Texas Instruments

Power Transistor and Darlington

Data Manual

1995

Power Transistor and Darlington

Data Manual

TEXAS
INSTRUMENTS

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INTRODUCTION

The 1995 POWER TRANSISTOR and DARLINGTON DATA MANUAL from Texas Instruments includes complete detailed specifications on the bipolar junction transistor product line.
The general purpose NPN and PNP power transistors are suitable for use in both analogue applications such as linear series regulators and switching applications such as inverters and relay drivers. The general purpose NPN and PNP Darlingtons have high gain and low drive current which means that these devices are extensively used in the output stages of analogue power amplifiers and for logic driven power switches. The high voltage planar switching transistors are an excellent choice for use in off-line switch mode power supplies and inverter applications.

The data book is divided into 7 chapters. Below you will find a brief description of each chapter.

Chapter 1. Alphanumeric Index - A list by device name with the relevant page number for the detailed specification.

Chapter 2. Selection Guide - An easy-to-use reference guide that includes specific device information. Page numbers are shown for easy access to the detailed specifications.

Chapter 3. Glossary - Defines terms and standards used throughout the book.

Chapters 4 - 6. Product specifications for over 90 Transistors and Darlingtons are given in these sections.

Chapter 7. Mechanical Data - Detailed package drawings and specifications are shown in this section.

For further assistance please contact the sales representation listed in the back of this book. For additional copies of this book please return the pre-paid order form included inside the back cover.

GENERAL PURPOSE NPN TRANSISTORS

Device Number	I_C Continuous (A)	V_{CEO} (V)	P_{tot} $T_C = 25°C$ (W)	h_{FE} Minimum	h_{FE} @I_C (A)	Package	Complementary	Page
TIP29 TIP29A TIP29B TIP29C	1	40 60 80 100	30	15	1	TO-220	TIP30 TIP30A TIP30B TIP30C	4-91
TIP29D TIP29E TIP29F	1	120 140 160	30	15	1	TO-220		4-95
BD239 BD239A BD239B BD239C	2	45 60 80 100	30	15	1	TO-220	BD240 BD240A BD240B BD240C	4-3
BD239D BD239E BD239F	2	120 140 160	30	15	1	TO-220		4-7
TIPP31 TIPP31A TIPP31B TIPP31C	2	40 60 80 100	0.8	10	2	TO-92	TIPP32 TIPP32A TIPP32B TIPP32C	4-147
BD241 BD241A BD241B BD241C	3	45 60 80 100	40	10	3	TO-220	BD242 BD242A BD242B BD242C	4-15
BD241D BD241E BD241F	3	120 140 160	40	5	3	TO-220		4-19
TIP31 TIP31A TIP31B TIP31C	3	40 60 80 100	40	10	3	TO-220	TIP32 TIP32A TIP32B TIP32C	4-103
TIP31D TIP31E TIP31F	3	120 140 160	40	5	3	TO-220		4-107
BD539 BD539A BD539B BD539C BD539D	5	40 60 80 100 120	45	12	3	TO-220	BD540 BD540A BD540B BD540C	4-51
BD243 BD243A BD243B BD243C	6	45 60 80 100	65	15	3	TO-220	BD244 BD244A BD244B BD244C	4-27
TIP41 TIP41A TIP41B TIP41C	6	40 60 80 100	65	15	3	TO-220	TIP42 TIP42A TIP42B TIP42C	4-131

GENERAL PURPOSE NPN TRANSISTORS (continued)

Device Number	I_C Continuous (A)	V_{CEO} (V)	P_{tot} $T_C = 25°C$ (W)	h_{FE} Minimum	h_{FE} @I_C (A)	Package	Complementary	Page
BD543 BD543A BD543B BD543C	8	40 60 80 100	70	15	5	TO-220	BD544 BD544A BD544B BD544C	4-59
BD245 BD245A BD245B BD245C	10	45 60 80 100	80	4	10	SOT-93	BD246 BD246A BD246B BD246C	4-35
TIP33 TIP33A TIP33B TIP33C	10	40 60 80 100	80	20	3	SOT-93	TIP34 TIP34A TIP34B TIP34C	4-115
BD545 BD545A BD545B BD545C	15	40 60 80 100	85	10	10	SOT-93	BD546 BD546A BD546B BD546C	4-67
BD743 BD743A BD743B BD743C	15	45 60 80 100	90	5	15	TO-220	BD744 BD744A BD744B BD744C	4-75
TIP3055	15	70	90	5	10	SOT-93	TIP2955	4-143
BD745 BD745A BD745B BD745C	20	45 60 80 100	115	5	20	SOT-93	BD746 BD746A BD746B BD746C	4-83
BD249 BD249A BD249B BD249C	25	45 60 80 100	125	5	25	SOT-93	BD250 BD250A BD250B BD250C	4-43
TIP35 TIP35A TIP35B TIP35C	25	40 60 80 100	125	10	15	SOT-93	TIP36 TIP36A TIP36B TIP36C	4-123

GENERAL PURPOSE PNP TRANSISTORS

Device Number	I_C Continuous (A)	V_{CEO} (V)	P_{tot} $T_C = 25°C$ (W)	h_{FE} Minimum	h_{FE} @I_C (A)	Package	Complementary	Page
TIP30	1	40	30	15	1	TO-220	TIP29	4-99
TIP30A		60					TIP29A	
TIP30B		80					TIP29B	
TIP30C		100					TIP29C	
BD240	2	45	30	15	1	TO-220	BD239	4-11
BD240A		60					BD239A	
BD240B		80					BD239B	
BD240C		100					BD239C	
TIPP32	2	40	0.8	10	2	TO-92	TIPP31	4-149
TIPP32A		60					TIPP31A	
TIPP32B		80					TIPP31B	
TIPP32C		100					TIPP31C	
BD242	3	45	40	10	3	TO-220	BD241	4-23
BD242A		60					BD241A	
BD242B		80					BD241B	
BD242C		100					BD241C	
TIP32	3	40	40	10	3	TO-220	TIP31	4-111
TIP32A		60					TIP31A	
TIP32B		80					TIP31B	
TIP32C		100					TIP31C	
BD540	5	40	45	12	3	TO-220	BD539	4-55
BD540A		60					BD539A	
BD540B		80					BD539B	
BD540C		100					BD539C	
BD244	6	45	65	15	3	TO-220	BD243	4-31
BD244A		60					BD243A	
BD244B		80					BD243B	
BD244C		100					BD243C	
TIP42	6	40	65	15	3	TO-220	TIP41	4-135
TIP42A		60					TIP41A	
TIP42B		80					TIP41B	
TIP42C		100					TIP41C	
BD544	8	40	70	15	5	TO-220	BD543	4-63
BD544A		60					BD543A	
BD544B		80					BD543B	
BD544C		100					BD543C	
BD246	10	45	80	4	10	SOT-93	BD245	4-39
BD246A		60					BD245A	
BD246B		80					BD245B	
BD246C		100					BD245C	
TIP34	10	40	80	20	3	SOT-93	TIP33	4-119
TIP34A		60					TIP33A	
TIP34B		80					TIP33B	
TIP34C		100					TIP33C	

GENERAL PURPOSE PNP TRANSISTORS (continued)

Device Number	I_C Continuous (A)	V_{CEO} (V)	P_{tot} $T_C = 25°C$ (W)	h_{FE} Minimum	h_{FE} @I_C (A)	Package	Complementary	Page
BD546	15	40	85	10	10	SOT-93	BD545	4-71
BD546A		60					BD545A	
BD546B		80					BD545B	
BD546C		100					BD545C	
BD744	15	45	90	5	15	TO-220	BD743	4-79
BD744A		60					BD743A	
BD744B		80					BD743B	
BD744C		100					BD743C	
TIP2955	15	70	90	5	10	SOT-93	TIP3055	4-139
BD746	20	45	115	5	20	SOT-93	BD745	4-87
BD746A		60					BD745A	
BD746B		80					BD745B	
BD746C		100					BD745C	
BD250	25	45	125	5	25	SOT-93	BD249	4-47
BD250A		60					BD249A	
BD250B		80					BD249B	
BD250C		100					BD249C	
TIP36	25	40	125	10	15	SOT-93	TIP35	4-127
TIP36A		60					TIP35A	
TIP36B		80					TIP35B	
TIP36C		100					TIP35C	

GENERAL PURPOSE NPN DARLINGTONS

Device Number	I_C Continuous (A)	V_{CEO} (V)	P_{tot} $T_C = 25°C$ (W)	h_{FE} Minimum	h_{FE} @I_C (A)	Package	Complementary	Page
TIPP110	2	60	0.8	500	2	TO-92	TIPP115	5-151
TIPP111		80					TIPP116	
TIPP112		100					TIPP117	
BDT61	4	60	50	750	1.5	TO-220	BDT60	5-31
BDT61A		80					BDT60A	
BDT61B		100					BDT60B	
BDT61C		120					BDT60C	
BDW53	4	45	40	100	4	TO-220	BDW54	5-51
BDW53A		60					BDW54A	
BDW53B		80					BDW54B	
BDW53C		100					BDW54C	
BDW53D		120					BDW54D	
TIP110	4	60	50	500	2	TO-220	TIP115	5-119
TIP111		80					TIP116	
TIP112		100					TIP117	
TIP120	5	60	65	1000	3	TO-220	TIP125	5-127
TIP121		80					TIP126	
TIP122		100					TIP127	
BDW23	6	45	50	100	6	TO-220	BDW24	5-43
BDW23A		60					BDW24A	
BDW23B		80					BDW24B	
BDW23C		100					BDW24C	
BDW63	6	45	60	100	6	TO-220	BDW64	5-59
BDW63A		60					BDW64A	
BDW63B		80					BDW64B	
BDW63C		100					BDW64C	
BDW63D		120					BDW64D	
BD645	8	60	62.5	750	3	TO-220	BD646	5-3
BD647		80					BD648	
BD649		100					BD650	
BD651		120					BD652	
BD895	8	45	70	750	3	TO-200	BD896	5-11
BD897		60					BD898	
BD899		80					BD900	
BD901		100					BD902	
BD895A	8	45	70	750	4	TO-220	BD896A	5-15
BD897A		60					BD898A	
BD899A		80					BD900A	
BDW73	8	45	80	100	8	TO-220	BDW74	5-67
BDW73A		60					BDW74A	
BDW73B		80					BDW74B	
BDW73C		100					BDW74C	
BDW73D		120					BDW74D	
BDX53	8	45	60	750	3	TO-220	BDX54	5-103
BDX53A		60					BDX54A	
BDX53B		80					BDX54B	
BDX53C		100					BDX54C	

GENERAL PURPOSE NPN DARLINGTONS (continued)

Device Number	I_C Continuous (A)	V_{CEO} (V)	P_{tot} $T_C = 25°C$ (W)	h_{FE} Minimum	h_{FE} $@I_C$ (A)	Package	Complementary	Page
TIP100	8	60	80	200	8	TO-220	TIP105	5-111
TIP101		80					TIP106	
TIP102		100					TIP107	
TIP130	8	60	70	1000	4	TO-220	TIP135	5-135
TIP131		80					TIP136	
TIP132		100					TIP137	
BDX33	10	45	70	750	4	TO-220	BDX34	5-91
BDX33A		60					BDX34A	
BDX33B		80		750	3		BDX34B	
BDX33C		100					BDX34C	
BDX33D		120					BDX34D	
TIP140	10	60	125	500	10	SOT-93	TIP145	5-143
TIP141		80					TIP146	
TIP142		100					TIP147	
BDV65	12	60	125	1000	5	SOT-93	BDV64	5-39
BDV65A		80					BDV64A	
BDV65B		100					BDV64B	
BDV65C		120					BDV64C	
BDW93	12	45	80	100	10	TO-220	BDW94	5-83
BDW93A		60					BDW94A	
BDW93B		80					BDW94B	
BDW93C		100					BDW94C	
BDW83	15	45	150	100	15	SOT-93	BDW84	5-75
BDW83A		60					BDW84A	
BDW83B		80					BDW84B	
BDW83C		100					BDW84C	
BDW83D		120					BDW84D	

GENERAL PURPOSE PNP DARLINGTONS

Device Number	I_C Continuous (A)	V_{CEO} (V)	P_{tot} $T_C = 25°C$ (W)	h_{FE} Minimum	h_{FE} @I_C (A)	Package	Complementary	Page
TIPP115 TIPP116 TIPP117	2	60 80 100	0.8	500	2	TO-92	TIPP110 TIPP111 TIPP112	5-153
BDT60 BDT60A BDT60B BDT60C	4	60 80 100 120	50	750	1.5	TO-220	BDT61 BDT61A BDT61B BDT61C	5-27
BDW54 BDW54A BDW54B BDW54C BDW54D	4	45 60 80 100 120	40	100	4	TO-220	BDW53 BDW53A BDW53B BDW53C BDW43D	5-55
TIP115 TIP116 TIP117	4	60 80 100	50	500	2	TO-220	TIP110 TIP111 TIP112	5-123
TIP125 TIP126 TIP127	5	60 80 100	65	1000	3	TO-220	TIP120 TIP121 TIP122	5-131
BDW24 BDW24A BDW24B BDW24C	6	45 60 80 100	50	100	6	TO-220	BDW23 BDW23A BDW23B BDW23C	5-47
BDW64 BDW64A BDW64B BDW64C BDW64D	6	45 60 80 100 120	60	100	6	TO-220	BDW63 BDW63A BDW63B BDW63C BDW63D	5-63
BD646 BD648 BD650 BD652	8	60 80 100 120	62.5	750	3	TO-220	BD645 BD647 BD649 BD651	5-7
BD896 BD898 BD900 BD902	8	45 60 80 100	70	750	3	TO-220	BD895 BD897 BD899 BD901	5-19
BD896A BD898A BD900A	8	45 60 80	70	750	4	TO-220	BD895A BD897A BD899A	5-23
BDW74 BDW74A BDW74B BDW74C BDW74D	8	45 60 80 100 120	80	100	8	TO-220	BDW73 BDW73A BDW73B BDW73C BDW73D	5-71
BDX54 BDX54A BDX54B BDX54C	8	45 60 80 100	60	750	3	TO-220	BDX53 BDX53A BDX53B BDX53C	5-107

GENERAL PURPOSE PNP DARLINGTONS (continued)

Device Number	I_C Continuous (A)	V_{CEO} (V)	P_{tot} $T_C = 25°C$ (W)	h_{FE} Minimum	h_{FE} @I_C (A)	Package	Complementary	Page
TIP105 TIP106 TIP107	8	60 80 100	80	200	8	TO-220	TIP100 TIP101 TIP102	5-115
TIP135 TIP136 TIP137	8	60 80 100	70	1000	4	TO-220	TIP130 TIP131 TIP132	5-139
BDX34 BDX34A BDX34B BDX34C BDX34D	10	45 60 80 100 120	70	750 750	4 3	TO-220	BDX33 BDX33A BDX33B BDX33C BDX33D	5-97
TIP145 TIP146 TIP147	10	60 80 100	125	500	10	SOT-93	TIP140 TIP141 TIP142	5-147
BDV64 BDV64A BDV64B BDV64C	12	60 80 100 120	125	1000	5	SOT-93	BDV65 BDV65A BDV65B BDV65C	5-35
BDW94 BDW94A BDW94B BDW94C	12	45 60 80 100	80	100	10	TO-220	BDW93 BDW93A BDW93B BDW93C	5-87
BDW84 BDW84A BDW84B BDW84C BDW84D	15	45 60 80 100 120	150	100	15	SOT-93	BDW83 BDW83A BDW83B BDW83C BDW83D	5-79

NPN SWITCHING TRANSISTORS

Device Number	I_C Continuous	V_{CEO}	V_{CBO}	$V_{CE(sat)}$		Resistive-load switching t_f		Inductive-load switching t_{fi}		Package	Page
				Max	@I_C	Max	@I_C	Max	@I_C		
	(A)	(V)	(V)	(V)	(A)	(ns)	(A)	(ns)	(A)		
TIP47 TIP48 TIP49 TIP50	1	250 300 350 400	350 400 450 500	1	1					TO-220	6-43
BUX84	2	400	800	1	1	200 (typical)	1			TO-220	6-31
BUX85	2	450	1000	1	1	200 (typical)	1			TO-220	6-37
TIPL770	2.5	400	850	2.5	2.5			200	2.5	TO-220	6-97
TIPL760 TIPL760A	4	400 450	850 1000	2.5	4			250	4	TO-220	6-61
TIPL760B TIPL760C	4	500 550	1100 1200	2.5	3			250	3	TO-220	6-67
TIPL761 TIPL761A	4	400 450	850 1000	2.5	4			250	4	SOT-93	6-73
TIPL761B TIPL761C	4	500 550	1100 1200	2.5	3			250	3	SOT-93	6-79
TIPL791 TIPL791A	4	400 450	850 1000	2.5	4			100	4	TO-220	6-109
BUT11	5	400	850	1.5	3			150	3	TO-220	6-15
BU426 BU426A	6	375 400	800 900	3	4	150 (typical)	2.5			SOT-93	6-9
TIPL762 TIPL762A	6	400 450	850 1000	2.5	6			150	6	SOT-93	6-85
BU406 BU407	7	200 150	400 330	1	5					TO-220	6-3
TIP150 TIP151 TIP152	7	300 350 400	300 350 400	2	5					TO-220	6-49
BUV47 BUV47A	9	400 450	850 1000	3	8	800	5	400	5	SOT-93	6-19
TIP160 TIP161 TIP162	10	320 350 380	320 350 380	2.9	10	2600	6.5			SOT-93	6-55
TIPL765 TIPL765A	10	400 450	850 1000	2.5	10			200	10	SOT-93	6-91
TIPL790 TIPL790A	10	120 150	150 200	2	10			400	10	TO-220	6-103
BUV48 BUV48A	15	400 450	850 1000	5	15	800	10	400	10	SOT-93	6-25

PART 1 - 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.

PART 2 - POWER TRANSISTOR STANDARDS

Following are sources of standard material relating to Power Transistors:

EIA and JEDEC Standards
Electronics Industries Association
2500 Wilson Boulevard
Arlington, Virginia, 22201 - 3834
Telephone: 703 907-7500

EIA Standard RS-313-B: Thermal Resistance Measurements of Conduction Cooled Power Transistors.

JEDEC Standard 77: Terms, Definitions, and Letter Symbols 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 Discreteness of Registration.

JEDEC Publication 104: Reference Guide to Letter Symbols for Semiconductor Devices.

JC-25 Power Transistor Registration Formats RDF-1 to RDF-6

International Electrotechnical Commission Standards
American National Standards Institute, Inc.
1430 Broadway
New York, N.Y. 10018
Telephone: 212 868-1220

IEC Publication 747: Semiconductor Devices. Discrete Devices.

IEC Publication 749: Semiconductor Devices. Mechanical and Climatic Test Methods.

IEC Publication 191: Mechanical Standardization of Semiconductor Devices

PART 3 - POWER TRANSISTOR TERMS AND DEFINITIONS

INTRODUCTION

Most of the information concerning letter symbols, abbreviations, terms, and definitions commonly used with Power transistors was obtained from JEDEC Standard 77 (JESD77-A, February 1992). This document and the JC-25 registration formats have overriding authority where any conflict occurs.

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, whose initiation 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-A).

Breakdown Region

A region of the volt-ampere characteristic beyond the initiation of breakdown for an increasing magnitude of reverse current. (Ref. RS-282-A).

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 Transistor

A compound semiconductor device consisting of two transistors, in which the collectors are connected together, and the emitter of the first transistor is connected to the base of the second transistor.

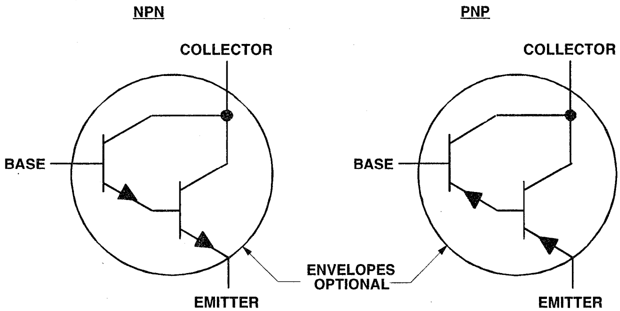
NOTE 1: This connection of two transistors can be regarded as a compound transistor with three terminals.

NOTE 2: The circuit may include a biasing network.

NOTE 3: The presence of a terminal to provide direct access to the base of the second transistor is optional.

* References to base, collector, and emitter symbolism (B, b, C, c, E, and e) refer to the device terminals connected to those regions.

Graphic symbols. (Ref. IEEE Std. 315):



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 (in a p-n junction)

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 (in a p-n junction)

The direction of current flow that results when the n-type semiconductor region is at a positive potential relative to the p-type region.

Saturation

A base-current and a collector-current condition resulting in a forward-biased collector junction.

* References to base, collector, and emitter symbolism (B, b, C, c, E, and e) refer to the device terminal connected to those regions.

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 that 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 747-1).

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 that causes the change of temperature difference. (Ref. EIA-282-A).

Transistor

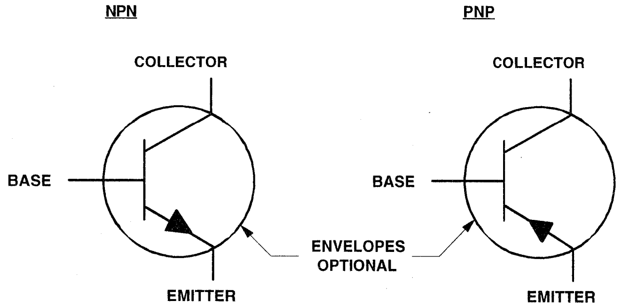
A semiconductor device capable of providing power amplification and having three or more electrodes. (Ref. IEC 747-1).

Transistor, Junction, Multijunctional Type

A transistor having a base and two or more junctions.

Graphic symbols for triode transistors. (Ref. IEEE Std. 315):

NOTE: In the graphic symbols, the envelope is optional if no element is connected to the envelope.



PART 4 - SYMBOLS, TERMS AND DEFINITIONS

SYMBOL	TERM	DEFINITION
C_{obo}	Common-base open-circuit output capacitance	The capacitance measured across the output terminals (collector and base) with the input open-circuited to ac.
f_{hfe}	Common-emitter small-signal short-circuit forward current transfer ratio cut off frequency	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).
f_T	Common-emitter transition frequency or frequency at which small-signal forward current transfer ratio extrapolates to unity	The product of the modulus (magnitude) of the common-emitter small-signal short-circuit forward current transfer ratio, hfe, and the frequency of measurement when this frequency is sufficiently high so that the modulus (magnitude) of hfe is decreasing with a slope of approximately 6 dB per octave.
h_{FE}	Common-emitter static forward current transfer ratio	The ratio of the dc output current to the dc input current (Ref. MIL-S-19500).
h_{fe}	Common-emitter small-signal short-circuit forward current transfer ratio	The ratio of the ac rms output current to the small-signal ac rms input current with the output ac short-circuited to the common terminal. (Ref. MIL-S-19500).
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.
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.

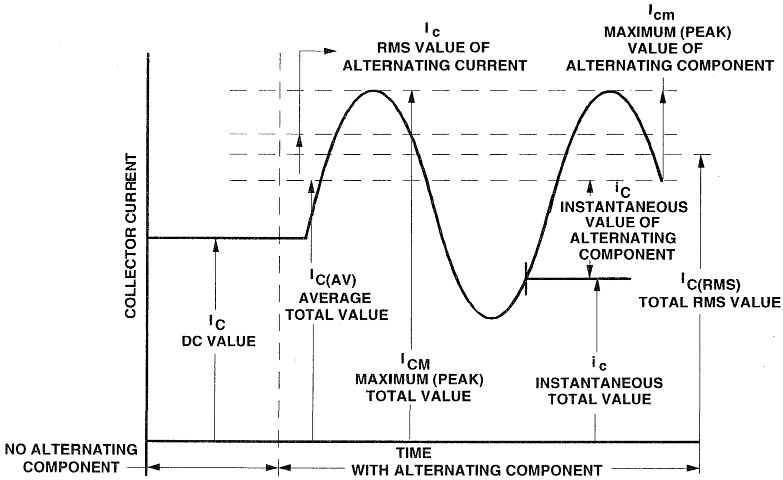


DIAGRAM ILLUSTRATING FOREGOING CURRENTS (REF. IEEE 255)

I_{CBO}	collector cut-off current, emitter open	The 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.
	collector cut-off current,	The 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):
I_{CEO}	base open	O = open-circuited.
I_{CER}	resistance between base and emitter,	R = returned to the emitter terminal through a specified resistance.
I_{CES}	base short circuited to emitter,	S = short circuited to the emitter terminal.
I_{CEV}	voltage between base and emitter,	V = returned to the emitter terminal through a specified voltage.
I_{CEX}	circuit between base and emitter,	X = returned to the emitter terminal through a specified circuit.
I_{EBO}	emitter cut-off current, collector open	The 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).

* 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.

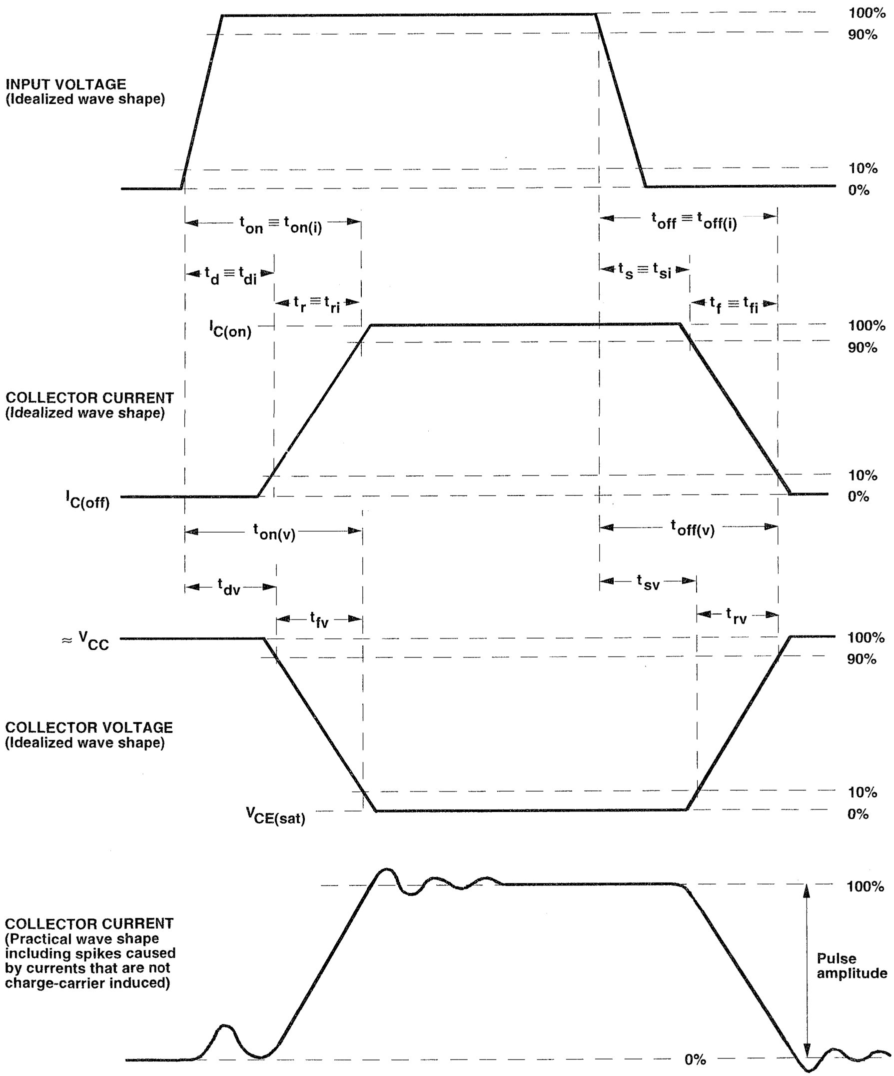
SYMBOL	TERM	DEFINITION
P_T	total dc power input to all terminals	The sum of the products of the dc input currents and voltages, i.e. $V_{BE} \bullet I_B + V_{CE} \bullet I_C$ or $V_{BE} \bullet I_E + V_{CB} \bullet I_C$
R_θ, R_{th} (formerly θ)	thermal resistance	Refer to thermal resistance (steady state)
$R_{\theta CA}$, R_{thCA}	case-to-ambient thermal resistance	The thermal resistance (steady-state) from the device case to the ambient.
$R_{\theta JA}$, R_{thJA} (formerly θJ-A)	junction-to-ambient thermal resistance	The thermal resistance (steady-state) from the semiconductor junction (s) to the ambient.
$R_{\theta JC}$, R_{thJC} (formerly θJ-C)	junction-to-case thermal resistance	The thermal resistance (steady-state) from the semiconductor junction(s) to the case.
$R_{\theta JM}$, R_{thJM}	junction-to-mounting surface thermal resistance	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, T_{VJ}	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 inter- changeably 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 note following t_{xo}).

* 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.

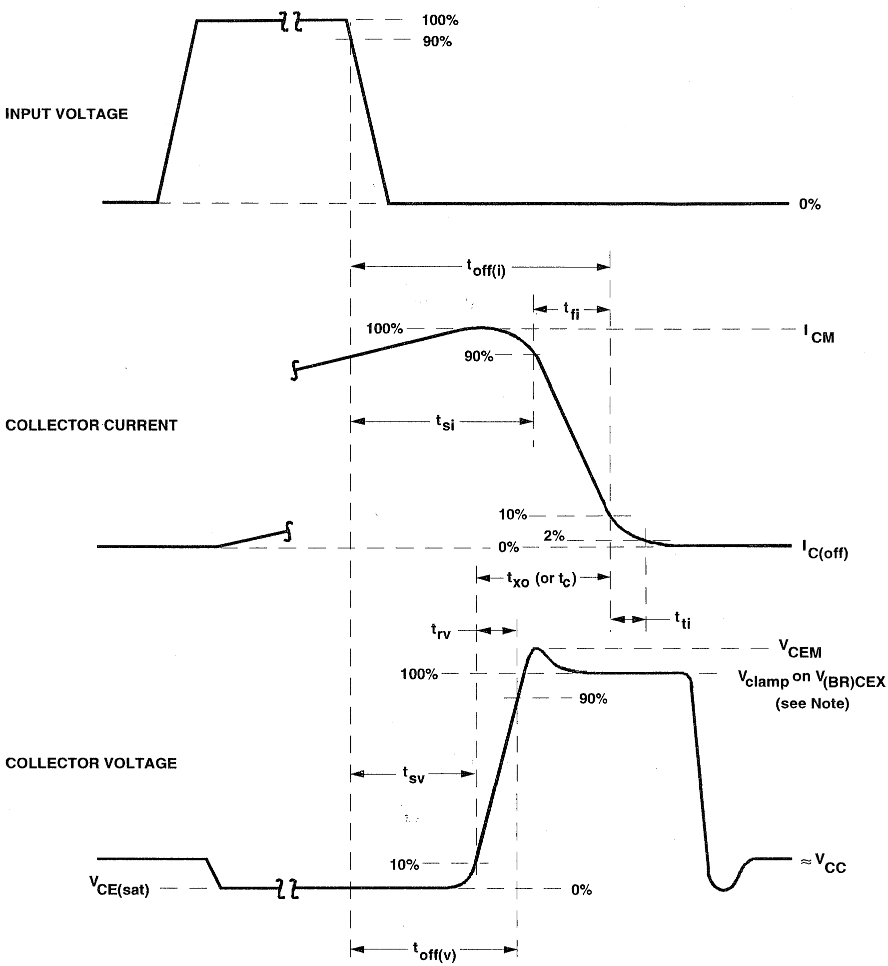
SYMBOL	TERM	DEFINITION
t_{di}	current delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector current waveform rises to 10% of its on-state amplitude, ignoring spikes that 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 note following t_{xo}).
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.
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 note following t_{xo}).
$t_{off(i)}$	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 note following t_{xo}).
$t_{on(i)}$	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 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 note following t_{xo}).
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.

SYMBOL	TERM	DEFINITION
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 non-conducting 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 non-conducting 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.
t_{xo}	turn-off crossover time	For definition, see t_c (t_{xo} is a reserve symbol to be used if use of t_c will cause confusion).
t_p	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 t_p and term pulse duration should be used.

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.



WAVEFORMS FOR RESISTIVE-LOAD SWITCHING



NOTE: V_{clamp} (in a clamped inductive-load 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})	collector-to-base breakdown voltage, 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.
	collector-to-emitter breakdown voltage (under conditions specified below):	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:
$V_{(BR)CEO}$ (formerly BV_{CEO})	(base open,	O = open circuited.
$V_{(BR)CER}$, (formerly BV_{CER})	resistance between base and emitter,	R = returned to the emitter terminal through a specified resistance.
$V_{(BR)CES}$, (formerly BV_{CES})	base short circuited to emitter,	S = short circuited to the emitter terminal.
$V_{(BR)CEV}$, (formerly BV_{CEV})	voltage between base and emitter,	V = returned to the emitter terminal through a specified voltage.
$V_{(BR)CEX}$, (formerly BV_{CEX})	circuit between base and emitter)	X = returned to the emitter terminal through a specified circuit.
$V_{(BR)EBO}$, (formerly BV_{EBO})	emitter-to-base breakdown voltage, 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.
V_{BB}, V_{CC}, V_{EE}	supply voltage, dc, base, collector, emitter	The dc supply voltage applied to a circuit connected to the base, collector, or emitter respectively.
V_{BC},	base-to-collector voltage, dc or average	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 voltage, dc	
V_{CB},	collector-to-base voltage, dc	
V_{CE},	collector-to-emitter voltage, dc	
V_{EB},	emitter-to-base voltage, dc	
V_{EC},	emitter-to-collector voltage, dc)	
$V_{BE(sat)}$	base-to-emitter saturation voltage	The 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, emitter open	The voltage between the collector terminal and the base terminal when the emitter terminal is open circuited.

* For these parameters, the collector terminal is considered to be biased in the reverse direction when it is made positive for NPN transistors, or negative for PNP transistors, with respect to the emitter terminal.

SYMBOL	TERM	DEFINITION
$V_{CE(sat)}$	saturation voltage, dc, collector-to-emitter	The voltage between the collector and the emitter terminals under conditions of base-emitter voltage beyond which the collector current remains essentially constant as the base current or voltage is increased
	collector-to-emitter voltage	The voltage between the collector terminal and the emitter terminal when the base terminal is (as indicated by the last subscript letter) as follows:
V_{CEO}	base open	O = open circuited.
V_{CER},	resistance between base and emitter	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.
	collector-to-emitter sustaining voltage	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:
$V_{CEO(sus)}$	base open	O = open-circuited.
$V_{CER(sus)}$	resistance between base and emitter	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_{EBO}	emitter-to-base voltage, collector open	The voltage between the emitter terminal and the base terminal with the collector terminal open circuited.

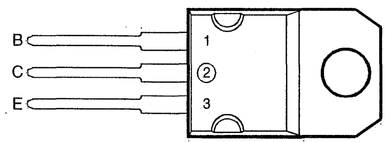
SYMBOL	TERM	DEFINITION
V_{EC}	forward (diode) voltage	The dc voltage across a semiconductor diode associated with forward current. NOTE: In this book this is specified as a parameter of an integrated diode across the collector and emitter of certain power transistors
Z_{θ},Z_{th} (formerly $\theta(t)$)	transient thermal impedance	Refer to transient thermal impedance.
$Z_{\theta JA}$,Z_{thJA} (formerly $\theta J\text{-}A(t)$)	junction-to-ambient transient thermal impedance	The transient thermal impedance from the semiconductor junction(s) to the ambient.
$Z_{\theta JC}$,Z_{thJC} (formerly $\theta JC(t)$)	junction-to-case transient thermal impedance	The transient thermal impedance from the semiconductor junction(s) to a stated location on the case.

BD239, BD239A, BD239B, BD239C
NPN SILICON POWER TRANSISTORS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD240 Series**
- **30 W at 25°C Case Temperature**
- **2 A Continuous Collector Current**
- **4 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD239	V_{CER}	55	V
	BD239A		70	
	BD239B		90	
	BD239C		115	
Collector-emitter voltage (I_C = 30 mA)	BD239	V_{CEO}	45	V
	BD239A		60	
	BD239B		80	
	BD239C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	2	A
Peak collector current (see Note 1)		I_{CM}	4	A
Continuous base current		I_B	0.6	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	30	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	I_B = 0	BD239 BD239A BD239B BD239C	45 60 80 100			V
I_{CES}	Collector-emitter 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	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 0.2 A I_C = 1 A	(see Notes 5 and 6)	40 15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.2 A	I_C = 1 A	(see Notes 5 and 6)			0.7	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 1 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		0.8		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

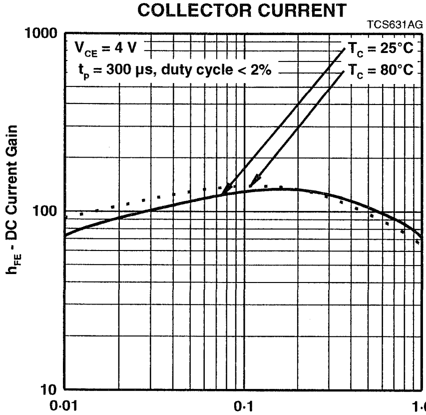


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

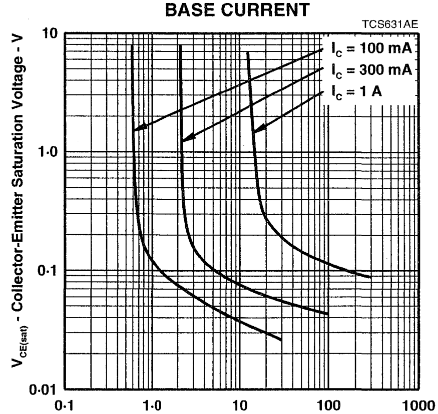


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

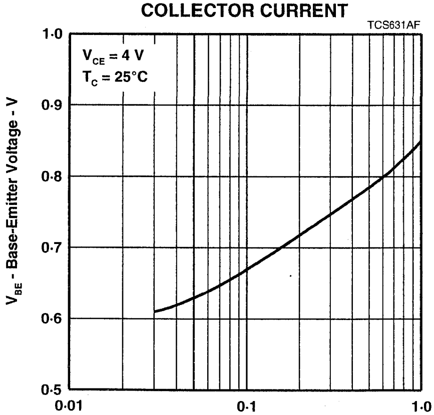


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

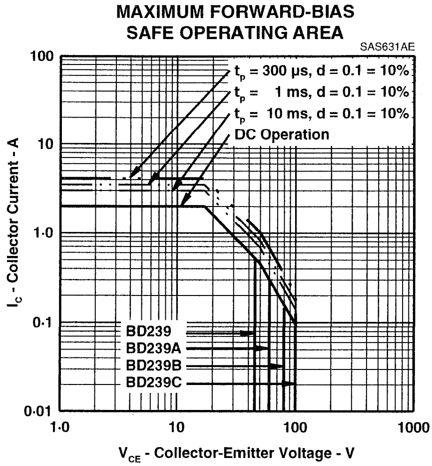


Figure 4.

THERMAL INFORMATION

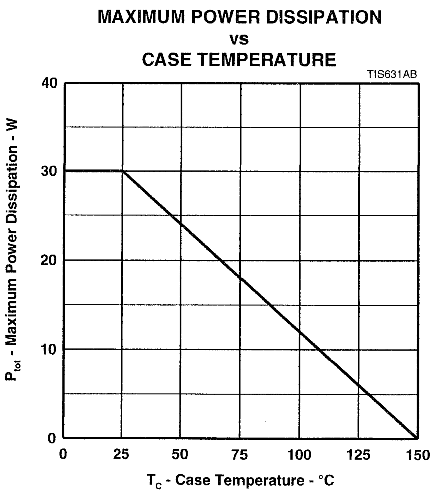
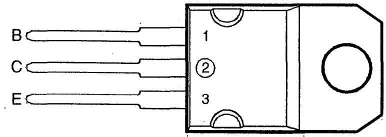


Figure 5.

TEXAS INSTRUMENTS

- **30 W at 25°C Case Temperature**
- **2 A Continuous Collector Current**
- **4 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD239D	V_{CER}	160	V
	BD239E		180	
	BD239F		200	
Collector-emitter voltage (I_B = 0)	BD239D	V_{CEO}	120	V
	BD239E		140	
	BD239F		160	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	2	A
Peak collector current (see Note 1)		I_{CM}	4	A
Continuous base current		I_B	0.6	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	30	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	BD239D BD239E BD239F	120 140 160			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 160 V V_{CE} = 180 V V_{CE} = 200 V	$V_{BE} = 0$ $V_{BE} = 0$ $V_{BE} = 0$	BD239D BD239E 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	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 0.2 A I_C = 1 A	(see Notes 5 and 6)	40 15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.2 A	I_C = 1 A	(see Notes 5 and 6)			0.7	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 1 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		0.8		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

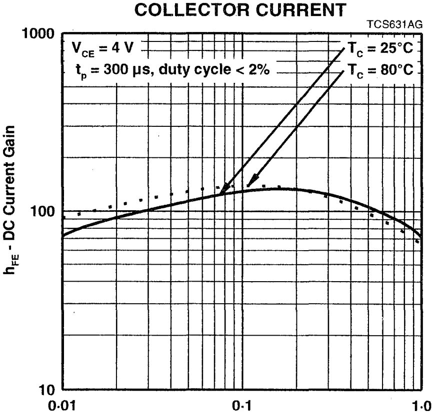


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

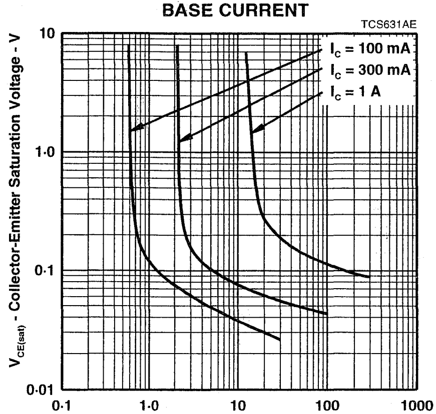


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

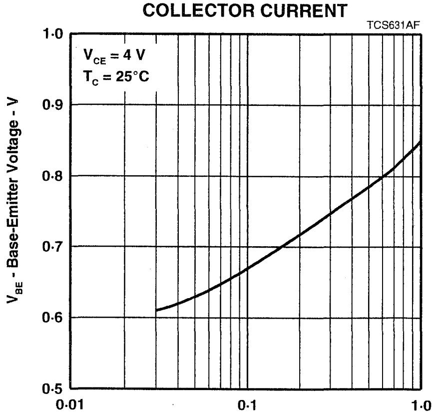


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

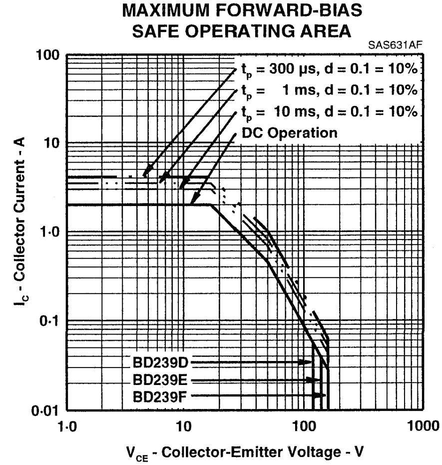


Figure 4.

THERMAL INFORMATION

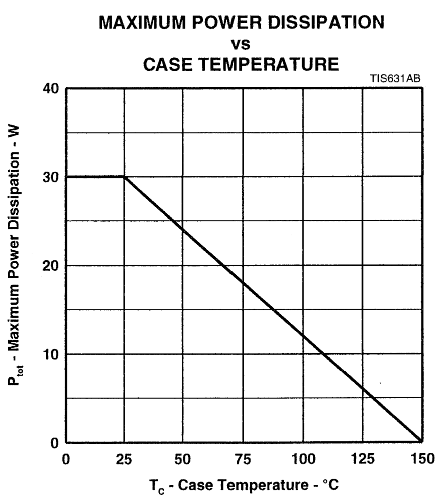
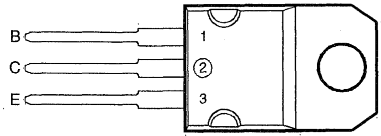


Figure 5.

TEXAS INSTRUMENTS

- Designed for Complementary Use with the BD241 Series
- 30 W at 25°C Case Temperature
- 2 A Continuous Collector Current
- 4 A Peak Collector Current
- Customer-Specified Selections Available

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD240	V_{CER}	-55	V
	BD240A		-70	
	BD240B		-90	
	BD240C		-115	
Collector-emitter voltage (I_C = -30 mA)	BD240	V_{CEO}	-45	V
	BD240A		-60	
	BD240B		-80	
	BD240C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-2	A
Peak collector current (see Note 1)		I_{CM}	-4	A
Continuous base current		I_B	-0.6	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	30	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	BD240 BD240A BD240B BD240C	-45 -60 -80 -100			V
I_{CES}	Collector-emitter 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	BD240 BD240A BD240B BD240C			-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	BD240/240A 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 V_{CE} = -4 V	I_C = -0.2 A I_C = -1 A	(see Notes 5 and 6)	40 15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.2 A	I_C = -1 A	(see Notes 5 and 6)			-0.7	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -1 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		0.4		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

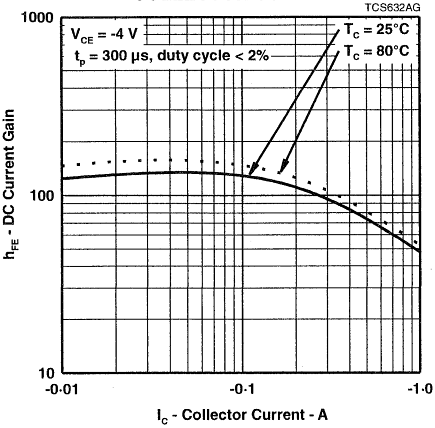


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

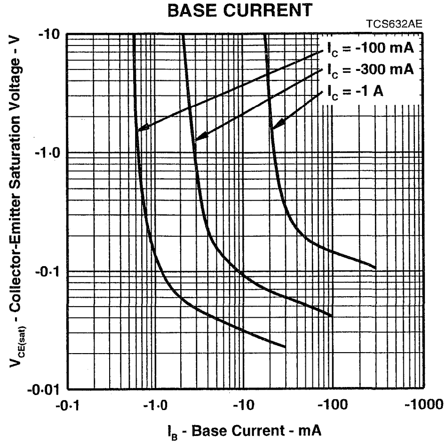


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

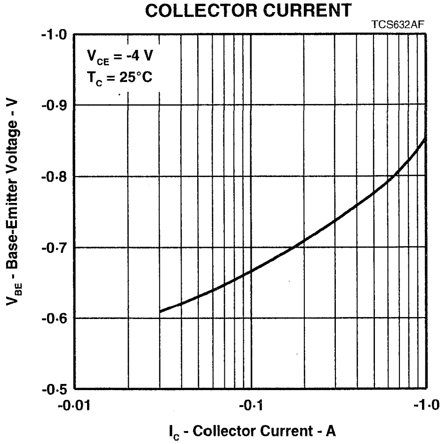


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

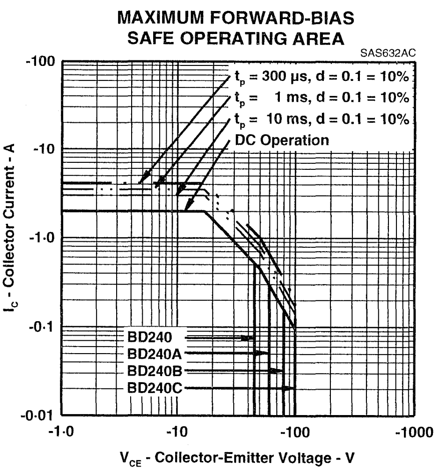


Figure 4.

THERMAL INFORMATION

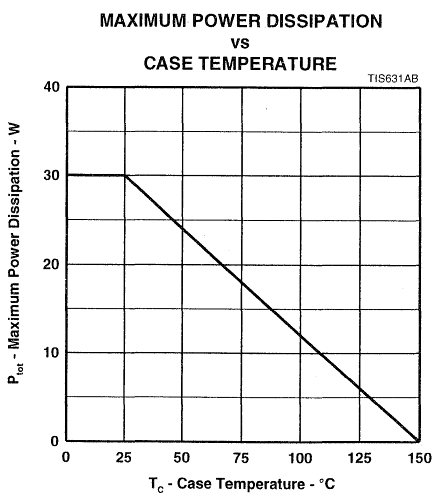


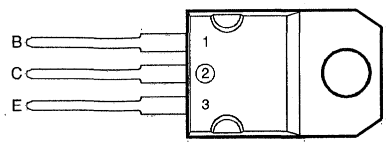
Figure 5.

BD241, BD241A, BD241B, BD241C
NPN SILICON POWER TRANSISTORS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD242 Series**
- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD241	V_{CER}	55	V
	BD241A		70	
	BD241B		90	
	BD241C		115	
Collector-emitter voltage (I_C = 30 mA)	BD241	V_{CEO}	45	V
	BD241A		60	
	BD241B		80	
	BD241C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	3	A
Peak collector current (see Note 1)		I_{CM}	5	A
Continuous base current		I_B	1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	40	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	BD241	45			V
				BD241A	60			
				BD241B	80			
				BD241C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 55 V	$V_{BE} = 0$	BD241			0.2	mA
		V_{CE} = 70 V	$V_{BE} = 0$	BD241A			0.2	
		V_{CE} = 90 V	$V_{BE} = 0$	BD241B			0.2	
		V_{CE} = 115 V	$V_{BE} = 0$	BD241C			0.2	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	BD241/241A			0.3	mA
		V_{CE} = 60 V	$I_B = 0$	BD241B/241C			0.3	
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 A	(see Notes 5 and 6)	25			
		V_{CE} = 4 V	I_C = 3 A		10			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.6 A	I_C = 3 A	(see Notes 5 and 6)			1.2	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 3 A	(see Notes 5 and 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			
$\lvert h_{fe}\rvert$	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_p = 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			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

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	$V_{BE(off)}$ = -3.7 V	R_L = 20 Ω	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

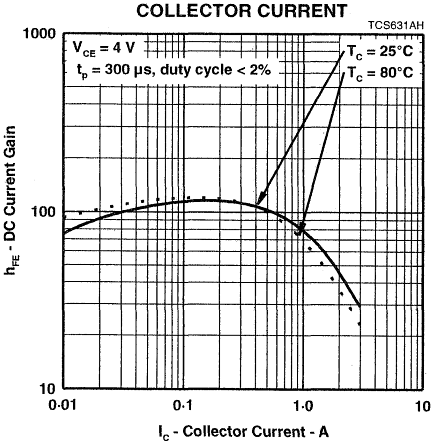


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

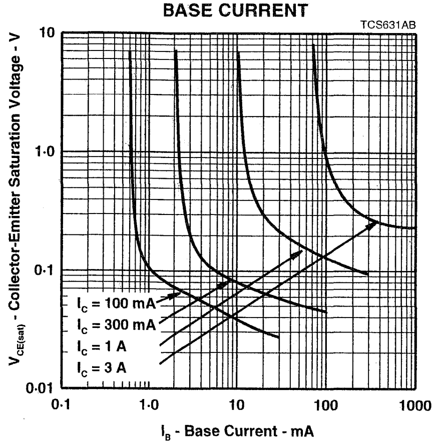


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

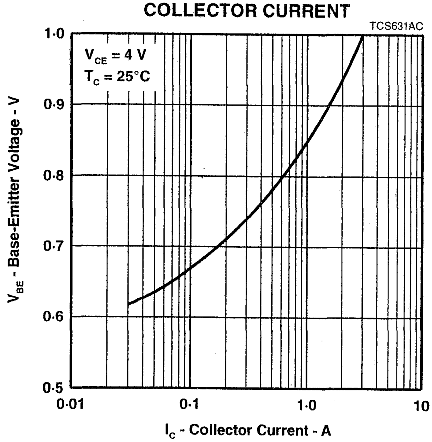


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

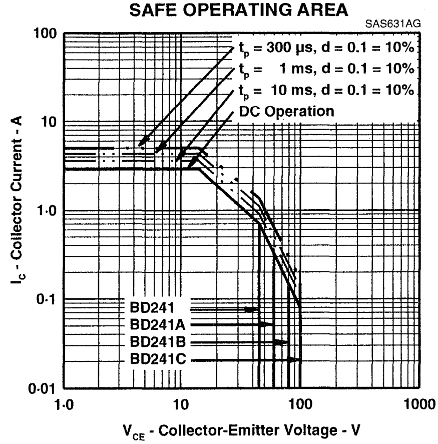


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

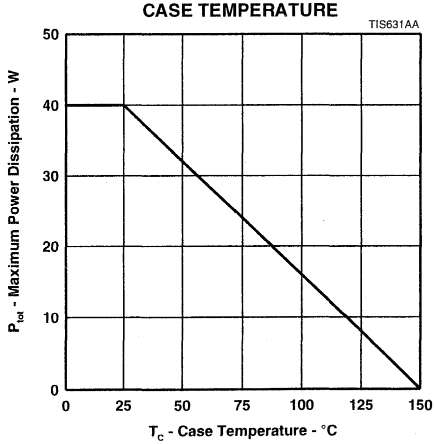
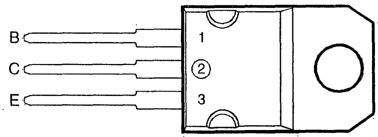


Figure 5.

- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD241D	V_{CER}	160	V
	BD241E		180	
	BD241F		200	
Collector-emitter voltage (I_B = 0)	BD241D	V_{CEO}	120	V
	BD241E		140	
	BD241F		160	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	3	A
Peak collector current (see Note 1)		I_{CM}	5	A
Continuous base current		I_B	1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	40	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	BD241D BD241E BD241F	120 140 160			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 160 V V_{CE} = 180 V V_{CE} = 200 V	$V_{BE} = 0$ $V_{BE} = 0$ $V_{BE} = 0$	BD241D BD241E 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	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 1 A I_C = 3 A	(see Notes 5 and 6)	25 5			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 750 mA	I_C = 3 A	(see Notes 5 and 6)			2.5	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 3 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	$V_{BE(off)}$ = -3.7 V	R_L = 20 Ω	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

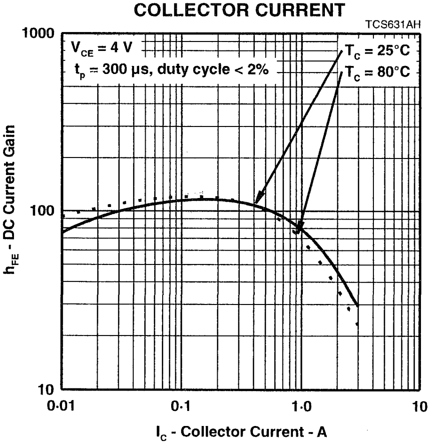


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

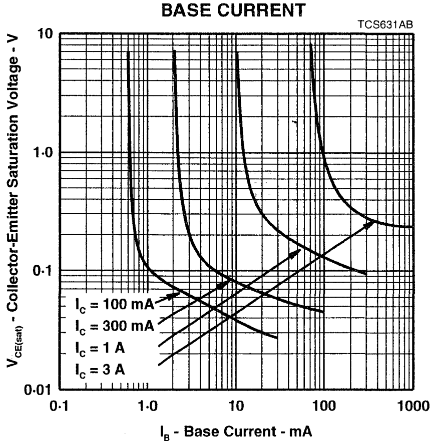


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

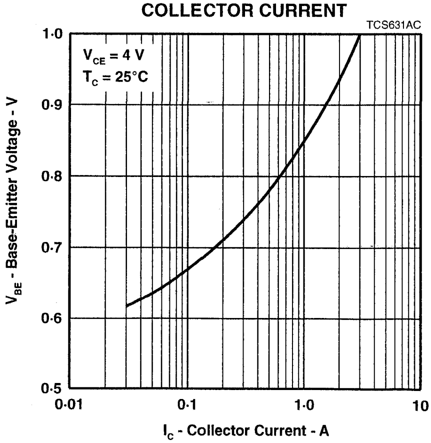


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

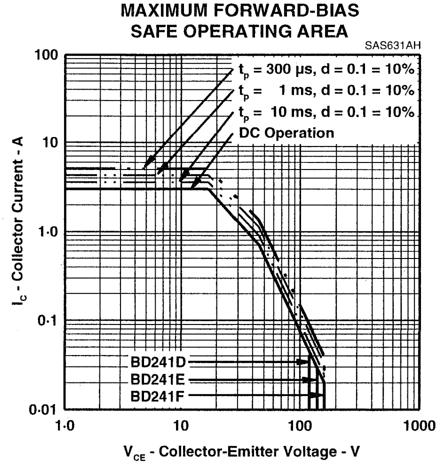


Figure 4.

THERMAL INFORMATION

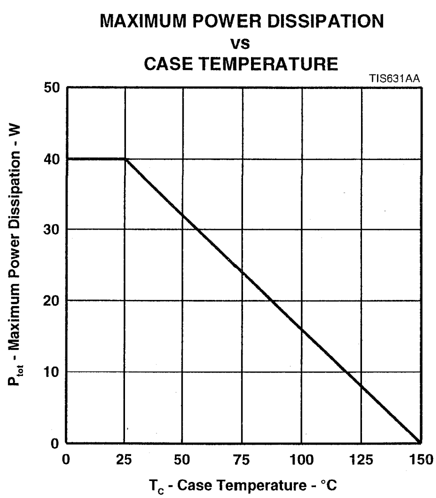
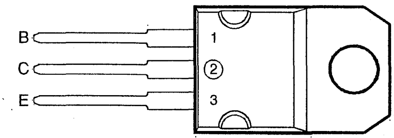


Figure 5.

- **Designed for Complementary Use with the BD241 Series**
- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD242	V_{CER}	-55	V
	BD242A		-70	
	BD242B		-90	
	BD242C		-115	
Collector-emitter voltage (I_C = -30 mA)	BD242	V_{CEO}	-45	V
	BD242A		-60	
	BD242B		-80	
	BD242C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-3	A
Peak collector current (see Note 1)		I_{CM}	-5	A
Continuous base current		I_B	-1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	40	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	$I_B = 0$	BD242	-45			V
				BD242A	-60			
				BD242B	-80			
				BD242C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -55 V	$V_{BE} = 0$	BD242			-0.2	mA
		V_{CE} = -70 V	$V_{BE} = 0$	BD242A			-0.2	
		V_{CE} = -90 V	$V_{BE} = 0$	BD242B			-0.2	
		V_{CE} = -115 V	$V_{BE} = 0$	BD242C			-0.2	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	$I_B = 0$	BD242/242A			-0.3	mA
		V_{CE} = -60 V	$I_B = 0$	BD242B/242C			-0.3	
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 A	(see Notes 5 and 6)	25			
		V_{CE} = -4 V	I_C = -3 A		10			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.6 A	I_C = -3 A	(see Notes 5 and 6)			-1.2	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -3 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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		0.2		µs
t_{off}	Turn-off time	$V_{BE(off)}$ = 3.7 V	R_L = 20 Ω	t_p = 20 µs, dc ≤ 2%		0.3		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

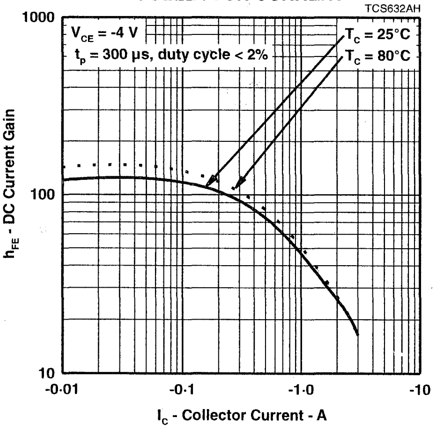


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

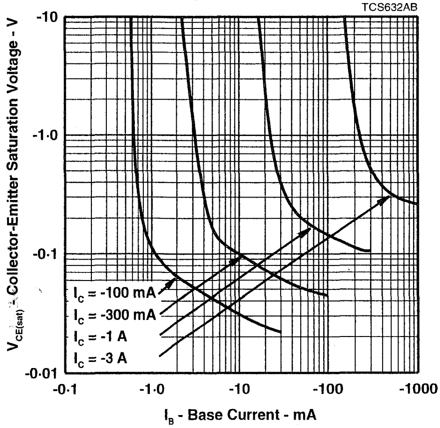


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

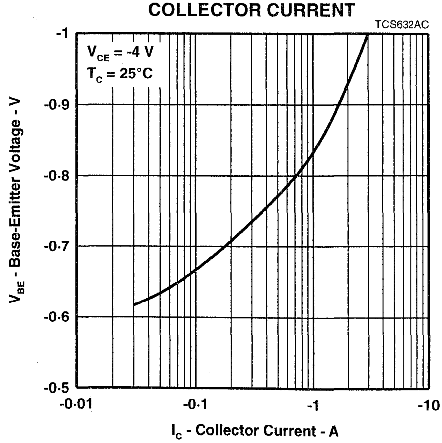


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

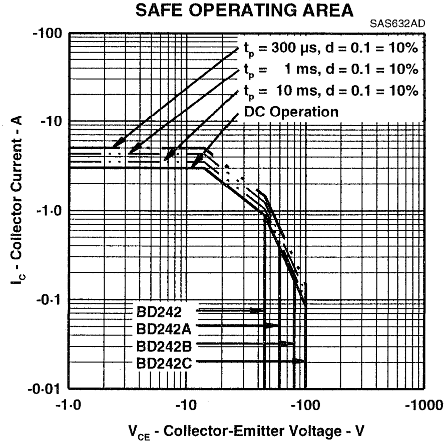


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

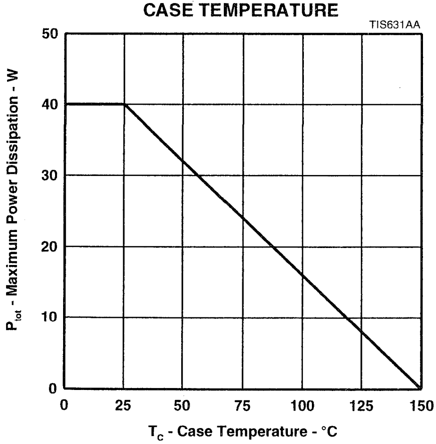


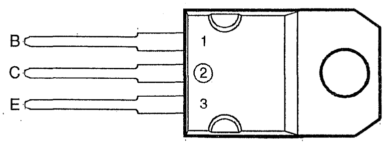
Figure 5.

BD243, BD243A, BD243B, BD243C
NPN SILICON POWER TRANSISTORS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD244 Series**
- **65 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD243	V_{CER}	55	V
	BD243A		70	
	BD243B		90	
	BD243C		115	
Collector-emitter voltage (I_C = 30 mA)	BD243	V_{CEO}	45	V
	BD243A		60	
	BD243B		80	
	BD243C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	6	A
Peak collector current (see Note 1)		I_{CM}	10	A
Continuous base current		I_B	3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	65	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	62.5	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	BD243	45			V
				BD243A	60			
				BD243B	80			
				BD243C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 55 V	$V_{BE} = 0$	BD243			0.4	mA
		V_{CE} = 70 V	$V_{BE} = 0$	BD243A			0.4	
		V_{CE} = 90 V	$V_{BE} = 0$	BD243B			0.4	
		V_{CE} = 115 V	$V_{BE} = 0$	BD243C			0.4	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	BD243/243A			0.7	mA
		V_{CE} = 60 V	$I_B = 0$	BD243B/243C			0.7	
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 = 0.3 A	(see Notes 5 and 6)	30			
		V_{CE} = 4 V	I_C = 3 A		15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 1 A	I_C = 6 A	(see Notes 5 and 6)			1.5	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 6 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.92	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	$V_{BE(off)}$ = -3.7 V	R_L = 20 Ω	t_p = 20 µs, dc ≤ 2%		1		µs

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

JUNE 1973 - REVISED MAY 1995

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

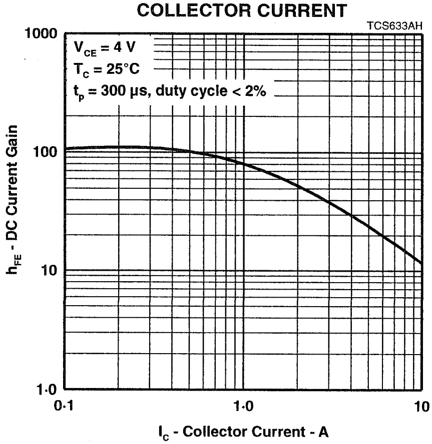


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

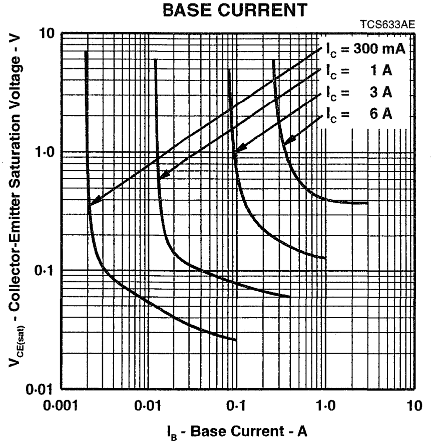


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

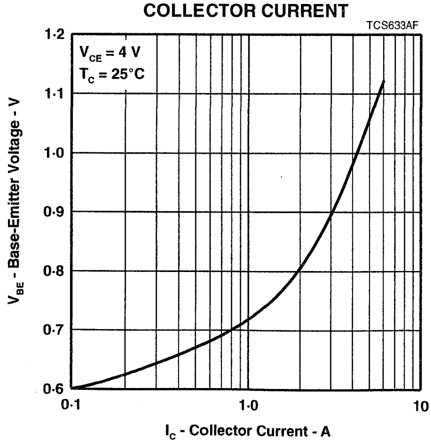


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

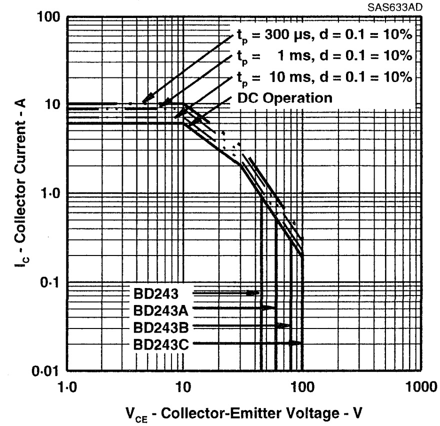


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

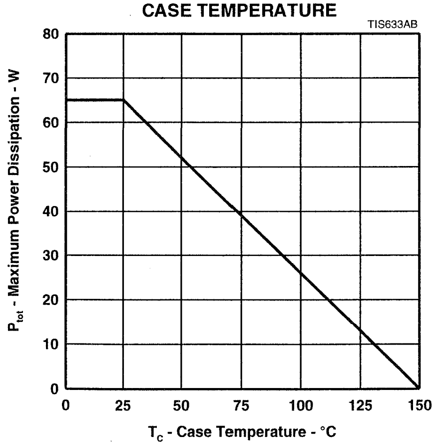
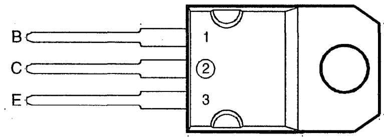


Figure 5.

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD243 Series**
- **65 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD244	V_{CER}	-55	V
	BD244A		-70	
	BD244B		-90	
	BD244C		-115	
Collector-emitter voltage (I_C = -30 mA)	BD244	V_{CEO}	-45	V
	BD244A		-60	
	BD244B		-80	
	BD244C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-6	A
Peak collector current (see Note 1)		I_{CM}	-10	A
Continuous base current		I_B	-3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	65	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	62.5	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES:
1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	BD244	-45			V
				BD244A	-60			
				BD244B	-80			
				BD244C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -55 V	V_{BE} = 0	BD244			-0.4	mA
		V_{CE} = -70 V	V_{BE} = 0	BD244A			-0.4	
		V_{CE} = -90 V	V_{BE} = 0	BD244B			-0.4	
		V_{CE} = -115 V	V_{BE} = 0	BD244C			-0.4	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0	BD244/244A			-0.7	mA
		V_{CE} = -60 V	I_B = 0	BD244B/244C			-0.7	
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 = -0.3 A	(see Notes 5 and 6)	30			
		V_{CE} = -4 V	I_C = -3 A		15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -1 A	I_C = -6 A	(see Notes 5 and 6)			-1.5	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -6 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.92	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	$V_{BE(off)}$ = 3.7 V	R_L = 20 Ω	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

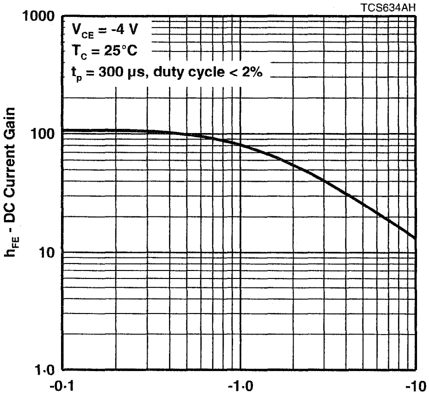


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

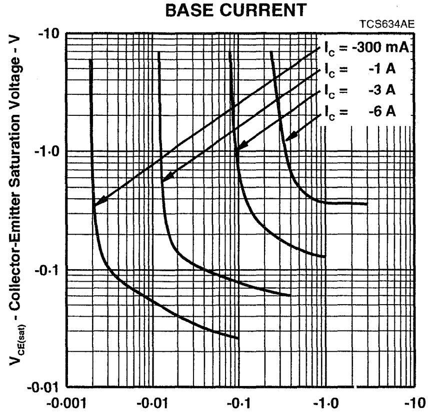


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

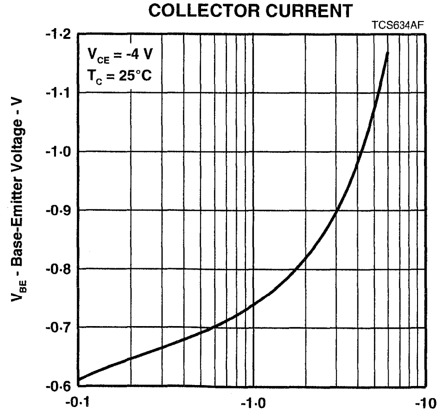


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

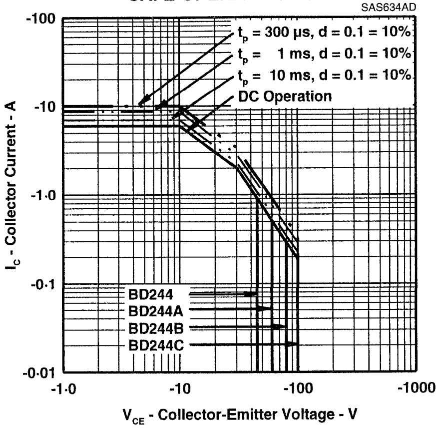


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

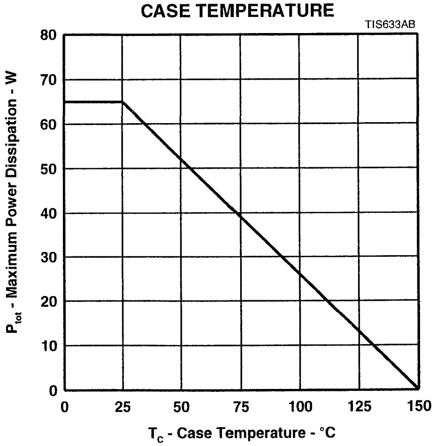
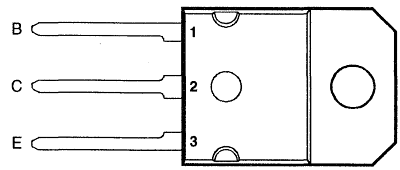


Figure 5.

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD246 Series**
- **80 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Customer-Specified Selections Available**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD245	V_{CER}	55	V
	BD245A		70	
	BD245B		90	
	BD245C		115	
Collector-emitter voltage (I_C = 30 mA)	BD245	V_{CEO}	45	V
	BD245A		60	
	BD245B		80	
	BD245C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	10	A
Peak collector current (see Note 1)		I_{CM}	15	A
Continuous base current		I_B	3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	62.5	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \le 0.3$ 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 24 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	BD245	45			V
				BD245A	60			
				BD245B	80			
				BD245C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 55 V	$V_{BE} = 0$	BD245			0.4	mA
		V_{CE} = 70 V	$V_{BE} = 0$	BD245A			0.4	
		V_{CE} = 90 V	$V_{BE} = 0$	BD245B			0.4	
		V_{CE} = 115 V	$V_{BE} = 0$	BD245C			0.4	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	BD245/245A			0.7	mA
		V_{CE} = 60 V	$I_B = 0$	BD245B/245C			0.7	
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 A	(see Notes 5 and 6)	40			
		V_{CE} = 4 V	I_C = 3 A		20			
		V_{CE} = 4 V	I_C = 10 A		4			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.3 A	I_C = 3 A	(see Notes 5 and 6)			1	V
		I_B = 2.5 A	I_C = 10 A				4	
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 3 A	(see Notes 5 and 6)			1.6	V
		V_{CE} = 4 V	I_C = 10 A				3	
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 0.5 A	f = 1 kHz	20			
$\lvert h_{fe} \rvert$	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_p = 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			42	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	$V_{BE(off)}$ = -3.7 V	R_L = 20 Ω	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

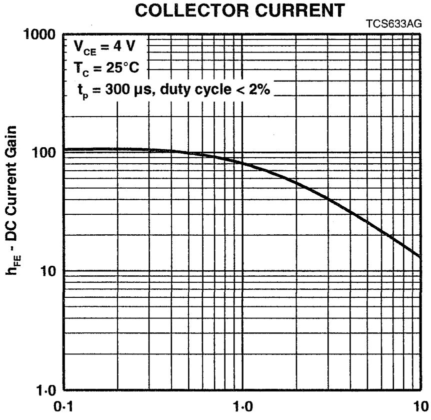


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

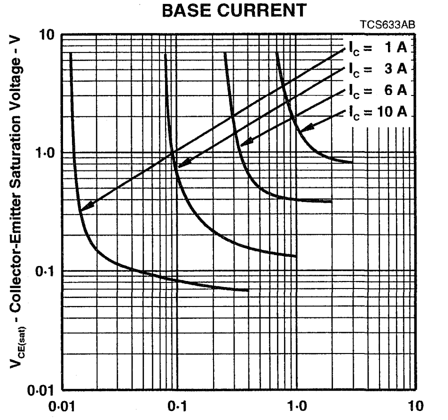


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

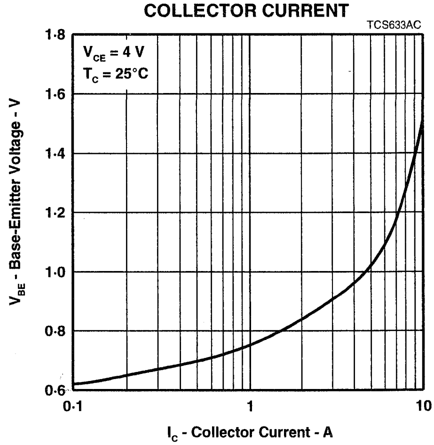


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

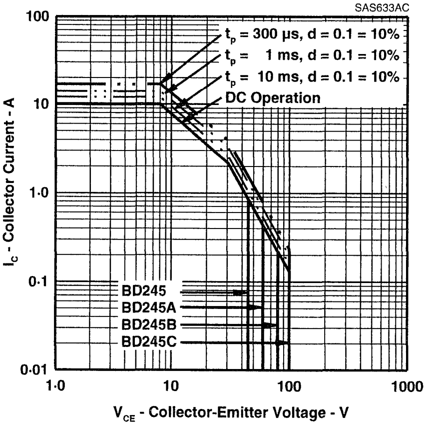


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

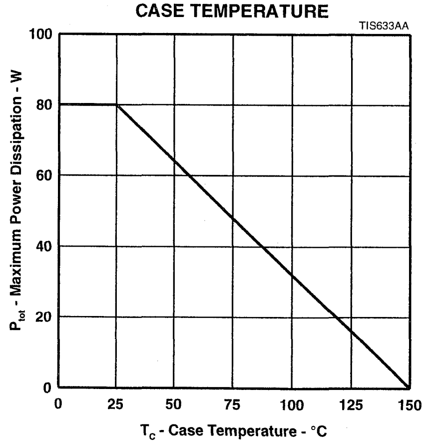
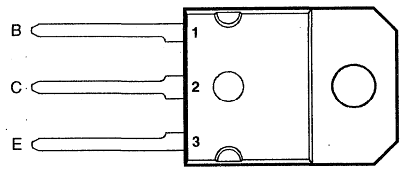


Figure 5.

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD245 Series**
- **80 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **15 A Peak Collector Current**
- **Customer-Specified Selections Available**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD246	V_{CER}	-55	V
	BD246A		-70	
	BD246B		-90	
	BD246C		-115	
Collector-emitter voltage (I_C = -30 mA)	BD246	V_{CEO}	-45	V
	BD246A		-60	
	BD246B		-80	
	BD246C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-10	A
Peak collector current (see Note 1)		I_{CM}	-15	A
Continuous base current		I_B	-3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	62.5	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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 24 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	BD246	-45			V
				BD246A	-60			
				BD246B	-80			
				BD246C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -55 V	V_{BE} = 0	BD246			-0.4	mA
		V_{CE} = -70 V	V_{BE} = 0	BD246A			-0.4	
		V_{CE} = -90 V	V_{BE} = 0	BD246B			-0.4	
		V_{CE} = -115 V	V_{BE} = 0	BD246C			-0.4	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0	BD246/246A			-0.7	mA
		V_{CE} = -60 V	I_B = 0	BD246B/246C			-0.7	
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 A	(see Notes 5 and 6)	40			
		V_{CE} = -4 V	I_C = -3 A		20			
		V_{CE} = -4 V	I_C = -10 A		4			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.3 A	I_C = -3 A	(see Notes 5 and 6)			-1	V
		I_B = -2.5 A	I_C = -10 A				-4	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -3 A	(see Notes 5 and 6)			-1.6	V
		V_{CE} = -4 V	I_C = -10 A				-3	
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -0.5 A	f = 1 kHz	20			
$\lvert h_{fe}\rvert$	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_p = 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			42	°C/W

resistive-load-switching characteristics at 25°C case temperature

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		0.2		µs
t_{off}	Turn-off time	$V_{BE(off)}$ = 3.7 V	R_L = 20 Ω	t_p = 20 µs, dc ≤ 2%		0.8		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

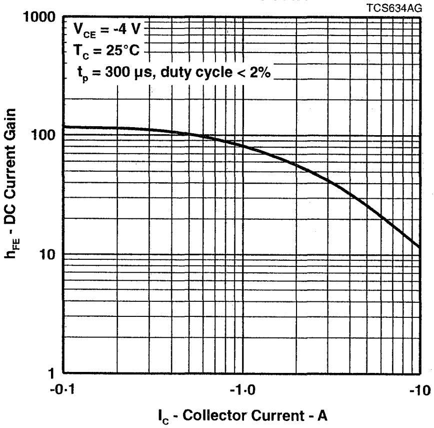


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

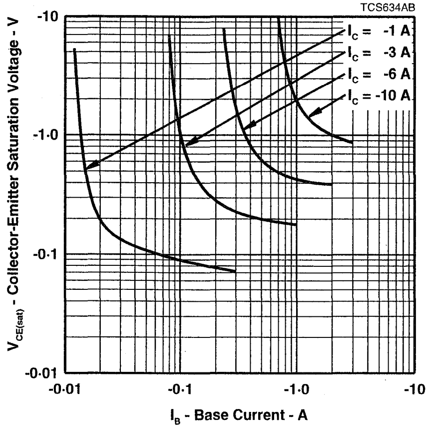


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

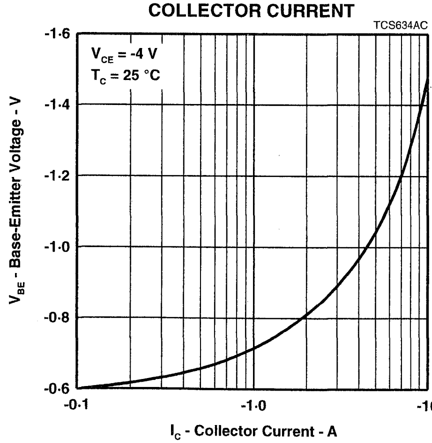


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

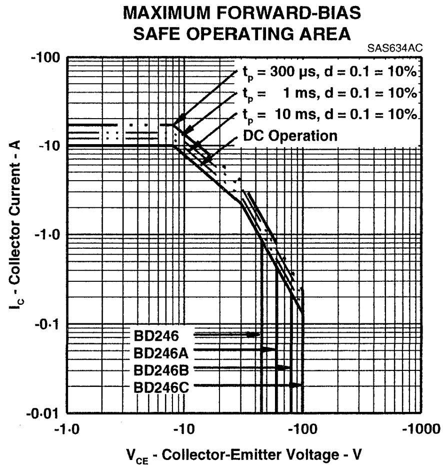


Figure 4.

THERMAL INFORMATION

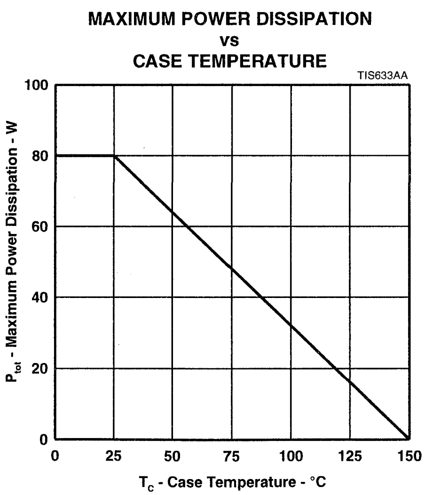


Figure 5.

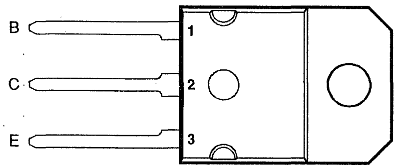
TEXAS INSTRUMENTS

BD249, BD249A, BD249B, BD249C
NPN SILICON POWER TRANSISTORS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD250 Series**
- **125 W at 25°C Case Temperature**
- **25 A Continuous Collector Current**
- **40 A Peak Collector Current**
- **Customer-Specified Selections Available**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD249	V_{CER}	55	V
	BD249A		70	
	BD249B		90	
	BD249C		115	
Collector-emitter voltage (I_C = 30 mA)	BD249	V_{CEO}	45	V
	BD249A		60	
	BD249B		80	
	BD249C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	25	A
Peak collector current (see Note 1)		I_{CM}	40	A
Continuous base current		I_B	5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	125	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	90	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES:
1. This value applies for $t_p \leq 0.3$ 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 24 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	BD249	45			V
				BD249A	60			
				BD249B	80			
				BD249C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 55 V	$V_{BE} = 0$	BD249			0.7	mA
		V_{CE} = 70 V	$V_{BE} = 0$	BD249A			0.7	
		V_{CE} = 90 V	$V_{BE} = 0$	BD249B			0.7	
		V_{CE} = 115 V	$V_{BE} = 0$	BD249C			0.7	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	BD249/249A			1	mA
		V_{CE} = 60 V	$I_B = 0$	BD249B/249C			1	
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	(see Notes 5 and 6)	25			
		V_{CE} = 4 V	I_C = 15 A		10			
		V_{CE} = 4 V	I_C = 25 A		5			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 1.5 A	I_C = 15 A	(see Notes 5 and 6)			1.8	V
		I_B = 5 A	I_C = 25 A				4	
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 15 A	(see Notes 5 and 6)			2	V
		V_{CE} = 4 V	I_C = 25 A				4	
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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			42	°C/W

resistive-load-switching characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_{on}	Turn-on time	I_C = 5 A	$I_{B(on)}$ = 0.5 A	$I_{B(off)}$ = -0.5 A		0.3		µs
t_{off}	Turn-off time	$V_{BE(off)}$ = -5 V	R_L = 5 Ω	t_p = 20 µs, dc ≤ 2%		0.9		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

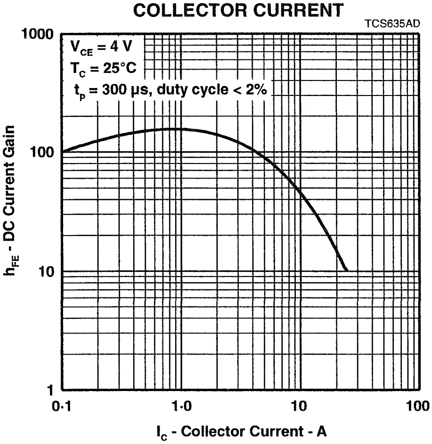


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

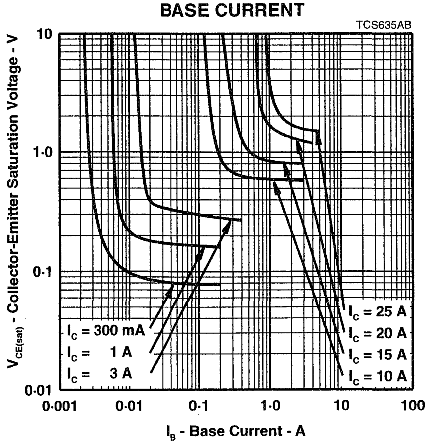


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

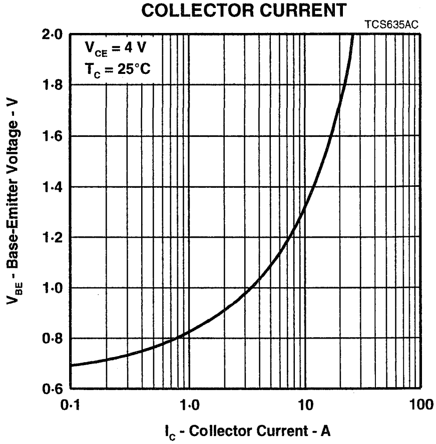


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

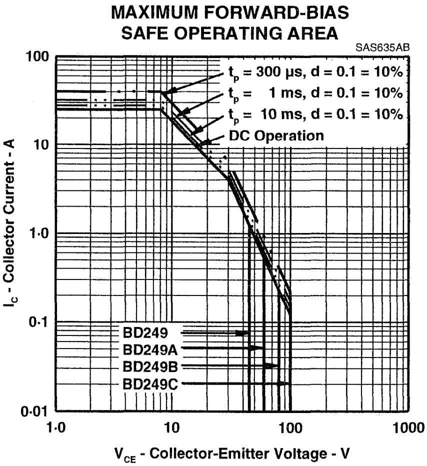


Figure 4.

THERMAL INFORMATION

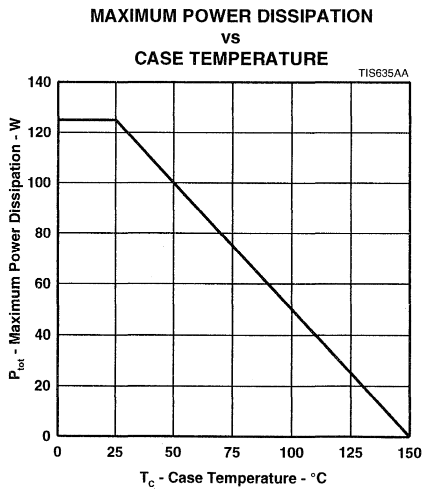
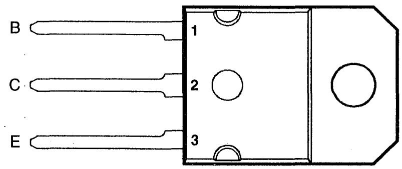


Figure 5.

- **Designed for Complementary Use with the BD249 Series**
- **125 W at 25°C Case Temperature**
- **25 A Continuous Collector Current**
- **40 A Peak Collector Current**
- **Customer-Specified Selections Available**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (R_{BE} = 100 Ω)	BD250	V_{CER}	-55	V
	BD250A		-70	
	BD250B		-90	
	BD250C		-115	
Collector-emitter voltage (I_C = -30 mA)	BD250	V_{CEO}	-45	V
	BD250A		-60	
	BD250B		-80	
	BD250C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-25	A
Peak collector current (see Note 1)		I_{CM}	-40	A
Continuous base current		I_B	-5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	125	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	90	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES:
1. This value applies for $t_p \leq 0.3$ 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 24 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	BD250	-45			V
				BD250A	-60			
				BD250B	-80			
				BD250C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -55 V	V_{BE} = 0	BD250			-0.7	mA
		V_{CE} = -70 V	V_{BE} = 0	BD250A			-0.7	
		V_{CE} = -90 V	V_{BE} = 0	BD250B			-0.7	
		V_{CE} = -115 V	V_{BE} = 0	BD250C			-0.7	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0	BD250/250A			-1	mA
		V_{CE} = -60 V	I_B = 0	BD250B/250C			-1	
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	(see Notes 5 and 6)	25			
		V_{CE} = -4 V	I_C = -15 A		10			
		V_{CE} = -4 V	I_C = -25 A		5			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -1.5 A	I_C = -15 A	(see Notes 5 and 6)			-1.8	V
		I_B = -5 A	I_C = -25 A				-4	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -15 A	(see Notes 5 and 6)			-2	V
		V_{CE} = -4 V	I_C = -25 A				-4	
h_{fe}	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -1 A	f = 1 kHz	25			
$\lvert h_{fe} \rvert$	Small signal forward current transfer ratio	V_{CE} = -10 V	I_C = -1 A	f = 1 MHz	3			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			42	°C/W

resistive-load-switching characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_{on}	Turn-on time	I_C = -5 A	$I_{B(on)}$ = -0.5 A	$I_{B(off)}$ = 0.5 A		0.2		µs
t_{off}	Turn-off time	$V_{BE(off)}$ = 5 V	R_L = 5 Ω	t_p = 20 µs, dc ≤ 2%		0.4		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

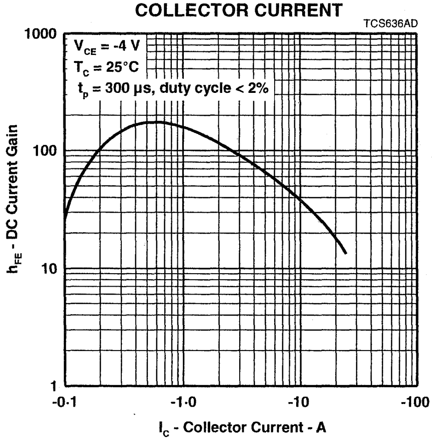


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

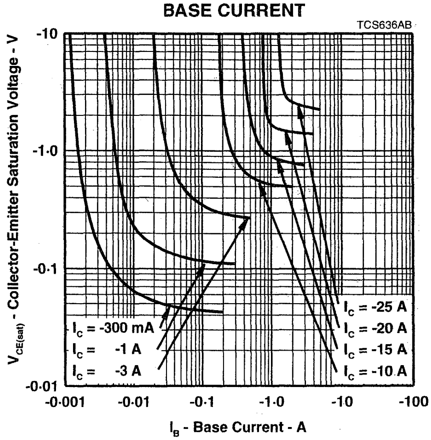


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

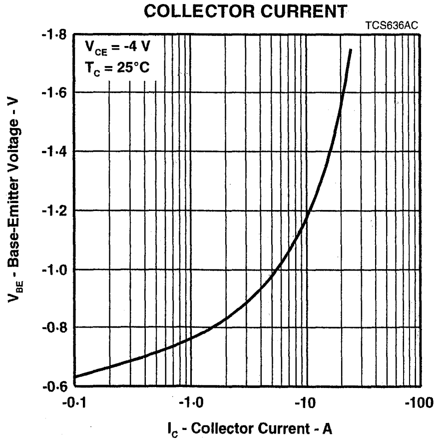


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

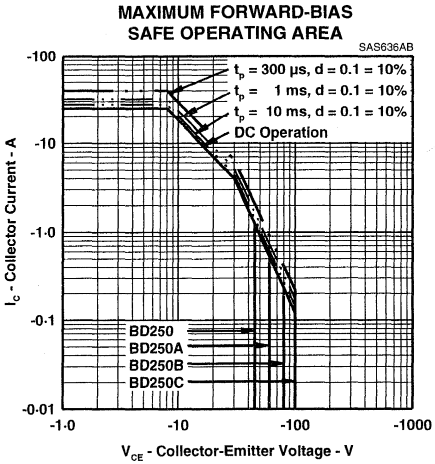


Figure 4.

THERMAL INFORMATION

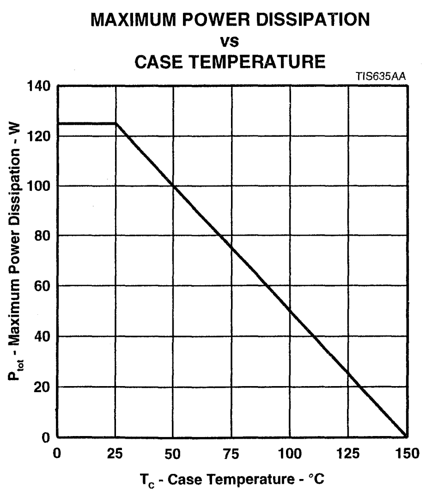


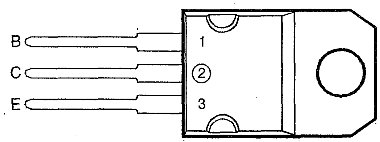
Figure 5.

BD539, BD539A, BD539B, BD539C, BD539D
NPN SILICON POWER TRANSISTORS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD540 Series**
- **45 W at 25°C Case Temperature**
- **5 A Continuous Collector Current**
- **Up to 120 V V_{CEO} rating**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage	BD539	V_{CBO}	40	V
	BD539A		60	
	BD539B		80	
	BD539C		100	
	BD539D		120	
Collector-emitter voltage (see Note 1)	BD539	V_{CEO}	40	V
	BD539A		60	
	BD539B		80	
	BD539C		100	
	BD539D		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	45	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	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.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 4)	I_B = 0	BD539	40			V
				BD539A	60			
				BD539B	80			
				BD539C	100			
				BD539D	120			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 40 V	V_{BE} = 0	BD539			0.2	mA
		V_{CE} = 60 V	V_{BE} = 0	BD539A			0.2	
		V_{CE} = 80 V	V_{BE} = 0	BD539B			0.2	
		V_{CE} = 100 V	V_{BE} = 0	BD539C			0.2	
		V_{CE} = 120 V	V_{BE} = 0	BD539D			0.2	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	I_B = 0	BD539/539A			0.3	mA
		V_{CE} = 60 V	I_B = 0	BD539B/539C			0.3	
		V_{CE} = 90 V	I_B = 0	BD539D			0.3	
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 = 0.5 A	(see Notes 4 and 5)	40			
		V_{CE} = 4 V	I_C = 1 A		30			
		V_{CE} = 4 V	I_C = 3 A		12			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 125 mA	I_C = 1 A	(see Notes 4 and 5)			0.25	V
		I_B = 375 mA	I_C = 3 A				0.8	
		I_B = 1 A	I_C = 5 A				1.5	
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 4 V	I_C = 3 A	(see Notes 4 and 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			

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. 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			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

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	t_p = 20 µs, dc ≤ 2%		2		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

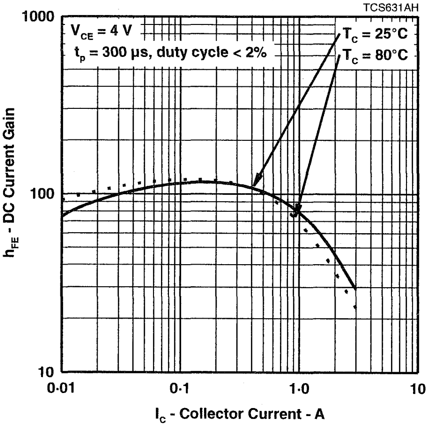


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

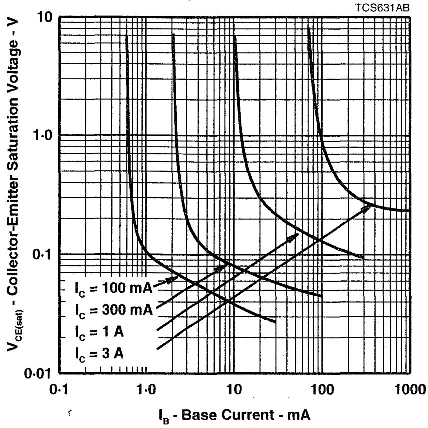


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

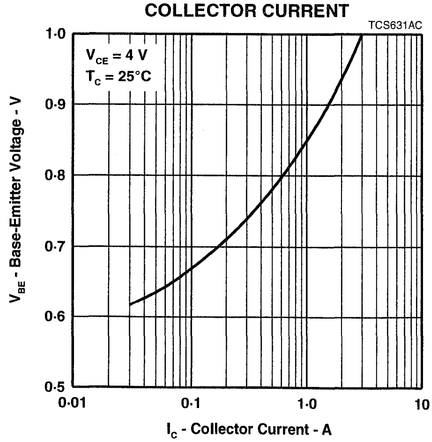


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

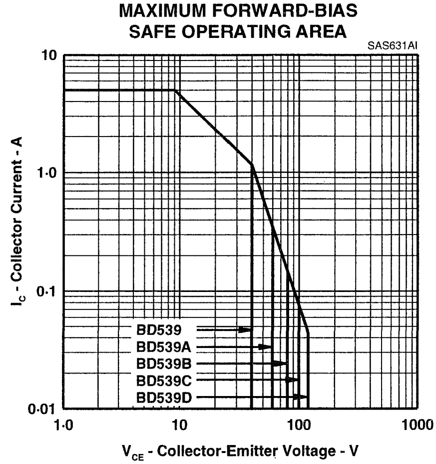


Figure 4.

THERMAL INFORMATION

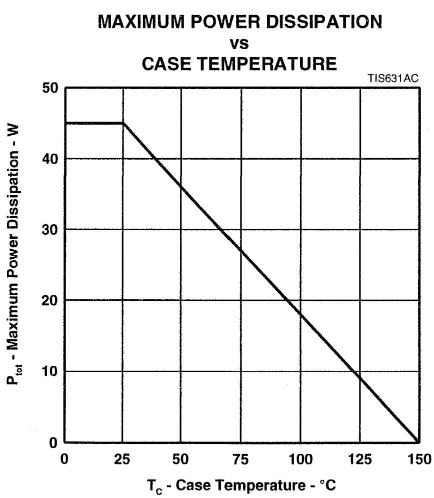


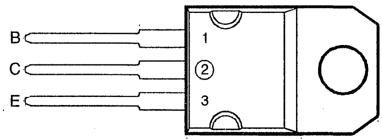
Figure 5.

BD540, BD540A, BD540B, BD540C
PNP SILICON POWER TRANSISTORS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD539 Series**
- **45 W at 25°C Case Temperature**
- **5 A Continuous Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD540	V_{CBO}	-40	V
	BD540A		-60	
	BD540B		-80	
	BD540C		-100	
Collector-emitter voltage (I_B = 0) (see Note 1)	BD540	V_{CEO}	-40	V
	BD540A		-60	
	BD540B		-80	
	BD540C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	45	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	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.

JUNE 1973 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 4)	I_B = 0	BD540	-40			V
				BD540A	-60			
				BD540B	-80			
				BD540C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -40 V	V_{BE} = 0	BD540			-0.2	mA
		V_{CE} = -60 V	V_{BE} = 0	BD540A			-0.2	
		V_{CE} = -80 V	V_{BE} = 0	BD540B			-0.2	
		V_{CE} = -100 V	V_{BE} = 0	BD540C			-0.2	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0	BD540/540A			-0.3	mA
		V_{CE} = -60 V	I_B = 0	BD540B/540C			-0.3	
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 = -0.5 A	(see Notes 4 and 5)	40			
		V_{CE} = -4 V	I_C = -1 A		30			
		V_{CE} = -4 V	I_C = -3 A		12			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -125 mA	I_C = -1 A	(see Notes 4 and 5)			-0.25	V
		I_B = -375 mA	I_C = -3 A				-0.8	
		I_B = -1 A	I_C = -5 A				-1.5	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -3 A	(see Notes 4 and 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			

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
5. 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			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

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	t_p = 20 μs, dc ≤ 2%		1		μs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

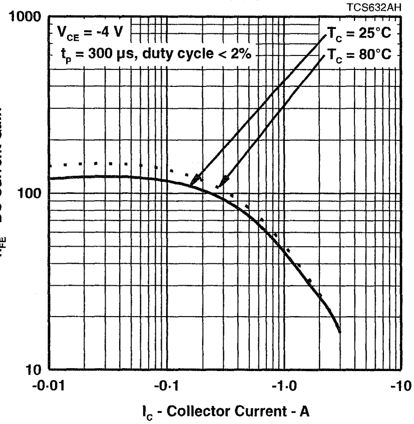


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

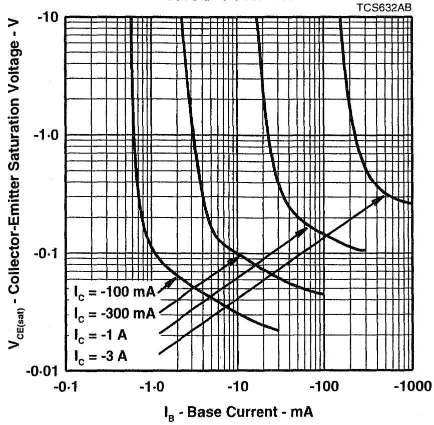


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

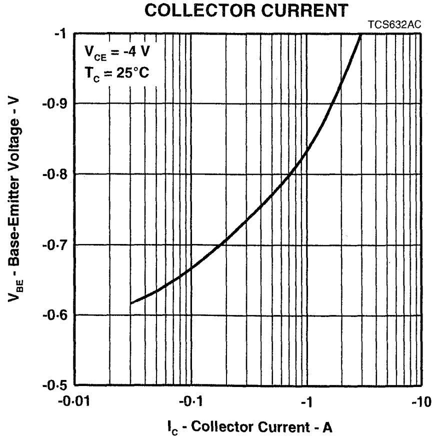


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

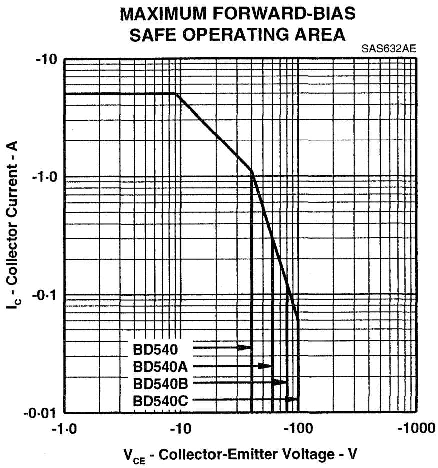


Figure 4.

THERMAL INFORMATION

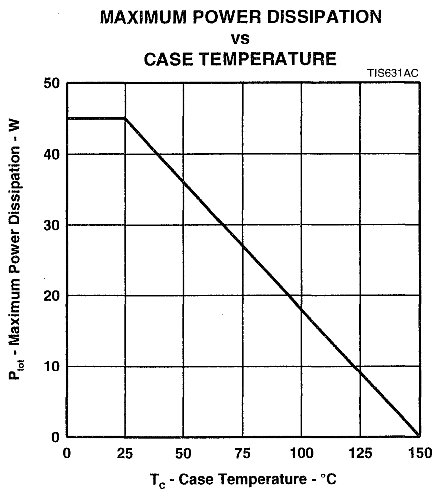


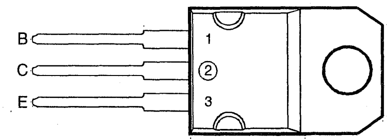
Figure 5.

BD543, BD543A, BD543B, BD543C
NPN SILICON POWER TRANSISTORS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD544 Series**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD543	V_{CBO}	40	V
	BD543A		60	
	BD543B		80	
	BD543C		100	
Collector-emitter voltage (I_B = 0)	BD543	V_{CEO}	40	V
	BD543A		60	
	BD543B		80	
	BD543C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Peak collector current (see Note 1)		I_{CM}	10	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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 16 mW/°C.

TEXAS INSTRUMENTS

JUNE 1973 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 4)	$I_B = 0$	BD543	40			V
				BD543A	60			
				BD543B	80			
				BD543C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 40 V	$V_{BE} = 0$	BD543			0.4	mA
		V_{CE} = 60 V	$V_{BE} = 0$	BD543A			0.4	
		V_{CE} = 80 V	$V_{BE} = 0$	BD543B			0.4	
		V_{CE} = 100 V	$V_{BE} = 0$	BD543C			0.4	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	BD543/543A			0.7	mA
		V_{CE} = 60 V	$I_B = 0$	BD543B/543C			0.7	
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 A	(see Notes 4 and 5)	60			
		V_{CE} = 4 V	I_C = 3 A		40			
		V_{CE} = 4 V	I_C = 5 A		15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.3 A	I_C = 3 A	(see Notes 4 and 5)			0.5	V
		I_B = 1 A	I_C = 5 A				0.5	
		I_B = 1.6 A	I_C = 8 A				1	
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 5 A	(see Notes 4 and 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			

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. 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			1.79	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

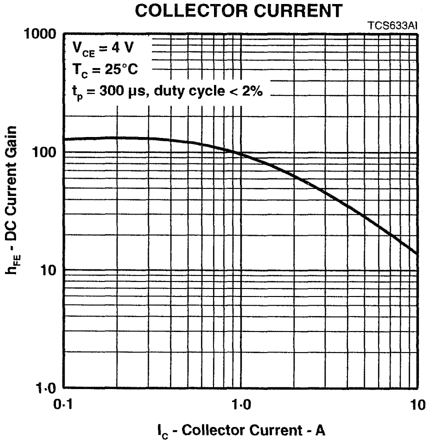


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

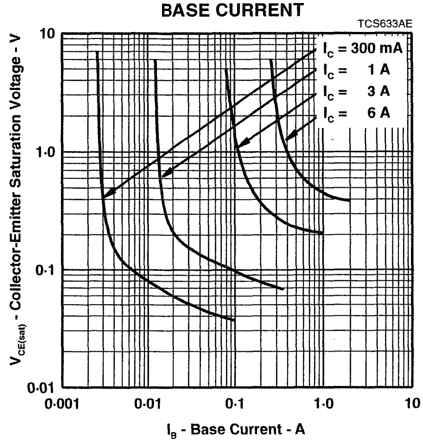


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

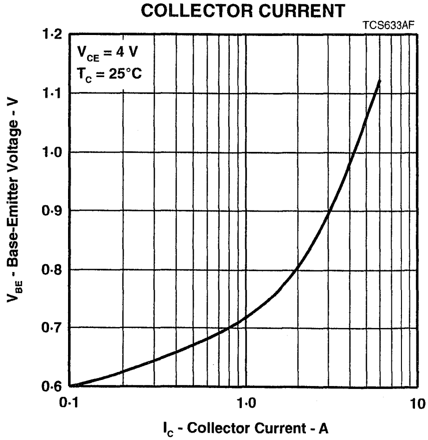


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

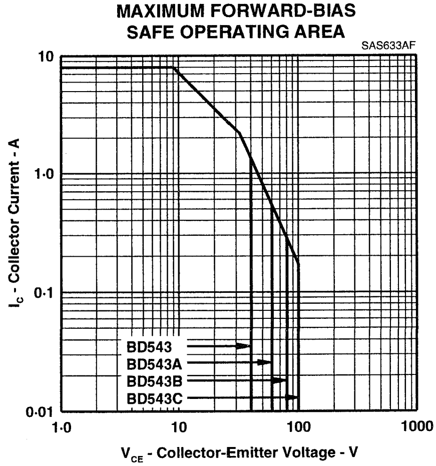


Figure 4.

THERMAL INFORMATION

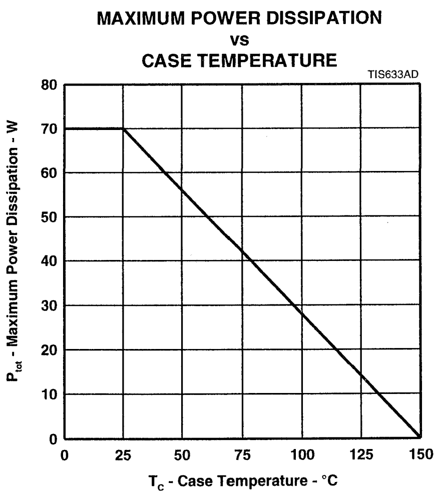
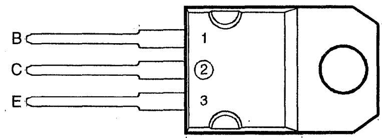


Figure 5.

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD543 Series**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **10 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD544	V_{CBO}	-40	V
	BD544A		-60	
	BD544B		-80	
	BD544C		-100	
Collector-emitter voltage (I_B = 0)	BD544	V_{CEO}	-40	V
	BD544A		-60	
	BD544B		-80	
	BD544C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-8	A
Peak collector current (see Note 1)		I_{CM}	-10	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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 16 mW/°C.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 4)	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	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	(see Notes 4 and 5)	60 40 15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.3 A I_B = -1 A I_B = -1.6 A	I_C = -3 A I_C = -5 A I_C = -8 A	(see Notes 4 and 5)			-0.5 -0.5 -1	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -5 A	(see Notes 4 and 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			

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. 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			1.79	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		0.7		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

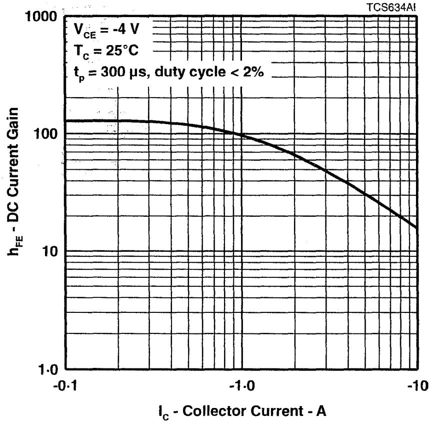


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

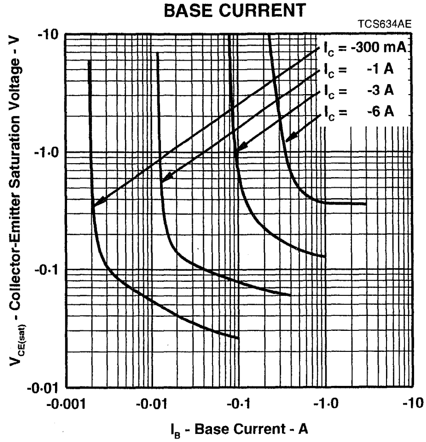


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

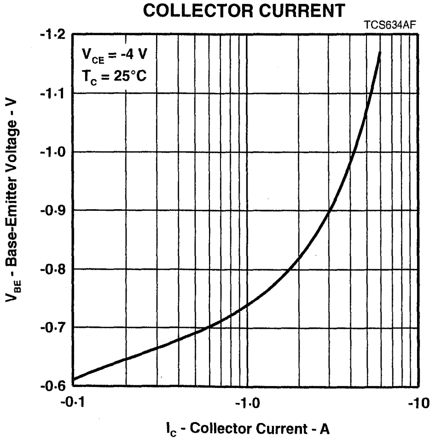


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

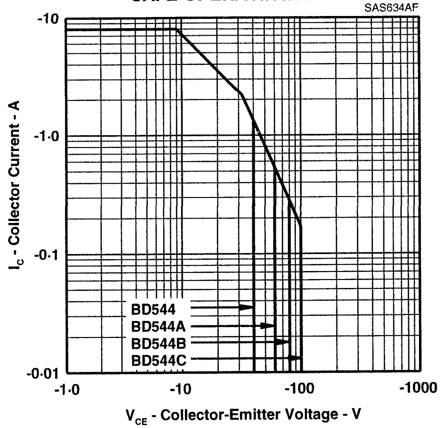


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

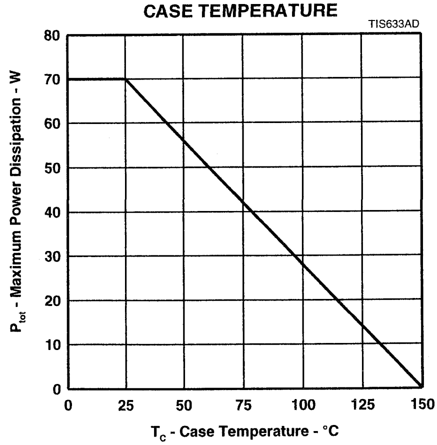


Figure 5.

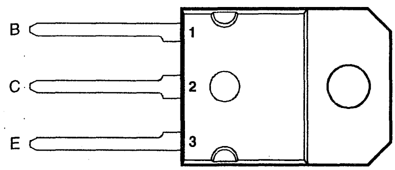
TEXAS INSTRUMENTS

BD545, BD545A, BD545B, BD545C
NPN SILICON POWER TRANSISTORS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with the BD546 Series**
- **85 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **Customer-Specified Selections Available**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD545	V_{CBO}	40	V
	BD545A		60	
	BD545B		80	
	BD545C		100	
Collector-emitter voltage (I_B = 0) (see Note 1)	BD545	V_{CEO}	40	V
	BD545A		60	
	BD545B		80	
	BD545C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	15	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	85	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	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 0.68 W/°C.
3. Derate linearly to 150°C free air temperature at the rate of 28 mW/°C.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 4)	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	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	(see Notes 4 and 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	(see Notes 4 and 5)			0.8 1	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 10 A	(see Notes 4 and 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_p = 300 µs, duty cycle ≤ 2%.
5. 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			1.47	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

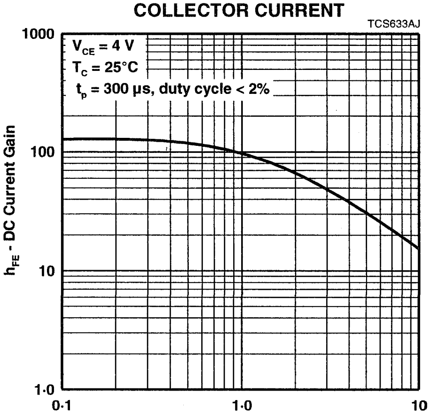


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

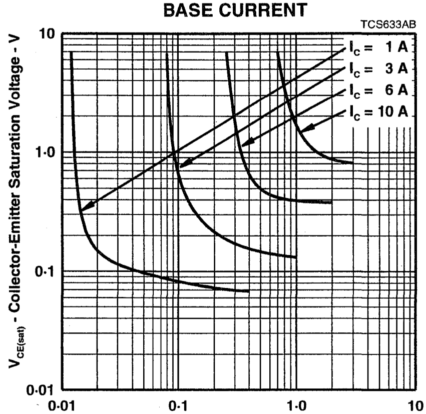


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

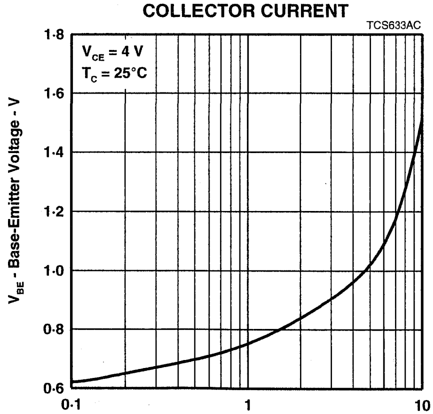


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

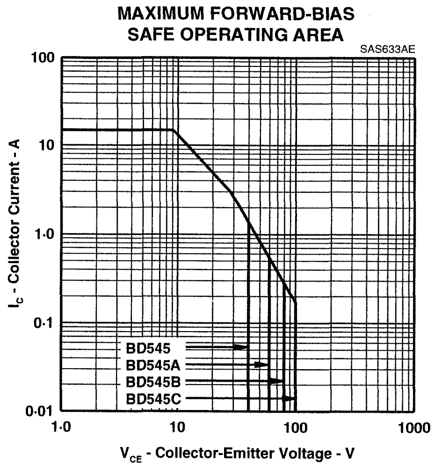


Figure 4.

THERMAL INFORMATION

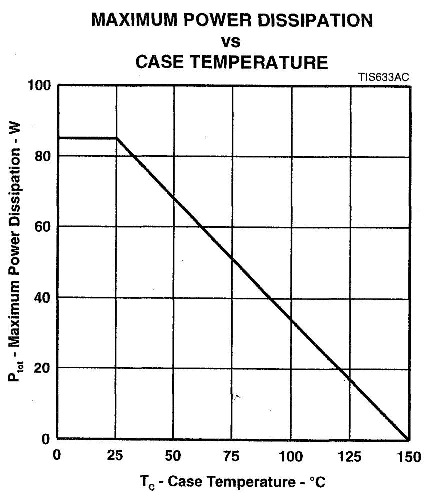
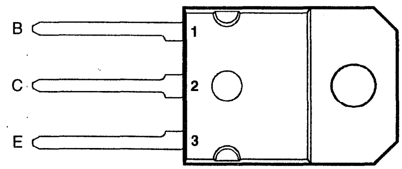


Figure 5.

JUNE 1973 - REVISED MAY 1995

- Designed for Complementary Use with the BD545 Series
- 85 W at 25°C Case Temperature
- 15 A Continuous Collector Current
- Customer-Specified Selections Available

**SOT-93 PACKAGE
(TOP VIEW)**



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	BD546	V_{CBO}	-40	V
	BD546A		-60	
	BD546B		-80	
	BD546C		-100	
Collector-emitter voltage ($I_B = 0$) (see Note 1)	BD546	V_{CEO}	-40	V
	BD546A		-60	
	BD546B		-80	
	BD546C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-15	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	85	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	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 0.68 W/°C.
3. Derate linearly to 150°C free air temperature at the rate of 28 mW/°C.

JUNE 1973 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 4)	$I_B = 0$	BD546	-40			V
				BD546A	-60			
				BD546B	-80			
				BD546C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -40 V	$V_{BE} = 0$	BD546			-0.4	mA
		V_{CE} = -60 V	$V_{BE} = 0$	BD546A			-0.4	
		V_{CE} = -80 V	$V_{BE} = 0$	BD546B			-0.4	
		V_{CE} = -100 V	$V_{BE} = 0$	BD546C			-0.4	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	$I_B = 0$	BD546/546A			-0.7	mA
		V_{CE} = -60 V	$I_B = 0$	BD546B/546C			-0.7	
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 A	(see Notes 4 and 5)	60			
		V_{CE} = -4 V	I_C = -5 A		25			
		V_{CE} = -4 V	I_C = -10 A		10			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -625 mA	I_C = -5 A	(see Notes 4 and 5)			-0.8	V
		I_B = -2 A	I_C = -10 A				-1	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -10 A	(see Notes 4 and 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_p = 300 µs, duty cycle ≤ 2%.
5. 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			1.47	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		0.7		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

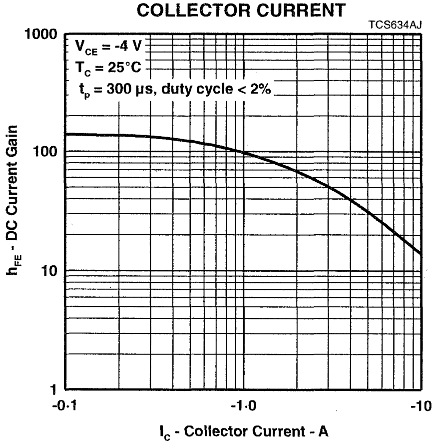


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

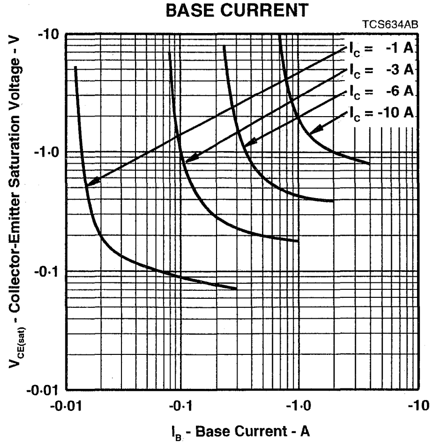


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

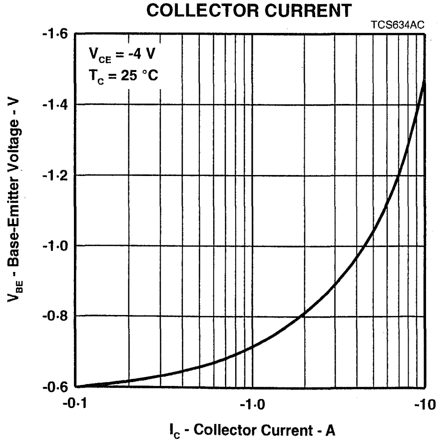


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

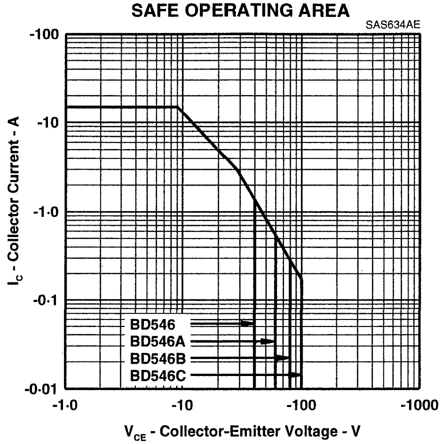


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

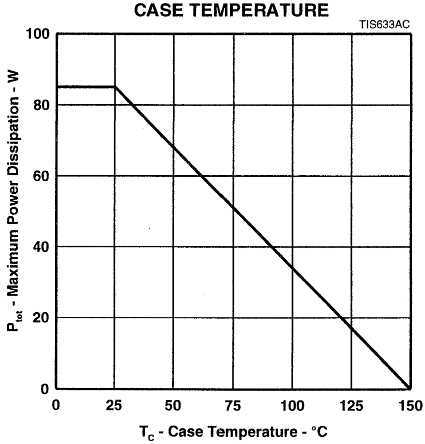
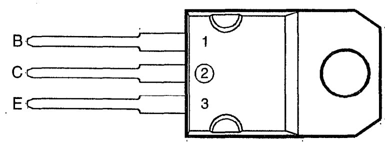


Figure 5.

- **Designed for Complementary Use with the BD744 Series**
- **90 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **20 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD743	V_{CBO}	50	V
	BD743A		70	
	BD743B		90	
	BD743C		110	
Collector-emitter voltage (I_B = 0)	BD743	V_{CEO}	45	V
	BD743A		60	
	BD743B		80	
	BD743C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	15	A
Peak collector current (see Note 1)		I_{CM}	20	A
Continuous base current		I_B	5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	90	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	90	mJ
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \le 0.3$ ms, duty cycle $\le$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, 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	(see Note 5)	BD743	45			V
					BD743A	60			
					BD743B	80			
					BD743C	100			
I_{CBO}	Collector cut-off current	V_{CE} = 50 V	V_{BE} = 0		BD743			0.1	mA
		V_{CE} = 70 V	V_{BE} = 0		BD743A			0.1	
		V_{CE} = 90 V	V_{BE} = 0		BD743B			0.1	
		V_{CE} = 110 V	V_{BE} = 0		BD743C			0.1	
		V_{CE} = 50 V	V_{BE} = 0	T_C = 125°C	BD743			5	
		V_{CE} = 70 V	V_{BE} = 0	T_C = 125°C	BD743A			5	
		V_{CE} = 90 V	V_{BE} = 0	T_C = 125°C	BD743B			5	
		V_{CE} = 110 V	V_{BE} = 0	T_C = 125°C	BD743C			5	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	I_B = 0		BD743/743A			0.1	mA
		V_{CE} = 60 V	I_B = 0		BD743B/743C			0.1	
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	I_C = 1 A	(see Notes 5 and 6)		40			
		V_{CE} = 4 V	I_C = 5 A			20		150	
		V_{CE} = 4 V	I_C = 15 A			5			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.5 A	I_C = 5 A	(see Notes 5 and 6)				1	V
		I_B = 5 A	I_C = 15 A					3	
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 5 A	(see Notes 5 and 6)				1	V
		V_{CE} = 4 V	I_C = 15 A					3	
h_{fe}	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 1 A	f = 1 kHz		25			
$\lvert h_{fe} \rvert$	Small signal forward current transfer ratio	V_{CE} = 10 V	I_C = 1 A	f = 1 MHz		5			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.4	°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 †	MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = 5 A, $I_{B(on)}$ = 0.5 A, $I_{B(off)}$ = -0.5 A, $V_{BE(off)}$ = -4.2 V, R_L = 6 Ω, t_p = 20 µs, dc ≤ 2%		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.

TYPICAL CHARACTERISTICS

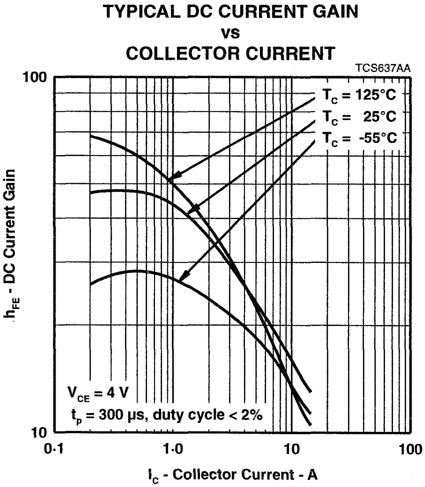


Figure 1.

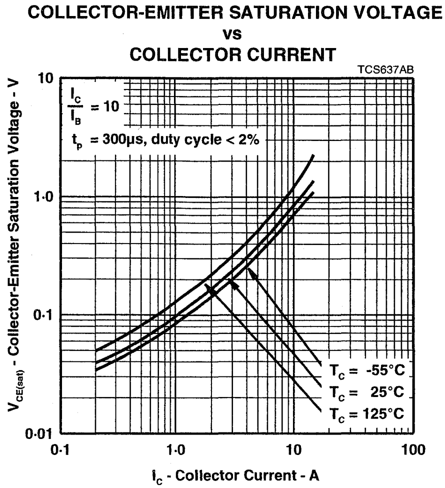


Figure 2.

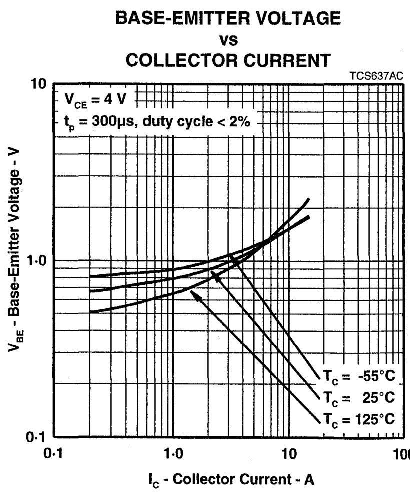


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

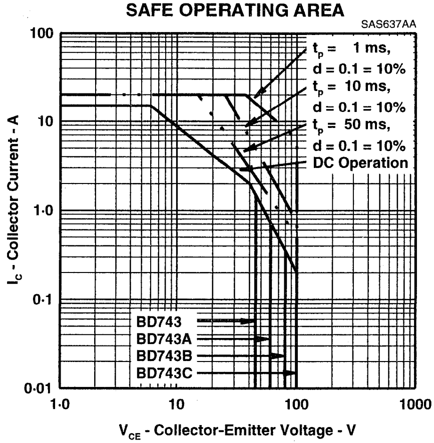


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

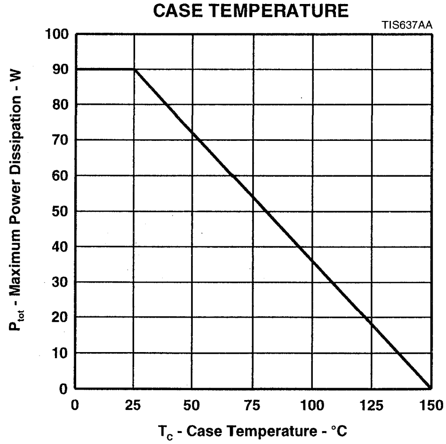
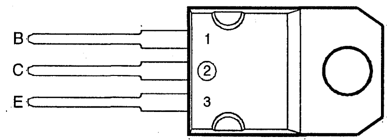


Figure 5.

- **Designed for Complementary Use with the BD743 Series**
- **90 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **20 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD744	V_{CBO}	-50	V
	BD744A		-70	
	BD744B		-90	
	BD744C		-110	
Collector-emitter voltage (I_B = 0)	BD744	V_{CEO}	-45	V
	BD744A		-60	
	BD744B		-80	
	BD744C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-15	A
Peak collector current (see Note 1)		I_{CM}	-20	A
Continuous base current		I_B	-5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	90	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	90	mJ
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ ms, duty cycle ≤ 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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

AUGUST 1978 - REVISED MAY 1995

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	(see Note 5)	BD744	-45			V
					BD744A	-60			
					BD744B	-80			
					BD744C	-100			
I_{CBO}	Collector cut-off current	V_{CE} = -50 V	V_{BE} = 0		BD744			-0.1	mA
		V_{CE} = -70 V	V_{BE} = 0		BD744A			-0.1	
		V_{CE} = -90 V	V_{BE} = 0		BD744B			-0.1	
		V_{CE} = -110 V	V_{BE} = 0		BD744C			-0.1	
		V_{CE} = -50 V	V_{BE} = 0	T_C = 125°C	BD744			-5	
		V_{CE} = -70 V	V_{BE} = 0	T_C = 125°C	BD744A			-5	
		V_{CE} = -90 V	V_{BE} = 0	T_C = 125°C	BD744B			-5	
		V_{CE} = -110 V	V_{BE} = 0	T_C = 125°C	BD744C			-5	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0		BD744/744A			-0.1	mA
		V_{CE} = -60 V	I_B = 0		BD744B/744C			-0.1	
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	I_C = -1 A	(see Notes 5 and 6)		40			
		V_{CE} = -4 V	I_C = -5 A			20		150	
		V_{CE} = -4 V	I_C = -15 A			5			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.5 A	I_C = -5 A	(see Notes 5 and 6)				-1	V
		I_B = -5 A	I_C = -15 A					-3	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -5 A	(see Notes 5 and 6)				-1	V
		V_{CE} = -4 V	I_C = -15 A					-3	
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		5			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.4	°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 †			MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = -5 A	$I_{B(on)}$ = -0.5 A	$I_{B(off)}$ = 0.5 A		20		ns
t_r	Rise time	$V_{BE(off)}$ = 4.2 V	R_L = 6 Ω	t_p = 20 µs, dc ≤ 2%		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.

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

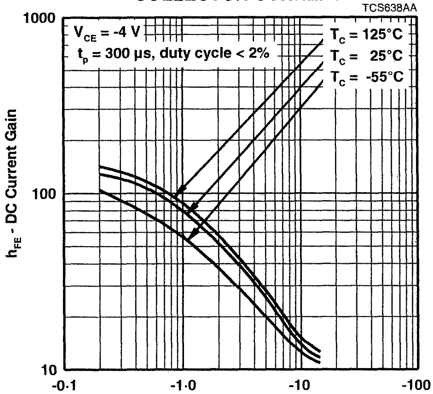


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

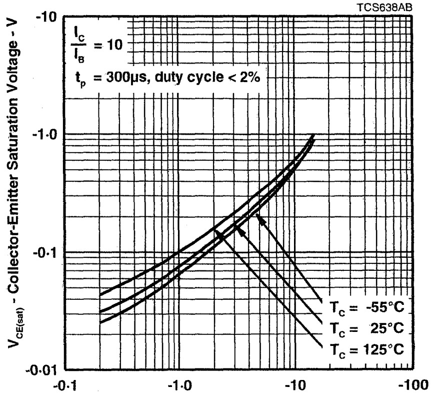


Figure 2.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

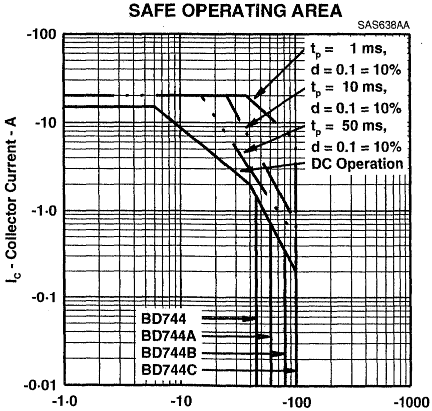


Figure 3.

THERMAL INFORMATION

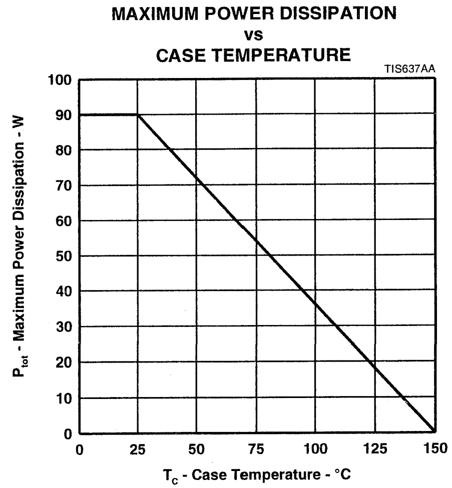
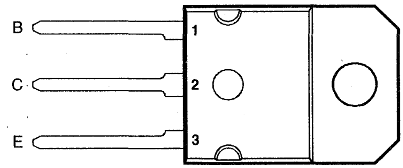


Figure 4.

AUGUST 1978 - REVISED MAY 1995

- **Designed for Complementary Use with the BD746 Series**
- **115 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **25 A Peak Collector Current**
- **Customer-Specified Selections Available**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.
MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD745	V_{CBO}	50	V
	BD745A		70	
	BD745B		90	
	BD745C		110	
Collector-emitter voltage (I_B = 0)	BD745	V_{CEO}	45	V
	BD745A		60	
	BD745B		80	
	BD745C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	20	A
Peak collector current (see Note 1)		I_{CM}	25	A
Continuous base current		I_B	7	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	115	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	90	mJ
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, 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	(see Note 5)	BD745	45			V
					BD745A	60			
					BD745B	80			
					BD745C	100			
I_{CBO}	Collector cut-off current	V_{CE} = 50 V	V_{BE} = 0		BD745			0.1	mA
		V_{CE} = 70 V	V_{BE} = 0		BD745A			0.1	
		V_{CE} = 90 V	V_{BE} = 0		BD745B			0.1	
		V_{CE} = 110 V	V_{BE} = 0		BD745C			0.1	
		V_{CE} = 50 V	V_{BE} = 0	T_C = 125°C	BD745			5	
		V_{CE} = 70 V	V_{BE} = 0	T_C = 125°C	BD745A			5	
		V_{CE} = 90 V	V_{BE} = 0	T_C = 125°C	BD745B			5	
		V_{CE} = 110 V	V_{BE} = 0	T_C = 125°C	BD745C			5	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	I_B = 0		BD745/745A			0.1	mA
		V_{CE} = 60 V	I_B = 0		BD745B/745C			0.1	
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	I_C = 1 A	(see Notes 5 and 6)		40			
		V_{CE} = 4 V	I_C = 5 A			20		150	
		V_{CE} = 4 V	I_C = 20 A			5			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.5 A	I_C = 5 A	(see Notes 5 and 6)				1	V
		I_B = 5 A	I_C = 20 A					3	
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 5 A	(see Notes 5 and 6)				1	V
		V_{CE} = 4 V	I_C = 20 A					3	
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		5			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.1	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = 5 A	$I_{B(on)}$ = 0.5 A	$I_{B(off)}$ = -0.5 A		20		ns
t_r	Rise time	$V_{BE(off)}$ = -4.2 V	R_L = 6 Ω	t_p = 20 µs, dc ≤ 2%		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.

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

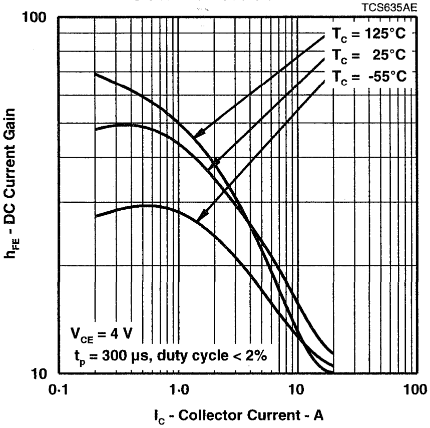


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

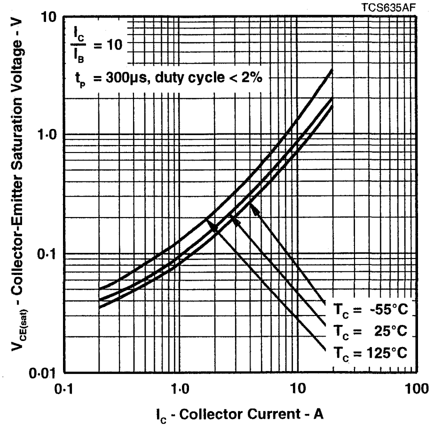


Figure 2.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

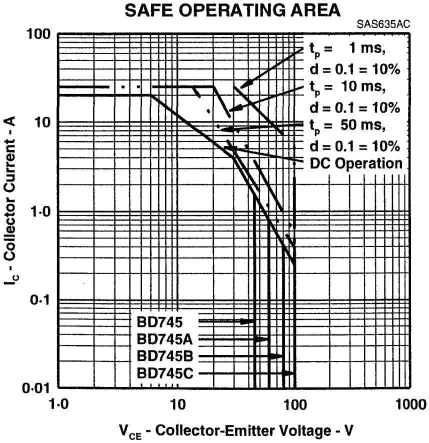


Figure 3.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

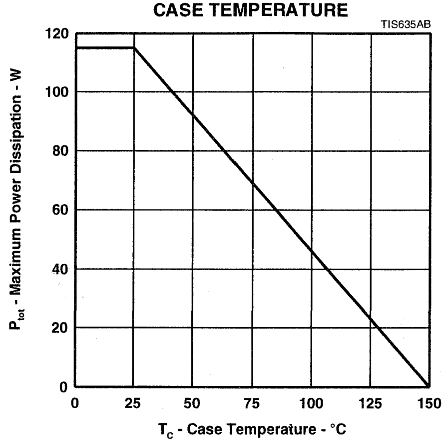
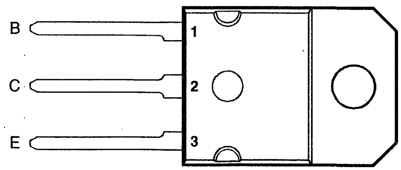


Figure 4.

- **Designed for Complementary Use with the BD745 Series**
- **115 W at 25°C Case Temperature**
- **20 A Continuous Collector Current**
- **25 A Peak Collector Current**
- **Customer-Specified Selections Available**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	BD746	V_{CBO}	-50	V
	BD746A		-70	
	BD746B		-90	
	BD746C		-110	
Collector-emitter voltage ($I_B = 0$)	BD746	V_{CEO}	-45	V
	BD746A		-60	
	BD746B		-80	
	BD746C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-20	A
Peak collector current (see Note 1)		I_{CM}	-25	A
Continuous base current		I_B	-7	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	115	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	90	mJ
Operating free air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)} = -0.4$ A, $R_{BE} = 100\ \Omega$, $V_{BE(off)} = 0$, $R_S = 0.1\ \Omega$, $V_{CC} = -20$ 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	(see Note 5)	BD746	-45			V
					BD746A	-60			
					BD746B	-80			
					BD746C	-100			
I_{CBO}	Collector cut-off current	V_{CE} = -50 V	V_{BE} = 0		BD746			-0.1	mA
		V_{CE} = -70 V	V_{BE} = 0		BD746A			-0.1	
		V_{CE} = -90 V	V_{BE} = 0		BD746B			-0.1	
		V_{CE} = -110 V	V_{BE} = 0		BD746C			-0.1	
		V_{CE} = -50 V	V_{BE} = 0	T_C = 125°C	BD746			-5	
		V_{CE} = -70 V	V_{BE} = 0	T_C = 125°C	BD746A			-5	
		V_{CE} = -90 V	V_{BE} = 0	T_C = 125°C	BD746B			-5	
		V_{CE} = -110 V	V_{BE} = 0	T_C = 125°C	BD746C			-5	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0		BD746/746A			-0.1	mA
		V_{CE} = -60 V	I_B = 0		BD746B/746C			-0.1	
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	I_C = -1 A	(see Notes 5 and 6)		40			
		V_{CE} = -4 V	I_C = -5 A			20		150	
		V_{CE} = -4 V	I_C = -20 A			5			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.5 A	I_C = -5 A	(see Notes 5 and 6)				-1	V
		I_B = -5 A	I_C = -20 A					-3	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -5 A	(see Notes 5 and 6)				-1	V
		V_{CE} = -4 V	I_C = -20 A					-3	
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	5			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.1	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = -5 A	$I_{B(on)}$ = -0.5 A	$I_{B(off)}$ = 0.5 A		20		ns
t_r	Rise time	$V_{BE(off)}$ = 4.2 V	R_L = 6 Ω	t_p = 20 µs, dc ≤ 2%		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.

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

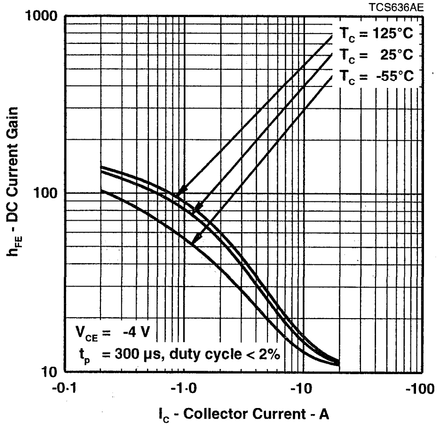


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

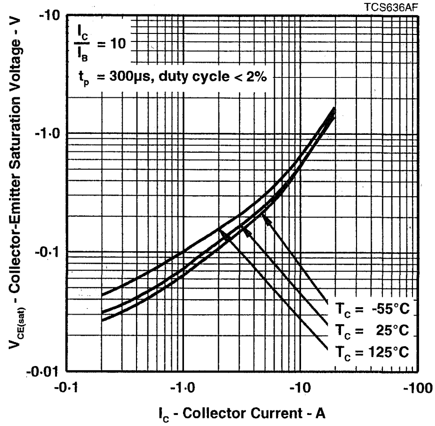


Figure 2.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

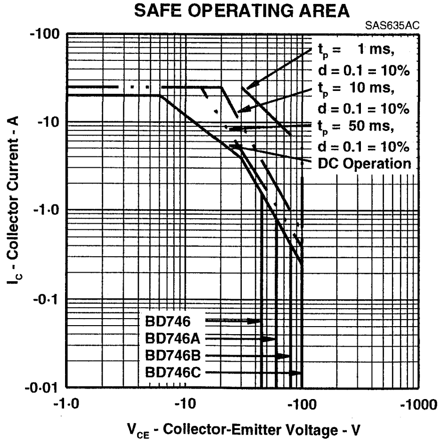


Figure 3.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION
vs
CASE TEMPERATURE

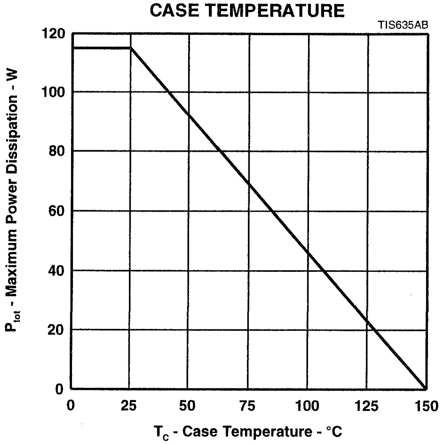


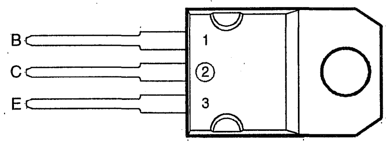
Figure 4.

TIP29, TIP29A, TIP29B, TIP29C
NPN SILICON POWER TRANSISTORS

JULY 1968 - REVISED MAY 1995

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

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	TIP29	40			V
				TIP29A	60			
				TIP29B	80			
				TIP29C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 80 V	$V_{BE} = 0$	TIP29			0.2	mA
		V_{CE} = 100 V	$V_{BE} = 0$	TIP29A			0.2	
		V_{CE} = 120 V	$V_{BE} = 0$	TIP29B			0.2	
		V_{CE} = 140 V	$V_{BE} = 0$	TIP29C			0.2	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	TIP29/29A			0.3	mA
		V_{CE} = 60 V	$I_B = 0$	TIP29B/29C			0.3	
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	(see Notes 5 and 6)	40			
		V_{CE} = 4 V	I_C = 1 A		15		75	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 125 mA	I_C = 1 A	(see Notes 5 and 6)			0.7	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 1 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		2		µs

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

TYPICAL CHARACTERISTICS

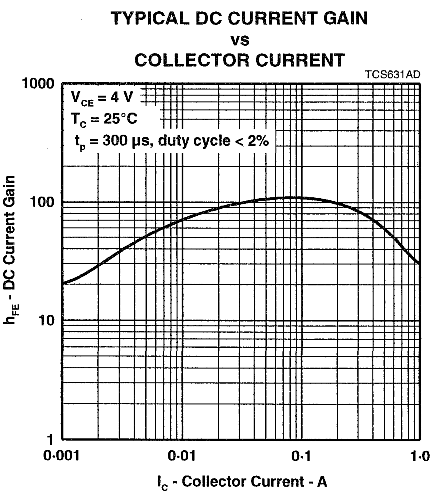


Figure 1.

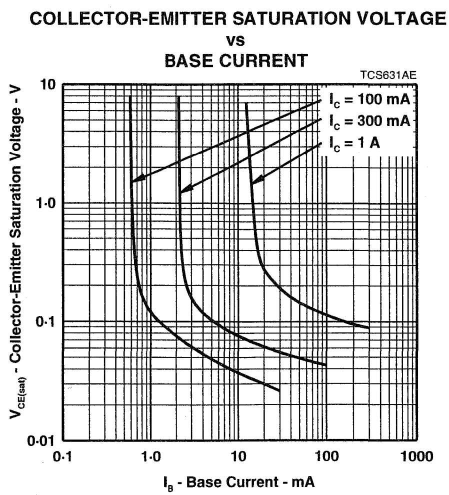


Figure 2.

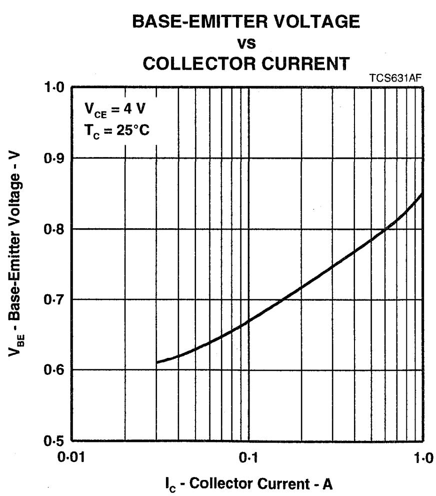


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

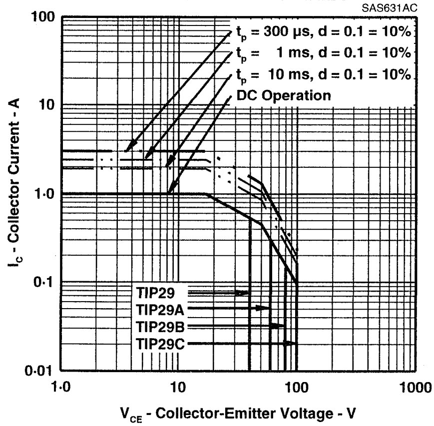


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

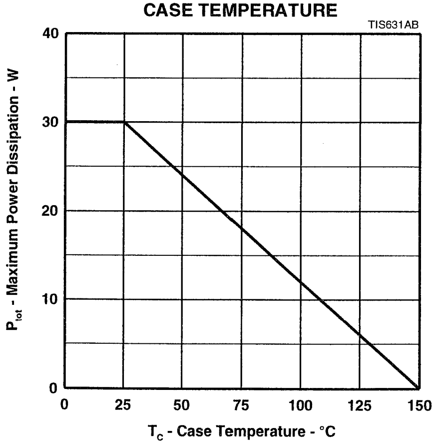


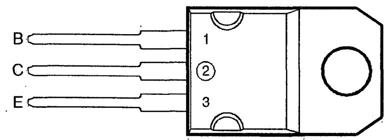
Figure 5.

TIP29D, TIP29E, TIP29F
NPN SILICON POWER TRANSISTORS

JULY 1968 - REVISED MAY 1995

- 30 W at 25°C Case Temperature
- 1 A Continuous Collector Current
- 3 A Peak Collector Current
- Customer-Specified Selections Available

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	TIP29D	V_{CBO}	160	V
	TIP29E		180	
	TIP29F		200	
Collector-emitter voltage ($I_B = 0$)	TIP29D	V_{CEO}	120	V
	TIP29E		140	
	TIP29F		160	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	1	A
Peak collector current (see Note 1)		I_{CM}	3	A
Continuous base current		I_B	0.4	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	30	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)} = 0.4$ A, $R_{BE} = 100\ \Omega$, $V_{BE(off)} = 0$, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	I_B = 0	TIP29D TIP29E TIP29F	120 140 160			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 160 V V_{CE} = 180 V V_{CE} = 200 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	TIP29D TIP29E 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	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 0.2 A I_C = 1 A	(see Notes 5 and 6)	40 15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 125 mA	I_C = 1 A	(see Notes 5 and 6)			0.7	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 1 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		2		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

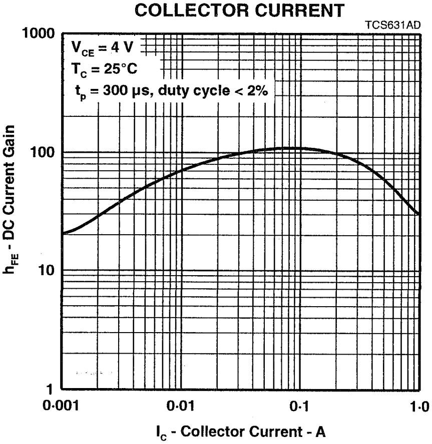


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

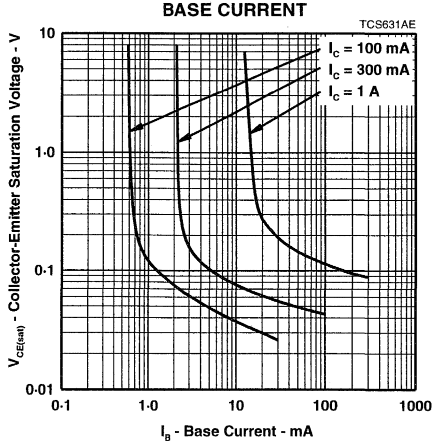


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

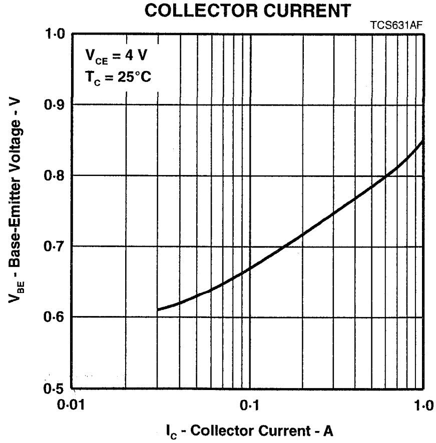


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

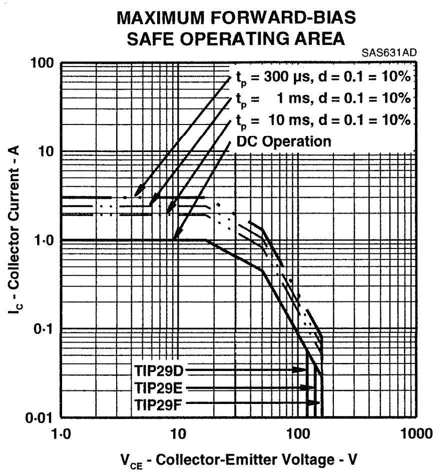


Figure 4.

THERMAL INFORMATION

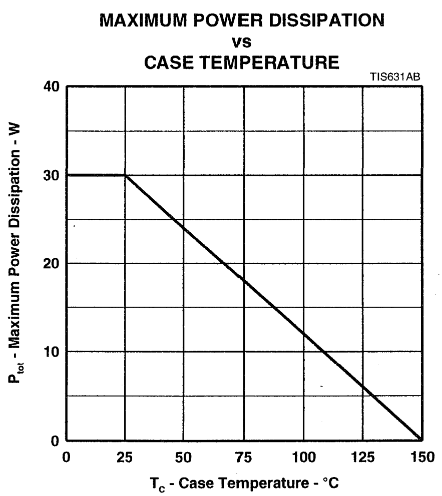


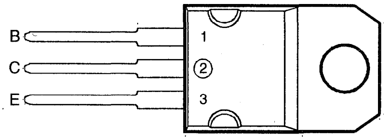
Figure 5.

TIP30, TIP30A,TIP30B, TIP30C
PNP SILICON POWER TRANSISTORS

JULY 1968 - REVISED MAY 1995

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

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	TIP30	V_{CBO}	-80	V
	TIP30A		-100	
	TIP30B		-120	
	TIP30C		-140	
Collector-emitter voltage ($I_B = 0$)	TIP30	V_{CEO}	-40	V
	TIP30A		-60	
	TIP30B		-80	
	TIP30C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-1	A
Peak collector current (see Note 1)		I_{CM}	-3	A
Continuous base current		I_B	-0.4	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	30	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)} = -0.4$ A, $R_{BE} = 100\ \Omega$, $V_{BE(off)} = 0$, $R_S = 0.1\ \Omega$, $V_{CC} = -20$ V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	TIP30	-40			V
				TIP30A	-60			
				TIP30B	-80			
				TIP30C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -80 V	V_{BE} = 0	TIP30			-0.2	mA
		V_{CE} = -100 V	V_{BE} = 0	TIP30A			-0.2	
		V_{CE} = -120 V	V_{BE} = 0	TIP30B			-0.2	
		V_{CE} = -140 V	V_{BE} = 0	TIP30C			-0.2	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0	TIP30/30A			-0.3	mA
		V_{CE} = -60 V	I_B = 0	TIP30B/30C			-0.3	
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	(see Notes 5 and 6)	40			
		V_{CE} = -4 V	I_C = -1 A		15		75	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -125 mA	I_C = -1 A	(see Notes 5 and 6)			-0.7	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -1 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

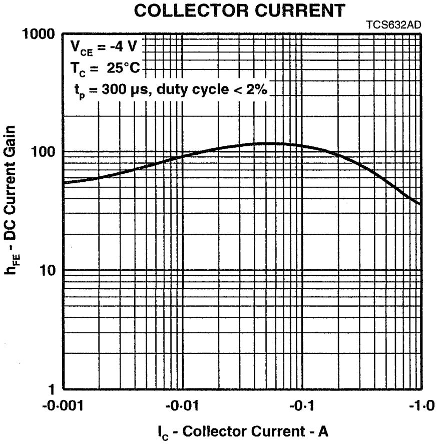


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

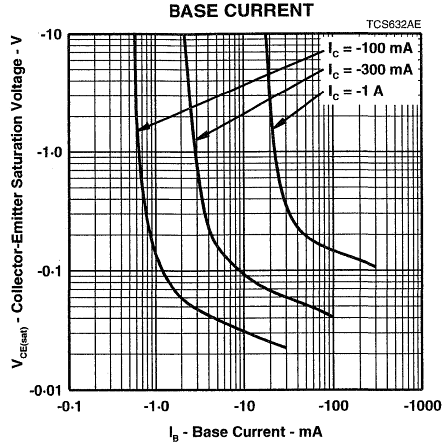


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

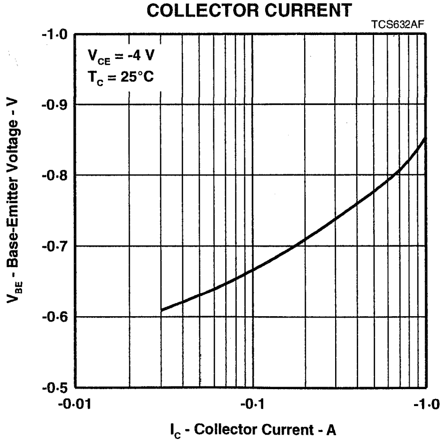


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

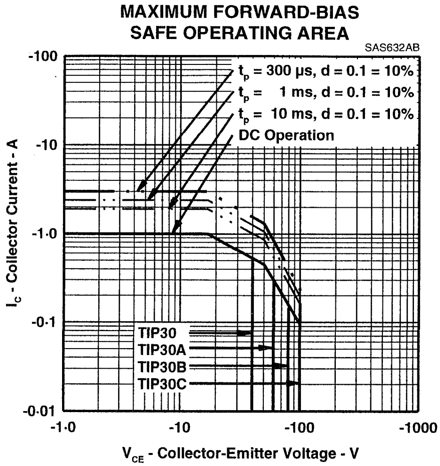


Figure 4.

THERMAL INFORMATION

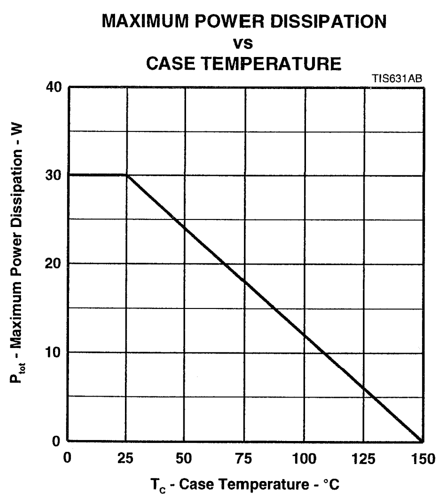
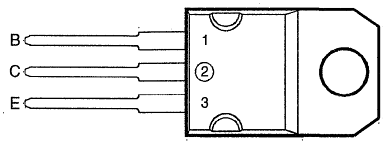


Figure 5.

- **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**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	TIP31	V_{CBO}	80	V
	TIP31A		100	
	TIP31B		120	
	TIP31C		140	
Collector-emitter voltage ($I_B = 0$)	TIP31	V_{CEO}	40	V
	TIP31A		60	
	TIP31B		80	
	TIP31C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	3	A
Peak collector current (see Note 1)		I_{CM}	5	A
Continuous base current		I_B	1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	40	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \le 0.3$ 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, $I_{B(on)} = 0.4$ A, $R_{BE} = 100\ \Omega$, $V_{BE(off)} = 0$, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

JULY 1968 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	TIP31	40			V
				TIP31A	60			
				TIP31B	80			
				TIP31C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 80 V	$V_{BE} = 0$	TIP31			0.2	mA
		V_{CE} = 100 V	$V_{BE} = 0$	TIP31A			0.2	
		V_{CE} = 120 V	$V_{BE} = 0$	TIP31B			0.2	
		V_{CE} = 140 V	$V_{BE} = 0$	TIP31C			0.2	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	TIP31/31A			0.3	mA
		V_{CE} = 60 V	$I_B = 0$	TIP31B/31C			0.3	
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 A	(see Notes 5 and 6)	25			
		V_{CE} = 4 V	I_C = 3 A		10		50	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 375 mA	I_C = 3 A	(see Notes 5 and 6)			1.2	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 3 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 μs, dc ≤ 2%		2		μs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

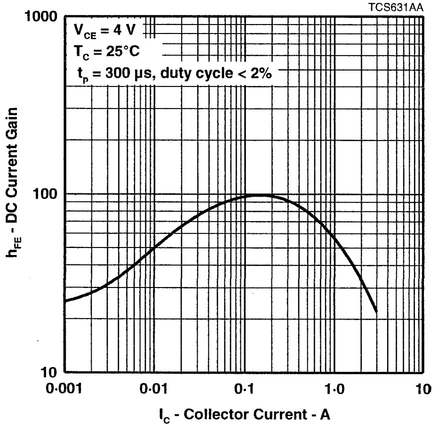


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

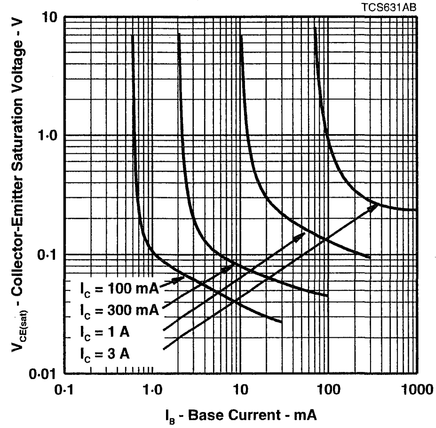


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

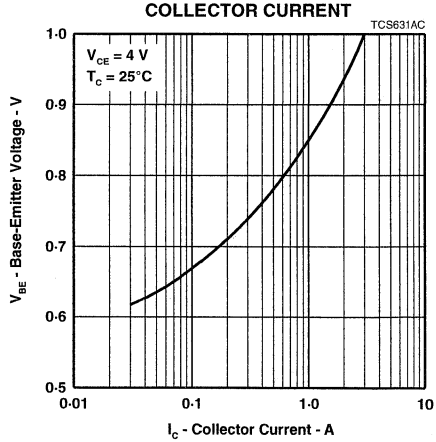


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

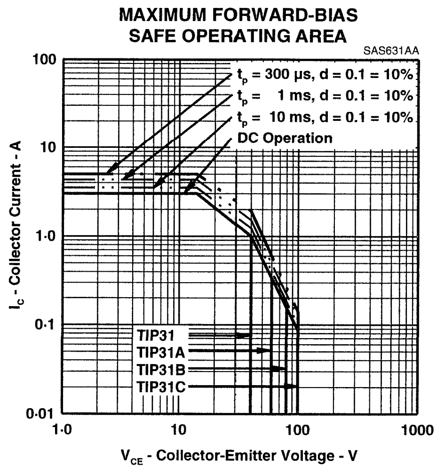


Figure 4.

THERMAL INFORMATION

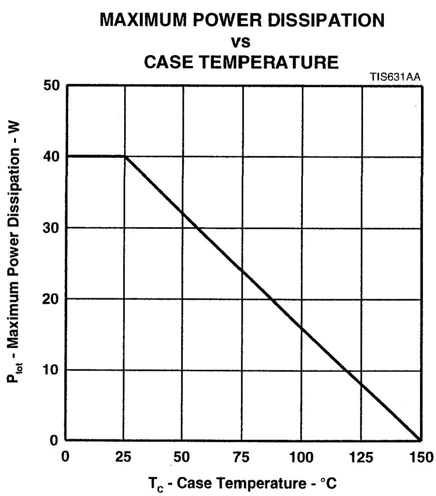


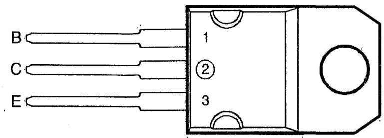
Figure 5.

TIP31D, TIP31E, TIP31F
NPN SILICON POWER TRANSISTORS

AUGUST 1978 - REVISED MAY 1995

- **40 W at 25°C Case Temperature**
- **3 A Continuous Collector Current**
- **5 A Peak Collector Current**
- **Customer-Specified Selections Available**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	TIP31D TIP31E TIP31F	120 140 160			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 160 V V_{CE} = 180 V V_{CE} = 200 V	$V_{BE} = 0$ $V_{BE} = 0$ $V_{BE} = 0$	TIP31D TIP31E 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	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 4 V V_{CE} = 4 V	I_C = 1 A I_C = 3 A	(see Notes 5 and 6)	25 5			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 750 mA	I_C = 3 A	(see Notes 5 and 6)			2.5	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 3 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		2		µs

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

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

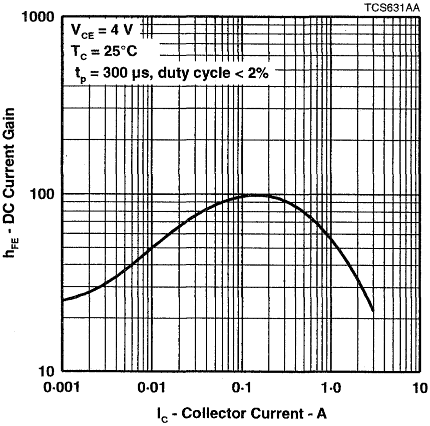


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

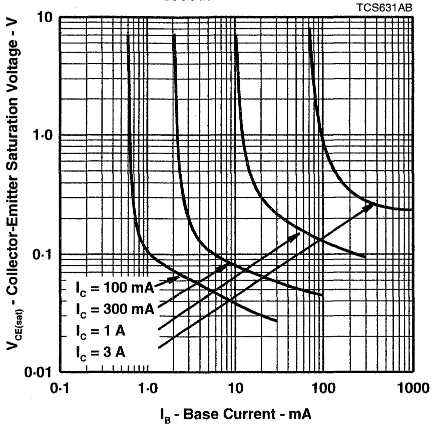


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

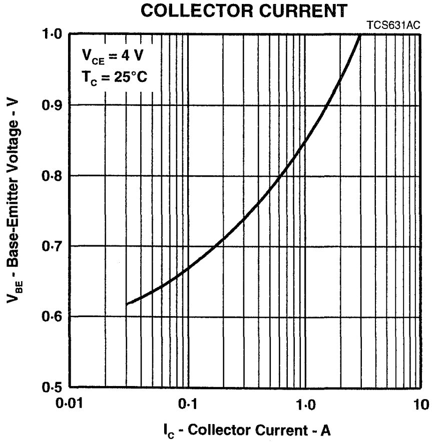


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

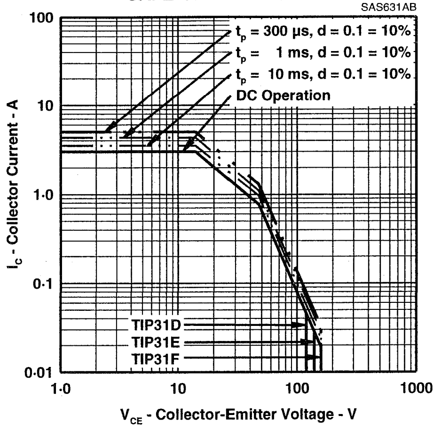


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

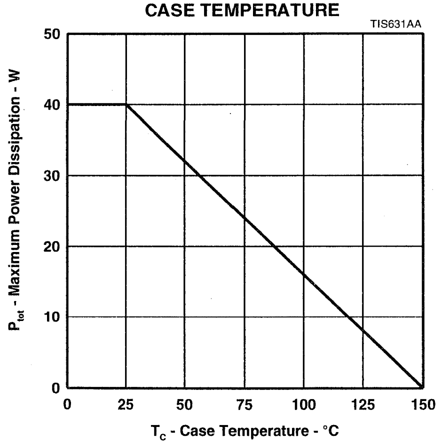
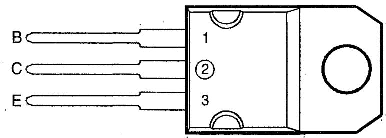


Figure 5.

JULY 1968 - REVISED MAY 1995

- **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**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP32	V_{CBO}	-80	V
	TIP32A		-100	
	TIP32B		-120	
	TIP32C		-140	
Collector-emitter voltage (I_B = 0)	TIP32	V_{CEO}	-40	V
	TIP32A		-60	
	TIP32B		-80	
	TIP32C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-3	A
Peak collector current (see Note 1)		I_{CM}	-5	A
Continuous base current		I_B	-1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	40	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	32	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	TIP32 TIP32A TIP32B TIP32C	-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	TIP32 TIP32A TIP32B TIP32C			-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	TIP32/32A TIP32B/32C			-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	(see Notes 5 and 6)	25 10		 50	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -375 mA	I_C = -3 A	(see Notes 5 and 6)			-1.2	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -3 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

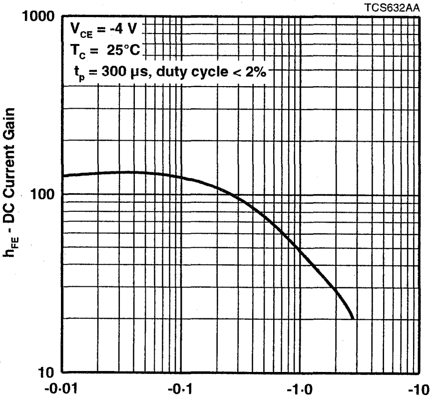


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

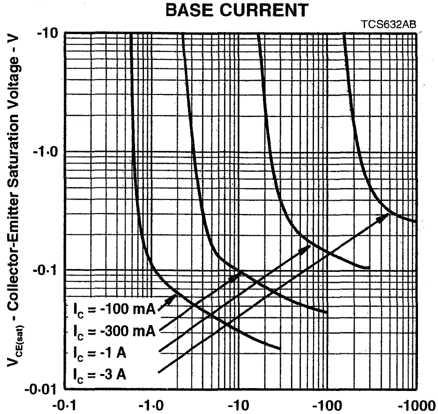


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

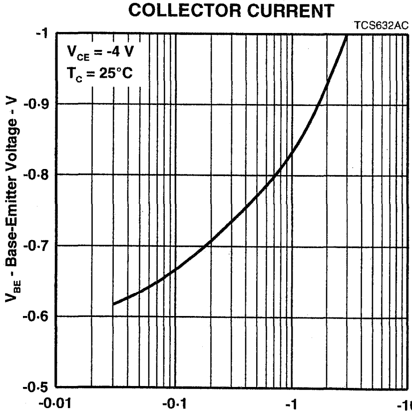


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

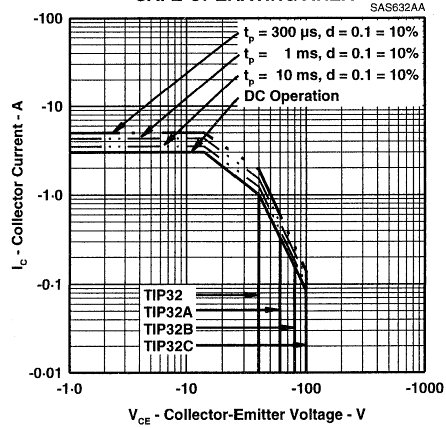


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

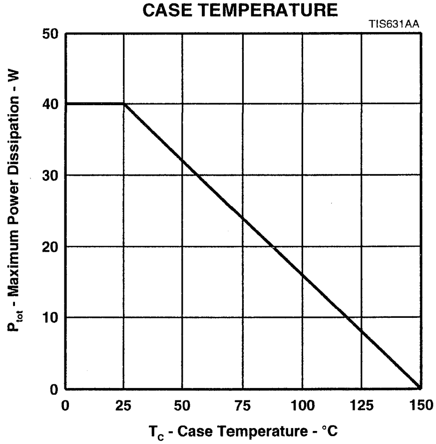
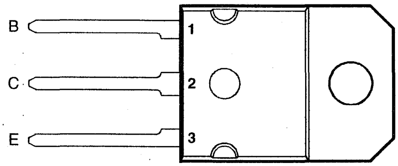


Figure 5.

TEXAS INSTRUMENTS

- **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**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	TIP33	V_{CBO}	80	V
	TIP33A		100	
	TIP33B		120	
	TIP33C		140	
Collector-emitter voltage ($I_B = 0$)	TIP33	V_{CEO}	40	V
	TIP33A		60	
	TIP33B		80	
	TIP33C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	10	A
Peak collector current (see Note 1)		I_{CM}	15	A
Continuous base current		I_B	3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	62.5	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES:
1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)} = 0.4$ A, $R_{BE} = 100\ \Omega$, $V_{BE(off)} = 0$, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	TIP33	40			V
				TIP33A	60			
				TIP33B	80			
				TIP33C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 80 V	$V_{BE} = 0$	TIP33			0.4	mA
		V_{CE} = 100 V	$V_{BE} = 0$	TIP33A			0.4	
		V_{CE} = 120 V	$V_{BE} = 0$	TIP33B			0.4	
		V_{CE} = 140 V	$V_{BE} = 0$	TIP33C			0.4	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	TIP33/33A			0.7	mA
		V_{CE} = 60 V	$I_B = 0$	TIP33B/33C			0.7	
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 A	(see Notes 5 and 6)	40			
		V_{CE} = 4 V	I_C = 3 A		20		100	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.3 A	I_C = 3 A	(see Notes 5 and 6)			1	V
		I_B = 2.5 A	I_C = 10 A				4	
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 3 A	(see Notes 5 and 6)			1.6	V
		V_{CE} = 4 V	I_C = 10 A				3	
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: 5. These parameters must be measured using pulse techniques, t_p = 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			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

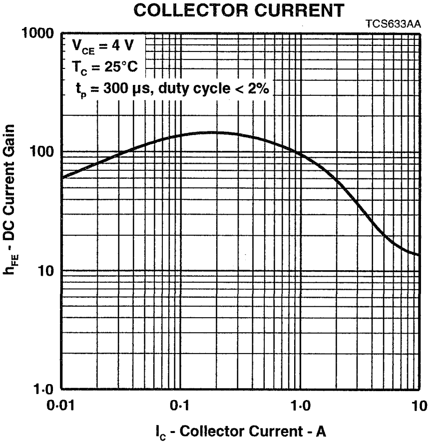


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

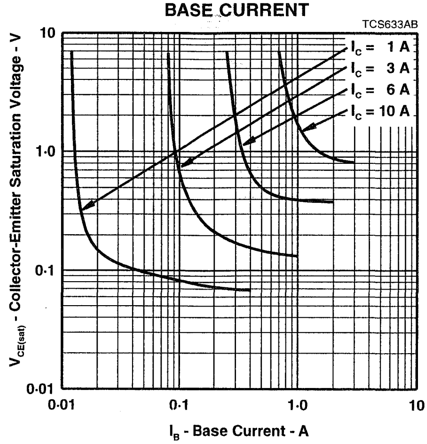


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

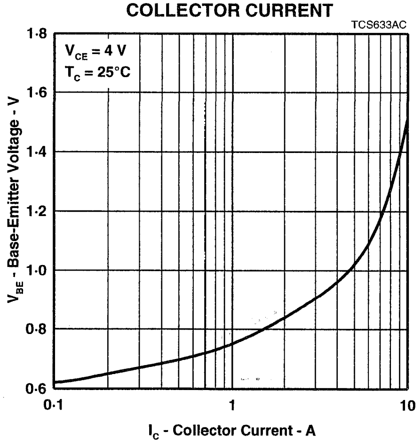


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

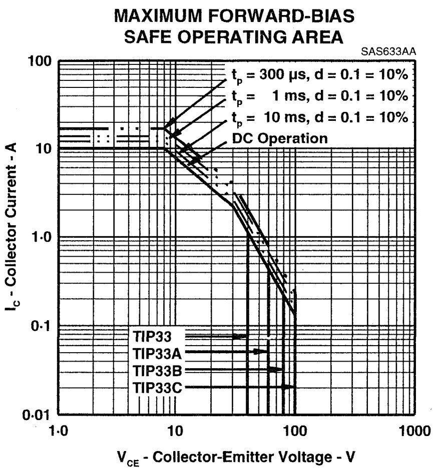


Figure 4.

THERMAL INFORMATION

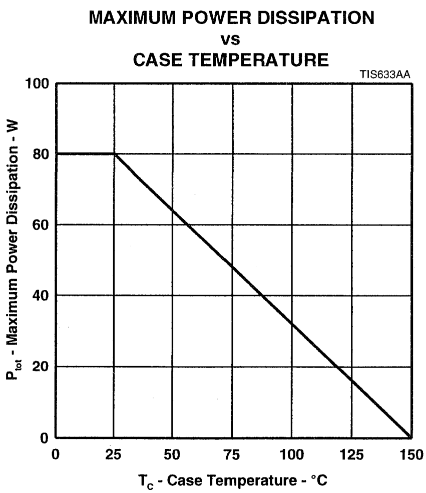


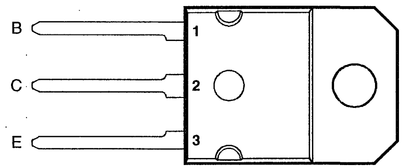
Figure 5.

TEXAS INSTRUMENTS

JULY 1968 - REVISED MAY 1995

- **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**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP34	V_{CBO}	-80	V
	TIP34A		-100	
	TIP34B		-120	
	TIP34C		-140	
Collector-emitter voltage (I_B = 0)	TIP34	V_{CEO}	-40	V
	TIP34A		-60	
	TIP34B		-80	
	TIP34C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-10	A
Peak collector current (see Note 1)		I_{CM}	-15	A
Continuous base current		I_B	-3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	62.5	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq$ 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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	TIP34	-40			V
				TIP34A	-60			
				TIP34B	-80			
				TIP34C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -80 V	V_{BE} = 0	TIP34			-0.4	mA
		V_{CE} = -100 V	V_{BE} = 0	TIP34A			-0.4	
		V_{CE} = -120 V	V_{BE} = 0	TIP34B			-0.4	
		V_{CE} = -140 V	V_{BE} = 0	TIP34C			-0.4	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0	TIP34/34A			-0.7	mA
		V_{CE} = -60 V	I_B = 0	TIP34B/34C			-0.7	
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 A	(see Notes 5 and 6)	40			
		V_{CE} = -4 V	I_C = -3 A		20		100	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.3 A	I_C = -3 A	(see Notes 5 and 6)			-1	V
		I_B = -2.5 A	I_C = -10 A				-4	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -3 A	(see Notes 5 and 6)			-1.6	V
		V_{CE} = -4 V	I_C = -10 A				-3	
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: 5. These parameters must be measured using pulse techniques, t_p = 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			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		0.7		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

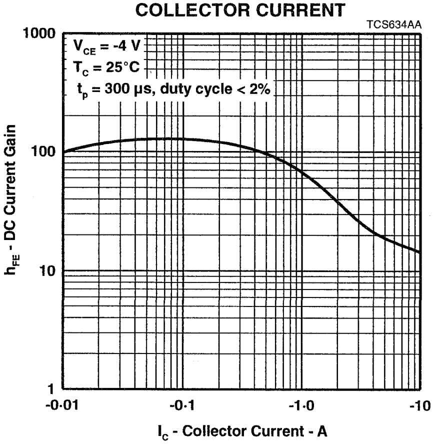


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

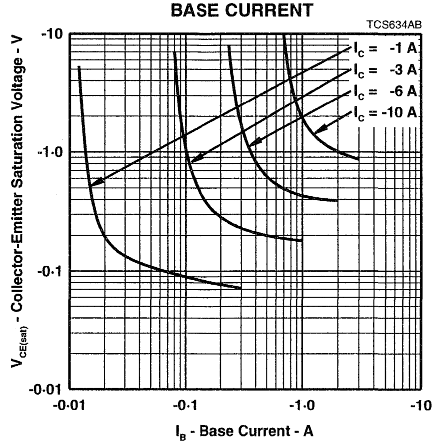


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

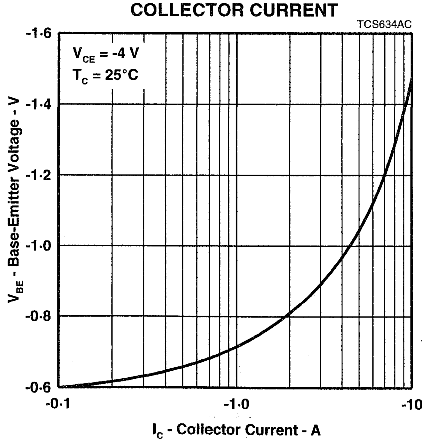


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

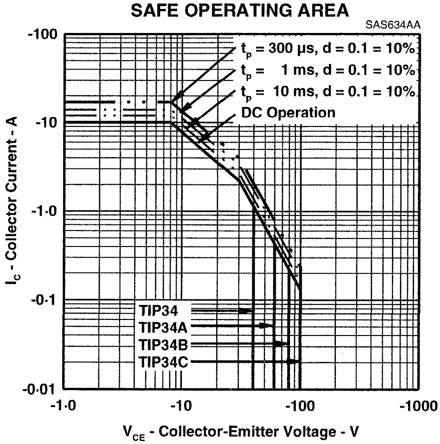


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

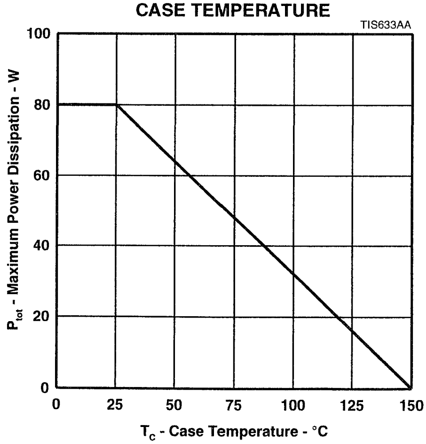
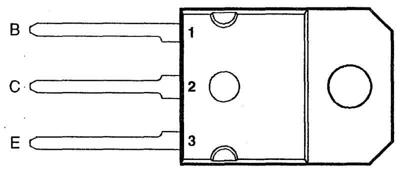


Figure 5.

JULY 1968 - REVISED MAY 1995

- **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**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP35	V_{CBO}	80	V
	TIP35A		100	
	TIP35B		120	
	TIP35C		140	
Collector-emitter voltage (I_B = 0)	TIP35	V_{CEO}	40	V
	TIP35A		60	
	TIP35B		80	
	TIP35C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	25	A
Peak collector current (see Note 1)		I_{CM}	40	A
Continuous base current		I_B	5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	125	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	90	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	TIP35	40			V
				TIP35A	60			
				TIP35B	80			
				TIP35C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 80 V	$V_{BE} = 0$	TIP35			0.7	mA
		V_{CE} = 100 V	$V_{BE} = 0$	TIP35A			0.7	
		V_{CE} = 120 V	$V_{BE} = 0$	TIP35B			0.7	
		V_{CE} = 140 V	$V_{BE} = 0$	TIP35C			0.7	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	TIP35/35A			1	mA
		V_{CE} = 60 V	$I_B = 0$	TIP35B/35C			1	
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	(see Notes 5 and 6)	25			
		V_{CE} = 4 V	I_C = 15 A		10		50	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 1.5 A	I_C = 15 A	(see Notes 5 and 6)			1.8	V
		I_B = 5 A	I_C = 25 A				4	
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 15 A	(see Notes 5 and 6)			2	V
		V_{CE} = 4 V	I_C = 25 A				4	
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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		0.9		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

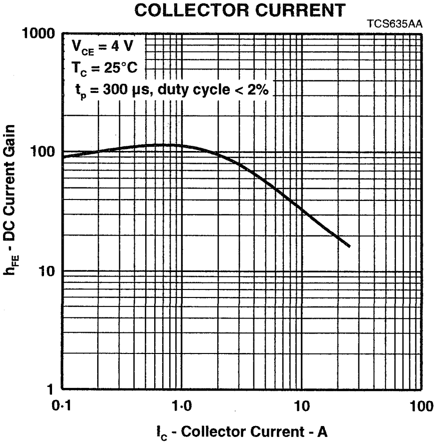


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

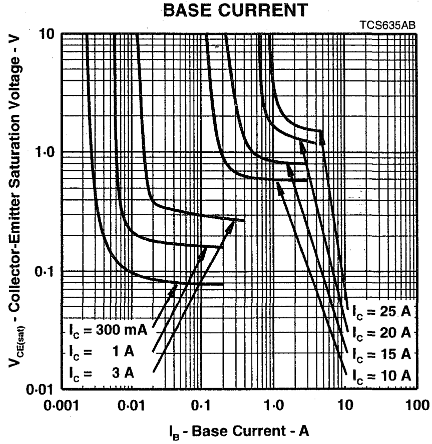


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

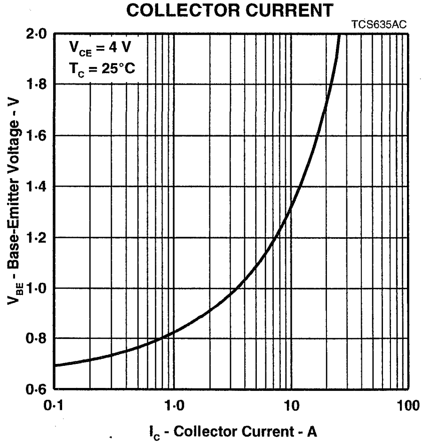


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

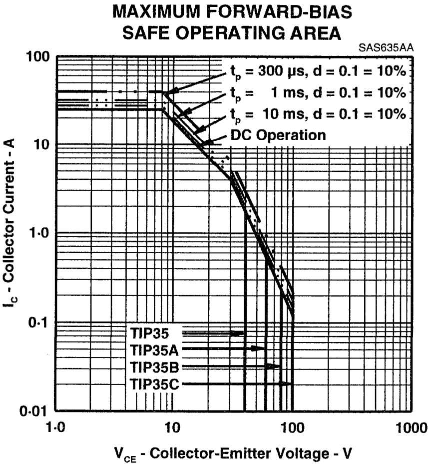


Figure 4.

THERMAL INFORMATION

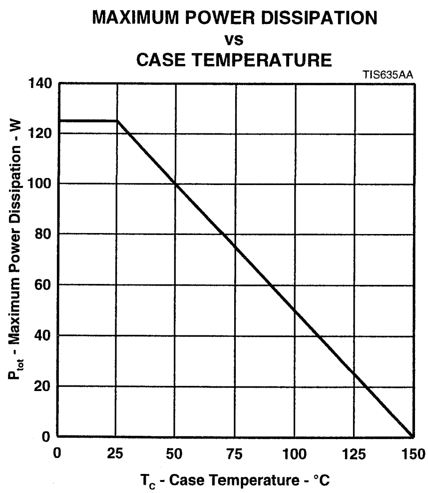


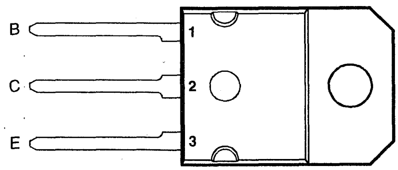
Figure 5.

TIP36, TIP36A, TIP36B, TIP36C
PNP SILICON POWER TRANSISTORS

JULY 1968 - REVISED MAY 1995

- **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**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	TIP36	V_{CBO}	-80	V
	TIP36A		-100	
	TIP36B		-120	
	TIP36C		-140	
Collector-emitter voltage ($I_B = 0$)	TIP36	V_{CEO}	-40	V
	TIP36A		-60	
	TIP36B		-80	
	TIP36C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-25	A
Peak collector current (see Note 1)		I_{CM}	-40	A
Continuous base current		I_B	-5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	125	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	90	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ ms, duty cycle $\leq$ 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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	TIP36	-40			V
				TIP36A	-60			
				TIP36B	-80			
				TIP36C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -80 V	V_{BE} = 0	TIP36			-0.7	mA
		V_{CE} = -100 V	V_{BE} = 0	TIP36A			-0.7	
		V_{CE} = -120 V	V_{BE} = 0	TIP36B			-0.7	
		V_{CE} = -140 V	V_{BE} = 0	TIP36C			-0.7	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0	TIP36/36A			-1	mA
		V_{CE} = -60 V	I_B = 0	TIP36B/36C			-1	
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	(see Notes 5 and 6)	25			
		V_{CE} = -4 V	I_C = -15 A		10		50	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -1.5 A	I_C = -15 A	(see Notes 5 and 6)			-1.8	V
		I_B = -5 A	I_C = -25 A				-4	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -15 A	(see Notes 5 and 6)			-2	V
		V_{CE} = -4 V	I_C = -25 A				-4	
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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 μs, dc ≤ 2%		0.8		μs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

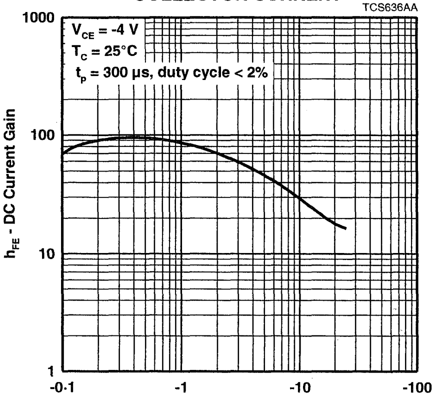


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

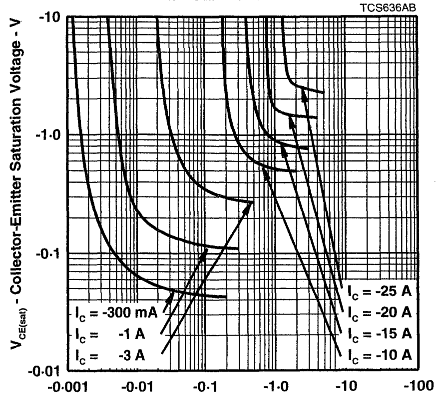


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

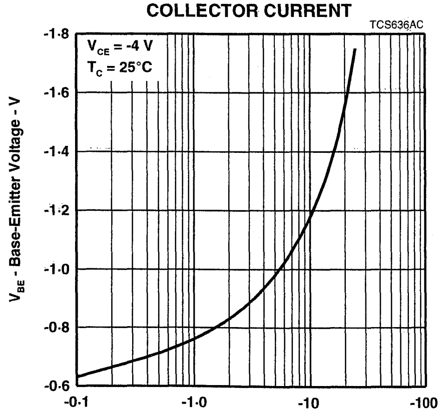


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

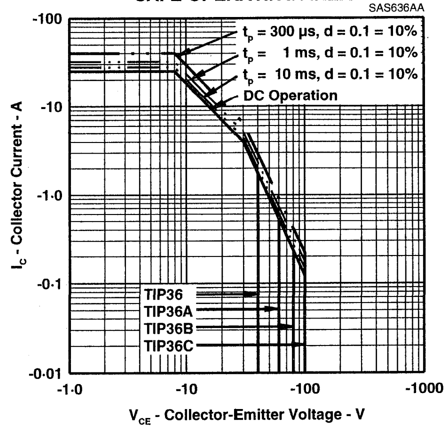


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

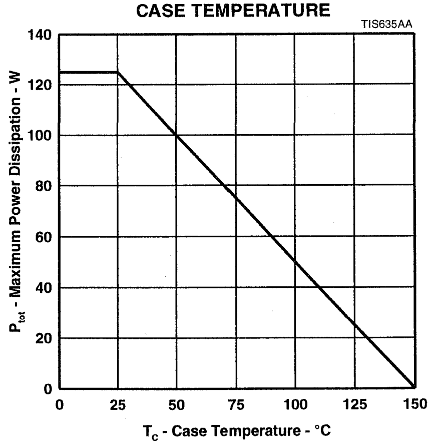
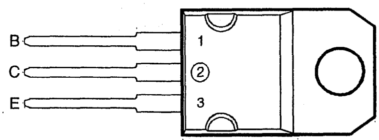


Figure 5.

DECEMBER 1970 - REVISED MAY 1995

- **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**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	TIP41	V_{CBO}	80	V
	TIP41A		100	
	TIP41B		120	
	TIP41C		140	
Collector-emitter voltage ($I_B = 0$)	TIP41	V_{CEO}	40	V
	TIP41A		60	
	TIP41B		80	
	TIP41C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	6	A
Peak collector current (see Note 1)		I_{CM}	10	A
Continuous base current		I_B	3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	65	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	62.5	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)} = 0.4$ A, $R_{BE} = 100\ \Omega$, $V_{BE(off)} = 0$, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	TIP41	40			V
				TIP41A	60			
				TIP41B	80			
				TIP41C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 80 V	$V_{BE} = 0$	TIP41			0.4	mA
		V_{CE} = 100 V	$V_{BE} = 0$	TIP41A			0.4	
		V_{CE} = 120 V	$V_{BE} = 0$	TIP41B			0.4	
		V_{CE} = 140 V	$V_{BE} = 0$	TIP41C			0.4	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	TIP41/41A			0.7	mA
		V_{CE} = 60 V	$I_B = 0$	TIP41B/41C			0.7	
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 = 0.3 A	(see Notes 5 and 6)	30			
		V_{CE} = 4 V	I_C = 3 A		15		75	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.6 A	I_C = 6 A	(see Notes 5 and 6)			1.5	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 6 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.92	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

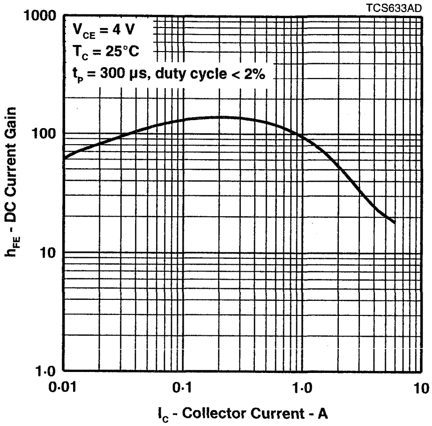


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

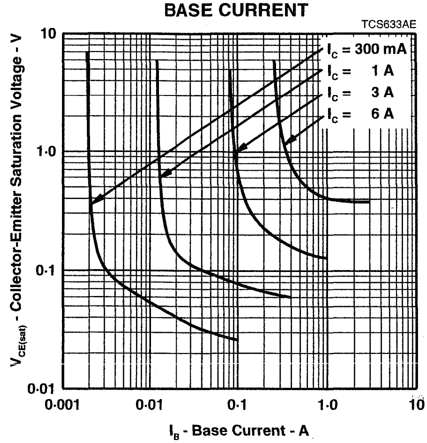


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

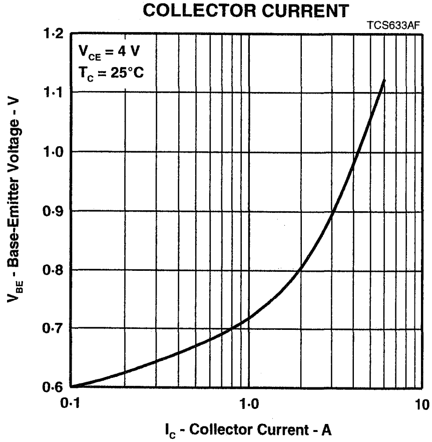


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

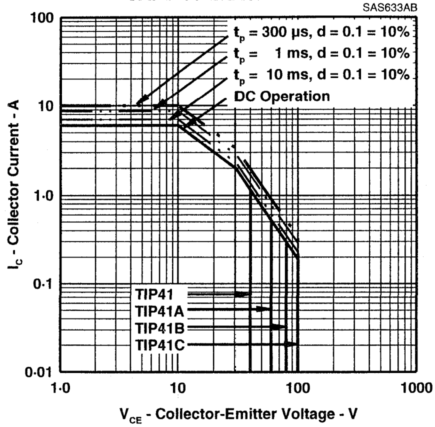


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

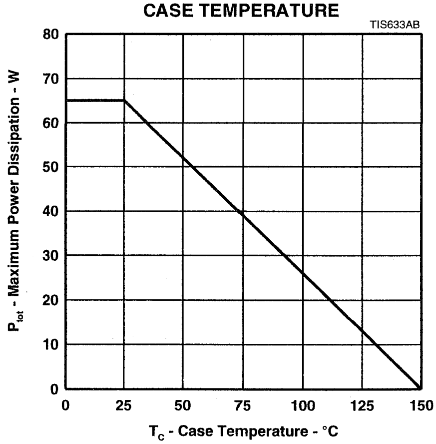


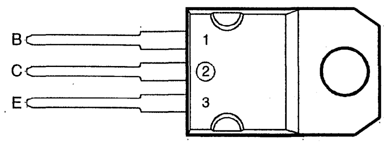
Figure 5.

TEXAS INSTRUMENTS

DECEMBER 1970 - REVISED MAY 1995

- **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**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP42	V_{CBO}	-80	V
	TIP42A		-100	
	TIP42B		-120	
	TIP42C		-140	
Collector-emitter voltage (I_B = 0)	TIP42	V_{CEO}	-40	V
	TIP42A		-60	
	TIP42B		-80	
	TIP42C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-6	A
Peak collector current (see Note 1)		I_{CM}	-10	A
Continuous base current		I_B	-3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	65	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	62.5	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	250	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

DECEMBER 1970 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	TIP42	-40			V
				TIP42A	-60			
				TIP42B	-80			
				TIP42C	-100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = -80 V	V_{BE} = 0	TIP42			-0.4	mA
		V_{CE} = -100 V	V_{BE} = 0	TIP42A			-0.4	
		V_{CE} = -120 V	V_{BE} = 0	TIP42B			-0.4	
		V_{CE} = -140 V	V_{BE} = 0	TIP42C			-0.4	
I_{CEO}	Collector cut-off current	V_{CE} = -30 V	I_B = 0	TIP42/42A			-0.7	mA
		V_{CE} = -60 V	I_B = 0	TIP42B/42C			-0.7	
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 = -0.3 A	(see Notes 5 and 6)	30			
		V_{CE} = -4 V	I_C = -3 A		15		75	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.6 A	I_C = -6 A	(see Notes 5 and 6)			-1.5	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -6 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.92	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		0.7		µs

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

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

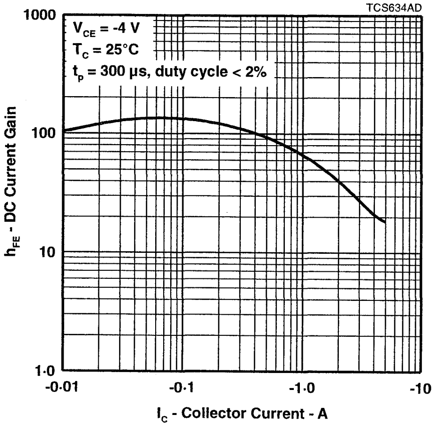


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

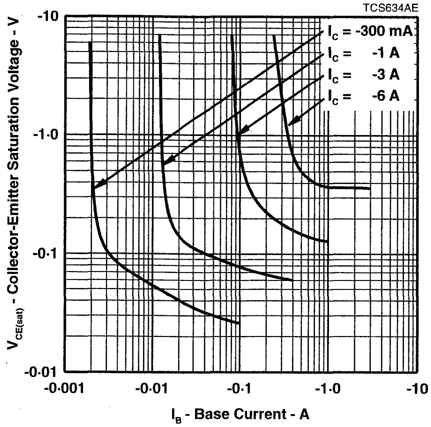


Figure 2.

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

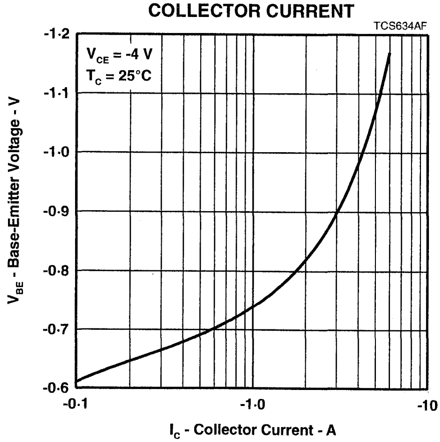


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

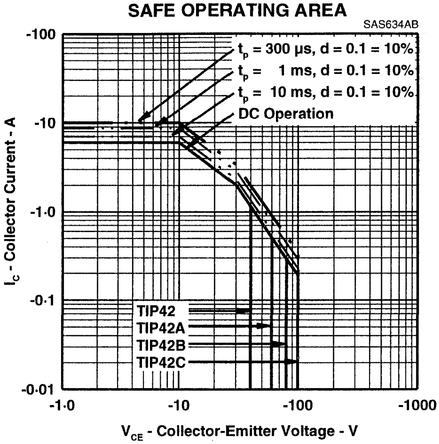


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

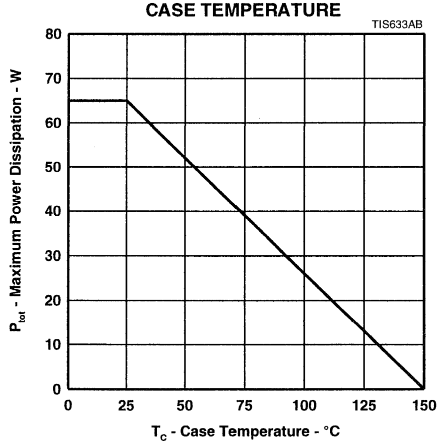
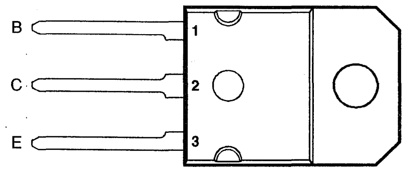


Figure 5.

JANUARY 1972 - REVISED MAY 1995

- **Designed for Complementary Use with the TIP3055 Series**
- **90 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	V_{CBO}	-100	V
Collector-emitter voltage (I_B = 0) (see Note 1)	V_{CER}	-70	V
Emitter-base voltage	V_{EBO}	-7	V
Continuous collector current	I_C	-15	A
Continuous base current	I_B	-7	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)	P_{tot}	90	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)	P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)	$\frac{1}{2}LI_C^2$	62.5	mJ
Operating junction temperature range	T_j	-65 to +150	°C
Storage temperature range	T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds	T_L	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, $I_{B(on)}$ = -0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -10 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA	I_B = 0	(see Note 5)	-60			V
I_{CEO}	Collector 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 V_{CE} = -4 V	I_C = -4 A I_C = -10 A	(see Notes 5 and 6)	20 5		70	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -0.4 A I_B = -3.3 A	I_C = -4 A I_C = -10 A	(see Notes 5 and 6)			-1.1 -3	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -4 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.39	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		0.7		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

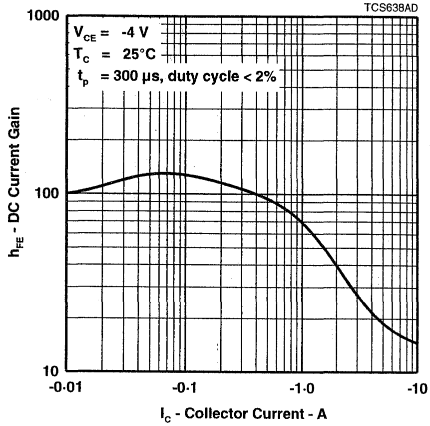


Figure 1.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

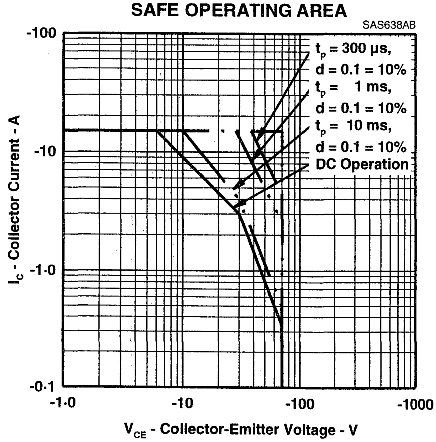


Figure 2.

THERMAL INFORMATION

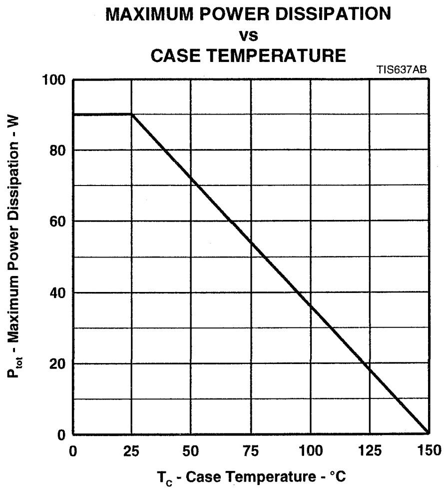
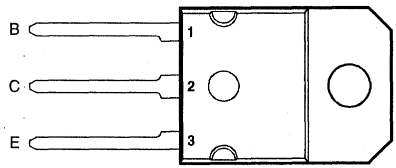


Figure 3.

DECEMBER 1970 - REVISED MAY 1995

- **Designed for Complementary Use with the TIP2955 Series**
- **90 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	V_{CBO}	100	V
Collector-emitter voltage (I_B = 0) (see Note 1)	V_{CER}	70	V
Emitter-base voltage	V_{EBO}	7	V
Continuous collector current	I_C	15	A
Continuous base current	I_B	7	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)	P_{tot}	90	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)	P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)	$½LI_C^2$	62.5	mJ
Operating junction temperature range	T_j	-65 to +150	°C
Storage temperature range	T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds	T_L	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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 10 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA	I_B = 0	(see Note 5)	60			V
I_{CER}	Collector-emitter cut-off current	V_{CE} = 70 V	R_{BE} = 100 Ω				1	mA
I_{CEO}	Collector 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 V_{CE} = 4 V	I_C = 4 A I_C = 10 A	(see Notes 5 and 6)	20 5		70	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.4 A I_B = 3.3 A	I_C = 4 A I_C = 10 A	(see Notes 5 and 6)			1.1 3	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 4 A	(see Notes 5 and 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_p = 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			1.39	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		1		µs

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

TYPICAL CHARACTERISTICS

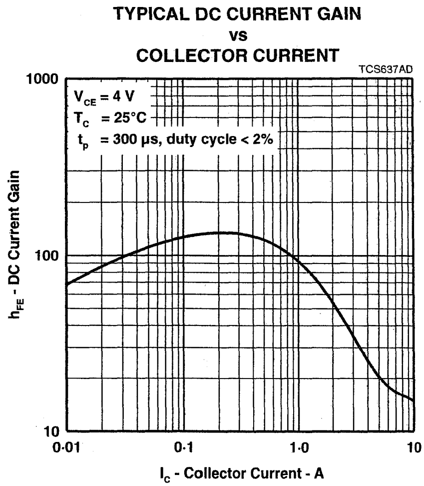


Figure 1.

MAXIMUM SAFE OPERATING REGIONS

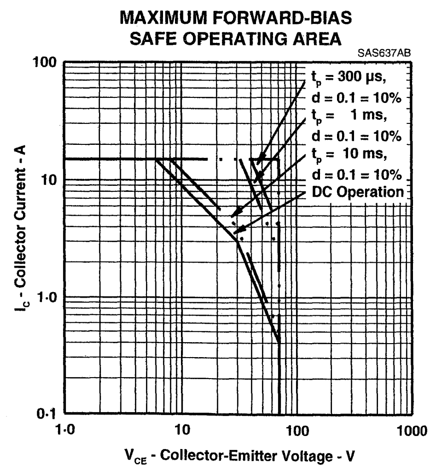


Figure 2.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

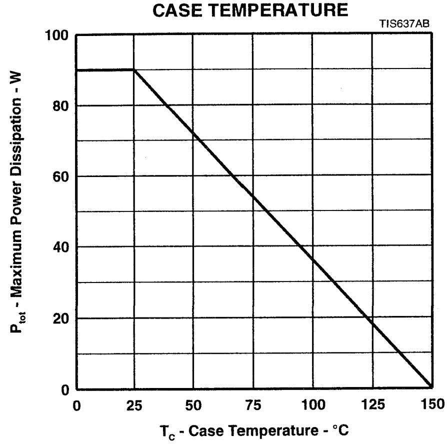
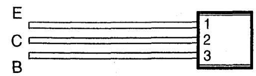


Figure 3.

- **20 W Pulsed Power Dissipation**
- **100 V Capability**
- **2 A Continuous Collector Current**
- **4 A Peak Collector Current**

LP PACKAGE
(TOP VIEW)



MDTRAB

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIPP31	V_{CBO}	40	V
	TIPP31A		60	
	TIPP31B		80	
	TIPP31C		100	
Collector-emitter voltage (I_B = 0)	TIPP31	V_{CEO}	40	V
	TIPP31A		60	
	TIPP31B		80	
	TIPP31C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	2	A
Peak collector current (see Note 1)		I_{CM}	4	A
Continuous base current		I_B	1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	0.8	W
Pulsed power dissipation (see Note 3)		P_T	20	W
Operating junction temperature range		T_j	-55 to +150	°C
Storage temperature range		T_{stg}	-55 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, t_p = 10 ms, duty cycle ≤ 2%.

MAY 1989 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 5 mA (see Note 4)	$I_B = 0$	TIPP31	40			V
				TIPP31A	60			
				TIPP31B	80			
				TIPP31C	100			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 40 V	$V_{BE} = 0$	TIPP31			0.2	mA
		V_{CE} = 60 V	$V_{BE} = 0$	TIPP31A			0.2	
		V_{CE} = 80 V	$V_{BE} = 0$	TIPP31B			0.2	
		V_{CE} = 100 V	$V_{BE} = 0$	TIPP31C			0.2	
I_{CEO}	Collector cut-off current	V_{CE} = 30 V	$I_B = 0$	TIPP31/31A			0.3	mA
		V_{CE} = 60 V	$I_B = 0$	TIPP31B/31C			0.3	
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 A	(see Notes 4 and 5)	20			
		V_{CE} = 4 V	I_C = 2 A		10			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 375 mA	I_C = 2 A	(see Notes 4 and 5)			1	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 2 A	(see Notes 4 and 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			

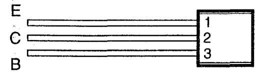
NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.

TIPP32, TIPP32A,TIPP32B, TIPP32C
PNP SILICON POWER TRANSISTORS

MAY 1989 - REVISED MAY 1995

- **20 W Pulsed Power Dissipation**
- **100 V Capability**
- **2 A Continuous Collector Current**
- **4 A Peak Collector Current**

LP PACKAGE
(TOP VIEW)



MDTRAB

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIPP32	V_{CBO}	-40	V
	TIPP32A		-60	
	TIPP32B		-80	
	TIPP32C		-100	
Collector-emitter voltage (I_B = 0)	TIPP32	V_{CEO}	-40	V
	TIPP32A		-60	
	TIPP32B		-80	
	TIPP32C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-2	A
Peak collector current (see Note 1)		I_{CM}	-4	A
Continuous base current		I_B	-1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	0.8	W
Pulsed power dissipation (see Note 3)		P_T	20	W
Operating junction temperature range		T_j	-55 to +150	°C
Storage temperature range		T_{stg}	-55 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, t_p = 10 ms, duty cycle ≤ 2%.

MAY 1989 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -5 mA (see 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	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -4 V V_{CE} = -4 V	I_C = -1 A I_C = -2 A	(see Notes 4 and 5)	20 10			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -375 mA	I_C = -2 A	(see Notes 4 and 5)			-1	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -2 A	(see Notes 4 and 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			

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
5. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.

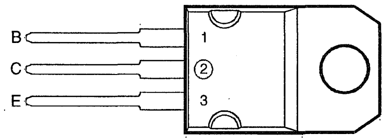
TEXAS INSTRUMENTS

BD645, BD647, BD649, BD651
NPN SILICON POWER DARLINGTONS

MAY 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BD646, BD648, BD650 and BD652**
- **62.5 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 3 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD645	V_{CBO}	80	V
	BD647		100	
	BD649		120	
	BD651		140	
Collector-emitter voltage (I_B = 0)	BD645	V_{CEO}	60	V
	BD647		80	
	BD649		100	
	BD651		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Peak collector current (see Note 1)		I_{CM}	12	A
Continuous base current		I_B	0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	62.5	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	50	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \le 0.3$ 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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, 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	(see Note 5)	BD645	60			V
					BD647	80			
					BD649	100			
					BD651	120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BD645			0.5	mA
		V_{CE} = 40 V	I_B = 0		BD647			0.5	
		V_{CE} = 50 V	I_B = 0		BD649			0.5	
		V_{CE} = 60 V	I_B = 0		BD651			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 60 V	I_E = 0		BD645			0.2	mA
		V_{CB} = 80 V	I_E = 0		BD647			0.2	
		V_{CB} = 100 V	I_E = 0		BD649			0.2	
		V_{CB} = 120 V	I_E = 0		BD651			0.2	
		V_{CB} = 40 V	I_E = 0	T_C = 150°C	BD645			2.0	
		V_{CB} = 50 V	I_E = 0	T_C = 150°C	BD647			2.0	
		V_{CB} = 60 V	I_E = 0	T_C = 150°C	BD649			2.0	
		V_{CB} = 70 V	I_E = 0	T_C = 150°C	BD651			2.0	
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0	(see Notes 5 and 6)				5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V	I_C = 3 A	(see Notes 5 and 6)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 12 mA	I_C = 3 A	(see Notes 5 and 6)				2	V
		I_B = 50 mA	I_C = 5 A					2.5	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 50 mA	I_C = 5 A	(see Notes 5 and 6)				3	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 3 A	(see Notes 5 and 6)				2.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			2.0	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

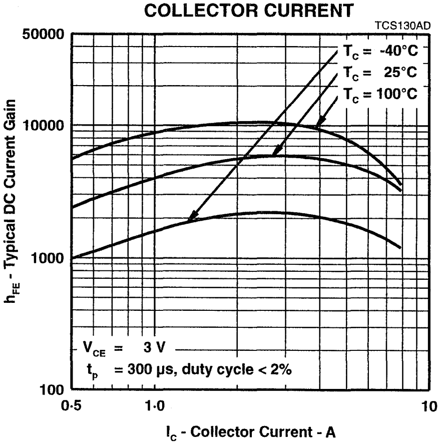


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

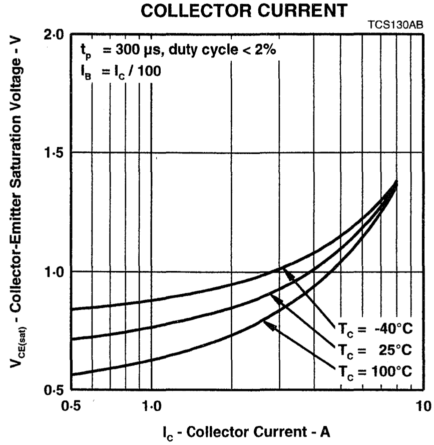


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

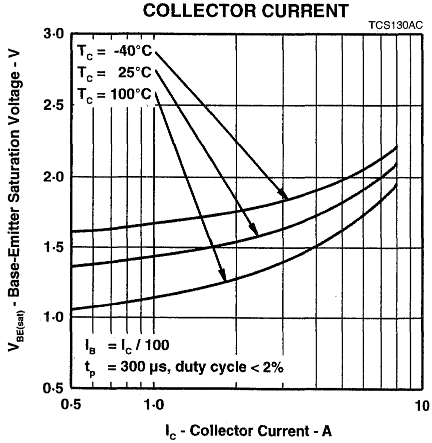


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

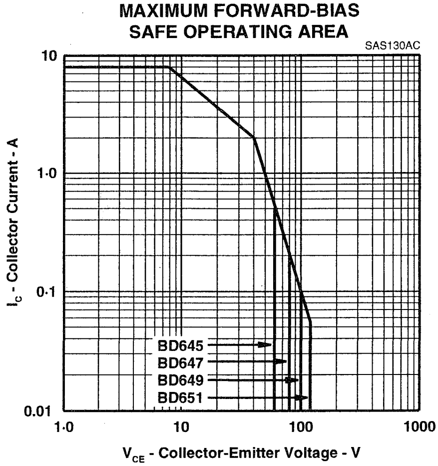


Figure 4.

THERMAL INFORMATION

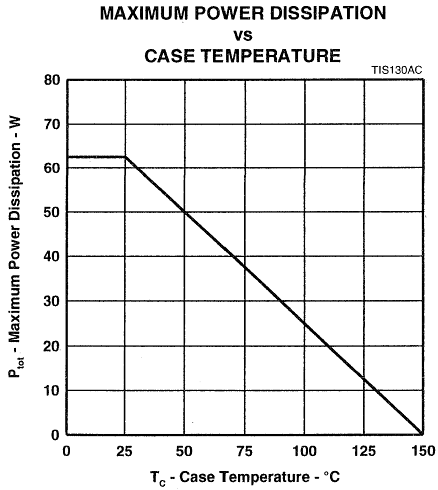
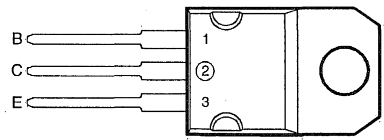


Figure 5.

- **Designed for Complementary Use with BD645, BD647, BD649 and BD651**
- **62.5 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 3 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD646	V_{CBO}	-80	V
	BD648		-100	
	BD650		-120	
	BD652		-140	
Collector-emitter voltage (I_B = 0)	BD646	V_{CEO}	-60	V
	BD648		-80	
	BD650		-100	
	BD652		-120	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-8	A
Peak collector current (see Note 1)		I_{CM}	-12	A
Continuous base current		I_B	-0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	62.5	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	50	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

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	$I_B = 0$	(see Note 5)	BD646	-60			V
					BD648	-80			
					BD650	-100			
					BD652	-120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	$I_B = 0$		BD646			-0.5	mA
		V_{CE} = -40 V	$I_B = 0$		BD648			-0.5	
		V_{CE} = -50 V	$I_B = 0$		BD650			-0.5	
		V_{CE} = -60 V	$I_B = 0$		BD652			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -60 V	$I_E = 0$		BD646			-0.2	mA
		V_{CB} = -80 V	$I_E = 0$		BD648			-0.2	
		V_{CB} = -100 V	$I_E = 0$		BD650			-0.2	
		V_{CB} = -120 V	$I_E = 0$		BD652			-0.2	
		V_{CB} = -40 V	$I_E = 0$	T_C = 150°C	BD646			-2.0	
		V_{CB} = -50 V	$I_E = 0$	T_C = 150°C	BD648			-2.0	
		V_{CB} = -60 V	$I_E = 0$	T_C = 150°C	BD650			-2.0	
		V_{CB} = -70 V	$I_E = 0$	T_C = 150°C	BD652			-2.0	
I_{EBO}	Emitter cut-off current	V_{EB} = -5 V	$I_C = 0$	(see Notes 5 and 6)				-5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V	I_C = -3 A	(see Notes 5 and 6)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -12 mA	I_C = -3 A	(see Notes 5 and 6)				-2	V
		I_B = -50 mA	I_C = -5 A					-2.5	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = -50 mA	I_C = -5 A	(see Notes 5 and 6)				-3	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -3 A	(see Notes 5 and 6)				-2.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			2.0	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

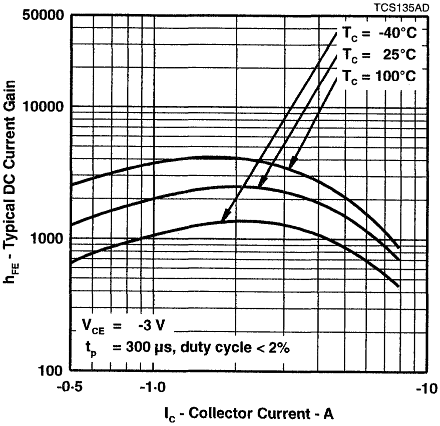


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

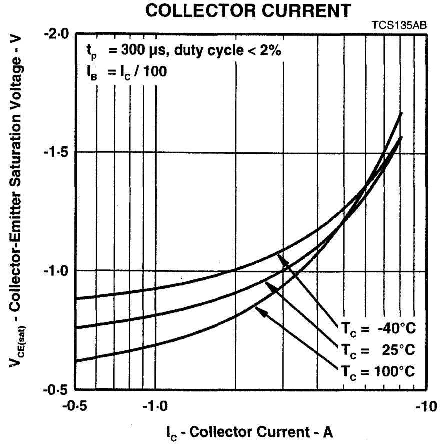


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

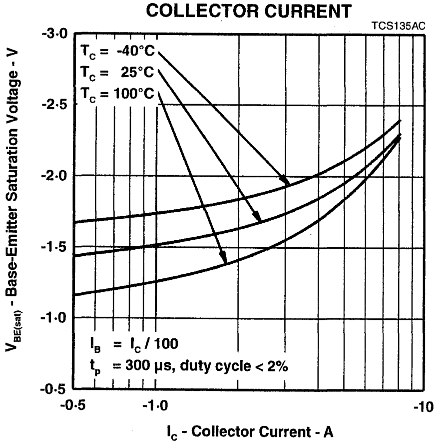


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

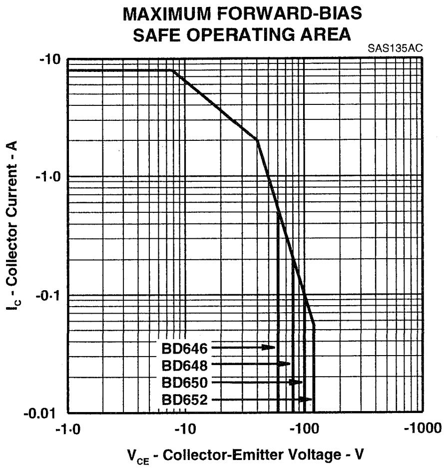


Figure 4.

THERMAL INFORMATION

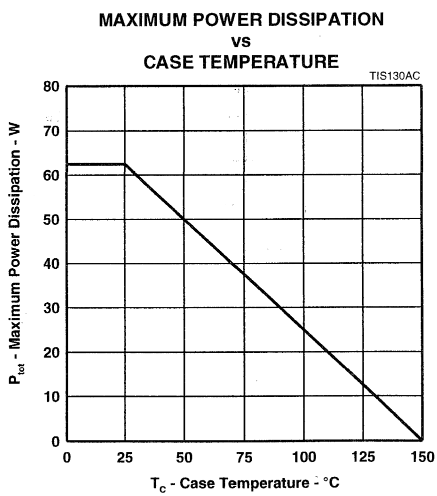
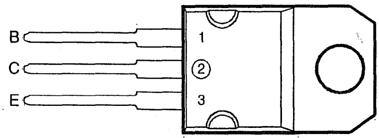


Figure 5.

- **Designed for Complementary Use with BD896, BD898, BD900 and BD902**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3V, 3A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD895	V_{CBO}	45	V
	BD897		60	
	BD899		80	
	BD901		100	
Collector-emitter voltage (I_B = 0)	BD895	V_{CEO}	45	V
	BD897		60	
	BD899		80	
	BD901		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Continuous base current		I_B	0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating free-air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTES: 1. Derate linearly to 150°C case temperature at the rate of 0.56 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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 100 mA	I_B = 0	(see Note 3)	BD895	45			V
					BD897	60			
					BD899	80			
					BD901	100			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BD895			0.5	mA
		V_{CE} = 30 V	I_B = 0		BD897			0.5	
		V_{CE} = 40 V	I_B = 0		BD899			0.5	
		V_{CE} = 50 V	I_B = 0		BD901			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	I_E = 0		BD895			0.2	mA
		V_{CB} = 60 V	I_E = 0		BD897			0.2	
		V_{CB} = 80 V	I_E = 0		BD899			0.2	
		V_{CB} = 100 V	I_E = 0		BD901			0.2	
		V_{CB} = 45 V	I_E = 0	T_C = 100°C	BD895			2	
		V_{CB} = 60 V	I_E = 0	T_C = 100°C	BD897			2	
		V_{CB} = 80 V	I_E = 0	T_C = 100°C	BD899			2	
		V_{CB} = 100 V	I_E = 0	T_C = 100°C	BD901			2	
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0	(see Notes 3 and 4)				2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V	I_C = 3 A	(see Notes 3 and 4)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 12 mA	I_C = 3 A	(see Notes 3 and 4)				2.5	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 3 A	(see Notes 3 and 4)				2.5	V
V_{EC}	Parallel diode forward voltage	I_E = 8 A	I_B = 0					3.5	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			1.79	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

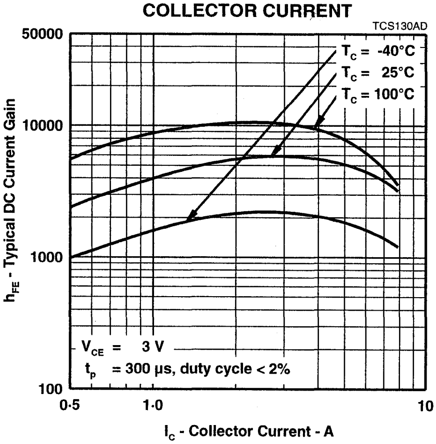


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

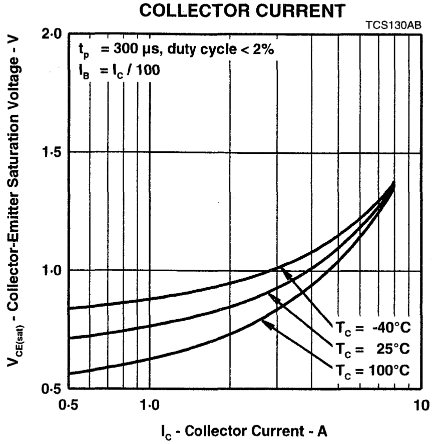


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

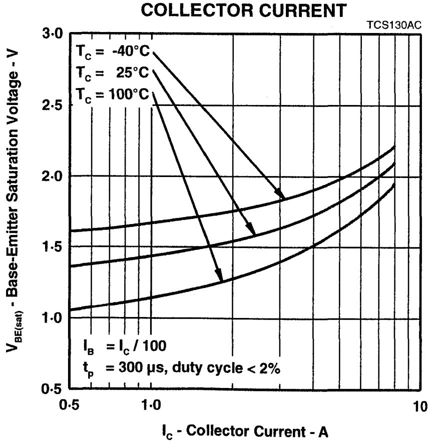


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

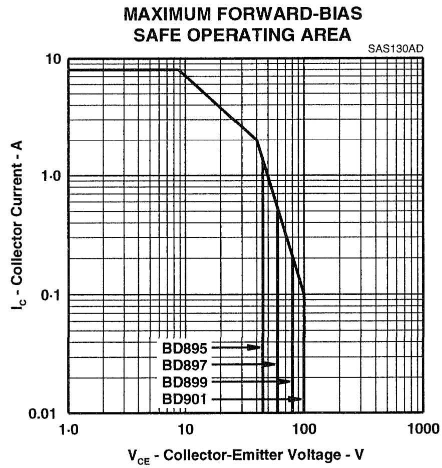


Figure 4.

THERMAL INFORMATION

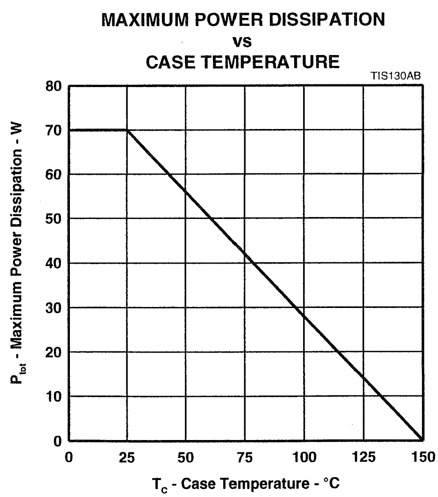


Figure 5.

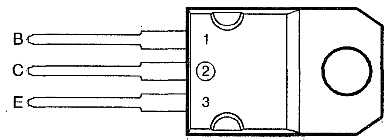
TEXAS INSTRUMENTS

BD895A, BD897A, BD899A
NPN SILICON POWER DARLINGTONS

AUGUST 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BD896A, BD898A and BD900A**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3V, 3A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD895A	V_{CBO}	45	V
	BD897A		60	
	BD899A		80	
Collector-emitter voltage (I_B = 0)	BD895A	V_{CEO}	45	V
	BD897A		60	
	BD899A		80	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Continuous base current		I_B	0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating free-air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTES: 1. Derate linearly to 150°C case temperature at the rate of 0.56 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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 100 mA	$I_B = 0$	(see Note 3)	BD895A	45			V
					BD897A	60			
					BD899A	80			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	$I_B = 0$		BD895A			0.5	mA
		V_{CE} = 30 V	$I_B = 0$		BD897A			0.5	
		V_{CE} = 40 V	$I_B = 0$		BD899A			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	$I_E = 0$		BD895A			0.2	mA
		V_{CB} = 60 V	$I_E = 0$		BD897A			0.2	
		V_{CB} = 80 V	$I_E = 0$		BD899A			0.2	
		V_{CB} = 45 V	$I_E = 0$	T_C = 100°C	BD895A			2	
		V_{CB} = 60 V	$I_E = 0$	T_C = 100°C	BD897A			2	
		V_{CB} = 80 V	$I_E = 0$	T_C = 100°C	BD899A			2	
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	$I_C = 0$	(see Notes 3 and 4)				2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V	I_C = 4 A	(see Notes 3 and 4)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 16 mA	I_C = 4 A	(see Notes 3 and 4)				2.8	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 4 A	(see Notes 3 and 4)				2.5	V
V_{EC}	Parallel diode forward voltage	I_E = 8 A	$I_B = 0$					3.5	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			1.79	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

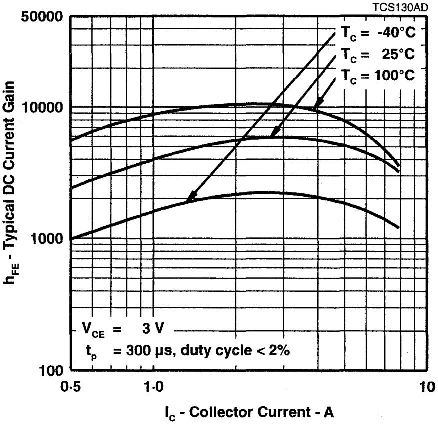


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

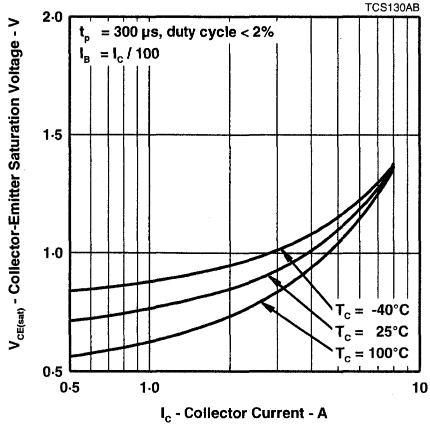


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

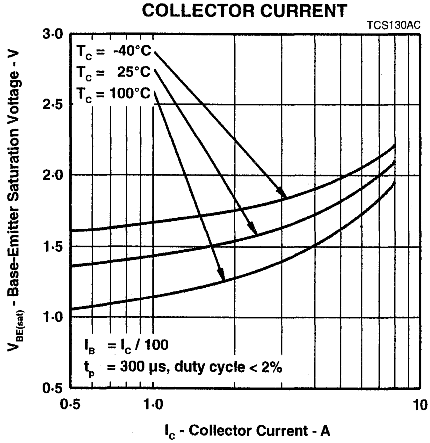


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

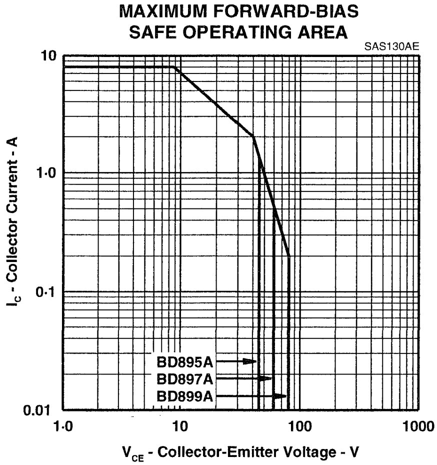


Figure 4.

THERMAL INFORMATION

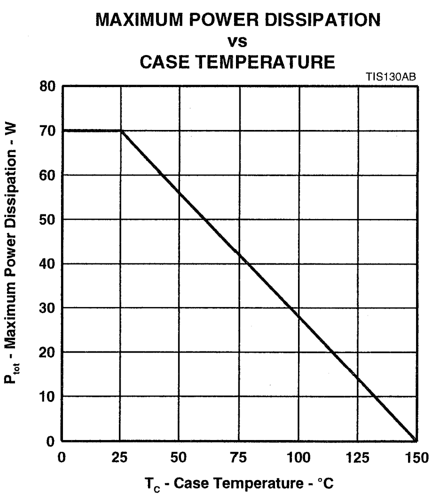
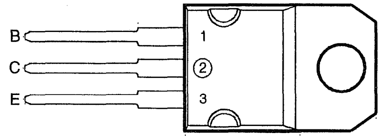


Figure 5.

TEXAS INSTRUMENTS

- **Designed for Complementary Use with BD895, BD897, BD899 and BD901**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3V, 3A**

**TO-220 PACKAGE
(TOP VIEW)**



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD896	V_{CBO}	-45	V
	BD898		-60	
	BD900		-80	
	BD902		-100	
Collector-emitter voltage (I_B = 0)	BD896	V_{CEO}	-45	V
	BD898		-60	
	BD900		-80	
	BD902		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-8	A
Continuous base current		I_B	-0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating free-air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTES: 1. Derate linearly to 150°C case temperature at the rate of 0.56 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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -100 mA	I_B = 0	(see Note 3)	BD896	-45			V
					BD898	-60			
					BD900	-80			
					BD902	-100			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0		BD896			-0.5	mA
		V_{CE} = -30 V	I_B = 0		BD898			-0.5	
		V_{CE} = -40 V	I_B = 0		BD900			-0.5	
		V_{CE} = -50 V	I_B = 0		BD902			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	I_E = 0		BD896			-0.2	mA
		V_{CB} = -60 V	I_E = 0		BD898			-0.2	
		V_{CB} = -80 V	I_E = 0		BD900			-0.2	
		V_{CB} = -100 V	I_E = 0		BD902			-0.2	
		V_{CB} = -45 V	I_E = 0	T_C = 100°C	BD896			-2	
		V_{CB} = -60 V	I_E = 0	T_C = 100°C	BD898			-2	
		V_{CB} = -80 V	I_E = 0	T_C = 100°C	BD900			-2	
		V_{CB} = -100 V	I_E = 0	T_C = 100°C	BD902			-2	
I_{EBO}	Emitter cut-off current	V_{EB} = -5 V	I_C = 0	(see Notes 3 and 4)				-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V	I_C = -3 A	(see Notes 3 and 4)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -12 mA	I_C = -3 A	(see Notes 3 and 4)				-2.5	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -3 A	(see Notes 3 and 4)				-2.5	V
V_{EC}	Parallel diode forward voltage	I_E = -8 A	I_B = 0					-3.5	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			1.79	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

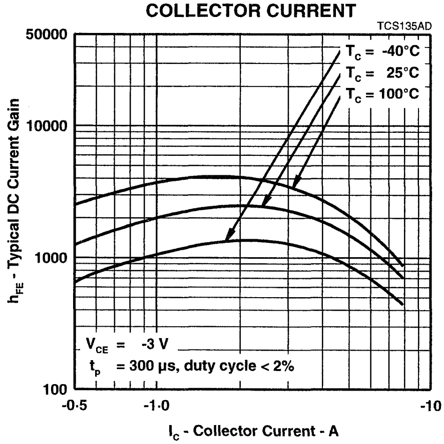


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

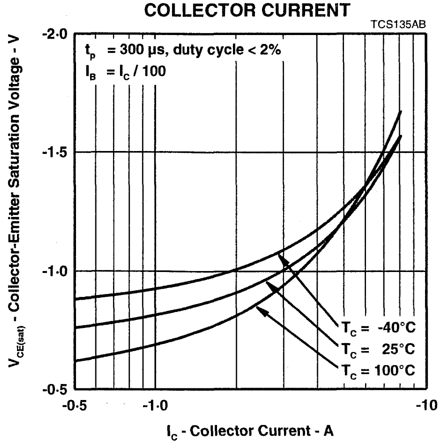


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

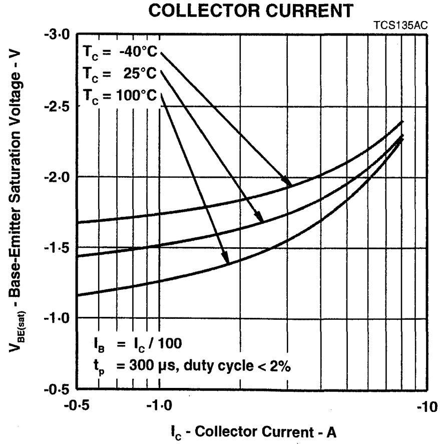


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

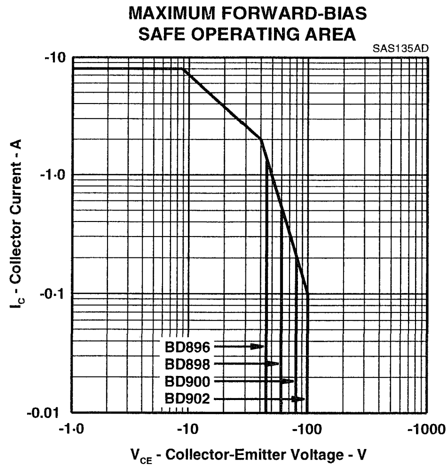


Figure 4.

THERMAL INFORMATION

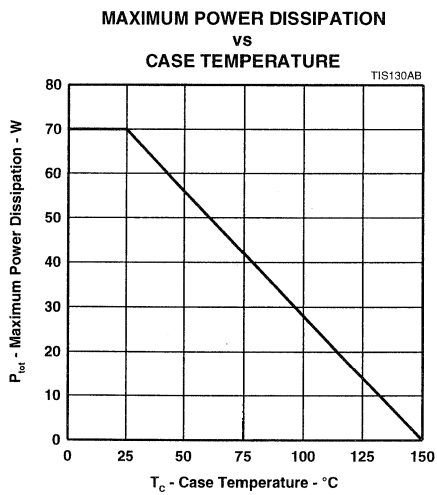


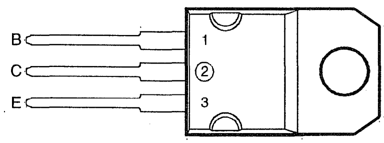
Figure 5.

BD896A, BD898A, BD900A
PNP SILICON POWER DARLINGTONS

AUGUST 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BD895A, BD897A and BD899A**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3V, 3A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BD896A	V_{CBO}	-45	V
	BD898A		-60	
	BD900A		-80	
Collector-emitter voltage (I_B = 0)	BD896A	V_{CEO}	-45	V
	BD898A		-60	
	BD900A		-80	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-8	A
Continuous base current		I_B	-0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating free-air temperature range		T_A	-65 to +150	°C
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTES: 1. Derate linearly to 150°C case temperature at the rate of 0.56 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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -100 mA	$I_B = 0$	(see Note 3)	BD896A	-45			V
					BD898A	-60			
					BD900A	-80			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	$I_B = 0$		BD896A			-0.5	mA
		V_{CE} = -30 V	$I_B = 0$		BD898A			-0.5	
		V_{CE} = -40 V	$I_B = 0$		BD900A			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	$I_E = 0$		BD896A			-0.2	mA
		V_{CB} = -60 V	$I_E = 0$		BD898A			-0.2	
		V_{CB} = -80 V	$I_E = 0$		BD900A			-0.2	
		V_{CB} = -45 V	$I_E = 0$	T_C = 100°C	BD896A			-2	
		V_{CB} = -60 V	$I_E = 0$	T_C = 100°C	BD898A			-2	
		V_{CB} = -80 V	$I_E = 0$	T_C = 100°C	BD900A			-2	
I_{EBO}	Emitter cut-off current	V_{EB} = -5 V	$I_C = 0$	(see Notes 3 and 4)				-2	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V	I_C = -4 A	(see Notes 3 and 4)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -16 mA	I_C = -4 A	(see Notes 3 and 4)				-2.8	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -4 A	(see Notes 3 and 4)				-2.5	V
V_{EC}	Parallel diode forward voltage	I_E = -8 A	$I_B = 0$					-3.5	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			1.79	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

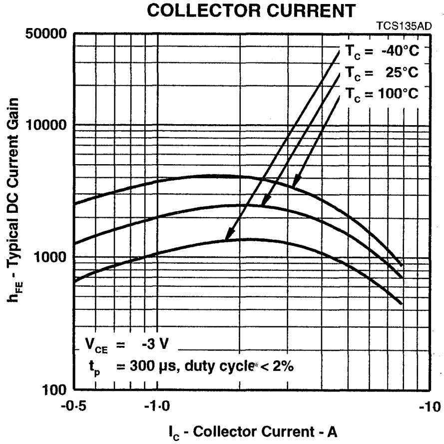


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

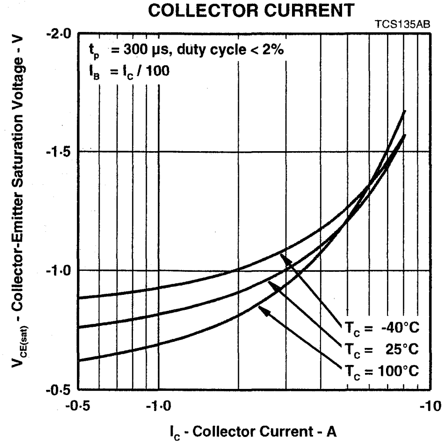


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

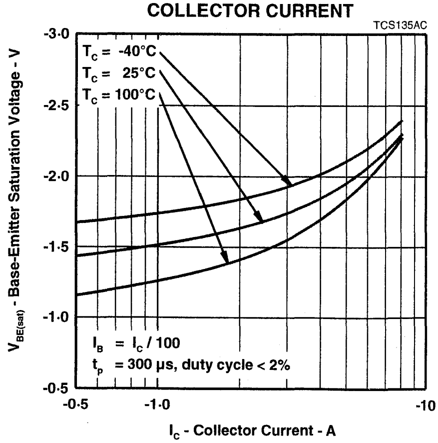


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

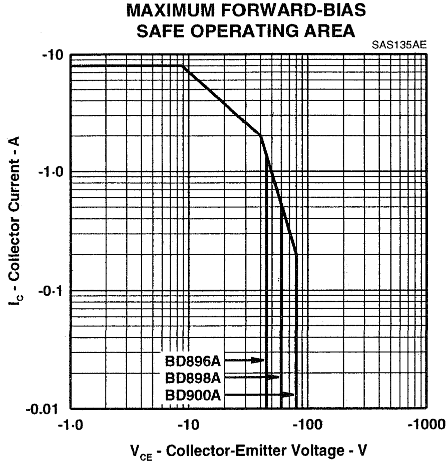


Figure 4.

THERMAL INFORMATION

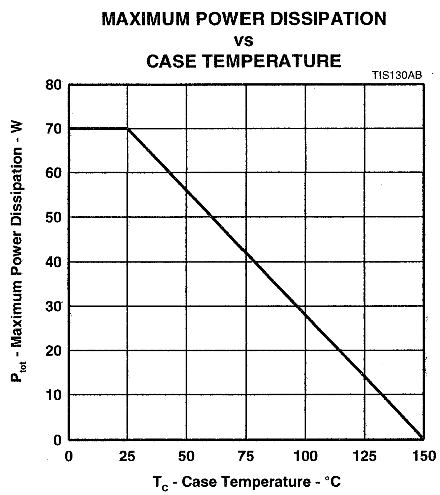
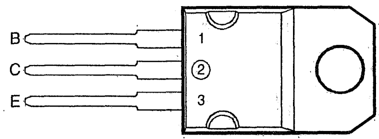


Figure 5.

- **Designed for Complementary Use with BDT61, BDT61A, BDT61B and BDT61C**
- **50 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 1.5 V, 3 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDT60	V_{CBO}	-60	V
	BDT60A		-80	
	BDT60B		-100	
	BDT60C		-120	
Collector-emitter voltage (I_B = 0)	BDT60	V_{CEO}	-60	V
	BDT60A		-80	
	BDT60B		-100	
	BDT60C		-120	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-4	A
Continuous base current		I_B	-0.1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	50	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA	I_B = 0	(see Note 3)	BDT60	-60			V
					BDT60A	-80			
					BDT60B	-100			
					BDT60C	-120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0		BDT60			-0.5	mA
		V_{CE} = -40 V	I_B = 0		BDT60A			-0.5	
		V_{CE} = -50 V	I_B = 0		BDT60B			-0.5	
		V_{CE} = -60 V	I_B = 0		BDT60C			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -60 V	I_E = 0		BDT60			-0.2	mA
		V_{CB} = -80 V	I_E = 0		BDT60A			-0.2	
		V_{CB} = -100 V	I_E = 0		BDT60B			-0.2	
		V_{CB} = -120 V	I_E = 0		BDT60C			-0.2	
		V_{CB} = -30 V	I_E = 0	T_C = 150°C	BDT60			-2.0	
		V_{CB} = -40 V	I_E = 0	T_C = 150°C	BDT60A			-2.0	
		V_{CB} = -50 V	I_E = 0	T_C = 150°C	BDT60B			-2.0	
		V_{CB} = -60 V	I_E = 0	T_C = 150°C	BDT60C			-2.0	
I_{EBO}	Emitter cut-off current	V_{EB} = -5 V	I_C = 0					-5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V	I_C = -1.5 A	(see Notes 3 and 4)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -6 mA	I_C = -1.5 A	(see Notes 3 and 4)				-2.5	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -1.5 A	(see Notes 3 and 4)				-2.5	V
V_{EC}	Parallel diode forward voltage	I_E = -1.5 A	I_B = 0					-2.0	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			2.5	°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 †			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 = 20 Ω	t_p = 20 µs, dc ≤ 2%		4.5		µs

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

TYPICAL CHARACTERISTICS

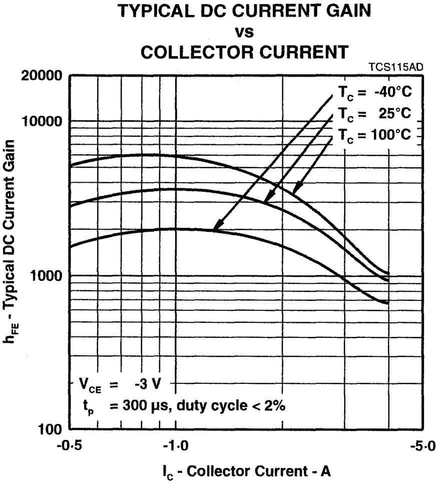


Figure 1.

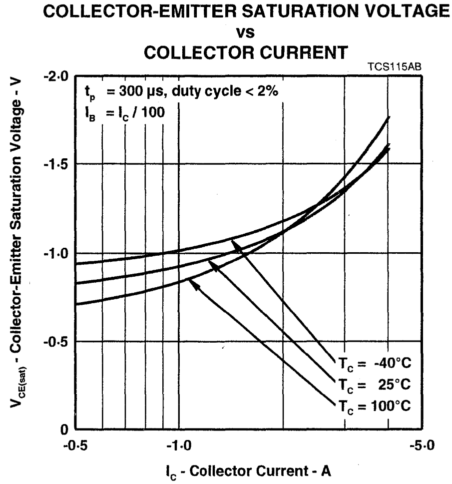


Figure 2.

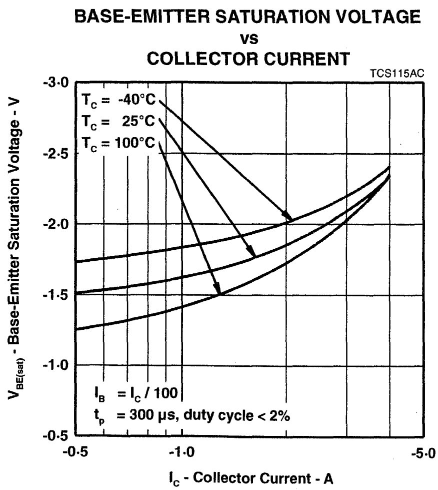


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

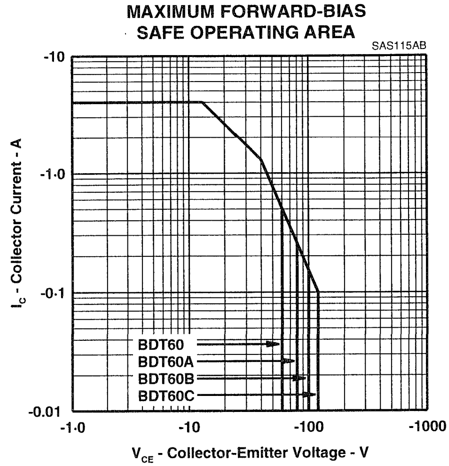


Figure 4.

THERMAL INFORMATION

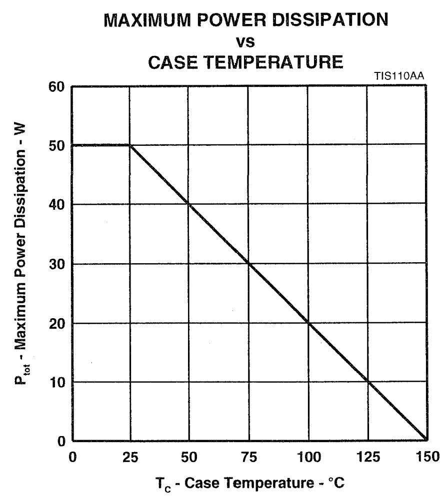


Figure 5.

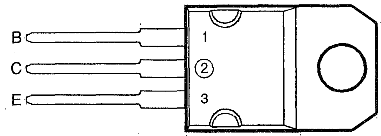
TEXAS INSTRUMENTS

BDT61, BDT61A, BDT61B, BDT61C
NPN SILICON POWER DARLINGTONS

AUGUST 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BDT60, BDT60A, BDT60B and BDT60C**
- **50 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 1.5 V, 3 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDT61	V_{CBO}	60	V
	BDT61A		80	
	BDT61B		100	
	BDT61C		120	
Collector-emitter voltage (I_B = 0)	BDT61	V_{CEO}	60	V
	BDT61A		80	
	BDT61B		100	
	BDT61C		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	4	A
Continuous base current		I_B	0.1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	50	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA	I_B = 0	(see Note 3)	BDT61	60			V
					BDT61A	80			
					BDT61B	100			
					BDT61C	120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BDT61			0.5	mA
		V_{CE} = 40 V	I_B = 0		BDT61A			0.5	
		V_{CE} = 50 V	I_B = 0		BDT61B			0.5	
		V_{CE} = 60 V	I_B = 0		BDT61C			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 60 V	I_E = 0		BDT61			0.2	mA
		V_{CB} = 80 V	I_E = 0		BDT61A			0.2	
		V_{CB} = 100 V	I_E = 0		BDT61B			0.2	
		V_{CB} = 120 V	I_E = 0		BDT61C			0.2	
		V_{CB} = 30 V	I_E = 0	T_C = 150°C	BDT61			2.0	
		V_{CB} = 40 V	I_E = 0	T_C = 150°C	BDT61A			2.0	
		V_{CB} = 50 V	I_E = 0	T_C = 150°C	BDT61B			2.0	
		V_{CB} = 60 V	I_E = 0	T_C = 150°C	BDT61C			2.0	
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0					5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V	I_C = 1.5 A	(see Notes 3 and 4)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 6 mA	I_C = 1.5 A	(see Notes 3 and 4)				2.5	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 1.5 A	(see Notes 3 and 4)				2.5	V
V_{EC}	Parallel diode forward voltage	I_E = 1.5 A	I_B = 0					2	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			2.5	°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 †			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 = 20 Ω	t_p = 20 µs, dc ≤ 2%		4.5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

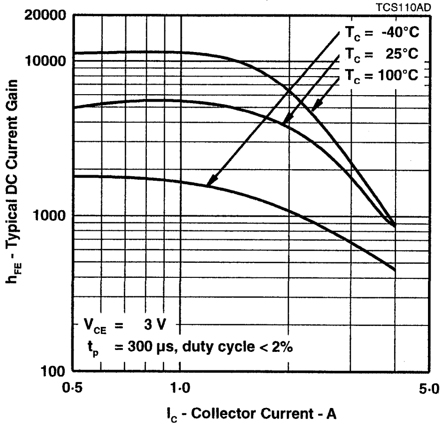


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

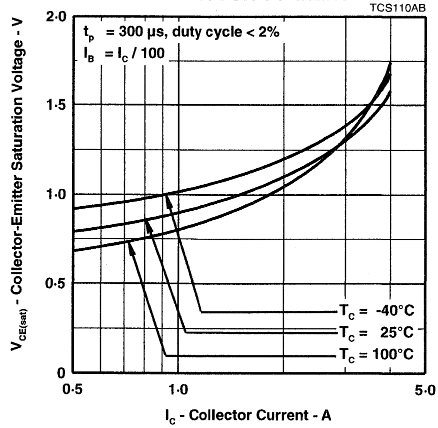


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

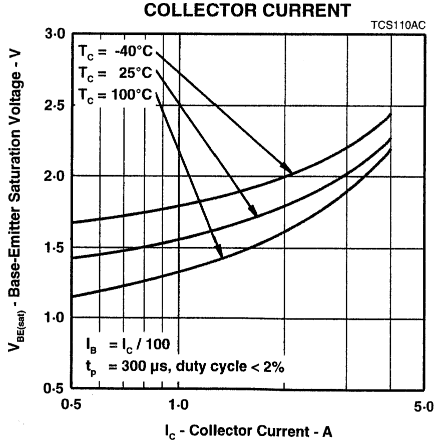


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

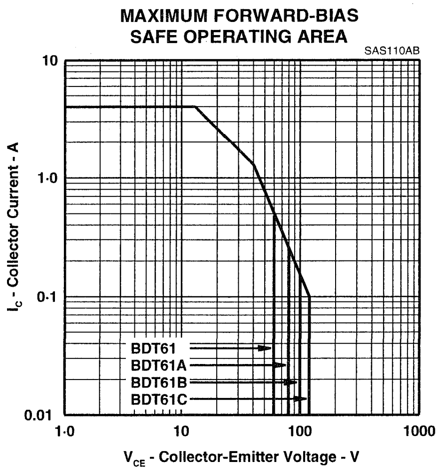


Figure 4.

THERMAL INFORMATION

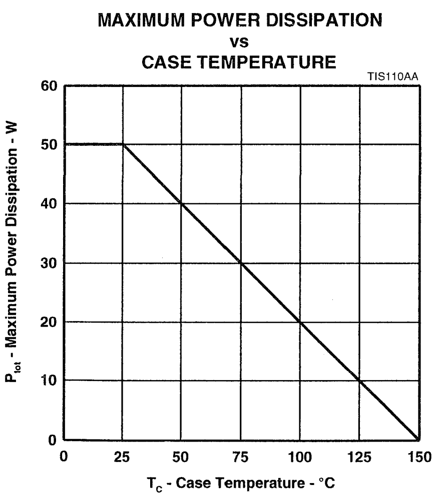
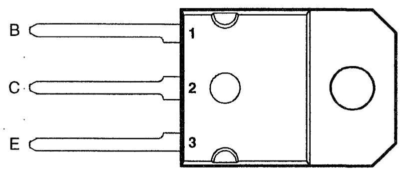


Figure 5.

JUNE 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BDV65, BDV65A, BDV65B and BDV65C**
- **125 W at 25°C Case Temperature**
- **12 A Continuous Collector Current**
- **Minimum h_{FE} of 1000 at 4 V, 5 A**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDV64	V_{CBO}	-60	V
	BDV64A		-80	
	BDV64B		-100	
	BDV64C		-120	
Collector-emitter voltage (I_B = 0)	BDV64	V_{CEO}	-60	V
	BDV64A		-80	
	BDV64B		-100	
	BDV64C		-120	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-12	A
Peak collector current (see Note 1)		I_{CM}	-15	A
Continuous base current		I_B	-0.5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	125	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.1$ 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 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 breakdown voltage	I_C = -30 mA	I_B = 0	(see Note 4)	BDV64	-60			V
					BDV64A	-80			
					BDV64B	-100			
					BDV64C	-120			
I_{CEO}	Collector-emitter cut-off current	V_{CB} = -30 V	I_B = 0		BDV64			-2	mA
		V_{CB} = -40 V	I_B = 0		BDV64A			-2	
		V_{CB} = -50 V	I_B = 0		BDV64B			-2	
		V_{CB} = -60 V	I_B = 0		BDV64C			-2	
I_{CBO}	Collector cut-off current	V_{CB} = -60 V	I_E = 0		BDV64			-0.4	mA
		V_{CB} = -80 V	I_E = 0		BDV64A			-0.4	
		V_{CB} = -100 V	I_E = 0		BDV64B			-0.4	
		V_{CB} = -120 V	I_E = 0		BDV64C			-0.4	
		V_{CB} = -30 V	I_E = 0	T_C = 150°C	BDV64			-2	
		V_{CB} = -40 V	I_E = 0	T_C = 150°C	BDV64A			-2	
		V_{CB} = -50 V	I_E = 0	T_C = 150°C	BDV64B			-2	
		V_{CB} = -60 V	I_E = 0	T_C = 150°C	BDV64C			-2	
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 = -5 A	(see Notes 4 and 5)		1000			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -20 mA	I_C = -5 A	(see Notes 4 and 5)				-2	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -5 A	(see Notes 4 and 5)				-2.5	V
V_{EC}	Parallel diode forward voltage	I_E = -10 A	I_B = 0	(see Notes 4 and 5)				-3.5	V

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. 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	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

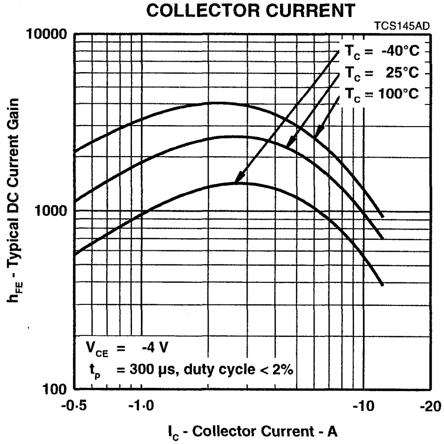


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

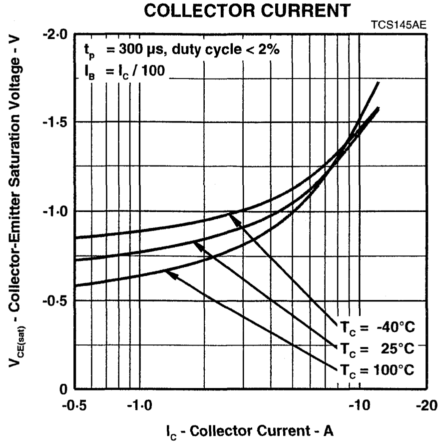


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

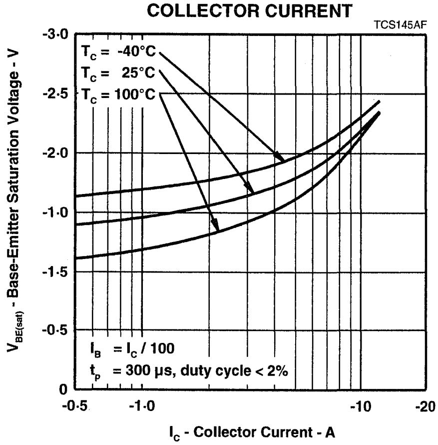


Figure 3.

THERMAL INFORMATION

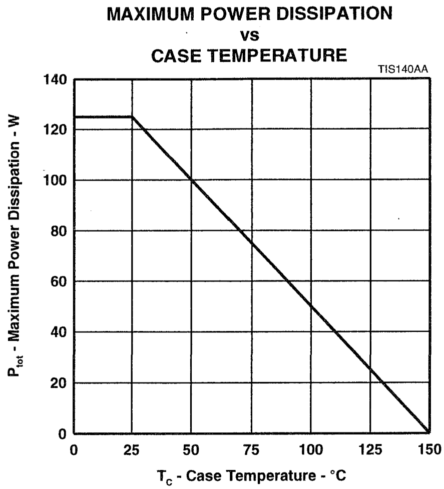
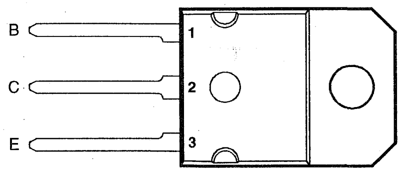


Figure 4.

JUNE 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BDV64, BDV64A, BDV64B and BDV64C**
- **125 W at 25°C Case Temperature**
- **12 A Continuous Collector Current**
- **Minimum h_{FE} of 1000 at 4 V, 5 A**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDV65	V_{CBO}	60	V
	BDV65A		80	
	BDV65B		100	
	BDV65C		120	
Collector-emitter voltage (I_B = 0)	BDV65	V_{CEO}	60	V
	BDV65A		80	
	BDV65B		100	
	BDV65C		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	12	A
Peak collector current (see Note 1)		I_{CM}	15	A
Continuous base current		I_B	0.5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	125	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.1$ 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 28 mW/°C.

JUNE 1993 - REVISED MAY 1995

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	(see Note 4)	BDV65	60			V
					BDV65A	80			
					BDV65B	100			
					BDV65C	120			
I_{CEO}	Collector-emitter cut-off current	V_{CB} = 30 V	I_B = 0		BDV65			2	mA
		V_{CB} = 40 V	I_B = 0		BDV65A			2	
		V_{CB} = 50 V	I_B = 0		BDV65B			2	
		V_{CB} = 60 V	I_B = 0		BDV65C			2	
I_{CBO}	Collector cut-off current	V_{CB} = 60 V	I_E = 0		BDV65			0.4	mA
		V_{CB} = 80 V	I_E = 0		BDV65A			0.4	
		V_{CB} = 100 V	I_E = 0		BDV65B			0.4	
		V_{CB} = 120 V	I_E = 0		BDV65C			0.4	
		V_{CB} = 30 V	I_E = 0	T_C = 150°C	BDV65			2	
		V_{CB} = 40 V	I_E = 0	T_C = 150°C	BDV65A			2	
		V_{CB} = 50 V	I_E = 0	T_C = 150°C	BDV65B			2	
		V_{CB} = 60 V	I_E = 0	T_C = 150°C	BDV65C			2	
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 = 5 A	(see Notes 4 and 5)		1000			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 20 mA	I_C = 5 A	(see Notes 4 and 5)				2	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 5 A	(see Notes 4 and 5)				2.5	V
V_{EC}	Parallel diode forward voltage	I_E = 10 A	I_B = 0	(see Notes 4 and 5)				3.5	V

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. 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	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			35.7	°C/W

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

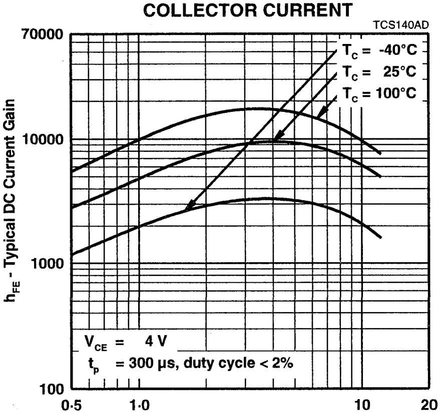


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

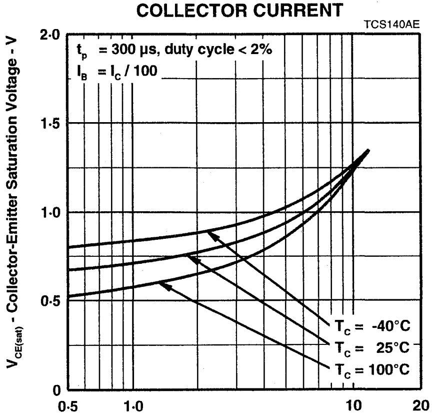


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

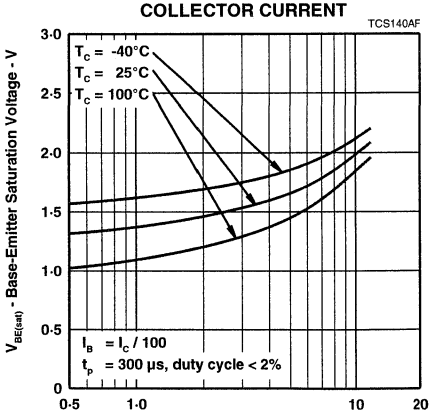


Figure 3.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

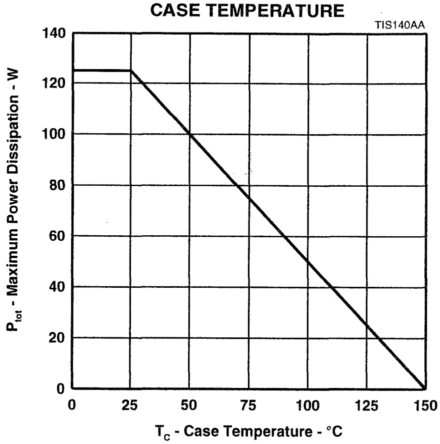
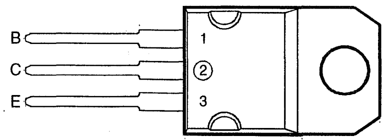


Figure 4.

TEXAS INSTRUMENTS

- **Designed for Complementary Use with BDW24, BDW24A, BDW24B and BDW24C**
- **50 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 2 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW23	V_{CBO}	45	V
	BDW23A		60	
	BDW23B		80	
	BDW23C		100	
Collector-emitter voltage (I_B = 0)	BDW23	V_{CEO}	45	V
	BDW23A		60	
	BDW23B		80	
	BDW23C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	6	A
Continuous base current		I_B	0.2	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	50	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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.

AUGUST 1993 - REVISED MAY 1995

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 = 100 mA	I_B = 0	(see Note 3)	BDW23	45			V
					BDW23A	60			
					BDW23B	80			
					BDW23C	100			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BDW23			0.5	mA
		V_{CE} = 30 V	I_B = 0		BDW23A			0.5	
		V_{CE} = 40 V	I_B = 0		BDW23B			0.5	
		V_{CE} = 50 V	I_B = 0		BDW23C			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	I_E = 0		BDW23			0.2	mA
		V_{CB} = 60 V	I_E = 0		BDW23A			0.2	
		V_{CB} = 80 V	I_E = 0		BDW23B			0.2	
		V_{CB} = 100 V	I_E = 0		BDW23C			0.2	
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 A	(see Notes 3 and 4)		1000			
		V_{CE} = 3 V	I_C = 2 A			750		20000	
		V_{CE} = 3 V	I_C = 6 A			100			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 8 mA	I_C = 2 A	(see Notes 3 and 4)				2	V
		I_B = 60 mA	I_C = 6 A					3	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 8 mA	I_C = 2 A	(see Notes 3 and 4)				2.5	
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 1 A	(see Notes 3 and 4)				2.5	V
		V_{CE} = 3 V	I_C = 6 A					3	
V_{EC}	Parallel diode forward voltage	I_E = 2 A	I_B = 0					1.8	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			2.5	°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 †			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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

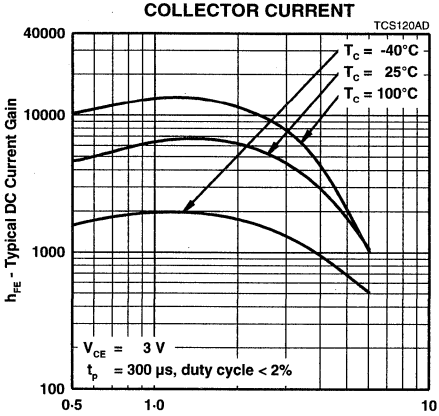


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

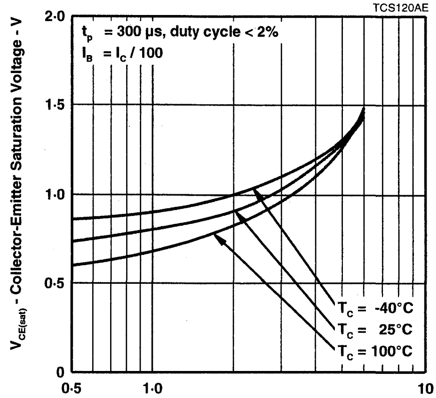


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

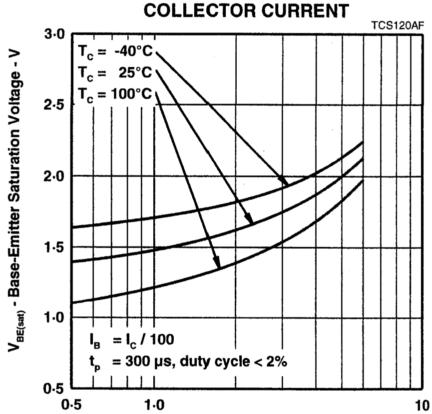


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

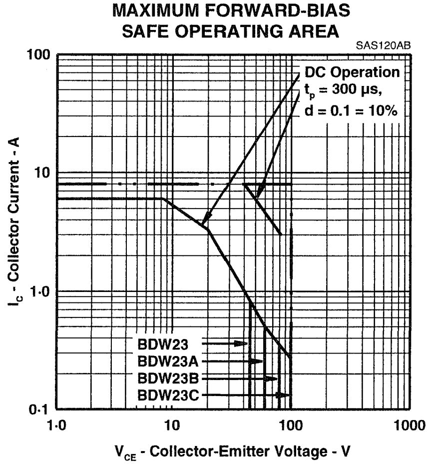


Figure 4.

THERMAL INFORMATION

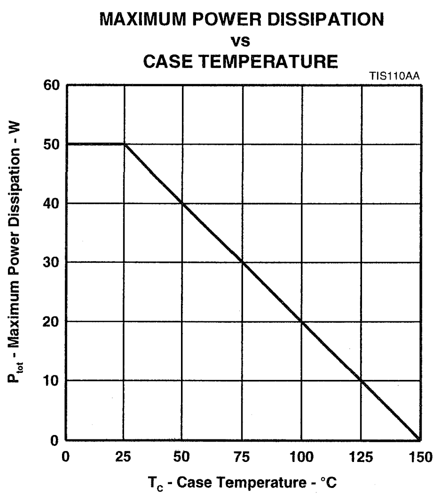
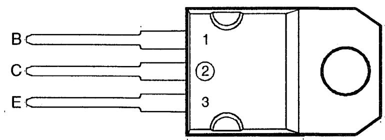


Figure 5.

- **Designed for Complementary Use with BDW23, BDW23A, BDW23B and BDW23C**
- **50 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 2 A, 3 V**

**TO-220 PACKAGE
(TOP VIEW)**



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW24	V_{CBO}	-45	V
	BDW24A		-60	
	BDW24B		-80	
	BDW24C		-100	
Collector-emitter voltage (I_B = 0)	BDW24	V_{CEO}	-45	V
	BDW24A		-60	
	BDW24B		-80	
	BDW24C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-6	A
Continuous base current		I_B	-0.2	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	50	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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.

MAY 1989 - REVISED MAY 1995

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 = -100 mA	I_B = 0	(see Note 3)	BDW24	-45			V
					BDW24A	-60			
					BDW24B	-80			
					BDW24C	-100			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0		BDW24			-0.5	mA
		V_{CE} = -30 V	I_B = 0		BDW24A			-0.5	
		V_{CE} = -40 V	I_B = 0		BDW24B			-0.5	
		V_{CE} = -50 V	I_B = 0		BDW24C			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	I_E = 0		BDW24			-0.2	mA
		V_{CB} = -60 V	I_E = 0		BDW24A			-0.2	
		V_{CB} = -80 V	I_E = 0		BDW24B			-0.2	
		V_{CB} = -100 V	I_E = 0		BDW24C			-0.2	
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 A	(see Notes 3 and 4)		1000		20000	
		V_{CE} = -3 V	I_C = -2 A			750			
		V_{CE} = -3 V	I_C = -6 A			100			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -8 mA	I_C = -2 A	(see Notes 3 and 4)				-2	V
		I_B = -60 mA	I_C = -6 A					-3	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = -8 mA	I_C = -2 A	(see Notes 3 and 4)				-2.5	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -1 A	(see Notes 3 and 4)				-2.5	V
		V_{CE} = -3 V	I_C = -6 A					-3	
V_{EC}	Parallel diode forward voltage	I_E = -2 A	I_B = 0					-1.8	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			2.5	°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 †			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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

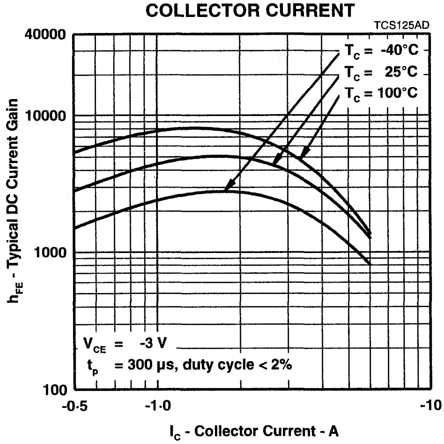


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

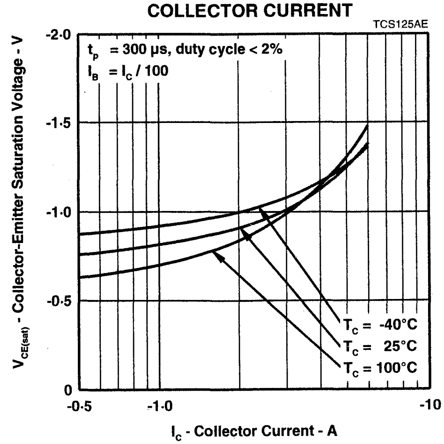


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

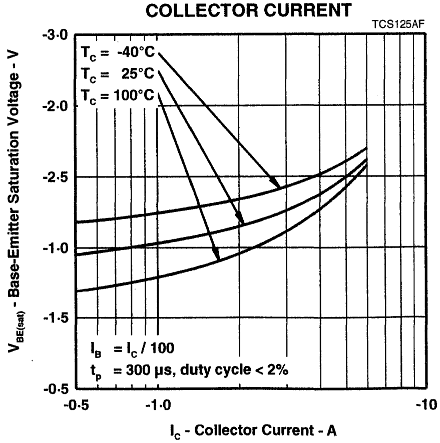


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

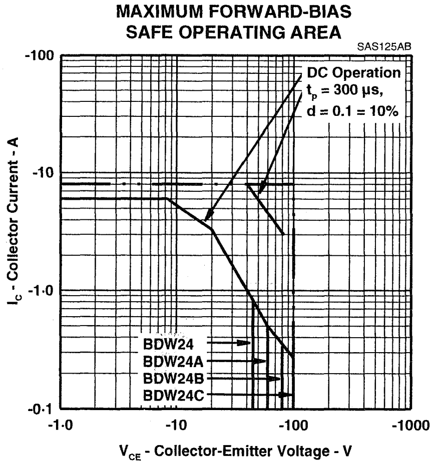


Figure 4.

THERMAL INFORMATION

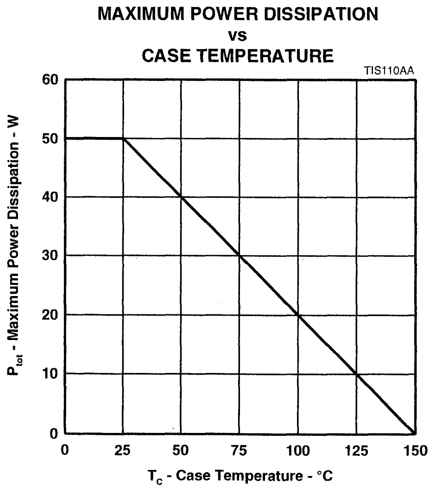


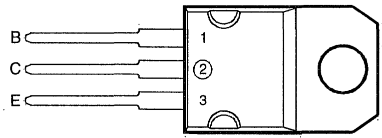
Figure 5.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

- **Designed for Complementary Use with BDW54, BDW54A, BDW54B, BDW54C and BDW54D**
- **40 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 1.5 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW53	V_{CBO}	45	V
	BDW53A		60	
	BDW53B		80	
	BDW53C		100	
	BDW53D		120	
Collector-emitter voltage (I_B = 0) (see Note 1)	BDW53	V_{CEO}	45	V
	BDW53A		60	
	BDW53B		80	
	BDW53C		100	
	BDW53D		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	4	A
Continuous base current		I_B	50	mA
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	40	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	25	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

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	(see Note 5)	BDW53	45			V
					BDW53A	60			
					BDW53B	80			
					BDW53C	100			
					BDW53D	120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BDW53			0.5	mA
		V_{CE} = 30 V	I_B = 0		BDW53A			0.5	
		V_{CE} = 40 V	I_B = 0		BDW53B			0.5	
		V_{CE} = 50 V	I_B = 0		BDW53C			0.5	
		V_{CE} = 60 V	I_B = 0		BDW53D			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	I_E = 0		BDW53			0.2	mA
		V_{CB} = 60 V	I_E = 0		BDW53A			0.2	
		V_{CB} = 80 V	I_E = 0		BDW53B			0.2	
		V_{CB} = 100 V	I_E = 0		BDW53C			0.2	
		V_{CB} = 120 V	I_E = 0		BDW53D			0.2	
		V_{CB} = 45 V	I_E = 0	T_C = 150°C	BDW53			5	
		V_{CB} = 60 V	I_E = 0	T_C = 150°C	BDW53A			5	
		V_{CB} = 80 V	I_E = 0	T_C = 150°C	BDW53B			5	
		V_{CB} = 100 V	I_E = 0	T_C = 150°C	BDW53C			5	
		V_{CB} = 120 V	I_E = 0	T_C = 150°C	BDW53D			5	
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	(see Notes 5 and 6)		750		20000	
		V_{CE} = 3 V	I_C = 4 A			100			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 1.5 A	(see Notes 5 and 6)				2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 30 mA	I_C = 1.5 A	(see Notes 5 and 6)				2.5	V
		I_B = 40 mA	I_C = 4 A					4	
V_{EC}	Parallel diode forward voltage	I_E = 4 A	I_B = 0					3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 μs, dc ≤ 2%		4.5		μs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

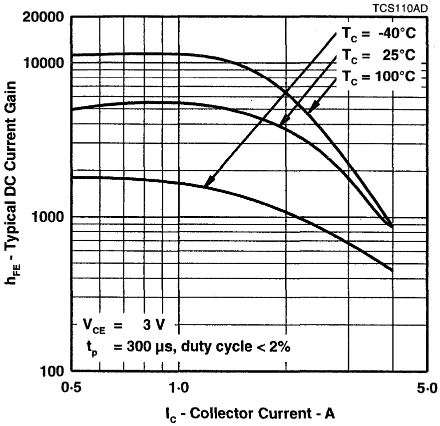


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

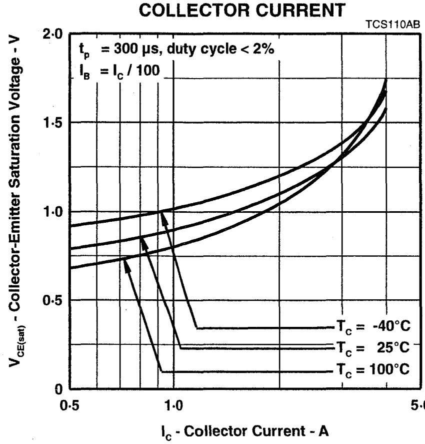


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

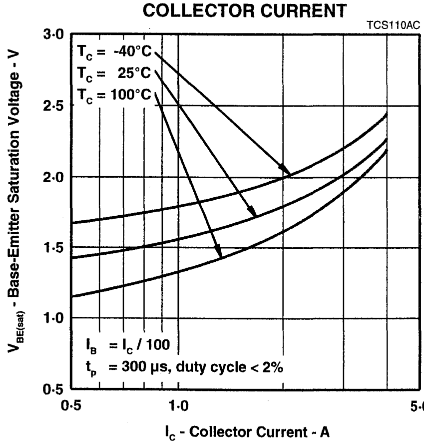


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

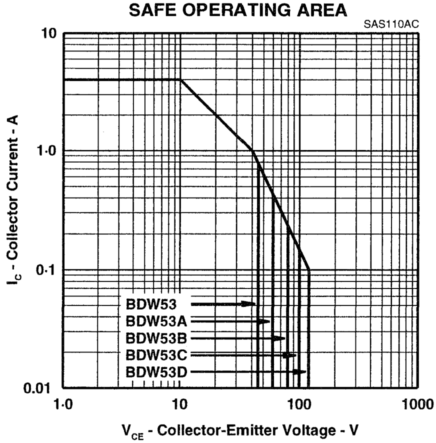


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

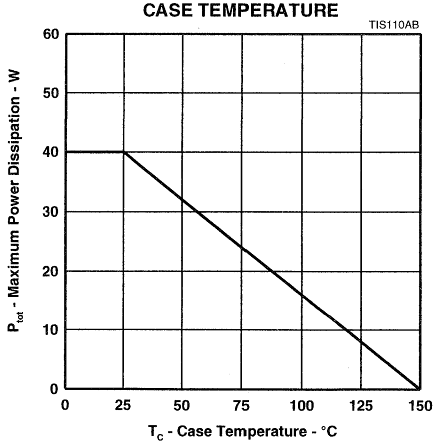


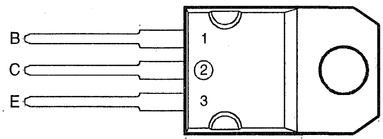
Figure 5.

BDW54, BDW54A, BDW54B, BDW54C, BDW54D
PNP SILICON POWER DARLINGTONS

AUGUST 1978 - REVISED MAY 1995

- **Designed for Complementary Use with BDW53, BDW53A, BDW53B, BDW53C and BDW53D**
- **40 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 1.5 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW54	V_{CBO}	-45	V
	BDW54A		-60	
	BDW54B		-80	
	BDW54C		-100	
	BDW54D		-120	
Collector-emitter voltage (I_B = 0) (see Note 1)	BDW54	V_{CEO}	-45	V
	BDW54A		-60	
	BDW54B		-80	
	BDW54C		-100	
	BDW54D		-120	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-4	A
Continuous base current		I_B	-50	mA
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	40	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	25	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

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	(see Note 5)	BDW54	-45			V
					BDW54A	-60			
					BDW54B	-80			
					BDW54C	-100			
					BDW54D	-120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0		BDW54			-0.5	mA
		V_{CE} = -30 V	I_B = 0		BDW54A			-0.5	
		V_{CE} = -40 V	I_B = 0		BDW54B			-0.5	
		V_{CE} = -50 V	I_B = 0		BDW54C			-0.5	
		V_{CE} = -60 V	I_B = 0		BDW54D			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	I_E = 0		BDW54			-0.2	mA
		V_{CB} = -60 V	I_E = 0		BDW54A			-0.2	
		V_{CB} = -80 V	I_E = 0		BDW54B			-0.2	
		V_{CB} = -100 V	I_E = 0		BDW54C			-0.2	
		V_{CB} = -120 V	I_E = 0		BDW54D			-0.2	
		V_{CB} = -45 V	I_E = 0	T_C = 150°C	BDW54			-5	
		V_{CB} = -60 V	I_E = 0	T_C = 150°C	BDW54A			-5	
		V_{CB} = -80 V	I_E = 0	T_C = 150°C	BDW54B			-5	
		V_{CB} = -100 V	I_E = 0	T_C = 150°C	BDW54C			-5	
		V_{CB} = -120 V	I_E = 0	T_C = 150°C	BDW54D			-5	
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	(see Notes 5 and 6)		750		20000	
		V_{CE} = -3 V	I_C = -4 A			100			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -1.5 A	(see Notes 5 and 6)				-2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -30 mA	I_C = -1.5 A	(see Notes 5 and 6)				-2.5	V
		I_B = -40 mA	I_C = -4 A					-4	
V_{EC}	Parallel diode forward voltage	I_E = -4 A	I_B = 0					-3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		4.5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

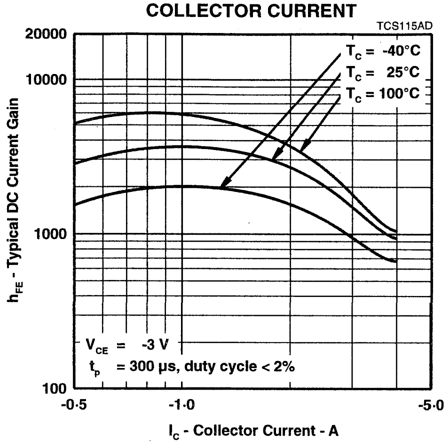


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

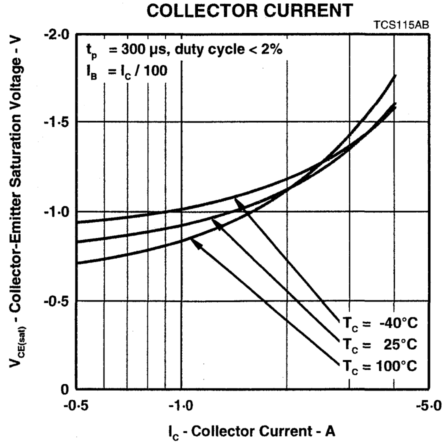


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

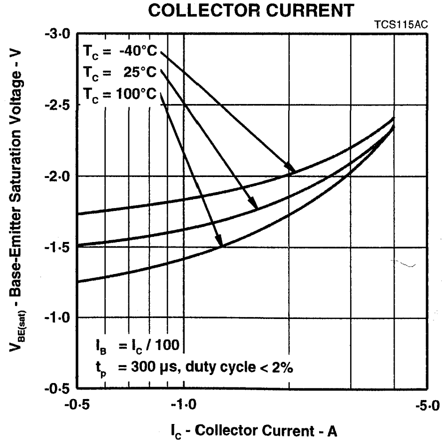


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

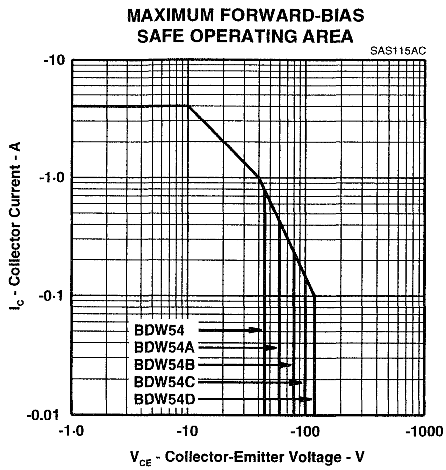


Figure 4.

THERMAL INFORMATION

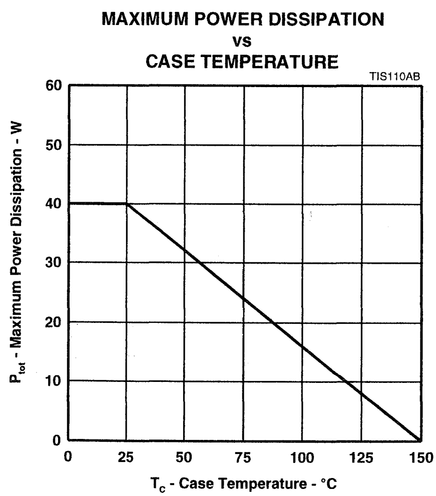
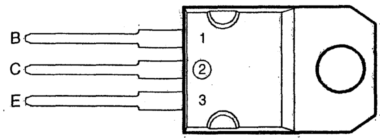


Figure 5.

- **Designed for Complementary Use with BDW64, BDW64A, BDW64B, BDW64C and BDW64D**
- **60 W at 25°C Case Temperature**
- **6 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 2 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW63	V_{CBO}	45	V
	BDW63A		60	
	BDW63B		80	
	BDW63C		100	
	BDW63D		120	
Collector-emitter voltage (I_B = 0) (see Note 1)	BDW63	V_{CEO}	45	V
	BDW63A		60	
	BDW63B		80	
	BDW63C		100	
	BDW63D		120	
Emitter-base voltage		V_{EB}	5	V
Continuous collector current		I_C	6	A
Continuous base current		I_B	0.1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	60	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	50	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.

TEXAS INSTRUMENTS

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	$I_B = 0$	(see Note 5)	BDW63	45			V
					BDW63A	60			
					BDW63B	80			
					BDW63C	100			
					BDW63D	120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	$I_B = 0$		BDW63			0.5	mA
		V_{CE} = 30 V	$I_B = 0$		BDW63A			0.5	
		V_{CE} = 40 V	$I_B = 0$		BDW63B			0.5	
		V_{CE} = 50 V	$I_B = 0$		BDW63C			0.5	
		V_{CE} = 60 V	$I_B = 0$		BDW63D			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	$I_E = 0$		BDW63			0.2	mA
		V_{CB} = 60 V	$I_E = 0$		BDW63A			0.2	
		V_{CB} = 80 V	$I_E = 0$		BDW63B			0.2	
		V_{CB} = 100 V	$I_E = 0$		BDW63C			0.2	
		V_{CB} = 120 V	$I_E = 0$		BDW63D			0.2	
		V_{CB} = 45 V	$I_E = 0$	T_C = 150°C	BDW63			5	
		V_{CB} = 60 V	$I_E = 0$	T_C = 150°C	BDW63A			5	
		V_{CB} = 80 V	$I_E = 0$	T_C = 150°C	BDW63B			5	
		V_{CB} = 100 V	$I_E = 0$	T_C = 150°C	BDW63C			5	
		V_{CB} = 120 V	$I_E = 0$	T_C = 150°C	BDW63D			5	
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 = 2 A	(see Notes 5 and 6)		750		20000	
		V_{CE} = 3 V	I_C = 6 A			100			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 2 A	(see Notes 5 and 6)				2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 12 mA	I_C = 2 A	(see Notes 5 and 6)				2.5	V
		I_B = 60 mA	I_C = 6 A					4	
V_{EC}	Parallel diode forward voltage	I_E = 6 A	$I_B = 0$					3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

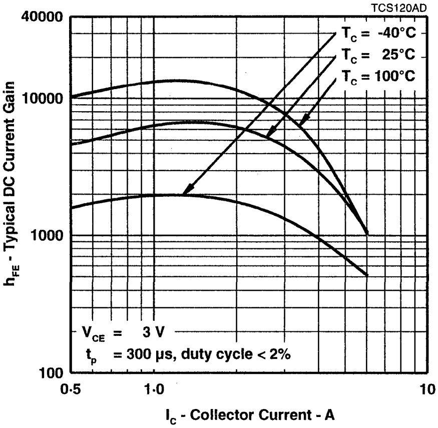


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

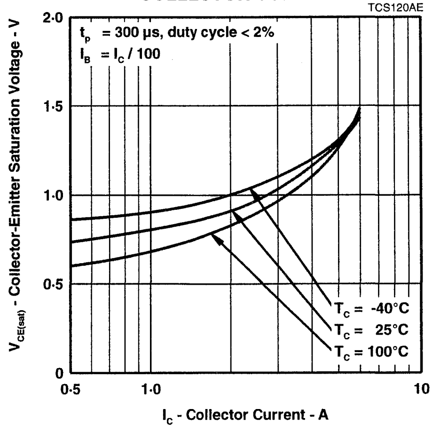


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

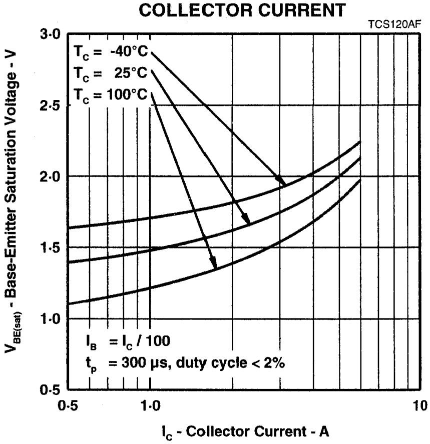


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

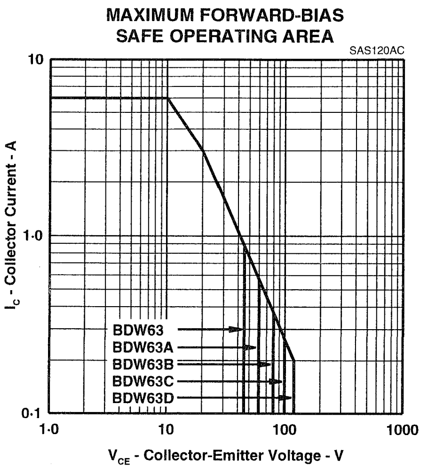


Figure 4.

THERMAL INFORMATION

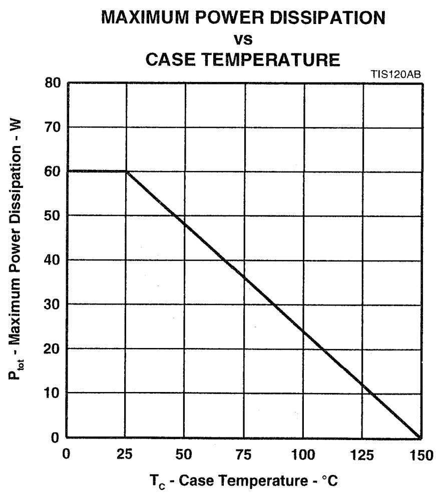
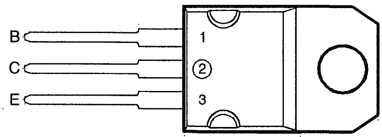


Figure 5.

AUGUST 1978 - REVISED MAY 1995

- Designed for Complementary Use with BDW63, BDW63A, BDW63B, BDW63C and BDW63D
- 60 W at 25°C Case Temperature
- 6 A Continuous Collector Current
- Minimum h_{FE} of 750 at 3 V, 2 A

**TO-220 PACKAGE
(TOP VIEW)**



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW64	V_{CBO}	-45	V
	BDW64A		-60	
	BDW64B		-80	
	BDW64C		-100	
	BDW64D		-120	
Collector-emitter voltage (I_B = 0) (see Note 1)	BDW64	V_{CEO}	-45	V
	BDW64A		-60	
	BDW64B		-80	
	BDW64C		-100	
	BDW64D		-120	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-6	A
Continuous base current		I_B	-0.1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	60	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	50	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, 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	$I_B = 0$	(see Note 5)	BDW64	-45			V
					BDW64A	-60			
					BDW64B	-80			
					BDW64C	-100			
					BDW64D	-120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	$I_B = 0$		BDW64			-0.5	mA
		V_{CE} = -30 V	$I_B = 0$		BDW64A			-0.5	
		V_{CE} = -40 V	$I_B = 0$		BDW64B			-0.5	
		V_{CE} = -50 V	$I_B = 0$		BDW64C			-0.5	
		V_{CE} = -60 V	$I_B = 0$		BDW64D			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	$I_E = 0$		BDW64			-0.2	mA
		V_{CB} = -60 V	$I_E = 0$		BDW64A			-0.2	
		V_{CB} = -80 V	$I_E = 0$		BDW64B			-0.2	
		V_{CB} = -100 V	$I_E = 0$		BDW64C			-0.2	
		V_{CB} = -120 V	$I_E = 0$		BDW64D			-0.2	
		V_{CB} = -45 V	$I_E = 0$	T_C = 150°C	BDW64			-5	
		V_{CB} = -60 V	$I_E = 0$	T_C = 150°C	BDW64A			-5	
		V_{CB} = -80 V	$I_E = 0$	T_C = 150°C	BDW64B			-5	
		V_{CB} = -100 V	$I_E = 0$	T_C = 150°C	BDW64C			-5	
		V_{CB} = -120 V	$I_E = 0$	T_C = 150°C	BDW64D			-5	
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 = -2 A	(see Notes 5 and 6)		750		20000	
		V_{CE} = -3 V	I_C = -6 A			100			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -2 A	(see Notes 5 and 6)				-2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -12 mA	I_C = -2 A	(see Notes 5 and 6)				-2.5	V
		I_B = -60 mA	I_C = -6 A					-4	
V_{EC}	Parallel diode forward voltage	I_E = -6 A	$I_B = 0$					-3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

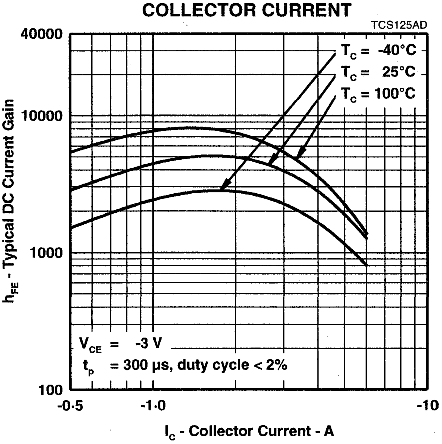


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

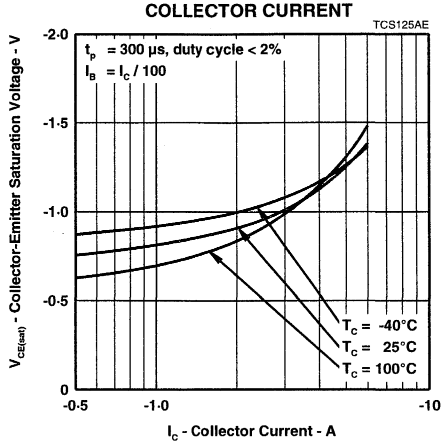


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

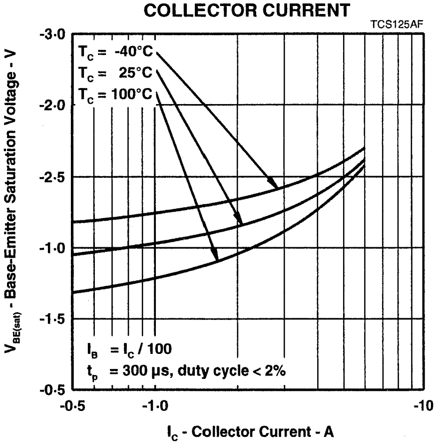


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

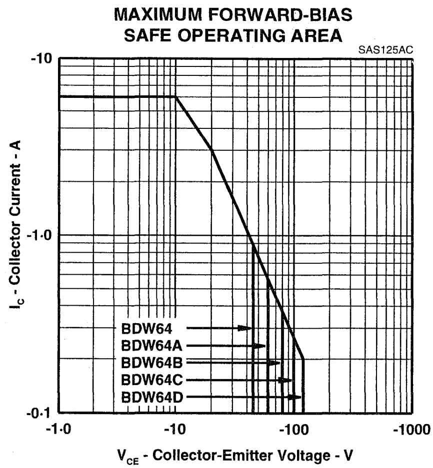


Figure 4.

THERMAL INFORMATION

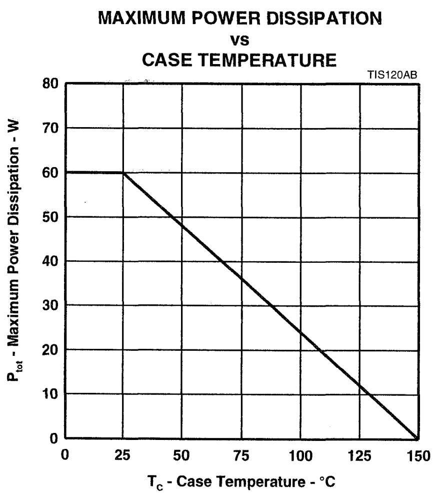
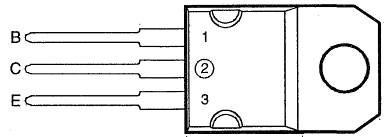


Figure 5.

- **Designed for Complementary Use with BDW74, BDW74A, BDW74B, BDW74C and BDW74D**
- **80 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 3 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW73	V_{CBO}	45	V
	BDW73A		60	
	BDW73B		80	
	BDW73C		100	
	BDW73D		120	
Collector-emitter voltage (I_B = 0) (see Note 1)	BDW73	V_{CEO}	45	V
	BDW73A		60	
	BDW73B		80	
	BDW73C		100	
	BDW73D		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Continuous base current		I_B	0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	75	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 0.64 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 operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, 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	(see Note 5)	BDW73	45			V
					BDW73A	60			
					BDW73B	80			
					BDW73C	100			
					BDW73D	120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BDW73			0.5	mA
		V_{CE} = 30 V	I_B = 0		BDW73A			0.5	
		V_{CE} = 40 V	I_B = 0		BDW73B			0.5	
		V_{CE} = 50 V	I_B = 0		BDW73C			0.5	
		V_{CE} = 60 V	I_B = 0		BDW73D			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	I_E = 0		BDW73			0.2	mA
		V_{CB} = 60 V	I_E = 0		BDW73A			0.2	
		V_{CB} = 80 V	I_E = 0		BDW73B			0.2	
		V_{CB} = 100 V	I_E = 0		BDW73C			0.2	
		V_{CB} = 120 V	I_E = 0		BDW73D			0.2	
		V_{CB} = 45 V	I_E = 0	T_C = 150°C	BDW73			5	
		V_{CB} = 60 V	I_E = 0	T_C = 150°C	BDW73A			5	
		V_{CB} = 80 V	I_E = 0	T_C = 150°C	BDW73B			5	
		V_{CB} = 100 V	I_E = 0	T_C = 150°C	BDW73C			5	
		V_{CB} = 120 V	I_E = 0	T_C = 150°C	BDW73D			5	
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	(see Notes 5 and 6)		750		20000	
		V_{CE} = 3 V	I_C = 8 A			100			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 3 A	(see Notes 5 and 6)				2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 12 mA	I_C = 3 A	(see Notes 5 and 6)				2.5	V
		I_B = 80 mA	I_C = 8 A					4	
V_{EC}	Parallel diode forward voltage	I_E = 8 A	I_B = 0					3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

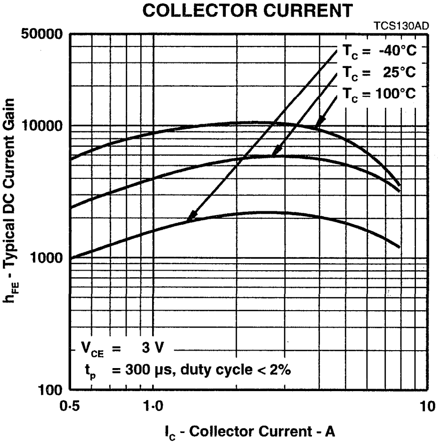


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

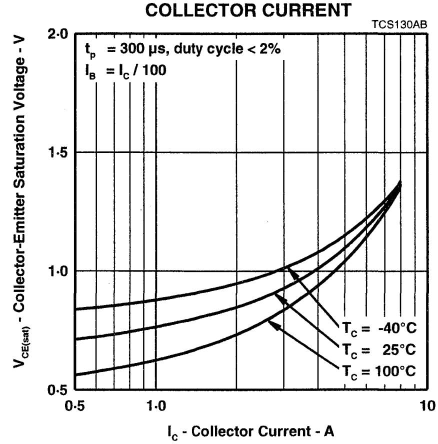


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

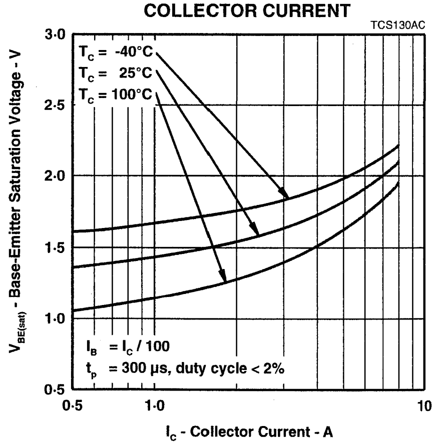


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

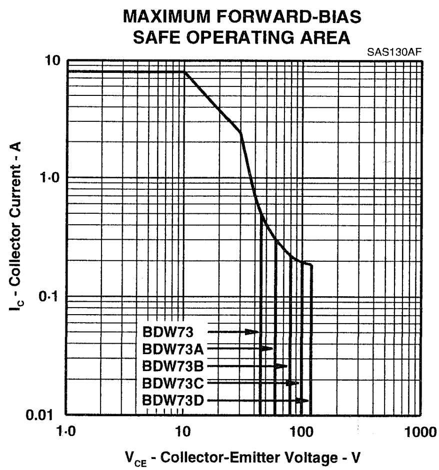


Figure 4.

THERMAL INFORMATION

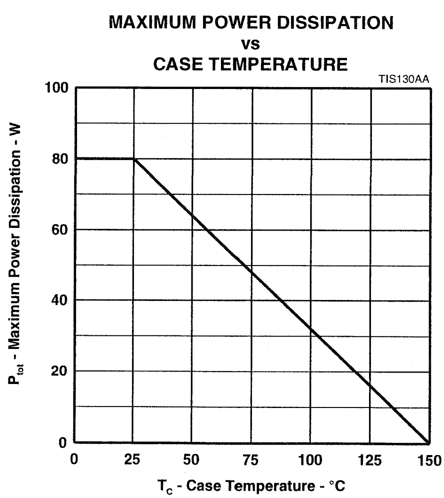
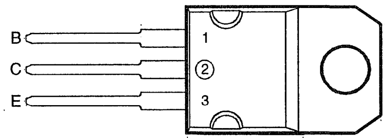


Figure 5.

AUGUST 1978 - REVISED MAY 1995

- Designed for Complementary Use with BDW73, BDW73A, BDW73B, BDW73C and BDW73D
- 80 W at 25°C Case Temperature
- 8 A Continuous Collector Current
- Minimum h_{FE} of 750 at 3 V, 3 A

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.
MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW74	V_{CBO}	-45	V
	BDW74A		-60	
	BDW74B		-80	
	BDW74C		-100	
	BDW74D		-120	
Collector-emitter voltage (I_B = 0) (see Note 1)	BDW74	V_{CEO}	-45	V
	BDW74A		-60	
	BDW74B		-80	
	BDW74C		-100	
	BDW74D		-120	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-8	A
Continuous base current		I_B	-0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	75	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 0.64 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 operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, 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	(see Note 5)	BDW74	-45			V
					BDW74A	-60			
					BDW74B	-80			
					BDW74C	-100			
					BDW74D	-120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0		BDW74			-0.5	mA
		V_{CE} = -30 V	I_B = 0		BDW74A			-0.5	
		V_{CE} = -40 V	I_B = 0		BDW74B			-0.5	
		V_{CE} = -50 V	I_B = 0		BDW74C			-0.5	
		V_{CE} = -60 V	I_B = 0		BDW74D			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	I_E = 0		BDW74			-0.2	mA
		V_{CB} = -60 V	I_E = 0		BDW74A			-0.2	
		V_{CB} = -80 V	I_E = 0		BDW74B			-0.2	
		V_{CB} = -100 V	I_E = 0		BDW74C			-0.2	
		V_{CB} = -120 V	I_E = 0		BDW74D			-0.2	
		V_{CB} = -45 V	I_E = 0	T_C = 150°C	BDW74			-5	
		V_{CB} = -60 V	I_E = 0	T_C = 150°C	BDW74A			-5	
		V_{CB} = -80 V	I_E = 0	T_C = 150°C	BDW74B			-5	
		V_{CB} = -100 V	I_E = 0	T_C = 150°C	BDW74C			-5	
		V_{CB} = -120 V	I_E = 0	T_C = 150°C	BDW74D			-5	
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	(see Notes 5 and 6)		750		20000	
		V_{CE} = -3 V	I_C = -8 A			100			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -3 A	(see Notes 5 and 6)				-2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -12 mA	I_C = -3 A	(see Notes 5 and 6)				-2.5	V
		I_B = -80 mA	I_C = -8 A					-4	
V_{EC}	Parallel diode forward voltage	I_E = -8 A	I_B = 0					-3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

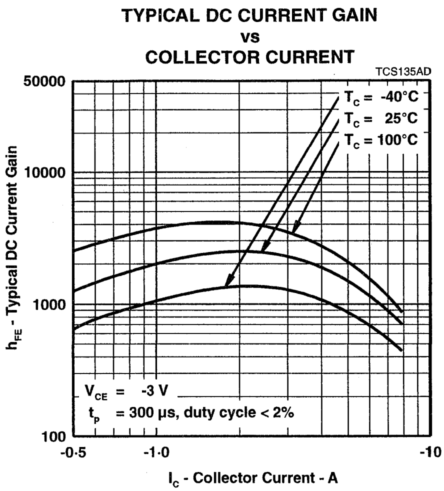


Figure 1.

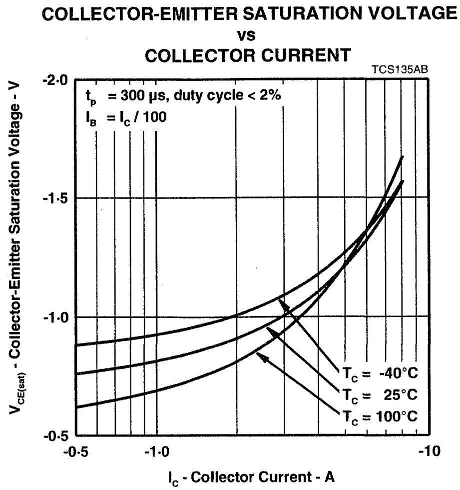


Figure 2.

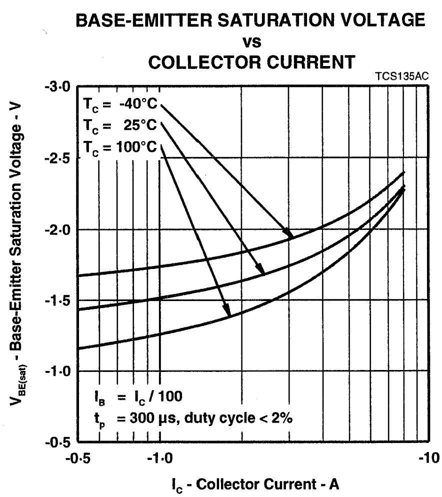


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

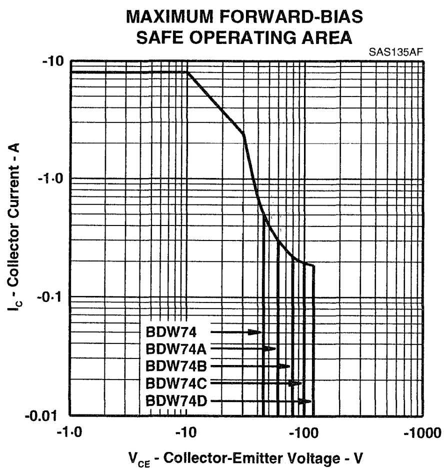


Figure 4.

THERMAL INFORMATION

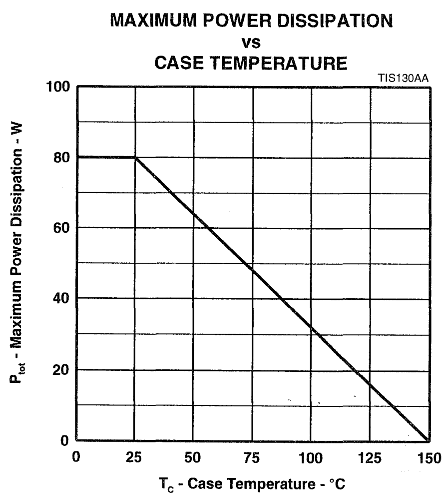
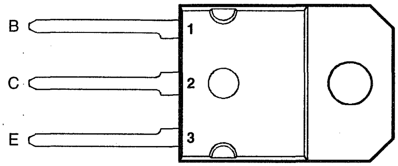


Figure 5.

AUGUST 1978 - REVISED MAY 1995

- **Designed for Complementary Use with BDW84, BDW84A, BDW84B, BDW84C and BDW84D**
- **150 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 6 A**

**SOT-93 PACKAGE
(TOP VIEW)**



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW83	V_{CBO}	45	V
	BDW83A		60	
	BDW83B		80	
	BDW83C		100	
	BDW83D		120	
Collector-emitter voltage (I_B = 0) (see Note 1)	BDW83	V_{CEO}	45	V
	BDW83A		60	
	BDW83B		80	
	BDW83C		100	
	BDW83D		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	15	A
Continuous base current		I_B	0.5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	150	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	100	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

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	(see Note 5)	BDW83	45			V
					BDW83A	60			
					BDW83B	80			
					BDW83C	100			
					BDW83D	120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BDW83			1	mA
		V_{CE} = 30 V	I_B = 0		BDW83A			1	
		V_{CE} = 40 V	I_B = 0		BDW83B			1	
		V_{CE} = 50 V	I_B = 0		BDW83C			1	
		V_{CE} = 60 V	I_B = 0		BDW83D			1	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	I_E = 0		BDW83			0.5	mA
		V_{CB} = 60 V	I_E = 0		BDW83A			0.5	
		V_{CB} = 80 V	I_E = 0		BDW83B			0.5	
		V_{CB} = 100 V	I_E = 0		BDW83C			0.5	
		V_{CB} = 120 V	I_E = 0		BDW83D			0.5	
		V_{CB} = 45 V	I_E = 0	T_C = 150°C	BDW83			5	
		V_{CB} = 60 V	I_E = 0	T_C = 150°C	BDW83A			5	
		V_{CB} = 80 V	I_E = 0	T_C = 150°C	BDW83B			5	
		V_{CB} = 100 V	I_E = 0	T_C = 150°C	BDW83C			5	
		V_{CB} = 120 V	I_E = 0	T_C = 150°C	BDW83D			5	
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	(see Notes 5 and 6)		750		20000	
		V_{CE} = 3 V	I_C = 15 A			100			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 6 A	(see Notes 5 and 6)				2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 12 mA	I_C = 6 A	(see Notes 5 and 6)				2.5	V
		I_B = 150 mA	I_C = 15 A					4	
V_{EC}	Parallel diode forward voltage	I_E = 15 A	I_B = 0					3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		7		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

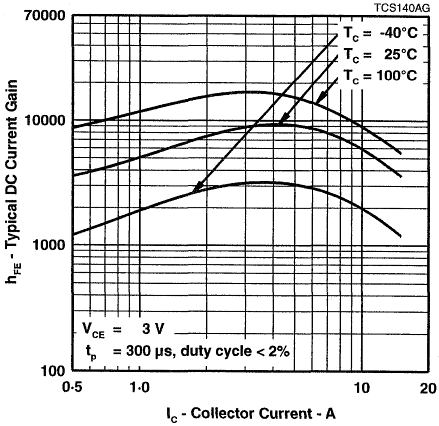


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

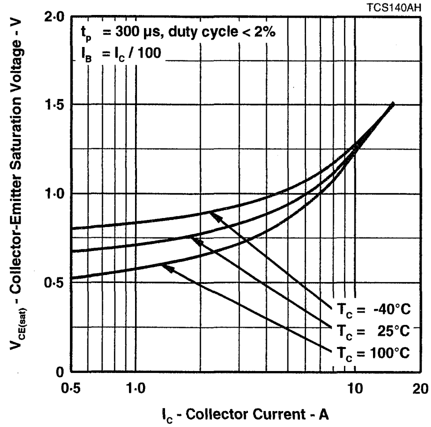


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

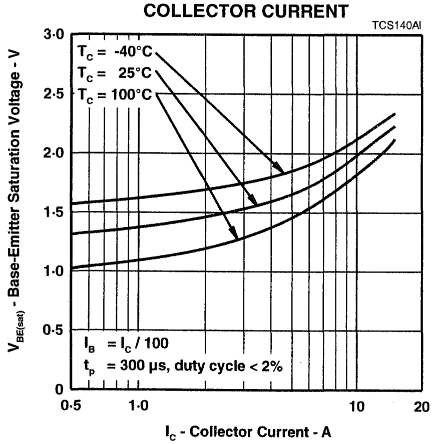


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

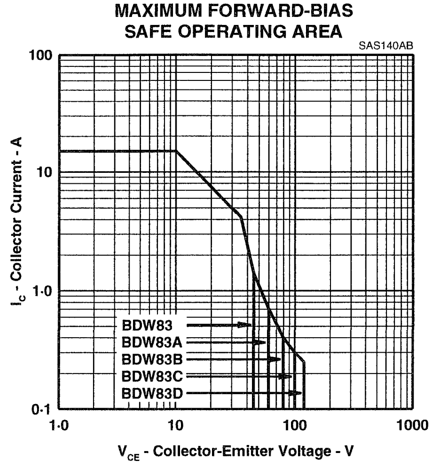


Figure 4.

THERMAL INFORMATION

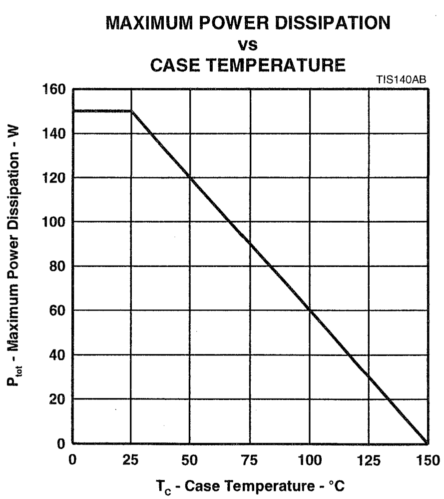
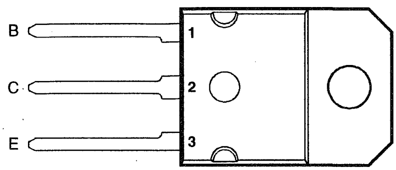


Figure 5.

AUGUST 1978 - REVISED MAY 1995

- **Designed for Complementary Use with BDW83, BDW83A, BDW83B, BDW83C and BDW83D**
- **150 W at 25°C Case Temperature**
- **15 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 6 A**

**SOT-93 PACKAGE
(TOP VIEW)**



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW84	V_{CBO}	-45	V
	BDW84A		-60	
	BDW84B		-80	
	BDW84C		-100	
	BDW84D		-120	
Collector-emitter voltage (I_B = 0) (see Note 1)	BDW84	V_{CEO}	-45	V
	BDW84A		-60	
	BDW84B		-80	
	BDW84C		-100	
	BDW84D		-120	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-15	A
Continuous base current		I_B	-0.5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	150	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	100	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, 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	(see Note 5)	BDW84	-45			V
					BDW84A	-60			
					BDW84B	-80			
					BDW84C	-100			
					BDW84D	-120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0		BDW84			-1	mA
		V_{CE} = -30 V	I_B = 0		BDW84A			-1	
		V_{CE} = -40 V	I_B = 0		BDW84B			-1	
		V_{CE} = -50 V	I_B = 0		BDW84C			-1	
		V_{CE} = -60 V	I_B = 0		BDW84D			-1	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	I_E = 0		BDW84			-0.5	mA
		V_{CB} = -60 V	I_E = 0		BDW84A			-0.5	
		V_{CB} = -80 V	I_E = 0		BDW84B			-0.5	
		V_{CB} = -100 V	I_E = 0		BDW84C			-0.5	
		V_{CB} = -120 V	I_E = 0		BDW84D			-0.5	
		V_{CB} = -45 V	I_E = 0	T_C = 150°C	BDW84			-5	
		V_{CB} = -60 V	I_E = 0	T_C = 150°C	BDW84A			-5	
		V_{CB} = -80 V	I_E = 0	T_C = 150°C	BDW84B			-5	
		V_{CB} = -100 V	I_E = 0	T_C = 150°C	BDW84C			-5	
		V_{CB} = -120 V	I_E = 0	T_C = 150°C	BDW84D			-5	
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	(see Notes 5 and 6)		750		20000	
		V_{CE} = -3 V	I_C = -15 A			100			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -6 A	(see Notes 5 and 6)				-2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -12 mA	I_C = -6 A	(see Notes 5 and 6)				-2.5	V
		I_B = -150 mA	I_C = -15 A					-4	
V_{EC}	Parallel diode forward voltage	I_E = -15 A	I_B = 0					-3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			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

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	t_p = 20 µs, dc ≤ 2%		7		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

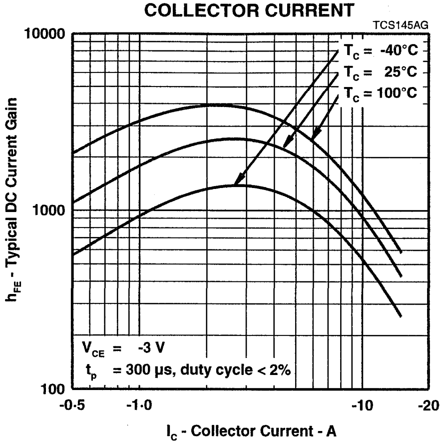


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

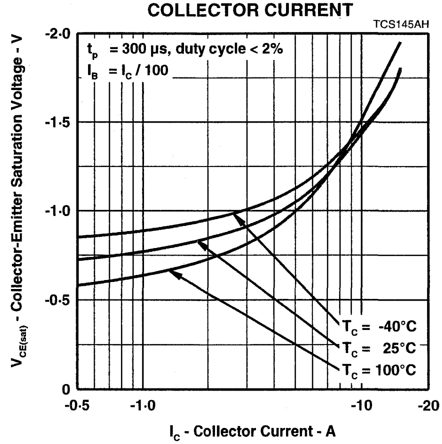


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

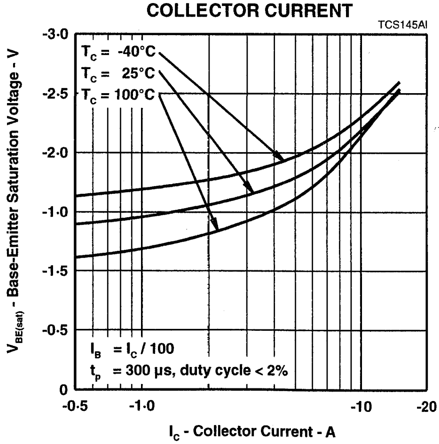


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

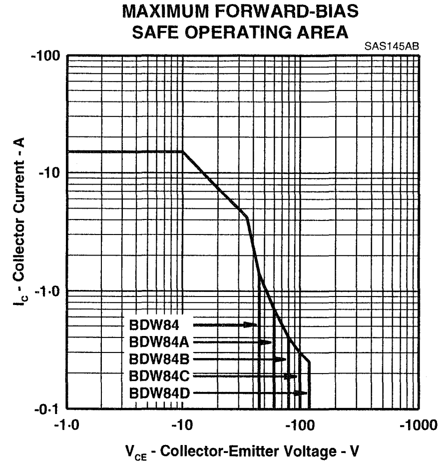


Figure 4.

THERMAL INFORMATION

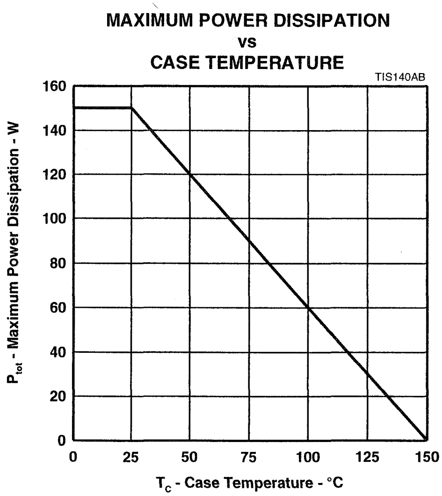


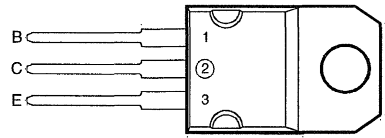
Figure 5.

BDW93, BDW93A, BDW93B, BDW93C
NPN SILICON POWER DARLINGTONS

SEPTEMBER 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BDW94, BDW94A, BDW94B and BDW94C**
- **80 W at 25°C Case Temperature**
- **12 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 5 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW93	V_{CBO}	45	V
	BDW93A		60	
	BDW93B		80	
	BDW93C		100	
Collector-emitter voltage (I_B = 0)	BDW93	V_{CEO}	45	V
	BDW93A		60	
	BDW93B		80	
	BDW93C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	12	A
Continuous base current		I_B	0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-65 to +150	°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.

SEPTEMBER 1993 - REVISED MAY 1995

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 = 100 mA	I_B = 0	(see Note 3)	BDW93	45			V
					BDW93A	60			
					BDW93B	80			
					BDW93C	100			
I_{CEO}	Collector-emitter cut-off current	V_{CB} = 40 V	I_B = 0		BDW93			1	mA
		V_{CB} = 60 V	I_B = 0		BDW93A			1	
		V_{CB} = 80 V	I_B = 0		BDW93B			1	
		V_{CB} = 80 V	I_B = 0		BDW93C			1	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	I_E = 0		BDW93			0.1	mA
		V_{CB} = 60 V	I_E = 0		BDW93A			0.1	
		V_{CB} = 80 V	I_E = 0		BDW93B			0.1	
		V_{CB} = 100 V	I_E = 0		BDW93C			0.1	
		V_{CB} = 45 V	I_E = 0	T_C = 150°C	BDW93			5	
		V_{CB} = 60 V	I_E = 0	T_C = 150°C	BDW93A			5	
		V_{CB} = 80 V	I_E = 0	T_C = 150°C	BDW93B			5	
		V_{CB} = 100 V	I_E = 0	T_C = 150°C	BDW93C			5	
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	(see Notes 3 and 4)		1000			
		V_{CE} = 3 V	I_C = 10 A			100			
		V_{CE} = 3 V	I_C = 5 A			750		20000	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 20 mA	I_C = 5 A	(see Notes 3 and 4)				2	V
		I_B = 100 mA	I_C = 10 A					3	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 20 mA	I_C = 5 A	(see Notes 3 and 4)				2.5	V
		I_B = 100 mA	I_C = 10 A					4	
V_{EC}	Parallel diode forward voltage	I_E = 5 A	I_B = 0					2	V
		I_E = 10 A	I_B = 0					4	

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

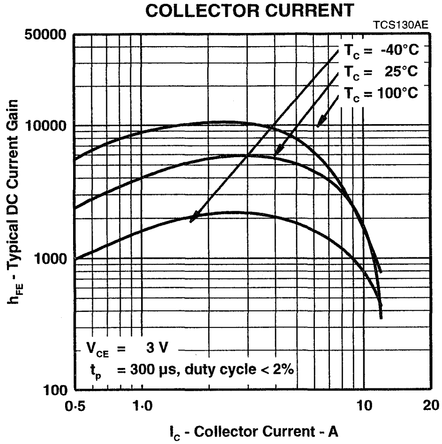


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

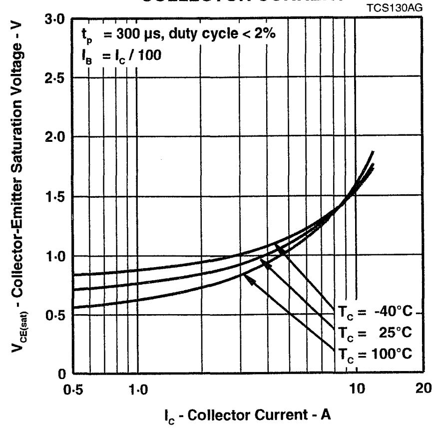


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

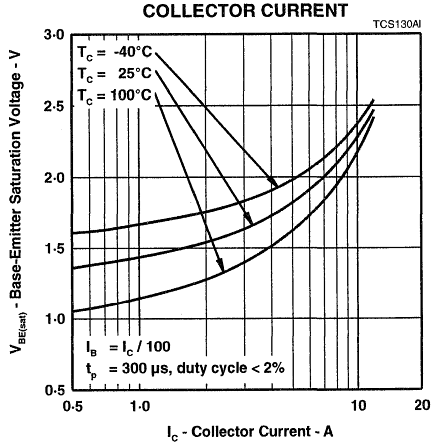


Figure 3.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

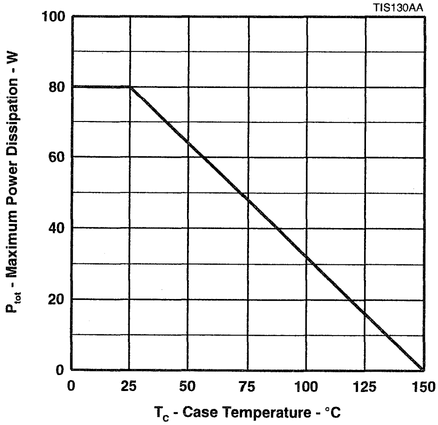
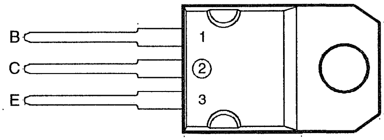


Figure 4.

SEPTEMBER 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BDW93, BDW93A, BDW93B and BDW93C**
- **80 W at 25°C Case Temperature**
- **12 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 5 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDW94	V_{CBO}	-45	V
	BDW94A		-60	
	BDW94B		-80	
	BDW94C		-100	
Collector-emitter voltage (I_B = 0)	BDW94	V_{CEO}	-45	V
	BDW94A		-60	
	BDW94B		-80	
	BDW94C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-12	A
Continuous base current		I_B	-0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-65 to +150	°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.

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 = -100 mA	I_B = 0	(see Note 3)	BDW94	-45			V
					BDW94A	-60			
					BDW94B	-80			
					BDW94C	-100			
I_{CEO}	Collector-emitter cut-off current	V_{CB} = -40 V	I_B = 0		BDW94			-1	mA
		V_{CB} = -60 V	I_B = 0		BDW94A			-1	
		V_{CB} = -80 V	I_B = 0		BDW94B			-1	
		V_{CB} = -80 V	I_B = 0		BDW94C			-1	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	I_E = 0		BDW94			-0.1	mA
		V_{CB} = -60 V	I_E = 0		BDW94A			-0.1	
		V_{CB} = -80 V	I_E = 0		BDW94B			-0.1	
		V_{CB} = -100 V	I_E = 0		BDW94C			-0.1	
		V_{CB} = -45 V	I_E = 0	T_C = 150°C	BDW94			-5	
		V_{CB} = -60 V	I_E = 0	T_C = 150°C	BDW94A			-5	
		V_{CB} = -80 V	I_E = 0	T_C = 150°C	BDW94B			-5	
		V_{CB} = -100 V	I_E = 0	T_C = 150°C	BDW94C			-5	
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	(see Notes 3 and 4)		1000			
		V_{CE} = -3 V	I_C = -10 A			100			
		V_{CE} = -3 V	I_C = -5 A			750		20000	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -20 mA	I_C = -5 A	(see Notes 3 and 4)				-2	V
		I_B = -100 mA	I_C = -10 A					-3	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = -20 mA	I_C = -5 A	(see Notes 3 and 4)				-2.5	V
		I_B = -100 mA	I_C = -10 A					-4	
V_{EC}	Parallel diode forward voltage	I_E = -5 A	I_B = 0					-2	V
		I_E = -10 A	I_B = 0					-4	

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

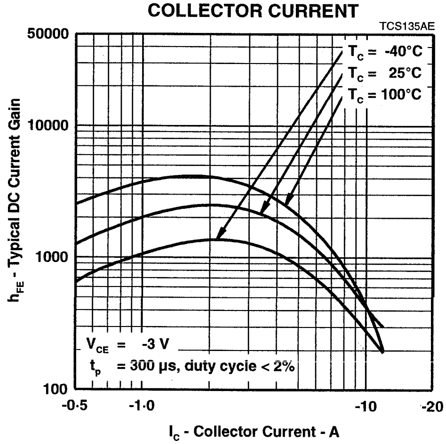


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

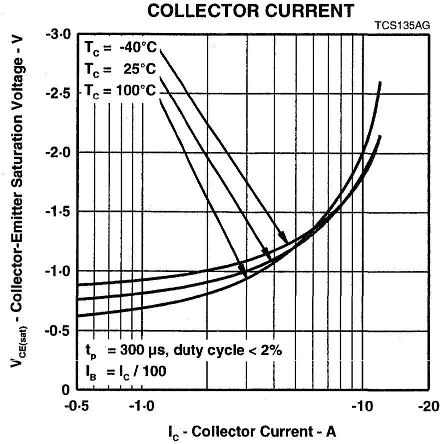


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

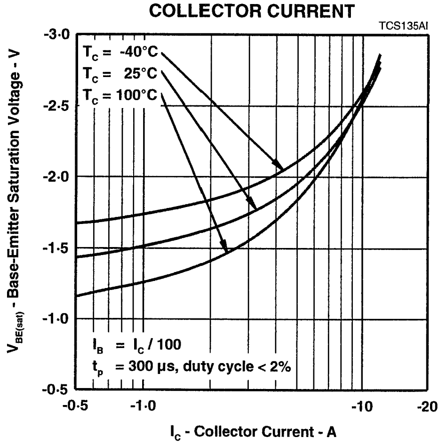


Figure 3.

THERMAL INFORMATION

**MAXIMUM POWER DISSIPATION
vs
CASE TEMPERATURE**

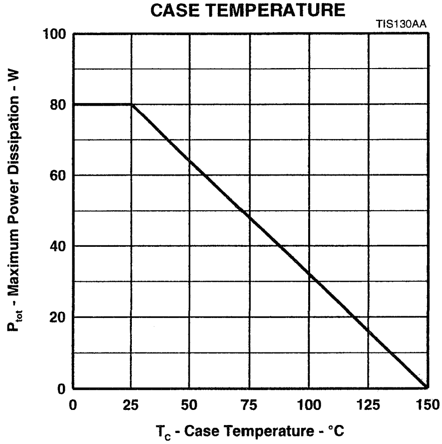
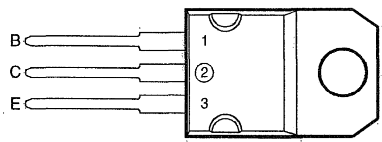


Figure 4.

AUGUST 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BDX34, BDX34A, BDX34B, BDX34C and BDX34D**
- **70 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 3 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDX33	V_{CBO}	45	V
	BDX33A		60	
	BDX33B		80	
	BDX33C		100	
	BDX33D		120	
Collector-emitter voltage (I_B = 0)	BDX33	V_{CEO}	45	V
	BDX33A		60	
	BDX33B		80	
	BDX33C		100	
	BDX33D		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	10	A
Continuous base current		I_B	0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating free air temperature range		T_J	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-65 to +150	°C

NOTES: 1. Derate linearly to 150°C case temperature at the rate of 0.56 W/°C.
2. Derate linearly to 150°C free air temperature at the rate of 16 mW/°C.

TEXAS INSTRUMENTS

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 = 100 mA	I_B = 0	(see Note 3)	BDX33	45			V
					BDX33A	60			
					BDX33B	80			
					BDX33C	100			
					BDX33D	120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BDX33			0.5	mA
		V_{CE} = 30 V	I_B = 0		BDX33A			0.5	
		V_{CE} = 40 V	I_B = 0		BDX33B			0.5	
		V_{CE} = 50 V	I_B = 0		BDX33C			0.5	
		V_{CE} = 60 V	I_B = 0		BDX33D			0.5	
		V_{CE} = 30 V	I_B = 0	T_C = 100°C	BDX33			10	
		V_{CE} = 30 V	I_B = 0	T_C = 100°C	BDX33A			10	
		V_{CE} = 40 V	I_B = 0	T_C = 100°C	BDX33B			10	
		V_{CE} = 50 V	I_B = 0	T_C = 100°C	BDX33C			10	
		V_{CE} = 60 V	I_B = 0	T_C = 100°C	BDX33D			10	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	I_E = 0		BDX33			1	mA
		V_{CB} = 60 V	I_E = 0		BDX33A			1	
		V_{CB} = 80 V	I_E = 0		BDX33B			1	
		V_{CB} = 100 V	I_E = 0		BDX33C			1	
		V_{CB} = 120 V	I_E = 0		BDX33D			1	
		V_{CB} = 45 V	I_E = 0	T_C = 100°C	BDX33			5	
		V_{CB} = 60 V	I_E = 0	T_C = 100°C	BDX33A			5	
		V_{CB} = 80 V	I_E = 0	T_C = 100°C	BDX33B			5	
		V_{CB} = 100 V	I_E = 0	T_C = 100°C	BDX33C			5	
		V_{CB} = 120 V	I_E = 0	T_C = 100°C	BDX33D			5	
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0					10	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V	I_C = 4 A	(see Notes 3 and 4)	BDX33	750			
		V_{CE} = 3 V	I_C = 4 A		BDX33A	750			
		V_{CE} = 3 V	I_C = 3 A		BDX33B	750			
		V_{CE} = 3 V	I_C = 3 A		BDX33C	750			
		V_{CE} = 3 V	I_C = 3 A		BDX33D	750			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 4 A	(see Notes 3 and 4)	BDX33			2.5	V
		V_{CE} = 3 V	I_C = 4 A		BDX33A			2.5	
		V_{CE} = 3 V	I_C = 3 A		BDX33B			2.5	
		V_{CE} = 3 V	I_C = 3 A		BDX33C			2.5	
		V_{CE} = 3 V	I_C = 3 A		BDX33D			2.5	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 8 mA	I_C = 4 A	(see Notes 3 and 4)	BDX33			2.5	V
		I_B = 8 mA	I_C = 4 A		BDX33A			2.5	
		I_B = 6 mA	I_C = 3 A		BDX33B			2.5	
		I_B = 6 mA	I_C = 3 A		BDX33C			2.5	
		I_B = 6 mA	I_C = 3 A		BDX33D			2.5	
V_{EC}	Parallel diode forward voltage	I_E = 8 A	I_B = 0					4	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			1.78	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN
vs
COLLECTOR CURRENT

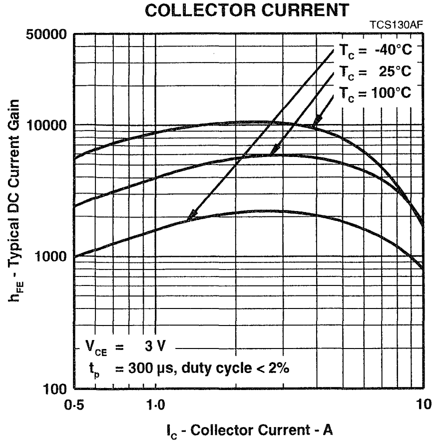


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

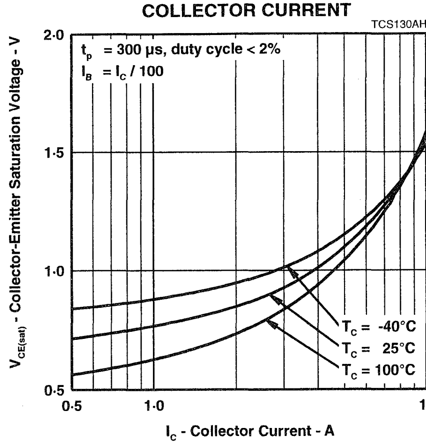


Figure 2.

BASE-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

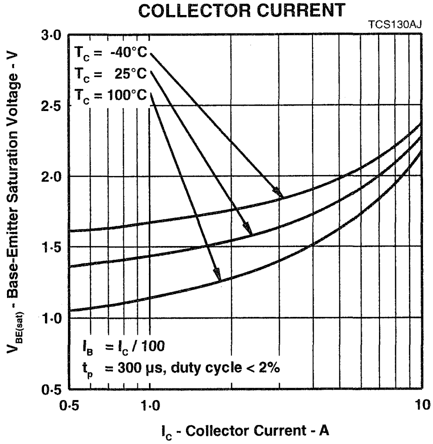


Figure 3.

TEXAS INSTRUMENTS

THERMAL INFORMATION

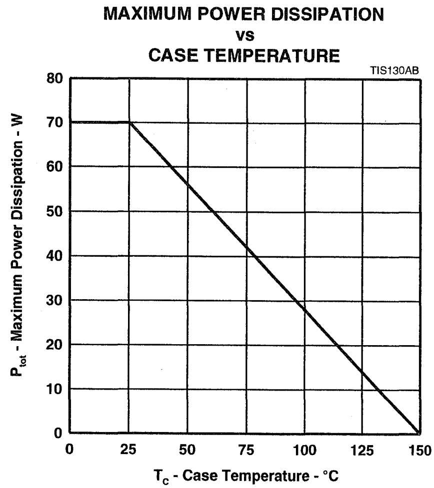
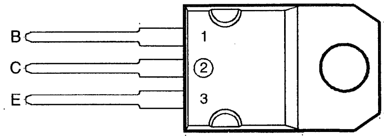


Figure 4.

AUGUST 1993 - REVISED MAY 1995

- **Designed for Complementary Use with BDX33, BDX33A, BDX33B, BDX33C and BDX33D**
- **70 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 3 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDX34	V_{CBO}	-45	V
	BDX34A		-60	
	BDX34B		-80	
	BDX34C		-100	
	BDX34D		-120	
Collector-emitter voltage (I_B = 0)	BDX34	V_{CEO}	-45	V
	BDX34A		-60	
	BDX34B		-80	
	BDX34C		-100	
	BDX34D		-120	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-10	A
Continuous base current		I_B	-0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating free air temperature range		T_J	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-65 to +150	°C

NOTES: 1. Derate linearly to 150°C case temperature at the rate of 0.56 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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -100 mA	I_B = 0	(see Note 3)	BDX34	-45			V
					BDX34A	-60			
					BDX34B	-80			
					BDX34C	-100			
					BDX34D	-120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0		BDX34			-0.5	mA
		V_{CE} = -30 V	I_B = 0		BDX34A			-0.5	
		V_{CE} = -40 V	I_B = 0		BDX34B			-0.5	
		V_{CE} = -50 V	I_B = 0		BDX34C			-0.5	
		V_{CE} = -60 V	I_B = 0		BDX34D			-0.5	
		V_{CE} = -30 V	I_B = 0	T_C = 100°C	BDX34			-10	
		V_{CE} = -30 V	I_B = 0	T_C = 100°C	BDX34A			-10	
		V_{CE} = -40 V	I_B = 0	T_C = 100°C	BDX34B			-10	
		V_{CE} = -50 V	I_B = 0	T_C = 100°C	BDX34C			-10	
		V_{CE} = -60 V	I_B = 0	T_C = 100°C	BDX34D			-10	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	I_E = 0		BDX34			-1	mA
		V_{CB} = -60 V	I_E = 0		BDX34A			-1	
		V_{CB} = -80 V	I_E = 0		BDX34B			-1	
		V_{CB} = -100 V	I_E = 0		BDX34C			-1	
		V_{CB} = -120 V	I_E = 0		BDX34D			-1	
		V_{CB} = -45 V	I_E = 0	T_C = 100°C	BDX34			-5	
		V_{CB} = -60 V	I_E = 0	T_C = 100°C	BDX34A			-5	
		V_{CB} = -80 V	I_E = 0	T_C = 100°C	BDX34B			-5	
		V_{CB} = -100 V	I_E = 0	T_C = 100°C	BDX34C			-5	
		V_{CB} = -120 V	I_E = 0	T_C = 100°C	BDX34D			-5	
I_{EBO}	Emitter cut-off current	V_{EB} = -5 V	I_C = 0					-10	mA
h_{FE}	Forward current transfer ratio	V_{CE} = -3 V	I_C = -4 A	(see Notes 3 and 4)	BDX34	750			
		V_{CE} = -3 V	I_C = -4 A		BDX34A	750			
		V_{CE} = -3 V	I_C = -3 A		BDX34B	750			
		V_{CE} = -3 V	I_C = -3 A		BDX34C	750			
		V_{CE} = -3 V	I_C = -3 A		BDX34D	750			
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = -3 V	I_C = -4 A	(see Notes 3 and 4)	BDX34			-2.5	V
		V_{CE} = -3 V	I_C = -4 A		BDX34A			-2.5	
		V_{CE} = -3 V	I_C = -3 A		BDX34B			-2.5	
		V_{CE} = -3 V	I_C = -3 A		BDX34C			-2.5	
		V_{CE} = -3 V	I_C = -3 A		BDX34D			-2.5	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -8 mA	I_C = -4 A	(see Notes 3 and 4)	BDX34			-2.5	V
		I_B = -8 mA	I_C = -4 A		BDX34A			-2.5	
		I_B = -6 mA	I_C = -3 A		BDX34B			-2.5	
		I_B = -6 mA	I_C = -3 A		BDX34C			-2.5	
		I_B = -6 mA	I_C = -3 A		BDX34D			-2.5	
V_{EC}	Parallel diode forward voltage	I_E = -8 A	I_B = 0					-4	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			1.78	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 μs, dc ≤ 2%		5		μs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

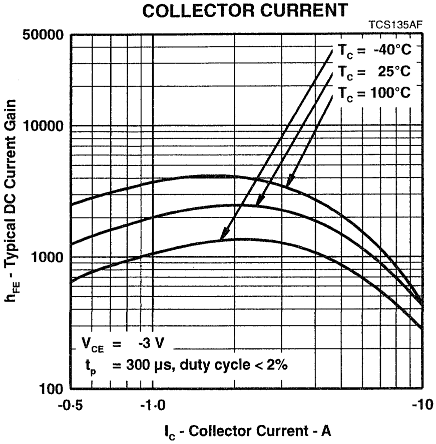


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

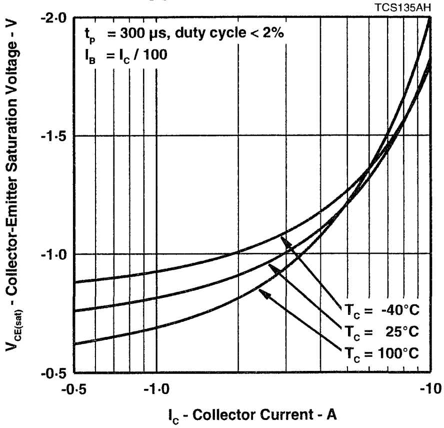


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

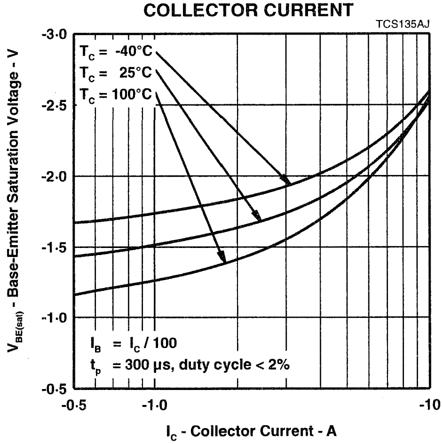


Figure 3.

TEXAS INSTRUMENTS

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

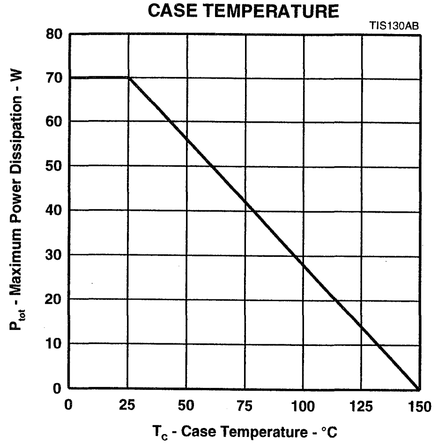
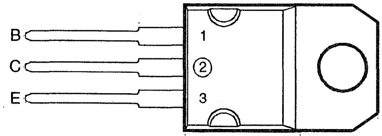


Figure 4.

- **Designed for Complementary Use with BDX54, BDX54A, BDX54B and BDX54C**
- **60 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 3 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDX53	V_{CBO}	45	V
	BDX53A		60	
	BDX53B		80	
	BDX53C		100	
Collector-emitter voltage (I_B = 0)	BDX53	V_{CEO}	45	V
	BDX53A		60	
	BDX53B		80	
	BDX53C		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Continuous base current		I_B	0.2	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	60	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 100 mA	$I_B = 0$	(see Note 3)	BDX53	45			V
					BDX53A	60			
					BDX53B	80			
					BDX53C	100			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	$I_B = 0$		BDX53			0.5	mA
		V_{CE} = 30 V	$I_B = 0$		BDX53A			0.5	
		V_{CE} = 40 V	$I_B = 0$		BDX53B			0.5	
		V_{CE} = 50 V	$I_B = 0$		BDX53C			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 45 V	$I_E = 0$		BDX53			0.2	mA
		V_{CB} = 60 V	$I_E = 0$		BDX53A			0.2	
		V_{CB} = 80 V	$I_E = 0$		BDX53B			0.2	
		V_{CB} = 100 V	$I_E = 0$		BDX53C			0.2	
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	(see Notes 3 and 4)		750			
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 12 mA	I_C = 3 A	(see Notes 3 and 4)				2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 12 mA	I_C = 3 A	(see Notes 3 and 4)				2	V
V_{EC}	Parallel diode forward voltage	I_E = 3 A	$I_B = 0$					2.5	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			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

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

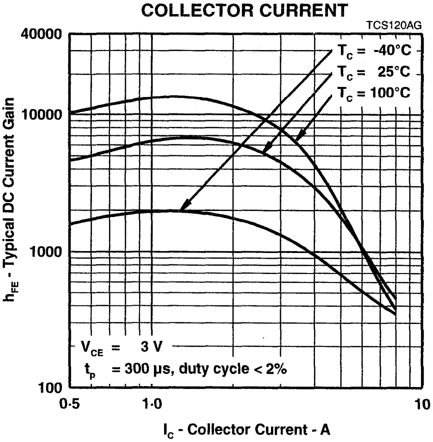


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

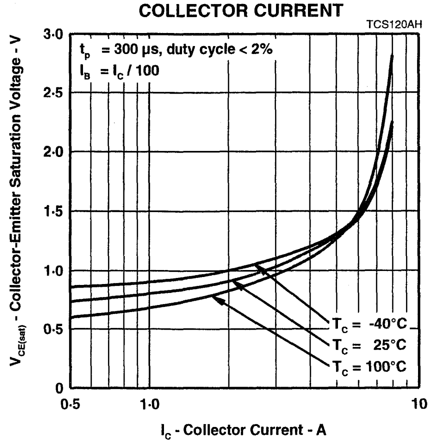


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

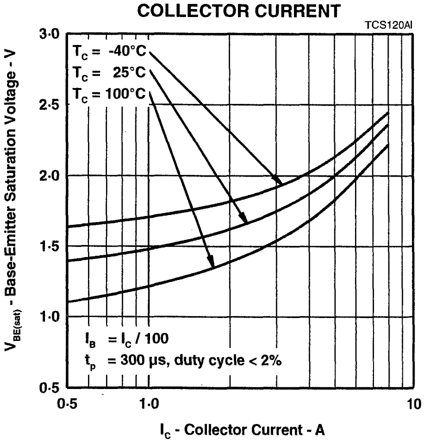


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

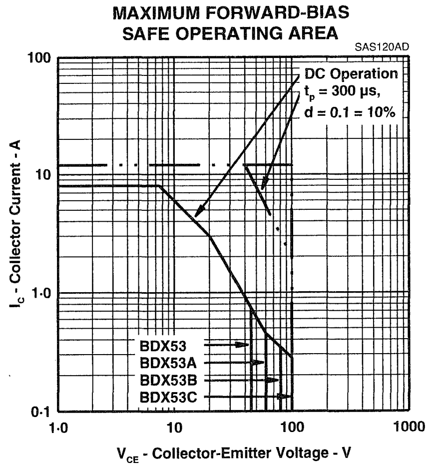


Figure 4.

THERMAL INFORMATION

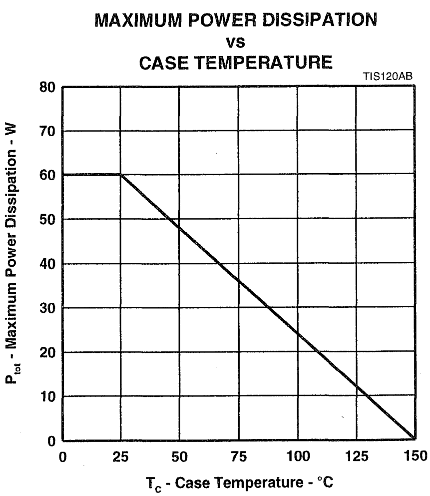
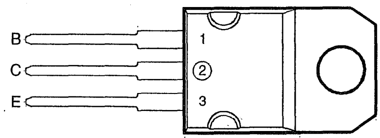


Figure 5.

- **Designed for Complementary Use with BDX53, BDX53A, BDX53B and BDX53C**
- **60 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3 V, 3 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BDX54	V_{CBO}	-45	V
	BDX54A		-60	
	BDX54B		-80	
	BDX54C		-100	
Collector-emitter voltage (I_B = 0)	BDX54	V_{CEO}	-45	V
	BDX54A		-60	
	BDX54B		-80	
	BDX54C		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-8	A
Continuous base current		I_B	-0.2	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 1)		P_{tot}	60	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 2)		P_{tot}	2	W
Operating junction temperature range		T_j	-65 to +150	°C
Operating temperature range		T_{stg}	-65 to +150	°C
Operating free-air temperature range		T_A	-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 noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -100 mA	I_B = 0	(see Note 3)	BDX54	-45			V
					BDX54A	-60			
					BDX54B	-80			
					BDX54C	-100			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0		BDX54			-0.5	mA
		V_{CE} = -30 V	I_B = 0		BDX54A			-0.5	
		V_{CE} = -40 V	I_B = 0		BDX54B			-0.5	
		V_{CE} = -50 V	I_B = 0		BDX54C			-0.5	
I_{CBO}	Collector cut-off current	V_{CB} = -45 V	I_E = 0		BDX54			-0.2	mA
		V_{CB} = -60 V	I_E = 0		BDX54A			-0.2	
		V_{CB} = -80 V	I_E = 0		BDX54B			-0.2	
		V_{CB} = -100 V	I_E = 0		BDX54C			-0.2	
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	(see Notes 3 and 4)		750			
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = -12 mA	I_C = -3 A	(see Notes 3 and 4)				-2.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -12 mA	I_C = -3 A	(see Notes 3 and 4)				-2	V
V_{EC}	Parallel diode forward voltage	I_E = -3 A	I_B = 0					-2.5	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			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

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	t_p = 20 µs, dc ≤ 2%		5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

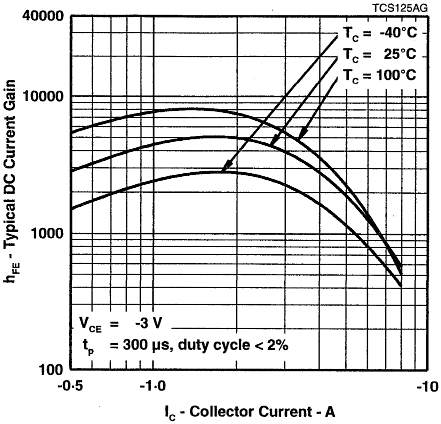


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

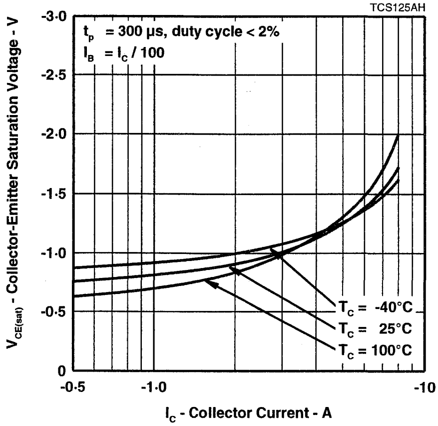


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

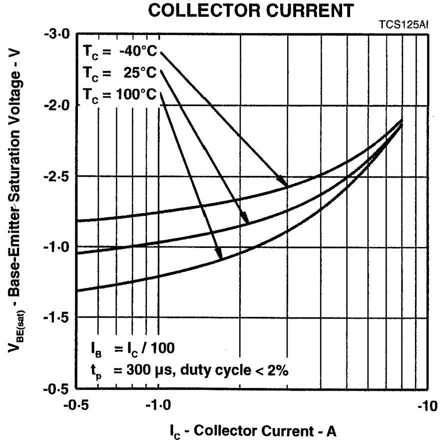


Figure 3.

MAY 1989 - REVISED MAY 1995

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

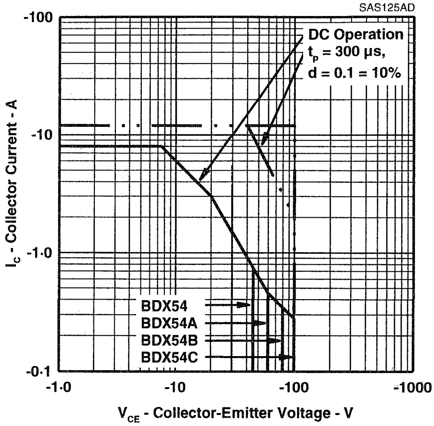


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

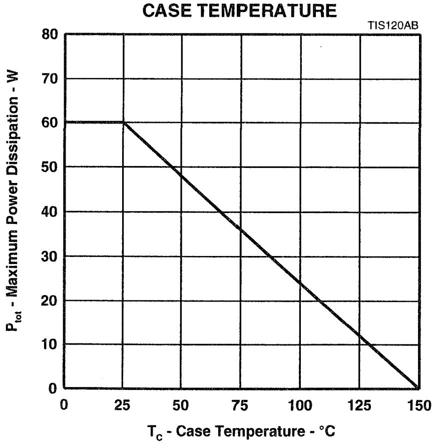


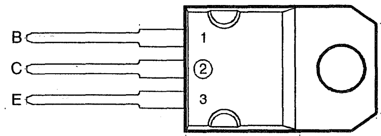
Figure 5.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

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

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP100 TIP101 TIP102	V_{CBO}	60 80 100	V
Collector-emitter voltage (I_B = 0)	TIP100 TIP101 TIP102	V_{CEO}	60 80 100	V
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Peak collector current (see Note 1)		I_{CM}	15	A
Continuous base current		I_B	1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	10	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see 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	(see Notes 5 and 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	(see Notes 5 and 6)			2 2.5	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 8 A	(see Notes 5 and 6)			2.8	V
V_{EC}	Parallel diode forward voltage	I_E = 8 A	I_B = 0	(see Notes 5 and 6)			3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

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, t_p = 20 μs, dc ≤ 2%		35		ns
t_r	Rise time			350		ns
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.

TYPICAL CHARACTERISTICS

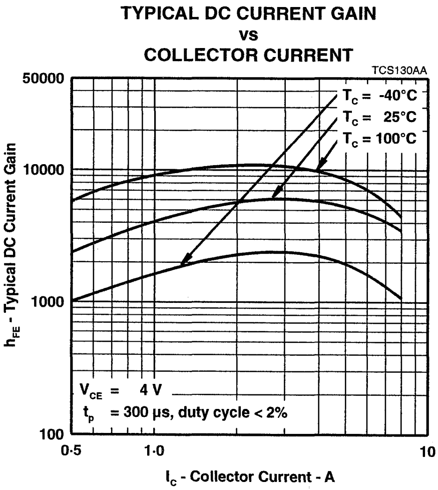


Figure 1.

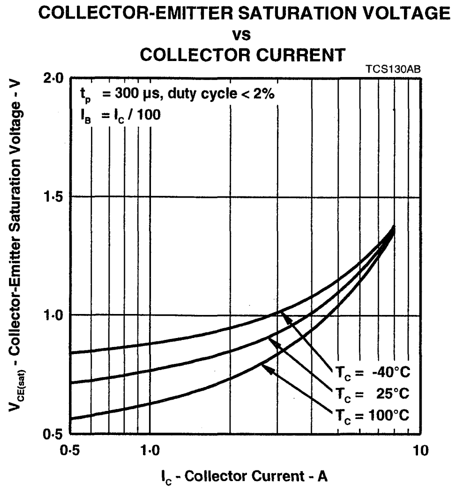


Figure 2.

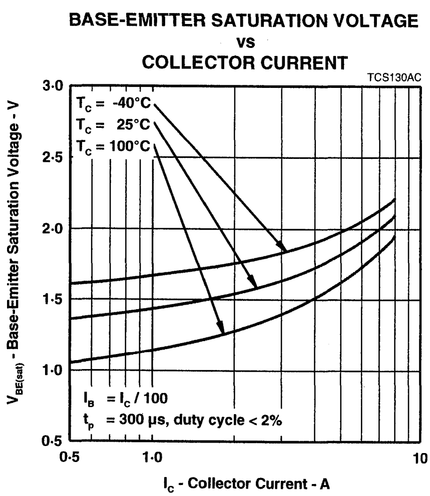


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

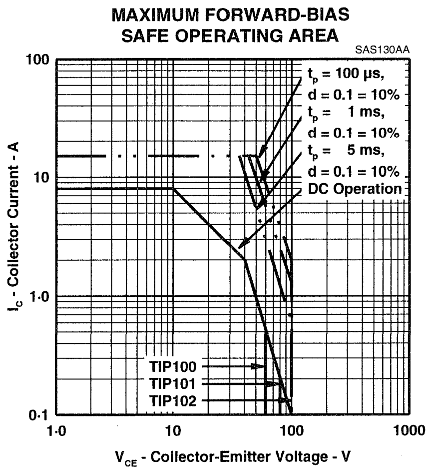


Figure 4.

THERMAL INFORMATION

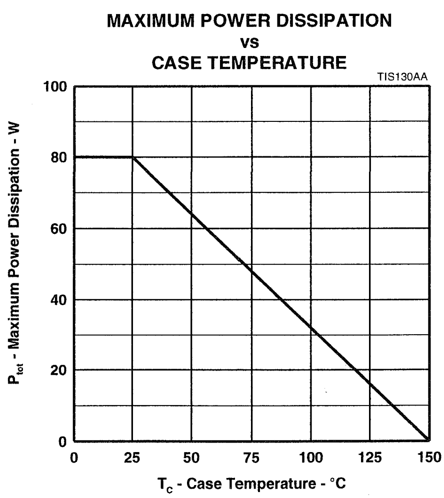
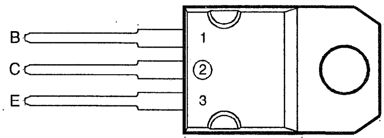


Figure 5.

AUGUST 1978 - REVISED MAY 1995

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

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP105	V_{CBO}	-60	V
	TIP106		-80	
	TIP107		-100	
Collector-emitter voltage (I_B = 0)	TIP105	V_{CEO}	-60	V
	TIP106		-80	
	TIP107		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-8	A
Peak collector current (see Note 1)		I_{CM}	-15	A
Continuous base current		I_B	-1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	80	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	10	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	$I_B = 0$	TIP105 TIP106 TIP107	-60 -80 -100			V
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V V_{CE} = -40 V V_{CE} = -50 V	$I_B = 0$ $I_B = 0$ $I_B = 0$	TIP105 TIP106 TIP107			-50 -50 -50	μA
I_{CBO}	Collector cut-off current	V_{CB} = -60 V V_{CB} = -80 V V_{CB} = -100 V	$I_E = 0$ $I_E = 0$ $I_E = 0$	TIP105 TIP106 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 V_{CE} = -4 V	I_C = -3 A I_C = -8 A	(see Notes 5 and 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	(see Notes 5 and 6)			-2 -2.5	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -8 A	(see Notes 5 and 6)			-2.8	V
V_{EC}	Parallel diode forward voltage	I_E = -8 A	$I_B = 0$	(see Notes 5 and 6)			-3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

resistive-load-switching characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_d	Delay time	I_C = -8 A $V_{BE(off)}$ = 5 V	$I_{B(on)}$ = -80 mA R_L = 5 Ω	$I_{B(off)}$ = 80 mA t_p = 20 μs, dc ≤ 2%		35		ns
t_r	Rise time					300		ns
t_s	Storage time					900		ns
t_f	Fall time					1.3		μs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

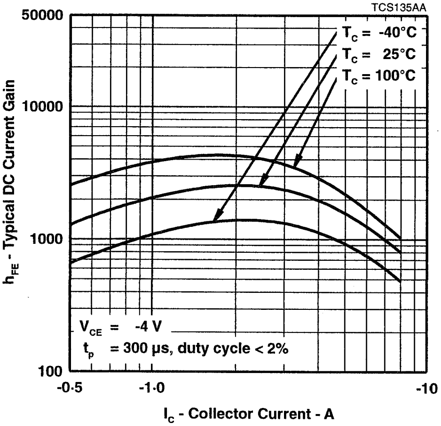


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

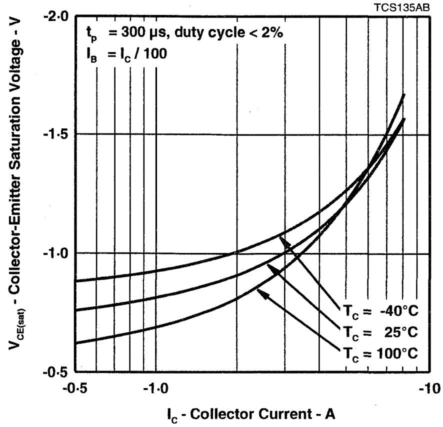


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

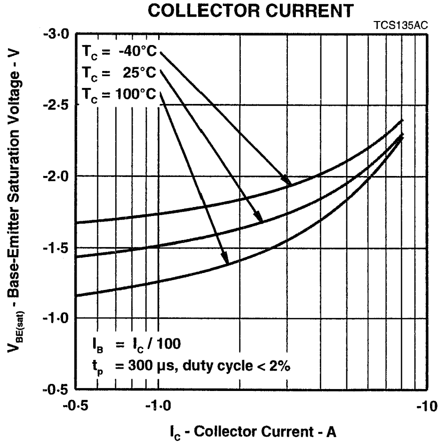


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

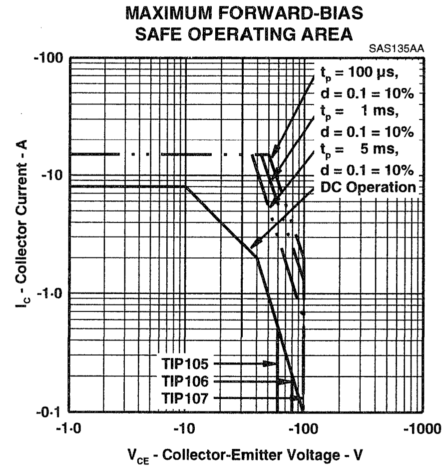


Figure 4.

THERMAL INFORMATION

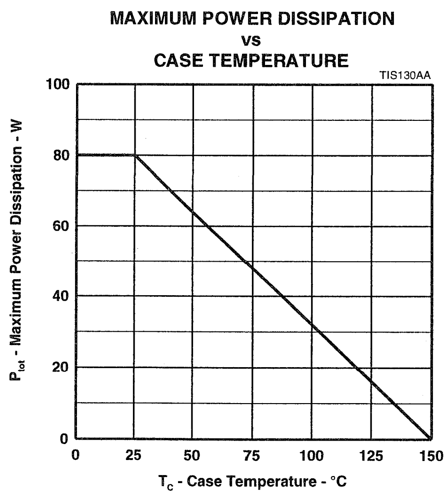
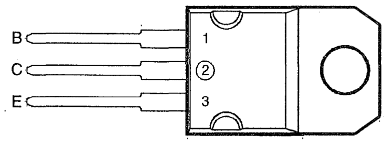


Figure 5.

DECEMBER 1971 - REVISED MAY 1995

- Designed for Complementary Use with TIP115, TIP116 and TIP117
- 50 W at 25°C Case Temperature
- 4 A Continuous Collector Current
- Minimum h_{FE} of 500 at 4 V, 2 A

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP110	V_{CBO}	60	V
	TIP111		80	
	TIP112		100	
Collector-emitter voltage (I_B = 0)	TIP110	V_{CEO}	60	V
	TIP111		80	
	TIP112		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	4	A
Peak collector current (see Note 1)		I_{CM}	6	A
Continuous base current		I_B	50	mA
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	50	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	25	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES:
1. This value applies for $t_p \le 0.3$ 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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see 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	(see Notes 5 and 6)	1000 500			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 8 mA	I_C = 2 A	(see Notes 5 and 6)			2.5	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 2 A	(see Notes 5 and 6)			2.8	V
V_{EC}	Parallel diode forward voltage	I_E = 4 A	$I_B = 0$	(see Notes 5 and 6)			3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 300 µs, 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

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	t_p = 20 µs, dc ≤ 2%		4.5		µs

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

TYPICAL CHARACTERISTICS

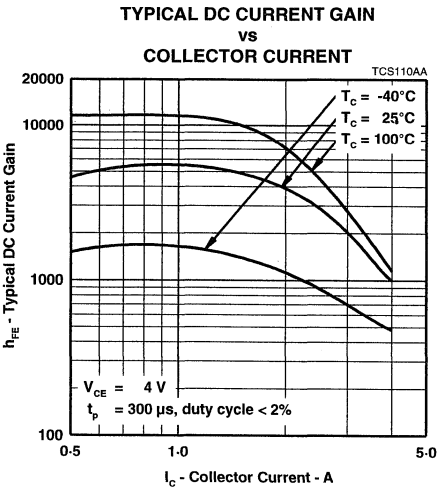


Figure 1.

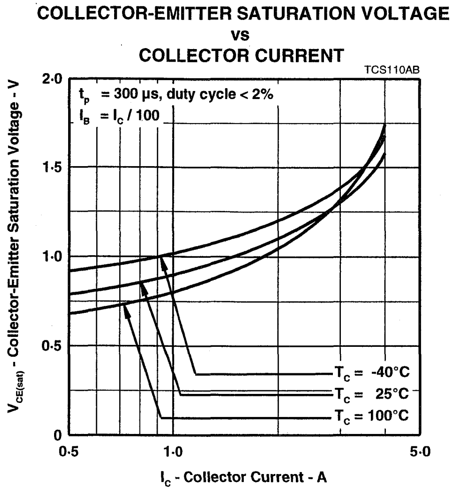


Figure 2.

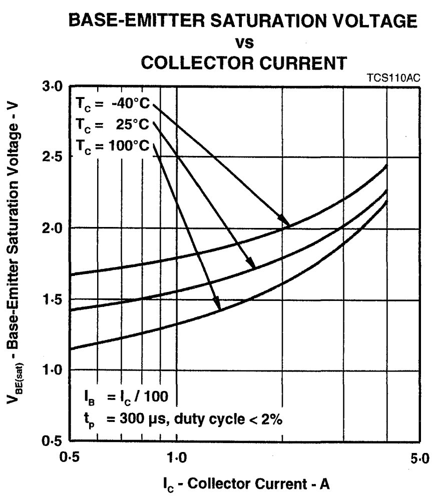


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

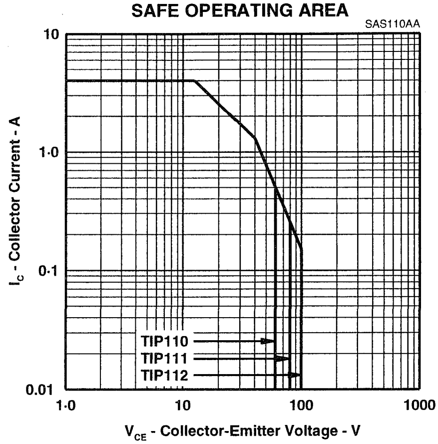


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

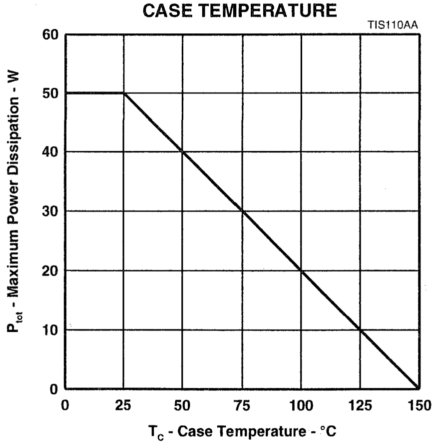
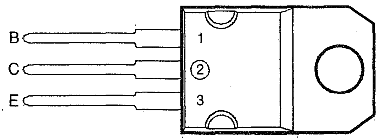


Figure 5.

- **Designed for Complementary Use with TIP110, TIP111 and TIP112**
- **50 W at 25°C Case Temperature**
- **4 A Continuous Collector Current**
- **Minimum h_{FE} of 500 at 4 V, 2 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP115	V_{CBO}	-60	V
	TIP116		-80	
	TIP117		-100	
Collector-emitter voltage (I_B = 0)	TIP115	V_{CEO}	-60	V
	TIP116		-80	
	TIP117		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-4	A
Peak collector current (see Note 1)		I_{CM}	-6	A
Continuous base current		I_B	-50	mA
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	50	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		½LI_C^2	25	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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 transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	$I_B = 0$	TIP115 TIP116 TIP117	-60 -80 -100			V
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V V_{CE} = -40 V V_{CE} = -50 V	$I_B = 0$ $I_B = 0$ $I_B = 0$	TIP115 TIP116 TIP117			-2 -2 -2	mA
I_{CBO}	Collector cut-off current	V_{CB} = -60 V V_{CB} = -80 V V_{CB} = -100 V	$I_E = 0$ $I_E = 0$ $I_E = 0$	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 V_{CE} = -4 V	I_C = -1 A I_C = -2 A	(see Notes 5 and 6)	1000 500			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -8 mA	I_C = -2 A	(see Notes 5 and 6)			-2.5	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -2 A	(see Notes 5 and 6)			-2.8	V
V_{EC}	Parallel diode forward voltage	I_E = -5 A	$I_B = 0$	(see Notes 5 and 6)			-3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 300 µs, 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

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	t_p = 20 µs, dc ≤ 2%		4.5		µs

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

TYPICAL CHARACTERISTICS

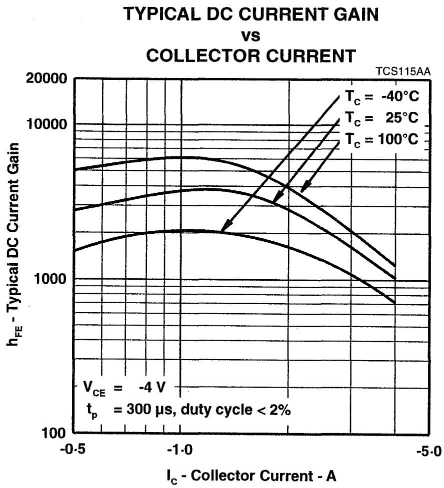


Figure 1.

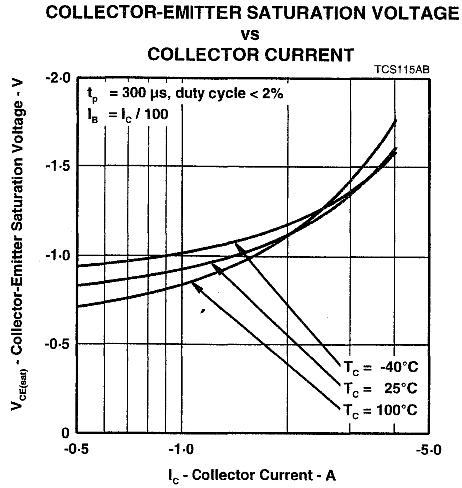


Figure 2.

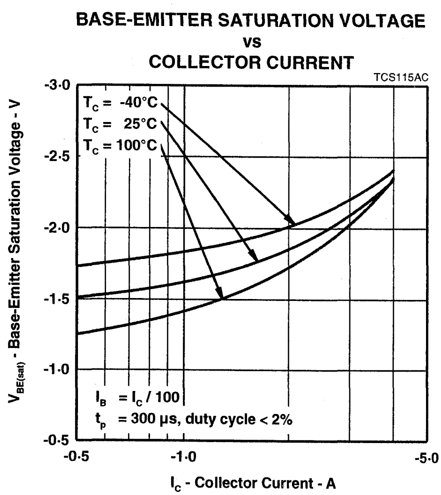


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

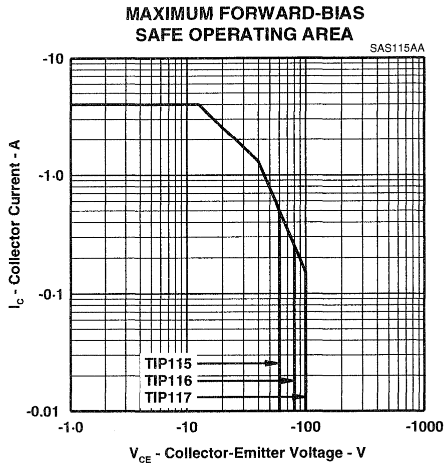


Figure 4.

THERMAL INFORMATION

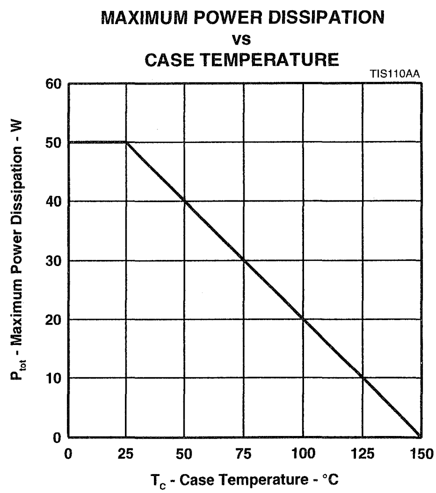


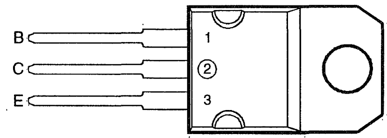
Figure 5.

TEXAS INSTRUMENTS

DECEMBER 1971 - REVISED MAY 1995

- **Designed for Complementary Use with TIP125, TIP126 and TIP127**
- **65 W at 25°C Case Temperature**
- **5 A Continuous Collector Current**
- **Minimum h_{FE} of 1000 at 3 V, 3 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP120	V_{CBO}	60	V
	TIP121		80	
	TIP122		100	
Collector-emitter voltage (I_B = 0)	TIP120	V_{CEO}	60	V
	TIP121		80	
	TIP122		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	5	A
Peak collector current (see Note 1)		I_{CM}	8	A
Continuous base current		I_B	0.1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	65	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	50	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES:
1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	TIP120 TIP121 TIP122	60 80 100			V
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V V_{CE} = 40 V V_{CE} = 50 V	$I_B = 0$ $I_B = 0$ $I_B = 0$	TIP120 TIP121 TIP122			0.5 0.5 0.5	mA
I_{CBO}	Collector cut-off current	V_{CB} = 60 V V_{CB} = 80 V V_{CB} = 100 V	$I_E = 0$ $I_E = 0$ $I_E = 0$	TIP120 TIP121 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 V_{CE} = 3 V	I_C = 0.5 A I_C = 3 A	(see Notes 5 and 6)	1000 1000			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 12 mA I_B = 20 mA	I_C = 3 A I_C = 5 A	(see Notes 5 and 6)			2 4	V
V_{BE}	Base-emitter voltage	V_{CE} = 3 V	I_C = 3 A	(see Notes 5 and 6)			2.5	V
V_{EC}	Parallel diode forward voltage	I_E = 5 A	$I_B = 0$	(see Notes 5 and 6)			3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.92	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 µs, dc ≤ 2%		8.5		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

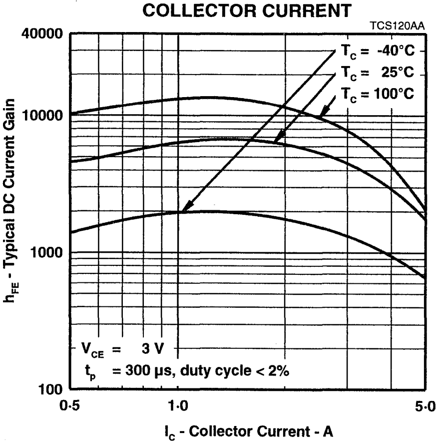


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

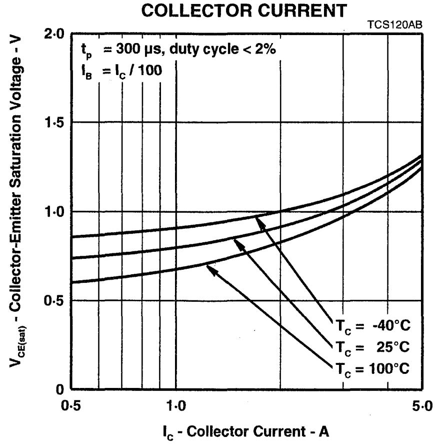


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

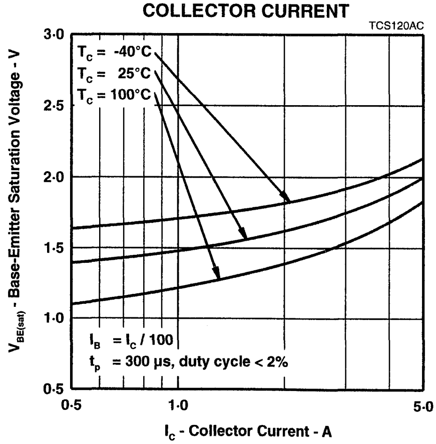


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

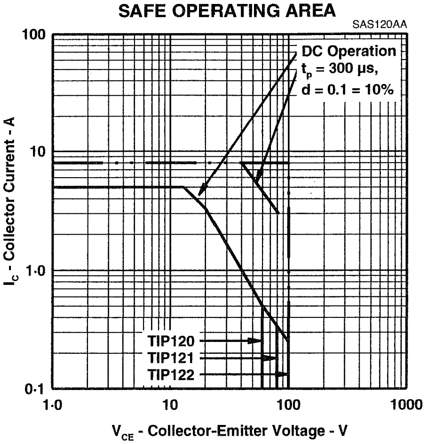


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

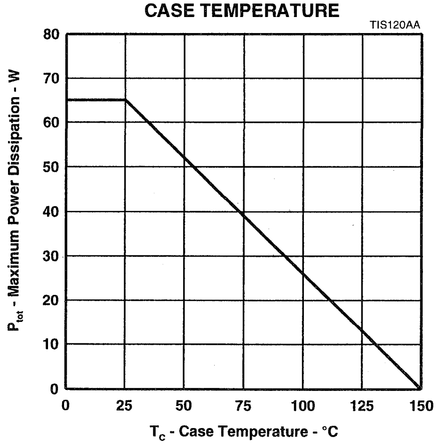
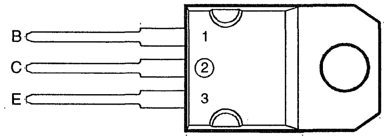


Figure 5.

DECEMBER 1971 - REVISED MAY 1995

- **Designed for Complementary Use with TIP120, TIP121 and TIP122**
- **65 W at 25°C Case Temperature**
- **5 A Continuous Collector Current**
- **Minimum h_{FE} of 1000 at 3 V, 3 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP125	V_{CBO}	-60	V
	TIP126		-80	
	TIP127		-100	
Collector-emitter voltage (I_B = 0)	TIP125	V_{CEO}	-60	V
	TIP126		-80	
	TIP127		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-5	A
Peak collector current (see Note 1)		I_{CM}	-8	A
Continuous base current		I_B	-0.1	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	65	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	50	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	TIP125 TIP126 TIP127	-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	TIP125 TIP126 TIP127			-0.5 -0.5 -0.5	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	TIP125 TIP126 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 V_{CE} = -3 V	I_C = -0.5 A I_C = -3 A	(see Notes 5 and 6)	1000 1000			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -12 mA I_B = -20 mA	I_C = -3 A I_C = -5 A	(see Notes 5 and 6)			-2 -4	V
V_{BE}	Base-emitter voltage	V_{CE} = -3 V	I_C = -3 A	(see Notes 5 and 6)			-2.5	V
V_{EC}	Parallel diode forward voltage	I_E = -5 A	I_B = 0	(see Notes 5 and 6)			-3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.92	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

resistive-load-switching characteristics at 25°C case temperature

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	t_p = 20 μs, dc ≤ 2%		8.5		μs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

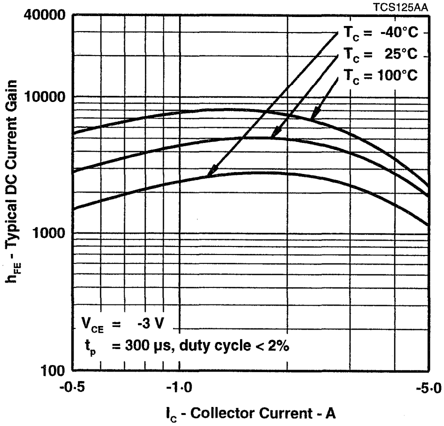


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

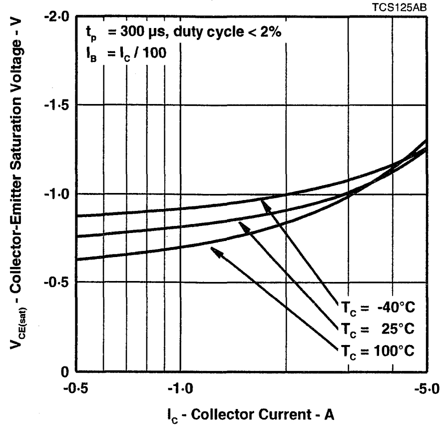


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

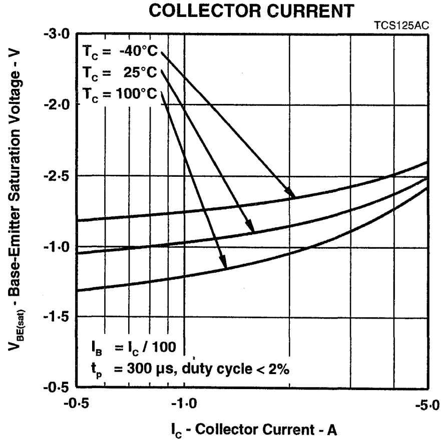


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

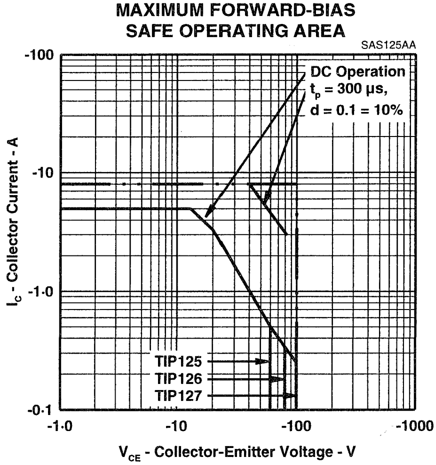


Figure 4.

THERMAL INFORMATION

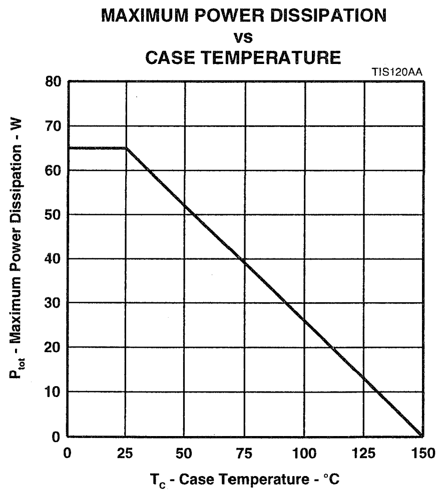


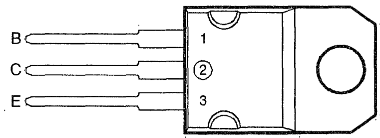
Figure 5.

TEXAS INSTRUMENTS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with TIP135, TIP136 and TIP137**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 1000 at 4 V, 4 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.
MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP130	V_{CBO}	60	V
	TIP131		80	
	TIP132		100	
Collector-emitter voltage (I_B = 0)	TIP130	V_{CEO}	60	V
	TIP131		80	
	TIP132		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Peak collector current (see Note 1)		I_{CM}	12	A
Continuous base current		I_B	0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	70	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	75	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \le 0.3$ 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 16 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = 5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

electrical characteristics at 25°C case temperature

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

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.78	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

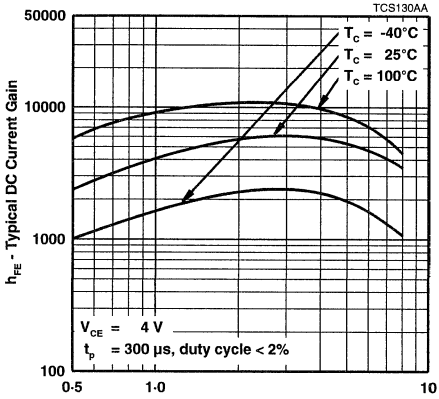


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

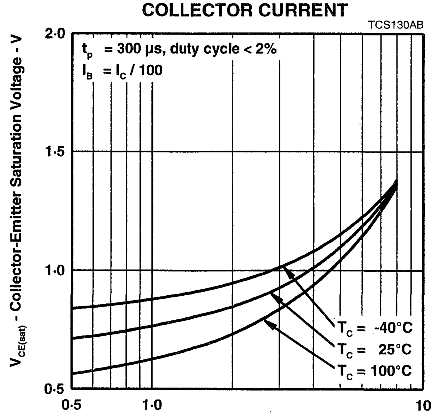


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

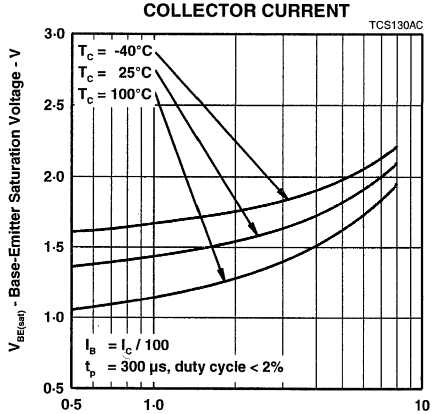


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

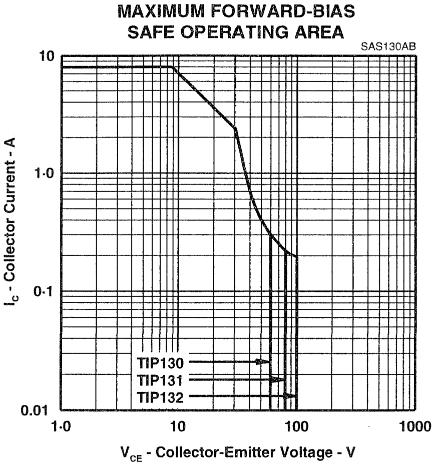


Figure 4.

THERMAL INFORMATION

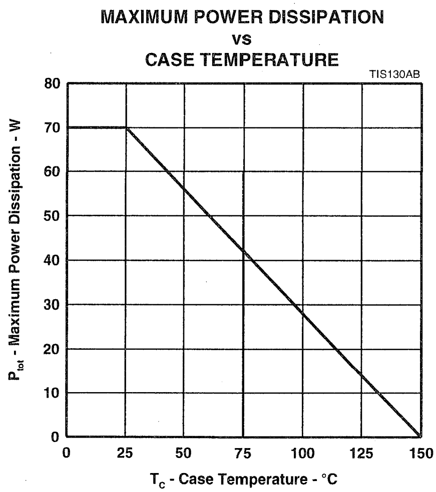


Figure 5.

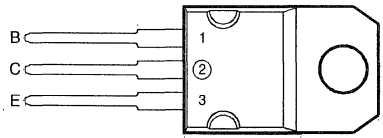
TEXAS INSTRUMENTS

TIP135, TIP136, TIP137
PNP SILICON POWER DARLINGTONS

JUNE 1973 - REVISED MAY 1995

- **Designed for Complementary Use with TIP130, TIP131 and TIP132**
- **70 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 1000 at 4 V, 4 A**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTES: 1. This value applies for $t_p \leq 0.3$ 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 16 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

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

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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			1.78	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

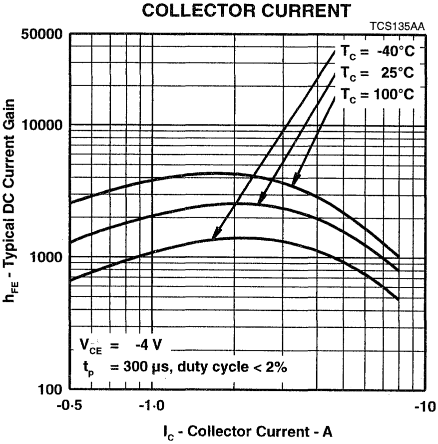


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

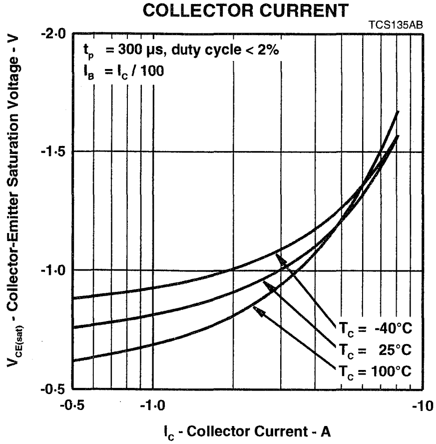


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

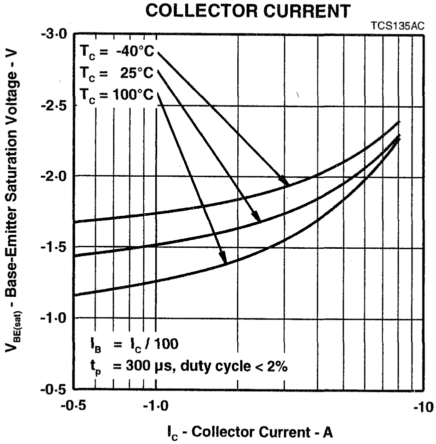


Figure 3.

JUNE 1973 - REVISED MAY 1995

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

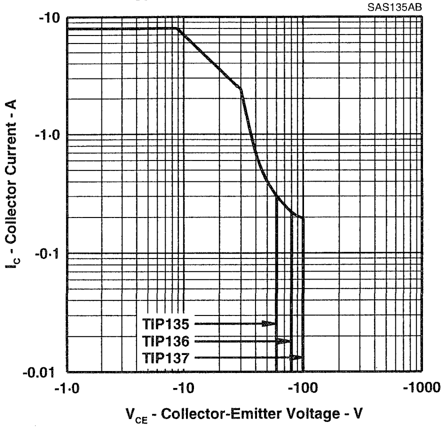


Figure 4.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

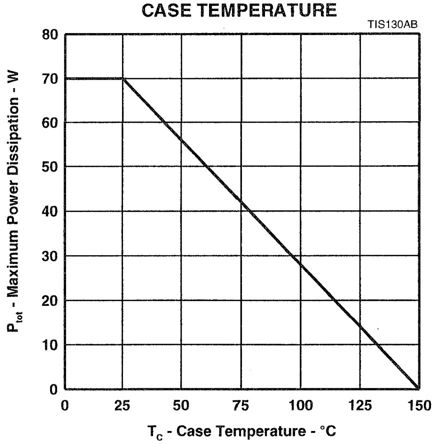


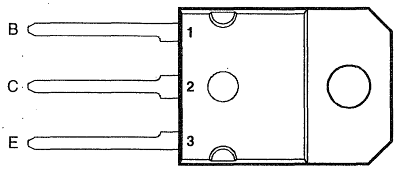
Figure 5.

TEXAS INSTRUMENTS

DECEMBER 1971 - REVISED MAY 1995

- **Designed for Complementary Use with TIP145, TIP146 and TIP147**
- **125 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **Minimum h_{FE} of 1000 at 4 V, 5 A**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.
MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	TIP140	V_{CBO}	60	V
	TIP141		80	
	TIP142		100	
Collector-emitter voltage ($I_B = 0$)	TIP140	V_{CEO}	60	V
	TIP141		80	
	TIP142		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	10	A
Peak collector current (see Note 1)		I_{CM}	15	A
Continuous base current		I_B	0.5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	125	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	100	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)} = 5$ mA, $R_{BE} = 100\ \Omega$, $V_{BE(off)} = 0$, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

TEXAS INSTRUMENTS

DECEMBER 1971 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	I_B = 0	TIP140 TIP141 TIP142	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	TIP140 TIP141 TIP142			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	TIP140 TIP141 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 V_{CE} = 4 V	I_C = 5 A I_C = 10 A	(see Notes 5 and 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	(see Notes 5 and 6)			2 3	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 10 A	(see Notes 5 and 6)			3	V
V_{EC}	Parallel diode forward voltage	I_E = 10 A	I_B = 0	(see Notes 5 and 6)			3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 300 μs, 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

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	t_p = 20 μs, dc ≤ 2%		11		μs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

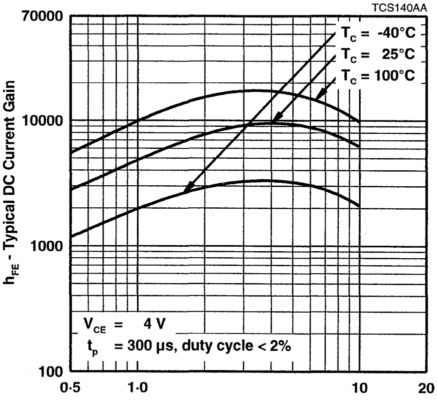


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

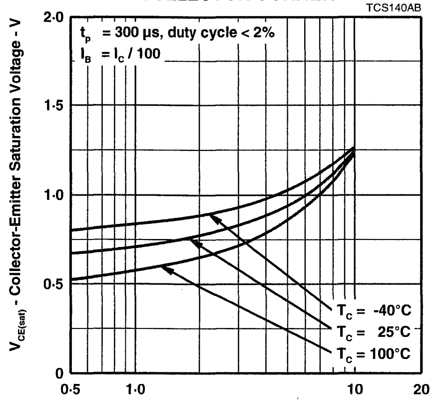


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

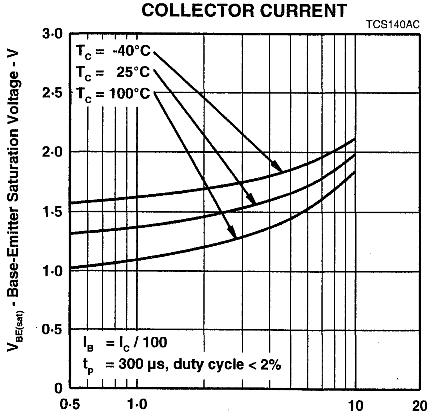


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

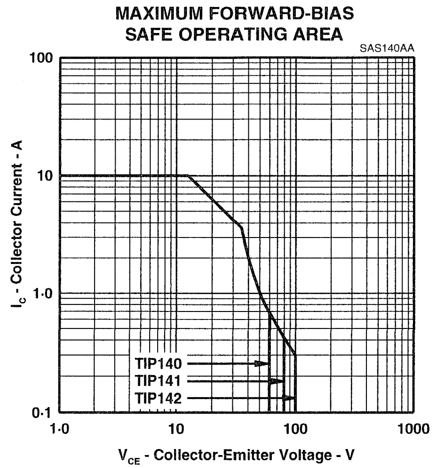


Figure 4.

THERMAL INFORMATION

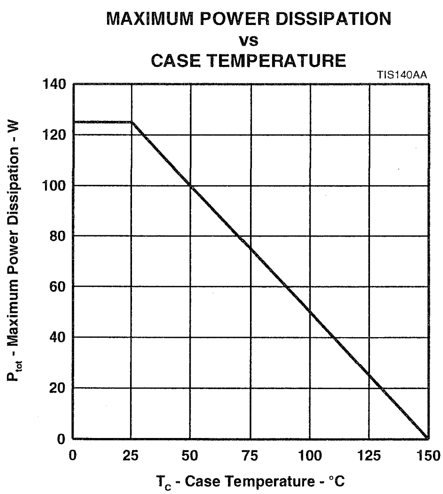
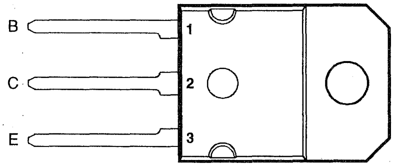


Figure 5.

- **Designed for Complementary Use with TIP140, TIP141 and TIP142**
- **125 W at 25°C Case Temperature**
- **10 A Continuous Collector Current**
- **Minimum h_{FE} of 1000 at 4 V, 5 A**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP145	V_{CBO}	-60	V
	TIP146		-80	
	TIP147		-100	
Collector-emitter voltage (I_B = 0)	TIP145	V_{CEO}	-60	V
	TIP146		-80	
	TIP147		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-10	A
Peak collector current (see Note 1)		I_{CM}	-15	A
Continuous base current		I_B	-0.5	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	125	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	3.5	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	100	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $I_{B(on)}$ = -5 mA, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = -20 V.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -30 mA (see Note 5)	I_B = 0	TIP145	-60			V
				TIP146	-80			
				TIP147	-100			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V	I_B = 0	TIP145			-2	mA
		V_{CE} = -40 V	I_B = 0	TIP146			-2	
		V_{CE} = -50 V	I_B = 0	TIP147			-2	
I_{CBO}	Collector cut-off current	V_{CB} = -60 V	I_E = 0	TIP145			-1	mA
		V_{CB} = -80 V	I_E = 0	TIP146			-1	
		V_{CB} = -100 V	I_E = 0	TIP147			-1	
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	(see Notes 5 and 6)	1000			
		V_{CE} = -4 V	I_C = -10 A		500			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -10 mA	I_C = -5 A	(see Notes 5 and 6)			-2	V
		I_B = -40 mA	I_C = -10 A				-3	
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -10 A	(see Notes 5 and 6)			-3	V
V_{EC}	Parallel diode forward voltage	I_E = -10 A	I_B = 0	(see Notes 5 and 6)			-3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 300 µs, 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

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	t_p = 20 µs, dc ≤ 2%		11		µs

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

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

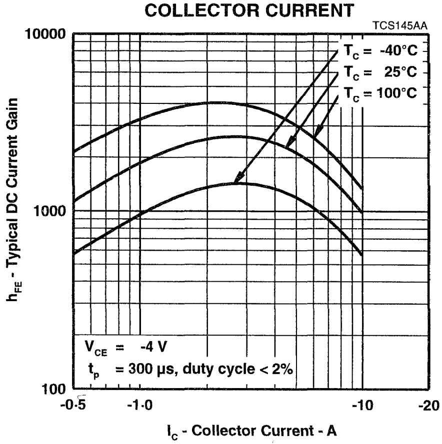


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

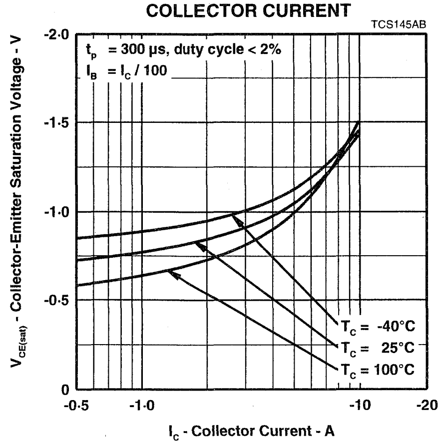


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

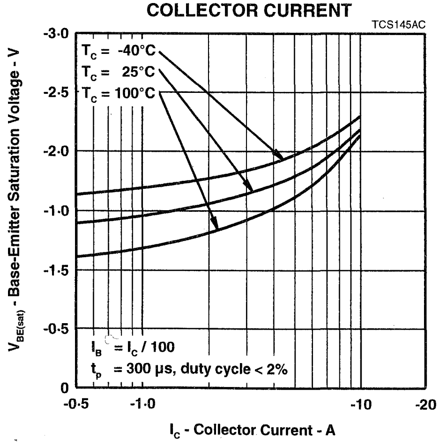


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

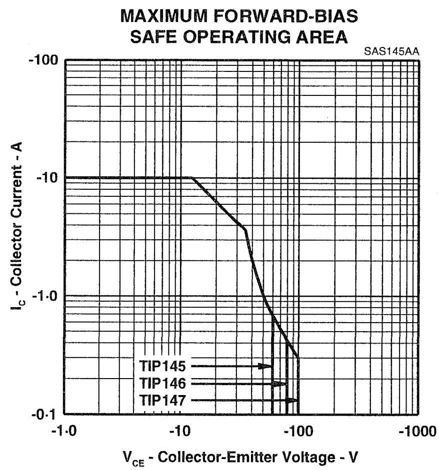


Figure 4.

THERMAL INFORMATION

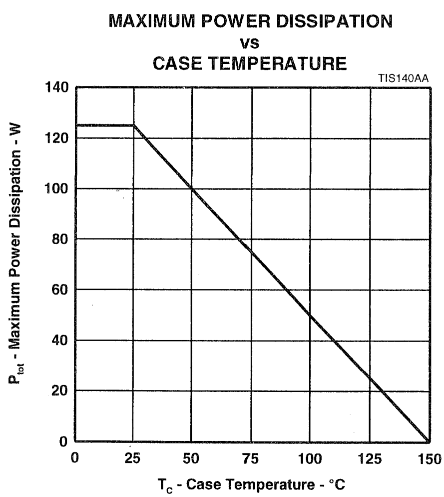


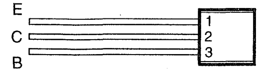
Figure 5.

TIPP110, TIPP111, TIPP112
NPN SILICON POWER DARLINGTONS

MAY 1989 - REVISED APRIL 1995

- **20 W Pulsed Power Dissipation**
- **100 V Capability**
- **2 A Continuous Collector Current**
- **4 A Peak Collector Current**

LP PACKAGE
(TOP VIEW)



MDTRAB

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	TIPP110	V_{CBO}	60	V
	TIPP111		80	
	TIPP112		100	
Collector-emitter voltage ($I_B = 0$)	TIPP110	V_{CEO}	60	V
	TIPP111		80	
	TIPP112		100	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	2	A
Peak collector current (see Note 1)		I_{CM}	4	A
Continuous base current		I_B	50	mA
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	0.8	W
Pulsed power dissipation (see Note 3)		P_T	20	W
Operating junction temperature range		T_j	-55 to +150	°C
Storage temperature range		T_{stg}	-55 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, $P_W = 10$ ms, duty cycle ≤ 2%.

electrical characteristics at 25°C case temperature

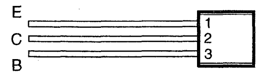
PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 10 mA (see Note 4)	$I_B = 0$	TIPP110	60			V
				TIPP111	80			
				TIPP112	100			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	$V_{BE} = 0$	TIPP110			2	mA
		V_{CE} = 40 V	$V_{BE} = 0$	TIPP111			2	
		V_{CE} = 50 V	$V_{BE} = 0$	TIPP112			2	
I_{CBO}	Collector-base cut-off current	V_{CE} = 60 V	$I_B = 0$	TIPP110			1	mA
		V_{CE} = 80 V	$I_B = 0$	TIPP111			1	
		V_{CE} = 100 V	$I_B = 0$	TIPP112			1	
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	(see Notes 4 and 5)	1000			
		V_{CE} = 4 V	I_C = 2 A		500			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 8 mA	I_C = 2 A	(see Notes 4 and 5)			2.5	V
V_{BE}	Base-emitter voltage	V_{CE} = 4 V	I_C = 2 A	(see Notes 4 and 5)			2.8	V
V_{EC}	Parallel diode forward voltage	I_E = 4 A	$I_B = 0$	(see Notes 4 and 5)			3.5	V

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts and located within 3.2 mm from device body.

MAY 1989 - REVISED APRIL 1995

- **20 W Pulsed Power Dissipation**
- **100 V Capability**
- **2 A Continuous Collector Current**
- **4 A Peak Collector Current**

LP PACKAGE
(TOP VIEW)



MDTRAB

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIPP115	V_{CBO}	-60	V
	TIPP116		-80	
	TIPP117		-100	
Collector-emitter voltage (I_B = 0)	TIPP115	V_{CEO}	-60	V
	TIPP116		-80	
	TIPP117		-100	
Emitter-base voltage		V_{EBO}	-5	V
Continuous collector current		I_C	-2	A
Peak collector current (see Note 1)		I_{CM}	-4	A
Continuous base current		I_B	-50	mA
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	0.8	W
Pulsed power dissipation (see Note 3)		P_T	20	W
Operating junction temperature range		T_j	-55 to +150	°C
Storage temperature range		T_{stg}	-55 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES: 1. This value applies for $t_p \leq 0.3$ 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, P_W = 10 ms, duty cycle ≤ 2%.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = -10 mA (see Note 4)	$I_B = 0$	TIPP115 TIPP116 TIPP117	-60 -80 -100			V
I_{CEO}	Collector-emitter cut-off current	V_{CE} = -30 V V_{CE} = -40 V V_{CE} = -50 V	$V_{BE} = 0$ $V_{BE} = 0$ $V_{BE} = 0$	TIPP115 TIPP116 TIPP117			-2 -2 -2	mA
I_{CBO}	Collector-base cut-off current	V_{CE} = -60 V V_{CE} = -80 V V_{CE} = -100 V	$I_B = 0$ $I_B = 0$ $I_B = 0$	TIPP115 TIPP116 TIPP117			-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	(see Notes 4 and 5)	1000 500			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = -8 mA	I_C = -2 A	(see Notes 4 and 5)			-2.5	V
V_{BE}	Base-emitter voltage	V_{CE} = -4 V	I_C = -2 A	(see Notes 4 and 5)			-2.8	V
V_{EC}	Parallel diode forward voltage	I_E = -4 A	$I_B = 0$	(see Notes 4 and 5)			-3.5	V

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.

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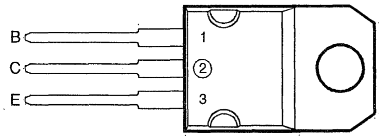
- 7 A Continuous Collector Current
- 15 A Peak Collector Current
- 60 W at 25°C Case Temperature

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.
MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BU406	V_{CBO}	400	V
	BU407		330	
Collector-emitter voltage (V_{BE} = -2 V)	BU406	V_{CEX}	400	V
	BU407		330	
Collector-emitter voltage (I_B = 0)	BU406	V_{CEO}	200	V
	BU407		150	
Emitter-base voltage		V_{EB}	6	V
Continuous collector current		I_C	7	A
Peak collector current (see Note 1)		I_{CM}	15	A
Continuous base current		I_B	4	A
Continuous device dissipation at (or below) 25°C case temperature		P_{tot}	60	W
Operating junction temperature range		T_j	-55 to +150	°C
Storage temperature range		T_{stg}	-55 to +150	°C

NOTE 1: This value applies for $t_p \leq 10$ 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 breakdown voltage	I_C = 30 mA	I_B = 0			140			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 400 V	V_{BE} = 0		BU406			5	mA
		V_{CE} = 330 V	V_{BE} = 0		BU407			5	
		V_{CE} = 250 V	V_{BE} = 0		BU406			0.1	
		V_{CE} = 200 V	V_{BE} = 0		BU407			0.1	
		V_{CE} = 250 V	V_{BE} = 0	T_C = 150°C	BU406			1	
		V_{CE} = 200 V	V_{BE} = 0	T_C = 150°C	BU407			1	
I_{EBO}	Emitter 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	(see Notes 2 and 3)		12			
		V_{CE} = 10 V	I_C = 0.5 A			20			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.5 A	I_C = 5 A	(see Notes 2 and 3)				1	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.5 A	I_C = 5 A	(see Notes 2 and 3)				1.2	V
f_t	Current gain bandwidth product	V_{CE} = 5 V	I_C = 0.5 A	f = 1 MHz	(see Note 4)		6		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 1 MHz			60		pF

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

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 noted)

PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_s	Storage time	I_C = 5 A	$I_{B(end)}$ = 0.5A	(see Figures 1 and 2)		2.7		µs
$t_{(off)}$	Turn off time						750	ns

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

PARAMETER MEASUREMENT INFORMATION

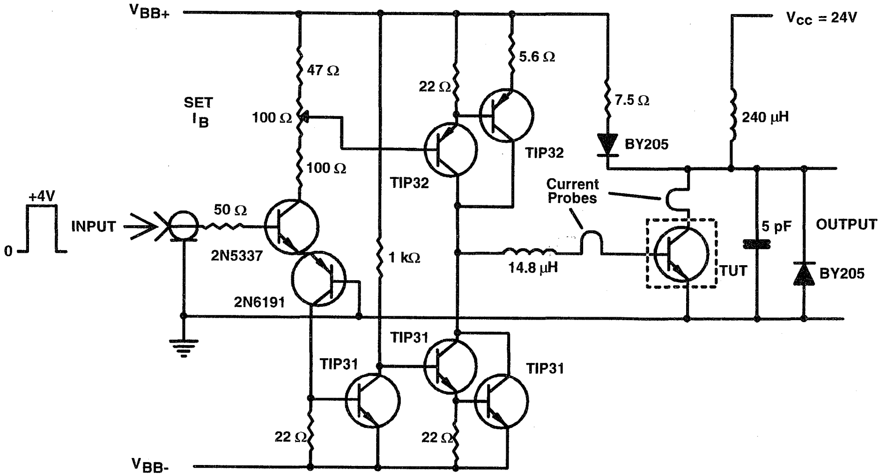
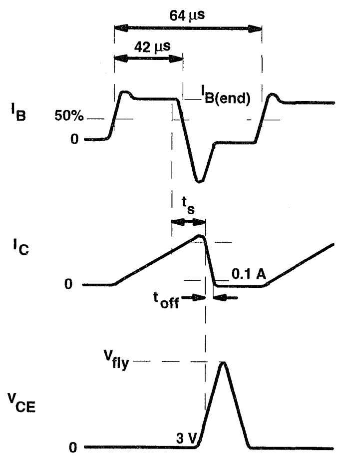


Figure 1. Inductive-Load Switching Test Circuit



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.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

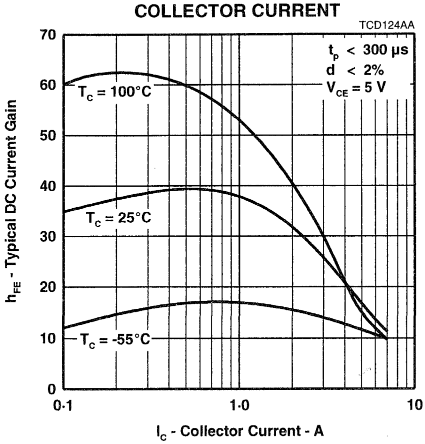


Figure 3.

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

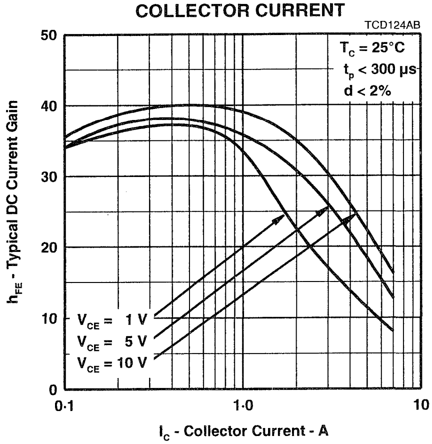


Figure 4.

COLLECTOR-EMITTER SATURATION VOLTAGE vs CASE TEMPERATURE

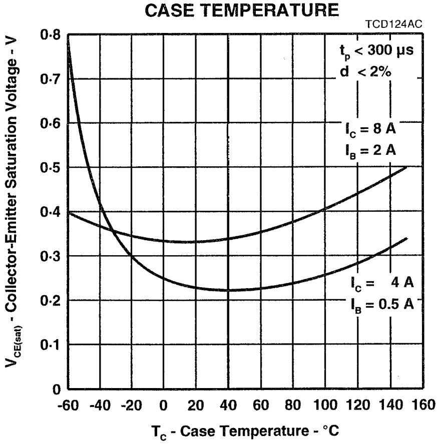


Figure 5.

MAXIMUM SAFE OPERATING REGIONS

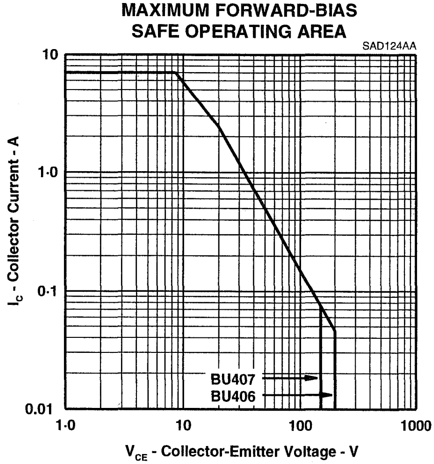
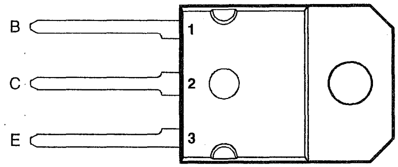


Figure 6.

- **Rugged Triple-Diffused Planar Construction**
- **900 Volt Blocking Capability**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	BU426 BU426A	V_{CBO}	800 900	V
Collector-emitter voltage (V_{BE} = 0)	BU426 BU426A	V_{CES}	800 900	V
Collector-emitter voltage (I_B = 0)	BU426 BU426A	V_{CEO}	375 400	V
Continuous collector current		I_C	6	A
Peak collector current (see Note 1)		I_{CM}	10	A
Continuous base current		I_B	+2, -0.1	A
Peak base current (see Note 1)		I_{BM}	±3	A
Continuous device dissipation at (or below) 50°C case temperature		P_{tot}	70	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTE 1: This value applies for $t_p \leq 2$ 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	I_C = 100 mA	L = 25 mH	(see Note 2)	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	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	 T_C = 125°C T_C = 125°C	BU426 BU426A BU426 BU426A			1 1 2 2	mA
I_{EBO}	Emitter 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	(see Notes 3 and 4)			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	(see Notes 3 and 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	(see Notes 3 and 4)				1.4 1.6	V

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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			1.1	°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 V_{CC} = 250 V	$I_{B(on)}$ = 0.5 A (see Figures 1 and 2)	$I_{B(off)}$ = -1 A		0.3	0.6	µs
t_s	Storage time					2	3.5	µs
t_f	Fall time					0.15		µs
t_f	Fall time	I_C = 2.5 A V_{CC} = 250 V	$I_{B(on)}$ = 0.5 A T_C = 95°C	$I_{B(off)}$ = -1 A		0.2	0.75	µs

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

PARAMETER MEASUREMENT INFORMATION

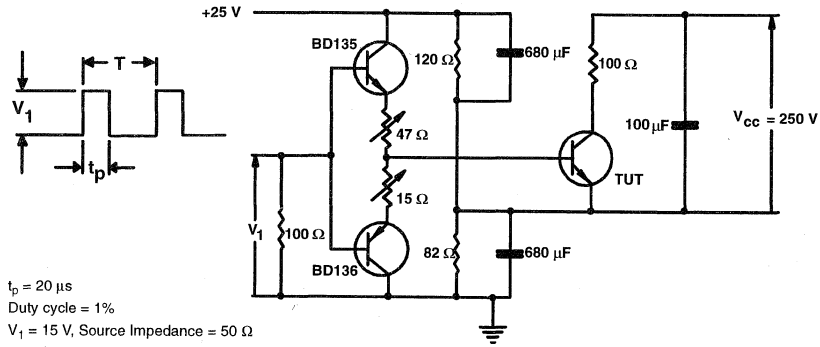


Figure 1. Resistive-Load Switching Test Circuit

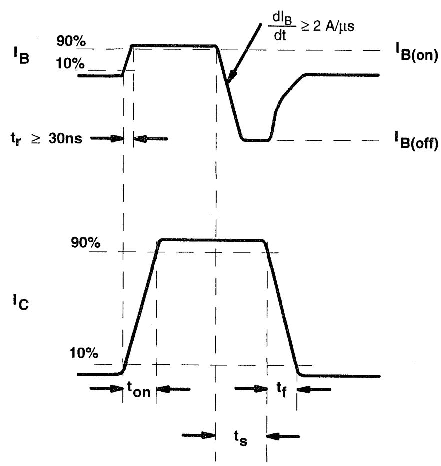


Figure 2. Resistive-Load Switching Waveforms

AUGUST 1978 - REVISED MAY 1995

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

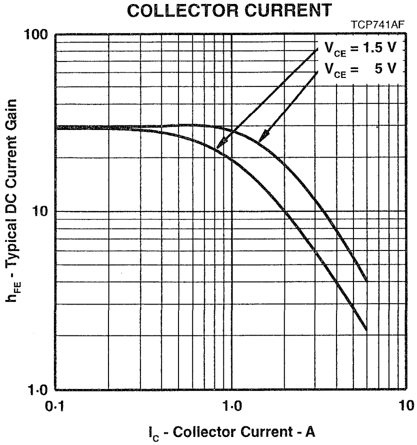


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

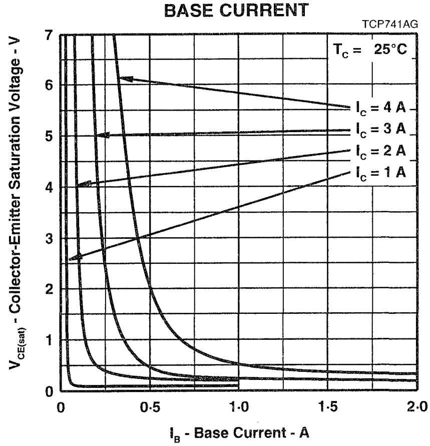


Figure 4.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

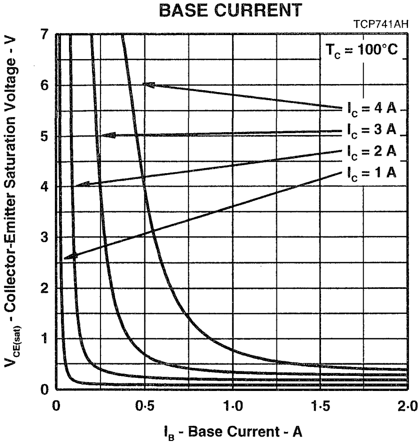


Figure 5.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

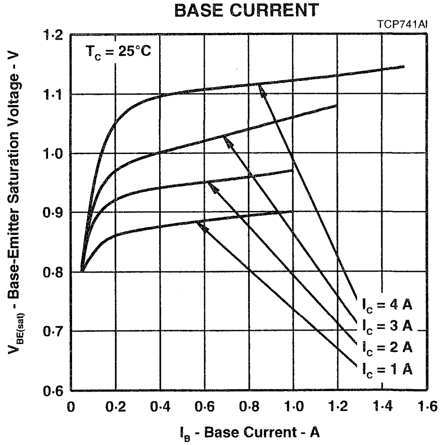


Figure 6.

MAXIMUM SAFE OPERATING REGIONS

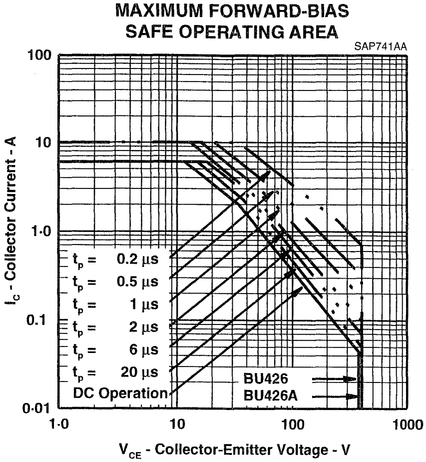
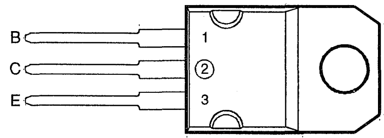


Figure 7.

MAY 1989 - REVISED MAY 1995

- **Rugged Triple-Diffused Planar Construction**
- **100 W at 25°C Case Temperature**
- **5 A Continuous Collector Current**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	V_{CBO}	850	V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	850	V
Collector-emitter voltage ($I_B = 0$)	V_{CEO}	400	V
Emitter-base voltage	V_{EBO}	10	V
Continuous collector current	I_C	5	A
Peak collector current (see Note 1)	I_{CM}	10	A
Continuous device dissipation at (or below) 25°C case temperature	P_{tot}	100	W
Operating junction temperature range	T_j	-65 to +150	°C
Storage temperature range	T_{stg}	-65 to +150	°C

NOTE 1: This value applies for $t_p \leq 10$ ms, 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 = 0.1 A	L = 25 mH	(see Note 2)	400			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 850 V V_{CE} = 850 V	V_{BE} = 0 V_{BE} = 0	 T_C = 125°C			50 500	µA
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0				1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)	20		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.6 A	I_C = 3 A	(see Notes 3 and 4)			1.5	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.6 A	I_C = 3 A	(see Notes 3 and 4)			1.3	V
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz		12		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz		110		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.

thermal characteristics

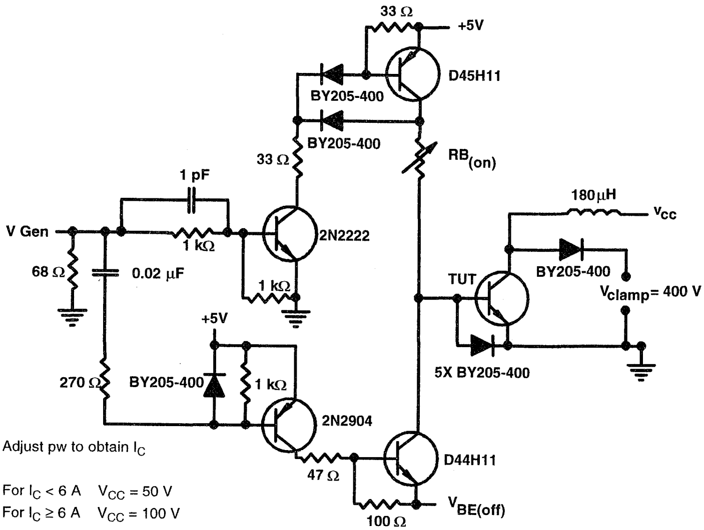
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to case thermal resistance			1.25	°C/W

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 = 3 A	$I_{B(on)}$ = 0.6A	$V_{BE(off)}$ = -5 V			1.4	µs
t_{fi}	Current fall time	V_{CC} = 50 V	(see Figures 1 and 2)				150	ns
t_{sv}	Voltage storage time	I_C = 3 A	$I_{B(on)}$ = 0.6A	$V_{BE(off)}$ = -5 V			1.5	µs
t_{fi}	Current fall time	V_{CC} = 50 V	T_C = 100°C				300	ns

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

PARAMETER MEASUREMENT INFORMATION

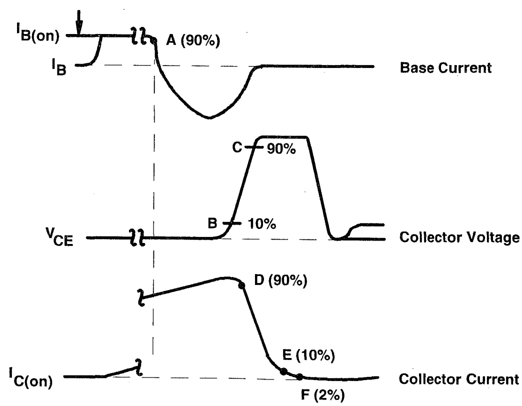


Adjust pw to obtain I_C

For $I_C < 6$ A $V_{CC} = 50$ V
For $I_C \geq 6$ A $V_{CC} = 100$ V

Figure 1. Inductive-Load Switching Test Circuit

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: $t_r < 15$ ns, $R_{in} > 10\ \Omega$, $C_{in} < 11.5$ pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

MAXIMUM SAFE OPERATING REGIONS

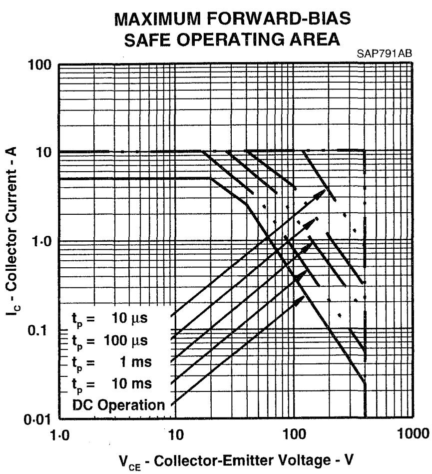


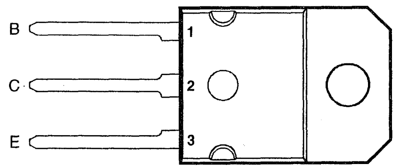
Figure 3.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

- Rugged Triple-Diffused Planar Construction
- 9 A Continuous Collector Current
- 1000 Volt Blocking Capability

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (V_{BE} = -2.5 V)	BUV47 BUV47A	V_{CEX}	850 1000	V
Collector-emitter voltage (R_{BE} = 10 Ω)	BUV47 BUV47A	V_{CER}	850 1000	V
Collector-emitter voltage (I_B = 0)	BUV47 BUV47A	V_{CEO}	400 450	V
Continuous collector current		I_C	9	A
Peak collector current (see Note 1)		I_{CM}	15	A
Continuous base current		I_B	3	A
Peak base current		I_{BM}	6	A
Continuous device dissipation at (or below) 25°C case temperature		P_{tot}	120	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTE 1: This value applies for $t_p \le 5$ ms, duty cycle $\le 2\%$.

TEXAS INSTRUMENTS

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	(see Note 2)	BUV47	400			V
					BUV47A	450			
$V_{(BR)EBO}$	Base-emitter breakdown voltage	I_E = 50 mA	$I_C = 0$	(see Note 3)		7		30	V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 850 V	$V_{BE} = 0$		BUV47			0.15	mA
		V_{CE} = 1000 V	$V_{BE} = 0$		BUV47A			0.15	
		V_{CE} = 850 V	$V_{BE} = 0$	T_C = 125°C	BUV47			1.5	
		V_{CE} = 1000 V	$V_{BE} = 0$	T_C = 125°C	BUV47A			1.5	
I_{CER}	Collector-emitter cut-off current	V_{CE} = 850 V	R_{BE} = 10 Ω		BUV47			0.4	mA
		V_{CE} = 1000 V	R_{BE} = 10 Ω		BUV47A			0.4	
		V_{CE} = 850 V	R_{BE} = 10 Ω	T_C = 125°C	BUV47			3.0	
		V_{CE} = 1000 V	R_{BE} = 10 Ω	T_C = 125°C	BUV47A			3.0	
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	(see Notes 3 and 4)				1.5	V
		I_B = 2.5 A	I_C = 8 A					3.0	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 1 A	I_C = 5 A	(see Notes 3 and 4)				1.6	V
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			8		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	$I_C = 0$	f = 0.1 MHz			105		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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	°C/W

resistive-load-switching characteristics at 25°C case temperature

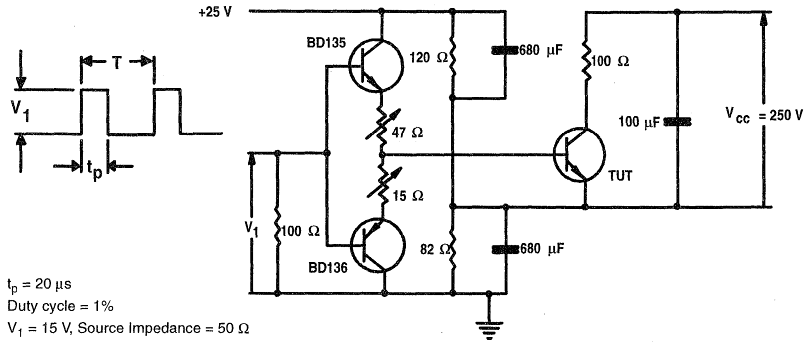
PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 5 A	$I_{B(on)}$ = 1 A	$I_{B(off)}$ = -1 A			1.0	µs
t_s	Storage time	V_{CC} = 150 V	(see Figures 1 and 2)				3.0	µs
t_f	Fall time						0.8	µs

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

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	$I_{B(on)}$ = 1 A	$V_{BE(off)}$ = -5 V			4.0	µs
t_{fi}	Current fall time	T_C = 100°C	(see Figures 3 and 4)				0.4	µs

PARAMETER MEASUREMENT INFORMATION



t_p = 20 µs
Duty cycle = 1%
V_1 = 15 V, Source Impedance = 50 Ω

Figure 1. Resistive-Load Switching Test Circuit

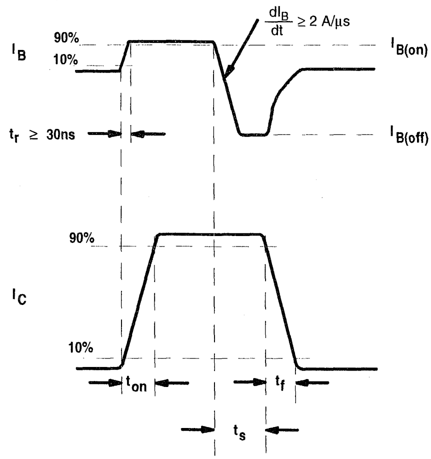


Figure 2. Resistive-Load Switching Waveforms

PARAMETER MEASUREMENT INFORMATION

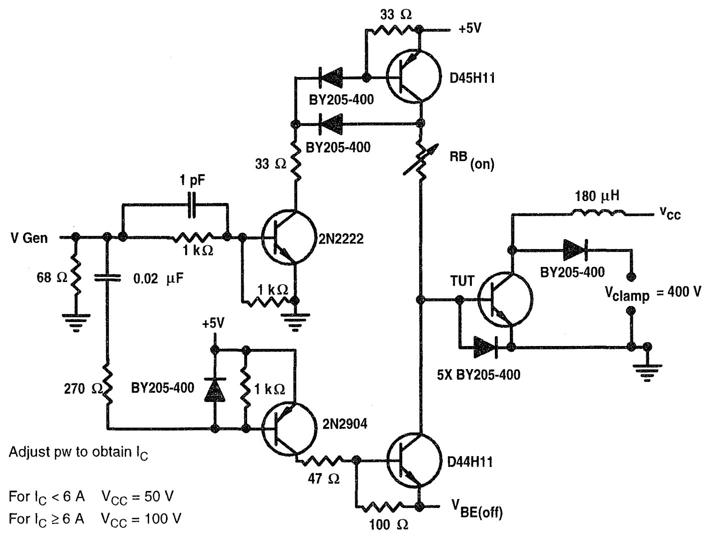
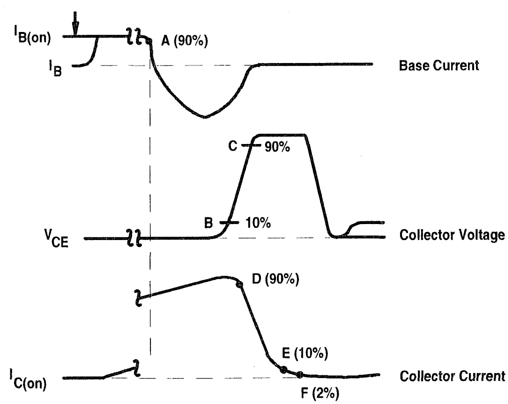


Figure 3. Inductive-Load Switching Test Circuit

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: $t_r < 15$ ns, $R_{in} > 10$ Ω, $C_{in} < 11.5$ pF.
B. Resistors must be noninductive types.

Figure 4. Inductive-Load Switching Waveforms

AUGUST 1978 - REVISED MAY 1995

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

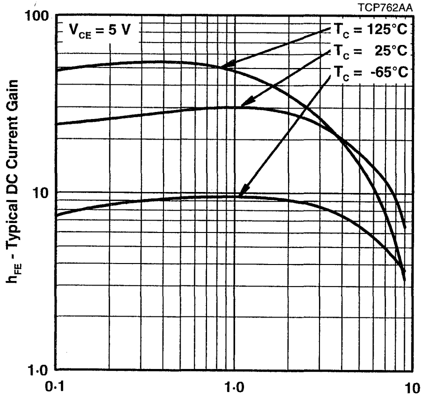


Figure 5.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

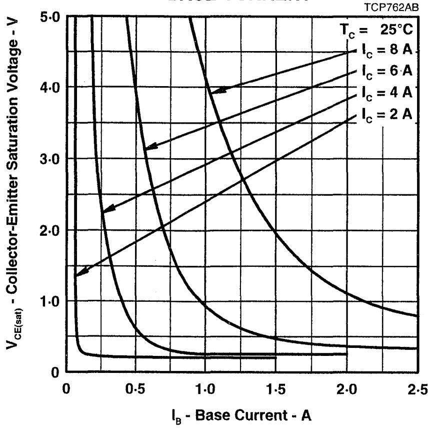


Figure 6.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

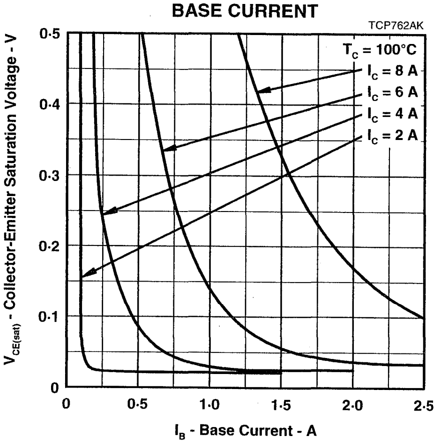


Figure 7.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

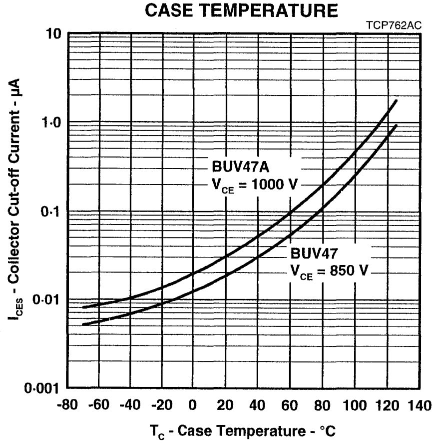


Figure 8.

MAXIMUM SAFE OPERATING REGIONS

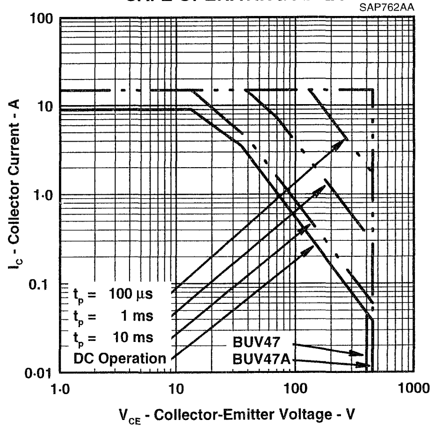


Figure 8.

THERMAL INFORMATION

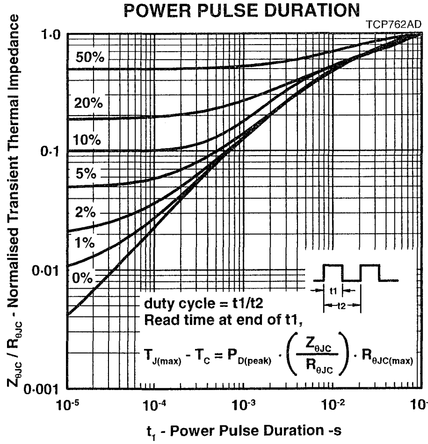


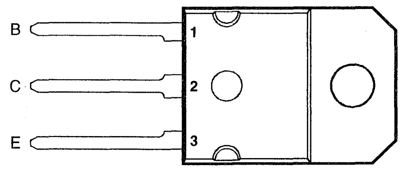
Figure 9.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

- Rugged Triple-Diffused Planar Construction
- 15 A Continuous Collector Current
- 1000 Volt Blocking Capability

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-emitter voltage (V_{BE} = 0 V)	BUV48 BUV48A	V_{CES}	850 1000	V
Collector-emitter voltage (R_{BE} = 10 Ω)	BUV48 BUV48A	V_{CER}	850 1000	V
Collector-emitter voltage (I_B = 0)	BUV48 BUV48A	V_{CEO}	400 450	V
Continuous collector current		I_C	15	A
Peak collector current (see Note 1)		I_{CM}	30	A
Continuous base current		I_B	4	A
Peak base current		I_{BM}	20	A
Non repetitive accidental peak surge current		I_{CSM}	55	A
Continuous device dissipation at (or below) 25°C case temperature		P_{tot}	125	W
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTE 1: This value applies for $t_p \leq 2$ ms, duty cycle ≤ 2%.

TEXAS INSTRUMENTS

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	(see Note 2)	BUV48	400			V
					BUV48A	450			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 850 V	V_{BE} = 0		BUV48			0.2	mA
		V_{CE} = 1000 V	V_{BE} = 0		BUV48A			0.2	
		V_{CE} = 850 V	V_{BE} = 0	T_C = 125°C	BUV48			2.0	
		V_{CE} = 1000 V	V_{BE} = 0	T_C = 125°C	BUV48A			2.0	
I_{CER}	Collector-emitter cut-off current	V_{CE} = 850 V	R_{BE} = 10 Ω		BUV48			0.5	mA
		V_{CE} = 1000 V	R_{BE} = 10 Ω		BUV48A			0.5	
		V_{CE} = 850 V	R_{BE} = 10 Ω	T_C = 125°C	BUV48			4.0	
		V_{CE} = 1000 V	R_{BE} = 10 Ω	T_C = 125°C	BUV48A			4.0	
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0					1	mA
V_{EBO}	Emitter-base breakdown voltage	I_E = 50 mA	I_C = 0			7		30	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 2 A	I_C = 10 A	(see Notes 3 and 4)	BUV48			1.5	V
		I_B = 3 A	I_C = 15 A		BUV48			5.0	
		I_B = 1.6 A	I_C = 8 A		BUV48A			1.5	
		I_B = 2.4 A	I_C = 12 A		BUV48A			5.0	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 2 A	I_C = 10 A	(see Notes 3 and 4)	BUV48			1.6	V
		I_B = 1.6 A	I_C = 8 A		BUV48A			1.6	
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			10		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_C = 0	f = 1 MHz			150		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. 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	°C/W

resistive-load-switching characteristics at 25°C case temperature

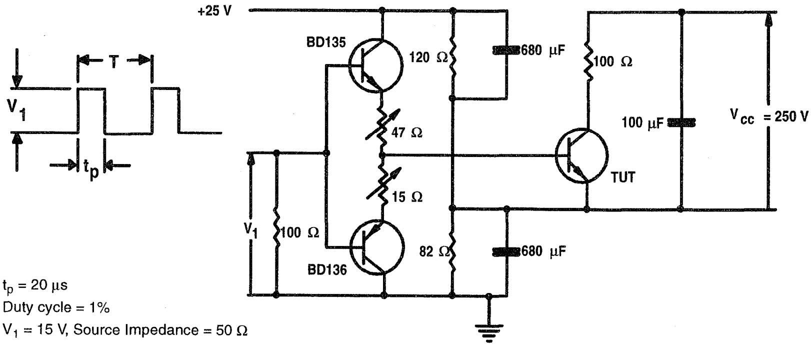
PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_{on}	Turn on time	I_C = 10 A	V_{CC} = 150 V	BUV48			1.0	µs
t_s	Storage time	$I_{B(on)}$ = 2 A	$I_{B(off)}$ = -2 A	(see Figures 1 and 2)			3.0	µs
t_f	Fall time						0.8	µs
t_{on}	Turn on time	I_C = 8 A	V_{CC} = 150 V	BUV48A			1.0	µs
t_s	Storage time	$I_{B(on)}$ = 1.6 A	$I_{B(off)}$ = -1.6 A	(see Figures 1 and 2)			3.0	µs
t_f	Fall time						0.8	µs

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

inductive-load-switching characteristics at 100°C case temperature

PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 10 A	$I_{B(on)}$ = 2 A	BUV48			4.0	µs
t_{fi}	Current fall time	$V_{BE(off)}$ = -5 V	(see Figures 3 and 4)				0.4	µs
t_{sv}	Voltage storage time	I_C = 8 A	$I_{B(on)}$ = 1.6 A	BUV48A			4.0	µs
t_{fi}	Current fall time	$V_{BE(off)}$ = -5 V	(see Figures 3 and 4)				0.4	µs

PARAMETER MEASUREMENT INFORMATION



t_p = 20 µs
Duty cycle = 1%
V_1 = 15 V, Source Impedance = 50 Ω

Figure 1. Resistive-Load Switching Test Circuit

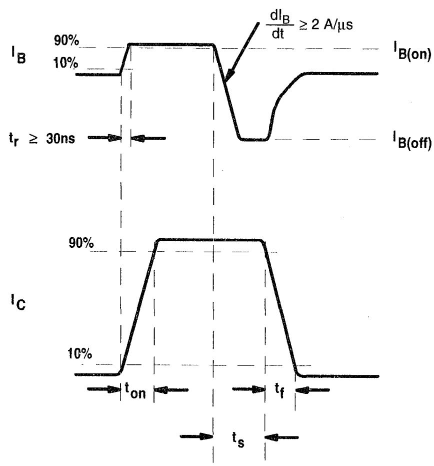


Figure 2. Resistive-Load Switching Waveforms

PARAMETER MEASUREMENT INFORMATION

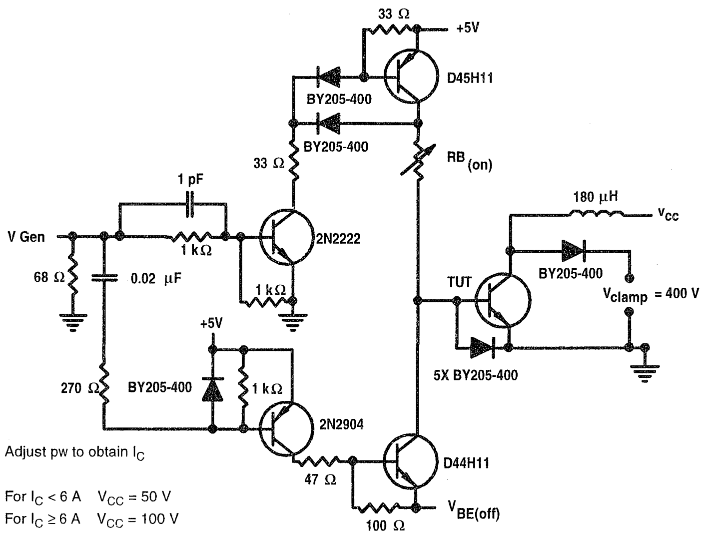
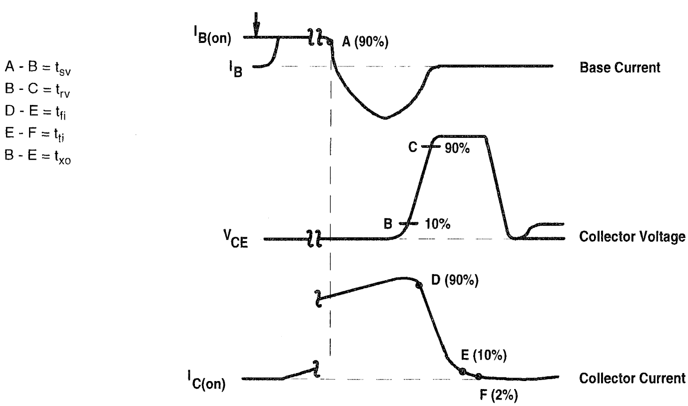


Figure 3. Inductive-Load Switching Test Circuit



NOTES: A. Waveforms are monitored on an oscilloscope with the following characteristics: t_r < 15 ns, R_{in} > 10 Ω, C_{in} < 11.5 pF.
B. Resistors must be noninductive types.

Figure 4. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

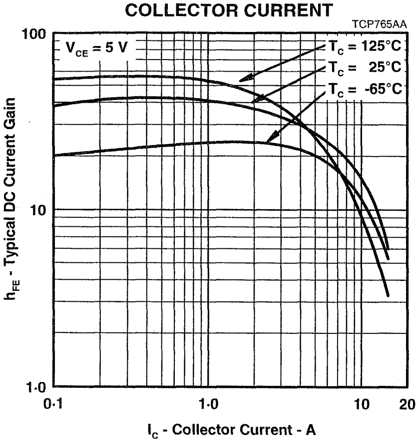


Figure 5.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

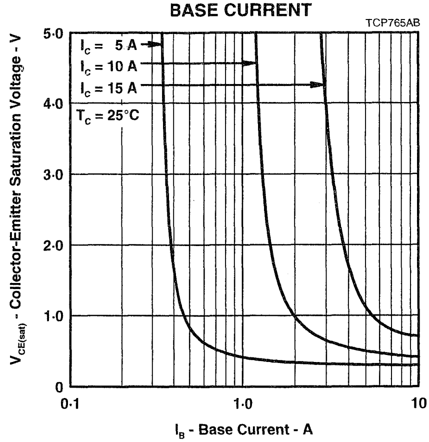


Figure 6.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

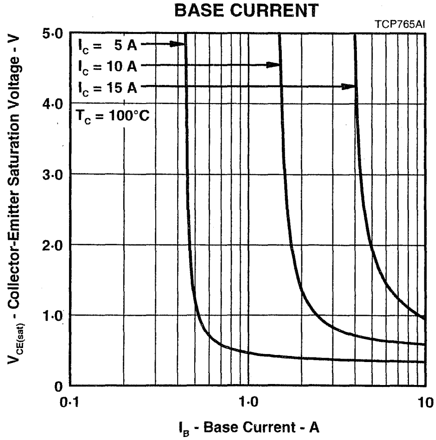


Figure 7.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

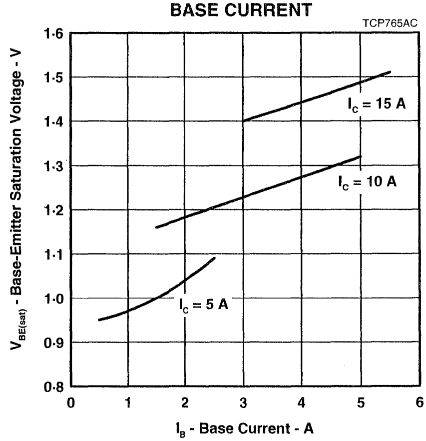


Figure 8.

TYPICAL CHARACTERISTICS

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

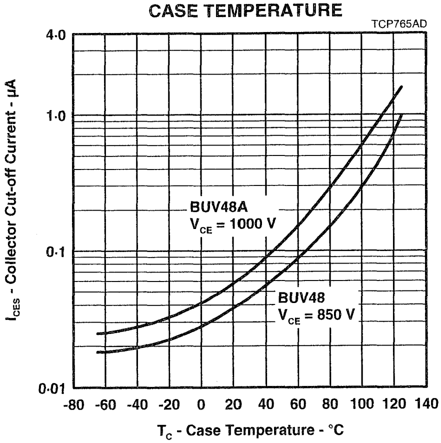


Figure 9.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

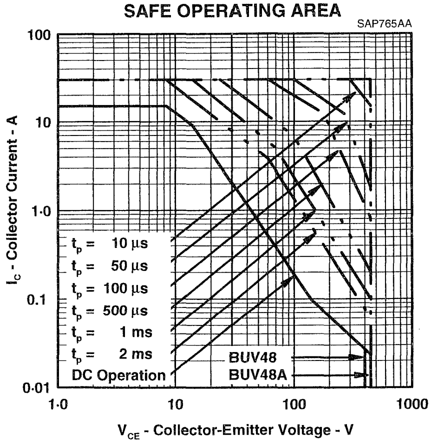


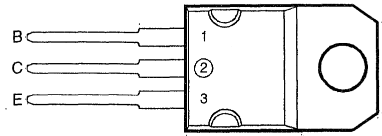
Figure 10.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

- 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

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	V_{CBO}	800	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	800	V
Collector-emitter voltage (I_B = 0)	V_{CEO}	400	V
Continuous collector current	I_C	2	A
Peak collector current (see Note 1)	I_{CM}	3	A
Continuous device dissipation at (or below) 25°C case temperature	P_{tot}	40	W
Operating junction temperature range	T_j	-65 to +150	°C
Storage temperature range	T_{stg}	-65 to +150	°C

NOTE 1: This value applies for $t_p \leq 2$ ms, duty cycle ≤ 2%.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector-emitter sustaining voltage	$I_C =$ 0.1 A	L = 25 mH	(see Note 2)	400			V
I_{CES}	Collector-emitter cut-off current	$V_{CE} =$ 800 V $V_{CE} =$ 800 V	$V_{BE} = 0$ $V_{BE} = 0$	 T_C = 125°C			0.2 1	mA
I_{EBO}	Emitter cut-off current	$V_{EB} =$ 5 V	$I_C = 0$				1	mA
h_{FE}	Forward current transfer ratio	$V_{CE} =$ 5 V	I_C = 0.1 A	(see Notes 3 and 4)		35		
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_B =$ 0.03 A $I_B =$ 0.2 A	I_C = 0.3 A $I_C =$ 1 A	(see Notes 3 and 4)			0.8 1	V
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_B =$ 0.2 A	$I_C =$ 1 A	(see Notes 3 and 4)			1.1	V
f_t	Current gain bandwidth product	$V_{CE} =$ 10 V	I_C = 0.2 A			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 must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.
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
$R_{\theta JC}$	Junction to case thermal resistance			2.5	°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 V_{CC} = 250 V	$I_{B(on)}$ = 0.2 A (see Figures 1 and 2)	$I_{B(off)}$ = -0.4 A		0.25	0.5	µs
t_s	Storage time					1.8		µs
t_f	Fall time					0.2		µs
t_f	Fall time	I_C = 1 A V_{CC} = 250 V	$I_{B(on)}$ = 0.2 A T_C = 95°C	$I_{B(off)}$ = -0.4 A			0.4	µs

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

PARAMETER MEASUREMENT INFORMATION

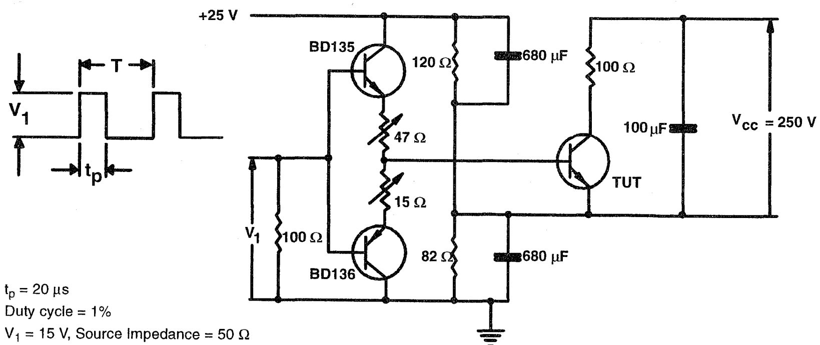


Figure 1. Resistive-Load Switching Test Circuit

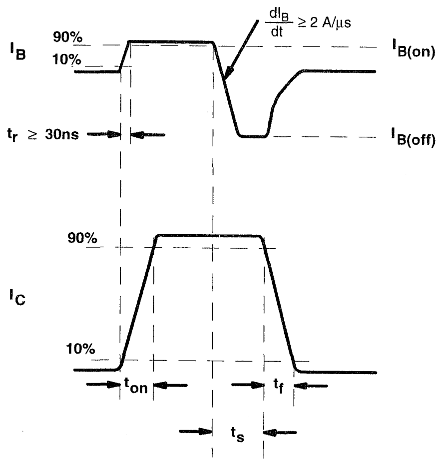


Figure 2. Resistive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

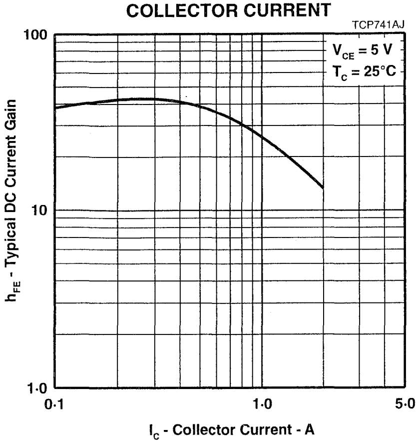


Figure 3.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

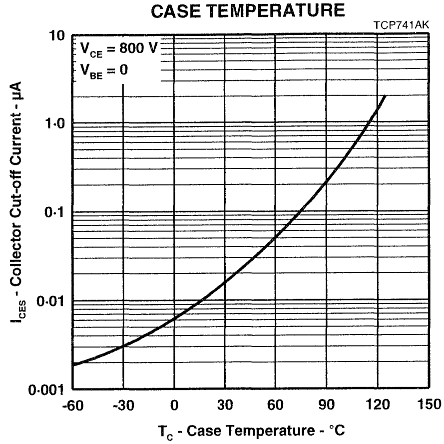


Figure 4.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

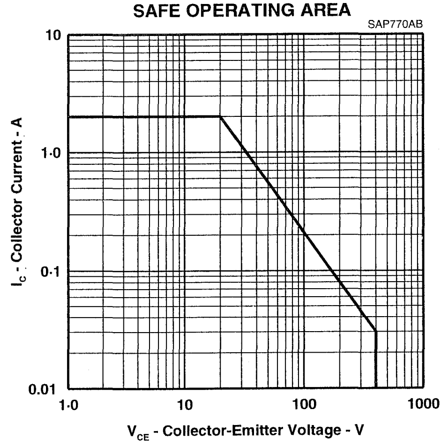


Figure 5.

THERMAL INFORMATION

THERMAL RESPONSE JUNCTION TO CASE vs POWER PULSE DURATION

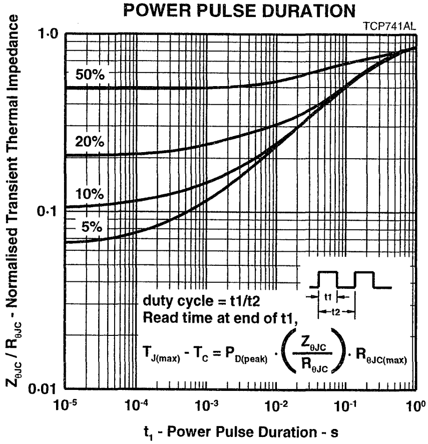
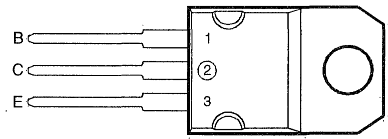


Figure 6.

AUGUST 1978 - REVISED MAY 1995

- 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

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	V_{CBO}	1000	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	1000	V
Collector-emitter voltage (I_B = 0)	V_{CEO}	450	V
Continuous collector current	I_C	2	A
Peak collector current (see Note 1)	I_{CM}	3	A
Continuous device dissipation at (or below) 25°C case temperature	P_{tot}	40	W
Operating junction temperature range	T_j	-65 to +150	°C
Storage temperature range	T_{stg}	-65 to +150	°C

NOTE 1: This value applies for $t_p \leq 2$ ms, duty cycle ≤ 2%.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector-emitter sustaining voltage	$I_C =$ 0.1 A	L = 25 mH	(see Note 2)	450			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 1000 V V_{CE} = 1000 V	V_{BE} = 0 V_{BE} = 0	 T_C = 125°C			0.2 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} = 5 V	I_C = 0.1 A	(see Notes 3 and 4)		35		
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.03 A I_B = 0.2 A	I_C = 0.3 A I_C = 1 A	(see Notes 3 and 4)			0.8 1	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.2 A	I_C = 1 A	(see Notes 3 and 4)			1.1	V
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.2 A			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 must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.
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

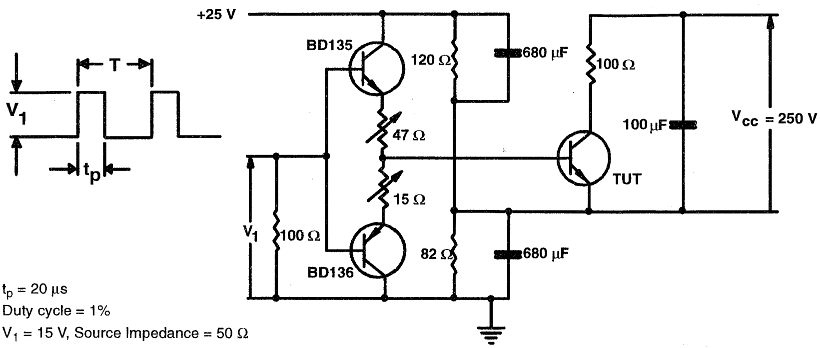
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to case thermal resistance			2.5	°C/W

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 V_{CC} = 250 V	$I_{B(on)}$ = 0.2 A (see Figures 1 and 2)	$I_{B(off)}$ = -0.4 A		0.25	0.5	µs
t_s	Storage time					1.8		µs
t_f	Fall time					0.2		µs
t_f	Fall time	I_C = 1 A V_{CC} = 250 V	$I_{B(on)}$ = 0.2 A T_C = 95°C	$I_{B(off)}$ = -0.4 A			0.4	µs

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

PARAMETER MEASUREMENT INFORMATION



t_p = 20 µs
Duty cycle = 1%
V_1 = 15 V, Source Impedance = 50 Ω

Figure 1. Resistive-Load Switching Test Circuit

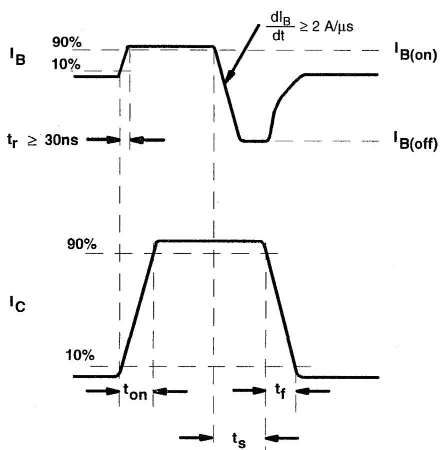


Figure 2. Resistive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

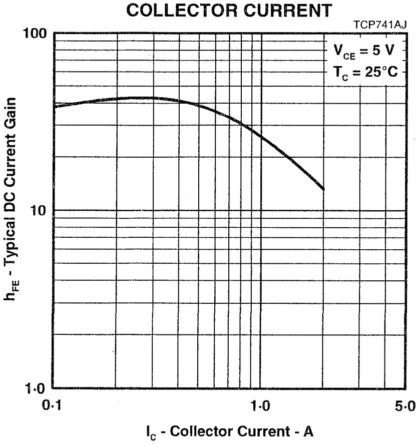


Figure 3.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

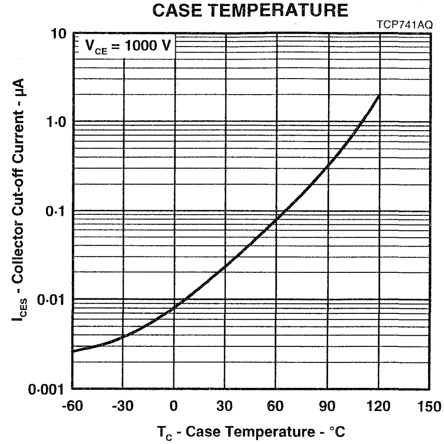


Figure 4.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

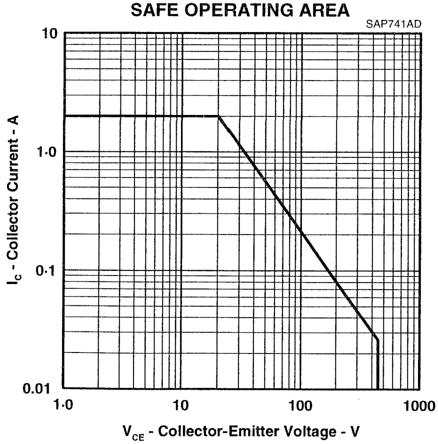


Figure 5.

TEXAS INSTRUMENTS

THERMAL INFORMATION

THERMAL RESPONSE JUNCTION TO CASE
vs
POWER PULSE DURATION

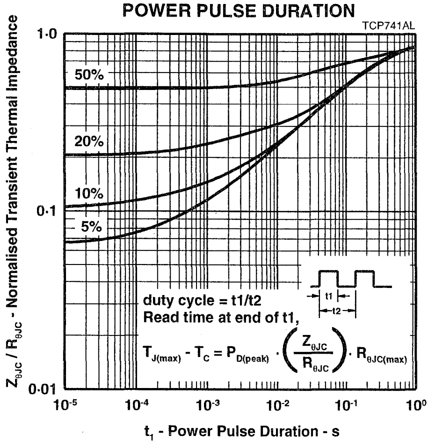


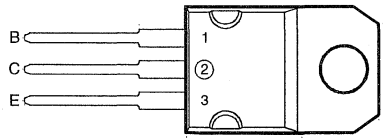
Figure 6.

TIP47, TIP48, TIP49, TIP50
NPN SILICON POWER TRANSISTORS

DECEMBER 1971 - REVISED MAY 1995

- **40 W at 25°C Case Temperature**
- **1 A Continuous Collector Current**
- **2 A Peak Collector Current**
- **20 mJ Reverse-Energy Rating**

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage (I_E = 0)	TIP47	V_{CBO}	350	V
	TIP48		400	
	TIP49		450	
	TIP50		500	
Collector-emitter voltage (I_B = 0)	TIP47	V_{CEO}	250	V
	TIP48		300	
	TIP49		350	
	TIP50		400	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	1	A
Peak collector current (see Note 1)		I_{CM}	2	A
Continuous base current		I_B	0.6	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	40	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	20	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTE 1: This value applies for $t_p \leq 1$ ms, duty cycle ≤ 2%.
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, $I_{B(on)}$ = 0.4 A, R_{BE} = 100 Ω, $V_{BE(off)}$ = 0, R_S = 0.1 Ω, V_{CC} = 20 V.

DECEMBER 1971 - REVISED MAY 1995

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA (see Note 5)	$I_B = 0$	TIP47	250			V
				TIP48	300			
				TIP49	350			
				TIP50	400			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 350 V	V_{BE} = 0	TIP47			1	mA
		V_{CE} = 400 V	V_{BE} = 0	TIP48			1	
		V_{CE} = 450 V	V_{BE} = 0	TIP49			1	
		V_{CE} = 500 V	V_{BE} = 0	TIP50			1	
I_{CEO}	Collector cut-off current	V_{CE} = 150 V	I_B = 0	TIP47			1	mA
		V_{CE} = 200 V	I_B = 0	TIP48			1	
		V_{CE} = 250 V	I_B = 0	TIP49			1	
		V_{CE} = 300 V	I_B = 0	TIP50			1	
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0				1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 10 V	I_C = 0.3 A	(see Notes 5 and 6)	30		150	
		V_{CE} = 10 V	I_C = 1 A		10			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.2 A	I_C = 1 A	(see Notes 5 and 6)			1	V
V_{BE}	Base-emitter voltage	V_{CE} = 10 V	I_C = 1 A	(see Notes 5 and 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			

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 300 µs, 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

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		0.2		µs
t_{off}	Turn off time	$V_{BE(off)}$ = -5 V	R_L = 200 Ω	(see Figures 1 and 2)		2		µs

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

PARAMETER MEASUREMENT INFORMATION

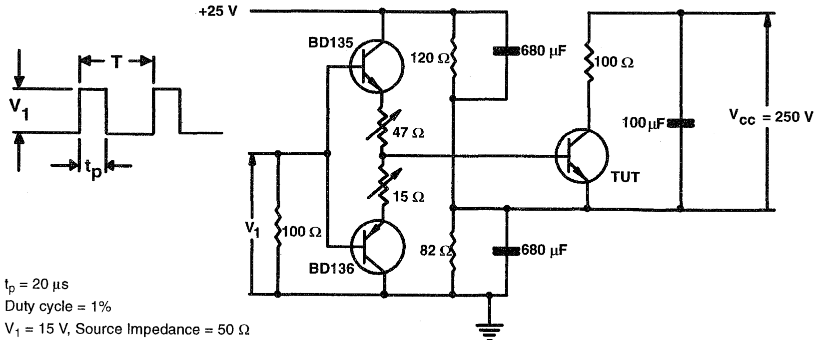


Figure 1. Resistive-Load Switching Test Circuit

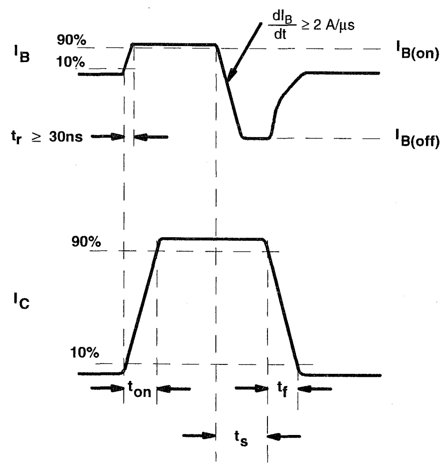


Figure 2. Resistive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

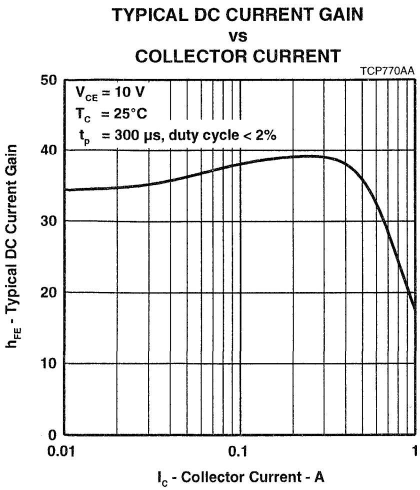


Figure 3.

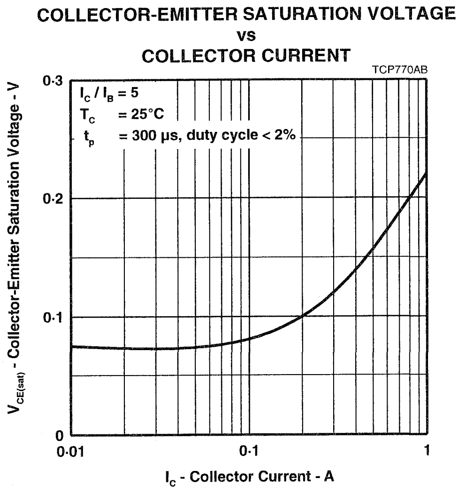


Figure 4.

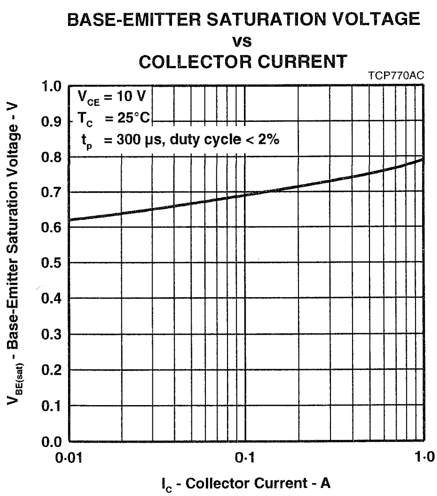


Figure 5.

MAXIMUM SAFE OPERATING REGIONS

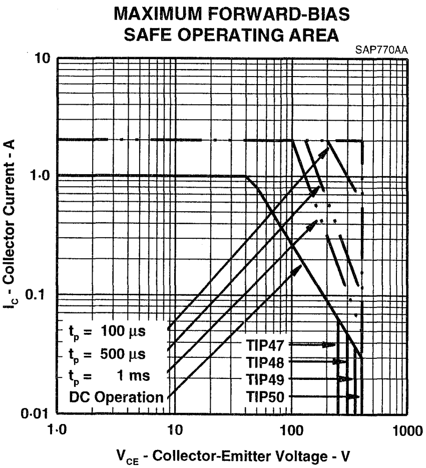
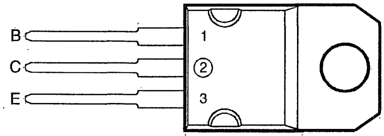


Figure 6.

JUNE 1973 - REVISED MAY 1995

- 80 W at 25°C Case Temperature
- 7 A Continuous Collector Current
- 10 A Peak Collector Current
- Maximum $V_{CE(sat)}$ of 2 V at I_C = 5 A
- $I_{CEX(sus)}$ 7 A at rated $V_{(BR)CEO}$

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTES: 1. This value applies for $t_p \le 5$ 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

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 breakdown voltage	I_C = 10 mA (see Note 4)	I_B = 0	TIP150 TIP151 TIP152	300 350 400			V
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 300 V V_{CE} = 350 V V_{CE} = 400 V	I_B = 0 I_B = 0 I_B = 0	TIP150 TIP151 TIP152			250 250 250	µA
$I_{CEX(sus)}$	Collector-emitter sustaining current	$V_{CLAMP} = V_{(BR)CEO}$			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 V_{CE} = 5 V V_{CE} = 5 V	I_C = 2.5 A I_C = 5 A I_C = 7 A	(see Notes 4 and 5)	150 50 15			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 10 mA I_B = 100 mA I_B = 250 mA	I_C = 1 A I_C = 2 A I_C = 5 A	(see Notes 4 and 5)			1.5 1.5 2	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 100 mA I_B = 250 mA	I_C = 2 A I_C = 5 A	(see Notes 4 and 5)			2.2 2.3	V
V_{EC}	Parallel diode forward voltage	I_E = 7 A	I_B = 0	(see Notes 4 and 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			
$\|h_{fe}\|$	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			100	pF

NOTES: 4. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
5. 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
$C_{\theta C}$	Thermal capacitance of case		0.9		J/°C

inductive-load-switching characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS †	MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 5 A, $V_{(clamp)} = V_{(BR)CEO}$, $I_{B(on)}$ = 250 mA, R_{BE} = 47 Ω		3.9		µs
t_{si}	Current storage time			4.7		µs
t_{rv}	Voltage transition time			1.2		µs
t_{ti}	Current transition time			1.2		µs
t_{xo}	Cross-over time			2.0		µs

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

PARAMETER MEASUREMENT INFORMATION

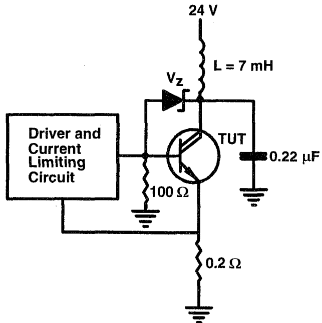


Figure 1. Functional Test Circuit

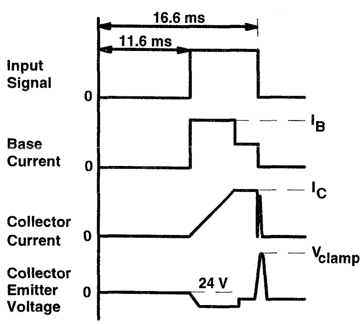


Figure 2. Functional Test Waveforms

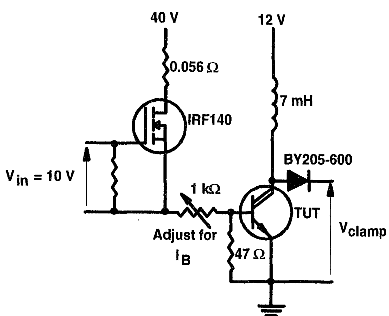


Figure 3. Switching Test Circuit

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

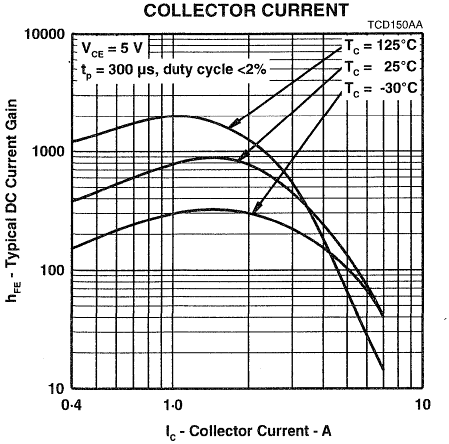


Figure 4.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

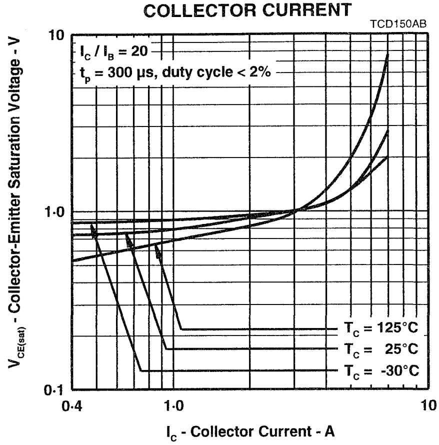


Figure 5.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

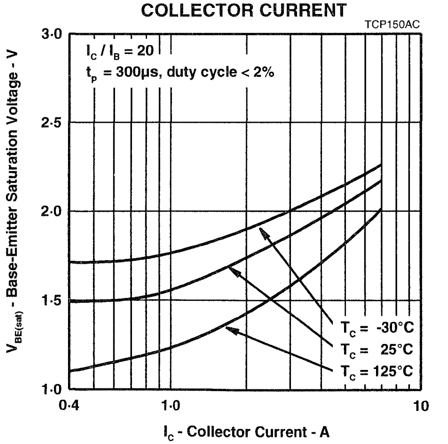


Figure 6.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

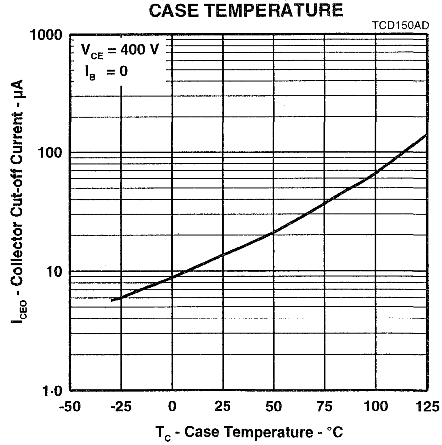


Figure 7.

TEXAS INSTRUMENTS

MAXIMUM SAFE OPERATING REGIONS

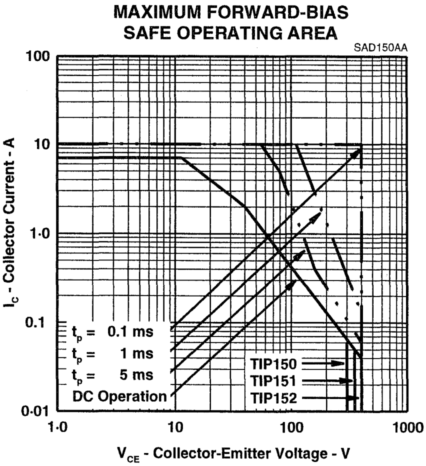


Figure 8.

THERMAL INFORMATION

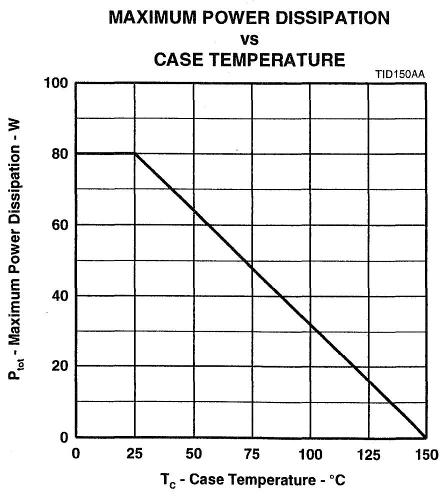
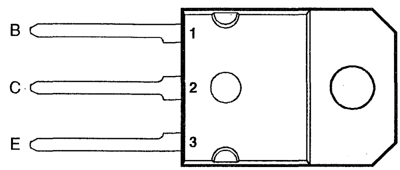


Figure 9.

JUNE 1973 - REVISED MAY 1995

- 50 W at 25°C Case Temperature
- 10 A Continuous Collector Current
- 15 A Peak Collector Current
- Maximum $V_{CE(sat)}$ of 2.8 V at I_C = 6.5 A
- $I_{CEX(sus)}$ 7 A at rated $V_{(BR)CEO}$

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTES: 1. This value applies for $t_p \leq 10$ ms, duty cycle ≤ 10%.
2. This value 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 0.4 W/°C.
4. Derate linearly to 150°C free air temperature at the rate of 24 mW/°C.

TEXAS INSTRUMENTS

electrical characteristics at 25°C case temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 320 V V_{CE} = 350 V V_{CE} = 380 V	I_B = 0 I_B = 0 I_B = 0	TIP160 TIP161 TIP162			1	mA
$I_{CEX(sus)}$	Collector-emitter sustaining current	$V_{CLAMP} = V_{(BR)CEO}$			7			A
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	(see Notes 5 and 6)	200			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.1A I_B = 1 A	I_C = 6.5 A I_C = 10 A	(see Notes 5 and 6)			2.8 2.9	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.1A	I_C = 6.5 A	(see Notes 5 and 6)			2.2	V
V_{EC}	Parallel diode forward voltage	I_E = 10 A	I_B = 0	(see Notes 5 and 6)			3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 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	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			41.7	°C/W
$C_{\theta C}$	Thermal capacitance of case		1.4		J/°C

resistive-load-switching characteristics at 25°C case temperature

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 Ω		40		ns
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.

PARAMETER MEASUREMENT INFORMATION

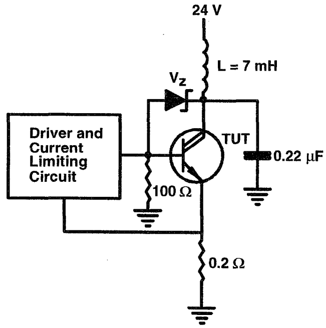


Figure 1. Functional Test Circuit

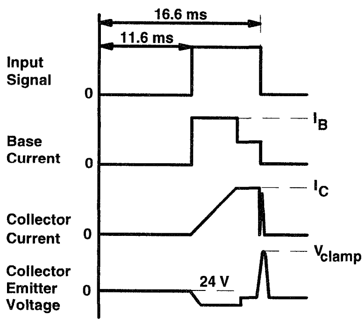


Figure 2. Functional Test Waveforms

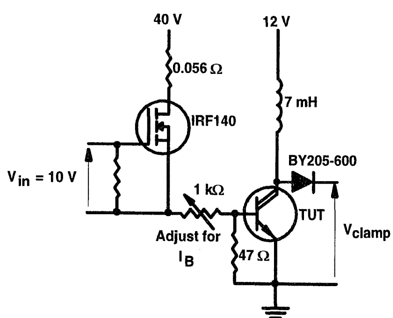


Figure 3. Switching Test Circuit

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

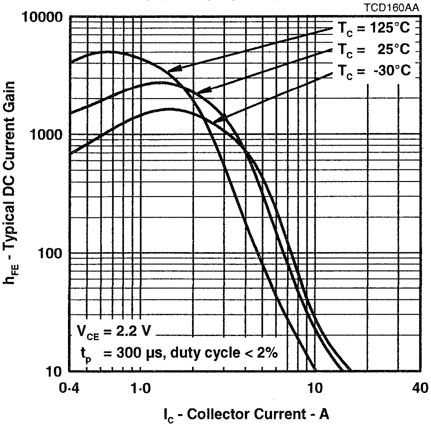


Figure 4.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

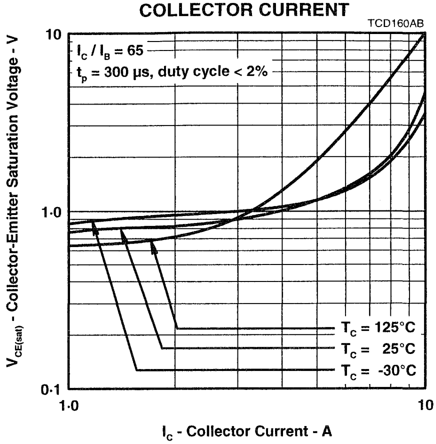


Figure 5.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

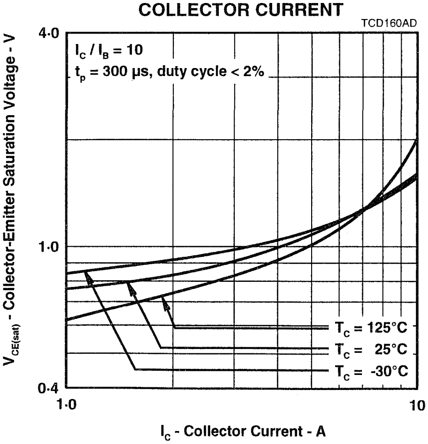


Figure 6.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

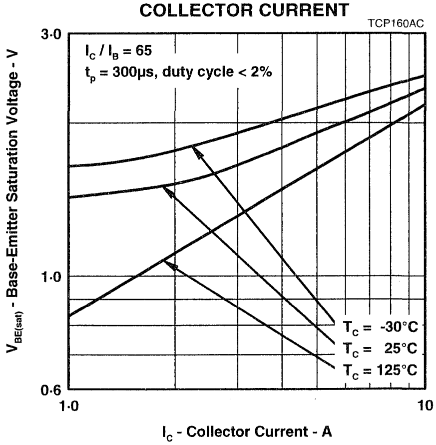


Figure 7.

MAXIMUM SAFE OPERATING REGIONS

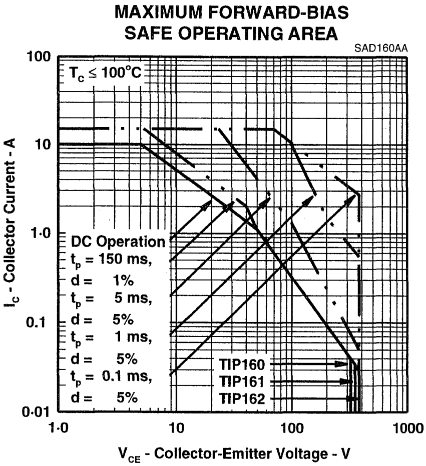
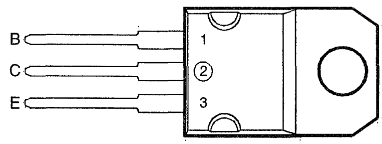


Figure 8.

AUGUST 1978 - REVISED MAY 1995

- **Rugged Triple-Diffused Planar Construction**
- **4 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **1000 Volt Blocking Capability**
- **75 W at 25°C Case Temperature**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq 10$ ms, duty cycle $\leq 2\%$.

TEXAS INSTRUMENTS

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 = 10 mA	L = 25 mH	(see Note 2)	TIPL760 TIPL760A	400 450			V
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 V_{BE} = 0 V_{BE} = 0	 T_C = 100°C T_C = 100°C	TIPL760 TIPL760A TIPL760 TIPL760A			50 50 200 200	μA
I_{CEO}	Collector cut-off current	V_{CE} = 400 V V_{CE} = 450 V	I_B = 0 I_B = 0		TIPL760 TIPL760A			50 50	μA
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0					1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)		20		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.5 A I_B = 0.8 A I_B = 0.8 A	I_C = 2.5 A I_C = 4 A I_C = 4 A	 (see Notes 3 and 4) T_C = 100°C				1.0 2.5 5.0	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.5 A I_B = 0.8 A I_B = 0.8 A	I_C = 2.5 A I_C = 4 A I_C = 4 A	 (see Notes 3 and 4) T_C = 100°C				1.2 1.4 1.3	V
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			12		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz			110		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
4. 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

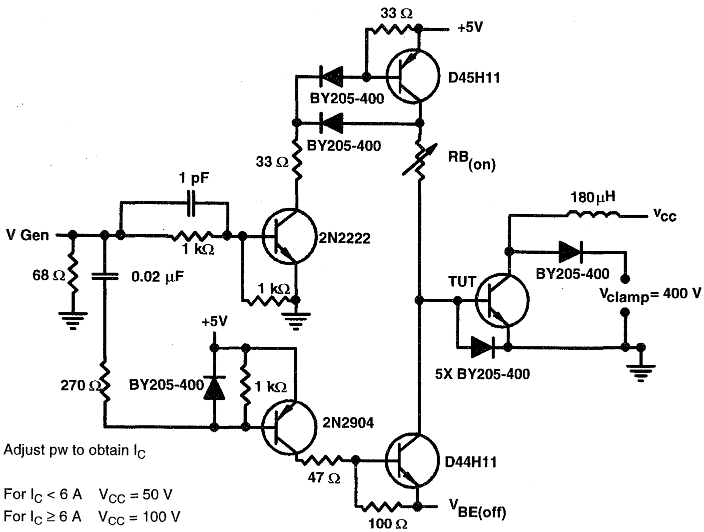
inductive-load-switching characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_{sv}	Voltage storage time	I_C = 4 A $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.8 A	(see Figures 1 and 2)			2.5	μs
t_{rv}	Voltage rise time						300	ns
t_{fi}	Current fall time						250	ns
t_{ti}	Current tail time						150	ns
t_{xo}	Cross over time						400	ns
t_{sv}	Voltage storage time	I_C = 4 A $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.8 A T_C = 100°C	(see Figures 1 and 2)			3	μs
t_{rv}	Voltage rise time						500	ns
t_{fi}	Current fall time						250	ns
t_{ti}	Current tail time						150	ns
t_{xo}	Cross over time						750	ns

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

AUGUST 1978 - REVISED MAY 1995

PARAMETER MEASUREMENT INFORMATION

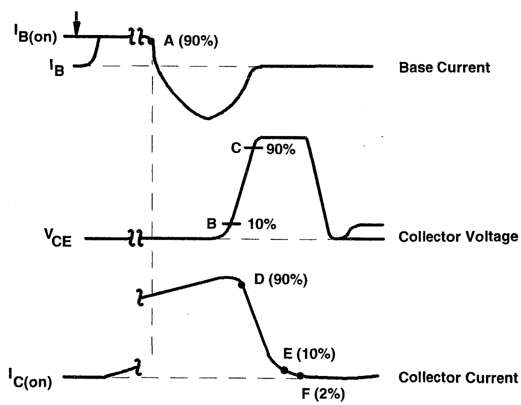


Adjust pw to obtain I_C

For $I_C < 6$ A $V_{CC} = 50$ V
For $I_C \geq 6$ A $V_{CC} = 100$ V

Figure 1. Inductive-Load Switching Test Circuit

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: $t_r < 15$ ns, $R_{in} > 10\ \Omega$, $C_{in} < 11.5$ pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

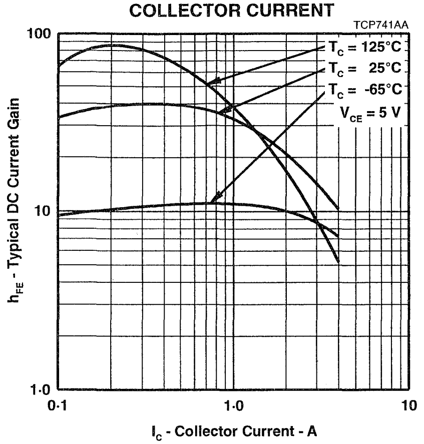


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

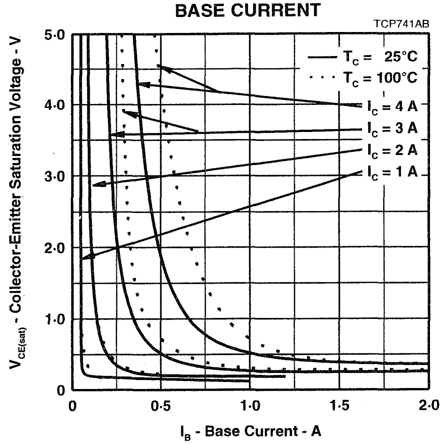


Figure 4.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

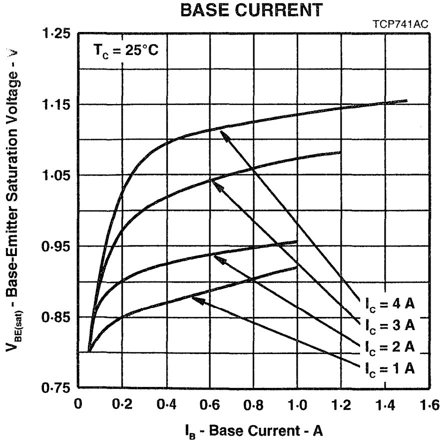


Figure 5.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

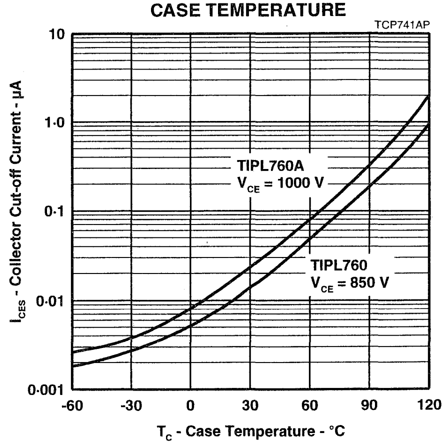


Figure 6.

TEXAS INSTRUMENTS

MAXIMUM SAFE OPERATING REGIONS

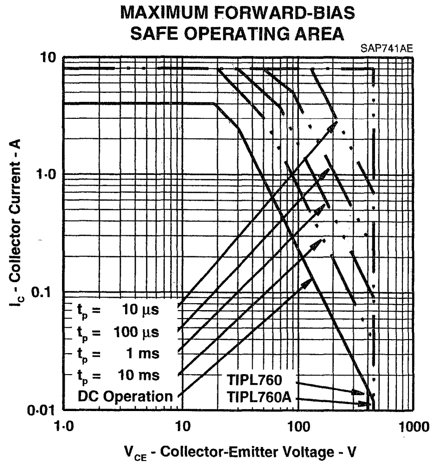


Figure 7.

THERMAL INFORMATION

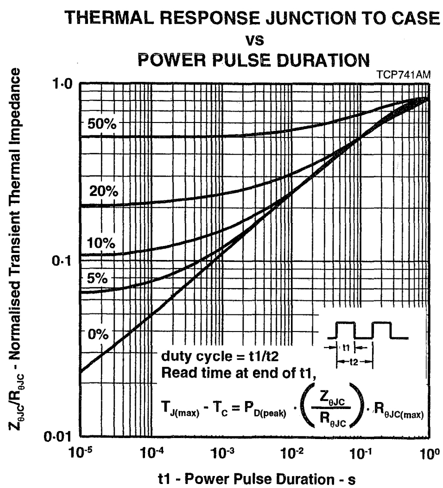
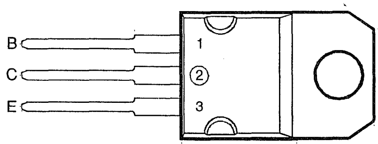


Figure 8.

- **Rugged Triple-Diffused Planar Construction**
- **4 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **1200 Volt Blocking Capability**
- **75 W at 25°C Case Temperature**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq 10$ ms, duty cycle $\leq 2\%$.

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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 = 10 mA	L = 25 mH	(see Note 2)	TIPL760B TIPL760C	500 550			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 1100 V V_{CE} = 1200 V V_{CE} = 1100 V V_{CE} = 1200 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	 T_C = 100°C T_C = 100°C	TIPL760B TIPL760C TIPL760B TIPL760C			50 50 200 200	µA
I_{CEO}	Collector cut-off current	V_{CE} = 500 V V_{CE} = 550 V	I_B = 0 I_B = 0		TIPL760B TIPL760C			50 50	µA
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0					1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)		20		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.4 A I_B = 0.6 A I_B = 0.6 A	I_C = 2 A I_C = 3 A I_C = 3 A	 (see Notes 3 and 4) T_C = 100°C				1.0 2.5 5.0	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.4 A I_B = 0.6 A I_B = 0.6 A	I_C = 2 A I_C = 3 A I_C = 3 A	 (see Notes 3 and 4) T_C = 100°C				1.2 1.4 1.3	V
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			12		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz			110		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.

thermal characteristics

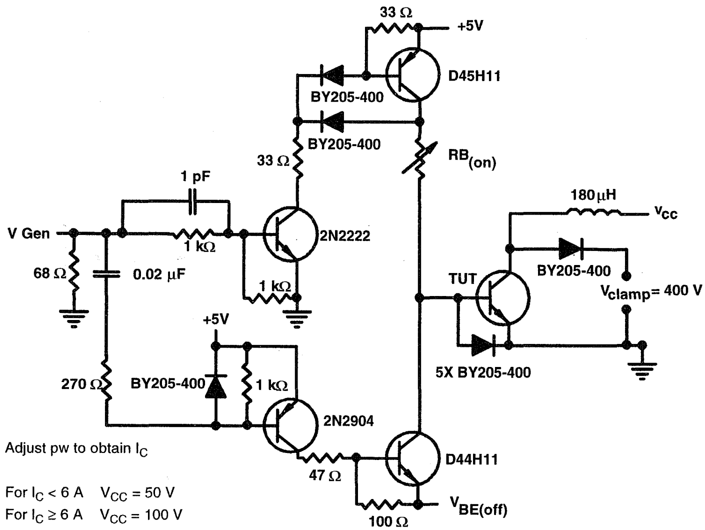
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to case thermal resistance			1.56	°C/W

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 A $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.6 A	(see Figures 1 and 2)			2.5	µs
t_{rv}	Voltage rise time						300	ns
t_{fi}	Current fall time						250	ns
t_{ti}	Current tail time						150	ns
t_{xo}	Cross over time						400	ns
t_{sv}	Voltage storage time	I_C = 3 A $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.6 A T_C = 100°C	(see Figures 1 and 2)			3	µs
t_{rv}	Voltage rise time						500	ns
t_{fi}	Current fall time						250	ns
t_{ti}	Current tail time						150	ns
t_{xo}	Cross over time						750	ns

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

PARAMETER MEASUREMENT INFORMATION

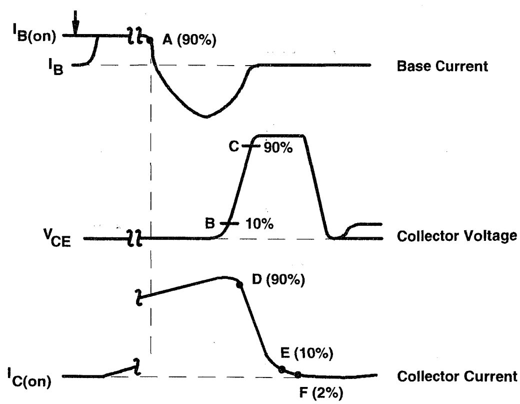


Adjust pw to obtain I_C

For $I_C < 6$ A $V_{CC} = 50$ V
For $I_C \geq 6$ A $V_{CC} = 100$ V

Figure 1. Inductive-Load Switching Test Circuit

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: $t_r < 15$ ns, $R_{in} > 10\ \Omega$, $C_{in} < 11.5$ pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

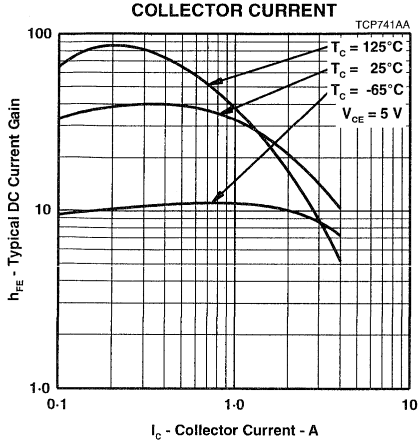


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

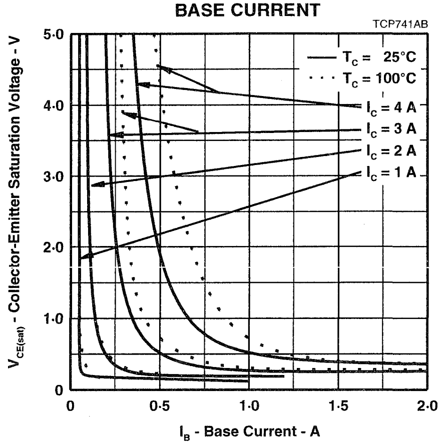


Figure 4.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

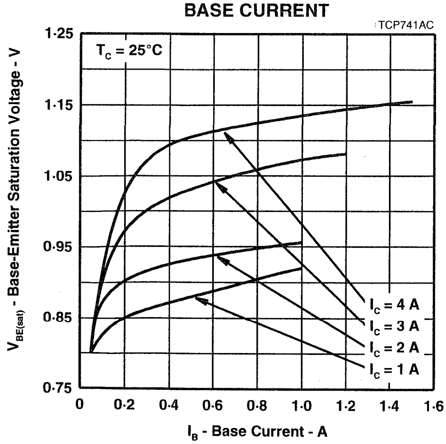


Figure 5.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

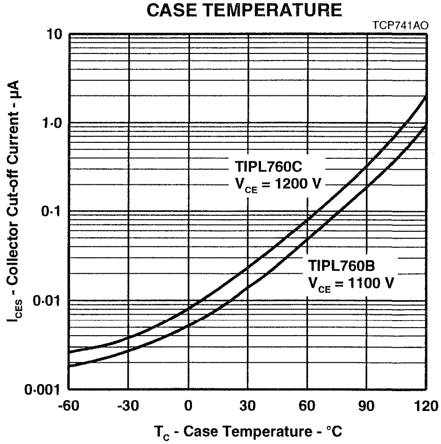


Figure 6.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

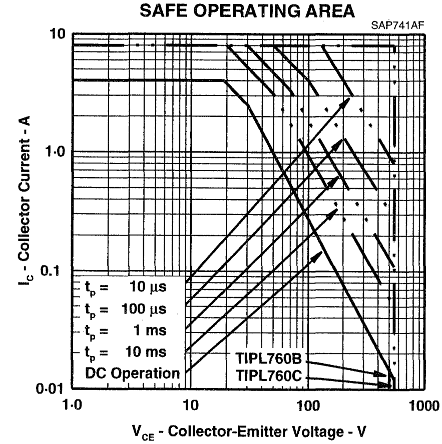


Figure 7.

THERMAL INFORMATION

THERMAL RESPONSE JUNCTION TO CASE vs POWER PULSE DURATION

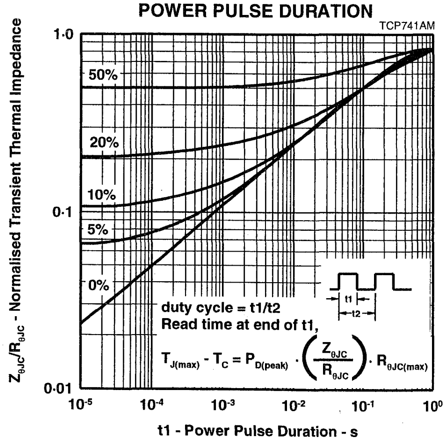
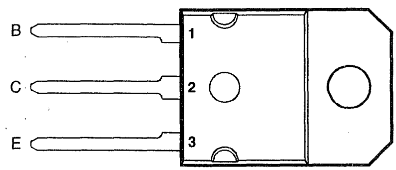


Figure 8.

AUGUST 1978 - REVISED MAY 1995

- **Rugged Triple-Diffused Planar Construction**
- **4 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **1000 Volt Blocking Capability**
- **100 W at 25°C Case Temperature**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq 10$ ms, duty cycle $\leq 2\%$.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

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 = 10 mA	L = 25 mH	(see Note 2)	TIPL761 TIPL761A	400 450			V
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 V_{BE} = 0 V_{BE} = 0	 T_C = 100°C T_C = 100°C	TIPL761 TIPL761A TIPL761 TIPL761A			50 50 200 200	μA
I_{CEO}	Collector cut-off current	V_{CE} = 400 V V_{CE} = 450 V	I_B = 0 I_B = 0		TIPL761 TIPL761A			50 50	μA
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0					1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)		20		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.5 A I_B = 0.8 A I_B = 0.8 A	I_C = 2.5 A I_C = 4 A I_C = 4 A	 (see Notes 3 and 4) T_C = 100°C				1.0 2.5 5.0	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.5 A I_B = 0.8 A I_B = 0.8 A	I_C = 2.5 A I_C = 4 A I_C = 4 A	 (see Notes 3 and 4) T_C = 100°C				1.2 1.4 1.3	V
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			12		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz			110		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
4. 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			1.25	°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 = 4 A, $V_{BE(off)}$ = -5 V, $I_{B(on)}$ = 0.8 A (see Figures 1 and 2)			2.5	μs
t_{rv}	Voltage rise time				300	ns
t_{fi}	Current fall time				250	ns
t_{ti}	Current tail time				150	ns
t_{xo}	Cross over time				400	ns
t_{sv}	Voltage storage time	I_C = 4 A, $V_{BE(off)}$ = -5 V, $I_{B(on)}$ = 0.8 A, T_C = 100°C (see Figures 1 and 2)			3	μs
t_{rv}	Voltage rise time				500	ns
t_{fi}	Current fall time				250	ns
t_{ti}	Current tail time				150	ns
t_{xo}	Cross over time				750	ns

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

PARAMETER MEASUREMENT INFORMATION

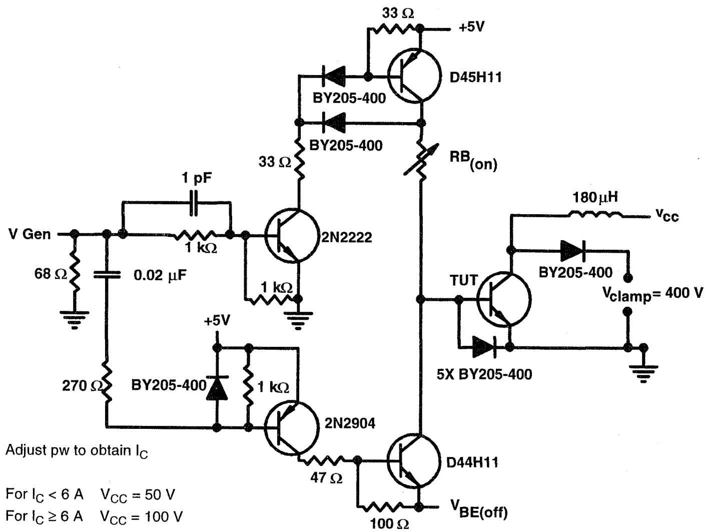
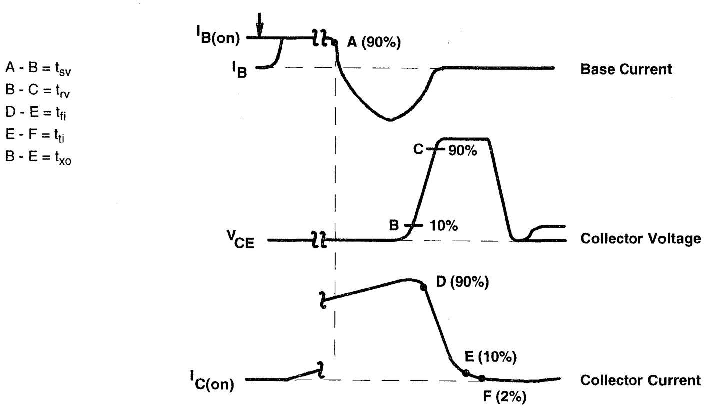


Figure 1. Inductive-Load Switching Test Circuit



NOTES: A. Waveforms are monitored on an oscilloscope with the following characteristics: t_r < 15 ns, R_{in} > 10 Ω, C_{in} < 11.5 pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

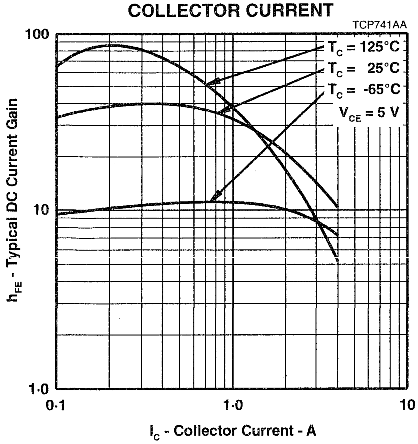


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

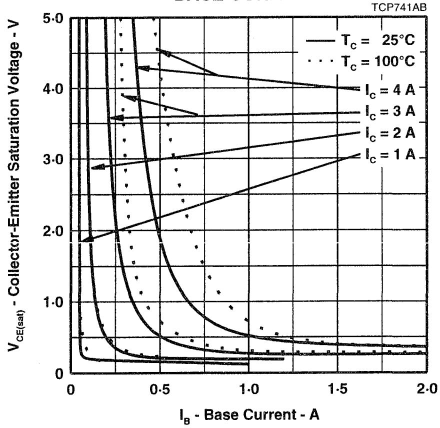


Figure 4.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

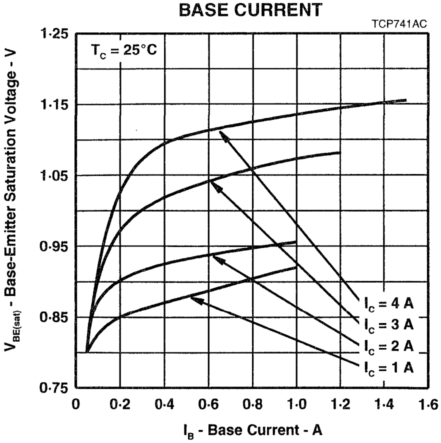


Figure 5.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

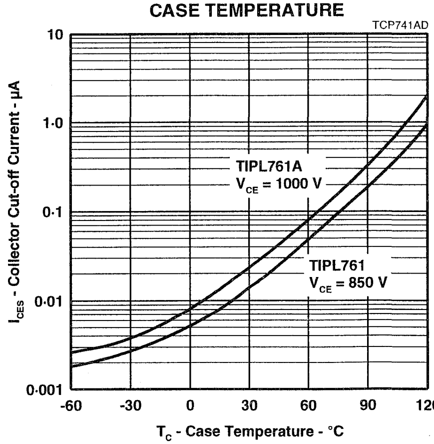


Figure 6.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

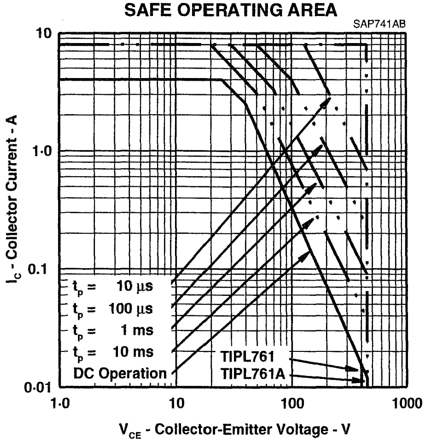


Figure 7.

THERMAL INFORMATION

THERMAL RESPONSE JUNCTION TO CASE vs POWER PULSE DURATION

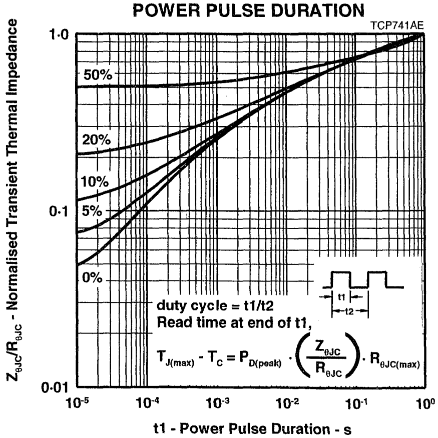
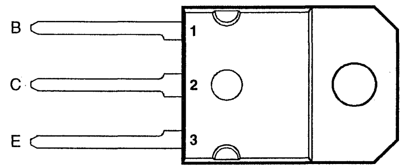


Figure 8.

- **Rugged Triple-Diffused Planar Construction**
- **4 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **1200 Volt Blocking Capability**
- **100 W at 25°C Case Temperature**

SOT-93 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq 10$ ms, duty cycle $\leq 2\%$.

TEXAS INSTRUMENTS

MAY 1989 - REVISED MAY 1995

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 = 10 mA	L = 25 mH	(see Note 2)	TIPL761B	500			V
					TIPL761C	550			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 1100 V	V_{BE} = 0		TIPL761B			50	μA
		V_{CE} = 1200 V	V_{BE} = 0		TIPL761C			50	
		V_{CE} = 1100 V	V_{BE} = 0	T_C = 100°C	TIPL761B			200	
		V_{CE} = 1200 V	V_{BE} = 0	T_C = 100°C	TIPL761C			200	
I_{CEO}	Collector cut-off current	V_{CE} = 500 V	I_B = 0		TIPL761B			50	μA
		V_{CE} = 550 V	I_B = 0		TIPL761C			50	
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0					1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)		20		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.4 A	I_C = 2 A					1.0	V
		I_B = 0.6 A	I_C = 3 A	(see Notes 3 and 4)				2.5	
		I_B = 0.6 A	I_C = 3 A	T_C = 100°C				5.0	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.4 A	I_C = 2 A					1.2	V
		I_B = 0.6 A	I_C = 3 A	(see Notes 3 and 4)				1.4	
		I_B = 0.6 A	I_C = 3 A	T_C = 100°C				1.3	
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			12		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz			110		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
4. 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			1.25	°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 = 3 A, $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.6 A	(see Figures 1 and 2)			2.5	μs
t_{rv}	Voltage rise time						300	ns
t_{fi}	Current fall time						250	ns
t_{ti}	Current tail time						150	ns
t_{xo}	Cross over time						400	ns
t_{sv}	Voltage storage time	I_C = 3 A, $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.6 A, T_C = 100°C	(see Figures 1 and 2)			3	μs
t_{rv}	Voltage rise time						500	ns
t_{fi}	Current fall time						250	ns
t_{ti}	Current tail time						150	ns
t_{xo}	Cross over time						750	ns

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

PARAMETER MEASUREMENT INFORMATION

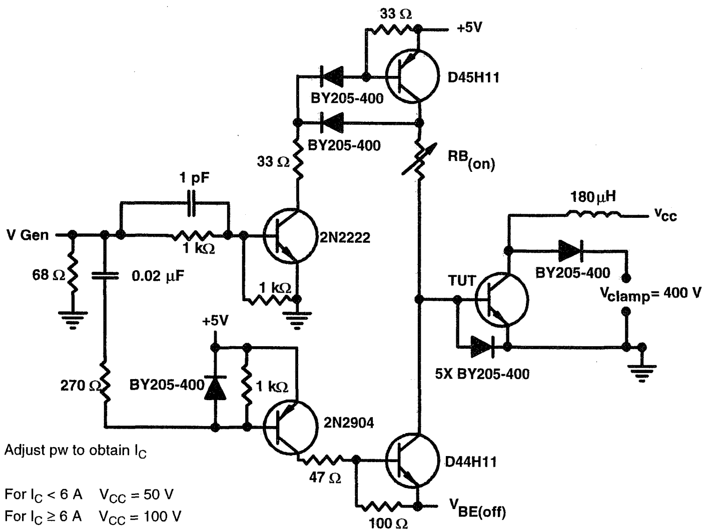
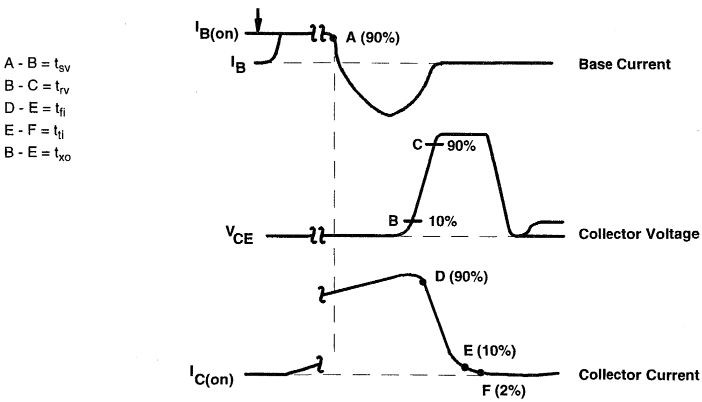


Figure 1. Inductive-Load Switching Test Circuit



NOTES: A. Waveforms are monitored on an oscilloscope with the following characteristics: t_r < 15 ns, R_{in} > 10 Ω, C_{in} < 11.5 pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

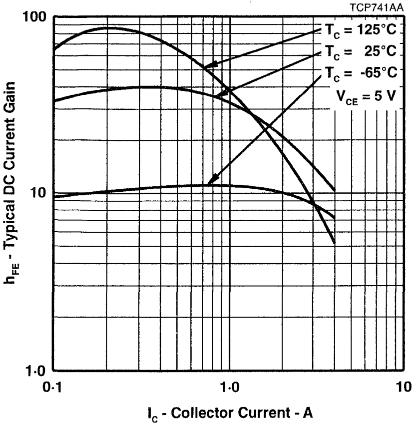


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

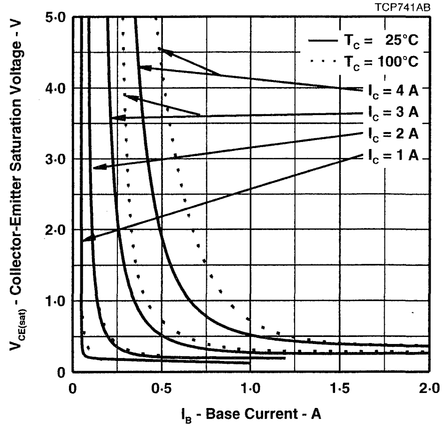


Figure 4.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

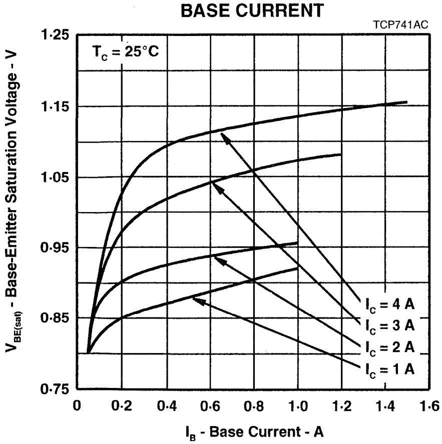


Figure 5.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

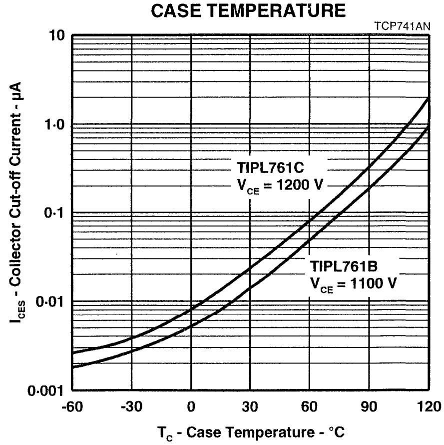


Figure 6.

MAXIMUM SAFE OPERATING REGIONS

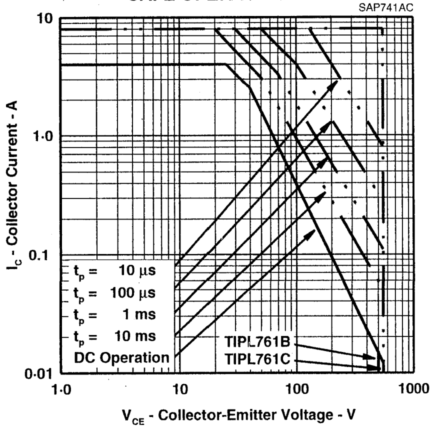


Figure 7.

THERMAL INFORMATION

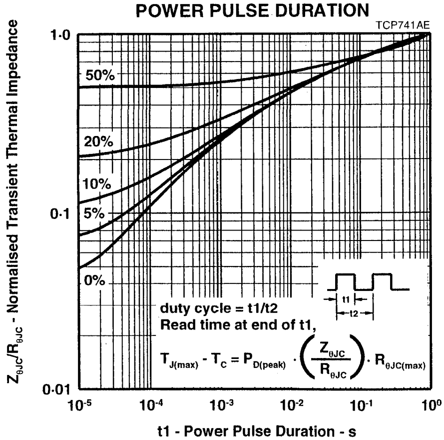
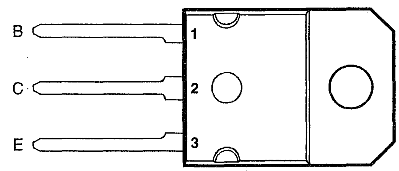


Figure 8.

AUGUST 1978 - REVISED MAY 1995

- **Rugged Triple-Diffused Planar Construction**
- **6 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **1000 Volt Blocking Capability**
- **120 W at 25°C Case Temperature**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq 10$ ms, duty cycle $\leq 2\%$.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

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	L = 25 mH	(see Note 2)	TIPL762 TIPL762A		400 450			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 850 V	V_{BE} = 0		TIPL762				50	μA
		V_{CE} = 1000 V	V_{BE} = 0		TIPL762A				50	
		V_{CE} = 850 V	V_{BE} = 0	T_C = 100°C	TIPL762				200	
		V_{CE} = 1000 V	V_{BE} = 0	T_C = 100°C	TIPL762A				200	
I_{CEO}	Collector cut-off current	V_{CE} = 400 V	I_B = 0		TIPL762				50	μA
		V_{CE} = 450 V	I_B = 0		TIPL762A				50	
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0						1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)			20		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.4 A	I_C = 2 A						0.5	V
		I_B = 0.8 A	I_C = 4 A	(see Notes 3 and 4)					1.0	
		I_B = 1.2 A	I_C = 6 A						2.5	
		I_B = 1.2 A	I_C = 6 A	T_C = 100°C					5.0	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.4 A	I_C = 2 A						1.1	V
		I_B = 0.8 A	I_C = 4 A	(see Notes 3 and 4)					1.3	
		I_B = 1.2 A	I_C = 6 A						1.5	
		I_B = 1.2 A	I_C = 6 A	T_C = 100°C					1.4	
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz				6		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz				105		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
4. 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			1.25	°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 $V_{BE(off)}$ = -10 V	$I_{B(on)}$ = 1.2 A	(see Figures 1 and 2)			2.5	μs
t_{rv}	Voltage rise time						200	ns
t_{fi}	Current fall time						150	ns
t_{ti}	Current tail time						50	ns
t_{xo}	Cross over time						300	ns
t_{sv}	Voltage storage time	I_C = 6 A $V_{BE(off)}$ = -10 V	$I_{B(on)}$ = 1.2 A T_C = 100°C	(see Figures 1 and 2)			3	μs
t_{rv}	Voltage rise time						300	ns
t_{fi}	Current fall time						150	ns
t_{ti}	Current tail time						50	ns
t_{xo}	Cross over time						500	ns

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

PARAMETER MEASUREMENT INFORMATION

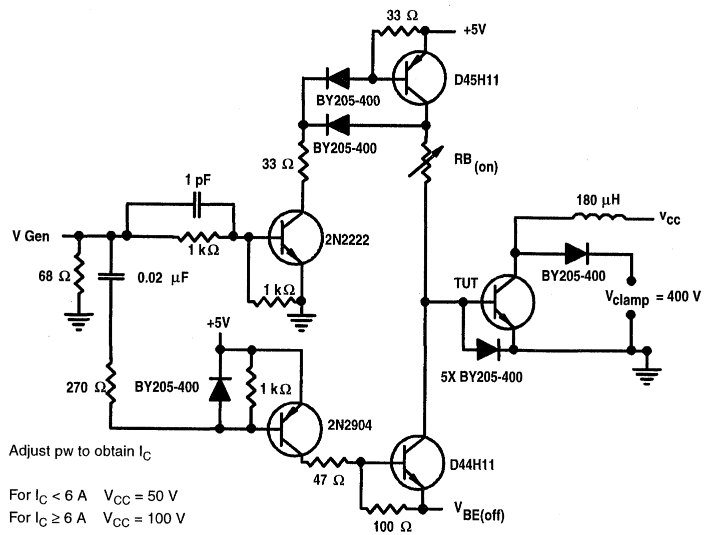
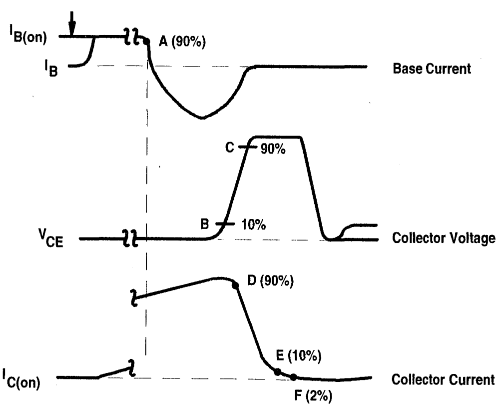


Figure 1. Inductive-Load Switching Test Circuit

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 < 15 ns, R_{in} > 10 Ω, C_{in} < 11.5 pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

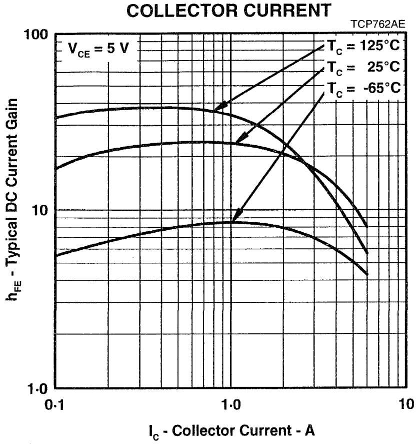


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

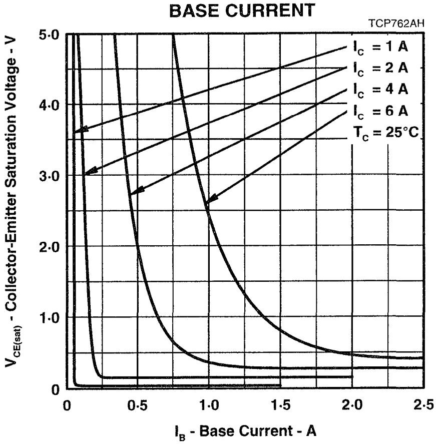


Figure 4.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

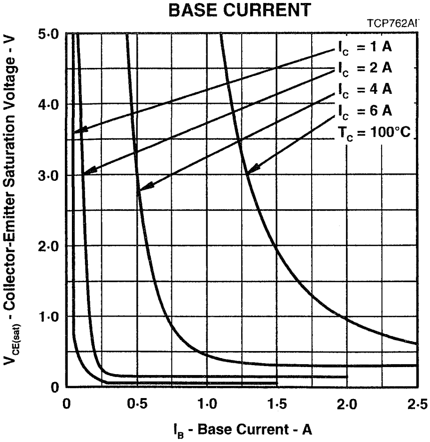


Figure 5.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

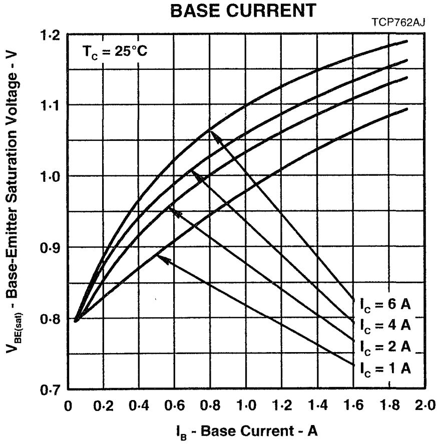


Figure 6.

TYPICAL CHARACTERISTICS

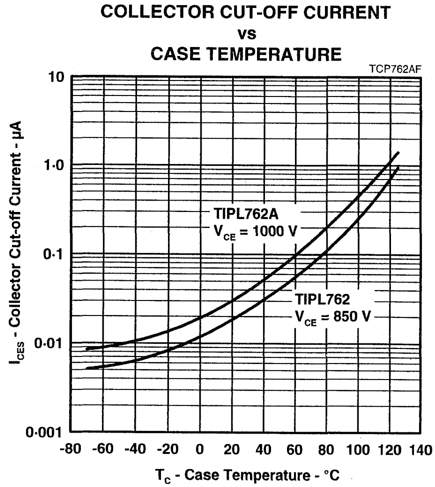


Figure 7.

MAXIMUM SAFE OPERATING REGIONS

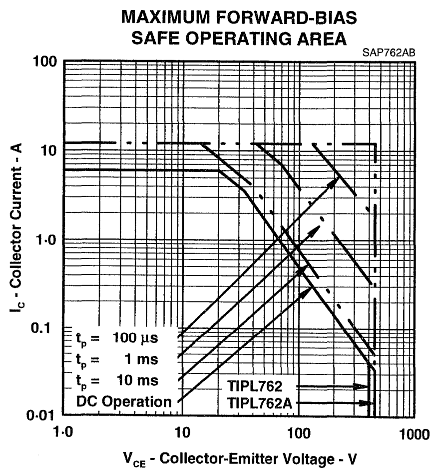


Figure 8.

THERMAL INFORMATION

THERMAL RESPONSE JUNCTION TO CASE vs POWER PULSE DURATION

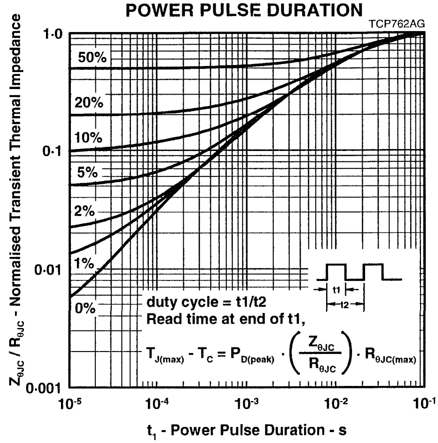
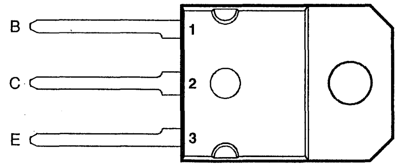


Figure 9.

- **Rugged Triple-Diffused Planar Construction**
- **10 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **1000 Volt Blocking Capability**
- **125 W at 25°C Case Temperature**

SOT-93 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq 10$ ms, 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 = 100 mA	L = 25 mH	(see Note 2)	TIPL765	400			V
					TIPL765A	450			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 850 V	V_{BE} = 0		TIPL765			50	μA
		V_{CE} = 1000 V	V_{BE} = 0		TIPL765A			50	
		V_{CE} = 850 V	V_{BE} = 0	T_C = 100°C	TIPL765			200	
		V_{CE} = 1000 V	V_{BE} = 0	T_C = 100°C	TIPL765A			200	
I_{CEO}	Collector cut-off current	V_{CE} = 400 V	I_B = 0		TIPL765			50	μA
		V_{CE} = 450 V	I_B = 0		TIPL765A			50	
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0					1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)		15		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.4 A	I_C = 2 A					0.5	V
		I_B = 1 A	I_C = 5 A	(see Notes 3 and 4)				1.0	
		I_B = 2 A	I_C = 10 A					2.5	
		I_B = 2 A	I_C = 10 A	T_C = 100°C				5.0	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.4 A	I_C = 2 A					1.1	V
		I_B = 1 A	I_C = 5 A	(see Notes 3 and 4)				1.3	
		I_B = 2 A	I_C = 10 A					1.7	
		I_B = 2 A	I_C = 10 A	T_C = 100°C				1.6	
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			8		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz			150		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
4. 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	°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, $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 2 A	(see Figures 1 and 2)			2	μs
t_{rv}	Voltage rise time						300	ns
t_{fi}	Current fall time						200	ns
t_{ti}	Current tail time						50	ns
t_{xo}	Cross over time						400	ns
t_{sv}	Voltage storage time	I_C = 10 A, $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 2 A, T_C = 100°C	(see Figures 1 and 2)			3.5	μs
t_{rv}	Voltage rise time						400	ns
t_{fi}	Current fall time						300	ns
t_{ti}	Current tail time						80	ns
t_{xo}	Cross over time						500	ns

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

PARAMETER MEASUREMENT INFORMATION

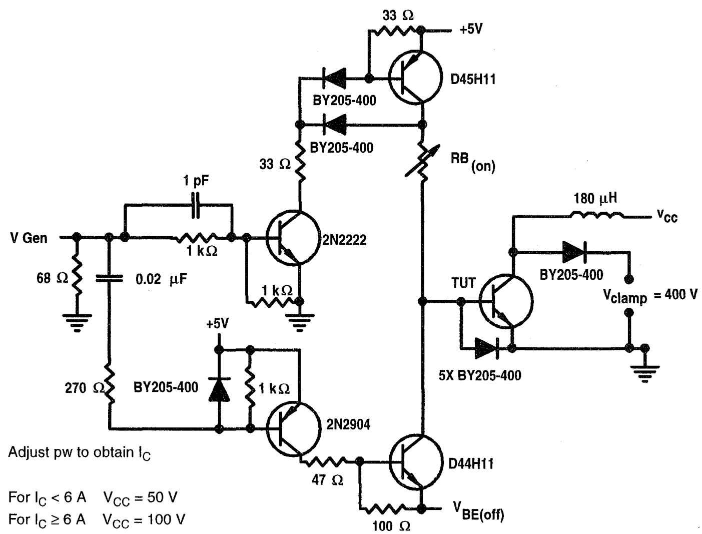
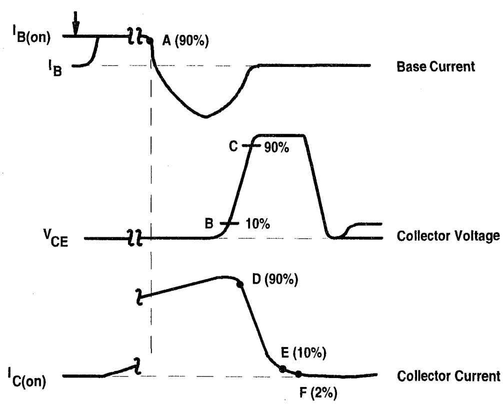


Figure 1. Inductive-Load Switching Test Circuit

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 < 15 ns, R_{in} > 10 Ω, C_{in} < 11.5 pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

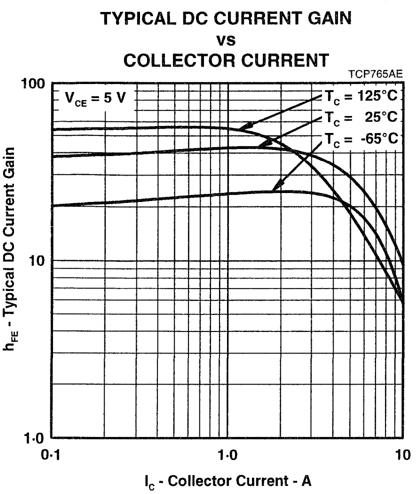


Figure 3.

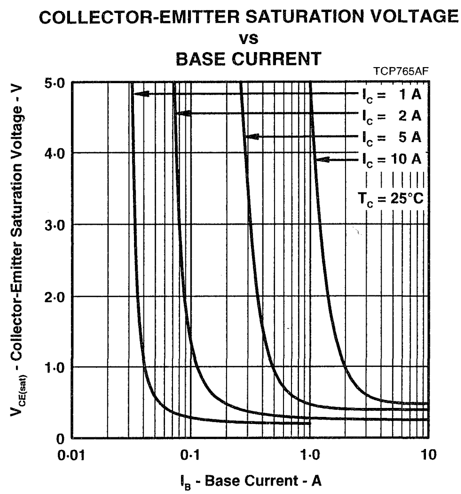


Figure 4.

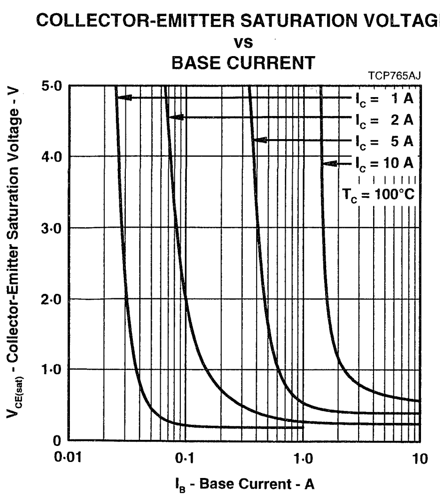


Figure 5.

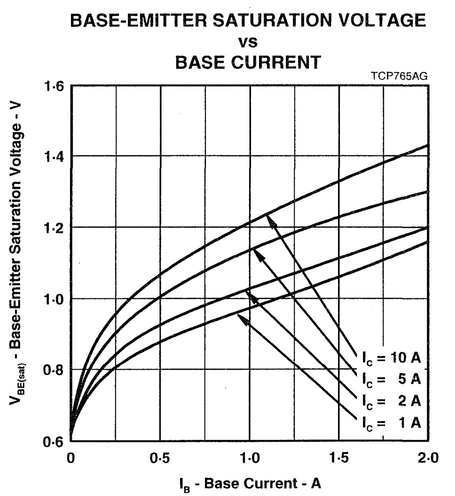


Figure 6.

TYPICAL CHARACTERISTICS

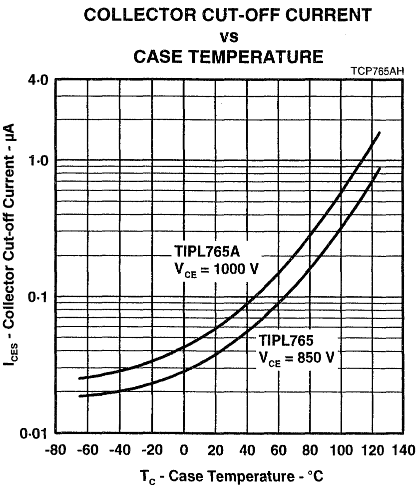


Figure 7.

MAXIMUM SAFE OPERATING REGIONS

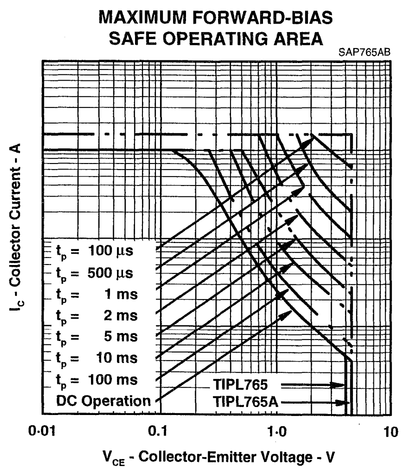
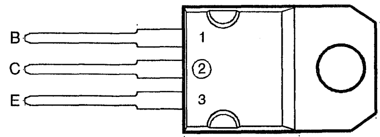


Figure 8.

MARCH 1984 - REVISED MAY 1995

- **Rugged Triple-Diffused Planar Construction**
- **2.5 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **850 Volt Blocking Capability**
- **50 W at 25°C Case Temperature**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq$ 10 ms, duty cycle ≤ 2%.

MARCH 1984 - REVISED MAY 1995

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	L = 25 mH	(see Note 2)	400			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 850 V V_{CE} = 850 V	V_{BE} = 0 V_{BE} = 0	 T_C = 100°C			5 200	µA
I_{CEO}	Collector cut-off current	V_{CE} = 400 V	I_B = 0				5	µA
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0				1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)	20		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.2 A I_B = 0.5 A I_B = 0.5 A	I_C = 1 A I_C = 2.5 A I_C = 2.5 A	(see Notes 3 and 4) T_C = 100°C			1.0 2.5 5.0	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.2 A I_B = 0.5 A I_B = 0.5 A	I_C = 1 A I_C = 2.5 A I_C = 2.5 A	(see Notes 3 and 4) T_C = 100°C			1.0 1.2 1.3	V
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz		12		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz		55		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.

thermal characteristics

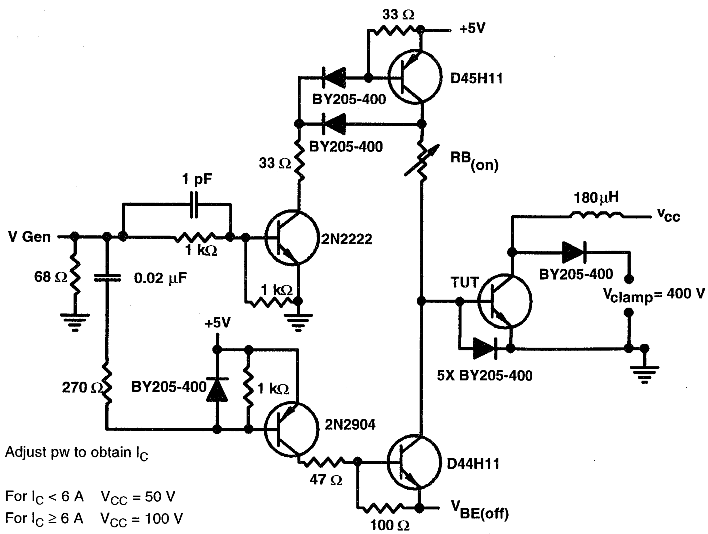
PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to case thermal resistance			2.5	°C/W

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 $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.5 A	(see Figures 1 and 2)			2	µs
t_{rv}	Voltage rise time						200	ns
t_{fi}	Current fall time						200	ns
t_{ti}	Current tail time						50	ns
t_{xo}	Cross over time						300	ns
t_{sv}	Voltage storage time	I_C = 2.5 A $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.5 A T_C = 100°C	(see Figures 1 and 2)			2.5	µs
t_{rv}	Voltage rise time						400	ns
t_{fi}	Current fall time						250	ns
t_{ti}	Current tail time						50	ns
t_{xo}	Cross over time						500	ns

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

PARAMETER MEASUREMENT INFORMATION

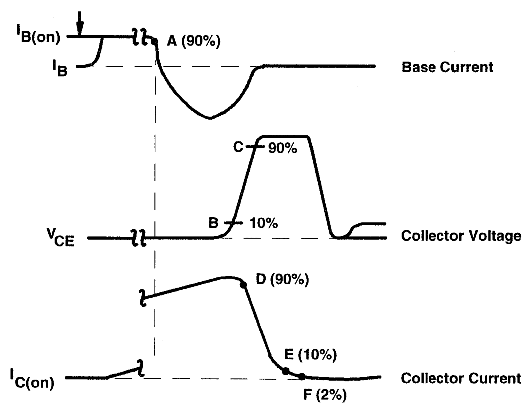


Adjust pw to obtain I_C

For $I_C < 6$ A $V_{CC} = 50$ V
For $I_C \geq 6$ A $V_{CC} = 100$ V

Figure 1. Inductive-Load Switching Test Circuit

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: $t_r < 15$ ns, $R_{in} > 10\ \Omega$, $C_{in} < 11.5$ pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

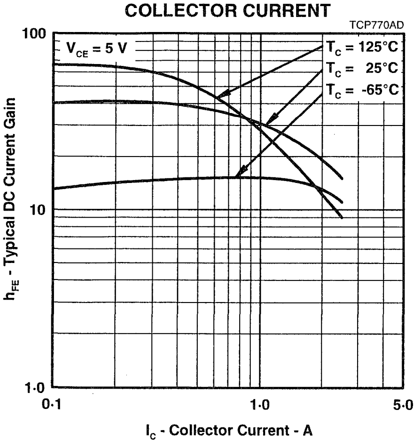


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

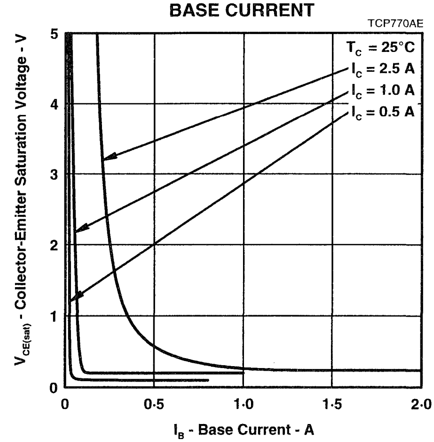


Figure 4.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

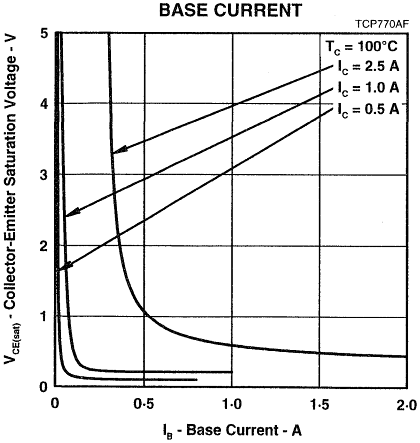


Figure 5.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

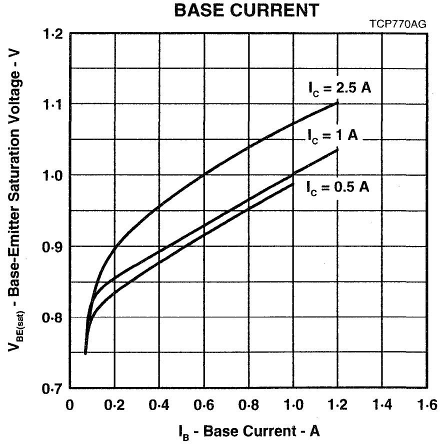


Figure 6.

MAXIMUM SAFE OPERATING REGIONS

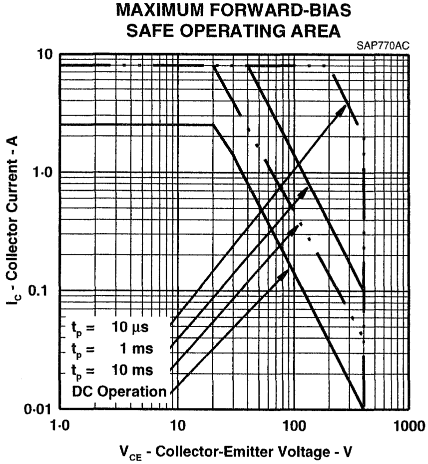
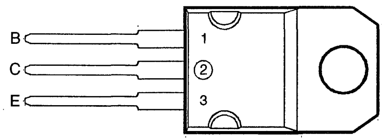


Figure 7.

AUGUST 1978 - REVISED MAY 1995

- **Rugged Epitaxial Planar Construction**
- **10 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **t_{xo} typically 320 ns, I_C = 10 A**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq 10$ ms, duty cycle ≤ 2%.

TEXAS INSTRUMENTS

AUGUST 1978 - REVISED MAY 1995

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	L = 25 mH	(see Note 2)	TIPL790 TIPL790A	120 150			V
V_{CBO}	Collector-base breakdown voltage	I_C = 1 mA		(see Note 3)	TIPL790 TIPL790A	150 200			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 150 V V_{CE} = 200 V V_{CE} = 150 V V_{CE} = 200 V	V_{BE} = 0 V_{BE} = 0 V_{BE} = 0 V_{BE} = 0	 T_C = 100°C T_C = 100°C	TIPL790 TIPL790A TIPL790 TIPL790A			0.05 0.05 1 1	mA
I_{CEV}	Collector cut-off current	V_{CE} = 150 V V_{CE} = 200 V	1.5 < V_{EB} <8 V		TIPL790 TIPL790A			50 50	μA
I_{CEO}	Collector cut-off current	V_{CE} = 120 V V_{CE} = 150 V	I_B = 0 I_B = 0		TIPL790 TIPL790A			50 50	μA
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0					4	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)		60		500	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 20 mA I_B = 30 mA I_B = 50 mA I_B = 50 mA	I_C = 4 A I_C = 7 A I_C = 10 A I_C = 10 A	 (see Notes 3 and 4) T_C = 100°C				1.2 1.5 2.0 2.0	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 20 mA I_B = 30 mA I_B = 50 mA I_B = 50 mA	I_C = 4 A I_C = 7 A I_C = 10 A I_C = 10 A	 (see Notes 3 and 4) T_C = 100°C				1.8 1.9 2.2 2.1	V
V_{EC}	Parallel diode forward voltage	I_E = 10 A	I_B = 0					3	V
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz	(see Note 5)		10		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz			90		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
4. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.
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
$R_{\theta JC}$	Junction to case thermal resistance			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, $I_{B(on)}$ = 50 mA, $I_{B(off)}$ = -2.5 A, $V_{BE(off)}$ = -5 V (see Figures 1 and 2)		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

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

PARAMETER MEASUREMENT INFORMATION

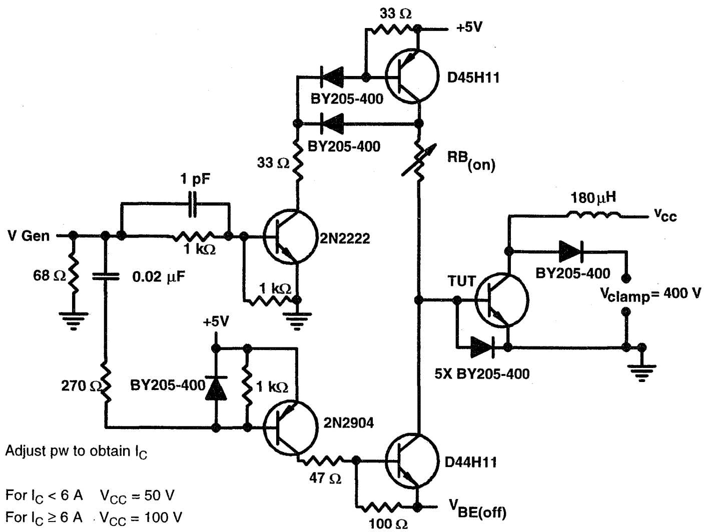
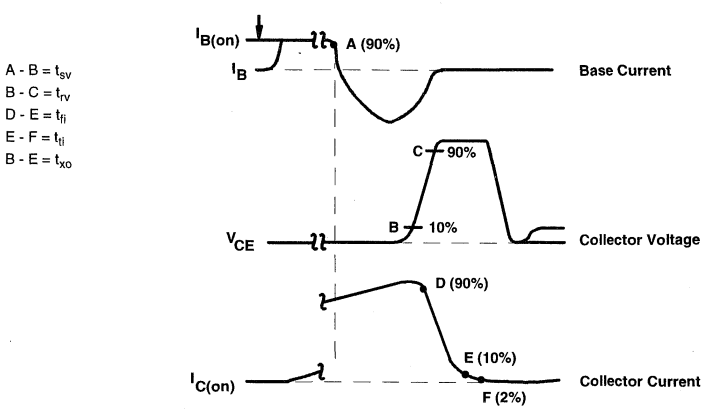


Figure 1. Inductive-Load Switching Test Circuit



NOTES: A. Waveforms are monitored on an oscilloscope with the following characteristics: t_r < 15 ns, R_{in} > 10 Ω, C_{in} < 11.5 pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

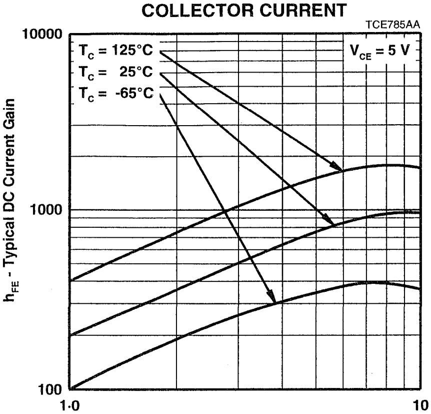


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

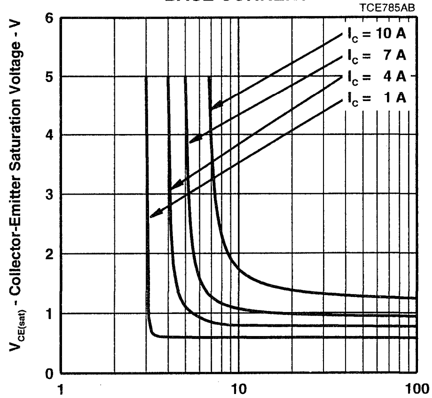


Figure 4.

BASE-EMITTER SATURATION VOLTAGE vs BASE CURRENT

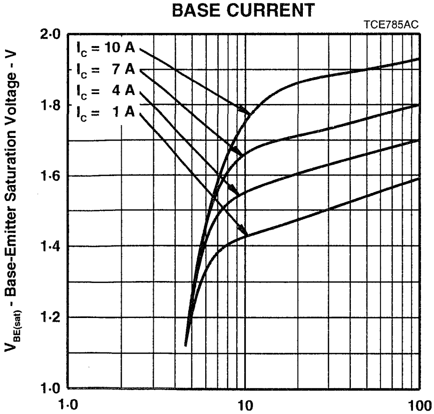


Figure 5.

COLLECTOR CUT-OFF CURRENT vs CASE TEMPERATURE

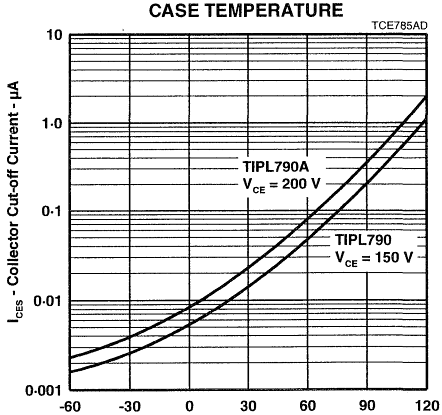


Figure 6.

MAXIMUM SAFE OPERATING REGIONS

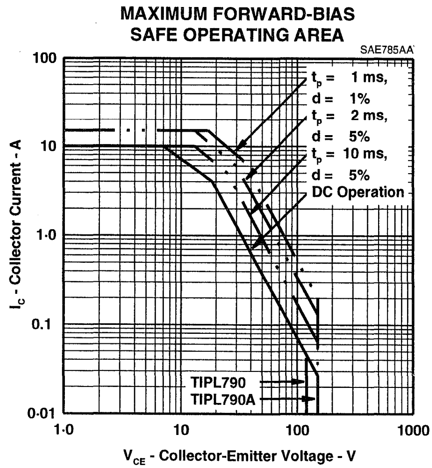
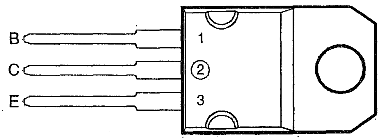


Figure 7.

MAY 1989 - REVISED MAY 1995

- **Rugged Triple-Diffused Planar Construction**
- **4 A Continuous Collector Current**
- **Operating Characteristics Fully Guaranteed at 100°C**
- **1000 Volt Blocking Capability**

**TO-220 PACKAGE
(TOP VIEW)**



Pin 2 is in electrical contact with the mounting base.

MDTRAC

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

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

NOTE 1: This value applies for $t_p \leq 10$ ms, duty cycle ≤ 2%.

MAY 1989 - REVISED MAY 1995

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	L = 25 mH	(see Note 2)	TIPL791	400			V
					TIPL791A	450			
I_{CES}	Collector-emitter cut-off current	V_{CE} = 850 V	V_{BE} = 0		TIPL791			5	μA
		V_{CE} = 1000 V	V_{BE} = 0		TIPL791A			5	
		V_{CE} = 850 V	V_{BE} = 0	T_C = 100°C	TIPL791			200	
		V_{CE} = 1000 V	V_{BE} = 0	T_C = 100°C	TIPL791A			200	
I_{CEO}	Collector cut-off current	V_{CE} = 400 V	I_B = 0		TIPL791			5	μA
		V_{CE} = 450 V	I_B = 0		TIPL791A			5	
I_{EBO}	Emitter cut-off current	V_{EB} = 10 V	I_C = 0					1	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 5 V	I_C = 0.5 A	(see Notes 3 and 4)		20		60	
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.2 A	I_C = 1 A					0.5	V
		I_B = 0.5 A	I_C = 2.5 A	(see Notes 3 and 4)				1.0	
		I_B = 1 A	I_C = 4 A					2.5	
		I_B = 1 A	I_C = 4 A	T_C = 100°C				5.0	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.2 A	I_C = 1 A					1.0	V
		I_B = 0.5 A	I_C = 2.5 A	(see Notes 3 and 4)				1.2	
		I_B = 1 A	I_C = 4 A					1.4	
		I_B = 1 A	I_C = 4 A	T_C = 100°C				1.3	
f_t	Current gain bandwidth product	V_{CE} = 10 V	I_C = 0.5 A	f = 1 MHz			12		MHz
C_{ob}	Output capacitance	V_{CB} = 20 V	I_E = 0	f = 0.1 MHz			110		pF

NOTES: 2. Inductive loop switching measurement.
3. These parameters must be measured using pulse techniques, t_p = 300 μs, duty cycle ≤ 2%.
4. 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			1.66	°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, $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.8A	(see Figures 1 and 2)			2	μs
t_{rv}	Voltage rise time						200	ns
t_{fi}	Current fall time						100	ns
t_{ti}	Current tail time						50	ns
t_{xo}	Cross over time						200	ns
t_{sv}	Voltage storage time	I_C = 4 A, $V_{BE(off)}$ = -5 V	$I_{B(on)}$ = 0.8A, T_C = 100°C	(see Figures 1 and 2)			2.5	μs
t_{rv}	Voltage rise time						400	ns
t_{fi}	Current fall time						200	ns
t_{ti}	Current tail time						50	ns
t_{xo}	Cross over time						600	ns

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

PARAMETER MEASUREMENT INFORMATION

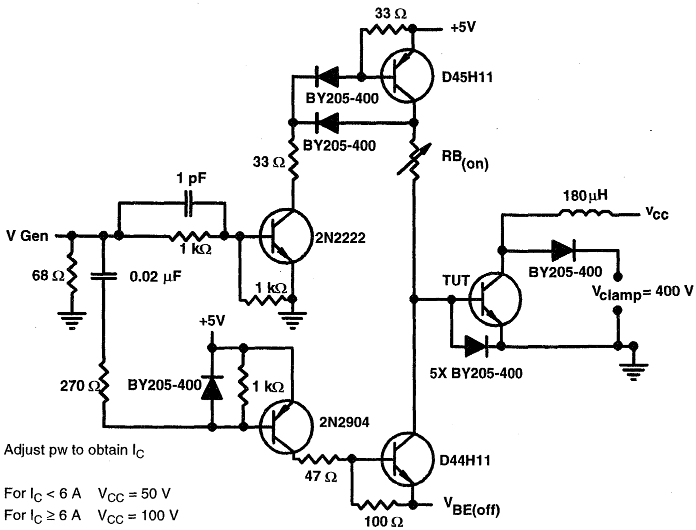
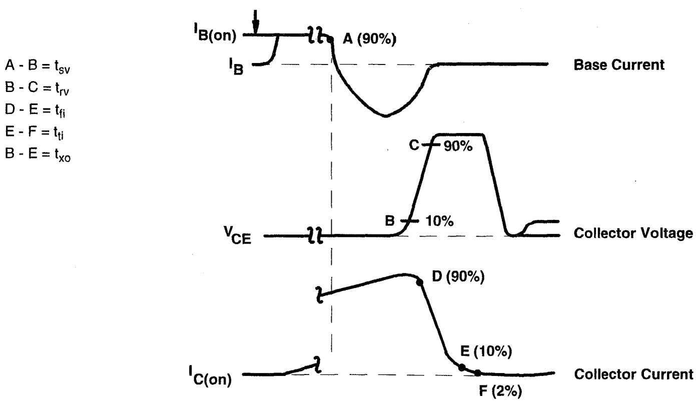


Figure 1. Inductive-Load Switching Test Circuit



NOTES: A. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r < 15$ ns, $R_{in} > 10\ \Omega$, $C_{in} < 11.5$ pF.
B. Resistors must be noninductive types.

Figure 2. Inductive-Load Switching Waveforms

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

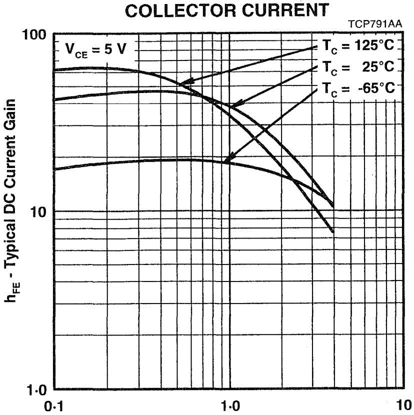


Figure 3.

COLLECTOR-EMITTER SATURATION VOLTAGE vs BASE CURRENT

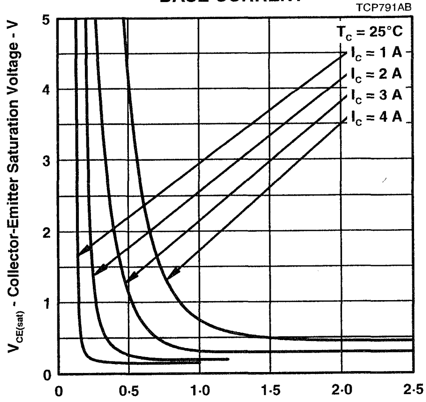


Figure 4.

MAXIMUM SAFE OPERATING REGIONS

MAXIMUM FORWARD-BIAS SAFE OPERATING AREA

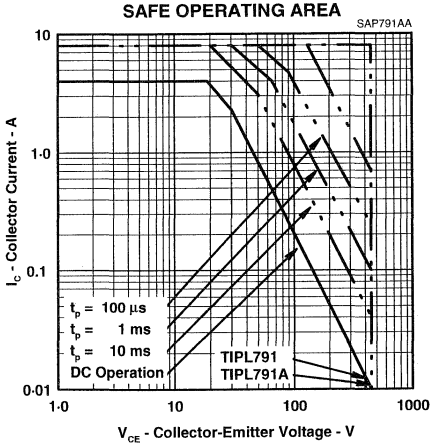


Figure 5.

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THERMAL INFORMATION

THERMAL RESPONSE JUNCTION TO CASE vs POWER PULSE DURATION

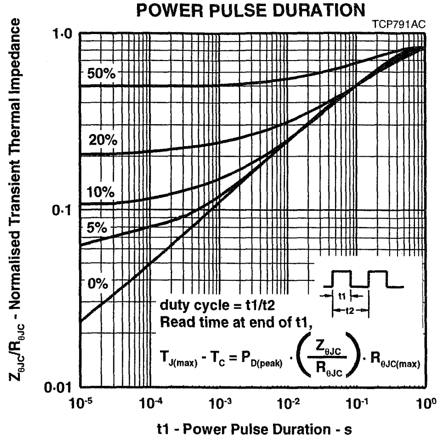
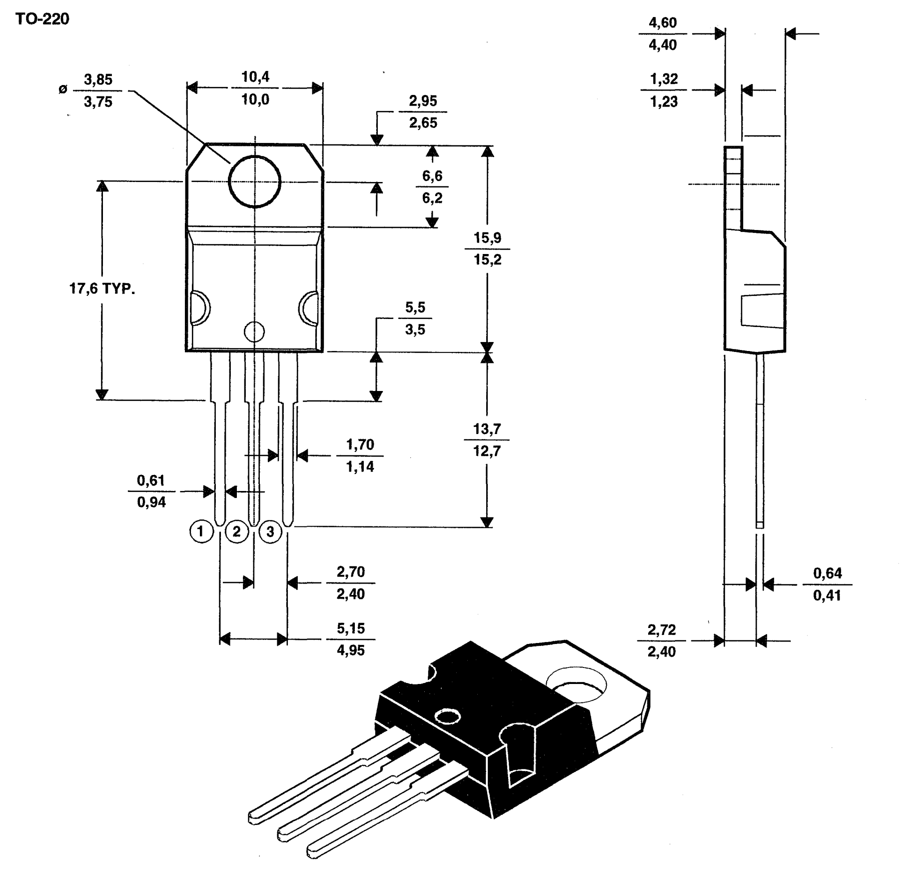


Figure 6.

TO-220
3-pin plastic flange-mount package

This single-in-line package consists of a circuit mounted on a lead frame and encapsulated within a plastic compound. The compound will withstand soldering temperature with no deformation, and circuit performance characteristics will remain stable when operated in high humidity conditions. Leads require no additional cleaning or processing when used in soldered assembly.



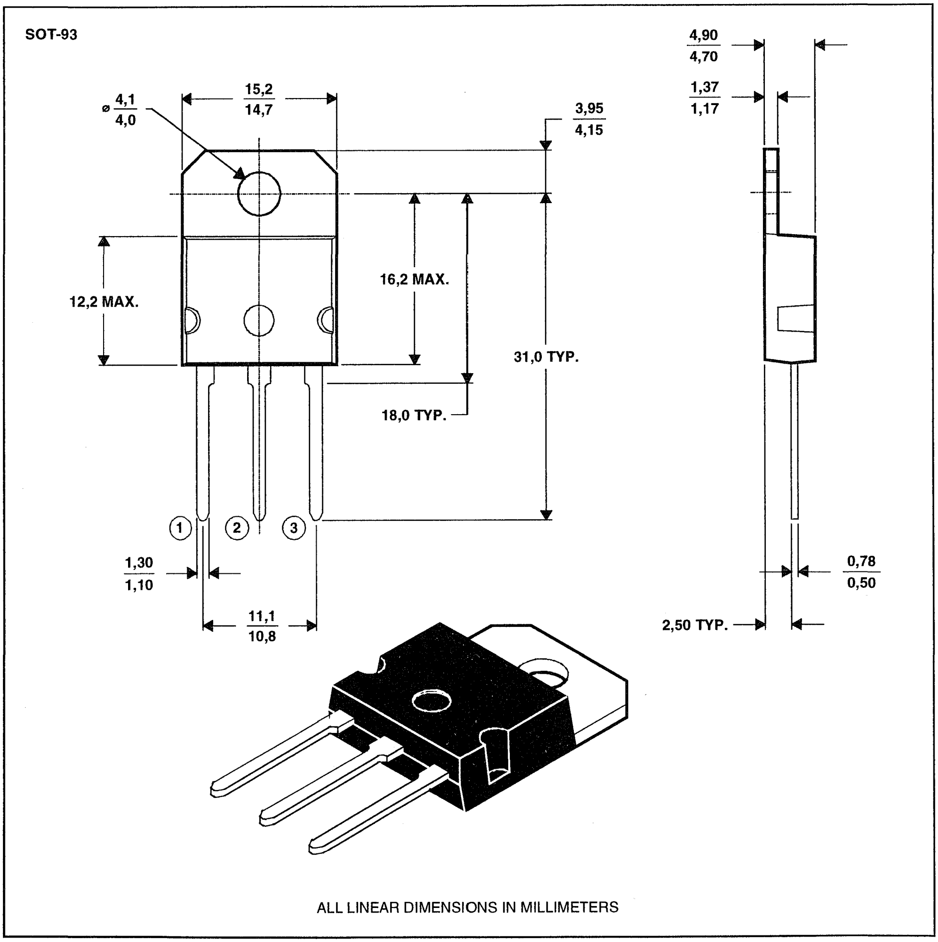
ALL LINEAR DIMENSIONS IN MILLIMETERS

NOTE A: The centre pin is in electrical contact with the mounting tab.

MDXXAP

SOT-93
3-pin plastic flange-mount package

This single-in-line package consists of a circuit mounted on a lead frame and encapsulated within a plastic compound. The compound will withstand soldering temperature with no deformation, and circuit performance characteristics will remain stable when operated in high humidity conditions. Leads require no additional cleaning or processing when used in soldered assembly.

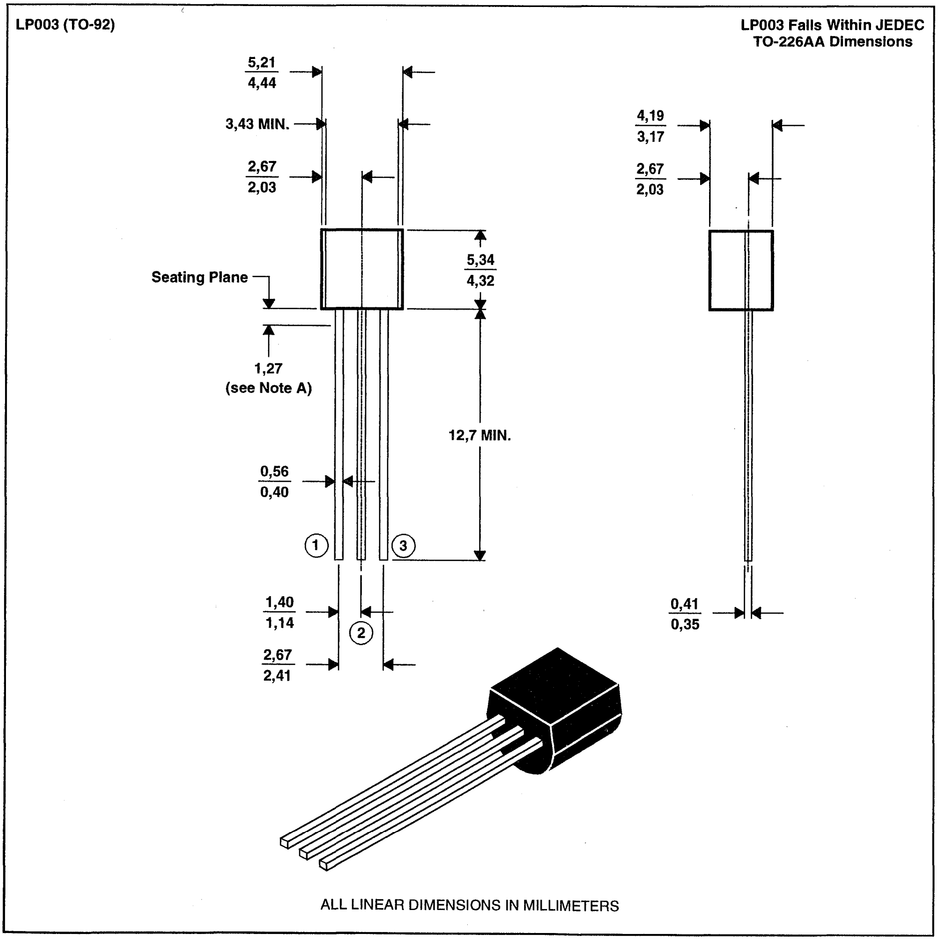


NOTE A: The centre pin is in electrical contact with the mounting tab.

MDXXAW

LP003 (TO-92)
3-pin cylindical plastic package

This single-in-line package consists of a circuit mounted on a lead frame and encapsulated within a plastic compound. The compound will withstand soldering temperature with no deformation, and circuit performance characteristics will remain stable when operated in high humidity conditions. Leads require no additional cleaning or processing when used in soldered assembly.



NOTE A: Lead dimensions are not controlled in this area.

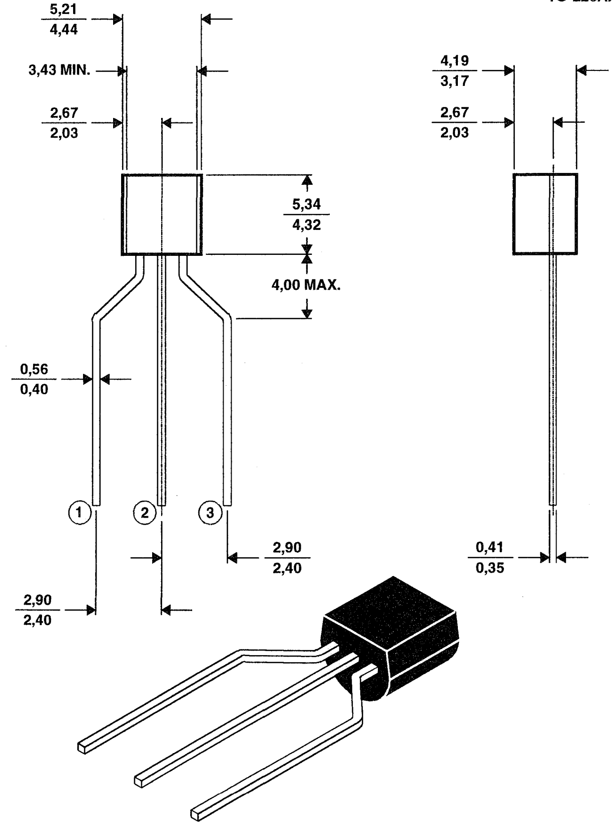
MDXXAX

LP003 (TO-92)
3-pin cylindical plastic package

This single-in-line package consists of a circuit mounted on a lead frame and encapsulated within a plastic compound. The compound will withstand soldering temperature with no deformation, and circuit performance characteristics will remain stable when operated in high humidity conditions. Leads require no additional cleaning or processing when used in soldered assembly.

LP003 (TO-92) - Formed Leads Version

LP003 Falls Within JEDEC TO-226AA Dimensions



ALL LINEAR DIMENSIONS IN MILLIMETERS

MDXXAR

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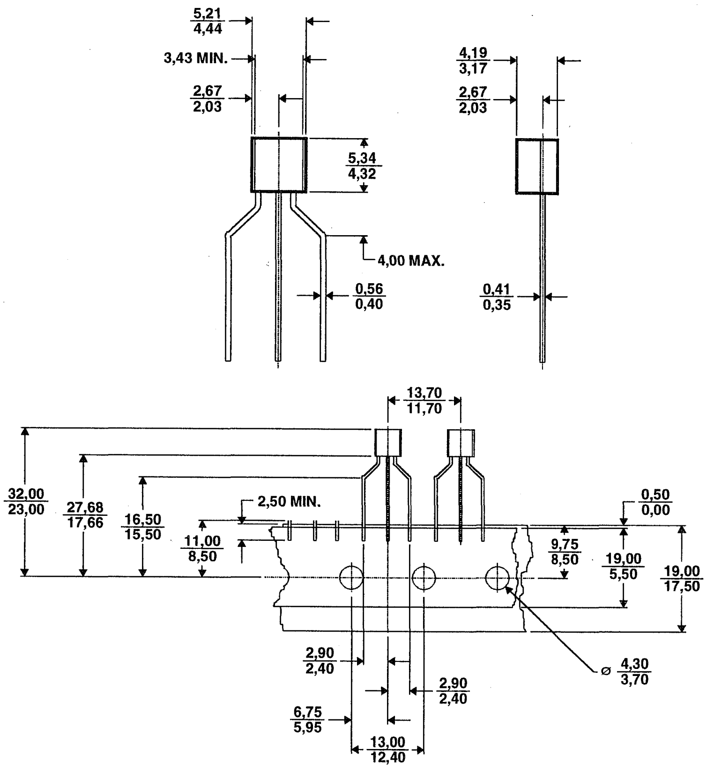
LPR
Tape dimensions

LP Package (TO-92) Tape (Formed Lead Version)



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MDXXAS

TI Sales Offices in Europe

BELGIQUE/BELGÏE
Avenue Jules Bordetlaan 11
1140 Bruxelles/Brussels
Tel: (02) 726 75 80
Fax: (02) 726 72 76

DEUTSCHLAND
Haggertystraße 1
85356 Freising
Tel: (08161) 80-0
Fax: (08161) 80 45 16

Kirchhorster Straße 2
30659 Hannover
Tel: (0511) 90 49 60
Fax: (0511) 64 90 331

Maybachstraße 11
73760 Osfildern
Tel: (0711) 34 03 0
Fax: (0711) 34 032 57

ESPAÑA
c/ Gobelas 43
28023 Madrid
Tel: (1) 372 80 51
Fax: (1) 372 82 66

FRANCE, MIDDLE-EAST & AFRICA
8-10 Avenue Morane-Saulnier,
B.P. 67
78141 Velizy-Viliacoublay Cedex
Tel: (1) 30 70 10 01
Fax: (1) 30 70 10 54
Service Technique: Tel (1) 30 70 10 33

HOLLAND
Amsterdamseweg 204
1182 HL Amstelveen

MAILING ADDRESS
P.B. 5320
1180 AM Amstelveen
Tel: (020) 6400416
Fax: (020) 5450660
(020) 6403846

HUNGARY
TI Representation
Budaörsi u. 50, 3rd floor
1112 Budapest
Tel: (1) 269 8310
Fax: (1) 267 1357

ITALIA
Centro Direzionale Colleoni
Palazzo Perseo - Via Paracelso, 12
20041 Agrate Brianza (Mi)
Tel: (039) 68 42 1
Fax: (039) 68 42 912

PORTUGAL
Eng. Frederico Ulricho, 2650
Moreira Da Maia
4470 Maia
Tel: (2) 948 10 03
Fax: (2) 948 19 29

REPUBLIC OF IRELAND
7/8 Harcourt Street
Dublin 2
Tel: (01) 475 52 33
Fax: (01) 478 14 63

SUOMI/FINLAND
Tekniikantie 12
02150 Espoo
Tel: (0) 43 54 20 33
Fax: (0) 46 73 23

SVERIGE
Box 30,
164 93 Kista
Visit address:
Isafjordsgatan 7, Kista
Tel: (08) 752 58 00
Fax: (08) 751 97 15

UNITED KINGDOM
Manton Lane
Bedford
England MK41 7PA
Tel: (01234) 270 111
Fax: (01234) 223 459

TI Technology Centres

FRANCE
8-10 Avenue Morane Saulnier
B.P. 67
78141 Velizy-Villacoublay Cedex
Tel: Standard: (1) 30 70 10 01
Service Technique: (1) 30 70 11 33

HOLLAND
1182 HL Amstelveen
Tel: (020) 545 06 00

ITALIA
Centro Direzionale Colleoni
Palazzo Perseo - Via Paracelso, 12
20041 Agrate Brianza (Mi)
Tel: (039) 68 42 1
Fax: (039) 68 42 912

SVERIGE
Box 30
164 93 Kista
Tel: (08) 752 58 00

UNITED KINGDOM
Manton Lane
Bedford
England MK41 7PA
Tel: (01234) 270 111

TI SC European Product Information Center

E-PIC

Tel:	French	(33) 1 30 70 11 64
	English	(33) 1 30 70 11 65
	Dutch	(33) 1 30 70 11 66
	Italian	(33) 1 30 70 11 67
	German	(33) 1 30 70 11 68
Fax:		(33) 1 30 70 10 32

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