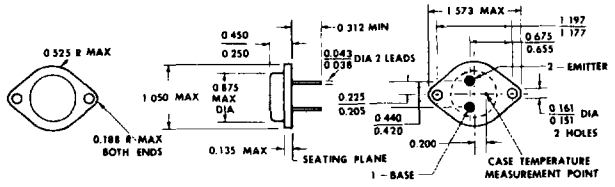
TYPES 2N1529 THRU 2N1548
P-N-P ALLOY-JUNCTION GERMANIUM POWER TRANSISTORS

FOR HIGH-POWER SWITCHING AND AMPLIFIER APPLICATIONS

mechanical data

These transistors are in precision welded, hermetically sealed enclosures. The mounting base provides an excellent heat path from the collector junction to a heat sink. The mounting base and heat sink must be in intimate contact for maximum heat transfer. Extreme cleanliness and the absence of flux during the assembly process prevents sealed-in contamination.

*THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE
*ALL JEDEC TO-3 DIMENSIONS AND NOTES ARE APPLICABLE



DIMENSIONS ARE IN INCHES

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

	2N1529 2N1534 2N1539 2N1544	2N1530 2N1535 2N1540 2N1545	2N1531 2N1536 2N1541 2N1546	2N1532 2N1537 2N1542 2N1547	2N1533 2N1538 2N1543 2N1548
Collector-Base Voltage	−40 V*	−60 V*	−80 V*	−100 V*	−120 V*
Collector-Emitter Voltage (See Note 1)	−30 V*	−45 V*	−60 V*	−75 V*	−90 V*
Emitter-Base Voltage	−20 V*	−30 V*	−40 V*	−50 V*	−60 V*
Continuous Collector Current	←		−5 A*		→
Continuous Emitter Current	←		5 A*		→
Continuous Device Dissipation at (or below) 25°C Case Temperature (See Note 2)	←		106 W		→
Operating Collector Junction Temperature	←		100°C* / 110°C†		→
Storage Temperature Range	←		−65°C to 100°C*		→

NOTES: 1. This value applies when base-emitter diode is short-circuited.
2. Derate linearly to 110°C case temperature at the rate of 1.25 W/deg.

*Indicates JEDEC registered data
†This value is guaranteed by Texas Instruments in addition to the JEDEC registered value which is also shown.

2N1529 THRU 2N1533

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

PARAMETER		TEST CONDITIONS		TYPE	MIN	MAX	UNIT
*$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = -500$ mA,	$I_B = 0$	2N1529 2N1530 2N1531 2N1532 2N1533	–20 –30 –40 –50 –60		V
*$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$I_C = -500$ mA,	$V_{BE} = 0$	2N1529 2N1530 2N1531 2N1532 2N1533	–30 –45 –60 –75 –90		V
*$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = -25$ mA,	$I_C = 0$	2N1529 2N1530 2N1531 2N1532 2N1533	–20 –30 –40 –50 –60		V
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -2$ V,	$I_E = 0$	All		–200	μA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -25$ V $V_{CB} = -40$ V $V_{CB} = -55$ V $V_{CB} = -65$ V $V_{CB} = -80$ V	$I_E = 0$	2N1529 2N1530 2N1531 2N1532 2N1533		–2	mA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -40$ V $V_{CB} = -60$ V $V_{CB} = -80$ V $V_{CB} = -100$ V $V_{CB} = -120$ V	$I_E = 0$	2N1529 2N1530 2N1531 2N1532 2N1533		–20	mA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -15$ V $V_{CB} = -22.5$ V $V_{CB} = -30$ V $V_{CB} = -37.5$ V $V_{CB} = -45$ V	$I_E = 0$, $T_C = 90$°C	2N1529 2N1530 2N1531 2N1532 2N1533		–20	mA
*I_{CEV}	Collector Cutoff Current	$V_{CE} = -40$ V $V_{CE} = -60$ V $V_{CE} = -80$ V $V_{CE} = -100$ V $V_{CE} = -120$ V	$V_{BE} = 1$ V	2N1529 2N1530 2N1531 2N1532 2N1533		–20	mA
*I_{EBO}	Emitter Cutoff Current	$V_{EB} = -12$ V,	$I_C = 0$	All		–0.5	mA
*h_{FE}	Static Forward Current Transfer Ratio	$V_{CE} = -2$ V,	$I_C = -3$ A	All	20	40	
*g_{FE}	Static Common-Emitter Forward Transfer Conductance	$V_{CE} = -2$ V,	$I_C = -3$ A	All	1.2		mho
*V_{BE}	Base-Emitter Voltage	$I_B = -300$ mA,	$I_C = -3$ A	All		–1.7	V
*$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_B = -300$ mA,	$I_C = -3$ A	All		–1.5	V
*f_{hfe}	Common-Emitter Forward Current Transfer Ratio Cutoff Frequency	$V_{CE} = -2$ V,	$I_C = -3$ A	All	2		kHz
f_T	Transition Frequency	$V_{CE} = -2$ V,	$I_C = -1$ A, See Note 4	All	200		kHz

thermal characteristics

PARAMETER		TYPE	MAX	UNIT
*θ_{J-C}	Junction-to-Case Thermal Resistance	All	0.8	deg/W

NOTE 4. To obtain f_T, the $|h_{fe}|$ response with frequency is extrapolated at the rate of — 6 dB/octave from $f = 100$ kHz to the frequency at which $|h_{fe}| = 1$.

*Indicates JEDEC registered data

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2N1534 THRU 2N1538

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

PARAMETER		TEST CONDITIONS		TYPE	MIN	MAX	UNIT
*$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = -500$ mA,	$I_B = 0$	2N1534 2N1535 2N1536 2N1537 2N1538	−20 −30 −40 −50 −60		V
*$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$I_C = -500$ mA,	$V_{BE} = 0$	2N1534 2N1535 2N1536 2N1537 2N1538	−30 −45 −60 −75 −90		V
*$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = -25$ mA,	$I_C = 0$	2N1534 2N1535 2N1536 2N1537 2N1538	−20 −30 −40 −50 −60		V
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -2$ V,	$I_E = 0$	All		−200	μA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -25$ V $V_{CB} = -40$ V $V_{CB} = -55$ V $V_{CB} = -65$ V $V_{CB} = -80$ V	$I_E = 0$	2N1534 2N1535 2N1536 2N1537 2N1538		−2	mA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -40$ V $V_{CB} = -60$ V $V_{CB} = -80$ V $V_{CB} = -100$ V $V_{CB} = -120$ V	$I_E = 0$	2N1534 2N1535 2N1536 2N1537 2N1538		−20	mA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -15$ V $V_{CB} = -22.5$ V $V_{CB} = -30$ V $V_{CB} = -37.5$ V $V_{CB} = -45$ V	$I_E = 0$, $T_C = 90°C$	2N1534 2N1535 2N1536 2N1537 2N1538		−20	mA
*I_{CEV}	Collector Cutoff Current	$V_{CE} = -40$ V $V_{CE} = -60$ V $V_{CE} = -80$ V $V_{CE} = -100$ V $V_{CE} = -120$ V	$V_{BE} = 1$ V	2N1534 2N1535 2N1536 2N1537 2N1538		−20	mA
*I_{EBO}	Emitter Cutoff Current	$V_{EB} = -12$ V,	$I_C = 0$	All		−0.5	mA
*h_{FE}	Static Forward Current Transfer Ratio	$V_{CE} = -2$ V,	$I_C = -3$ A	All	35	70	
*g_{FE}	Static Common-Emitter Forward Transfer Conductance	$V_{CE} = -2$ V,	$I_C = -3$ A	All	1.5		mho
*V_{BE}	Base-Emitter Voltage	$I_B = -300$ mA,	$I_C = -3$ A	All		−1.5	V
*$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_B = -300$ mA,	$I_C = -3$ A	All		−1.2	V
*f_{hfe}	Common-Emitter Forward Current Transfer Ratio Cutoff Frequency	$V_{CE} = -2$ V,	$I_C = -3$ A	All	2		kHz
f_T	*Transition Frequency*	$V_{CE} = -2$ V,	$I_C = -1$ A, See Note 4	All	200		kHz

thermal characteristics

PARAMETER		TYPE	MAX	UNIT
*θ_{J-C}	Junction-to-Case Thermal Resistance	All	0.8	deg/W

NOTE: 4. To obtain f_T, the $|h_{fe}|$ response with frequency is extrapolated at the rate of −6 dB/octave from f = 100 kHz to the frequency at which $|h_{fe}| = 1$.

*Indicates JEDEC registered data

2N1539 THRU 2N1543

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

PARAMETER		TEST CONDITIONS		TYPE	MIN	MAX	UNIT
*$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = -500$ mA,	$I_B = 0$	2N1539 2N1540 2N1541 2N1542 2N1543	−20 −30 −40 −50 −60		V
*$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$I_C = -500$ mA,	$V_{BE} = 0$	2N1539 2N1540 2N1541 2N1542 2N1543	−30 −45 −60 −75 −90		V
*$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = -25$ mA,	$I_C = 0$	2N1539 2N1540 2N1541 2N1542 2N1543	−20 −30 −40 −50 −60		V
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -2$ V,	$I_E = 0$	All		−200	μA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -25$ V $V_{CB} = -40$ V $V_{CB} = -55$ V $V_{CB} = -65$ V $V_{CB} = -80$ V	$I_E = 0$	2N1539 2N1540 2N1541 2N1542 2N1543		−2	mA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -40$ V $V_{CB} = -60$ V $V_{CB} = -80$ V $V_{CB} = -100$ V $V_{CB} = -120$ V	$I_E = 0$	2N1539 2N1540 2N1541 2N1542 2N1543		−20	mA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -15$ V $V_{CB} = -22.5$ V $V_{CB} = -30$ V $V_{CB} = -37.5$ V $V_{CB} = -45$ V	$I_E = 0$, $T_C = 90°C$	2N1539 2N1540 2N1541 2N1542 2N1543		−20	mA
*I_{CEV}	Collector Cutoff Current	$V_{CE} = -40$ V $V_{CE} = -60$ V $V_{CE} = -80$ V $V_{CE} = -100$ V $V_{CE} = -120$ V	$V_{BE} = 1$ V	2N1539 2N1540 2N1541 2N1542 2N1543		−20	mA
*I_{EBO}	Emitter Cutoff Current	$V_{EB} = -12$ V,	$I_C = 0$	All		−0.5	mA
*h_{FE}	Static Forward Current Transfer Ratio	$V_{CE} = -2$ V,	$I_C = -3$ A	All	50	100	
*g_{FE}	Static Common-Emitter Forward Transfer Conductance	$V_{CE} = -2$ V,	$I_C = -3$ A	All	3		mho
*V_{BE}	Base-Emitter Voltage	$I_B = -300$ mA,	$I_C = -3$ A	All		−0.7	V
*$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_B = -300$ mA,	$I_C = -3$ A	All		−0.3	V
*f_{hfe}	Common-Emitter Forward Current Transfer Ratio Cutoff Frequency	$V_{CE} = -2$ V,	$I_C = -5$ A	All	1		kHz
f_T	Transition Frequency	$V_{CE} = -2$ V,	$I_C = -1$ A, See Note 4	All	200		kHz

thermal characteristics

PARAMETER		TYPE	MAX	UNIT
*θ_{J-C}	Junction-to-Case Thermal Resistance	All	0.8	deg/W

NOTE: 4. To obtain f_T, the $|h_{fe}|$ response with frequency is extrapolated at the rate of −6 dB/octave from $f = 100$ kHz to the frequency at which $|h_{fe}| = 1$.

*Indicates JEDEC registered data

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2N1544 THRU 2N1548

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

PARAMETER		TEST CONDITIONS		TYPE	MIN	MAX	UNIT
*$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = -500$ mA,	$I_B = 0$	2N1544 2N1545 2N1546 2N1547 2N1548	–20 –30 –40 –50 –60		V
*$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$I_C = -500$ mA,	$V_{BE} = 0$	2N1544 2N1545 2N1546 2N1547 2N1548	–30 –45 –60 –75 –90		V
*$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = -20$ mA,	$I_C = 0$	2N1544 2N1545 2N1546 2N1547 2N1548	–20 –30 –40 –50 –60		V
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -2$ V,	$I_E = 0$	All		–200	μA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -25$ V $V_{CB} = -40$ V $V_{CB} = -55$ V $V_{CB} = -65$ V $V_{CB} = -80$ V	$I_E = 0$	2N1544 2N1545 2N1546 2N1547 2N1548		–2	mA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -40$ V $V_{CB} = -60$ V $V_{CB} = -80$ V $V_{CB} = -100$ V $V_{CB} = -120$ V	$I_E = 0$	2N1544 2N1545 2N1546 2N1547 2N1548		–20	mA
*I_{CBO}	Collector Cutoff Current	$V_{CB} = -15$ V $V_{CB} = -22.5$ V $V_{CB} = -30$ V $V_{CB} = -37.5$ V $V_{CB} = -45$ V	$I_E = 0$, $T_C = 90°C$	2N1544 2N1545 2N1546 2N1547 2N1548		–20	mA
*I_{CEV}	Collector Cutoff Current	$V_{CE} = -40$ V $V_{CE} = -60$ V $V_{CE} = -80$ V $V_{CE} = -100$ V $V_{CE} = -120$ V	$V_{BE} = 1$ V	2N1544 2N1545 2N1546 2N1547 2N1548		–20	mA
*I_{EBO}	Emitter Cutoff Current	$V_{EB} = -12$ V,	$I_C = 0$	All		–0.5	mA
*h_{FE}	Static Forward Current Transfer Ratio	$V_{CE} = -2$ V,	$I_C = -3$ A	All	75	150	
*g_{FE}	Static Common-Emitter Forward Transfer Conductance	$V_{CE} = -2$ V,	$I_C = -3$ A	All	4		mho
*V_{BE}	Base-Emitter Voltage	$I_B = -300$ mA,	$I_C = -3$ A	All		–0.6	V
*$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_B = -300$ mA,	$I_C = -3$ A	All		–0.2	V
*f_{hfe}	Common-Emitter Forward Current Transfer Ratio Cutoff Frequency	$V_{CE} = -2$ V,	$I_C = -5$ A	All	1		kHz
f_T	Transition Frequency	$V_{CE} = -2$ V,	$I_C = -1$ A, See Note 4	All	200		kHz

thermal characteristics

PARAMETER		TYPE	MAX	UNIT
*$\theta_{J\text{-}C}$	Junction-to-Case Thermal Resistance	All	0.8	deg/W

NOTE: 4. To obtain f_T, the $|h_{fe}|$ response with frequency is extrapolated at the rate of — 6 dB/octave from f = 100 kHz to the frequency at which $|h_{fe}| = 1$.

*Indicates JEDEC registered data

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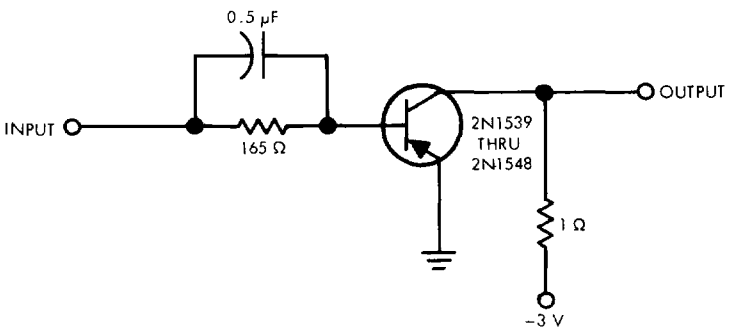
2N1539 THRU 2N1548

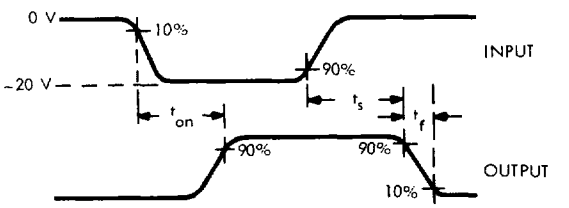
switching characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS	TYP	UNIT
t_{on} Turn-On Time	$I_C \approx 3$ A, $R_L = 1\ \Omega$, See Figure 1	5	μs
t_s Storage Time		3	μs
t_f Fall Time		5	μs

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: a. The input pulse is supplied by a generator with the following characteristics: $t_r \leq 0.1$ μs, $t_p = 50$ μs, duty cycle $\leq 10\%$.
b. The waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 0.1$ μs, $R_{in} \geq 100$ kΩ, $C_{in} \leq 20$ pF.

FIGURE 1

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THERMAL INFORMATION

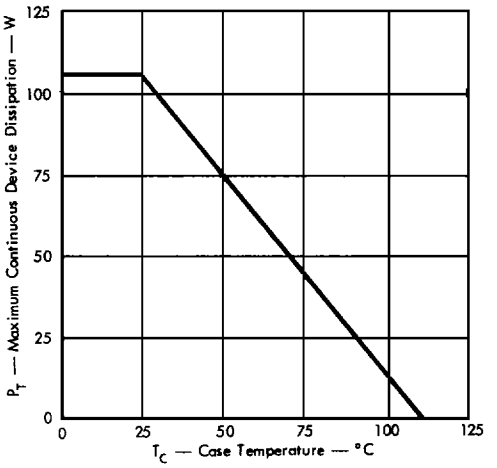

FIGURE 2

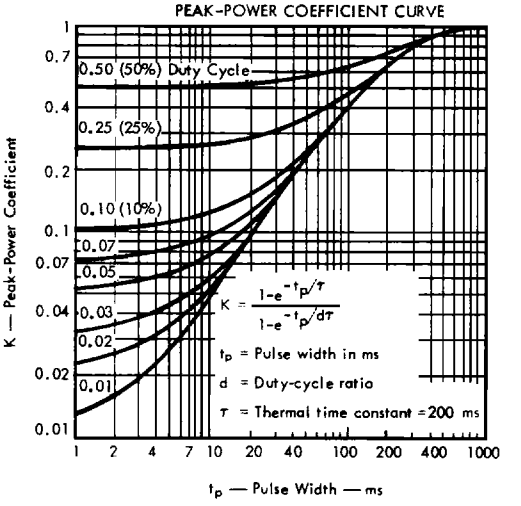

FIGURE 3

SYMBOL DEFINITION

SYMBOL	DEFINITION	VALUE	UNIT
$P_{T(av)}$	Average Power Dissipation		W
$P_{T(max)}$	Peak Power Dissipation		W
$\theta_{J\text{-}C}$	Junction-to-Case Thermal Resistance	0.8	deg/W
$\theta_{C\text{-}HS}$	Case-to-Heat-Sink Thermal Resistance		deg/W
$\theta_{HS\text{-}A}$	Heat-Sink-to-Free-Air Thermal Resistance		deg/W
T_A	Free-Air Temperature		°C
T_C	Case Temperature		°C
$T_{J(av)}$	Average Junction Temperature	$\leq$ 110	°C
$T_{J(max)}$	Peak Junction Temperature	$\leq$ 110	°C
K	Peak-Power Coefficient	See Figure 3	
t_p	Pulse Width		ms
d	Duty-Cycle Ratio		

Equation No. 1 — Application: d-c power dissipation, heat sink used.

$$P_{T(av)} = \frac{T_{J(av)} - T_A}{\theta_{J\text{-}C} + \theta_{C\text{-}HS} + \theta_{HS\text{-}A}} \quad \text{for } 25°C \leq T_C \leq 110°C \text{ as in Figure 2}$$

Equation No. 2 — Application: Peak power dissipation, heat sink used.

$$P_{T(max)} = \frac{T_{J(max)} - T_A}{d\,(\theta_{C\text{-}HS} + \theta_{HS\text{-}A}) + K\,\theta_{J\text{-}C}} \quad \text{for } 25°C \leq T_C \leq 110°C$$

Example — Find $P_{T(max)}$ (design limit)

OPERATING CONDITIONS:

$\theta_{C\text{-}HS} + \theta_{HS\text{-}A} = 2.25$ deg/W (From information supplied with heat sink.)

$T_{J(av)}$ (design limit) $= 110°C$

$T_A = 50°C$

$d = 10\%$ (0.1)

$t_p = 10$ ms

Solution:

From Figure 3, Peak-Power Coefficient

$K = 0.125$ and by use of equation No. 2

$$P_{T(max)} = \frac{T_{J(max)} - T_A}{d\,(\theta_{C\text{-}HS} + \theta_{HS\text{-}A}) + K\,\theta_{J\text{-}C}}$$

$$P_{T(max)} = \frac{110 - 50}{0.1(2.25) + 0.125\ (0.8)} = 184\ W$$