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TI

for your
power
applications

Here is your personal copy of Texas Instruments specifications bulletin covering the 2N511-series P-N-P alloy-junction germanium power transistors in the popular diamond case.

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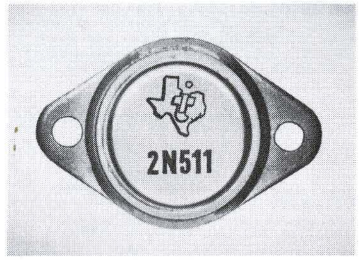
TYPES 2N511, 2N511A, 2N511B
P-N-P ALLOY JUNCTION GERMANIUM POWER TRANSISTORS

40, 60, 80 VOLTS
10-AMP COLLECTOR CURRENT
80-WATT DISSIPATION — 0.05 OHM MAX R_{CS}
LOW I_{CO} LOW V_{BE}
for
AUDIO AMPLIFIERS — SWITCHING CIRCUITS



ACTUAL SIZE

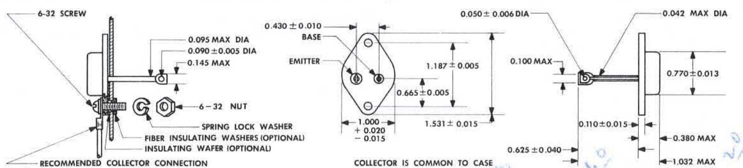
qualification testing

All units are subjected to a high-pressure leak test and are heat cycled from −55°C and room humidity to +95°C and 95% relative humidity, for four complete cycles over an eight-hour period. In addition, all units are stored at +95°C for 100 hours and then thoroughly tested for rigid adherence to electrical design characteristics.

mechanical data

The use of high-temperature silver solder to assemble the mounting base and the use of projection welds to seal the can, provide a hermetically-sealed enclosure which can withstand up to 300 psi. During the assembly process, the absence of flux, soft solder, and wet processing combined with extra cleanliness, prevents sealed-in contamination.

The mounting base is a high conductivity copper which provides an excellent heat path from the collector junction to a heat sink which must be tightly attached to permit operation at maximum rated dissipation. The approximate weight of the unit is 23 grams.



maximum ratings at 25°C*

		2N511	2N511A	2N511B	unit
V_{CBO}	Collector-to-Base Voltage ($I_C = -5$ma, $I_E = 0$)	−40	−60	−80	v
V_{CEX}	Collector-to-Emitter Voltage ($V_{BE} = +0.2$ v, $I_C = -5$ma)	−40	−60	−80	v
V_{EBO}	Emitter-to-Base Voltage ($I_E = -5$ma, $I_C = 0$)	−30	−30	−30	v
I_C	DC Collector Current	−10	−10	−10	a
I_E	DC Emitter Current	−10	−10	−10	a
I_B	Base Current	−5	−5	−5	a
	Total Dissipation†	80	80	80	w
T_J	Junction Temperature	95	95	95	°C

typical characteristics at 25°C*

		2N511	2N511A	2N511B	unit
h_{FE}	Forward Current Transfer Ratio ($V_{CE} = -1.5$ v, $I_C = -2.5$a)	30	30	30	
	($V_{CE} = -1.5$ v, $I_C = -10$a)	12	12	12	
R_{CS}	Common Emitter Saturation Resistance ($I_C = -10$a, $I_B = -1.5$a)	0.025	0.025	0.025	ohm
K	Thermal Resistance from Collector Junction to Mounting Base	0.7	0.7	0.7	°C/w
BV_{CES}	Collector to Emitter Breakdown Voltage with Base Shorted to Emitter ($I_C = -300$ma, $V_{BE} = 0$)	−55	−65	−75	v
BV_{CEO}	Collector to Emitter Breakdown Voltage ($I_C = -300$ma, $I_B = 0$)	−40	−50	−60	v
I_{CBO}	Collector Reverse Current ($V_{CB} = ½V_{CBO}$ max, $T_J = 85$°C)	−8.0	−8.0	−8.0	ma

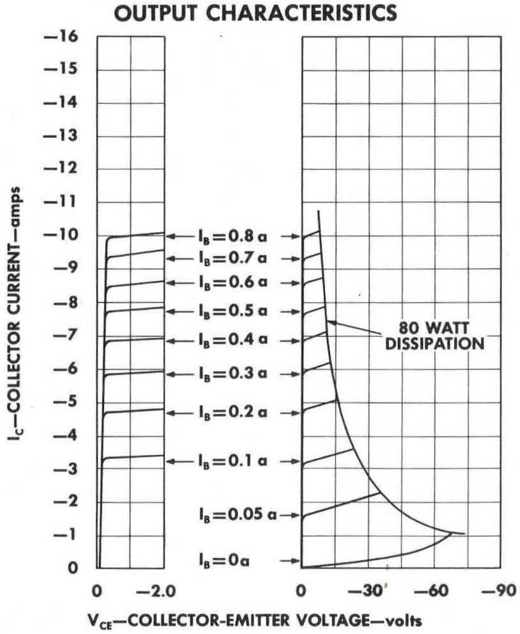
* Temperature is measured on mounting base.
† For operation at higher temperatures refer to derating curve.

design characteristics at 25°C

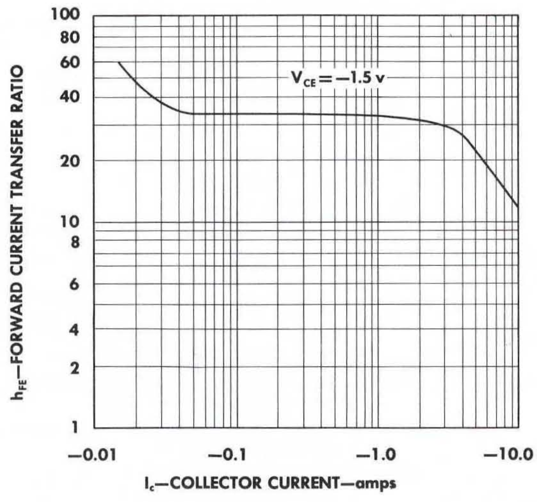
type	symbol	parameter	test conditions	min	design center	max	unit
2N511	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−40	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -20 v, I_E = 0$	—	−0.2	−2.0	ma
2N511A	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−60	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -30 v, I_E = 0$	—	−0.2	−2.0	ma
2N511B	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−80	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -40 v, I_E = 0$	—	−0.2	−2.0	ma
All	I_{CBO}	Collector Reverse Current	$V_{CB} = -2 v, I_E = 0$	—	−0.14	—	ma
All	BV_{EBO}	Emitter-to-Base Breakdown Voltage	$I_E = -5ma, I_C = 0$	−30	—	—	v
All	I_{EBO}	Emitter Reverse Current	$V_{EB} = 15 v, I_C = 0$	—	−0.2	—	ma
All	I_B	Base Current	$V_{CE} = -1.5 v, I_C = -2.5a$	—	−80.	−125	ma
			$V_{CE} = -1.5 v, I_C = -10a$	—	−0.8	−1.0	a
All	V_{BE}	Base Voltage	$V_{CE} = -1.5 v, I_C = -2.5a$	—	−0.4	—	v
			$V_{CE} = -1.5 v, I_C = -10a$	—	−0.84	−1.5	v
All	$V_{CE}(SAT)$	Collector-to-Emitter Saturation Voltage	$I_C = -10a, I_B = -1.5a$	—	−0.25	−0.5	v
All	$f_{\alpha e}$	Common-Emitter Frequency Cutoff	$V_{CE} = -6 v, I_C = -1a$	—	7.0	—	kc

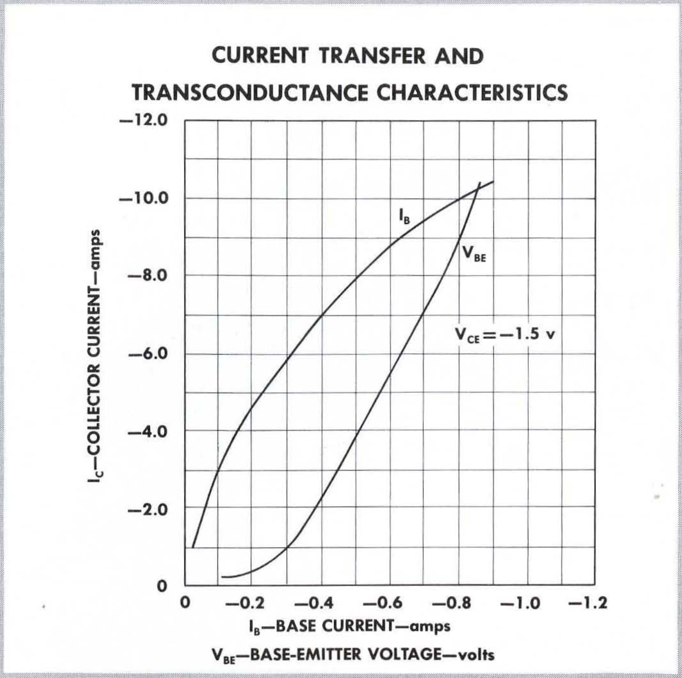
TYPICAL CHARACTERISTICS — COMMON EMITTER

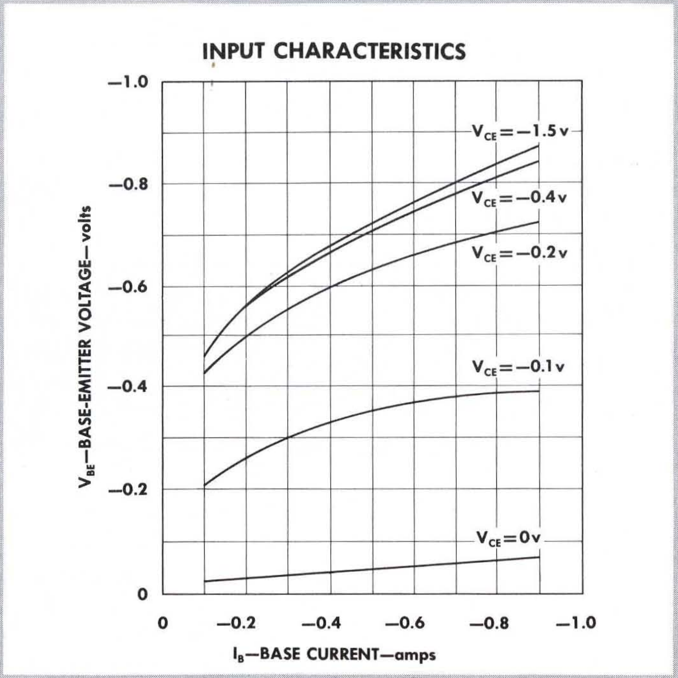
OUTPUT CHARACTERISTICS

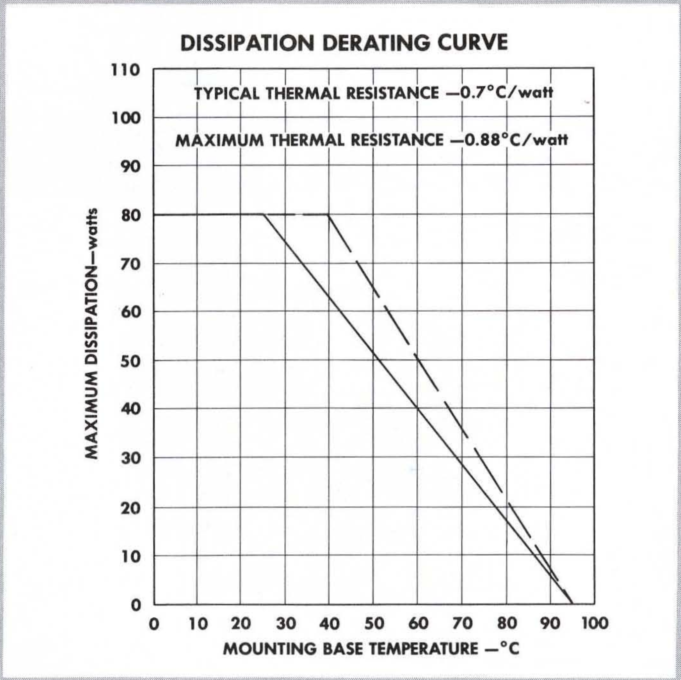


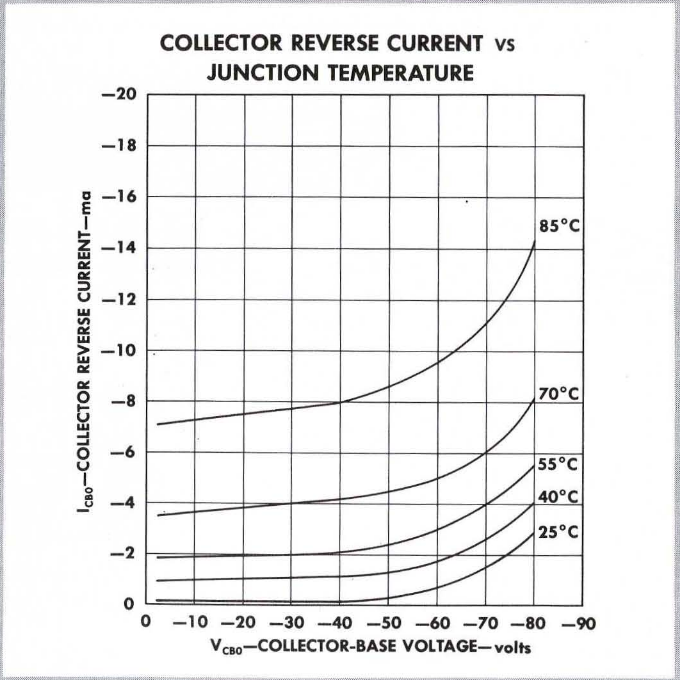
h_{FE} CHARACTERISTICS



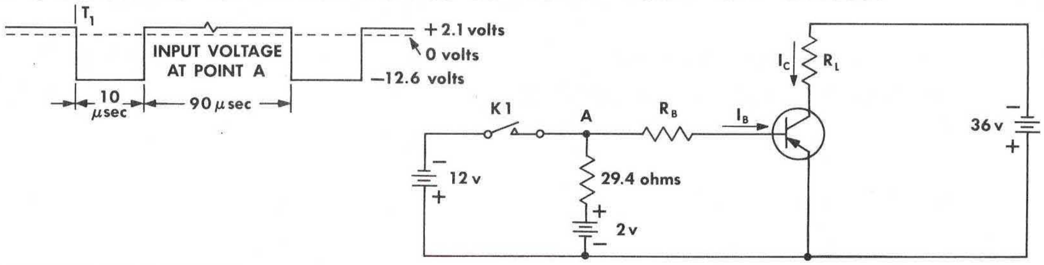

CURRENT TRANSFER AND
TRANSCONDUCTANCE CHARACTERISTICS
I_C—COLLECTOR CURRENT—amps
I_B—BASE CURRENT—amps
V_{BE}—BASE-EMITTER VOLTAGE—volts
I_B
V_{BE}
V_{CE} = −1.5 v


INPUT CHARACTERISTICS
V_{BE}—BASE-EMITTER VOLTAGE—volts
I_B—BASE CURRENT—amps
V_{CE} = −1.5 v
V_{CE} = −0.4 v
V_{CE} = −0.2 v
V_{CE} = −0.1 v
V_{CE} = 0 v


DISSIPATION DERATING CURVE
TYPICAL THERMAL RESISTANCE —0.7°C/watt
MAXIMUM THERMAL RESISTANCE —0.88°C/watt
MAXIMUM DISSIPATION—watts
MOUNTING BASE TEMPERATURE —°C


COLLECTOR REVERSE CURRENT vs
JUNCTION TEMPERATURE
I_{CBO}—COLLECTOR REVERSE CURRENT—ma
V_{CBO}—COLLECTOR-BASE VOLTAGE—volts
85°C
70°C
55°C
40°C
25°C

TYPICAL SWITCHING CHARACTERISTICS AT 25°C – TURN ON CIRCUIT

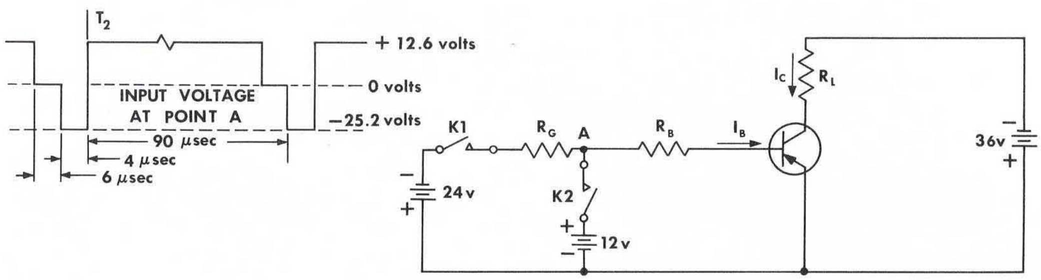


T_{on} is time from T_1 until 0.9 I_C
t_d is time from T_1 until 0.1 I_C
t_r is time from 0.1 I_C until 0.9 I_C
$t_d \approx 0.1\ T_{on}$

I_C	I_{B1}	R_B	R_L	T_{on}
–10a	–1.2a	9.5 ohms	3.68 ohms	12.5 μsec

K1 is a mercury contact relay.
All power sources are batteries.

TYPICAL SWITCHING CHARACTERISTICS AT 25°C – TURN OFF CIRCUIT



t_s is time from T_2 until 0.9 I_C
t_f is time from 0.9 I_C until 0.1 I_C

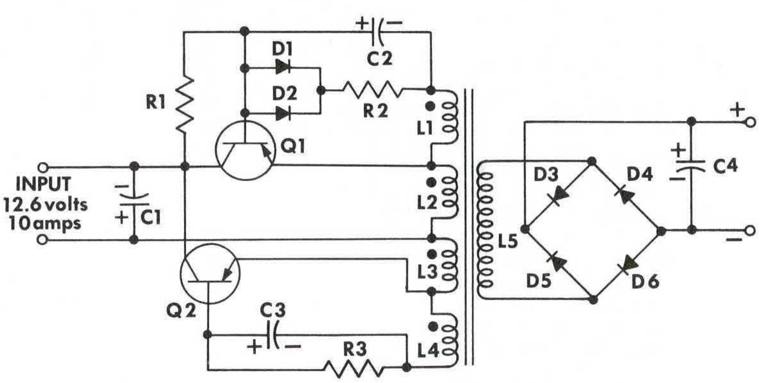
I_C	$I_{B2} = -I_{B1}$	R_G	R_B	R_L	t_s	t_f
–10a	1.2a	10.5 ohms	9.5 ohms	3.68 ohms	2.5 μses	5.5 μsec

K1 and K2 are mercury contact relay.
All power sources are batteries.

DC-TO-DC POWER CONVERTER

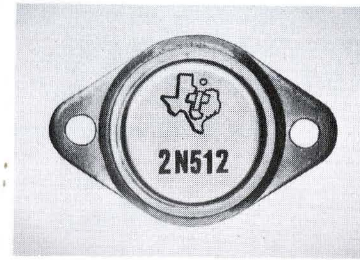
115-WATT OUTPUT AT 95% EFFICIENCY

L5 may be wound according to the output voltage desired, allowing about 2.42 turns per volt. The wire should be large enough to allow one circular mil per millampere. The output voltage and current will then determine D3, D4, D5, D6 and C4.
L2, L3—29 turns each bifilar wound No. 12
L1, L4—10 turns each No. 20
Q1, Q2—2N511, 10 amp 40 volt each mounted on a total of 70 sq. in. of ⅛″ aluminum.
Operating to 60°C
D1, D2—1N2069
R1—1K ¼ watt
R2—2 ohms 10 watt
R3—2.5 ohms 10 watt
C1—500 μf 20 volt (must not be omitted)
C2, C3—20 μf 6 volt
Core-type 50017-2A Magnetics, Inc.



TYPES 2N512, 2N512A, 2N512B
P-N-P ALLOY - JUNCTION GERMANIUM POWER TRANSISTORS

40, 60, 80 VOLTS
15-AMP COLLECTOR CURRENT
80-WATT DISSIPATION — 0.05 OHM MAX R_{CS}
LOW I_{CO} LOW V_{BE}
for
AUDIO AMPLIFIERS — SWITCHING CIRCUITS



ACTUAL SIZE

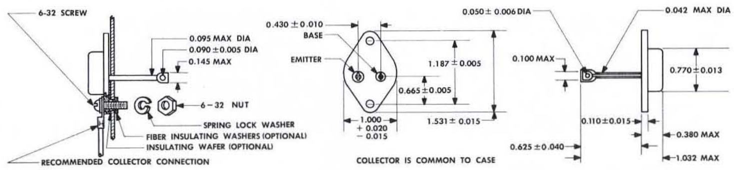
qualification testing

All units are subjected to a high-pressure leak test and are heat cycled from −55°C and room humidity to +95°C and 95% relative humidity, for four complete cycles over an eight-hour period. In addition, all units are stored at +95°C for 100 hours and then thoroughly tested for rigid adherence to electrical design characteristics.

mechanical data

The use of high-temperature silver solder to assemble the mounting base and the use of projection welds to seal the can, provide a hermetically-sealed enclosure which can withstand up to 300 psi. During the assembly process, the absence of flux, soft solder, and wet processing combined with extra cleanliness, prevents sealed-in contamination.

The mounting base is a high conductivity copper which provides an excellent heat path from the collector junction to a heat sink which must be tightly attached to permit operation at maximum rated dissipation. The approximate weight of the unit is 23 grams.



maximum ratings at 25°C*

		2N512	2N512A	2N512B	unit
V_{CBO}	Collector-to-Base Voltage ($I_C = -5$ma, $I_E = 0$)	−40	−60	−80	v
V_{CEX}	Collector-to-Emitter Voltage ($V_{BE} = +0.2$ v, $I_C = -5$ma)	−40	−60	−80	v
V_{EBO}	Emitter-to-Base Voltage ($I_E = -5$ma, $I_C = 0$)	−30	−30	−30	v
I_C	DC Collector Current	−15	−15	−15	a
I_E	DC Emitter Current	−15	−15	−15	a
I_B	Base Current	−5	−5	−5	a
	Total Dissipation†	80	80	80	w
T_J	Junction Temperature	95	95	95	°C

typical characteristics at 25°C*

		2N512	2N512A	2N512B	unit
h_{FE}	Forward Current Transfer Ratio ($V_{CE} = -1.5$ v, $I_C = -3.7$a)	30	30	30	
	($V_{CE} = -1.5$ v, $I_C = -15$a)	12	12	12	
R_{CS}	Common Emitter Saturation Resistance ($I_C = -15$a, $I_B = -2.25$a)	0.025	0.025	0.025	ohm
K	Thermal Resistance from Collector Junction to Mounting Base	0.7	0.7	0.7	°C/w
BV_{CES}	Collector to Emitter Breakdown Voltage with Base Shorted to Emitter ($I_C = -300$ma, $V_{BE} = 0$)	−55	−65	−75	v
BV_{CEO}	Collector to Emitter Breakdown Voltage ($I_C = -300$ma, $I_B = 0$)	−40	−50	−60	v
I_{CBO}	Collector Reverse Current ($V_{CB} = ½ V_{CBO}$ max, $T_J = 85$°C)	−8.0	−8.0	−8.0	ma

* Temperature is measured on mounting base.
† For operation at higher temperatures refer to derating curve.

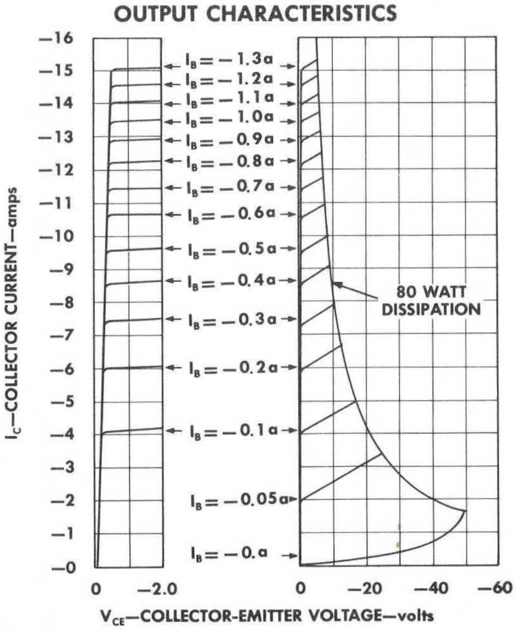
TYPES 2N512, 2N512A, 2N512B

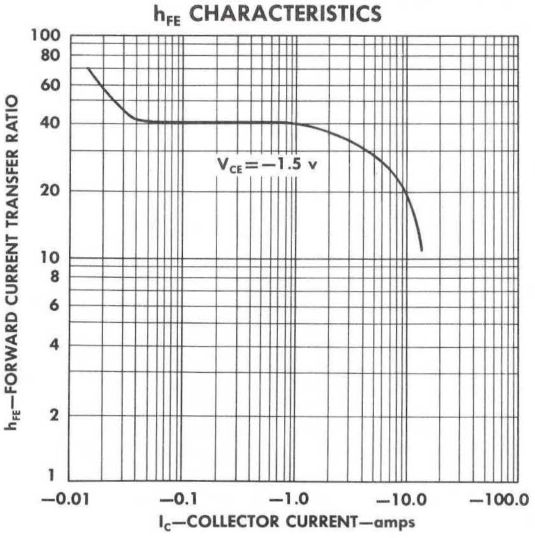
TYPICAL CHARACTERISTICS

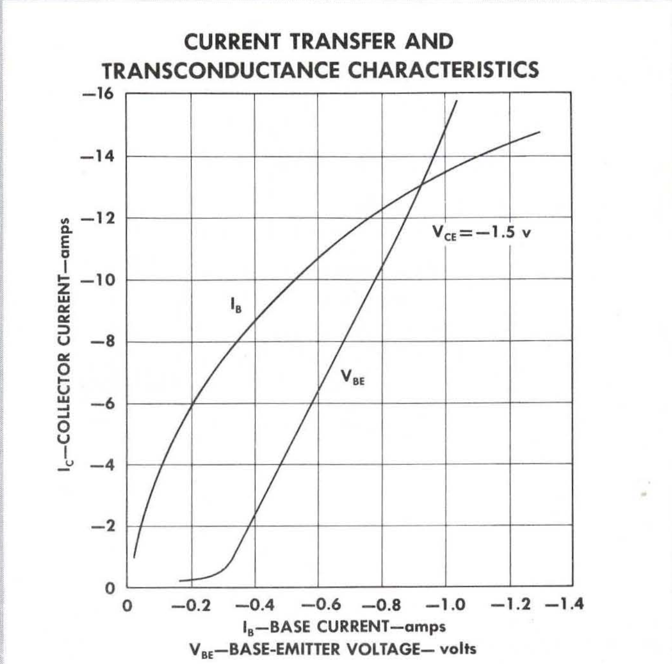
design characteristics at 25°C

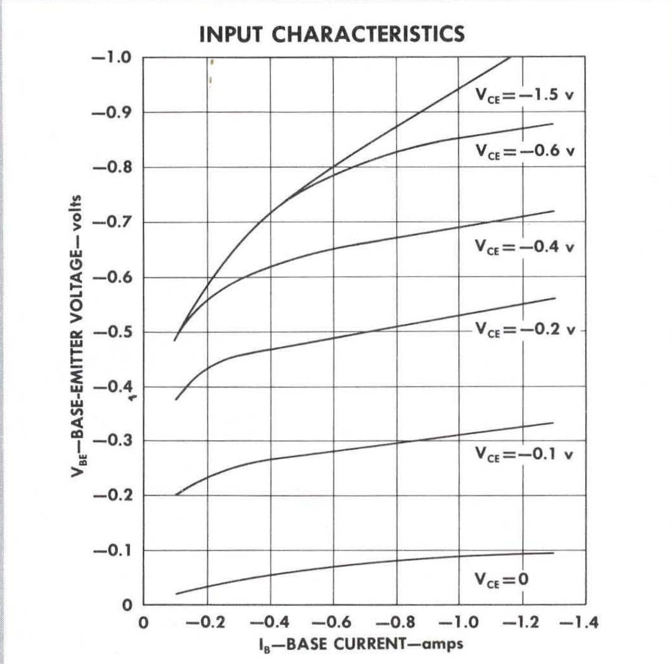
type	symbol	parameter	test conditions	min	design center	max	unit
2N512	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−40	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CBO} = -20\ v, I_E = 0$	—	−0.2	−2.0	ma
2N512A	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−60	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -30\ v, I_E = 0$	—	−0.2	−2.0	ma
2N512B	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−80	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -40\ v, I_E = 0$	—	−0.2	−2.0	ma
All	I_{CBO}	Collector Reverse Current	$V_{CB} = -2\ v, I_E = 0$	—	−0.14	—	ma
All	BV_{EBO}	Emitter-to-Base Breakdown Voltage	$I_E = -5ma, I_C = 0$	−30	—	—	v
All	I_{EBO}	Emitter Reverse Current	$V_{EB} = -15\ v, I_C = 0$	—	−0.25	—	ma
All	I_B	Base Current	$V_{CE} = -1.5\ v, I_C = -3.7a$	—	−120.	200.	ma
			$V_{CE} = -1.5\ v, I_C = -15a$	—	−1.2	−1.5	a
All	V_{BE}	Base Voltage	$V_{CE} = -1.5\ v, I_C = -3.7a$	—	−0.4	—	v
			$V_{CE} = -1.5\ v, I_C = -15a$	—	−1.0	−1.5	v
All	$V_{CE}(SAT)$	Collector-to-Emitter Saturation Voltage	$I_C = -15a, I_B - 2.25a$	—	−0.38	−0.75	v
All	$f\alpha e$	Common-Emitter Frequency Cutoff	$V_{CE} = -6\ v, I_C -1a$	—	7.0	—	kc

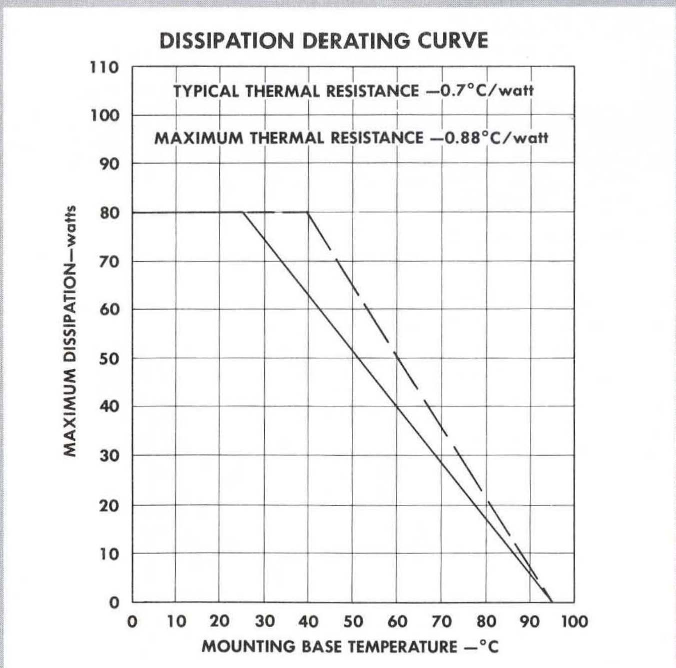
TYPICAL CHARACTERISTICS — COMMON EMITTER

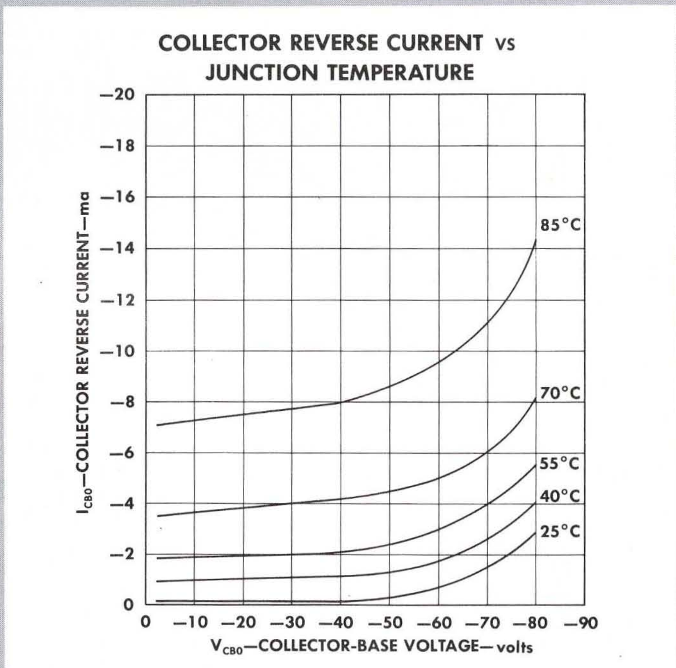




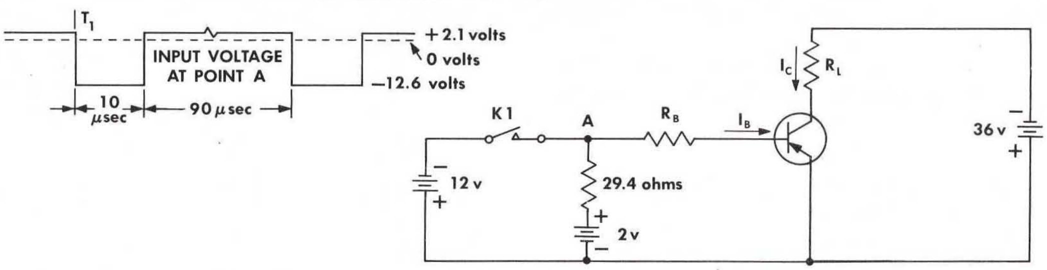

CURRENT TRANSFER AND
TRANSCONDUCTANCE CHARACTERISTICS
V_{CE} = −1.5 v
I_B
V_{BE}
I_C—COLLECTOR CURRENT—amps
I_B—BASE CURRENT—amps
V_{BE}—BASE-EMITTER VOLTAGE— volts


INPUT CHARACTERISTICS
V_{CE} = −1.5 v
V_{CE} = −0.6 v
V_{CE} = −0.4 v
V_{CE} = −0.2 v
V_{CE} = −0.1 v
V_{CE} = 0
V_{BE}—BASE-EMITTER VOLTAGE—volts
I_B—BASE CURRENT—amps


DISSIPATION DERATING CURVE
TYPICAL THERMAL RESISTANCE —0.7°C/watt
MAXIMUM THERMAL RESISTANCE —0.88°C/watt
MAXIMUM DISSIPATION—watts
MOUNTING BASE TEMPERATURE —°C


COLLECTOR REVERSE CURRENT vs
JUNCTION TEMPERATURE
85°C
70°C
55°C
40°C
25°C
I_{CBO}—COLLECTOR REVERSE CURRENT—ma
V_{CBO}—COLLECTOR-BASE VOLTAGE—volts

TYPICAL SWITCHING CHARACTERISTICS AT 25°C—TURN ON CIRCUIT



T_{on} is time from T_1 until 0.9 I_C

t_d is time from T_1 until 0.1 I_C

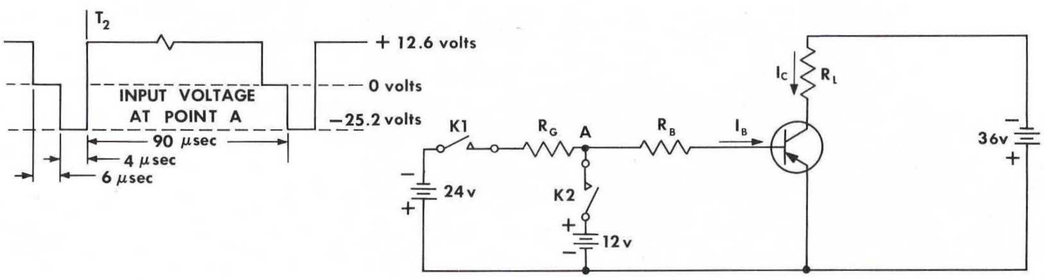
t_r is time from 0.1 I_C until 0.9 I_C

$t_d \approx 0.1\ T_{on}$

I_C	I_{B1}	R_B	R_L	T_{on}
−15a	−1.8a	6.33 ohms	2.42 ohms	12.5 μsec

K1 is a mercury contact relay
All power sources are batteries

TYPICAL SWITCHING CHARACTERISTICS AT 25°C—TURN OFF CIRCUIT



t_s is time from T_2 until 0.9 I_C

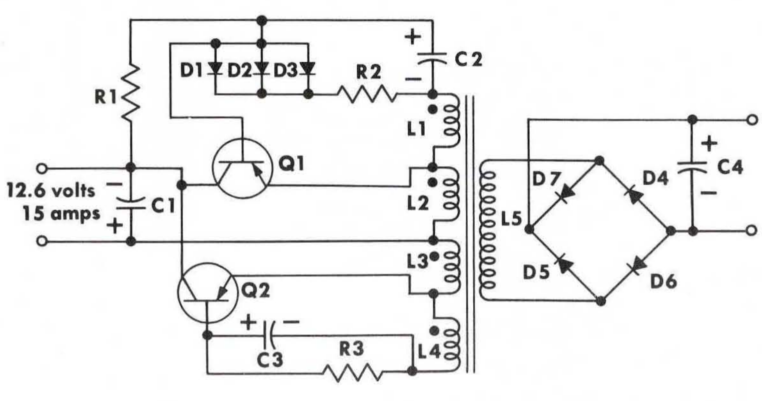
t_f is time from 0.9 I_C until 0.1 I_C

I_C	$I_{B2} = -I_{B1}$	R_G	R_B	R_L	t_s	t_f
−15a	1.8a	6.98 ohms	6.33 ohms	2.42 ohms	25 μsec	5.5 μsec

K1 and K2 are mercury contact relays
All power sources are batteries

DC-TO-DC POWER CONVERTER

180-WATT OUTPUT AT 95% EFFICIENCY



L5 may be wound according to the output voltage desired, allowing about turns per volt. The wire size should be large enough to allow one circular mil per millampere. The output current and load will then determine D4, D5, D6, D_7 and C4.

L2, L3—29 turns each bifilar wound #12

L1, L4—10 turns each 318 #18

Q1, Q2—2N512 15 amp 40 volt each mounted on a total of 150 sq. in. exposed surface of ⅛″ aluminum sheet. Operation to 60°C.

D1, D2, D3—1N2069

R1 = 1 K ¼ volt

R2 = 1.4 ohms 10 watt

R3 = 1.8 ohms 10 watt

C1 = 500 μf 20 volt (must not be omitted)

C2, C3 = 20 μf 6 volt

Frequency about 1 kc.

Core-type 50017-2a Magnetics, Inc.

TYPES 2N513, 2N513A, 2N513B
P-N-P ALLOY-JUNCTION GERMANIUM POWER TRANSISTORS

40, 60, 80 VOLTS

20-AMP COLLECTOR CURRENT

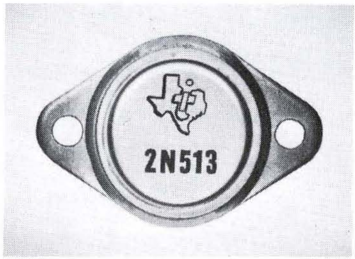
80-WATT DISSIPATION — 0.05 OHM MAX R_{CS}

LOW I_{CO} LOW V_{BE}

for

HIGH POWER CONVERSION — HIGH CURRENT SWITCHING

AUDIO AMPLIFIER OUTPUTS



ACTUAL SIZE

qualification testing

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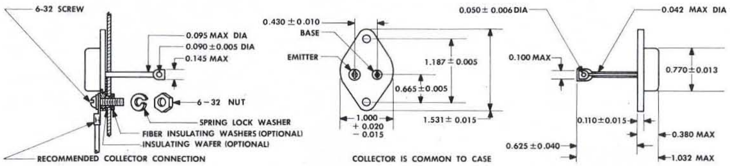
The use of high-temperature silver solder to assemble the mounting base and the use of projection welds to seal the can, provide a hermetically-sealed enclosure which can withstand up to 300 psi. During the assembly process, the absence of flux, soft solder, and wet processing combined with extra cleanliness, prevents sealed-in contamination.

The mounting base is a high conductivity copper which provides an excellent heat path from the collector junction to a heat sink which must be tightly attached to permit operation at maximum rated dissipation. The approximate weight of the unit is 23 grams.



maximum ratings at 25°C*

		2N513	2N513A	2N513B	unit
V_{CBO}	Collector-to-Base Voltage ($I_C = -5$ma, $I_E = 0$)	−40	−60	−80	v
V_{CEX}	Collector-to-Emitter Voltage ($V_{BE} = +0.2$ v, $I_C = -5$ma)	−40	−60	−80	v
V_{EBO}	Emitter-to-Base Voltage ($I_E = -5$ma, $I_C = 0$)	−30	−30	−30	v
I_C	DC Collector Current	−20	−20	−20	a
I_E	DC Emitter Current	−20	−20	−20	a
I_B	Base Current	−5	−5	−5	a
	Total Dissipation†	80	80	80	w
T_J	Junction Temperature	95	95	95	°C

typical characteristics at 25°C*

h_{FE}	Forward Current Transfer Ratio ($V_{CE} = -1.5$ v, $I_C = -5$a)	36	36	36	
	($V_{CE} = -1.5$ v, $I_C = -20$a)	12	12	12	
R_{CS}	Common Emitter Saturation Resistance ($I_C = -20$a, $I_B = -3$)	0.025	0.025	0.025	ohm
K	Thermal Resistance from Collector Junction to Mounting Base	0.7	0.7	0.7	°C/w
BV_{CES}	Collector to Emitter Breakdown Voltage with Base Shorted to Emitter ($I_C = -300$ma, $V_{BE} = 0$)	−55	−65	−75	v
BV_{CEO}	Collector to Emitter Breakdown Voltage ($I_C = -300$ma, $I_B = 0$)	−40	−50	−60	v
I_{CBO}	Collector Reverse Current ($V_{CB} = ½V_{CBO}$ max, $T_J = 85$°C)	−8.0	−8.0	−8.0	ma

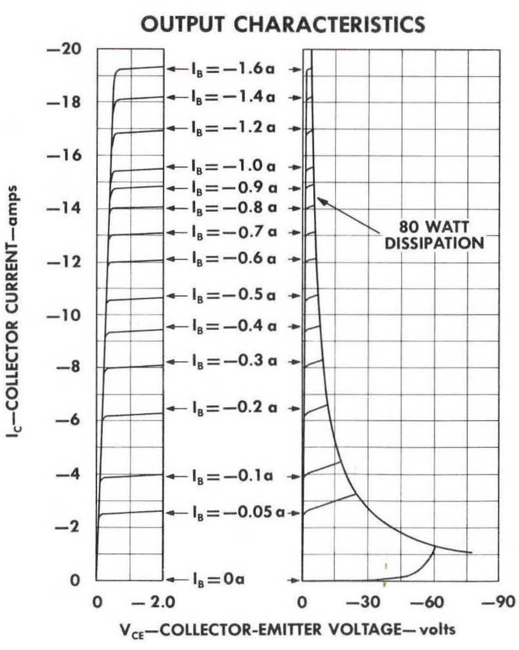
* Temperature is measured on mounting base.

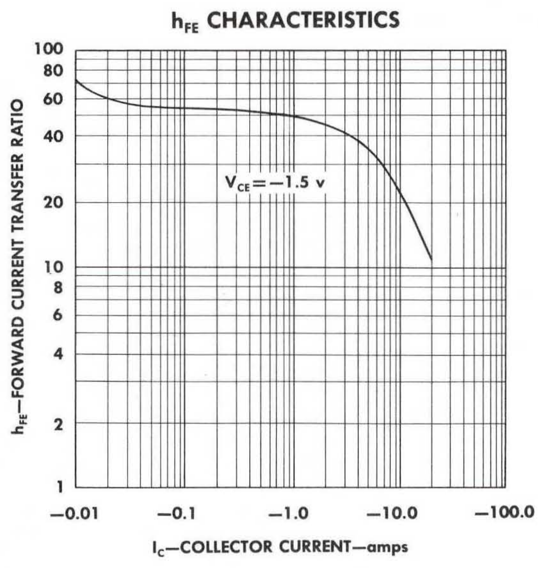
† For operation at higher temperatures refer to derating curve.

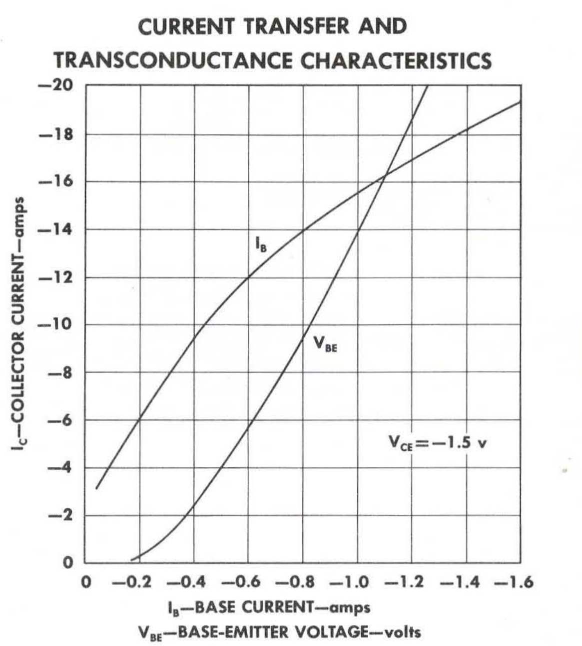
design characteristics at 25°C

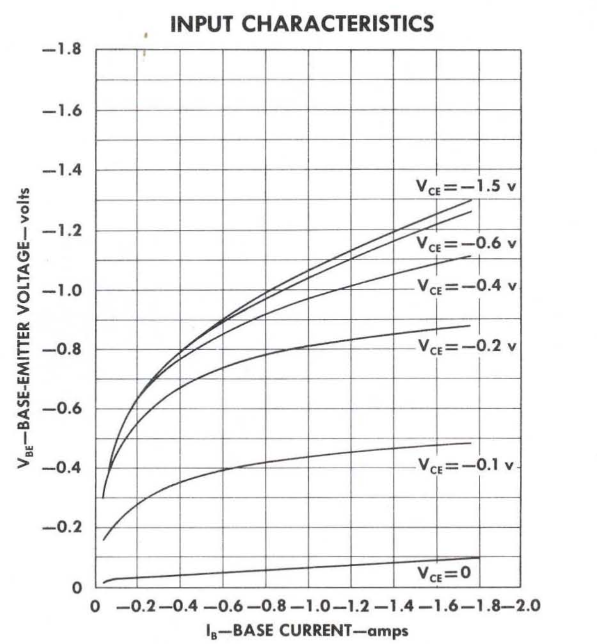
type	symbol	parameter	test conditions	min	design center	max	unit
2N513	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma$, $I_E = 0$	−40	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CBO} = -20\ v$, $I_E = 0$	—	−0.2	−2.0	ma
2N513A	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma$, $I_E = 0$	−60	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -30\ v$, $I_E = 0$	—	−0.2	−2.0	ma
2N513B	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma$, $I_E = 0$	−80	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -40\ v$, $I_E = 0$	—	−0.2	−2.0	ma
All	I_{CBO}	Collector Reverse Current	$V_{CB} = -2\ v$, $I_E = 0$	—	−0.14	—	ma
All	BV_{EBO}	Emitter-to-Base Breakdown Voltage	$I_E = -5ma$, $I_C = 0$	−30	—	—	v
All	I_{EBO}	Emitter Reverse Current	$V_{EB} = 15\ v$, $I_C = 0$	—	−0.2	—	ma
All	I_B	Base Current	$V_{CE} = -1.5\ v$, $I_C = -5a$	—	−140	−250	ma
			$V_{CE} = -1.5\ v$, $I_C = -20a$	—	−1.6	−2.0	a
All	V_{BE}	Base Voltage	$V_{CE} = -1.5\ v$, $I_C = -5a$	—	−0.4	—	v
			$V_{CE} = -1.5\ v$, $I_C = -20a$	—	−1.2	−1.5	v
All	$V_{CE}(SAT)$	Collector-to-Emitter Saturation Voltage	$I_C = -20a$, $I_B = -3a$	—	−0.5	−1.25	v
All	$f_{\alpha e}$	Common-Emitter Frequency Cutoff	$V_{CE} = -6\ v$, $I_C = -1A$a	—	7.0	—	kc

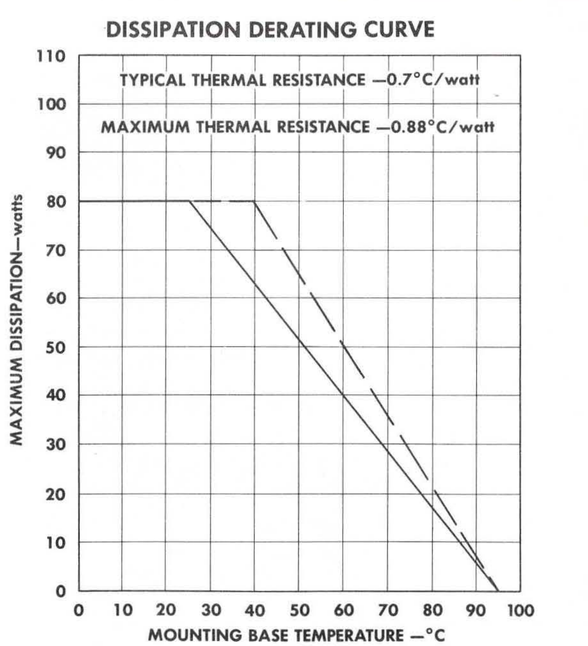
TYPICAL CHARACTERISTICS — COMMON EMITTER

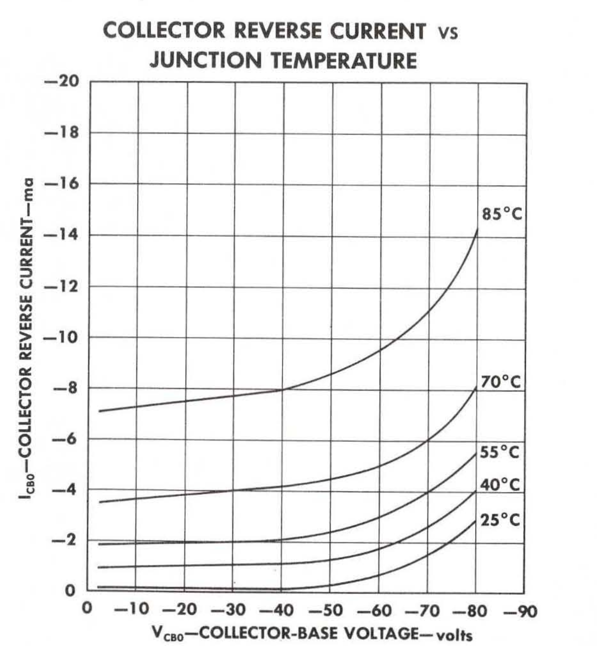




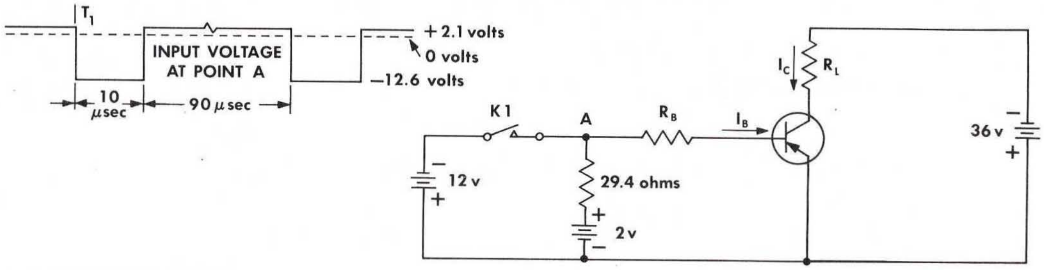

CURRENT TRANSFER AND
TRANSCONDUCTANCE CHARACTERISTICS
I_C—COLLECTOR CURRENT—amps
I_B
V_{BE}
V_{CE}=−1.5 v
I_B—BASE CURRENT—amps
V_{BE}—BASE-EMITTER VOLTAGE—volts


INPUT CHARACTERISTICS
V_{BE}—BASE-EMITTER VOLTAGE—volts
V_{CE}=−1.5 v
V_{CE}=−0.6 v
V_{CE}=−0.4 v
V_{CE}=−0.2 v
V_{CE}=−0.1 v
V_{CE}=0
I_B—BASE CURRENT—amps


DISSIPATION DERATING CURVE
TYPICAL THERMAL RESISTANCE —0.7°C/watt
MAXIMUM THERMAL RESISTANCE —0.88°C/watt
MAXIMUM DISSIPATION—watts
MOUNTING BASE TEMPERATURE —°C


COLLECTOR REVERSE CURRENT vs
JUNCTION TEMPERATURE
I_{CBO}—COLLECTOR REVERSE CURRENT—ma
85°C
70°C
55°C
40°C
25°C
V_{CBO}—COLLECTOR-BASE VOLTAGE—volts

TYPICAL SWITCHING CHARACTERISTICS AT 25°C–TURN ON CIRCUIT



T_{on} is time from T_1 until 0.9 I_C

t_d is time from T_1 until 0.1 I_C

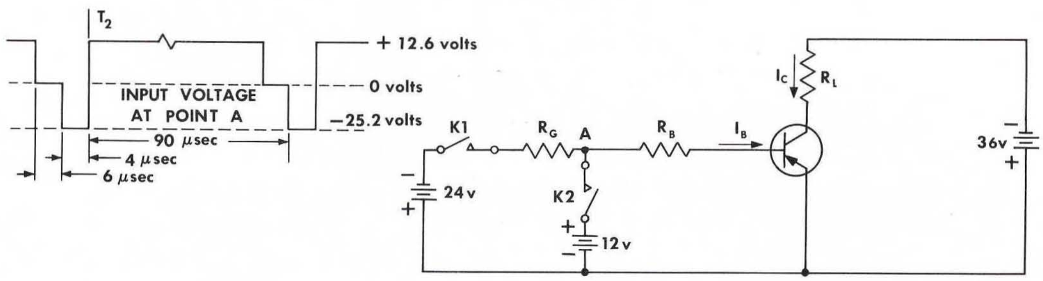
t_r is time from 0.1 I_C until 0.9 I_C

$t_d \approx 0.1\ T_{on}$

I_C	I_{B1}	R_B	R_L	T_{on}
–20a	–2.4a	4.77 ohms	1.79 ohms	12.0 μsec

K1 is a mercury contact relay.
All power sources are batteries.

TYPICAL SWITCHING CHARACTERISTICS AT 25°C–TURN OFF CIRCUIT



t_s is time from T_2 until 0.9 I_C

t_f is time from 0.9 I_C until 0.1 I_C

I_C	$I_{B2} = -I_{B1}$	R_G	R_B	R_L	t_s	t_f
–20a	2.4a	5.25 ohms	4.77 ohms	1.79 ohms	2.0 μsec	5.0 μsec

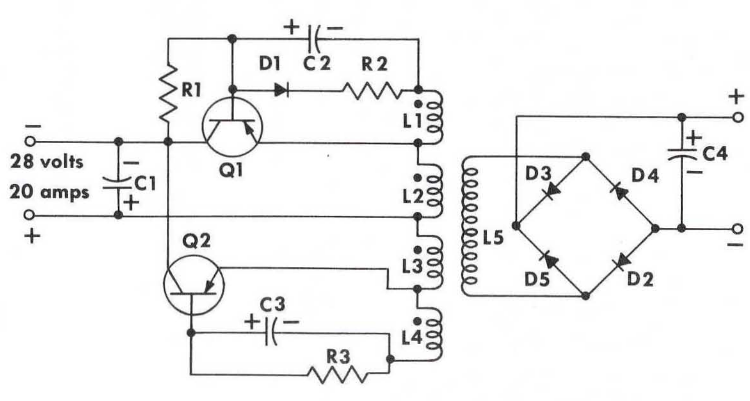
K 1and K2 are mercury contact relays.
All power sources are batteries.

DC-TO-DC POWER CONVERTER

500-WATT OUTPUT AT 90% EFFICIENCY

L5 may be wound according to the output voltage desired, allowing about 0.639 turns per volt. The wire size should be large enough to allow one circular mil per milampere. The output current and load will then determine D2, D3, D4, D5 and C4.

L2, L3—17 turns each No. 10 bifilar wound
L1, L2—4 turns each No. 17
Q1, Q2—2N513 B 80 volt 20 amp each mounted on a minimum of 160 sq. in. of 1/8″ aluminum. Operation to 50°C.
D1—1N1124 mounted on a min. of 1 sq. in. 1/16″ aluminum
R1—1.5 K ohms 1/4 watt
R2—1.8 ohms 20 watt
R3—2.4 ohms 20 watt
C1—500 μf 50 volts (must not be omitted)
C2, C3—20 μf 20 volts
frequency—about 1kc
Core type 50022-2A Magnetics, Inc.



TYPES 2N514, 2N514A, 2N514B
P-N-P ALLOY-JUNCTION GERMANIUM POWER TRANSISTORS

40, 60, 80 VOLTS

25-AMP COLLECTOR CURRENT

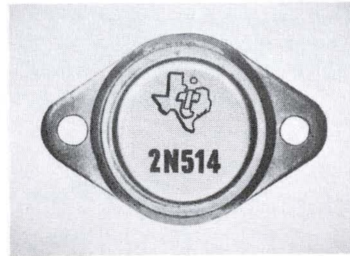
80-WATT DISSIPATION — 0.05 OHM MAX R_{CS}

LOW I_{CO} LOW V_{BE}

for

HIGH POWER CONVERSION — HIGH CURRENT SWITCHING

AUDIO AMPLIFIER OUTPUTS



ACTUAL SIZE

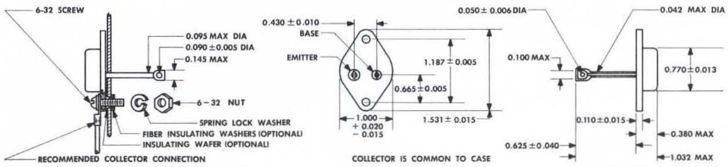
qualification testing

All units are subjected to a high-pressure leak test and are heat cycled from —55°C and room humidity to +95°C and 95% relative humidity, for four complete cycles over an eight-hour period. In addition, all units are stored at + 95°C for 100 hours and then thoroughly tested for rigid adherence to electrical design characteristics.

mechanical data

The use of high-temperature silver solder to assemble the mounting base and the use of projection welds to seal the can, provide a hermetically-sealed enclosure which can withstand up to 300 psi. During the assembly process, the absence of flux, soft solder, and wet processing combined with extra cleanliness, prevents sealed-in contamination.

The mounting base is a high conductivity copper which provides an excellent heat path from the collector junction to a heat sink which must be tightly attached to permit operation at maximum rated dissipation. The approximate weight of the unit is 23 grams.



maximum ratings at 25°C*

		2N514	2N514A	2N514B	unit
V_{CBO}	Collector-to-Base Voltage (I_C = —5ma, I_E = 0)	—40	—60	—80	v
V_{CEX}	Collector-to-Emitter Voltage (V_{BE} = +0.2 v, I_C = —5ma)	—40	—60	—80	v
V_{EBO}	Emitter-to-Base Voltage (I_E = —5ma, I_C = 0)	—30	—30	—30	v
I_C	DC Collector Current	—25	—25	—25	a
I_E	DC Emitter Current	—25	—25	—25	a
I_B	Base Current	—5	—5	—5	a
	Total Dissipation†	80	80	80	w
T_J	Junction Temperature	95	95	95	°C

typical characteristics at 25°C*

		2N514	2N514A	2N514B	unit
h_{FE}	Forward Current Transfer Ratio (V_{CE} = —1.5 v, I_C = —6.25a)	40	40	40	
	(V_{CE} = —1.5 v, I_C = —25a)	12	12	12	
R_{CS}	Common Emitter Saturation Resistance (I_C = —25a, I_B = —3.75a)	0.025	0.025	0.025	ohm
K	Thermal Resistance from Collector Junction to Mounting Base	0.7	0.7	0.7	°C/w
BV_{CES}	Collector to Emitter Breakdown Voltage with Base Shorted to Emitter (I_C = —300ma, V_{BE} = 0)	—55	—65	—75	v
BV_{CEO}	Collector to Emitter Breakdown Voltage (I_C = —300ma, I_B = 0)	—40	—50	—60	v
I_{CBO}	Collector Reverse Current (V_{CB} = ½V_{CBO} max, T_J = 85°C)	—8.0	—8.0	—8.0	ma

* Temperature is measured on mounting base.

† For operation at higher temperatures refer to derating curve.

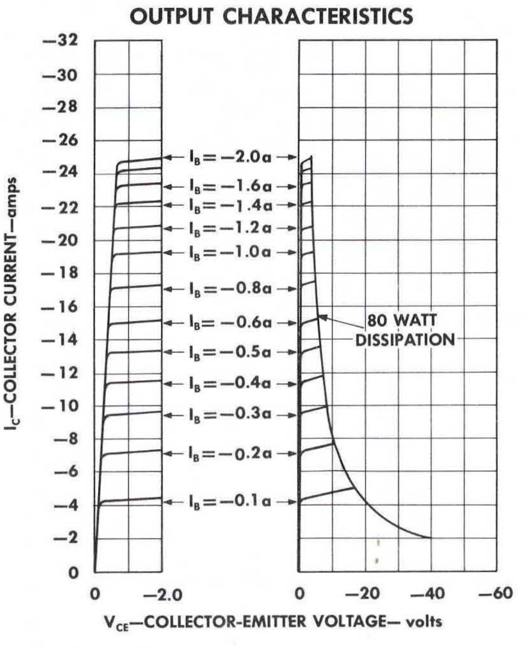
TYPES 2N514, 2N514A, 2N514B

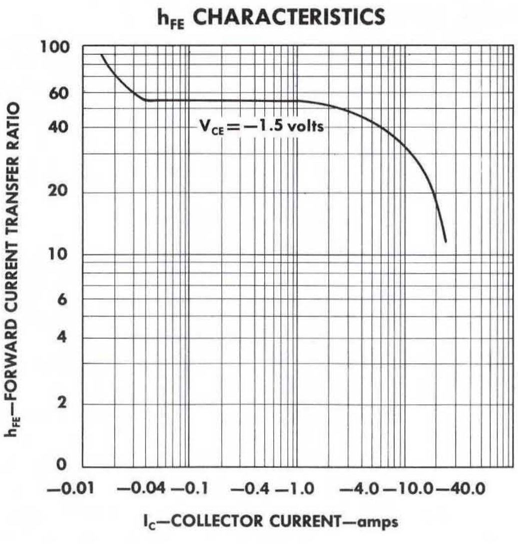
TYPICAL CHARACTERISTICS

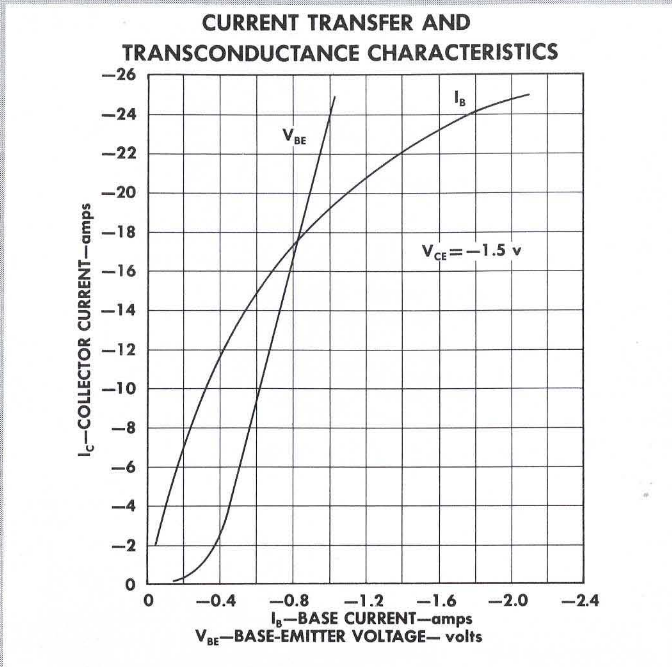
design characteristics at 25°C

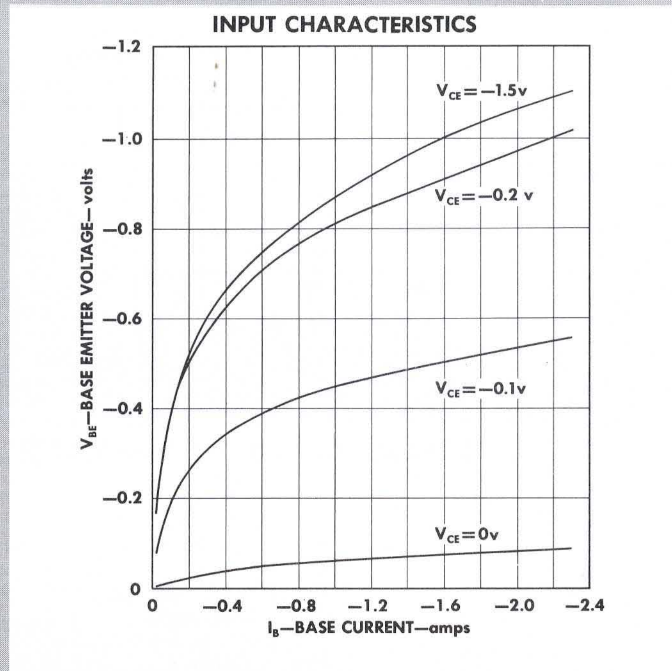
type	symbol	parameter	test conditions	min	design center	max	unit
2N514	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−40	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CBO} = -20$ v, $I_E = 0$	—	−0.2	−2.0	ma
2N514A	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−60	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -30$ v, $I_E = 0$	—	−0.2	−2.0	ma
2N514B	BV_{CBO}	Collector-to-Base Breakdown Voltage	$I_C = -5ma, I_E = 0$	−80	—	—	v
	I_{CBO}	Collector Reverse Current	$V_{CB} = -40$ v, $I_E = 0$	—	−0.2	−2.0	ma
All	I_{CBO}	Collector Reverse Current	$V_{CB} = -2$ v, $I_E = 0$	—	−0.14	—	ma
All	BV_{EBO}	Emitter-to-Base Breakdown Voltage	$I_E = -5ma, I_C = 0$	−30	—	—	v
All	I_{EBO}	Emitter Reverse Current	$V_{EB} = 15$ v, $I_C = 0$	—	−0.20	—	ma
All	I_B	Base Current	$V_{CE} = -1.5$ v, $I_C = -6.25a$	—	−156	−340	ma
			$V_{CE} = -1.5$ v, $I_C = -25a$	—	−2.1	−2.5	a
All	V_{BE}	Base Voltage	$V_{CE} = -1.5$ v, $I_C = -6.25a$	—	−0.50	—	v
			$V_{CE} = -1.5$ v, $I_C = -25a$	—	−1.1	−1.5	v
All	V_{CE} (SAT)	Collector-to-Emitter Saturation Voltage	$I_C = -25a, I_B = -3.75a$	—	−0.62	−1.25	v
All	$f\alpha e$	Common-Emitter Frequency Cutoff	$V_{CE} = -6$ v, $I_C = -1a$	—	7.0	—	kc

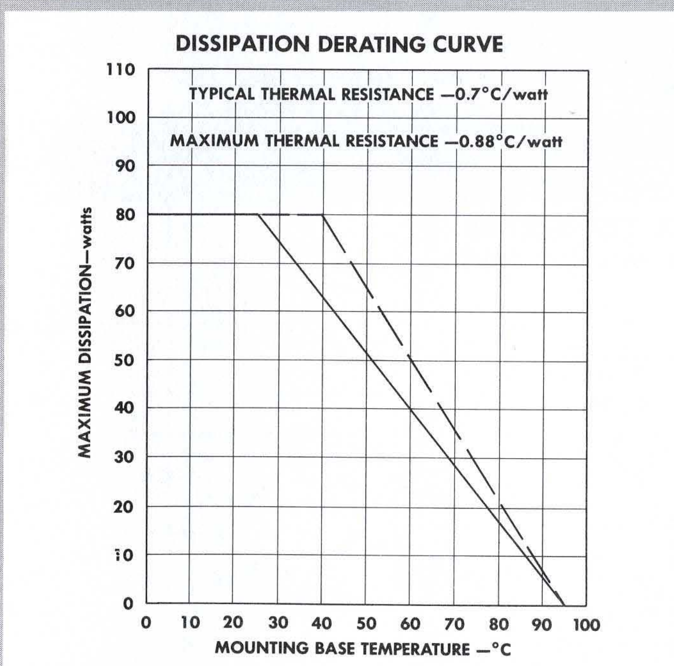
TYPICAL CHARACTERISTICS — COMMON EMITTER

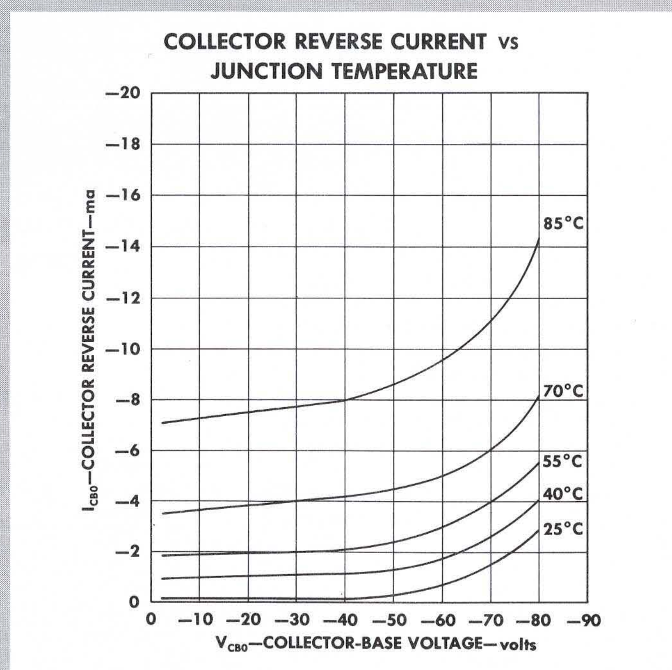





CURRENT TRANSFER AND
TRANSCONDUCTANCE CHARACTERISTICS
I_C—COLLECTOR CURRENT—amps
I_B—BASE CURRENT—amps
V_{BE}—BASE-EMITTER VOLTAGE— volts
V_{BE}
I_B
V_{CE}=−1.5 v
−26
−24
−22
−20
−18
−16
−14
−12
−10
−8
−6
−4
−2
0
−0.4
−0.8
−1.2
−1.6
−2.0
−2.4


INPUT CHARACTERISTICS
V_{BE}—BASE EMITTER VOLTAGE—volts
I_B—BASE CURRENT—amps
V_{CE}=−1.5v
V_{CE}=−0.2 v
V_{CE}=−0.1v
V_{CE}=0v
−1.2
−1.0
−0.8
−0.6
−0.4
−0.2
0
−0.4
−0.8
−1.2
−1.6
−2.0
−2.4

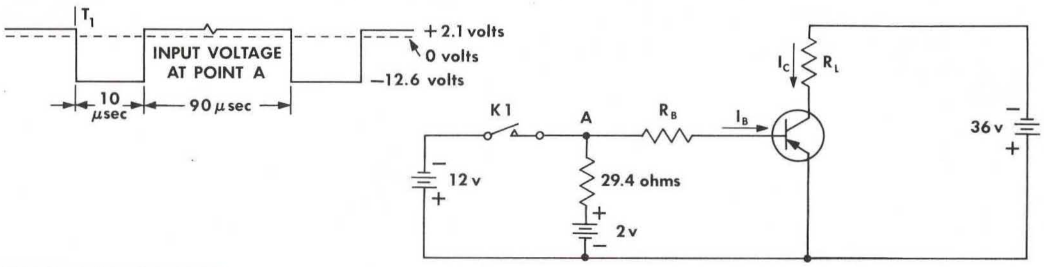

DISSIPATION DERATING CURVE
TYPICAL THERMAL RESISTANCE −0.7°C/watt
MAXIMUM THERMAL RESISTANCE −0.88°C/watt
MAXIMUM DISSIPATION—watts
MOUNTING BASE TEMPERATURE —°C
110
100
90
80
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100


COLLECTOR REVERSE CURRENT vs
JUNCTION TEMPERATURE
I_{CBO}—COLLECTOR REVERSE CURRENT—ma
V_{CBO}—COLLECTOR-BASE VOLTAGE—volts
85°C
70°C
55°C
40°C
25°C
−20
−18
−16
−14
−12
−10
−8
−6
−4
−2
0
−10
−20
−30
−40
−50
−60
−70
−80
−90

TYPES 2N514, 2N514A, 2N514B

TYPICAL CHARACTERISTICS AND APPLICATION NOTES

TYPICAL SWITCHING CHARACTERISTICS AT 25°C – TURN ON CIRCUIT

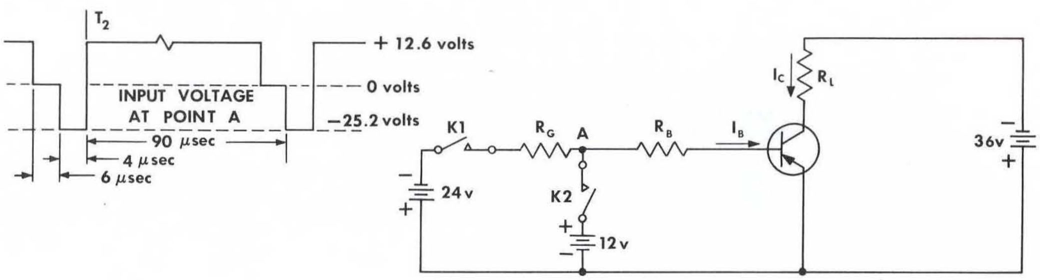


T_{on} is time from T_1 until 0.9 I_C
t_d is time from T_1 until 0.1 I_C
t_r is time from 0.1 I_C until 0.9 I_C
$t_d \approx 0.1\ T_{on}$

I_C	I_{B1}	R_B	R_L	T_{on}
−25a	−3.0a	3.81 ohms	1.41 ohms	11.5 μsec

K1 is a mercury contact relay
All power sources are batteries

TYPICAL SWITCHING CHARACTERISTICS AT 25°C–TURN OFF CIRCUIT

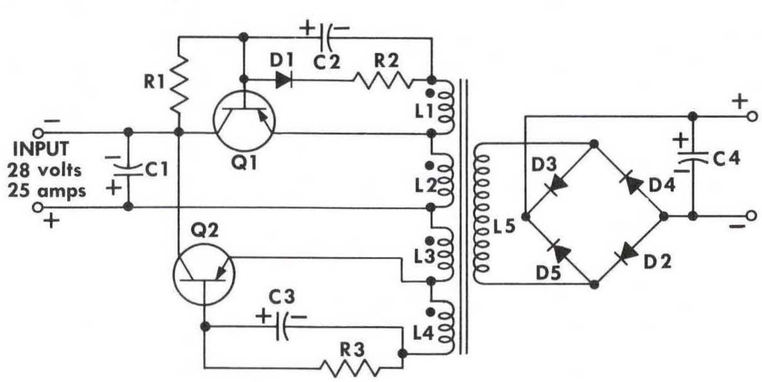


t_s is time from T_2 until 0.9 I_C
t_f is time from 0.9 I_C until 0.1 I_C

I_C	$I_{B2} = -I_{B1}$	R_G	R_B	R_L	t_s	t_f
−25a	3.0a	4.24 ohms	3.81 ohms	1.41 ohms	2.0 μsec	5.0 μsec

K1 and K2 are mercury contact relays
All power sources are batteries

DC-TO-DC POWER CONVERTER
620-WATT OUTPUT AT 90% EFFICIENCY



L5 may be wound according to the output voltage desired, allowing about 0.639 turns per volt. The wire size should be large enough to allow one circular mil per millampere. The output current and load will then determine D3, D4, D5, D6 and C4.
L2, L3—17 turns each #10 bifilar wound
L1, L2—4 turns each #16
Q1, Q2—2N514B 80 volt 25 amp each mounted on a min of 200 sq. in. of ¼″ aluminum to be good to 50°C.
D1—1N1124 mounted on a min of 1 sq. in. of exposed aluminum 1/16″ thick. Operation to 50°C.
R1—1K ohms ¼ watt
R2—1.5 ohms 20 watt
R3—2 ohms 20 watt
C1—500 μf @50 volt (must not be omitted)
C2, C3—20μf @20 volt
Frequency about 1 kc.
Core-type 50022-2A Magnetics, Inc.

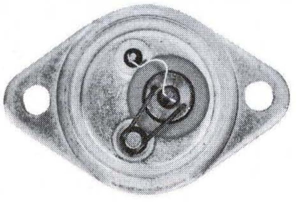
TI'S COMPLETE LINE OF GERMANIUM TRANSISTORS AVAILABLE OFF-THE-SHELF AT FACTORY PRICES

	Type	Case Type	Former Designation	Dissipation at 25°C mw	Collector Voltage-v max	Collector current ma max	$h_{fe}^{\triangle}$ or h_{FE} min	$h_{fe}^{\triangle}$ or h_{FE} max	Collector Reverse Current I_{co} max µa	Collector Reverse Current I_{co} max v	Conversion Gain db or R_{cs} typ	Audio Gain db min	Alpha Cutoff Frequency mc avg	Bulletin Number
Computer-mesa type	2N705	U		300	−15	−50	25 @ 10 ma		3	−5	30 ohms R_{cs}		250	DL-S 1081
ultra-high-speed pnp	2N710	U		300	−15	−50	20 @ 10 ma		3	−5	30 ohms R_{cs}		250	DL-S 1128
Computer-mesa type ultra-high-speed non-saturating pnp	2N1385	S		750	−25	−100	△8@ 10 ma, 100 mc		10	−15			700	
Computer-alloy type pnp	2N395	X		150	−30	−250	20 @ 10 ma		150			−15	4.5	DL-S 1119
pnp	2N396	X		150	−30	−250	30 @ 10 ma		150			−20	8	
pnp	2N397	X		150	−30	−250	40 @ 10 ma		150			−15	12	
pnp	2N1093	X	320	150	−30	−250	50		200		−6	−20	8	
npn	2N1302	Y		150	25	300	20	50 typ @ 10 ma	6	25			4.5	DL-S 1136
pnp	2N1303	Y		150	−30	300	20	50 typ @ 10 ma	6	25			4.5	DL-S 1136
npn	2N1304	Y		150	25	300	40	70 typ @ 10 ma	6	25			8	DL-S 1136
pnp	2N1305	Y		150	−30	300	40	70 typ @ 10 ma	6	25			8	DL-S 1136
npn	2N1306	Y		150	25	300	60	100 typ @ 10 ma	6	25			12	DL-S 1136
pnp	2N1307	Y		150	−30	300	60	100 typ @ 10 ma	6	25			12	DL-S 1136
npn	2N1308	Y		150	25	300	80	150 typ @ 10 ma	6	25			20	DL-S 1136
pnp	2N1309	Y		150	−30	300	80	150 typ @ 10 ma	6	25			20	DL-S 1136
Computer power core driver pnp	2N1046	K		15w	−80	−3a	40 (70 typ)		−1 ma	−40			12	DL-S 974
Very high frequency	2N1141	S		750	−35	−100	△12db @ 10 ma, 100 mc		−5	−15	30 ohms R_{cs}		750	DL-S 1032
pnp	2N1142	S		750	−30	−100	△10db @ 10 ma, 100 mc		−5	−15	30 ohms R_{cs}		600	DL-S 1032
	2N1143	S		750	−25	−100	△ 8db @ 10 ma, 100 mc		−5	−15	30 ohms R_{cs}		480	DL-S 1032
	2N1195	S		225	−30	−40	△12db @ 10 ma, 100 mc		−5	−20	30 ohms R_{cs}		750	
	2N248	A		30	−25	−5	20 typ		−10	−12			50	DL-S 661
Radio RF, converter,	2N1107	A		30	−16	−5	△34db at 455kc		−10	−12				DL-S 1017
osc and IF	2N1108	A		30	−16	−5	△33db at 455kc		−10	−12				DL-S 1018
	2N1109	A		30	−16	−5	△20db at 455kc		−10	−12				DL-S 1019
pnp	2N1110	A		30	−16	−5	△29db at 455kc		−10	−12				DL-S 1020
	2N1111	A		30	−20	−5	△25db at 455kc		−10	−12				DL-S 1020
	2N1111A	A		30	−20	−5	△25db at 455kc		−10	−12				DL-S 1021
	2N1111B	A		30	−27	−5	△25db at 455kc		−10	−12				DL-S 1021
Audio	2N185	A	352	150	−20	−150	50	(70 avg)	−15	−20		39/26†		DL-S 610
output	2N238	A	310	50	−20	−150	30	(50 avg)	−20	−20		37		DL-S 638
	2N291	E	357	180	−25	−200	30	(45 avg)	−25	−25		31/22†		DL-S 672
pnp	2N680	A		150	−20	−150		(35 avg)	−14	−12				
	2N1370	Z		150	−25	−150	80		−14				2	
	2N1371	Z		150	−45	−150	80		−14				2	
	2N1273	Z		150	−15	−150	50		−14				2	
	2N1274	Z		150	−25	−150	50		−14				2	
Power and	2N250	K	356	25w	−30	−3a	30 at 0.5a		−1ma	−30		30	12 kc	DL-S 726
medium power pnp	2N251	K	356A	25w	−60	−3a	30 at 0.5a		−2ma	−60		30	12 kc	DL-S 727
audio	2N1382	Z		200	−25	−200	80		−14				2	
	2N1383	Z		200	−25	−200	50		−14				2	
General	2N364	A	200A	150	30	50	9 @ 1 ma	19	10	30			2.5	DL-S 944
purpose npn	2N365	A	201A	150	30	50	19 @ 1 ma	49	10	30			3	DL-S 944
	2N366	A	202A	150	30	50	49 @ 1 ma	142	10	30			3.5	DL-S 944
	204A	A		150	60	50	9 @ 1 ma	49	10	30			2.5	DL-S 943
	2N368	A	301	150	−30	−50	19 @ 1 ma	49	−20	−30			1	DL-S 873
	2N369	A	302	150	−30	−50	49 @ 1 ma	142	−20	−30			1.3	DL-S 873
	2N1372	Z		250	−25	−200	45*		−7				2	
	2N1373	Z		250	−45	−200	45*		−7				2	
	2N1374	Z		250	−25	−200	70*		−7				2	
pnp	2N1375	Z		250	−45	−200	70*		−7				2	
	2N1376	Z		250	−25	−200	95*		−7				2	
	2N1377	Z		250	−45	−200	95*		−7				2	
	2N1380	Z		250	−12	−200	100		−14				2	
	2N1381	Z		250	−25	−200	100		−14				2	
	2N1378	Z		250	−12	−200	200*		−14				2	
	2N1379	Z		250	−25	−200	200*		−7				2	
Medium	2N1038	T		1.25w	−40	−3a	20 @1a	60	−125	−20	0.2 ohm Rcs			DL-S 1065
power pnp	2N1039	T		1.25w	−60	−3a	20 @1a	60	−125	−30	0.2 ohm Rcs			DL-S 1065
	2N1040	T		1.25w	−80	−3a	20 @1a	60	−125	−40	0.2 ohm Rcs			DL-S 1065
	2N1041	T		1.25w	−100	−3a	20 @1a	60	−125	−50	0.2 ohm Rcs			DL-S 1065
power	2N456	K		50w	−40	−5	40@1a @200		−2ma	−40	0.048 ohm			DL-S 909
	2N457	K		50w	−60	−5	40@1a @200		−2ma	−60	0.048 ohm			DL-S 909
	2N458	K		50w	−80	−5	40@1a @200		−2ma	−80	0.048 ohm			DL-S 909
	2N511	K		80w	40	10	10 at 10a		−2ma	−20	0.025 ohm			DL-S 1050
	2N511A	K		80w	60	10	10 at 10a		−2ma	−30	0.025 ohm			DL-S 1050
	2N511B	K		80w	80	10	10 at 10a		−2ma	−40	0.025 ohm			DL-S 1050
	2N512	K		80w	40	15	10 at 15a		−2ma	−20	0.025 ohm			DL-S 1051
	2N512A	K		80w	60	15	10 at 15a		−2ma	−30	0.025 ohm			DL-S 1051
	2N512B	K		80w	80	15	10 at 15a		−2ma	−40	0.025 ohm			DL-S 1051
	2N513	K		80w	40	20	10 at 20a		−2ma	−20	0.025 ohm			DL-S 1052
pnp	2N513A	K		80w	60	20	10 at 20a		−2ma	−30	0.025 ohm			DL-S 1052
	2N513B	K		80w	80	20	10 at 20a		−2ma	−40	0.025 ohm			DL-S 1052
	2N514	K		80w	40	25	10 at 25a		−2ma	−20	0.025 ohm			DL-S 1053
	2N514A	K		80w	60	25	10 at 25a		−2ma	−30	0.025 ohm			DL-S 1053
	2N514B	K		80w	80	25	10 at 25a		−2ma	−40	0.025 ohm			DL-S 1053
	2N1021	K		50w	−100	−5	23 at 5a avg.		−2ma	−100	0.08 ohm			DL-S 963
	2N1022	K		50w	−120	−5	23 at 5a avg.		−2ma	−120	0.08 ohm			DL-S 963
	2N1042	B§		20w	−40	−3	20 at 3a	60	−125	−20	0.16 ohm			DL-S 1066
	2N1043	B§		20w	−60	−3	20 at 3a	60	−125	−30	0.16 ohm			DL-S 1066
	2N1044	B§		20w	−80	−3	20 at 3a	60	−125	−40	0.16 ohm			DL-S 1066
	2N1045	B§		20w	−100	−3	20 at 3a	60	−125	−50	0.16 ohm			DL-S 1066
phototransistor npn	800			65	20	5								DL-S 810

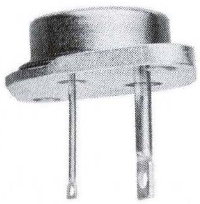
* Current Gain (h_{fe}) spread 2:1 or less † Min. audio power gain—Class A/Class B. § To specify case type C add suffix (−1) to type number To specify case type T add suffix (−2) to type number

FOR OFF-THE-SHELF DELIVERY ON ALL TI SEMICONDUCTORS AND COMPONENTS, ORDER IN THE FOLLOWING QUANTITIES: silicon and germanium transistors, silicon diodes and rectifiers, carbon film resistors, 1-999; *sensistor* silicon resistors, 1-499; *tan*-TI-*cap* tantalum capacitors, 1-99.

BUILT-IN RELIABILITY



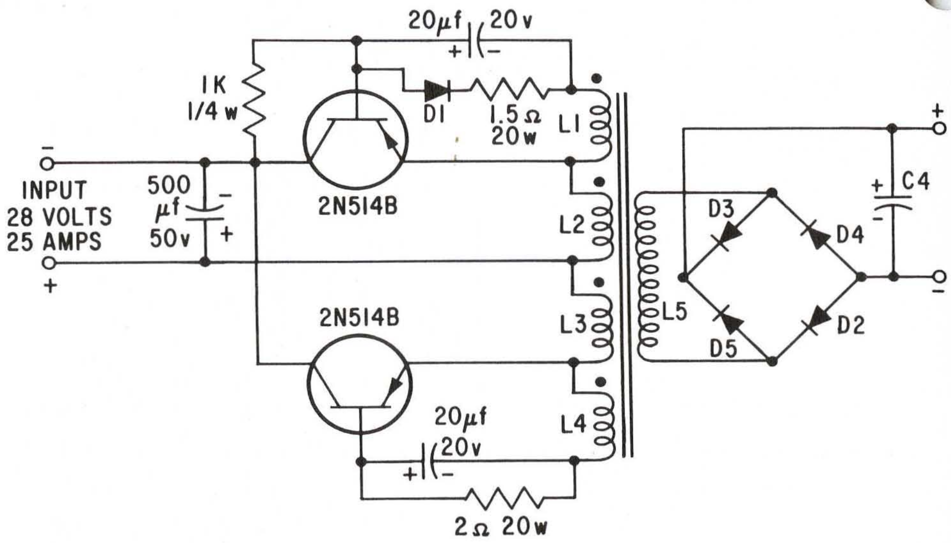
Low R_{CS} (0.05Ω) at high temperatures insured by large ring emitter-base area. Leakage currents minimized by all welded construction . . . no contaminating solders or fluxes used!



High current-carrying capacity and maximum safety against over-heating provided by heavy 90-mil emitter lead.

GERMANIUM TRANSISTOR APPLICATION NOTES

630 WATT DC-TO-DC POWER CONVERTER 90% EFFICIENT



NOTES

L5 may be wound according to the output voltage desired, allowing about 0.639 turns per volt. The wire size should be large enough to allow one circular mil per millampere. The output current and load will then determine D2, D3, D4, D5, and C4.

L2, L3—17 turns each #10 bifilar wound

L1, L2—4 turns each #16

Core-type 50022-2A Magnetics, Inc.

Q1, Q2—2N514B 80 volt 25 amp each mounted on a minimum of 200 sq in. of ¼″ aluminum for operation up to 50°C.

D1—1N1124 mounted on a minimum of 1 sq in. of exposed aluminum 1/16″ thick. Operation to 50°C.

Frequency about 1 kc.

REDUCE YOUR COMPONENT COSTS WITH ONE TI POWER TRANSISTOR!

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GET OFF-THE-SHELF DELIVERY at factory prices in 1-999 quantities on these high-reliability germanium transistors, use-proved by hundreds of customers and guaranteed for one full year by TI!

maximum ratings at 25° C

		2N511	2N511A	2N511B	2N512	2N512A	2N512B	2N513	2N513A	2N513B	2N514	2N514A	2N514B	unit
V_{CBO}	Collector-to-Base Voltage (I_C = −5ma, I_E = 0)	−40	−60	−80	−40	−60	−80	−40	−60	−80	−40	−60	−80	v
V_{CEX}	Collector-to-Emitter Voltage (V_{BE} = +0.2 v, I_C = −5ma)	−40	−60	−80	−40	−60	−80	−40	−60	−80	−40	−60	−80	v
V_{EBO}	Emitter-to-Base Voltage (I_E = −5ma, I_C = 0)	←	−30	→	←	−30	→	←	−30	→	←	−30	→	v
I_C	DC Collector Current	←	−10	→	←	−15	→	←	−20	→	←	−25	→	a
I_E	DC Emitter Current	←	10	→	←	15	→	←	20	→	←	25	→	a
I_B	Base Current	←						−5					→	a
	Total Dissipation	←						80					→	w
T_J	Junction Temperature	←						95					→	°C

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