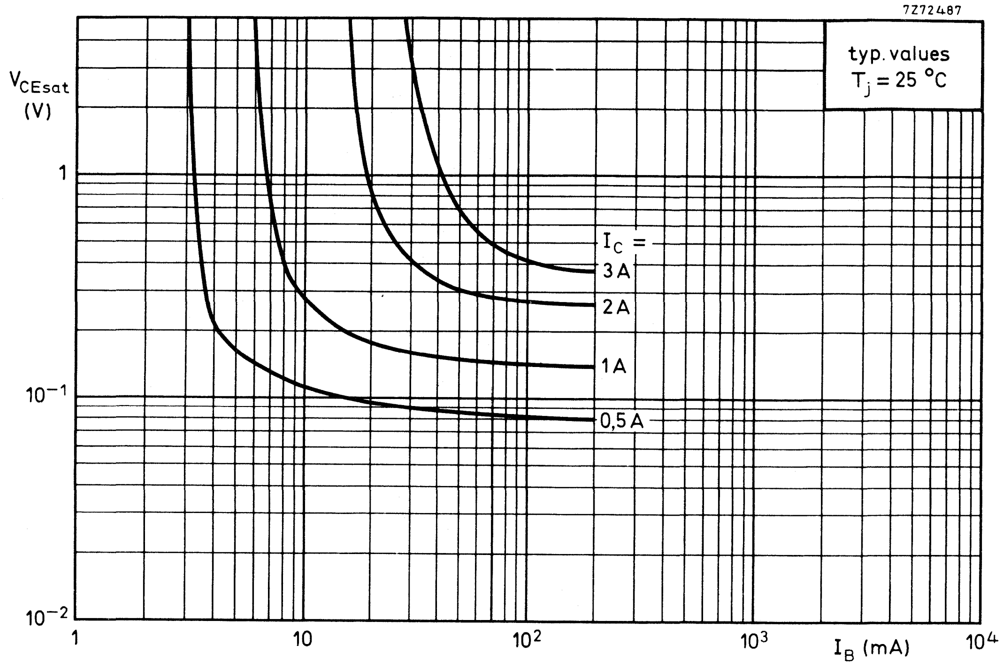

7Z62125.1
10^2
$Z_{th\ j-mb}$
(K/W)
10
δ = 1
0,75
0,5
0,33
0,2
1
0,1
0,05
0,02
0,01
10^{-1}
10^{-2}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (ms)
10^3
t_p
T
$\delta = \frac{t_p}{T}$


7Z72269.1
S.B. voltage multiplying factor at the I_{Cmax} level
M_V
10^2
10
1
δ = 0,01
0,05
0,1
0,2
0,33
0,5
0,75
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}


7Z72270.1
S.B. current multiplying factor at the V_{CEOmax} level
M_I
10^2
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10^{-5}
10^{-4}
10^{-3}
10^{-2}
t_p (s)
10^{-1}


7Z72488
V_{CE} = 1 V
T_j = 25 °C
h_{FE}
typ
200
150
100
50
0
10^{-2}
10^{-1}
1
10
I_C (A)


7Z72489
V_{CE} = 1 V
T_j = 25 °C
V_{BE}
(V)
typ
1,5
1
0,5
0
10^{-2}
10^{-1}
1
10
I_C (A)


7Z72487
typ. values
T_j = 25 °C
V_{CEsat}
(V)
1
10^{-1}
10^{-2}
1
10
10^2
10^3
10^4
I_B (mA)
I_C =
3 A
2 A
1 A
0,5 A

SILICON PLANAR EPITAXIAL POWER TRANSISTOR

P-N-P transistor in a SOT-32 plastic envelope intended for car-radio output stages.
N-P-N complement is BD329. Matched pairs can be supplied.

QUICK REFERENCE DATA

Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current (peak value)	$-I_{CM}$	max.	3	A
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	150	°C
D.C. current gain $-I_C$ = 0,5 A; $-V_{CE}$ = 1 V	h_{FE}		85 to 375	
Transition frequency $-I_C$ = 50 mA; $-V_{CE}$ = 5 V	f_T	typ.	100	MHz

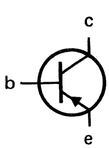
MECHANICAL DATA

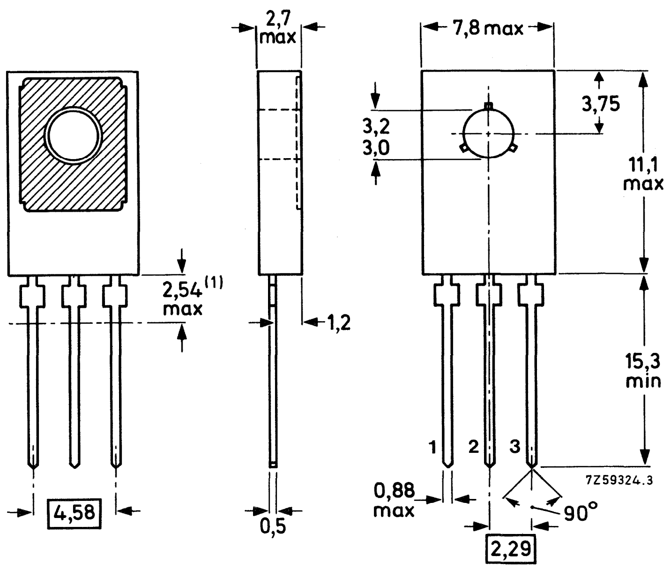
Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface

Pinning
1 = emitter
2 = collector
3 = base





See chapters Mounting Instructions and Accessories.

1) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V
Collector current (d.c.)	$-I_C$	max.	3	A
Collector current (peak value)	$-I_{CM}$	max.	3	A
Base current (d.c.)	$-I_B$	max.	1	A
Emitter current (d.c.)	I_E	max.	3	A
Total power dissipation up to T_{mb} = 45 ^oC	P_{tot}	max.	15	W
Storage temperature	T_{stg}		− 65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

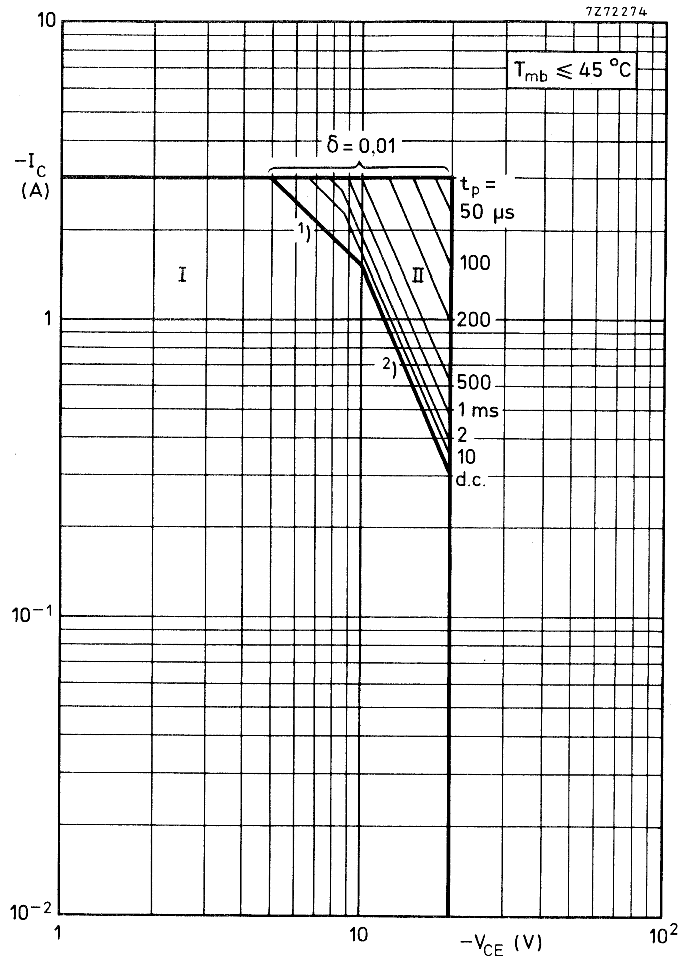
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	7	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	100	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 32$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 32$ V; $T_j = 150$ °C	$-I_{CBO}$	<	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10	μA
Base-emitter voltage				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	0,6	V
$-I_C = 2$ A; $-V_{CE} = 1$ V	$-V_{BE}$	<	1,2	V
Collector-emitter saturation voltage				
$-I_C = 2$ A; $-I_B = 0,2$ A	$-V_{CEsat}$	<	0,5	V
D.C. current gain				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	h_{FE}	>	50	
$-I_C = 0,5$ A; $-V_{CE} = 1$ V	h_{FE}		85 to 375	
$-I_C = 2$ A; $-V_{CE} = 1$ V	h_{FE}	>	40	
Transition frequency at f = 35 MHz				
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	typ.	100	MHz
D.C. current gain ratio of matched pairs				
BD329/BD330				
$\lvert I_C \rvert = 0,5$ A; $\lvert V_{CE} \rvert = 1$ V	h_{FE1}/h_{FE2}	<	1,6	

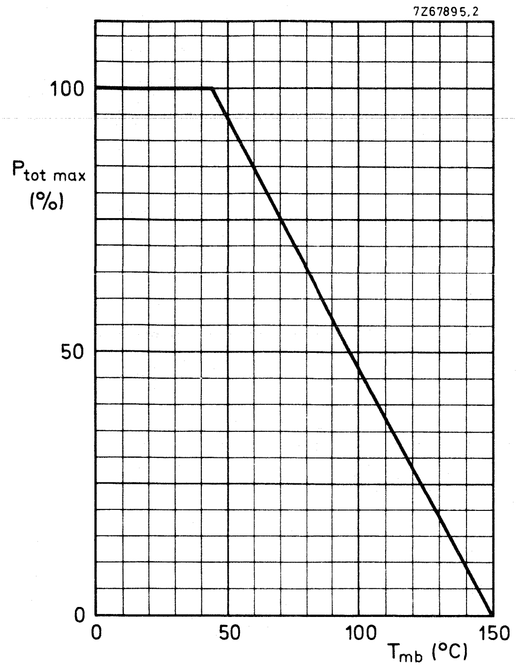


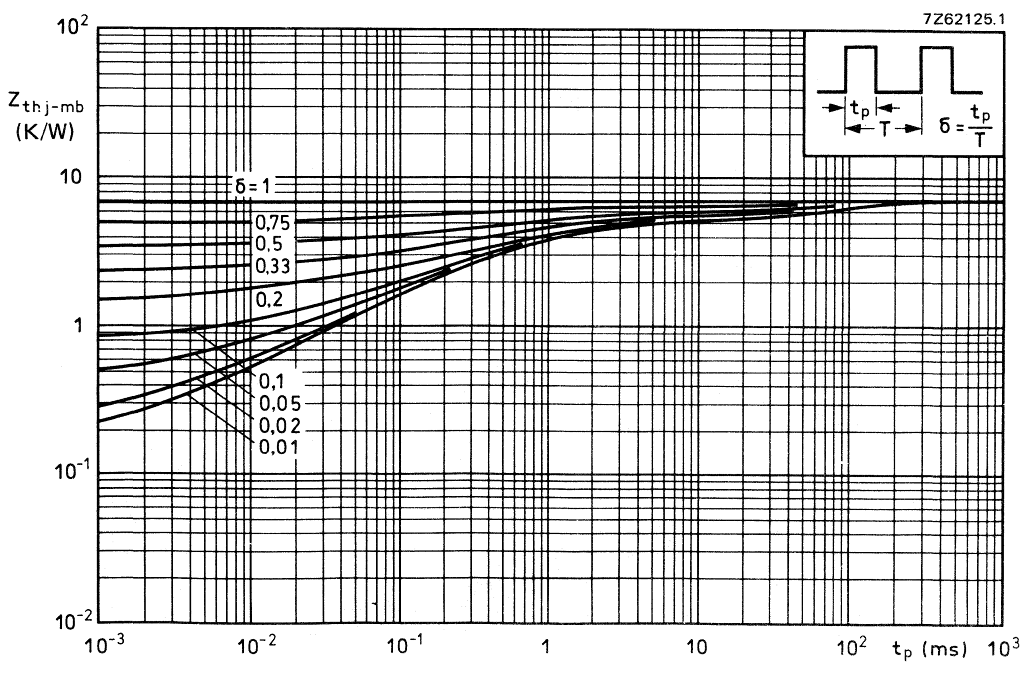
Safe Operating ARea with the transistor forward biased

I Region of permissible d.c. operation
II Permissible extension for repetitive pulse operation

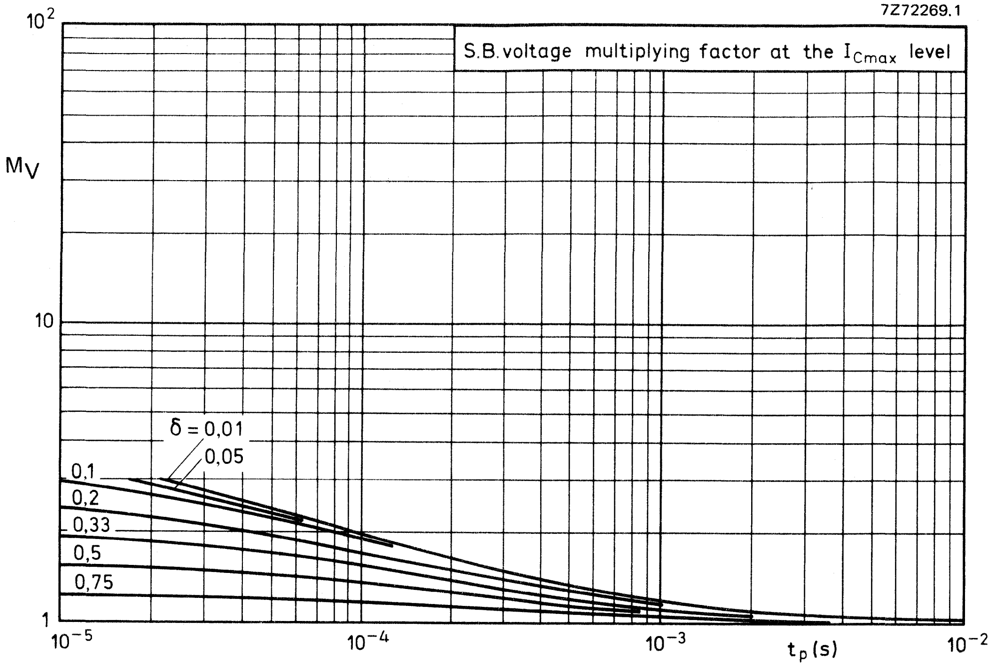
1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

2) Second-breakdown limits

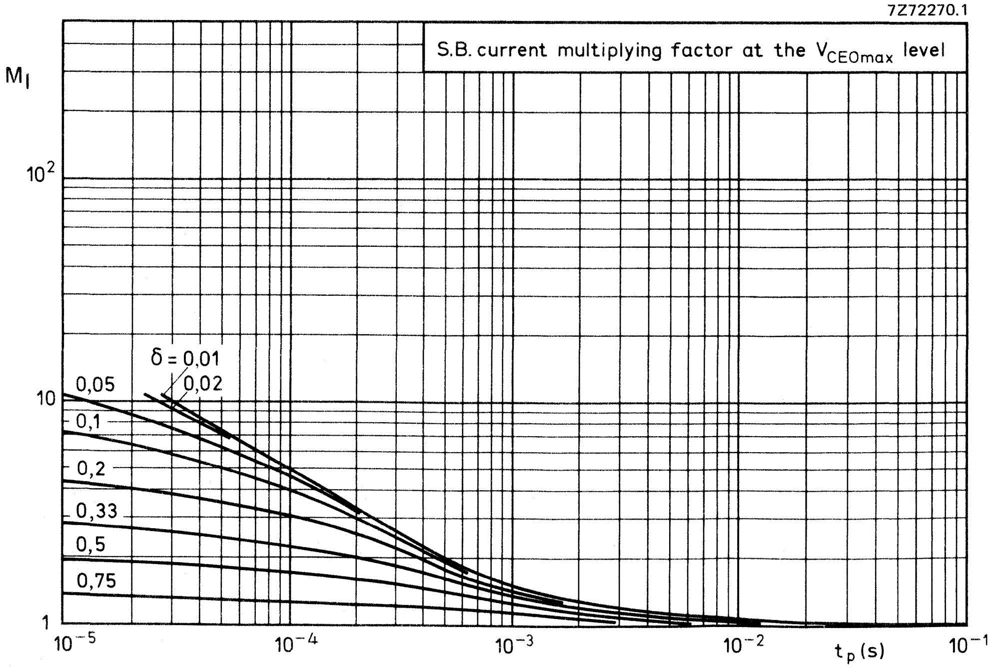

7Z67895.2
100
50
0
$P_{tot\ max}$ (%)
0
50
100
150
T_{mb} (°C)

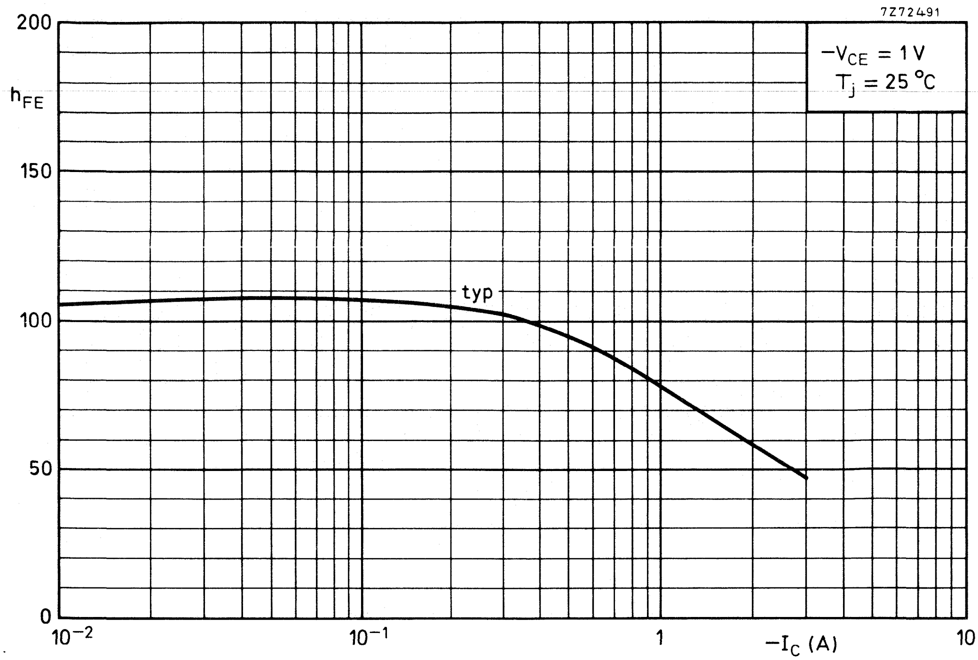

7Z62125.1
10^2
10
1
10^{-1}
10^{-2}
$Z_{th\ j\text{-}mb}$ (K/W)
t_p
T
$\delta = \frac{t_p}{T}$
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (ms)
10^3

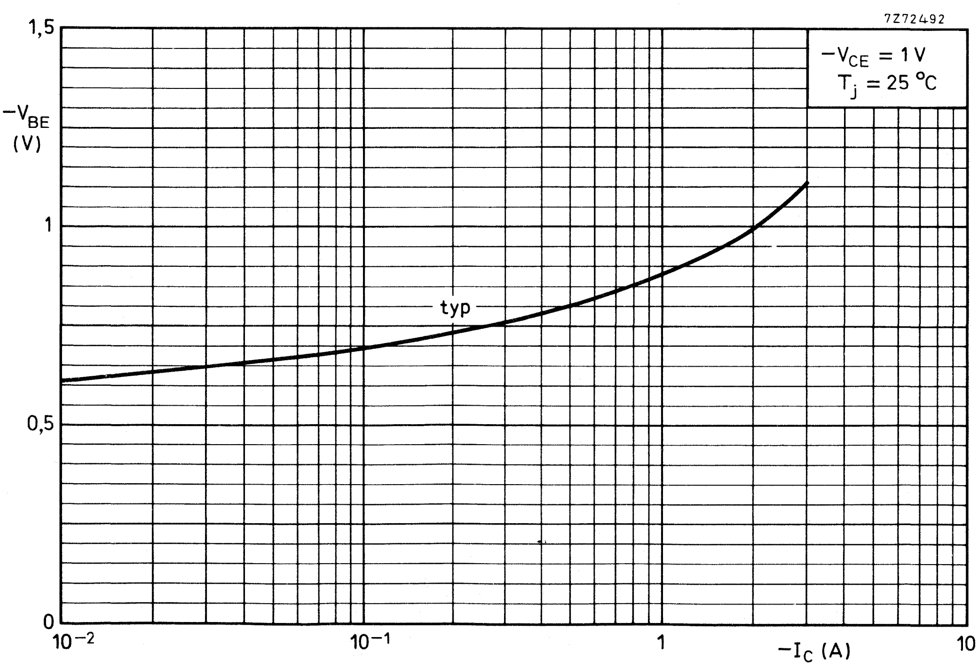
7Z72269.1

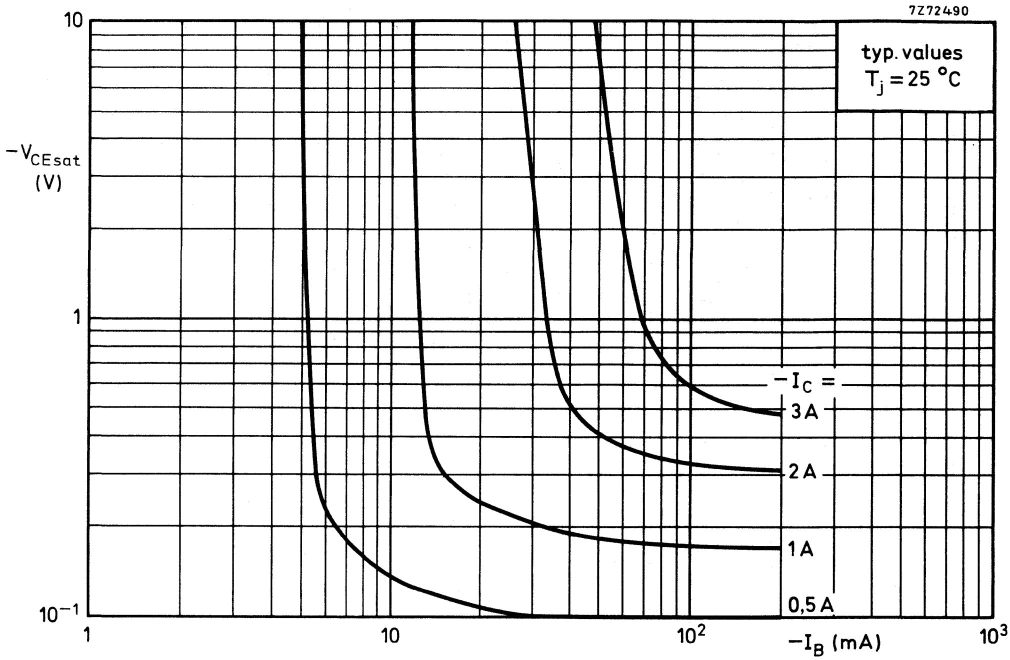


7Z72270.1




7Z72491
$-V_{CE}$ = 1 V
T_j = 25 °C
200
h_{FE}
150
100
50
0
typ
10^{-2}
10^{-1}
1
$-I_C$ (A)
10


7Z72492
$-V_{CE}$ = 1 V
T_j = 25 °C
1,5
$-V_{BE}$
(V)
1
0,5
0
typ
10^{-2}
10^{-1}
1
$-I_C$ (A)
10


7Z72490
typ. values
$T_j = 25\ °C$
10
$-V_{CEsat}$
(V)
1
10^{-1}
1
10
10^2
10^3
$-I_B$ (mA)
$-I_C =$
3 A
2 A
1 A
0,5 A

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; plastic SOT-82 envelope for clip mounting; can also be soldered or adhesive mounted into a hybrid circuit. P-N-P complements are BD332, BD334, BD336 and BD338.

QUICK REFERENCE DATA

			BD331	333	335	337	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector-current (d.c.)	I_C	max.	6				A
Base current (d.c.)	I_B	max.	150				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60				W
Junction temperature	T_j	max.	150				°C
D.C. current gain I_C = 3,0 A; V_{CE} = 3 V	h_{FE}	>	750				

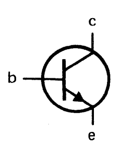
MECHANICAL DATA

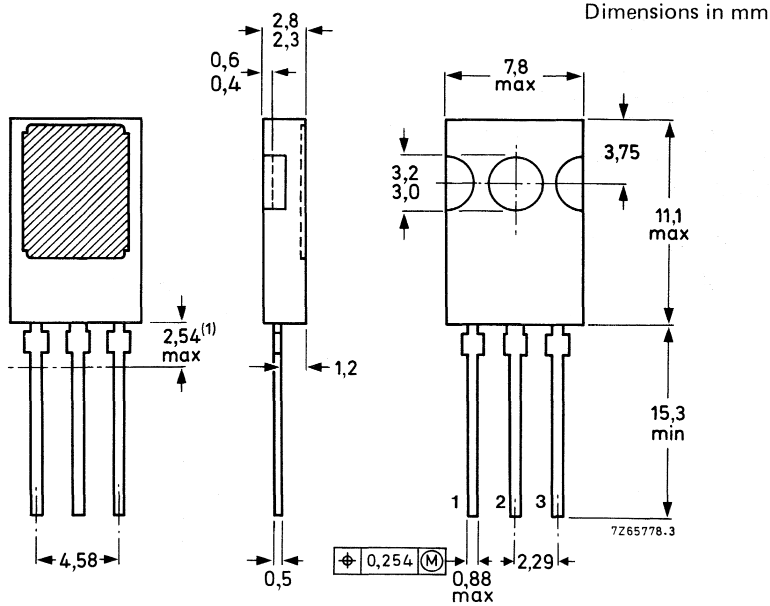
Dimensions in mm

Fig. 1 SOT-82.

Collector connected to metal part of mounting surface

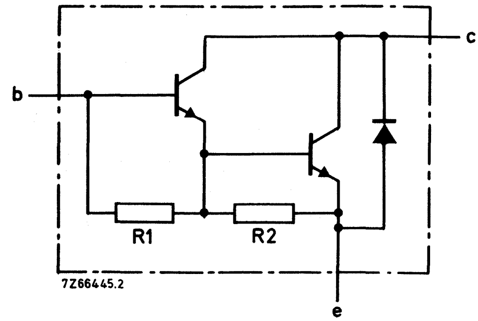
Pinning
1 = base
2 = collector
3 = emitter





(1) Within this region the cross-section of the leads is uncontrolled.

See also chapters Mounting Instructions and Accessories.



R_1 typ. 4 kΩ
R_2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD331	333	335	337	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V
Collector current (d.c.)	I_C	max.	6				A
Collector current (peak value) $t_p \leqslant 10$ ms; $\delta \leqslant 0,1$	I_{CM}	max.	10				A
Base current (d.c.)	I_B	max.	150				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature *	T_j	max.	150				°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,08	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,1 mA	←
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	1 mA	←
$I_B = 0$; V_{CE} = ½ V_{CEOmax}	I_{CEO}	<	0,2 mA	←
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5 mA	
D.C. current gain *				
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	1900	
I_C = 3 A; V_{CE} = 3 V	h_{FE}	>	750	
I_C = 6 A; V_{CE} = 3 V	h_{FE}	typ.	3000	
Base-emitter voltage **				
I_C = 3 A; V_{CE} = 3 V	V_{BE}	<	2,5 V	
Collector-emitter saturation voltage				
I_C = 3 A; I_B = 12 mA	V_{CEsat}	<	2 V	
Cut-off frequency				
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	50 kHz	
Turn-off breakdown energy with inductive load (see Fig. 12)				
$-I_{Boff} = 0$; I_{Con} = 4,5 A	$E_{(BR)}$	>	50 mJ	
Diode forward voltage				
I_F = 3 A	V_F	typ.	1,8 V	
D.C. current gain ratio of complementary matched pairs				
I_C = 3 A; V_{CE} = 3 V	h_{FE1}/h_{FE2}	<	2,5	
Small signal current gain				
I_C = 3 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	>	10	←
Second-breakdown collector current				
V_{CE} = 60 V; t_p = 25 ms	$I_{(SB)}$	>	1 A	
Switching times (between 10% and 90% levels)				
I_{Con} = 3 A; $I_{Bon} = -I_{Boff}$ = 12 mA				
Turn-on time	t_{on}	typ.	1 μs	
		<	2 μs	
Turn-off time	t_{off}	typ.	5 μs	
		<	10 μs	

* Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.

** V_{BE} decreases by about 3,8 mV/K with increasing temperature.

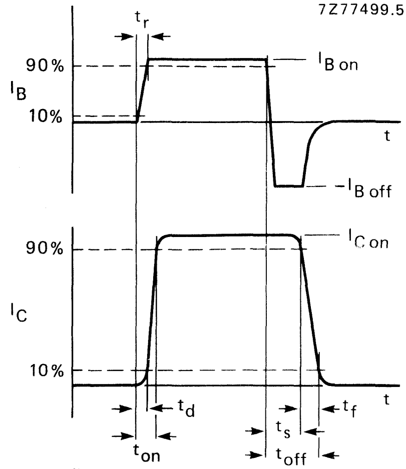
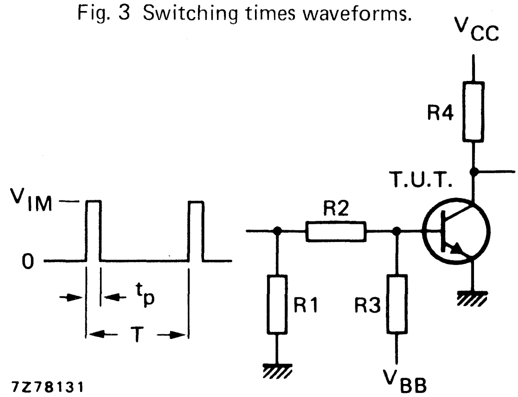
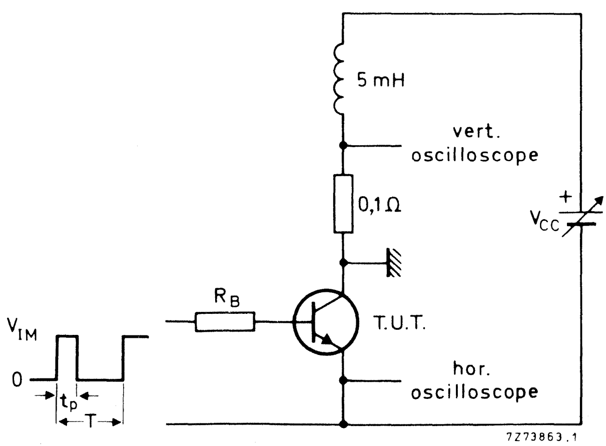


Fig. 3 Switching times waveforms.



V_{IM} = 10 V
V_{CC} = 10 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 3 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.



V_{IM} = 12 V
R_B = 270 Ω
I_C = 4,5 A
δ = 1 %
t_p = 1 ms

Fig. 5 Test circuit for turn-off breakdown energy.

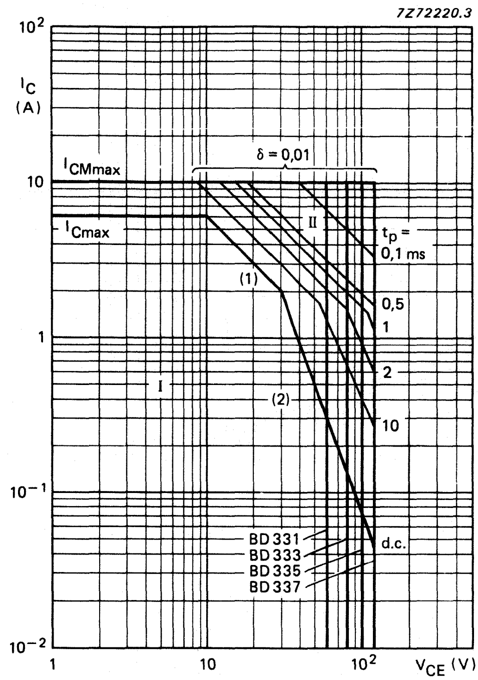


Fig. 6 Safe Operating ARea, $T_{mb} \leqslant 25\ ^oC$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

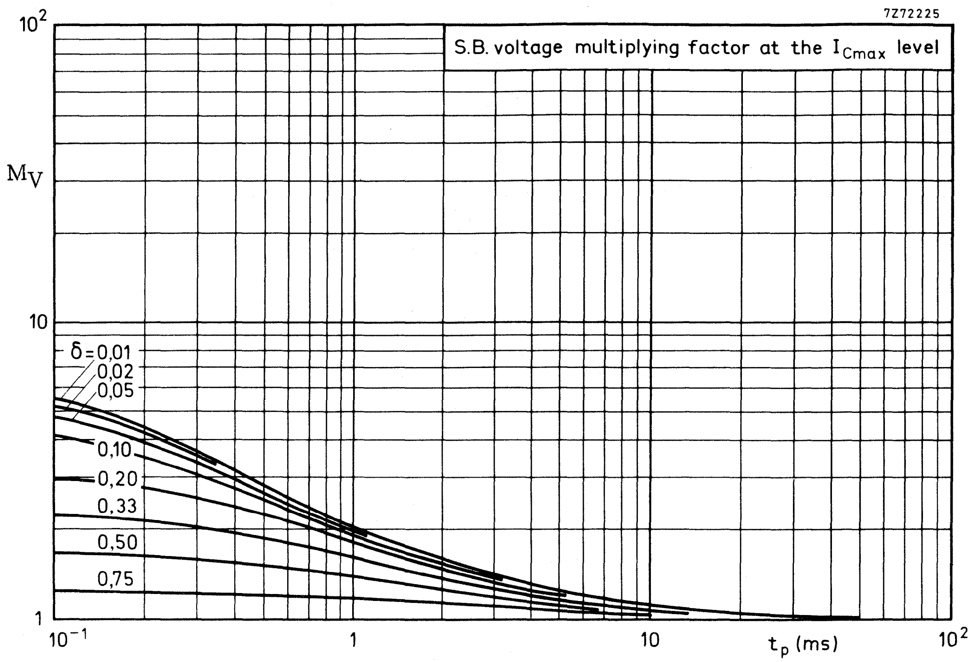


Fig. 7 Second breakdown voltage multiplying factor at I_{Cmax} level.

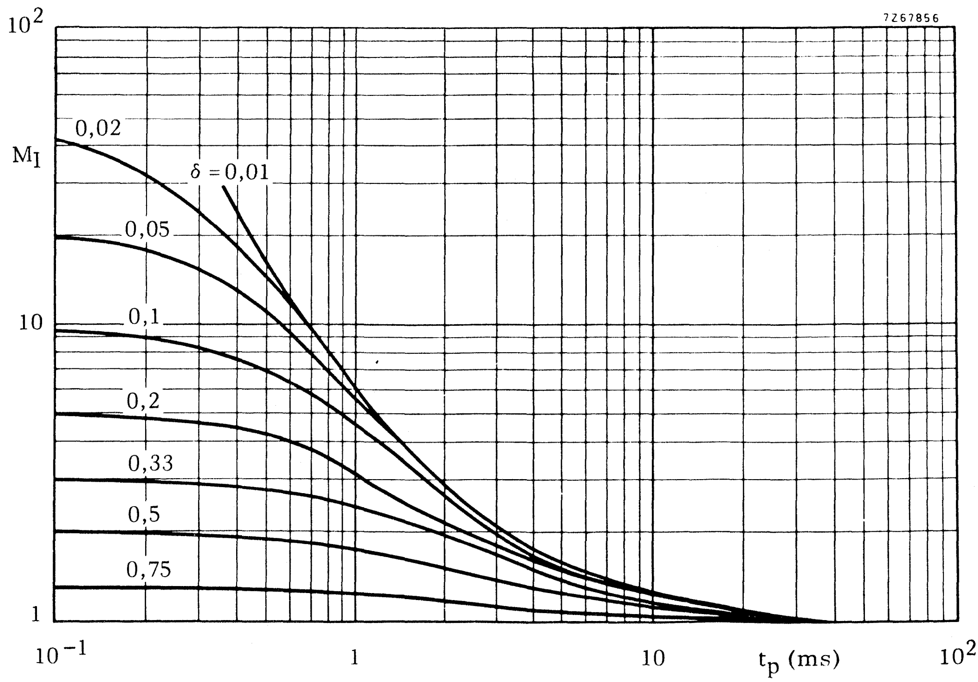


Fig. 8 Second breakdown current multiplying factor at V_{CEOmax} level.

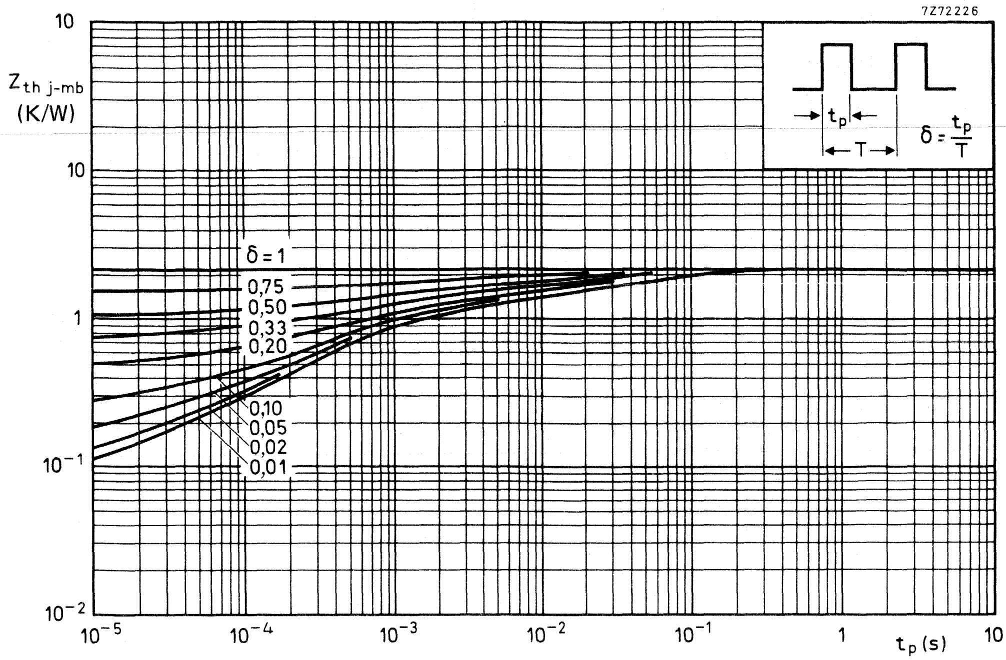


Fig. 9 Pulse power rating chart.

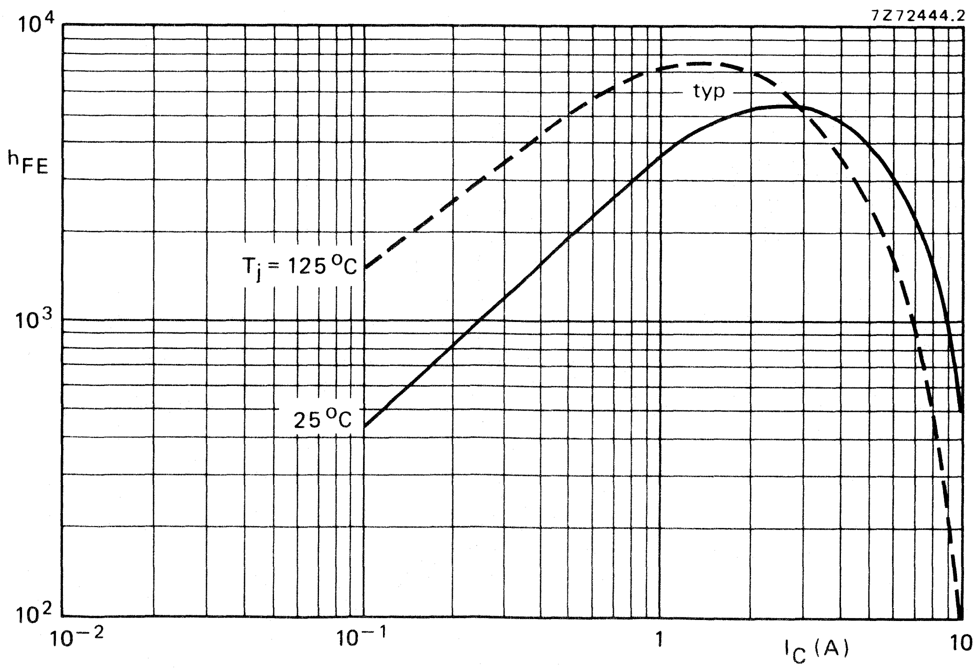


Fig. 10 D.C. current gain. $V_{CE} = 3$ V.

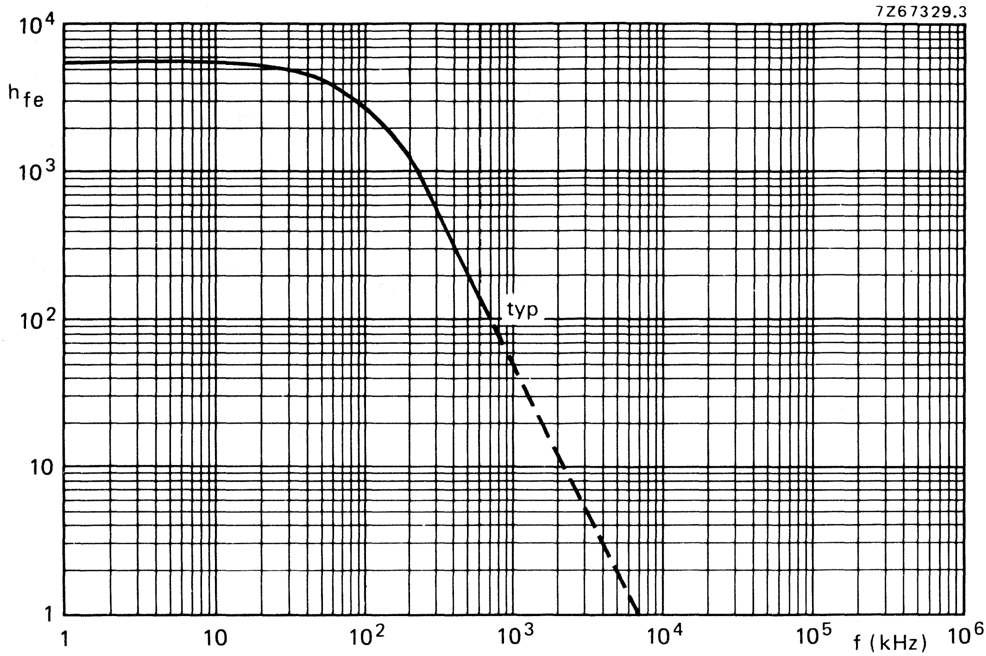


Fig. 11 Small signal current gain at I_C = 3 A; V_{CE} = 3 V.

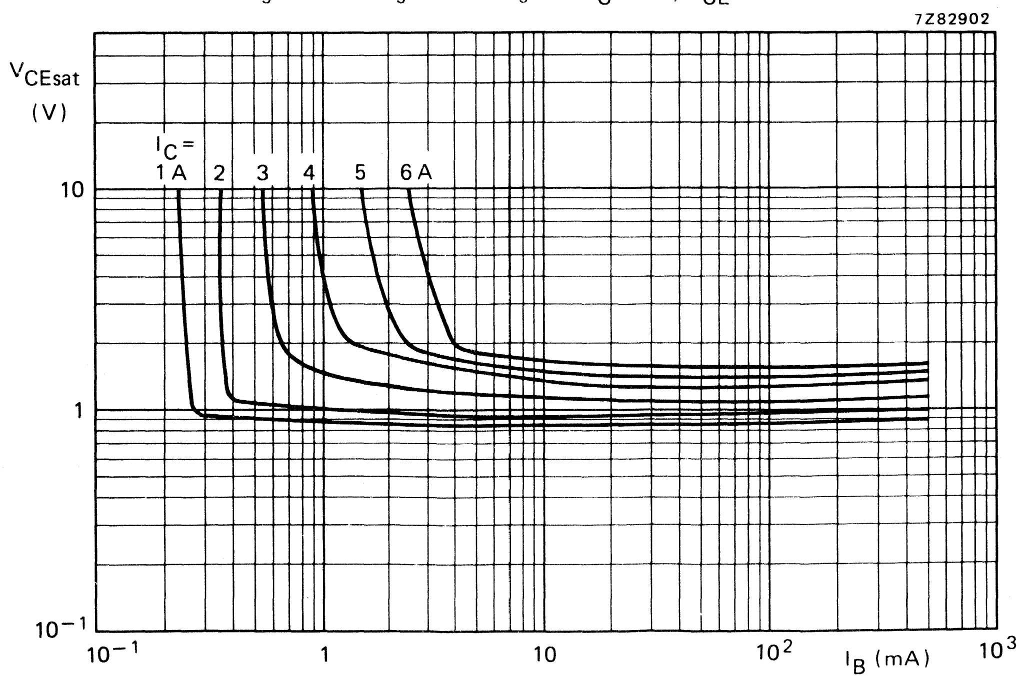


Fig. 12 Typical values collector-emitter saturation. T_j = 25 °C.

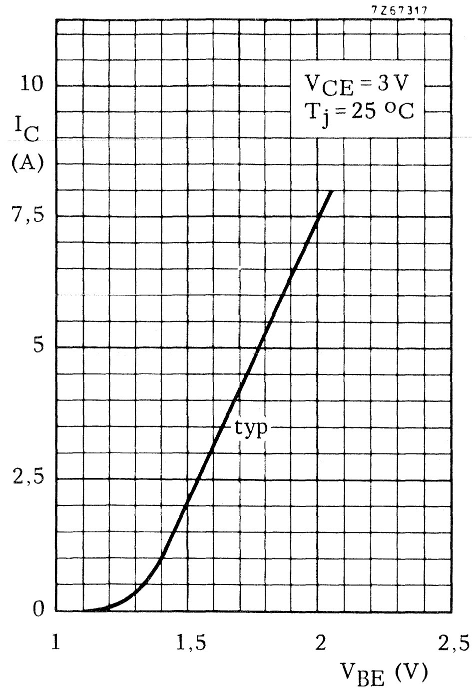


Fig. 13 Collector current.

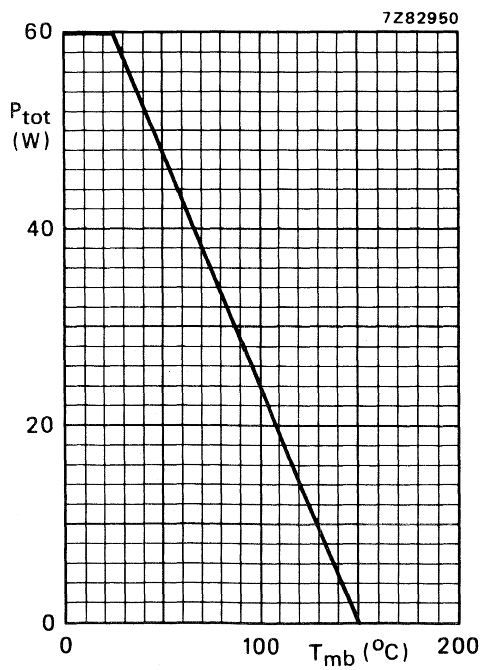


Fig. 14 Power derating curve.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; plastic SOT-82 envelope for clip mounting; can also be soldered or adhesive mounted into a hybrid circuit. N-P-N complements are BD331, BD333, BD335 and BD337.

QUICK REFERENCE DATA

			BD332	334	336	338	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector-current (d.c.)	$-I_C$	max.	6				A
Base current (d.c.)	$-I_B$	max.	150				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 3,0 A; $-V_{CE}$ = 3 V	h_{FE}	>	750				

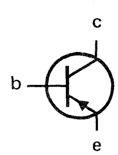
MECHANICAL DATA

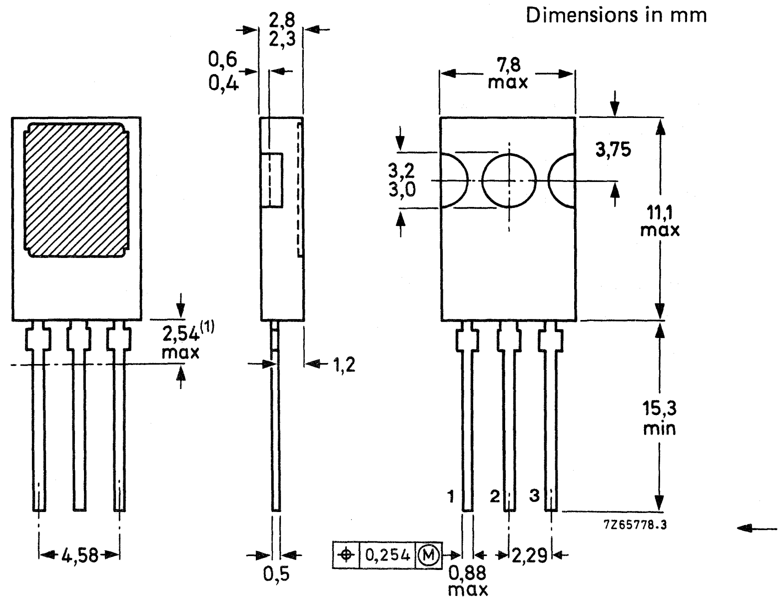
Dimensions in mm

Fig. 1 SOT-82.

Collector connected to metal part of mounting surface.

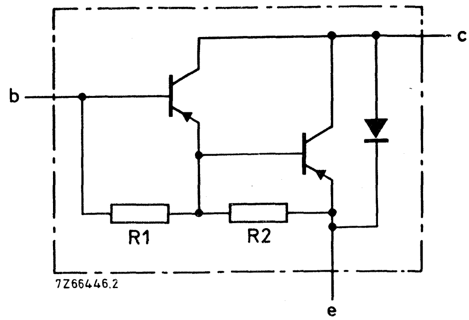
Pinning
1 = base
2 = collector
3 = emitter





(1) Within this region the cross-section of the leads is uncontrolled.

See also chapters Mounting instructions and Accessories.



R1 typ. 4 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD332	334	336	338	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.	6				A
Collector current (peak value) $t_p \leqslant 10$ ms; $\delta \leqslant 0,1$	$-I_{CM}$	max.	10				A
Base current (d.c.)	$-I_B$	max.	150				mA
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	60				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature *	T_j	max.	150				°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,08	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current					
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,1	mA	←
$I_E = 0; -V_{CB} = -V_{CBOmax}; T_j = 150$ °C	$-I_{CBO}$	<	1	mA	←
$I_B = 0; -V_{CE} = -½ V_{CEO}$	$-I_{CEO}$	<	0,2	mA	←
Emitter cut-off current					
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	5	mA	
D.C. current gain *					
$-I_C = 0{,}5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2700		
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	>	750		
$-I_C = 6$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	400		
Base-emitter voltage **					
$-I_C = 3$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5	V	
Collector-emitter saturation voltage					
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	<	2	V	
Small signal current gain					
$-I_C = 3$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	>	10		←
Cut-off frequency					
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100	kHz	
Diode, forward voltage					
$I_F = 3$ A	V_F	typ.	1,8	V	
D.C. current gain ratio of complementary matched pairs					
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE1}/h_{FE2}	<	2,5		
Second breakdown collector current non-repetitive; without heatsink					
$-V_{CE} = 60$ V; $t_p = 25$ ms	$-I_{(SB)}$	>	1	A	
Switching times (see Figs 3 and 4)					
$-I_{Con} = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA					
turn-on time	t_{on}	typ.	1	μs	
		<	2	μs	
turn-off time	t_{off}	typ.	5	μs	
		<	10	μs	

* Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.

** V_{BE} decreases by about 3,8 mV/K with increasing temperature.

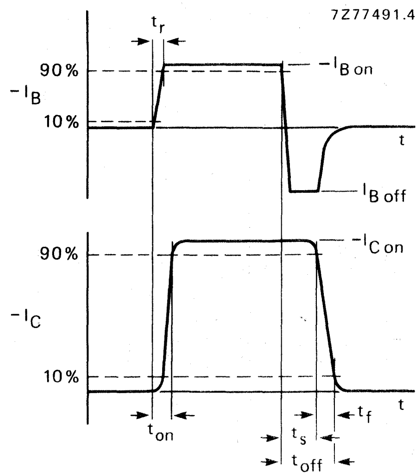
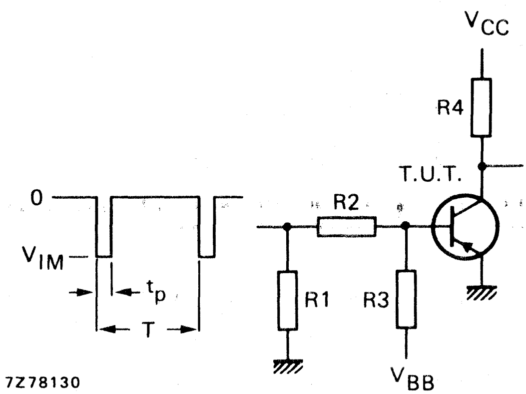


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	10 V
$-V_{CC}$	=	10 V
V_{BB}	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

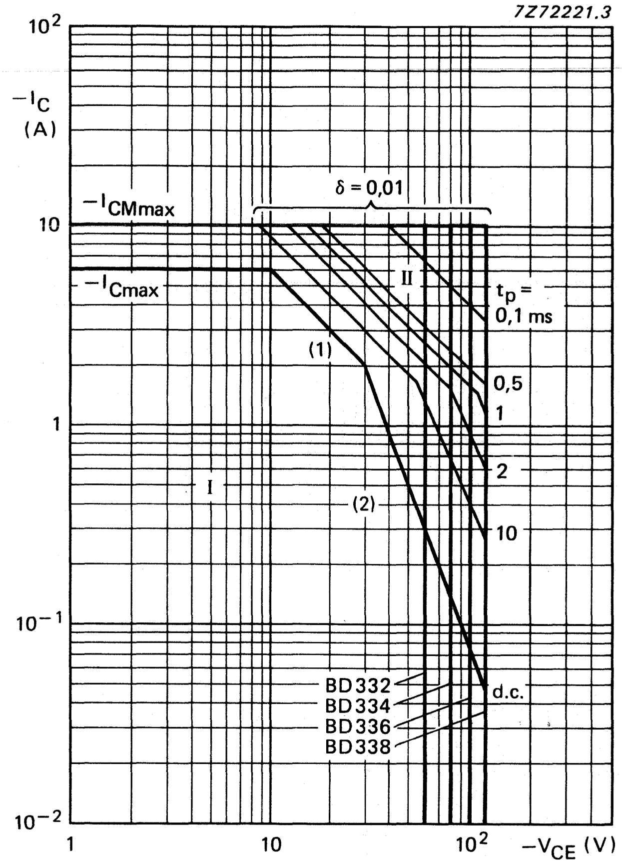


Fig. 5 Safe Operating Area with the transistor forward biased; T_{mb} = 25 °C.

I Region of permissible d.c. operation
II Permissible extension for repetitive pulse operation

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second breakdown limits.

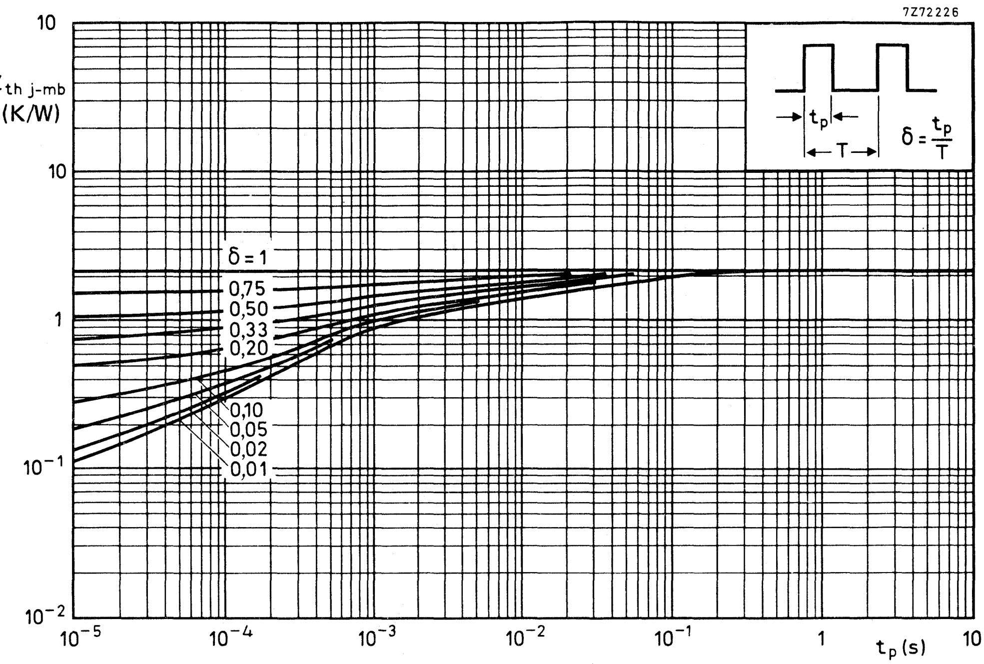


Fig. 6 Pulse power rating chart.

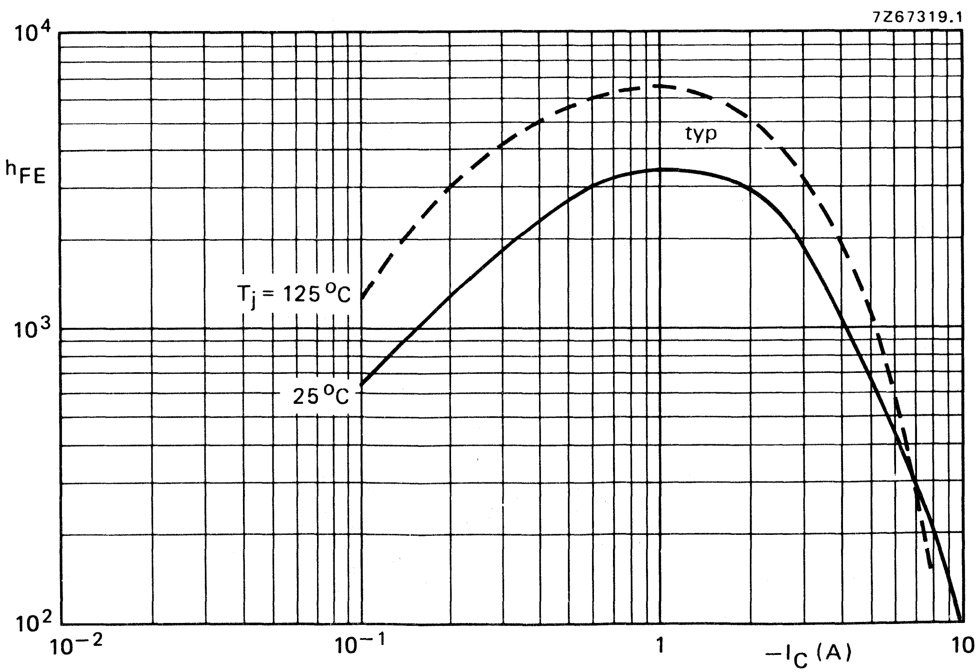


Fig. 7 D.C. current gain at $-V_{CE}$ = 3 V.

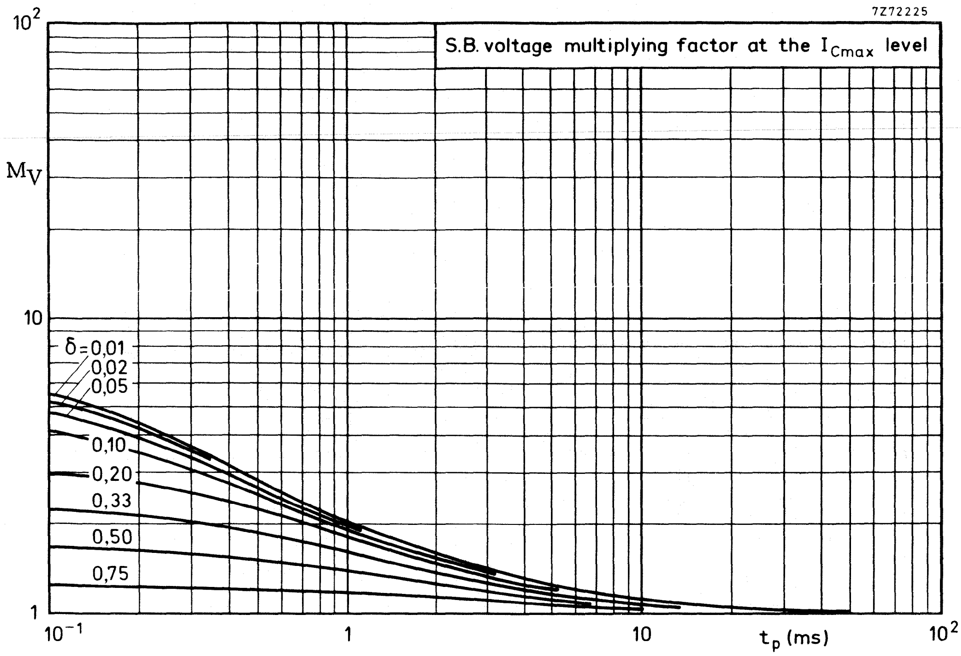


Fig. 8 Second breakdown voltage multiplying factor at the I_{Cmax} level.

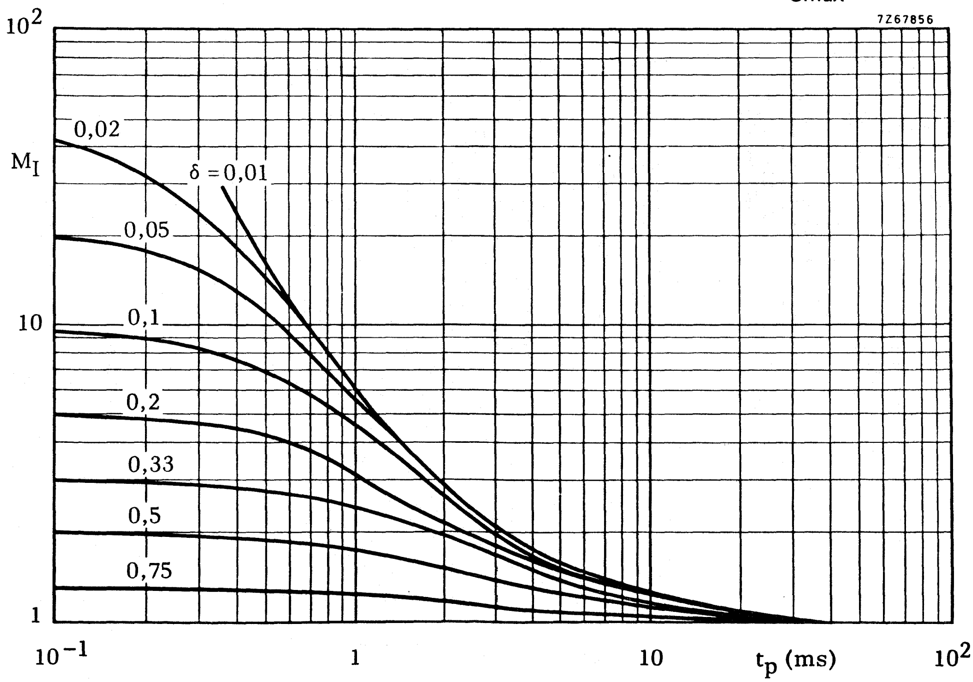


Fig. 9 Second breakdown current multiplying factor at the V_{CEOmax} level.

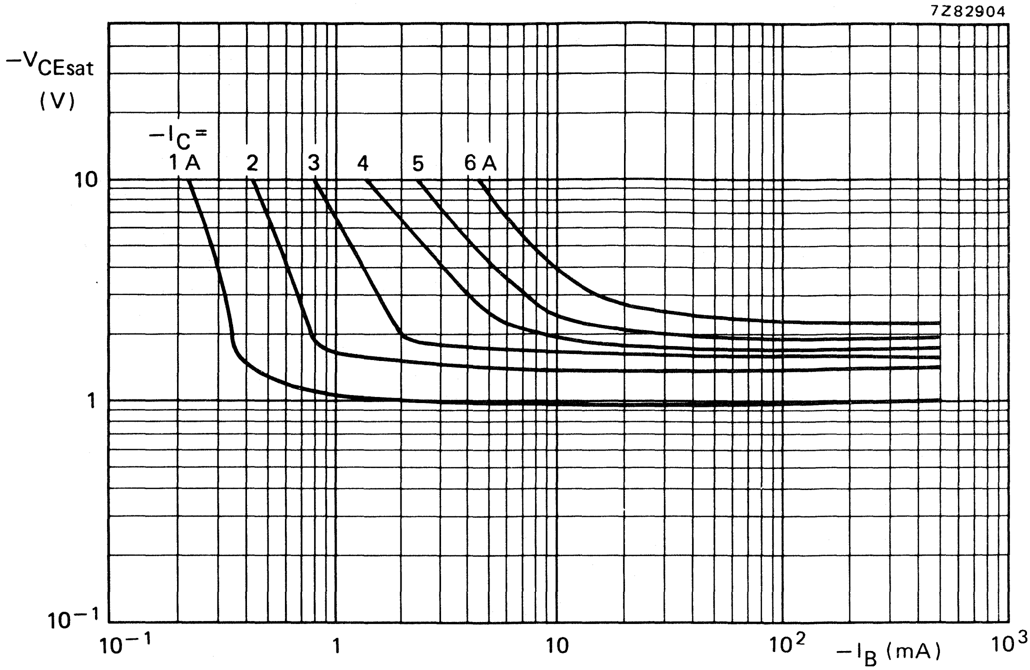


Fig. 10 Typical values collector-emitter saturation voltage. T_j = 25 °C.

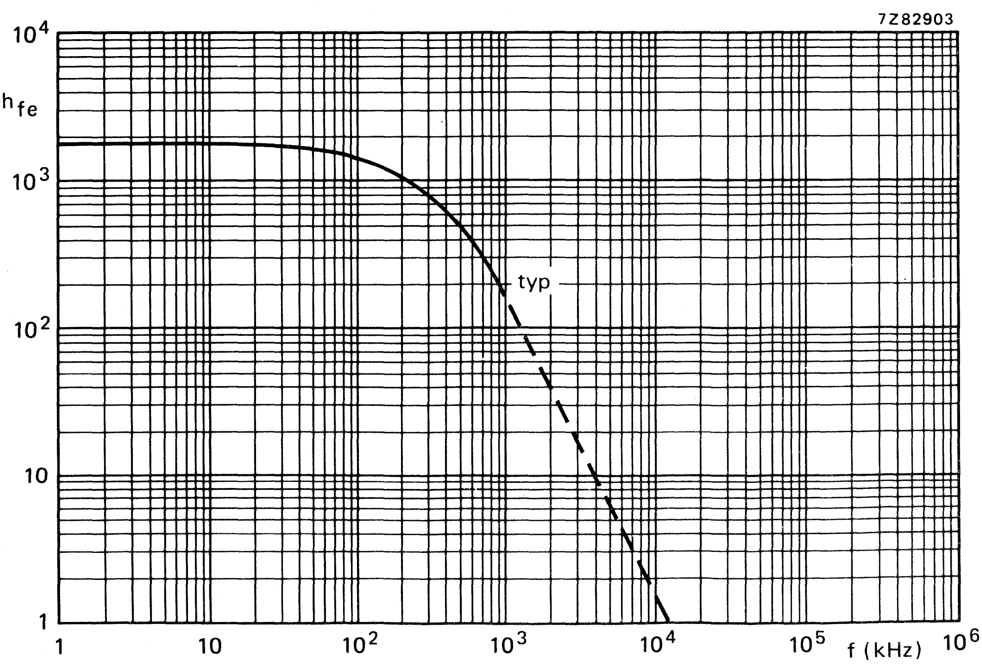


Fig. 11 Small signal current gain. $-I_C$ = 3 A; $-V_{CE}$ = 3 V.

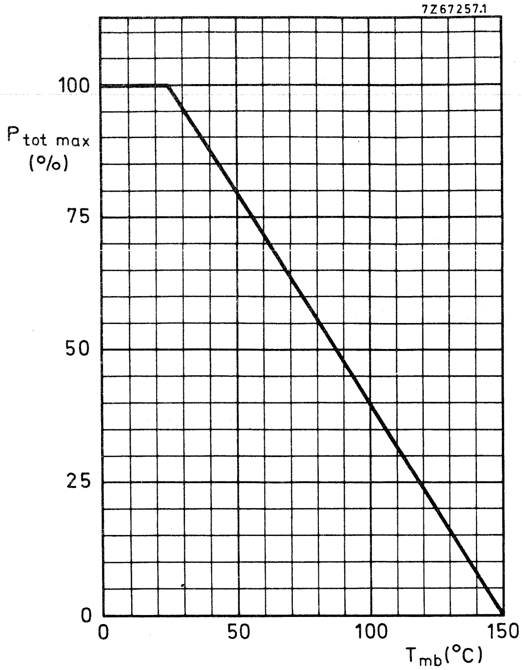


Fig. 12 Power derating curve.

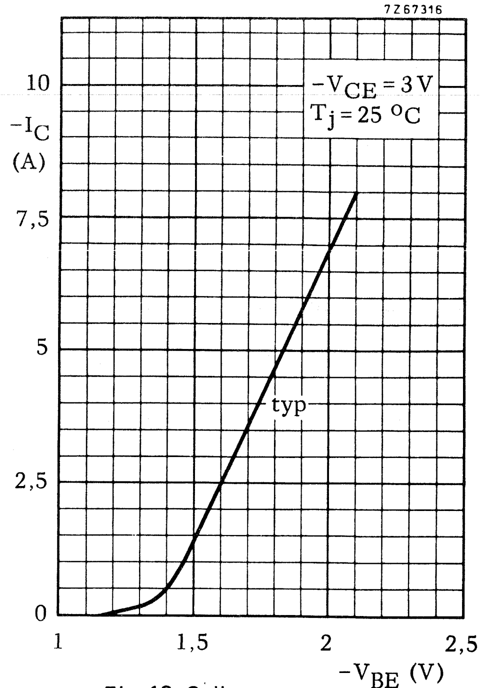


Fig. 13 Collector current.

SILICON EPITAXIAL-BASE TRANSISTORS

N-P-N transistors in a SOT-32 plastic envelope, intended for use in complementary output stages of audio amplifiers up to 15 W.

The complementary pairs are BD433/BD434, BD435/BD436 and BD437/BD438.

QUICK REFERENCE DATA

			BD433	BD435	BD437	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Collector current (peak value)	I_{CM}	max.	7	7	7	A
Collector current (d.c.)	I_C	max.	4	4	4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	36	36	36	W
D.C. current gain						
I_C = 2 A; V_{CE} = 1 V	h_{FE}	>	50	50	40	
Transition frequency						
I_C = 250 mA; V_{CE} = 1 V	f_T	>	7	7	7	

MECHANICAL DATA

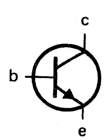
Dimensions in mm

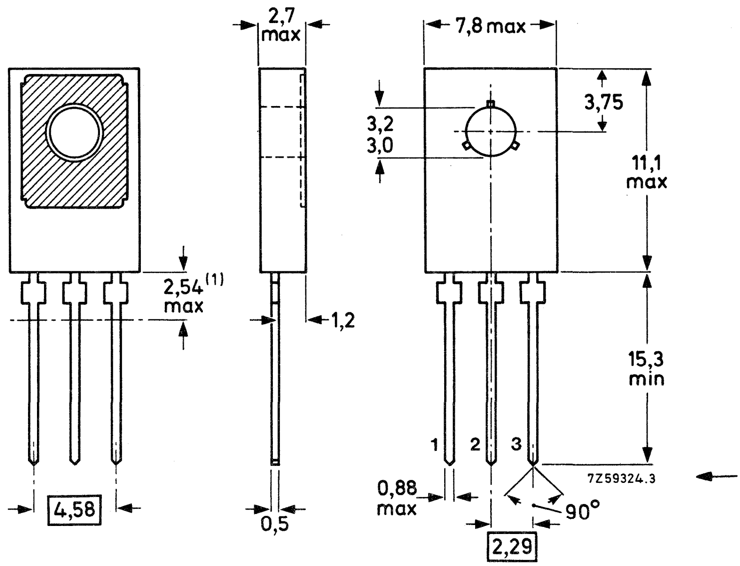
Fig. 1 TO-126 (SOT-32)

Collector connected to metal part of mounting surface

Pinning

1 = emitter
2 = collector
3 = base





[1]) Witin this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD433	BD435	BD437	
Collector-base voltage (open emitter)	V_{CBO}	max.	22	32	45	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V

Collector current (d.c.)	I_C	max.	4	A
Collector current (peak value)	I_{CM}	max.	7	A
Base current (d.c.)	I_B	max.	1	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	36	W
Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	3,5	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	100	K/W

CHARACTERISTICS $T_j = 25$ °C unless otherwise specified

			BD433	BD435	BD437	
Collector cut-off current						
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<		50		μA ←
$I_E = 0$; $V_{CB} = 10$ V; $T_j = 150$ °C	I_{CBO}	<		1		mA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; $T_j = 150$ °C	I_{CBO}	<		1		mA ←
Emitter cut-off current						
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<		0,2		mA ←
Knee voltage						
$I_C = 2$ A; I_B = value for which $I_C = 2,2$ A at $V_{CE} = 1$ V	V_{CEK}	<	0,8	0,8	0,8	V
Base-emitter voltage [1]						
$I_C = 10$ mA; $V_{CE} = 5$ V	V_{BE}	typ.	580	580	580	mV
$I_C = 2$ A; $V_{CE} = 1$ V	V_{BE}	<	1,1	1,1	–	V
$I_C = 3$ A; $V_{CE} = 1$ V	V_{BE}	<	–	–	1,3	V
Collector-emitter saturation voltage						
$I_C = 2$ A; $I_B = 0,2$ A	V_{CEsat}	<	0,5	0,5	–	V
$I_C = 3$ A; $I_B = 0,3$ A	V_{CEsat}	<	–	–	0,7	V
D.C. current gain						
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	25	25	
$I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}	>	85	85	85	
		<	475	475	375	
$I_C = 2$ A; $V_{CE} = 1$ V	h_{FE}	>	50	50	40	
$I_C = 3$ A; $V_{CE} = 1$ V	h_{FE}	>	–	–	30	
Transition frequency at f = 1 MHz						
$I_C = 250$ mA; $V_{CE} = 1$ V	f_T	>		7		MHz
D.C. current gain ratio of the complementary pairs						
$\lvert I_C \rvert = 500$ mA; $\lvert V_{CE} \rvert = 1$ V						
BD433/BD434 and BD435/BD436	h_{FE1}/h_{FE2}	<		1,4		
BD437/BD438	h_{FE1}/h_{FE2}	<		1,8		

[1] V_{BE} decreases by typ. 2,3 mV/K with increasing temperature.

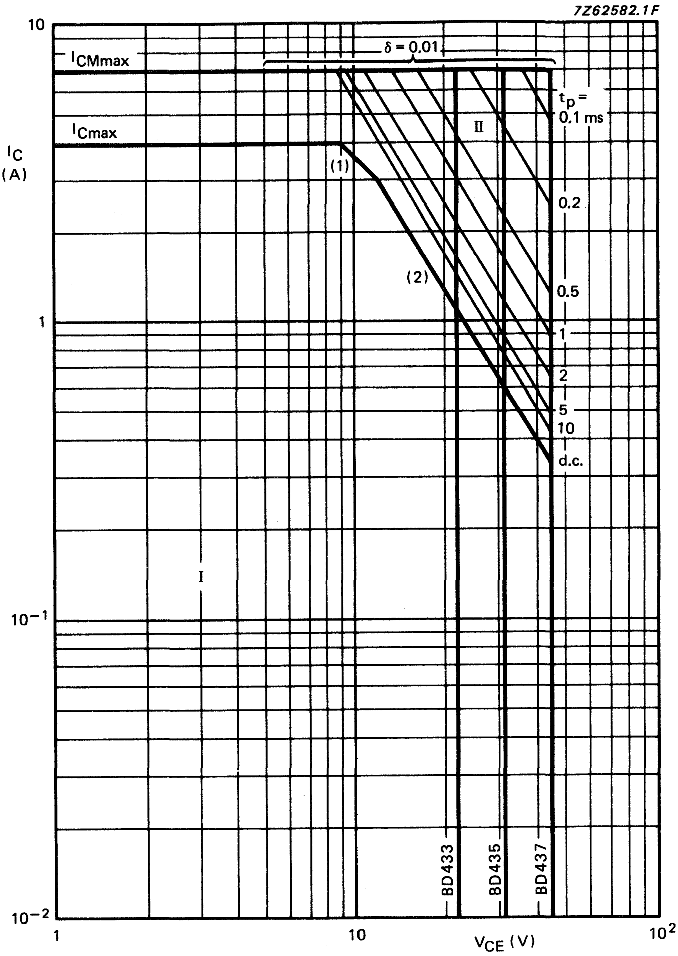


Fig. 2 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second breakdown limits.

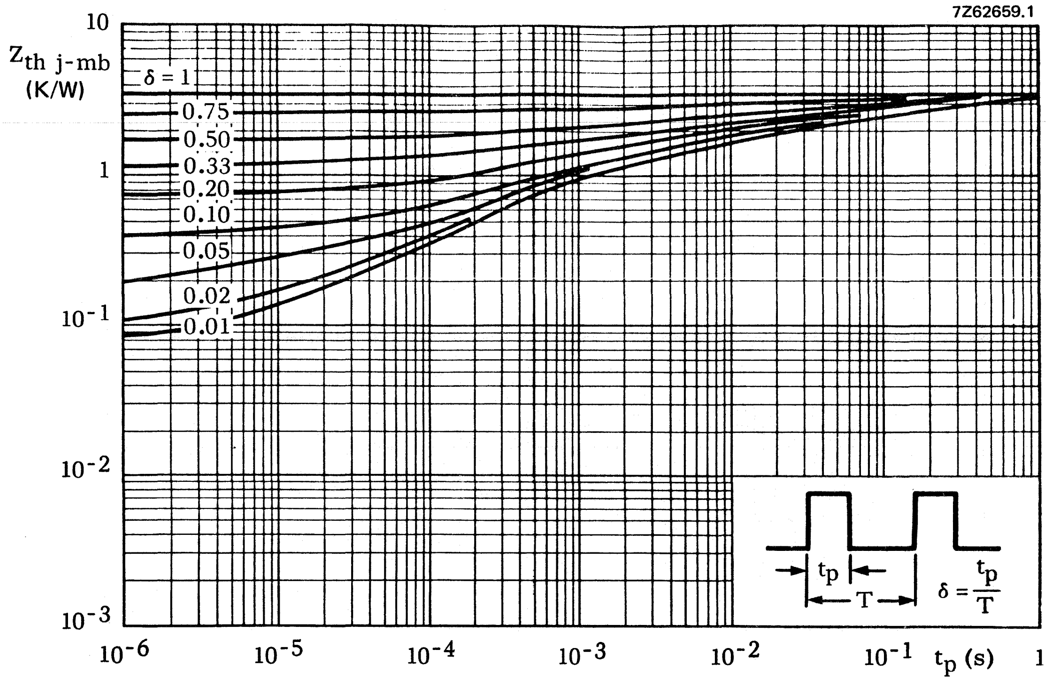

7Z62659.1
$Z_{th\ j\text{-}mb}$ (K/W)
10
1
10^{-1}
10^{-2}
10^{-3}
$\delta = 1$
0.75
0.50
0.33
0.20
0.10
0.05
0.02
0.01
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
t_p (s)
1
t_p
T
$\delta = \frac{t_p}{T}$

Fig. 3

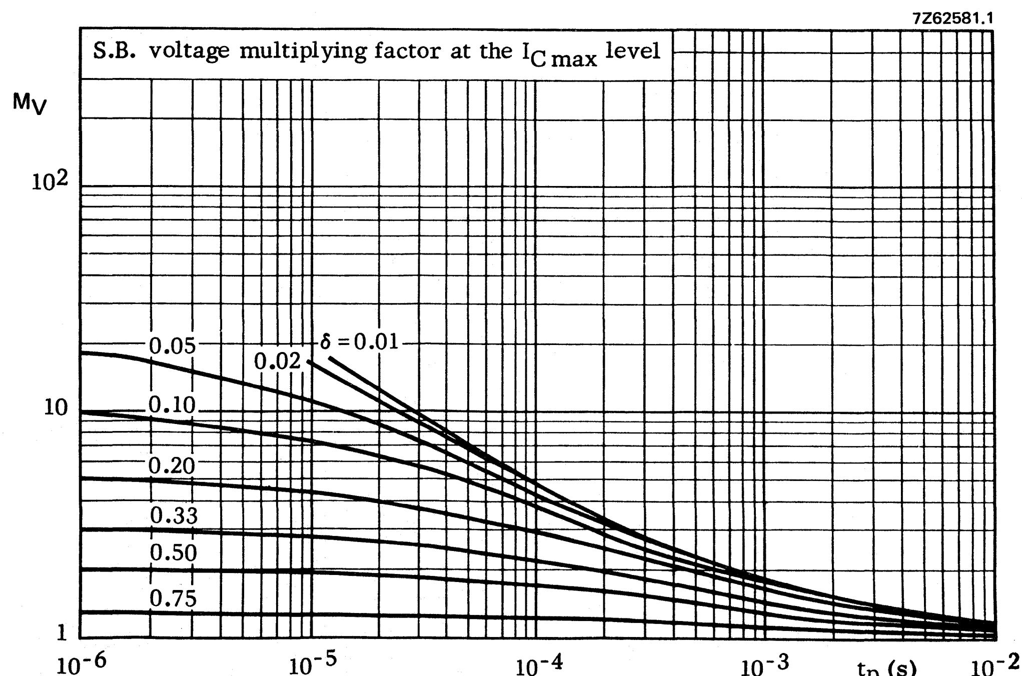

7Z62581.1
S.B. voltage multiplying factor at the $I_{C\,max}$ level
M_V
10^2
10
1
0.05
0.02
$\delta = 0.01$
0.10
0.20
0.33
0.50
0.75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 4

BD433; BD435

7Z62580.1

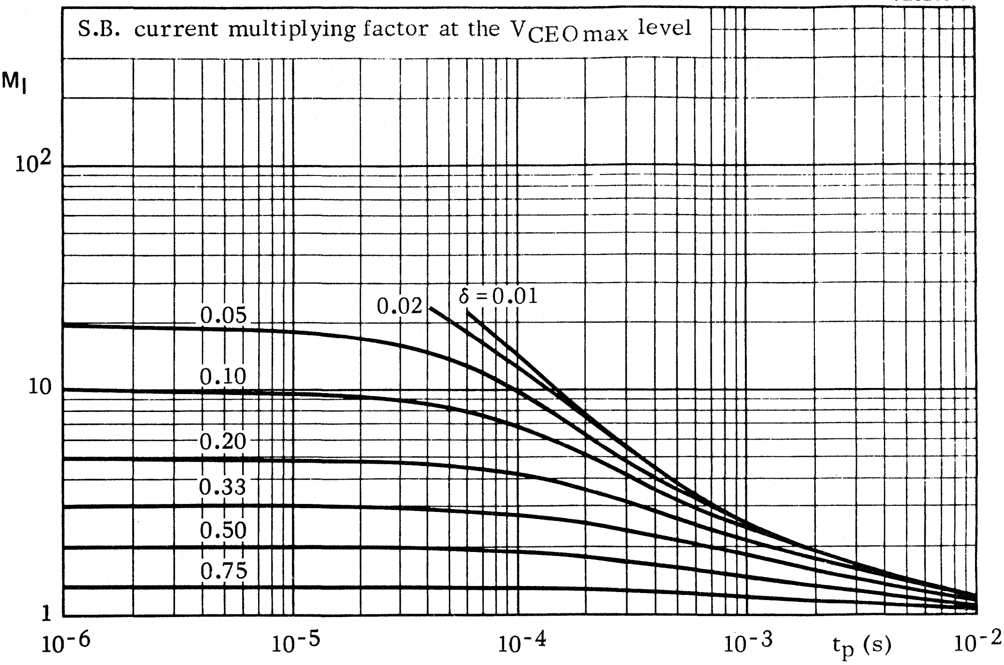


Fig. 5

BD437

7Z62579.1

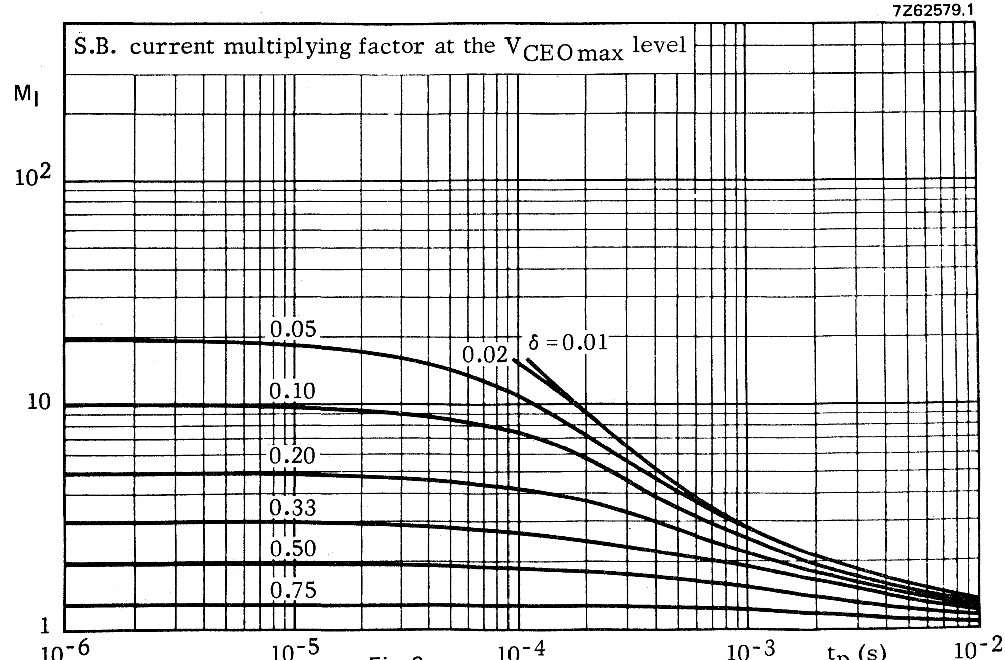


Fig. 6

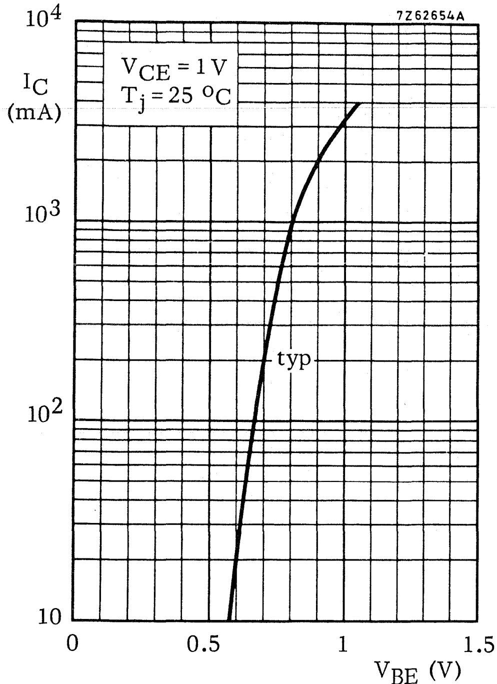


Fig. 7

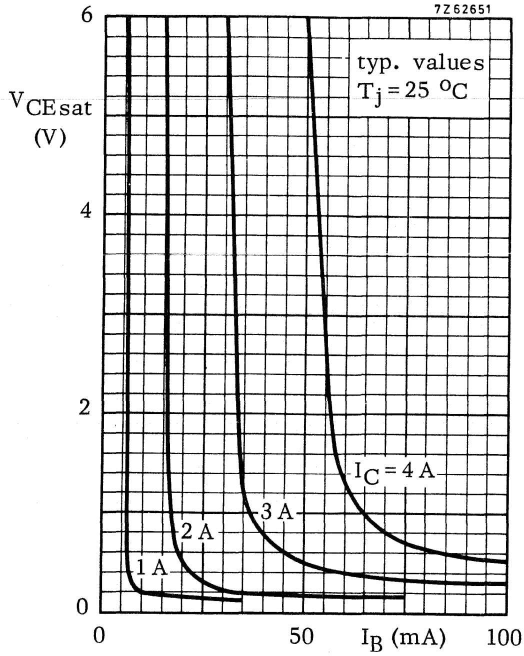


Fig. 8

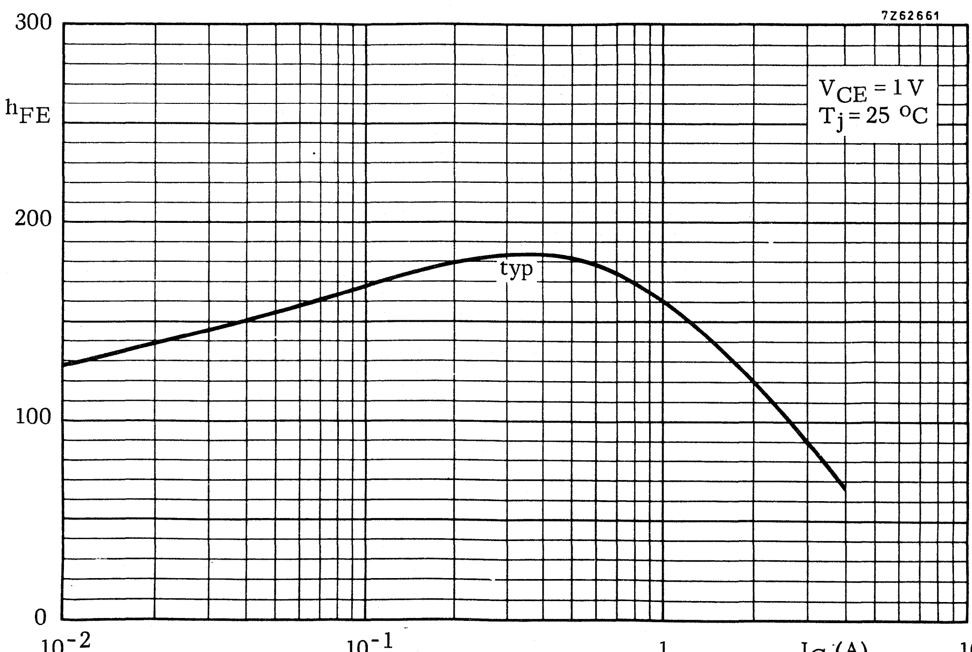


Fig. 9

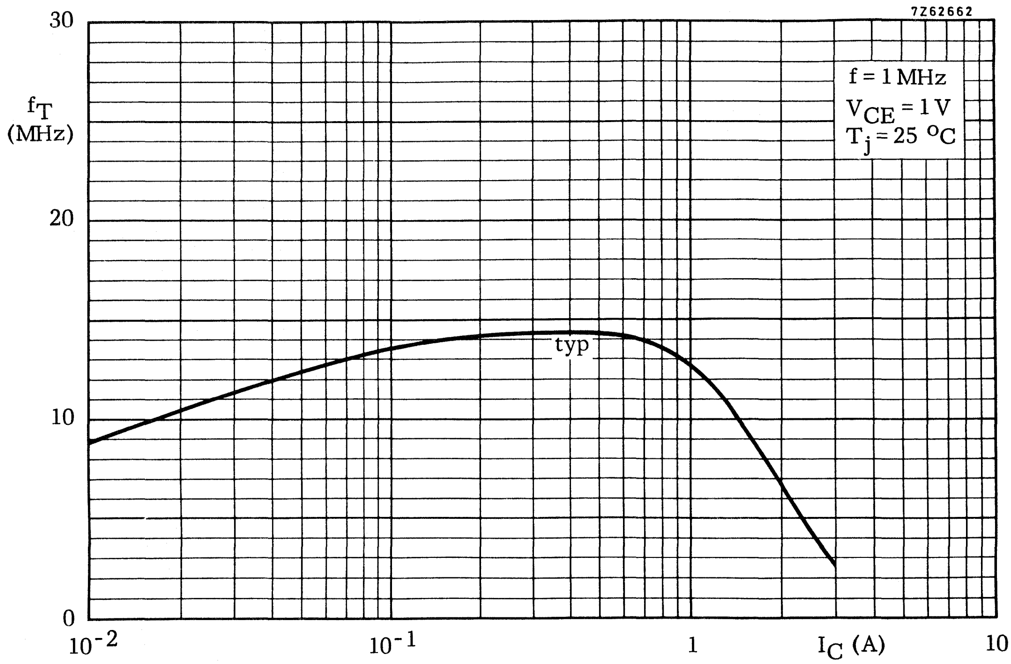

7Z62662
30
20
10
0
f_T
(MHz)
f = 1 MHz
V_{CE} = 1 V
T_j = 25 °C
typ
10^{-2}
10^{-1}
1
I_C (A)
10

Fig. 11

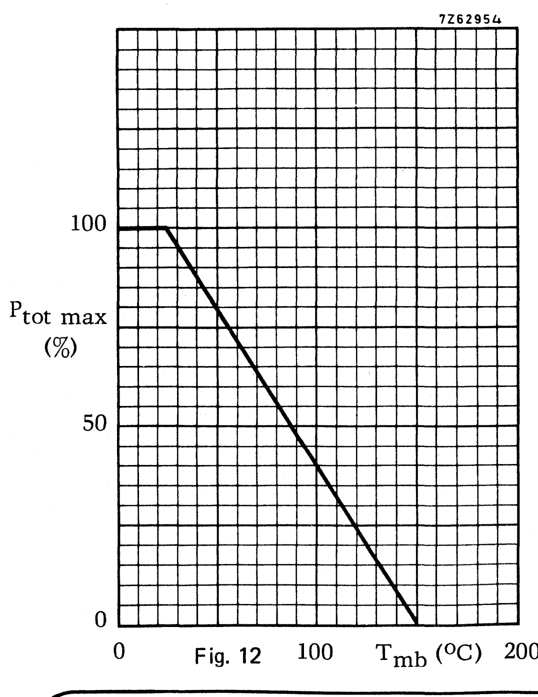

7Z62954
100
$P_{tot\ max}$
(%)
50
0
0
100
T_{mb} (°C)
200

Fig. 12

SILICON EPITAXIAL-BASE POWER TRANSISTORS

P-N-P transistors in a SOT-32 plastic envelope, intended for use in complementary output stages of audio amplifiers up to 15 W.
The complementary pairs are BD433/BD434, BD435/BD436 and BD437/BD438.

QIUCK REFERENCE DATA

			BD434	BD436	BD438	
Collector-emitter voltage ($-V_{BE}$ = 0)	$-V_{CES}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Collector current (d.c.)	$-I_C$	max.	4	4	4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	36	36	36	W
D.C. current gain $-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	>	50	50	40	
Transition frequency $-I_C$ = 250 mA; $-V_{CE}$ = 1 V	f_T	>	7	7	7	MHz

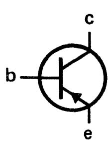
MECHANICAL DATA

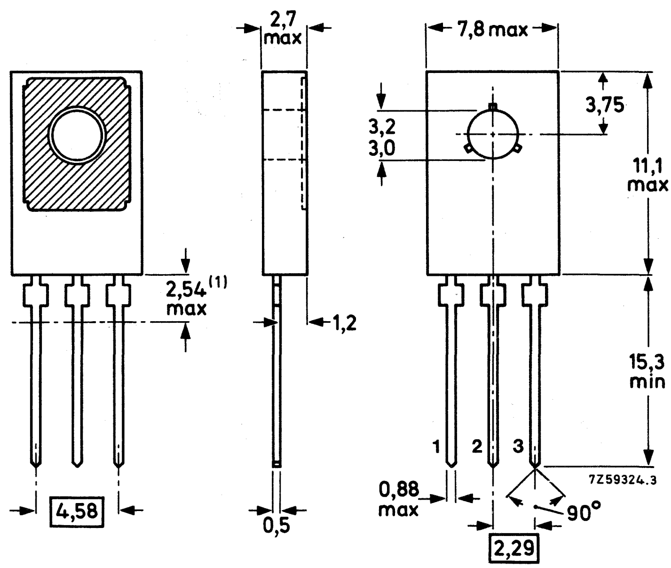
Dimensions in mm

Fig. 1 TO-126 (SOT-32)

Collector connected to metal part of mounting surface

Pinning
1 = emitter
2 = collector
3 = base





See chapters Mounting Instructions and Accessories.

[1]) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD434	BD436	BD438	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	22	32	45	V
Collector-emitter voltage ($-V_{BE} = 0$)	$-V_{CES}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	4	A
Collector current (peak value)	$-I_{CM}$	max.	7	A
Base current (d.c.)	$-I_B$	max.	1	A
Total power dissipation up to $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	36	W
Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3, 5	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD434	BD436	BD438	
Collector cut-off current						
I_E = 0; $-V_{CB}$ = $-V_{CBOmax}$	$-I_{CBO}$	<		50		μA ←
I_E = 0; $-V_{CB}$ = 10 V; T_j = 150 °C	$-I_{CBO}$	<		1		mA
I_E = 0; $-V_{CB}$ = $-V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<		1		mA ←
Emitter cut-off current						
I_C = 0; $-V_{EB}$ = 5 V	$-I_{EBO}$	<		0,2		mA ←
Knee voltage						
$-I_C$ = 2 A; $-I_B$ = value for which $-I_C$ = 2,2 A at $-V_{CE}$ = 1 V	$-V_{CEK}$	<	0,8	0,8	0,8	V
Base-emitter voltage [1]						
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	$-V_{BE}$	typ.	580	580	580	mV
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	1,1	1,1	–	V
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	–	–	1,3	V
Collector-emitter saturation voltage						
$-I_C$ = 2 A; $-I_B$ = 0,2 A	$-V_{CEsat}$	<	0,5	0,5	–	V
$-I_C$ = 3 A; $-I_B$ = 0,3 A	$-V_{CEsat}$	<	–	–	0,7	V
D.C. current gain						
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	>	25	25	25	
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}	>	85	85	85	
		<	475	475	375	
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	>	50	50	40	
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	h_{FE}	>	–	–	30	
Transition frequency at f = 1 MHz						
$-I_C$ = 250 mA; $-V_{CE}$ = 1 V	f_T	>		7		MHz
D.C. current gain ratio of the complementary pairs						
$\|I_C\|$ = 500 mA; $\|V_{CE}\|$ = 1 V						
BD433/BD434 and BD435/BD436	h_{FE1}/h_{FE2}	<		1,4		
BD437/BD438	h_{FE1}/h_{FE2}	<		1,8		

1) $-V_{BE}$ decreases by typ. 2,3 mV/K with increasing temperature.

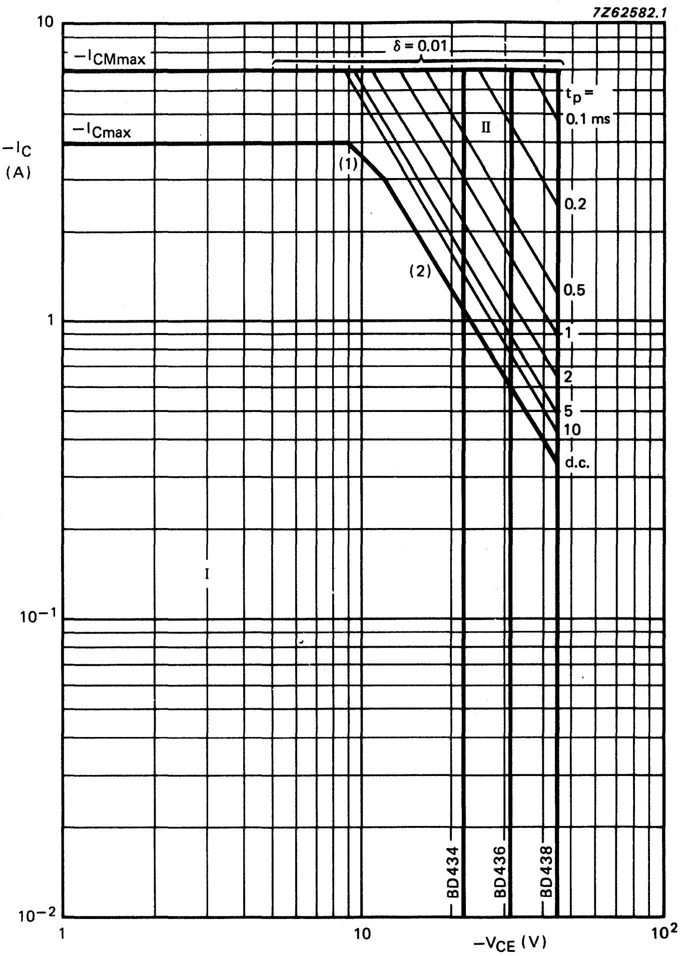


Fig. 2 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second breakdown limits.

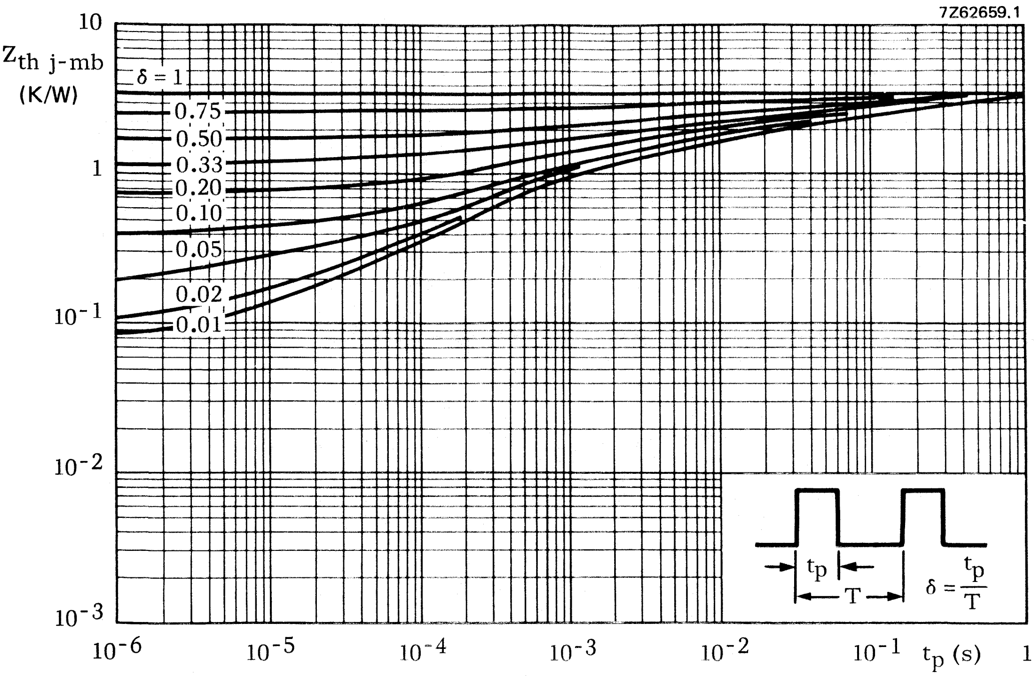

7Z62659.1
10
$Z_{th\ j\text{-}mb}$
(K/W)
δ = 1
0.75
0.50
0.33
0.20
0.10
0.05
0.02
0.01
1
10^{-1}
10^{-2}
10^{-3}
t_p
T
$\delta = \frac{t_p}{T}$
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
t_p (s)
1

Fig 3

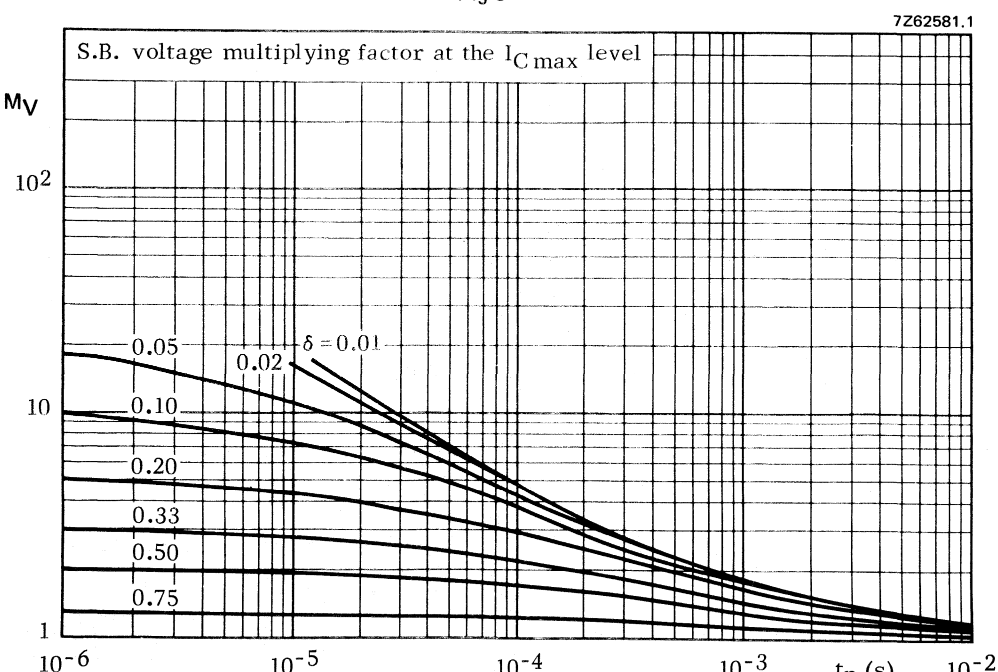

7Z62581.1
S.B. voltage multiplying factor at the $I_{C\,max}$ level
M_V
10^2
10
1
0.05
0.02
δ = 0.01
0.10
0.20
0.33
0.50
0.75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig 4

BD434; BD436
7Z62580.1

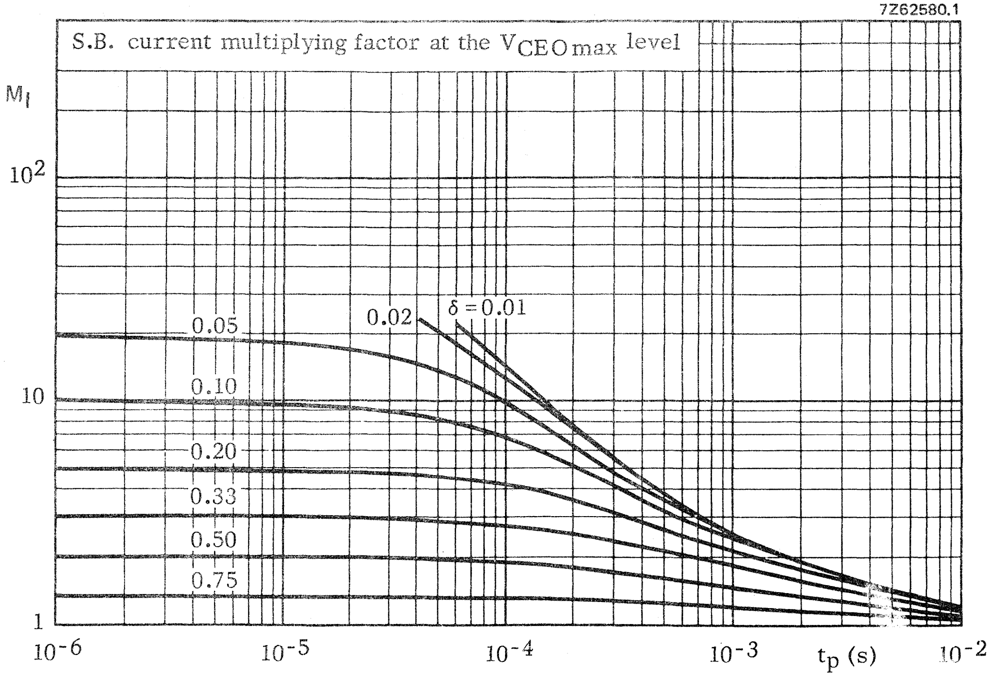


Fig 5

BD438
7Z62579.1

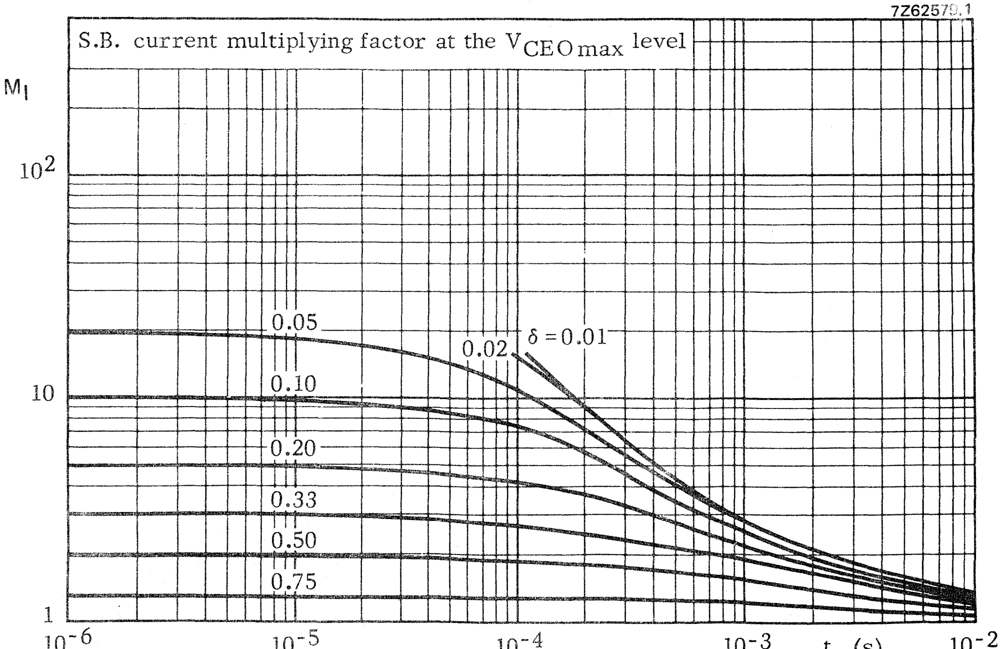


Fig 6

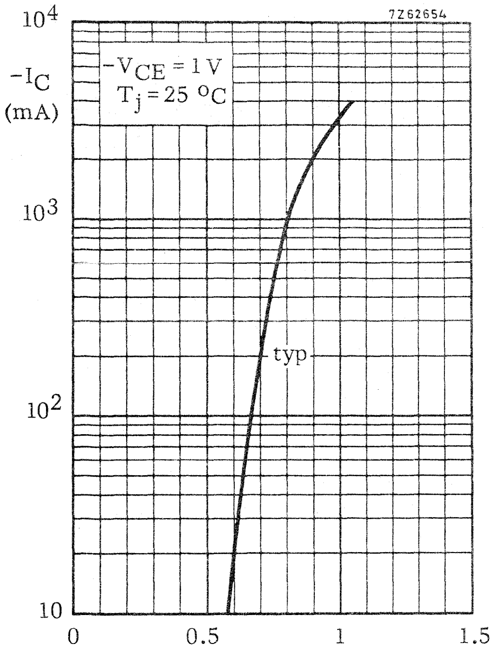


Fig 7

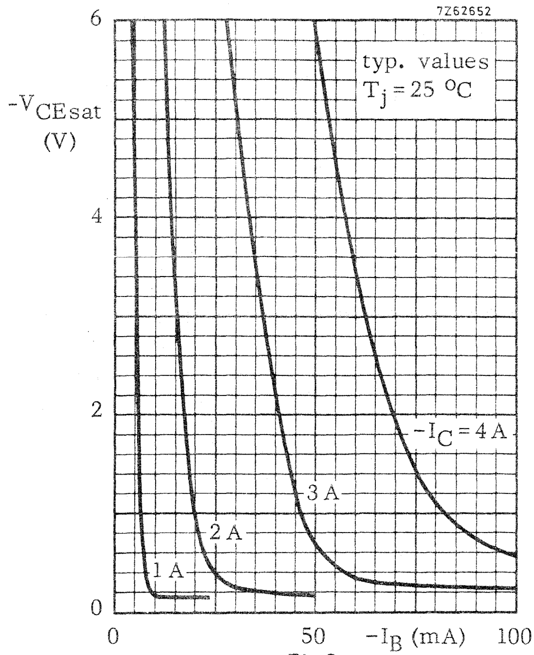


Fig 8

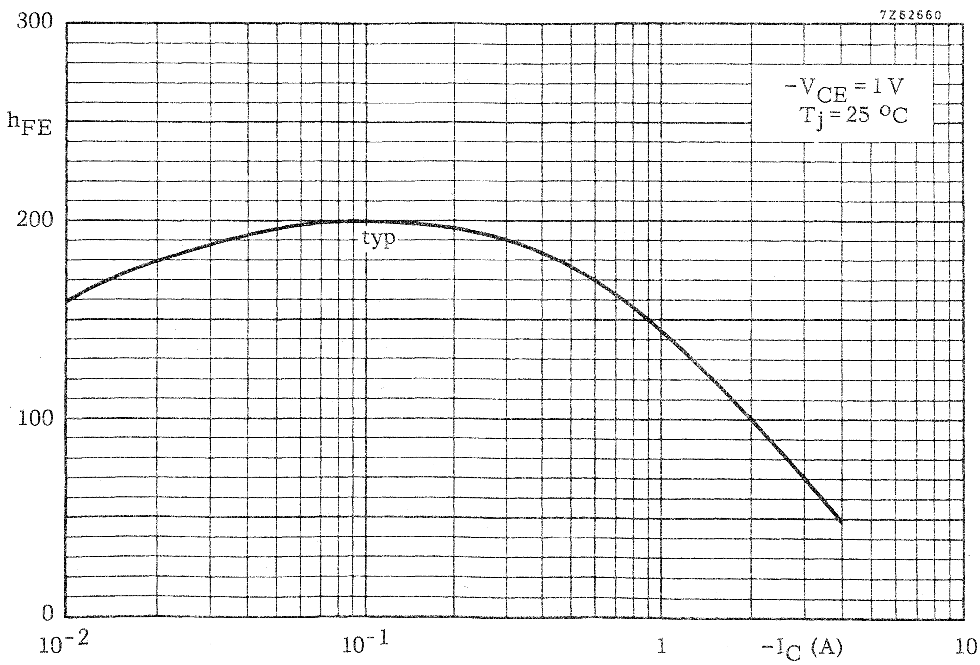


Fig 9

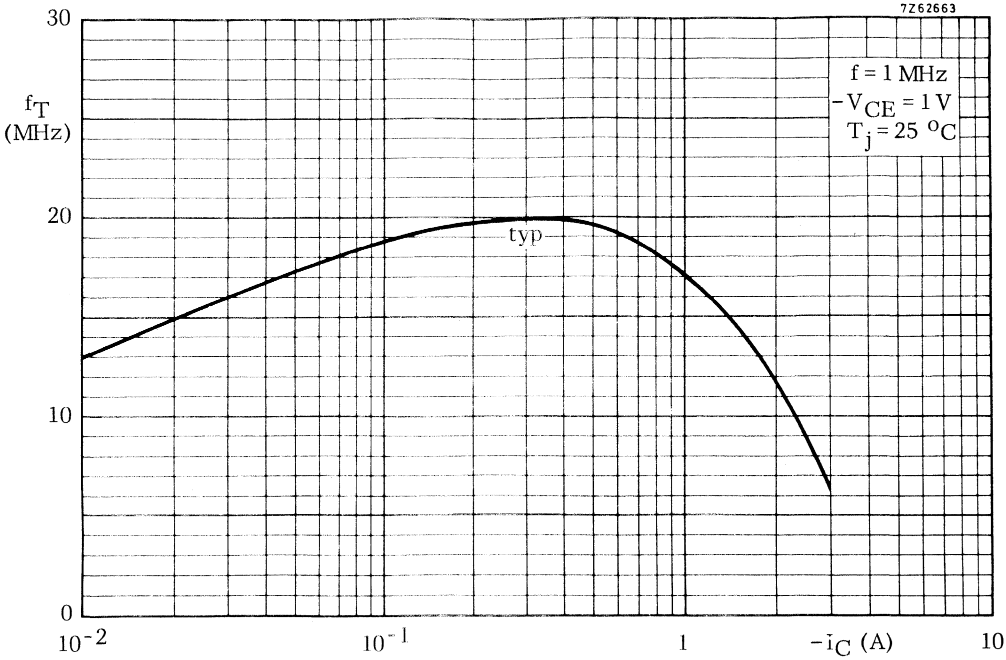

7Z62663
30
20
10
0
f_T
(MHz)
f = 1 MHz
$-V_{CE}$ = 1 V
T_j = 25 °C
typ
10^{-2}
10^{-1}
1
$-I_C$ (A)
10

Fig 10

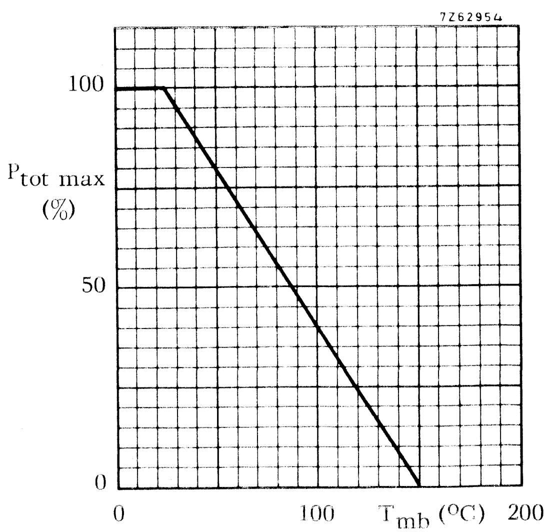

7Z62954
100
50
0
$P_{tot\ max}$
(%)
0
100
T_{mb} (°C)
200

Fig 11

SILICON DARLINGTON POWER TRANSISTORS

NPN epitaxial-base transistors in a monolithic Darlington circuit and housed in a TO-220 envelope. They are intended for output stages in audio equipment, general amplifiers, and analogue switching applications.

PNP complements are BD644, BD646, BD648, BD650 and BD652.

QUICK REFERENCE DATA

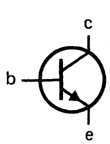
			BD643	645	647	649	651	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V
Collector current DC	I_C	max.			8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			62.5			W
Junction temperature	T_j	max.			150			°C
DC current gain I_C = 3 A; V_{CE} = 3 V	h_{FE}	min.	–	750	750	750	750	
I_C = 4 A; V_{CE} = 3 V		min.	750	–	–	–	–	

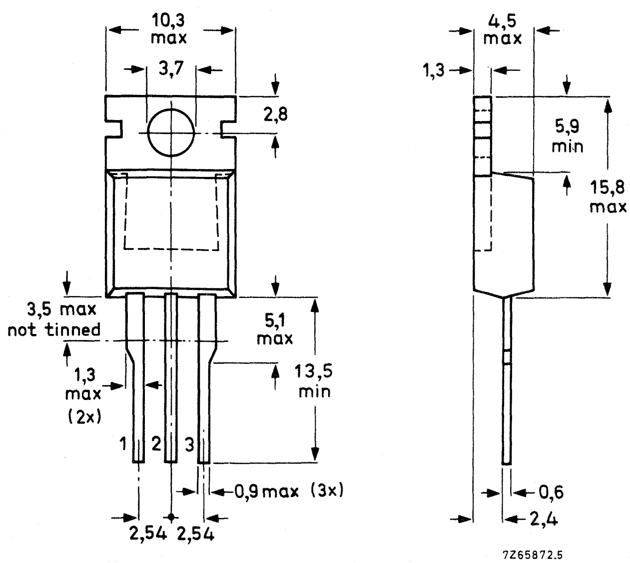
MECHANICAL DATA

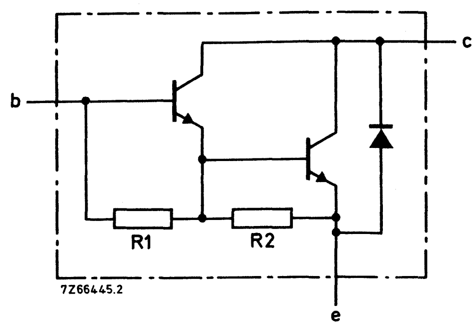
Dimensions in mm

Fig. 1 TO-220AB.

Pinning
1 = Base
2 = Collector
3 = Emitter







R1 typ. 4 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD643	645	647	649	651	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.			5			V
Collector current								
DC	I_C	max.			8			A
peak value	I_{CM}	max.			12			A
Base current (DC)	I_B	max.			150			mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			62.5			W
Storage temperature range	T_{stg}				−55 to + 150			°C
Junction temperature	T_j	max.			150			°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\,j\text{-}mb}$	max.	2.0	K/W
From junction to ambient in free air	$R_{th\,j\text{-}a}$	max.	70	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents								
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	max.			0.1			mA
$I_E = 0$; $V_{CB} = ½ V_{CBOmax}$; T_j = 150 °C	I_{CBO}	max.			1			mA
$I_E = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	max.			0.2			mA
Emitter cut-off current								
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	max.			5			mA
			BD643	645	647	649	651	
DC current gain (see note 1)								
I_C = 0.5 A; V_{CE} = 3 V	h_{FE}	typ.	1900	1900	1900	1900	1900	
I_C = 4 A; V_{CE} = 3 V	h_{FE}	min.	750	–	–	–	–	
I_C = 3 A; V_{CE} = 3 V	h_{FE}	min.	–	750	750	750	750	
I_C = 8 A; V_{CE} = 3 V	h_{FE}	typ.	1800	1800	1800	1800	1800	
Base-emitter voltage (see notes 1 and 2)								
I_C = 4 A; V_{CE} = 3 V	V_{BE}	max.	2.5	–	–	–	–	V
I_C = 3 A; V_{CE} = 3 V	V_{BE}	max.	–	2.5	2.5	2.5	2.5	V
Saturation voltages (1)								
I_C = 4 A; I_B = 16 mA	V_{CEsat}	max.	2	–	–	–	–	V
I_C = 3 A; I_B = 12 mA	V_{CEsat}	max.	–	2	2	2	2	V
I_C = 5 A; I_B = 50 mA	V_{CEsat}	max.	2.5	2.5	2.5	2.5	2.5	V
I_C = 5 A; I_B = 50 mA	V_{BEsat}	max.	3	3	3	3	3	V
Small signal current gain								
I_C = 4 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	min.	10	–	–	–	–	
I_C = 3 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	min.	–	10	10	10	10	
Cut-off frequency								
I_C = 4 A; V_{CE} = 3 V	f_{hfe}	typ.	50	–	–	–	–	
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	–	50	50	50	50	kHz
Second-breakdown collector current t_p = 0.1 s; non-repetitive, without heatsink								
V_{CE} = 50 V	$I_{(SB)}$	min.	1.25	–	–	–	–	A
V_{CE} = 60 V	$I_{(SB)}$	min.	–	1.04	1.04	1.04	1.04	A
DC current gain ratio of matched pairs at V_{CE} = 3 V								
I_C = 4 A BD643/BD644	h_{FE1}/h_{FE2}	max.	2.5	–	–	–	–	
I_C = 3 A BD645/BD646	h_{FE1}/h_{FE2}	max.	–	2.5	2.5	2.5	2.5	
Diode forward voltage								
I_F = 3 A	V_F	typ.			0.9			V
Collector capacitance at f = 1 MHz								
V_{CB} = 10 V	C_c	typ.			75			pF
Turn-off breakdown energy with inductive load; I_C = 4.5 A (see Fig. 3)	$E_{(BR)}$	min.			50			mJ

(1) Measured under pulse conditions: t_p = 300 μs, $\delta \leqslant 2\%$.
(2) V_{BE} decreases by about 3.8 mV/K with increasing temperature.

Switching times (see Figs 4 and 5)

I_C = 3 A; $I_{Bon} = -I_{Boff}$ = 12 mA

turn-on time	t_{on}	typ.	1.0 μs
		max.	2.0 μs
turn-off time	t_{off}	typ.	5.0 μs
		max.	10 μs

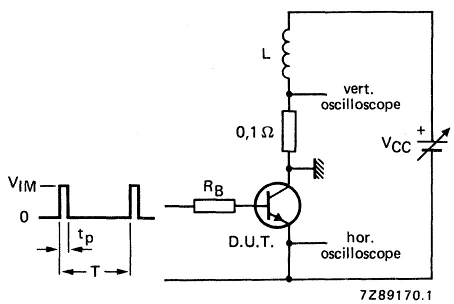


Fig. 3 Test circuit for turn-off breakdown energy; V_{IM} = 12 V; R_B = 270; I_C = 4.5 A; t_p = 1 ms; δ = 1%.

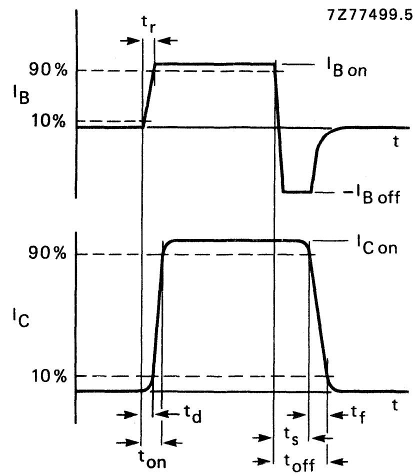
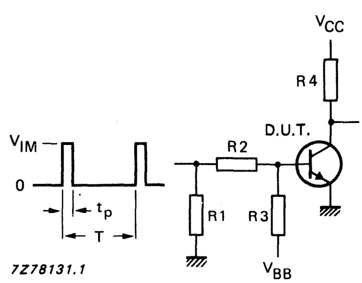


Fig. 4 Switching times waveforms.



V_{CC}	=	10 V
V_{IM}	=	10 V
$-V_{BB}$	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 5 Switching times test circuit.

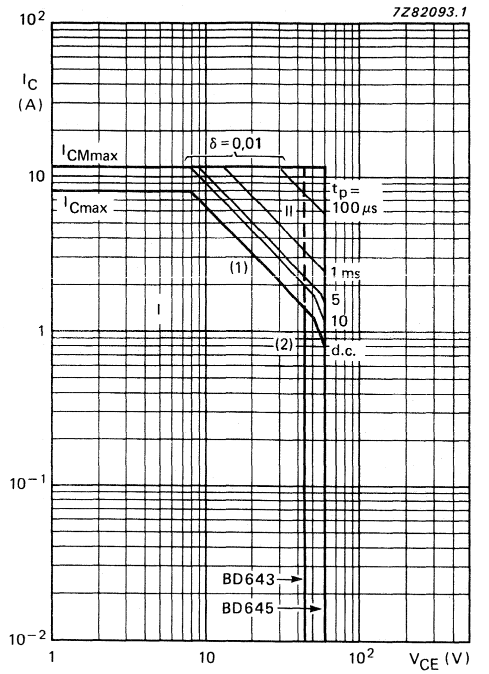


Fig. 6 **BD643; BD645** Safe Operating ARea, T_{mb} = 25 °C.

I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

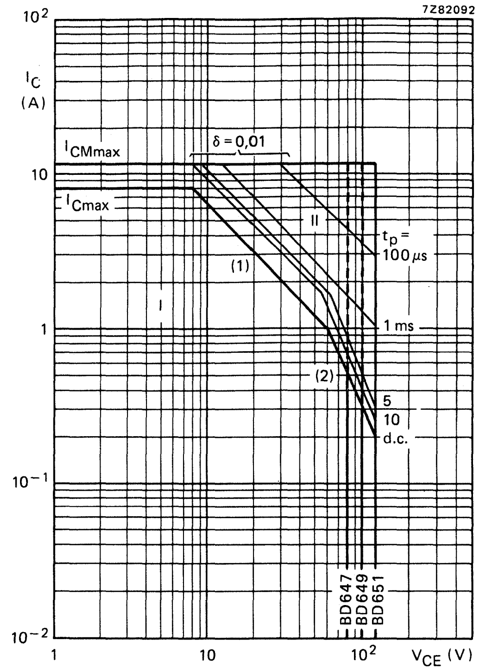


Fig. 7 **BD647, BD649, BD651** Safe Operating ARea, T_{mb} = 25 °C.

I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

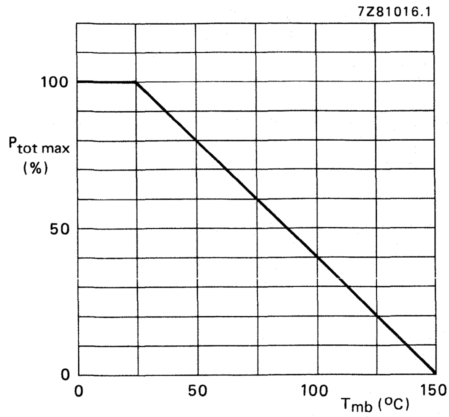


Fig. 8 Power derating curve.

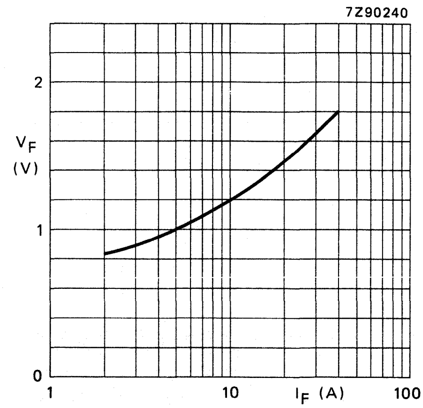


Fig. 9 Diode forward voltage versus forward current; T_j = 25 °C; typical values.

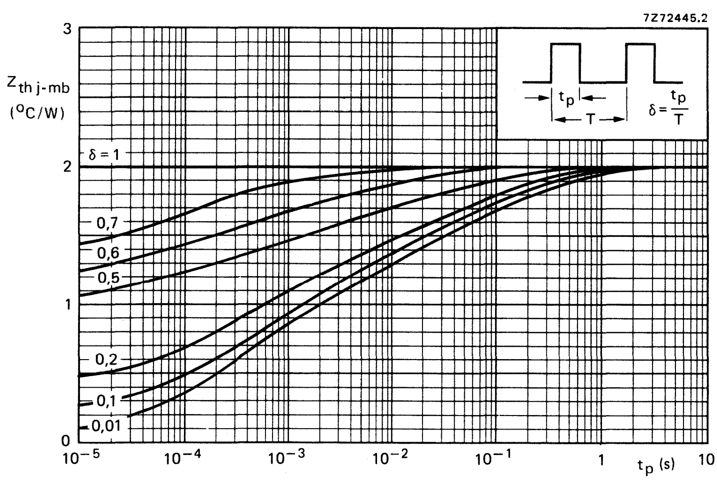


Fig. 10 Pulse power rating chart.

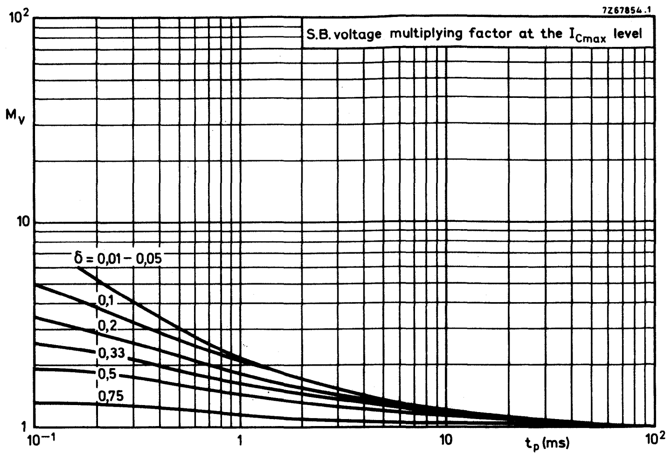


Fig. 11 Second breakdown voltage multiplying factor at the $I_{C\,max}$ level.

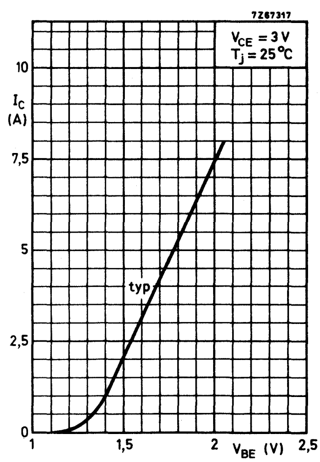


Fig. 12 Collector current as a function of base-emitter voltage; V_{CE} = 3 V; T_j = 25 °C; typical values.

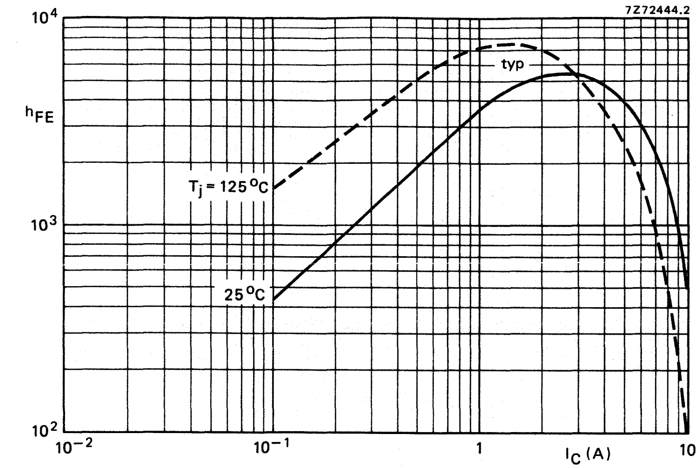


Fig. 13 DC current gain; $V_{CE} = 3$ V; typical values.

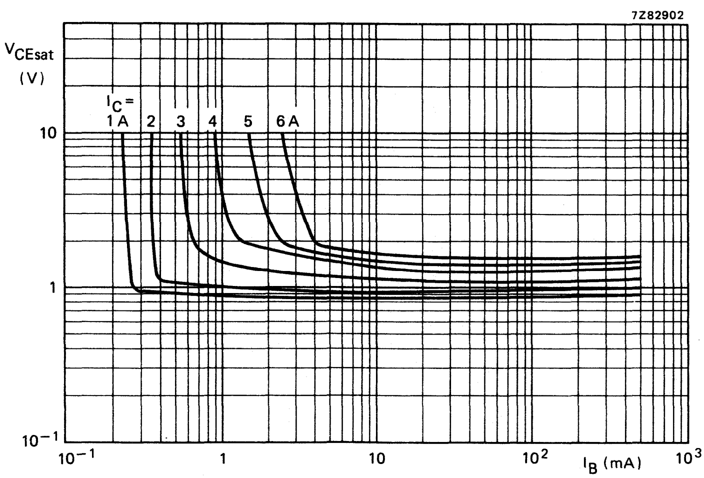


Fig. 14 Collector-emitter saturation voltage; $T_j = 25\ ^oC$; typical values.

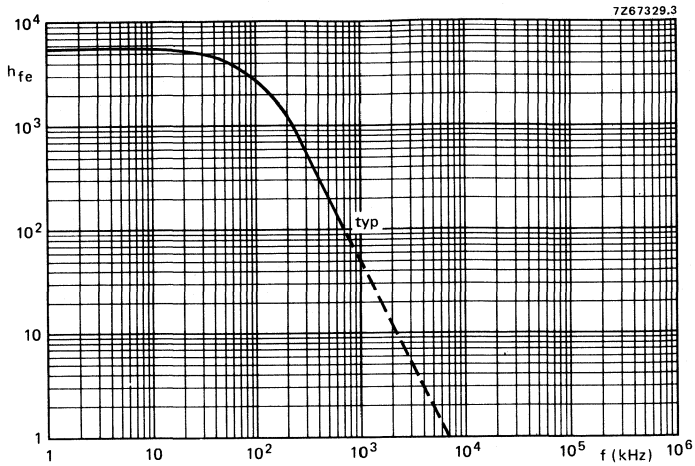


Fig. 15 Small signal current gain; I_C = 3 A; V_{CE} = 3 V; typical values.

SILICON DARLINGTON POWER TRANSISTORS

NPN silicon Darlington transistors in a SOT186 envelope with an electrically insulated mounting base. PNP complements are BD644F, BD646F, BD648F, BD650F and BD652F.

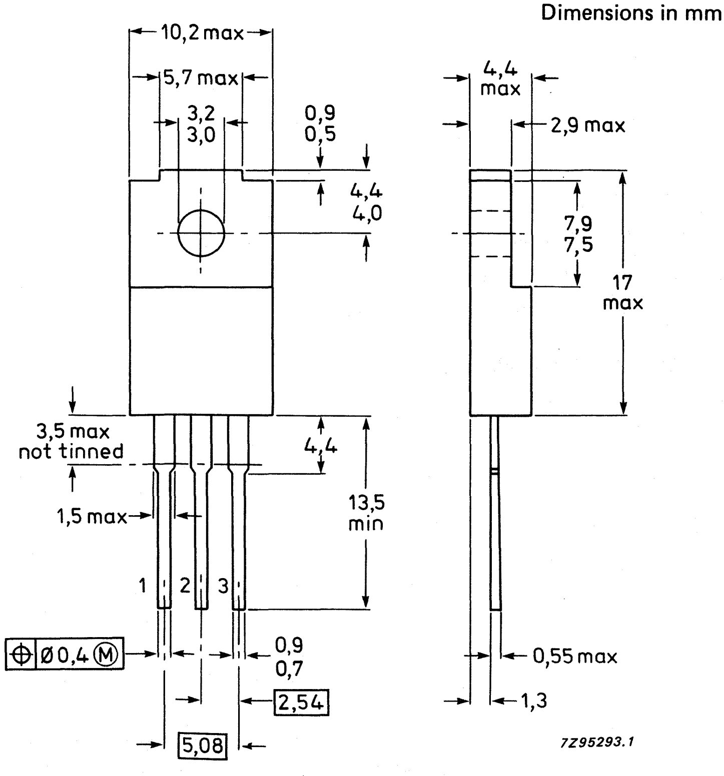
QUICK REFERENCE DATA

			BD643F	645F	647F	649F	651F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V
Collector current (DC)	I_C	max.			8			A
Total power dissipation at $T_h \leq 25$ °C	P_{tot}	max.			20			W
Junction temperature	T_j	max.			150			°C

MECHANICAL DATA

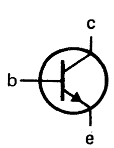
Dimensions in mm

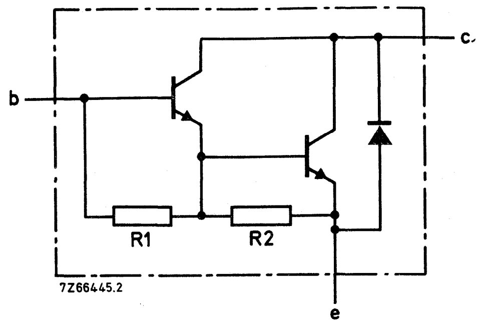
Fig. 1 SOT186.



Pinning

1 = emitter
2 = collector
3 = base





R1 typ. 4 kΩ
R2 typ. 100 kΩ

Fig. 2 Darlington circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD643F	645F	647F	649F	651F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.			5			V
Collector current (DC)	I_C	max.			8			A
(peak value)	I_{CM}	max.			12			A
Base current (DC)	I_B	max.			150			mA
Total power dissipation at $T_h \leqslant 25\ ^oC$ (note 1)	P_{tot}	max.			20			W
at $T_h \leqslant 25\ ^oC$ (note 2)	P_{tot}	max.			32			W
Storage temperature range	T_{stg}				−65 to + 150			^oC
Junction temperature	T_j	max.			150			^oC

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\text{-}jmb}$	=	1.6	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.3	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W

INSULATION

Voltage allowed between all terminals and external heatsink (peak value)	V_{insul}	max.	1000	V
Isolation capacitance from collector to external heatsink	C_{th}	max.	12	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

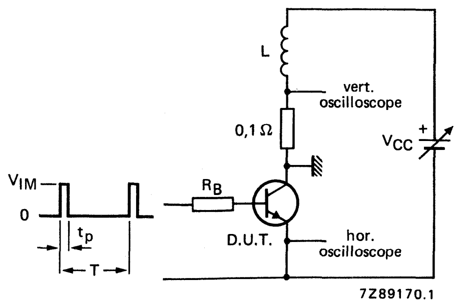
Collector cut-off currents				
$I_E = 0$; $V_{CB} = V_{CEO}max$	I_{CBO}	max.	0.1	mA
$I_E = 0$; $V_{CB} = 1/2\ V_{CBO}max$; $T_j = 150$ °C	I_{CBO}	max.	1	mA
$I_B = 0$; $V_{CE} = 1/2\ V_{CEO}max$	I_{CEO}	max.	0.2	mA
Emitter cut-off current				
$V_{BE} = 5$ V; $I_C = 0$	I_{EBO}	max.	5	mA

			BD643F	645F	647F	649F	651F	
Static forward current transfer ratio (note 1)								
$I_C = 0.5$ A; $V_{CE} = 3$ V	h_{FE}	typ.	1900	1900	1900	1900	1900	
$I_C = 4$ A; $V_{CE} = 3$ V	h_{FE}	min.	750	—	—	—	—	
$I_C = 3$ A; $V_{CE} = 3$ V	h_{FE}	min.	—	750	750	750	750	
$I_C = 8$ A; $V_{CE} = 3$ V	h_{FE}	typ.	1800	1800	1800	1800	1800	
Collector-emitter saturation voltage (note 1)								
$I_C = 4$ A; $I_B = 16$ mA	V_{CEsat}	max.	2	—	—	—	—	V
$I_C = 3$ A; $I_B = 12$ mA	V_{CEsat}	max.	—	2	2	2	2	V
$I_C = 5$ A; $I_B = 50$ mA	V_{CEsat}	max.	2.5	2.5	2.5	2.5	2.5	V
Base-emitter saturation voltage (note 1)								
$I_C = 5$ A; $I_B = 50$ mA	V_{BEsat}	max.	3	3	3	3	3	V
Base-emitter voltage (note 1)								
$I_C = 4$ A; $V_{CE} = 3$ V	V_{BE}	max.	2.5	—	—	—	—	V
$I_C = 3$ A; $V_{CE} = 3$ V	V_{BE}	max.	—	2.5	2.5	2.5	2.5	V
Common-emitter cut-off frequency								
$I_C = 4$ A; $V_{CE} = 3$ V	f_{hfe}	typ.	50	—	—	—	—	kHz
$I_C = 3$ A; $V_{CE} = 3$ V	f_{hfe}	typ.	—	50	50	50	50	kHz
Small signal current gain								
$I_C = 4$ A; $V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	10	—	—	—	—	
$I_C = 3$ A; $V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	—	10	10	10	10	

Forward bias second breakdown collector current				
$V_{CE} = 50$ V; $t_p = 0.1$ s	$I_{(SB)}$	min.	0.55	A
Forward voltage				
$I_F = 3$ A	V_F	typ.	0.9	V
Switching times				
$I_C = 3$ A; $I_{B\ on} = I_{B\ off} = 12$ mA				
Turn on time	t_{on}	max.	2	μs
		typ.	1	μs
Turn off time	t_{off}	max.	10	μs
		typ.	5	μs

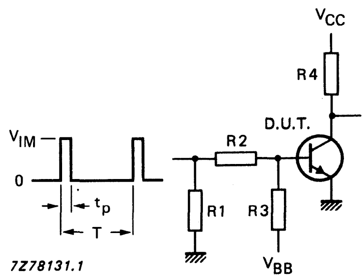
Note

1. To be measured under pulsed conditions, $t_p < 300$ μs; $\delta < 2\%$.



V_{IM} = 12 V
R_B = 270 Ω
L = 5 mH
I_{CC} = 4.5 A
δ = $t_p/T \times 100\%$

Fig. 3 Test circuit for turn-off breakdown energy.



V_{IM}	=	10 V
V_{CC}	=	10 V
$-V_{BB}$	=	4 V
R_1	=	56 Ω
R_2	=	410 Ω
R_3	=	560 Ω
R_4	=	3 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

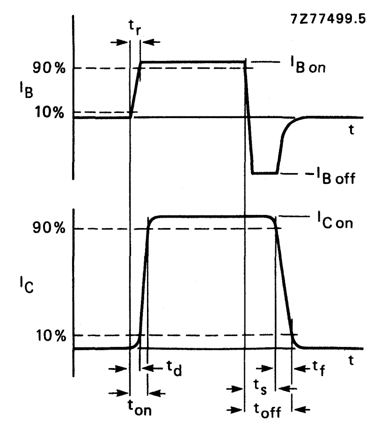
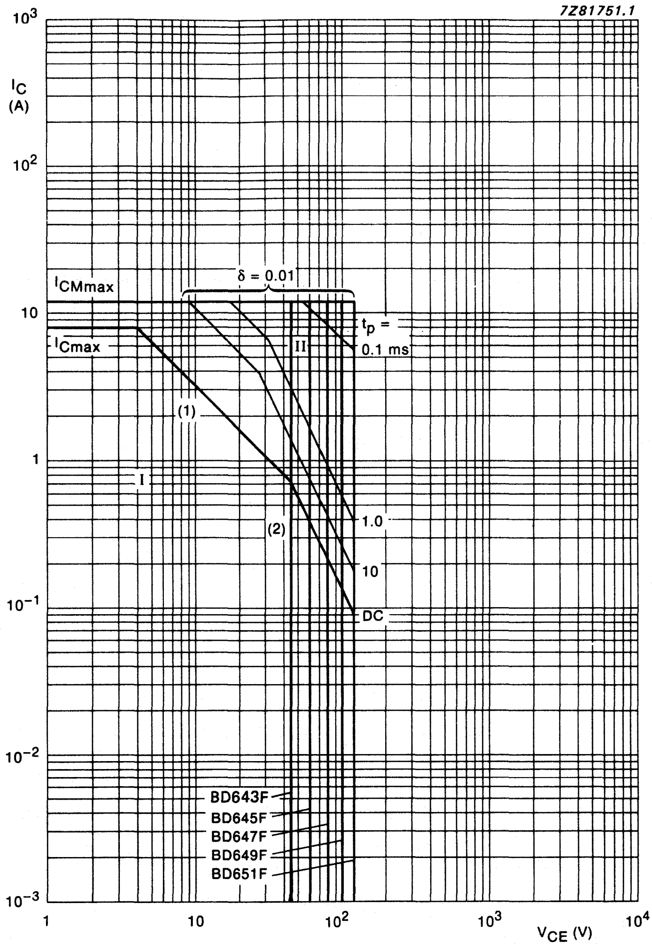


Fig. 5 Switching times waveforms.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and P_{peak} lines.
(2) Second-breakdown limits.

Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

Fig.6 Safe operating area; T_{amb} = 25 °C.

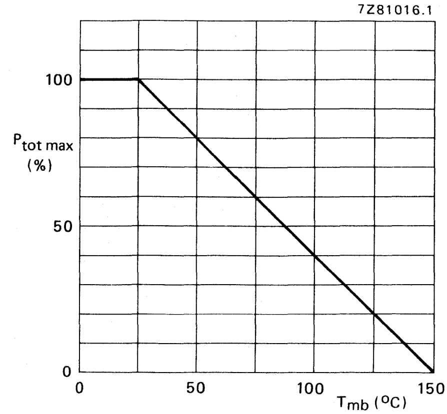


Fig. 7 Power derating curve.

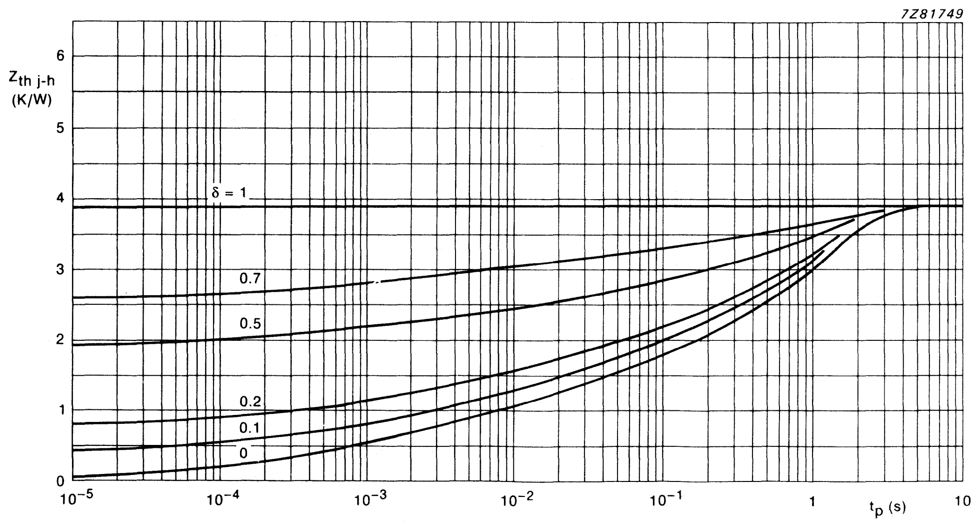


Fig. 8 Pulse power rating chart.

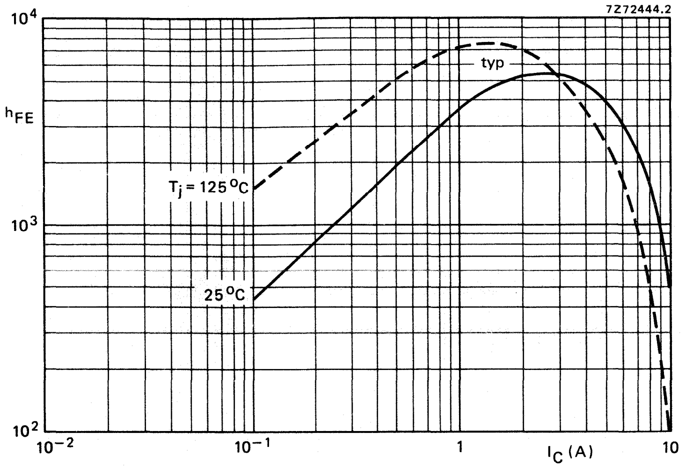


Fig. 9 Typical DC current gain curves; V_{CE} = 3 V.

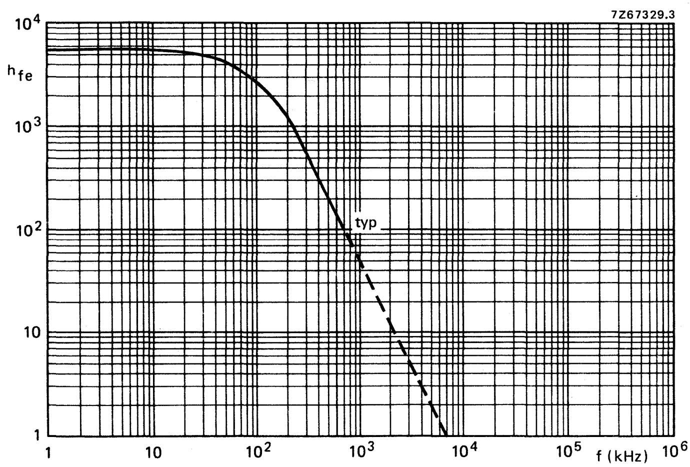


Fig. 10 Small signal current gain.

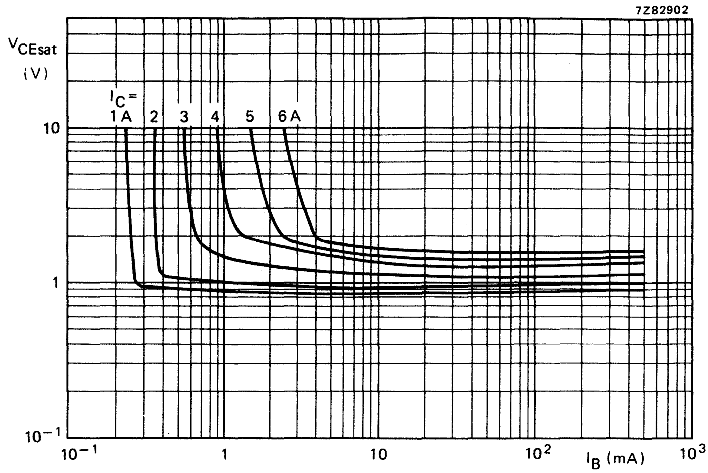


Fig. 11 Typical collector-emitter saturation voltage; T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

PNP epitaxial-base transistors in a monolithic Darlington circuit. They are housed in a TO-220 envelope and intended for applications such as audio output stages, switching, and general amplifiers.

The NPN complements are BD644, BD646, BD648, BD650 and BD652.

QUICK REFERENCE DATA

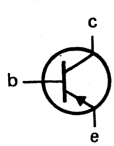
			BD644	646	648	650	652	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Collector current (DC)	$-I_C$	max.			8			A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.			62.5			W
Junction temperature	T_j	max.			150			°C
DC current gain								
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	h_{FE}	min.	–	750	750	750	750	
$-I_C$ = 4 A; $-V_{CE}$ = 3 V		min.	750	–	–	–	–	

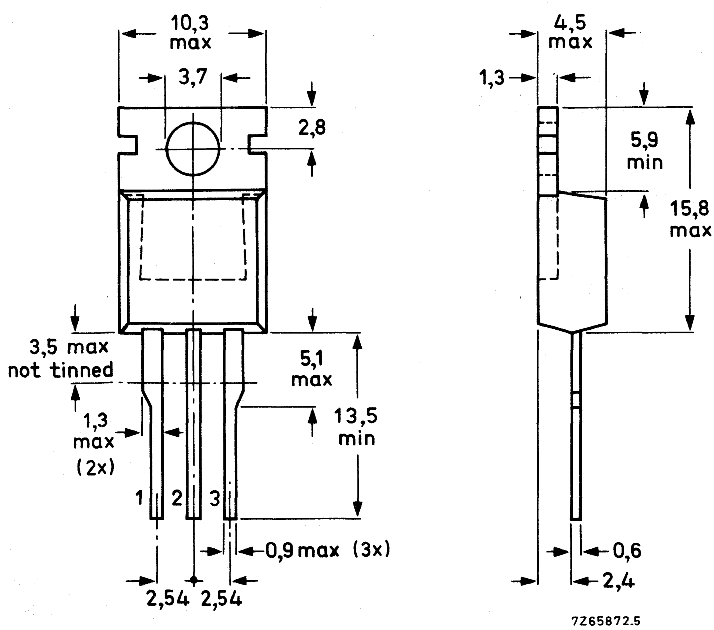
MECHANICAL DATA

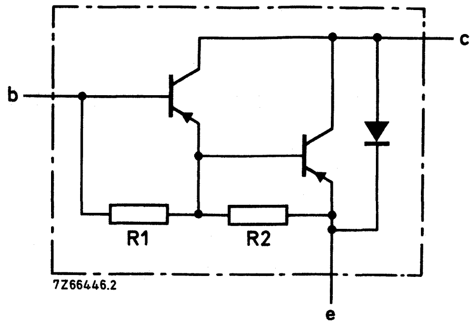
Dimensions in mm

Fig. 1 TO-220AB

Pinning
1 = base
2 = collector
3 = emitter







R1 typ. 4 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD644	646	648	650	652	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.			5			V
Collector current (DC)	$-I_C$	max.			8			A
Collector current (peak value)	$-I_{CM}$	max.			12			A
Base current (DC)	$-I_B$	max.			150			mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.			62.5			W
Storage temperature range	T_{stg}				−55 to +150			°C
Junction temperature	T_j	max.			150			°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	max.	2	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	max.	70	K/W

* Based on maximum junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents								
$-I_E = 0; -V_{CB} = -V_{CEO}$ max.	$-I_{CBO}$	max.			0.1			mA
$-I_E = 0; -V_{CB} = -1/2\ V_{CBO}$ max. T_j = 150 °C	$-I_{CBO}$	max.			1			mA
$-I_E = 0; -V_{CE} = -1/2\ V_{CEO}$ max.	$-I_{CEO}$	max.			0.2			mA
Emitter cut-off current								
$-I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	max.			5			mA
			BD644	646	648	650	652	
DC current gain (see note 1)								
$-I_C = 0.5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2700	2700	2700	2700	2700	
$-I_C = 4$ A; $-V_{CE} = 3$ V	h_{FE}	min.	750	–	–	–	–	
$-I_C = 3$ A; $-V_{CE} = 3$V	h_{FE}	min.	–	750	750	750	750	
$-I_C = 8$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2000	2000	2000	2000	2000	
Base-emitter voltage (see notes 1 and 2)								
$-I_C = 4$ A; $-V_{CE} = 3$ V	$-V_{BE}$	max.	2.5	–	–	–	–	V
$-I_C = 3$ A; $-V_{CE} = 3$ V	$-V_{BE}$	max.	–	2.5	2.5	2.5	2.5	V
Saturation voltages (see note 1)								
$-I_C = 4$ A; $-I_B = 16$ mA	$-V_{CEsat}$	max.	2	–	–	–	–	V
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	max.	–	2	2	2	2	V
$-I_C = 5$ A; $-I_B = 50$ mA	$-V_{CEsat}$	max.	2.5	2.5	2.5	2.5	2.5	V
$-I_C = 5$ A; $-I_B = 50$ mA	$-V_{BEsat}$	max.	3	3	3	3	3	V
Small signal current gain; f = 1 MHz								
$-I_C = 4$ A; $-V_{CE} = 3$ V	h_{fe}	min.	10	–	–	–	–	
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{fe}	min.	–	10	10	10	10	
Cut-off frequency								
$-I_C = 4$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100	–	–	–	–	kHz
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	–	100	100	100	100	kHz
Second-breakdown collector current t_p = 0.1 s; non-repetitive; without heatsink								
$-V_{CE} = 50$ V	$-I_{(SB)}$	min.	1.25	–	–	–	–	A
$-V_{CE} = 60$ V	$-I_{(SB)}$	min.	–	1.04	1.04	1.04	1.04	A
DC current gain ratio of matched pairs at $-V_{CE} = 3$ V								
$-I_C = 4$ A BD644/BD643	h_{FE1}/h_{FE2}	max.	2.5	–	–	–	–	
$-I_C = 3$A BD652/BD651	h_{FE1}/h_{FE2}	max.	–	2.5	2.5	2.5	2.5	
Diode forward voltage; $-I_F = 3$ A	$-V_F$	typ.			1.6			V
Collector capacitance at f = 1 MHz								
$-V_{CB} = 10$ V	C_c	typ.			75			pF

1. Measured under pulse conditions: $t_p = 300\ \mu s$, $\delta \leqslant 2\%$.
2. V_{BE} decreases by about 3.8 mV/K with increasing temperature.

Switching times (see Figs 3 and 4)

$-I_C = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA

turn-on time	t_{on}	typ.	1	μs
turn-off time	t_{off}	typ.	5	μs

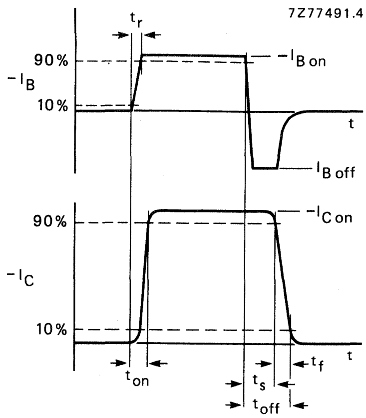
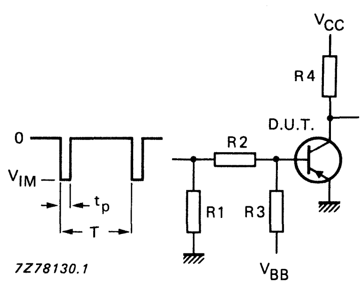


Fig. 3 Switching times waveforms.



$-V_{CC} = 10$ V
$-V_{IM} = 10$ V
$V_{BB} = 4$ V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 3 Ω
$t_r = t_f = 15$ ns
$t_p = 10$ μs
T = 500 μs

Fig. 4 Switching times test circuit.

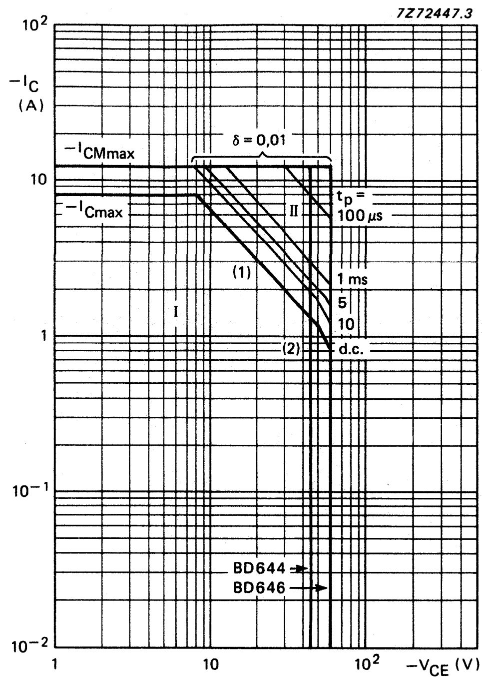


Fig. 5 **BD644; BD646** Safe Operating ARea, T_{mb} = 25 °C.

I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines
(2) Second-breakdown limits.

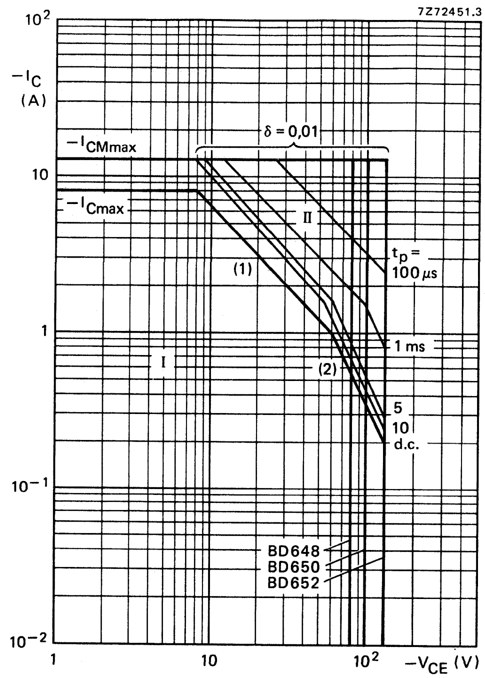


Fig. 6 **BD648, BD650, BD652** Safe Operating ARea, T_{mb} = 25 °C.

I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines
(2) Second-breakdown limits.

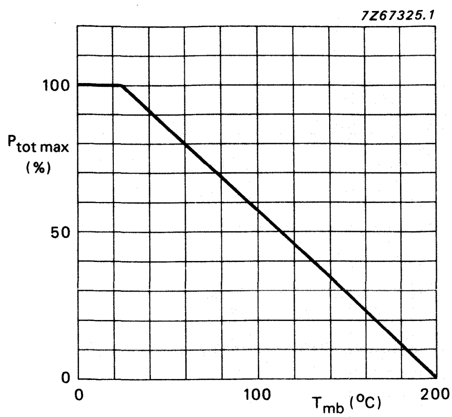


Fig. 7 Power derating curve.

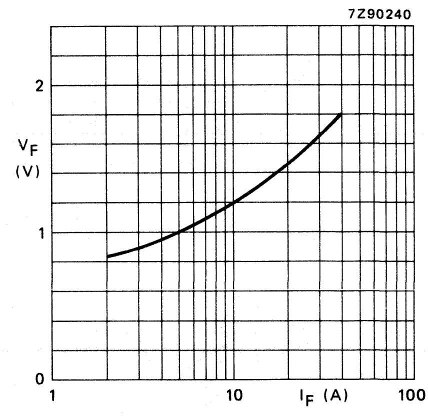


Fig. 8 Diode forward voltage versus forward current; T_j = 25 °C; typical values.

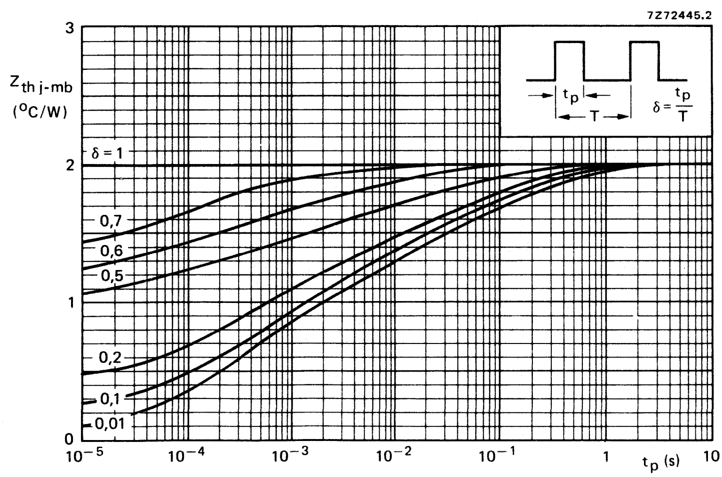


Fig. 9 Pulse power rating chart.

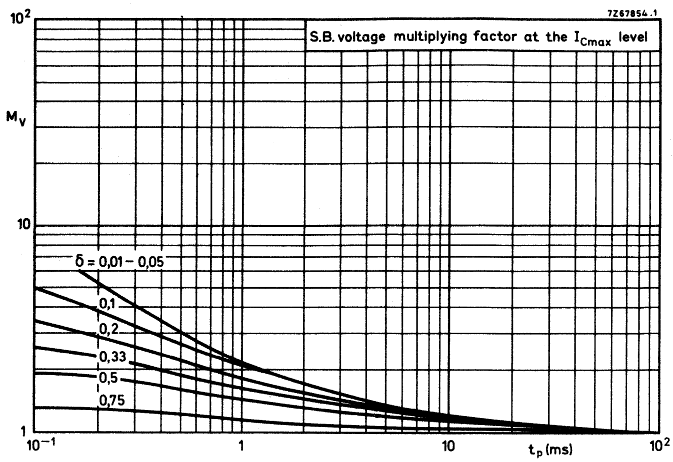


Fig. 10 Second breakdown voltage multiplying factor at the I_{Cmax} level.

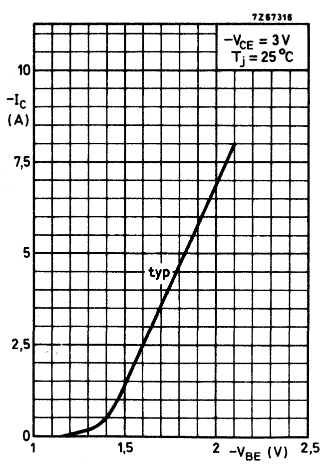


Fig. 11 Collector current versus base-emitter voltage; $-V_{CE}$ = 3 V; T_j = 25 °C; typical value.

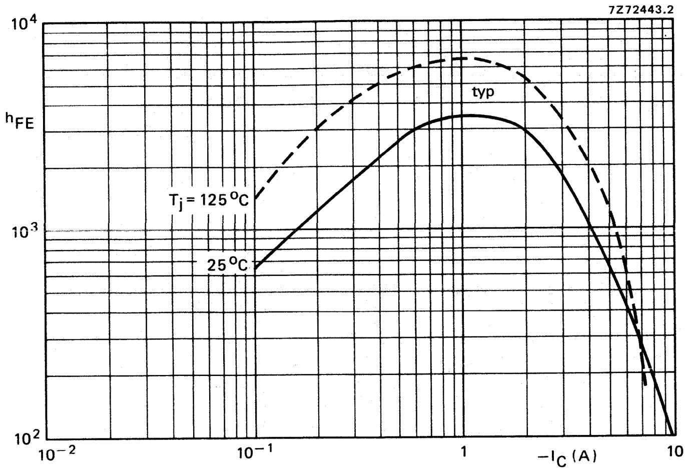


Fig. 12 DC current gain; $-V_{CE}$ = 3 V; typical values.

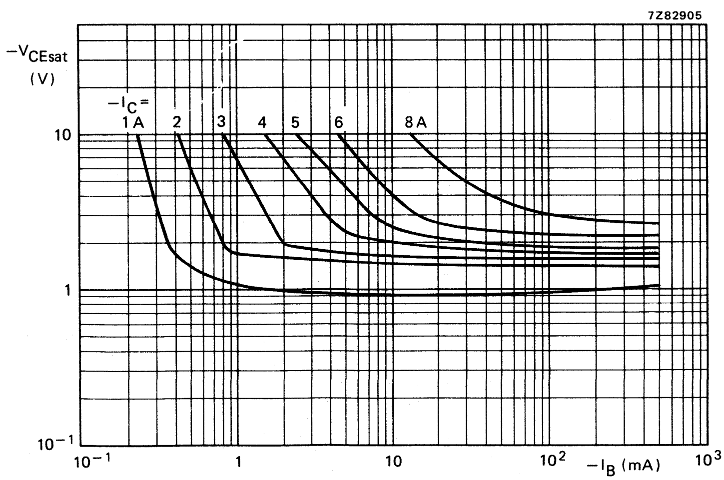


Fig. 13 Collector-emitter saturation voltage; T_j = 25 °C; typical values.

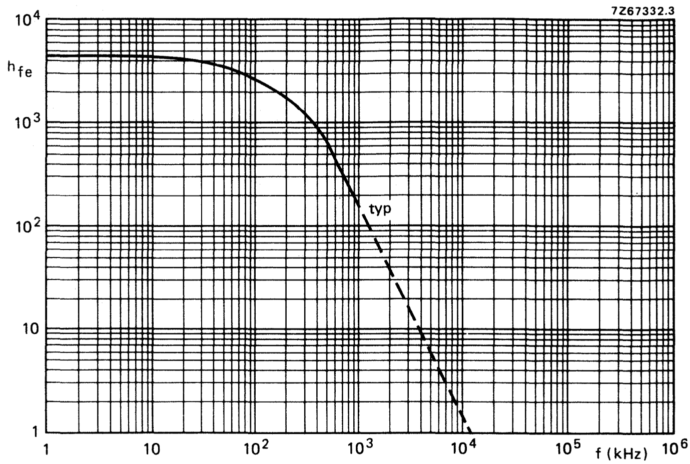


Fig. 14 Small signal current gain; $-I_C$ = 3 A; $-V_{CE}$ = 3 V; typical values.

SILICON DARLINGTON POWER TRANSISTORS

PNP silicon Darlington transistors in a SOT186 envelope with an electrically insulated mounting base. NPN complements are BD643F, BD645F, BD647F, BD649F and BD651F.

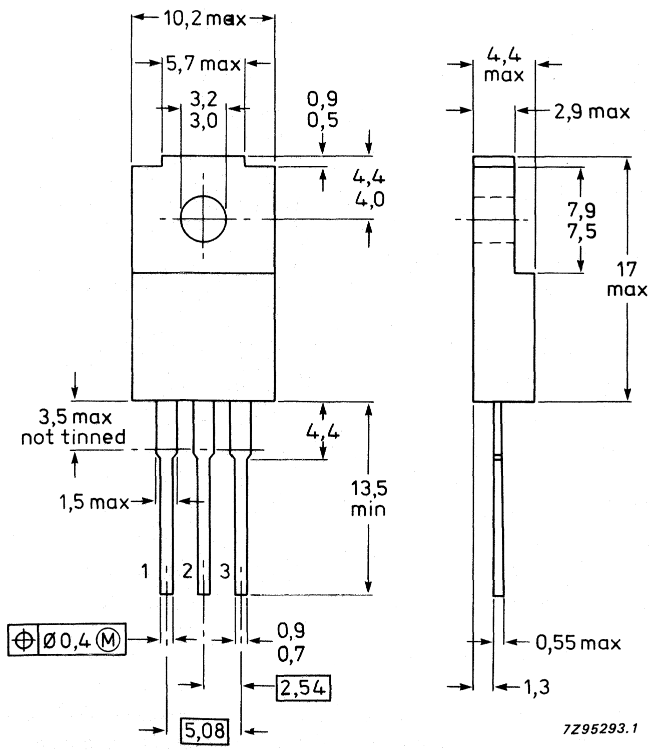
QUICK REFERENCE DATA

			BD644F	646F	648F	650F	652F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Collector current (DC)	$-I_C$	max.			8			A
Total power dissipation at $T_h \leq 25\ ^oC$	P_{tot}	max.			20			W
Junction temperature	T_j	max.			150			^oC

MECHANICAL DATA

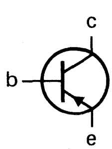
Dimensions in mm

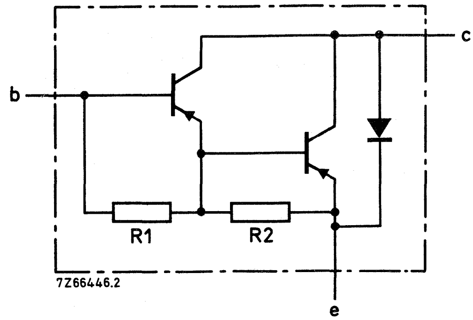
Fig. 1 SOT186.



Pinning

1 = emitter
2 = collector
3 = base





R1 typ. 4 kΩ
R2 typ. 80 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD644F	646F	648F	650F	652F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.			5			V
Collector current (DC)	$-I_C$	max.			8			A
(peak value)	$-I_{CM}$	max.			12			A
Base current (DC)	$-I_B$	max.			150			mA
Total power dissipation at $T_h \leq 25$ °C (note 1)	P_{tot}	max.			20			W
at $T_h \leq 25$ °C (note 2)	P_{tot}	max.			32			W
Storage temperature range	T_{stg}				–65 to + 150			°C
Junction temperature	T_j	max.			150			°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.6	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.3	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W

INSULATION

Voltage allowed between all terminals and external heatsink (peak value)	V_{insul}	max.	1000	V
Isolation capacitance from collector to external heatsink	C_{th}	max.	12	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Emitter cut-off current				
V_{EB} = 5 V; I_C = 0	$-I_{EBO}$	max.	5	mA
Collector-emitter leakage current				
$-V_{CE} = -1/2\ V_{CEO}$; I_B = 0	$-I_{CEO}$	max.	0.2	mA
Collector cut-off current				
$-V_{CB} = -V_{CBO}$; I_E = 0	$-I_{CBO}$	max.	0.1	mA

			BD644F	646F	648F	650F	652F	
$-V_{CB}$ = 30 V; I_E = 0; T_j = 150 °C	$-I_{CBO}$	max.	1	–	–	–	–	mA
$-V_{CB}$ = 40 V; I_E = 0; T_j = 150 °C	$-I_{CBO}$	max.	–	1	–	–	–	mA
$-V_{CB}$ = 50 V; I_E = 0; T_j = 150 °C	$-I_{CBO}$	max.	–	–	1	–	–	mA
$-V_{CB}$ = 60 V; I_E = 0; T_j = 150 °C	$-I_{CBO}$	max.	–	–	–	1	–	mA
$-V_{CB}$ = 70 V; I_E = 0; T_j = 150 °C	$-I_{CBO}$	max.	–	–	–	–	1	mA
Collector-emitter leakage current								
$-V_{CE}$ = 25 V; I_B = 0	$-I_{CEO}$	max.	0.5	–	–	–	–	mA
$-V_{CE}$ = 30 V; I_B = 0	$-I_{CEO}$	max.	–	0.5	–	–	–	mA
$-V_{CE}$ = 40 V; I_B = 0	$-I_{CEO}$	max.	–	–	0.5	–	–	mA
$-V_{CE}$ = 50 V; I_B = 0	$-I_{CEO}$	max.	–	–	–	0.5	–	mA
$-V_{CE}$ = 60 V; I_B = 0	$-I_{CEO}$	max.	–	–	–	–	0.5	mA
Static forward current transfer ratio (note 1)								
$-I_C$ = 0.5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	2700	2700	2700	2700	2700	
$-I_C$ = 4 A; $-V_{CE}$ = 3 V	h_{FE}	min.	750	–	–	–	–	
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	h_{FE}	min.	–	750	750	750	750	
$-I_C$ = 8 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	2000	2000	2000	2000	2000	
Collector-emitter saturation voltage (note 1)								
$-I_C$ = 4 A; $-I_B$ = 16 mA	$-V_{CEsat}$	max.	2	–	–	–	–	V
$-I_C$ = 3 A; $-I_B$ = 12 mA	$-V_{CEsat}$	max.	–	2	2	2	2	V
$-I_C$ = 5 A; $-I_B$ = 50 mA	$-V_{CEsat}$	max.	2.5	2.5	2.5	2.5	2.5	V
Base-emitter saturation voltage (note 1)								
$-I_C$ = 5 A; $-I_B$ = 50 mA	$-V_{BEsat}$	max.	3	3	3	3	3	V
Base-emitter voltage (note 1)								
$-I_C$ = 4 A; $-V_{CE}$ = 3 V	$-V_{BE}$	max.	2.5	–	–	–	–	V
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	$-V_{BE}$	max.	–	2.5	2.5	2.5	2.5	V
Common-emitter cut-off frequency								
$-I_C$ = 4 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	100	–	–	–	–	kHz
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	–	100	100	100	100	kHz
Small signal current gain								
$-I_C$ = 4 A; $-V_{CE}$ = 3 V; f = 1 MHz	h_{fe}	typ.	150	–	–	–	–	
$-I_C$ = 3 A; $-V_{CE}$ = 3 V; f = 1 MHz	h_{fe}	typ.	–	150	150	150	150	

Forward bias second breakdown collector current				
$-V_{CE}$ = 50 V; t_p = 0.1 s	$-I_{(SB)}$	min.	0.55	A
Forward voltage				
I_F = 3 A	V_F	typ.	1.8	V

Note

1. To be measured under pulsed conditions, pulse time 300 μs; duty cycle 2%.

CHARACTERISTICS (continued)

Switching times
$-I_C = 3$ A; $-I_{B\,on} = -I_{B\,off} = 12$ mA

Turn on time	t_{on}	max.	2	μs
		typ.	1	μs
Turn off time	t_{off}	max.	10	μs
		typ.	5	μs

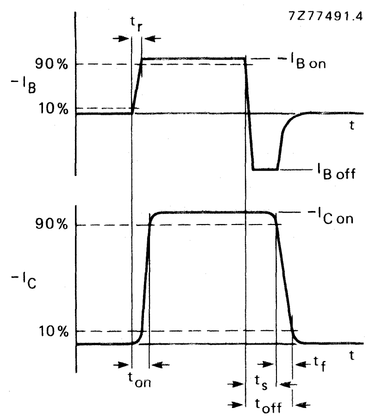
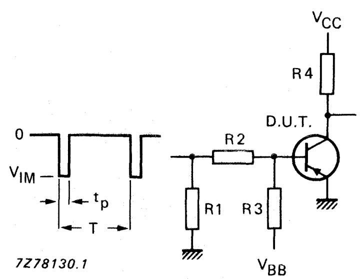
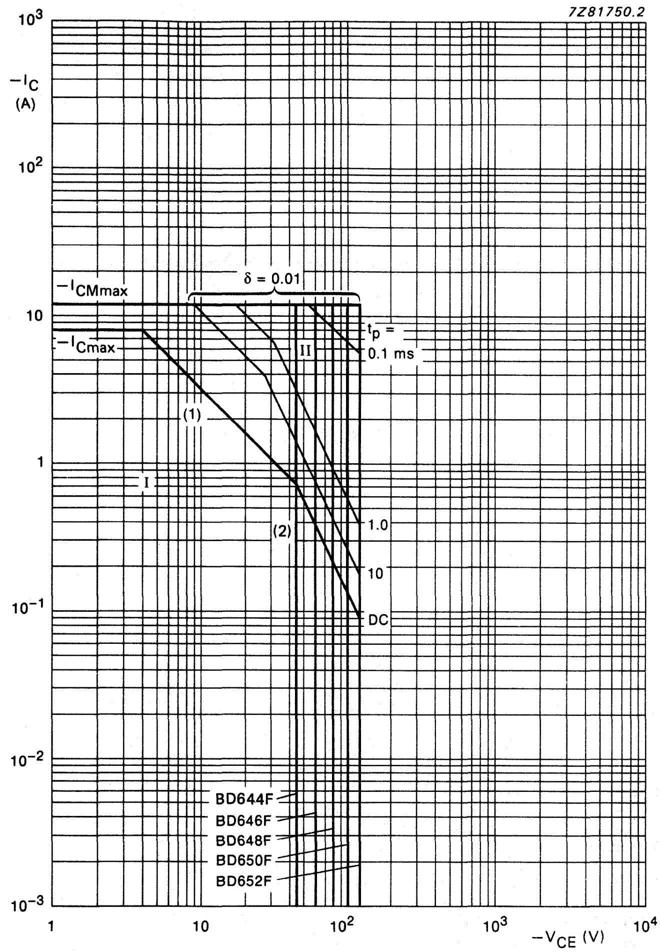


Fig. 3 Switching times waveforms.



$-V_{IM}$ = 10 V
$-V_{CC}$ = 10 V
$+V_{BB}$ = 4 V
R_1 = 56 Ω
R_2 = 410 Ω
R_3 = 560 Ω
R_4 = 3 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and P_{peak} lines.
(2) Second-breakdown limits.

Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

Fig.5 Safe operating area; T_{amb} = 25 °C.

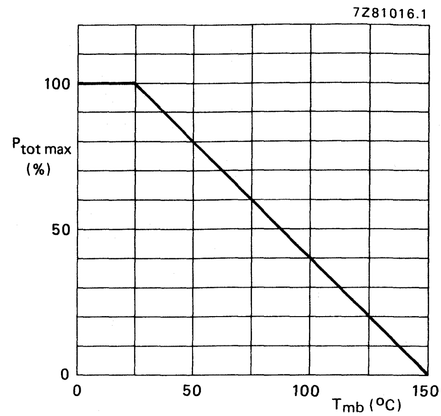


Fig. 6 Power derating curve.

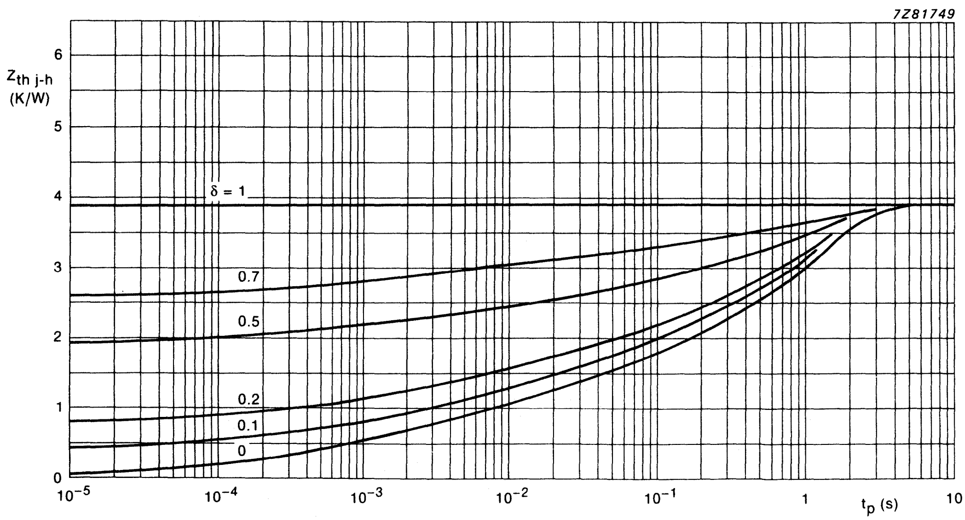


Fig. 7 Pulse power rating chart.

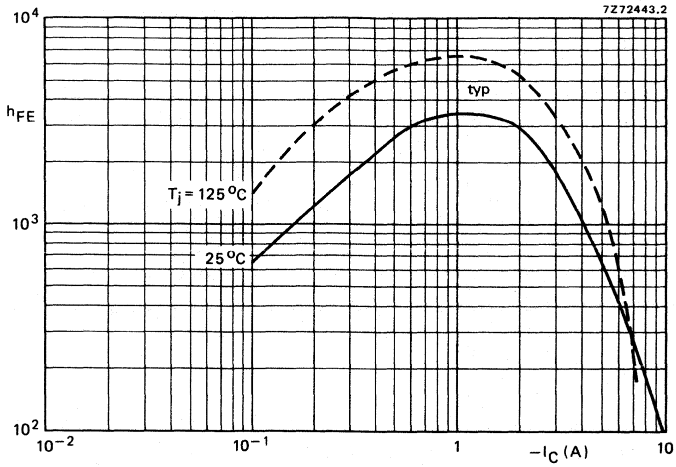


Fig. 8 Typical DC current gain curves, $-V_{CE} = 3$ V.

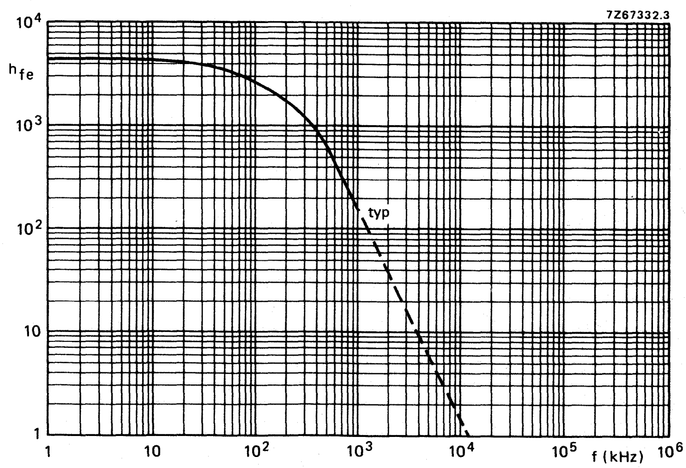


Fig. 9 Small signal current gain.

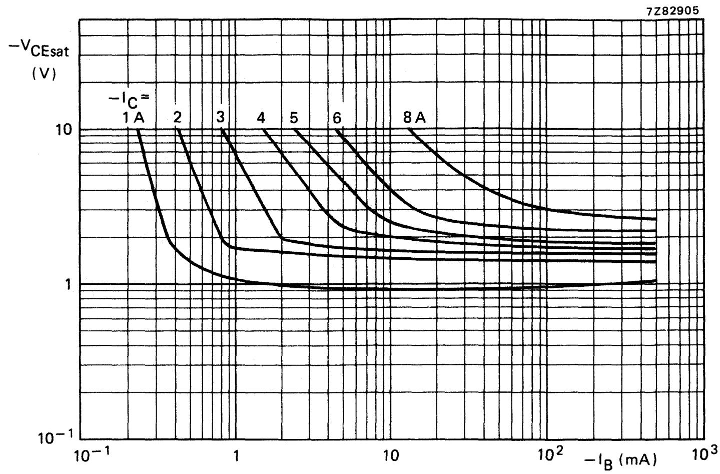


Fig. 10 Typical collector-emitter saturation voltage; T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial-base transistors in monolithic Darlington circuit for audio and video applications; SOT-32 plastic envelope. P-N-P complements are BD676, BD678, BD680, BD682 and BD684.

QUICK REFERENCE DATA

			BD675	677	679	681	683	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V

Collector current (d.c.)	I_C	max.	4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40	W
Junction temperature	T_j	max.	150	°C
D.C. current gain				
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	2200	
I_C = 1,5 A; V_{CE} = 3 V	h_{FE}	>	750	
Cut-off frequency				
I_C = 1,5 A; V_{CE} = 3 V	f_{hfe}	typ.	60	kHz

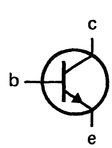
MECHANICAL DATA

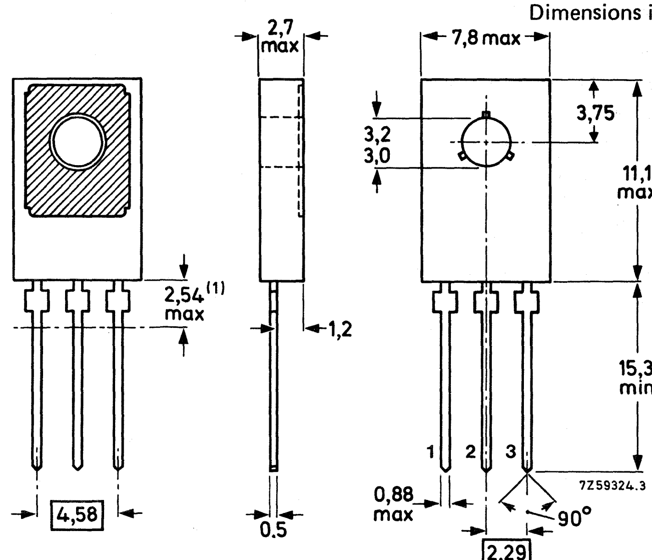
Dimensions in mm

Fig. 1 TO-126 (SOT-32).

Collector connected to mounting base.

Pinning
1 = emitter
2 = collector
3 = base

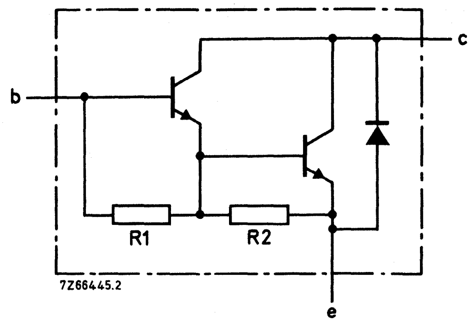




(1) Within this region the cross-section of the leads is uncontrolled.

See also chapters Mounting Instructions and Accessories.

CIRCUIT DIAGRAM



R_1 typ. 3 kΩ
R_2 typ. 120 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD675	677	679	681	683	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	5	V

Collector current (d.c.)	I_C	max.	4	A
Collector current (peak value)	I_{CM}	max.	6	A
Base current (d.c.)	I_B	max.	100	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W

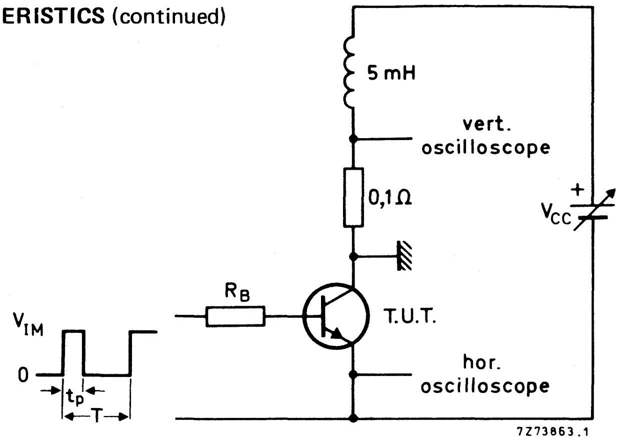
CHARACTERISTICS

T_j = 25 °C, unless otherwise specified; where I_C = 1,5 A for BD675 read I_C = 2 A.

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	0,2	mA
$I_E = 0$; V_{CB} = ½ V_{CBOmax}; T_{mb} = 150 °C	I_{CBO}	<	1	mA ←
$I_B = 0$; V_{CE} = ½ V_{CEOmax}	I_{CEO}	<	0,2	mA ←
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5	mA
D.C. current gain (note 1)				
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	2200	
I_C = 1,5 A; V_{CE} = 3 V	h_{FE}	>	750	
I_C = 4 A; V_{CE} = 3 V	h_{FE}	typ.	1500	
Base-emitter voltage (notes 1 and 2)				
I_C = 1,5 A; V_{CE} = 3 V (BD675; I_C = 2 A)	V_{BE}	<	2,5	V
Collector-emitter saturation voltage (note 1)				
I_C = 1,5 A; I_B = 6 mA (BD675; I_C = 2 A)	V_{CEsat}	<	2,5	V
Small signal current gain				
I_C = 1,5 A; V_{CE} = 3 V; f = 1 MHz (BD675; I_C = 2 A)	h_{fe}	>	10	
Cut-off frequency				
I_C = 1,5 A; V_{CE} = 3 V (BD675; I_C = 2 A)	f_{hfe}	typ.	60	kHz
Turn-off breakdown energy with inductive load				
$-I_{Boff} = 0$; I_C = 3,5 A; (Fig. 3)	$E_{(BR)}$	>	30	mJ
D.C. current gain ratio of matched complementary pairs				
I_C = 1,5 A; V_{CE} = 3 V	h_{FE1}/h_{FE2}	<	2,5	
Diode forward voltage				
I_F = 1,5 A (BD675; I_F = 2 A)	V_F	typ.	1,5	V
Second-breakdown collector current				
V_{CE} = 50 V; t_p = 20 ms, non rep.; without heatsink	$I_{(SB)}$	>	0,8	A
BD675; V_{CE} = 40 V; t_p = ms	$I_{(SB)}$	>	1	A
Switching times (between 10% and 90% levels)				
I_{Con} = 1,5 A; $I_{Bon} = -I_{Boff}$ = 6 mA; V_{CC} = 30 V				
Turn-on time	t_{on}	typ.	0,8	μs
		<	2	μs
Turn-off time	t_{off}	typ.	4,5	μs
		<	8	μs

Notes
1. Measured under pulse conditions: $t_p < 300$ μs; $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)



V_{IM} = 12 V
R_B = 270 Ω
I_{CC} = 3,5 A
T = 1 ms
δ = 1 %

Fig. 3 Test circuit for turn-off breakdown energy.

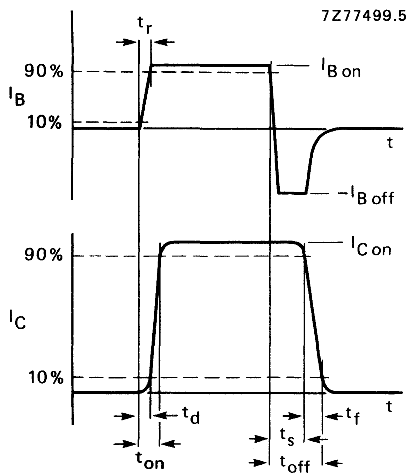
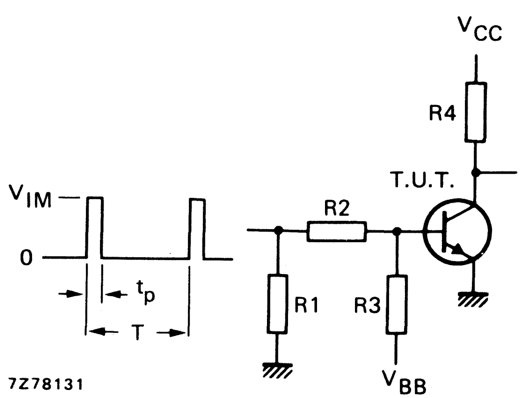


Fig. 4 Switching times waveforms.



V_{IM} = 12 V
V_{CC} = 30 V
V_{BB} = −3 V
R1 = 56 Ω
R2 = 1 kΩ
R3 = 680 Ω
R4 = 22 Ω
$t_r = t_f \leqslant$ 15 ns
t_p = 10 μs
T = 500 μs

Fig. 5 Switching times test circuit.

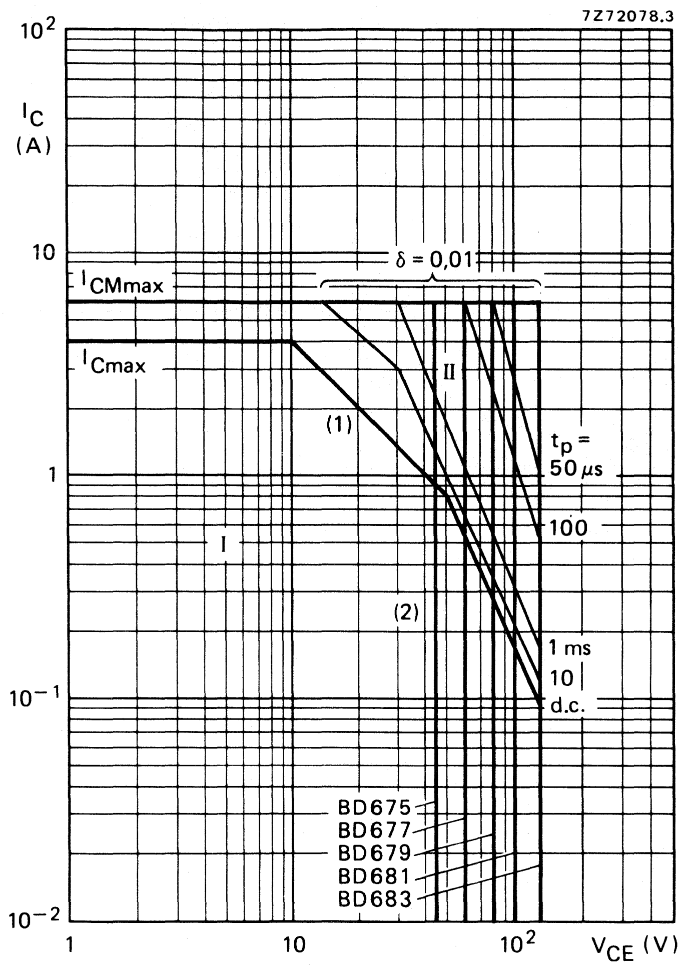


Fig. 6 Safe Operating ARea. T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ line.
(2) Second-breakdown limits.

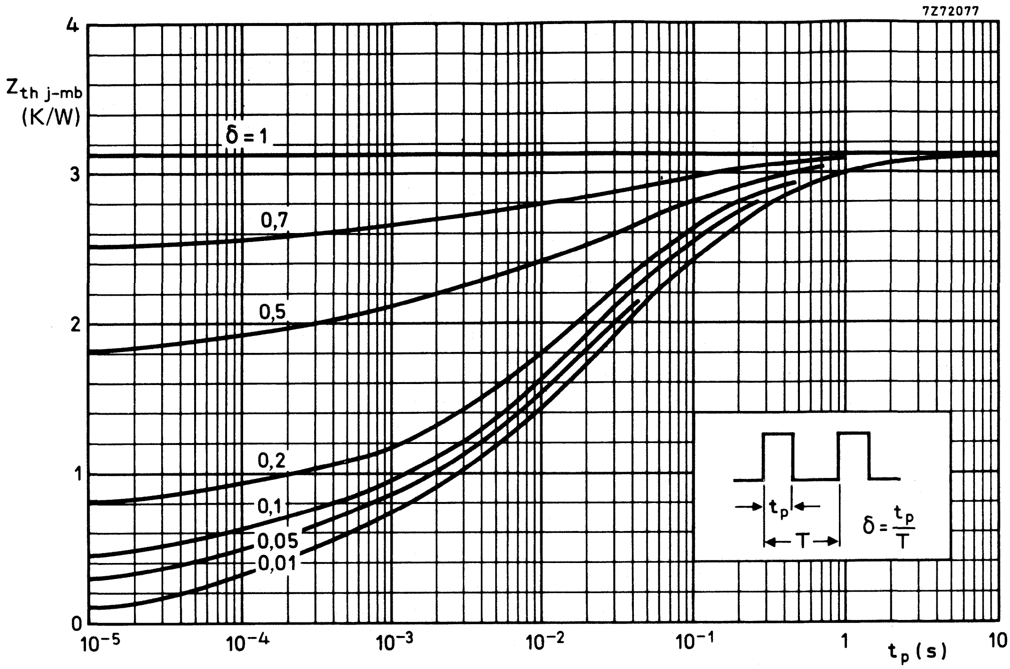


Fig. 7 Pulse power rating chart.

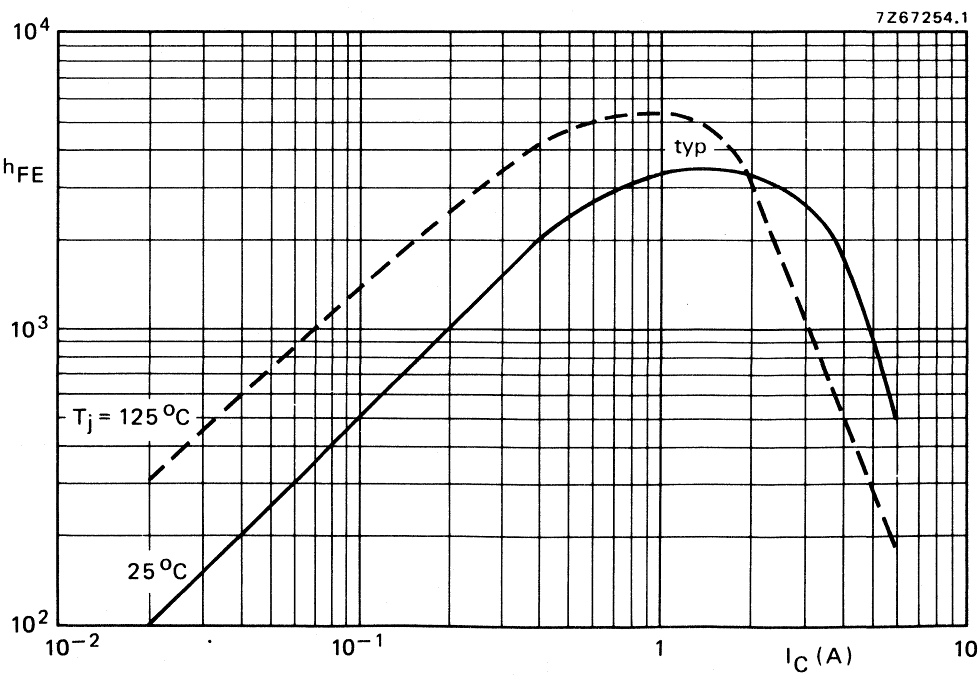


Fig. 8 D.C. current gain at V_{CE} = 3 V.

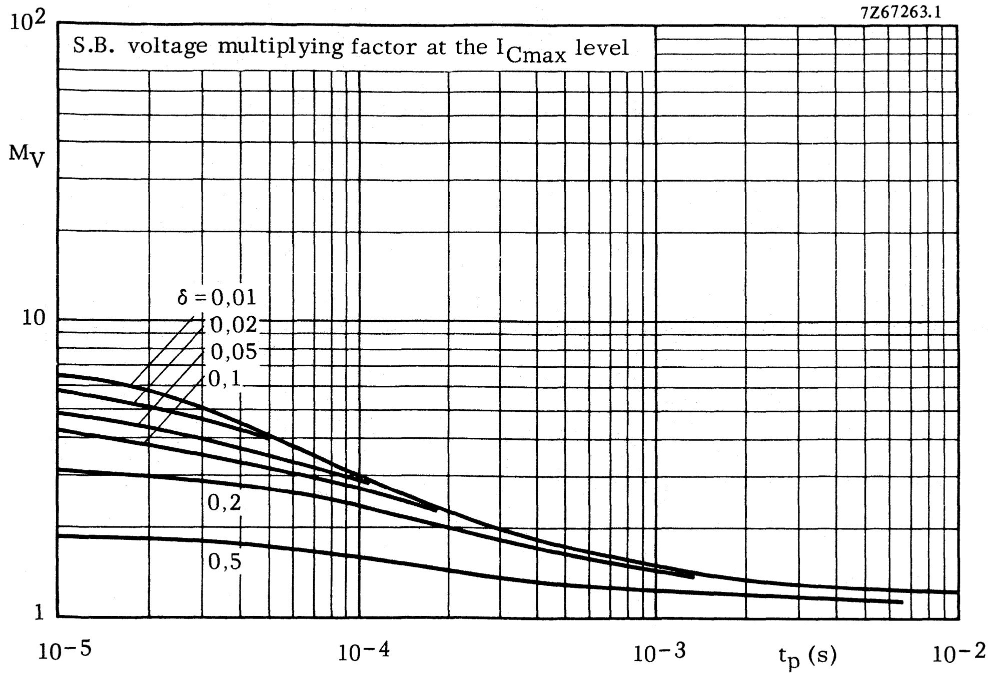


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

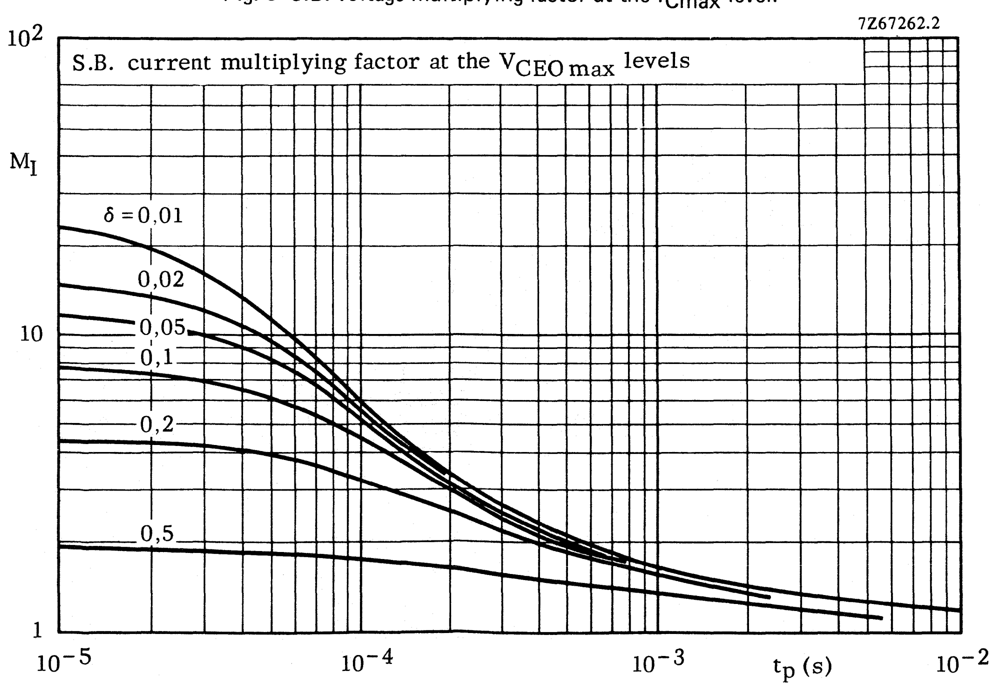


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} levels.

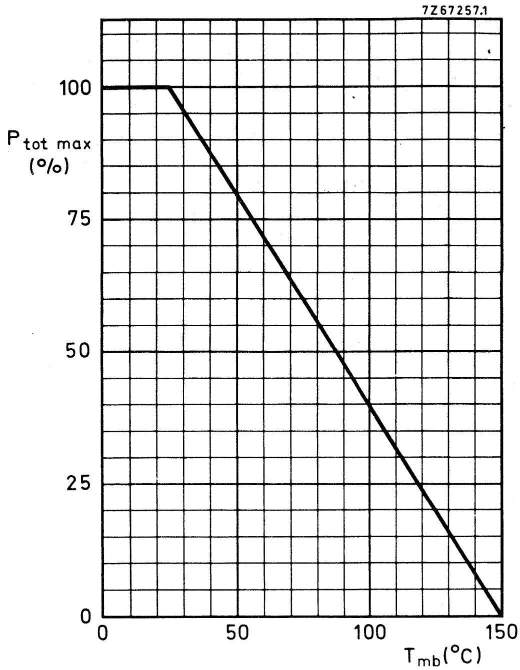


Fig. 11 Power derating curve.

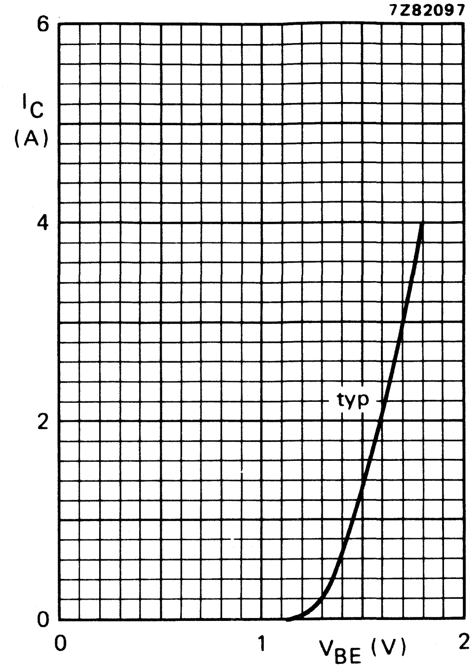


Fig. 12 Typical collector current.

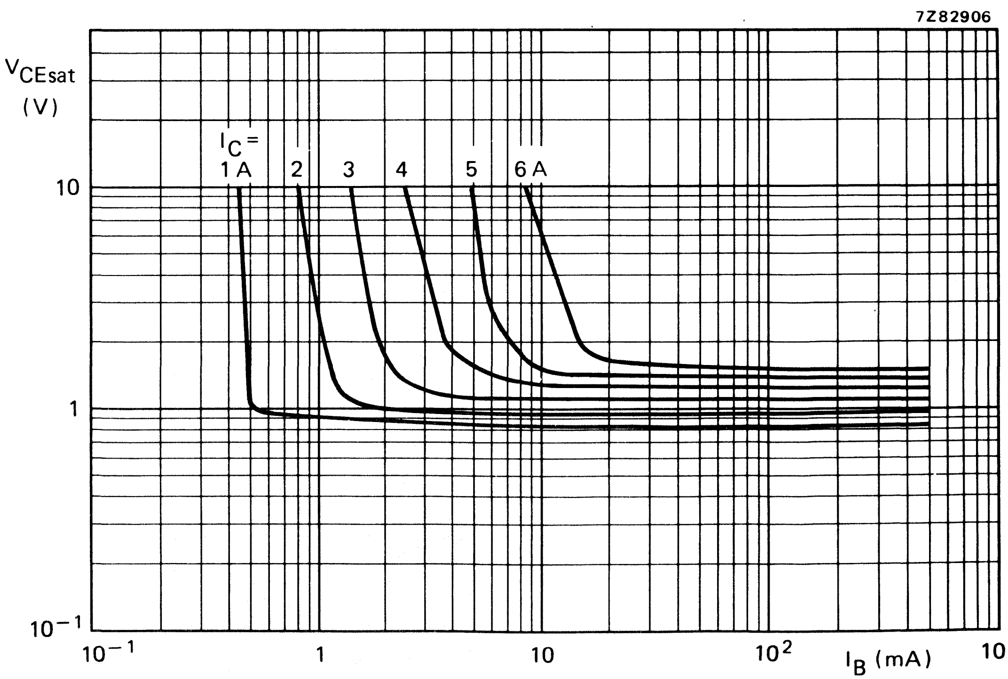


Fig. 13 Typical values collector-emitter saturation voltage. T_{mb} = 25 °C.

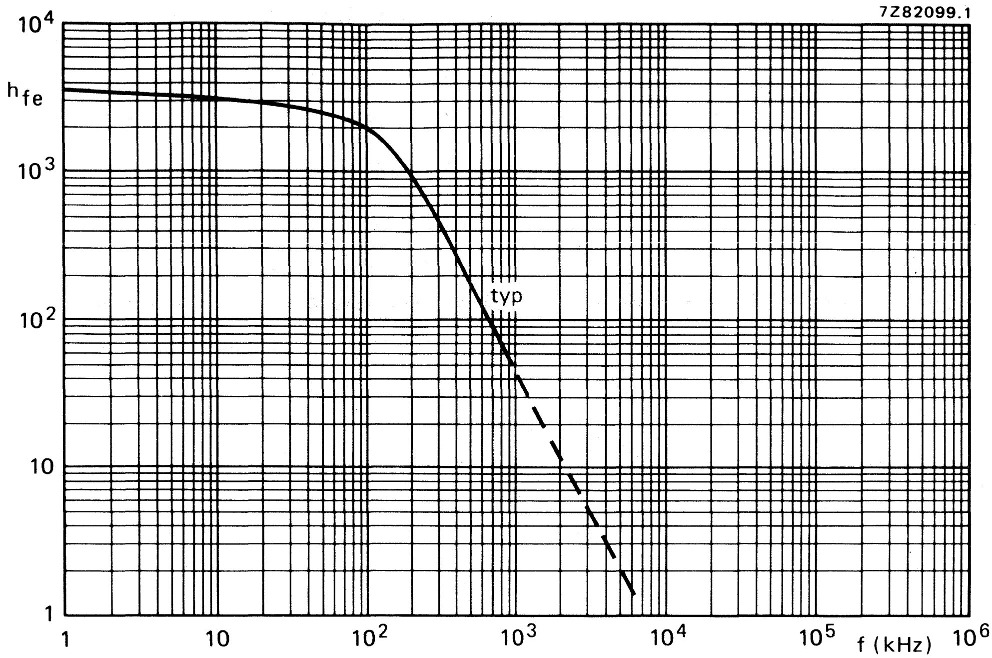


Fig. 14 Small signal current gain. I_C = 1,5 A; V_{CE} = 3 V.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio and video output applications; SOT-32 plastic envelope. N-P-N complements are BD675, BD677, BD679, BD681 and BD683.

QUICK REFERENCE DATA

			BD676	678	680	682	684	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Collector-current (d.c.)	$-I_C$	max.			4			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			40			W
Junction temperature	T_j	max.			150			°C
D.C. current gain								
$-I_C$ = 0,5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.			2200			
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V	h_{FE}	>			750			
Cut-off frequency								
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.			60			kHz

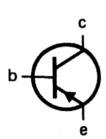
MECHANICAL DATA

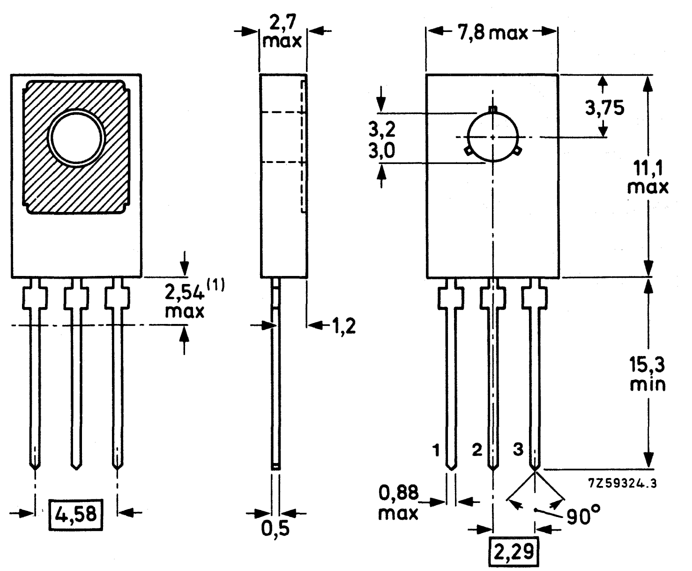
Dimensions in mm

Fig. 1 TO-126 (SOT-32).

Collector connected to mounting base.

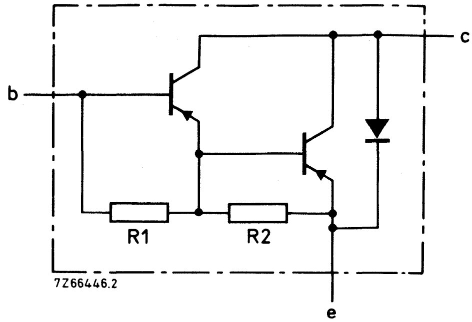
Pinning
1 = emitter
2 = collector
3 = base





(1) Within this region the cross-section of the leads is uncontrolled.

See also chapters Mounting instructions and Accessories.



R1 typ. 3 kΩ
R2 typ. 80 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD676	678	680	682	684	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	4	A
Collector current (peak value)	$-I_{CM}$	max.	6	A
Base current (d.c.)	$-I_B$	max.	100	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified; where $-I_C$ = 1,5 A for BD676 read $-I_C$ = 2 A.

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2	mA
$I_E = 0$; $-V_{CB} = -0{,}6\ V_{CBOmax}$; T_{mb} = 150 °C	$-I_{CBO}$	<	1	mA ←
$I_B = 0$; $-V_{CE} = -½\ V_{CEOmax}$	$-I_{CEO}$	<	0,2	mA ←
Emitter cut-off current				
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	5	mA
D.C. current gain (note 1)				
$-I_C$ = 0,5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	2200	
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V*	h_{FE}	>	750	
$-I_C$ = 4 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	650	
Base-emitter voltage (notes 1 and 2)				
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V*	$-V_{BE}$	<	2,5	V
Collector-emitter saturation voltage (note 1)				
$-I_C$ = 1,5 A; $-I_B$ = 6 mA*	$-V_{CEsat}$	<	2,5	V
Small-signal current gain				
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V; f = 1 MHz*	h_{fe}	>	10	
Cut-off frequency				
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V*	f_{hfe}	typ.	60	kHz
D.C. current gain ratio of matched complementary pairs				
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V	h_{FE1}/h_{FE2}	<	2,5	
Diode, forward voltage				
I_F = 1,5 A*	V_F	typ.	1,5	V
Switching times (see Figs 3 and 4)				
$-I_{Con}$ = 1,5 A; $-I_{Bon} = I_{Boff}$ = 6 mA				
turn-on time	t_{on}	typ.	0,3	μs
		<	1,5	μs
turn-off time	t_{off}	typ.	1,5	μs
		<	5	μs
Second-breakdown collector current				
$-V_{CE}$ = 50 V; t_p = 20 ms	$-I_{(SB)}$	>	0,8	A
for BD676 $-V_{CE}$ = 40 V	$-I_{(SB)}$	>	1	A

* for BD676 condition $-I_C$ or $-I_F$ = 2 A.

Notes

1. Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

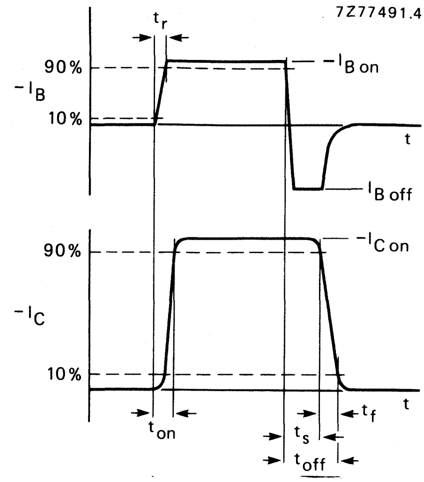


Fig. 3 Switching times waveform.

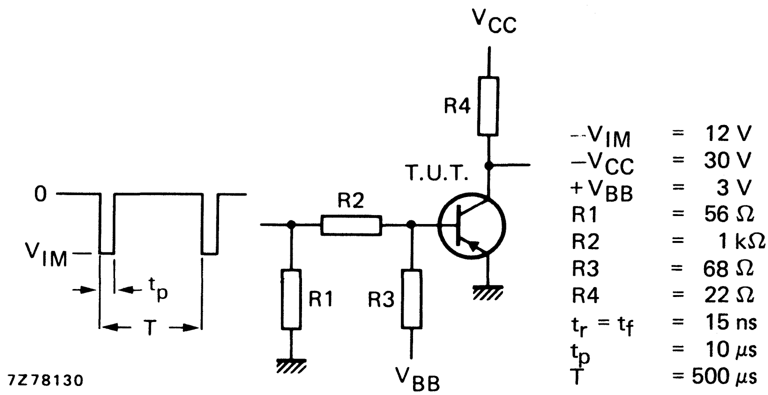


Fig. 4 Switching times test circuits.

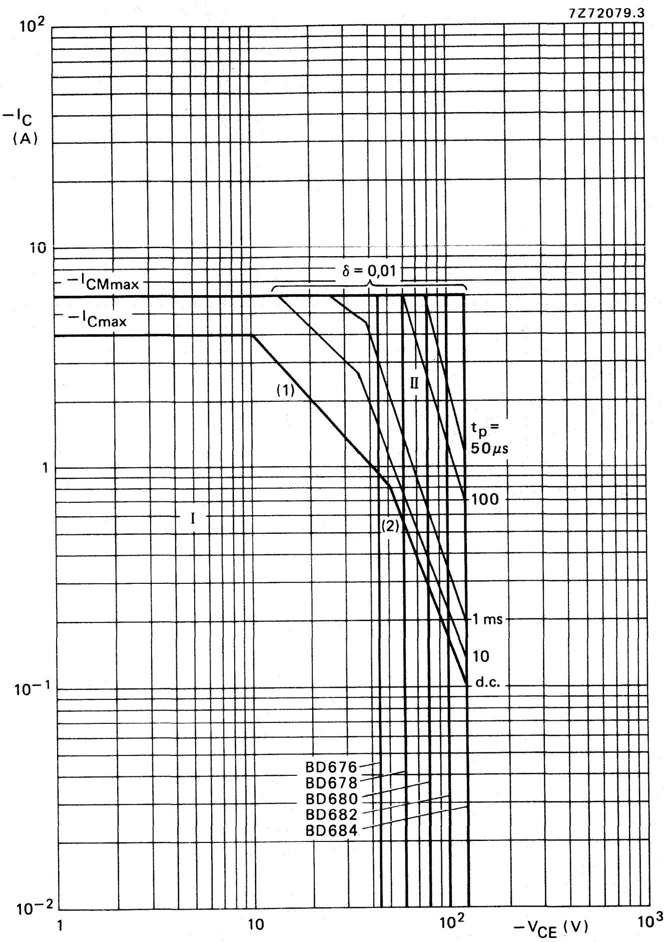


Fig. 5 Safe Operating ARea. T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ line.
(2) Second-breakdown limits.

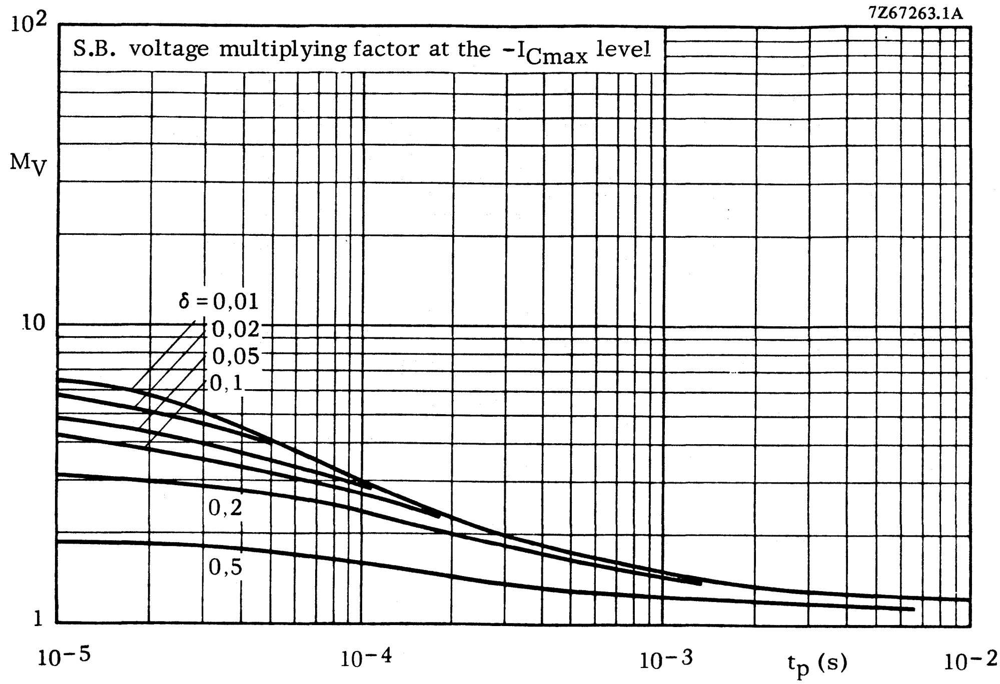


Fig. 6 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

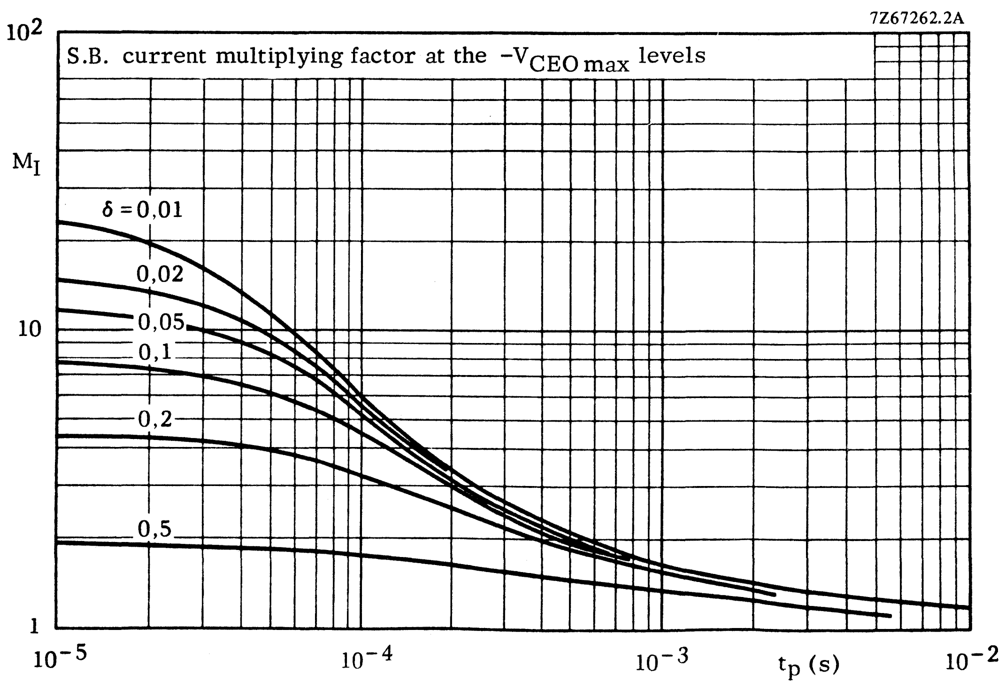


Fig. 7 S.B. current multiplying factor at the $-V_{CEOmax}$ levels.

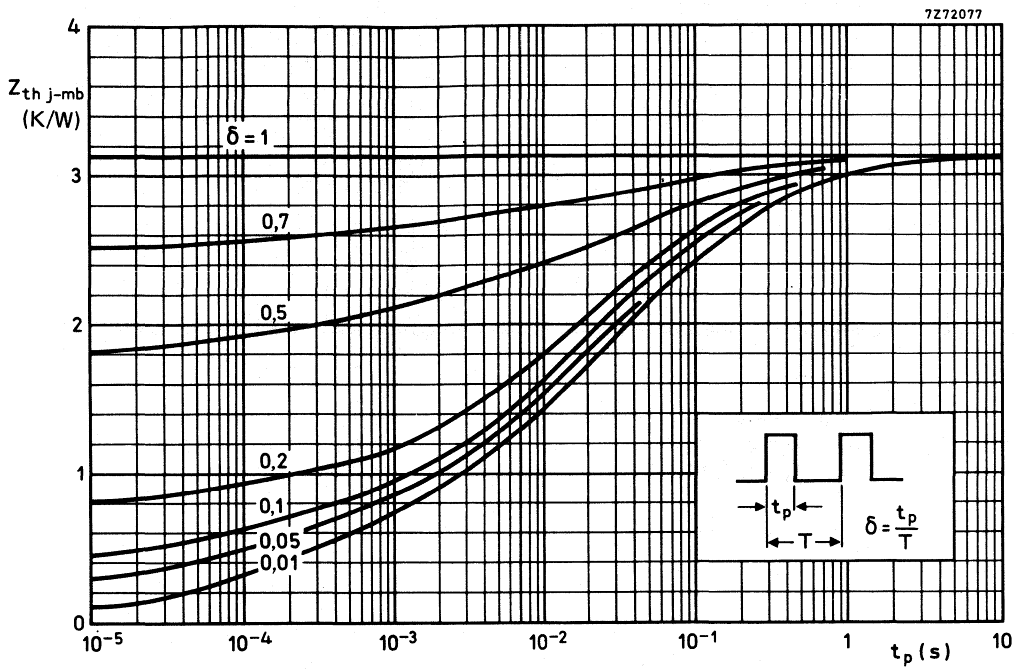


Fig. 8 Pulse power rating chart.

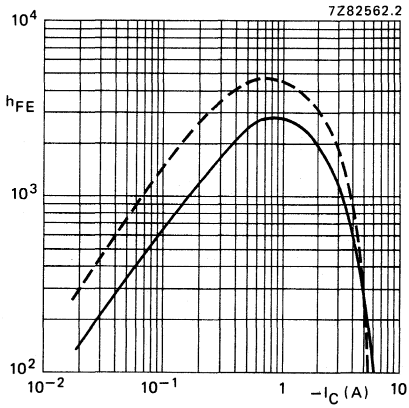


Fig. 9 D.C. current gain. $-V_{CE}$ = 3 V;
——— T_j = 25 °C;
- - - - T_j = 125 °C.

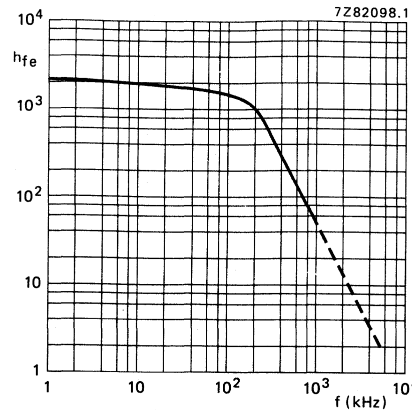


Fig. 10 Typical values small signal current gain. $-I_C$ = 1,5 A; $-V_{CE}$ = 3 V.

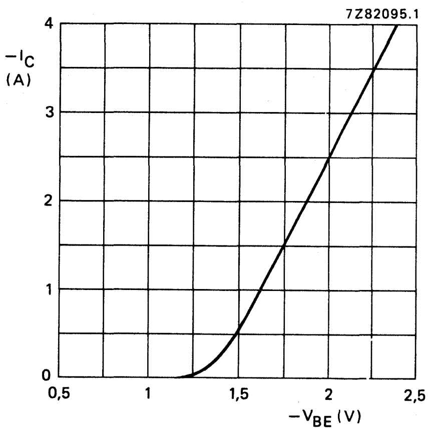


Fig. 11 Typical values; $-V_{CE}$ = 3 V
T_j = 25 °C.

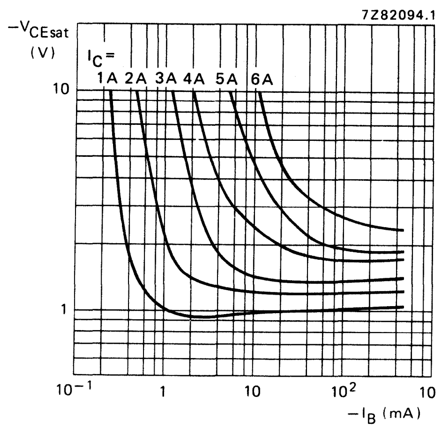


Fig. 12 Typical values collector-emitter saturation voltage as a function of base current. T_{mb} = 25 °C.

SILICON EPITAXIAL-BASE POWER TRANSISTOR

N-P-N transistor in a SOT-32 plastic envelope intended for use in audio output and general purpose amplifier applications. P-N-P complements are BD720; 722; 724 and BD726.

QUICK REFERENCE DATA

			BD719	BD721	BD723	BD725	
Collector-base voltage	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage	V_{EBO}	max.	5	5	5	5	V
Collector current (d.c.)	I_C	max.	4	4	4	4	A
(peak value)	I_{CM}	max.	7	7	7	7	A
Junction temperature	T_j	max.	150	150	150	150	°C
D.C. current gain $I_C = 2$ A; $V_{CE} = 4$ V	h_{FE}	min.	20	20	20	20	
Transition frequency $I_C = 500$ mA; $V_{CE} = 4$ V	f_T	min.	3	3	3	3	MHz

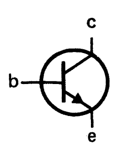
MECHANICAL DATA

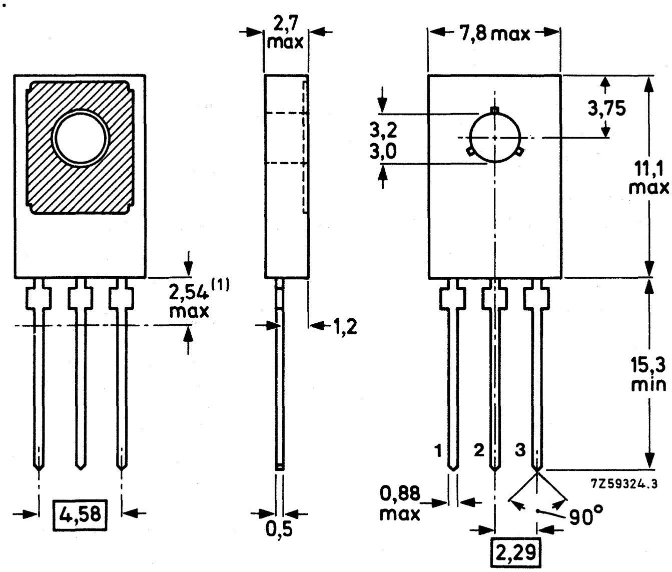
Dimensions in mm

Fig. 1 TO- 126 (SOT32).

Collector connected to metal part of mounting surface

Pinning
1 = emitter
2 = collector
3 = base





(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD719	BD721	BD723	BD725	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage	V_{EBO}	max.	5	5	5	5	V
Collector current							
d.c. value	I_C	max.		4			A
peak value	I_{CM}	max.		7			A
Base current (d.c.)	I_B	max.		1			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		36			W
Storage temperature	T_{stg}			−65 to + 150			°C
Junction temperature	T_j	max.		150			°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	max.	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	max.	3,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD719	BD721	BD723	BD725	
→ Collector cut-off current							
$I_E = 0$; $V_{CB} = V_{CBO}$	I_{CBO}	max.	50	50	50	50	μA
$I_E = 0$; $V_{CB} = ½ V_{CBO}$; T_j = 150 °C	I_{CBO}	max.	1	1	1	1	mA
$I_B = 0$; $V_{CE} = ½ V_{CEO}$	I_{CEO}	max.	0,1	0,1	0,1	0,1	mA
→ Emitter cut-off current							
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	max.	0,2	0,2	0,2	0,2	mA
D.C. current gain (1)							
I_C = 500 mA; V_{CE} = 4 V	h_{FE}	min.	40	40	40	40	
I_C = 2 A; V_{CE} = 4 V	h_{FE}	min.	20	20	20	20	
Base-emitter voltage (1) (2)							
I_C = 2 A; V_{CE} = 4 V	V_{BE}	max.	1,4	1,4	1,4	1,4	V
Collector-emitter saturation voltage (1)							
I_C = 2 A; I_B = 0,2 A	V_{CEsat}	max.	1	1	1	1	V

(1) t_p = 300 μs; $\delta \leq 2\%$.
(2) V_{BE} decreases by approximately 2,3 mV/K with increasing temperature.

			BD719	BD721	BD723	BD725	
Transition frequency at f = 1 MHz							
I_C = 0,5 A; V_{CE} = 4 V	f_T	min.	3	3	3	3	MHz
Switching times							
I_{Con} = 1 A;							
$I_{Bon} = -I_{Boff}$ = 0,1 A							
Turn-on time	t_{on}	typ.	0,3	0,3	0,3	0,3	μs
Turn-off time	t_{off}	typ.	1,5	1,5	1,5	1,5	μs

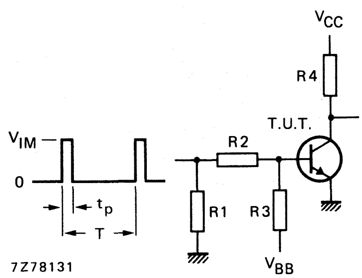


Fig. 2 Test circuit.

V_{IM} = 30 V
V_{CC} = 20 V
$-V_{BB}$ = 3,5 V
R1 = 82 Ω
R2 = 150 Ω
R3 = 39 Ω
R4 = 20 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

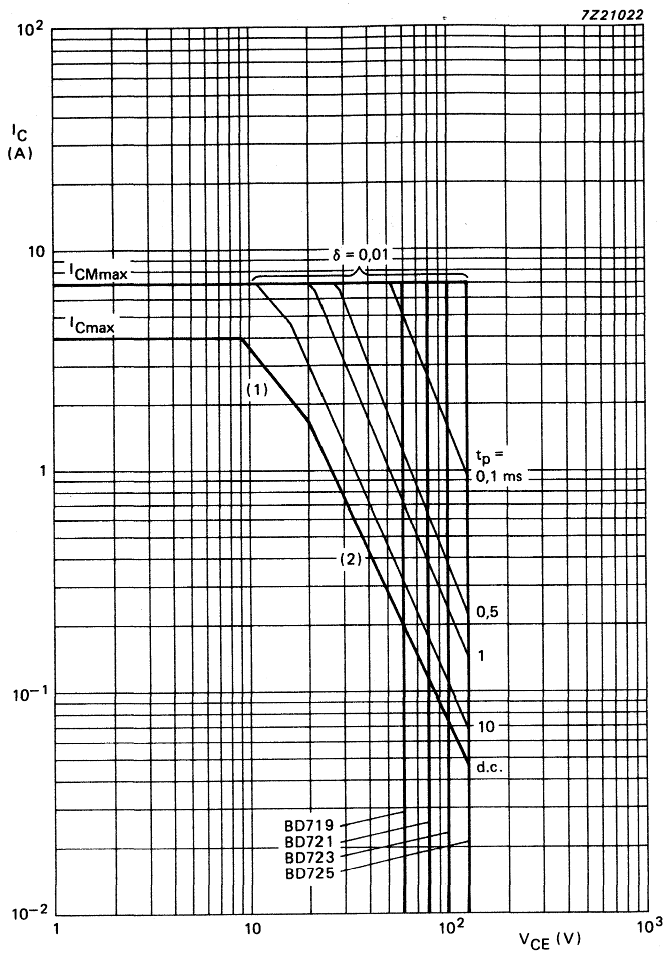


Fig. 3 Safe Operating ARea, T_{mb} = 25 °C.

(1) $P_{tot\,max}$ line.
(2) Second-breakdown limits.

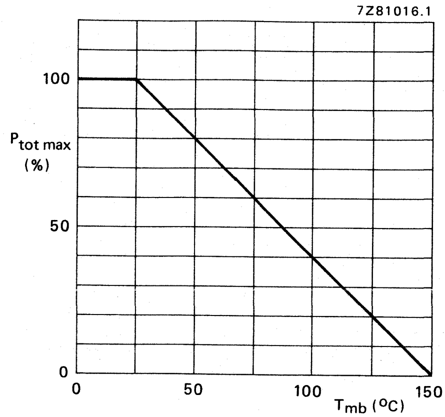


Fig. 4 Power derating curve.

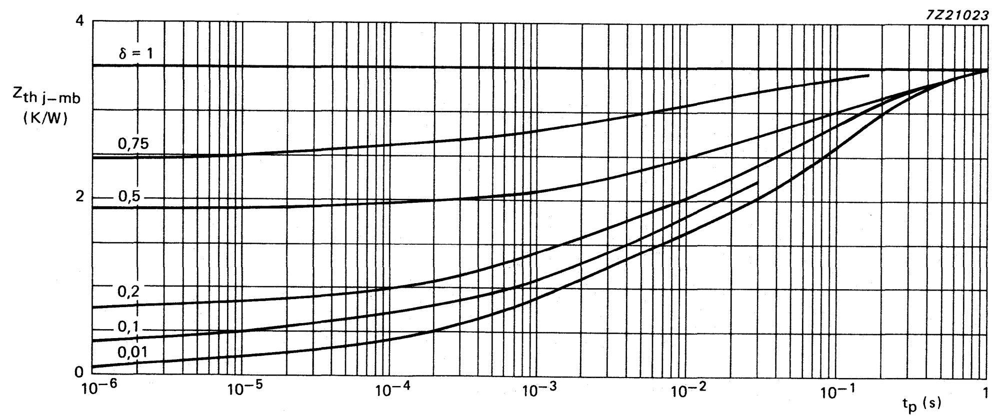


Fig. 5 Pulse power rating chart.

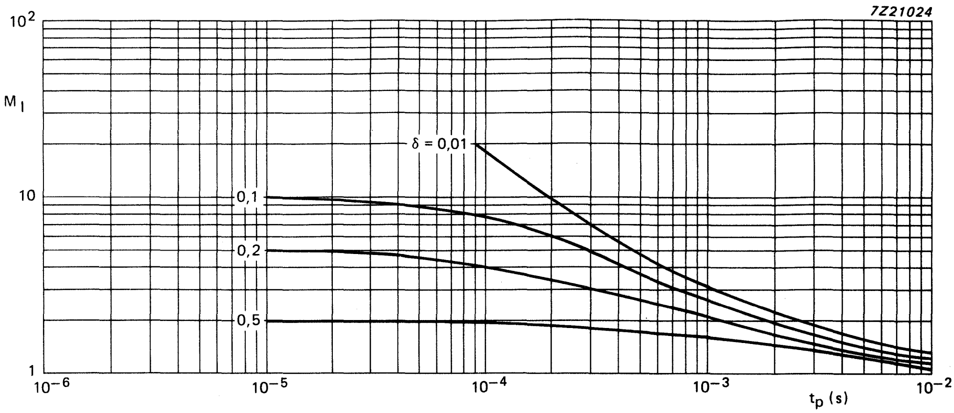


Fig. 6 Second breakdown current multiplying factor at $V_{CEO\,max}$ level.

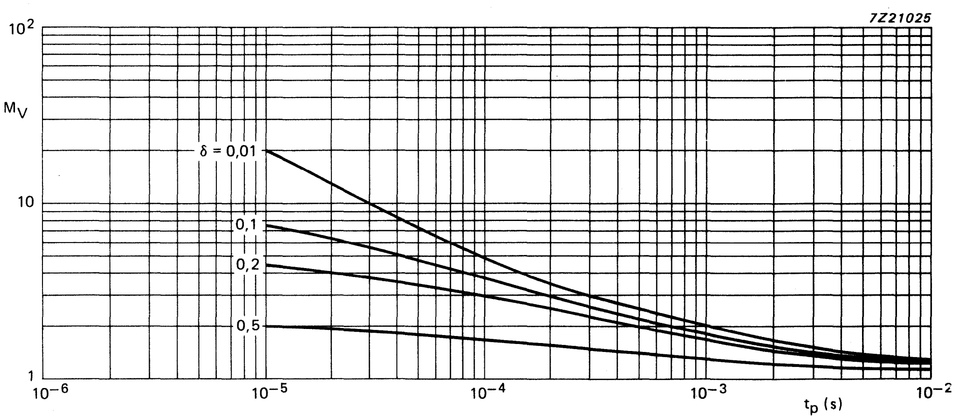


Fig. 7 Second breakdown voltage multiplying factor at $I_{C\,max}$ level.

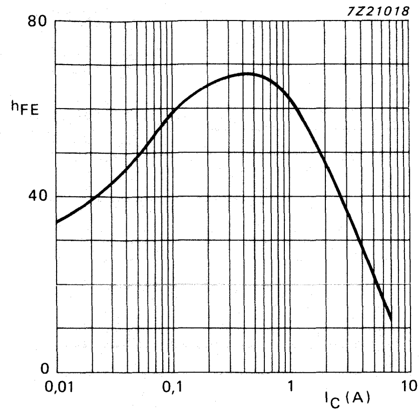


Fig. 8 Typical D.C. current gain. T_j = 25 °C; V_{CE} = 4 V.

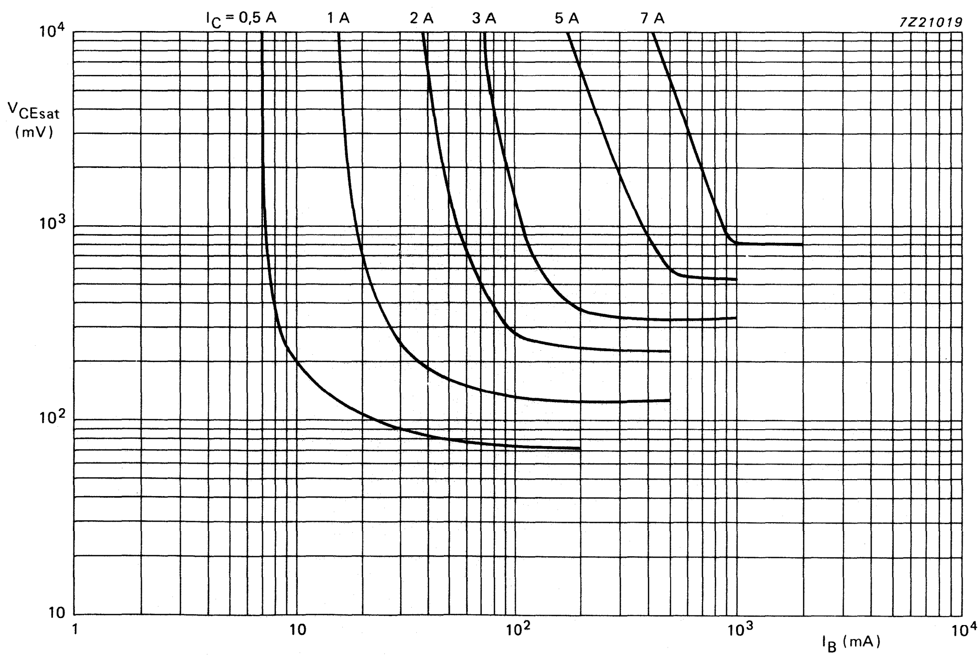


Fig. 9 Typical values collector-emitter saturation. T_j = 25 °C.

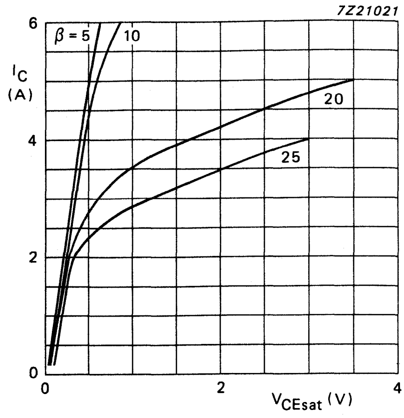


Fig. 10 Typical collector-emitter saturation voltage versus collector current (h_{FE} constant). $T_j = 25\ ^oC$.

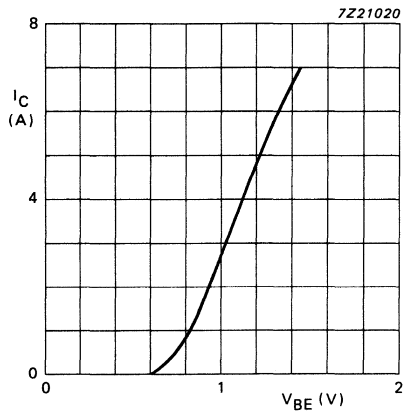


Fig. 11 Collector current. $V_{CE} = 4$ V; $T_j = 25\ ^oC$.

SILICON EPITAXIAL-BASE POWER TRANSISTOR

PNP transistor in a SOT-32 plastic envelope intended for use in audio output and general purpose amplifier applications. NPN complements are BD719; 721; 723 and BD724.

QUICK REFERENCE DATA

			BD720	BD722	BD724	BD726	
Collector-base voltage	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.	4	4	4	4	A
(peak value)	$-I_{CM}$	max.	7	7	7	7	A
Junction temperature	T_j	max.	150	150	150	150	°C
D.C. current gain $I_C = -2$ A; $V_{CE} = -4$ V	h_{FE}	min.	20	20	20	20	
Transition frequency $I_C = -0{,}5$ A; $V_{CE} = -4$ V	f_T	min.	3	3	3	3	MHz

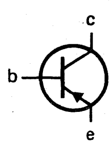
MECHANICAL DATA

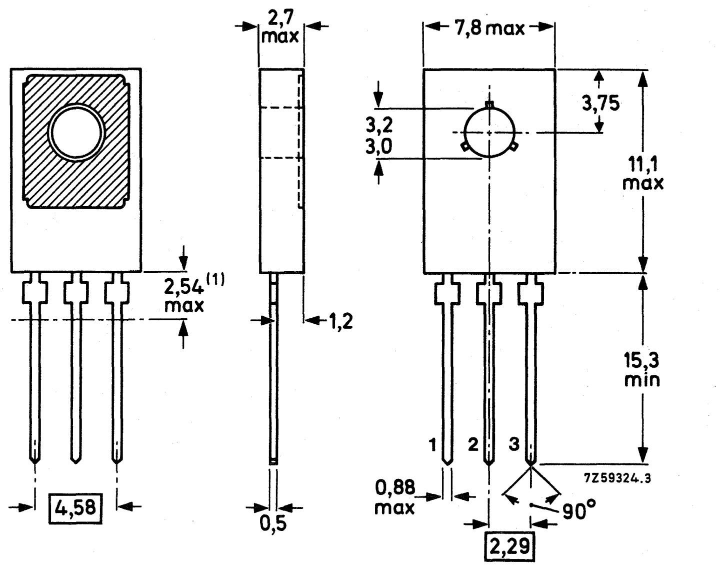
Dimensions in mm

Fig. 1 TO-126 (SOT32).

Collector connected to metal part of mounting surface

Pinning
1 = emitter
2 = collector
3 = base





(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD720	BD722	BD724	BD726	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage	$-V_{EBO}$	max.	5	5	5	5	V
Collector current							
d.c. value	$-I_C$	max.	4				A
peak value	$-I_{CM}$	max.	7				A
Base current (d.c.)	$-I_B$	max.	1				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	36				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	max.	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	max.	3,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD720	BD722	BD724	BD726	
→ Collector cut-off current							
$I_E = 0; -V_{CB} = -V_{CBO}$	$-I_{CBO}$	max.	50	50	50	50	mA
$I_E = 0; -V_{CB} = -½\ V_{CBO}$; T_j = 150 °C;	$-I_{CBO}$	max.	1	1	1	1	mA
$I_B = 0; -V_{CE} = -½\ V_{CEO}$	$-I_{CEO}$	max.	0,1	0,1	0,1	0,1	mA
→ Emitter cut-off current							
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	max.	0,2	0,2	0,2	0,2	mA
D.C. current gain (1)							
$-I_C$ = 0,5 A; $-V_{CE}$ = 4 V	h_{FE}	min.	40	40	40	40	
$-I_C$ = 2 A; $-V_{CE}$ = 4 V	h_{FE}	min.	20	20	20	20	
Base-emitter voltage (1) (2)							
$-I_C$ = 2 A; $-V_{CE}$ = 4 V	$-V_{BE}$	max.	1,4	1,4	1,4	1,4	V
Collector-emitter saturation voltage (1)							
$-I_C$ = 2 A; $-I_B$ = 0,2 A	$-V_{CEsat}$	max.	1	1	1	1	V

(1) $t_p = 300\ \mu s$; $\delta \leqslant 2\%$.
(2) V_{BE} decreases by about 2,3 mV/K with increasing temperature.

			BD720	BD722	BD724	BD726	
Transition frequency at f = 1 MHz							
$-I_C$ = 0,5 A; $-V_{CE}$ = 4 V	f_t	min.	3	3	3	3	MHz
Switching times							
$-I_{Con}$ = 1 A;							
$-I_{Bon}$ = I_{Boff} = 0,1 A							
Turn-on time	t_{on}	typ.	0,1	0,1	0,1	0,1	μs
Turn-off time	t_{off}	typ.	0,4	0,4	0,4	0,4	μs

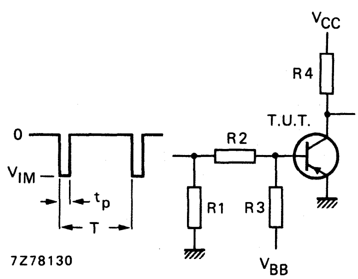


Fig. 2 Switching times test circuit.

$-V_{IM}$ = 30 V
$-V_{CC}$ = 20 V
$+V_{BB}$ = 3,5 V
R1 = 82 Ω
R2 = 150 Ω
R3 = 39 Ω
R4 = 20 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

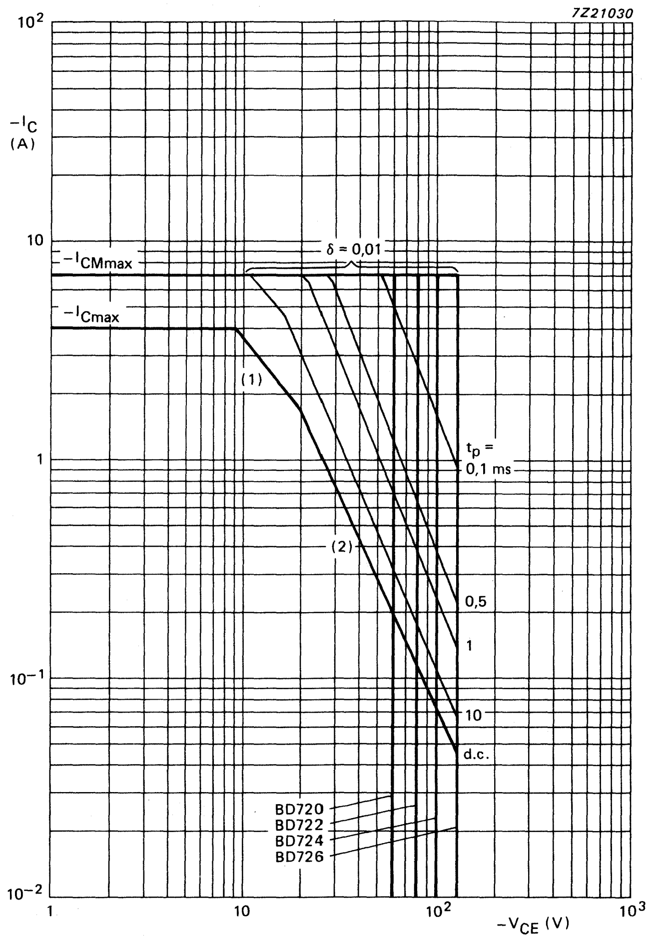


Fig. 3 Safe Operating ARea, T_{mb} = 25 °C.

(1) $P_{tot\ max}$ line.
(2) Second-breakdown limits.

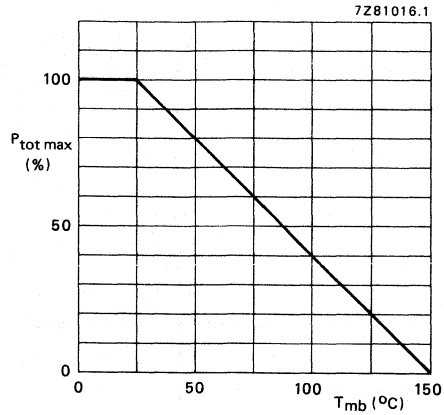


Fig. 4 Power derating curve.

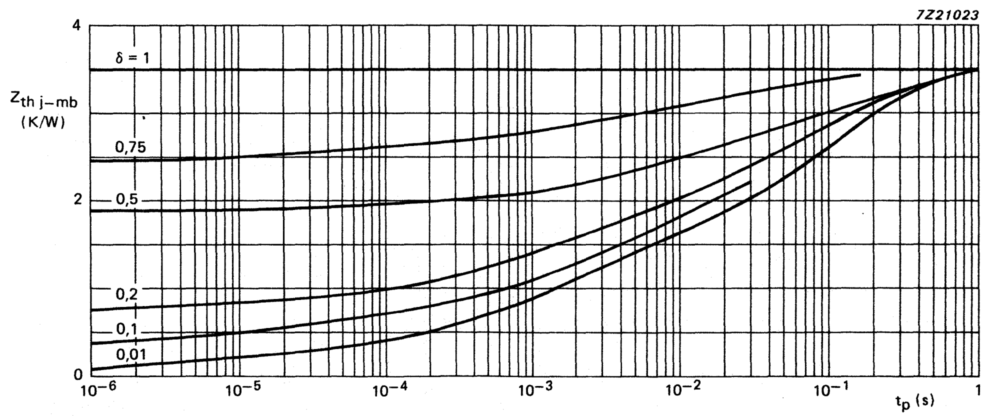


Fig. 5 Pulse power rating chart.

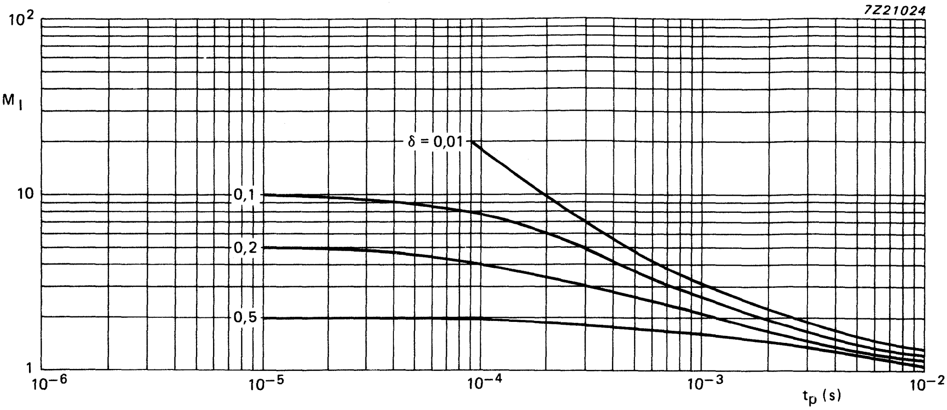


Fig. 6 Second breakdown current multiplying factor at $V_{CEO\,max}$ level.

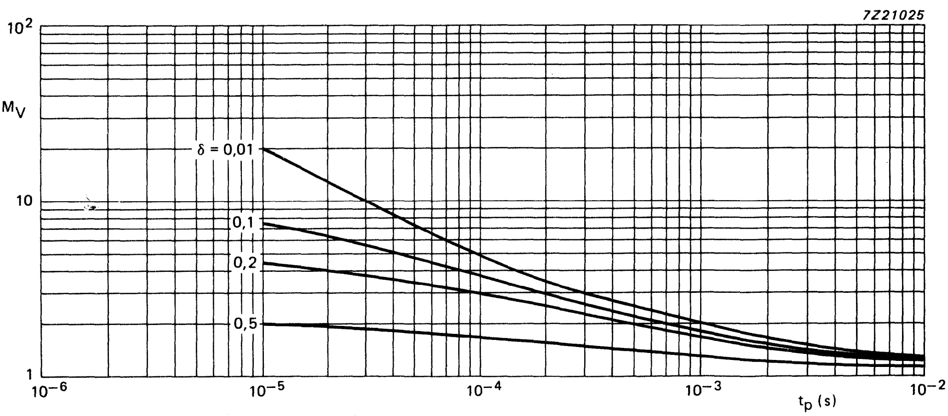


Fig. 7 Second breakdown voltage multiplying factor at $I_{C\,max}$ level.

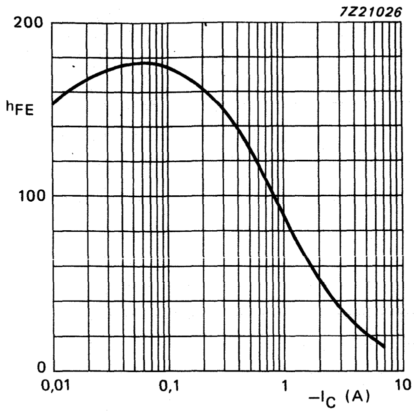


Fig. 8 Typical D.C. current gain. T_j = 25 °C; V_{CE} = 4 V.

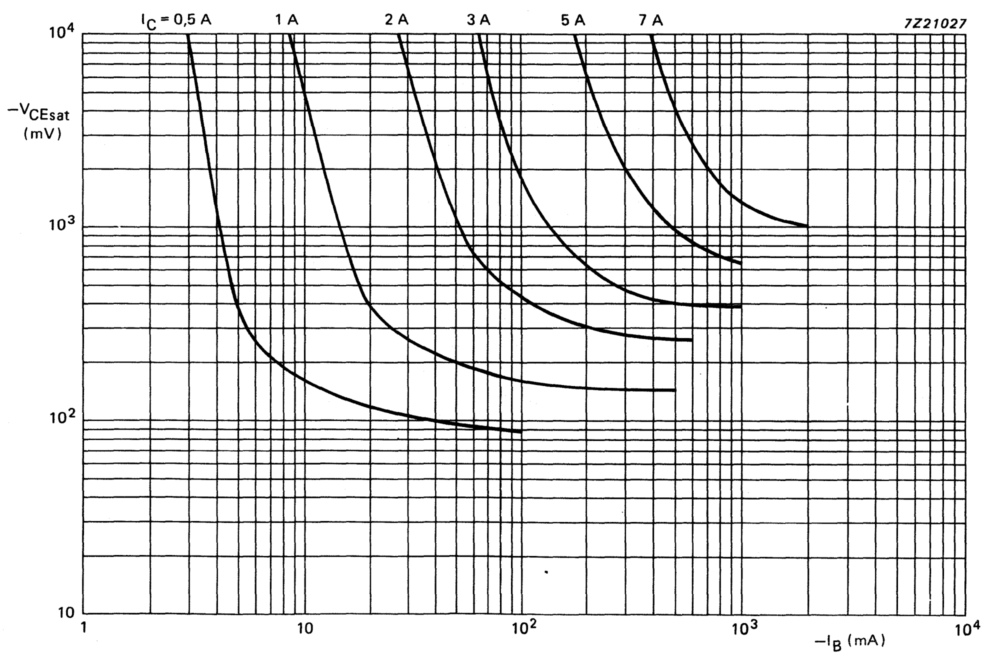


Fig. 9 Typical values collector-emitter saturation. T_j = 25 °C.

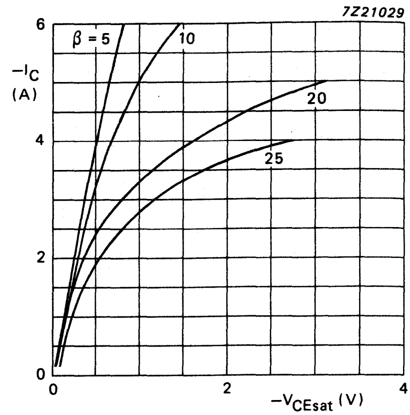


Fig. 10 Typical collector-emitter saturation voltage versus collector current (h_{FE} constant). $T_j = 25\ ^oC$.

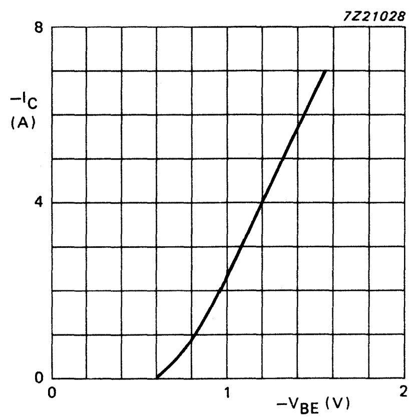


Fig. 11 Collector current. $V_{CE} = 4$ V; $T_j = 25\ ^oC$.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose N-P-N transistors, in TO-202 plastic envelopes, recommended for driver-stages in hi-fi amplifiers and television circuits.

P-N-P complements are BD826, BD828 and BD830. Matched pairs can be supplied.

QUICK REFERENCE DATA

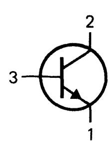
			BD825	BD827	BD829	
Collector-base voltage	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.		1,5		A
Total power dissipation at T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
at T_{mb} = 50 °C	P_{tot}	max.		8		W
Junction temperature	T_j	max.		150		°C
D.C. current gain I_C = 150 mA; V_{CE} = 2 V	h_{FE}			40 to 250		
Transition frequency I_C = 50 mA; V_{CE} = 5 V	f_T	typ.		250		MHz

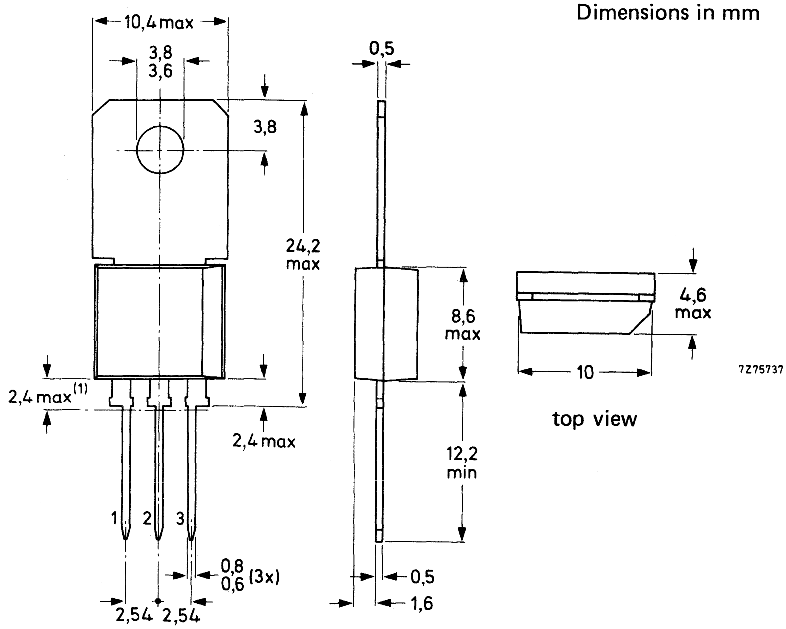
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected to mounting base





(1) Plastic flash allowed within this zone.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD825	BD827	BD829	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (d.c.)	I_C	max.		1,0		A
Collector current (peak)	I_{CM}	max.		1,5		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 50 °C	P_{tot}	max.		8		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents			
I_E = 0; V_{CB} = 30 V	I_{CBO}	<	100 nA
I_E = 0; V_{CB} = 30 V; T_j = 125 °C	I_{CBO}	<	10 μA
Emitter cut-off current			
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	10 μA
D.C. current gain			
I_C = 5 mA; V_{CE} = 2 V	h_{FE}	>	25
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 to 250
I_C = 500 mA; V_{CE} = 2 V	h_{FE}	>	25
Collector-emitter saturation voltage			
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	0,5 V
Base-emitter voltage			
I_C = 500 mA; V_{CE} = 2 V	V_{BE}	<	1 V
Transition frequency at f = 35 MHz			
I_C = 50 mA; V_{CE} = 5 V	f_T	typ.	250 MHz
D.C. current gain ratio of matched complementary pairs			
$\|I_C\|$ = 150 mA; $\|V_{CE}\|$ = 2 V	h_{FE1}/h_{FE2}	typ.	1,3
		<	1,6

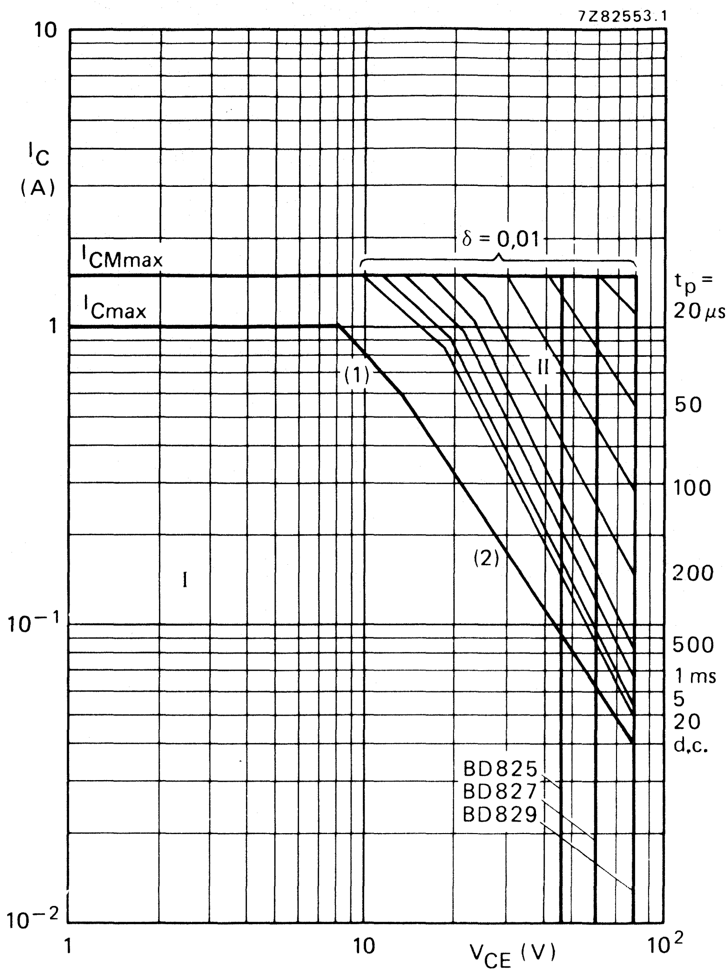


Fig. 2 Safe Operating ARea. $T_{mb} \leqslant 25\,^{o}C$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

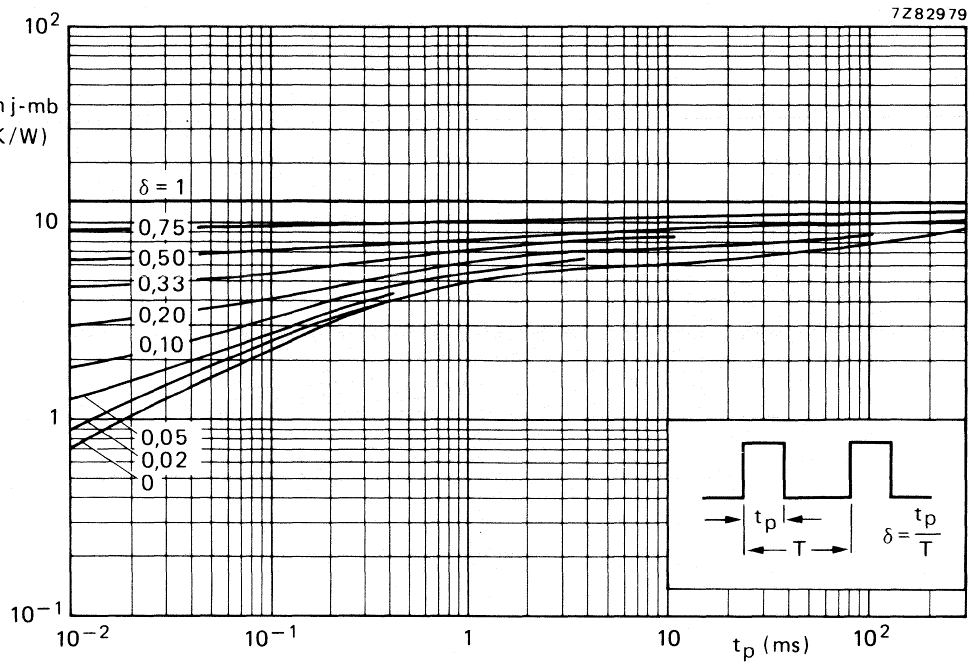


Fig. 3 Pulse power rating chart.

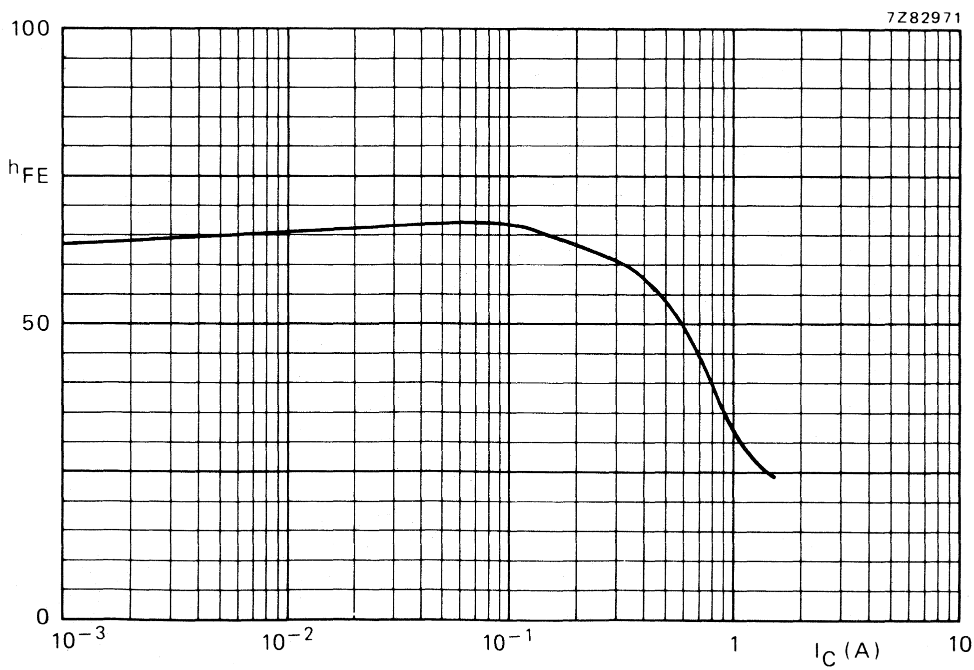


Fig. 4 Typical values d.c. current gain. V_{CE} = 2 V; T_{amb} = 25 °C.

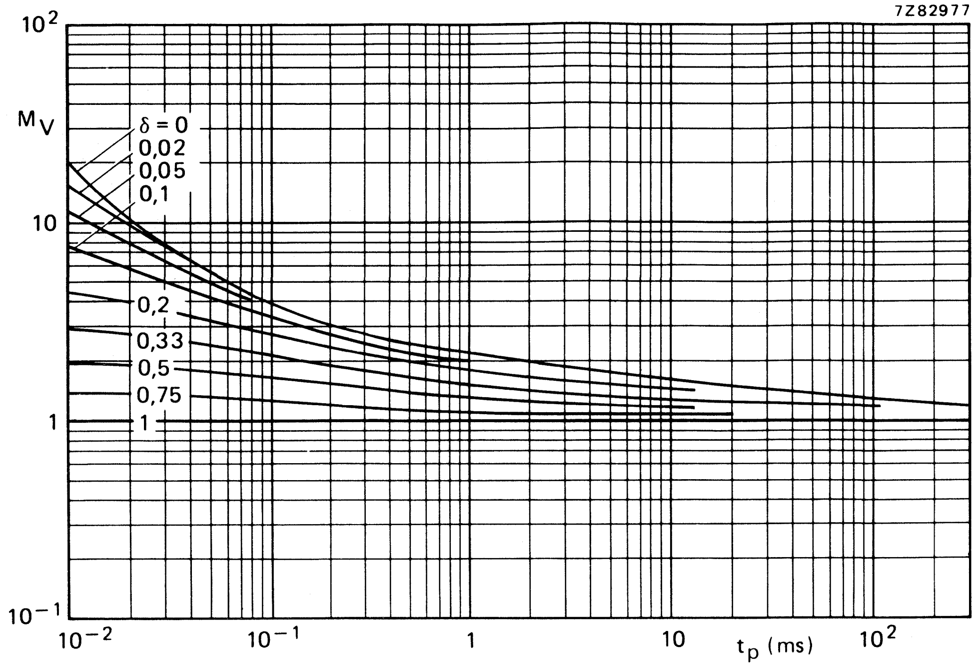


Fig. 5 S.B. voltage multiplying factor at I_{Cmax} level.

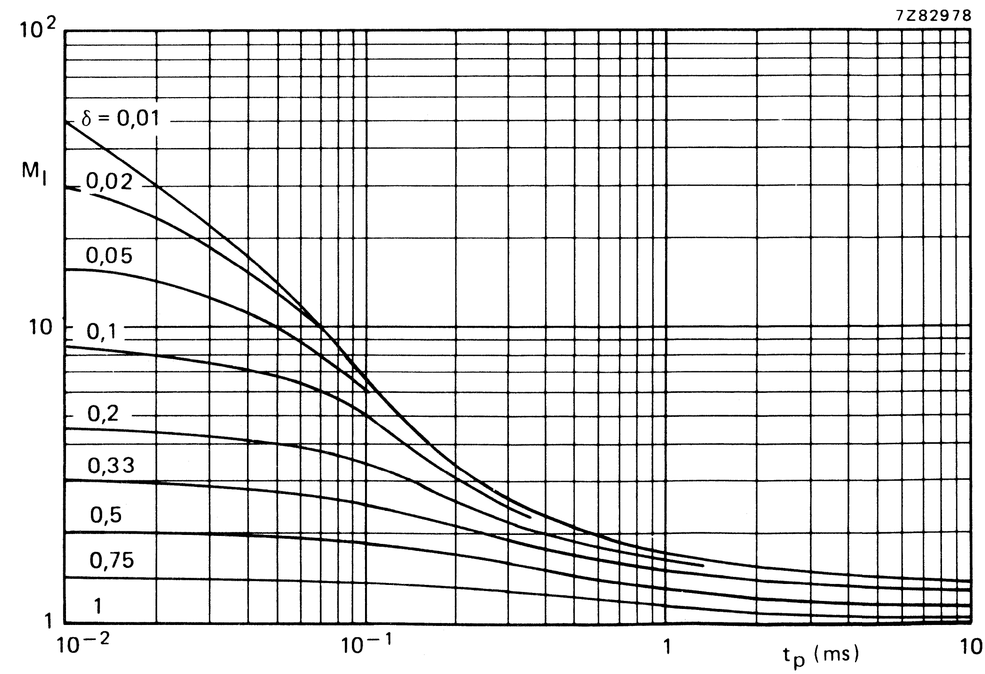


Fig. 6 S.B. current multiplying factor at V_{CEOmax} level.

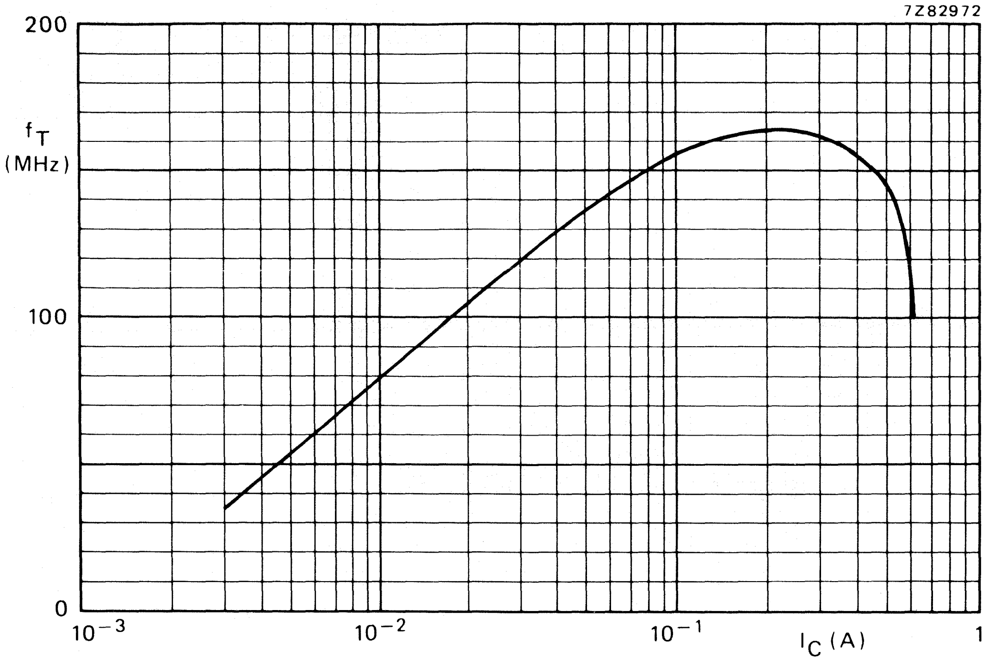


Fig. 7 Typical values transition frequency. V_{CE} = 5 V; f = 35 MHz; T_{amb} = 25 °C.

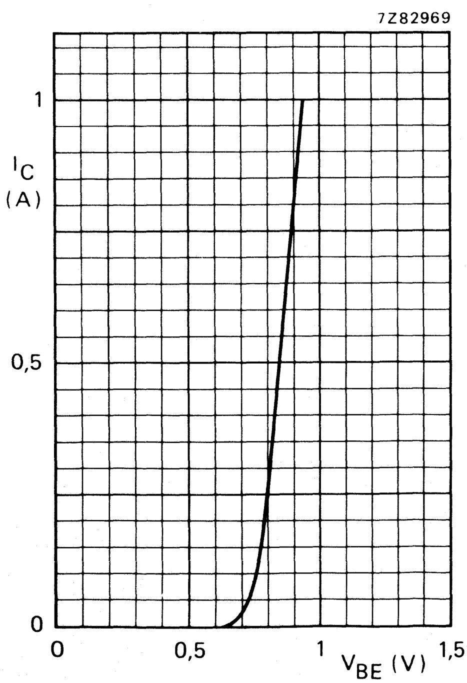


Fig. 8 Typical values. V_{CE} = 2 V; T_{amb} = 25 °C.

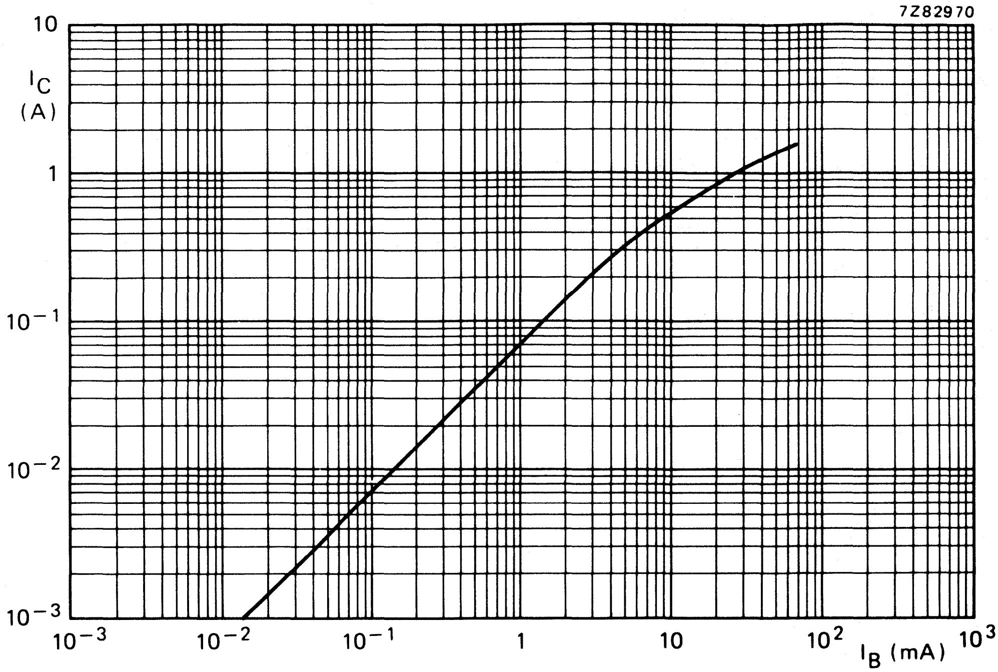


Fig. 9 Typical values at V_{CE} = 2 V; T_{amb} = 25 ^oC:

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose P-N-P transistors, in TO-202 plastic envelopes, recommended for driver stages in hi-fi amplifiers and television circuits.

N-P-N complements are BD825, BD827 and BD829. Matched pairs can be supplied.

QUICK REFERENCE DATA

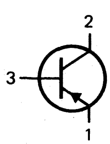
			BD826	BD828	BD830	
Collector-base voltage	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.		1,5		A
Total power dissipation						
at T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
at T_{mb} = 50 °C	P_{tot}	max.		8		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}			40 to 250		
Transition frequency						
$-I_C$ = 50 mA; $-V_{CE}$ = 5 V	f_T	typ.		75		MHz

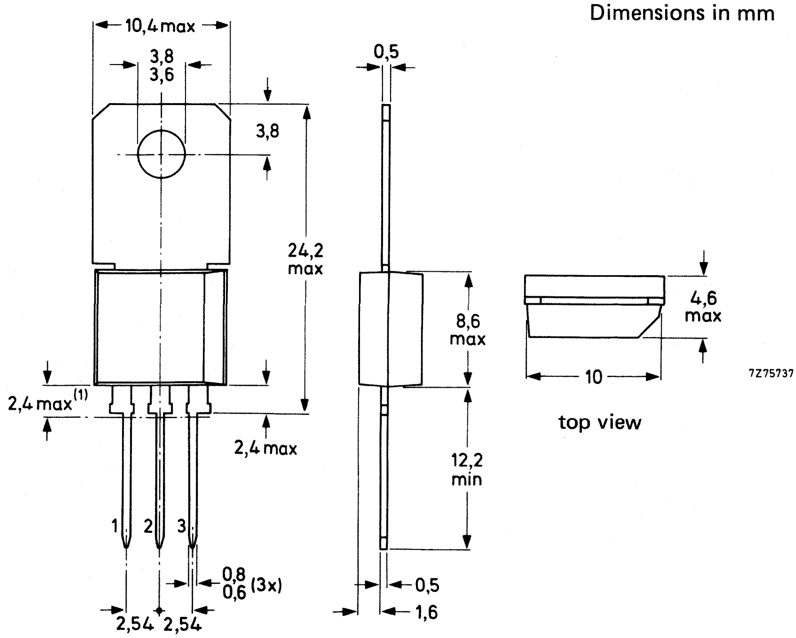
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected to mounting base.





(1) Plastic flash allowed within this zone.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD826	BD828	BD830	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	1	A
Collector current (peak value)	$-I_{CM}$	max.	1,5	A
Total power dissipation				
T_{amb} = 25 °C (free air)	P_{tot}	max.	2	W
T_{mb} = 50 °C	P_{tot}	max.	8	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $-V_{CB} = 30$ V	$-I_{CBO}$	<	100 nA
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 125$ °C	$-I_{CBO}$	<	10 μA
Emitter cut-off current			
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10 μA
D.C. current gain			
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}		40 to 250
$-I_C = 500$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
Collector-emitter saturation voltage			
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	0,5 V
Base-emitter voltage			
$-I_C = 500$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	<	1 V
Transition frequency at f = 35 MHz			
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	typ.	75 MHz
D.C. current gain ratio of matched complementary pairs			
$\|I_C\| = 150$ mA; $\|V_{CE}\| = 2$ V	h_{FE1}/h_{FE2}	typ. <	1,3 1,6

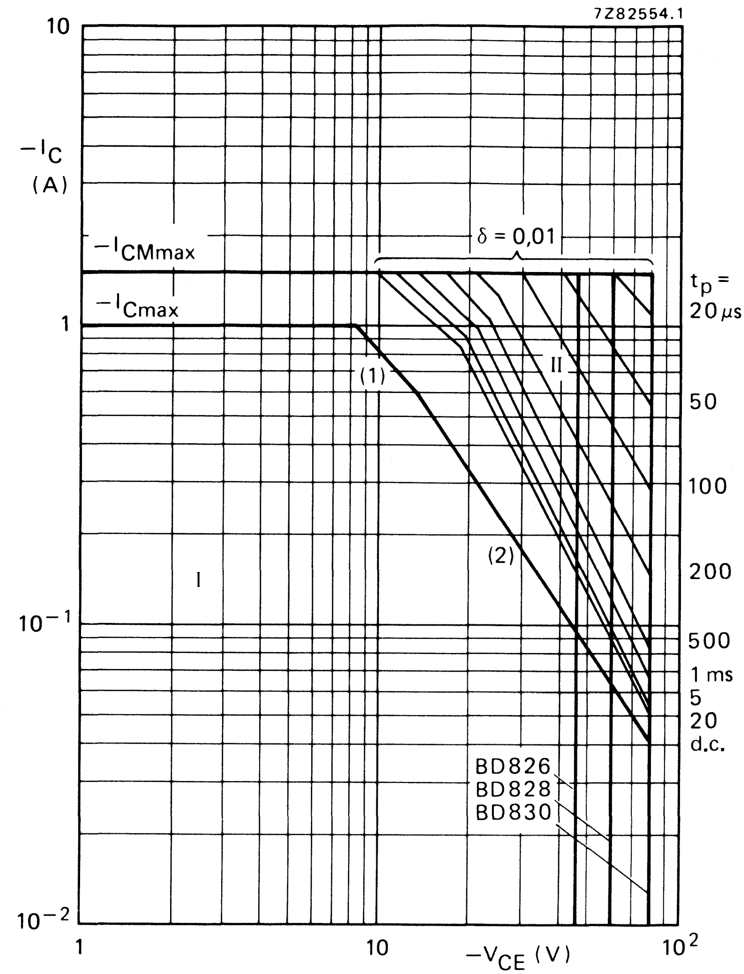


Fig. 2 Safe Operating ARea, $T_{mb} \leqslant 25\ ^{o}C$.

I Region of permissible d.c. operation.
II Permissible extension for repetition pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

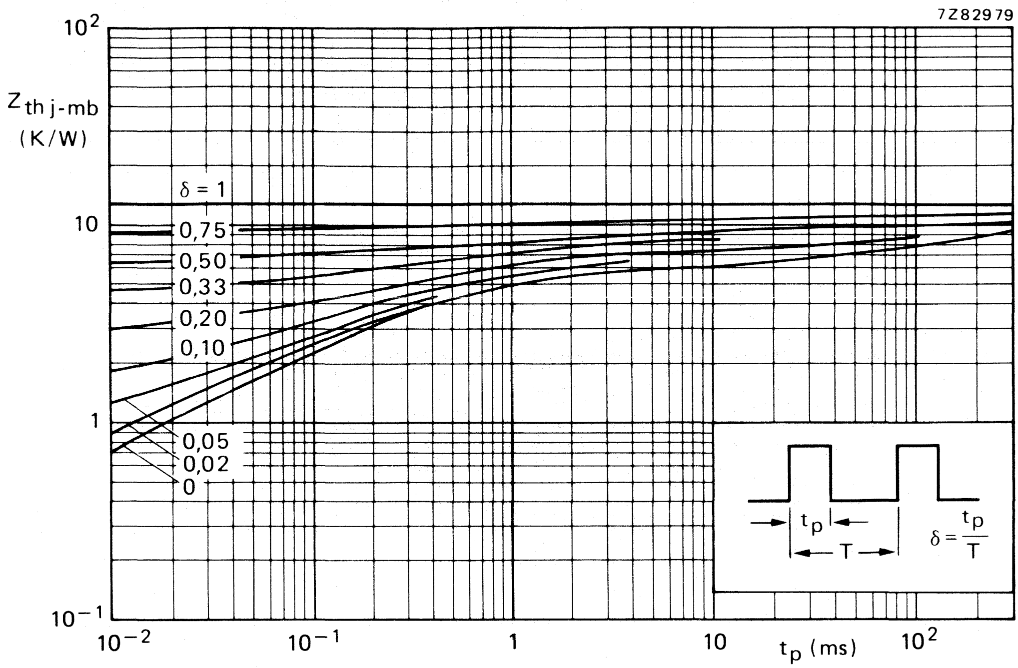


Fig. 3 Pulse power rating chart.

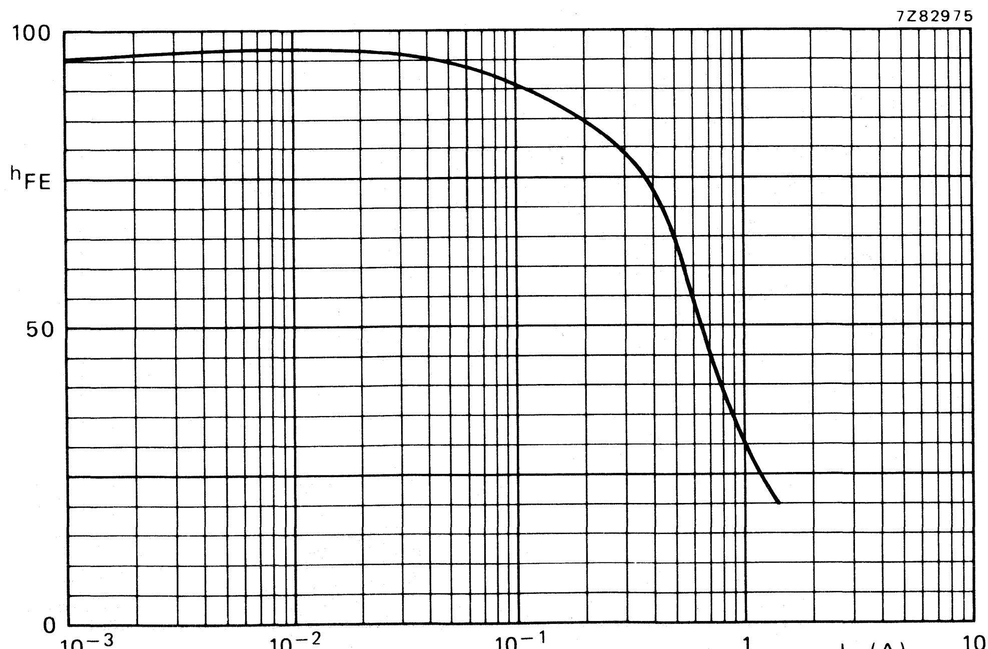


Fig. 4 Typical values d.c. current gain. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

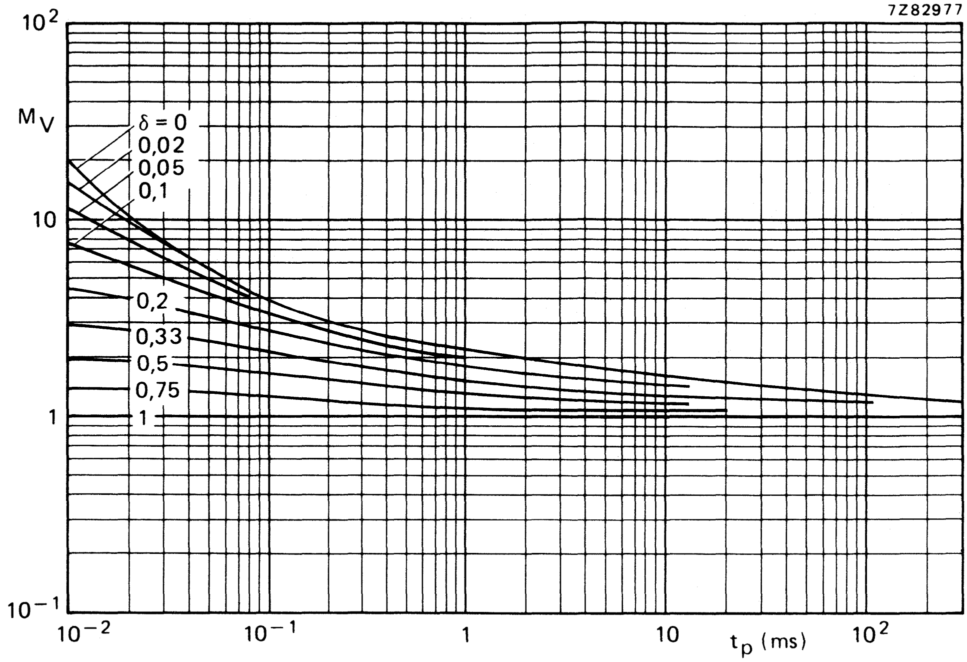


Fig. 5 S.B. voltage multiplying factor at I_{Cmax} level.

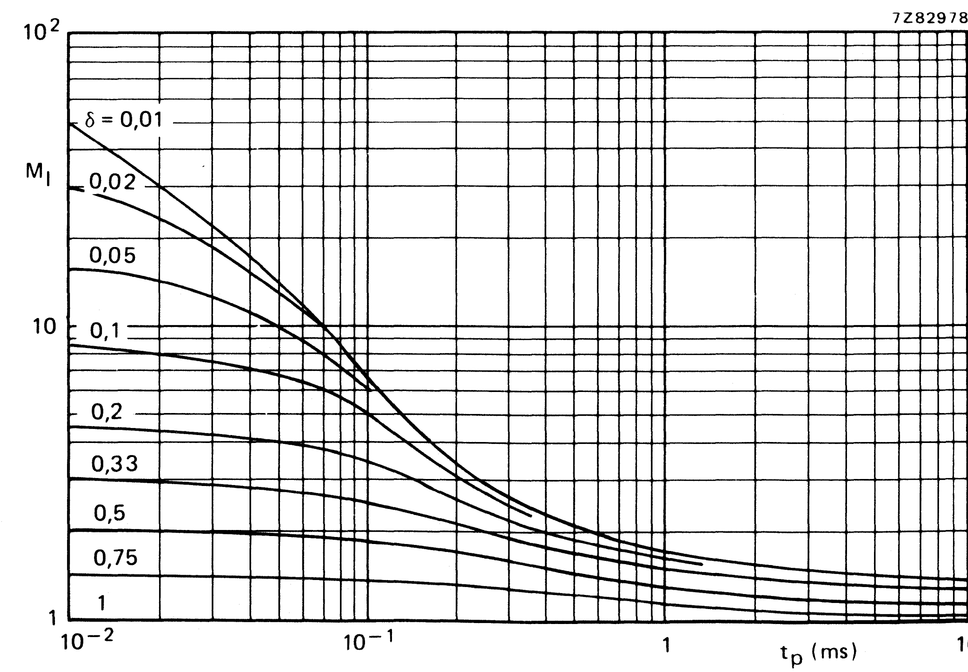


Fig. 6 S.B. current multiplying factor at V_{CEOmax} level.

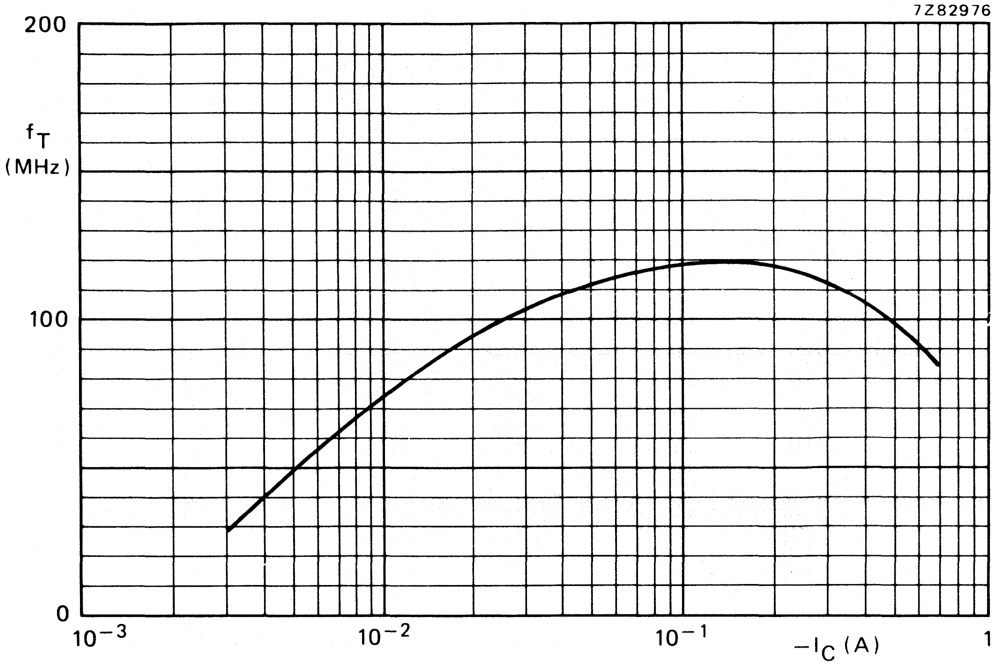


Fig. 7 Typical values transition frequency at $-V_{CE}$ = 5 V; f = 35 MHz; T_{amb} = 25 °C.

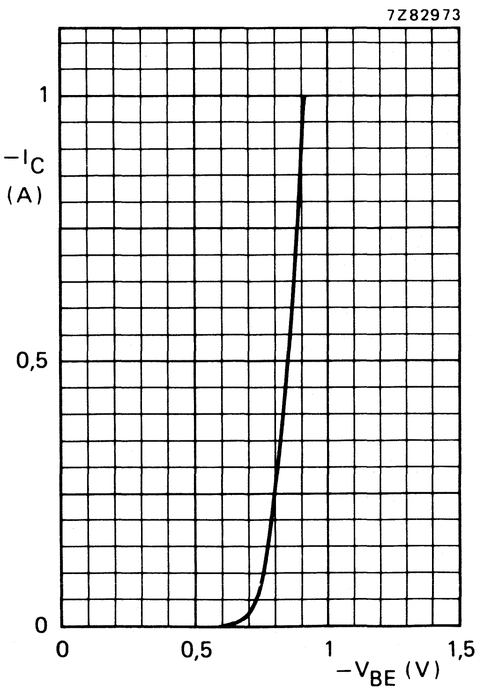


Fig. 8 Typical values. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

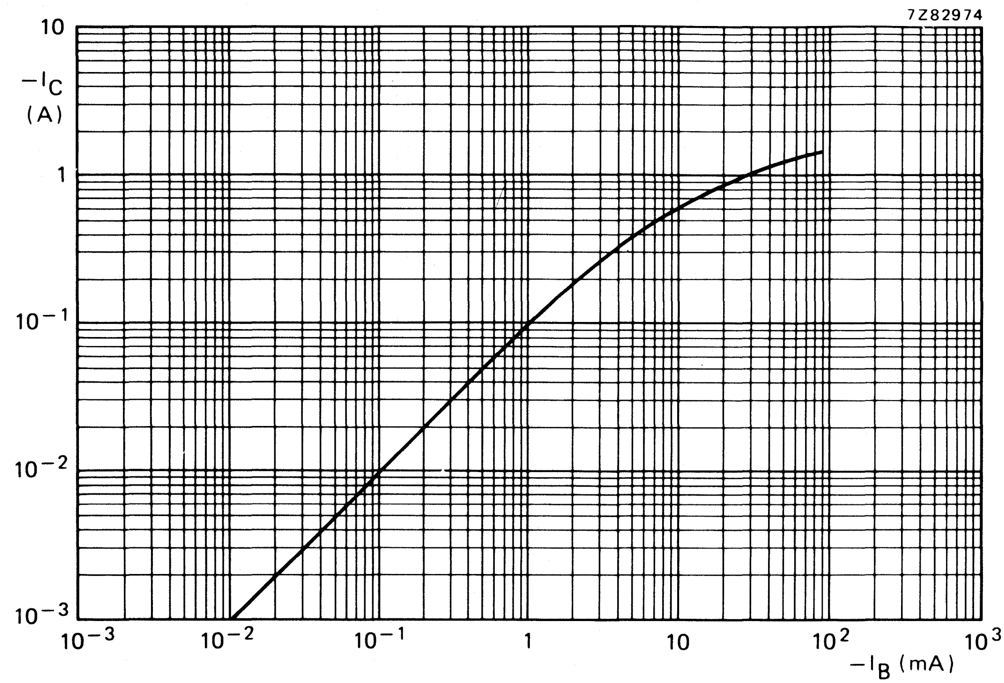


Fig. 9 Typical values at $-V_{CE} = 2$ V; $T_{amb} = 25$ °C.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

N-P-N silicon transistors, in a plastic TO-202 envelope, recommended for use in television circuits and audio applications.
P-N-P complements are BD840, BD842 and BD844.

QUICK REFERENCE DATA

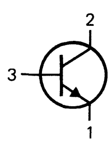
			BD839	BD841	BD843	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.		3		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °C	P_{tot}	max.		10		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>		25		
Transition frequency at f = 35 MHz						
I_C = 50 mA; V_{CE} = 5 V	f_T	typ.		125		MHz

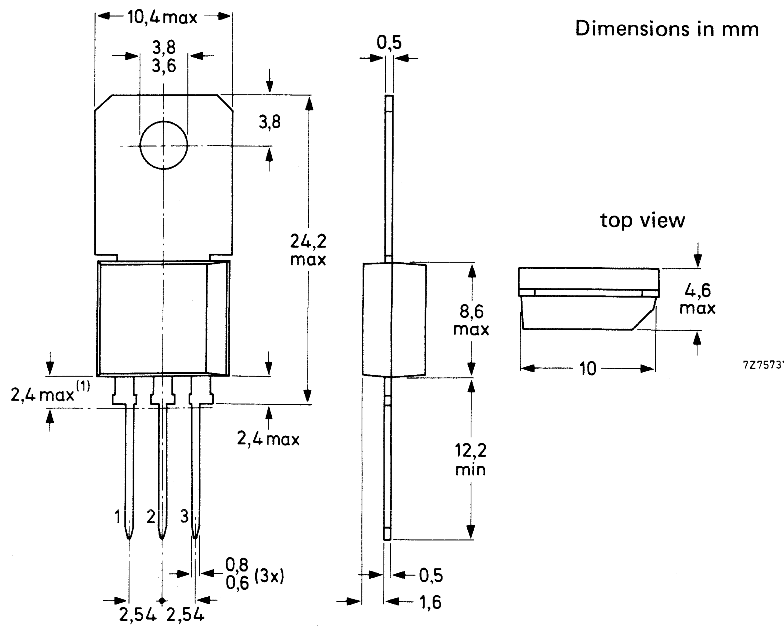
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected to mounting base.





(1) Plastic flash allowed within this zone.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD839	BD841	BD843	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
Collector current (d.c.)	I_C	max.		1,5		A
Collector current (peak value)	I_{CM}	max.		3		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °C	P_{tot}	max.		10		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	<	100 nA
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 125$ °C	I_{CBO}	<	10 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10 μA
Base-emitter voltage*			
$I_C = 1$ A; $V_{CE} = 2$ V	V_{BE}	<	1,3 V
Collector-emitter saturation voltage			
$I_C = 1$ A; $I_B = 0{,}1$ A	V_{CEsat}	<	0,8 V
D.C. current gain			
$I_C = 5$ mA; $V_{CE} = 2$ V	h_{FE}	>	25
$I_C = 150$ mA; $V_{CE} = 2$ V	h_{FE}		40 to 250
$I_C = 1$ A; $V_{CE} = 2$ V	h_{FE}	>	25
Transition frequency at f = 35 MHz			
$I_C = 50$ mA; $V_{CE} = 5$ V	f_T	typ.	125 MHz
D.C. current gain ratio of			
BD839/BD840, BD841/BD842, BD843/BD844		typ.	1,3
$\lvert I_C \rvert = 150$ mA; $\lvert V_{CE} \rvert = 2$ V	h_{FE1}/h_{FE2}	<	1,6

* V_{BE} decreases by about 2,3 mV/K with increasing temperature.

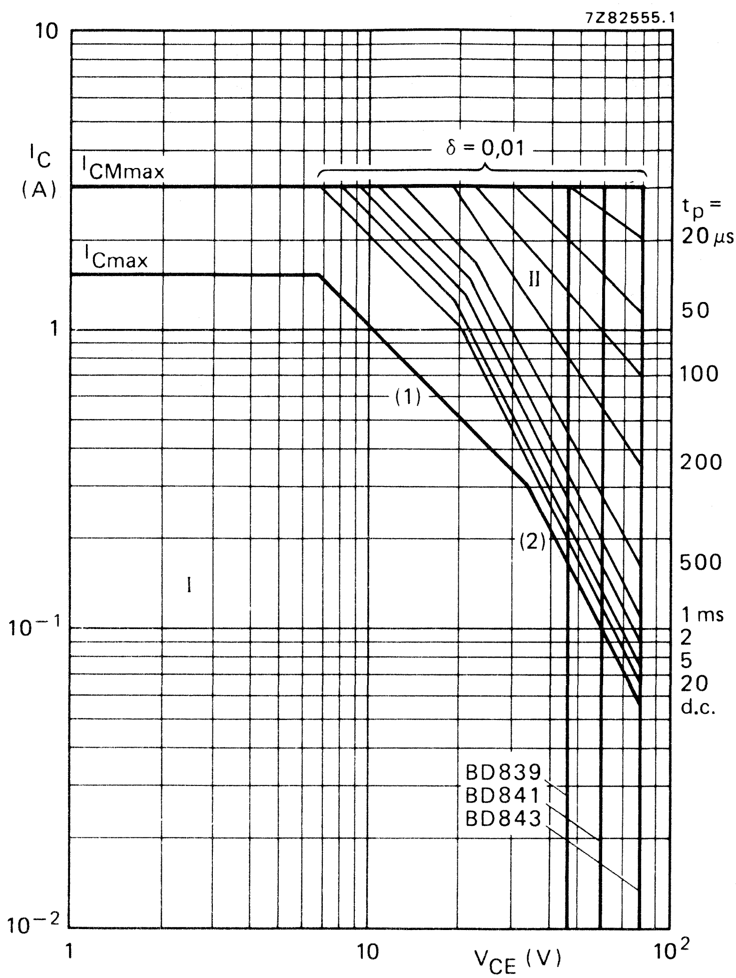


Fig. 2 Safe Operating ARea, $T_{mb} \leqslant 25$ °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

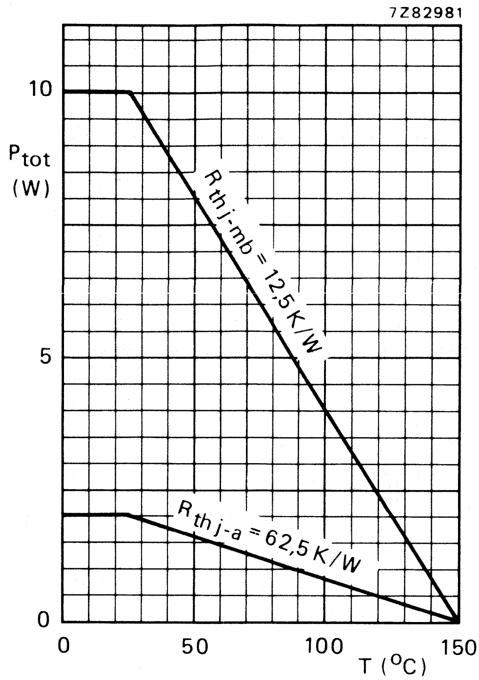


Fig. 3 Power derating curve.

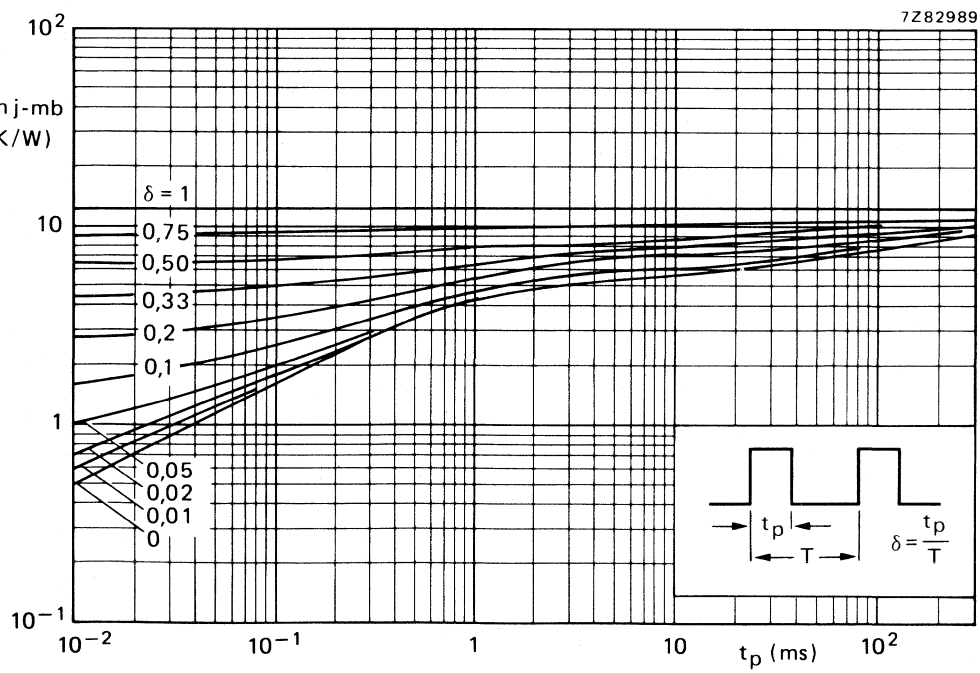


Fig. 4 Pulse power rating chart.

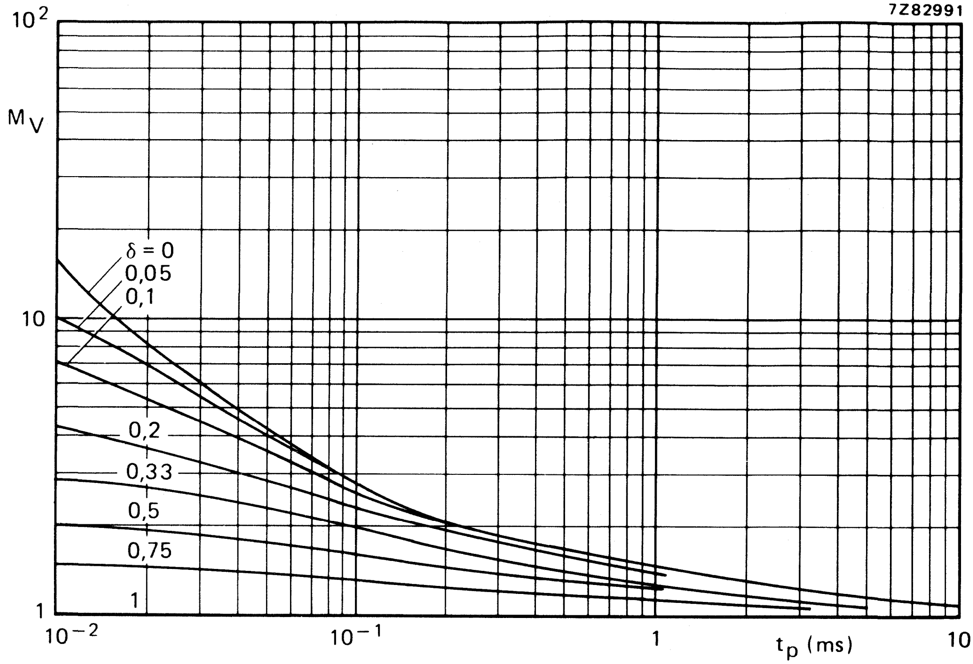


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

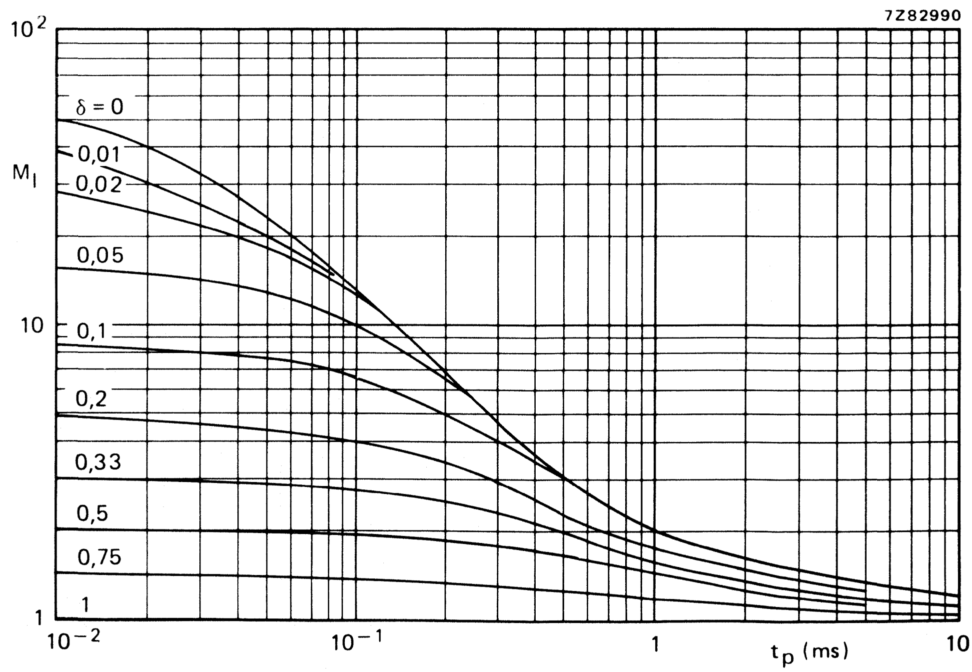


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level.

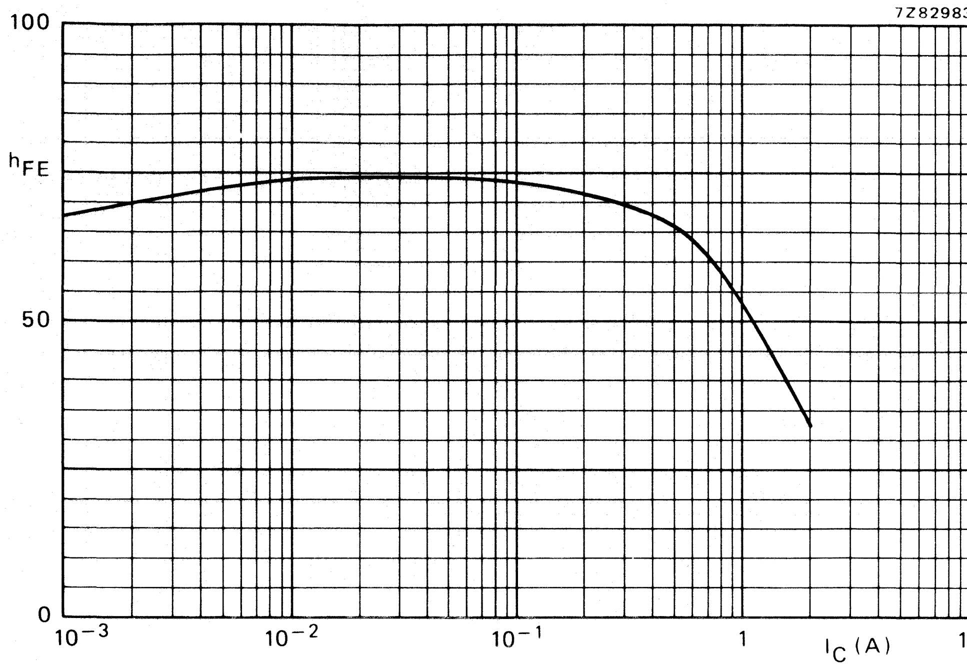


Fig. 7 Typical values d.c. current gain. V_{CE} = 2 V; T_{amb} = 25 °C.

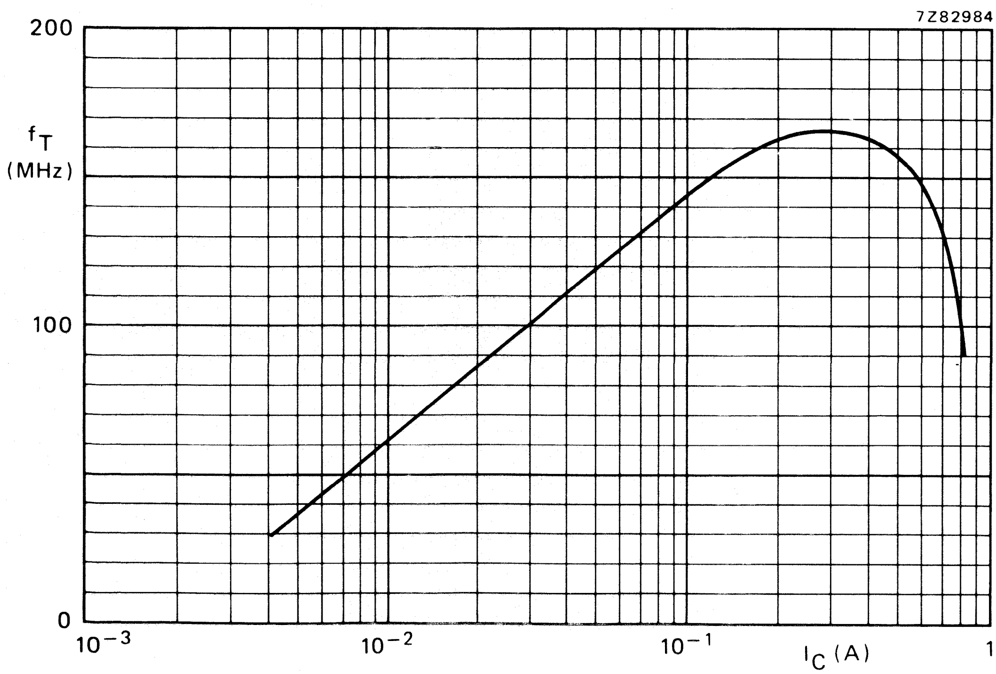


Fig. 8 Typical values transition frequency. V_{CE} = 5 V; T_{amb} = 25 °C; f = 35 MHz.

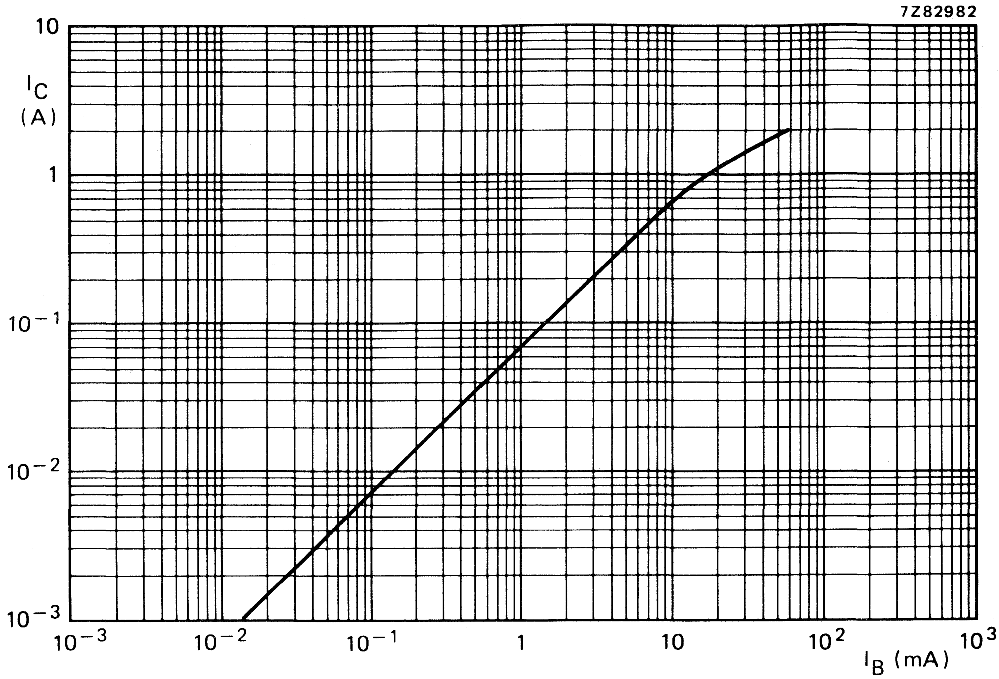


Fig. 9 Typical values at V_{CE} = 2 V; T_{amb} = 25 °C.

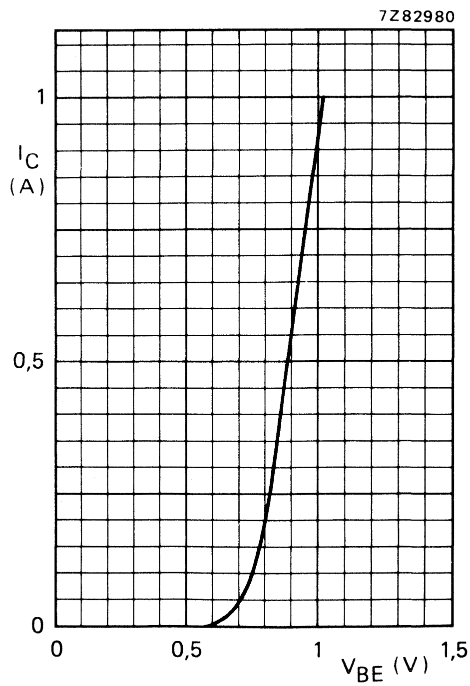


Fig. 10 Typical values. V_{CE} = 2 V; T_{amb} = 25 °C.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

P-N-P silicon transistors, in a plastic TO-202 envelope, recommended for use in television circuits and audio applications.
N-P-N complements are BD839, BD841 and BD843.

QUICK REFERENCE DATA

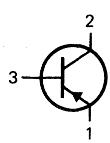
			BD840	BD842	BD844	
Collector-base voltage	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage	$-V_{EBO}$	max.	5	5	5	V
Collector current (peak value)	$-I_{CM}$	max.		3		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °C	P_{tot}	max.		10		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>		25		
Transition frequency at f = 35 MHz	f_T	typ.		50		MHz

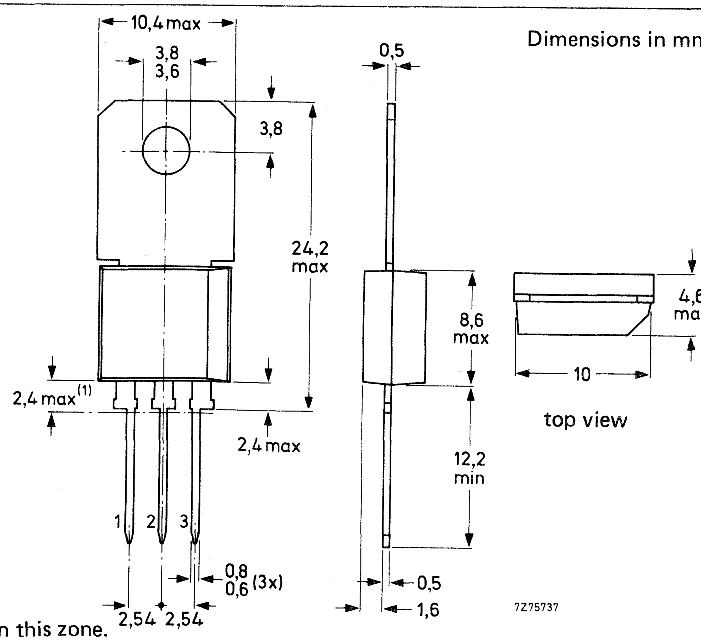
MECHANICAL DATA

Fig. 1 TO-202.

Collector connected to mounting base.

Dimensions in mm





(1) Plastic flash allowed within this zone.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD840	BD842	BD844	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (d.c.)	$-I_C$	max.		1,5		A
Collector current (peak value)	$-I_{CM}$	max.		3		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °C	P_{tot}	max.		10		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $-V_{CB} = 30$ V	$-I_{CBO}$	<	100 nA
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 125$ °C	$-I_{CBO}$	<	10 μA
Emitter cut-off current			
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10 μA
Base-emitter voltage*			
$-I_C = 1$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1,3 V
Collector-emitter saturation voltage			
$-I_C = 1$ A; $-I_B = 0,1$ A	$-V_{CEsat}$	<	0,8 V
D.C. current gain			
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}		40 to 250
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	25
Transition frequency at f = 35 MHz			
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	typ.	50 MHz
D.C. current gain ratio			
of BD839/BD840, BD841/BD842, BD843/BD844		typ.	1,3
$\|I_C\| = 150$ mA; $\|V_{CE}\| = 2$ V	h_{FE1}/h_{FE2}	<	1,6

* V_{BE} decreases by about 2,3 mV/K with increasing temperature.

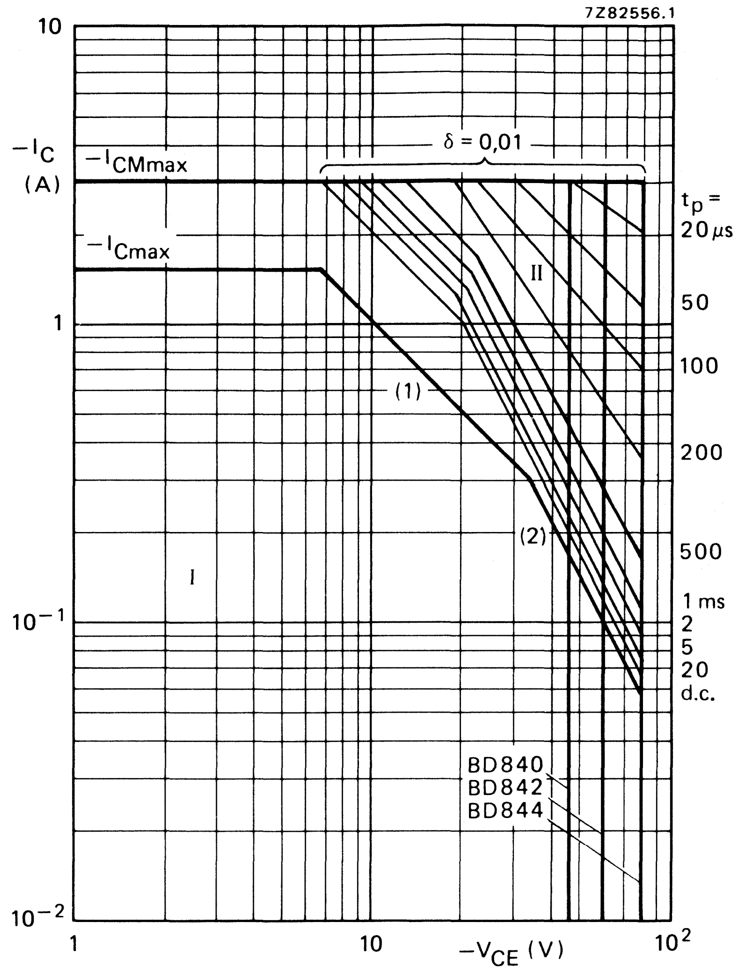


Fig. 2 Safe Operating ARea, $T_{mb} \leqslant 25\ ^{o}C$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

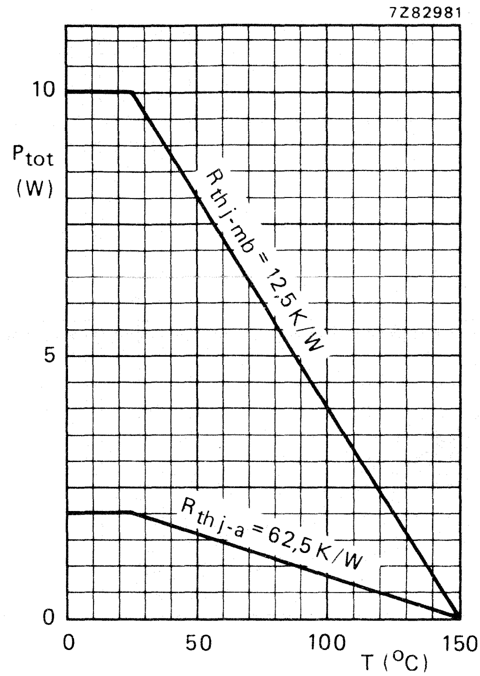


Fig. 3 Power derating curve.

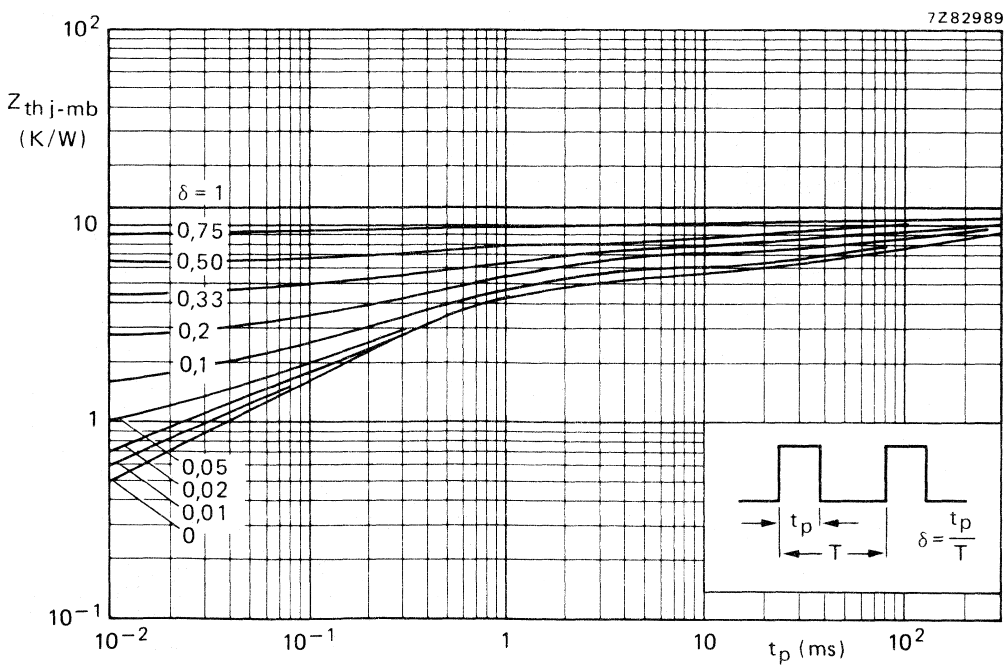


Fig. 4 Pulse power rating chart.

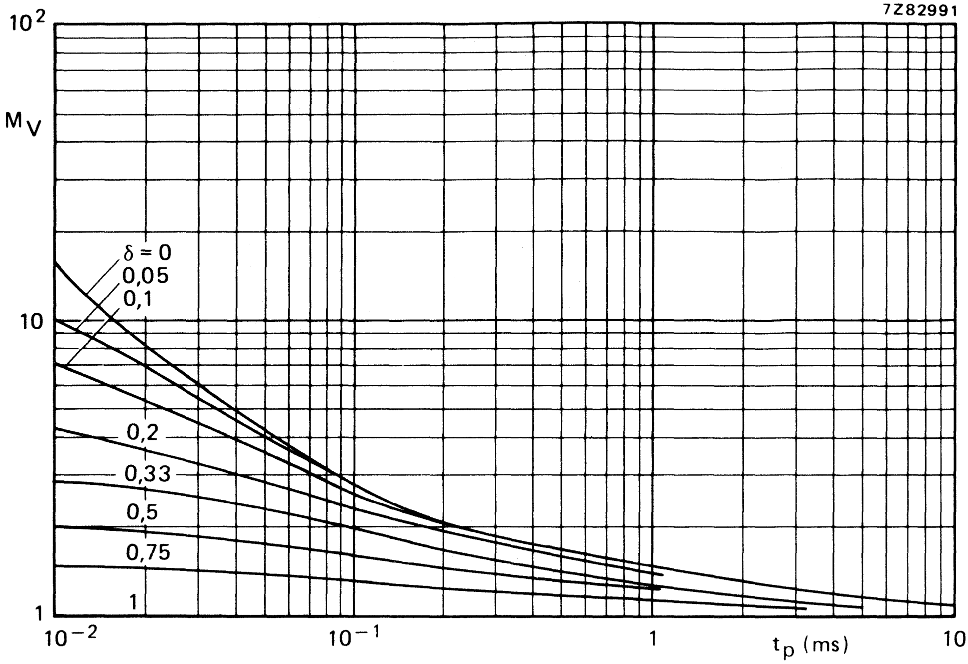


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

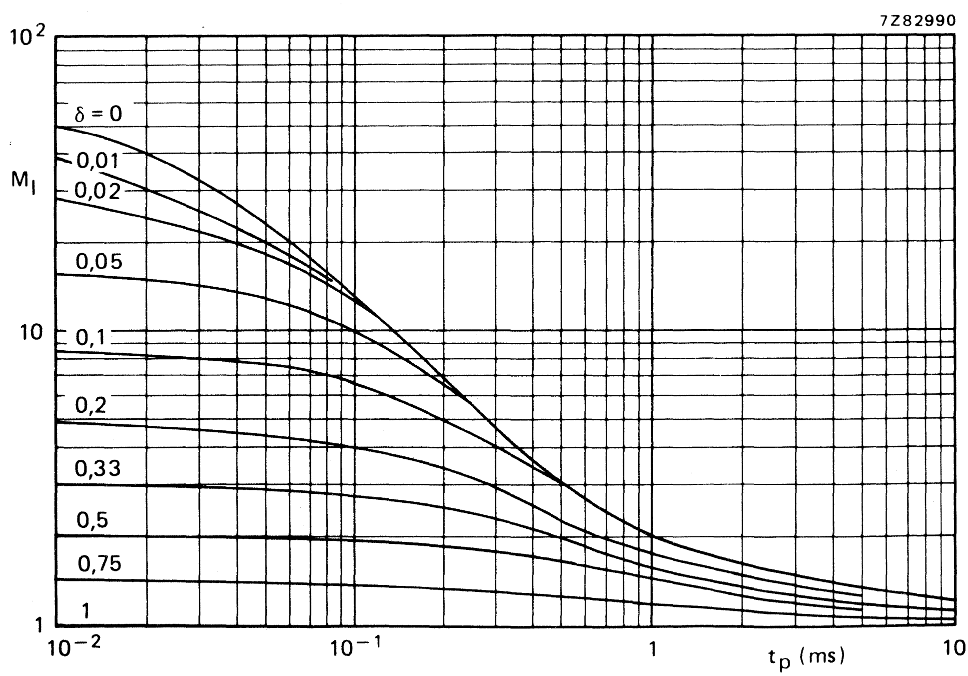


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level.

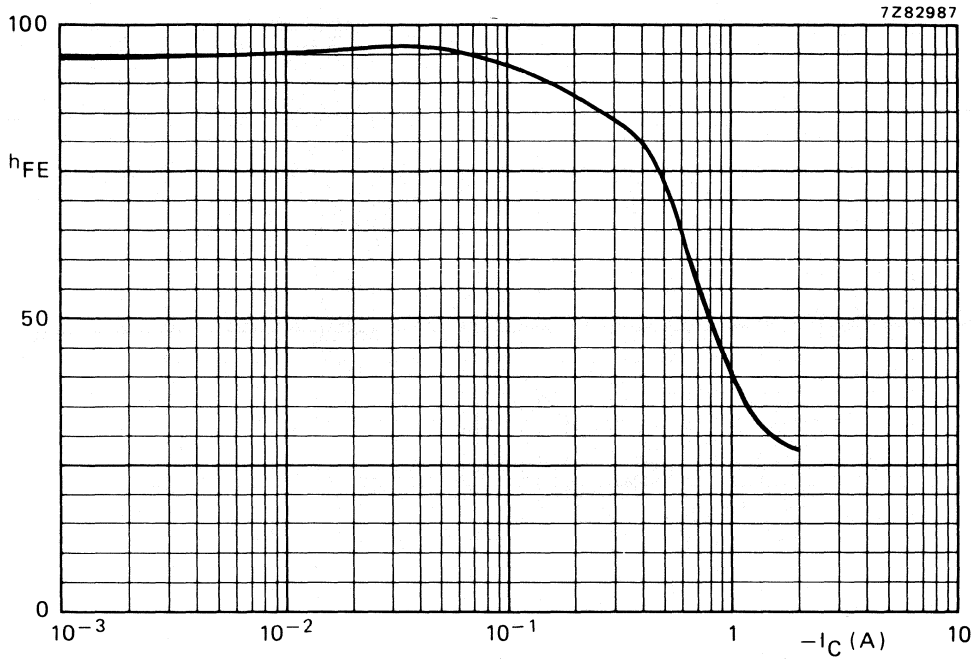


Fig. 7 Typical values d.c. current gain. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

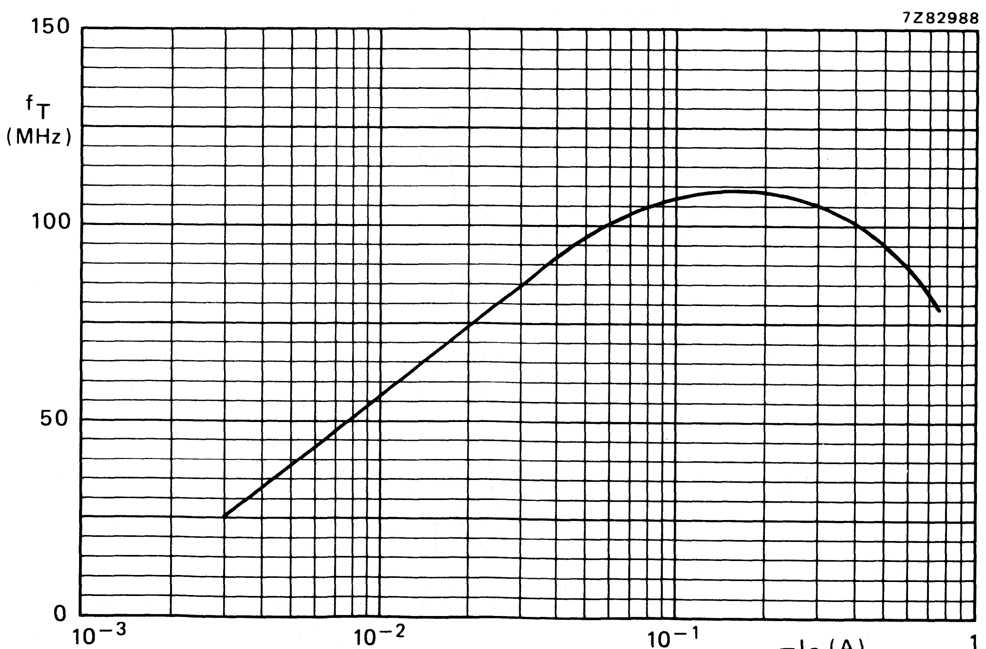


Fig. 8 Typical values transition frequency. $-V_{CE}$ = 5 V; f = 35 MHz; T_{amb} = 25 °C.

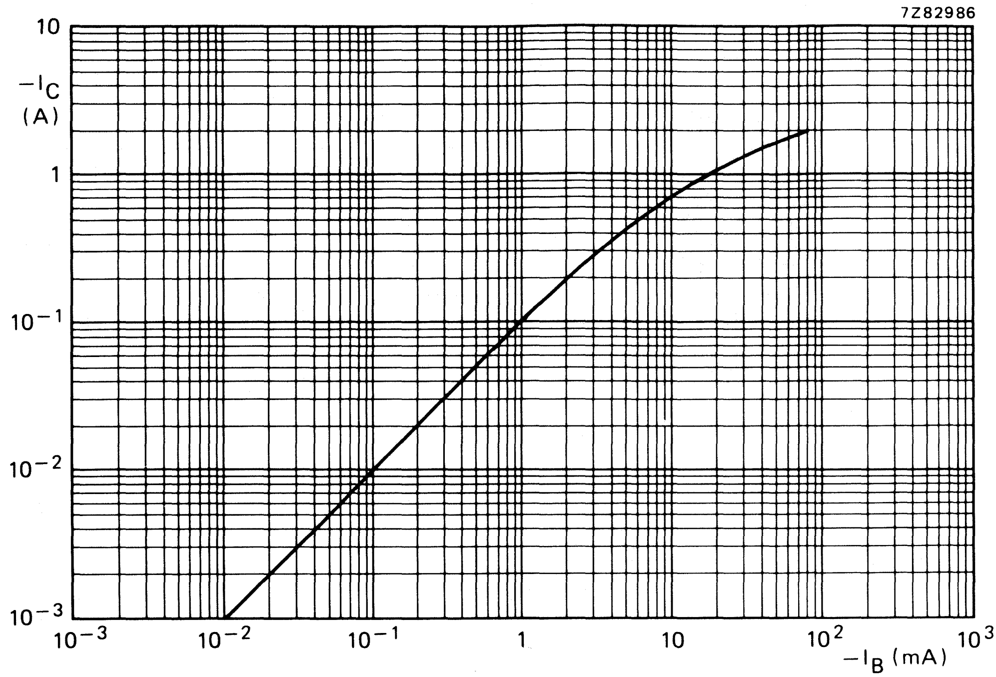


Fig. 9 Typical values at $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

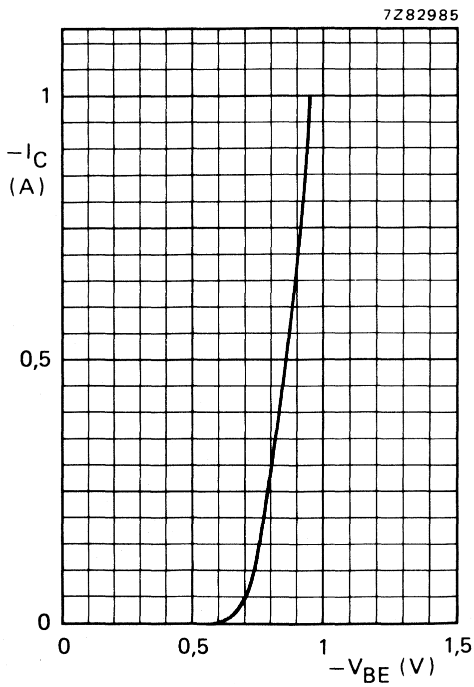


Fig. 10 Typical values. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur.
P-N-P complements are BD934; 936; 938; 940 and 942.

QUICK REFERENCE DATA

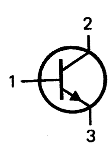
			BD933	935	937	939	941	
Collector-base voltage	V_{CBO}	max.	45	60	100	120	140	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	120	V
Collector current (d.c.)	I_C	max.			3			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			30			W
Junction temperature	T_j	max.			150			°C
D.C. current gain								
I_C = 150 mA; V_{CE} = 2 V	h_{FE}				40 to 250			
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>			25			
Transition frequency								
I_C = 250 mA; V_{CE} = 10 V	f_T	>			3			MHz

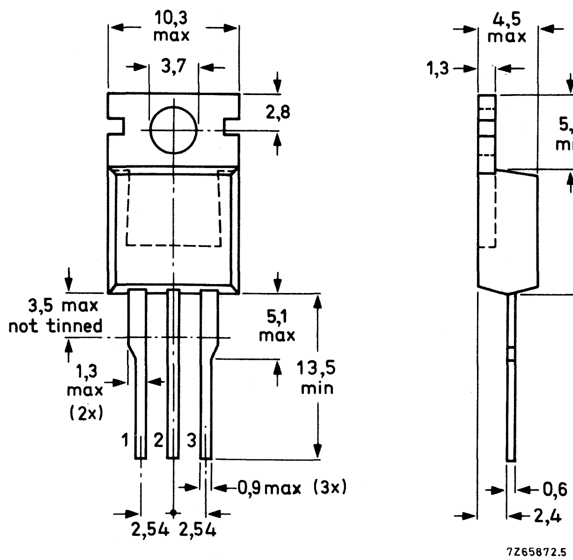
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD933	935	937	939	941	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	3	A
Collector current (peak value)	I_{CM}	max.	7	A
Base current (d.c.)	I_B	max.	0,5	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30	W
Storage temperature	T_{stg}		–65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

→ Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	50	μA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	1	mA
$I_E = 0$; $V_{CE} = V_{CEOmax}$	I_{CEO}	<	0,1	mA
→ Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	0,2	mA
D.C. current gain *				
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 to 250	
i_C = 1 A; V_{CE} = 2 V	h_{FE}	>	25	
Base-emitter voltage **				
I_C = 1 A; V_{CE} = 2 V	V_{BE}	<	1,3	V
Collector-emitter saturation voltage *				
I_C = 1 A; I_B = 0,1 A	V_{CEsat}	<	0,6	V
Transition frequency at f = 1 MHz				
I_C = 250 mA; V_{CE} = 10 V	f_T	>	3	MHz
Switching times				
I_{Con} = 1 A; $I_{Bon} = -I_{Boff}$ = 0,1 A turn-on time	t_{on}	typ	0,4	μs
		<	1	μs
Turn-off time	t_{off}	typ.	1,5	μs
		<	3	μs
Second-breakdown collector current				
V_{CE} = 40 V; t_p = 0,1 s; non-repetitive	$I_{(SB)}$	>	0,75	A

* Measured under pulse conditions: $t_p \leqslant 300$ μs; $\delta < 2\%$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

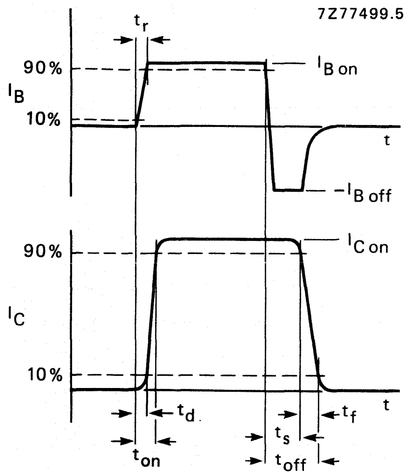


Fig. 2 Switching times waveforms.

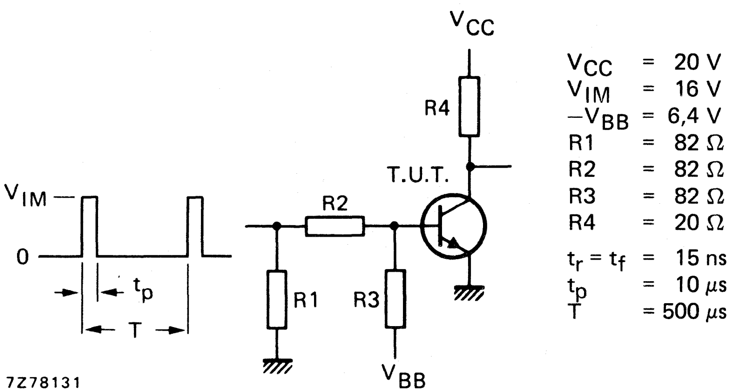


Fig. 3 Switching times test circuit.

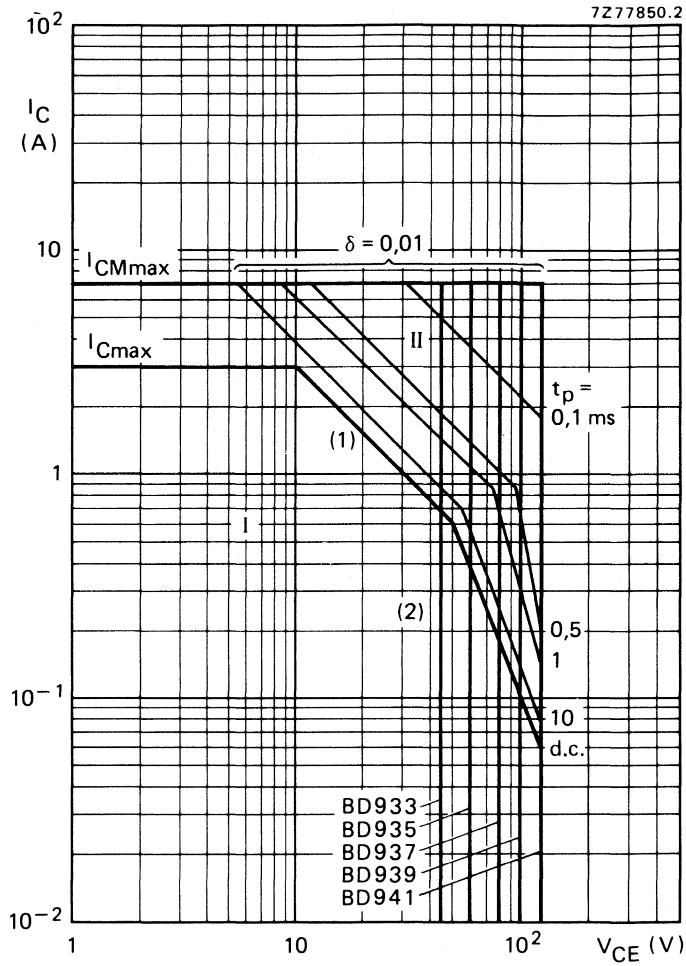


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

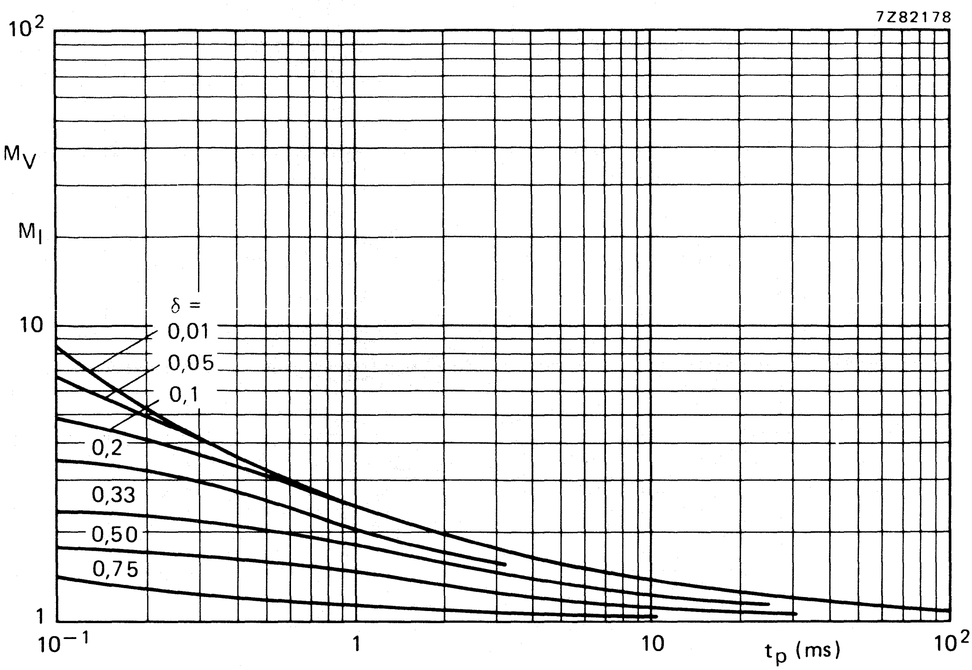


Fig. 5 Second-breakdown voltage multiplying factor at the I_{Cmax} level and second-breakdown current multiplying factor at the V_{CEOmax} level.

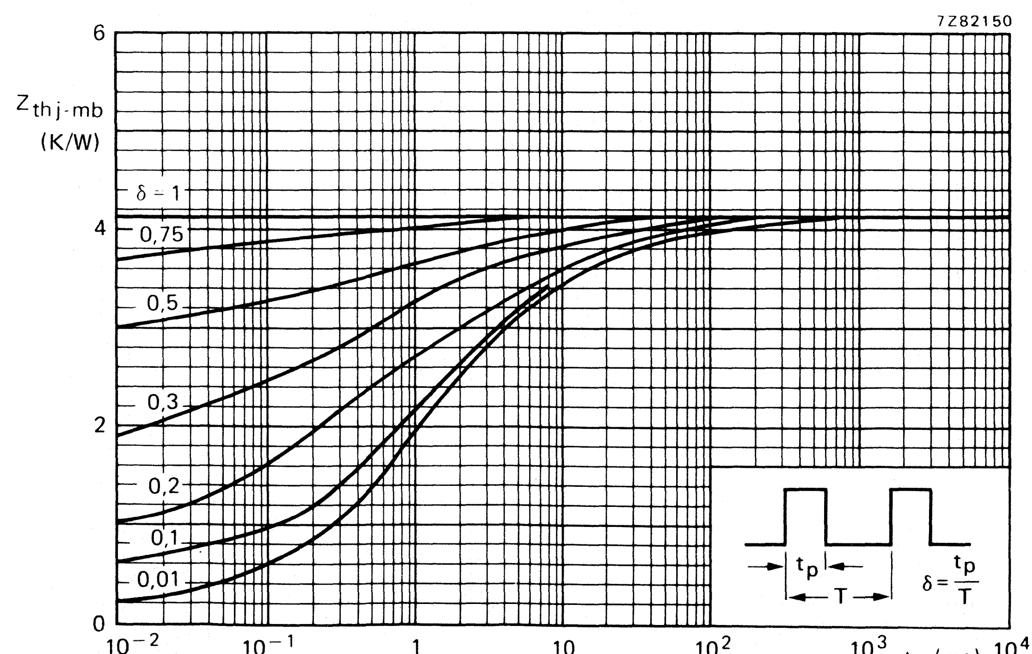


Fig. 6 Pulse power rating chart.

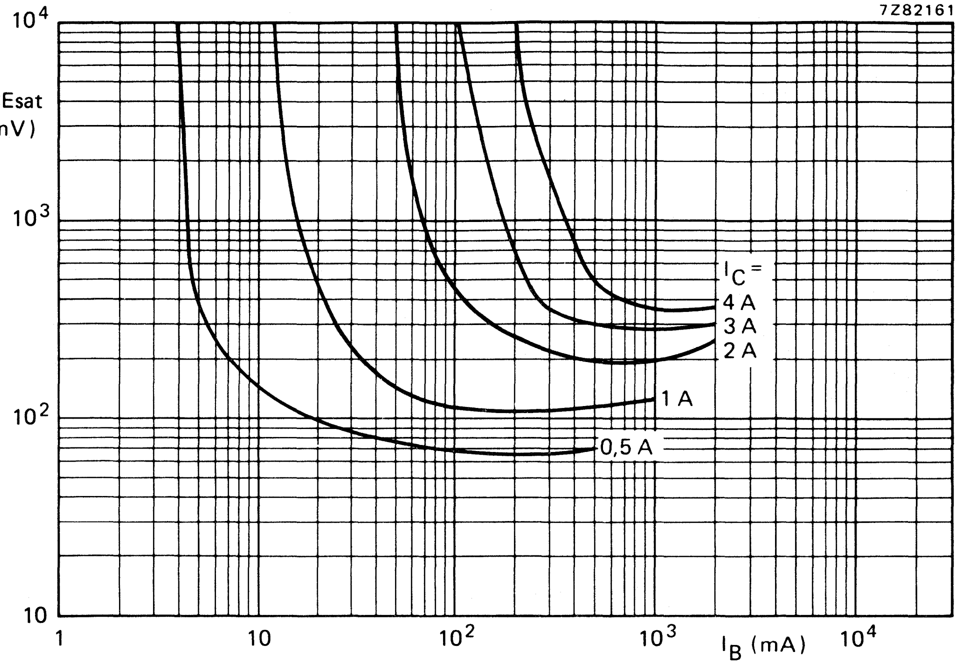


Fig. 7 Typical collector-emitter saturation voltage as a function of base current with collector current as a parameter.

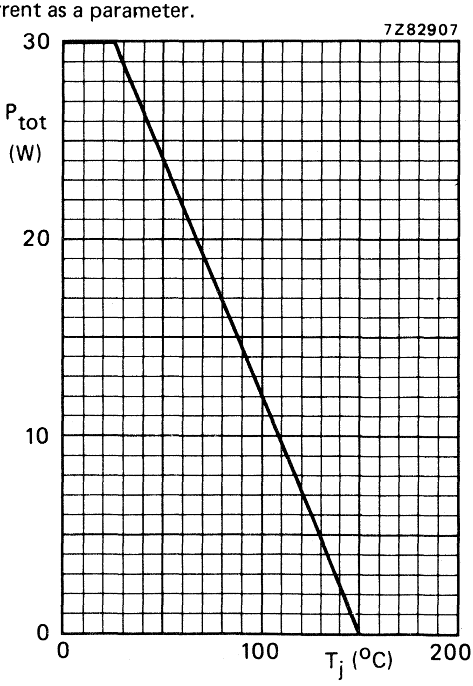


Fig. 8 Power derating curve.

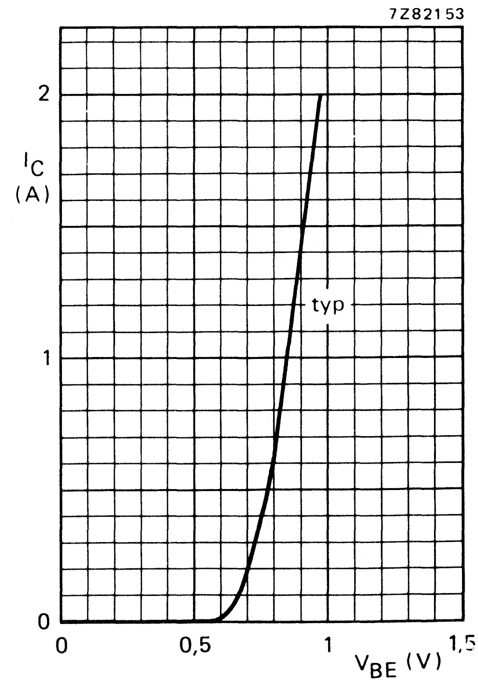


Fig. 9 V_{CE} = 2 V; T_j = 25 °C.

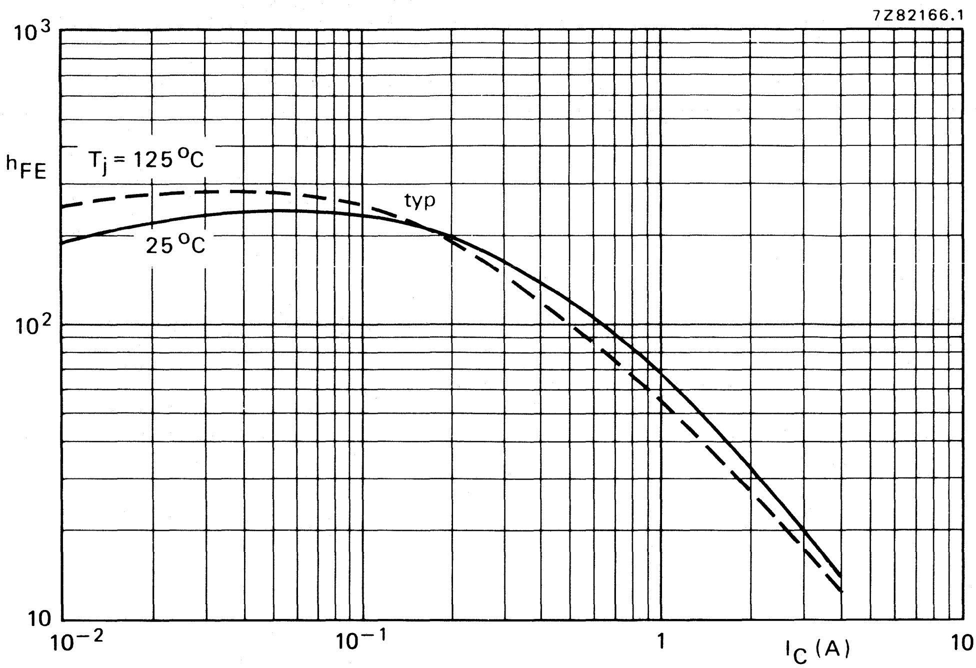


Fig. 10 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 2$ V

SILICON EPITAXIAL POWER TRANSISTORS

N-P-N silicon power transistor in a SOT-186 envelope with an electrically insulated mounting base, intended for use in audio output stages and for general purpose amplifier applications.

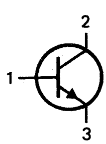
P-N-P complements are BD934F, BD936F, BD938F, BD940F and BD942F.

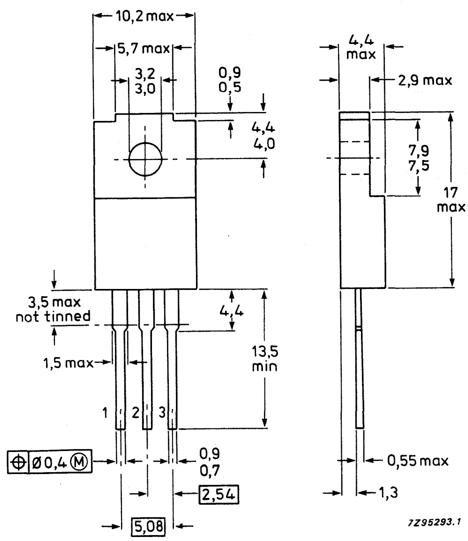
QUICK REFERENCE DATA

			BD933F	935F	937F	939F	941F	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.			5			V
Collector current d.c.	I_C	max.			3			A
peak value	I_{CM}	max.			7			A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.			19			W
D.C. current gain I_C = 1 A; V_{CE} = 2 V	h_{FE}	min.			25			
Transition frequency at f = 1 MHz I_C = 250 mA; V_{CE} = 10 V	f_T	min.			3			MHz

Fig. 1 SOT-186.

Dimensions in mm





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD933F	935F	937F	939F	941F	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current				
d.c.	I_C	max.	3	A
peak value	I_{CM}	max.	7	A
Base current (d.c.)	I_B	max.	0,5	A
Total power dissipation				
up to T_h = 25 °C (1)	P_{tot}	max.	14	W
up to T_h = 25 °C (2)	P_{tot}	max.	19	W
Storage temperature	T_{stg}		−65 to 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\,j\text{-}mb}$	=	4,17	K/W
From junction to external heatsink (1)	$R_{th\,j\text{-}h}$	=	9,17	K/W
From junction to external heatsink (2)	$R_{th\,j\text{-}h}$	=	6,67	K/W
From junction to ambient	$R_{th\,j\text{-}a}$	=	55	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value (3)	V_{insul}	max.	1000	V
Insulation capacitance between collector and external heatsink	$C_{c\text{-}h}$	typ.	12	pF

(1) Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

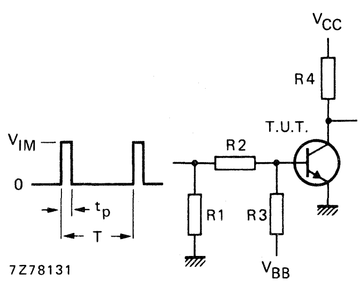
(2) Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

(3) Heatsink temperature T_h = 25 °C; relative humidity $R_H \leqslant 75\%$; atmospheric pressure p_{amb} = 1013 mbar.

CHARACTERISTICS

T_h = 25 °C unless otherwise specified

Collector cut-off currents				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_h = 150 °C	I_{CBO}	<	3	mA
$I_E = 0$; $V_{CE} = V_{CEOmax}$	I_{CEO}	<	0,5	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	1	mA
D.C. current gain (1)				
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>	25	
I_C = 150 mA; V_{CE} = 2 V	h_{FE}	40 to 250		
Base-emitter voltage (1)+(2)				
I_C = 1 A; V_{CE} = 2 V	V_{BE}	<	1,3	V
Collector-emitter saturation voltage (1)				
I_C = 1 A; I_B = 0,1 A	V_{CEsat}	<	0,6	V
Transition frequency at f = 1 MHz				
I_C = 250 mA; V_{CE} = 10 V	f_T	>	3	MHz
Second-breakdown collector current				
V_{CE} = 40 V; t_p = 1 s; non-repetitive, without heatsink	I_{SB}	>	475	mA
Switching times				
I_C = 1 A; $I_{Bon} = -I_{Boff}$ = 0,1 A				
turn-on time	t_{on}	typ.	0,4	μs
		<	1	μs
turn-off time	t_{off}	typ.	1,5	μs
		<	3	μs



V_{CC} = 20 V
V_{IM} = 16 V
$-V_{BB}$ = 6,4 V
R1 = 82 Ω
R2 = 82 Ω
R3 = 82 Ω
R4 = 20 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 2 Switching times test circuit.

(1) Measured under pulse conditions: t_p = 300 μs; δ = 0,02.
(2) V_{BE} decreases by about 2,3 mV/K with increasing temperature.

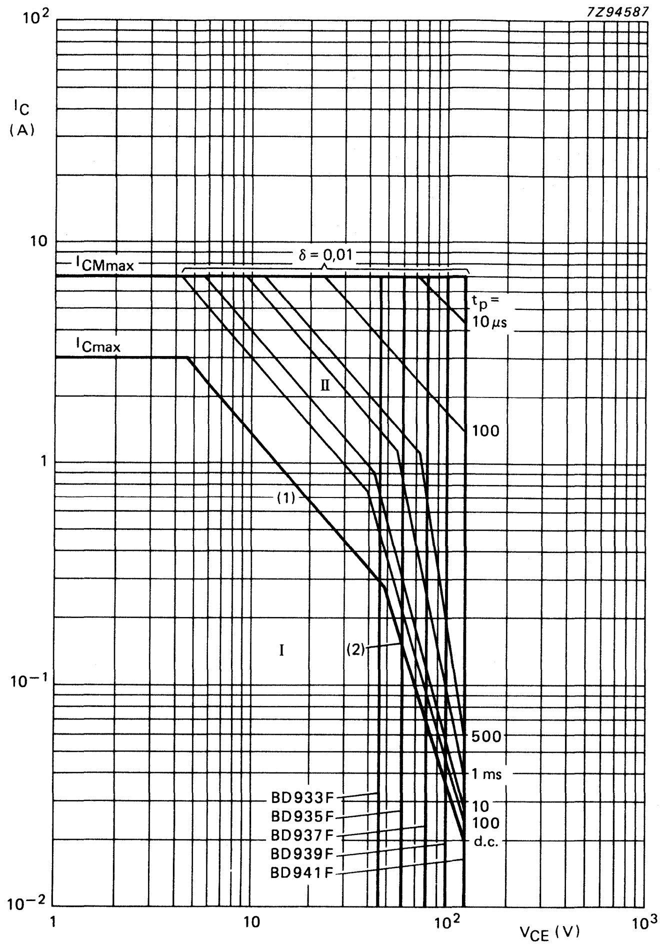


Fig. 4 Safe Operating ARea, T_{amb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Mounted *without* heatsink compound and 30 ± 5 Newton pressure on the centre of the envelope.

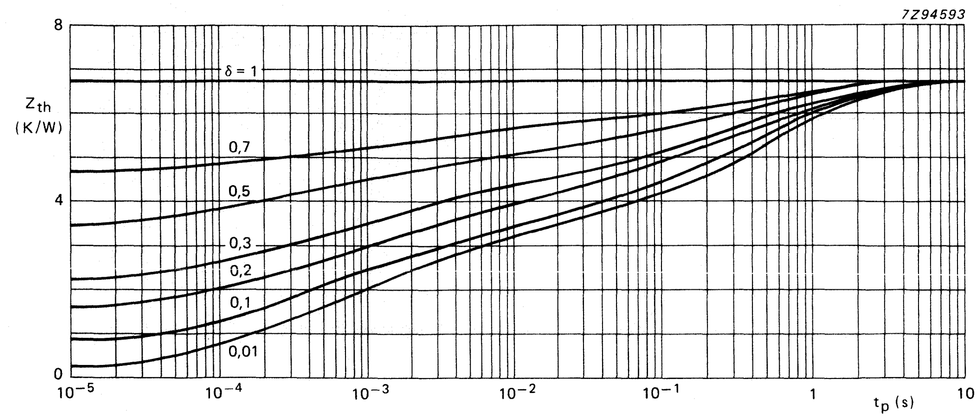


Fig. 5 Pulse power rating chart; mounted *with* heatsink compound and 30 ± 5 Newton pressure on the envelope.

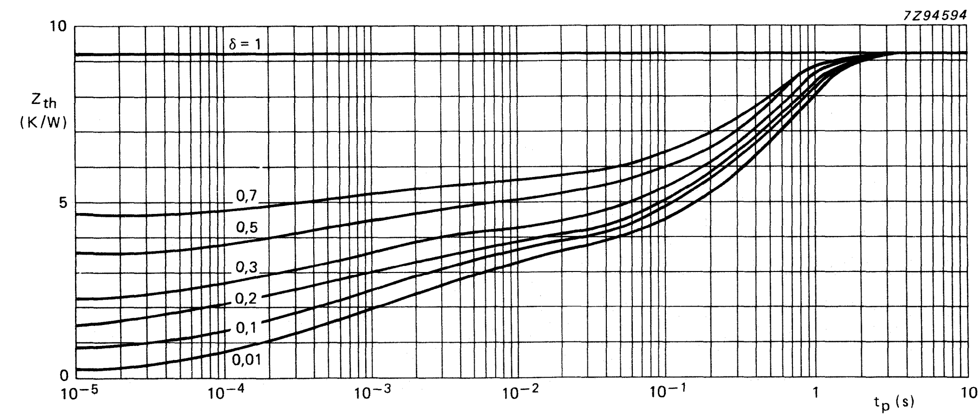


Fig. 6 Pulse power rating chart; mounted *without* heatsink compound and 30 ± 5 Newton pressure on the envelope.

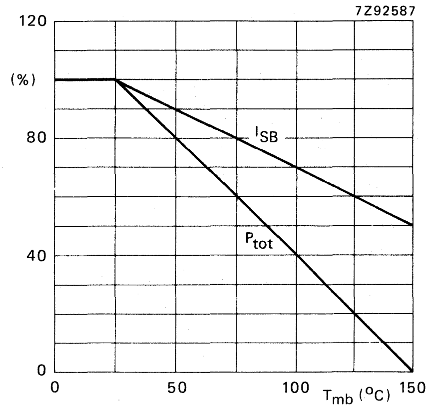


Fig. 7 Total power dissipation and second-breakdown current derating curve.

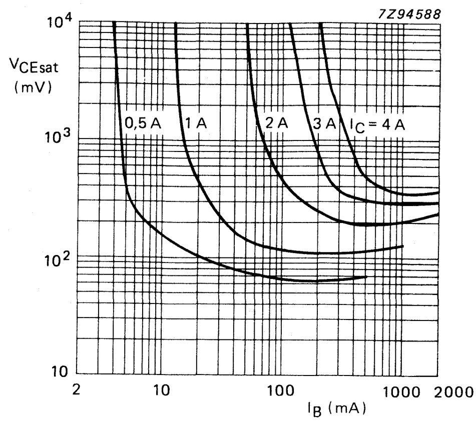


Fig. 8 Collector-emitter saturation voltage; typical values.

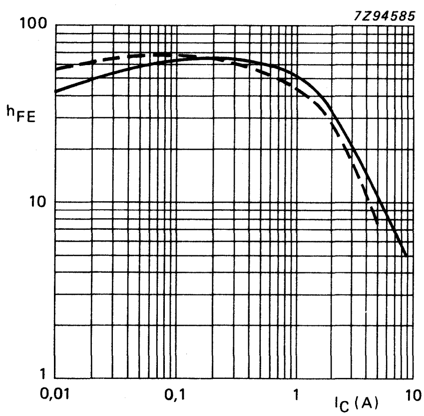


Fig. 9 D.C. current gain; V_{CE} = 2 V; typical values;
——— T_j = 25 °C; – – – – T_j = 125 °C.

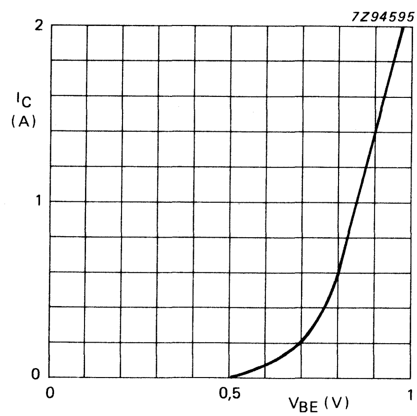


Fig. 10 V_{CE} = 2 V; typical values.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur.
N-P-N complements are BD933; 935; 937; 939 and 941.

QUICK REFERENCE DATA

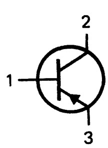
			BD934	936	938	940	942	
Collector-base voltage	$-V_{CBO}$	max.	45	60	100	120	140	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	100	120	V
Collector current (d.c.)	$-I_C$	max.			3			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			30			W
Junction temperature	T_j	max.			150			°C
D.C. current gain								
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}				40 to 250			
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>			25			
Transition frequency								
$-I_C$ = 250 mA; $-V_{CE}$ = 10 V	f_T	>			3			MHz

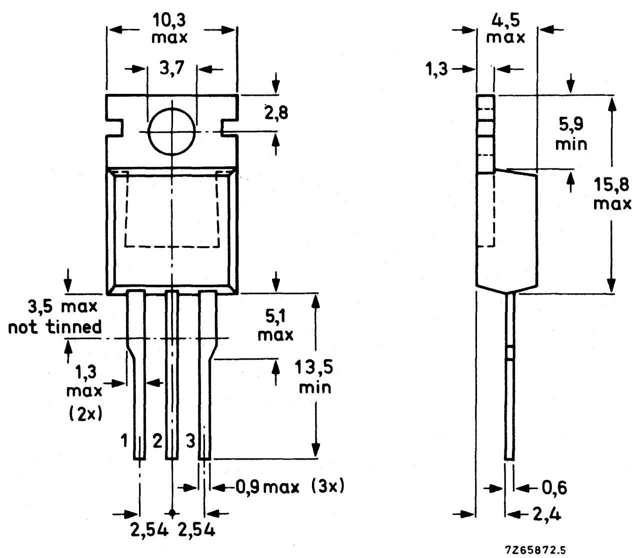
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD934	936	938	940	942	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V

Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V
Collector current (d.c.)	$-I_C$	max.	3	A
Collector current (peak value)	$-I_{CM}$	max.	7	A
Base current (d.c.)	$-I_B$	max.	0,5	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

→ Collector cut-off current				
$-I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	50	µA
$-I_E = 0; -V_{CB} = -V_{CBOmax}; T_j = 150$ °C	$-I_{CBO}$	<	1	mA
$I_B = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CEO}$	<	0,1	mA
→ Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	0,2	mA
D.C. current gain (note 1)				
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}		40 to 250	
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	25	
Base-emitter voltage (notes 1 and 2)				
$-I_C = 1$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1,3	V
Collector-emitter saturation voltage (note 1)				
$-I_C = 1$ A; $-I_B = 0,1$ A	$-V_{CEsat}$	<	0,6	V
Transition frequency at f = 1 MHz				
$-I_C = 250$ mA; $-V_{CE} = 10$ V	f_T	>	3	MHz
Switching times				
$-I_{Con} = 1$ A; $-I_{Bon} = I_{Boff} = 0,1$ A				
turn-on time	t_{on}	typ.	0,2	µs
		<	0,6	µs
turn-off time	t_{off}	typ.	0,7	µs
		<	2,4	µs

Notes

1. Measured under pulse conditions: $t_p \leqslant 300$ µs; $\delta < 2\%$.
2. $-V_{BE}$ decreases by about 2,3 mV/K with increasing temperature.

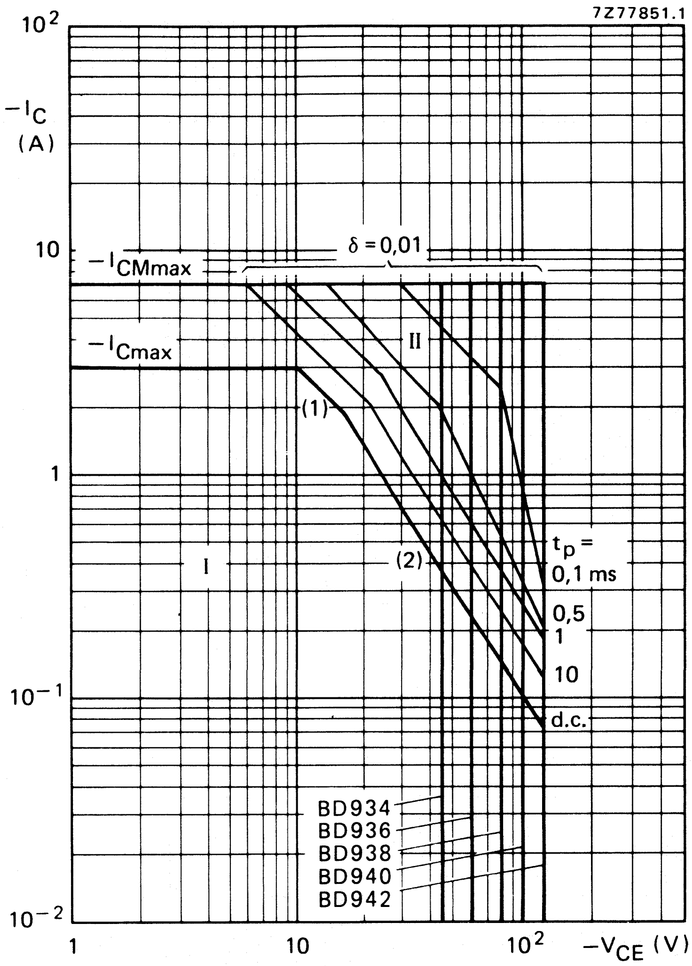


Fig. 2 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

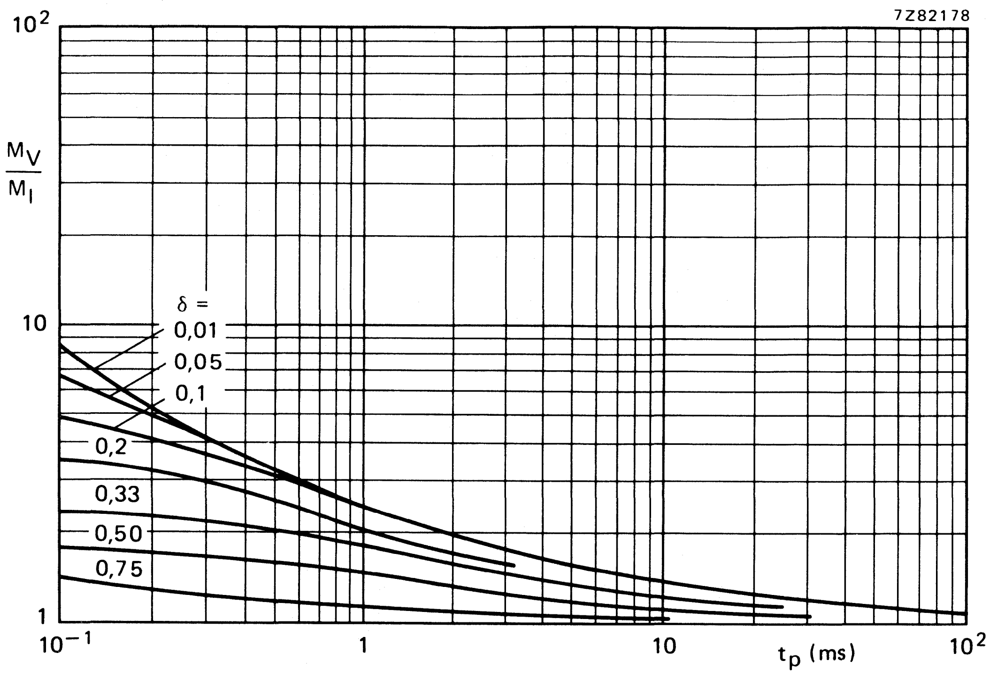


Fig. 3 Second breakdown voltage multiplying factor at the I_{Cmax} level and second breakdown current multiplying factor at the V_{CEOmax} level.

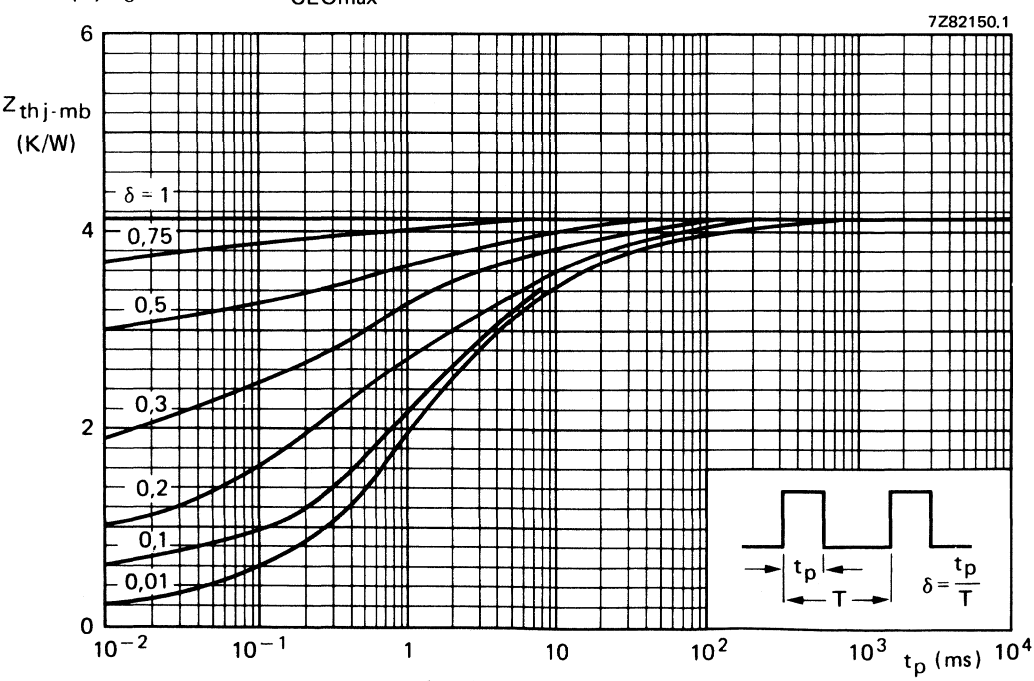


Fig. 4 Pulse power rating chart.

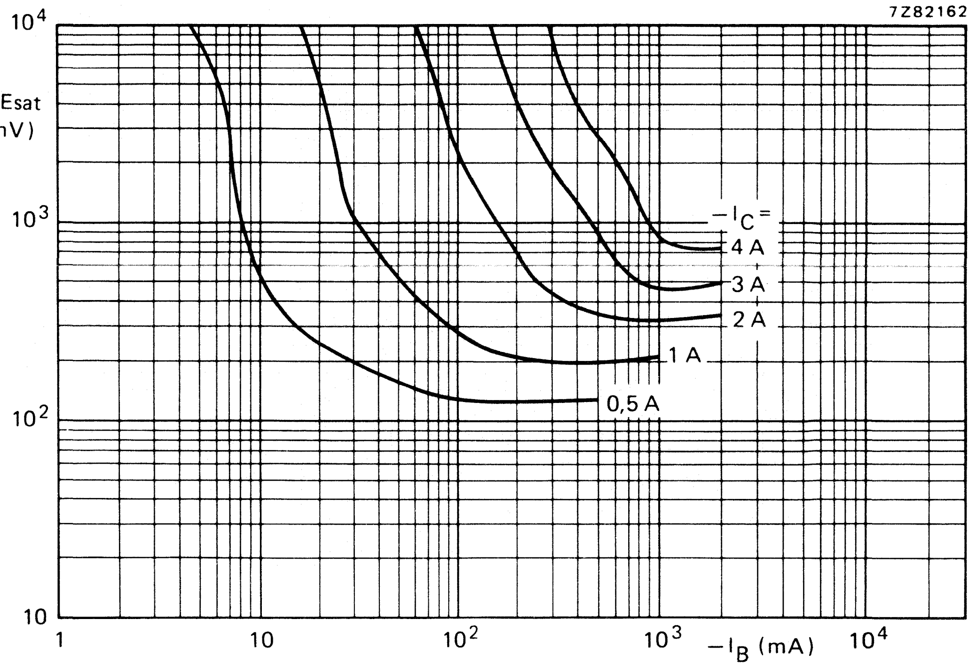


Fig. 5 Typical collector-emitter saturation voltage as a function of base current with collector current as a parameter.

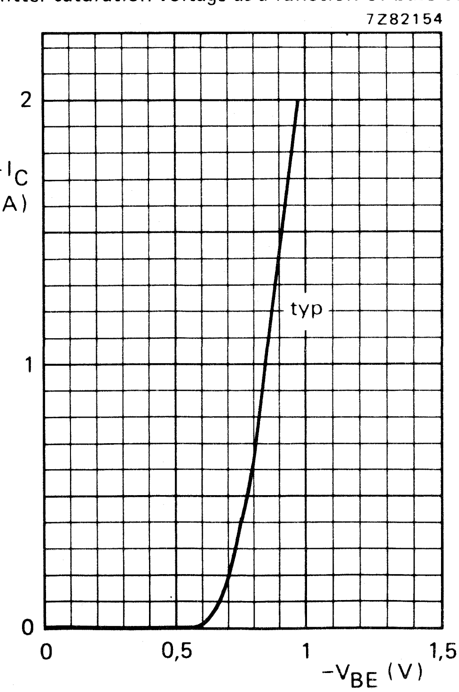


Fig. 6 Typical collector current as a function of base-emitter voltage. $-V_{CE}$ = 2 V; T_j = 25 °C.

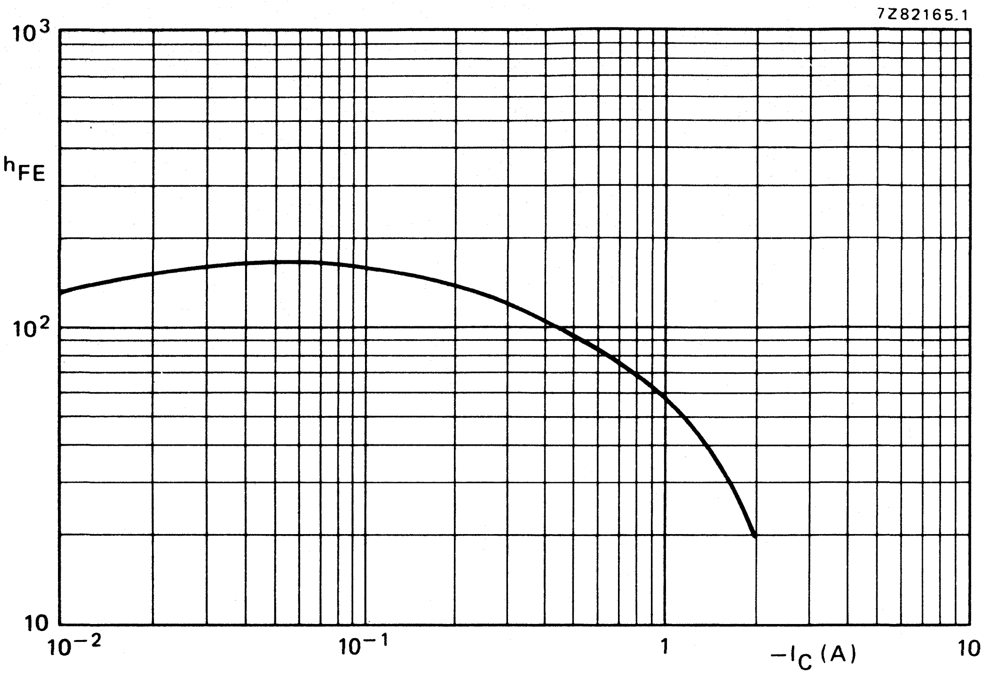


Fig. 7 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE}$ = 2 V; $T_j \leqslant 25$ °C.

SILICON EPITAXIAL POWER TRANSISTORS

P-N-P silicon power transistor in a SOT-186 envelope with an electrically insulated mounting base, intended for use in audio output stages and for general purpose amplifier applications.

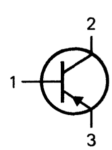
N-P-N complements are BD933F, BD935F, BD937F, BD939F and BD941F.

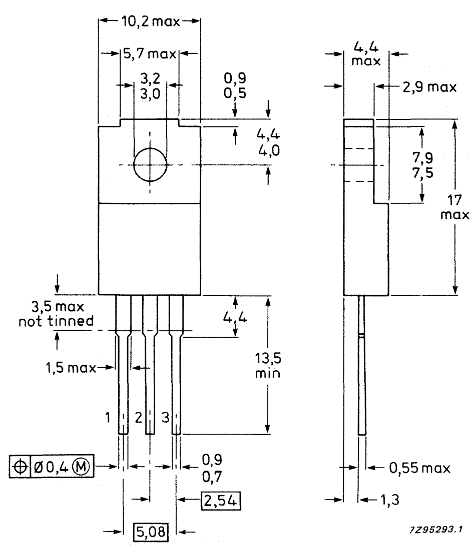
QUICK REFERENCE DATA

			BD934F	936F	938F	940F	942F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.			5			V
Collector current d.c.	$-I_C$	max.			3			A
Collector current peak value	$-I_{CM}$	max.			7			A
Total power dissipation up to $T_h = 25\ ^oC$	P_{tot}	max.			19			W
D.C. current gain $-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	min.			25			
Transition frequency at f = 1 MHz $-I_C = 250$ mA; $-V_{CE} = 10$ V	f_T	min.			3			MHz

Fig. 1 SOT-186.

Dimensions in mm





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD934F	936F	938F	940F	942F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.			5			V
Collector current d.c.	$-I_C$	max.			3			A
peak value	$-I_{CM}$	max.			7			A
Base current (d.c.)	$-I_B$	max.			0,5			A
Total power dissipation up to T_h = 25 °C (1)	P_{tot}	max.			14			W
up to T_h = 25 °C (2)	P_{tot}	max.			19			W
Storage temperature	T_{stg}				−65 to 150			°C
Junction temperature	T_j	max.			150			°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to external heatsink (1)	$R_{th\ j\text{-}h}$	=	9,17	K/W
From junction to external heatsink (2)	$R_{th\ j\text{-}h}$	=	6,67	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	55	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value (3)	V_{insul}	max.	1000	V
Insulation capacitance between collector and external heatsink	$C_{c\text{-}h}$	typ.	12	pF

(1) Mounted without heatsink compound and 30 ± 5 Newton pressure on centre of envelope.

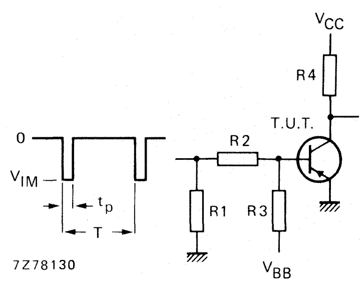
(2) Mounted with heatsink compound and 30 ± 5 Newton pressure on centre of envelope.

(3) Heatsink temperature T_h = 25 °C; relative humidity $R_H \leqslant 75\%$; atmospheric pressure p_{amb} = 1013 mbar.

CHARACTERISTICS

T_h = 25 °C unless otherwise specified

Collector cut-off currents			
$-I_E = 0; -V_{CB} = V_{CBOmax}$	$-I_{CBO}$	<	0,1 mA
$-I_E = 0; -V_{CB} = V_{CBOmax}; T_h = 150\ ^oC$	$-I_{CBO}$	<	3 mA
$-I_E = 0; -V_{CE} = V_{CEOmax}$	$-I_{CEO}$	<	0,5 mA
Emitter cut-off current			
$-I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	1 mA
D.C. current gain (1)			
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	25
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}		40 to 250
Base-emitter voltage (1)+(2)			
$-I_C = 1$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1,3 V
Collector-emitter saturation voltage (1)			
$-I_C = 1$ A; $-I_B = 0,1$ A	$-V_{CEsat}$	<	0,6 V
Transition frequency at f = 1 MHz			
$-I_C = 250$ mA; $-V_{CE} = 10$ V	f_T	>	3 MHz
Second-breakdown collector current			
$-V_{CE} = 40$ V; $t_p = 1$ s; non-repetitive, without heatsink	$-I_{SB}$	>	475 mA
Switching times			
$-I_C = 1$ A; $-I_{Bon} = +I_{Boff} = 0,1$ A			
turn-on time	t_{on}	typ.	0,2 µs
		<	0,6 µs
turn-off time	t_{off}	typ.	0,7 µs
		<	2,4 µs



$-V_{CC}$	=	20 V
$-V_{IM}$	=	16 V
$+V_{BB}$	=	6,4 V
R1	=	82 Ω
R2	=	82 Ω
R3	=	82 Ω
R4	=	20 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 µs
T	=	500 µs

Fig. 2 Switching times test circuit.

(1) Measured under pulse conditions: $t_p = 300\ \mu s$; $\delta = 0,02$.
(2) V_{BE} decreases by about 2,3 mV/K with increasing temperature.

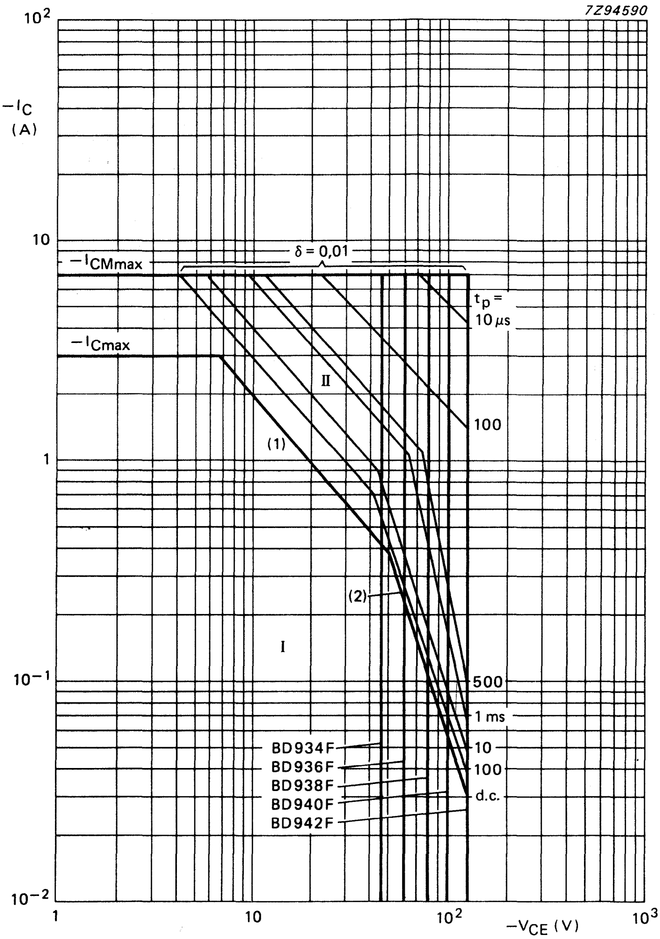


Fig. 3 Safe Operating ARea, T_{amb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Mounted *with* heatsink compound and 30 ± 5 Newton pressure on the centre of the envelope.

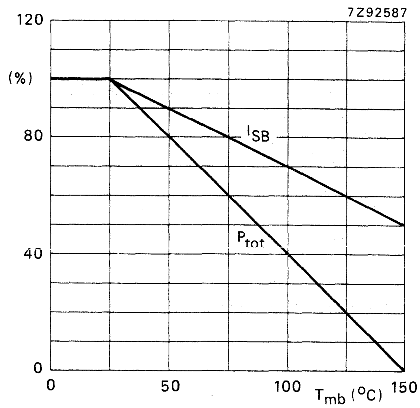


Fig. 7 Total power dissipation and second-breakdown current derating curve.

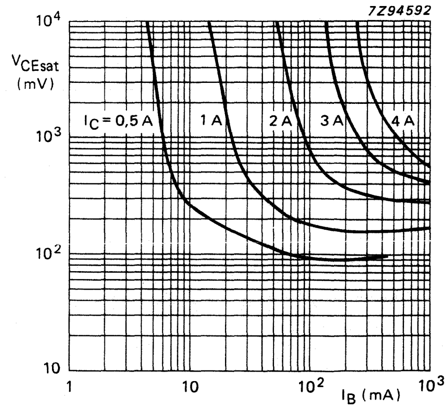


Fig. 8 Collector-emitter saturation voltage; typical values.

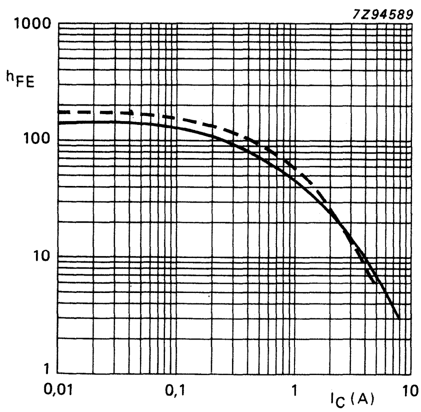


Fig. 9 D.C. current gain; $-V_{CE}$ = 2 V; typical values;
—— T_j = 25 °C; – – – – T_j = 125 °C.

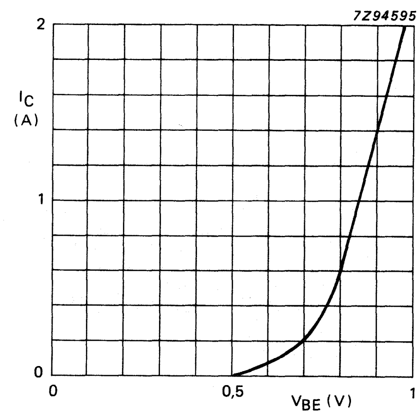


Fig. 10 $-V_{CE}$ = 2 V; typical values.

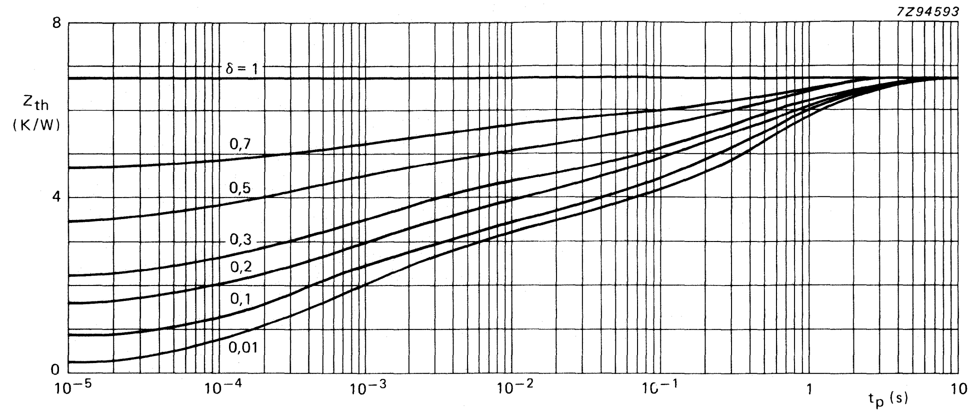


Fig. 5 Pulse power rating chart; mounted *with* heatsink compound and 30 ± 5 Newton pressure on the envelope.

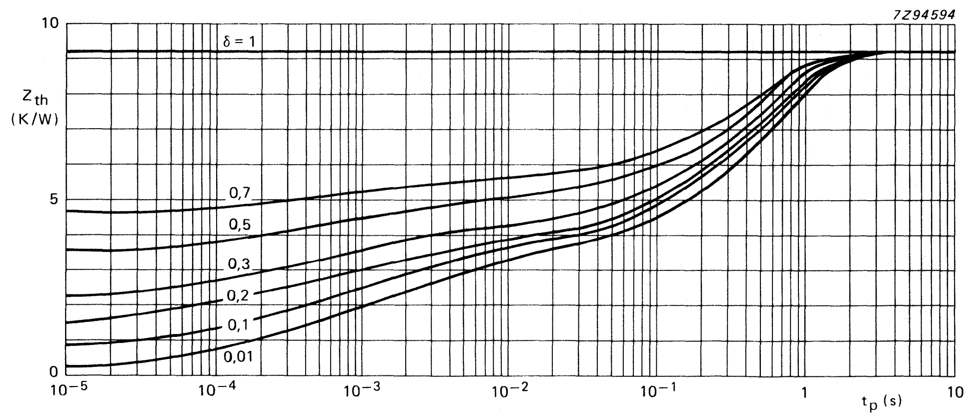


Fig. 6 Pulse power rating chart; mounted *without* heatsink compound and 30 ± 5 Newton pressure on the envelope.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in audio output stages and general purpose amplifier applications. P-N-P complements are BD944; 946 and 948.

QUICK REFERENCE DATA

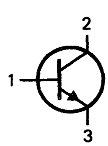
			BD943	945	947	
Collector-base voltage (open emitter)	V_{CBO}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Collector current (d.c.)	I_C	max.		5		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>		25		
I_C = 500 mA; V_{CE} = 1 V	h_{FE}			85 to 475		
I_C = 2 A; V_{CE} = 1 V	h_{FE}	>	50	50	40	
Transition frequency at f = 1 MHz						
I_C = 250 mA; V_{CE} = 1 V	f_T	>		3		MHz

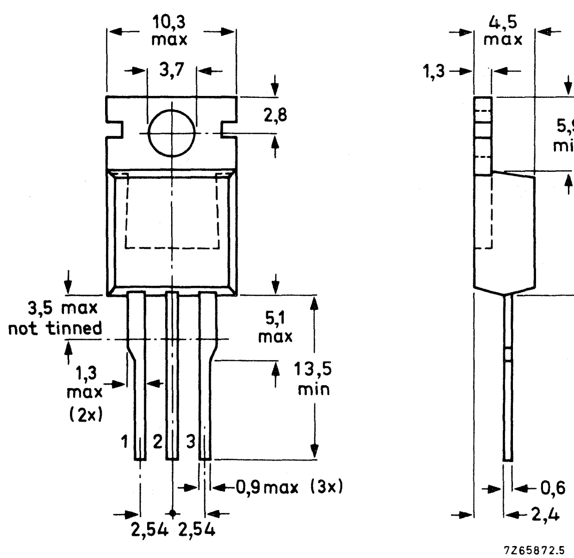
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD943	945	947	
Collector-base voltage (open emitter)	V_{CBO}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current (d.c.)	I_C	max.		5		A
Collector current (peak value)	I_{CM}	max.		8		A
Base current (d.c.)	I_B	max.		1		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD943	945	947	
Collector cut-off current						
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<		0,1		mA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<		3		mA
$I_B = 0$; V_{CE} = 15 V; BD943 20 V; BD945 25 V; BD947	I_{CEO}	<		0,5		mA
Emitter cut-off current						
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<		1		mA
D.C. current gain (note 1)						
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>		25		
I_C = 500 mA; V_{CE} = 1 V	h_{FE}			85 to 475		
I_C = 2 A; V_{CE} = 1 V	h_{FE}	>	50	50	40	
I_C = 3 A; V_{CE} = 1 V	h_{FE}	>	–	–	30	
Base-emitter voltage (notes 1 and 2)						
I_C = 2 A; V_{CE} = 1 V	V_{BE}	<	1,1	1,1	–	V
I_C = 3 A; V_{CE} = 1 V	V_{BE}	<	–	–	1,3	V
Collector-emitter saturation voltage (note 1)						
I_C = 2 A; I_B = 0,2 A	V_{CEsat}	<	0,5	0,5	–	V
I_C = 3 A; I_B = 0,3 A	V_{CEsat}	<	–	–	0,7	V

Notes
1. Measured under pulse conditions; $t_p \leq 300\ \mu s$; $\delta < 2\%$.
2. V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Knee voltage*			
I_C = 2 A; I_B value for which I_C = 2,2 A and V_{CE} = 1 V	V_{CEK}	<	0,8 V
Transition frequency at f = 1 MHz			
I_C = 250 mA; V_{CE} = 1 V	f_T	>	3 MHz

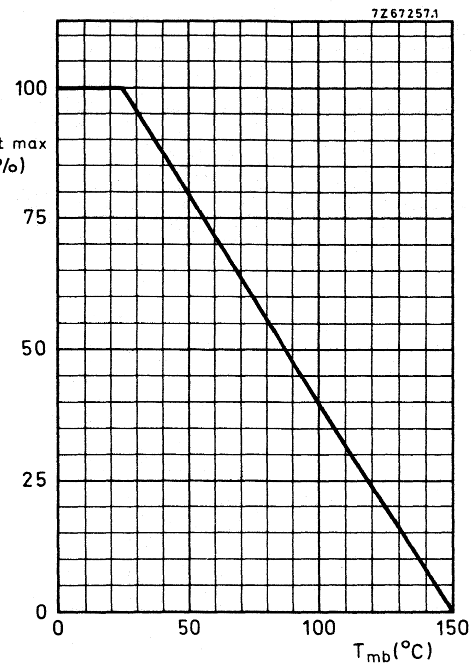


Fig. 2 Power derating curve.

* Measured under pulse conditions; $t_p \leqslant 300\ \mu s$; $\delta < 2\%$.

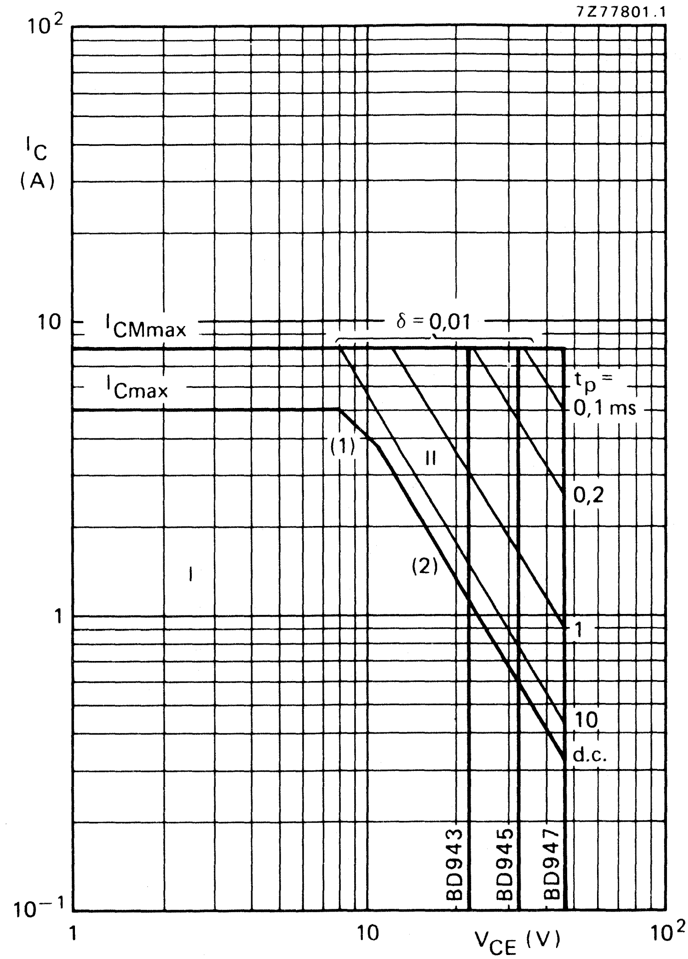


Fig. 3 Safe Operating ARea, T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

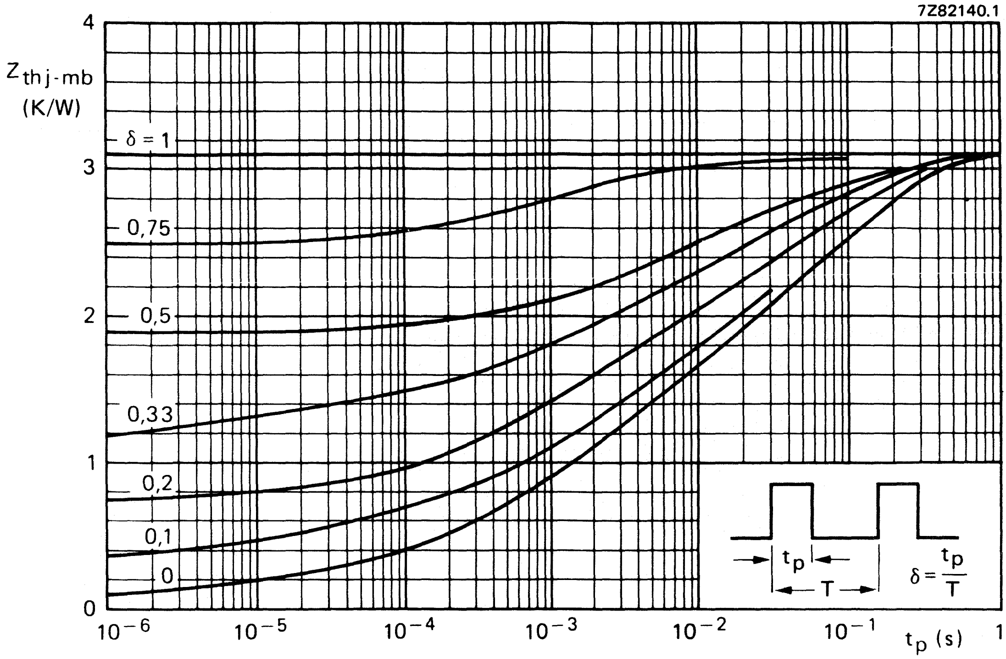


Fig. 4 Pulse power rating chart.

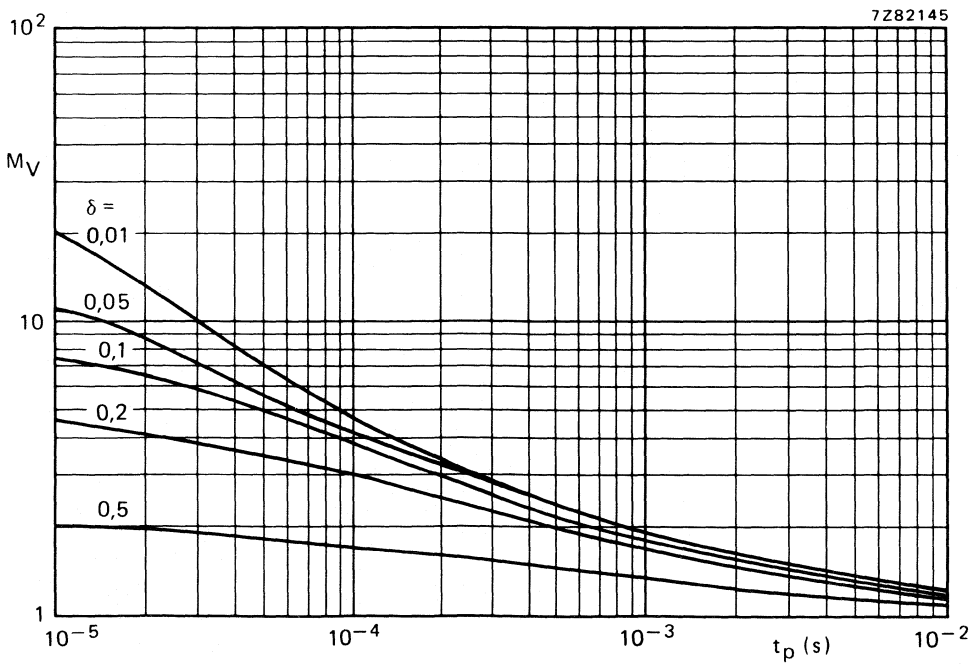


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

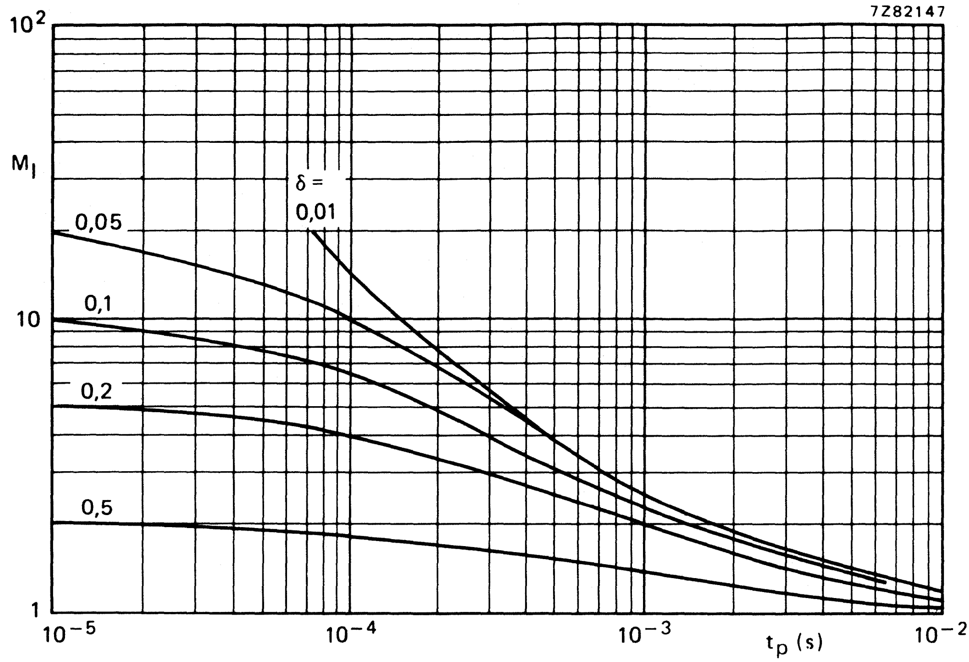


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level for BD943 and BD945.

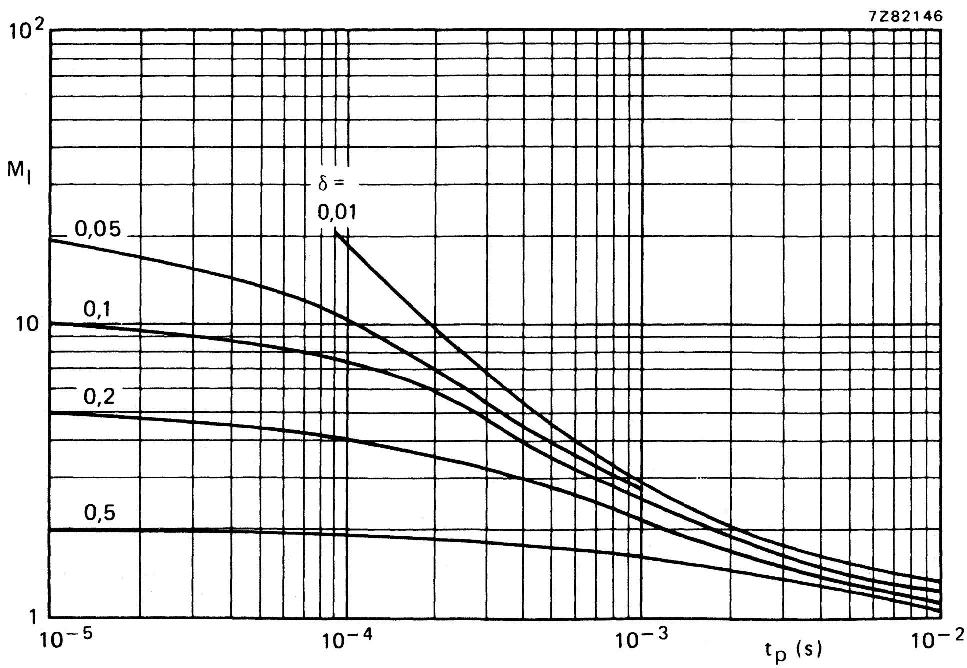


Fig. 7 S.B. current multiplying factor at the V_{CEOmax} level for BD947.

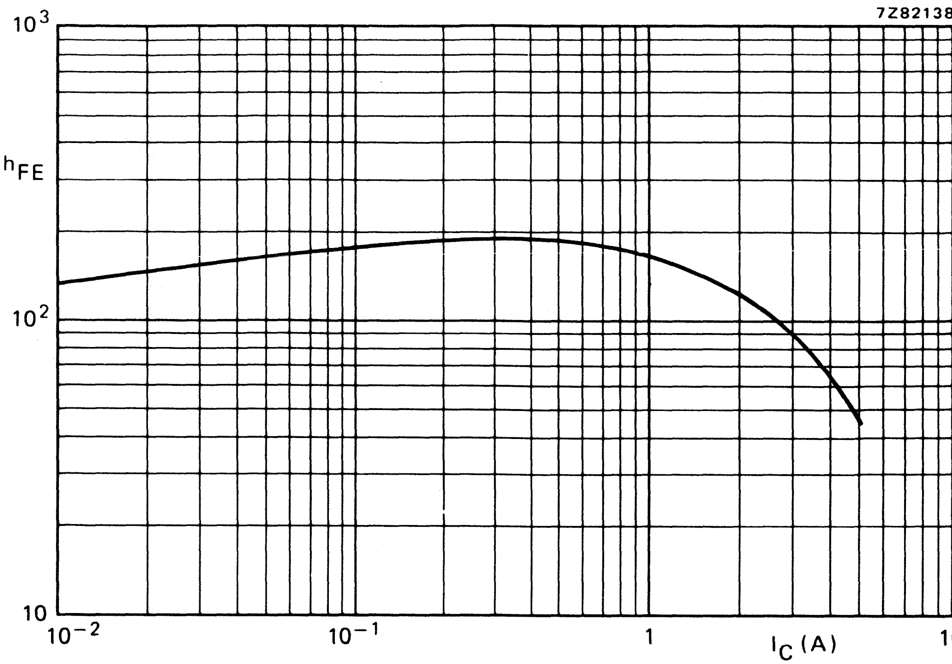


Fig. 8 Typical d.c. current gain at V_{CE} = 1 V; T_j = 25 °C.

SILICON EPITAXIAL POWER TRANSISTORS

NPN silicon epitaxial power transistors, each in a SOT186 envelope with an electrically insulated mounting base.

PNP complements are BD944F, BD946F, and BD948F.

QUICK REFERENCE DATA

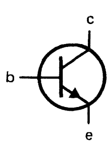
			BD943F	945F	947F	
Collector-base voltage (open emitter)	V_{CBO}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
DC collector current	I_C	max.		5		A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.		22		W

MECHANICAL DATA

Dimensions in mm

Pinning

1 = base
2 = collector
3 = emitter



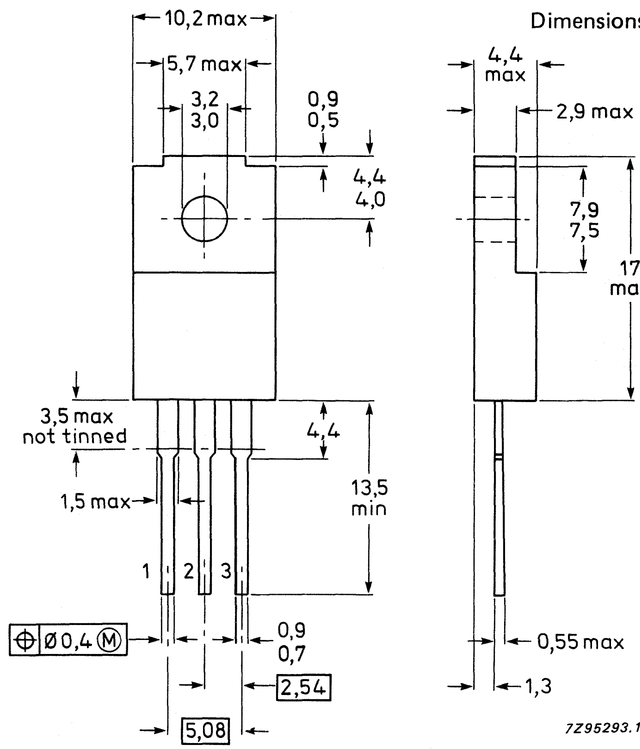


Fig. 1 SOT186.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD943F	945F	947F	
Collector-base voltage (open emitter)	V_{CBO}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
DC collector current	I_C	max.		5		A
Peak collector current	I_{CM}	max.		8		A
Base current	I_B	max.		1		A
Total power dissipation						
up to T_h = 25 °C (note 1)	P_{tot}	max.		15		W
up to T_h = 25 °C (note 2)	P_{tot}	max.		22		W
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	2.93	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	7.93	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	5.43	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current					
$I_E = 0$; $V_{CB} = V_{CBOmax}$		I_{CBO}	max.	50	μA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C		I_{CBO}	max.	1	mA
$I_B = 0$; V_{CE} = 15 V	BD943F	I_{CEO}	max.	0.1	mA
$I_B = 0$; V_{CE} = 20 V	BD945F	I_{CEO}	max.	0.1	mA
$I_B = 0$; V_{CE} = 25 V	BD947F	I_{CEO}	max.	0.1	mA
Emitter cut-off current					
$I_C = 0$; V_{EB} = 5 V		I_{EBO}	max.	0.2	mA

Notes

1. Mounted without heatsink compound and 30 ± 5 newton pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newton pressure on centre of envelope.

			BD943F	945F	947F	
DC current gain (note 1)						
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min.	25	25	25	
I_C = 500 mA; V_{CE} = 1 V	h_{FE}	min.	85	85	85	
		max.	475	475	475	
I_C = 2 A; V_{CE} = 1 V	h_{FE}	min.	50	50	40	
I_C = 3 A; V_{CE} = 1 V	h_{FE}	min.	—	—	30	
Base-emitter voltage (notes 1 and 2)						
I_C = 2 A; V_{CE} = 1 V	V_{BE}	max.	1.1	1.1	—	V
I_C = 3 A; V_{CE} = 1 V	V_{BE}	max.	—	—	1.3	V
Collector-emitter saturation voltage (note 1)						
I_C = 2 A; I_B = 0.2 A	V_{CEsat}	max.	0.5	0.5	—	V
I_C = 3 A; I_B = 0.3 A	V_{CEsat}	max.	—	—	0.7	V
Knee voltage (note 1)						
I_C = 2 A; I_B = 20 mA	V_{CEK}	max.		0.8		V
Transition frequency at f = 1 MHz						
I_C = 250 mA; V_{CE} = 1 V	f_T	min.		3		MHz

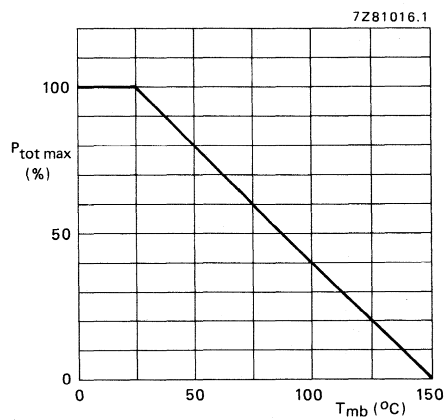
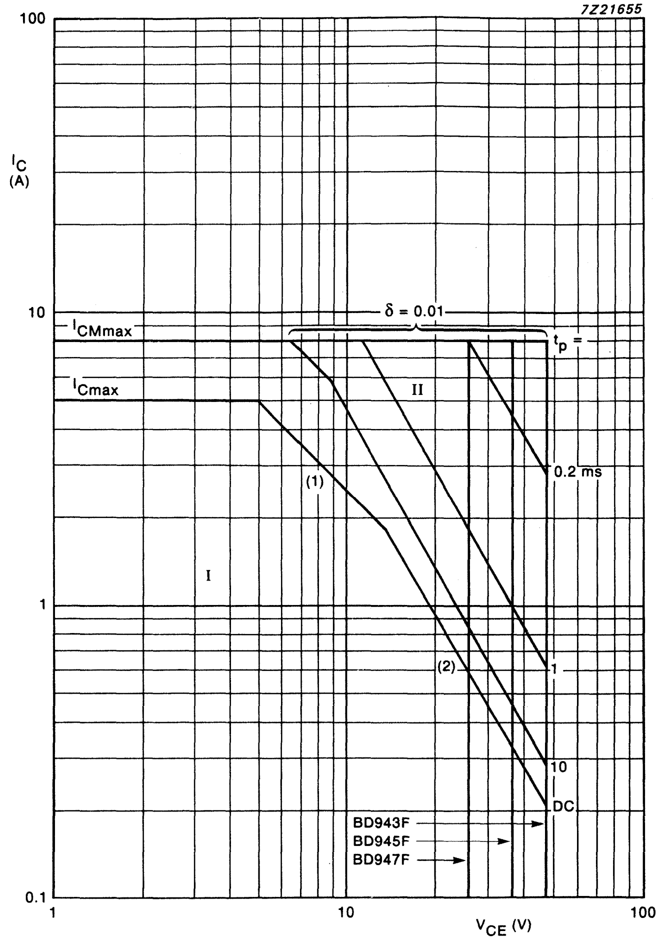


Fig. 2 Power derating curve.

Notes

1. Measured under pulse conditions; $t_p \leqslant 300\ \mu s$; $\delta < 2\%$.
2. V_{BE} decreases by about 2.3 mV/K with increasing temperature.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

Fig. 3 Safe Operating ARea, T_{mb} = 25 °C.

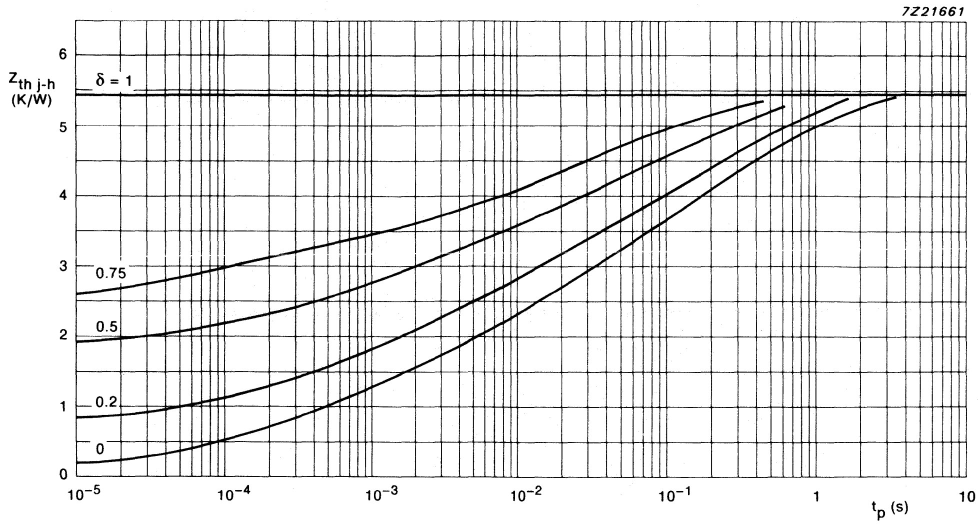


Fig. 4 Pulse power rating chart.

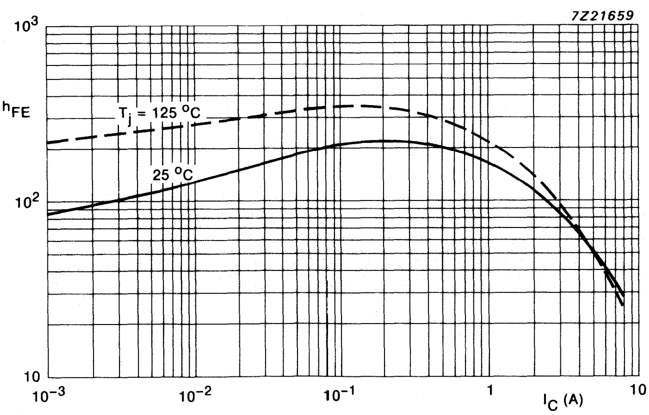


Fig. 5 DC current gain; V_{CE} = 1 V; typical values.

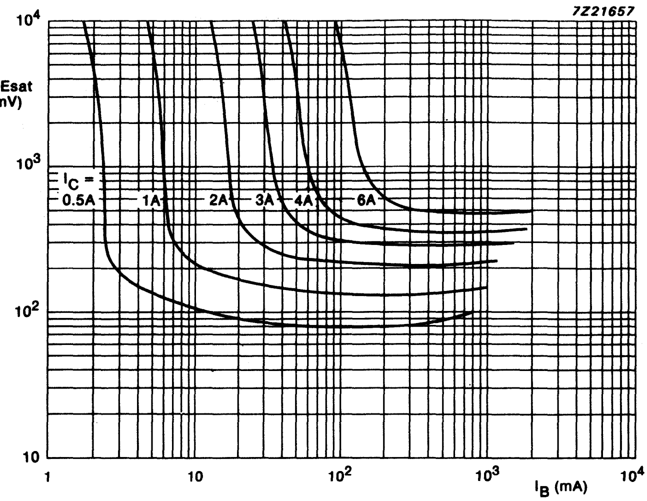


Fig.6 Collector-emitter saturation voltage as a function of base current $T_h = 25^oC$.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in audio output stages and general purpose amplifiers. N-P-N complements are BD943; 945 and 947.

QUICK REFERENCE DATA

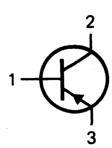
			BD944	946	948	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Collector current (d.c.)	$-I_C$	max.		5		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	>		25		
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}			85 to 475		
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	>	50	50	40	
Transition frequency at f = 1 MHz						
$-I_C$ = 250 mA; $-V_{CE}$ = 1 V	f_T	>		3		MHz

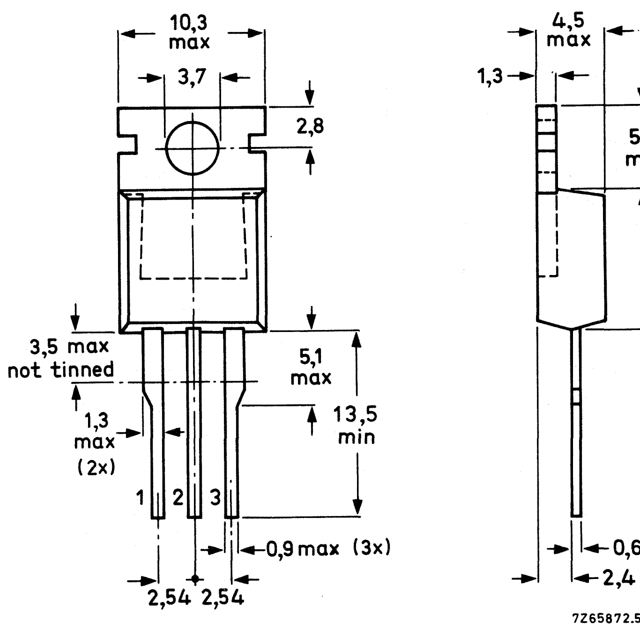
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD944	946	948	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current (d.c.)	$-I_C$	max.		5		A
Collector current (peak value)	$-I_{CM}$	max.		8		A
Base current (d.c.)	$-I_B$	max.		1		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD944	946	948	
→ Collector cut-off current						
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<		50		μA
$I_E = 0; -V_{CB} = -V_{CBOmax}; T_j$ = 150 °C	$-I_{CBO}$	<		1		mA
$I_B = 0; -V_{CE}$ = 15 V; BD944 $-V_{CE}$ = 20 V; BD946 $-V_{CE}$ = 25 V; BD948	$-I_{CEO}$	<		0,1		mA
→ Emitter cut-off current						
$-I_C = 0; -V_{EB}$ = 5 V	$-I_{EBO}$	<		0,2		mA
D.C. current gain (note 1)						
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	>		25		
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}			85 to 475		
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	>	50	50	40	
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	h_{FE}	>	–	–	30	
Base-emitter voltage (notes 1 and 2)						
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	1,1	1,1	–	V
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	–	–	1,3	V
Collector-emitter saturation voltage (note 1)						
$-I_C$ = 2 A; $-I_B$ = 0,2 A	$-V_{CEsat}$	<	0,5	0,5	–	V
$-I_C$ = 3 A; $-I_B$ = 0,3 V	$-V_{CEsat}$	<	–	–	0,7	V

Notes
1. Measured under pulse conditions; $t_p \leq 300$ μs; $\delta < 2\%$.
2. V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Knee voltage *
$-I_C$ = 2 A; $-I_B$ = value for which
$-I_C$ = 2,2 A and $-V_{CE}$ = 1 V — $-V_{CEK}$ < 0,8 V

Transition frequency at f = 1 MHz
$-I_C$ = 250 mA; $-V_{CE}$ = 1 V — f_T > 3 MHz

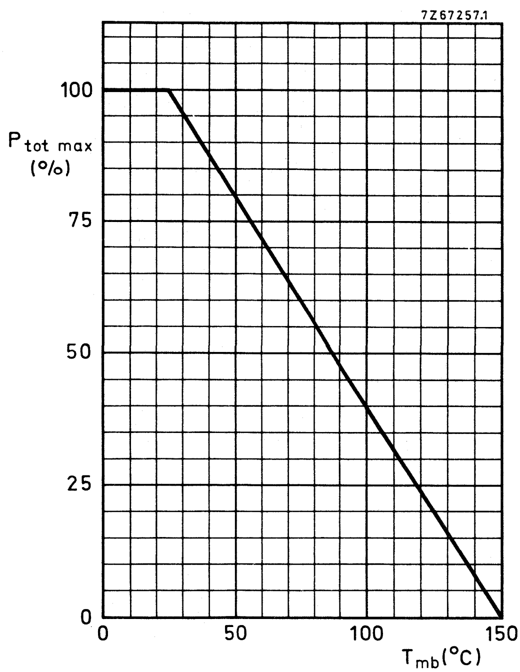


Fig. 2 Power derating curve.

* Measured under pulse conditions; $t_p \leqslant 300\ \mu s$; $\delta < 2\%$.

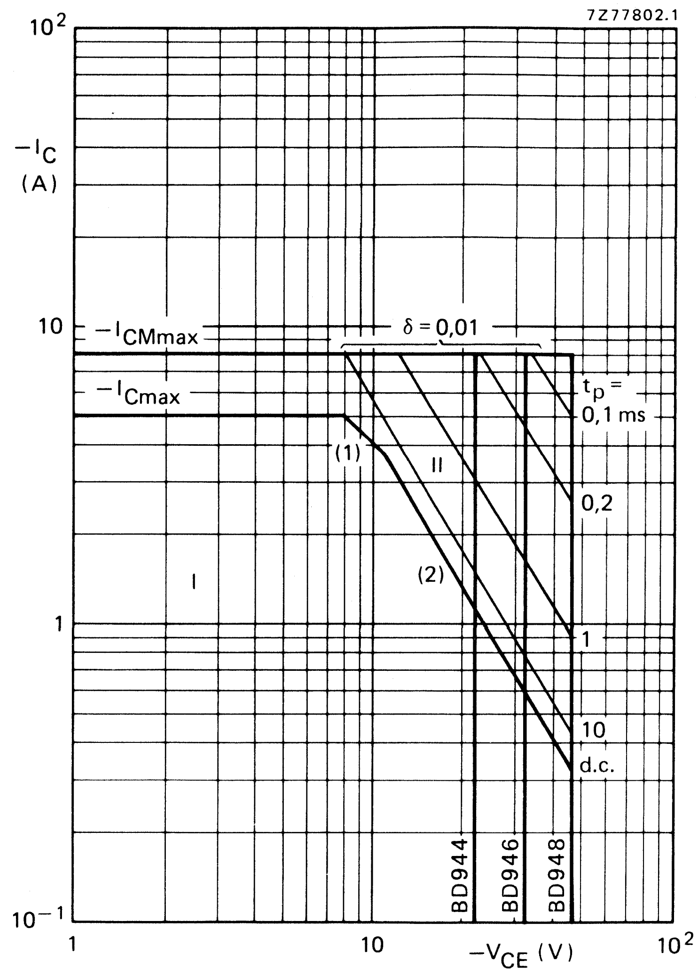


Fig. 3 Safe Operating ARea, $T_{mb} = 25\ ^oC$.

I Region of permissible d.c operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

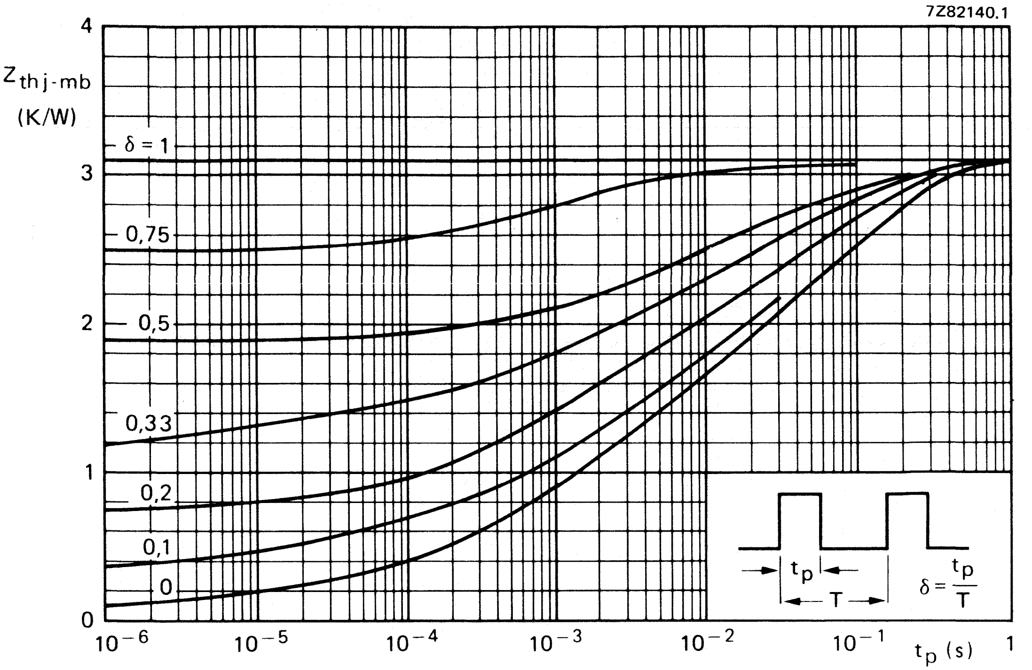


Fig. 4 Pulse power rating chart.

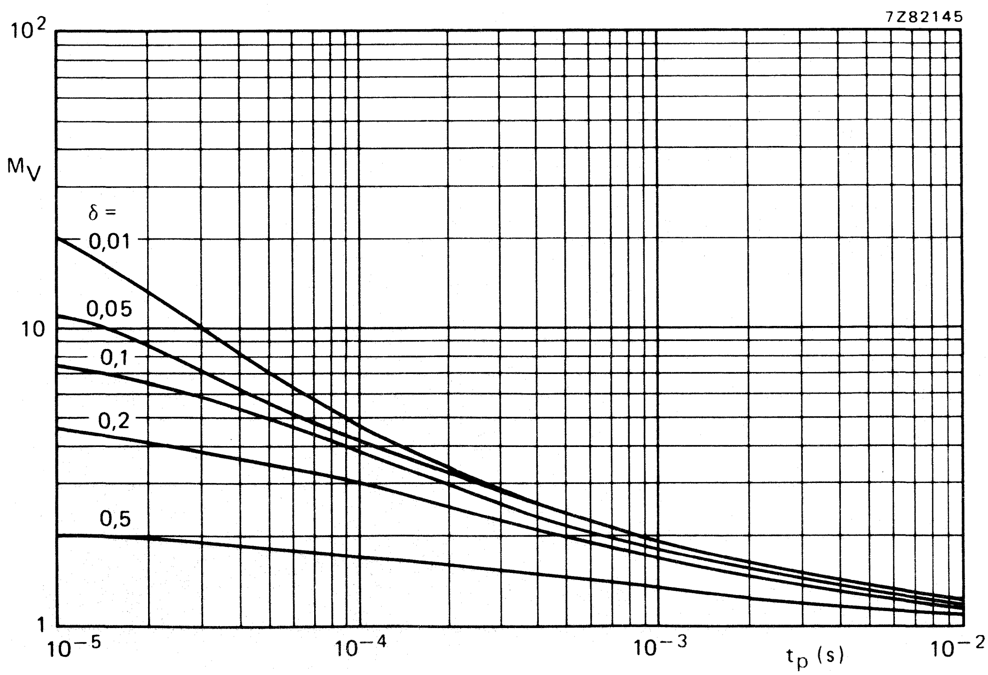


Fig. 5 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

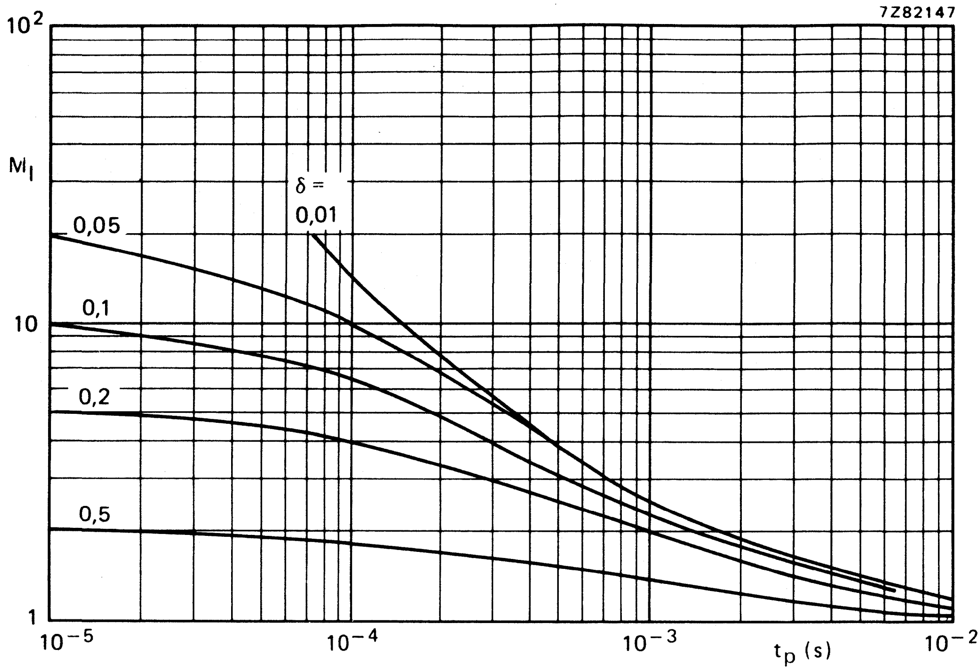


Fig. 6 S.B. current multiplying factor at the $-V_{CEOmax}$ level for BD944/946.

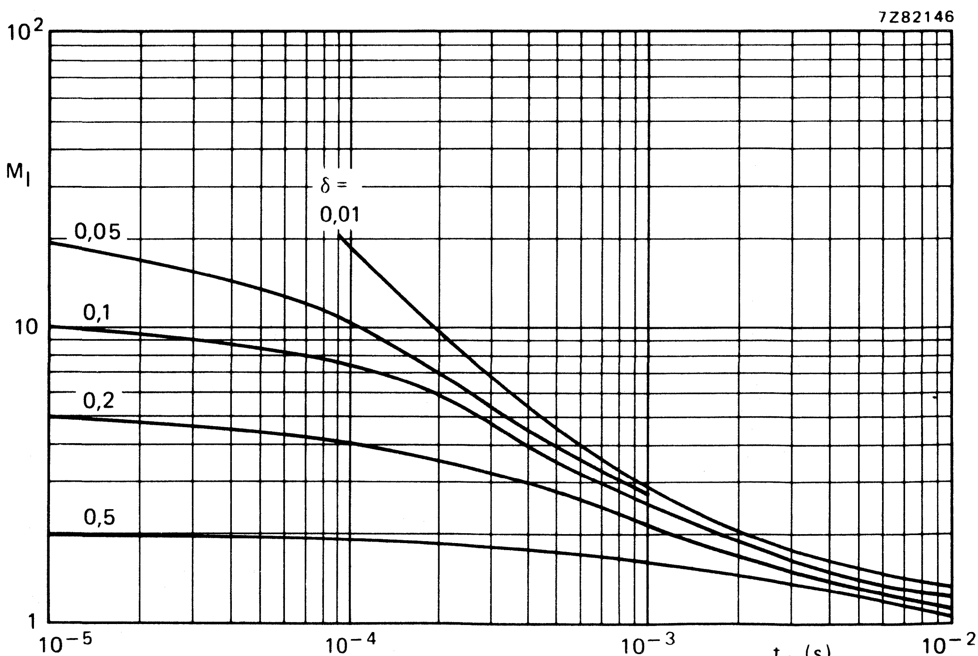


Fig. 7 S.B. current multiplying factor at the $-V_{CEOmax}$ level for BD948.

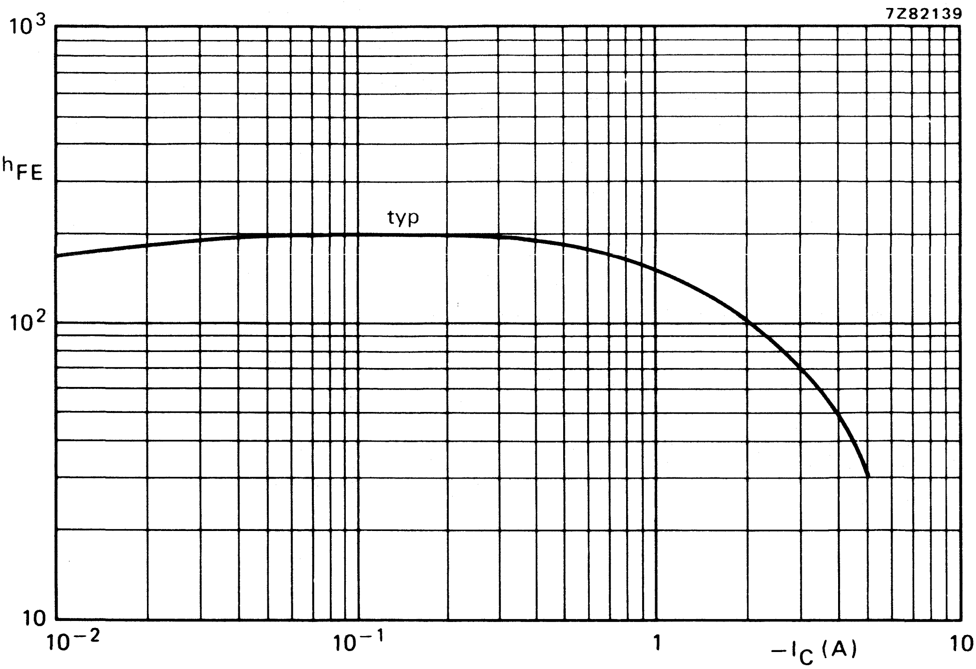


Fig. 8 Typical d.c. current gain at $-V_{CE}$ = 1 V; T_j = 25 °C.

SILICON EPITAXIAL POWER TRANSISTORS

PNP silicon epitaxial power transistors each in a SOT186 envelope with an electrically insulated mounting base.

NPN complements are BD943F, BD945F and BD947F.

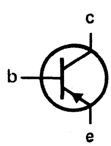
QUICK REFERENCE DATA

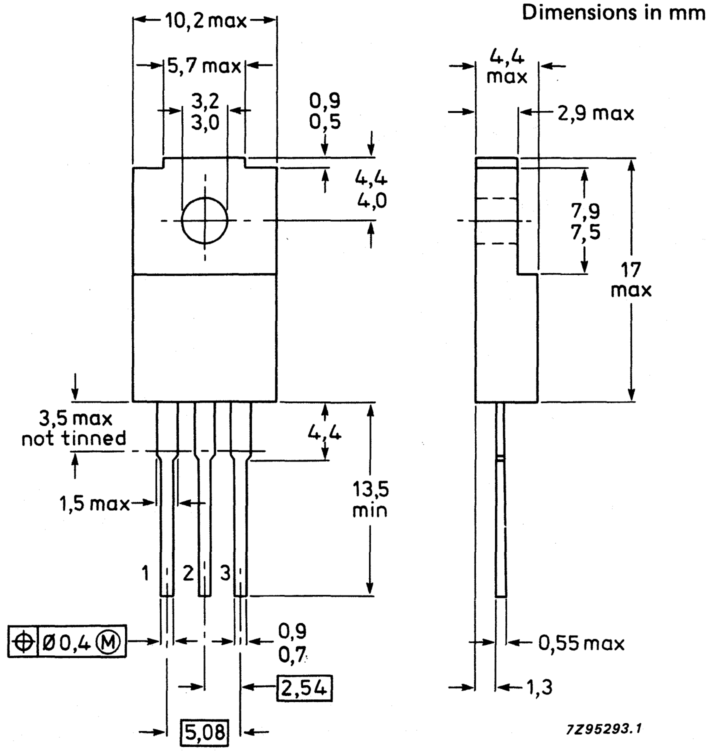
			BD944F	BD946F	BD948F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current (DC)	$-I_C$	max.		5		A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.		22		W

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT186.





Pinning

1 = base
2 = collector
3 = emitter

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD944F	BD946F	BD948F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current DC	$-I_C$	max.		5		A
peak value	$-I_{CM}$	max.		8		A
Base current	$-I_B$	max.		1		A
Total power dissipation up to T_h = 25 °C (note 1)	P_{tot}	max.		15		W
up to T_h = 25 °C (note 2)	P_{tot}	max.		22		W
Storage temperature range	T_{stg}			−65 to 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	2.93	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	7.93	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	5.43	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	max.	50	µA
$I_E = 0; -V_{CB} = -V_{CBOmax}; T_j = 150$ °C	$-I_{CBO}$	max.	1	mA
$I_B = 0; -V_{CE} = 15$ V; BD944F $-V_{CE} = 20$ V; BD946F $-V_{CE} = 25$ V; BD948F	$-I_{CEO}$	max.	0.1	mA
Emitter cut-off current $-I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	max.	0.2	mA

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

			BD944F	946F	948F	
DC current gain (note 1)						
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	min.	25	25	25	
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	85	85	85	
		max.	475	475	475	
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	min.	50	50	40	
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	h_{FE}	min.	–	–	30	
Base-emitter voltage (note 1 and 2)						
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	$-V_{BE}$	max.	1.1	1.1	–	V
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	$-V_{BE}$	max.	–	–	1.3	V
Collector-emitter saturation voltage (note 1)						
$-I_C$ = 2 A; $-I_B$ = 0.2 A	$-V_{CEsat}$	max.	0.5	0.5	–	V
$-I_C$ = 3 A; $-I_B$ = 0.3 A	$-V_{CEsat}$	max.	–	–	0.7	V
Knee voltage (1)						
$-I_C$ = 2 A; $-I_B$ = value when $-I_C$ = 2.2 A; $-V_{CE}$ = 1 V	$-V_{CEK}$	max.		0.8		V
Transition frequency at f = 1 MHz						
$-I_C$ = 250 mA; $-V_{CE}$ = 1 V	f_T	min.		3		MHz

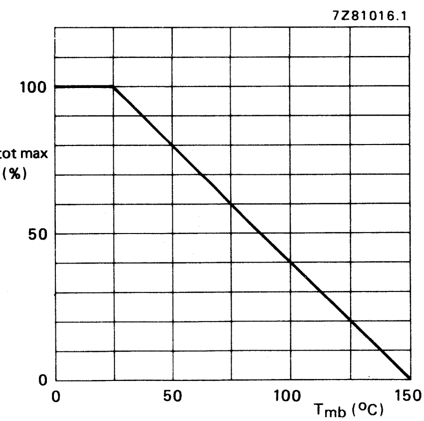
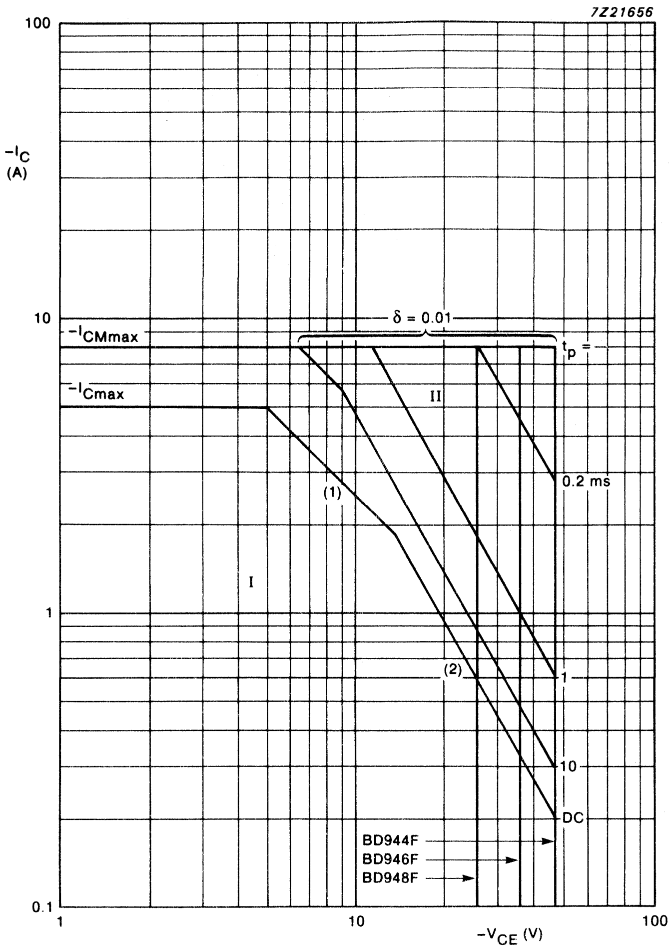


Fig.2 Power derating curve.

Notes

1. Measured under pulse conditions; $t_p \leqslant 300\ \mu s$; $\delta < 2\%$.
2. V_{BE} decreases by about 2.3 mV/K with increasing temperature.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Fig.3 Safe Operating Area, T_{mb} = 25 °C.

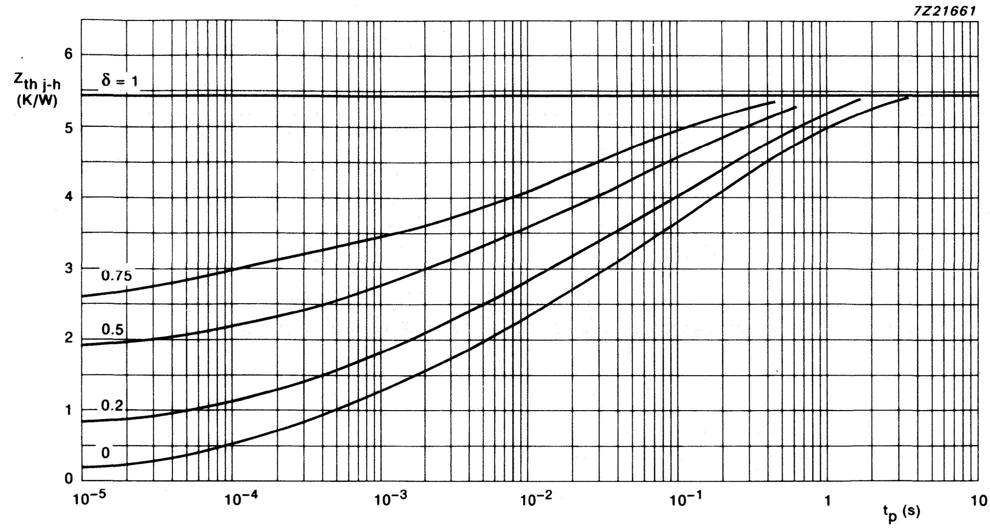


Fig.4 Pulse power rating chart.

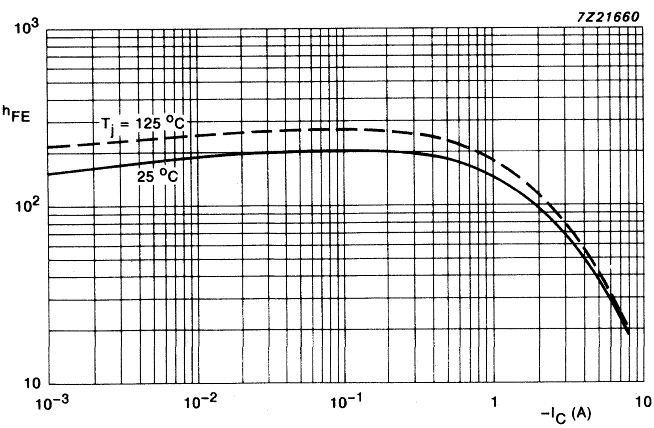


Fig.5 DC current gain; $-V_{CE}$ = 1 V; typical values.

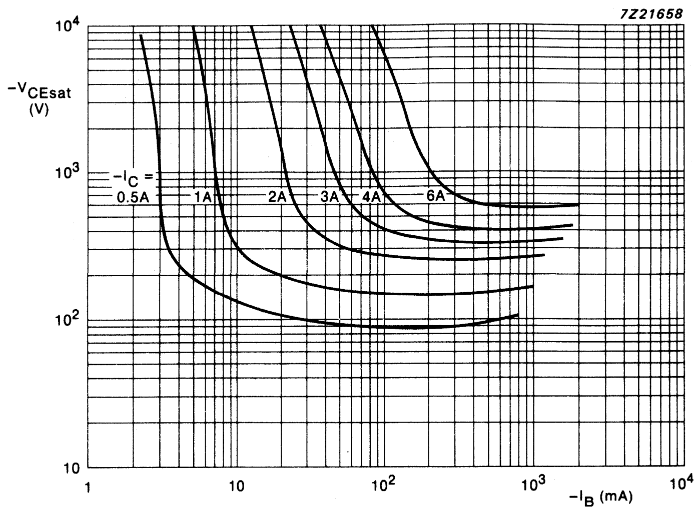


Fig.6 Collector-emitter saturation voltage as a function of base current; T_h = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N transistors in a plastic TO-220 envelope. With their p-n-p complements BD950; 952; 954 and 956 they are intended for use in a wide range of power amplifiers and for switching applications.

QUICK REFERENCE DATA

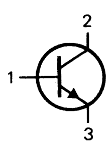
			BD949	BD951	BD953	BD955	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (d.c.)	I_C	max.		5			A
Collector current (peak value)	I_{CM}	max.		8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
I_C = 0,5 A; V_{CE} = 4 V	h_{FE}	>		40			
I_C = 2 A; V_{CE} = 4 V	h_{FE}	>		20			

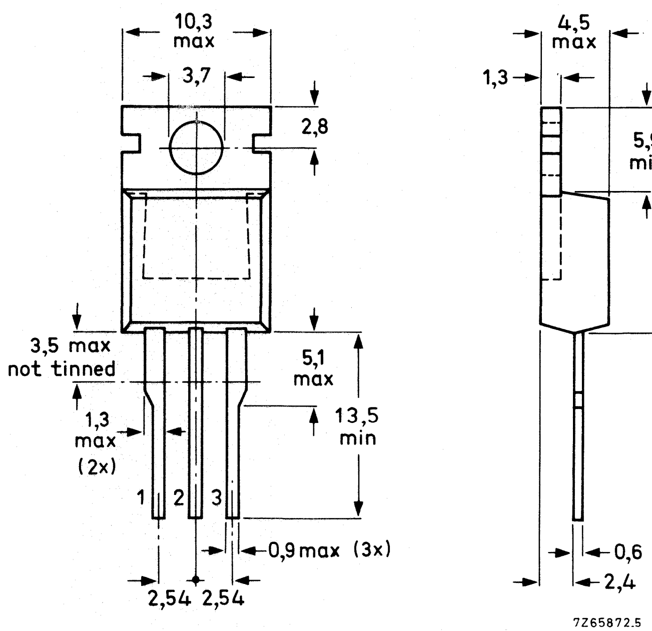
MECHANICAL DATA

Fig. 1 TO-220AB.

Dimensions in mm

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD949	951	953	955	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	5				A
Collector current (peak value)	I_{CM}	max.	8				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40				W
Storage temperature	T_{stg}		−65 to 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

from junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
from junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

→ Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBO\,max}$	I_{CBO}	$<$	50	μA
$I_E = 0$; $V_{CB} = ½\, V_{CBO\,max}$; T_j = 150 °C	I_{CBO}	$<$	1	mA
$I_B = 0$; $V_{CE} = ½\, V_{CEO\,max}$	I_{CEO}	$<$	0,1	mA
→ Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	$<$	0,2	mA
D.C. current gain (note 1)				
I_C = 0,5 A; V_{CE} = 4 V	h_{FE}	$>$	40	
I_C = 2 A; V_{CE} = 4 V	h_{FE}	$>$	20	
Base-emitter voltage (notes 1 and 2)				
I_C = 2 A; V_{CE} = 4 V	V_{BE}	$<$	1,4	V
Collector-emitter saturation voltage (note 1)				
I_C = 2 A; I_B = 0,2 A	V_{CEsat}	$<$	1	V
Transition frequency at f = 1 MHz				
I_C = 0,5 A; V_{CE} = 4 V	f_T	$>$	3	MHz

(1) Measured under pulse conditions: $t_p \leqslant 300\ \mu s$, $\delta < 2\%$.
(2) V_{EB} decreases by about 2,3 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Switching times			
(between 10% and 90% levels)			
I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A			
Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	1,5 μs

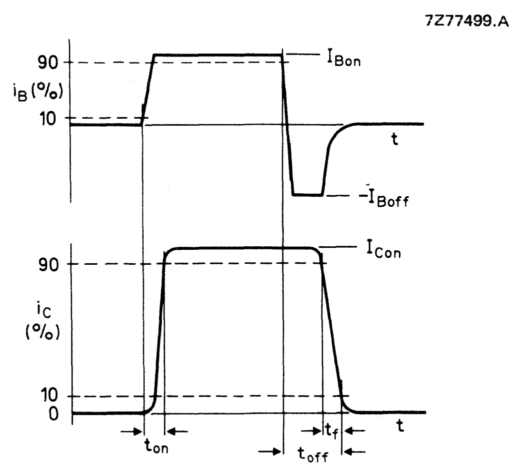
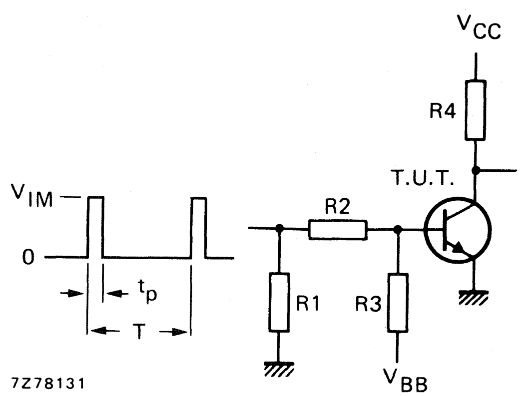


Fig. 2 Switching times waveforms.



V_{IM}	=	30 V
V_{CC}	=	20 V
V_{BB}	=	−3,5 V
R1	=	82 Ω
R2	=	150 Ω
R3	=	39 Ω
R4	=	20 Ω
$t_r = t_f$	⩽	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

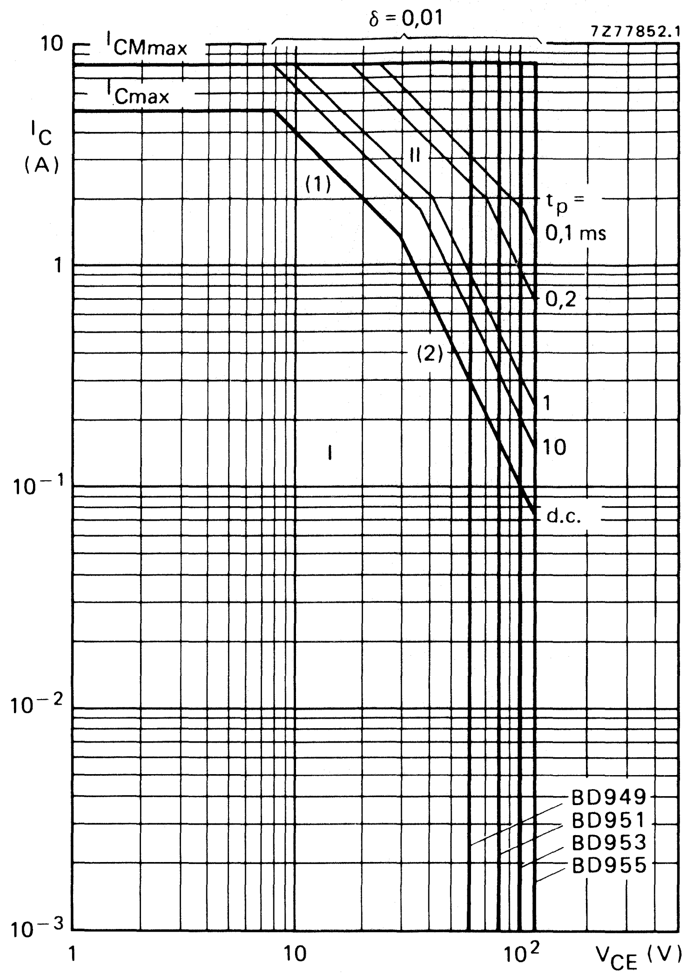


Fig. 4 Safe Operating ARea; $T_{mb} \leqslant 25\ ^{o}C$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

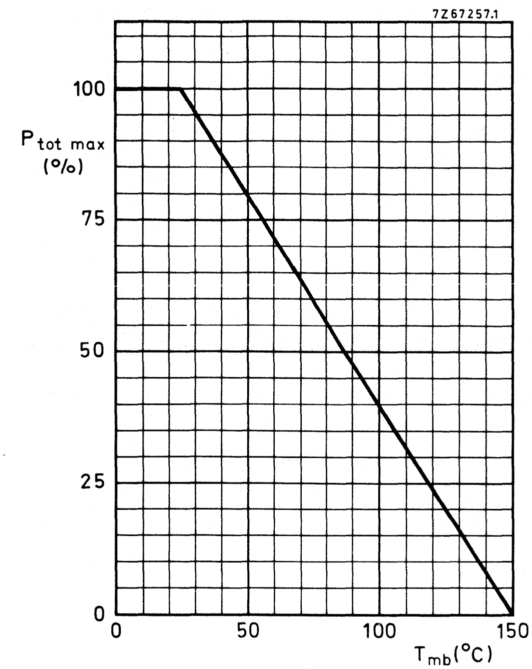


Fig. 5 Power derating curve.

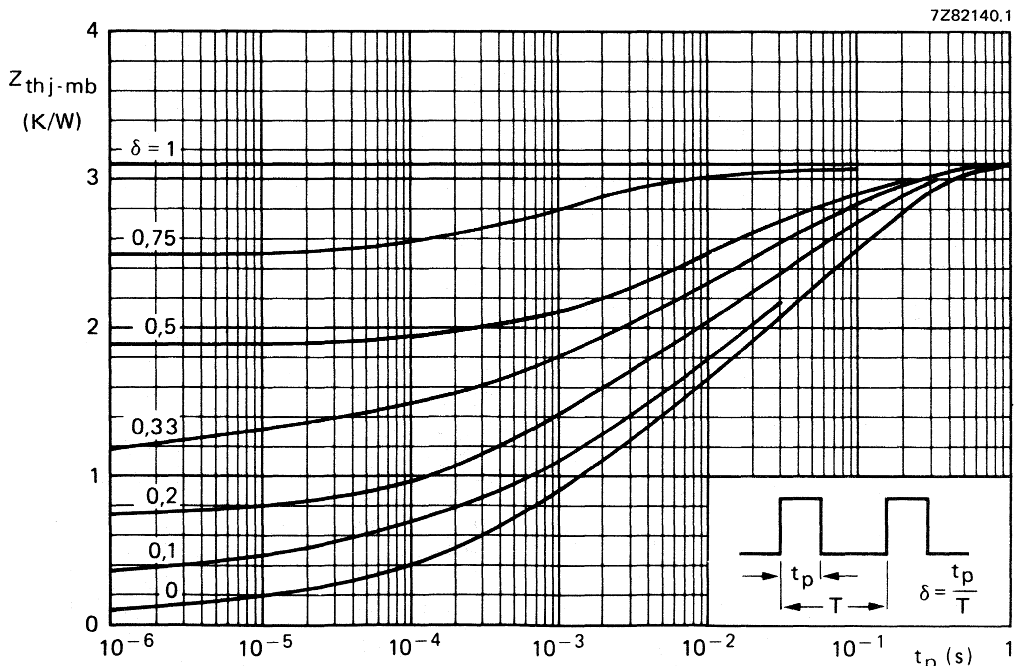


Fig. 6 Pulse power rating chart.

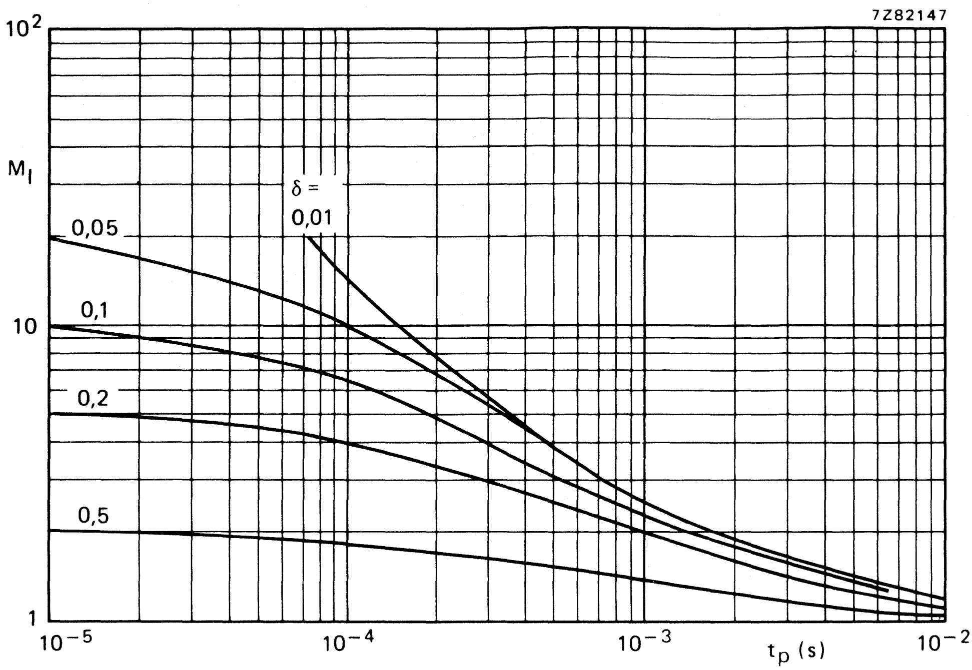


Fig. 7 S.B. current multiplying factor at the $V_{CEO\,max}$ level for BD949/951.

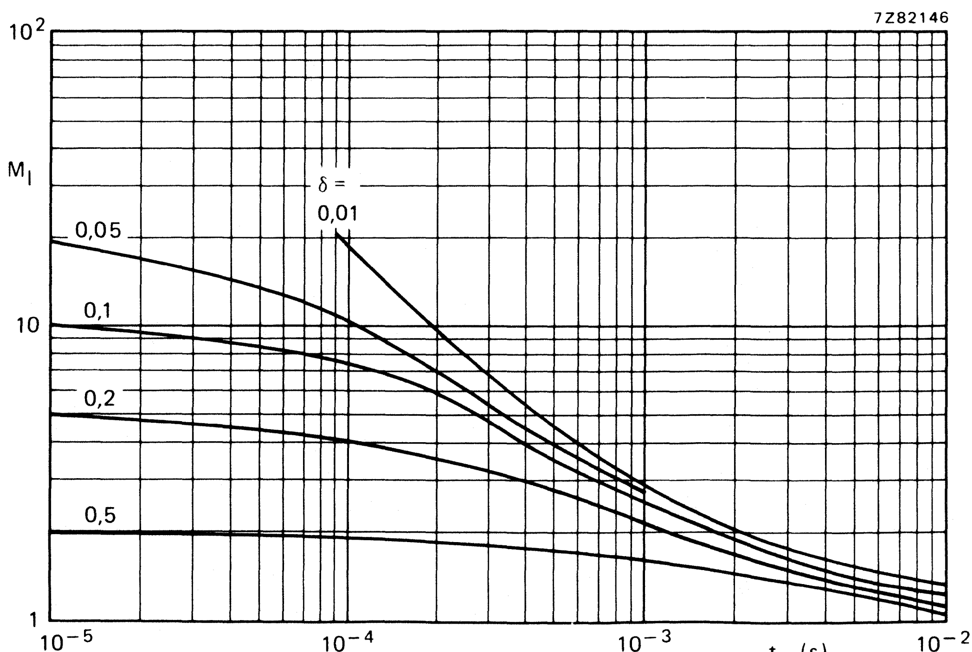


Fig. 8 S.B. current multiplying factor at the $V_{CEO\,max}$ level for BD953/955.

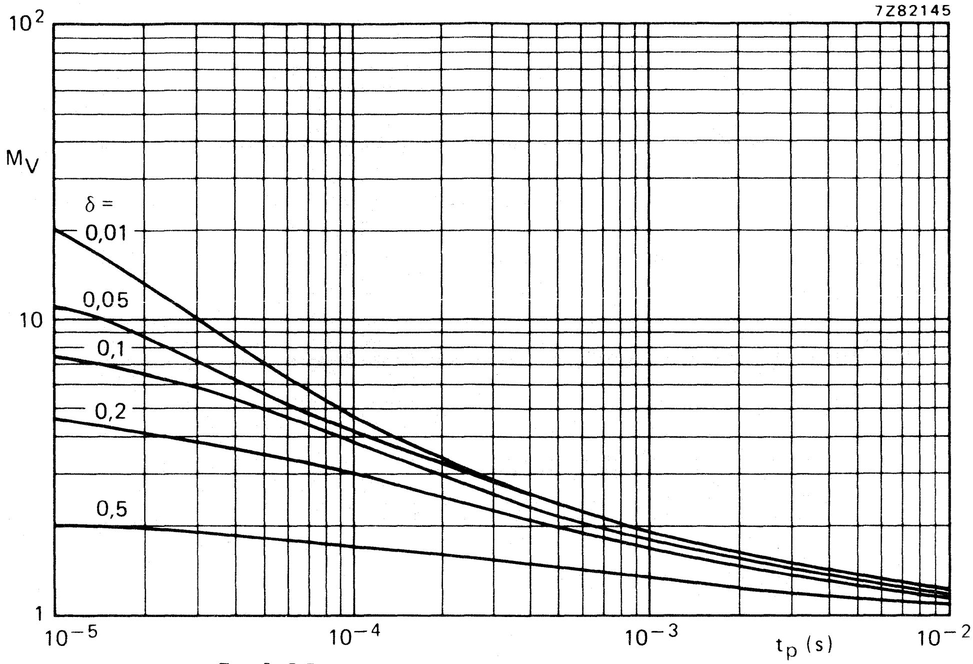


Fig. 9 S.B. voltage multiplying factor at the $I_{C\,max}$ level.

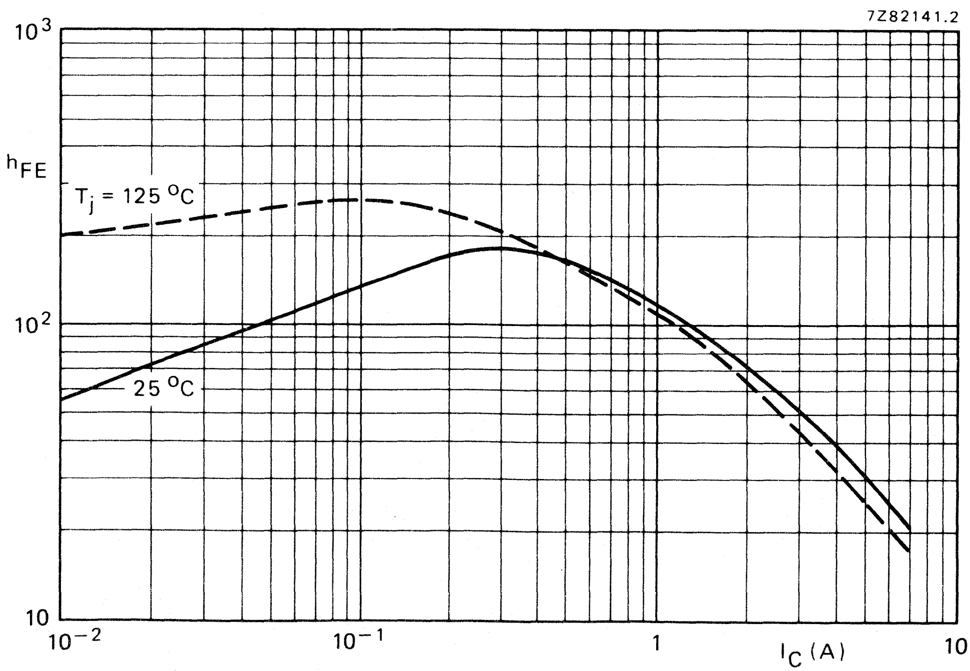


Fig. 10 Typical d.c. current gain at V_{CE} = 4 V.

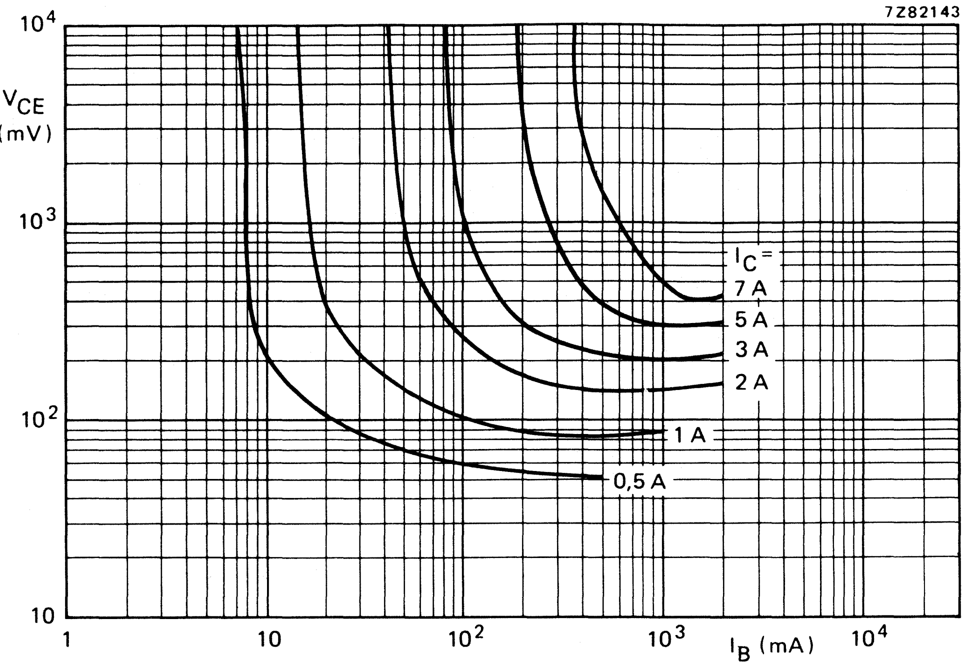


Fig. 11 Collector-emitter voltage as a function of base current.

SILICON EPITAXIAL POWER TRANSISTORS

NPN silicon power transistors each in a SOT186 envelope with an electrically insulated mounting base. PNP complements are BD950F, BD952F, BD954F, and BD956F.

QUICK REFERENCE DATA

			BD949F	951F	953F	955F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5			V
Collector current (DC)	I_C	max.		5			A
peak value	I_{CM}	max.		8			A
Total power dissipation at $T_h \leq 25\ ^oC$	P_{tot}	max.		22			W
DC current gain $I_C = 2$ A; $V_{CE} = 4$ V	h_{FE}	typ.		20			

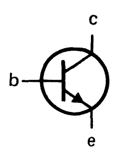
MECHANICAL DATA

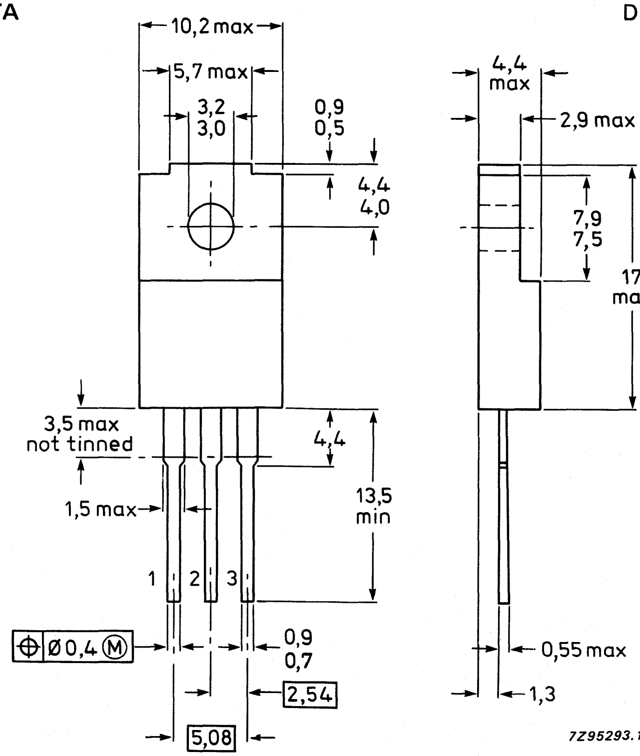
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD949F	951F	953F	955F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (DC)	I_C	max.	5				A
peak value	I_{CM}	max.	8				A
Base current (DC)	I_B	max.	5				A
Total power dissipation at $T_h \leqslant 25$ °C (note 1)	P_{tot}	max.	15				W
at $T_h \leqslant 25$ °C (note 2)	P_{tot}	max.	22				W
Storage temperature range	T_{stg}		−65 to 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\,j\text{-}mb}$	=	3.12	K/W
From junction to external heatsink (note 1)	$R_{th\,j\text{-}h}$	=	8.12	K/W
From junction to external heatsink (note 2)	$R_{th\,j\text{-}h}$	=	5.62	K/W

INSULATION

Voltage allowed between all terminals and external heatsink (peak value)	V_{insul}	max.	1000	V

CHARACTERISTICS

Collector-emitter saturation voltage $I_C = 2$ A; $I_B = 0.2$ A	V_{CEsat}	max.	1	V
DC current gain $I_C = 2$ A; $V_{CE} = 4$ V	h_{FE}	typ.	20	

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic TO-220 envelope. With their n-p-n complements BD949; 951; 953 and 955 they are intended for use in a wide range of power amplifiers and for switching applications.

QUICK REFERENCE DATA

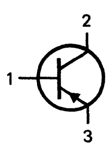
			BD950	952	954	956	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (d.c.)	$-I_C$	max.		5			A
Collector current (peak value)	$-I_{CM}$	max.		8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
$-I_C$ = 0,5 A; $-V_{CE}$ = 4 V	h_{FE}	>		40			
$-I_C$ = 2 A; $-V_{CE}$ = 4 V	h_{FE}	>		20			

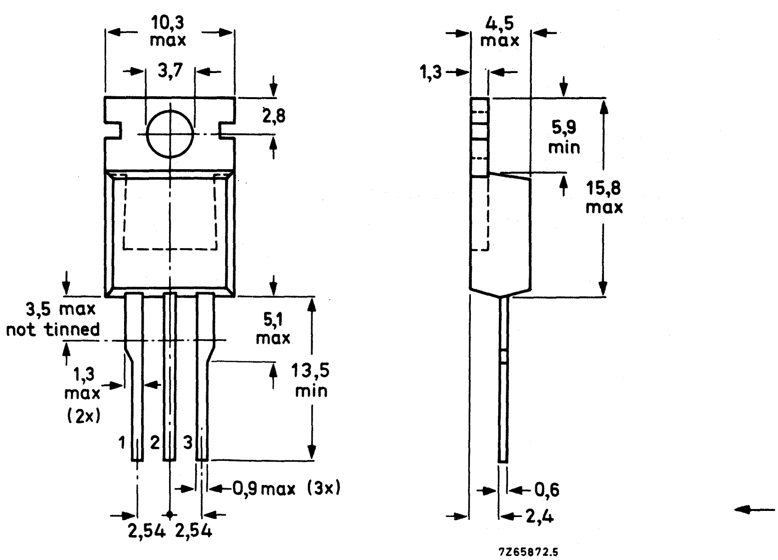
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD950	952	954	956	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5			V
Collector current (d.c.)	$-I_C$	max.		5			A
Collector current (peak value)	$-I_{CM}$	max.		8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Storage temperature	T_{stg}			−65 to 150			°C
Junction temperature	T_j	max.		150			°C

THERMAL RESISTANCE

from junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
from junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

→ Collector cut-off current				
$I_E = 0; -V_{CB} = -V_{CBO\,max}$	$-I_{CBO}$	<	50	μA
$I_E = 0; -V_{CB} = -½\ V_{CBO\,max}$; T_j = 150 °C	$-I_{CBO}$	<	1	mA
$I_B = 0; -V_{CE} = -½\ V_{CEO\,max}$	$-I_{CEO}$	<	0,1	mA
→ Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	0,2	mA
D.C. current gain (note 1)				
$-I_C$ = 0,5 A; $-V_{CE}$ = 4 V	h_{FE}	>	40	
$-I_C$ = 2 A; $-V_{CE}$ = 4 V	h_{FE}	>	20	
Base-emitter voltage (notes 1 and 2)				
$-I_C$ = 2 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	1,4	V
Collector-emitter saturation voltage (note 1)				
$-I_C$ = 2 A; $-I_B$ = 0,2 A	$-V_{CEsat}$	<	1	V
Transition frequency at f = 1 MHz				
$-I_C$ = 0,5 A; $-V_{CE}$ = 4 V	f_T	>	3	MHz

(1) Measured under pulse conditions: $t_p \leq 300\ \mu s$, $\delta < 2\%$.
(2) V_{EB} decreases by about 2,3 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)
I_{Con} = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A

Turn-on time	t_{on}	typ.	0,1	μs
Turn-off time	t_{off}	typ.	0,4	μs

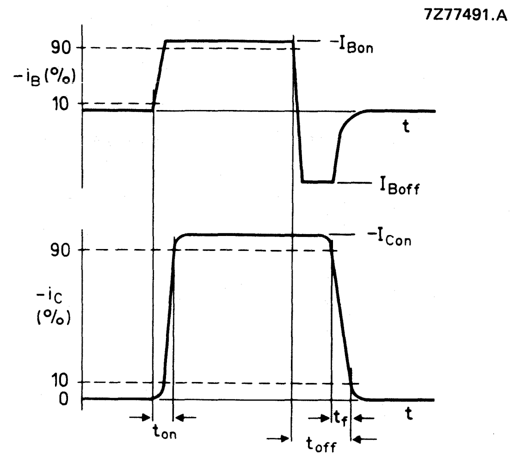
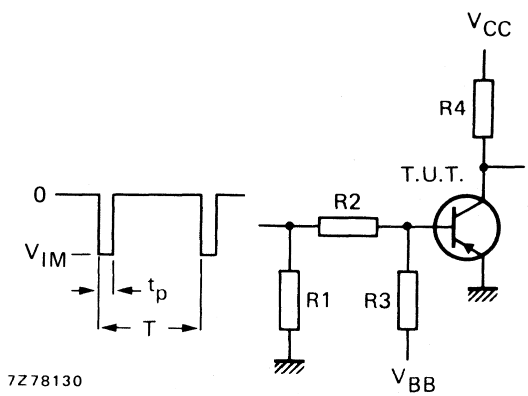


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	30	V
$-V_{CC}$	=	20	V
V_{BB}	=	3,5	V
R1	=	82	Ω
R2	=	150	Ω
R3	=	39	Ω
R4	=	20	Ω
$t_r = t_f$	≤	15	ns
t_p	=	10	μs
T	=	500	μs

Fig. 3 Switching times test circuit.

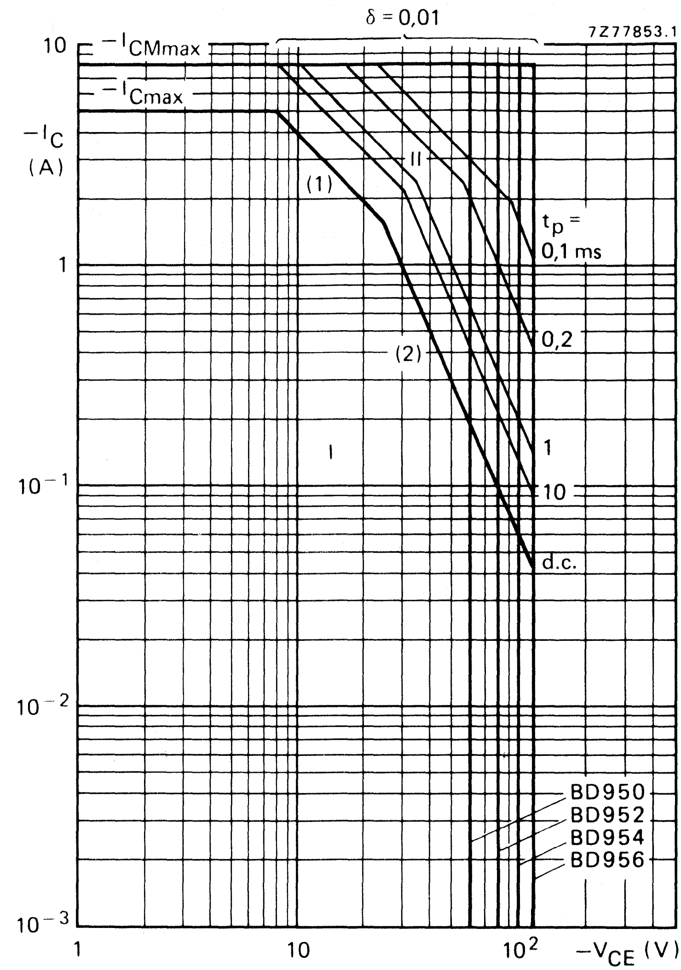


Fig. 4 Safe Operating ARea; $T_{mb} \leqslant 25$ °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

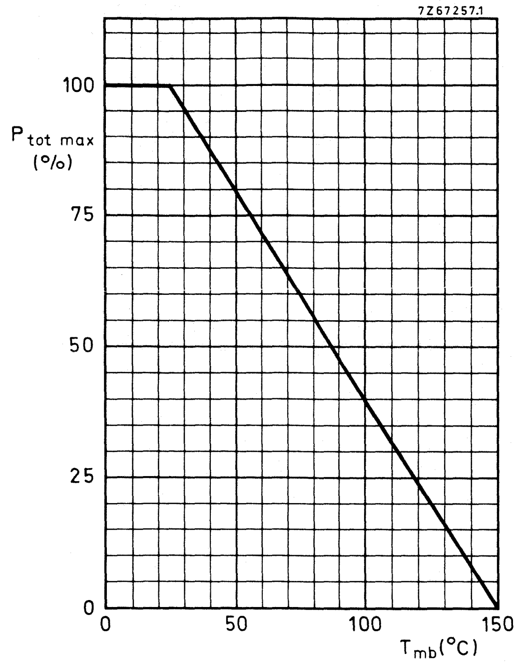


Fig. 5 Power derating curve.

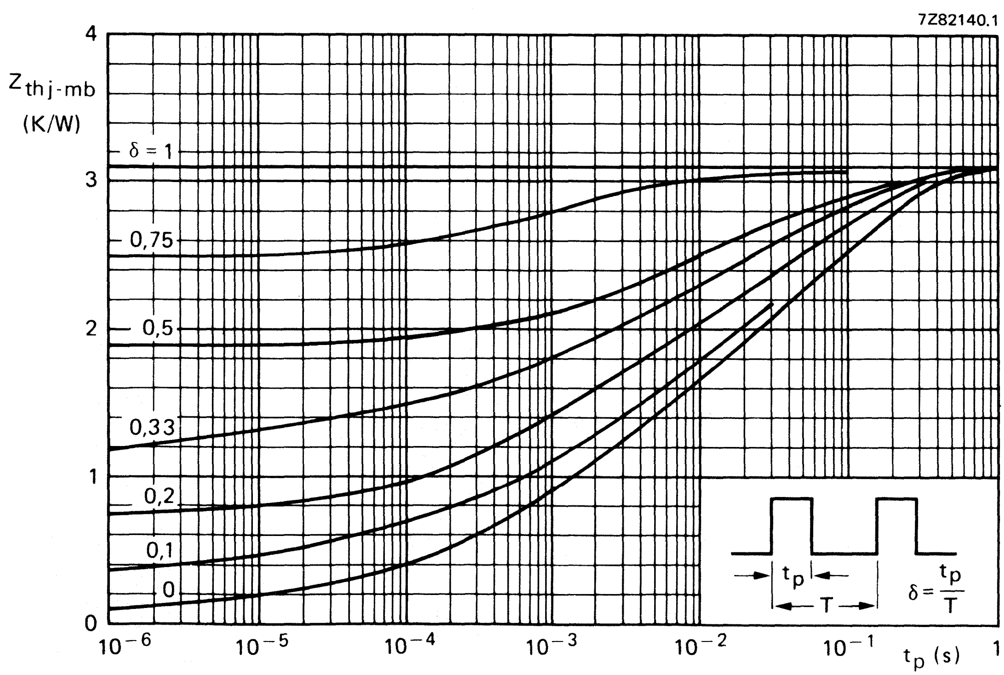


Fig. 6 Pulse power rating chart.

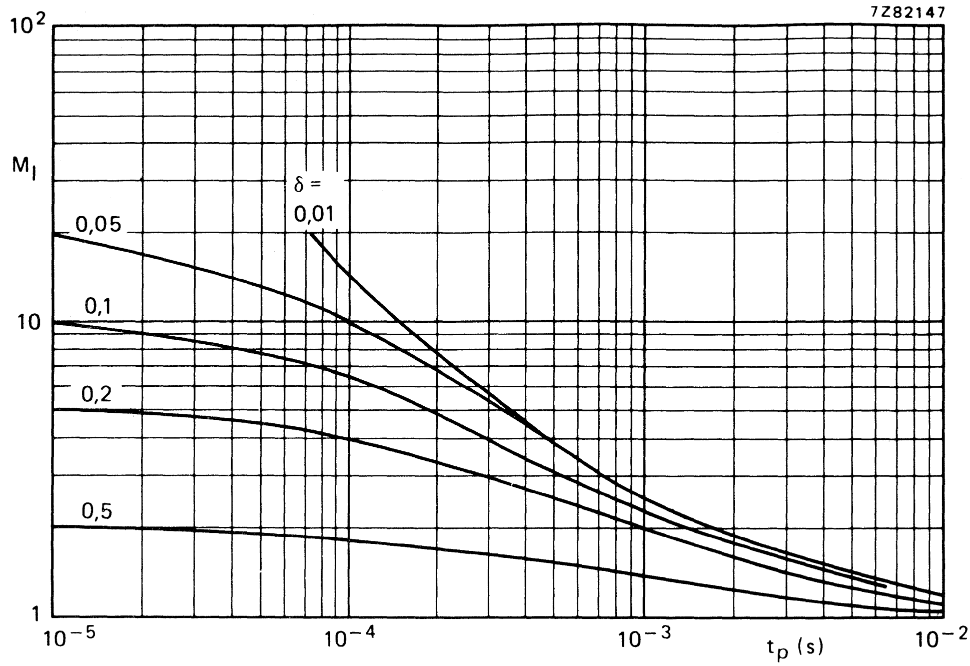


Fig. 7 S.B. current multiplying factor at the $-V_{CEO\,max}$ level for BD950 and BD952.

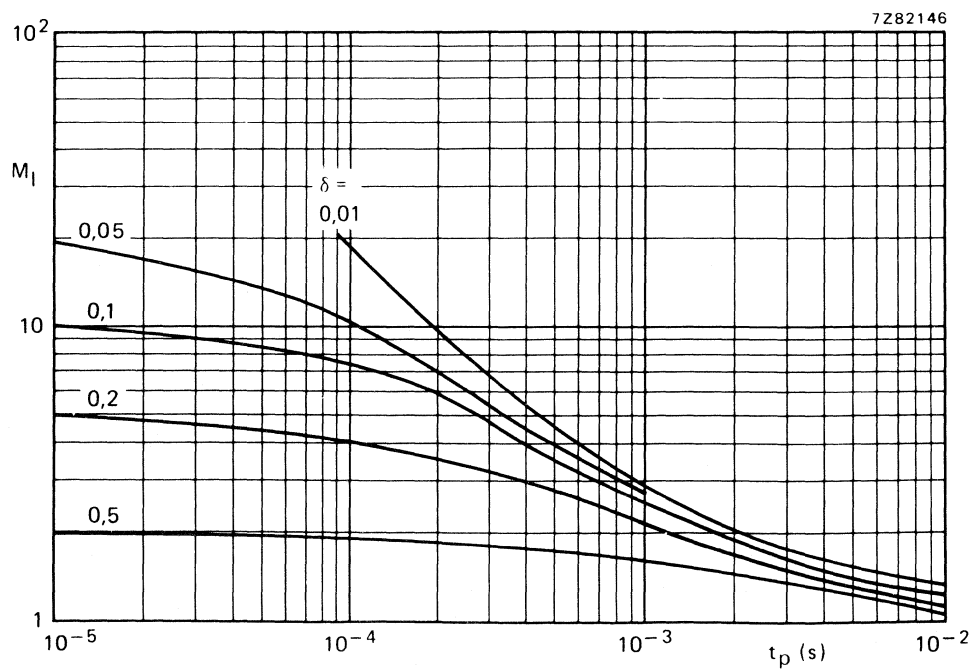


Fig. 8 S.B. current multiplying factor at the $-V_{CEO\,max}$ level for BD954 and BD956.

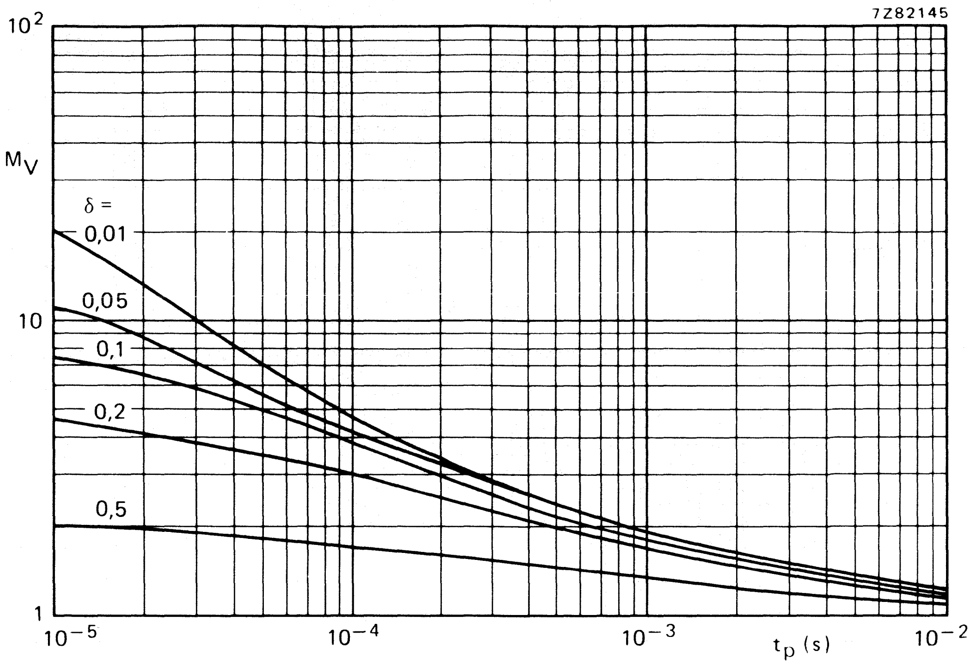


Fig. 9 S.B. voltage multiplying factor at the $-I_{C\,max}$ level.

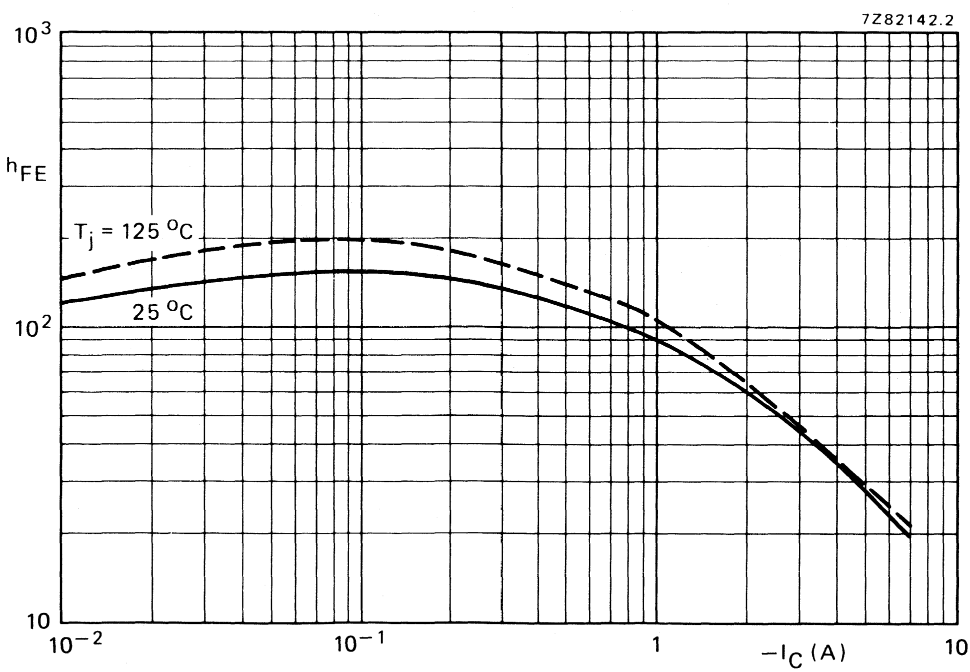


Fig. 10 Typical d.c. current gain at $-V_{CE}$ = 4 V.

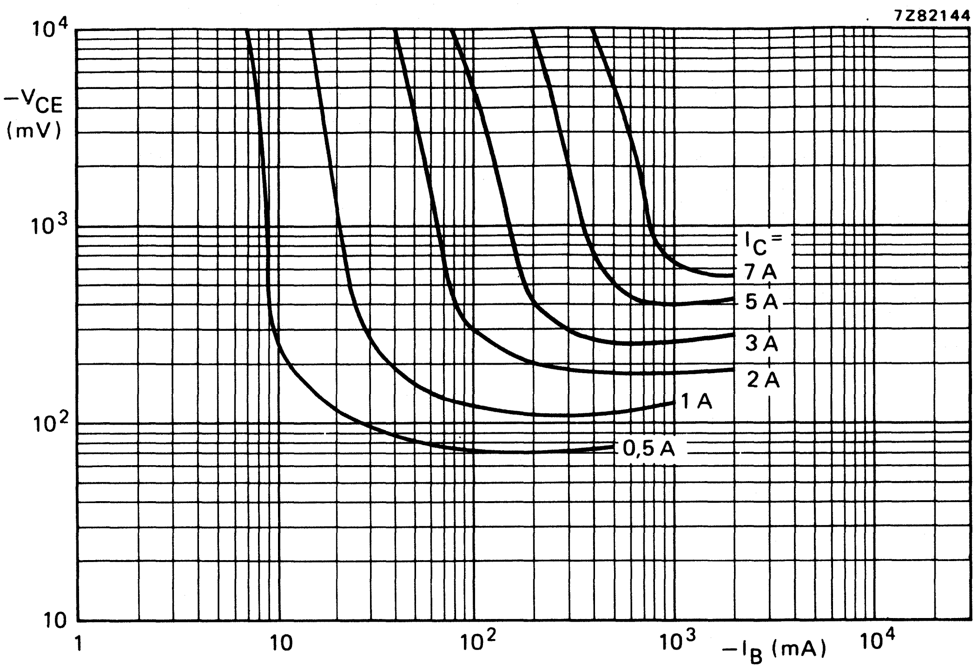


Fig. 11 Collector-emitter voltage as a function of base current.

SILICON EPITAXIAL POWER TRANSISTORS

PNP silicon power transistors each in a SOT186 envelope with an electrically insulated mounting base. NPN complements are BD949F, BD951F, BD953F, and BD955F.

QUICK REFERENCE DATA

			BD950F	952F	954F	956F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5			V
Collector current (DC)	$-I_C$	max.		5			A
peak value	$-I_{CM}$	max.		8			A
Total power dissipation at $T_h \leqslant 25\ ^oC$	P_{tot}	max.		22			W
DC current gain $-I_C = 2$ A; $-V_{CE} = 4$ V	h_{FE}	typ.		20			

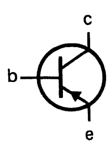
MECHANICAL DATA

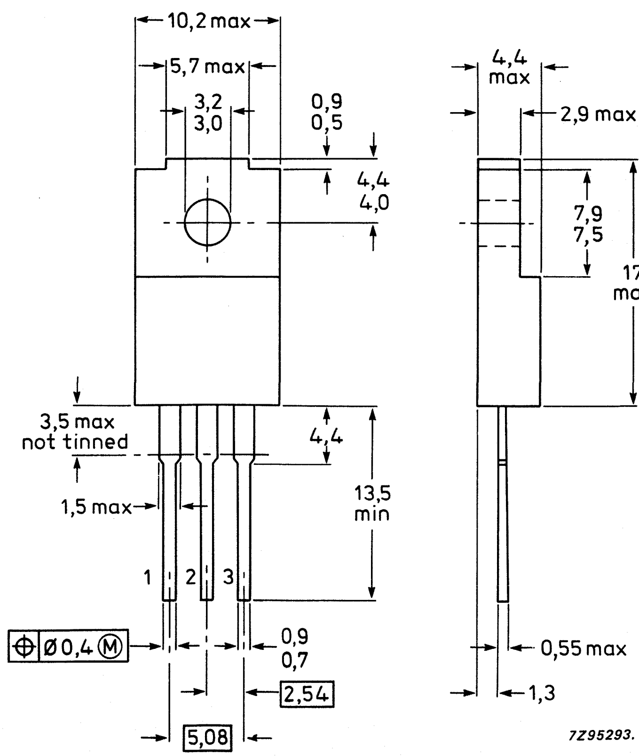
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD950F	952F	954F	956F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V

Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V
Collector current (DC)	$-I_C$	max.	5	A
peak value	$-I_{CM}$	max.	8	A
Base current (DC)	$-I_B$	max.	5	A
Total power dissipation at $T_h \leqslant 25$ °C (note 1)	P_{tot}	max.	15	W
at $T_h \leqslant 25$ °C (note 2)	P_{tot}	max.	22	W
Storage temperature range	T_{stg}		−65 to 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\,j\text{-}mb}$	=	3.12	K/W
From junction to external heatsink (note 1)	$R_{th\,j\text{-}h}$	=	8.12	K/W
From junction to external heatsink (note 2)	$R_{th\,j\text{-}h}$	=	5.62	K/W

INSULATION

Voltage allowed between all terminals and external heatsink (peak value)	V_{insul}	max.	1000	V

CHARACTERISTICS

Collector-emitter saturation voltage $-I_C = 2$ A; $-I_B = 0.2$ A	V_{CEsat}	max.	1	V
DC current gain $-I_C = 2$ A; $-V_{CE} = 4$ V	h_{FE}	typ.	20	

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur. P-N-P complements are BDT30 series.
The TIP29 series is an equivalent type.

QUICK REFERENCE DATA

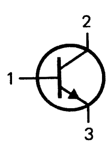
			BDT29	A	B	C	
Collector-base voltage	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.	1				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
I_C = 200 mA; V_{CE} = 4 V	h_{FE}	>	40				
I_C = 1 A; V_{CE} = 4 V	h_{FE}		15 to 75				
Transition frequency at f = 1 MHz							
I_C = 200 mA; V_{CE} = 10 V	f_T	>	3				MHz

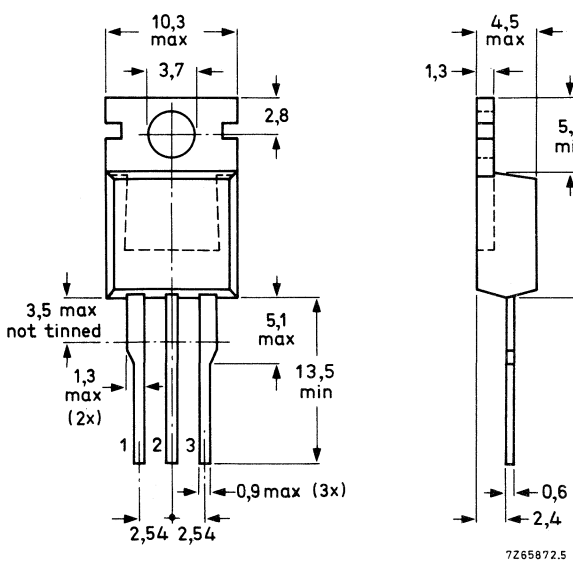
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT29	A	B	C	
→ Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	1				A
Collector current (peak value)	I_{CM}	max.	3				A
Base current (d.c.)	I_B	max.	0,4				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT29; A	BDT29B; C	
Collector cut-off current					
→ $I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	0,1	—	mA
→ $I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	<	—	0,1	mA
$V_{BE} = 0$; $V_{CE} = V_{CEOmax}$	I_{CES}	<	0,2		mA
Emitter cut-off current					
→ $I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	0,2		mA
D.C. current gain*					
$I_C = 200$ mA; $V_{CE} = 4$ V	h_{FE}	>	40		
$I_C = 1$ A; $V_{CE} = 4$ V	h_{FE}		15 to 75		
Base-emitter voltage**					
$I_C = 1$ A; $V_{CE} = 4$ V	V_{BE}	<	1,3		V
Collector-emitter saturation voltage*					
$I_C = 1$ A; $I_B = 0,125$ A	V_{CEsat}	<	0,7		V

			BDT29	A	B	C	
Collector-emitter breakdown voltage*							
$I_B = 0$; $I_C = 30$ mA	$V_{(BR)CEO}$	>	40	60	80	100	V
Small-signal current gain							
$I_C = 0,2$ A; $V_{CE} = 10$ V; f = 1 kHz	$\|h_{fe}\|$	>	20				
Turn off breakdown energy							
L = 20 mH; $I_{CC} = 1,8$ A	$E_{(BR)}$	>	32				mJ

* Measured under pulse conditions: $t_p \leq 300$ µs; $\delta < 2\%$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Transition frequency at f = 1 MHz			
I_C = 0,2 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times (between 10% and 90% levels)			
I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A			
Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	1 μs

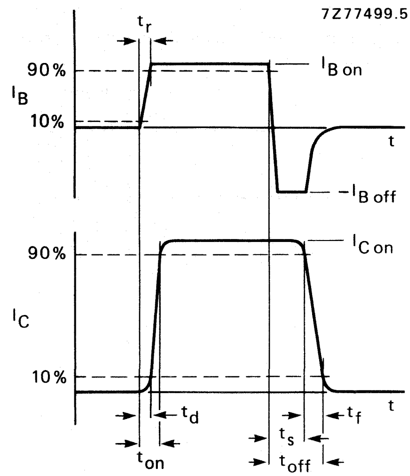


Fig. 2 Switching times waveforms.

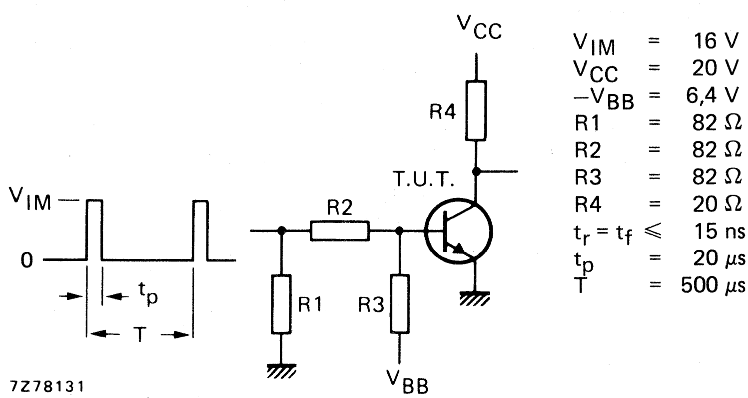


Fig. 3 Switching times test circuit.

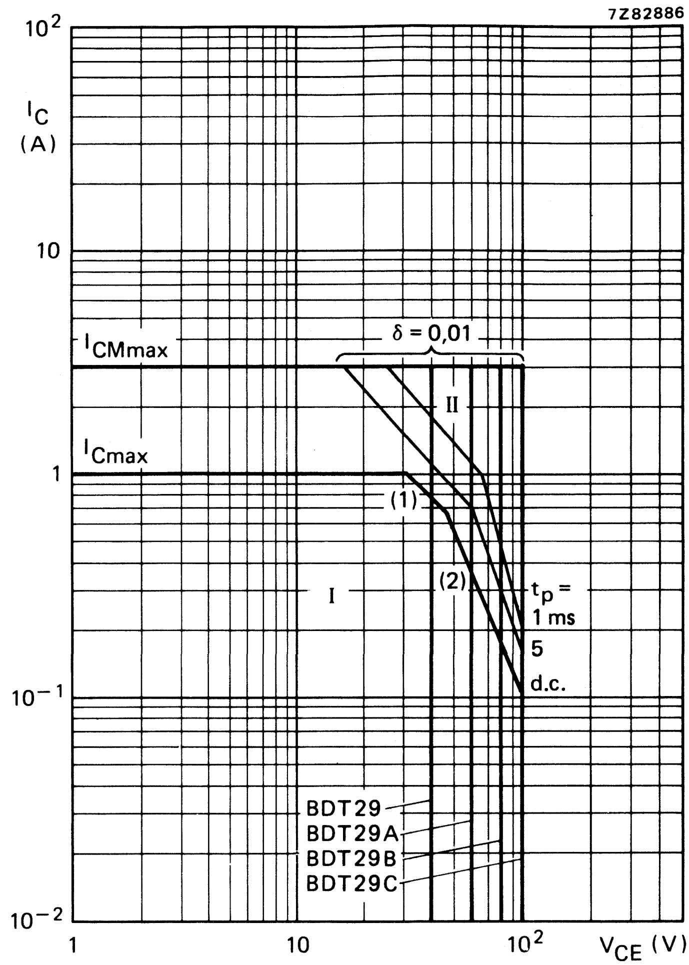


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second-breakdown limits.

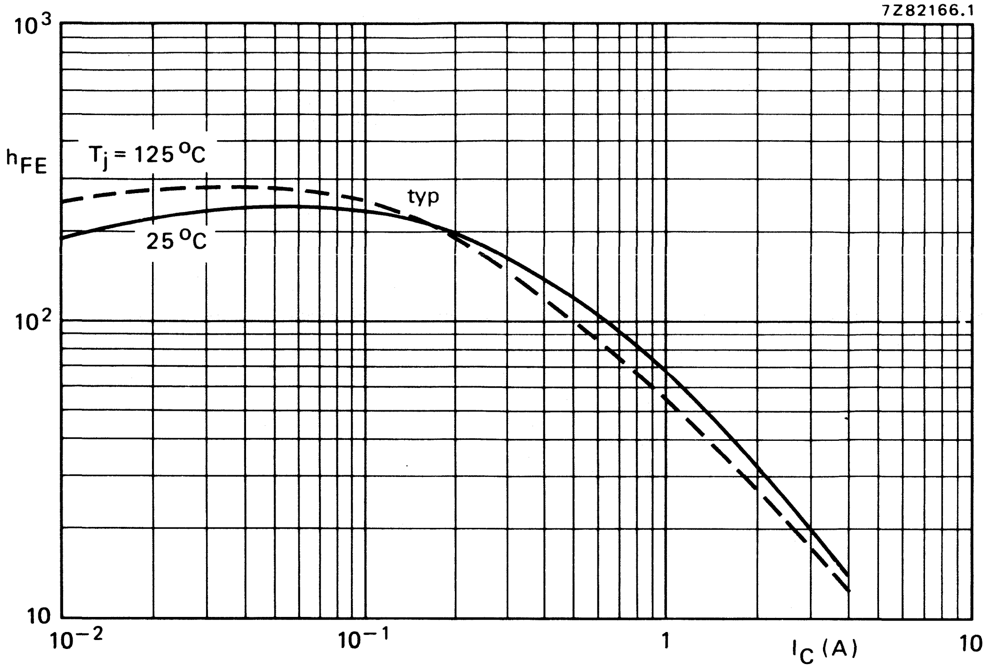


Fig. 5 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 4$ V.

BDT29F
BDT29AF; 29BF
BDT29CF; 29DF

SILICON EPITAXIAL POWER TRANSISTORS

N-P-N silicon power transistors in a SOT-186 envelope with an electrically insulated mounting base, intended for use in audio output stages, general purpose amplifier and high-speed switching applications.

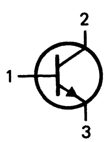
P-N-P complements are BDT30F, BDT30AF, BDT30BF, BDT30CF and BDT30DF.

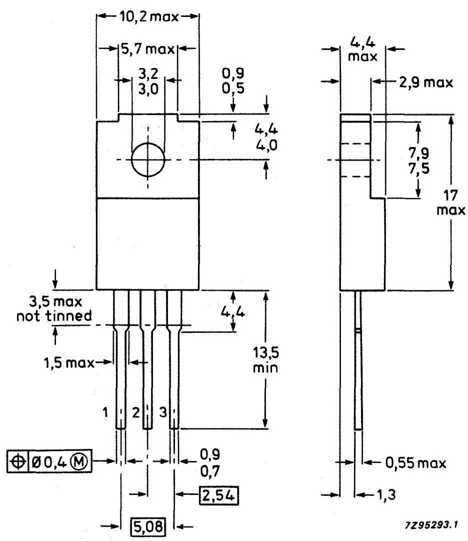
QUICK REFERENCE DATA

			BDT29F	29AF	29BF	29CF	29DF	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	160	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	5	V
Collector current d.c.	I_C	max.	3	3	3	3	3	A
peak value	I_{CM}	max.	7	7	7	7	7	A
Total power dissipation up to $T_h = 25\ ^oC$	P_{tot}	max.	19	19	19	19	19	W
D.C. current gain $I_C = 1$ A; $V_{CE} = 4$ V	h_{FE}		15 to 75					
Transition frequency at f = 1 MHz $I_C = 0{,}2$ A; $V_{CE} = 10$ V	f_T	min.	3					MHz

Fig. 1 SOT-186.

Dimensions in mm





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT29F	29AF	29BF	29CF	29DF	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	160	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	120	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current				
d.c.	I_C	max.	3	A
peak value	I_{CM}	max.	7	A
Base current (d.c.)	I_B	max.	0,4	A
Total power dissipation				
up to T_h = 25 °C (1)	P_{tot}	max.	14	W
up to T_h = 25 °C (2)	P_{tot}	max.	19	W
Storage temperature	T_{stg}		−65 to 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\,j\text{-}mb}$	=	4,17	K/W
From junction to external heatsink (1)	$R_{th\,j\text{-}h}$	=	9,17	K/W
From junction to external heatsink (2)	$R_{th\,j\text{-}h}$	=	6,67	K/W
From junction to ambient	$R_{th\,j\text{-}a}$	=	55	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value (3)	V_{insul}	max.	1000	V
Insulation capacitance between collector and external heatsink	$C_{c\text{-}h}$	typ.	12	pF

(1) Mounted without heatsink compound and 30 ± 5 newtons pressure on centre envelope.

(2) Mounted with heatsink compound and 30 ± 5 newtons pressure on centre envelope.

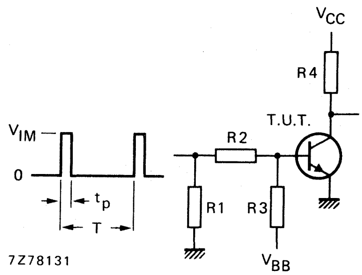
(3) Heatsink temperature T_h = 25 °C; relative humidity $R_H \leqslant$ 75%; atmospheric pressure p_{amb} = 1013 mbar.

CHARACTERISTICS

T_h = 25 °C unless otherwise specified

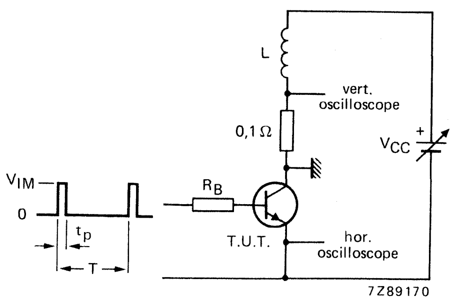
			BDT29F	29AF	29BF	29CF	29DF		
Collector cut-off currents									
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	0,1	0,1	—	—	—	mA	←
$I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	<	—	—	0,1	0,1	—	mA	←
$I_B = 0$; $V_{CE} = 90$ V	I_{CEO}	<	—	—	—	—	0,1	mA	←
$V_{BE} = 0$; $V_{CE} = V_{CBO\,max}$	I_{CES}	<	0,2	0,2	0,2	0,2	0,2	mA	
Emitter cut-off current									
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	0,2	0,2	0,2	0,2	0,2	mA	←
Collector-emitter breakdown voltages (1)									
$I_B = 0$; $I_C = 30$ mA	$V_{(BR)CEO}$	>	40	60	80	100	120	V	
D.C. current gain (1)									
$I_C = 0{,}2$ A; $V_{CE} = 4$ V	h_{FE}	>			40				
$I_C = 1$ A; $V_{CE} = 4$ V	h_{FE}				15 to 75				
Base-emitter voltages (1)+(2)									
$I_C = 1$ A; $V_{CE} = 4$ V	V_{BE}	<			1,3				
Collector-emitter saturation voltage (1)									
$I_C = 1$ A; $I_B = 0{,}125$ A	V_{CEsat}	<			0,7			V	
Transition frequency at f = 1 MHz									
$I_C = 0{,}2$ A; $V_{CE} = 10$ V	f_T	>			3			MHz	
Small-signal current gain									
$I_C = 0{,}2$ A; $V_{CE} = 10$ V									
at 1 kHz	h_{fe}	>			20				
at 1 MHz	h_{fe}	>			3				
Turn-off breakdown energy with inductive load (see Fig. 3)									
$I_C = 1{,}8$ A; L = 20 mH	$E_{(BR)}$	>			32			mJ	
Switching times (see Fig. 2)									
$I_C = 1$ A; $I_{Bon} = -I_{Boff} = 0{,}1$ A									
turn-on time	t_{on}	typ.			0,3			μs	
turn-off time	t_{off}	typ.			1			μs	

(1) Measured under pulse conditions: t_p = 300 μs; δ = 2%.
(2) V_{BE} decreases by about 2,3 mV/K with increasing temperature.



V_{CC} = 20 V
V_{IM} = 16 V
$-V_{BB}$ = 6,4 V
R1 = 82 Ω
R2 = 82 Ω
R3 = 82 Ω
R4 = 20 Ω
$t_r = t_f$ = 15 ns
t_p = 20 µs
T = 500 µs

Fig. 2 Switching times test circuit.



V_{IM} = 12 V
R_B = 270 Ω
L = 20 mH
I_C = 1,8 A
t_p = 1 ms
δ = 1 %

Fig. 3 Test circuit for turn-off breakdown energy.

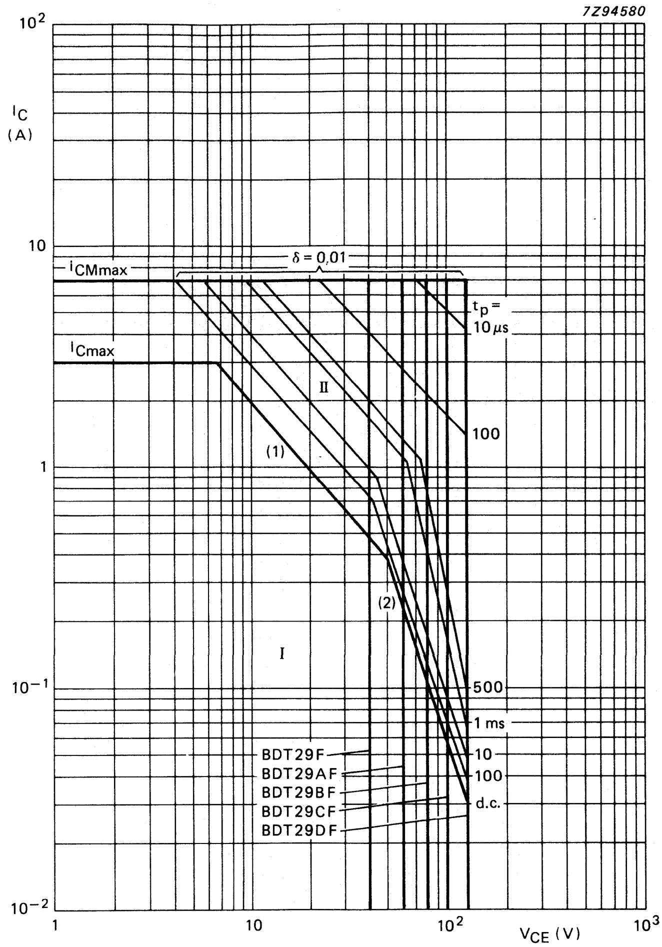


Fig. 4 Safe Operating ARea, T_{amb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Mounted *with* heatsink compound and 30 ± 5 Newton pressure on the centre of the envelope.

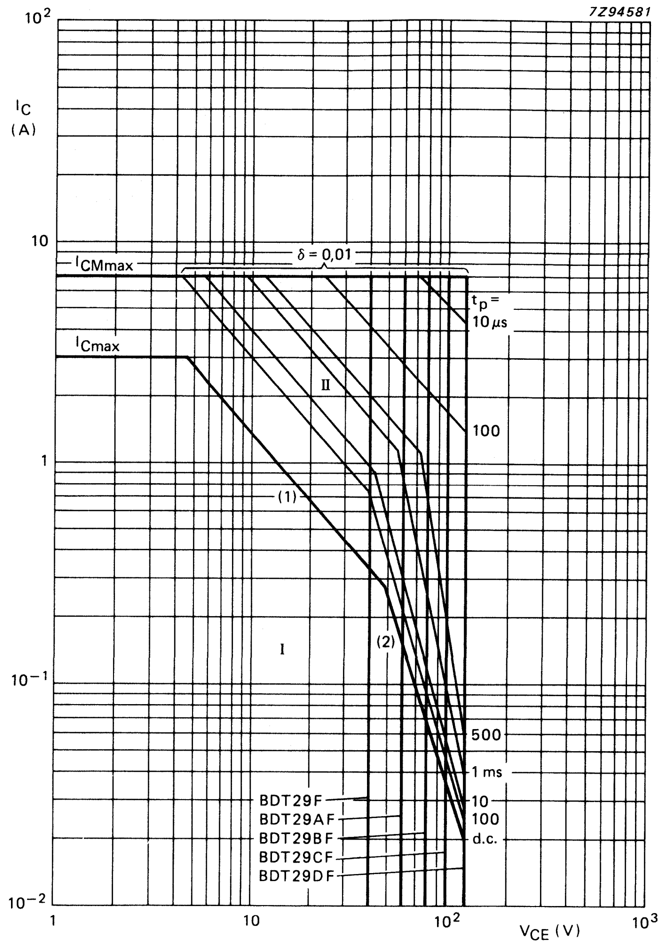


Fig. 5 Safe Operating ARea, T_{amb} = 25 °C

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Mounted *without* heatsink compound and 30 ± 5 Newton pressure on the centre of the envelope.

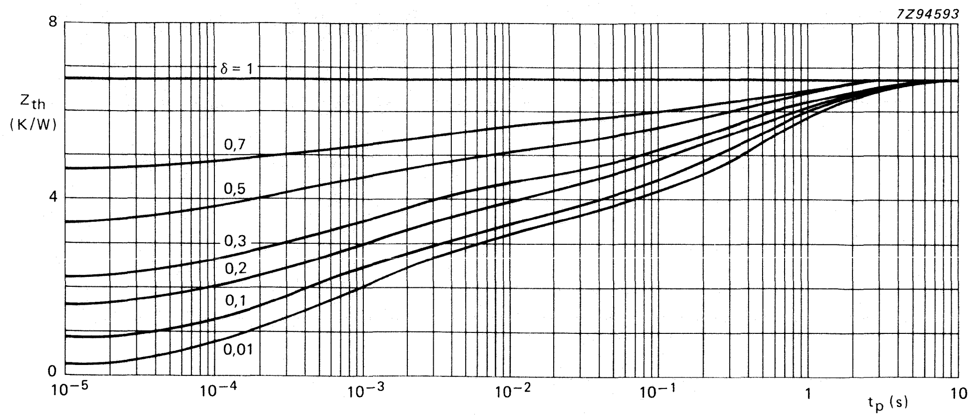


Fig. 6 Pulse power rating chart; mounted *with* heatsink compound and 30 ± 5 Newton pressure on the envelope.

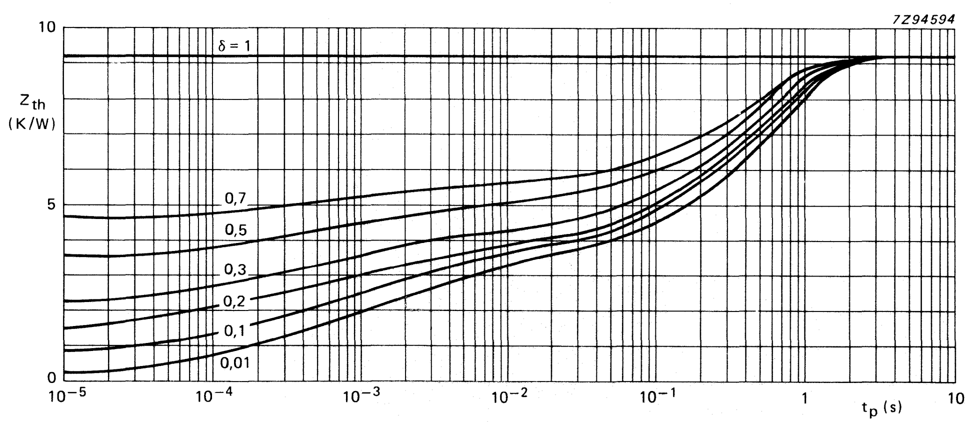


Fig. 7 Pulse power rating chart; mounted *without* heatsink compound and 30 ± 5 Newton pressure on the envelope.

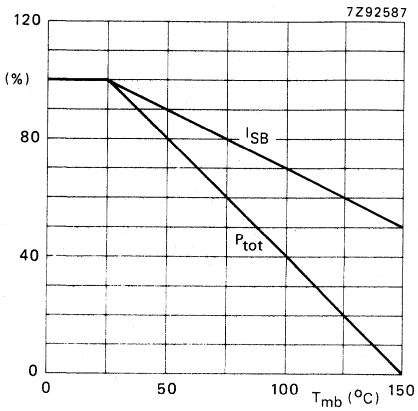


Fig. 8 Total power dissipation and second-breakdown current derating curve.

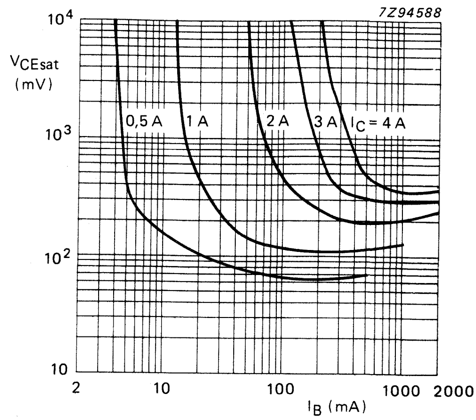


Fig. 9 Collector-emitter saturation voltage; typical values.

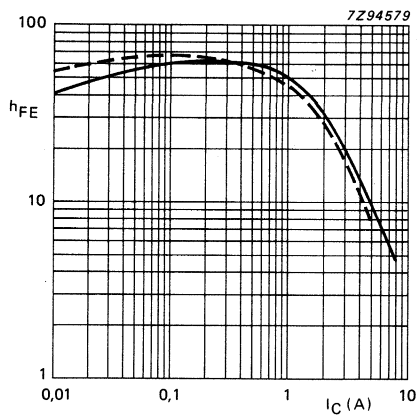


Fig. 10 D.C. current gain; V_{CE} = 4 V; typical values;
—— T_j = 25 °C; – – – – T_j = 125 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur. The TIP30 series is an equivalent type.
P-N-P complements are BDT29 series.

QUICK REFERENCE DATA

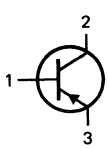
			BDT30	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	1				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}		15 to 75				
Transition frequency $-I_C$ = 200 mA; $-V_{CE}$ = 10 V	f_T	>	3				MHz

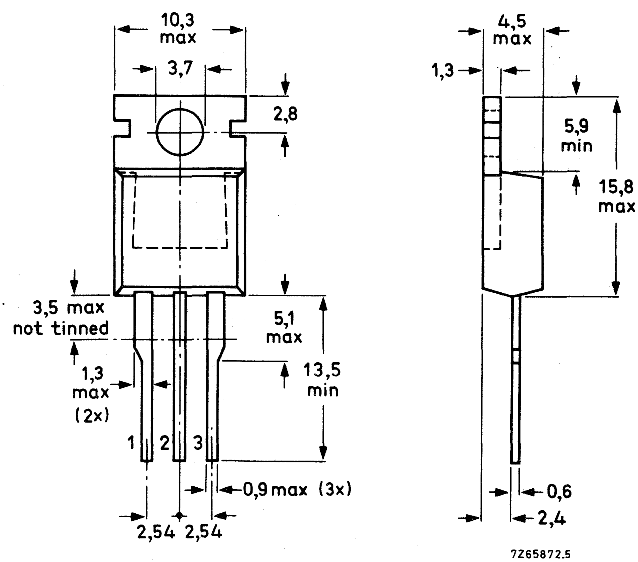
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT30	A	B	C	
→ Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
Collector current (d.c.)	$-I_C$	max.	1				A
Collector current (peak value)	$-I_{CM}$	max.	3				A
Base current (d.c.)	$-I_B$	max.	0,4				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Storage temperature	T_{stg}		−65 to +150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT30;A	BDT30B;C	
Collector cut-off current					
→ $-I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	<	0,1	–	mA
→ $-I_B = 0$; $-V_{CE} = 60$ V	$-I_{CEO}$	<	–	0,1	mA
$-V_{BE} = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,2		mA
Emitter cut-off current					
→ $I_C = 0$; $-V_{EB} = 5$V	$-I_{EBO}$	<	0,2		mA
D.C. current gain*					
$-I_C = 200$ mA; $-V_{CE} = 4$ V	h_{FE}	>	40		
$-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}		15 to 75		
Base-emitter voltage*					
$-I_C = 1$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,3		V
Collector-emitter saturation voltage*					
$-I_C = 1$ A; $-I_B = 0,125$ A	$-V_{CEsat}$	<	0,7		V

			BDT30	A	B	C	
Collector-emitter breakdown voltage* $I_B = 0$; $-I_C = 30$ mA	$-V_{(BR)CEO}$	>	40	60	80	100	
Small-signal current gain $-I_C = 0,2$ A; $-V_{CE} = 10$ V; f = 1 kHz	$\lvert h_{fe} \rvert$	>	20				
Turn off breakdown energy L = 20 mH; $I_{CC} = 1,22$ A	$E_{(BR)}$	>	15				mJ

* Measured under pulse conditions: $t_p \leq 300$ µs; $\delta < 2\%$.

Transition frequency at f = 1 MHz			
$-I_C$ = 200 mA; $-V_{CE}$ = 10 V	f_T	>	3 MHz
Switching times			
$-I_{Con}$ = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A			
turn-on time	t_{on}	typ.	0,3 μs
turn-off time	t_{off}	typ.	1 μs

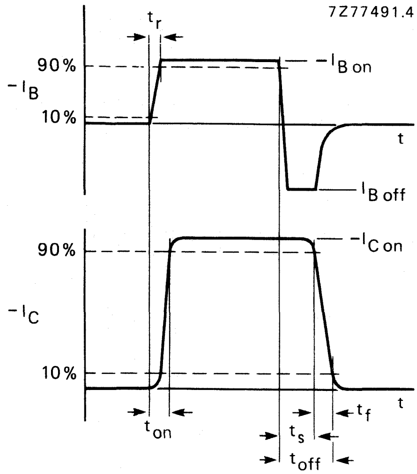
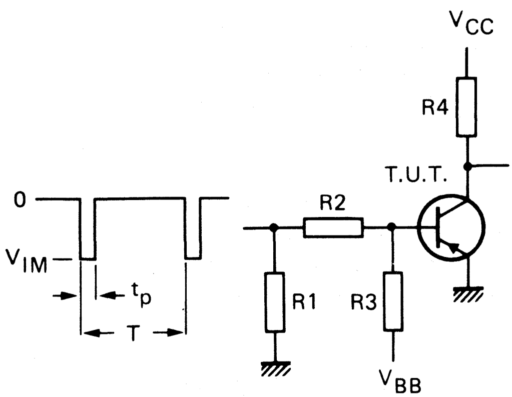


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	16 V
$-V_{CC}$	=	20 V
$+V_{BB}$	=	6,4 V
R1	=	82 Ω
R2	=	82 Ω
R3	=	82 Ω
R4	=	20 Ω
$t_r = t_f$	=	15 ns
t_p	=	20 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

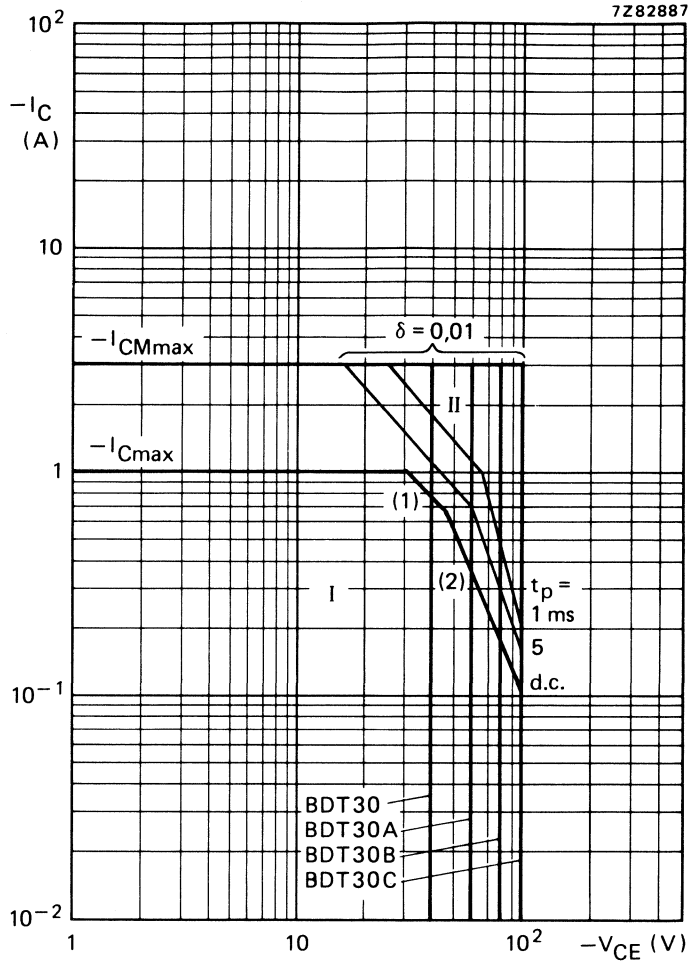


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second-breakdown limits.

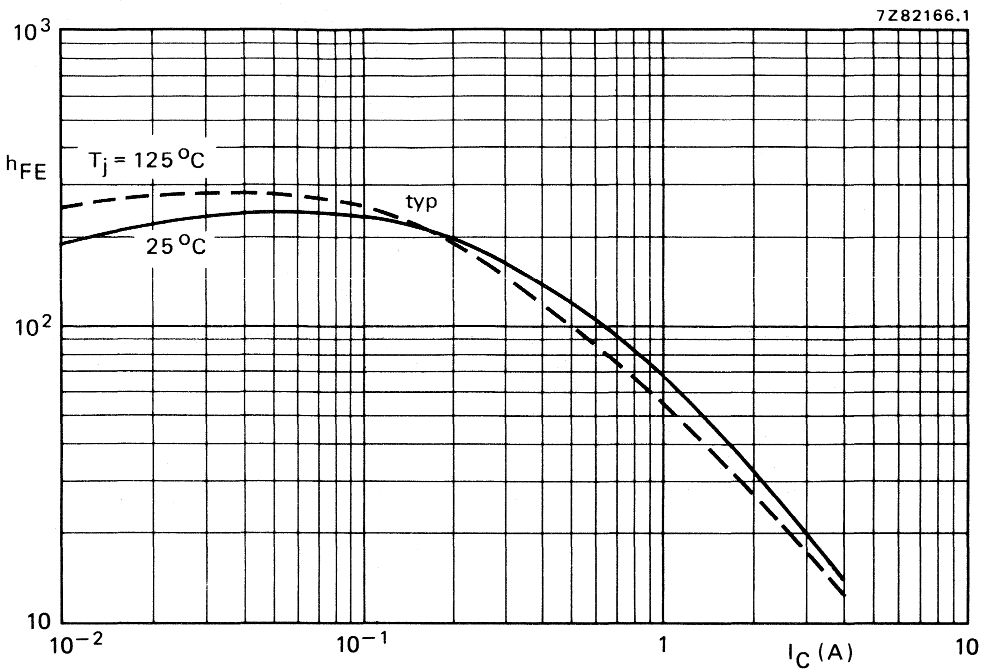


Fig. 5 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V.

SILICON EPITAXIAL POWER TRANSISTORS

P-N-P silicon power transistor in a SOT-186 envelope with an electrically insulated mounting base, for use in audio output stages and for general purpose amplifier and high-speed switching applications.

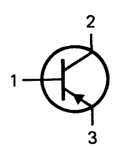
N-P-N complements are BDT29F, BDT29AF, BDT29BF, BDT29CF and BDT29DF.

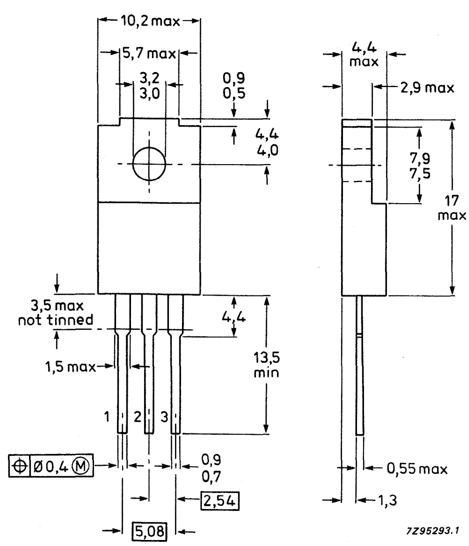
QUICK REFERENCE DATA

			BDT30F	30AF	30BF	30CF	30DF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	5	V
Collector current d.c.	$-I_C$	max.	3	3	3	3	3	A
peak value	$-I_{CM}$	max.	7	7	7	7	7	A
Total power dissipation up to $T_h = 25\ ^oC$	P_{tot}	max.	19	19	19	19	19	W
D.C. current gain $-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}				15 to 75			
Transition frequency at f = 1 MHz $-I_C = 0{,}2$ A; $-V_{CE} = 10$ V	f_T	min.			3			MHz

Fig. 1 SOT-186.

Dimensions in mm





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT30F	30AF	30BF	30CF	30DF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.			5			V
Collector current d.c.	$-I_C$	max.			3			A
peak value	$-I_{CM}$	max.			7			A
Base current (d.c.)	$-I_B$	max.			0,4			A
Total power dissipation up to T_h = 25 °C (1)	P_{tot}	max.			14			W
up to T_h = 25 °C (2)	P_{tot}	max.			19			W
Storage temperature	T_{stg}				−65 to 150			°C
Junction temperature	T_j	max.			150			°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\,j\text{-}mb}$	=	4,17	K/W
From junction to external heatsink (1)	$R_{th\,j\text{-}h}$	=	9,17	K/W
From junction to external heatsink (2)	$R_{th\,j\text{-}h}$	=	6,67	K/W
From junction to ambient	$R_{th\,j\text{-}a}$	=	55	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value (3)	V_{insul}	max.	1000	V
Insulation capacitance between collector and external heatsink	$C_{c\text{-}h}$	typ.	12	pF

(1) Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

(2) Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

(3) Heatsink temperature T_h = 25 °C; relative humidity $R_H \leqslant 75\%$; atmospheric pressure p_{amb} = 1013 mbar.

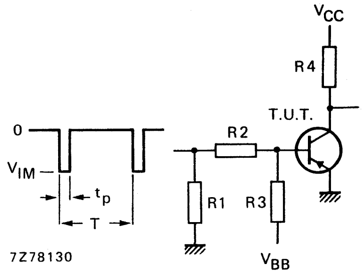
CHARACTERISTICS

T_h = 25 °C unless otherwise specified

			BST30F	30AF	30BF	30CF	30DF		
Collector cut-off currents									
$-I_B = 0; -V_{CE} = 30$ V	$-I_{CEO}$	<	0,1	0,1	–	–	–	mA	←
$-I_B = 0; -V_{CE} = 60$ V	$-I_{CEO}$	<	–	–	0,1	0,1	–	mA	←
$-I_B = 0; -V_{CE} = 90$ V	$-I_{CEO}$	<	–	–	–	–	0,1	mA	←
$-V_{BE} = 0; -V_{CE} = V_{CBOmax}$	$-I_{CES}$	<	0,2	0,2	0,2	0,2	0,2	mA	
Emitter-cut-off current									
$-I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	0,2	0,2	0,2	0,2	0,2	mA	←
Collector-emitter breakdown voltages (1)									
$-I_B = 0; -I_C = 30$ mA	$-V_{(BR)CEO}$	>	40	60	80	100	120	V	

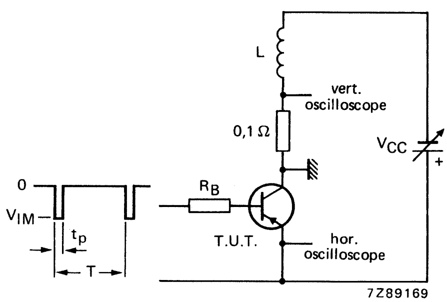
D.C. current gain (1)				
$-I_C = 0,2$ A; $-V_{CE} = 4$ V	h_{FE}	>	40	
$-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}		15 to 75	
Base-emitter voltage (1)+(2)				
$-I_C = 1$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,3	V
Collector-emitter saturation voltage (1)				
$-I_C = 1$ A; $-I_B = 0,125$ A	$-V_{CEsat}$	<	0,7	V
Transition frequency at f = 1 MHz				
$-I_C = 0,2$ A; $-V_{CE} = 10$ V	f_T	>	3	MHz
Small-signal current gain				
$-I_C = 0,2$ A; $-V_{CE} = 10$ V				
at 1 kHz	h_{fe}	>	20	
at 1 MHz	h_{fe}	>	3	
Turn-off breakdown energy with inductive load (see Fig. 3)				
$-I_C = 1,8$ A; L = 20 mH	$E_{(BR)}$	>	32	mJ
Switching times (see Fig. 2)				
$-I_C = 1$ A; $-I_{Bon} = +I_{Boff} = 0,1$ A				
turn-on time	t_{on}	typ.	0,3	μs
turn-off time	t_{off}	typ.	1	μs

(1) Measured under pulse conditions: $t_p = 300$ μs; $\delta = 2\%$.
(2) V_{BE} decreases by about 2,3 mV/K with increasing temperature.



$-V_{CC}$ = 20 V
$-V_{IM}$ = 16 V
$+V_{BB}$ = 6,4 V
R1 = 82 Ω
R2 = 82 Ω
R3 = 82 Ω
R4 = 20 Ω
$t_r = t_f$ = 15 ns
t_p = 20 μs
T = 500 μs

Fig. 2 Switching times test circuit.



$-V_{IM}$ = 12 V
R_B = 270 Ω
L = 20 mH
$-I_C$ = 1,8 A
t_p = 1 ms
δ = 1 %

Fig. 3 Test circuit for turn-off breakdown energy.

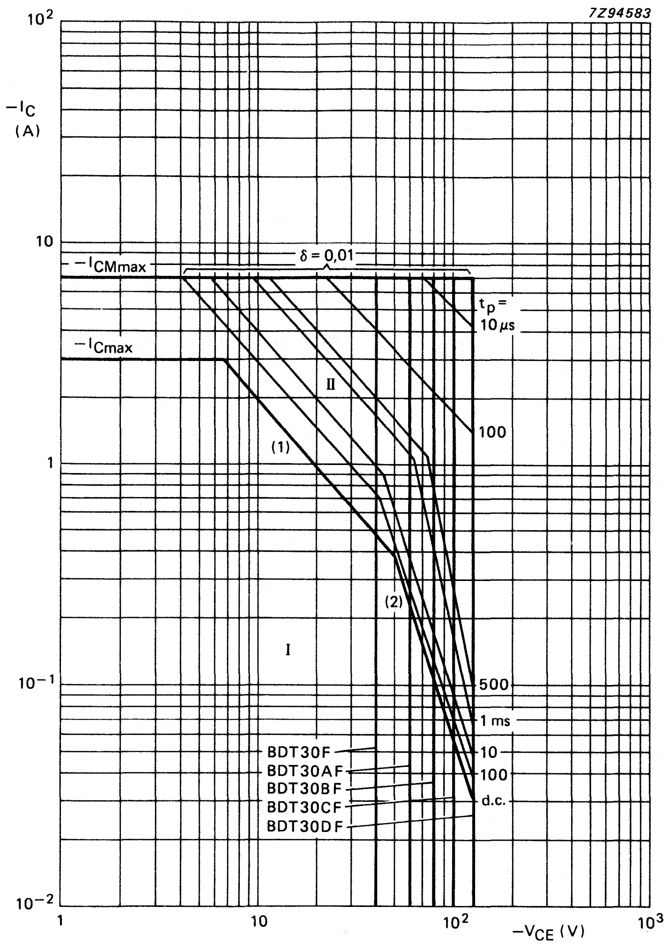


Fig. 4 Safe Operating ARea, T_{amb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Mounted *with* heatsink compound and 30 ± 5 Newton pressure on the centre of the envelope.

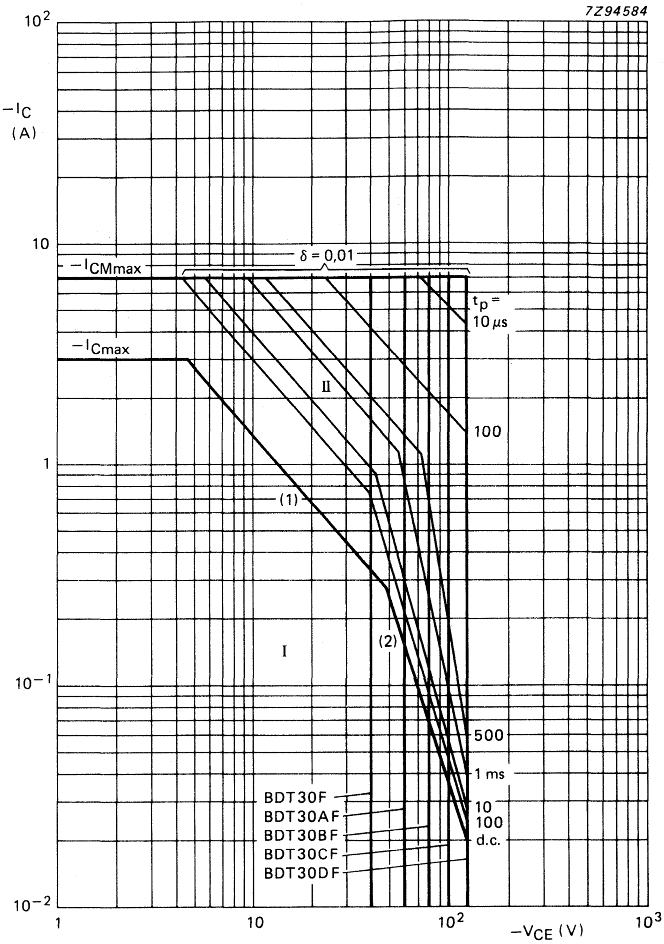


Fig. 5 Safe Operating ARea, T_{amb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Mounted *without* heatsink compound and 30 ± 5 Newton pressure on the centre of the envelope.

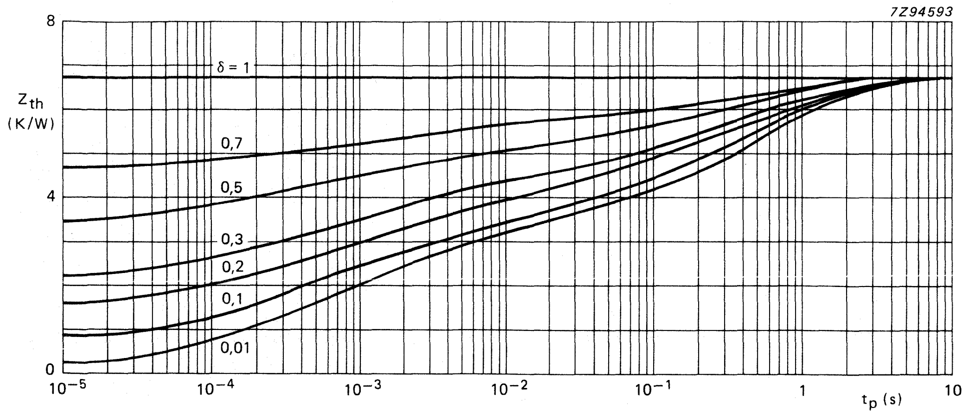


Fig. 6 Pulse power rating chart; mounted *with* heatsink compound and 30 ± 5 Newton pressure on the envelope.

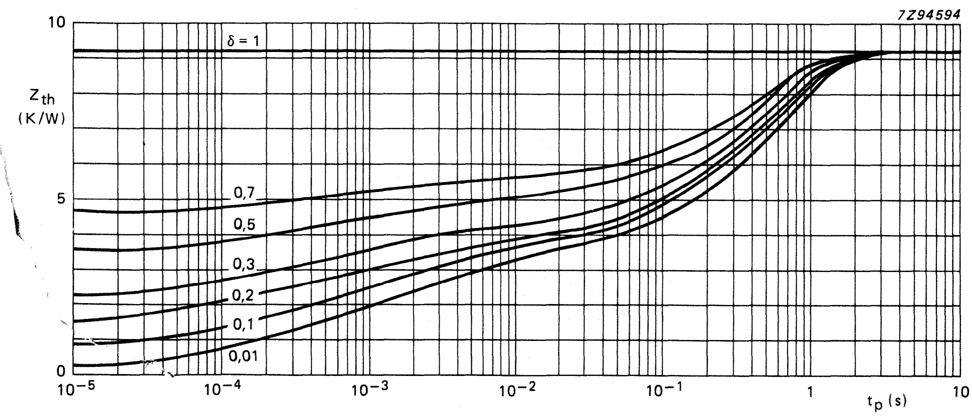


Fig. 7 Pulse power rating chart; mounted *without* heatsink compound and 30 ± 5 Newton pressure on the envelope.

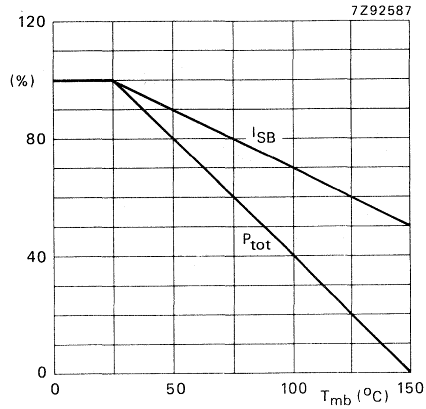


Fig. 8 Total power dissipation and second-breakdown current derating curve.

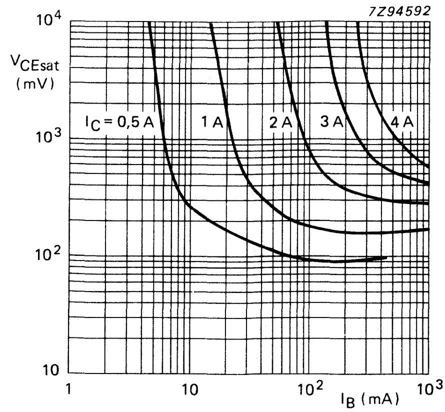


Fig. 9 Collector-emitter saturation voltage; typical values.

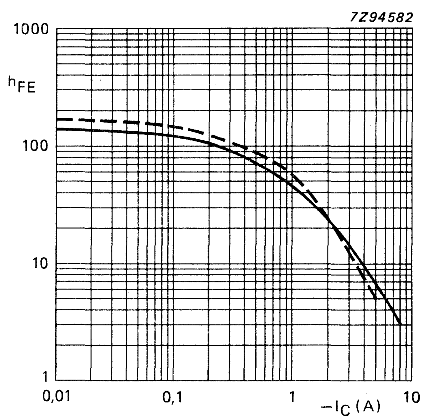


Fig. 10 D.C. current gain; $-V_{CE}$ = 4 V; typical values;
—— T_j = 25 °C; – – – – T_j = 125 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N transistors in a plastic envelope intended for use in audio output stages and general amplifier and switching applications. The TIP31 series is an equivalent type. P-N-P complements are BDT32 series. ←

QUICK REFERENCE DATA

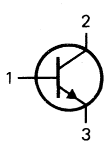
			BDT31	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V ←
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.	3				A
Collector current (peak value)	I_{CM}	max.	5				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
I_C = 1 A; V_{CE} = 4 V	h_{FE}	>	25				
I_C = 3 A; V_{CE} = 4 V	h_{FE}		10 to 50				

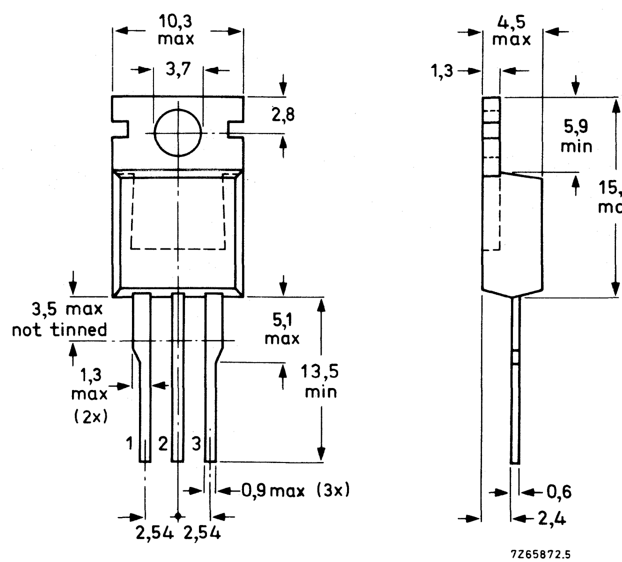
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT31	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	3				A
Collector current (peak value)	I_{CM}	max.	5				A
Base current (d.c.)	I_B	max.	1				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT31; A	BDT31B; C	
Collector cut-off current					
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	0,1	–	mA
$I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	<	–	0,1	mA
$V_{BE} = 0$; $V_{CE} = V_{CEOmax}$	I_{CES}	<	0,2		mA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	0,2		mA
D.C. current gain *					
$I_C = 1$ A; $V_{CE} = 4$ V	h_{FE}	>	25		
$I_C = 3$ A; $V_{CE} = 4$ V	h_{FE}		10 to 50		
Base-emitter voltage * **					
$I_C = 3$ A; $V_{CE} = 4$ V	V_{BE}	<	1,8		V
Collector-emitter saturation voltage *					
$I_C = 3$ A; $I_B = 0,375$ A	V_{CEsat}	<	1,2		V

			BDT31	A	B	C	
Collector-emitter breakdown voltage *							
$I_B = 0$; $I_C = 30$ mA	$V_{(BR)CEO}$	>	40	60	80	100	V
Small-signal current transfer ratio							
$I_C = 0,5$ A; $V_{CE} = 10$ V; f = 1 kHz	$\|h_{fe}\|$	>	20				
$I_C = 0,5$ A; $V_{CE} = 10$ V; f = 1 MHz	$\|h_{fe}\|$	>	3				
Turn-off breakdown energy							
L = 20 mH; $I_{CC} = 1,8$ A	$E_{(BR)}$	>	32				mJ

* Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta \leqslant 2\%$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Switching times
(between 10% and 90% levels)
$I_{Con} = 1$ A; $I_{Bon} = -I_{Boff} = 0,1$ A

Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	1 μs

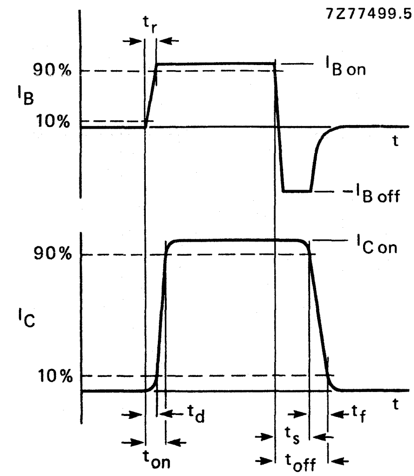


Fig. 2 Switching times waveforms.

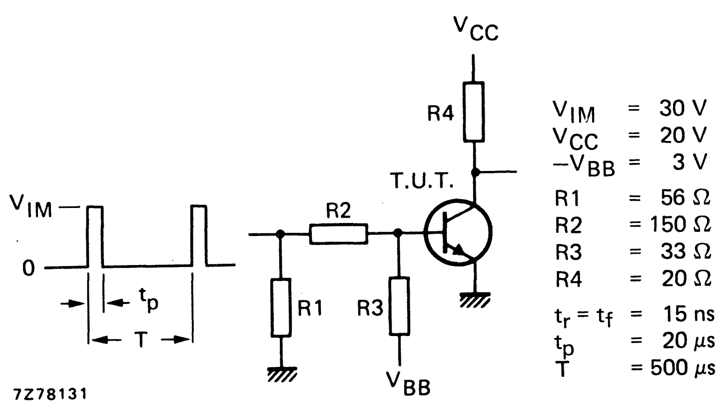


Fig. 3 Switching times test circuit.

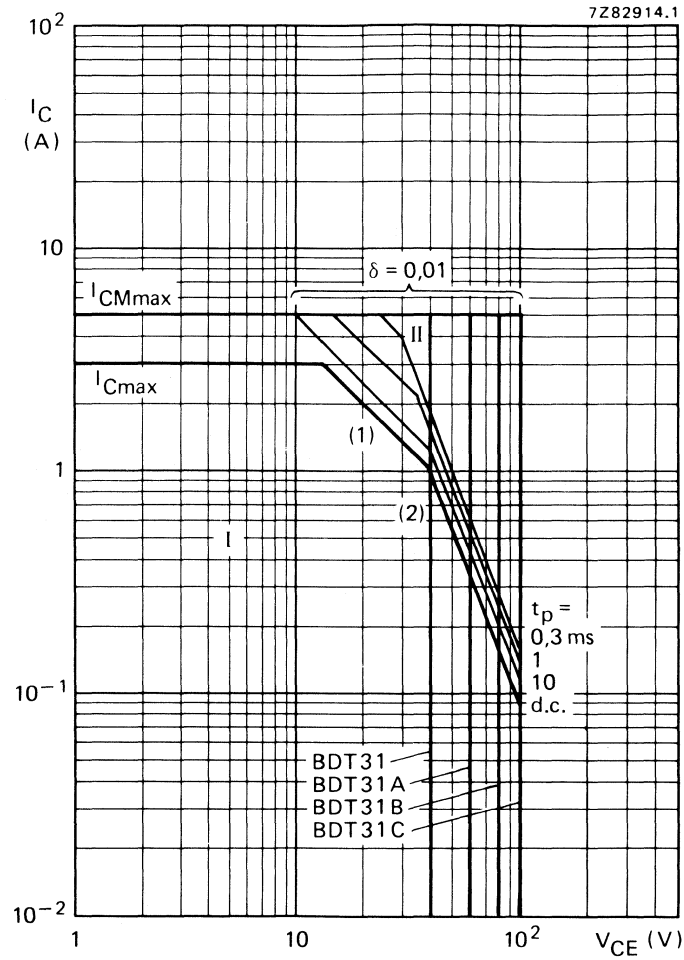


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

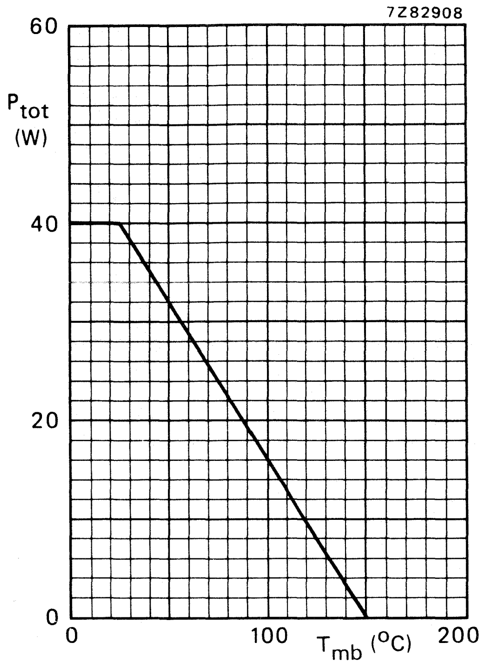


Fig. 5 Power derating curve.

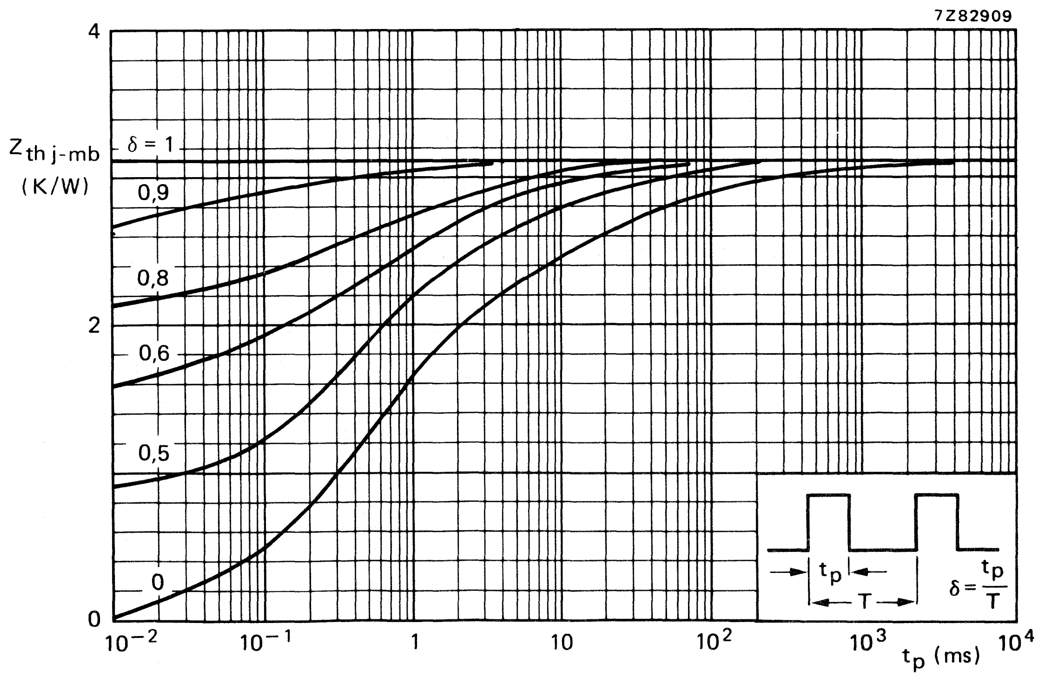


Fig. 6 Pulse power rating cnart.

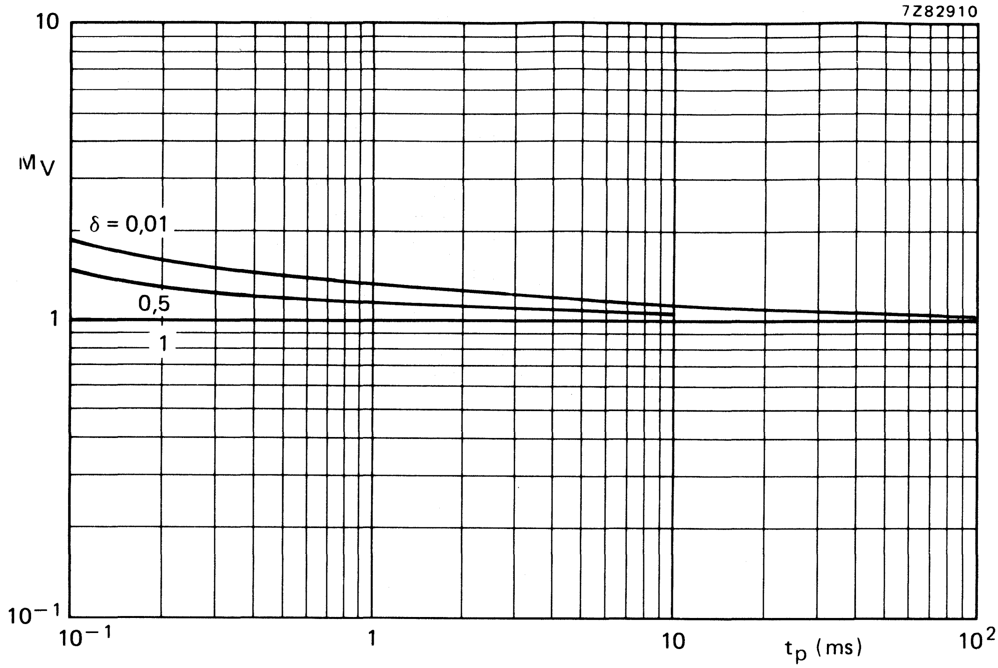


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

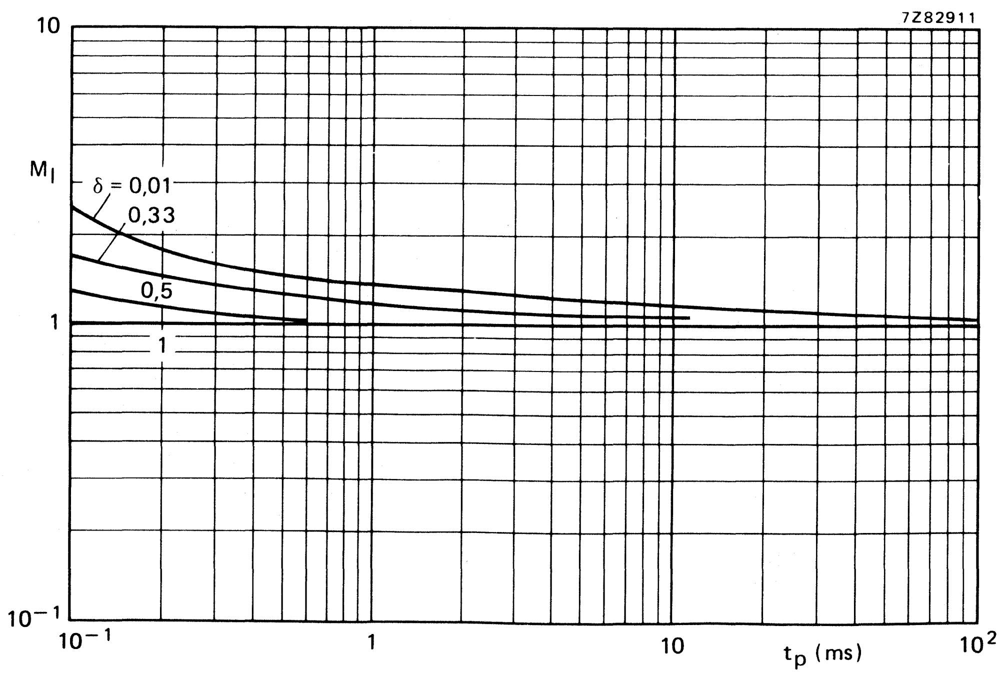


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

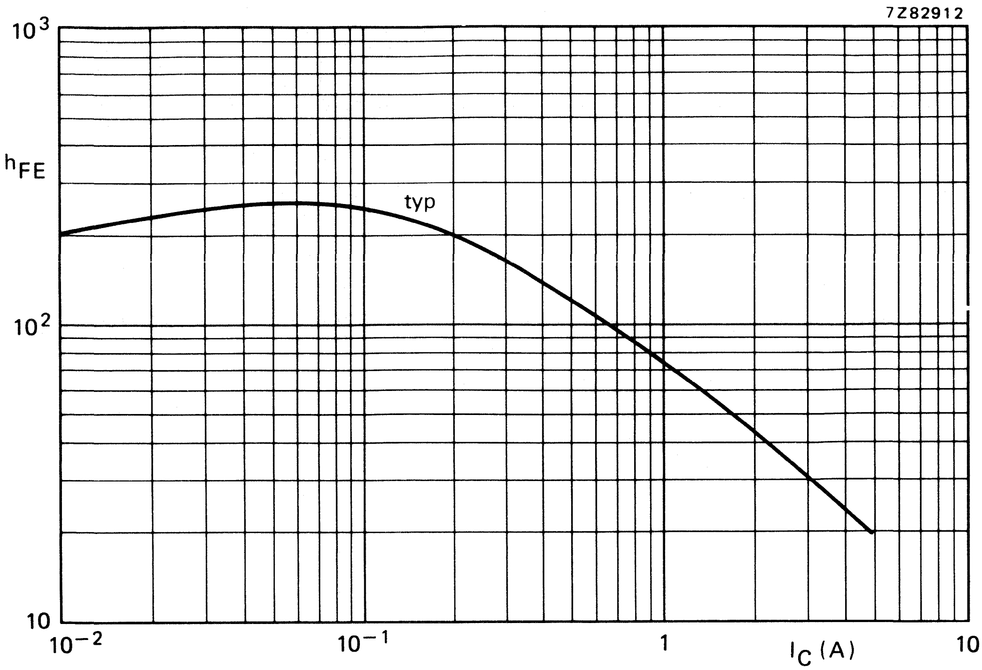


Fig. 9 Typical values d.c. current gain at V_{CE} = 4 V.

SILICON EPITAXIAL POWER TRANSISTORS

NPN silicon power transistors in a SOT186 envelope with an electrically insulated mounting base.

They are intended for use in audio amplifier output stages, general purpose amplifiers, and high-speed switching applications.

PNP complements are BDT32F, BDT32AF, BDT32BF, BDT32CF, and BDT32DF.

QUICK REFERENCE DATA

			BDT31F	31AF	31BF	31CF	31DF	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	160	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.			5			V
DC collector current	I_C	max.			3			A
Peak collector current	I_{CM}	max.			5			A
DC current gain $I_C = 3$ A; $V_{CE} = 4$ V	h_{FE}	min.			10			
Small-signal current gain at f = 1 MHz $I_C = 0.5$ A; $V_{CE} = 10$ V	h_{fe}	min.			3			

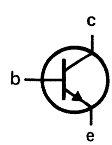
MECHANICAL DATA

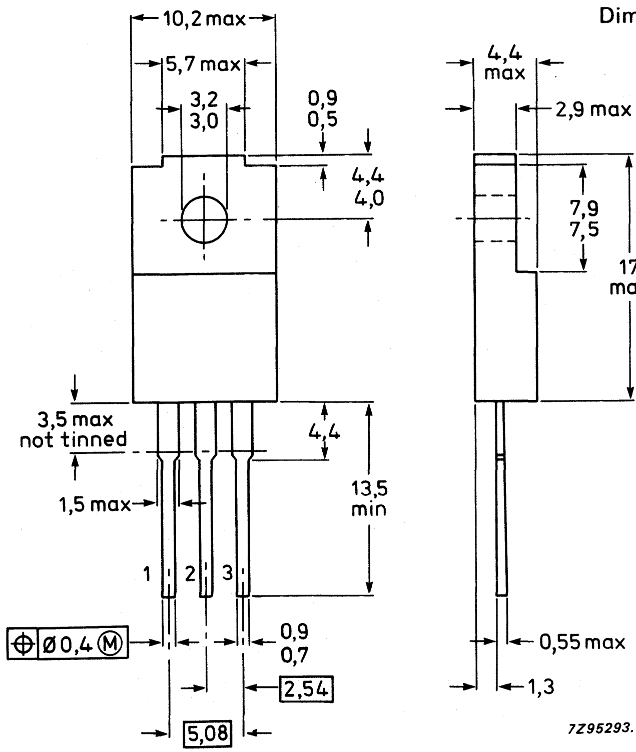
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT31F	31AF	31BF	31CF	31DF	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	160	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.			5			V
DC collector current	I_C	max.			3			A
Peak collector current	I_{CM}	max.			5			A
DC base current	I_B	max.			1			A
Total power dissipation up to T_h = 25 °C (note 1)	P_{tot}	max.			15			W
up to T_h = 25 °C (note 2)	P_{tot}	max.			22			W
Storage temperature range	T_{stg}				−65 to 150			°C
Junction temperature	T_j	max.			150			°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	3.12	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	8.12	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	5.62	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	55	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value (note 3)	V_{insul}	max.	1000	V
Insulation capacitance between collector and external heatsink	$C_{c\text{-}h}$	typ.	12	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
3. Heatsink temperature T_h = 25 °C; relative humidity $R_H \leqslant 75\%$; atmospheric pressure P_{amb} = 1013 mbar.

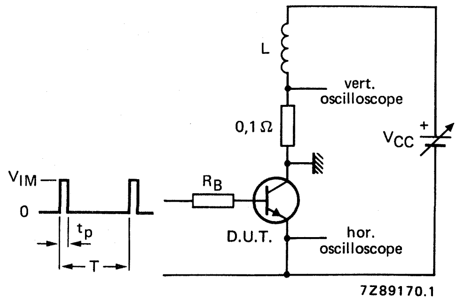
CHARACTERISTICS

T_h = 25 °C unless otherwise specified

			BDT31F	31AF	31BF	31CF	31DF	
Collector cut-off current								
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	max.	0.1	0.1	–	–	–	mA
$I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	max.	–	–	0.1	0.1	–	mA
$I_B = 0$; $V_{CE} = 90$ V	I_{CEO}	max.	–	–	–	–	0.1	mA
$V_{BE} = 0$; $V_{CE} = V_{CBOmax}$	I_{CES}	max.	0.2	0.2	0.2	0.2	0.2	mA
Emitter cut-off current								
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	0.2	0.2	0.2	0.2	0.2	mA
DC current gain (note 1)								
$I_C = 1$ A; $V_{CE} = 4$ V	h_{FE}	min.	25	25	25	25	25	
$I_C = 3$ A, $V_{CE} = 4$ V	h_{FE}	min.	10	10	10	10	5	
		max.	50	50	50	50	–	
Collector-emitter breakdown voltage (note 1)								
$I_B = 0$; $I_C = 30$ mA	$V_{(BR)CEO}$	min.	40	60	80	100	120	V
Collector-emitter saturation voltage (note 1)								
$I_C = 3$ A; $I_B = 375$ mA	V_{CEsat}	max.	1.2	1.2	1.2	1.2	–	V
$I_C = 3$ A; $I_B = 750$ mA	V_{CEsat}	max.	–	–	–	–	2.5	V
Base-emitter voltages (notes 1 and 2)								
$I_C = 3$ A; $V_{CE} = 4$ V	V_{BE}	max.			1.8			V
Small-signal current gain								
$I_C = 0.5$ A; $V_{CE} = 10$ V								
at 1 kHz	h_{fe}	min.			20			
at 1 MHz	h_{fe}	min.			3			
Turn-off breakdown energy with inductive load (see Fig.3)								
$I_C = 1.8$ A; L = 20 mH	$E_{(BR)}$	min.			32			mJ
Switching times (see Fig.2)								
$I_C = 1$ A; $I_{B\,on} = -I_{B\,off} = 0.1$ A								
turn-on time	t_{on}	typ.			0 3			μs
turn-off time	t_{off}	typ.			1			μs

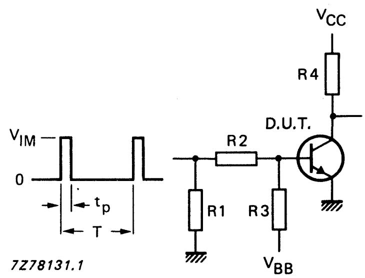
Notes

1. Measured under pulse conditions: $t_p = 300$ μs; $\delta = 2\%$.
2. V_{BE} decreases by about 2.3 mV/K with increasing temperature.



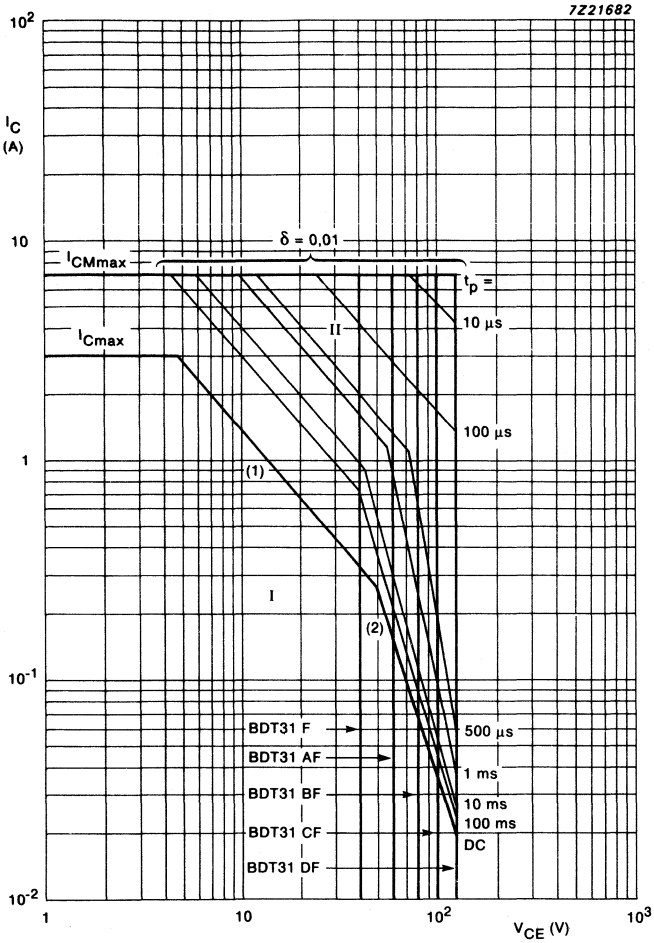
V_{CC} = 20 V
V_{IM} = 30 V
$-V_{BB}$ = 3 V
R_1 = 56 Ω
R_2 = 150 Ω
R_3 = 33 Ω
R_4 = 20 Ω
$t_r = t_f$ = 15 ns
t_p = 20 μs
T = 500 μs

Fig.2 Switching times test circuit.



V_{IM} = 12 V
R_B = 270 Ω
L = 20 mH
I_C = 1.8 A
t_p = 1 ms
δ = 1 %

Fig.3 Test circuit for turn-off breakdown energy.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

Mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

Fig.4 Safe operating area, T_{amb} = 25 °C.

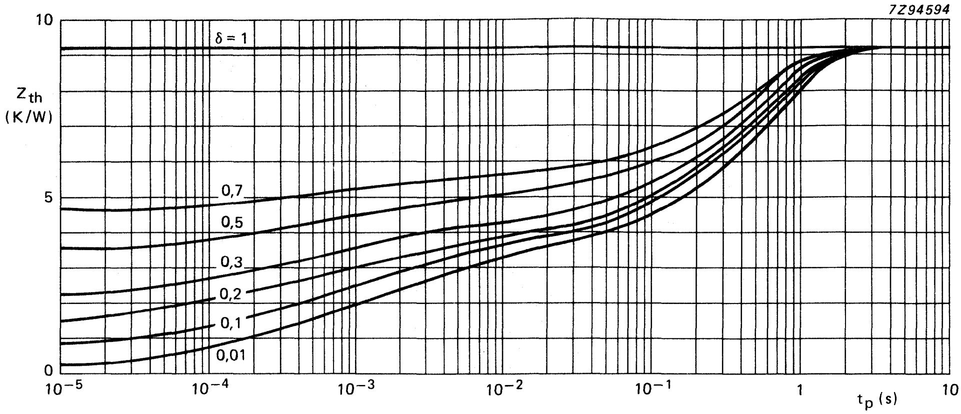


Fig.5 Pulse power rating chart; mounted without heatsink compound and 30 ± 5 newtons pressure on the envelope.

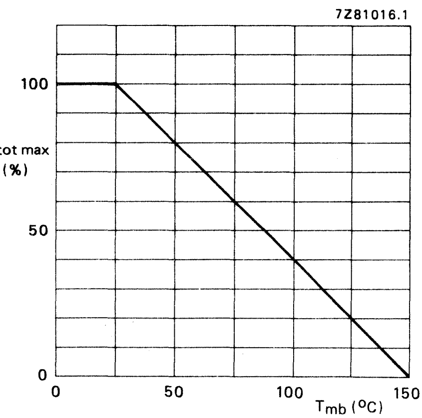


Fig.6 Total power dissipation.

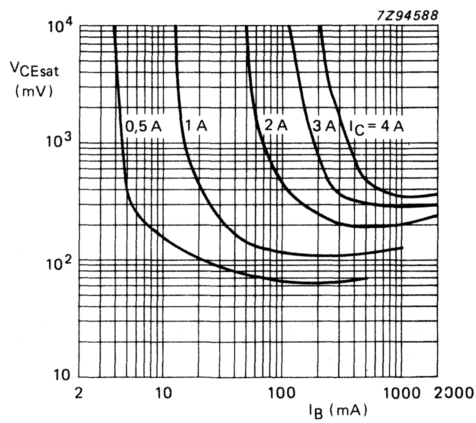


Fig.7 Typical collector-emitter saturation voltage; T_j = 25 °C.

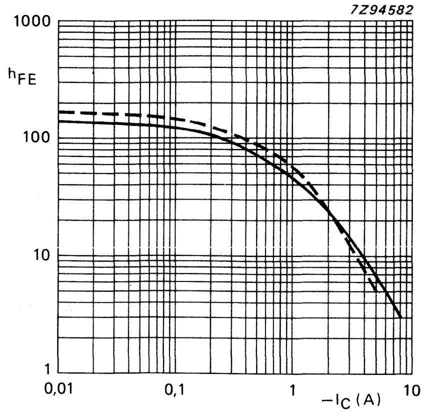


Fig.8 Typical DC current gain; V_{CE} = 4 V; T_j = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic TO-220 envelope. They are intended for use in a wide range of power amplifiers and for switching applications. The TIP32 series is an equivalent type. P-N-P complements are BDT31 series.

QUICK REFERENCE DATA

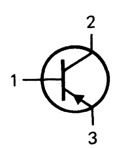
			BDT32	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	3				A
Collector current (peak value)	$-I_{CM}$	max.	5				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
$-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	>	25				
$-I_C$ = 3 A; $-V_{CE}$ = 4 V	h_{FE}		10 to 50				

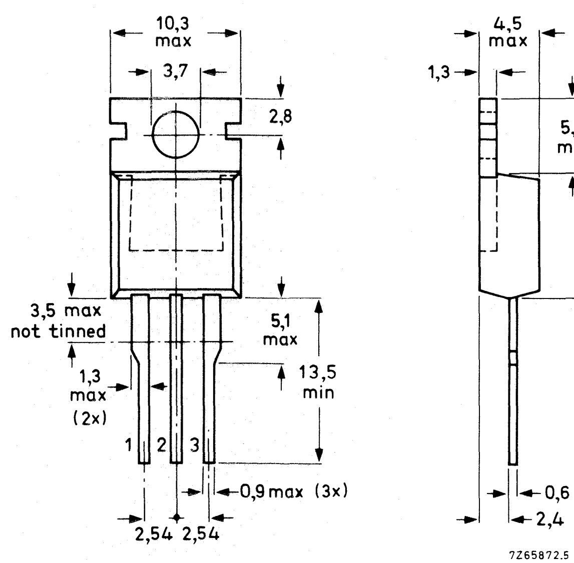
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT32	A	B	C	
→ Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5			V
Collector current (d.c.)	$-I_C$	max.		3			A
Collector current (peak value)	$-I_{CM}$	max.		5			A
Base current	$-I_B$	max.		1			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Storage temperature	T_{stg}			−65 to 150			°C
Junction temperature	T_j	max.		150			°C

THERMAL RESISTANCE

from junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
from junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT32; A	B; C	
Collector cut-off current					
→ $I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	<	0,1		mA
→ $I_B = 0$; $-V_{CE} = 60$ V	$-I_{CEO}$	<		0,1	mA
$V_{EB} = 0$; $-V_{CE} = -V_{CEO}$	$-I_{CES}$	<	0,2		mA
Emitter cut-off current					
→ $I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	0,2		mA
D.C. current gain *					
$-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}	>	25		
$-I_C = 3$ A; $-V_{CE} = 4$ V	h_{FE}		10 to 50		
Base-emitter voltage * **					
$-I_C = 3$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,8		V
Collector-emitter saturation voltage					
$-I_C = 3$ A; $-I_B = 0,375$ A	$-V_{CEsat}$	<	1,2		V

			BDT32	A	B	C	
Collector-emitter breakdown voltage *							
$I_B = 0$; $-I_C = 30$ mA	$-V_{(BR)CEO}$	>	40	60	80	100	V

Small signal current transfer ratio				
$-I_C = 0,5$ A; $-V_{CE} = 10$ V; f = 1 kHz	$\|h_{fe}\|$	>	20	
$-I_C = 0,5$ A; $-V_{CE} = 10$ V; f = 1 MHz	$\|h_{fe}\|$	>	3	
Turn-off breakdown energy				
L = 20 mH; $I_{CC} = 1,22$ A	$E_{(BR)}$	>	15	mJ

* Measured under pulse conditions: $t_p \leq 300\ \mu s$, $\delta < 2\%$.
** V_{EB} decreases by about 2,3 mV/K with increasing temperature.

Switching times
(between 10% and 90% levels)
$-I_{Con} = 1$ A; $-I_{Bon} = I_{Boff} = 0,1$ A

Turn-on time	t_{on}	typ. 0,3 μs
Turn-off time	t_{off}	typ. 1 μs

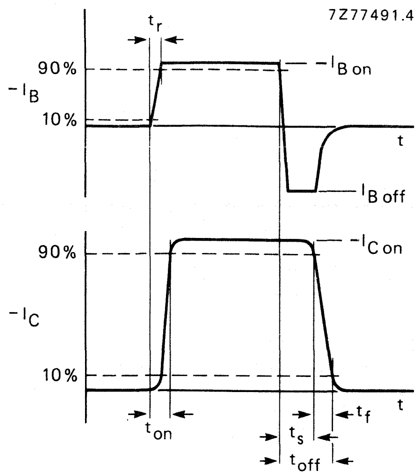
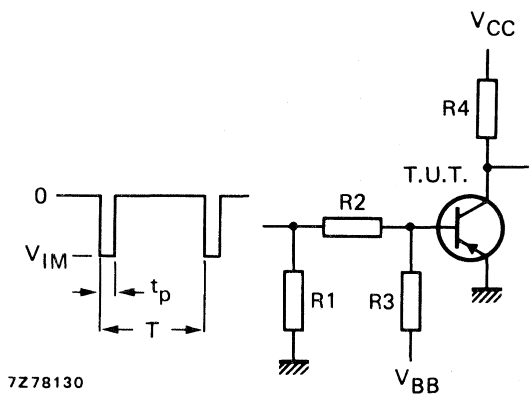


Fig. 2 Switching times waveforms.



$-V_{IM} = 30$ V
$-V_{CC} = 20$ V
$V_{BB} = 3$ V
$R_1 = 56\ \Omega$
$R2 = 150\ \Omega$
$R3 = 33\ \Omega$
$R4 = 20\ \Omega$
$t_r = t_f \leqslant 15$ ns
$t_p = 20\ \mu s$
$T = 500\ \mu s$

Fig. 3 Switching times test circuit.

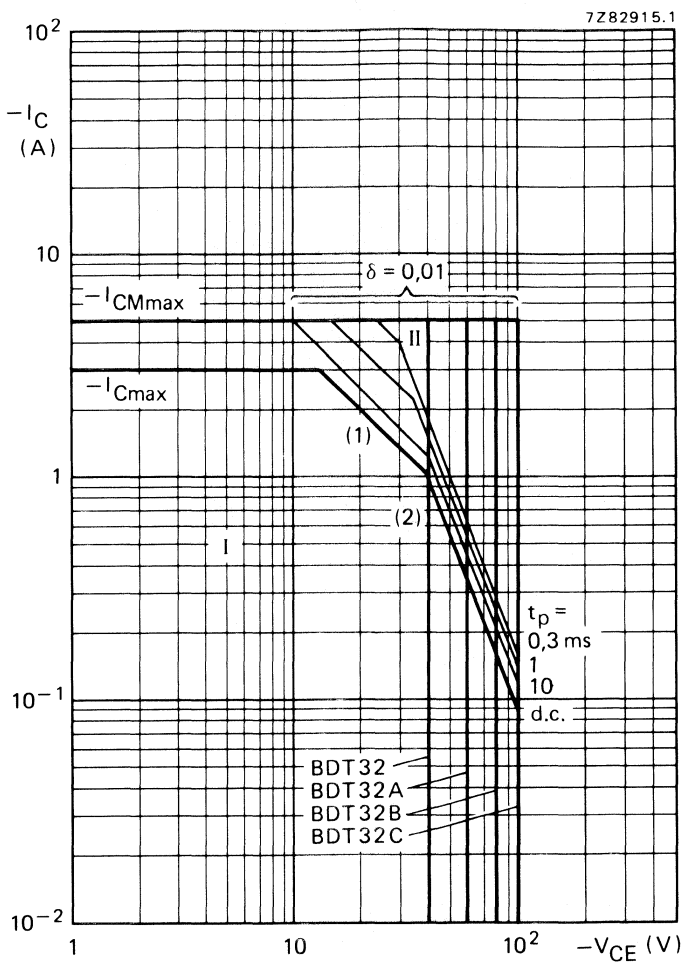


Fig. 4 Safe Operating ARea; $T_{mb} \leqslant 25\ ^oC$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

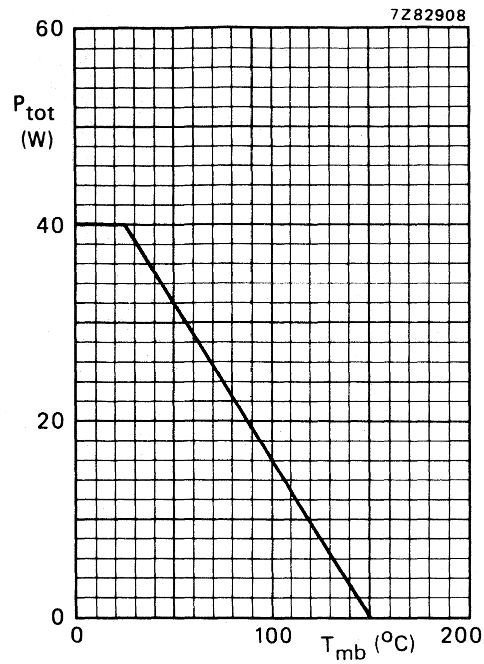


Fig. 5 Power derating curve.

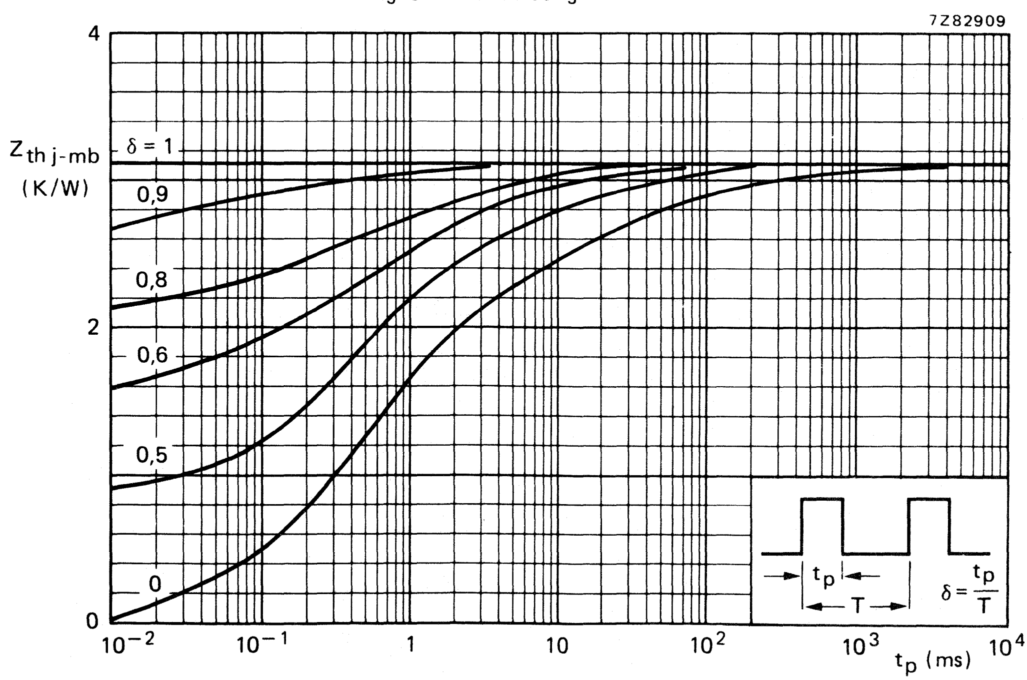


Fig. 6 Pulse power rating chart.

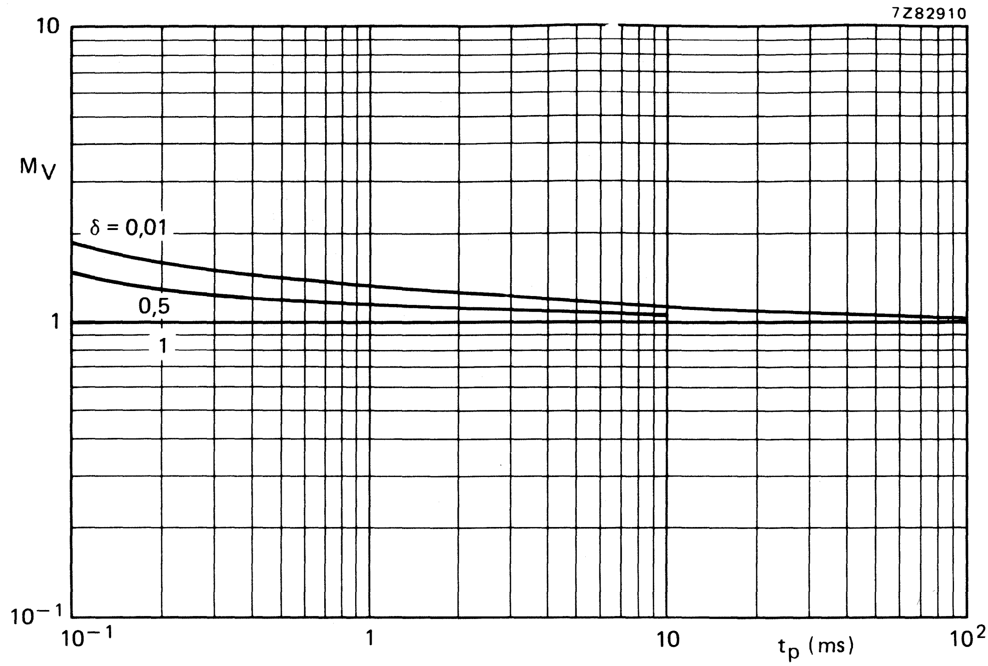


Fig. 7 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

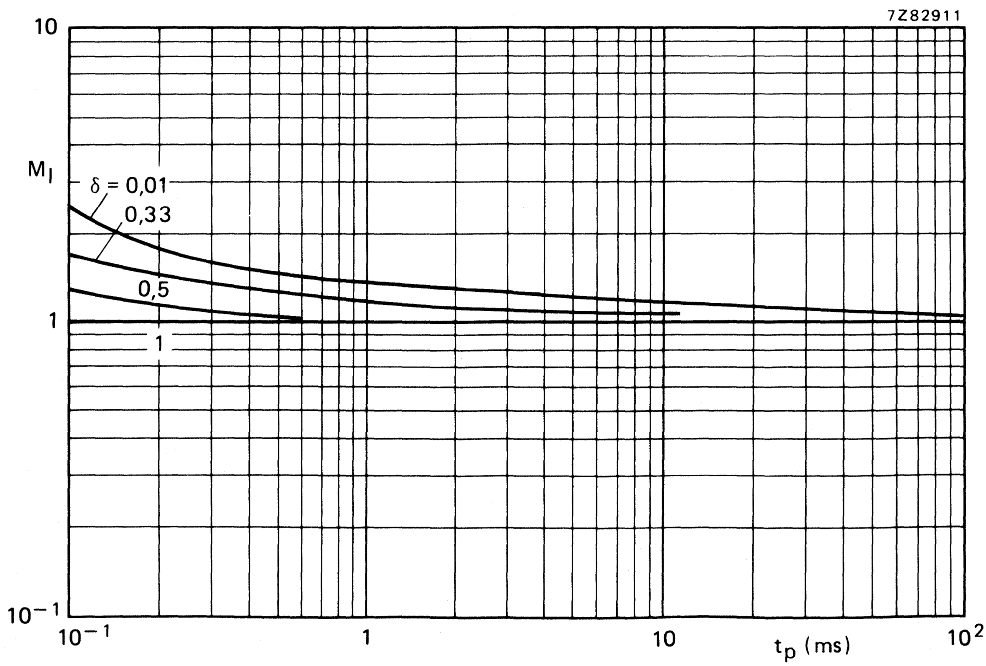


Fig. 8 S.B. current multiplying factor at the $-V_{CEOmax}$ level.

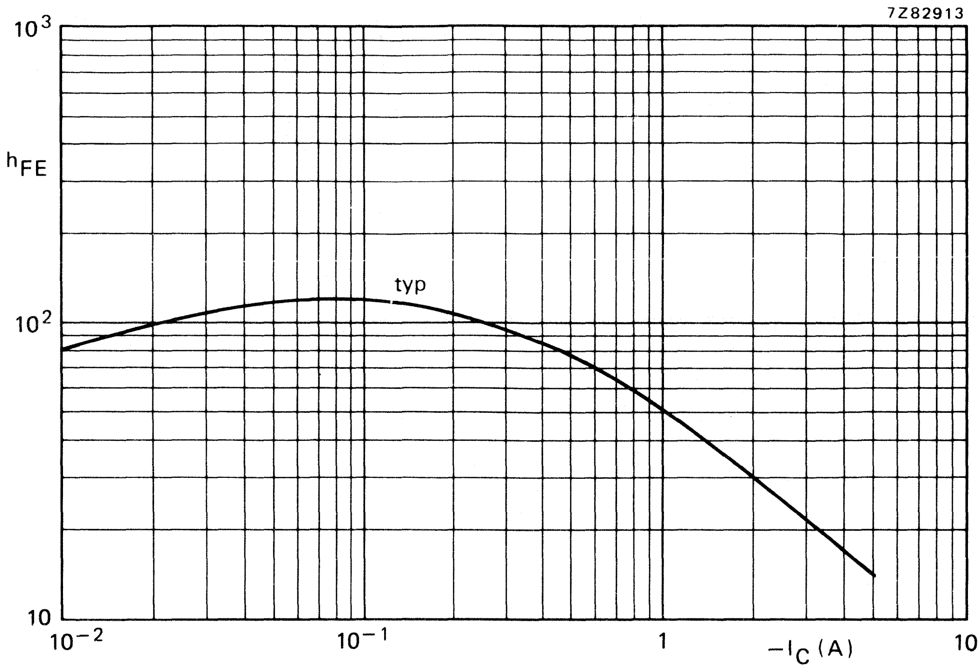


Fig. 9 Typical d.c. current gain at $-V_{CE}$ = 4 V; T_j = 25 °C.

SILICON EPITAXIAL POWER TRANSISTORS

PNP silicon power transistors each, in a SOT186 envelope with an electrically insulated mounting base. They are intended for use in audio amplifier output stages, general purpose amplifiers, and high-speed switching applications.

NPN complements are BDT31F, BDT31AF, BDT31BF, BDT31CF, and BDT31DF.

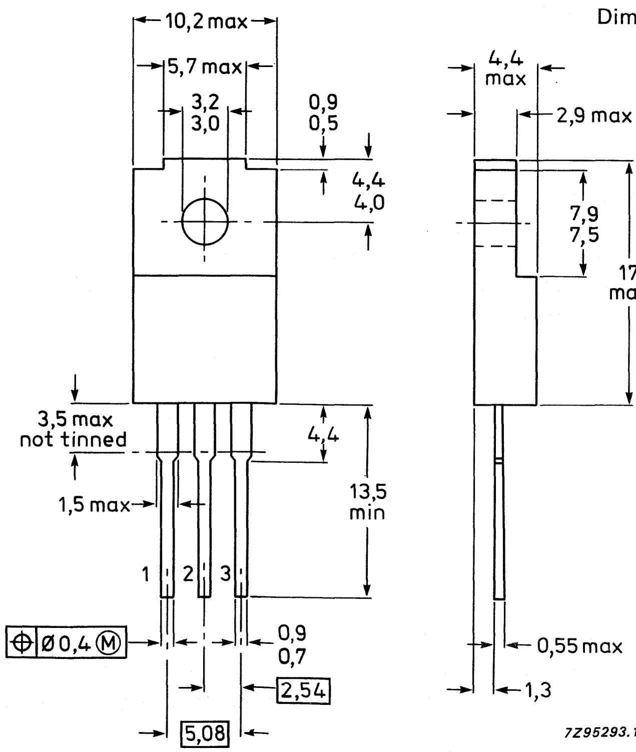
QUICK REFERENCE DATA

			BDT32F	32AF	32BF	32CF	32DF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.			5			V
DC collector current	$-I_C$	max.			3			A
Peak collector current	$-I_{CM}$	max.			7			A
DC current gain $-I_C = 3$ A; $-V_{CE} = 4$V	h_{FE}	min.			10			
Small-signal current gain at f = 1 MHz $-I_C = 0.5$ A; $-V_{CE} = 10$ V	h_{fe}	min.			3			

MECHANICAL DATA

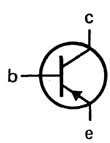
Dimensions in mm

Fig.1 SOT186.



Pinning

1 = base
2 = collector
3 = emitter



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT32F	32AF	32BF	32CF	32DF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.			5			V
DC collector current	$-I_C$	max.			3			A
Peak collector current	$-I_{CM}$	max.			7			A
DC base current	$-I_B$	max.			1			A
Total power dissipation up to $T_h = 25$ °C (note 1)	P_{tot}	max.			15			W
up to $T_h = 25$ °C (note 2)	P_{tot}	max.			22			W
Storage temperature range	T_{stg}				−65 to 150			°C
Junction temperature	T_j	max.			150			°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	3.12	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	8.12	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	5.62	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	55	K/W

INSULATION

Peak voltage allowed between all terminals and external heatsink (note 3)	V_{insul}	max.	1000	V
Insulation capacitance between collector and external heatsink	$C_{c\text{-}h}$	typ.	12	pF

Notes

(1) Mounted without heatsink compound and 30 ± 5 newton pressure on centre of envelope.

(2) Mounted with heatsink compound and 30 ± 5 newton pressure on centre of envelope.

(3) Heatsink temperature $T_h = 25$ °C; relative humidity $R_H \leq 75\%$; atmospheric pressure P_{amb} = 1013 mbar.

CHARACTERISTICS

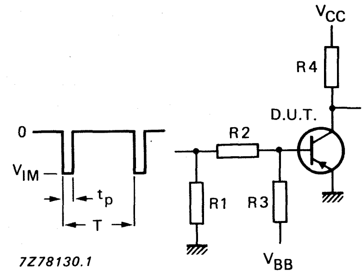
T_h = 25 °C unless otherwise specified

			BDT32F	32AF	32BF	32CF	32DF	
Collector cut-off current								
$-I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	max.	0.1	0.1	–	–	–	mA
$-I_B = 0$; $-V_{CE} = 60$ V	$-I_{CEO}$	max.	–	–	0.1	0.1	–	mA
$-I_B = 0$; $-V_{CE} = 90$ V	$-I_{CEO}$	max.	–	–	–	–	0.1	mA
$-V_{BE} = 0$; $-V_{CE} = -V_{CBOmax}$	$-I_{CES}$	max.	0.2	0.2	0.2	0.2	0.2	mA
Emitter cut-off current								
$-I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	max.	0.2	0.2	0.2	0.2	0.2	mA
DC current gain (1)								
$-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}	min.	25	25	25	25	25	
$-I_C = 3$ A; $-V_{CE} = 4$ V	h_{FE}	min.	10	10	10	10	5	
		max.	50	50	50	50	–	
Collector-emitter breakdown voltage (note 1)								
$-I_B = 0$; $-I_C = 30$ mA	$-V_{(BR)CEO}$	min.	40	60	80	100	120	V
Collector-emitter saturation voltage (note 1)								
$-I_C = 3$ A; $-I_B = 375$ mA	$-V_{CEsat}$	max.	1.2	1.2	1.2	1.2	–	V
$-I_C = 3$ A; $-I_B = 750$ mA	$-V_{CEsat}$	max.	–	–	–	–	2.5	V
Base-emitter voltages (notes 1 and 2)								
$-I_C = 3$ A; $-V_{CE} = 4$ V	$-V_{BE}$	max.			1.8			V
Small-signal current gain								
$-I_C = 0.5$ A; $-V_{CE} = 10$ V								
at 1 kHz	h_{fe}	min.			20			
at 1 MHz	h_{fe}	min.			3			
Turn-off breakdown energy with inductive load (see Fig.3)								
$-I_C = 1.8$ A; L = 20 mH	$E_{(BR)}$	min.			32			mJ
Switching times (see Fig.2)								
$-I_C = 1$ A; $-I_{B\,on} = +I_{B\,off} = 0.1$ A								
turn-on time	t_{on}	typ.			0.3			μs
turn-off time	t_{off}	typ.			1			μs

Notes

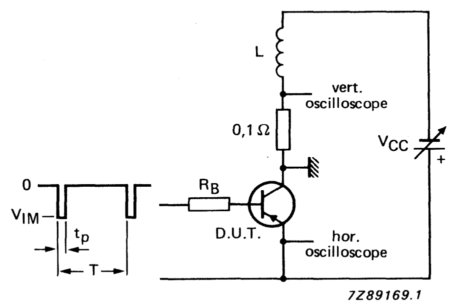
(1) Measured under pulse conditions: $t_p = 300$ μs; $\delta = 2\%$.

(2) V_{BE} decreases by about 2.3 mV/K with increasing temperature.



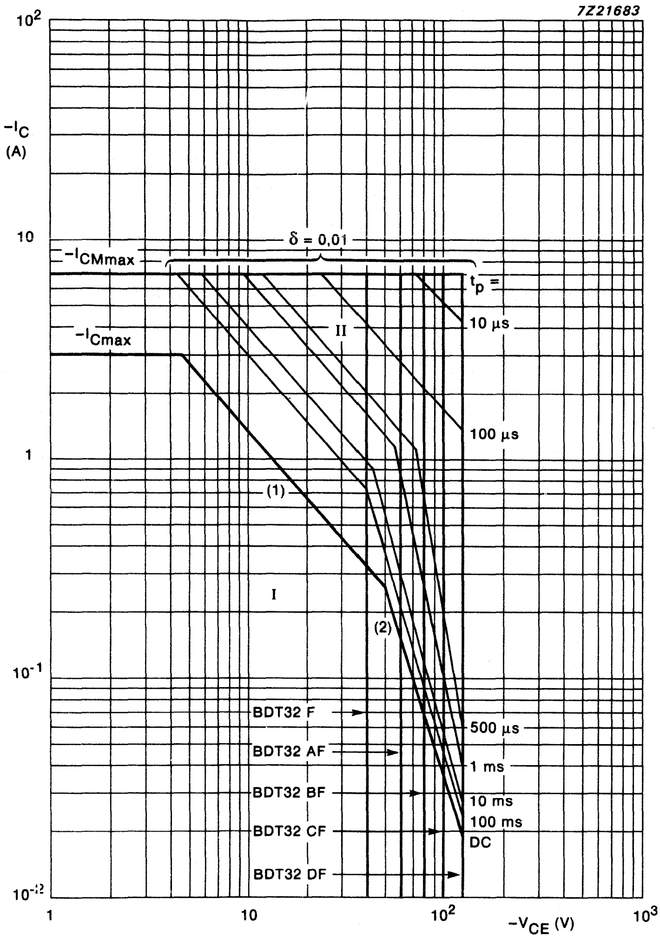
$-V_{CC}$ = 20 V
$-V_{IM}$ = 30 V
$+V_{BB}$ = 3 V
R_1 = 56 Ω
R_2 = 150 Ω
R_3 = 33 Ω
R_4 = 20 Ω
$t_r = t_f$ = 15 ns
t_p = 20 μs
T = 500 μs

Fig.2 Switching times test circuit.



$-V_{IM}$ = 12 V
R_B = 270 Ω
L = 20 mH
$-I_C$ = 1.8 A
t_p = 1 ms
δ = 1 %

Fig.3 Test circuit for turn-off breakdown energy.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

Mounted **without** heatsink compound and 30 ± 5 Newton pressure on the centre of the envelope.

Fig.4 Safe operating area, T_{amb} = 25 °C.

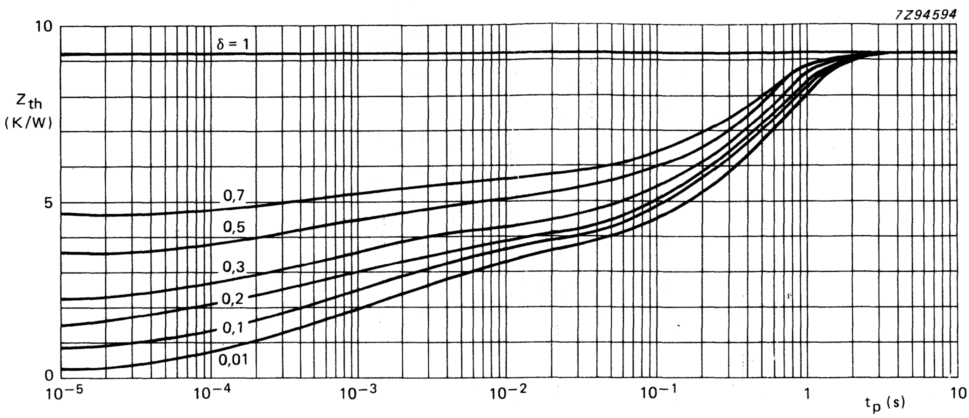


Fig.5 Pulse power rating chart; mounted **without** heatsink compound and 30 ± 5 Newton pressure on the envelope.

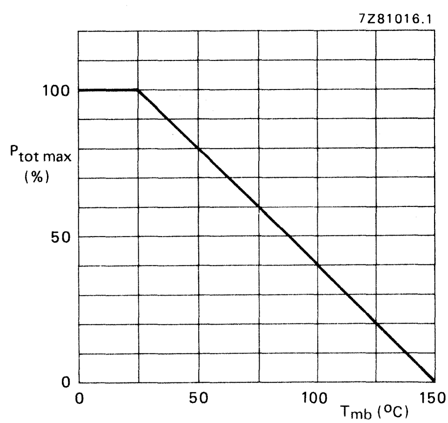


Fig.6 Total power dissipation.

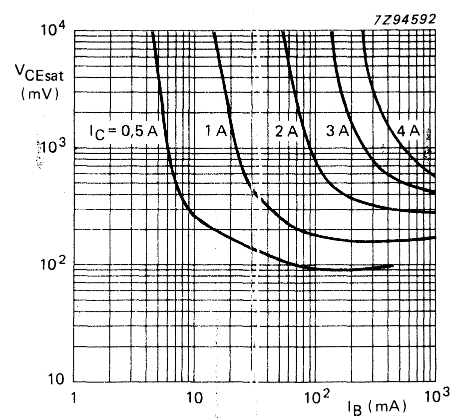


Fig.7 Typical collector-emitter saturation voltage; T_j = 25 °C.

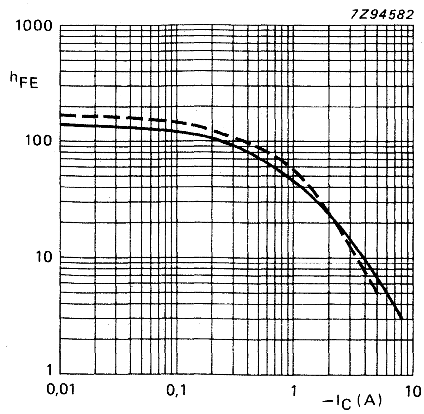


Fig.8 Typical DC current gain; $-V_{CE} = 4$ V; $T_j = 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in general purpose amplifier and switching applications. The TIP41 series is an equivalent type. P-N-P complements are BDT42 series.

QUICK REFERENCE DATA

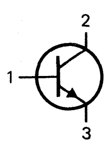
			BDT41	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.	6				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Junction temperature	T_j	max.	150				°C
D.C. current gain I_C = 3 A; V_{CE} = 4 V	h_{FE}		15 to 75				

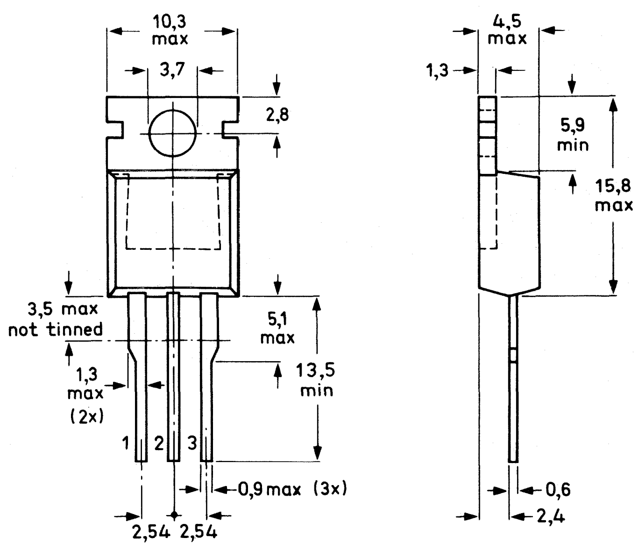
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT41	A	B	C	
→ Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	6				A
Collector current (peak value)	I_{CM}	max.	10				A
Base current (d.c.)	I_B	max.	3				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT41;A	B;C	
Collector cut-off current					
→ $I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	0,2	–	mA
→ $I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	<	–	0,2	mA
$V_{BE} = 0$; $V_{CE} = V_{CEOmax}$	I_{CES}	<	0,4		mA
Emitter cut-off current					
→ $I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	0,5		mA
D.C. current gain*					
$I_C = 0{,}3$ A; $V_{CE} = 4$ V	h_{FE}	>	30		
$I_C = 3$ A; $V_{CE} = 4$ V	h_{FE}		15 to 75		
Base-emitter voltage**					
$I_C = 6$ A; $V_{CE} = 4$ V	V_{BE}	<	2		V
Collector-emitter saturation voltage*					
$I_C = 6$ A; $I_B = 0{,}6$ A	V_{CEsat}	<	1,5		V

			BDT41	A	B	C	
Collector-emitter breakdown voltage* $I_B = 0$; $I_C = 30$ mA	$V_{(BR)CEO}$	>	40	60	80	100	V

Small-signal current transfer ratio $I_C = 0{,}5$ A; $V_{CE} = 10$ V; f = 1 kHz	$\|h_{fe}\|$	>	20	
Transition frequency at f = 1 MHz $I_C = 0{,}5$ A; $V_{CE} = 10$ V	f_T	>	3	MHz

* Measured under pulse conditions: $t_p \leq 300\ \mu s$, $\delta < 2\%$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Turn-off breakdown energy with inductive load (Fig. 4) $-I_{Boff} = 0$; $I_{CC} = 2,5$ A	$E_{(BR)}$	>	62,5 mJ
Switching times (between 10% and 90% levels) $I_{Con} = 6$ A; $I_{Bon} = -I_{Boff} = 0,6$ A			
Turn-on time	t_{on}	typ.	0,6 μs
Turn-off time	t_{off}	typ.	1 μs

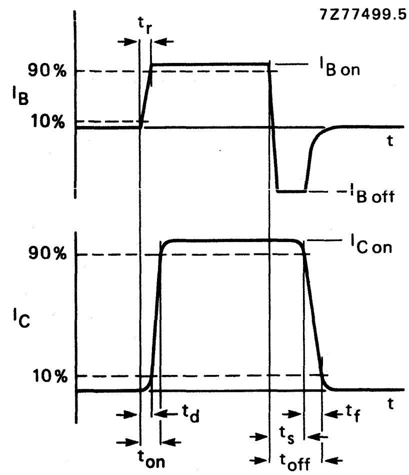
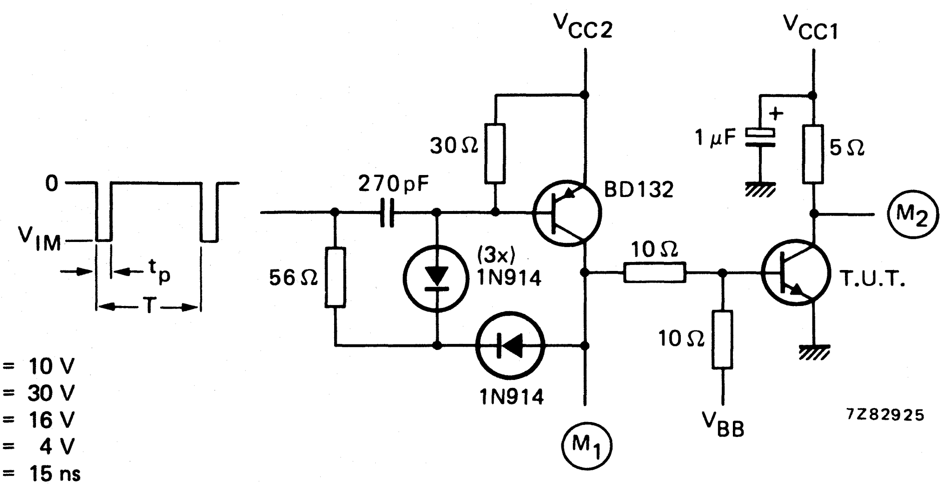


Fig. 2 Switching times waveforms.



$-V_{IM}$ = 10 V
V_{CC1} = 30 V
V_{CC2} = 16 V
$-V_{BB}$ = 4 V
$t_r = t_f$ = 15 ns
t_p = 20 μs
δ ⩽ 2 %

Fig. 3 Switching times test circuit.
Adjust V_{CC2} so that the input to M_1 = 14 V.

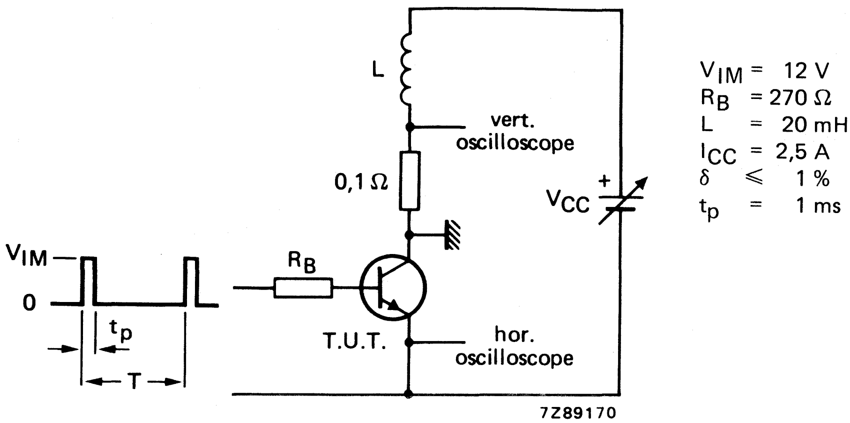


Fig. 4 Test circuit for turn-off breakdown energy.

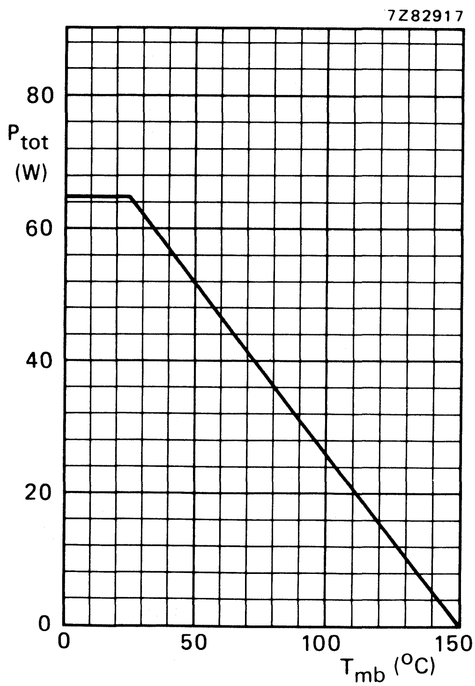


Fig. 5 Power derating curve.

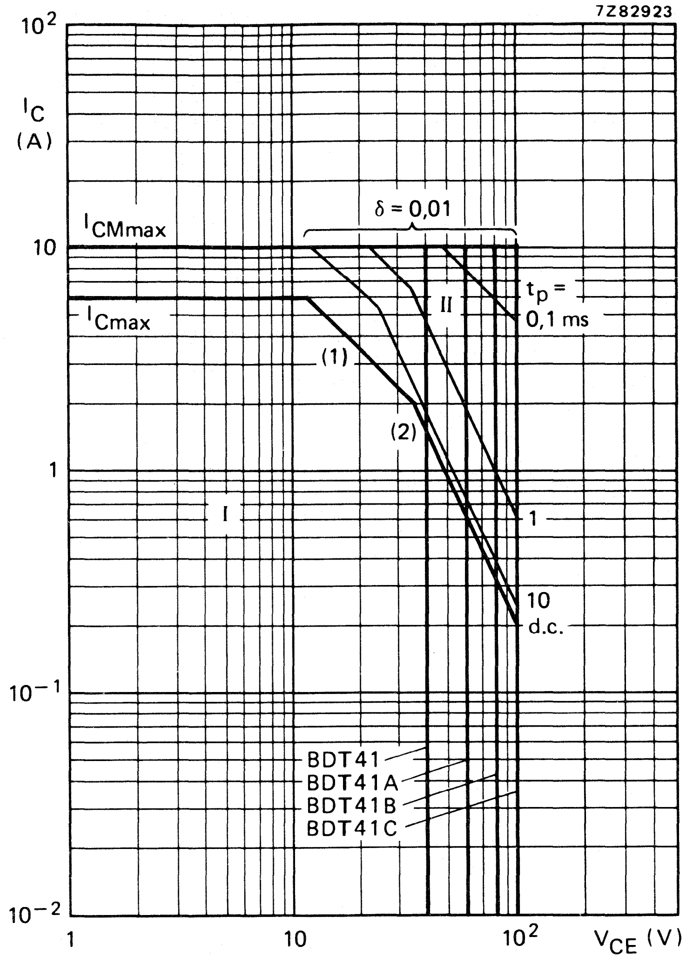


Fig. 6 Safe Operating ARea, T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

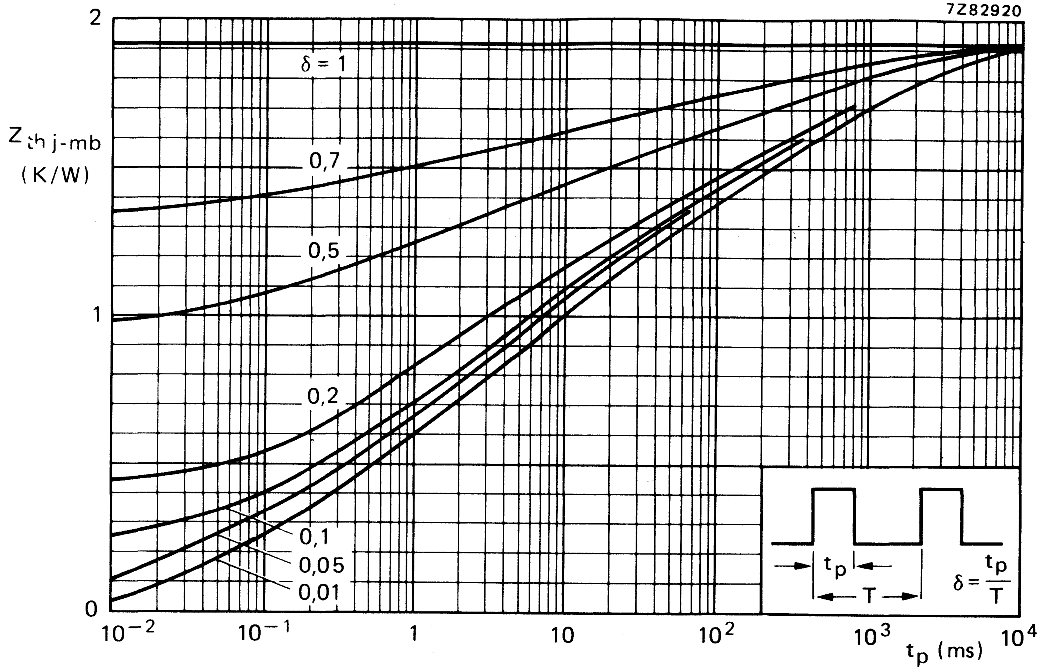


Fig. 7 Pulse power rating chart.

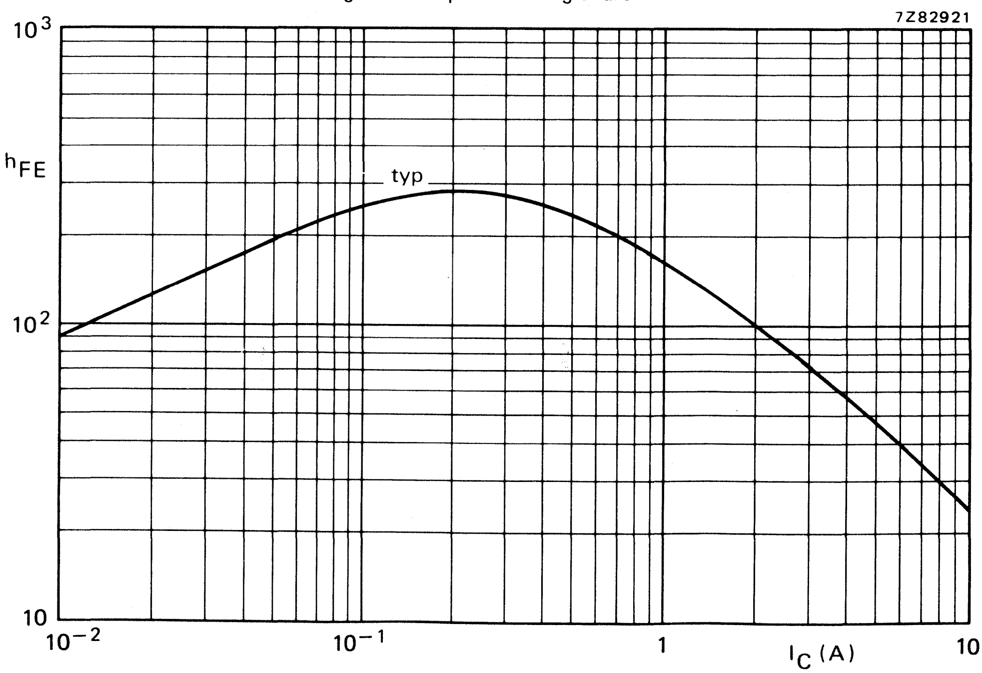


Fig. 8 D.C. current gain at V_{CE} = 4 V; T_j = 25 °C.

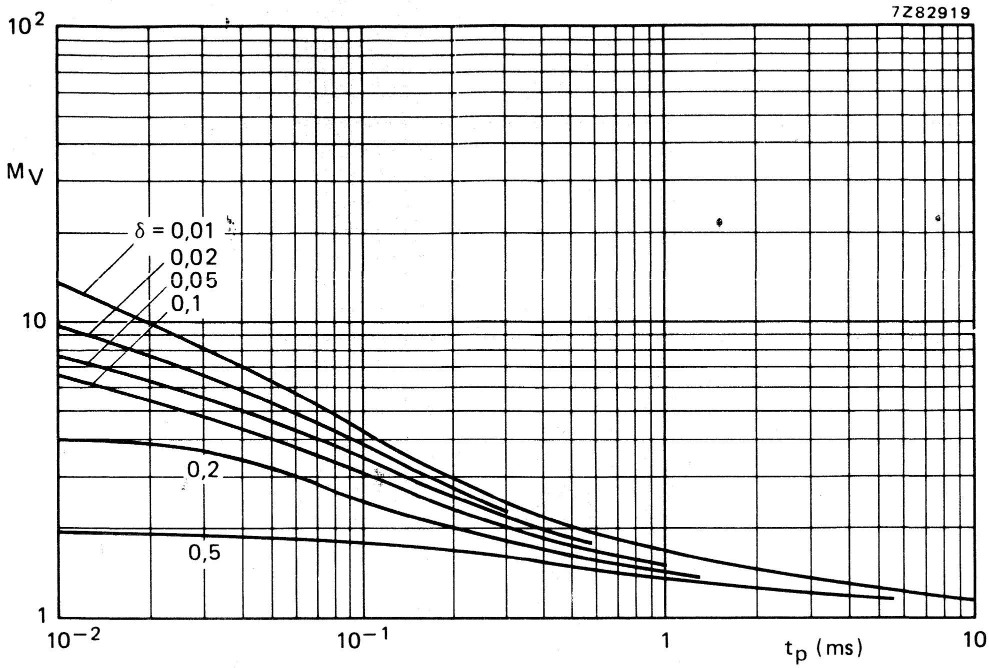


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

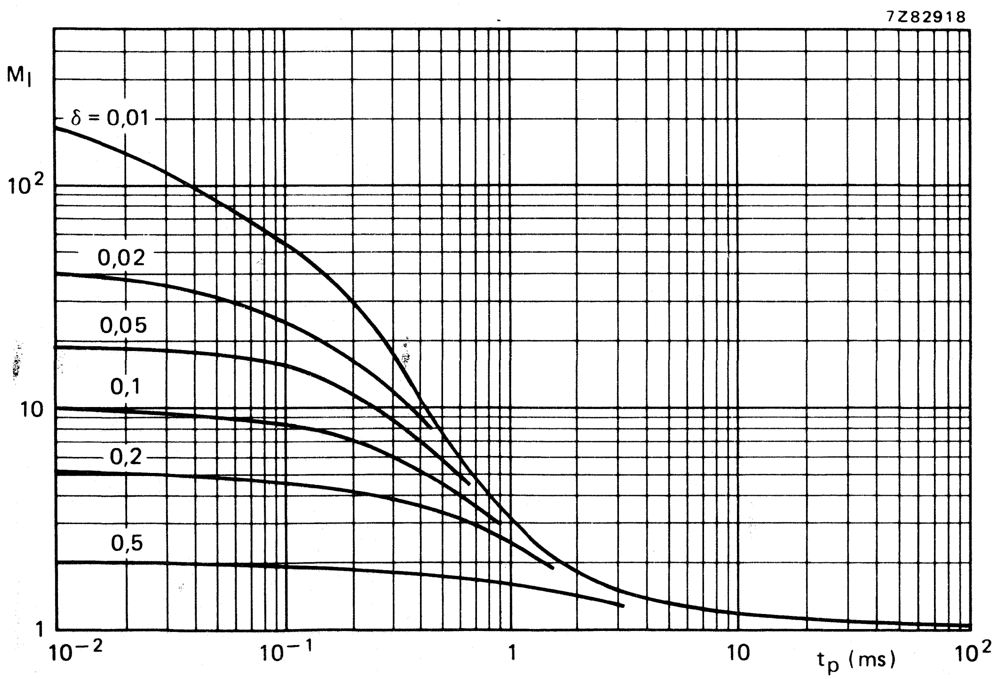


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} level.

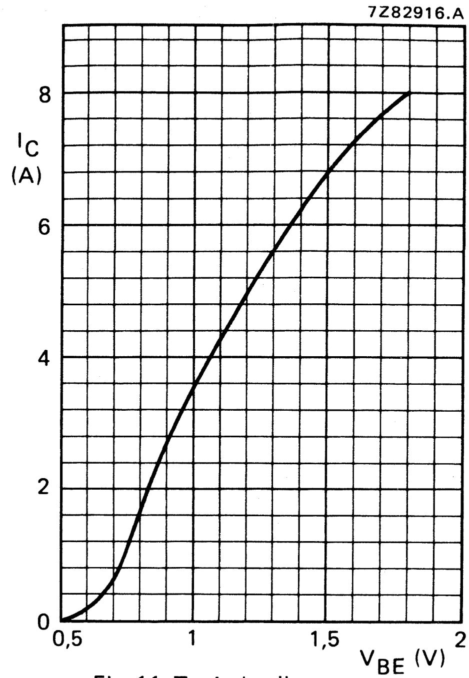


Fig. 11 Typical collector current.
V_{CE} = 4 V; T_j = 25 °C.

SILICON EPITAXIAL POWER TRANSISTORS

NPN silicon epitaxial power transistors, each in a SOT186 envelope with an electrically insulated mounting base.

PNP complements are BDT42F, BDT42AF, BDT42BF, and BDT42CF.

QUICK REFERENCE DATA

			BDT41F	AF	BF	CF	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
DC collector current	I_C	max.			6		A
Peak collector current	I_{CM}	max.			10		A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.			32		W
Junction temperature	T_j	max.			150		°C
DC current gain I_C = 3 A; V_{CE} = 4 V	h_{FE}	min.			15		
		max.			75		

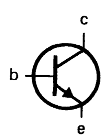
MECHANICAL DATA

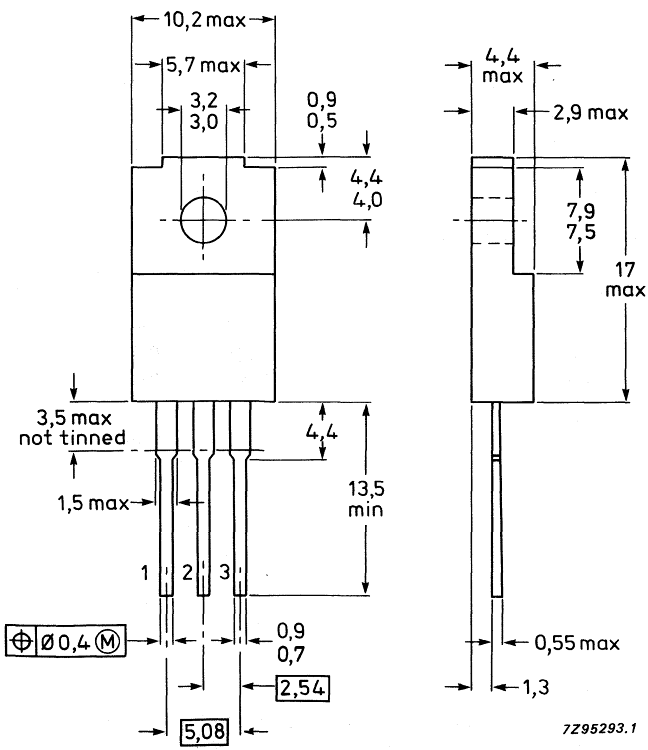
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT41F	AF	BF	CF	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
DC collector current	I_C	max.	6				A
Peak collector current	I_{CM}	max.	10				A
DC base current	I_B	max.	3				A
Total power dissipation							
up to T_h = 25 °C (note 1)	P_{tot}	max.	20				W
up to T_h = 25 °C (note 2)	P_{tot}	max.	32				W
Storage temperature range	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.6	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.3	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V
Isolation capacitance from collector to external heatsink	C_{th}	typ.	12	pF

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT41F	AF	BF	CF	
Collector cut-off currents							
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	max.	0.2	0.2	–	–	mA
$I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	max.	–	–	0.2	0.2	mA
$V_{BE} = 0$; $V_{CE} = V_{CEOmax}$	I_{CES}	max.	0.4				mA
Emitter cut-off current							
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	0.5				mA

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

			BDT41F	AF	BF	CF	
DC current gain (note 1)							
I_C = 0.3 A; V_{CE} = 4 V	h_{FE}	min.	30				
I_C = 3 A; V_{CE} = 4 V	h_{FE}	min.	15				
		max.	75				
Base-emitter voltage (note 2)							
I_C = 6 A; V_{CE} = 4 V	V_{BE}	max.	2				V
Collector-emitter saturation voltage (note 1)							
I_C = 6 A; I_B = 0.6 A	V_{CEsat}	max.	1.5				V
Collector-emitter breakdown voltage (note 1)							
I_C = 30 mA; I_B = 0	$V_{(BR)CEO}$	max.	40	60	80	100	V
Small-signal current transfer ratio							
I_C = 0.5 A; V_{CE} = 10 V; f = 1 kHz	$\|h_{fe}\|$	min.	20				
Transition frequency							
I_C = 0.5 A; V_{CE} = 10 V; f = 1 kHz	f_T	min.	3				MHz
Turn-off breakdown energy with inductive load (Fig.4)							
I_{Boff} = 0; I_{CC} = 2.5 V	$E_{(BR)}$	min.	62.5				mJ
Switching times (Figs 2 and 3) (between 10% and 90% levels)							
I_{Con} = 6 A; I_{Bon} = $-I_{Boff}$ = 0.6 A							
turn-on time	t_{on}	typ.	0.6				μs
turn-off time	t_{off}	typ.	1				μs

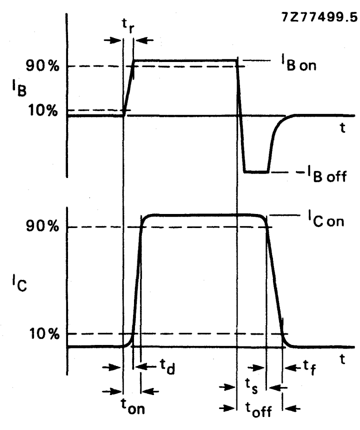
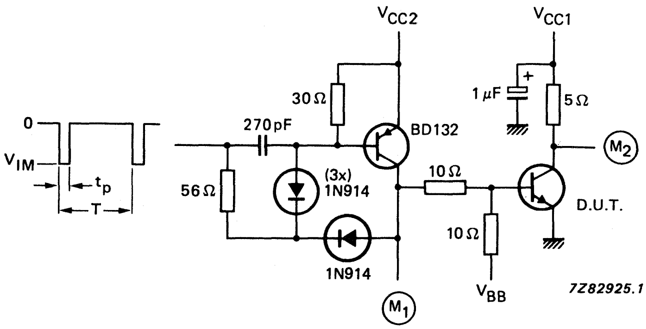


Fig.2 Switching times waveform.

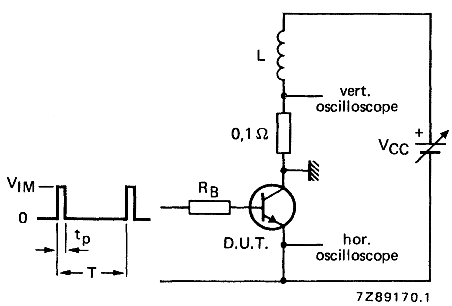
Notes

1. Measured under pulse conditions: t_p max. 300 μs; δ max. 2%.
2. V_{BE} decreases by about 2.3 mV/K with increasing temperature.



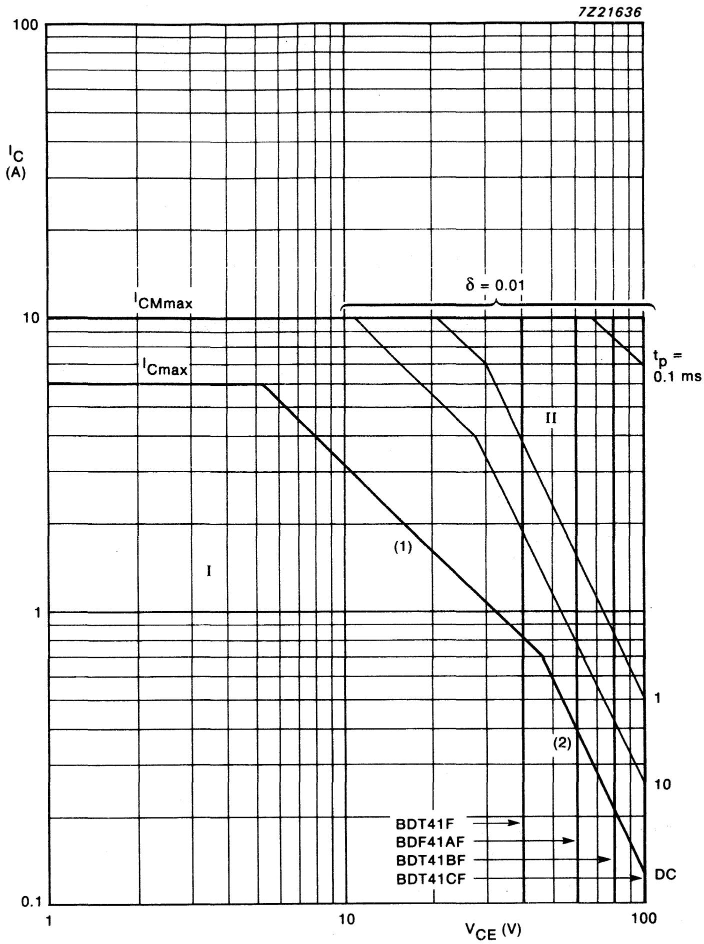
$-V_{IM}$	= 10 V
V_{CC1}	= 30 V
V_{CC2}	= 16 V
$-V_{BB}$	= 4 V
$t_r = t_f$	= 15 ns
t_p	= 20 μs
δ max.	2%

Fig.3 Switching times test circuit.
Adjust V_{CC2} to give M_1 = 14 V.



V_{IM}	= 12 V
R_B	= 270 Ω
L	= 20 mH
I_{CC}	= 2.5 A
δ	max. 1%
t_p	= 1 ms

Fig.4 Test circuit for turn-off breakdown energy.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Fig.5 Safe operating area, T_{mb} = 25 °C.

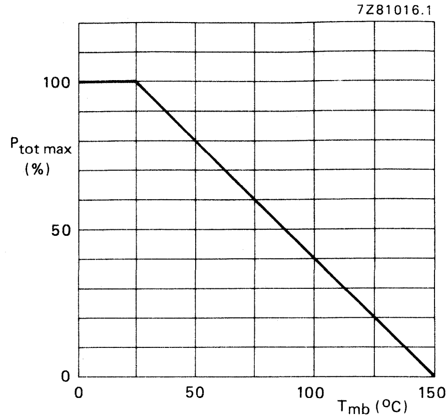


Fig.6 Total power dissipation.

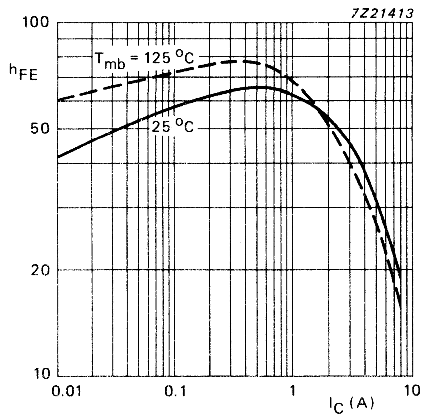


Fig.7 DC current gain; V_{CE} = 4 V; typical values.

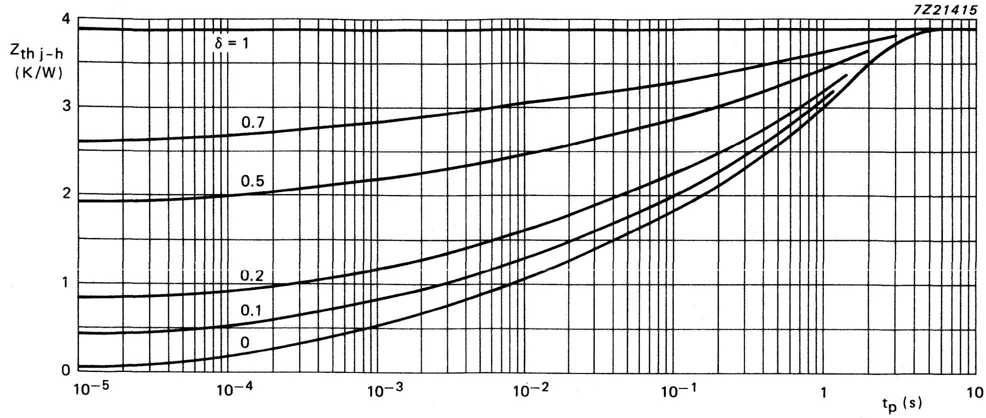


Fig.8 Pulse power rating chart.

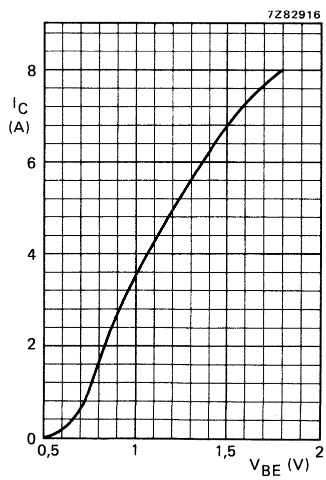


Fig.9 Typical collector current.
V_{CE} = 4 V; T_j = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in general output stages of amplifier circuits and switching applications. The TIP42 series is an equivalent type. P-N-P complements are BDT41 series.

QUICK REFERENCE DATA

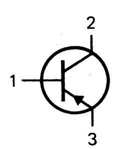
			BDT42	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	6				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 3 A; $-V_{CE}$ = 4 V	h_{FE}		15 to 75				

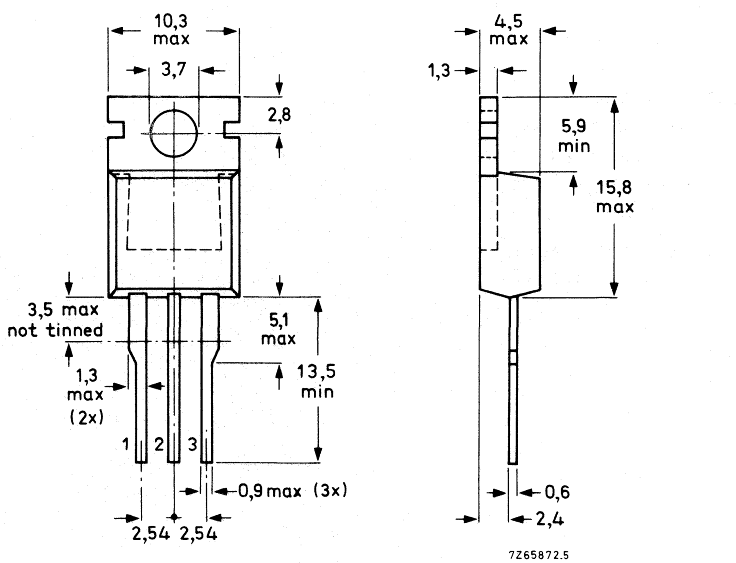
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base





See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT42	A	B	C	
→ Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
Collector current (d.c.)	$-I_C$	max.	6				A
Collector current (peak value)	$-I_{CM}$	max.	10				A
Base current (d.c.)	$-I_B$	max.	3				A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	65				W
Storage temperature	T_{stg}		−65 to + 150				^oC
Junction temperature	T_j	max.	150				^oC

THERMAL RESISTANCE

From junction to mouting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			BDT42;A	B;C	
→ Collector cut-off current					
$I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	<	0,2	–	mA
$I_B = 0$; $-V_{CE} = 60$ V	$-I_{CEO}$	<	–	0,2	mA
$V_{BE} = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,4		mA
→ Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	0,5		mA
D.C. current gain*					
$-I_C = 300$ mA; $-V_{CE} = 4$ V	h_{FE}	>	30		
$-I_C = 3$ A; $-V_{CE} = 4$ V	h_{FE}		15 to 75		
Base-emitter voltage**					
$-I_C = 6$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	2		V
Collector-emitter saturation voltage*					
$-I_C = 6$ A; $-I_B = 0,6$ A	$-V_{CEsat}$	<	1,5		V

			BDT42	A	B	C	
Collector-emitter breakdown voltage*							
$I_B = 0$; $-I_C = 30$ mA	$-V_{(BR)CEO}$	>	40	60	80	100	V
Transition frequency at f = 1 MHz							
$-I_C = 500$ mA; $-V_{CE} = 10$ V	f_T	>	3				MHz
Small signal current transfer ratio							
$-I_C = 0,5$ A; $-V_{CE} = 10$ V; f = 1 kHz	$\lvert h_{fe} \rvert$	>	20				

* Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta < 2\%$.
** V_{EB} decreases by about 2,3 mV/K with increasing temperature.

Turn-off breakdown energy with inductive load (Fig. 4)			
$I_{Boff} = 0; -I_{CC} = 2{,}5$ A	$E_{(BR)}$	>	62,5 mJ
Switching times			
$-I_{Con} = 6$ A; $-I_{Bon} = I_{Boff} = 0{,}6$ A			
turn-on time	t_{on}	typ.	0,4 μs
turn-off time	t_{off}	typ.	0,7 μs

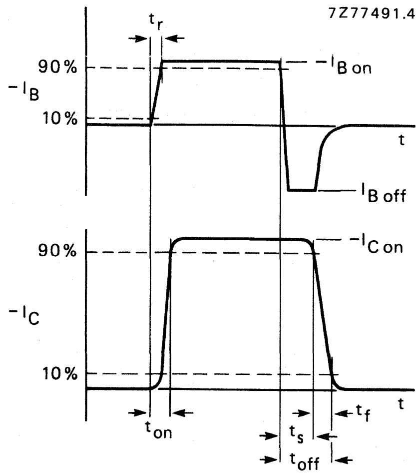
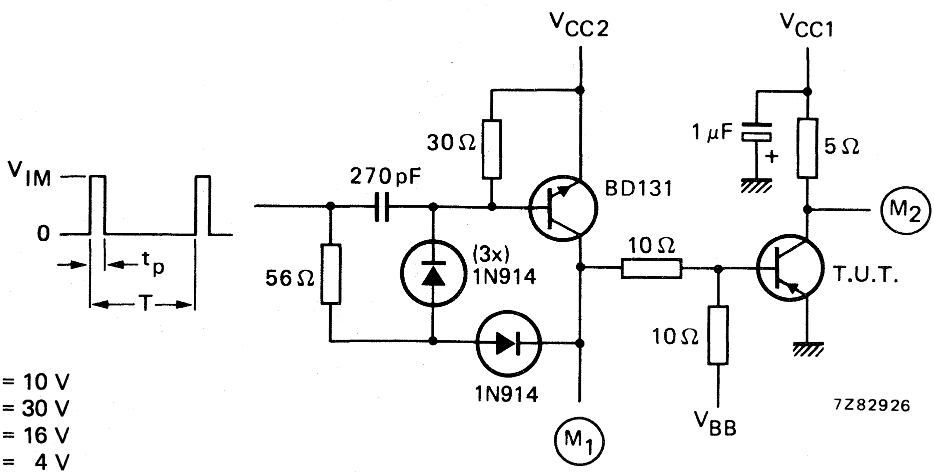
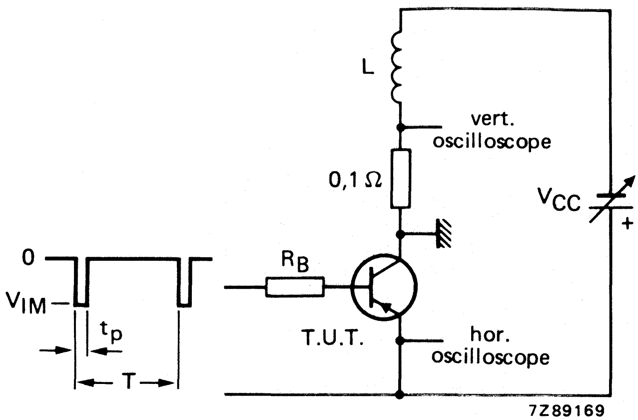


Fig. 2 Switching times waveforms.



V_{IM} = 10 V
$-V_{CC1}$ = 30 V
$-V_{CC2}$ = 16 V
V_{BB} = 4 V
$t_r = t_f$ = 15 ns
t_p = 20 μs
δ ⩽ 2 %

Fig. 3 Switching times test circuit.
Adjust V_{CC2} so that the input to M1 = 14 V.



$-V_{IM}$	=	12 V
R_B	=	270 Ω
L	=	20 mH
$-I_{CC}$	=	2,5 A
t_p	=	1 ms
δ	=	1 %

Fig. 4 Test circuit for turn-off breakdown energy.

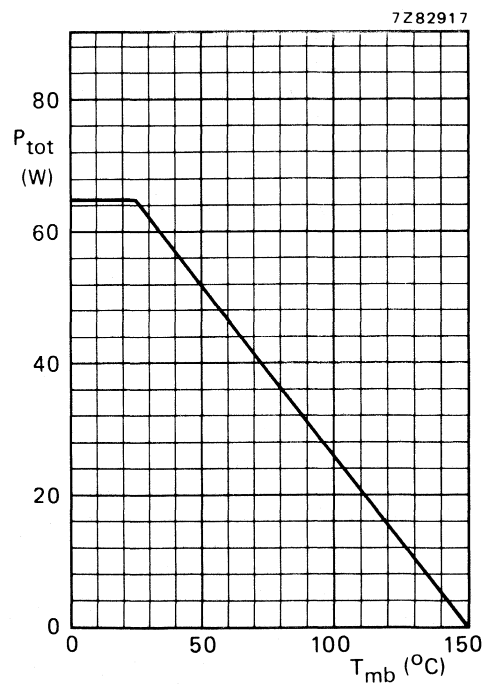


Fig. 5 Power derating curve.

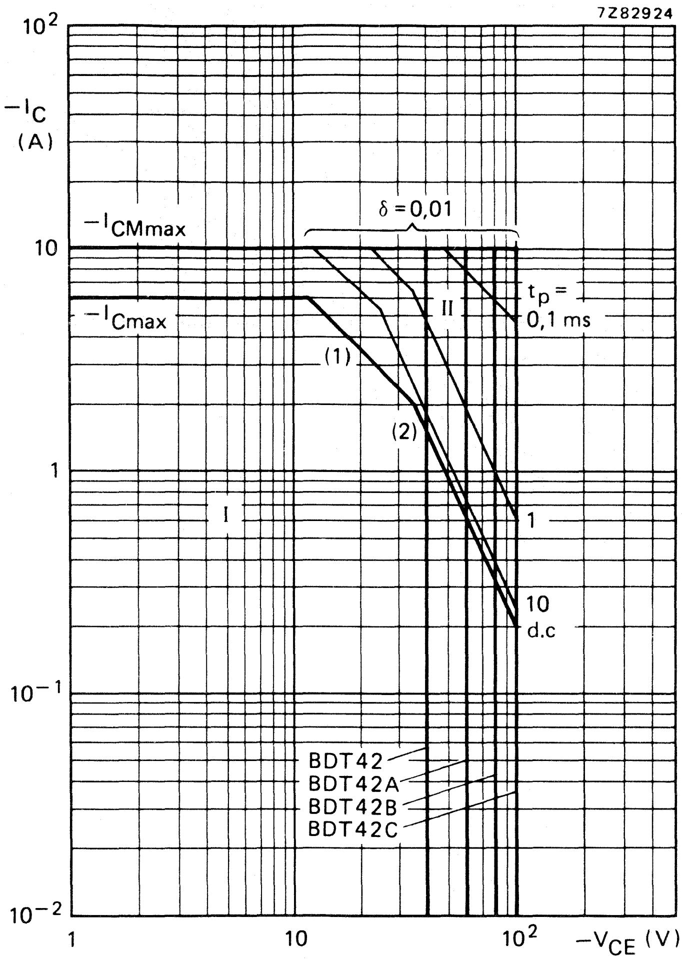


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(2) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(3) Second-breakdown limits.

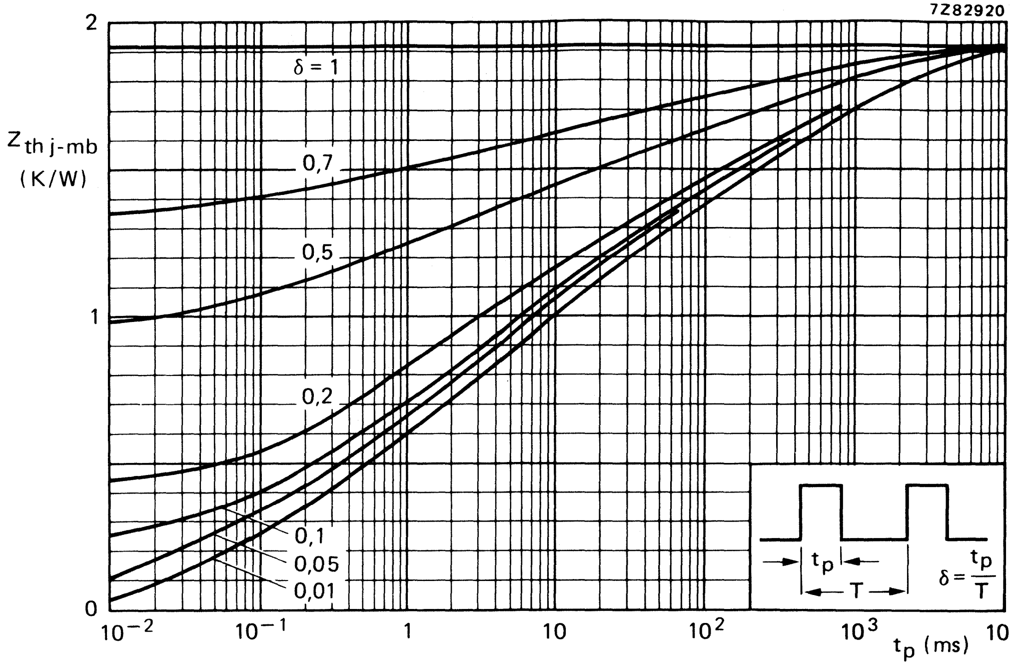


Fig. 7 Pulse power rating chart.

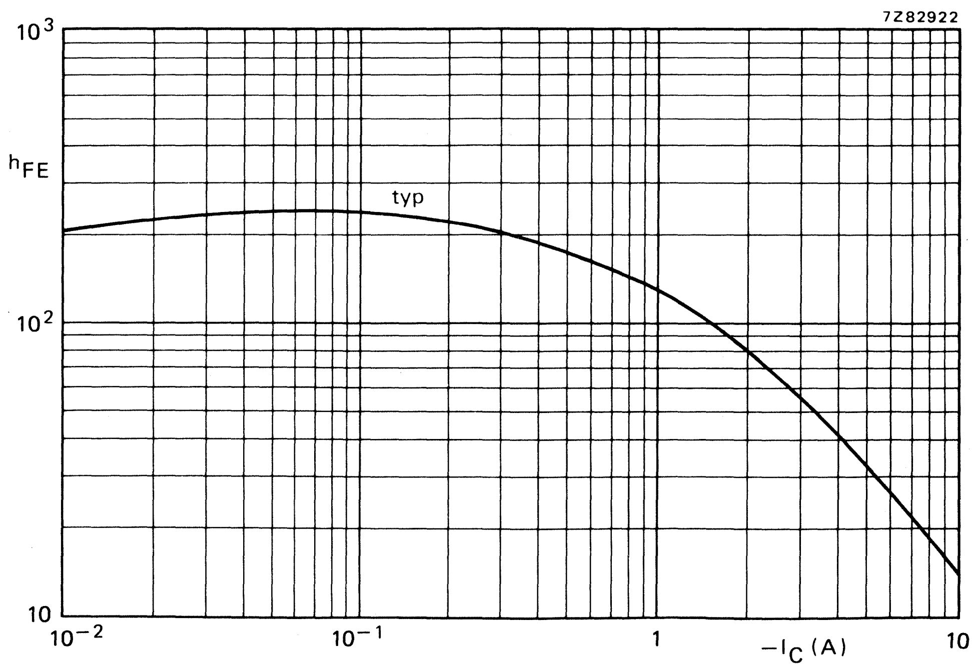


Fig. 8 Typical values d.c. current gain. $-V_{CE}$ = 4 V; T_j = 25 °C.

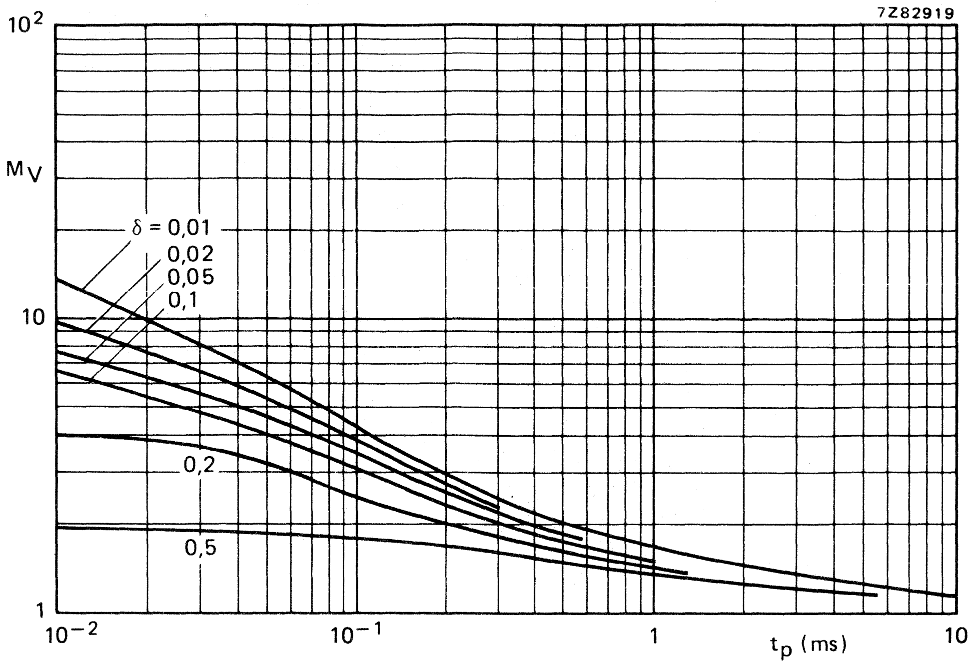


Fig. 9 Second breakdown voltage multiplying factor at the I_{Cmax} level.

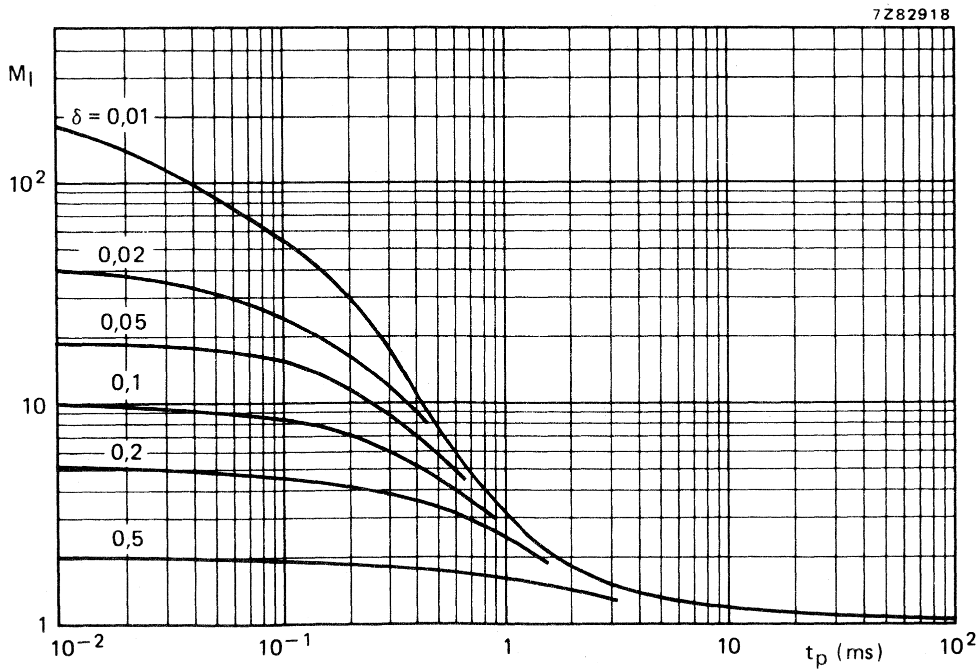


Fig. 10 Second breakdown current multiplying factor at the V_{CEOmax} level.

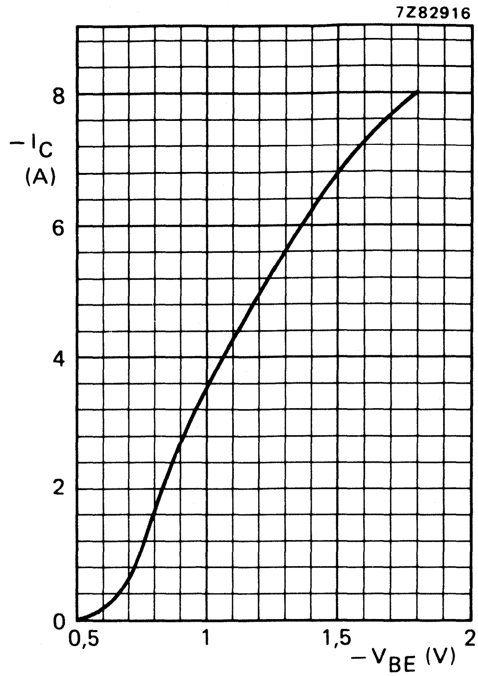


Fig. 11 Typical collector current.
$-V_{CE} = 4$ V; $T_j = 25$ °C.

SILICON EPITAXIAL POWER TRANSISTORS

PNP silicon epitaxial power transistors, each in a SOT186 envelope with an electrically insulated mounting base.

NPN complements are BDT41F, BDT41AF, BDT41BF, and BDT41CF.

QUICK REFERENCE DATA

			BDT42F	AF	BF	CF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
DC collector current	$-I_C$	max.		6			A
Peak collector current	I_{CM}	max.		10			A
Total power dissipation up to $T_h = 25\ ^oC$	P_{tot}	max.		32			W
Junction temperature	T_j	max.		150			^oC
DC current gain $-I_C = 3$ A; $-V_{CE} = 4$ V	h_{FE}	min.		15			
		max.		75			

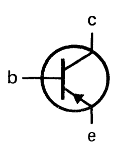
MECHANICAL DATA

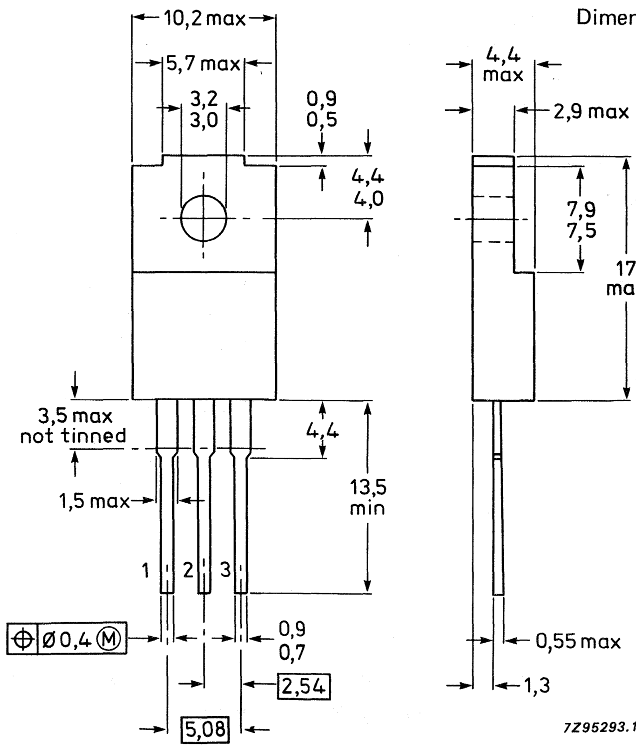
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT42F	AF	BF	CF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
DC collector current	$-I_C$	max.	6				A
Peak collector current	$-I_{CM}$	max.	10				A
DC base current	$-I_B$	max.	3				A
Total power dissipation							
up to $T_h = 25$ °C (note 1)	P_{tot}	max.	20				W
op to $T_h = 25$ °C (note 2)	P_{tot}	max.	32				W
Storage temperature range	T_{stg}		−65 to 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.6	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.3	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	12	pF

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

			BDT42F	AF	BF	CF	
Collector cut-off currents							
$-I_B = 0; -V_{CE} = 30$ V	$-I_{CEO}$	max.	0.2	0.2	–	–	mA
$-I_B = 0; -V_{CE} = 60$ V	$-I_{CEO}$	max.	–	–	0.2	0.2	mA
$-V_{BE} = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CES}$	max.	0.4				mA
Emitter cut-off current							
$-I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	max.	0.5				mA

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

DC current gain (note 1)				
$-I_C = 0.3$ A; $-V_{CE} = 4$ V	h_{FE}		30	
$-I_C = 3$ A; $-V_{CE} = 4$ V	h_{FE}	min.	15	
		max.	75	
Base-emitter voltage (note 2)				
$-I_C = 6$ A; $-V_{CE} = 4$ V	$-V_{BE}$	max.	2	V
Collector-emitter saturation voltage (note 1)				
$-I_C = 6$ A; $-I_B = 0.6$ A	$-V_{CEsat}$	max.	1.5	V

			BDT42F	AF	BF	CF	
Collector-emitter breakdown voltage (note 1)							
$-I_C = 30$ mA; $-I_B = 0$	$-V_{(BR)CEO}$	max.	40	60	80	100	V

Small-signal current transfer ratio				
$-I_C = 0.5$ A; $-V_{CE} = 10$ V; f = 1 kHz	h_{fe}	min.	20	
Transition frequency				
$-I_C = 0.5$ A; $-V_{CE} = 10$ V; f = 1 kHz	f_T	min.	3	MHz
Turn-off breakdown energy with inductive load (Fig.4)				
$-I_{B\,off} = 0$; $-I_{CC} = 2.5$ V	$E_{(BR)}$	min.	62.5	mJ
Switching times (Figs 2 and 3) (between 10% and 90% levels)				
$-I_{C\,on} = 6$ A; $-I_{B\,on} = I_{B\,off} = 0.6$ A				
turn-on time	t_{on}	typ.	0.6	μs
turn-off time	t_{off}	typ.	1	μs

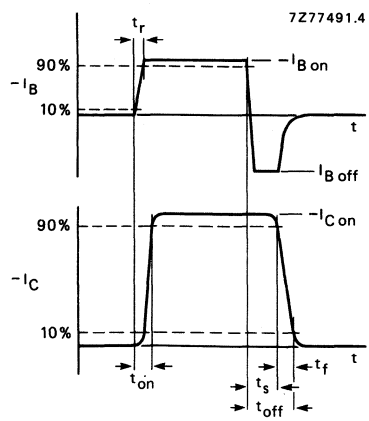
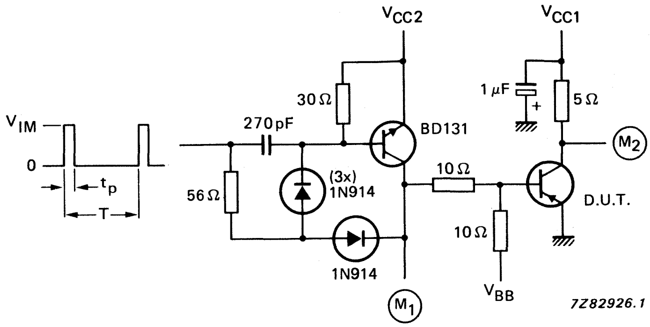


Fig.2 Switching times waveform.

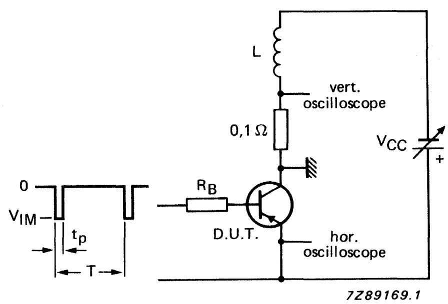
Notes

1. Measured under pulse conditions: t_p max. 300 μs; δ max. 2%.
2. V_{BE} decreases by about 2.3 mV/K with increasing temperature.



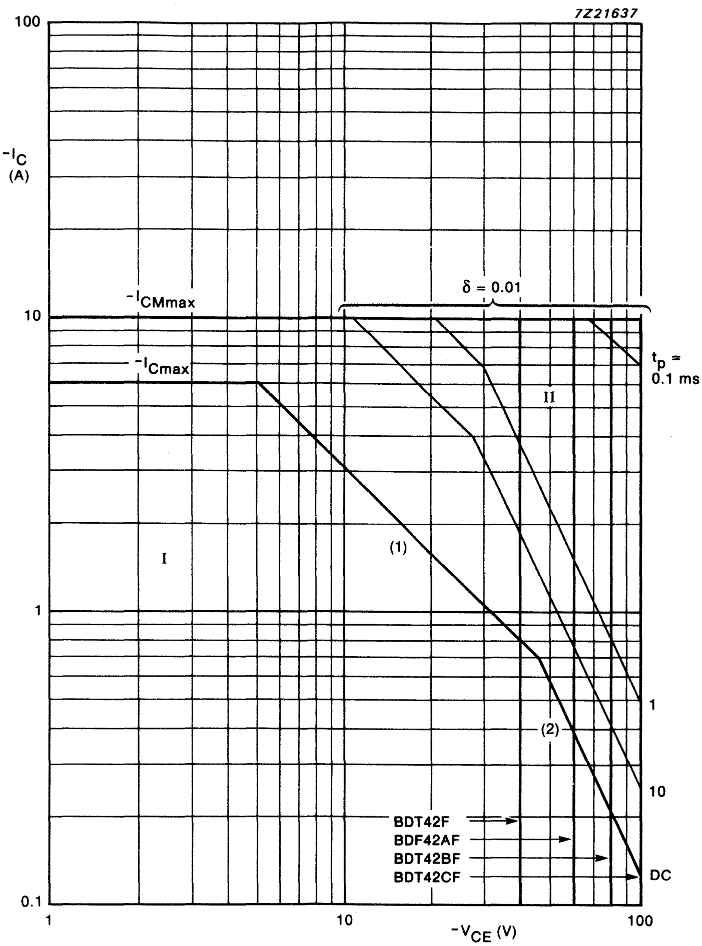
V_{IM} = 10 V
$-V_{CC1}$ = 30 V
$-V_{CC2}$ = 16 V
V_{BB} = 4 V
$t_r = t_f$ = 15 ns
t_p = 20 µs
δ max. 2%

Fig.3 Switching times test circuit.
Adjust V_{CC2} to give M_1 = 14 V.



$-V_{IM}$ = 12 V
R_B = 270 Ω
L = 20 mH
$-I_{CC}$ = 2.5 A
δ = 1%
t_p = 1 ms

Fig.4 Test circuit for turn-off breakdown energy.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines
(2) Second-breakdown limits.

Fig.5 Safe operating area; T_{mb} = 25 °C.

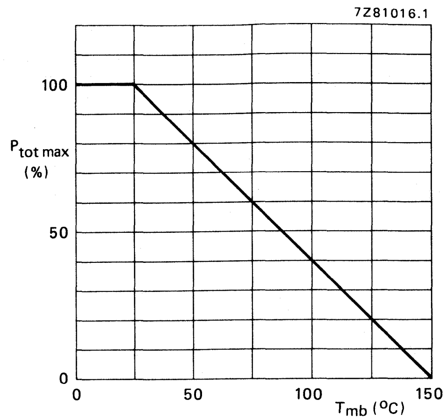


Fig.6 Total power dissipation.

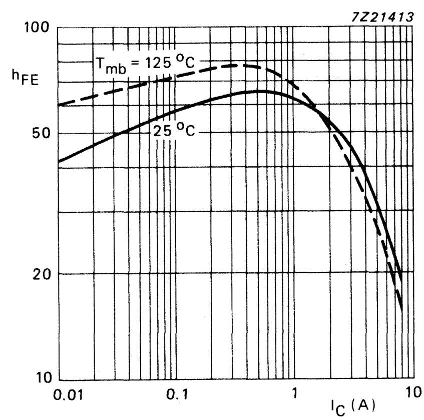


Fig.7 DC current gain; $-V_{CE}$ = 4 V; typical values.

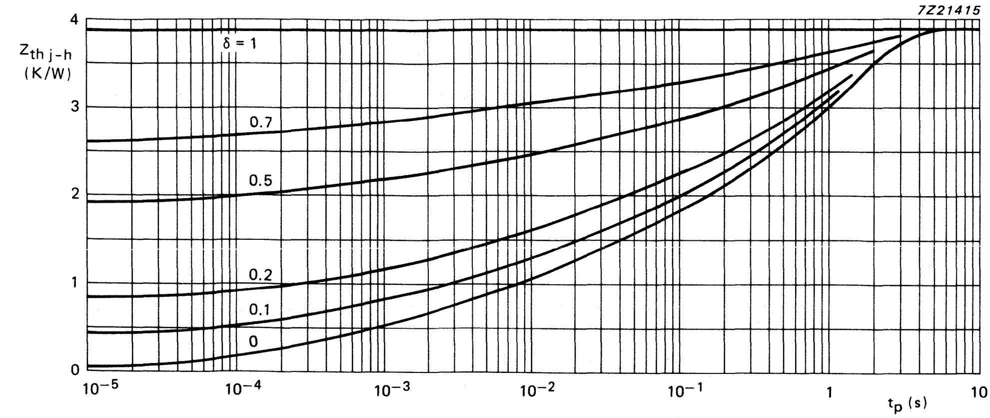


Fig.8 Pulse power rating chart.

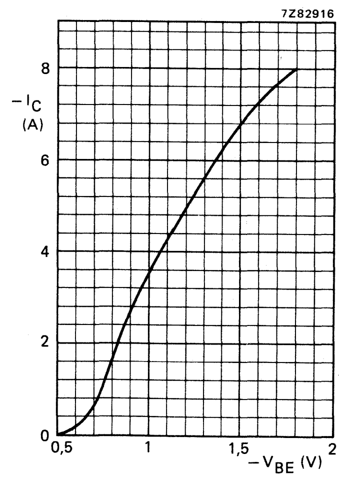


Fig.9 Typical collector current; $-V_{CE} = 4$ V; $T_j = 25$ °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P silicon power transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier applications.
N-P-N complements are BDT61, BDT61A, BDT61B and BDT61C.

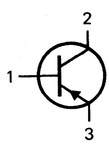
QUICK REFERENCE DATA

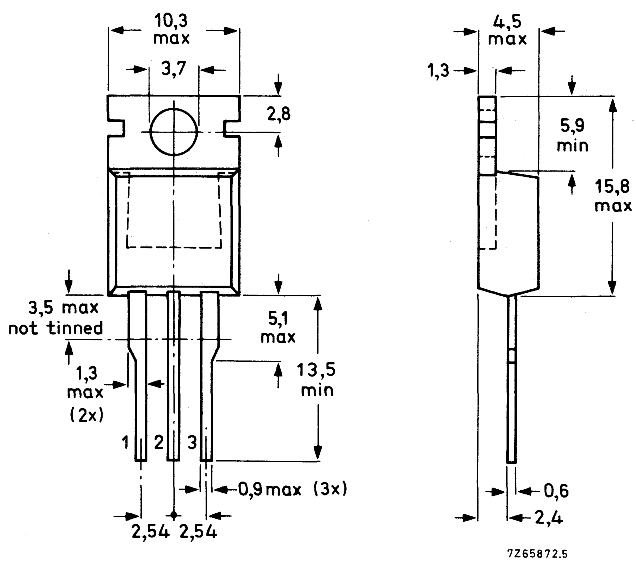
			BDT60	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (d.c.)	$-I_C$	max.		4			A
Collector current (peak value)	$-I_{CM}$	max.		6			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		50			W
Junction temperature	T_j	max.		150			°C
D.C. current gain $-I_C$ = 0,5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.		2200			

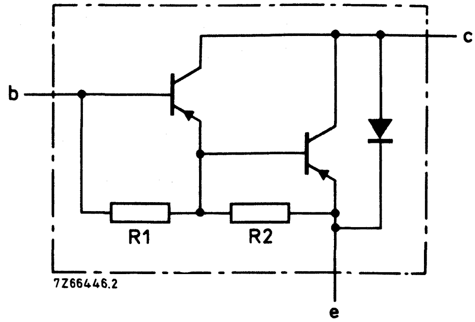
MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.







R1 typ. 6 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT60	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5			V
Collector current (d.c.)	$-I_C$	max.		4			A
Collector current (peak value)	$-I_{CM}$	max.		6			A
Reverse diode current	$I_R = I_C$	max.		4			A
Base current (d.c.)	$-I_B$	max.		100			mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		50			W
Storage temperature	T_{stg}			−65 to + 150			°C
Junction temperature*	T_j	max.		150			°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,5	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	⩽	0,2 mA
$I_E = 0; -V_{CB} = -½V_{CBOmax}; T_j = 150$ °C	$-I_{CBO}$	⩽	1 mA ←
$I_B = 0; -V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	⩽	0,2 mA ←
Emitter cut-off current			
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	⩽	5 mA
Forward bias second-breakdown collector current			
$-V_{CE} = 50$ V; t = 0,1 s; non-repetitive (without heatsink); T_{amb} = 25 °C	$-I_{(SB)}$	⩾	1 A
D.C. current gain*			
$-I_C = 0,5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2200
$-I_C = 1,5$ A; $-V_{CE} = 3$ V	h_{FE}	⩾	750
$-I_C =$ 4 A; $-V_{CE} = 3$ V	h_{FE}	typ.	270
Base-emitter voltage			
$-I_C = 1,5$ A; $-V_{CE} = 3$ V	$-V_{BE}$	⩽	2,5 V
Collector-emitter saturation voltage*			
$-I_C = 1,5$ A; $-I_B = 6$ mA	$-V_{CEsat}$	⩽	2,5 V
Cut-off frequency			
$-I_C = 1,5$ A; $-V_{CE} = 3$ V	f_{hfe}	⩾	25 kHz
Small-signal current gain at f = 1 MHz			
$-I_C = 1,5$ A; $-V_{CE} = 3$ V	h_{fe}	⩾	10
Diode, forward voltage			
$I_F = 1,5$ A	V_F	<	2 V
$I_F = 4$ A	V_F	typ.	2,1 V
Switching times (between 10% and 90% levels)			
$-I_{Con} = 1,5$ A; $-I_{Bon} = I_{Boff} = 6$ mA; $-V_{CC} = 30$ V			
turn-on time	t_{on}	typ.	0,3 μs
		<	1,5 μs
turn-off time	t_{off}	typ.	1,5 μs
		<	5 μs

* Measured under pulse conditions; $t_p < 300$ μs; $\delta < 2\%$.

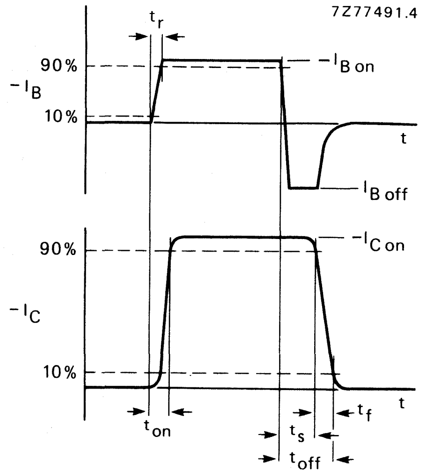
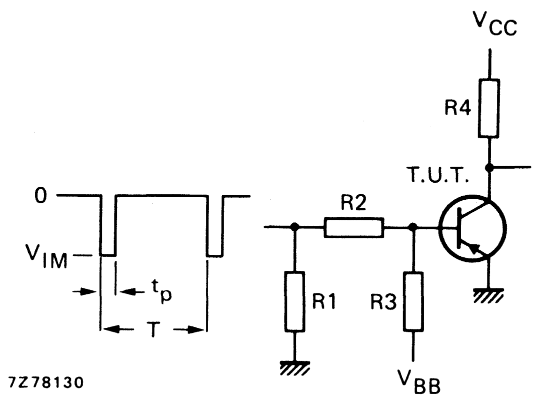


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	12 V
$-V_{CC}$	=	30 V
$+V_{BB}$	=	3 V
R1	=	56 Ω
R2	=	1 kΩ
R3	=	680 Ω
R4	=	22 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

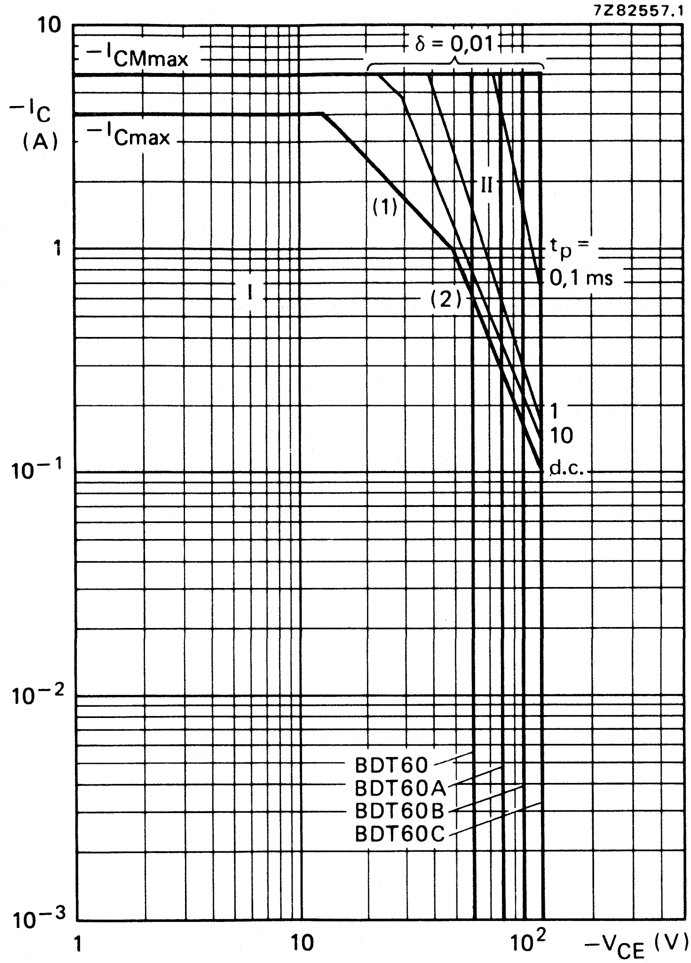


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

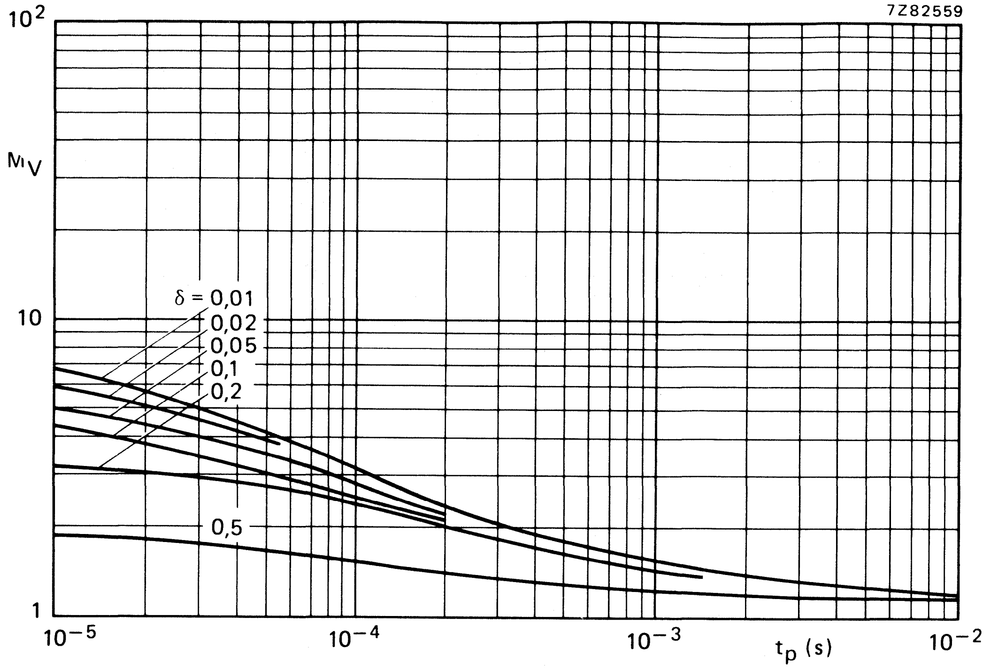


Fig. 6 Second-breakdown voltage multiplying factor at the $I_{C\,max}$ level.

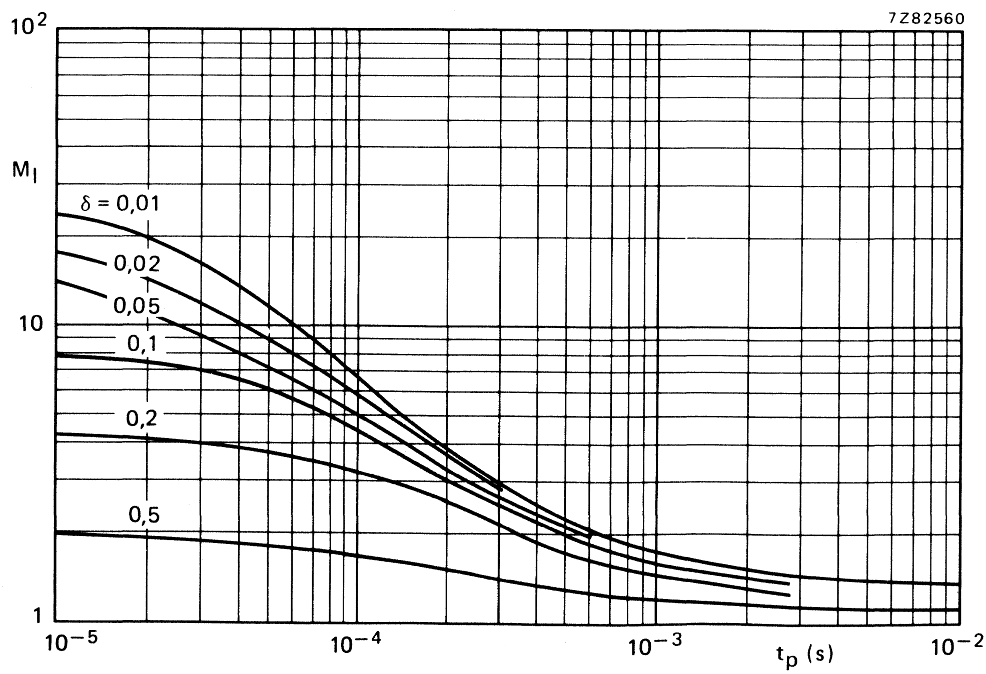


Fig. 7 Second-breakdown current multiplying factor at the $V_{CEO\,max}$ level.

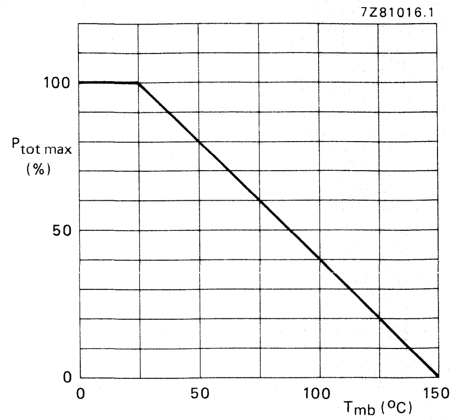


Fig. 8 Power derating curve.

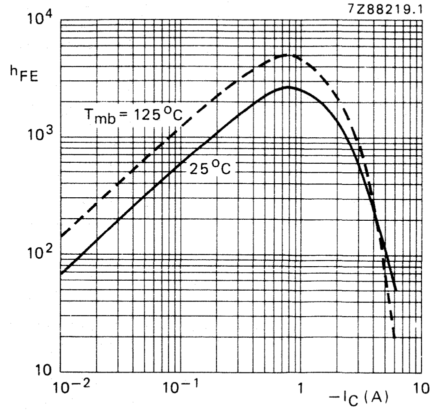


Fig. 9 Typical d.c. current gain. $-V_{CE}$ = 3 V.

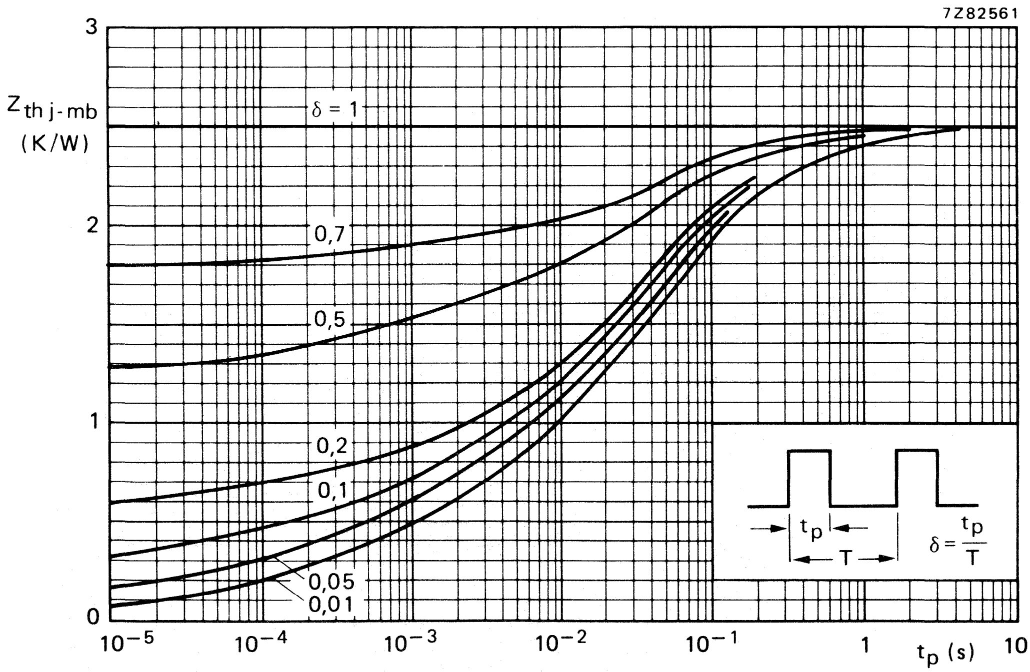


Fig. 10 Pulse power rating chart.

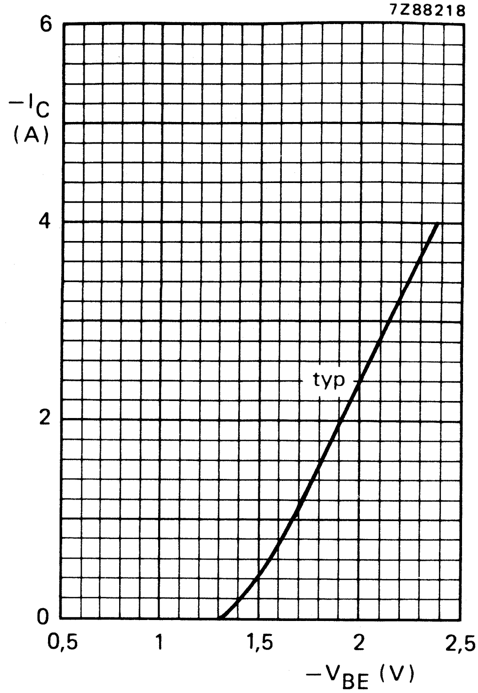


Fig. 11 $-V_{CE} = 3$ V; $T_j = 25$ °C.

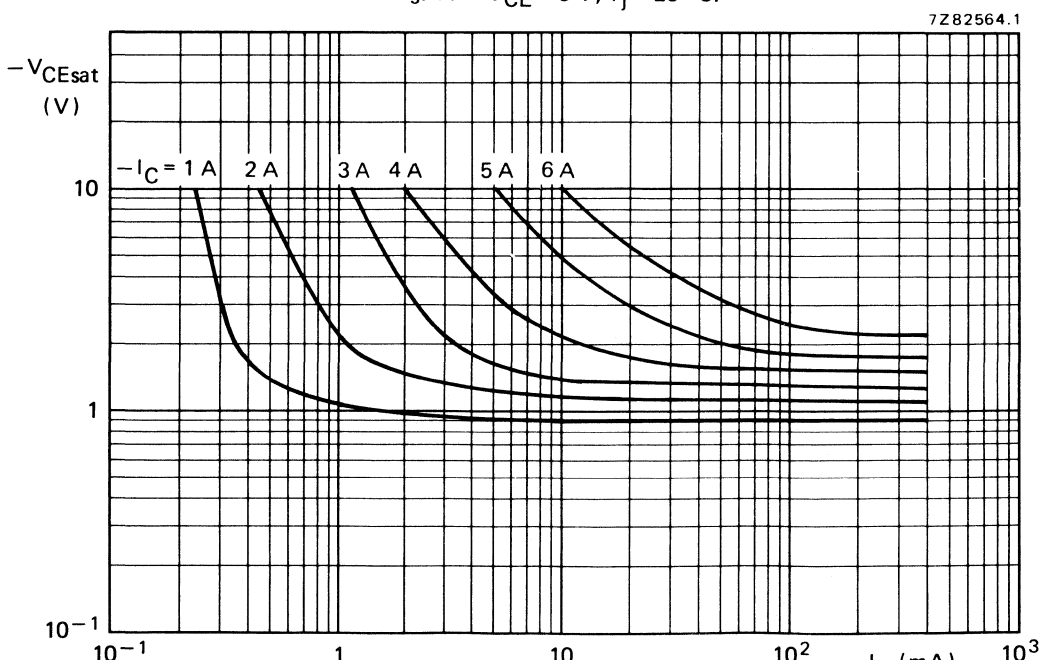


Fig. 12 Typical values collector-emitter saturation voltage at $T_{mb} = 25$ °C.

SILICON DARLINGTON POWER TRANSISTORS

PNP silicon power transistors in a monolithic Darlington circuit and housed in a SOT-186 envelope with an electrically insulated mounting base.

They are recommended for applications such as audio output stages and general purpose amplifiers.

NPN complements are BDT61F, BDT61AF, BDT61BF, and BDT61CF.

QUICK REFERENCE DATA

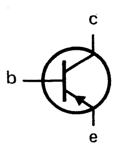
			BDT60F	60AF	60BF	60CF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current							
DC	$-I_C$	max.		4			A
peak value	$-I_{CM}$	max.		6			A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.		25			W
DC current gain							
$-I_C$ = 0.5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.		2000			

MECHANICAL DATA

Dimensions in mm

Pinning:

1 = base
2 = collector
3 = emitter



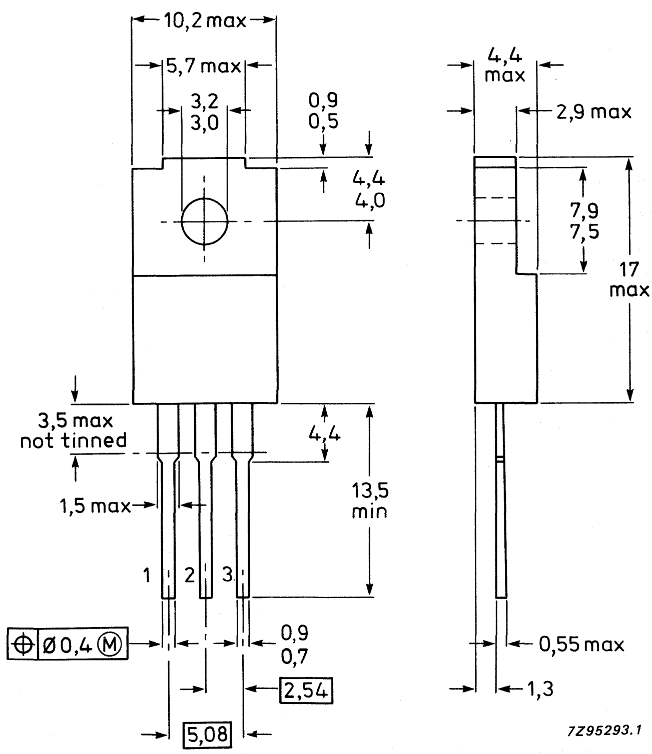
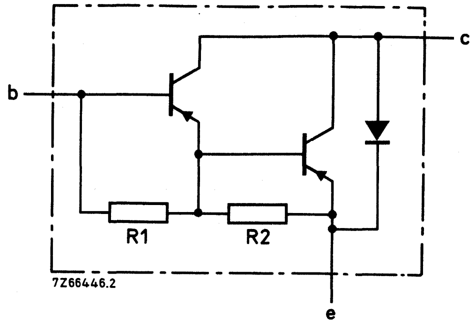


Fig. 1 SOT-186.



R1 typ. 6 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT60F	60AF	60BF	60CF	
Collector-base voltage (open collector)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5			V
Collector current DC	$-I_C$	max.		4			A
Collector current peak value	$-I_{CM}$	max.		6			A
Reverse diode current	I_R	max.		4			A
Base current (DC)	$-I_B$	max.		100			mA
Total power dissipation up to T_h = 25 °C*	P_{tot}	max.		17			W
Total power dissipation up to T_h = 25 °C**	P_{tot}	max.		25			W
Storage temperature range	T_{stg}			−65 to 150			°C
Junction temperature	T_j	max.		150			°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\,j\text{-}mb}$	=	2.7	K/W
From junction to external heatsink*	$R_{th\,j\text{-}h}$	=	5	K/W
From junction to external heatsink**	$R_{th\,j\text{-}h}$	=	7.35	K/W

* Mounted without heatsink compound and 30 ± 5 newtons pressure on centre envelope.
** Mounted with heatsink compound and 30 ± 5 newtons pressure on centre envelope.

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000 V
Isolation capacitor from collector to external heatsink	C_{th}	typ.	12 pF

CHARACTERISTICS

T_h = 25 °C unless otherwise specified

Collector cut-off currents			
$-I_E = 0; -V_{CB} = 30$ V	$-I_{CBO}$	max.	0.2 mA
$-I_E = 0; -V_{CB} = -½ V_{CBO\,max}; T_j = 150$ °C	$-I_{CBO}$	max.	1 mA
$-I_B = 0; -V_{CE} = -½ V_{CEO\,max}$	$-I_{CEO}$	max.	0.2 mA
Emitter cut-off current			
$-I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	max.	5 mA
Forward bias second breakdown collector current V_{CE} = 50 V			
t_p = 0.1 s; non-repetitive	$-I_{(SB)}$	min.	0.5 A
DC current gain*			
$-I_C = 0.5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2000
$-I_C = 1.5$ A; $-V_{CE} = 3$ V	h_{FE}	min.	750
$-I_C = 4$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	250
Base-emitter voltage*	$-V_{BE}$	max.	2.5 V
Collector-emitter saturation voltage*			
$-I_C = 1.5$ A; $-I_B = 6$ mA	$-V_{CEsat}$	max.	2.5 V
Cut-off frequency			
$-I_C = 1.5$ A; $-V_{CE} = 3$ V	f_{hfe}	min.	25 KHz
Small-signal current gain at f = 1 MHz			
$-I_C = 1.5$ A; $-V_{CE} = 3$ V	h_{fe}	min.	10
Diode forward voltage			
$I_F = 1.5$ A	V_F	max.	2 V
$I_F = 4$ A	V_F	typ.	2.1 V

* Measured under pulse conditions: t_p max. 300 μs; δ max. 2%.

CHARACTERISTICS (continued)

Switching times (see Fig. 3)

$-I_{C\,on} = 1.5$ A; $-I_{B\,on} = +I_{B\,off} = 6$ A

turn-on time	t_{on}	typ.	0.3 μs
		max.	1.5 μs
turn-off time	t_{off}	typ.	1.5 μs
		max.	5 μs

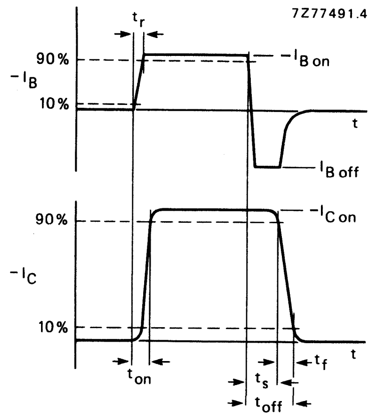
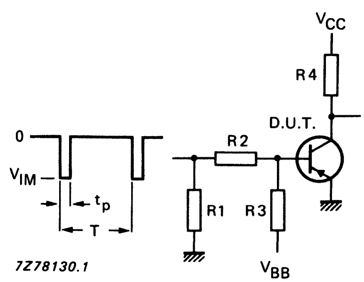


Fig. 3 Switching times waveforms.



$-V_{CC}$ = 30 V
$-V_{IM}$ = 12 V
$+V_{BB}$ = 3 V
R1 = 56 Ω
R2 = 1 kΩ
R3 = 680 Ω
R4 = 22 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.

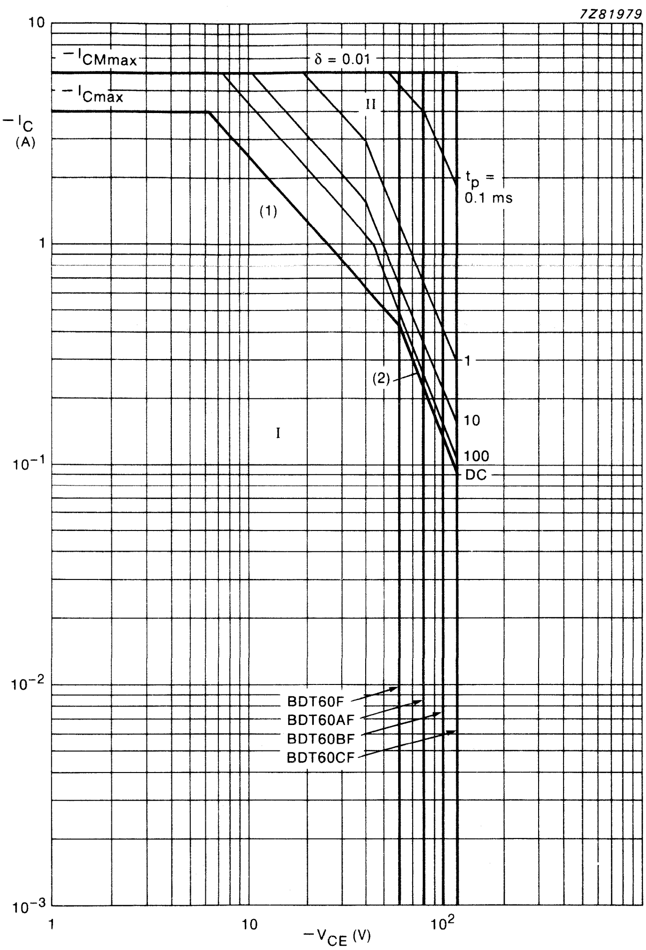


Fig. 5 Safe Operating ARea, $T_h = 25\ ^oC$.

I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

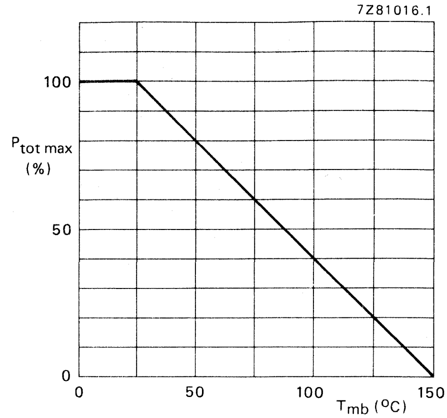


Fig. 6 Total power dissipation.

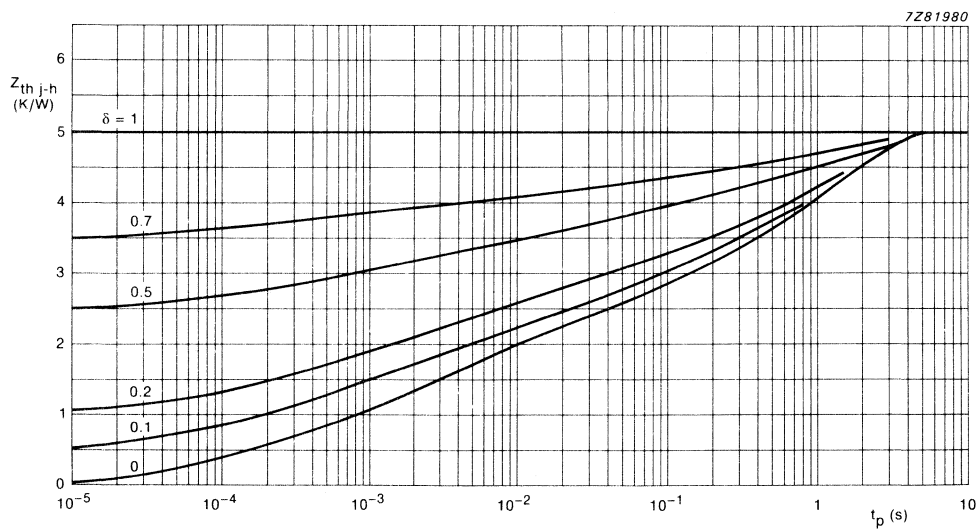


Fig. 7 Pulse power rating chart.

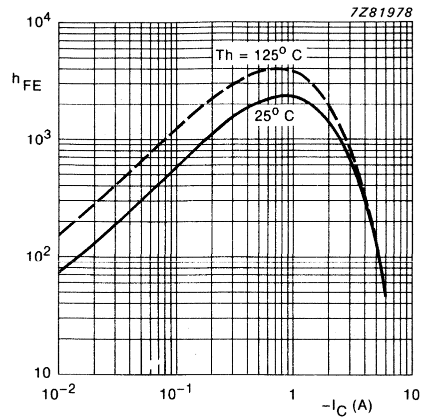


Fig. 8 DC current gain; $-V_{CE} = 3$ V; typical values.

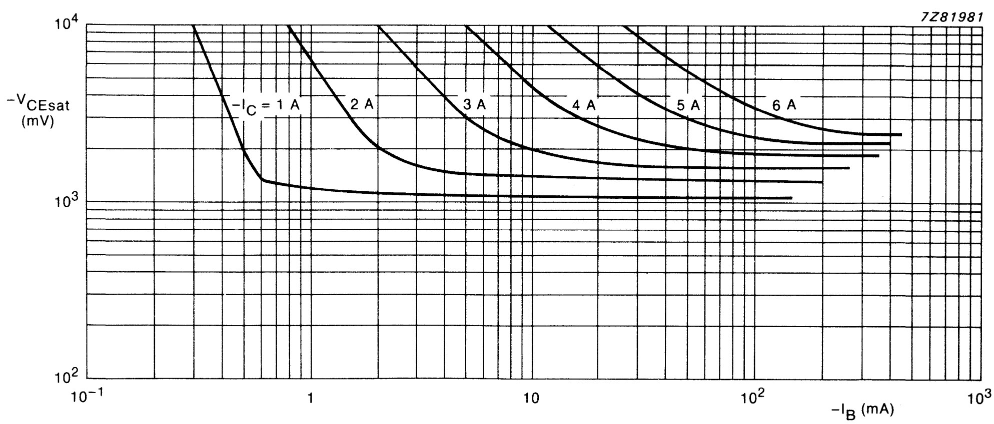


Fig. 9 Collector-emitter saturation voltage; $T_h = 25$ °C; typical values.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N silicon power transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier applications.

P-N-P complements are BDT60, 60A, 60B and 60C.

QUICK REFERENCE DATA

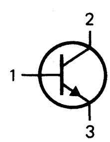
			BDT61	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (d.c.)	I_C	max.		4			A
Collector current (peak value)	I_{CM}	max.		6			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		50			W
Junction temperature	T_j	max.		150			°C
D.C. current gain I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.		1150			

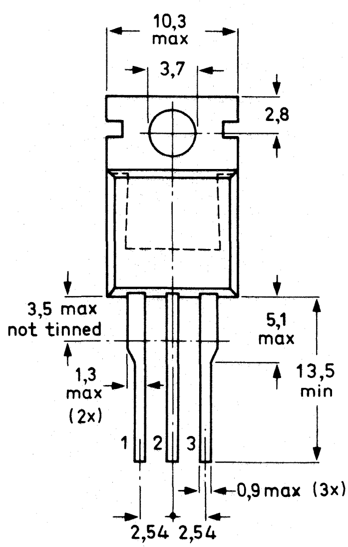
MECHANICAL DATA

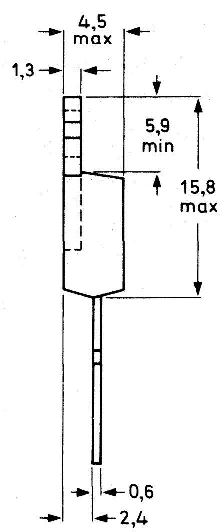
Dimensions in mm

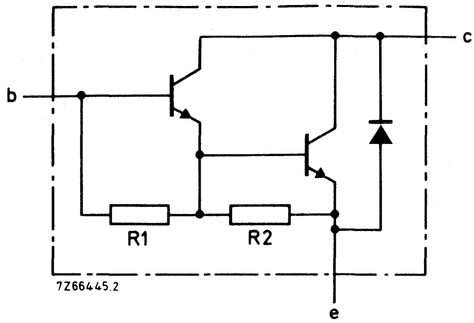
Fig. 1 TO-220AB.

Collector connected to mounting base.









R1 typ. 6 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT61	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	4	A
Collector current (peak value)	I_{CM}	max.	6	A
Reverse diode current	$I_R = -I_C$	max.	4	A
Base current (d.c.)	I_B	max.	100	mA
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	50	W
Storage temperature	T_{stg}		−65 to + 150	^oC
Junction temperature *	T_j	max.	150	^oC

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,5	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	≤	0,2 mA	
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 150 °C	I_{CBO}	≤	0,5 mA	←
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	≤	0,2 mA	←
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	≤	5 mA	
Forward-bias second-breakdown collector current				
V_{CE} = 50 V; t = 0,1 s; non-repetitive (without heatsink); T_{amb} = 25 °C	$I_{(SB)}$	≥	1 A	
D.C. current gain *				
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	1150	←
I_C = 1,5 A; V_{CE} = 3 V	h_{FE}	≥	750	
I_C = 4 A; V_{CE} = 3 V	h_{FE}	typ.	1000	←
Base-emitter voltage *				
I_C = 1,5 A; V_{CE} = 3 V	V_{BE}	≤	2,5 V	
Collector-emitter saturation voltage *				
I_C = 1,5 A; I_B = 6 mA	V_{CEsat}	≤	2,5 V	
Turn-off breakdown energy with inductive load (Fig. 3)				
$-I_{Boff} = 0$; L = 5 mH; I_{CC} = 3,2 A	$E_{(BR)}$	≥	25 mJ	
Small-signal current gain at f = 1 MHz				
I_C = 1,5 A; V_{CE} = 3 V	h_{fe}	≥	10	
Cut-off frequency				
I_C = 1,5 A; V_{CE} = 3 V	f_{hfe}	typ.	25 kHz	

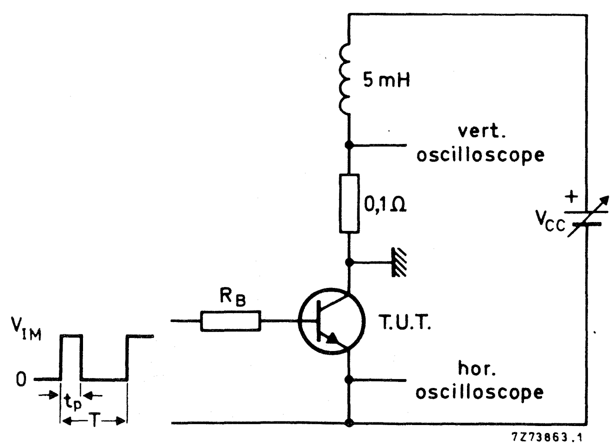


Fig. 3 Turn-off breakdown energy with inductive load.

V_{IM} = 12 V; R_B = 270 Ω; $\delta = \frac{t_p}{T} \times 100\% = 1\%$; I_{CC} = 3,2 A.

* Measured under pulse conditions; $t_p < 300\ \mu s$; $\delta < 2\%$.

CHARACTERISTICS (continued)

Diode, forward voltage			
I_F = 1,5 A	V_F	<	2 V
I_F = 4 A	V_F	typ.	2,1 V
Switching times (between 10% and 90% levels) I_{Con} = 1,5 A; $I_{Bon} = -I_{Boff}$ = 6 mA			
turn-on time	t_{on}	typ.	0,8 μs
		<	2 μs
turn-off time	t_{off}	typ.	4,5 μs
		<	8 μs

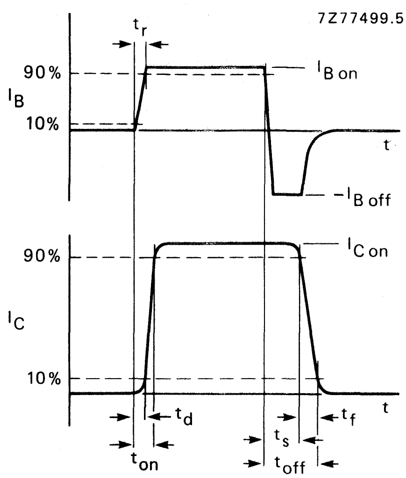
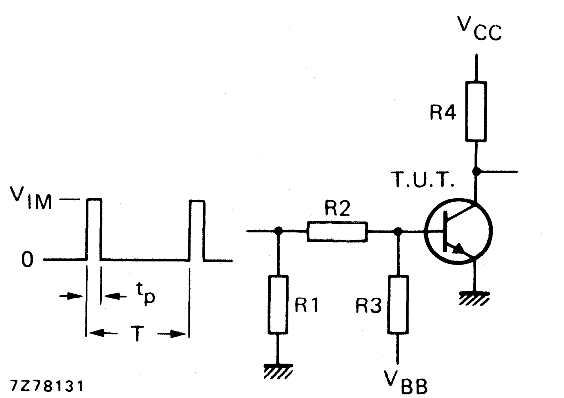


Fig. 4 Switching times waveforms.



V_{IM} = 12 V
V_{CC} = 30 V
$-V_{BB}$ = 3 V
R1 = 56 Ω
R2 = 1 kΩ
R3 = 680 Ω
R4 = 22 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 5 Switching times test circuit.

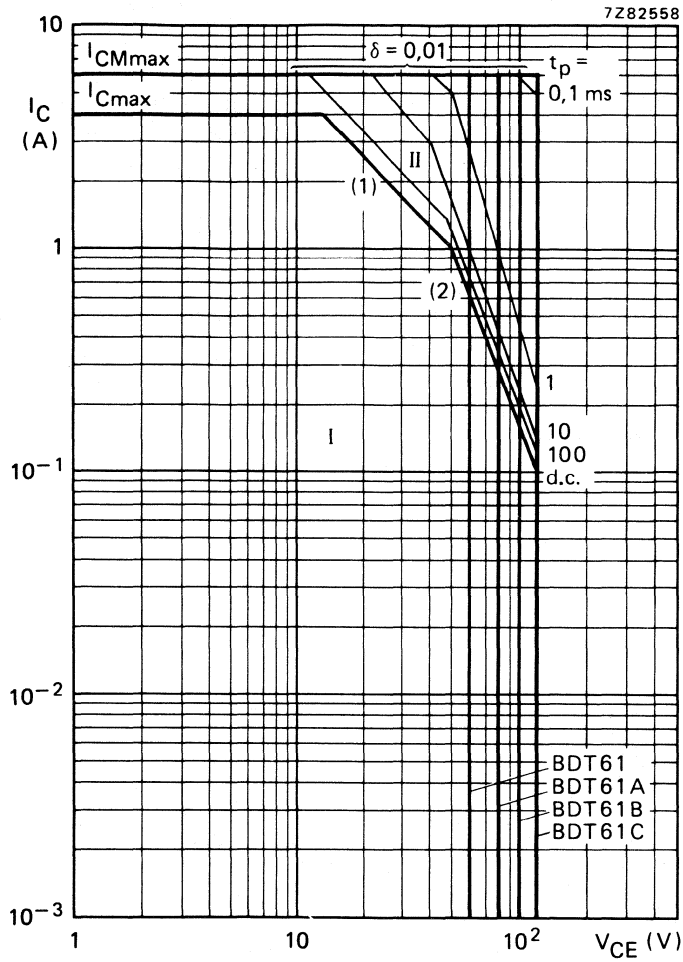


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

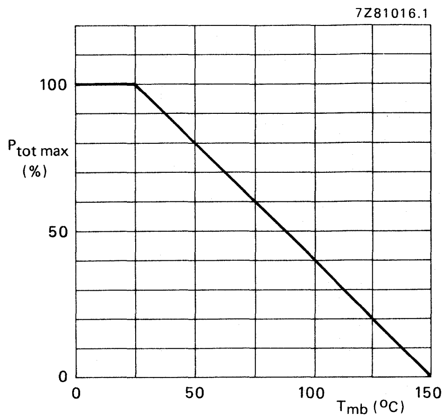


Fig. 7 Power derating curve.

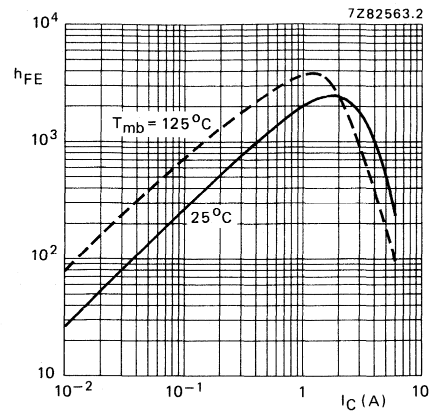


Fig. 8 Typical d.c. current gain. V_{CE} = 3 V.

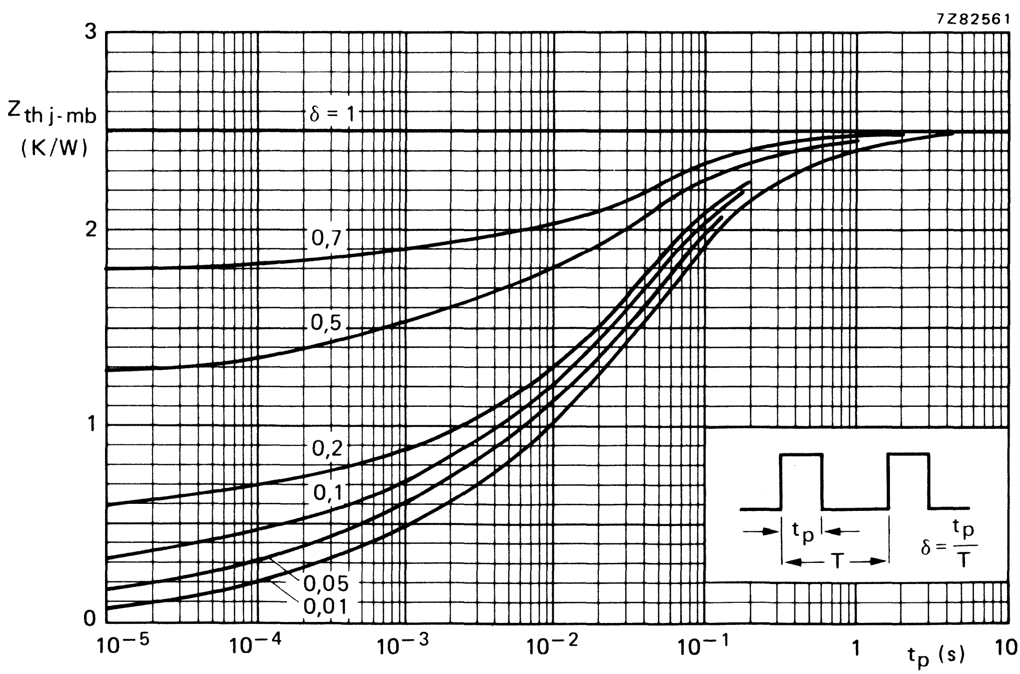


Fig. 9 Pulse power rating chart.

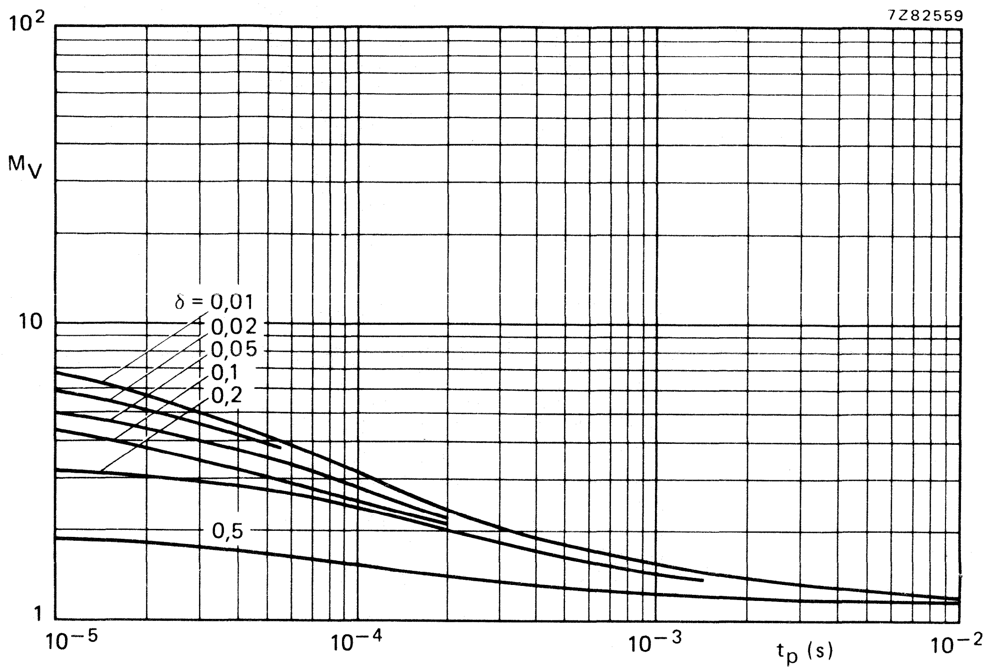


Fig. 10 Second breakdown voltage multiplying factor at the I_{Cmax} level.

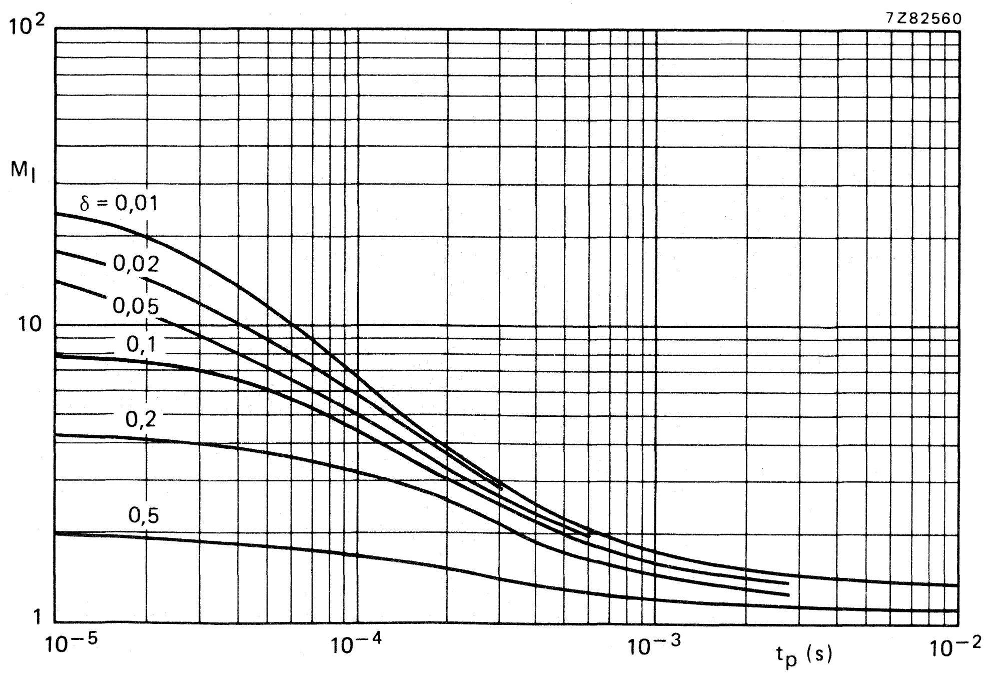


Fig. 11 Second breakdown current multiplying factor at the V_{CEOmax} level.

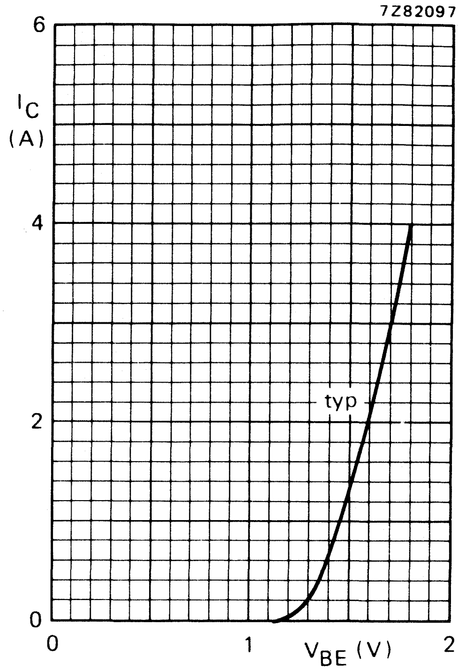


Fig. 12 V_{CE} = 3 V; T_j = 25 °C.

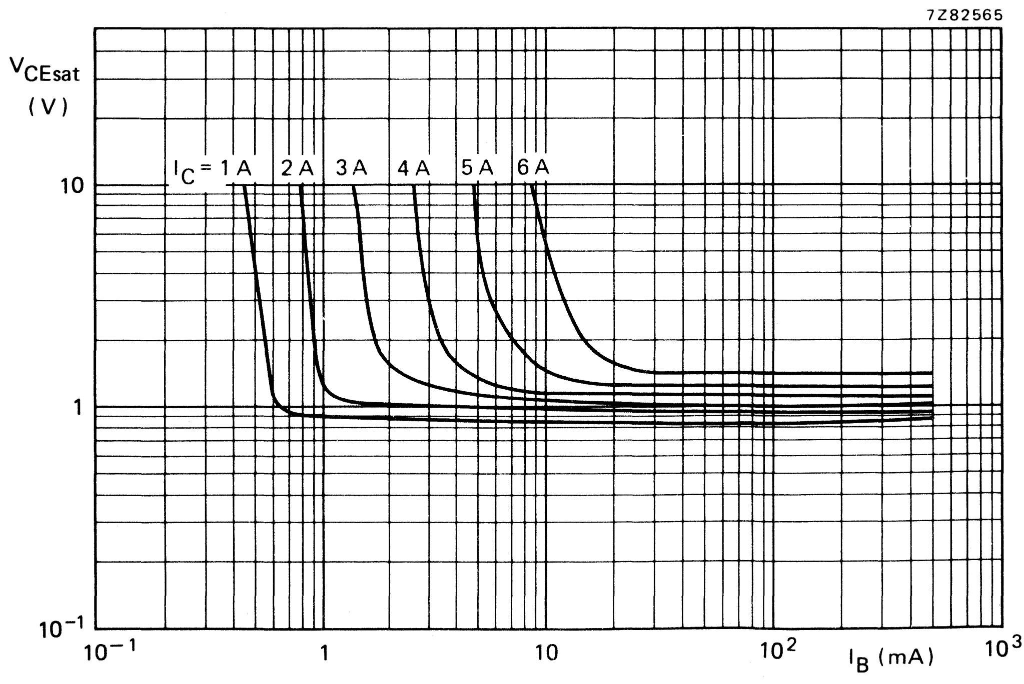


Fig. 13 Typical values collector-emitter saturation voltage at T_{mb} = 25 °C.

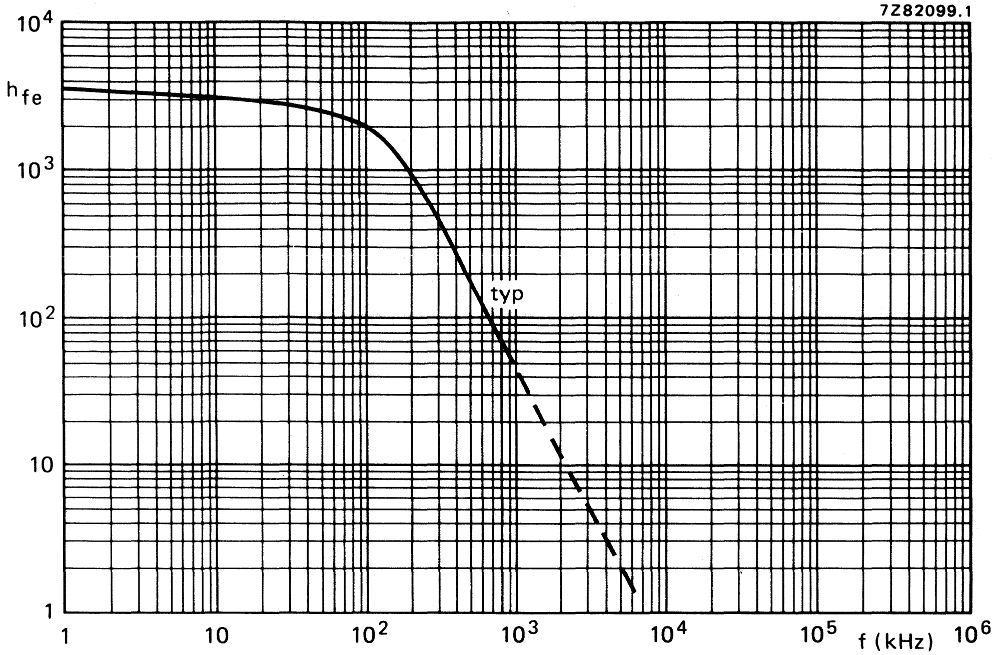


Fig. 14 Small signal current gain. I_C = 1,5 A; V_{CE} = 3 V; T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

NPN silicon power transistors in a monolithic Darlington circuit and housed in a SOT186 envelope with an electrically insulated mounting base.

They are recommended for applications such as audio output stages and general purpose amplifiers.

PNP complements are BDT60F, BDT60AF, BDT60BF, and BDT60CF.

QUICK REFERENCE DATA

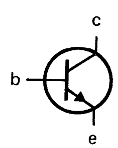
			BDT61F	61AF	61BF	61CF	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current							
DC	I_C	max.		4			A
peak value	I_{CM}			6			A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.		25			W
DC current gain							
I_C = 0.5 A; V_{CE} = 3 V	h_{FE}	typ.		2000			

MECHANICAL DATA

Dimensions in mm

Pinning

1 = base
2 = collector
3 = emitter



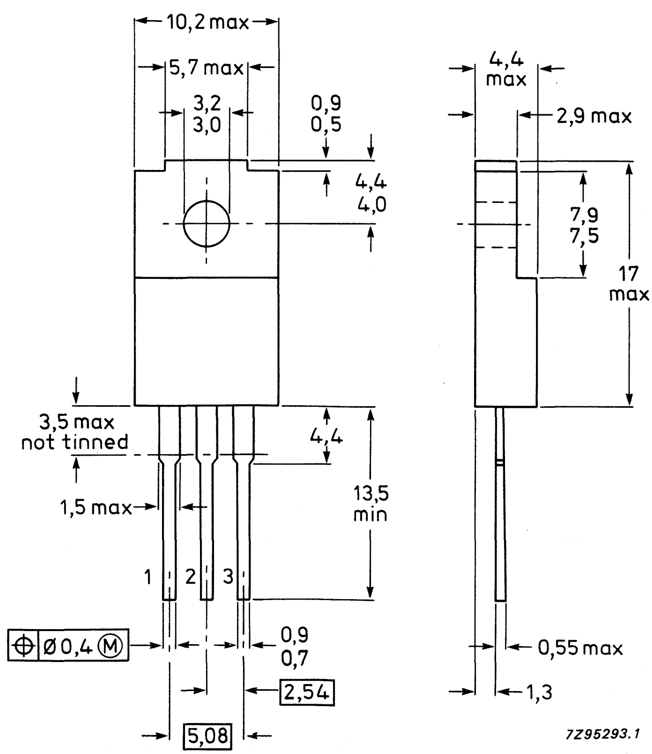
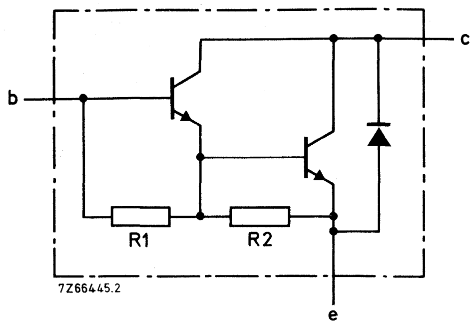


Fig. 1 SOT186.



R1 typ. 3500 Ω
R2 typ. 150 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT61F	61AF	61BF	61CF	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5			V
Collector current DC	I_C	max.		4			A
peak value	I_{CM}	max.		6			A
Reverse diode current	I_R	max.		4			A
Base current (DC)	I_B	max.		100			mA
Total power dissipation up to T_h = 25 °C*	P_{tot}	max.		17			W
up to T_h = 25 °C**	P_{tot}	max.		25			W
Storage temperature range	T_{stg}			−65 to 150			°C
Junction temperature	T_j	max.		150			°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	2.7	K/W
From junction to external heatsink**	$R_{th\ j\text{-}h}$	=	5	K/W
From junction to external heatsink*	$R_{th\ j\text{-}h}$	=	7.35	K/W

* Mounted without heatsink compound and 30 ± 5 newton pressure on centre of envelope.
** Mounted with heatsink compound and 30 ± 5 newton pressure on centre of envelope.

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000 V
Isolation capacitor from collector to external heatsink	C_{th}	typ.	12 pF

CHARACTERISTICS

$T_h = 25\ ^oC$ unless otherwise specified

Collector cut-off currents			
$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	max.	0.2 mA
$I_E = 0$; $T_j = 150\ ^oC$ $V_{CB} = ½\ V_{CBO\,max}$	I_{CBO}	max.	1 mA
$I_B = 0$ $V_{CE} = ½\ V_{CEO\,max}$	I_{CEO}	max.	0.2 mA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	5 mA
Forward bias second breakdown collector current $V_{CE} = 50$ V $t_p = 0.1$ s; non-repetitive	$I_{(SB)}$	min.	0.5 A
DC current gain*			
$I_C = 0.5$ A; $V_{CE} = 3$ V	h_{FE}	typ.	2000
$I_C = 1.5$ A; $V_{CE} = 3$ V	h_{FE}	min.	750
$I_C = 4$ A; $V_{CE} = 3$ V	h_{FE}	typ.	1000
Base-emitter voltage*	V_{BE}	max.	2.5 V
Collector-emitter saturation voltage*			
$I_C = 1.5$ A; $I_B = 6$ mA	V_{CEsat}	max.	2.5 V
Cut-off frequency			
$I_C = 1.5$ A; $V_{CE} = 3$ V	f_{hfe}	min.	25 KHz
Small-signal current gain at f = 1 MHz			
$I_C = 1.5$ A; $V_{CE} = 3$ V	h_{fe}	min.	10
Diode forward voltage			
$I_F = 1.5$ A	V_F	max.	2 V
$I_F = 4$ A	V_F	typ.	2.1 V

* Measured under pulse conditions: t_p max. 300 μs; δ max. 2%.

CHARACTERISTICS (continued)

Switching times (see Fig. 3)

$I_{C\,on} = 1.5$ A; $I_{B\,on} = -I_{B\,off} = 6$ mA

turn-on time	t_{on}	typ.	0.8 μs
		max.	2 μs
turn-off time	t_{off}	typ.	4.5 μs
		max.	8 μs

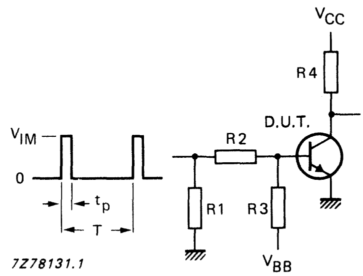
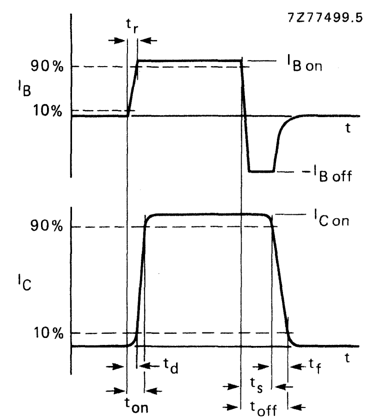
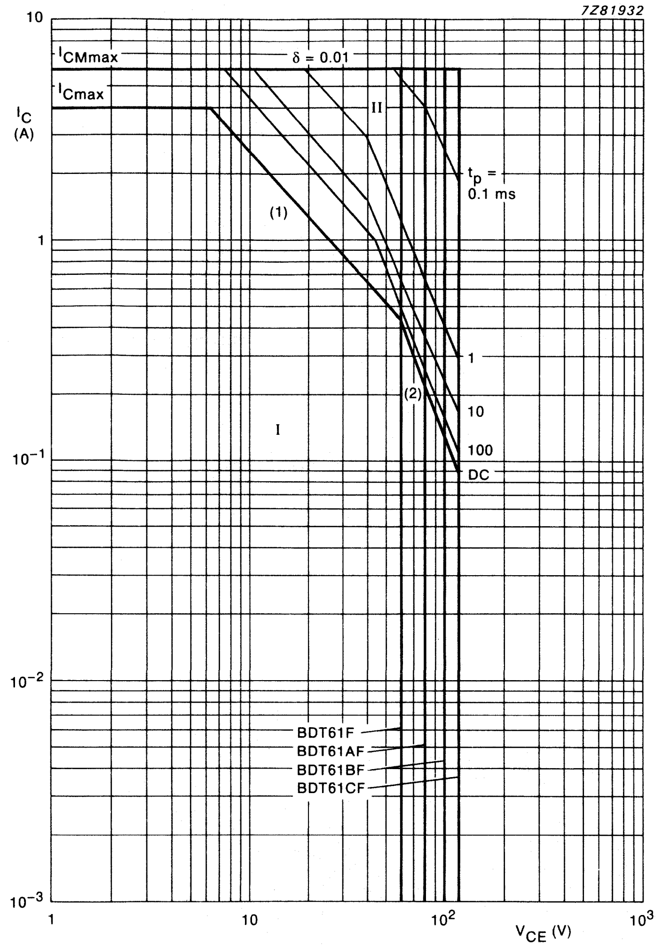


Fig. 3 Switching times waveforms.



V_{CC} = 30 V
V_{IM} = 12 V
$-V_{BB}$ = 3 V
R1 = 56 Ω
R2 = 1 kΩ
R3 = 680 Ω
R4 = 22 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.



I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

Fig. 5 Safe Operating ARea, T_h = 25 °C.

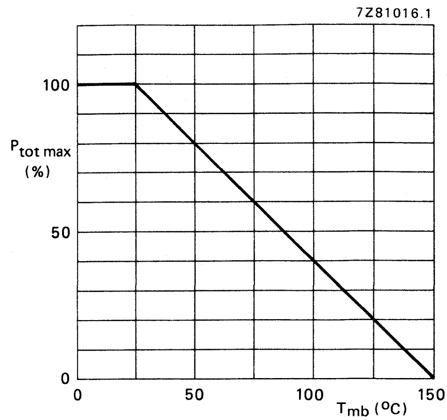


Fig. 6 Total power dissipation.

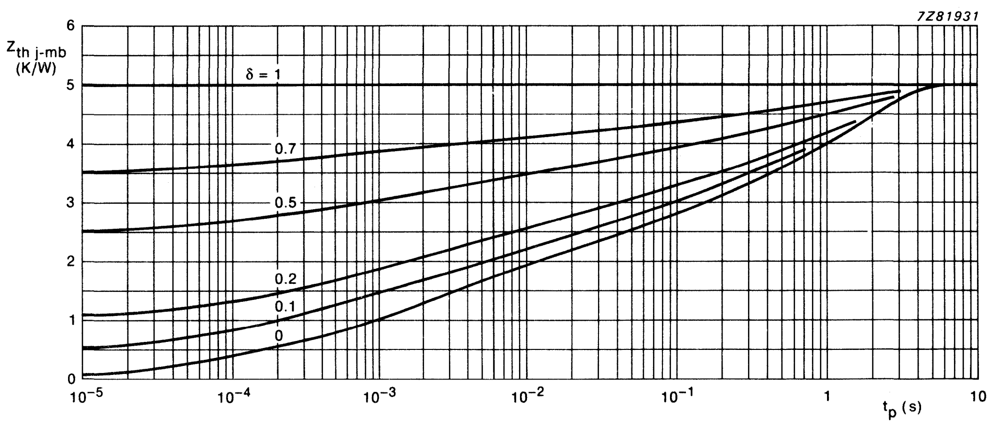


Fig. 7 Pulse power rating chart.

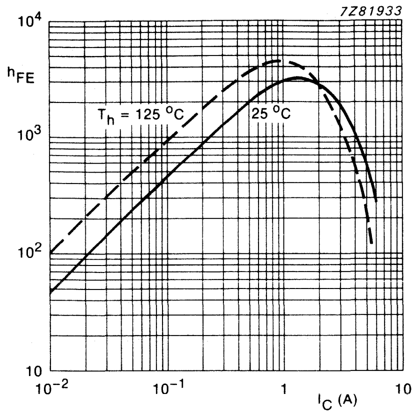


Fig. 8 DC current gain; V_{CE} = 3 V; typical values.

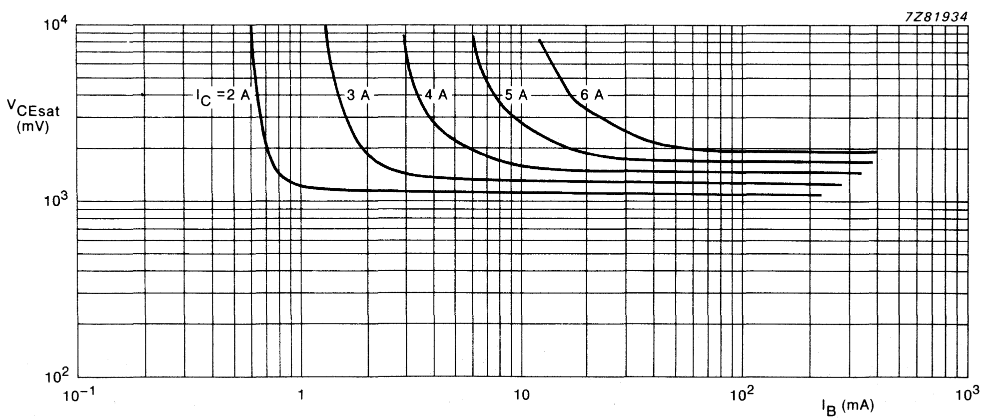


Fig. 9 Collector-emitter saturation voltage; T_h = 25 °C; typical values.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. TO-220 plastic envelope. N-P-N complements are BDT63, BDT63A, BDT63B and BDT63C.

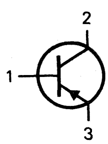
QUICK REFERENCE DATA

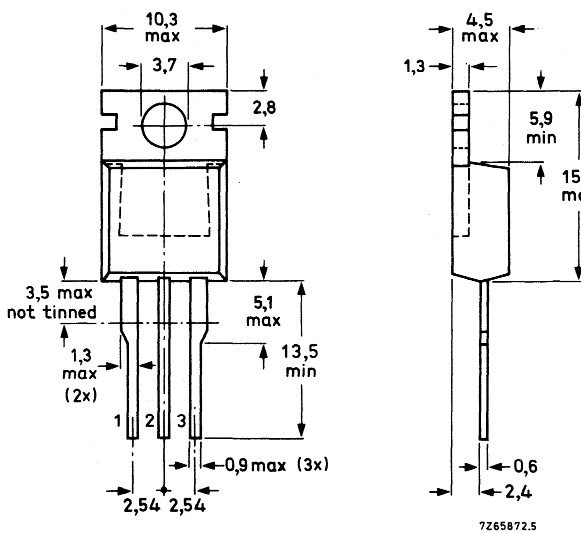
			BDT62	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (d.c.)	$-I_C$	max.	10				A
Collector current (peak value) t_p = 0,3 ms; δ = 10%	$-I_{CM}$	max.	15				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	90				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 3 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000				

MECHANICAL DATA

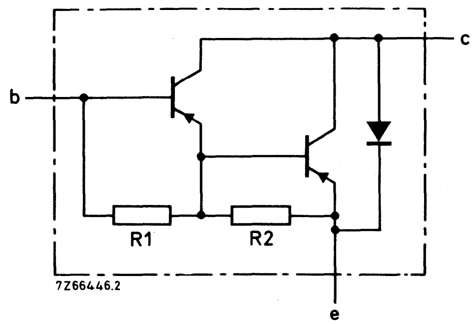
Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.



R1 typ. 4 kΩ
R2 typ. 60 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT62	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
Collector current (d.c.)	$-I_C$	max.	10				A
Collector current (peak value) t_p = 0,3 ms; δ = 10%	$-I_{CM}$	max.	15				A
Base current (d.c.)	$-I_B$	max.	250				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	90				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature*	T_j	max.	150				°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,39	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

* Base on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2	mA
$I_E = 0$; $-V_{CB} = -½V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<	2	mA
$I_B = 0$; $-V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	<	0,2	mA ←
Emitter cut-off current				
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	5	mA
Forward bias second-breakdown collector current				
$-V_{CE}$ = 40 V; t = 0,1 s; non-repetitive (without heatsink)				
BDT62	$I_{(SB)}$	>	0,45	A
BDT62A, B and C	$I_{(SB)}$	>	1,4	A
D.C. current gain*				
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000	
$-I_C$ = 10 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	200	
Base-emitter voltage*				
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	$-V_{BE}$	<	2,5	V
Collector-emitter saturation voltage*				
$-I_C$ = 3 A; $-I_B$ = 12 mA	$-V_{CEsat}$	<	2	V
$-I_C$ = 8 A; $-I_B$ = 80 mA	$-V_{CEsat}$	<	2,5	V
Cut-off frequency				
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	100	kHz
Collector capacitance				
$-V_{CB}$ = 10 V; f = 1 MHz	C_{ob}	typ.	100	pF
D.C. current gain ratio of matched complementary pairs				
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	h_{FE1}/h_{FE2}	<	2,5	
Small-signal current gain at f = 1 MHz				
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	h_{fe}	>	10	

* Measured under pulse conditions; $t_p < 300$ µs; $\delta < 2\%$.

CHARACTERISTICS (continued)

Diode, forward voltage			
$I_F = 3$ A	V_F	<	2 V
Switching times			
(between 10% and 90% levels)			
$-I_{Con} = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA			
turn-on time	t_{on}	typ.	0,5 μs
		<	1,5 μs
turn-off time	t_{off}	typ.	2,5 μs
		<	5 μs

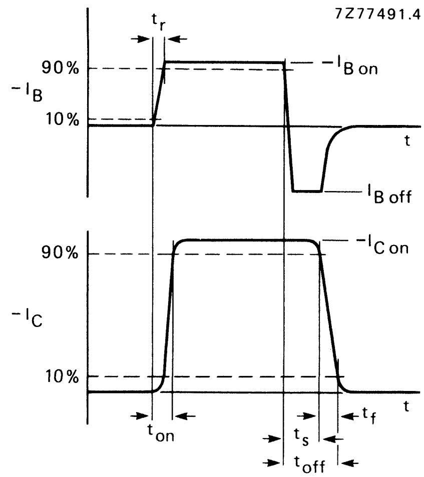
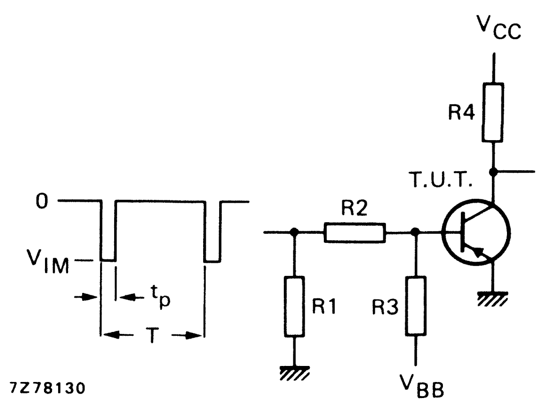


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	10 V
$-V_{CC}$	=	10 V
$+V_{BB}$	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

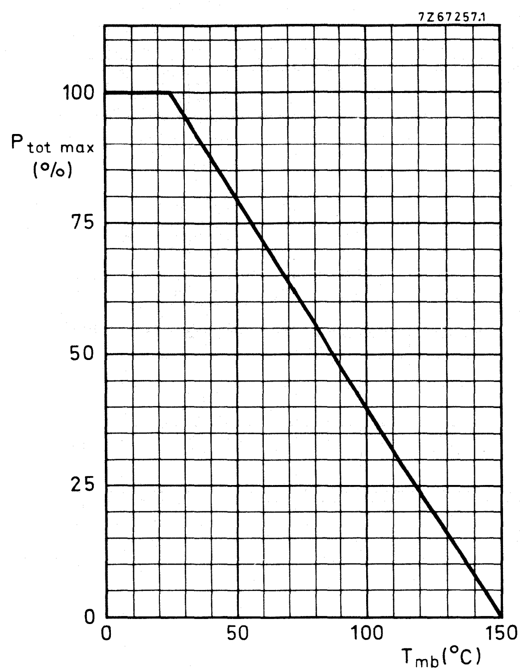


Fig. 5 Power derating curve.

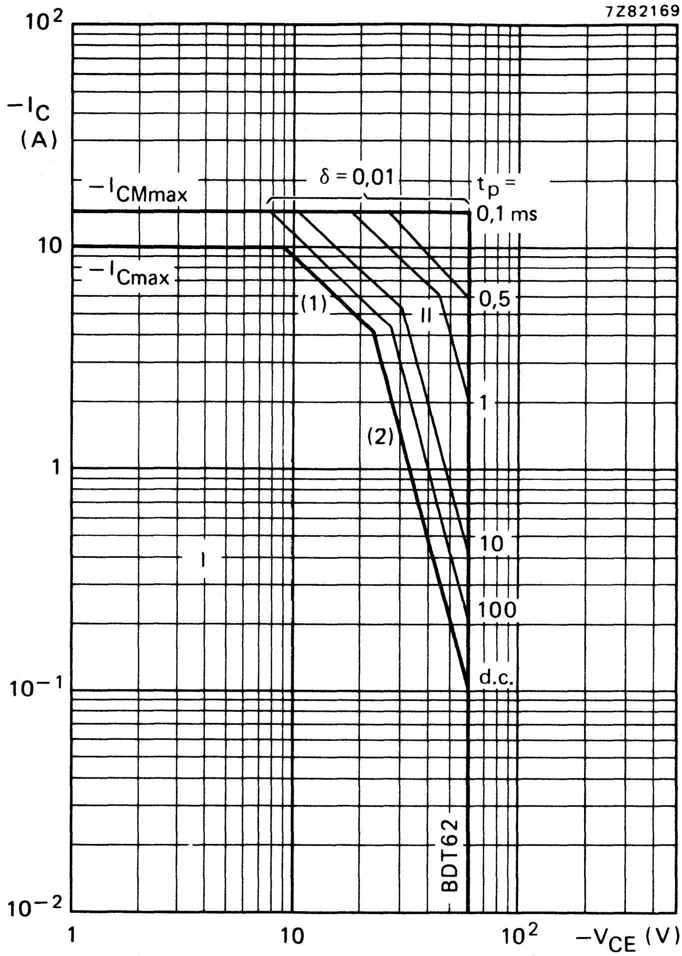


Fig. 6 Safe Operating ARea BDT62; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

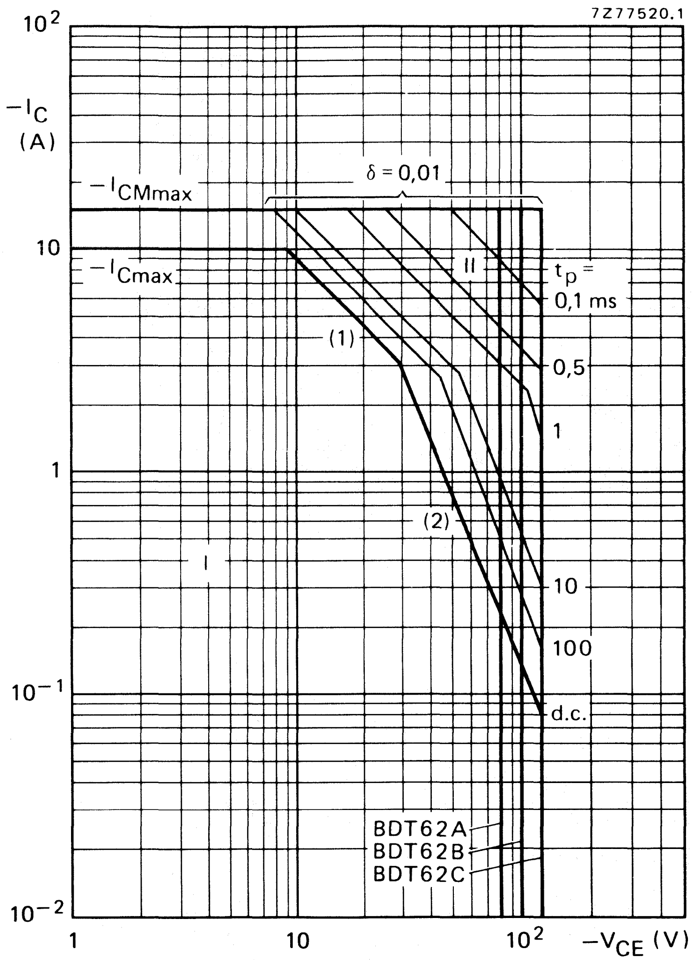


Fig. 7 Safe Operating ARea BDT62A; 62B and 62C; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

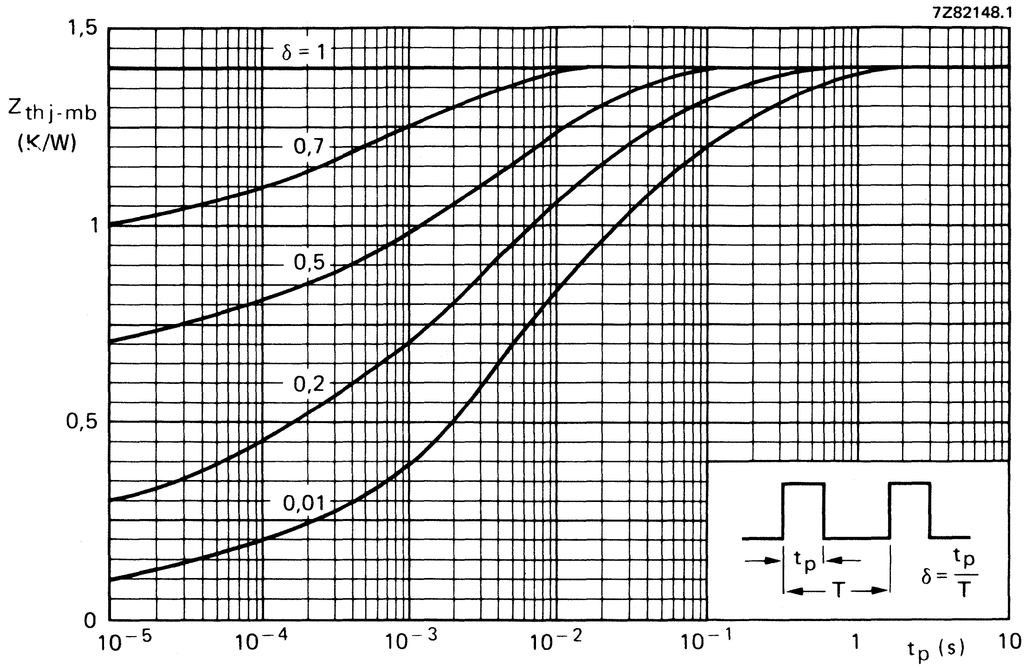


Fig. 8 Pulse power rating chart.

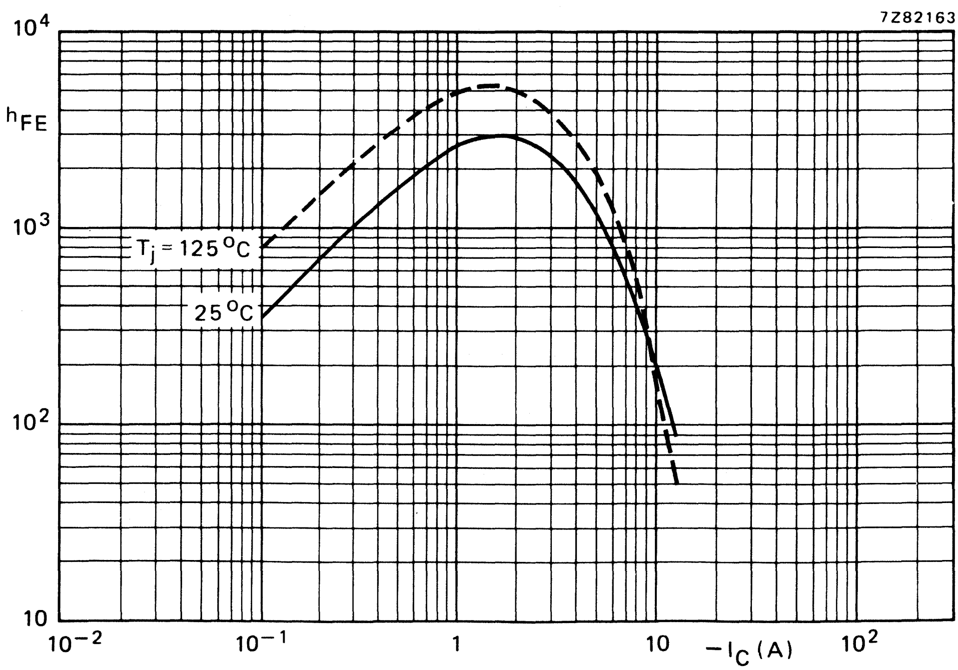


Fig. 9 Typical d.c. current gain at $-V_{CE} = 3$ V.

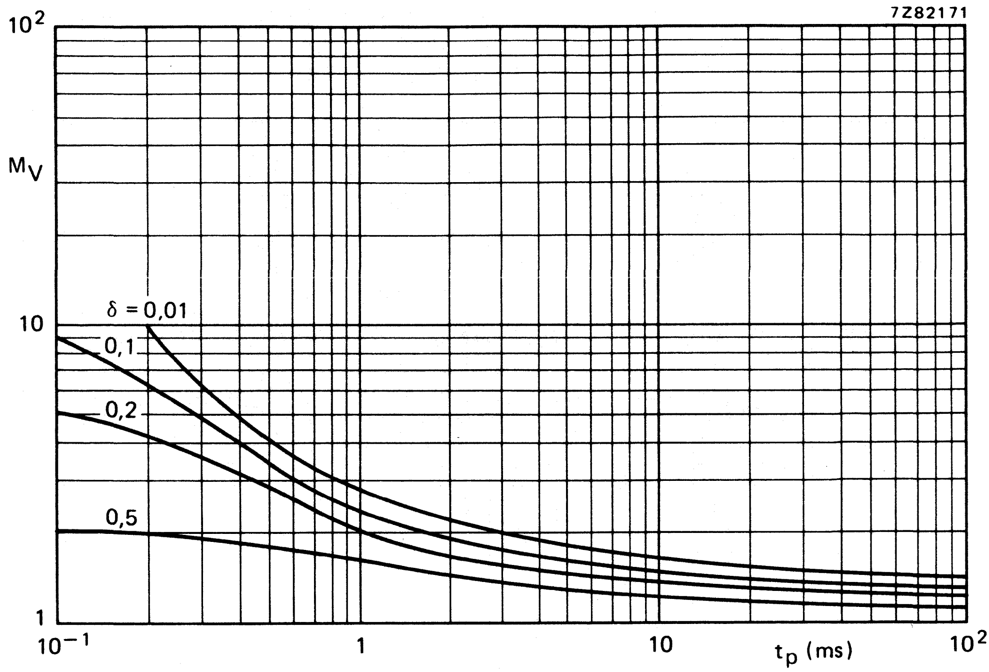


Fig. 10 S.B. voltage multiplying factor at the $I_{C\,max}$ level.

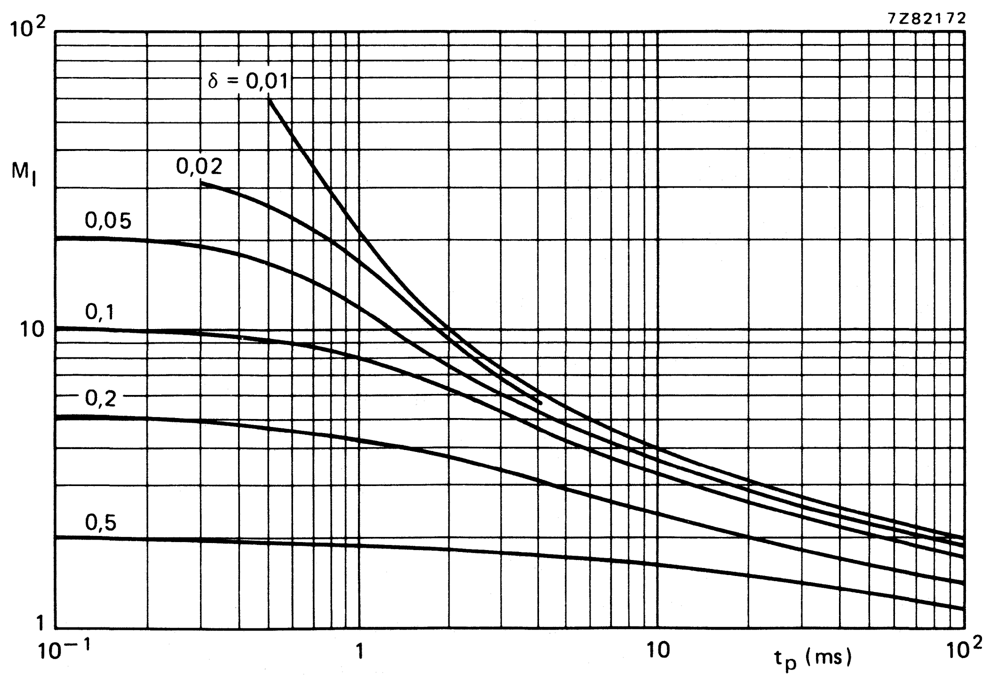


Fig. 11 S.B. current multiplying factor at the $V_{CEO\,max}$ level.

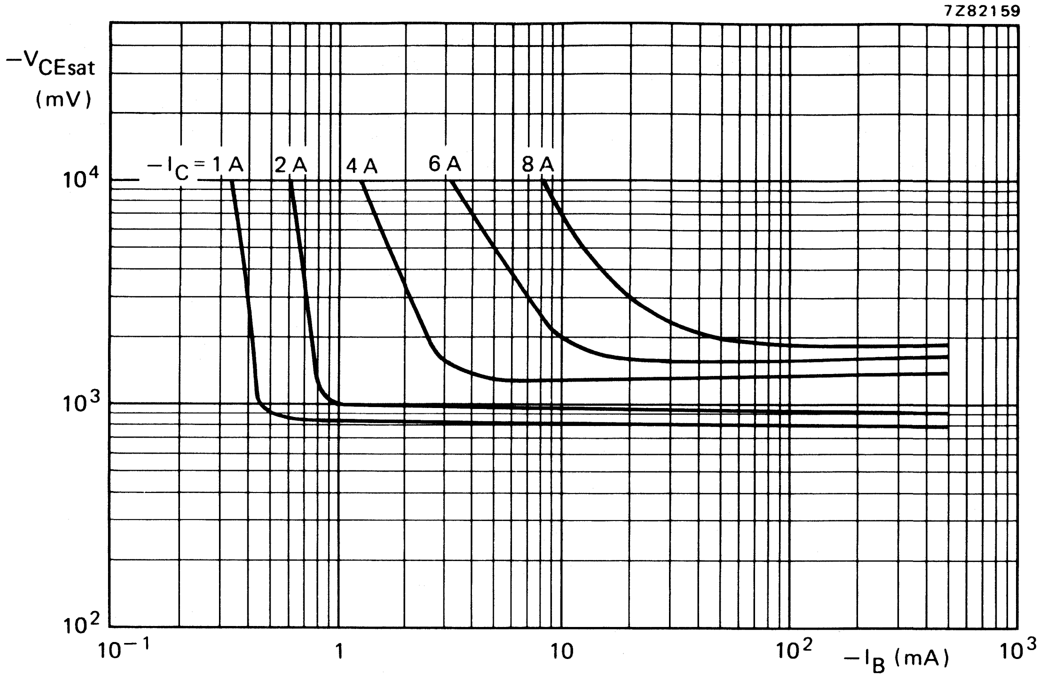


Fig. 12 Typical collector-emitter saturation voltage.

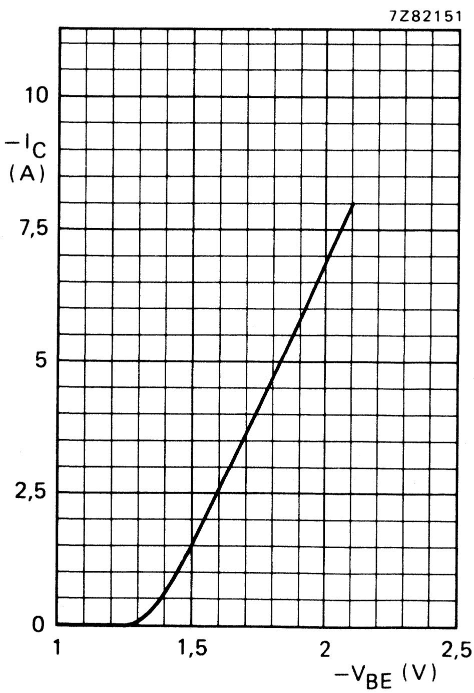


Fig. 13 Typical base emitter voltage as a function of the collector current.

SILICON DARLINGTON POWER TRANSISTORS

PNP silicon darlington power transistors in a SOT-186 envelope with an electrically insulated mounting base. The devices are designed for audio output stages and general amplifier and switching applications. NPN complements are BDT63F, BDT63AF, BDT63BF and BDT63CF.

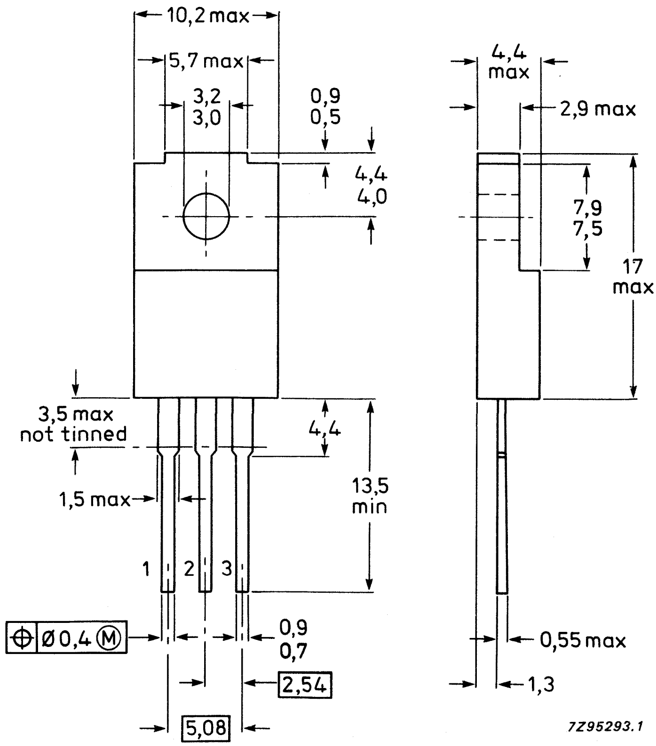
QUICK REFERENCE DATA

			BDT62F	62AF	62BF	62CF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current DC	$-I_C$	max.		10			A
Total power dissipation up to $T_h = 25\ ^oC$	P_{tot}	max.		36			W
Junction temperature	T_j	max.		150			^oC
DC current gain $-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	min.		1000			

MECHANICAL DATA

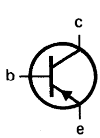
Dimensions in mm

Fig. 1 SOT-186.



Pinning:

1 = Base
2 = Collector
3 = Emitter



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT62F	62AF	62BF	62CF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5.0				V
Collector current							
DC	$-I_C$	max.	10				A
peak value	$-I_{CM}$	max.	15				A
Base current (DC)	$-I_B$	max.	250				mA
Total power dissipation							
up to T_h = 25 °C (1)	P_{tot}	max.	21				W
up to T_h = 25 °C (2)	P_{tot}	max.	36				W
Storage temperature	T_{stg}		−65 to 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

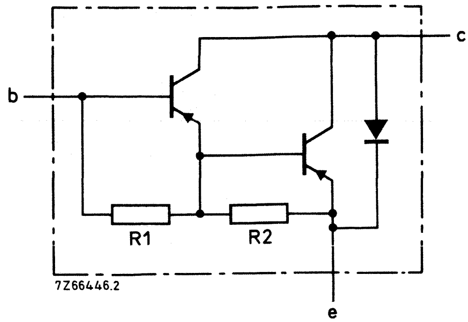
From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.17	K/W
From junction to external heatsink (1)	$R_{th\ j\text{-}h}$	=	5.95	K/W
From junction to external heatsink (2)	$R_{th\ j\text{-}h}$	=	3.47	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V
Insulation capacitance from collector to external heatsink	C_{th}	typ.	12	pF

(1) Mounted without heatsink compound and 30 ± 5 newton pressure on centre of envelope.

(2) Mounted with heatsink compound and 30 ± 5 newton pressure on centre of envelope.



R1 typ. 4 kΩ
R2 typ. 60 Ω

Fig. 2 Circuit diagram.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	max.	0.2	mA
$I_E = 0; T_j = 150$ °C; $-V_{CB} = -1/2\ V_{CBOmax}$	$-I_{CBO}$	max.	2.0	mA
$I_B = 0; -V_{CE} = -1/2\ V_{CEOmax}$	$-I_{CEO}$	max.	0.5	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	max.	5.0	mA
Forward bias second-breakdown collector current				
$-V_{CE} = 40$ V; t = 0.1 s; non-repetitive (without heatsink)	$I_{(SB)}$	min.	0.9	A
DC current gain (3)				
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	min.	1000	
$-I_C = 10$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	150	
Base-emitter voltage (3)				
$-I_C = 3$ A; $-V_{CE} = 3$ V	$-V_{BE}$	max.	2.5	V
Collector-emitter saturation voltage (3)				
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	max.	2.0	V
$-I_C = 8$ A; $-I_B = 80$ mA	$-V_{CEsat}$	max.	2.5	V
Cut-off frequency				
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100	kHz
Collector capacitance				
$-V_{CB} = 10$ V; f = 1 MHz	C_c	typ.	100	pF
Small-signal current gain at f = 1 MHz				
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{fe}	min.	10	
Diode, forward voltage				
$I_F = 3$ A	V_F	max.	2.0	V

(3) Measured under pulse conditions; $t_p < 300\ \mu s$; $\delta < 2\%$.

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)
$-I_{Con} = 3$ A;
$-I_{Bon} = I_{Boff} = 12$ mA

Turn-on time	t_{on}	typ.	0.5	μs
		max.	1.5	μs
Turn-off time	t_{off}	typ.	2.5	μs
		max.	5.0	μs

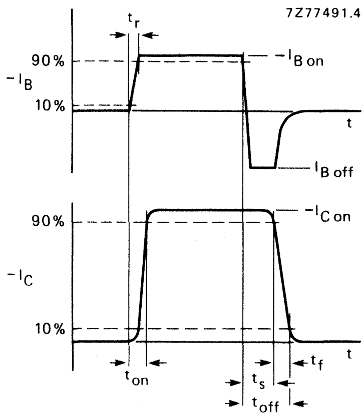
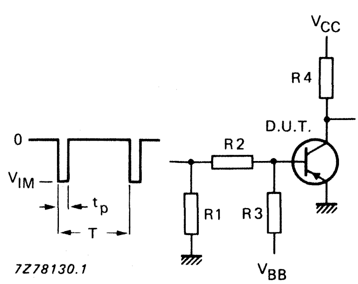


Fig. 3 Switching times waveforms.



$-V_{IM}$	= 10 V
$-V_{CC}$	= 10 V
$+V_{BB}$	= 4.0 V
R1	= 56 Ω
R2	= 410 Ω
R3	= 560 Ω
R4	= 3.0 Ω
$t_r = t_f$	= 15 ns
t_p	= 10 μs
T	= 500 μs

Fig. 4 Switching times test circuit.

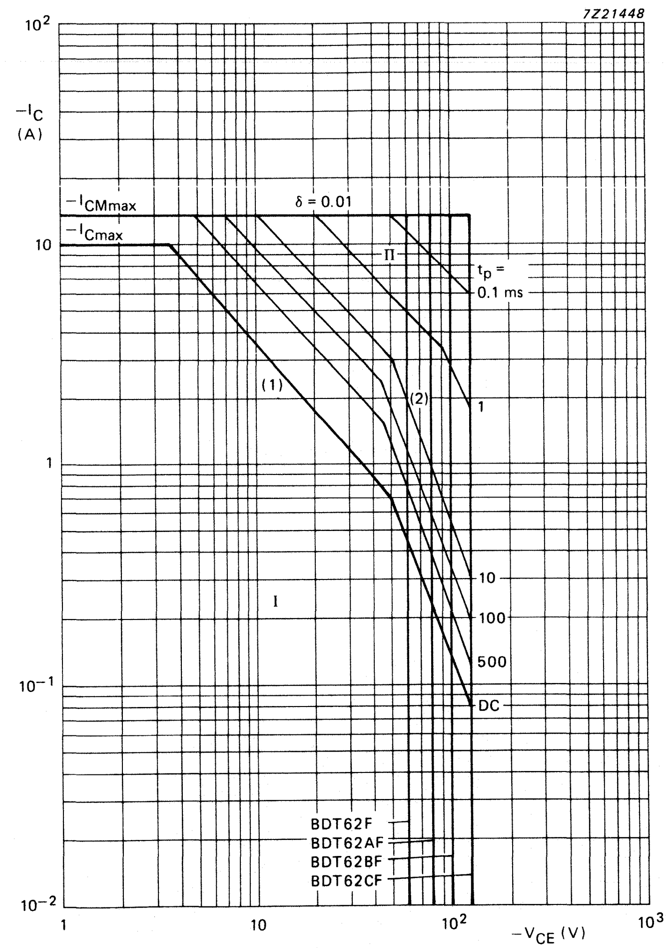


Fig. 5 Safe Operating Area; T_h = 25 °C.

I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

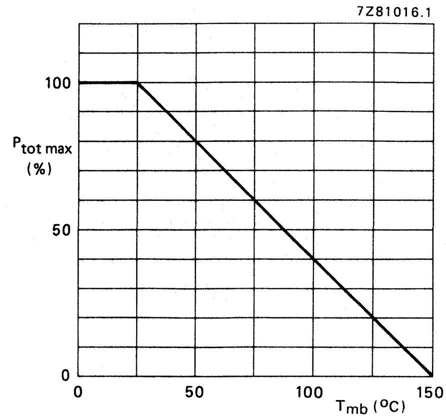


Fig. 6 Power derating curve.

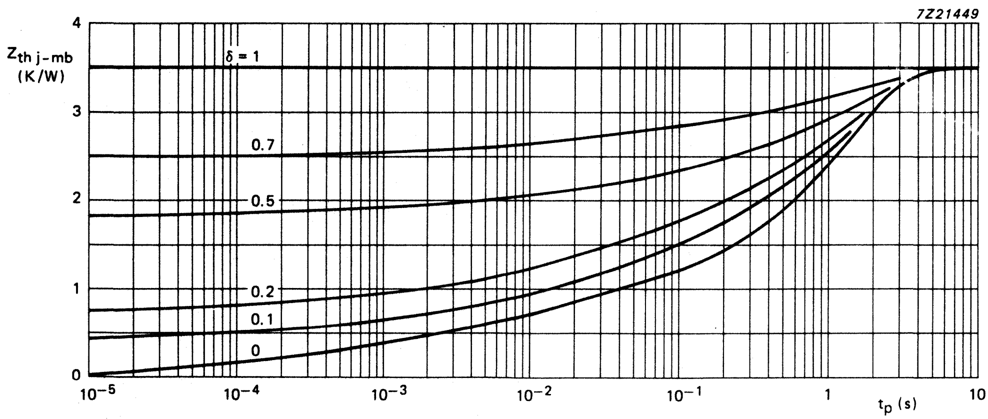


Fig. 7 Pulse power rating chart.

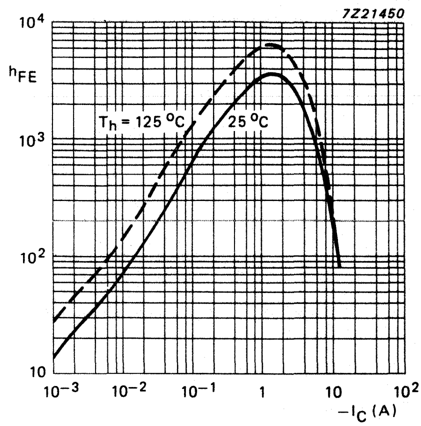


Fig. 8 Typical DC current gain at $-V_{CE}$ = 3 V.

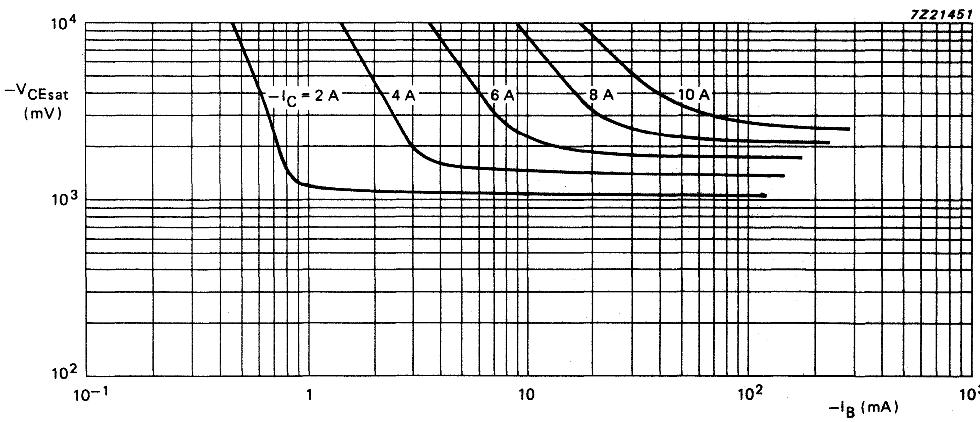


Fig. 9 Typical collector-emitter saturation voltage; T_h = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-220 plastic envelope. P-N-P complements are BDT62, BDT62A; BDT62B and BDT62C.

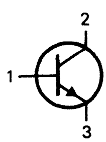
QUICK REFERENCE DATA

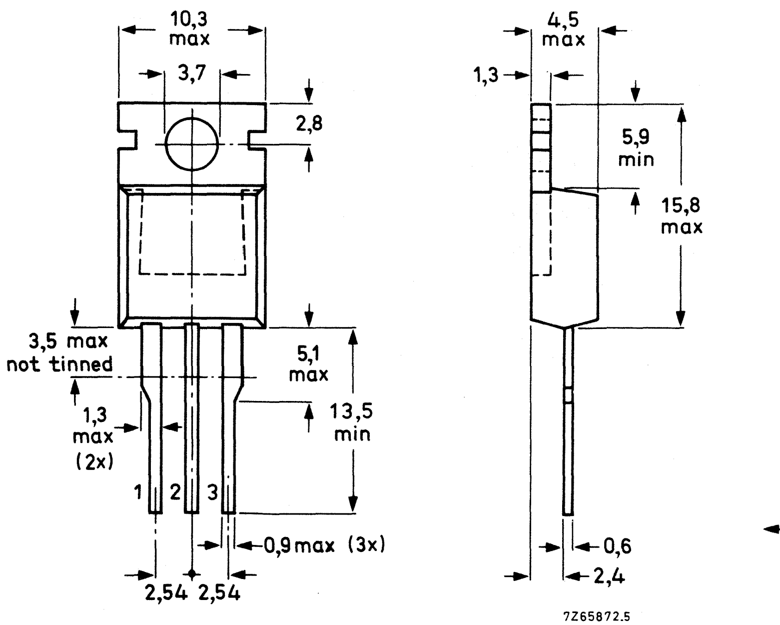
			BDT63	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (d.c.)	I_C	max.		10			A
Collector current (peak value) t_p = 0,3 ms; δ = 10%	I_{CM}	max.		15			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90			W
Junction temperature	T_j	max.		150			°C
D.C. current gain I_C = 3 A; V_{CE} = 3 V	h_{FE}	>		1000			

MECHANICAL DATA

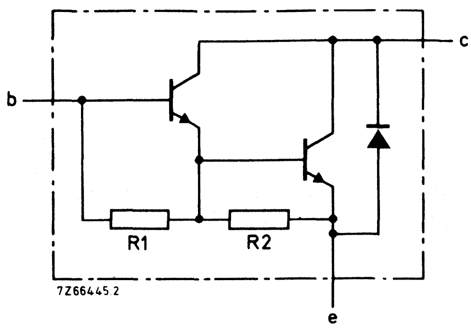
Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.



R1 typ. 8 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT63	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	10				A
Collector current (peak value) t_p = 0,3 ms; δ = 10%	I_{CM}	max.	15				A
Base current (d.c.)	I_B	max.	250				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	90				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature*	T_j	max.	150				°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,39	K/W
From junction to ambient (in free air)	$R_{th\,j\text{-}a}$	=	70	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,2 mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	2 mA
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	0,2 mA ←
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5 mA
Forward-bias second-breakdown collector current V_{CE} = 60 V; t = 0,1 s; non-repetitive (without heatsink)	$I_{(SB)}$	>	1,5 A
D.C. current gain*			
I_C = 3 A; V_{CE} = 3 V	h_{FE}	>	1000
I_C = 10 A; V_{CE} = 3 V	h_{FE}	typ.	3000
Base-emitter voltage*			
I_C = 3 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage*			
I_C = 3 A; I_B = 12 mA	V_{CEsat}	<	2 V
I_C = 8 A; I_B = 80 mA	V_{CEsat}	<	2,5 V
Diode, forward voltage			
I_F = 3 A	V_F	<	2 V
Turn-off breakdown energy with inductive load (Fig. 6)			
$-I_{Boff} = 0$; L = 5 mH	$E_{(BR)}$	>	100 mJ
Small-signal current gain at f = 1 MHz			
I_C = 3 A; V_{CE} = 3 V	h_{fe}	>	10
Cut-off frequency			
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	50 kHz
Collector capacitance			
V_{CB} = 10 V; f = 1 MHz	C_{ob}	typ.	100 pF
D.C. current gain ratio of matched complementary pairs			
I_C = 3 A; V_{CE} = 3 V	h_{FE1}/h_{FE2}	<	2,5

* Measured under pulse conditions; $t_p < 300\ \mu s$; $\delta < 2\%$.

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)
I_{Con} = 3 A; I_{Bon} = $-I_{Boff}$ = 12 mA

turn-on time	t_{on}	typ.	1 μs
		<	2,5 μs
turn-off time	t_{off}	typ.	5 μs
		<	10 μs

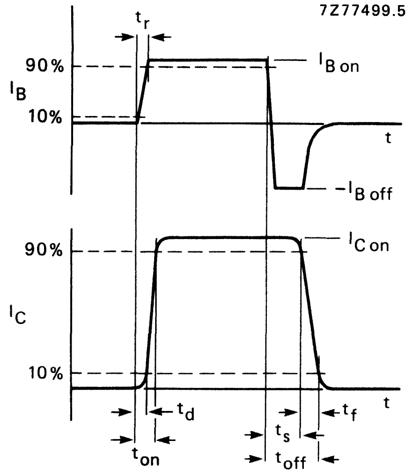
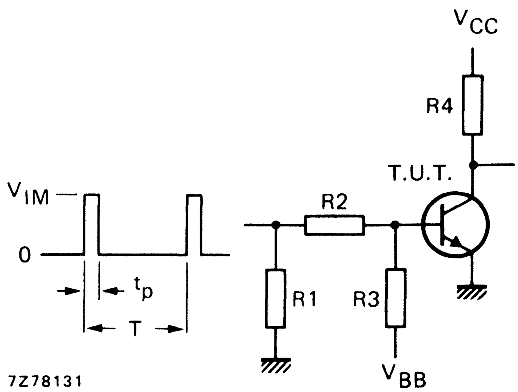


Fig. 3 Switching times waveforms.



V_{IM}	=	10 V
V_{CC}	=	10 V
$-V_{BB}$	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

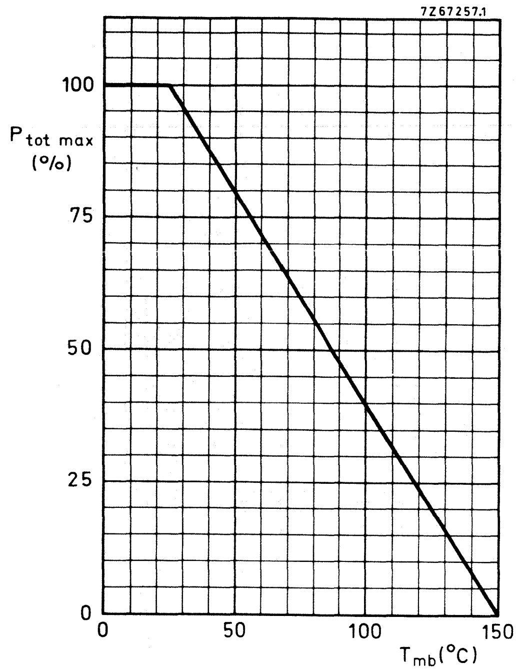


Fig. 5 Power derating curve.

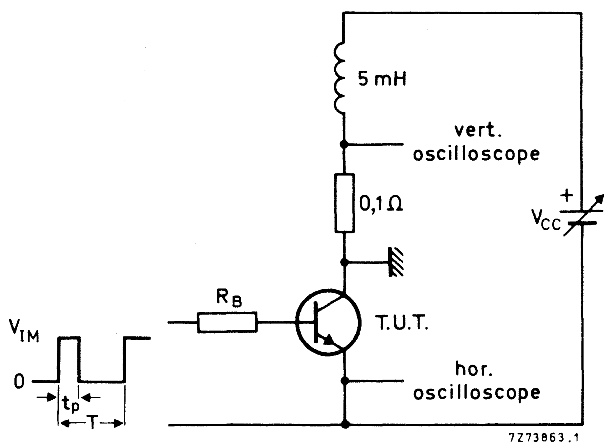


Fig. 6 Turn-off breakdown energy with inductive load.
V_{IM} = 12 V; R_B = 270 Ω; $\delta = \frac{t_p}{T} \times 100\% = 1\%$; I_{CC} = 6,3 A.

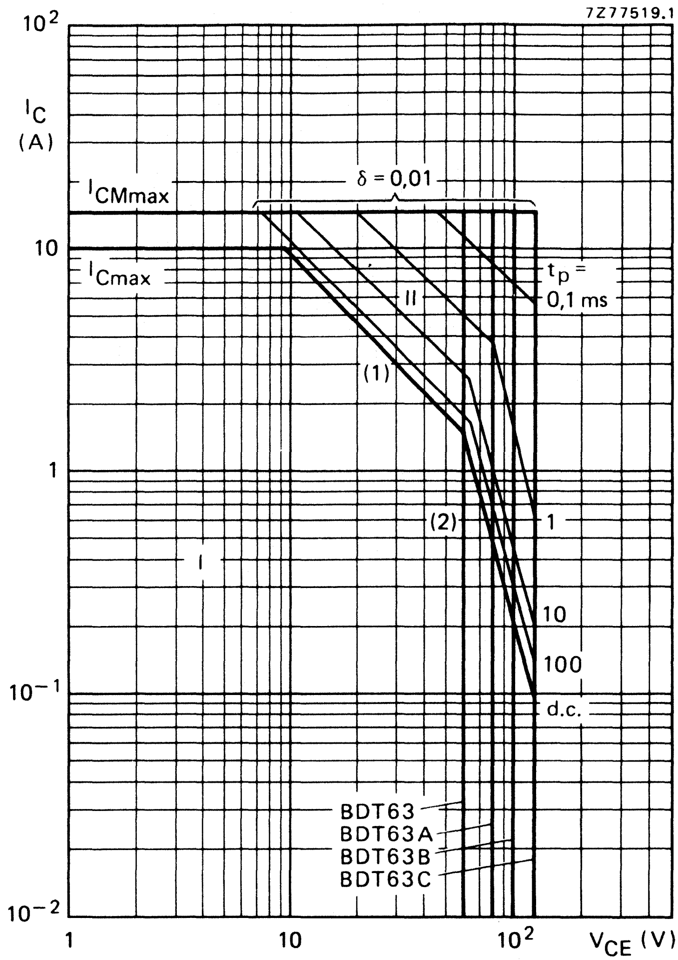


Fig. 7 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

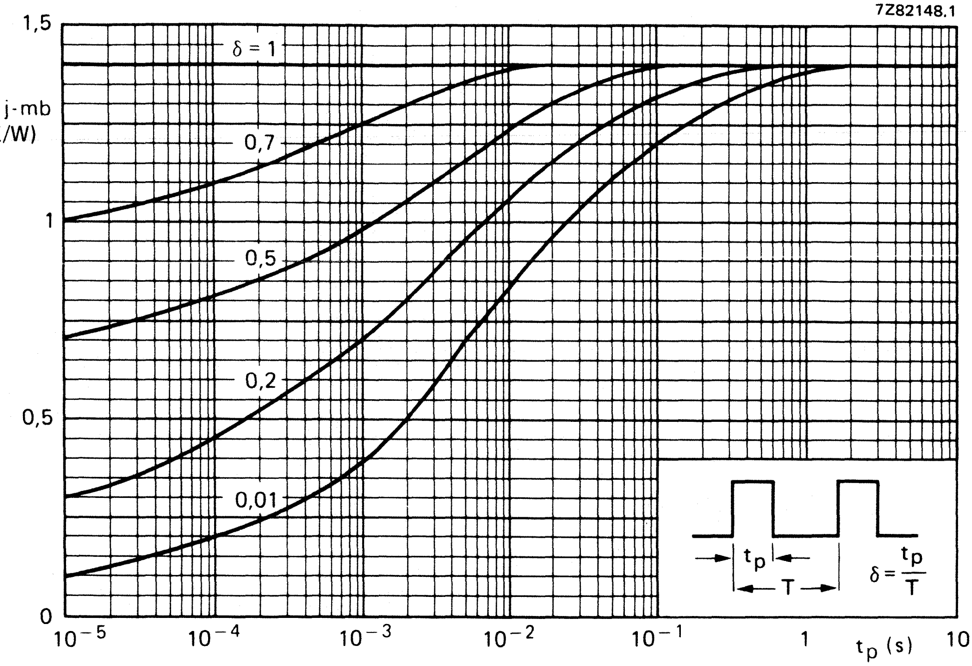


Fig. 8 Pulse power rating chart.

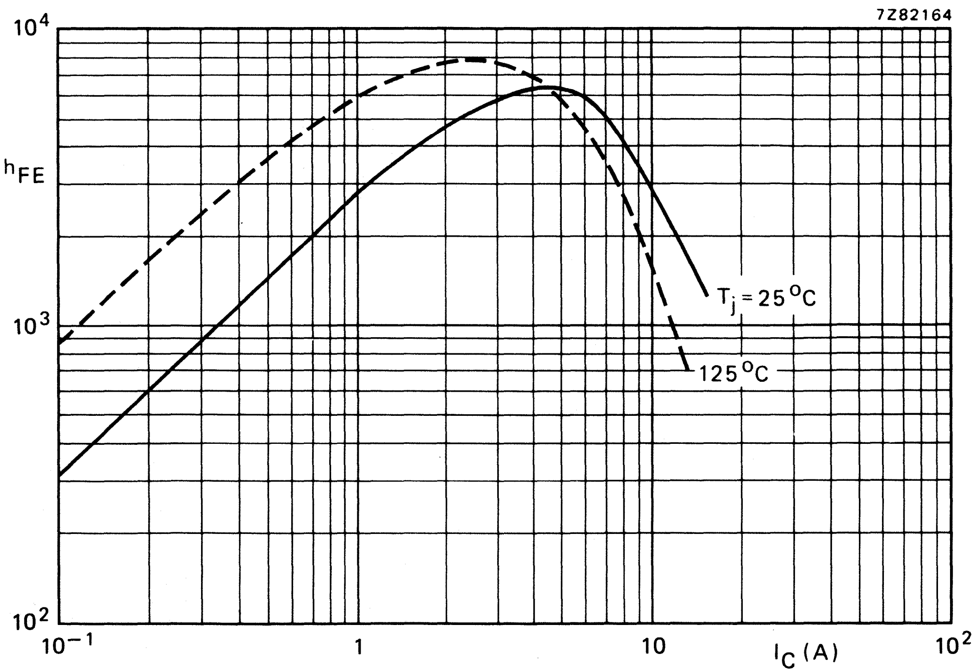


Fig. 9 Typical d.c. current gain at V_{CE} = 3 V.

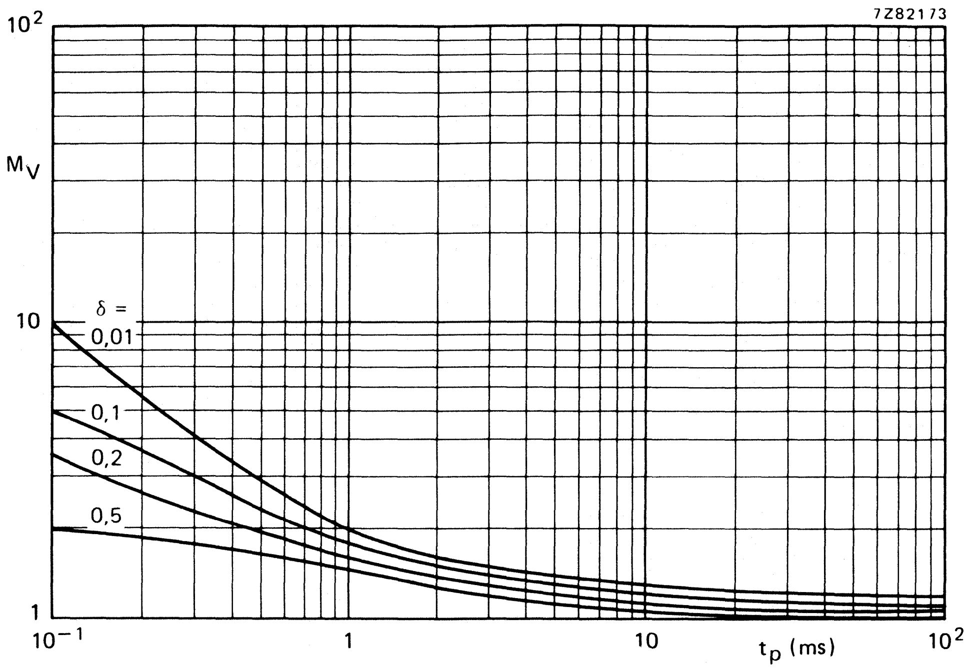


Fig. 10 S.B. voltage multiplying factor at the $I_{C\,max}$ level.

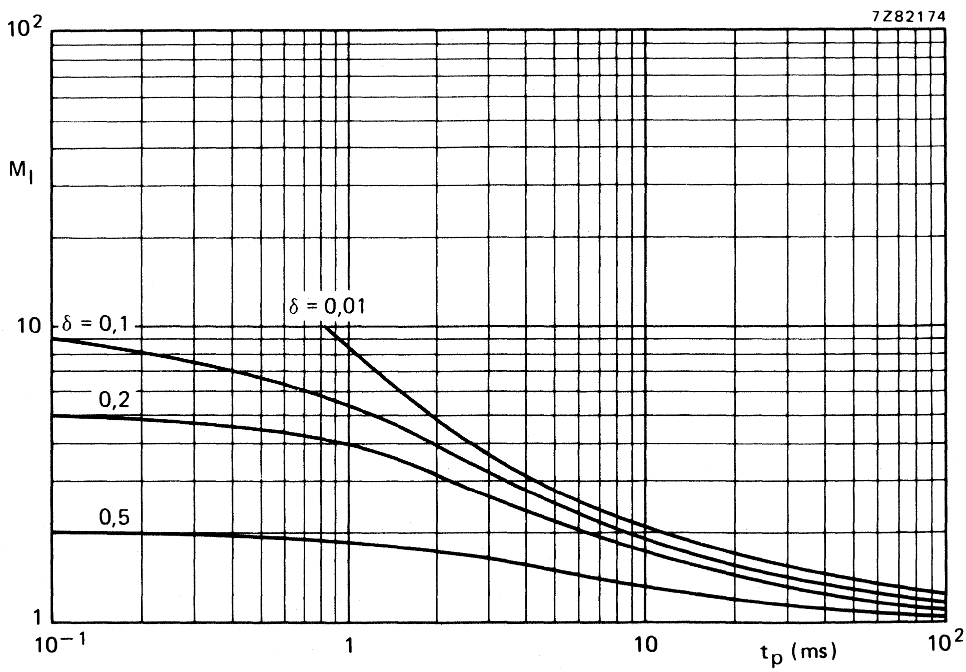


Fig. 11 S.B. current multiplying factor at V_{CEO} level = 60 V and 100 V.

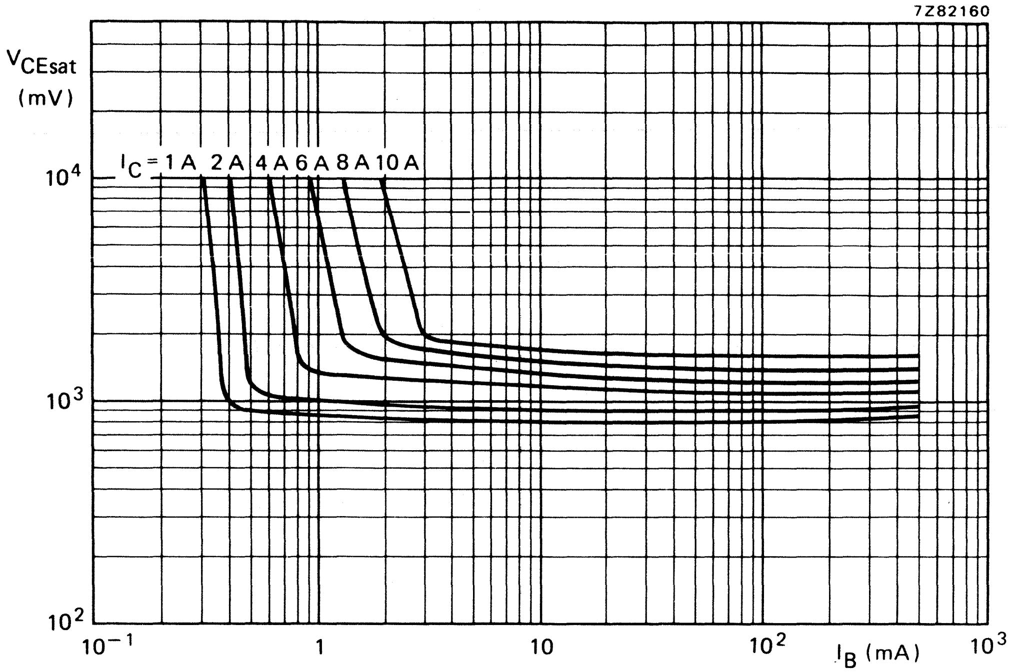


Fig. 12 Typical collector-emitter saturation voltage.

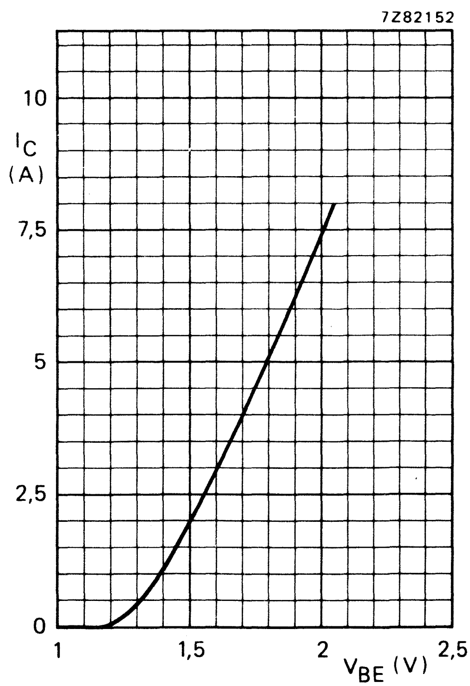


Fig. 13 Typical base-emitter voltage as a function of the collector current.

SILICON DARLINGTON POWER TRANSISTORS

NPN silicon darlington power transistors in a SOT-186 envelope with an electrically insulated mounting base. The devices are designed for audio output stages and general amplifier and switching applications. PNP complements are BDT62F, BDT62AF, BDT62BF and BDT62CF.

QUICK REFERENCE DATA

			BDT63F	63AF	63BF	63CF	
Collector-base voltage	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage	V_{CEO}	max.	60	80	100	120	V
Collector current DC	I_C	max.		10			A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.		36			W
Junction temperature	T_j	max.		150			°C
DC current gain I_C = 3 A; V_{CE} = 3 V	h_{FE}	min.		1000			

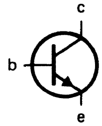
MECHANICAL DATA

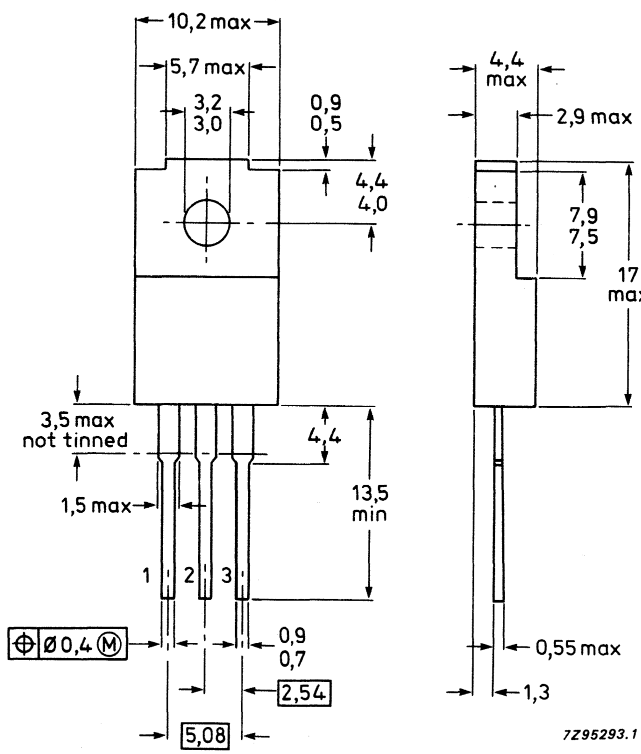
Dimensions in mm

Fig. 1 SOT-186.

Pinning:

1 = Base
2 = Collector
3 = Emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT63F	63AF	63BF	63CF	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5.0	V
Collector current				
DC	I_C	max.	10	A
peak value	I_{CM}	max.	15	A
Base current (DC)	I_B	max.	250	mA
Total power dissipation				
up to T_h = 25 °C (1)	P_{tot}	max.	21	W
up to T_h = 25 °C (2)	P_{tot}	max.	36	W
Storage temperature range	T_{stg}		−65 to 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

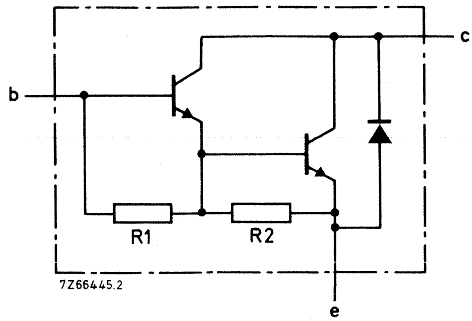
From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.17	K/W
From junction to internal heatsink (1)	$R_{th\ j\text{-}h}$	=	5.95	K/W
From junction to internal heatsink (2)	$R_{th\ j\text{-}h}$	=	3.47	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V
Insulation capacitance from collector to external heatsink	C_{th}	typ.	12	pF

(1) Mounted without heatsink compound and 30 ± 5 newton pressure on centre of envelope.

(2) Mounted with heatsink compound and 30 ± 5 newton pressure on centre of envelope.



R1 typ. 8 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	max.	0.2	mA
$I_E = 0$; $V_{CB} = 1/2\ V_{CBOmax}$; T_j = 150 °C	I_{CBO}	max.	2.0	mA
$I_B = 0$; $V_{CE} = 1/2\ V_{CEOmax}$	I_{CEO}	max.	0.5	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	max.	5.0	mA
Forward-bias second breakdown collector current				
V_{CE} = 40 V; t = 0.1 s; non-repetitive (without heatsink)	$I_{(SB)}$	min.	0.9	A
DC current gain (3)				
I_C = 3 A; V_{CE} = 3 V	h_{FE}	min.	1000	
I_C = 10 A; V_{CE} = 3 V	h_{FE}	typ.	800	
Base-emitter voltage (3)				
I_C = 3 A; V_{CE} = 3 V	V_{BE}	max.	2.5	V
Collector-emitter saturation voltage (3)				
I_C = 3 A; I_B = 12 mA	V_{CEsat}	max.	2.0	V
I_C = 8 A; I_B = 80 mA	V_{CEsat}	max.	2.5	V
Diode, forward voltage				
I_F = 3 A	V_F	max.	2.0	V
Turn-off breakdown energy with inductive load				
$-I_{Boff} = 0$; L = 5 mH	$E_{(BR)}$	min.	100	mJ
Small-signal current gain at f = 1 MHz				
I_C = 3 A; V_{CE} = 3 V	h_{fe}	min.	10	
Cut-off frequency				
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	50	kHz
Collector capacitance				
V_{CB} = 10 V; f = 1 MHz	C_c	typ.	100	pF

(3) Measured under pulse conditions; $t_p < 300\ \mu s$; $\delta < 2\%$.

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)
$I_{Con} = 3$ A;
$I_{Bon} = -I_{Boff} = 12$ mA

Turn-on time	t_{on}	typ.	1.0	μs
		max.	2.5	μs
Turn-off time	t_{off}	typ.	5.0	μs
		max.	10	μs

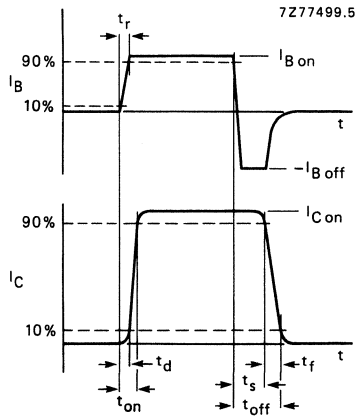
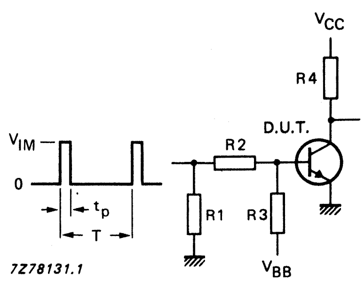


Fig. 3 Switching times waveforms.



V_{IM} = 10 V
V_{CC} = 10 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 3 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.

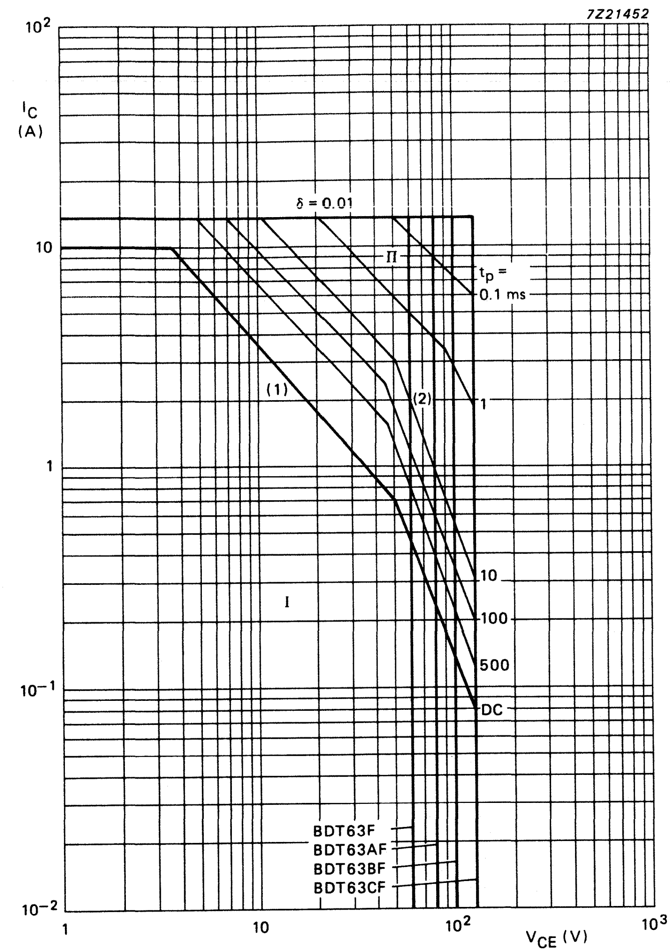


Fig. 5 Safe Operating Area; $T_{MB} \leqslant 25$ °C.

1 Region of permissible DC operation.

11 Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second-breakdown limits.

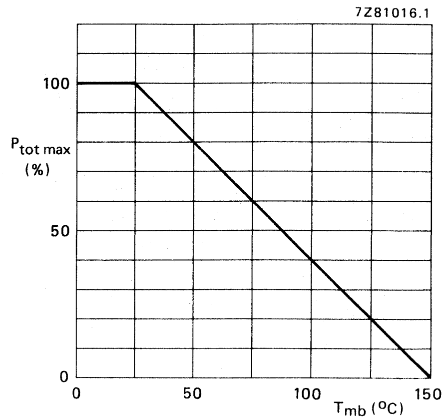


Fig. 6 Power derating curve.

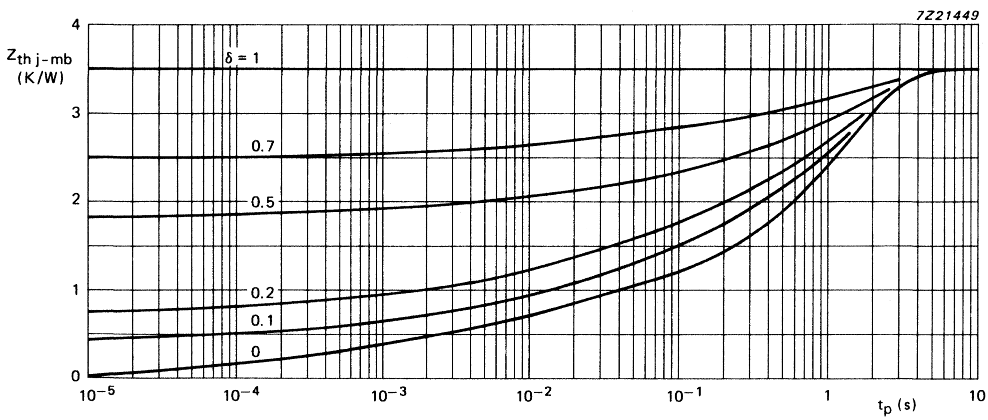


Fig. 7 Pulse power rating chart.

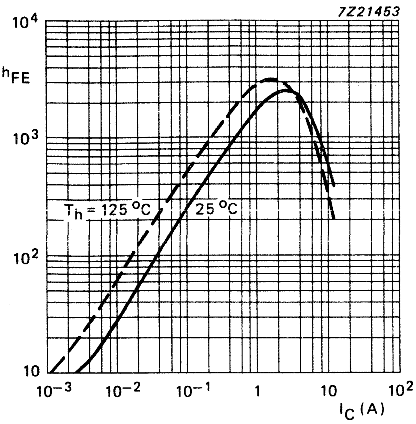


Fig. 8 Typical DC current gain at V_{CE} = 3 V.

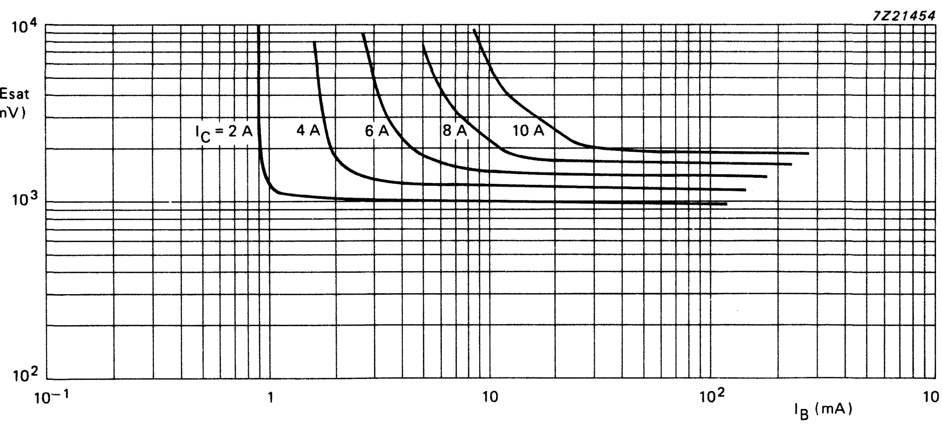


Fig. 9 Typical collector-emitter saturation voltage; T_h = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier and switching applications. TO-220 plastic envelope. N-P-N complements are BDT65, BDT65A, BDT65B and BDT65C.

QUICK REFERENCE DATA

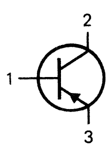
			BDT64	64A	64B	64C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.	12				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	>	1000				

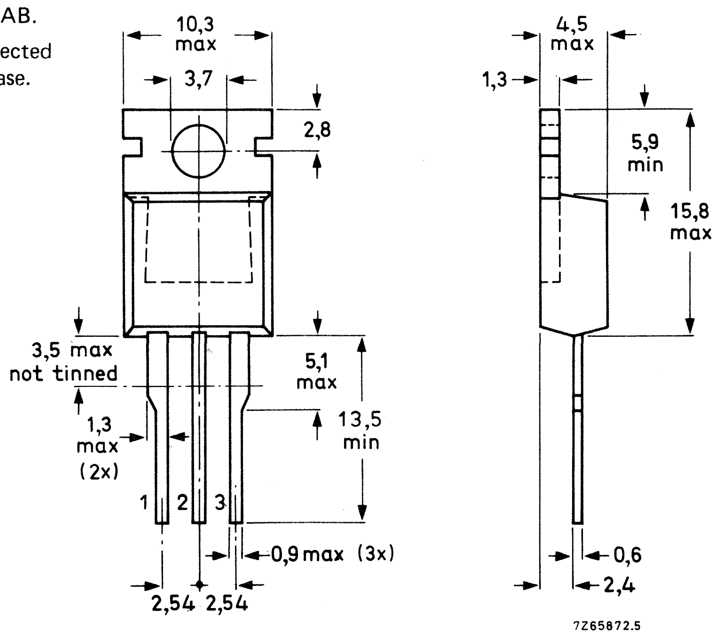
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

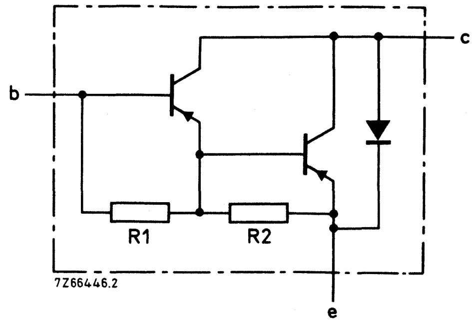


Fig. 2 Circuit diagram. R1 typ. 3 kΩ; R2 typ. 45 Ω.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT64	64A	64B	64C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.		12			A
Collector current (peak value)	$-I_{CM}$	max.		20			A
Base current (d.c.)	$-I_B$	max.		500			mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		125			W
Storage temperature	T_{stg}			−65 to + 150			°C
Junction temperature	T_j	max.		150			°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current			
$-V_{CB} = -V_{CBOmax}$; $I_E = 0$	$-I_{CBO}$	<	0,4 mA
$I_E = 0$; $-V_{CB} = -½ V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<	2 mA
$I_B = 0$; $-V_{CE} = -½ V_{CEOmax}$	$-I_{CEO}$	<	0,2 mA ←
Emitter cut-off current			
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	5 mA
D.C. current gain*			
$-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	typ.	1500
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	>	1000
$-I_C$ = 12 A; $-V_{CE}$ = 4 V	h_{FE}	typ.	750
Base-emitter voltage			
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage*			
$-I_C$ = 5 A; $-I_B$ = 20 mA	$-V_{CEsat}$	<	2 V
$-I_C$ = 10 A; $-I_B$ = 100 mA	$-V_{CEsat}$	<	3 V
Diode, forward voltage			
I_F = 5 A	V_F	<	2 V
I_F = 12 A	V_F	typ.	2 V
Collector capacitance at f = 1 MHz			
$-V_{CB}$ = 10 V; $I_E = I_e = 0$	C_c	typ.	200 pF
Second breakdown collector current non-repetitive; without heatsink			
$-V_{CE}$ = 60 V; t_p = 0,1 s	$-I_{SB}$	>	2 A
Switching times (see Figs 3 and 4) $-I_{Con}$ = 5 A; $-I_{Bon} = I_{Boff}$ = 20 mA; $-V_{CC}$ = 30 V			
turn-on time	t_{on}	typ.	0,5 μs
		<	2 μs
turn-off time	t_{off}	typ.	2,5 μs
		<	5 μs
Small-signal current gain			
$-I_C$ = 5 A; $-V_{CE}$ = 3 V; f = 1 MHz	h_{fe}	>	10

* Measured under pulse conditions: $t_p < 300$ μs; $\delta < 2\%$.

CHARACTERISTICS (continued)

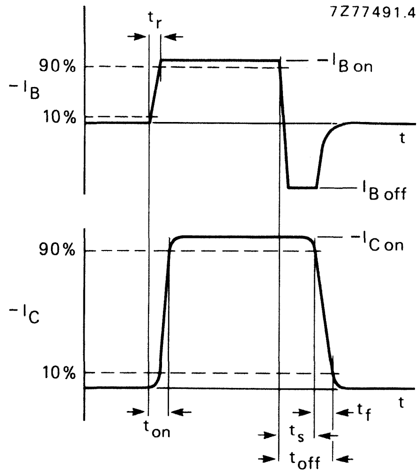
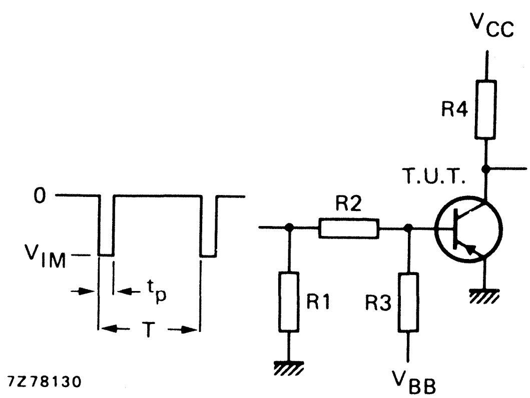


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	15 V
$-V_{CC}$	=	30 V
V_{BB}	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	6 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

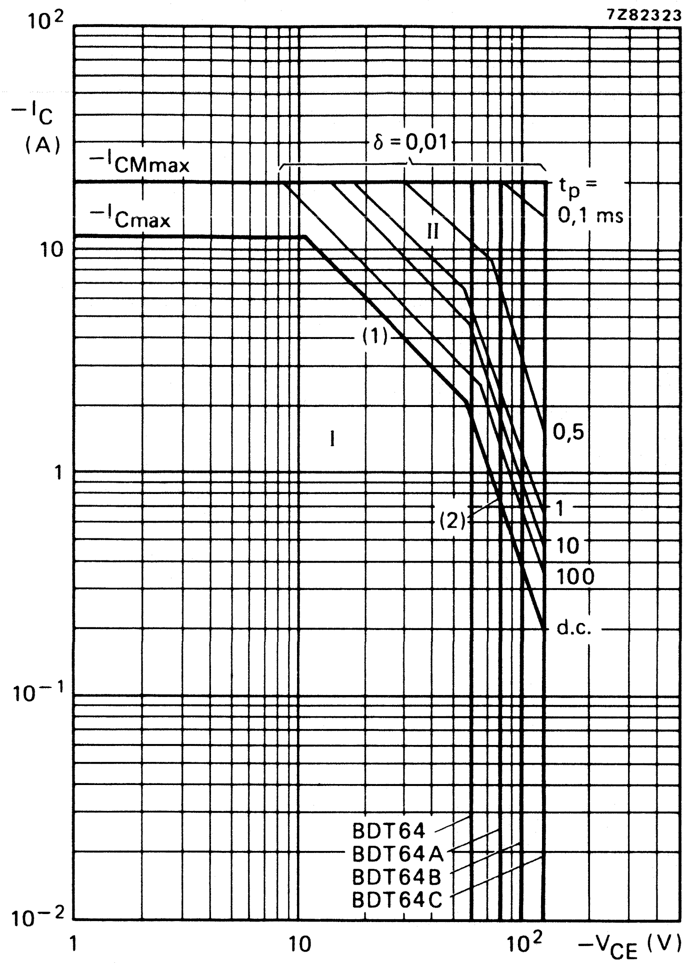


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

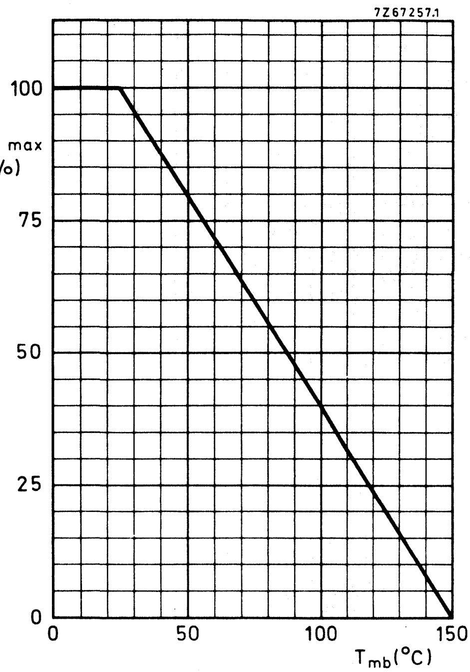


Fig. 6 Power derating curve.

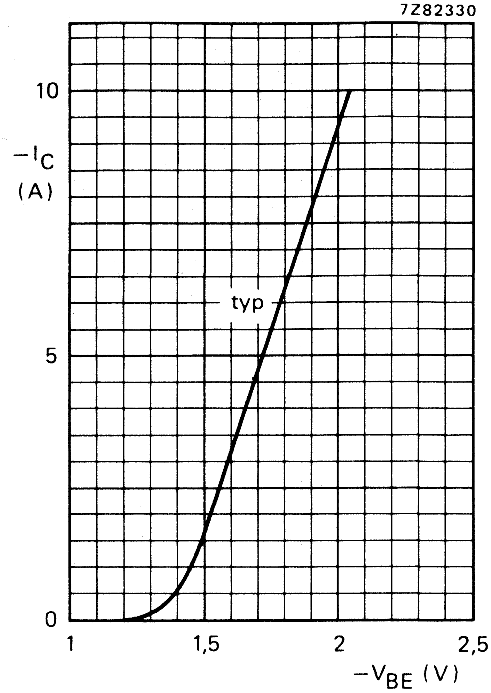


Fig. 7 $-V_{CE} = 3$ V; $T_{amb} = 25$ °C.

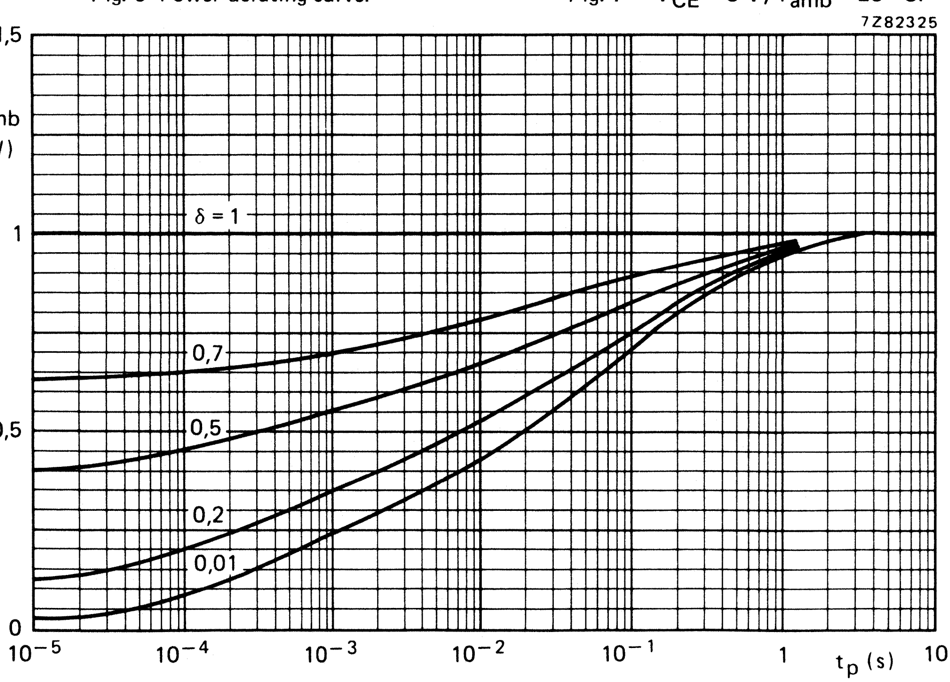


Fig. 8 Pulse power rating chart.

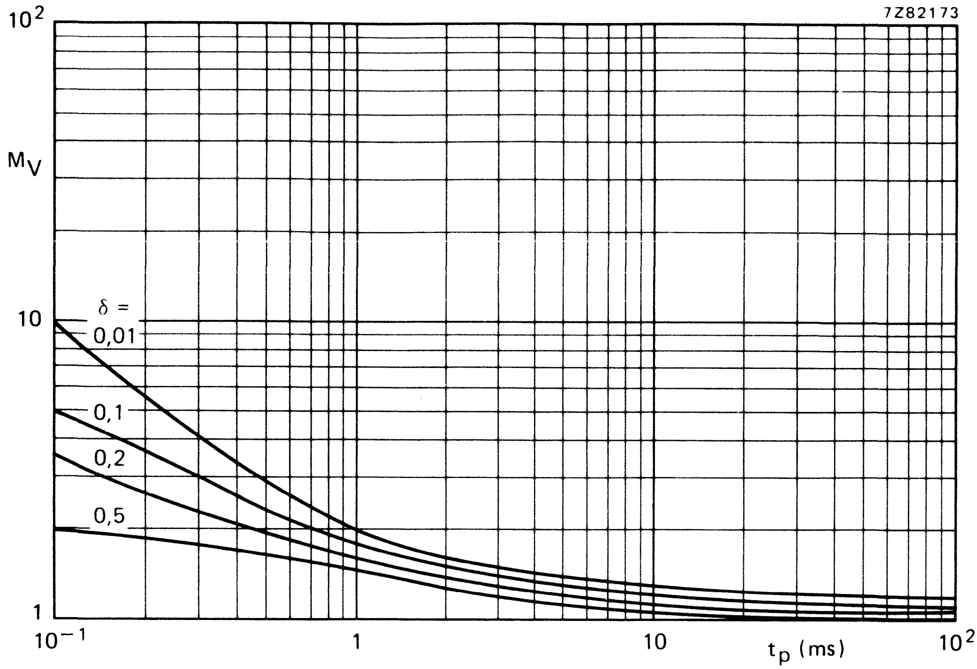


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

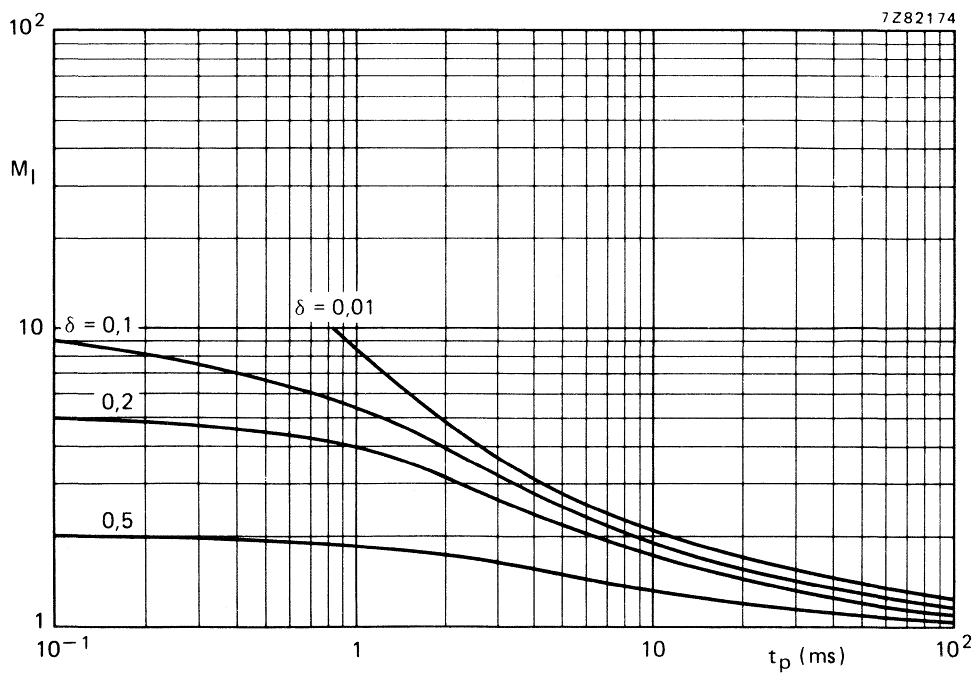


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} level.

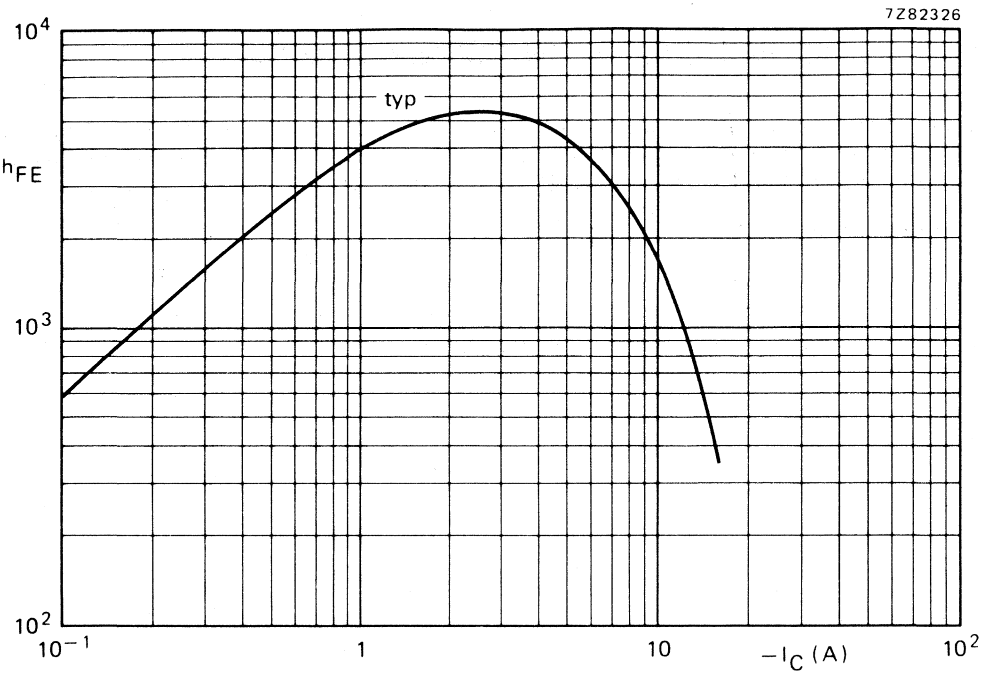


Fig. 11 D.C. current gain. $-V_{CE}$ = 3 V; T_j = 25 °C.

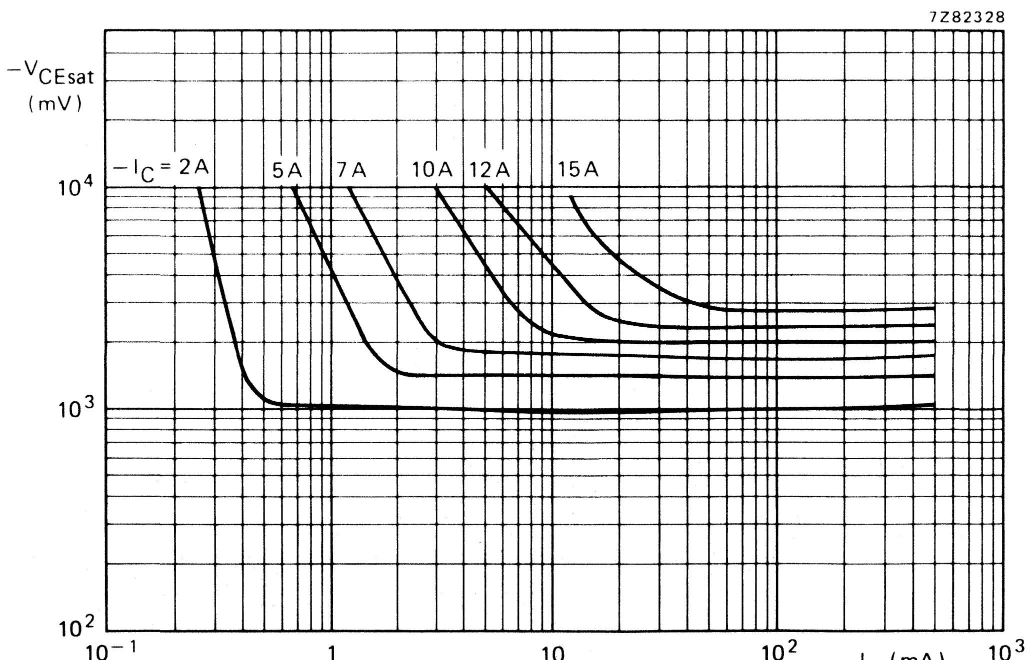


Fig. 12 Typical collector-emitter saturation voltages.

SILICON DARLINGTON POWER TRANSISTORS

PNP Silicon Darlington power transistors in a SOT-186 envelope with an electrically insulated mounting base. The devices are designed for audio output stages and general amplifier and switching applications. NPN complements are BDT65F, BDT65AF, BDT65BF and BDT65CF.

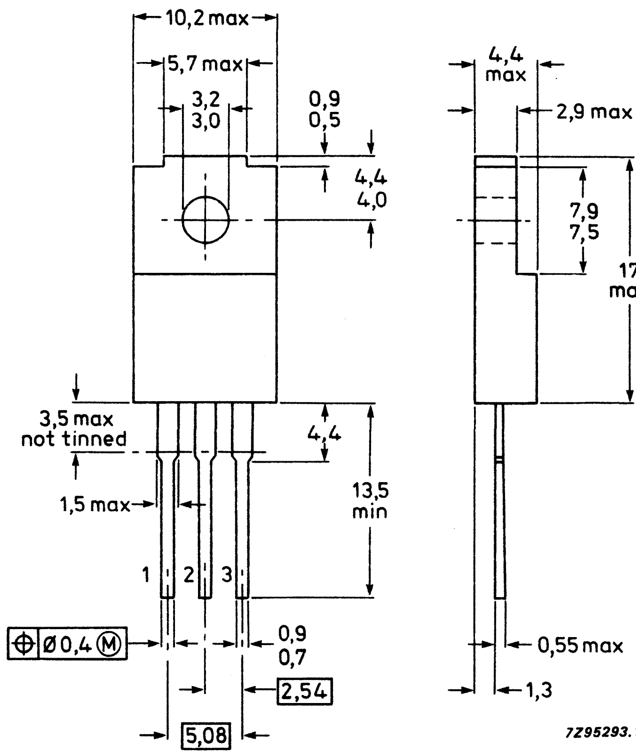
QUICK REFERENCE DATA

			BDT64F	64AF	64BF	64CF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current DC	$-I_C$	max.	12				A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.	39				W
Junction temperature	T_j	max.	150				°C
DC current gain $-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	min.	1000				

MECHANICAL DATA

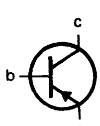
Dimensions in mm

Fig. 1 SOT-186.



Pinning:

1 = Base
2 = Collector
3 = Emitter



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT64F	64AF	64BF	64CF	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5.0				V
Collector current DC	$-I_C$	max.	12				A
Collector current peak value	$-I_{CM}$	max.	20				A
Base current (DC)	$-I_B$	max.	500				mA
Total power dissipation up to T_h = 25 °C (1)	P_{tot}	max.	22				W
Total power dissipation up to T_h = 25 °C (2)	P_{tot}	max.	39				W
Storage temperature	T_{stg}		−65 to 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

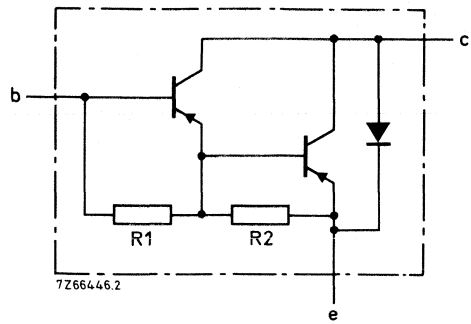
From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	0.9	K/W
From junction to external heatsink (1)	$R_{th\ j\text{-}h}$	=	5.7	K/W
From junction to external heatsink (2)	$R_{th\ j\text{-}h}$	=	3.2	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V
Insulation capacitance from collector to external heatsink	C_{th}	typ.	12	pF

(1) Mounted without heatsink compound and 30 ± 5 newton pressure on centre of envelope.

(2) Mounted with heatsink compound and 30 ± 5 newton pressure on centre of envelope.



R1 typ. 3 kΩ
R2 typ. 45 Ω

Fig. 2 Circuit diagram.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	max.	0.4	mA
$I_E = 0$; $T_j = 150$ °C; $-V_{CB} = -1/2\ V_{CBOmax}$	$-I_{CBO}$	max.	2.0	mA
$I_B = 0$; $-V_{CE} = -1/2\ V_{CEOmax}$	$-I_{CEO}$	max.	1.0	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	max.	5.0	mA
DC current gain (3)				
$-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}	typ.	4000	
$-I_C = 5$ A; $-V_{CE} = 4$ V	h_{FE}	min.	1000	
$-I_C = 12$ A; $-V_{CE} = 4$ V	h_{FE}	typ.	800	
Base-emitter voltage (3)				
$-I_C = 5$ A; $-V_{CE} = 4$ V	$-V_{BE}$	max.	2.5	V
Collector-emitter saturation voltage (3)				
$-I_C = 5$ A; $-I_B = 20$ mA	$-V_{CEsat}$	max.	2.0	V
$-I_C = 10$ A; $-I_B = 100$ mA	$-V_{CEsat}$	max.	3.0	V
Diode, forward voltage				
$I_F = 5$ A	V_F	max.	2.0	V
Collector capacitance at f = 1 MHz				
$-V_{CB} = 10$ V; $I_E = I_C = 0$	C_c	typ.	200	pF
Second-breakdown collector current non-repetitive; without heatsink				
$-V_{CE} = 60$ V; $t_p = 0.1$ s	$-I_{(SB)}$	min.	0.65	A
Switching times $-I_{Con} = 5$ A; $-I_{Bon} = I_{Boff} = 20$ mA; $-V_{CC} = 30$ V				
Turn-on time	t_{on}	typ.	0.5	μs
		max.	2.0	μs
Turn-off time	t_{off}	typ.	2.5	μs
		max.	5.0	μs
Small-signal current gain at f = 1 MHz				
$-I_C = 5$ A; $-V_{CE} = 3$ V	h_{fe}	min.	10	

(3) Measured under pulse conditions; $t_p < 300\ \mu s$; $\delta < 2\%$.

CHARACTERISTICS (continued)

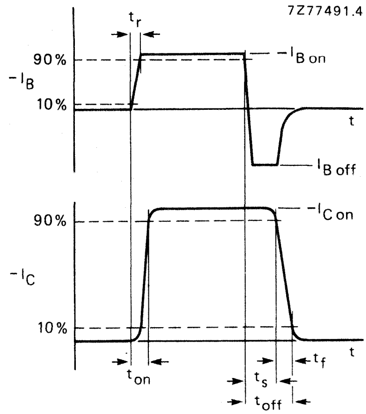
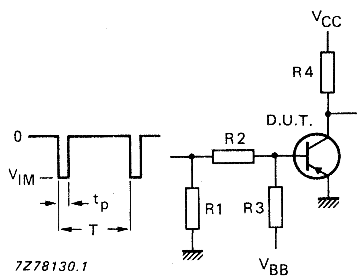


Fig. 3 Switching times waveforms.



$-V_{IM}$ = 15 V
$-V_{CC}$ = 30 V
$+V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 6 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.

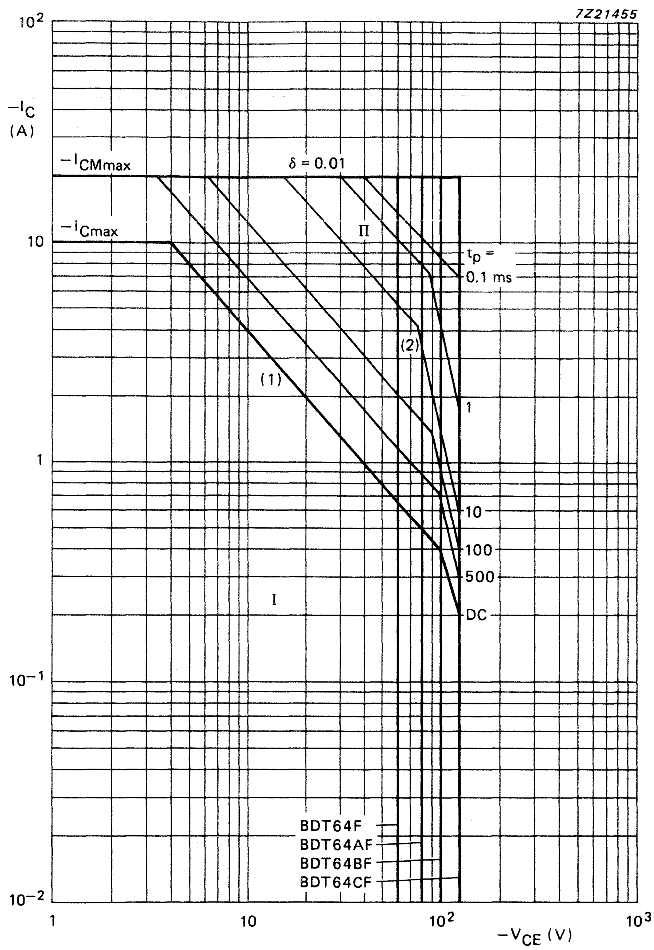


Fig. 5 Safe Operating Area; T_h = 25 °C.

(I) Region of permissible DC operation.

(II) Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

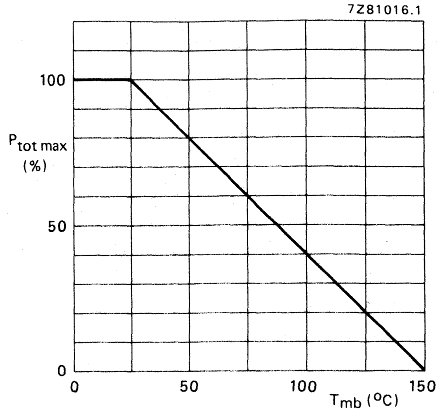


Fig. 6 Power derating curve.

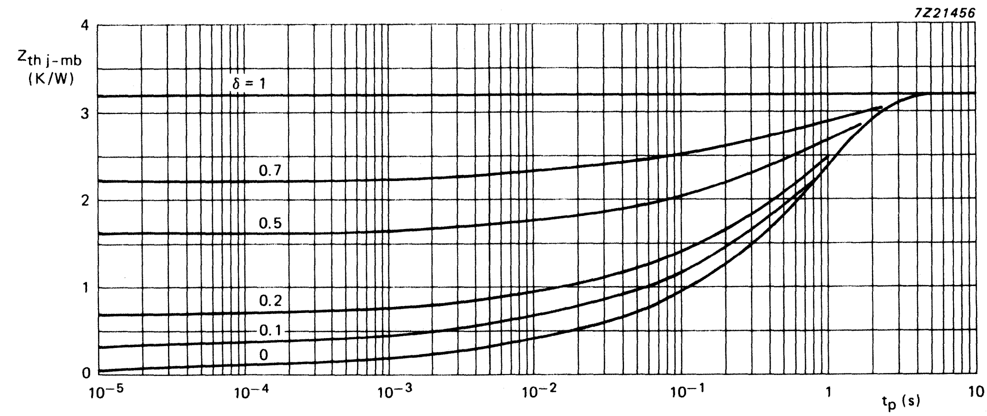


Fig. 7 Pulse power rating chart.

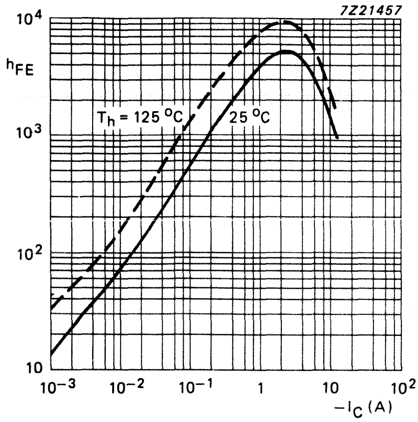


Fig. 8 Typical DC current gain as a function of collector current; $-V_{CE}$ = 4 V; T_j = 25 °C.

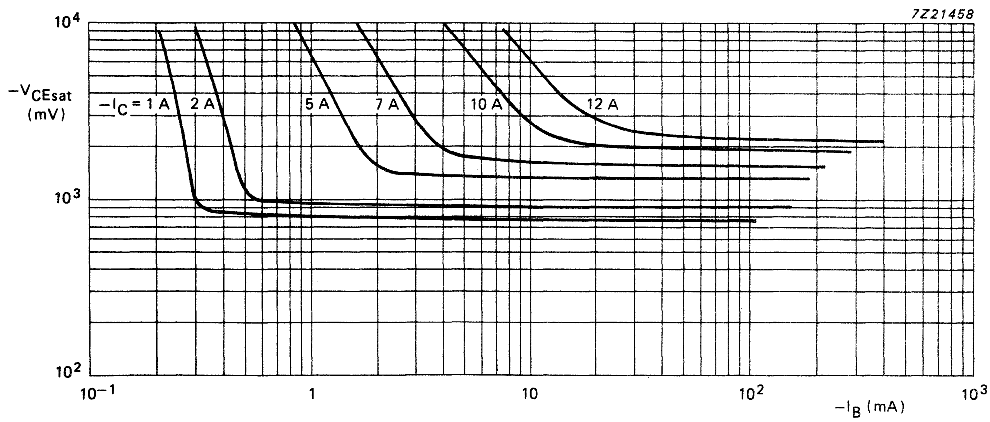


Fig. 9 Typical collector-emitter saturation voltages; T_h = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier and switching applications. TO-220 plastic envelope. P-N-P complements are BDT64; BDT64A; BDT64B and BDT64C.

QUICK REFERENCE DATA

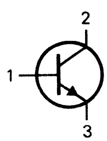
			BDT65	65A	65B	65C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V
Collector current (d.c.)	I_C	max.	12				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125				W
Junction temperature	T_j	max.	150				°C
D.C. current gain I_C = 5 A; V_{CE} = 4 V	h_{FE}	>	1000				

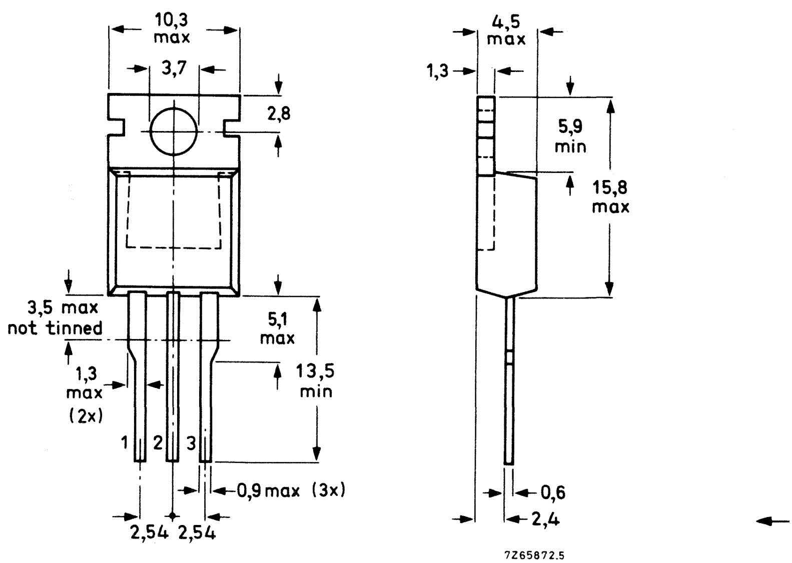
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

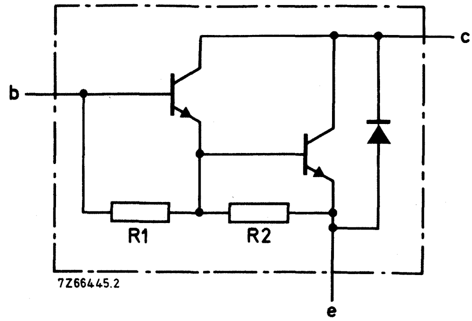


Fig. 2 Circuit diagram. R1 typ. 5 kΩ; R2 typ. 80 Ω.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT65	65A	65B	65C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	20	A
Base current (d.c.)	I_B	max.	500	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W

CHARACTERISTICS

T_j = 25 °C, unless otherwise specified

Collector cut-off current				
$V_{CB} = V_{CBOmax}$; I_E = 0	I_{CBO}	<	0,4	mA
$V_{CB} = ½V_{CBOmax}$; I_E = 0; T_j = 150 °C	I_{CBO}	<	2	mA
I_B = 0; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	0,2	mA ←
Emitter cut-off current				
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	5	mA
D.C. current gain*				
I_C = 1 A; V_{CE} = 4 V	h_{FE}	typ.	1500	
I_C = 5 A; V_{CE} = 4 V	h_{FE}	>	1000	
I_C = 12 A; V_{CE} = 4 V	h_{FE}	typ.	1000	
Base-emitter voltage				
I_C = 5 A; V_{CE} = 4 V	V_{BE}	<	2,5	V
Collector-emitter saturation voltage*				
I_C = 5 A; I_B = 20 mA	V_{CEsat}	<	2	V
I_C = 10 A; I_B = 100 mA	V_{CEsat}	<	3	V
Diode, forward voltage				
I_F = 5 A	V_F	<	2	V
I_F = 12 A	V_F	typ.	2	V
Collector capacitance at f = 1 MHz				
V_{CB} = 10 V; $I_E = I_e$ = 0	C_c	typ.	200	pF
Second-breakdown collector current non-repetitive; without heatsink				
V_{CE} = 60 V; t_p = 0,1 s	I_{SB}	>	2	A
Turn-off breakdown energy with inductive load; $-I_{Boff}$ = 0; I_{CM} = 6,3 A				
L = 5 mH (see Fig. 3)	$E_{(BR)}$	>	100	mJ
Switching times (see Figs 4 and 5)				
I_{Con} = 5 A; $I_{Bon} = -I_{Boff}$ = 20 mA				
turn-on time	t_{on}	typ.	1	μs
		<	2,5	μs
turn-off time	t_{off}	typ.	6,0	μs
		<	10	μs
Small-signal current gain				
I_C = 5 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	>	10	

* Measured under pulse conditions $t_p \leq 300$ μs; $\delta < 2\%$.

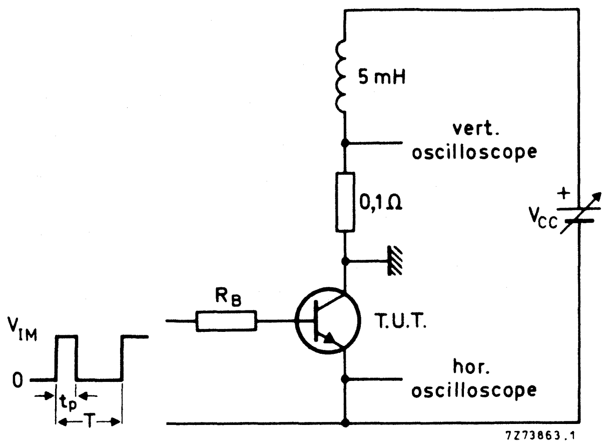


Fig. 3 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω;
t_p = 1 ms; δ = 1%.

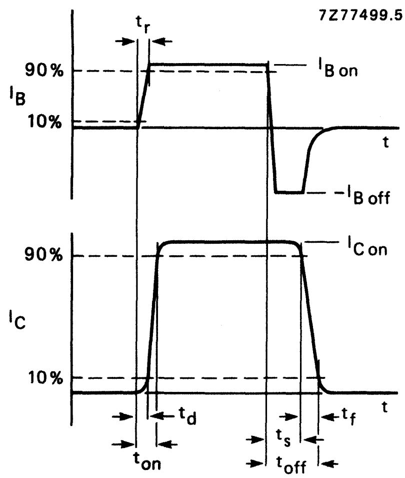
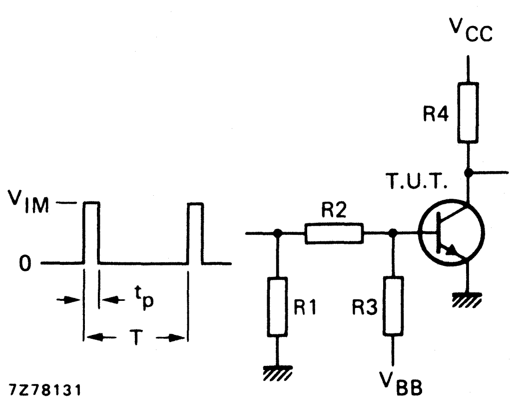


Fig. 4 Switching times waveforms.



V_{CC} = 30 V
V_{IM} = 15 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 6 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 5 Switching times test circuit.

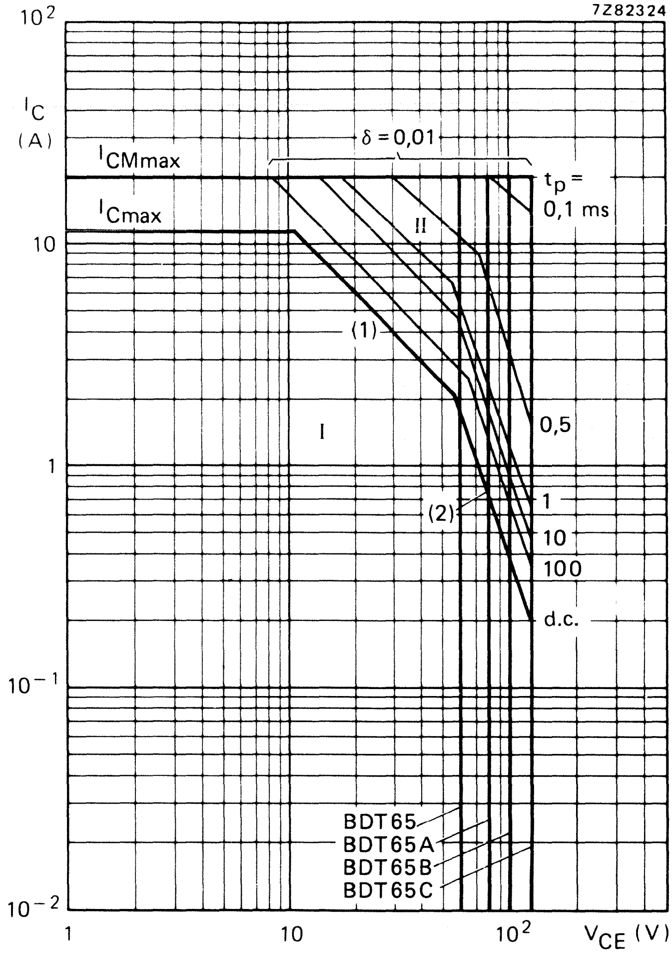


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

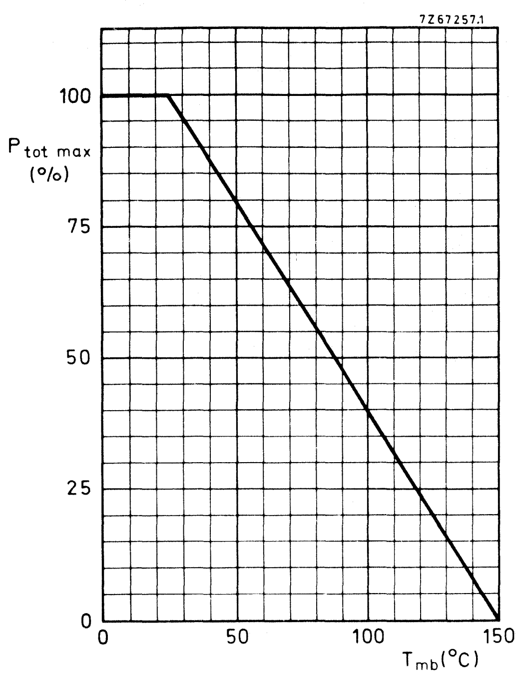


Fig. 7 Power derating curve.

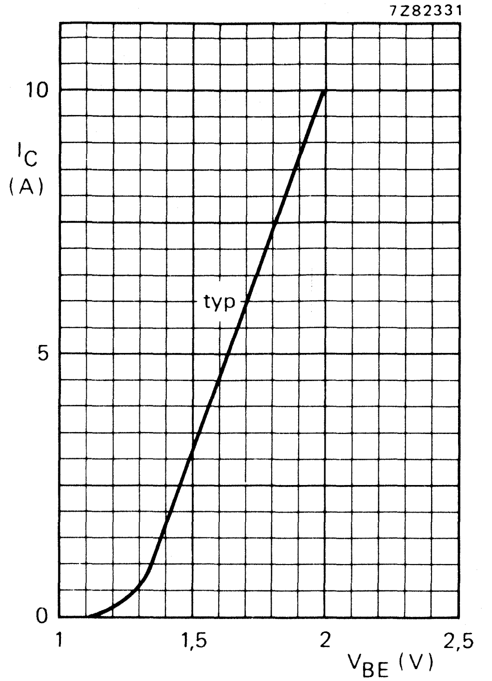


Fig. 8 Base-emitter voltage as a function of collector current. V_{CE} = 3 V; T_{amb} = 25 °C.

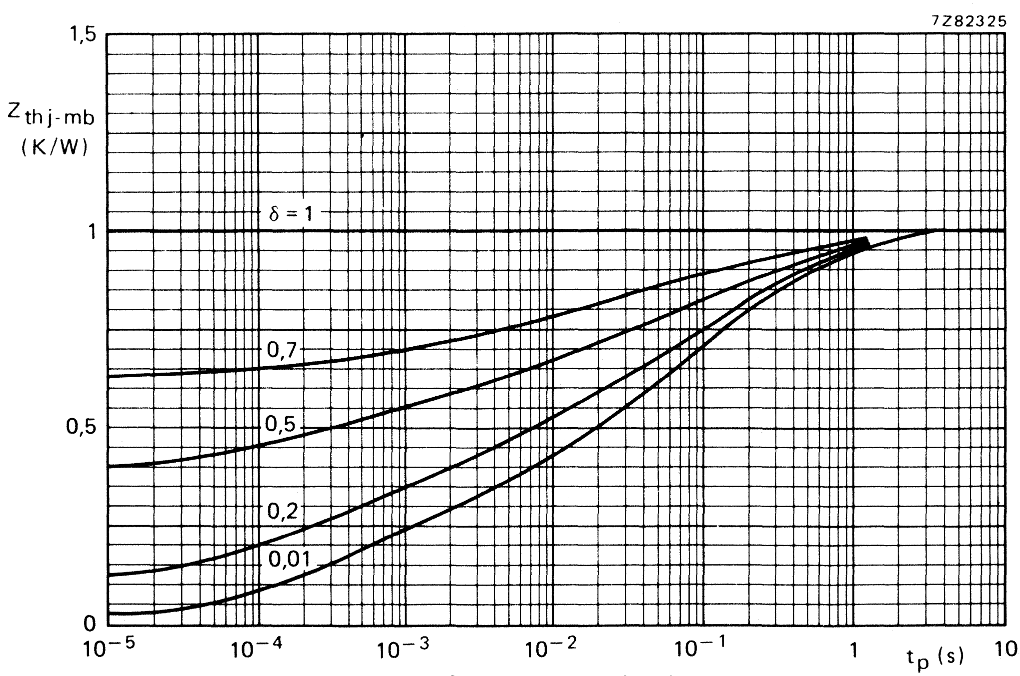


Fig. 9 Pulse power rating chart.

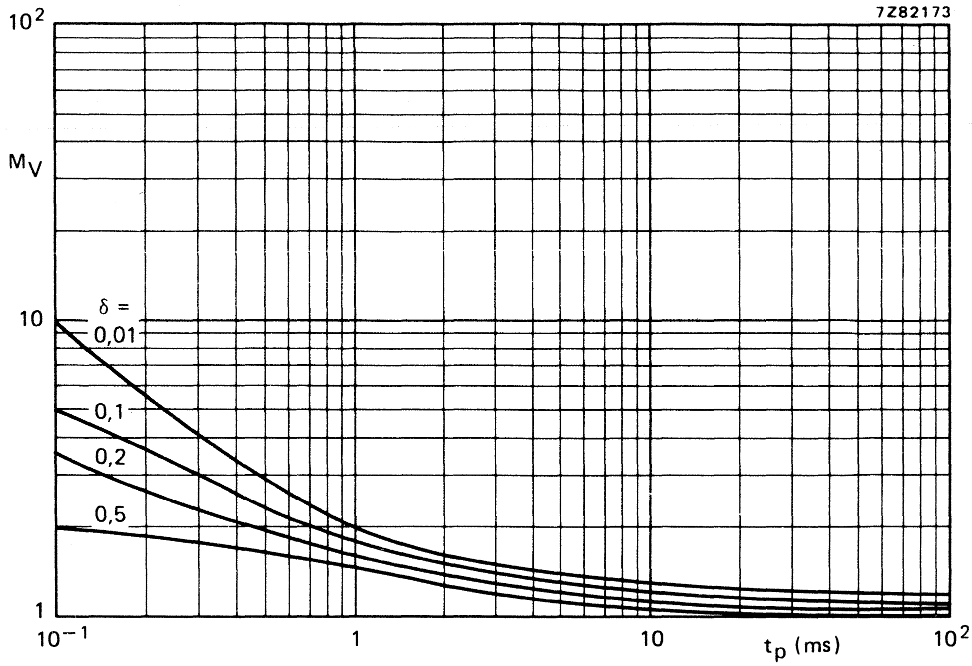


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

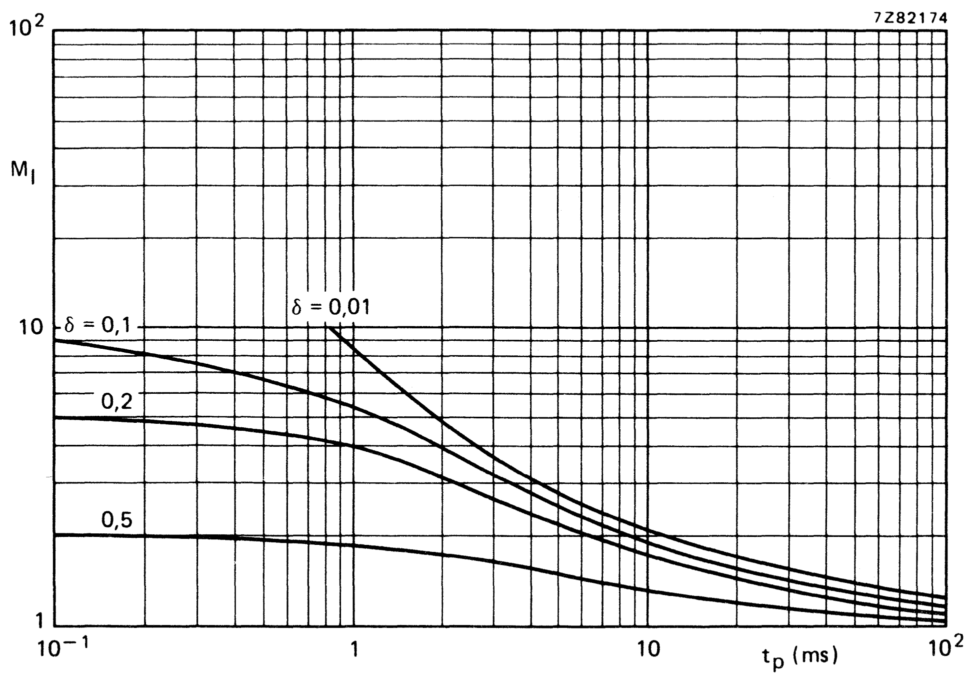


Fig. 11 S.B. current multiplying factor at the V_{CEOmax} level.

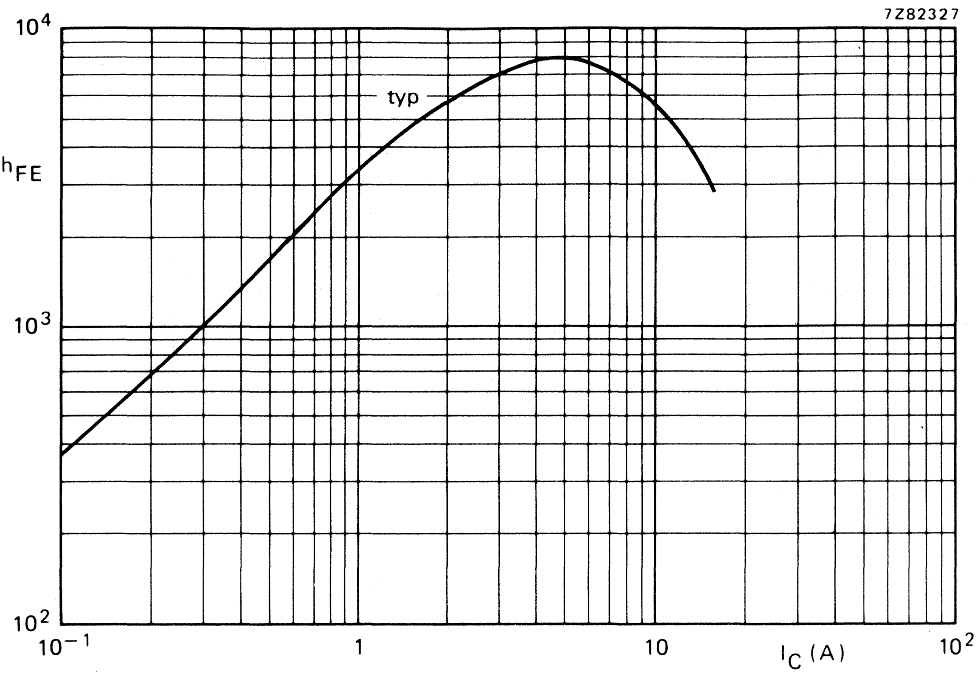


Fig. 12 Typical d.c. current gain as a function of collector current; V_{CE} = 3 V; T_j = 25 °C.

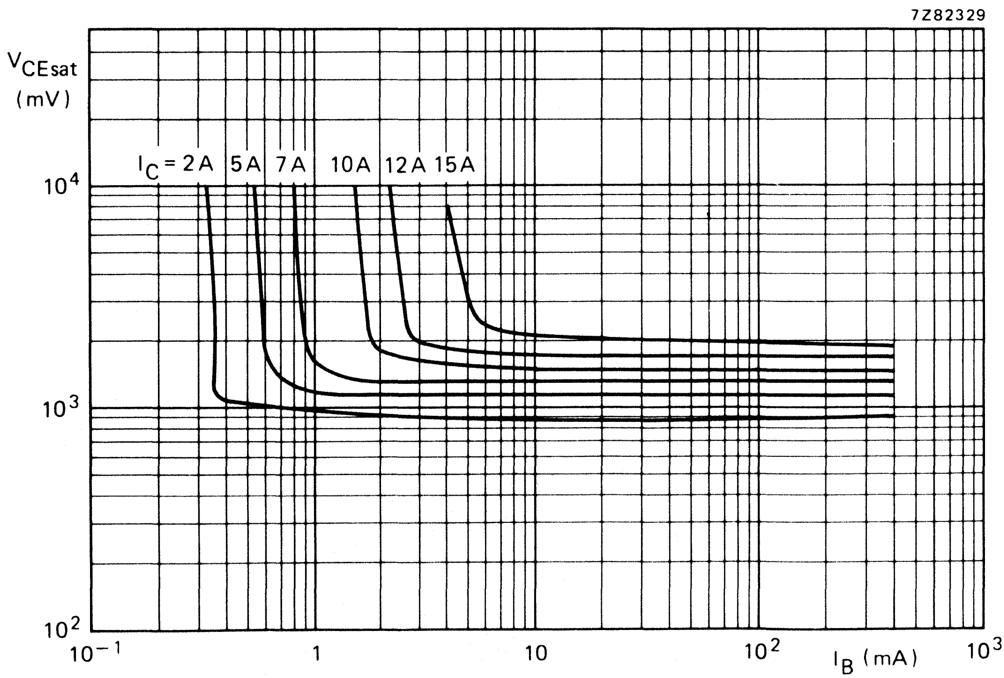


Fig. 13 Typical collector-emitter saturation voltages.

SILICON DARLINGTON POWER TRANSISTORS

NPN silicon darlington power transistors in a SOT-186 envelope with an electrically insulated mounting base. The devices are designed for audio output stages and general amplifier and switching applications. PNP complements are BDT64F, BDT64AF, BDT64BF and BDT64CF.

QUICK REFERENCE DATA

			BDT65F	65AF	65BF	65CF	
Collector-base voltage	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage	V_{CEO}	max.	60	80	100	120	V
Collector current DC	I_C	max.		12			A
Total power dissipation up to T_h = 25 °C	P_{tot}	max.		39			W
Junction temperature	T_j	max.		150			°C
DC current gain	h_{FE}	min.		1000			

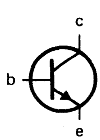
MECHANICAL DATA

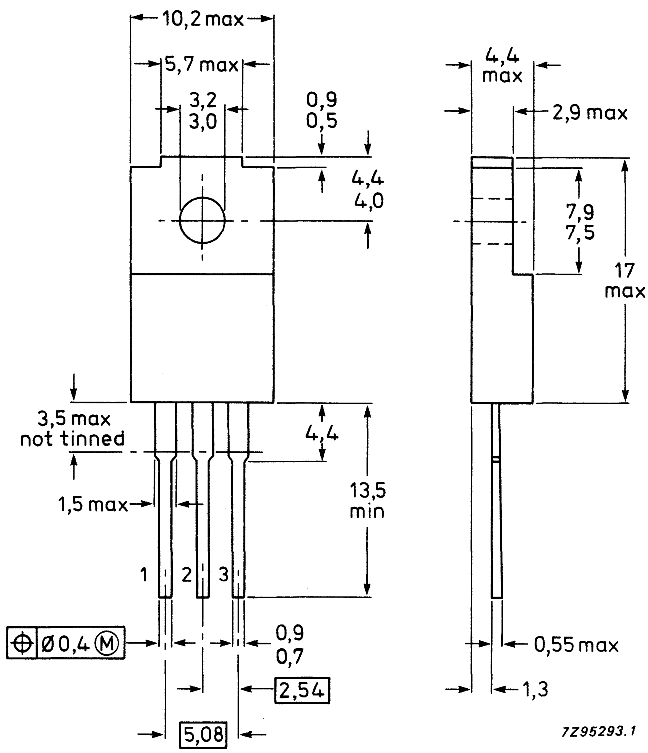
Dimensions in mm

Fig. 1 SOT-186.

Pinning:

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT65F	65AF	65BF	65CF	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5.0	V
Collector current				
DC	I_C	max.	12	A
peak value	I_{CM}	max.	20	A
Base current (DC)	I_B	max.	500	mA
Total power dissipation				
up to T_h = 25 °C (1)	P_{tot}	max.	22	W
up to T_h = 25 °C (2)	P_{tot}	max.	39	W
Storage temperature	T_{stg}		−65 to 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

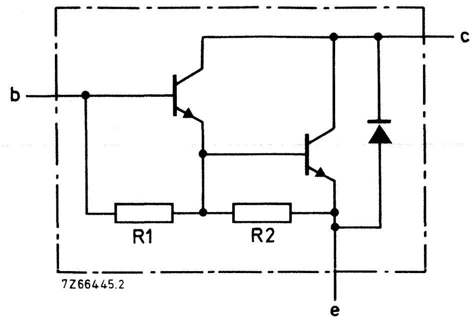
From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	0.9	K/W
From junction to internal heatsink (1)	$R_{th\ j\text{-}h}$	=	5.7	K/W
From junction to internal heatsink (2)	$R_{th\ j\text{-}h}$	=	3.2	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V
Insulation capacitance from collector to external heatsink	C_{th}	typ.	12	pF

(1) Mounted without heatsink compound and 30 ± 5 newton pressure on centre of envelope.

(2) Mounted with heatsink compound and 30 ± 5 newton pressure on centre of envelope.



R1 typ. 5 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	max.	0.4	mA
$I_E = 0$; $T_j = 150$ °C; $V_{CB} = 1/2\ V_{CBOmax}$;	I_{CBO}	max.	2.0	mA
$I_B = 0$; $V_{CE} = 1/2\ V_{CEOmax}$	I_{CEO}	max.	1.0	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	5.0	mA
DC current gain (3)				
$I_C = 1$ A; $V_{CE} = 4$ V	h_{FE}	typ.	1500	
$I_C = 5$ A; $V_{CE} = 4$ V	h_{FE}	min.	1000	
$I_C = 12$ A; $V_{CE} = 4$ V	h_{FE}	typ.	1500	
Base-emitter voltage				
$I_C = 5$ A; $V_{CE} = 4$ V	V_{BE}	max.	2.5	V
Collector-emitter saturation voltage (3)				
$I_C = 5$ A; $I_B = 20$ mA	V_{CEsat}	max.	2.0	V
$I_C = 10$ A; $I_B = 100$ mA	V_{CEsat}	max.	3.0	V
Diode, forward voltage				
$I_F = 5$ A	V_F	max.	2.0	V
Collector capacitance at f = 1 MHz				
$V_{CB} = 10$ V; $I_E = I_C = 0$	C_c	typ.	200	pF
Second-breakdown collector current non-repetitive; without heatsink				
$V_{CE} = 60$ V; $t_p = 0.1$ s	$I_{(SB)}$	min.	0.65	A
Turn-off breakdown energy with inductive load;				
$-I_{Boff} = 0$; $I_{CM} = 6.3$ A; L = 5 mH	$E_{(BR)}$	min.	100	mJ
Switching times				
$I_{Con} = 5$ A; $I_{Bon} = -I_{Boff} = 20$ mA				
Turn-on time	t_{on}	typ.	1.0	μs
		max.	2.5	μs
Turn-off time	t_{off}	typ.	6.0	μs
		max.	10	μs
Small-signal current gain at f = 1 MHz				
$I_C = 5$ A; $V_{CE} = 3$ V	h_{fe}	min.	10	

(3) Measured under pulse conditions; $t_p \leqslant 300\ \mu s$; $\delta < 2\%$.

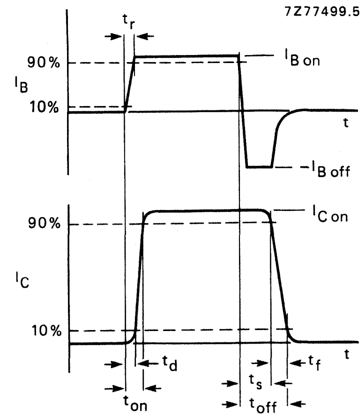
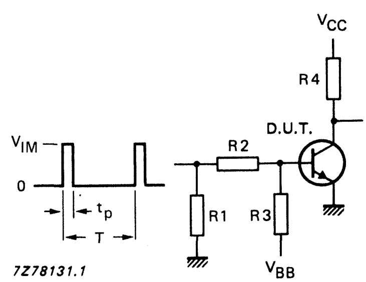


Fig. 3 Switching times waveforms.



V_{IM} = 15 V
V_{CC} = 30 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 6 Ω
$t_r = t_f$ = 15 ns
t_p = 10 µs
T = 500 µs

Fig. 4 Switching times test circuit.

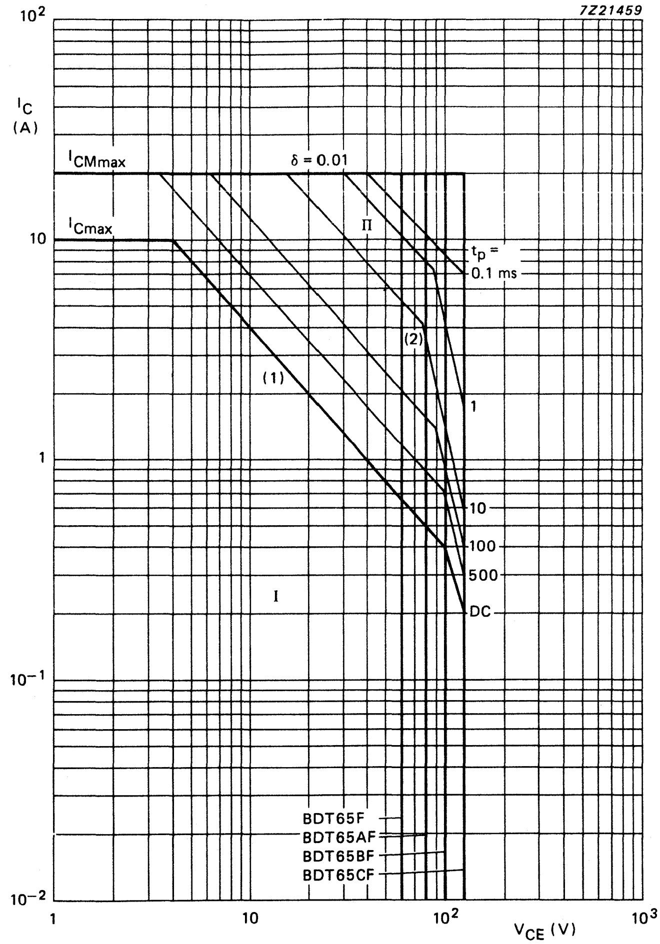


Fig. 5 Safe Operating Area; T_h = 25 °C.

I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

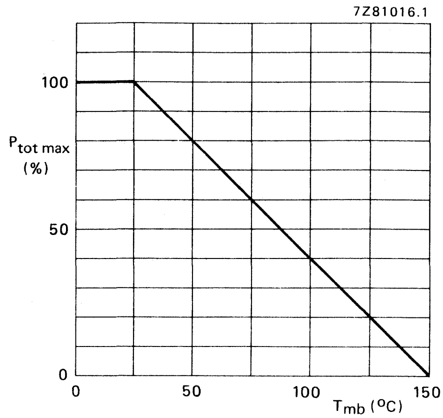


Fig. 6 Power derating curve.

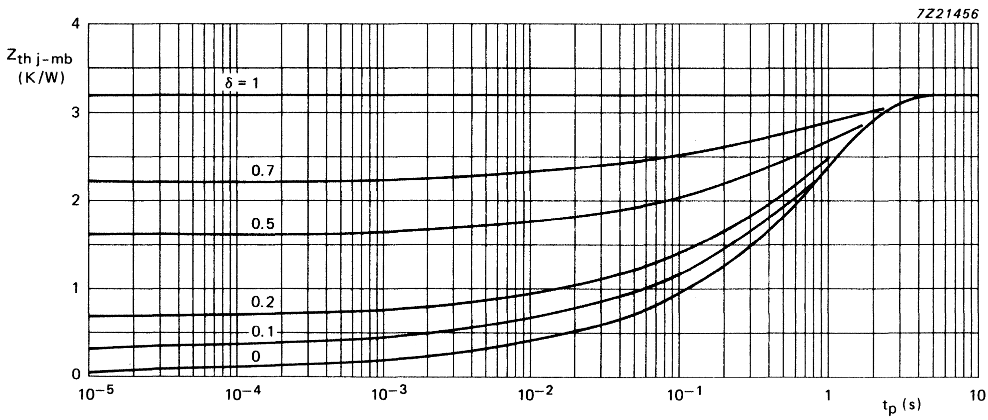


Fig. 7 Pulse power rating chart.

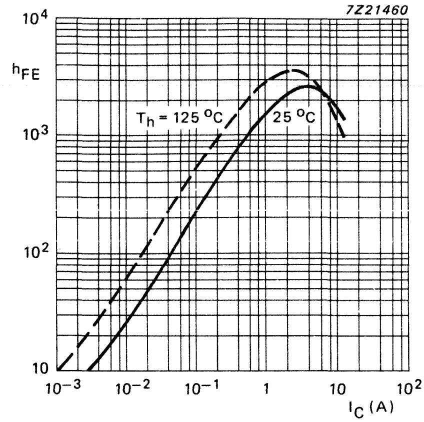


Fig. 8 Typical DC current gain as a function of collector current; V_{CE} = 4 V.

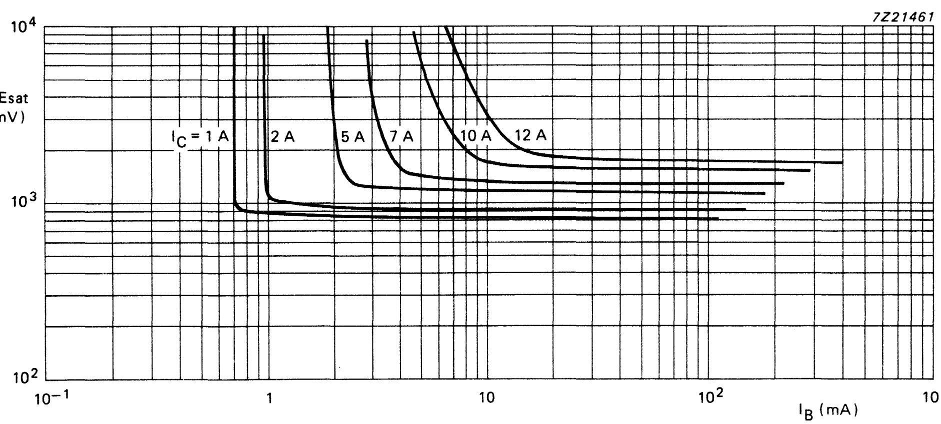


Fig. 9 Typical collector-emitter saturation voltages; T_{mb} = 25 °C.

SILICON POWER TRANSISTORS

N-P-N epitaxial base transistors in a TO-220 plastic envelope, designed for use in audio output stages and general amplifier and switching applications.

P-N-P complements are BDT82, BDT84, BDT86 and BDT88.

QUICK REFERENCE DATA

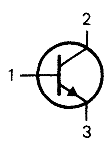
			BDT81	BDT83	BDT85	BDT87	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	7	7	7	V
Collector current (d.c.)	I_C	max.	15				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125				W
Junction temperature	T_j	max.	150				°C
D.C. current gain I_C = 5 A; V_{CE} = 4 V	h_{FE}	min.	40				

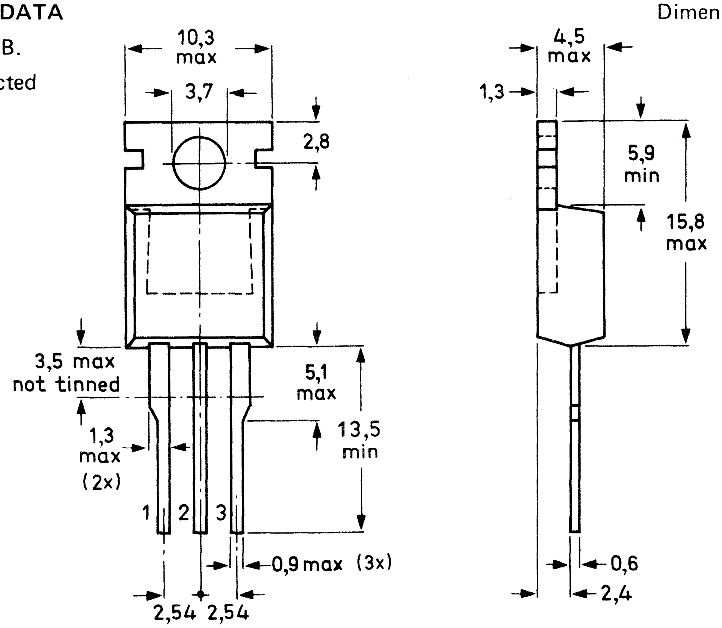
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to case.





See also chapters Mounting instructions and Accessories

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT81	BDT83	BDT85	BDT87	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	7	7	7	V

Collector current (d.c.)	I_C	max.	15	A
Collector current (peak value)	I_{CM}	max.	20	A
Base current (d.c.)	I_B	max.	4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
→ $I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,2	mA
$V_{BE} = 0$; $V_{CE} = 0{,}8\ V_{CBOmax}$	I_{CES}	<	1	mA
Emitter cut-off current				
→ $I_C = 0$; $V_{EB} = 7$ V	I_{EBO}	<	0,1	mA
D.C. current gain*				
→ I_C = 50 mA; V_{CE} = 10 V	h_{FE}	>	40	
→ I_C = 5 A; V_{CE} = 4 V	h_{FE}	>	40	
Collector-emitter saturation voltage*				
I_C = 5 A; I_B = 0,5 A	V_{CEsat}	<	1	V*
I_C = 7 A; I_B = 0,7 A	V_{CEsat}	<	1,6	V*
Base-emitter voltage*				
I_C = 5 A; V_{CE} = 4 V	V_{BE}	<	1,5	V*
Transition frequency at f = 1 MHz				
I_C = 0,5 A; V_{CE} = 10 V	f_T	typ.	10	MHz
Second breakdown collector current				
V_{CE} = 50 V; t_p = 100 ms	I_{SB}	>	2,5	A

* Measured under pulse conditions: $t_p \leq 300\ \mu s$; $\delta \leq 2\%$.

Switching times (see Fig. 2)
$I_C = 7$ A; $I_{B1} = -I_{B2} = 0{,}7$ A

t_{on}	$\leqslant$	1 μs
t_{off}	$\leqslant$	2 μs

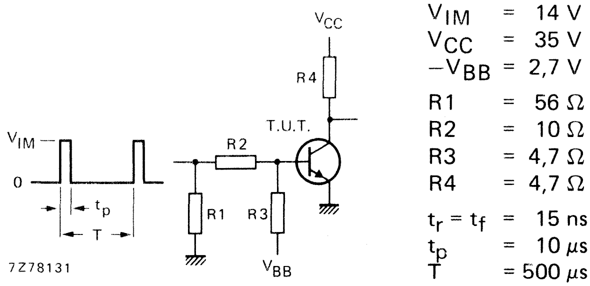


Fig. 2 Switching times test circuit.

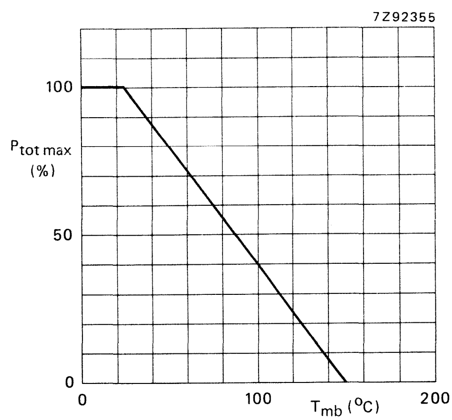


Fig. 3 Power derating curve.

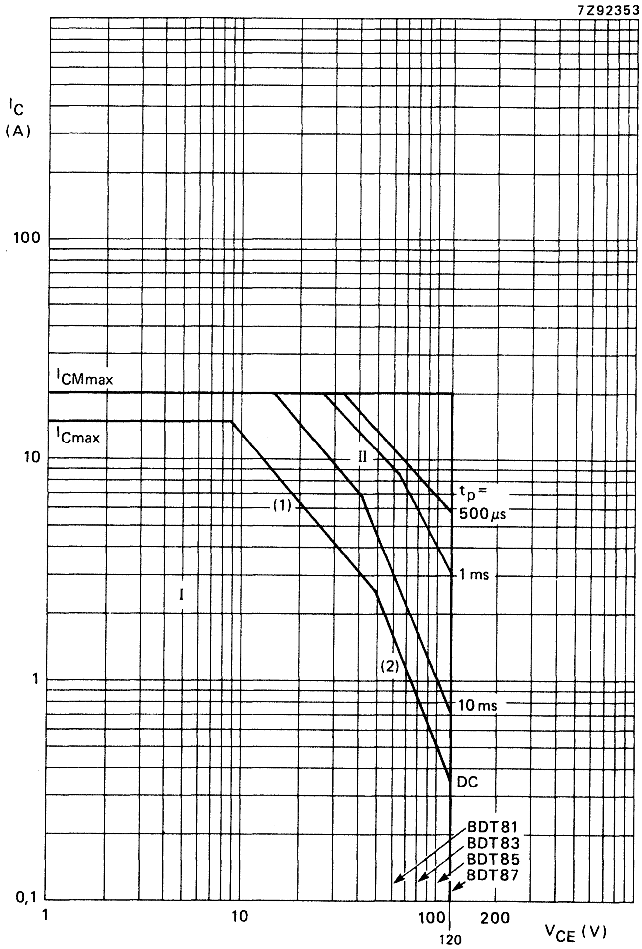


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C; δ = 0,01.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

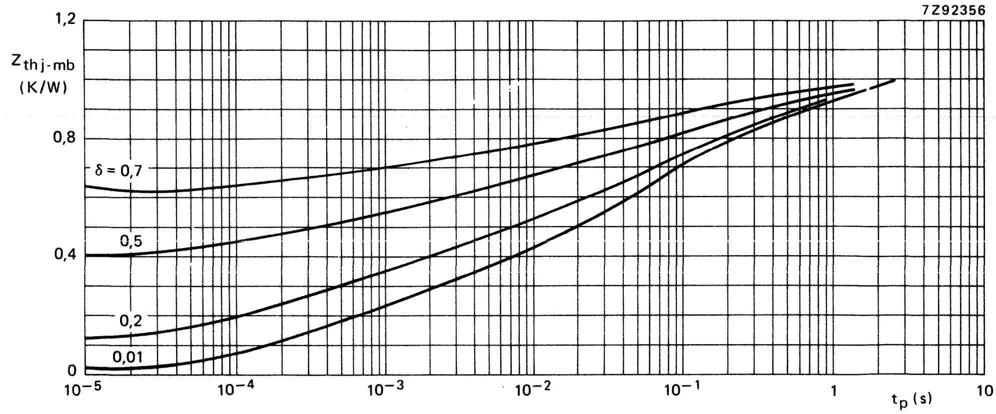


Fig. 5 Pulse power rating chart.

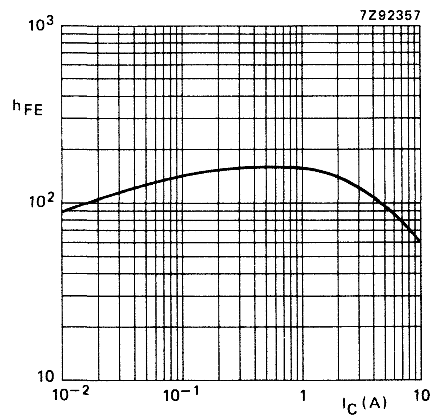


Fig. 6 Typical d.c. current gain; T_{amb} = 25 °C; V_{CE} = 4 V.

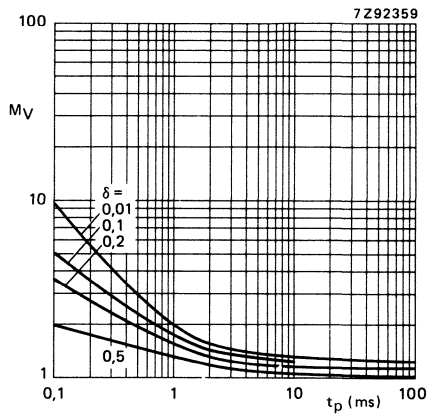


Fig. 7 Second-breakdown voltage multiplying factor at I_{Cmax} level.

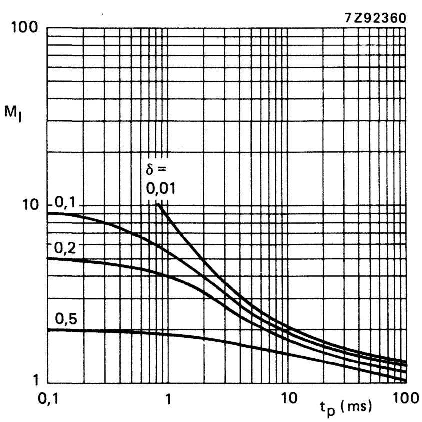


Fig. 8 Second-breakdown current multiplying factor at the V_{CEOmax} level.

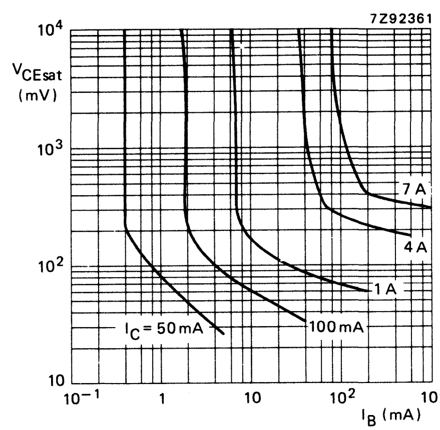


Fig. 9 Typical values collector-emitter saturation voltage.

SILICON EPITAXIAL POWER TRANSISTORS

NPN silicon epitaxial power transistors, each in a SOT186 envelope with an electrically insulated mounting base.

PNP complements are BDT82F, BDT84F, BDT86F and BDT88F.

QUICK REFERENCE DATA

			BDT81F	83F	85F	87F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7				V
DC collector current	I_C	max.	15				A
Peak collector current	I_{CM}	max.	20				A
Total power dissipation at $T_h \leq 25\ ^oC$	P_{tot}	max.	36				W
DC current gain $I_C = 5\ A$; $V_{CE} = 4\ V$	h_{FE}	typ.	40				

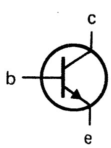
MECHANICAL DATA

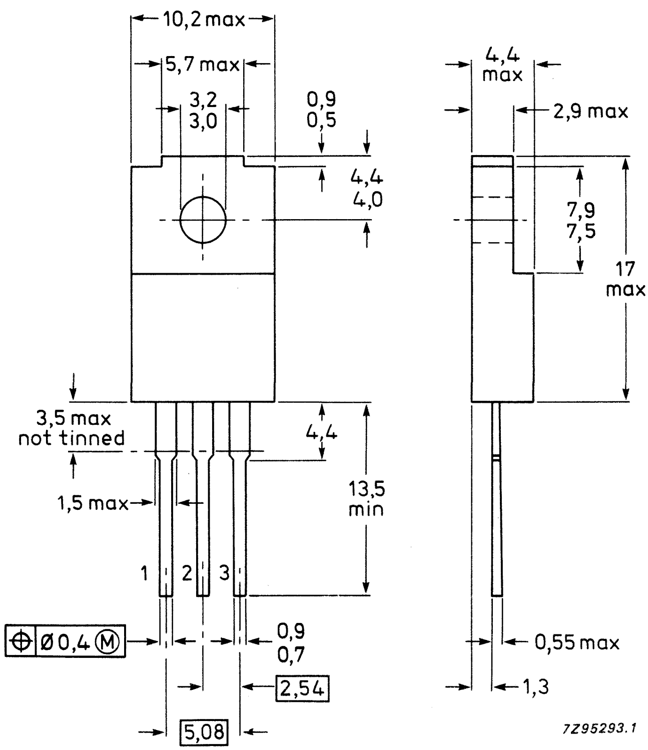
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT81F	83F	85F	87F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.		7			V
DC collector current	I_C	max.		15			A
Peak collector current	I_{CM}	max.		20			A
DC base current	I_B	max.		4			A
Total power dissipation at $T_h \leqslant 25$ °C (note 1)	P_{tot}	max.		21			W
at $T_h \leqslant 25$ °C (note 2)	P_{tot}	max.		36			W
Storage temperature range	T_{stg}			−65 to 150			°C
Junction temperature	T_j	max.		150			°C

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.5	K/W

INSULATION

Voltage allowed between all terminals and external heatsink (peak value)	V_{insul}	max.	1000	V

CHARACTERISTICS

Collector-emitter saturation voltage $I_C = 5$ A; $I_B = 0.5$ A	V_{CEsat}	max.	1.0	V
$I_C = 7$ A; $I_B = 0.7$ A	V_{CEsat}	max.	1.6	V
DC current gain $I_C = 5$ A; $V_{CE} = 4$ V	h_{FE}	typ.	40	

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

SILICON POWER TRANSISTORS

P-N-P epitaxial base transistors in a TO-220 plastic envelope, designed for use in audio output stages and general amplifier and switching applications.

N-P-N complements are BDT81, BDT83, BDT85 and BDT87.

QUICK REFERENCE DATA

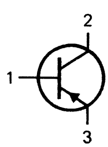
			BDT82	BDT84	BDT86	BDT88	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	7	7	7	7	V
Collector current (d.c.)	$-I_C$	max.		15			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		125			W
Junction temperature	T_j	max.		150			°C
D.C. current gain $-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	min.		40			

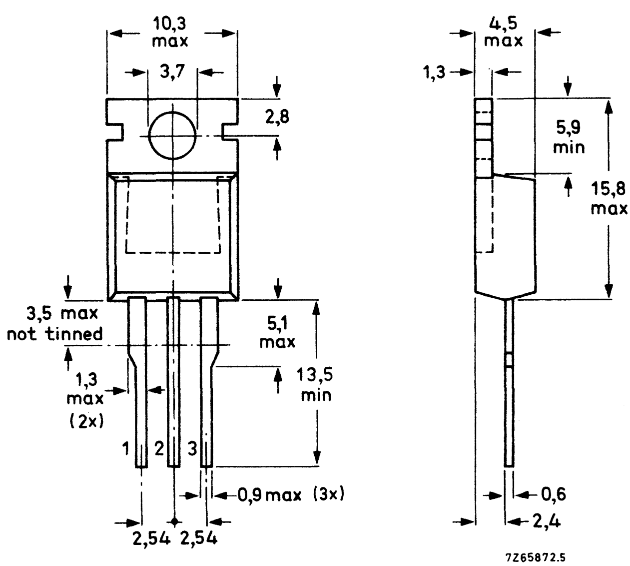
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to case.





See also chapters Mounting instructions and Accessories

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT82	BDT84	BDT86	BDT88	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	7	7	7	7	V

Collector current (d.c.)	$-I_C$	max.	15	A
Collector current (peak value)	$-I_{CM}$	max.	20	A
Base current (d.c.)	$-I_B$	max.	4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	max.	1	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	max.	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
→ $-I_E = 0$; $-V_{CB} = V_{CBOmax}$	$-I_{CBO}$	<	0.2	mA
$-V_{BE} = 0$; $-V_{CE} = 0,8\ V_{CBOmax}$	$-V_{CES}$	<	1	mA
Emitter cut-off current				
→ $-I_C = 0$; $-V_{EB} = 7$ V	$-I_{EBO}$	<	0.1	mA
D.C. current gain*				
→ $-I_C = 50$ mA; $-V_{CE} = 10$ V	h_{FE}	>	40	
→ $-I_C = 5$ A; $-V_{CE} = 4$ V	h_{FE}	>	40	
Collector-emitter saturation voltage*				
$-I_C = 5$ A; $-I_B = 0,5$ A	$-V_{CEsat}$	<	1	V*
$-I_C = 7$ A; $-I_B = 0,7$ A	$-V_{CEsat}$	<	1,6	V*
Base-emitter voltage*				
$-I_C = 5$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,5	V*
Transition frequency at f = 1 MHz				
$-I_C = 0,5$ A; $-V_{CE} = 10$ V	f_T	typ.	20	MHz
Second breakdown collector current				
$-V_{CE} = 50$ V; $t_p = 100$ ms (non-repetitive without heatsink)	$-I_{SB}$	>	2,5	A

* Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta \leqslant 2\%$.

Switching times (see Fig. 2)

$-I_C = 7$ A; $-I_{B1} = I_{B2} = 0,7$ A	t_{on}	$\leqslant$	1 μs
	t_{off}	$\leqslant$	2 μs

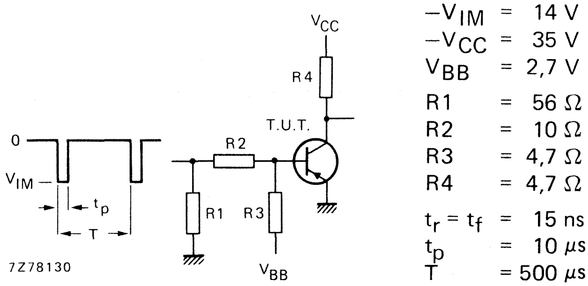


Fig. 2 Switching times test circuit.

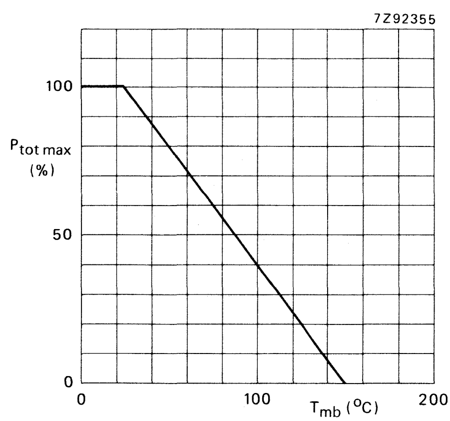


Fig. 3 Power derating curve.

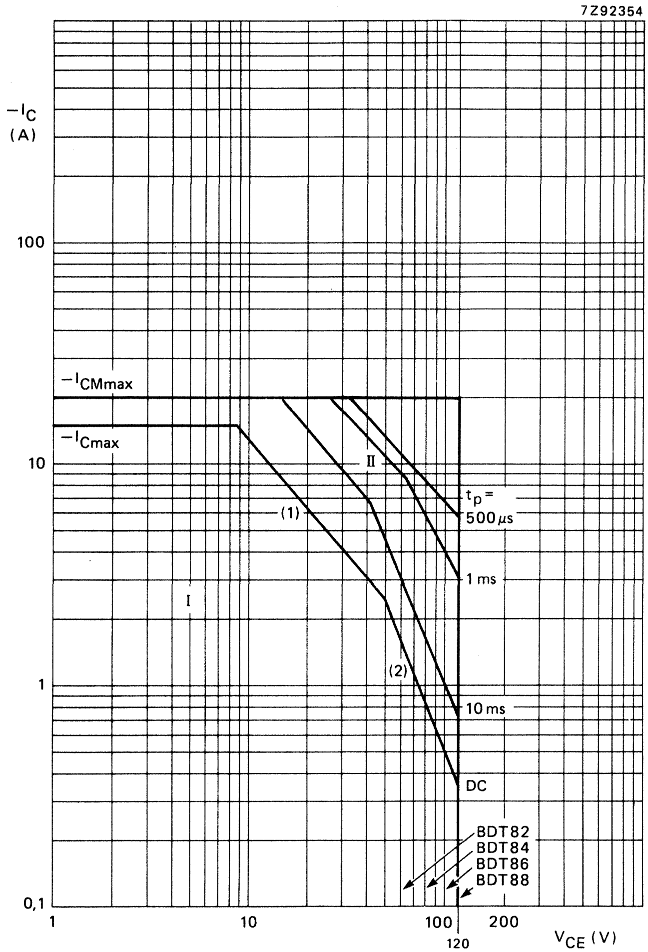


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C; δ = 0,01.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

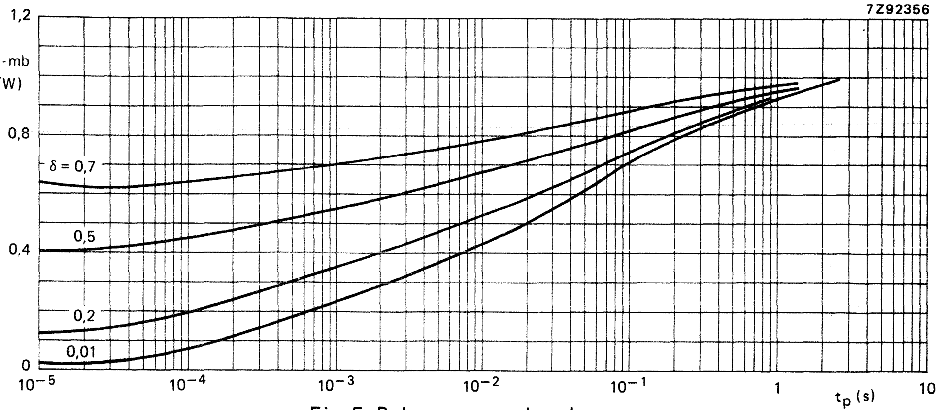


Fig. 5 Pulse power rating chart.

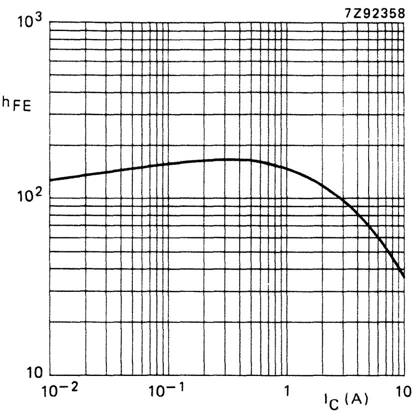


Fig. 6 Typical d.c. current gain; T_{amb} = 25 °C; $-V_{CE}$ = 4 V.

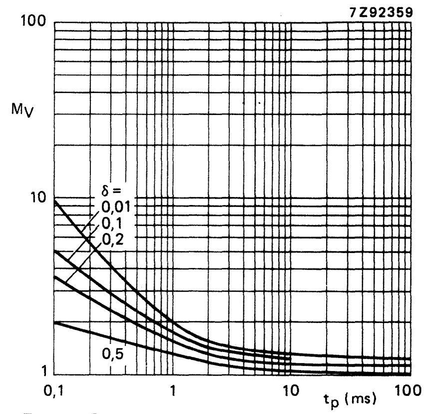


Fig. 7 Second-breakdown voltage multiplying factor at I_{Cmax} level.

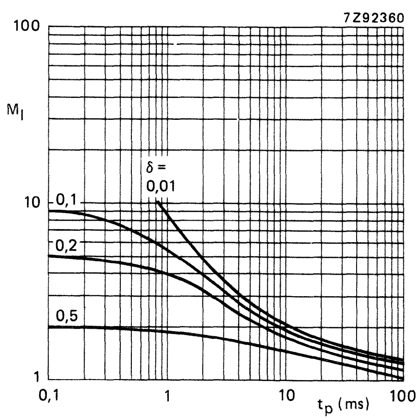


Fig. 8 Second-breakdown current multiplying factor at V_{CEOmax} level.

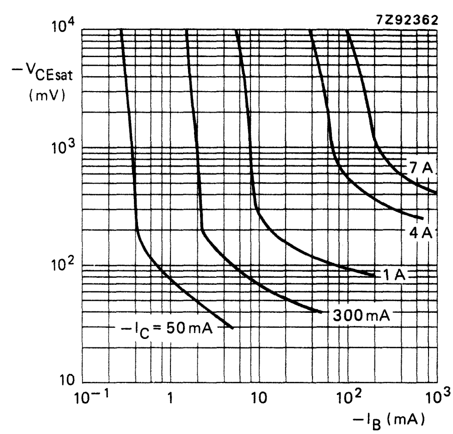


Fig. 9 Typical values collector-emitter saturation voltage.

SILICON EPITAXIAL POWER TRANSISTORS

PNP silicon epitaxial power transistors, each in a SOT186 envelope with an electrically insulated mounting base.
NPN complements are BDT81F, BDT83F, BDT85F, and BDT87F.

QUICK REFERENCE DATA

			BDT82F	84F	86F	88F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		7			V
DC collector current	$-I_C$	max.		15			A
Peak collector current	$-I_{CM}$	max.		20			A
Total power dissipation at $T_h \leq 25\ ^oC$	P_{tot}	max.		36			W
DC current gain $-I_C = 5$ A; $-V_{CE} = 4$ V	h_{FE}	typ.		40			

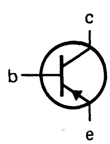
MECHANICAL DATA

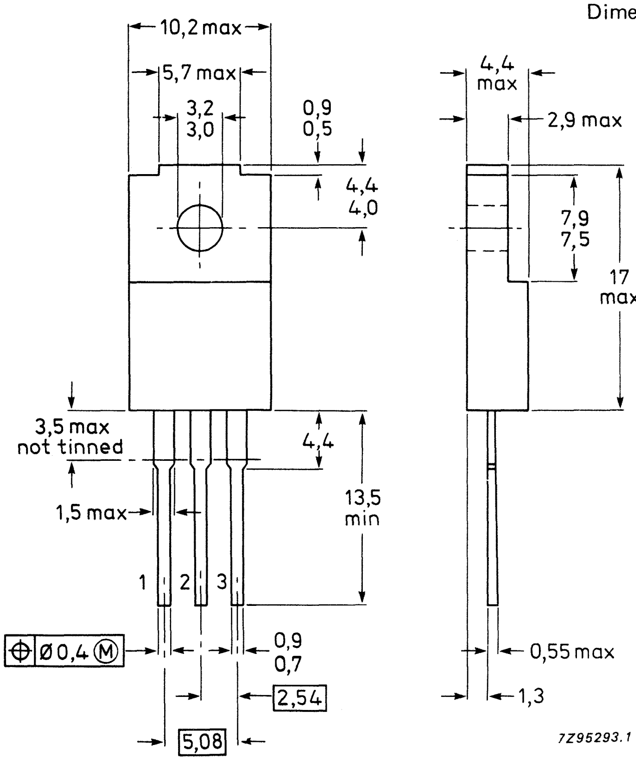
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT82F	84F	86F	88F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	7				V
DC collector current	$-I_C$	max.	15				A
Peak collector current	$-I_{CM}$	max.	20				A
DC base current	$-I_B$	max.	4				A
Total power dissipation at $T_h \leqslant 25\ ^oC$ (note 1)	P_{tot}	max.	21				W
at $T_h \leqslant 25\ ^oC$ (note 2)	P_{tot}	max.	36				W
Storage temperature range	T_{stg}		−65 to 150				^oC
Junction temperature	T_j	max.	150				^oC

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.5	K/W

INSULATION

Voltage allowed between all terminals and external heatsink, peak value	V_{insul}	max.	1000	V

CHARACTERISTICS

Collector-emitter saturation voltage $-I_C = 5$ A; $-I_B = 0.5$ A	$-V_{CEsat}$	max.	1.0	V
$-I_C = 7$ A; $-I_B = 0.7$ A	$-V_{CEsat}$	max.	1.6	V
DC current gain $-I_C = 5$ A; $-V_{CE} = 4$ V	h_{FE}	typ.	40	

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound 30 ± 5 newtons pressure on centre of envelope.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N transistors in a plastic envelope intended for use in audio output stages and general amplifier and switching applications.
P-N-P complements are BDT92, BDT94 and BDT96.

QUICK REFERENCE DATA

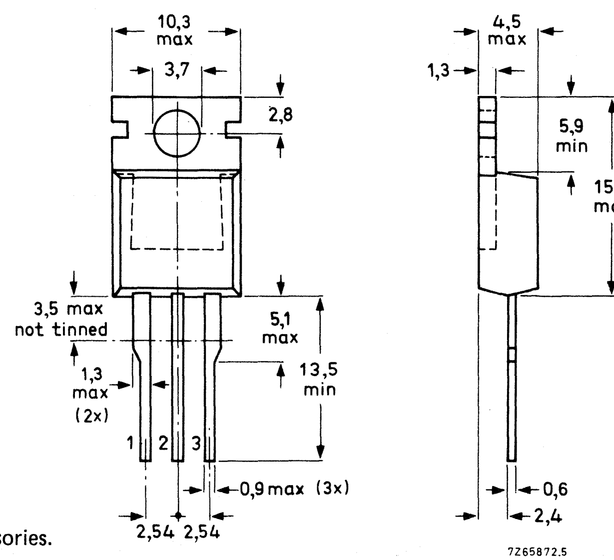
			BDT91	BDT93	BDT95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value)	I_{CM}	max.		20		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		90		W
Junction temperature	T_j	max.		150		^oC
D.C. current gain						
$I_C = 4$ A; $V_{CE} = 4$ V	h_{FE}			20 to 200		
$I_C = 10$ A; $V_{CE} = 4$ V	h_{FE}	>		5		
Transition frequency						
$I_C = 0{,}5$ A; $V_{CE} = 10$ V	f_T	>		4		MHz

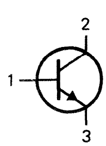
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters
Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT91	BDT93	BDT95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.		7		V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value)	I_{CM}	max.		20		A
Base current (d.c.)	I_B	max.		4		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,4	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 150 °V	I_{CBO}	<	5	mA
$I_B = 0$; $V_{CE} = V_{CEOmax}$	I_{CEO}	<	1	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 7 V	I_{EBO}	<	1	mA
D.C. current gain (note 1)				
I_C = 4 A; V_{CE} = 4 V	h_{FE}		20 to 200	
I_C = 10 A; V_{CE} = 4 V	h_{FE}	>	5	
Base-emitter voltage (notes 1 and 2)				
I_C = 4 A; V_{CE} = 4 V	V_{BE}	<	1,6	V
Collector-emitter saturation voltage (note 1)				
I_C = 4 A; I_B = 0,4 A	V_{CEsat}	<	1	V
I_C = 10 A; I_B = 3,3 A	V_{CEsat}	<	3	V
Transition frequency at f = 1 MHz				
I_C = 0,5 A; V_{CE} = 10 V	f_T	>	4	MHz
Cut-off frequency				
I_C = 0,5 A; V_{CE} = 10 V	f_{hfe}	>	20	kHz

Notes
1. Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta \leqslant 2\%$.
2. V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Second-breakdown collector current			
V_{CE} = 60 V; t_p = 0,1 s	$I_{(SB)}$	>	1,5 A
Switching times			
(between 10% and 90% levels)			
I_{Con} = 4 A; I_{Bon} = $-I_{Boff}$ = 0,4 A			
Turn-on time	t_{on}	typ.	0,5 μs
		<	1 μs
Turn-off time	t_{off}	typ.	2 μs
		<	4 μs

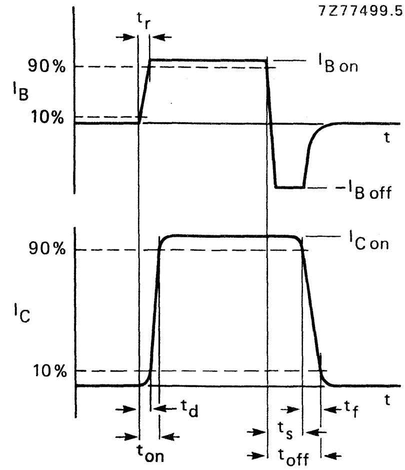


Fig. 2 Switching times waveforms.

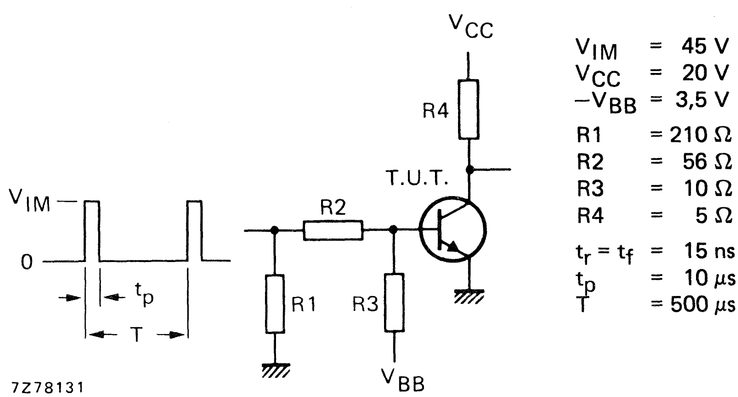


Fig. 3 Switching times test circuit.

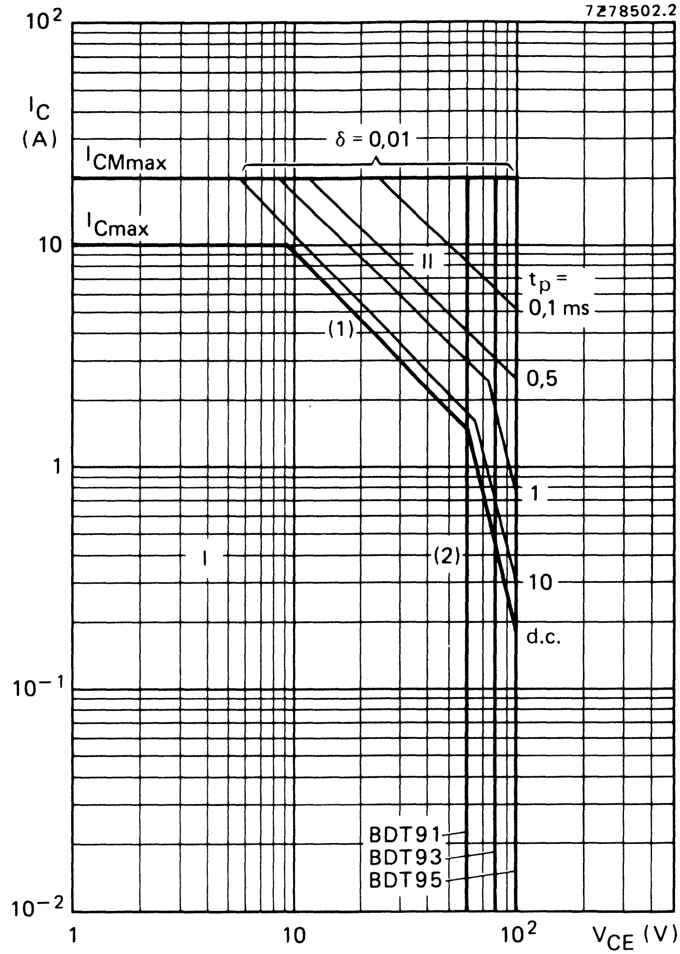


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

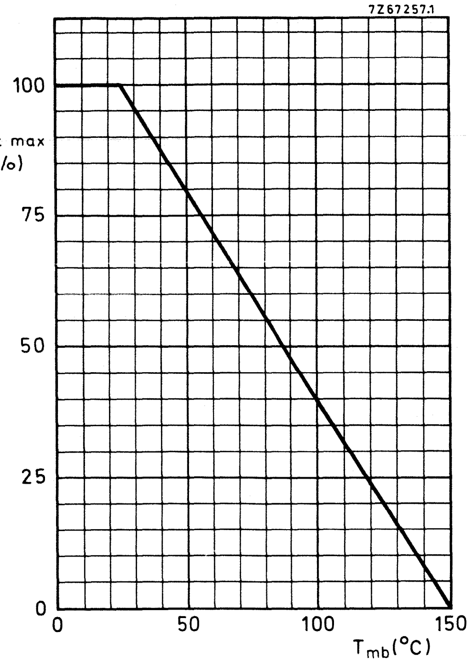


Fig. 5 Power derating curve.

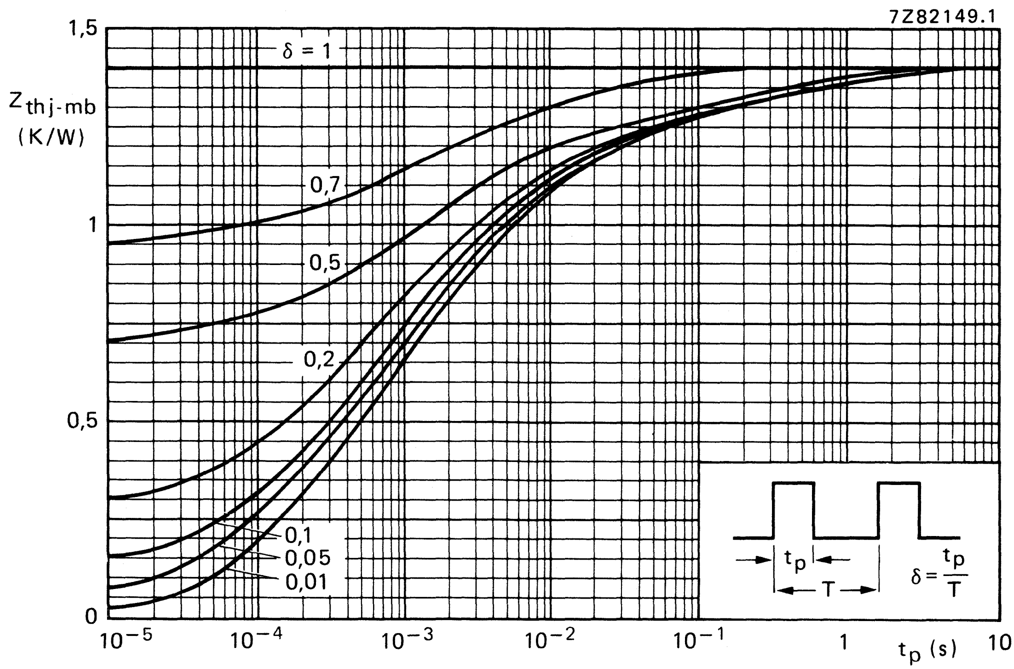


Fig. 6 Pulse power rating chart.

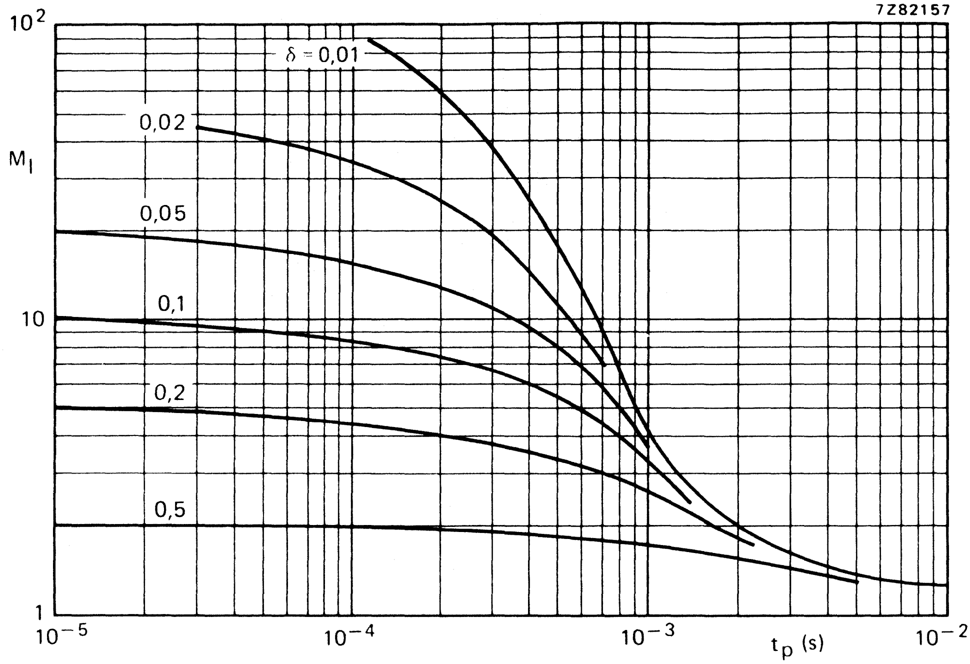


Fig. 7 S.B. current multiplying factor at the V_{CEOmax} level.

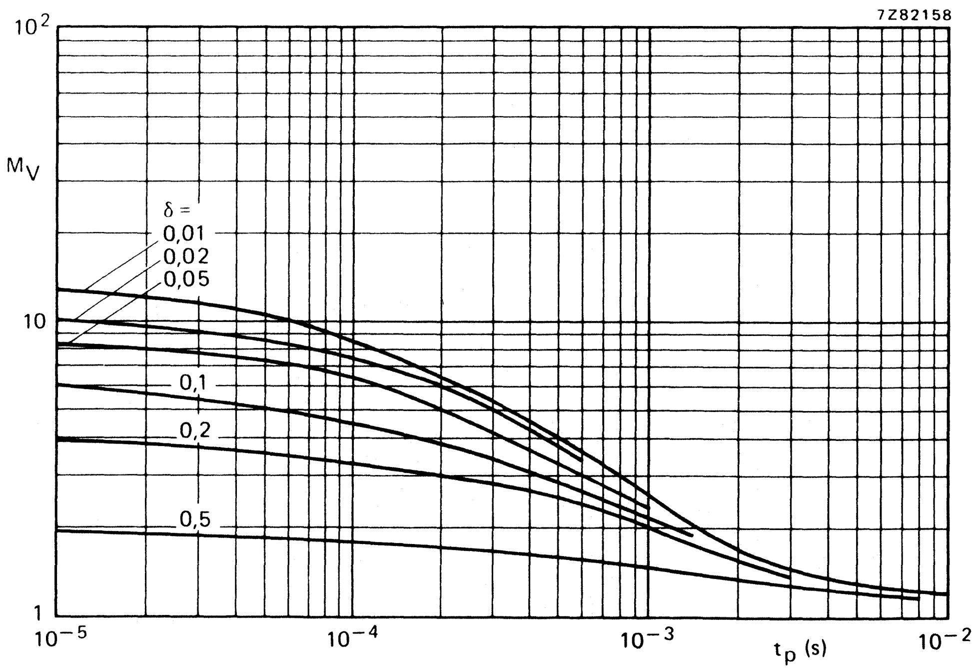


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

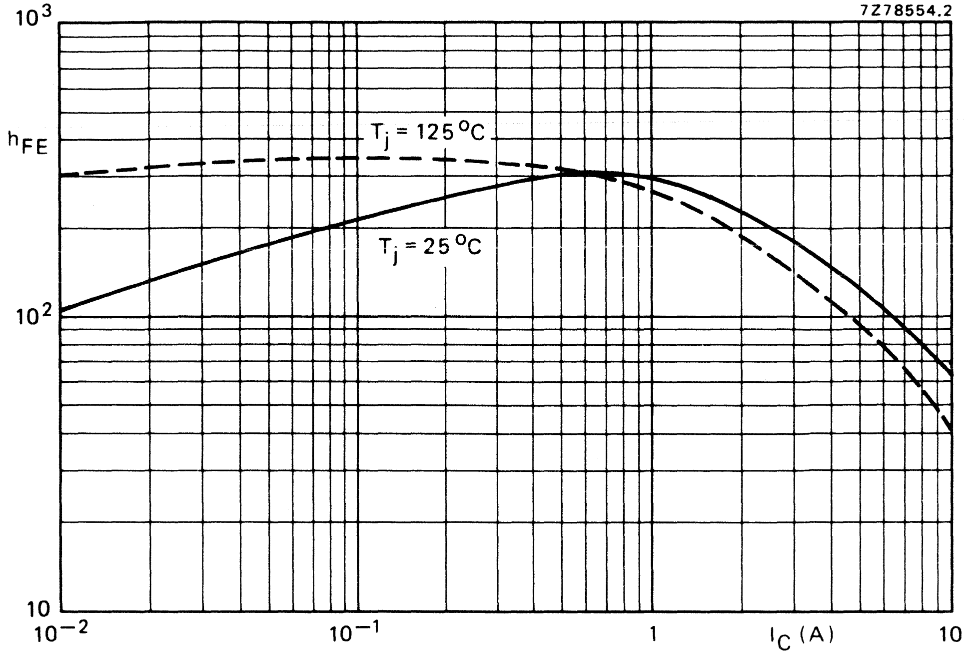


Fig. 9 Typical d.c. current gain at $V_{CE} = 4$ V.

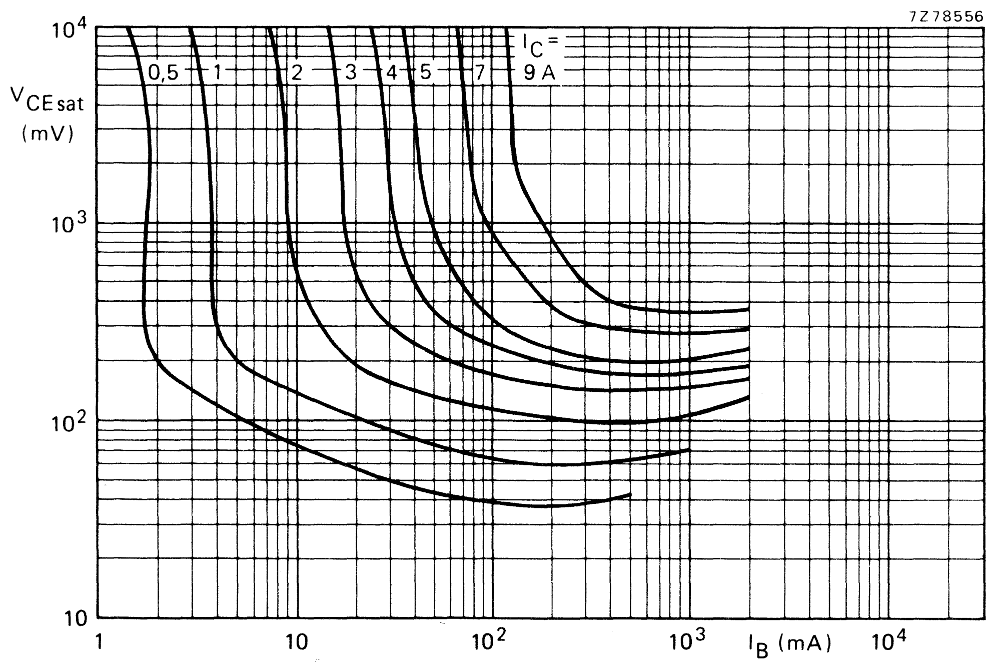


Fig. 10 Typical collector-emitter saturation voltage. $T_{mb} = 25\ ^oC$.

SILICON EPITAXIAL POWER TRANSISTORS

NPN silicon epitaxial power transistors, each in a SOT186 envelope with an electrically insulated mounting base.

PNP complements are BDT92F, BDT94F, and BDT96F.

QUICK REFERENCE DATA

			BDT91F	93F	95F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.		7		V
DC collector current	I_C	max.		10		A
Peak collector current	I_{CM}	max.		20		A
Total power dissipation at $T_h \leqslant 25\ ^oC$	P_{tot}	max.		32		W
DC current gain $I_C = 4$ A; $V_{CE} = 4$ V	h_{FE}	min.		20		
		max.		200		

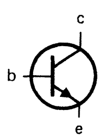
MECHANICAL DATA

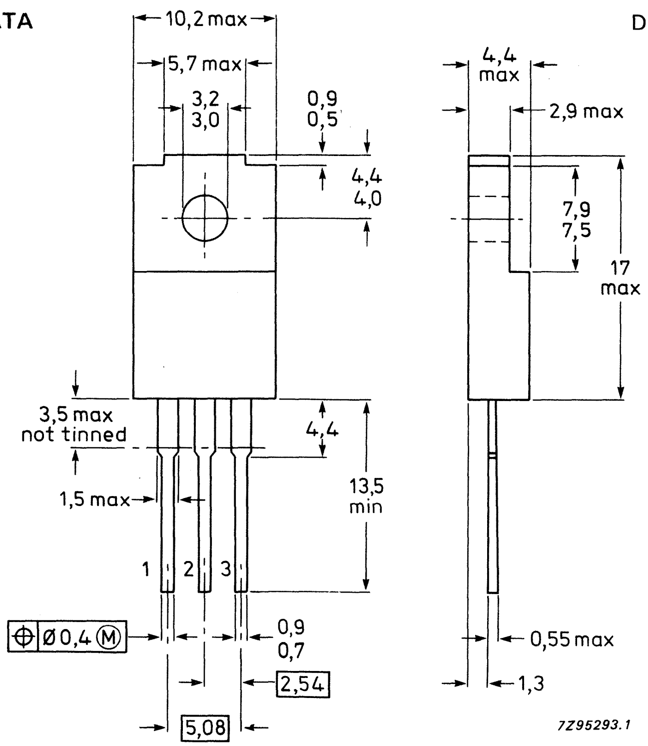
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT91F	93F	95F	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.		7		V
DC collector current	I_C	max.		10		A
Peak collector current	I_{CM}	max.		20		A
Base current	I_B	max.		4		A
Total power dissipation						
at $T_h \leqslant 25\ ^oC$ (note 1)	P_{tot}	max.		20		W
at $T_h \leqslant 25\ ^oC$ (note 2)	P_{tot}	max.		32		W
Storage temperature range	T_{stg}			−65 to + 150		^oC
Junction temperature	T_j	max.		150		^oC

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.4	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.4	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W

INSULATION

Voltage allowed between all terminals and external heatsink (peak value)	V_{insul}	max.	1000	V

CHARACTERISTICS

Collector-emitter saturation voltage				
$I_C = 4$ A; $I_B = 0.4$ A	V_{CEsat}	max.	1	V
$I_C = 10$ A; $I_B = 3.3$ A	V_{CEsat}	max.	3	V
DC current gain				
$I_C = 4$ A; $V_{CE} = 4$ V	h_{FE}	min.	20	
		max.	200	

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic envelope intended for use in audio output stages and general amplifier and switching applications.
N-P-N complements are BDT91, BDT93 and BDT95.

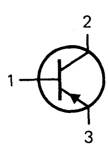
QUICK REFERENCE DATA

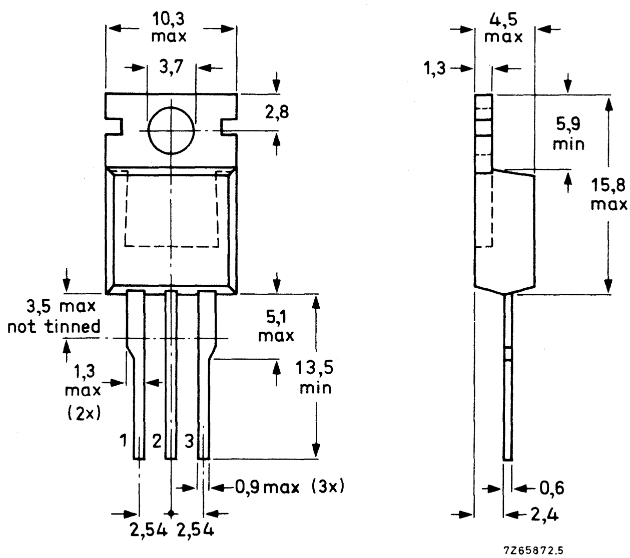
			BDT92	BDT94	BDT96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		10		A
Collector current (peak value)	$-I_{CM}$	max.		20		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
$-I_C$ = 4 A; $-V_{CE}$ = 4 V	h_{FE}			20 to 200		
$-I_C$ = 10 A; $-V_{CE}$ = 4 V	h_{FE}	>		5		
Transition frequency						
$-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_T	>		4		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.





See also chapters
Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT92	BDT94	BDT96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		7		V
Collector current (d.c.)	$-I_C$	max.		10		A
Collector current (peak value)	$-I_{CM}$	max.		20		A
Base current (d.c.)	$-I_B$	max.		4		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,4	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

→ Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,1	mA
$I_E = 0$; $-V_{CB} = -½V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<	1	mA
$I_B = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CEO}$	<	0,2	mA
→ Emitter cut-off current				
$I_C = 0$; $-V_{EB}$ = 7 V	$-I_{EBO}$	<	0,1	mA
D.C. current gain (note 1)				
$-I_C$ = 4 A; $-V_{CE}$ = 4 V	h_{FE}		20 to 200	
$-I_C$ = 10 A; $-V_{CE}$ = 4 V	h_{FE}	>	5	
Base-emitter voltage (notes 1 and 2)				
$-I_C$ = 4 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	1,6	V
Collector-emitter saturation voltage (note 1)				
$-I_C$ = 4 A; $-I_B$ = 0,4 A	$-V_{CEsat}$	<	1	V
$-I_C$ = 10 A; $-I_B$ = 3,3 A	$-V_{CEsat}$	<	3	V
Transition frequency at f = 1 MHz				
$-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_T	>	4	MHz
Cut-off frequency				
$-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_{hfe}	>	20	kHz
D.C. current gain ratio of matched pairs				
BDT91/92; $-I_C$ = 3 A; $-V_{CE}$ = 3 V	h_{FE1}/h_{FE2}	<	2,5	

Notes
1. Measured under pulse conditions: $t_p \leq 300\ \mu s$; $\delta \leq 2\%$.
2. V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Second-breakdown collector current			
$-V_{CE} = 60$ V; $t_p = 0,1$ s	$-I_{(SB)}$	>	1,5 A
Switching times			
(between 10% and 90% levels)			
$-I_{Con} = 4$ A; $-I_{Bon} = +I_{Boff} = 0,4$ A			
Turn-on time	t_{on}	typ.	0,5 μs
		<	1,5 μs
Turn-off time	t_{off}	typ.	1 μs
		<	3 μs

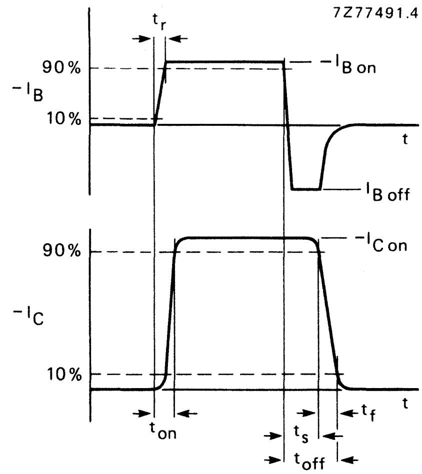
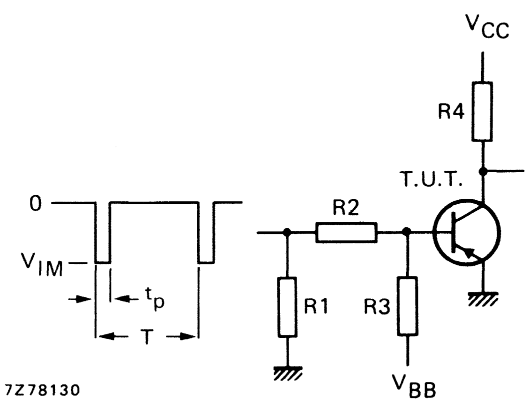


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	45 V
$-V_{CC}$	=	20 V
V_{BB}	=	3,5 V
R1	=	210 Ω
R2	=	56 Ω
R3	=	10 Ω
R4	=	5 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

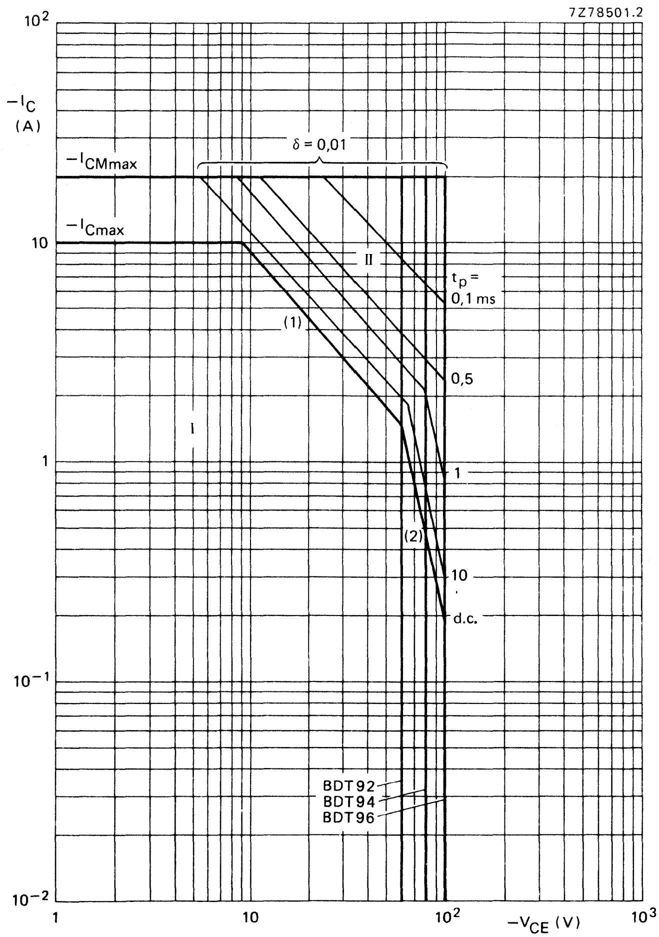


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits

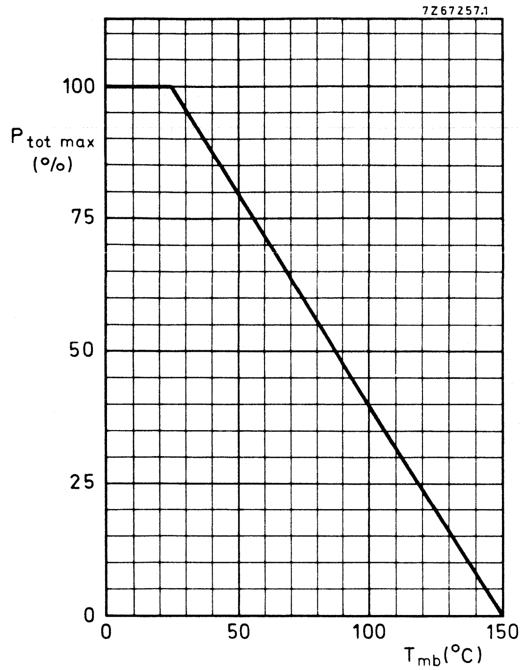


Fig. 5 Power derating curve.

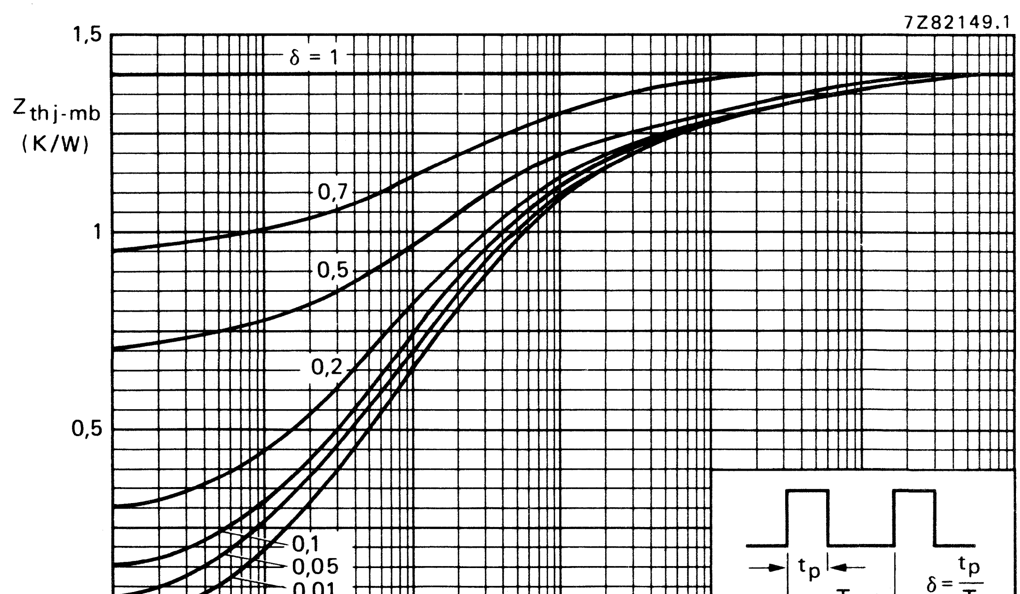


Fig. 6 Pulse power rating chart.

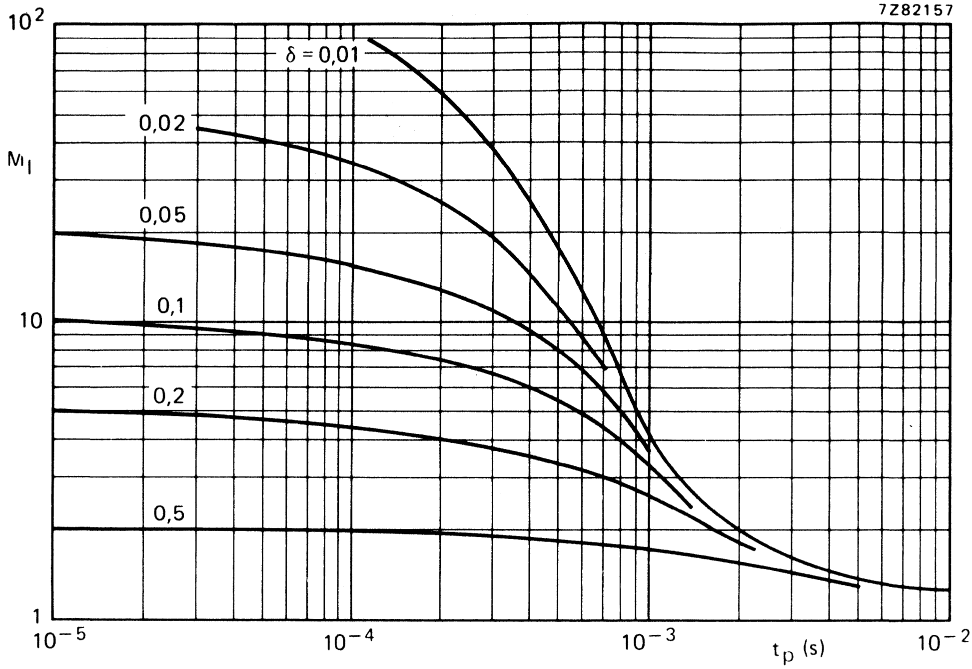


Fig. 7 S.B. current multiplying factor at the V_{CEOmax} level.

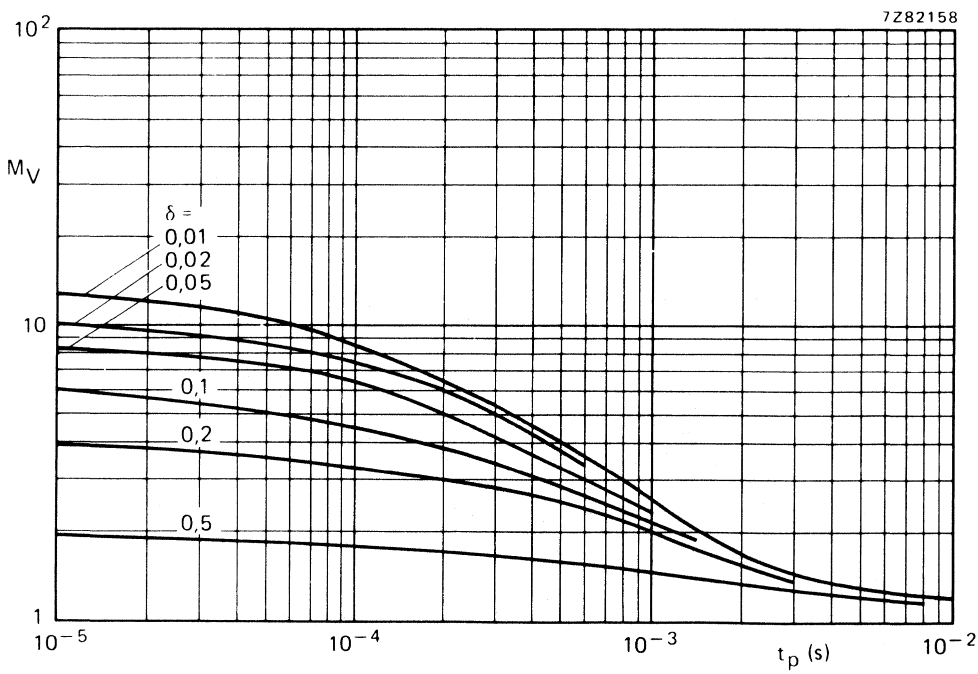


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

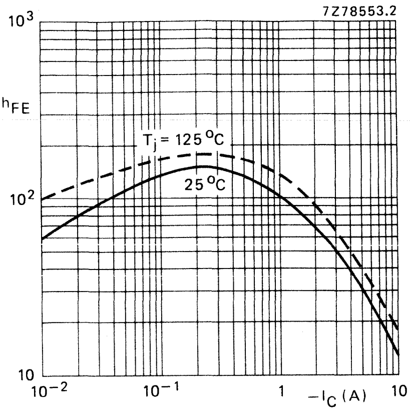


Fig. 9 Typical d.c. current gain at $-V_{CE}$ = 4 V.

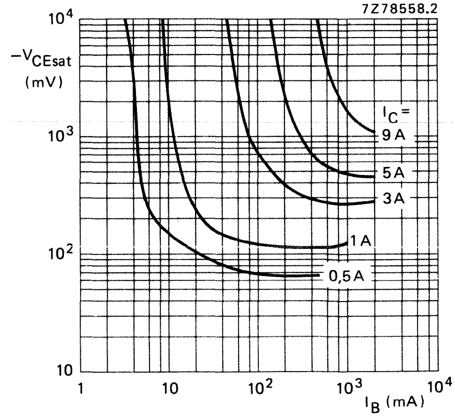


Fig. 10 Typical collector-emitter saturation voltage. T_{mb} = 25 °C.

SILICON EPITAXIAL POWER TRANSISTORS

PNP silicon epitaxial power transistors, each in a SOT186 envelope with an electrically insulated mounting base.

NPN complements are BDT91F, BDT93F, and BDT95F.

QUICK REFERENCE DATA

			BDT92F	94F	96F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		7		V
DC collector current	$-I_C$	max.		10		A
Peak collector current	$-I_{CM}$	max.		20		A
Total power dissipation at $T_h \leq 25\ ^oC$	P_{tot}	max.		32		W
DC current gain $-I_C = 4$ A; $-V_{CE} = 4$ V	h_{FE}	min.		20		
		max.		200		

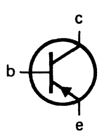
MECHANICAL DATA

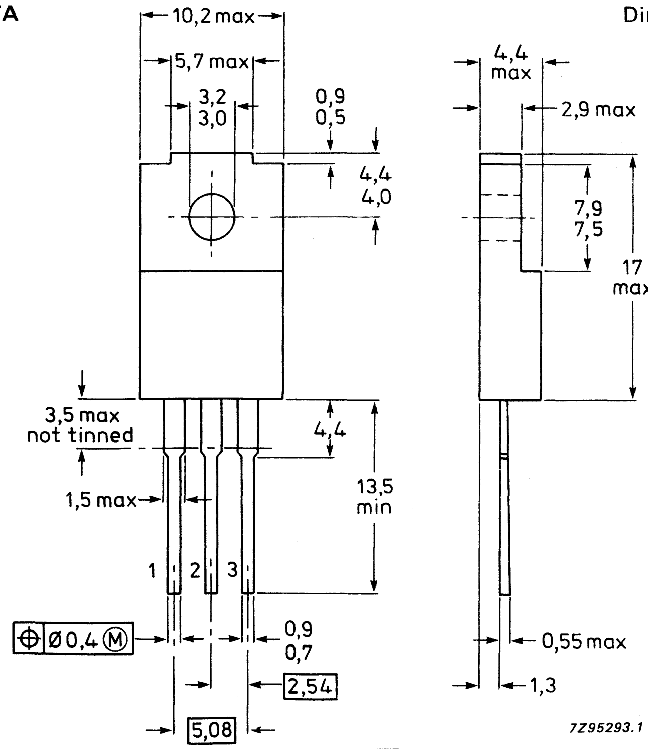
Dimensions in mm

Fig.1 SOT186.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDT92F	94F	96F	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		7		V
DC collector current	$-I_C$	max.		10		A
Peak collector current	$-I_{CM}$	max.		20		A
Base current	$-I_B$	max.		4		A
Total power dissipation at $T_h \leqslant 25\ ^oC$ (note 1)	P_{tot}	max.		20		W
Total power dissipation at $T_h \leqslant 25\ ^oC$ (note 2)	P_{tot}	max.		32		W
Storage temperature range	T_{stg}			−65 to + 150		^oC
Junction temperature	T_j	max.		150		^oC

THERMAL RESISTANCE

From junction to internal heatsink	$R_{th\ j\text{-}mb}$	=	1.4	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.4	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W

INSULATION

Voltage allowed between all terminals and external heatsink (peak value)	V_{insul}	max.	1000	V

CHARACTERISTICS

Collector-emitter saturation voltage $-I_C = 4$ A; $-I_B = 0.4$ A	$-V_{CEsat}$	max.	1	V
Collector-emitter saturation voltage $-I_C = 10$ A; $-I_B = 3.3$ A	$-V_{CEsat}$	max.	3	V
DC current gain $-I_C = 4$ A; $-V_{CE} = 4$ V	h_{FE}	min.	20	
		max.	200	

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. N-P-N complements are BDV65, 65A, 65B and 65C.

QUICK REFERENCE DATA

			BDV64	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (d.c.)	$-I_C$	max.	12				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125				W
Junction temperature	T_j	max.	150				°C
DC current gain $-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	>	1000				
Cut-off frequency $-I_C$ = 5 A; $-V_{CE}$ = 4 V	f_{hfe}	typ.	100				kHz

MECHANICAL DATA

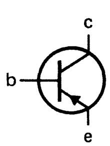
Fig. 1 SOT-93.

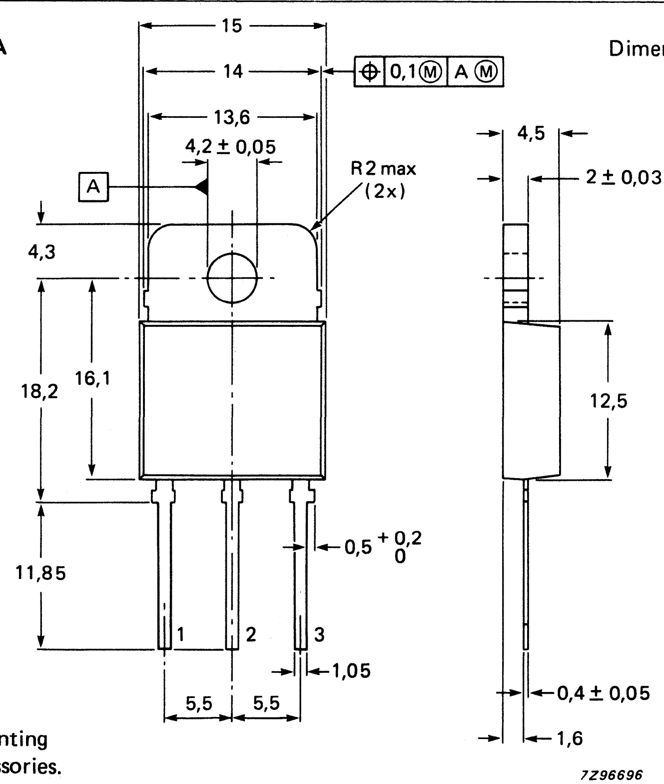
Collector connected to mounting base.

Dimensions in mm

Pinning

1 = base
2 = collector
3 = emitter





See also chapters Mounting instructions and Accessories.

CIRCUIT DIAGRAM

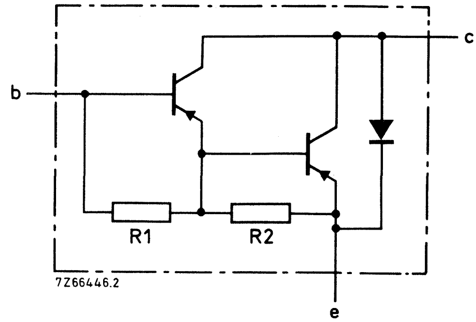


Fig. 2.
R1 typical 5 kΩ
R2 typical 80 Ω.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDV64	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	12	A
Collector current (peak value)	$-I_{CM}$	max.	20	A
Base current (d.c.)	$-I_B$	max.	0,5	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C*

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W*

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off currents				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	400	μA
$I_E = 0$; $-V_{CB} = -½V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<	2	mA
→ $I_B = 0$; $-V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	<	0,2	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	5	mA

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified.

D.C. current gain*			
$-I_C = 1\ A; -V_{CE} = 4\ V$	h_{FE}	typ.	1500
$-I_C = 5\ A; -V_{CE} = 4\ V$	h_{FE}	>	1000
$-I_C = 10\ A; -V_{CE} = 4\ V$	h_{FE}	typ.	1000
Base-emitter voltage*			
$-I_C = 5\ A; -V_{CE} = 4\ V$	$-V_{BE}$	<	2,5 V**
Collector-emitter saturation voltage*			
$-I_C = 5\ A; -I_B = 20\ mA$	$-V_{CEsat}$	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0; -V_{CB} = 10\ V$	C_c	typ.	200 pF
Cut-off frequency			
$-I_C = 5\ A; -V_{CE} = 4\ V$	f_{hfe}	typ.	100 kHz
Diode, forward voltage			
$I_F = 5\ A$	V_F	typ.	1,8 V
$I_F = 12\ A$	V_F	typ.	2 V
Switching times (see also Fig. 4)			
$-I_{Con} = 5\ A; -I_{Bon} = I_{Boff} = 20\ mA; V_{CC} = -16\ V$			
Turn-on time	t_{on}	typ.	0,5 μs
Fall time	t_f	typ.	1,0 μs
Turn-off time	t_{off}	typ.	2,0 μs

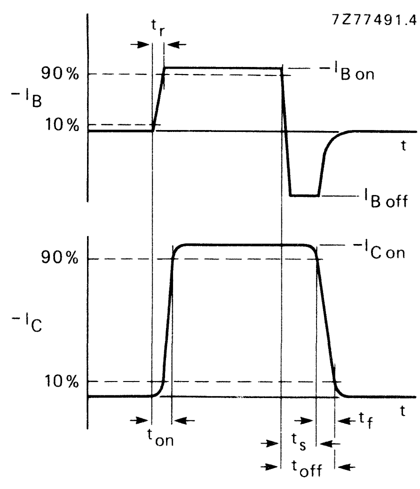


Fig. 3 Waveforms.

* Measured under pulse conditions: $t_p < 300\ \mu s$; $\delta < 2\%$.
**$-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

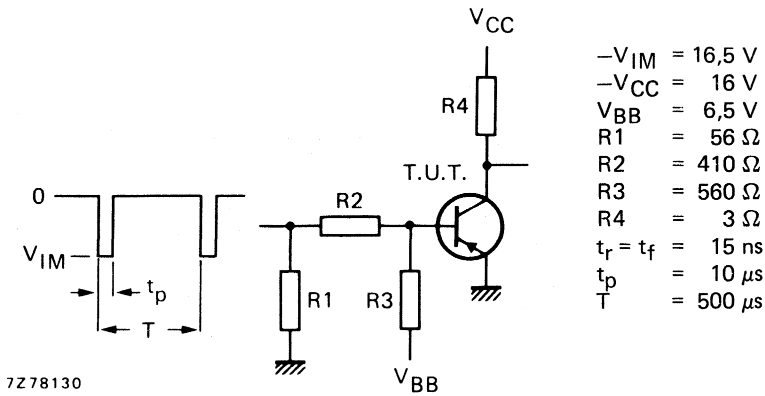


Fig. 4 Switching times test circuit.

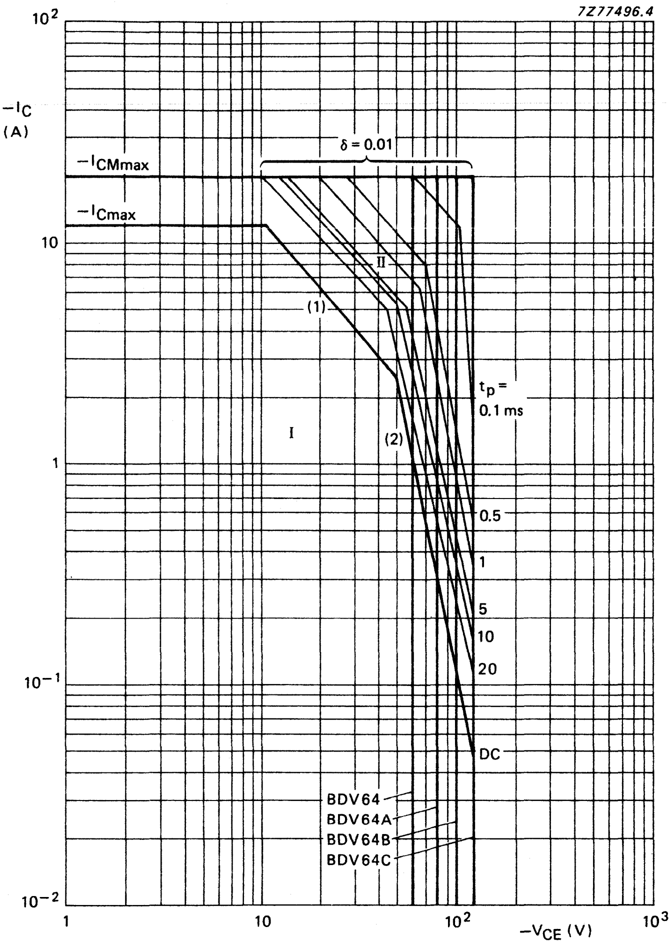


Fig. 5 Safe Operating ARea; $T_{mb} \leq 25\ ^oC$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second breakdown limits.

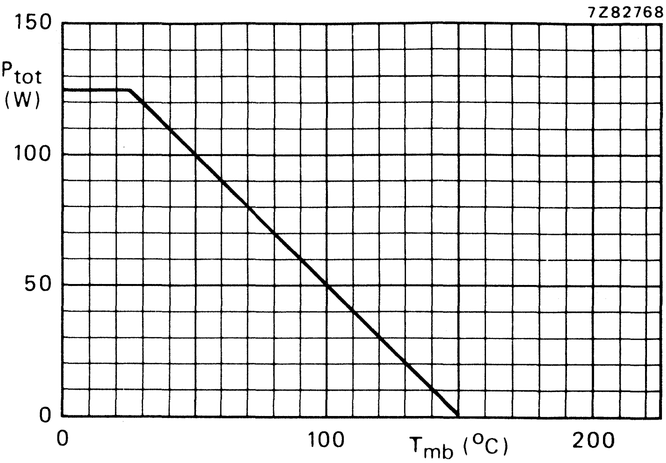


Fig. 6 Power derating curve.

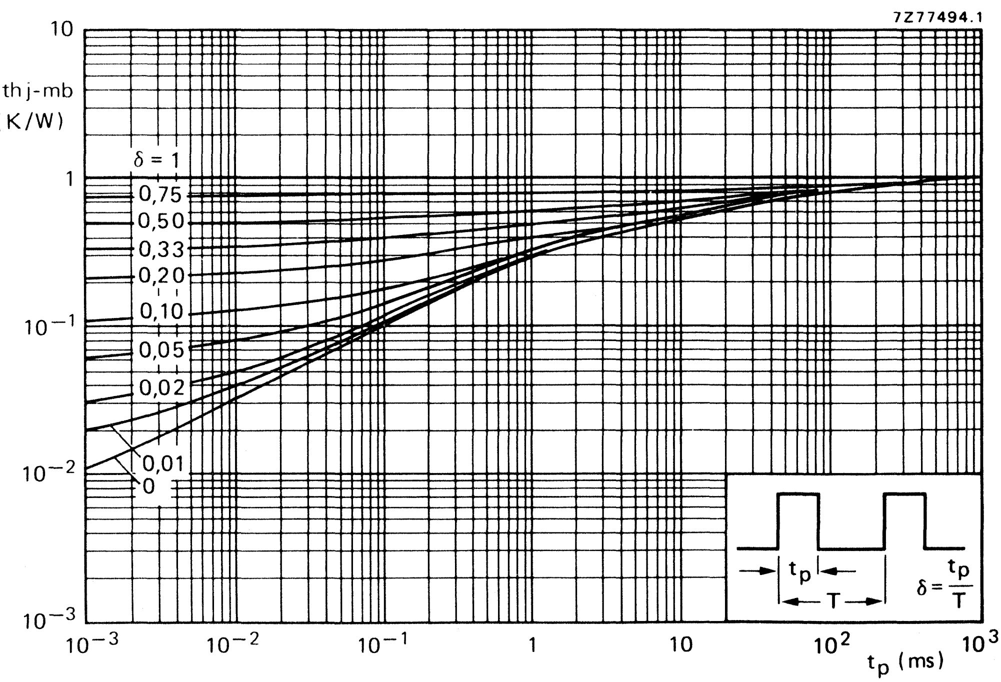


Fig. 7 Pulse power rating chart.

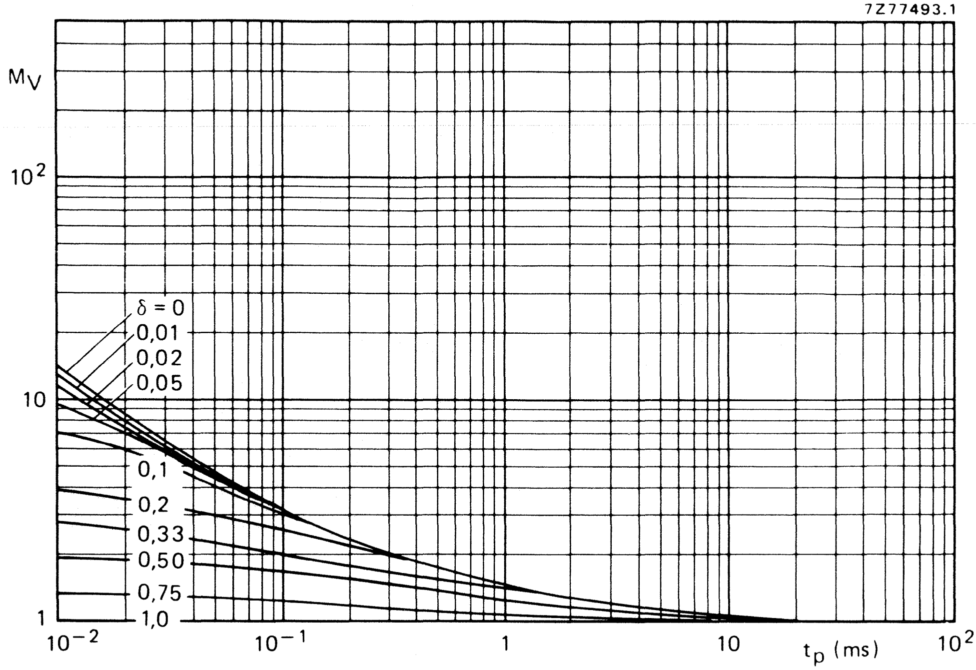


Fig. 8 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

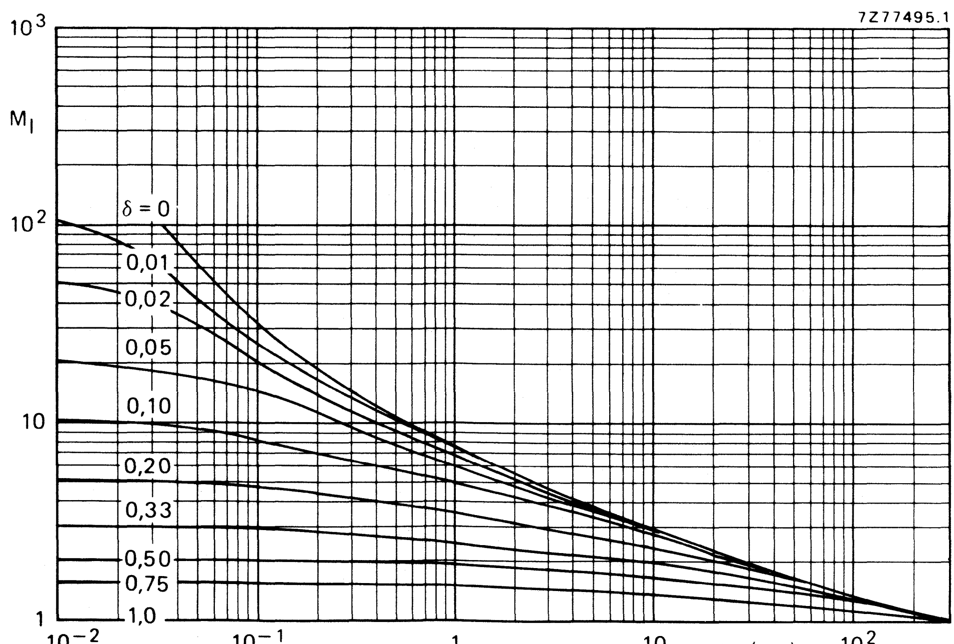


Fig. 9 S.B. current multiplying factor at the $-V_{CEOmax}$ level (100 V).

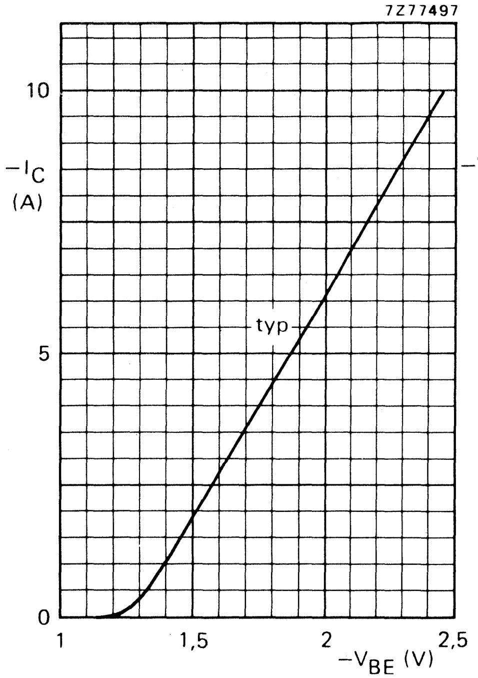


Fig. 10 $-V_{CE}$ = 4 V; T_j = 25 °C.

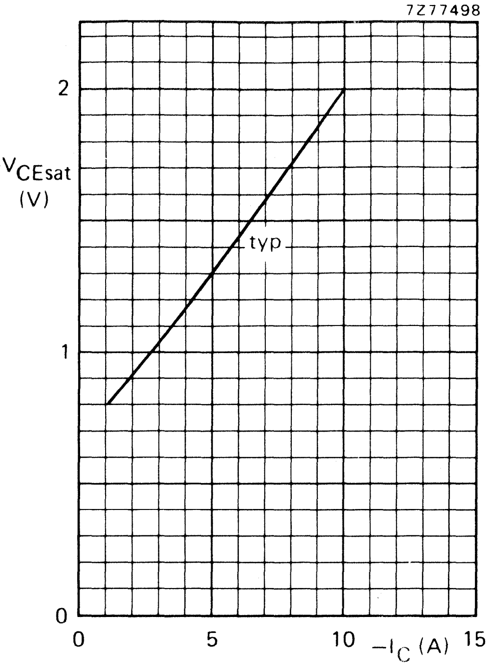


Fig. 11 $-I_C/I_B$ = 250; T_j = 25 °C.

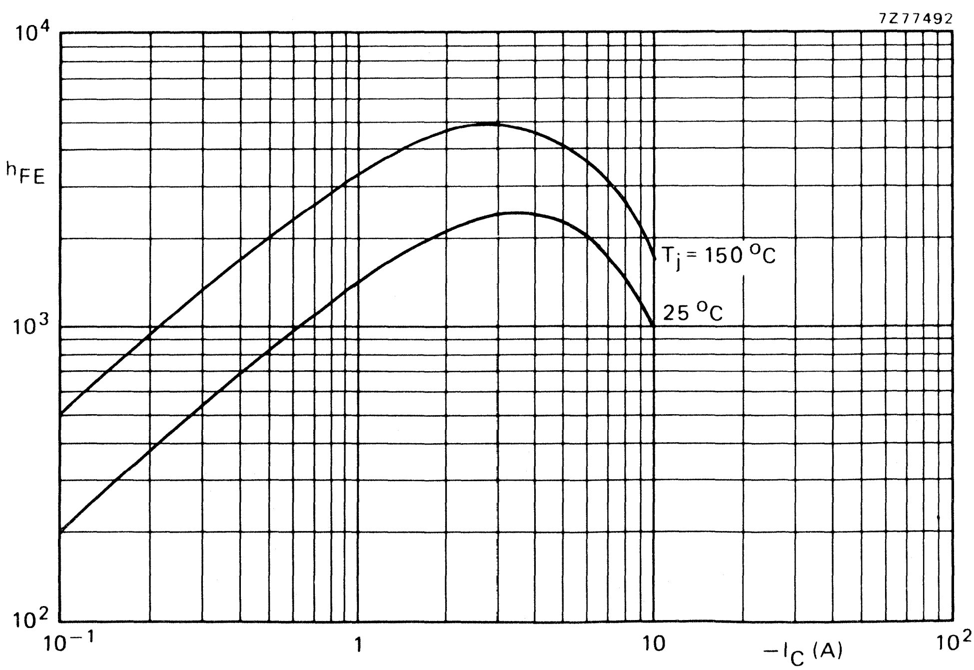


Fig. 12 Typical values; $-V_{CE}$ = 4 V.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. P-N-P complements are BDV64, 64B and 64C.

QUICK REFERENCE DATA

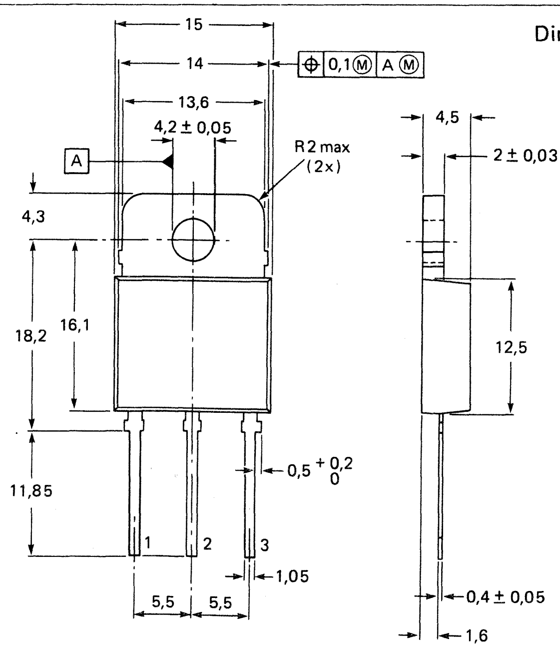
			BDV65	A	B	C	
Collector-base voltage (open emitter	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (DC)	I_C	max.	12				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
I_C = 1 A; V_{CE} = 4 V	h_{FE}	typ.	1500				
I_C = 5 A; V_{CE} = 4 V	h_{FE}	>	1000				
Cut-off frequency							
I_C = 5 A; V_{CE} = 4 V	f_{hfe}	typ.	70				kHz

MECHANICAL DATA

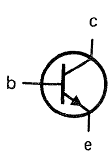
Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting-base.



Pinning:
1 = base
2 = collector
3 = emitter



See also chapters Mounting instructions and Accessories.

CIRCUIT DIAGRAM

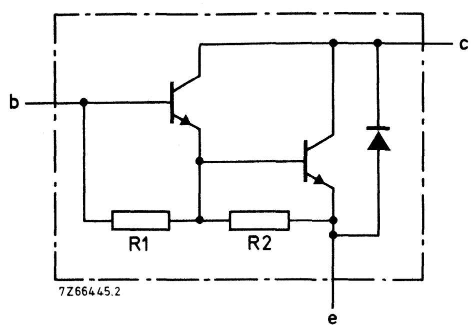


Fig. 2.
R1 typical 5 kΩ
R2 typical 80 Ω.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDV65	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	20	A
Base current (d.c.)	I_B	max.	0,5	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C*

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W*

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off currents				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	400	μA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	2	mA
→ $I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	0,2	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5	mA

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

D.C. current gain*			
I_C = 1 A; V_{CE} = 4 V	h_{FE}	typ.	1500
I_C = 5 A; V_{CE} = 4 V	h_{FE}	>	1000
I_C = 10 A; V_{CE} = 4 V	h_{FE}	typ.	1750
Base-emitter voltage*			
I_C = 5 A; V_{CE} = 4 V	V_{BE}	<	2,5 V**
Collector-emitter saturation voltage*			
I_C = 5 A; I_B = 20 mA	V_{CEsat}	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	typ.	150 pF
Cut-off frequency			
I_C = 5 A; V_{CE} = 4 V	f_{hfe}	typ.	70 kHz
Diode, forward voltage			
I_F = 5 A	V_F	typ.	1,2 V
I_F = 12 A	V_F	typ.	2 V
Switching times (see also Fig. 4)			
I_{Con} = 5 A; $I_{Bon} = -I_{Boff}$ = 20 mA; V_{CC} = 16 V			
Turn-on time	t_{on}	typ.	1 μs
Fall time	t_f	typ.	3 μs
Turn-off time	t_{off}	typ.	6 μs

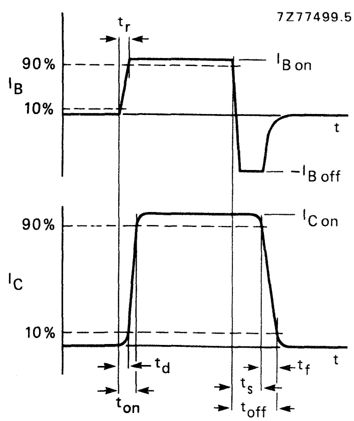


Fig. 3 Waveforms showing t_{on}; $t_s + t_f = t_{off}$.

* Measured under pulse conditions: t_p < 300 μs; δ < 2%.
** V_{BE} decreases by about 3,6 mV/K with increasing temperature.

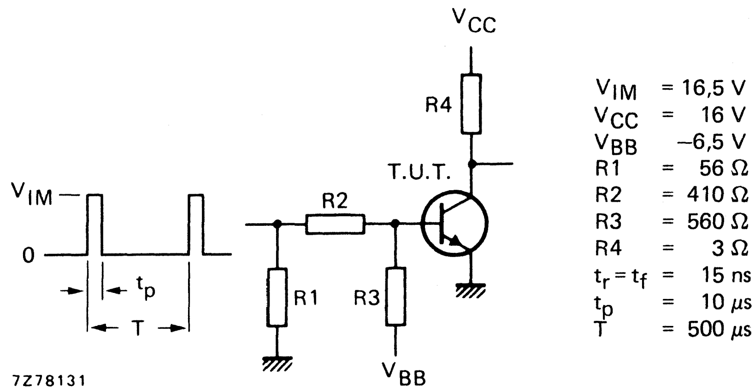


Fig. 4 Switching times test circuit.

Turn-off breakdown energy with inductive load (see also Fig. 5).

I_{Con} = 6,3 A; $-I_{Boff}$ = 0; t_p = 1 ms; T = 100 ms	$E_{(BR)}$	>	100 mJ

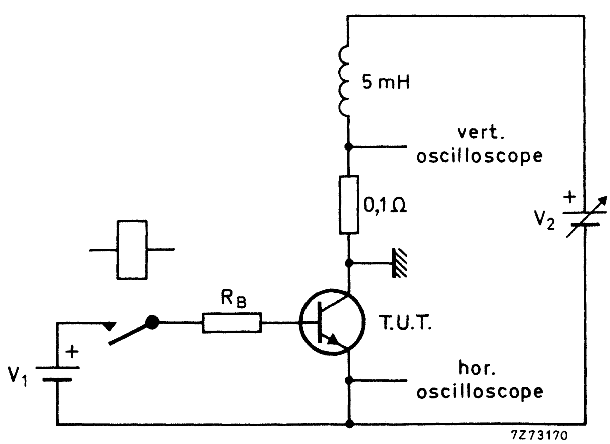


Fig. 5 Test circuit; V_1 = 12 V; R_B = 270 Ω.

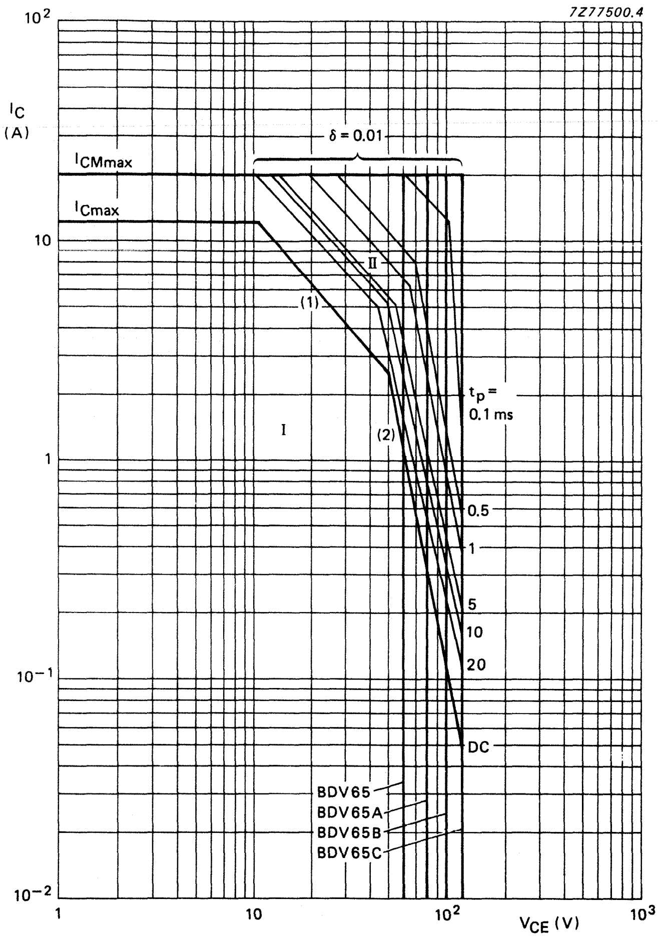


Fig. 6 Safe Operating ARea; $T_{mb} \leqslant 25$ °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second breakdown limits.

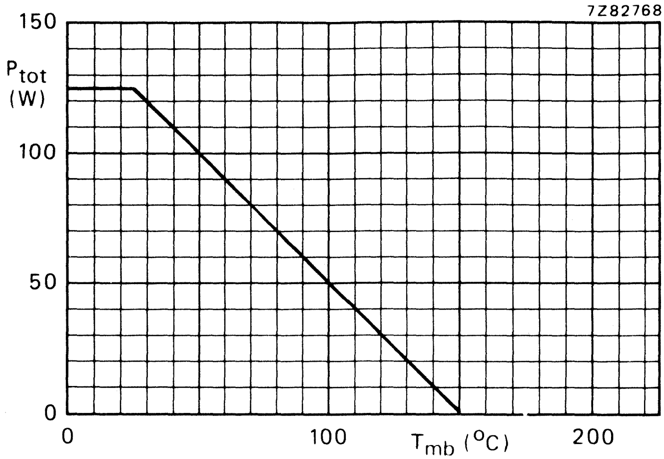


Fig. 7 Power derating curve.

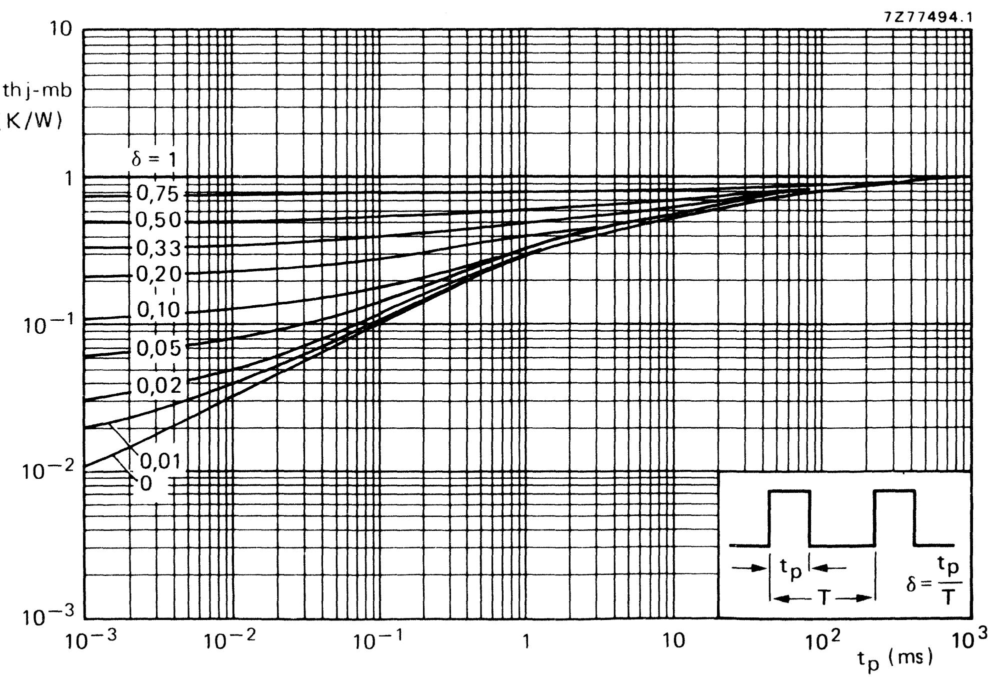


Fig. 8 Pulse power rating chart.

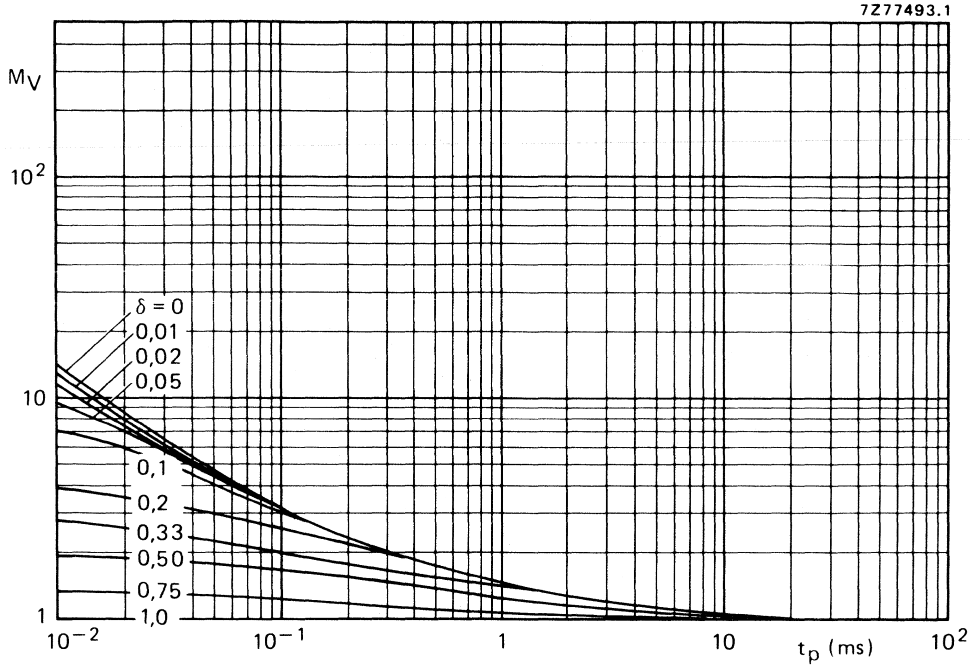


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

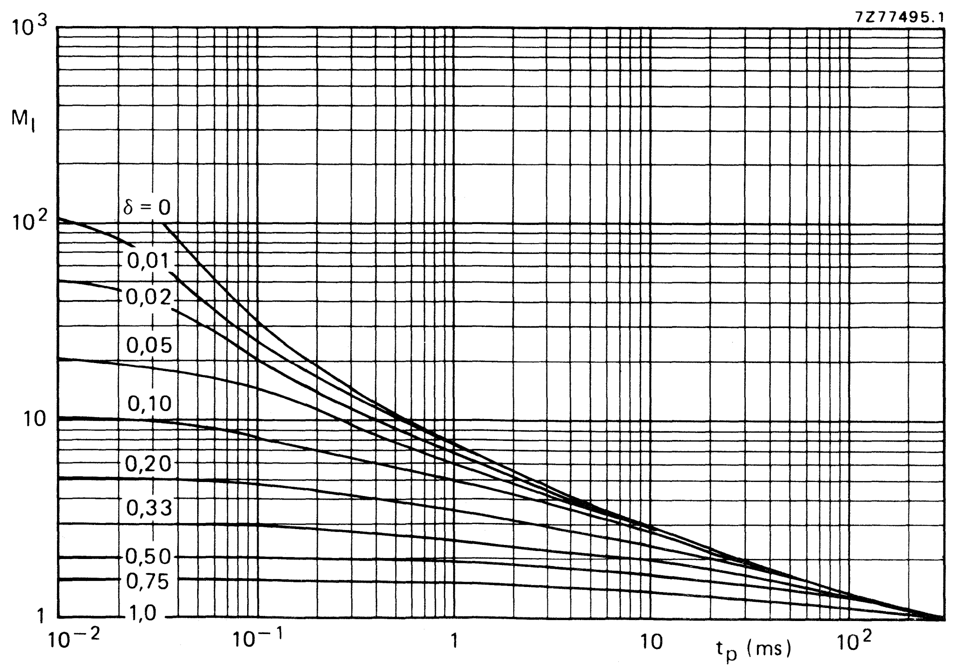


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} level (100 V).

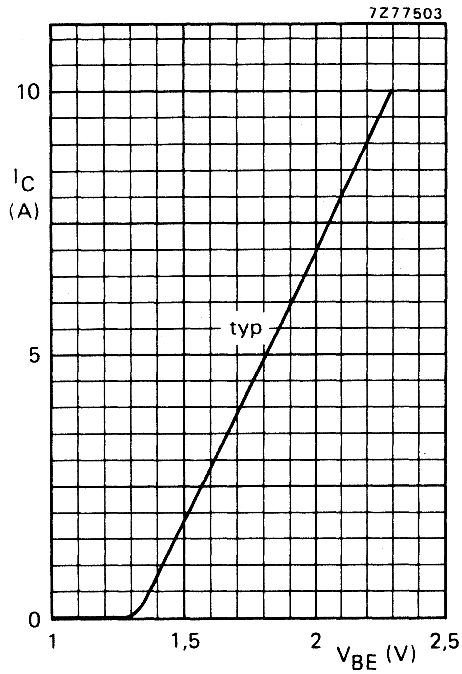


Fig. 11 V_{CE} = 4 V; T_j = 25 °C.

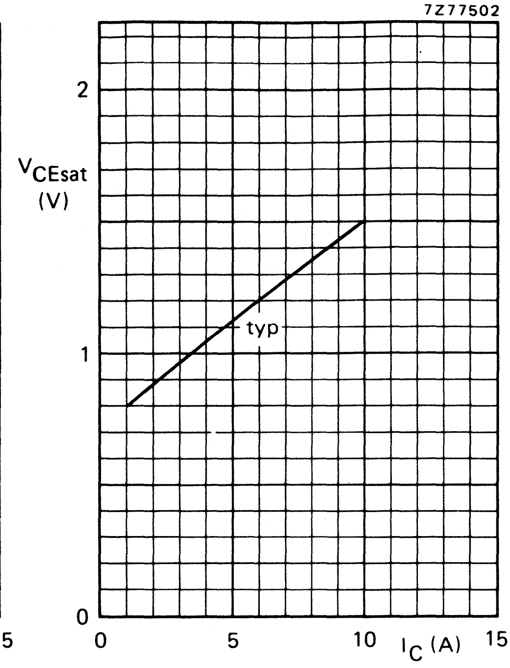


Fig. 12 I_C/I_B = 250; T_j = 25 °C.

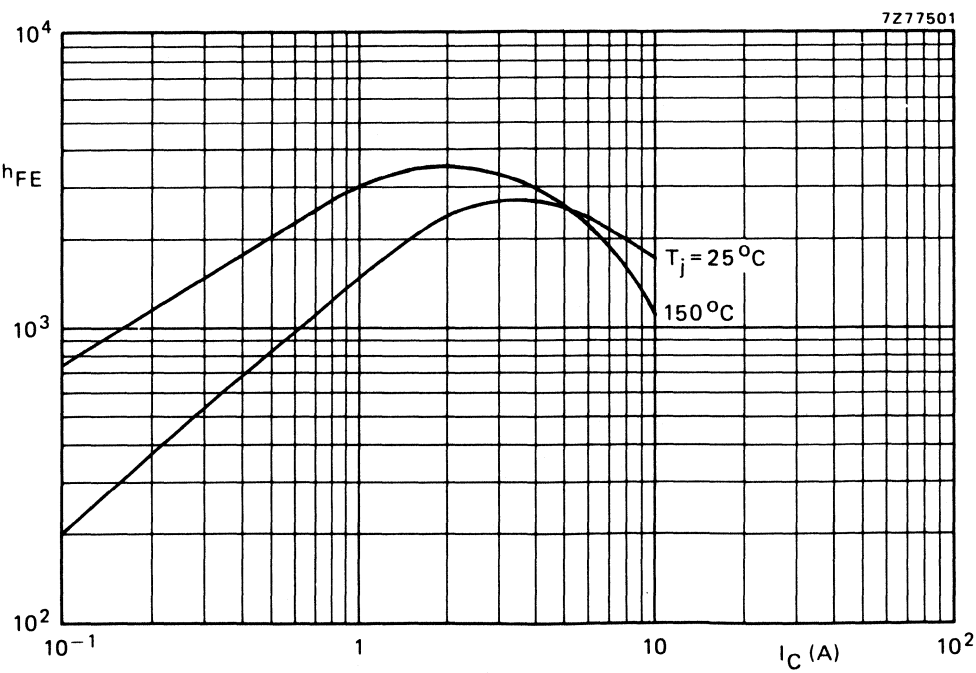


Fig. 13 Typical values; V_{CE} = 4 V.

DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base Darlington transistors for audio output stages and general amplifier and switching applications. N-P-N complements are BDV67A; B; C and D. Matched complementary pairs can be supplied.

QUICK REFERENCE DATA

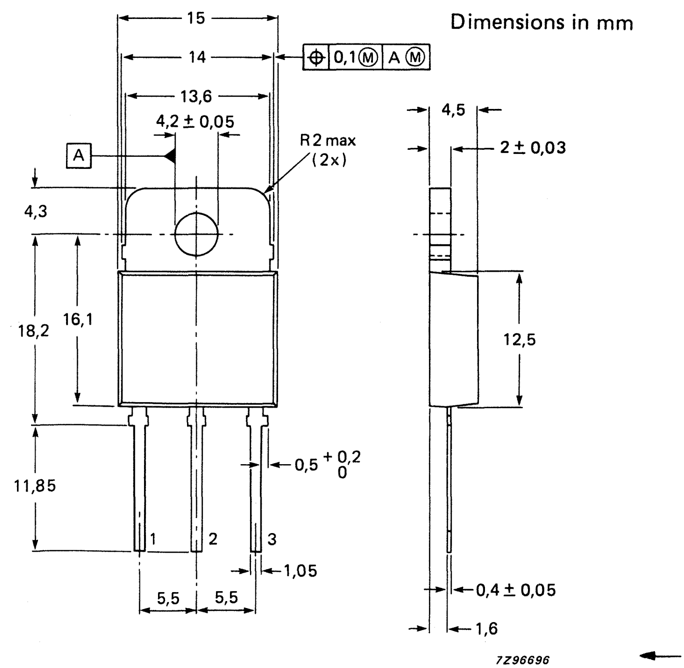
			BDV66A	B	C	D	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	100	120	140	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80	100	120	150	V
Collector current (d.c.)	$-I_C$	max.	16				A
Collector current (peak value)	$-I_{CM}$	max.	20				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	175				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
$-I_C$ = 1 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	3000				
$-I_C$ = 10 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000				
Cut-off frequency							
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	60				kHz

MECHANICAL DATA

Dimensions in mm

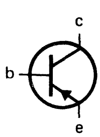
Fig. 1 SOT-93

Collector connected to mounting base.



Pinning

1 = base
2 = collector
3 = emitter



See also chapters Mounting instructions and Accessories.

CIRCUIT DIAGRAM

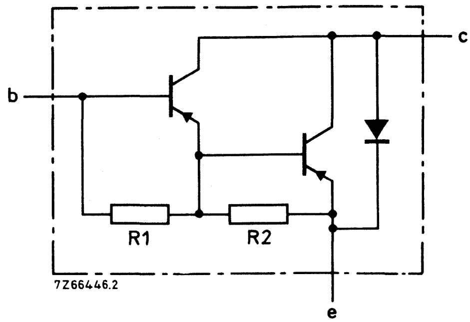


Fig. 2.
R1 typical 3 kΩ
R2 typical 80 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDV66A	B	C	D	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	100	120	140	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80	100	120	150	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	16	A
Collector current (peak value)	$-I_{CM}$	max.	20	A
Base current (d.c.)	$-I_B$	max.	0,5	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	175	W
Storage temperature	T_{stg}		–65 to + 150	°C
Junction temperature*	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base*	$R_{th\ j\text{-}mb}$	=	0,625	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off currents				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	1	mA
$I_E = 0; -V_{CB} = -½V_{CBOmax}; T_j = 150$ °C	$-I_{CBO}$	<	4	mA
→ $I_B = 0; -V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	<	1	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	5	mA

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

D.C. current gain*				
$-I_C = 1$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	3000	
$-I_C = 10$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000	
$-I_C = 16$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	1000	
Base-emitter voltage**				
$-I_C = 10$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5	V
Collector-emitter saturation voltage*				
$-I_C = 10$ A; $-I_B = 40$ mA	$-V_{CEsat}$	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	300	pF
Cut-off frequency				
$-I_C = 5$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	60	kHz
Diode, forward voltage				
$I_F = 10$ A	V_F	<	3	V
D.C. current gain ratio of matched complementary pairs				
$-I_C = 10$ A; $-V_{CE} = 3$ V	h_{FE1}/h_{FE2}	<	2,5	
Small-signal current gain				
$-I_C = 5$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	40	
Switching times				
$-I_{Con} = 10$ A; $-I_{Bon} = I_{Boff} = 40$ mA; $V_{CC} = -12$ V				
Turn-on time	t_{on}	typ.	1	μs
Turn-off time	t_{off}	typ.	3,5	μs

* Measured under pulse conditions: $t_p < 300$ μs; $\delta < 2\%$.

** $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

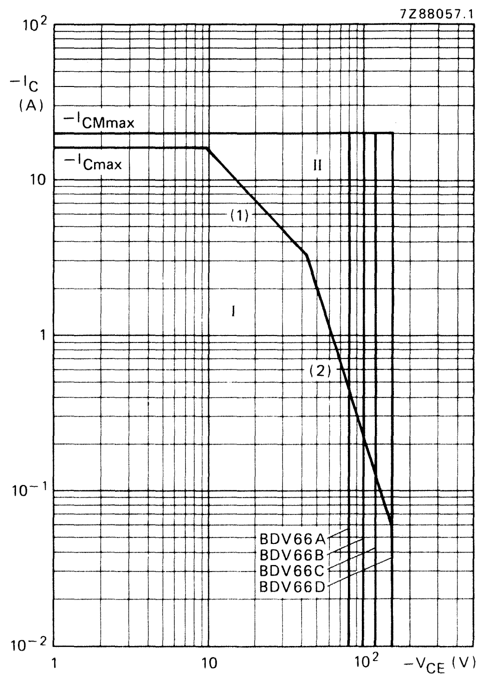


Fig. 3 Safe Operating ARea; $T_{mb} \leqslant 25\ ^oC$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ line.
(2) Second breakdown limits.

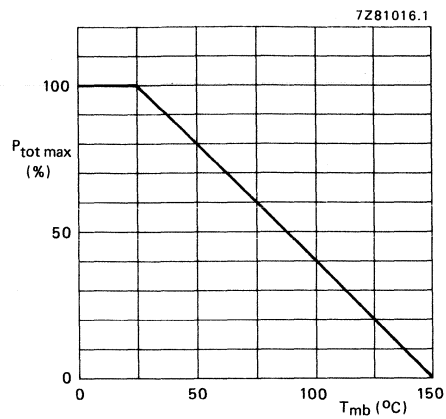


Fig. 4 Power derating curve.

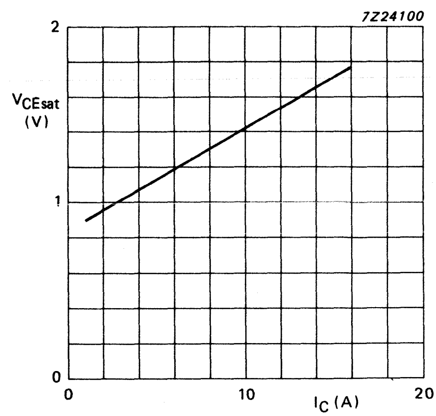


Fig. 5 Typical collector-emitter saturation voltage $-I_C/-I_B = 250$; $T_{mb} = 25\ ^oC$.

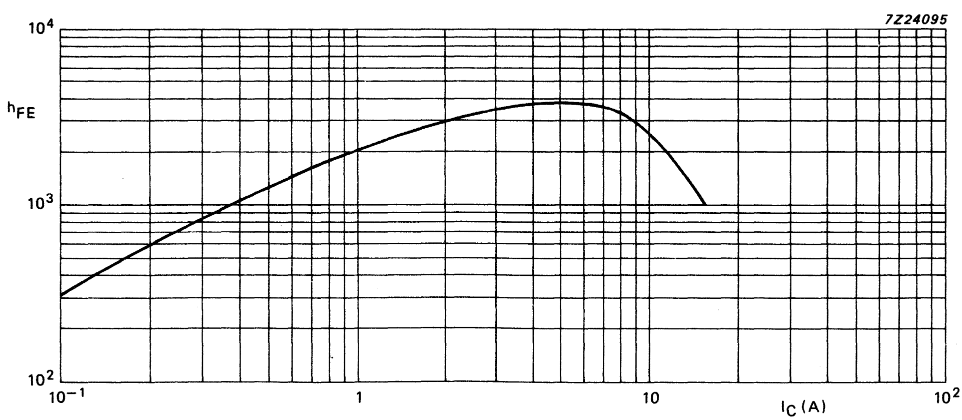


Fig. 6 Typical DC current gain $-V_{CE} = 3$ V; $T_j = 25\ ^oC$.

DARLINGTON POWER TRANSISTORS

NPN epitaxial base Darlington transistors for audio output stages and general amplifier and switching applications. PNP complements are BDV66A, B, C and D. Matched complementary pairs can be supplied.

QUICK REFERENCE DATA

			BDV67A	B	C	D	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	140	160	V
Collector-emitter voltage (open base)	V_{CEO}	max.	80	100	120	150	V
Collector current (DC)	I_C	max.	16				A
Collector current (peak value)	I_{CM}	max.	20				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.	3000				
I_C = 10 A; V_{CE} = 3 V	h_{FE}	>	1000				
Cut-off frequency							
I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.	60				kHz

MECHANICAL DATA

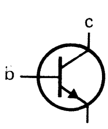
Dimensions in mm

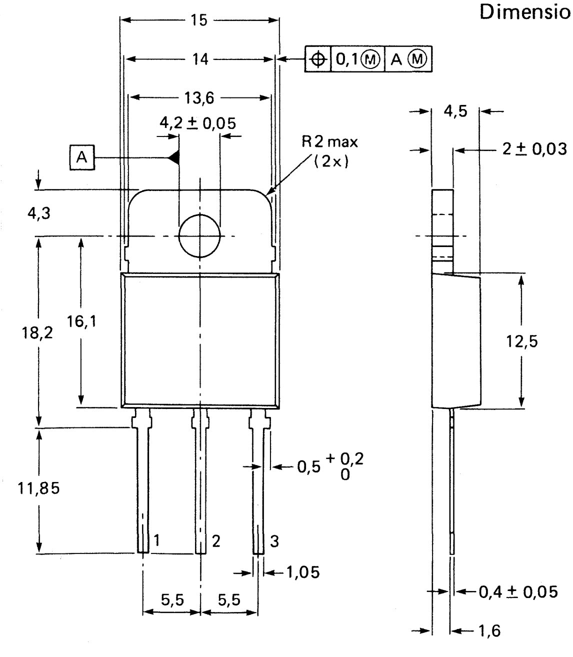
Fig. 1 SOT-93.

Collector connected to mounting-base.

Pinning:

1 = base
2 = collector
3 = emitter





See also chapters Mounting instructions and Accessories.

CIRCUIT DIAGRAM

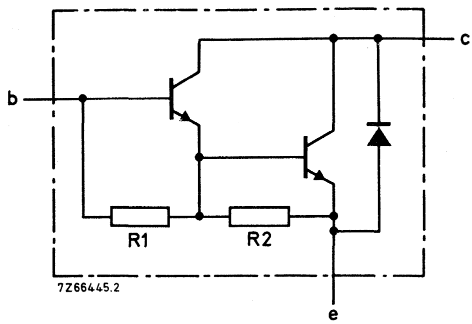


Fig. 2.
R1 typical 3 kΩ
R2 typical 80 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDV67A	B	C	D	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	140	160	V
Collector-emitter voltage (open base)	V_{CEO}	max.	80	100	120	150	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	16	A
Collector current (peak value)	I_{CM}	max.	20	A
Base current (d.c.)	I_B	max.	0,5	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature*	T_j	max.	150	°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,625	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off currents				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	1	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	4	mA
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	1	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5	mA

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

D.C. current gain*			
I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.	3000
I_C = 10 A; V_{CE} = 3 V	h_{FE}	>	1000
I_C = 16 A; V_{CE} = 3 V	h_{FE}	typ.	1000
Base-emitter voltage**			
I_C = 10 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage*			
I_C = 10 A; I_B = 40 mA	V_{CEsat}	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	typ.	300 pF
Cut-off frequency			
I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.	60 kHz
Diode, forward voltage			
I_F = 10 A	V_F	<	3 V
D.C. current gain ratio of matched complementary pairs			
I_C = 10 A; V_{CE} = 3 V	h_{FE1}/h_{FE2}	<	2,5
Small-signal current gain			
I_C = 5 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	typ.	40
Turn-off breakdown energy with inductive load (see also Fig. 3).			
I_{Con} = 6,3 A; $-I_{Boff}$ = 0; t_p = 1 ms; T = 100 ms	$E_{(BR)}$	>	150 mJ
Switching times			
I_{Con} = 10 A; $I_{Bon} = -I_{Boff}$ = 40 mA; V_{CC} = 12 V			
Turn-on time	t_{on}	typ.	1 μs
Turn-off time	t_{off}	typ.	3,5 μs

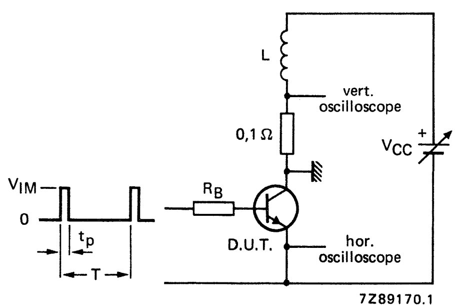


Fig. 3 Test circuit; V_1 = 12 V; R_B = 270 Ω.

* Measured under pulse conditions: t_p < 300 μs; δ < 2%.

** V_{BE} decreases by about 3,6 mV/K with increasing temperature.

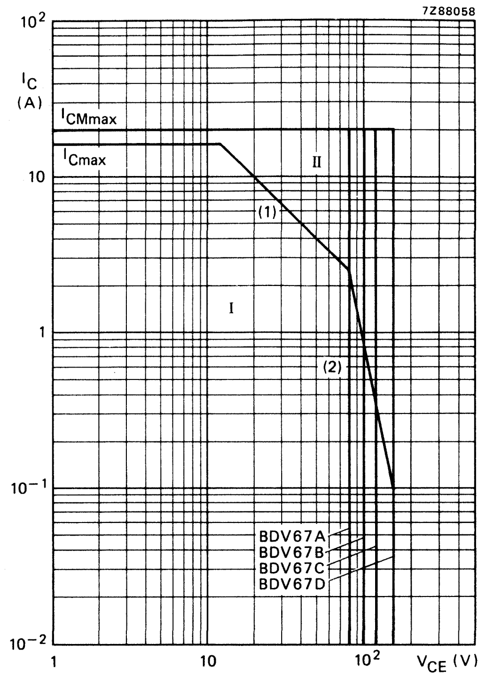


Fig. 4 Safe Operating ARea; $T_{mb} \leqslant 25\ ^oC$.

I Region of permissible DC operation.
II Permissible extension for repetitive operation.

(1) $P_{tot\ max}$ line.
(2) Second breakdown limits.

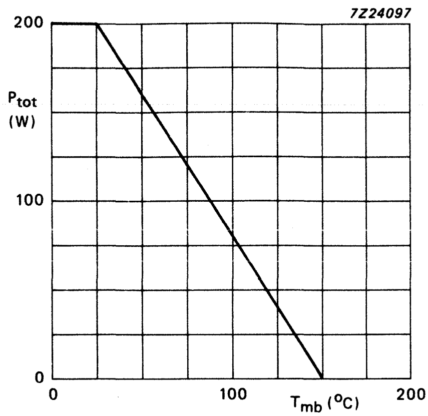


Fig. 5 Power derating curve.

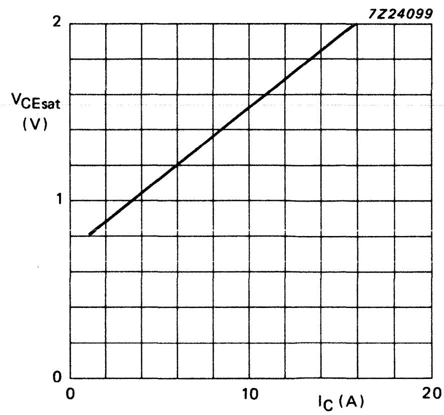


Fig. 6 Typical collector-emitter saturation voltage at T_{mb} = 25 °C; I_C/I_B = 250.

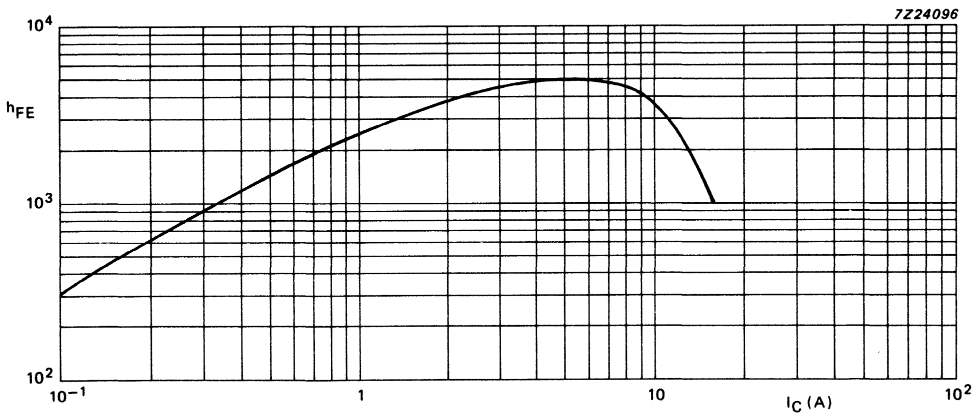


Fig. 7 Typical DC current gain at V_{CE} = 3 V.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N epitaxial base power transistors in the plastic SOT-93 envelope. These transistors are intended for use in audio output stages and general amplifier and switching applications.

P-N-P complements are BDV92, BDV94 and BDV96.

QUICK REFERENCE DATA

			BDV91	BDV93	BDV95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		10		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		100		W
Junction temperature	T_j	max.		150		°C
D.C. current gain I_C = 4 A; V_{CE} = 4 V	h_{FE}	>		20		
Transition frequency I_C = 0,5 A; V_{CE} = 10 V	f_T	>		3		MHz

MECHANICAL DATA

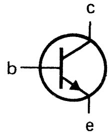
Dimensions in mm

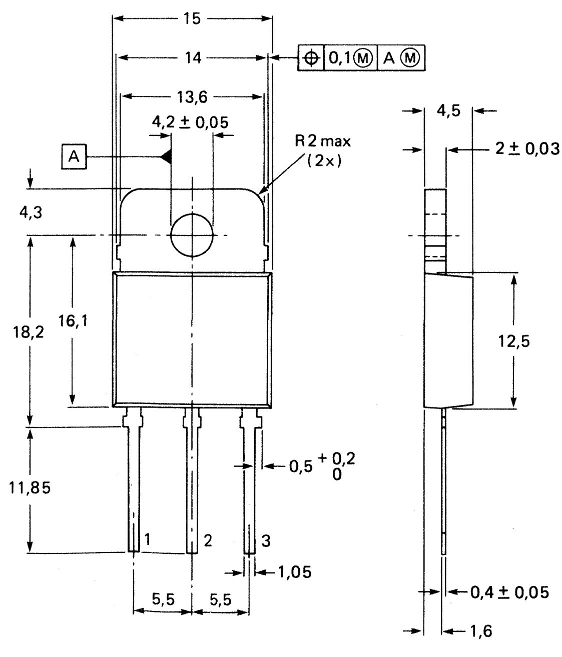
Fig. 1 SOT-93.

Collector connected to mounting base

Pinning

1 = base
2 = collector
3 = emitter





See chapters Mounting instructions SOT-93 and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDV91	BDV93	BDV95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	7	7	V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value)	I_{CM}	max.		20		A
Base current (d.c.)	I_B	max.		7		A
Emitter current (d.c.)	I_E	max.		14		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		100		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents				
$I_E = 0$; $V_{CB} = V_{CBO\,max}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = ½V_{CBO\,max}$; T_j = 150 °C	I_{CBO}	<	1	mA
→ $I_B = 0$; $V_{CE} = V_{CEO\,max}$	I_{CEO}	<	0,2	mA
→ Emitter cut-off current				
$I_C = 0$; V_{EB} = 7 V	I_{EBO}	<	0,1	mA
D.C. current gain				
I_C = 4 A; V_{CE} = 4 V	h_{FE}	>	20	
I_C = 10 A; V_{CE} = 4 V	h_{FE}	>	5	
Collector-emitter saturation voltage				
I_C = 4 A; I_B = 0,4 A	$V_{CE\,sat}$	<	1	V
I_C = 10 A; I_B = 3,3 A	$V_{CE\,sat}$	<	3	V
Base-emitter saturation voltage				
I_C = 4 A; I_B = 0,4 A	$V_{BE\,sat}$	<	1,6	V
Base-emitter voltage				
I_C = 4 A; V_{CE} = 4 V	V_{BE}	<	1,6	V

CHARACTERISTICS (continued)

Transition frequency			
$I_C = 0,5$ A; $V_{CE} = 10$ V	f_T	>	3 MHz
Switching times (between 10% and 90% levels)			
$I_{Con} = 4$ A; $I_{Bon} = -I_{Boff} = 0,4$ A; $V_{CC} = 30$ V			
Turn-on time	t_{on}	typ.	0,5 µs
Turn-off time	t_{off}	typ.	2,0 µs
Fall time	t_f	typ.	0,7 µs

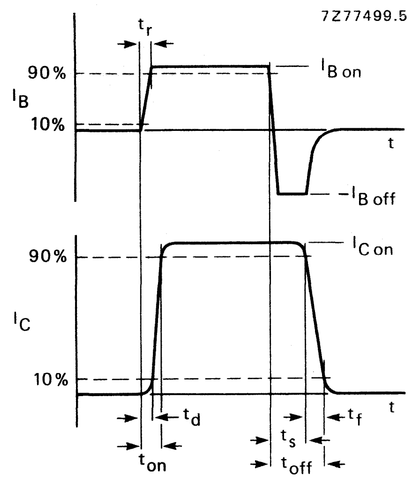


Fig. 2 Switching times waveforms.

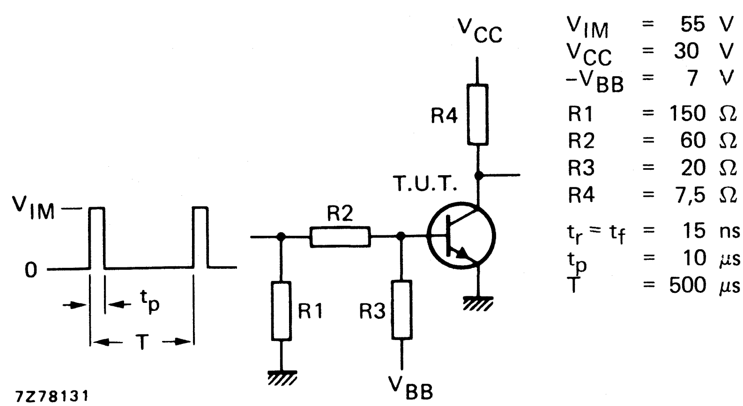


Fig. 3 Switching times test circuit.

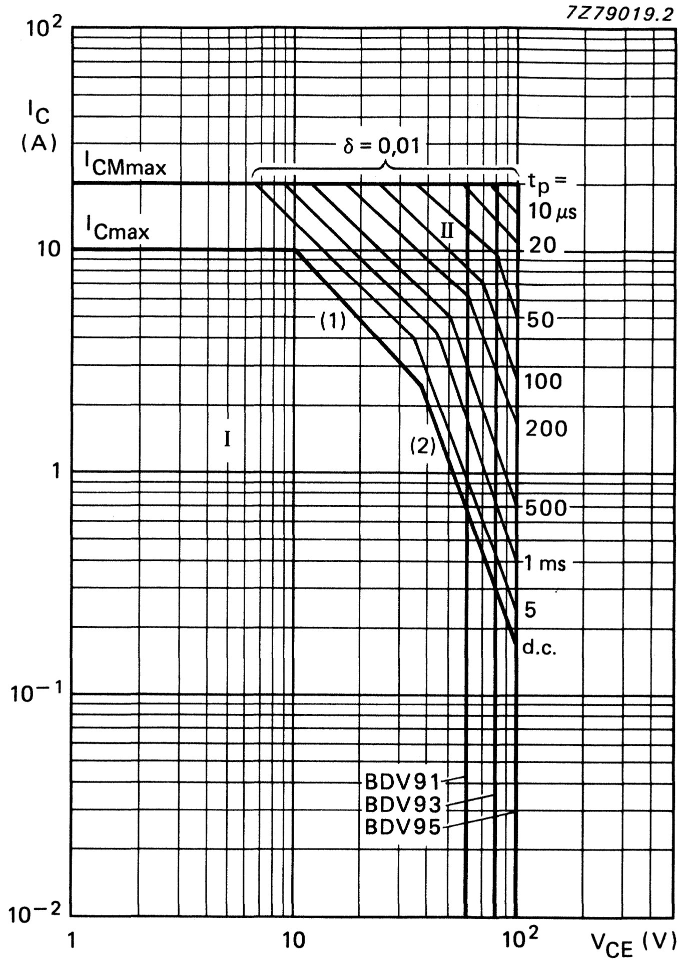


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second breakdown limits.

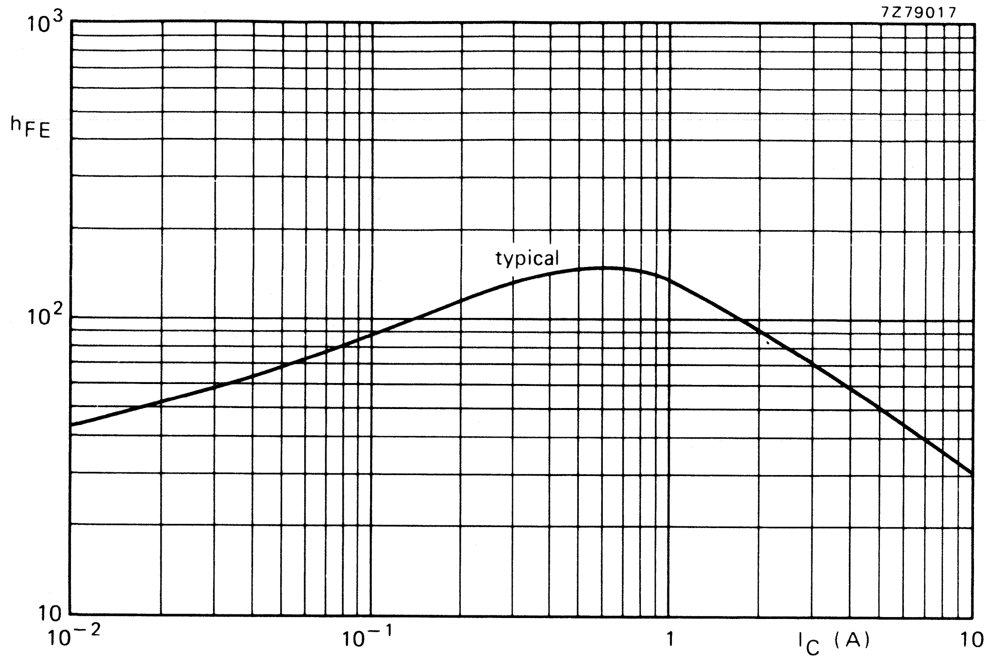


Fig. 5 V_{CE} = 4 V; T_j = 25 °C.

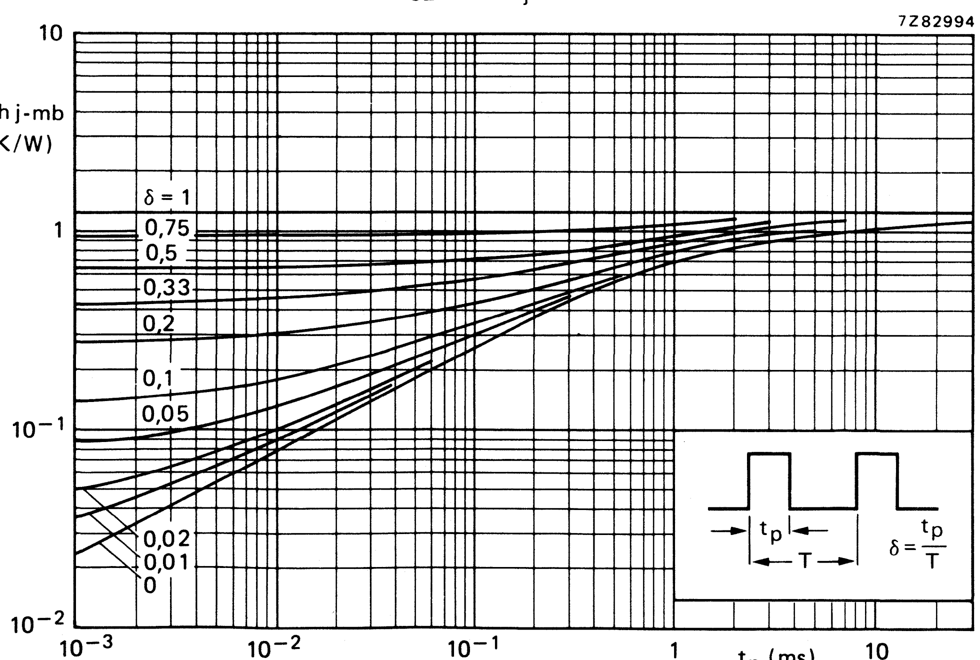


Fig. 6 Pulse power rating chart.

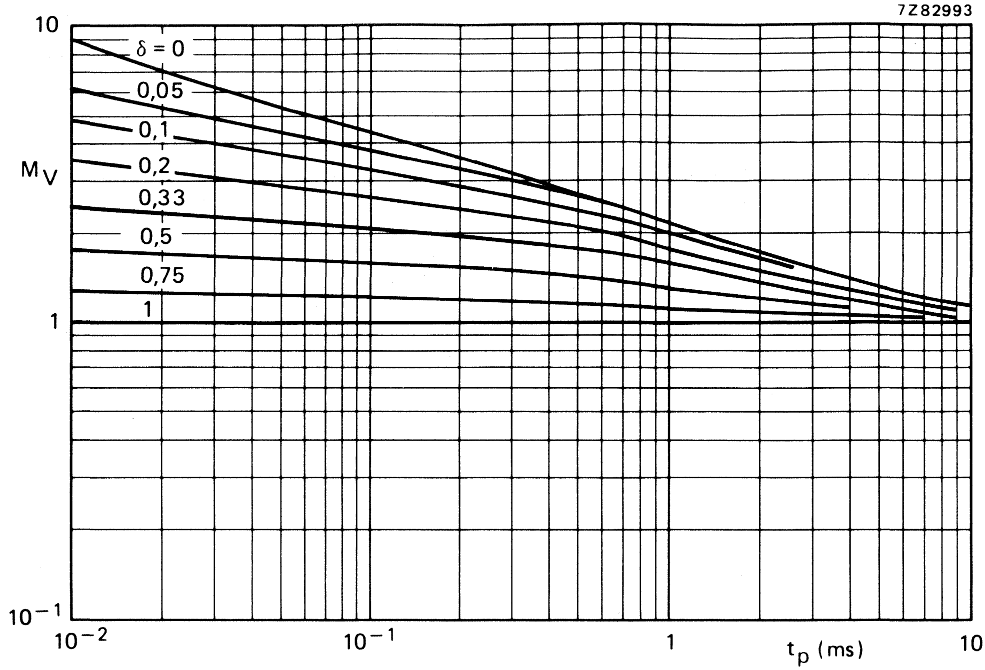


Fig. 7 Second-breakdown voltage multiplying factor at the I_{Cmax} level.

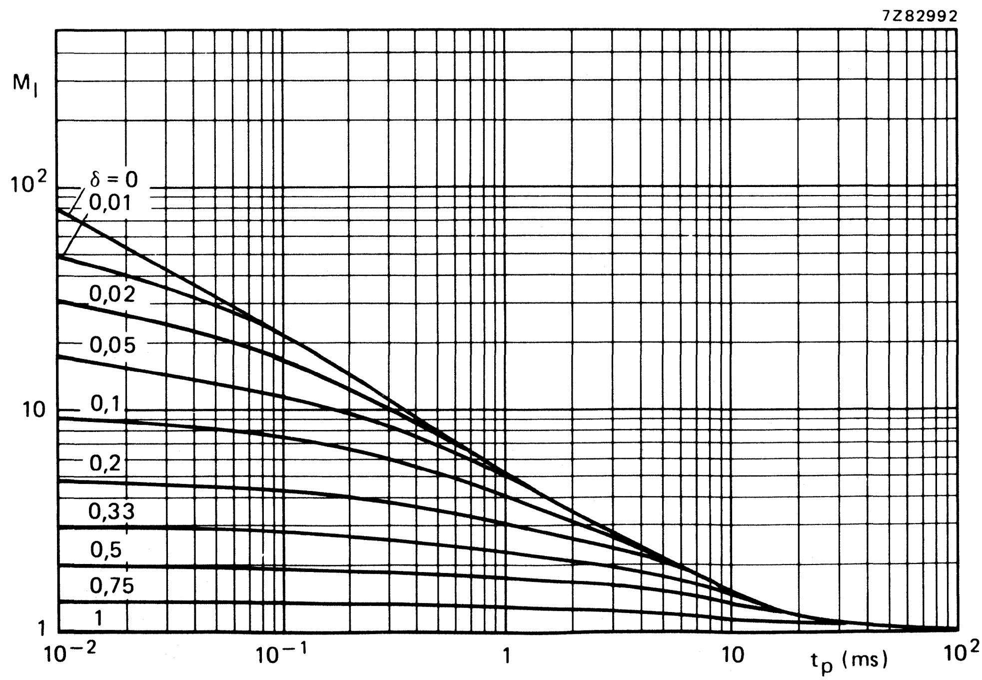


Fig. 8 Second-breakdown current multiplying factor at the V_{CEOmax} level.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P epitaxial base power transistors in the plastic SOT-93 envelope. These transistors are intended for use in audio output stages and general amplifier and switching applications.

N-P-N complements are BDV91, BDV93 and BDV95.

QUICK REFERENCE DATA

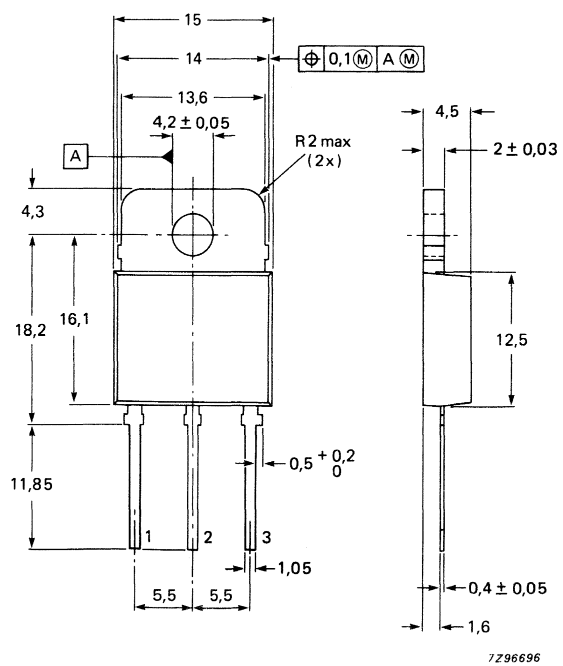
			BDV92	BDV94	BDV96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		10		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		100		W
Junction temperature	T_j	max.		150		°C
D.C. current gain $-I_C$ = 4 A; $-V_{CE}$ = 4 V	h_{FE}	>		20		
Transition frequency $-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_T	>		4		MHz

MECHANICAL DATA

Dimensions in mm

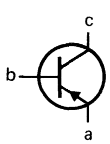
Fig. 1 SOT-93.

Collector connect to mounting base



Pinning

1 = base
2 = collector
3 = emitter



See chapters Mounting instructions SOT-93 and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDV92	BDV94	BDV96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	7	7	7	V
Collector current (d.c.)	$-I_C$	max.		10		A
Collector current (peak value)	$-I_{CM}$	max.		20		A
Base current (d.c.)	$-I_B$	max.		7		A
Emitter current (d.c.)	$-I_E$	max.		14		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		100		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

→ Collector cut-off currents				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,1	mA
$I_E = 0; -V_{CB} = -½V_{CBOmax}; T_j = 150$ °C	$-I_{CBO}$	<	1	mA
$I_B = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CEO}$	<	0,2	mA
→ Emitter cut-off current				
$I_C = 0; -V_{EB} = 7$ V	$-I_{EBO}$	<	0,1	mA
D.C. current gain				
$-I_C = 4$ A; $-V_{CE} = 4$ V	h_{FE}	>	20	
$-I_C = 10$ A; $-V_{CE} = 4$ V	h_{FE}	>	5	
Collector-emitter saturation voltage				
$-I_C = 4$ A; $-I_B = 0,4$ A	$-V_{CEsat}$	<	1	V
$-I_C = 10$ A; $-I_B = 3,3$ A	$-V_{CEsat}$	<	3	V
Base-emitter saturation voltage				
$-I_C = 4$ A; $-I_B = 0,4$ A	$-V_{BEsat}$	<	1,6	V
Base-emitter voltage				
$-I_C = 4$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,6	V

CHARACTERISTICS (continued)

Transition frequency			
$-I_C = 0{,}5$ A; $-V_{CE} = 10$ V	f_T	>	4 MHz
Switching times (between 10% and 90% levels)			
$-I_{Con} = 4$ A; $-I_{Bon} = I_{Boff} = 0{,}4$ A; $-V_{CC} = 30$ V			
Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	0,7 μs
Fall time	t_f	typ.	0,3 μs

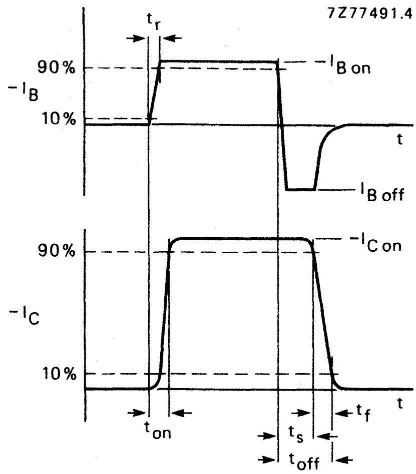
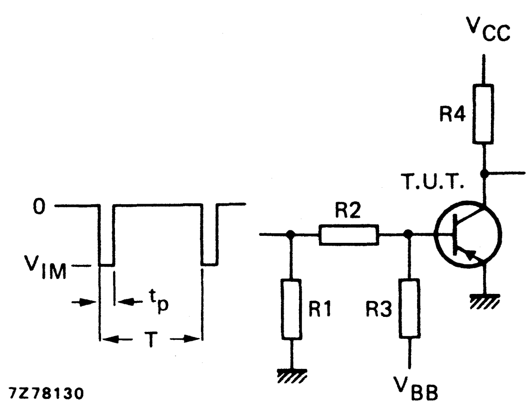


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	55 V
$-V_{CC}$	=	30 V
V_{BB}	=	7 V
R1	=	150 Ω
R2	=	60 Ω
R3	=	20 Ω
R4	=	7,5 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

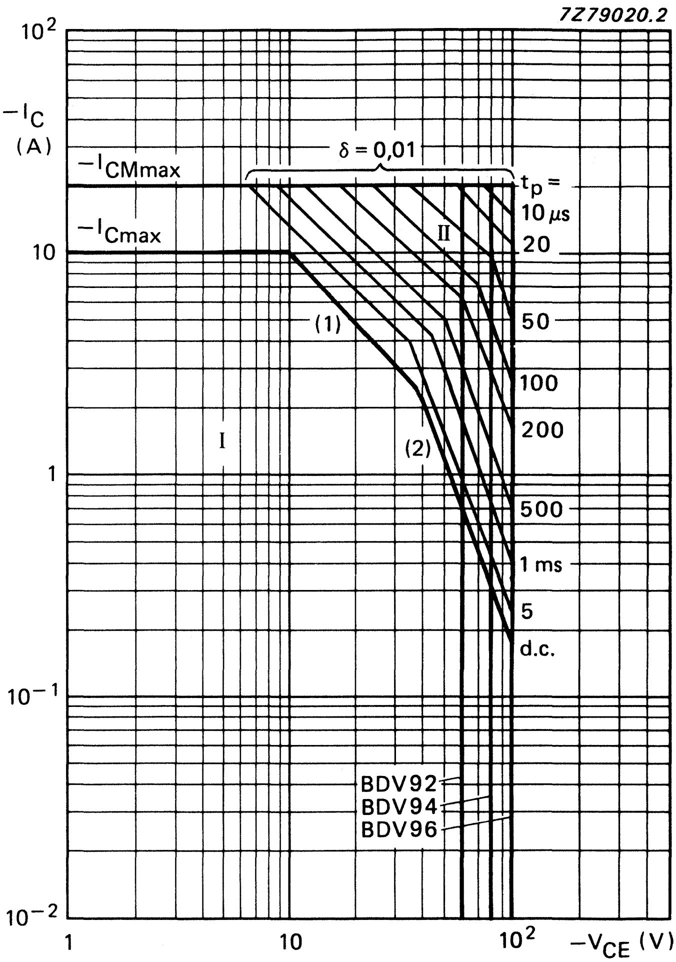


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second breakdown limits.

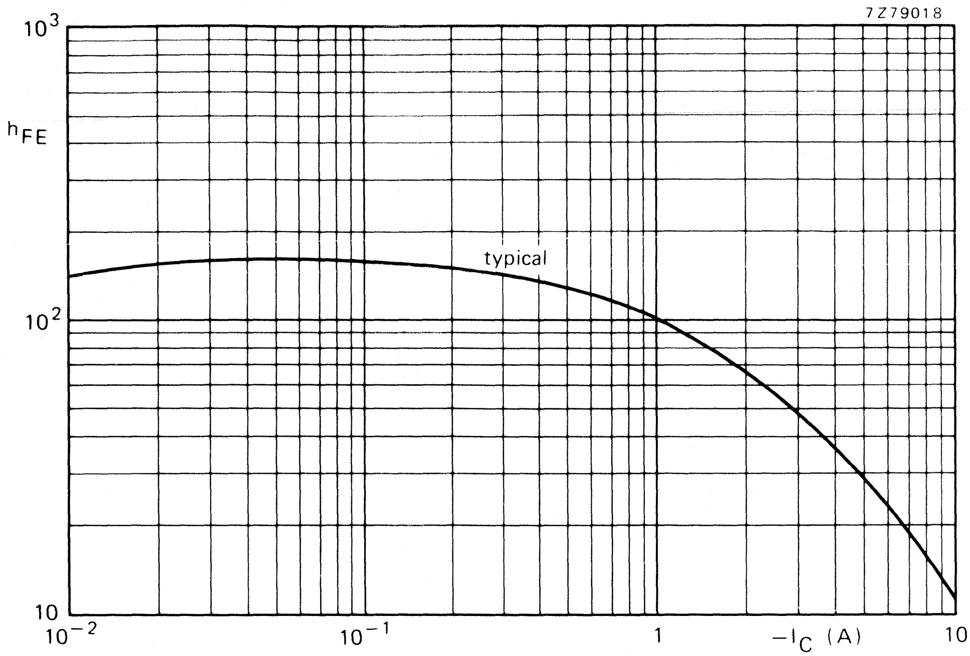


Fig. 5 $-V_{CE}$ = 4 V; T_j = 25 °C.

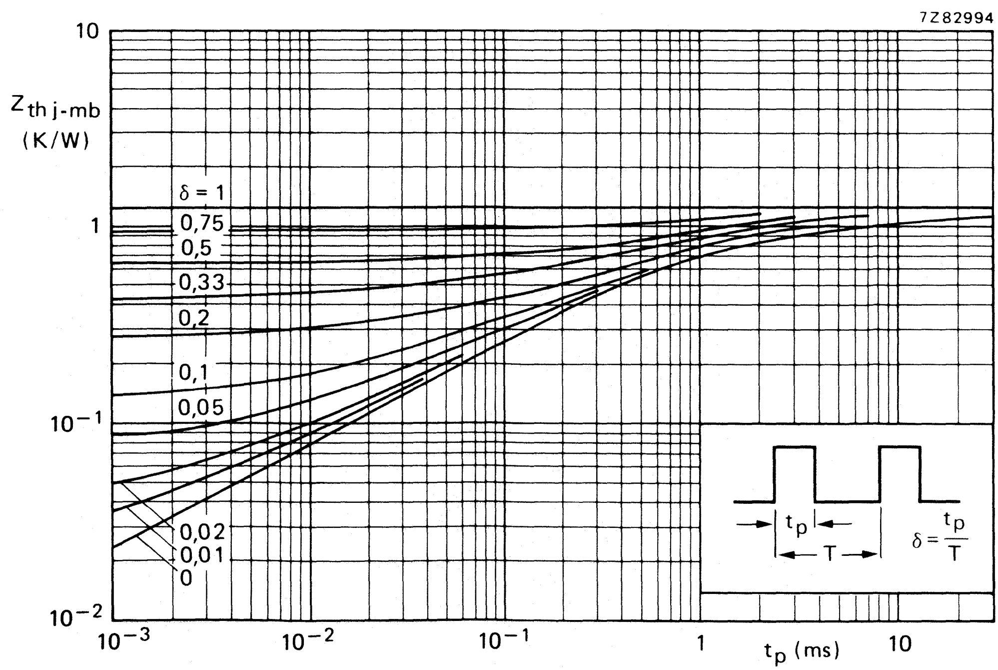


Fig. 6 Pulse power rating chart.

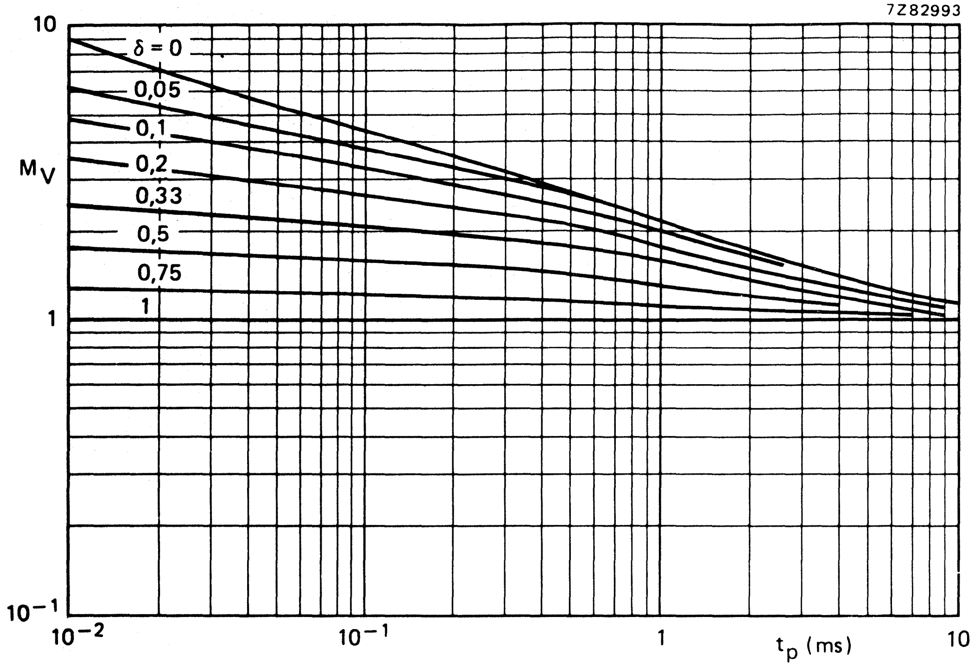


Fig. 7 Second-breakdown voltage multiplying factor at the I_{Cmax} level.

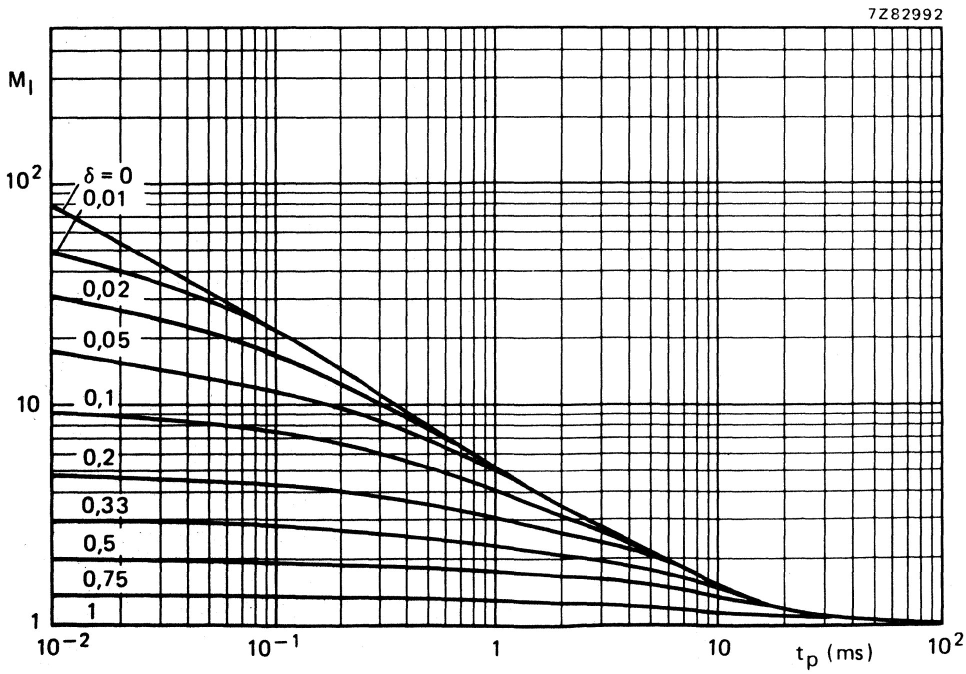


Fig. 8 Second-breakdown current multiplying factor at the V_{CEOmax} level.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

N-P-N transistors in TO-126 plastic envelopes intended for high current switching applications, e.g. inverters, and switching regulator circuits.

QUICK REFERENCE DATA

			BDX35	BDX36	BDX37	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	60	80	V
Collector current (d.c.)	I_C	max.	5	5	5	A
Collector current (peak value)	I_{CM}	max.	10	10	10	A
Total power dissipation up to T_{mb} = 75 °C	P_{tot}	max.	15	15	15	W
D.C. current gain I_C = 0,5 A; V_{CE} = 10 V	h_{FE}	>	45	45	45	
Collector-emitter saturation voltage I_C = 5 A; I_B = 0,5 A	V_{CEsat}	<	0,9	0,7	0,9	V
Turn-off time I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 0,5 A	t_{off}	typ.	350	350	350	ns

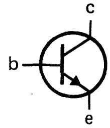
MECHANICAL DATA

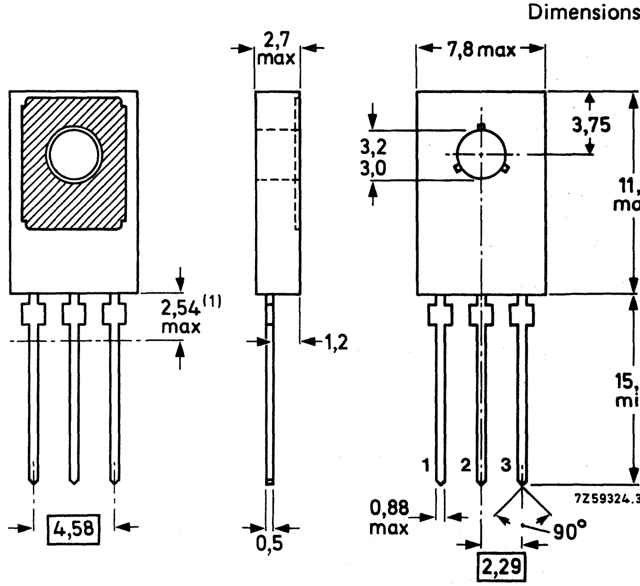
Dimensions in mm

Fig. 1 TO-126 (SOT-32)

Collector connected to the metal part of the mounting surface

Pinning
1 = emitter
2 = collector
3 = base





(1) Within this region the cross-section of the leads is uncontrolled.
See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages			BDX35	BDX36	BDX37	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	120	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	100	120	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	60	80	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	5	A
Collector current (peak value)	I_{CM}	max.	10	A
Base current (d.c.)	I_B	max.	1	A
Base current (peak value)	I_{BM}	max.	2	A
Reverse base current (peak value)	$-I_{BM}$	max.	2	A
Total power dissipation				
up to T_{mb} = 75 °C	P_{tot}	max.	15	W
up to T_{amb} = 25 °C	P_{tot}	max.	1,25	W
Storage temperature	T_{stg}		–65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current					
I_E = 0; V_{CB} = 80 V	BDX35	I_{CBO}	<	10	μA
I_E = 0; V_{CB} = 80 V; T_j = 100 °C	BDX35	I_{CBO}	<	50	μA
I_E = 0; V_{CB} = 100 V	BDX36/37	I_{CBO}	<	10	μA
I_E = 0; V_{CB} = 100 V; T_j = 100 °C	BDX36/37	I_{CBO}	<	50	μA
Emitter cut-off current					
I_C = 0; V_{EB} = 4 V		I_{EBO}	typ.	5	nA
			<	10	μA
I_C = 0; V_{EB} = 5 V		I_{EBO}	<	1	mA
D.C. current gain		h_{FE}	45 to 450		
I_C = 0,5 A; V_{CE} = 10 V	BDX35/36	h_{FE}	typ.	130	
	BDX37	h_{FE}	typ.	80	
Collector-emitter saturation voltage					
I_C = 5 A; I_B = 0,5 A	BDX35/37	V_{CEsat}	<	0,9	V
	BDX36	V_{CEsat}	<	0,7	V
I_C = 7 A; I_B = 0,7 A	BDX35/37	V_{CEsat}	<	1,2	V
I_C = 10 A; I_B = 1 A	BDX36	V_{CEsat}	<	1,5	V
Base-emitter saturation voltage					
I_C = 5 A; I_B = 0,5 A		V_{BEsat}	<	1,6	V
I_C = 7 A; I_B = 0,7 A	BDX35/37	V_{BEsat}	<	1,9	V ←
I_C = 10 A; I_B = 1 A	BDX36	V_{BEsat}	<	2,5	V ←
Collector capacitance at f = 1 MHz					
I_E = I_e = 0; V_{CB} = 10 V		C_c	typ.	40	pF
			<	60	pF
Transition frequency at f = 35 MHz					
I_C = 0,5 A; V_{CE} = 5 V; T_{amb} = 25 °C		f_T	typ.	100	MHz
Switching times (between 10% and 90% levels)					
I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A					
turn-on time		t_{on}	typ.	0,06	μs
			<	0,1	μs
turn-off time		t_{off}	typ.	0,6	μs
			<	0,8	μs
I_{Con} = 2 A; I_{Bon} = $-I_{Boff}$ = 0,2 A					
turn-on time		t_{on}	<	80	ns
turn-off time		t_{off}	typ.	0,45	μs
			<	0,7	μs
I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 0,5 A					
turn-on time		t_{on}	typ.	180	ns
			<	300	ns
turn-off time		t_{off}	typ.	320	ns
			<	500	ns

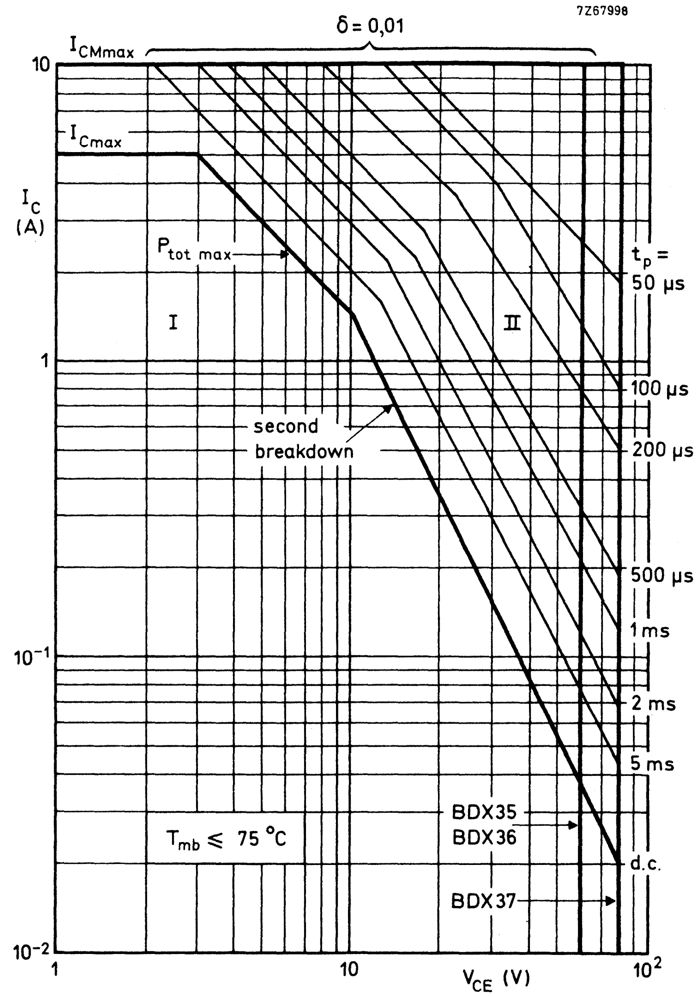


Fig. 2 Safe Operating Area with the transistor forward biased.

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation.

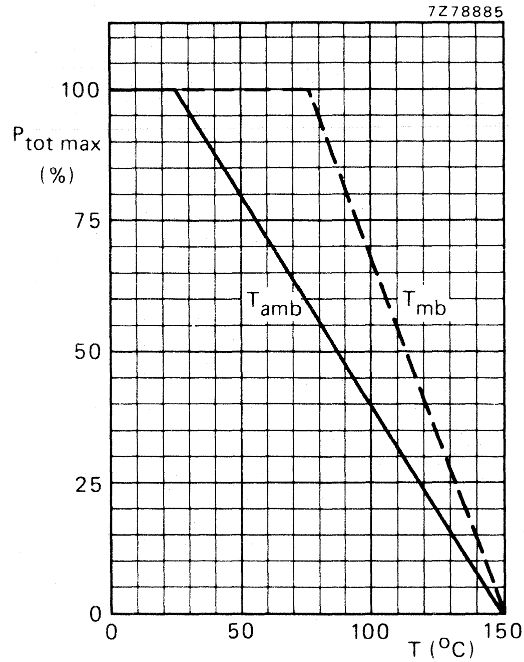


Fig. 3 Power derating curve.

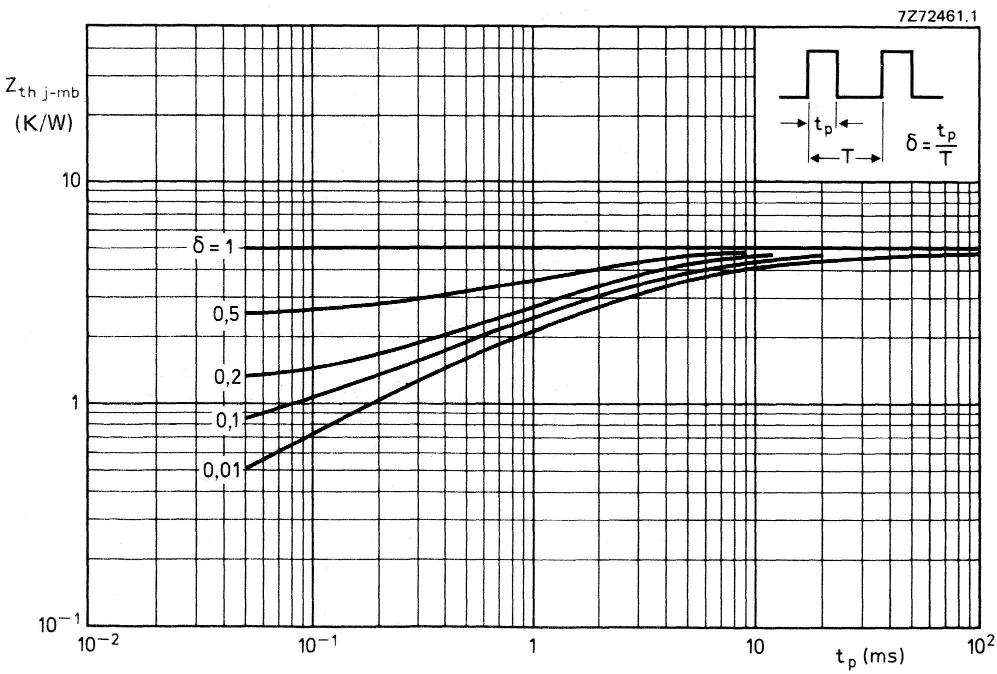


Fig. 4 Pulse power rating chart.

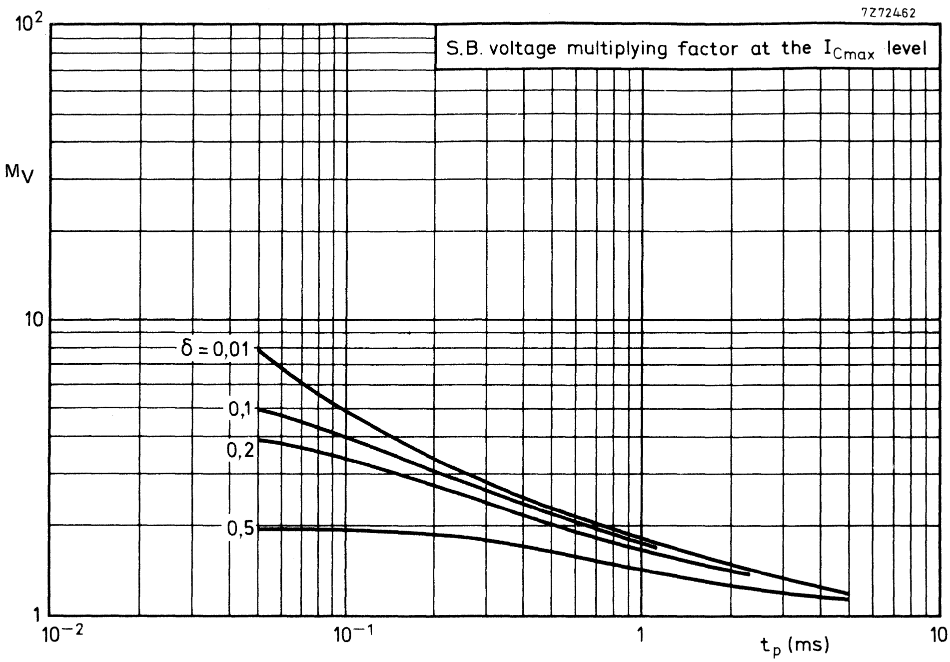


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

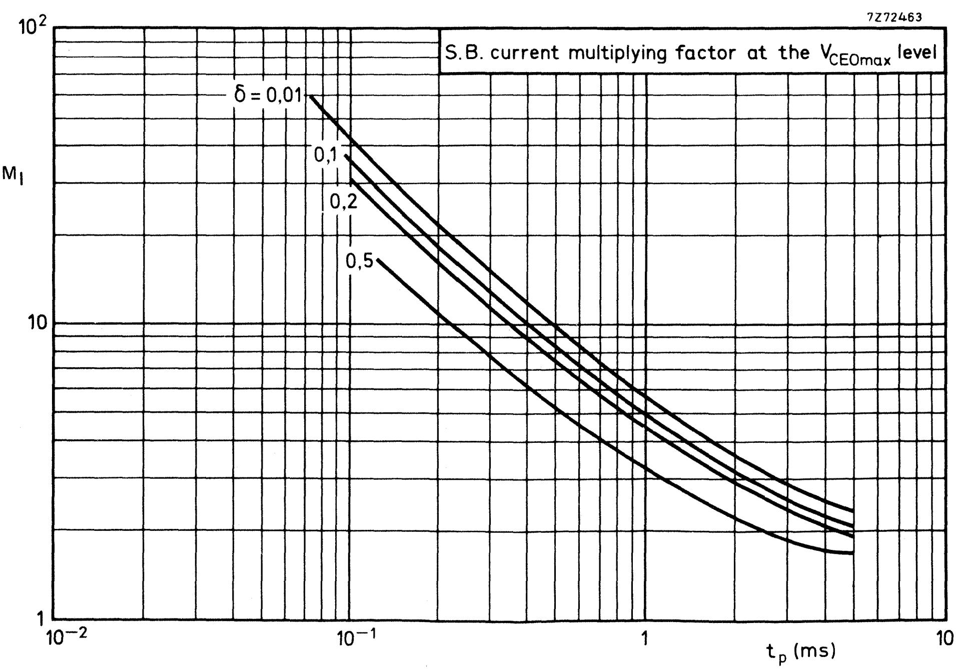


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level.

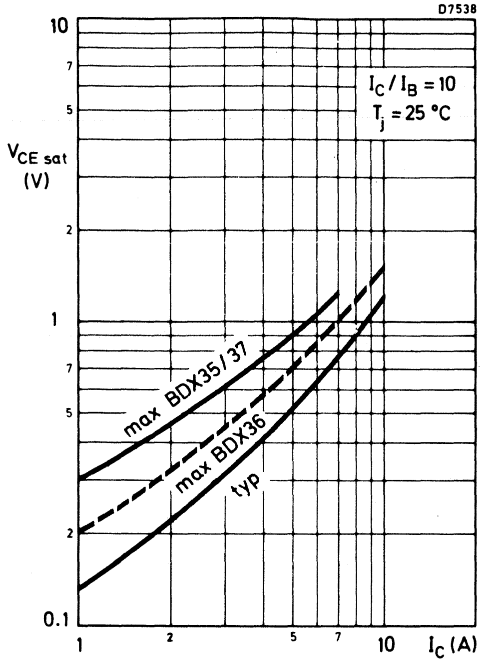


Fig. 7 Collector-emitter saturation voltage as a function of the collector current.

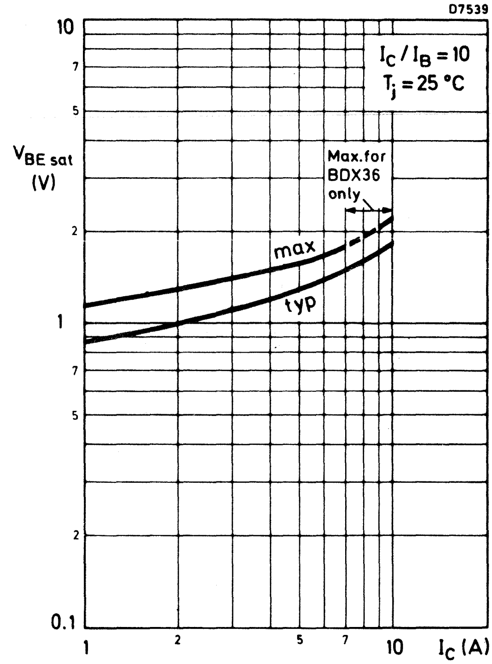


Fig. 8 Base-emitter saturation voltage as a function of the collector current.

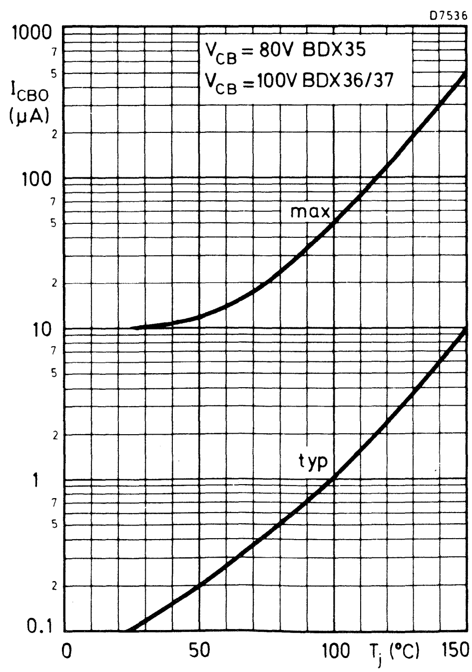


Fig. 9 Collector-base current with an open emitter as a function of junction temperature.

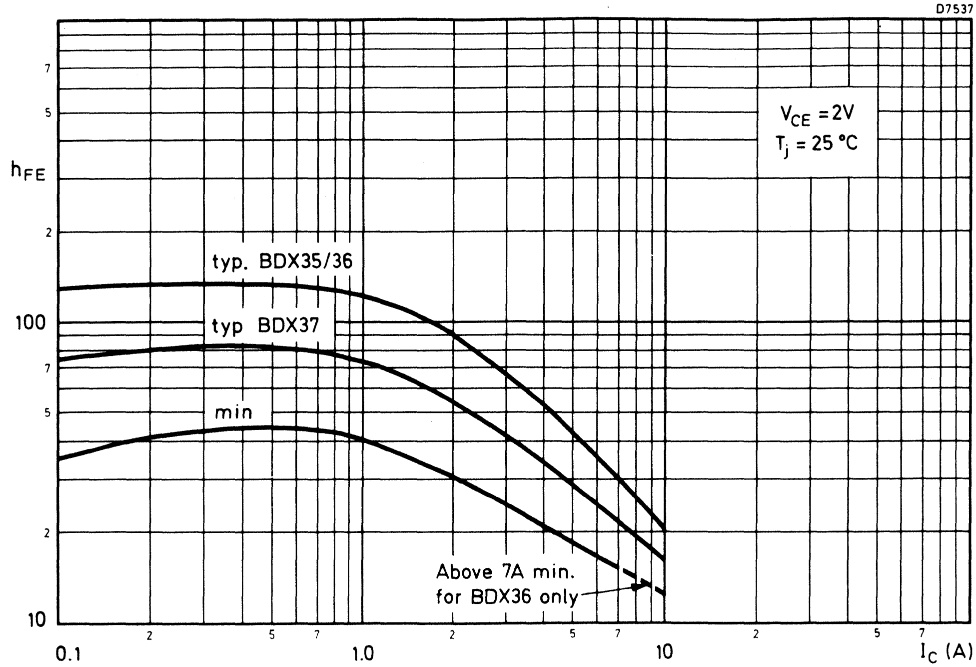


Fig. 10 D.C. current gain as a function of collector current.

N-P-N SILICON PLANAR DARLINGTON TRANSISTORS

Silicon n-p-n planar Darlington transistors for industrial switching applications, e.g. print hammer, solenoid, relay and lamp driving. Encapsulated in a TO-126 plastic envelope with collector connected to the heatsink.
P-N-P complements are BDX45, BDX46 and BDX47 respectively.

QUICK REFERENCE DATA

			BDX42	BDX43	BDX44	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	90	V
Collector-emitter voltage	V_{CER}	max.	45	60	80	V
Collector current	I_C	max.	1	1	1	A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.	1,25	1,25	1,25	W
up to T_{mb} = 100 °C	P_{tot}	max.	5	5	5	W
D.C. current gain						
I_C = 500 mA; V_{CE} = 10 V	h_{FE}	>	2000	2000	2000	
Collector-emitter saturation voltage						
I_C = 1 A; I_B = 1 mA	V_{CEsat}	<	–	1,6	–	V
I_C = 1 A; I_B = 4 mA	V_{CEsat}	<	1,6	–	1,6	V
Turn-off time						
I_C = 500 mA; I_{Bon} = $-I_{Boff}$ = 0,5 mA	t_{off}	typ.	1500	1500	1500	ns

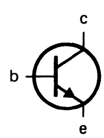
MECHANICAL DATA

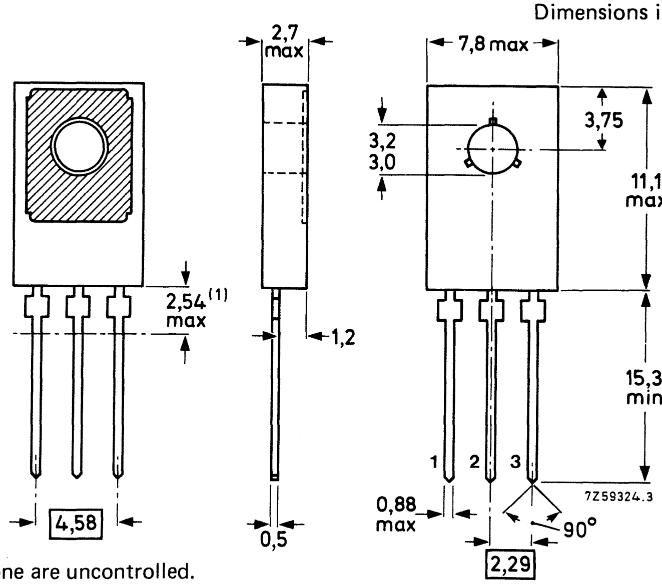
Dimensions in mm

Fig. 1 TO-126.

Collector connected to the metal part of mounting surface.

Pinning
1 = emitter
2 = collector
3 = base





(1) Dimensions within this zone are uncontrolled.

See also chapters Mounting Instructions and Accessories.

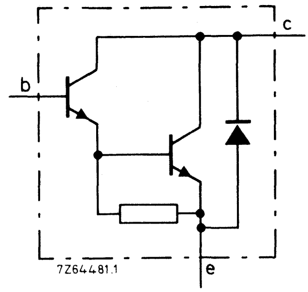


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX42	BDX43	BDX44	
→ Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	90	V
Collector-emitter voltage *	V_{CER}	max.	45	60	80	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current (d.c.)	I_C	max.		1		A
Collector current (peak)	I_{CM}	max.		2		A
Base current (d.c.)	I_B	max.		0,1		A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		1,25		W
up to T_{mb} = 100 °C	P_{tot}	max.		5		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature **	T_j	max.		150		°C

THERMAL RESISTANCE **

From junction to ambient	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	K/W

* External R_{BE} not to exceed value shown in Fig. 12.

** Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
V_{BE} = 0; V_{CE} = 45 V	BDX42	I_{CES}	<	10 μA
V_{BE} = 0; V_{CE} = 60 V	BDX43	I_{CES}	<	10 μA
V_{BE} = 0; V_{CE} = 80 V	BDX44	I_{CES}	<	10 μA
Emitter cut-off current				
I_C = 0; V_{EB} = 4 V		I_{EBO}	<	10 μA
D.C. current gain				
I_C = 150 mA; V_{CE} = 10 V		h_{FE}	>	1000
I_C = 500 mA; V_{CE} = 10 V		h_{FE}	>	2000
Collector-emitter saturation voltage				
I_C = 500 mA; I_B = 0,5 mA		V_{CEsat}	<	1,3 V
I_C = 1 A; I_B = 1 mA	BDX43	V_{CEsat}	<	1,6 V
I_C = 1 A; I_B = 4 mA	BDX42, 44	V_{CEsat}	<	1,6 V
I_C = 500 mA; I_B = 0,5 mA; T_j = 150 °C		V_{CEsat}	<	1,3 V
I_C = 1 A; I_B = 1 mA; T_j = 150 °C	BDX43	V_{CEsat}	<	1,8 V
I_C = 1 A; I_B = 4 mA; T_j = 150 °C	BDX42, 44	V_{CEsat}	<	1,6 V
Base-emitter saturation voltage				
I_C = 500 mA; I_B = 0,5 mA		V_{BEsat}	<	1,9 V
I_C = 1 A; I_B = 1 mA	BDX43	V_{BEsat}	<	2,2 V
I_C = 1 A; I_B = 4 mA	BDX42, 44	V_{BEsat}	<	2,2 V
Small signal current gain				
I_C = 500 mA; V_{CE} = 5 V; f = 35 MHz		h_{fe}	typ.	10
Switching times (see also Fig. 3 and Fig. 4)				
I_C = 500 mA; I_{Bon} = $-I_{Boff}$ = 0,5 mA				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns
I_C = 1 A; I_{Bon} = $-I_{Boff}$ = 1 mA				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns

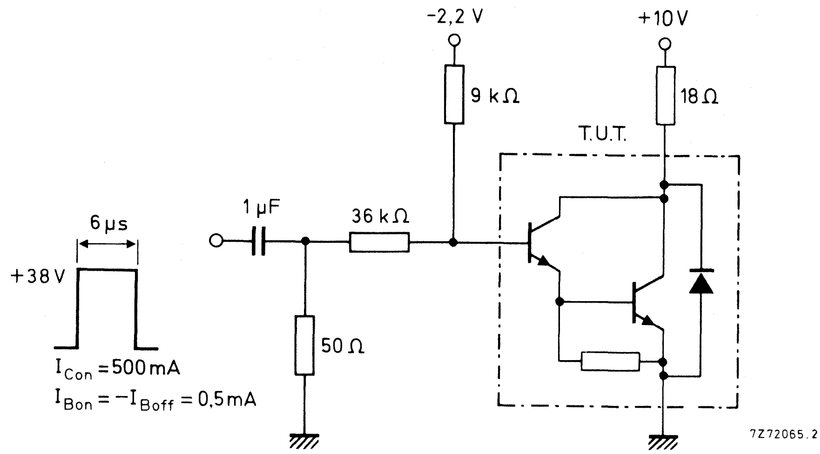


Fig. 3 Test circuit for 500 mA switching.

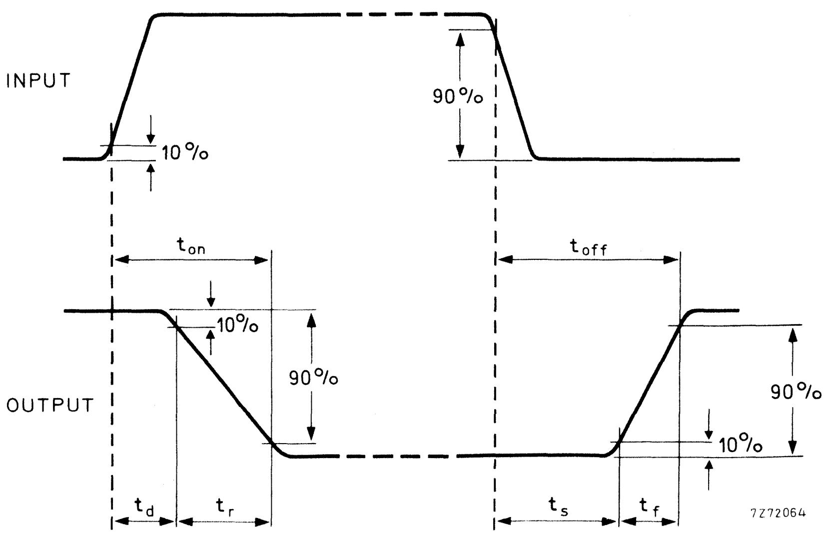


Fig. 4 Switching waveforms.

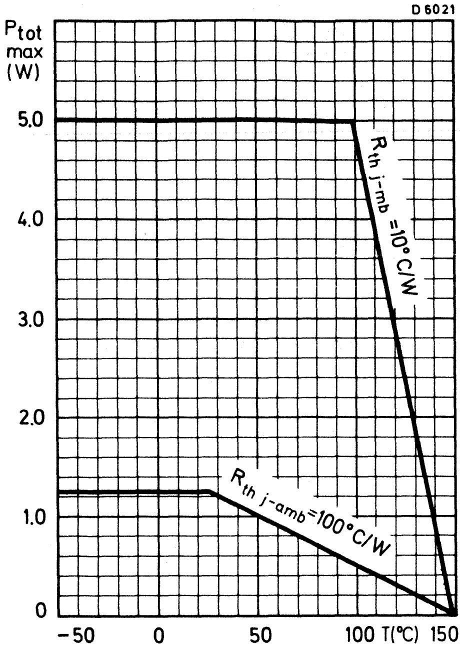


Fig. 5.

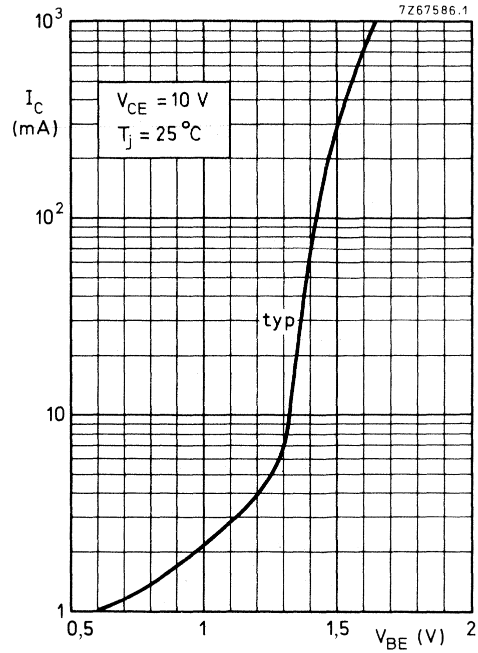


Fig. 6.

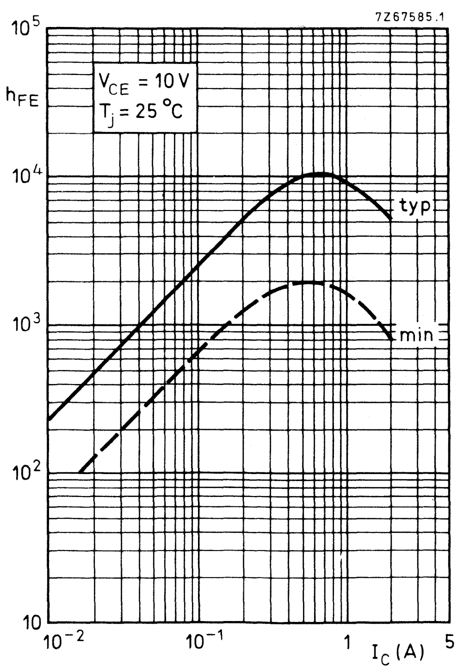


Fig. 7.

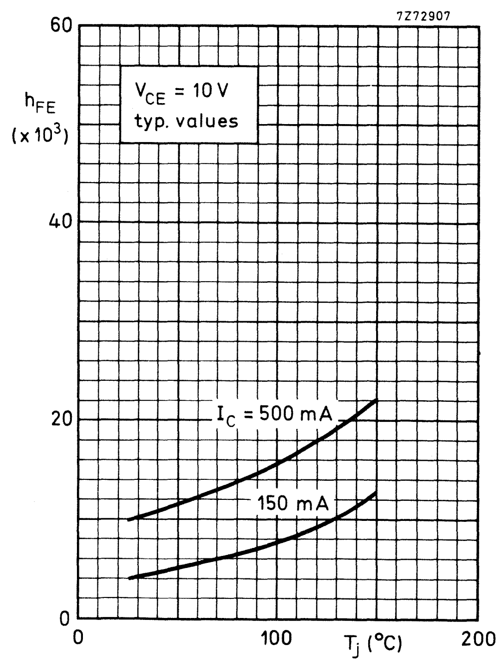


Fig. 8.

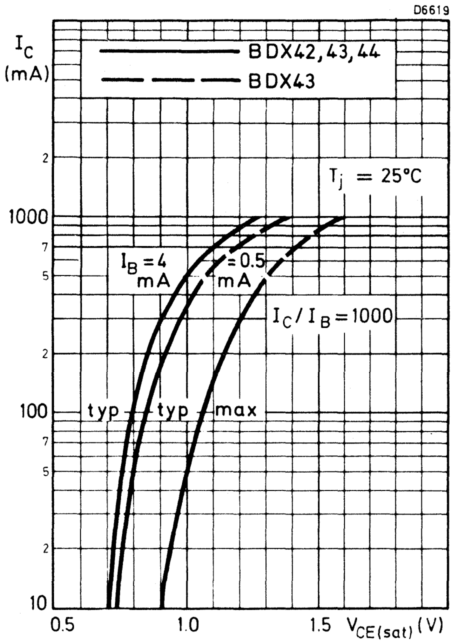


Fig. 9.

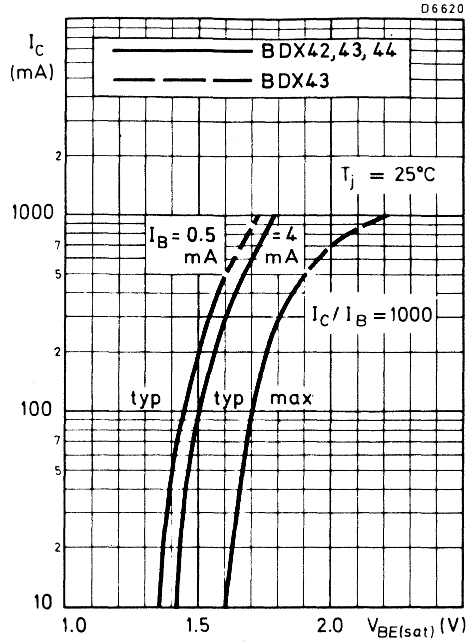


Fig. 10.

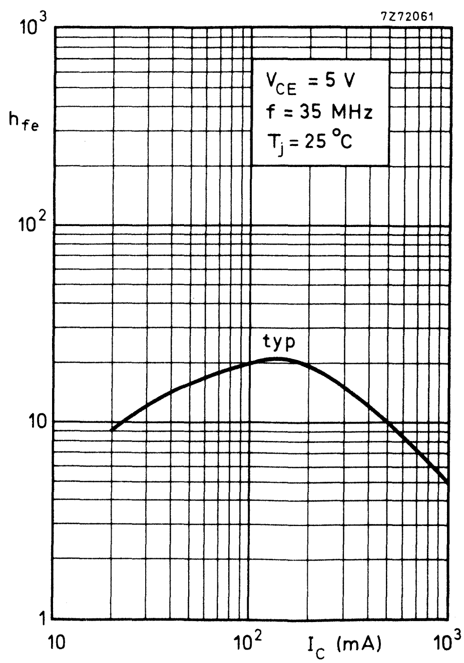


Fig. 11.

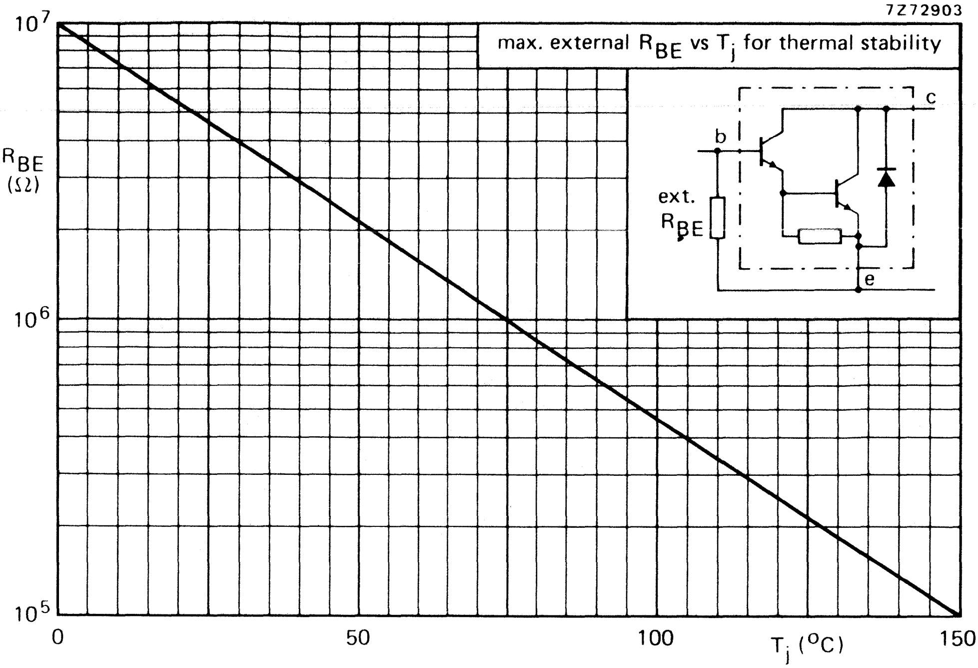

7Z72903
max. external R_{BE} vs T_j for thermal stability
10^7
R_{BE} (Ω)
10^6
10^5
0
50
100
T_j (°C)
150
c
b
ext. R_{BE}
e

Fig. 12.

P-N-P SILICON PLANAR DARLINGTON TRANSISTORS

Silicon p-n-p planar Darlington transistors for industrial switching applications, e.g. print hammer, solenoid, relay and lamp driving. Encapsulated in a TO-126 plastic envelope with collector connected to the heatsink.
N-P-N complements are BDX42, BDX43 and BDX44 respectively.

QUICK REFERENCE DATA

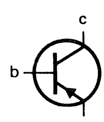
			BDX45	BDX46	BDX47	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	90	V
Collector-emitter voltage	$-V_{CER}$	max.	45	60	80	V
Collector current	$-I_C$	max.	1	1	1	A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.	1,25	1,25	1,25	W
up to T_{mb} = 100 °C	P_{tot}	max.	5	5	5	W
D.C. current gain						
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	>	2000	2000	2000	
Collector-emitter saturation voltage						
$-I_C$ = 1 A; $-I_B$ = 1 mA	$-V_{CEsat}$	<	–	1,6	–	V
$-I_C$ = 1 A; $-I_B$ = 4 mA	$-V_{CEsat}$	<	1,6	–	1,6	V
Turn-off time						
$-I_C$ = 500 mA; $-I_{Bon}$ = I_{Boff} = 0,5 mA	t_{off}	typ.	1500	1500	1500	ns

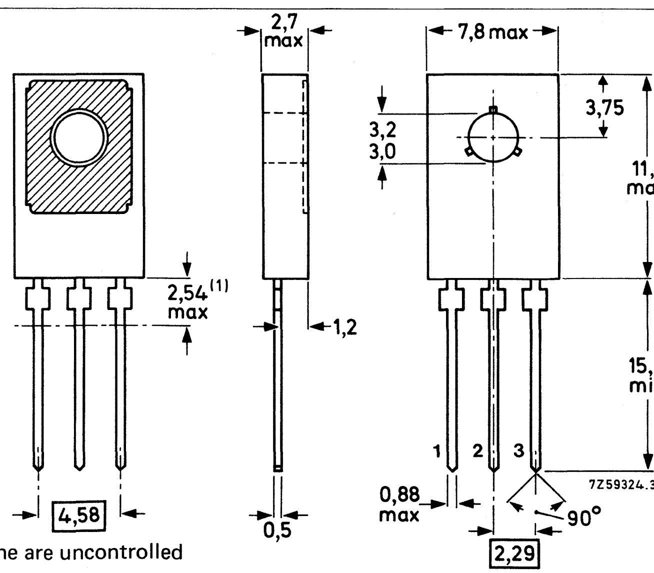
MECHANICAL DATA

Fig. 1 TO-126.

Collector connected to the metal part of mounting surface.

Pinning
1 = emitter
2 = collector
3 = base





(1) Dimensions within this zone are uncontrolled

See also chapters Mounting Instructions and Accessories.

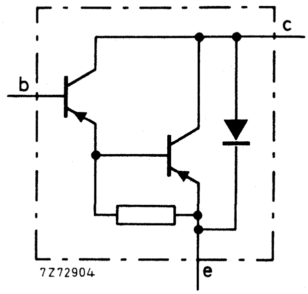


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX45	BDX46	BDX47	
→ Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	90	V
Collector-emitter voltage *	$-V_{CER}$	max.	45	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current (d.c.)	$-I_C$	max.		1		A
Collector current (peak)	$-I_{CM}$	max.		2		A
Base current (d.c.)	$-I_B$	max.		0,1		A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		1,25		W
up to T_{mb} = 100 °C	P_{tot}	max.		5		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature**	T_j	max.		150		°C

THERMAL RESISTANCE **

From junction to ambient	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	K/W

* External R_{BE} not to exceed value shown in Fig. 12.

** Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$V_{BE} = 0$; $-V_{CE} = 45$ V	BDX45	$-I_{CES}$	<	10 µA
$V_{BE} = 0$; $-V_{CE} = 60$ V	BDX46	$-I_{CES}$	<	10 µA
$V_{BE} = 0$; $-V_{CE} = 80$ V	BDX47	$-I_{CES}$	<	10 µA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4$ V		$-I_{EBO}$	<	10 µA
D.C. current gain				
$-I_C = 150$ mA; $-V_{CE} = 10$ V		h_{FE}	>	1000
$-I_C = 500$ mA; $-V_{CE} = 10$ V		h_{FE}	>	2000
Collector-emitter saturation voltage				
$-I_C = 500$ mA; $-I_B = 0,5$ mA		$-V_{CEsat}$	<	1,3 V
$-I_C = 1$ A; $-I_B = 1$ mA	BDX46	$-V_{CEsat}$	<	1,6 V
$-I_C = 1$ A; $-I_B = 4$ mA	BDX45, 47	$-V_{CEsat}$	<	1,6 V
$-I_C = 500$ mA; $-I_B = 0,5$ mA; $T_j = 150$ °C		$-V_{CEsat}$	<	1,3 V
$-I_C = 1$ A; $-I_B = 1$ mA; $T_j = 150$ °C	BDX46	$-V_{CEsat}$	<	1,8 V
$-I_C = 1$ A; $-I_B = 4$ mA; $T_j = 150$ °C	BDX45, 47	$-V_{CEsat}$	<	1,6 V
Base-emitter saturation voltage				
$-I_C = 500$ mA; $-I_B = 0,5$ mA		$-V_{BEsat}$	<	1,9 V
$-I_C = 1$ A; $-I_B = 1$ mA	BDX46	$-V_{BEsat}$	<	2,2 V
$-I_C = 1$ A; $-I_B = 4$ mA	BDX45, 47	$-V_{BEsat}$	<	2,2 V
Small signal current gain				
$-I_C = 500$ mA; $-V_{CE} = 5$ V, f = 35 MHz		h_{fe}	typ.	10
Switching times (see also Fig. 3 and Fig. 4)				
$-I_C = 500$ mA; $-I_{Bon} = I_{Boff} = 0,5$ mA				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns
$-I_C = 1$ A; $-I_{Bon} = I_{Boff} = 1$ mA				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns

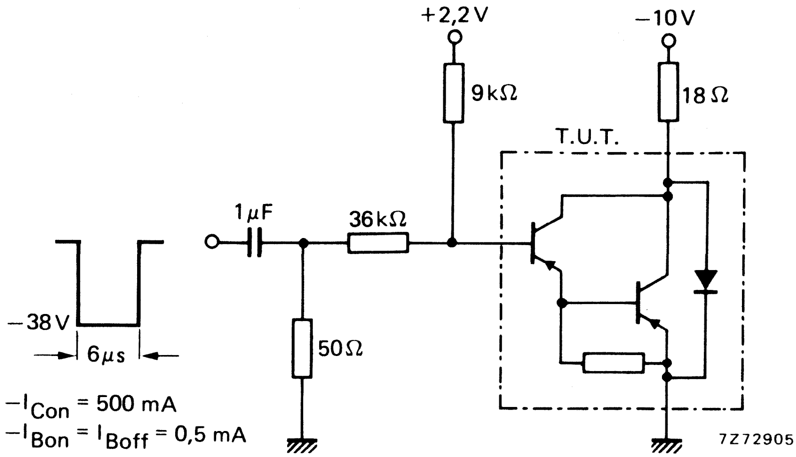


Fig. 3 Test circuit for 500 mA switching.

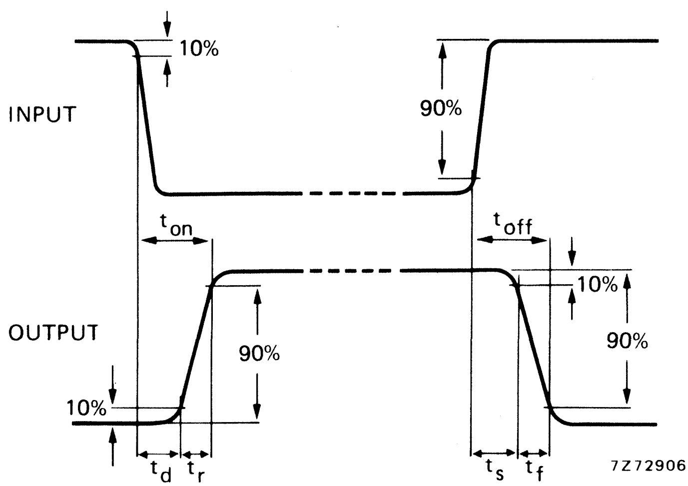


Fig. 4 Switching waveforms.

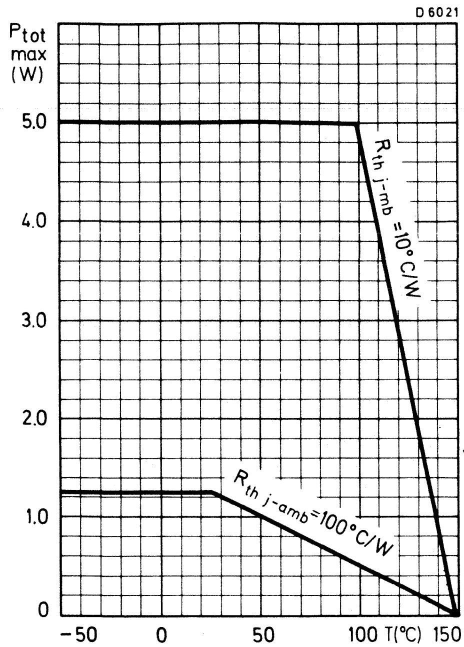


Fig. 5.

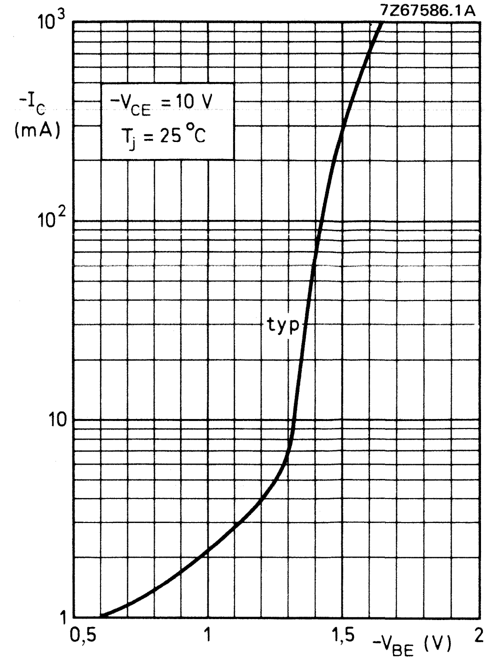


Fig. 6.

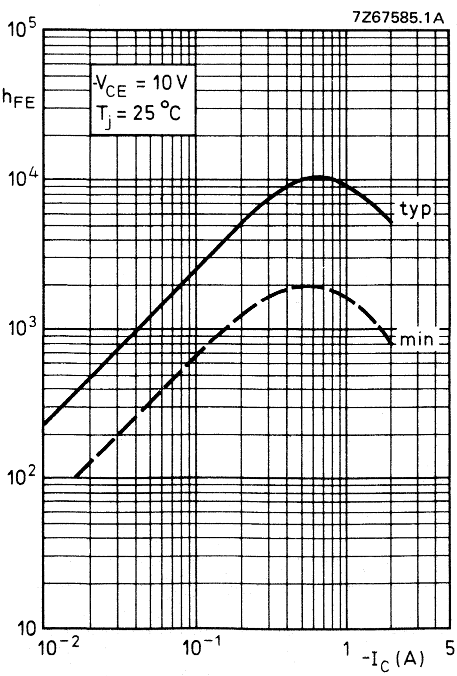


Fig. 7.

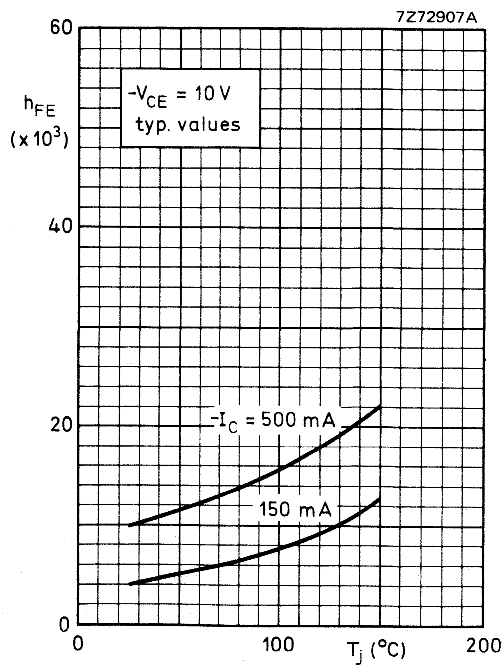


Fig. 8.

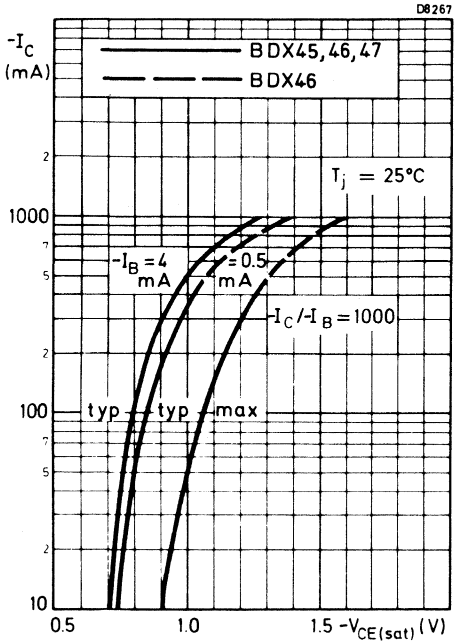


Fig. 9.

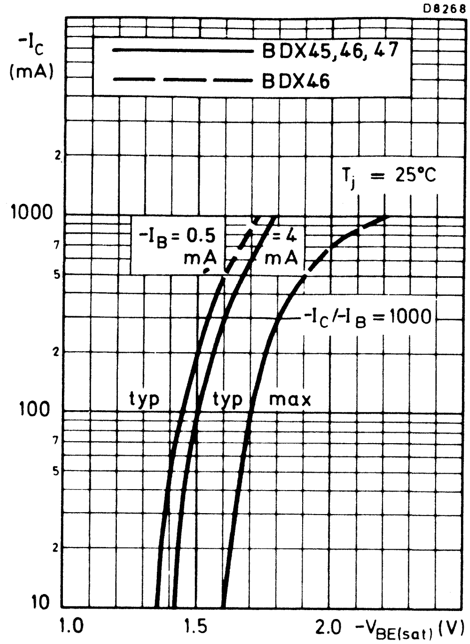


Fig. 10.

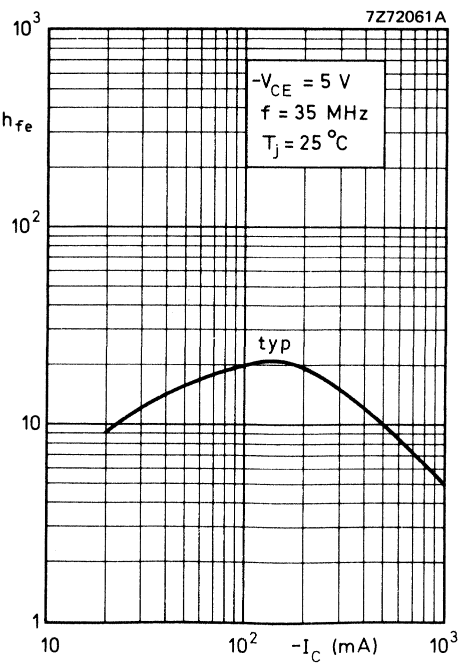


Fig. 11.

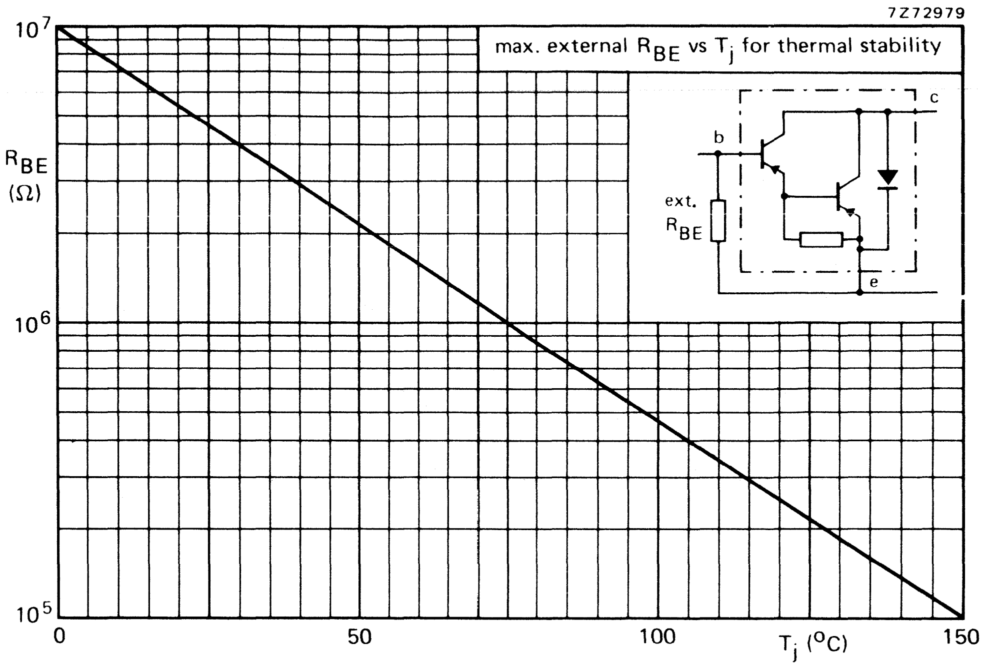

7Z72979
max. external R_{BE} vs T_j for thermal stability
R_{BE} (Ω)
10^7
10^6
10^5
0
50
100
150
T_j (°C)
b
c
e
ext. R_{BE}

Fig. 12.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications: TO-3 envelope, N-P-N complements are BDX63, BDX63A, BDX63B and BDX63C.

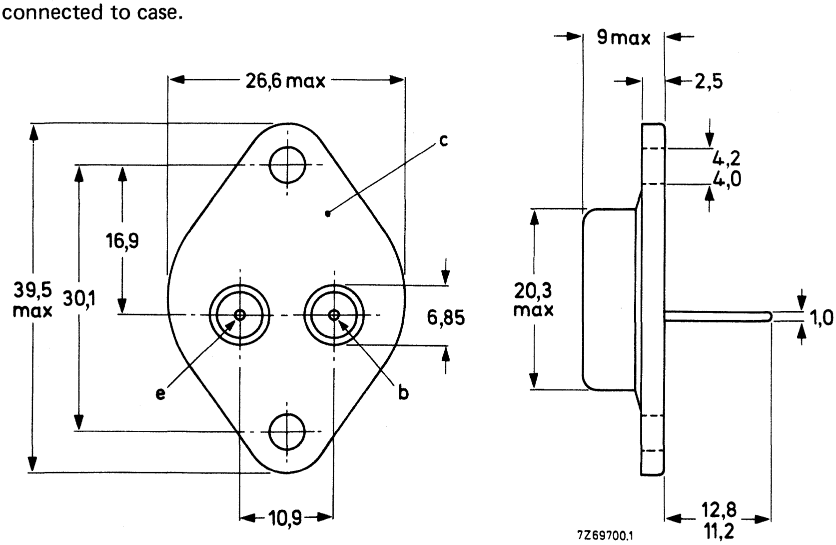
QUICK REFERENCE DATA

			BDX62	62A	62B	62C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.	12				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	90				W
Junction temperature	T_j	max.	200				°C
D.C. current gain $-I_C$ = 0,5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	1500				
$-I_C$ = 3,0 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000				
Cut-off frequency $-I_C$ = 3 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	100				kHz

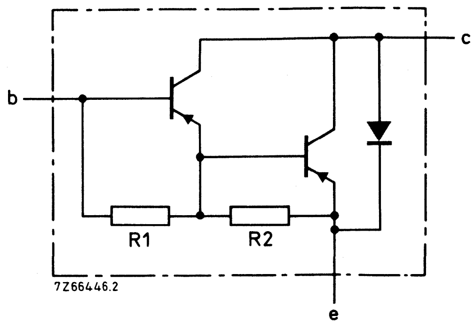
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.
Collector connected to case.



See also chapters Mounting instructions and Accessories.



R_1 typ. 6 kΩ
R_2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX62	62A	62B	62C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.	8				A
Collector current (peak value)	$-I_{CM}$	max.	12				A
Base current (d.c.)	$-I_B$	max.	150				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	90				W
Storage temperature	T_{stg}		−65 to +200				°C
Junction temperature*	T_j	max.	200				°C

THERMAL RESISTANCE*

From junction to mounting base $R_{th\ j\text{-}mb}$ = 1,94 K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2	mA
$I_E = 0$; $-V_{CB} = 40$ V; $T_j = 200$ °C; BDX62				
$I_E = 0$; $-V_{CB} = 50$ V; $T_j = 200$ °C; BDX62A	$-I_{CBO}$	<	2	mA
$I_E = 0$; $-V_{CB} = 60$ V; $T_j = 200$ °C; BDX62B				
$I_E = 0$; $-V_{CB} = 70$ V; $T_j = 200$ °C; BDX62C				
$I_B = 0$; $-V_{CE} = -½V_{CEO}$	$-I_{CEO}$	<	0,2	mA ←
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	5	mA
D.C. current gain (note 1)				
$-I_C = 0,5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	1500	
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000	
$-I_C = 8$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	750	
Base-emitter voltage (notes 1 and 2)				
$-I_C = 3$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5	V
Collector-emitter saturation voltage (note 1)				
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	100	pF
Cut-off frequency				
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100	kHz
Small-signal current gain				
$-I_C = 3$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	100	

Notes
1. Measured under pulse conditions: $t_p < 300$ µs, $\delta < 2\%$.
2. $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)

$-I_{Con} = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA			
turn-on time	t_{on}	typ.	0,5 μs
turn-off time	t_{off}	typ.	2,5 μs

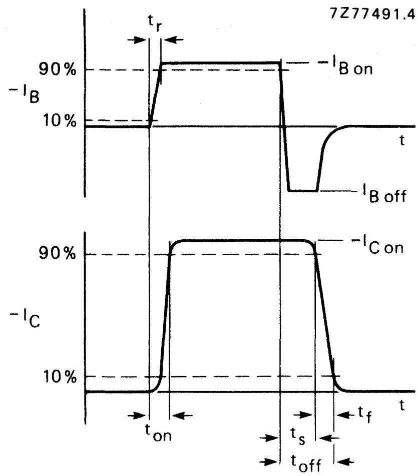


Fig. 3 Switching times waveforms.

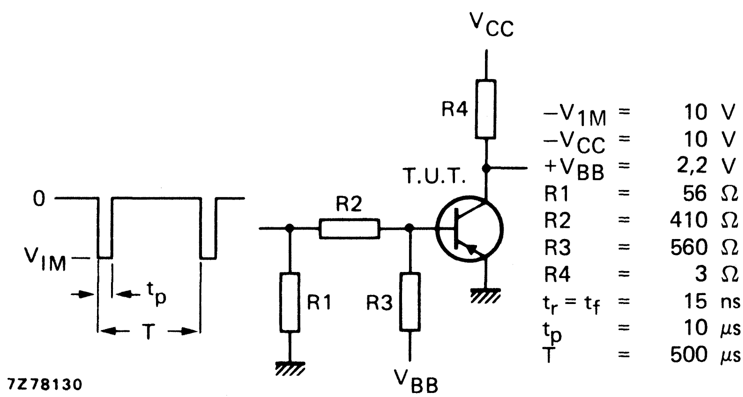


Fig. 4 Switching times test circuit.

Diode forward voltage

$I_F = 3$ A	V_F	typ.	1,8 V

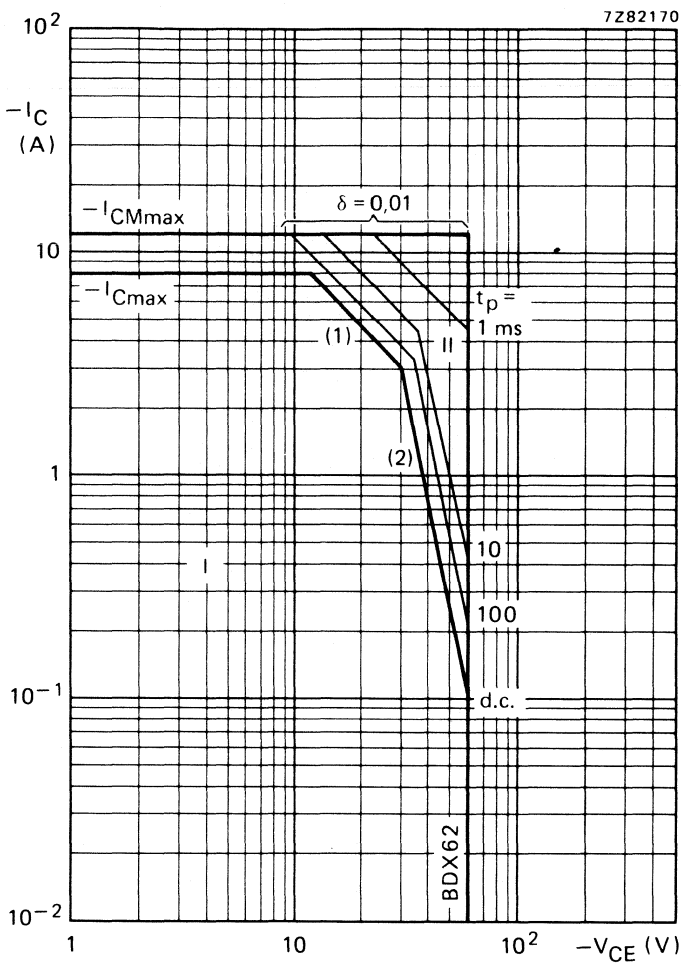


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second-breakdown limits.

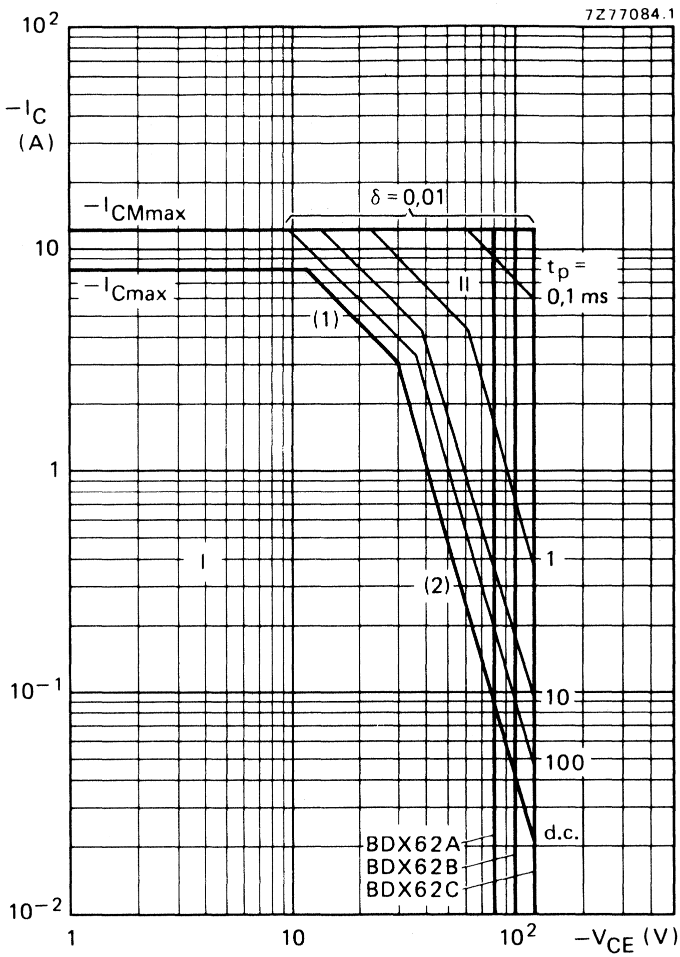


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second-breakdown limits.

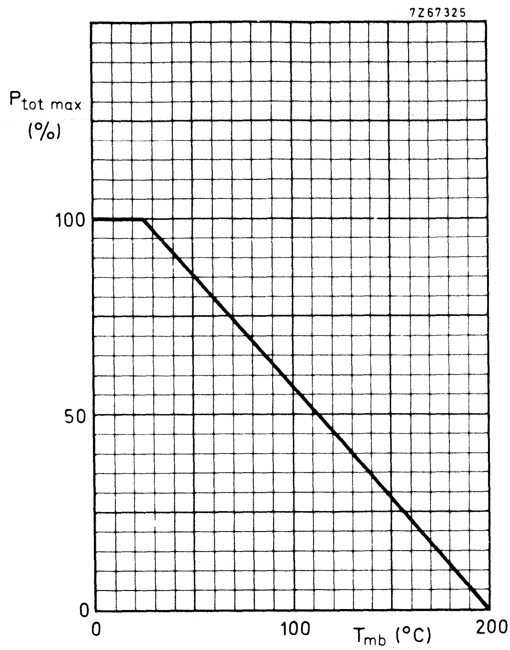


Fig. 7 Power derating curve.

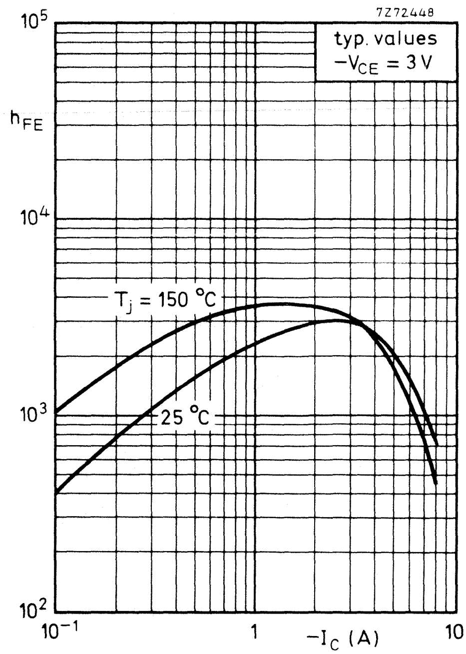


Fig. 8 D.C. current gain.

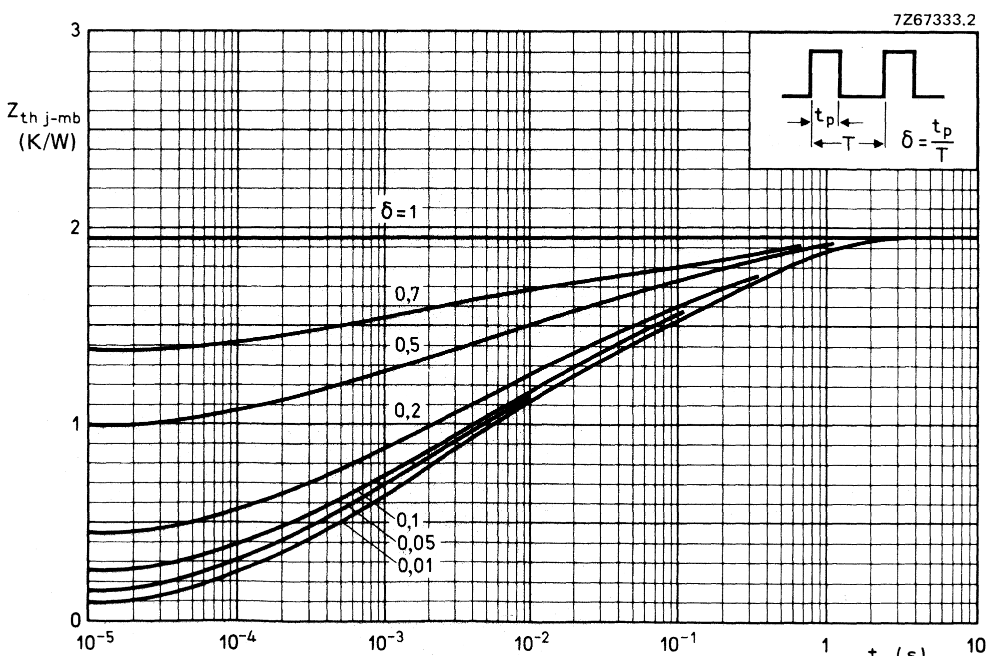


Fig. 9 Pulse power rating chart.

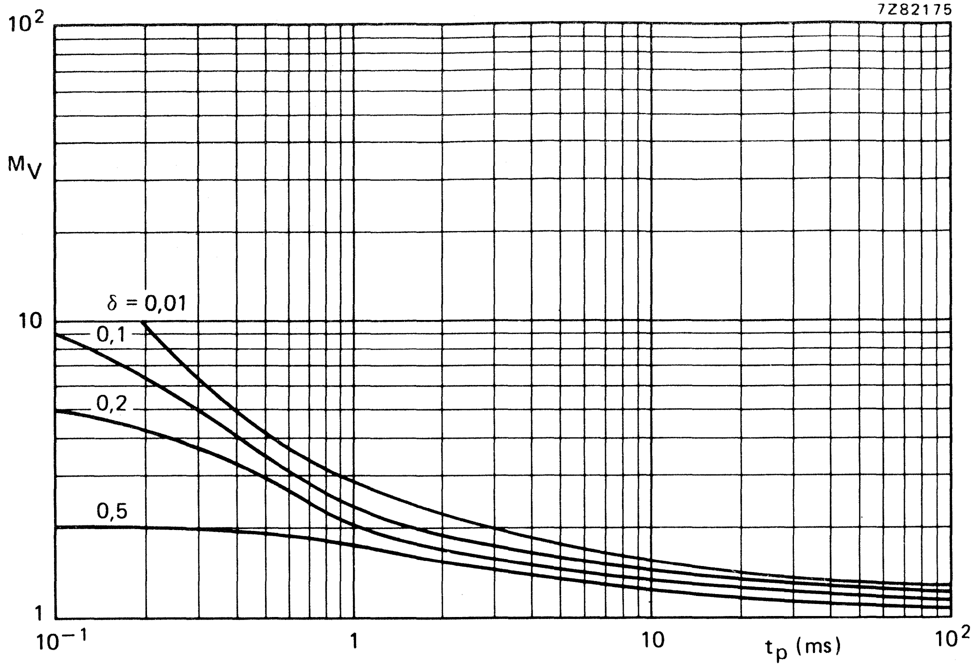


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

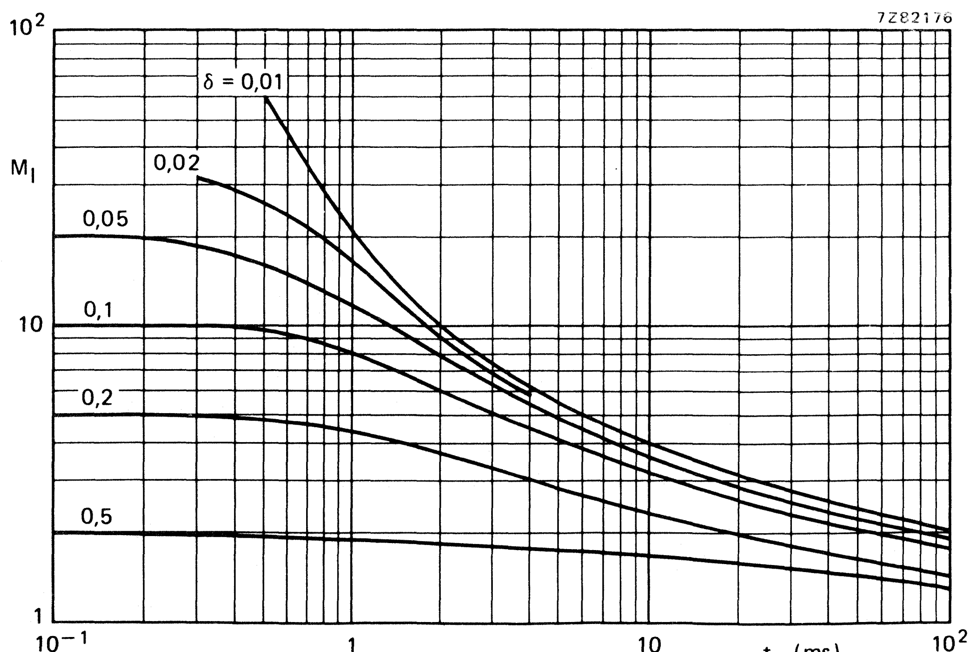


Fig. 11 S.B. current multiplying factor at the V_{CEO} 100 V and 60 V level.

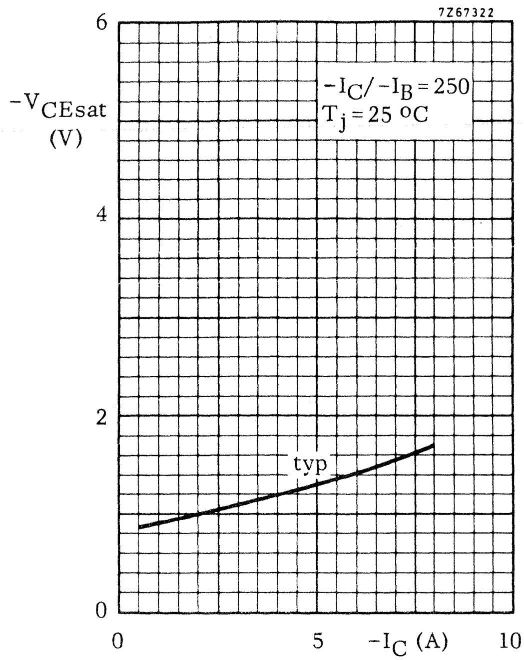


Fig. 12.

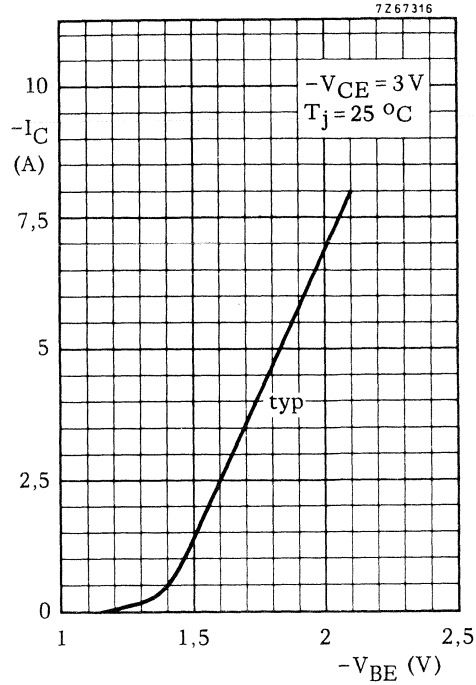


Fig. 13.

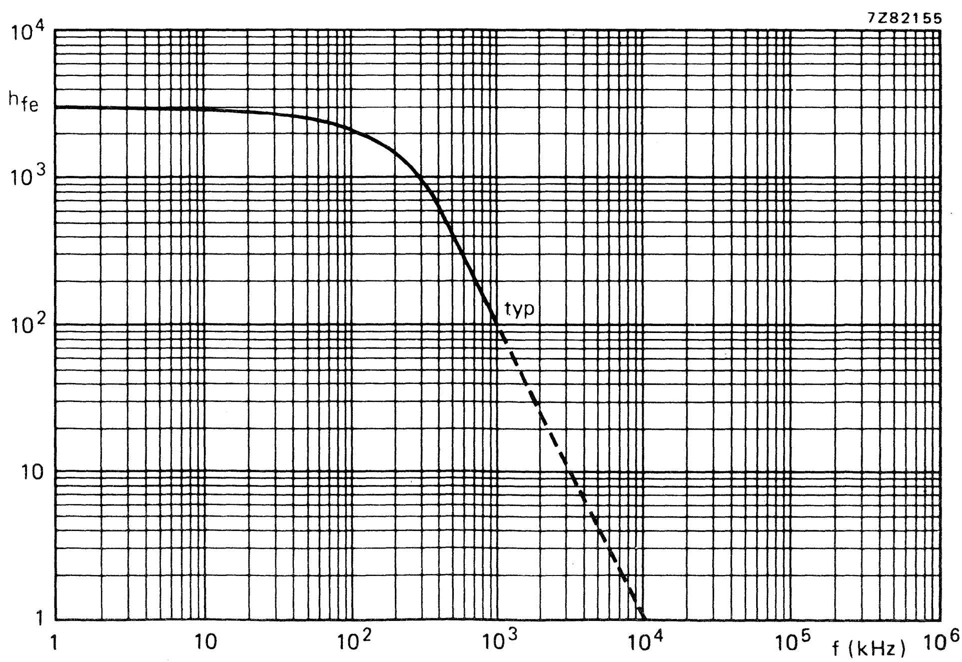


Fig. 14 Small signal current gain at $-I_C = 3$ A; $-V_{CE} = 3$ V.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope, P-N-P complements are BDX62, BDX62A, BDX62B and BDX62C.

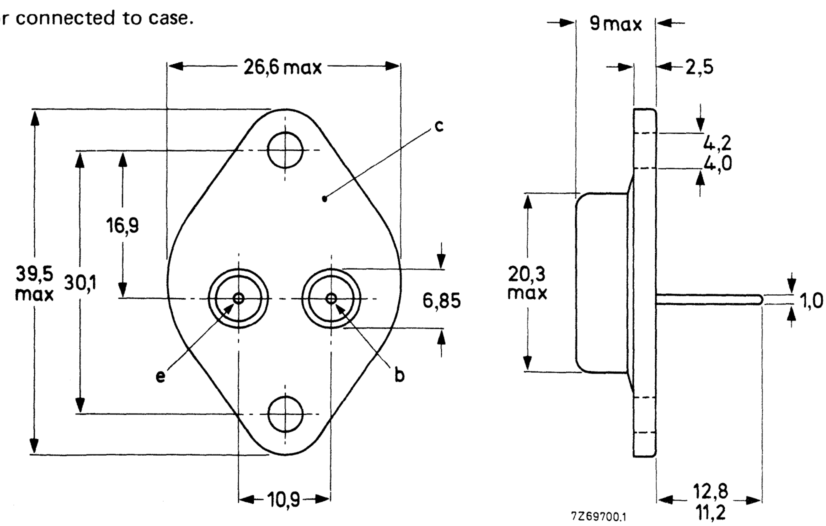
QUICK REFERENCE DATA

			BDX63	63A	63B	63C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.		12			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90			W
Junction temperature	T_j	max.		200			°C
D.C. current gain							
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.		2500			
I_C = 3,0 A; V_{CE} = 3 V	h_{FE}	>		1000			
Cut-off frequency							
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.		100			kHz

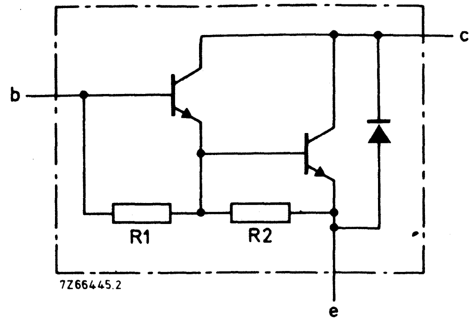
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.
Collector connected to case.



See also chapters Mounting Instructions and Accessories.



R1 typ. 8 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX63	63A	63B	63C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open-base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V
Collector current (d.c.)	I_C	max.	8				A
Collector current (peak value)	I_{CM}	max.	12				A
Base current (d.c.)	I_B	max.	150				mA
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	90				W
Storage temperature	T_{stg}		−65 to +200				^oC
Junction temperature*	T_j	max.	200				^oC

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,94	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	0,2	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 200 °C	I_{CBO}	<	2	mA
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	0,2	mA ←
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5	mA
D.C. current gain (note 1)				
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	2500	
I_C = 3 A; V_{CE} = 3 V	h_{FE}	>	1000	
I_C = 8 A; V_{CE} = 3 V	h_{FE}	typ.	2600	
Base-emitter voltage (notes 1 and 2)				
I_C = 3 A; V_{CE} = 3 V	V_{BE}	<	2,5	V
Collector-emitter saturation voltage (note 1)				
I_C = 3 A; I_B = 12 mA	V_{CEsat}	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	100	pF
Cut-off frequency				
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	100	kHz
Turn-off breakdown energy with inductive load (Fig. 4)				
$-I_{Boff} = 0$; I_{Con} = 4,5 A; t_p = 1 ms; T = 100 ms	$E_{(BR)}$	>	50	mJ
Small signal current gain				
I_C = 3 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	typ.	100	
Diode, forward voltage				
I_F = 3 A	V_F	typ.	1,2	V

Notes

1. Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)
I_{Con} = 3 A; I_{Bon} = $-I_{Boff}$ = 12 mA

turn-on time	t_{on}	typ.	0,5 μs
turn-off time	t_{off}	typ.	5 μs

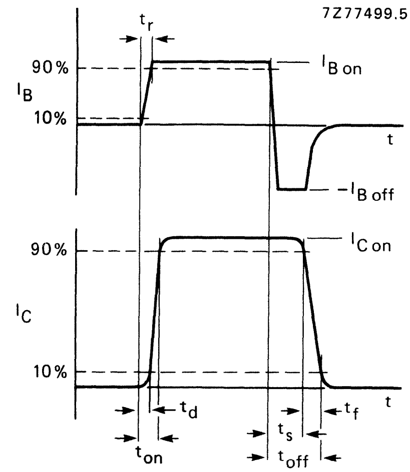
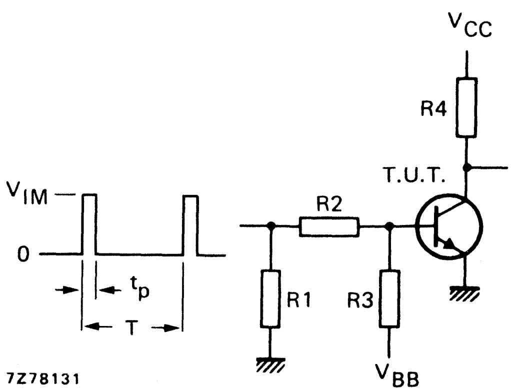


Fig. 3 Switching time waveforms.



V_{IM}	=	10 V
V_{CC}	=	10 V
V_{BB}	=	−4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	⩽	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

Diode, forward voltage

$I_F = 3$ A — V_F typ. 1,2 V

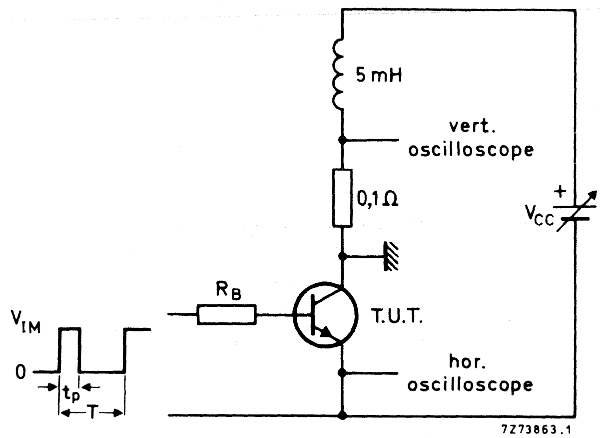


Fig. 5 Test circuit for turn-off breakdown energy.
$V_{IM} = 12$ V; $R_B = 270\ \Omega$; $I_{CC} = 4{,}5$ A; $t_p = 1$ ms; $\delta = 1\%$.

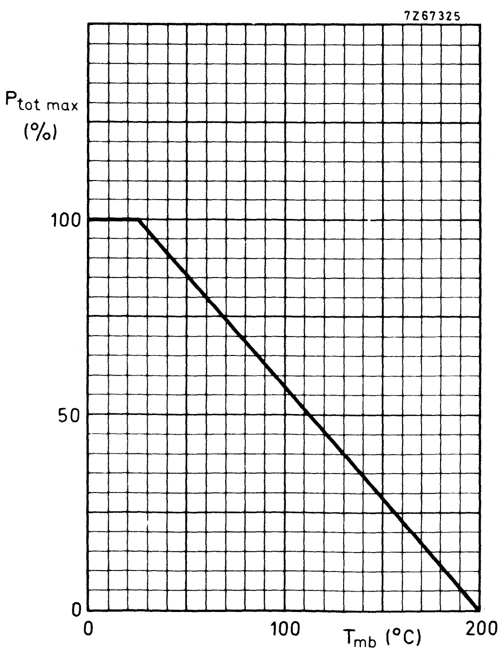


Fig. 6 Power derating curve.

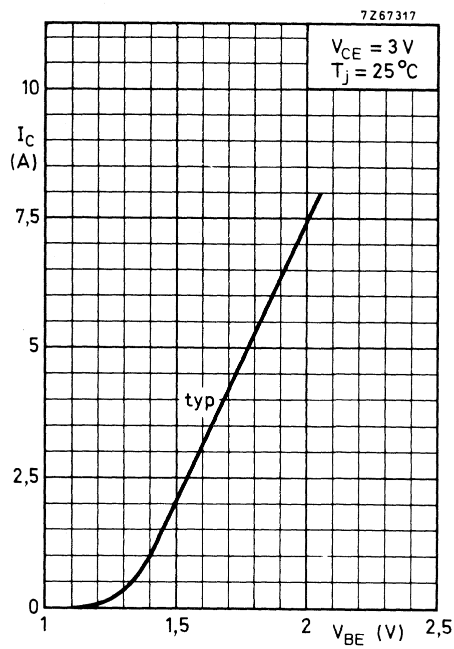


Fig. 7.

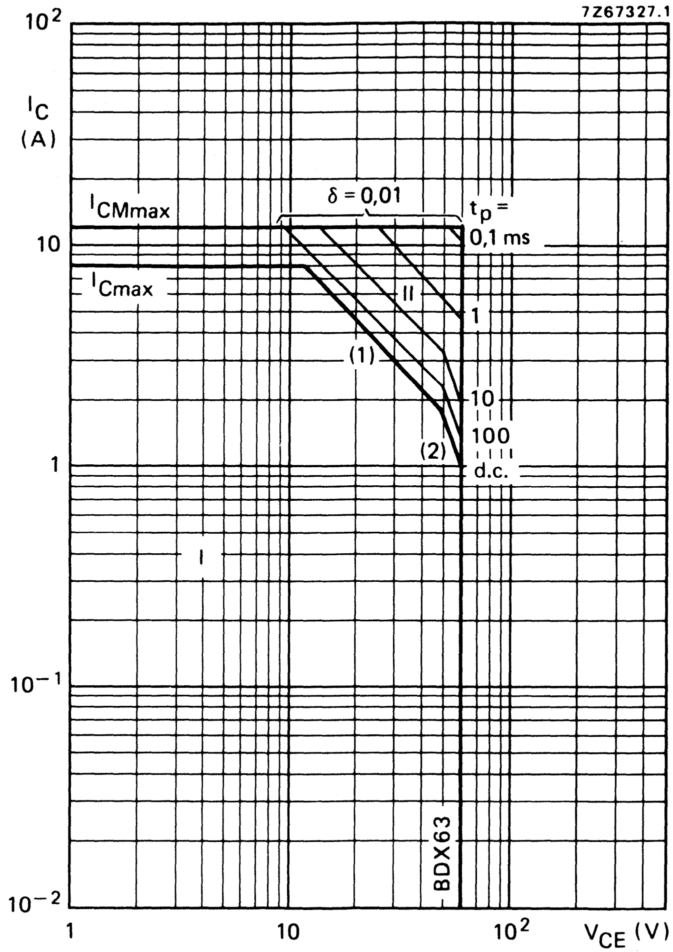


Fig. 8 Safe Operating ARea, $T_{mb} \leqslant 25$ °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(2) Second-breakdown limits.

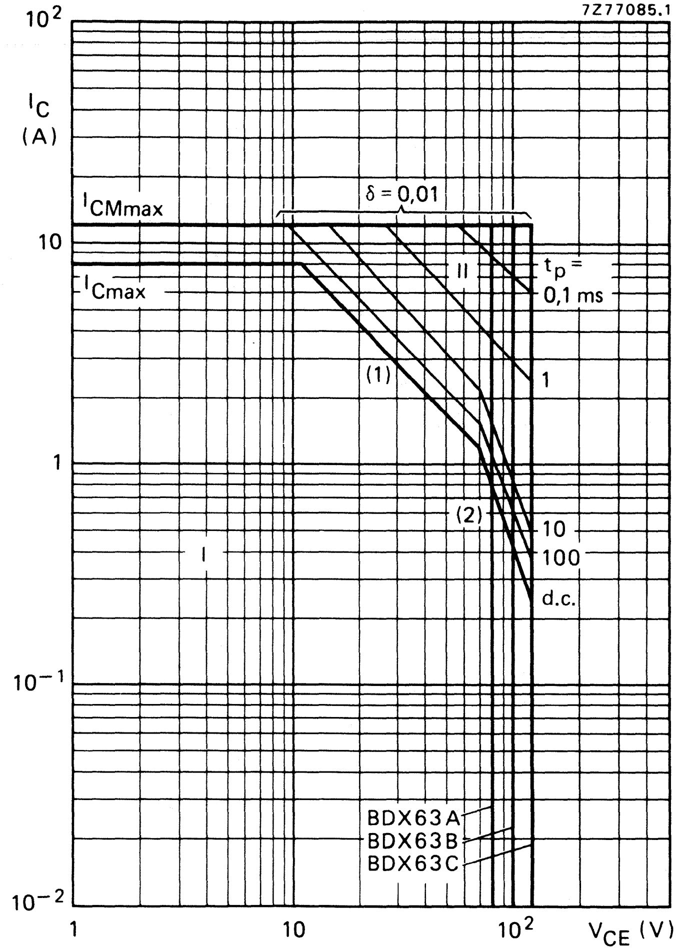


Fig. 9 Safe Operating ARea, $T_{mb} \leqslant 25\ ^{o}C$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits.

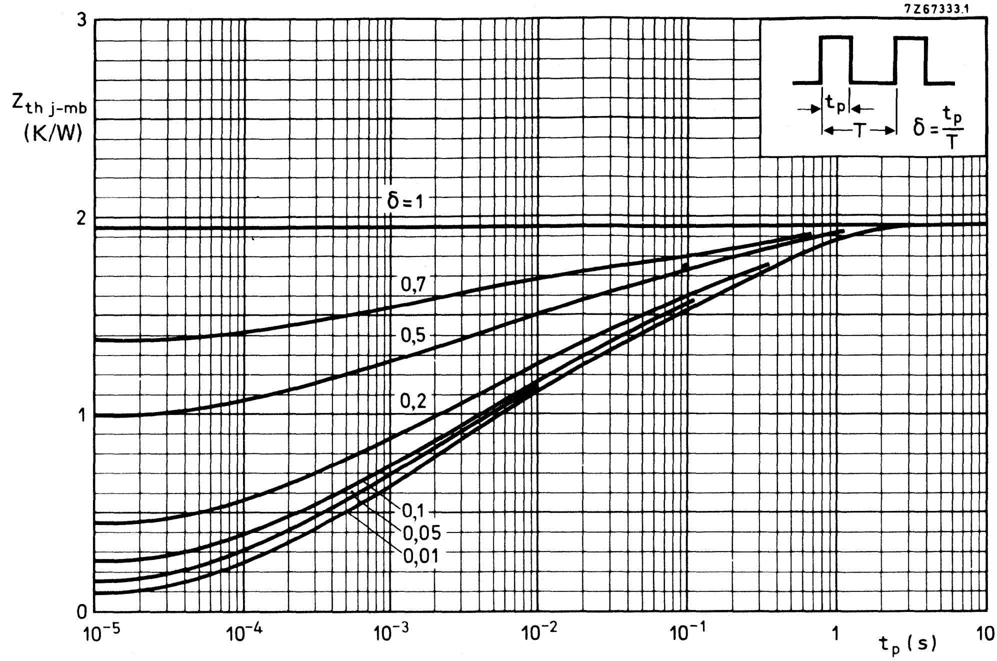


Fig. 10 Pulse power rating chart.

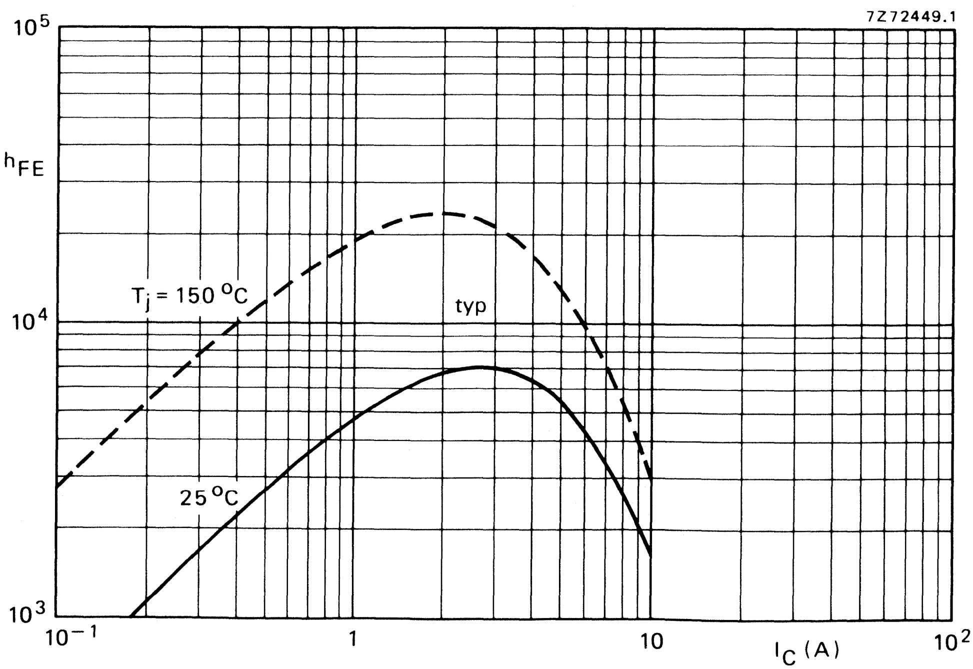


Fig. 11 Typical values d.c. current gain at V_{CE} = 3 V.

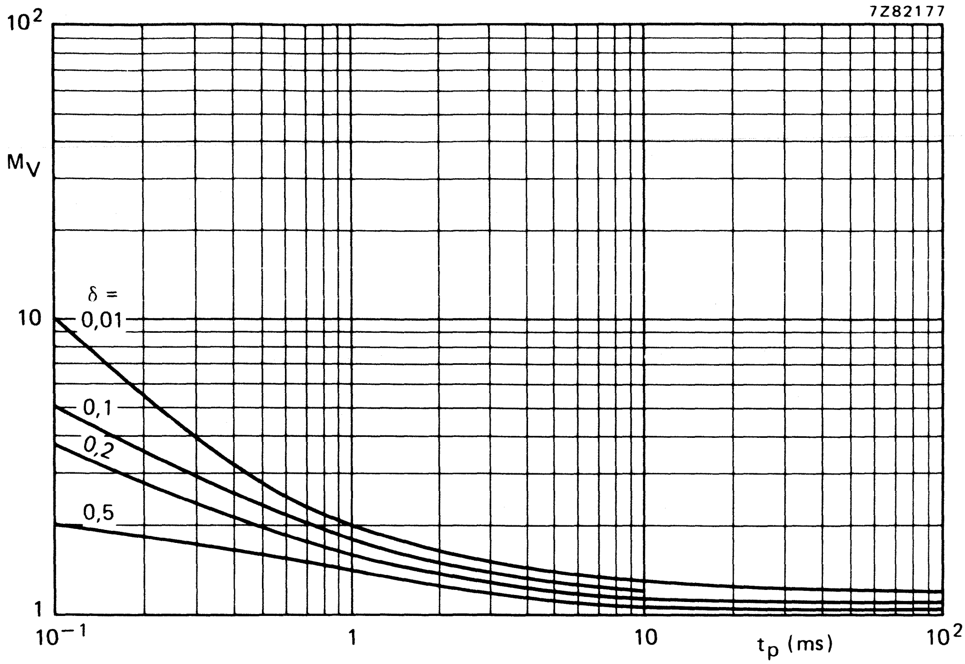


Fig. 12 S.B. voltage multiplying factor at the I_{Cmax} level.

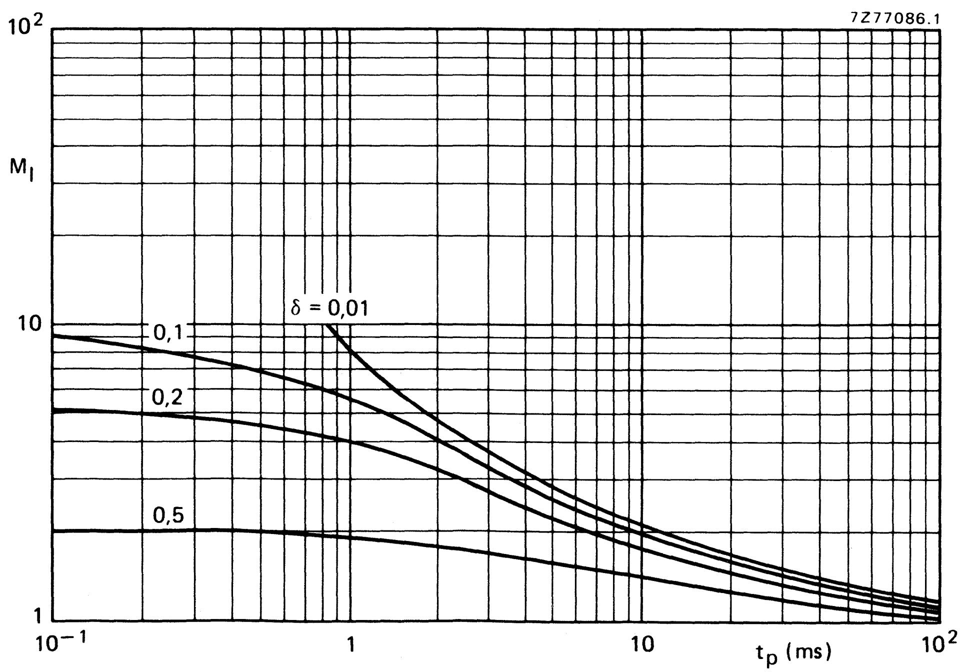


Fig. 13 S.B. current multiplying factor at the V_{CEO} 100 V and 60 V level.

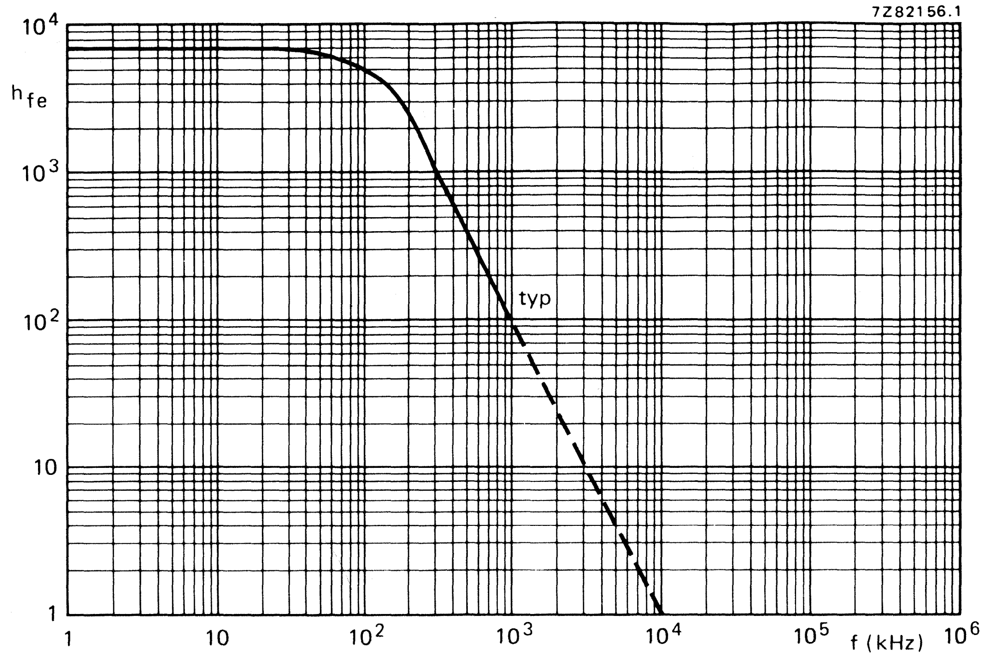


Fig. 14 Small-signal current gain at I_C = 3 A; V_{CE} = 3 V.

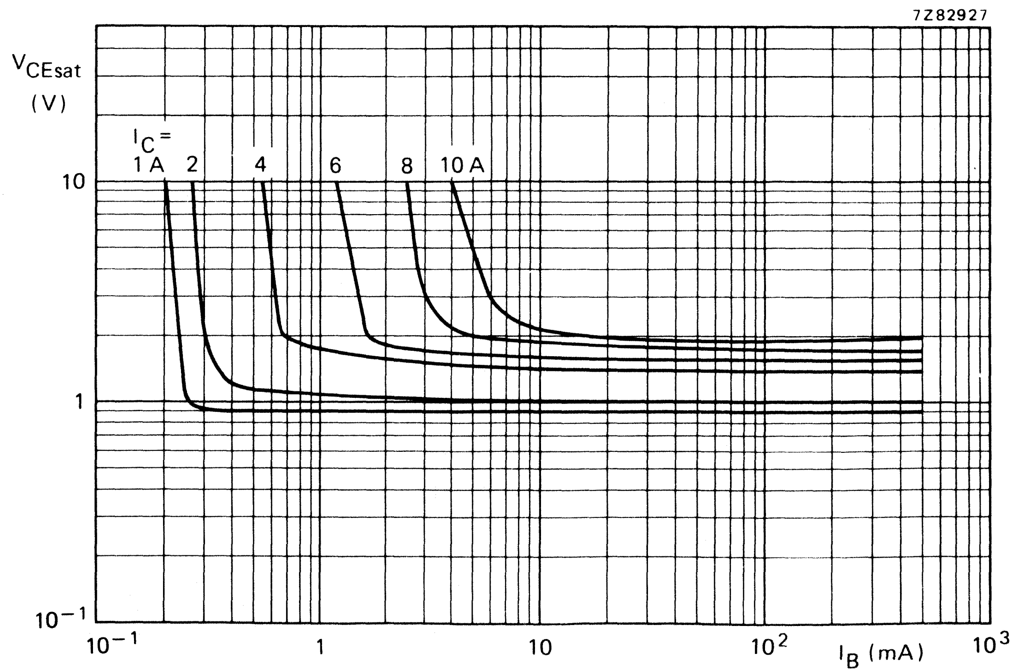


Fig. 15 Typical values collector-emitter saturation voltage at T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. N-P-N complements are BDX65, BDX65A, BDX65B and BDX65C.

QUICK REFERENCE DATA

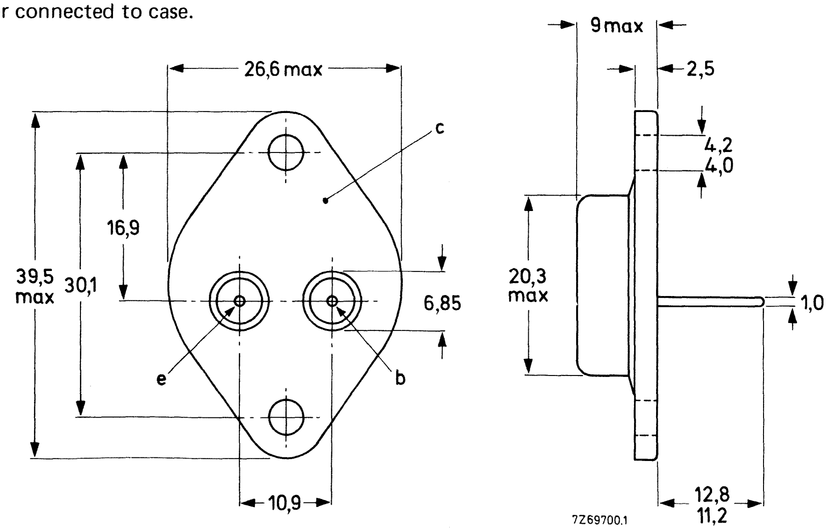
			BDX64	64A	64B	64C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.		16			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		117			W
Junction temperature	T_j	max.		200			°C
D.C. current gain							
$-I_C$ = 1 A; $-V_{CE}$ = 3 V	h_{FE}	typ.		1500			
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	h_{FE}	>		1000			
Cut-off frequency							
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.		80			kHz

MECHANICAL DATA

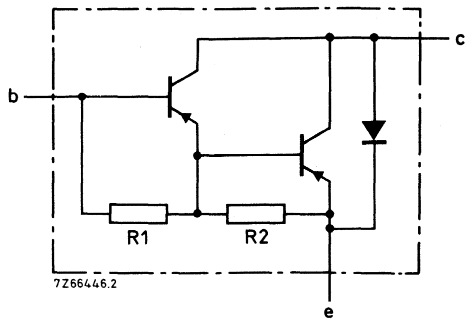
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.



R1 typ. 5 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX64	64A	64B	64C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.	12				A
Collector current (peak value)	$-I_{CM}$	max.	16				A
Base current (d.c.)	$-I_B$	max.	200				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	117				W
Storage temperature	T_{stg}		–65 to + 200				°C
Junction temperature*	T_j	max.	200				°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,5	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,4	mA
$I_E = 0$; $-V_{CB}$ = 40 V; T_j = 200 °C: BDX64 $I_E = 0$; $-V_{CB}$ = 50 V; T_j = 200 °C: BDX64A $I_E = 0$; $-V_{CB}$ = 60 V; T_j = 200 °C: BDX64B $I_E = 0$; $-V_{CB}$ = 70 V; T_j = 200 °C: BDX64C	$-I_{CBO}$	<	3	mA
$I_B = 0$; $-V_{CE} = -½\ V_{CEOmax}$	$-I_{CEO}$	<	0,2	mA ←
Emitter cut-off current				
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	5	mA
D.C. current gain (note 1)				
$-I_C$ = 1 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	1500	
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000	
$-I_C$ = 12 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	750	
Base-emitter voltage (notes 1 and 2)				
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	$-V_{BE}$	<	2,5	V
Collector-emitter saturation voltage (note 1)				
$-I_C$ = 5 A; $-I_B$ = 20 mA	$-V_{CEsat}$	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	typ.	200	pF
Cut-off frequency				
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	80	kHz
Small-signal current gain				
$-I_C$ = 5 A; $-V_{CE}$ = 3 V; f = 1 MHz	h_{fe}	typ.	30	

Notes

1. Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.
2. $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Diode, forward voltage				
$I_F = 5$ A	V_F	<	1,8	V
Switching times (between 10% and 90% levels)				
$-I_{Con} = 5$ A; $-I_{Bon} = I_{Boff} = 20$ mA				
turn-on time	t_{on}	typ.	1	μs
turn-off time	t_{off}	typ.	2,5	μs

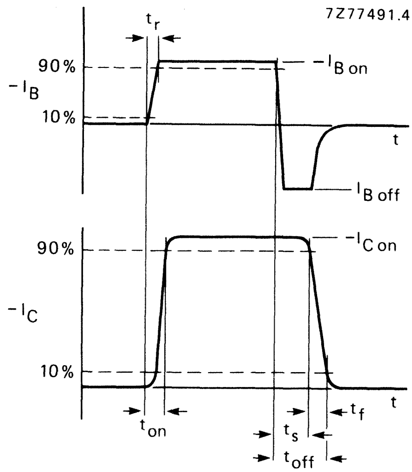
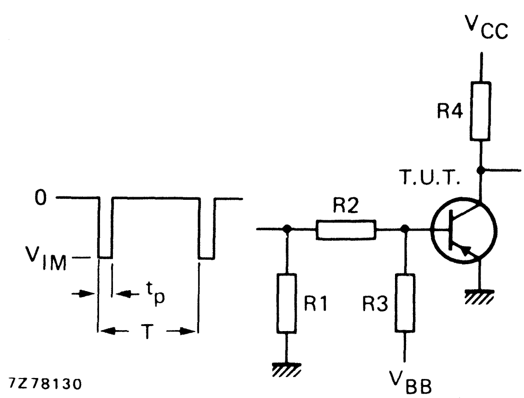


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	16,5	V
$-V_{CC}$	=	16	V
$+V_{BB}$	=	6,5	V
R1	=	56	Ω
R2	=	410	Ω
R3	=	560	Ω
R4	=	3	Ω
$t_r = t_f$	⩽	15	ns
t_p	=	10	μs
T	=	500	μs

Fig. 4 Switching times test circuit.

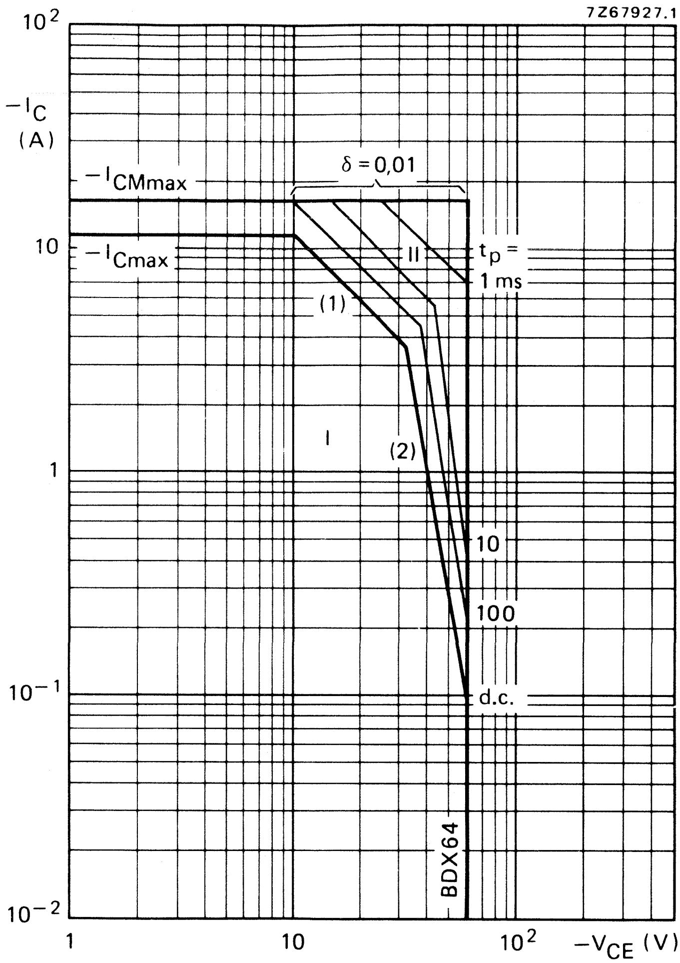


Fig. 5 Safe Operating ARea; $T_{mb} \leqslant 25\ ^{o}C$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

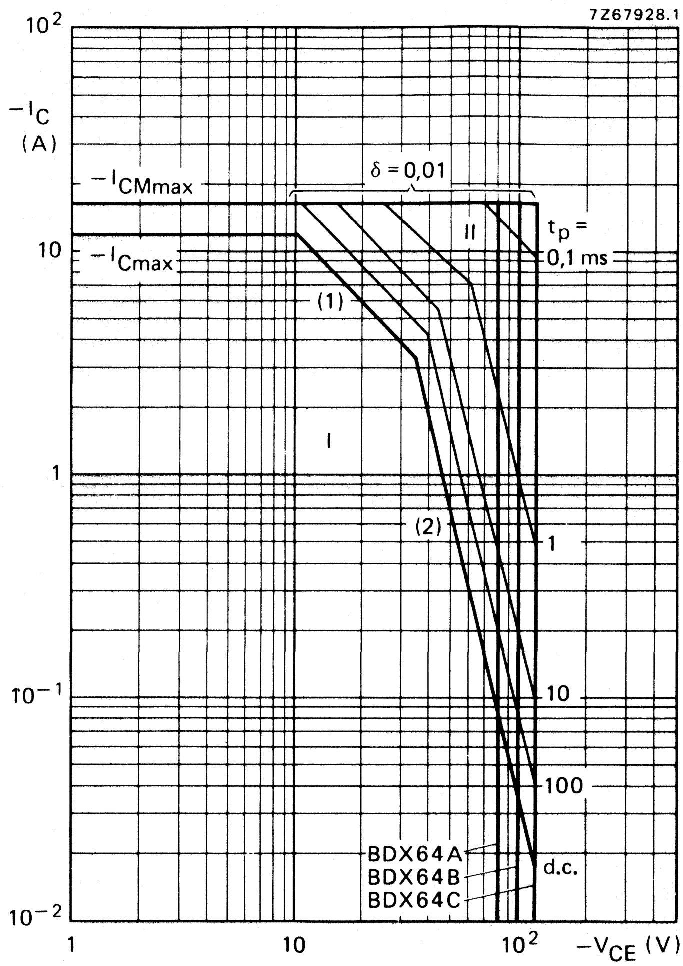


Fig. 6 Safe Operating ARea; $T_{mb} \leqslant 25\ ^oC$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

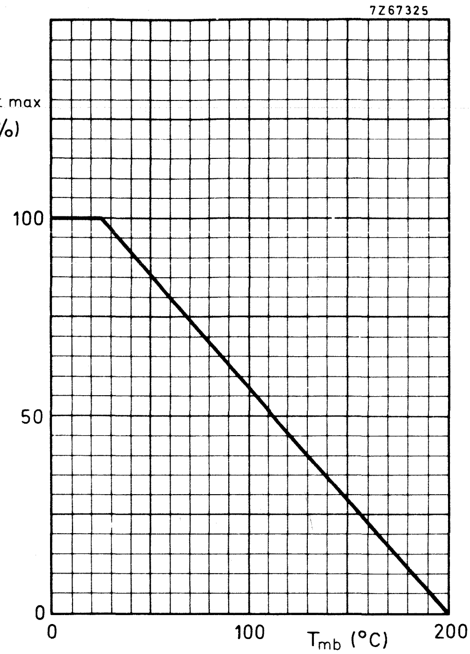


Fig. 7 Power derating curve.

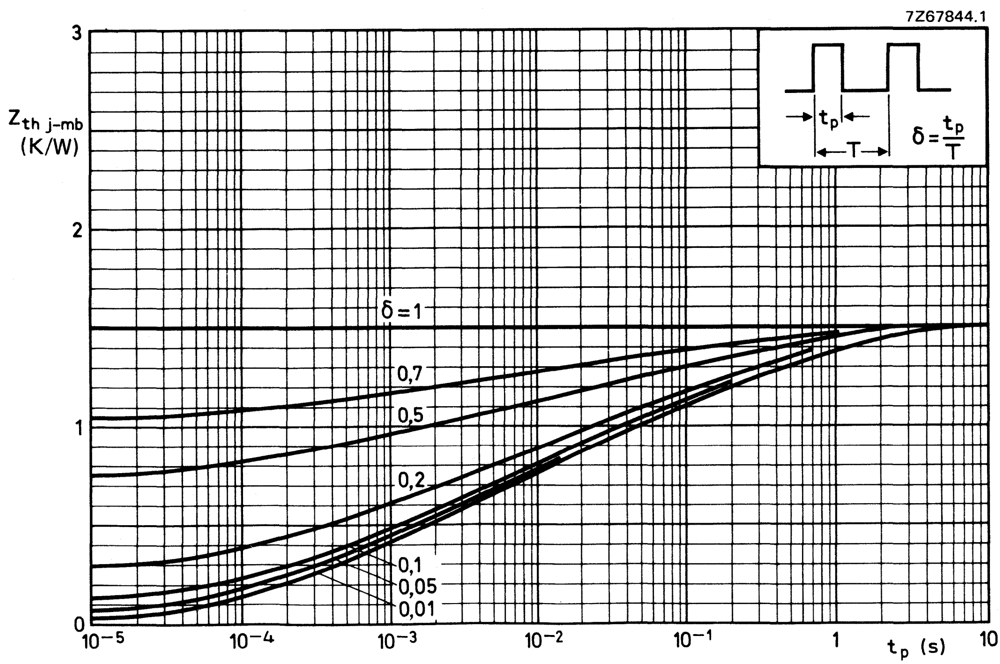


Fig. 8 Pulse power rating chart.

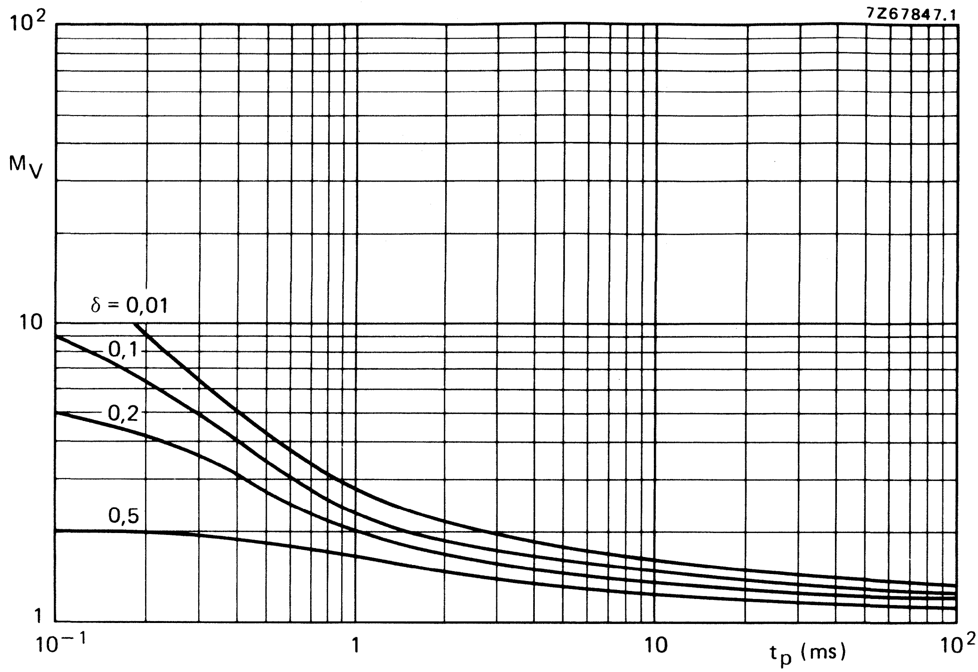


Fig. 9 S.B. voltage multiplying factor at the $-I_{C\,max}$ level.

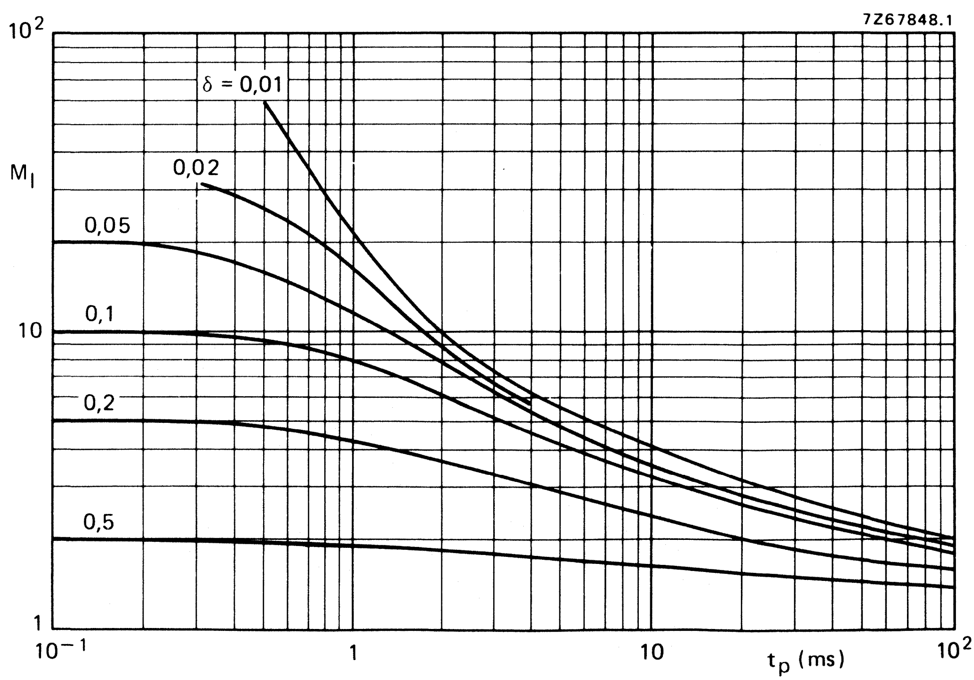


Fig. 10 S.B. current multiplying factor at $-V_{CEO}$ 100 V and 60 V level.

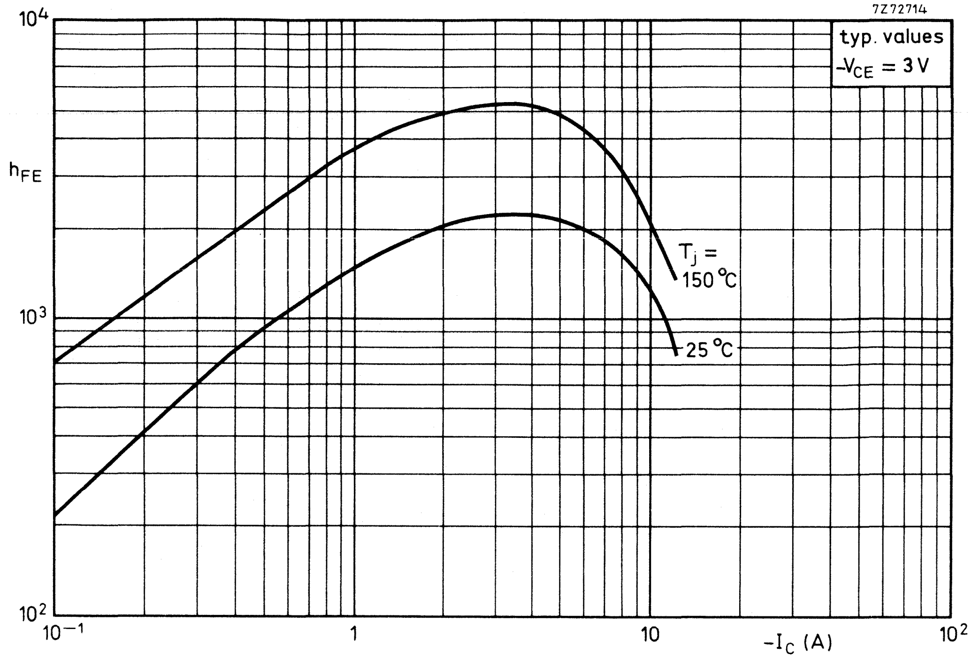


Fig. 11 D.C. current gain.

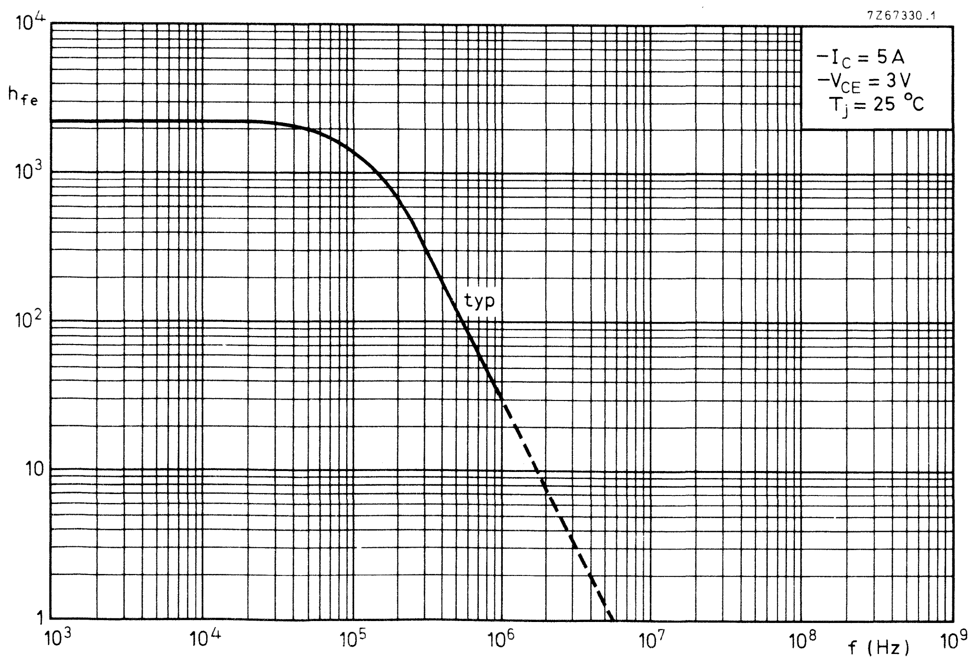


Fig. 12 Small-signal current gain.

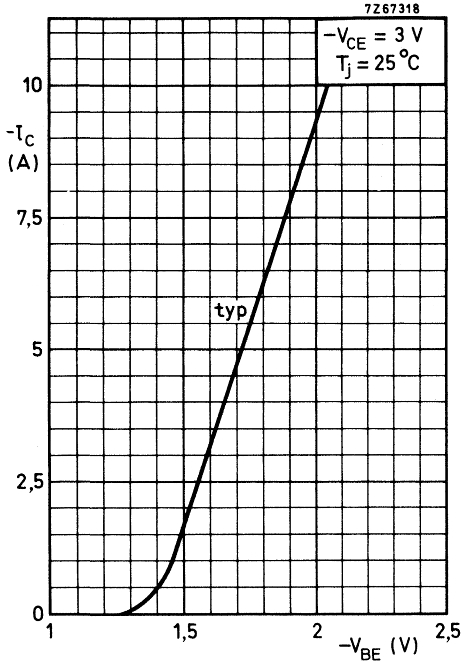


Fig. 13 Typical collector current.

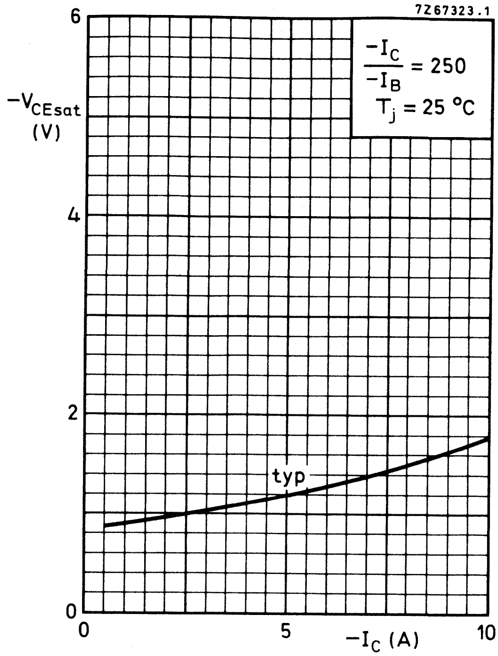


Fig. 14 Typical collector-emitter saturation voltage.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. P-N-P complements are BDX64, BDX64A, BDX64B and BDX64C.

QUICK REFERENCE DATA

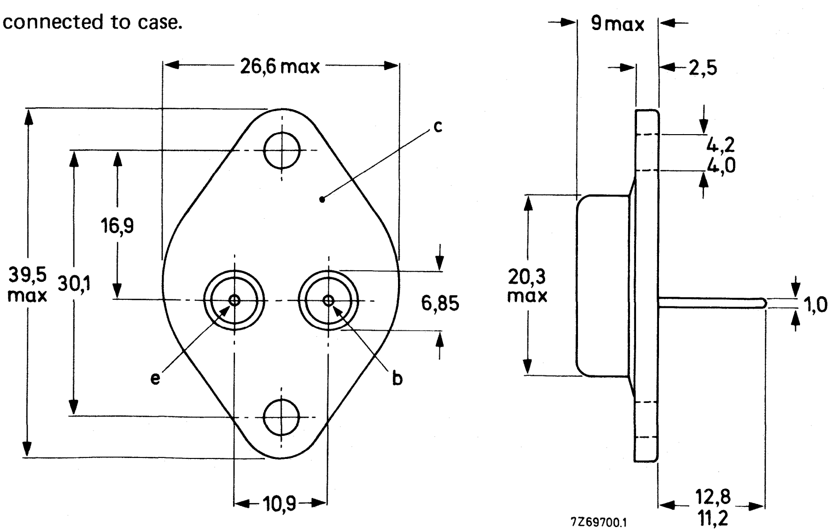
			BDX65	65A	65B	65C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.	16				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	117				W
Junction temperature	T_j	max.	200				°C
D.C. current gain I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.	3300				
I_C = 5 A; V_{CE} = 3 V	h_{FE}	>	1000				
Cut-off frequency I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.	50				kHz

MECHANICAL DATA

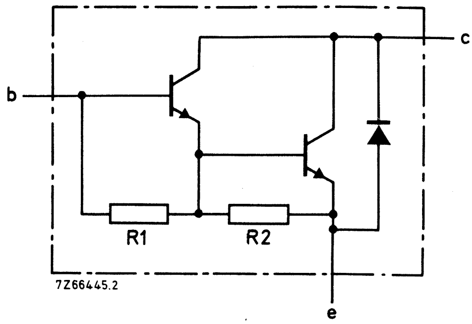
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.



R1 typ. 5 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX65	65A	65B	65C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	16	A
Base current (d.c.)	I_B	max.	200	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	117	W
Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature*	T_j	max.	200	°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,5	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	0,4	mA
$I_E = 0$; $V_{CB} = ½ V_{CBOmax}$; T_j = 200 °C	I_{CBO}	<	3	mA
$I_B = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	<	0,2	mA ←
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5	mA
D.C. current gain (note 1)				
I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.	3300	
I_C = 5 A; V_{CE} = 3 V	h_{FE}	>	1000	
I_C = 12 A; V_{CE} = 3 V	h_{FE}	typ.	3700	
Base-emitter voltage (notes 1 and 2)				
I_C = 5 A; V_{CE} = 3 V	V_{BE}	<	2,5	V
Collector-emitter saturation voltage (note 1)				
I_C = 5 A; I_B = 20 mA	V_{CEsat}	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	200	pF
Cut-off frequency				
I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.	50	kHz
Turn-off breakdown energy with inductive load (Fig. 5)				
$-I_{Boff} = 0$; I_{CC} = 6,3 A	$E_{(BR)}$	>	100	mJ

Notes
1. Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Diode, forward voltage			
$I_F = 5$ A	V_F	typ.	1,2 V
Switching times			
(between 10% and 90% levels)			
$I_{Con} = 5$ A; $I_{Bon} = -I_{Boff} = 20$ mA			
Turn-on time	t_{on}	typ.	1 μs
Turn-off time	t_{off}	typ.	6 μs

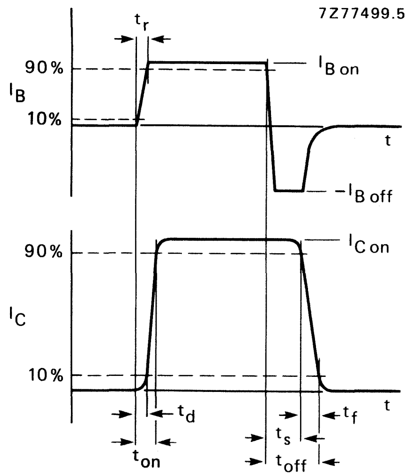
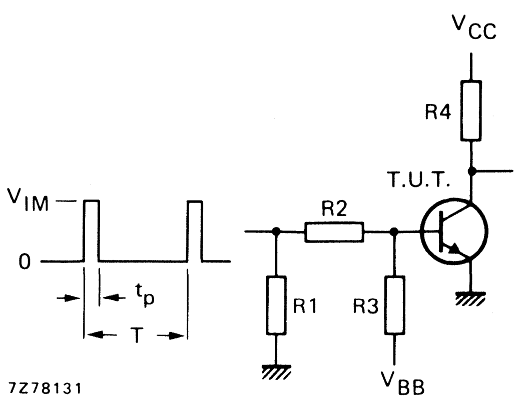


Fig. 3 Switching times waveforms.



V_{IM} = 15 V
V_{CC} = 15 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 3 Ω
$t_r = t_f \leqslant$ 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.

CHARACTERISTICS (continued)

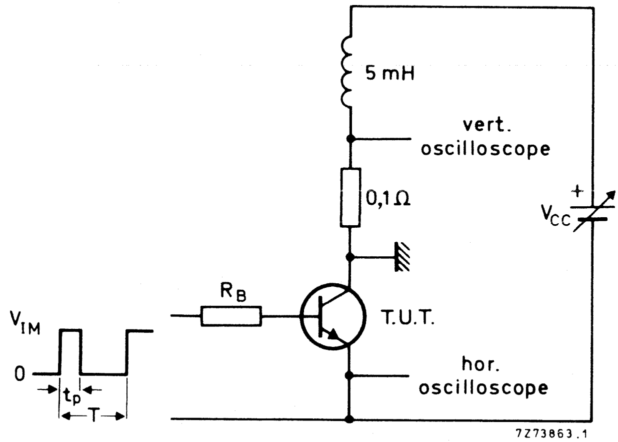


Fig. 5 Test circuit for turn-off breakdown energy. V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 6,3 A; δ = 1%.

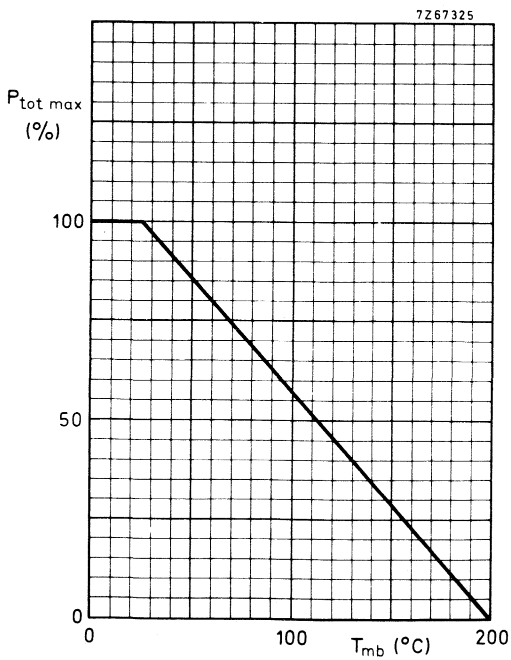


Fig. 6 Power derating curve.

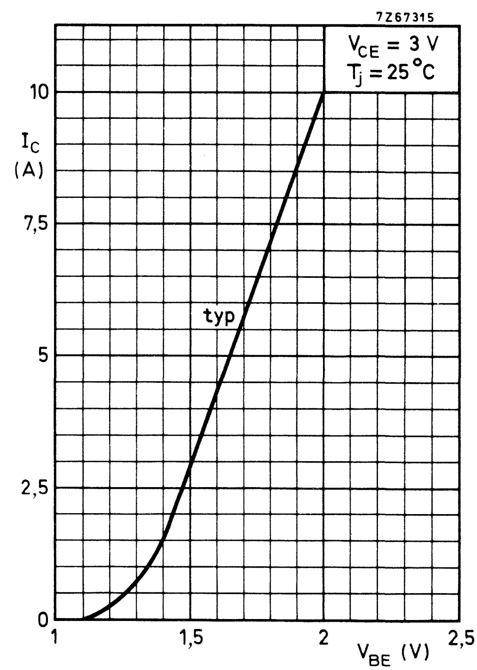


Fig. 7 Typical collector current.

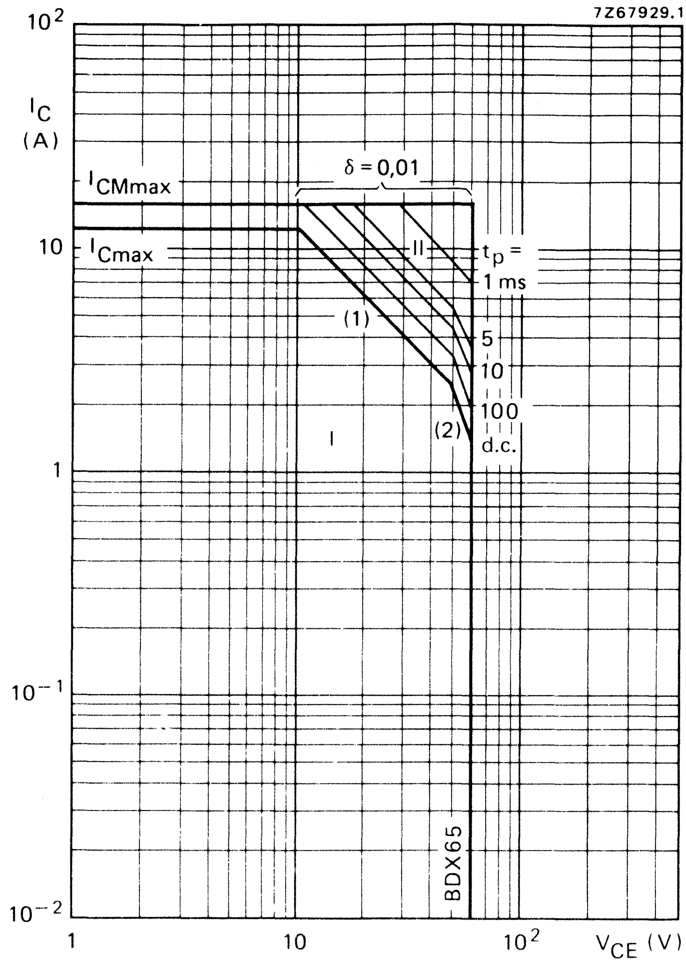


Fig. 8 Safe Operating ARea at $T_{mb} \leqslant 25$ °C of BDX65.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.

(2) Second-breakdown limits.

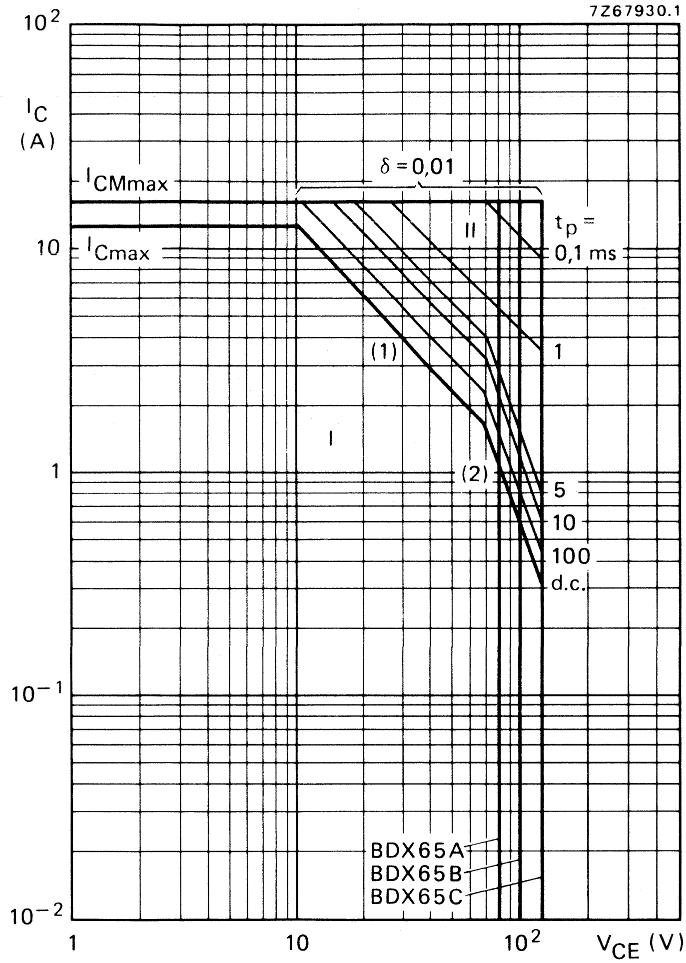


Fig. 9 Safe Operating ARea at $T_{mb} \leqslant 25\ ^oC$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.

(2) Second-breakdown limits.

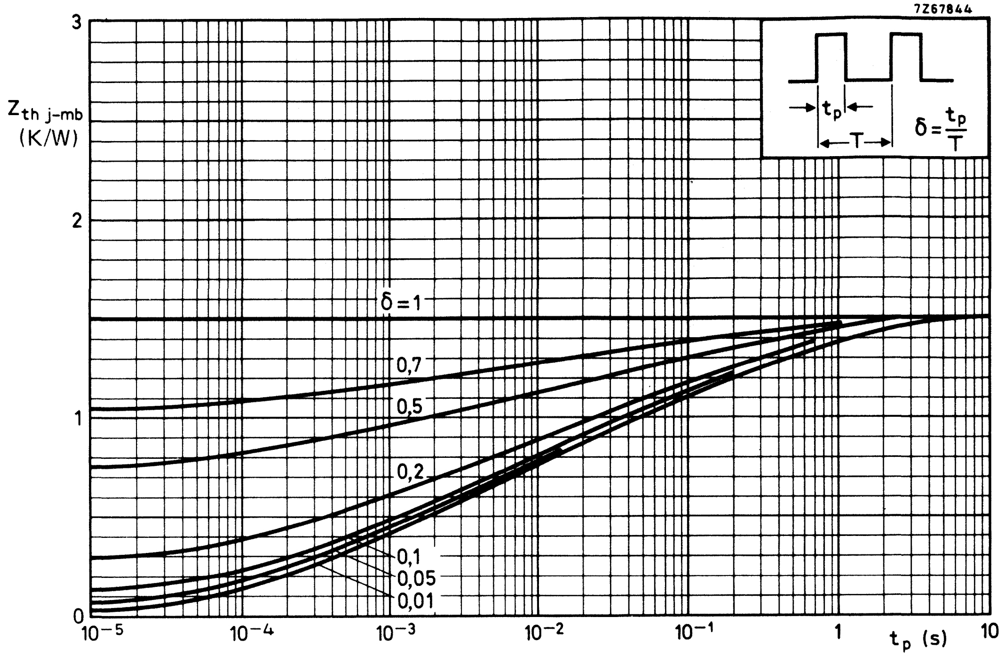


Fig. 10 Pulse power rating chart.

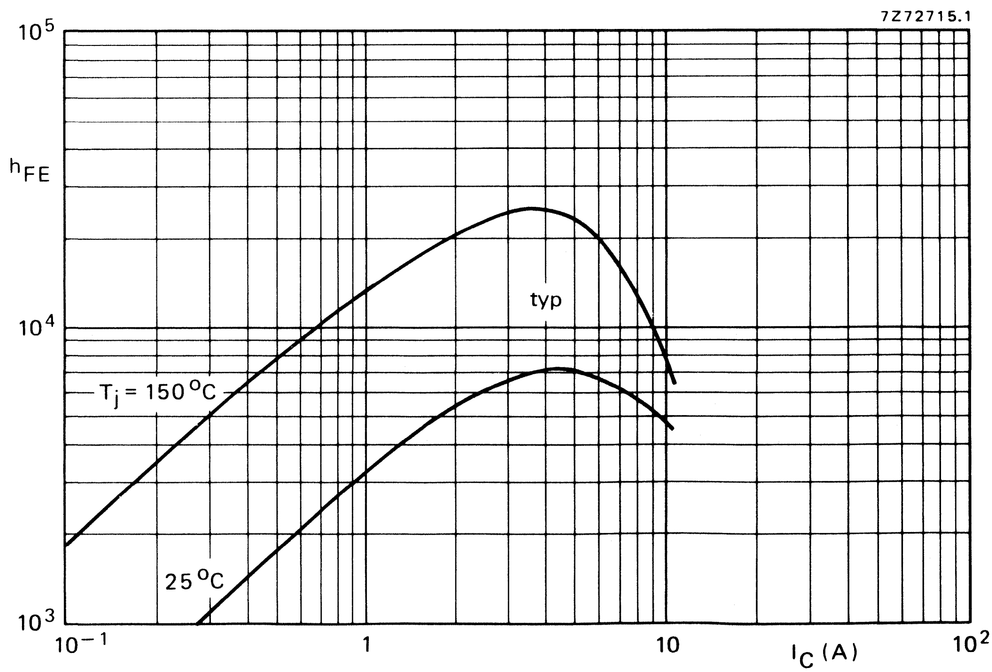


Fig. 11 Typical d.c. current gain at V_{CE} = 3 V.

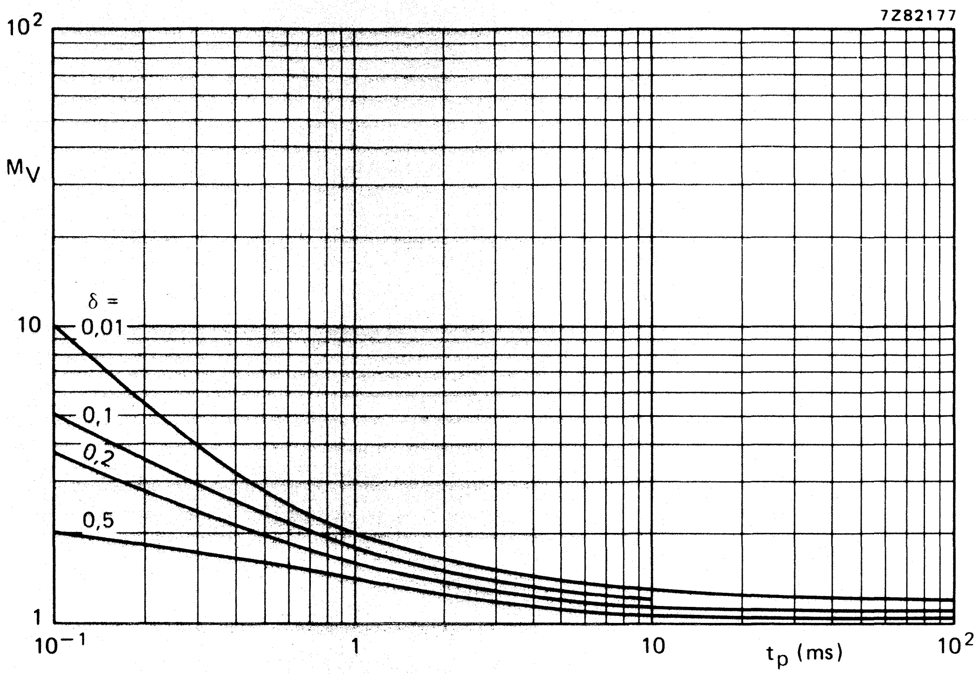


Fig. 12 S.B. voltage multiplying factor at the I_{Cmax} level.

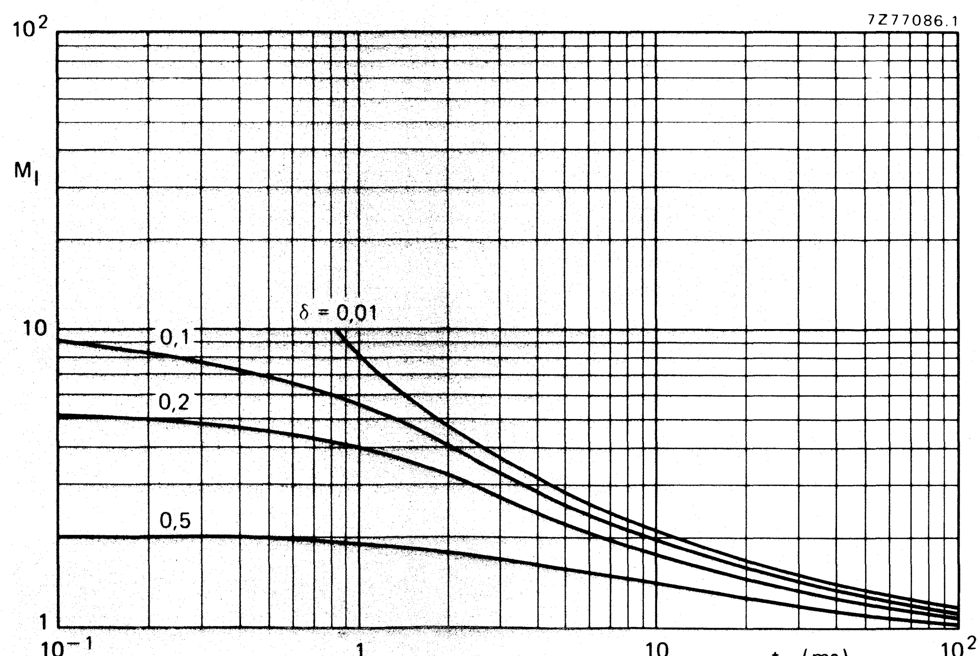


Fig. 13 S.B. current multiplying factor at V_{CEO} 100 V and 60 V level.

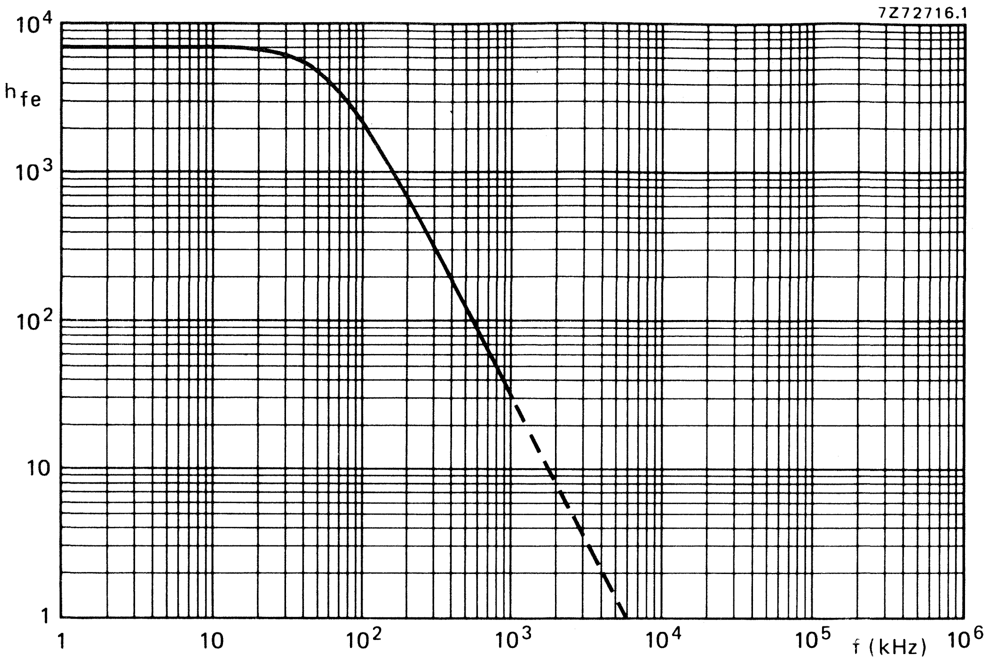


Fig. 14 Typical small-signal current gain, I_C = 5 A; V_{CE} = 3 V; T_j = 25 °C.

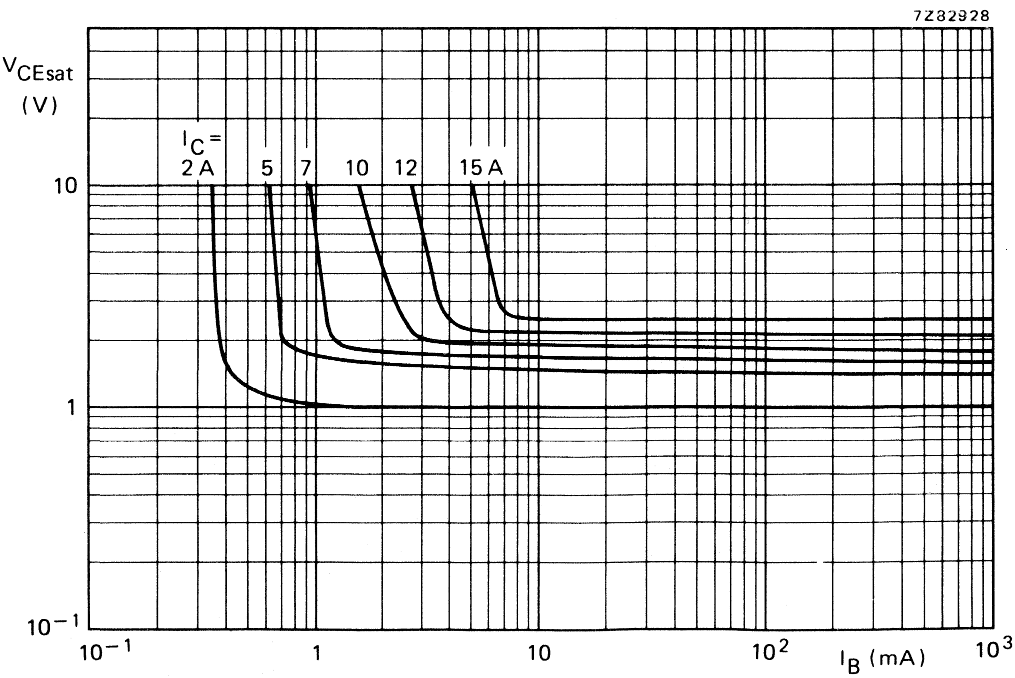


Fig. 15 Typical values collector-emitter saturation voltage. T_{amb} = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. N-P-N complements are BDX67, BDX67A, BDX67B and BDX67C.

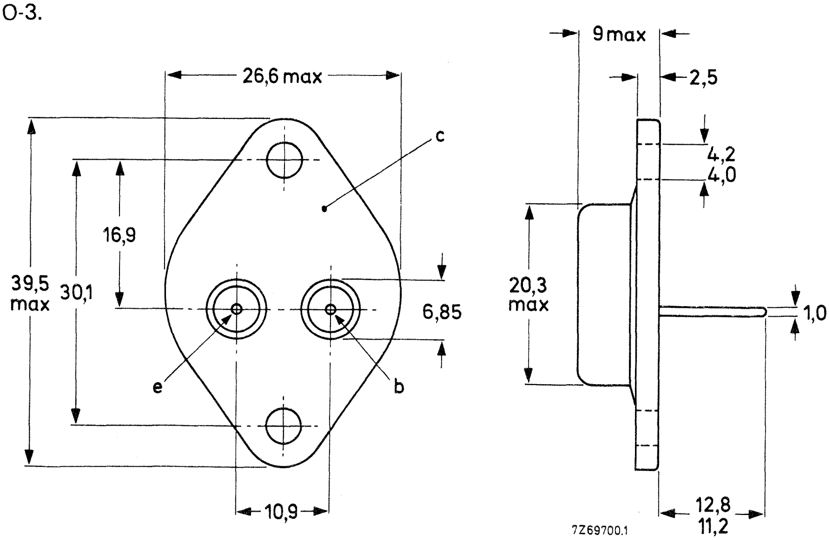
QUICK REFERENCE DATA

			BDX66	66A	66B	66C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.	20				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150				W
Junction temperature	T_j	max.	200				°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	2000				
$-I_C$ = 10 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000				
Cut-off frequency $-I_C$ = 5 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	60				kHz

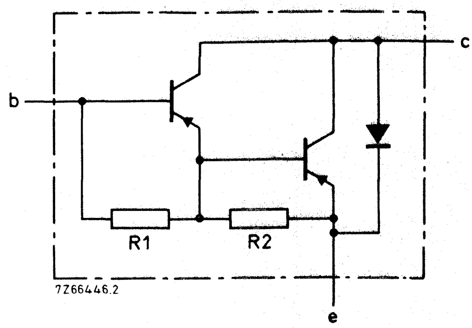
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



See also chapters Mounting instructions and Accessories.



R1 typ. 3 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX66	66A	66B	66C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open-base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.	16				A
Collector current (peak value)	$-I_{CM}$	max.	20				A
Base current	$-I_B$	max.	250				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150				W
Storage temperature	T_{stg}		−65 to +200				°C
Junction temperature*	T_j	max.	200				°C

THERMAL RESISTANCE *

From junction to mounting base $R_{th\ j\text{-}mb}$ = 1,17 K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	1 mA	
$I_E = 0$; $-V_{CB} = 40$ V; $T_j = 200$ °C; BDX66	$-I_{CBO}$	<	5 mA	
$I_E = 0$; $-V_{CB} = 50$ V; $T_j = 200$ °C; BDX66A				
$I_E = 0$; $-V_{CB} = 60$ V; $T_j = 200$ °C; BDX66B				
$I_E = 0$; $-V_{CB} = 70$ V; $T_j = 20$ °C; BDX66C				
$I_B = 0$; $-V_{CE} = -\frac{1}{2}V_{CEOmax}$	$-I_{CEO}$	<	1 mA	←
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	5 mA	
D.C. current gain *				
$-I_C = 1$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2000	
$-I_C = 10$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000	
$-I_C = 16$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	1000	
Base-emitter voltage *				
$-I_C = 10$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5 V	
Collector-emitter saturation voltage *				
$-I_C = 10$ A; $-I_B = 40$ mA	$-V_{CEsat}$	<	2 V	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	300 pF	
Cut-off frequency				
$-I_C = 5$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	60 kHz	
Small-signal current gain				
$-I_C = 5$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	50	
Diode, forward voltage				
$I_F = 10$ A	V_F	typ.	2 V	

* Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

Switching times
(between 10% and 90% levels)

$-I_{Con}$ = 10 A; $-I_{Bon} = I_{Boff}$ = 40 mA

turn-on time	t_{on}	typ.	1 μs
turn-off time	t_{off}	typ.	3,5 μs

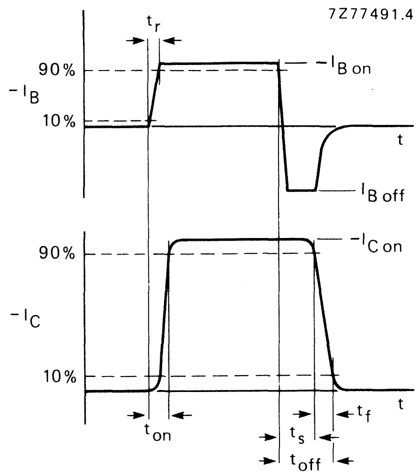
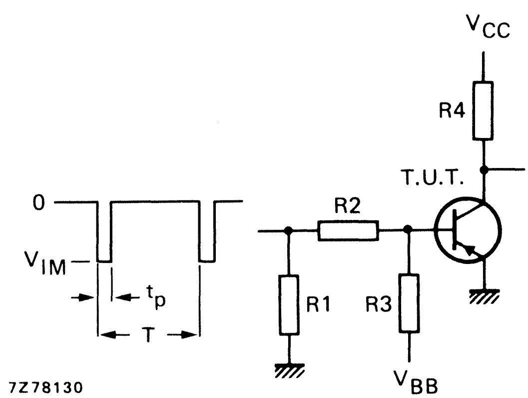


Fig. 3 Switching times waveforms.



$-V_{IM}$ = 18 V
$-V_{CC}$ = 12 V
$+V_{BB}$ = 3 V
R1 = 56 Ω
R2 = 220 Ω
R3 = 180 Ω
R4 = 1 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.

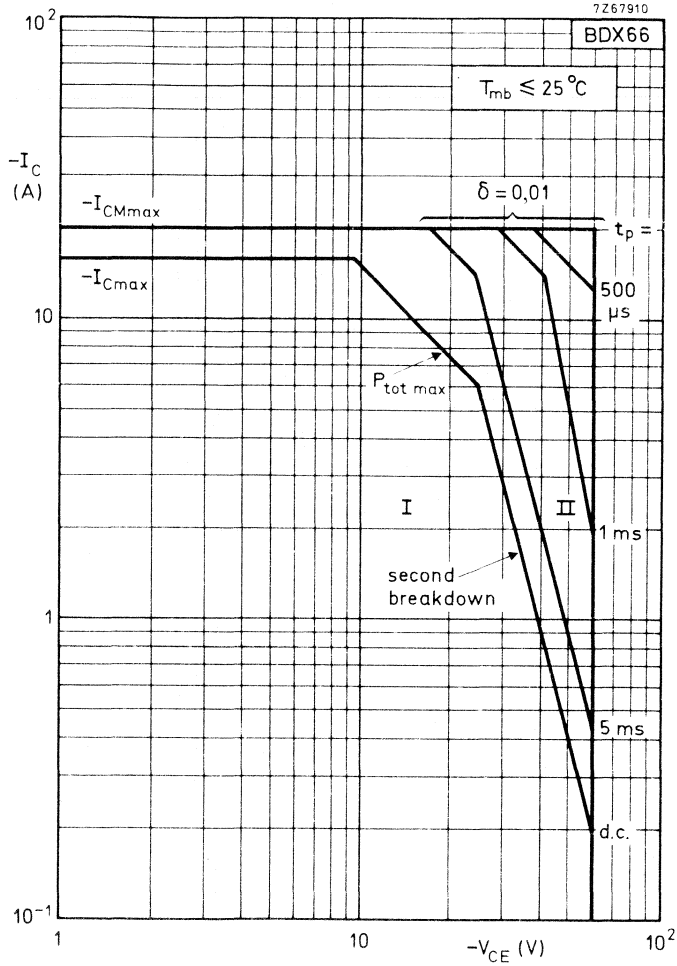


Fig. 5 Safe Operating ARea with the transistor forward biased.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

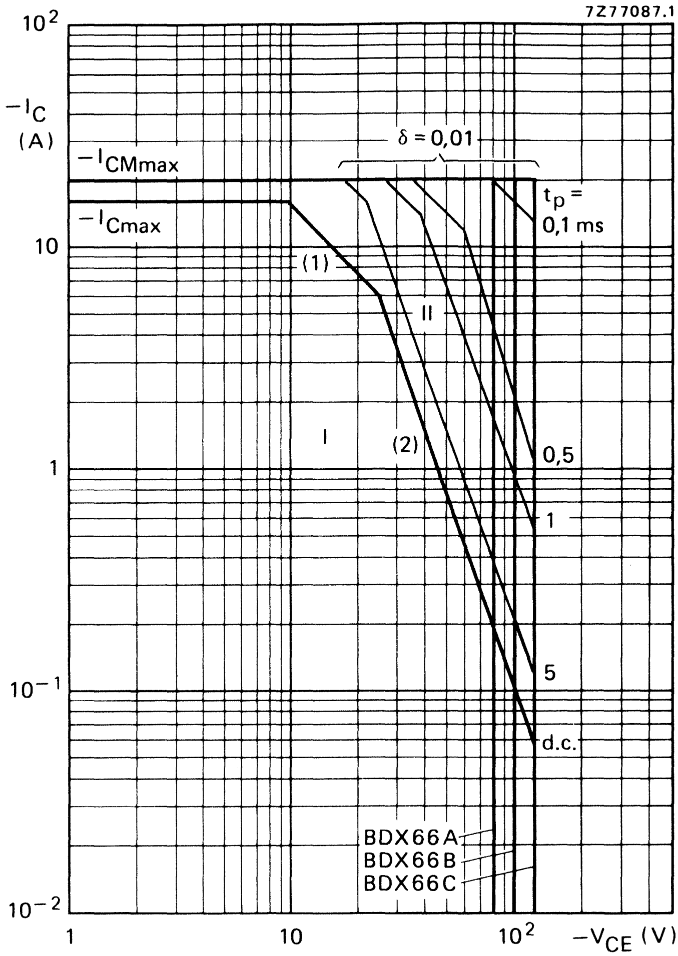


Fig. 6 Safe Operating ARea.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{tot\,peak\,max}$ lines.

(2) Second breakdown limits.

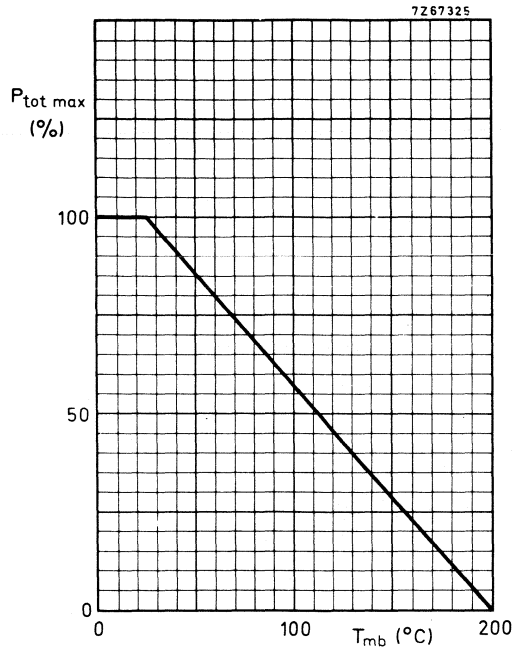


Fig. 7 Power derating curve.

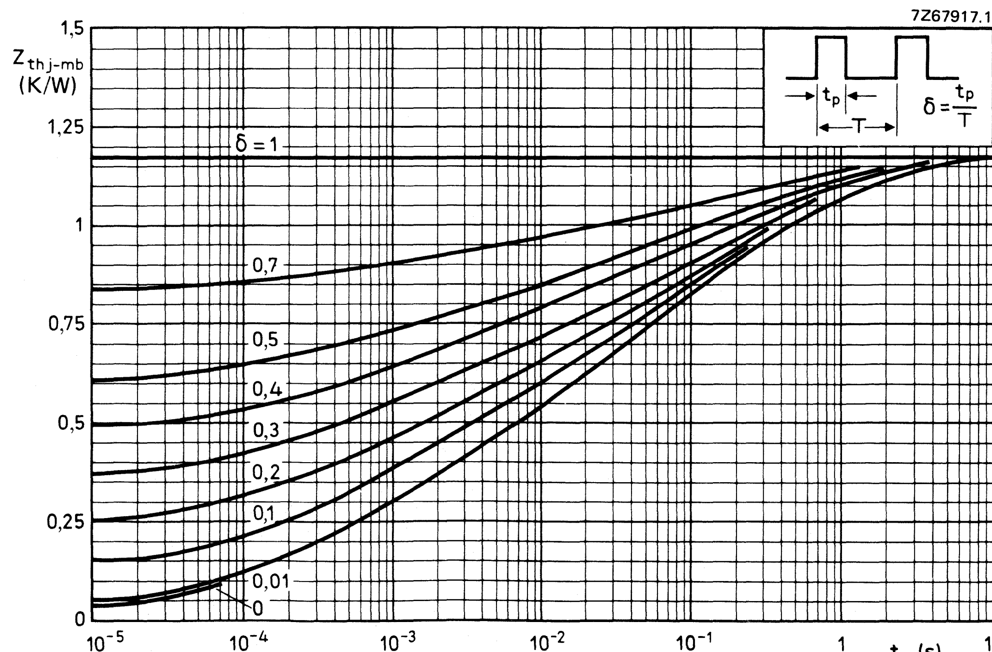


Fig. 8 Pulse power rating chart.

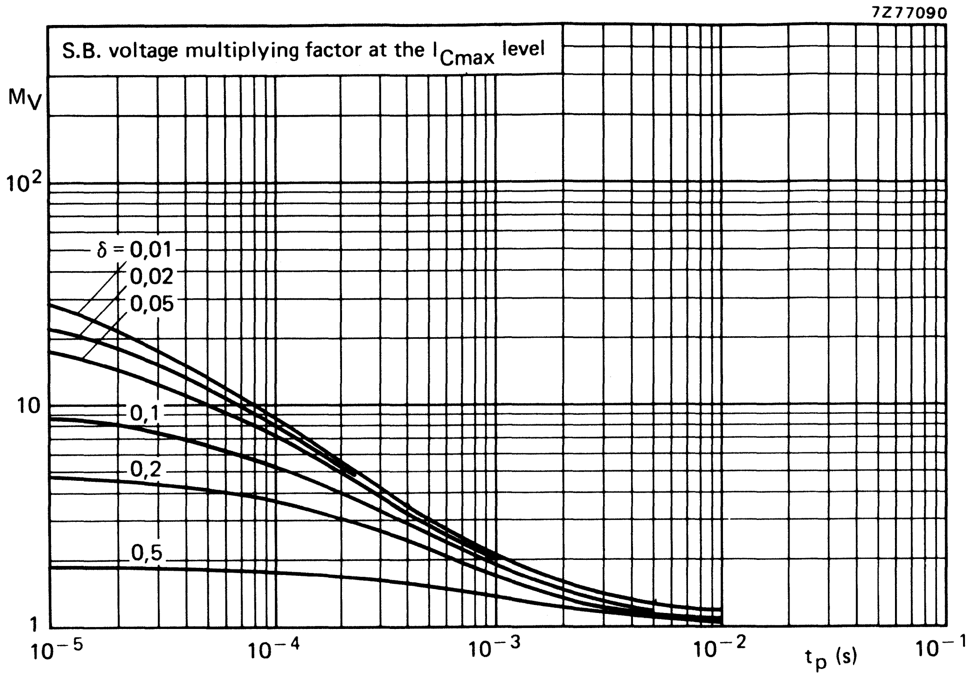


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

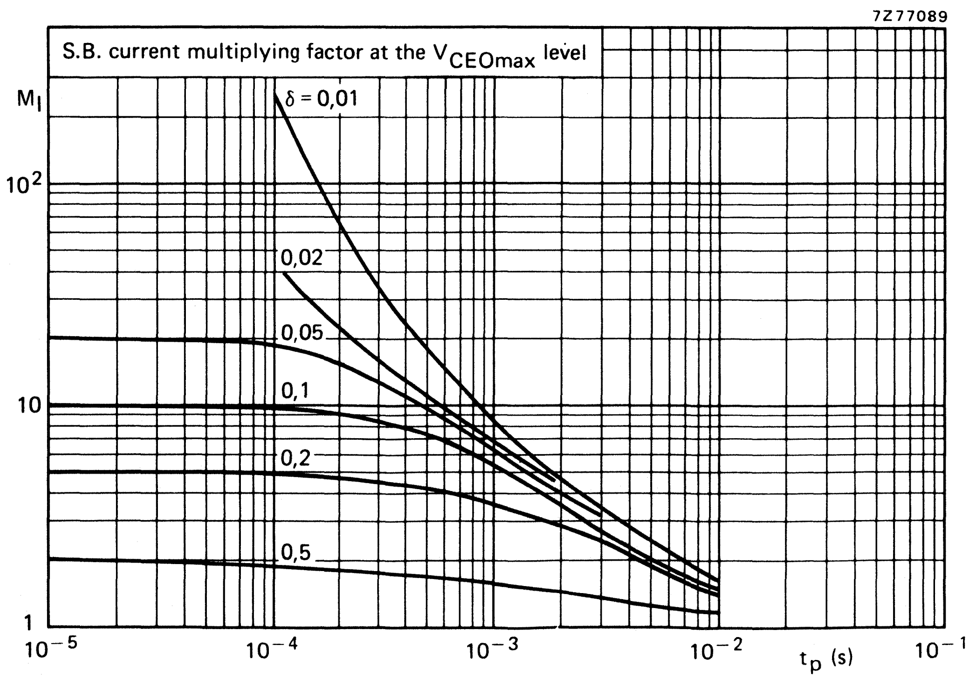


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} level.

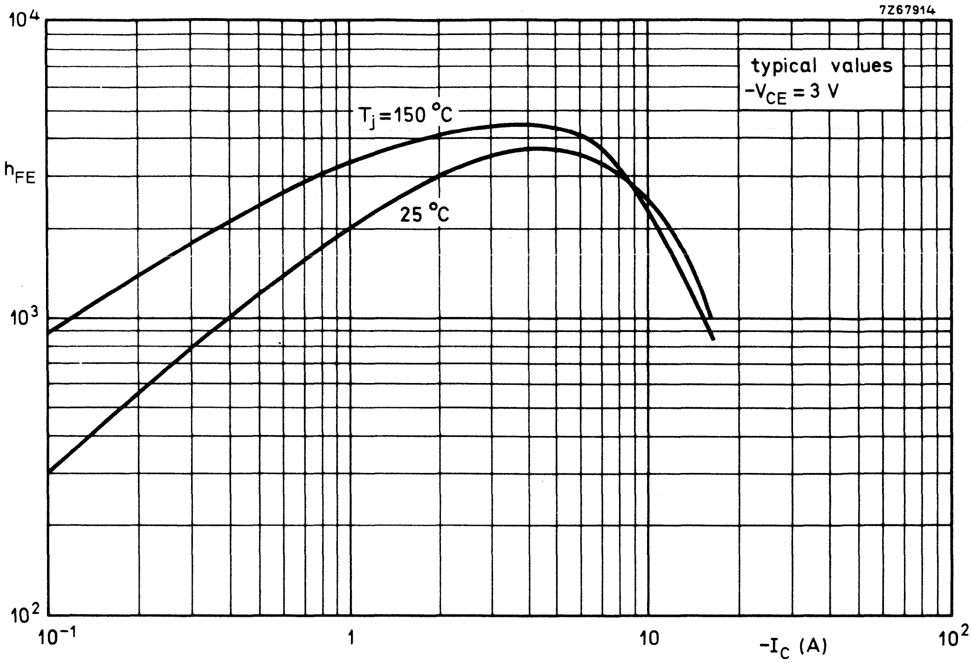


Fig. 11 D.C. current gain.

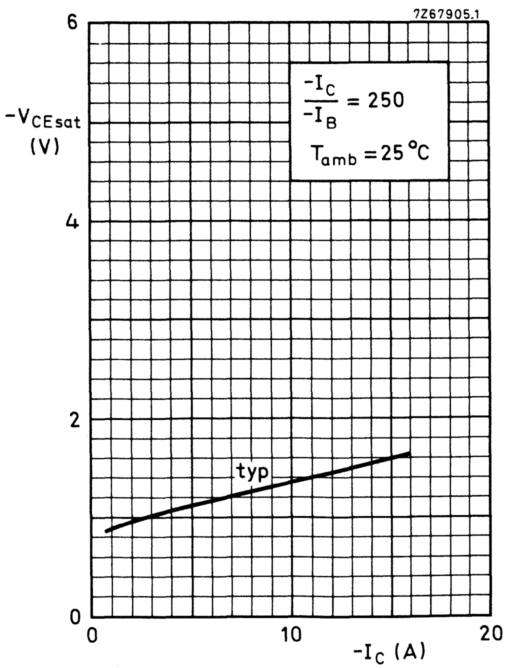


Fig. 12 Collector-emitter saturation voltage.

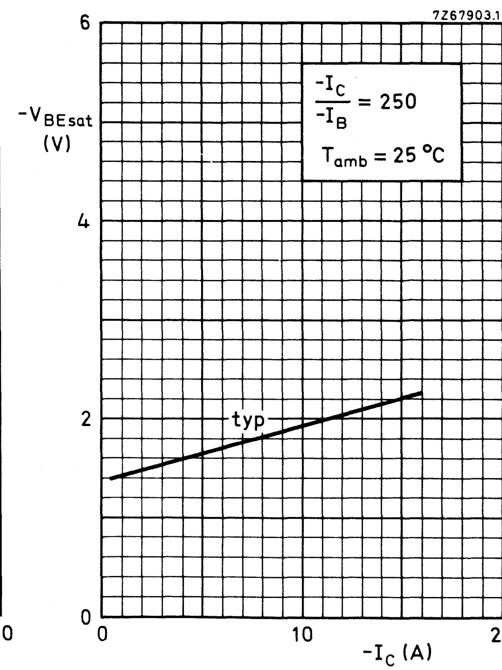


Fig. 13 Base-emitter saturation voltage.

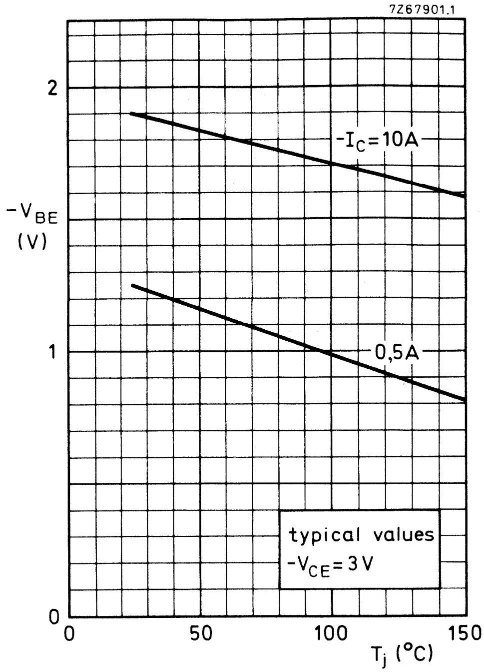


Fig. 14 Typical base-emitter voltage.

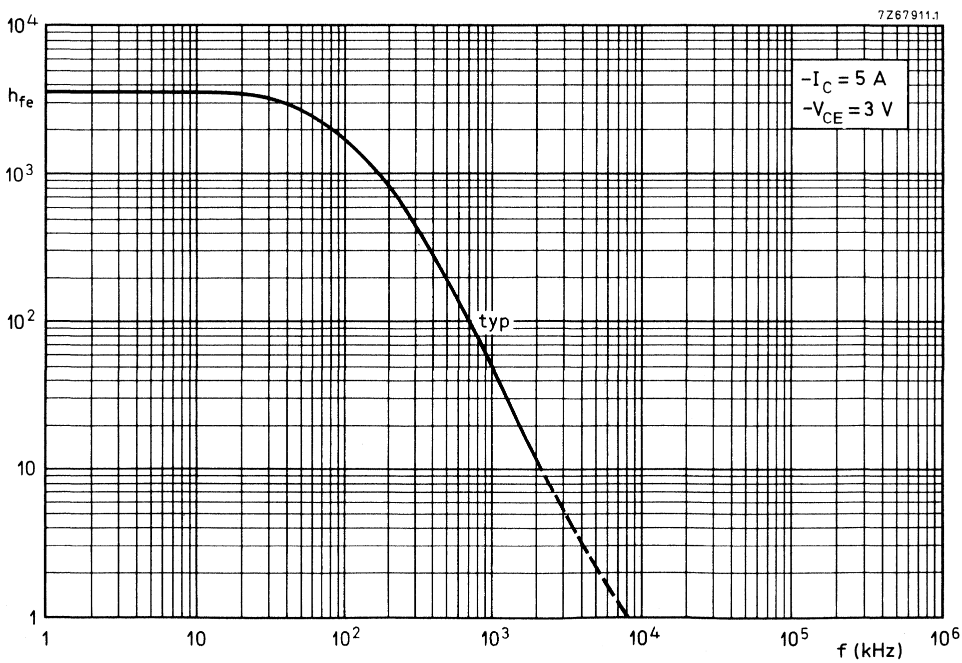


Fig. 15 Small-signal current gain.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. P-N-P complements are BDX66, BDX66A, BDX66B and BDX66C.

QUICK REFERENCE DATA

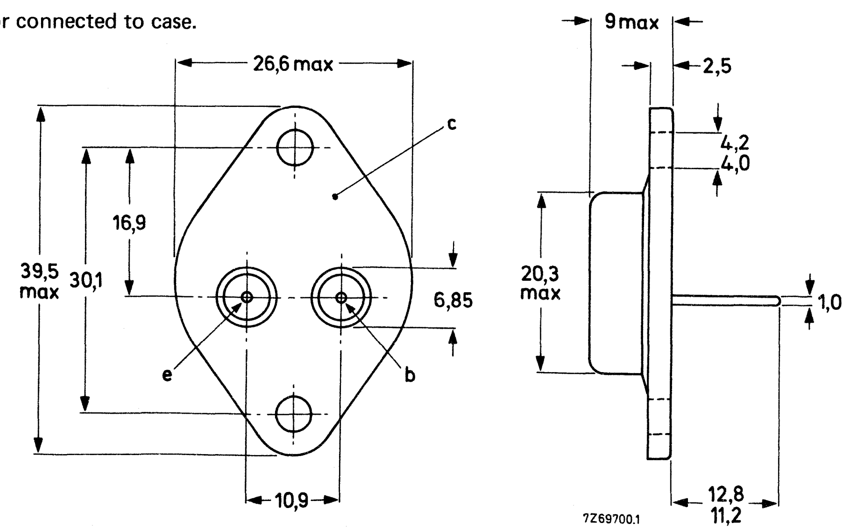
			BDX67	67A	67B	67C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.		20			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		150			W
Junction temperature	T_j	max.		200			°C
D.C. current gain I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.		5200			
I_C = 10 A; V_{CE} = 3 V	h_{FE}	>		1000			
Cut-off frequency I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.		50			kHz

MECHANICAL DATA

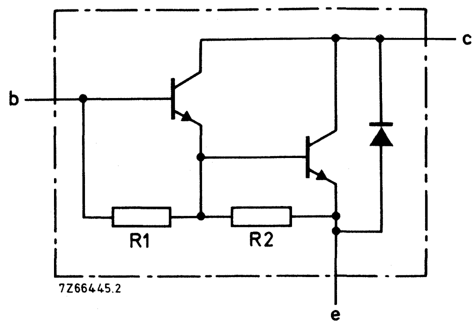
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting Instructions and Accessories.



R1 typ. 3 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX67	67A	67B	67C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	16	A
Collector current (peak value)	I_{CM}	max.	20	A
Base current (d.c.)	I_B	max.	250	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150	W
Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature *	T_j	max.	200	°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,17	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	1	mA
$I_E = 0$; $V_{CB} = ½ V_{CBOmax}$; $T_j = 200$ °C	I_{CBO}	<	5	mA
$I_B = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	<	1	mA ←
Emitter-cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	5	mA
D.C. current gain *				
$I_C = 1$ A; $V_{CE} = 3$ V	h_{FE}	typ.	5200	
$I_C = 10$ A; $V_{CE} = 3$ V	h_{FE}	>	1000	
$I_C = 16$ A; $V_{CE} = 3$ V	h_{FE}	typ.	4000	
Base-emitter voltage *				
$I_C = 10$ A; $V_{CE} = 3$ V	V_{BE}	<	2,5	V
Collector-emitter saturation voltage *				
$I_C = 10$ A; $I_B = 40$ mA	V_{CEsat}	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	300	pF
Cut-off frequency				
$I_C = 5$ A; $V_{CE} = 3$ V	f_{hfe}	typ.	50	kHz
Turn-off breakdown energy with inductive load				
$-I_{Boff} = 0$; $I_{CC} = 7{,}8$ A; see Fig. 5	$E_{(BR)}$	>	150	mJ
Small-signal current gain				
$I_C = 5$ A; $V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	20	
Diode, forward voltage				
$I_F = 10$ A	V_F	typ.	2,5	V

* Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

Switching times
(between 10% and 90% levels)
I_{Con} = 10 A; $I_{Bon} = -I_{Boff}$ = 40 mA;

turn-on time	t_{on}	typ.	1 μs
turn-off time	t_{off}	typ.	3,5 μs

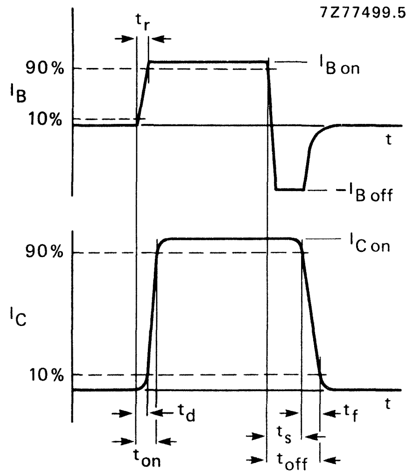


Fig. 3 Switching times waveforms.

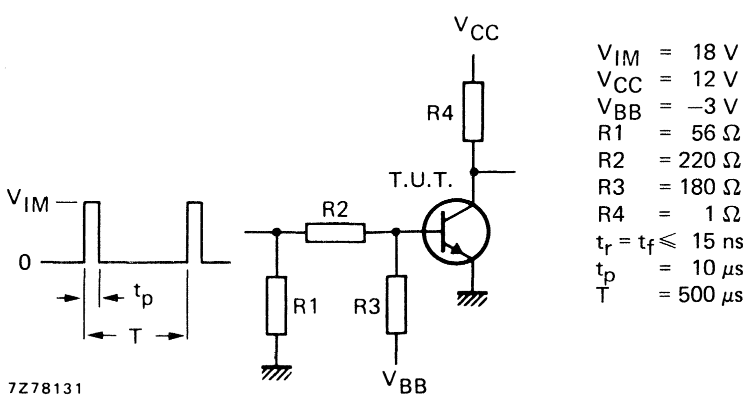


Fig. 4 Switching times test circuit.

CHARACTERISTICS (continued)

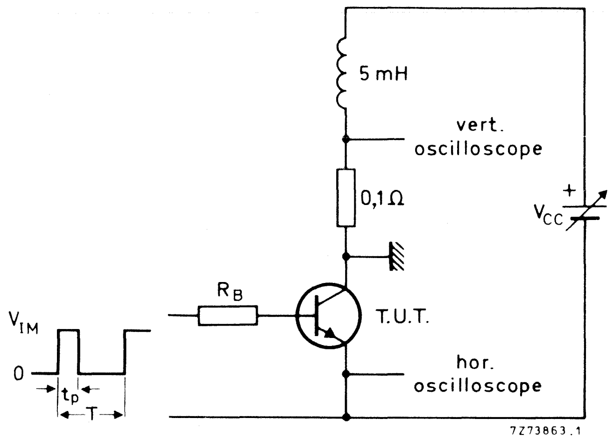


Fig. 5 Test circuit for turn-off breakdown energy. V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 7,8 A; t_p = 1 ms; δ = 1%.

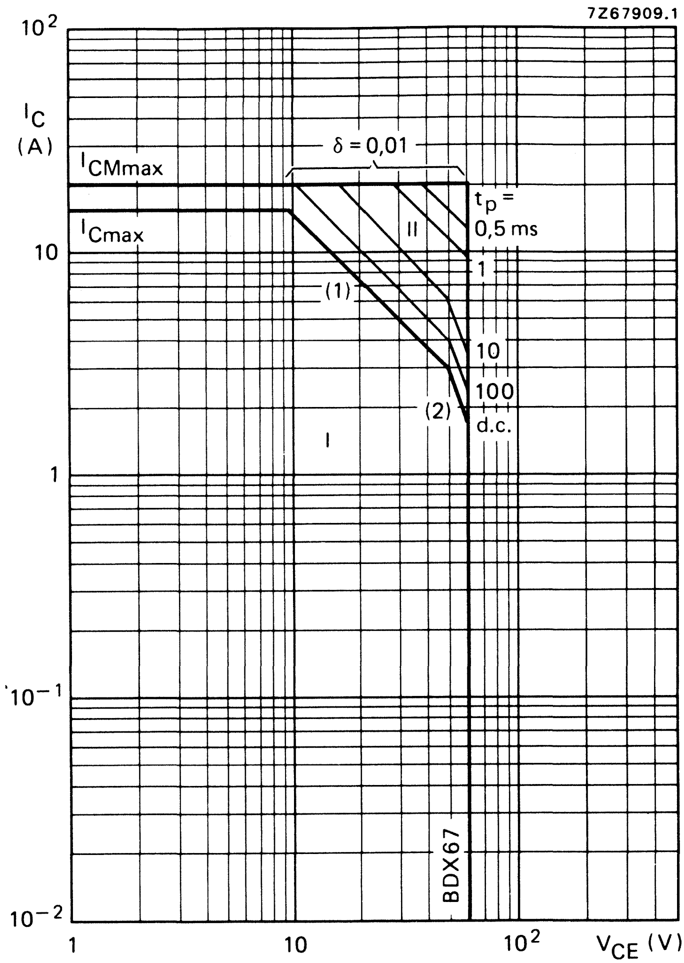


Fig. 6 Safe Operating ARea at T_{mb} = 25 °C of BDX67.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.

(2) Second breakdown limits.

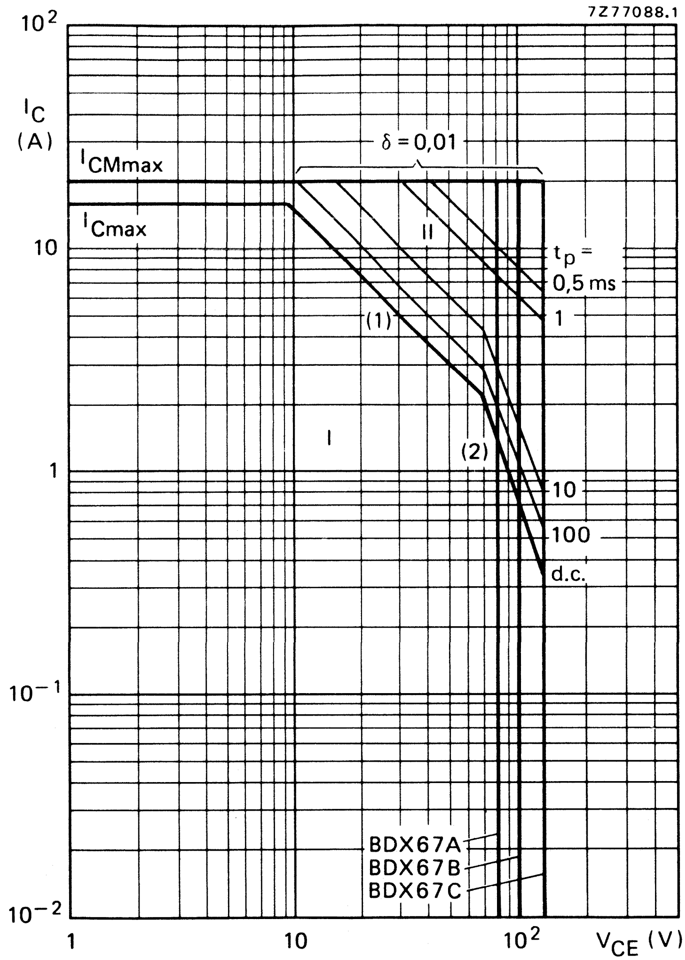


Fig. 7 Safe Operating ARea at $T_{mb} = 25\ ^oC$.

I   Region of permissible d.c. operation.

II   Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.

(2) Second breakdown limits.

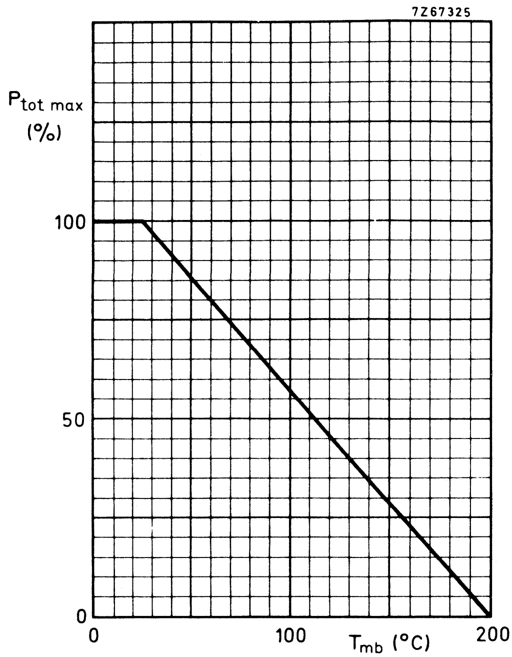


Fig. 8 Power derating curve.

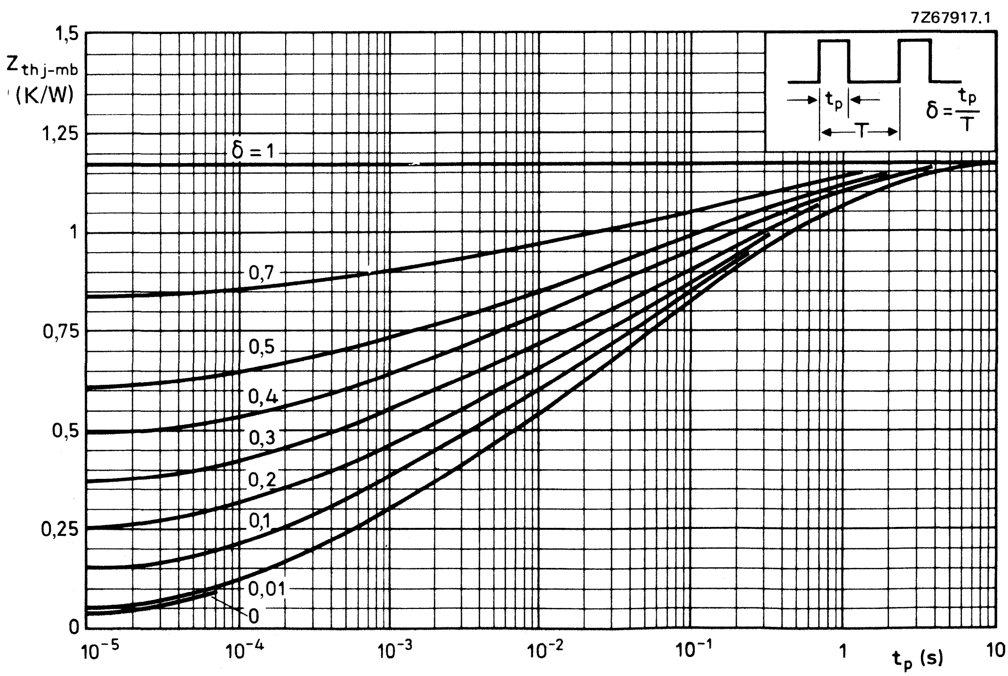


Fig. 9 Pulse power rating chart.

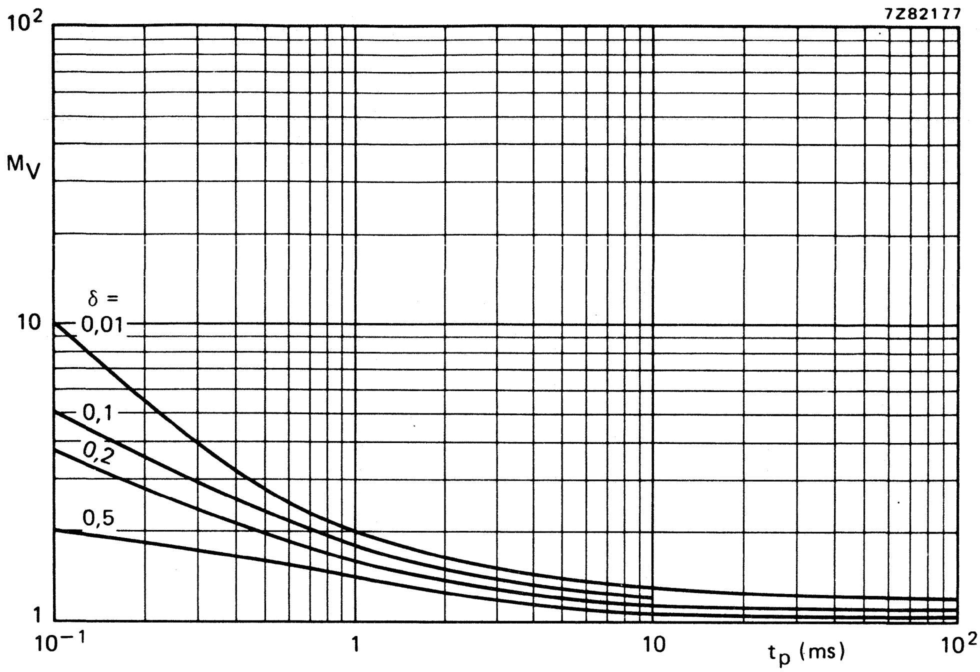


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

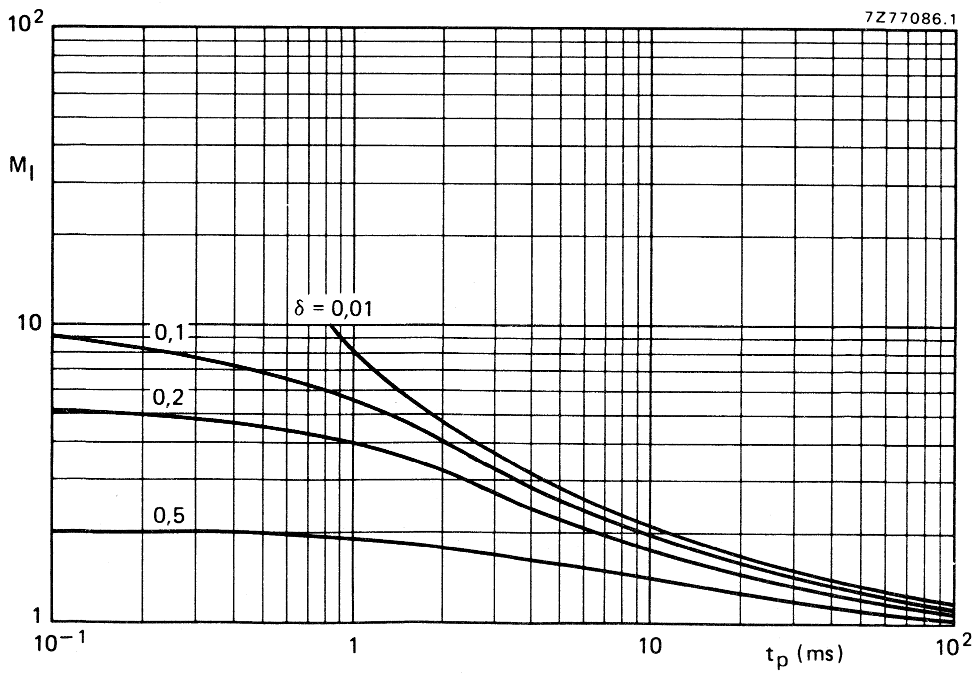


Fig. 11 S.B. current multiplying factor at the V_{CEOmax} level.

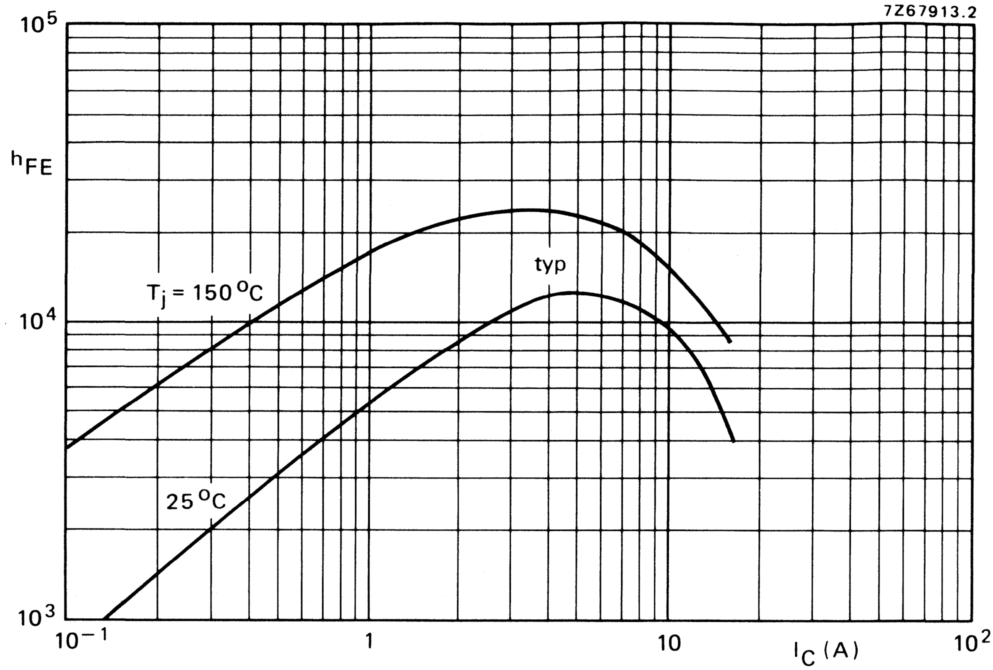


Fig. 12 D.C. current gain.

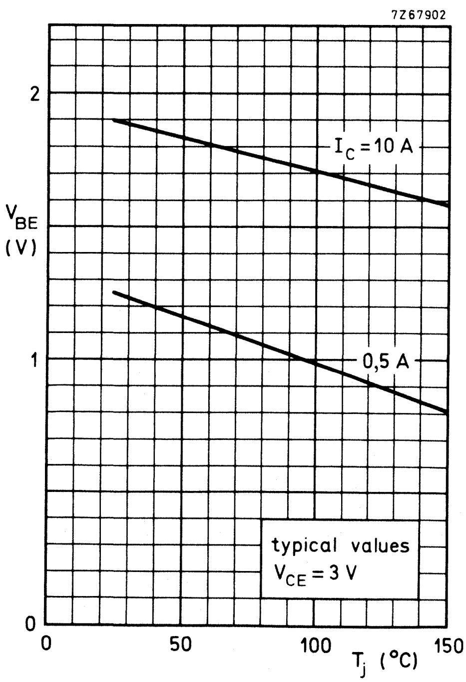


Fig. 13 Typical base-emitter voltage.

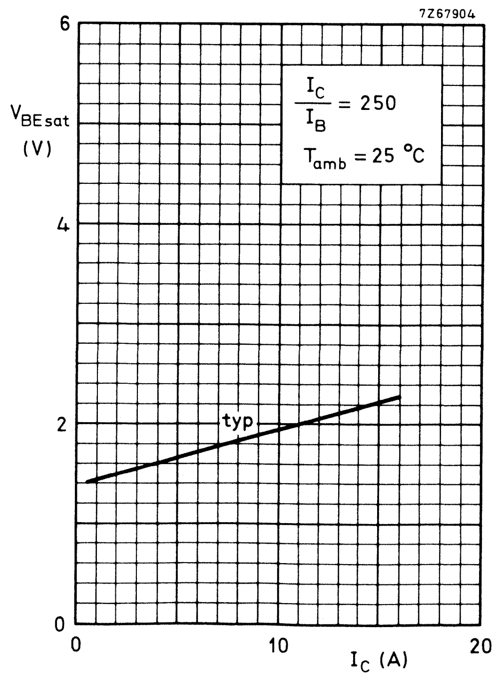


Fig. 14 Base-emitter saturation voltage.

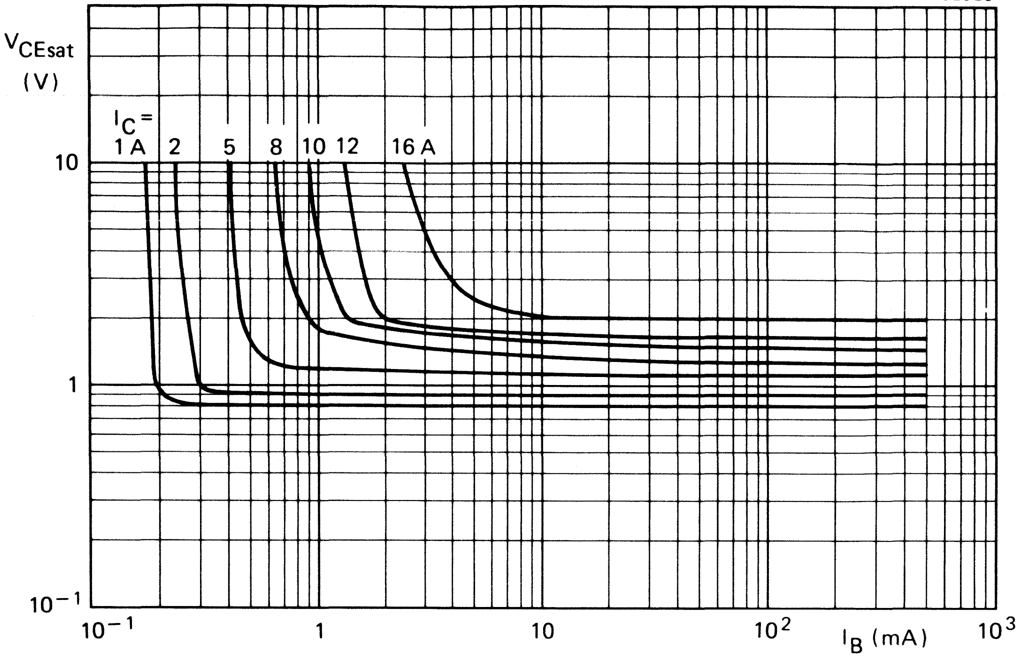


Fig. 15 Typical values collector-emitter saturation voltage at $T_j = 25\ ^oC$.

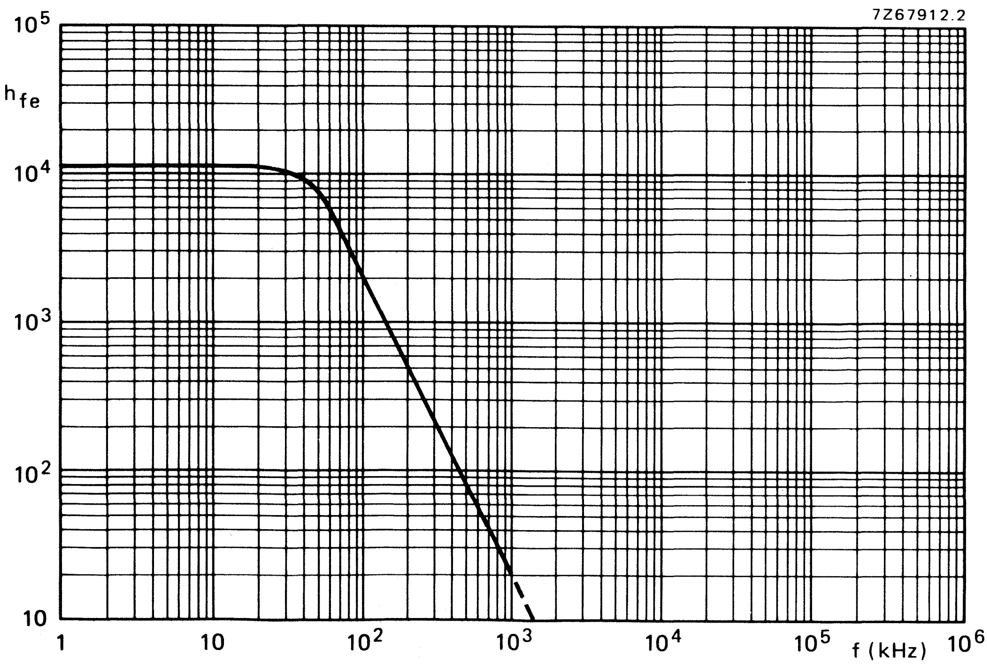


Fig. 16 Small-signal current gain, $I_C = 5$ A; $V_{CE} = 3$ V.

DARLINGTON POWER TRANSISTORS

P-N-P Darlingtons for audio output stages and general amplifier and switching applications. In a TO-3 envelope. N-P-N complements are BDX69, BDX69A, BDX69B and BDX69C.

QUICK REFERENCE DATA

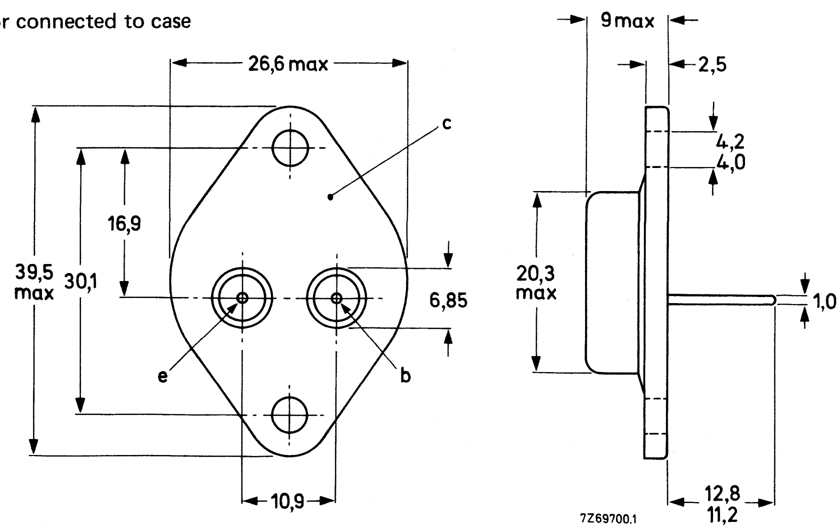
			BDX68	68A	68B	68C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.	40				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200				W
Junction temperature	T_j	max.	200				°C
D.C. current gain							
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	3000				
$-I_C$ = 20 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000				
Cut-off frequency $-I_C$ = 10 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	60				kHz

MECHANICAL DATA

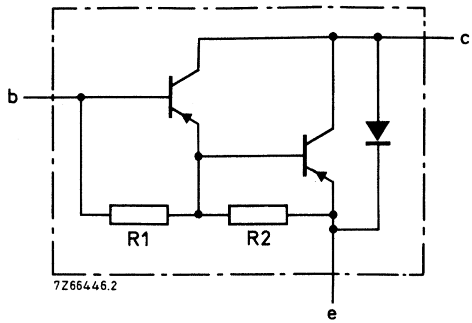
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case



See also chapters Mounting instructions and Accessories.



R1 typ. 1,5 kΩ
R2 typ. 40 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX68	68A	68B	68C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	25	A
Collector current (peak value)	$-I_{CM}$	max.	40	A
Base current	$-I_B$	max.	500	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200	W
Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature*	T_j	max.	200	°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,875	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	2	mA
$I_E = 0; -V_{CB} = -½V_{CBOmax}; T_j = 200$ °C	$-I_{CBO}$	<	10	mA
$I_B = 0; -V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	<	6	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	10	mA
D.C. current gain*				
$-I_C = 5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	3000	
$-I_C = 20$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000	
$-I_C = 30$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	1000	
Base-emitter voltage*				
$-I_C = 20$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5	V
Collector-emitter saturation voltage*				
$-I_C = 20$ A; $-I_B = 80$ mA	$-V_{CEsat}$	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	typ.	600	pF
Cut-off frequency				
$-I_C = 10$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	60	kHz
Small-signal current gain				
$-I_C = 10$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	20	
Diode, forward voltage				
$I_F = 20$ A	V_F	typ.	2,0	V
Switching times (between 10% and 90% levels)				
$-I_{Con} = 20$ A; $-I_{Bon} = I_{Boff} = 80$ mA				
turn-on time	t_{on}	typ.	1	µs
turn-off time	t_{off}	typ.	3,5	µs

* Measured under pulse conditions: $t_p < 300$ µs, $\delta < 2\%$.

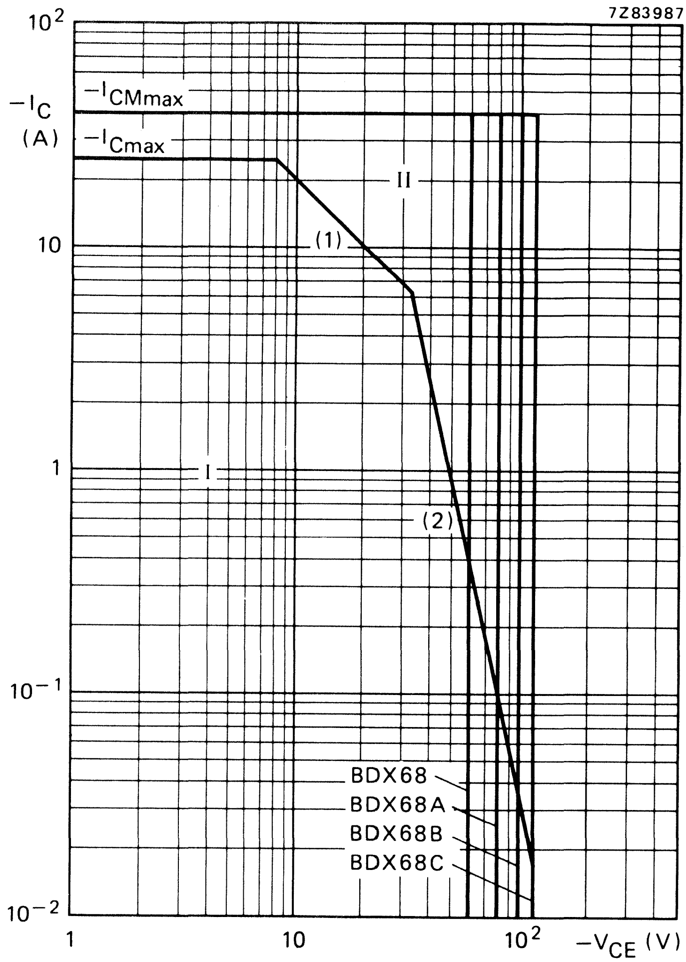


Fig. 3 Safe Operating ARea.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.
(2) Second breakdown limits.

DARLINGTON POWER TRANSISTORS

N-P-N Darlingtons for audio output stages and general amplifier and switching applications. In TO-3 envelope. P-N-P complements are BDX68, BDX68A, BDX68B and BDX68C.

QUICK REFERENCE DATA

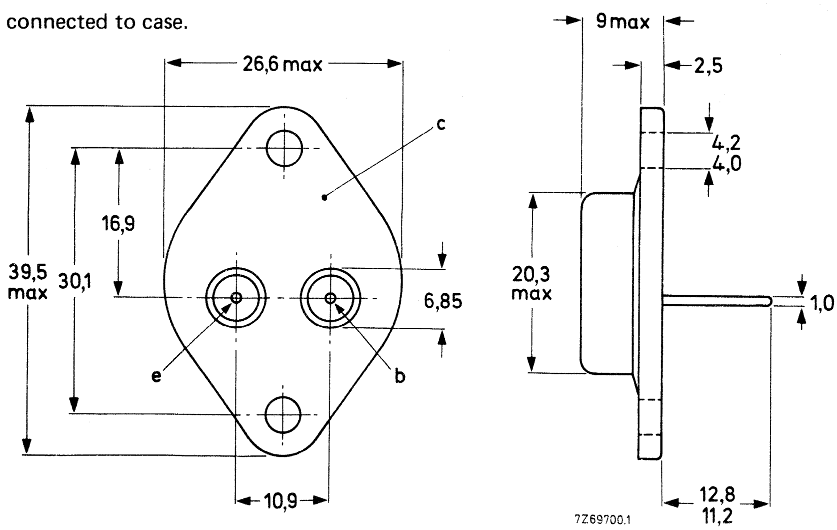
			BDX69	69A	69B	69C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.	40				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200				W
Junction temperature	T_j	max.	200				°C
D.C. current gain							
I_C = 5 A; V_{CE} = 3 V	h_{FE}	typ.	3000				
I_C = 20 A; V_{CE} = 3 V	h_{FE}	>	1000				
Cut-off frequency I_C = 10 A; V_{CE} = 3 V	f_{hfe}	typ.	50				kHz

MECHANICAL DATA

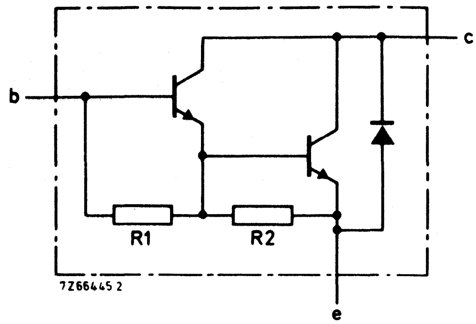
Dimensions in mm

Fig. 1 TO.3.

Collector connected to case.



See also chapters Mounting Instructions and Accessories in l.f. power transistor handbook.



R1 typ. 1,5 kΩ
R2 typ. 40 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX69	69A	69B	69C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	25	A
Collector current (peak value)	I_{CM}	max.	40	A
Base current (d.c.)	I_B	max.	500	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200	W
Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature*	T_j	max.	200	°C

THERMAL RESISTANCE*

From junction to mounting base $R_{th\ j\text{-}mb}$ = 0,875 K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	2	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 200 °C	I_{CBO}	<	10	mA
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	6	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	10	mA
D.C. current gain*				
I_C = 5 A; V_{CE} = 3 V	h_{FE}	typ.	3000	
I_C = 20 A; V_{CE} = 3 V	h_{FE}	>	1000	
I_C = 30 A; V_{CE} = 3 V	h_{FE}	typ.	4000	
Base-emitter voltage*				
I_C = 20 A; V_{CE} = 3 V	V_{BE}	<	2,5	V
Collector-emitter saturation voltage*				
I_C = 20 A; I_B = 80 mA	V_{CEsat}	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	600	pF
Cut-off frequency				
I_C = 10 A; V_{CE} = 3 V	f_{hfe}	typ.	50	kHz
Small-signal current gain				
I_C = 10 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	typ.	20	
Diode, forward voltage				
I_F = 20 A	V_F	typ.	2,5	V
Switching times (between 10% and 90% levels)				
I_{Con} = 20 A; $I_{Bon} = -I_{Boff}$ = 80 mA				
turn-on time	t_{on}	typ.	1	μs
turn-off time	t_{off}	typ.	3,5	μs

* Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.

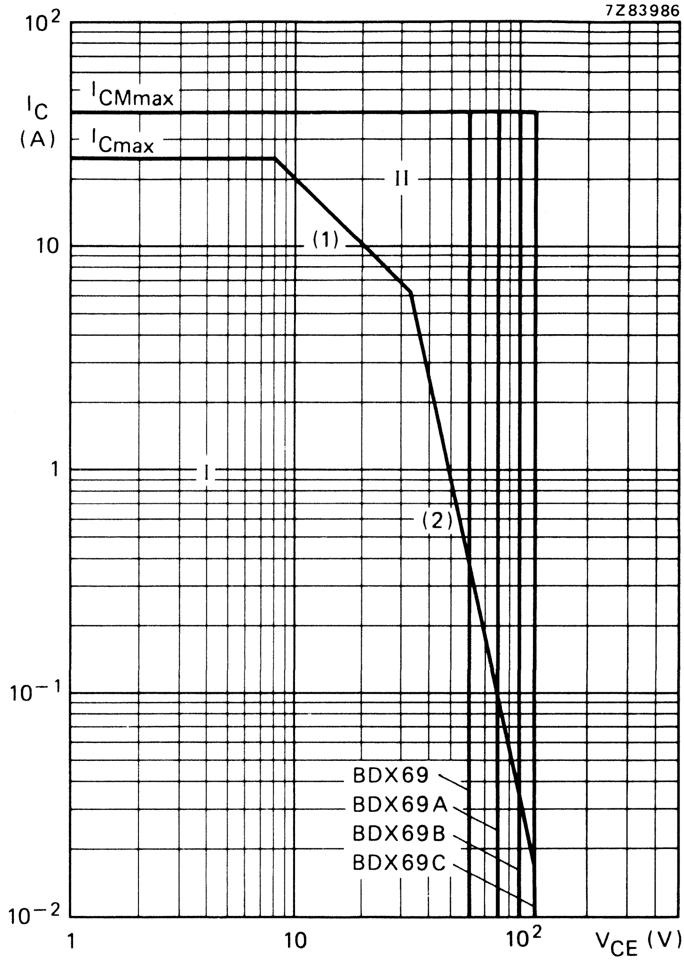


Fig. 3 Safe Operating ARea at T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ line.
(2) Second breakdown limits.

SILICON EPITAXIAL-BASE POWER TRANSISTOR

N-P-N transistor in a plastic envelope, intended for industrial amplifier and switching applications.
P-N-P complement is BDX78.

QUICK REFERENCE DATA

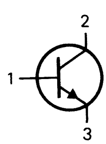
Collector-emitter voltage (open base)	V_{CEO}	max.	80	V
Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector current (DC)	I_C	max.	8	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60	W
D.C. current gain I_C = 2 A; V_{CE} = 2 V	h_{FE}	>	30	
Cut-off frequency I_C = 0,3 A; V_{CE} = 3 V	f_{hfe}	>	25	kHz

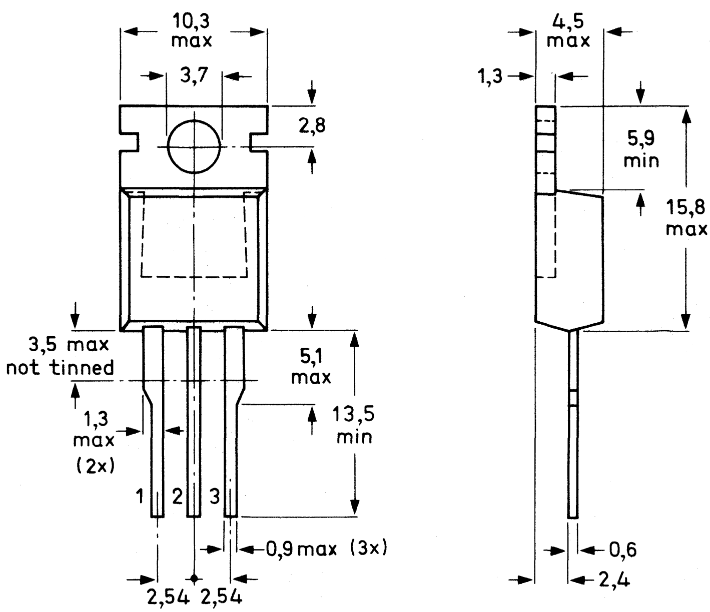
MECHANICAL DATA

Dimensions in mm

TO-220

Collector connected to mounting base





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For more information see BD201/BD203/BDX77 data

SILICON EPITAXIAL-BASE POWER TRANSISTOR

P-N-P transistor in a plastic envelope, intended for industrial amplifier and switching applications.
N-P-N complement BDX77.

QUICK REFERENCE DATA

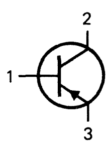
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80 V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	100 V
Collector current (DC)	$-I_C$	max.	8 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60 W
D.C. current gain $-I_C$ = 2 A; $-V_{CE}$ = 2 V	h_{FE}	>	30
Cut-off frequency $-I_C$ = 0,3 A; $-V_{CE}$ = 3 V	f_{hfe}	>	25 kHz

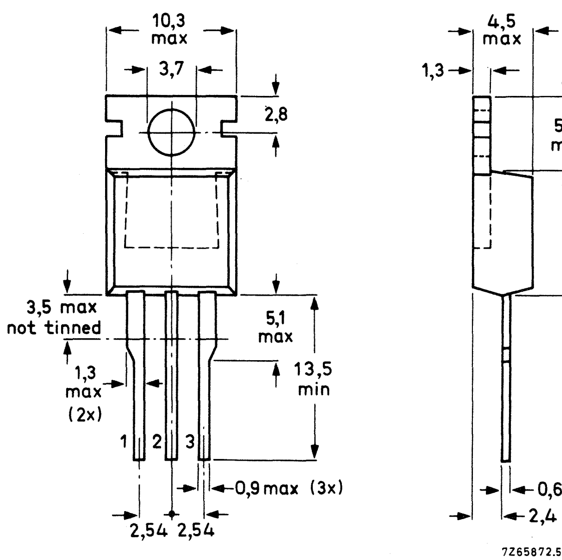
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220

Collector connected to mounting base





For more information see BD202/BD204/BDX78 data

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N transistors in TO-3 envelope for audio output stages and general amplifier and switching applications. P-N-P complements are BDX92, BDX94 and BDX96.

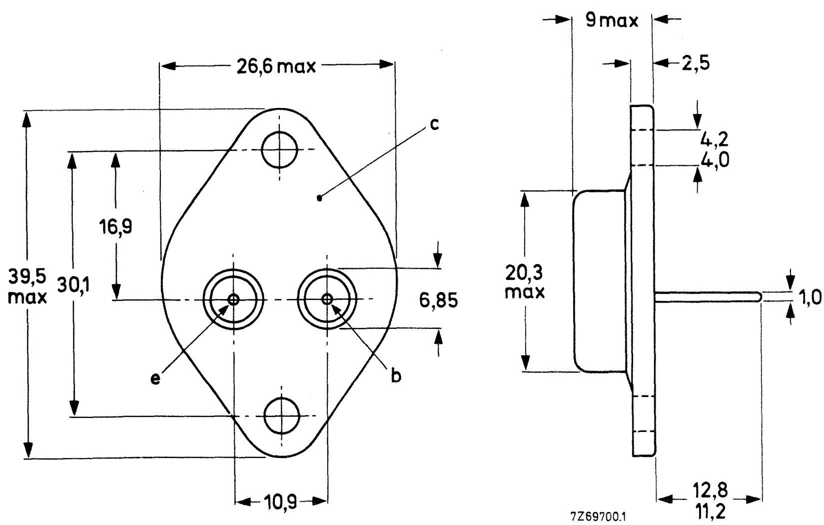
QUICK REFERENCE DATA

			BDX91	BDX93	BDX95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		10		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Junction temperature	T_j	max.		200		°C
D.C. current gain I_C = 3 A; V_{CE} = 2 V	h_{FE}	>		20		
Transition frequency I_C = 1 A; V_{CE} = 10 V	f_T	>		4		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX91	BDX93	BDX95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
→ Collector current (d.c.)	I_C	max.		10		A
→ Collector current (peak value)	I_{CM}	max.		15		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Storage temperature	T_{stg}			−65 to +200		°C
Junction temperature	T_j	max.		200		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,94	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 200 °C	I_{CBO}	<	2	mA
→ $I_B = 0$; $V_{CE} = V_{CEOmax}$	I_{CEO}	<	0,2	mA
Emitter cut-off current				
→ $I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	0,1	mA
D.C. current gain*				
I_C = 3 A; V_{CE} = 2 V	h_{FE}	>	20	
I_C = 5 A; V_{CE} = 2 V	h_{FE}	>	10	
Base-emitter voltage*				
I_C = 3 A; V_{CE} = 2 V	V_{BE}	<	1,4	V
Collector-emitter saturation voltage*				
I_C = 3 A; I_B = 0,3 A	V_{CEsat}	<	0,8	V
I_C = 5 A; I_B = 1 A	V_{CEsat}	<	1	V
Base-emitter saturation voltage*				
I_C = 3 A; I_B = 0,3 A	V_{BEsat}	<	1,5	V
I_C = 5 A; I_B = 1 A	V_{BEsat}	<	2	V

* Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.

Small-signal current gain at f = 1 kHz						
I_C = 0,5 A; V_{CE} = 10 V	h_{fe}	>		40		
Transition frequency						
I_C = 1 A; V_{CE} = 10 V	f_T	>		4		MHz
			BDX91	BDX93	BDX95	
Collector-emitter breakdown voltage*						
I_C = 100 mA	$V_{(BR)CEO}$	>	60	80	100	V
Switching times						
(between 10% and 90% levels)						
I_{Con} = 3 A; I_{Bon} = $-I_{Boff}$ = 0,3 A						
Turn-on time	t_{on}	typ.		0,2		μs
		<		1		μs
Turn-off time	t_{off}	typ.		1,2		μs
		<		2		μs

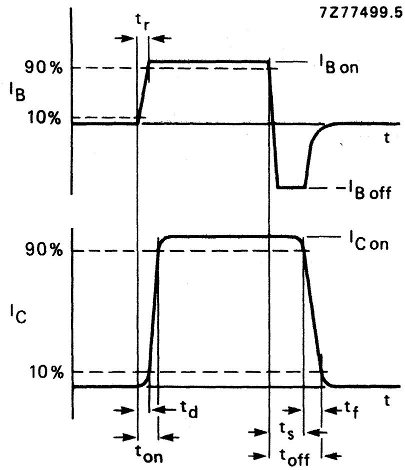
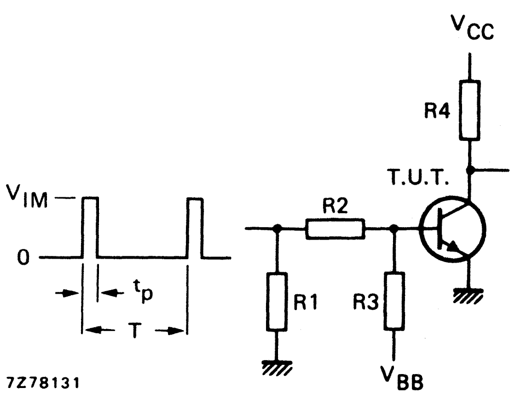


Fig. 2 Switching times waveforms.



V_{IM} = 55 V
V_{CC} = 30 V
$-V_{BB}$ = 5 V
R1 = 150 Ω
R2 = 82 Ω
R3 = 20 Ω
R4 = 10 Ω
$t_r = t_f \leqslant$ 15 ns
t_p = 10 μs
T = 500 μs

Fig. 3 Switching times test circuit.

* Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.

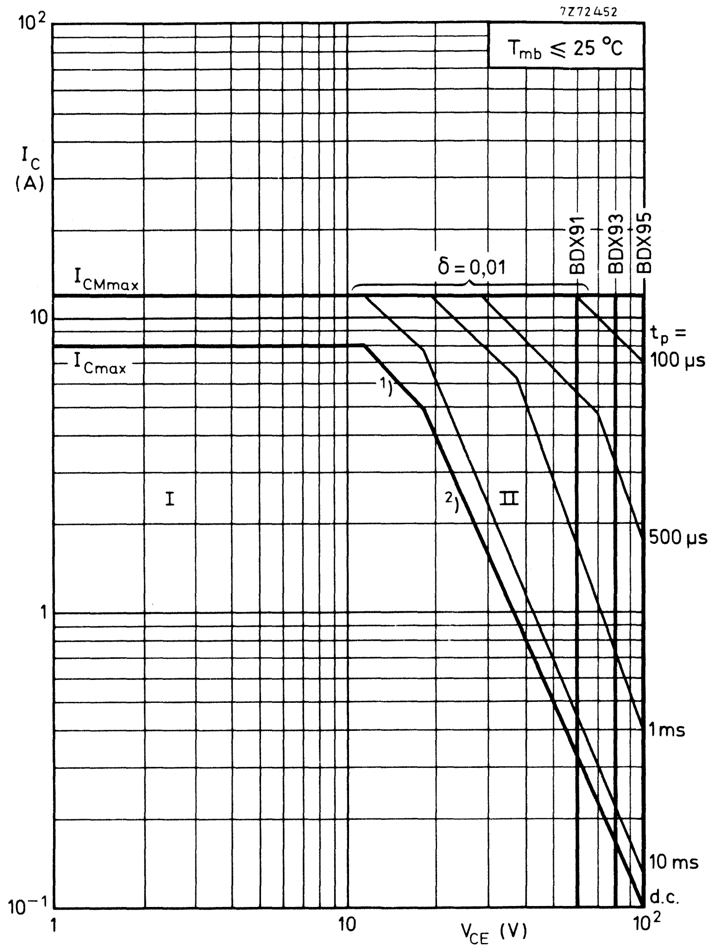


Fig. 4 Safe Operating ARea at $T_{mb} \leqslant 25$ °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{tot\,peak\,max}$ lines.

(2) Second-breakdown limits.

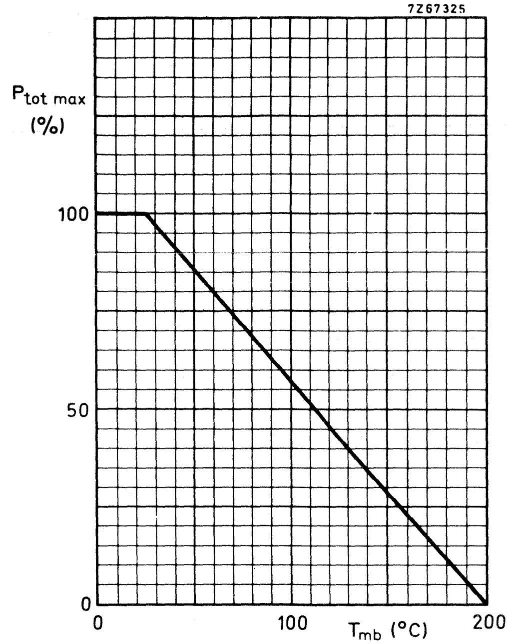


Fig. 5 Power derating curve

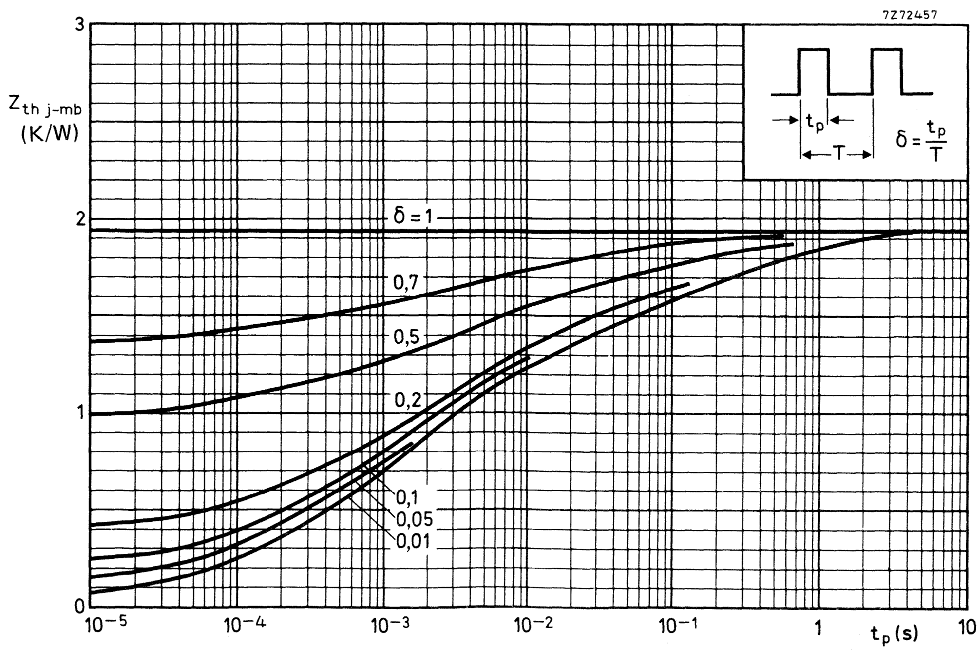


Fig. 6 Pulse power rating chart.

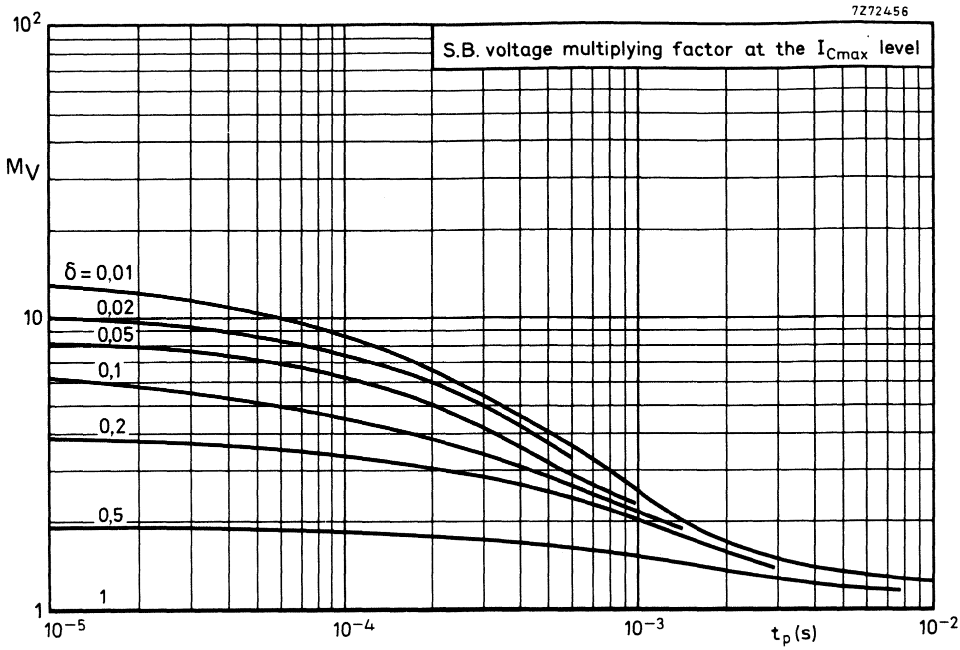


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

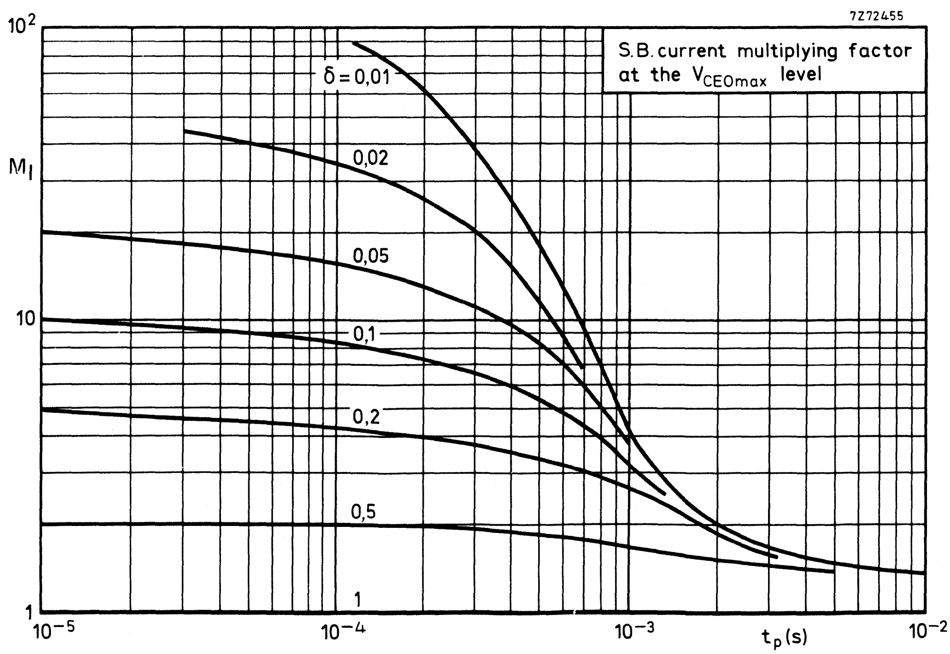


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

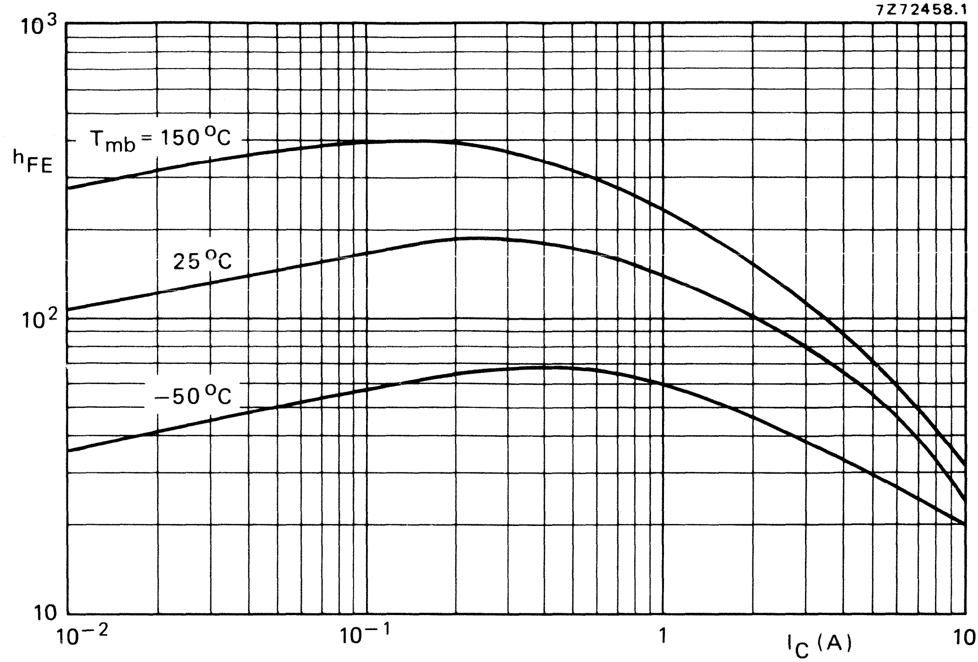


Fig. 9 D.C. current gain at V_{CE} = 2 V; T_j = 25 °C.

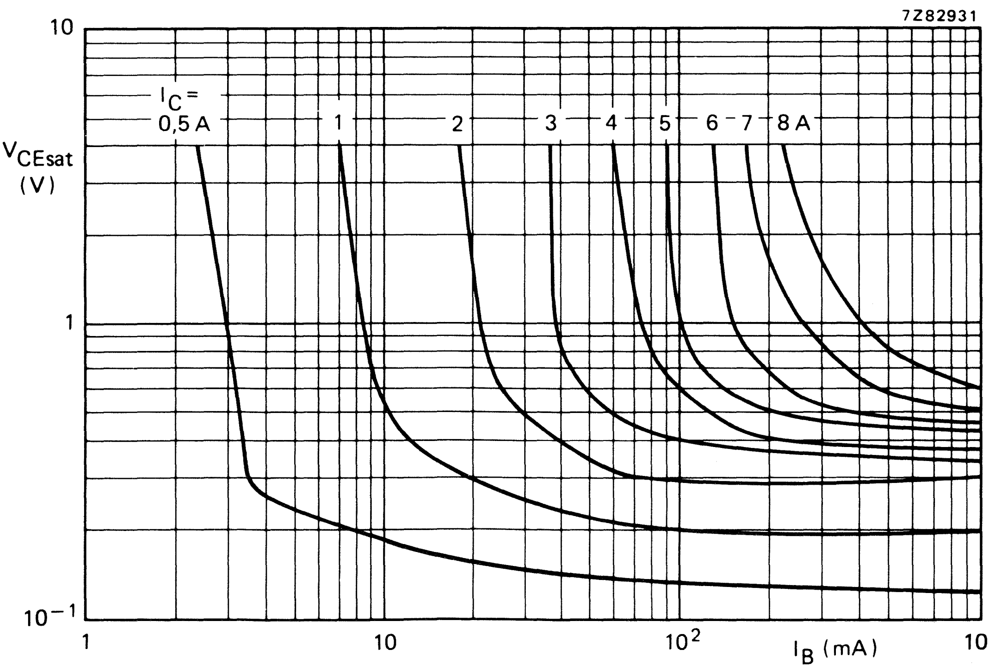


Fig. 10 Typical values collector-emitter saturation voltage.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in TO-3 envelope for audio output stages and general amplifier and switching applications. N-P-N complements are BDX91, BDX93 and BDX95.

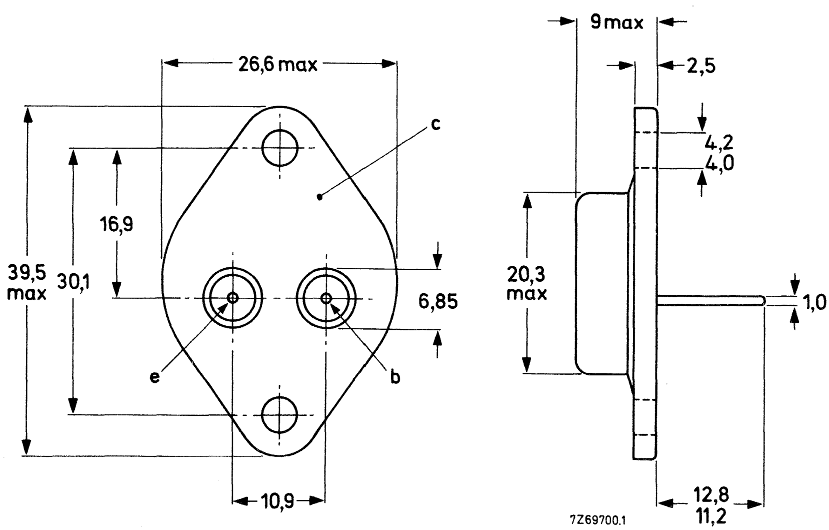
QUICK REFERENCE DATA

			BDX92	BDX94	BDX96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		10		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Junction temperature	T_j	max.		200		°C
D.C. current gain $-I_C$ = 3 A; $-V_{CE}$ = 2 V	h_{FE}	>		20		
Transition frequency $-I_C$ = 1 A; $-V_{CE}$ = 10 V	f_T	>		4		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.
Collector connected to envelope



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX92	BDX94	BDX96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (d.c.)	$-I_C$	max.		10		A
Collector current (peak value)	$-I_{CM}$	max.		15		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Storage temperature	T_{stg}			−65 to +200		°C
Junction temperature	T_j	max.		200		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	1,94	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current					
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,1	mA	
$I_E = 0$; $-V_{CB}$ = 30 V; T_j = 200 °C; BDX92 $I_E = 0$; $-V_{CB}$ = 40 V; T_j = 200 °C: BDX94 $I_E = 0$; $-V_{CB}$ = 50 V; T_j = 200 °C: BDX96	$-I_{CBO}$	<	2	mA	
$I_B = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CEO}$	<	0,2	mA	←
Emitter cut-off current					
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	0,1	mA	←
D.C. current gain [1]					
$-I_C$ = 3 A; $-V_{CE}$ = 2 V	h_{FE}	>	20		
$-I_C$ = 5 A; $-V_{CE}$ = 2 V	h_{FE}	>	10		
Base-emitter voltage [1]					
$-I_C$ = 3 A; $-V_{CE}$ = 2 V	$-V_{BE}$	<	1,4	V	
Collector-emitter saturation voltage [1]					
$-I_C$ = 3 A; $-I_B$ = 0,3 A	$-V_{CEsat}$	<	0,8	V	
$-I_C$ = 5 A; $-I_B$ = 1 A	$-V_{CEsat}$	<	1	V	
Base-emitter saturation voltage [1]					
$-I_C$ = 3 A; $-I_B$ = 0,3 A	$-V_{BEsat}$	<	1,5	V	
$-I_C$ = 5 A; $-I_B$ = 1 A	$-V_{BEsat}$	<	2	V	
Small-signal current gain at f = 1 kHz					
$-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	h_{fe}	>	40		
Transition frequency					
$-I_C$ = 1 A; $-V_{CE}$ = 10 V	f_T	>	4	MHz	

[1]) Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

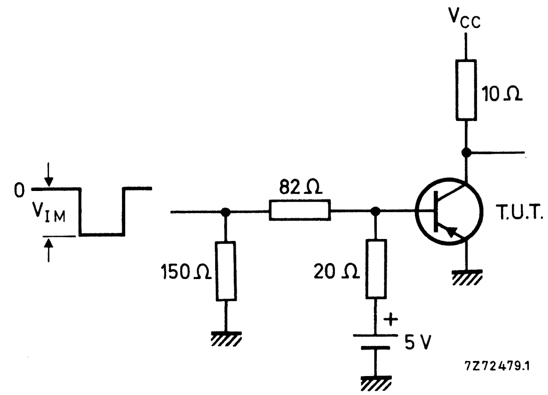
Switching times (between 10% and 90% levels)

$-I_{Con}$ = 3 A; $-I_{Bon}$ = I_{Boff} = 0,3 A; V_{CC} = −30 V

Turn-on time	t_{on}	typ.	0,2	μs
		<	1	μs
Turn-off time	t_{off}	typ.	1	μs
		<	2	μs

Test circuit

V_{IM} = 55 V
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs



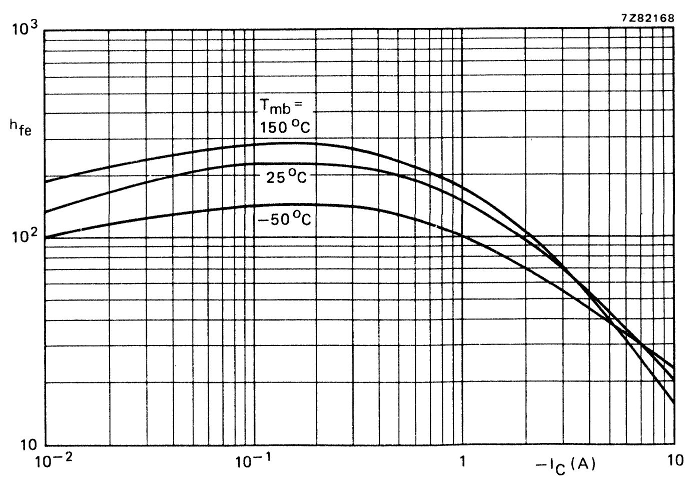


Fig. 3 Typical small-signal current gain as a function of collector current; $-V_{CE}$ = 2 V.

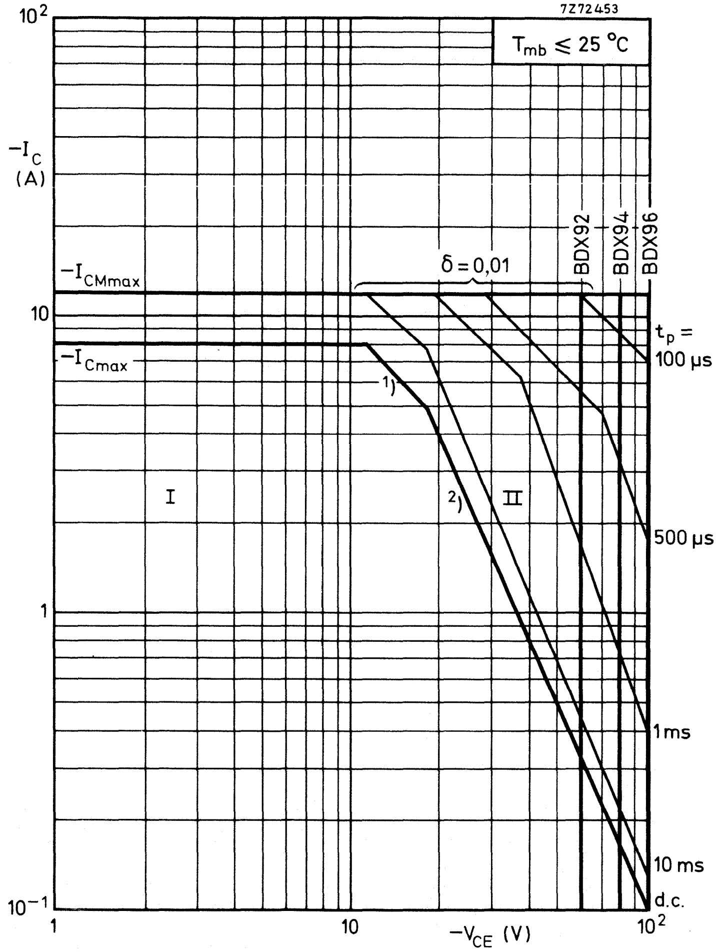


Fig. 4 Safe Operating ARea with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

[1]) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

[2]) Second-breakdown limits.

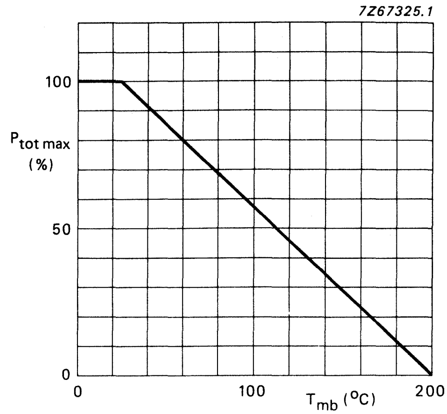

7Z67325.1
100
$P_{tot\,max}$
(%)
50
0
0
100
T_{mb} (°C)
200

Fig. 5.

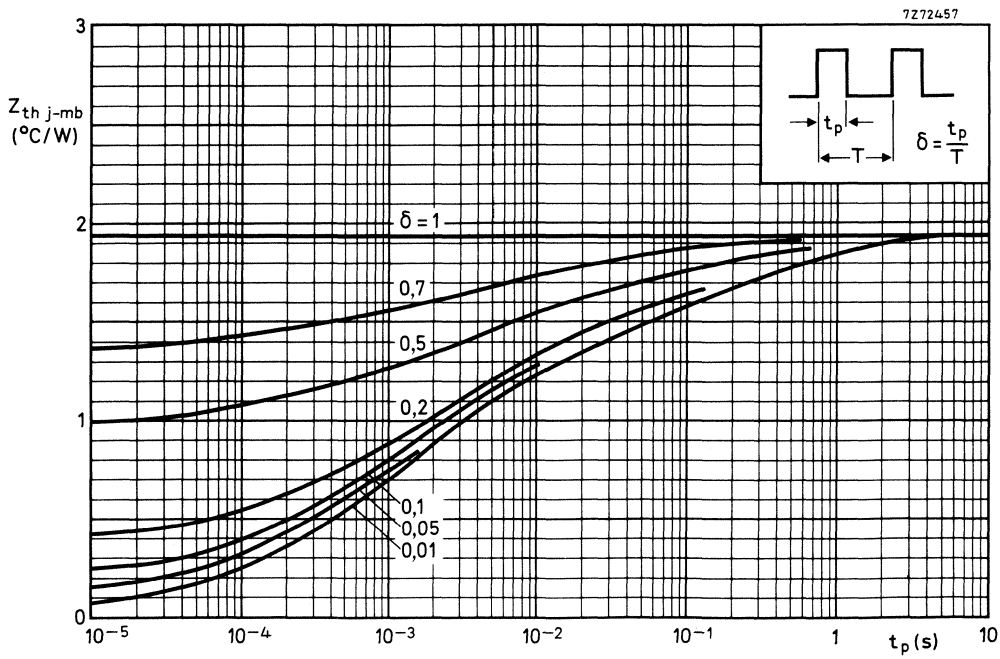

7Z72457
3
$Z_{th\ j\text{-}mb}$
(°C/W)
2
1
0
δ = 1
0,7
0,5
0,2
0,1
0,05
0,01
t_p
T
$\delta = \frac{t_p}{T}$
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
t_p (s)
10

Fig. 6.

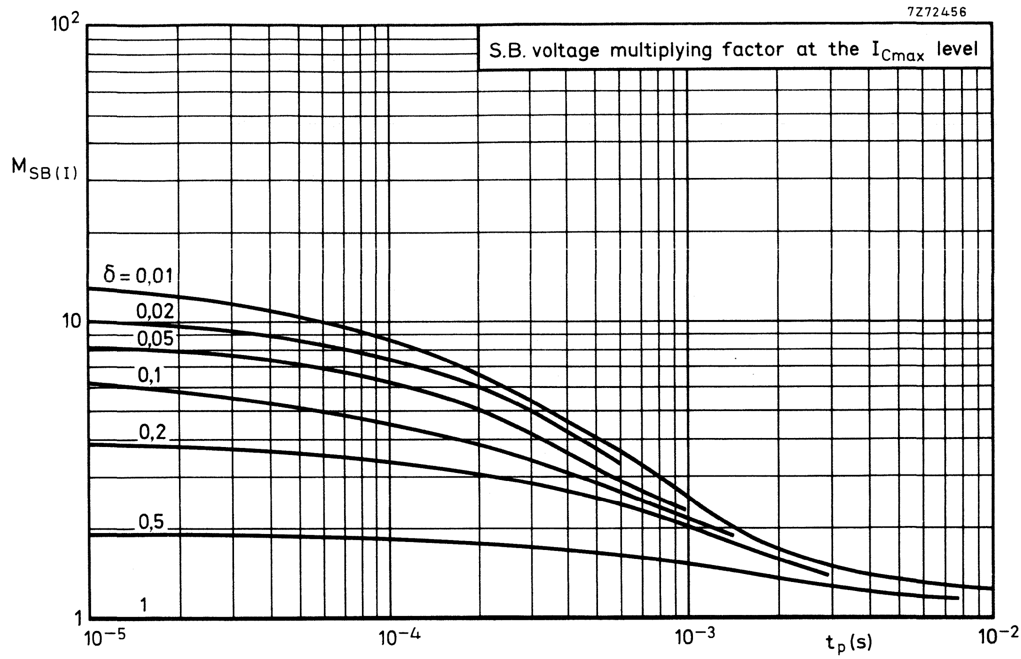

7Z72456
S.B. voltage multiplying factor at the I_{Cmax} level
$M_{SB(I)}$
10^2
10
1
$\delta = 0,01$
0,02
0,05
0,1
0,2
0,5
1
10^{-5}
10^{-4}
10^{-3}
t_p(s)
10^{-2}

Fig. 7.

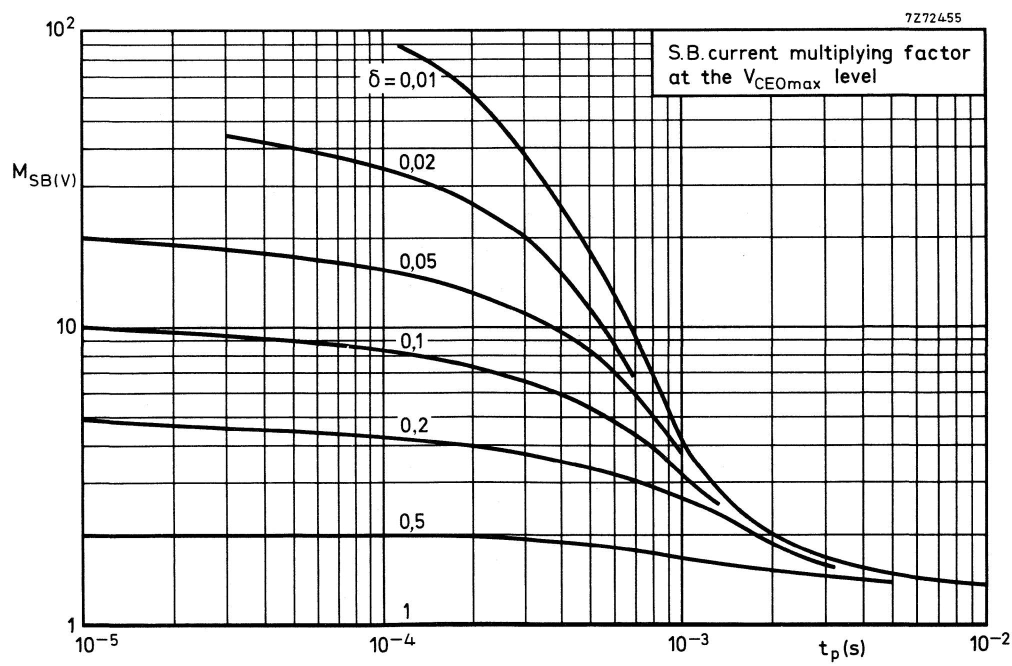

7Z72455
S.B. current multiplying factor at the V_{CEOmax} level
$M_{SB(V)}$
10^2
10
1
$\delta = 0,01$
0,02
0,05
0,1
0,2
0,5
1
10^{-5}
10^{-4}
10^{-3}
t_p(s)
10^{-2}

Fig. 8.

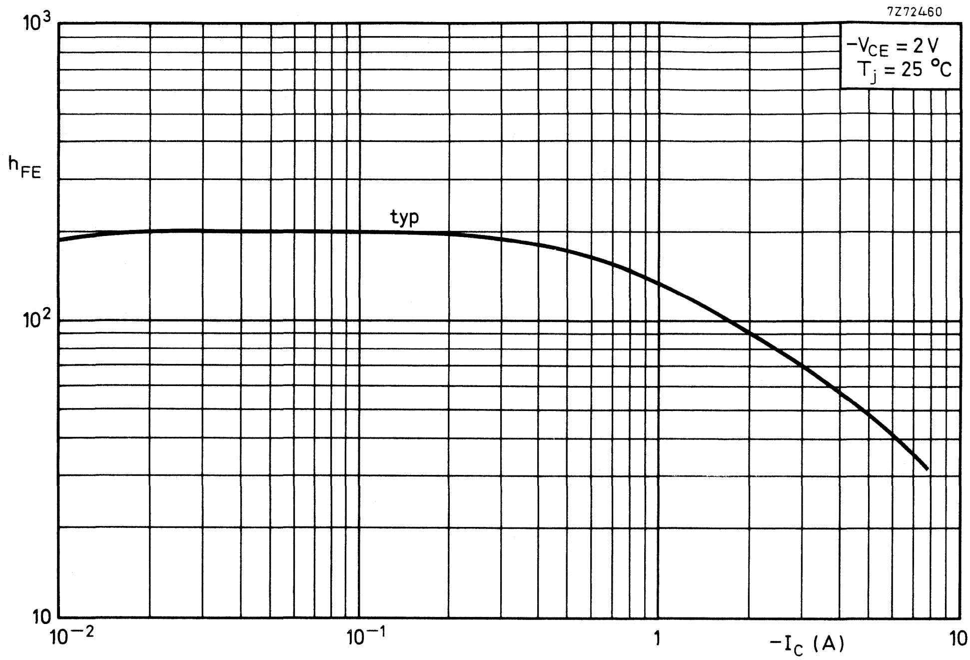

7Z72460
$-V_{CE}$ = 2 V
T_j = 25 °C
h_{FE}
typ
10^3
10^2
10
10^{-2}
10^{-1}
1
$-I_C$ (A)
10

Fig. 9.

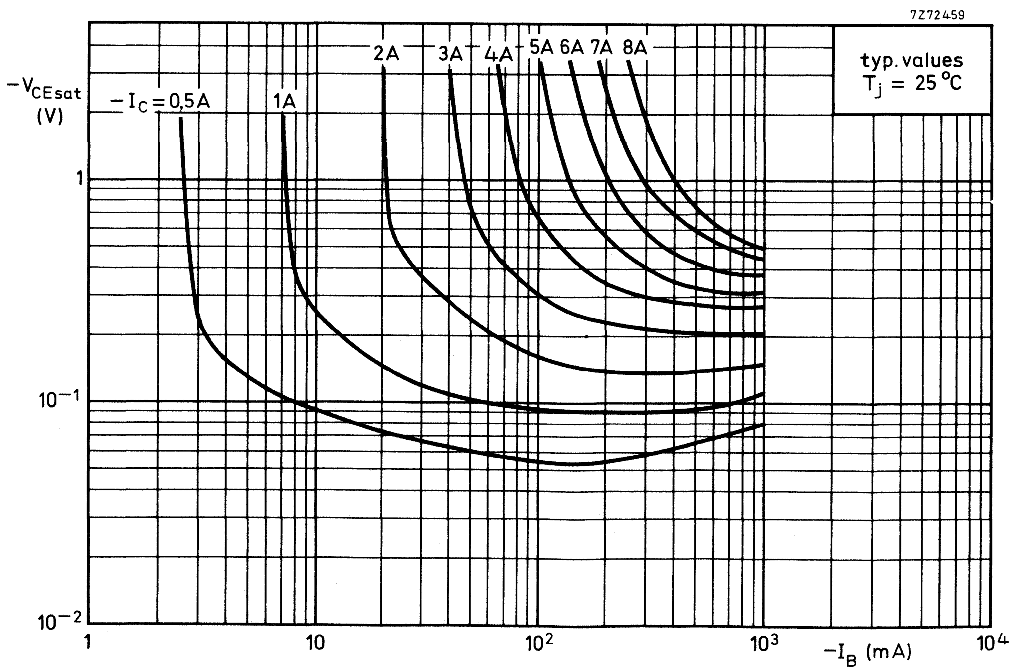

7Z72459
typ. values
T_j = 25 °C
$-V_{CEsat}$ (V)
$-I_C$ = 0,5 A
1A
2A
3A
4A
5A
6A
7A
8A
1
10^{-1}
10^{-2}
1
10
10^2
10^3
$-I_B$ (mA)
10^4

Fig. 10.

SILICON DIFFUSED POWER TRANSISTORS

High-speed switching n-p-n transistors in a metal envelope intended for use in converters, inverters, switching regulators and switching control amplifiers.

QUICK REFERENCE DATA

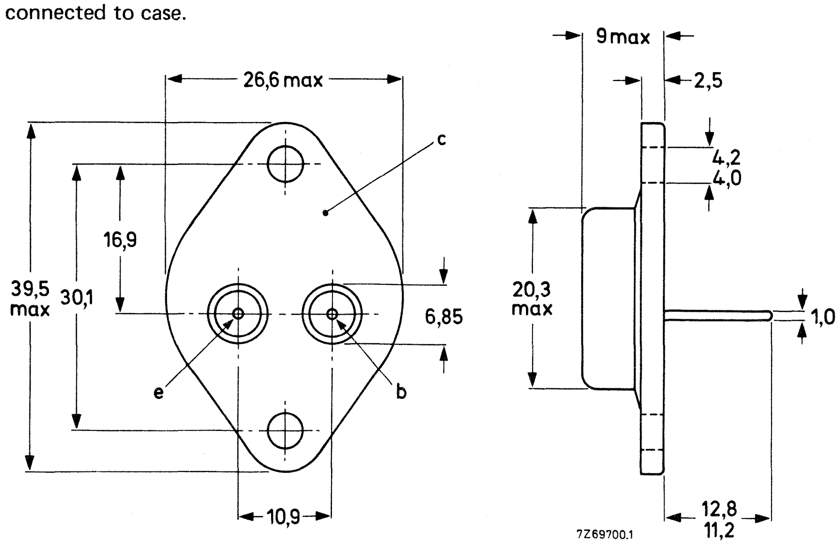
			BDY90	BDY91	BDY92	
Collector-base voltage (open emitter)	V_{CBO}	max.	120	100	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	100	80	60	V
Collector current (peak value)	I_{CM}	max.		15		A
Total power dissipation up to $T_{mb} = 70\ ^oC$	P_{tot}	max.		40		W
Collector-emitter saturation voltage $I_C = 10$ A; $I_B = 1$ A	V_{CEsat}	<		1		V
Fall time $I_C = 5$ A; $I_B = -I_{BM} = 0,5$ A; $V_{CC} = 30$ V	t_f	<		0,2		μs
Transition frequency at f = 5 MHz $I_C = 0,5$ A; $V_{CE} = 5$ V	f_T	typ.		70		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDY90	BDY91	BDY92	
Collector-base voltage (open emitter)	V_{CBO}	max.	120	100	80	V
Collector-emitter voltage (V_{EB} = 1,5 V)	V_{CEX}	max.	120	100	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	100	80	60	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	6	6	V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value)	I_{CM}	max.		15		A
Base current (d.c.)	I_B	max.		2		A
Base current (peak value)	I_{BM}	max.		3		A
Emitter current (d.c.)	$-I_E$	max.		11		A
Emitter current (peak value)	$-I_{EM}$	max.		15		A
Total power dissipation up to T_{mb} = 70 °C	P_{tot}	max.		40		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,0	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
V_{EB} = 1,5 V; V_{CE} = V_{CEXmax};	I_{CEX}	<	1	mA
V_{EB} = 1,5 V; V_{CE} = V_{CEXmax}; T_{mb} = 150 °C	I_{CEX}	<	3	mA
Saturation voltages				
I_C = 5 A; I_B = 0,5 A	V_{CEsat}	<	0,5	V
	V_{BEsat}	<	1,2	V
I_C = 10 A; I_B = 1 A	V_{CEsat}	<	1,0	V
	V_{BEsat}	<	1,5	V

CHARACTERISTICS

D.C. current gain			
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>	35
I_C = 5 A; V_{CE} = 5 V	h_{FE}		30 to 120
I_C = 10 A; V_{CE} = 5 V	h_{FE}	>	20
Transition frequency at f = 5 MHz			
I_C = 0,5 A; V_{CE} = 5 V	f_T	typ.	70 MHz
Switching times			
Turn on time			
I_C = 5 A; $I_B = -I_{BM}$ = 0,5 A; V_{CC} = 30 V	t_{on}	<	0,35 μs
Turn off time			
I_C = 5 A; $I_B = -I_{BM}$ = 0,5 A; V_{CC} = 30 V storage time	t_s	<	1,3 μs
fall time	t_f	<	0,2 μs

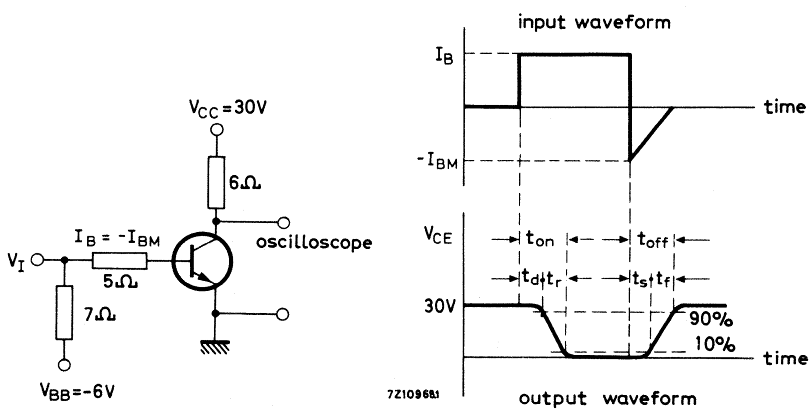


Fig. 2 Test circuit and waveforms.

Pulse generator:

Rise time	t_r	<	50 ns	Pulse duration	t_p	=	20 μs
Fall time	t_f	<	50 ns	Duty cycle	δ	=	0,02

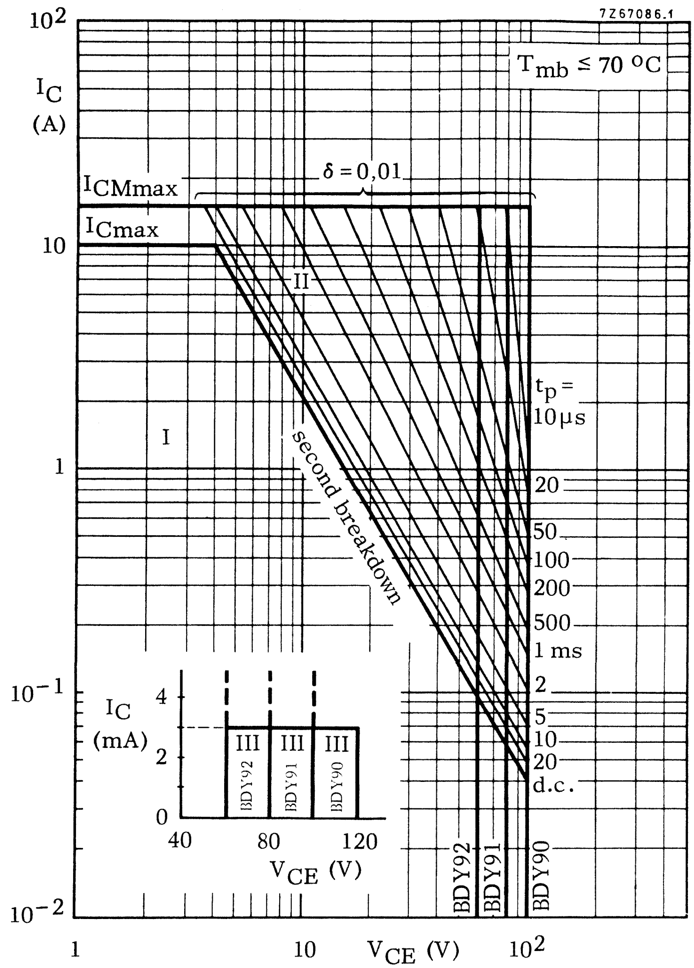


Fig. 3 Safe Operating ARea (Regions I and II forward biased).

I Region of permissible d.c. operation

II Permissible extension for repetitve pulse operation

III Repetitive pulse operation in this region is allowable, provided $-V_{BE} \geqslant 1,5$ V

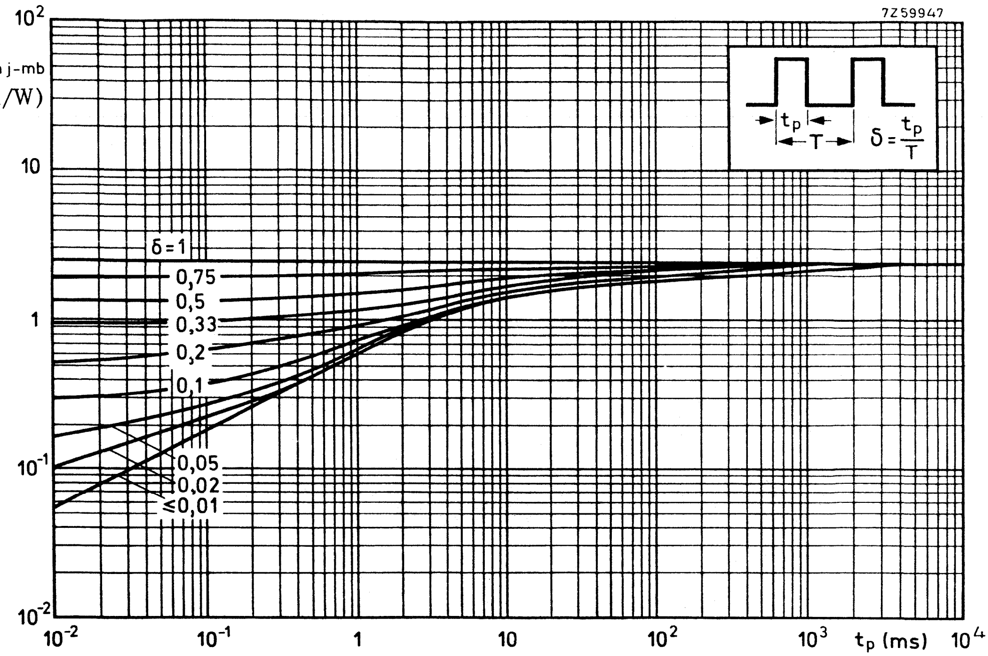


Fig. 4 Pulse power rating chart.

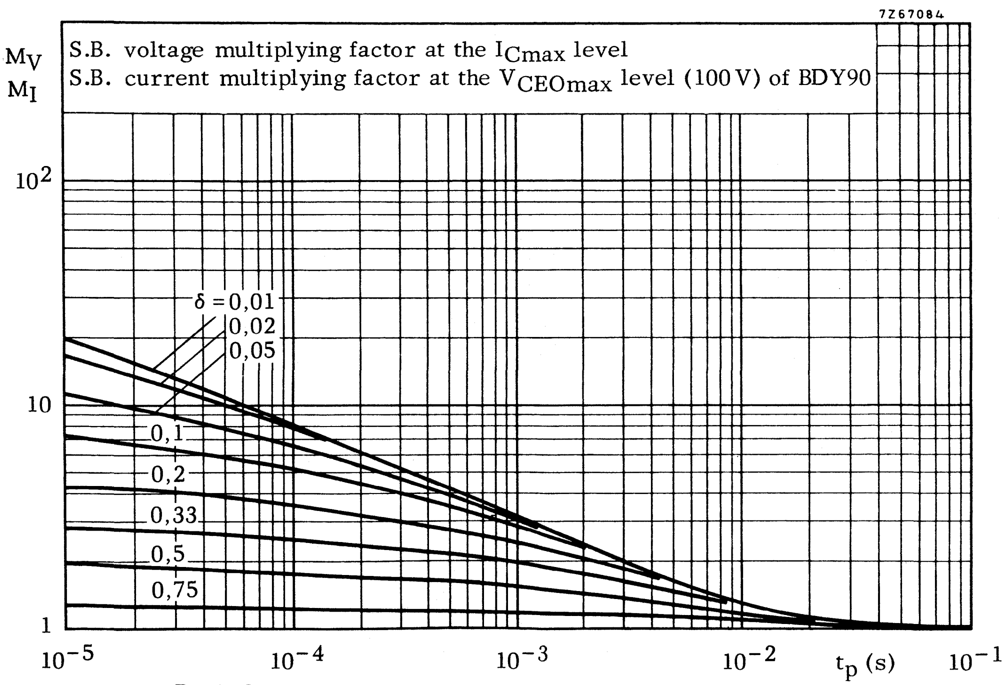


Fig. 5 S.B. voltage multiplying factor at the I_C max level.
S.B. current multiplying factor at the BDY90 V_{CEOmax} level (100 V).

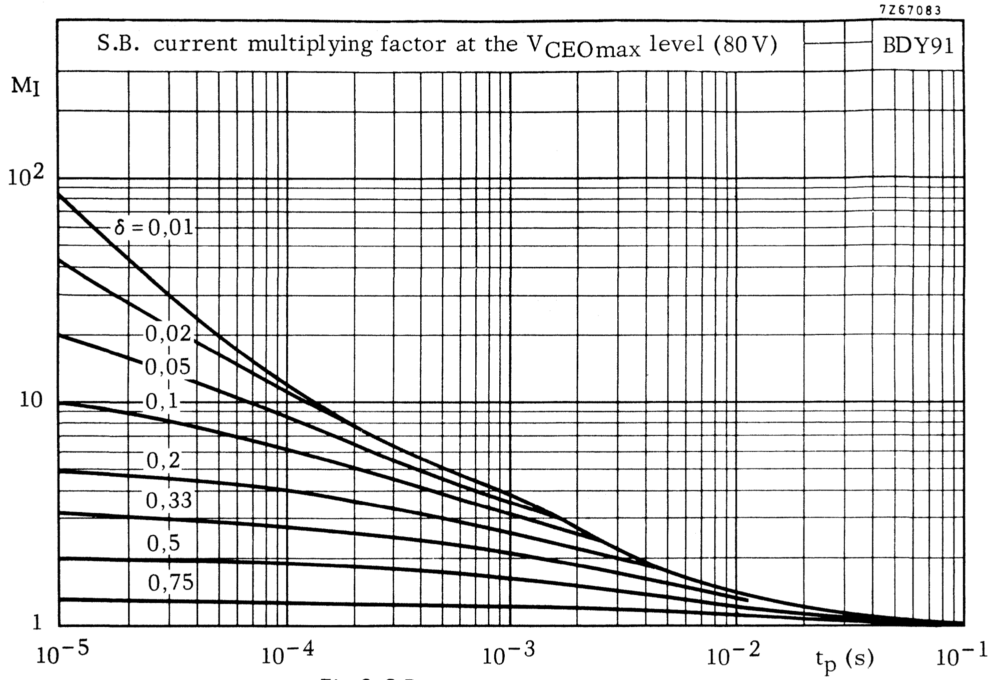


Fig. 6 S.B. current multiplying factor.

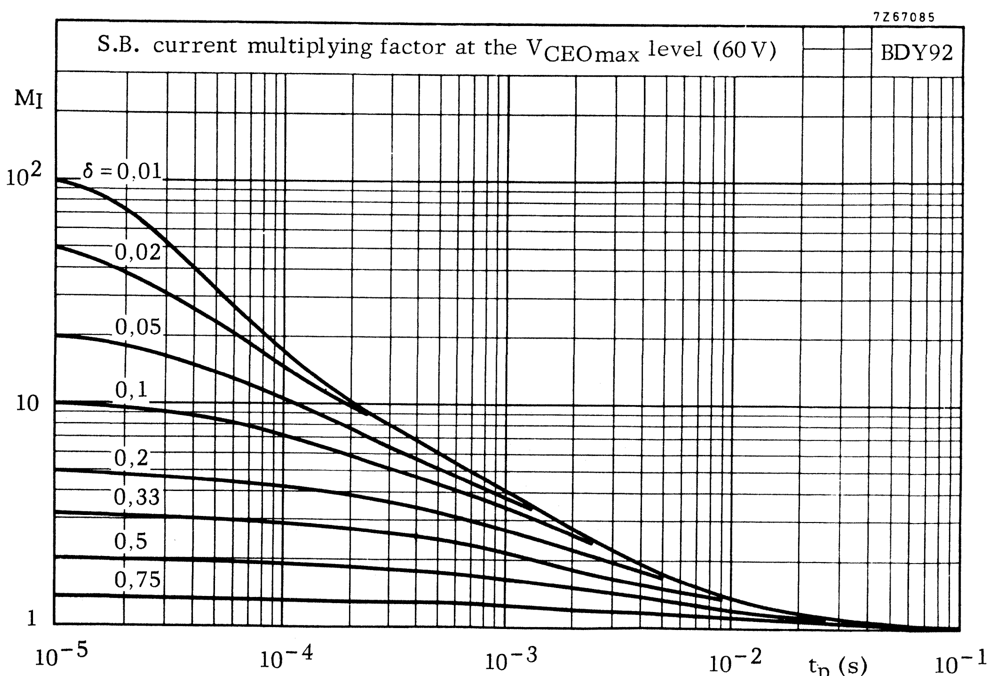


Fig. 7 S.B. current multiplying factor.

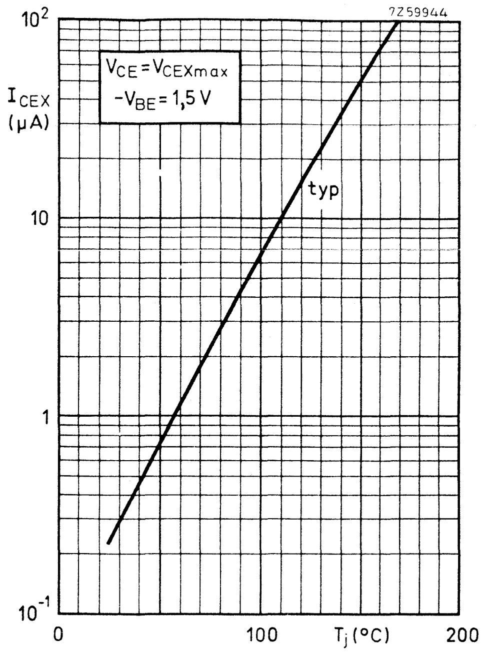


Fig. 8 Collector-emitter current.

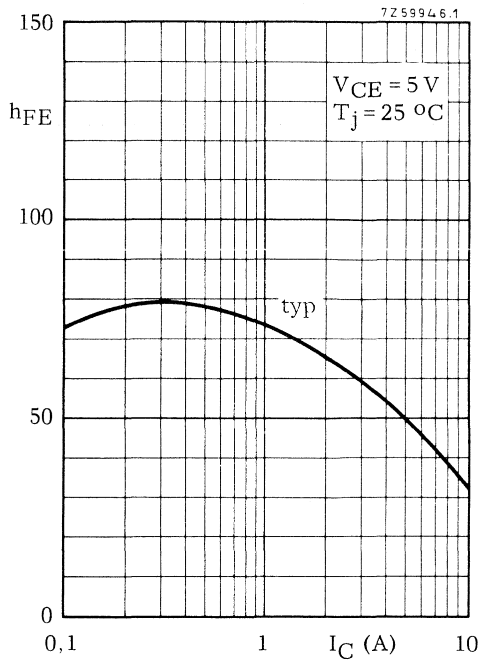


Fig. 9 D.C. current gain.

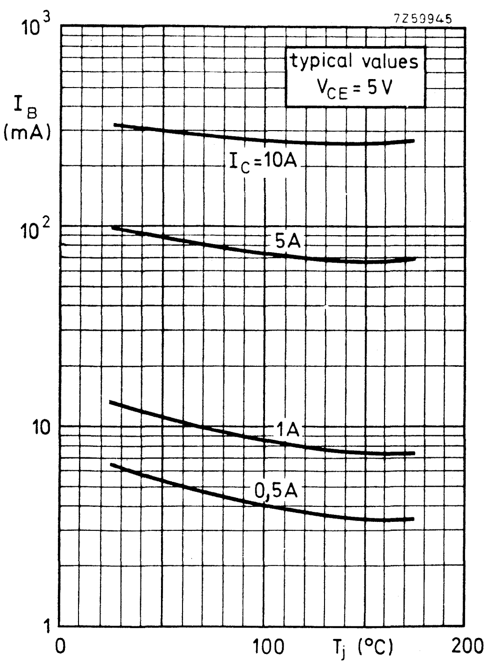


Fig. 10 Typical base current.

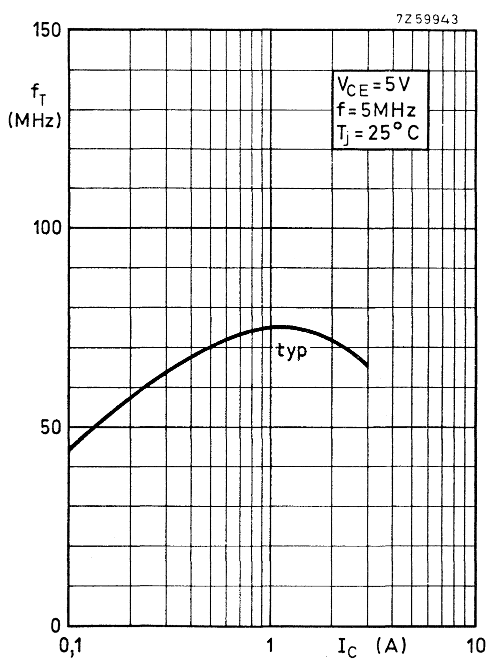


Fig. 11 Transition frequency.

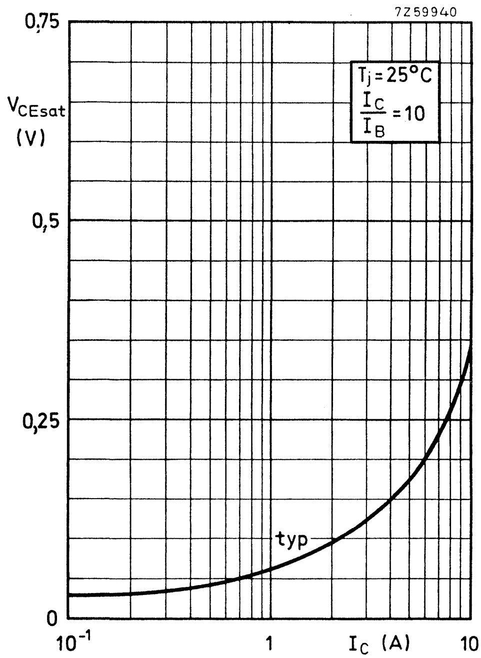


Fig. 12 Collector-emitter saturation voltage as a function of collector current.

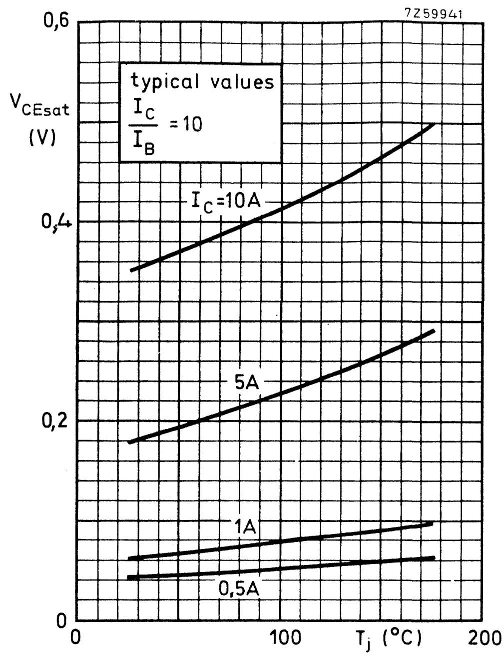


Fig. 13 Collector-emitter saturation voltage as a function of junction temperature.

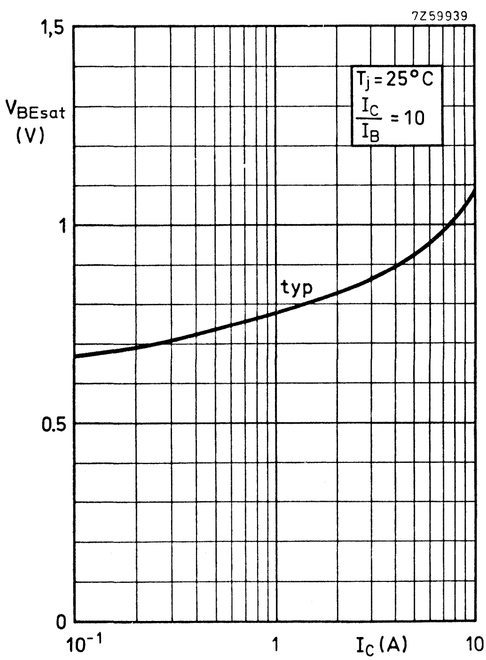


Fig. 14 Typical base-emitter saturation voltage.

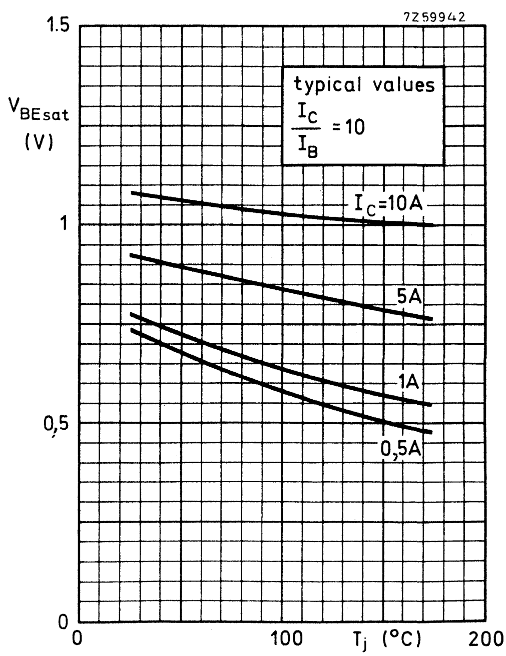


Fig. 15 Typical base-emitter saturation voltage.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur.

QUICK REFERENCE DATA

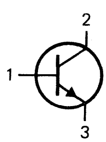
			TIP29	A	B	C	
Collector-base voltage	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.	1				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
I_C = 200 mA; V_{CE} = 4 V	h_{FE}	>	40				
I_C = 1 A; V_{CE} = 4 V	h_{FE}		15 to 75				
Transition frequency at f = 1 MHz							
I_C = 200 mA; V_{CE} = 10 V	f_T	>	3				MHz

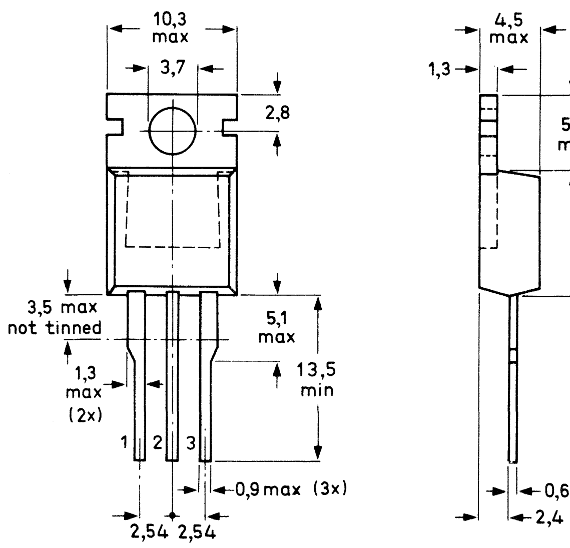
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





For more information see BDT29 series data.
See also chapters Mounting Instructions and Accessories.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur.

QUICK REFERENCE DATA

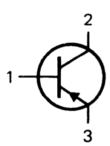
			TIP30	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	1				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}		15 to 75				
Transition frequency $-I_C$ = 200 mA; $-V_{CE}$ = 10 V	f_T	>	3				MHz

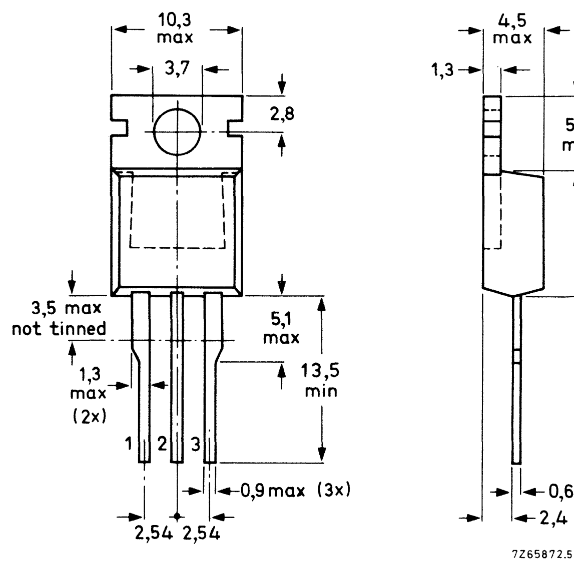
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





For more information see BDT30 series data.
See also chapters Mounting Instructions and Accessories.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N transistors in a plastic envelope intended for use in audio output stages and general amplifier and switching applications.

QUICK REFERENCE DATA

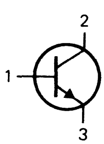
			TIP31	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.		3			A
Collector current (peak value)	I_{CM}	max.		5			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
I_C = 1 A; V_{CE} = 4 V	h_{FE}	>		25			
I_C = 3 A; V_{CE} = 4 V	h_{FE}			10 to 50			

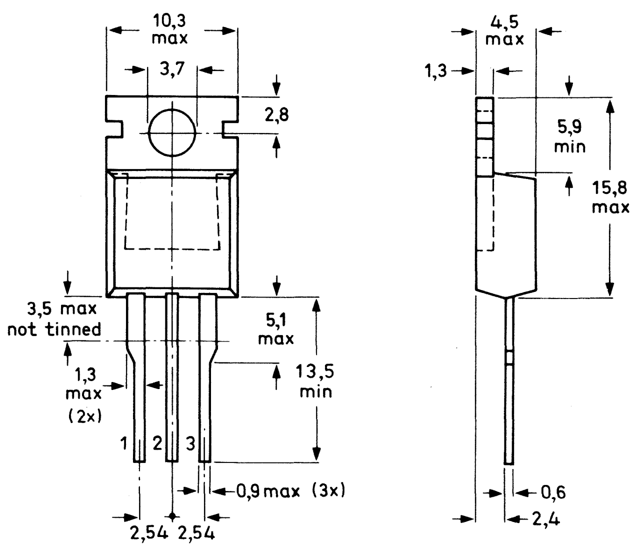
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





7Z65872.5

For more information see BDT31 series data.
See also chapters Mounting Instructions and Accessories.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic TO-220 envelope. They are intended for use in a wide range of power amplifiers and for switching applications.

QUICK REFERENCE DATA

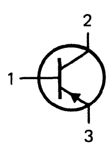
			TIP32	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	3				A
Collector current (peak value)	$-I_{CM}$	max.	5				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
$-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	>	25				
$-I_C$ = 3 A; $-V_{CE}$ = 4 V	h_{FE}		10 to 50				

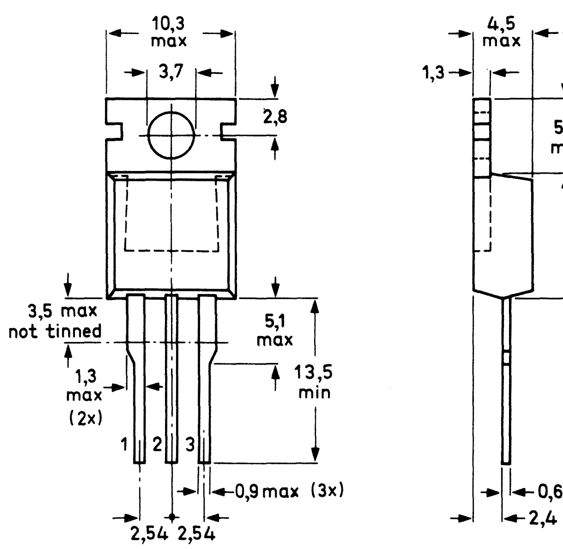
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





For more information see BDT32 series data.
See also chapters Mounting Instructions and Accessories.

SILICON POWER TRANSISTORS

N-P-N epitaxial-base power transistors in the plastic SOT-93 envelope. These transistors are intended for use in audio output stages and general amplifier and switching applications. P-N-P complements are TIP34, TIP34A, TIP34B and TIP34C.

QUICK REFERENCE DATA

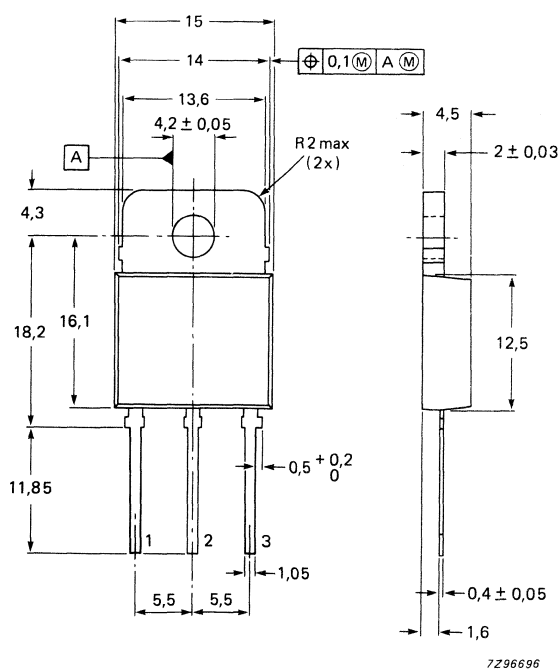
			TIP33	33A	33B	33C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.	10				A
Collector current (peak value); $t_p \leqslant 0{,}3$ ms	I_{CM}	max.	15				A
Power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	80				W
D.C. current gain							
$V_{CE} = 4$ V; $I_C = 3$ A	h_{FE}		20 to 100				
Collector-emitter saturation voltage							
$I_C = 3$ A; $I_B = 0{,}3$ A	V_{CEsat}	<	1				V

MECHANICAL DATA

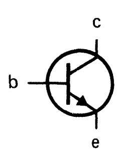
Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



Pinning:
1 = base
2 = collector
3 = emitter



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP33	33A	33B	33C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	10	A
Collector current (peak value); $t_p \leqslant 0{,}3$ ms	I_{CM}	max.	15	A
Base current (d.c.)	I_B	max.	3	A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	80	W
Total power dissipation in free air	P_{tot}	max.	3,5	W
Storage temperature	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

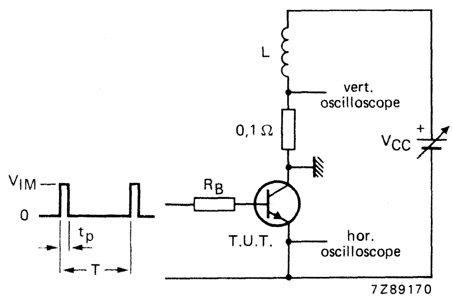
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,56	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	35,7	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

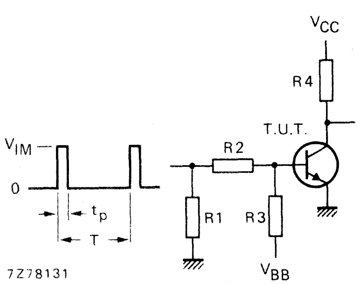
→ Collector cut-off currents					
$V_{CE} = V_{CBOmax}$; $V_{BE} = 0$		I_{CES}	<	0,4	mA
$V_{CE} = 30$ V; $I_B = 0$	TIP33	I_{CEO}	<	0,2	mA
	TIP33A	I_{CEO}	<	0,2	mA
$V_{CE} = 60$ V; $I_B = 0$	TIP33B	I_{CEO}	<	0,2	mA
	TIP33C	I_{CEO}	<	0,2	mA
→ Emitter cut-off current					
$V_{EB} = 5$ V; $I_C = 0$		I_{EBO}	<	0,1	mA
Collector-emitter sustaining voltage					
$I_C = 30$ mA; $I_B = 0$	TIP33	$V_{CEOsust}$	>	40	V
	TIP33A	$V_{CEOsust}$	>	60	V
	TIP33B	$V_{CEOsust}$	>	80	V
	TIP33C	$V_{CEOsust}$	>	100	V
D.C. current gain					
$V_{CE} = 4$ V; $I_C = 1$ A		h_{FE}	>	40	
$V_{CE} = 4$ V; $I_C = 3$ A		h_{FE}		20 to 100	
Base-emitter voltage					
$V_{CE} = 4$ V; $I_C = 3$ A		V_{BE}	<	1,6	V
$V_{CE} = 4$ V; $I_C = 10$ A		V_{BE}	<	3	V

Collector-emitter saturation voltage				
$I_C = 3$ A; $I_B = 0,3$ A	V_{CEsat}	<	1	V
$I_C = 10$ A; $I_B = 2,5$ A	V_{CEsat}	<	4	V
Small-signal current gain				
$V_{CE} = 10$ V; $I_C = 0,5$ A; f = 1 kHz	h_{fe}	>	20	
Transition frequency				
$V_{CE} = 10$ V; $I_C = 0,5$ A; f = 1 MHz	f_T	>	3	MHz
Turn-off breakdown energy (see Fig. 2)				
L = 20 mH; $I_C = 2,5$ A	$E_{(BR)}$	>	62,5	mJ
Switching times (see Figs 3 and 4)				
$I_C = 6$ A; $I_{Bon} = -I_{Boff} = 0,6$ A; $V_{CC} = 30$ V				
turn-on time	t_{on}	typ.	0,6	μs
turn-off time	t_{off}	typ.	1,7	μs



V_{IM} = 12 V
R_B = 270 Ω
L = 20 mH
I_{CC} = 2,5 A
δ ⩽ 1 %
t_p = 1 ms

Fig. 2 Test circuit for turn-off breakdown energy.



V_{IM} = 47 V
V_{CC} = 30 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 39 Ω
R3 = 10 Ω
R4 = 5 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 3 Switching times test circuit.

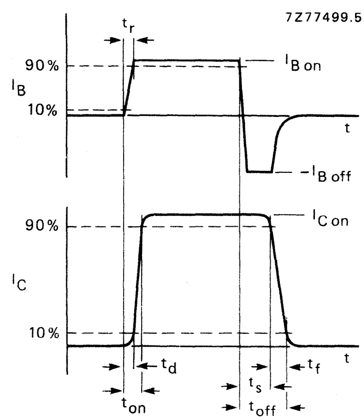


Fig. 4 Switching times waveforms.

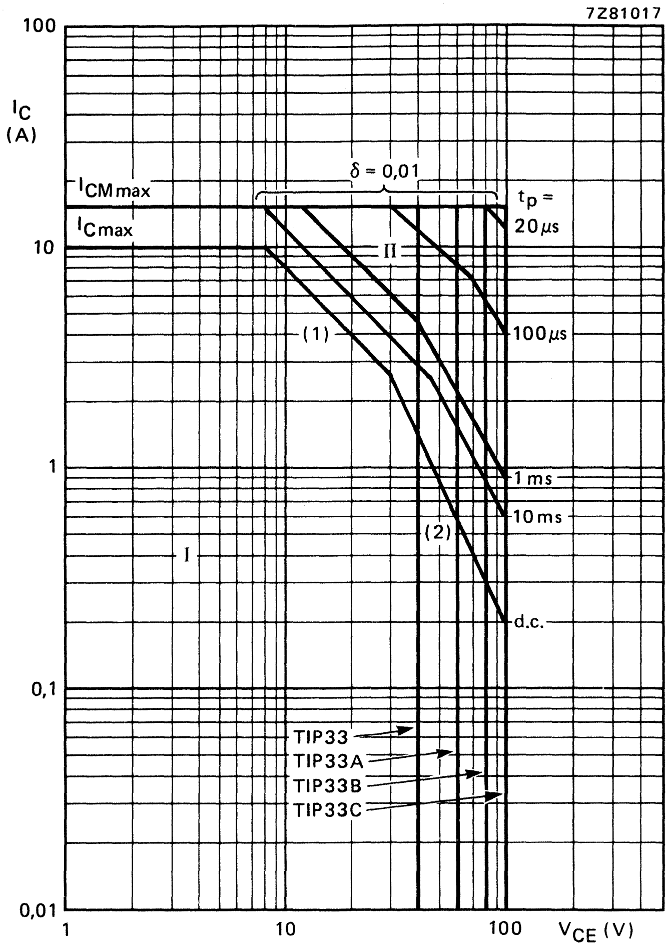


Fig. 5 Safe Operating ARea at $T_{mb} \leqslant 25\ ^oC$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.
(2) Second-breakdown limits.

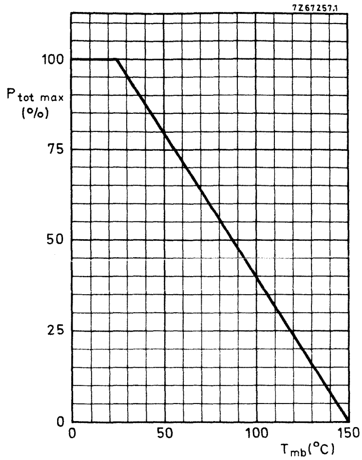


Fig. 6 Power derating curve.

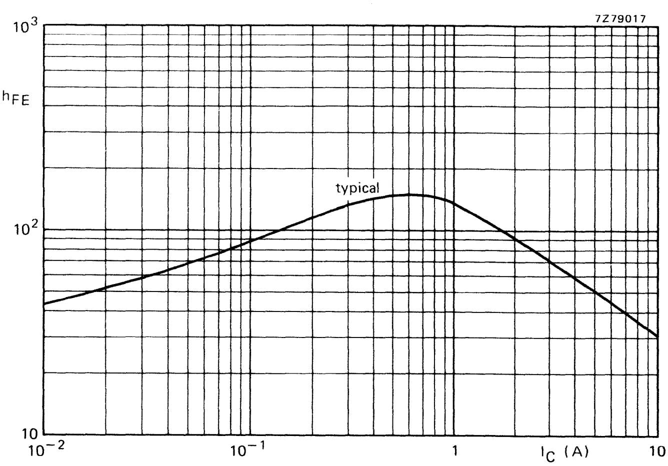


Fig. 7 V_{CE} = 4 V; T_j = 25 °C.

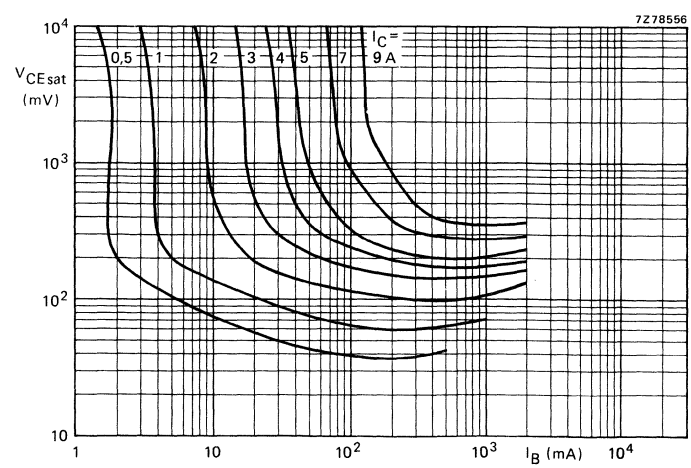


Fig. 8 Typical collector-emitter saturation voltage; T_j = 25 °C.

SILICON POWER TRANSISTORS

P-N-P epitaxial-base power transistors in the plastic SOT-93 envelope. These transistors are intended for use in audio output stages and general amplifier and switching applications. N-P-N complements are TIP33, TIP33A, TIP33B and TIP33C.

QUICK REFERENCE DATA

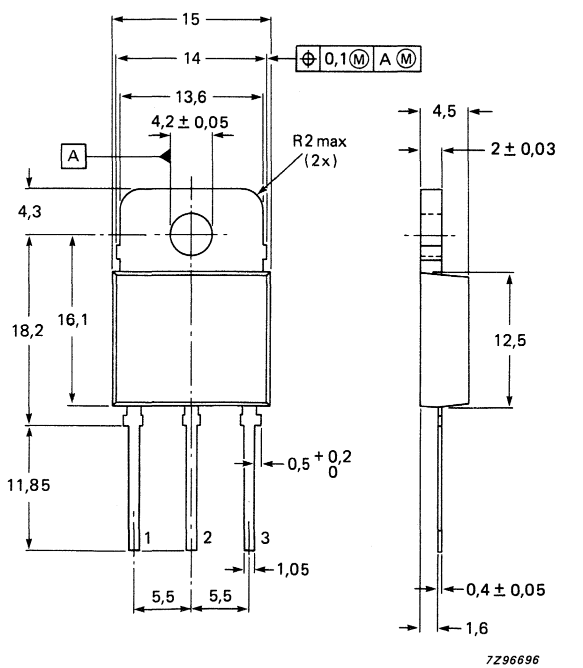
			TIP34	34A	34B	34C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	10				A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.	15				A
Power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	80				W
D.C. current gain							
$-V_{CE}$ = 4 V; $-I_C$ = 3 A	h_{FE}		20 to 100				
Collector-emitter saturation voltage							
$-I_C$ = 3 A; $-I_B$ = 0,3 A	$-V_{CEsat}$	<	1				V

MECHANICAL DATA

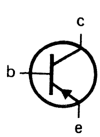
Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



Pinning:
1 = base
2 = collector
3 = emitter



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP34	34A	34B	34C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	10	A
Collector current (peak value); $t_p \leqslant 0,3$ ms	$-I_{CM}$	max.	15	A
Base current (d.c.)	$-I_B$	max.	3	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	80	W
Total power dissipation in free air	P_{tot}	max.	3,5	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

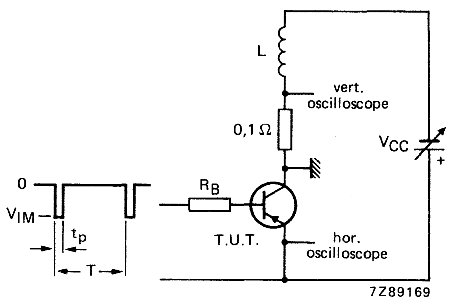
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,56	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	35,7	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

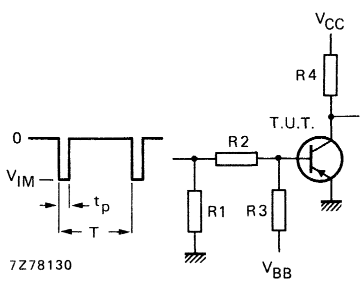
→ Collector cut-off currents					
$-V_{CE} = -V_{CBOmax}$; $V_{BE} = 0$		$-I_{CES}$	<	0,4	mA
$-V_{CE}$ = 30 V; $I_B = 0$	TIP34	$-I_{CEO}$	<	0,2	mA
	TIP34A	$-I_{CEO}$	<	0,2	mA
$-V_{CE}$ = 60 V; $I_B = 0$	TIP34B	$-I_{CEO}$	<	0,2	mA
	TIP34C	$-I_{CEO}$	<	0,2	mA
→ Emitter cut-off current					
$-V_{EB}$ = 5 V; $I_C = 0$		$-I_{EBO}$	<	0,1	mA
Collector-emitter sustaining voltage					
$-I_C$ = 30 mA; $I_B = 0$	TIP34	$-V_{CEOsust}$	>	40	V
	TIP34A	$-V_{CEOsust}$	>	60	V
	TIP34B	$-V_{CEOsust}$	>	80	V
	TIP34C	$-V_{CEOsust}$	>	100	V
D.C. current gain					
$-V_{CE}$ = 4 V; $-I_C$ = 1 A		h_{FE}	>	40	
$-V_{CE}$ = 4 V; $-I_C$ = 3 A		h_{FE}		20 to 100	
Base-emitter voltage					
$-V_{CE}$ = 4 V; $-I_C$ = 3 A		$-V_{BE}$	<	1,6	V
$-V_{CE}$ = 4 V; $-I_C$ = 10 A		$-V_{BE}$	<	3	V

Collector-emitter saturation voltage				
$-I_C = 3$ A; $-I_B = 0,3$ A	$-V_{CEsat}$	<	1	V
$-I_C = 10$ A; $-I_B = 2,5$ A	$-V_{CEsat}$	<	4	V
Small-signal current gain				
$-V_{CE} = 10$ V; $-I_C = 0,5$ A; f = 1 kHz	h_{fe}	>	20	
Transition frequency				
$-V_{CE} = 10$ V; $-I_C = 0,5$ A; f = 1 MHz	f_T	>	3	MHz
Turn-off breakdown energy (see Fig. 2)				
L = 20 mH; $-I_C = 2,5$ A	$E_{(BR)}$	>	62,5	mJ
Switching times (see Figs 3 and 4)				
$-I_C = 6$ A; $-I_{Bon} = +I_{Boff} = 0,6$ A; $-V_{CC} = 30$ V				
turn-on time	t_{on}	typ.	0,4	μs
turn-off time	t_{off}	typ.	0,7	μs



$-V_{IM}$ = 12 V
R_B = 270 Ω
L = 20 mH
$-I_{CC}$ = 2,5 A
t_p = 1 ms
δ = 1 %

Fig. 2 Test circuit for turn-off breakdown energy.



$-V_{IM}$ = 47 V
$-V_{CC}$ = 30 V
V_{BB} = 4 V
R1 = 56 Ω
R2 = 39 Ω
R3 = 10 Ω
R4 = 5 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 3 Switching times test circuit.

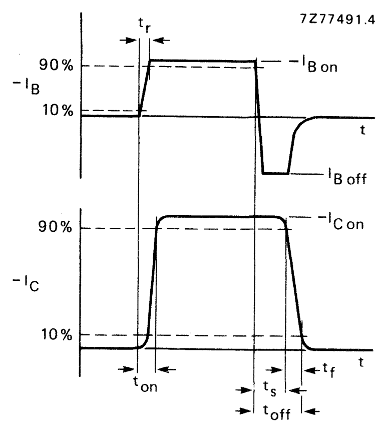


Fig. 4 Switching times waveforms.

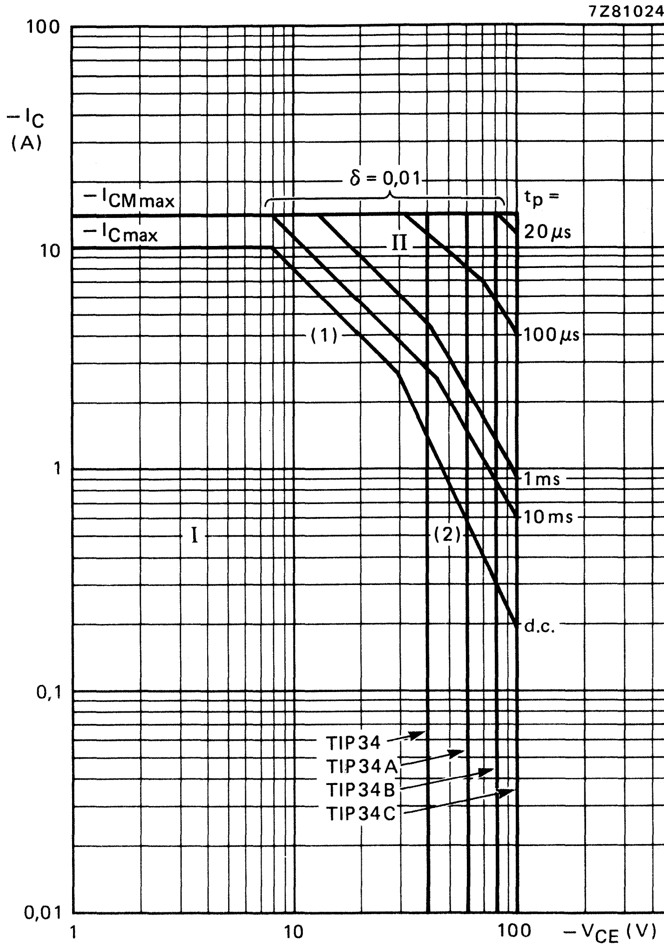


Fig. 5 Safe Operating ARea at T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{tot\,peak\,max}$ lines.
(2) Second breakdown limits.

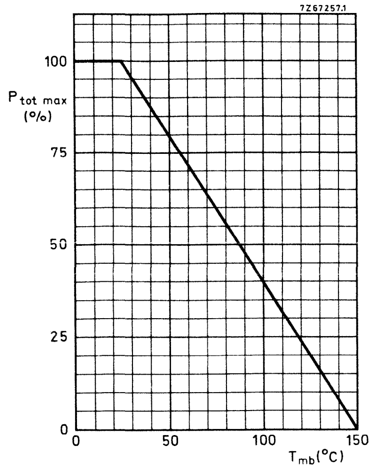


Fig. 6 Power derating curve.

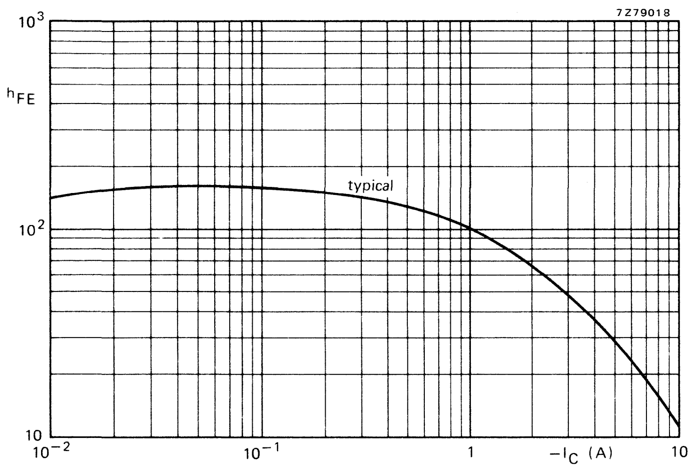


Fig. 7 $-V_{CE} = 4$ V; $T_j = 25$ °C.

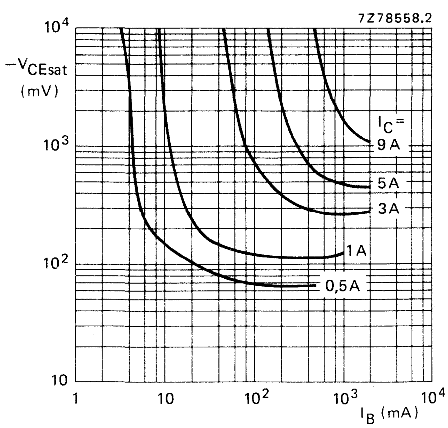


Fig. 8 Typical collector-emitter saturation voltage. $T_j = 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in general purpose amplifier and switching applications.

QUICK REFERENCE DATA

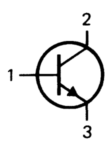
			TIP41	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.	6				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Junction temperature	T_j	max.	150				°C
D.C. current gain I_C = 3 A; V_{CE} = 4 V	h_{FE}		15 to 75				

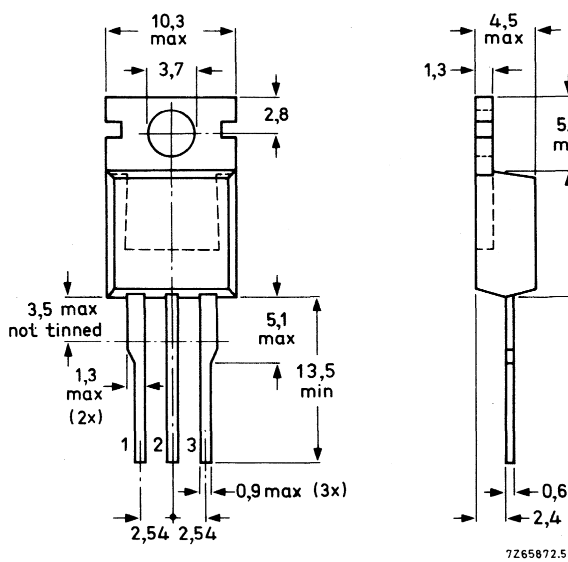
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





For more information see BDT41 series data.
See also chapters Mounting Instructions and Accessories.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in general output stages of amplifier circuits and switching applications.

QUICK REFERENCE DATA

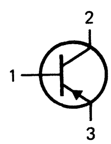
			TIP42	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	6				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 3 A; $-V_{CE}$ = 4 V	h_{FE}		15 to 75				

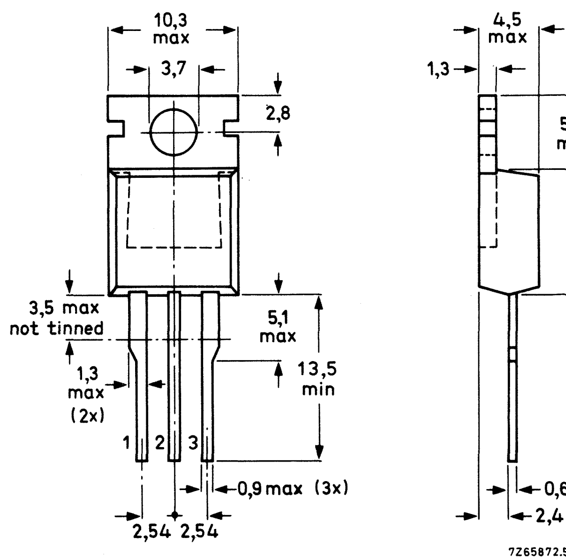
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base





For more information see BDT42 series data.
See also chapters Mounting Instructions and Accessories.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier and switching applications. TO-220AB plastic envelope. P-N-P complements are TIP115, TIP116 and TIP117.

QUICK REFERENCE DATA

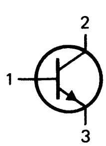
			TIP110	TIP111	TIP112	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		4		A
Collector current (peak value); $t_p \leqslant 0,3$ ms	I_{CM}	max.		6		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		50		W
D.C. current gain						
V_{CE} = 4 V; I_C = 2 A	h_{FE}	>		500		
Collector-emitter saturation voltage						
I_C = 2 A; I_B = 8 mA	V_{CEsat}	<		2,5		V

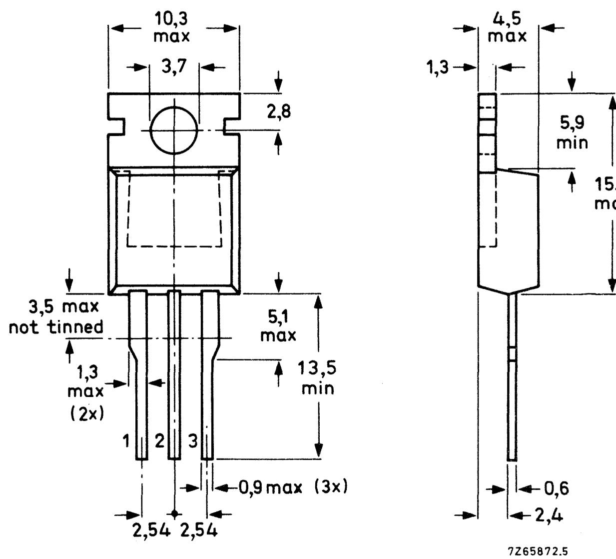
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





CIRCUIT DIAGRAM

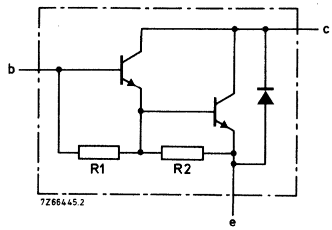


Fig. 2.
R1 typ. 6 kΩ
R2 typ. 100 Ω

RATINGS

Limiting value in accordance with the Absolute Maximum System (IEC 134).

			TIP110	TIP111	TIP112	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
Collector current (d.c.)	I_C	max.		4		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.		6		A
Base current (d.c.)	I_B	max.		50		mA
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		50		W
Total power dissipation in free air	P_{tot}	max.		2		W
Storage temperature	T_{stg}			−65 to + 150		^oC
Junction temperature	T_j	max.		150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,5	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	62,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents					
$V_{CB} = V_{CBOmax}$; $I_E = 0$		I_{CBO}	<	0,2	mA
$V_{CE} = 1/2\ V_{CEOmax}$; $I_B = 0$		I_{CEO}	<	0,2	mA
Emitter cut-off current					
V_{EB} = 5 V; $I_C = 0$		I_{EBO}	<	5	mA
Collector-emitter sustaining voltage					
I_C = 30 mA; $I_B = 0$	TIP110	$V_{CEOsust}$	>	60	V
	TIP111	$V_{CEOsust}$	>	80	V
	TIP112	$V_{CEOsust}$	>	100	V
D.C. current gain					
V_{CE} = 4 V; I_C = 1 A		h_{FE}	>	1000	
V_{CE} = 4 V; I_C = 2 A		h_{FE}	>	500	
Base-emitter voltage					
V_{CE} = 4 V; I_C = 2 A		V_{BE}	<	2,8	V
Collector-emitter saturation voltage					
I_C = 2 A; I_B = 8 mA		V_{CEsat}	<	2,5	V
Switching times					
I_C = 2 A; $I_{Bon} = -I_{Boff}$ = 8 mA; V_{CC} = 30 V					
turn-on time		t_{on}	typ.	2,6	μs
turn-off time		t_{off}	typ.	4,5	μs

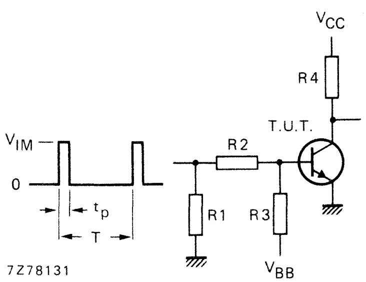


Fig. 3 Switching times test circuit with resistive load.

V_{IM} = 12 V	R1 = 56 Ω	$t_r = t_f$ = 15 ns
V_{CC} = 30 V	R2 = 750 Ω	t_p = 10 μs
$-V_{BB}$ = 5 V	R3 = 910 Ω	T = 500 μs
	R4 = 15 Ω	

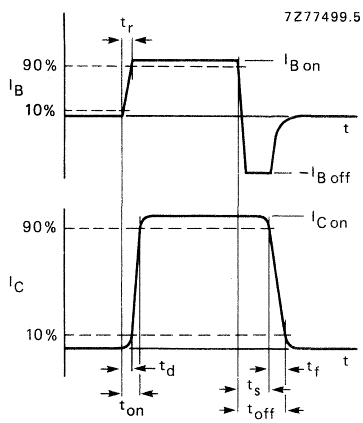


Fig. 4 Switching times waveforms.

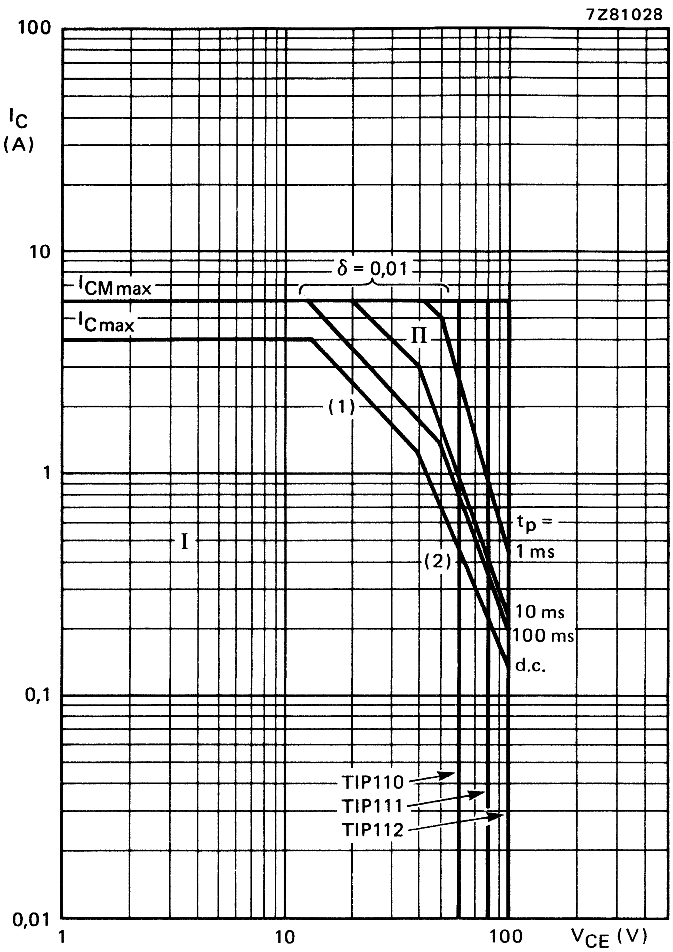


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second breakdown limits.

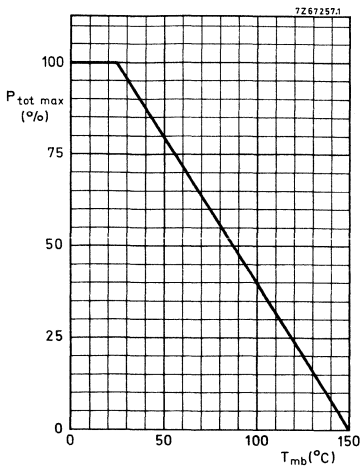


Fig. 6 Power derating curve.

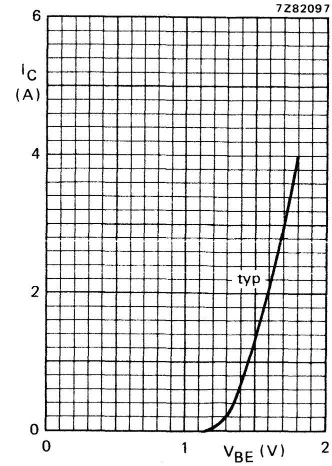


Fig. 7 $V_{CE} = 4$ V; $T_j = 25$ °C.

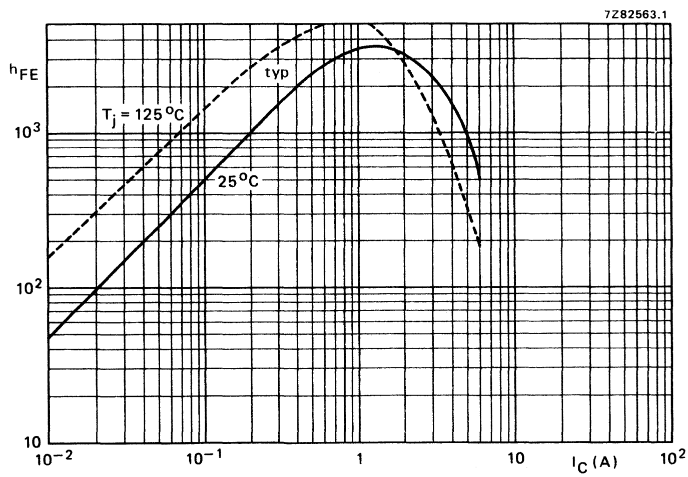


Fig. 8 Typical d.c. current gain; $V_{CE} = 4$ V.

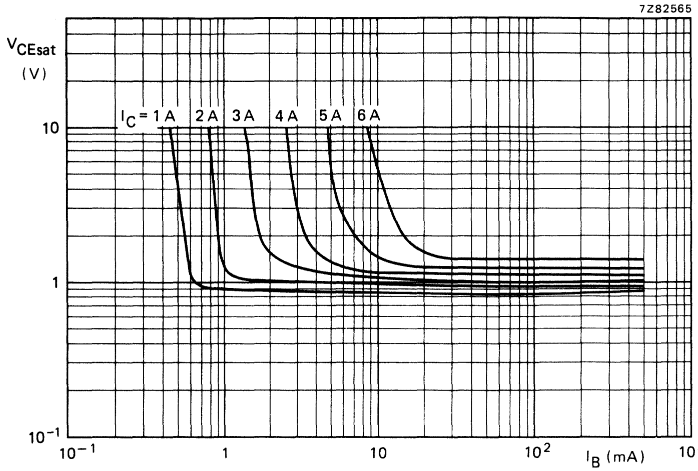


Fig. 9 Typical values; T_j = 25 °C.

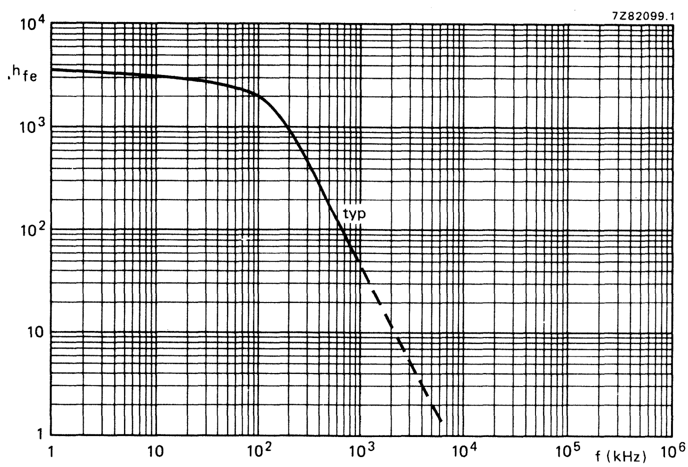


Fig. 10 Small-signal current gain; I_C = 1,5 A; V_{CE} = 4 V; T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier and switching applications. TO-220AB plastic envelope. N-P-N complements are TIP110, TIP111 and TIP112.

QUICK REFERENCE DATA

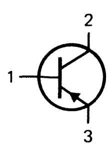
			TIP115	TIP116	TIP117	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		4		A
Collector current (peak value); $t_p \leqslant 0,3$ ms	$-I_{CM}$	max.		6		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		50		W
D.C. current gain						
$-V_{CE}$ = 4 V; $-I_B$ = 2 A	h_{FE}	>		500		
Collector-emitter saturation voltage						
$-I_C$ = 2 A; $-I_B$ = 8 mA	$-V_{CEsat}$	<		2,5		V

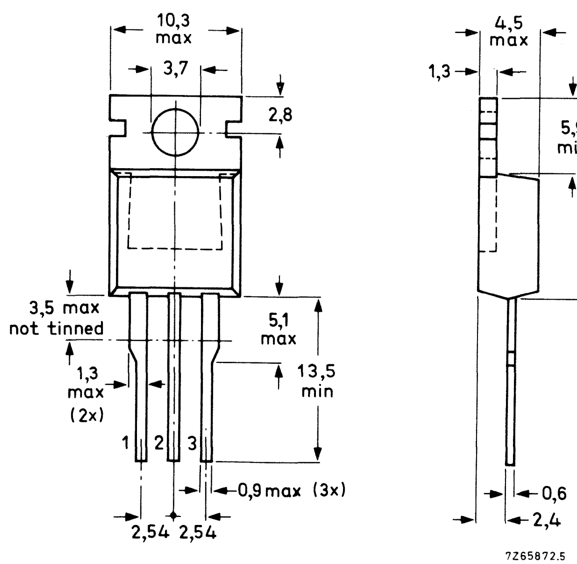
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





CIRCUIT DIAGRAM

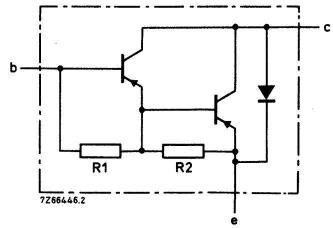


Fig. 2.
R1 typ. 6 kΩ
R2 typ. 100 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP115	TIP116	TIP117	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	4	A
Collector current (peak value); $t_p \leq 0{,}3$ ms	$-I_{CM}$	max.	6	A
Base current (d.c.)	$-I_B$	max.	50	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	50	W
Total power dissipation in free air	P_{tot}	max.	2	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,5	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	62,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents					
$-V_{CB} = -V_{CBOmax}$; $I_E = 0$		$-I_{CBO}$	<	0,2	mA ←
$-V_{CE} = 1/2\ V_{CEOmax}$; $I_B = 0$		$-I_{CEO}$	<	0,2	mA ←
Emitter cut-off current					
$-V_{EB} = 5$ V; $I_C = 0$		$-I_{EBO}$	<	5	mA
Collector-emitter sustaining voltage					
$-I_C = 30$ mA; $I_B = 0$	TIP115	$-V_{CEOsust}$	>	60	V
	TIP116	$-V_{CEOsust}$	>	80	V
	TIP117	$-V_{CEOsust}$	>	100	V
D.C. current gain					
$-V_{CE} = 4$ V; $-I_C = 1$ A		h_{FE}	>	1000	
$-V_{CE} = 4$ V; $-I_C = 2$ A		h_{FE}	>	500	
Base-emitter voltage					
$-V_{CE} = 4$ V; $-I_C = 2$ A		$-V_{BE}$	<	2,8	V
Collector-emitter saturation voltage					
$-I_C = 2$ A; $-I_B = 8$ mA		$-V_{CEsat}$	<	2,5	V
Switching times					
$-I_C = 2$ A; $-I_{Bon} = +I_{Boff} = 8$ mA;					
$-V_{CC} = 30$ V					
turn-on time		t_{on}	typ.	2,6	μs
turn-off time		t_{off}	typ.	4,5	μs

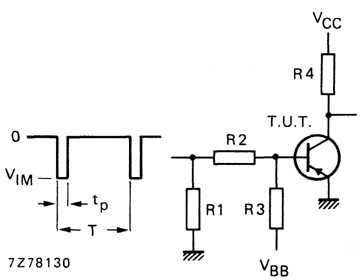


Fig. 3 Switching times test circuit.

$-V_{IM} = 12$ V	R1 = 56 Ω	$t_r = t_f = 15$ ns
$-V_{CC} = 30$ V	R2 = 750 Ω	$t_p = 10$ μs
$+V_{BB} = 5$ V	R3 = 910 Ω	T = 500 μs
	R4 = 15 Ω	

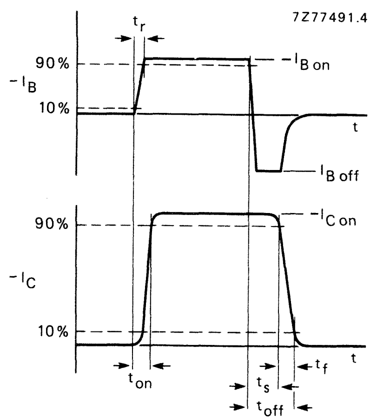


Fig. 4 Switching times waveforms.

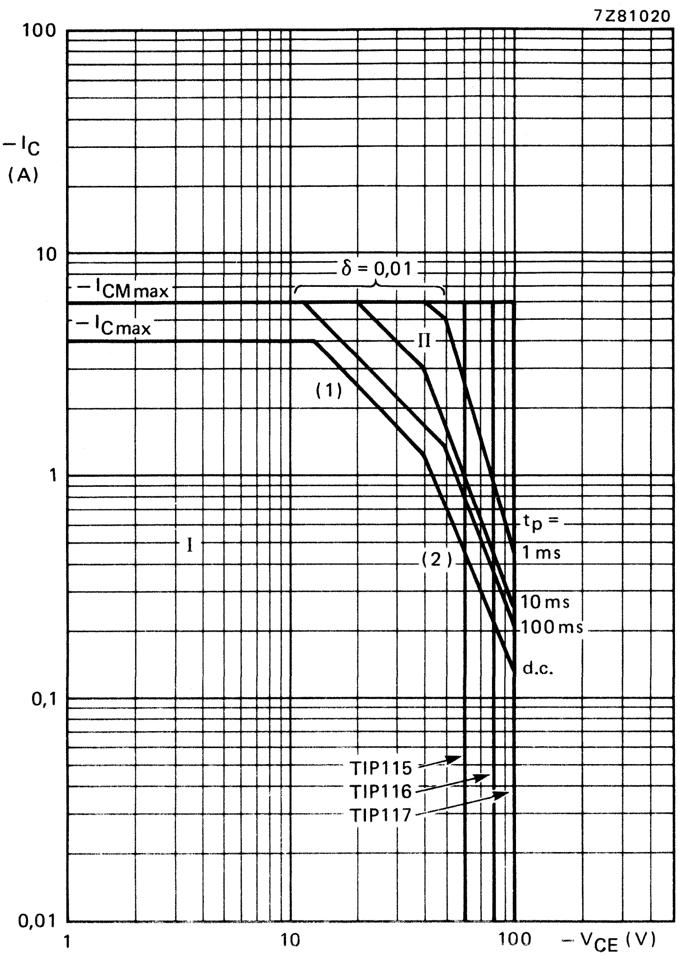


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

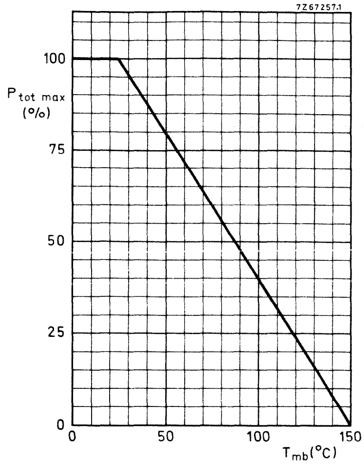


Fig. 6 Power derating curve.

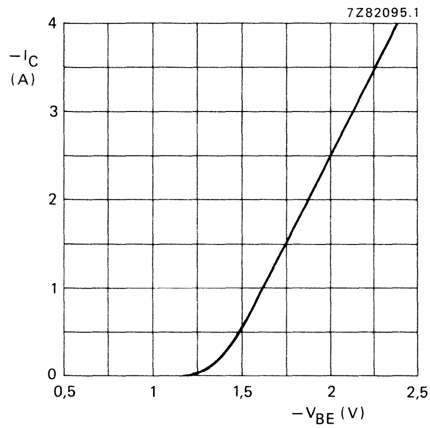


Fig. 7 $-V_{CE}$ = 4 V; T_j = 25 °C; typical values.

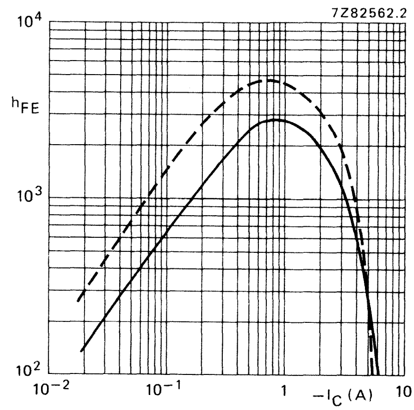


Fig. 8 Typical d.c. current gain; $-V_{CE}$ = 4 V; —— T_j = 25 °C; – – – – T_j = 125 °C.

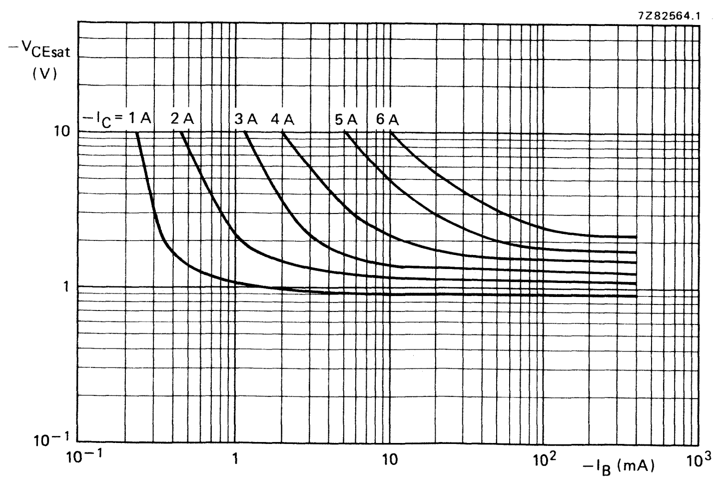


Fig. 9 Typical collector-emitter saturation voltage at T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. TO-220 plastic envelope. P-N-P complements are TIP125, TIP126 and TIP127.

QUICK REFERENCE DATA

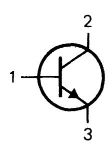
			TIP120	TIP121	TIP122	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		5		A
Collector current (peak value); $t_p \leq 0{,}3$ ms	I_{CM}	max.		8		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		65		W
D.C. current gain						
$V_{CE} = 3$ V; $I_C = 3$ A	h_{FE}	>		1000		
Collector-emitter saturation voltage						
$I_C = 3$ A; $I_B = 12$ mA	V_{CEsat}	<		2,0		V

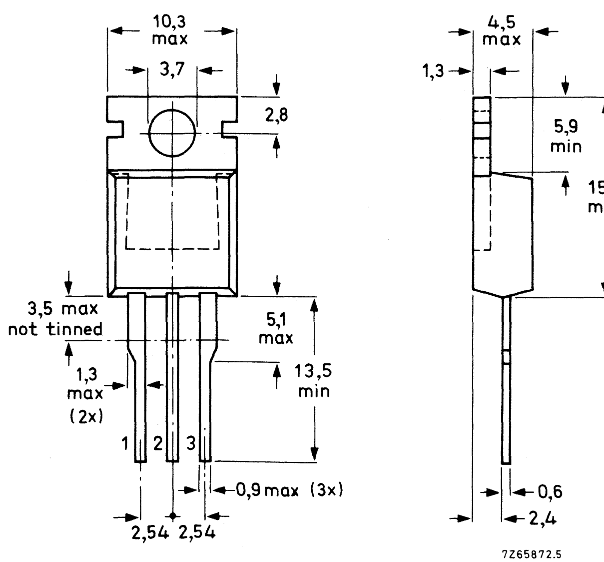
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





CIRCUIT DIAGRAM

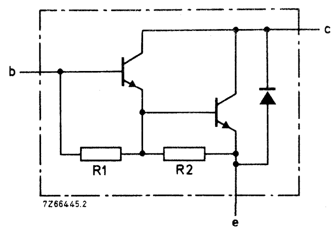


Fig. 2.
R1 typ. 4 kΩ
R2 typ. 100 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP120	TIP121	TIP122	
Collector-base voltage ($I_E = 0$)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	V_{EBO}	max.		5		V
Collector current (d.c.)	I_C	max.		5		A
Collector current (peak value); $t_p \leqslant 0,3$ ms	I_{CM}	max.		8		A
Base current (d.c.)	I_B	max.		0,1		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		65		W
Total power dissipation in free air	P_{tot}	max.		2		W
Storage temperature	T_{stg}			−65 to + 150		^oC
Junction temperature	T_j	max.		150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	62,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents					
$V_{CB} = V_{CBOmax}$; $I_E = 0$		I_{CBO}	<	0,1	mA ←
V_{CE} = 1/2 V_{CEOmax}; $I_B = 0$		I_{CEO}	<	0,2	mA ←
Emitter cut-off current					
V_{EB} = 5 V; I_C = 0		I_{EBO}	<	5,0	mA
Collector-emitter sustaining voltage					
I_C = 30 mA; I_B = 0	TIP120	$V_{CEOsust}$	>	60	V
	TIP121	$V_{CEOsust}$	>	80	V
	TIP122	$V_{CEOsust}$	>	100	V
D.C. current gain					
V_{CE} = 3 V; I_C = 0,5 A		h_{FE}	>	1000	
V_{CE} = 3 V; I_C = 3 A		h_{FE}	>	1000	
Base-emitter voltage					
V_{CE} = 3 V; I_C = 3 A		V_{BE}	<	2,5	V
Collector-emitter saturation voltage					
I_C = 3 A; I_B = 12 mA		V_{CEsat}	<	2,0	V
I_C = 5 A; I_B = 20 mA		V_{CEsat}	<	4,0	V
Switching times					
I_C = 3 A; $I_{Bon} = -I_{Boff}$ = 12 mA;					
V_{CC} = 30 V					
turn-on time		t_{on}	typ.	1,5	μs
turn-off time		t_{off}	typ.	8,5	μs

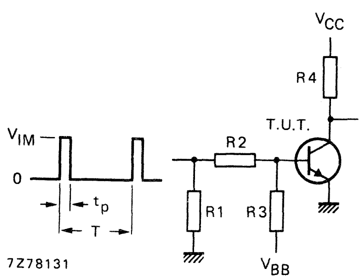


Fig. 3 Switching times test circuit.

V_{CC} = 30 V	R1 = 56 Ω	$t_r = t_f$ = 15 ns
V_{IM} = 10 V	R2 = 410 Ω	t_p = 10 μs
$-V_{BB}$ = 5 V	R3 = 560 Ω	T = 500 μs
	R4 = 10 Ω	

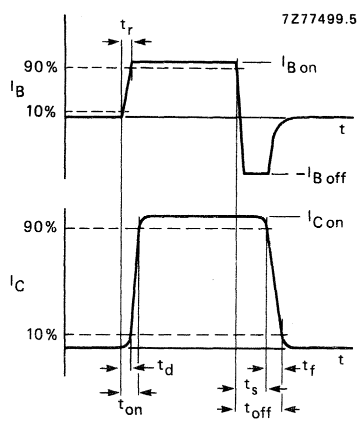


Fig. 4 Switching times waveforms.

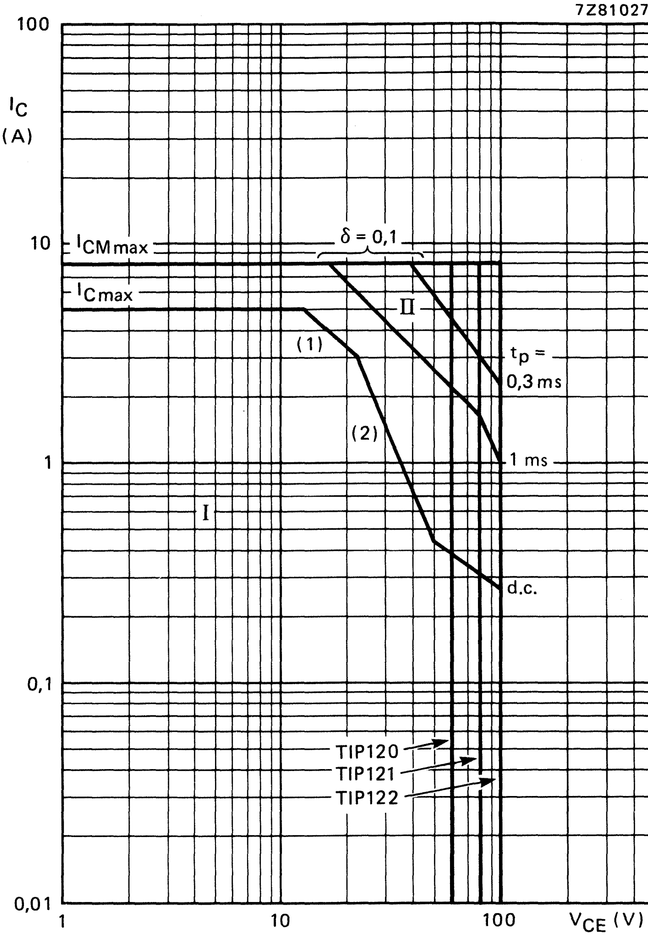


Fig. 5 Safe Operating ARea; $T_{mb} = 25\ ^oC$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

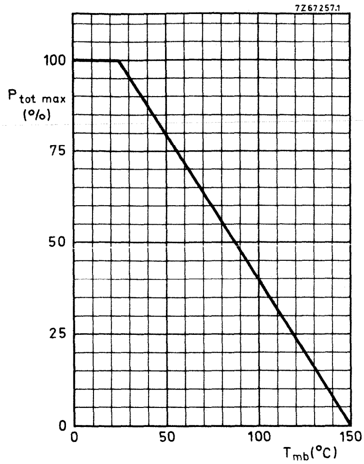


Fig. 6 Power derating curve.

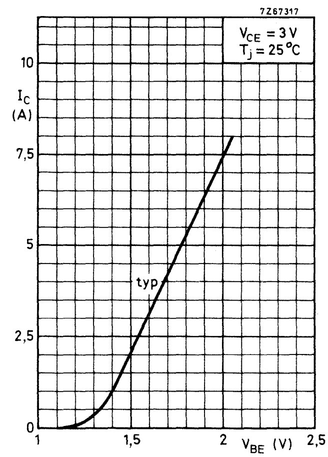


Fig. 7.

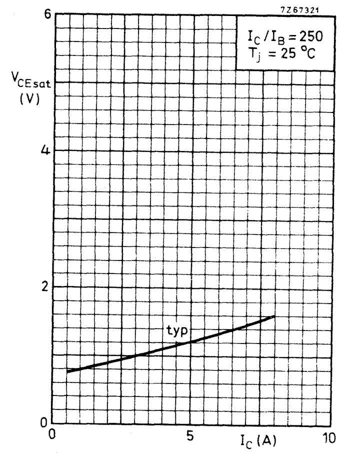


Fig. 8.

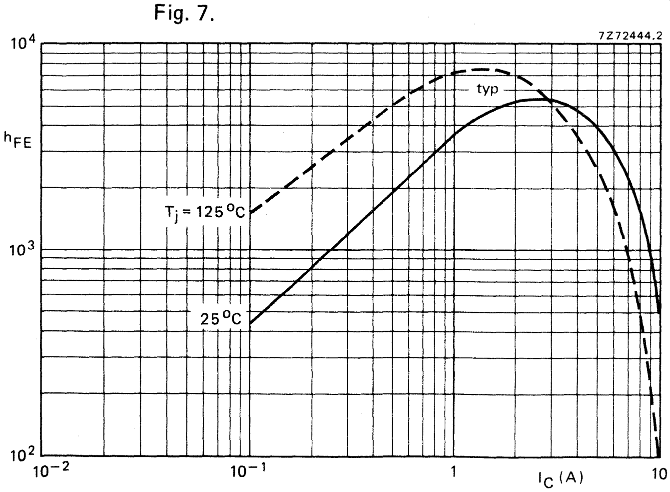


Fig. 9 Typical d.c. current gain; V_{CE} = 3 V.

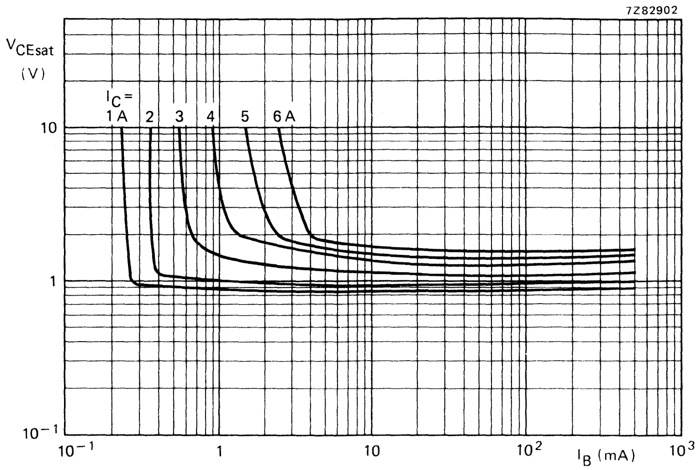


Fig. 10 Typical values; T_j = 25 °C.

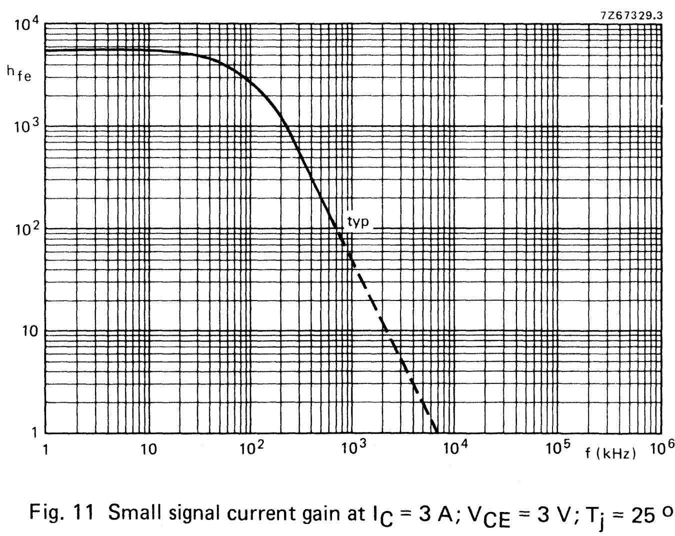


Fig. 11 Small signal current gain at I_C = 3 A; V_{CE} = 3 V; T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. TO-220 plastic envelope. N-P-N complements are TIP120, TIP121 and TIP122.

QUICK REFERENCE DATA

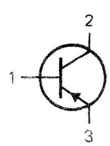
			TIP125	TIP126	TIP127	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		5		A
Collector current (peak value; $t_p \leq 0,3$ ms)	$-I_{CM}$	max.		8		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		65		W
D.C. current gain						
$-V_{CE}$ = 3 V; $-I_C$ = 3 A	h_{FE}	>		1000		
Collector-emitter saturation voltage						
$-I_C$ = 3 A; $-I_B$ = 12 mA	$-V_{CEsat}$	<		2,0		V

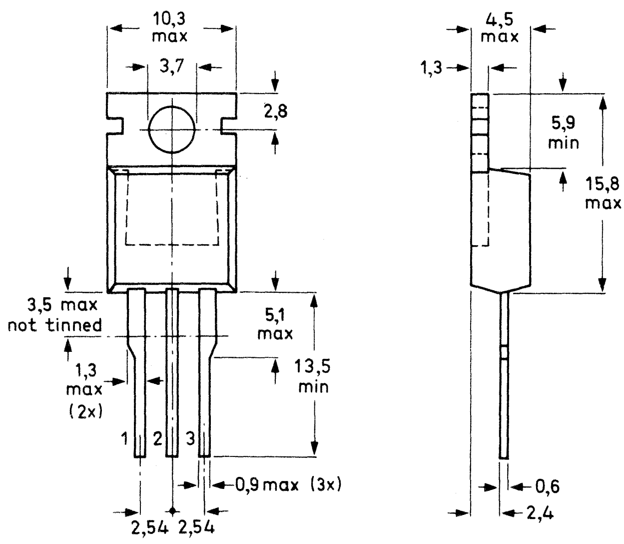
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





CIRCUIT DIAGRAM

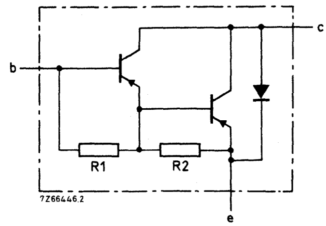


Fig. 2.
R1 typ. 4 kΩ
R2 typ. 80 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP125	TIP126	TIP127	
Collector-base voltage ($I_E = 0$)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	$-V_{EBO}$	max.		5		V
Collector current (d.c.)	$-I_C$	max.		5		A
Collector current (peak value); $t_p \leqslant 0,3$ ms	$-I_{CM}$	max.		8		A
Base current (d.c.)	$-I_B$	max.		0,1		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		65		W
Total power dissipation in free air	P_{tot}	max.		2		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	62,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents						
$V_{CB} = V_{CBOmax}$; $I_E = 0$		$-I_{CBO}$	<	0,1	mA	←
$V_{CE} = 1/2\ V_{CEOmax}$; $I_B = 0$		$-I_{CEO}$	<	0,2	mA	←
Emitter cut-off current						
$-V_{EB} = 5$ V; $I_C = 0$		$-I_{EBO}$	<	5,0	mA	
Collector-emitter sustaining voltage						
$-I_C = 30$ mA; $I_B = 0$	TIP125	$-V_{CEOsust}$	>	60	V	
	TIP126	$-V_{CEOsust}$	>	80	V	
	TIP127	$-V_{CEOsust}$	>	100	V	
D.C. current gain						
$-V_{CE} = 3$ V; $-I_C = 0{,}5$ A		h_{FE}	>	1000		
$-V_{CE} = 3$ V; $-I_C = 3$ A		h_{FE}	>	1000		
Base-emitter voltage						
$-V_{CE} = 3$ V; $-I_C = 3$ A		$-V_{BE}$	<	2,5	V	
Collector-emitter saturation voltage						
$-I_C = 3$ A; $-I_B = 12$ mA		$-V_{CEsat}$	<	2,0	V	
$-I_C = 5$ A; $-I_B = 20$ mA		$-V_{CEsat}$	<	4,0	V	
Switching times						
$-I_C = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA;						
$-V_{CC} = 30$ V						
turn-on time		t_{on}	typ.	1,5	µs	
turn-off time		t_{off}	typ.	8,5	µs	

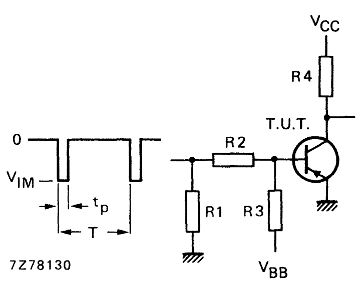


Fig. 3 Switching times test circuit.

$-V_{IM} = 10$ V	R1 = 56 Ω	$t_r = t_f = 15$ ns
$-V_{CC} = 30$ V	R2 = 410 Ω	$t_p = 10$ µs
$+V_{BB} = 5$ V	R3 = 560 Ω	T = 500 µs
	R4 = 10 Ω	

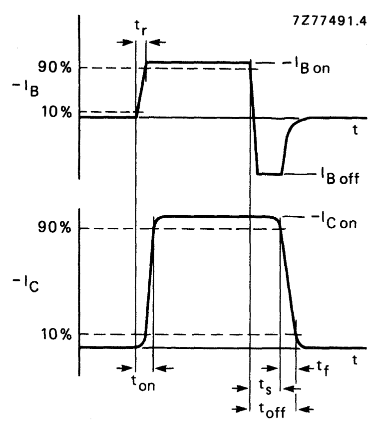


Fig. 4 Switching times waveforms.

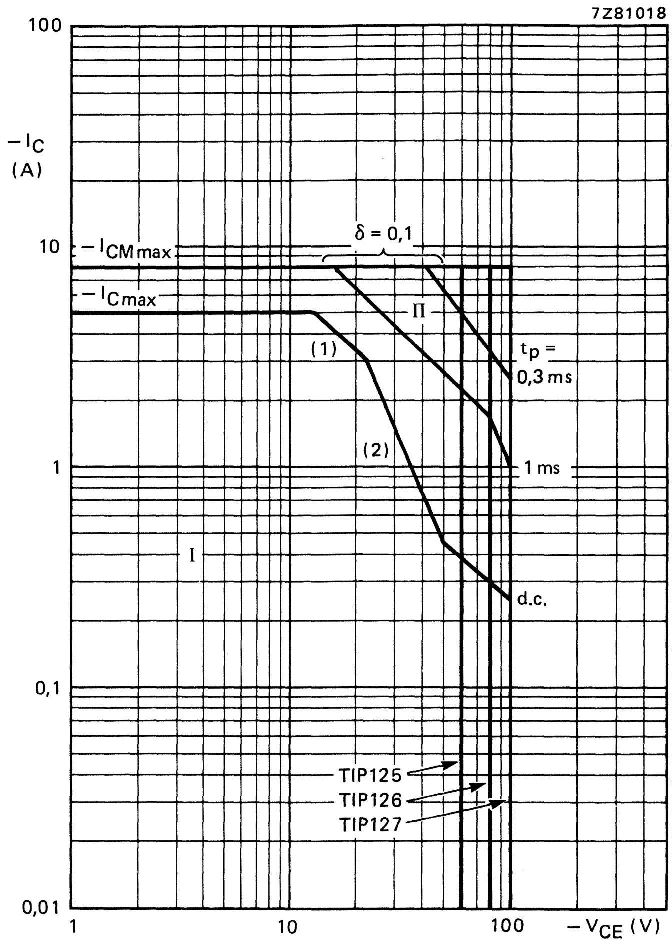


Fig. 5 Safe Operating ARea at T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

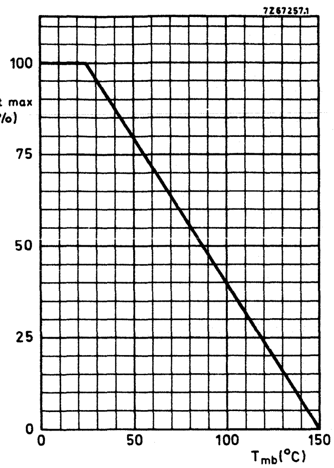


Fig. 6 Power derating curve.

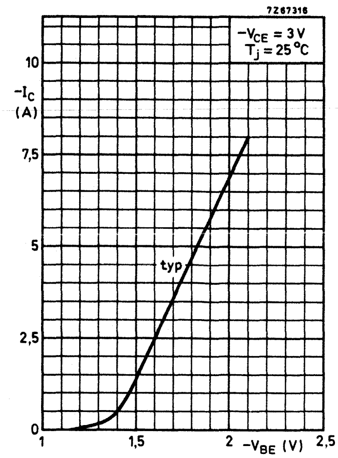


Fig. 7.

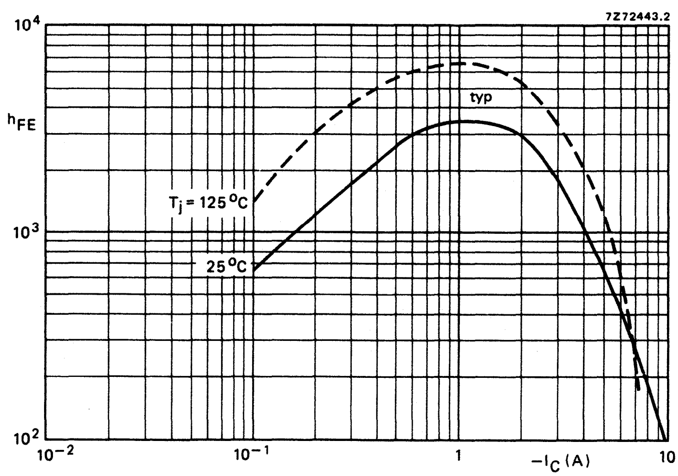


Fig. 8 D.C. current gain at $-V_{CE}$ = 3 V.

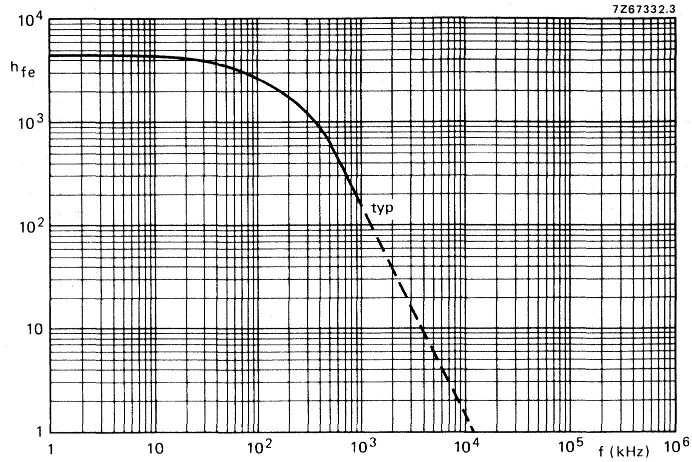


Fig. 9 Small-signal current gain at $-I_C$ = 3 A; $-V_{CE}$ = 3 V; T_j = 25 °C.

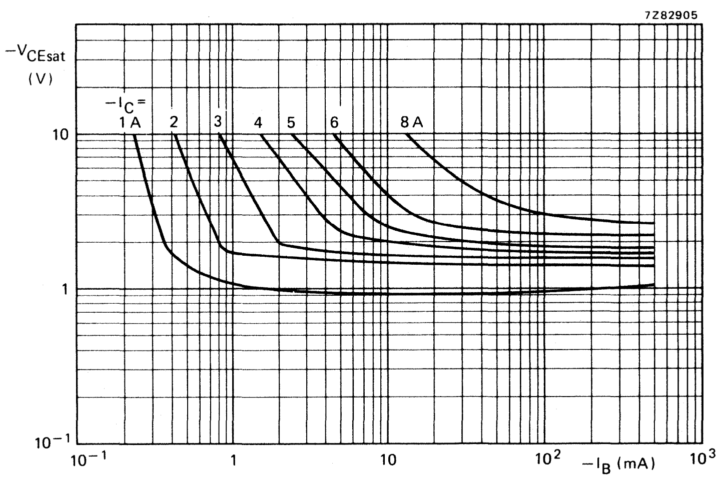


Fig. 10 Typical collector-emitter saturation voltage at T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. TO-220AB plastic envelope. P-N-P equivalents are TIP135, TIP136 and TIP137.

QUICK REFERENCE DATA

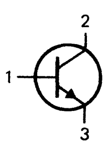
			TIP130	TIP131	TIP132	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		8		A
Collector current (peak value); $t_p \leqslant 0,3$ ms	I_{CM}	max.		12		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		70		W
D.C. current gain						
$V_{CE} = 4$ V; $I_C = 4$ A	h_{FE}			1000 to 15 000		
Collector-emitter saturation voltage						
$I_C = 4$ A; $I_B = 16$ mA	V_{CEsat}	<		2		V

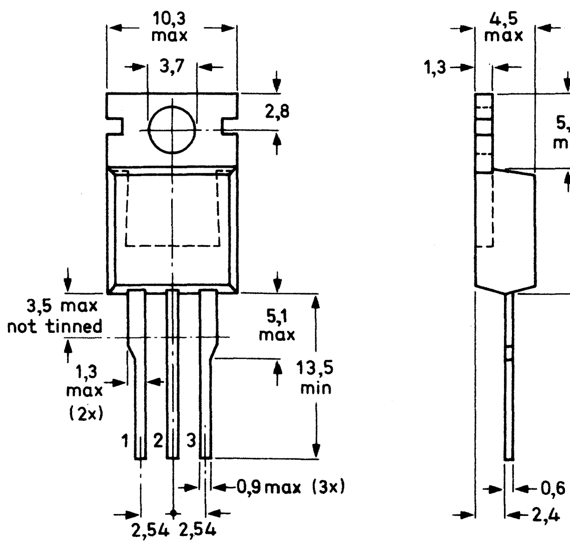
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





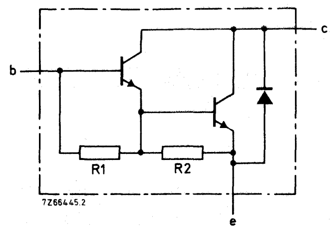


Fig. 2.
R1 typ. 8 kΩ
R2 typ. 100 kΩ

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP130	TIP131	TIP132	
Collector-base voltage (I_E = 0)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (I_B = 0)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage (I_C = 0)	V_{EBO}	max.	5	5	5	V

Collector current (d.c.)	I_C	max.	8	A
Collector current (peak value); $t_p \leq 0{,}3$ ms	I_{CM}	max.	12	A
Base current (d.c.)	I_B	max.	0,3	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	70	W
Total power dissipation in free air	P_{tot}	max.	2	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,79	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	62,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents					
$V_{CB} = V_{CBOmax}$; $I_E = 0$		I_{CBO}	<	0,2	mA
$V_{CB} = V_{CBOmax}$; $I_E = 0$; T_j = 100 °C		I_{CBO}	<	1	mA
V_{CE} = 1/2 V_{CEOmax}; $I_B = 0$		I_{CEO}	<	0,5	mA
Emitter cut-off current					
V_{EB} = 5 V; $I_C = 0$		I_{EBO}	<	5	mA
Collector-emitter sustaining voltage					
I_C = 30 mA; $I_B = 0$	TIP130	$V_{CEOsust}$	>	60	V
	TIP131	$V_{CEOsust}$	>	80	V
	TIP132	$V_{CEOsust}$	>	100	V
D.C. current gain					
V_{CE} = 4 V; I_C = 1 A		h_{FE}	>	500	
V_{CE} = 4 V; I_C = 4 A		h_{FE}		1000 to 15 000	
Base-emitter voltage					
V_{CE} = 4 V; I_C = 4 A		V_{BE}	<	2,5	V
Collector-emitter saturation voltage					
I_C = 4 A; I_B = 16 mA		V_{CEsat}	<	2	V
I_C = 6 A; I_B = 30 mA		V_{CEsat}	<	3	V
Collector-base capacitance					
V_{CB} = 10 V; $I_E = 0$		C_{ob}	<	200	pF
Switching times					
I_C = 3 A; $I_{Bon} = -I_{Boff}$ = 12 mA					
V_{CC} = 10 V					
turn-on time		t_{on}	typ.	1	μs
turn-off time		t_{off}	typ.	5	μs

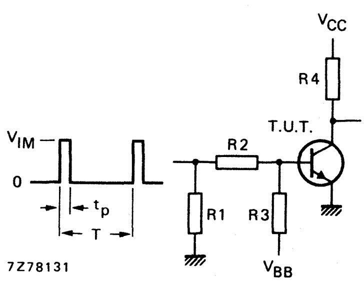


Fig. 3 Switching times test circuit with resistive load.

V_{IM} = 10 V	R1 = 56 Ω	$t_r = t_f$ = 15 ns
V_{CC} = 10 V	R2 = 410 Ω	t_p = 10 μs
$-V_{BB}$ = 4 V	R3 = 560 Ω	T = 500 μs
	R4 = 3 Ω	

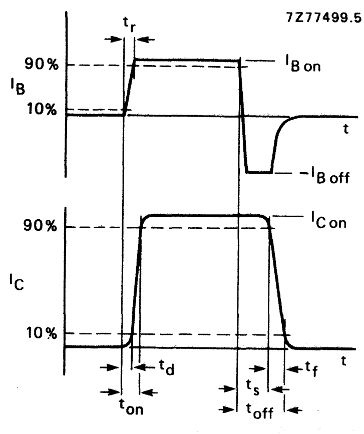


Fig. 4 Switching times waveforms.

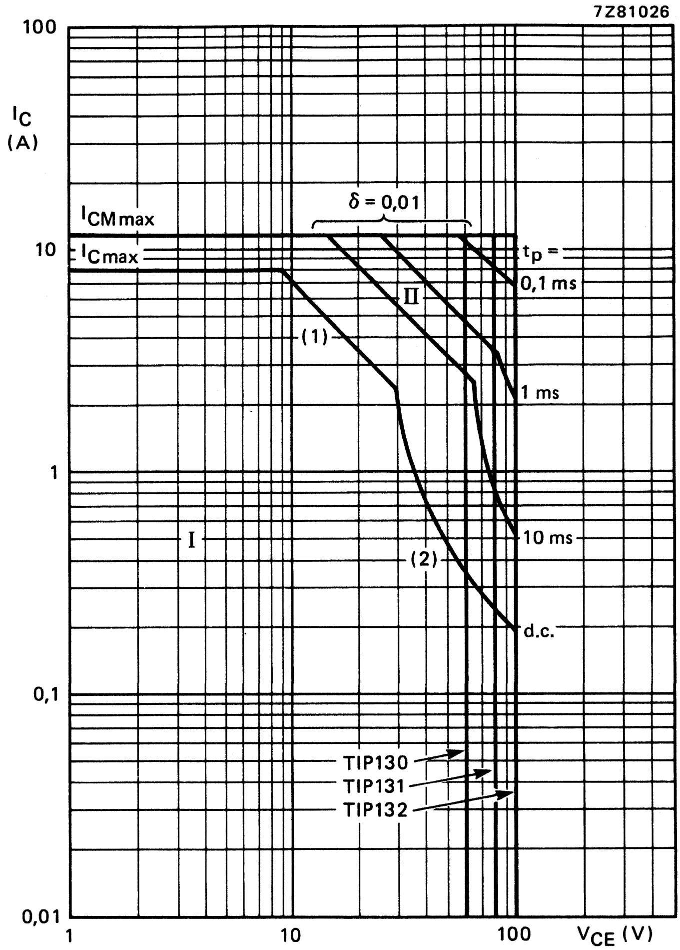


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

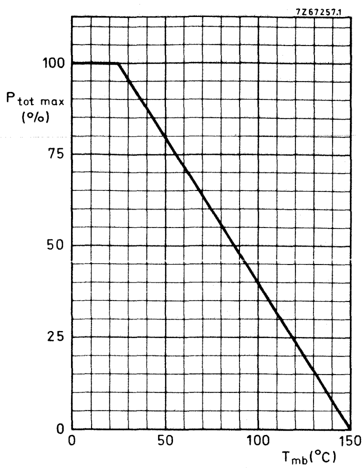


Fig. 6 Power derating curve.

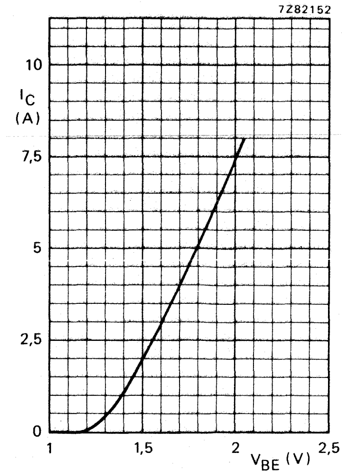


Fig. 7 Typical values; $V_{CE} = 4$ V; $T_j = 25$ °C.

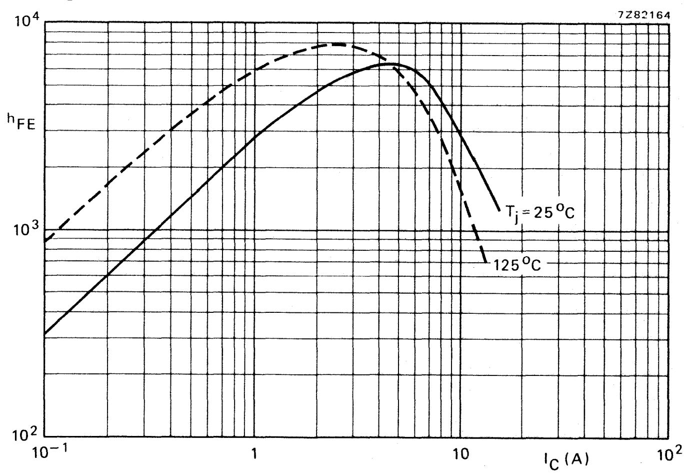


Fig. 8 Typical d.c. current gain at $V_{CE} = 4$ V.

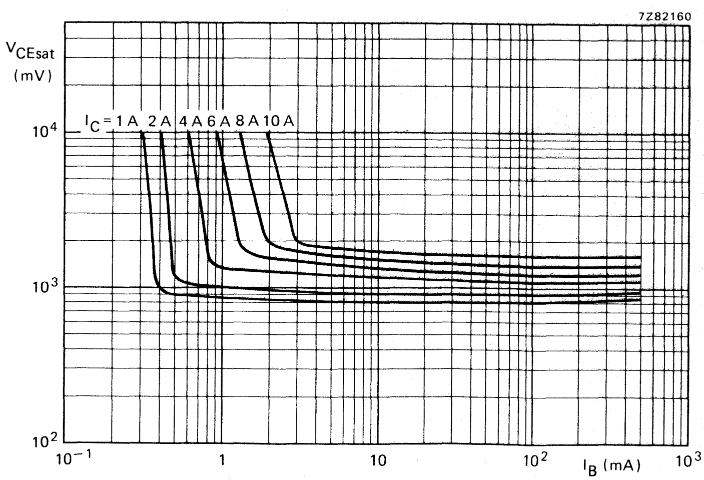


Fig. 9 Typical values; $T_j = 25$ °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. TO-220AB plastic envelope. N-P-N equivalents are TIP130, TIP131 and TIP132.

QUICK REFERENCE DATA

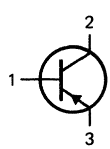
			TIP135	TIP136	TIP137	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		8		A
Collector current (peak value); $t_p \leqslant 0{,}3$ ms	$-I_{CM}$	max.		12		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		70		W
D.C. current gain						
$-V_{CE}$ = 4 V; $-I_C$ = 4 A	h_{FE}			1000 to 15 000		
Collector-emitter saturation voltage						
$-I_C$ = 4 A; $-I_B$ = 16 mA	$-V_{CEsat}$	<		2		V

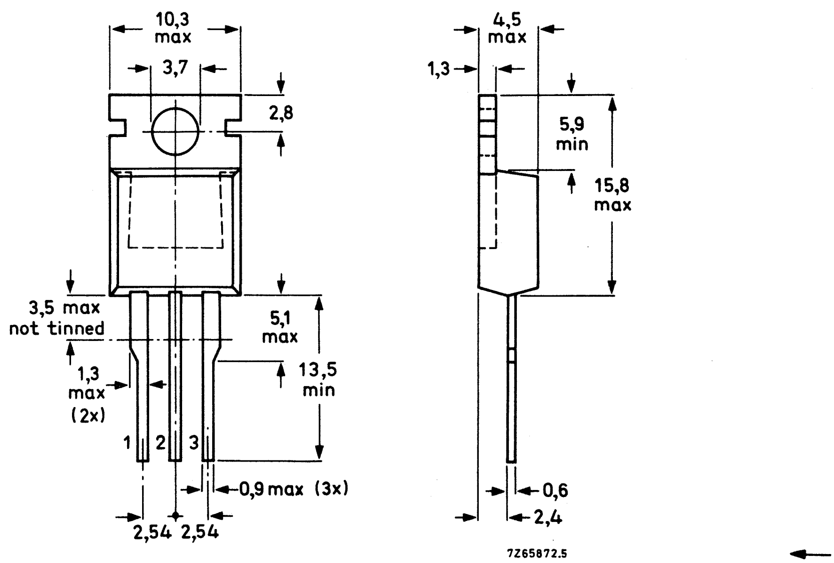
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





CIRCUIT DIAGRAM

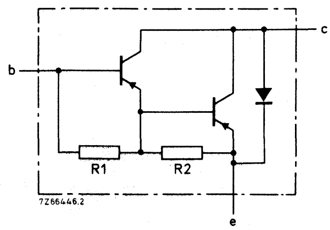


Fig. 2.
R1 typ. 4 kΩ
R2 typ. 60 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP135	TIP136	TIP137	
Collector-base voltage (I_E = 0)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (I_B = 0)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage (I_C = 0)	$-V_{EBO}$	max.	5	5	5	V

Collector current (d.c.)	$-I_C$	max.	8	A
Collector current (peak value); $t_p \leqslant 0{,}3$ ms	$-I_{CM}$	max.	12	A
Base current (d.c.)	$-I_B$	max.	0,3	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	70	W
Total power dissipation in free air	P_{tot}	max.	2	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,79	K/W
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	62,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents					
$-V_{CB} = -V_{CBOmax}$; $I_E = 0$		$-I_{CBO}$	<	0,2	mA
$-V_{CB} = -V_{CBOmax}$; $I_E = 0$; T_j = 100 °C		$-I_{CBO}$	<	1	mA
$-V_{CE} = -1/2\ V_{CEOmax}$; $I_B = 0$		$-I_{CEO}$	<	0,5	mA
Emitter cut-off current					
$-V_{EB}$ = 5 V; $I_C = 0$		$-I_{EBO}$	<	5	mA
Collector-emitter sustaining voltage					
$-I_C$ = 30 mA; $I_B = 0$	TIP135	$-V_{CEOsust}$	>	60	V
	TIP136	$-V_{CEOsust}$	>	80	V
	TIP137	$-V_{CEOsust}$	>	100	V
D.C. current gain					
$-V_{CE}$ = 4 V; $-I_C$ = 1 A		h_{FE}	>	500	
$-V_{CE}$ = 4 V; $-I_C$ = 4 A		h_{FE}		1000 to 15 000	
Base-emitter voltage					
$-V_{CE}$ = 4 V; $-I_C$ = 4 A		$-V_{BE}$	<	2,5	V
Collector-emitter saturation voltage					
$-I_C$ = 4 A; $-I_B$ = 16 mA		$-V_{CEsat}$	<	2	V
$-I_C$ = 6 A; $-I_B$ = 30 mA		$-V_{CEsat}$	<	3	V
Collector-base capacitance					
$-V_{CB}$ = 10 V; $I_E = 0$		C_{ob}	<	200	pF
Switching times					
$-I_C$ = 3 A; $-I_{Bon} = +I_{Boff}$ = 12 mA					
$-V_{CC}$ = 10 V					
turn-on time		t_{on}	typ.	0,5	μs
turn-off time		t_{off}	typ.	2,5	μs

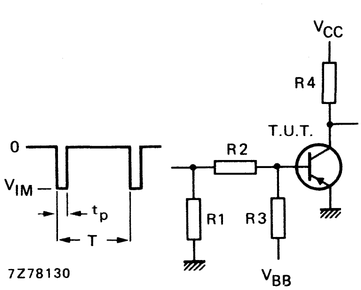


Fig. 3 Switching times test circuit.

$-V_{IM}$ = 10 V	R1 = 56 Ω	$t_r = t_f$ = 15 ns
$-V_{CC}$ = 10 V	R2 = 410 Ω	t_p = 10 μs
$+V_{BB}$ = 4 V	R3 = 560 Ω	T = 500 μs
	R4 = 3 Ω	

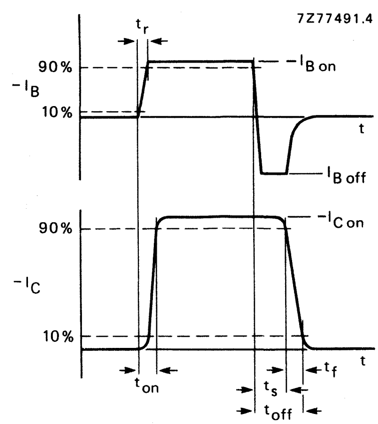


Fig. 4 Switching times waveforms.

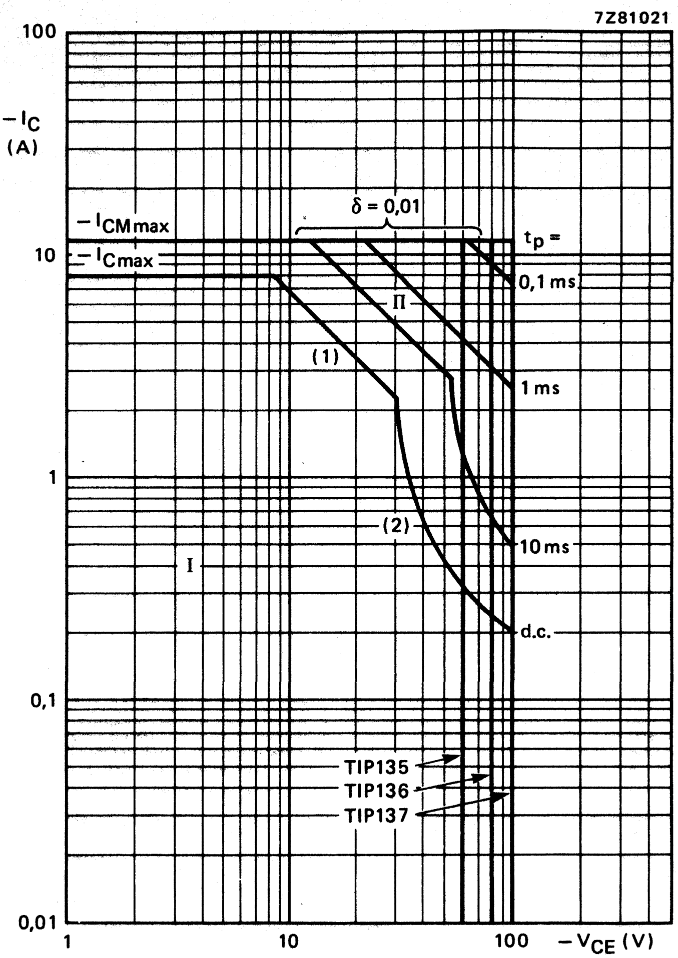


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second breakdown limits.

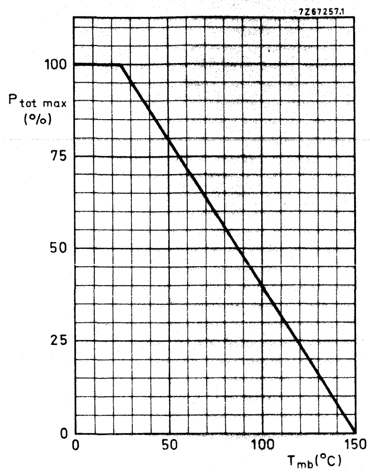


Fig. 6 Power derating curve.

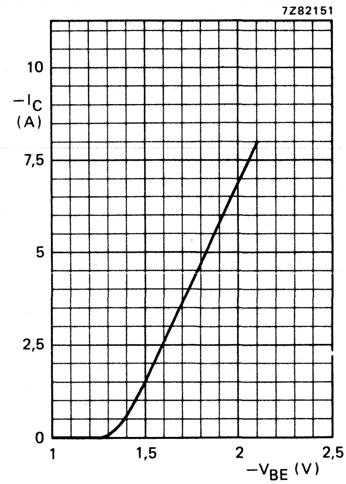


Fig. 7 Typical values; $-V_{CE}$ = 4 V; T_j = 25 °C.

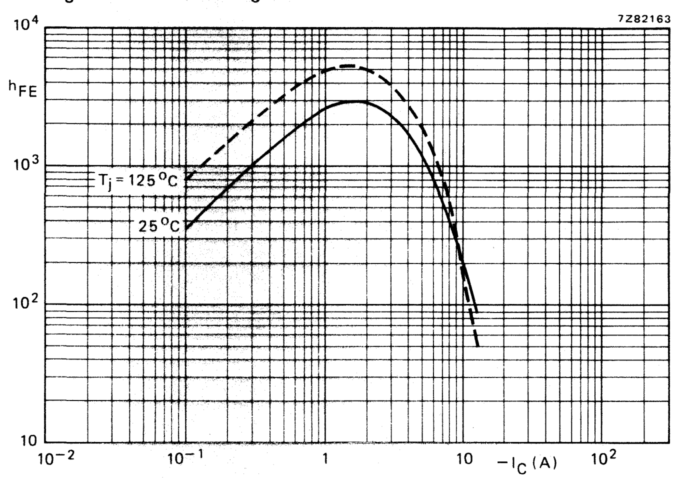


Fig. 8 Typical d.c. current gain at $-V_{CE}$ = 4 V.

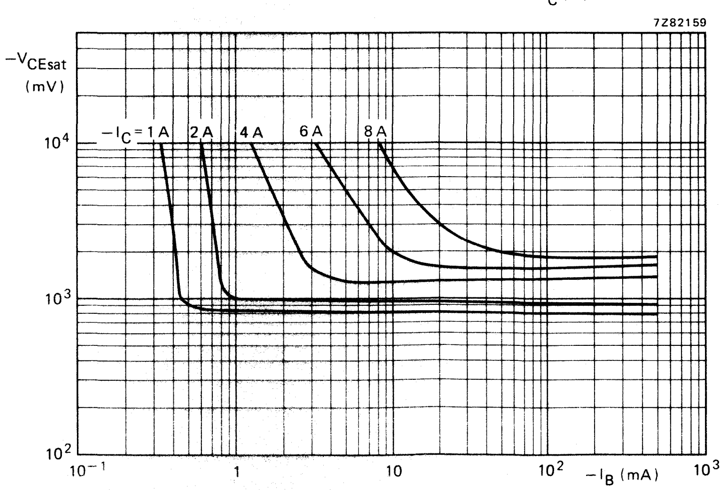


Fig. 9 Typical collector-emitter saturation voltage; T_j = 25 °C.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. SOT-93 plastic envelope. P-N-P complements are TIP145, TIP146 and TIP147.

QUICK REFERENCE DATA

			TIP140	TIP141	TIP142	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.		15		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		125		W
D.C. current gain						
$V_{CE} = 4$ V; $I_C = 5$ A	h_{FE}	>		1000		
Collector-emitter saturation voltage						
$I_C = 5$ A; $I_B = 10$ mA	V_{CEsat}	<		2,0		V

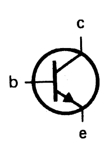
MECHANICAL DATA

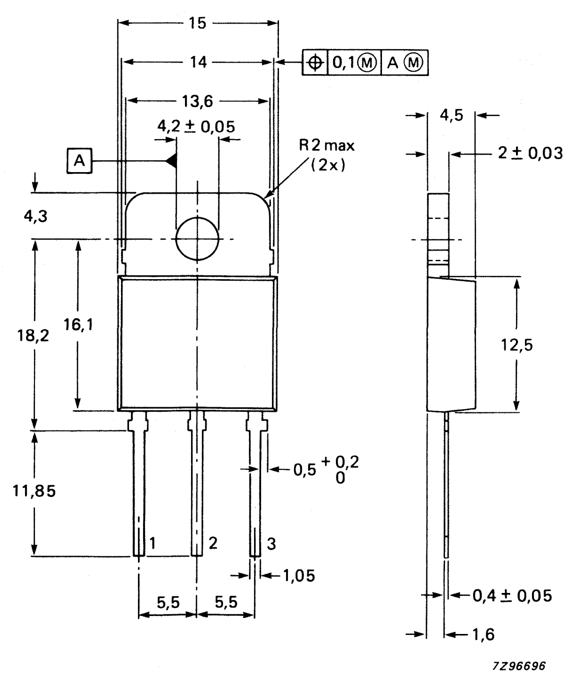
Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.

Pinning:
1 = base
2 = collector
3 = emitter





CIRCUIT DIAGRAM

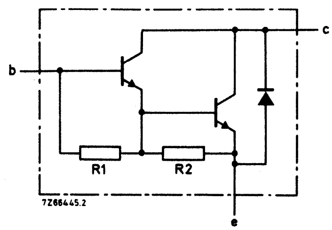


Fig. 2.
R1 typ. 5 kΩ
R2 typ. 80 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP140	TIP141	TIP142	
Collector-base voltage ($I_E = 0$)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	V_{EBO}	max.		5		V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value); $t_p \leqslant 0,3$ ms	I_{CM}	max.		15		A
Base current (d.c.)	I_B	max.		0,5		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		125		W
Total power dissipation in free air	P_{tot}	max.		3,5		W
Storage temperature	T_{stg}			−65 to + 150		^oC
Junction temperature	T_j	max.		150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	35,7	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents						
$V_{CB} = V_{CBOmax}$; $I_E = 0$		I_{CBO}	<	0,4	mA	←
$V_{CE} = 1/2\ V_{CEOmax}$; $I_B = 0$		I_{CEO}	<	0,2	mA	←
Emitter cut-off current						
$V_{EB} = 5$ V; $I_C = 0$		I_{EBO}	<	5	mA	
Collector-emitter sustaining voltage						
$I_C = 30$ mA; $I_B = 0$	TIP140	$V_{CEOsust}$	>	60	V	
	TIP141	$V_{CEOsust}$	>	80	V	
	TIP142	$V_{CEOsust}$	>	100	V	
D.C. current gain						
$V_{CE} = 4$ V; $I_C = 5$ A		h_{FE}	>	1000		
$V_{CE} = 4$ V; $I_C = 10$ A		h_{FE}	>	500		
Base-emitter voltage						
$V_{CE} = 4$ V; $I_C = 10$ A		V_{BE}	<	3	V	
Collector-emitter saturation voltage						
$I_C = 5$ A; $I_B = 10$ mA		V_{CEsat}	<	2	V	
$I_C = 10$ A; $I_B = 40$ mA		V_{CEsat}	<	3	V	
Switching times (see Figs 3 and 4)						
$I_C = 10$ A; $I_{Bon} = -I_{Boff} = 40$ mA						
$V_{CC} = 30$ V						
turn-on time		t_{on}	typ.	0,9	μs	
turn-off time		t_{off}	typ.	11	μs	

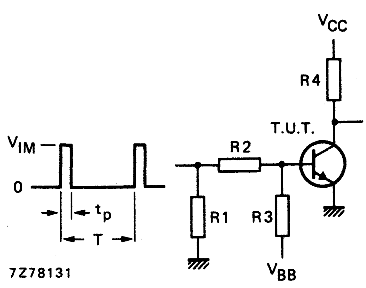


Fig. 3 Switching times test circuit.

$V_{IM} = 33$ V	R1 = 56 Ω	$t_r = t_f = 15$ ns
$V_{CC} = 30$ V	R2 = 410 Ω	$t_p = 10$ μs
$V_{BB} = -4{,}2$ V	R3 = 150 Ω	T = 500 μs
	R4 = 3 Ω	

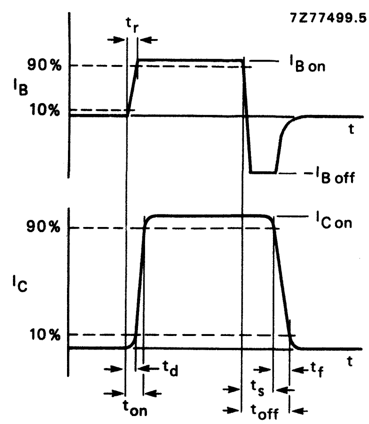


Fig. 4 Waveforms showing t_{on}; $t_s + t_f = t_{off}$.

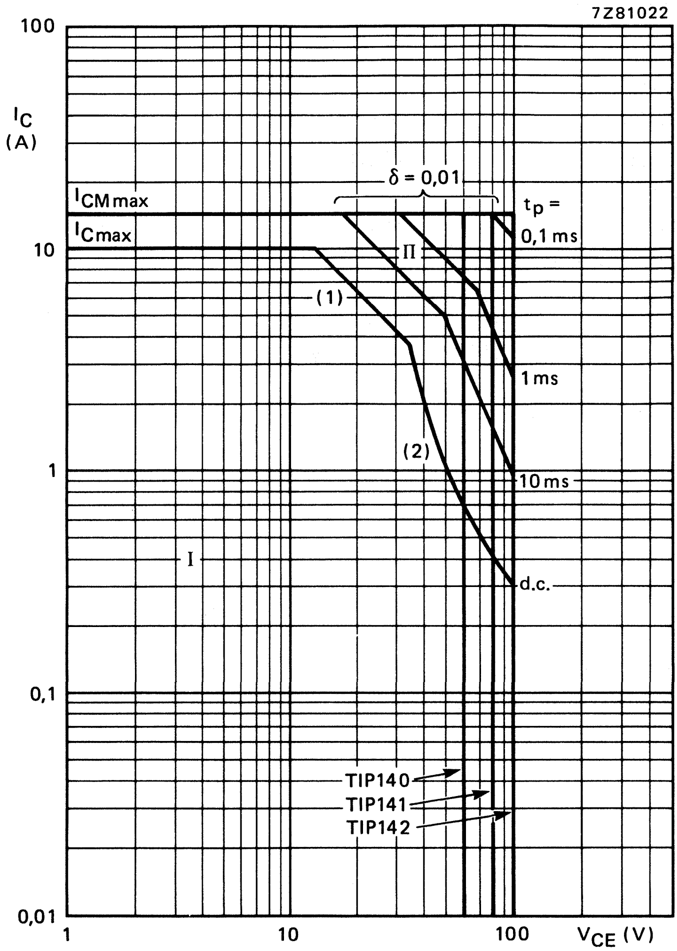


Fig. 5 Safe Operating ARea; $T_{mb} \leqslant 25\ ^{o}C$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second breakdown limits.

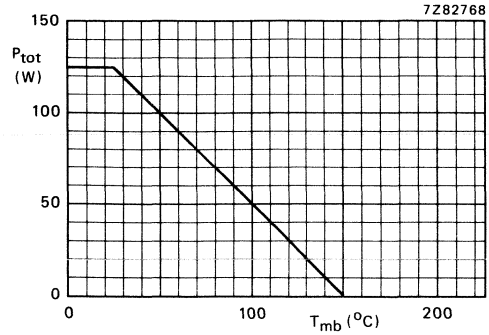


Fig. 6 Power derating curve.

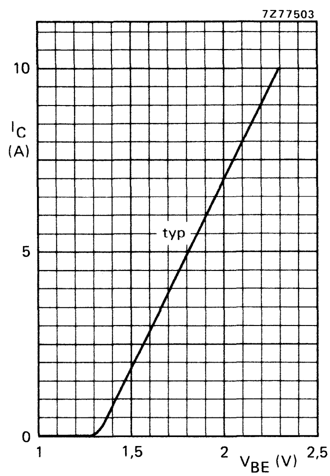


Fig. 7 V_{CE} = 4 V; T_j = 25 °C.

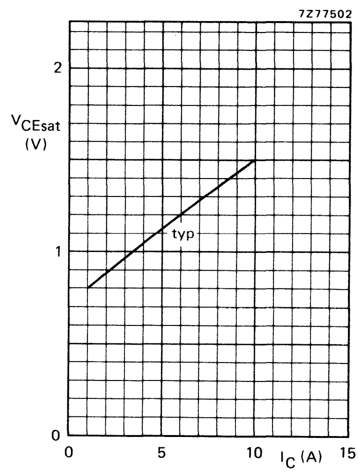


Fig. 8 I_C/I_B = 250; T_j = 25 °C.

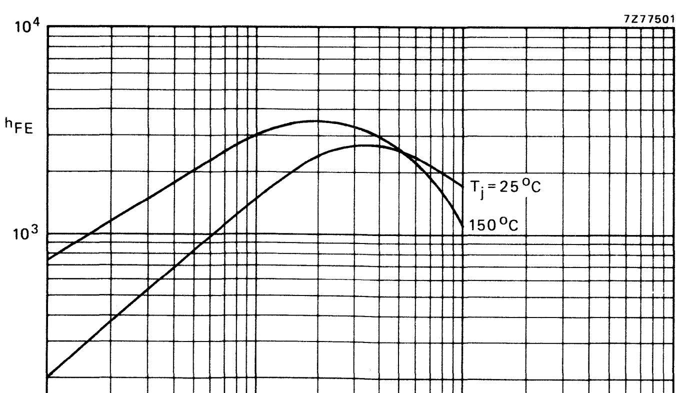


Fig. 9 Typical values; V_{CE} = 4 V.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. SOT-93 plastic envelope. N-P-N complements are TIP140, TIP141 and TIP142.

QUICK REFERENCE DATA

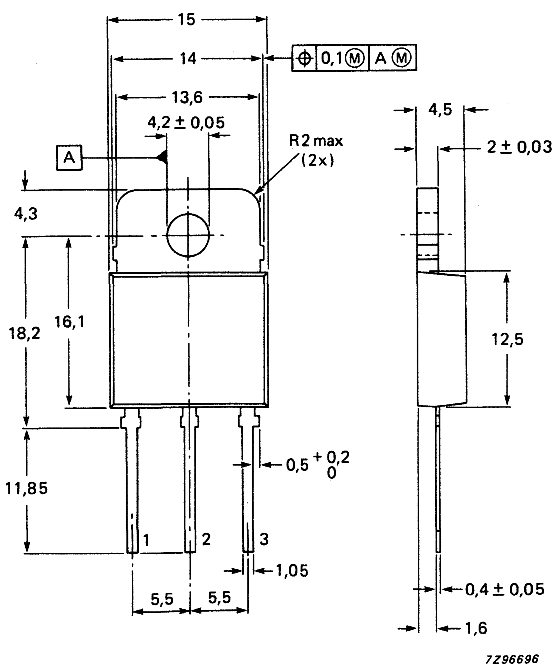
			TIP145	TIP146	TIP147	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		10		A
Collector current (peak value); $t_p \leqslant 0{,}3$ ms	$-I_{CM}$	max.		15		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		125		W
D.C. current gain						
$-V_{CE} = 4$ V; $-I_C = 5$ A	h_{FE}	>		1000		
Collector-emitter saturation voltage						
$-I_C = 5$ A; $-I_B = 10$ mA	$-V_{CEsat}$	<		2,0		V

MECHANICAL DATA

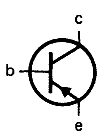
Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



Pinning:
1 = base
2 = collector
3 = emitter



CIRCUIT DIAGRAM

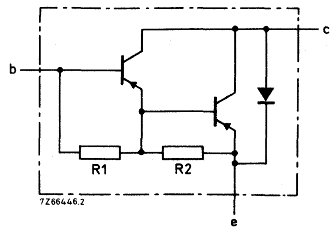


Fig. 2.
R1 typ. 5 kΩ
R2 typ. 80 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

			TIP145	TIP146	TIP147	
Collector-base voltage ($I_E = 0$)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	$-V_{EBO}$	max.		5		V
Collector current (d.c.)	$-I_C$	max.		10		A
Collector current (peak value); $t_p \leqslant 0,3$ ms	$-I_{CM}$	max.		15		A
Base current (d.c.)	$-I_B$	max.		0,5		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		125		W
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.		3,5		W
Storage temperature	T_{stg}			−65 to + 150		^oC
Junction temperature	T_j	max.		150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	35,7	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents						
$-V_{CB} = -V_{CBOmax}$; $I_E = 0$		$-I_{CBO}$	<	0,4	mA	←
$-V_{CE}$ = 1/2 V_{CEOmax}; $I_B = 0$		$-I_{CEO}$	<	0,2	mA	←
Emitter cut-off current						
$-V_{EB}$ = 5 V; $I_C = 0$		$-I_{EBO}$	<	5	mA	
Collector-emitter sustaining voltage						
$-I_C$ = 30 mA; $I_B = 0$	TIP145	$-V_{CEOsust}$	>	60	V	
	TIP146	$-V_{CEOsust}$	>	80	V	
	TIP147	$-V_{CEOsust}$	>	100	V	
D.C. current gain						
$-V_{CE}$ = 4 V; $-I_C$ = 5 A		h_{FE}	>	1000		
$-V_{CE}$ = 4 V; $-I_C$ = 10 A		h_{FE}	>	500		
Base-emitter voltage						
$-V_{CE}$ = 4 V; $-I_C$ = 10 A		$-V_{BE}$	<	3	V	
Collector-emitter saturation voltage						
$-I_C$ = 5 A; $-I_B$ = 10 mA		$-V_{CEsat}$	<	2	V	
$-I_C$ = 10 A; $-I_B$ = 40 mA		$-V_{CEsat}$	<	3	V	
Switching times (see Figs 3 and 4)						
$-I_C$ = 10 A; $-I_{Bon} = I_{Boff}$ = 40 mA						
$-V_{CC}$ = 30 V						
turn-on time		t_{on}	typ.	0,9	μs	
turn-off time		t_{off}	typ.	11	μs	

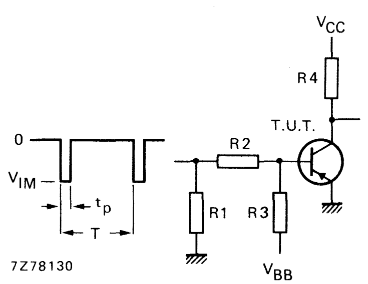


Fig. 3 Switching times test circuit.

$-V_{IM}$ = 33 V　R1 = 56 Ω　$t_r = t_f$ = 15 ns
$-V_{CC}$ = 30 V　R2 = 410 Ω　t_p = 10 μs
V_{BB} = 4,2 V　R3 = 150 Ω　T = 500 μs
R4 = 3 Ω

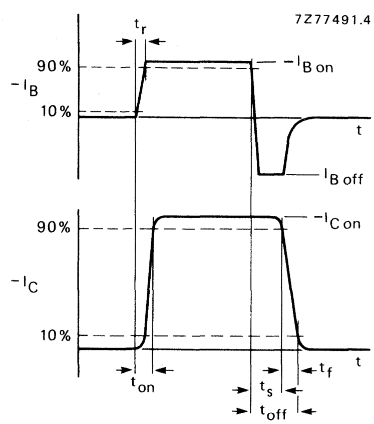


Fig. 4 Switching times waveforms.

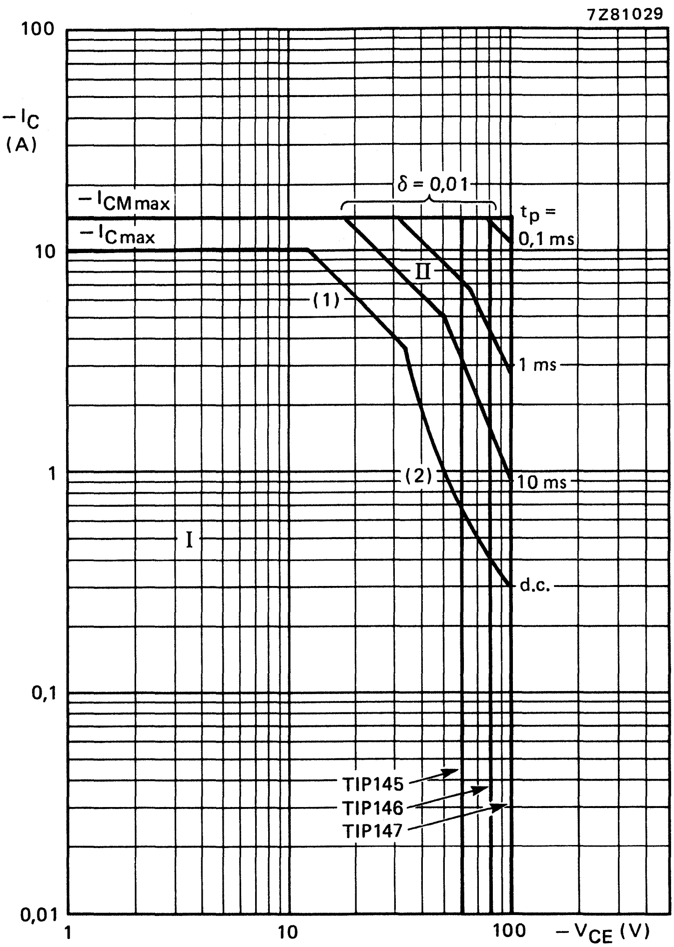


Fig. 5 Safe Operating ARea; $T_{mb} \leqslant 25\ ^{o}C$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second breakdown limits.

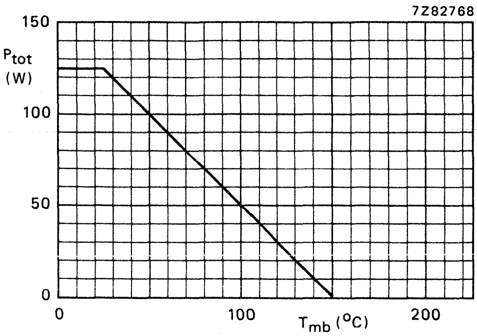


Fig. 6 Power derating curve.

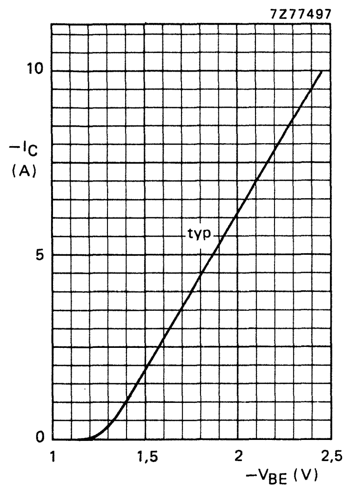


Fig. 7 $-V_{CE} = 4$ V; $T_j = 25$ °C.

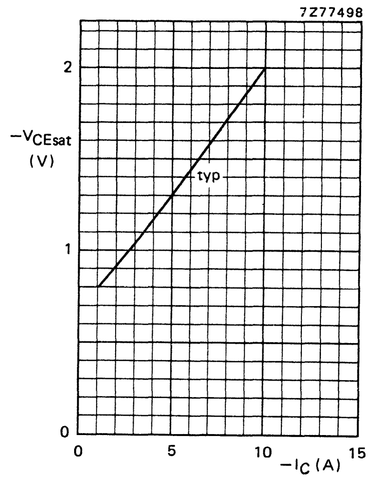


Fig. 8 $-I_C/I_B = 250$; $T_j = 25$ °C.

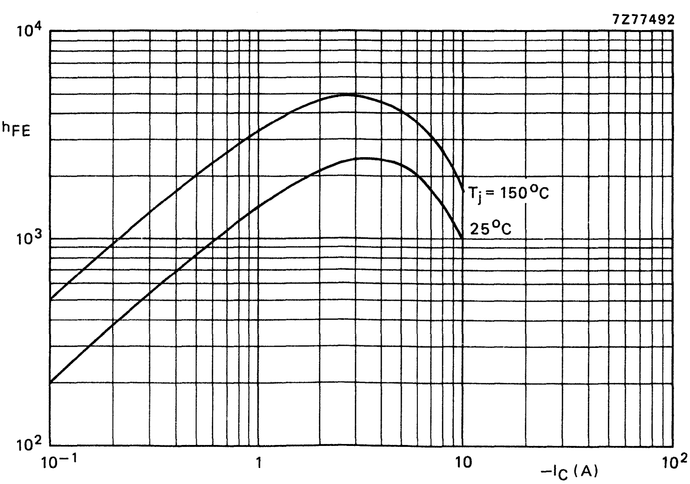


Fig. 9 Typical values; $-V_{CE} = 4$ V.

SILICON POWER TRANSISTOR

P-N-P epitaxial-base power transistor in a plastic SOT-93 envelope, for use in audio output stages and general amplifier and switching applications. N-P-N complement is TIP3055.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	100 V
Collector-emitter voltage ($R_{BE} \leqslant 100\ \Omega$)	$-V_{CER}$	max.	70 V
Collector current (d.c.)	$-I_C$	max.	15 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	100 W
D.C. current gain			
$-V_{CE}$ = 4 V; $-I_C$ = 4 A	h_{FE}		20 – 70
Collector-emitter saturation voltage			
$-I_C$ = 4 A; $-I_B$ = 0,4 A	$-V_{CEsat}$	<	1,1 V
Transition frequency			
$-V_{CE}$ = 10 V; $-I_C$ = 0,5 A; f = 1 MHz	f_T	>	3 MHz

MECHANICAL DATA

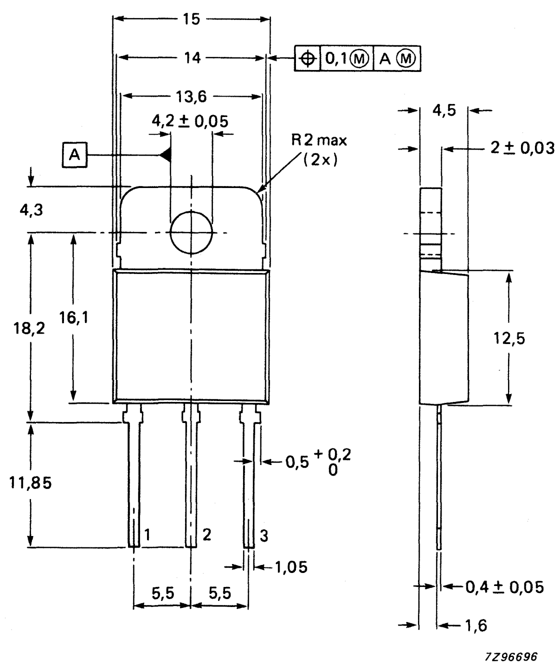
Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.

Pinning

1 = base
2 = collector
3 = emitter



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

Collector-base voltage ($I_E = 0$)	$-V_{CBO}$	max.	100	V
Collector-emitter voltage ($R_{BE} \leq 100\ \Omega$)	$-V_{CER}$	max.	70	V
Collector-emitter voltage ($I_B = 0$)	$-V_{CEO}$	max.	60	V
Emitter-base voltage ($I_C = 0$)	$-V_{EBO}$	max.	7	V
Collector current (d.c.)	$-I_C$	max.	15	A
Base current (d.c.)	$-I_B$	max.	7	A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100	W
Total power dissipation in free air	P_{tot}	max.	3,5	W
Storage temperature	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,25	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	35,7	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off currents				
$-V_{CE} = 100$ V; $+ V_{BE} = 1,5$ V	$-I_{CEX}$	<	5	mA
$-V_{CE} = 30$ V; $I_B = 0$	$-I_{CEO}$	<	0,7	mA
Emitter cut-off current				
$-V_{EB} = 7$ V; $I_C = 0$	$-I_{EBO}$	<	5	mA
Collector-emitter sustaining voltage				
$-I_C = 30$ mA; $I_B = 0$	$-V_{CEOsust}$	>	60	V
D.C. current gain				
$-V_{CE} = 4$ V; $-I_C = 4$ A	h_{FE}		20 – 70	
$-V_{CE} = 4$ V; $-I_C = 10$ A	h_{FE}	>	5	
Base-emitter voltage				
$-V_{CE} = 4$ V; $-I_C = 4$ A	$-V_{BE}$	<	1,8	V
Collector-emitter saturation voltage				
$-I_C = 4$ A; $-I_B = 0,4$ A	$-V_{CEsat}$	<	1,1	V
$-I_C = 10$ A; $-I_B = 3,3$ A	$-V_{CEsat}$	<	3,0	V
Small-signal current gain				
$-V_{CE} = 10$ V; $-I_C = 0,5$ A; f = 1 kHz	h_{fe}	>	20	
Transition frequency				
$-V_{CE} = 10$ V; $-I_C = 0,5$ A; f = 1 MHz	f_T	>	3	MHz

Unclamped inductive load energy			
$L = 20$ mH; $-I_C = 2{,}5$ A	$E_{(BR)}$	<	62,5 mJ
Switching times			
$-I_C = 6$ A; $-I_{Bon} = I_{Boff} = 0{,}6$ A; $-V_{CC} = 30$ V			
turn-on time	t_{on}	typ.	0,4 μs
turn-off time	t_{off}	typ.	0,7 μs

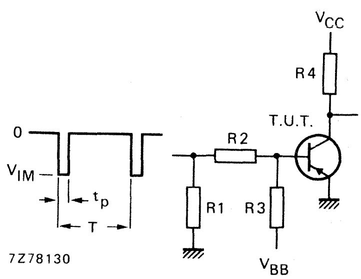


Fig. 2 Switching times test circuit.

$-V_{CC}$ = 30 V
$-V_{IM}$ = 24 V
V_{BB} = 4 V
R1 = 56 Ω
R2 = 24 Ω
R3 = 10 Ω
R4 = 5 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

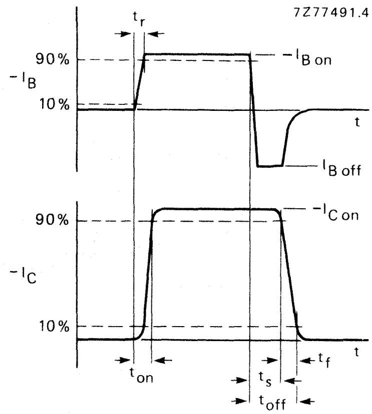


Fig. 3 Switching times waveforms.

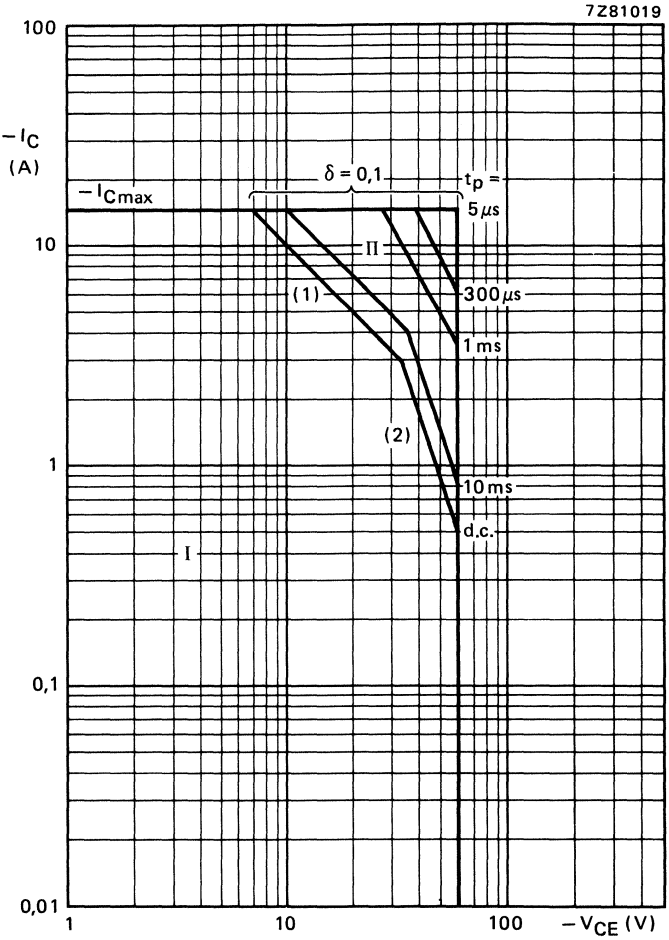


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second breakdown limits.

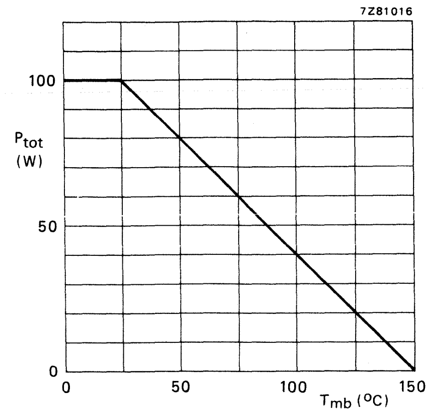


Fig. 5 Power derating curve.

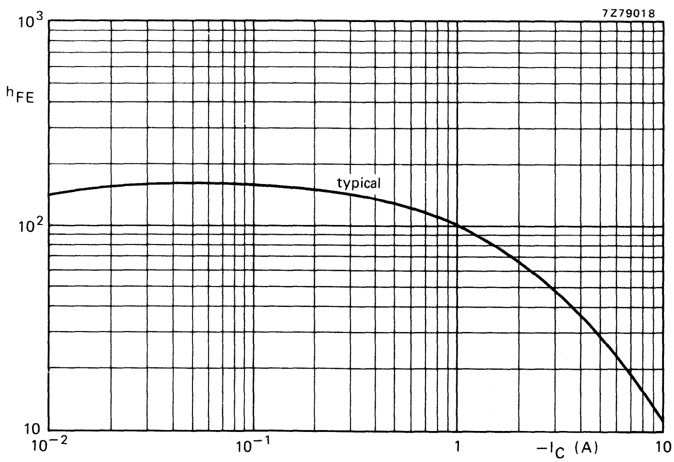


Fig. 6 $-V_{CE} = 4$ V; $T_j = 25$ °C

SILICON EPITAXIAL-BASE POWER TRANSISTOR

P-N-P transistor in a plastic envelope. With its n-p-n complement TIP3055T they are primarily intended for use in hi-fi equipment delivering an output of 15 to 25 W into a 4 Ω or 8 Ω load.

QUICK REFERENCE DATA

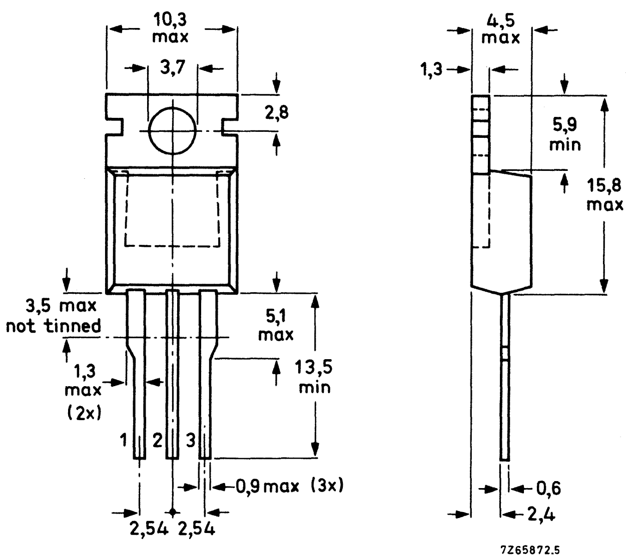
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	V
Collector current (d.c.)	$-I_C$	max.	10	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	75	W
Transition frequency at f = 1 MHz $-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_T	>	2	MHz

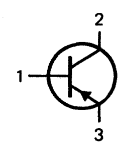
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	70	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V
Collector current (d.c.)	$-I_C$	max.	10	A
Collector current (peak value, $t_p \leqslant 10$ ms)	$-I_{CM}$	max.	12	A
Base current (d.c.)	$-I_B$	max.	4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	75	W
Storage temperature	T_{stg}		−65 to + 175	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,67	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

→ Collector cut-off current				
$I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	<	0,2	mA
$I_E = 0$; $-V_{CB} = 70$ V	$-I_{CBO}$	<	0,1	mA
$I_E = 0$; $-V_{CB} = 70$ V; T_j = 150 °C	$-I_{CBO}$	<	1	mA
$V_{BE} = 1{,}5$ V; $-V_{CB} = 70$ V	$-I_{CEX}$	<	1	mA
$V_{BE} = 1{,}5$ V; $-V_{CB} = 70$ V; T_j = 150 °C	$-I_{CEX}$	<	5	mA
→ Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	0,5	mA
Saturation voltages*				
$-I_C$ = 4 A; $-I_B$ = 0,4 A	$-V_{CEsat}$	<	0,8	V
	$-V_{BEsat}$	<	1,8	V
$-I_C$ = 10 A; $-I_B$ = 3,3 A	$-V_{CEsat}$	<	4	V
Base-emitter voltage*				
$-I_C$ = 4 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	1,8	V
D.C. current gain*				
$-I_C$ = 4 A; $-V_{CE}$ = 4 V	h_{FE}		20 to 70	
$-I_C$ = 10 A; $-V_{CE}$ = 4 V	h_{FE}	>	5	
Transition frequency at f = 1 MHz				
$-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_T	>	2	MHz

* Measured under pulse conditions: $t_p < 300$ µs, $\delta < 2\%$.

Switching times

$-I_{Con} = 2$ A; $I_{Bon} = I_{Boff} = 0{,}2$ A

turn-on time	t_{on}	<	1 μs
turn-off time	t_{off}	<	2 μs

DEVELOPMENT DATA

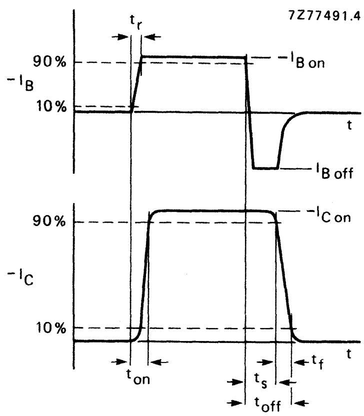


Fig. 2 Switching times waveforms.

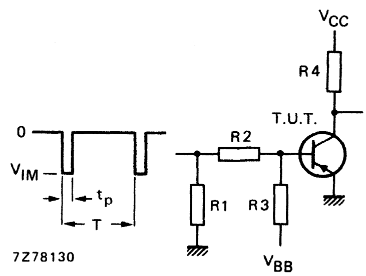


Fig. 3 Switching times test circuit.

$-V_{IM}$	= 15 V	R3	= 22 Ω
$-V_{CC}$	= 20 V	R4	= 10 Ω
$+V_{BB}$	= 4 V	$t_r = t_f$	= 15 ns
R1	= 56 Ω	t_p	= 10 μs
R2	= 33 Ω	T	= 500 μs

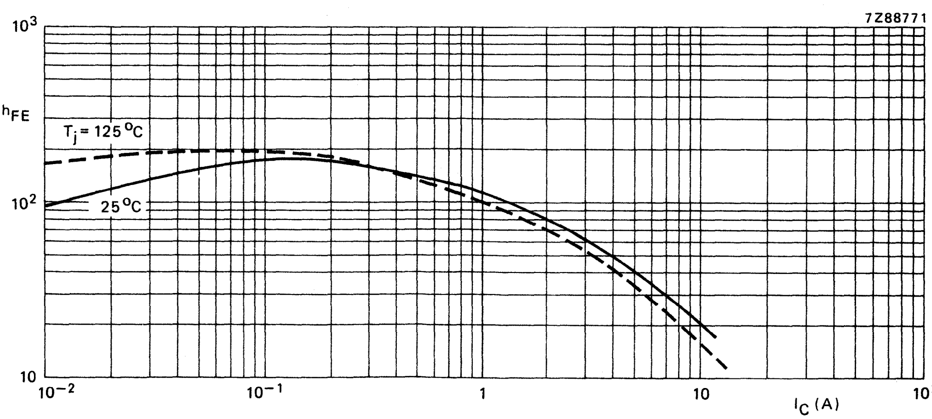


Fig. 4 Typical values d.c. current gain at $-V_{CE} = 2$ V.

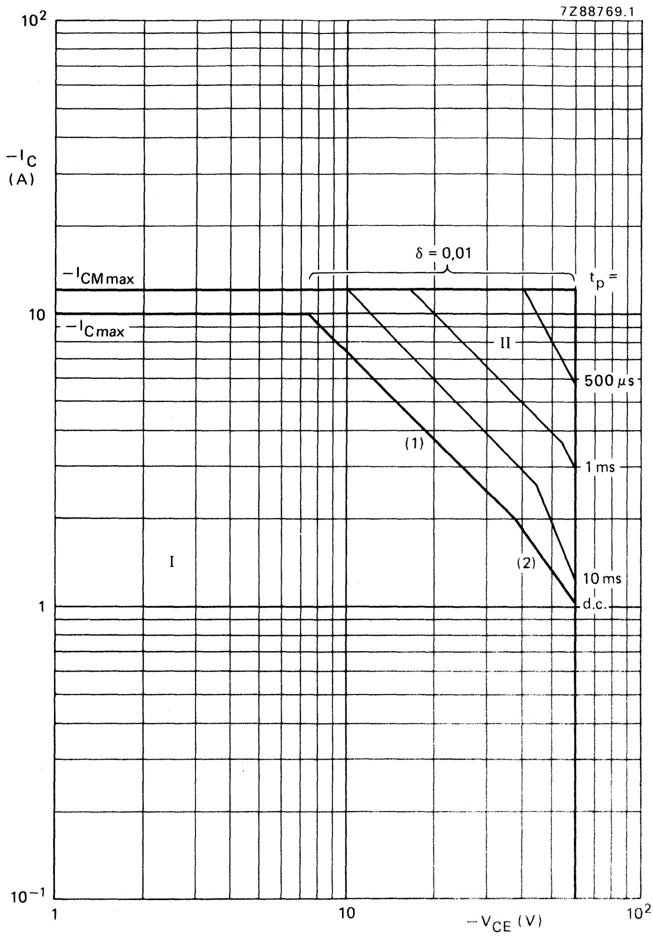


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

SILICON POWER TRANSISTOR

N-P-N epitaxial-base power transistor in a plastic SOT-93 envelope for use in audio output stages and general amplifier and switching applications. P-N-P complement is TIP2955.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	100 V
Collector-emitter voltage ($R_{BE} \leqslant 100\ \Omega$)	V_{CER}	max.	70 V
Collector current (d.c.)	I_C	max.	15 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	100 W
D.C. current gain			
V_{CE} = 4 V; I_C = 4 A	h_{FE}		20 to 70
Collector-emitter saturation voltage			
I_C = 4 A; I_B = 0,4 A	V_{CEsat}	<	1,1 V
Transition frequency			
V_{CE} = 10 V; I_C = 0,5 A; f = 1 MHz	f_T	>	3 MHz

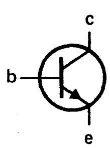
MECHANICAL DATA

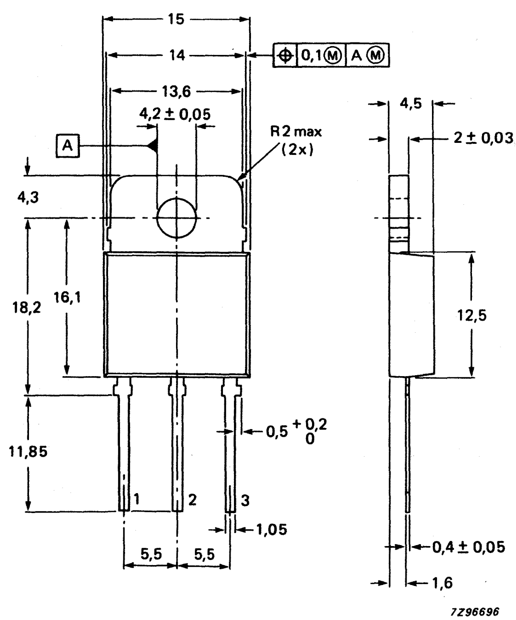
Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.

Pinning
1 = base
2 = collector
3 = emitter





RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

Collector-base voltage ($I_E = 0$)	V_{CBO}	max.	100 V
Collector-emitter voltage ($R_{BE} \leqslant 100\ \Omega$)	V_{CER}	max.	70 V
Collector-emitter voltage ($I_B = 0$)	V_{CEO}	max.	60 V
Emitter-base voltage ($I_C = 0$)	V_{EBO}	max.	7 V
Collector current (d.c.)	I_C	max.	15 A
Base current (d.c.)	I_B	max.	7 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	100 W
Total power dissipation in free air	P_{tot}	max.	3,5 W
Storage temperature	T_{stg}	−65 to + 150 °C	
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,25 K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	35,7 K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents			
V_{CE} = 100 V; $-V_{BE}$ = 1,5 V	I_{CEX}	<	5 mA
V_{CE} = 30 V; I_B = 0	I_{CEO}	<	0,7 mA
Emitter cut-off current			
V_{EB} = 7 V; I_C = 0	I_{EBO}	<	5 mA
Collector-emitter sustaining voltage			
I_C = 30 mA; I_B = 0	$V_{CEOsust}$	>	60 V
D.C. current gain			
V_{CE} = 4 V; I_C = 4 A	h_{FE}		20 to 70
V_{CE} = 4 V; I_C = 10 A	h_{FE}	>	5
Base-emitter voltage			
V_{CE} = 4 V; I_C = 4 A	V_{BE}	<	1,8 V
Collector-emitter saturation voltage			
I_C = 4 A; I_B = 0,4 A	V_{CEsat}	<	1,1 V
I_C = 10 A; I_B = 3,3 A	V_{CEsat}	<	3,0 V
Small-signal current gain			
V_{CE} = 10 V; I_C = 0,5 A; f = 1 kHz	h_{fe}	>	20
Transition frequency			
V_{CE} = 10 V; I_C = 0,5 A; f = 1 MHz	f_T	>	3 MHz

Unclamped inductive load energy			
$L = 20\ mH$; $I_C = 2{,}5\ A$	$E_{(BR)}$	>	62,5 mJ
Switching times (see Figs 2 and 3)			
$I_C = 6\ A$; $I_{Bon} = -I_{Boff} = 0{,}6\ A$; $V_{CC} = 30\ V$			
turn-on time	t_{on}	typ.	0,6 μs
turn-off time	t_{off}	typ.	1,0 μs

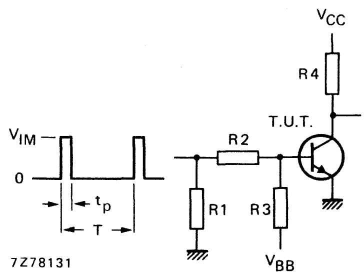


Fig. 2 Switching times test circuit.

V_{CC} = 30 V
V_{IM} = 24 V
V_{BB} = −4 V
R1 = 56 Ω
R2 = 24 Ω
R3 = 10 Ω
R4 = 5 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

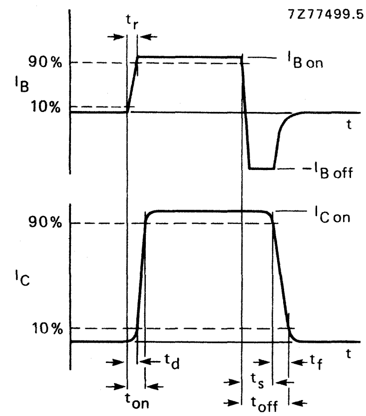


Fig. 3 Switching times waveforms.

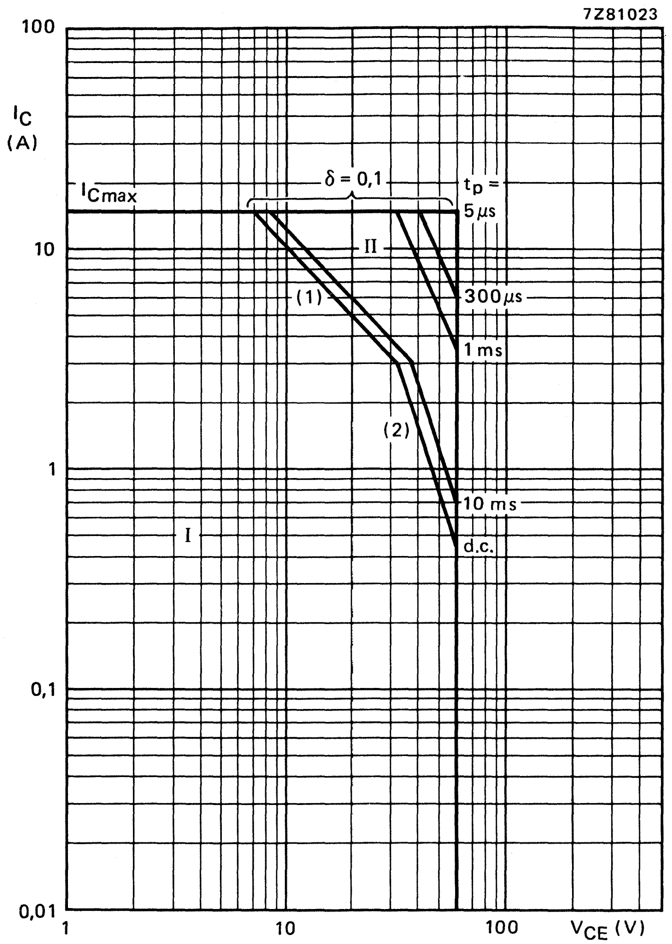


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.

(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second breakdown limits

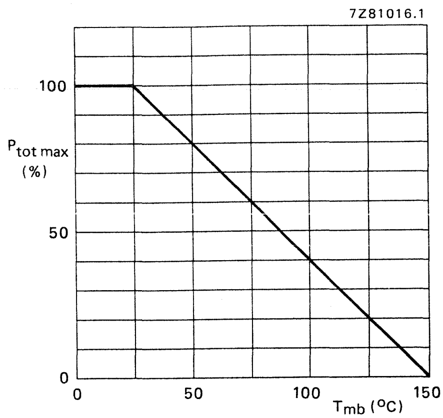


Fig. 5 Power derating curve.

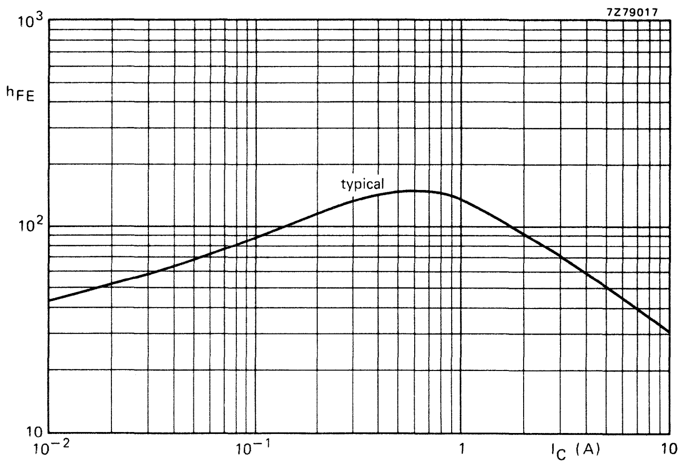


Fig. 6 $V_{CE} = 4$ V; $T_j = 25$ °C.

SILICON EPITAXIAL-BASE POWER TRANSISTOR

N-P-N transistor in a plastic envelope. With its p-n-p complement TIP2955T they are primarily intended for use in hi-fi equipment delivering an output of 15 to 25 W into a 4 Ω or 8 Ω load.

QUICK REFERENCE DATA

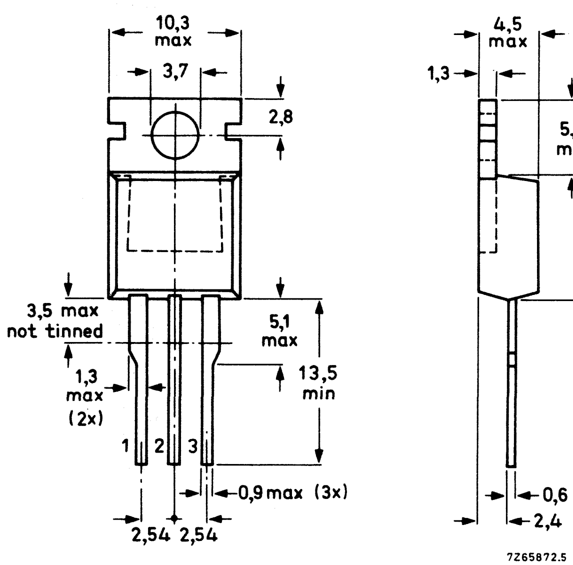
Collector-emitter voltage (open base)	V_{CEO}	max.	60	V
Collector current (d.c.)	I_C	max.	10	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	75	W
Transition frequency at f = 1 MHz I_C = 0,5 A; V_{CE} = 10 V	f_T	>	2	MHz

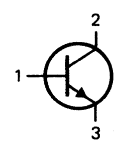
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220.

Collector connected to mounting base.





See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	V_{CBO}	max.	70	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	10	A
Collector current (peak value, $t_p \leqslant 10$ ms)	I_{CM}	max.	12	A
Base current (d.c.)	I_B	max.	4	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	75	W
Storage temperature	T_{stg}	−65 to + 175		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,67	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

→ Collector cut-off current				
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	0,2	mA
$I_E = 0$; $V_{CB} = 70$ V	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = 70$ V; $T_j = 150$ °C	I_{CBO}	<	1	mA
$V_{CE} = 70$ V; $V_{BE} = -1,5$ V	I_{CEX}	<	1	mA
$V_{CE} = 70$ V; $V_{BE} = -1,5$ V; $T_j = 150$ °C	I_{CEX}	<	5	mA
→ Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	0,5	mA
Base-emitter voltage*				
$I_C = 4$ A; $V_{CE} = 4$ V	V_{BE}	<	1,8	V
Saturation voltage*				
$I_C = 4$ A; $I_B = 0,4$ A	V_{CEsat}	<	0,8	V
	V_{BEsat}	<	1,8	V
$I_C = 10$ A; $I_B = 3,3$ A	V_{CEsat}	<	4	V
D.C. current gain*				
$I_C = 4$ A; $V_{CE} = 4$ V	h_{FE}		20 to 70	
$I_C = 10$ A; $V_{CE} = 4$ V	h_{FE}	>	5	
Transition frequency at f = 1 MHz				
$I_C = 0,5$ A; $V_{CE} = 10$ V	f_T	>	2	MHz

* Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.

Switching times

$I_{Con} = 2$ A; $I_{Bon} = -I_{Boff} = 0{,}2$ A

Turn-on time	t_{on}	<	1 μs
Turn-off time	t_{off}	<	4 μs

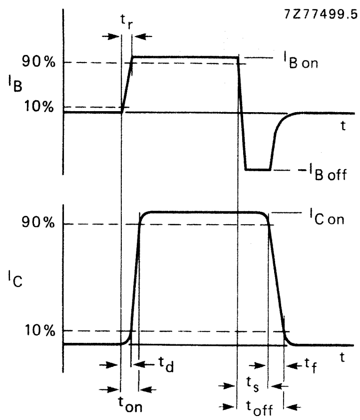


Fig. 2 Switching time waveforms.

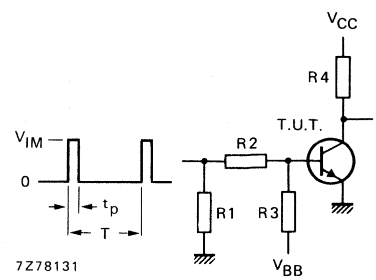


Fig. 3 Switching times test circuit.

V_{IM} =	15 V	R3 =	22 Ω
V_{CC} =	20 V	R4 =	10 Ω
V_{BB} =	−4 V	$t_r = t_f \leqslant$	15 ns
R1 =	none	t_p	20 μs
R2 =	33 Ω	T =	500 μs

DEVELOPMENT DATA

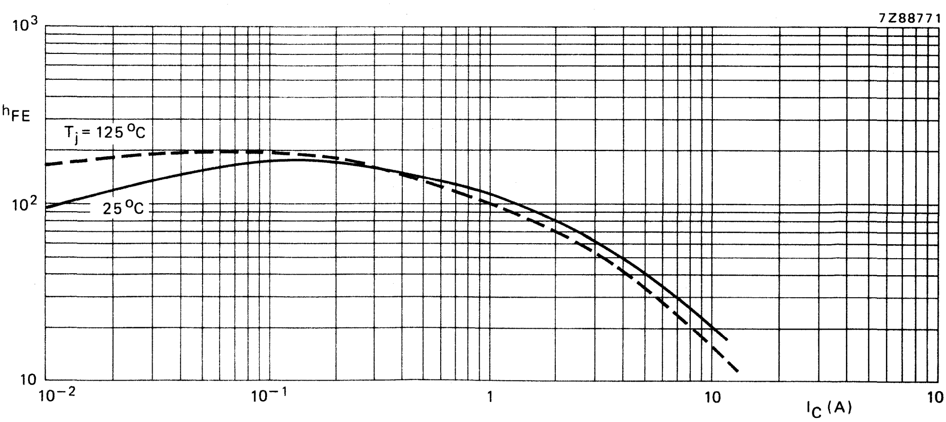


Fig. 4 Typical values d.c. current gain at V_{CE} = 2 V.

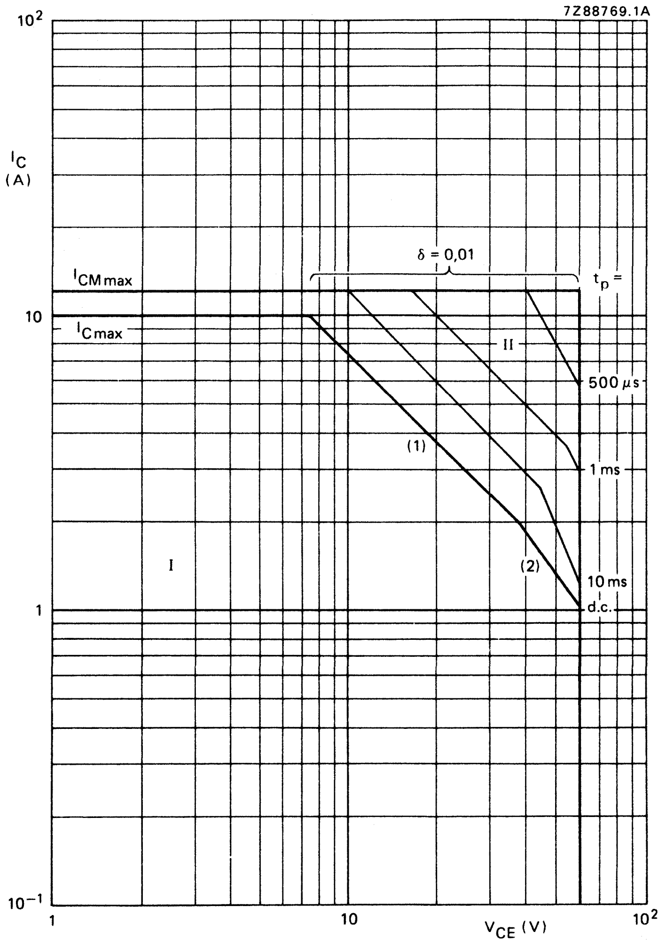


Fig. 5 Safe Operating ARea, $T_{mb} \leqslant 25\ ^oC$.

I Region of permissible d.c. operation.
II Permissible extension for repetitive pulse operation.
(1) $P_{tot\,max}$ and $P_{peak\,max}$ lines.
(2) Second-breakdown limits.

HYBRID MODULES

HYBRID INTEGRATED CIRCUIT HI-FI AUDIO POWER AMPLIFIERS

The OM931 and OM961 are thin-film hybrid integrated circuit hi-fi audio amplifiers for sinusoidal output power up to 60 W. The modules offer maximum design possibilities regarding amplification, ripple rejection, stability for complex loads, etc. The amplifiers have built-in short-circuit protection (SOAR protected), and are especially designed for low transient and harmonic distortion. All built-in resistors are dynamically adjusted for optimum performance over a wide temperature range.

QUICK REFERENCE DATA

		OM931	OM961
Sinusoidal output power for $d_{tot} < 0,2$ %			
f = 20 Hz to 20 kHz			
$R_L = 4\ \Omega$	P_o	> 30 W at ± 23 V	> 60 W at ± 31 V
$R_L = 8\ \Omega$	P_o	> 30 W at ± 26 V	> 60 W at ± 35 V
Total harmonic distortion			
$P_o = 1$ W; f = 1 kHz	d_{tot}	typ. 0,02	0,02 %

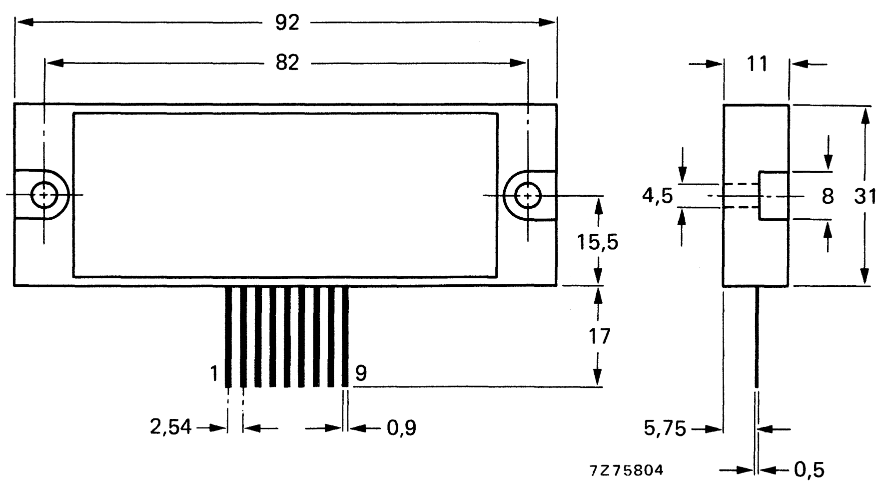


Fig. 1 Outline; dimensions in mm.

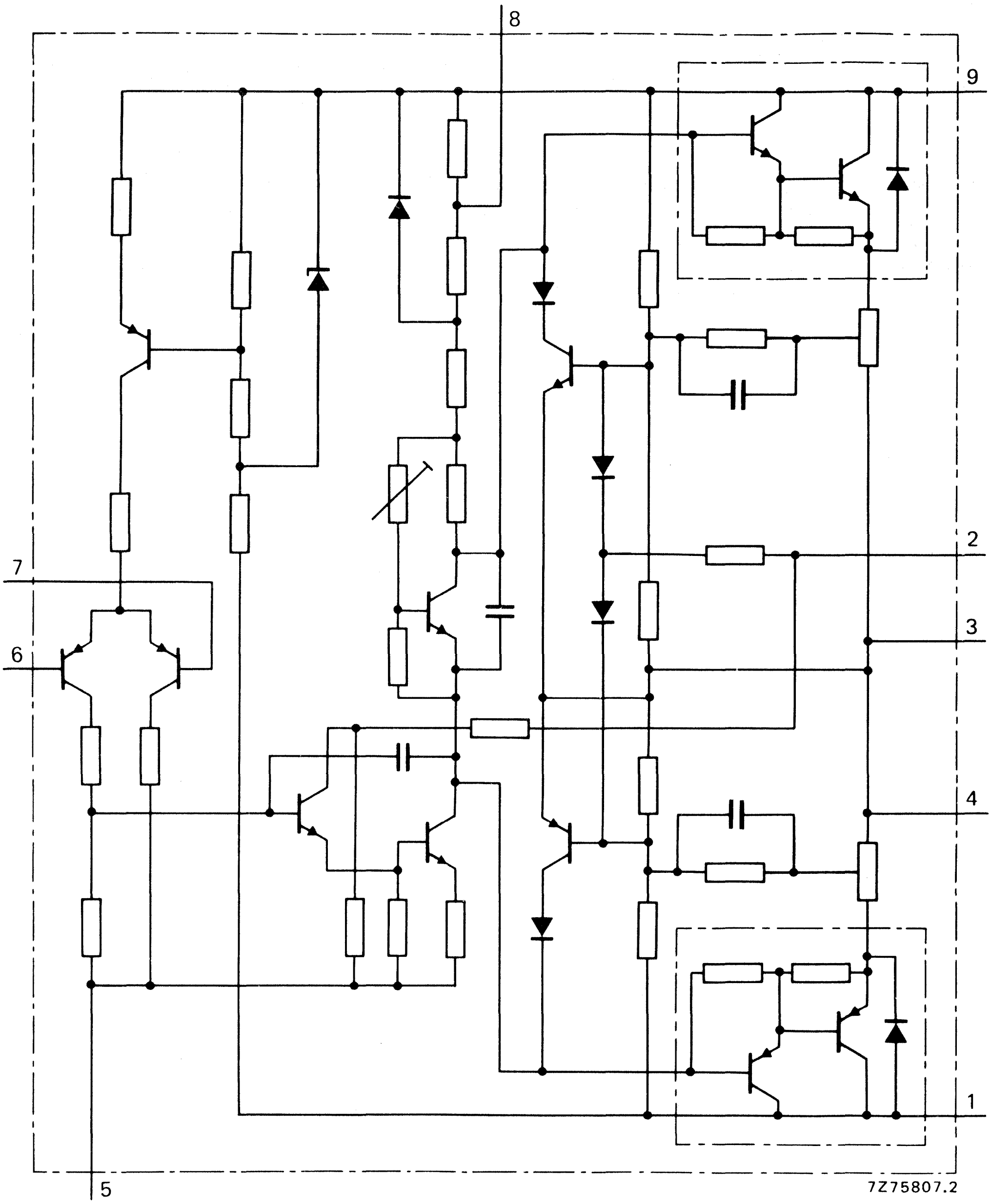


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Symmetrical supply voltage	**OM931**	V_S	max.	±40 V
	OM961	V_S	max.	±45 V
Operating mounting base temperature		T_{mb}	max.	95 °C
Storage temperature		T_{stg}		−30 to +100 °C

CHARACTERISTICS

Mounted on a heatsink with $R_{th\,h\text{-}a}$ = 1,4 K/W (OM931) and $R_{th\,h\text{-}a}$ = 0,8 K/W (OM961); measured in the circuit of Fig. 3.

			OM931		OM961		
Symmetrical supply voltage	V_S	typ.	±23	±26	±31	±35	V
Total supply current (zero signal)	I_{tot}	typ.	80		100		mA
Sinusoidal output power for d_{tot} < 0,2 % f = 20 Hz to 20 kHz (Federal Trade Commission, U.S.A.)							
R_L = 4 Ω	P_o	>	30	–	60	–	W*
R_L = 8 Ω	P_o	>	–	30	–	60	W*
Clipping level at f = 1 kHz; R_L = 4 Ω; d_{tot} = 0,7%	P_o	typ.	40		75		W
Total harmonic distortion P_o = 1 W; f = 1 kHz	d_{tot}	typ.	0,02		0,02		%
Intermodulation distortion at f_1 = 250 Hz and f_2 = 8 kHz; amplitude ratio V_{f1}/V_{f2} = 4/1							
P_o = 1 W	d_{im}	typ.	0,05		0,05		%
P_o = rated value	d_{im}	typ.	0,1		0,1		%
Input sensitivity for P_o = rated value	V_i	typ.	0,7	1	1	1,4	V

Input impedance determined by input circuitry	R_i	typ.	10 kΩ
Open loop gain	G_o	typ.	80 dB
Closed loop gain	G_c	typ.	24 dB
Frequency response P_o = rated value −10 dB (−1 dB)	f		30 Hz to 40 kHz
Power bandwidth (−3 dB)	f_p		20 Hz to 40 kHz
Signal-to-noise ratio (unweighted) P_o = 50 mW; wide band	S/N	typ.	75 dB
Signal-to-noise ratio (weighted) P_o = 50 mW; A-curve	S/N	typ.	87 dB
D.C. output offset voltage	V_{off}	typ.	±20 mV
Ripple rejection	RR	⩾	65 dB
Output impedance	R_o	typ.	0,05 Ω

* P_o is stated as rated value.

APPLICATION INFORMATION

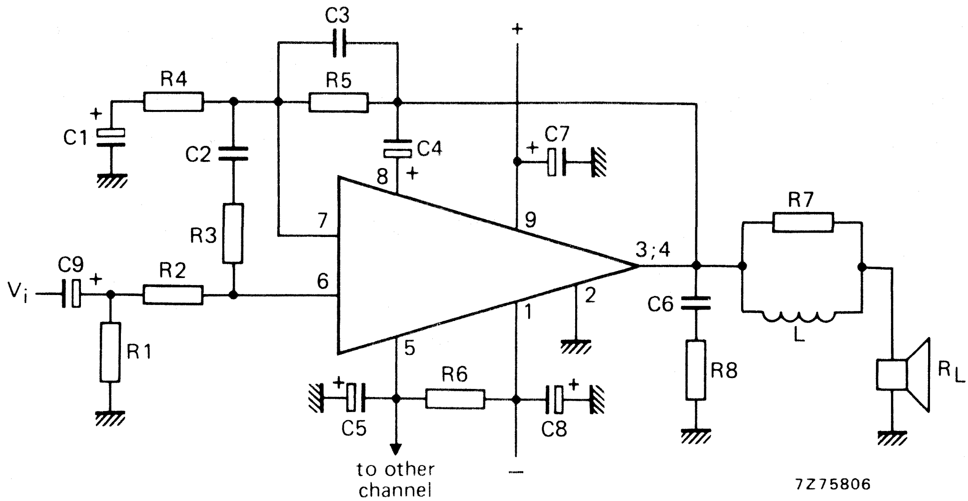


Fig. 3 Example of an amplifier with external components.

List of components:

R1 = 10 kΩ (0,25 W)	C1 = 47 μF (10 V)	L = 4 μH
R2 = 4,7 kΩ (0,25 W)	C2 = 270 pF (10%)	
R3 = 300 Ω (0,25 W)	C3 = 120 pF (10%)	R_L = 4 or 8 Ω
R4 = 680 Ω (0,25 W)	C4 = 100 μF	
R5 = 10 kΩ (0,25 W)	C5 = 470 μF	
R6 = 22 Ω (0,5 W)	C6 = 100 nF	
R7 = 2,2 Ω (0,25 W)	C7 = 10 μF (63 V)	
R8 = 10 Ω (0,5 W)	C8 = 10 μF (63 V)	
	C9 = 1 μF (63 V)	

MOUNTING RECOMMENDATIONS

The modules are delivered with leads in SIL (single in-line) but leads may also be bent to DIL (dual in-line).

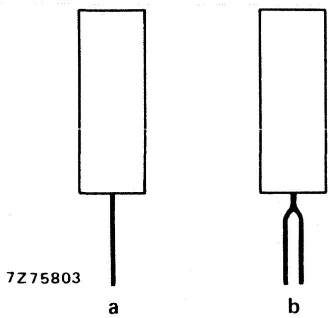
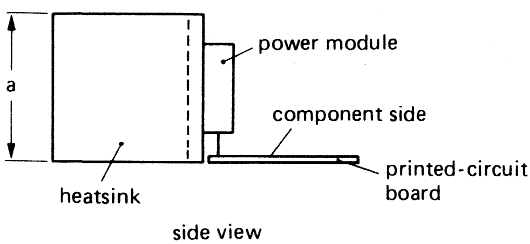


Fig. 4:
a. Single in-line (SIL) leads.
b. Dual in-line (DIL) leads.



Thermal resistance values from heatsink to ambient for various heatsink lengths (a):

$R_{th\ h\text{-}a}$ = 1,4 K/W: a = 50 mm
$R_{th\ h\text{-}a}$ = 1,0 K/W: a = 75 mm
$R_{th\ h\text{-}a}$ = 0,8 K/W: a = 90 mm

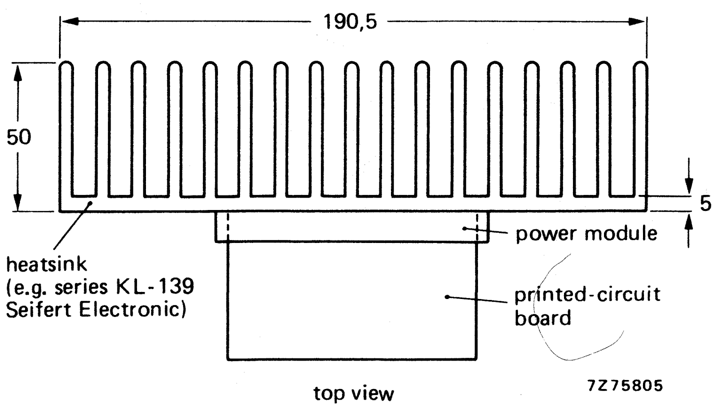


Fig. 5 Example of a heatsink to be used for the module; dimensions in mm.

PRINTED-CIRCUIT BOARDS for OM931 and OM961

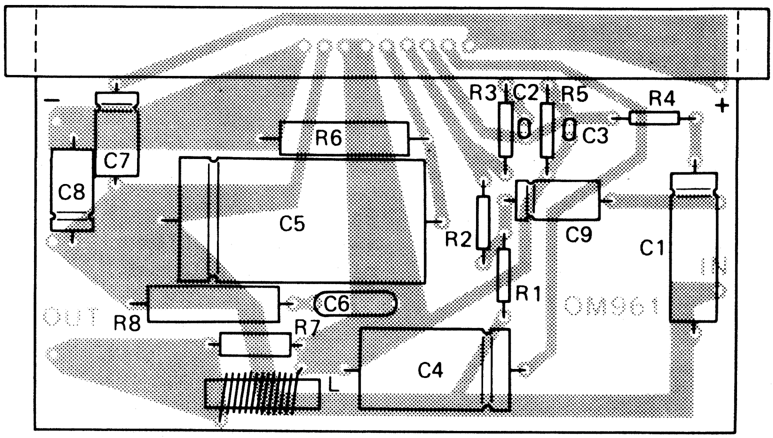


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Fig. 6 Component side of SIL-version showing component layout.

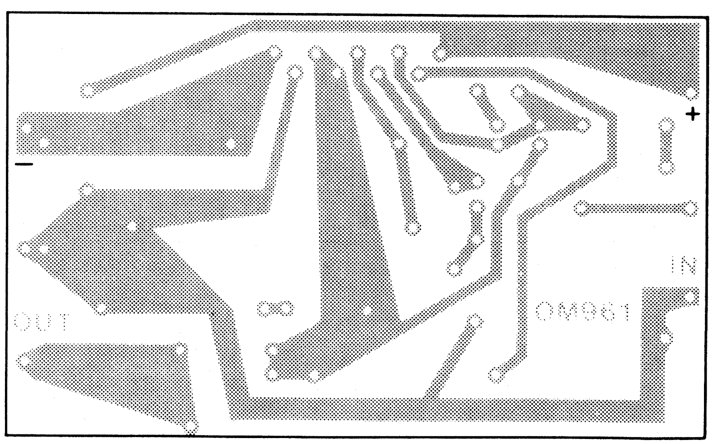

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Fig. 7 Component side of DIL-version; for component layout see Fig. 6.

Dimensions in mm

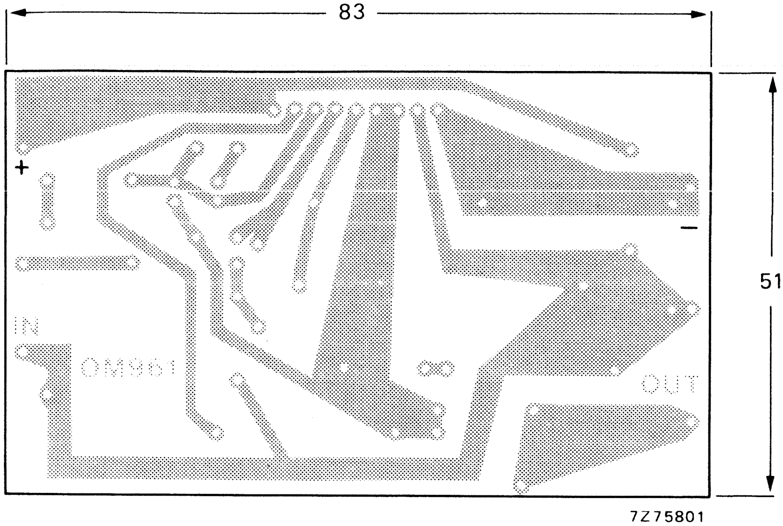


Fig. 8 Track side of SIL-version.

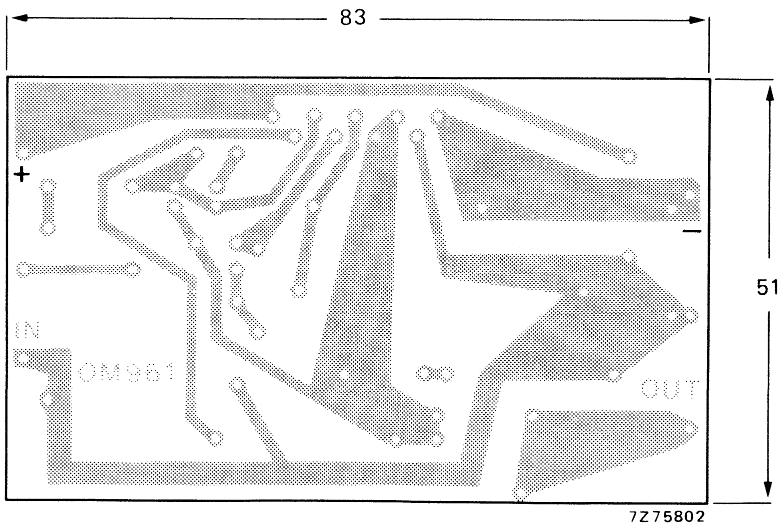


Fig. 9 Track side of DIL-version.

ACCESSORIES

TYPE NUMBER SURVEY ACCESSORIES

type number	description	envelope
56201d	mica washer (up to 500 V)	TO-3
56201j	insulating bushes (up to 500 V)	TO-3
56261a	insulating bushes (up to 500 V)	TO-3
56326	metal washer	TO-126
56339	mica washer (500 to 2000 V)	TO-3
56352	insulating mounting support	TO-3
56353	spring clip	TO-126/SOT82
56354	mica insulator	TO-126/SOT82
56359b	mica washer (up to 1000 V)	TO-220
56359c	insulating bush (up to 800 V)	TO-220
56359d	rectangular insulating bush (up to 1000 V)	TO-220
56360a	rectangular washer (brass)	TO-220
56363	spring clip (direct mounting)	TO-220
56364	spring clip (insulated mounting)	TO-220
56367	alumina insulator (up to 2000 V)	TO-220
56368a	mica insulator (up to 800 V)	SOT93
56368b	insulating bush (up to 800 V)	SOT93
56369	mica insulator (up to 2 kV)	TO-220
56378	mica insulator (up to 1500 V)	SOT93
56379	spring clip	SOT93
56387a	mica insulator (up to 300 V)	TO-126
56387b	insulating bush (up to 300 V)	TO-126

SELECTION GUIDE

CLIP MOUNTING

envelope	direct mounting		insulated mounting		
	clip		mica	alumina	clip
TO-126 (SOT32)	56353		56354		56353
SOT82	56353		56354		56353
TO-220 (SOT78)	56363		56369	56367	56364
SOT186	56363				
SOT93	56379		56378		56379
SOT199	56379				

SCREW MOUNTING

envelope	direct mounting		insulated mounting			
	metal washer	mounting size	mica washer	insulated bush	metal washer	mounting size
TO-126 (SOT32)	56326	M3				
up to 300 V			56387a	56387b	56326	M2,5
TO-220 (SOT78)	56360a	M3				
up to 800 V			56359b	56359c	56360a	M3
up to 1000 V			56359b	56359d	56360a	M3
SOT186	56360a	M3				
SOT93	–	M4	56368a	56368b		M3
SOT199	–	M				
TO-3 (SOT3)	–	M4				
up to 500 V			56201d	56201j or 56261a		M3
up to 2000 V			56339	56352		M3

The accessories included in this section can be supplied on request. Details of their use can be found in the Mounting Instructions section.

Mounting TO-126 and SOT82 envelopes.

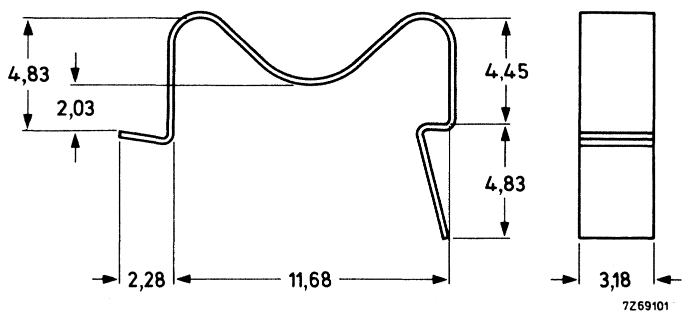
56353 CLIP

for TO-126 and SOT82 envelopes

MECHANICAL DATA

Material: high carbon spring steel

Dimensions in mm



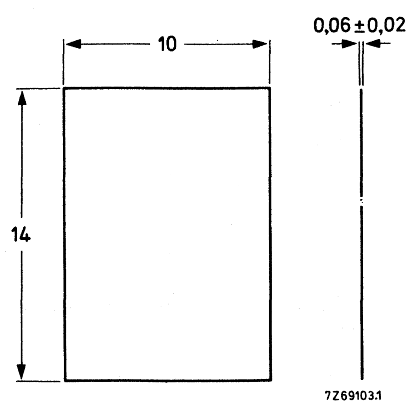
Spring clip suitable for heatsink of 1,5 to 2 mm.

56354 MICA INSULATOR

for TO-126 and SOT82 envelopes

MECHANICAL DATA

Dimensions in mm



Mounting of TO-126 envelopes

56326 WASHER

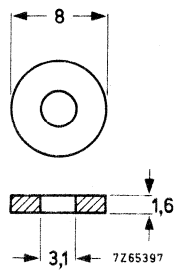
for direct mounting of TO-126 envelopes

MECHANICAL DATA

Dimensions in mm

Material: brass, nickel plated

9390 238 60112

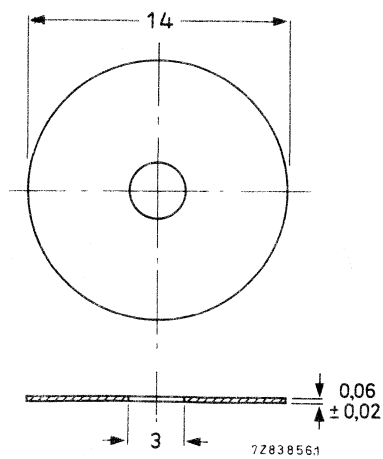


56387a MICA WASHER

for insulated screw mounting of TO-126 envelopes (up to 300 V)

MECHANICAL DATA

Dimensions in mm



Mounting of TO-126 envelopes

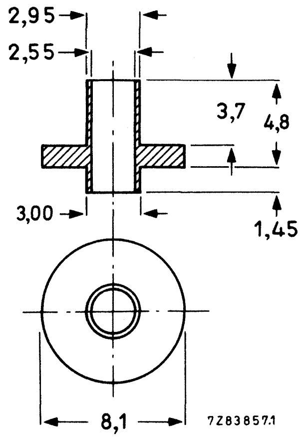
56387b INSULATING BUSH

for insulated screw mounting of TO-126 envelopes (up to 300 V)

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature T_{max} 150 °C

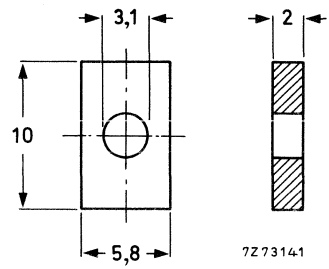
56360a RECTANGULAR WASHER

For direct and insulated mounting.

MECHANICAL DATA

Dimensions in mm

Material: brass; nickel plated.



56363 SPRING CLIP

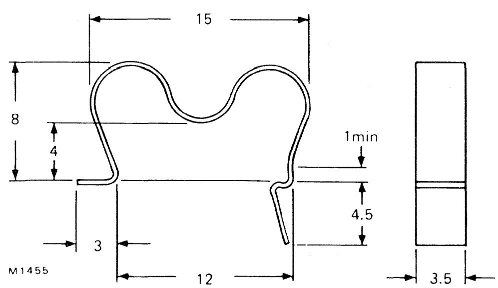
For direct mounting.

MECHANICAL DATA

Dimensions in mm

Material: stainless steel; for mounting on heatsink of 1.0 to 2.0 mm.

Recommended force of clip on device is 20 N (2 kgf).



56364 SPRING CLIP

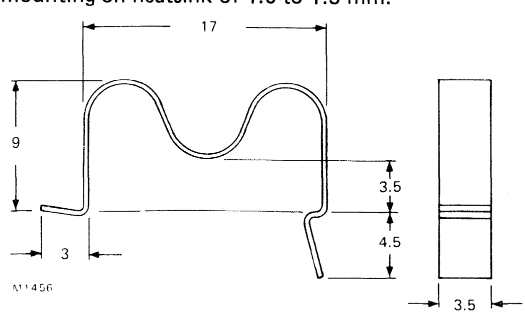
For insulated mounting.

MECHANICAL DATA

Dimensions in mm

Material: stainless steel; for mounting on heatsink of 1.0 to 1.5 mm.

Recommended force of clip on device is 20 N (2 kgf).



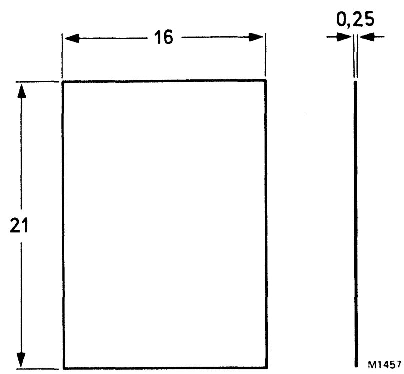
To be used in conjunction with insulators **56367** or **56369**

56367 ALUMINA INSULATOR

For insulated clip mounting up to 2 kV.

MECHANICAL DATA Dimensions in mm

Material: 96-alumina.

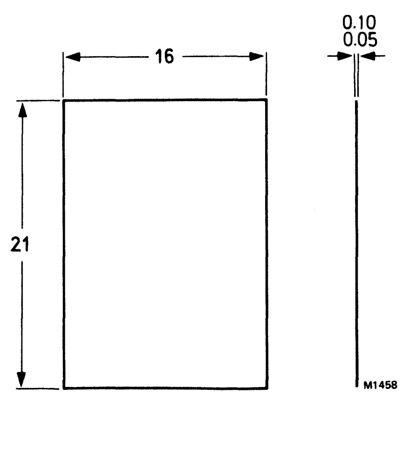


*Because alumina is brittle, extreme care must be taken when mounting devices not to crack the alumina, particularly when used without heatsink compound.

56369 MICA INSULATOR

For insulated clip mounting up to 2 kV.

MECHANICAL DATA Dimensions in mm

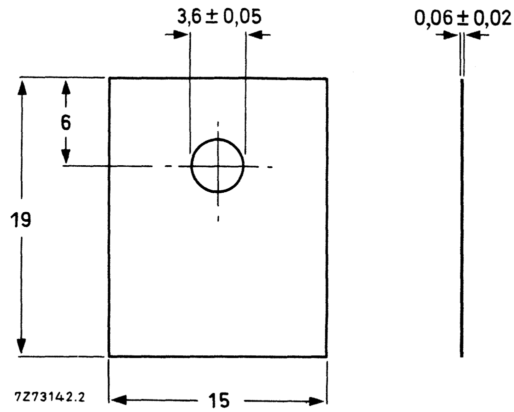


Mounting TO-220 envelopes

56359b MICAWASHER

for TO-220 envelopes (up to 1000 V)

Dimensions in mm



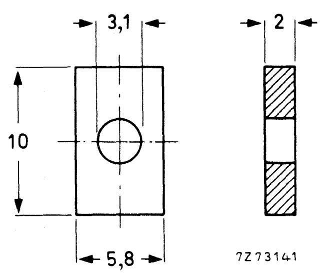
56360a RECTANGULAR WASHER

for direct and insulated mounting of TO-220 envelopes

MECHANICAL DATA

Material: brass; nickel plated.

Dimensions in mm



Mounting TO-220 envelopes

56359c INSULATING BUSH

for TO-220 envelopes (up to 800 V)

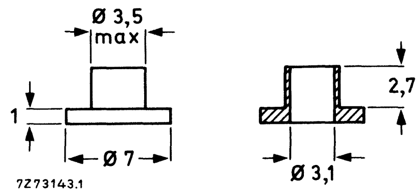
MECHANICAL DATA

Dimensions in mm

Material: polyester

TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C



56359d RECTANGULAR INSULATING BUSH

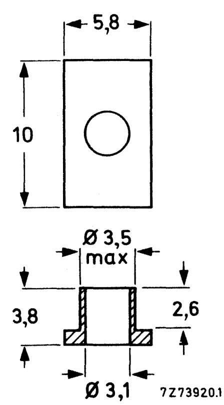
for TO-220 envelopes (up to 1000 V)

MECHANICAL DATA

Dimensions in mm

TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C



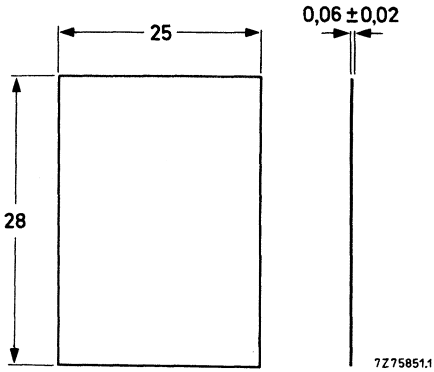
Clip mounting of SOT93 envelopes.

56378 MICA INSULATOR

for SOT93 clip mounting (up to 1500 V)

MECHANICAL DATA

Dimensions in mm



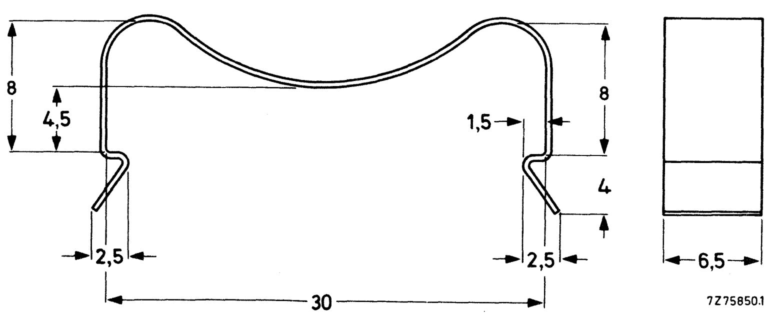
56379 SPRING CLIP

for direct and insulated mounting of SOT93 envelopes

MECHANICAL DATA

Dimensions in mm

Material:
CrNi steel NLN-939;
thickness 0,4 ± 0,04.



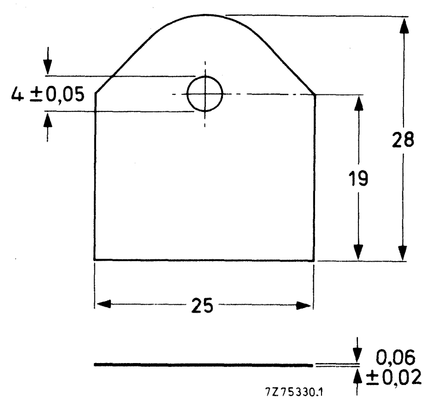
Screw mounting of SOT93 envelopes.

56368a MICA INSULATOR

for insulated screw mounting of SOT93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm



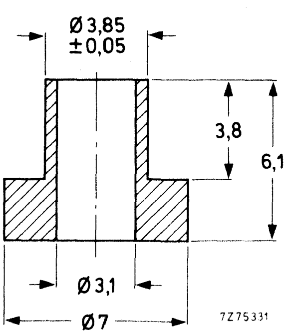
56368b INSULATING BUSH

for insulated screw mounting of SOT93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

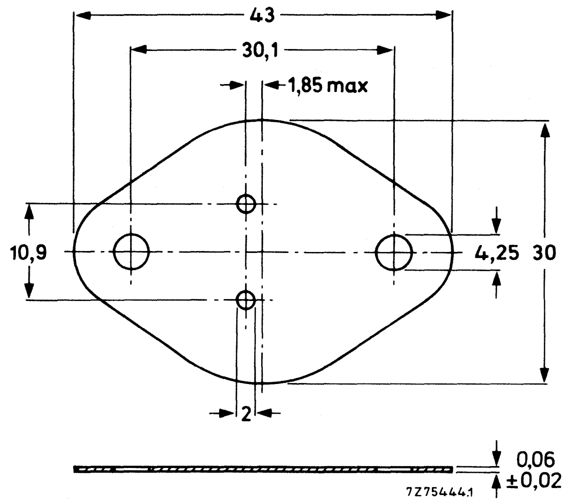
Mounting TO-3 envelopes

56201d MICA WASHER

Mica washer for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm



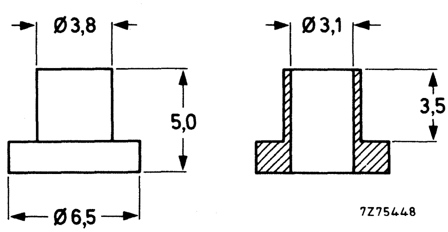
56201j 2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm

material: polyester



TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

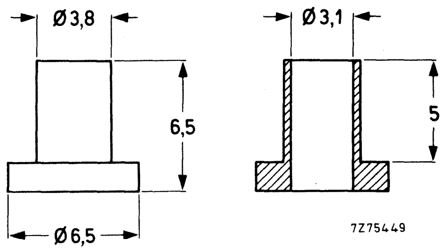
Mounting TO-3 envelopes

56261a 2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA Dimensions in mm

Material: polyester



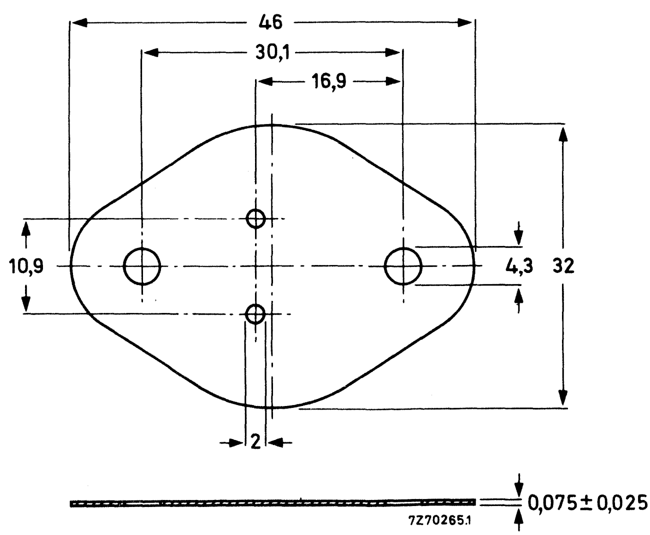
TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

56339 MICA WASHER

Mica washer for 500 to 2000 V insulation of TO-3 envelopes, for which it should be combined with mounting support 56352.

MECHANICAL DATA Dimensions in mm



Mounting TO-3 envelopes

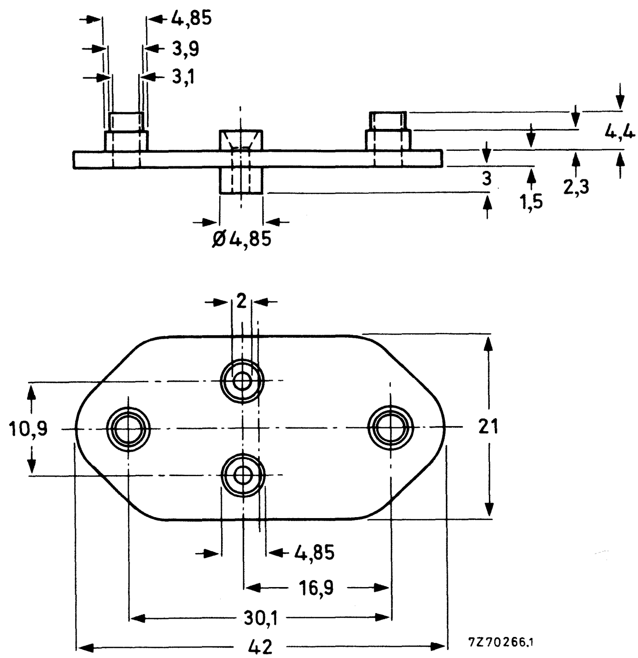
56352 MOUNTING SUPPORT

Mounting support for 500 to 2000 V insulation of TO-3 envelopes, for which it should be combined with mica washer 56339.

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature $T_{max} = 125\ ^oC$

MOUNTING INSTRUCTIONS

General note on flat heatsinks

All information on thermal resistances of the accessories combined with flat heatsinks is valid for *square* heatsinks of *1,5 mm blackened aluminium.*

For a few variations the thermal resistance may be derived as follows:

- Rectangular heatsinks (sides a and 2a)
  When mounted with long side horizontal, multiply by 0,95.
  When mounted with short side horizontal, multiply by 1,10.
- Unblackened or thinner heatsinks
  Multiply by the factor given in Fig. 1 as a function of the heatsink size A.

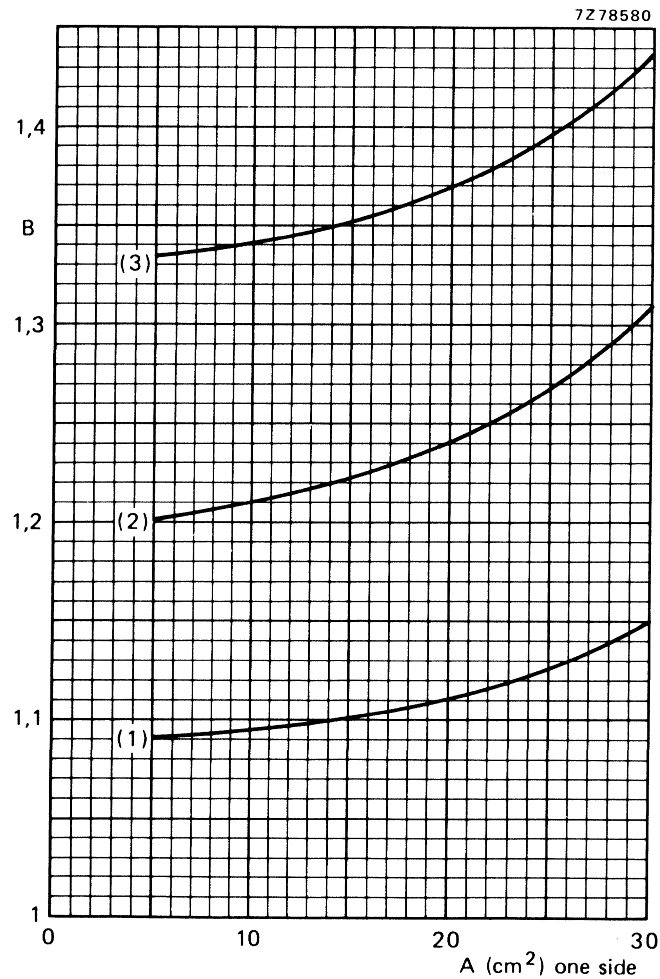


Fig. 1 Multiplication factor (B) as a function of heatsink area (A).
(1) 1 mm blackened aluminium.
(2) 1,5 mm unblackened aluminium.
(3) 1 mm unblackened aluminium.

MOUNTING INSTRUCTIONS FOR TO-3 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

Instructions for direct mounting.

Mounting instructions for up to 500 V insulation.
Using insulating bushes 56201j or 56261a and mica washer 56201d.

Mounting instructions for 500 to 2000 V insulation.
Using mounting support 56352 and mica washer 56339.

Heatsink requirements

Flatness in the mounting area: 0,05 mm per 40 mm

Mounting holes must be deburred.

Mounting torques

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the transistor)	0,6 Nm (6 kgcm)

N.B.: When the driven nut or screw is in direct contact with a toothed lock washer (e.g. Fig. 10), the torques are as follows:

Minimum torque	0,55 Nm (5,5 kgcm)
Maximum torque	0,8 Nm (8 kgcm)

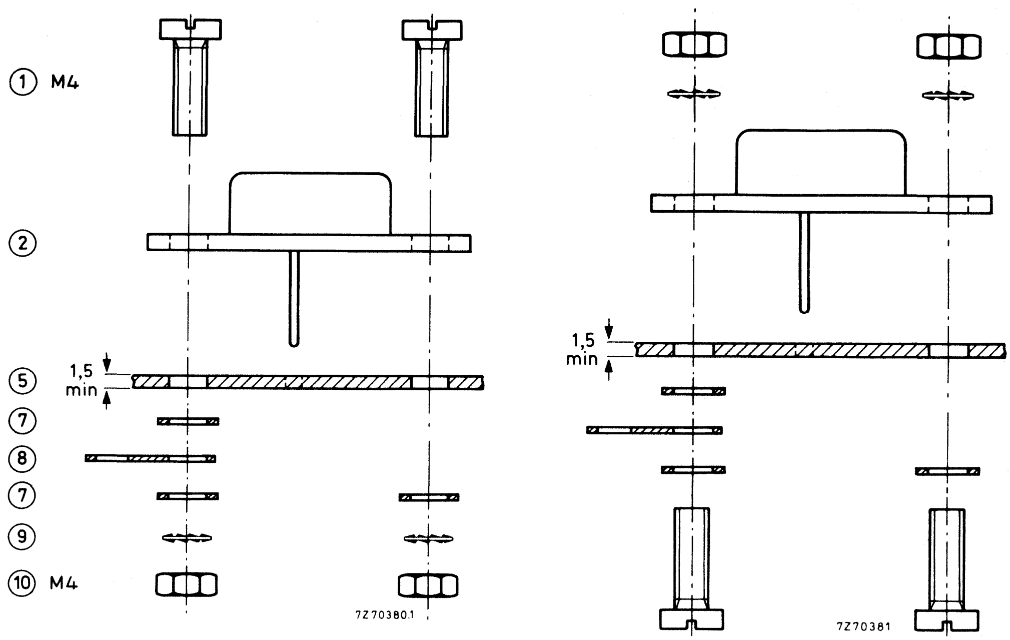
Thermal data

The thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) can be reduced by applying a heat conducting compound between transistor and heatsink. For insulated mounting the compound should be applied to the bottom of both device and insulator.

		Direct mounting	Insulated mounting 500 V mica	Insulated mounting 2000 V mica	
From mounting base to heatsink					
without heatsink compound	$R_{th\ mb\text{-}h}$	0,6	1,0	1,25	K/W
with heatsink compound	$R_{th\ mb\text{-}h}$	0,1	0,3	0,5	K/W

INSTRUCTIONS FOR DIRECT MOUNTING

The transistors should be mounted with M4 screws, see Figs 1 and 2. Minimum heatsink thickness (for good heat transfer) 1,5 mm. Hole pattern: Fig. 3.
A heatsink with tapped holes or insert nuts can also be used, but a torque washer is necessary between metal washer and transistor. See Fig. 4.



Figs 1 and 2. Direct mounting with nuts.

Legend for TO-3 mounting figures

(1) = screw
(2) = TO-3
(4) = mica
(5) = heatsink
(6) = insulating bush
(7) = metal washer
(8) = soldering tag
(9) = lock washer
(10) = nut
(11) = tapped hole
(12) = insert nut
Dimensions in mm

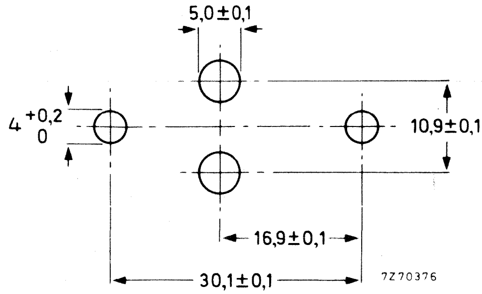


Fig. 3 Hole pattern for direct mounting with nuts.

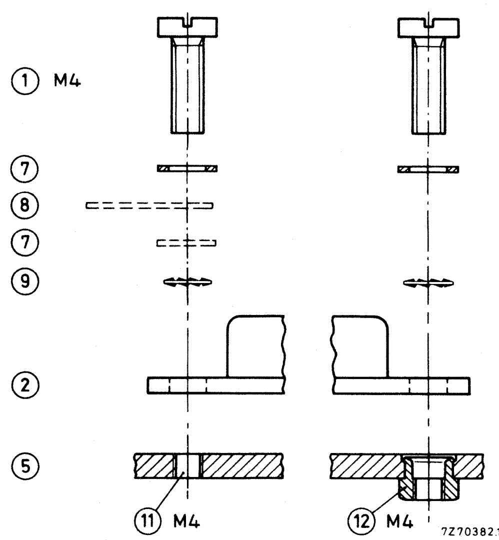


Fig. 4 Direct mounting with tapped holes or insert nuts.

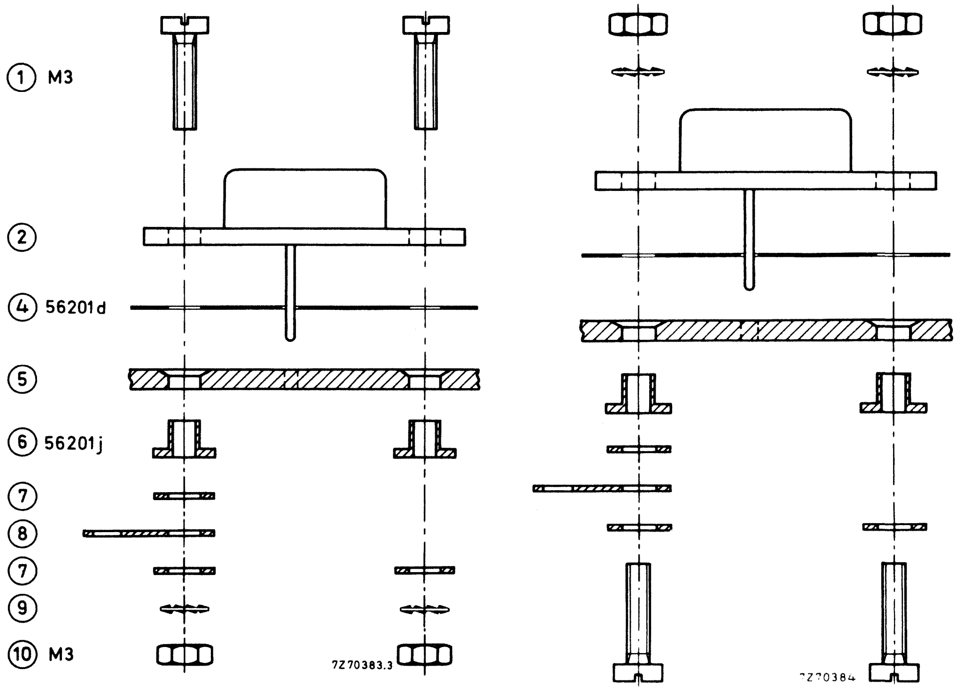
MOUNTING INSTRUCTIONS FOR UP TO 500 V INSULATION

Using insulating bushes 56201j and mica washer 56201d

For the component arrangement with minimum heatsink thickness see Figs 5 and 6. For hole pattern and shape of holes see Figs 7 and 8.

Using insulating bush 56261a and mica washer 56201d

For an arrangement with M3 screws and nuts see Fig. 9, mounting holes are given in Figs 7 and 8. The accessories can also be used in combination with M3 screws and heatsinks provided with tapped holes or insert nuts. Lock washers are necessary between screw-head and metal washer, see Fig. 10. For an assembly drawing with tapped holes see Fig. 11, with insert nuts see Fig. 12.



Figs 5 and 6. Insulated mounting (500 V) with 56201j and 56201d. Heatsink thickness: 1,5 to 2,5 mm.

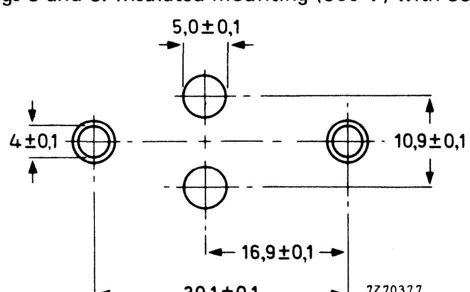


Fig. 7 Hole pattern for 500 V insulation, nut fastening.

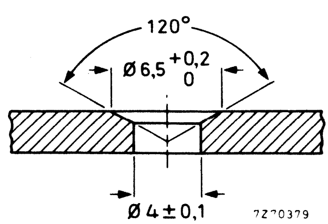


Fig. 8 Shape of hole for 500 V insulation, nut fastening.

For legend see Figs 1 and 2.

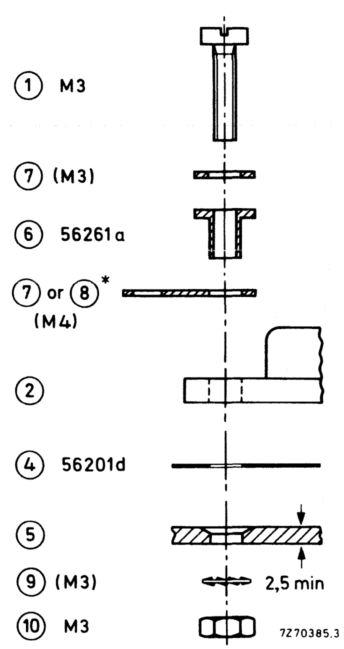


Fig. 9 Insulated mounting (500 V) with nuts.

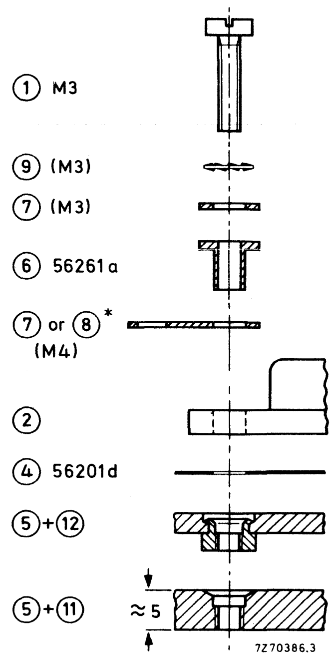


Fig. 10 Insulated mounting (500 V) with tapped holes or insert nuts.

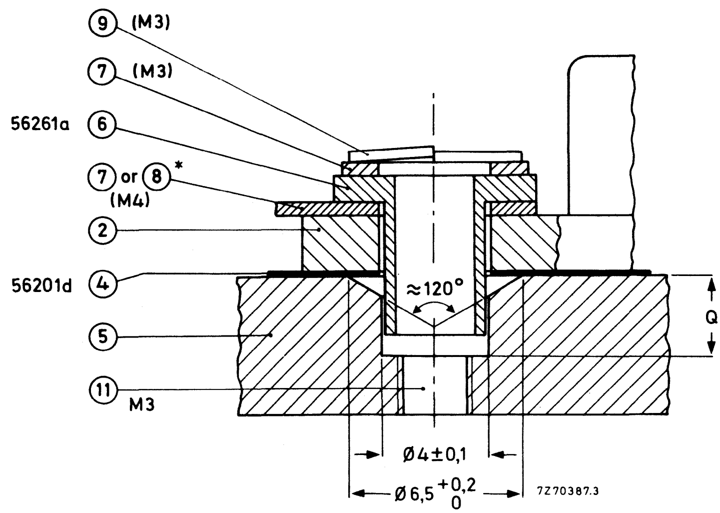


Fig. 11 Assembly (partial) for Fig. 10 - tapped holes.
Q minimum 2,5 mm.

For legend see Figs 1 and 2.

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

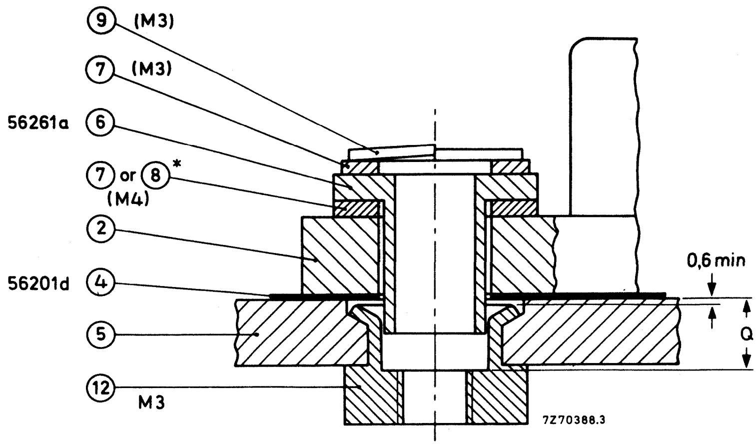


Fig. 12 Assembly (partial) for Fig. 10 - insert nuts Q minimum 2,5 mm.

For legend see Figs 1 and 2.

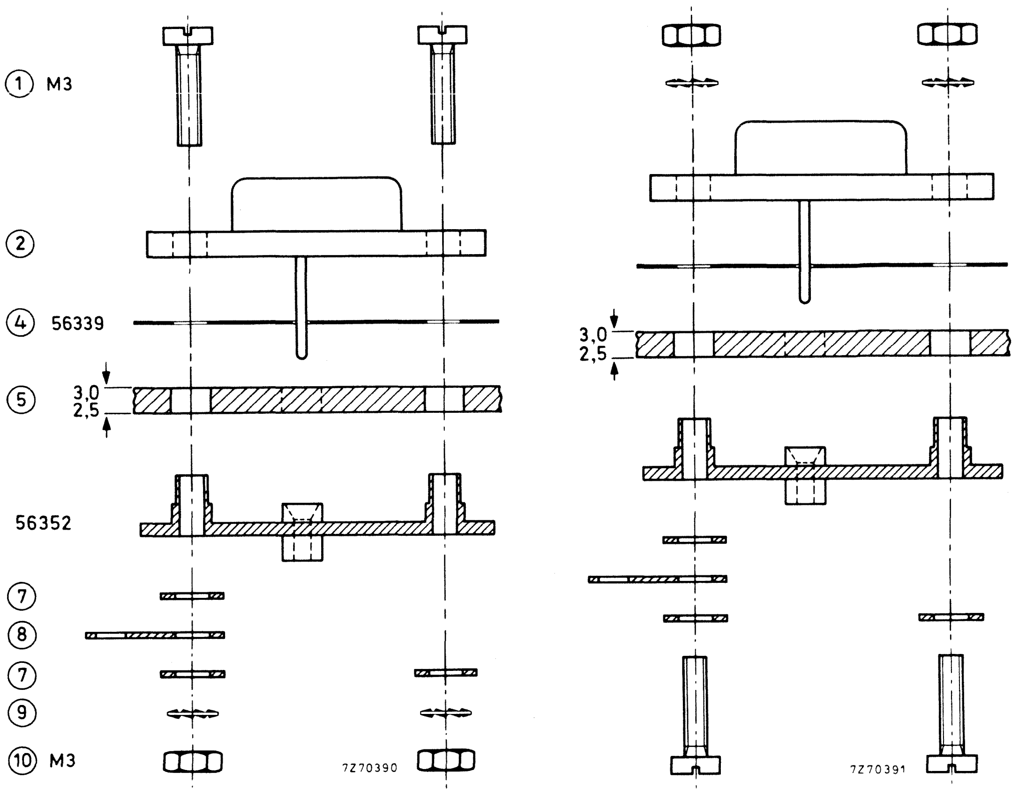
Dimensions in mm

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

MOUNTING INSTRUCTIONS FOR 500 V TO 2000 V INSULATION

Using mounting support 56352 and mica washer 56339

The transistor should be mounted with M3 screws. For component arrangement see Figs 13 and 14.
For hole pattern see Fig. 15. Thickness of heatsink 2,5 mm to 3 mm.



Figs 13 and 14. Insulated mounting (500 V—2000 V).

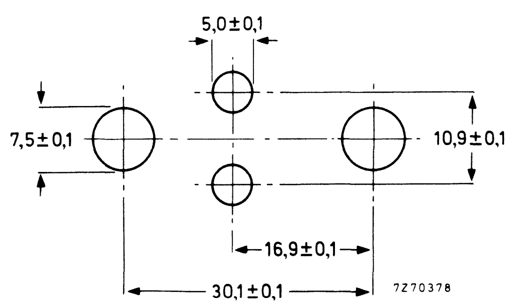


Fig. 15 Hole pattern for Figs 13 and 14.

For legend see Figs 1 and 2.

MOUNTING INSTRUCTIONS FOR TO-126 AND SOT-82 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rules

1. First fasten the devices to the heatsink before soldering the leads.
2. Avoid axial stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Heatsink requirements

Minimum thickness: 2 mm.
Flatness in the mounting area: 0,02 mm maximum per 10 mm.
Mounting holes must be deburred and should also be perpendicular to the plane of the heatsink, within 10^{o} tolerance for M2,5 thread and within 2^{o} tolerance for M3 thread. If the hole in the heatsink is threaded, it should be counter-sunk and free of burrs.

Heatsink compound

Values of the thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting methods for power transistors

1. Clip mounting (TO-126 and SOT-82)

   Mounting by means of spring clip offers:

   a. A good thermal contact under the crystal area.
   b. Safe insulation for mains and high voltage operation

2. M2,5 and M3 screw mounting. (TO-126 only).

   The spacing washer should be inserted between screw head and body.

   Mounting torque for screw mounting:

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)

   N.B. when the driven nut or screw is in direct contact with a toothed lock washer the torques are as follows:

Minimum torque (for good heat transfer)	0,55 Nm (5,5 kgcm)
Maximum torque (to avoid damaging the device)	0,80 Nm (8,0 kgcm)

3. Body mounting (SOT-82).

   A SOT-82 envelope can be adhesive mounted or soldered into a hybrid circuit.
   For soldering a copper plate or an anodized aluminium plate with copper layer is recommended.
   When adhesive mounting is applied also a ceramic substrate may be used.

Thermal data

From mounting base to heatsink

	$R_{th\ mb\text{-}h}$ (K/W)			
	clip mounting		screw mounting	
	direct	insulated	direct	insulated
TO-126, with heatsink compound	1,0	3,0	0,5	3,0
TO-126, without heatsink compound	3,0	6,0	1,0	6,0
SOT-82, with heatsink compound	0,4	2,0	–	–
SOT-82, without heatsink compound	2,0	5,0	–	–

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 20 N (2 kgf).

The leads can be bent through 90° maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body, using pliers. The leads should neither be bent nor twisted less than 2,4 mm from the body.

Lead soldering

For devices with a maximum junction temperature $\leqslant$ 150 $^{\circ}$C.

a. Dip or wave soldering
   Temperature $\leqslant$ 260 $^{\circ}$C at a distance from the body $>$ 5 mm and for a total contact time with soldering bath or waves $<$ 7 s.
b. Hand soldering
   Temperature at a distance from the body $>$ 3 mm for a total contact time $<$ 5 s is $<$ 275 $^{\circ}$C or $<$ 250 $^{\circ}$C for a total contact time of $<$ 10 s.

The body of the device must be kept clear of anything with a temperature $>$ 200 $^{\circ}$C.
Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

Mounting base soldering

Recommended metal-alloy of solder paste (85% metal weight)
62 Sm/36 Pb/2 Ag or 60 Sn/40 Pb.
Maximum soldering temperature $\leqslant$ 200 $^{\circ}$C (tab-temperature).
Soldering cycle duration including pre-heating $\leqslant$ 30 sec.

For good soldering and avoiding damage to the encapsulation pre-heating is recommended to a temperature $\leqslant$ 165 $^{\circ}$C at a duration $\leqslant$ 10 s.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56353

1. Place the device on the heatsink, applying heatsink compound to the mounting base.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 1 and 2).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body (see Fig. 3).

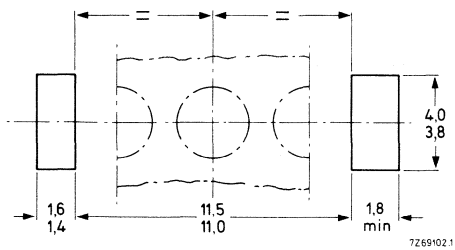


Fig. 1 Heatsink requirements.

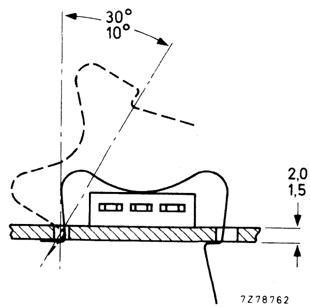


Fig. 2 Mounting spring clip.

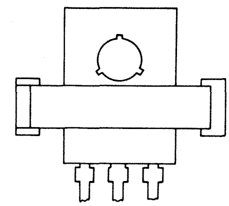


Fig. 3 Position of transistor (top view).

Insulated mounting with clip 56353 and mica 56354 (up to 1000 V insulation)

1. Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 4 and 5).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body (Fig. 6). Ensure that the device is centred on the mica insulator to prevent creepage.

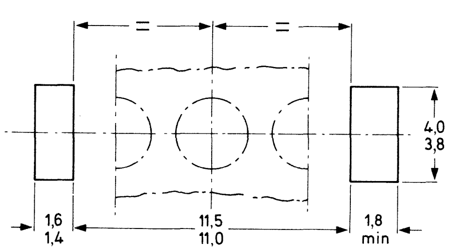


Fig. 4 Heatsink requirements.

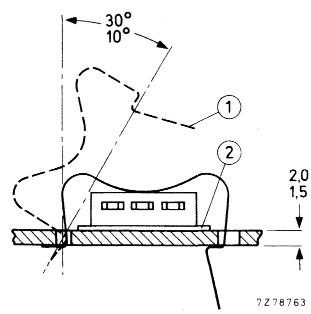


Fig. 5 Mounting.
(1) spring clip 56353.
(2) insulator 56354.

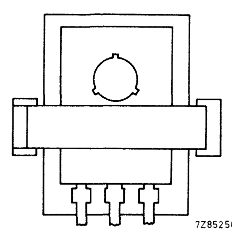


Fig. 6 Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

Direct mounting with screw and spacing washer

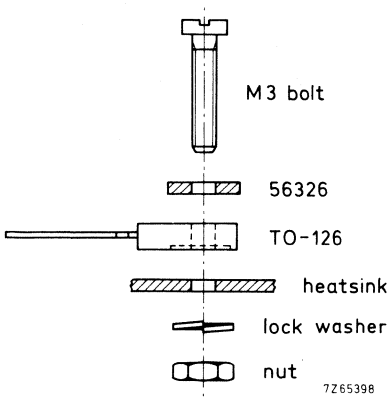


Fig. 7 Assembly through heatsink with nut.

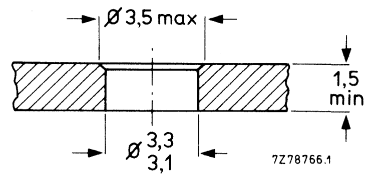


Fig. 8 Heatsink requirements.

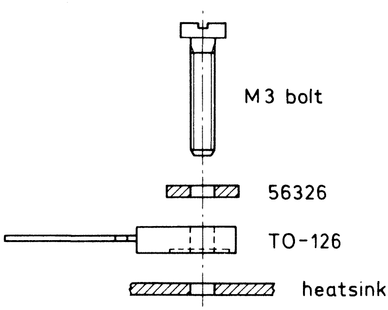


Fig. 9 Assembly into tapped heatsink.

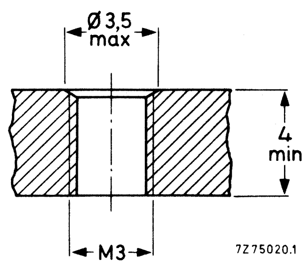


Fig. 10 Heatsink requirements.

INSTRUCTIONS FOR SCREW MOUNTING

Insulated mounting with 56326, 56387a and 56387b (up to 300 V)

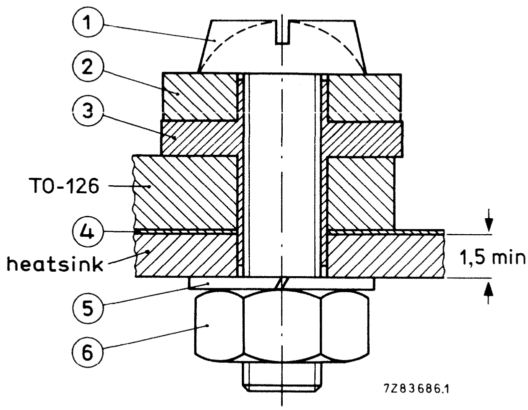


Fig. 15 Assembly through heatsink with nut.

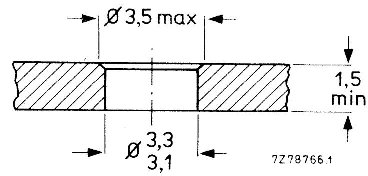


Fig. 16 Heatsink requirements.

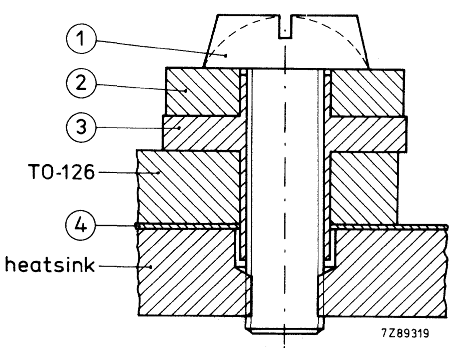


Fig. 17 Assembly with tapped heatsink.

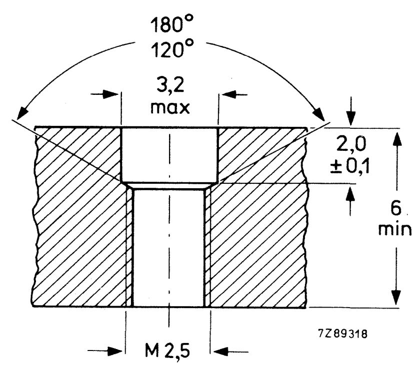


Fig. 18 Heatsink requirements.

Legend

1 M2,5 screw
2 metal washer 56326
3 insulating bush 56387b
4 mica washer 56387 a
5 lock washer
6 M2,5 nut

MOUNTING INSTRUCTIONS FOR TO-220 AND SOT-186 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rules

1. First fasten the device to the heatsink before soldering the leads.
2. Avoid axial stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.
4. The rectangular washer may only touch the plastic part of the body; it should not exert any force on that part (screw mounting).

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum per 10 mm.
Mounting holes must be deburred, see further mounting instructions.

Heatsink compound

Values of the thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting methods for power transistors

1. Clip mounting

   Mounting with a spring clip gives:

   a. A good thermal contact under the crystal area, and slightly lower $R_{th\ mb\text{-}h}$ values than screw mounting.
   b. Safe insulation for mains operation.

2. M3 screw mounting

   It is recommended that the rectangular spacing washer is inserted between screw head and mounting tab.

   Mounting torque for screw mounting:

   (For thread-forming screws these are final values. Do not use self-tapping screws.)

Minimum torque (for good heat transfer)	0,55 Nm (5,5 kgcm)
Maximum torque (to avoid damaging the device)	0,80 Nm (8,0 kgcm)

N.B.: When a nut or screw is not driven direct against a curved spring washer or lock washer (not for thread-forming screw), the torques are as follows:

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)

N.B.: Data on accessories are given in separate data sheets.

3. Rivet mounting non-insulated

   The device should not be pop-rivetted to the heatsink. However, it is permissible to press-rivet providing that eyelet rivets of soft material are used, and the press forces are slowly and carefully controlled so as to avoid shock and deformation of either heatsink or mounting tab.

Thermal data

			clip mounting	screw mounting	
From mounting base to heatsink					
with heatsink compound, direct mounting	$R_{th\ mb\text{-}h}$	=	0,3	0,5	K/W
without heatsink compound, direct mounting	$R_{th\ mb\text{-}h}$	=	1,4	1,4	K/W
with heatsink compound and 0,1 mm maximum mica washer	$R_{th\ mb\text{-}h}$	=	2,2	–	K/W
with heatsink compound and 0,25 mm maximum alumina insulator	$R_{th\ mb\text{-}h}$	=	0,8	–	K/W
with heatsink compound and 0,05 mm mica washer					
insulated up to 500 V	$R_{th\ mb\text{-}h}$	=	–	1,4	K/W
insulated up to 800 V/1000 V	$R_{th\ mb\text{-}h}$	=	–	1,6	K/W
without heatsink compound and 0,05 mm mica washer					
insulated up to 500 V	$R_{th\ mb\text{-}h}$	=	–	3,0	K/W
insulated up to 800 V/1000 V	$R_{th\ mb\text{-}h}$	=	–	4,5	K/W

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 20 N (2 kgf).

The leads can be bent through 90° maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body, using pliers. The leads should neither be bent nor twisted less than 2,4 mm from the body.

Soldering

Lead soldering temperature at > 3 mm from the body; $t_{sld} < 5$ s:

Devices with $T_{j\ max} \leqslant 175$ °C, soldering temperature $T_{sld\ max} = 275$ °C.
Devices with $T_{j\ max} \leqslant 110$ °C, soldering temperature $T_{sld\ max} = 240$ °C.

Avoid any force on body and leads during or after soldering: do not correct the position of the device or of its leads after soldering.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise its junction temperature rating will be exceeded.

Mounting base soldering

Recommended metal-alloy of solder paste (85% metal weight)
62 Sm/36 Pb/2 Ag or 60 Sn/40 Pb.
Maximum soldering temperature ⩽ 200 °C (tab-temperature).
Soldering cycle duration including pre-heating ⩽ 30 sec.

For good soldering and avoiding damage to the encapsulation pre-heating is recommended to a temperature ⩽ 165 °C at a duration ⩽ 10 s.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56363

1. Apply heatsink compound to the mounting base, then place the transistor on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 1 and 2).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 2a).

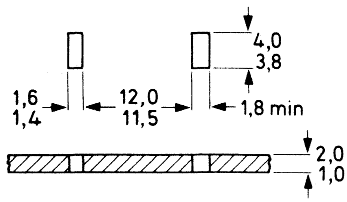


Fig. 1 Heatsink requirements.

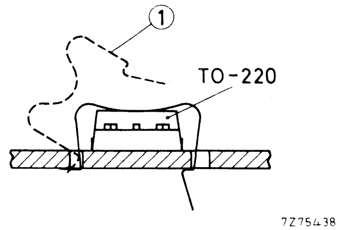


Fig. 2 Mounting.
(1) spring clip 56363.

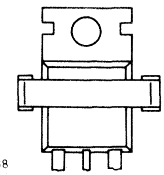


Fig. 2a Position of transistor (top view).

Insulated mounting with clip 56364

With the insulators 56367 or 56369 insulation up to 2 kV is obtained.

1. Apply heatsink compound to the bottom of both transistor and insulator, then place the transistor with the insulator on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 3 and 4).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab. Ensure that the device is centred on the mica insulator to prevent creepage.

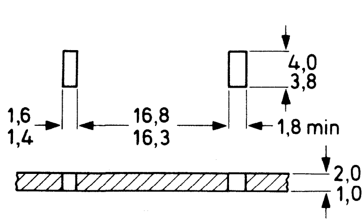


Fig. 3 Heatsink requirements.

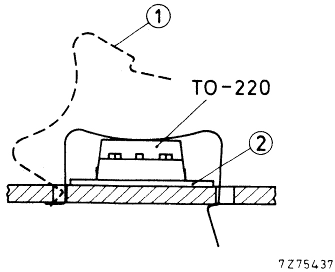


Fig. 4 Mounting.
(1) spring clip 56364.
(2) insulator 56369 or 56367.

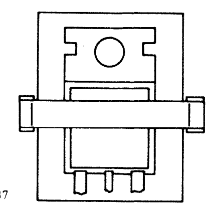


Fig. 4a Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

Direct mounting with screw and spacing washer

- *through heatsink with nut*

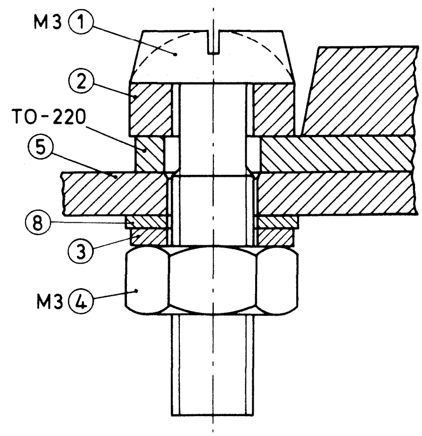


Fig. 5 Assembly.

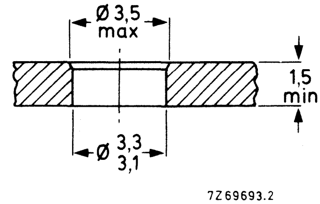


Fig. 6 Heatsink requirements.

(1) M3 screw.
(2) rectangular washer (56360a).
(3) lock washer.
(4) M3 nut.
(5) heatsink.
(8) plain washer.

- *into tapped heatsink*

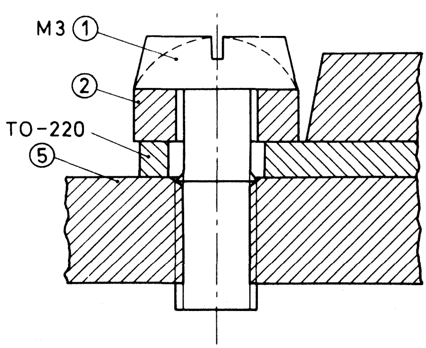


Fig. 7 Assembly.

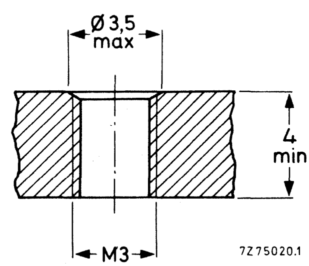


Fig. 8 Heatsink requirements.

(1) M3 screw.
(2) rectangular washer 56360a.
(5) heatsink.

Insulated mounting with screw and spacing washer
(not recommended where mounting tab is on mains voltage)

Dimensions in mm

- *through heatsink with nut*

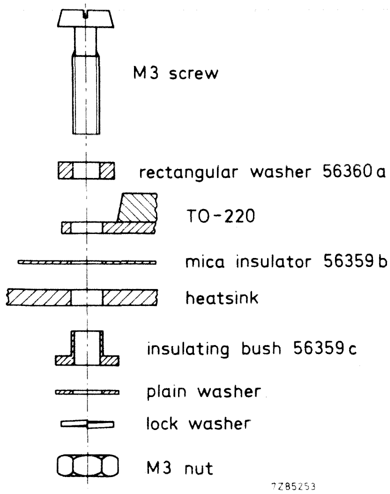


Fig. 9 Insulated screw mounting with rectangular washer. Known as a "bottom mounting".

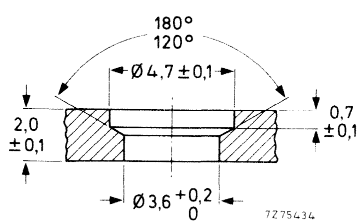


Fig. 10 Heatsink requirements for 500 V insulation.

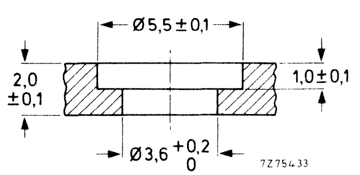


Fig. 11 Heatsink requirements for 800 V insulation.

- *into tapped heatsink*

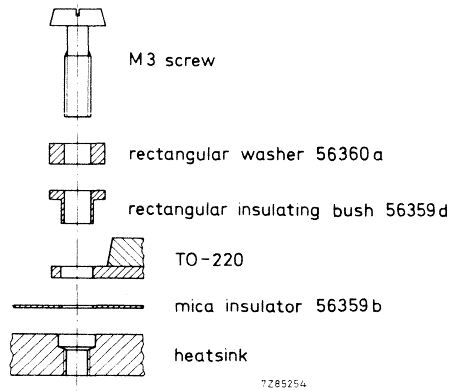


Fig. 12 Insulated screw mounting with rectangular washer into tapped heatsink. Known as a "top mounting".

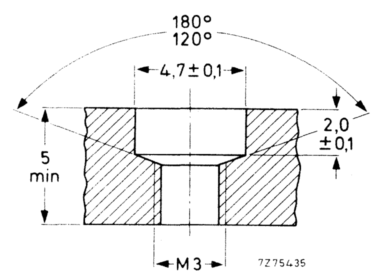


Fig. 13 Heatsink requirements for 500 V insulation.

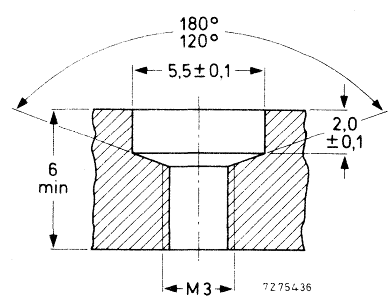


Fig. 14 Heatsink requirements for 1000 V insulation.

MOUNTING INSTRUCTIONS FOR SOT-93 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rule

Avoid any sudden forces on leads and body; these forces, such as from falling on a hard surface, are easily underestimated. In the direct screw mounting an M4 screw must be used; an M3 screw in the insulating mounting.

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum per 10 mm.
The mounting hole must be deburred.

Heatsink compound

The thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) can be reduced by applying a metallic-oxide heatsink compound between the contact surfaces. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Maximum play

The bush or the washer may only just touch the plastic part of the body, but should not exert any force on that part. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Mounting torques

For M3 screw (insulated mounting):	
Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)
For M4 screw (direct mounting only):	
Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	1,0 Nm (10 kgcm)

Note: The M4 screw head should not touch the plastic part of the envelope.

Lead bending

Maximum permissible tensile force on the body for 5 s — 20 N (2 kgf)

No torsion is permitted at the emergence of the leads.

Bending or twisting is not permitted within a lead length of 0,3 mm.

The leads can be bent through 90° maximum, twisted or straightened; to keep forces within the above-mentioned limits, the leads are generally clamped near the body.

N.B.: Data on accessories are given in chapter Accessories.

Soldering

Recommendations for devices with a maximum junction temperature rating ⩽ 175 °C:

a. Dip or wave soldering

Maximum permissible solder temperature is 260 °C at a distance from the body of > 5 mm and for a total contact time with soldering bath or waves of < 7 s.

b. Hand soldering

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

The body of the device must not touch anything with a temperature > 200 °C.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise the junction temperature rating will be exceeded.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

Thermal data

			clip mounting	screw mounting
Thermal resistance from mounting base to heatsink				
direct mounting				
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0,3	0,3 K/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	1,5	0,8 K/W
with 0,05 mm mica washer				
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0,8	0,8 K/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	3,0	2,2 K/W

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56379

1. Place the device on the heatsink, applying heatsink compound to the mounting base.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Fig. 1b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 1(c)).

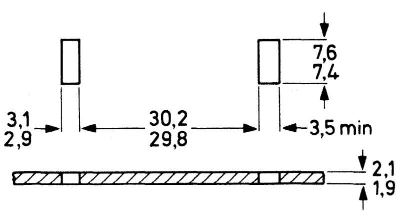


Fig. 1a Heatsink requirements.

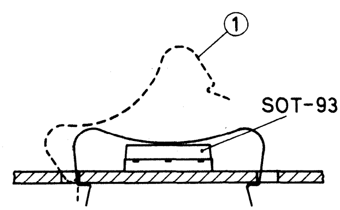


Fig. 1b Mounting.
(1) = spring clip 56379.

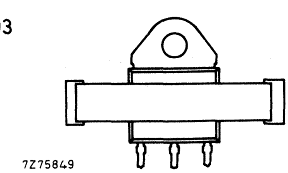


Fig. 1c Position of the device.

Insulated mounting with clip 56379

With the mica 56378 insulation up to 1500 V is obtained.

1. Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10^{o} to 20^{o} to the vertical (see Figs 2a and 2b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 2c). There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

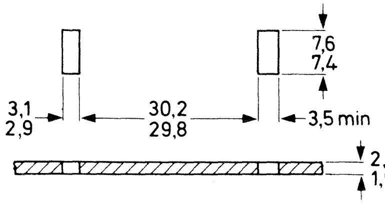


Fig. 2a Heatsink requirements.

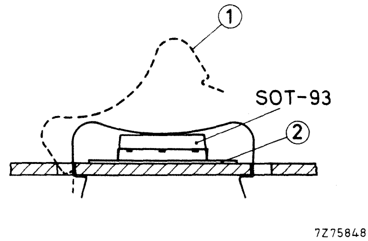


Fig. 2b Mounting.
(1) = spring clip 56379
(2) = insulator 56378

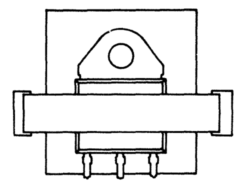


Fig. 2c Position of the device.

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting

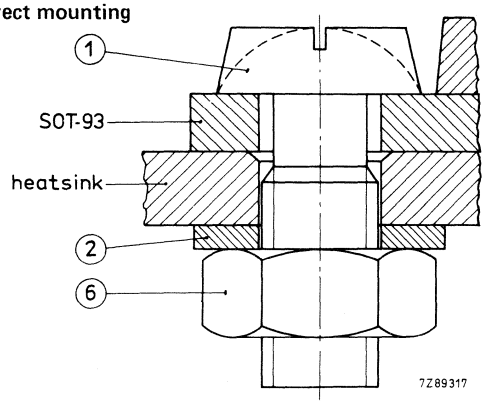


Fig. 3a Assembly through heatsink with nut.

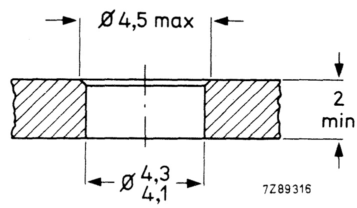


Fig. 3b Heatsink requirements.

When screw mounting the SOT-93 envelope, it is particularly important to apply a thin, even layer of heatsink compound to the mounting base, and to apply torque to the screw slowly so that the compound has time to flow and the mounting base is not deformed. Most SOT-93 envelopes contain a crystal larger than that in the other plastic envelopes, and it is more likely to crack if the mounting base is deformed.

Legend: (1) M4 screw; (2) plain washer; (6) M4 nut.
Where vibrations are to be expected the use of a lock washer or of a curved spring washer is recommended, with a plain washer between aluminium heatsink and spring washer.

Insulated screw mounting with nut; up to 800 V.

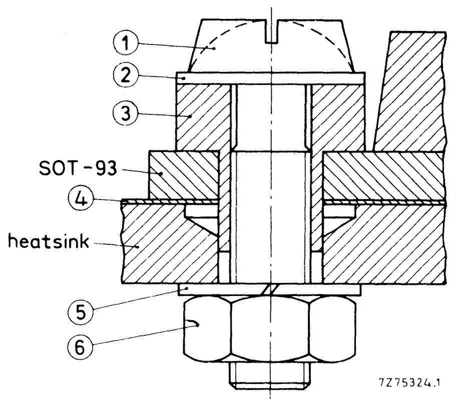


Fig. 4 Assembly.
See also Fig. 9.

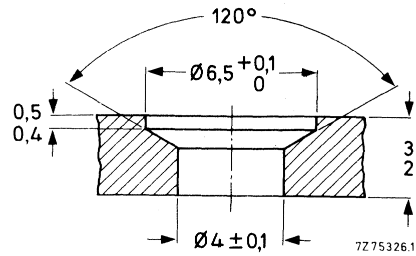


Fig. 5 Heatsink requirements up to 800 V insulation.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368a)
(5) lock washer
(6) M3 nut

Insulated screw mounting with tapped hole; up to 800 V.

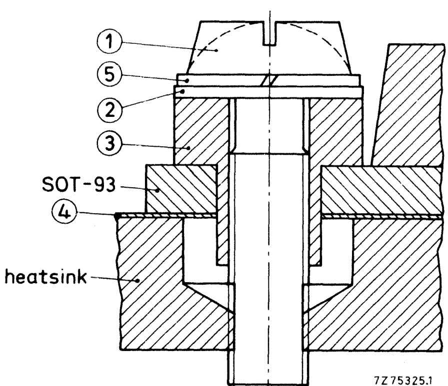


Fig. 6 Assembly.
See also Fig. 9.

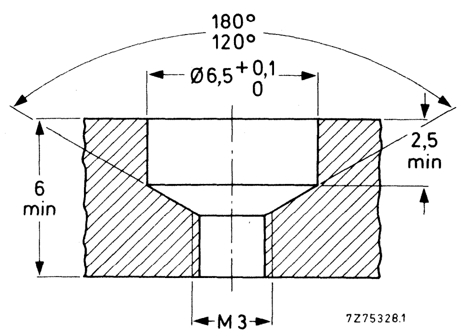


Fig. 7 Heatsink requirements up to 800 V insulation.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368a)
(5) lock washer

Insulated screw mounting with insert nut; up to 500 V

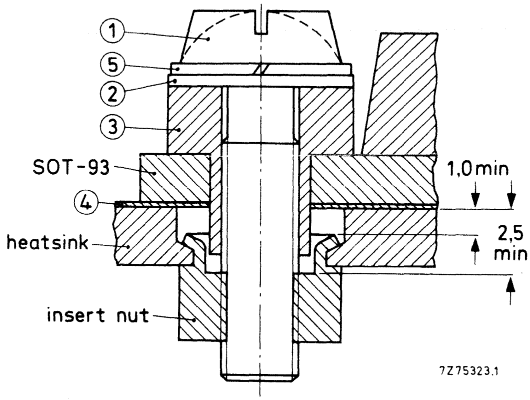


Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368a)
(5) lock washer

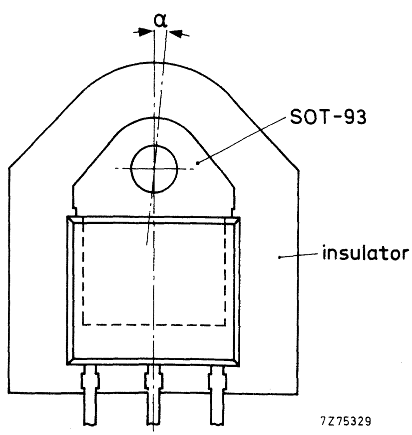


Fig. 9 Mica insulator.

The axial deviation (α) between SOT-93 and mica should not exceed 5^o.

INDEX OF TYPE NUMBERS

The inclusion of a type number in this publication does not necessarily imply its availability.

Key to handbook sections

A = Accessories
FET = Field-effect transistors
I = Infrared devices
LED = Light-emitting diodes
LCD = Liquid crystal displays
Mm = Surface-mounted devices
M = Microwave transistors
P = Low-frequency power transistors and modules
PDT = Photodiodes or transistors
Ph = Photoconductive devices
PhC = Photocouplers
PM = PowerMOS transistors
R = Rectifier diodes
RFP = RF power transistors and modules
RT = Triplers
SEN = Semiconductor sensors
SD = Small-signal diodes
Sm = Small-signal transistors
Sp = Special diodes
SP = Low-frequency switching power diodes
St = Rectifier stacks
T = Tuner diodes
Th = Thyristors
Tri = Triacs
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes
WBT = Wideband hybrid IC transistors
WBM = Wideband hybrid IC modules

* series.

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T4	*	**Magnetrons for microwave heating**
T5	**PC02****	**Cathode-ray tubes**
T6	**PC03****	**Geiger-Müller tubes**
T9	**PC04****	**Photo and electron multipliers**
T10	**PC05****	**Plumbicon camera tubes and accessories**
T11	**PC06****	**Microwave diodes and sub-assemblies**
T12	**PC07**	**Vidicon and Newvicon camera tubes and deflection units**
T13	**PC08**	**Image intensifiers**
T15	**PC09****	**Dry reed switches**
C8	**PC10**	**Variable mains transformers; annular fixed transformers**
	PC11	**Solid state image sensors and peripheral integrated circuits**

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