Texas Instruments

Power Products

Data Book

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1990

POWER PRODUCTS DATA BOOK

TEXAS INSTRUMENTS

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TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
1	NPN	40	80	TIP29	30	TO220	4-3
1	NPN	60	100	TIP29A	30	TO220	4-3
1	NPN	80	120	TIP29B	30	TO220	4-3
1	NPN	100	140	TIP29C	30	TO220	4-3
1	NPN	120	160	TIP29D	30	TO220	4-5
1	NPN	140	180	TIP29E	30	TO220	4-5
1	NPN	160	200	TIP29F	30	TO220	4-5
1	PNP	40	80	TIP30	30	TO220	4-7
1	PNP	60	100	TIP30A	30	TO220	4-7
1	PNP	80	120	TIP30B	30	TO220	4-7
1	PNP	100	140	TIP30C	30	TO220	4-7
1	NPN	250	350	TIP47	40	TO220	4-27
1	NPN	300	400	TIP48	40	TO220	4-27
1	NPN	350	450	TIP49	40	TO220	4-27
1	NPN	400	500	TIP50	40	TO220	4-27
2	NPN	45	55	BD239	30	TO220	5-3
2	NPN	60	70	BD239A	30	TO220	5-3
2	NPN	80	90	BD239B	30	TO220	5-3
2	NPN	100	115	BD239C	30	TO220	5-3
2	NPN	120	160	BD239D	30	TO220	5-5
2	NPN	140	180	BD239E	30	TO220	5-5
2	NPN	160	200	BD239F	30	TO220	5-5
2	PNP	45	55	BD240	30	TO220	5-7
2	PNP	60	70	BD240A	30	TO220	5-7
2	PNP	80	90	BD240B	30	TO220	5-7
2	PNP	100	115	BD240C	30	TO220	5-7
2	NPN	400	850	BUX46	30	TO3	-
2	NPN	400	850	BUX84	40	TO220	5-91
2	NPN	450	1000	BUX85	40	TO220	5-91
2	NPN	40	40	TIPP31	0.8	TO92	4-89
2	NPN	60	60	TIPP31A	0.8	TO92	4-89

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General Information

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
2	NPN	80	80	TIPP31B	0.8	TO92	4-89
2	NPN	100	100	TIPP31C	0.8	TO92	4-89
2	PNP	40	40	TIPP32	0.8	TO92	4-91
2	PNP	60	60	TIPP32A	0.8	TO92	4-91
2	PNP	80	80	TIPP32B	0.8	TO92	4-91
2	PNP	100	100	TIPP32C	0.8	TO92	4-91
2.5	NPN	400	850	TIPL770	50	TO220	2-27
3	NPN	45	55	BD241	40	TO220	5-9
3	NPN	60	70	BD241A	40	TO220	5-9
3	NPN	80	90	BD241B	40	TO220	5-9
3	NPN	100	115	BD241C	40	TO220	5-9
3	NPN	120	160	BD241D	40	TO220	5-11
3	NPN	140	180	BD241E	40	TO220	5-11
3	NPN	160	200	BD241F	40	TO220	5-11
3	PNP	45	55	BD242	40	TO220	5-13
3	PNP	60	70	BD242A	40	TO220	5-13
3	PNP	80	90	BD242B	40	TO220	5-13
3	PNP	100	115	BD242C	40	TO220	5-13
3	NPN	40	80	TIP31	40	TO220	4-9
3	NPN	60	100	TIP31A	40	TO220	4-9
3	NPN	80	120	TIP31B	40	TO220	4-9
3	NPN	100	140	TIP31C	40	TO220	4-9
3	NPN	120	160	TIP31D	40	TO220	4-11
3	NPN	140	180	TIP31E	40	TO220	4-11
3	NPN	160	200	TIP31F	40	TO220	4-11
3	PNP	40	80	TIP32	40	TO220	4-13
3	PNP	60	100	TIP32A	40	TO220	4-13
3	PNP	80	120	TIP32B	40	TO220	4-13
3	PNP	100	140	TIP32C	40	TO220	4-13
3	NPN	250	350	TIP51	100	SOT93	4-29
3	NPN	300	400	TIP52	100	SOT93	4-29

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
3	NPN	350	450	TIP53	100	SOT93	4-29
3	NPN	400	500	TIP54	100	SOT93	4-29
3	NPN	200	350	TIP75	65	TO220	4-37
3	NPN	250	400	TIP75A	65	TO220	4-37
3	NPN	300	450	TIP75B	65	TO220	4-37
3	NPN	400	500	TIP75C	65	TO220	4-37
4	NPN	60	60	2N6122	40	TO220	-
4	PNP	60	60	2N6125	40	TO220	-
4	NPN	130	130	2N6474	130	TO220	-
4	NPN	300	600	MJE13004		TO220	-
4	NPN	400	700	MJE13005		TO220	-
4	NPN	600	1300	R4050	100	SOT93	-
4	NPN	600	1300	R4060	80	TO220	-
4	NPN	400	850	TIPL751	120	TO3	2-3
4	NPN	450	1000	TIPL751A	120	TO3	2-3
4	NPN	400	850	TIPL760	80	TO220	2-13
4	NPN	450	1000	TIPL760A	80	TO220	2-13
4	NPN	500	1100	TIPL760B	80	TO220	2-15
4	NPN	550	1200	TIPL760C	80	TO220	2-15
4	NPN	400	850	TIPL761	100	SOT93	2-17
4	NPN	450	1000	TIPL761A	100	SOT93	2-17
4	NPN	500	1100	TIPL761B	100	SOT93	2-19
4	NPN	550	1200	TIPL761C	100	SOT93	2-19
4	NPN	400	850	TIPL791	75	TO220	2-49
4	NPN	450	1000	TIPL791A	75	TO220	2-49
4	NPN	300	700	TIPL13004	75	TO220	2-51
4	NPN	400	850	TIPL13005	75	TO220	2-51
5	PNP	40	40	2N4901	87.5	TO3	-
5	PNP	80	80	2N4903	87.5	TO3	-
5	PNP	40	40	2N4904	87.5	TO3	-
5	PNP	60	60	2N4905	87.5	TO3	-

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
5	PNP	80	80	2N4906	87.5	TO3	-
5	NPN	40	40	2N4913	87.5	TO3	-
5	NPN	40	40	2N4914	87.5	TO3	-
5	NPN	40	40	2N4915	87.5	TO3	-
5	NPN	40	40	2N5067	87.5	TO3	-
5	NPN	60	60	2N5068	87.5	TO3	-
5	NPN	80	80	2N5069	87.5	TO3	-
5	PNP	60	60	2N5867	87.5	TO3	-
5	PNP	80	60	2N5868	87.5	TO3	-
5	NPN	60	60	2N5869	87.5	TO3	-
5	NPN	80	80	2N5870	87.5	TO3	-
5	NPN	300	650	2N6542	100	TO3	-
5	NPN	400	850	2N6543		TO3	-
5	NPN	40	40	BD539	45	TO220	5-27
5	NPN	60	60	BD539A	45	TO220	5-27
5	NPN	80	80	BD539B	45	TO220	5-27
5	NPN	100	100	BD539C	45	TO220	5-27
5	NPN	120	120	BD539D	45	TO220	5-27
5	PNP	40	40	BD540	45	TO220	5-29
5	PNP	60	60	BD540A	45	TO220	5-29
5	PNP	80	80	BD540B	45	TO220	5-29
5	PNP	100	100	BD540C	45	TO220	5-29
5	NPN	400	850	BUT11	80	TO220	-
5	NPN	400	850	BUW11		TO220	-
5	NPN	200	200	MJ410	105	TO3	-
5	NPN	300	300	MJ411	100	TO3	-
6	NPN	100	100	2N5758	150	TO3	-
6	NPN	45	55	BD243	65	TO220	5-15
6	NPN	60	70	BD243A	65	TO220	5-15
6	NPN	80	90	BD243B	65	TO220	5-15
6	NPN	100	115	BD243C	65	TO220	5-15

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
6	PNP	45	55	BD244	65	TO220	5-17
6	PNP	60	70	BD244A	65	TO220	5-17
6	PNP	80	90	BD244B	65	TO220	5-17
6	PNP	100	115	BD244C	65	TO220	5-17
6	NPN	375	800	BU426	70	SOT93	5-75
6	NPN	400	900	BU426A	70	SOT93	5-75
6	NPN	400	850	BUV46	70	TO220	5-77
6	NPN	400	850	BUX82	60	TO3	5-89
6	NPN	450	1000	BUX83	60	TO3	5-89
6	NPN	350	750	BUX97		TO3	-
6	NPN	400	800	BUX97A		TO3	-
6	NPN	450	800	BUX97B		TO3	-
6	NPN	40	80	TIP41	65	TO220	4-23
6	NPN	60	100	TIP41A	65	TO220	4-23
6	NPN	80	120	TIP41B	65	TO220	4-23
6	NPN	100	140	TIP41C	65	TO220	4-23
6	PNP	40	80	TIP42	65	TO220	4-25
6	PNP	60	100	TIP42A	65	TO220	4-25
6	PNP	80	120	TIP42B	65	TO220	4-25
6	PNP	100	140	TIP42C	65	TO220	4-25
6	NPN	400	850	TIPL752	150	TO3	2-5
6	NPN	450	1000	TIPL752A	150	TO3	2-5
6	NPN	400	850	TIPL762	120	SOT93	2-21
6	NPN	450	1000	TIPL762A	120	SOT93	2-21
7	NPN	60	60	2N5759	115	TO3	-
7	PNP	60	60	2N5871	115	TO3	-
7	PNP	80	80	2N5872	115	TO3	-
7	NPN	60	60	2N5873	115	TO3	-
7	NPN	80	80	2N5874	115	TO3	-
7	NPN	80	80	2N6292	65	TO220	-
7	NPN	200	400	BU406	60	TO220	5-73

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
7	NPN	150	330	BU407	60	TO220	5-73
7.5	NPN	250	350	TIP55A	50	SOT93	4-31
7.5	NPN	300	400	TIP56A	50	SOT93	4-31
7.5	NPN	350	450	TIP57A	50	SOT93	4-31
7.5	NPN	400	500	TIP58A	50	SOT93	4-31
7.5	NPN	250	350	TIP558	100	TO3	-
7.5	NPN	300	400	TIP559	100	TO3	-
7.5	NPN	350	450	TIP560	100	TO3	-
7.5	NPN	400	500	TIP561	100	TO3	-
8	NPN	250	500	2N6306	71	TO3	-
8	NPN	300	600	2N6307	71	TO3	-
8	NPN	350	700	2N6308	71	TO3	-
8	NPN	300	650	2N6544	125	TO3	-
8	NPN	400	850	2N6545	125	TO3	-
8	NPN	40	40	BD543	70	TO220	5-31
8	NPN	60	60	BD543A	70	TO220	5-31
8	NPN	80	80	BD543B	70	TO220	5-31
8	NPN	100	100	BD543C	70	TO220	5-31
8	PNP	40	40	BD544	70	TO220	5-33
8	PNP	60	60	BD544A	70	TO220	5-33
8	PNP	80	80	BD544B	70	TO220	5-33
8	PNP	100	100	BD544C	70	TO220	5-33
8	NPN	375	800	BU326	60	TO3	5-71
8	NPN	400	900	BU326A	60	TO3	5-71
8	NPN	400	850	TIPL753	150	TO3	2-7
8	NPN	450	1000	TIPL753A	150	TO3	2-7
8	NPN	400	850	TIPL763	120	SOT93	2-23
8	NPN	450	1000	TIPL763A	120	SOT93	2-23
9	NPN	400	850	BUV47	120	SOT93	5-79
9	NPN	450	1000	BUV47A	120	SOT93	5-79
9	NPN	400	850	BUV47B	120	SOT93	-

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
9	NPN	400	850	BUX47	125	TO3	5-83
9	NPN	450	1000	BUX47A	125	TO3	5-83
9	NPN	400	850	BUX47B	125	TO3	5-83
10	NPN	60	80	2N3715	150	TO3	-
10	NPN	80	100	2N3716	150	TO3	-
10	PNP	60	60	2N3789	150	TO3	-
10	PNP	80	80	2N3790	150	TO3	-
10	PNP	60	60	2N3791	150	TO3	-
10	PNP	80	80	2N3792	150	TO3	-
10	NPN	60	70	2N6099	75	TO220	-
10	NPN	225	300	2N6249	100	TO3	-
10	NPN	200	375	2N6250	100	TO3	-
10	NPN	45	55	BD245	80	SOT93	5-19
10	NPN	60	70	BD245A	80	SOT93	5-19
10	NPN	80	90	BD245B	80	SOT93	5-19
10	NPN	100	115	BD245C	80	SOT93	5-19
10	PNP	45	55	BD246	80	SOT93	5-21
10	PNP	60	70	BD246A	80	SOT93	5-21
10	PNP	80	90	BD246B	80	SOT93	5-21
10	PNP	100	115	BD246C	80	SOT93	5-21
10	NPN	150	350	BU124	50	SOT93	5-69
10	NPN	150	400	BU124A	50	SOT93	5-69
10	NPN	450	800	BUW26	125	TO3	-
10	NPN	400	500	BUW34	125	TO3	-
10	NPN	400	800	BUW35	125	TO3	-
10	NPN	450	900	BUW36	125	TO3	-
10	NPN	400	800	BUX80	150	TO3	5-87
10	NPN	450	1000	BUX81	150	TO3	5-87
10	NPN	400	1000	BUY69A	100	TO3	5-95
10	NPN	325	800	BUY69B	100	TO3	5-95
10	NPN	200	500	BUY69C	100	TO3	5-95

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
10	NPN	400	1000	BUY70A	75	TO3	5-97
10	NPN	325	800	BUY70B	75	TO3	5-97
10	NPN	200	500	BUY70C	75	TO3	5-97
10	NPN	350	550	MJ13014	150	TO3	-
10	NPN	400	600	MJ13015	150	TO3	-
10	NPN	400	400	MJ413	125	TO3	-
10	NPN	400	400	MJ423	125	TO3	-
10	NPN	40	80	TIP33	80	SOT93	4-15
10	NPN	60	100	TIP33A	80	SOT93	4-15
10	NPN	80	120	TIP33B	80	SOT93	4-15
10	NPN	100	140	TIP33C	80	SOT93	4-15
10	PNP	40	80	TIP34	80	SOT93	4-17
10	PNP	60	100	TIP34A	80	SOT93	4-17
10	PNP	80	120	TIP34B	80	SOT93	4-17
10	PNP	100	140	TIP34C	80	SOT93	4-17
10	NPN	300	300	TIP562	100	TO3	-
10	NPN	400	400	TIP563	100	TO3	-
10	NPN	400	850	TIPL755	180	TO3	2-9
10	NPN	450	1000	TIPL755A	180	TO3	2-9
10	NPN	400	850	TIPL765	125	SOT93	2-25
10	NPN	450	1000	TIPL765A	125	SOT93	2-25
15	PNP	70	70	2N6246	71	TO3	-
15	PNP	90	90	2N6247	71	TO3	-
15	NPN	50	50	2N6470	71	TO3	-
15	NPN	70	70	2N6471	71	TO3	-
15	NPN	90	90	2N6472	71	TO3	-
15	NPN	400	850	2N6546	175	TO3	-
15	NPN	300	650	2N6547	175	TO3	-
15	NPN	40	40	BD545	85	SOT93	5-35
15	NPN	60	60	BD545A	85	SOT93	5-35
15	NPN	80	80	BD545B	85	SOT93	5-35

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
15	NPN	100	100	BD545C	85	SOT93	5-35
15	PNP	40	40	BD546	85	SOT93	5-37
15	PNP	60	60	BD546A	85	SOT93	5-37
15	PNP	80	80	BD546B	85	SOT93	5-37
15	PNP	100	100	BD546C	85	SOT93	5-37
15	NPN	45	50	BD743	90	TO220	5-39
15	NPN	60	70	BD743A	90	TO220	5-39
15	NPN	80	90	BD743B	90	TO220	5-39
15	NPN	100	110	BD743C	90	TO220	5-39
15	PNP	45	50	BD744	90	TO220	5-41
15	PNP	60	70	BD744A	90	TO220	5-41
15	PNP	80	90	BD744B	90	TO220	5-41
15	PNP	100	100	BD744C	90	TO220	5-41
15	NPN	400	850	BUS48	175	TO3	-
15	NPN	450	1000	BUS48A	175	TO3	-
15	NPN	400	850	BUV48	125	SOT93	5-81
15	NPN	450	1000	BUV48A	125	SOT93	5-81
15	NPN	400	500	BUW44	175	TO3	-
15	NPN	400	800	BUW45	175	TO3	-
15	NPN	450	900	BUW46	175	TO3	-
15	NPN	400	850	BUX48	175	TO3	5-85
15	NPN	450	1000	BUX48A	175	TO3	5-85
15	NPN	400	850	BUX48PL	175	TO3	-
15	NPN	450	1000	BUX48APL	175	TO3	-
15	PNP	60	100	MJ2955	115	TO3	-
15	NPN	40	50	TIP73	32	TO220	4-33
15	NPN	60	70	TIP73A	32	TO220	4-33
15	NPN	80	90	TIP73B	32	TO220	4-33
15	NPN	100	110	TIP73C	32	TO220	4-33
15	PNP	40	50	TIP74	32	TO220	4-35
15	PNP	60	70	TIP74A	32	TO220	4-35

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
15	PNP	80	90	TIP74B	32	TO220	4-35
15	PNP	100	110	TIP74C	32	TO220	4-35
15	PNP	70	100	TIP2955	90	SOT93	4-85
15	NPN	70	100	TIP3055	90	SOT93	4-87
15	NPN	375	800	TIPL757	200	TO3	2-11
15	NPN	420	1000	TIPL757A	200	TO3	2-11
20	NPN	90	150	2N5038	140	TO3	-
20	NPN	75	120	2N5039	140	TO3	-
20	NPN	80	80	2N5303	200	TO3	-
20	NPN	45	50	BD745	115	SOT93	5-43
20	NPN	60	70	BD745A	115	SOT93	5-43
20	NPN	80	90	BD745B	115	SOT93	5-43
20	NPN	100	110	BD745C	115	SOT93	5-43
20	PNP	45	50	BD746	115	SOT93	5-45
20	PNP	60	70	BD746A	115	SOT93	5-45
20	PNP	80	90	BD746B	115	SOT93	5-45
20	PNP	100	110	BD746C	115	SOT93	5-45
25	PNP	60	60	2N5883	200	TO3	-
25	PNP	80	80	2N5884	200	TO3	-
25	NPN	60	60	2N5885	200	TO3	-
25	NPN	80	80	2N5886	200	TO3	-
25	NPN	45	55	BD249	125	SOT93	5-23
25	NPN	60	70	BD249A	125	SOT93	5-23
25	NPN	80	90	BD249B	125	SOT93	5-23
25	NPN	100	115	BD249C	125	SOT93	5-23
25	PNP	45	55	BD250	125	SOT93	5-25
25	PNP	60	70	BD250A	125	SOT93	5-25
25	PNP	80	90	BD250B	125	SOT93	5-25
25	PNP	100	115	BD250C	125	SOT93	5-25
25	NPN	40	80	TIP35	125	SOT93	4-19
25	NPN	60	100	TIP35A	125	SOT93	4-19

TRANSISTORS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
25	NPN	80	120	TIP35B	125	SOT93	4-19
25	NPN	100	140	TIP35C	125	SOT93	4-19
25	PNP	40	80	TIP36	125	SOT93	4-21
25	PNP	60	100	TIP36A	125	SOT93	4-21
25	PNP	80	120	TIP36B	125	SOT93	4-21
25	PNP	100	140	TIP36C	125	SOT93	4-21
30	NPN	40	50	2N3771	150	TO3	-
30	NPN	60	100	2N3772	150	TO3	-
30	PNP	40	40	2N4398	200	TO3	-
30	PNP	60	60	2N4399	200	TO3	-
30	NPN	40	40	2N5301	200	TO3	-
30	NPN	60	60	2N5302	200	TO3	-
30	NPN	60	60	2N6326	114	TO3	-
30	NPN	80	80	2N6327	200	TO3	-
30	NPN	100	100	2N6328	200	TO3	-
30	PNP	60	60	2N6329	200	TO3	-
30	NPN	400	850	BUX98	250	TO3	5-93
30	NPN	420	1000	BUX98A	250	TO3	5-93
30	NPN	90	100	MJ802	200	TO3	-

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
2	NPN	60	60	TIPK110	0.8	TO92	4-93
2	NPN	80	80	TIPK111	0.8	TO92	4-93
2	NPN	100	100	TIPK112	0.8	TO92	4-93
2	PNP	60	60	TIPK115	0.8	TO92	4-95
2	PNP	80	80	TIPK116	0.8	TO92	4-95
2	PNP	100	100	TIPK117	0.8	TO92	4-95
2	NPN	60	60	TIPP110	0.8	TO92	4-93
2	NPN	80	80	TIPP111	0.8	TO92	4-93
2	NPN	100	100	TIPP112	0.8	TO92	4-93
2	PNP	60	60	TIPP115	0.8	TO92	4-95
2	PNP	80	80	TIPP116	0.8	TO92	4-95
2	PNP	100	100	TIPP117	0.8	TO92	4-95
4	PNP	60	60	BDT60	50	TO220	-
4	PNP	80	80	BDT60A	50	TO220	-
4	PNP	100	100	BDT60B	50	TO220	-
4	PNP	120	120	BDT60C	50	TO220	-
4	NPN	60	60	BDT61	50	TO220	-
4	NPN	80	80	BDT61A	50	TO220	-
4	NPN	100	100	BDT61B	50	TO220	-
4	NPN	120	120	BDT61C	50	TO220	-
4	NPN	45	45	BDW53	40	TO220	5-49
4	NPN	60	60	BDW53A	40	TO220	5-49
4	NPN	80	80	BDW53B	40	TO220	5-49
4	NPN	100	100	BDW53C	40	TO220	5-49
4	NPN	120	120	BDW53D	40	TO220	5-49
4	PNP	45	45	BDW54	40	TO220	5-51
4	PNP	60	60	BDW54A	40	TO220	5-51
4	PNP	80	80	BDW54B	40	TO220	5-51
4	PNP	100	100	BDW54C	40	TO220	5-51
4	PNP	120	120	BDW54D	40	TO220	5-51
4	NPN	60	60	TIP110	50	TO220	4-45

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
4	NPN	80	80	TIP111	50	TO220	4-45
4	NPN	100	100	TIP112	50	TO220	4-45
4	PNP	60	60	TIP115	50	TO220	4-47
4	PNP	80	80	TIP116	50	TO220	4-47
4	PNP	100	100	TIP117	50	TO220	4-47
5	NPN	60	60	TIP120	65	TO220	4-49
5	NPN	80	80	TIP121	65	TO220	4-49
5	NPN	100	100	TIP122	65	TO220	4-49
5	PNP	60	60	TIP125	65	TO220	4-51
5	PNP	80	80	TIP126	65	TO220	4-51
5	PNP	100	100	TIP127	65	TO220	4-51
5	NPN	60	60	TIP620	65	TO3	4-71
5	NPN	80	80	TIP621	65	TO3	4-71
5	NPN	100	100	TIP622	65	TO3	4-71
5	PNP	60	60	TIP625	65	TO3	4-73
5	PNP	80	80	TIP626	65	TO3	4-73
5	PNP	100	100	TIP627	65	TO3	4-73
6	NPN	45	45	BDW23	50	TO220	-
6	NPN	60	60	BDW23A	50	TO220	-
6	NPN	80	80	BDW23B	50	TO220	-
6	NPN	100	100	BDW23C	50	TO220	-
6	PNP	45	45	BDW24	50	TO220	5-47
6	PNP	60	60	BDW24A	50	TO220	5-47
6	PNP	80	80	BDW24B	50	TO220	5-47
6	PNP	100	100	BDW24C	50	TO220	5-47
6	NPN	45	45	BDW63	60	TO220	5-53
6	NPN	60	60	BDW63A	60	TO220	5-53
6	NPN	80	80	BDW63B	60	TO220	5-53
6	NPN	100	100	BDW63C	60	TO220	5-53
6	NPN	120	120	BDW63D	60	TO220	5-53
6	PNP	45	45	BDW64	60	TO220	5-55

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
6	PNP	60	60	BDW64A	60	TO220	5-55
6	PNP	80	80	BDW64B	60	TO220	5-55
6	PNP	100	100	BDW64C	60	TO220	5-55
6	PNP	120	120	BDW64D	60	TO220	5-55
6	NPN	350	350	BU910	60	TO220	-
7	NPN	300	300	TIP150	60	TO220	4-61
7	NPN	350	350	TIP151	60	TO220	4-61
7	NPN	400	400	TIP152	60	TO220	4-61
8	NPN	60	60	2N6055	100	TO3	-
8	NPN	60	60	2N6300	75	TO3	-
8	NPN	80	80	2N6301	75	TO3	-
8	NPN	60	80	BD645	63	TO220	-
8	PNP	60	80	BD646	63	TO220	-
8	NPN	80	100	BD647	63	TO220	-
8	PNP	80	100	BD648	63	TO220	-
8	NPN	100	120	BD649	63	TO220	-
8	PNP	100	120	BD650	63	TO220	-
8	NPN	120	140	BD651	63	TO220	-
8	PNP	120	140	BD652	63	TO220	-
8	NPN	45	45	BD895	70	TO220	-
8	NPN	45	45	BD895A	70	TO220	-
8	PNP	45	45	BD896	70	TO220	-
8	PNP	45	45	BD896A	70	TO220	-
8	NPN	60	60	BD897	70	TO220	-
8	NPN	60	60	BD897A	70	TO220	-
8	PNP	60	60	BD898	70	TO220	-
8	PNP	60	60	BD898A	70	TO220	-
8	NPN	80	80	BD899	70	TO220	-
8	NPN	80	80	BD899A	70	TO220	-
8	PNP	80	80	BD900	70	TO220	-
8	PNP	80	80	BD900A	70	TO220	-

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General Information

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General Information

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
8	NPN	100	100	BD901	70	TO220	-
8	PNP	100	100	BD902	70	TO220	-
8	NPN	45	45	BDW73	80	TO220	5-57
8	NPN	60	60	BDW73A	80	TO220	5-57
8	NPN	80	80	BDW73B	80	TO220	5-57
8	NPN	100	100	BDW73C	80	TO220	5-57
8	NPN	120	120	BDW73D	80	TO220	5-57
8	PNP	45	45	BDW74	80	TO220	5-59
8	PNP	60	60	BDW74A	80	TO220	5-59
8	PNP	80	80	BDW74B	80	TO220	5-59
8	PNP	100	100	BDW74C	80	TO220	5-59
8	PNP	120	120	BDW74D	80	TO220	5-59
8	NPN	45	45	BDX53	60	TO220	5-65
8	NPN	60	60	BDX53A	60	TO220	5-65
8	NPN	80	80	BDX53B	60	TO220	5-65
8	NPN	100	100	BDX53C	60	TO220	5-65
8	PNP	45	45	BDX54	60	TO220	5-67
8	PNP	60	60	BDX54A	60	TO220	5-67
8	PNP	80	80	BDX54B	60	TO220	5-67
8	PNP	100	100	BDX54C	60	TO220	5-67
8	PNP	60	60	BDX62	90	TO3	-
8	PNP	80	80	BDX62A	90	TO3	-
8	PNP	100	100	BDX62B	90	TO3	-
8	PNP	120	120	BDX62C	90	TO3	-
8	NPN	60	80	BDX63	90	TO3	-
8	NPN	80	100	BDX63A	90	TO3	-
8	NPN	100	120	BDX63B	90	TO3	-
8	NPN	120	140	BDX63C	90	TO3	-
8	NPN	60	60	MJ1000	90	TO3	-
8	NPN	80	80	MJ1001	90	TO3	-
8	PNP	60	60	MJ900	90	TO3	-

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
8	PNP	80	80	MJ901	90	TO3	-
8	NPN	60	60	TIP100	80	TO220	4-41
8	NPN	80	80	TIP101	80	TO220	4-41
8	NPN	100	100	TIP102	80	TO220	4-41
8	PNP	60	60	TIP105	80	TO220	4-43
8	PNP	80	80	TIP106	80	TO220	4-43
8	PNP	100	100	TIP107	80	TO220	4-43
8	NPN	60	60	TIP130	70	TO220	4-53
8	NPN	80	80	TIP131	70	TO220	4-53
8	NPN	100	100	TIP132	70	TO220	4-53
8	PNP	60	60	TIP135	70	TO220	4-55
8	PNP	80	80	TIP136	70	TO220	4-55
8	PNP	100	100	TIP137	70	TO220	4-55
10	NPN	40	40	2N6386	60	TO220	-
10	NPN	60	60	2N6387	60	TO220	-
10	NPN	80	80	2N6388	60	TO220	-
10	PNP	60	60	2N6667	60	TO220	-
10	NPN	45	45	BDX33	70	TO220	-
10	NPN	60	60	BDX33A	70	TO220	-
10	NPN	80	80	BDX33B	70	TO220	-
10	NPN	100	100	BDX33C	70	TO220	-
10	NPN	120	120	BDX33D	70	TO220	-
10	PNP	45	45	BDX34	70	TO220	-
10	PNP	60	60	BDX34A	70	TO220	-
10	PNP	80	80	BDX34B	70	TO220	-
10	PNP	100	100	BDX34C	70	TO220	-
10	PNP	120	120	BDX34D	70	TO220	-
10	NPN	45	45	BDX85	100	TO3	-
10	NPN	60	60	BDX85A	100	TO3	-
10	NPN	80	80	BDX85B	100	TO3	-
10	NPN	100	100	BDX85C	100	TO3	-

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
10	PNP	45	45	BDX86	100	TO3	-
10	PNP	60	60	BDX86A	100	TO3	-
10	PNP	80	80	BDX86B	100	TO3	-
10	PNP	100	100	BDX86C	100	TO3	-
10	NPN	300	500	BU323	175	TO3	-
10	NPN	350	600	BU323A	175	TO3	-
10	PNP	60	60	MJ2500	86	TO3	-
10	PNP	80	80	MJ2501	86	TO3	-
10	NPN	60	60	MJ3000	86	TO3	-
10	NPN	80	80	MJ3001	86	TO220	-
10	NPN	60	60	TIP140	125	SOT93	4-57
10	NPN	80	80	TIP141	125	SOT93	4-57
10	NPN	100	100	TIP142	125	SOT93	4-57
10	PNP	60	60	TIP145	125	SOT93	4-59
10	PNP	80	80	TIP146	125	SOT93	4-59
10	PNP	100	100	TIP147	125	SOT93	4-59
10	NPN	320	320	TIP160	50	SOT93	4-65
10	NPN	350	350	TIP161	50	SOT93	4-65
10	NPN	380	380	TIP162	50	SOT93	4-65
10	NPN	60	60	TIP600	100	TO3	4-67
10	NPN	80	80	TIP601	100	TO3	4-67
10	NPN	100	100	TIP602	100	TO3	4-67
10	PNP	60	60	TIP605	100	TO3	4-69
10	PNP	80	80	TIP606	100	TO3	4-69
10	PNP	100	100	TIP607	100	TO3	4-69
10	NPN	60	60	TIP640	175	TO3	4-75
10	NPN	80	80	TIP641	175	TO3	4-75
10	NPN	320	320	TIP642	175	TO3	4-75
10	PNP	60	60	TIP645	175	TO3	4-77
10	PNP	80	80	TIP646	175	TO3	4-77
10	PNP	100	100	TIP647	175	TO3	4-77

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
10	NPN	320	320	TIP660	80	TO3	4-79
10	NPN	350	350	TIP661	80	TO3	4-79
10	NPN	380	380	TIP662	80	TO3	4-79
10	NPN	120	100	TIPL775	100	TO3	2-37
10	NPN	150	200	TIPL775A	100	TO3	2-37
10	NPN	120	150	TIPL785	80	SOT93	2-45
10	NPN	150	200	TIPL785A	80	SOT93	2-45
10	NPN	120	150	TIPL790	70	TO220	2-47
10	NPN	150	200	TIPL790A	70	TO220	2-47
12	PNP	60	60	2N6050	86	TO3	-
12	PNP	80	80	2N6051	86	TO3	-
12	PNP	100	100	2N6052	86	TO3	-
12	NPN	60	60	2N6057	86	TO3	-
12	NPN	80	80	2N6058	86	TO3	-
12	NPN	100	100	2N6059	86	TO3	-
12	PNP	60	60	BDV64	125	SOT93	-
12	PNP	80	80	BDV64A	125	SOT93	-
12	PNP	100	100	BDV64B	125	SOT93	-
12	PNP	120	120	BDV64C	125	SOT93	-
12	NPN	60	60	BDV65	125	SOT93	-
12	NPN	80	80	BDV65A	125	SOT93	-
12	NPN	100	100	BDV65B	125	SOT93	-
12	NPN	120	120	BDV65C	125	SOT93	-
12	NPN	45	45	BDW93	80	TO220	-
12	NPN	60	60	BDW93A	80	TO220	-
12	NPN	80	80	BDW93B	80	TO220	-
12	NPN	100	100	BDW93C	80	TO220	-
12	PNP	45	45	BDW94	80	TO220	-
12	PNP	60	60	BDW94A	80	TO220	-
12	PNP	80	80	BDW94B	80	TO220	-
12	PNP	100	100	BDW94C	80	TO220	-

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	V_{CEO} (V)	V_{CBO} (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
12	PNP	60	60	BDX64	117	TO3	-
12	PNP	80	80	BDX64A	117	TO3	-
12	PNP	100	100	BDX64B	117	TO3	-
12	PNP	120	120	BDX64C	117	TO3	-
12	NPN	60	80	BDX65	117	TO3	-
12	NPN	80	100	BDX65A	117	TO3	-
12	NPN	100	120	BDX65B	117	TO3	-
12	NPN	120	140	BDX65C	117	TO3	-
12	NPN	45	45	BDX87	120	TO3	-
12	NPN	60	60	BDX87A	120	TO3	-
12	NPN	80	80	BDX87B	120	TO3	-
12	NPN	100	100	BDX87C	120	TO3	-
12	PNP	45	45	BDX88	120	TO3	-
12	PNP	60	60	BDX88A	120	TO3	-
12	PNP	80	80	BDX88B	120	TO3	-
12	PNP	100	100	BDX88C	120	TO3	-
15	NPN	45	45	BDW83	150	SOT93	5-61
15	NPN	60	60	BDW83A	150	SOT93	5-61
15	NPN	80	80	BDW83B	150	SOT93	5-61
15	NPN	100	100	BDW83C	150	SOT93	5-61
15	NPN	120	120	BDW83D	150	SOT93	5-61
15	PNP	45	45	BDW84	150	SOT93	5-63
15	PNP	60	60	BDW84A	150	SOT93	5-63
15	PNP	80	80	BDW84B	150	SOT93	5-63
15	PNP	100	100	BDW84C	150	SOT93	5-63
15	PNP	120	120	BDW84D	150	SOT93	5-63
16	PNP	60	60	BDX66	150	TO3	-
16	PNP	80	80	BDX66A	150	TO3	-
16	PNP	100	100	BDX66B	150	TO3	-
16	PNP	120	120	BDX66C	150	TO3	-
16	NPN	60	80	BDX67	150	TO3	-

DARLINGTONS

I_C CONTINUOUS (A)	Polarity	VCEO (v)	VCBO (V)	DEVICE NUMBER	P_T T_C-25°C (W)	PACKAGE	PAGE
16	NPN	80	100	BDX67A	150	TO3	-
16	NPN	100	120	BDX67B	150	TO3	-
16	NPN	120	140	BDX67C	150	TO3	-
16	PNP	60	60	MJ4030	86	TO3	-
16	PNP	80	80	MJ4031	86	TO3	-
16	PNP	100	100	MJ4032	86	TO3	-
16	NPN	60	60	MJ4033	86	TO3	-
16	NPN	80	80	MJ4034	86	TO3	-
16	NPN	100	100	MJ4035	86	TO3	-
20	NPN	300	400	TIP663	150	TO3	4-81
20	NPN	350	450	TIP664	150	TO3	4-81
20	NPN	400	500	TIP665	150	TO3	4-81
20	NPN	600	950	TIPL773	180	TO3	2-29
20	NPN	700	1050	TIPL773A	180	TO3	2-31
20	NPN	800	1150	TIPL773B	180	TO3	2-33
20	NPN	450	550	TIPL774	175	TO3	2-35
20	NPN	600	950	TIPL777	180	TO3	2-39
20	NPN	700	1050	TIPL777A	180	TO3	2-41
20	NPN	800	1150	TIPL777B	180	TO3	2-43

THYRISTORS

SCR's

I_{TSM} (A)	I_T (A)	I_{GT} (mA)	V_{DRM} (V)	DEVICE NUMBER	PACKAGE	PAGE
15	2.0	0.20	400	TICK106D	TO92	3-29
15	2.0	0.20	500	TICK106E	TO92	3-29
15	2.0	0.20	600	TICK106M	TO92	3-29
15	2.0	0.20	400	TICP106D	TO92	3-29
15	2.0	0.20	500	TICP106E	TO92	3-29
15	2.0	0,20	600	TICP106M	TO92	3-29
30	5.0	0.2	100	TIC106A	TO220	3-3
30	5.0	0.2	200	TIC106B	TO220	3-3
30	5.0	0.2	300	TIC106C	TO220	3-3
30	5.0	0.2	400	TIC106D	TO220	3-3
30	5.0	0.2	500	TIC106E	TO220	3-3
30	5.0	0.2	600	TIC106M	TO220	3-3
30	5.0	0.2	700	TIC106S	TO220	3-3
30	5.0	0.2	800	TIC106N	TO220	3-3
20	5.0	1.0	100	TIC108A	TO220	3-5
20	5.0	1.0	200	TIC108B	TO220	3-5
20	5.0	1.0	300	TIC108C	TO220	3-5
20	5.0	1.0	400	TIC108D	TO220	3-5
20	5.0	1.0	500	TIC108E	TO220	3-5
20	5.0	1.0	600	TIC108M	TO220	3-5
20	5.0	1.0	700	TIC108S	TO220	3-5
20	5.0	1.0	800	TIC108N	TO220	3-5
80	8.0	20	100	TIC116A	TO220	3-7
80	8.0	20	200	TIC116B	TO220	3-7
80	8.0	20	300	TIC116C	TO220	3-7
80	8.0	20	400	TIC116D	TO220	3-7
80	8.0	20	500	TIC116E	TO220	3-7
80	8.0	20	600	TIC116M	TO220	3-7
80	8.0	20	700	TIC116S	TO220	3-7
80	8.0	20	800	TIC116N	TO220	3-7
80	12.0	20	100	TIC126A	TO220	3-9
100	12.0	20	200	TIC126B	TO220	3-9

THYRISTORS

SCR's

I_{TSM} (A)	I_T (A)	I_{GT} (mA)	V_{DRM} (V)	DEVICE NUMBER	PACKAGE	PAGE
100	12.0	20	300	TIC126C	TO220	3-9
100	12.0	20	400	TIC126D	TO220	3-9
100	12.0	20	500	TIC126E	TO220	3-9
100	12.0	20	600	TIC126M	TO220	3-9
100	12.0	20	700	TIC126S	TO220	3-9
100	12.0	20	800	TIC126N	TO220	3-9

TRIAC'S

I_{TSM} (A)	I_T (A)	I_{GM} (A)	V_{DRM} (V)	DEVICE NUMBER	PACKAGE	PAGE
12	1.5		400	TICK206D	TO92	3-31
12	1.5		500	TICK206E	TO92	3-31
12	1.5		600	TICK206M	TO92	3-31
12	1.5		400	TICP206D	TO92	3-31
12	1.5		500	TICP206E	TO92	3-31
12	1.5		600	TICP206M	TO92	3-31
14	2.5	0.2	100	TIC201A	TO220	3-11
14	2.5	0.2	200	TIC201B	TO220	3-11
14	2.5	0.2	300	TIC201C	TO220	3-11
14	2.5	0.2	400	TIC201D	TO220	3-11
14	2.5	0.2	500	TIC201E	TO220	3-11
14	2.5	0.2	600	TIC201M	TO220	3-11
14	2.5	0.2	700	TIC201S	TO220	3-11
30	4.0	0.2	100	TIC206A	TO220	3-13
30	4.0	0.2	200	TIC206B	TO220	3-13
30	4.0	0.2	300	TIC206C	TO220	3-13
30	4.0	0.2	400	TIC206D	TO220	3-13
30	4.0	0.2	500	TIC206E	TO220	3-13
30	4.0	0.2	600	TIC206M	TO220	3-13
30	4.0	0.2	700	TIC206S	TO220	3-13
80	6.0	1	100	TIC216A	TO220	3-15
80	6.0	1	200	TIC216B	TO220	3-15

THYRISTORS

TRIAC'S

I_{TSM} (A)	I_T (A)	I_{GM} (A)	V_{DRM} (V)	DEVICE NUMBER	PACKAGE	PAGE
80	6.0	1	300	TIC216C	TO220	3-15
80	6.0	1	400	TIC216D	TO220	3-1
80	6.0	1	500	TIC216E	TO220	3-15
80	6.0	1	600	TIC216M	TO220	3-15
80	6.0	1	700	TIC216S	TO220	3-15
80	8.0	1	200	TIC225B	TO220	3-17
80	8.0	1	300	TIC225C	TO220	3-17
80	8.0	1	400	TIC225D	TO220	3-17
80	8.0	1	500	TIC225E	TO220	3-17
80	8.0	1	600	TIC225M	TO220	3-17
80	8.0	1	700	TIC225S	TO220	3-17
80	8.0	1	200	TIC226B	TO220	3-19
80	8.0	1	300	TIC226C	TO220	3-19
80	8.0	1	400	TIC226D	TO220	3-19
80	8.0	1	500	TIC226E	TO220	3-19
80	8.0	1	600	TIC226M	TO200	3-19
80	8.0	1	700	TIC226S	TO220	3-19
80	8.0	1	800	TIC226N	TO220	3-19
100	12.0	1	200	TIC236B	TO220	3-21
100	12.0	1	300	TIC236C	TO220	3-21
100	12.0	1	400	TIC236D	TO220	3-21
100	12.0	1	500	TIC236E	TO220	3-21
100	12.0	1	600	TIC236M	TO220	3-21
100	12.0	1	700	TIC236S	TO220	3-21
100	12.0	1	800	TIC236N	TO220	3-21
125	16.0	1	200	TIC246B	TO220	3-23
125	16.0	1	300	TIC246C	TO220	3-23
125	16.0	1	400	TIC246D	TO220	3-23
125	16.0	1	500	TIC246E	TO220	3-23
125	16.0	1	600	TIC246M	TO220	3-23
125	16.0	1	700	TIC246S	TO220	3-23
125	16.0	1	800	TIC246N	TO220	3-23

THYRISTORS

TRIAC's

I_{TSM} (A)	I_T (A)	I_{GM} (A)	V_{DRM} (V)	DEVICE NUMBER	PACKAGE	PAGE
150	20.0	1	200	TIC253B	SOT93	3-25
150	20.0	1	300	TIC253C	SOT93	3-25
150	20.0	1	400	TIC253D	SOT93	3-25
150	20.0	1	500	TIC253E	SOT93	3-25
150	20.0	1	600	TIC253M	SOT93	3-25
150	20.0	1	700	TIC253S	SOT93	3-25
150	20.0	1	800	TIC253N	SOT93	3-25
175	25.0	1	200	TIC263B	SOT93	3-27
175	25.0	1	300	TIC263C	SOT93	3-27
175	25.0	1	400	TIC263D	SOT93	3-27
175	25.0	1	500	TIC263E	SOT93	3-27
175	25.0	1	600	TIC263M	SOT93	3-27
175	25.0	1	700	TIC263S	SOT93	3-27
175	25.0	1	800	TIC263N	SOT93	3-27

TRANSIENT SUPPRESSORS

SUBSCRIBER LINE INTERFACE CIRCUITS

DESCRIPTION	DEVICE NUMBER	PACKAGE		LINE VOLTAGE	PAGE
Direct Coupled SLIC IC	TISP1082	TO220	3 wire	0/-58 V	6-3
	TISP1082L	SOT82	3 wire	0/-58 V	6-55
Transformer Coupled SLIC Earth/ground Backed Ringing	TISP3180	TO220	3 wire	145 V	6-27
	TISP8180	TO220	3 wire	145 V	6-51
	TISP8180L	SOT82	3 wire	145 V	6-63
	TISP8290	TO220	3 wire	200 V	6-51
	TISP8290L	SOT82	3 wire	200 V	6-63
Transformer Coupled SLIC Battery Backed Ringing	TISP2180	TO220	3 wire	145 V	6-13
	TISP2180L	SOT82	3 wire	145 V	6-59
	TISP7180	TO220	3 wire	145 V	6-49
	TISP7180L	SOT82	3 wire	145 V	6-61
	TISP2290	TO220	3 wire	200 V	6-13
	TISP2290L	SOT82	3 wire	200 V	6-59
	TISP7290	TO220	3 wire	200 V	6-49
	TISP7290L	SOT82	3 wire	200 V	6-61

RING GENERATOR/LINE TEST EQUIPMENT

DESCRIPTION	DEVICE NUMBER	PACKAGE		LINE VOLTAGE	PAGE
Earth/ground Backed Ringing	TISP3180	TO220	3 wire	145 V	6-27
	TISP8180	TO220	3 wire	145 V	6-51
	TISP8180L	SOT82	3 wire	145 V	6-63
	TISP8290	TO220	3 wire	200 V	6-51
	TISP8290L	SOT82	3 wire	200 V	6-63
Battery Backed Ringing	TISP2180	TO220	3 wire	145 V	6-13
	TISP2180L	SOT82	3 wire	145 V	6-59
	TISP7180	TO220	3 wire	145 V	6-49
	TISP7180L	SOT82	3 wire	145 V	6-61
	TISP2290	TO220	3 wire	200 V	6-13
	TISP2290L	SOT82	3 wire	200 V	6-59
	TISP7290	TO220	3 wire	200 V	6-49
	TISP7290L	SOT82	3 wire	200 V	6-61

SUBSCRIBER EQUIPMENT - 2 WIRE

DESCRIPTION	DEVICE NUMBER	PACKAGE		LINE VOLTAGE	PAGE
Telephone/Modem	TISP4082	DO220	2 wire	58 V	6-35
	TISP5160	TO92	2 wire	120 V	6-43
	TISP4180	DO220	2 wire	145 V	6-37
	TISP5180	TO92	2 wire	145 V	6-45
	TISP9180	DO220	2 wire	145 V	6-53
	TISP5290	TO92	2 wire	200 V	6-47
	TISP9290	DO220	2 wire	200 V	6-53

SUBSCRIBER EQUIPMENT - 3 WIRE

DESCRIPTION	DEVICE NUMBER	PACKAGE		LINE VOLTAGE	PAGE
PABX Telephone/payphone/ telex/modem	TISP2082	TO220	3 wire	58 V	6-11
	TISP2082L	SOT82	3 wire	58 V	6-57
	TISP3082	TO220	3 wire	58 V	6-25
	TISP2180	TO220	3 wire	145 V	6-13
	TISP2180L	SOT82	3 wire	145 V	6-59
	TISP3180	TO220	3 wire	145 V	6-27
	TISP7180	TO220	3 wire	145 V	6-49
	TISP7180L	SOT82	3 wire	145 V	6-61
	TISP8180	TO220	3 wire	145 V	6-51
	TISP8180L	SOT82	3 wire	145 V	6-63
	TISP2290	TO220	3 wire	200 V	6-13
	TISP2290L	SOT82	3 wire	200 V	6-59
	TISP7290	TO220	3 wire	200 V	6-49
	TISP7290L	SOT82	3 wire	200 V	6-61
	TISP8290	TO220	3 wire	200 V	6-51
	TISP8290L	SOT82	3 wire	200 V	6-63

INTEGRATED SERVICES DIGITAL NETWORK

DESCRIPTION	DEVICE NUMBER	PACKAGE		LINE VOLTAGE	PAGE
Inter-wire ISDN	TISP4082	DO220	2 wire	58 V	6-35
3 Wire ISDN	TISP2082	TO220	3 wire	58 V	6-11
3 Wire ISDN	TISP2082L	SOT82	3 wire	58 V	6-57
3 Wire ISDN	TISP3082	TO220	3 wire	58 V	6-25

TRANSMISSION EQUIPMENT

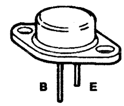
DESCRIPTION	DEVICE NUMBER	PACKAGE		LINE VOLTAGE	PAGE
Repeaters/analogue Concentrators Earth/ground Backed Ringing	TISP3180	TO220	3 wire	145 V	6-27
	TISP8180	TO220	3 wire	145 V	6-51
	TISP8180L	SOT82	3 wire	145 V	6-63
	TISP8290	TO220	3 wire	200 V	6-51
	TISP8290L	SOT82	3 wire	200 V	6-63
Repeaters/analogue Concentrators Battery Backed Ringing	TISP2180	TO220	3 wire	145 V	6-13
	TISP2180L	SOT82	3 wire	145 V	6-59
	TISP7180	TO220	3 wire	145 V	6-49
	TISP7180L	SOT82	3 wire	145 V	6-61
	TISP2290	TO220	3 wire	200 V	6-13
	TISP2290L	SOT82	3 wire	200 V	6-59
	TISP7290	TO220	3 wire	200 V	6-49
	TISP7290L	SOT82	3 wire	200 V	6-61

2

TIPL751, TIPL751A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **4 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **120 W at 25°C Case Temperature**



PACKAGE: TO3

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL751	TIPL751A
V_{CBO}	Collector - base voltage ($I_E = 0$)	850 V	1000 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	850 V	1000 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	8 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	120 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 °C to + 200°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage (Note 2)	$I_C = 100$ mA, $L = 25$ mH TIPL751 TIPL751A	400 450			V V
I_{CES}	Collector - emitter cut - off current ($V_{BE} = 0$)	$V_{CE} = 850$ V TIPL751 $V_{CE} = 1000$ V TIPL751A $V_{CE} = 850$ V 100°C TIPL751 $V_{CE} = 1000$ V 100°C TIPL751A			50 50 100 100	μA μA μA μA
I_{CEO}	Collector cut - off current	$V_{CE} = 400$ V TIPL751 $V_{CE} = 450$ V TIPL751A			50 50	μA μA
I_{EBO}	Emitter cut - off current	$V_{EB} = 10$ V $I_C = 0$			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	$I_C = 1$ A $I_B = 0.2$ A $I_C = 2.5$ A $I_B = 0.5$ A $I_C = 4$ A $I_B = 0.8$ A $I_C = 4$ A $I_B = 0.8$ A 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	$I_C = 1$ A $I_B = 0.2$ A $I_C = 2.5$ A $I_B = 0.5$ A $I_C = 4$ A $I_B = 0.8$ A $I_C = 4$ A $I_B = 0.8$ A 100°C			1.0 1.2 1.4 1.3	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	$I_C = 500$ mA $V_{CE} = 5$ V	20		60	
f_t	Current gain band-width product	$I_C = 500$ mA $V_{CE} = 10$ V $f = 1$ MHz		12		MHz
C_{ob}	Output capacitance	$I_E = 0$ $V_{CB} = 20$ V $f = 0.1$ MHz		110		pF
$R_{\theta JC}$	Thermal resistance junction - case				1.46	°C/W

TIPL751, TIPL751A
NPN SILICON POWER TRANSISTORS

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

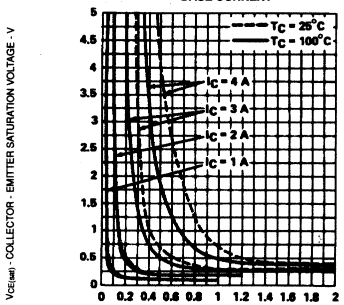
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 4 A $I_B(on)$ = 0.8 A $V_{BE}(off)$ = -5 V			2.50	µs
t_{rv}	Voltage rise time				0.30	µs
t_{fi}	Current fall time				0.25	µs
t_{ti}	Current tail time				0.15	µs
t_{xo}	Cross over time				0.40	µs
t_{sv}	Voltage storage time	I_C = 4 A $I_B(on)$ = 0.8 A $V_{BE}(off)$ = -5 V T_C = 100°C			3.00	µs
t_{rv}	Voltage rise time				0.50	µs
t_{fi}	Current fall time				0.25	µs
t_{ti}	Current tail time				0.15	µs
t_{xo}	Cross over time				0.75	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

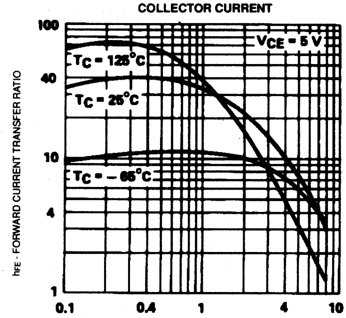
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

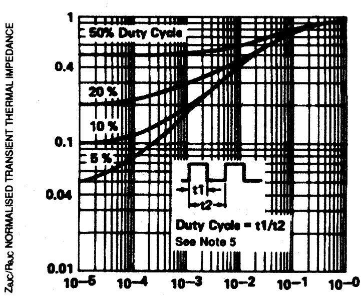
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



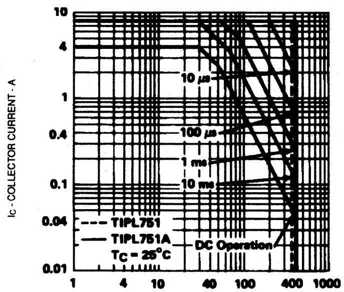
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



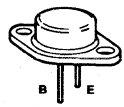
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TEXAS INSTRUMENTS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **6 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **150 W at 25°C Case Temperature**



PACKAGE: TO3

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL752	TIPL752A
V_{CBO}	Collector - base voltage (I_E = 0)	850 V	1000 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B =0)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	6 A	
I_{CM}	Peak collector current (Note 1)	12 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	150 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA TIPL752 L = 25 mH TIPL752A	400 450			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 850 V TIPL752 V_{CE} =1000 V TIPL752A V_{CE} = 850 V 100°C TIPL752 V_{CE} =1000 V 100°C TIPL752A			1 1 100 100	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL752 V_{CE} = 450 V TIPL752A			1 1	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2 A I_B = 0.4 A I_C = 4 A I_B = 0.8 A I_C = 6 A I_B = 1.2 A I_C = 6 A I_B = 1.2 A 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 &4)	I_C = 2 A I_B = 0.4 A I_C = 4 A I_B = 0.8 A I_C = 6 A I_B = 1.2 A I_C = 6 A I_B = 1.2 A 100°C			1.1 1.3 1.5 1.4	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	15		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		6		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		105		pF
$R_{θJC}$	Thermal resistance junction - case				1.17	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

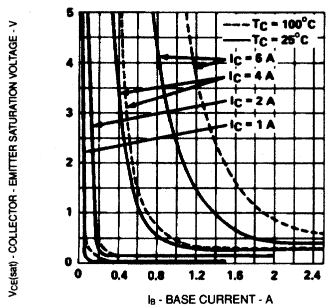
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 6 A; $I_B(on)$ = 1.2 A $V_{BE}(off)$ = -10 V			2.50	µs
t_{rv}	Voltage rise time				0.20	µs
t_{fi}	Current fall time				0.15	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.30	µs
t_{sv}	Voltage storage time	I_C = 6 A; $I_B(on)$ = 1.2 A $V_{BE}(off)$ = -10 V T_C = 100°C			3.00	µs
t_{rv}	Voltage rise time				0.30	µs
t_{fi}	Current fall time				0.15	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

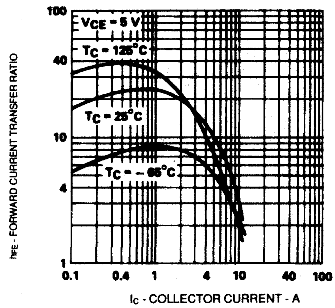
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

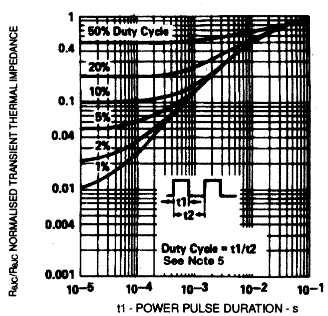
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



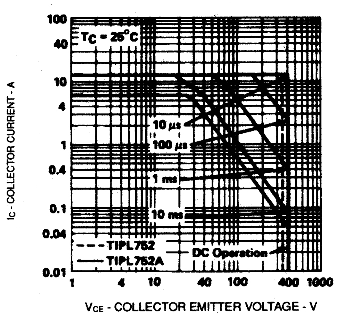
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



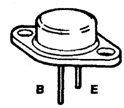
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIPL753, TIPL753A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **8 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **150 W at 25°C Case Temperature**



PACKAGE: TO3

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL753	TIPL753A
V_{CBO}	Collector - base voltage (I_E = 0)	850 V	1000 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B =0)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	8 A	
I_{CM}	Peak collector current (Note 1)	14 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	150 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\,(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA, L = 25 mH TIPL753 TIPL753A	400 450			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 850 V TIPL753 V_{CE} =1000 V TIPL753A V_{CE} = 850 V 100°C TIPL753 V_{CE} =1000 V 100°C TIPL753A			1 1 100 100	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL753 V_{CE} = 450 V TIPL753A			1 1	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2 A I_B = 0.4 A I_C = 5 A I_B = 1.0 A I_C = 8 A I_B = 1.6 A I_C = 8 A I_B = 1.6 A 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 2 A I_B = 0.4 A I_C = 5 A I_B = 1.0 A I_C = 8 A I_B = 1.6 A I_C = 8 A I_B = 1.6 A 100°C			0.9 1.1 1.5 1.4	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	20		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		6		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		105		pF
$R_{\theta JC}$	Thermal resistance junction - case				1.17	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

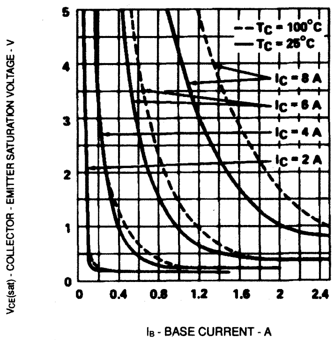
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 8 A			2.50	µs
t_{rv}	Voltage rise time	$I_B(on)$ = 1.6 A $V_{BE}(off)$ = -10 V			0.20	µs
t_{fi}	Current fall time				0.15	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.30	µs
t_{sv}	Voltage storage time	I_C = 8 A			3.00	µs
t_{rv}	Voltage rise time	$I_B(on)$ = 1.6 A $V_{BE}(off)$ = -10 V T_C = 100°C			0.30	µs
t_{fi}	Current fall time				0.15	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive Loop Switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

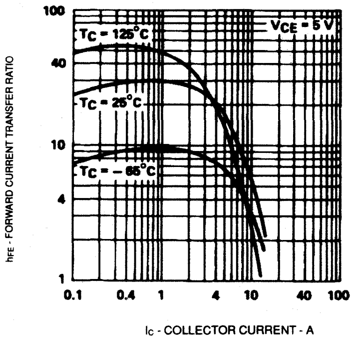
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

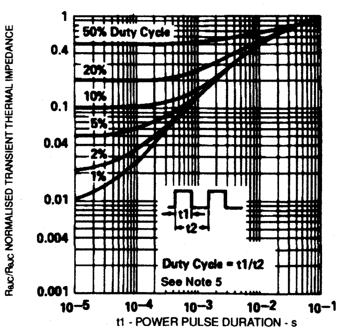
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



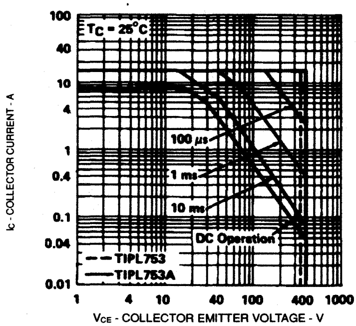
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



THERMAL RESPONSE

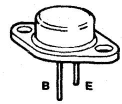


MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **10 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **180 W at 25°C Case Temperature**



PACKAGE: TO3

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL755	TIPL755A
V_{CBO}	Collector - base voltage (I_E = 0)	850 V	1000 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B =0)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	10 A	
I_{CM}	Peak collector current (Note 1)	15 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	180 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA, L = 25 mH TIPL755 TIPL755A	400 450			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 850 V TIPL755 V_{CE} =1000 V TIPL755A V_{CE} = 850 V 100°C TIPL755 V_{CE} =1000 V 100°C TIPL755A			1 1 100 100	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL755 V_{CE} = 450 V TIPL755A			1 1	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2 A I_B = 400 mA I_C = 5 A I_B = 1 A I_C = 10 A I_B = 2 A I_C = 10 A I_B = 2 A 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 2 A I_B = 400 mA I_C = 5 A I_B = 1 A I_C = 10 A I_B = 2 A I_C = 10 A I_B = 2 A 100°C			1.1 1.3 1.8 1.7	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	15		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		10		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		150		pF
$R_{\theta JC}$	Thermal resistance junction - case				0.97	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

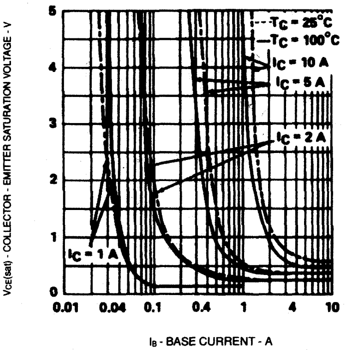
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 10 A, $I_{B(on)}$ = 2 A, $V_{BE(off)}$ = -5 V			3.00	µs
t_{rv}	Voltage rise time				0.30	µs
t_{fi}	Current fall time				0.20	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.40	µs
t_{sv}	Voltage storage time	I_C = 10 A, $I_{B(on)}$ = 2 A, $V_{BE(off)}$ = -5 V, T_C = 100°C			3.50	µs
t_{rv}	Voltage rise time				0.40	µs
t_{fi}	Current fall time				0.30	µs
t_{ti}	Current tail time				0.08	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive Loop Switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300µs,duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

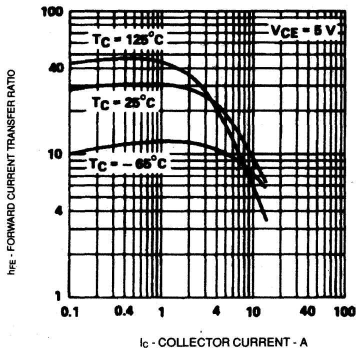
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

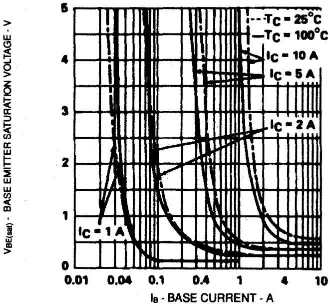
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



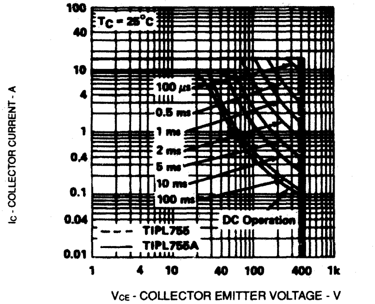
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE
vs
BASE CURRENT

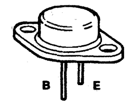


MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **15 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **200 W at 25°C Case Temperature**



PACKAGE: TO3

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL757	TIPL757A
V_{CBO}	Collector - base voltage (I_E = 0)	850 V	1000 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B =0)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	15 A	
I_{CM}	Peak collector current (Note 1)	25 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	200 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle < 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA TIPL757 L = 25 mH TIPL757A	400 450			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 850 V TIPL757 V_{CE} =1000 V TIPL757A V_{CE} = 850 V 100°C TIPL757 V_{CE} =1000 V 100°C TIPL757A			1 1 100 100	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL757 V_{CE} = 450 V TIPL757A			1 1	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 5 A I_B = 1A I_C = 10 A I_B = 2 A I_C = 15 A I_B = 3 A I_C = 15 A I_B = 3 A 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	IC = 5 A I_B = 1 A I_C = 10 A I_B = 2 A I_C = 15 A I_B = 3 A I_C = 15 A I_B = 3 A 100°C			1.4 1.5 1.7 1.8	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	15		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		12		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		200		pF
$R_{\theta JC}$	Thermal resistance junction - case				0.9	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

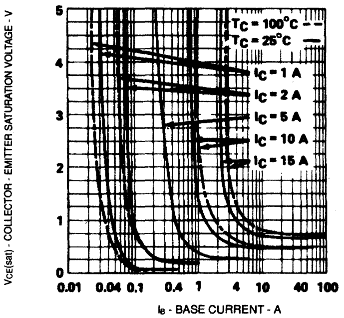
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 15 A, $I_{B(on)}$ = 3 A, $V_{BE(off)}$ = -10 V			2.50	µs
t_{rv}	Voltage rise time				0.20	µs
t_{fi}	Current fall time				0.30	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.50	µs
t_{sv}	Voltage storage time	I_C = 15 A, $I_{B(on)}$ = 3 A, $V_{BE(off)}$ = -10 V, T_C = 100°C			3.00	µs
t_{rv}	Voltage rise time				0.35	µs
t_{fi}	Current fall time				0.40	µs
t_{ti}	Current tail time				0.08	µs
t_{xo}	Cross over time				0.80	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

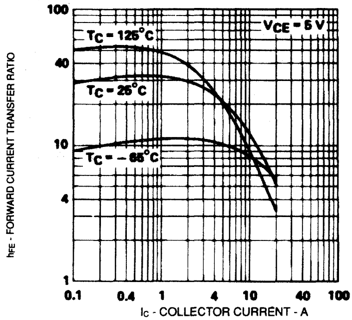
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

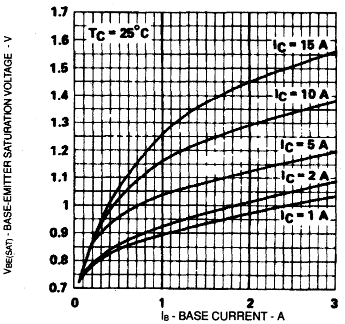
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



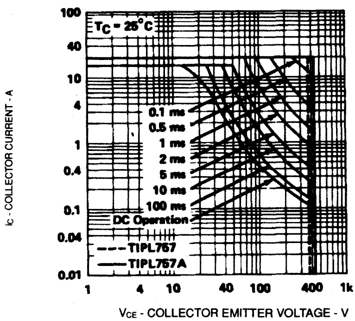
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT



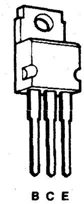
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



Revised March 1990

TIPL760, TIPL760A
NPN SILICON POWER TRANSISTORS

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **4 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **75 W at 25°C Case Temperature**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL760	TIPL760A
V_{CBO}	Collector - base voltage ($I_E = 0$)	850 V	1000 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	850 V	1000 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	8 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	75 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle < 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\,(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 10 mA TIPL760 L = 25 mH TIPL760A	400 450			V V
I_{CES}	Collector - emitter cut - off current ($V_{BE} = 0$)	V_{CE} = 850 V TIPL760 V_{CE} =1000 V TIPL760A V_{CE} = 850 V 100°C TIPL760 V_{CE} =1000 V 100°C TIPL760A			50 50 200 200	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL760 V_{CE} = 450 V TIPL760A			50 50	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V $I_C = 0$			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2.5 A I_B = 500 mA I_C = 4.0 A I_B = 800 mA I_C = 4.0 A I_B = 800 mA 100°C			1.0 2.5 5.0	V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 2.5 A I_B = 500 mA I_C = 4.0 A I_B = 800 mA I_C = 4.0 A I_B = 800 mA 100°C			1.2 1.4 1.3	V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	20		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		12		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		110		pF
$R_{\theta JC}$	Thermal resistance junction - case				1.56	°C/W

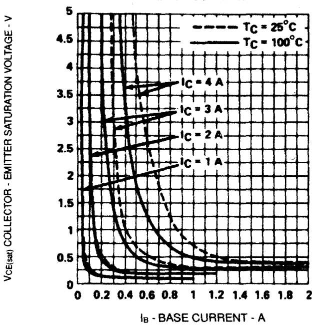
Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

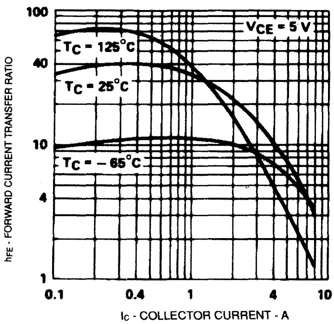
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 4.0 A, $I_{B(on)}$ = 0.8 A, $V_{BE(off)}$ = -5 V			2.50	µs
t_{rv}	Voltage rise time				0.30	µs
t_{fi}	Current fall time				0.25	µs
t_{ti}	Current tail time				0.15	µs
t_{xo}	Cross over time				0.40	µs
t_{sv}	Voltage storage time	I_C = 4.0 A, $I_{B(on)}$ = 0.8 A, $V_{BE(off)}$ = -5 V, T_C = 100°C			3.00	µs
t_{rv}	Voltage rise time				0.50	µs
t_{fi}	Current fall time				0.25	µs
t_{ti}	Current tail time				0.15	µs
t_{xo}	Cross over time				0.75	µs

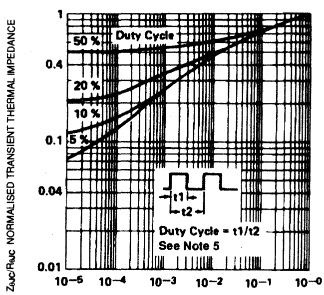
NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(PEAK)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

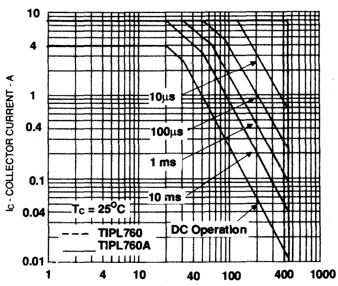
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS





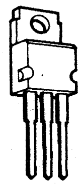




NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **4 A Continuous Collector Current**
- **1200 Volt Blocking Capability**
- **75 W at 25°C Case Temperature**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL760B	TIPL760C
V_{CBO}	Collector - base voltage ($I_E = 0$)	1100 V	1200 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	1100 V	1200 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	500 V	550 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	8 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	75 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 °C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{CEO\,(sus)}$	Collector - emitter sustaining voltage (Note 2)	$I_C = 10$ mA $L = 25$ mH	TIPL760B TIPL760C	500 550			V V
I_{CES}	Collector - emitter cut - off current ($V_{BE} = 0$)	$V_{CE} = 1100$ V $V_{CE} = 1200$ V $V_{CE} = 1100$ V 100°C $V_{CE} = 1200$ V 100°C	TIPL760B TIPL760C TIPL760B TIPL760C			50 50 200 200	µA µA µA µA
I_{CEO}	Collector cut - off current	$V_{CE} = 500$ V $V_{CE} = 550$ V	TIPL760B TIPL760C			50 50	µA µA
I_{EBO}	Emitter cut - off current	$V_{EB} = 10$ V $I_C = 0$				1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	$I_C = 2.0$ A $I_B = 400$ mA $I_C = 3.0$ A $I_B = 600$ mA $I_C = 3.0$ A $I_B = 600$ mA 100°C				1.0 2.5 5.0	V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	$I_C = 2.0$ A $I_B = 400$ mA $I_C = 3.0$ A $I_B = 600$ mA $I_C = 3.0$ A $I_B = 600$ mA 100°C				1.2 1.4 1.3	V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	$I_C = 500$ mA $V_{CE} = 5$ V		20		60	
f_t	Current gain band-width product	$I_C = 500$ mA $V_{CE} = 10$ V $f = 1$ MHz			12		MHz
C_{ob}	Output capacitance	$I_E = 0$ $V_{CB} = 20$ V $f = 0.1$ MHz			110		pF
$R_{\theta JC}$	Thermal resistance junction - case					1.56	°C/W

Inductive Load Switching characteristics at 25°C Case Temperature (unless otherwise noted)

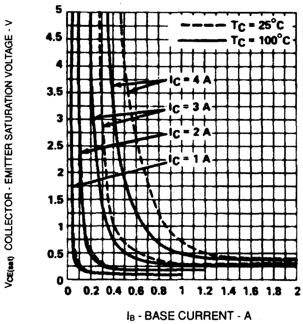
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time				2.50	µs
t_{rv}	Voltage rise time	I_C = 3.0 A			0.30	µs
t_{fi}	Current fall time	$I_{B(on)}$ = 0.6 A $V_{BE(off)}$ = -5 V			0.25	µs
t_{ti}	Current tail time				0.15	µs
t_{xo}	Cross over time				0.40	µs
t_{sv}	Voltage storage time				3.00	µs
t_{rv}	Voltage rise time	I_C = 3.0 A			0.50	µs
t_{fi}	Current fall time	$I_{B(on)}$ = 0.6 A $V_{BE(off)}$ = -5 V T_C = 100°C			0.25	µs
t_{ti}	Current tail time				0.15	µs
t_{xo}	Cross over time				0.75	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(PEAK)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

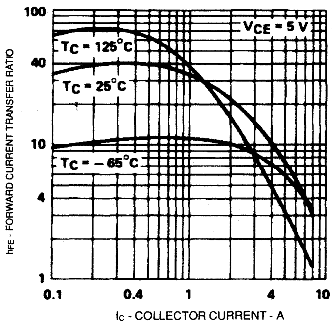
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

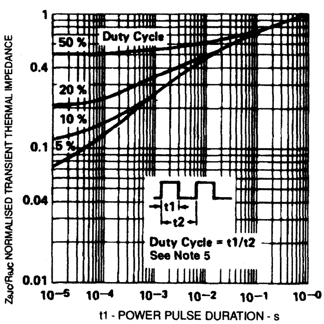
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



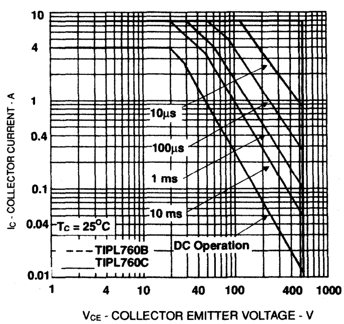
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



THERMAL RESPONSE



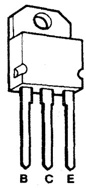
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIPL761, TIPL761A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **4 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **100 W at 25°C Case Temperature**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL761	TIPL761A
V_{CBO}	Collector - base voltage (I_E = 0)	850 V	1000 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B =0)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	8 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	100 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 °C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\,(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 10 mA, L = 25 mH TIPL761 TIPL761A	400 450			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 850 V TIPL761 V_{CE} =1000 V TIPL761A V_{CE} = 850 V 100°C TIPL761 V_{CE} = 1000 V 100°C TIPL761A			50 50 200 200	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL761 V_{CE} = 450 V TIPL761A			50 50	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2.5 A I_B = 500 mA I_C = 4.0 A I_B = 800 mA I_C = 4.0 A I_B = 800 mA 100°C			1.0 2.5 5.0	V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 2.5 A I_B = 500 mA I_C = 4.0 A I_B = 800 mA I_C = 4.0 A I_B = 800 mA 100°C			1.2 1.4 1.3	V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	20		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		12		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		110		pF
$R_{\theta JC}$	Thermal resistance junction - case				1.56	°C/W

Inductive Load Switching characteristics at 25°C Case Temperature (unless otherwise noted)

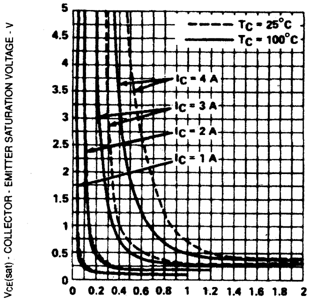
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 4.0 A, $I_{B(on)}$ = 0.8 A, $V_{BE(off)}$ = -5 V			2.50	µs
t_{rv}	Voltage rise time				0.30	µs
t_{fi}	Current fall time				0.25	µs
t_{ti}	Current tail time				0.15	µs
t_{xo}	Cross over time				0.40	µs
t_{sv}	Voltage storage time	I_C = 4.0 A, $I_{B(on)}$ = 0.8 A, $V_{BE(off)}$ = -5 V, T_C = 100°C			3.00	µs
t_{rv}	Voltage rise time				0.50	µs
t_{fi}	Current fall time				0.25	µs
t_{ti}	Current tail time				0.15	µs
t_{xo}	Cross over time				0.75	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µS, duty cycle ≤2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

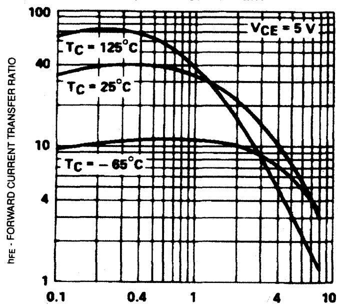
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

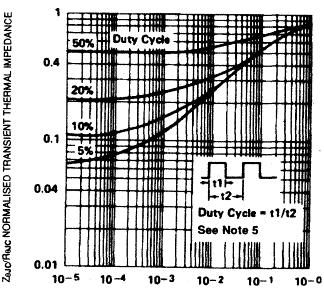
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



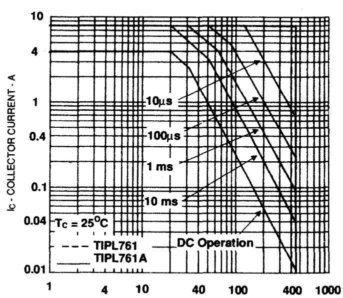
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



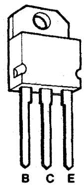
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TEXAS INSTRUMENTS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **4 A Continuous Collector Current**
- **1200 Volt Blocking Capability**
- **100 W at 25°C Case Temperature**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C AmbientTemperature

		TIPL761B	TIPL761C
V_{CBO}	Collector - base voltage (I_E = 0)	1100 V	1200 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	1100 V	1200 V
V_{CEO}	Collector - emitter voltage (I_B =0)	500 V	550 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	8 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	100 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 10 mA TIPL761B L = 25 mH TIPL761C	500 550			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 1100 V TIPL761B V_{CE} = 1200 V TIPL761C V_{CE} = 1100 V 100°C TIPL761B V_{CE} = 1200 V 100°C TIPL761C			50 50 200 200	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 500 V TIPL761B V_{CE} = 500 V TIPL761C			50 50	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2.0 A I_B = 400 mA I_C = 3.0 A I_B = 600 mA I_C = 3.0 A I_B = 600 mA 100°C			1.0 2.5 5.0	V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 2.0 A I_B = 400 mA I_C = 3.0 A I_B = 600 mA I_C = 3.0 A I_B = 600 mA 100°C			1.2 1.4 1.3	V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	20		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		12		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		110		pF
$R_{\theta JC}$	Thermal resistance junction - case				1.56	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

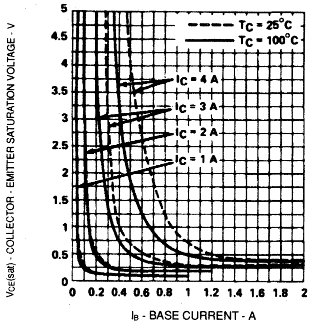
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 3.0 A			2.50	μs
t_{rv}	Voltage rise time	$I_{B(on)}$ = 0.6 A $V_{BE(off)}$ = -5 V			0.30	μs
t_{fi}	Current fall time				0.25	μs
t_{ti}	Current tail time				0.15	μs
t_{xo}	Cross over time				0.40	μs
t_{sv}	Voltage storage time	I_C = 3.0 A			3.00	μs
t_{rv}	Voltage rise time	$I_{B(on)}$ = 0.6 A $V_{BE(off)}$ = -5 V T_C = 100°C			0.50	μs
t_{fi}	Current fall time				0.25	μs
t_{ti}	Current tail time				0.15	μs
t_{xo}	Cross over time				0.75	μs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300μs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(PEAK)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

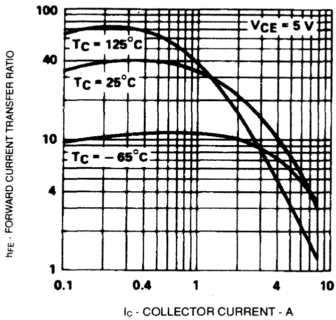
See Appendices For Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

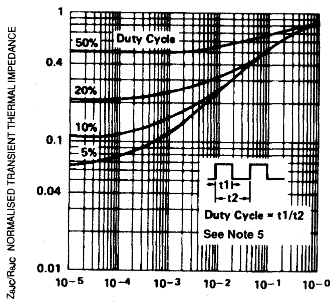
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



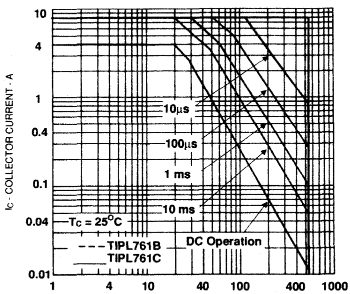
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



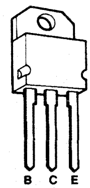
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **6 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **120 W at 25°C Case Temperature**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL762	TIPL762A
V_{CBO}	Collector - base voltage ($I_E = 0$)	850 V	1000 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	850 V	1000 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	6 A	
I_{CM}	Peak collector current (Note 1)	12 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	120 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\,(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA TIPL762 L = 25 mH TIPL762A	400 450			V V
I_{CES}	Collector - emitter cut - off current ($V_{BE} = 0$)	V_{CE} = 850 V TIPL762 V_{CE} = 1000 V TIPL762A V_{CE} = 850 V 100°C TIPL762 V_{CE} = 1000 V 100°C TIPL762A			50 50 200 200	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL762 V_{CE} = 450 V TIPL762A			50 50	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0 A			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2 A I_B = 0.4 A I_C = 4 A I_B = 0.8 A I_C = 6 A I_B = 1.2 A I_C = 6 A I_B = 1.2 A 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 2 A I_B = 0.4 A I_C = 4 A I_B = 0.8 A I_C = 6 A I_B = 1.2 A I_C = 6 A I_B = 1.2 A 100°C			1.1 1.3 1.5 1.4	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	20		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		6		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1MHz		105		pF
$R_{\theta JC}$	Thermal resistance junction - case				1.25	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

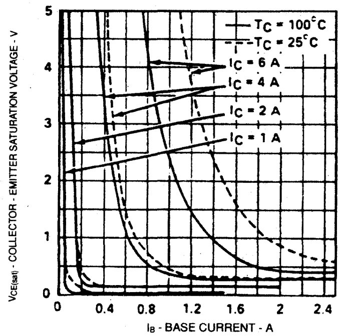
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 6 A $I_{B(on)}$ = 1.2 A $V_{BE(off)}$ = -10 V			2.50	µs
t_{rv}	Voltage rise time				0.20	µs
t_{fi}	Current fall time				0.15	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.30	µs
t_{sv}	Voltage storage time	I_C = 6 A $I_{B(on)}$ = 1.2 A $V_{BE(off)}$ = -10 V T_C = 100°C			3.00	µs
t_{rv}	Voltage rise time				0.30	µs
t_{fi}	Current fall time				0.15	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, t_w = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(PEAK)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

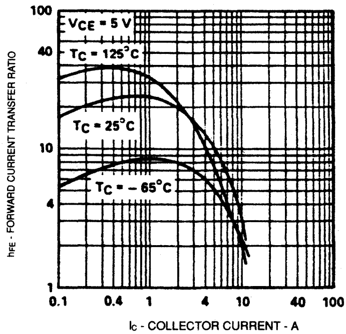
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

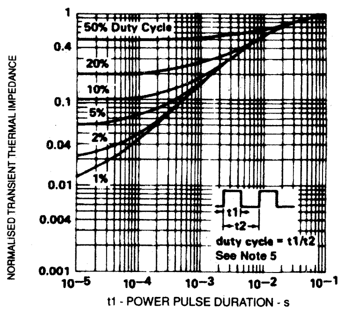
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



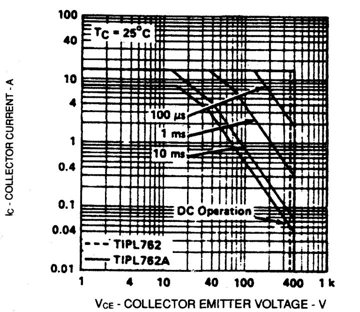
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



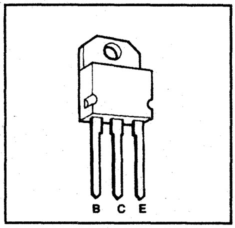
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIPL763, TIPL763A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **8 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **120 W at 25°C Case Temperature**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL763	TIPL763A
V_{CBO}	Collector - base voltage ($I_E = 0$)	850 V	1000 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	850 V	1000 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	8 A	
I_{CM}	Peak collector current (Note 1)	14 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	120 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\,(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA, L = 25 mH TIPL763 TIPL763A	400 450			V V
I_{CES}	Collector - emitter cut - off current ($V_{BE} = 0$)	V_{CE} = 850 V TIPL763 V_{CE} = 1000 V TIPL763A V_{CE} = 850 V 100°C TIPL763 V_{CE} = 1000 V 100°C TIPL763A			50 50 200 200	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL763 V_{CE} = 450 V TIPL763A			50 50	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V $I_C = 0$			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2 A I_B = 0.4 A I_C = 5 A I_B = 1.0 A I_C = 8 A I_B = 1.6 A I_C = 8 A I_B = 1.6 A 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 2 A I_B = 0.4 A I_C = 5 A I_B = 1.0 A I_C = 8 A I_B = 1.6 A I_C = 8 A I_B = 1.6 A 100°C			1.1 1.3 1.7 1.6	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	15		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		8		MHz
C_{ob}	Output capacitance	$I_E = 0$ V_{CB} = 20 V f = 0.1 MHz		150		pF
$R_{\theta JC}$	Thermal resistance junction - case				1.0	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

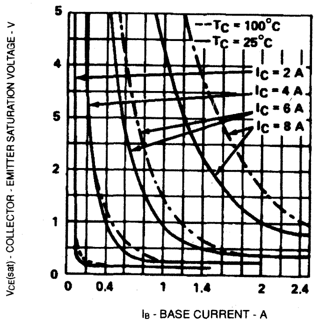
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 8 A, $I_{B(on)}$ = 1.6 A, $V_{BE(off)}$ = -10 V			2.50	µs
t_{rv}	Voltage rise time				0.20	µs
t_{fi}	Current fall time				0.15	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.30	µs
t_{sv}	Voltage storage time	I_C = 8 A, $I_{B(on)}$ = 1.6 A, $V_{BE(off)}$ = -10 V, T_C = 100°C			3.00	µs
t_{rv}	Voltage rise time				0.30	µs
t_{fi}	Current fall time				0.15	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(PEAK)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

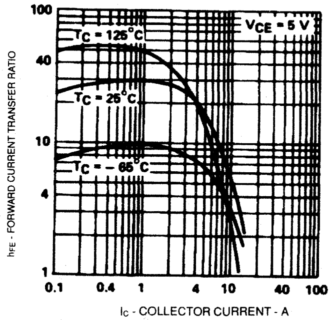
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

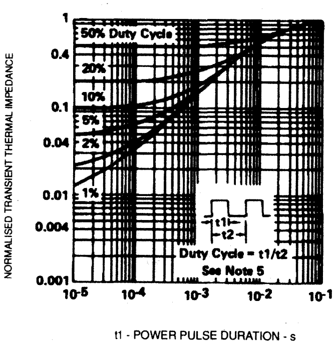
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



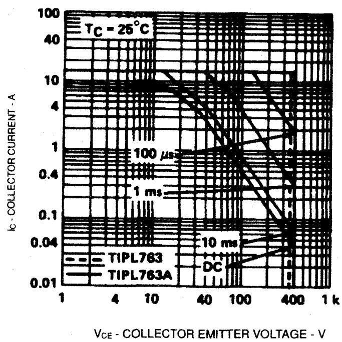
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



THERMAL RESPONSE



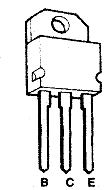
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIPL765, TIPL765A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **10 A Continuous Collector Current**
- **1000 Volt Blocking Capability**
- **125 W at 25°C Case Temperature**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL765	TIPL765A
V_{CBO}	Collector - base voltage ($I_E = 0$)	850 V	1000 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	850 V	1000 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	10 A	
I_{CM}	Peak collector current (Note 1)	15 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	125 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 °C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage (Note 2)	$I_C = 100$ mA, $L = 25$ mH, TIPL765 TIPL765A	400 450			V V
I_{CES}	Collector - emitter cut - off current ($V_{BE} = 0$)	$V_{CE} = 850$ V, TIPL765 $V_{CE} = 1000$ V, TIPL765A $V_{CE} = 850$ V, 100°C, TIPL765 $V_{CE} = 1000$ V, 100°C, TIPL765A			50 50 200 200	µA µA µA µA
I_{CEO}	Collector cut - off current	$V_{CE} = 400$ V, TIPL765 $V_{CE} = 450$ V, TIPL765A			50 50	µA µA
I_{EBO}	Emitter cut - off current	$V_{EB} = 10$ V, $I_C = 0$			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	$I_C = 2$ A, $I_B = 0.4$ A $I_C = 5$ A, $I_B = 1.0$ A $I_C = 10$ A, $I_B = 2$ A $I_C = 10$ A, $I_B = 2$ A, 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	$I_C = 2$ A, $I_B = 0.4$ A $I_C = 5$ A, $I_B = 1.0$ A $I_C = 10$ A, $I_B = 2$ A $I_C = 10$ A, $I_B = 2$ A, 100°C			1.1 1.3 1.7 1.6	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	$I_C = 500$ mA, $V_{CE} = 5$ V	15		60	
f_t	Current gain band-width product	$I_C = 500$ mA, $V_{CE} = 10$ V, f = 1 MHz		8		MHz
C_{ob}	Output capacitance	$I_E = 0$, $V_{CB} = 20$ V, f = 0.1 MHz		150		pF
$R_{\theta JC}$	Thermal resistance junction - case				1.0	°C/W

Inductive Load Switching characteristics at 25°C Case Temperature (unless otherwise noted)

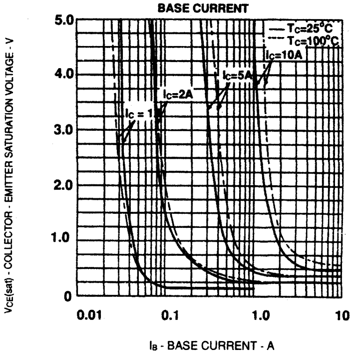
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 10 A $I_{B(on)}$ = 2.0 A $V_{BE(off)}$ = -5 V			2.00	µs
t_{rv}	Voltage rise time				0.30	µs
t_{fi}	Current fall time				0.20	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.40	µs
t_{sv}	Voltage storage time	I_C = 10 A $I_{B(on)}$ = 2.0 A $V_{BE(off)}$ = -5 V T_C = 100°C			3.50	µs
t_{rv}	Voltage rise time				0.40	µs
t_{fi}	Current fall time				0.30	µs
t_{ti}	Current tail time				0.08	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

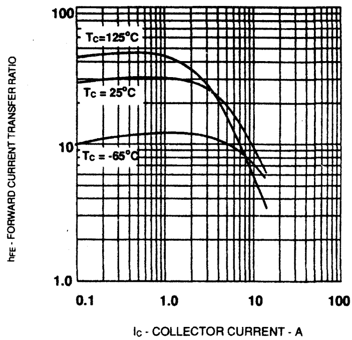
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

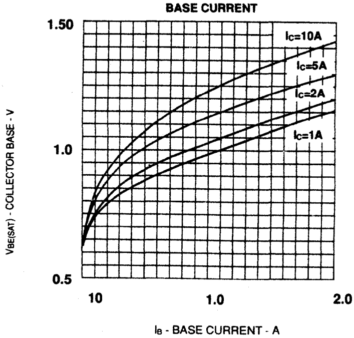
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



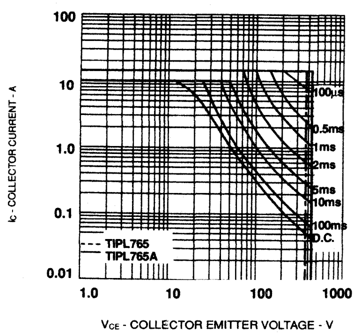
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



COLLECTOR-BASE SATURATION VOLTAGE vs BASE CURRENT



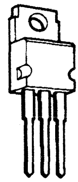
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



NPN SILICON POWER TRANSISTOR

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **2.5 A Continuous Collector Current**
- **850 Volt Blocking Capability**
- **50 W at 25°C Case Temperature**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL770
V_{CBO}	Collector - base voltage (I_E = 0)	850 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V
V_{CEO}	Collector - emitter voltage (I_B =0)	400 V
V_{EBO}	Base - emitter voltage	10 V
I_C	Continuous collector current	2.5 A
I_{CM}	Peak collector current (Note 1)	8 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	50 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA L = 25 mH	400			V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 850 V V_{CE} = 850 V 100°C			5.0 0.2	µA mA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V			5.0	µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 1 A I_B = 200 mA I_C = 2.5 A I_B = 500 mA I_C = 2.5 A I_B = 500 mA 100°C			1.0 2.5 5.0	V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 1 A I_B = 200 mA I_C = 2.5 A I_B = 500 mA I_C = 2.5 A I_B = 500 mA 100°C			1.0 1.2 1.3	V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 0.5 A V_{CE} = 5 V	20		60	
f_t	Current gain band-width product	I_C = 0.5 A V_{CE} = 10 V f = 1 MHz		12		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		55		pF
$R_{\theta JC}$	Thermal resistance junction - case				2.5	°C/W

2

TIPL Devices

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

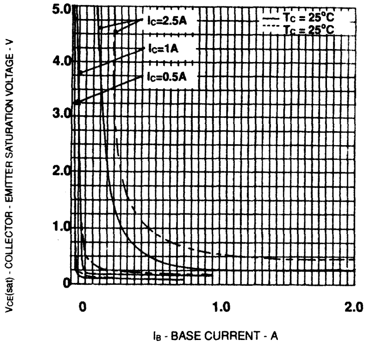
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time				2.0	µs
t_{rv}	Voltage rise time	I_C = 2.5 A			0.20	µs
t_{fi}	Current fall time	$I_{B(on)}$ = 0.5 A $V_{BE(off)}$ = -5 V			0.20	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.30	µs
t_{sv}	Voltage storage time				2.50	µs
t_{rv}	Voltage rise time	I_C = 2.5 A			0.40	µs
t_{fi}	Current fall time	$I_{B(on)}$ = 0.5 A $V_{BE(off)}$ = -5 V T_C = 100°C			0.25	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

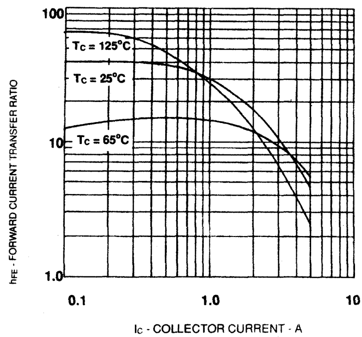
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

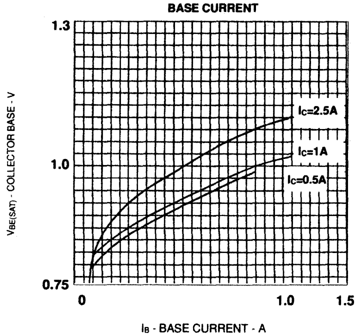
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



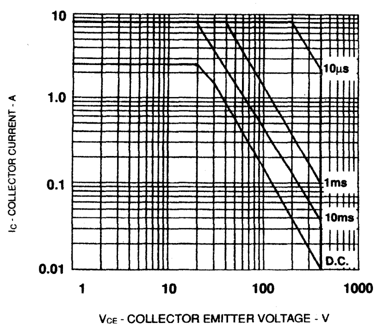
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



COLLECTOR - BASE SATURATION VOLTAGE vs BASE CURRENT



MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

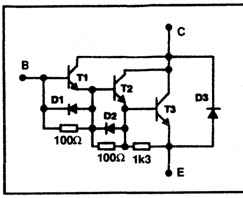


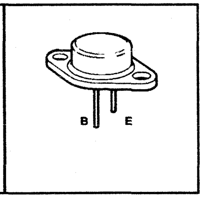
TEXAS INSTRUMENTS

TIPL773
NPN SILICON HIGH VOLTAGE ADVANCED POWER DARLINGTON

Revised March 1990

- **Designed for High Voltage Switching in Industrial Environments**
- **180 W at 25°C Case Temperature**
- **20 A Continuous Collector Current.**
- **Large RBSOA (up to 20 A at 800 V) Permits Snubberless Operation.**
- **All Major Parameters Specified at 100°C**





PACKAGE: TO3

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL773
V_{CBO}	Collector - base voltage (I_E = 0)	950 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	950 V
V_{CEO}	Collector - emitter voltage (I_B =0)	600 V
V_{EBO}	Base - emitter voltage	6 V
I_C	Continuous collector current	20 A
I_{CM}	Peak collector current (Note 1)	± 55 A
I_B	Continuous base - current	3 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	180 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C

NOTE 1: This value applies for $t_w \le 300$ µs, duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEX\,(sus)}$	Collector - emitter sustaining voltage	I_C = 6 A $I_{B(off)}$ = -1 A	710			V
$V_{CEO\,(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA L = 25 mH	600			V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 950 V V_{CE} = 950 V 100°C			0.1 1	mA mA
I_{CEV}	Collector cut - off current	V_{CE} = 950 V V_{BE} = -1.5 V to -6 V			0.1	mA
I_{CEO}	Collector cut - off current	V_{CE} = 600 V			50	µA
I_{EBO}	Emitter cut - off current	V_{EB} = 6 V I_C = 0		5	10	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 3 A I_B = 60 mA I_C = 10 A I_B = 0.2 A I_C = 15 A I_B = 0.3 A I_C = 15 A I_B = 0.3 A 100°C		1.6 2.0 2.2 2.1	2.0 2.5 3.0 3.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 3 A I_B = 60 mA I_C = 10 A I_B = 0.2 A I_C = 15 A I_B = 0.3 A I_C = 15 A I_B = 0.3 A 100°C		2.4 2.7 3.0 2.7	3.0 3.5 3.5 3.5	V V V V
V_F	Parallel diode forward voltage (Notes 3 & 4)	I_F = 15 A			2.0	V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	50			
C_{obo}	Output capacitance	I_E = 0 V_{CB} = 5 V f = 0.1 MHz		185		pF
$R_{\theta JC}$	Thermal resistance junction - case				0.97	°C/W

TIPL773
NPN SILICON HIGH VOLTAGE ADVANCED POWER DARLINGTON

Inductive Load Switching characteristics at 25°C Case Temperature (unless otherwise noted)

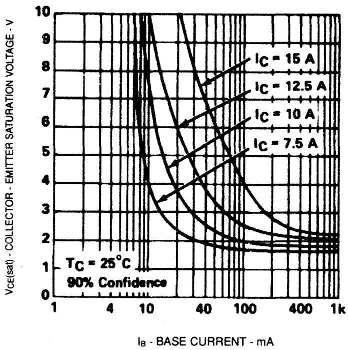
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 15 A V_{CE} = 300 V $I_{B(off)}$ = -1.5 A			2.80	µs
t_{rv}	Voltage rise time				0.50	µs
t_{fi}	Current fall time				0.30	µs
t_{ti}	Current tail time				0.80	µs
t_{xo}	Cross over time				0.10	µs
t_{sv}	Voltage storage time	I_C = 15 A V_{CE} = 300 V $I_{B(off)}$ = -1.5 A T_C = 100°C			4.80	µs
t_{rv}	Voltage rise time				1.50	µs
t_{fi}	Current fall time				0.50	µs
t_{ti}	Current tail time				2.00	µs
t_{xo}	Cross over time				0.15	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

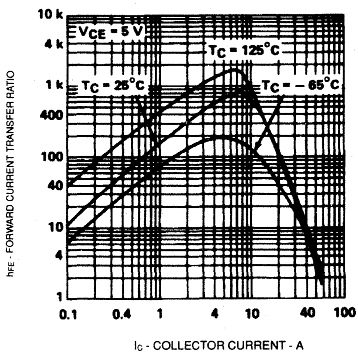
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

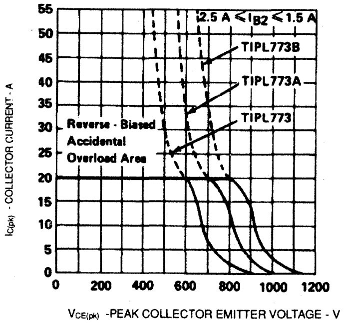
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



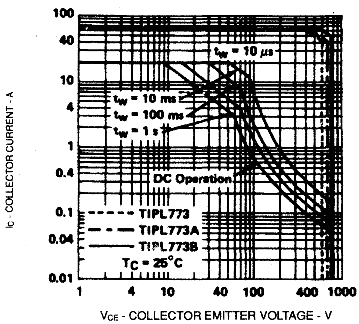
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



REVERSE BIAS SAFE OPERATING AREA



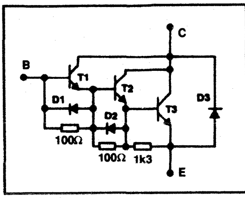
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

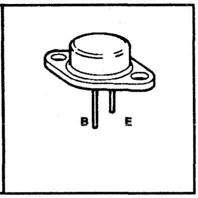


NPN SILICON HIGH VOLTAGE ADVANCED POWER DARLINGTON

Revised March 1990

- **Designed for High Voltage Switching in Industrial Environments**
- **180 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **Large RBSOA (up to 20 A at 800 V) Permits Snubberless Operation.**
- **All Major Parameters Specified at 100°C**





PACKAGE: TO3

Absolute Maximum Ratings at 25°C AmbientTemperature

		TIPL773A
V_{CBO}	Collector - base voltage (I_E = 0)	1050 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	1050 V
V_{CEO}	Collector - emitter voltage (I_B =0)	700 V
V_{EBO}	Base - emitter voltage	6 V
I_C	Continuous collector current	20 A
I_{CM}	Peak collector current (Note 1)	± 55 A
I_B	Continuous base - current	3 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	180 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C

NOTE 1: This value applies for tw ≤ 300 µs, duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEX\ (sus)}$	Collector - emitter sustaining voltage	I_C = 6 A I_B(off) = 1 A	860			V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA L = 25 mH	700			V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} =1050 V V_{CE} =1050 V 100°C			0.1 1	mA mA
I_{CEV}	Collector cut - off current	V_{CE} =1050 V V_{BE} = -1.5 V to -6 V			0.1	mA
I_{CEO}	Collector cut - off current	V_{CE} = 700 V			50	µA
I_{EBO}	Emitter cut - off current	V_{EB} = 6 V I_C = 0		5	10	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 2.5 A I_B = 50 mA I_C = 7.5 A I_B = 0.15 A I_C = 12.5 A I_B = 0.25 A I_C = 12.5 A I_B = 0.25 A 100°C		1.6 1.9 2.2 2.0	2.0 2.5 3.0 3.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 2.5 A I_B = 50 mA I_C = 7.5 A I_B = 0.15 A I_C = 12.5 A I_B = 0.25 A I_C = 12.5 A I_B = 0.25 A 100°C		2.3 2.6 2.9 2.7	3.0 3.5 3.5 3.5	V V V V
V_F	Parallel diode foward voltage (Notes 3 & 4)	I_F = 15 A			2.0	V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	50			
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 5 V f = 0.1 MHz		185		pF
$R_{\theta JC}$	Thermal resistance junction - case				0.97	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

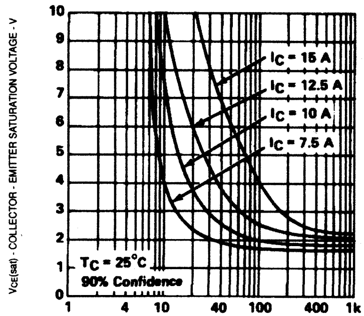
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 12.5 A V_{CE} = 300 V			3.00	µs
t_{rv}	Voltage rise time	$I_B(off)$ = -1.5 A			0.50	µs
t_{fi}	Current fall time				0.30	µs
t_{ti}	Current tail time				0.80	µs
t_{xo}	Cross over time				0.10	µs
t_{sv}	Voltage storage time	I_C = 12.5 A V_{CE} = 300 V			5.00	µs
t_{rv}	Voltage rise time	$I_B(off)$ = -1.5 A T_C = 100°C			1.50	µs
t_{fi}	Current fall time				0.50	µs
t_{ti}	Current tail time				2.00	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

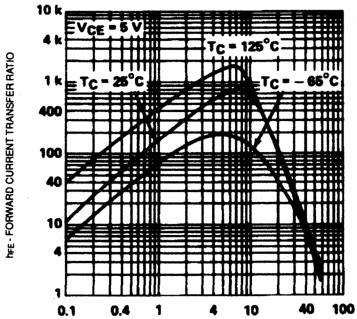
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

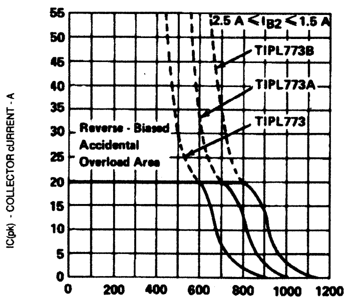
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



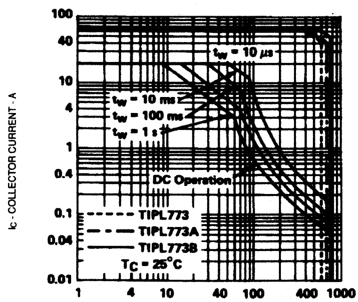
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



REVERSE BIAS SAFE OPERATING AREA



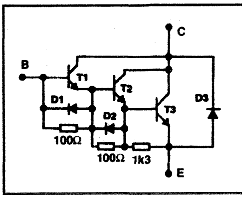
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

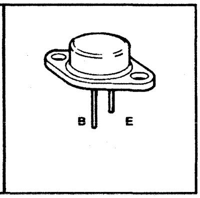


TIPL773B
NPN SILICON HIGH VOLTAGE ADVANCED POWER DARLINGTON

Revised March 1990

- **Designed for High Voltage Switching in Industrial Environments**
- **180 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **Large RBSOA (up to 20 A at 800 V) Permits Snubberless Operation**
- **All Major Parameters Specified at 100°C**





PACKAGE: TO3

Absolute Maximum Ratings at 25°C AmbientTemperature

		TIPL773B
V_{CBO}	Collector - base voltage ($I_E = 0$)	1150 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	1150 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	800 V
V_{EBO}	Base - emitter voltage	6 V
I_C	Continuous collector current	20 A
I_{CM}	Peak collector current (Note 1)	± 55 A
I_B	Continuous base - current	3 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	180 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C

NOTE 1: This value applies for $t_w \le 300$ µs, duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEX\ (sus)}$	Collector - emitter sustaining voltage	$I_C = 6$ A $I_{B(off)} = 1$ A	970			V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	$I_C = 100$ mA $L = 25$ mH	800			V
I_{CES}	Collector - emitter cut - off current ($V_{BE} = 0$)	$V_{CE} = 1150$ V $V_{CE} = 1150$ V 100°C			0.1 1	mA mA
I_{CEV}	Collector cut - off current	$V_{CE} = 1150$ V $V_{BE} = -1.5$ V to -6 V			0.1	mA
I_{CEO}	Collector cut - off current	$V_{CE} = 800$ V			50	µA
I_{EBO}	Emitter cut - off current	$V_{EB} = 6$ V $I_C = 0$		5	10	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	$I_C = 1$ A $I_B = 20$ mA $I_C = 5$ A $I_B = 0.1$ A $I_C = 10$ A $I_B = 0.2$ A $I_C = 10$ A $I_B = 0.2$ A 100°C		1.5 1.8 2.1 1.9	2.0 2.5 3.0 3.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	$I_C = 1$ A $I_B = 20$ mA $I_C = 5$ A $I_B = 0.1$ A $I_C = 10$ A $I_B = 0.2$ A $I_C = 10$ A $I_B = 0.2$ A 100°C		2.2 2.5 2.8 2.6	3.0 3.5 3.5 3.5	V V V V
V_F	Parallel diode forward voltage (Notes 3 & 4)	$I_F = 15$ A			2.0	V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	$I_C = 500$ mA $V_{CE} = 5$ V	50			
C_{obo}	Output capacitance	$I_E = 0$ $V_{CB} = 5$ V f = 0.1 MHz		185		pF
$R_{\theta JC}$	Thermal resistance junction - case				0.97	°C/W

TIPL773B
NPN SILICON HIGH VOLTAGE
ADVANCED POWER DARLINGTON

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

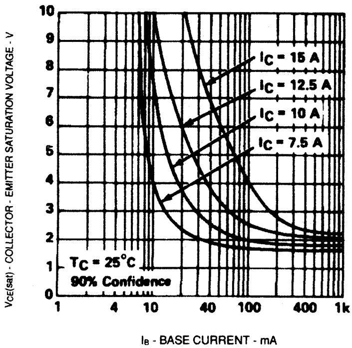
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 10 A V_{CE} = 300 V I_B(off) = -1.5 A			3.20	µs
t_{rv}	Voltage rise time				0.50	µs
t_{fi}	Current fall time				0.30	µs
t_{ti}	Current tail time				0.80	µs
t_{xo}	Cross over time				0.10	µs
t_{sv}	Voltage storage time	I_C = 10 A V_{CE} = 300 V I_B(off) = -1.5 A T_C = 100°C			5.20	µs
t_{rv}	Voltage rise time				1.50	µs
t_{fi}	Current fall time				0.50	µs
t_{ti}	Current tail time				2.00	µs
t_{xo}	Cross over time				0.15	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

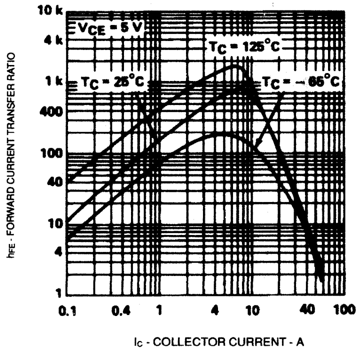
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

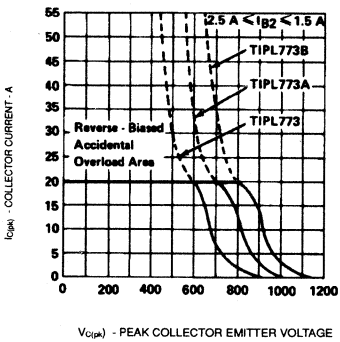
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



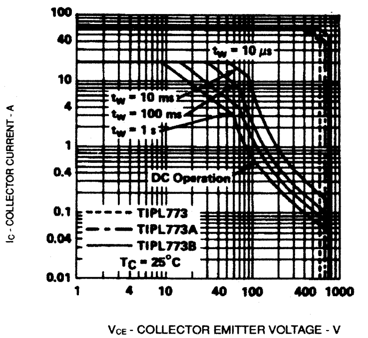
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



REVERSE BIAS SAFE OPERATING AREA



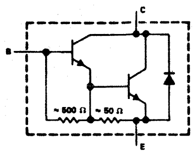
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

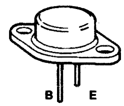


NPN DARLINGTON CONNECTED SILICON POWER TRANSISTOR

Revised March 1990

- **20 A Continuous Collector Current**
- **Forward Pulse Energy - 300 mJ**
- **V_{CEO} - 450 V Min**
- **High Voltage, High - Forward & Clamped Reverse Energy**
- **Designed for Automotive Ignition Systems**





PACKAGE: TO3

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL774
V_{CBO}	Collector - base voltage ($I_E = 0$)	550 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$) (Note 1)	450 V
V_{EBO}	Base - emitter voltage	8 V
I_C	Continuous collector current	20 A
I_{CM}	Peak collector current (Note 2)	± 30 A
I_B	Continuous base - current	3 A
P_{tot}	Continuous device dissipation at 50°C case temperature (Note3)	150 W
P_{tot}	Continuous device dissipation at 25°C free air temperature (Note 4)	5.5 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C
	Lead temperature 3.2mm from case for 10 seconds	300°C

NOTES : 1: These values apply when the base - emitter diode is reverse - biased or open circuited.
2: This value applies for t_w = 5 ms, duty cycle ≤ 10%
3: Derate linearly to 200°C case temperature at the rate of 1 W/°C
4: Derate linearly to 200°C free - air temperature at the rate of 31.4 mW/°C
5: These parameters must be measured using pulsed techniques, t_w = 300 µs, duty cycle ≤ 2%
6: These parameters are measured with voltage-sensing contacts separate from the current carrying contacts and located within 3.2mm from the device body
7: Inductive loop switching measurement.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{CBO}	Collector - base breakdown voltage (Note 5)	I_C = 1 mA I_E = 0	550			V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 5)	I_C = 10 mA I_B = 0	450			V
$V_{CER(sus)}$	Collector - emitter sustaining voltage	R = 100Ω V_{CLAMP} = 460 V I_C = 7 A L = 500 µH (Note 7)	450			V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 450 V V_{CE} = 450 V 150°C			250 1.0	µA mA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V V_{CE} = 400 V 150°C			250 1.0	µA mA
I_{EBO}	Emitter cut - off current	V_{EB} = 1 V I_C = 0			3	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 5 &6)	I_C = 5 A I_B = 35 mA I_C = 15 A I_B = 1.5 A			2.0 3.0	V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 5 & 6)	I_C = 5 A I_B = 35 mA			2.0	V
V_F	Parallel diode forward voltage (Notes 5 &6)	$I_F = -I_C$ = 10 A			3	V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 5 A V_{CE} = 10 V -30°C I_C = 5 A V_{CE} = 10 V I_C = 5 A V_{CE} = 10 V 125°C	200 300 500			
C_{obo}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		120		pF

TIPL774
NPN DARLINGTON CONNECTED SILICON POWER TRANSISTOR

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.00	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			32	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (see Note 9)		0.4		°C/W
$C_{\theta C}$	Thermal capacitance of case		5.3		J/°C

2

TIPL Devices

Resistive Load Switching Characteristics at 25°C Case Temperature

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{on}	Delay time + rise time	I_C = 5 A $I_B(on)$ = 70 mA			5.0	µs
t_s	Storage time	$V_{BE}(off)$ = 0 V R_{BE} = 100 Ω			20.0	µs
t_f	Fall time	V_{CC} = 17.5 V			10.0	µs

Functional tests at 25°C free - air temperature

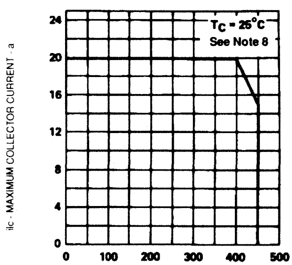
TEST	CONDITIONS	MAX	UNIT
Forward pulse energy $\frac{I_C{}^2 L}{2}$	I_{CM} = 7 A L = 12 mH T_{test} = 1s V_{CLAMP} = 400 V V_{BE} = 0 V f = 100 Hz	300	mJ

NOTES : 8: This combination of maximum Voltage and Current may be achieved only when switching from Saturation to Cut - Off with a clamped Inductive Load as in figure , V_{BB} = 0, R_{BB} = 100 Ω

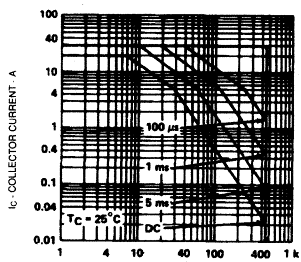
9: This parameter is measured using a 3.06mm Mica Insulator with Dow Corning 11 Compound on both sides of the Insulator with 0.138-32 mounting screws with bushings, and a mounting torque of 8 inch - pounds (0.9 Newton Meters)

TYPICAL CHARACTERISTICS

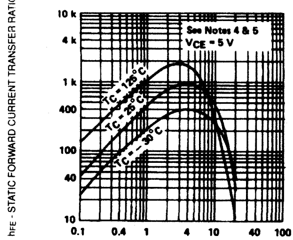
MAXIMUM IC VS CLAMPED VE



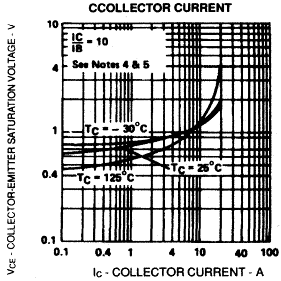
MAXIMUM FORWARD - BIAS SAFE OPERATING



STATIC FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



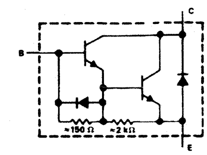
COLLECTOR-EMITTER SATURATION VOLTAGE vs CCOLLECTOR CURRENT

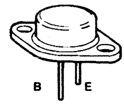


TIPL775, TIPL775A
MONOLITHIC DARLINGTON CONNECTED NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Epitaxial Planar Construction**
- **Specifically Designed for Low Loss, High Current, High Speed Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **T_{XO} Typically 320 ns, I_C = 10 A**
- **I_{CES} Better than 1mA at Maximum Rated V_{CE} at 100°C**
- **$V_{CEO(sus)}$ 150 V min TIPL775A - 120 V min TIPL775**





PACKAGE: TO3

Absolute Maximum Ratings at 25°C AmbientTemperature

		TIPL775	TIPL775A
V_{CBO}	Collector - base voltage (I_E = 0)	150 V	200 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	150 V	200 V
V_{CEO}	Collector - emitter voltage (I_B =0)	120 V	150 V
V_{EBO}	Base - emitter voltage	5 V	
I_C	Continuous collector current	10 A	
I_{CM}	Peak collector current (Note 1)	15 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	100 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{CBO}	Collector base breakdown voltage (Note 3)	I_C = 1mA	TIPL775 TIPL775A	150 200			V V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA L = 25 mH	TIPL775 TIPL775A	120 150			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 150 V V_{CE} = 200 V V_{CE} = 150 V 100°C V_{CE} = 200 V 100°C	TIPL775 TIPL775A TIPL775 TIPL775A			5 5 1 1	µA µA mA mA
I_{CEV}	Collector cut - off current	V_{CE} = 150 V V_{CE} = 200 V	TIPL775 TIPL775A			5 5	µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 120 V V_{CE} = 150 V	TIPL775 TIPL775A			5 5	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0				4.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 4 A I_B = 0.02 A I_C = 7 A I_B = 0.03 A I_C = 10 A I_B = 0.05 A I_C = 10 A I_B = 0.05 A 100°C				1.2 1.5 2.0 2.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 4 A I_B = 0.02 A I_C = 7 A I_B = 0.03 A I_C = 10 A I_B = 0.05 A I_C = 10 A I_B = 0.05 A 100°C				1.8 1.9 2.2 2.1	V V V V
V_F	Parallel diode forward voltage (see Notes 3 & 4)	I_C = 10 A				3.0	V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V		60		500	

Electrical Characteristics at 25°C Case Temperature (continued)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		90		pF
$R_{\theta JC}$	Thermal resistance junction case				1.75	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature

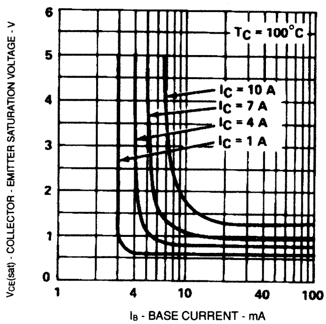
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sl}	Current storage time	I_C = 10 A V_{EB}(off) = -5 V I_B(off) = -2.5 A I_B(on) = 0.05 A		450		ns
t_{rv}	Voltage rise time			160		ns
t_{fi}	Current fall time			250		ns
t_{ti}	Current tail time			280		ns
t_{xo}	Cross over time			320		ns

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 μs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

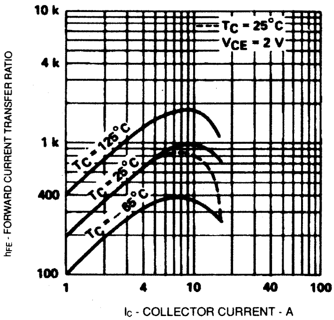
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

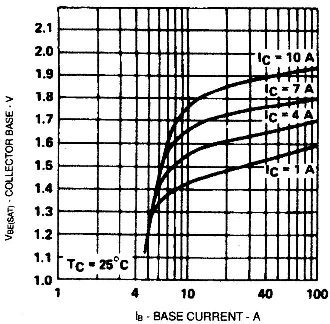
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



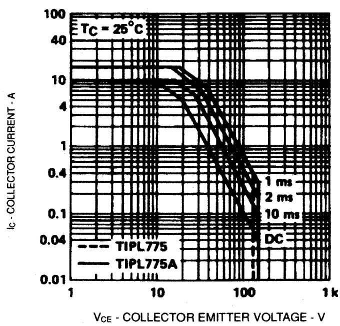
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



COLLECTOR - BASE SATURATION VOLTAGE
vs
BASE CURRENT



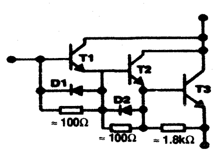
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

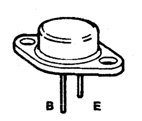


TIPL777
NPN SILICON HIGH VOLTAGE ADVANCED POWER DARLINGTON

Revised March 1990

- **Designed for High Voltage Switching in Industrial Environments**
- **180 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **Large RBSOA (up to 20 A at 800 V) Permits Snubberless Operation**
- **All Major Parameters Specified at 100°C**





PACKAGE: TO3

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL777
V_{CBO}	Collector - base voltage (I_E = 0)	950 V
V_{CES}	Collector - emitter voltage (R_{BE} = 100 Ω)	950 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	600 V
V_{EBO}	Base - emitter voltage (I_C = 0)	6 V
I_C	Continuous collector current	20 A
I_{CM}	Peak collector current (Note 1)	55 A
I_B	Base Current	3 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	180 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C

NOTE 1: This value applies for $t_w \leq 300$ μs, duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEX\ (sus)}$	Collector - emitter sustaining voltage	I_C = 6 A $I_{B(off)}$ = 1 A	710			V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA L = 25 mH	600			V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 950 V V_{CE} = 950 V 100°C			0.1 1	mA mA
I_{CEV}	Collector cut - off current	V_{CE} = 950 V V_{BE} = -1.5 V to -6 V			0.1	mA
I_{CEO}	Collector cut - off current	V_{CE} = 600 V I_B = 0			50	μA
I_{ECO}	Collector reverse current	V_{EC} = 2 V		7	15	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 6 V I_C = 0		5	10	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 3 A I_B = 60 mA I_C = 10 A I_B = 0.2 A I_C = 15 A I_B = 0.3 A I_C = 15 A I_B = 0.3 A 100°C		1.6 2.0 2.2 2.1	2.0 2.5 3.0 3.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 3 A I_B = 60 mA I_C = 10 A I_B = 0.2 A I_C = 15 A I_B = 0.3 A I_C = 15 A I_B = 0.3 A 100°C		2.4 2.7 3.0 2.7	3.0 3.5 3.5 3.5	V V V V
C_{obo}	Output Capacitance	I_E = 0 f = 0.1 MHz V_{CE} = 20 V		200		pF
$R_{\theta JC}$	Thermal resistance junction - case				0.97	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

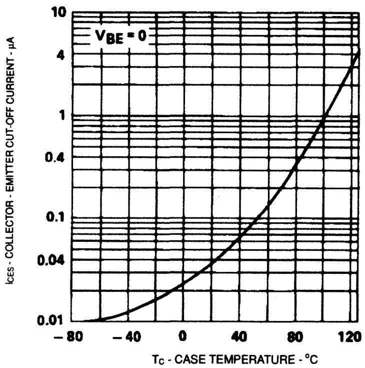
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 15 A V_{CE} = 300 V $I_B(off)$ = -1.5 A			2.80	µs
t_{rv}	Voltage rise time				0.50	µs
t_{fi}	Current fall time				0.20	µs
t_{xo}	Cross over time				0.70	µs
t_{sv}	Voltage storage time	I_C = 15 A V_{CE} = 300 V $I_B(on)$ = -1.5 A T_C = 100°C			4.80	µs
t_{rv}	Voltage rise time				1.50	µs
t_{fi}	Current fall time				0.30	µs
t_{xo}	Cross over time				0.80	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

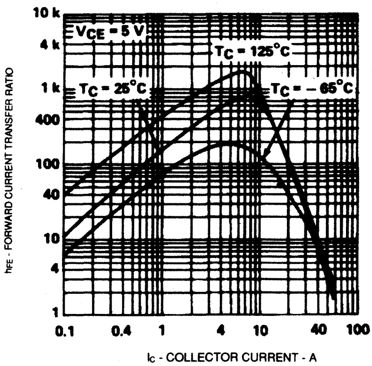
See Appendices For Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

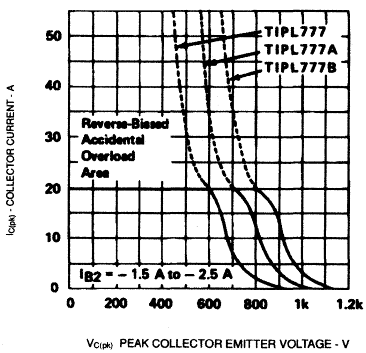
CUT-OFF CURRENT vs TEMPERATURE



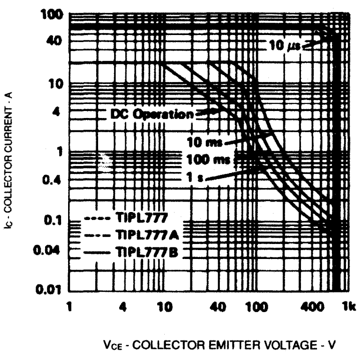
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



REVERSE BIAS SAFE OPERATING AREA



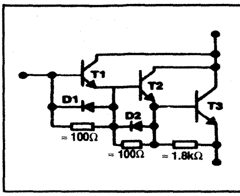
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

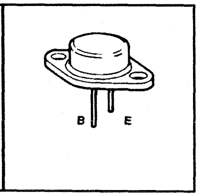


TIPL777A
NPN SILICON HIGH VOLTAGE ADVANCED POWER DARLINGTON

Revised March 1990

- **Designed for High Voltage Switching in Industrial Environments**
- **180 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **Large RBSOA (up to 20 A at 800 V) Permits Snubberless Operation**
- **All Major Parameters Specified at 100°C**





PACKAGE: T03

Absolute Maximum Ratings at 25°C AmbientTemperature

		TIPL777A
V_{CBO}	Collector - base voltage ($I_E = 0$)	1050 V
V_{CES}	Collector - emitter voltage ($R_{BE} = 100\ \Omega$)	1050 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	700 V
V_{EBO}	Base - emitter voltage ($I_C = 0$)	6 V
I_C	Continuous collector current	20 A
I_{CM}	Peak collector current (Note 1)	55 A
I_B	Base Current	3 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	180 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C

NOTE 1: This value applies for $t_w \le 300\ \mu s$, duty cycle $\le 2\%$

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEX\ (sus)}$	Collector - emitter sustaining voltage	$I_C = 6$ A $I_B(off) = 1$ A	860			V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	$I_C = 100$ mA $L = 25$ mH	700			V
I_{CES}	Collector - emitter cut - off current ($V_{BE} = 0$)	$V_{CE} = 1050$ V $V_{CE} = 1050$ V 100°C			0.1 1	mA mA
I_{CEV}	Collector cut - off current	$V_{CE} = 1050$ V $V_{BE} = -1.5$ V to -6 V			0.1	mA
I_{CEO}	Collector cut - off current	$V_{CE} = 700$ V $I_B = 0$			50	µA
I_{ECO}	Collector reverse current	$V_{EC} = 2$ V		7	15	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = 6$ V $I_C = 0$		5	10	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	$I_C = 2.5$ A $I_B = 50$ mA $I_C = 7.5$ A $I_B = 0.15$ A $I_C = 12.5$ A $I_B = 0.25$ A $I_C = 12.5$ A $I_B = 0.25$ A 100°C		1.6 1.9 2.2 2.0	2.0 2.5 3.0 3.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	$I_C = 2.5$ A $I_B = 50$ mA $I_C = 7.5$ A $I_B = 0.15$ A $I_C = 12.5$ A $I_B = 0.25$ A $I_C = 12.5$ A $I_B = 0.25$ A 100°C		2.3 2.6 2.9 2.7	3.0 3.5 3.5 3.5	V V V V
C_{ob}	Output capacitance	$I_E = 0$ f = 0.1 MHz $V_{CE} = 20$ V		200		pF
$R_{\theta JC}$	Thermal resistance junction - case				0.97	°C/W

TIPL777A
NPN SILICON HIGH VOLTAGE
ADVANCED POWER DARLINGTON

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

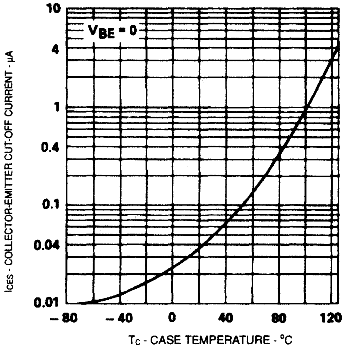
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 12.5 A V_{CE} = 300 V $I_B(off)$ = -1.5 A			3.00	μs
t_{rv}	Voltage rise time				0.50	μs
t_{fi}	Current fall time				0.20	μs
t_{xo}	Cross over time				0.70	μs
t_{sv}	Voltage storage time	I_C = 12.5 A V_{CE} = 300 V $I_B(off)$ = -1.5 A T_C = 100°C			5.00	μs
t_{rv}	Voltage rise time				1.50	μs
t_{fi}	Current fall time				0.50	μs
t_{xo}	Cross over time				2.00	μs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 μs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

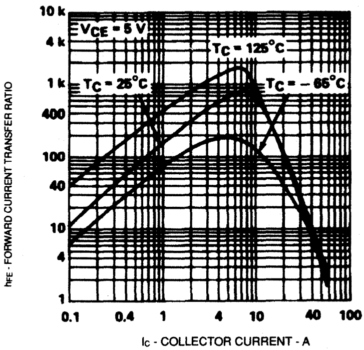
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

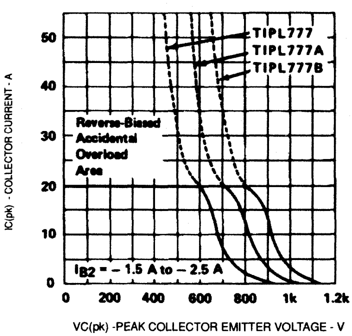
CUT-OFF CURRENT vs BASE CURRENT



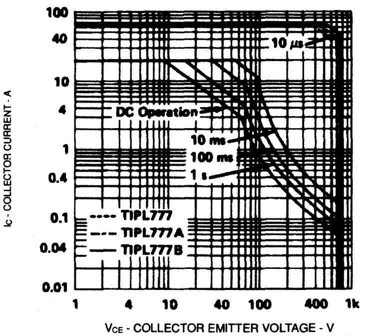
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



REVERSE BIAS SAFE OPERATING AREA



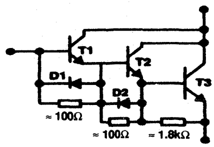
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

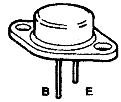


TIPL777B
NPN SILICON HIGH VOLTAGE ADVANCED POWER DARLINGTON

Revised March 1990

- **Designed for High Voltage Switching in Industrial Environments**
- **180 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **Large RBSOA (up to 20 A at 800 V) Permits Snubberless Operation**
- **All Major Parameters Specified at 100°C**





PACKAGE: TO3

Absolute Maximum Ratings at 25°C AmbientTemperature

		TIPL777B
V_{CBO}	Collector - base voltage (I_E = 0)	1150 V
V_{CES}	Collector - emitter voltage (R_{BE} = 100 Ω)	1150 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	800 V
V_{EBO}	Base - emitter voltage (I_C = 0)	6 V
I_C	Continuous collector current	20 A
I_{CM}	Peak collector current (Note 1)	55 A
I_B	Base Current	3 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	180 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C

NOTE 1: This value applies for $t_w \le 300$ µs, duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEX\ (sus)}$	Collector - emitter sustaining voltage	I_C = 6 A $I_{B(off)}$ = 1 A	860			V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA L = 25 mH	700			V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} =1150 V V_{CE} =1150 V 100°C			0.1 1	mA mA
I_{CEV}	Collector cut - off current	V_{CE} =1150 V V_{BE} = -1.5 V to -6 V			0.1	mA
I_{CEO}	Collector cut - off current	V_{CE} = 800 V I_B = 0			50	µA
I_{ECO}	Collector reverse current	V_{EC} = 2 V		7	15	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 6 V I_C = 0		5	10	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 1 A I_B = 20 mA I_C = 5 A I_B = 0.1 A I_C = 10 A I_B = 0.2 A I_C = 10 A I_B = 0.2 A 100°C		1.5 1.8 2.1 1.9	2.0 2.5 3.0 3.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 1 A I_B = 20 mA I_C = 5 A I_B = 0.1 A I_C = 10 A I_B = 0.2 A I_C = 10 A I_B = 0.2 A 100°C		2.2 2.5 2.8 2.6	3.0 3.5 3.5 3.5	V V V V
C_{ob}	Output capacitance	I_E = 0 V_{CE} = 20 V f = 0.1 MHz		200		pF
$R_{\theta JC}$	Thermal resistance junction - case				0.97	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

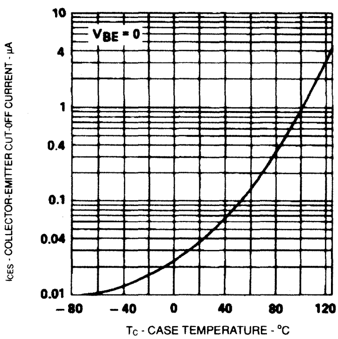
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time				3.20	µs
t_{rv}	Voltage rise time	I_C = 10 A V_{CE} = 300 V			0.50	µs
t_{fi}	Current fall time	I_B(off) = -1.5 A			0.20	µs
t_{xo}	Cross over time				0.70	µs
t_{sv}	Voltage storage time				5.20	µs
t_{rv}	Voltage rise time	I_C = 10 A V_{CE} = 300 V			1.50	µs
t_{fi}	Current fall time	I_B(off) = -1.5 A T_C = 100°C			0.50	µs
t_{xo}	Cross over time				2.00	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

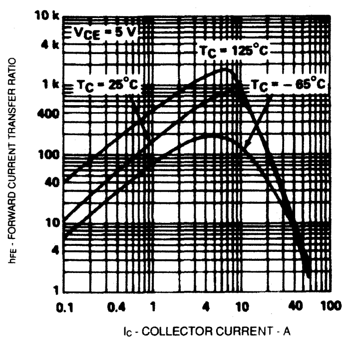
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

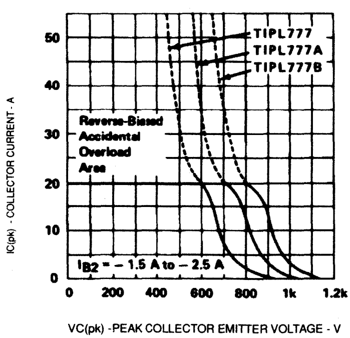
CUT-OFF CURRENT vs TEMPERATURE



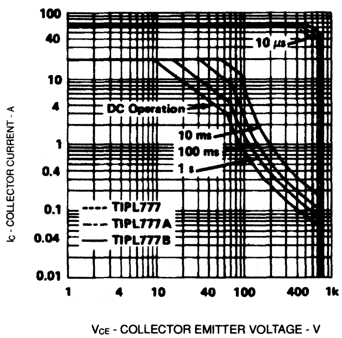
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



REVERSE BIAS SAFE OPERATING AREA



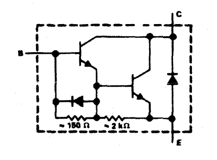
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

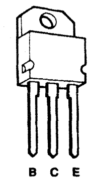


TIPL785, TIPL785A
MONOLITHIC DARLINGTON CONNECTED NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Epitaxial Planar Construction**
- **Specifically Designed for Low Loss, High Current, High Speed Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **txo Typically 320 ns, I_C = 10 A**





PACKAGE: SOT93

Absolute Maximum Ratings at 25°C AmbientTemperature

		TIPL785	TIPL785A
V_{CBO}	Collector - base voltage (I_E = 0)	150 V	200 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	150 V	200 V
V_{CEO}	Collector - emitter voltage (I_B =0)	120 V	150 V
V_{EBO}	Base - emitter voltage	8 V	
I_C	Continuous collector current	10 A	
I_{CM}	Peak collector current (Note 1)	15 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	80 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE 1: Pulse Test, Pulse Duration = 10 ms Duty Cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{CBO}	Collector base breakdown voltage (Note 3)	I_C = 1 mA TIPL785 TIPL785A	150 200			V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA TIPL785 L = 25 mH TIPL785A	120 150			V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 150 V TIPL785 V_{CE} = 200 V TIPL785A V_{CE} = 150 V 100°C TIPL785 V_{CE} = 200 V 100°C TIPL785A			50 50 1 1	µA µA mA mA
I_{CEV}	Collector cut - off current	V_{CE} = 150 V 1.5<V_{EB}<8V TIPL785 V_{CE} = 200 V TIPL785A			50 50	µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 120 V TIPL785 V_{CE} = 150 V TIPL785A			50 50	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			4.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 4 A I_B = 0.02 A I_C = 7 A I_B = 0.03 A I_C = 10 A I_B = 0.05 A I_C = 10 A I_B = 0.05 A 100°C			1.2 1.5 2.0 2.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 4 A I_B = 0.02 A I_C = 7 A I_B = 0.03 A I_C = 10 A I_B = 0.05 A I_C = 10 A I_B = 0.05 A 100°C			1.8 1.9 2.2 2.1	V V V V
V_F	Parallel diode forward voltage (Notes 3 & 4)	I_C = 10 A			3.0	V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	60		500	
C_{ob}	Output capacitance	IE = 0 V_{CB} = 20 V f = 0.1 MHz		90		pF

Electrical Characteristics at 25°C Case Temperature (continued)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_t	Current gain band width product	I_C = 500 mA V_{CE} = 10 V see Note 5		10		MHz
$R_{\theta JC}$	Thermal resistance junction - case				1.56	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

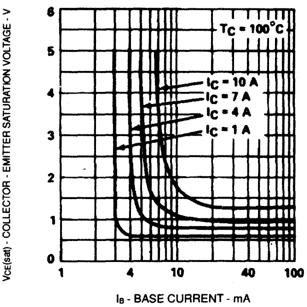
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sl}	Current storage time	I_C = 10 A $V_{BE(off)}$ = -5 V $I_{B(off)}$ = -2.5 A $I_{B(on)}$ = 0.05 A		450	700	ns
t_{rv}	Voltage rise time			160	750	ns
t_{fi}	Current fall time			250	400	ns
t_{ti}	Current tail time			280	450	ns
t_{xo}	Cross over time			320	500	ns

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, t_w = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: To obtain f_t the $|h_{FE}|$ response is extrapolated at the rate of -6 dB per octave from f = 1 MHz to the frequency at which $|h_{FE}|$ = 1

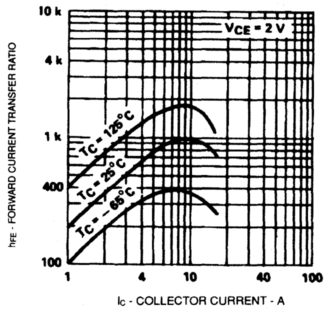
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

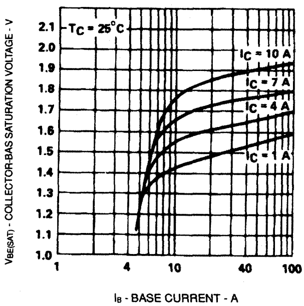
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



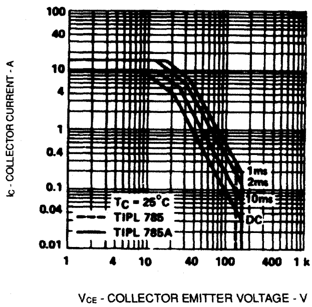
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



COLLECTOR - BASE SATURATION VOLTAGE vs BASE CURRENT



MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

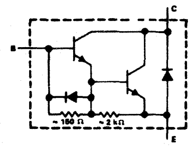


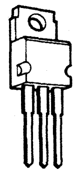
TEXAS INSTRUMENTS

TIPL790, TIPL790A
MONOLITHIC DARLINGTON CONNECTED NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Epitaxial Planar Construction**
- **Specifically Designed for Low Loss, High Current, High Speed Switching Applications**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **Txo typically 320 ns, I_C = 10 A**





B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C AmbientTemperature

		TIPL790	TIPL790A
V_{CBO}	Collector - base voltage (I_E = 0)	150 V	200 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	150 V	200 V
V_{CEO}	Collector - emitter voltage (I_B =0)	120 V	150 V
V_{EBO}	Base - emitter voltage	8 V	
I_C	Continuous collector current	10 A	
I_{CM}	Peak collector current (Note 1)	15 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	70 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{CBO}	Collector base breakdown voltage (Note 3)	I_C = 1 mA TIPL790 TIPL790A	150 200			V
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA TIPL790 L = 25 mH TIPL790A	120 150			V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 150 V TIPL790 V_{CE} = 200 V TIPL790A V_{CE} = 150 V 100°C TIPL790 V_{CE} = 200 V 100°C TIPL790A			50 50 1 1	µA µA mA mA
I_{CEV}	Collector cut - off current	V_{CE} = 150 V 1.5V<V_{EB}<8v TIPL790 V_{CE} = 200 V TIPL790A			50 50	µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 120 V TIPL790 V_{CE} = 150 V TIPL790A			50 50	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			4.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 4 A I_B = 0.02 A I_C = 7 A I_B = 0.03 A I_C = 10 A I_B = 0.05 A I_C = 10 A I_B = 0.05 A 100°C			1.2 1.5 2.0 2.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 4 A I_B = 0.02 A I_C = 7 A I_B = 0.03 A I_C = 10 A I_B = 0.05 A I_C = 10 A I_B = 0.05 A 100°C			1.8 1.9 2.2 2.1	V V V V
V_F	Parallel diode forward voltage (Notes 3 & 4)	I_C = 10 A			3.0	V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	60		500	
C_{ob}	Output capacitance	I_E = 0 f = 0.1 MHz VCB = 20 V		90		pF

Electrical Characteristics at 25°C Case Temperature (continued)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_t	Current gain band width product	I_C = 500 mA V_{CE} = 10 V see Note 5		10		MHz
$R_{\theta JC}$	Thermal resistance junction - case				1.79	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

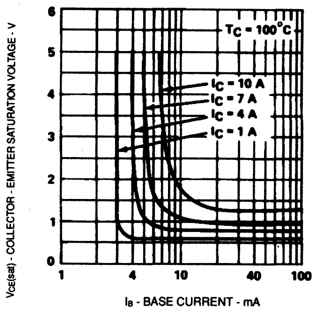
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{si}	Current storage time	I_C = 10 A $V_{BE(off)}$ = -5 V $I_{B(off)}$ = -2.5 A $I_{B(on)}$ = 0.05 A		450	700	ns
t_{rv}	Voltage rise time			160	750	ns
t_{fi}	Current fall time			250	400	ns
t_{ti}	Current tail time			280	450	ns
t_{xo}	Cross over time			320	500	ns

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, t_w = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: To obtain f_t the $|h_{FE}|$ response is extrapolated at the rate of -6 dB per octave from f = 1 MHz to the frequency at which $|h_{FE}|$ = 1

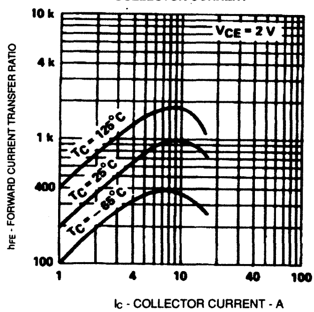
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

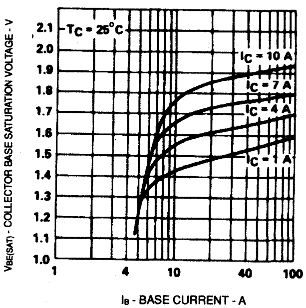
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



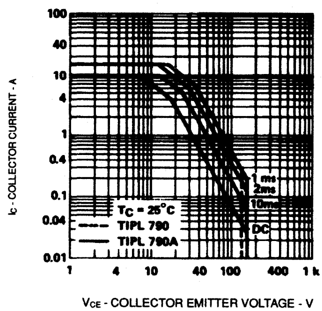
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



COLLECTOR - BASE SATURATION VOLTAGE
vs
BASE CURRENT

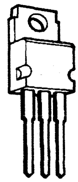


MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **4 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **1000 Volt Blocking Capability**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL791	TIPL791A
V_{CBO}	Collector - base voltage (I_E = 0)	850 V	1000 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B =0)	400 V	450 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	8 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	75 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA TIPL791 L = 25 mH TIPL791A	400 450			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 850 V TIPL791 V_{CE} =1000 V TIPL791A V_{CE} = 850 V 100°C TIPL791 V_{CE} =1000 V 100°C TIPL791A			5 5 200 200	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V TIPL791 V_{CE} = 450 V TIPL791A			5 5	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 1 A I_B = 0.2 A I_C = 2.5 A I_B = 0.5 A I_C = 4 A I_B = 1 A I_C = 4 A I_B = 1 A 100°C			0.5 1.0 2.5 5.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 1 A I_B = 0.2 A I_C = 2.5 A I_B = 0.5 A I_C = 4 A I_B = 1 A I_C = 4 A I_B = 1 A 100°C			1.0 1.2 1.4 1.3	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 500 mA V_{CE} = 5 V	20		60	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		12		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		110		pF
$R_{\theta JC}$	Thermal resistance junction case				1.66	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

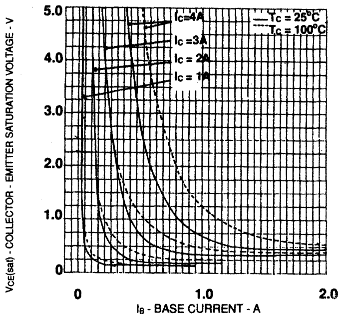
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 4 A $I_{B(on)}$ = 0.8 A $V_{BE(off)}$ = -5 V			2.00	µs
t_{rv}	Voltage rise time				0.20	µs
t_{fi}	Current fall time				0.10	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.20	µs
t_{sv}	Voltage storage time	I_C = 4 A $I_{B(on)}$ = 0.8 A $V_{BE(off)}$ = -5 V T_C = 100°C			2.50	µs
t_{rv}	Voltage rise time				0.40	µs
t_{fi}	Current fall time				0.20	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.60	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

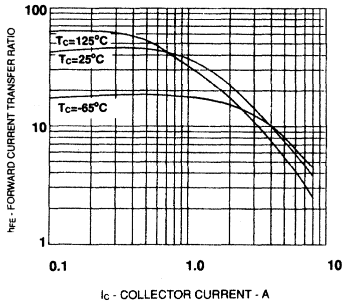
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

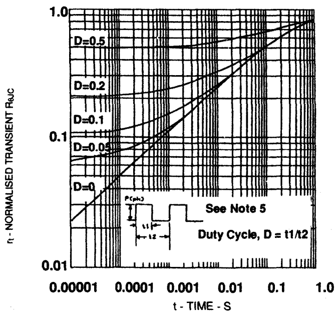
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



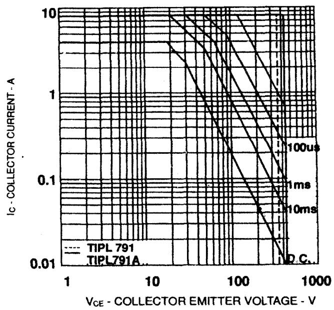
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



THERMAL RESPONSE

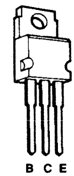


MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Specifically Designed for High Voltage, Inductive Load Switching Applications**
- **4 A Continuous Collector Current**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Ambient Temperature

		TIPL13004	TIPL13005
V_{CEV}	Collector - emitter voltage (V_{BE} = 0)	700 V	800 V
V_{CEO}	Collector - emitter voltage (IB =0)	300 V	400 V
V_{EBO}	Base - emitter voltage	10 V	
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	8 A	
I_B	Continuous base current	2 A	
I_{BM}	Peak base current (Note 1)	4 A	
I_E	Continuous emitter current	6 A	
I_{EM}	Peak emitter current (Note 1)	12 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	50 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE 1: Pulse test, pulse duration = 10 ms duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA TIPL13004 L = 25 mH TIPL13005	300 400			V V
I_{CES}	Collector - emitter cut - off current (V_{BE} = 0)	V_{CE} = 700 V TIPL13004 V_{CE} = 800 V TIPL13005 V_{CE} = 700 V 100°C TIPL13004 V_{CE} = 800 V 100°C TIPL13005			50 50 500 500	µA µA µA µA
I_{CEO}	Collector cut - off current	V_{CE} = 300 V TIPL13004 V_{CE} = 400 V TIPL13005			50 50	µA µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 1.0 A I_B = 200 mA I_C = 2.0 A I_B = 500 mA I_C = 4.0 A I_B = 1.25 A I_C = 2.0 A I_B = 500 mA 100°C			0.5 0.6 3.0 1.0	V V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 1.0 A I_B = 200 mA I_C = 2.0 A I_B = 500 mA I_C = 4.0 A I_B = 1.25 A I_C = 2.0 A I_B = 500 mA 100°C			1.0 1.2 1.3 1.3	V V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 1 A V_{CE} = 5 V I_C = 2 A V_{CE} = 5 V	10 8		60 40	
f_t	Current gain band-width product	I_C = 500 mA V_{CE} = 10 V f = 1 MHz		12		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		55		pF
$R_{\theta JC}$	Thermal resistance junction case				2.5	°C/W
$R_{\theta JA}$	Thermal resistance junction ambient				62.5	°C/W

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

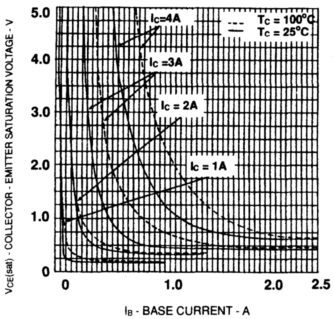
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 2.5 A $I_{B(on)}$ = 0.5 A $V_{BE(off)}$ = -5 V		1.00	2.00	µs
t_{rv}	Voltage rise time				0.20	µs
t_{fi}	Current fall time			0.15	0.20	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time			0.24	0.30	µs
t_{sv}	Voltage storage time	I_C = 2.5 A $I_{B(on)}$ = 0.5 A $V_{BE(off)}$ = -5 V T_C = 100°C		1.1	2.50	µs
t_{rv}	Voltage rise time				0.40	µs
t_{fi}	Current fall time			0.18	0.25	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time			0.35	0.50	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using p ulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body
NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

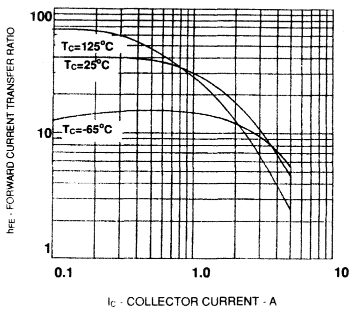
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

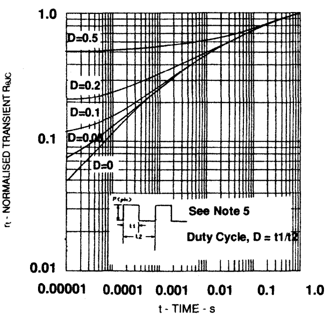
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



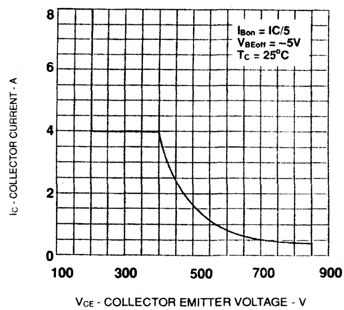
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



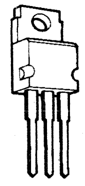
MAXIMUM REVERSE - BIAS SAFE OPERATING AREA



3

Revised March 1990

- **5 A Continuous On - State Current**
- **30 A Surge - Current**
- **Glass Passivated Wafer**
- **800 V Off - State Voltage**
- **Max I_{GT} of 200 μA**



PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

V_{DRM} & V_{RRM}		TIC106A	TIC106B	TIC106C	TIC106D	TIC106E	TIC106M	TIC106S	TIC106N
	Repetitive peak off - state voltage (Note 1) / Repetitive peak reverse voltage	100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Continuous on - state current at (or below) 80°C case temperature (Note 2)	5 A
$I_{T(AV)}$	Average on - state current (180° conduction angle) at (or below) 80°C case temperature (Note 3)	3.2 A
I_{TM}	Surge on - state current (Note 4)	30 A
I_{GM}	Peak positive gate current (pulse width ≤ 300 μs)	0.2 A
P_{GM}	Peak gate power dissipation (pulse width ≤ 300 μs)	1.3 W
$P_{G(AV)}$	Average gate power dissipation (Note 5)	0.3 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTE 1: These values apply when the gate - cathode resistance R_{GK} = 1 kΩ.
2: These values apply for continuous d-c operation with resistive load. Above 80°C derate linearly to zero at 110°C.
3: This value may be applied continuously under single phase 50-Hz half sine - wave operation with resistive load. Above 80°C derate linearly to zero at 110°C.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) rated values of peak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off- state current	V_D = rated V_{DRM} R_{GK} = 1 kΩ T_C = 110°C			400	μA
I_{RRM}	Repetitive peak reverse current	V_R = rated V_{RRM} I_G = 0 T_C = 110°C			1	mA
I_{GT}	Gate trigger current	V_{AA} = 6 V R_L = 100 Ω $t_{p(g)} \geq$ 20 μs		60	200	μA
V_{GT}	Gate trigger voltage	V_{AA} = 6 V R_L = 100 Ω T_C = -40°C $t_{p(g)} \geq$ 20 μs R_{GK} = 1kΩ			1.2	V
		V_{AA} = 6 V R_L = 100 Ω $t_{p(g)} \geq$ 20 μs R_{GK} = 1kΩ	0.4	0.6	1	
		V_{AA} = 6 V R_L = 100 Ω $t_{p(g)} \geq$ 20 μs R_{GK} = 1kΩ T_C = 110°C	0.2			
I_H	Holding current	V_{AA} = 6 V R_{GK} = 1kΩ T_C = -40°C Initiating I_t = 10 mA			8	mA
		V_{AA} = 6 V R_{GK} = 1kΩ Initiating I_t = 10 mA			5	
V_{TM}	Peak on-state voltage	I_{TM} = 5 A (Note 6)			1.7	V
dv/dt	Critical rate of rise of off - state voltage	V_D = rated V_D R_{GK} = 1kΩ T_C = 110°C		10		V/μs

NOTE: 6: These parameters must be measured using pulse tecniques, t_w = 300 μs, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body.

Thermal Characteristics

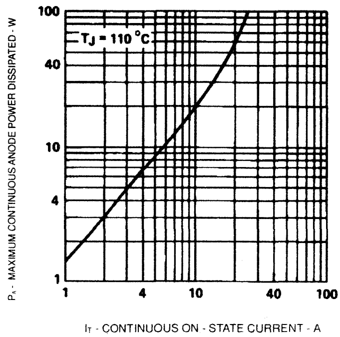
	PARAMETER	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	3.5	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature

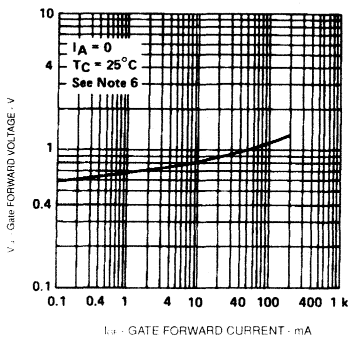
	PARAMETER	TEST CONDITIONS			TYP	UNIT
t_{gt}	Gate - controlled turn - on - time	I_T = 5A	V_{AA} = 30V	I_G = 10 mA	1.75	µs
t_q	Circuit - commutated turn - off - time	I_T = 5A	V_{AA} = 30 V	I_{RM} = 8 A	7.7	µs

TYPICAL CHARACTERISTICS

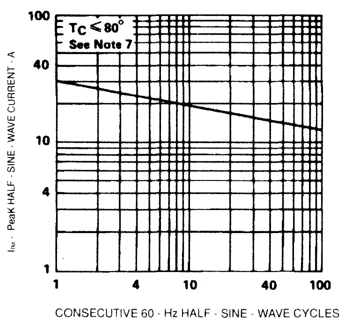
MAXIMUM CONTINUOUS POWER DISSIPATION



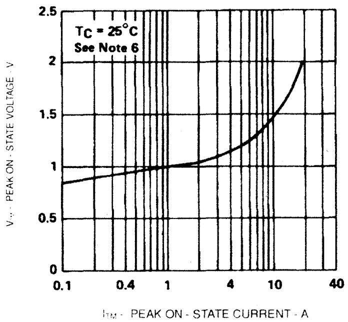
GATE FORWARD VOLTAGE
VS
GATE FORWARD CURRENT



MAXIMUM SURGE ON - STATE CURRENT



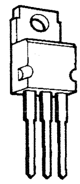
PEAK ON - STATE VOLTAGE



NOTE 7: This curve shows the maximum number of cycles of surge current for which gate control is guaranteed provided the device is initially at nonoperating thermal equilibrium.

Revised March 1990

- **5 A Continuous On - State Current**
- **20 A Surge - Current**
- **Glass Passivated Wafer**
- **800 V Off - State Voltage**
- **Max I_{GT} of 1 mA**



K A G

PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC108A	TIC108B	TIC108C	TIC108D	TIC108E	TIC108M	TIC108S	TIC108N
V_{DRM} & V_{RRM}	Repetitive peak off - state voltage (Note 1) / Repetitive peak reverse voltage	100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Continuous on - state current at (or below) 80°C case temperature (Note 2)	5 A
$I_{T(AV)}$	Average on - state current (180° conduction angle) at (or below) 80°C case temperature (Note 3)	3.2 A
I_{TM}	Surge on - state current (Note 4)	20 A
I_{GM}	Peak positive gate current (pulse width ≤ 300 μs)	0.2 A
P_{GM}	Peak gate power dissipation (pulse width ≤ 300 μs)	1.3 W
$P_{G(AV)}$	Average gate power dissipation (Note 5)	0.3 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTE 1: These values apply when the gate - cathode resistance R_{GK} = 1 kΩ.
2: These values apply for continuous d-c operation with resistive load. Above 80°C deratelinearly to zero at 110°C.
3: This value may be applied continuously under single phase 50-Hz half sine - wave operation with resistive load. Above 80°C derate linearly to zero at 110°C.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) rated values of peak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off- state current	V_D = rated V_{DRM} R_{GK} = 1 kΩ T_C = 110°C			400	μA
I_{RRM}	Repetitive peak reverse current	V_R = rated V_{RRM} I_G = 0 T_C = 110°C			1	mA
I_{GT}	Gate trigger current	V_{AA} = 6 V R_L = 100 Ω $t_{p(g)} \geq 20$ μs	0.2		1	mA
V_{GT}	Gate trigger voltage	V_{AA} = 6 V R_L = 100 Ω T_C = -40°C $t_{p(g)} \geq 20$ μs R_{GK} = 1kΩ			1.2	V
		V_{AA} = 6 V R_L = 100 Ω $t_{p(g)} \geq 20$ μs R_{GK} = 1kΩ	0.4	0.6	1	
		V_{AA} = 6 V R_L = 100 Ω T_C = 110°C $t_{p(g)} \geq 20$ μs R_{GK} = 1kΩ	0.2			
I_H	Holding current	V_{AA} = 6 V R_{GK} = 1kΩ T_C = -40°C Initiating I_t = 10 mA			15	mA
		V_{AA} = 6 V R_{GK} = 1kΩ Initiating I_t = 10 mA			10	
V_{TM}	Peak on - state voltage	I_{TM} = 5 A (Note 6)			1.7	V
dv/dt	Critical rate of rise of off - state voltage	V_D = rated V_D R_{GK} = 1kΩ T_C = 110°C		80		V/μs

NOTE: 6: These parameters must be measured using pulse tecniques, t_w = 300 μs, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body.

Thermal Characteristics

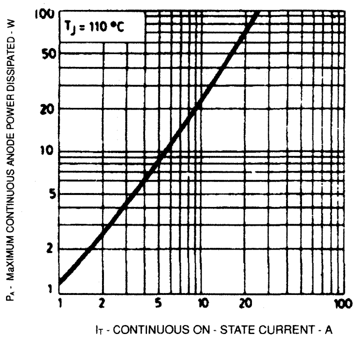
PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	3.5	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature

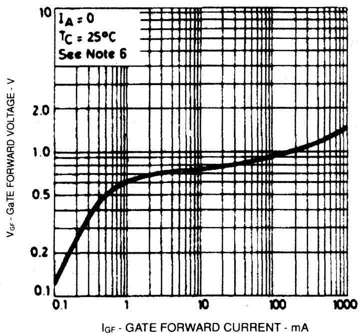
PARAMETER		TEST CONDITIONS			TYP	UNIT
t_{gt}	Gate - controlled turn - on - time	I_T = 5A	V_{AA} = 30 V	I_G = 10 mA	2.9	µs
t_q	Circuit - commutated turn - off - time	I_T = 5A	V_{AA} = 30 V	I_{RM} = 8 A	13.3	µs

TYPICAL CHARACTERISTICS

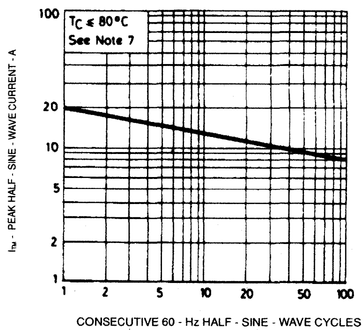
MAXIMUM CONTINUOUS POWER DISSIPATION



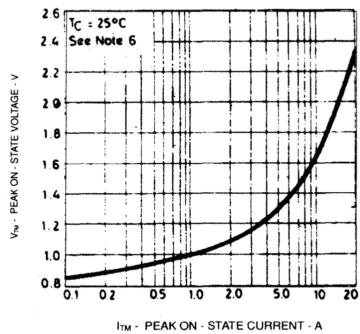
GATE FORWARD VOLTAGE
VS
GATE FORWARD CURRENT



MAXIMUM SURGE ON - STATE CURRENT

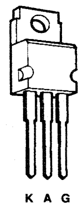


PEAK ON - STATE VOLTAGE



NOTE 7: This curve shows the maximum number of cycles of surge current for which gate control is guaranteed provided the device is initially at nonoperating thermal equilibrium.

- **8 A Continuous On - State Current**
- **80 A Surge - Current**
- **Glass Passivated Wafer**
- **800 V Off - State Voltage**
- **Max I_{GT} of 20 mA**



PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC116A	TIC116B	TIC116C	TIC116D	TIC116E	TIC116M	TIC116S	TIC116N
V_{DRM} & V_{RRM}	Repetitive peak off - state voltage (Note 1) Repetitive peak reverse voltage	100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Continuous on - state current at (or below) 80°C case temperature (Note 2)	8 A
$I_{T(AV)}$	Average on - state current (180° conduction angle) at (or below) 80°C case temperature (Note 3)	5 A
I_{TM}	Surge on - state current (Note 4)	80 A
I_{GM}	Peak positive gate current (pulse width ≤ 300 μs)	3 A
P_{GM}	Peak gate power dissipation (pulse width ≤ 300 μs)	5 W
$P_{G(AV)}$	Average gate power dissipation (Note 5)	1 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTE 1: These values apply when the gate - cathode resistance R_{GK} = 1 kΩ.
2: These values apply for continuous d-c operation with resistive load. Above 80°C derate linearly to zero at 110°C.
3: This value may be applied continuously under single phase 50-Hz half sine - wave operation with resistive load. Above 80°C derate linearly to zero at 110°C.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) rated values of peak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off- state current	V_D = rated V_{DRM} R_{GK} = 1 kΩ T_C = 110°C			2	mA
I_{RRM}	Repetitive peak reverse current	V_R = rated V_{RRM} I_G = 0 T_C = 110°C			2	mA
I_{GT}	Gate trigger current	V_{AA} = 6 V R_L = 100 Ω $t_{p(g)} \geq$ 20 μs		5	20	mA
V_{GT}	Gate trigger voltage	V_{AA} = 6 V R_L = 100 Ω T_C = -40°C $t_{p(g)} \geq$ 20 μs R_{GK} = 1kΩ			2.5	V
		V_{AA} = 6 V R_L = 100 Ω $t_{p(g)} \geq$ 20 μs R_{GK} = 1kΩ		0.8	1.5	
		V_{AA} = 6 V R_L = 100 Ω T_C = 110°C $t_{p(g)} \geq$ 20 μs R_{GK} = 1kΩ	0.2			
I_H	Holding current	V_{AA} = 6 V R_{GK} = 1kΩ T_C = -40°C Initiating I_T = 100 mA			70	mA
		V_{AA} = 6 V R_{GK} = 1kΩ Initiating I_T = 100 mA			40	
V_{TM}	Peak on - state voltage	I_{TM} = 8 A (Note 6)			1.7	V
dv/dt	Critical rate of rise of off - state voltage	V_D = rated V_D I_G = 0 T_C = 110°C		100		V/μs

NOTE: 6: These parameters must be measured using pulse tecniques, t_w = 300 μs, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body.

Thermal Characteristics

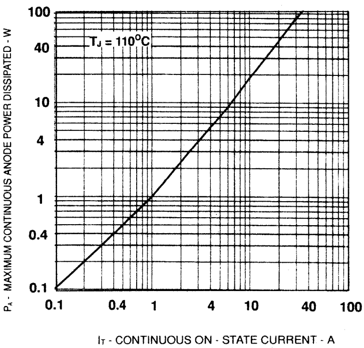
PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	3	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature

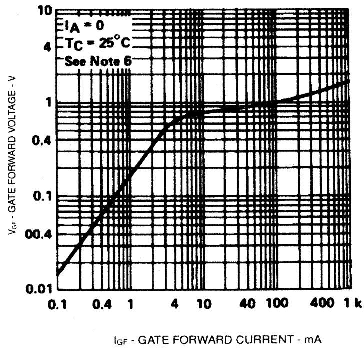
PARAMETER		TEST CONDITIONS			TYP	UNIT
t_{gt}	Gate - controlled turn - on - time	I_T = 5A	V_{AA} = 30 V	I_G = 200 mA	0.8	µs
t_q	Circuit - commutated turn - off - time	I_T = 5A	V_{AA} = 30 V	I_{RM} = 10 A	11	µs

TYPICAL CHARACTERISTICS

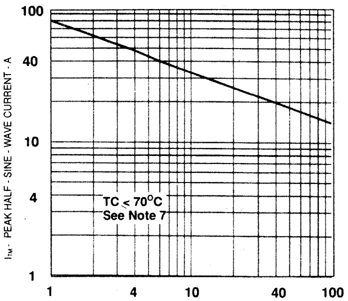
MAXIMUM CONTINUOUS POWER DISSIPATION



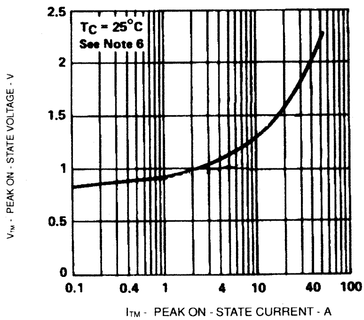
GATE FORWARD VOLTAGE
VS
GATE FORWARD CURRENT



MAXIMUM SURGE ON - STATE CURRENT



PEAK ON - STATE VOLTAGE

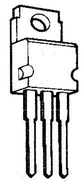


NOTE 7: This curve shows the maximum number of cycles of surge current for which gate control is guaranteed provided the device is initially at nonoperating thermal equilibrium.

TEXAS INSTRUMENTS

Revised March 1990

- **12 A Continuous On - State Current**
- **100 A Surge - Current**
- **Glass Passivated Wafer**
- **800 V Off - State Voltage**
- **Max I_{GT} of 20 mA**



K A G

PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC126A	TIC126B	TIC126C	TIC126D	TIC126E	TIC126M	TIC126S	TIC126N
V_{DRM} & V_{RRM}	Repetitive peak off - state voltage (Note 1) / Repetitive peak reverse voltage	100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Continuous on - state current at (or below) 80°C case temperature (Note 2)	12 A
$I_{T(AV)}$	Average on - state current (180° conduction angle) at (or below) 80°C case temperature (Note 3)	7.5 A
I_{TM}	Surge on -state current (Note 4)	100 A
I_{GM}	Peak positive gate current (pulse width ≤ 300 μs)	3 A
P_{GM}	Peak gate power dissipation (pulse width ≤ 300 μs)	5 W
$P_{G(AV)}$	Average gate power dissipation (Note 5)	1 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTE 1: These values apply when the gate - cathode resistance R_{GK} = 1 kΩ.
2: These values apply for continuous d-c operation with resistive load. Above 80°C derate linearly to zero at 110°C.
3: This value may be applied continuousiy under single phase 50-Hz half sine - wave operation with resistive load. Above 80°C derate linearly to zero at 110°C.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) rated values of peak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off - state current	V_D = rated V_{DRM} R_{GK} = 1 kΩ T_C = 110°C			2	mA
I_{RRM}	Repetitive peak reverse current	V_R = rated V_{RRM} I_G = 0 T_C = 110°C			2	mA
I_{GT}	Gate trigger current	V_{AA} = 6 V R_L = 100 Ω $t_{p(g)}$ ≥ 20 μs		5	20	mA
V_{GT}	Gate trigger voltage	V_{AA} = 6 V R_L = 100 Ω T_C = -40°C $t_{p(g)}$ ≥ 20 μs R_{GK} = 1kΩ			2.5	V
		V_{AA} = 6 V R_L = 100 Ω $t_{p(g)}$ ≥ 20 μs R_{GK} = 1kΩ		0.8	1.5	
		V_{AA} = 6 V R_L = 100 Ω T_C = 110°C $t_{p(g)}$ ≥ 20 μs R_{GK} = 1kΩ	0.2			
I_H	Holding current	V_{AA} = 6 V R_{GK} = 1kΩ T_C = -40°C Initiating I_T = 100 mA			70	mA
		V_{AA} = 6 V R_{GK} = 1kΩ Initiating I_T = 100 mA			40	
V_{TM}	Peak on - state voltage	I_{TM} = 12 A (Note 6)			1.4	V
dv/dt	Critical rate of rise of off - state voltage	V_D = rated V_D I_G = 0 T_C = 110°C		100		V/μs

NOTE: 6: These parameters must be measured using pulse tecniques, t_w = 300 μs, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body.

Thermal Characteristics

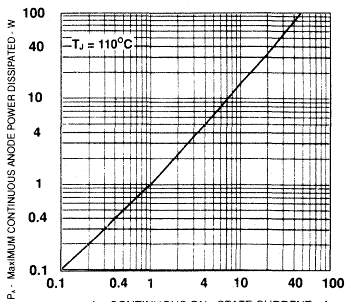
PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	2.4	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature

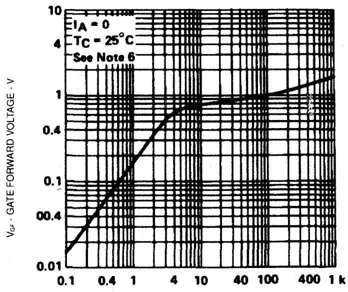
PARAMETER		TEST CONDITIONS	TYP	UNIT
t_{gt}	Gate - controlled turn - on - time	I_T = 5A V_{AA} = 30 V I_G = 200mA	0.8	μs
t_q	Circuit - commutated turn - off - time	I_T = 5A V_{AA} = 30 V I_{RM} = 10 A	11	μs

TYPICAL CHARACTERISTICS

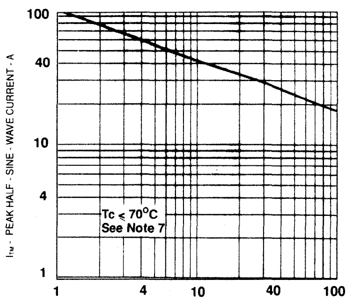
MAXIMUM CONTINUOUS POWER DISSIPATION



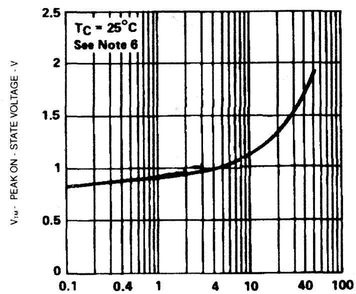
GATE FORWARD VOLTAGE
VS
GATE FORWARD CURRENT



MAXIMUM SURGE ON - STATE CURRENT



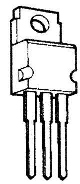
PEAK ON - STATE VOLTAGE



NOTE 7: This curve shows the maximum number of cycles of surge current for which gate control is guaranteed provided the device is initially at nonoperating thermal equilibrium.

Revised March 1990

- **Sensitive Gate Triacs**
- **2.5 A RMS**
- **100 V to 700 V**
- **Max I_{GT} of 5 mA (Quadrant 1)**



MT1 MT2 G

PACKAGE TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC201A	TIC201B	TIC201C	TIC201D	TIC201E	TIC201M	TIC201S
V_{DRM}	Repetitive peak off - state voltage (Note 1)	100 V	200 V	300 V	400 V	500 V	600 V	700 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 85°C case temperature (Note 2)	2.5 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	12 A
I_{TSM}	Peak on - state surge current half - sine - wave (Note 4)	14 A
I_{GM}	Peak gate current	±0.2 A
P_{GM}	Peak gate power dissipation, at (or below) 85°C case temperature (pulse width ≤ 200 µs)	1.3 W
$P_{G(AV)}$	Average gate power dissipation at (or below) 85°C case temperature (Note 5)	0.3 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 85°C derate linearly to 110°C case temperature at the rate of 100 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value of on - state current. Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) the rated value of on - state current.Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off-state current	V_D = rated V_{DRM} $I_G = 0$ $T_C = 110°C$			± 1	mA
I_{GTM}	Peak gate trigger current	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs			5 -8 -10 25	mA
V_{GTM}	Peak gate trigger voltage	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs		0.9 -1.2 -1.2 1.2	2.5 -2.5 -2.5	V
V_{TM}	Peak on-state voltage	I_{TM} = ± 3.5 A I_G = 50 mA (Note 6)			± 1.9	V
I_H	Holding current	V_{supply} = + 12 V† $I_G = 0$ Init' I_{TM} = 100 mA V_{supply} = -12 V† $I_G = 0$ Init' I_{TM} = -100 mA			30 -30	mA mA
I_L	Latching current	V_{supply} = + 12 V† V_{supply} = -12 V† (Note 7)			40 -40	mA mA
dv/dt	Critical rate of rise of off - state voltage	V_{DRM} = rated V_{DRM} $I_G = 0$ $T_C = 110°C$		50		V/µs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_{DRM} = rated V_{DRM} I_{TRM} = ± 3.5 A T_C = 85°C	2			V/µs

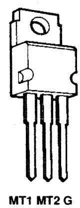
† All voltages are with respect to Main Terminal 1.
NOTES: 6: This parameter must be measured using pulse techniques, $t_w \leq$ 1ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body.
7: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, t_w = 20 µs, $t_r \leq$ 15 ns, f = 1kHz

Thermal Characteristics

PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	10	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

Revised March 1990

- **Sensitive Gate Triacs**
- **4 A RMS**
- **100 V to 700 V**
- **Max I_{GT} of 5 mA (Quadrants 1 - 3)**



PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC206A	TIC206B	TIC206C	TIC206D	TIC206E	TIC206M	TIC206S
V_{DRM}	Repetitive peak off - state voltage (Note 1)	100 V	200 V	300 V	400 V	500 V	600 V	700 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 85°C case temperature (Note 2)	4 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	25 A
I_{TSM}	Peak on - state surge current half - sine - wave (Note 4)	30 A
I_{GM}	Peak gate current	±0.2 A
P_{GM}	Peak gate power dissipation at (or below) 85°C case temperature (pulse width ≤ 200 μs)	1.3 W
$P_{G(AV)}$	Average gate power dissipation at (or below)85°C case temperature (Note 5)	0.3 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 85°C derate linearly to 110°C case temperature at the rate of 160 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value of on - state current. Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) the rated value of on - state current.Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off- state current	V_D = rated V_{DRM} $I_G = 0$ $T_C = 110°C$			± 1	mA
I_{GTM}	Peak gate trigger current	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs		0.5 -1.5 -2.0 3.6	5.0 -5.0 -5.0 10	mA
V_{GTM}	Peak gate trigger voltage	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs		0.7 -0.7 -0.8 0.8	2.0 -2.0 -2.0 2.0	V
V_{TM}	Peak on - state voltage	I_{TM} = ± 4.2 A I_G = 50 mA (Note 6)		± 1.3	± 2.2	V
I_H	Holding current	V_{supply} = + 12 V† $I_G = 0$ Init' I_{TM} = 100 mA V_{supply} = -12 V† $I_G = 0$ Init' I_{TM} = -100 mA		2 -4	15 -15	mA mA
I_L	Latching current	V_{supply} = + 12 V† V_{supply} = -12 V† (Note 7)			30 -30	mA mA
dv/dt	Critical rate of rise of off - state voltage	V_{DRM} = rated V_{DRM} $I_G = 0$ $T_C = 110°C$		50		V/μs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_{DRM} = rated V_{DRM} I_{TRM} = ± 4.2 A T_C = 85°C	1	1.3	2.5	V/μs

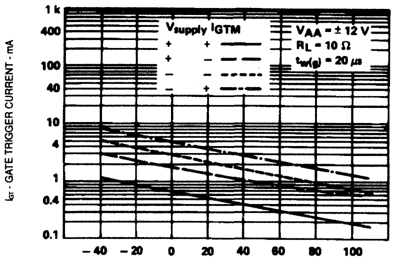
† All voltages are with respect to Main Terminal 1.
NOTES: 6: This parameter must be measured using pulse techniques, $t_w \le 1$ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body.
7: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, t_w= 20 μs, $t_r \le$ 15 ns, f = 1kHz

Thermal Characteristics

PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	7.8	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

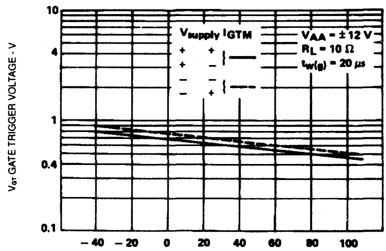
TYPICAL CHARACTERISTICS

GATE TRIGGER CURRENT
vs
TEMPERATURE



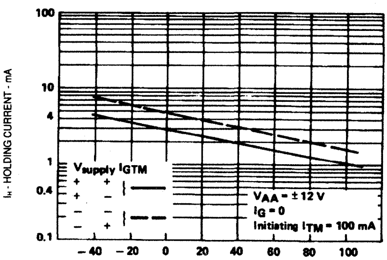
T_C - CASE TEMPERATURE - °C

GATE TRIGGER VOLTAGE
vs
TEMPERATURE



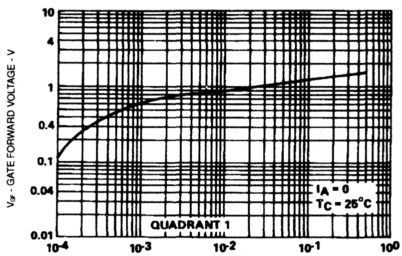
T_C - CASE TEMPERATURE - °C

HOLDING CURRENT
vs
TEMPERATURE



T_C - CASE TEMPERATURE - °C

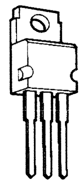
GATE FORWARD VOLTAGE
vs
GATE FORARD CURRENT



I_{GF} - GATE FORWARD CURRENT - A

Revised March 1990

- **Sensitive Gate Triacs**
- **100 V to 700 V**
- **Max I_{GT} of 5 mA (Quadrants 1 to 3)**



PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC216A	TIC216B	TIC216C	TIC216D	TIC216E	TIC216M	TIC216S
V_{DRM}	Repetitive peak off - state voltage (Note 1)	100 V	200 V	300 V	400 V	500 V	600 V	700 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 70°C case temperature (Note 2)	6 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	60 A
I_{TSM}	Peak on - state surge current half - sine - wave (Note 4)	70 A
I_{GM}	Peak gate current	1 A
P_{GM}	Peak gate power dissipation at (or below) 85°C case temperature (pulse width ≤ 200 µs)	2.2 W
$P_{G(AV)}$	Average gate power dissipation at (or below)85°C case temperature (Note 5)	0.9 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 70°C derate linearly to 110°C case temperature at the rate of 150 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value of on - state current. Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) the rated value of on - state current.Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off - state current	V_D = rated V_{DRM} $I_G = 0$ $T_C = 110°C$			± 2	mA
I_{GTM}	Peak gate trigger current	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs			5.0 -5.0 -5.0 10	mA
V_{GTM}	Peak gate trigger voltage	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs			2.2 -2.2 -2.2 3.0	V
V_{TM}	Peak on - state voltage	I_{TM} = ± 8.4 A I_G = 50 mA (Note 6)			± 1.7	V
I_H	Holding current	V_{supply} = + 12 V† $I_G = 0$ Init' I_{TM} = 100 mA V_{supply} = -12 V† $I_G = 0$ Init' I_{TM} = -100 mA			30 -30	mA mA
I_L	Latching current	V_{supply} = + 12 V† V_{supply} = -12 V† (Note 7)		50 -20		mA mA
dv/dt	Critical rate of rise of off - state voltage	V_{DRM} = rated V_{DRM} $I_G = 0$ $T_C = 110°C$		50		V/µs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_{DRM} = rated V_{DRM} I_{TRM} = ± 8.4 A T_C = 70°C	5			V/µs

† All voltages are with respect to Main Terminal 1.
NOTES: 6: This parameter must be measured using pulse techniques, $t_w \leq$ 1ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body.
7: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, t_w= 20 µs, $t_r \leq$ 15 ns, f = 1kHz

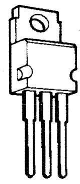
Thermal Characteristics

PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	2.5	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

TIC225 SERIES
SILICON TRIACS

Revised March 1990

- **Sensitive Gate Triacs**
- **8 A RMS, 70 A Peak**
- **100 to 700 V**
- **Max I_{GT} of 5 mA (Quadrant 1)**



MT1 MT2 G

PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC225A	TIC225B	TIC225C	TIC225D	TIC225E	TIC225M	TIC225S
V_{DRM}	Repetitive peak off - state voltage (Note 1)	100 V	200 V	300 V	400 V	500 V	600 V	700 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 70°C case temperature (Note 2)	8 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	70 A
I_{TSM}	Peak on - state surge current half - sine - wave (Note 4)	80 A
I_{GM}	Peak gate current	1 A
P_{GM}	Peak gate power dissipation at (or below) 85°C case temperature (pulse width ≤ 200 μs)	2.2 W
$P_{G(AV)}$	Average gate power dissipation at (or below)85°C case temperature (Note 5)	0.9 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 70°C derate linearly to 110°C case temperature at the rate of 200 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value of on - state current. Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) the rated value of on - state current.Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off- state current	V_D = rated V_{DRM} $I_G = 0$ $T_C = 110°C$			± 2	mA
I_{GTM}	Peak gate trigger current	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs		0.8 -4.5 -3.5 11.7	5 -20 -10 30	mA
V_{GTM}	Peak gate trigger voltage	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ μs		0.7 -0.7 -0.8 0.9	2.0 -2.0 -2.0 2.0	V
V_{TM}	Peak on - state voltage	I_{TM} = ± 12 A I_G = 50 mA (Note 6)		± 1.6	± 2.1	V
I_H	Holding current	V_{supply} = + 12 V† $I_G = 0$ Init' I_{TM} = 100 mA V_{supply} = -12 V† $I_G = 0$ Init' I_{TM} = -100 mA		3.0 -4.7	20 -20	mA mA
I_L	Latching current	V_{supply} = + 12 V† V_{supply} = -12 V† (Note 7)			30 -30	mA mA
dv/dt	Critical rate of rise of off - state voltage	V_{DRM} = rated V_{DRM} $I_G = 0$ $T_C = 110°C$		50		V/μs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_{DRM} = rated V_{DRM} I_{TRM} = ± 12 A T_C = 70°C	1	1.5	4.5	V/μs

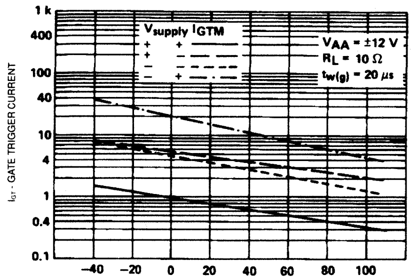
† All voltages are with respect to Main Terminal 1.
NOTES: 6: This parameter must be measured using pulse techniques, $t_w \le$ 1ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body
7: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, t_w= 20 μs, $t_r \le$ 15 ns, f = 1kHz

Thermal Characteristics

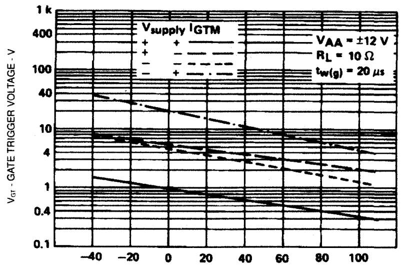
	PARAMETER	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	2.5	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

TYPICAL CHARACTERISTICS

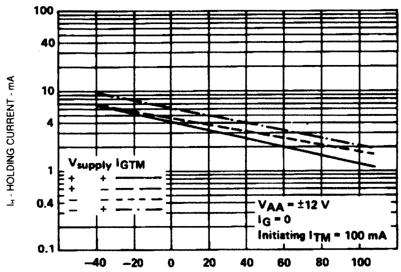
GATE TRIGGER CURRENT
vs
CASE TEMPERATURE



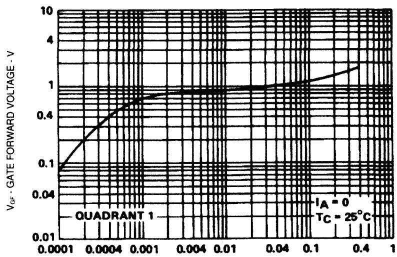
GATE TRIGGER VOLTAGE
vs
CASE TEMPERATURE



HOLDING CURRENT
vs
CASE TEMPERATURE



GATE FORWARD VOLTAGE
vs
GATE FORWARD CURRENT



3

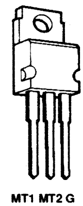
TIC Devices

TEXAS INSTRUMENTS

TIC226 SERIES
SILICON TRIACS

Revised March 1990

- **8 A RMS, 70 A Peak**
- **100 V to 800 V**
- **Max I_{GT} of 50 mA (Quadrants 1 - 3)**



PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC226A	TIC226B	TIC226C	TIC226D	TIC226E	TIC226M	TIC226S	TIC226N
V_{DRM}	Repetitive peak off - state voltage (Note 1)	100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 85°C case temperature (Note 2)	8 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	70 A
I_{TSM}	Peak on - state surge current half - sine - wave (Note 4)	80 A
I_{GM}	Peak gate current	1 A
P_{GM}	Peak gate power dissipation at (or below) 85°C case temperature (pulse width ≤ 200 µs)	2.2 W
$P_{G(AV)}$	Average gate power dissipation at (or below)85°C case temperature (Note 5)	0.9 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 85°C derate linearly to 110°C case temperature at the rate of 320 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value of on - state current. Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
4: This value applies for one 50-Hz half - sine - wave when the device is operating at (or below) the rated value of on - state current.Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
5: This value applies for a maximum averaging time of 20 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off- state current	V_D = rated V_{DRM} I_G = 0 T_C = 110°C			± 2	mA
I_{GTM}	Peak gate trigger current	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs		2 -12 -9 20	50 -50 -50	mA
V_{GTM}	Peak gate trigger voltage	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs		0.7 -0.8 -0.8 0.9	2.0 -2.0 -2.0 2.0	V
V_{TM}	Peak on - state voltage	I_{TM} = ± 12 A I_G = 50 mA (Note 6)		± 1.6	± 2.1	V
I_H	Holding current	V_{supply} = + 12 V† I_G = 0 Init' I_{TM} = 100 mA V_{supply} = -12 V† I_G = 0 Init' I_{TM} = -100 mA		5 -9	30 -30	mA mA
I_L	Latching current	V_{supply} = + 12 V† V_{supply} = -12 V† (Note 7)			50 -50	mA mA
dv/dt	Critical rate of rise of off - state voltage	V_{DRM} = rated V_{DRM} I_G = 0 T_C = 110°C		100		V/µs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_{DRM} = rated V_{DRM} I_{TRM} = ± 12 A T_C = 85°C	5			V/µs

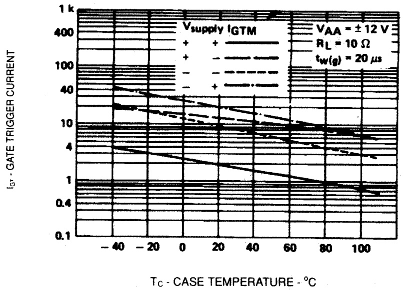
† All voltages are with respect to Main Terminal 1.
NOTES: 6: This parameter must be measured using pulse techniques, t_w ≤ 1ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts,are located within 3.2mm from the device body
7: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, t_w= 20 µs, t_r ≤ 15 ns, f = 1kHz

Thermal Characteristics

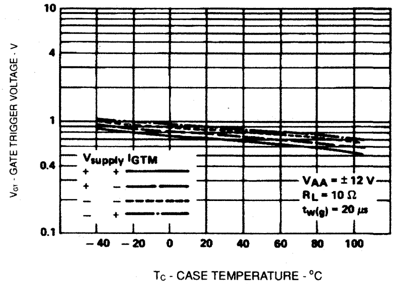
PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	1.8	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

TYPICAL CHARACTERISTICS

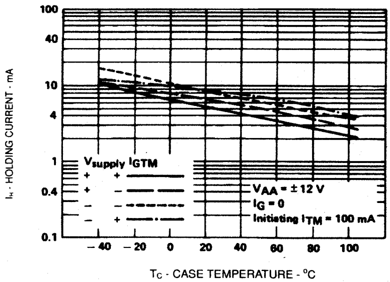
GATE TRIGGER CURRENT
vs
CASE TEMPERATURE



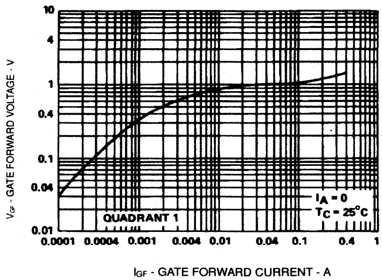
GATE TRIGGER VOLTAGE
vs
CASE TEMPERATURE



HOLDING CURRENT
vs
CASE TEMPERATURE

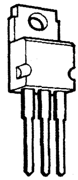


GATE FORWARD VOLTAGE
vs
GATE FORWARD CURRENT



Revised March 1990

- **High Current Triacs**
- **12 A RMS**
- **100 V to 800 V**
- **Max I_{GT} of 50 mA (Quadrants 1 - 3)**



MT1 MT2 G

PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC236A	TIC236B	TIC236C	TIC236D	TIC236E	TIC236M	TIC236S	TIC236N
V_{DRM}	Repetitive peak off - state voltage (Note 1)	100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 70°C case temperature (Note 2)	12 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	100 A
I_{GM}	Peak gate current	±1 A
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 70°C derate linearly to 110°C case temperature at the rate of 300 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value ofpeak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off- state current	V_D = rated V_{DRM} $I_G = 0$ $T_C = 110°C$			±2	mA
I_{GTM}	Peak gate trigger current	$V_{supply} = +12 V^†$ $R_L = 10\,\Omega$ $t_{p(g)} > 20\,\mu s$ $V_{supply} = +12 V^†$ $R_L = 10\,\Omega$ $t_{p(g)} > 20\,\mu s$ $V_{supply} = -12 V^†$ $R_L = 10\,\Omega$ $t_{p(g)} > 20\,\mu s$ $V_{supply} = -12 V^†$ $R_L = 10\,\Omega$ $t_{p(g)} > 20\,\mu s$		5 -11 -20 28	50 -50 -50	mA
V_{GTM}	Peak gate trigger voltage	$V_{supply} = +12 V^†$ $R_L = 10\,\Omega$ $t_{p(g)} > 20\,\mu s$ $V_{supply} = +12 V^†$ $R_L = 10\,\Omega$ $t_{p(g)} > 20\,\mu s$ $V_{supply} = -12 V^†$ $R_L = 10\,\Omega$ $t_{p(g)} > 20\,\mu s$ $V_{supply} = -12 V^†$ $R_L = 10\,\Omega$ $t_{p(g)} > 20\,\mu s$		0.7 -0.8 -0.8 0.9	2.0 -2.0 -2.0 2.0	V
V_{TM}	Peak on - state voltage	$I_{TM} = \pm 17$ A $I_G = 100$ mA (Note 4)		±1.5	±2.1	V
I_H	Holding current	$V_{supply} = +12 V^†$ $I_G = 0$ Init' $I_{TM} = 100$ mA $V_{supply} = -12 V^†$ $I_G = 0$ Init' $I_{TM} = -100$ mA		12 -12	40 -40	mA mA
I_L	Latching current	$V_{supply} = +12 V^†$ $V_{supply} = -12 V^†$ (Note 5)			80 -80	mA mA
dv/dt	Critical rate of rise of off - state voltage	V_D = rated V_D $I_G = 0$ $T_C = 110°C$		400		V/µs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_D = rated V_D $T_C = 80°C$ di/dt = 0.5 $I_{T(RMS)}$/ms $I_T = 1.4\ I_{T(RMS)}$	1.2	2		V/µs
di/dt	Critical rate of rise of on - state current	V_D = rated V_D $I_{GT} = 50$ mA $T_C = 110°C$ $di_G/dt = 50$ mA/µs		200		A/µs

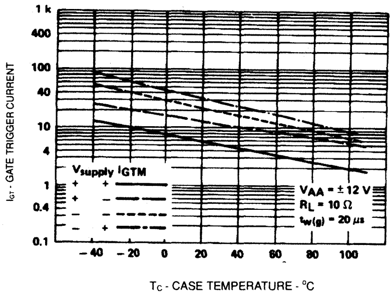
† All voltages are with respect to Main Terminal 1.
NOTES: 4: This parameter must be measured using pulse techniques, $t_w \le 1$ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body
5: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: $R_G = 100\,\Omega$, $t_w = 20\,\mu s$, $t_r \le 15$ ns, f = 1kHz

Thermal Characteristics

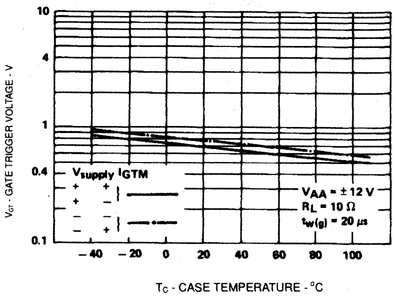
PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	2	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

TYPICAL CHARACTERISTICS

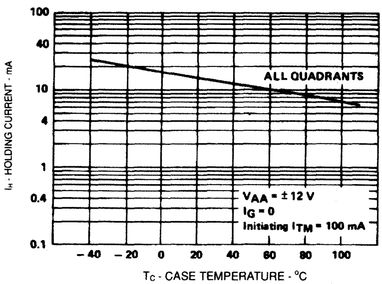
GATE TRIGGER CURRENT
vs
CASE TEMPERATURE



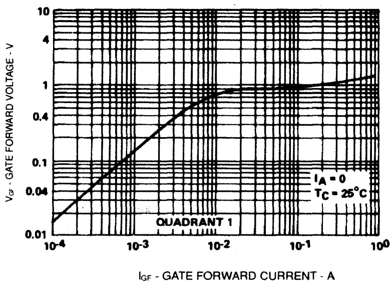
GATE TRIGGER VOLTAGE
vs
CASE TEMPERATURE



HOLDING CURRENT
vs
CASE TEMPERATURE

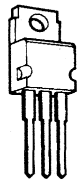


GATE FORWARD VOLTAGE
vs
GATE FORWARD CURRENT



Revised March 1990

- **High Current Triacs**
- **100 V to 800 V**
- **16 A RMS**
- **125 A Peak Current**
- **Max I_{GT} of 50 mA (Quadrants 1 - 3)**



MT1 MT2 G

PACKAGE: TO220

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC246A	TIC246B	TIC246C	TIC246D	TIC246E	TIC246M	TIC246S	TIC246N
V_{DRM}	Repetitive peak off - state voltage (Note 1)	100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 70°C case temperature (Note 2)	16 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	125 A
I_{GM}	Peak gate current	± 1 A
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 70°C derate linearly to 110°C case temperature at the rate of 400 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value ofpeak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off - state current	V_D = rated V_{DRM} $I_G = 0$ $T_C = 110°C$			± 2	mA
I_{GTM}	Peak gate trigger current	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs		5 -11 -20 28	50 -50 -50	mA
V_{GTM}	Peak gate trigger voltage	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs		0.7 -0.8 -0.8 0.9	2.0 -2.0 -2.0 2.0	V
V_{TM}	Peak on - state voltage	I_{TM} = ± 22.5 A I_G = 100 mA (Note 4)		± 1.4	± 1.7	V
I_H	Holding current	V_{supply} = + 12 V† $I_G = 0$ Init' I_{TM} = 100 mA V_{supply} = -12 V† $I_G = 0$ Init' I_{TM} = 100 mA		12 -12	40 -40	mA mA
I_L	Latching current	V_{supply} = + 12 V† V_{supply} = -12 V† (Note 5)			80 -80	mA mA
dv/dt	Critical rate of rise of off - state voltage	V_D = rated V_D $I_G = 0$ $T_C = 110°C$		400		V/µs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_D = rated V_D T_C = 80°C di/dt = 0.5 $I_{T(RMS)}$/ms $I_T = 1.4\ I_{T(RMS)}$	1.2	2		V/µs
di/dt	Critical rate of rise of on - state current	V_D = rated V_D I_{GT} = 50m A $T_C = 110°C$ di_G/dt = 50 mA/µs		200		A/µs

† All voltages are with respect to Main Terminal 1.

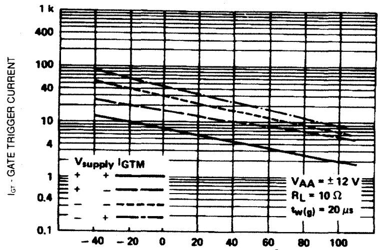
NOTES: 4: This parameter must be measured using pulse techniques, $t_w \leq$ 1ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body
5: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, t_w= 20 µs, $t_r \leq$ 15 ns, f = 1kHz

Thermal Characteristics

	PARAMETER	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	1.9	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	62.5	°C/W

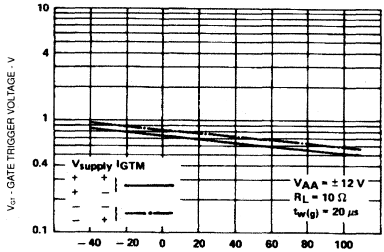
TYPICAL CHARACTERISTICS

GATE TRIGGER CURRENT
vs
CASE TEMPERATURE



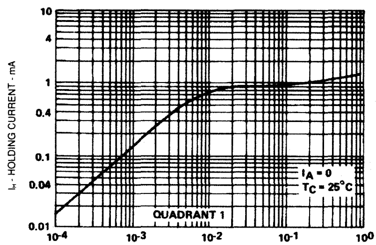
T_C - CASE TEMPERATURE - °C

GATE TRIGGER VOLTAGE
vs
CASE TEMPERATURE



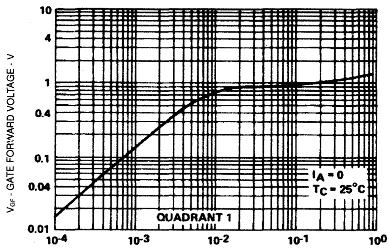
T_C - CASE TEMPERATURE - °C

HOLDING CURRENT
vs
CASE TEMPERATURE



T_C - CASE TEMPERATURE - °C

GATE FORWARD VOLTAGE
vs
GATE FORWARD CURRENT

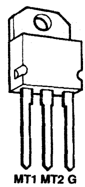


I_{GF} - GATE FORWARD CURRENT - A

TIC253 SERIES
SILICON TRIACS

Revised March 1990

- **High Current Triacs**
- **100 V to 800 V**
- **20 A RMS**
- **150 A Peak Current**
- **Max I_{GT} of 50 mA (Quadrants 1 - 3)**



PACKAGE: SOT93

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

V_{DRM}	Repetitive peak off - state voltage (Note 1)	**TIC253A**	**TIC253B**	**TIC253C**	**TIC253D**	**TIC253E**	**TIC253M**	**TIC253S**	**TIC253N**
		100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 70°C case temperature (Note 2)	20 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	150 A
I_{GM}	Peak gate current	± 1 A
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 70°C derate linearly to 110°C case temperature at the rate of 500 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value ofpeak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off - state current	V_D = rated V_{DRM} $I_G = 0$ $T_C = 110°C$			± 2	mA
I_{GTM}	Peak gate trigger current	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs		7 -15 -16 28	50 -50 -50	mA
V_{GTM}	Peak gate trigger voltage	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)} > 20$ µs		0.7 -0.7 -0.8 0.8	2.0 -2.0 -2.0 2.0	V
V_{TM}	Peak on - state voltage	I_{TM} = ± 28.2 A I_G = 50 mA (Note 4)		± 1.4	± 1.7	V
I_H	Holding current	V_{supply} = + 12 V† $I_G = 0$ Init' I_{TM} = 100 mA V_{supply} = -12 V† $I_G = 0$ Init' I_{TM} = -100 mA		6 -13	40 -40	mA mA
I_L	Latching current	V_{supply} = + 12 V† V_{supply} = -12 V† (Note 5)		20 -20		mA mA
dv/dt	Critical rate of rise of off - state voltage	V_D = rated V_D $I_G = 0$ $T_C = 110°C$		450		V/µs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_D = rated V_D T_C = 80°C di/dt = 0.5 $I_{T(RMS)}$/ms I_T = 1.4 $I_{T(RMS)}$		1		V/µs
di/dt	Critical rate of rise of on - state current	V_D = rated V_D I_{GT} = 50 mA $T_C = 110°C$ di_G/dt = 50 mA/µs		200		A/µs

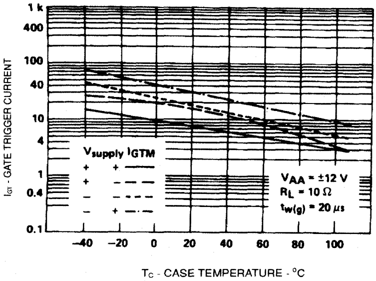
† All voltages are with respect to Main Terminal 1.
NOTES: 4: This parameter must be measured using pulse techniques, $t_w \leq$ 1ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body
5: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, t_w = 20 µs, $t_r \leq$ 15 ns, f = 1kHz

Thermal Characteristics

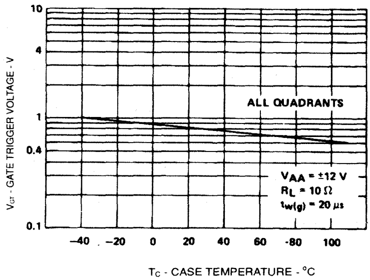
	PARAMETER	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	1.52	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	36	°C/W

TYPICAL CHARACTERISTICS

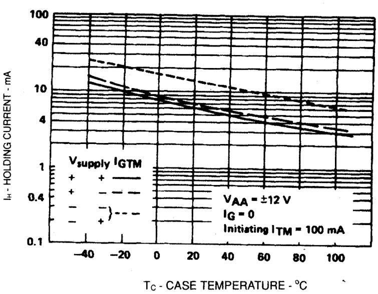
GATE TRIGGER CURRENT
vs
CASE TEMPERATURE



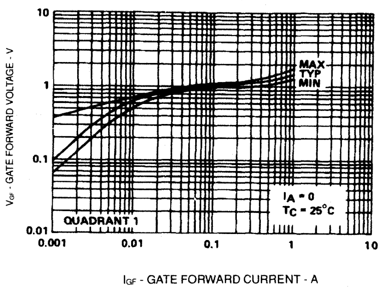
GATE TRIGGER VOLTAGE
vs
CASE TEMPERATURE



HOLDING CURRENT
vs
CASE TEMPERATURE



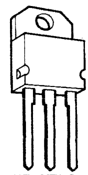
GATE FORWARD VOLTAGE
vs
GATE FORWARD CURRENT



TEXAS INSTRUMENTS

Revised March 1990

- **High Current Triacs**
- **100 V to 800 V**
- **25 A RMS**
- **175 A Peak Current**
- **Max I_{GT} of 50 mA (Quadrants 1 - 3)**



PACKAGE: SOT93

Absolute Maximum Ratings over Operating Case Temperature (unless otherwise noted)

		TIC263A	TIC263B	TIC263C	TIC263D	TIC263E	TIC263M	TIC263S	TIC263N
V_{DRM}	Repetitive peak off - state voltage (Note 1)	100 V	200 V	300 V	400 V	500 V	600 V	700 V	800 V

$I_{T(RMS)}$	Full - cycle RMS on - state current at (or below) 70°C case temperature (Note 2)	25 A
I_{TSM}	Peak on - state surge current full - sine - wave (Note 3)	175 A
I_{GM}	Peak gate current	± 1 A
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Storage temperature range	-40°C to + 125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 70°C derate linearly to 110°C case temperature at the rate of 625 mA/°C.
3: This value applies for one 50-Hz full - sine - wave when the device is operating at (or below) the rated value ofpeak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off- state current	V_D = rated V_{DRM} $I_G = 0$ $T_C = 110°C$			± 2	mA
I_{GTM}	Peak gate trigger current	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs		7 -15 -16 28	50 -50 -50	mA
V_{GTM}	Peak gate trigger voltage	V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = + 12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs V_{supply} = -12 V† R_L = 10 Ω $t_{p(g)}$ > 20 µs		0.7 -0.7 -0.8 0.8	2.0 -2.0 -2.0 2.0	V
V_{TM}	Peak on - state voltage	I_{TM} = ± 35.2 A I_G = 50 mA (Note 4)		± 1.5	± 1.7	V
I_H	Holding current	V_{supply} = + 12 V† $I_G = 0$ Init' I_{TM} = 100 mA V_{supply} = -12 V† $I_G = 0$ Init' I_{TM} = -100 mA		6 -13	40 -40	mA mA
I_L	Latching current	V_{supply} = + 12 V† V_{supply} = -12 V† (Note 5)		20 -20		mA mA
dv/dt	Critical rate of rise of off - state voltage	V_D = rated V_D $I_G = 0$ $T_C = 110°C$		450		V/µs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_D = rated V_D T_C = 80°C di/dt = 0.5 $I_{T(RMS)}$/ms I_T = 1.4 $I_{T(RMS)}$		1		V/µs
di/dt	Critical rate of rise of on - state current	V_D = rated V_D I_{GT} = 50 mA T_C = 110°C di_G/dt = 50 mA/µs		200		A/µs

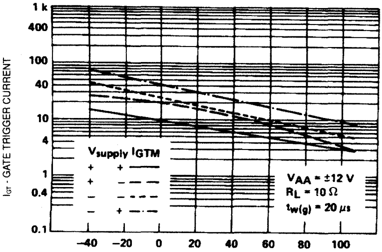
† All voltages are with respect to Main Terminal 1.
NOTES: 4: This parameter must be measured using pulse techniques, $t_w \leq$ 1ms, duty cycle ≤ 2%. Voltage sensing contacts seperate from the current carrying contacts are located within 3.2mm from the device body
5: The triacs are triggered by a 15-V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, t_w= 20 µs, $t_r \leq$ 15 ns, f = 1kHz

Thermal Characteristics

PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance	1.22	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance	36	°C/W

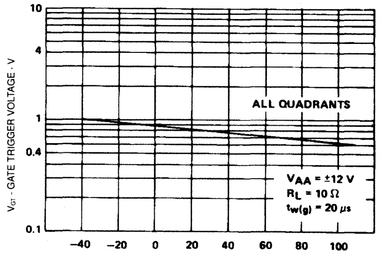
TYPICAL CHARACTERISTICS

GATE TRIGGER CURRENT vs CASE TEMPERATURE



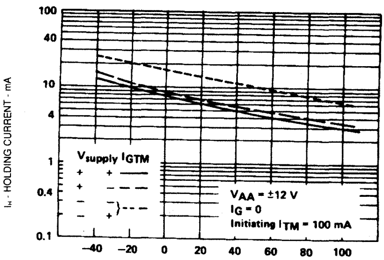
TC - CASE TEMPERATURE - °C

GATE TRIGGER VOLTAGE vs CASE TEMPERATURE



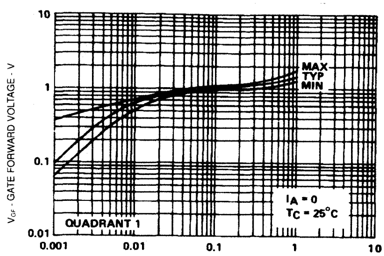
TC - CASE TEMPERATURE - °C

HOLDING CURRENT vs CASE TEMPERATURE



TC - CASE TEMPERATURE - °C

GATE FORWARD VOLTAGE vs GATE FORWARD CURRENT



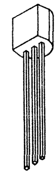
IGF - GATE FORWARD CURRENT - A

TEXAS INSTRUMENTS

TICP106D,TICP106E,TICP106M
TICK106D,TICK106E,TICK106M
GLASS PASSIVATED SILICON THYRISTOR

Revised March 1990

- **2A Continuous On - State Current**
- **15A Surge - Current**
- **600 V Off-State Voltage**
- **Max I_{GT} of 200 μA**
- **Available with 2 Pinout Options:**
  TICP106X - Anode Centre Pin
  TICK106X - Anode Side Pin



PACKAGE: TO92

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TICP106D	TICP106E	TICP106M
V_{DRM} V_{RRM}	Repetitive Peak Off-State Voltage (Note1) Repetitive Peak Reverse Voltage R_{GK}=1kΩ	400 V	500 V	600 V

I_T	Continuous on-state current at (or below) 85°C Case Temperature (Note 2)	2 A
I_{TSM}	Surge on-state current (Note 3)	15 A
I_{GM}	Peak positive gate current (pulse width ≤300 μs)	0.2A
$P_{G(AV)}$	Average gate power dissipation (Note 4)	0.3 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Operating storage temperature range	-40°C to +125°C
T_L	Lead temperature 3.2mm from case for 10 seconds	230°C

NOTE 1: These values apply when the gate - cathode resistance R_{GK} = 1 kΩ.
2: These values apply for continuous d-c operation with resistive load. Above 85°C derate linearly to zero at 110°C.
3: This value applies for one 60-Hz half - sine - wave when the device is operating at (or below) rated values of peak reverse voltage and on - state current. Surge may be repeated after the device has returned to original thermal equilibrium.
4: This value applies for a maximum averaging time of 16.6 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

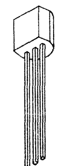
PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off-state current	V_D=400V V_D=500V V_D=600V	R_{GK}=1kΩ	TICP106D TICP106E TICP106M			10	μA
I_{RRM}	Repetitive peak reverse current	V_R= 400V V_R= 500V V_R= 600V	I_G=0	TICP106D TICP106E TICP106M			200 200 200	μA
I_{GT}	Gate trigger current	V_{AA} = 6 V	R_L=100Ω	$t_{p(g)}$≥20μs		60	200	μA
V_{GT}	Gate trigger voltage	V_{AA} = 6 V	R_L =100Ω R_{GK}=1kΩ	$t_{p(g)}$≥ 20μs	0.4		1.0	V
I_H	Holding current	V_{AA} = 6 V	R_{GK}=1kWΩ	Init I_t=10mA			5.0	mA
V_{TM}	Peak on-state voltage (See Note 5)	I_{TM} = 1A					1.5	V

NOTE 5: Use pulse techniques for this test. t_w = 1ms duty cycle < 2% voltage sensing contacts separate from the current carrying contacts, are located within 3.2mm from the device body.

TICP206D,TICP206E,TICP206M
TICK206D,TICK206E,TICK206M
GLASS PASSIVATED SILICON TRIAC

Revised March 1990

- **1.5 A RMS**
- **400 V - 600 V**
- **Max I_{GT} of 10 mA**
- **Available with 2 Pinout Options:**
  TICP206X - MT2 Centre Pin
  TICK206X - MT2 Side Pin



PACKAGE: TO92

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

	PARAMETER	TICP206D	TICP206E	TICP206M
V_{DRM}	Repetitive Peak Off-State Voltage (Note1)	400 V	500 V	600 V

$I_{T(RMS)}$	Full-cycle RMS on-state current at (or below) 85°C case temperature (Note 2)	1.5 A
I_{TSM}	Peak on-state surge current full - sine - wave (Note 3)	10 A
I_{TSM}	Peak on-state surge current half - sine - wave (Note 4)	12A
I_{GM}	Peak gate current	±0.2A
$P_{G(AV)}$	Average gate power dissipation at (or below) 85°C case temperature (Note 5)	0.3 W
T_C	Operating case temperature range	-40°C to + 110°C
T_{stg}	Operating storage temperature range	-40°C to +125°C
T_L	Lead temperature 1.6mm from case for 10 seconds	230°C

NOTES: 1: These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2: This value applies for 50-Hz full - sine - wave operation with resistive load. Above 85°C derate linearly to 110°C case temperature at the rate of 60 mA/°C.
3: This value applies for one 60-Hz full - sine - wave when the device is operating at (or below) the rated value of on - state current. Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
4: This value applies for one 60-Hz half - sine - wave when the device is operating at (or below) the rated value of on - state current.Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
5: This value applies for a maximum averaging time of 16.6 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off-state current	V_D=400V I_G=0 TICP206D V_D=500V I_G=0 TICP206E V_D=600V I_G=0 TICP206M			10	µA
I_{GTM}	Peak gate trigger current	V_{supply}=+12V† R_L=10Ω $t_{p(g)}$>20µs V_{supply}=+12V† R_L=10Ω $t_{p(g)}$>20 µs V_{supply}= -12V† R_L=10Ω $t_{p(g)}$>20µs V_{supply}= -12V† R_L=10Ω $t_{p(g)}$>20µs			8.0 -8.0 -8.0 10.0	mA mA mA mA
V_{GTM}	Peak gate trigger voltage	V_{supply}=+12V† R_L=10Ω $t_{p(g)}$>20µs V_{supply}=+12V† R_L=10Ω $t_{p(g)}$>20 µs V_{supply}= -12V† R_L=10Ω $t_{p(g)}$>20µs V_{supply}= -12V† R_L=10Ω $t_{p(g)}$>20µs			2.5 -2.5 -2.5 2.5	V V V V
I_H	Holding current (See Note7)	V_{supply}=+12V† I_G=0 Init' I_{TM}= 100mA V_{supply}= -12V† I_G=0 Init' I_{TM}=-100mA			30 -30	mA mA
V_{TM}	Peak on-state voltage (See Note 6)	I_{TM} = 1A I_G= 50mA			± 2.2	V
I_L	Latching Current	V_{supply}=+12V† V_{supply}= -12V†			40 -40	mA mA

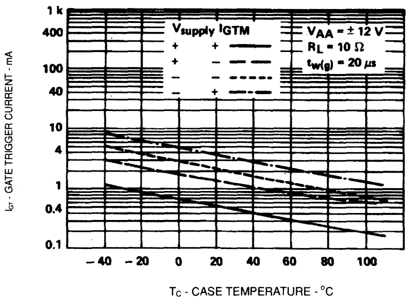
† All voltages are with respect to Main Terminal 1
NOTE 5: 6: This parameter must be measured using pulse techniques, tw≤1ms, duty cycle ≤ 20%. Voltage sensing contacts separate from the current carrying contacts are located within 3.2 mm from the device body.
7: The Triacs are triggered by a 15V (open circuit amplitude) pulse supplied by a generator with the following characteristics: R_G= 100Ω, tw=20µs, tr≤ 15ns, f=1kHz

3

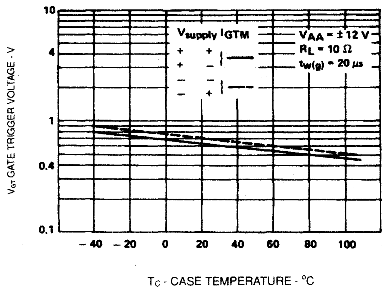
TIC Devices

TYPICAL CHARACTERISTICS

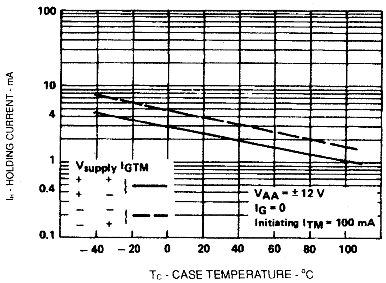
GATE TRIGGER CURRENT
vs
TEMPERATURE



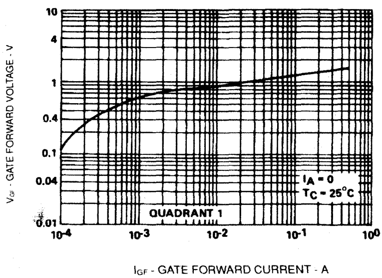
GATE TRIGGER VOLTAGE
vs
TEMPERATURE



HOLDING CURRENT
vs
TEMPERATURE



GATE FORWARD VOLTASGE
vs
GATE FORARD CURRENT

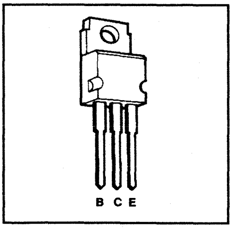


4

TIP29,TIP29A,TIP29B,TIP29C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP30 Series**
- **30 W at 25°C Case Temperature**
- **1 A Continuous Collector Current**
- **3 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP29	TIP29A	TIP29B	TIP29C
V_{CBO}	Collector - base voltage (I_E = 0)	80 V	100 V	120 V	140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	1 A			
I_{CM}	Peak collector current (Note 1)	3 A			
I_B	Continuous base current	0.4 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	30 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.24 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA (Note 5)	I_B = 0	TIP29 TIP29A TIP29B TIP29C	40 60 80 100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 80 V V_{CE} = 100 V V_{CE} = 120 V V_{CE} = 140 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	TIP29 TIP29A TIP29B TIP29C			0.2 0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	TIP29/29A TIP29B/29C			0.3 0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 0.2 A I_C = 1 A	(Notes 5 & 6)	40 15		 75	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 125 mA	I_C = 1 A	(Notes 5 & 6)			0.7	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 1 A	(Notes 5 & 6)			1.3	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.2 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.2 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			4.17	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

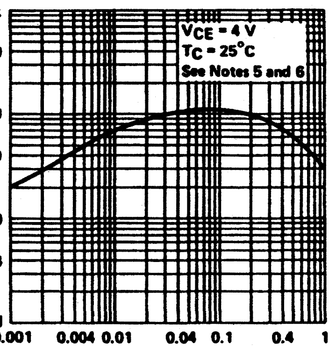
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A $I_{B(on)}$ = 0.1 A $I_{B(off)}$ = -0.1 A		0.5		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -4.3 V R_L = 30 Ω		2		µs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters

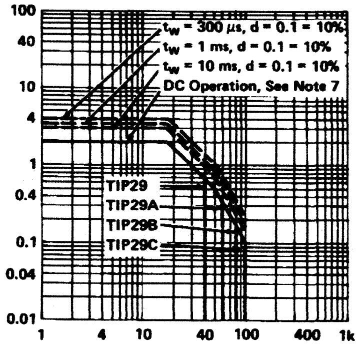
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT

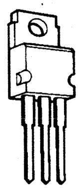


MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



Revised March 1990

- **Designed for Complementary Use with TIP30 Series**
- **30 W at 25°C Case Temperature**
- **1 A Continuous Collector Current**
- **3 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP29D	TIP29E	TIP29F
V_{CBO}	Collector - base voltage ($I_E = 0$)	160 V	180 V	200 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	120 V	140 V	160 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	1 A		
I_{CM}	Peak collector current (Note 1)	3 A		
I_B	Continuous base current	0.4 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	30 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to +150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C		

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle $\leq 10\%$
2: Derate linearly to 150°C case temperature at the rate of 0.24 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
$L = 20$ mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	$I_C = 30$ mA, $I_B = 0$ (Note 5) TIP29D TIP29E TIP29F	120 140 160			V
I_{CES}	Collector - emitter cut - off current	$V_{CE} = 160$ V, $V_{BE} = 0$ TIP29D $V_{CE} = 180$ V, $V_{BE} = 0$ TIP29E $V_{CE} = 200$ V, $V_{BE} = 0$ TIP29F			0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	$V_{CE} = 90$ V, $I_B = 0$			0.3	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = 5$ V, $I_C = 0$			1.0	mA
h_{FE}	Forward current transfer ratio	$V_{CE} = 4$ V, $I_C = 0.2$ A $V_{CE} = 4$ V, $I_C = 1$ A (Notes 5 & 6)	40 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = 125$ mA, $I_C = 1$ A (Notes 5 & 6)			0.7	V
V_{BE}	Base - emitter voltage	$V_{CE} = 4$ V, $I_C = 1$ A (Notes 5 & 6)			1.3	V
h_{fe}	Small signal forward current transfer ratio	$V_{CE} = 10$ V, $I_C = 0.2$ A, $f = 1$ kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	$V_{CE} = 10$ V, $I_C = 0.2$ A, $f = 1$ MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			4.17	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive Load Switching characteristics at 25°C Case Temperature (unless otherwise noted)

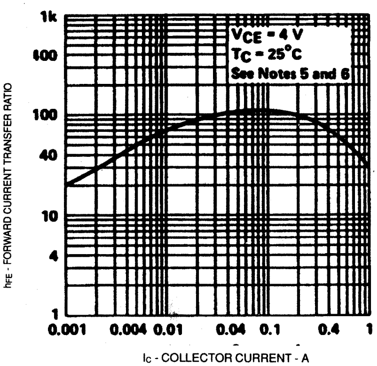
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	$I_C = 1$ A $I_{B(on)} = 0.1$ A $I_{B(off)} = -0.1$ A		0.5		µs
t_{off}	Turn off time	$V_{BE(off)} = -4.3$ V $R_L = 30\ \Omega$		2		µs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters

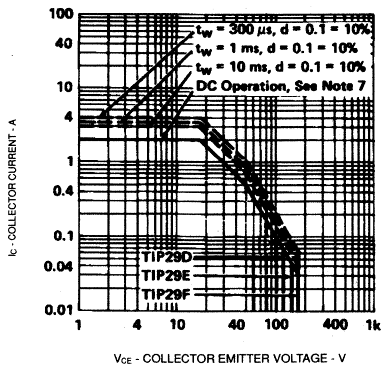
NOTES: 5: These parameters must be measured using pulse techniques, $t_w = 300$ µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT



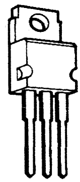
MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



TIP30,TIP30A,TIP30B,TIP30C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP29 Series**
- **30 W at 25°C Case Temperature**
- **1 A Continuous Collector Current**
- **3 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP30	TIP30A	TIP30B	TIP30C
V_{CBO}	Collector - base voltage (I_E = 0)	-80 V	-100 V	-120 V	-140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-1 A			
I_{CM}	Peak collector current (Note 1)	-3 A			
I_B	Continuous base current	-0.4 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	30 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.24 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5) TIP30 TIP30A TIP30B TIP30C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -80 V V_{BE} = 0 TIP30 V_{CE} = -100 V V_{BE} = 0 TIP30A V_{CE} = -120 V V_{BE} = 0 TIP30B V_{CE} = -140 V V_{BE} = 0 TIP30C			-0.2 -0.2 -0.2 -0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 TIP30/30A V_{CE} = -60 V I_B = 0 TIP30B/30C			-0.3 -0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -0.2 A V_{CE} = -4 V I_C = -1 A (Notes 5 & 6)	20 15		75	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -125 mA I_C = -1 A (Notes 5 & 6)			-0.7	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -1 A (Notes 5 & 6)			-1.3	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.2 A f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.2 A f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			4.17	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

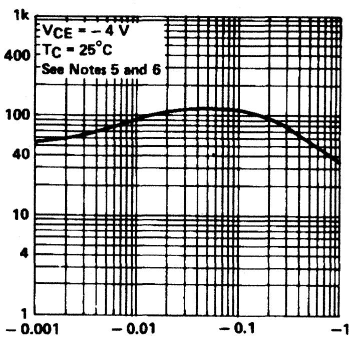
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -1 A $I_{B(on)}$ = -0.1 A $I_{B(off)}$ = 0.1 A		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4.3 V R_L = 30 Ω		1		µs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

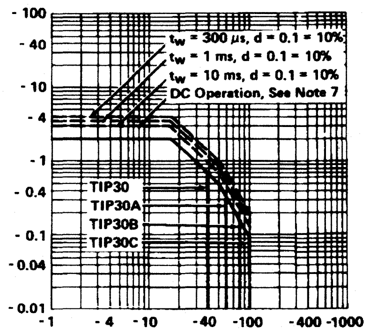
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must measured using voltage sensing contacts separate from the current carrying contacts
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT



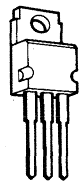
MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



TIP31,TIP31A,TIP31B,TIP31C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with the TIP32 Series**
- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP31	TIP31A	TIP31B	TIP31C
V_{CBO}	Collector - base voltage (I_E = 0)	80 V	100 V	120 V	140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	3 A			
I_{CM}	Peak collector current (Note 1)	5 A			
I_B	Continuous base current	1 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA (Note 5)	I_B = 0	TIP31 TIP31A TIP31B TIP31C	40 60 80 100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 80 V V_{CE} = 100 V V_{CE} = 120 V V_{CE} = 140 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	TIP31 TIP31A TIP31B TIP31C			0.2 0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	TIP31/31A TIP31B/31C			0.3 0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 1 A I_C = 3 A	(Notes 5 & 6)	25 10		 50	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 375 mA	I_C = 3 A	(Notes 5 & 6)			1.2	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 3 A	(Notes 5 & 6)			1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz	3			

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			3.125	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

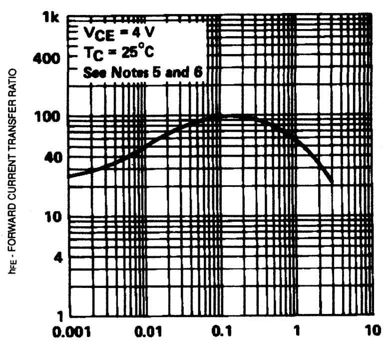
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A $I_{B(on)}$ = 0.1 A $I_{B(off)}$ = -0.1 A		0.5		μs
t_{off}	Turn off time	$V_{BE(off)}$ = -4.3 V R_L = 30 Ω		2		μs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

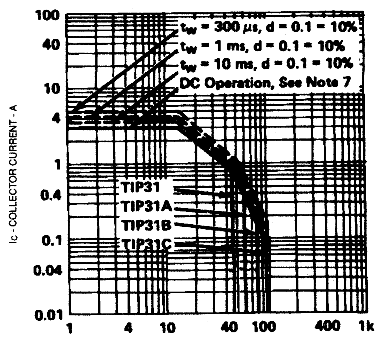
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT



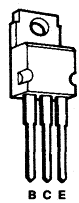
MAXIMUM FORWARD - BIAS
MAXIMUM SAFE OPERATING AREA



NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with the TIP32 Series**
- **30 W at 25°C Case Temperature**
- **1 A Continuous Collector Current**
- **3 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP31D	TIP31E	TIP31F
V_{CBO}	Collector - base voltage ($I_E = 0$)	160 V	180 V	200 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	120 V	140 V	160 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	3 A		
I_{CM}	Peak collector current (Note 1)	5 A		
I_B	Continuous base current	1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to +150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C		

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle $\leq 10\%$
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
$L = 20$ mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	$I_C = 30$ mA $I_B = 0$ (Note 5) TIP31D TIP31E TIP31F	120 140 160			V
I_{CES}	Collector - emitter cut - off current	$V_{CE} = 160$ V $V_{BE} = 0$ TIP31D $V_{CE} = 180$ V $V_{BE} = 0$ TIP31E $V_{CE} = 200$ V $V_{BE} = 0$ TIP31F			0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	$V_{CE} = 90$ V $I_B = 0$			0.3	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = 5$ V $I_C = 0$			1.0	mA
h_{FE}	Forward current transfer ratio	$V_{CE} = 4$ V $I_C = 1$ A (Notes 5 & 6) $V_{CE} = 4$ V $I_C = 3$ A	25 5			
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = 750$ mA $I_C = 3$ A (Notes 5 & 6)			2.5	V
V_{BE}	Base - emitter voltage	$V_{CE} = 4$ V $I_C = 3$ A (Notes 5 & 6)			1.8	V
h_{fe}	Small signal forward current transfer ratio	$V_{CE} = 10$ V $I_C = 0.5$ A f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	$V_{CE} = 10$ V $I_C = 0.5$ A f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			3.125	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

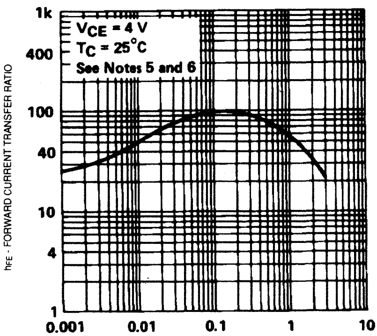
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A $I_{B(on)}$ = 0.1 A $I_{B(off)}$ = -0.1 A		0.5		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -4.3 V R_L = 30 Ω		2		µs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

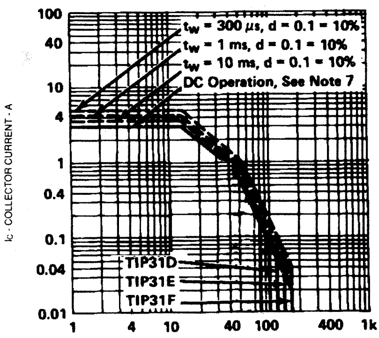
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT



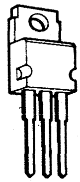
MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



TIP32,TIP32A,TIP32B,TIP32C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with the TIP31 Series**
- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP32	TIP32A	TIP32B	TIP32C
V_{CBO}	Collector - base voltage (I_E = 0)	-80 V	-100 V	-120 V	-140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-3 A			
I_{CM}	Peak collector current (Note 1)	-5 A			
I_B	Continuous base current	-1 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5)	TIP32 TIP32A TIP32B TIP32C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -80 V V_{BE} = 0 V_{CE} = -100 V V_{BE} = 0 V_{CE} = -120 V V_{BE} = 0 V_{CE} = -140 V V_{BE} = 0	TIP32 TIP32A TIP32B TIP32C			-0.2 -0.2 -0.2 -0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 V_{CE} = -60 V I_B = 0	TIP31/31A TIP31B/31C			-0.3 -0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0				-1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -1 A V_{CE} = -4 V I_C = -3 A	(Notes 5 & 6)	25 10		50	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -0.375 A I_C = -3 A	(Notes 5 & 6)			-1.2	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -3 A	(Notes 5 & 6)			-1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			3.125	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

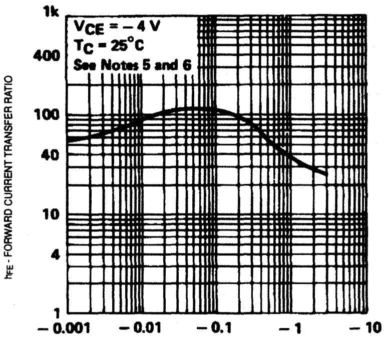
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -1 A $I_{B(on)}$ = -0.1 A $I_{B(off)}$ = 0.1 A		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4.3 V R_L = 30 Ω		1		µs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

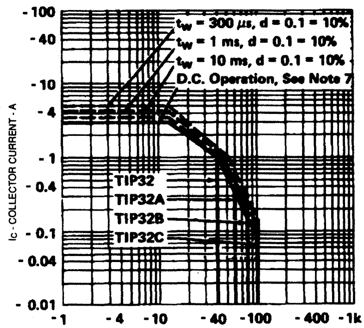
TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT



I_C - COLLECTOR CURRENT - A

MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA

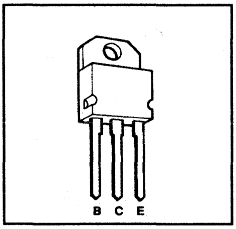


V_{CE} - COLLECTOR EMITTER VOLTAGE - V

TIP33,TIP33A,TIP33B,TIP33C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with the TIP34 Series**
- **80 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP33	TIP33A	TIP33B	TIP33C
V_{CBO}	Collector - base voltage ($I_E = 0$)	80 V	100 V	120 V	140 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	10 A			
I_{CM}	Peak collector current (Note 1)	15 A			
I_B	Continuous base current	3 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature(Note 2)	80 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
$L = 20$ mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	$I_C = 30$ mA $I_B = 0$ (Note 5) TIP33 TIP33A TIP33B TIP33C	40 60 80 100			V
I_{CES}	Collector - emitter cut - off current	$V_{CE} = 80$ V $V_{BE} = 0$ TIP33 $V_{CE} = 100$ V $V_{BE} = 0$ TIP33A $V_{CE} = 120$ V $V_{BE} = 0$ TIP33B $V_{CE} = 140$ V $V_{BE} = 0$ TIP33C			0.4 0.4 0.4 0.4	mA
I_{CEO}	Collector cut - off current	$V_{CE} = 30$ V $I_B = 0$ TIP33/33A $V_{CE} = 60$ V $I_B = 0$ TIP33B/33C			0.7 0.7	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = 5$ V $I_C = 0$			1.0	mA
h_{FE}	Forward current transfer ratio	$V_{CE} = 4$ V $I_C = 1$ A $V_{CE} = 4$ V $I_C = 3$ A (Notes 5 & 6)	40 20		 100	
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = 0.3$ A $I_C = 3$ A $I_B = 2.5$ A $I_C = 10$ A (Notes 5 & 6)			1 4	V
V_{BE}	Base - emitter voltage	$V_{CE} = 4$ V $I_B = 3$ A $V_{CE} = 4$ V $I_B = 10$ A (Notes 5 & 6)			1.6 3	V
h_{fe}	Small signal forward current transfer ratio	$V_{CE} = 10$ V $I_C = 0.5$ A f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	$V_{CE} = 10$ V $I_C = 0.5$ A f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

Resistive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted

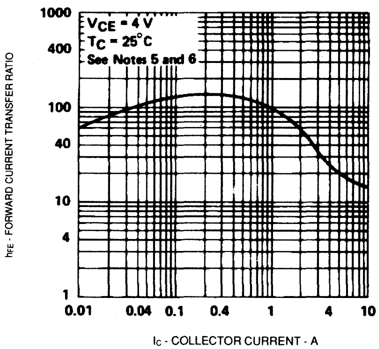
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 6 A $I_{B(on)}$ = 0.6 A $I_{B(off)}$ = -0.6 A		0.6		μs
t_{off}	Turn off time	$V_{BE(off)}$ = -4 V R_L = 5 Ω		1		μs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

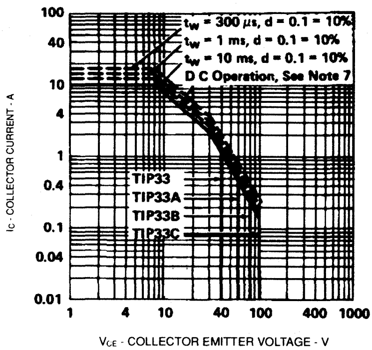
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT



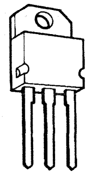
MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



TIP34,TIP34A,TIP34B,TIP34C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with the TIP33 Series**
- **80 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP34	TIP34A	TIP34B	TIP34C
V_{CBO}	Collector - base voltage (I_E = 0)	-80 V	-100 V	-120 V	-140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-10 A			
I_{CM}	Peak collector current (Note 1)	-15 A			
I_B	Continuous base current	-3 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	80 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5)	TIP34 TIP34A TIP34B TIP34C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -80 V V_{BE} = 0 V_{CE} = -100 V V_{BE} = 0 V_{CE} = -120 V V_{BE} = 0 V_{CE} = -140 V V_{BE} = 0	TIP34 TIP34A TIP34B TIP34C			-0.4 -0.4 -0.4 -0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 V_{CE} = -60 V I_B = 0	TIP34/34A TIP34B/34C			-0.7 -0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0				-1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -1 A V_{CE} = -4 V I_C = -3 A	(Notes 5 & 6)	40 20		 100	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -0.3 A I_C = -3 A I_B = -2.5 A I_C = -10 A	(Notes 5 & 6)			-1 -4	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -3 A V_{CE} = -4 V I_C = -10 A	(Notes 5 & 6)			-1.6 -3	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A	f = 1 MHz	3			

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

Resistive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

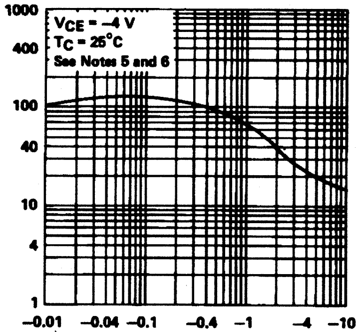
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -6 A $I_{B(on)}$ = -0.6 A $I_{B(off)}$ = 0.6 A		0.4		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4 V R_L = 5 Ω		0.7		µs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

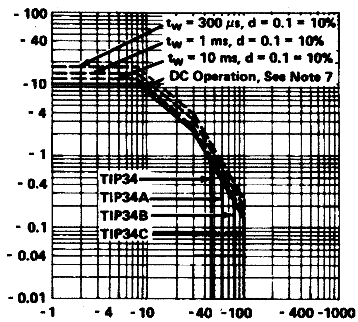
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT

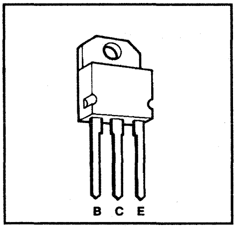


MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



Revised March 1990

- **Designed for Complementary Use with the TIP36 Series**
- **125 W at 25°C Case Temperature**
- **25 A Continuous Collector Current**
- **40 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP35	TIP35A	TIP35B	TIP35C
V_{CBO}	Collector - base voltage (I_E = 0)	80 V	100 V	120 V	140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	25 A			
I_{CM}	Peak collector current (Note 1)	40 A			
I_B	Continuous base current	5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	125 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
$I_C^2L/2$	Unclamped inductive load energy (note 4)	90 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 1 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
$L = 20$ mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA (Note 5)	I_B = 0	TIP35 TIP35A TIP35B TIP35C	40 60 80 100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 80 V V_{CE} = 100 V V_{CE} = 120 V V_{CE} = 140 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	TIP35 TIP35A TIP35B TIP35C			0.7 0.7 0.7 0.7	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	TIP35/35A TIP35B/35C			1.0 1.0	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 1.5 A I_C = 15 A	(Notes 5 & 6)	25 10		 50	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 1.5 A I_B = 5 A	I_C = 15 A I_C = 25 A	(Notes 5 & 6)			1.8 4	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V V_{CE} = 4 V	I_C = 15 A I_C = 25 A	(Notes 5 & 6)			2 4	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 1 A	f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 1 A	f = 1 MHz	3			

4

TIP Devices

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

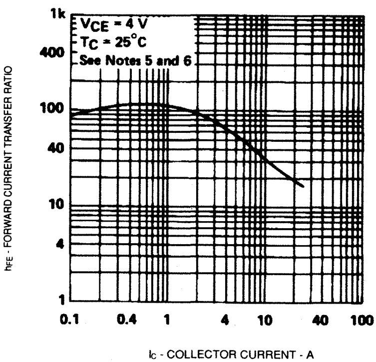
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 15 A $I_{B(on)}$ = 1.5 A $I_{B(off)}$ = -1.5 A		1.2		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -4.15 V R_L = 2 Ω		0.9		µs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

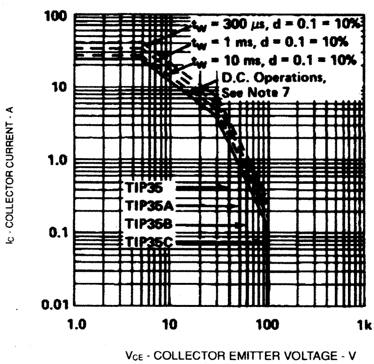
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA

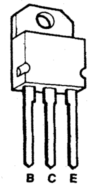


TEXAS INSTRUMENTS

TIP36,TIP36A,TIP36B,TIP36C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with the TIP35 Series**
- **125 W at 25°C Case Temperature**
- **25 A Continuous Collector Current**
- **40 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP36	TIP36A	TIP36B	TIP36C
V_{CBO}	Collector - base voltage (I_E = 0)	80 V	100 V	120 V	140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-25 A			
I_{CM}	Peak collector current (Note 1)	-40 A			
I_B	Continuous base current	-5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	125 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
I_C^2L/L	Unclamped inductive load energy (Note 4)	90 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 1 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V .

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5) TIP36 TIP36A TIP36B TIP36C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -80 V V_{BE} = 0 TIP36 V_{CE} = -100 V V_{BE} = 0 TIP36A V_{CE} = -120 V V_{BE} = 0 TIP36B V_{CE} = -140 V V_{BE} = 0 TIP36C			-0.7 -0.7 -0.7 -0.7	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 TIP36/36A V_{CE} = -60 V I_B = 0 TIP36B/36C			-1.0 -1.0	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -1.5 A (Notes 5 & 6) V_{CE} = -4 V I_C = -15 A	25 10		 50	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -1.5 A I_C = -15 A (Notes 5 & 6) I_B = -5 A I_C = -25 A			-1.8 -4	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -15 A (Notes 5 & 6) V_{CE} = -4 V I_C = -25 A			-2 -4	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -1 A f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -1 A f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

Resistive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

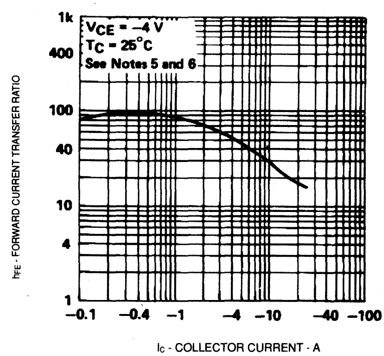
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -15 A $I_{B(on)}$ = -1.5 A $I_{B(off)}$ = 1.5 A		1.1		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4.15 V R_L = 2 Ω		0.8		µs

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters

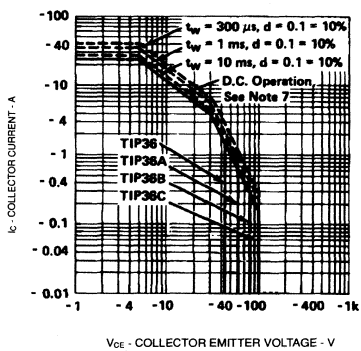
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT



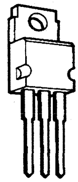
MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



TIP41, TIP41A, TIP41B, TIP41C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with the TIP42 Series**
- **65 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP41	TIP41A	TIP41B	TIP41C
V_{CBO}	Collector - base voltage (I_E = 0)	80 V	100 V	120 V	140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	6 A			
I_{CM}	Peak collector current (Note 1)	10 A			
I_B	Continuous base current	3 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	65 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.52 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA (Note 5)	I_B = 0	TIP41 TIP41A TIP41B TIP41C	40 60 80 100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 80 V V_{CE} = 100 V V_{CE} = 120 V V_{CE} = 140 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	TIP41 TIP41A TIP41B TIP41C			0.4 0.4 0.4 0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	TIP41/41A TIP41B/41C			0.7 0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 0.3 A I_C = 3 A	(Notes 5 & 6)	30 15		 75	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.6 A	I_C = 6 A	(Notes 5 & 6)			1.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 6 A	(Notes 5 & 6)			2	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.92	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

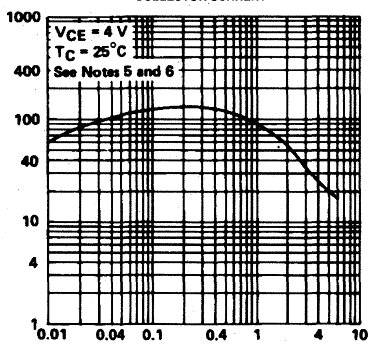
PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 6 A	$I_{B(on)}$ = 0.6 A	$I_{B(off)}$ = -0.6 A		0.6		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -4. V	R_L = 5 Ω			1		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

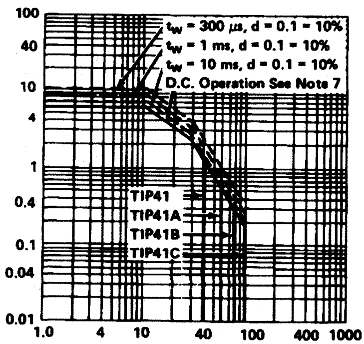
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT

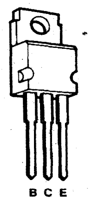


MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



Revised March 1990

- **Designed for Complementary Use with the TIP41 Series**
- **65 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP42	TIP42A	TIP42B	TIP42C
V_{CBO}	Collector - base voltage (I_E = 0)	-80 V	-100 V	-120 V	-140 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-6 A			
I_{CM}	Peak collector current (Note 1)	-10 A			
I_B	Continuous base current	-3 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	65 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.52 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5) TIP42 TIP42A TIP42B TIP42C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -80 V V_{BE} = 0 TIP42 V_{CE} = -100 V V_{BE} = 0 TIP42A V_{CE} = -120 V V_{BE} = 0 TIP42B V_{CE} = -140 V V_{BE} = 0 TIP42C			-0.4 -0.4 -0.4 -0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 TIP42/42A V_{CE} = -60 V I_B = 0 TIP42B/42C			-0.7 -0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -0.3 A V_{CE} = -4 V I_C = -3 A (Notes 5 & 6)	30 15		 75	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -0.6 A I_C = -6 A (Notes 5 & 6)			-1.5	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -6 A (Notes 5 & 6)			-2	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.92	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

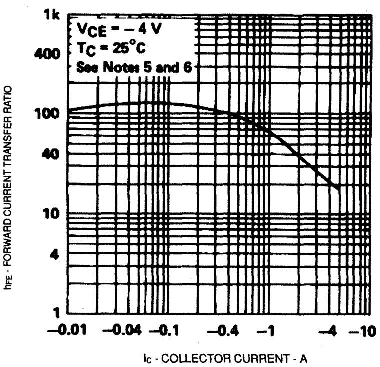
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -6 A $I_{B(on)}$ = -0.6 A $I_{B(off)}$ = 0.6 A		0.4		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4. V R_L = 5 Ω		0.7		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

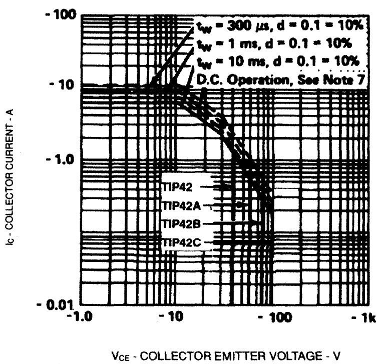
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
VS
COLLECTOR CURRENT

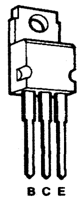


MAXIMUM FORWARD - BIAS SAFE
OPERATING AREA



Revised March 1990

- **Designed for High Voltage, High Forward, and Reverse Energy Applications**
- **40 W at 25°C Case Temperature**
- **1 A Continuous Collector Current**
- **2 A Peak Collector Current**
- **20 mJ Reverse - Energy Rating**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP47	TIP48	TIP49	TIP50
V_{CBO}	Collector - base voltage (I_E = 0)	350 V	400 V	450 V	500 V
V_{CEO}	Collector - emitter voltage (I_B =0)	250 V	300 V	350 V	400 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	1 A			
I_{CM}	Peak collector current (Note 1)	2 A			
I_B	Continuous base current	0.6 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	20 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \leq 1$ ms, duty cycle $\leq$ 10%
2: Derate linearly to 150°C case temperature at a rate of 0.32 W/°C
3: Derate linearly to 150°C case temperature at a rate of 16 mW/°C
4: This rating is based on the capability of the transistor to operate safely in a circuit of:
L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA I_B = 0 (Note 5) TIP47 TIP48 TIP49 TIP50	250 300 350 400			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 350 V V_{BE} = 0 TIP47 V_{CE} = 400 V V_{BE} = 0 TIP48 V_{CE} = 450 V V_{BE} = 0 TIP49 V_{CE} = 500 V V_{BE} = 0 TIP50			1 1 1 1	mA
I_{CEO}	Collector cut - off current	V_{CE} = 150 V I_B = 0 TIP47 V_{CE} = 200 V I_B = 0 TIP48 V_{CE} = 250 V I_B = 0 TIP49 V_{CE} = 300 V I_B = 0 TIP50			 1 1 	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 10 V I_C = 0.3 A V_{CE} = 10 V I_C = 1 A (Notes 5 & 6)	30 10		150	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.2 A I_C = 1 A (Notes 5 & 6)			1	V
V_{BE}	Base - emitter voltage	V_{CE} = 10 V I_C = 1 A (Notes 5 & 6)			1.5	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 0.2 A f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 0.2 A f = 2 MHz	5			

4

TIP Devices

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

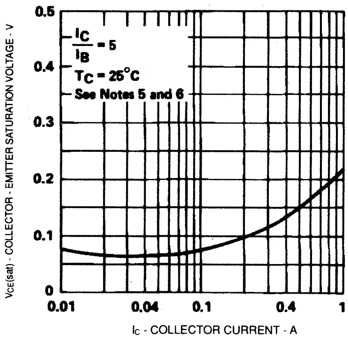
PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A	$I_{B(on)}$ = 100 mA	$I_{B(off)}$ = -100 mA		0.2		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -5 V	R_L = 200 Ω			2		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

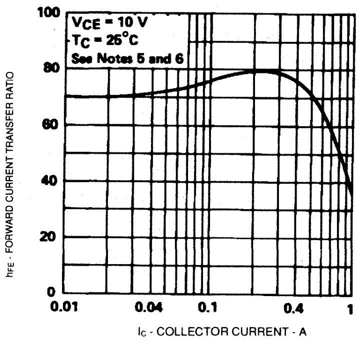
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

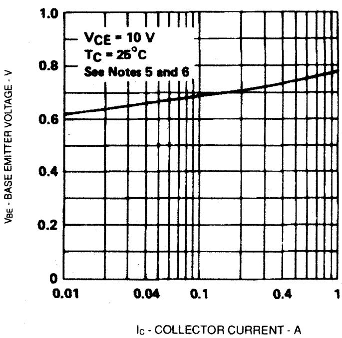
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



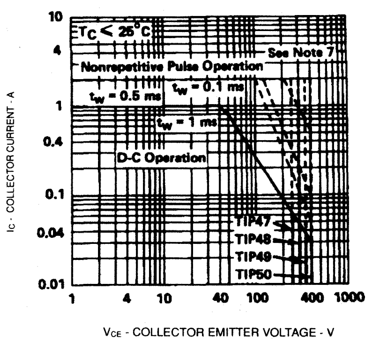
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



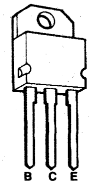
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TIP51,TIP52,TIP53,TIP54
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for High Voltage, High Forward, and Reverse Energy Applications**
- **100 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5 A Peak Collector Current**
- **100 mJ Reverse - Energy Rating**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP51	TIP52	TIP53	TIP54
V_{CBO}	Collector - base voltage ($I_E = 0$)	350 V	400 V	450 V	500 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	250 V	300 V	350 V	400 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	3 A			
I_{CM}	Peak collector current (Note 1)	5 A			
I_B	Continuous base current	0.6 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	100 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	100 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \leq 1$ ms, duty cycle $\leq 10\%$
2: Derate linearly to 150°C case temperature at the rate of 0.8 W/°C
3: Derate linearly to 150°C free - air - temperature at the rate of 28mW/°C
4: This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA $I_B = 0$ (Note 5)	TIP51 TIP52 TIP53 TIP54	250 300 350 400			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 350 V $V_{BE} = 0$ V_{CE} = 400 V $V_{BE} = 0$ V_{CE} = 450 V $V_{BE} = 0$ V_{CE} = 500 V $V_{BE} = 0$	TIP52 TIP52 TIP53 TIP54			1 1 1 1	mA
I_{CEO}	Collector cut - off current	V_{CE} = 150 V $I_B = 0$ V_{CE} = 200 V $I_B = 0$ V_{CE} = 250 V $I_B = 0$ V_{CE} = 300 V $I_B = 0$	TIP51 TIP52 TIP53 TIP54			 1 1 	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V $I_C = 0$				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 10 V I_C = 0.3 A V_{CE} = 10 V I_C = 3 A	(Notes 5 & 6)	30 10		150	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.6 A I_C = 3 A	(Notes 5 & 6)			1.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 10 V I_C = 3 A	(Notes 5 & 6)			1.5	V
h_{fe}	Small signal l foward current transfer ratio	V_{CE} = 10 V I_C = 0.2 A	f = 1 kHz	30			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 0.2 A	f = 1 MHz	2.5			

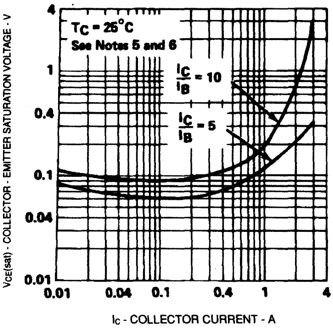
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A	$I_{B(on)}$ = 0.1 A	$I_{B(off)}$ = -0.1 A		0.25		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -5 V	R_L = 200 Ω			5		µs

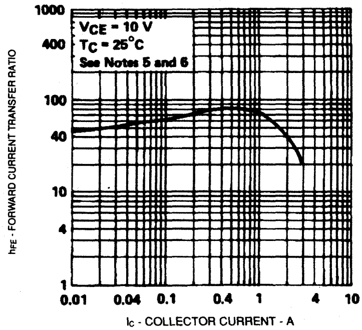
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

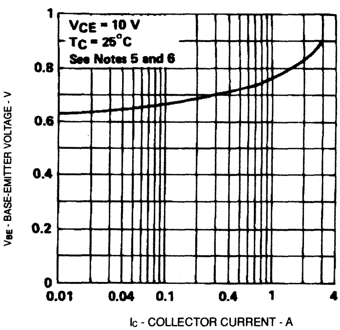
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



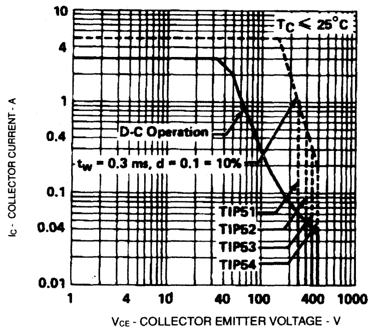
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



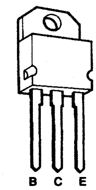
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TIP55A,TIP56A,TIP57A,TIP58A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Automotive Ignition and Switching Regulator Applications**
- **High Voltage, High Forward, and Reverse Energy**
- **50 W at 100°C Case Temperature**
- **10 A Peak Collector Current**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP55A	TIP56A	TIP57A	TIP58A
V_{CBO}	Collector - base voltage (I_E = 0)	350 V	400 V	450 V	500 V
V_{CEO}	Collector - emitter voltage (I_B =0)	250 V	300 V	350 V	400 V
V_{EBO}	Base - emitter voltage	8 V			
I_C	Continuous collector current	7.5 A			
I_{CM}	Peak collector current (Note 1)	10 A			
I_B	Continuous base current	4 A			
P_{tot}	Continuous device dissipation at (or below) 100°C case temperature (Note 2)	50 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	250 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	300°C			

NOTES: 1: This value applies for $t_w \leq 1$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 1W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 24mW/°C.
4: This rating is based on the capability of the transistor to operatre safely in a circuit of:
$L = 20$ mH, $R_{BB2} = 100\Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V, Energy= $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 20 mA I_B = 0 (Note 5) TIP55A TIP56A TIP57A TIP58A	250 300 350 400			V
I_{CER}	Collector - emitter cut - off current	V_{CE} = 350 V R_{BE} = 27 Ω TIP55A V_{CE} = 400 V R_{BE} = 27 Ω TIP56A V_{CE} = 450 V R_{BE} = 27 Ω TIP57A V_{CE} = 500 V R_{BE} = 27 Ω TIP58A			100 100 100 100	μA
I_{EBO}	Emitter cut - off current	V_{EB} = 8 V I_C = 0			100	μA
h_{FE}	Forward current transfer ratio	V_{CE} = 2 V I_C = 1 A V_{CE} = 2 V I_C = 5 A (Notes 5 & 6)	10 6		100	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 1 A I_C = 5 A I_B = 4 A I_C = 10 A (Notes 5 & 6)			1.2 2.5	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 1 A I_C = 5 A (Notes 5 & 6)			1.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	$I_C = 5$ A, $I_{B(on)} = 1$ A, $I_{B(off)} = -1$ A, $V_{BE(off)} = -4$ V, $R_L = 40\ \Omega$		0.04		μs
t_r	Rise time			0.13		μs
t_s	Storage time			1.5		μs
t_f	Fall time			0.2		μs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

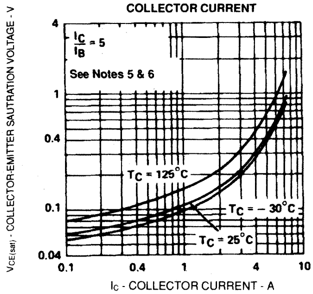
Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			41.7	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 7)		0.6		°C/W
$C_{\theta C}$	Thermal capacitance of case		1.4		J/°C

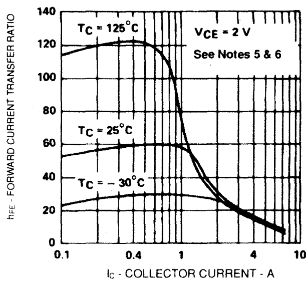
NOTE: 7: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, a 0.138-32 mounting screws with bushing, and a mounting torque of 0.9 newton meter.

TYPICAL CHARACTERISTICS

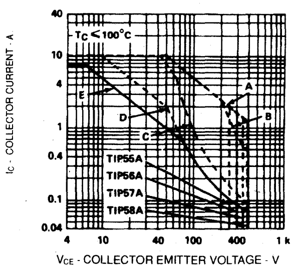
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA

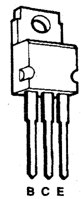


CURVE	CONDITIONS
A	tw = 100 μs, d = 0.1 = 10%
B	tw = 1 ms, d = 0.1 = 10%
C	tw = 10 ms, d = 0.1 = 10%
D	tw = 150 ms, d = 0.01 = 1%
E	DC Operation

TIP73,TIP73A,TIP73B,TIP73C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP74 Series**
- **80 W at 25°C Case Temperature**
- **15 A Rated Collector Current**
- **Designed for Power - Amplifier and High - Speed Switching Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP73	TIP73A	TIP73B	TIP73C
V_{CBO}	Collector - base voltage (I_E = 0)	50 V	70 V	90 V	110 V
V_{CEO}	Collector - emitter voltage (I_B =0)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	15 A			
I_B	Continuous base current	5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 1)	80 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 2)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 3)	90 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
2: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
3: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 200 mA (Note 4)	I_B = 0	TIP73 TIP73A TIP73B TIP73C	40 60 80 100			V
$V_{(BR)CEV}$	Voltage between base and emitter	I_C = 200 mA (Note 4)	V_{BE} = -1.5 V	TIP73 TIP73A TIP73B TIP73C	50 70 90 110			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 40 V V_{CE} = 60 V V_{CE} = 80 V V_{CE} = 100 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	TIP73 TIP73A TIP73B TIP73C			50 50 50 50	µA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	TIP73/73A TIP73B/73C			50 50	µA
I_{EBO}	Emitter cut - off current	V_{EB} = 4.5 V	I_C = 0				50	µA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 5 A I_C = 15 A	(Notes 4 & 5)	20 5		150	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.5 A I_B = 5 A	I_C = 5 A I_C = 15 A	(Notes 4 & 5)			1.3 3.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V V_{CE} = 4 V	I_C = 5 A I_C = 15 A	(Notes 4 & 5)			1.3 3.5	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 4 V	I_C = 1 A	f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 4 V	I_C = 1 A	f = 1 MHz	5			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 6)		0.7		°C/W
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = 5 A, $I_{B(on)}$ = 500 mA, $I_{B(off)}$ = -500 mA, $V_{BE(off)}$ = -4.2 V, R_L = 6 Ω		20		ns
t_r	Rise time			350		ns
t_s	Storage time			500		ns
t_f	Fall time			400		ns

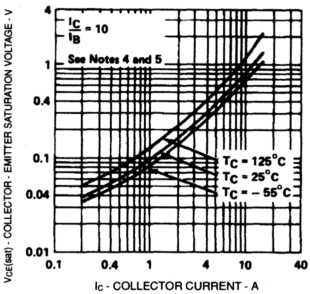
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
6: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, 32 mounting screws with bushing, and a mounting torque of 0.9 newton - meter.

4

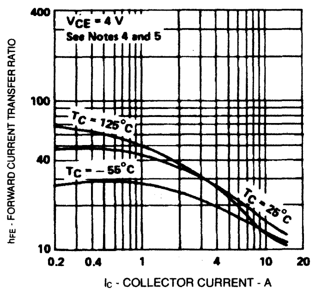
TIP Devices

TYPICAL CHARACTERISTICS

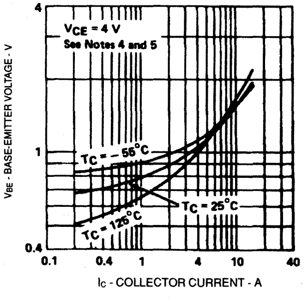
COLLECTOR - EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT



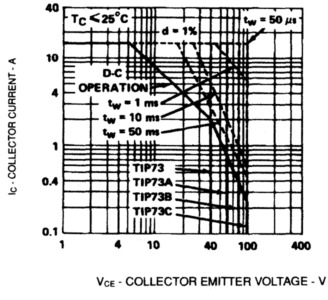
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT



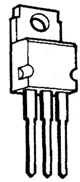
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIP74,TIP74A,TIP74B,TIP74C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP73 Series**
- **80 W at 25°C Case Temperature**
- **15 A Rated Collector Current**
- **Designed for Power - Amplifier and High - Speed Switching Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP74	TIP74A	TIP74B	TIP74C
V_{CBO}	Collector - base voltage (I_E = 0)	-50 V	-70 V	-90 V	-110 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-15 A			
I_B	Continuous base current	-5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 1)	80 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free-air temperature (Note 2)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 3)	90 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
2: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
3: This rating is based on the capability of the transistor to operate safely in circuit of: 2. L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -200 mA I_B = 0 (Note 4) TIP74 / TIP74A / TIP74B / TIP74C	-40 / -60 / -80 / -100			V
$V_{(BR)CEV}$	Voltage between base and emitter	I_C = -200 mA V_{BE} = 1.5 V (Note 4) TIP74 / TIP74A / TIP74B / TIP74C	-50 / -70 / -90 / -110			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -40 V V_{BE} = 0 TIP74 / V_{CE} = -60 V V_{BE} = 0 TIP74A / V_{CE} = -80 V V_{BE} = 0 TIP74B / V_{CE} = -100 V V_{BE} = 0 TIP74C			-50 / -50 / -50 / -50	μA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 TIP74/74A / V_{CE} = - 60 V I_B = 0 TIP74B/74C			-50 / -50	μA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-50	μA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -5 A / V_{CE} = -4 V I_C = -15 A (Notes 4 & 5)	20 / 5		150	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -0.5 A I_C = - 5 A / I_B = -5 A I_C = -15 A (Notes 4 & 5)			-1.3 / -3.5	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -5 A / V_{CE} = -4 V I_C = -15 A (Notes 4 & 5)			-1.3 / -3.5	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -4 V I_C = -1 A f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -4 V I_C = -1 A f = 1 MHz	5			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 6)		0.7		°C/W
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

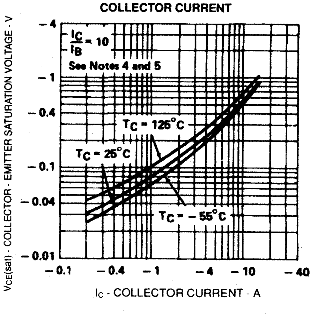
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = -5 A, $I_{B(on)}$ = -500 mA, $I_{B(off)}$ = 500 mA, $V_{BE(off)}$ = 4.2 V, R_L = 6 Ω		20		ns
t_r	Rise time			120		ns
t_s	Storage time			600		ns
t_f	Fall time			300		ns

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

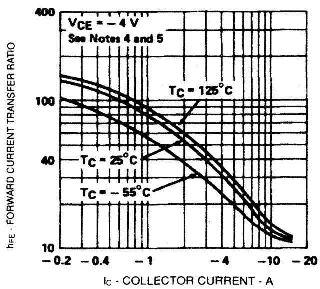
NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
6: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, 6 - 32 mounting screws with bushing, and a mounting torque of 0.9 newton - meter.

TYPICAL CHARACTERISTICS

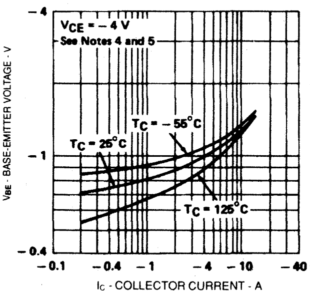
COLLECTOR - EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT



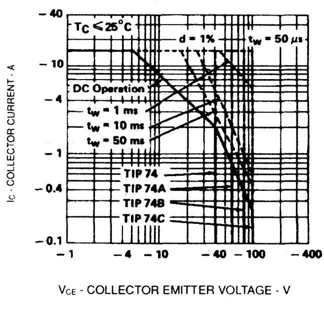
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT



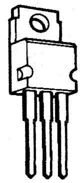
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIP75,TIP75A,TIP75B,TIP75C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **High -Voltage, High - Forward and Clamped Reverse Energy Circuit Characteristics**
- **65 W at 25°C Case Temperature**
- **5 A Peak Collector Current**
- **Reverse - Bias SOA...200 V to 400 V, 3 A**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP75	TIP75A	TIP75B	TIP75C
V_{CBO}	Collector - base voltage (I_E = 0)	350 V	400 V	450 V	500 V
V_{CEO}	Collector - emitter voltage (I_B =0)	200 V	250 V	300 V	400 V
V_{EBO}	Base - emitter voltage	8 V			
I_C	Continuous collector current	3 A			
I_{CM}	Peak collector current (Note 1)	5 A			
I_B	Continuous base current	1.5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 1)	65 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 2)	2 W			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \le$ 5ms, duty cycle $\le$ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.52 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CBO}$	Collector-base breakdown voltage	I_C = 10 mA I_E = 0	TIP75 TIP75A TIP75B TIP75C	350 400 450 500			V
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 10 mA I_B = 0	TIP75 TIP75A TIP75B TIP75C	200 250 300 400			
$V_{CEX(sus)}$	Collector - emitter sustaining voltage	L = 180 µH I_C = 3 A V_{CLAMP} = $V_{(BR)CEO}$	TIP75 TIP75A TIP75B TIP75C	200 250 300 400			
I_{CES}	Collector - emitter cut - off current	V_{CE} = 300 V V_{BE} = 0 V_{CE} = 350 V V_{BE} = 0 V_{CE} = 400 V V_{BE} = 0 V_{CE} = 450 V V_{BE} = 0	TIP75 TIP75A TIP75B TIP75C			50 50 50 50	µA
I_{CEO}	Collector cut - off current	V_{CE} = 150 V I_B = 0 V_{CE} = 250 V I_B = 0	TIP75/75A TIP75B/75C			150 150	µA
I_{EBO}	Emitter cut-off current	V_{EB} = 8 V I_C = 0				1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V I_C = 0.5 A V_{CE} = 2 V I_C = 2 A V_{CE} = 4 V I_C = 3 A	(Notes 4 & 5)	30 12 10		250	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 50 mA I_C = 0.5 A I_B = 0.6 A I_C = 3 A	(Notes 4 & 5)			0.5 1.9	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 50 mA I_C = 0.5 A I_B = 0.6 A I_C = 3 A	(Notes 4 & 5)			1 1.2	V

Electrical Characteristics (continued) at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 5 V I_C = 0.5 A f = 1 kHz	30			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 5 V I_C = 0.5 A f = 1 MHz	10			
C_{ob}	Output capacitance	V_{CB} = 10 V I_E = 0 f = 1 MHz			275	pF

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.92	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 6)		0.7		°C/W
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

4

Resistive - Load Switching characteristics at 25°C Case Temperature (unless otherwise noted)

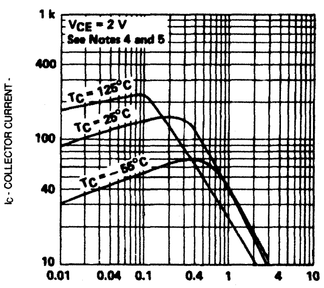
PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = 2 A $I_{B(on)}$ = 0.2 A $I_{B(off)}$ = -0.2 A $V_{BE(off)}$ = -4 V R_L = 100 Ω		20		ns
t_r	Rise time			340		ns
t_s	Storage time			1400		ns
t_f	Fall time			800		ns

TIP Devices

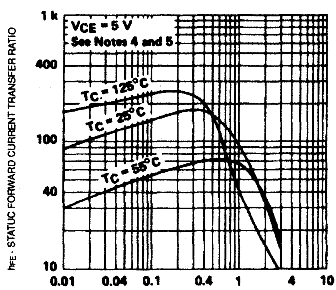
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
6: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, 6 - 32 mounting screws with bushing, and a mounting torque of o.9 newton meter.

TYPICAL CHARACTERISTICS

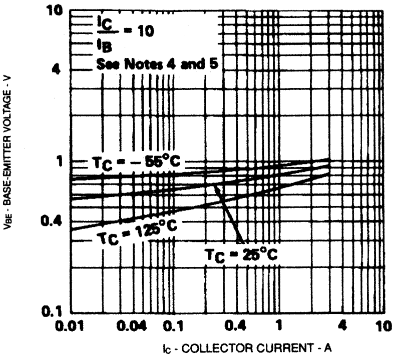
STATIC FORWARD CURRENT TRANSFER RATI
vs
COLLECTOR CURRENT



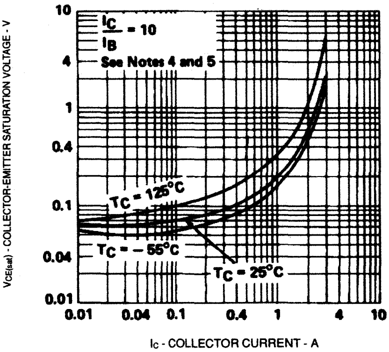
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



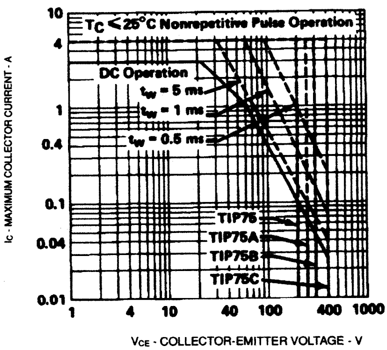
BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



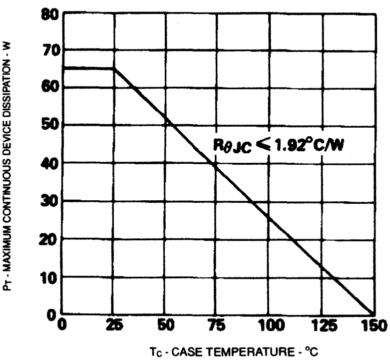
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



MAXIMUM FORWARD-BIAS
SAFE OPERATING AREA



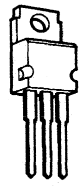
CASE TEMPERATURE
DISSIPATION DERATING CURVE



TIP100, TIP101, TIP102
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP105, TIP106 and TIP107**
- **80 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **MAX $V_{CE(sat)}$ of 2.5 V at I_C = 8 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP100	TIP101	TIP102
V_{CBO}	Collector - base voltage (I_E = 0)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	8 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_B	Continuous base current	1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	80 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	10 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	300°C		

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 W/°C.
4: This rating is based on the capability of the transistor to operatre safely in a circuit of:
L = 20 mH, R_{BB2} = 100Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V, Energy≈ $I_C^2L/2$

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA (Note 5)	I_B = 0	TIP100 TIP101 TIP102	60 80 100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V V_{CE} = 40 V V_{CE} = 50 V	I_B = 0 I_B = 0 I_B = 0	TIP100 TIP101 TIP102			50 50 50	µA
I_{CBO}	Collector cut - off current	V_{CB} = 60 V V_{CB} = 80 V V_{CB} = 100 V	I_E = 0 I_E = 0 I_E = 0	TIP100 TIP101 TIP102			50 50 50	µA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				8	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 3 A I_C = 8 A	(Notes 5 & 6)	1000 200		20000	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 6 mA I_B = 80 mA	I_C = 3 A I_C = 8 A	(Notes 5 & 6)			2 2.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 8 A	(Notes 5 & 6)			2.8	V
V_F	Parallel diode forward voltage	I_F = 8 A	I_B = 0	(Notes 5 & 6)			2.8	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 7)		0.7		°C/W
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

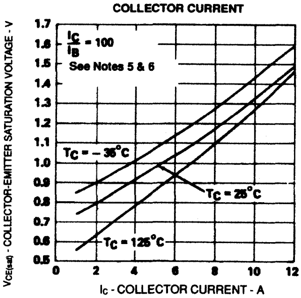
PARAMETER	TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_d					0.035		µs
t_r	I_C = 8 A	$I_{B(on)}$ = 80 mA	$I_{B(off)}$ = -80 mA		0.35		µs
t_s	$V_{BE(off)}$ = -5 V	R_L = 5 Ω			1.8		ms
t_f					2.45		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

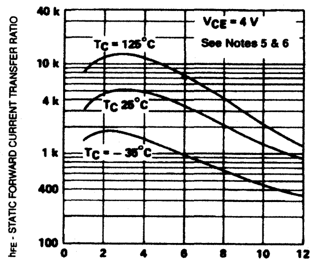
NOTE: 7: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, a 0.138-32 mounting screws with bushing, and a mounting torque of 0.9 newton meter.

TYPICAL CHARACTERISTICS

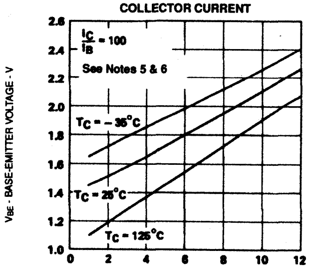
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



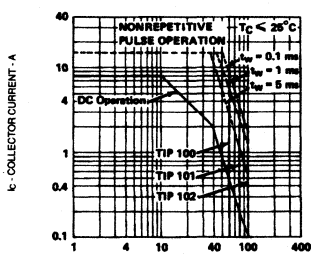
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



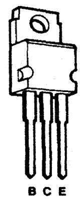
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TIP105,TIP106,TIP107
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP100, TIP101 and TIP102**
- **80 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **MAX $V_{CE(sat)}$ of 2.5 V at I_C = 8 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP105	TIP106	TIP107
V_{CBO}	Collector - base voltage (I_E = 0)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-8 A		
I_{CM}	Peak collector current (Note 1)	-15 A		
I_B	Continuous base current	-1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	80 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	10 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	300°C		

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operatre safely in a circuit of:
L = 20 mH, R_{BB2} = 100Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC}= -20 V, Energy= $I_C^2L/2$

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5) TIP105 TIP106 TIP107	-60 -80 -100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V I_B = 0 TIP105 V_{CE} = -40 V I_B = 0 TIP106 V_{CE} = -50 V I_B = 0 TIP107			-50 -50 -50	µA
I_{CBO}	Collector cut - off current	V_{CB} = -60 V I_E = 0 TIP105 V_{CB} = -80 V I_E = 0 TIP106 V_{CB} = -100 V I_E = 0 TIP107			-50 -50 -50	µA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-8	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -3 A V_{CE} = -4 V I_C = -8 A (Notes 5 & 6)	1000 200		20000	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -6 mA I_C = -3 A I_B = -80 mA I_C = -8 A (Notes 5 & 6)			-2 -2.5	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -8 A (Notes 5 & 6)			-2.8	V
V_F	Parallel diode forward voltage	I_F = 8 A I_B = 0 (Notes 5 & 6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300 µs, duty cycle ≤ 2%.
6: These parameters must be measured using voltage sensing contacts separate from the current-carrying contacts.

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 6)		0.7		°C/W
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

NOTE: 7: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, a 0.138-32 mounting screws with bushing, and a mounting torque of 0.9 newton meter.

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d			0.035		µs
t_r	I_C = -8 A $I_{B(on)}$ = -80 mA $I_{B(off)}$ = 80 mA		0.3		µs
t_s	$V_{BE(off)}$ = 5 V R_L = 5 Ω		0.9		µs
t_f			1.3		µs

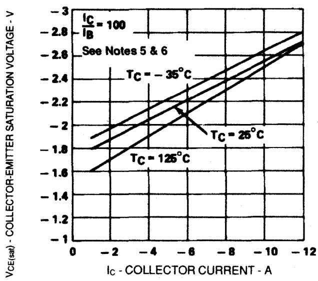
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

4

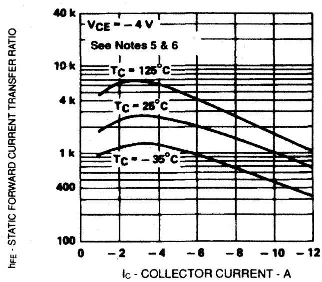
TIP Devices

TYPICAL CHARACTERISTICS

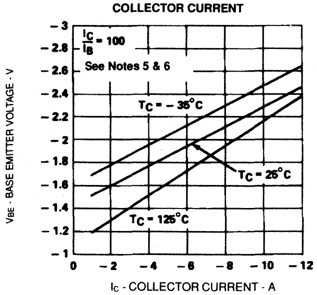
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



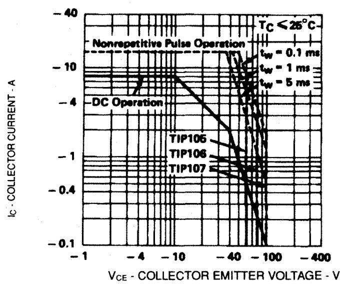
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



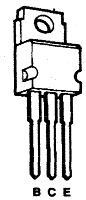
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TIP110, TIP111, TIP112
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP115, TIP116 and TIP117**
- **50 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **Min h_{FE} of 500 at 4 V, 2 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP110	TIP111	TIP112
V_{CBO}	Collector - base voltage (I_E = 0)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	4 A		
I_{CM}	Peak collector current (Note 1)	6 A		
I_B	Continuous base current	50 mA		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	50 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	25 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.4W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} 20 V, Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA (Note 5)	I_B = 0	TIP110 TIP111 TIP112	60 80 100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V V_{CE} = 40 V V_{CE} = 50 V	I_B = 0 I_B = 0 I_B = 0	TIP110 TIP111 TIP112			2 2 2	mA
I_{CBO}	Collector cut - off current	V_{CB} = 60 V V_{CB} = 80 V V_{CB} = 100 V	I_E = 0 I_E = 0 I_E = 0	TIP110 TIP111 TIP112			1 1 1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 1 A I_C = 2 A	(Notes 5 & 6)	1000 500			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 8 mA	I_C = 2 A	(Notes 5 & 6)			2.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 2 A	(Notes 5 & 6)			2.8	V
V_F	Parallel diode forward voltage	I_F = $-I_C$ = 4 A	I_B = 0	(Notes 5 & 6)			3.5	V

TIP110, TIP111, TIP112
NPN DARLINGTON - CONNECTED
SILICON POWER TRANSISTORS

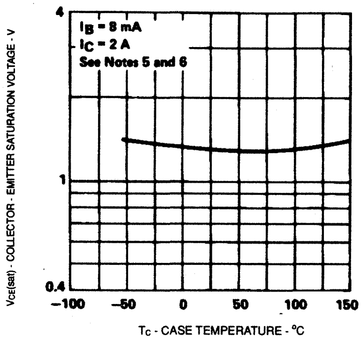
Resistive - Load - Switching Characteristics at 25°C Case Temperature

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	$I_C = 2$ A	$I_{B(on)} = 8$ mA	$I_{B(off)} = -8$ mA		2.6		µs
t_{off}	Turn off time	$V_{BE(off)} = -5$ V	$R_L = 15\ \Omega$			4.5		µs

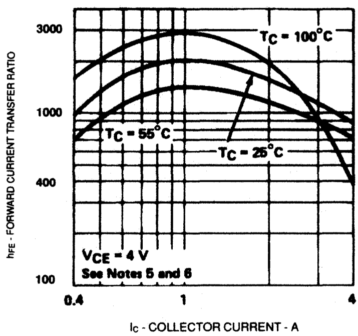
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, $t_w = 300$µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

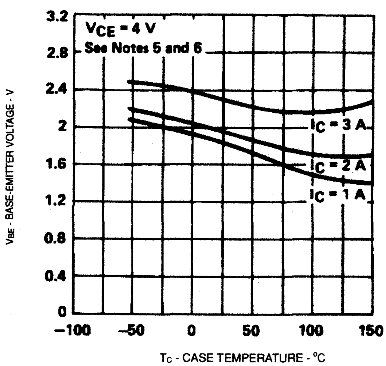
COLLECTOR - EMITTER SATURATION VOLTAGE vs CASE TEMPERATURE



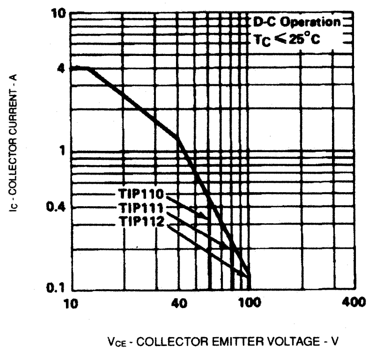
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs CASE TEMPERATURE



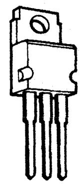
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIP115,TIP116,TIP117
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP110, TIP111 and TIP112**
- **50 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **Min h_{FE} of 500 at 4 V, 2 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP115	TIP116	TIP117
V_{CBO}	Collector - base voltage ($I_E = 0$)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-4 A		
I_{CM}	Peak collector current (Note 1)	-6 A		
I_B	Continuous base current	-50 mA		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	50 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	25 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.4 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = -20$ V, Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	$I_C = -30$ mA $I_B = 0$ (Note 5)	TIP115 TIP116 TIP117	-60 -80 -100			V
I_{CEO}	Collector - emitter cut - off current	$V_{CE} = -30$ V $I_B = 0$ $V_{CE} = -40$ V $I_B = 0$ $V_{CE} = -50$ V $I_B = 0$	TIP115 TIP116 TIP117			-2 -2 -2	mA
I_{CBO}	Collector cut - off current	$V_{CB} = -60$ V $I_E = 0$ $V_{CB} = -80$ V $I_E = 0$ $V_{CB} = -100$ V $I_E = 0$	TIP115 TIP116 TIP117			-1 -1 -1	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = -5$ V $I_C = 0$				-2	mA
h_{FE}	Forward current transfer ratio	$V_{CE} = -4$ V $I_C = -1$ A $V_{CE} = -4$ V $I_C = -2$ A	(Notes 5 & 6)	1000 500			
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = -8$ mA $I_C = -2$ A	(Notes 5 & 6)			-2.5	V
V_{BE}	Base - emitter voltage	$V_{CE} = -4$ V $I_C = -2$ A	(Notes 5 & 6)			-2.8	V
V_F	Parallel diode forward voltage	$I_F = -I_C = -5$ A $I_B = 0$	(Notes 5 & 6)			3.5	V

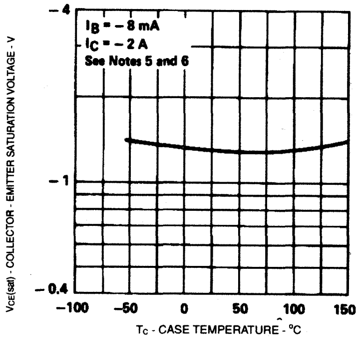
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -2 A	$I_{B(on)}$ = -8 mA	$I_{B(off)}$ = 8 mA		2.6		μs
t_{off}	Turn off time	$V_{BE(off)}$ = 5 V	R_L = 15 Ω			4.5		μs

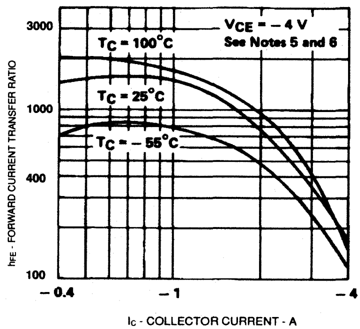
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

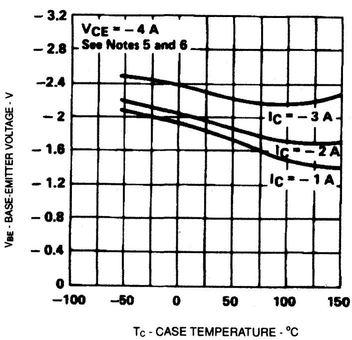
COLLECTOR - EMITTER SATURATION VOLTAGE vs CASE TEMPERATURE



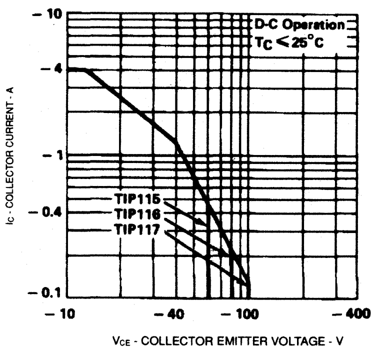
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs CASE TEMPERATURE



MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

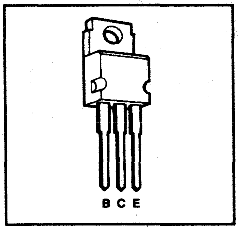


TEXAS INSTRUMENTS

TIP120, TIP121, TIP122
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP125, TIP126 and TIP127**
- **65 W at 25°C Case Temperature**
- **5 A Continuous Collector Current**
- **Min h_{FE} of 1000 at 3 V, 3 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP120	TIP121	TIP122
V_{CBO}	Collector - base voltage ($I_E = 0$)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	5 A		
I_{CM}	Peak collector current (Note 1)	8 A		
I_B	Continuous base current	0.1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	65 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	50 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.52 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16mW/°C
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} 20 V, Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA $I_B = 0$ (Note 5) TIP120 TIP121 TIP122	60 80 100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V $I_B = 0$ TIP120 V_{CE} = 40 V $I_B = 0$ TIP121 V_{CE} = 50 V $I_B = 0$ TIP122			0.5 0.5 0.5	mA
I_{CBO}	Collector cut - off current	V_{CB} = 60 V $I_E = 0$ TIP120 V_{CB} = 80 V $I_E = 0$ TIP121 V_{CB} = 100 V $I_E = 0$ TIP122			0.2 0.2 0.2	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V $I_C = 0$			2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V I_C = 0.5 A V_{CE} = 3 V I_C = 3 A (Notes 5 & 6)	1000 1000			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 4 mA I_C = 3 A I_B = 20 mA I_C = 5 A (Notes 5 & 6)			2 4	V
V_{BE}	Base - emitter voltage	V_{CE} = 3 V I_C = 3 A (Notes 5 & 6)			2.5	V
V_F	Parallel diode forward voltage	$I_F = -I_C$ = 5 A $I_B = 0$ (Notes 5 & 6)			3.5	V

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.92	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

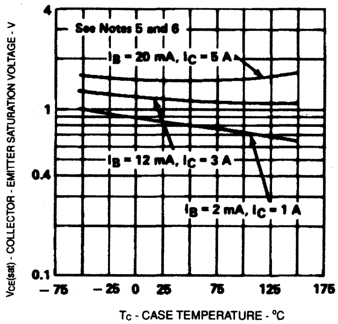
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 3 A, $I_{B(on)}$ = 12 mA, $I_{B(off)}$ = -12 mA, $V_{BE(off)}$ = -5 V, R_L = 10 Ω		1.5		μs
t_{off}	Turn off time			8.5		μs

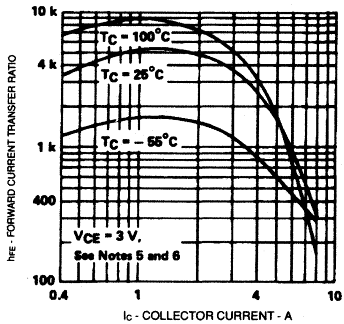
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

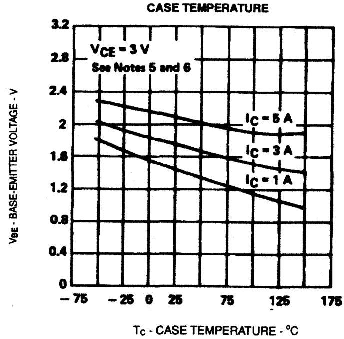
COLLECTOR - EMITTER SATURATION VOLTAGE vs CASE TEMPERATURE



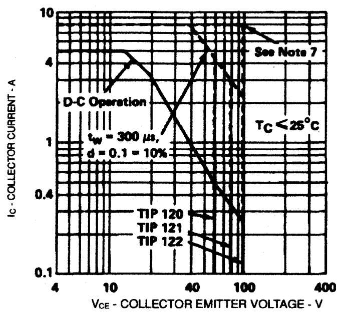
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs CASE TEMPERATURE



MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

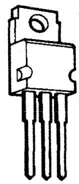


NOTE: 7. This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TIP125,TIP126,TIP127
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP120, TIP121 and TIP122**
- **65 W at 25°C Case Temperature**
- **5 A Continuous Collector Current**
- **Min h_{FE} of 1000 at 3 V, 3 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP125	TIP126	TIP127
V_{CBO}	Collector - base voltage (I_E = 0)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-5 A		
I_{CM}	Peak collector current (Note 1)	-8 A		
I_B	Continuous base current	-0.1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	65 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	50 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.52 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistors to operate safely ina circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V, Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5) TIP125 TIP126 TIP127	-60 -80 -100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V I_B = 0 TIP125 V_{CE} = -40 V I_B = 0 TIP126 V_{CE} = -50 V I_B = 0 TIP127			-0.5 -0.5 -0.5	mA
I_{CBO}	Collector cut - off current	V_{CB} = -60 V I_E = 0 TIP125 V_{CB} = -80 V I_E = 0 TIP126 V_{CB} = -100 V I_E = 0 TIP127			-0.2 -0.2 -0.2	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V I_C = -0.5 A V_{CE} = -3 V I_C = -3 A (Notes 5 & 6)	1000 1000			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -12 mA I_C = -3 A I_B = -20 mA I_C = -5 A (Notes 5 & 6)			-2 -4	V
V_{BE}	Base - emitter voltage	V_{CE} = -3 V I_C = -3 A (Notes 5 & 6)			-2.5	V
V_F	Parallel diode forward voltage	I_F = 5 A I_B = 0 (Notes 5 & 6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TIP125, TIP126, TIP127
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.92	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

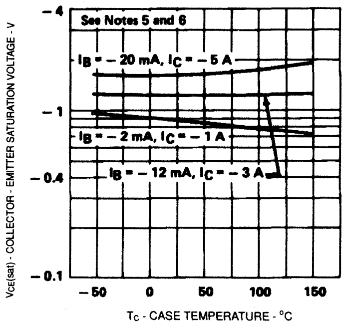
PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -3 A	$I_{B(on)}$ = -12 mA	$I_{B(off)}$ = 12 mA		1.5		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 5 V	R_L = 10 Ω			8.5		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

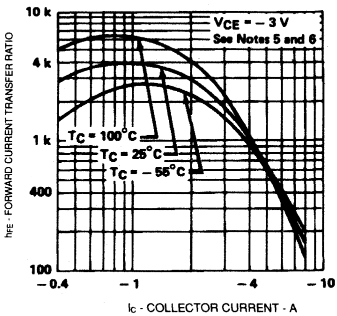
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300 µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current-carrying contacts.
7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

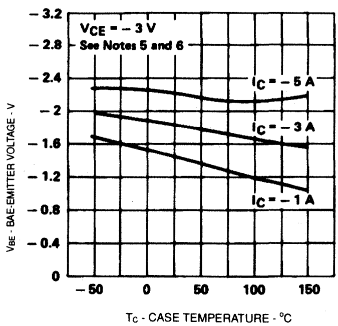
COLLECTOR - EMITTER SATURATION VOLTAGE vs CASE TEMPERATURE



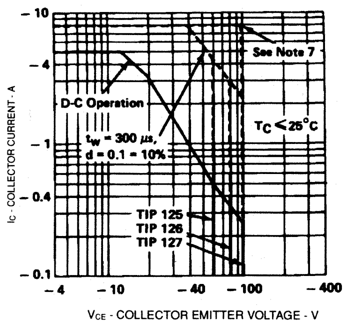
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs CASE TEMPERATURE



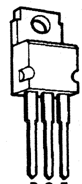
MAXIMUMFORWARD - BIAS SAFE OPERATING AREA



TEXAS INSTRUMENTS

TIP130,TIP131,TIP132
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS
Revised March 1990

- **Designed for Complementary Use with TIP135, TIP136 and TIP137**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Min h_{FE} of 1000 at 4 V, 4 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP123	TIP131	TIP132
V_{CBO}	Collector - base voltage (I_E = 0)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	8 A		
I_{CM}	Peak collector current (Note 1)	12 A		
I_B	Continuous base current	0.3 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	70 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	75 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.56°C/W, refer to Dissipation Derating Curve.
3: Derate linearly to 150°C free - air - temperature at the rate of 20°C/mW or refer to Dissipation Derating Curve.
4: This rating is based on the capability of the transistors to operate safely in the circuit of figure 2. L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} 20 V, Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA I_B = 0 (Note 5) TIP130 TIP131 TIP132	60 80 100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V I_B = 0 TIP130 V_{CE} = 40 V I_B = 0 TIP131 V_{CE} = 50 V I_B = 0 TIP132			0.5 0.5 0.5	mA
I_{CBO}	Collector cut - off current	V_{CB} = 60 V I_E = 0 TIP130 V_{CB} = 80 V I_E = 0 TIP131 V_{CB} = 100 V I_E = 0 TIP132 V_{CB} = 60 V I_E = 0 TIP130 T_C = 100°C V_{CB} = 80 V I_E = 0 TIP131 T_C = 100°C V_{CB} = 100 V I_E = 0 TIP132 T_C = 100°C			0.2 0.2 0.2 1 1 1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V I_C = 1 A V_{CE} = 4 V I_C = 4 A (Notes 5 & 6)	500 1000		 15000	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 16 mA I_C = 4 A I_B = 30 mA I_C = 6 A (Notes 5 & 6)			2 3	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V I_C = 4 A (Notes 5 & 6)			2.5	V
C_{obo}	Output capacitance	V_{CB} = 10 V I_E = 0			200	pF
V_F	Parallel diode forward voltage	I_F = 8 A (Notes 5 & 6)			3.5	V

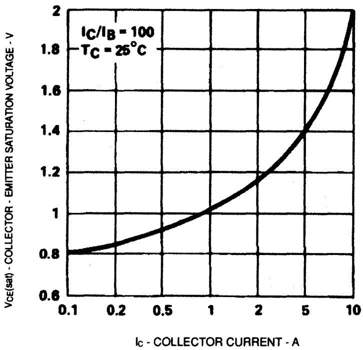
NOTES: 5. These parameters must be measured using pulse techniques, t_w = 300 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts located within 3.2 mm (0.125 inch) from the device body.

Thermal Characteristics

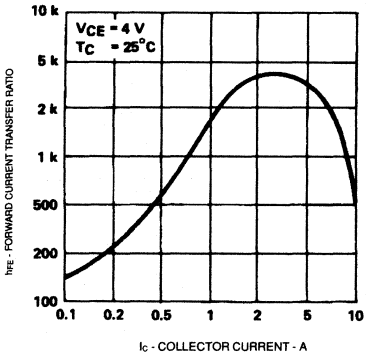
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			62.5	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			1.78	°C/W

TYPICAL CHARACTERISTICS

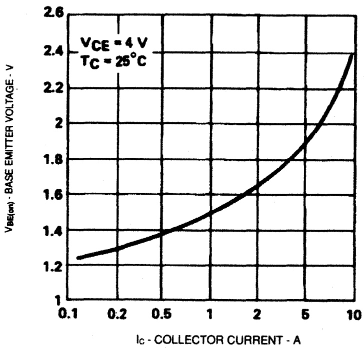
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



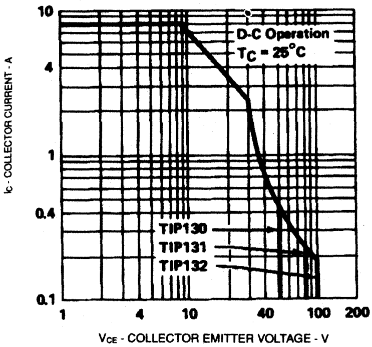
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



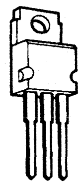
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TIP135,TIP136,TIP137
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP130, TIP131 and TIP132**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Min h_{FE} of 1000 at 4 V, 4 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP135	TIP136	TIP137
V_{CBO}	Collector - base voltage (I_E = 0)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-8 A		
I_{CM}	Peak collector current (Note 1)	-12 A		
I_B	Continuous base current	-0.3 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	70 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	75 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \le 1$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.56 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 20 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} 20 V, Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5) TIP135 TIP136 TIP137	-60 -80 -100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V I_B = 0 TIP135 V_{CE} = -40 V I_B = 0 TIP136 V_{CE} = -50 V I_B = 0 TIP137			-0.5 -0.5 -0.5	mA
I_{CBO}	Collector cut - off current	V_{CB} = -60 V I_E = 0 TIP135 V_{CB} = -80 V I_E = 0 TIP136 V_{CB} = -100 V I_E = 0 TIP137 V_{CB} = -60 V I_E = 0 TIP135 T_C = 100°C V_{CB} = -80 V I_E = 0 TIP136 T_C = 100°C V_{CB} = -100 V I_E = 0 TIP137 T_C = 100°C			-0.2 -0.2 -0.2 -1.0 -1.0 -1.0	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -1 A (Notes 5 & 6) V_{CE} = -4 V I_C = -4 A	500 1000		15000	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -16 mA I_C = -4 A (Notes 5 & 6) I_B = -30 mA I_C = -6 A			-2 -3	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -4 A (Notes 5 & 6)			-2.5	V
C_{obo}	Output capacitance	V_{CB} = -10 V I_E = 0			200	pF
V_F	Parallel diode forward voltage	I_F = 8 A (Notes 5 & 6)			3.5	V

NOTES: 5 These parameters must be measured using pulse techniques, t_w = 300 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts located within 3.2 mm (0.125 inch) from the device body.

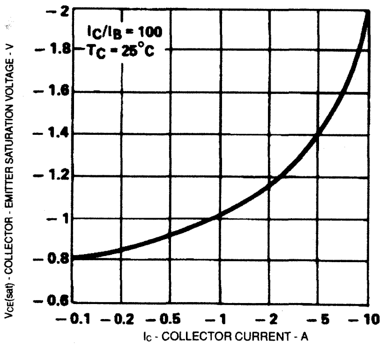
TIP135, TIP136, TIP137
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Thermal Characteristics

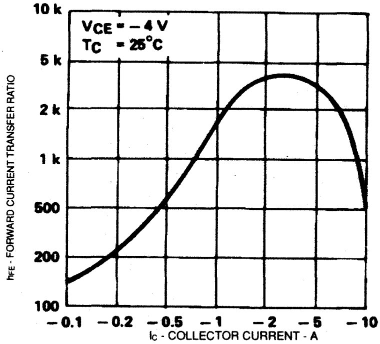
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			62.5	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			1.78	°C/W

TYPICAL CHARACTERISTICS

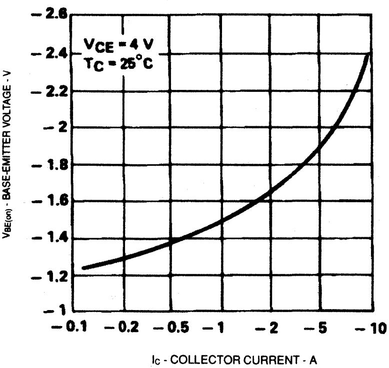
COLLECTOR - EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT



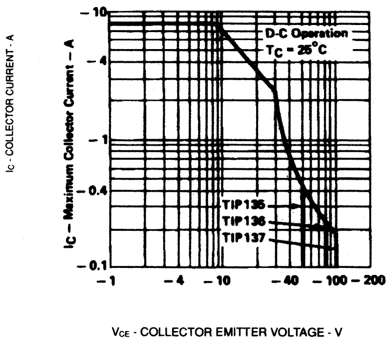
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT



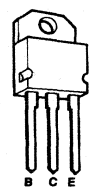
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIP140,TIP141,TIP142
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP145, TIP146 and TIP147**
- **125 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **Min h_{FE} of 1000 at 4 V, 5 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP140	TIP141	TIP142
V_{CBO}	Collector - base voltage (I_E = 0)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	10 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_B	Continuous base current	0.5 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	125 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	100 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq$ 0.1 ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 1 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} 20 V, Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA I_B = 0 (Note 5) TIP140 TIP141 TIP142	60 80 100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V I_B = 0 TIP140 V_{CE} = 40 V I_B = 0 TIP141 V_{CE} = 50 V I_B = 0 TIP142			2 2 2	mA
I_{CBO}	Collector cut - off current	V_{CB} = 60 V I_E = 0 TIP140 V_{CB} = 80 V I_E = 0 TIP141 V_{CB} = 100 V I_E = 0 TIP142			1 1 1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V I_C = 5 A V_{CE} = 4 V I_C = 10 A (Notes 5 & 6)	1000 500			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 10 mA I_C = 5 A I_B = 40 mA I_C = 10 A (Notes 5 & 6)			2 3	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V I_C = 10 A (Notes 5 & 6)			3	V
V_F	Parallel diode forward voltage	I_F = 10 A (Notes 5 & 6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

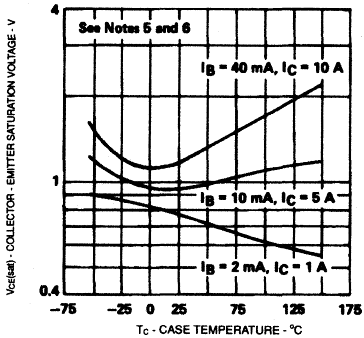
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 10 A $I_{B(on)}$ = 40 mA $I_{B(off)}$ = -40 mA		0.9		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -4.2 V R_L = 3 Ω		11		µs

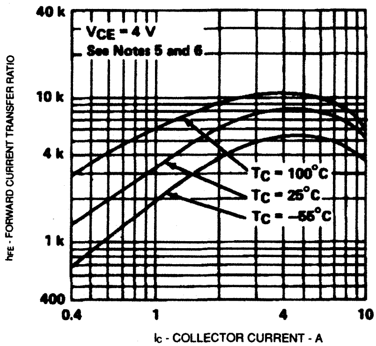
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

TYPICAL CHARACTERISTICS

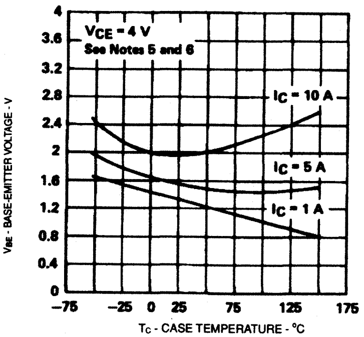
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



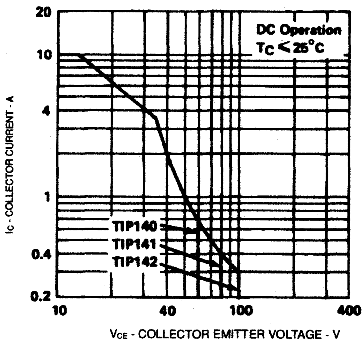
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE



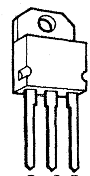
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP140, TIP141 and TIP142**
- **125 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **Min h_{FE} of 1000 at 4 V, 4 A**
- **Designed for Ignition Systems, Motor Control and Solenoid Driver Applications**



B C E

PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP145	TIP146	TIP147
V_{CBO}	Collector - base voltage ($I_E = 0$)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-10 A		
I_{CM}	Peak collector current (Note 1)	-15 A		
I_B	Continuous base current	-0.5 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	125 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	100 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 1W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_C = -20 V, Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5)	TIP145 TIP146 TIP147	-60 -80 -100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V I_B = 0 V_{CE} = -40 V I_B = 0 V_{CE} = -50 V I_B = 0	TIP145 TIP146 TIP147			-2 -2 -2	mA
I_{CBO}	Collector cut - off current	V_{CB} = -60 V I_E = 0 V_{CB} = -80 V I_E = 0 V_{CB} = -100 V I_E = 0	TIP145 TIP146 TIP147			-1 -1 -1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0				-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -5 A V_{CE} = -4 V I_C = -10 A	(Notes 5 & 6)	1000 500			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -10 mA I_C = -5 A I_B = -40 mA I_C = -10 A	(Notes 5 & 6)			-2 -3	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -10 A	(Notes 5 & 6)			-3	V
V_F	Parallel diode forward voltage	I_F = 10 A	(Notes 5 & 6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

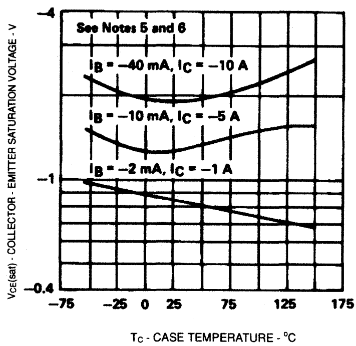
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -10 A $I_{B(on)}$ = -40 mA $I_{B(off)}$ = 40 mA		0.9		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4.2 V R_L = 3 Ω		11		µs

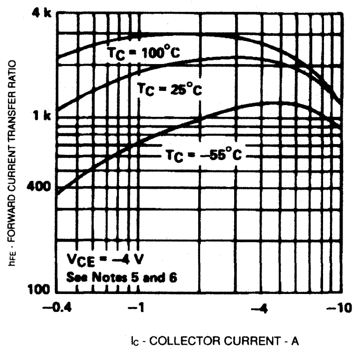
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

TYPICAL CHARACTERISTICS

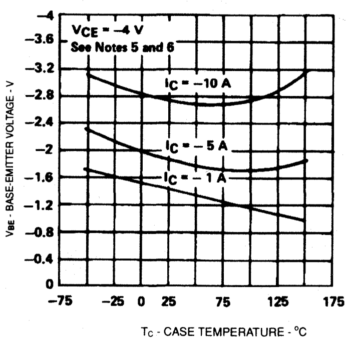
COLLECTOR - EMITTER SATURATION VOLTAGE vs CASE TEMPERATURE



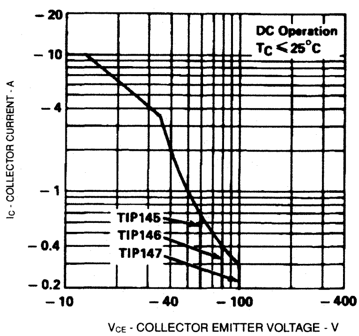
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs CASE TEMPERATURE



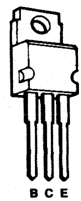
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIP150,TIP151,TIP152
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Ignition Applications**
- **80 W at 25°C Case Temperature**
- **10 A Peak Collector Current**
- **Max $V_{CE(sat)}$ of 2 A at 5 A**
- **$I_{CEX(sus)}$ 7 A at rated $V_{(BR)CEO}$**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP150	TIP151	TIP152
V_{CBO}	Collector - base voltage ($I_E = 0$)	300 V	350 V	400 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	300 V	350 V	400 V
V_{EBO}	Base - emitter voltage	8 V		
I_C	Continuous collector current	7 A		
I_{CM}	Peak collector current (Note 1)	10 A		
I_B	Continuous base current	1.5 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	80 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \le 5$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CBO}$	Collector - base breakdown voltage	I_C = 1 mA $I_E = 0$ TIP150 TIP151 TIP152	300 350 400			V
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 4)	I_C = 10 mA $I_B = 0$ TIP150 TIP151 TIP152	300 350 400			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 300 V $I_B = 0$ TIP150 V_{CE} = 350 V $I_B = 0$ TIP151 V_{CE} = 400 V $I_B = 0$ TIP152			250 250 250	µA
$I_{CEX(sus)}$	Collector - emitter sustaining current	See Functional Test Circuit in Appendices $V_{CLAMP} = V_{(BR)CEO}$	7			A
I_{EBO}	Emitter cut - off current	V_{EB} = 8 V $I_C = 0$			15	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V I_C = 2.5 A V_{CE} = 5 V I_C = 5 A (Notes 4 & 5) V_{CE} = 5 V I_C = 7 A	150 50 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 10 mA I_C = 1 A I_B = 100 mA I_C = 2 A (Notes 4 & 5) I_B = 250 mA I_C = 5 A			1.5 1.5 2	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 100 mA I_C = 2 A (Notes 4 & 5) I_B = 250 mA I_C = 5 A			2.2 2.3	V
V_F	Parallel diode forward voltage	I_F = 7 A (Notes 4 & 5)			3.5	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 5 V I_C = 0.5 A f = 1 kHz	200			

Electrical Characteristics at 25°C Case Temperature (continued)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$\lvert h_{fe} \rvert$	Small signal forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	f = 1MHz	10			
C_{ob}	Output capacitance	V_{CB} = 10 V	I_E = 0	f = 1 MHz			100	pF

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 6)		0.7		°C/W
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

Inductive - Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 5 A $I_{B(on)}$ = 250 mA R_{BE} = 47Ω $V_{(clamp)} = V_{(BR)CEO}$		3900		ns
t_{si}	Current storage time			4700		ns
t_{tv}	Voltage transition time			1200		ns
t_{ti}	Current transition time			1200		ns
t_{xo}	Cross - over time			2000		ns

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%

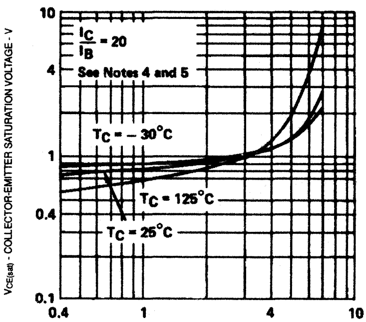
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

6: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, 32 mounting screws with bushing, and a mounting torque of 0.9 newton - meter.

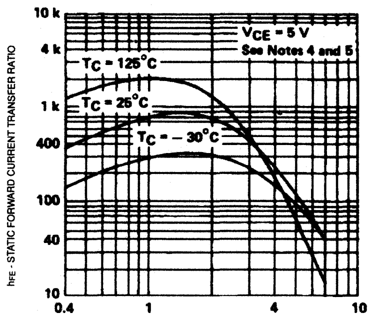
See Appendices for Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

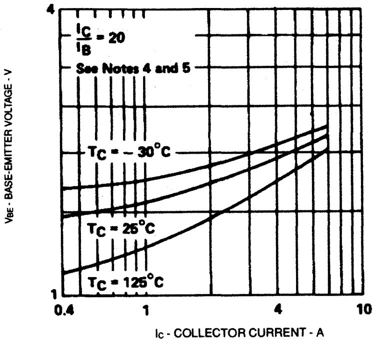
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



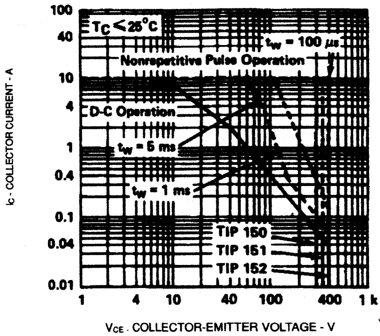
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



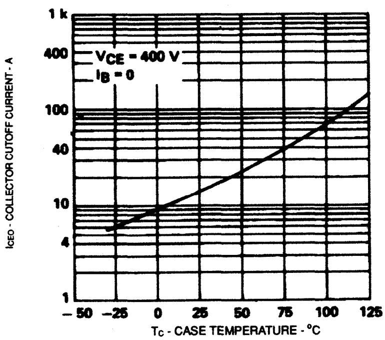
BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT



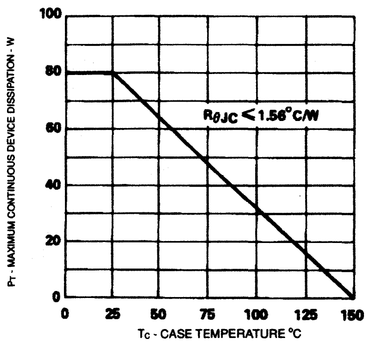
MAXIMUM FORWARD-BIAS SAFE OPERATING AREA



COLLECTOR CUTOFF CURRENT vs CASE TEMPERATURE



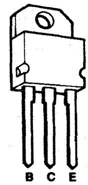
CASE TEMPERATURE DISSIPATION DERATING CURVE



TIP160,TIP161,TIP162
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Ignition Applications**
- **50 W at 100°C Case Temperature**
- **10 A Rated Continuous Collector Current**
- **Max $V_{CE(sat)}$ of 2.8 V at 6.5 A**
- **$I_{CEX(sus)}$ 7 A at rated $V_{(BR)CEO}$**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP160	TIP161	TIP162
V_{CBO}	Collector - base voltage (I_E = 0)	320 V	350 V	380 V
V_{CEO}	Collector - emitter voltage (I_B =0)	320 V	350 V	380 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	10 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_{FM}	Commutating at diode current (Note 2)	10 A		
I_B	Continuous base current	1 A		
P_{tot}	Continuous device dissipation at (or below) 100°C case temperature (Note 3)	50 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 4)	3 W		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle $\leq$ 10%
2: This applies to the total collector - terminal current when the collector is at negative potential with respect to the emitter.
3: Derate linearly to 150°C case temperature at the rate of 1 W/°C.
4: Derate linearly to 150°C free - air - temperature at the rate of 24 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 320 V I_B = 0 TIP160 V_{CE} = 350 V I_B = 0 TIP161 V_{CE} = 380 V I_B = 0 TIP162			1 1 1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			100	mA
$I_{CEX(sus)}$	Collector - emitter sustaining current	See Functional Test Circuit in Appendices V_{CLAMP} = $V_{(BR)CEO}$	7			A
h_{FE}	Forward current transfer ratio	V_{CE} = 2.2 V I_C = 4 A (Notes 5 & 6)	200			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.1 A I_C = 6.5 A I_B = 1 A I_C = 10 A (Notes 5 & 6)			2.8 2.9	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 0.1 A I_C = 6.5 A (Notes 5 & 6)			2.2	V
V_F	Parallel diode forward voltage	I_F = 10 A (Notes 5 &6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle $\leq$ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{si}	Storage time	I_C = 6.5 A	$I_{B(on)}$ = 100 mA	R_{BE} = 47Ω		10		µs
t_{fi}	Fall time	L = 7 mH	V_{CLAMP} = V_{CEO}			0.8		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

Thermal Characteristics

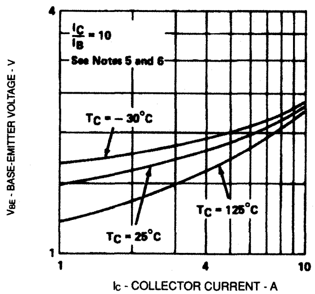
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			41.7	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 7)		0.6		°C/W
$C_{\theta C}$	Thermal capacitance of case		1.4		J/°C

NOTE: 7: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, a 0.138-32 mounting screws with bushing, and a mounting torque of 0.9 newton meter.

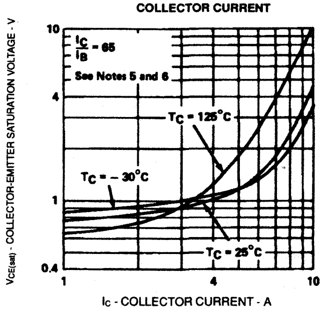
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

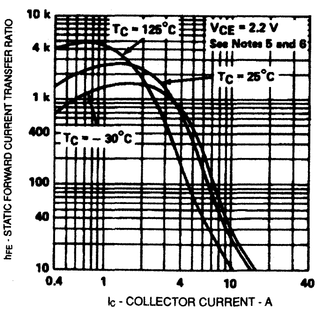
BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT



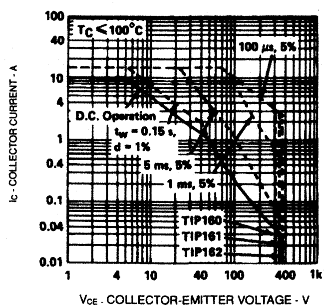
COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT



FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



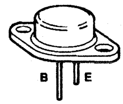
MAXIMUM FORWARD-BIAS SAFE OPERATING AREA



TIP600,TIP601,TIP602
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed forComplementary Use with TIP605, TIP606 and TIP607**
- **100 W at 25°C Case Temperature**
- **10 A Rated Collector Current**
- **Min h_{FE} of 200 at 4 V, 10 A**
- **Max $V_{CE(sat)}$ of 2.5 V at I_C = 10 A**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP600	TIP601	TIP602
V_{CBO}	Collector - base voltage (I_E = 0)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	10 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_B	Continuous base current	1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note2)	100 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	5 W		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	300°C		

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle ≤ 10%
2: Derate linearly to 200°C case temperature at the rate of 0.57 W/°C.
3: Derate linearly to 200°C free - air - temperature at the rate of 28.6 mW/°C .
4: This rating is based on the capability of the transistor to operatre safely in a circuit of: L = 20 mH, R_{BB2} = 100Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V, Energy= $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA I_B = 0 (Note 5) TIP600 TIP601 TIP602	60 80 100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V I_B = 0 TIP600 V_{CE} = 40 V I_B = 0 TIP601 V_{CE} = 50 V I_B = 0 TIP602			50 50 50	µA
I_{CBO}	Collector cut - off current	V_{CB} = 60 V I_E = 0 TIP600 V_{CB} = 80 V I_E = 0 TIP601 V_{CB} = 100 V I_E = 0 TIP602			50 50 50	µA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			8	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V I_C = 3 A V_{CE} = 4 V I_C = 10 A (Notes5 & 6)	1000 200		20000	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 6 mA I_C = 3 A I_B = 100 mA I_C = 10 A (Notes5 & 6)			2 2.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V I_C = 10 A (Notes 5 & 6)			2.8	V
V_F	Parallel diode forward voltage	I_F = 10 A (Notes 5 & 6)			3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, tw = 300 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts located within 3.2mm (0.125 inch) from the device body.

Resistive - Load - Switching Characteristics at 25°C Case Temperature

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = 8 A, $I_{B(on)}$ = 80 mA, $I_{B(off)}$ = -80 mA, $V_{BE(off)}$ = -5 V, R_L = 5 Ω		0.035		µs
t_r	Rise time			0.35		µs
t_s	Storage time			1.8		µs
t_f	Fall time			2.45		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

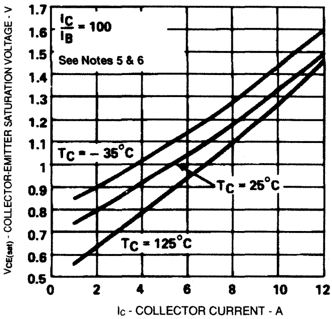
Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.75	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 7)		0.4		°C/W

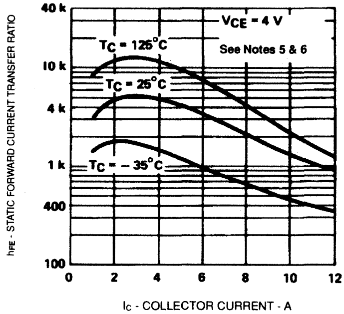
NOTES: 7: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulatror, a 0.138-32 mounting screws with bushing, and a mounting torque of 0.9 newton meter

TYPICAL CHARACTERISTICS

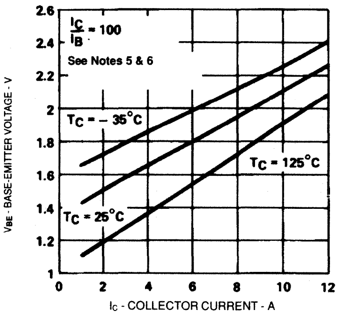
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



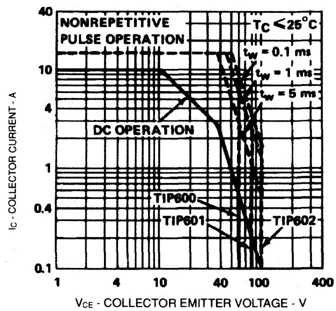
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



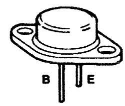
MAXIMUM FORWARD - BIAS
SAFEOPERATING AREA



TIP605, TIP606, TIP607
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed forcomplementary Use with TIP600, TIP601 and TIP602**
- **100 W at 25°C Case Temperature**
- **10 A Rated Collector Current**
- **Min h_{FE} of 200 at 4 V, 10 A**
- **Max $V_{CE(sat)}$ of 2.5 V at I_C = 10 A**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP605	TIP606	TIP607
V_{CBO}	Collector - base voltage (I_E = 0)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-10 A		
I_{CM}	Peak collector current (Note 1)	-15 A		
I_B	Continuous base current	-1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	100 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	5 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	10 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C		
T_L	Lead temperature 3.2mm from case for 10 seconds	300°C		

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle ≤ 10%
2: Derate linearly to 200°C case temperature at the rate of 0.57W/°C, refer to Dissipation Derating Curve.
3: Derate linearly to 200°C free - air - temperature at the rate of 26.6 mW/°C or refer to Dissipation Derating Curve.
4: This rating is based on the capability of the transistor to operatre safely in a circuit of:
L = 20 mH, R_{BB2} = 100Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V, Energy≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5) TIP605 TIP606 TIP607	-60 -80 -100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V I_B = 0 TIP605 V_{CE} = -40 V I_B = 0 TIP606 V_{CE} = -50 V I_B = 0 TIP607			-50 -50 -50	µA
I_{CBO}	Collector cut - off current	V_{CB} = -60 V I_E = 0 TIP605 V_{CB} = -80 V I_E = 0 TIP606 V_{CB} = -100 V I_E = 0 TIP607			-50 -50 -50	µA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-8	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -3 A V_{CE} = -4 V I_C = -16 A (Notes 5 & 6)	1000 200		20000	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -6 mA I_C = -3 A I_B = -100 mA I_C = -10 A (Notes 5 & 6)			-2 -2.5	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -10 A (Notes 5 & 6)			-2.8	V
V_F	Parallel diode forward voltage	I_F = 10 A (Notes 5 & 6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = -8 A, $I_{B(on)}$ = -80 mA, $I_{B(off)}$ = 80 mA, $V_{BE(off)}$ = 5 V, R_L = 5 Ω		0.035		μs
t_r	Rise time			0.3		μs
t_s	Storage time			0.9		μs
t_f	Fall time			1.3		μs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

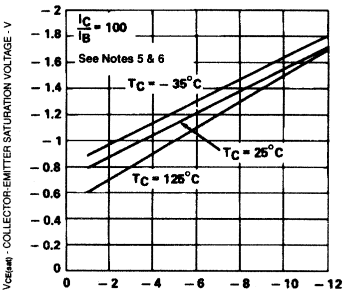
Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{θJC}$	Junction - to - cae thermal resistance			1.75	°C/W
$R_{θJA}$	Junction - to - free - air thermal resistance			35	°C/W
$R_{θCHS}$	Case - to - heat - sink thermal resistance (Note 7)		0.4		

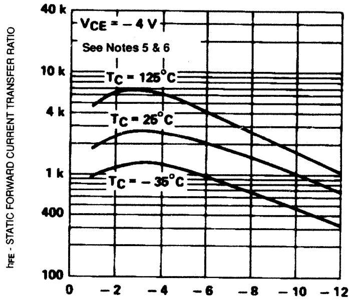
NOTE: 7. This parameter is measured using a 0.08 mm mica insulator with Dow-Corning 11 compound on both sides of the insulator, a 6-32 mounting screw with bushing, and a mounting torque of 0.9 mm Newton-meter.

TYPICAL CHARACTERISTICS

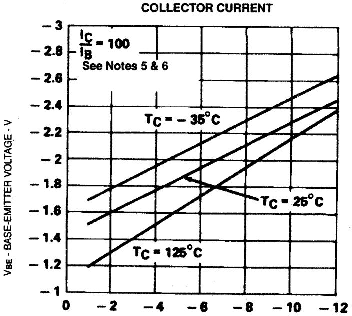
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



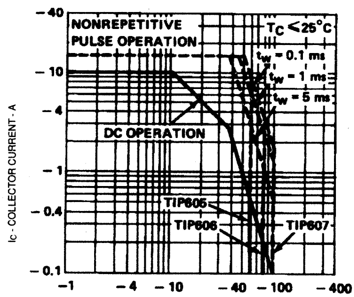
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



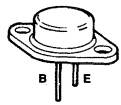
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TIP620,TIP621,TIP622
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed forcomplementary use with TIP625, TIP626 and TIP627**
- **65 W at 25°C Case Temperature**
- **5 A Rated Collector Current**
- **Min h_{FE} of 1000 at 3 V, 3 A**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP620	TIP621	TIP622
V_{CBO}	Collector - base voltage (I_E = 0)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	5 A		
I_{CM}	Peak collector current (Note 1)	8 A		
I_B	Continuous base current	0.1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	65 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	4 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	50 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C		
T_L	Lead temperature 3.2mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle $\leq$ 10%
2: Derate linearly to 200°C case temperature at the rate of 0.37W/°C.
3: Derate linearly to 200°C free - air - temperature at the rate of 23 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V. Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA I_B = 0 (Note 5) TIP620 TIP621 TIP622	60 80 100			
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V I_B = 0 TIP620 V_{CE} = 40 V I_B = 0 TIP621 V_{CE} = 50 V I_B = 0 TIP622			0.5 0.5 0.5	mA
I_{CBO}	Collector cut - off current	V_{CB} = 60 V I_E = 0 TIP620 V_{CB} = 80 V I_E = 0 TIP621 V_{CB} = 100 V I_E = 0 TIP622			0.2 0.2 0.2	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V I_C = 0.5 A (Notes 5 &6) V_{CE} = 3 V I_C = 3 A	1000 1000			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 12 mA I_C = 3 A (Notes 5 &6) I_B = 20 mA I_C = 5 A			2 4	V
V_{BE}	Base - emitter voltage	V_{CE} = 3 V I_C = 3 A (Notes 5 &6)			2.5	V
V_F	Parallel diode forward voltage	I_F = 5 A (Notes 5 &6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle $\leq$ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts located within 3.2mm from the device body.

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	$I_C = 3$ A	$I_{B(on)} = 12$ mA	$I_{B(off)} = -12$ mA		1.5		µs
t_{off}	Turn off time	$V_{BE(off)} = -5$ V	$R_L = 10\ \Omega$			8.5		µs

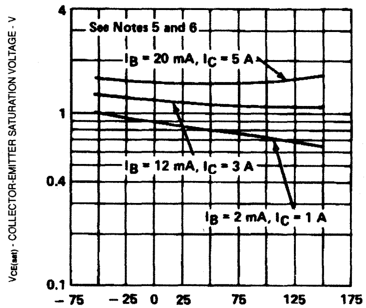
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

Thermal Characteristics

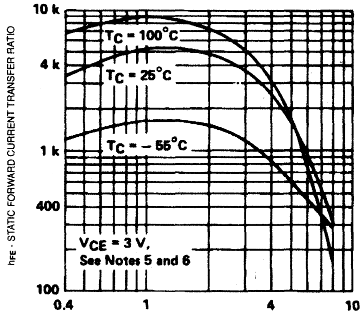
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.69	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			43.75	°C/W

TYPICAL CHARACTERISTICS

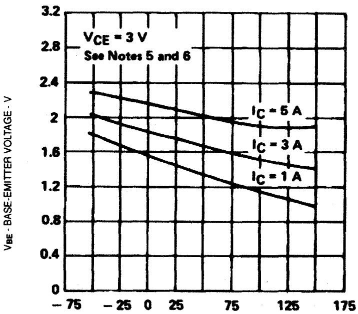
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



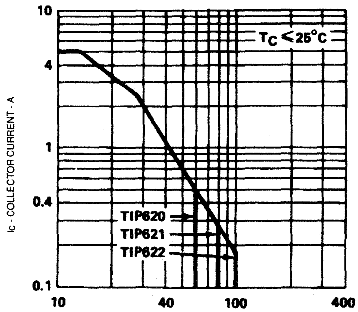
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



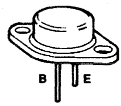
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TIP625,TIP626,TIP627
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP620, TIP621 and TIP622**
- **65 W at 25°C Case Temperature**
- **5 A Rated Collector Current**
- **Min h_{FE} of 1000 at 3 V, 3 A**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP625	TIP626	TIP627
V_{CBO}	Collector - base voltage (I_E = 0)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-5 A		
I_{CM}	Peak collector current (Note 1)	-8 A		
I_B	Continuous base current	-0.1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	65 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	4 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	50 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle $\leq$ 10%
2: Derate linearly to 200°C case temperature at the rate of 0.37W/°C.
3: Derate linearly to 200°C free - air - temperature at the rate of 23 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V. Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA I_B = 0 (Note 5) TIP625 TIP626 TIP627	-60 -80 -100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V I_B = 0 TIP625 V_{CE} = -40 V I_B = 0 TIP626 V_{CE} = -50 V I_B = 0 TIP627			-0.5 -0.5 -0.5	mA
I_{CBO}	Collector cut - off current	V_{CB} = -60 V I_E = 0 TIP625 V_{CB} = -80 V I_E = 0 TIP626 V_{CB} = -100 V I_E = 0 TIP627			-0.2 -0.2 -0.2	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V I_C = -0.5 A V_{CE} = -3 V I_C = -3 A (Notes 5 &6)	1000 1000			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -12 mA I_C = -3 A I_B = -20 mA I_C = -5 A (Notes 5 &6)			-2 -4	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -3 A (Notes 5 &6)			-2.5	V
V_F	Parallel diode forward voltage	I_F = 10 A I_B = 0 (Notes 5 &6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle $\leq$ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts located within 3.2mm from the device body.

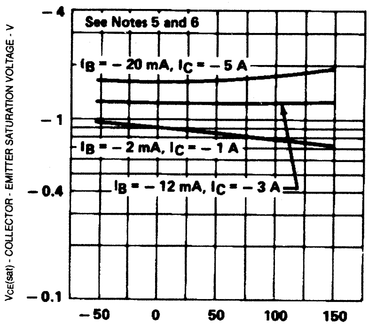
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -3 A	$I_{B(on)}$ = -12 mA	$I_{B(off)}$ = 12 mA		1.5		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 5 V	R_L = 10 Ω			8.5		µs

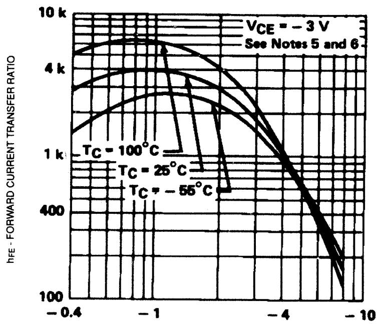
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

TYPICAL CHARACTERISTICS

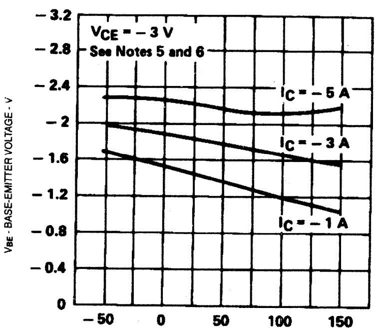
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



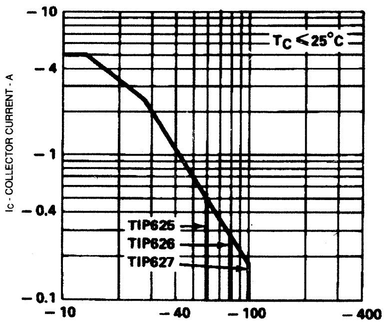
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE °C



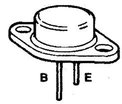
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed forComplementary Use with TIP645, TIP646 and TIP647**
- **175 W at 25°C Case Temperature**
- **10 A Rated Collector Current**
- **Min h_{FE} of 1000 at 4V, 5 A**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP640	TIP641	TIP642
V_{CBO}	Collector - base voltage (I_E = 0)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	10 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_B	Continuous base current	0.5 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	175 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	5 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	100 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \le$ 10ms, duty cycle $\le$ 10%
2: Derate linearly to 200°C case temperature at the rate of 1 W/°C.
3: Derate linearly to 200°C free - air - temperature at the rate of 28.6 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V. Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 30 mA I_B = 0 (Note 5) TIP640 TIP641 TIP642	60 80 100			
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V I_B = 0 TIP640 V_{CE} = 40 V I_B = 0 TIP641 V_{CE} = 50 V I_B = 0 TIP642			2 2 2	mA
I_{CBO}	Collector cut - off current	V_{CB} = 60 V I_E = 0 TIP640 V_{CB} = 80 V I_E = 0 TIP641 V_{CB} = 100 V I_E = 0 TIP642			1 1 1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V I_C = 5 A V_{CE} = 4 V I_C = 10 A (Notes 5 &6)	1000 500			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 10 mA I_C = 5 A I_B = 40 mA I_C = 10 A (Notes 5 &6)			2 3	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V I_C = 10 A (Notes 5 &6)			3	V
V_F	Parallel diode forward voltage	I_F = 10 A I_B = 0 (Notes 5 &6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle $\le$ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts located within 3.2mm from the device body.

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 10 A $I_{B(on)}$ = 40 mA $I_{B(off)}$ = -40 mA		0.9		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -4.2 V R_L = 3 Ω		11		µs

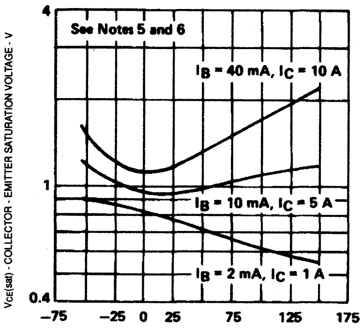
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

Thermal Characteristics

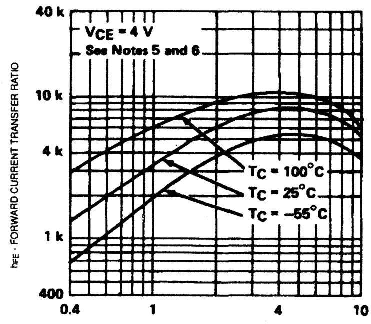
PARAMETER		MIN	TYP	MAX	UNIT
$R_{θJC}$	Junction - to - case thermal resistance			1	°C/W
$R_{θJA}$	Junction - to - free - air thermal resistance			35	°C/W

TYPICAL CHARACTERISTICS

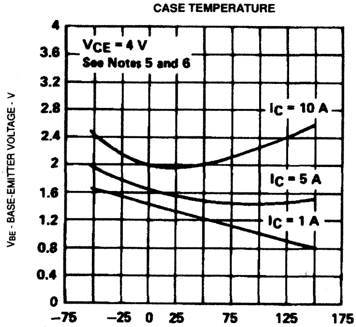
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



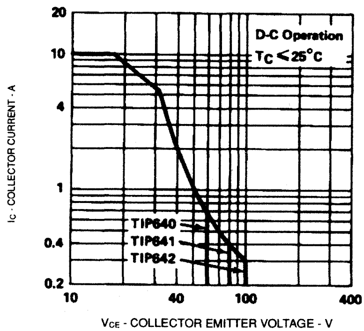
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



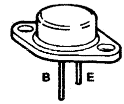
4

TIP Devices

TIP645,TIP646,TIP647
PNP DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP640, TIP641 and TIP642**
- **175 W at 25°C Case Temperature**
- **10 A Rated Collector Current**
- **Min h_{FE} of 1000 at 4V, 5 A**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP645	TIP646	TIP647
V_{CBO}	Collector - base voltage (I_E = 0)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-10 A		
I_{CM}	Peak collector current (Note 1)	-15 A		
I_B	Continuous base current	-0.5 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	175 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	5 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	100 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C		
T_L	Lead temperature 3.2mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle ≤ 10%
2: Derate linearly to 200°C case temperature at the rate of 1 W/°C.
3: Derate linearly to 200°C free - air - temperature at the rate of 28.6 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V. Energy ≈ I_C^2L/2.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -30 mA (Note 5)	I_B = 0	TIP645 TIP646 TIP647	-60 -80 -100			
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V V_{CE} = -40 V V_{CE} = -50 V	I_B = 0 I_B = 0 I_B = 0	TIP645 TIP646 TIP647			-2 -2 -2	mA
I_{CBO}	Collector cut - off current	V_{CB} = -60 V V_{CB} = -80 V V_{CB} = -100 V	I_E = 0 I_E = 0 I_E = 0	TIP645 TIP646 TIP647			-1 -1 -1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V	I_C = 0				-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V V_{CE} = -4 V	I_C = -5 A I_C = -10 A	(Notes 5 &6)	1000 500			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -10 mA I_B = -40 mA	I_C = -5 A I_C = -10 A	(Notes 5 &6)			-2 -3	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V	I_C = -10 A	(Notes 5 &6)			-3	V
V_F	Parallel diode forward voltage	I_F = 10 A		(Notes 5 &6)			3.5	V

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6 : These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts located within 3.2mm from the device body.

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -10 A $I_{B(on)}$ = -40 mA $I_{B(off)}$ = 40 mA		0.9		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4.2 V R_L = 3 Ω		11		µs

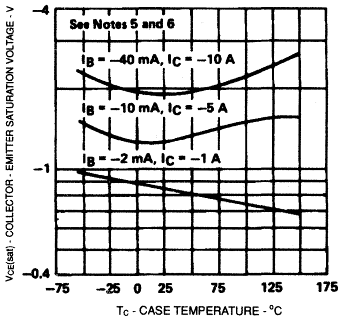
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

Thermal Characteristics

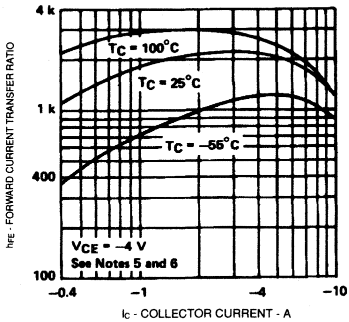
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35	°C/W

TYPICAL CHARACTERISTICS

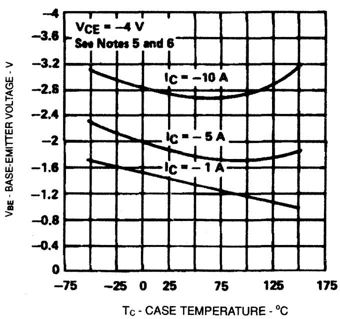
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



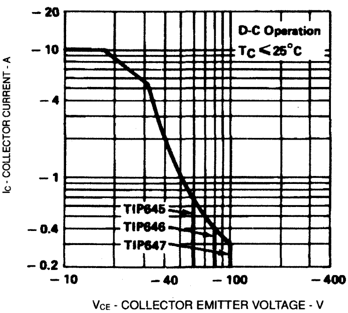
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE EMITTER VOLTAGE
vs
CASE TEMPERATURE



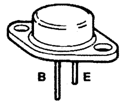
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TIP660, TIP661, TIP662
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed forAutomotive Ignition Applications**
- **10 A Rated Continuous Collector Current**
- **Max $V_{CE(sat)}$ of 2.8 V at I_C = 6.5 A**
- **High Voltage, High Energy**
- **Characterised for Operation in Ignition and Switching Regulator Applications**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP660	TIP661	TIP662
V_{CBO}	Collector - base voltage (I_E = 0)	320 V	350 V	380 V
V_{CEO}	Collector - emitter voltage (I_B =0)	320 V	350 V	380 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	10 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_{FM}	Commutating diode current (Note 2)	10 A		
I_B	Continuous base current	1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note3)	80 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 4)	8.5 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 5)	122.5 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	300°C		

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle $\leq$ 10%

2: This applies to the total collector terminal current when the collector is at negative potential with respect to the emitter.

3: Derate linearly to 200°C case temperature at the rate of 0.8 W/°C, refer to Dissipation Derating Curve.

4: Derate linearly to 200°C free - air - temperature at the rate of 31.4 mW/°C or refer to Dissipation Derating Curve.

5: This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V. Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 320 V I_B = 0 TIP660 V_{CE} = 350 V I_B = 0 TIP661 V_{CE} = 380 V I_B = 0 TIP662			1 1 1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			100	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 2.2 V I_C = 4 A (Notes 6 & 7)	200			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.1 A I_C = 6.5 A I_B = 1 A I_C = 10 A (Notes 6 & 7)			2.8 2.9	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 0.1A I_C = 6.5 A (Notes 6 & 7)			2.2	V
V_F	Parallel diode forward voltage	I_F = 10 A I_B = 0 (Notes 6 & 7)			3.5	V

NOTES: 6: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle $\leq$ 2%

7: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TIP660, TIP661, TIP662
NPN DARLINGTON - CONNECTED
SILICON POWER TRANSISTORS

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	$I_C = 6.5$ A $I_{B(on)} = 100$ mA $I_{B(off)} = -100$ mA $V_{BE(off)} = -5$ V $R_L = 5\ \Omega$		0.04		µs
t_r	Rise time			1.5		µs
t_s	Storage time			2.2		µs
t_f	Fall time			2.6		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

Thermal Characteristics

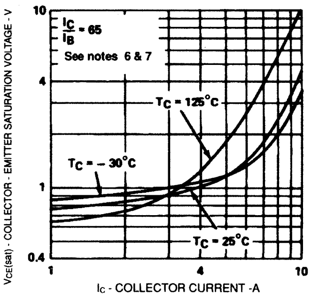
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.25	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			31.8	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 8)		0.4		°C/W

NOTES: 8: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, a 0.138-32 mounting screws with bushing, and a mounting torque of 0.9 newton meter.

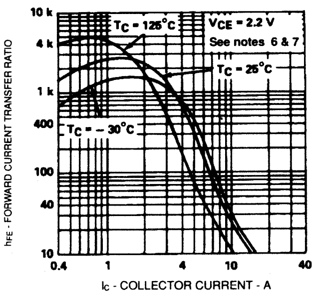
See Appendices for Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

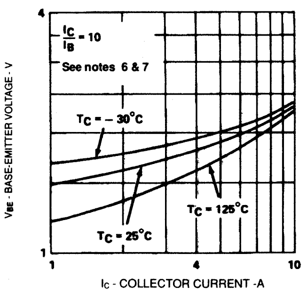
COLLECTOR - EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT



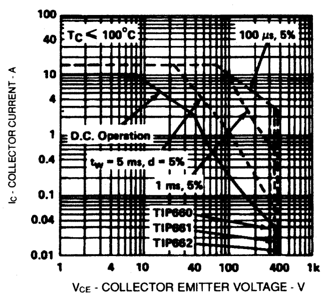
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE EMITTER VOLTAGE vs COLLECTOR CURRENT



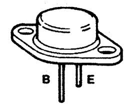
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



TIP663,TIP664,TIP665
NPN DARLINGTON - CONNECTED SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Ignition Systems, Motor Controls and Solenoid Driver Applications**
- **150 W at 100°C Case Temperature**
- **20 A Continuous Collector Current**
- **Min h_{FE} of 250 at 5 V, 10 A**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP663	TIP664	TIP665
V_{CBO}	Collector - base voltage (I_E = 0)	400 V	450 V	500 V
V_{CEO}	Collector - emitter voltage (I_B =0)	300 V	350 V	400 V
V_{EBO}	Base - emitter voltage	8 V		
I_C	Continuous collector current	20 A		
I_{CM}	Peak collector current (Note 1)	30 A		
I_B	Continuous base current	5 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note2)	150 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	5.5 W		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 200°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	300°C		

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle $\leq$ 10%
2: Derate linearly to 200°C case temperature at the rate of 1.5 W/°C.
3: Derate linearly to 200°C free - air - temperature at the rate of 31.4 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CBO}$	Collector - base breakdown voltage	I_C = 1 mA I_E = 0 (Note 4) TIP663 TIP664 TIP665	400 450 500			V
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 10 mA I_B = 0 (Note 4) TIP663 TIP664 TIP665	300 350 400			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 250 V I_B = 0 TIP663 V_{CE} = 300 V I_B = 0 TIP664 V_{CE} = 350 V I_B = 0 TIP665			250 250 250	μA
I_{CES}	Collector cu t- off current	V_{CE} = 350 V V_{BE} = 0 TIP663 V_{CE} = 400 V V_{BE} = 0 TIP664 V_{CE} = 450 V V_{BE} = 0 TIP665			250 250 250	μA
I_{EBO}	Emitter cut - off current	V_{EB} = 8 V I_C = 0			50	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V I_C = 5 A V_{CE} = 5 V I_C = 10 A (Notes 4 &5) V_{CE} = 5 V I_C = 20 A	500 250 25		10000	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 400 mA I_C = 10 A I_B = 1 A I_C = 20 A (Notes 4 &5)			1.3 3	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 1 A I_C = 10 A I_B = 1 A I_C = 20 A (Notes 4 &5)			2.1 2.5	V
V_F	Parallel diode forward voltage	I_F = 20 A I_B = 0 (Notes 4 &5)			3.5	V

Electrical Characteristics at 25°C Case Temperature (continued)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 5 V	I_C = 1 A	f = 1 kHz	1000			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 5 V	I_C = 1 A	f = 5 MHz	2			
C_{obo}	Output capacitance	V_{CB} = 10 V	I_E = 0	f = 1 MHz			250	pF

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			0.67	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			31.8	°C/W
$R_{\theta CHS}$	Case - to - heat - sink thermal resistance (Note 6)		0.4		°C/W

Inductive - Load Switching Characteristics at 25°C Case Temperature

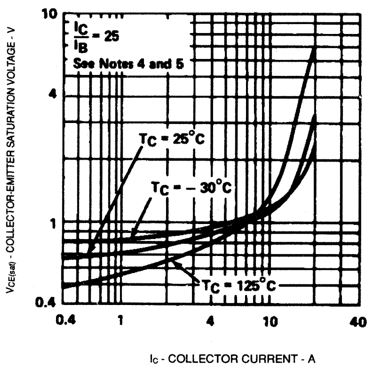
PARAMETER		TEST CONDITIONS†		MIN	TYP	MAX	UNIT
t_{si}	Storage time	I_C = 10 A	$I_{B(on)}$ = 400 mA		10.5		µs
t_{fi}	Fall time	$V_{CLAMP} = V_{(BR)CEO}$	R_{BE} = 47 Ω		1.3		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.
6: This parameter must be measured using a 0.08mm mica insulator with Dow - Corning 11 compound on both sides of the insulator, 32 mounting screws with bushing, and a mounting torque of 0.9 newton - meter.

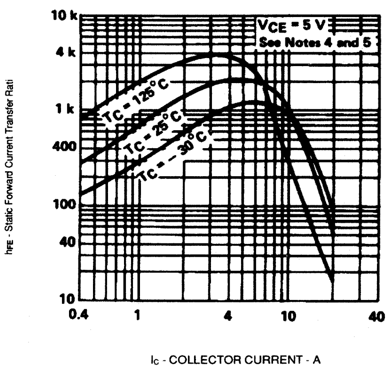
See Appendices for Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

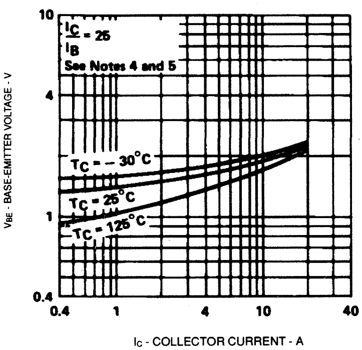


STATIC FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT

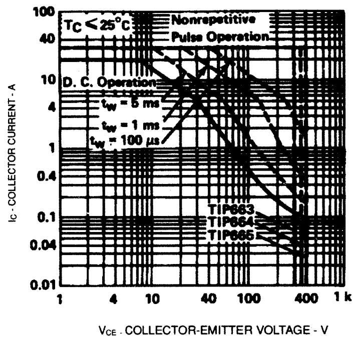


TYPICAL CHARACTERISTICS

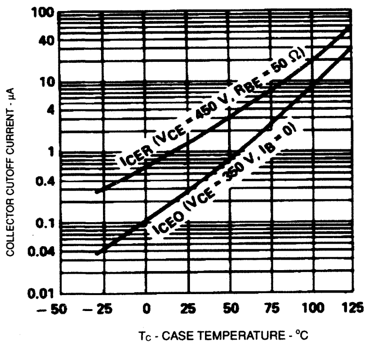
BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



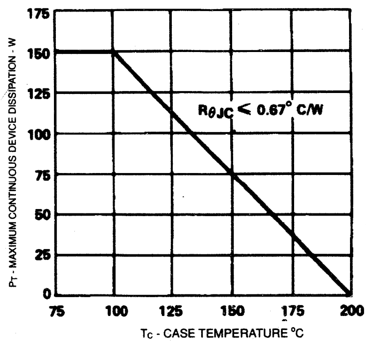
MAXIMUM FORWARD-BIAS
SAFE OPERATING AREA



TIP665
COLLECTOR CUTOFF CURRENT
vs
CASE TEMPERATURE



CASE TEMPERATURE
DISSIPATION DERATING CURVE



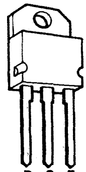
4

TIP Devices

TIP2955
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP3055**
- **90 W at 25°C Case Temperature**
- **15 A Rated Collector Current**
- **Designed for Automotive Ignition, Linear Amplifier and Power Amplifier Applications**



B C E

PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP2955
V_{CBO}	Collector - base voltage ($I_E = 0$)	-100 V
V_{CER}	Collector - emitter voltage ($R_{BE} = 100\ \Omega$)	-70 V
V_{EBO}	Base - emitter voltage	-7 V
I_C	Continuous collector current	-15 A
I_B	Continuous base current	-7 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 1)	90 W
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W
$I_C^2L/2$	Unclamped inductive load energy (Note 3)	62.5 mJ
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C

NOTES: 1: Derate linearly to 150°C case temperature at the rate of 0.72 W/°C.
2: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
3: This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = -10$ V Energy ≈ $I_C^2/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = -30 mA I_B = 0 (Note 4)	-60			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V I_B = 0			-0.7	mA
I_{CEV}	Voltage between base and emitter	V_{CE} = -100 V V_{BE} = 1.5 V			-5	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -7 V I_C = 0			-5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -4 A V_{CE} = -4 V I_C = -10 A (Notes 4 & 5)	20 5		70	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -0.4 A I_C = -4 A I_B = -3.3 A I_C = -10 A (Notes 4 & 5)			-1.1 -3	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -4 A (Notes 4 & 5)			-1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A f = 1 MHz	3			

NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts located within 3.2mm from the device body.
6: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.39	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

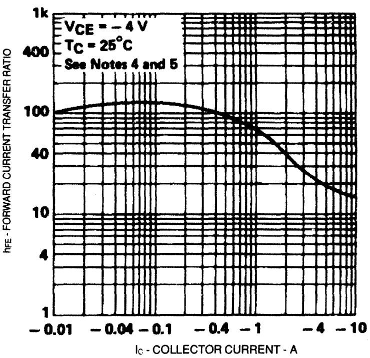
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -6 A $I_{B(on)}$ = -0.6 A $I_{B(off)}$ = 0.6 A		0.4		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4 V R_L = 5 Ω		0.7		µs

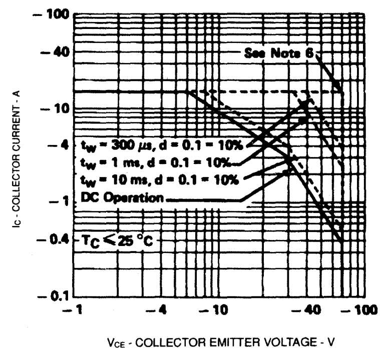
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



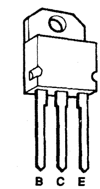
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Complementary Use with TIP2955**
- **90 W at 25°C Case Temperature**
- **15 A Rated Collector Current**
- **Designed for Automotive Ignition, Linear Amplifier and Power Amplifier Applications**



PACKAGE: S0T93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIP3055
V_{CBO}	Collector - base voltage ($I_E = 0$)	100 V
V_{CEO}	Collector - emitter voltage (Note 1)	70 V
V_{EBO}	Base - emitter voltage	7 V
I_C	Continuous collector current	15 A
I_B	Continuous base current	7 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	90 W
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C
T_L	Lead temperature 3.2mm from case for 10 seconds	260°C

NOTES: 1: This value applies when the base - emitter resistance R_{BE} = 100 Ω.
2: Derate linearly to 150°C case temperature at the rate of 0.72 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 10 V Energy ≈ $I_C^2L/2$.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 30 mA I_B = 0 (Note 5)	60			V
I_{CER}	Collector-emitter cut-off current	V_{CE} = 70 V R_{BE} = 100 Ω			1	mA
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V I_B = 0			0.7	mA
I_{CEV}	Voltage between base and emitter	V_{CE} = 100 V V_{BE} = -1.5 V			5	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 7 V I_C = 0			5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V I_C = 4 A V_{CE} = 4 V I_C = 10 A (Notes 5 & 6)	20 5		70	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.4 A I_C = 4 A I_B = 3.3 A I_C = 10 A (Notes 5 & 6)			1.1 3	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V I_C = 4 A (Notes 5 & 6)			1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 0.5 A f = 1 kHz	15			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 0.5 A f = 1 MHz	3			

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts located within 3.2mm from the device body.

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.39	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

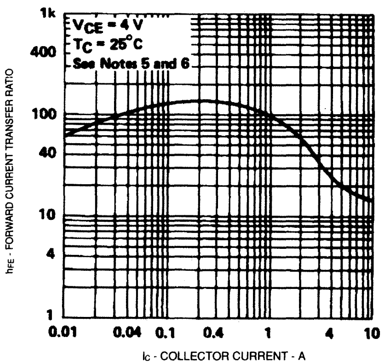
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	$I_C = 6$ A $I_{B(on)} = 0.6$ A $I_{B(off)} = -0.6$ A		0.6		μs
t_{off}	Turn off time	$V_{BE(off)} = -4$ V $R_L = 5\ \Omega$		1		μs

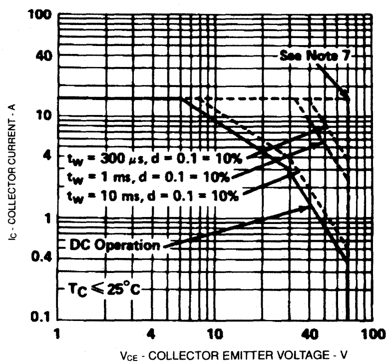
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTE: 7. This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



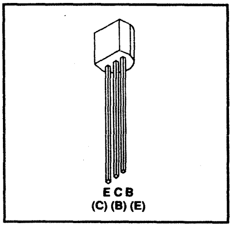
MAXIMUM FORWARD - BIAS
SAFE 2 FOPERATING AREA



TIPP31, TIPP31A, TIPP31B, TIPP31C
TIPK31, TIPK31A, TIPK31B, TIPK31C
NPN SILICON SILECT TRANSISTORS

Revised March 1990

- **20 W Pulsed Power Dissipation**
- **100V Capability**
- **2A Rated Collector Current**
- **4A Peak Collector Current**
- **Available with 2 Pinout Options**
  TIPP31X - Collector Centre Pin
  TIPK31X - Collector Side Pin



PACKAGE: TO92

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIPP31	TIPP31A	TIPP31B	TIPP31C
V_{CBO}	Collector - base voltage ($I_E = 0$)	40 V	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	2 A			
I_{CM}	Peak collector current (Note 1)	4 A			
I_B	Continuous base current	1 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	0.8 W			
P_T	Pulsed power dissipation (Note 3)	20 W			
T_j & T_{stg}	Operating junction and storage temperature range	-55°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle $\leq 10\%$
2: Derate linearly to 150°C case temperature at the rate of 6.4 mW/°C.
3: $V_{CE} = 20$ V, $I_C = 1$ A, $P_w = 10$ ms, duty cycle $\leq 2\%$

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

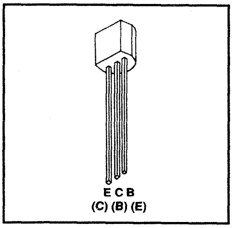
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	$I_C = 5$ mA $I_B=0$ (Note 4) TIPP31 TIPP31A TIPP31B TIPP31C	40 60 80 100			V
I_{CES}	Collector - emitter cut - off current	$V_{CE} = 40$ V $V_{BE}=0$ TIPP31 $V_{CE} = 60$ V $V_{BE}=0$ TIPP31A $V_{CE} = 80$ V $V_{BE}=0$ TIPP31B $V_{CE} = 100$ V $V_{BE}=0$ TIPP31C			0.2 0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	$V_{CE} = 30$ V $I_B=0$ TIPP31/31A $V_{CE} = 60$ V $I_B=0$ TIPP31B/31C			0.3 0.3	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = 5$ V $I_C = 0$			1.0	mA
h_{FE}	Forward current transfer ratio	$V_{CE} = 4$ V $I_C = 1$ A $V_{CE} = 4$ V $I_C = 2$ A (Notes 4 & 5)	20 10			
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = 375$ mA $I_C = 2$ A (Notes 4 & 5)			1.0	V
V_{BE}	Base - emitter voltage	$V_{CE} = 4$ V $I_C = 2$ A (Notes 4 & 5)			1.5	V
h_{fe}	Small signal forward current transfer ratio	$V_{CE} = 10$ V $I_C = 0.5$ A f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	$V_{CE} = 10$ V $I_C = 0.5$ A f = 1 MHz		3.0		

NOTES: 4: These parameters must be measured using pulse techniques tw=300µs, d.c. ≤ 2%
5: These parameters are measured with voltage sensing contacts separated from the current carrying contactsand located within 3.2 mm from device body

TIPP32,TIPP32A,TIPP32B,TIPP32C
TIPK32,TIPK32A,TIPK32B,TIPK32C
PNP SILICON SILECT TRANSISTORS

Revised March 1990

- **20 W Pulsed Power Dissipation**
- **100V Capability**
- **2A Rated Collector Current**
- **4A Peak Collector Current**
- **Available with 2 Pinout Options:**
  TIPP32X - Collector Centre Pin
  TIPK32X - Collector Side Pin



PACKAGE: TO92

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIPP32	TIPP32A	TIPP32B	TIPP32C
V_{CBO}	Collector - base voltage (I_E = 0)	-40 V	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-2 A			
I_{CM}	Peak collector current (Note 1)	-4 A			
I_B	Continuous base current	-1 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	0.8 W			
P_T	Pulsed power dissipation (Note 3)	20 W			
T_j & T_{stg}	Operating junction and storage temperature range	-55°C to + 150°C			
T_L	Lead temperature 3.2mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \le 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 6.4 mW/°C.
3: V_{CE} = 20 V, I_C = 1 A, Pw = 10 ms, duty cycle ≤ 2%
4: These parameters must be measured using pulse techniques . Tw= 300 μs, d.c. ≤ 2%
5: These parameters are measured with voltage sensing contacts separated from the current carrying contactsand located within3.2mm from device body

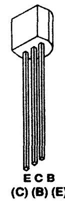
Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -5 mA (Note 4)	I_B = 0	TIPP32 TIPP32A TIPP32B TIPP32C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -40 V V_{CE} = -60 V V_{CE} = -80 V V_{CE} = -100 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	TIPP32 TIPP32A TIPP32B TIPP32C			-0.2 -0.2 -0.2 -0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V V_{CE} = -60 V	I_B = 0 I_B = 0	TIPP32/32A TIPP32B/32C			-0.3 -0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				-1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V V_{CE} = -4 V	I_C = -1 A I_C = -2 A	(Notes 4 &5)	20 10			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -375 mA	I_C = -2 A	(Notes 4 & 5)			-1.0	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V	I_C = -2 A	(Notes 4 & 5)			-1.5	V

TIPP110,TIPP111,TIPP112
TIPK110,TIPK111,TIPK112
NPN DARLINGTON-CONNECTED TRANSISTORS

Revised March 1990

- **20 W Pulsed Power Dissipation**
- **100V Capability**
- **2A Rated Collector Current**
- **4A Peak Collector Current**
- **Available with 2 Pinout Options:**
  TIPP11X - Collector Centre Pin
  TIPK11X - Collector Side Pin



PACKAGE: TO92

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIPP110	TIPP111	TIPP112
V_{CBO}	Collector - base voltage (I_E = 0)	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	2 A		
I_{CM}	Peak collector current (Note 1)	4 A		
I_B	Continuous base current	50 mA		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	0.8 W		
P_T	Pulsed power dissipation (Note 3)	20 W		
T_j & T_{stg}	Operating junction and storage temperature range	-55°C to + 150°C		
T_L	Lead temperature 3.2mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: V_{CE} = 20 V, I_C = 1 A, Pw = 10 ms, duty cycle ≤ 2%
4: These parameters must be measured using pulse techniques . Tw = 300 µs, d.c. ≤ 2%
5: These parameters are measured with voltage sensing contacts separated from the current carrying contactsand located within3.2mm from device body

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = 10 mA I_B=0 (Note 4) TIPP110 TIPP111 TIPP112	60 80 100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = 30 V V_{BE}=0 TIPP110 V_{CE} = 40 V V_{BE}=0 TIPP111 V_{CE} = 50 V V_{BE}=0 TIPP112			2.0 2.0 2.0 2.0	mA
I_{CBO}	Collector -base cut - off current	V_{CE} = 60 V I_B=0 TIPP110 V_{CE} = 80 V I_B=0 TIPP111 V_{CE}= 100V I_B=0 TIPP112			1.0 1.0	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			2.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V I_C = 1 A V_{CE} = 4 V I_C = 2 A (Notes 4 & 5)	1000 500			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 8 mA I_C = 2 A (Notes 4 & 5)			2.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V I_C = 2 A (Notes 4 & 5)			2.8	V
V_F	Parallel diode forward voltage	I_F = $-I_C$ = 4A I_B = 0 (Notes 4 & 5)			3.5	V

PNP DARLINGTON-CONNECTED TRANSISTORS

Revised March 1990

- **20 W Pulsed Power Dissipation**
- **100V Capability**
- **2A Rated Collector Current**
- **4A Peak Collector Current**
- **Available with 2 Pinout Options:**
  TIPP11X - Collector Centre Pin
  TIPK11X - Collector Side Pin

E C B
(C) (B) (E)

PACKAGE: TO92

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		TIPP115	TIPP116	TIPP117
V_{CBO}	Collector - base voltage (I_E = 0)	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V		
I_C	Continuous collector current	-2 A		
I_{CM}	Peak collector current (Note 1)	-4 A		
I_B	Continuous base current	-50 mA		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	0.8 W		
P_T	Pulsed power dissipation (Note 3)	20 W		
T_j & T_{stg}	Operating junction and storage temperature range	-55°C to + 150°C		
T_L	Lead temperature 3.2mm from case for 10 seconds	260°C		

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: V_{CE} = 20 V, I_C = 1 A, Pw = 10 ms, duty cycle ≤ 2%
4: These parameters must be measured using pulse techniques . Tw = 300 μs, d.c. ≤ 2%
5: These parameters are measured with voltage sensing contacts separated from the current carrying contactsand located within3.2mm from device body

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

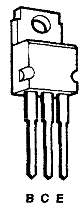
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	I_C = -10 mA I_B=0 (Note 4)	TIPP115 TIPP116 TIPP117	-60 -80 -100			V
I_{CEO}	Collector - emitter cut - off current	V_{CE} = -30 V V_{BE}=0 V_{CE} = -40 V V_{BE}=0 V_{CE} = -50 V V_{BE}=0	TIPP115 TIPP116 TIPP117			-2.0 -2.0 -2.0 -2.0	mA
I_{CBO}	Collector -base cut - off current	V_{CE} = -60 V I_E= 0 V_{CE} = -80 V I_E= 0 V_{CE}= -100V I_E= 0	TIPP115 TIPP116 TIPP117			-1.0 -1.0	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0				-2.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -1 A V_{CE} = -4 V I_C = -2 A	(Notes-4 &5)	1000 500			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -8 mA I_C = -2 A	(Notes 4 & 5)			-2.5	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -2 A	(Notes 4 & 5)			-2.8	V
V_F	Parallel diode forward voltage	I_F = -I_C = -5A I_B = 0	(Notes 4 & 5)			3.5	V

5

BD239, BD239A, BD239B, BD239C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **30 W at 25°C Case Temperature**
- **2 A Continuous Collector Current**
- **4A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD239	BD239A	BD239B	BD239C
V_{CER}	Collector - emitter voltage (R_{BE}=100Ω)	55 V	70 V	90 V	115 V
V_{CEO}	Collector - emitter voltage @ 30 mA	45 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	2 A			
I_{CM}	Peak collector current (Note 1)	4 A			
I_B	Continuous base current	0.6 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	30 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ms, duty cycle $\leq 10\%$.
2: Derate linearly to 150°C case temperature at the rate of 0.24 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C=30 mA	I_B=0	BD239 BD239A BD239B BD239C	45 60 80 100			V
I_{CES}	Collector cut - off current	V_{CE} = 55 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 115 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD239 BD239A BD239B BD239C			0.2 0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	BD239/239A BD239B/239C			0.3 0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 0.2 A I_C = 1.0 A	(Notes 5 & 6)	40 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 200 mA	I_C = 1.0 A	(Notes 5 & 6)			0.7	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 1 A	(Notes 5 & 6)			1.3	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.2 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.2 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			4.17	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

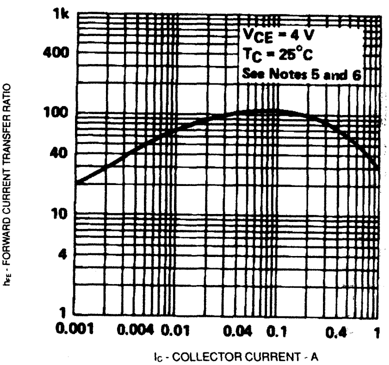
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 200 mA $I_{B(on)}$ = 20 mA $I_{B(off)}$ = -20 mA		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -3.4 V R_L = 150 Ω		0.8		µs

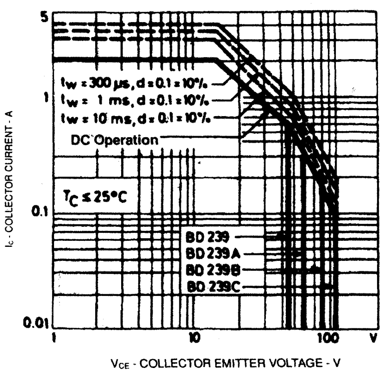
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



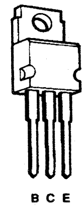
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



BD239D, BD239E, BD239F
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **30 W at 25°C Case Temperature**
- **2 A Continuous Collector Current**
- **4A Peak CollectorCurrent**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD239D	BD239E	BD239F
V_{CER}	Collector - emitter voltage (R_{BE} = 100 Ω)	160 V	180 V	200 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	120 V	140 V	160 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	2 A		
I_{CM}	Peak collector current (Note 1)	4 A		
I_B	Continuous base current	0.6 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	30 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to +150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C		

NOTES: 1: This value applies for $t_w \leq$ 0.3ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.24 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 5)	I_C = 30 mA, I_B = 0: BD239D BD239E BD239F	120 140 160			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 160 V, V_{BE} = 0, BD239D V_{CE} = 180 V, V_{BE} = 0, BD239E V_{CE} = 200 V, V_{BE} = 0, BD239F			0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = 90 V, I_B = 0			0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V, I_C = 0			1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V, I_C = 0.2 A (Notes 5 & 6) V_{CE} = 4 V, I_C = 1.0 A	40 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 200 mA, I_C = 1.0 A (Notes 5 & 6)			0.7	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V, I_C = 1 A (Notes 5 & 6)			1.3	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V, I_C = 0.2 A, f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V, I_C = 0.2 A, f = 1 MHz	3			

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			4.17	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

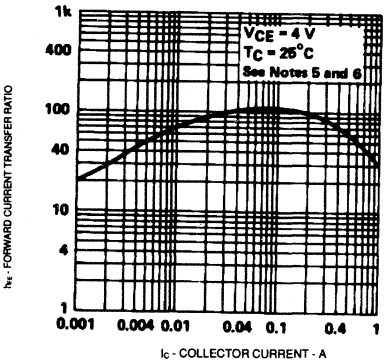
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

	PARAMETER	TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 200 mA $I_{B(on)}$ = 20 mA $I_{B(off)}$ = -20 mA		0.3		µs
t_{off}	Turn on time	$V_{BE(off)}$ = -3.4 V R_L = 150 Ω		0.8		µs

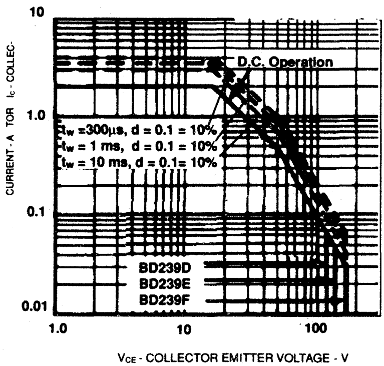
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



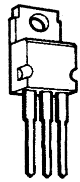
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BD240, BD240A, BD240B, BD240C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **30 W at 25°C Case Temperature**
- **2 A Continuous Collector Current**
- **4 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD240	BD240A	BD240B	BD240C
V_{CER}	Collector - emitter voltage (R_{BE}=100Ω)	-55 V	-70 V	-90 V	-115 V
V_{CEO}	Collector - emitter voltage @ -30 mA	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-2 A			
I_{CM}	Peak collector current (Note 1)	-4 A			
I_B	Continuous base current	-0.6 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	30 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leqslant 0.3$ ms, duty cycle $\leqslant 10\%$.
2: Derate linearly to 150°C case temperature at the rate of 0.24 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C= -30mA I_B=0 BD240 BD240A BD240B BD240C	-45 -60 -80 -100			V
I_{CES}	Collector cut - off current	V_{CE} = -55 V V_{BE} = 0 BD240 V_{CE} = -70 V V_{BE} = 0 BD240A V_{CE} = -90 V V_{BE} = 0 BD240B V_{CE} = -115 V V_{BE} = 0 BD240C			-0.2 -0.2 -0.2 -0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 BD240/240A V_{CE} = -60 V I_B = 0 BD240B/240C			-0.3 -0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = - 5 V I_C = 0			-1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = - 4 V I_C = -0.2 A (Notes 5 & 6) V_{CE} = - 4 V I_C = -1.0 A	40 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -200 mA I_C = -1 A (Notes 5 & 6)			-0.7	V
V_{BE}	Base - emitter voltage	V_{CE} = - 4 V I_C = - 1 A (Notes 5 & 6)			-1.3	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = - 10 V I_C = -0.2 A f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = - 10 V I_C = -0.2 A f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			4.17	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

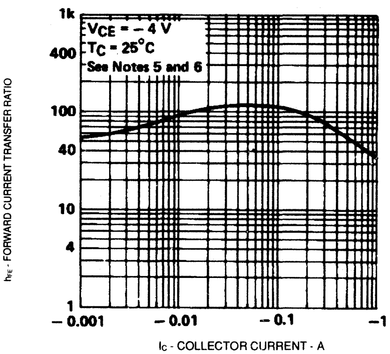
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -200 mA $I_{B(on)}$ = -20 mA $I_{B(off)}$ = 20 mA		0.2		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 3.4 V R_L = 150 Ω		0.4		µs

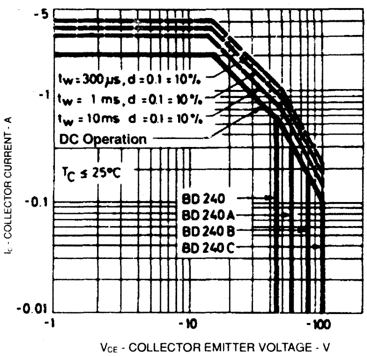
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



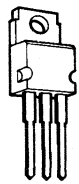
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BD241, BD241A, BD241B, BD241C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD241	BD241A	BD241B	BD241C
V_{CER}	Collector -emitter voltage (R_{BE}=100Ω)	55 V	70 V	90 V	115 V
V_{CEO}	Collector - emitter voltage @ 30 mA	45 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	3 A			
I_{CM}	Peak collector current (Note 1)	5 A			
I_B	Continuous base current	1 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C=30mA	I_B=0	BD241 BD241A BD241B BD241C	45 60 80 100			V
I_{CES}	Collector cut - off current	V_{CE} = 55 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 115 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD241 BD241A BD241B BD241C			0.2 0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	BD241/241A BD241B/241C			0.3 0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 1 A I_C = 3 A	(Notes 5 & 6)	25 10			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.6 A	I_C = 3 A	(Notes 5 & 6)			1.2	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 3 A	(Notes 5 & 6)			1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz	3			

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			3.125	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

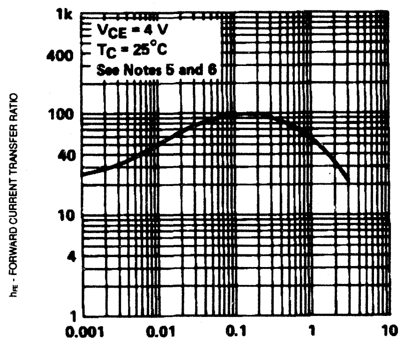
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A $I_{B(on)}$ = 100 mA $I_{B(off)}$ = -100 mA		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -3.7 V R_L = 20 Ω		1		µs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

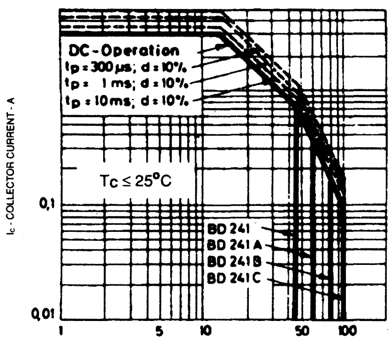
TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



I_C - COLLECTOR CURRENT - A

MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA

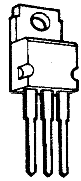


V_{CE} - COLLECTOR EMITTER VOLTAGE - V

BD241D, BD241E, BD241F
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5A Peak CollectorCurrent**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD241D	BD241E	BD241F
V_{CER}	Collector - emitter voltage (R_{BE} = 100 Ω)	160 V	180 V	200 V
V_{CEO}	Collector - emitter voltage (I_B =0)	120 V	140 V	160 V
V_{EBO}	Base - emitter voltage	5 V		
I_C	Continuous collector current	3 A		
I_{CM}	Peak collector current (Note 1)	5 A		
I_B	Continuous base current	1 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W		
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W		
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ		
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to +150°C		
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C		

NOTES: 1: This value applies for $t_w \leqslant$ 0.3 ms, duty cycle $\leqslant$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 5)	I_C = 30 mA I_B = 0 BD241D BD241E BD241F	120 140 160			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 160 V V_{BE} = 0 BD241D V_{CE} = 180 V V_{BE} = 0 BD241E V_{CE} = 200 V V_{BE} = 0 BD241F			0.2 0.2 0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = 90 V I_B = 0			0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V I_C = 1 A V_{CE} = 4 V I_C = 3 A (Notes 5 & 6)	25 5			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.75 mA I_C = 3 A (Notes 5 & 6)			2.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V I_C = 3 A (Notes 5 & 6)			1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 0.5 A f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 0.5 A f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			3.125	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

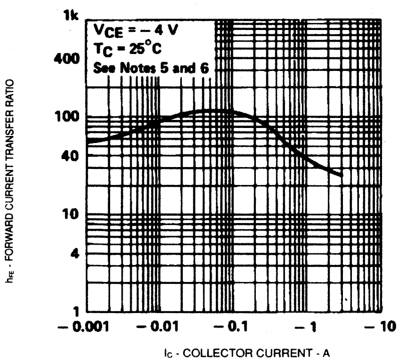
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A $I_{B(on)}$ = 100 mA $I_{B(off)}$ = -100 mA		0.3		µs
t_{off}	Turn on time	$V_{BE(off)}$ = -3.7 V R_L = 20 Ω		1		µs

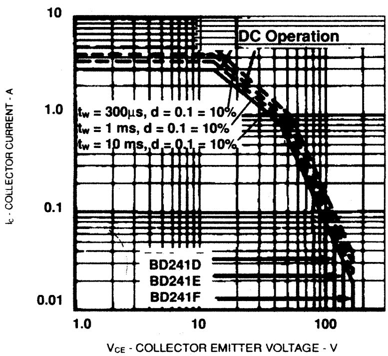
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



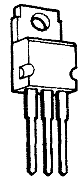
5

BD, BDW, BDX, BU, BUV, BUX, BUY Devices

BD242, BD242A, BD242B, BD242C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD242	BD242A	BD242B	BD242C
V_{CER}	Collector - emitter voltage (R_{BE}=100Ω)	-55 V	-70 V	-90 V	-115 V
V_{CEO}	Collector - emitter voltage @ -30 mA	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-3 A			
I_{CM}	Peak collector current (Note 1)	-5 A			
I_B	Continuous base current	-1 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	32 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C=-30mA	I_B=0	BD242 BD242A BD242B BD242C	-45 -60 -80 -100			V
I_{CES}	Collector cut - off current	V_{CE} = -55 V V_{CE} = -70 V V_{CE} = -90 V V_{CE} = -115 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD242 BD242A BD242B BD242C			-0.2 -0.2 -0.2 -0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V V_{CE} = -60 V	I_B = 0 I_B = 0	BD242/242A BD242B/242C			-0.3 -0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = - 5 V	I_C = 0				-1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = - 4 V V_{CE} = - 4 V	I_C = -1 A I_C = -3 A	(Notes 5 & 6)	25 10			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -0.6 A	I_C = -3 A	(Notes 5 & 6)			-1.2	V
V_{BE}	Base - emitter voltage	V_{CE} = - 4 V	I_C = - 3 A	(Notes 5 & 6)			-1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = - 10 V	I_C = -0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = - 10 V	I_C = -0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			3.125	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

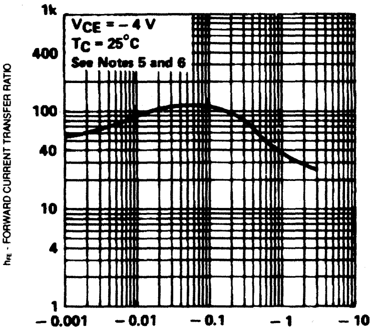
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -1A $I_{B(on)}$ = -100 mA $I_{B(off)}$ = 100 mA		0.2		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 3.7 V R_L = 20 Ω		0.3		µs

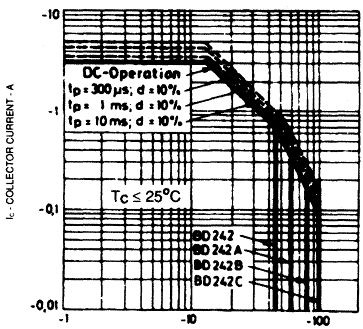
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



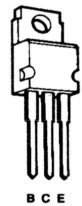
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BD243, BD243A, BD243B, BD243C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **65 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **10A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD243	BD243A	BD243B	BD243C
V_{CER}	Collector -emitter voltage (R_{BE}=100Ω)	55 V	70 V	90 V	115 V
V_{CEO}	Collector - emitter voltage @ 30 mA	45 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	6 A			
I_{CM}	Peak collector current (Note 1)	10 A			
I_B	Continuous base current	3 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	65 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.52 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C=30mA	I_B=0	BD243 BD243A BD243B BD243C	45 60 80 100			V
I_{CES}	Collector cut - off current	V_{CE} = 55 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 115 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD243 BD243A BD243B BD243C			0.4 0.4 0.4 0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	BD243/243A BD243B/243C			0.7 0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 0.3 A I_C = 3 A	(Notes 5 & 6)	30 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 1.0 A	I_C = 6 A	(Notes 5 & 6)			1.5	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 6 A	(Notes 5 & 6)			2	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 KHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.92	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

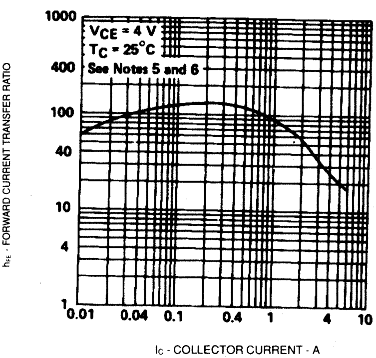
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A $I_{B(on)}$ = 0.1A $I_{B(off)}$ = -0.1A		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -3.7 V R_L = 20 Ω		1		µs

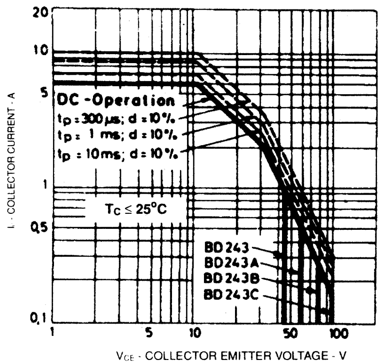
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



5

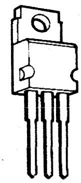
BD, BDW, BDX, BU, BUV, BUX, BUY Devices

TEXAS INSTRUMENTS

BD244, BD244A, BD244B, BD244C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **65 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD244	BD244A	BD244B	BD244C
V_{CER}	Collector - emitter voltage (R_{BE}=100Ω)	-55 V	-70 V	-90 V	-115 V
V_{CEO}	Collector - emitter voltage @ -30 mA	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-6 A			
I_{CM}	Peak collector current (Note 1)	-10 A			
I_B	Continuous base current	-3 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	65 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.52 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C= -30mA	I_B=0	BD244 BD244A BD244B BD244C	-45 -60 -80 -100			V
I_{CES}	Collector cut - off current	V_{CE} = -55 V V_{CE} = -70 V V_{CE} = -90 V V_{CE} = -115 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD244 BD244A BD244B BD244C			-0.4 -0.4 -0.4 -0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V V_{CE} = -60 V	I_B = 0 I_B = 0	BD244/244A BD244B/244C			-0.7 -0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = - 5 V	I_C = 0				-1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = - 4 V V_{CE} = - 4 V	I_C = -0.3 A I_C = -3 A	(Notes 5 & 6)	30 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -1.0 A	I_C = -6 A	(Notes 5 & 6)			-1.5	V
V_{BE}	Base - emitter voltage	V_{CE} = - 4 V	I_C = - 6 A	(Notes 5 & 6)			-2	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = - 10 V	I_C = -0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = - 10 V	I_C = -0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.92	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

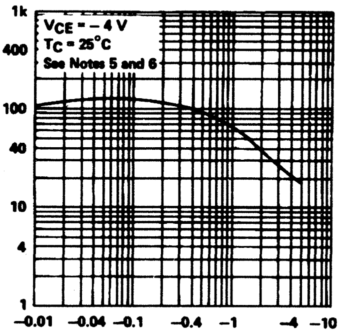
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -1A $I_{B(on)}$ = -0.1A $I_{B(off)}$ = 0.1A		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 3.7 V R_L = 20 Ω		1		µs

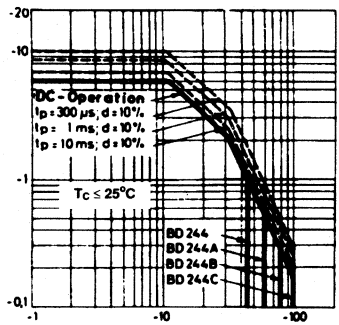
L† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



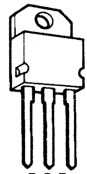
5

BD, BDW, BDX, BU, BUV, BUX, BUY Devices

BD245, BD245A, BD245B, BD245C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **80 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD245	BD245A	BD245B	BD245C
V_{CER}	Collector - emitter voltage (R_{BE} = 100Ω)	55 V	70 V	90 V	115 V
V_{CEO}	Collector - emitter voltage @ 30 mA	45 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	10 A			
I_{CM}	Peak collector current (Note 1)	15 A			
I_B	Continuous base current	3 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	80 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.0 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C=30mA	I_B=0	BD245 BD245A BD245B BD245C	45 60 80 100			V
I_{CES}	Collector cut - off current	V_{CE} = 55 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 115 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD245 BD245A BD245B BD245C			0.4 0.4 0.4 0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	BD245/245A BD245B/245C			0.7 0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V V_{CE} = 4V	I_C = 1 A I_C = 3 A I_C = 10A	(Notes 5 & 6)	40 20 4			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.3 A I_B= 2.5 A	I_C = 3 A I_C = 10A	(Notes 5 & 6)			1 4	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V V_{CE}= 4V	I_C = 3 A I_C = 10A	(Notes 5 & 6)			1.6 3	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			42.0	°C/W

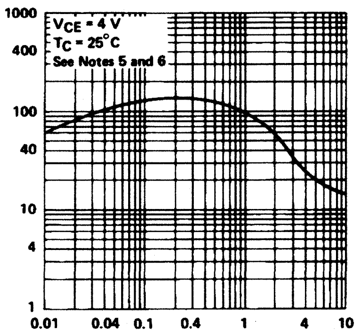
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A $I_{B(on)}$ = 0.1A $I_{B(off)}$ = -0.1A		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -3.7 V R_L = 20 Ω		1		µs

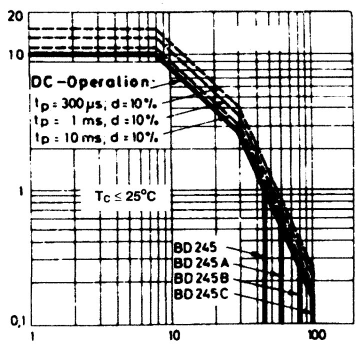
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



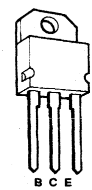
5

BD, BDW, BDX, BU, BUV, BUX, BUY Devices

BD246, BD246A, BD246B, BD246C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **80 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD246	BD246A	BD246B	BD246C
V_{CER}	Collector - emitter voltage (R_{BE}=100Ω)	-55 V	-70 V	-90 V	-115 V
V_{CEO}	Collector - emitter voltage @ -30 mA	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-10 A			
I_{CM}	Peak collector current (Note 1)	-15 A			
I_B	Continuous base current	-3 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	80 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.0 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	62.5 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C= -30mA	I_B=0	BD246 BD246A BD246B BD246C	-45 -60 -80 -100			V
I_{CES}	Collector cut - off current	V_{CE} = -55 V V_{CE} = -70 V V_{CE} = -90 V V_{CE} = -115 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD246 BD246A BD246B BD246C			-0.4 -0.4 -0.4 -0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V V_{CE} = -60 V	I_B = 0 I_B = 0	BD246/246A BD246B/246C			-0.7 -0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V	I_C = 0				-1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V V_{CE} = -4 V V_{CE} = -4 V	I_C = -1 A I_C = -3 A I_C =-10 A	(Notes 5 & 6)	40 20 4			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -0.3 A I_B = -2.5A	I_C = -3 A I_C= -10 A	(Notes 5 & 6)			-1 -4	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V V_{CE} = -4V	I_C = -3 A I_C= -10 A	(Notes 5 & 6)			-1.6 -3	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -0.5 A	f = 1 KHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			42.0	°C/W

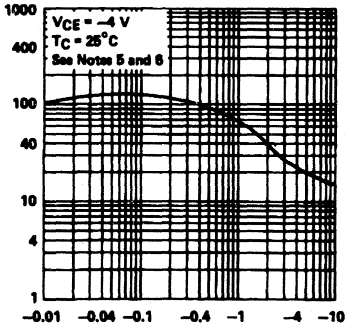
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -1A $I_{B(on)}$ = -0.1A $I_{B(off)}$ = 0.1A		0.2		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 3.7 V R_L = 20 Ω		0.8		µs

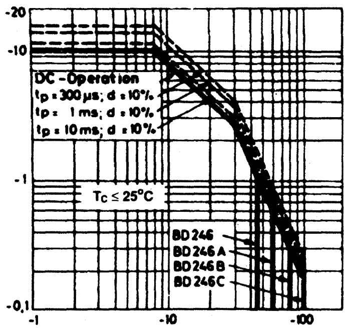
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

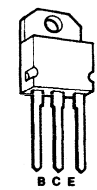


MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



Revised March 1990

- **125 W at 25°C Case Temperature**
- **25 A Continuous Collector Current**
- **40A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD249	BD249A	BD249B	BD249C
V_{CER}	Collector - emitter voltage (R_{BE}=100Ω)	55 V	70 V	90 V	115 V
V_{CEO}	Collector - emitter voltage @ 30 mA	45 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	25 A			
I_{CM}	Peak collector current (Note 1)	40 A			
I_B	Continuous base current	5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	125 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.0 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	90 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 1.0 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C=30mA	I_B=0	BD249 BD249A BD249B BD249C	45 60 80 100			V
I_{CES}	Collector cut - off current	V_{CE} = 55 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 115 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD249 BD249A BD249B BD249C			0.7 0.7 0.7 0.7	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	BD249/249A BD249B/249C			1 1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V V_{CE} = 4 V	I_C = 1.5 A I_C = 15 A I_C= 25 A	(Notes 5 & 6)	25 10 5			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 1.5 A I_B= 5.0 A	I_C = 15 A I_C= 25 A	(Notes 5 & 6)			1.8 4.0	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V V_{CE} = 4 V	I_C = 15 A I_C= 25 A	(Notes 5 & 6)			2 4	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 1 A	f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 1 A	f = 1 MHz	3			

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			42	°C/W

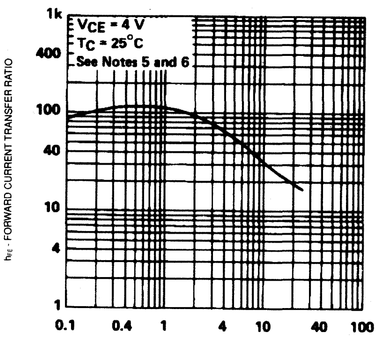
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

	PARAMETER	TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 5A $I_{B(on)}$ = 0.5A $I_{B(off)}$ = -0.5A		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -5 V R_L = 5 Ω		0.9		µs

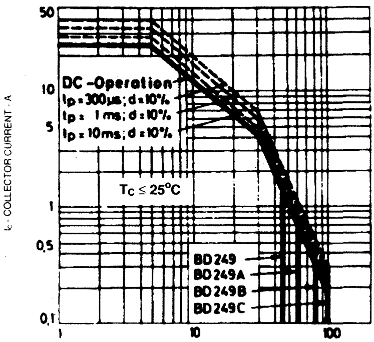
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

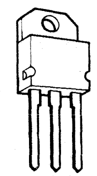


MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



Revised March 1990

- **125 W at 25°C Case Temperature**
- **25 A Continuous Collector Current**
- **40A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD250	BD250A	BD250B	BD250C
V_{CER}	Collector - emitter voltage (R_{BE}=100Ω)	-55 V	-70 V	-90 V	-115 V
V_{CEO}	Collector - emitter voltage @ -30 mA	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-25 A			
I_{CM}	Peak collector current (Note 1)	-40 A			
I_B	Continuous base current	-5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	125 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.0 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	90 mJ			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 1.0 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector -emitter sustaining voltage (Note 5)	I_C= -30mA I_B=0 BD250 BD250A BD250B BD250C	-45 -60 -80 -100			V
I_{CES}	Collector cut - off current	V_{CE} = -55 V V_{BE} = 0 BD250 V_{CE} = -70 V V_{BE} = 0 BD250A V_{CE} = -90 V V_{BE} = 0 BD250B V_{CE} = -115 V V_{BE} = 0 BD250C			-0.7 -0.7 -0.7 -0.7	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 BD250/250A V_{CE} = -60 V I_B = 0 BD250B/250C			-1 -1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -1.5 A V_{CE} = -4 V I_C = -15 A (Notes 5 & 6) V_{CE} = -4 V I_C = -25 A	25 10 5			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -1.5 A I_C = - 15 A I_B = -5.0 A I_C = - 25A (Notes 5 & 6)			-1.8 -4.0	V
V_{BE}	Base - emitter voltage	V_{CE} = - 4 V I_C = - 15 A V_{CE} = - 4 V I_C= - 25A (Notes 5 & 6)			-2 -4	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = - 10 V I_C = - 1 A f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = - 10 V I_C = - 1 A f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			42.0	°C/W

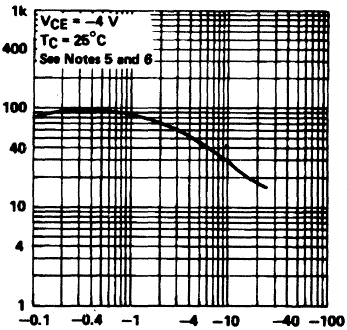
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -5A $I_{B(on)}$ = -0.5A $I_{B(off)}$ = 0.5A		0.2		μs
t_{off}	Turn off time	$V_{BE(off)}$ = 5 V R_L = 5 Ω		0.4		μs

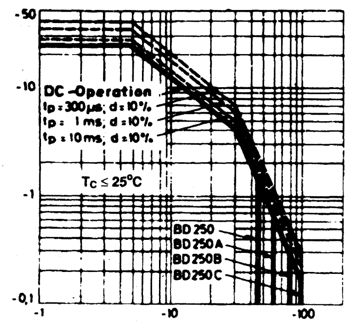
L† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



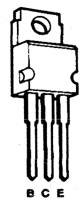
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



BD539, BD539A, BD539B, BD539C, BD539D
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **45W at 25°C Case Temperature**
- **5A Rated Collector Current**
- **Up to 120V V_{CEO} rating**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD539	BD539A	BD539B	BD539C	BD539D
V_{CBO}	Collector - base voltage	40 V	60 V	80 V	100 V	120 V
V_{CEO}	Collector - emitter voltage (Note 1)	40 V	60 V	80 V	100 V	120 V
V_{EBO}	Base - emitter voltage	5 V				
I_C	Continuous collector current	5 A				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	45 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W				
T_A	Operating free - air temperature range	-65 to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C				
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.36 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 4)	I_C = 30 mA	I_B = 0	BD539 BD539A BD539B BD539C BD539D	40 60 80 100 120			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = 30 V V_{CE} = 60 V V_{CE} = 90 V	I_B = 0 I_B = 0 I_B = 0	BD539/539A BD539B/539C BD539D			0.3 0.3 0.3	mA
I_{CES}	Collector cut- off current	V_{CB} = 40 V V_{CB} = 60 V V_{CB} = 80 V V_{CB} = 100 V V_{CB} = 120 V	I_E = 0 I_E = 0 I_E = 0 I_E = 0 I_E = 0	BD539 BD539A BD539B BD539C BD539D			0.2 0.2 0.2 0.2 0.2	mA
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0				1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V V_{CE} = 4 V	I_C = 0.5 A I_C = 1.0 A I_C = 3.0 A	(Notes 4 & 5)	40 30 12			
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = 4 V	I_C = 3.0A	(Notes 4 & 5)			1.25	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 125 mA I_B = 375 mA I_B = 1.0 A	I_C = 1.0 A I_C = 3.0 A I_C = 5.0 A	(Notes 4 & 5)			0.25 0.8 1.5	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10V	I_C = 0.5 A	f=1kHz	20			V
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE}=10V	I_C=0.5A	f=1MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.78	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

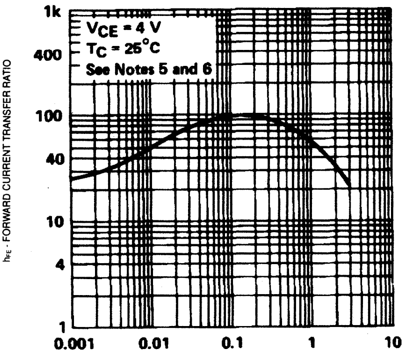
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1 A $I_{B(on)}$ = 100 mA $I_{B(off)}$ = -100 mA		0.5		μs
t_{off}	Turn off time	$V_{BE(off)}$ = -4.3 V R_L = 30 Ω		2.0		μs

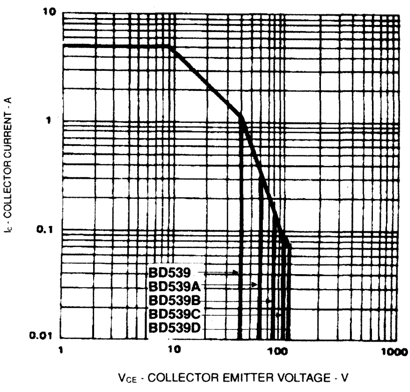
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



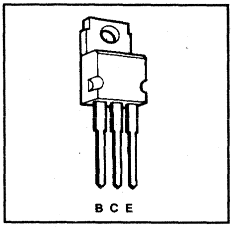
5

BD, BDW, BDX, BU, BUV, BUX, BUY Devices

BD540, BD540A, BD540B, BD540C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- 45 W at 25°C Case Temperature
- 5 A Continuous Collector Current
- Customer Specified Selections Available



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD540	BD540A	BD540B	BD540C
V_{CBO}	Collector - base voltage (I_E = 0)	-40 V	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0) (Note 1)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	45 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies when the base-emitter diode is open-circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.36 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 4)	I_C = -30 mA I_B = 0	BD540 BD540A BD540B BD540C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -40 V V_{BE} = 0 V_{CE} = - 60 V V_{BE} = 0 V_{CE} = - 80 V V_{BE} = 0 V_{CE} = -100 V V_{BE} = 0	BD540 BD540A BD540B BD540C			-0.2 -0.2 -0.2 -0.2	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V I_B = 0 V_{CE} = -60 V I_B = 0	BD540/540A BD540B/540C			-0.3 -0.3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0				-1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V I_C = -0.5 A V_{CE} = -4 V I_C = -1.0 A V_{CE} = -4 V I_C = -3.0 A	(Notes 4 & 5)	40 30 12			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -125 mA I_C = -1.0 A I_B = -375 mA I_C = -3.0 A I_B = -1.0 A I_C = -5.0 A	(Notes 4 & 5)			-0.25 -0.8 -1.5	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V I_C = -3.0 A	(Notes 4 & 5)			-1.25	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -0.5 A	f = 1 MHz	3			

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.78	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

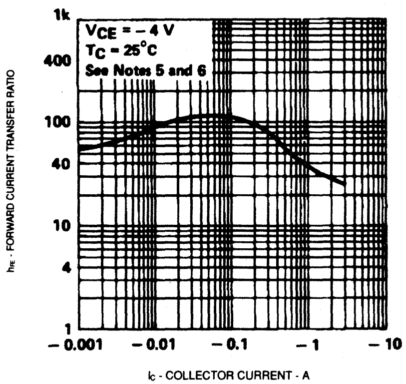
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -1 A $I_{B(on)}$ = -100 mA $I_{B(off)}$ = 100 mA		0.3		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4.3 V R_L = 30 Ω		1.0		µs

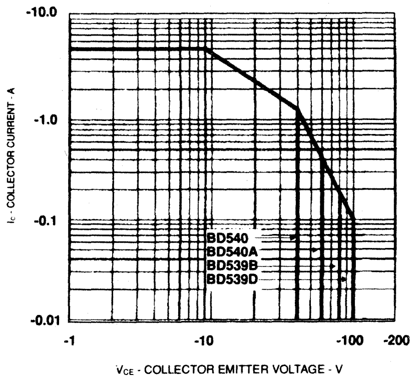
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

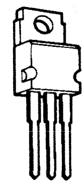


MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



Revised March 1990

- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD543	BD543A	BD543B	BD543C
V_{CBO}	Collector - base voltage (I_E = 0)	40 V	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	8 A			
I_{CM}	Peak collector current (Note 1)	10 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	70 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.56 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 4)	I_C = 30 mA	I_B = 0	BD543 BD543A BD543B BD543C	40 60 80 100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 40 V V_{CE} = 60 V V_{CE} = 80 V V_{CE} = 100 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD543 BD543A BD543B BD543C			0.4 0.4 0.4 0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	BD543/543A BD543B/543C			0.7 0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V V_{CE} = 4 V	I_C = 1 A I_C = 3 A I_C = 5 A	(Notes 4 & 5)	60 40 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 300 mA I_B = 1A I_B = 1.6 A	I_C = 3 A I_C = 5 A I_C = 8 A	(Notes 4 & 5)			0.5 0.5 1.0	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 5 A	(Notes 4 & 5)			1.4	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.79	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

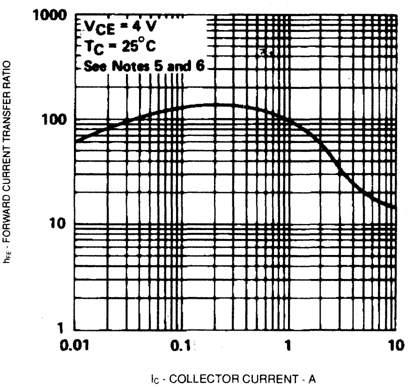
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	$I_C = 6$ A	$I_{B(on)} = 0.6$ A	$I_{B(off)} = -0.6$ A		0.6		µs
t_{off}	Turn off time	$V_{BE(off)} = -4$ V	$R_L = 5\ \Omega$			1		µs

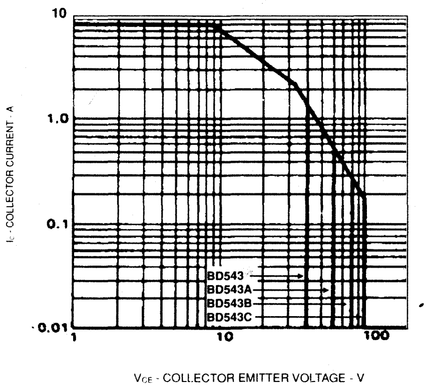
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, $t_w = 300\mu s$, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



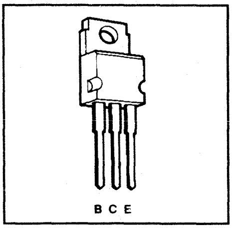
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BD544, BD544A, BD544B, BD544C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD544	BD544A	BD544B	BD544C
V_{CBO}	Collector - base voltage (I_E = 0)	-40 V	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-8 A			
I_{CM}	Peak collector current (Note 1)	-10 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	70 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_W \leq$ 0.3 ms, duty cycle $\leq$ 10%.
2: Derate linearly to 150°C case temperature at the rate of 0.56 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 4)	I_C = -30 mA	I_B = 0	BD544 BD544A BD544B BD544C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -40 V V_{CE} = - 60 V V_{CE} = - 80 V V_{CE} = -100 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD544 BD544A BD544B BD544C			-0.4 -0.4 -0.4 -0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V V_{CE} = -60 V	I_B = 0 I_B = 0	BD544/544A BD544B/544C			-0.7 -0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V	I_C = 0				-1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V V_{CE} = -4 V V_{CE} = -4 V	I_C = -1 A I_C = -3 A I_C = -5 A	(Notes 4 & 5)	60 40 15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -300 mA I_B = -1 A I_B = -1.6 A	I_C = -3 A I_C = -5 A I_C = -8 A	(Notes 4 & 5)			-0.5 -0.5 -1.0	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V	I_C = -5 A	(Notes 4 & 5)			-1.4	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -0.5 A	f = 1 MHz	3			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.79	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

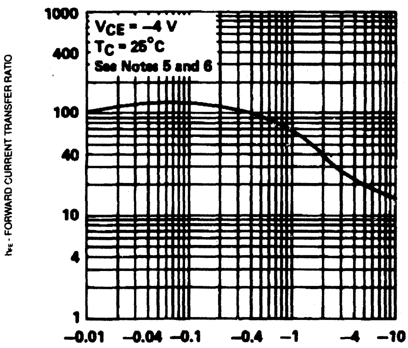
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -6 A $I_{B(on)}$ = -0.6 A $I_{B(off)}$ = 0.6 A		0.4		µs
t_{off}	Turn off time	$V_{BE(off)}$ = 4 V R_L = 5 Ω		0.7		µs

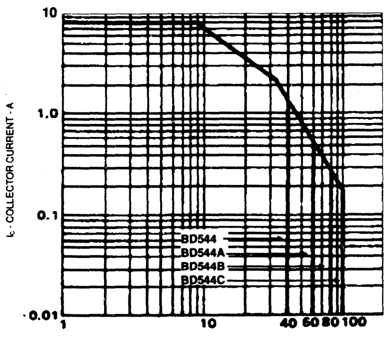
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



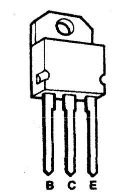
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



NPN SILICON POWER TRANSISTORS

Revised March 1990

- **85 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD545	BD545A	BD545B	BD545C
V_{CBO}	Collector - base voltage (I_E = 0)	40 V	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage (I_B =0) (Note 1)	40 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	15 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature(Note 2)	85 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies when the base-emitter diode is open circuited
2: Derate linearly to 150°C case temperature at the rate of 0.68 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 4)	I_C = 30 mA	I_B = 0	BD545 BD545A BD545B BD545C	40 60 80 100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 40 V V_{CE} = 60 V V_{CE} = 80 V V_{CE} = 100 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD545 BD545A BD545B BD545C			0.4 0.4 0.4 0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	BD545/545A BD545B/545C			0.7 0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				1.0	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V V_{CE} = 4 V	I_C = 1 A I_C = 5 A I_C = 10 A	(Notes 4 & 5)	60 25 10			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 625mA I_B = 2 A	I_C = 5 A I_C = 10 A	(Notes 4 & 5)			0.8 1	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V	I_C = 10 A	(Notes 4 & 5)			1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz	3			

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.47	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

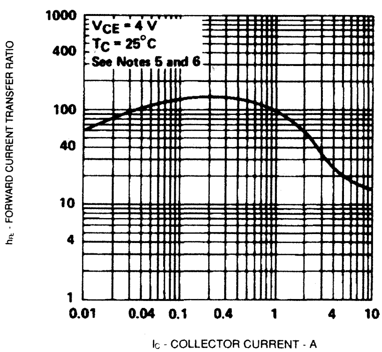
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	$I_C = 6$ A	$I_{B(on)} = 0.6$ A	$I_{B(off)} = -0.6$ A		0.6		µs
t_{off}	Turn off time	$V_{BE(off)} = -4$ V	$R_L = 5\ \Omega$			1		µs

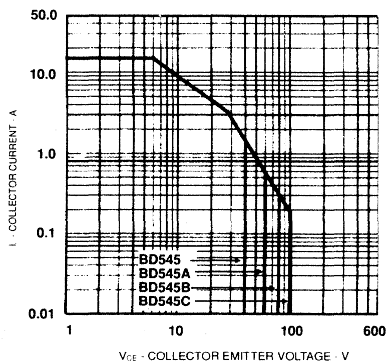
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, $t_w = 300\mu s$, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



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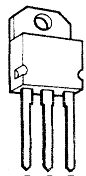
BD, BDW, BDX, BU, BUV, BUX, BUY Devices

Revised March 1990

- **85 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD546	BD546A	BD546B	BD546C
V_{CBO}	Collector - base voltage (I_E = 0)	-40 V	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B =0) (Note 1)	-40 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-15 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature(Note 2)	85 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies when the base-emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.68 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 4)	I_C = -30 mA	I_B = 0	BD546 BD546A BD546B BD546C	-40 -60 -80 -100			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = -40 V V_{CE} = -60 V V_{CE} = -80 V V_{CE} = -100 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD546 BD546A BD546B BD546C			-0.4 -0.4 -0.4 -0.4	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V V_{CE} = -60 V	I_B = 0 I_B = 0	BD546/546A BD546B/546C			-0.7 -0.7	mA
I_{EBO}	Emitter cut - off current	V_{EB} = - 5 V	I_C = 0				-1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = - 4 V V_{CE} = - 4 V V_{CE} = - 4 V	I_C = - 1 A I_C = - 5 A i_C = -10 A	(Notes 4 & 5)	60 25 10			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -625 mA I_B = -2 A	I_C = - 5 A I_C = -10 A	(Notes 4 & 5)			-0.8 -1	V
V_{BE}	Base - emitter voltage	V_{CE} = -4 V	I_C = -10 A	(Notes 4 & 5)			-1.8	V
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -0.5 A	f = 1 kHz	20			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -0.5 A	f = 1 MHz	3			

Thermal Characteristics

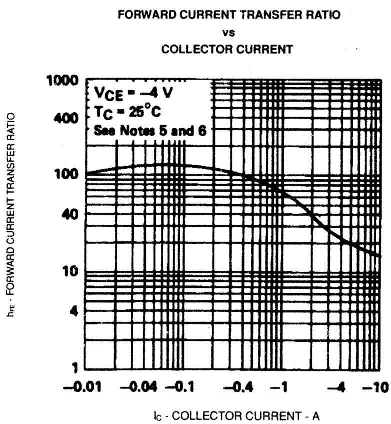
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.47	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

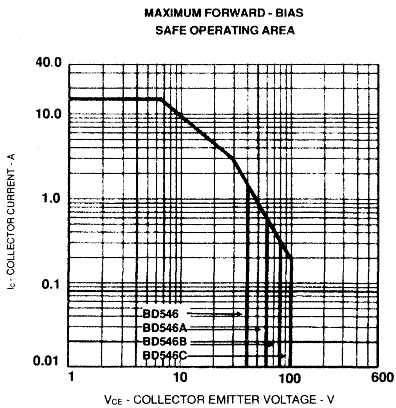
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = -6 A	$I_{B(on)}$ = -0.6 A	$I_{B(off)}$ = 0.6 A		0.4		μs
t_{off}	Turn off time	$V_{BE(off)}$ = 4 V	R_L = 5 Ω			0.7		μs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 4: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
5: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS





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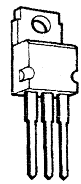
BD, BDW, BDX, BU, BUV, BUX, BUY Devices

BD743, BD743A, BD743B, BD743C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **90 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **20 A Peak Collector Current**
- **Customer Specified Selections Available**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD743	BD743A	BD743B	BD743C
V_{CBO}	Collector - base voltage ($I_E = 0$)	50 V	70 V	90 V	110 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	45 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	15 A			
I_{CM}	Peak collector current (Note 1)	20 A			
I_B	Continuous base current	5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	90 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	90 mJ			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle $\leq 10\%$.
2: Derate linearly to 150°C case temperature at the rate of 0.72 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of $L = 20$ mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 5)	$I_C = 30$ mA	$I_B = 0$	BD743 BD743A BD743B BD743C	45 60 80 100			V
I_{CBO}	Collector cut - off current	$V_{CE} = 50$ V $V_{CE} = 70$ V $V_{CE} = 90$ V $V_{CE} = 110$ V	$V_{BE} = 0$ $V_{BE} = 0$ $V_{BE} = 0$ $V_{BE} = 0$	BD743 BD743A BD743B BD743C			0.1 0.1 0.1 0.1	mA
I_{CBO}	Collector cut - off current ($T_C = 125°C$)	$V_{CE} = 50$ V $V_{CE} = 70$ V $V_{CE} = 90$ V $V_{CE} = 110$ V	$V_{BE} = 0$ $V_{BE} = 0$ $V_{BE} = 0$ $V_{BE} = 0$	BD743 BD743A BD743B BD743C			5 5 5 5	mA
I_{CEO}	Collector cut - off current	$V_{CE} = 30$ V $V_{CE} = 60$ V	$I_B = 0$ $I_B = 0$	BD743/743A BD743B/743C			0.1 0.1	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = 5$ V	$I_C = 0$				0.5	mA
h_{FE}	Forward current transfer ratio	$V_{CE} = 4$ V $V_{CE} = 4$ V $V_{CE} = 4$ V	$I_C = 1$ A $I_C = 5$ A $I_C = 15$ A	(Notes 5 & 6)	40 20 5		150	
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = 0.5$ A $I_B = 5$ A	$I_C = 5$ A $I_C = 15$ A	(Notes 5 & 6)			1 3	V
V_{BE}	Base - emitter voltage	$V_{CE} = 4$ V $V_{CE} = 4$ V	$I_C = 5$ A $I_C = 15$ A	(Notes 5 & 6)			1 3	V

Electrical Characteristics at 25°C Case Temperature (continued)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 1A f = 1kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 1A f = 1MHz	5			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.4	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

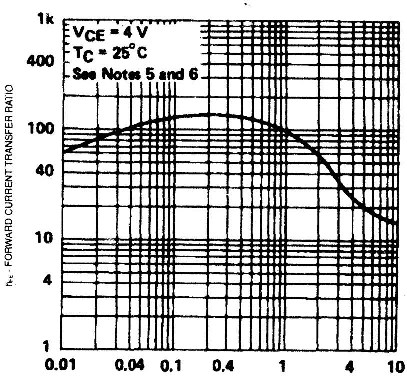
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = 5A $I_{B(on)}$ = 500mA $I_{B(off)}$ = -500mA $V_{BE\,(off)}$ = -4.2V R_L = 6 Ω		20		ns
t_r	Rise time			350		ns
t_s	Storage time			500		ns
t_f	Fall time			400		ns

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

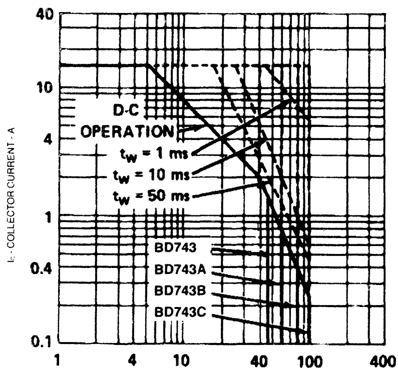
TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



I_C - COLLECTOR CURRENT - A

MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA

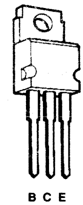


V_{CE} - COLLECTOR EMITTER VOLTAGE - V

BD744, BD744A, BD744C, BD744D
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **90 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **20 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD744	BD744A	BD744B	BD744C
V_{CBO}	Collector - base voltage (I_E = 0)	-50 V	-70 V	-90 V	-110 V
V_{CEO}	Collector - emitter voltage (I_B =0)	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-15 A			
I_{CM}	Peak collector current (Note 1)	-20 A			
I_B	Continuous base current	-5 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	90 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	90 mJ			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \leq$ 0.3 ms, duty cycle $\leq$ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.72 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC}= -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 5)	I_C = -30 mA	I_B = 0	BD744 BD744A BD744B BD744C	-45 -60 -80 -100			V
I_{CBO}	Collector - emitter cut - off current	V_{CE} = 50 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 110 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD744 BD744A BD744B BD744C			-0.1 -0.1 -0.1 -0.1	mA
I_{CBO}	Collector - emitter cut - off current (T_C = 125°C)	V_{CE} = 50 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 110 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD744 BD744A BD744B BD744C			-5 -5 -5 -5	mA
I_{CEO}	Collector cut - off current	V_{CE} = - 30 V V_{CE} = - 60 V	I_B = 0 I_B = 0	BD744/744A, BD744B/744C			-0.1 -0.1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V	I_C = 0				-0.5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V V_{CE} = -4 V V_{CE} = -4 V	I_C = -1 A I_C = -5 A I_C= -15 A	(Notes 5 & 6)	40 20 5		150	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -0.5 A I_B = -5 A	I_C = -5 A I_C = -15A	(Notes 5 & 6)			-1 -3	V
V_{BE}	Base - emitter voltage	V_{CE} = -4V V_{CE}= -4V	I_C = -5 A I_C = -15A	(Notes 5 & 6)			-1 -3	V

Electrical Characteristics at 25°C Case Temperature (continued)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -1A f = 1 kHz	25			
$\lvert h_{fe} \rvert$	Small signal forward current transfer ratio	V_{CE} = -10 V I_C = -1A f = 1 MHz	5			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.4	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = -5A $I_{B(on)}$= -500mA IB(off) = 500mA $V_{BE\ (off)}$ = 4.2V RL = 6 Ω		20		ns
t_r	Rise time			120		ns
t_s	Storage time			600		ns
t_f	Fall time			300		ns

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

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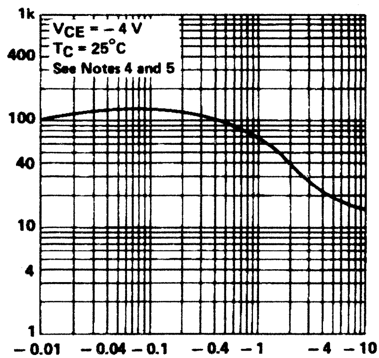
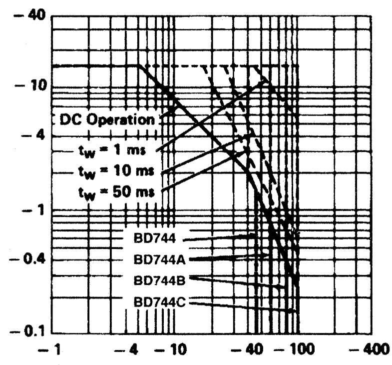
BD, BDW, BDX, BU, BUV, BUX, BUY Devices

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



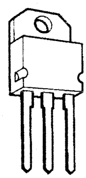
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BD745, BD745A, BD745B, BD745C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **115 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **25 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD745	BD745A	BD745B	BD745C
V_{CBO}	Collector - base voltage (I_E = 0)	50 V	70 V	90 V	110 V
V_{CEO}	Collector - emitter voltage (I_B =0)	45 V	60 V	80 V	100 V
V_{EBO}	Base - emitter voltage	5 V			
I_C	Continuous collector current	20 A			
I_{CM}	Peak collector current (Note 1)	25 A			
I_B	Continuous base current	7 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	115 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	90 mJ			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2 mm from case for 10 seconds	260°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%
2: Derate linearly to 150°C case temperature at the rate of 0.92 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 5)	I_C = 30 mA	I_B = 0	BD745 BD745A BD745B BD745C	45 60 80 100			V
I_{CBO}	Collector cut - off current	V_{CE} = 50 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 110 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD745 BD745A BD745B BD745C			0.1 0.1 0.1 0.1	mA
I_{CBO}	Collector cut - off current (T_C = 125°C)	V_{CE} = 50 V V_{CE} = 70 V V_{CE} = 90 V V_{CE} = 110 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD745 BD745A BD745B BD745C			5.0 5.0 5.0 5.0	mA
I_{CEO}	Collector cut - off current	V_{CE} = 30 V V_{CE} = 60 V	I_B = 0 I_B = 0	BD745/745A, BD745B/745C			0.1 0.1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				0.5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V V_{CE} = 4 V	I_C = 1 A I_C = 5 A I_C = 20 A	(Notes 5 & 6)	40 20 5		150	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.5 A I_B = 5 A	I_C = 5 A I_C = 20 A	(Notes 5 & 6)			1 3	V
V_{BE}	Base - emitter voltage	V_{CE} = 4 V V_{CE} = 4 V	I_C = 5 A I_C = 20 A	(Notes 5 & 6)			1 3	V

Electrical Characteristics at 25°C Case Temperature (continued)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 1A f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = 10 V I_C = 1A f = 1 MHz	5			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = 5A $I_{B(on)}$ = 500mA $I_{B(off)}$ = -500mA $V_{BE\ (off)}$ = -4.2V RL = 6 Ω		20		ns
t_r	Rise time			350		ns
t_s	Storage time			500		ns
t_f	Fall time			400		ns

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%

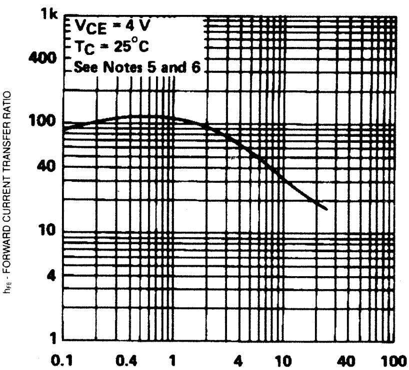
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

5

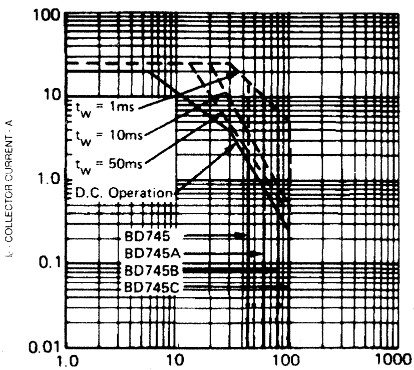
BD, BDW, BDX, BU, BUV, BUX, BUY Devices

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



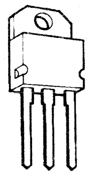
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BD746, BD746A, BD746B, BD746C
PNP SILICON POWER TRANSISTORS

Revised March 1990

- **115 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **25 A Peak Collector Current**
- **Customer Specified Selections Available**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BD746	BD746A	BD746B	BD746C
V_{CBO}	Collector - base voltage ($I_E = 0$)	-50 V	-70 V	-90 V	-110 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-20 A			
I_{CM}	Peak collector current (Note 1)	-25 A			
I_B	Continuous base current	-7 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	115 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W			
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	90 mJ			
T_A	Operating free - air temperature range	-65°C to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C			
T_L	Lead temperature 3.2mm from case for 10 seconds	250°C			

NOTES: 1: This value applies for $t_w \leq 0.3$ ms, duty cycle $\leq 10\%$
2: Derate linearly to 150°C case temperature at the rate of 0.92 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistor to operate safely in a circuit of L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage (Note 5)	I_C = -30 mA	I_B = 0	BD746 BD746A BD746B BD746C	-45 -60 -80 -100			V
I_{CBO}	Collector cut - off current	V_{CE} = -50 V V_{CE} = -70 V V_{CE} = -90 V V_{CE} = -110 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD746 BD746A BD746B BD746C			-0.1 -0.1 -0.1 -0.1	mA
I_{CBO}	Collector cut - off current (T_C = 125°C)	V_{CE} = -50 V V_{CE} = -70 V V_{CE} = -90 V V_{CE} = -110 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BD746 BD746A BD746B BD746C			-5 -5 -5 -5	mA
I_{CEO}	Collector cut - off current	V_{CE} = -30 V V_{CE} = -60 V	I_B = 0 I_B = 0	BD746/746A, BD746B/746C			-0.1 -0.1	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V	I_C = 0				-0.5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = - 4 V V_{CE} = - 4 V V_{CE} = - 4 V	I_C = -1 A I_C = -5 A I_C= -20 A	(Notes 5 & 6)	40 20 5		150	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = - 0.5 A I_B = - 5 A	I_C = - 5 A I_C= -20 A	(Notes 5 & 6)			-1 -3	V
V_{BE}	Base - emitter voltage	V_{CE} = - 4 V V_{CE} = - 5 V	I_C = -5 V I_C= -20 A	(Notes 5 & 6)			-1 -3	V

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
h_{fe}	Small signal forward current transfer ratio	V_{CE} = - 10 V I_C = -1A f = 1 kHz	25			
$\|h_{fe}\|$	Small signal forward current transfer ratio	V_{CE} = - 10 V I_C = -1A f = 1 MHz	5			

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.1	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

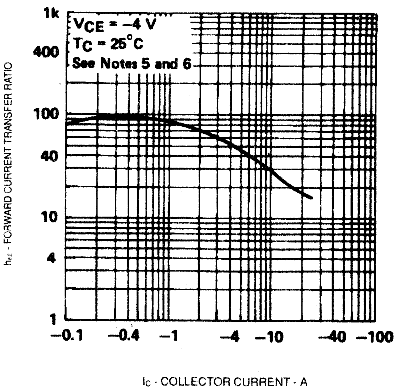
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = -5A $I_{B(on)}$ = -500mA $I_{B(off)}$ = 500mA $V_{BE\ (off)}$ = 4.2V RL = 6 Ω		20		ns
t_r	Rise time			120		ns
t_s	Storage time			600		ns
t_f	Fall time			300		ns

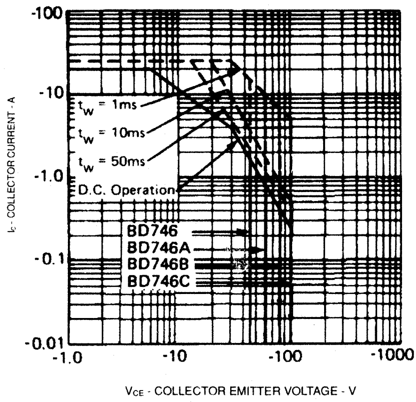
† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
6: These parameters must be measured using voltage sensing contacts separate from the current - carrying contacts.

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

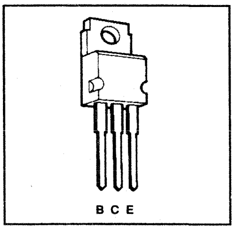


MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



Revised March 1990

- **50 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **Min h_{FE} of 750 at 2 A, 3 V**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BDW24	BDW24A	BDW24B	BDW24C
V_{CBO}	Collector - base voltage ($I_E = 0$)	-45 V	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Emitter - base voltage	-5 V			
I_C	Continuous collector current	-6 A			
I_B	Continuous base current	-0.2 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 1)	50 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 2)	2 W			
T_A	Operating free - air temperature range	-65 to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C			

NOTES: 1: Derate linearly to 150°C case temperature at the rate of 0.4 W/°C.
2: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage (Note 3)	I_C = -100 mA (Note 3) $I_B = 0$ BDW24 BDW24A BDW24B BDW24C	-45 -60 -80 -100			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = -30 V $I_B = 0$ BDW24/24A V_{CE} = -40 V $I_B = 0$ BDW24B V_{CE} = -50 V $I_B = 0$ BDW24C			-500 -500 -500	μA
I_{CBO}	Collector -base cut- off current	V_{CB} = -45 V $I_E = 0$ BDW24 V_{CB} = -60 V $I_E = 0$ BDW24A V_{CB} = -80 V $I_E = 0$ BDW24B V_{CB} = -100 V $I_E = 0$ BDW24C			-200 -200 -200 -200	μA
I_{EBO}	Emitter -base cut - off current	V_{EB} = -5 V $I_C = 0$			-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V I_C = -1 A V_{CE} = -3 V I_C = -2 A (Notes 3 & 4) V_{CE} = -3 V I_C = -6 A	1000 750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = -3 V I_C = -1 A V_{CE} = -3 V I_C = -6 A (Notes 3 & 4)			-2.5 -3	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -8 mA I_C = -2 A I_B = -60 mA I_C = -6 A (Notes 3 & 4)			-2 -3	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = -8 mA I_C = -2 A (Notes 3 & 4)			-2.5	V
V_F	Parallel diode forward voltage	I_F = 2 A			1.8	V

Thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.5	°C
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C

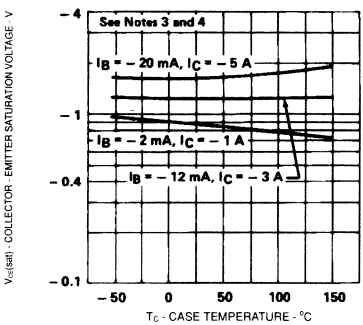
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
$t_{(on)}$	Rise time	I_C = -3 A $I_{B(on)}$ = -12 mA $I_{B(off)}$ = 12 mA		1		µs
$t_{(off)}$	Storage time	$V_{BE(off)}$ = 4.5 V R_L = 10 Ω		5		µs

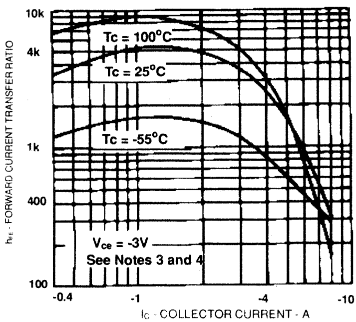
NOTES: 3: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
4: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3.2mm from the device body.
5: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

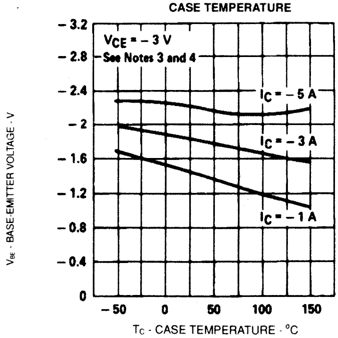
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



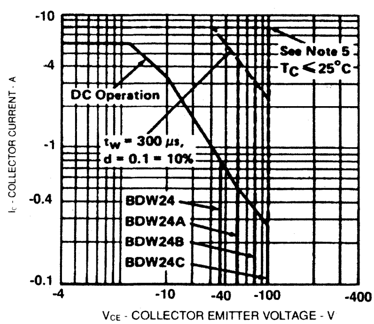
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE



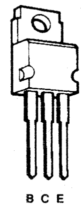
FORWARD - BIAS OPERATING AREA



BDW53, BDW53A BDW53B, BDW53C, BDW53D
NPN SILICON POWER DARLINGTONS

Revised March 1990

- **High SOA Capability, 40 V and 1 A**
- **40 W at 25°C Case Temperature**
- **4 A Rated Collector Current**
- **Min h_{FE} of 750 at 1.5 A, 3 V**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BDW53	BDW53A	BDW53B	BDW53C	BDW53D
V_{CBO}	Collector - base voltage	45 V	60 V	80 V	100 V	120 V
V_{CEO}	Collector - emitter voltage (Note 1)	45 V	60 V	80 V	100 V	120 V
V_{EBO}	Emitter - base voltage	5 V				
I_C	Continuous collector current	4 A				
I_B	Continuous base current	50 mA				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W				
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	25 mJ				
T_A	Operating free - air temperature range	-65 to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{B2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 30 mA (Note 5)	I_B = 0	BDW53 BDW53A BDW53B BDW53C BDW53D	45 60 80 100 120			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = 30 V V_{CE} = 40 V V_{CE} = 50 V V_{CE} = 60 V	I_B = 0 I_B = 0 I_B = 0 I_B = 0	BDW53/53A BDW53B BDW53C BDW53D			500 500 500 500	µA
I_{CBO}	Collector - base cut- off current	V_{CB} = 45 V V_{CB} = 60 V V_{CB} = 80 V V_{CB} = 100 V V_{CB} = 120 V	I_E = 0 I_E = 0 I_E = 0 I_E = 0 I_E = 0	BDW53 BDW53A BDW53B BDW53C BDW53D			200 200 200 200 200	µA
I_{CBO}	Collector - base cut-off current	V_{CB} = Rated	I_E = 0	T_C = 150°C			5	mA
I_{EBO}	Emitter base cut - off current	V_{EB} = 5 V	I_C = 0				2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V V_{CE} = 3 V	I_C = 1.5 A I_C = 4 A	(Notes 5 & 6)	750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = 3 V	I_C = 1.5 A	(Notes 5 & 6)			2.5	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 30 mA I_B = 40 mA	I_C = 1.5 A I_C = 4 A	(Notes 5 & 6)			2.5 4	V
V_{FR}	Reverse diode forward voltage		I_F = -4 A				-3.5	V

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			3.125	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.0	°C/W

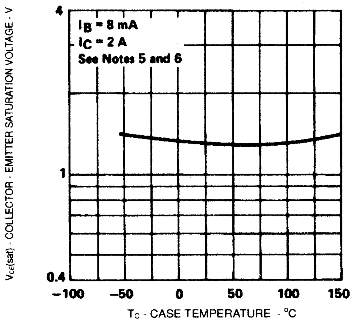
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = 2 A	$I_{B(on)}$ = 8 mA	$I_{B(off)}$ = -8 mA		1		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = -5 V	R_L = 15 Ω			4.5		µs

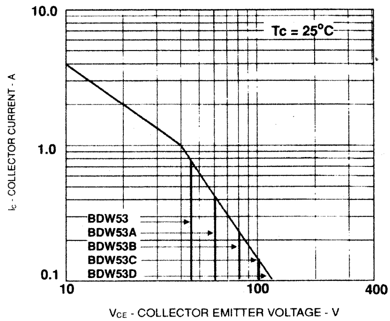
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3 mm from the device body.

TYPICAL CHARACTERISTICS

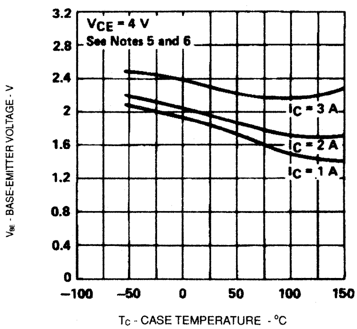
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



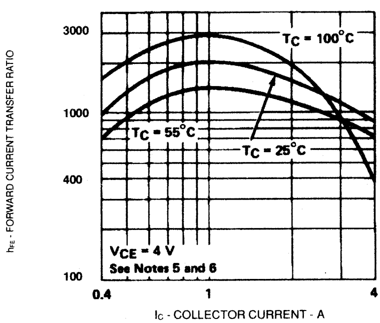
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BASE -EMITTER VOLTAGE
vs
CASE TEMPERATURE



FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



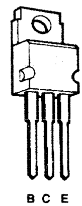
TEXAS INSTRUMENTS

BDW54, BDW54A BDW54B, BDW54C, BDW54D
PNP SILICON POWER DARLINGTONS

Revised March 1990

- **High SOA Capability, 40 V and 1 A**
- **40 W at 25°C Case Temperature**
- **4 A Rated Collector Current**

Min h_{FE} of 750 at 1.5 A, 3 V



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BDW54	BDW54A	BDW54B	BDW54C	BDW54D
V_{CBO}	Collector - base voltage	-45 V	-60 V	-80 V	-100 V	-120 V
V_{CEO}	Collector - emitter voltage (Note 1)	-45 V	-60 V	-80 V	-100 V	-120 V
V_{EBO}	Base - emitter voltage	-5 V				
I_C	Continuous collector current	-4 A				
I_B	Continuous base current	-50 mA				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	40 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W				
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	25 mJ				
T_A	Operating free - air temperature range	-65 to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in the circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = -30 mA I_B = 0 (Note 5) BDW54 BDW54A BDW54B BDW54C BDW54D	-45 -60 -80 -100 -120			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = -30 V I_B = 0 BDW54/54A V_{CE} = -40 V I_B = 0 BDW54B V_{CE} = -50 V I_B = 0 BDW54C V_{CE} = -60 V I_B = 0 BDW54D			-500 -500 -500 -500	µA
I_{CBO}	Collector base cut-off current	V_{CB} = -45 V I_E = 0 BDW54 V_{CB} = -60 V I_E = 0 BDW54A V_{CB} = -80 V I_E = 0 BDW54B V_{CB} = -100 V I_E = 0 BDW54C V_{CB} = -120 V I_E = 0 BDW54D			-200 -200 -200 -200 -200	µA
I_{CBO}	Collector base cut-off current	V_{CB} = rated I_E = 0 T_C = 150°C			-5	mA
I_{EBO}	Emitter cut - off current	V_{EB} = -5 V I_C = 0			-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V I_C = -1.5 A V_{CE} = -3 V I_C = -4 A (Notes 5 & 6)	750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = -3 V I_C = -1.5 A (Notes 5 & 6)			-2.5	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -30 mA I_C = -1.5 A I_B = -40 mA I_C = -4 A (Notes 5 & 6)			-2.5 -4	V
V_{FR}	Reverse diode forward voltage	I_C = 4 A			3.5	V

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			3.125	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.0	°C/W

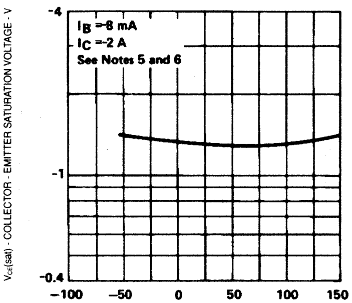
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = -2 A $I_{B(on)}$ = -8 mA $I_{B(off)}$ = 8 mA		1		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = 5 V R_L = 15 Ω		4.5		µs

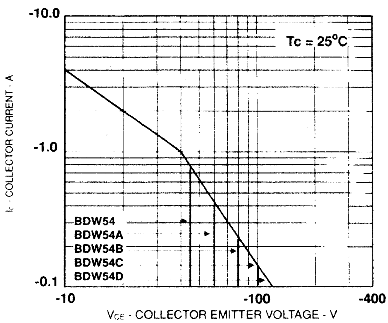
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3 mm from the device body.

TYPICAL CHARACTERISTICS

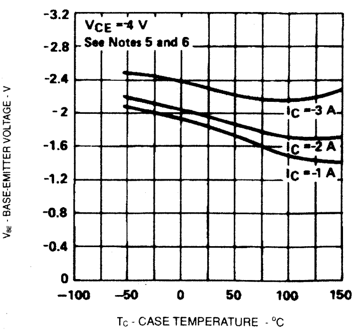
COLLECTOR - EMITTER SATURATION VOLTAGE vs CASE TEMPERATURE



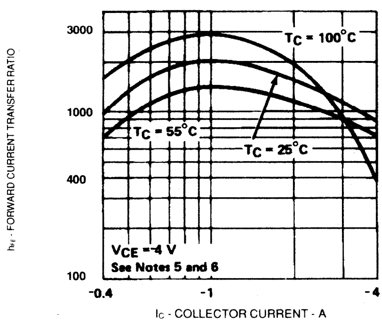
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



BASE -EMITTER VOLTAGE vs CASE TEMPERATURE



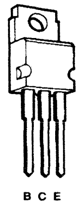
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BDW63, BDW63A BDW63B, BDW63C, BDW63D
NPN SILICON POWER DARLINGTONS

Revised March 1990

- **High SOA Capability, 20 V and 3 A**
- **60 W at 25°C Case Temperature**
- **6 A Rated Collector Current**
- **Min h_{FE} of 750 at 2 A, 3 V**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BDW63	BDW63A	BDW63B	BDW63C	BDW63D
V_{CBO}	Collector - base voltage (I_E = 0)	45 V	60 V	80 V	100 V	120 V
V_{CEO}	Collector - emitter voltage (I_B = 0) (Note 1)	45 V	60 V	80 V	100 V	120 V
V_{EB}	Base - emitter voltage	5 V				
I_C	Continuous collector current	6 A				
I_B	Continuous base current	100 mA				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	60 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W				
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	50 mJ				
T_A	Operating free - air temperature range	-65 to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.48 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistors to operate safely ina circuit of $L = 20$ mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 30 mA (Note 5)	I_B = 0	BDW63 BDW63A BDW63B BDW63C BDW63D	45 60 80 100 120			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = 30 V V_{CE} = 40 V V_{CE} = 50 V V_{CE} = 60 V	I_B = 0 I_B = 0 I_B = 0 I_B = 0	BDW63/63A BDW63B BDW63C BDW63D			500 500 500 500	µA
I_{CBO}	Collector base cut- off current	V_{CB} = 45 V V_{CB} = 60 V V_{CB} = 80 V V_{CB} = 100 V V_{CB} = 120 V	I_E = 0 I_E = 0 I_E = 0 I_E = 0 I_E = 0	BDW63 BDW63A BDW63B BDW63C BDW63D			200 200 200 200 200	µA
I_{CBO}	Collector - base cut-off current	V_{CB} = rated	I_E = 0	T_C = 150°C			5	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V V_{CE} = 3 V	I_C = 2 A I_C = 6 A	(Notes 5 & 6)	750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = 3 V	I_C = 2 A	(Notes 5 & 6)			2.5	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 12 mA I_B = 60 mA	I_C = 2 A I_C = 6 A	(Notes 5 & 6)			2.5 4	V
V_{FR}	Reverse diode forward voltage		I_C = -6 A				-3.5	V

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.08	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

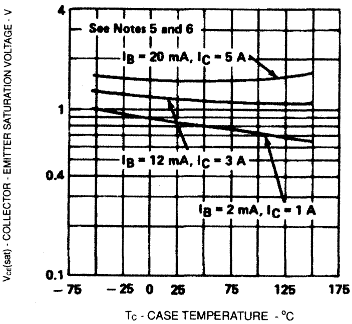
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = 3 A $I_{B(on)}$ = 12 mA $I_{B(off)}$ = -12 mA		1		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = -4.5 V R_L = 10 Ω		5		µs

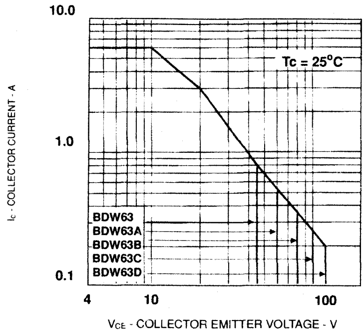
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3 mm from the device body.

TYPICAL CHARACTERISTICS

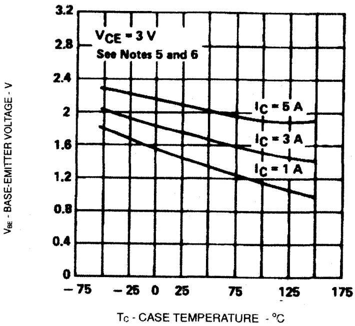
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



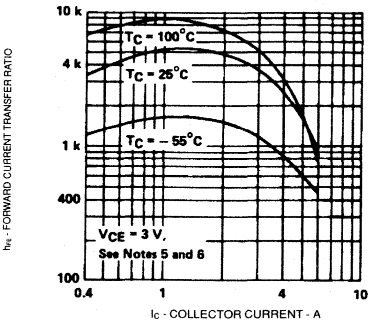
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BASE -EMITTER VOLTAGE
vs
CASE TEMPERATURE



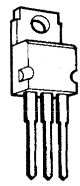
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BDW64, BDW64A BDW64B, BDW64C, BDW64D
PNP SILICON POWER DARLINGTONS

Revised March 1990

- **High SOA Capability, 20 V and 3 A**
- **60 W at 25°C Case Temperature**
- **6 A Rated Collector Current**
- **Min h_{FE} of 750 at 2 A, 3 V**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BDW64	BDW64A	BDW64B	BDW64C	BDW64D
V_{CBO}	Collector - base voltage (I_E = 0)	-45 V	-60 V	-80 V	-100 V	-120 V
V_{CEO}	Collector - emitter voltage (I_B = 0) (Note 1)	-45 V	-60 V	-80 V	-100 V	-120 V
V_{EBO}	Emitter - base voltage	-5 V				
I_C	Continuous collector current	-6 A				
I_B	Continuous base current	-100 mA				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	60 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W				
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	50 mJ				
T_A	Operating free - air temperature range	-65 to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.48 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = -20 V

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = -30 mA (Note 5)	I_B = 0	BDW64 BDW64A BDW64B BDW64C BDW64D	-45 -60 -80 -100 -120			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = -30 V V_{CE} = -40 V V_{CE} = -50 V V_{CE} = -60 V	I_B = 0 I_B = 0 I_B = 0 I_B = 0	BDW64/64A BDW64B BDW64C BDW64D			-500 -500 -500 -500	μA
I_{CBO}	Collector base cut- off current	V_{CB} = -45 V V_{CB} = -60 V V_{CB} = -80 V V_{CB} = -100 V V_{CB} = -120 V	I_E = 0 I_E = 0 I_E = 0 I_E = 0 I_E = 0	BDW64 BDW64A BDW64B BDW64C BDW64D			-200 -200 -200 -200 -200	μA
I_{CBO}	Collector - base cut-off current	V_{CB} = Rated	I_E = 0	T_C = 150°C			-5	mA
I_{EBO}	Emitter base cut - off current	V_{EB} = -5 V	I_C = 0				-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V V_{CE} = -3 V	I_C = -2 A I_C = -6 A	(Notes 5 & 6)	750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = -3 V	I_C = -2 A	(Notes 5 & 6)			-2.5	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -12 mA I_B = -60 mA	I_C = -2 A I_C = -6 A	(Notes 5 & 6)			-2.5 -4	V
V_{FR}	Reverse diode forward voltage		I_F = 6 A				3.5	V

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.08	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.0	°C/W

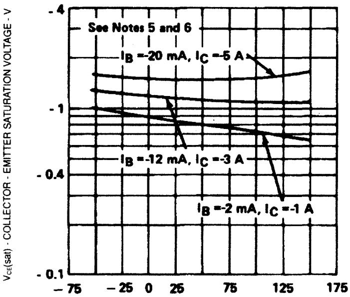
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = -3 A $I_{B(on)}$ = -12 mA $I_{B(off)}$ = 12 mA		1		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = 4.5 V R_L = 10 Ω		5		µs

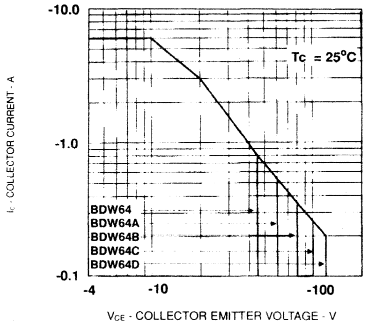
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3 mm from the device body.

TYPICAL CHARACTERISTICS

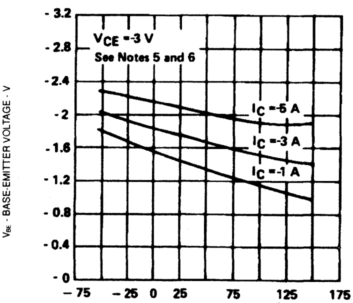
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



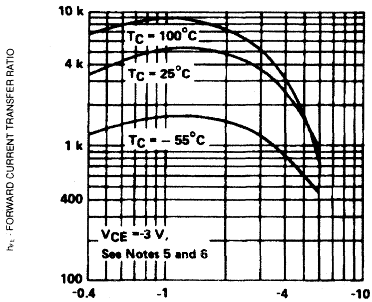
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BASE -EMITTER VOLTAGE
vs
CASE TEMPERATURE



FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

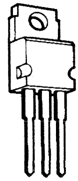


TEXAS INSTRUMENTS

BDW73, BDW73A BDW73B, BDW73C, BDW73D
NPN SILICON POWER DARLINGTONS

Revised March 1990

- **High SOA Capability, 20 V & 4 A**
- **80 W at 25°C Case Temperature**
- **8 A Rated Collector Current**
- **Min h_{FE} of 750 at 3 A, 3 V**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BDW73	BDW73A	BDW73B	BDW73C	BDW73D
V_{CBO}	Collector - base voltage (I_E = 0)	45 V	60 V	80 V	100 V	120 V
V_{CEO}	Collector - emitter voltage (I_E = 0) (Note 1)	45 V	60 V	80 V	100 V	120 V
V_{EBO}	Emitter - base voltage	5 V				
I_C	Continuous collector current	8 A				
I_B	Continuous base current	300 mA				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	80 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W				
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	75 mJ				
T_A	Operating free - air temperature range	-65°C to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 30 mA (Note 5)	I_B = 0	BDW73 BDW73A BDW73B BDW73C BDW73D	45 60 80 100 120			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = 30 V V_{CE} = 40 V V_{CE} = 50 V V_{CE} = 60 V	I_B = 0 I_B = 0 I_B = 0 I_B = 0	BDW73/73A BDW73B BDW73C BDW73D			500 500 500 500	µA
I_{CBO}	Collector - base cut- off current	V_{CB} = 45 V V_{CB} = 60 V V_{CB} = 80 V V_{CB} = 100 V V_{CB} = 120 V	I_E = 0 I_E = 0 I_E = 0 I_E = 0 I_E = 0	BDW73 BDW73A BDW73B BDW73C BDW73D			200 200 200 200 200	µA
I_{CBO}	Collector - base cut-off current	V_{CB} = Rated	I_E = 0	T_C = 150°C			5	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0				2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V V_{CE} = 3 V	I_C = 3 A I_C = 8 A	(Notes 5 & 6)	750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = 3 V	I_C = 3 A	(Notes 5 & 6)			2.5	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 12 mA I_B = 80 mA	I_C = 3 A I_C = 8 A	(Notes 5 & 6)			2.5 4	V
V_{FR}	Reverse diode forward voltage		I_F = -8 A				-3.5	V

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.0	°C/W

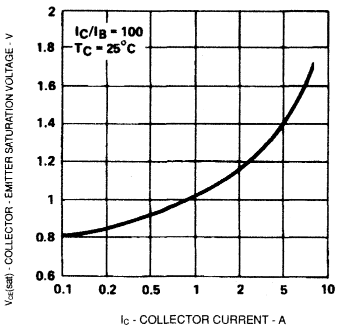
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = 3 A $I_{B(on)}$ = 12 mA $I_{B(off)}$ = -12 mA		1		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = -3.5 V R_L = 10 Ω		5		µs

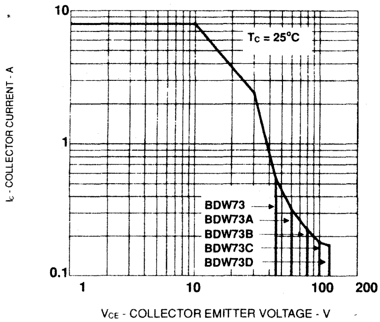
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3 mm from the device body.

TYPICAL CHARACTERISTICS

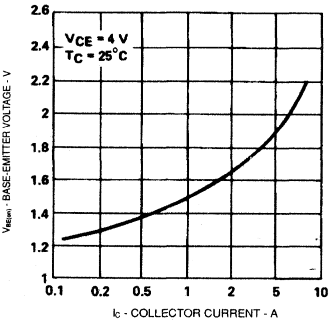
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



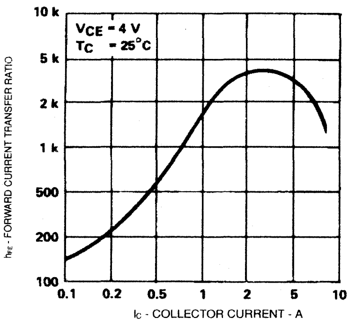
FORWARD - BIAS
MAXIMUM SAFE OPERATING AREA



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



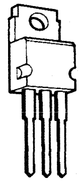
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BDW74, BDW74A BDW74B, BDW74C, BDW74D
PNP SILICON POWER DARLINGTONS

Revised March 1990

- **High SOA Capability, 20 V & 4 A**
- **80 W at 25°C Case Temperature**
- **8 A Rated Collector Current**
- **Min h_{FE} of 750 at 3 A, 3 V**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BDW74	BDW74A	BDW74B	BDW74C	BDW74D
V_{CBO}	Collector - base voltage ($I_E = 0$)	-45 V	-60 V	-80 V	-100 V	-120 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$) (Note 1)	-45 V	-60 V	-80 V	-100 V	-120 V
V_{EBO}	Emitter - base voltage	-5 V				
I_C	Continuous collector current	-8 A				
I_B	Continuous base current	-300 mA				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	80 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	2 W				
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	75 mJ				
T_A	Operating free - air temperature range	-65°C to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: $L = 20$ mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = -20$ V

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = -30 mA $I_B = 0$ (Note 5)	BDW74 BDW74A BDW74B BDW74C BDW74D	-45 -60 -80 -100 -120			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = -30 V $I_B = 0$ V_{CE} = -40 V $I_B = 0$ V_{CE} = -50 V $I_B = 0$ V_{CE} = -60 V $I_B = 0$	BDW74/74A BDW74B BDW74C BDW74D			-500 -500 -500 -500	µA
I_{CBO}	Collector base cut- off current	V_{CB} = -45 V $I_E = 0$ V_{CB} = -60 V $I_E = 0$ V_{CB} = -80 V $I_E = 0$ V_{CB} = -100 V $I_E = 0$ V_{CB} = -120 V $I_E = 0$	BDW74 BDW74A BDW74B BDW74C BDW74D			-200 -200 -200 -200 -200	µA
I_{CBO}	Collector-base cut-off current	V_{CB} = Rated $I_E = 0$	T_C = 150°C			-5	mA
I_{EBO}	Emitter cut-off current	V_{EB} = -5 V $I_C = 0$				-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V I_C = -3 A V_{CE} = -3 V I_C = -8 A	(Notes 5 & 6)	750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = -3 V I_C = -3 A	(Notes 5 & 6)			-2.5	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -12 mA I_C = -3 A I_B = -80 mA I_C = -8 A	(Notes 5 & 6)			-2.5 -4	V
V_{FR}	Reverse diode forward voltage	I_F = 8 A				3.5	V

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.56	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.0	°C/W

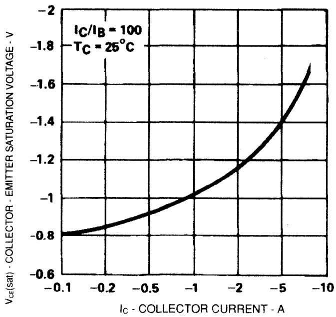
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = -3 A $I_{B(on)}$ = -12 mA $I_{B(off)}$ = 12 mA		1		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = 3.5 V R_L = 10 Ω		5		µs

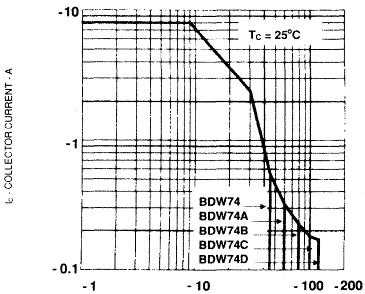
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3 mm from the device body.

TYPICAL CHARACTERISTICS

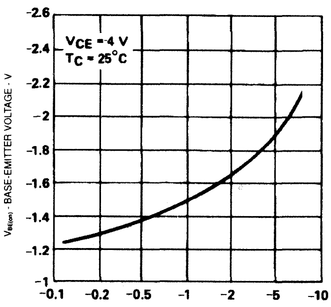
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



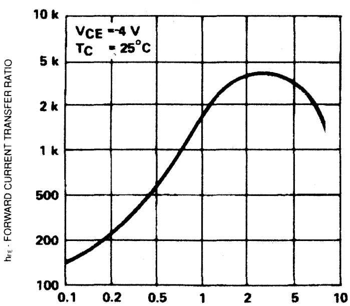
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



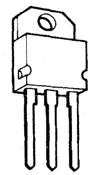
5

BD, BDW, BDX, BU, BUV, BUX, BUY Devices

BDW83, BDW83A BDW83B, BDW83C, BDW83D
NPN SILICON POWER DARLINGTONS

Revised March 1990

- **High SOA Capability, 40 V & 1 A**
- **150 W at 25°C Case Temperature**
- **15 A Rated Collector Current**
- **Min h_{FE} of 750 at 6 A, 3 V**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BDW83	BDW83A	BDW83B	BDW83C	BDW83D
V_{CBO}	Collector - base voltage (I_E = 0)	45 V	60 V	80 V	100 V	120 V
V_{CEO}	Collector - emitter voltage (I_B = 0) (Note 1)	45 V	60 V	80 V	100 V	120 V
V_{EBO}	Emitter - base voltage	5 V				
I_C	Continuous collector current	15 A				
I_B	Continuous base current	500 mA				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	150 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W				
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	100 mJ				
T_A	Operating free - air temperature range	-65 to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 1.2 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: L = 20 mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 30 mA I_B = 0 (Note 5) BDW83 BDW83A BDW83B BDW83C BDW83D	45 60 80 100 120			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = 30 V I_B = 0 BDW83/83A V_{CE} = 40 V I_B = 0 BDW83B V_{CE} = 50 V I_B = 0 BDW83C V_{CE} = 60 V I_B = 0 BDW83D			1 1 1 1	mA
I_{CBO}	Collector - base cut- off current	V_{CB} = 45 V I_E = 0 BDW83 V_{CB} = 60 V I_E = 0 BDW83A V_{CB} = 80 V I_E = 0 BDW83B V_{CB} = 100 V I_E = 0 BDW83C V_{CB} = 120 V I_E = 0 BDW83D			500 500 500 500 500	µA
I_{CBO}	Collector - base cut-off current	V_{CB} = Rated I_E = 0 T_C = 150°C			5	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V I_C = 6 A V_{CE} = 3 V I_C = 15 A (Notes 5 & 6)	750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	V_{CE} = 3 V I_C = 6 A (Notes 5 & 6)			2.5	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 12 mA I_C = 6 A I_B = 150 mA I_C = 15 A (Notes 5 & 6)			2.5 4	V
V_{FR}	Reverse diode forward voltage	I_F = -15 A			-3.5	V

Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			0.83	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

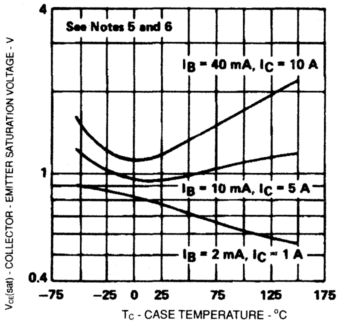
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = 10 A $I_{B(on)}$ = 40 mA $I_{B(off)}$ = -40 mA		0.9		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = -4.2 V R_L = 3 Ω		7		µs

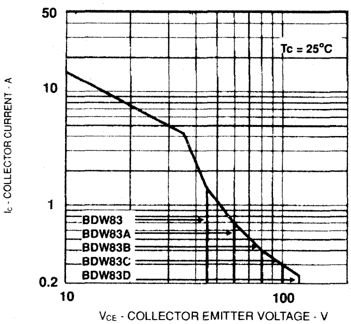
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3 mm from the device body.

TYPICAL CHARACTERISTICS

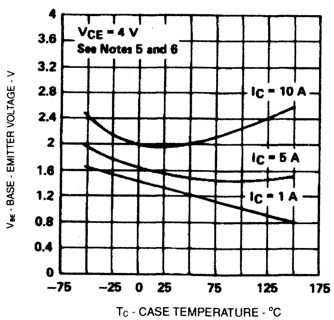
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



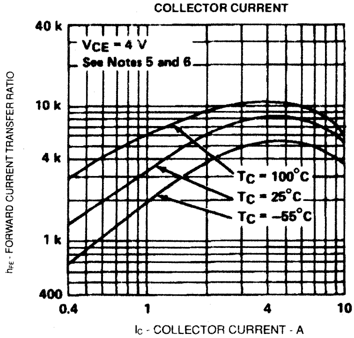
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE



FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

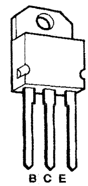


BDW84, BDW84A BDW84B, BDW84C, BDW84D
PNP SILICON POWER DARLINGTONS

Revised March 1990

- **High SOA Capability, 40 V & 1 A**
- **150 W at 25°C Case Temperature**
- **15A Rated Collector Current**

Min h_{FE} of 750 at 6 A, 3 V



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BDW84	BDW84A	BDW84B	BDW84C	BDW84D
V_{CBO}	Collector - base voltage ($I_E = 0$)	-45 V	-60 V	-80 V	-100 V	-120 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$) (Note 1)	-45 V	-60 V	-80 V	-100 V	-120 V
V_{EBO}	Emitter - base voltage	-5 V				
I_C	Continuous collector current	-15 A				
I_B	Continuous base current	-500 mA				
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 2)	150 W				
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 3)	3.5 W				
$I_C^2L/2$	Unclamped inductive load energy (Note 4)	100 mJ				
T_A	Operating free - air temperature range	-65 to + 150°C				
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C				

NOTES: 1: These values apply when the base - emitter diode is open circuited.
2: Derate linearly to 150°C case temperature at the rate of 1.2 W/°C.
3: Derate linearly to 150°C free - air - temperature at the rate of 28 mW/°C.
4: This rating is based on the capability of the transistors to operate safely in a circuit of: $L = 20$ mH, $R_{BB2} = 100\ \Omega$, $V_{BB2} = 0$ V, $R_S = 0.1\ \Omega$, $V_{CC} = -20$ V.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	$I_C = -30$ mA (Note 5)	$I_B = 0$	BDW84 BDW84A BDW84B BDW84C BDW84D	-45 -60 -80 -100 -120			V
I_{CEO}	Collector-emitter cut - off current	$V_{CE} = -30$ V $V_{CE} = -40$ V $V_{CE} = -50$ V $V_{CE} = -60$ V	$I_B = 0$ $I_B = 0$ $I_B = 0$ $I_B = 0$	BDW84/84A BDW84B BDW84C BDW84D			-1 -1 -1 -1	mA
I_{CBO}	Collector - base cut- off current	$V_{CB} = -45$ V $V_{CB} = -60$ V $V_{CB} = -80$ V $V_{CB} = -100$ V $V_{CB} = -120$ V	$I_E = 0$ $I_E = 0$ $I_E = 0$ $I_E = 0$ $I_E = 0$	BDW84 BDW84A BDW84B BDW84C BDW84D			-500 -500 -500 -500 -500	µA
I_{CBO}	Collector - base cut-off current	V_{CB} = Rated	$I_E = 0$	$T_C = 150$°C			-5	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = -5$ V	$I_C = 0$				-2	mA
h_{FE}	Forward current transfer ratio	$V_{CE} = -3$ V $V_{CE} = -3$ V	$I_C = -6$ A $I_C = -15$ A	(Notes 5 & 6)	750 100		20000	
$V_{BE(on)}$	Base -emitter voltage	$V_{CE} = -3$ V	$I_C = -6$ A	(Notes 5 & 6)			-2.5	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = -12$ mA $I_B = -150$ mA	$I_C = -6$ A $I_C = -15$ A	(Notes 5 & 6)			-2.5 -4	V
V_{FR}	Reverse diode forward voltage		$I_F = 15$ A				3.5	V

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			0.83	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			35.7	°C/W

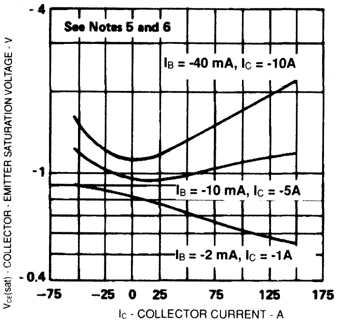
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = -10 A $I_{B(on)}$ = -40 mA $I_{B(off)}$ = 40 mA		0.9		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = 4.2 V R_L = 3 Ω		7		µs

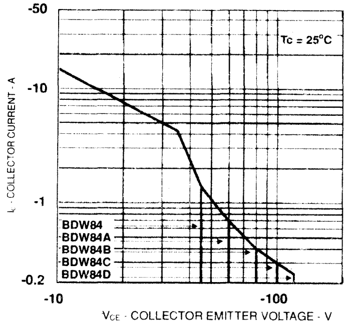
NOTES: 5: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
6: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3 mm from the device body.

TYPICAL CHARACTERISTICS

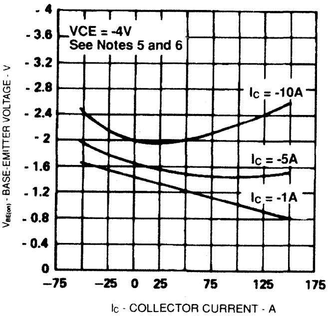
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



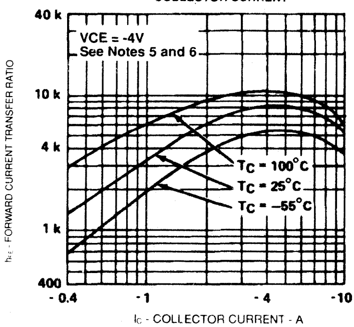
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT



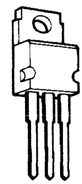
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BDX53, BDX53A, BDX53B, BDX53C
NPN SILICON POWER DARLINGTONS

Revised March 1990

- **60 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Min h_{FE} of 750 at 3 V, 3 A**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BDX53	BDX53A	BDX53B	BDX53C
V_{CBO}	Collector - base voltage	45 V	60 V	80 V	100 V
V_{CEO}	Collector - emitter voltage	45 V	60 V	80 V	100 V
V_{EBO}	Emitter - base voltage	5 V			
I_C	Continuous collector current	8 A			
I_B	Continuous base current	0.2 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 1)	60 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 2)	2 W			
T_A	Operating free - air temperature range	-65 to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C			

NOTES: 1: Derate linearly to 150°C case temperature at the rate of 0.48 W/°C.
2: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 100 mA (Note 3)	I_B = 0	BDX53 BDX53A BDX53B BDX53C	45 60 80 100			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = 30 V V_{CE} = 40 V V_{CE} = 50 V	I_B = 0 I_B = 0 I_B = 0	BDX53/53A BDX53B BDX53C			500 500 500	μA
I_{CBO}	Collector base cut- off current	V_{CB} = 45 V V_{CB} = 60 V V_{CB} = 80 V V_{CB} = 100 V	I_E = 0 I_E = 0 I_E = 0 I_E = 0	BDX53 BDX53A BDX53B BDX53C			200 200 200 200	μA
I_{EBO}	Emitter base cut - off current	V_{EB} = 5 V	I_C = 0				2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V	I_C = 3 A	(Notes 3 & 4)	750			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 12 mA	I_C = 3 A	(Notes 3 & 4)			2	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 12 mA	I_C = 3 A	(Notes 3 & 4)			2.5	V
V_F	Parallel diode forward voltage	I_F = -3 A					-2.5	V

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.08	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

BDX53, BDX53A, BDX53B, BDX53C
NPN SILICON POWER DARLINGTONS

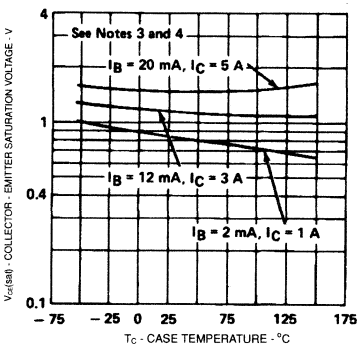
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Rise time	I_C = 3 A $I_{B(on)}$ = 12 mA $I_{B(off)}$ = -12 mA		1		μs
$t_{(off)}$	Storage time	$V_{BE(off)}$ = -4.5 V R_L = 10 Ω		5		μs

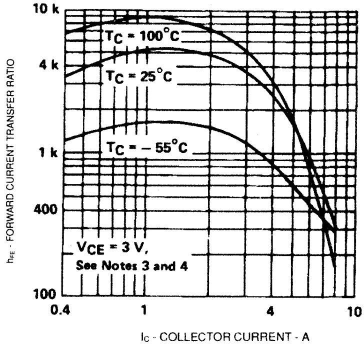
NOTES: 3: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
4: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3.2mm from the devoice body.
5: This combination of maximum voltage and current may be achieved only when switching from saturation to cuttoff with a clamped inductive load.

TYPICAL CHARACTERISTICS

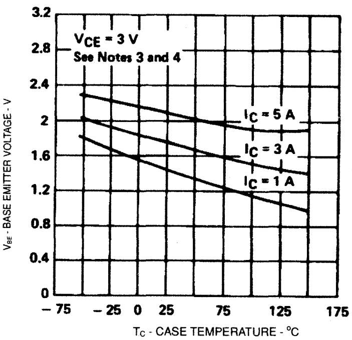
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



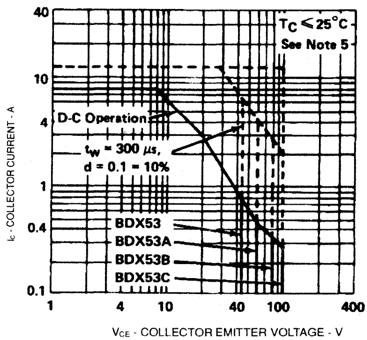
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE



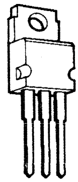
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BDX54, BDX54A, BDX54B, BDX54C
PNP SILICON POWER DARLINGTONS

Revised March 1990

- **60 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Min h_{FE} of 750 at 3 V, 3 A**



B C E

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BDX54	BDX54A	BDX54B	BDX54C
V_{CBO}	Collector - base voltage (I_E = 0)	-45 V	-60 V	-80 V	-100 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	-45 V	-60 V	-80 V	-100 V
V_{EBO}	Base - emitter voltage	-5 V			
I_C	Continuous collector current	-8 A			
I_B	Continuous base current	-0.2 A			
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature (Note 1)	60 W			
P_{tot}	Continuous device dissipation at (or below) 25°C free - air temperature (Note 2)	2 W			
T_A	Operating free - air temperature range	-65 to + 150°C			
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C			

NOTES: 1: Derate linearly to 150°C case temperature at the rate of 0.48 W/°C.
2: Derate linearly to 150°C free - air - temperature at the rate of 16 mW/°C.

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = -100 mA I_B = 0 (Note 3)	BDX54 BDX54A BDX54B BDX54C	-45 -60 -80 -100			V
I_{CEO}	Collector-emitter cut - off current	V_{CE} = -30 V I_B = 0 V_{CE} = -40 V I_B = 0 V_{CE} = -50 V I_B = 0	BDX54/54A BDX54B BDX54C			-500 -500 -500	µA
I_{CBO}	Collector base cut- off current	V_{CB} = -45 V I_E = 0 V_{CB} = -60 V I_E = 0 V_{CB} = -80 V I_E = 0 V_{CB} = -100 V I_E = 0	BDX54 BDX54A BDX54B BDX54C			-200 -200 -200 -200	µA
I_{EBO}	Emitter base cut - off current	V_{EB} = -5 V I_C = 0				-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V I_C = -3 A	(Notes 3 & 4)	750			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = -12 mA I_C = -3 A	(Notes 3 & 4)			-2	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = -12 mA I_C = -3 A	(Notes 3 & 4)			-2.5	V
V_F	Parallel diode forward voltage	I_F = 3 A				2.5	V

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.08	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			62.5	°C/W

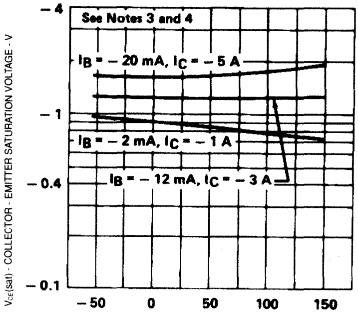
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(on)}$	Turn on time	I_C = -3 A $I_{B(on)}$ = -12 mA $I_{B(off)}$ = 12 mA		1		µs
$t_{(off)}$	Turn off time	$V_{BE(off)}$ = 4.2 V R_L = 10 Ω		5		µs

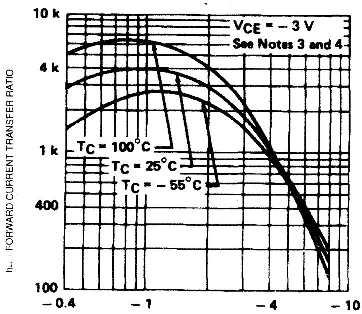
NOTES: 3: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
4: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3.2mm from the device body.
5: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load

TYPICAL CHARACTERISTICS

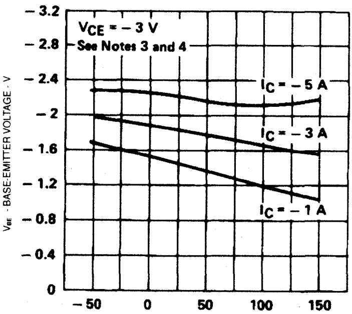
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



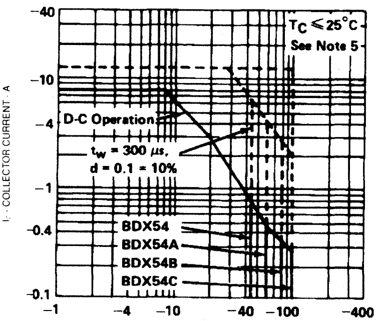
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER VOLTAGE vs CASE TEMPERATURE



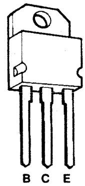
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



BU124, BU124A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **50 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Designed for portable TV Linescan Applications and other Switching Functions**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BU124	BU124A
V_{CBO}	Collector - base voltage (I_E = 0)	350 V	400 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	150 V	150 V
V_{CEX}	Collector - emitter voltage (V_{BE} = -2V)	350 V	400 V
V_{EBO}	Emitter - base voltage	8 V	
I_C	Continuous collector current	10 A	
I_{CM}	Peak collector current (Note 1)	15 A	
I_B	Continuous base current	3 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	50 W	
T_j & T_{stg}	Operating junction and storage temperature range	-55 to + 150°C	

NOTES: 1: This value applies for $t_w \leq$ 1ms, duty cycle $\leq$ 25%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CBO}$	Collector - base breakdown voltage	I_C=1 mA BU124 BU124A	350 400			V V
$V_{(BR)CEO}$	Collector - emitter breakdown voltage	I_C = 50 mA I_B = 0	150			V
$V_{(BR)EBO}$	Emitter - base breakdown voltage	I_E=10 mA I_C = 0	8			V
I_{CBO}	Collector cut-off current	V_{CB} = 300 V BU124 V_{CB} = 350 V BU124A			500 500	µA µA
h_{FE}	Forward current transfer ratio	V_{CE} = 10 V I_C = 4 A (Note 2) V_{CE} = 10 V I_C = 0.5 A	12 20			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.5 A I_C = 4 A (Note 2) I_B = 2 A I_C = 8 A			0.5 1.0	V
$V_{BE(sat)}$	Base - emitter voltage	I_B = 0.5 A I_C = 4 A (Note 2) I_B = 2 A I_C = 8 A			1.2 1.4	V
f_t	Transition frequency	V_{CE} = 5 V I_C = 0.5 A f = 1 MHz		6.0		MHz
C_{obo}	Output capacitance	V_{CB} = 20 V I_E = 0 f = 1 MHz		60		pF

NOTE 2: Measured using pulse techniques pulse width, tp=300µs, duty cycle, d=2%

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
Rθjc	Junction to case thermal resistance			2.5	°C/W

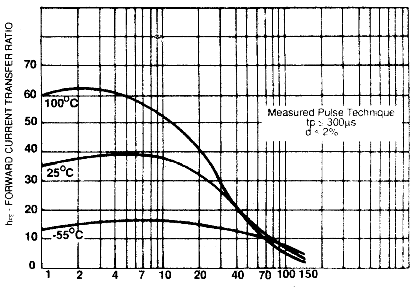
Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_s	Storage time	I_{Bend} = 0.5A I_C = 4 A		2.7		µs
t_f	Fall time				1.0	µs

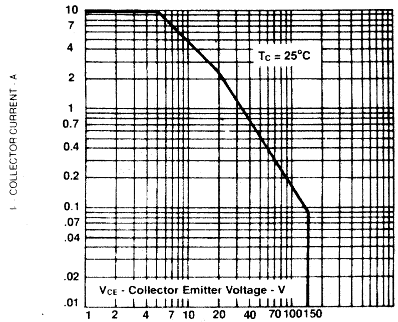
See Appendices for Switching Waveforms and Test Circuits

TYPICAL CHARACTERISTICS

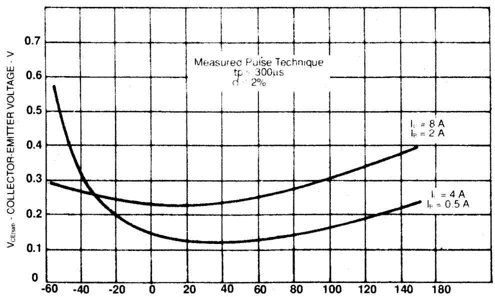
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



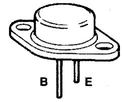
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
JUNCTION TEMPERATURE



BU326, BU326A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **60 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **8 A Peak Collector Current**
- **Designed for Use in Consumer and Industrial High - Voltage Switching Applications, Particularly Switching - Mode Power Supplies**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BU326	BU326A
V_{CBO}	Collector - base voltage (I_E = 0)	800 V	900 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	800 V	900 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	375 V	400 V
V_{EBO}	Emitter - base voltage	10 V	
I_C	Continuous collector current	6 A	
I_{CM}	Peak collector current (Note 1)	8 A	
I_B	Continuous base current	2 A	
I_{BM}	Peak base current (Note 1)	3 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	60 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C	

NOTES: 1: This value applies for $t_w \le$ 2ms, duty cycle $\le$ 10%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 0.1 A L = 25mH (Note 2) BU326 I_C = 0.1 A L = 25mH BU326A	375 400			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 800 V V_{BE} = 0 BU326 V_{CE} = 900 V V_{BE} = 0 BU326A V_{CE} = 800 V T_j = 125°C V_{BE} = 0 BU326 V_{CE} = 900 V T_j = 125°C V_{BE} = 0 BU326A			1 1 2 2	mA
I_{EBO}	Emitter base cut - off current	V_{EB} = 10 V I_C = 0			10	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V I_C = 0.6 A		40		
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.5 A I_C = 2.5 A I_B = 1.25 A I_C = 4 A			1.5 3	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 0.5 A I_C = 2.5 A I_B = 1.25 A I_C = 4 A			1.4 1.6	V

NOTE 2: Inductive loop switching measurement.

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.67	°C

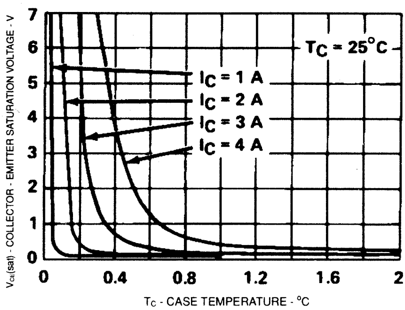
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
t_{on}	Turn on time			T_C= 25°C		0.3	0.5	μs
t_s	Storage time	I_C = 2.5 A	$I_{B(on)}$ = 0.5 A			2	3.5	μs
t_f	Fall time	V_{CC} = 250 V	$I_{B(off)}$ = -1 A			0.15		μs
t_f	Fall time			T_C= 95°C		0.2	1	μs

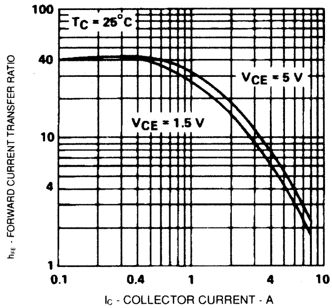
See Appendices for Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

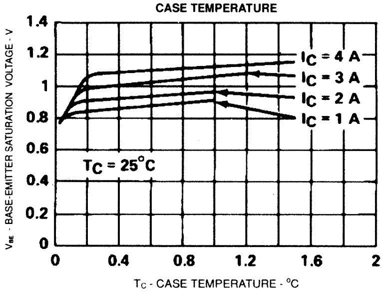
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



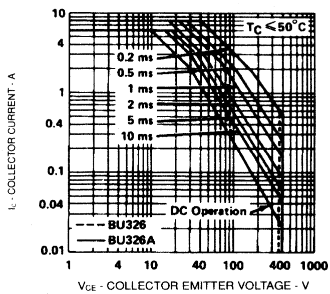
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA

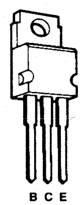


TEXAS INSTRUMENTS

BU406, BU407
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **60 W at 25°C Case Temperature**
- **7 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Designed for Portable TV Linescan Applications for MTV Receiver with 110 - degree Tubes**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BU406	BU407
V_{CBO}	Collector - base voltage ($I_E = 0$)	400 V	330 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	200 V	150 V
V_{CEX}	Collector - emitter voltage (V_{BE} = -2V)	400 V	330 V
V_{EB}	Base - emitter voltage	6 V	
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	7 A	
I_B	Continuous base current	15 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	60 W	
T_j & T_{stg}	Operating junction and storage temperature range	-55 to + 150°C	

NOTES: 1: This value applies for $t_w \leq$ 10ms, duty cycle $\leq$ 25%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector - emitter sustaining voltage	IC = 30 mA IB = 0	140			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 400 V V_{BE} = 0 BU406 V_{CE} = 250 V V_{BE} = 0 BU406 V_{CE} = 330 V V_{BE} = 0 BU407 V_{CE} = 200 V V_{BE} = 0 BU407 V_{CE} = 250 V T_j = 150°C V_{BE} = 0 BU406 V_{CE} = 200 V T_j = 150°C V_{BE} = 0 BU407			5.0 0.1 5.0 0.1 1.0 1.0	mA
I_{EBO}	Emitter base cut - off current	V_{EB} = 6 V I_C = 0			1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 10 V I_C = 4 A (Note 2) V_{CE} = 10 V I_C = 0.5 A	12 20			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.5 A I_C = 5 A (Note 2)			1	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 0.5 A I_C = 5 A (Note 2)			1.2	V
f_T	Transition frequency	V_{CE} = 5 V I_C = 0.5 A f = 1 MHz (Note 3)		6		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V I_E = 0 f = 1 MHz		60		pF

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.08	°C/W
$R_{\theta JA}$	Junction - to - free - air thermal resistance			70	°C/W

Inductive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_s	Storage time	$I_C = 5$ A $I_{B(end)} = 0.5$ A		2.7		μs
$t_{(off)}$	Turn off time				0.75	μs

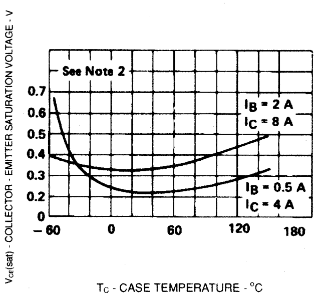
NOTES: 2: These parameters must be measured using pulse techniques, $t_w = 300$μs, duty cycle ≤ 2%

3: To obtain f_T, the $|h_{fe}|$ response is extrapolated at the rate of -6 dB per octave from f = 1 MHz to the frequency at which $|h_{fe}| = 1$.

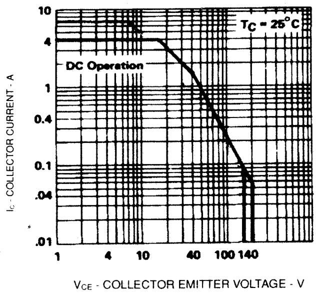
See Appendices for Inductive Switching Test Circuits and Waveforms

TYPICAL CHARACTERISTICS

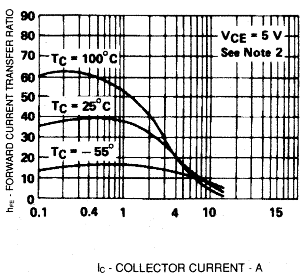
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE



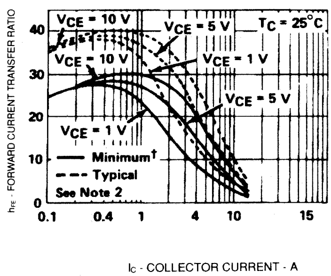
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

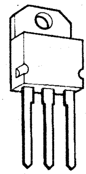


TEXAS INSTRUMENTS

BU426, BU426A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Designed for High Voltage Inductive Load Switching Applications**
- **900 Volt Blocking Capability**



B C E

PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BU426	BU426A
V_{CBO}	Collector - Base voltage (I_E = 0)	800 V	900 V
V_{CES}	Collector -emitter voltage (V_{BE} =0)	800 V	900 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	375 V	400 V
I_C	Continuous collector current	6 A	
I_{CM}	Peak collector current (Note 1)	10 A	
I_B	Continuous base current	+ 2 A, - 0.1A	
I_{BM}	Peak base current (Note 1)	± 3 A	
P_{tot}	Continuous device dissipation at (or below) 50°C case temperature	70 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTES: 1: This value applies for $t_w \leq$ 2ms, duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 100 mA (Note 2)	L = 25 mH		BU426 BU426A	375 400			V
I_{CES}	Collector - emitter cut -off current	V_{CE} = 800 V V_{CE} = 900 V V_{CE} = 800 V V_{CE} = 900 V	 T_j = 125°C T_j = 125°C	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BU426 BU426A BU426 BU426A			1 1 2 2	mA
I_{EBO}	Emitter base cut - off current	V_{EB} = 10 V	I_C = 0					10	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.6 A				30	60	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.5 A I_B = 1.25 A	I_C = 2.5 A I_C = 4 A		(Notes 3 & 4)			1.5 3	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 0.5 A I_B = 1.25 A	I_C = 2.5 A I_C = 4 A		(Notes 3 & 4)			1.4 1.6	V

NOTES 2: Inductive loop switch measurement.
3: These parameters must be measured using pulse techniques. t_w = 300µs, duty cycle ≤ 2%
4: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3.2mm of the device body.

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta jc}$	Thermal Resistance Junction-Case			1.1	°C/W

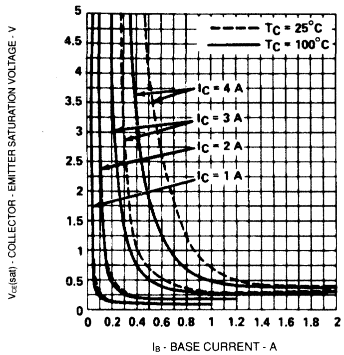
Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 2.5 A Vcc = 250 V	$I_{B(on)}$ = 0.5 A $I_{B(off)}$ = -1 A	T_C = 25°C		0.3	0.6	µs
t_s	Storage time					2.0	3.5	µs
t_f	Fall time					0.15		µs
t_f	Fall time			T_C= 95°C		0.2	0.75	µs

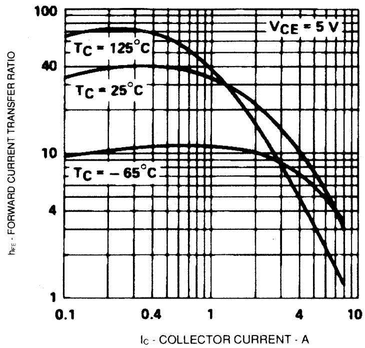
See Appendices for Switching Waveforms and Test Circuits

TYPICAL CHARACTERISTICS

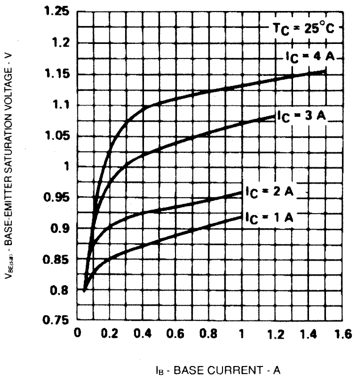
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



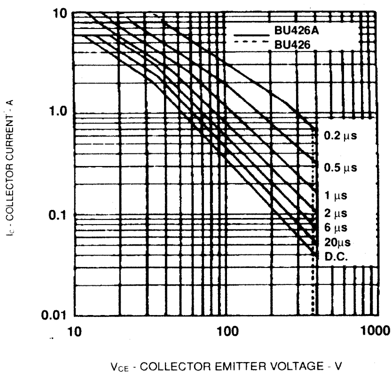
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT



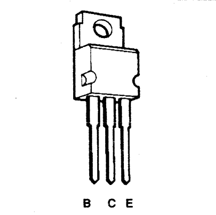
MAXIMU FORWARD - BIAS SAFE OPERATING AREA



NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Designed for Switching-Mode Power Supplies, CRT Scanning, Inverters and Other Industrial Applications, where Rapid Switching of Inductive Load is necessary**
- **Features High Voltage and Peak Current Ratings, Low Saturation Voltages, and a High Degree of Electrical Robustness**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BUV46
V_{CEX}	Collector - emitter voltage (V_{BE} = -2.5 V)	850 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	400 V
V_{EBO}	Emitter - base voltage (I_C = 0)	7 V
I_C	Continuous collector current	6 A
I_{CM}	Peak collector current (Note 1)	8 A
I_B	Continuous base current	2 A
I_{BM}	Peak base current	4 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	70 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C

NOTES: 1: This value applies for $t_w \leq$ 10ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 200 mA L =25 mH (Note 2)	400			V
I_{CEX}	Collector - emitter Cut-off Current	V_{CE} = 850V T_j = 125°C V_{BE}=-2.5V V_{CE} = 850V V_{BE}=-2.5V			1.0 0.1	mA mA
I_{CER}	Collector - emitter cut - off current	VCE = 850 V T_j = 125°C R_{BE} = 10 Ω V_{CE} = 850 V			2.0 0.3	mA mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			1	mA
BV_{EBO}	Emitter base break-down voltage	I_E= 50mA I_C = 0	7		30	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.5 A I_C = 2.5 A (Notes 3 & 4) I_B = 0.7 A I_C = 3.5 A			1.5 5.0	V V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 0.5 A I_C = 2.5 A (Notes 3 & 4)			1.3	V
f_T	Current gain band width product	V_{CE} = 10 V I_C = 500 mA (Note 5)		12		MHz
C_{obo}	Output capacitance	V_{CB} = 20 V I_E = 0 f = 0.1 MHz		110		pF

NOTES : 2: Inductive loop switching measurements.
3: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
4: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3.2mm from the device body
5: To obtain f_T, the $|h_{fe}|$ response is extrapolated at the rate of -6 dB per octave from f = 1 MHz to the frequency at which $|h_{fe}|$ = 1

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta jc}$	Thermal Resistance Junction-Case			1.79	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 2.5 A	$I_{B(on)}$ = 0.5 A			1.0	µs
t_s	Storage time	V_{CC} = 150 V	$I_{B(off)}$ = -0.5 A			3.0	µs
t_f	Fall time					0.8	µs

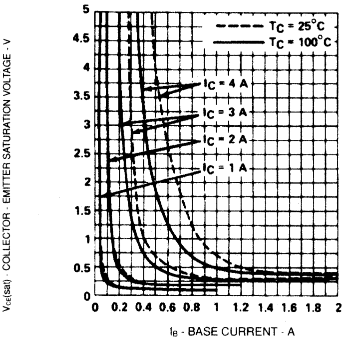
Inductive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_f	Fall time	I_C = 2.5 A	V_B = -5 V		0.15		µs

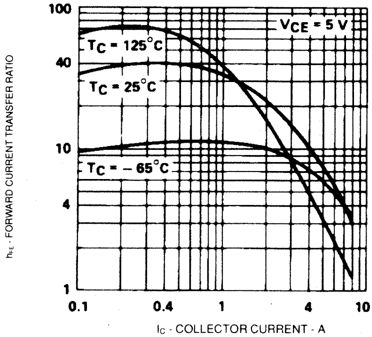
See Appendices for Switching Test Circuit and Waveforms

TYPICAL CHARACTERISTICS

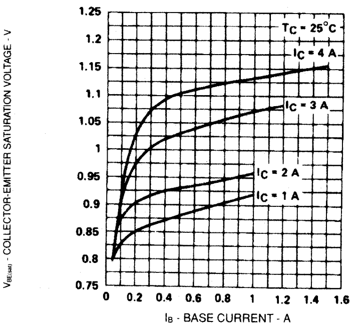
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



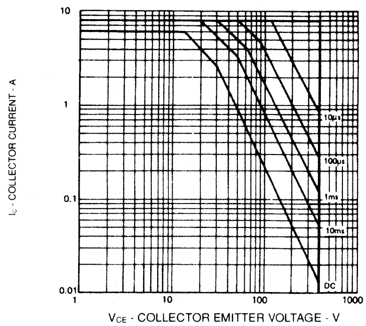
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA

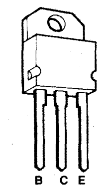


TEXAS INSTRUMENTS

BUV47, BUV47A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Designed for High Voltage Inductive Load Switching Applications**
- **1000 Volt Blocking Capability**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		BUV47	BUV47A
V_{CES}	Collector - emitter voltage (V_{BE} = -2.5 V)	850 V	1000 V
V_{CER}	Collector - emitter voltage (R_{BE} = 10Ω)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	400 V	450 V
I_C	Continuous collector current	9 A	
I_{CM}	Peak collector current (Note 1)	15 A	
I_B	Continuous base current	3 A	
I_{BM}	Peak base current	6 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	120 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTES: 1: This value applies for $t_w \leq$ 5ms, duty cycle $\leq$ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 200 mA L =25 mH (Note 2) BUV47 BUV47A	400 450			V
$V_{(BR)EBO}$	Base - emitter breakdown voltage	I_E = 0.05 A I_C = 0	7		30	V
I_{CES}	Collector - emitter cut-off current	V_{CE} = 850 V V_{BE} = 0 BUV47 V_{CE} =1000 V V_{BE} = 0 BUV47A V_{CE} = 850 V T_j = 125°C V_{BE} = 0 BUV47 V_{CE} =1000 V T_j = 125°C V_{BE} = 0 BUV47A			0.15 0.15 1.5 1.5	mA
I_{CER}	Collector - emitter cut - off current (RBE = 10Ω)	V_{CE} = 850 V V_{BE} = 0 BUV47 V_{CE} =1000 V V_{BE} = 0 BUV47A V_{CE} = 850 V T_j = 125°C V_{BE} = 0 BUV47 V_{CE} =1000 V T_j = 125°C V_{BE} = 0 BUV47A			0.4 0.4 3 3	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			1	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 1 A I_C = 5 A I_B = 2.5 A I_C = 8 A Notes 3 & 4			1.5 3.0	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 1 A I_C = 5 A Notes 3 & 4			1.6	V
f_T	Current gain band width product	V_{CE} = 10 V I_C = 0.5 A f = 1 MHz		8		MHz
C_{obo}	Output capacitance	V_{CB} = 20 V I_C = 0 f = 0.1 MHz		105		pF

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta jc}$	Thermal Resistance Junction-Case			1.25	°C/W

NOTES: 2: Inductive loop switching measurement.
3: These parameters must be measured using pulse techniques, t_w = 300 µs, duty cycle ≤2%
4: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3.2 mm from the device body.

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 5 A V_{CC} = 150 V	IB(on) = 1 A IB(off) = -1 A			1.0	µs
t_s	Storage time					3.0	µs
t_f	Fall time					0.8	µs

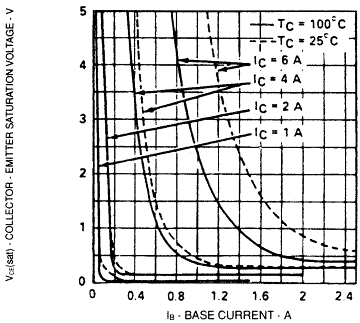
Inductive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 5 A $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 1 A T_C = 100°C			4.0	µs
t_{fi}	Current fall time					0.4	µs

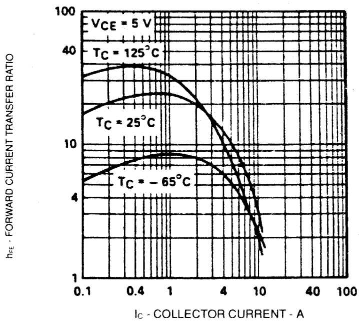
See Appendices for Switching Waveforms and Test Circuits

TYPICAL CHARACTERISTICS

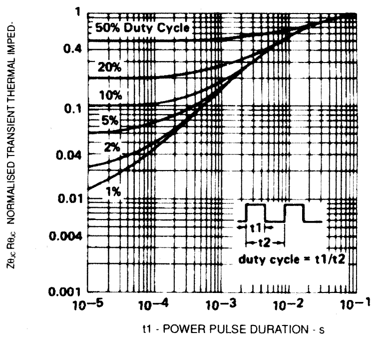
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



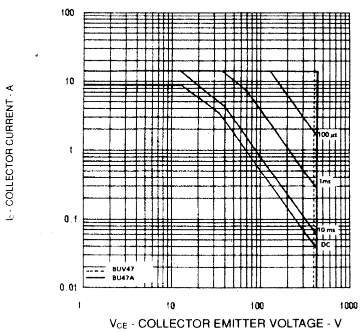
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



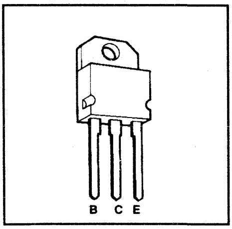
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



BUV48, BUV48A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **Rugged Triple - Diffused Planar Construction**
- **Designed for High Voltage Inductive Load Switching Applications**
- **1000 Volt Blocking Capability**



PACKAGE: SOT93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUV48	BUV48A
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V	1000 V
V_{CER}	Collector - emitter voltage (R_{BE} = 10Ω)	850 V	1000 V
V_{CER}	Collector - emitter voltage (open base)	400 V	450 V
I_C	Continuous collector current	15 A	
I_{CM}	Peak collector current (Note 1)	30 A	
I_B	Continuous base current	4 A	
I_{BM}	Peak base current (Note 1)	20 A	
I_{CSM}	Non repetitive accidental peak surge current	55 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	125 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTES: 1: This value applies for $t_w \leq$ 2ms, duty cycle ≤ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 200 mA L =25 mH			BUV48 BUV48A	400 450			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 850V V_{CE} = 1000V V_{CE} = 850V V_{CE} = 1000V	 T_j = 125°C T_j = 125°C	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BUV48 BUV48A BUV48 BUV48A			0.2 0.2 2.0 2.0	mA
I_{CER}	Collector - emitter cut - off current	VCE = 850V V_{CE} = 1000V V_{CE} = 850V V_{CE} = 1000V	 T_j = 125°C T_j = 125°C	R_{BE} = 10Ω R_{BE} = 10Ω R_{BE} = 10Ω R_{BE} = 10Ω	BUV48 BUV48A BUV48 BUV48A			0.5 0.5 4.0 4.0	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0					1	mA
V_{EBO}	Emitter base breakdown voltage	I_E = 0.05 A	I_C = 0			7		30	V
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 2 A I_B = 3 A I_B = 1.6 A I_B = 2.4 A	I_C = 10 A I_C = 15 A I_C = 8 A I_C = 12 A	Notes 3 & 4	BUV48 BUV48 BUV48A BUV48A			1.5 5.0 1.5 5.0	V
$V_{BE(sat)}$	Base - emitter voltage	I_B = 2 A I_B = 1.6 A	I_C = 10 A I_C = 8 A	Notes 3 & 4	BUV48 BUV48A			1.6 1.6	V
f_T	Current gain band width product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			10		MHz
C_{obo}	Output capacitance	V_{CB} = 20 V	I_C = 0	f = 1 MHz			150		pF

BUV48, BUV48A
NPN SILICON POWER TRANSISTORS

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 10 A, $I_{B(on)}$ = 2 A, V_{CC} = 150V, $I_{B(off)}$ = -2 A, BUV48			1	µs
t_s	Storage time				3	µs
t_f	Fall time				0.8	µs
t_{on}	Turn on time	I_C = 8 A, $I_{B(on)}$ = 1.6 A, V_{CC} = 150V, $I_{B(off)}$ = -1.6 A, BUV48A			1	µs
t_s	Storage time				3	µs
t_f	Fall time				0.8	µs

Inductive - Load - Switching characteristics at 100°C Case Temperature

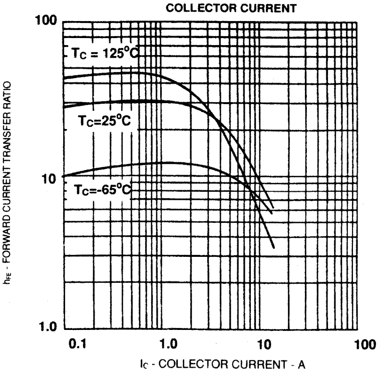
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_s	Storage time	I_C = 10 A, $I_{B(on)}$ = 2 A, $V_{B(off)}$ = -5 V, BUV48			4	µs
t_f	Fall time				0.4	µs
t_s	Storage time	I_C = 8 A, $I_{B(on)}$ = 1.6 A, $V_{B(off)}$ = -5 V, BUV48A			4	µs
t_f	Fall time				0.4	µs

NOTES: 2: Inductive loop switching measurement.
3: These parameters must be measured using pulse techniques, t_w = 300 µs, duty cycle ≤ 2%
4: These parameters are measured with voltage sensing contacts separated from the current carrying contacts and located within 3.2mm from the device body.

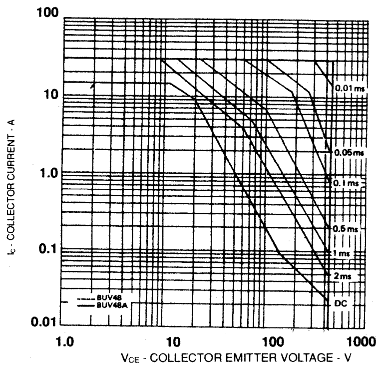
See Appendices for Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



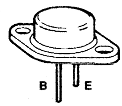
MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



BUX47, BUX47A, BUX47B
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **125 W at 25°C Case Temperature**
- **9 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Designed for Switching - Mode Power Supplies and Industrial Applications**
- **Series Features High - Voltage and Peak Current Ratings, Low Saturation Voltages and a High Degree of Electrical Robustness**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUX47	BUX47A	BUX47B
V_{CEX}	Collector - emitter voltage (V_{BE} = - 2.5 V)	850 V	1000 V	850 V
V_{CER}	Collector - emitter voltage (R_{BE} = 10 Ω)	850 V	1000 V	850 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	400 V	450 V	400 V
I_C	Continuous collector current	9 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_B	Continuous base current	6 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	125 W		
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 200°C		

NOTES: 1: This value applies for $t_w \leq$ 5ms, duty cycle ≤ 12%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 0.2 A L = 25mH (Note 2) BUX47 BUX47A BUX47B	400 450 400			V
$V_{(BR)EBO}$	Base - emitter breakdown voltage	I_E = 50 mA I_C = 0	7		30	V
I_{CER}	Collector - emitter cut-off current	V_{CE} = 850 V R_{BE} ≤ 10 Ω BUX47/47B V_{CE} =1000 V R_{BE} ≤ 10 Ω BUX47A V_{CE} = 850 V T_j = 125°C R_{BE} ≤ 10 Ω BUX47/47B V_{CE} =1000 V T_j = 125°C R_{BE} ≤ 10 Ω BUX47A			0.4 0.4 3 3	mA
I_{CEX}	Collector - emitter cut-off current	V_{CE} = 850 V V_{BE} = -2.5 V BUX47/47B V_{CE} =1000 V V_{BE} = -2.5 V BUX47A V_{CE} = 850 V T_j = 125°C V_{BE} = -2.5 V BUX47/47B V_{CE} =1000 V T_j = 125°C V_{BE} = -2.5 V BUX47A			0.15 0.15 1.5 1.5	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			1	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 1.2 A I_C = 6 A BUX47B I_B = 3 A I_C = 9 A BUX47B I_B = 1 A I_C = 5 A BUX47/47A I_B = 2.5 A I_C = 8 A BUX47			1.5 3 1.5 3	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 1 A I_C = 5 A BUX47/47A I_B = 1.2 A I_C = 6 A BUX47B			1.6 1.6	V
f_T	Current Gain Band Width Product	V_{CE} = 10 V I_C = 0.5 A (Note 3)		8		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V I_C = 0 f = 0.1 MHz		105		pF

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.4	°C/W

Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 5 A, Vcc = 150 V	$I_{B(on)}$ = 1 A, $I_{B(off)}$ = -1 A	BUX47/47A			1	μs
t_s	Storage time						3	μs
t_f	Fall time						0.8	μs
t_{on}	Turn on time	I_C = 6 A, Vcc = 150 V	$I_{B(on)}$ = 1.2 A, $I_{B(off)}$ = -1.2 A	BUX47B			1	μs
t_s	Storage time						3	μs
t_f	Fall time						0.8	μs

Inductive - Load - Switching characteristics at 100°C Case Temperature

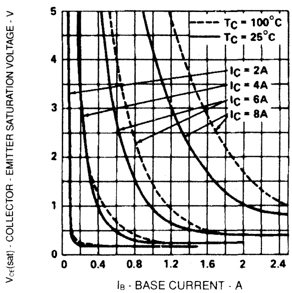
PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
t_s	Storage time	I_C = 5 A, $V_{B(off)}$ = -5 V	$I_{B(on)}$ = 1 A	BUX47/47A			4	μs
t_f	Fall time						0.4	μs
t_s	Storage time	I_C = 6 A, $V_{B(off)}$ = -5 V	$I_{B(on)}$ = 1.2 A	BUX47B			4	μs
t_f	Fall time						0.4	μs

NOTES 2: These parameters must be measured using pulse techniques, t_w = 300μs, duty cycle ≤ 2%
3: To obtain f_T, the $|h_{fe}|$ response is extrapolated at the rate of -6 dB per octave from f = 1 MHz to the frequency at which $|h_{fe}|$ = 1
4: Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

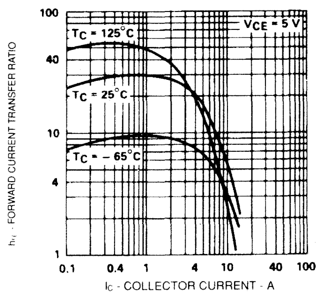
See Appendices for Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

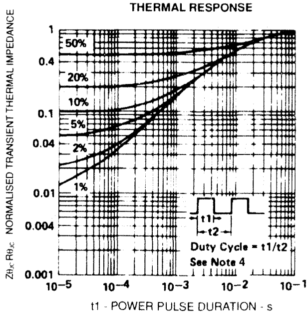
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



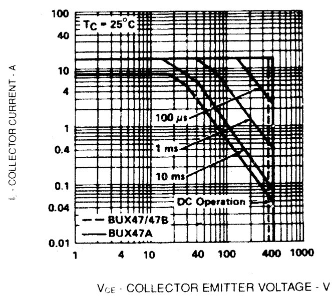
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



THERMAL RESPONSE



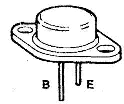
FORWARD - BIAS OPERATING AREA



BUX48, BUX48A
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **175 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **30 A Peak Collector Current**
- **Designed for Switching - Mode Power Supplies and Industrial Applications**
- **Series features High - Voltage and Peak Current Ratings, Low Saturation Voltages and a High Degree of Electrical Robustness**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUX48	BU48A
V_{CEX}	Collector - emitter voltage (V_{BE} = -2.5 V)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (R_{BE} = 10 Ω)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	400 V	450 V
I_C	Continuous collector current	15 A	
I_{CM}	Peak collector current (Note 1)	30 A	
I_{CSM}	Non-repetitive accidental peak surge current	55 A	
I_B	Continuous base current	4 A	
I_{BM}	Peak base current (Note 1)	20 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	175 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 200°C	

NOTES: 1: This value applies for $t_w \leq$ 5ms, duty cycle ≤ 10%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 200 mA (Note 2) L = 25mH BUX48 BUX48A	400 450			V
$V_{(BR)EBO}$	Base - emitter breakdown voltage	I_E = 50 mA I_C = 0	7		30	V
I_{CER}	Collector - emitter cut off current	V_{CE} = 850 V $R_{BE} \leq$ 10 Ω BUX48 V_{CE} =1000 V $R_{BE} \leq$ 10 Ω BUX48A V_{CE} = 850 V T_j = 125°C $R_{BE} \leq$ 10 Ω BUX48 V_{CE} =1000 V T_j = 125°C $R_{BE} \leq$ 10 Ω BUX48A			0.5 0.5 4 4	mA
I_{CEX}	Collector - emitter cut off current	V_{CE} = 850 V V_{BE} = -2.5 V BUX48 V_{CE} =1000 V V_{BE} = -2.5 V BUX48A V_{CE} = 850 V T_j = 125°C V_{BE} = -2.5 V BUX48 V_{CE} =1000 V T_j = 125°C V_{BE} = -2.5 V BUX48A			0.2 0.2 2 2	mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V I_C = 0			1	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 2 A I_C = 10 A BUX 48 I_B = 3 A I_C = 15 A BUX 48 I_B = 1.6 A I_C = 8 A BUX 48A I_B = 2.4 A I_C = 12 A BUX 48A			1.5 5 1.5 5	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 2 A I_C = 10 A BUX 48 I_B = 1.6 A I_C = 6 A BUX 48A			1.6 1.6	V
f_T	Current gain band-width product	V_{CE} = 10 V I_C = 0.5 A (Note 3)		10		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V I_C = 0 f = 0.1 MHz		150		pF

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1	°C/W

Inductive - Load - Switching characteristics at 100°C Case Temperature (unless otherwise stated)

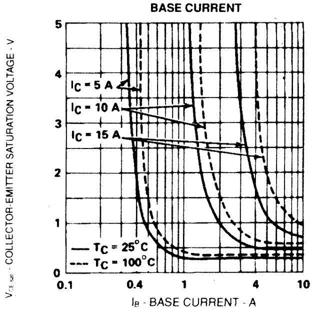
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_s	Storage time	I_C = 10 A	$I_{B(on)}$ = 2 A			5	µs
t_f	Fall time	$V_{B(off)}$ = -5 V	BUX48			0.4	µs
t_s	Storage time	I_C = 8 A	$I_{B(on)}$ = 1.6 A			5	µs
t_f	Fall time	$V_{B(off)}$ = -5 V	BUX48A			0.4	µs

NOTES 2: These parameters must be measured using pulse techniques, t_w = 5 ms, duty cycle ≤ 2%
3: To obtain f_T, the $|h_{fe}|$ response is extrapolated at the rate of -6 dB per octave from f = 1 MHz to the frequency at which $|h_{fe}|$ = 1

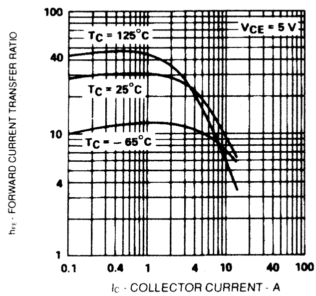
See Appendices for Inductive Switching Waveforms and Test Circuits

TYPICAL CHARACTERISTICS

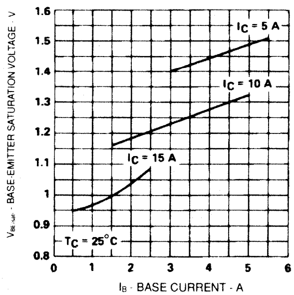
COLLECTOR-EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



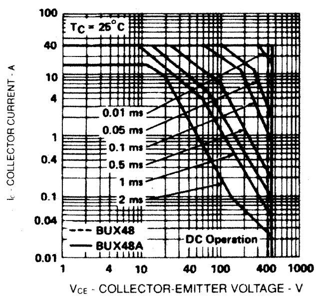
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE
vs
BASE CURRENT

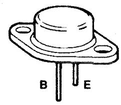


MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



Revised March 1990

- **150 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Designed for Switching - Mode Power Supplies and Industrial Applications**
- **Series Features High - Voltage and Peak Current Ratings, Low Saturation Voltages and a High Degree of Electrical Robustness**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUX80	BUX81
V_{CES}	Collector - base voltage ($V_{BE} = 0$)	850 V	1000 V
V_{CER}	Collector - emitter voltage ($R_{BE} = 10\ \Omega$)	500 V	500 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	400 V	450 V
I_C	Continuous collector current	10 A	
I_{CM}	Peak collector current (Note 1)	15 A	
I_B	Continuous base current	4 A	
I_{BM}	Peak base current (Note 1)	6 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	150 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 200°C	

NOTES: 1: This value applies for $t_w \leq 2$ms, duty cycle $\leq 10\%$

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	$I_C = 0.1$A (Note 2)	L = 25mH	BUX80 BUX81	400 450			V
$V_{CER(sus)}$	Collector - emitter sustaining voltage	$I_C = 0.1$A (Note 2)	L = 25mH	$R_{BE} = 50\ \Omega$	500			
I_{CES}	Collector - emitter cut-off current	$V_{CE} = 850$ V $V_{CE} = 1000$ V $V_{CE} = 850$ V $V_{CE} = 1000$ V	$V_{BE} = 0$ $V_{BE} = 0$ $T_j = 125°C$ $V_{BE} = 0$ $T_j = 125°C$ $V_{BE} = 0$	BUX80 BUX81 BUX80 BUX81			1 1 3 3	mA
I_{EBO}	Emitter cut - off current	$V_{EB} = 10$ V	$I_C = 0$				10	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = 1$ A $I_B = 2.5$ A	$I_C = 5$ A $I_C = 8$ A	(Notes 3 & 4)			1.5 3	V
$V_{BE(sat)}$	Base - emitter saturation voltage	$I_B = 1$ A $I_B = 2.5$ A	$I_C = 5$ A $I_C = 8$ A	(Notes 3 & 4)			1.4 1.8	V
f_T	Current gain band-width product	$V_{CE} = 10$ V	$I_C = 0.5$ A	(Note 5)		8		MHz
C_{obo}	Output capacitance	$V_{CB} = 20$ V	$I_C = 0$	f = 0.1 MHz		105		pF

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.17	°C/W

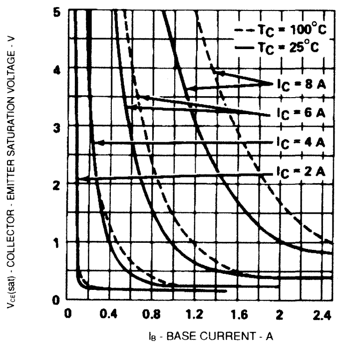
Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 5 A	$I_{B(on)}$ = 1 A				0.5	µs
t_s	Storage time	V_{CC} = 250 V	$I_{B(off)}$ = -2 A	T_C= 25°C			3.5	µs
t_f	Fall time			T_C = 95°C			0.8	µs

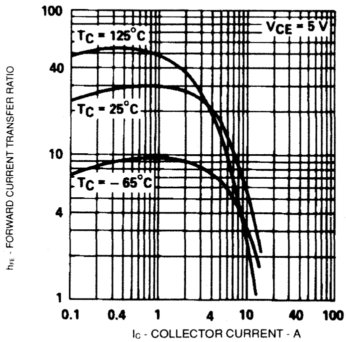
NOTES: 3: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%
4: These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3.2mm from the device body
5: To obtain f_T, the $|h_{fe}|$ response is extrapolated at the rate of -6 dB per octave from f = 1 MHz to the frequency at which $|h_{fe}|$ = 1
6: Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

TYPICAL CHARACTERISTICS

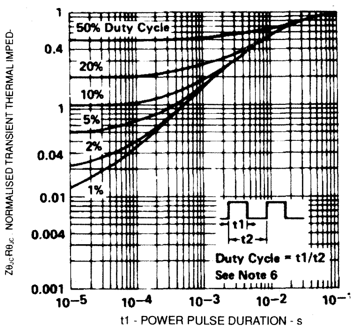
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



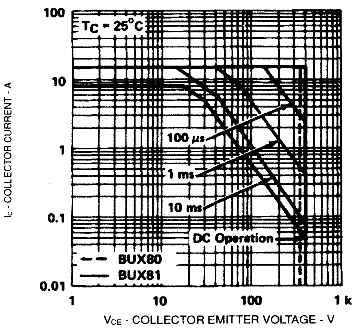
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



THERMAL RESPONSE



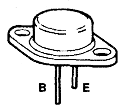
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



TEXAS INSTRUMENTS

Revised March 1990

- **60 W at 50°C Case Temperature**
- **6 A Continuous Collector Current**
- **8 A Peak Collector Current**
- **Designed for Switching - Mode Power Supplies and Industrial Applications**
- **Series Features High - Voltage and Peak Current Ratings, LowSaturation Voltages and a High Degree of Electrical Robustness**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUX82	BUX83
V_{CBO}	Collector - base voltage ($I_E = 0$)	800 V	1000 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	800 V	1000 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	400 V	450 V
I_C	Continuous collector current	6 A	
I_{CM}	Peak collector current (Note 1)	8 A	
I_B	Continuous base current	2 A	
I_{BM}	Peak base current (Note 1)	3 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	60 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C	

NOTES: 1: This value applies for $t_w \leq 2ms$, duty cycle $\leq 2\%$

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage (Note 2)	$I_C = 0.1A$ L = 25mH BUX82 BUX83	400 450			V
$V_{CER(sus)}$	Base - emitter resistance (Note 2)	$I_C = 0.1A$ L = 15mH $R_{BE} = 100\ \Omega$	500			V
I_{CEO}	Collector - emitter cut - off current	$V_{CE} = 400$ V $I_B = 0$ BUX82 $V_{CE} = 450$ V $I_B = 0$ BUX83			1 1	µA
I_{CES}	Collector-emitter cut-off current	$V_{CE} = 800$ V BUX82 $V_{CE} = 1000$ V BUX83 $V_{CE} = 800$ V $T_C = 125°C$ BUX82 $V_{CE} = 1000$ V $T_C = 125°C$ BUX83			1 1 150 150	µA µA µA µA
I_{EBO}	Emitter cut - off current	$V_{EB} = 10$ V $I_C = 0$			1	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage	$I_B = 0.5$ A $I_C = 2.5$ A (Notes 2 & 3) $I_B = 1.25$ A $I_C = 4$ A			1 2	V V
$V_{BE(sat)}$	Base - emitter saturation voltage	$I_B = 0.5$ A $I_C = 2.5$ A (Notes 2 & 3) $I_B = 1.25$ A $I_C = 4$ A			1.2 1.4	V V
h_{FE}	Forward current transfer ratio	$V_{CE} = 5$ V $I_C = 0.6$ A (Note 3)		40		
f_T	Current gain band-width product	$V_{CE} = 10$ V $I_C = 0.2$ A (Note 4)		12		MHz
C_{ob}	Output capacitance	$V_{CB} = 20$ V $I_E = 0$ f = 0.1 MHz		110		pF

NOTE: 2: Inductive loop switching measurement
3: These parameters must be measured using pulse techniques, $t_w = 300\mu s$, duty cycle $\leq 2\%$
4: To obtain f_T, the $|h_{fe}|$ response is extrapolated at the rate of -6 dB per octave from f = 1 MHz to the frequency at which $|h_{fe}| = 1$
5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$.

Thermal Characteristics

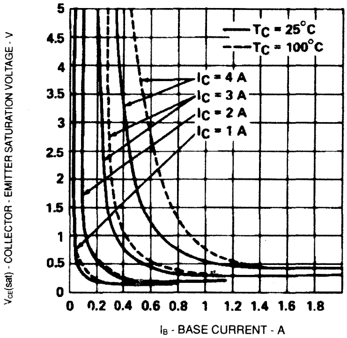
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.65	°C/W

Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

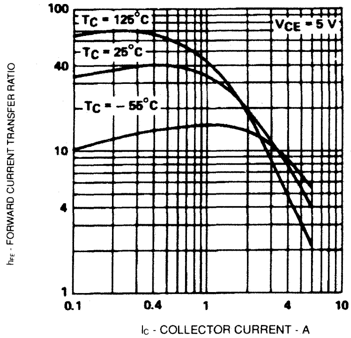
PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 2.5 A	$I_{B(on)}$ = 0.5 A	T_C = 25°C			0.4	µs
t_s	Storage time	V_{CC} = 250 V	$I_{B(off)}$ = -1 A				2.5	µs
t_f	Fall time						0.25	µs
t_{on}	Turn on time	I_C = 2.5 A	$I_{B(on)}$ = 0.5 A	T_C = 100°C			0.8	µs
t_s	Storage time	V_{CC} = 250 V	$I_{B(off)}$ = -1 A				3	µs
t_f	Fall time						0.5	µs

TYPICAL CHARACTERISTICS

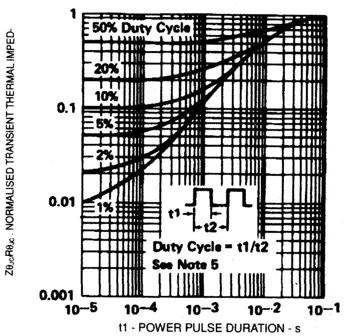
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



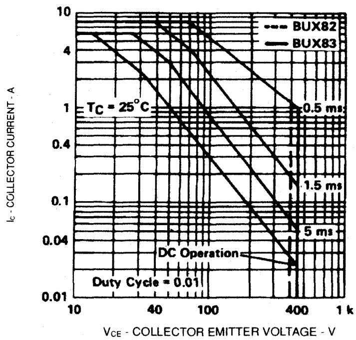
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



MAXIMUM FORWARD - BIAS SAFE OPERATING AREA

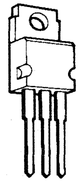


TEXAS INSTRUMENTS

NPN SILICON POWER TRANSISTORS

Revised March 1990

- **40 W at 25°C Case Temperature**
- **2 A Continuous Collector Current**
- **3 A Peak Collector Current**
- **Typical t_f = 200 ns at 25°C**
- **Designed for Switching - Mode Power Supplies and Industrial Applications**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUX84	BUX85
V_{CBO}	Collector - base voltage (I_E = 0)	800 V	1000 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	800 V	1000 V
V_{CES}	Collector - emitter voltage (I_B = 0)	400 V	450 V
I_C	Continuous collector current	2 A	
I_{CM}	Peak collector current (Note 1)	3 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	40 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 150°C	

NOTES: 1: This value applies for $t_w \le$ 2ms, duty cycle $\le$ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 0.1 A	L = 25 mH	(Note 2)	BUX84 BUX85	400 450			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 800 V V_{CE} = 1000 V V_{CE} = 800 V V_{CE} = 1000 V	 T_C = 125°C T_C = 125°C	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	BUX84 BUX85 BUX84 BUX85			200 200 1 1	µA µA mA mA
I_{EBO}	Emitter cut - off current	V_{EB} = 5 V	I_C = 0					1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.1 A		(Note 3)		35		
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 30 mA I_B = 0.2 A	I_C = 0.3 A I_C = 1 A		(Note 3)			0.8 1	V
$V_{BE(sat)}$	Base - emitter voltage	I_B = 0.2 A	I_C = 1 A		(Note 3)			1.1	V
f_T	Current gain band width product	V_{CE} = 10 V	I_C = 0.2 A		(Note 4)		12		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0		f = 0.1 MHz		60		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters muct be measured using pulse techniques, t_w = 300 µs, duty cycle $\le$ 2%.
4. To obtain the $|h_{fe}|$ response is extrapolated at the rate of -6 dB per octave from f = 1MHz to the frequency at which $|h_{fe}|$ = 1.
5. Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

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BD, BDW, BDX, BU, BUV, BUX, BUY Devices

Thermal Characteristics

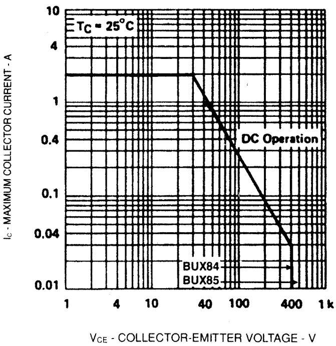
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.5	°C/W

Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

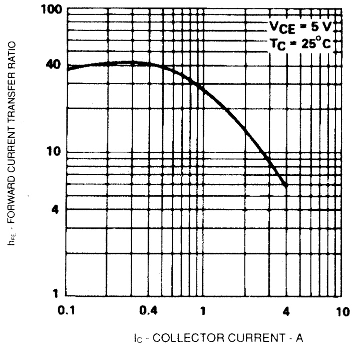
PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 1A	$I_{B(on)}$ = 0.2 A	T Case = 25°C		0.25	0.5	µs
t_s	Storage time					1.8		µs
t_f	Fall time	Vcc = 250 V	$I_{B(off)}$ = -0.4 A			0.2		µs
t_f	Fall time			T Case = 95°C			0.4	µs

TYPICAL CHARACTERISTICS

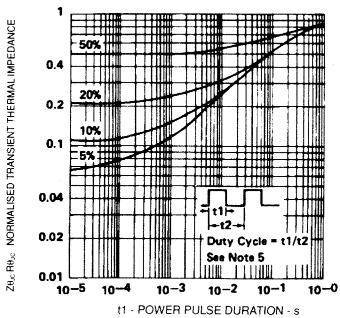
MAXIMUM COLLECTOR CURRENT
vs
COLLECTOR-EMITTER VOLTAGE



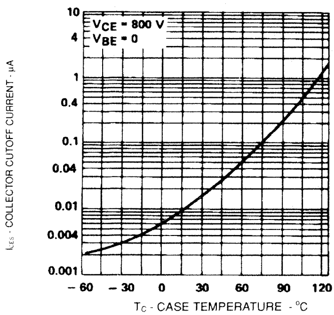
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



THERMAL RESPONSE

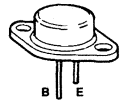


COLLECTOR CUTOFF CURRENT
vs
CASE TEMPERATURE



Revised March 1990

- **250 W at 25°C Case Temperature**
- **30 A Continuous Collector Current**
- **60 A Peak Collector Current**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUX98	BU98A
V_{CEX}	Collector - emitter voltage (V_{BE} = -3 V)	850 V	1000 V
V_{CER}	Collector - emitter voltage (R_{BE} = 10 Ω)	850 V	1000 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	400 V	450 V
I_C	Continuous collector current	30 A	
I_{CM}	Peak collector current (Note 1)	60 A	
I_{CSM}	Non repetitive accidental peak surge current	110 A	
I_B	Continuous base current	8 A	
I_{BM}	Peak base current (Note 1)	30 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	250 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 200°C	

NOTES: 1: This value applies for $t_w \leq$ 2ms, duty cycle $\leq$ 2%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 100 mA L = 25mH (Note 2)	BUX98 BUX98A	400 450			V
I_{CEX}	Collector - emitter cut-off current	V_{CE} = 850 V V_{BE} = -3 V V_{CE} =1000 V V_{BE} = -3 V V_{CE} = 850 V V_{BE} = -3 V T_C = 125°C V_{CE} =1000 V V_{BE} = -3 V T_C = 125°C	BUX98 BUX98A BUX98 BUX98A			10 10 200 200	µA µA µA µA
I_{CER}	Collector - emitter cut-off current	V_{CE} = 850 V R_{BE} = 10Ω V_{CE} =1000 V R_{BE} = 10Ω V_{CE} = 850 V R_{BE} = 10Ω T_C = 125°C V_{CE} =1000 V R_{BE} = 10Ω T_C = 125°C	BUX98 BUX98A BUX98 BUX98A			50 50 500 500	µA µA µA µA
I_{EBO}	Emitter-Base cut-off current	V_{EB} = 5 V I_C = 0				1.0	mA
B_{VEBO}	Base - emitter breakdown voltage	I_E = 0.1 A I_C = 0		7		30	V
$V_{BE}(sat)$	Base - emitter saturation voltage	I_B = 4.0 A I_C = 20 A (Note 3 & 4) I_B = 3.2 A I_C = 16 A	BUX98 BUX98A			1.6 1.6	V
$V_{CE}(sat)$	Collector - emitter saturation voltage	I_B = 4.0 A I_C = 20 A I_B = 8.0 A I_C = 30 A (Note 3 & 4) I_B = 3.2 A I_C = 16 A I_B = 5.0 A I_C = 24 A	BUX98 BUX98A BUX98 BUX98A			1.5 3.5 1.5 5	V
f_T	Current Gain Band Width Product	V_{CE} = 10 V I_C = 0.5 A F = 1MHz			10		MHz
C_{obo}	Output capacitance	V_{CB} = 20 V I_E = 0 F = 0.1 MHz			300		pf

NOTES: 2. Inductive loop switching measurement.
3. Measured using pulse techniques pulse width = 300 us, duty cycle = 2%
4. Measured with voltage sensing contacts separated from the current carrying contacts and located within 0.125 inches (3.2mm) from the device body.
5. Read time at end of t1, $T_{J(max)} - T_C = P_{D(peak)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$.

Thermal Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			0.70	°C/W

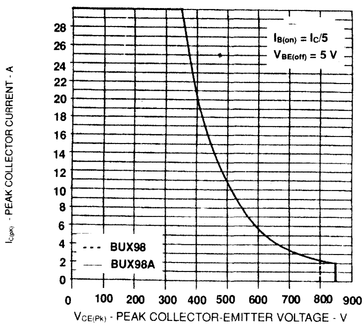
Inductive - Load - Switching characteristics at 100°C Case Temperature

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_s	Storage time	I_C = 20 A	$I_{B(on)}$ = 4 A			5	µs
t_f	Fall time	V_{BE} = -5 V	BUX98			0.4	ms
t_s	Storage time	I_C = 16 A	$I_{B(on)}$ = 3.2 A			5	µs
t_f	Fall time	V_{BE} = -5 V	BUX98A			0.4	ms

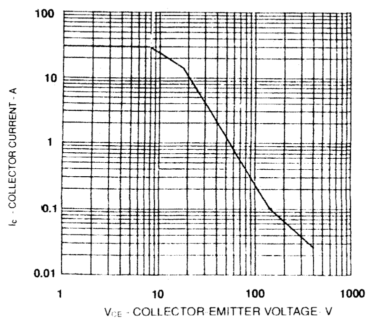
See Appendices for Inductive Switching Waveforms and Test Circuits

TYPICAL CHARACTERISTICS

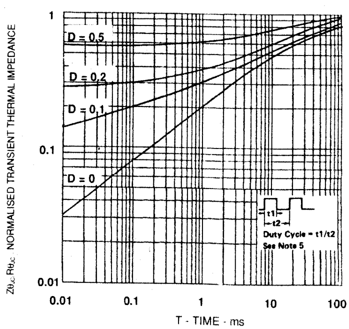
MAXIMUM REVERSE BIAS OPERATING AREA



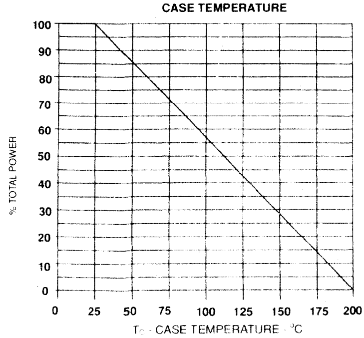
MAXIMUM FORWARD-BIAS
SAFE OPERATING AREA



THERMAL RESPONSE



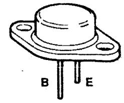
MAXIMUM POWER DISSIPATION
vs
CASE TEMPERATURE



BUY69A, BUY69B, BUY69C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **100 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Designed for Switching - Mode Power Supplies and Industrial Applications**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUY69A	BUY69B	BUY69C
V_{CBO}	Collector - base voltage (I_E = 0)	100 V	800 V	500 V
V_{CEO}	Collector - emitter voltage (I_B = 0)	400 V	325 V	200 V
V_{CEX}	Collector - emitter voltage (V_{BE} = -2 V)	1000 V	800 V	500 V
V_{EBO}	Base - emitter voltage	8 V		
I_C	Continuous collector current	10 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_B	Continuous base current	3 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	100 W		
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 200°C		

NOTES: 1: This value applies for $t_w \leq 500$ µs, duty cycle ≤ 25%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CBO}$	Collector - base breakdown voltage (Note 2)	I_C = 1 mA I_E = 0 BUY69A / BUY69B / BUY69C	1000 / 800 / 500			
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 50 mA I_B = 0 BUY69A / BUY69B / BUY69C	400 / 325 / 200			V
$V_{(BR)EBO}$	Base - emitter breakdown voltage	I_E = 10 mA	8			V
I_{CEX}	Collector-emitter leakage current	V_{CE} =1000 V V_{BE} = -2 V BUY69A / V_{CE} = 800 V V_{BE} = -2 V BUY69B / V_{CE} = 500 V V_{BE} = -2 V BUY69C			1 / 1 / 1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 10 V I_C = 2.5 A / V_{CE} = 3.3 V I_C = 8 A / V_{CE} = 10 V I_C = 10 A (Note 3)	15 / 3.2 / 2.5		20	
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 2.5 A I_C = 8 A (Note 3)			3.3	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 2.5 A I_C = 8 A (Note 3)			2.2	V
V_{BE}	Base - emitter voltage	V_{CE} = 10 V I_C = 10 mA	0.5			V
f_T	Current Gain Band Width Product	V_{CE} = 10 V I_C = 0.5 A	2	6		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V I_E = 0 f = 0.1 MHz			150	pF

NOTES: 2: These parameters must be measured using pulse techniques, t_w = 500 µs, duty cycle ≤ 25%
3: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle ≤ 2%

Thermal Characteristics

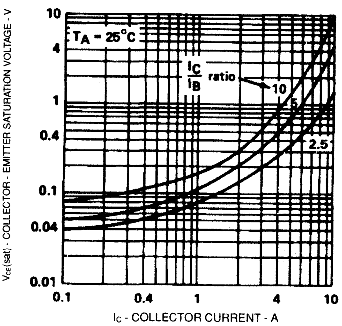
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			1.75	°C/W

Resistive - Load - Switching characteristics at 25°C Case Temperature (unless otherwise stated)

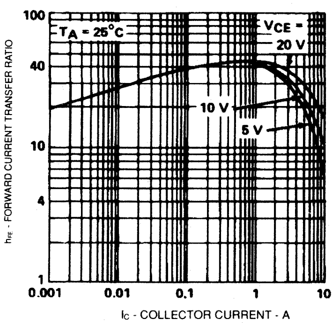
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{on}	Turn on time					3.5	µs
t_s	Storage time	I_C = 8 A	$I_{B(on)}$ = 2.5 A			3	µs
t_f	Fall time	V_{CC} = 40 V	$I_{B(off)}$ = -2.5 A			1	µs
$t_{(off)}$	Turn off time					4	µs

TYPICAL CHARACTERISTICS

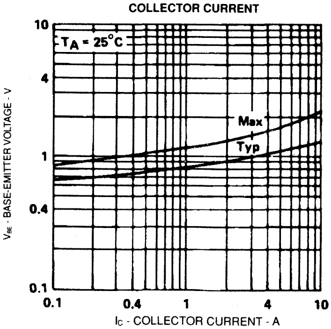
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



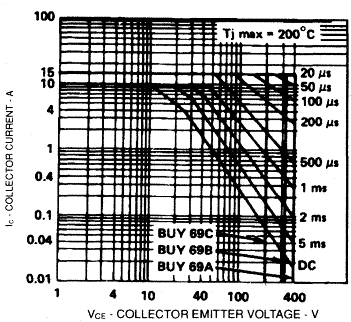
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



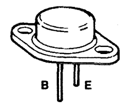
MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA



BUY70A, BUY70B, BUY70C
NPN SILICON POWER TRANSISTORS

Revised March 1990

- **75 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Designed for Switching - Mode Power Supplies**



The Collector is in electrical contact with the case

PACKAGE: TO3

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise stated)

		BUY70A	BUY70B	BUY70C
V_{CBO}	Collector - base voltage (I_E = 0)	1000 V	800 V	500 V
I_{CEO}	Collector - emitter voltage (I_B = 0)	400 V	325 V	200 V
V_{EBO}	Base - emitter voltage	8 V		
I_C	Continuous collector current	10 A		
I_{CM}	Peak collector current (Note 1)	15 A		
I_B	Continuous base current	3 A		
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	75 W		
T_j & T_{stg}	Operating junction and storage temperature range	-65 to + 200°C		

NOTES: 1: This value applies for $t_w \leq 500\ \mu s$, duty cycle $\leq$ 25%

Electrical Characteristics at 25°C Case Temperature (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(BR)CBO}$	Collector - base breakdown voltage (Note 2)	I_C = 1 mA I_E = 0 BUY70A BUY70B BUY70C	1000 800 500			
$V_{CEO(sus)}$	Collector - emitter sustaining voltage	I_C = 50 mA I_B = 0 BUY70A BUY70B BUY70C	400 325 200			V
$V_{(BR)EBO}$	Base - emitter breakdown voltage	I_E = 10 mA	8			V
I_{CEX}	Collector-emitter leakage current	V_{CE} =1000 V V_{BE} = -2.0 V BUY69A V_{CE} = 800 V V_{BE} = -2.0 V BUY69B V_{CE} = 500 V V_{BE} = -2.0 V BUY69C			1 1 1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 10 V I_{CE} = 1 A (Note 3)	15			
$V_{CE(sat)}$	Collector - emitter saturation voltage	I_B = 0.8 A I_C = 4 A (Note 3)			5	V
$V_{BE(sat)}$	Base - emitter saturation voltage	I_B = 0.8 A I_C = 4 A (Note 3)			1.5	V
f_T	Current Gain Band Width Product	V_{CE} = 10 V I_C = 0.5 A		6		MHz
C_{obo}	Output capacitance	V_{CB} = 20 V I_C = 0 A f = 0.1 MHz			150	pF

NOTES: 2: These parameters must be measured using pulse techniques, t_w = 500 µs, duty cycle $\leq$ 25%
3: These parameters must be measured using pulse techniques, t_w = 300µs, duty cycle $\leq$ 2%

Thermal Characteristics

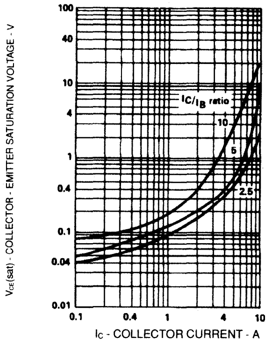
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction - to - case thermal resistance			2.3	°C/W

Resistive - Load - Switching Characteristics at 25°C Case Temperature (unless otherwise stated)

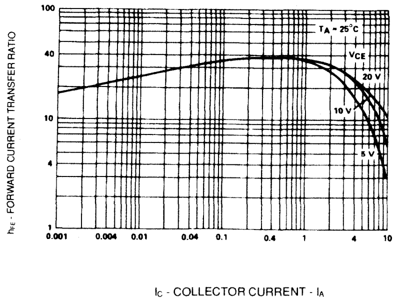
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{(off)}$	Turn off time	$I_C = 4$ A $V_{CC} = 40$ V	$I_{B(on)} = 0.8$ A $I_{B(off)} = -0.8$ A			1	µs

TYPICAL CHARACTERISTICS

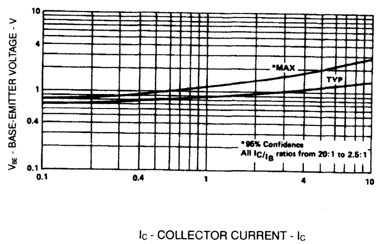
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



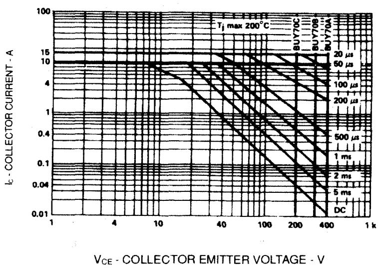
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT



MAXIMUM FORWARD - BIAS
SAFE OPERATING AREA

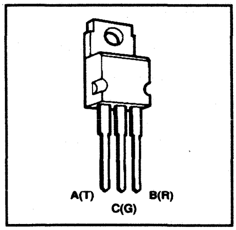


6

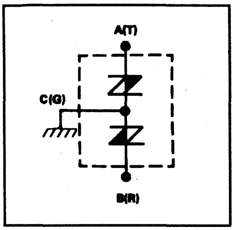
DUAL ASYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

November 1986 - Revised March 1990

- **Breakover Voltage, $V_{(BO)}$ Max** **82 V**
- **Zener Voltage, V_Z Min** **58 V**
- **Holding Current, I_H Min** **150 mA**
- **Surge Rating:**
  - **ANSI** **150 A**
  - **VDE0433** **2.0 kV**
  - **RLM88** **1.5 kV**
  - **CCITT IX K17** **1.5 kV**



PACKAGE: TO220
Pin C is in electrical contact with the mounting pad.



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP1082 is designed specifically for telephone line card protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Negative transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides. Positive transients are clipped by diode action.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/210 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_i/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES: 1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B Terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1kHz (Note 4)		1	5	pF

electrical characteristics for the A and C, or the B and C terminals†, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = -1mA	-58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			-82	V
$I_{(BO)}$	Breakover current	Note 5	-0.15		-0.6	A
V_F	Forward voltage	I_F = 5A Notes 5 and 6			3	V
V_{TM}	Peak on-state voltage	I_T = -5A Notes 5 and 6		-2.2	-3	V
I_H	Holding current	Note 5	-150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			-5	kV/µs
I_D	Off-state leakage current	V_D = -50V			-10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		300	500	pF

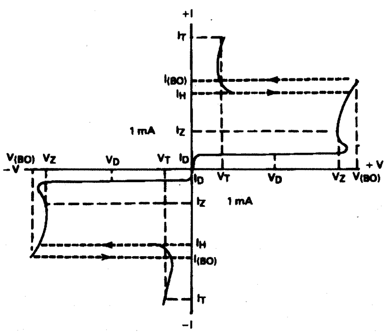
thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

6

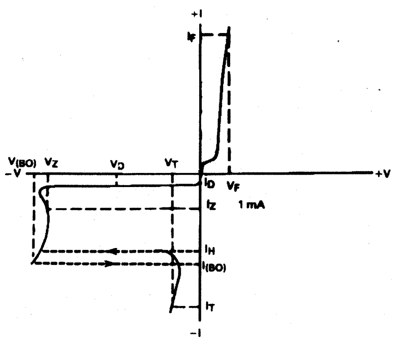
TISP Devices

PARAMETER MEASUREMENT INFORMATION



VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

The high level characteristics for terminals A and B are not guaranteed.



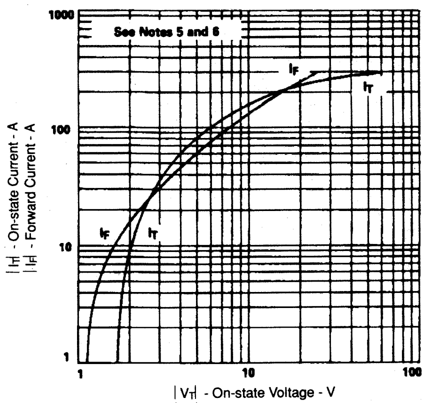
VOLTAGE CURRENT CHARACTERISTICS FOR TERMINALS A AND C OR B AND C†

†Polarity is determined at terminal A or B with respect to C

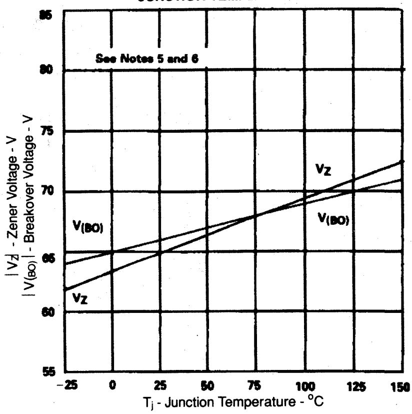
TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals†

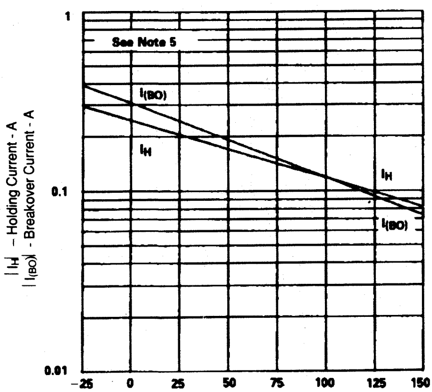
ON-STATE AND FORWARD CURRENTS vs ON-STATE AND FORWARD VOLTAGES



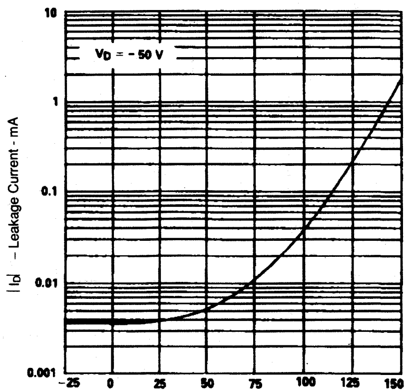
ZENER VOLTAGE AND BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE



HOLDING CURRENT AND BREAKOVER UCRRENT vs JUNCTION TEMPERATURE



LEAKAGE CURRENT vs JUNCTION TEMPERATURE



†Polarity is determined at terminals A or B with respect to C

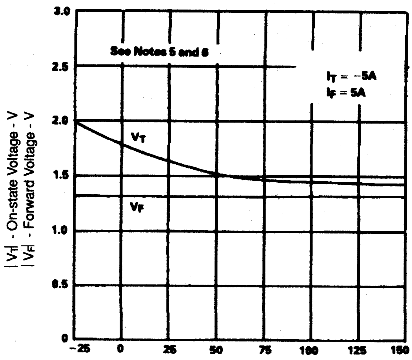
NOTES: 5. These parameters must be measured using pulse techniques, tw = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

6

TISP Devices

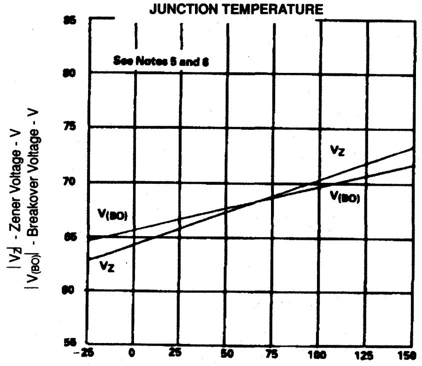
TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals†

ON-STATE VOLTAGE AND FORWARD VOLTAGE vs JUNCTION TEMPERATURE

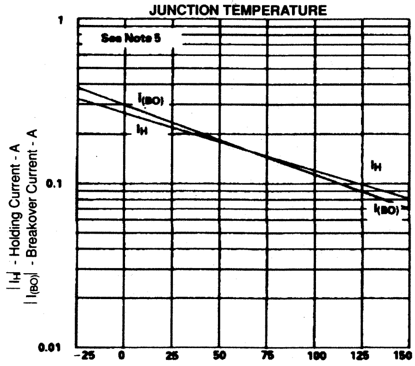


TYPICAL CHARACTERISTICS
for the A and B terminals†

ZENER VOLTAGE AND BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE



HOLDING CURRENT AND BREAKOVER CURRENT vs JUNCTION TEMPERATURE

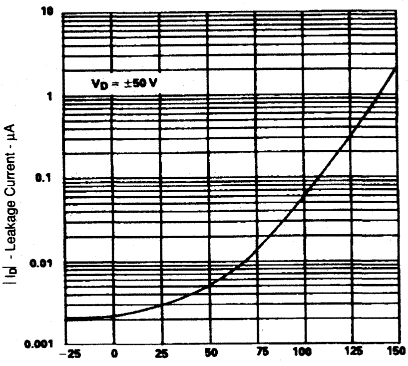


†Polarity is determined at terminals A or B with respect to C

NOTES: 5. These parameters must be measured using pulse techniques, tw = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

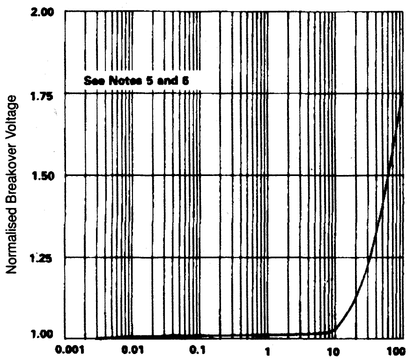
TYPICAL CHARACTERISTICS for the A and B terminals

LEAKAGE CURRENT vs JUNCTION TEMPERATURE

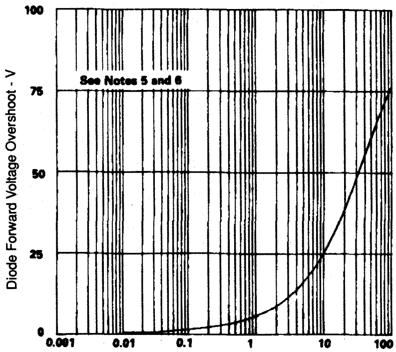


TYPICAL CHARACTERISTICS for the A and C, or the B and C terminals†

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPAL CURRENT



PEAK DIODE FORWARD VOLTAGE vs RATE OF RISE OF PRINCIPALCURRENT

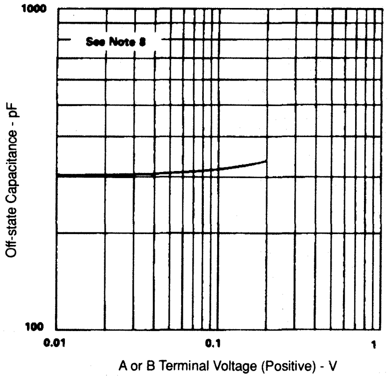


†Polarity is determined at terminals A or B with respect to C

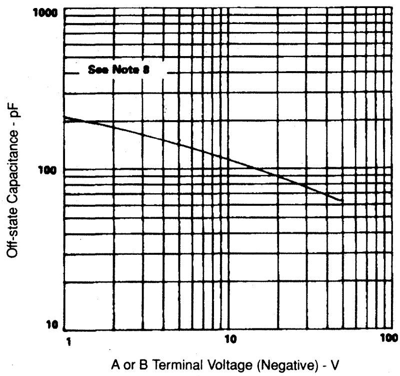
NOTES: 5. These parameters must be measured using pulse techniques, tw = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals

OFF-STATE CAPACITANCE vs A OR B TERMINAL VOLTAGE (POSITIVE)

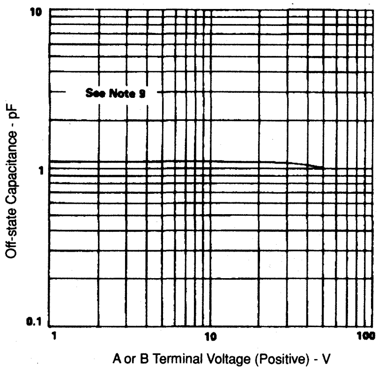


OFF-STATE CAPACITANCE vs A OR B TERMINAL VOLTAGE (NEGATIVE)

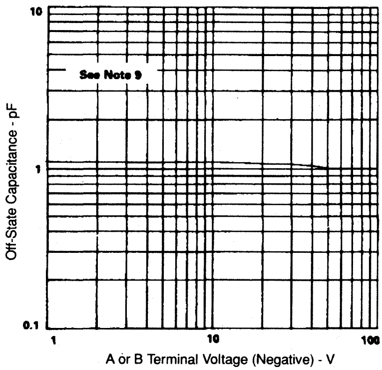


TYPICAL CHARACTERISTICS
for the A and B terminals

OFF-STATE CAPACITANCE vs A OR B TERMINAL VOLTAGE (POSITIVE)



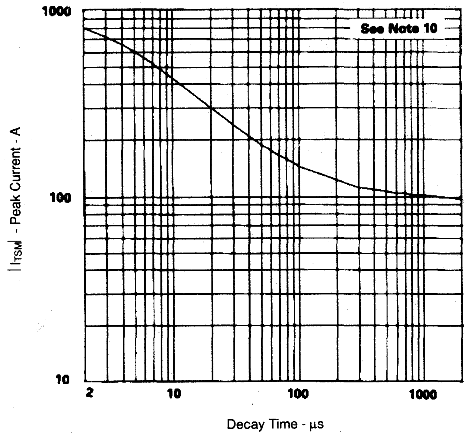
OFF-STATE CAPACITANCE vs A OR B TERMINAL VOLTAGE (NEGATIVE)



NOTES: 8. Third terminal = 0 V to -50 V
9. Only for C = + 50 V

TYPICAL CHARACTERISTICS

SURGE CURRENT
vs
DECAY TIME

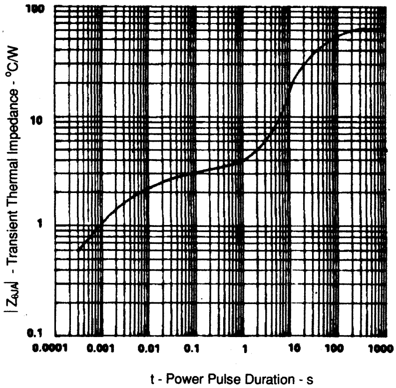


NOTE: 10. Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Waveforms will be specified in terms of a Peak Amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The surge rating graph comprehends the rise times of commonly used surge waveforms. When the transient suppressor operates it presents a very low impedance. As a result, waveforms principally specified in terms of voltage, are converted into current waveforms with differenct timings. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A 5/310 µs waveform when driving into a short circuit. Thus the TISP surge current capability will be found for the CCITT IX K17 waveform at 310 µs on the above graph and not 700 µs. Some common short circuit equivalents are tabulated below:

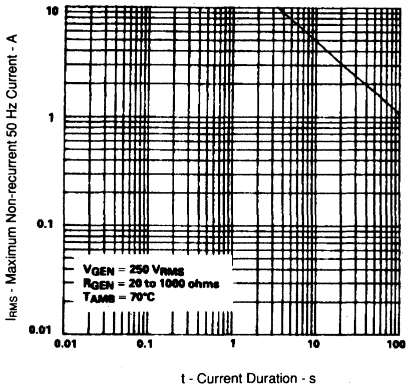
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs

THERMAL INFORMATION

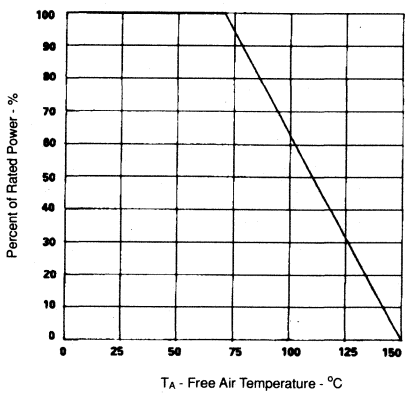
THERMAL RESPONSE



MAXIMUM NON-RECURRENT 50 Hz CURRENT vs CURRENT DURATION



FREE AIR TEMPERATURE DERATING CURVE



6

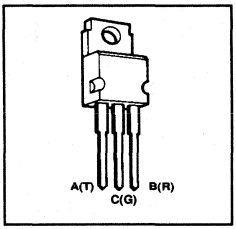
TISP Devices

DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

April 1987 - Revised March 1990

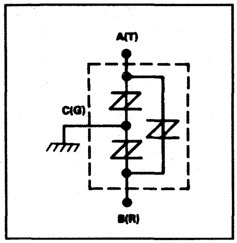
- **Breakover Voltage, $V_{(BO)}$ Max 82 V**
- **Zener Voltage, V_Z Min 58 V**
- **Holding Current, I_H Min 150 mA**
- **Surge Rating:**

ANSI	**150 A**
VDE0433	**2.0 kV**
RLM88	**1.5 kV**
CCITT IX K17	**1.5 kV**



PACKAGE: TO220

Pin C is in electrical contact with the mounting pad



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP2082 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/210 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_t/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4: These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
I_D	Off-state leakage current	V_D = ± 50 v			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 F = 1 kHz Note 4		70	150	pF

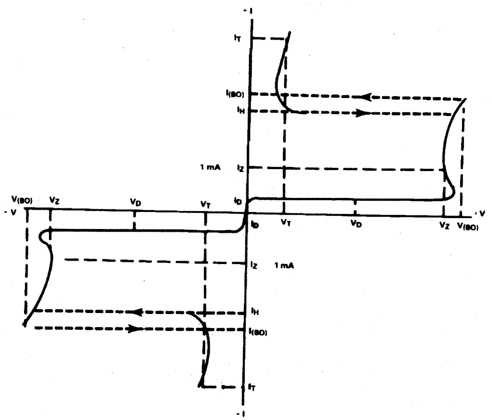
electrical characteristics for the A and C or the B and C terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 82	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

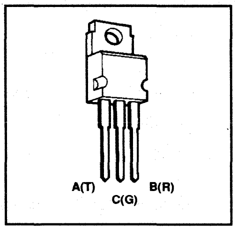


VOLTAGE-CURRENT CHARACTERISTICS FOR ANY PAIR OF TERMINALS
The high-level characteristics for terminal A and B are not guaranteed.

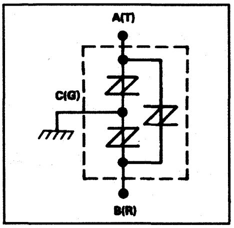
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

November 1986 - Revised March 1990

	TISP2180	TISP2290
• **Breakover Voltage, $V_{(BO)}$ Max**	180 V	290 V
• **Zener Voltage, V_Z Min**	145 V	200 V
• **Holding Current, I_H Min**	150 mA	
• **Surge Rating:**		
ANSI	150 A	
VDE0433	2.0 kV	
RLM88	1.5 kV	
CCITT IX K17	1.5 kV	



PACKAGE: TO220
Pin C is in electrical contact with the mounting pad



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP2000 series is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_t/dt	Initial rate of rise of on - state current	250 A/µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1. Above 70°C, derate linearly to zero at 150°C case temperature.
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	TISP2180			TISP2290			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		40	100		40	100	pF

electrical characteristics for the A and C, or the B and C terminals, T_j = 25°C

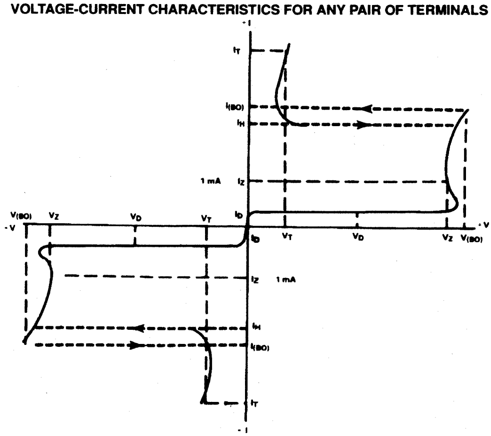
PARAMETER		TEST CONDITIONS	TISP2180			TISP2290			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180			± 290	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3		± 1.9	± 3	V
I_H	Holding current	Note 5	± 150			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			6.25			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

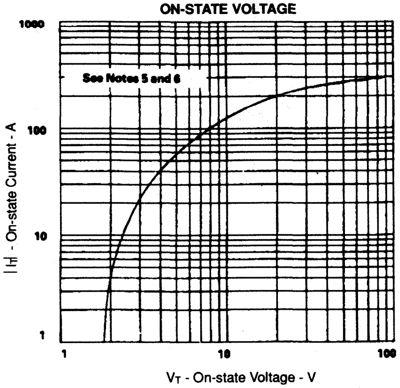
VOLTAGE-CURRENT CHARACTERISTICS FOR ANY PAIR OF TERMINALS



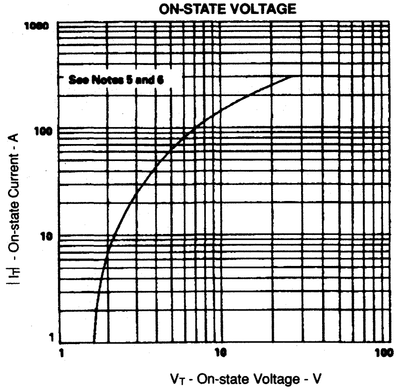
The high-level characteristics for terminals A and B are not guaranteed

TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals

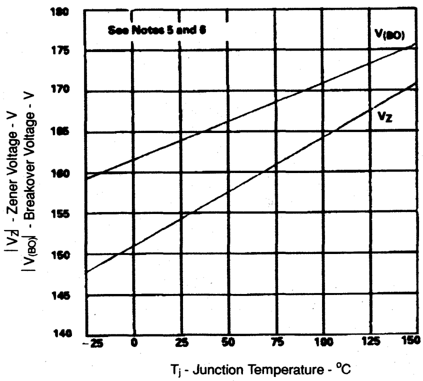
TISP2180
ON-STATE CURRENT
vs
ON-STATE VOLTAGE



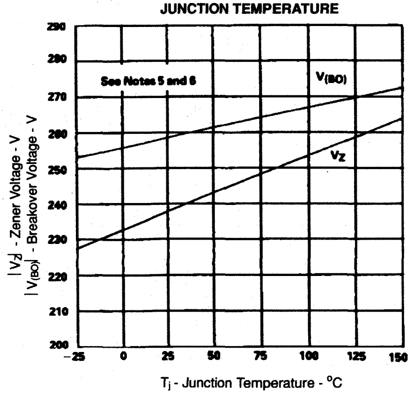
TISP2290
ON-STATE CURRENT
vs
ON-STATE VOLTAGE



TISP2180
ZENER VOLTAGE AND BREAKOVER VOLTAGE
vs
JUNCTION TEMPERATURE



TISP2290
ZENER VOLTAGE AND BREAKOVER VOLTAGE
vs
JUNCTION TEMPERATURE



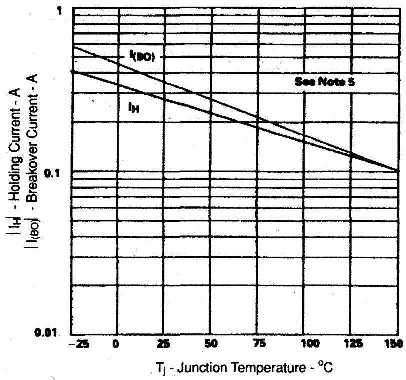
NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

6

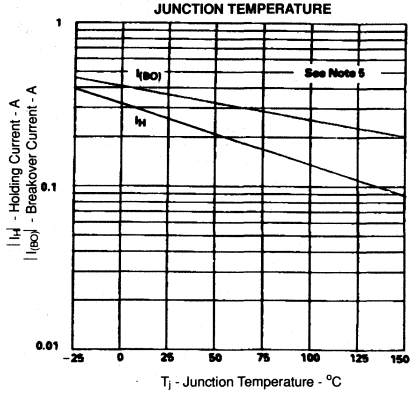
TISP Devices

TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals

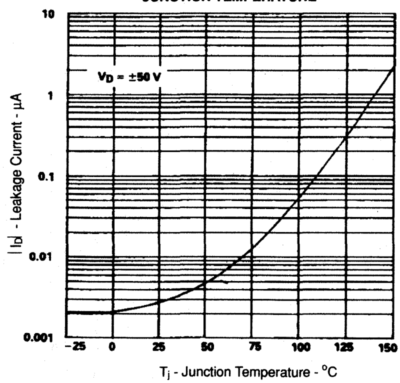
TISP2180
HOLDING CURRENT AND BREAKOVER CURRENT
vs
JUNCTION TEMPERATURE



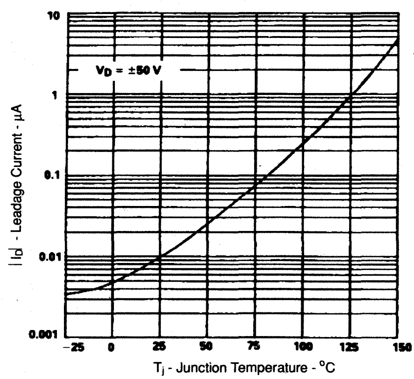
TISP2290
HOLDING CURRENT AND BREAKOVER CURRENT
vs
JUNCTION TEMPERATURE



TISP2180
LEAKAGE CURRENT
vs
JUNCTION TEMPERATURE



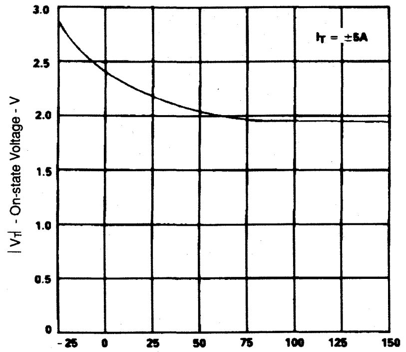
TISP2290
LEAKAGE CURRENT
vs
JUNCTION TEMPERATURE



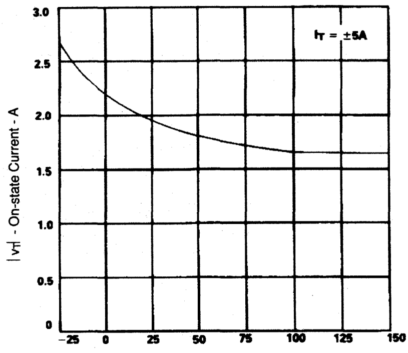
NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.

TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals

TISP2180
ON-STATE VOLTAGE
vs
JUNCTION TEMPERATURE

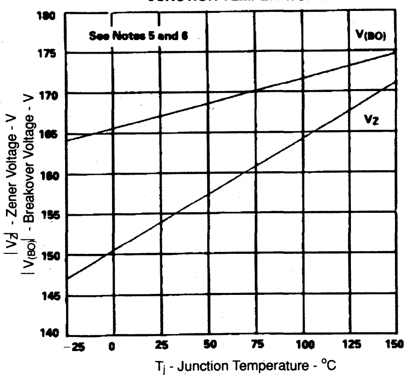


TISP2290
ON-STATE VOLTAGE
vs
JUNCTION TEMPERATURE

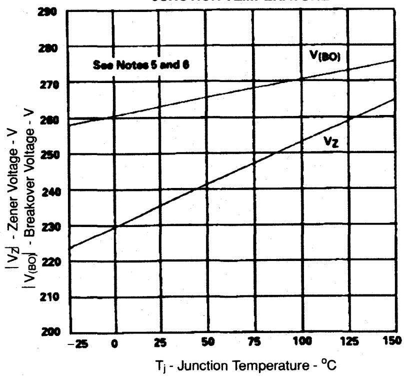


TYPICAL CHARACTERISTICS
for the A and B terminals

TISP2180
ZENER VOLTAGE AND BREAKOVER VOLTAGE
vs
JUNCTION TEMPERATURE



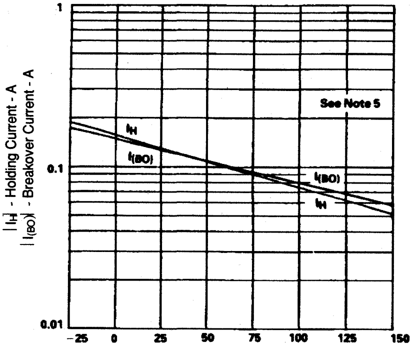
TISP2290
ZENER VOLTAGE AND BREAKOVER VOLTAGE
vs
JUNCTION TEMPERATURE



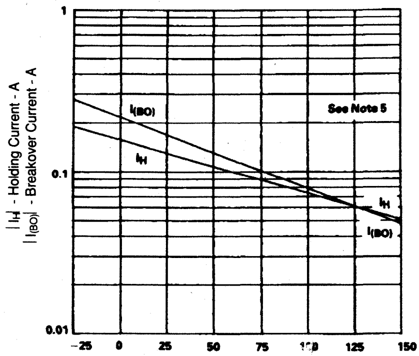
NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

TYPICAL CHARACTERISTICS
for the A and B terminals

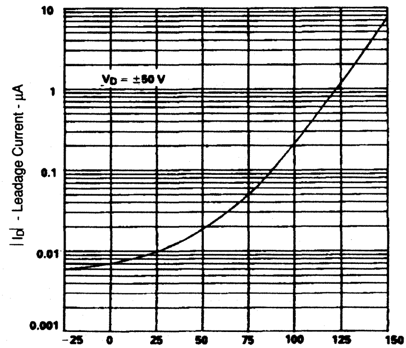
TISP2180
HOLDING CURRENT AND BREAKOVER CURRENT
vs
JUNCTION TEMPERATURE



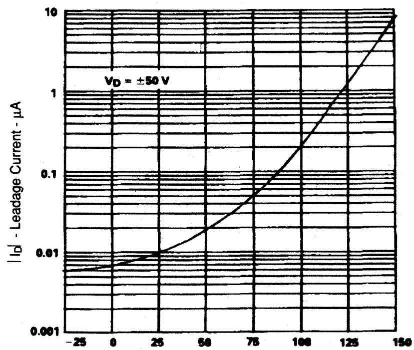
TISP2290
HOLDING CURRENT AND BREAKOVER CURRENT
vs
JUNCTION TEMPERATURE



TISP2180
LEAKAGE CURRENT
vs
JUNCTION TEMPERATURE



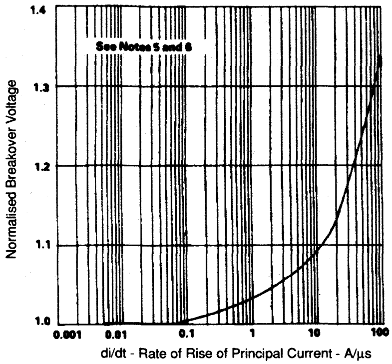
TISP2290
LEAKAGE CURRENT
vs
JUNCTION TEMPERATURE



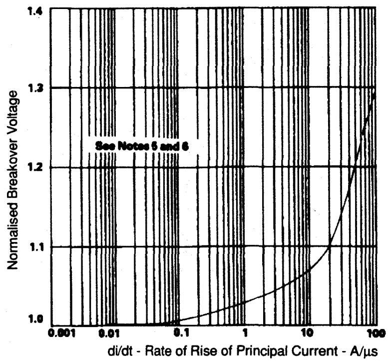
NOTES: 5. These parameters must be measured using pulse techniques, $t_w = 100$ µs, duty cycle ≤ 2%.

TYPICAL CHARACTERISTICS
for the A and C, B and C terminals

TISP2180
NORMALISED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPAL CURRENT

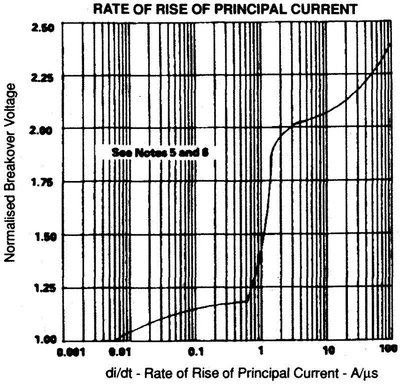


TISP2290
NORMALISED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPAL CURRENT

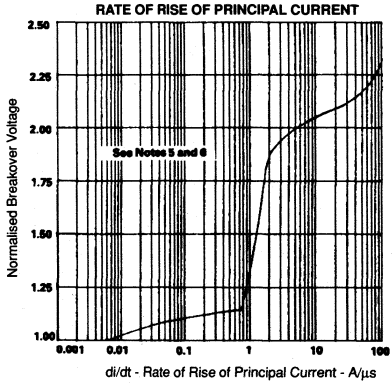


TYPICAL CHARACTERISTICS
for the A and B terminals

TISP2180
NORMALISED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPAL CURRENT



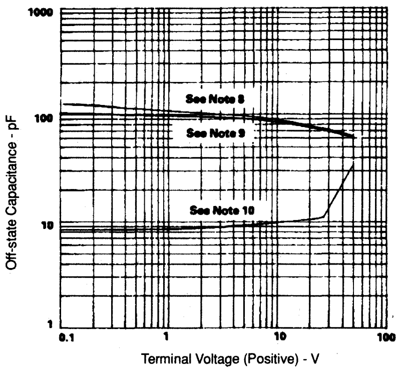
TISP2290
NORMALISED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPAL CURRENT



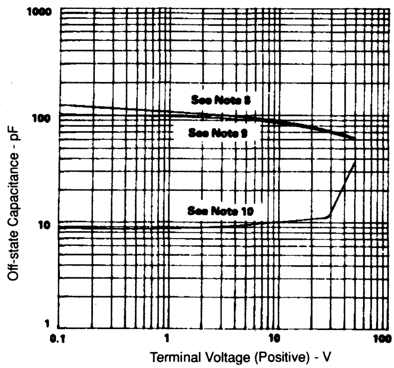
NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

TYPICAL CHARACTERISTICS
for the A and C, B and C terminals†

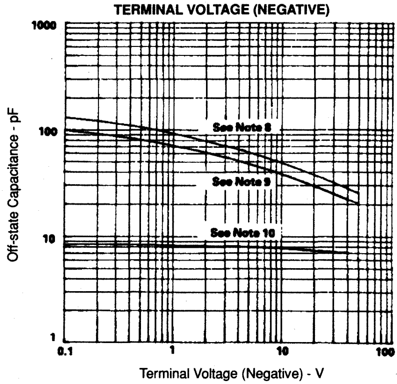
TISP2180
OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (POSITIVE)



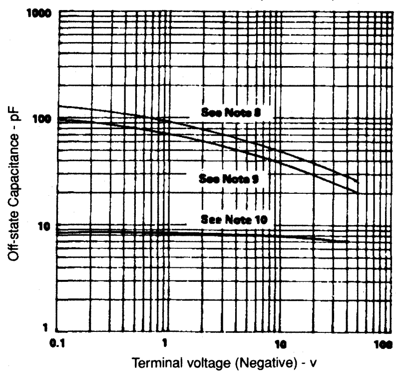
TISP2290
OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (POSITIVE)



TISP2180
OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (NEGATIVE)



TISP2290
OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (NEGATIVE)



†Polarity is determined at terminal A or B with respect to C

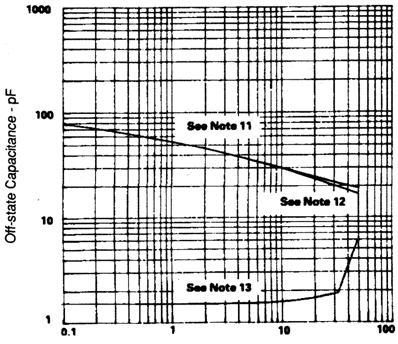
NOTES: 8. Third terminal bias = -50 V
9. Third terminal bias = 0 V
10. Third terminal bias = +50 V

6

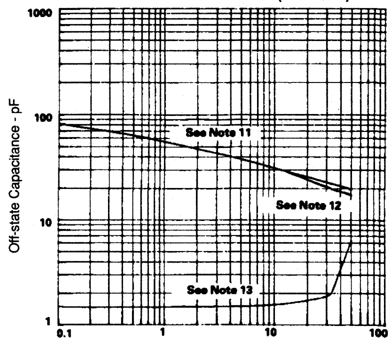
TISP Devices

TYPICAL CHARACTERISTICS
for the A and B terminals

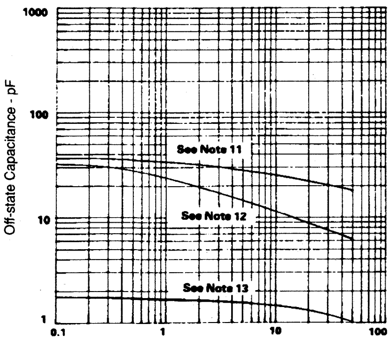
TISP2180
OFF-STATE CPACITANCE
vs
TERMINAL VOLTAGE (POSITIVE)



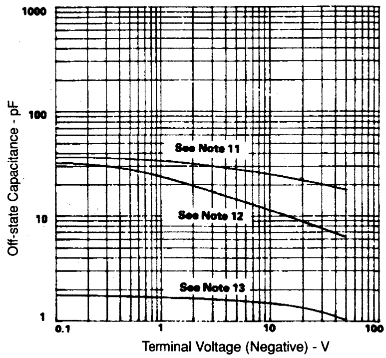
TISP2290
OFF-STATE CPACITANCE
vs
TERMINAL VOLTAGE (POSITIVE)



TISP2180
OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (NEGATIVE)



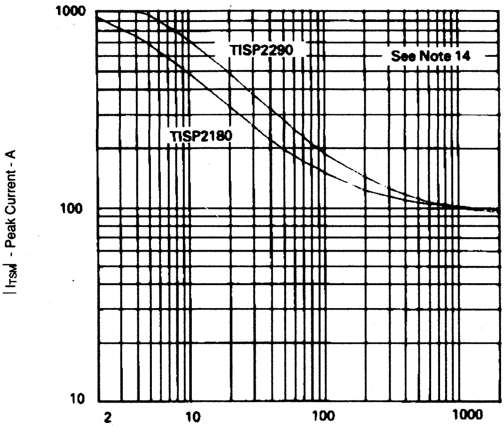
TISP2290
OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (NEGATIVE)



NOTES: 11. Third terminal bias = -50 V
12. Third terminal bias = 0 V
13. Third terminal bias = +50 V

TYPICAL CHARACTERISTICS

SURGE CURRENT
vs
DECAY TIME

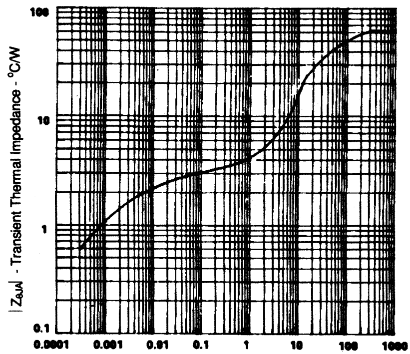


NOTE: 14. Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay time to 50% of the maximum amplitude. The surge rating graph comprehends the rise times of commonly used surge waveforms. When the transient suppressor operates it presents a very low impedance. As a result, waveforms principally specified in terms of voltage, are converted into current waveforms with different timings. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38A, 5/310 µs waveform when driving into a short circuit. Thus the TISP surge current capability will be found for the CCITT IX K17 waveform at 310 µs on the above graph and not 700 µs. Some common short circuit equivalents are tabulated below:

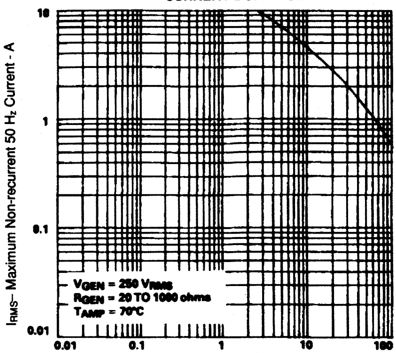
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs

THERMAL INFORMATION

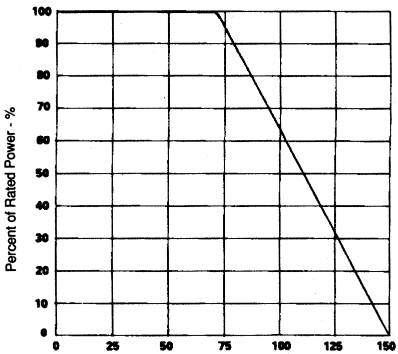
TISP2180, TISP2290
THERMAL RESPONSE



TISP2180, TISP2290
MAXIMUM NON-RECURRENT 50 Hz CURRENT
vs
CURRENT DURATION



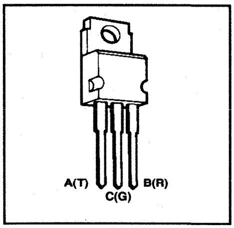
TISP2180, TISP2290
FREE AIR TEMPERATURE DERATING CURVE



TISP3082
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

April 1987 - Revised March 1990

- **Breakover Voltage, $V_{(BO)}$ Max 82 V**
- **Zener Voltage, V_Z Min 58 V**
- **Holding Current, I_H Min 150 mA**
- **Surge Rating:**
  - **ANSI 150 A**
  - **VDE0433 2.0 kV**
  - **RLM88 1.5 kV**
  - **CCITT IX K17 1.5 kV**



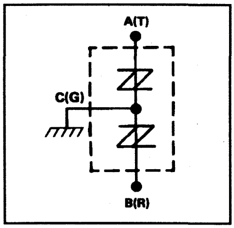
PACKAGE: TO220
Pin C is in electrical contact with the mounting pad

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP3082 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.



device schematic

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 μs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/210 μs (VDE0433 10/700 μs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 μs (RLM88 0.5/700 μs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 μs (CCITT IX K17 10/700 μs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_T/dt	Initial rate of rise of on - state current	250 A/ μs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES: 1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 116			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		0.5	5	pF

electrical characteristics for the A and C or the B and C terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 82	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200	pF

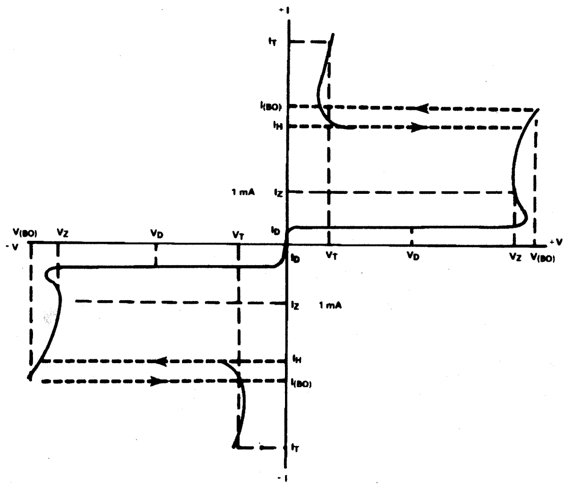
thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

6

TISP Devices

PARAMETER MEASUREMENT INFORMATION



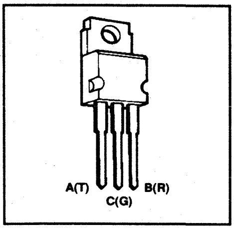
VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND C OR B AND C

TEXAS INSTRUMENTS

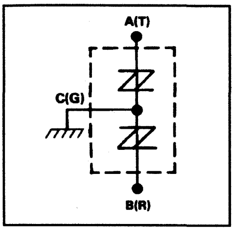
TISP3180
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

November 1986 - Revised March 1990

- **Breakover Voltage, $V_{(BO)}$ Max 180 V**
- **Zener Voltage, V_Z Min 145 V**
- **Holding Current, I_H Min 150 mA**
- **Surge Rating:**
  - **ANSI 150 A**
  - **VDE0433 2.0 kV**
  - **RLM88 1.5 kV**
  - **CCITT IX K17 1.5 kV**



PACKAGE: TO220
Pin C is in electrical contact with the mounting pad



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP3180 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 μs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/210 μs (VDE0433 10/700 μs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 μs (RLM88 0.5/700 μs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 μs (CCITT IX K17 10/700 μs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_t/dt	Initial rate of rise of on - state current	250 A/ μs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 290			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		0.5	5	pF

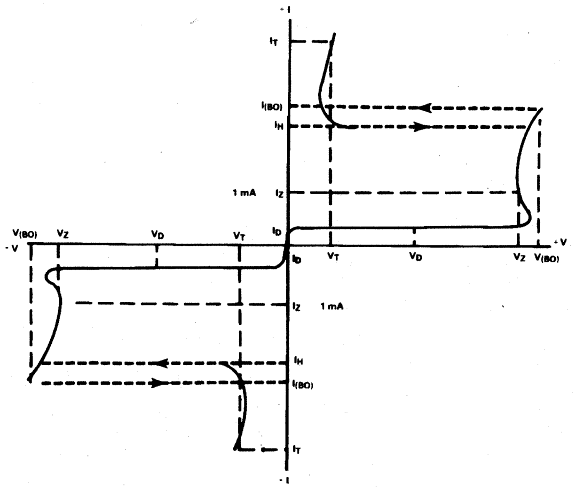
electrical characteristics for the A and C or the B and C terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

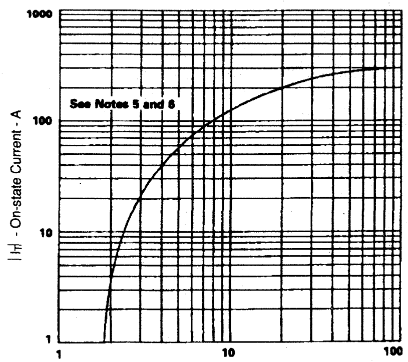
PARAMETER MEASUREMENT INFORMATION

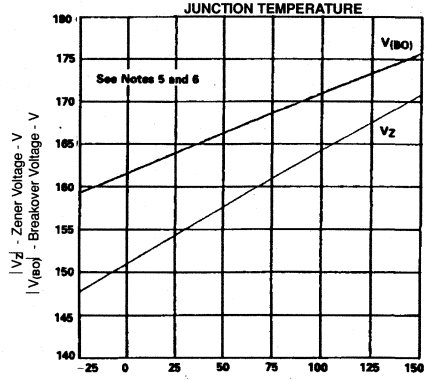


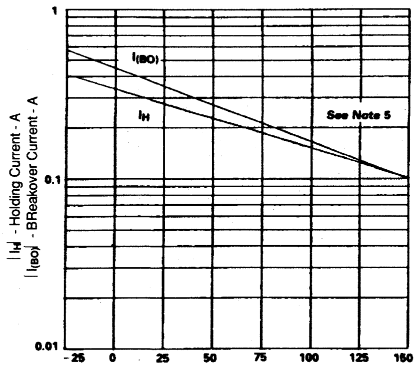
VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND C OR B AND C

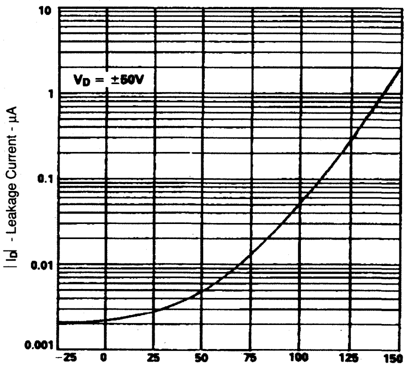
TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals









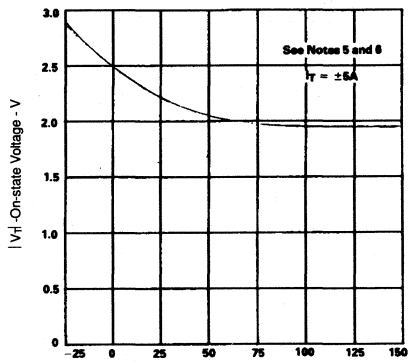
6

TISP Devices

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals

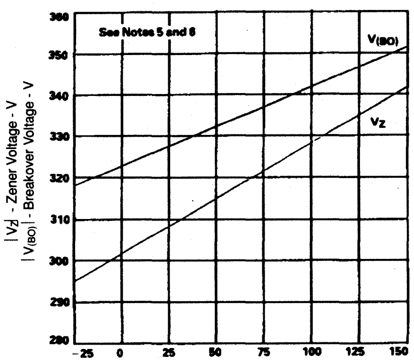
ON-STATE VOLTAGE
vs
JUNCTION TEMPERATURE



T_j - JUNCTION TEMPERATURE - °C

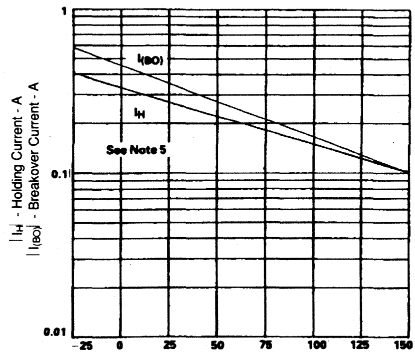
TYPICAL CHARACTERISTICS
for the A and B terminals

ZENER VOLTAGE AND BREAKOVER VOLTAGE
vs
JUNCTION TEMPERATURE



T_j - Junction Temperature - °C

HOLDING CURRENT AND BREAKOVER CURRENT
vs
JUNCTION TEMPERATURE

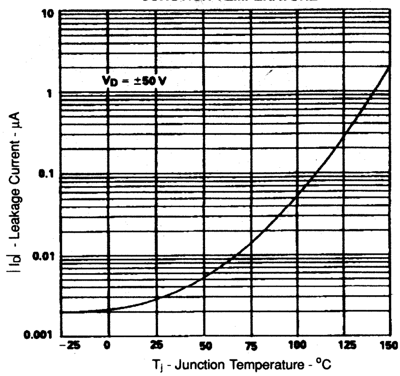


T_j - Junction Temperature - °C

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

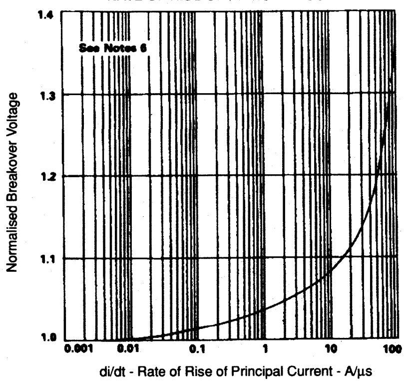
TYPICAL CHARACTERISTICS
for the A and B terminals

LEAKAGE CURRENT
vs
JUNCTION TEMPERATURE

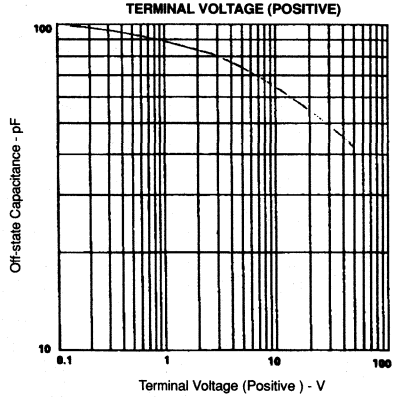


TYPICAL CHARACTERISTICS
for the A and C, or the B and C Terminals†

NORMALISED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPAL CURRENT



OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (POSITIVE)

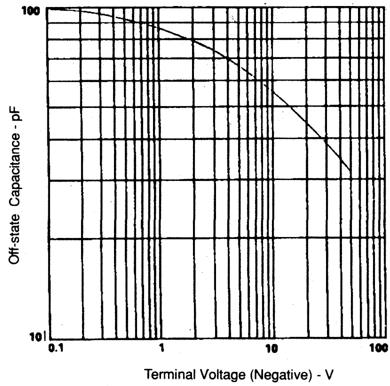


†Polarity is determined at terminal A or B with respect to C

NOTES: 6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

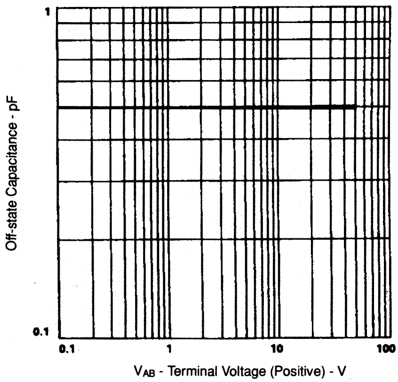
TYPICAL CHARACTERISTICS
for the A and C, or the B and C terminals†

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

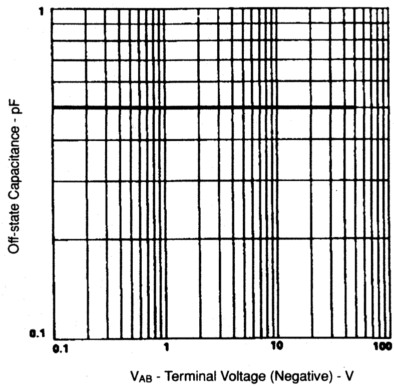


TYPICAL CHARACTERISTICS
for the A and B terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)



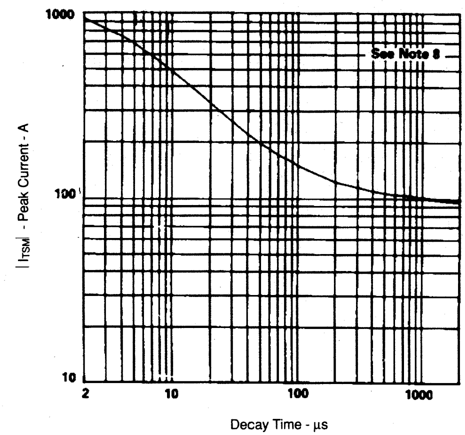
OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)



†Polarity is determined at terminal A or B with respect to C

TYPICAL CHARACTERISTICS

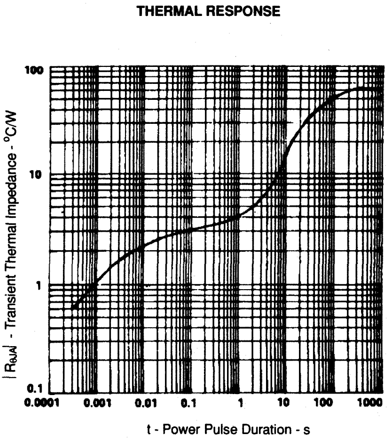
SURGE CURRENT vs DECAY TIME

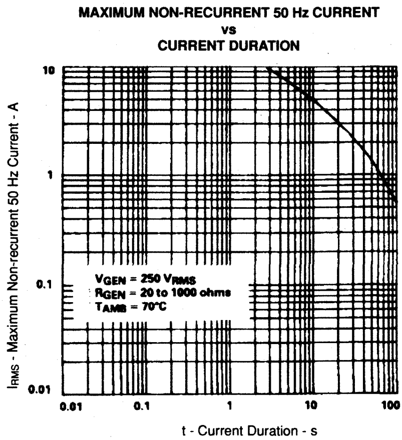


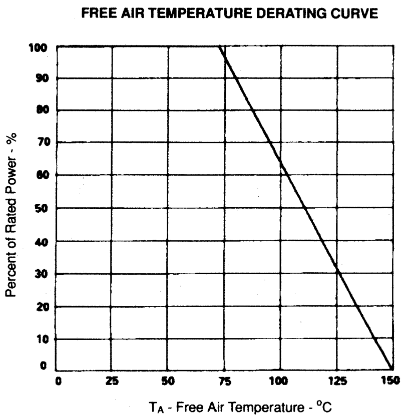
NOTE: 8. Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Waveforms will be specified in terms of a Peak Amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The surge rating graph comprehends the rise times of commonly used surge waveforms. When the transient suppressor operates it presents a very low impedance. As a result, waveforms principally specified in terms of voltage, are converted into current waveforms with differenct timings. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A 5/310 µs waveform when driving into a short circuit. Thus the TISP surge current capability will be found for the CCITT IX K17 waveform at 310 µs on the above graph and not 700 µs. Some common short circuit equivalents are tabulated below:

CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs

THERMAL INFORMATION







6

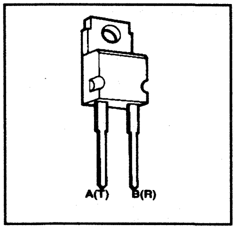
TISP Devices

TEXAS INSTRUMENTS

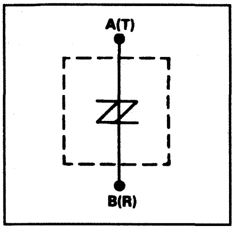
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

April 1987 - Revised March 1990

- **Breakover Voltage, $V_{(BO)}$ Max 82 V**
- **Zener Voltage, V_Z Min 58 V**
- **Holding Current, I_H Min 150 mA**
- **Surge Rating:**
  - **ANSI 150 A**
  - **VDE0433 2.0 kV**
  - **RLM88 1.5 kV**
  - **CCITT IX K17 1.5 kV**



PACKAGE: DO220
Pin A is in electrical contact with the mounting pad



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP4082 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will supress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_t/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

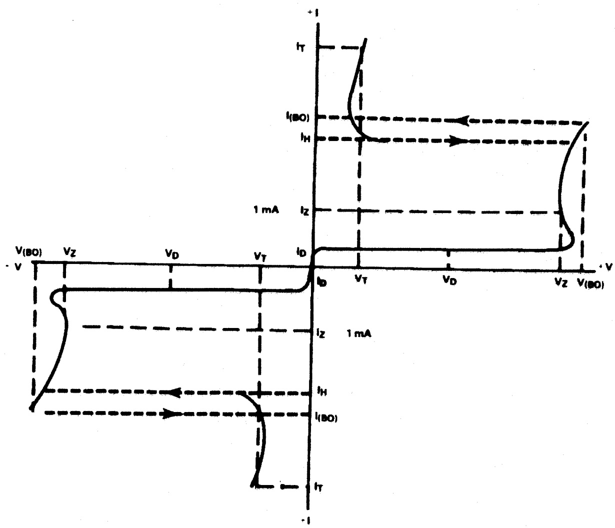
electrical characteristics $T_j = 25°C$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm$ 1mA	± 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 82	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	$I_T = \pm$ 5 A Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/µs
I_D	Off-state leakage current	$V_D = \pm$ 50 V			± 10	µA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz Note 4		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

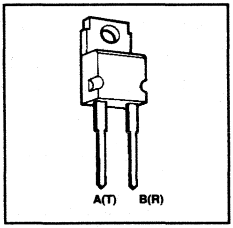


VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

TISP4180
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

November 1976 - Revised March 1990

- **Breakover Voltage, $V_{(BO)}$ Max** **180 V**
- **Zener Voltage, V_Z Min** **145 V**
- **Holding Current, I_H Min** **150 mA**
- **Surge Rating:**
  - **ANSI** **150 A**
  - **VDE0433** **2.0 kV**
  - **RLM88** **1.5 kV**
  - **CCITT IX K17** **1.5 kV**



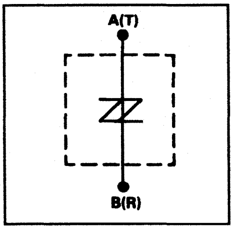
PACKAGE: DO220
Pin A is in electrical contact with the mounting pad

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP4180 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will supress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.



device schematic

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_t/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

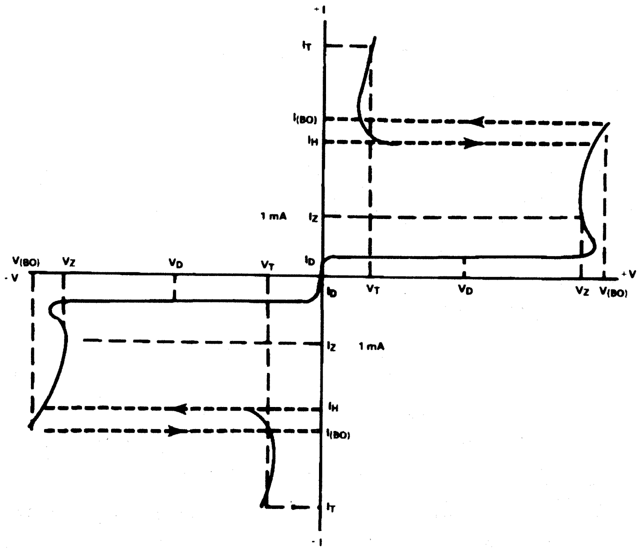
electrical characteristics, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

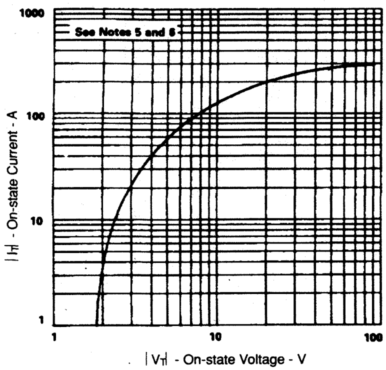


VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

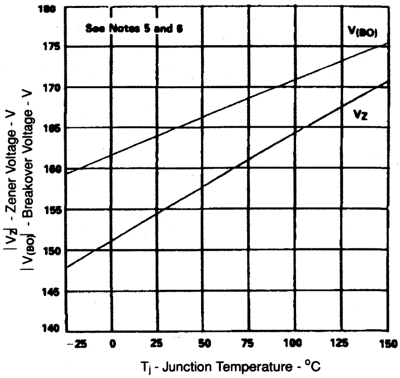
TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
for the A and B Terminals

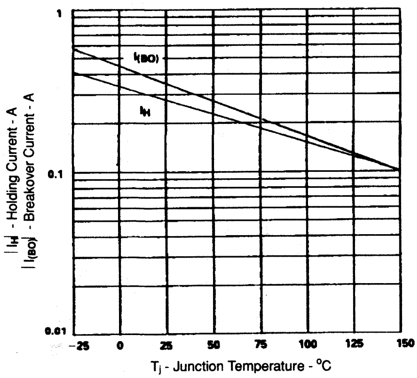
ON-STATE CURRENT
vs
ON-STATE VOLTAGE



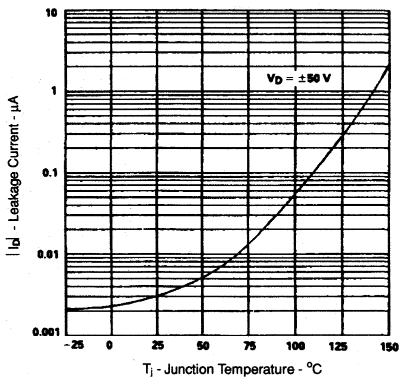
ZENER VOLTAGE AND BREAKOVER VOLTAGE
vs
JUNCTION TEMPERATURE



HOLDING CURRENT AND BREAKOVER CURRENT
vs
JUNCTION TEMPERATURE



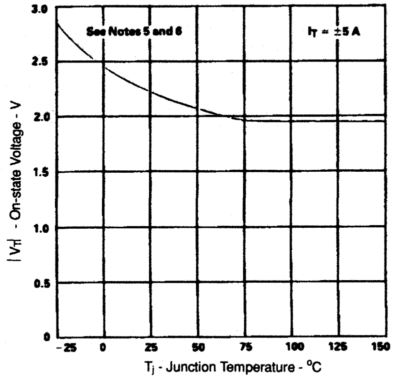
LEAKAGE CURRENT
vs
JUNCTION TEMPERATURE



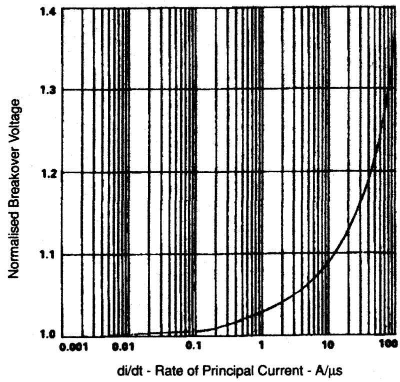
NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

TYPICAL CHARACTERISTICS
for the A and B terminals

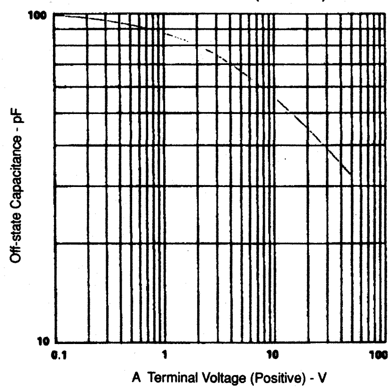
**ON-STATE VOLTAGE
vs
JUNCTION TEMPERATURE**



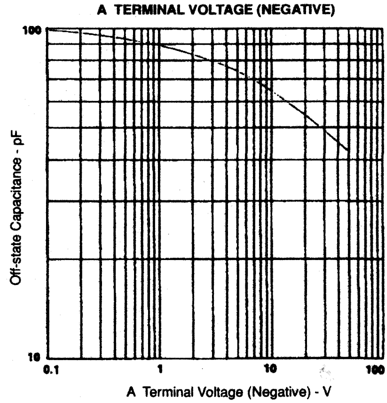
**NORMALISED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPAL CURRENT**



**OFF-STATE CAPACITANCE
vs
A TERMINAL VOLTAGE (POSITIVE)**



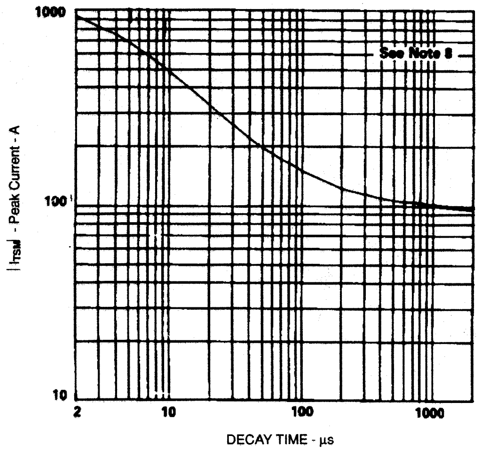
**OFF-STATE CAPACITANCE
vs
A TERMINAL VOLTAGE (NEGATIVE)**



NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

TYPICAL CHARACTERISTICS

SURGE CURRENT
vs
DECAY TIME

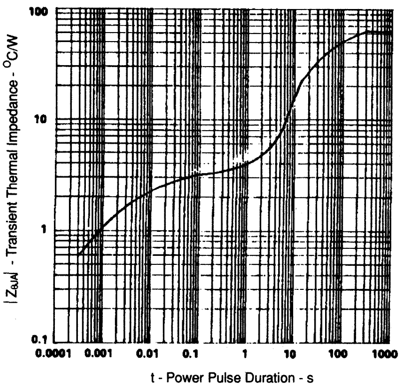


NOTE: 8. Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Waveforms will be specified in terms of a Peak Amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The surge rating graph comprehends the rise times of commonly used surge waveforms. When the transient suppressor operates it presents a very low impedance. As a result, waveforms principally specified in terms of voltage, are converted into current waveforms with differenct timings. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A 5/310 µs waveform when driving into a short circuit. Thus the TISP surge current capability will be found for the CCITT IX K17 waveform at 310 µs on the above graph and not 700 µs. Some common short circuit equivalents are tabulated below:

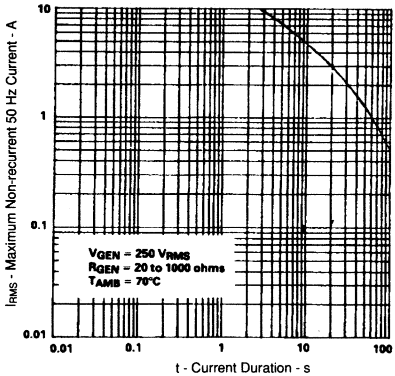
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs

THERMAL INFORMATION

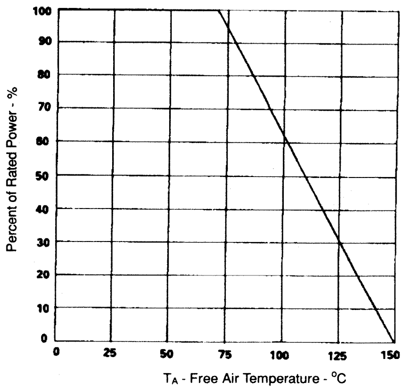
THERMAL RESPONSE



MAXIMUM NON-RECURRENT 50 Hz CURRENT vs CURRENT DURATION

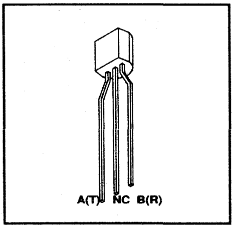


FREE AIR TEMPERATURE DERATING CURVE



TISP5160 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

- **Breakover Voltage, $V_{(BO)}$ Max** **160 V**
- **Zener Voltage, V_Z Min** **120 V**
- **Holding Current, I_H Min** **150 mA**
- **Surge Rating:**
  - **ANSI** **100 A**
  - **VDE0433** **2.0 kV**
  - **RLM88** **1.5 kV**
  - **CCITT IX K17** **1.5 kV**



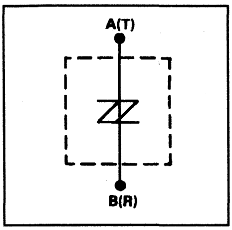
PACKAGE: TO92
(NC - No internal connection)

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP5160 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will supress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.



device schematic

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	100 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 1 s (Notes 1&2)	2.5 A
di_t/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES: 1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

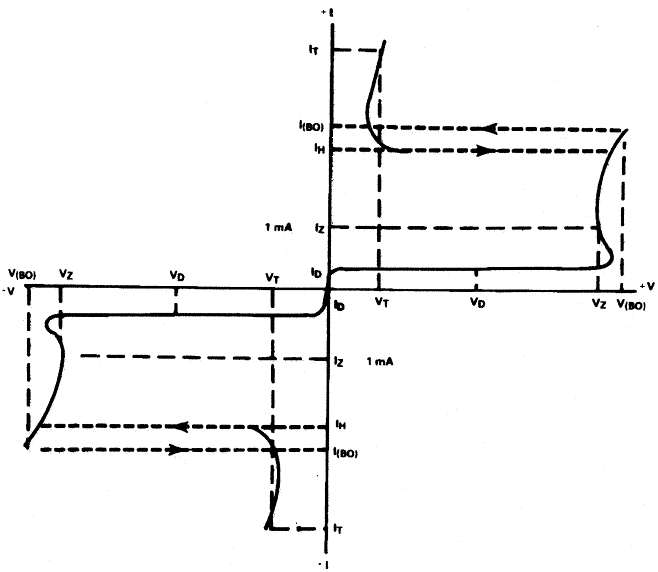
electrical characteristics, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 120			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 160	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		70	150	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			156	°C/W

PARAMETER MEASUREMENT INFORMATION



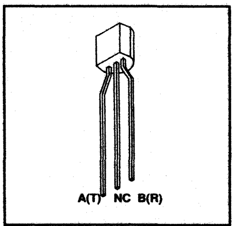
VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

TEXAS INSTRUMENTS

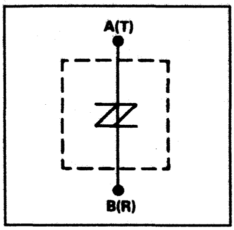
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

April 1987 - Revised March 1990

- **Breakover Voltage, $V_{(BO)}$ Max** **180 V**
- **Zener Voltage, V_Z Min** **145 V**
- **Holding Current, I_H Min** **150 mA**
- **Surge Rating:**
  - **ANSI** **100 A**
  - **VDE0433** **2.0 kV**
  - **RLM88** **1.5 kV**
  - **CCITT IX K17** **1.5 kV**



PACKAGE: TO92
(NC - No internal connection)



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP5180 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will supress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	100 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 1 s (Notes 1&2)	2.5 A
di_t/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

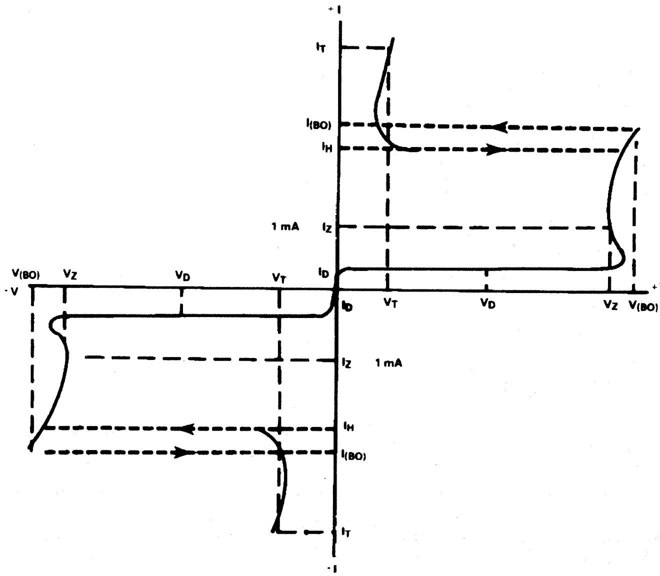
electrical characteristics, $T_j = 25°C$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm 1mA$	± 145			V
$\propto V_Z$	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	$I_T = \pm 5A$ Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/µs
I_D	Off-state leakage current	$V_D = \pm 50V$			± 10	µA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz Note 4		70	150	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			156	°C/W

PARAMETER MEASUREMENT INFORMATION

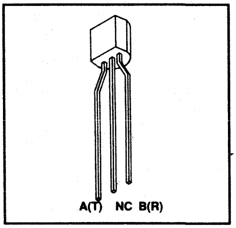


VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

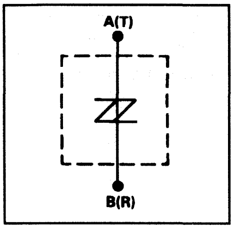
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

April 1987 - Revised March 1990

- **Breakover Voltage, $V_{(BO)}$ Max 290 V**
- **Zener Voltage, V_Z Min 200 V**
- **Holding Current, I_H Min 150 mA**
- **Surge Rating:**
  - **ANSI 150 A**
  - **VDE0433 2.0 kV**
  - **RLM88 1.5 kV**
  - **CCITT IX K17 1.5 kV**



PACKAGE: TO92
(NC - No internal connection)



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP5290 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will supress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 1 s (Notes 1&2)	2.5 A
di_t/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

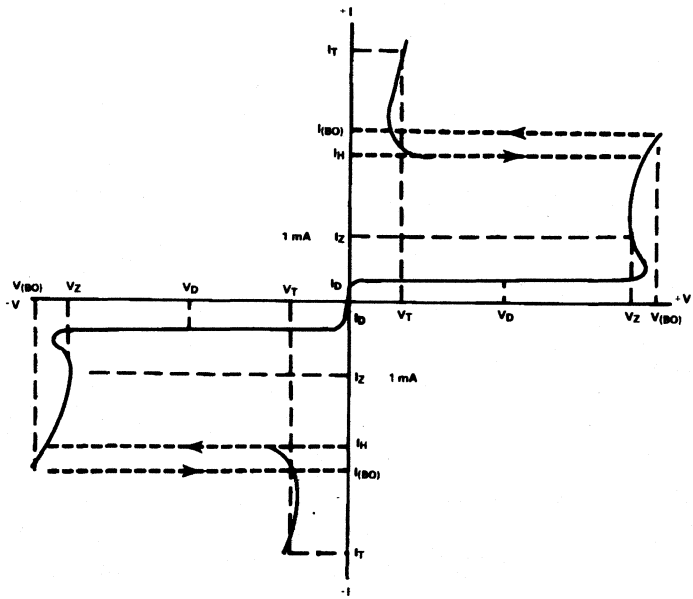
electrical characteristics, $T_J = 25°C$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm 1mA$	± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 290	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	$I_T = \pm 5A$ Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/µs
I_D	Off-state leakage current	$V_D = \pm 50V$			± 10	µA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz Note 4		70	150	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			156	°C/W

PARAMETER MEASUREMENT INFORMATION



VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

6

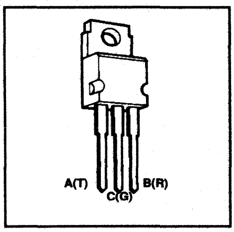
TISP Devices

TEXAS INSTRUMENTS

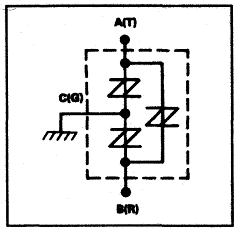
TISP7180, TISP7290
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

April 1987 - Revised March 1990

	TISP7180	TISP7290
• **Breakover Voltage, $V_{(BO)}$ Max**	**180 V**	**290 V**
• **Zener Voltage, V_Z Min**	**145 V**	**200 V**
• **Holding Current, I_H Min**	**150 mA**	
• **Surge Rating:**		
ANSI	**150 A**	
VDE0433	**2.0 kV**	
RLM88	**1.5 kV**	
CCITT IX K17	**1.5 kV**	



PACKAGE: TO220
Pin C is in electrical contact with the mounting pad



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP7000 series is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_i/dt	Initial rate of rise of on - state current	250 A/µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C, derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	TISP7180			TISP7290			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		40	100		40	100	pF

electrical characteristics for the A and C, or the B and C terminals, T_j = 25°C

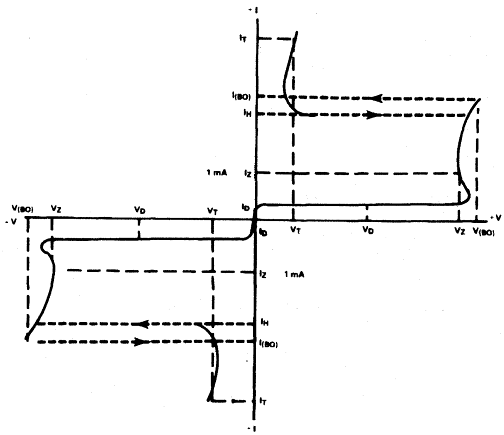
PARAMETER		TEST CONDITIONS	TISP7180			TISP7290			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
α_{VZ}	Temperature coefficient of reference voltage			0.1			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180			± 290	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3		± 1.9	± 3	V
I_H	Holding current	Note 5	± 150			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

VOLTAGE-CURRENT CHARACTERISTICS FOR ANY PAIR OF TERMINALS

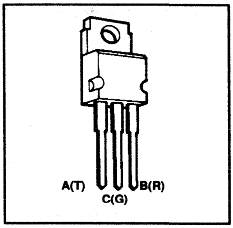


TEXAS INSTRUMENTS

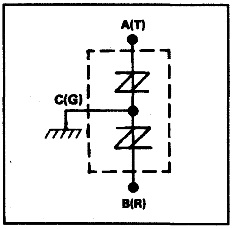
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

April 1987 - Revised March 1990

	TISP8180	TISP8290
• **Breakover Voltage, $V_{(BO)}$ Max**	180 V	290V
• **Zener Voltage, V_Z Min**	145 V	200 V
• **Holding Current, I_H Min**	150 mA	
• **Surge Rating:**		
ANSI	100 A	150 A
VDE0433	2.0 kV	
RLM88	1.5 kV	
CCITT IX K17	1.5 kV	



PACKAGE: TO220
Pin C is in electrical contact with the mounting pad



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP8000 series is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. They will suppress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 μs (ANSI STD C62) (Notes 1&2)	100/150 A
I_{TSP}	5/200 μs (VDE0433 10/700 μs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 μs (RLM88 0.5/700 μs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 μs (CCITT IX K17 10/700 μs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_T/dt	Initial rate of rise of on - state current	250 A/ μs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	TISP7180			TISP7290			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 290			± 400			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		0.5	5		0.5	5	pF

electrical characteristics for the A and C, or the B and C terminals, T_j = 25°C

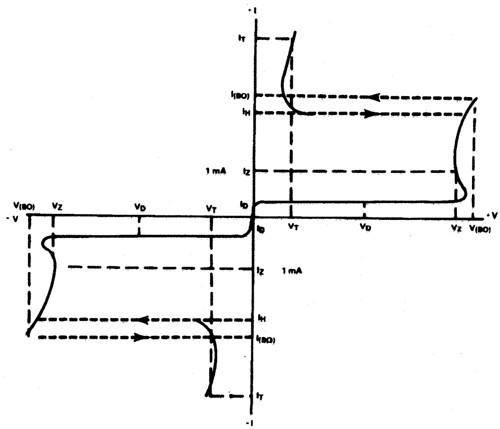
PARAMETER		TEST CONDITIONS	TISP8180			TISP8290			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180			± 290	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3		± 1.9	± 3	V
I_H	Holding current	Note 5	± 150			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		70	150		70	150	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

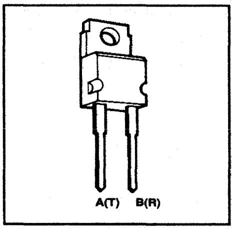
VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND C, OR B AND C



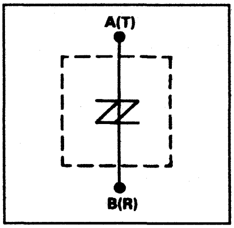
TISP9180, TISP9290
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

April 1987 - Revised March 1990

	TISP9180	TISP9290
• **Breakover Voltage, $V_{(BO)}$ Max**	180 V	290V
• **Zener Voltage, V_Z Min**	145 V	200 V
• **Holding Current, I_H Min**	150 mA	
• **Surge Rating:**		
ANSI	100 A	150 A
VDE0433	2.0 kV	
RLM88	1.5 kV	
CCITT IX K17	1.5 kV	



PACKAGE: DO220
Pin A is in electrical contact with the monting pad



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP9000 series is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will suppess inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	100/150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 2.5 s (Notes 1&2)	10 A
di_T/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics, T_j = 25°C

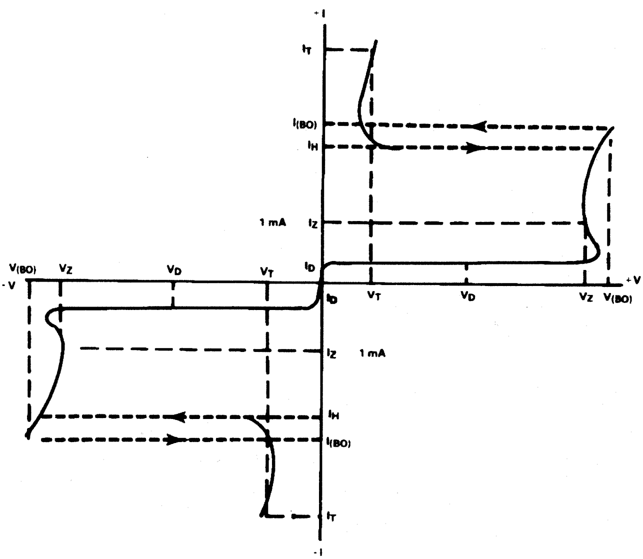
PARAMETER		TEST CONDITIONS	TISP9180			TISP9290			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180			± 290	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3		± 1.9	± 3	V
I_H	Holding current	Note 5	± 150			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

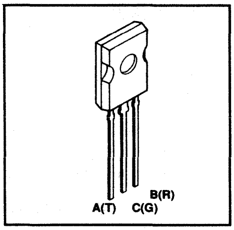
VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B



TEXAS INSTRUMENTS

February 1990 - Revised March 1990

- **Breakover Voltage, $V_{(BO)}$ Max 82 V**
- **Zener Voltage, V_Z Min 58 V**
- **Holding Current, I_H Min 150 mA**
- **Surge Rating:**
  - **ANSI 150 A**
  - **VDE0433 2.0 kV**
  - **RLM88 1.5 kV**
  - **CCITT IX K17 1.5 kV**



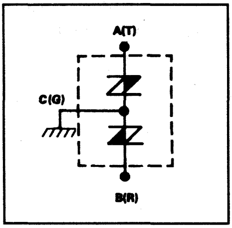
PACKAGE: SOT82
Pin C is in electrical contact with the mounting pad.

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP1082L is designed specifically for telephone line card protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Negative transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides. Positive transients are clipped by diode action.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.



device schematic

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/210 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 0.7 s (Notes 1&2)	10 A
di_T/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES: 1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B Terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1kHz (Note 4)		1	5	pF

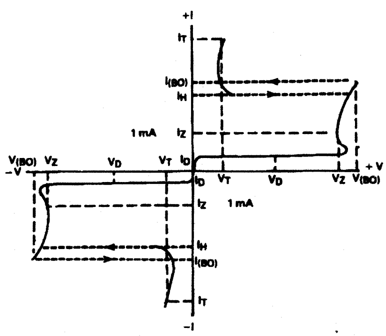
electrical characteristics for the A and C, or the B and C terminals†, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = -1mA	-58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			-82	V
$I_{(BO)}$	Breakover current	Note 5	-0.15		-0.6	A
V_F	Forward voltage	I_F = 5A Notes 5 and 6			3	V
V_{TM}	Peak on-state voltage	I_T = -5A Notes 5 and 6		-2.2	-3	V
I_H	Holding current	Note 5	-150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			-5	kV/µs
I_D	Off-state leakage current	V_D = -50V			-10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		300	500	pF

thermal characteristics

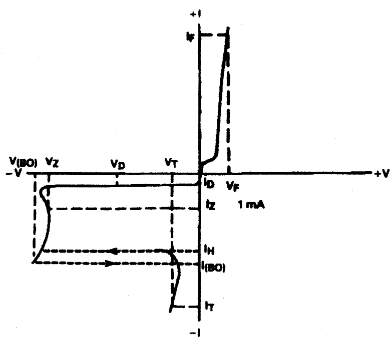
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

PARAMETER MEASUREMENT INFORMATION



VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

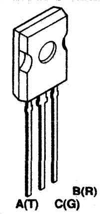
The high level characteristics for terminals A and B are not guaranteed.



VOLTAGE CURRENT CHARACTERISTICS FOR TERMINALS A AND C OR B AND C†

†Polarity is determined at terminal A or B with respect to C

- **Breakover Voltage, $V_{(BO)}$ Max** **82 V**
- **Zener Voltage, V_Z Min** **58 V**
- **Holding Current, I_H Min** **150 mA**
- **Surge Rating:**
  - **ANSI** **150 A**
  - **VDE0433** **2.0 kV**
  - **RLM88** **1.5 kV**
  - **CCITT IX K17** **1.5 kV**



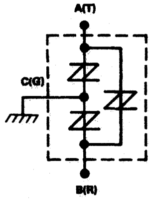
PACKAGE: SOT82
Pin C is in electrical contact with the mounting pad

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP2082L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.



device schematic

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/210 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 0.7 s (Notes 1&2)	10 A
di_t/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4: These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

6

TISP Devices

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
I_D	Off-state leakage current	V_D = ± 50 v			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 F = 1 kHz Note 4		70	150	pF

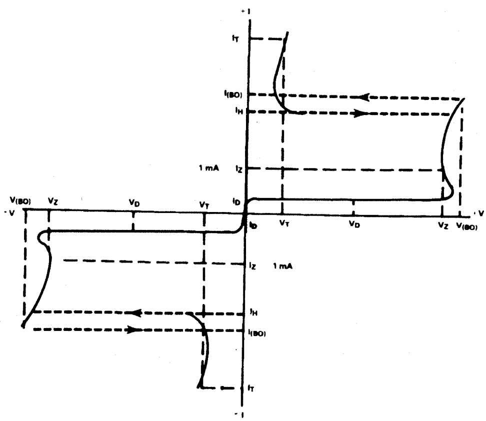
electrical characteristics for the A and C or the B and C terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 82	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A Notes 5 and 6		± 2.2	± 3	V
I_H	Holding current	Note 5	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

PARAMETER MEASUREMENT INFORMATION

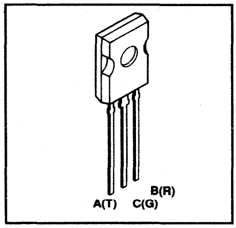


VOLTAGE-CURRENT CHARACTERISTICS FOR ANY PAIR OF TERMINALS
The high-level characteristics for terminal A and B are not guaranteed.

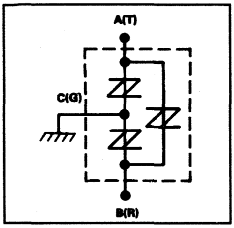
TISP2180L, TISP2290L
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

February 1990 - Revised March 1990

	TISP2180	TISP2290
• **Breakover Voltage, $V_{(BO)}$ Max**	**180 V**	**290 V**
• **Zener Voltage, V_Z Min**	**145 V**	**200 V**
• **Holding Current, I_H Min**	**150 mA**	
• **Surge Rating:**		
ANSI	**150 A**	
VDE0433	**2.0 kV**	
RLM88	**1.5 kV**	
CCITT IX K17	**1.5 kV**	



PACKAGE: SOT82
Pin C is in electrical contact with the mounting pad.



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP2000L series is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 0.7 s (Notes 1&2)	10 A
di_T/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1. Above 70°C,derate linearly to zero at 150°C case temperature.
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	TISP2180L			TISP2290L			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		40	100		40	100	pF

electrical characteristics for the A and C, or the B and C terminals, T_j = 25°C

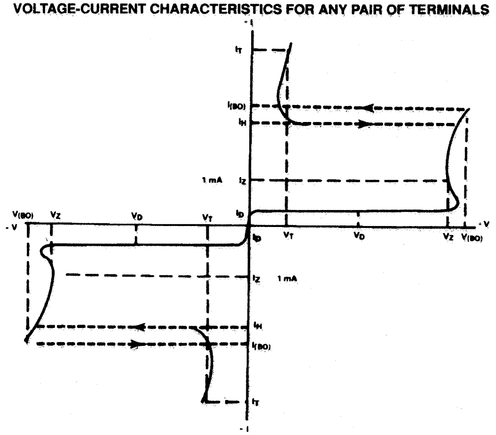
PARAMETER		TEST CONDITIONS	TISP2180L			TISP2290L			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180			± 290	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3		± 1.9	± 3	V
I_H	Holding current	Note 5	± 150			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100			100	°C/W

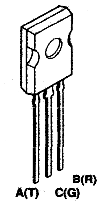
PARAMETER MEASUREMENT INFORMATION

VOLTAGE-CURRENT CHARACTERISTICS FOR ANY PAIR OF TERMINALS



The high-level characteristics for terminals A and B are not guaranteed

	TISP7180L	TISP7290L
• **Breakover Voltage, $V_{(BO)}$ Max**	180 V	290 V
• **Zener Voltage, V_Z Min**	145 V	200 V
• **Holding Current, I_H Min**	150 mA	
• **Surge Rating:**		
ANSI	150 A	
VDE0433	2.0 kV	
RLM88	1.5 kV	
CCITT IX K17	1.5 kV	



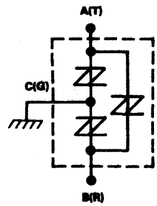
PACKAGE: SOT82
Pin C is in electrical contact with the mounting pad

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP7000L series is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.



device schematic

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 0.7 s (Notes 1&2)	10 A
di_T/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES:
1: Above 70°C, derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP7180L			TISP7290L			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		40	100		40	100	pF

electrical characteristics for the A and C, or the B and C terminals, T_J = 25°C

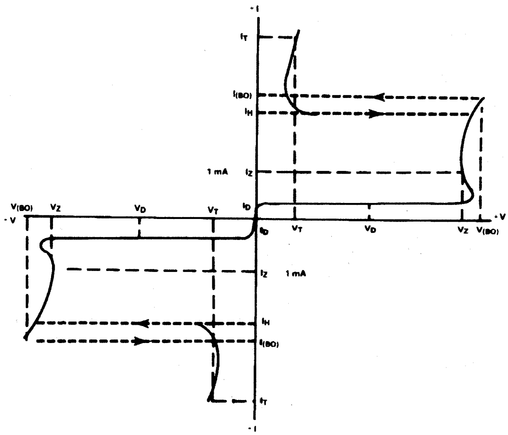
PARAMETER		TEST CONDITIONS	TISP7180L			TISP7290L			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180			± 290	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3		± 1.9	± 3	V
I_H	Holding current	Note 5	± 150			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100			100	°C/W

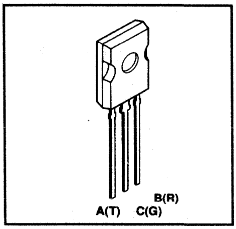
PARAMETER MEASUREMENT INFORMATION

VOLTAGE-CURRENT CHARACTERISTICS FOR ANY PAIR OF TERMINALS

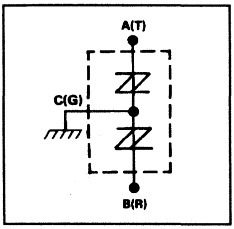


February 1990 - Revised March 1990

	TISP8180L	TISP8290L
• **Breakover Voltage, $V_{(BO)}$ Max**	**180 V**	**290V**
• **Zener Voltage, V_Z Min**	**145 V**	**200 V**
• **Holding Current, I_H Min**	**150 mA**	
• **Surge Rating:**		
ANSI	**100 A**	**150 A**
VDE0433	**2.0 kV**	
RLM88	**1.5 kV**	
CCITT IX K17	**1.5 kV**	



PACKAGE: SOT82
Pin C is in electrical contact with the mounting pad



device schematic

FOR APPLICATIONS IN TELECOMMUNICATIONS EQUIPMENT

The TISP8000L series is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. They will suppress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion - implanted planar structures to ensure precise and symmetrical breakover control.

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	Non - repetitive peak on - state pulse current:	
I_{TSP}	8/20 µs (ANSI STD C62) (Notes 1&2)	100/150 A
I_{TSP}	5/200 µs (VDE0433 10/700 µs, 2 kV) (Notes 1,2 & 3)	50 A
I_{TSP}	0.2/310 µs (RLM88 0.5/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSP}	5/310 µs (CCITT IX K17 10/700 µs, 1.5 kV) (Notes 1,2 & 3)	38 A
I_{TSM}	50 Hz RMS on - state current 0.7 s (Notes 1&2)	10 A
di_t/dt	Initial rate of rise of on - state current	250 A/ µs
T_{jmax}	Junction temperature	150°C
	Operating free - air temperature range	0°C - 70°C
T_{stg}	Storage temperature range	-40°C - 150°C
T_{lead}	Lead temperature 1.5 mm from case for 10 s	260°C

NOTES: 1: Above 70°C,derate linearly to zero at 150°C case temperature.
2: This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3: Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.
4. These capacitance measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts separate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80% V_Z (minimum).

electrical characteristics for the A and B terminals, T_j = 25°C

PARAMETER		TEST CONDITIONS	TISP7180L			TISP7290L			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 290			± 400			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		0.5	5		0.5	5	pF

electrical characteristics for the A and C, or the B and C terminals, T_j = 25°C

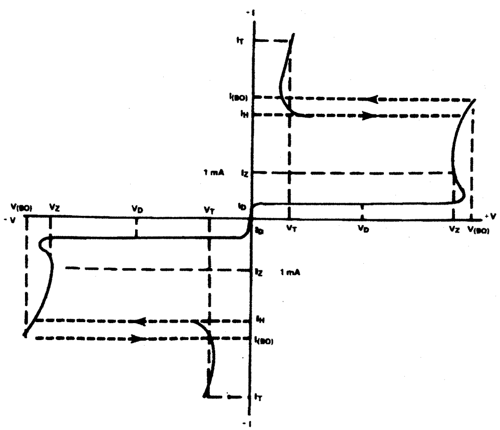
PARAMETER		TEST CONDITIONS	TISP8180L			TISP8290L			
			MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1			0.1		%/°C
$V_{(BO)}$	Breakover voltage	Notes 5 and 6			± 180			± 290	V
$I_{(BO)}$	Breakover current	Note 5	± 0.15		± 0.6	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5A Notes 5 and 6		± 2.2	± 3		± 1.9	± 3	V
I_H	Holding current	Note 5	± 150			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	Note 7			± 5			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz Note 4		110	200		110	200	pF

thermal characteristics

PARAMETER		MIN	TYP	MAX	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100			100	°C/W

PARAMETER MEASUREMENT INFORMATION

VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND C, OR B AND C

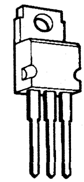


7

R3460
NPN SILICON POWER TRANSISTOR

Revised March 1990

- **Specifically Designed for Fluorescent Lamp Electronic Ballast applications up to 120 W**
- **h_{FE} Banding 20 - 45**
- **Rugged Triple - Diffused Planar Construction**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **2.5 A Continuous Collector Current**
- **850 Volt Blocking Capability**



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Ambient Temperature

		R3460
V_{CBO}	Collector - base voltage (I_E = 0)	850 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	850 V
V_{CEO}	Collector - emitter voltage (I_B =0)	400 V
V_{EBO}	Base - emitter voltage	10 V
I_C	Continuous collector current	2.5 A
I_{CM}	Peak collector current (Note 1)	8 A
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	50 W
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C

NOTE 1: Pulse test, pulse duration = 10 ms.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CEO\ (sus)}$	Collector - emitter sustaining voltage (Note 2)	I_C = 100 mA L = 25 mH	400			V
I_{CES}	Collector - emitter cut - off current	V_{CE} = 850 V V_{CE} = 850 V 100°C			5.0 0.2	µA mA
I_{CEO}	Collector cut - off current	V_{CE} = 400 V			5.0	µA
I_{EBO}	Emitter cut - off current	V_{EB} = 10 V I_C = 0			1.0	mA
$V_{CE(sat)}$	Collector - emitter saturation voltage (Notes 3 &4)	I_C = 1 A I_B = 200 mA I_C = 2.5 A I_B = 500 mA I_C = 2.5 A I_B = 500 mA 100°C			1.0 2.5 5.0	V V V
$V_{BE(sat)}$	Base - emitter saturation voltage (Notes 3 & 4)	I_C = 1 A I_B = 200 mA I_C = 2.5 A I_B = 500 mA I_C = 2.5 A I_B = 500 mA 100°C			1.0 1.2 1.3	V V V
h_{FE}	Forward current transfer ratio (Notes 3 & 4)	I_C = 0.5 A V_{CE} = 5 V	20		45	
f_t	Current gain bandwidth product	I_C = 0.5 A V_{CE} = 10 V f = 1 MHz		12		MHz
C_{ob}	Output capacitance	I_E = 0 V_{CB} = 20 V f = 0.1 MHz		55		pF
$R_{\theta JC}$	Thermal resistance junction - case				2.5	°C/W

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, pulse width = 300 µs, duty cycle = 2%
4. These parameters are measured with voltage sensing contacts separated from the current carrying contacts within 3.2 mm from the device body.

Inductive Load Switching Characteristics at 25°C Case Temperature (unless otherwise noted)

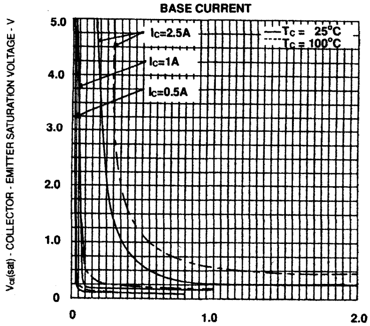
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 2.5 A, V_{CE} = 125 V, $I_{B(on)}$ = 0.5 A, $V_{BE(off)}$ = -5 V			2.0	µs
t_{rv}	Voltage rise time				0.20	µs
t_{fi}	Current fall time				0.20	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.30	µs
t_{sv}	Voltage storage time	I_C = 2.5 A, V_{CE} = 125 V, $I_{B(on)}$ = 0.5 A, $V_{BE(off)}$ = -5 V, T_C = 100°C			2.50	µs
t_{rv}	Voltage rise time				0.40	µs
t_{fi}	Current fall time				0.25	µs
t_{ti}	Current tail time				0.05	µs
t_{xo}	Cross over time				0.50	µs

NOTE 2: Inductive loop switching measurement.
NOTE 3: These parameters must be measured using pulsed techniques, tw = 300 µs, duty cycle ≤ 2%
NOTE 4: These parameters measured with voltage-sensing contacts separated from the current carrying contacts located within 3.2mm from the device body

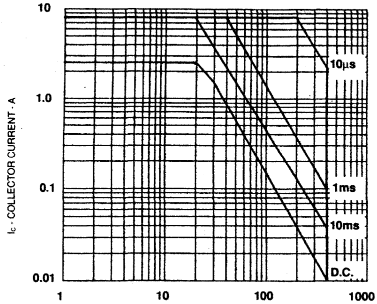
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

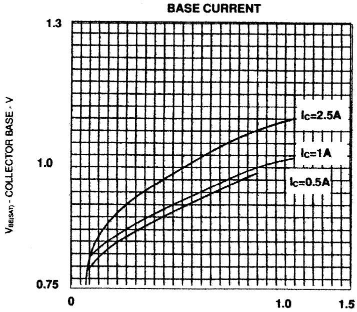
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



COLLECTOR - BASE SATURATION VOLTAGE vs BASE CURRENT



Miscellaneous

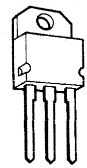
7

TEXAS INSTRUMENTS

NPN SILICON POWER TRANSISTORS

March 1990

- **Specifically Designed for High Voltage Inductive Switching applications such as SMPS and CRT Scanning**
- **1300 V Blocking capability**
- **100 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **6 A Peak Collector Current**



PACKAGE: SOT-93

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		R4050	R4051
V_{CBO}	Collector - base voltage (I_E = 0)	1300 V	1100 V
V_{CES}	Collector - emitter voltage (V_{BE} = 0)	1300 V	1100 V
V_{CEO}	Collector - emitter voltage (I_B =0)	600 V	550 V
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	6 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	100 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE: 1 This value applies for $t_w \leq$ 2ms, duty cycle ≤ 10%.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	R4050			R4051			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{CEO(sus)}$	Collector-emitter sustaining voltage	I_C = 0.2 A L = 25 mH (Note 2)	600			550			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 600 V V_{BE} = 0			2.0				µA
		V_{CE} = 550 V V_{BE} = 0						2.0	µA
		V_{CE} = 1300 V V_{BE} = 0			50				µA
		V_{CE} = 1100 V V_{BE} = 0						50	µA
		V_{CE} = 1300 V V_{BE} = 0 T_C = 100°C			1.0				mA
		V_{CE} = 1100 V V_{BE} = 0 T_C = 100°C						1.0	mA
I_{EBO}	Emitter-base cut-off current	V_{EB} = 10 V			1.0			1.0	mA
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.5 A I_C= 2.5 A (Note3)			1.2			1.2	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.5 A I_C = 2.5 A			2.5			2.5	V
		I_B = 1.25 A I_C = 4 A (Note 3)			2.0			2.0	V
$R_{\theta JC}$	Thermal resistance junction - case							1.25	°C/W

NOTES: 2. Inductive loop switching measurement.
3. Measured using pulse techniques pulse width, t_w = 300 µs, duty cycle ≤ 2%.

Inductive Load Switching characteristics at 25°C Case Temperature (unless otherwise noted)

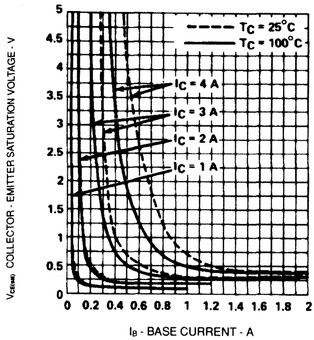
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 2.5 A $I_{B(on)}$ = 0.5 A $V_{BE(off)}$ = -5 V			2.0	υs
t_{rv}	Voltage rise time				0.25	υs
t_{fi}	Current fall time				0.10	υs
t_{ti}	Current tail time				0.05	υs
t_{xo}	Cross over time				0.30	υs

NOTE 4: Read time at end of t1, $T_{J(max)} - T_C = P_{D(PEAK)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

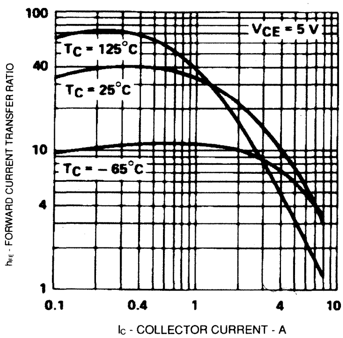
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

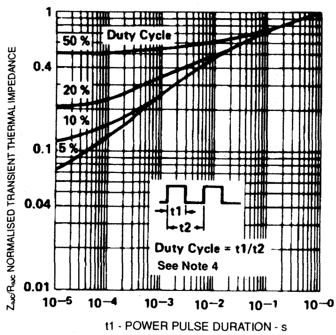
COLLECTOR - EMITTER SATURATION VOLTAGE
vs
BASE CURRENT



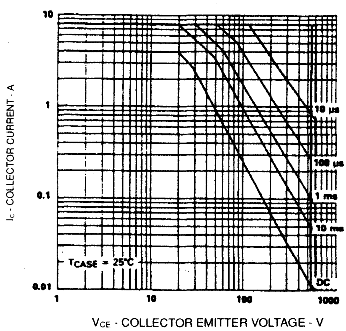
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT



THERMAL RESPONSE

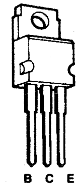


MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



March 1990

- **Specifically Designed for High Voltage Inductive Switching applications such as SMPS and CRT Scanning**
- **1300 V Blocking capability**
- **80 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **6 A Peak Collector Current**



PACKAGE: TO 220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

		R4060	R4061
V_{CBO}	Collector - base voltage ($I_E = 0$)	1300 V	1100 V
V_{CES}	Collector - emitter voltage ($V_{BE} = 0$)	1300 V	1100 V
V_{CEO}	Collector - emitter voltage ($I_B = 0$)	600 V	550 V
I_C	Continuous collector current	4 A	
I_{CM}	Peak collector current (Note 1)	6 A	
P_{tot}	Continuous device dissipation at (or below) 25°C case temperature	80 W	
T_j & T_{stg}	Operating junction and storage temperature range	-65°C to + 150°C	

NOTE: 1 This value applies for $t_w \leq 2ms$, duty cycle ≤ 10%.

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	R4060			R4061			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{CEO(sus)}$	Collector-emitter sustaining voltage	$I_C = 0.2$ A L = 25 mH (Note 2)	600			550			V
I_{CES}	Collector-emitter cut-off current	$V_{CE} =$ 600 V $V_{BE} = 0$ $V_{CE} =$ 550 V $V_{BE} = 0$ $V_{CE} =$ 1300 V $V_{BE} = 0$ $V_{CE} =$ 1100 V $V_{BE} = 0$ $V_{CE} =$ 1300 V $V_{BE} = 0$ $T_C = 100°C$ $V_{CE} =$ 1100 V $V_{BE} = 0$ $T_C = 100°C$			2.0 50 1.0 			 2.0 50 1.0	µA µA µA µA mA mA
I_{EBO}	Emitter-base cut-off current	$V_{EB} = 10$ V			1.0			1.0	mA
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_B = 0.5$ A $I_C = 2.5$ A (Notes 3 & 4)			1.2			1.2	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_B = 0.5$ A $I_C = 2.5$ A $I_B = 1.25$ A $I_C = 4$ A (Notes 3 & 4)			2.5 2.0			2.5 2.0	V
$R_{\theta JC}$	Thermal resistance junction - case							1.56	°C/W

NOTES: 2. Inductive loop switching measurement.
3. Measured using pulse techniques pulse width, $t_w = 300$ µs, duty cycle ≤ 2%.
4. These parameters are measured with voltage sensing contacts separate from the current carrying contacts and located within 3.2 mm from the device body.

Inductive Load Switching characteristics at 25°C Case Temperature (unless otherwise noted)

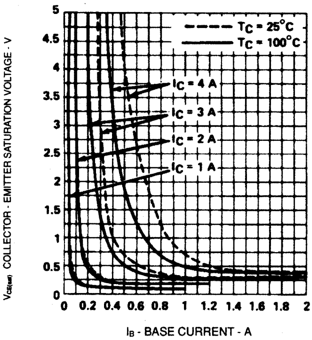
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 2.5 A $I_{B(on)}$ = 0.5 A $V_{BE(off)}$ = -5 V			2.0	υs
t_{rv}	Voltage rise time				0.25	υs
t_{fi}	Current fall time				0.10	υs
t_{ti}	Current tail time				0.05	υs
t_{xo}	Cross over time				0.30	υs

NOTE 5: Read time at end of t1, $T_{J(max)} - T_C = P_{D(PEAK)} \bullet \left(\frac{Z_{\theta JC}}{R_{\theta JC}}\right) \bullet R_{\theta JC(max)}$

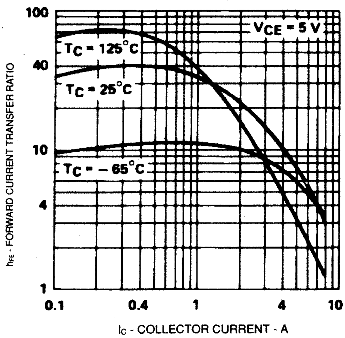
See Appendices for Inductive Switching Waveforms and Test Circuit

TYPICAL CHARACTERISTICS

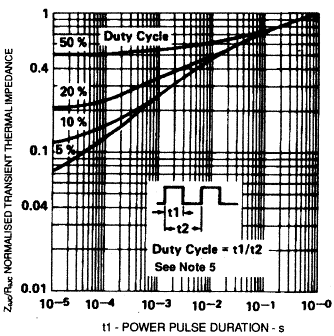
COLLECTOR - EMITTER SATURATION VOLTAGE vs BASE CURRENT



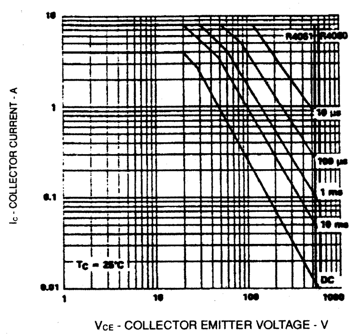
FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT



THERMAL RESPONSE



MAXIMUM FORWARD - BIAS SAFE OPERATING AREA



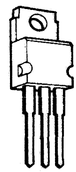
TEXAS INSTRUMENTS

FLUORESCENT LAMP STARTER SWITCH

June 1984 - Revised March 1990

- $V_{(BR)}$ 1000 - 1300 V
- I_H > 175 mA
- I_{GT} < 2 mA

This product is intended for use as a T8/T12 fluorescent tube starter switch on 200-240V ac supplies with tube sizes up to 3 ft with leading and lagging ballast circuits.



C A G

PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

V_{DWM}	Crest working off-state voltage (Full wave rectified 50 Hz ac)	375 V
V_{RGM}	Peak reverse gate voltage	6 V
I_T I_{TRM} I_{TSM}	On-state current -continuous - repetitive peak - non-repetitive peak	1.5 A 2 A 10 A
I_{GRM}	Gate current - peak	0.5 A
$P_{G(AV)}$	Gate power - average	0.3 W
T_C	Operating case temperature range	-5°C to +85°C
T_{stg}	Storage temperature range	-10°C to +110°C
T_{lead}	Lead temperature during soldering 1.6 mm from case for 10 seconds	230°C

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
I_D	Off-state current	$V_D = V_{DWM}$ $T_j = 65°C$		1	mA
V_T	On-state voltage	$I_T = 2$ A		3.1	V
$V_{(BR)}$	Clamping voltage	$I_T = 5$ mA tp <200 µs 2% duty cycle	1000	1300	V
I_H	Holding current	See applications circuit	175		mA
I_{GTM}	Peak gate trigger current	$V_{AA} = 10$ V $R_L = 10\ \Omega$		2.0	mA
V_{GTM}	Peak gate trigger voltage	$V_{AA} = 10$ V $R_L = 10\ \Omega$		3.0	V

Thermal Characteristics

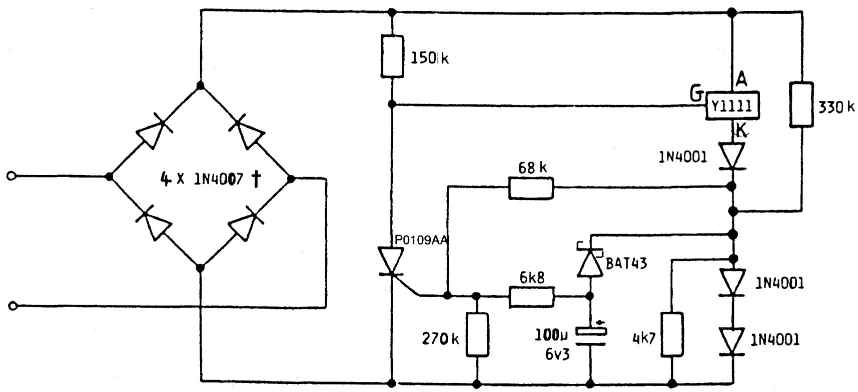
PARAMETERS		MAX	UNIT
$R_{\theta JC}$	Junction to case thermal resistance	3.5	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance	62.5	°C/W

APPLICATIONS DATA

The conventional method of starting fluorescent tubes employs the use of an electromechanical canister. This consists of a bimetallic strip which opens as it cools and in conjunction with the ballast inductor, provides the tube striking voltage. However, the random nature of the pulsing results in repeated striking attempts and degradation of both the tube and starter. The tube degradation is illustrated by its progressively blackening ends and ultimately required tube replacement.

The Y1111, "Fluoractor"™, has been specifically introduced for use in electronic starters. This unique device offers the lighting industry an opportunity to develop electronic starters small enough to be retrofit replacements for the established electromechanical canisters. Its double thyristor structure with integrated zener clamp diode and current mirror provides the technology for a starter with enhanced features such as controlled flicker free start up, automatic tube shutdown at end of tube life and reduced degradation of tube ends leading to extended life. The increased functionality, lifetime and reliability of these starters has led in some cases to them being embodied in the ballast itself, a development not feasible with the old electromechanical canisters.

TYPICAL APPLICATIONS DATA



TWO TERMINAL STARTER CIRCUIT

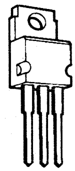
† NOTE: These diodes must be voltage selected for $V_R \geq V_{(BR\ MAX)} + 150$ V

FLUORESCENT LAMP STARTER SWITCH

June 1984 - Revised March 1990

- **$V_{(BR)}$ 1200 - 1500 V**
- **I_H > 175 mA**
- **I_{GT} < 2 mA**

This product is intended for use as a T8/T12 fluorescent tube starter switch on 200-240V ac supplies with tube sizes up to 5 ft with leading and lagging ballast circuits.



PACKAGE: TO220

Absolute Maximum Ratings at 25°C Case Temperature (unless otherwise noted)

V_{DWM}	Crest working off-state voltage (Full wave rectified 50 Hz ac)	375 V
V_{RGM}	Peak reverse gate voltage	6 V
I_T I_{TRM} I_{TSM}	On-state current - continuous - repetitive peak - non-repetitive peak	1.5 A 2 A 10 A
I_{GRM}	Gate current - peak	0.5 A
$P_{G(AV)}$	Gate power - average	0.3 W
T_C	Operating case temperature range	-5°C to +85°C
T_{stg}	Storage temperature range	-10°C to +110°C
T_{lead}	Lead temperature during soldering 1.6 mm from case for 10 seconds	230°C

Electrical Characteristics at 25°C Case Temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
I_D	Off-state current	$V_D = V_{DWM}$ $T_j = 65°C$		1	mA
V_T	On-state voltage	$I_T = 2$ A		3.1	V
$V_{(BR)}$	Clamping voltage	$I_T = 5$ mA tp <200 µs 2% duty cycle	1200	1500	V
I_H	Holding current	See application circuit	175		mA
I_{GTM}	Peak gate trigger current	$V_{AA} = 10$ V $R_L = 10\ \Omega$		2.0	mA
V_{GTM}	Peak gate trigger voltage	$V_{AA} = 10$ V $R_L = 10\ \Omega$		3.0	V

Thermal Characteristics

PARAMETERS		MAX	UNIT
$R_{\theta JC}$	Junction to case thermal resistance	3.5	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance	62.5	°C/W

Miscellaneous

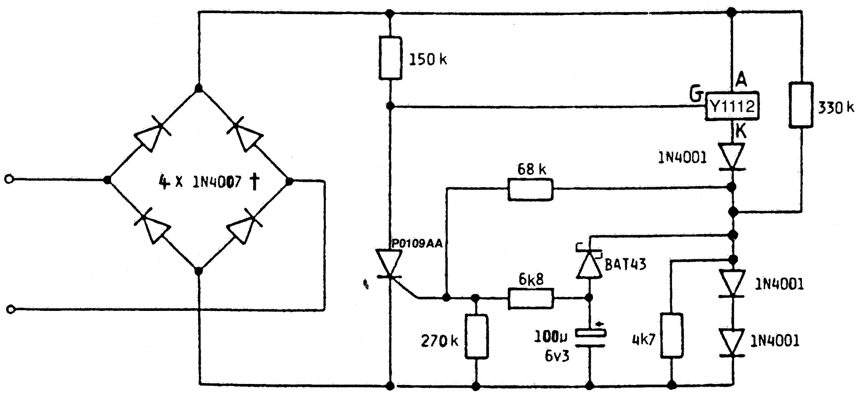
7

APPLICATIONS DATA

The conventional method of starting fluorescent tubes employs the use of an electromechanical canister. This consists of a bimetallic strip which opens as it cools and in conjunction with the ballast inductor, provides the tube striking voltage. However, the random nature of the pulsing results in repeated striking attempts and degradation of both the tube and starter. The tube degradation is illustrated by its progressively blackening ends and ultimately required tube replacement.

The Y1112, "Fluoractor"™, has been specifically introduced for use in electronic starters. This unique device offers the lighting industry an opportunity to develop electronic starters small enough to be retrofit replacements for the established electromechanical canisters. Its double thyristor structure with integrated zener clamp diode and current mirror provides the technology for a starter with enhanced features such as controlled flicker free start up, automatic tube shutdown at end of tube life and reduced degradation of tube ends leading to extended life. The increased functionality, lifetime and reliability of these starters has led in some cases to them being embodied in the ballast itself, a development not feasible with the old electromechanical canisters.

TYPICAL APPLICATIONS DATA



TWO TERMINAL STARTER CIRCUIT

† NOTE: These rectifiers need to be voltage selected for $V_R \geq V_{(BR\ MAX)} + 150$ V

Miscellaneous
7

TEXAS INSTRUMENTS

8

POWER TRANSISTORS

POWER TRANSISTOR SAFETY CONSIDERATIONS

The designer, maker, and user of electrical equipment containing power transistors should give attention to the following points relative to the safety of personnel that may operate the equipment.

The electrical potentials of the collector, emitter, and base terminals on the transistor present an electrical shock hazard when the equipment is energized.

The normal operating case temperature of energized transistors is often high enough to present burn hazards to both operating personnel and flammable material touching the transistor.

If the transistor is falsely turned "on" or fails, power will be applied to the equipment load. Operator safety may be affected by an unexpected energizing of the load.

In the event that an equipment output short or internal fault condition develops, very high surge current can be passed through the transistor. If this condition exceeds transistor ratings for magnitude and duration, the transistor may be damaged; and if the surge is severe enough, internal heating can cause the transistor to rupture and perhaps sustain an arc.

POWER TRANSISTOR STANDARDS

Following are sources of standard material relating to Power Transistors:

EIA and JEDEC Standards:
Electronic Industries Association
2001 Eye St. N.W., Washington, D.C. 20006
Telephone: 202 659-2200

EIA Standard RS-313-B: Test Procedures for Verification of Maximum Ratings of Power Transistors.

JEDEC Standard 77: Letter Symbols, Abbreviations, Terms, and Definitions for Discrete Semiconductor and Optoelectronic Devices.

JEDEC Publication 65: Test Procedures for Verification of Maximum Ratings of Power Transistors.

JEDEC Publication 74: Standard List of Values to be used in Power Transistor Device Registration and Minimum Differences for Discreetness of Registration.

JEDEC Publication 104: Quick Reference Guide to Letter Symbols.

JC-25 Power Transistor Registration Formats RDF-1 to RDF-6

IEC Standards
American National Standards Institute, Inc.
1430 Broadway
New York, N.Y. 10018
Telephone: 212 868-1220

IEC Publication 147: Essential Ratings and Characteristics of Semiconductor Devices and General Principles of Measuring Methods.

IEC Publication 148: Letter Symbols for Semiconductor Devices and Integrated Microcircuits.

IEC Publication 191: Mechanical Standardization of Semiconductor Devices.

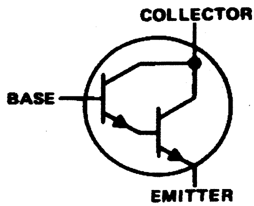
GLOSSARY
POWER TRANSISTORS

Introduction

Most of the information concerning letter symbols, abbreviations, terms, and definitions commonly used with Power transistors was obtained from JEDEC Standard 77. This document and the JC-25 registration formats have overriding authority where any conflict occurs.

Power Transistor Terms and Definitions

Term	Definition
base (B,b)*	A region which lies between an emitter and collector of a transistor and into which minority carriers are injected. (Ref. IEEE Std. 100)
breakdown	A phenomenon occuring in a reverse-biased semiconductor junction, the initiation of which is observed as a transition from a region of high small-signal resistance to a region of substantially lower small-signal resistance for an increasing magnitude of reverse current. (Ref. RS-282)
breakdown region	A region of the volt-ampere characteristic beyond the initiation of breakdown for an increasing magnitude of reverse current. (Ref. RS-282)
breakdown voltage	The voltage measured at a specified current in a breakdown region. (Ref. MIL-S-19500)
collector (C,c)*	A region through which a primary flow of charge carriers leaves the base. (Ref. IEEE Std. 100)
Darlington amplifier	A current amplifier consisting essentially of two separate transistors and often mounted in a single transistor housing. (Ref. McGraw Hill Dictionary of Scientific and Technical Terms). Graphic symbol for N-P-N Darlington transistor: (Ref. ANSI Y32.2).



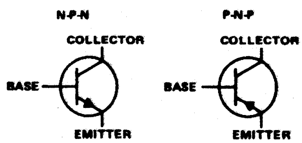
Term	Definition
emitter (E,e)*	A region from which charge carriers that are minority carriers in the base are injected into the base. (Ref. IEEE Std.100)
forward direction	The direction of current that results when the p-type semiconductor region is at a positive potential relative to the n-type region. (Ref. IEEE Std. 253)
junction, collector	A semiconductor junction normally biased in the reverse direction, the current through which can be controlled by the introduction of minority carriers into the base. (Ref. IEEE Std. 100)
junction, emitter	A semiconductor junction normally biased in the forward direction to inject minority carriers into the base. (Ref. IEEE Std.100)
open-circuit	A circuit in which halving the magnitude of the terminating impedance does not produce a change in the parameter being measured greater than the required accuracy of the measurement (Ref. MIL-S-19500)
reverse current	The current that flows through a semiconductor junction in the reverse direction.
reverse direction	The direction of current flow that results when the n-type semiconductor region is at a positive potential relative to the p-type region.

* References to base, collector, and emitter symbolism (B, b, C, c, E and e) refer to the device terminals connected to those regions.

Term	Definition
saturation	A base-current and a collector-current condition resulting in a forward-biased collector junction.
second breakdown	A condition of the transistor, resulting from a lateral current instability, in which the electrical characteristics are determined principally by the spreading resistance of a thermally maintained current constriction. The initiation of second breakdown is observed as a decrease in the voltage sustained by the collector. NOTE: Second breakdown differs from thermal failure in that its initiation cannot be predicted from low-voltage thermal resistance measurements. Unless the current and duration in second breakdown are limited, the high junction temperature at the current constriction will result in failure, usually as a collector-to-emitter short-circuit. Second breakdown can occur at positive, negative, or zero base current.
semiconductor junction	A region of transition between semiconductor regions of different electrical properties (e.g., *n-n+, p-n, p-p+* semiconductors), or between a metal and a semiconductor. (Ref. RS-282)
short-circuit	A circuit in which doubling the magnitude of the terminating impedance does not produce a change in the parameter being measured that is greater than the required accuracy of the measurement. (Ref. MIL-S-19500)
small-signal	A signal which when doubled in magnitude does not produce a change in the parameter being measured that is greater than the required accuracy of the measurement (Ref. MIL-S-19500)
static-value	A non-varying value or quantity of measurement at a specified fixed point, or the slope of the line from the origin to the operating point on the appropriate characteristic curve. (Ref. IEEE 255)
terminal	An externally available point of connection (Ref. IEC 147-0)
thermal resistance (steady state)	The temperature difference between two specified points or regions divided by the power dissipation under conditions of thermal equilibrium. (Ref. IEEE 100)
transient thermal impedance	The change of temperature difference between two specified points or regions at the end of a time interval divided by the step-function change in power dissipation at the beginning of the same time interval causing the change of temperature difference. (Ref. IEEE 223)
transistor	A semiconductor device capable of providing power amplification and having three or more terminals. (Ref. IEC 147-0)
transistor, junction, multijunction type	A transistor having a base and two or more junctions.

Graphic symbols for emitter, base, collector transistors:
(Ref. ANS Y32.2)

NOTE: In the graphic symbols, the envelope is optional if no element is connected to the envelope.



Power Transistor Letter Symbols, Terms and Definitions

Symbol	Term	Definition
C_{ibo}	open-circuit input capacitance	The capacitance measured across the input terminals (emitter and base) with the collector open-circuited to ac. (Ref. IEEE 255)
C_{obo}	open-circuit output capacitance	The capacitance measured across the output terminals (collector and base) with the input open-circuited to ac. (Ref. IEEE 255)
f_{hfe}	small-signal short-circuit forward current transfer ratio cutoff frequency (common-emitter)	The lowest frequency at which the magnitude of the small-signal short-circuit forward current transfer ratio is 0.707 of its value at a specified low frequency (usually 1 kHz or less). (Ref. IEEE 255)
f_T	transition frequency or frequency at which small-signal forward current transfer ratio (common-emitter) extrapolates to unity	The product of the modulus (magnitude) of the common-emitter small-signal short-circuit forward current transfer ratio, h_{fe}, and the frequency of measurement when this frequency is sufficiently high so that the modulus (magnitude) of h_{fe} is decreasing with a slope of approximately 6 dB per octave. (Ref. IEEE 255)
G_{PE}	large-signal insertion power gain (common-emitter)	The ratio, usually expressed in dB, of (1) the signal power delivered to the load after insertion of a transducer between the source and the load to (2) the signal power that was delivered to the load when the load was connected directly to the source, under large-signal conditions.
h_{FE}	static forward current transfer ratio (common-emitter)	The ratio of the dc collector current to the dc base current (Ref. MIL-S-19500)
h_{fe}	small-signal short-circuit forward current transfer ratio (common-emitter)	The ratio of the ac collector current to the small-signal ac base current with the collector short-circuited to the emitter for ac. (Ref. MIL-S-19500)
h_{IE}	static input resistance (common -emitter)	The ratio of the dc base-emitter voltage to the dc base current. (Ref. MIL-S-19500)
h_{ie}	small-signal short-circuit input impedance (common-emitter)	The ratio of the small-signal ac base-emitter voltage to the ac base current with the collector short-circuited to the emitter for ac. (Ref. MIL-S-19500)
$h_{ie(imag)}$	imaginary part of the small-signal short-circuit input impedance, (common-emitter)	The ratio of the out-of-phase (imaginary) component of the small-signal ac base-emitter voltage to the ac base current with the collector terminal short-circuited to the emitter terminal for ac.
$h_{ie(real)}$	real part of the small-signal short-circuit input impedance, (common-emitter)	The ratio of the in-phase (real) component of the small-signal ac base emitter voltage to the ac base current with the collector terminal short-circuited to the emitter terminal for ac.
h_{oe}	small-signal open-circuit output admittance, (common-emitter)	The ratio of the ac collector current to the small-signal ac collector-emitter voltage with the base terminal open-circuited to ac. (Ref. MIL-S-19500)
$h_{oe(imag)}$	imaginary part of the small-signal open-circuit output admittance, (common-emitter)	The ratio of the ac collector current to the out-of-phase (imaginary) component of the small-signal collector-emitter voltage with the base terminal open-circuited to ac.
$h_{oe(real)}$	real part of the small-signal open-circuit output admittance, (common-emitter)	The ratio of the ac collector current to the in-phase (real) component of the small-signal collector-emitter voltage with the base terminal open-circuited to ac.
I_B, I_C I_E	current, dc (base-terminal, collector-terminal, emitter-terminal)	The value of the dc current into the terminal indicated by the subscript.

Symbol	Term	Definition
I_b, I_c, I_e	current, rms value of alternating component (base-terminal, collector-terminal, emitter terminal)	The root-mean-square value of alternating current into the terminal indicated by the subscript.
i_B, i_C, i_E	current, instantaneous total value (base-terminal, collector-terminal, emitter-terminal)	The instantaneous total value of alternating current into the terminal indicated by the subscript.

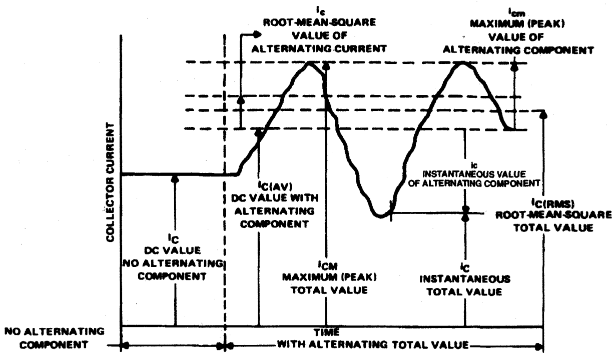


DIAGRAM ILLUSTRATING FOREGOING CURRENTS (REF. IEEE 255)

Glossary

8

Symbol	Term	Definition
I_{CBO}	collector cutoff current, dc, emitter open	The dc current into the collector terminal when it is biased in the reverse direction with respect to the base terminal and the emitter terminal is open-circuited. (Ref. IEEE 255)
I_{CEO}	collector cutoff current, dc (base open	The dc current into the collector terminal when it is biased in the reverse direction * with respect to the emitter terminal and the base terminal is (as indicated by the first subscript letter as follows): O = open-circuited. R = returned to the emitter terminal through a specified resistance. S = short-circuited to the emitter terminal. V = returned to the emitter terminal through a specified voltage X = returned to the emitter terminal through a specified circuit. (Ref. IEEE 255)
I_{CER}	resistance between base and emitter,	
I_{CES}	base short-circuited to emitter,	
I_{CEV}	voltage between base and emitter,	
I_{CEX}	circuit between base and emitter)	
I_{EBO}	emitter cutoff current, dc, collector open	The dc current into the emitter terminal when it is biased in the reverse direction with respect to the base terminal and the collector terminal is open-circuited. (Ref. IEEE 255)
I_F	forward (diode) current	The dc current through a semiconductor diode in the forward direction. NOTE: In this book this is specified as a test condition for the forward voltage of an integrated diode across the collector and emitter of certain power transistors.
P_{BE}	power input, dc (to the base, common-emitter)	The product of the dc input current and voltage with the common-emitter circuit configuration.
p_{BE}	power input; instantaneous total (to the base, common emitter)	The product of the instantaneous input current and voltage with the common-emitter circuit configuration.
P_{OE}	large-signal output power (common-emitter)	The product of the large-signal ac output current and voltage with the common-emitter circuit configuration.
P_T	total nonreactive power input to all terminals	The sum of the products of the dc input current and voltages, i.e. $V_{BE} \bullet I_B + V_{CE} \bullet I_C$ or $V_{BE} \bullet I_E + V_{CB} \bullet I_C$
p_T	nonreactive power input, instantaneous total, to all terminals	The sum of the products of the instantaneous input currents and voltages.
$r_{b'}C_c$	collector-base time constant	The product of the intrinsic base resistance and collector capacitance under specified small-signal conditions.
R_θ (formerly θ)	thermal resistance	Refer to thermal resistance (steady state)
$R_{\theta CA}$	thermal resistance case-to-ambient	The thermal resistance (steady-state) from the device case to the ambient.
$R_{\theta JA}$ (formerly $\theta_{J\text{-}A}$)	thermal resistance junction-to-ambient	The thermal resistance (steady-state) from the semiconductor junction (s) to the ambient.

* For these parameters, the collector terminal is considered to be biased in the reverse direction when it is made positive for N-P-N transistors or negative for P-N-P transistors with respect to the emitter terminal.

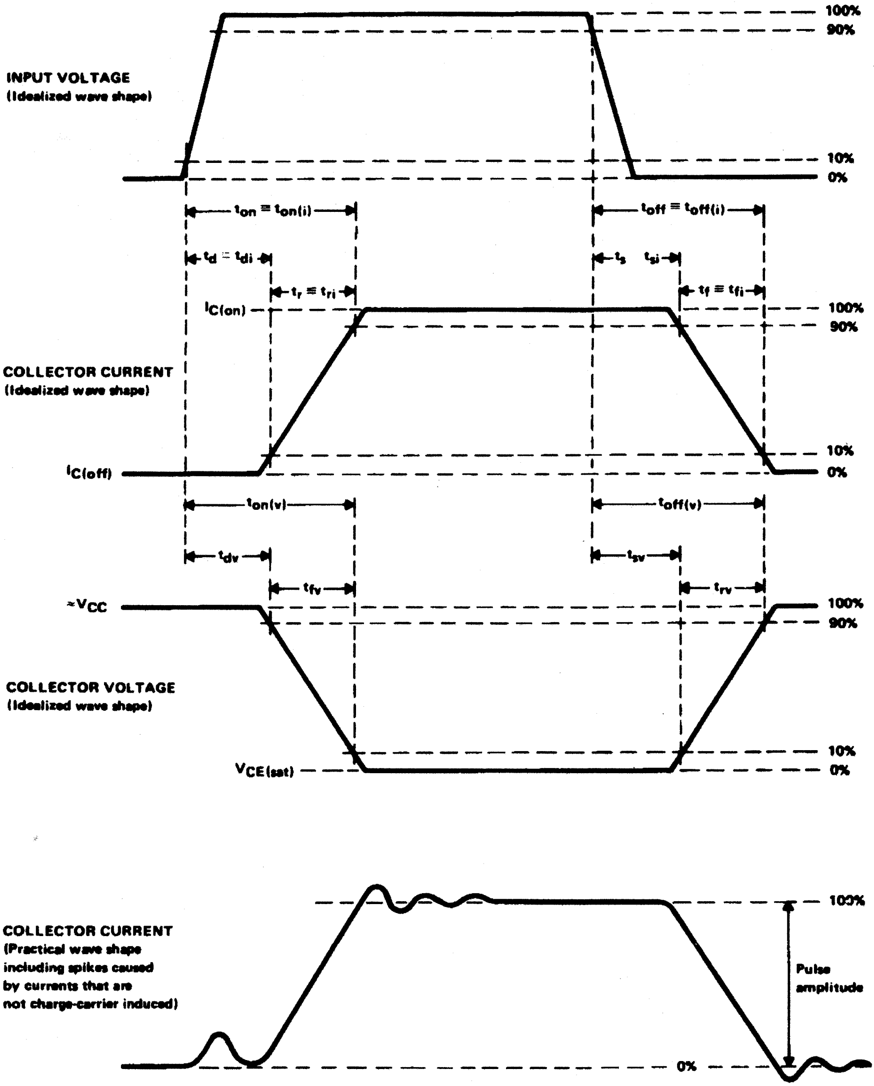
Symbol	Term	Definition
$R_{\theta JC}$ (formerly $\theta_{J\text{-}C}$)	thermal resistance junction-to-case	The thermal resistance (steady-state) from the semiconductor junction(s) to the case.
$R\theta_{JM}$	thermal resistance junction-to-mounting surface	The thermal resistance (steady-state) from the semiconductor junction(s) to the mounting surface.
T_A	ambient temperature or free-air temperature	The air temperature measured below a device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces. (Ref. MIL-S-19500)
T_C	case temperature	The temperature measured at a specified location on the case of a device. (REF. MIL-S.19500)
T_j	virtual junction temperature	A temperature representing the temperature of the junction(s) calculated on the basis of a simplified model of the thermal and electrical behaviour of the semiconductor device. NOTE: This term (and its definition) is taken from IEC standards. It is particularly applicable to multi-junction semi-conductors and is used in this publication to denote the temperature of the active semiconductor element when required in specifications and test methods. The term "junction temperature" is used interchangeably with the term "virtual junction temperature" in this publication.
T_{stg}	storage temperature	The temperature at which the device, without any power applied, is stored. (Ref. MIL-S-19500)
t_c	turn-off crossover time (for reserve symbol, see t_{xo})	The time interval during which collector voltage rises from 10% of its peak off-state value and collector current falls to 10% of its peak on-state value, in both cases ignoring spikes that are not charge-carrier induced.
t_d	delay time	Synonym for current delay time (see footnote)
t_{di}	current delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector current waveform rises to 10% of its on-state amplitude, ignoring spikes that are not charge-carrier induced.
t_{dv}	voltage delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector voltage waveform falls to 90% of its off-state amplitude, ignoring spikes that are not charge-carrier induced.
t_f	fall time	Synonym for current fall time (see footnote)
t_{fi}	current fall time	The time interval during which the collector current changes from 90% to 10% of its peak on-state value, ignoring spikes that are not charge-carrier induced.

NOTE: As names of time intervals for characterizing switching transistors, the terms 'fall time' and 'rise time' always refer to the change that is taking place in the magnitude of the output current even though measurements may be made using voltage waveforms in a purely resistive circuit, the (current) rise time may be considered equal and coincident to the voltage fall time and the (current) fall time may be considered equal and coincident to the voltage rise time. The delay times for current and voltage will be equal and coincident, as will the storage times. When significant amounts of inductance are present in a circuit, these equalities and coincidences no longer exist, and use of the unmodified terms delay time, fall time, rise time, and storage time must be avoided.

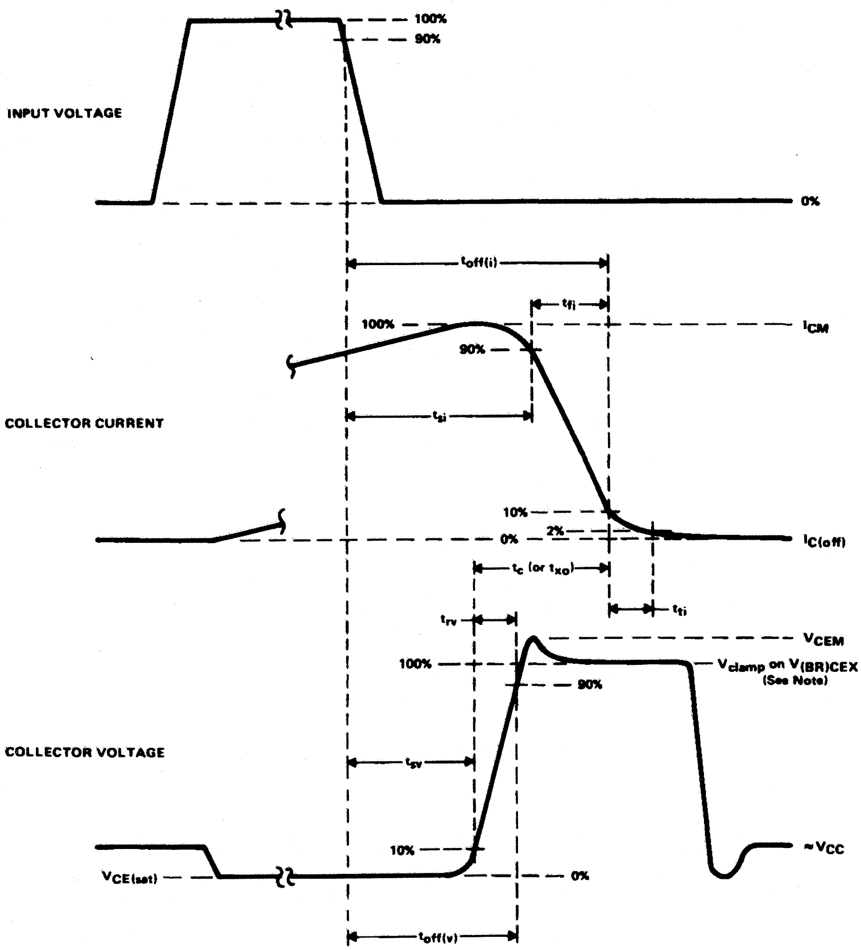
Symbol	Term	Definition
t_{fv}	voltage fall time	The time interval during which the collector voltage changes from 90% to 10% of its peak off-state value, ignoring spikes that are not charge-carrier induced.
t_{off}	turn-off time	Synonym for current turn-off time (see footnote)
$t_{off(i)}$	current turn-off time	The sum of current storage time and current fall time, i.e., $t_{si} + t_{fi}$.
$t_{off(v)}$	voltage turn-off time	The sum of voltage storage time and voltage rise time, i.e., $t_{sv} + t_{rv}$.
t_{on}	turn-on time	Synonym for current turn-on time (see footnote)
$t_{on(i)}$	current turn-on time	The sum of current delay time and current rise time, i.e., $t_{di} + t_{ri}$
$t_{on(v)}$	voltage turn-on time	The sum of voltage delay time and voltage fall time, i.e., $t_{dv} + t_{fv}$.
t_p	pulse duration (formerly pulse time)	The time interval between a reference point on the leading edge of a pulse waveform and a reference point on the trailing edge of the same waveform. NOTE: The two reference points are usually 90% of the steady-state amplitude of the waveform existing after the leading edge, measured with respect to the steady-state amplitude existing after the leading edge, measured with respect to the steady- state amplitude existing before the leading edge. If the reference points are 50% points, the symbol t_w and term average pulse duration should be used.
t_r	rise time	Synonym for current rise time (see footnote)
t_{ri}	current rise time	The time interval during which the collector current changes from 10% to 90% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
t_{rv}	voltage rise time	The time interval during which the collector voltage changes from 10% to 90% of its peak off-state value, ignoring spikes that are not charge-carrier induced.
t_s	storage time	Synonym for current storage time (see footnote)
t_{si}	current storage time	The time interval during which an input pulse that is switching the transistor from a conducting to a nonconducting state falls from 90% of its peak amplitude and the collector current waveform falls to 90% of its on-state amplitude, ignoring spikes that are not charge-carrier induced.
t_{sv}	voltage storage time	The time interval during which an input pulse that is switching the transistor from a conducting to a nonconducting state falls from 90% of its peak amplitude and the collector voltage waveform rises to 10% of its off-state amplitude, ignoring spikes that are not charge carrier induced.
t_{ti}	current tail time	The time interval following current fall time during which the collector current changes from 10% to 2% of its peak on-state value, ignoring spikes that are not charge-carrier induced.

NOTE: As names of time intervals for characterizing switching transistors, the terms 'fall time' and 'rise time' always refer to the change that is taking place in the magnitude of the output current even though measurements may be made using voltage waveforms in a purely resistive circuit, the (current) rise time may be considered equal and coincident to the voltage fall time and the (current) fall time may be considered equal and coincident to the voltage rise time. The delay times for current and voltage will be equal and coincident, as will the storage times. When significant amounts of inductance are present in a circuit, these equalities and coincidences no longer exist, and use of the unmodified terms delay time, fall time, rise time, and storage time must be avoided.

Symbol	Term	Definition
t_{xo}	turn-off crossover time	For definition, see tc (t_{xo} is a reserve symbol to be used if use of t_c will cause confusion).
t_w	average pulse duration (formerly pulse average time)	The time interval between a reference point on the leading edge of a pulse waveform and a reference point on the trailing edge of the same waveform, with both reference points being 50% of the steady-state amplitude of the waveform existing after the leading edge, measured with respect to the steady-state amplitude existing before the leading edge. NOTE: If the reference points are not 50% points, the symbol tp and term pulse duration should be used.



WAVEFORMS FOR RESISTIVE-LOAD SWITCHING



NOTE: V_{clamp} (in a clamped inductive-load switching circuit) or switching circuit) or $V_{(BR)CEX}$ (in an unclamped circuit) is the peak off-state voltage excluding spikes.

WAVEFORMS FOR INDUCTIVE-LOAD SWITCHING, TURN-OFF

Symbol	Term	Definition
$V_{(BR)CBO}$ (formerly BV_{CBO})	breakdown voltage, collector-to-base, emitter open	The breakdown voltage between the collector terminal and the base terminal when the collector terminal is biased in the reverse direction with respect to the base terminal and the emitter terminal is open-circuited. (Ref. IEEE 255)
$V_{(BR)CEO}$ (formerly BV_{CEO})	breakdown voltage, collector-to-emitter with (base open,	The breakdown voltage between the collector terminal and the emitter terminal when the collector terminal is biased in the reverse direction* with respect to the emitter terminal and the base terminal is (as indicated by the last subscript letter as follows): O = open circuited R = returned to the emitter terminal through a specified resistance S = short-circuited to the emitter terminal V = returned to the emitter terminal through a specified voltage. X = returned to the emitter terminal through a specified circuit (Ref. IEEE 255)
$V_{(BR)CER}$, (formerly BV_{CER})	resistance between base and emitter,	
$V_{(BR)CES}$, (formerly BV_{CES})	base short-circuited to emitter,	
$V_{(BR)CEV}$, (formerly BV_{CEV})	voltage between base and emitter	
$V_{(BR)CEX}$, (formerly BV_{CEX})	circuit between base and emitter)	
$V_{(BR)EBO}$, (formerly BV_{EBO})	breakdown voltage, emitter-to-base, collector open	The breakdown voltage between the emitter and base terminals when the emitter terminal is biased in the reverse direction with respect to the base terminal and the collector terminal is open-circuited. (Ref. IEEE 255)
V_{BB}, V_{CC}, V_{EE}	supply voltage, dc (base, collector, emitter)	The dc supply voltage applied to a circuit connected to the reference terminal.
V_{BC},	voltage, dc or average (base-to-collector,	The dc voltage between the terminal indicated by the first subscript and the reference terminal (stated in terms of the polarity at the terminal indicated by the first subscript).
V_{BE},	base-to-emitter,	
V_{CB},	collector-to-base,	
V_{CE},	collector-to-emitter,	
V_{EB},	emitter-to-base	
V_{EC},	emitter-to-collector)	
$V_{BE(sat)}$	saturation voltage, dc, base-to-emitter	The dc voltage between the base and emitter terminals for specified base-current and collector-current conditions which are intended to ensure that the collector junction is forward-biased.
V_{CBO}	collector-to-base voltage, dc, emitter open	The dc voltage between the collector terminal and the base terminal when the emitter terminal is open-circuited.
$V_{CE(sat)}$	saturation voltage, dc, collector-to-emitter	The dc voltage between the collector and the emitter terminals for specified saturation conditions. (Ref. IEEE 255)

* For these parameters, the collector terminal is considered to be biased in the reverse direction when it is made positive for N-P-N transistors or negative for P-N-P transistors with respect to the emitter terminal.

Symbol	Term	Definition
V_{CEO}	collector-to-emitter voltage, dc, with (base open	The dc voltage between the collector terminal and the emitter terminal when the base terminal is (as indicated by the last subscript letter);
V_{CER}	resistance between base and emitter	O = open circuited R = returned to the emitter terminal through a specified resistance
V_{CES},	base short-circuited to emitter,	S = short-circuited to the emitter terminal
V_{CEV},	voltage between base and emitter,	V = returned to the emitter terminal through a specified voltage.
V_{CEX},	circuit between base and emitter)	X = returned to the emitter terminal through a specified circuit
$V_{CEO(sus)}$	sustaining voltage, collector-to-emitter with (base open,	The collector-to-emitter breakdown voltage at relatively high values of collector current where the breakdown voltage is relatively insensitive to changes in collector current. The base terminal is (as indicated by the third subscript letter as follows):
$V_{CER(sus)}$	resistance between base and emitter	O = open-circuited R = returned to the emitter terminal through a specified resistance
$V_{CES(sus)}$	base short-circuited to emitter,	S = short-circuited to the emitter terminal
$V_{CEV(sus)}$	voltage between base and emitter,	V = returned to the emitter terminal through a specified voltage
$V_{CEX(sus)}$	circuit between base and emitter)	X = returned to the emitter terminal through a specified circuit NOTE: This would be the transient voltage between the collector and emitter terminals during switching with an inductive load from a forward-biased base-emitter to an external condition described by the third subscript letter.
$V_{EB(fl)}$	dc open-circuit voltage (floating potential) (emitter-to-base)	The dc open-circuit voltage (floating potential) between the emitter terminal and the base terminal when the collector terminal is biased in the reverse direction with respect to the base terminal. (Ref. IEEE 255)
V_{EBO}	emitter-to-base voltage, dc, collector open	The dc voltage between the emitter terminal and the base terminal with the collector terminal open-circuited.
V_F	forward (diode) voltage	The dc voltage across a semiconductor diode associated with forward current. NOTE: In this book this is specified as a parameter of an integrated diode across the collector and emitter of certain power transistors.
Z_θ (formerly $\theta(t)$)	transient thermal impedance	Refer to transient thermal impedance.
$Z_{\theta JA}$ (formerly $\theta_{J\text{-}A(t)}$)	transient thermal impedance, junction-to-ambient	The transient thermal impedance from the semiconductor junction(s) to the ambient.
$Z_{\theta JC}$ (formerly $\theta_{JC(t)}$)	transient thermal impedance, junction-to-case	The transient thermal impedance from the semiconductor junction(s) to the case.

THYRISTORS

Thyristor Standards

The documents listed below have overriding authority where any conflict may occur with this data book.

EIA and JEDEC Standards:
Electronic Industries Association
2001 Eye St. N.W.,
Washington, D.C. 20006
Telephone: 202 659-2200

EIA Standard RS-397: Recommended Standards for Thyristors

JEDEC Standard 77: Letter Symbols, Abbreviations, Terms, and Definitions for Discrete Semiconductor and Optoelectronic Devices.

JEDEC Publication 104: Quick Reference Guide to Letter Symbols.

IEEE Standards
Institute of Electrical and Electronic Engineers, Inc.
345 East 47th Street
New York, N.Y. 10017

IEEE No. 233: Standard Definitions of Terms for Thyristors

International Electrotechnical Commission Standards
American National Standards Institute, Inc.
1430 Broadway
New York, N.Y. 10018

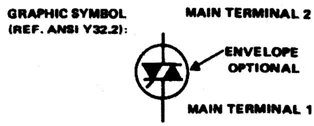
IEC Publication 147-IC: Essential Ratings and Characteristics of Semiconductor Devices and General Principles of Measuring Methods

IEC Publication 148: Letter Symbols for Semiconductor Devices and Integrated Circuits

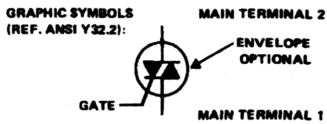
IEC Publication 191: Mechanical Standardisation of Semiconductor Devices.

Classes of Thyristors

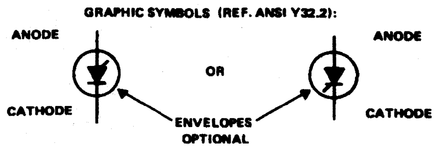
Term	Definition
bidirectional diode; Diac	A two-terminal thyristor having substantially the same switching behaviour in the first and third quadrants of the principal voltage-current characteristics. (See Figures 3 and 4)



Term	Definition
bidirectional triode; Triac	An n-gate or p-gate thyristor having substantially the same switching behaviour in the first and third quadrants of the principal voltage-current characteristic. (See Figures 3 and 4).

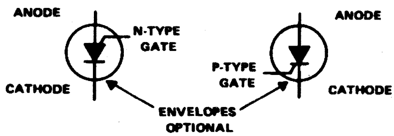


Term	Definition
N-gate	A three-terminal thyristor in which the gate terminal is connected to the N-region adjacent to the region to which the anode terminal is connected and that is normally switched to the on-state by applying a negative signal between gate and anode terminals. (See Figure 1).
P-gate	A three-terminal thyristor in which the gate terminal is connected to the P-region adjacent to the region to which the cathode terminal is connected and that is normally switched to the on-state by applying a positive signal between gate and cathode terminals. (See Figure 1.)
reverse-blocking diode	A two-terminal thyristor that switches only for positive anode-to-cathode voltage and exhibits a reverse blocking state for negative anode-to-cathode voltages. (See Figure 1).



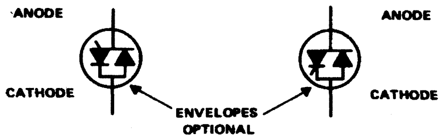
Term	Definition
reverse-blocking triode	An n-gate or p-gate thyristor that switches only for positive anode-to-cathode voltages and exhibits a reverse-blocking state for negative anode-to-cathode voltages. (See Figure 1).

GRAPHIC SYMBOLS (REF. ANSI Y32.2):



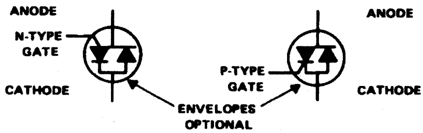
reverse-conducting diode.	A two-terminal thyristor that switches only for positive anode-to-cathode voltages and conducts large currents at negative anode-to-cathode voltages comparable in magnitude to the on-state voltage.

GRAPHIC SYMBOLS (UNDER CONSIDERATION BY ANSI):



reverse-conducting triode.	An n-gate or p-gate that switches only for positive anode-to-cathode voltages and conducts large currents at negative anode-to-cathode voltages comparable in magnitude to the on-state voltage.

GRAPHIC SYMBOLS (UNDER CONSIDERATION BY ANSI):



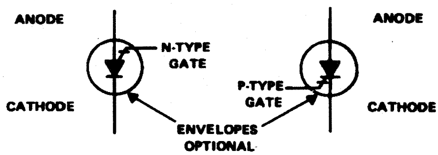
semiconductor controlled .... rectifier (SCR)	An alternative name used for the reverse-blocking triode thyristor.

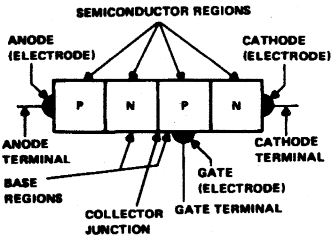
NOTE: The term "thyristor" is used as a generic term to cover the whole range of pnpn-type switches. It may be used by itself for any member of the thyristor family when such use does not result in ambiguity or misunderstanding. In particular the abbreviated term "thyristor" is widely used for the reverse-blocking triode thyristor alternatively called "silicon controlled rectifier" or "semiconductor controlled rectifier" (SCR).

thyristor	A bistable semiconductor device that comprises three or more junctions and can be switched from the off-state to the on-state or vice versa, (Ref. IEC 147-0) (See Figures 1 through 5).

NOTE:The term "thyristor" is used as a generic term to cover the whole range of pnpn-type switches. It may be used by itself for any member of the thyristor family when such use does not result in ambiguity or misunderstanding. In particular the abbreviated term "thyristor" is widely used for the reverse-blocking triode thyristor alternatively called "silicon controlled rectifier" or "semiconductor controlled rectifier" (SCR).

Term	Definition
triac.	An alternative name used for the bidirectional triode thyristor.
turn-off	A thyristor that can be switched from the on state to the off state and vice versa by applying control signals of appropriate polarities to the gate terminal, with the ratio of triggering power to triggered power appreciably less than one. (See Figures 1 and 2.)

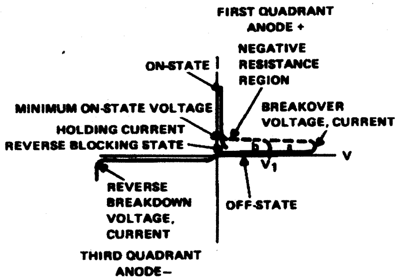




Schematic representation of a reverse-blocking triode thyristor.

NOTE: The gate electrode is connected to the N-type (or P-type) base region in some structures or omitted in the case of a diode thyristor.

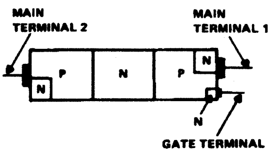
FIGURE 1



Principal voltage-current characteristics (anode-to-cathode voltage-current characteristic) of a typical reverse-blocking thyristor.

NOTE: Curve "a" applies or zero gate current or a diode thyristor.
Curve "b" is with gate trigger current present when off-state voltage is V_1

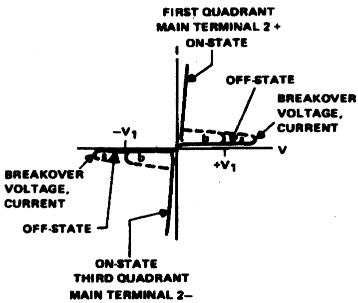
FIGURE 2



Schematic representation of typical bidirectional triode thyristor.

NOTE: Gate is omitted in a diode bidirectional thyristor.

FIGURE 3



Principal voltage-current characteristics of a typical bidirectional thyristor.

NOTE: Curve "a" applies for zero gate current or a diode bidirectional thyristor. Curve "b" applies for the case of gate trigger current applied when the off-state voltage is $\pm V_1$

FIGURE 4

Glossary

8

Physical Structure Nomenclature

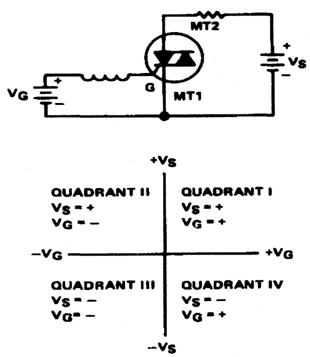
Term	Definition
anode	The electrode by which current enters the thyristor when the thyristor is in the on state with the gate open circuited. (Ref. RS-397) NOTE: This term does not apply to bidirectional thyristors.
anode terminal	The terminal that is connected to the anode. NOTE: This term does not apply to bidirectional thyristors.
cathode	The electrode by which current leaves the thyristor when the thyristor is in the on state with the gate open circuited. NOTE: This term does not apply to bidirectional thyristors.
cathode terminal	The terminal that is connected to the cathode. NOTE: This term does not apply to bidirectional thyristors.
collector junction	The junction across which the polarity of the voltage reverses when switching occurs. (See Figures 1,3 and 5) (Ref. RS-397)
electrode (of a semiconductor device)	An element that performs one or more of the functions of emitting or collecting electrons or holes, or of controlling their movement by an electric field. (Ref. IEEE Std. 100).
gate	An electrode connected on one of the semiconductor regions for introducing control current. (Ref. RS-397).
gate terminal	A terminal that is connected to a gate.
junction (in a semiconductor device)	A region of transition between semiconductor regions of different electrical properties (e.g., n-n+, p-n, p-p+ semiconductors), or between a metal and a semiconductor. (Ref. RS-282)
main terminals	The terminals through which the principal current flows. (Ref. RS-397)
main terminal 1 (of a bidirectional thyristor)	The main terminal which is named "1" by the device manufacturer. (Ref. RS-397) NOTE: This is normally the reference terminal for all voltages.
main terminal 2 (of a bidirectional thyristor)	The main terminal which is named "2" by the device manufacturer. (Ref. RS-397)
terminal (of a semiconductor device)	An externally available point of connection.(Ref. IEC 147-0)

Electrical Characteristic and Rating Terms

Term	Definition
anode-to-cathode voltage (anode voltage)	The voltage between the anode terminal and the cathode terminal. NOTE: It is called positive when the anode potential is more positive than the cathode potential, and called negative when the anode potential is less positive than the cathode potential.
anode-to-cathode voltage-current characteristic (anode characteristics)	A function, usually represented graphically, relating the anode-to-cathode voltage to the principal current with gate current, where applicable, as a parameter. (Ref. RS-397). NOTE: This term does not apply to bidirectional thyristors.
breakover point	Any point on the principal voltage-current characteristic for which the differential resistance is zero and where the principal voltage reaches a maximum value. (See Figures 2 and 4) (Ref. RS-397).
negative-differential-resistance region	Any portion of the principal voltage-current characteristic in the switching quadrant(s) within which the differential resistance is negative. (See Figures 2 and 4) (Ref. RS-397)
off-impedance	The differential impedance between the terminals through which the principal current flows when the thyristor is in the off-state. (Ref. RS-397)
off-state	The condition of the thyristor corresponding to the high-resistance, low-current portion of the principal voltage-current characteristic between the origin and the breakover point(s) in the switching quadrant(s). (Ref. RS-397)
on-impedance	The differential impedance between the terminals through which the principal current flows when the thyristor is in the on-state (Ref. RS-397)
on-state	The condition of a thyristor corresponding to the low-resistance, low-voltage portion of the principal voltage-current characteristic in the switching quadrant(s). (Ref. RS-397) NOTE: In the case of reverse-conducting thyristors, this definition is applicable only for a positive anode-to-cathode voltage.
principal voltage	The voltage between the main terminals. (Ref. RS-397) NOTES: 1. In the case of reverse-blocking and reverse-conducting thyristors, the principal voltage is called positive when the anode potential is more positive than the cathode potential, and called negative when the anode potential is less positive than the cathode potential. 2. For bidirectional thyristors, the principal voltage is called positive when the potential of main terminal 2 is more positive than the potential of main terminal 1.
principal voltage-current characteristic (principal characteristic)	A function, usually represented graphically, relating the principal voltage to the principal current with gate current, where applicable, as a parameter. (Ref. RS-397)

Term	Definition
reverse-blocking impedance . . . . (of a reverse-blocking thyristor)	The differential impedance between the two terminals through which the principal current flows when the thyristor is in the reverse-blocking state at a stated operating point. (Ref. RS-397)
reverse-blocking state . . . . (of a reverse-blocking thyristor)	The condition of a reverse-blocking thyristor corresponding to the portion of the anode-to-cathode voltage-current characteristic for which reverse currents are of lower magnitude than the reverse breakdown current. (See Figure 2.) (Ref. RS-397)

QUADRANT DEFINITIONS



The polarities of Vs and Vg are with respect to Main Terminal 1.

FIGURE 5

Symbols, Terms and Definitions

Symbol	Term	Definition
dv/dt	critical rate of rise of off-state voltage	The maximum rate of rise of principal voltage that will not cause switching from the off-state to the on-state.
dv/dt(c)	critical rate of rise of commutation voltage (of a bidirectional thyristor)	The maximum rate of rise of principal voltage that will not cause switching from the off-state to the on-state immediately following on-state current conduction in the opposite quadrant.
$I_{(BO)}$	static breakover current	The principal current at the breakover point.
$i_{(BO)}$	instantaneous breakover current	
$I_{(BR)}$	static reverse breakdown current	The principal current at the reverse breakdown voltage
$i_{(BR)}$	instantaneous reverse breakdown current	
$I_{D(RMS)}$	RMS off-state current	The principal current when the thyristor is in the off state
I_D	static off-state current	
$I_{D(AV)}$	average off-state current	
i_D	instantaneous off-state current	
I_{DM}	peak off-state current	
I_{DRM}	repetitive peak off-state current	The maximum (peak) instantaneous value of the off-state current that results from the application of repetitive peak off-state voltage.
I_G	static gate current	The current that results from the gate voltage.
$I_{G(AV)}$	average gate current	NOTES: 1. Positive gate current refers to conventional current entering the gate terminal.
i_G	instantaneous gate current	
I_{GM}	peak gate current	2. Negative gate current refers to conventional current leaving the gate terminal.
I_{GD}	static gate nontrigger current	The maximum gate current that will not cause the thyristor to switch from the off-state to the on-state.
i_{GD}	instantaneous gate nontrigger current	
I_{GDM}	peak gate nontrigger current	
I_{GQ}	static gate turn-off current	The minimum gate current required to switch a thyristor from the on-state to the off-state.
i_{GQ}	instantaneous gate turn-off current	
I_{GQM}	peak gate turn-off current	
I_{GT}	static gate trigger current	The minimum gate current required to switch a thyristor from the off-state to the on-state.
i_{GT}	instantaneous gate trigger current	
I_{GTM}	peak gate trigger current	
I_H	static holding current	The minimum principal current required to maintain the thyristor in the on-state.
i_H	instantaneous hold current	

Symbol	Term	Definition
I_L	static latching current	The minimum principal current required to maintain the thyristor in the on-state immediately after switching from the off-state to the on-state has occurred and the triggering signal has been removed.
i_L	instantaneous latching current	
$I_{R(RMS)}$	RMS reverse current	The current for negative anode-to-cathode voltage.
I_R	static reverse current	
$I_{R(AV)}$	average reverse current	
i_R	instantaneous reverse current	
I_{RM}	peak reverse current	
I_{RRM}	repetitive peak reverse current	The maximum (peak) instantaneous value of the reverse current that results from the application of repetitive peak reverse voltage.
$I_{T(RMS)}$	RMS on-state current	The principal current when the thyristor is in the on-state.
I_T	static on-state current	
$I_{T(AV)}$	average on-state current	
i_T	instantaneous on-state current	
I_{TM}	peak on-state current	
$I_{TM(OV)}$	overload peak on-state current	The maximum (peak) value of the on-state current having substantially the same waveshape as the normal on-state current and having a greater value than the normal on-state current.
I_{TRM}	repetitive peak on-state current	The maximum (peak) value of the on-state current including all repetitive transient currents.
I_{TSM}	surge (nonrepetitive) peak on-state current	The maximum (peak) value of the surge on-state current having a specified waveform and a short specified time interval.
P_G	static gate power dissipation	The power dissipation resulting from the respective gate currents.
$P_{G(AV)}$	average gate power dissipation	
p_G	instantaneous gate power dissipation	
P_{GM}	peak gate power dissipation	
T_A	free-air temperature (ambient temperature)	The air temperature measured below a device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces. (Ref. MIL-S-19500)
T_C	case temperature	The temperature measured at a specified location on the case of a device. (Ref. MIL-S-19500)
T_J	virtual junction temperature (junction temperature)	A temperature representing the temperature of the junction(s) calculated on the basis of a simplified model of the thermal and electrical behaviour of the semiconductor device. NOTE: This term (and its definition) is taken from IEC standards. It is particularly applicable to multi-junction semiconductors and is used in this publication to denote the temperature of the active semiconductor element when required in specifications and test methods. The term "junction temperature" is used interchangeably with the term "virtual junction temperature" in this publication.

Symbol	Term	Definition
T_{stg}	storage temperature	The temperature at which the device, without any power applied, is stored. (Ref. MIL-S-19500)
t_{gt}	gate-controlled turn-on time	The time interval between a specified point at the beginning of the gate pulse and the instant when the principal voltage (current) has dropped (risen) to a specified low (high) value during switching of a thyristor from the off-state to the on-state by a gate pulse.
t_{gq}	gate-controlled turn-off time	The time interval between a specified point at the beginning of the gate pulse and the instant when the principal current has decreased to a specified value during switching from the on-state to the off- state by a gate pulse.
t_q	circuit-commutated turn-off time	The time interval between the instant when the principal current has decreased to zero after external switching of the principal voltage circuit, and the instant when the thyristor is capable of supporting a specified principal voltage without turning on.
R_θ	thermal resistance	The temperature difference between two specified points or regions divided by the power dissipation under conditions of thermal equilibrium.
$R_{\theta JA}$	thermal resistance, junction to ambient	
$R_{\theta JC}$	thermal resistance, junction-to-case	
$R_{\theta CA}$	thermal resistance, case-to-ambient	
$V_{(BO)}$	static breakover voltage	The principal voltage at the breakover point.
$v_{(BO)}$	instantaneous breakover voltage	
$V_{(BR)}$	static reverse breakdown voltage	The value of negative anode-to-cathode voltage at which the differential resistance between the anode and cathode terminals changes from a high value to a substantially lower value.
$v_{(BR)}$	instantaneous reverse breakdown voltage.	
$V_{D(RMS)}$	RMS off-state voltage	The principal voltage when the thyristor is in the off-state.
V_D	static off-state voltage	
$V_{D(AV)}$	average off-state voltage	
v_D	instantaneous off-state voltage	
V_{DM}	peak off-state voltage	
V_{DRM}	repetitive peak off-state voltage	The maximum instantaneous value of the off-state voltage that occurs across a thyristor, including all repetitive transient voltages, but excluding all non-repetitive transient voltages.
V_{DSM}	nonrepetitive peak off-state voltage	The maximum instantaneous value of any non-repetitive transient off-state voltage that occurs across the thyristor.
V_{DWM}	working peak off-state voltage	The maximum instantaneous value of the off-state voltage that occurs across a thyristor, excluding all repetitive and non-repetitive transient voltages.
V_G	static gate voltage	The voltage between a gate terminal and a specified main terminal.
$V_{G(AV)}$	average gate voltage	NOTE: Gate voltage polarity is referenced to the specified main terminal.
v_G	instantaneous gate voltage	
V_{GM}	peak gate voltage	
V_{GD}	static gate nontrigger voltage	The maximum gate voltage that will not cause the thyristor to switch from the off-state to the on-state.
v_{GD}	instantaneous gate nontrigger voltage	
V_{GDM}	peak gate nontrigger voltage	

Symbol	Term	Definition
V_{GQ}	static gate turn-off voltage	The gate voltage resulting from the gate turn-off current
v_{GQ}	instantaneous gate turn-off voltage	
V_{GQM}	peak gate turn-off voltage	
V_{GT}	static gate trigger voltage	The gate voltage resulting from the gate trigger current
v_{GT}	instantaneous gate trigger voltage	
V_{GTM}	peak gate trigger voltage	
$V_{R(RMS)}$	RMS reverse voltage	A negative anode-to-cathode voltage.
V_R	static reverse voltage	
$V_{R(AV)}$	average reverse voltage	
v_R	instantaneous reverse voltage	
V_{RM}	peak reverse voltage	
V_{RRM}	repetitive peak reverse voltage	The maximum instantaneous value of the reverse voltage that occurs across the thyristor, including all repetitive transient voltages, but excluding all nonrepetitive transient voltages.
V_{RSM}	non-repetitive peak reverse voltage	The maximum instantaneous value of any nonrepetitive transient reverse voltage that occurs across the thyristor.
V_{RWM}	working peak reverse voltage	The maximum instantaneous value of the reverse voltage that occurs across a thyristor, excluding all repetitive and non-repetitive transient voltages.
$V_{T(RMS)}$	RMS on-state voltage	The principal voltage when the thyristor is in the on-state
V_T	static on-state voltage	
$V_{T(AV)}$	average on-state voltage	
v_T	instantaneous on-state voltage	
V_{TM}	peak on-state voltage	
$V_{T(MIN)}$	static minimum on-state voltage	The minimum positive principal voltage for which the differential resistance is zero with the gate open-circuited.
Z_θ	transient thermal impedance	The change of temperature difference between two specified points or regions at the end of a time interval divided by the step-function change in power dissipation at the beginning of the same time interval causing the change of temperature difference.
$Z_{\theta JA}$	transient thermal impedance, junction-to-ambient	
$Z_{\theta JC}$	transient thermal impedance, junction-to-case	

Nomenclature

A terminal (T terminal, USA)	Device terminal normally connected to the A-wire of a telephone line. In the exchange the A-wire normally connects to the Tip (USA) or battery + wire. Equivalent to main terminal 2.
asymmetrical	A condition when a two terminal thyristor has substantially different switching behaviour in the first and third quadrants of principal voltage-current characteristics. Normal qualifier for a transient suppressor which has a forward biased diode characteristic for positive voltages and crowbar characteristic for negative voltages (see Figure 3).
B terminal (R terminal, USA)	Device terminal normally connected to the B-wire of a telephone line. In the exchange the B-wire normally connects to the Ring, (USA) or battery - wire, equivalent to a second main terminal 2 in dual devices and main terminal 1 in single devices.
C terminal (G terminal, USA)	Common connection of a dual device, equivalent to main terminal 1. The C terminal is normally connected to the exchange earth/Ground.
crowbar	A bistable shunt device which switches from a high-resistance, low current off-state condition to a low resistance low voltage on-state condition when the applied voltage exceeds a specific value. Overvoltages are effectively "shorted out". The device is reset to an off-state by reducing the current below a certain value.
main terminals	The terminals through which the principal current flows.
main terminal 1 (of a bidirectional thyristor)	The main terminal which is named "1" by the device manufacturer. This is normally the reference terminal for all voltages.
main terminal 2 (of a bidirectional thyristor)	The main terminal which is named "2" by the device manufacturer.
terminal (of a semiconductor device)	The externally available point of connection to one or more electrodes.
breakover point	Any point on the principal voltage-current characteristic for which the differential resistance is zero and where the principal voltage reaches a maximum value (see Figures 1 through 3). Specifically for transient suppressors, it is defined as the point at which the principal voltage-current off-state characteristic terminates and the negative-differential-resistance region begins.
negative-differential-resistance region	Any portion of the principal voltage-current characteristic in the switching quadrant(s) within which the differential resistance is negative (see Figure 1).
off-impedance	The differential impedance between the terminals through which the principal current flows when the thyristor is in the off-state at a stated operating point.
off-state	The condition of the thyristor corresponding to the high-resistance, lcw-current portion of the principal voltage-current characteristic between the origin and the breakover point(s) in the switching quadrant(s)

on-impedance .... The differential impedance between the terminals through which the principal current flows when the thyristor is in the on-state at a stated operating point.

on-state .... The condition of the thyristor corresponding to the low-resistance, low-voltage portion of the principal voltage-current characteristic in the switching quadrant(s).

principal voltage .... The voltage between the main terminals.

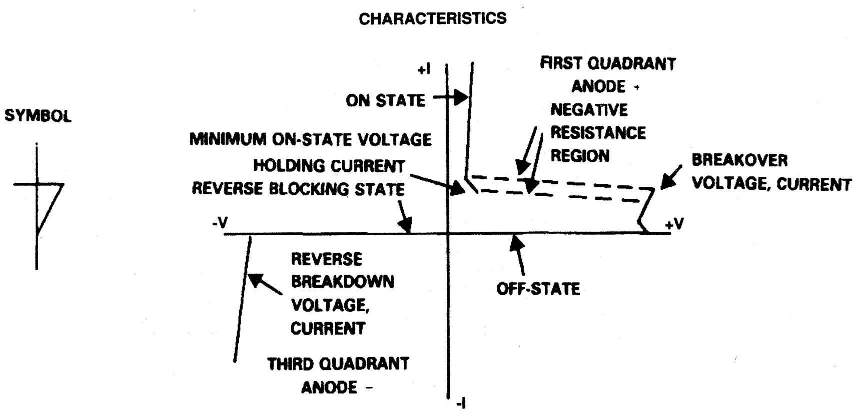
NOTES: 1 In the case of reverse-blocking and reverse-conducting thyristors, the principal voltage is called positive when the anode potential is more positive than the cathode potential, and called negative when the anode potential is less positive than the cathode potential.

2. For bidirectional thyristors, the principal voltage is called positive when the potential of main terminal 2 is more positive than the potential of main terminal 1.

principal voltage-current characteristic (principal characteristic) .... The function, usually represented graphically, relating the principal voltage to the principal current with gate current, where applicable, as a parameter.

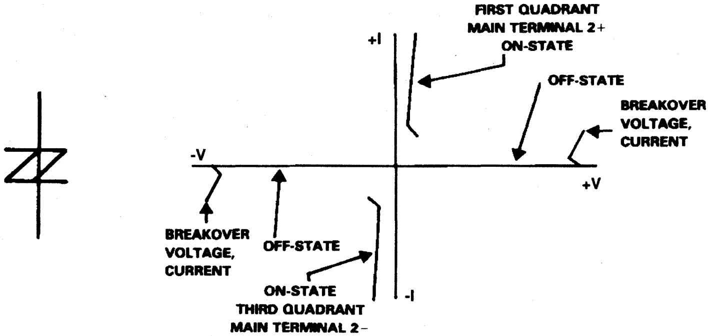
symmetrical .... A condition when a two terminal thyristor has substantially the same switching behaviour in the first and third quadrants of principal voltage-current characteristics (see Figure 2).

thyristor .... A bistable semiconductor device that comprises of three or more junctions and can be switched from the off-state to on-state or vice versa (Ref., IEC 147-0) (see Figures 1 through 3).



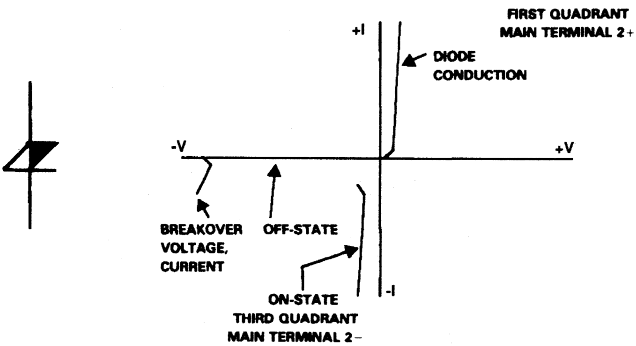
Principal voltage-current characteristics (anode-to-cathode voltage-current characteristic) of a typical reverse-blocking thyristor.

FIGURE 1



Principal voltage-current characteristic of a typical bidirectional thyristor.

FIGURE 2



Principal voltage-current characteristic of a typical forward-conducting thyristor.

FIGURE 3

Symbol	Term	Definition
C_{OFF}	off-state capacitance	The capacitance measured across two terminals at a defined frequency and inter-terminal bias voltage. Dual devices are measured using three-terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the bridge guard terminal which may incorporate a dc bias.
di/dt	initial rate of rise of on-state current	The maximum rate of rise of the on-state current which the thyristor can withstand without degradation.
dv/dt	critical rate of rise of off-state voltage	The maximum rate of rise of principal voltage that will not cause switching from the off-state to the on-state.
$I_{(BO)}$	static breakover current	The principal current at the breakover point.
I_D	static off-state current or static stand-off current	The principal current when the thyristor is in the off-state.
I_F	forward (diode) current	The dc value used for the measurement of forward voltage.
I_H	static holding current	The minimum principal current required to maintain the thyristor in the on-state.
I_L	static latching current	The minimum principal current required to maintain the thyristor in the on-state immediately after switching from the off-state to the on-state has occurred and the triggering signal has been removed.
$I_{T(RMS)}$	RMS on-state current	The principal current when the thyristor is in the on-state.
I_T	static on-state current	
$I_{T(AV)}$	average on-state current	
I_{TM}	peak on-state current	
$I_{T(OV)}$	overload peak on-state current	An on-state current of substantially the same waveshape as the normal on-state current and having a greater value than the normal on-state current.
I_{TRM}	repetitive peak on-state current	The peak value of the on-state current including all repetitive transient currents.
I_{TSM}	surge (non-repetitive) peak on-state current	An on-state current of short-time duration and specified waveshape.
I_{TSP}	surge (non-repetitive) peak pulse on-state current	A short duration on-state current having a waveform with an exponential rise and decay (eg 8/20 µs).
I_Z	static regulator current	The principal current in the off-state characteristic which is strongly dependent on the applied voltage.

Symbol	Term	Definition
T_A	free-air temperature (ambient temperature)	The air temperature measured below a device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces. (Ref MIL-S-19500)
T_C	case temperature	The temperature measured at a specified location on the case of a device. (Ref MIL-S-19500).
T_J	virtual junction temperature (junction temperature)	A theoretical temperature based on a simplified representation of the thermal and electrical behaviour of the semi-conductor device. NOTE: This term (and its definition) is taken from IEC standards. It is particularly applicable to multi-junction semiconductors and is used in this publication to denote the temperature of the active semiconductor element when required in specifications and test methods. The term "junction temperature" is used interchangeably with the term "virtual junction temperautre" in this publication.
T_{jmax}	maximum junction temperature	The maximum value of permissible junction temperature, due to self heating, which the thyristor can withstand without degradation.
T_{lead}	lead temperature	
Tstg	storage temperature	The temperature at which the device, without any power applied, is stored. (Ref MIL-S-19500).
R_θ	thermal resistance	The temperature difference between two specified points or regions divided by the power dissipation under conditions of thermal equilibrium.
$R_{\theta JA}$	thermal resistance, junction-to-ambient	
$R_{\theta JC}$	thermal resistance, junction-to-case	
$R_{\theta CA}$	thermal resistance, case-to-ambient	
$V_{(BO)}$	static breakover voltage	The principal voltage at the breakover point.
V_D	static off-state voltage or static stand-off voltage	The principal voltage when the thyristor is in the off-state.
V_F	forward (diode) voltage	The dc voltage across a semiconductor diode associated with a forward current.
V_T	static on-state voltage	The principal voltage when the thyristor is in the on-state.

Symbol	Term	Definition
V_{TM}	peak on-state voltage	
V_Z	static regulator voltage	The principal voltage in the off-state characteristic at a specified value of regulator current (I_Z).
V_{ZM}	peak regulator voltage	The peak of off-state regulator voltage occurring as the regulator current is increased from 0 to a specified value.
$Z_{\theta(t)}$	transient thermal impedance	The change of temperature difference between two specified points or regions at the end of a time interval divided by the step function change in power dissipation at the beginning of the same time interval causing the change of temperature difference.
$Z_{\theta JA(t)}$	transient thermal impedance, junction-to-ambient	
$Z_{\theta JC(t)}$	transient thermal impedance, junction-to-case	
α_{IH}	temperature coefficient of holding current	This is expressed as an average %/°C change over a given temperature range. It is calculated by dividing the difference between the upper and lower temperature values of holding current by the temperature change and the holding current at 25°C.
$\alpha_{I(BO)}$	temperature coefficient of breakover current	This is expressed as an average %/°C change over a given temperature range. It is calculated by dividing the difference between the upper and lower temperature values of breakover current by the temperature change and the breakover current at 25°C.
$\alpha_{V(BO)}$	temperature coefficient of breakover voltage	This is expressed as an average %/°C change over a given temperature range. It is calculated by dividing the difference between the upper and lower temperature values of breakover voltage by the temperature change and the breakover voltage at 25°C.
α_{VZ}	temperature coefficient of regulator voltage	This is expressed as an average %/°C change over a given temperature range. It is calculated by dividing the difference between the upper and lower temperature values of regulator voltage by the temperature change and the regulator voltage at 25°C.

9

CUSTOM SELECTIONS AND SYMBOLISATION

In addition to the standard device types listed in this Data Book, **Texas Instruments** offers the service of performing custom parametric selections and symbolisation to meet your specific device requirements. If this requirement is for Transistors, Darlingtons, SCR's, Triacs or TISP's with parametric selections different from those devices in the standard product range we will be happy to evaluate your need.
Wether your requirement is for a Transistor with banded h_{FE} or a Triac with selected I_{GT}, **Texas Instruments** may be able to help you. The following is a list of most commonly selected parametric selections:

TRANSISTOR AND DARLINGTON SELECTION PARAMETERS

h_{FE}	static forward transfer ratio
V_{CEO}	collector emitter breakdown voltage
V_{CBO}	collector base breakdown voltage
$V_{CE(SAT)}$	collector emitter saturation voltage

SCR/TRIAC SELECTION PARAMETERS

I_{GT}	gate trigger current
V_{TM}	peak on-state voltage
V_{DRM}	repetative peak off-state voltage

TRANSIENT SUPPRESSOR SELECTION PARAMETERS

V_{BO}	breakover voltage
V_Z	zener voltage
I_H	holding current

DEVICE SYMBOLISATION

Texas Instruments standard practice for custom selections is to assign an 'R' number to Transistor and Transient Supressor selections and a 'Y' number to SCR/Triac selections. The prefix 'R' or 'Y' is followed by a four digit number so the final part number for any particular selection becomes RXXXX or YXXXX, where XXXX is the individually assigned customer number.

VOLUME CONDITIONS

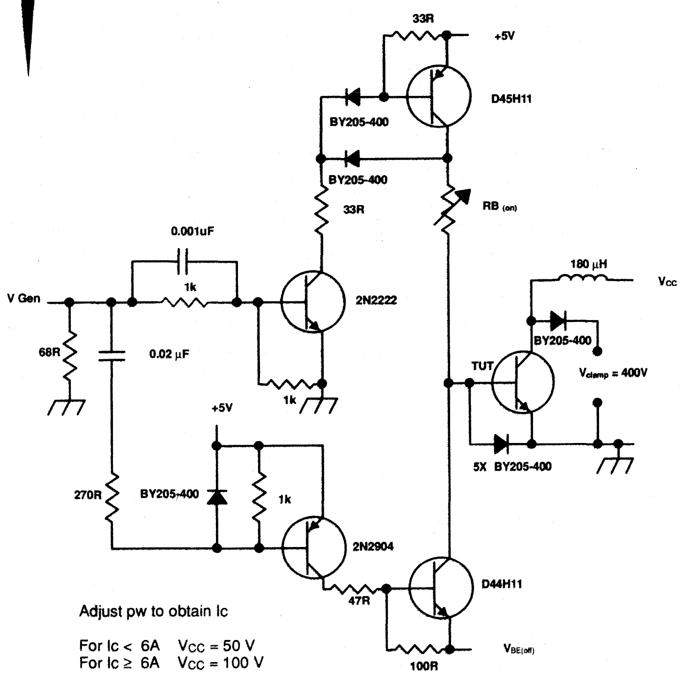
Due to the additional administrave and technical complexities involved, this service can only be offered where the annual demand for any particular selection exceeds 50Ku.

FURTHER INFORMATION

For further information on this service or any other questions, please contact your local **Texas Instruments** Sales Office or Franchised Distributor.

A

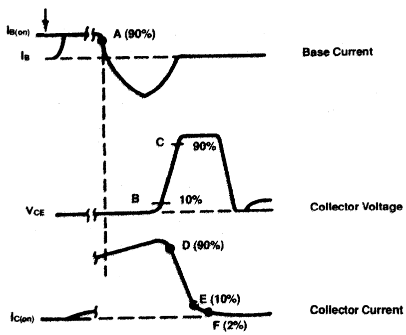
FIGURE 1. INDUCTIVE SWITCHING TEST CIRCUIT



Circuit and Waveforms apply to the following Data Sheets
TIPL751/A
TIPL752/A
TIPL753/A
TIPL755/A
TIPL757/A
TIPL760/A/B/C
TIPL761/A/B/C
TIPL762/A/B/C
TIPL763/A
TIPL765/A
TIPL770
TIPL791/A
TIPL3004/5
R4050/1
R4060/1
R3460
All BUV No's
All BUW No's
All BUX No's
All BUS No's

FIGURE 2. INDUCTING SWITCHING WAVEFORMS

$A - B = t_{sv}$
$B - C = t_{rv}$
$D - E = t_{fi}$
$E - F = t_{ti}$
$B - E = t_{xo}$

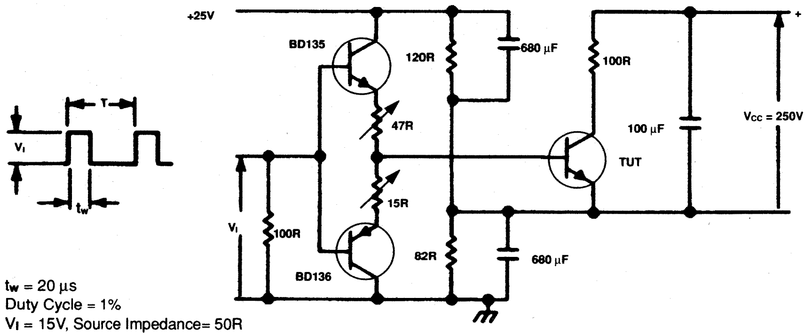


NOTES: A: Waveforms are monitored on an oscilloscope with the following characteristics: $t_r < 15ns$, $R_{in} > 10\ \Omega$, $C_{in} < 11.5pF$.
B: Resistors must be noninductive types.

Appendix

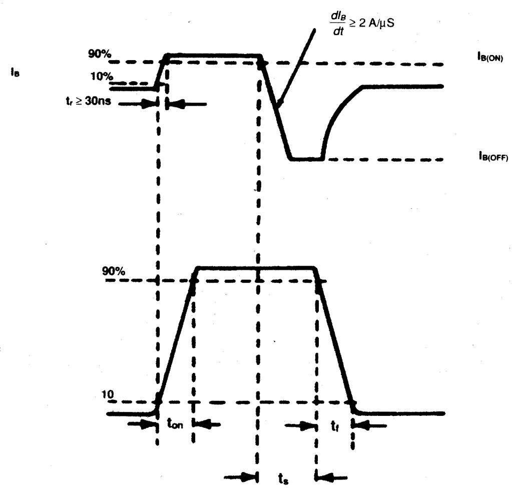
A

FIGURE 1. RESISTIVE LOAD SWITCHING CIRCUIT



t_w = 20 µs
Duty Cycle = 1%
V_I = 15V, Source Impedance= 50R

FIGURE 2. RESISTIVE LOAD SWITCHING WAVEFORMS



Circuit and Waveforms apply to the following Data Sheets
BU326/A
BU426/A

Appendix

A

TEXAS INSTRUMENTS

FIGURE 1. SWITCHING TEST CIRCUIT

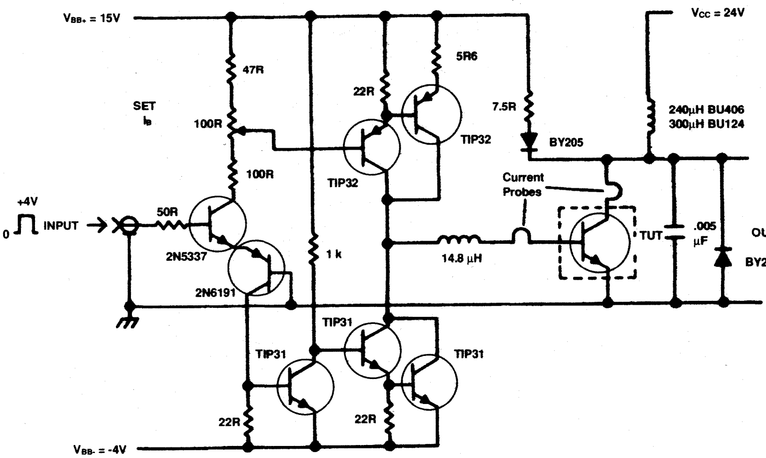
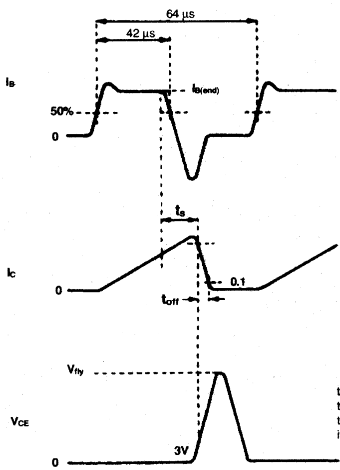


FIGURE 2. SWITCHING TEST WAVEFORMS



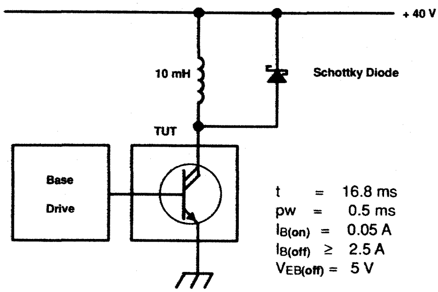
Circuit and Waveforms apply to the following Data Sheets
BU124/A
BU406/7

t_{off} is the time for the collector current I_C to decrease to 0.1 A after the collector to emitter voltage V_{CE} has risen 3 V into its flyback excursion

Appendix

A

FIGURE 1. COLLECTOR CIRCUIT USED TO MEASURE INDUCTIVE SWITCHING PARAMETERS



$t = 16.8$ ms
$pw = 0.5$ ms
$I_{B(on)} = 0.05$ A
$I_{B(off)} \geq 2.5$ A
$V_{EB(off)} = 5$ V

Circuit and Waveforms apply to the following Data Sheets
TIPL775/A
TIPL785/A
TIPL790/A

Circuit and Waveforms apply to the following Data Sheets
TIP150/1/2
TIP160/1/2
TIP660/1/2/3/4/5

FIGURE 1. FUNCTIONAL TEST CIRCUIT

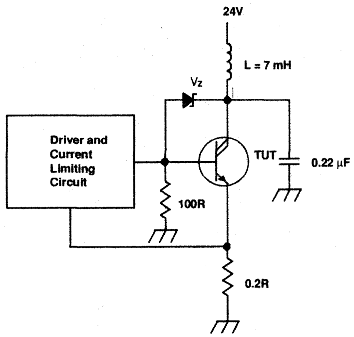


FIGURE 2. FUNCTIONAL TEST WAVEFORMS

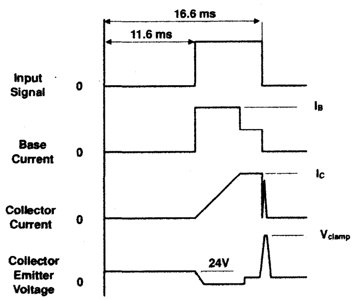
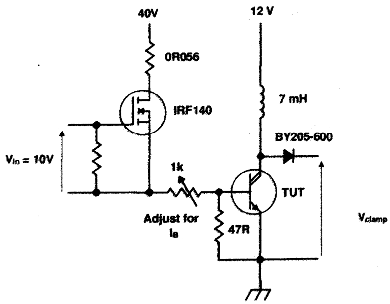
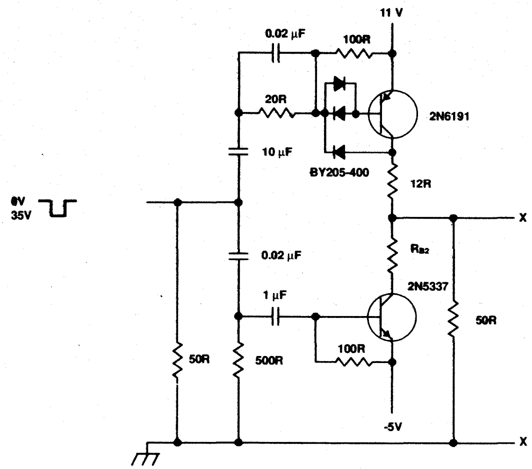


FIGURE 3. SWITCHING TIMES TEST CIRCUIT



Appendix
A

FIGURE 1. BASE DRIVE CIRCUIT



Circuit and Waveforms apply to the following Data Sheets
TIPL773/A/B
TIPL777/A/B

FIGURE 1a. VCEX

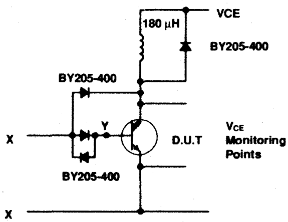


FIGURE 1b. INDUCTIVE SWITCHING

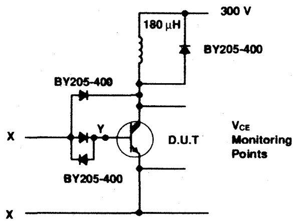
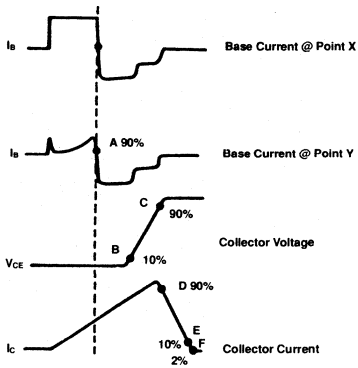


FIGURE 2. INDUCTIVE SWITCHING WAVEFORMS



A - D = t_{si}
B - C = t_{rv}
D - E = t_{fi}
B - E = t_{xo}
E - F = t_{ti}

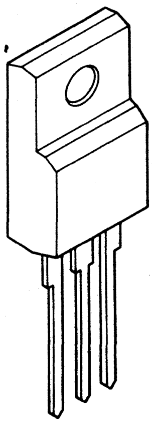
Appendix

A

June 1990

ISOWATT220 PACKAGE

- **Fully Isolated Package**
- **Reduced Component Count**
- **Reduced assembly Costs**
- **TO220 Replacement**



Texas Instruments announce the introduction of their fully isolated ISOWATT220 package.

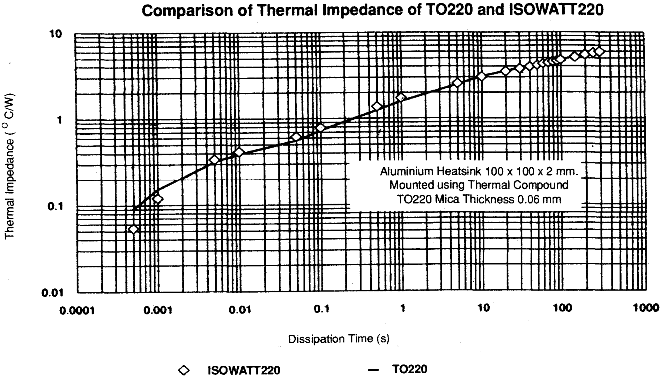
This package is manufactured with high thermal conductivity epoxy resin and when mounted on a heatsink with thermal compound will provide thermal resistance comparable with that of a conventional TO220 device using an insulating washer.

The package is both easy to mount and fully isolated, therefore removing the need for isolating washers and bushes and hence reducing overall assembly and system costs.

With the absence of mica washers, the improved long term reliability of the isolation will further reduce costs associated with test and field failures.

This new package is to be introduced on the Transistor, Darlington, SCR and Triac series currently offered in the conventional TO220 package.

Comparison of Thermal Impedance of TO220 and ISOWATT220



For further information contact your local **Texas Instruments** Sales Office.

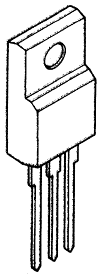
ADVANCE INFORMATION documents contain information on new products in the sampling or preproduction phase of devolpment. Charateristic data and other specifications are subject to change without notice

TEXAS INSTRUMENTS

MECHANICAL OUTLINE DATA
ADVANCED INFORMATION

June 1990

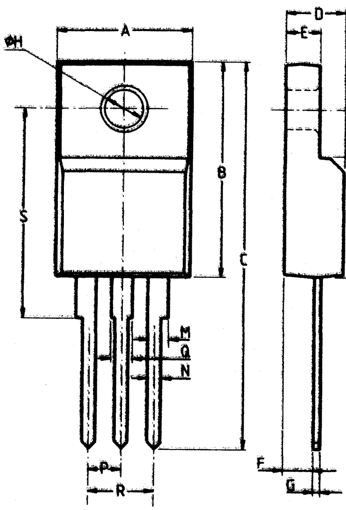
ISOWATT220 PACKAGE



The Mounting Tab is Isolated

	Pin 1	Pin 2	Pin 3
TRANSISTORS	Base	Collector	Emitter
TRIACS	MT1	MT2	Gate
SCR	K	A	G

	PACKAGE DIMENSIONS	
	mm	
	min	max
A	10.00	10.40
B	15.90	16.40
C	28.60	30.60
D	4.40	4.60
E	2.50	2.70
F	2.40	2.75
G	0.40	0.70
dia. H	3.00	3.20
L	9.00	9.30
M	1.15	1.70
N	0.75	1.00
P	2.40	2.70
Q	1.15	1.70
R	4.95	5.20
S	16.00 typ	



Appendix

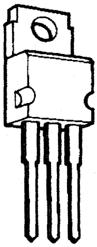
A

TEXAS INSTRUMENTS

ADVANCE INFORMATION documents contain information on new products in the sampling or preproduction phase of devolpment. Charateristic data and other specifications are subject to change without notice

Revised March 1990

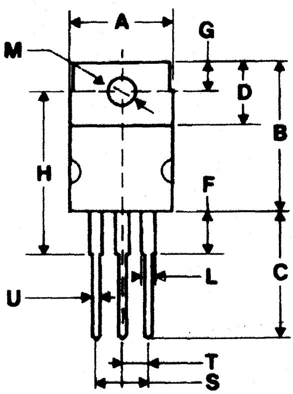
TO-220 PACKAGE

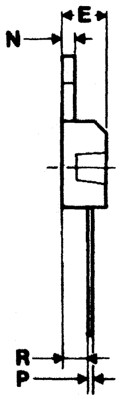


The centre Pin is in electrical contact with the mounting tab

	Pin 1	Pin 2	Pin 3
TRANSISTORS	Base	Collector	Emitter
TRIACS	MT1	MT2	Gate
TISPS	Tip	Ground	Ring
SCR	K	A	G

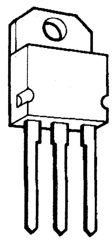
	PACKAGE DIMENSIONS	
	mm	
	min	max
A	10.0	10.4
B	15.2	15.9
C	12.7	13.7
D	6.2	6.6
E	4.4	4.6
F	3.5	5.5
G	2.65	2.95
H	17.6 typ	
L	1.14	1.7
M	3.75	3.85
N	1.23	1.32
P	0.41	0.64
R	2.4	2.72
S	4.95	5.15
T	2.4	2.7
U	0.61	0.94





Revised March 1990

SOT-93 PACKAGE

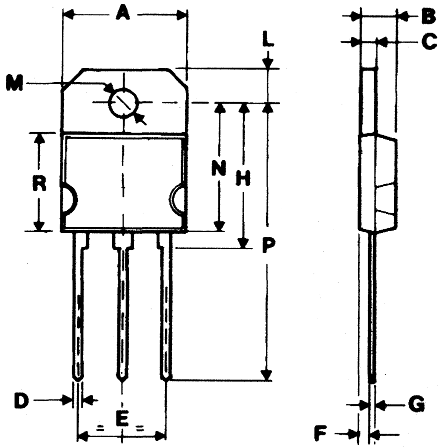


1 2 3

The centre Pin is in electrical contact with the mounting tab

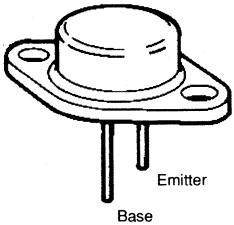
	Pin 1	Pin 2	Pin 3
TRANSISTORS	Base	Collector	Emitter
TRIACS	MT1	MT2	Gate

	PACKAGE DIMENSIONS	
	mm	
	min	max
A	14.7	15.2
B	4.7	4.9
C	1.9	2.1
D	1.1	1.3
E	10.8	11.1
F	2.5 typ	
G	0.5	0.78
H	18.0 typ	
L	3.95	4.15
M	4.0	4.1
N	-	16.2
P	31.0 typ	
R	-	12.2



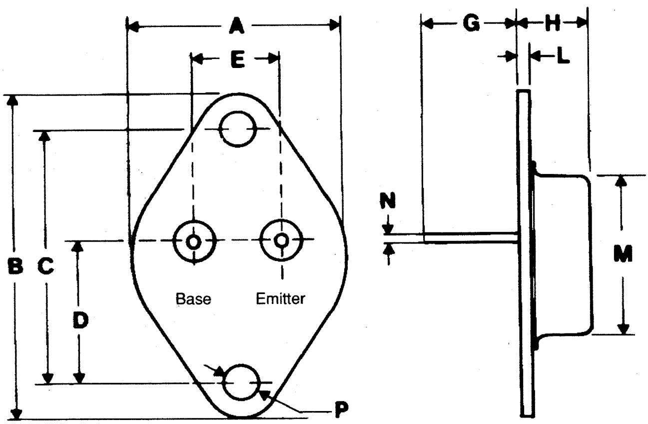
Revised March 1990

TO-3 PACKAGE



The collector is in electrical contact with the case

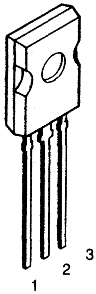
	PACKAGE DIMENSIONS mm	
	min	max
A	25.0	26.0
B	38.5	39.3
C	30.0	30.3
D	16.5	17.2
E	10.7	11.1
G	11.0	13.1
H	8.32	8.92
L	1.5	1.65
M	19.0	20.0
N	0.97	1.15
P	4.0	4.09



UNDERSIDE DIMENSIONS

Revised March 1990

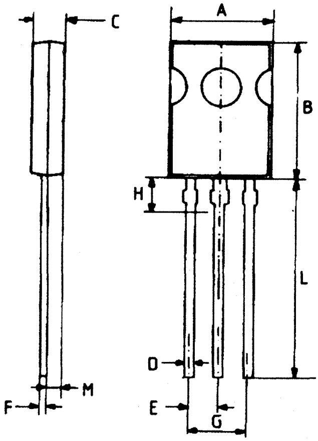
SOT-82 PACKAGE



The centre Pin is in electrical contact with the mounting tab

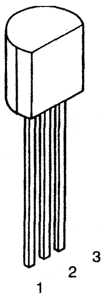
	Pin 1	Pin 2	Pin 3
TRANSISTORS	Base	Collector	Emitter
TISPS	Tip	Ground	Ring

	PACKAGE DIMENSIONS mm	
	min	max
A	7.4	7.8
B	10.5	10.8
C	2.4	2.7
D	0.7	0.9
E	2.2 typ	
F	0.49	0.75
G	4.4 typ	
H	2.54 typ	
L	15.7 typ	
M	1.2 typ	



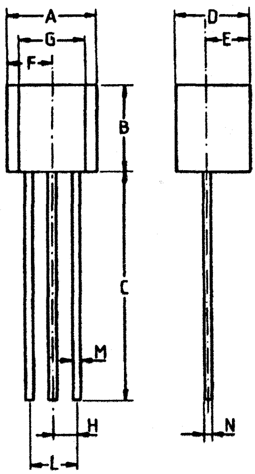
Revised March 1990

TO-92 PACKAGE



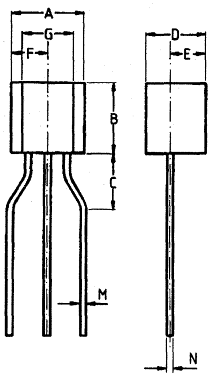
	PACKAGE DIMENSIONS	
	mm	
	min	max
A	4.44	5.21
B	4.32	5.34
C	12.70	-
D	3.17	4.19
E	2.03	2.67
F	2.03	2.67
G	3.43	-
H	1.14	1.40
L	2.41	2.67
M	0.40	0.56
N	0.35	0.41

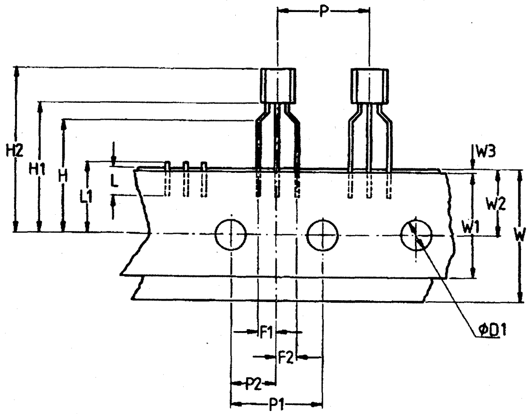
	Pin 1	Pin 2	Pin 3
TRANSISTORS	Emitter	Collector	Base
TRIACS	Gate	MT2	MT1
TISPS	Tip	Ground	Ring
SCR	G	A	K



Revised March 1990

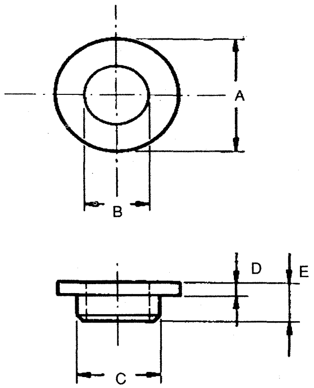
TO-92 TAPE AND REEL PACKAGE





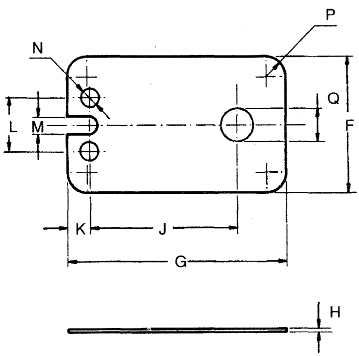
	INDIVIDUAL UNIT	
	mm	
	min.	max.
A	4.44	5.21
B	4.32	5.34
C	-	4.00
D	3.17	4.19
E	2.03	2.67
F	2.03	2.67
G	3.43	
M	0.40	0.56
N	0.35	0.41

	TAPE AND REEL	
	mm	
	min.	max.
dia. D1	3.70	4.30
F1	2.40	2.90
F2	2.40	2.90
H	15.50	16.50
H1	H1 + B ≤ H2	
H2	23.00	32.00
L	2.50	
L1	8.50	11.00
P	11.70	13.70
P1	12.40	13.00
P2	5.95	6.75
W	17.50	19.00
W1	5.50	19.00
W2	8.50	9.75
W3	0.00	0.50



	INSULATING BUSH		
	mm		
	min.	typ.	max.
A	-	5.40	-
B	3.00	-	3.10
C	3.72	-	3,77
D	0.60	-	0.65
E	-	1.75	-

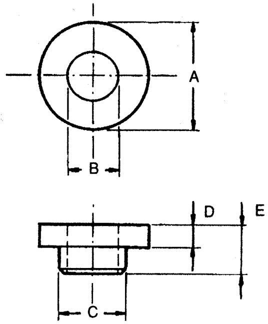
Order Part Number: 15.1002 B



	INSULATOR		
	mm		
	min.	typ.	max.
F	-	13.20	-
G	-	22.00	-
H	0.04	-	0.08
J	14.60	-	15.00
K	2.10	-	2.30
L	5.10	-	5.30
M	1.80	-	1.90
N	1.80	-	1.90
P	-	2.00	-
Q	3.10	-	3.25

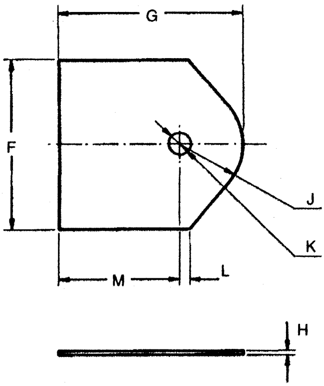
Order Part Number: 15.1005

STANDARD MOUNTING HARDWARE
SOT93
Revised March 1990



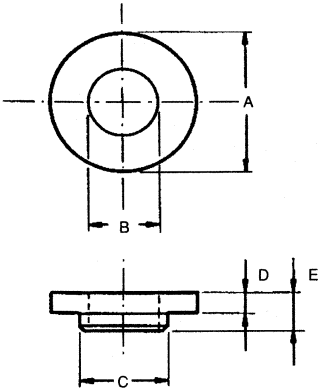
	INSULATING BUSH		
	mm		
	min.	typ.	max.
A	-	6.50	-
B	3.00	-	3.10
C	4.00	-	4.05
D	1.30	-	1.40
E	-	2.80	-

Order Part Number: 15.1002 C



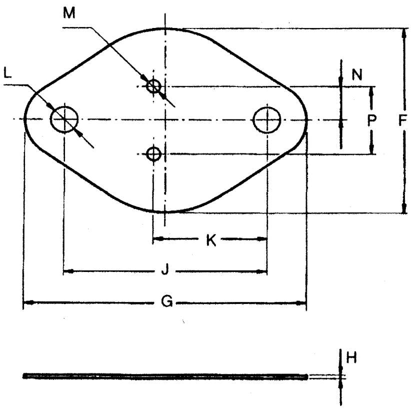
	INSULATOR		
	mm		
	min.	typ.	max.
F	-	23.50	-
G	-	25.00	-
H	0.04	-	0.08
J	-	8.50	-
K	3.10	-	3.20
L	1.15	-	1.35
M	16.40	-	16.60

Order Part Number: 15.1006



	INSULATING BUSH		
	mm		
	min.	typ.	max.
A	-	6.50	-
B	3.00	-	3.10
C	4.00	-	4.05
D	-	-	1.10
E	-	1.60	-

Order Part Number: 15.1002 A



	INSULATOR		
	mm		
	min.	typ.	max.
F	-	28.75	-
G	-	42.00	-
H	0.05	-	0.10
J	30.05	-	30.29
K	16.80	-	17.04
L	4.05	-	4.15
M	1.28	-	1.52
N	5.34	-	5.58
P	10.80	-	11.04

Order Part Number: 15.1007

TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT
2N1069	2N3713	2N5466	TIPL753	2N6022	TIP42B
2N1070	2N3713	2N5467	TIPL753	2N6023	TIP42
2N1208	2N3715	2N5490	TIP41A	2N6024	TIP42
2N1470	2N3713	2N5491	TIP41A	2N6025	TIP42B
2N1723	2N3716	2N5492	TIP41A	2N6026	TIP42B
2N2015	2N3713	2N5493	TIP41A	2N6040	TIP105
2N2016	2N3714	2N5494	TIP41A	2N6041	TIP105
2N2305	2N3713	2N5495	TIP41A	2N6042	TIP105
2N2338	2N3713	2N5496	TIP41B	2N6043	TIP100
2N3024	2N3791	2N5497	TIP41B	2N6044	TIP100
2N3025	2N3791	2N5614	2N3715	2N6045	TIP100
2N3026	2N3791	2N5616	2N3714	2N6053	TIP605
2N3076	TIPL757	2N5618	2N3716	2N6054	TIP606
2N3080	TIPL751	2N5620	2N3716	2N6055	TIP600
2N3226	2N3713	2N5621	2N4399	2N6056	TIP601
2N3236	2N5303	2N5622	2N5303	2N6098	TIP73A
2N3237	2N5302	2N5624	2N3716	2N6099	TIP73A
2N3445	2N3713	2N5737	2N3791	2N6100	TIP73A
2N3447	2N3715	2N5804	TIPL752	2N6101	TIP73A
2N3667	2N3713	2N5805	TIPL751	2N6102	TIP73A
2N3788	TIPL751	2N5869	2N3713	2N6103	TIP73A
2N3863	2N3715	2N5870	2N3714	2N6106	TIP42B
2N4070	TIPL752	2N5873	2N3713	2N6107	TIP42B
2N4071	TIPL752	2N5874	2N3714	2N6108	TIP42A
2N4111	2N3715	2N5974	TIP74	2N6109	TIP42A
2N4113	2N3716	2N5975	TIP74	2N6110	TIP42A
2N4234	TIP30	2N5976	TIP74A	2N6111	TIP42
2N4235	TIP30A	2N5977	TIP73	2N6121	TIP31A
2N4236	TIP30B	2N5978	TIP73	2N6122	TIP31A
2N4395	2N3713	2N5979	TIP73	2N6123	TIP31B
2N4396	2N3713	2N5980	TIP74	2N6124	TIP32A
2N5157	TIPL753	2N5981	TIP74	2N6125	TIP32A
2N5239	TIPL752	2N5982	TIP74	2N6126	TIP32B
2N5240	TIPL753	2N5983	TIP73	2N6129	TIP41
2N5293	TIP31B	2N5984	TIP73	2N6130	TIP41A
2N5294	TIP31B	2N5985	TIP73	2N6131	TIP41B
2N5295	TIP31	2N5986	TIP74	2N6132	TIP42
2N5296	TIP31	2N5987	TIP74	2N6133	TIP42A
2N5297	TIP31A	2N5988	TIP74	2N6134	TIP42B
2N5298	TIP31B	2N5989	TIP73	2N6249	TIPL755
2N5387	TIPL755	2N5990	TIP73	2N6250	TIPL755
2N5388	TIPL755	2N5991	TIP73	2N6251	TIPL755
2N5389	TIPL755	2N6021	TIP42B	2N6288	TIP41

TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT
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2N6290	TIP41A	2N6490	TIP74A	2SA815	TIP30C
2N6291	TIP41B	2N6491	TIP74B	2SA816	TIP30B
2N6292	TIP41B	2N6492	TIP600	2SA839	TIP32C
2N6293	TIP41B	2N6493	TIP601	2SA966	TIP32
2N6306	TIPL752	2N6494	TIP601	2SA1008	TIP32C
2N6307	TIPL752	2N6510	TIPL753	2SA1010	TIP42C
2N6308	TIPL752	2N6511	TIPL753	2SA1012	TIP42A
2N6342	TIC226B	2N6512	TIPL753	2SA1020	TIP32
2N6342A	TIC236B	2N6513	TIPL753	2SA1069	TIP42B
2N6343	TIC226D	2N6514	TIPL753	2SB502A	TIP41A
2N6343A	TIC236D	2N6530	TIP101	2SB503A	TIP41A
2N6344	TIC226M	2N6531	TIP102	2SB507	TIP42B
2N6344A	TIC236M	2N6532	TIP102	2SB509	TIP42B
2N6346	TIC226B	2N6533	TIP102	2SB511	TIP32
2N6346A	TIC236B	2N6535	TIP102	2SB513	TIP42B
2N6347	TIC226D	2N6536	TIP102	2SB514	TIP32A
2N6347A	TIC236D	2N6542	TIPL751	2SB515	TIP32A
2N6348	TIC226M	2N6543	TIPL751	2SB521	TIP42A
2N6348A	TIC236M	2N6544	TIPL753	2SB522	TIP42A
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2N6383	TIP640	2N6546	TIPL755	2SB537	TIP42B
2N6384	TIP641	2N6547	TIPL755	2SB565	TIP42A
2N6385	TIP642	2N6573	TIPL755	2SB566	TIP42B
2N6386	TIP100	2N6574	TIPL755	2SB595	TIP42C
2N6387	TIP100	2N6576	TIP640	2SB596	TIP42B
2N6388	TIP101	2N6577	TIP642	2SB604	TIP42B
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2N6398	TIC126M	2N6668	TIP107	2SB674	TIP105
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2N6400	TIC126F	2N6672	TIPL752	2SB676	TIP127
2N6401	TIC126A	2N6673	TIPL752	2SB677	TIP125
2N6402	TIC126B	2SA489	TIP42B	2SB679	TIP117
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2N6404	TIC126M	2SA700	TIP30	2SB690	TIP42C
2N6473	TIP41C	2SA755	TIP42B	2SB707	TIP42A
2N6475	TIP42C	2SA768	TIP42B	2SB708	TIP42A
2N6486	TIP73	2SA769	TIP42B	2SB711	TIP105
2N6487	TIP73A	2SA771	TIP42	2SB712	TIP105
2N6488	TIP73B	2SA775	TIP30C	2SB724	TIP32A

TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT
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2SB753	TIP42C	2SC1506	TIP48	2SD390	TIP31A
2SB754	TIP42A	2SC1507	TIP48	2SD396	TIPL755
2SC163	2N3715	2SC1586	TIPL755	2SD401	TIP47
2SC409	TIPL753	2SC1669	TIP47	2SD402	TIP47
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2SC412	TIPL755	2SC1723	TIP48	2SD429	TIPL755
2SC675	TIPL752	2SC1749	TIP48	2SD459	TIP121
2SC676	TIPL752	2SD171	TIPL751	2SD460	TIP121
2SC677	TIPL752	2SD231	2N5302	2SD475	TIP31
2SC678	TIPL752	2SD234	TIP31A	2SD476	TIP31
2SC758	TIPL752	2SD235	TIP31A	2SD525	TIP41C
2SC759	TIPL752	2SD249	2N5302	2SD526	TIP41B
2SC760	TIPL752	2SD262	TIPL755	2SD531	TIP41C
2SC789	TIP31	2SD265	TIPL753	2SD544	TIP41C
2SC790	TIP31A	2SD266	TIPL753	2SD552	TIPL755
2SC885	TIPL752	2SD273	TIPL753	2SD553	TIP41B
2SC886	TIPL752	2SD274	TIPL753	2SD570	TIP31
2SC901	TIPL752	2SD288	TIP31B	2SD608	TIP47
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2SC1141	TIPL755	2SD325	TIP31	2SD686	TIP122
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2SC1409	TIP47	2SD343	TIP31B	2SD722	TIP100
2SC1410	TIP47	2SD344	TIP31B	2SD723	TIP31C
2SC1418	TIP31	2SD345	TIP31B	2SD724	TIPL760
2SC1419	TIP31	2SD346	TIP41A	2SD726	TIP31C
2SC1434	TIPL755	2SD347	TIP41A	2SD731	TIPL752
2SC1447	TIP47	2SD351	TIPL753	2SD732	TIPL752
2SC1448	TIP47	2SD365	TIP31A	2SD749	TIPL751
2SC1463	TIPL751	2SD366	TIP31A	2SD759	TIP47

TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT
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2SD761	TIP47	BD245	TIP73	BD810	TIP74B
2SD762	TIP31A	BD245A	TIP73A	BD905	TIP73
2SD768	TIP100	BD245B	TIP73B	BD906	TIP74
2SD801	TIPL753	BD246	TIP74	BD907	TIP73A
2SD802	TIPL753	BD246A	TIP74A	BD908	TIP74A
2SD836	TIP110	BD246B	TIP74B	BD909	TIP73A
2SD837	TIP120	BD265	TIP100	BD910	TIP74B
2SD844	TIP41A	BD265A	TIP100	BD912	TIP74C
2SD872	TIPL760	BD543	TIP73	BD943	TIP41A
2SD880	TIP31A	BD543A	TIP73	BD944	TIP42B
40250	TIP31	BD543B	TIP73	BD945	TIP41A
40613	TIP31	BD544	TIP74	BD946	TIP42B
40618	TIP31	BD544A	TIP74	BD947	TIP41A
40621	TIP31	BD544B	TIP74	BD948	TIP42A
40622	TIP31	BD545	TIP73	BDT91	TIP73
40624	TIP41A	BD545A	TIP73	BDT92	TIP74A
40627	TIP41A	BD545B	TIP74	BDT93	TIP73B
40629	TIP31	BD546	TIP73	BDT94	TIP74A
40630	TIP31	BD546A	TIP74	BDX33A	TIP130
40631	TIP31A	BD546B	TIP74	BDX33B	TIP131
40632	TIP41A	BD567	TIP73	BDX33C	TIP132
40852	TIPL751	BD567A	TIP73	BDX34A	TIP135
40853	TIPL755	BD605	TIP73	BDX34B	TIP136
40854	TIPL755	BD606	TIP74	BDX34C	TIP137
40871	TIP41C	BD607	TIP73	BDX92	TIP34A
40872	TIP42C	BD608	TIP74	BDX94	TIP34B
40873	TIP41B	BD609	TIP73	BDY82A	TIP42
40874	TIP41B	BD610	TIP74	BDY83A	TIP42A
40875	TIP41C	BD661	TIP73	BU104	TIPL752
40876	TIP41A	BD662	TIP74	BU109	TIPL752
41500	TIP29	BD663B	TIP73	BU112	TIPL752
41501	TIP30	BD664	TIP74	BU116	TIPL752
41504	TIP31	BD705	TIP73	BU134	TIPL752
BD205	TIP73	BD706	TIP74	BU606	TIPL752
BD206	TIP74	BD707	TIP73	BU607	TIPL752
BD207	TIP73	BD708	TIP74	BU608	TIPL752
BD208	TIP74	BD709	TIP73	BU910	TIP152
BD213-45	TIP73	BD710	TIP74	BU911	TIP152
BD213-60	TIP73A	BD805	TIP73	BU920P	TIP661
BD213-80	TIP73B	BD806	TIP74	BU921P	TIP662
BD214-45	TIP74	BD807	TIP73A	BUW24	TIPL751
BD214-60	TIP74A	BD808	TIP74A	BUW34	TIPL752

TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT
BUW35	TIPL752	D43C1	TIP42	D44R4	TIP48
BUW36	TIPL752	D43C2	TIP42	D44R5	TIP47
BUW44	TIPL755	D43C3	TIP42	D44R6	TIP48
BUW74	TIPL753	D43C4	TIP42A	D44TD3	TIPL752
BUW75	TIPL753	D43C5	TIP42A	D44TD4	TIPL752
BUX31	BUY70A	D43C6	TIP42A	D44TD5	TIPL752
BUX31A	BUY70A	D43C7	TIP42B	D45C1	TIP42
BUX31B	BUY70B	D43C8	TIP42B	D45C2	TIP42
BUX41	TIPL755	D43C9	TIP42B	D45C3	TIP42
BUX42	TIPL755	D43C10	TIP42B	D45C4	TIP42A
BUY18S	TIPL752	D43C11	TIP42B	D45C5	TIP42A
BUY20	TIPL752	D43C12	TIP42B	D45C6	TIP42A
BUY21	TIPL752	D44C1	TIP41	D45C7	TIP42B
BUY21A	TIPL752	D44C2	TIP41	D45C8	TIP42B
BUY22	TIPL755	D44C3	TIP41	D45C9	TIP42B
BUY23	TIPL755	D44C4	TIP41A	D45C10	TIP42B
BUY23A	TIPL755	D44C5	TIP41A	D45C11	TIP42B
BUY51A	TIPL755	D44C6	TIP41A	D45C12	TIP42B
BUY53A	TIPL755	D44C7	TIP41B	D45E1	TIP125
C122A	TIC116A	D44C8	TIP41B	D45E2	TIP125
C122D	TIC116D	D44C9	TIP41B	D45E3	TIP126
C122E	TIC116E	D44C10	TIP41B	D45H1	TIP42
C122F	TIC116F	D44C11	TIP41B	D45H10	TIP42B
C122M	TIC116M	D44D1	TIP100	D45H11	TIP42B
C123A	TIC126A	D44D2	TIP100	D45H12	TIP42B
C123B	TIC126B	D44D3	TIP100	D45H2	TIP42
C123C	TIC126C	D44D4	TIP100	D45H4	TIP42A
C123D	TIC126D	D44D5	TIP100	D45H5	TIP42A
C123E	TIC126E	D44D6	TIP100	D45H7	TIP42B
C123F	TIC126E	D44E1	TIP100	D45H8	TIP42B
C123M	TIC126F	D44E2	TIP101	D64VE3	TIPL752
D41C2	TIP41	D44E3	TIP102	D64VE4	TIPL752
D42C1	TIP41	D44H1	TIP41	D64VE5	TIPL752
D42C2	TIP41	D44H2	TIP41	D64VP3	TIPL753
D42C4	TIP41A	D44H4	TIP41A	D64VP4	TIPL753
D42C5	TIP41A	D44H5	TIP41A	D64VP5	TIPL753
D42C6	TIP41A	D44H7	TIP41B	D64VS3	TIPL753
D42C7	TIP41B	D44H8	TIP41B	D64VS4	TIPL753
D42C8	TIP41B	D44H10	TIP41B	DBX34C	TIP137
D42C9	TIP41B	D44H11	TIP41B	DTS310	TIPL752
D42C10	TIP41B	D44R1	TIP47	DTS311	TIPL752
D42C11	TIP41B	D44R2	TIP47	DTS403	TIPL752
D42C12	TIP41B	D44R3	TIP48	DTS409	TIPL752

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EC107D1	TIC106D	IR802	2N3716	MJ480	2N3713
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ESM218	TIP100	IR1020	TIP642	MJ1000	TIP600
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GSTU4035	TIPL752	IR4502	2N4399	MJ3055	TIP3055
GSTU4040	TIPL752	ITT2500A	TIC216A	MJ3771	2N3771
GSTU6030	TIPL753	ITT2500B	TIC216B	MJ3772	2N3772
GSTU6035	TIPL753	ITT2500C	TIC216D	MJ4000	TIP621
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GSTU10030	TIPL753	ITT2800D	TIC226D	MJ4032	TIP647
GSTU10035	TIPL753	ITT2800E	TIC226E	MJ4033	TIP645
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NSP42A	TIP42A
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TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT
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RCA30C	TIP30C	S0310RS3	TIC126F	S4006RS2	TIC106D
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RCA31A	TIP31A	S0503RS3	TIC106F	S4008RS3	TIC116D
RCA31B	TIP31B	S0506RS2	TIC106F	S4010RS3	TIC126D
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RCA32B	TIP32B	S1003RS2	TIC106A	S6008RS3	TIC116M
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RCA41	TIP41	S1006RS2	TIC106A	S6100C	TIC126C
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RCA42A	TIP42A	S2003RS3	TIC106B	SC141M	TIC226M
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TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT
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TYPE	TI NEAREST REPLACEMENT	TYPE	TI NEAREST REPLACEMENT
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T2500B	TIC226B		
T2500D	TIC226D		
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T2800C	TIC226D		
T2800D	TIC226D		

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