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RCA Power Devices

RCA Power Devices

This DATABOOK contains complete technical information on the full line of RCA solid-state power devices: power transistors, rf/microwave power transistors, power hybrid circuits, triacs, SCR's, diacs, rectifiers, and high-reliability types.

General operating considerations for RCA solid-state power devices and a listing of symbols and special terms used in the data are given on the following pages. The book is then divided into eight major sections, one for each of the various types of devices. General information such as test circuits and waveforms, dimensional outlines, and suggested mounting hardware is included in an Appendix at the back of the book. The Appendix also contains abstracts of relevant RCA Application Notes. The final pages contain a complete index to individual type numbers.

To facilitate type selection, comprehensive product selection charts are included at the beginning of each major section. In many cases, industry cross-reference or replacement guides are also included. Data pages for individual devices are then given as nearly as possible in alpha-numerical sequence of basic family type numbers. Because many devices may be included in the same basic family, individual type numbers are not necessarily in sequence. If you don't find a type number where you expect it to be, check the index to devices.

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Operating Considerations

Solid state devices are being designed into an increasing variety of electronic equipment because of their high standards of reliability and performance. However, it is essential that equipment designers be mindful of good engineering practices in the use of these devices to achieve the desired performance.

This Note summarizes important operating recommendations and precautions which should be followed in the interest of maintaining the high standards of performance of solid state devices.

The ratings included in RCA Solid State Devices data bulletins are based on the Absolute Maximum Rating System, which is defined by the following Industry Standard (JEDEC) statement:

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

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in device characteristics.

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

It is recommended that equipment manufacturers consult RCA whenever device applications involve unusual electrical, mechanical or environmental operating conditions.

GENERAL CONSIDERATIONS

The design flexibility provided by these devices makes possible their use in a broad range of applications and under many different operating conditions. When incorporating these devices in equipment, therefore, designers should anticipate the rare possibility of device failure and make certain that no safety hazard would result from such an occurrence.

The small size of most solid state products provides obvious advantages to the designers of electronic equipment. However, it should be recognized that these compact devices usually provide only relatively small insulation area between adjacent leads and the metal envelope. When these devices are used in moist or contaminated atmospheres, therefore, supplemental protection must be provided to prevent the development of electrical conductive paths across the relatively small insulating surfaces. For specific information on voltage creepage, the user should consult references such as the JEDEC Standard No. 7 "Suggested Standard on Thyristors," and JEDEC Standard RS282 "Standards for Silicon Rectifier Diodes and Stacks".

The metal shells of some solid state devices operate at the collector voltage and for some rectifiers and thyristors at the anode voltage. Therefore, consideration should be given to the possibility of shock hazard if the shells are to operate at voltages appreciably above or below ground potential. In general, in any application in which devices are operated at voltages which may be dangerous to personnel, suitable precautionary measures should be taken to prevent direct contact with these devices.

Devices should not be connected into or disconnected from circuits with the power on because high transient voltages may cause permanent damage to the devices.

TESTING PRECAUTIONS

In common with many electronic components, solid-state devices should be operated and tested in circuits which have reasonable values of current limiting resistance, or other forms of effective current overload protection. Failure to observe these precautions can cause excessive internal heating of the device resulting in destruction and/or possible shattering of the enclosure.

TRANSISTORS AND THYRISTORS WITH FLEXIBLE LEADS

Flexible leads are usually soldered to the circuit elements. It is desirable in all soldering operatings to provide some slack or an expansion elbow in each lead to prevent excessive tension on the leads. It is important during the soldering operation to avoid excessive heat in order to prevent possible damage to the devices. Some of the heat can be absorbed if the flexible lead of the device is grasped between the case and the soldering point with a pair of pliers.

TRANSISTORS AND THYRISTORS WITH MOUNTING FLANGES

The mounting flanges of JEDEC-type packages such as the TO-3 or TO-66 often serve as the collector or anode terminal. In such cases, it is essential that the mounting flange be securely fastened to the heat sink, which may be the equipment chassis. Under no circumstances, however, should the mounting flange of a transistor be soldered directly to the heat sink or chassis because the heat of the soldering operation could permanently damage the device. Soldering is the preferred method for mounting thyristors; see "Rectifiers and Thyristors," below. Devices which cannot be soldered can be installed in commercially available sockets. Electrical connections may also be made by soldering directly to the terminal pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals; otherwise the heat of the soldering operation could crack the pin seals and damage the device.

During operation, the mounting-flange temperature is higher than the ambient temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capacity to assure that the heat dissipated in the heat sink itself does not raise the device mounting-flange temperature above the rated value. The heat sink or chassis may be connected to either the positive or negative supply.

In many applications the chassis is connected to the voltage-supply terminal. If the recommended mounting hardware shown in the data bulletin for the specific solid-state device is not available, it is necessary to use either an anodized aluminum insulator having high thermal conductivity or a mica insulator between the mounting-flange and the chassis. If an insulating aluminum washer is required, it should be drilled or punched to provide the two mounting holes for the terminal pins. The burrs should then be removed from the washer and the washer anodized. To insure that the anodized insulating layer is not destroyed during mounting, it is necessary to remove the burrs from the holes in the chassis.

It is also important that an insulating bushing, such as glass-filled nylon, be used between each mounting bolt and the chassis to prevent a short circuit. However, the insulating bushing should not exhibit shrinkage or softening under the operating temperatures encountered. Otherwise the thermal resistance at the interface between device and heat sink may increase as a result of decreasing pressure.

PLASTIC POWER TRANSISTORS AND THYRISTORS

RCA power transistors and thyristors (SCR's and triacs) in molded-silicone-plastic packages are available in a wide range of power-dissipation ratings and a variety of package configurations. The following paragraphs provide guidelines for handling and mounting of these plastic-package devices, recommend forming of leads to meet specific mounting requirements, and describe various mounting arrangements, thermal considerations, and cleaning methods. This information is intended to augment the data on electrical characteristics, safe operating area, and performance capabilities in the technical bulletin for each type of plastic-package transistor or thyristor.

Lead-Forming Techniques

The leads of the RCA VERSAWATT in-line plastic packages can be formed to a custom shape, provided they are not indiscriminately twisted or bent. Although these leads can be formed, they are not flexible in the general sense, nor are they sufficiently rigid for unrestrained wire wrapping

Before an attempt is made to form the leads of an in-line package to meet the requirements of a specific application, the desired lead configuration should be determined, and a lead-bending fixture should be designed and constructed. The use of a properly designed fixture for this operation eliminates the need for repeated lead bending. When the use of a special bending fixture is not practical, a pair of long-nosed pliers may be used. The pliers should hold the lead firmly between the bending point and the case, but should not touch the case.

When the leads of an in-line plastic package are to be formed, whether by use of long-nosed pliers or a special bending fixture, the following precautions must be observed to avoid internal damage to the device:

1. Restrain the lead between the bending point and the plastic case to prevent relative movement between the lead and the case.
2. When the bend is made in the plane of the lead (spreading), bend only the narrow part of the lead.
3. When the bend is made in the plane perpendicular to that of the leads, make the bend at least 1/8 inch from the plastic case.
4. Do not use a lead-bend radius of less than 1/16 inch.
5. Avoid repeated bending of leads.

The leads of the TO-220AB VERSAWATT in-line package are not designed to withstand excessive axial pull. Force in this direction greater than 4 pounds may result in permanent damage to the device. If the mounting arrangement tends to impose axial stress on the leads, some method of strain relief should be devised.

Wire wrapping of the leads is permissible, provided that the lead is restrained between the plastic case and the point of the wrapping. Soldering to the leads is also allowed. The maximum soldering temperature, however, must not exceed 275°C and must be applied for not more than 5 seconds at a distance not less than 1/8 inch from the plastic case. When wires are used for connections, care should be exercised to assure that movement of the wire does not cause movement of the lead at the lead-to-plastic junctions.

The leads of RCA molded-plastic high-power packages are not designed to be reshaped. However, simple bending of the leads is permitted to change them from a standard vertical to a standard horizontal configuration, or conversely. Bending of the leads in this manner is restricted to three 90-degree bends; repeated bendings should be avoided.

Mounting

Recommended mounting arrangements and suggested hardward for the VERSAWATT package are given in the data bulletins for specific devices and in RCA Application Note AN-4142. When the package is fastened to a heat sink, a rectangular washer (RCA Part No. NR231A) is recommended to minimize distortion of the mounting flange. Excessive distortion of the flange could cause damage to the package. The washer is particularly important when the size of the mounting hole exceeds 0.140 inch (6-32 clearance). Larger holes are needed to accommodate insulating bushings; however, the holes should not be larger than necessary to provide hardware clearance and, in any case, should not exceed a diameter of 0.250 inch.

Flange distortion is also possible if excessive torque is used during mounting. A maximum torque of 8 inch-pounds is specified. Care should be exercised to assure that the tool used to drive the mounting screw never comes in contact with the plastic body during the driving operation. Such contact can result in damage to the plastic body and internal device connections. An excellent method of avoiding this problem is to use a spacer or combination spacer-isolating bushing which raises the screw head or nut above the top surface of the plastic body. The material used for such a spacer or spacer-isolating bushing should, of course, be carefully selected to avoid "cold flow" and consequent reduction in mounting force. Suggested materials for these bushings are diallphtalate, fiberglass-filled nylon, or fiberglass-filled polycarbonate. Unfilled nylon should be avoided.

Modification of the flange can also result in flange distortion and should not be attempted. The package should not be soldered to the heat sink by use of lead-tin solder because the heat required with this type of solder will cause the junction temperature of the device to become excessively high.

The TO-220AA plastic package can be mounted in commercially available TO-66 sockets, such as UID Electronics Corp. Socket No. PTS-4 or equivalent. For testing purposes, the TO-220AB in-line package can be mounted in a Jetron Socket No. DC74-104 or equivalent. Regardless of the mounting method, the following precautions should be taken:

1. Use appropriate hardware.
2. Always fasten the package to the heat sink before the leads are soldered to fixed terminals.
3. Never allow the mounting tool to come in contact with the plastic case.
4. Never exceed a torque of 8 inch-pounds.
5. Avoid oversize mounting holes.
6. Provide strain relief if there is any probability that axial stress will be applied to the leads.
7. Use insulating bushings to prevent hot-creep problems. Such bushings should be made of diallphthalate, fiber-glass-filled nylon, or fiberglass-filled polycarbonate.

The maximum allowable power dissipation in a solid state device is limited by the junction temperature. An important factor in assuring that the junction temperature remains below the specified maximum value is the ability of the associated thermal circuit to conduct heat away from the device.

When a solid state device is operated in free air, without a heat sink, the steady-state thermal circuit is defined by the junction-to-free-air thermal resistance given in the published data for the device. Thermal considerations require that a free flow of air around the device is always present and that the power dissipation be maintained below the level which would cause the junction temperature to rise above the maximum rating. However, when the device is mounted on a heat sink, care must be taken to assure that all portions of the thermal circuit are considered.

To assure efficient heat transfer from case to heat sink when mounting RCA molded-plastic solid state power devices, the following special precautions should be observed:

1. Mounting torque should be between 4 and 8 inch-pounds.
2. The mounting holes should be kept as small as possible.
3. Holes should be drilled or punched clean with no burrs or ridges, and chamfered to a maximum radius of 0.010 inch.
4. The mounting surface should be flat within 0.002 inch/inch.
5. Thermal grease (Dow Corning 340 or equivalent) should always be used on both sides of the insulating washer if one is employed.
6. Thin insulating washers should be used. (Thickness of factory-supplied mica washers range from 2 to 4 mils).
7. A lock washer or torque washer, made of material having sufficient creep strength, should be used to prevent degradation of heat sink efficiency during life.

A wide variety of solvents is available for degreasing and flux removal. The usual practice is to submerge components in a solvent bath for a specified time. However, from a reliability stand point it is extremely important that the solvent, together with other chemicals in the solder-cleaning system (such as flux and solder covers), do not adversely affect the life of the component. This consideration applies to all non-hermetic and molded-plastic components.

It is, of course, impractical to evaluate the effect on long-term device life of all cleaning solvents, which are marketed with numerous additives under a variety of brand names. These solvents can, however, be classified with respect to their component parts as either acceptable or unacceptable. Chlorinated solvents tend to dissolve the outer package and, therefore, make operation in a humid atmosphere unreliable. Gasoline and other hydrocarbons cause the inner encapsulant to swell and damage the transistor. Alcohol is an acceptable solvent. Examples of specific, acceptable alchols are isopropanol, methanol, and special denatured alcohols, such as SDA1, SDA30, SDA34, and SDA44.

Under certain conditions, dimethyl silicone fluids may react chemically with the encapsulant of plastic devices and cause damage to the package. These fluids do not cause damage when they are contained in materials such as thermal compounds. These fluids, however, are unacceptable for use as baths or encapsulants for plastic-package devices. In addition, plastic-package devices should not be used or stored in environments that contain significant amounts of dimethyl silicone fluid.

Care must also be used in the selection of fluxes for lead soldering. Rosin or activated rosin fluxes are recommended, while organic or acid fluxes are not. Examples of acceptable fluxes are:

1. Alpha Reliaros No. 320-33
2. Alpha Reliaros No. 346
3. Alpha Reliaros No. 711
4. Alpha Reliafoam No. 807
5. Alpha Reliafoam No. 809
6. Alpha Reliafoam No. 811-13
7. Alpha Reliafoam No. 815-35
8. Kester No. 44

If the completed assembly is to be encapsulated, the effect on the molded-plastic transistor must be studied from both a chemical and a physical standpoint.

RECTIFIERS AND THYRISTORS

A surge-limiting impedance should always be used in series with silicon rectifiers and thyristors. The impedance value must be sufficient to limit the surge current to the value specified under the maximum ratings. This impedance may be provided by the power transformer winding, or by an external resistor or choke.

A very efficient method for mounting thyristors utilizing the "modified TO-5" package is to provide intimate contact between the heat sink and at least one half of the base of the device opposite the leads. This package can be mounted to the heat sink mechanically with glue or an expoxy adhesive, or by soldering, the most efficient method.

The use of a "self-jigging" arrangement and a solder preform is recommended. If each unit is soldered individually, the heat source should be held on the heat sink and the solder on the unit. Heat should be applied only long enough to permit solder to flow freely. For more detailed thyristor mounting considerations, refer to Application Note AN3822, "Thermal Considerations in Mounting of RCA Thyristors".

RF POWER TRANSISTORS

Mounting and Handling

Stripline rf devices should be mounted so that the leads are not bent or pulled away from the stud (heat sink) side of the device. When leads are formed, they should be supported to avoid transmitting the bending or cutting stress to the ceramic portion of the device. Excessive stresses may destroy the hermeticity of the package without displaying visible damage.

Devices employing silver leads are susceptible to tarnishing; these parts should not be removed from the original tarnish-preventive containers and wrappings until ready for use. Lead solderability is retarded by the presence of silver tarnish; the tarnish can be removed with a silver cleaning solution, such as thiourea.

The ceramic bodies of many rf devices contain beryllium oxide as a major ingredient. These portions of the transistors should not be crushed, ground, or abraded in any way because the dust created could be hazardous if inhaled.

Operating

Forward-Biased Operation. For Class A or AB operation, the allowable quiescent bias point is determined by reference to the infrared safe-area curve in the appropriate data bulletin. This curve depicts the safe current/voltage combinations for extended continuous operation.

Load VSWR. Excessive collector load or tuning mismatch can cause device destruction by over-dissipation or secondary breakdown. Mismatch capability is generally included on the data bulletins for the more recent rf transistors.

See RCA RF Power Transitor Manual, Technical Series RMF-430, pp 39-41, for additional information concerning the handling and mounting of rf power transistors.

SOLID STATE CHIPS

Solid state chips, unlike packaged devices, are non-hermetic devices, normally fragile and small in physical size, and therefore, require special handling considerations as follows:

1. Chips must be stored under proper conditions to insure that they are not subjected to a moist and/or contaminated atmosphere that could alter their electrical, physical, or mechanical characteristics. After the shipping container is opened, the chip must be stored under the following conditions:
   A. Storage temperature, 40°C max.
   B. Relative humidity, 50% max.
   C. Clean, dust-free environment.
2. The user must exercise proper care when handling chips to prevent even the slightest physical damage to the chip.
3. During mounting and lead bonding of chips the user must use proper assembly techniques to obtain proper electrical, thermal, and mechanical performance.
4. After the chip has been mounted and bonded, any necessary procedure must be followed by the user to insure that these non-hermetic chips are not subjected to moist or contaminated atmosphere which might cause the development of electrical conductive paths across the relatively small insulating surfaces. In addition, proper consideration must be given to the protection of these devices from other harmful environments which could conceivably adversely affect their proper performance.

Terms and Symbols

General

AQL	acceptance quality level
CM	cross modulation
IMD	intermodulation distortion
K	post-radiation neutron-damage constant
LTPD	lot tolerance per cent defective
MTBF	mean time between failures
MTTF	mean time to failure
NF	noise factor (or noise figure)
P_D	device dissipation
pps	pulses per second
P_{rr}	pulse repetition rate
prt	pulse recurrence time
PW	pulse width
RMS	root mean square
$R_{\theta JA}$	thermal resistance, junction-to-ambient
$R_{\theta JC}$	thermal resistance, junction-to-case
$R_{\theta JF}$	thermal resistance, junction-to-flange
$R_{\theta JHS}$	thermal resistance, junction-to-heat sink
T_A	ambient temperature
T_C	case temperature
THD	total harmonic distortion
T_J	operating (junction) temperature
T_L	lead temperature during soldering
t_p	pulse duration
T_{stg}	storage temperature
η	efficiency
θ	conduction angle
ϕ	phase angle
ϕL	lead radius (for bending)
τ	torque
τ_s	device stud torque

Power Transistors

(C)	collector-to-base charge-generation constant (during gamma exposure)
C_{cb}	collector-to-base feedback capacitance
C_{ib}	common-base input capacitance
C_{ob}	common-base output capacitance
C_{obo}	open-circuit common-base output capacitance
$E_{S/b}$	reverse-bias second-breakdown energy
f_{ab}	base (alpha) cutoff frequency
f_{ae}	emitter (beta) cutoff frequency
f_{hfe}	common-emitter, small-signal, short-circuit forward-current transfer ratio cutoff frequency
h_{FE}	dc forward-current transfer ratio
h_{fe}	common-emitter, small-signal, short-circuit, forward-current transfer ratio
$\lvert h_{fe} \rvert$	magnitude of common-emitter, small-signal, short-circuit, forward-current transfer ratio
f_T	gain-bandwidth product (unity-gain frequency for devices in which gain roll off has a −1 slope)
G_c	conversion gain
G_{pb}	small-signal, common-base power gain
G_{PB}	large-signal, common-base power gain
G_{pe}	small-signal, common-emitter power gain
G_{PE}	large-signal, common-emitter power gain
G_{VE}	wide-band voltage gain
h_{ib}	common-base, small-signal, short-circuit input impedance
h_{ob}	common-base, small-signal, open circuit output admittance
h_{rb}	common-base, small-signal, open-circuit reverse-voltage transfer ratio
I_B	continuous base current
I_{BM}	peak base current
I_C	continuous collector current
I_{CBO}	collector-cutoff current, emitter open
I_{CEO}	collector-cutoff current, base open
I_{CER}	collector-cutoff current with specified resistance between base and emitter
I_{CES}	collector-cutoff current with base-emitter junction short-circuited
I_{CEV}	collector-cutoff current with specified voltage between base and emitter
I_{CEX}	collector-cutoff current with specified circuit between base and emitter
I_{CM}	peak collector current
I_E	continuous emitter current
I_{EBO}	emitter-cutoff current, collector open
I_{EM}	peak emitter current
$I_{S/b}$	forward-bias, second-breakdown collector current
PRT	power rating test
P_T	transistor dissipation at specified temperature
$r_b'C_c$	collector-to-base time constant
R_{BE}	external base-to-emitter resistance
$r_{CE}(sat)$	dc collector-to-emitter saturation resistance
$Re(h_{ie})$	real part of common-emitter, small-signal, short-circuit input impedance
R_s	collector-to-emitter saturation resistance
t_d	delay time
t_f	fall time
t_{OFF}	turn-off time (storage time + fall time)
t_{ON}	turn-on time (delay time + rise time)
t_r	rise time
t_s	storage time
V_{BE}	base-to-emitter voltage
$V_{BE}(sat)$	base-to-emitter saturation voltage
$V_{(BR)CBO}$	collector-to-base breakdown voltage, emitter open
$V_{(BR)CEO}$	collector-to-emitter breakdown voltage, base open
$V_{(BR)CEV}$	collector-to-emitter breakdown voltage with specified circuit between base and emitter
$V_{(BR)EBO}$	emitter-to-base breakdown voltage, collector open
V_{CB}	collector-to-base voltage
V_{CBO}	collector-to-base voltage, emitter open
V_{CC}	collector supply voltage
V_{CE}	collector-to-emitter voltage
V_{CEO}	collector-to-emitter voltage, base open
$V_{CE}(sat)$	collector-to-emitter saturation voltage
$V_{CEO}(sus)$	collector-to-emitter sustaining voltage, base open

Power Transistors (Cont'd)

V_{CER} collector-to-emitter voltage with specified resistance between base and emitter
$V_{CER}(sus)$ collector-to-emitter sustaining voltage with specified resistance between base and emitter
V_{CES} collector-to-emitter voltage with base-emitter junction short-circuited
V_{CEV} collector-to-emitter voltage with specified voltage between base and emitter
$V_{CEV}(sus)$ collector-to-emitter sustaining voltage with specified voltage between base and emitter
V_{CEX} collector-to-emitter voltage with specified circuit between base and emitter
$V_{CEX}(sus)$ collector-to-emitter sustaining voltage with specified circuit between base and emitter
V_{EB} emitter-to-base voltage
V_{EBO} emitter-to-base voltage, collector open
V_F diode forward-voltage drop
V_{RT} collector-to-emitter reach-through (or punch through) voltage
α common-base current gain (alpha)
β collector-emitter current gain (beta)
η_C collector efficiency
τ_I thermal time constant

Power Hybrid Operational Amplifiers

A voltage gain
A_{CL} closed-loop voltage gain
A_{OL} open-loop voltage gain
CMRR common-mode rejection ratio
f_H closed-loop bandwidth
I_i idling current
I_{IB} input bias current
I_{IO} input offset current
I_o quiescent current
I_{om} maximum peak quiescent current
I_S short-circuit current
P_T total power dissipation for each output transistor
R_{em} common-mode input impedance
S/N signal-to-noise ratio
SR slew rate
V_{ICR} common-mode input voltage range
V_{IN} input signal voltage swing
V_{IO} input offset voltage
V_{offset} offset voltage
V_{OUT} output voltage swing
V_{OUT}/V_{IN} voltage gain
V_{RR} supply-voltage ripple rejection ratio
V_S supply voltage
Z_{IN} input impedance
ΔI_i idling-current drift

Silicon Rectifiers

I_F forward current
$I_{F(AV)}$ average forward current
$I_{F(RMS)}$ rms forward current
I_{FM} maximum (peak) forward current
I_{FRM} repetitive peak forward current
I_{FSM} peak surge (nonrepetitive) forward current
I_o average forward current, 180-degree conduction angle, half-sine wave
I_R reverse current
$I_{R(AV)}$ average dynamic reverse current, single-phase, full-cycle
I_{RM} maximum (peak) reverse current
I_{rr} reverse recovery current
I^2t amperes squared-seconds (fusing current for rectifier protection)
P_F forward power dissipation
$P_{F(AV)}$ average forward power dissipation
P_{FM} maximum (peak) forward power dissipation
P_R reverse power dissipation
R_s surge-limiting resistance
t_{rr} reverse recovery time
V_F forward voltage drop
v_F instantaneous forward voltage drop
V_R reverse (dc blocking) voltage
$V_{R(RMS)}$ RMS reverse voltage
V_{RRM} repetitive peak reverse voltage
V_{RSM} nonrepetitive peak reverse voltage
V_{RWM} working peak reverse voltage

Thyristors (Triacs, SCR's, GTO's, and ITR's) and Diacs

di/dt rate of change of on-state current
di_F/dt rate of change of forward current (rectifier unit of ITR)
dv/dt critical rate of rise of off-state voltage
$I_{(BO)}$ peak breakover current
i_D instantaneous off-state current
i_{DO} instantaneous off-state current, gate open
I_{DOM} maximum (peak) off-state current, gate open
I_{DROM} maximum peak (repetitive) off-state current, gate open
I_{DRX} dc off-state current, specified circuit between gate and cathode
I_{DRXM} maximum (peak) repetitive dc off-state current with specified circuit between gate and cathode
I_{DXM} maximum (peak) off-state current, specified circuit between gate and cathode
i_F instantaneous forward current
I_{FM} peak forward current
I_{FRM} peak repetitive forward current
I_{FSM} peak surge forward current (nonrepetitive)
I_G dc gate current
I_g pulsed gate trigger current (gate drive current)
I_{ggM} maximum gate turn-off current
I_{GM} maximum (peak) gate current
$I_{GR(BR)}$ reverse gate breakdown current
I_{GRRM} maximum (peak) reverse gate current
I_{GT} dc gate trigger current
i_{HO} instantaneous holding current, gate open
I_{HO} dc holding current, gate open
i_L instantaneous latching current
I_L dc latching current
I_o average dc forward current
I_R dc reverse current
i_R instantaneous reverse current
i_{RO} instantaneous reverse current, gate open
I_{RM} maximum (peak) reverse current

Thyristors (Triacs, SCR's, GTO's, and ITR's and Diacs) (Cont'd)

I_{RROM}	maximum (peak) reverse current, gate open
I_{RRX}	dc reverse current, specified circuit between gate and cathode
I_{RRXM}	maximum (peak) reverse current, specified circuit between gate and cathode
I^2t	amperes squared-seconds (fusing current for device protection)
i_T	instantaneous on-state current
I_T	dc on-state current
I_{TGQM}	maximum (peak) on-state current gate-turn-off capability
$I_{T(AV)}$	average on-state current
I_{TM}	maximum (peak) on-state current
$I_{TM(pulse)}$	maximum (peak) pulse on-state current
$I_{T(RMS)}$	rms on-state current
I_{TRXM}	maximum (peak) (repetitive) on-state current, specified operating circuit
I_{TSM}	maximum (peak) surge (non-repetitive) on-state current
I_{TXM}	maximum (peak) on-state current, specified operating circuit
P_D	device dissipation
$P_{D(AV)}$	average device dissipation
$P_{G(AV)}$	average gate power dissipation
P_{GM}	maximum (peak) gate power dissipation
P_{GRM}	maximum (peak) reverse gate power
P_T	on-state power dissipation
$P_{T(AV)}$	average on-state power dissipation
t_d	delay time
t_f	fall time
t_{gq}	gate controlled turn-off time ($t_s + t_f$)
$t_{g(rec)}$	gate recovery time
t_{gt}	gate controlled turn-on time ($t_d + t_r$)
t_q	circuit commutated turn-off time ($t_{rr} + t_{g(rec)}$)
t_r	rise time
t_{rr}	reverse recovery time
t_s	storage time
$V_{(BO)}$	breakover voltage
$\lvert +V_{(BO)} \rvert - \lvert -V_{(BO)} \rvert$	breakover voltage symmetry (for diacs)
$v_{(BO)O}$	instantaneous breakover voltage, gate open
V_D	dc off-state voltage
v_D	instantaneous off-state voltage
V_{DM}	maximum (peak) dc off-state voltage
V_{DROM}	maximum (peak) (repetitive) off-state voltage, gate open
V_{DRXM}	maximum (peak) (repetitive) off-state voltage, specified circuit between gate and cathode
V_{DSOM}	maximum (peak) (nonrepetitive) off-state voltage, gate open
V_{DSXM}	maximum (peak) (nonrepetitive) off-state voltage, specified circuit between gate and cathode
v_{DX}	instantaneous off-state voltage, specified circuit between gate and cathode
V_{DX}	dc off-state voltage, specified circuit between gate and cathode
v_F	instantaneous forward voltage drop
V_{FM}	maximum (peak) forward voltage
V_G	dc gate voltage
V_{GK}	dc gate-to-cathode voltage
V_{gq}	gate turn-off voltage
V_{GR}	dc reverse gate voltage
$V_{GR(BR)}$	reverse gate breakdown voltage
V_{GRM}	maximum (peak) gate reverse voltage
V_{GRRM}	Maximum (peak) repetitive reverse gate voltage
V_{GT}	dc gate trigger voltage
V_R	dc reverse voltage
V_{RROM}	maximum (peak) (repetitive) reverse voltage, gate open
V_{RRXM}	maximum (peak) (repetitive) voltage, specified circuit between gate and cathode
V_{RSOM}	maximum (peak) (nonrepetitive)reverse voltage, gate open
V_{RSXM}	maximum (peak) (nonrepetitive) reverse voltage, specified circuit between gate and cathode
V_{RX}	dc reverse voltage, specified circuit between gate and cathode
V_{RXM}	maximum (peak) reverse voltage, specified circuit between gate and cathode
v_T	instantaneous on-state voltage
V_T	dc on-state voltage
$v_{T(I)}$	initial on-state voltage
V_{TM}	maximum (peak) dc on-state voltage
Z_{GS}	gate source impedance
$\Delta V\pm$	dynamic breakback voltage

Power Transistors

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Selection Charts

N-P-N SILICON POWER TRANSISTORS

Type No.	DATA-BOOK Page No.	$V_{CEO}(sus)$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	f_T MHz	Sw. Times▲ t_{ON} μs	t_f μs	Package	p-n-p Complement
I_C(Max.) = 0.15 to 1 A, f_T = 3 to 25 MHz												
40346	45	175	25 min.	0.010	10	10	1	15	–	–	TO-39	–
41505♦	128	200	20 min.	0.050	10	20	1	21	–	–	Plastic TO-5	–
2N3440	45	250	40-160	0.020	10	10	1	15	–	–	TO-39	2N5415
40412	45	250*	40 min.	0.030	20	10	1	15	–	–	TO-39	–
40321	238	300*	25-200	0.020	10	5	1	15	–	–	TO-39	–
2N3439	45	350	40-160	0.020	10	10	1	15	–	–	TO-39	2N5416
I_C(Max.) = 0.15 to 1 A, f_T = 50 to 100 MHz												
41502	20	30	20 min.	0.150	10	3	1	60	–	–	TO-39	41503
2N3053	20	40	50-250	0.150	10	5	1	60	–	–	TO-39	2N4037
2N2102	20	65	25 min.	0.500	10	5	1	60	30 ns⊕	–	TO-39	2N4036
RCP115	228	100	50 min.	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP117	228	100	20 min.	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP111A	228	200	50-300	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP113A	228	200	30-150	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP111B	228	250	50-300	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP113B	228	250	30-150	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP115B	228	250	50 min.	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP117B	228	250	20 min.	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP111C	228	300	50-300	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP113C	228	300	30-150	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP111D	228	350	50-300	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
RCP113D	228	350	30-150	0.025	10	6.25	0.150	80	–	–	TO-202AB	–
I_C(Max.) = 1.5 to 2 A, f_T = 0.2 to 1.5 MHz												
2N1479	26	40	20-60	0.200	4	5	1.5	1.4	1.2	1	TO-39#	–
2N1481	26	40	35-100	0.200	4	5	1.5	1.4	1.2	1	TO-39#	–
40347	26	40	20-150	0.450	4	8.75	1.5	1.5	–	–	TO-39#	–
2N1480	26	55	20-60	0.200	4	5	1.5	1.4	1.2	1	TO-39#	–
2N1482	26	55	35-100	0.200	4	5	1.5	1.4	1.2	1	TO-39#	–
40348	26	65	10 min.	1	4	8.75	1.5	1.5	–	–	TO-39#	–
40349	26	140	10 min.	0.450	4	8.75	1.5	0.9	–	–	TO-39#	–
I_C(Max.) = 1.5 to 2 A, f_T = 3 to 25 MHz												
BUX67	218	150	10-150	1	5	35	2	10	3	3	TO-66	BUX66
2N3584	56	250	8-80	1	2	35	2	10	3	3	TO-66	2N6211
BUX67A	218	250	10-150	1	5	35	2	10	3	3	TO-66	BUX66A
2N3585	56	300	8-80	1	2	35	2	10	3	3	TO-66	2N6212
2N4240	56	300	10-100	0.750	2	35	2	15	0.5	3	TO-66	–
40850	56	300	25 min.	0.750	10	35	2	10	–	–	TO-66	–
BUX67B	218	300	10-150	1	5	35	2	10	3	3	TO-66	BUX66B
BUX67C	218	350	10-150	1	5	35	2	10	3	3	TO-66	BUX66C
I_C (Max.) = 1.5 to 2 A, f_T = 50 to 100 MHz												
RCP705	233	30	50 min.	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP704
RCP707	233	30	20 min.	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP706
RCP701A	233	40	50-250	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP700A
RCP703A	233	40	30-150	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP702A
2N5321	84	50	40-250	0.500	4	10	2	50	80 ns	800 ns★	TO-39	2N5323
2N6179	132	50	40-250	0.500	4	25	2	50	80 ns	800 ns★	Plastic TO-5	2N6181
RCP701B	233	60	50-250	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP700B
RCP703B	233	60	30-150	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP702B
RCP705B	233	60	50 min.	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP704B
RCP707B	233	60	20 min.	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP706B
2N5320	84	75	30-130	0.500	4	10	2	50	80 ns	800 ns★	TO-39	2N5322
2N6178	132	75	30-130	0.500	4	25	2	50	80 ns	800 ns★	Plastic TO-5	2N6180
RCP701C	233	80	50-250	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP700C
RCP703C	233	80	30-150	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP702C
RCA1A03	238	95*	70-300	0.300	4	10	2	50	–	–	TO-39	RCA1A04
RCP701D	233	100	50-250	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP700D
RCP703D	233	100	30-150	0.500	4	10	2	50	80 ns	800 ns★	TO-202AB	RCP702D

▲ Measured at same current level as h_{FE} unless otherwise indicated * $V_{CER}(sus)$ ⊕ $t_d + t_r + t_f$ ★ t_{OFF}

\# Also available in JEDEC TO-5 package

♦Check availability in Europe, the Middle East, and Africa.

N-P-N SILICON POWER TRANSISTORS (cont'd)

Type No.	DATA-BOOK Page No.	$V_{CEO(sus)}$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	f_T MHz	Sw. Times▲ t_{ON} µs	t_f µs	Package	p-n-p Complement
I_C (Max.) = 2.5 to 5 A, f_T = 0.2 to 1 MHz												
41504	80	35*	25 min.	1	4	36	4	0.8	–	–	TO-220AB	–
2N1483	31	40	20-60	0.750	4	25	3	0.8	1.2	1.1	TO-8	–
2N1485	31	40	35-100	0.750	4	25	3	0.8	1.2	1.1	TO-8	–
2N5786	98	40	20-100	1.6	2	10	3.5	1	5○	15★○	TO-39#	2N5783
2N5295	80	40	30-120	1	4	36	4	0.8	5	15★	TO-220AA	2N6108
2N5296	80	40	30-120	1	4	36	4	0.8	5	15★	TO-220AB	2N6109
2N6260	35	40	3 min.	4	2	29	3	0.8	–	–	TO-66	–
40250	35	40	25 min.	1.5	4	29	4	1	–	–	TO-66	2N5956
RCA29/SDH ♦	237	40	15 min.	1	4	36	4	0.8	2.3	6★	TO-220AB	–
RCA31/SDH ♦	237	40	25 min.	1	4	36	4	0.8	2.3	6★	TO-220AB	–
2N5785	98	50	20-100	1.2	2	10	3.5	1	5○	15★○	TO-39#	2N5782
2N1484	31	55	20-80	0.750	4	25	3	0.8	1.2	1.1	TO-8	–
2N1486	31	55	35-100	0.750	4	25	3	0.8	1.2	1.1	TO-8	–
2N3054	35	55	5 min.	3	4	25	4	0.8	–	–	TO-66	2N5955
RCA3054	80	55	5 min.	3	4	36	4	0.8	–	–	TO-220AB	–
BDY71	201	55	5 min.	3	4	29	4	0.8	–	–	TO-66	–
2N5297	80	60	20-80	1.5	4	36	4	0.8	5	15★	TO-220AA	2N6106
2N5298	80	60	20-80	1.5	4	36	4	0.8	5	15★	TO-220AB	2N6107
RCA29A/SDH ♦	237	60	15 min.	1	4	36	4	0.8	2.3	6★	TO-220AB	–
RCA31A/SDH ♦	237	60	25 min.	1	4	36	4	0.8	2.3	6★	TO-220AB	–
2N5784	98	65	20-100	1	2	10	3.5	1	5	15★	TO-39#	2N5781
2N5293	80	70	30-120	0.5	4	36	4	0.8	5	15★	TO-220AA	2N6106
2N5294	80	70	30-120	0.5	4	36	4	0.8	5	15★	TO-220AB	2N6107
2N6261	35	80	5 min.	4	2	50	4	0.8	–	–	TO-66	–
RCA29B/SDH ♦	237	80	15 min.	4	4	36	4	0.8	2.3	6★	TO-220AB	–
RCA31B/SDH ♦	237	80	25 min.	4	4	36	4	0.8	2.3	6★	TO-220AB	–
RCA29C/SDH ♦	237	100	15 min.	1	4	50	2.5	0.8	2.3	6★	TO-220AB	–
RCA31C/SDH ♦	237	100	25 min.	1	4	50	2.5	0.8	2.3	6★	TO-220AB	–
2N6477	157	120	5 min.	2.5	4	50	2.5	0.2	–	–	TO-220AB	–
2N6263	48	120	3 min.	3	2	20	3	0.2	–	–	TO-66	2N6468
RCA6263	157	120	20-150	0.5	4	36	3	0.2	–	–	TO-220AB	–
2N4347	52	120	10 min.	5	4	100	5	0.2	–	–	TO-3	2N6248
2N6478	157	140	5 min.	2.5	4	50	2.5	0.2	–	–	TO-220AB	–
2N3441	48	140	5 min.	2.7	4	25	3	0.2	–	–	TO-66	2N6468
RCA3441	157	140	20-150	0.5	4	36	3	0.2	–	–	TO-220AB	–
2N6264	48	150	5 min.	3	2	50	3	0.2	–	–	TO-66	–
I_C = 2.5 to 5 A, f_T = 3 to 25 MHz												
RCA29 ♦	237	40	15-150	1	4	30	3	3	0.4	1.2★	TO-220AB	RCA30
RCA31 ♦	237	40	25 min.	1	4	40	5	3	0.4	1.2★	TO-220AB	RCA32
RCS29 ♦	237	40	15-150	1	4	30	3	3	0.4	1.2★	TO-66	RCS30
RCS31 ♦	237	40	25 min.	1	4	40	5	3	0.4	1.2★	TO-66	RCS32
BD239	182	45	15 min.	1	4	30	4	3	–	–	TO-220AB	BD240
BD241	184	45	25 min.	1	4	40	5	3	–	–	TO-220AB	BD242
BD239A	182	60	15 min.	1	4	30	4	3	–	–	TO-220AB	BD240A
BD241A	184	60	25 min.	1	4	40	5	3	–	–	TO-220AB	BD242A
RCA29A ♦	237	60	15-150	1	4	30	3	3	0.4	1.2★	TO-220AB	RCA30A
RCA31A ♦	237	60	25 min.	1	4	40	5	3	0.4	1.2★	TO-220AB	RCA32A
RCS29A ♦	237	60	15-150	1	4	30	3	3	0.4	1.2★	TO-66	RCS30A
RCS31A ♦	237	60	25 min.	1	4	40	5	3	0.4	1.2★	TO-66	RCS32A
BD239B	182	80	15 min.	1	4	30	4	3	–	–	TO-220AB	BD240B
BD241B	184	80	25 min.	1	4	40	5	3	–	–	TO-220AB	BD242B
RCA29B ♦	237	80	15-150	1	4	30	3	3	0.4	1.2★	TO-220AB	RCA30B
RCA31B ♦	237	80	25 min.	1	4	40	5	3	0.4	1.2★	TO-220AB	RCA32B
RCS29B ♦	237	80	15-150	1	4	30	3	3	0.4	1.2★	TO-66	RCS30B
RCS31B ♦	237	80	25 min.	1	4	40	5	3	0.4	1.2★	TO-66	RCS32B
2N6465	105	100	5 min.	4	4	40	4	5	–	–	TO-66	2N6467
2N6473	121	100	2 min.	4	2.5	40	4	4	–	–	TO-220AB	2N6475

▲ Measured at same current level as h_{FE} unless otherwise indicated * $V_{CER(sus)}$ ★ t_{OFF}

Also available in JEDEC TO-5 package ○ At I_C = 1A

♦Check availability in Europe, the Middle East, and Africa.

N-P-N SILICON POWER TRANSISTORS (cont'd)

Type No.	DATA-BOOK Page No.	V_{CEO}(sus) V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	f_T MHz	Sw. Times▲ t_{ON} μs	t_f μs	Package	p-n-p Complement
I_C = 2.5 to 5 A, f_T = 3 to 25 MHz												
BD239C	182	100	15 min.	1	4	30	4	3	–	–	TO-220AB	BD240C
BD241C	184	100	25 min.	1	4	40	5	3	–	–	TO-220AB	BD242C
RCA29C ♦	237	100	15-150	1	4	30	3	3	0.4	1.2★	TO-220AB	RCA30C
RCA31C ♦	237	100	25 min.	1	4	40	5	3	0.4	1.2★	TO-220AB	RCA32C
RCS29C ♦	237	100	15-150	1	4	30	3	3	0.4	1.2★	TO-66	RCS30C
RCS31C ♦	237	100	25 min.	1	4	40	5	3	0.4	1.2★	TO-66	RCS32C
2N6466	105	120	5 min.	4	4	40	4	5	–	–	TO-66	2N6468
2N6474	121	120	2 min.	4	2.5	40	4	4	–	–	TO-220AB	2N6476
BUX16	210	200	5 min.	4.5	10	100	5	5	–	–	TO-3	–
2N5239	77	225	5 min.	4.5	10	100	5	5	–	–	TO-3	–
2N5838	102	250	8-40	3	2	100	3	5	0.86	0.4	TO-3	–
BU133	209	250	15-80	1	5	80	3	3.5	–	0.5	TO-3	–
BUX16A	210	250	5 min.	4.5	10	100	5	5	–	–	TO-3	–
2N5839	102	275	10-50	2	3	100	3	5	0.67	0.35	TO-3	–
2N5240	77	300	5 min.	4.5	10	100	5	5	–	–	TO-3	–
BU126	209	300	15-60	1	5	80	3	3.5	–	0.5	TO-3	–
BUX16B	210	300	5 min.	4.5	10	100	5	5	–	–	TO-3	–
2N5840	102	350	10-50	2	3	100	3	5	0.67	0.35	TO-3	–
40852	77	350	12 min.	1.2	1	100	7	5	–	–	TO-3	–
BUX16C	210	350	5 min.	4.5	10	100	5	5	–	–	TO-3	–
I_C = 2.5 to 5 A, f_T = 50 to 100 MHz												
2N3878	66	50	20 min.	4	5	35	4	40	–	–	TO-66	–
2N5202	66	50	10-100	4	1.2	35	4	60	0.44	0.4	TO-66	–
2N6500	66	90	15-60	3	2	35	4	60	0.44	0.5	TO-66	–
I_C = 6 to 10 A, f_T = 0.2 to 1 MHz												
2N1487	33	40	15-45	1.5	4	75	6	0.8	–	–	TO-3	–
2N1489	33	40	25-75	1.5	4	75	6	0.8	–	–	TO-3	–
2N5490	90	40	20-100	2	4	50	7	0.8	5	15★	TO-220AB	2N6109
2N5491	90	40	20-100	2	4	50	7	0.8	5	15★	TO-220AA	2N6108
2N5494	90	40	20-100	3	4	50	7	0.8	5	15★	TO-220AB	2N6109
2N5495	90	40	20-100	3	4	50	7	0.8	5	15★	TO-220AA	2N6108
BD278	189	45	15-75	4	4	75	10	0.8	–	–	TO-220AB	–
2N1488	33	55	15-45	1.5	4	75	6	0.8	–	–	TO-3	–
2N1490	33	55	25-75	1.5	4	75	6	0.8	–	–	TO-3	–
2N5492	90	55	20-100	2.5	4	50	7	0.8	5	15★	TO-220AB	2N6107
2N5493	90	55	20-100	2.5	4	50	7	0.8	5	15★	TO-220AA	2N6106
2N6098	117	60	5 min.	10	4	75	10	0.8	–	–	TO-220AA	–
2N6099	117	60	5 min.	10	4	75	10	0.8	–	–	TO-220AB	–
BD278A	189	60	15-75	4	4	75	10	0.8	–	–	TO-220AB	–
RCA41A/SDH ♦	237	60	15 min.	3	4	75	10	0.8	3.2●	3.7★●	TO-220AB	–
2N5496	90	70	20-100	3.5	4	50	7	0.8	5	15★	TO-220AB	2N6107
2N5497	90	70	20-100	3.5	4	50	7	0.8	5	15★	TO-220AA	2N6106
2N6100	117	70	20-80	5	4	75	10	0.8	–	–	TO-220AA	–
2N6101	117	70	20-80	5	4	75	10	0.8	–	–	TO-220AB	–
RCA41B/SDH ♦	237	80	15 min.	3	4	75	10	0.8	3.2●	3.7★●	TO-220AB	–
2N4348	62	120	10 min.	10	4	120	10	0.2	–	–	TO-3	2N6248
2N3442	52	140	7.5 min.	10	4	117	10	0.8	–	–	TO-3	–
2N6262	52	150	5 min.	10	2	150	10	0.8	–	–	TO-3	–
2N6078	113	250	12-70	1.2	1	45	7	1	0.32	0.3	TO-66	–
2N6077	113	275	12-70	1.2	1	45	7	1	0.32	0.3	TO-66	–
2N6079	113	350	12-50	1.2	1	45	7	1	0.32	0.3	TO-66	–
40851	113	350	12 min.	1.2	1	45	7	1	–	–	TO-66	–
I_C = 6 to 10 A, f_T = 2.5 to 25 MHz												
41500	121	25	25 min.	1	4	40	7	4	–	–	TO-220AB	41501
2N6288	121	30	2.3 min.	7	4	40	7	4	–	–	TO-220AB	2N6111
2N6289	121	30	2.3 min.	7	4	40	7	4	–	–	TO-220AA	2N6110
2N6374	105	40	5 min.	6	4	40	6	4	–	–	TO-66	2N5956
RCA41 ♦	237	40	15-150	3	4	65	7	3	0.6●	1.4★●	TO-220AB	RCA42

▲ Measured at same current level as h_{FE} unless otherwise indicated ● At I_C = 6A ★ t_{OFF}

♦Check availability in Europe, the Middle East, and Africa.

N-P-N SILICON POWER TRANSISTORS (cont'd)

Type No.	DATA-BOOK Page No.	V_{CEO}(sus) V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	f_T MHz	Sw. Times▲ t_{ON} µs	t_f µs	Package	p-n-p Complement
I_C = 6 to 10 A, f_T = 2.5 to 25 MHz (cont'd)												
BD243	186	45	15 min.	3	4	65	7	2	–	–	TO-220AB	BD244
2N6290	121	50	2.3 min.	7	4	40	7	4	–	–	TO-220AB	2N6109
2N6291	121	50	2.3 min.	7	4	40	7	4	–	–	TO-222AA	2N6108
2N6373	105	60	5 min.	6	4	40	6	4	–	–	TO-66	2N5955
BD243A	186	60	15 min.	3	4	65	7	3	–	–	TO-220AB	BD244A
RCA41A♦	237	60	15-150	3	4	65	7	3	0.6●	1.4★●	TO-220AB	RCA42A
2N6292	52	70	2.3 min.	7	4	40	7	4	–	–	TO-220AB	2N6107
2N6293	121	70	2.3 min.	7	4	40	7	4	–	–	TO-220AA	2N6106
2N6372	105	80	5 min.	6	4	40	6	4	–	–	TO-66	2N5954
BD243B	186	80	15 min.	3	4	65	7	3	–	–	TO-220AB	BD244B
RCA41B	237	80	15-150	3	4	65	7	3	0.6●	1.4★●	TO-220AB	RCA42B
BD243C	186	100	15 min.	3	4	65	7	3	–	–	TO-220AB	BD244C
RCA41C	237	100	15-150	3	4	65	7	3	0.6●	1.4★●	TO-220AB	RCA42C
BU106	207	140	8 min.	4	5	75	7	3	–	1.5	TO-3	–
BUX17	213	150	7 min.	10	3	150	10	2.5	2	1	TO-3	–
2N6249	142	200	10-50	10	3	175	10	8	0.8@	0.5	TO-3	–
2N6510	165	200	10-50	3	3	120	7	3	0.8	0.5	TO-3	–
BUX18	216	200	7 min.	6	3	120	8	3	–	0.6♠	TO-3	–
RCA410	237	200	30 min.	1	5	125	7	4	0.35@	0.15	TO-3	–
2N6306	146	250	15-75	3	5	125	8	5	0.6@	0.4	TO-3	–
2N6511	165	250	10-50	4	3	120	7	3	0.8	0.5	TO-3	–
BUX17A	213	250	7 min.	10	3	150	10	2.5	2	1	TO-3	–
RCS579♦	146	250	12 min.	3	5	125	8	5	0.6@	0.4	TO-3	–
2N6250	142	275	8-50	10	3	175	10	8	0.8@	0.5	TO-3	–
BUX18A	216	275	7 min.	5	3	120	8	3	–	0.6♠	TO-3	–
2N6307	146	300	15-75	3	5	125	8	5	0.6@	0.4	TO-3	–
2N6512	165	300	10-50	4	3	120	7	3	1.7	1.5	TO-3	–
2N6514	165	300	10-50	5	3	120	7	3	0.8	0.5	TO-3	–
40854	142	300	8 min.	10	4	175	15	8	–	–	TO-3	–
BUX17B	213	300	7 min.	8	3	150	10	2.5	2	1	TO-3	–
RCA411	237	300	30-90	1	5	125	7	2.5	0.35@	0.15	TO-3	–
BUX18B	216	325	10 min.	4	3	120	8	3	–	0.6♠	TO-3	–
RCA413	237	325	15 min.	1	5	125	7	4	0.35@	0.15	TO-3	–
RCA423	237	325	30-90	1	5	125	7	4	0.35@	0.15	TO-3	–
RCA431	237	325	15-35	2.5	5	125	7	4	0.35@	0.15	TO-3	–
2N6251	142	350	6-50	10	3	175	10	8	0.8@	0.5	TO-3	–
2N6308	146	350	12-60	3	5	125	8	5	0.6@	0.4	TO-3	–
2N6513	165	350	10-50	4	3	120	7	3	0.8	0.5	TO-3	–
BUX17C	213	350	7 min.	8	3	150	10	2.5	2	1	TO-3	–
BUX18C	216	375	10 min.	4	3	120	8	3	–	0.6♠	TO-3	–
I_C = 6 to 10 A, f_T = 50 to 100 MHz												
2N3879	66	75	12-100	4	2	35	7	60	0.44	0.4	TO-66	–
2N6354	72	120	2 min.	10	2	140	10	80	1@	0.2	TO-3	–
I_C = 12 to 20 A, f_T = 0.2 to 1 MHz												
2N6102	117	40	5 min.	16	4	75	16	0.8	–	–	TO-220AA	–
2N6103	117	40	5 min.	16	4	75	16	0.8	–	–	TO-220AB	–
2N6257	59	40	5 min.	20	4	150	20	0.2	–	–	TO-3	–
2N6371	39	40	4 min.	16	4	117	16	0.8	–	–	TO-3	2N6469
RCA41/SDH♦	237	40	15 min.	3	4	75	16	0.8	3.23@	3.7★●	TO-220AB	–
2N6253	39	45	3 min.	15	4	115	15	0.8	–	–	TO-3	–
BD142	178	45	12.5-160	4	4	117	15	0.8	–	–	TO-3	–
BD181	180	45	20-70	3	4	117	15	0.8	–	–	TO-3	–
2N3055	39	60	5 min.	10	4	115	15	0.8	–	–	TO-3	2N6246
2N3772	59	60	5 min.	20	4	150	20	0.2	–	–	TO-3	2N6246
BD182	180	60	20-70	4	4	117	15	0.8	–	–	TO-3	–
RCA3055	117	60	5 min.	10	4	75	15	0.8	–	–	TO-220AB	–
RCS258♦	59	60	5 min.	20	4	250	20	0.2	–	–	TO-3	–
40363	238	70*	20-70	4	4	115	15	0.7	–	–	TO-3	–
2N6254	39	80	5 min.	15	4	150	15	0.8	–	–	TO-3	–

▲ Measured at same current level as h_{FE} unless otherwise indicated   ● At I_C = 6A   ♠ At I_C = 4A   @ t_r ★ t_{OFF}

♦Check availability in Europe, the Middle East, and Africa.

N-P-N SILICON POWER TRANSISTORS (cont'd)

Type No.	DATA-BOOK Page No.	$V_{CEO}(sus)$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	f_T MHz	Sw. Times▲ t_{ON} µs	t_f µs	Package	p-n-p Complement
I_C = 12 to 20 A, f_T = 0.2 to 1 MHz (cont'd)												
BD183	180	80	20-70	3	4	117	15	0.8	–	–	TO-3	–
RCA1B01♦	238	95*	20-70	4	4	115	15	0.8	–	–	TO-3	–
2N3773	62	120	5 min.	16	4	150	16	0.2	–	–	TO-3	–
BDY37	199	140	15-60	8	4	150	16	0.2	–	–	TO-3	–
2N6259	62	150	10 min.	16	4	250	16	0.2	–	–	TO-3	–
I_C = 12 to 20 A, f_T = 2.5 to 25 MHz												
2N6470	138	40	5 min.	15	4	125	15	5	–	–	TO-3	2N6469
2N6486	163	40	5 min.	15	4	75	15	5	–	–	TO-220AB	2N6489
2N6471	131	60	5 min.	15	4	125	15	5	–	–	TO-3	2N6246
2N6487	163	60	5 min.	15	4	75	15	5	–	–	TO-220AB	2N6490
2N6472	138	80	5 min.	15	4	125	15	5	–	–	TO-3	2N6247
2N6488	163	80	5 min.	15	4	75	15	5	–	–	TO-220AB	2N6491
I_C = 12 to 20 A, f_T = 50 to 100 MHz												
2N6479%■	160	60	20-300	12	2	87	12	100	–	–	Radial■	–
2N6481%	160	60	20-300	12	2	117	12	100	–	–	Radial	–
2N5039	72	75	20-100	10	5	140	20	60	0.5@	0.5	TO-3	–
2N6480%■	160	80	20-300	12	2	87	12	100	–	–	Radial■	–
2N6482%	160	80	20-300	12	2	117	12	100	–	–	Radial	–
2N5038	72	90	20-100	12	5	140	20	60	0.5@	0.5	TO-3	–
2N6496	72	110	12-100	8	2	140	15	60	0.5@	0.5	TO-3	–
I_C = 25 to 50 A, f_T = 0.2 to 1 MHz												
2N3771	59	40	5 min.	30	4	150	30	0.2	–	–	TO-3	–
BDY29	201	75	15-60	15	2	220	30	0.2	–	–	TO-3	–
I_C = 25 to 50 A, f_T = 2.5 to 25 MHz												
2N3264	43	60	20-80	15	3	125	25	20	0.5	0.5	Radial	–
2N3266	43	60	20-80	15	3	125	25	20	0.5	0.5	TO-63	–
2N3263	43	90	25-75	15	3	125	25	20	0.5	0.5	Radial	–
2N3265	43	90	25-75	15	3	125	25	20	0.5	0.5	TO-63	–
I_C = 25 to 50 A, f_T = 50 to 100 MHz												
2N6032	110	90	10-50	50	2.6	140	50	50	1@	0.5	Mod. TO-3	–
2N5671	96	90	20-100	15	2	140	30	50	0.5	0.5	TO-3	–
2N6033	110	120	10-50	40	2	140	40	50	1@	0.5	Mod. TO-3	–
2N5672	96	120	20-100	15	2	140	30	50	0.5	0.5	TO-3	–
$I_C \geqslant$ 60 A, f_T = 0.4 MHz												
2N5575	93	50	10-40	60	4	300	80	0.4	15	15	Mod. TO-3	–
2N5578	93	70	10-40	40	3	300	60	0.4	15	15	Mod. TO-3	–

P-N-P SILICON POWER TRANSISTORS

Type No.	DATA-BOOK Page No.	$V_{CEO}(sus)$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	f_T MHz	Sw. Times▲ t_{ON} µs	t_f µs	Package	n-p-n Complement
I_C = –0.15 to –1 A, f_T = 0.2 to 1 MHz												
BFT28	205	–100	20 min.	–0.010	–10	5	–1	25	–	–	TO-39	–
BFT19	203	–150	20 min.	–0.050	–10	5	–1	25	–	–	TO-39	–
BFT28A	205	–150	20 min.	–0.010	–10	5	–1	25	–	–	TO-39	–
RCS880♦	87	–150	20-150	–0.050	–10	7.5	–1	15	–	–	TO-39	–
2N5415	87	–200	30-150	–0.050	–10	10	–1	15	–	–	TO-39	2N3440
BFT28B	205	–200	20 min.	–0.010	–10	5	–1	25	–	–	TO-39	–
BFT19A	203	–250	20 min.	–0.050	–10	5	–1	25	–	–	TO-39	–
BFT28C	205	–250	20 min.	–0.010	–10	5	–1	25	–	–	TO-39	–
RC881♦	87	–250	20 min.	–0.035	–10	7.5	–1	15	–	–	TO-39	–
2N5416	87	–300	30-120	–0.050	–10	10	–1	15	–	–	TO-39	2N3439

▲ Measured at same current level as h_{FE} unless otherwise indicated * $V_{CER}(sus)$ @ t_r ★ t_{OFF}

% Radiation hardened ■ Isolated Collector

♦Check availability in Europe, the Middle East, and Africa.

P-N-P SILICON POWER TRANSISTORS (cont'd)

Type No.	DATA-BOOK Page No.	$V_{CEO}(sus)$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	f_T MHz	Sw. Times▲ t_{ON} µs	t_f µs	Package	n-p-n Complement
I_C = −0.15 to −1 A, f_T = 0.2 to 1 MHz (cont'd)												
RCS882♦	87	−300	20 min.	−0.035	−10	7.5	−1	15	–	–	TO-39	–
BFT19B	203	−350	20 min.	−0.050	−10	5	−1	25	–	–	TO-39	–
I_C = −0.15 to −1 A, f_T = 50 to 100 MHz												
41503	69	−30	20 min.	−0.150	−10	7	−1	60	–	–	TO-39	41502
2N4037	69	−40	50-250	−0.150	−10	7	−1	60	–	–	TO-39	2N3053
2N4036	69	−65	40-140	−0.150	−10	7	−1	60	0.11	0.1	TO-39	2N2102
2N4314	69	−65	50-250	−0.150	−10	7	−1	60	–	–	TO-39	–
I_C = −1.5 to −2 A, f_T = 2.5 to 25 MHz												
BUX66	218	−150	10-150	−1	−5	35	−2	20	0.6@	0.6	TO-66	BUX67
2N6211	136	−225	10-100	−1	−2.8	20	−2	20	0.6@	0.6	TO-66	2N3584
BUX66A	218	−250	10-150	−1	−5	35	−2	20	0.6@	0.6	TO-66	BUX67A
2N6212	136	−300	10-100	−1	−3.2	20	−2	20	0.6@	0.6	TO-66	2N3585
BUX66B	218	−300	10-150	−1	−5	35	−2	20	0.6@	0.6	TO-66	BUX67B
2N6213	136	−350	10-100	−1	−4	20	−2	20	0.6@	0.6	TO-66	2N3585
BUX66C	218	−350	10-150	−1	−5	35	−2	20	0.6@	0.6	TO-66	BUX67C
2N6214	136	−400	10-100	−1	−5	20	−2	20	0.6@	0.6	TO-66	–
I_C = −1.5 to −2 A, f_T = 50 to 100 MHz												
RCP704	233	−30	50 min.	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP705
RCP706	233	−30	20 min.	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP707
RCP700A	233	−40	50-250	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP701A
RCP702A	233	−40	30-150	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP703A
2N5323	84	−50	40-250	−0.5	−4	10	−2	50	0.1	1★	TO-39	2N5321
2N6181	132	−50	40-250	−0.5	−4	25	−2	50	0.1	1★	Plastic TO-5	2N6179
RCP700B	233	−60	50-250	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP701B
RCP702B	233	−60	30-150	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP703B
RCP704B	233	−60	50 min.	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP705B
RCP706B	233	−60	20 min.	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP707B
2N5322	84	−75	30-130	−0.5	−4	10	−2	50	0.1	1★	TO-39	2N5320
2N6180	132	−75	30-150	−0.5	−4	25	−2	50	0.1	1★	Plastic TO-5	2N6178
RCP700C	233	−80	50-250	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP701C
RCP702C	233	−80	30-150	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP703C
RCA1A04♦	238	−95*	50 min.	−0.1	−4	10	−2	50	–	–	TO-39	RCA1A03
RCP700D	233	−100	50-250	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP701D
RCP702D	233	−100	30-150	−0.5	−4	10	−2	50	0.1	1★	TO-202AB	RCP703D
I_C = −2.5 to −5 A, f_T = 2.5 to 25 MHz												
2N5783	98	−40	4 min.	−3.2	−2	10	−3.5	8	0.5○	2.5★○	TO-39#	2N5786
RCA30♦	237	−40	15-150	−1	−4	30	−3	3	0.2	1★	TO-220AB	RCA29
RCA32♦	237	−40	25 min.	−1	−4	40	−5	3	0.2	1★	TO-220AB	RCA31
RCS30♦	237	−40	15-150	−1	−4	30	−3	3	0.2	1★	TO-66	RCS29
RCS32♦	237	−40	25 min.	−1	−4	40	−5	3	0.2	1★	TO-66	RCS31
BD240	182	−45	15 min.	−1	−4	30	−4	3	–	–	TO-220AB	BD239
BD242	182	−45	25 min.	−1	−4	40	−5	3	–	–	TO-220AB	BD241
2N5782	98	−50	4 min.	−3.2	−4	10	−3.5	8	0.5○	2.5★○	TO-39#	2N5785
BD240A	182	−60	15 min.	−1	−4	30	−4	3	–	–	TO-220AB	BD239A
BD242A	184	−60	10 min.	−3	−4	40	−5	3	–	–	TO-220AB	BD241A
RCA30A♦	237	−60	15-150	−1	−4	30	−5	3	0.2	1★	TO-220AB	RCA29A
RCA32A♦	237	−60	25 min.	−1	−4	40	−5	3	0.2	1★	TO-220AB	RCA31A
RCS30A♦	237	−60	15-150	−1	−4	30	−3	3	0.2	1★	TO-66	RCS29A
RCS32A♦	237	−60	25 min.	−1	−4	40	−5	3	0.2	1★	TO-66	RCS31A
2N5781	98	−65	20-100	−1	−2	10	−3.5	8	0.5	2.5★	TO-39#	2N5784
BD240B	182	−80	15 min.	−1	−4	30	−4	3	–	–	TO-220AB	BD239B
BD242B	184	−80	25 min.	−1	−4	40	−5	3	–	–	TO-220AB	BD241B
RCA30B♦	237	−80	15-150	−1	−4	30	−3	3	0.2	1★	TO-220AB	RCA29B
RCA32B♦	237	−80	25 min.	−1	−4	40	−5	3	0.2	1★	TO-220AB	RCA31B
RCS30B♦	237	−80	15-150	−1	−4	30	−3	3	0.2	1★	TO-220AB	RCS29B
RCS32B♦	237	−80	25 min.	−1	−4	40	−5	3	0.2	1★	TO-66	RCS31B
2N6467	105	−100	5 min.	−4	−4	40	−4	5	–	–	TO-66	2N6465
2N6475	121	−100	2 min.	−2.5	−4	40	−4	10	–	–	TO-220AB	2N6473
BD240C	182	−100	15 min.	−1	−4	30	−4	3	–	–	TO-220AB	BD239C
BD242C	184	−100	10 min.	−3	−4	40	−5	3	–	–	TO-220AB	BD241C

▲Measured at same current level as h_{FE} unless otherwise indicated ○At I_C = 1A @ t_r ★ t_{OFF}

♦Check availability in Europe, the Middle East, and Africa.

P-N-P SILICON POWER TRANSISTORS (cont'd)

Type No.	DATA-BOOK Page No.	$V_{CEO}(sus)$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	f_T MHz	Sw. Times▲ t_{ON} µs	t_f µs	Package	n-p-n Complement
I_C = −2.5 to −5 A, f_T = 2.5 to 25 MHz												
RCA30C ♦	237	−100	15-150	−1	−4	30	−3	3	0.2	1★	TO-220AB	RCA29C
RCA32C ♦	237	−100	25 min.	−1	−4	40	−5	3	0.2	1★	TO-220AB	RCA31C
RCS30C ♦	237	−100	15-150	−1	−4	30	−3	3	0.2	1★	TO-66	RCS29C
RCS32C ♦	237	−100	25 min.	−1	−4	40	−5	3	0.2	1★	TO-66	RCS31C
2N6468	105	−120	5 min.	−4	−4	40	−4	5	–	–	TO-66	2N6466
2N6476	121	−120	2 min.	−4	−2.5	40	−4	10	–	–	TO-220AB	2N6474
I_C = −6 to −10 A, f_T = 2.5 to 25 MHz												
41501	121	−25	25 min.	−1	−4	40	−7	10	–	–	TO-220AB	41500
2N6110	121	−30	2.3 min.	−7	−4	40	−7	10	–	–	TO-220AA	2N6289
2N6111	121	−30	2.3 min.	−7	−4	40	−7	10	–	–	TO-220AB	2N6288
2N5956	105	−40	5 min.	−6	−4	40	−6	5	–	–	TO-66	2N6374
RCA42 ♦	237	−40	15-150	−3	−4	65	−7	3	0.3●	0.7★●	TO-220AB	RCA41
BD244	186	−45	15 min.	−3	−4	65	−7	3	–	–	TO-220AB	BD243
BD277	188	−45	30-150	−1.75	−2	70	−7	10	–	–	TO-220AB	–
2N6108	121	−50	2.3 min.	−7	−4	40	−7	10	–	–	TO-220AA	2N6291
2N6109	121	−50	2.3 min.	−7	−4	40	−7	10	–	–	TO-220AB	2N6290
2N5955	105	−60	5 min.	−6	−4	40	−6	5	–	–	TO-66	2N6373
BD244A	186	−60	15 min.	−3	−4	65	−7	3	–	–	TO-220AB	BD243A
RCA42A ♦	237	−60	15-150	−3	−4	65	−7	3	0.3●	0.7★●	TO-220AB	RCA41A
2N6106	121	−70	2.3 min.	−7	−4	40	−7	10	–	–	TO-220AA	2N6293
2N6107	121	−70	2.3 min	−7	−4	40	−7	10	–	–	TO-220AB	2N6292
2N5954	105	−80	5 min.	−6	−4	40	−6	5	–	–	TO-66	2N6372
BD244B	186	−80	15 min.	−3	−4	65	−7	3	–	–	TO-220AB	BD243B
RCA42B ♦	237	−80	15-150	−3	−4	65	−7	3	0.3●	0.7★●	TO-220AB	RCA41B
2N6248	142	−100	5 min.	−10	−4	125	−10	10	–	–	TO-3	–
BD244C	186	−100	15 min.	−3	−4	65	−7	3	–	–	TO-220AB	BD243C
RCA42C ♦	237	−100	15-150	−3	−4	65	−7	3	0.3●	0.7★●	TO-220AB	RCA41C
I_C = −12 to −20 A, f_T = 2.5 to 25 MHz												
2N6469	138	−40	5 min.	−15	−4	125	−15	5	–	–	TO-3	2N6470
2N6489	163	−40	5 min.	−15	−4	75	−15	5	–	–	TO-220AB	2N6486
2N6246	138	−60	5 min.	−15	−4	125	−15	5	–	–	TO-3	2N6471
2N6490	163	−60	5 min.	−15	−4	75	−15	5	–	–	TO-220AB	2N6487
2N6247	138	−80	5 min.	−15	−4	125	−15	5	–	–	TO-3	2N6472
2N6491	163	−80	5 min.	−15	−4	75	−15	5	–	–	TO-220AB	2N6488

N-P-N MONOLITHIC DARLINGTON TRANSISTORS

Type No.	DATA-BOOK Page No.	$V_{CEO}(sus)$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	Package	p-n-p Complement
I_C(Max.) = 8 A, $f_{UNITY\ GAIN}$ = 20 MHz for all types									
2N6055	149	60	750-18,000	4	3	100	8	TO-3	–
RCA120 ♦	153	60	1000 min.	3	3	65	8	TO-220AB	RCA125
RCA1000	149	60	1000 min.	3	3	90	8	TO-3	–
2N6056	149	80	750-18,000	4	3	100	8	TO-3	–
2N6530	168	80	1000-10,000	5	3	65	8	TO-220AB	–
2N6534	172	80	1000-10,000	5	3	36	8	TO-66	–
RCA121 ♦	153	80	1000 min.	3	3	65	8	TO-220AB	RCA126
RCA1001	149	80	1000 min.	3	3	90	8	TO-3	–
2N6531	168	100	500-10,000	3	3	65	8	TO-220AB	–
2N6532	168	100	1000-10,000	5	3	65	8	TO-220AB	–
2N6535	172	100	500-10,000	3	3	36	8	TO-66	–
2N6536	172	100	1000-10,000	5	3	36	8	TO-66	–
RCA122 ♦	153	100	1000 min.	3	3	65	8	TO-220AB	–
2N6533	168	120	1000-10,000	3	3	65	8	TO-220AB	–
2N6537	172	120	1000-10,000	3	3	36	8	TO-66	–

▲ Measured at same current level as h_{FE} unless otherwise indicated ● At I_C = 6A ★ t_{OFF}

♦ Check availability in Europe, the Middle East, and Africa.

N-P-N MONOLITHIC DARLINGTON TRANSISTORS (cont'd)

Type No.	DATA-BOOK Page No.	$V_{CEO}(sus)$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	Package	p-n-p Complement
I_C(Max.) = 10 A, $f_{UNITY\ GAIN}$ = 20 MHz for all types									
2N6383	149	40	1000-20,000	5	3	100	10	TO-3	RCA8350
2N6386	153	40	1000-10,000	3	3	65	10	TO-220AB	RCA8203
BDX33	191	45	750 min.	4	3	70	10	TO-220AB	BDX34
BDX83	194	45	1000 min.	5	3	125	10	TO-3	–
2N6384	149	60	1000-20,000	5	3	100	10	TO-3	RCA8350A
2N6387	153	60	1000-20,000	5	3	65	10	TO-220AB	RCA8203A
BDX33A	191	60	750 min.	4	3	70	10	TO-220AB	BDX34A
BDX83A	194	60	1000 min.	5	3	125	10	TO-3	–
2N6385	149	80	1000-20,000	5	3	100	10	TO-3	RCA8350B
2N6388	153	80	1000-20,000	5	3	65	10	TO-220AB	RCA8203B
BDX33B	191	80	750 min.	3	3	70	10	TO-220AB	RDX34B
BDX83B	194	80	1000 min.	5	3	125	10	TO-3	–
BDX33C	191	100	750 min.	3	3	70	10	TO-220AB	BDX34C
BDX83C	194	100	1000 min.	5	3	125	10	TO-3	–
BDX33D	191	120	750 min.	3	3	70	10	TO-220AB	–

P-N-P MONOLITHIC DARLINGTON TRANSISTORS

Type No.	DATA-BOOK Page No.	$V_{CEO}(sus)$ V	Current Gain h_{FE}	I_C A	V_{CE} V	P_T (Max.) W	I_C (Max.) A	Package	n-p-n Complement
I_C = –8 A, $f_{UNITY\ GAIN}$ = 20 MHz for all types									
RCA8203	222	–40	1000-20,000	–3	–3	65	–8	TO-220AB	2N6386
RCA125 ♦	222	–60	1000 min.	–3	–3	65	–8	TO-220AB	RCA120
RCA126 ♦	222	–80	1000 min.	–3	–3	65	–8	TO-220AB	RCA121
I_C = –10 A, $f_{UNITY\ GAIN}$ = 20 MHz for all types									
RCA8350	226	–40	1000-20,000	–5	–3	70	–10	TO-3	2N6383
BDX34	191	–45	750 min.	–4	–3	70	–10	TO-22AB	BDX33
BDX34A	191	–60	750 min.	–4	–3	70	–10	TO-220AB	BDX33A
RCA8203A	222	–60	1000-20,000	–5	–3	65	–10	TO-220AB	2N6387
RCA8350A	226	–60	1000-20,000	–5	–3	70	–10	TO-3	2N6384
BDX34B	191	–80	750 min.	–3	–3	70	–10	TO-220AB	BDX33B
RCA8203B	222	–80	1000-10,000	–5	–3	65	–10	TO-220AB	2N6388
RCA8350B	226	–80	1000-20,00	–5	–3	70	–10	TO-3	2N6385
BDX34C	191	–100	750 min.	–3	–3	70	–10	TO-220AB	BDX33C

♦Check availability in Europe, the Middle East, and Africa.

RCA Power-Transistor Cross Reference Guide

This guide provides a quick reference to more than 625 industry power transistors and their nearest RCA replacements. The nearest RCA device is determined on the basis of electrical similarity as well as package similarity.

INDUSTRY No.	RCA No.	INDUSTRY No.	RCA No.	INDUSTRY No.	RCA No.	INDUSTRY No.	RCA No.	INDUSTRY No.	RCA No.	INDUSTRY No.	RCA No.
DTS410	RCA410	D44H2	2N6288	MJE2101	2N6387	MJ3701	2N5956	SDT413	RCA413	SDT6902	2N6078
DTS411	RCA411	D44H4	2N6290	MJE2102	2N6388	MJ3771	2N3771	SDT423	RCA423	SDT6903	2N6078
DTS413	RCA413	D44H5	2N6290	MJE2103	2N6388	MJ3772	2N3772	SDT431	RCA431	SDT6904	2N6078
DTS423	RCA423	D44H7	2N6292	MJE2370	2N6109	MJ4000	RCA1000	SDT3550	2N5781	SDT6905	2N6078
DTS431	RCA431	D44H8	2N6292	MJE2371	2N6107	MJ4001	RCA1001	SDT3552	2N5783	SDT6906	2N6078
D40D1	RCP707	D44H10	2N6292	MJE2480	2N6290	MJ4010	RCA8350	SDT3553	2N5781	SDT6907	2N6078
D40D2	RCP707	D44H11	2N6292	MJE2481	2N6292	MJ4011	RCA8350	SDT3575	2N5956	SDT6908	2N6078
D40D3	RCP707	D45C1	2N6111	MJE2482	2N6290	MJ4502	2N6248	SDT3576	2N5955	SDT7601	2N5039
D40D4	RCP707	D45C2	2N6111	MJE2483	2N6292	MJ5600	2N3772	SDT3577	2N5954	SDT7602	2N5039
D40D5	RCP707	D45C3	2N6111	MJE2490	2N6109	MJ5601	2N6258	SDT3701	2N5956	SDT7603	2N5038
D40D6	RCP701B	D45C4	2N6109	MJE2491	2N6107	MJ5602	2N3773	SDT3702	2N5955	SDT7605	2N6249
D40D7	RCP701B	D45C5	2N6109	MJE2520	2N6290	MJ5603	2N3773	SDT3703	2N5956	SDT7607	2N5039
D40D8	RCP701B	D45C6	2N6109	MJE2521	2N6292	MJ6000	2N3772	SDT3704	2N5955	SDT7608	2N5039
D40D10	RCP701C	D45C7	2N6107	MJE2522	2N6290	MJ6001	2N6258	SDT3705	2N5954	SDT7609	2N5038
D40D11	RCP701C	D45C8	2N6107	MJE2523	2N6292	MJ6002	2N3773	SDT3706	2N5956	SDT7610	2N6249
D40N1	RCP113B	D45C9	2N6107	MJE2801	2N6099	MJ6003	2N6258	SDT3707	2N5955	SDT7611	2N6249
D40N2	RCP111B	D45C10	2N6107	MJE2901	2N6107	MJ6004	2N6258	SDT3708	2N5955	SDT7612	2N6249
D40N3	RCP113C	D45C11	2N6107	MJE2955	2N6107	MJ7000	2N3265	SDT3709	2N5956	SDT7731	2N6254
D40N4	RCP111C	D45H1	2N6111	MJE3054	RCA3054	MJ9000	2N5805	SDT3710	2N5955	SDT7732	2N6254
D40P1	2N6175	D45H2	2N6111	MJE3055	RCA3055	MPSU01	RCP705	SDT3711	2N5955		
D40P3	2N6175	D45H4	2N6109	MJE3740	2N6107	MPSU02	RCP701B	SDT3712	2N5956	SDT7733	2N6254
D40P5	2N6175	D45H5	2N6109	MJE3741	2N6107	MPSU05	RCP701B	SDT3713	2N5955	SDT7734	2N3773
D41D1	RCP706	D45H7	2N6107	MJE6040	RCA125	MPSU06	RCP701C	SDT3714	2N5954	SDT7735	2N3773
D41D2	RCP706	D45H8	2N6107	MJE6041	RCA125	MPSU07	RCP701D	SDT3715	2N5956	SDT7736	2N6259
D41D4	RCP700B	D45H10	2N6107	MJE6042	RCA126	MPSU10	RCP111D	SDT3716	2N5956	SDT8002	2N3266
D41D5	RCP700B	D45H11	2N6107	MJE6043	2N6531	MPSU51	RCP704	SDT3717	2N5955	SDT8003	2N3265
D41D6	RCP700B	MJE101	RCA101	MJE6044	2N6531	MPSU52	RCP700A	SDT3718	2N5954	SDT8012	2N3266
D41D7	RCP700B	MJE102	RCA102	MJE6045	2N6531	MPSU55	RCP700B	SDT3720	2N5956	SDT8013	2N3265
D41D8	RCP700B	MJE103	RCA103	MJ400	2N3585	MPSU56	RCP700C	SDT3721	2N5956	SDT8015	2N3266
D41D10	RCP700C	MJE104	RCA104	MJ410	RCA410	MPSU57	RCP700D	SDT3722	2N5955	SDT8016	2N3265
D41D11	RCP700C	MJE105	RCA105	MJ411	RCA411	NSD102	RCP701B	SDT3723	2N5954	SDT8105	2N3264
D42C1	2N6288	MJE201	RCA201	MJ413	RCA413	NSD103	RCP701B	SDT3725	2N5956	SDT8106	2N3263
D42C2	2N6288	MJE202	RCA202	MJ423	RCA423	NSD104	RCP701C	SDT3726	2N5956	SDT8112	2N3264
D42C3	2N6288	MJE203	RCA203	MJ431	RCA431	NSD105	RCP701C	SDT3727	2N5955	SDT8113	2N3263
D42C4	2N6290	MJE204	RCA204	MJ450	2N6246	NSD106	RCP701D	SDT3728	2N5954	SDT8301	2N3266
D42C5	2N6290	MJE205	RCA205	MJ490	2N6246	NSD131	RCP113B	SDT3729	2N5956	SDT8302	2N3265
D42C6	2N6290	MJE370	RCA370	MJ491	2N6246	NSD132	RCP111B	SDT3730	2N5955	SDT8303	2N3266
D42C7	2N6292	MJE371	RCA371	MJ802	RCA258	NSD133	RCP113C	SDT3731	2N5954	SDT8304	2N3265
D42C8	2N6292	MJE520	RCA520	MJ900	RCA8203A	NSD134	RCP111C	SDT3733	2N5956	SDT9201	2N3055
D42C9	2N6292	MJE521	RCA521	MJ901	RCA8203B	NSD135	RCP111D	SDT3750	2N6246	SDT9202	2N6254
D42C10	2N6292	MJE700	RCA125	MJ1000	RCA1000	NSD202	RCP700B	SDT3751	2N6246	SDT9203	2N4348
D42C11	2N6292	MJE701	RCA126	MJ1001	RCA1001	NSD203	RCP700B	SDT3752	2N6246	SDT9204	2N4348
D43C1	2N6111	MJE702	RCA126	MJ1800	2N5838	NSD204	RCP700C	SDT3753	2N6246	SDT9205	2N3055
D43C2	2N6111	MJE703	RCA126	MJ2249	2N3879	NSD205	RCP700C	SDT3754	2N6247	SDT9206	2N3055
D43C3	2N6111	MJE800	RCA120	MJ2250	2N3879	NSD206	RCP700D	SDT3755	2N6248	SDT9207	2N6254
D43C4	2N6109	MJE801	RCA120	MJ2251	2N3584	SD1345	2N6290	SDT3756	2N6246	SDT9208	2N4348
D43C5	2N6109	MJE802	RCA121	MJ2252	2N3585	SD1445	2N6109	SDT3757	2N6246	SDT9209	2N4348
D43C6	2N6109	MJE803	RCA121	MJ2253	2N5955	SDJ345	2N6290	SDT3758	2N6246	SDT9210	2N6253
D43C7	2N6107	MJE1090	RCA8203	MJ2254	2N5954	SDJ445	2N6109	SDT3759	2N6247	SDT9701	2N6258
D43C8	2N6107	MJE1091	RCA8203A	MJ2267	2N6246	SDK345	2N6290	SDT3760	2N6248	SDT9702	2N3773
D43C9	2N6107	MJE1092	RCA8203B	MJ2268	2N6246	SDK445	2N6109	SDT3761	2N6246	SDT9703	2N3773
D43C10	2N6107	MJE1093	RCA8203B	MJ2500	RCA8350	SDL345	2N6292	SDT3762	2N6246	SDT9704	2N6254
D43C11	2N6107	MJE1100	2N6388	MJ2501	RCA8350	SDL445	2N6107	SDT3763	2N6246	SDT9705	2N3773
D44C1	2N6288	MJE1101	2N6388	MJ2801	40251	SDM3100	2N6534	SDT3764	2N6247	SDT9706	2N3773
D44C2	2N6288	MJE1102	2N6388	MJ2840	2N3055	SDM3101	2N6535	SDT3765	2N6248	SDT9707	2N3055
D44C3	2N6288	MJE1103	2N6388	MJ2841	2N6254	SDM3102	2N6536	SDT3766	2N6246	SDT9801	2N6254
D44C4	2N6290	MJE1290	2N6109	MJ2901	2N6246	SDM3103	2N6535	SDT3825	2N6246	SDT9802	2N6254
D44C5	2N6290	MJE1291	2N6107	MJ2940	2N6246	SDM3104	2N6535	SDT3826	2N6247	SDT9803	2N6254
D44C6	2N6290	MJE1660	2N6103	MJ2941	2N6247	SDM3105	2N6535	SDT3827	2N6246	SDT9804	2N3773
D44C7	2N6292	MJE1661	2N6101	MJ3000	2N6385	SDM20301	2N6384	SDT4901	2N6078	SE9300	2N6055
D44C8	2N6292	MJE2090	RCA8203	MJ3001	2N6385	SDM20302	2N6384	SDT4902	2N6078	SE9301	2N6055
D44C9	2N6292	MJE2091	RCA8203A	MJ3026	2N5839	SDM20303	2N6385	SDT4903	2N6078	SE9302	2N6056
D44C10	2N6292	MJE2092	RCA8203B	MJ3027	2N5840	SDM20304	2N6385	SDT4904	2N6077	SE9303	RCA8350
D44C11	2N6292	MJE2093	RCA203B	MJ3202	2N3585	SDT410	RCA410	SDT4905	2N6079	SE9304	RCA8350A
D44H1	2N6288	MJE2100	2N6387	MJ3430	2N5840	SDT411	RCA411	SDT6901	2N6078	SE9305	RCA8350B

INDUSTRY No.	RCA No.
SPC410	RCA410
SPC411	RCA411
SPC413	RCA413
SPC423	RCA423
SPC431	RCA431
STS410	RCA410
STS411	RCA411
STS413	RCA413
STS423	RCA423
STS431	RCA431
TIP29	RCA29
TIP29A	RCA29A
TIP29B	RCA29B
TIP29C	RCA29C
TIP30	RCA30
TIP30A	RCA30A
TIP30B	RCA30B
TIP30C	RCA30C
TIP31	RCA31
TIP31A	RCA31A
TIP31B	RCA31B
TIP31C	RCA31C
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TIP32A	RCA32A
TIP32B	RCA32B
TIP32C	RCA32C
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TIP41B	RCA41B
TIP41C	RCA41C
TIP42	RCA42
TIP42A	RCA42A
TIP42B	RCA42B
TIP42C	RCA42C
TIP120	RCA120
TIP121	RCA121
TIP122	RCA122
TIP125	RCA125
TIP126	RCA126
TIP127	RCA8203B
TIP140	2N6387
TIP141	2N6530
TIP142	2N6531
TIP145	RCA8203
TIP146	RCA8203A
TIP147	RCA8203B
TIP640	2N6384
TIP641	2N6385
TIP642	2N6385
TIP645	RCA8350
TIP646	RCA8350A
TIP647	RCA8350B
TIP2955	2N6247
TIP3055	RCA3055
2N3036	2N5320
2N3122	2N5321
2N3171	2N6246
2N3172	2N6246
2N3173	2N6247
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2N3197	2N6247
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2N3203	2N5781
2N3208	2N5783
2N3224	2N5415
2N3225	2N5415
2N3226	2N6253
2N3232	2N3055
2N3233	2N3442
2N3234	2N6262
2N3235	2N3055
2N3236	2N6254
2N3237	2N6258
2N3238	2N6258
2N3239	2N6258
2N3240	2N6259
2N3464	2N3053
2N3597	2N3266
2N3598	2N3266
2N3599	2N3265
2N3712	2N3440
2N3713	2N3055
2N3714	2N6254
2N3715	2N3055
2N3716	2N6254
2N3738	2N3584
2N3739	2N3585
2N3740	2N5955
2N3741	2N5954
2N3742	2N3439
2N3743	2N5416
2N3766	2N3879
2N3767	2N3879
2N3774	2N5783
2N3775	2N5781
2N3778	2N5783
2N3779	2N5781
2N3782	2N5783
2N3788	2N5840
2N3789	2N6246
2N3790	2N6247
2N3791	2N6246
2N3792	2N6247
2N3795	2N5415
2N3863	2N3055
2N3864	2N3442
2N3865	2N6262
2N3902	2N5840
2N3945	2N2102
2N4000	2N5320
2N4002	2N3265
2N4004	2N3263
2N4054	2N6176
2N4055	2N6175
2N4056	2N6175
2N4057	2N6175
2N4070	2N5038
2N4071	2N6249
2N4210	2N3266
2N4211	2N3265
2N4231	2N6374
2N4232	2N6373
2N4233	2N6372
2N4234	2N5783
2N4235	2N5781
2N4237	2N5786
2N4238	2N5784
2N4387	2N5956
2N4388	2N5955
2N4438	2N3439
2N4898	2N5956
2N4899	2N5955
2N4900	2N5954
2N4901	2N6246
2N4902	2N6246
2N4903	2N6247
2N4904	2N6246
2N4905	2N6246
2N4906	2N6247
2N4907	2N6246
2N4908	2N6246
2N4909	2N6247
2N4910	2N6260
2N4911	2N3054
2N4912	2N6261
2N4913	2N6253
2N4914	2N3055
2N4915	2N6254
2N4926	2N3440
2N4927	2N3440
2N4930	2N5415
2N4931	2N5416
2N5050	2N3584
2N5051	2N3584
2N5052	2N3584
2N5058	2N3439
2N5059	2N3440
2N5067	2N6253
2N5068	2N3055
2N5069	2N6254
2N5091	2N5416
2N5092	2N3439
2N5110	2N5783
2N5157	2N5840
2N5241	2N5805
2N5264	2N5804
2N5279	2N3439
2N5280	2N4063
2N5281	2N5415
2N5282	2N5416
2N5301	2N6258
2N5302	2N6258
2N5303	2N6258
2N5331	2N3265
2N5344	2N6211
2N5345	2N6212
2N5539	2N3265
2N5560	2N3265
2N5597	2N5955
2N5598	2N5202
2N5599	2N5954
2N5600	2N3879
2N5601	2N5954
2N5602	2N3879
2N5608	2N3879
2N5613	2N6246
2N5614	2N5039
2N5615	2N6247
2N5616	2N5038
2N5617	2N6247
2N5618	2N5038
2N5619	2N6248
2N5620	2N5038
2N5624	2N5038
2N5628	2N5038
2N5629	2N6259
2N5630	2N6259
2N5631	2N6259
2N5632	2N3773
2N5633	2N3773
2N5634	2N3773
2N5655	2N6175
2N5656	2N6176
2N5657	2N6177
2N5660	2N6078
2N5661	2N6079
2N5664	2N6078
2N5665	2N6079
2N5685	2N6032
2N5686	2N6032
2N5732	2N5671
2N5733	2N3265
2N5734	2N5671
2N5737	2N6246
2N5738	2N6248
2N5758	2N6262
2N5759	2N6262
2N5760	2N6262
2N5867	2N6246
2N5868	2N6247
2N5869	2N6471
2N5870	2N6472
2N5871	2N6246
2N5872	2N6247
2N5873	2N6471
2N5874	2N6472
2N5875	2N6246
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2N5885	2N6258
2N5886	2N6258
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2N5930	2N5672
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2N5933	2N5672
2N5935	2N6032
2N5936	2N6033
2N5968	2N3265
2N5970	2N6254
2N5971	2N6254
2N5972	2N6254
2N5973	2N6254
2N6034	RCA8203
2N6035	RCA125
2N6036	RCA126
2N6037	2N6386
2N6038	RCA120
2N6039	RCA121
2N6040	RCA125
2N6041	RCA126
2N6042	RCA126
2N6043	RCA120
2N6044	RCA121
2N6045	2N6531
2N6046	2N3266
2N6047	2N3265
2N6048	2N3265
2N6049	2N5955
2N6062	2N3265
2N6063	2N3265
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2N6054	RCA8350
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2N6123	2N6292
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2N6125	2N6109
2N6126	2N6107
2N6129	2N6290
2N6130	2N6290
2N6131	2N6292
2N6132	2N6109
2N6133	2N6109
2N6134	2N6107
2N6226	2N6248
2N6229	2N6248
2N6233	2N6078
2N6234	2N6077
2N6235	2N6079
2N6270	2N5671
2N6271	2N5672
2N6294	2N6384
2N6295	2N6385
2N6296	RCA8350
2N6297	RCA8350
2N6300	2N6534
2N6301	2N6534
2N6312	2N5956
2N6313	2N5955
2N6314	2N5954
2N6338	2N5672
2N6339	2N5672
2N6554	RCP700B
2N6555	RCP700C
2N6556	RCP700D
2N6557	RCP111B
2N6558	RCP111C
2N6559	RCP111D

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 40366, 40389, 40392, 41502

Low-Power Silicon N-P-N Planar Transistors

For Small-Signal Applications In Industrial and Commercial Equipment

These RCA types are silicon n-p-n planar transistors intended for a variety of small-signal and medium-power applications. They feature exceptionally high collector-to-emitter sustaining voltage, low leakage characteristics, high switching speeds, and high pulse beta (h_{FE}).

RCA-2N2102 is a direct replacement for the 2N1613. RCA-2N2405 is a direct replacement for the 2N1893. All of these devices are supplied in the JEDEC TO-39 hermetic package.

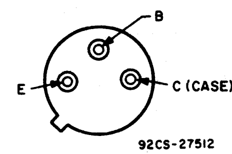
Features:

- Planar construction for low noise and low leakage
- Low output capacitance
- Low saturation voltages

Additional Features for 40366:

- High reliability assured by five pre-conditioning steps
- Group A test data included in data sheet.

TERMINAL DESIGNATIONS



JEDEC TO-39

Maximum Ratings, *Absolute-Maximum Values:*

		2N697	2N699	2N2102 40366	2N1613 2N1711	2N1893	2N2270	2N2405	2N3053 40389 40392	41502	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	120	120	75	120	60	120	60	–	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:											
With external base-to-emitter resistance (R_{BE}) ≤ 10 Ω	$V_{CER}(sus)$	–	80	80	50	100	60	140	50	–	V
With base-emitter junction reverse-biased	$V_{CEV}(sus)$	–	–	–	–	120	–	120	60	–	V
* With base open	$V_{CEO}(sus)$	–	–	65	–	80	45	90	40	30	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	7	7	7	7	7	5	4	V
* COLLECTOR CURRENT	I_C	0.5	1	1	1	0.5	1	1	0.7	1	A
* TRANSISTOR DISSIPATION:	P_T										
At case temperatures up to 25°C		2	2	5	3	3	5	5	5●	3	W
At free-air temperatures up to 25°C		0.6	0.6	1	0.8	0.8	1	1	1■	0.8	W
At temperatures above 25°C		Derate linearly to maximum temperature									
* TEMPERATURE RANGE:											
Storage	T_{stg}	−65 to +175		−65 to 200							°C
Operating (Junction)	T_C	−65 to +175		−65 to 200							°C
* LEAD TEMPERATURE (During soldering): At distance from seating plane for 10 s max. ≥ 1/16 in. (1.58 mm)	T_L	255	230	300	300	255	230	255	235	300	°C

* 2N-Series types in accordance with JEDEC registration data

●7 for 40392. ■3.5 for 40389

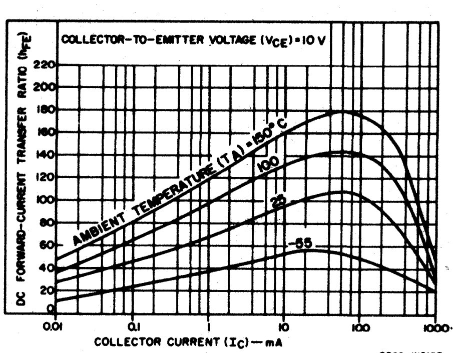


Fig. 1 - Typical dc beta characteristics for 2N699, 2N1613, 2N2102, 2N2270, 41502.

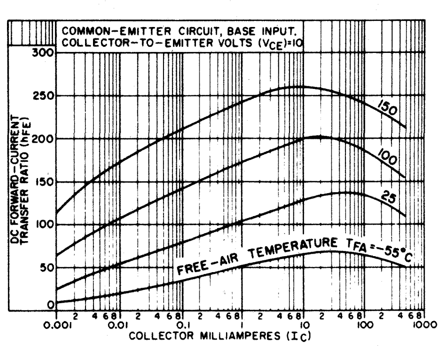


Fig. 2 - Typical dc beta characteristics for 2N1711.

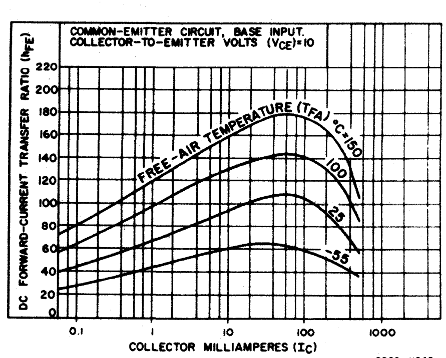


Fig. 3 - Typical dc beta characteristics for 2N1893, 2N2405.

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102 , 2N2270, 2N2405, 2N3053, 40366, 40389, 40392, 41502

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CB}	V_{CE}	CURRENT mA dc I_C	I_B	LIMITS 2N697 MIN.	2N697 TYP.	2N697 MAX.	2N699 MIN.	2N699 MAX.	2N1613 MIN.	2N1613 MAX.	2N2102 40366 MIN.	2N2102 40366 MAX.	2N1711 MIN.	2N1711 MAX.	UNITS
* Collector Cutoff Current:		30				–	0.01	1	–	–	–	–	–	–	–	–	
With emitter open	I_{CBO}	60				–	–	–	–	0.05	–	0.01	–	0.002	–	0.01	μA
At T_C = 150°C		60				–	–	–	–	–	–	10	–	2	–	10	
* Emitter Cutoff Current: V_{EB} = 5 V	I_{EBO}			0		–	–	–	–	0.05	–	0.01	–	0.002	–	0.005	μA
* DC Forward-Current Transfer Ratio	h_{FE}		10	0.01		–	–	–	–	–	–	–	10	–	20	–	
			10	0.1		–	–	–	–	–	20	–	20	–	35	–	
			10	10[a]		–	–	–	–	–	35	–	35	–	75	–	
			10	150[a]		40	–	120	40	120	40	120	40	120	100	300	
			10	500[a]		–	–	–	–	–	20	–	25	–	40	–	
At T_C = −55°C			10	10[a]		–	–	–	–	–	20	–	20	–	35	–	
* Collector-to-Emitter Reachthrough Voltage: V_{EB} = 1.5 V, I_E = 0	V_{RT}					–	–	–	–	–	–	–	120	–	75	–	V
* Collector-to-Base Breakdown Voltage: With emitter open	$V_{(BR)CBO}$			0.1		60	75	–	120	–	75	–	120	–	75	–	V
* Emitter-to-Base Breakdown Voltage: I_E = 0.1 mA	$V_{(BR)EBO}$			0		5	7.5	–	–	–	7	–	7	–	7	–	V
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO(sus)}$			100[a]	0	–	–	–	–	–	–	–	65	–	–	–	V
With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER(sus)}$			100[a]		40	60	–	80	–	50	–	80	–	50	–	V
* Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$			150[a]	15	–	1	1.3	–	1.3	–	1.3	–	1.1	–	1.3	V
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			150[a]	15	–	0.7	1.5	–	5	–	1.5	–	0.5	–	1.5	V
* Common-Emitter, Small-Signal, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}		5	1		–	–	–	35	100	30	100	30	100	50	200	
			10	5		–	–	–	45	–	35	150	35	150	70	300	
Magnitude of Common-Emitter, Small-Signal, Forward Current Transfer Ratio (f = 20 MHz)	$\|h_{fe}\|$		10	50		2.5	5	–	2.5	–	3	–	3	–	3.5	–	
* Input Resistance: f = 1 kHz	h_{ib}	5		1		–	–	–	20	30	24	34	24	34	24	34	Ω
		10		5		–	–	–	–	10	4	8	4	8	4	8	
* Small-Signal Reverse Voltage Transfer (Feedback) Ratio: f = 1 kHz	h_{rb}	5		1		–	–	–	–	3×10^{-4}	–	3×10^{-4}	–	3×10^{-4}	–	5×10^{-4}	
		10		1		–	–	–	–	–	–	3×10^{-4}	–	–	–	–	
		10		5		–	–	–	–	3×10^{-4}	–	–	–	3×10^{-4}	–	5×10^{-4}	
* Output Conductance: f = 1 kHz	h_{ob}	5		1		–	–	–	0.05	0.5	0.05	0.5	0.01	0.5	0.05	0.5	μmho
		10		5		–	–	–	–	1	0.05	0.5	0.01	1	0.05	0.5	
* Output Capacitance: I_E = 0	C_{ob}	10				–	20	35	–	20	–	25	–	15	–	25	pF
* Input Capacitance: V_{EB} = 0.5 V	C_{ib}			0		–	–	–	–	–	–	80	–	80	–	80	pF
Gain-Bandwidth Product	f_T					50	100	–	50	–	60	–	60	–	70	–	MHz
* Noise Figure: Circuit Bandwidth (BW) = 1 Hz; Reference signal freq. = 1 kHz; Generator resistance (R_G) =	NF	10		0.3													dB
510 Ω (2N1613, 2N1711)						–	–	–	–	–	–	12	–	–	–	8	
1 KΩ (2N2102)						–	–	–	–	–	–	–	–	6	–	–	
* Saturated Switching Time	$t_d+t_r+t_f$					–	–	–	–	–	–	30	–	30	–	–	ns
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					–	–	75	–	75*	–	58.3*	–	35*	–	58.3*	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	–	250	–	250*	–	219*	–	175*	–	219*	

*2N-Series types in accordance with JEDEC registration data

[a] Pulsed, pulse duration = 300 μs, duty factor = 2% (1.8% for 2N2102 only).

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 40366, 40389, 40392, 41502,

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified.*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS										UNITS
		VOLTAGE V dc		CURRENT mA dc		2N1893		2N2405		2N2270		2N3053 40389 40392		41502		
		V_{CB}	V_{CE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX	
* Collector Cutoff Current:	I_{CBO}	15				–	–	–	–	–	–	–	–	–	2	μA
With emitter open		30				–	–	–	–	–	–	–	0.25	–	–	
		60				–	–	–	–		0.05	–	–	–	–	
		90				–	0.01	–	0.01	–	–	–	–	–	–	
At T_C = 150°C		60				–	–	–	–	–	50	–	–	–	–	
		90				–	15	–	10	–	–	–	–	–	–	
* Emitter Cutoff Current: V_{EB} = 5 V, (4 V for 2N3053)	I_{EBO}			0		–	0.01	–	0.01	–	0.1	–	0.25	–	–	μA
* DC Forward-Current Transfer Ratio	h_{FE}		10	0.1		–	–	20	–	–	–	–	–	–	–	
			10	1		–	–	–	–	30	–	–	–	–	–	
			10	10^{a}		35	–	35	–	–	–	–	–	–	–	
			10	150^{a}		40	120	60	200	50	200	50	250	20	–	
At T_C = 55°C			10	10^{a}		20	–	20	–	–	–	–	–	–	–	
* Collector-to-Base Breakdown Voltage: With emitter open	$V_{(BR)CBO}$			0.1		120	–	120	–	60	–	60	–	–	–	V
* Emitter-to-Base Breakdown Voltage: I_E = 0.1 mA	$V_{(BR)EBO}$			0		7	–	7	–	7	–	5	–	4	–	V
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			100^{a}	0	–	–	90	–	45	–	40	–	–	–	V
				30^{a}		80	–	90	–	–	–	–	–	30	–	
With external base-to-emitter resistance (R_{BE}) = 10Ω	$V_{CER}(sus)$			100^{a}		100	–	140	–	60	–	50	–	–	–	V
= 500Ω				100^{a}		–	–	120	–	–	–	–	–	–	–	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			150^{a}	15	–	5	–	0.5	–	1.2	–	1.7	–	–	V
				50^{a}	5	–	1.2	–	0.2	–	–	–	–	–	–	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			150^{a}	15	–	1.3	–	1.1	–	0.9	–	1.4	–	1.5	V
				50^{a}	5	–	0.9	–	0.9	–	–	–	–	–	–	
Base-to-Emitter Voltage	V_{BE}		10	150^{a}		–	–	–	–	–	–	–	–	–	2.5	V
* Common Emitter, Small-Signal, Forward Current Transfer Ratio	h_{fe}															
* f = 1 kHz			5	1		30	100	–	–	–	–	–	–	–	–	
* = 1 kHz			5	5		–	–	50	275	5	–	–	–	–	–	
* = 1 kHz			10	5		45	–	–	–	5	275	–	–	–	–	
= 20 MHz			10	50		2.5*	–	6	–	5*	–	5*	–	–	–	
* Input Resistance:	h_{ib}	5		1		20	30	24	34	–	–	–	–	–	–	Ω
f = 1 kHz		10		5		4	8	4	8	–	–	–	–	–	–	
* Small Signal Reverse Voltage Transfer (Feedback) Ratio:	h_{rb}	5		1		–	1.25×10^{-4}	–	3×10^{-4}	–	–	–	–	–	–	
f = 1 kHz		10		5		–	1.25×10^{-4}	–	3×10^{-4}	–	–	–	–	–	–	
* Output Conductance:	h_{ob}	5		1		–	0.5	–	0.5	–	–	–	–	–	–	μmho
f = 1 kHz		10		5		–	0.5	–	0.5	–	–	–	–	–	–	
* Output Capacitance: I_E = 0	C_{ob}	10				–	15	–	15	–	15	–	15	–	25	pF
* Input Capacitance: V_{EB} = 0.5 V	C_{ib}			0		–	85	–	85	–	80	–	80	–	80	pF
Gain-Bandwidth Product	f_T					50	–	120	–	100	–	100	–	–	–	MHz
Noise Figure: Circuit Bandwidth (BW) = 1 Hz Reference signal freq. = 1 kHz Generator resistance (R_G) = 500 Ω (2N2405) 1 kΩ (2N2270)	NF	10		0.3		–	–	–	6	–	10*	–	–	–	–	dB
* Saturated Switching Time	$t_d+t_r+t_f$					–	–	–	–	–	30	–	–	–	–	ηs
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					–	58.3	–	35	–	35	–	35●	–	58.3	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	219	–	175	–	175	–	175■	–	219	

● 25 for 40392. ■ 50 for 40389.

* 2N-Series types in accordance with JEDEC registration data

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 40366, 40389, 40392, 41502

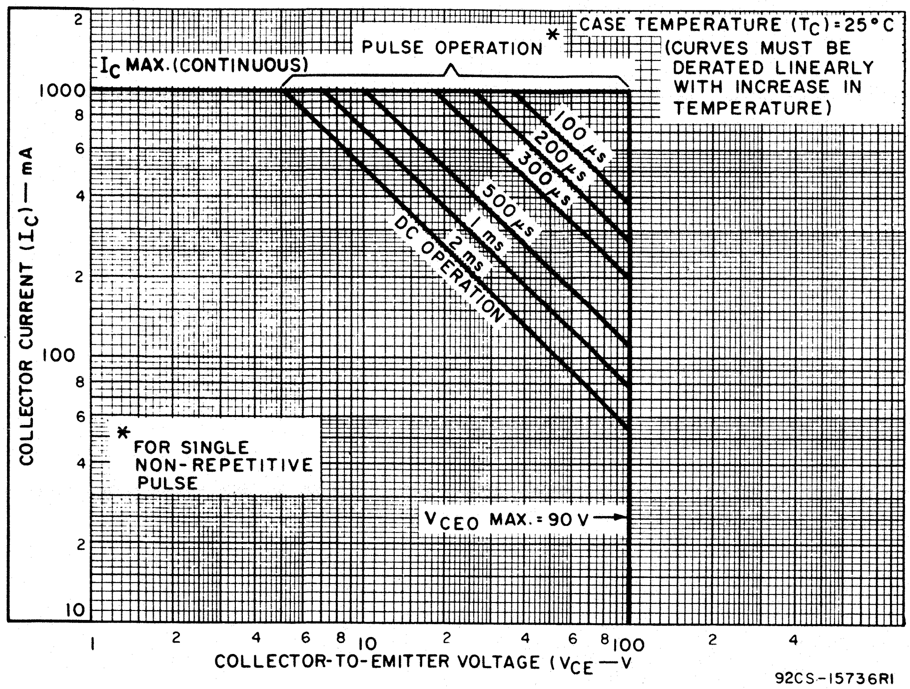


Fig. 4 - Maximum operating areas for 2N2405.

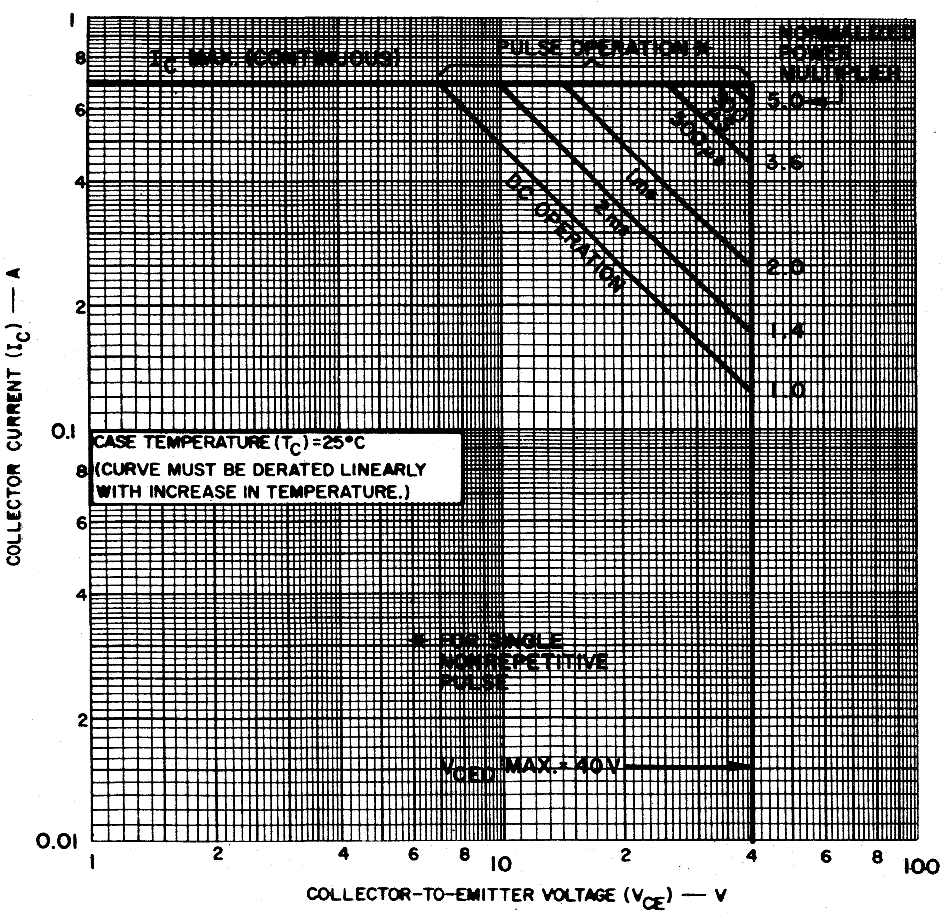


Fig. 5 - Maximum operating areas for 2N3053.

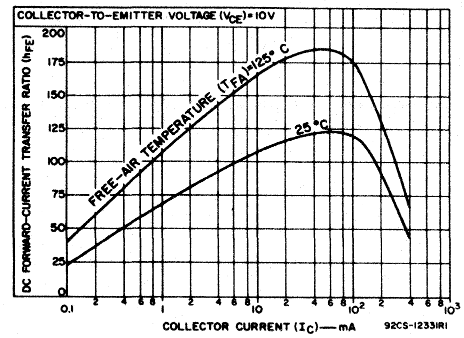


Fig. 6 - Typical dc beta characteristics for 2N3053, 40389, 40392.

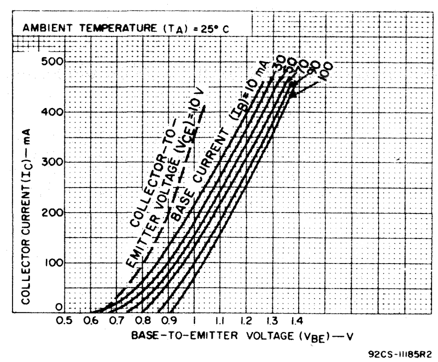


Fig. 7 - Typical transfer characteristics for 2N1613, 2N1711, 2N1893, 2N2102, 2N2405.

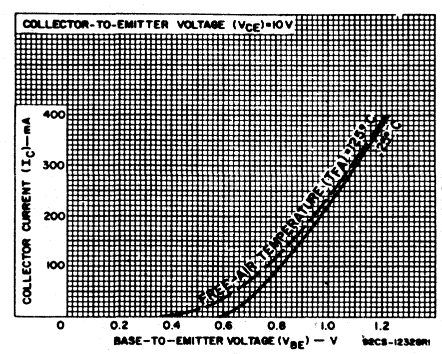


Fig. 8 - Typical transfer characteristics for 2N3053, 40389, 40392.

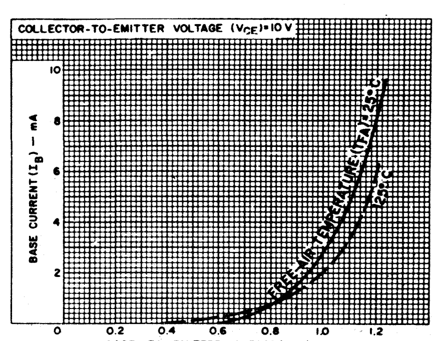


Fig. 9 - Typical input characteristics for 2N3053, 40389, 40392.

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 40366, 40389, 40392, 41502

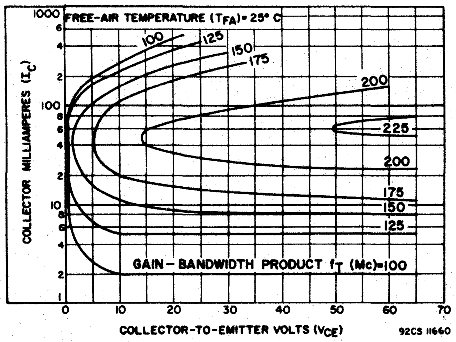


Fig. 10 - Typical gain bandwidth product (f_T) for 2N1711, 2N1893, 2N2405.

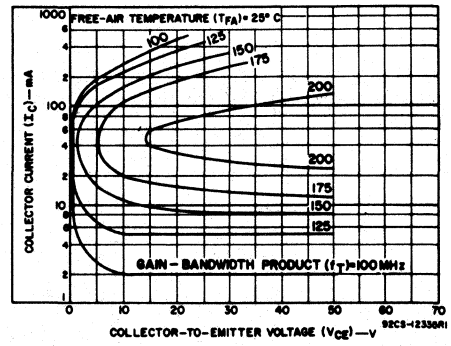


Fig. 11 - Typical gain bandwidth product (f_T) for 2N699, 2N1613, 2N2102, 2N2270, 2N3053, 40389, 40392.

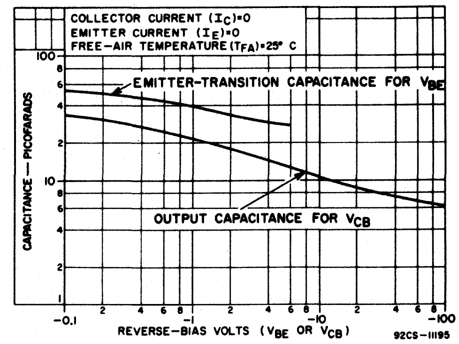


Fig. 12 - Typical capacitance characteristics for all types.

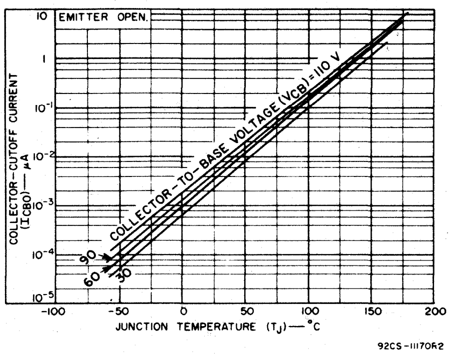


Fig. 13 - Typical collector-cutoff current characteristics for 2N699, 2N1893, 2N2405.

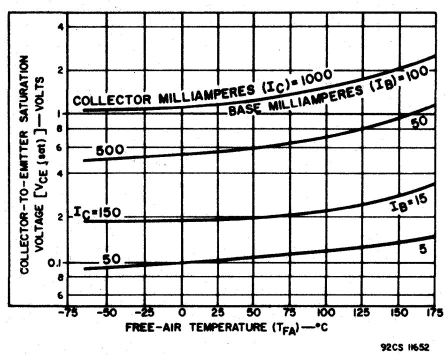


Fig. 14 - Typical collector-to-emitter saturation characteristics for 2N1893, 2N2405.

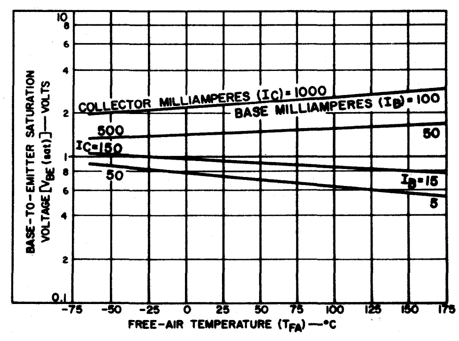


Fig. 15 - Typical base-to-emitter saturation characteristics for 2N1893, 2N2405.

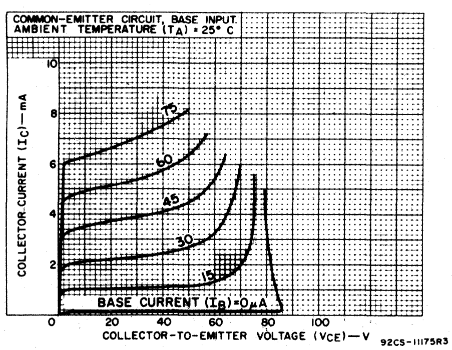


Fig. 16 - Typical low-current output characteristics for 2N699, 2N1613, 2N2102, 2N2270, 41502.

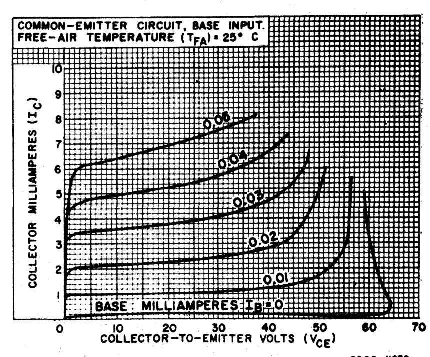


Fig. 17 - Typical low-current output characteristics for 2N1711.

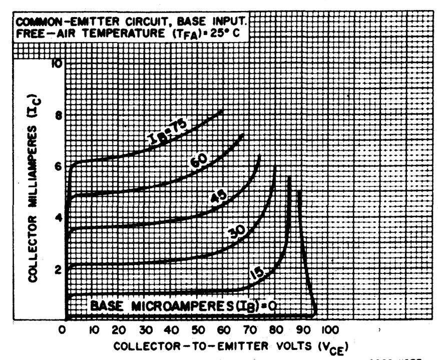


Fig. 18 - Typical low-current output characteristics for 2N1893.

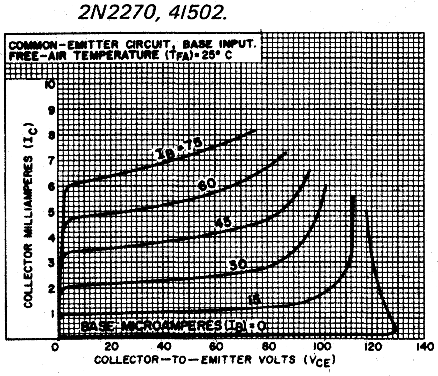


Fig. 19 - Typical low-current output characteristics for 2N2405.

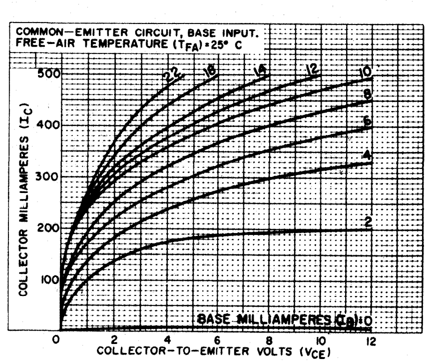


Fig. 20 - Typical high-current output characteristics for 2N699, 2N2270.

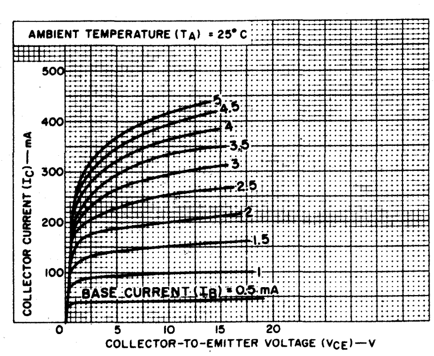


Fig. 21 - Typical high-current output characteristics for 2N1613, 2N2102, 41502.

2N697, 2N699, 2N1613, 2N1711, 2N1893, 2N2102, 2N2270, 2N2405, 2N3053, 40366, 40389, 40392, 41502

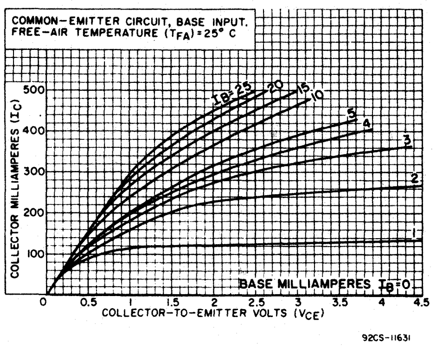


Fig. 22 - Typical high-current output characteristics for 2N1711.

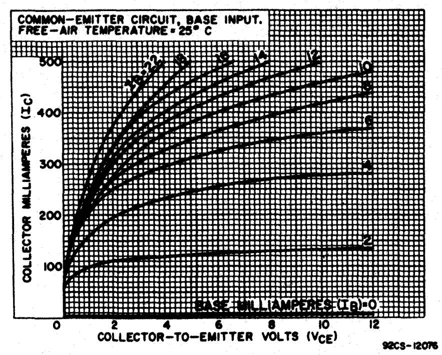


Fig. 23 - Typical high-current output characteristics for 2N1893.

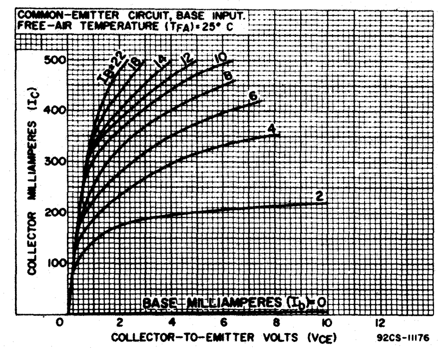


Fig. 24 - Typical high-current output characteristics for 2N2405.

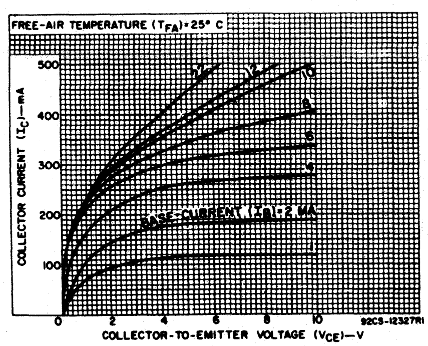


Fig. 25 - Typical high-current output characteristics for 2N3053. 40389, 40392.

2N1479-2N1482, 2N1700, 40347-40349, 40367
Hometaxial-Base Silicon N-P-N Power Transistors

General-Purpose Types for Low-Power Applications

These RCA types are hometaxial-base, silicon n-p-n power transistors intended for a wide variety of applications in industrial and military equipment. They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay controls; in oscillator, regulator, and pulse-amplifier circuits; and as class A and class B push-pull audio and servo amplifiers.

These devices feature high beta at high current, and excellent high-temperature performance. They employ the hermetic JEDEC TO-39 or TO-5; TO-39 or TO-5 with factory-attached mounting flange; or TO-39 or TO-5 with factory-attached heat radiator packages.

Features:
- High-temperature characterization
- High dc beta at 200 mA
- Full switching-time characterization at 200 mA

Additional features for 40367:
- High realiability assured by five preconditioning steps
- Group A test data in data bulletin

These devices are available with either 1½-inch leads (TO-5 package) or ½-inch leads (TO-39 package). The longer-lead versions are specified by suffix "L" after the type number; the shorter-lead versions are specified by suffix "S" after the type number.

Maximum Ratings, *Absolute-Maximum Values:*		2N1479 2N1481	2N1480 2N1482	2N1700	40347 40347V1 40347V2	40348 40348V1 40348V2	40349 40349V1 40349V2	40367	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	100	60	60	90	160	100	V
* COLLECTOR-TO-EMITTER VOLTAGE:									
With base open, sustaining	$V_{CEO}(sus)$	40	55	40	40	65	140	55	V
With emitter-to-base reverse biased (V_{EB} = 1.5 volts)	V_{CEV}	60	100	60	60	90	160	100	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	12	12	6	7	7	7	12	V
* COLLECTOR CURRENT	I_C	1.5	1.5	1	1.5	1.5	1.5	1.5	A
PEAK COLLECTOR CURRENT	I_{CM}	–	–	–	3.0	3.0	3.0	–	A
* EMITTER CURRENT	I_E	−1.75	−1.75	–	–	–	–	–	A
* BASE CURRENT	I_B	1	1	0.75	0.5	0.5	0.5	1	A
* TRANSISTOR DISSIPATION:	P_T								
At case temperature of 25°C		5	5	5	11.7 (40347V2) 8.75 (40347)	11.7 (40348V2) 8.75 (40348)	11.7 (40349V2) 8.75 (40349)	5	W
At ambient temperature up to 25°C		–	–	–	1.0 (40347) 4.4 (40347V1)	1.0 (40348) 4.4 (40348V1)	1.0 (40349) 4.4 (40349V1)	1	W
* TEMPERATURE RANGE:									
Operating and Storage	T_C, T_{stg}	←			−65 to 200			→	°C
* LEAD TEMPERATURE (During soldering): At distances ⩾ 1/32 in (0.8 mm) from seating plane for 10 s max.	T_L	–	–	255	230	230	230	255	°C

*2N-Series types in accordance with JEDEC registration data

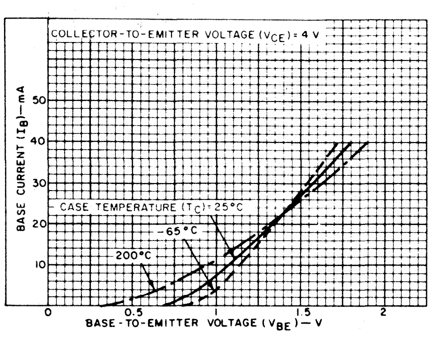


Fig. 1 — Typical input characteristics for 2N1479—2N1482.

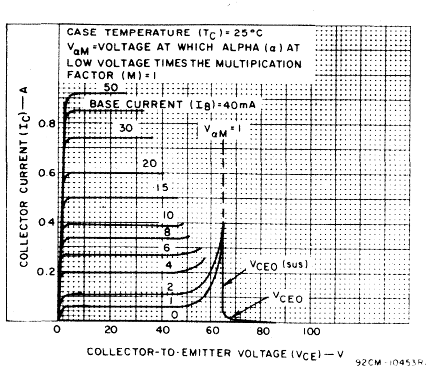
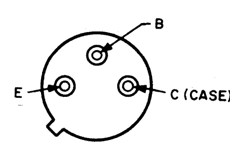
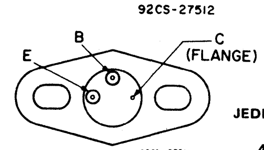


Fig. 2 — Typical output characteristics for 2N1479—2N1482.

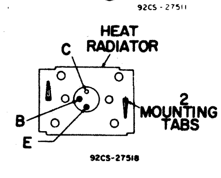
TERMINAL DESIGNATIONS



JEDEC TO-39 or TO-5
2N1479-2N1482,2N1700, 40347-40349,40367



JEDEC TO-39 or TO-5 with Mounting Flange
40347V2, 40348V2,40349V2



JEDEC TO-39 or TO-5 with Heat Radiator
40347V1,40348V1,40349V1

2N1479-2N1482, 2N1700, 40347-40349, 40367

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 40347 MIN.	40347 MAX.	40348 MIN.	40348 MAX.	40349 MIN.	40349 MAX.	UNITS
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 1 kΩ	I_{CER}	30				–	1	–	–	–	–	μA
		60				–	–	–	1	–	–	
		90				–	–	–	–	–	2	
With R_{BE} = 1 kΩ and T_C = 150°C	I_{CER}	30				–	1	–	–	–	–	mA
		60				–	–	–	1	–	–	
		90				–	–	–	–	–	1	
Emitter-Cutoff Current	I_{EBO}		–7			–	10	–	10	–	10	μA
DC Forward-Current Transfer Ratio	h_{FE}	4		0.15		–	–	–	–	30	125	
		4		0.30		–	–	30	125	–	–	
		4		0.45		25	100	–	–	10	–	
		4		1.00		–	–	10	–	–	–	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse biased	$V_{CEV}(sus)$		–1.5	0.050		60	–	90	–	160[a]	–	V
With base open	$V_{CEO}(sus)$			0.050		40	–	65	–	140[a]	–	V
Base-to-Emitter Voltage	V_{BE}	4		0.15		–	–	–	–	–	1.1	V
		4		0.30		–	–	–	1.3	–	–	
		4		0.45		–	1.5	–	–	–	–	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			0.15	15 mA	–	–	–	–	–	0.15	V
				0.30	30 mA	–	–	–	0.75	–	–	
				0.45	45 mA	–	1	–	–	–	–	
Forward-Bias Second Break-down Collector Current (1-s non-repetitive pulse)	$I_{S/b}$	38				345	–	–	–	–	–	mA
		63				–	–	208	–	–	–	
		138				–	–	–	–	95	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					20(max.) 40347 15(max.) 40347V2		20(max.) 40348 15(max.) 40348V2		20(max.) 40349 15(max) 40349V2		°C/W
Thermal Resistance: Junction-to-Ambient	$R_{\theta JA}$					40(max.) 40347V1		40(max.) 40348V1		40(max) 40349V1		°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ⩽2%.

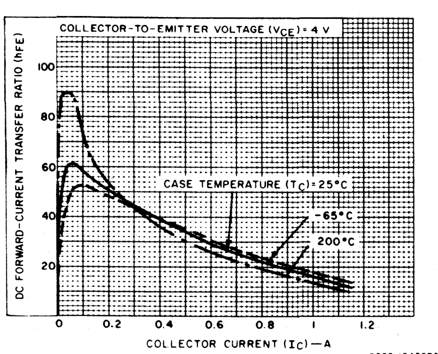


Fig. 3— Typical dc beta characteristics for 2N1479—2N1482.

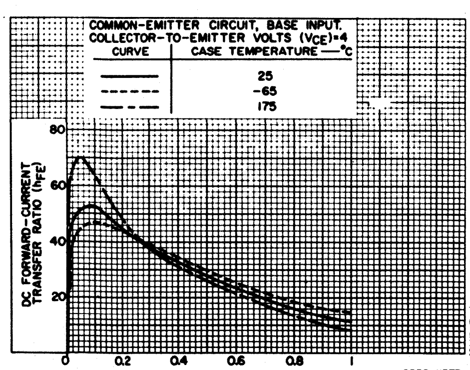


Fig.4—Typical dc beta characteristics for 2N1700.

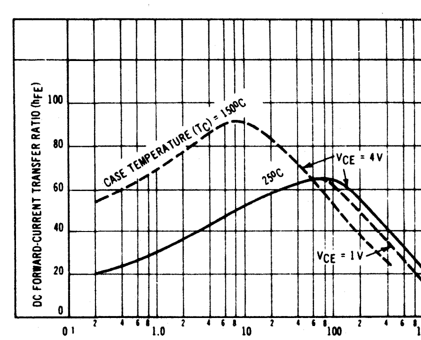


Fig.5—Typical dc beta characteristics for 40347.

2N1479-2N1482, 2N1700, 40347-40349, 40367

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CB}	V_{CE}	V_{EB}	CURRENT mA dc I_C	I_B	I_E	LIMITS 2N1479 MIN.	MAX.	2N1480 MIN.	MAX.	2N1481 MIN.	MAX.	2N1482 MIN.	MAX.	2N1700 MIN.	MAX.	40367 MIN.	MAX.	UNITS
* Collector Cutoff Current:	I_{CBO}	30					0	–	10	–	10	–	10	–	10	–	75	–	4	μA
T_C = 150°C		30					0	–	500	–	500	–	500	–	500	–	1000	–	–	
* Emitter Cutoff Current	I_{EBO}			12	0			–	10	–	10	–	10	–	10	–	–	–	2	μA
				6	0			–	–	–	–	–	–	–	–	–	25	–	–	
* Collector-To-Emitter Voltage: With base-emitter junction reverse-biased	V_{CEV}			1.5	0.25			60	–	100	–	60	–	100	–	–	–	100	–	V
				1.5	0.5			–	–	–	–	–	–	–	–	60	–	–	–	
With base open, sustaining	V_{CEO}(sus)				50	0		40	–	55	–	40	–	55	–	–	–	55	–	
* Base-To-Emitter Voltage	V_{BE}		4		200			–	3	–	3	–	3	–	3	–	–	–	3	V
			4		100			–	–	–	–	–	–	–	–	–	2	–	–	
Collector-Emitter Saturation Voltage	V_{CE}(sat)				200	10		–	–	–	–	–	–	–	–	–	–	–	1.4	V
* DC Current Transfer Ratio	h_{FE}		4		200			20	60	20	60	35	100	35	100	–	–	35	100	
			4		100			–	–	–	–	–	–	–	–	20	80	–	–	
Small-Signal Current Transfer Ratio	h_{fe}		4		5			50 Typ.*		50 typ.*		50 Typ.*		50 Typ.*		40 Typ.		–	–	
* DC Collector-To-Emitter Saturation Resistance	r_{CE}(sat)				200	20		–	7	–	7	–	–	–	–	–	–	–	–	Ω
					200	10	–	–	–	–	–	–	7	–	7	–	–	–	–	
					100	10	–	–	–	–	–	–	–	–	–	–	10	–	–	
Collector-To-Base Capacitance	C_{ob}	40						150 Typ.*		150 Typ.*		150 Typ.*		150 Typ.*		150 Typ.		–	–	pF
Thermal Time Constant	τ_1							10 Typ.*		10 Typ.*		10 Typ.*		10 Typ.*		10 Typ.		–	–	ms
Alpha-Cutoff Frequency	$f_{\alpha b}$	28			5			1.5 Typ.*		1.5 Typ.*		1.5 Typ.*		1.5 Typ.*		1.5 Typ.		–	–	MHz
Switching Time: Delay Time	t_d●							0.2 Typ.*		0.2 Typ.*		0.2 Typ.*		0.2 Typ.*		0.2 Typ.		–	–	
Rise Time	t_r●							1 Typ.*		1 Typ.*		1 Typ.*		1 Typ.*		1 Typ.		–	–	
Storage Time	t_s●							0.6 Typ.*		0.6 Typ.*		0.6 Typ.*		0.6 Typ.*		0.6 Typ.		–	–	
Fall Time	t_f●							1 Typ.*		1 Typ.*		1 Typ.*		1 Typ.*		1 Typ.		–	–	
* Thermal Resistance: Junction-to-case	$R_{\theta JC}$								35		35		35		35		35	–	35	
Junction-to-free air	$R_{\theta JFA}$								200		200		200		200		200	–	–	

*2N-Series types in accordance with JEDEC registration data.

● I_C = 200 mA, I_{B1} = 20 mA, I_{B2} = –85. mA

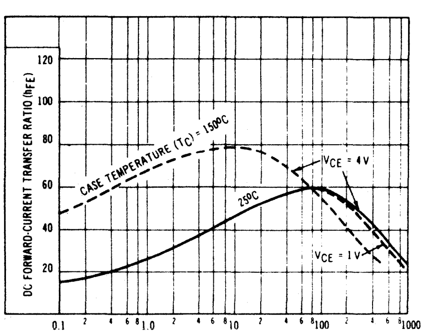


Fig.6—Typical dc beta characteristics for 40348.

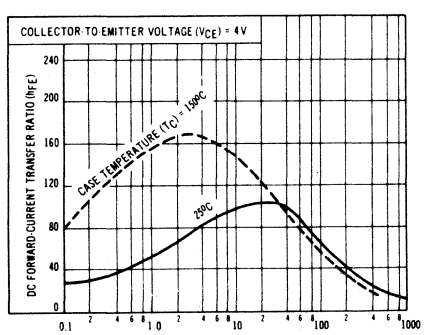


Fig.7—Typical dc beta characteristics for 40349.

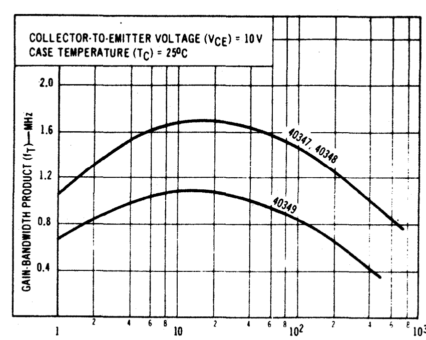


Fig.8—Typical gain-bandwidth product vs. collector current for 40347, 40348 and 40349.

2N1479-2N1482, 2N1700, 40347-40349, 40367

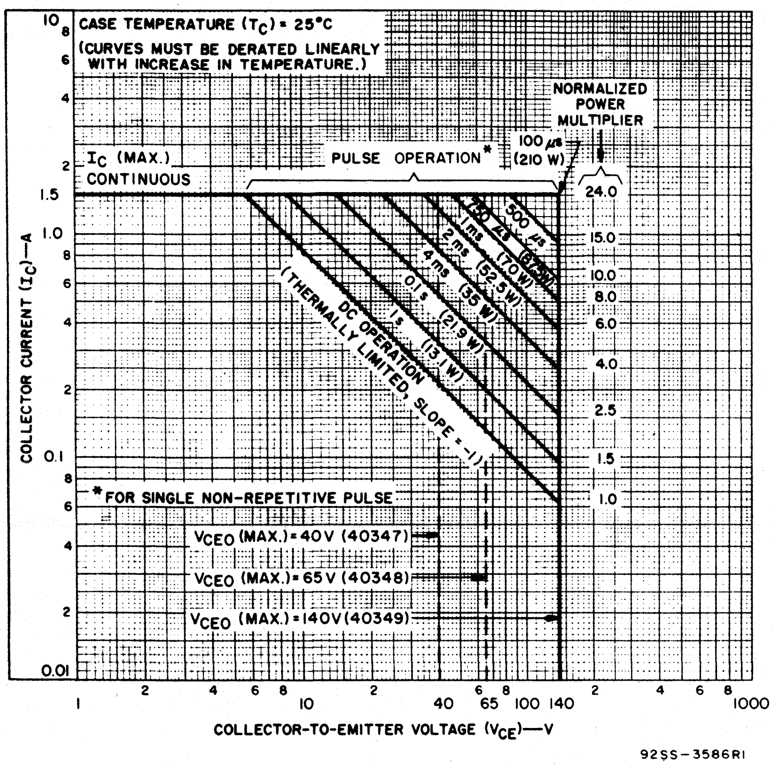


Fig.9—Maximum operating areas for 40347, 40348, and 40349.

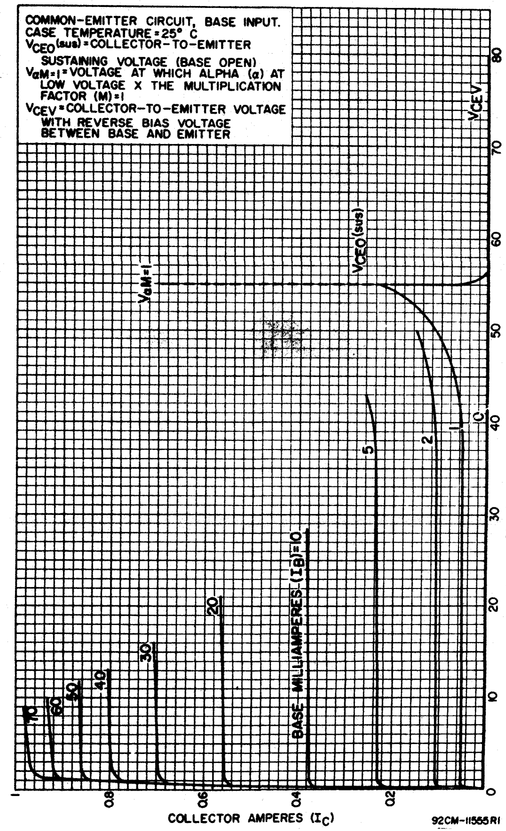


Fig.10—Typical output characteristics for 2N1700.

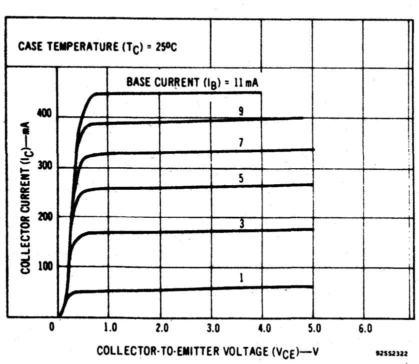


Fig.11—Typical output characteristics for 40347.

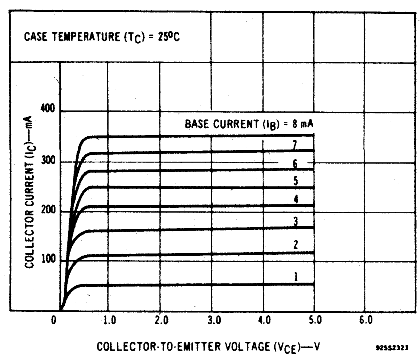


Fig.12—Typical output characteristics for 40348.

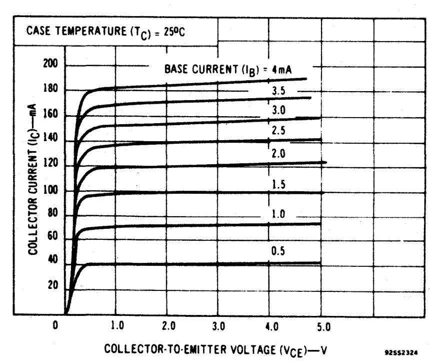


Fig.13—Typical output characteristics for 40349.

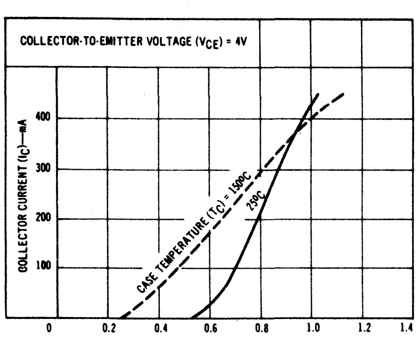


Fig.14—Typical transfer characteristics for 40347.

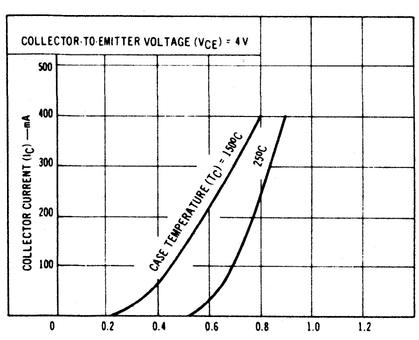


Fig.15—Typical transfer characteristics for 40348.

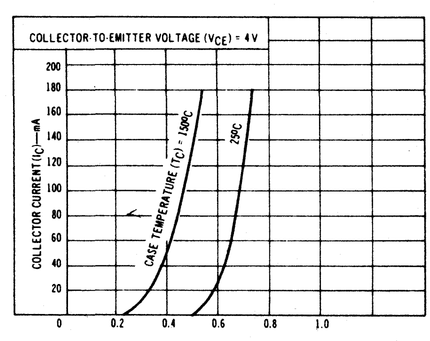


Fig.16—Typical transfer characteristics for 40349.

2N1479-2N1482, 2N1700, 40347-40349, 40367

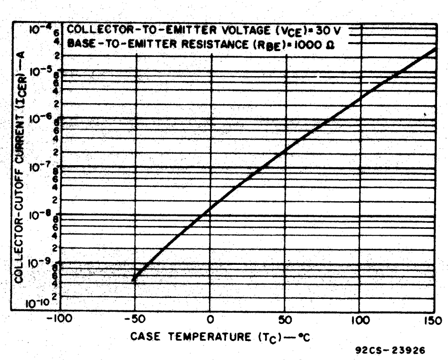


Fig.17—Collector-cutoff-current characteristic for 40347.

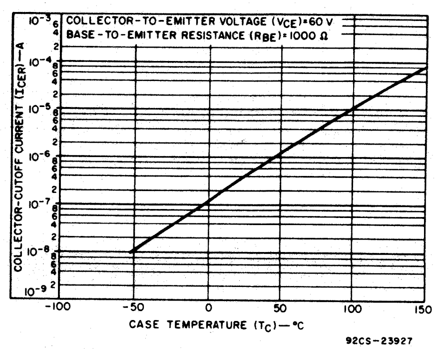


Fig.18—Collector-cutoff-current characteristic for 40348.

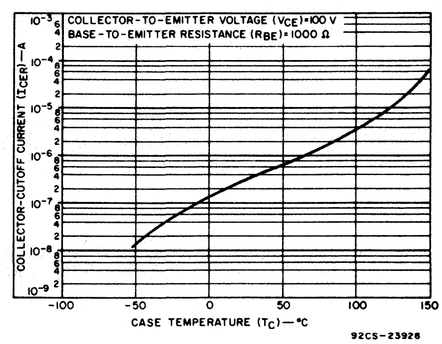


Fig.19—Collector-cutoff-current characteristic for 40349.

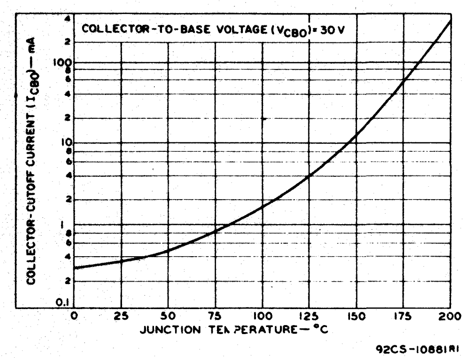


Fig.20—Typical leakage characteristics for 2N1479—2N1482.

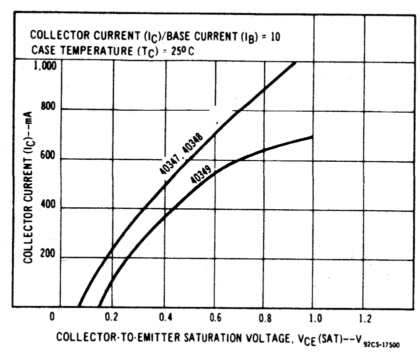


Fig.21—Typical saturation characteristics for 40347, 40348 and 40349.

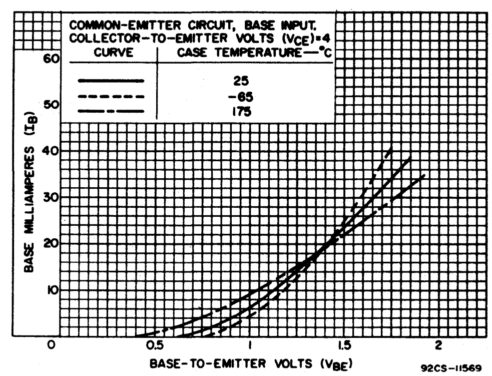


Fig.22—Typical input characteristics for 2N1700.

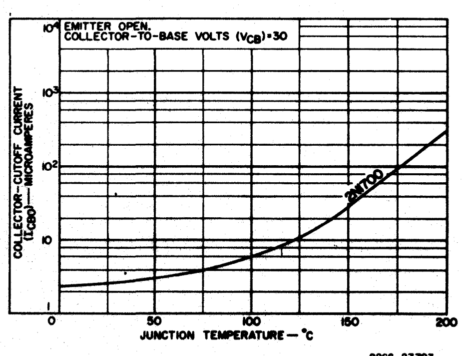


Fig. 23 - Typical operation characteristics for 2N1700.

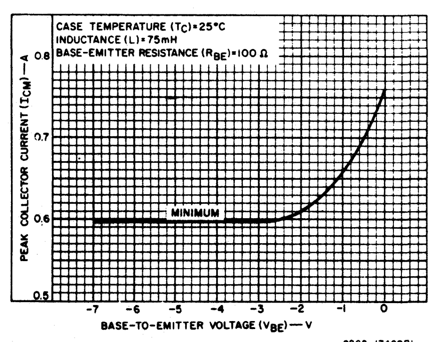


Fig.24—Reverse-bias second-breakdown characteristics for 40347, 40348 and 40349.

2N1483-2N1486, 2N1701, 40368
Hometaxial-Base Silicon N-P-N Power Transistors

General-Purpose Types for Medium-Power Applications

These RCA types are hometaxial-base power transistors of the silicon n-p-n type intended for a wide variety of applications in industrial and military equipment. They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay control; in oscillator, regulator, and pulse amplifier circuits; and as class-A and class-B push-pull audio and servo amplifiers.

These transistors feature high beta at high current, and excellent high-temperature performance. They are supplied in the JEDEC TO-8 hermetic package.

Features:

- High-temperature characterization
- High dc beta at 750 mA
- Full switching-time characterization at 750 mA

Additional Features for 40368:

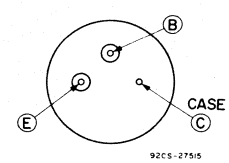
- High reliability assured by five pre-conditioning steps
- Group A test data in data bulletin.

Maximum Ratings, *Absolute-Maximum Values:*

		2N1483 2N1485	2N1484 2N1486 40368	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	100	volts
* COLLECTOR-TO-EMITTER VOLTAGE:				
With base open (sustaining voltage)	$V_{CEO}(sus)$	40	55	volts
With emitter-to-base reverse biased (V_{EB}) = 1.5 volts)	V_{CEV}	60	100	volts
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	12	12	volts
* COLLECTOR CURRENT	I_C	3	3	amp
* EMITTER CURRENT	I_E	−3.5	−3.5	amp
* BASE CURRENT	I_B	1.5	1.5	amp
* TRANSISTOR DISSIPATION:	P_T			
At case temperature of 25°C		25	25	watts
At case temperature of 100°C		14.1	14.1	watts
* TEMPERATURE RANGE:				
Operating and Storage	T_C, T_{stg}	−65 to +200		°C
PIN TEMPERATURE (During soldering):				
At distance ≥1/32 in. (0.79 min) from seating plane for 10 s max.	T_L	235		°C

*2N-Series types in accordance with JEDEC registration data

TERMINAL DESIGNATIONS



JEDEC-TO-8

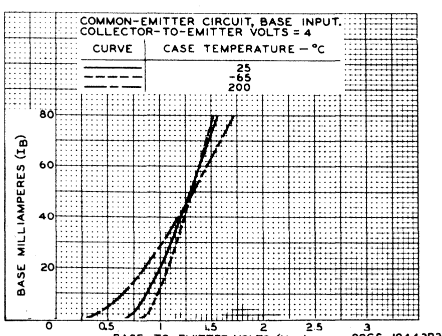


Fig. 1—Typical input characteristics for all types.

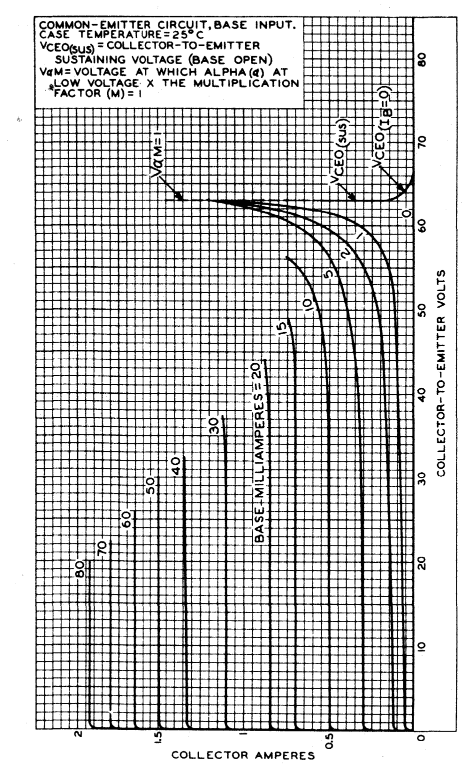


Fig. 2—Typical collector characteristics for all types.

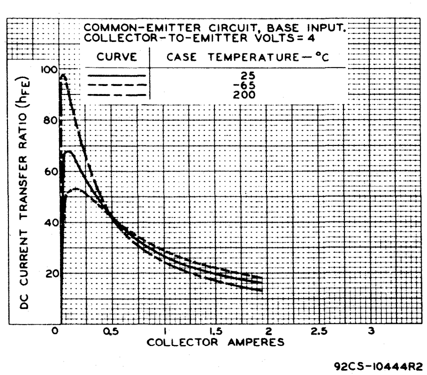


Fig. 3—Typical operation characteristics for all types.

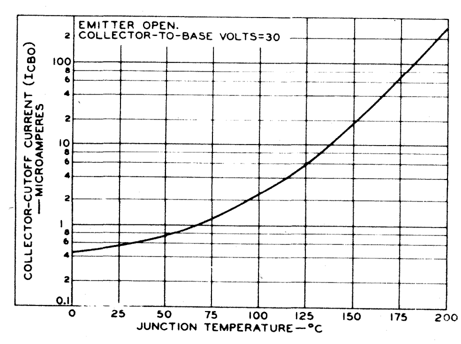


Fig. 4—Typical operation characteristics for all types.

2N1483-2N1486, 2N1701, 40368

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS										UNITS
		VOLTAGE V dc		CURRENT mA dc		2N1483		2N1484		2N1485		2N1486		40368		
		V_{CB}	V_{CE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* Collector Cutoff Current:																
With emitter open	I_{CBO}	30				–	15	–	15	–	15	–	15	–	9	µA
At T_C = 150°C	I_{CBO}	30				–	750	–	750	–	750	–	750	–	–	µA
* Emitter Cutoff Current V_{EB} = 12 V	I_{EBO}			0		–	15	–	15	–	15	–	15	–	5	µA
* DC Forward-Current Transfer Ratio	h_{FE}		4	750[a]		20	60	20	60	35	100	35	100	35	100	
* Collector-to-Emitter Sustaining Voltage:																
With base open	$V_{CEO}(sus)$			100[a]	0	40	–	55	–	40	–	55	–	55	–	V
With base-emitter junction reverse-biased (V_{BE} = −1.5 V)	V_{CEV}			0.25		60	–	100	–	60	–	100	–	100	–	V
* Base-to-Emitter Voltage	V_{BE}		4	750[a]		–	3.5	–	3.5	–	2.5	–	2.5	–	2.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			750	40	–	–	–	–	–	–	–	–	–	0.75	V
* Collector-to-Emitter Saturation Resistance	$r_{CE}(sat)$			750	75	–	2.67	–	2.67	–	1	–	1	–	–	Ω
* Collector-to-Base Capacitance	C_{ob}	40				175 (typ.)		175 (typ.)		175 (typ.)		175 (typ.)		–	–	pF
* Thermal Time Constant	τ_1					10 (typ.)		10 (typ.)		10 (typ.)		10 (typ.)		–	–	ms
* Alpha Cutoff Frequency	$f_{\alpha b}$	28		5		1.25 (typ.)		1.25 (typ.)		1.25 (typ.)		1.25 (typ.)		–	–	MHz
Saturated Switching Time																
Delay time	t_d●					0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		–	–	µs
Rise time	t_r●					1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		–	–	µs
Storage time	t_s●					0.8 (typ.)		0.8 (typ.)		0.8 (typ.)		0.8 (typ.)		–	–	µs
Fall time	t_f●					1.1 (typ.)		1.1 (typ.)		1.1 (typ.)		1.1 (typ.)		–	–	µs
* Thermal Resistance:																
Junction-to-case	$R_{\theta JC}$					–	7	–	7	–	7	–	7	–	–	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	100	–	100	–	100	–	100	–	–	°C/W

[a]Pulsed, pulse duration = 300 µs, duty factor = 1.8%.
●I_C = 750 mA, I_{B_1}, = 20 mA, I_{B_2} = −8.5 mA
*2N-Series types in accordance with JDEDC registration data

2N1487-2N1490, 40369

Hometaxial-Base Silicon N-P-N Power Transistors

General-Purpose Types for High-Power Applications

These RCA types are hometaxial-base power transistors of the silicon n-p-n type intended for a wide variety of applications in industrial and military equipment. They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay controls; in oscillator, regulator, and pulse-amplifier circuits; and as class-A and class-B push-pull audio and servo amplifiers.

These transistors feature high power-dissipation ratings, high beta at high current, and excellent high-temperature performance. They are supplied in the JEDEC TO-3 hermetic package.

Features:

- High-temperature characterization
- High dc beta at 1.5A
- Full switching-time characterization at 1.5A

Additional Features for 40369:

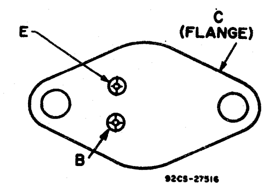
- High reliability assured by five preconditioned steps
- Group A test data included.

Maximum Ratings, ***Absolute-Maximum Values:***

		2N1487 2N1489	2N1488 2N1490 40369	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	100	volts
* COLLECTOR-TO-EMITTER VOLTAGE:				
With base open (sustaining voltage)	$V_{CEO}(sus)$	40	55	volts
With emitter-to-base reverse biased (V_{EB}) = 1.5 volts)	V_{CEV}	60	100	volts
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	10	10	volts
* COLLECTOR CURRENT	I_C	6	6	amp
* EMITTER CURRENT	I_E	−8	−8	amp
* BASE CURRENT	I_B	3	3	amp
* TRANSISTOR DISSIPATION:	P_T			
At mounting-flange temperature of 25°C		75	75	watts
At mounting-flange temperature of 100°C		43	43	watts
* TEMPERATURE RANGE:				
Operating and Storage	T_C, T_{stg}	−65 to +200		°C
PIN TEMPERATURE (During soldering):				
At distance ≥ 1/32 in. (0.79 mm) from seating plane for 10 s max.	T_L	235		°C

*2N-Series types in accordance with JEDEC registration data

TERMINAL DESIGNATIONS



JEDEC TO-3

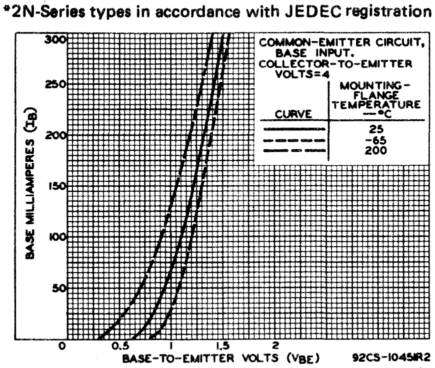


Fig. 1 — Typical input characteristics for all types.

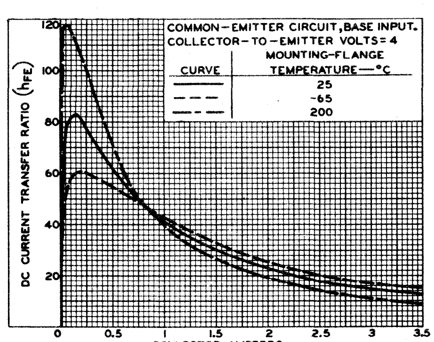


Fig. 3 — Typical dc beta characteristics for all types.

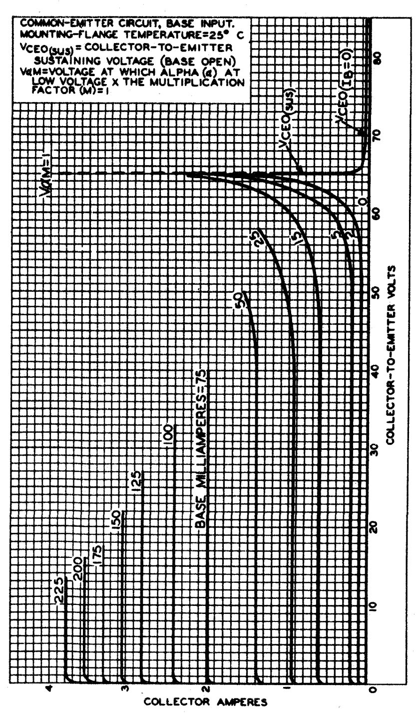


Fig. 2 — Typical output characteristics for all types.

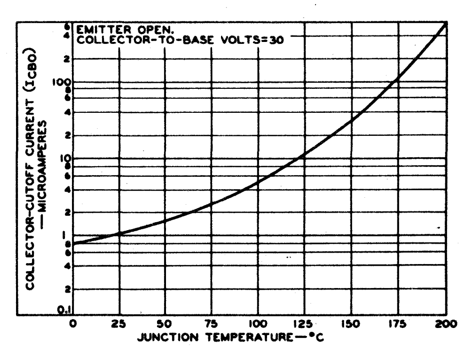


Fig. 4 — Typical operation characteristic for all types.

2N1487-2N1490, 40369

ELECTRICAL CHARACTERISTICS *Mounting-flange temperature = 25°C unless otherwise specified.*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTAGE (VOLTS) V_{CB}	V_{CE}	DC EMITTER VOLTAGE (VOLTS) V_{EB}	DC COLLECTOR CURRENT (mA) I_C	DC BASE CURRENT (mA) I_B	LIMITS: TYPE 2N1487 MIN.	MAX.	TYPE 2N1488 MIN.	MAX.	TYPE 2N1489 MIN.	MAX.	TYPE 2N1490 MIN.	MAX.	TYPE 40369 MIN.	MAX.	UNITS
Collector-Cutoff Current With I_E = 0 and at mounting-flange temperature of;	I_{CBO}																
25°C		30						25	–	25	–	25	–	25	–	10	µA
150°C		30						1000	–	1000	–	1000	–	1000	–	–	µA
Emitter-Cutoff Current	I_{EBS}			10	0		–	25	–	25	–	25	–	25	–	6	µA
Collector-To-Emitter Voltage: (Emitter-to-base				1.5	0.25		–	–	–	–	–	–	–	–	100	–	
reverse bias)	V_{CEX}			1.5	0.5		60	–	100	–	60	–	100	–	–	–	volts
(Base open sustaining voltage)	V_{CEO} (sus)				100	0	40	–	55	–	40	–	55	–	55	–	volts
DC Current Transfer Ratio	h_{FE}		4		1.5 amps		15	45	15	45	25	75	25	75	25	75	
DC Collector-To-Emitter Saturation Resistance	$r_{CE}(sat)$				1.5 amps	300	–	2	–	2	–	–	–	–	–	–	ohms
					1.5 amps	100	–	–	–	–	–	0.67	–	0.67	–	–	ohm
Base-To-Emitter Voltage	V_{BE}		4		1.5 amps		–	3.5	–	3.5	–	2.5	–	2.5	–	2.5	volts
*Collector-To-Base Capacitance	C_{ob}	40					–	200	–	200	–	200	–	200	–	–	pF
*Thermal Time Constant	τ_l						12 (typ.)		12 (typ.)		12 (typ.)		12 (typ.)		–	–	ms
*Alpha Cutoff Frequency	$f_{\alpha b}$	12			100		1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		–	–	MHz
Saturated Switch-Time Delay time	t_d■						0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		–	–	µs
Rise time	t_r■						1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		–	–	µs
Storage time	t_s■						1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		–	–	µs
Fall time	t_f■						1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		–	–	µs
*Thermal Resistance: Junction-to-mounting flange	$R_{\theta JC}$							2.33		2.33		2.33		2.33	–	–	°C/W

*2N-Series types in accordance with JEDEC registration data

■ I_C = 1.5 A, I_{B1} = 300 mA, I_{B2} = -150 mA

2N3054, 2N6260, 2N6261, 40250, 40572, 40910, 40911

Hometaxial-Base Medium-Power Silicon N-P-N Transistors

Rugged Devices for Intermediate-Power Applications in Industrial and Commercial Equipment

These RCA types are hometaxial-base silicon n-p-n transistors intended for a wide variety of medium- to high-power applications. Types 2N3054, 2N6260, 2N6261, and 40250 are supplied in the JEDEC TO-66 hermetic package.

Types 40250V1, 40372, 40910, and 40911 are the 40250, 2N3054, 2N6260, and 2N6061 with factory-attached heat radiators intended for printed-circuit-board applications.

Features:

- f_T = 800 kHz at 0.2A (2N3064, 40372)
- Maximum safe-area-of-operation curves for dc and pulse operation
- V_{CEV}(sus) = 90 V min (2N3054, 2N6261)
- Low saturation voltage: V_{CE}(sat) = 1.0 V at I_C = 0.5 A (2N3054)

Applications:

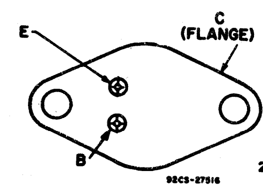
- Power switching circuits
- Series- and shunt-regulator driver and output stages
- High-fidelity amplifiers
- Solenoid drivers.

Maximum Ratings, *Absolute-Maximum Values:*

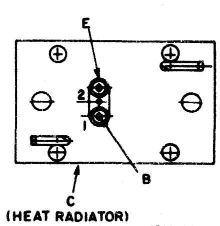
		40250 40250V1	2N6260 40910	2N3054 40372	2N6261 40911	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	50	90	90	V
COLLECTOR-TO-EMITTER VOLTAGE:						
* With base open	V_{CEO}	40	40	55	80	V
* With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER(sus)}$	–	45	60	85	V
With base reverse-biased (V_{BE} = -1.5 V)	$V_{CEV(sus)}$	50	50	90	90	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	7	7	V
* CONTINUOUS COLLECTOR CURRENT	I_C	4	3	4	4	A
* CONTINUOUS BASE CURRENT	I_B	2	2	2	2	A
* TRANSISTOR DISSIPATION:	P_T					
* At case temperature up to 25°C		29 (40250)	29 (2N6260)	25 (2N3054)	50 (2N6261)	W
At ambient temperatures up to 25°C		5.8 (40250V1)	5.8 (40910)	5.8 (40372)	5.8 (40911)	W
* At temperatures above 25°C		Derate linearly to 200°C				
* TEMPERATURE RANGE:						
Storage & Operating (Junction)		-65 to 200				°C
PIN TEMPERATURE (During soldering): At distance ≥1/32 in. (0.8 mm) from seating plane for 10 s max.		235				°C

*In accordance with JEDEC registration data format JS-9 RDF-10 (2N3054), JS-6 RDF-2 (2N6260, 2N6261)

TERMINAL DESIGNATIONS



JEDEC TO-66
2N3054, 2N6260, 2N6261, 40250



JEDEC TO-66 with Heat Radiator
40250V1, 40372, 40910, 40911

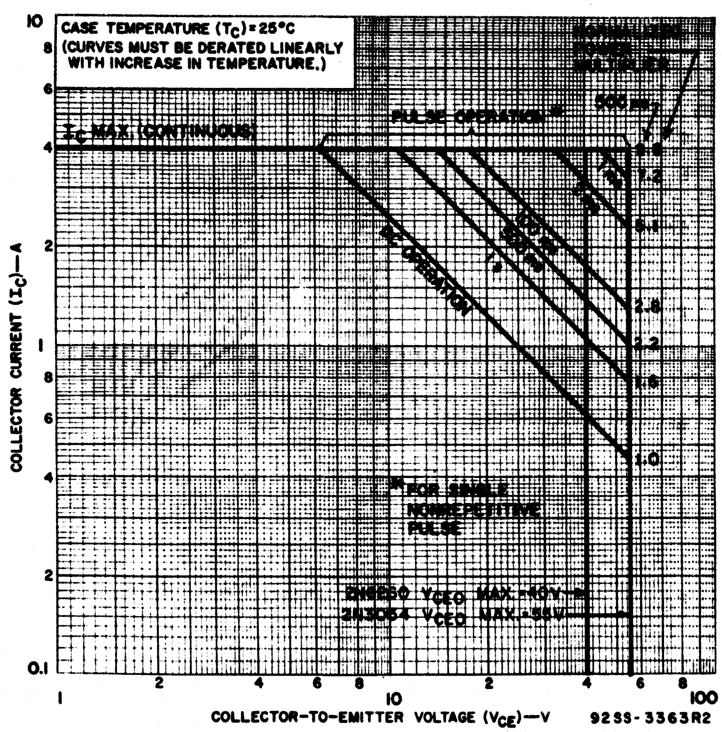


Fig. 1—Maximum operating areas for 2N3054 and 2N6260.

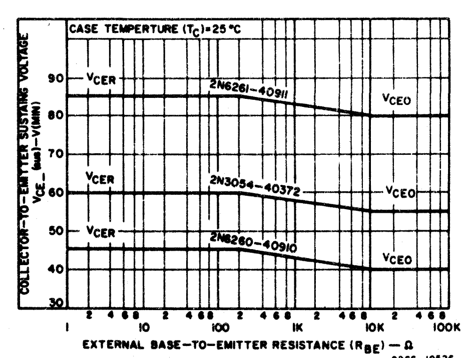


Fig. 2 — Sustaining voltage vs. base-to-emitter resistance for 2N3054, 2N6260, 2N6261, 40372, 40910 and 40911.

2N3054, 2N6260, 2N6261, 40250, 40572, 40910, 40911

ELECTRICAL CHARABTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		2N6260 40910		2N3054 40372		2N6261 40911		40250 40250V1		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* Collector-Cutoff Current: With base open		V_{CB} = 30		I_E = 0		–	–	–	–	–	–	–	1	
	I_{CEO}	30			0	–	1	–	0.5	–	–	–	–	
		60			0	–	–	–	–	–	0.5	–	–	
With base-emitter junction reverse-biased		40	−1.5			–	5	–	–	–	–	–	–	
	I_{CEV}	80	−1.5			–	–	–	–	–	0.5	–	–	mA
		90	−1.5			–	–	–	1.0	–	–	–	–	
	I_{CBO}	VCB = 30		I_E = 0		–	–	–	–	–	–	–	5	
At T_C = 150°C		40	−1.5			–	25	–	–	–	–	–	–	
	I_{CE}	80	−1.5			–	–	–	–	–	1.0	–	–	
		90	−1.5			–	–	–	6.0	–	–	–	–	
* Emitter-Cutoff Current			−5		0	–	5	–	–	–	–	–	5	mA
	I_{EBO}		−7		0	–	–	–	1.0	–	0.2	–	–	
Collector-to-Base Breakdown Votlage	$V_{(BR)CBO}$			0.05		–	–	–	–	–	–	50	–	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEV}$		−1.5	0.05		–	–	–	–	–	–	50	–	V
Collector-to-Emitter Sustaining Voltage: With base open	V_{CEO}(sus)			0.1[a]	0	40	–	55	–	80	–	40	–	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}(sus)			0.1[a]		45	–	60	–	85	–	–	–	
Emitter-to-Base Breakdown Voltage I_E = 0.005 mA	$V_{(BR)EBO}$					–	–	–	–	–	–	5	–	V
* DC Forward-Current Transfer Ratio		2		4[a]		3	–	–	–	5	–	–	–	
		2		1.5[a]		–	–	–	–	25	100	–	–	
	h_{FE}	4		3[a]		–	–	5	–	–	–	–	–	
		4		0.5[a]		–	–	25	150	–	–	–	–	
		4		1.5[a]		20	100	–	–	–	–	25	100	
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			0.5[a]	0.05[a]	–	–	–	1.0	–	–	–	–	
				1.5[a]	0.15[a]	–	1.5	–	–	–	0.5	–	1.5	V
				3[a]	1[a]	–	–	–	6.0	–	–	–	–	
* Base-to-Emitter Voltage		2		1.5		–	–	–	–	–	1.5	–	–	
	V_{BE}	4		1.5		–	2.2	–	–	–	–	–	2.2	V
		4		0.5		–	–	–	1.7	–	–	–	–	
* Common-Emitter Small-Signal Short-Circuit, Forward Current Transfer Ratio Cutoff Frequency	f_{hfe}	4		0.1		0.03	–	0.03	–	0.03	–	–	–	MHz
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 0.4 MHz)	$\|h_{fe}\|$	4		0.1		2	–	–	–	2	–	–	–	
* Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		0.1		25		25	–	25	–	–	–	
Forward-Bias Second Breakdown Collector Current (t - 1 s)		40				0.725	–	–	–	–	–	–	–	
	$I_{S/b}$	80				–	–	–	–	0.625	–	–	–	A
		55				–	–	0.455	–	–	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					6 (max.) 2N6260		7 (max.) 2N3054		3.5 (max.) 2N6261		6 (max.) 40250		°C/W
Junction-to-Ambient	$R_{\theta JA}$					30 (max.) 40901		30 (max.) 40372		30 (max.) 40911		30 (max.) 40250V1		

[a]Pulsed: Pulse duration = 300 μs duty factor = 1.8%.

*In accordance with JEDEC registration data format JS-9 RDF-10 (2N3054) JS-6 RDF-2 (2N6260-61)

2N3054, 2N6260, 2N6261, 40250, 40572, 40910, 40911

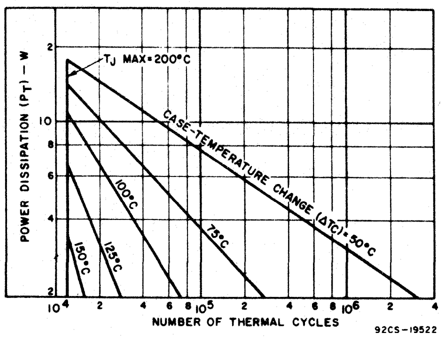


Fig. 3 - Thermal-cycling rating chart for 2N3054.

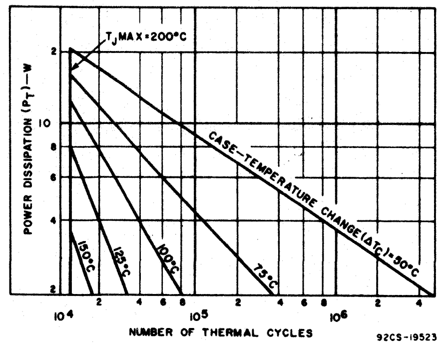


Fig. 4 - Thermal-cycling rating chart for 2N6260.

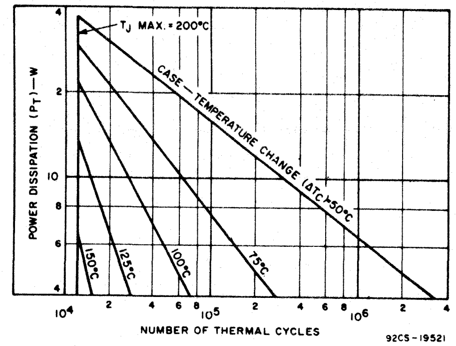


Fig. 5 - Thermal-cycling rating chart for 2N6261.

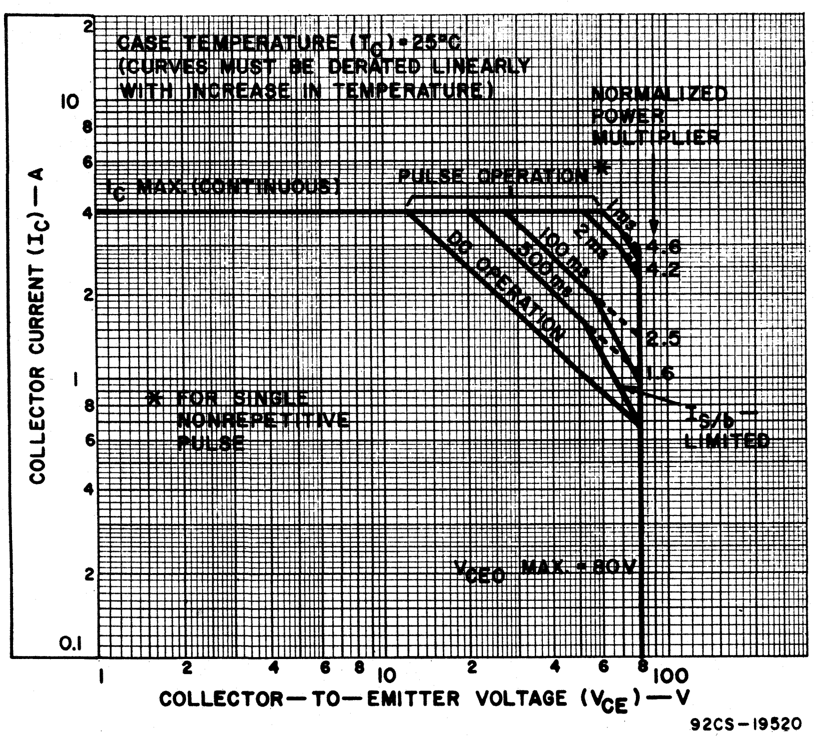


Fig. 6 - Maximum operating areas for 2N6261.

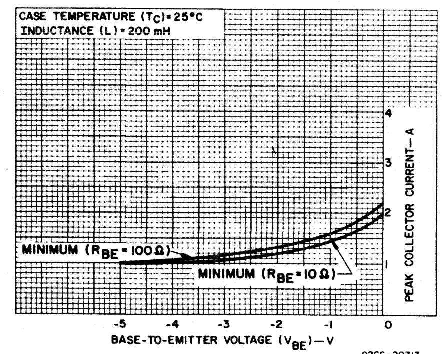


Fig. 7 - Reverse-bias second-breakdown characteristics for all types.

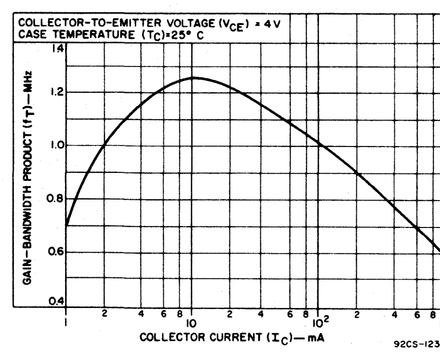


Fig. 8 - Typical gain-bandwidth product for all types.

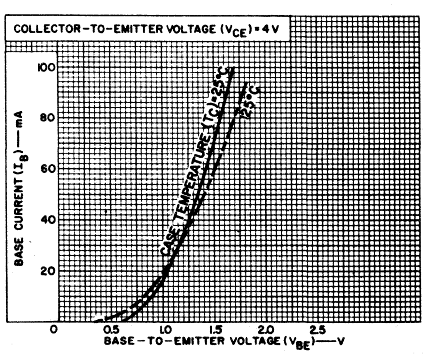


Fig. 9 - Typical input characteristics for 2N3054, 2N6260, 40250, 40250V1, 40372, and 40910.

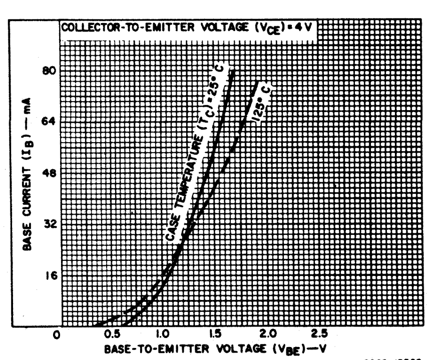


Fig. 10 - Typical input characteristics for 2N6261 and 40911.

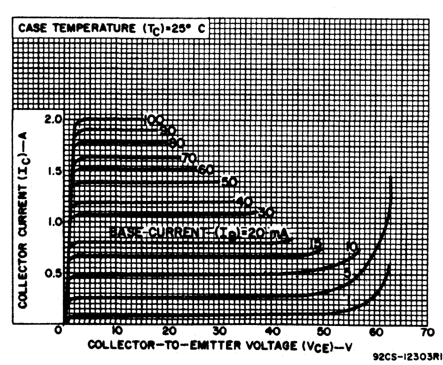


Fig. 11 — Typical output characteristics for 2N3054 and 40372.

2N3054, 2N6260, 2N6261, 40250, 40572, 40910, 40911

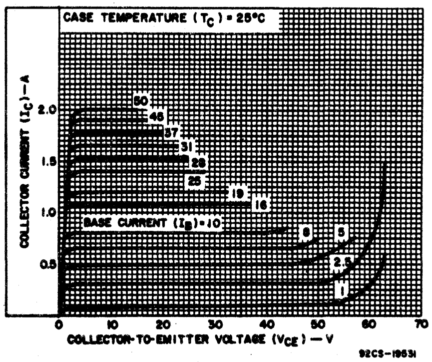


Fig. 12 — Typical output characteristics for 2N6260 and 40910.

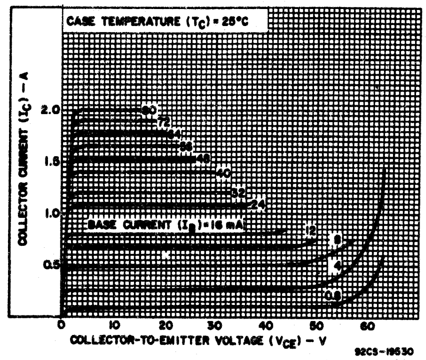


Fig. 13 — Typical output characteristics for 2N6261 and 40911.

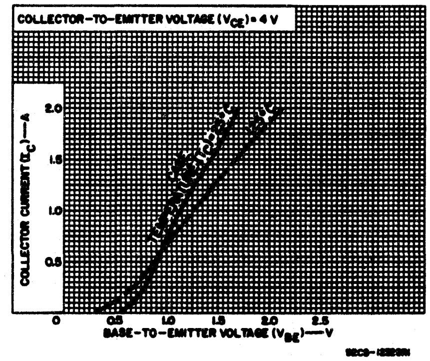


Fig. 14 — Typical transfer characteristics for 2N3054, 2N6260, 40250, 40250V1, 40372 and 40910.

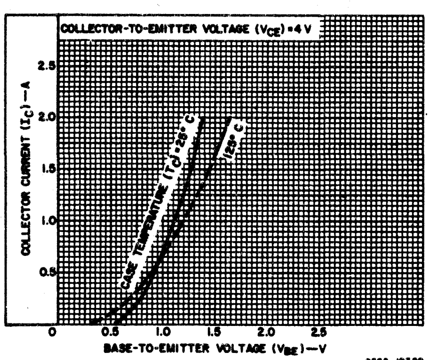


Fig. 15 - Typical transfer characteristics for 2N6261 and 40911.

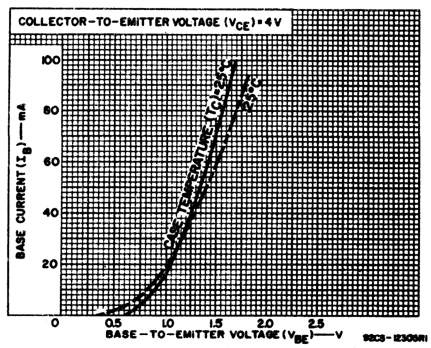


Fig. 16 — Typical input characteristics for 2N6260, 40250, 40250V1, 40372 and 40910.

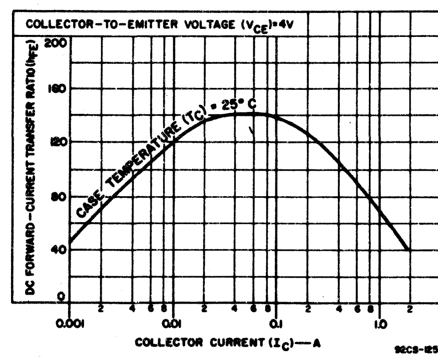


Fig. 17 — Typical dc beta characteristics for 2N6260 40250, 40250V1 and 40910.

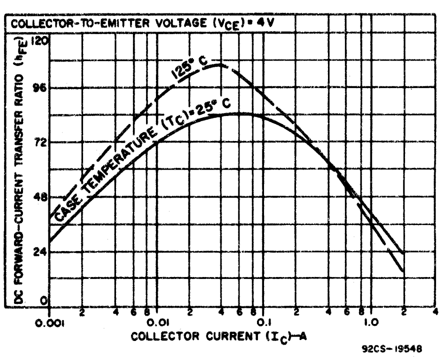


Fig. 18 - Typical dc beta characteristics for 2N6261 and 40911.

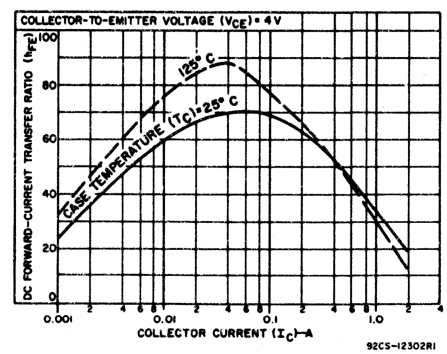


Fig. 19 — Typical dc beta characteristics for 2N3054 and 40372.

2N3055, 2N6253, 2N6254, 2N6371, 40251

Hometaxial-Base High-Power Silicon N-P-N Transistors

Rugged, Broadly Applicable Devices For Industrial and Commercial Use

These RCA types are silicon n-p-n transistors intended for a wide variety of high-power linear and switching applications. The hometaxial-base construction of these devices makes them highly resistant to second breakdown; for example, the 2N3055 can withstand an $I_{S/b}$ current of 1.95 amperes (min.) at a V_{CEO} of up to 60 volts. For the 2N6254, the $I_{S/b}$ rating is 1.87 amperes (min.) at V_{CEO} up to 80 volts.

All of these transistors are supplied in the JEDEC TO-3 hermetic steel package.

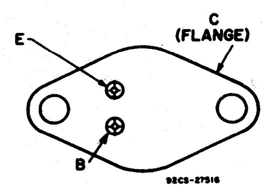
Features:

- 2N6254: premium type from 2N3055 family
- Maximum safe-area-of-operation curves
- Low saturation voltages
- High dissipation ratings
- Thermal-cycle rating curves

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers
- Low-frequency inverters

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N3055	2N6253	2N6254	2N6371	40251	
*V_{CBO}	100	55	100	50	50	V
*$V_{CER}(sus)$						
R_{BE} = 100 Ω	70	55	85	45	–	V
*$V_{CEO}(sus)$	60	45	80	40	40	V
$V_{CEV}(sus)$						
V_{BE} = −1.5 V	90	55	90	50	50	V
*V_{EBO}	7	5	7	5	5	V
*I_C	15	15	15	15	15	A
*I_B	7	7	7	7	7	A
*P_T:						
≤25°C	115	115	150	117	117	W
>25°C	Derate linearly to 200°C					
*T_J, T_{stg}	−65 to +200					°C
*T_L: During soldering, at distances 1/32 in. (0.8 mm) from seating plane for 10 s max.	235					°C

*In accordance with JEDEC registration data formats JS-9 RDF-10: 2N3055; JS-6 RDF-2: 2N6253, 2N6254, 2N6371.

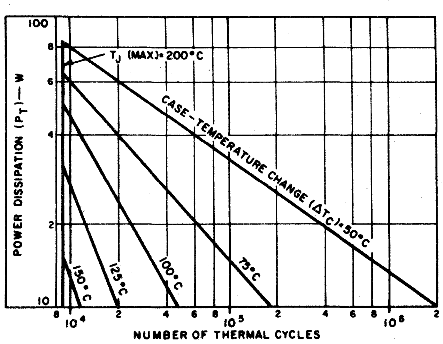


Fig. 1 - Thermal-cycling rating chart for 2N3055, 2N6253, 2N6371.

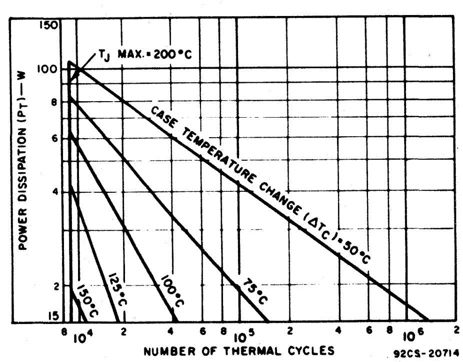


Fig. 2 - Thermal cycling rating chart for 2N6254.

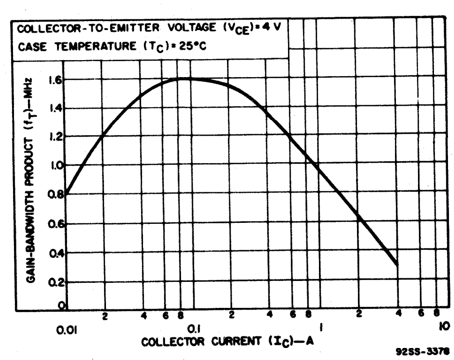


Fig. 3 - Typical gain-bandwidth product for all types.

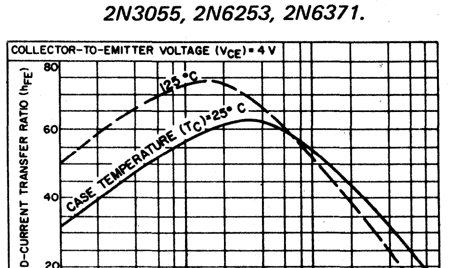


Fig. 4 - Typical dc beta characteristics for 2N3055 and 2N6371.

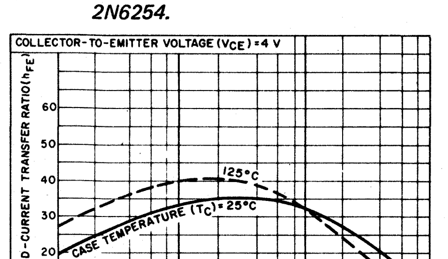


Fig. 5 - Typical dc beta characteristics for 2N6253.

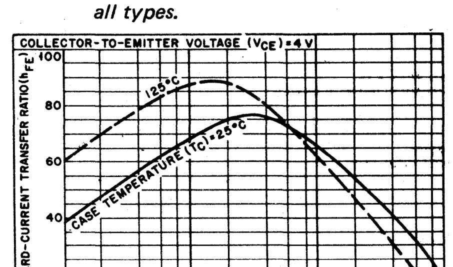


Fig. 6 - Typical dc beta characteristics for 2N6254.

2N3055, 2N6253, 2N6254, 2N6371, 40251

ELECTRICAL CHARACTERISTICS, *T_C = 25°C Unless Otherwise Specified.*

CHARACTERISTIC	TEST CONDITIONS				LIMITS										UNITS
	VOLTAGE V dc		CURRENT A dc		2N3055		2N6253		2N6254		2N6371		40251		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	25			0	–	–	–	1.5	–	–	–	1.5	–	–	
	30			0	–	0.7	–	–	–	–	–	–	–	–	mA
	60			0	–	–	–	–	–	1	–	–	–	–	
I_{CEX}	40	−1.5			–	–	–	–	–	–	–	–	–	2	
	45	−1.5			–	–	–	–	–	–	–	2	–	–	
	55	−1.5			–	–	–	2	–	–	–	–	–	–	
	100	−1.5			–	1	–	–	–	0.5	–	–	–	–	mA
T_C = 150°C	40	−1.5			–	–	–	–	–	–	–	10	–	10	
	50	−1.5			–	–	–	10	–	–	–	–	–	–	
	100	−1.5			–	5	–	–	–	5	–	–	–	–	
* I_{EBO}		−5			–	–	–	10	–	–	–	–	–	–	mA
		−7			–	5	–	–	–	0.5	–	–	–	–	
$V_{(BR)CBO}$			0.1		–	–	–	–	–	–	–	–	50	–	V
$V_{(BR)CEV}$		−1.5	0.1		–	–	–	–	–	–	–	–	50	–	V
$V_{(BR)EBO}$ I_E = 0.01 mA			0		–	–	–	–	–	–	–	–	5	–	V
* V_{CEO}(sus)			0.2[a]	0	60	–	45	–	80	–	40	–	40	–	
* V_{CER}(sus) R_{BE} = 100 Ω			0.2[a]		70	–	55	–	85	–	45	–	–	–	V
V_{CEV}(sus)		−1.5	0.1[a]		90	–	55	–	90	–	50	–	–	–	
* h_{FE}	4		3[a]		–	–	20	70	–	–	–	–	–	–	
	4		4[a]		20	70	–	–	–	–	–	–	–	–	
	2		5[a]		–	–	–	–	20	70	–	–	–	–	
	4		8[a]		–	–	–	–	–	–	15	60	15	60	
	4		10[a]		5	–	-	–	..	–	–	–	–	–	
	4		15[a]		–	–	3	–	5	–	–	–	–	–	
	4		16[a]		–	–	–	–	–	–	4	–	–	–	
* V_{BE}	4		3[a]		–	–	–	1.7	–	–	–	–	–	–	
	4		4[a]		–	1.8	–	–	–	–	–	–	–	–	
	2		5[a]		–	–	–	–	–	1.5	–	–	–	–	V
	4		8[a]		–	–	–	–	–	–	–	–	–	2.2	
	4		16[a]		–	–	–	–	–	–	–	4	–	–	
* V_{CE}(sat)			3[a]	0.3[a]	–	–	–	1	–	–	–	–	–	–	
			4[a]	0.4[a]	–	1.1	–	–	–	–	–	–	–	–	
			5[a]	0.5[a]	–	–	–	–	–	0.5	–	–	–	–	
			8[a]	0.8[a]	–	–	–	–	–	–	–	1.5	–	1.5	V
			10[a]	3.3[a]	–	8	–	–	–	–	–	–	–	–	
			15[a]	3[a]	–	–	–	–	–	4	–	–	–	–	
			15[a]	5[a]	–	–	–	4	–	–	–	–	–	–	
			16[a]	4[a]	–	–	–	–	–	–	–	4	–	–	
* h_{fe} f = 1 kHz	4		1		15	120	10	–	10	–	10	–	–	–	
f_T			1		2.5	–	–	–	–	–	800	–	–	–	MHz
* $\|h_{fe}\|$ f = 0.4 MHz	4		1		–	–	2	–	2	–	2	–	–	–	
* f_{hfe}	4		1		10	–	10	–	10	–	–	–	–	–	kHz
$I_{S/b}$ t_p = 1 s nonrep.	39				–	–	–	–	–	–	–	–	3	–	
	40				2.9	–	–	–	–	–	2.9	–	–	–	
	45				–	–	2.55	–	–	–	–	–	–	–	A
	60				1.95	–	–	–	–	–	–	–	–	–	
	80				–	–	–	–	1.87	–	–	–	–	–	
$R\theta_{JC}$					–	1.5	–	1.5	–	1.17	–	1.5	–	1.5	°C/W

* In accordance with JEDEC registration data formats JS-9 RDF-10: 2N3055; JS-6 RDF-2: 2N6253, 2N6254, 2N6371.

[a] Pulsed: Pulse duration ≈300 μs, duty factor = 1.8%.

2N3055, 2N6253, 2N6254, 2N6371, 40251

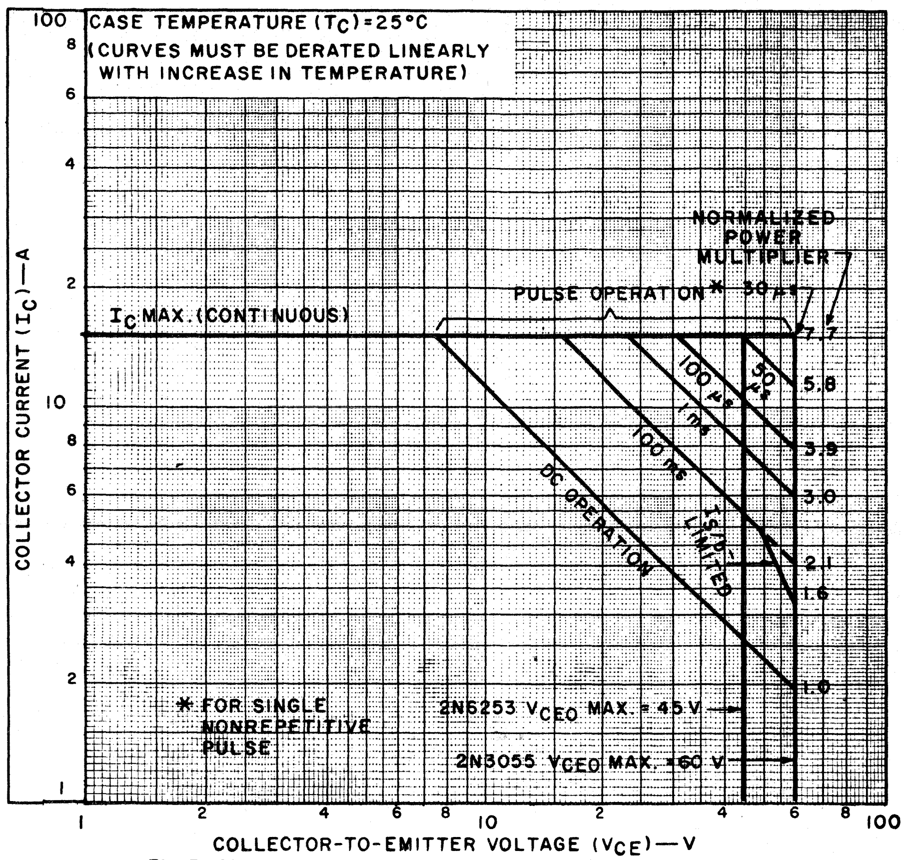


Fig. 7 - Maximum operating areas for types 2N6253 and 2N3055.

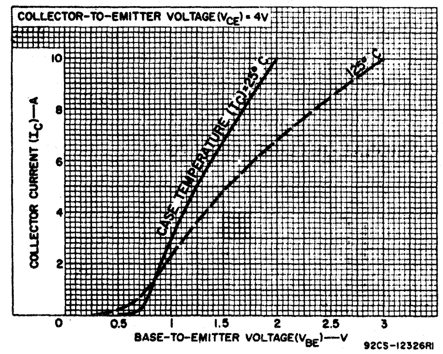


Fig. 8 - Typical transfer characteristics for 2N6254, 2N3055, 2N6371, 40251.

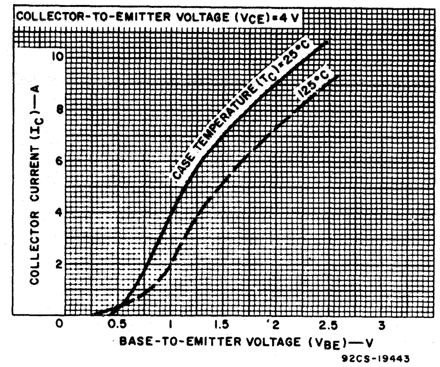


Fig. 9 - Typical transfer characteristics for 2N6253.

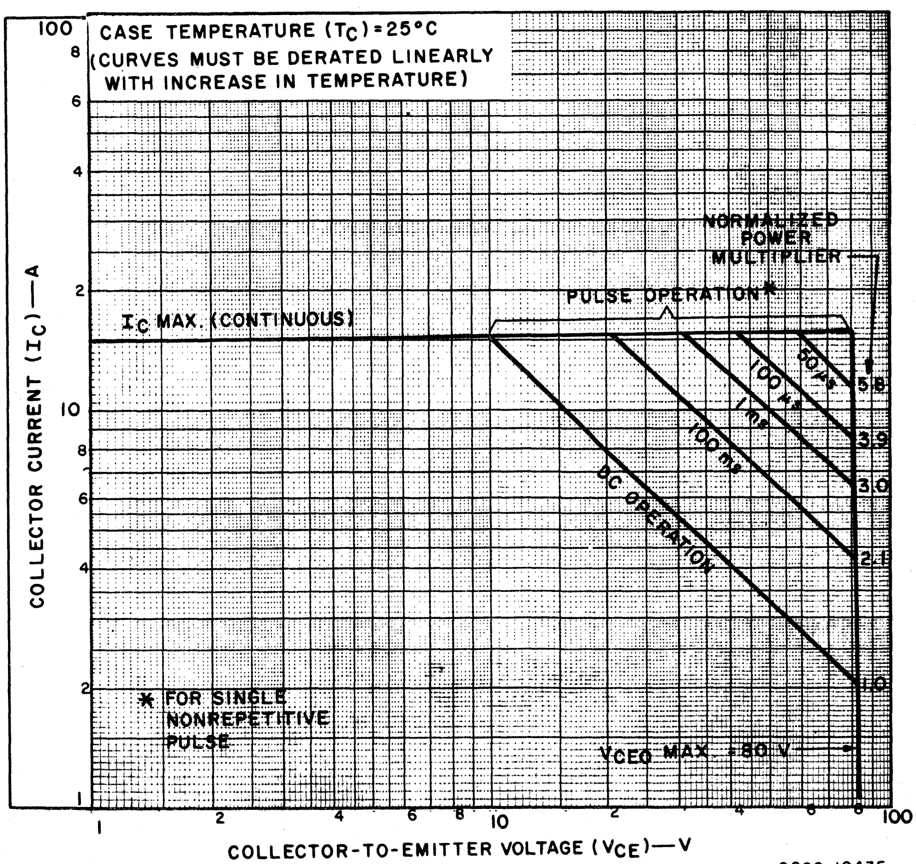


Fig. 10 - Maximum operating areas for 2N6254.

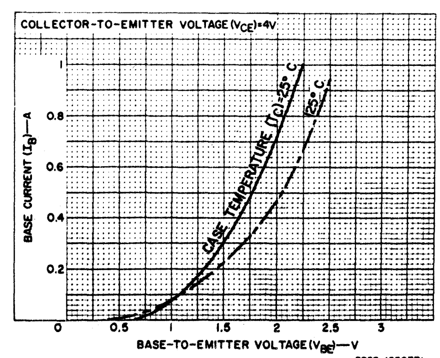


Fig. 11 - Typical input characteristics for 2N3055, 2N6371, 40251.

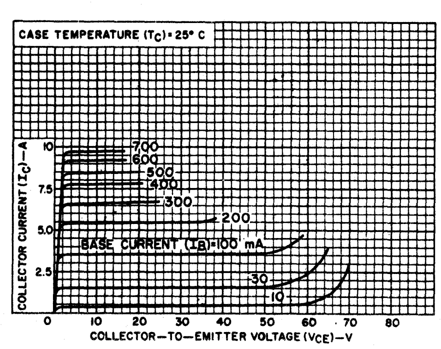


Fig. 12 - Typical output characteristics for 2N3055, 2N6371.

2N3055, 2N6253, 2N6254, 2N6371, 40251

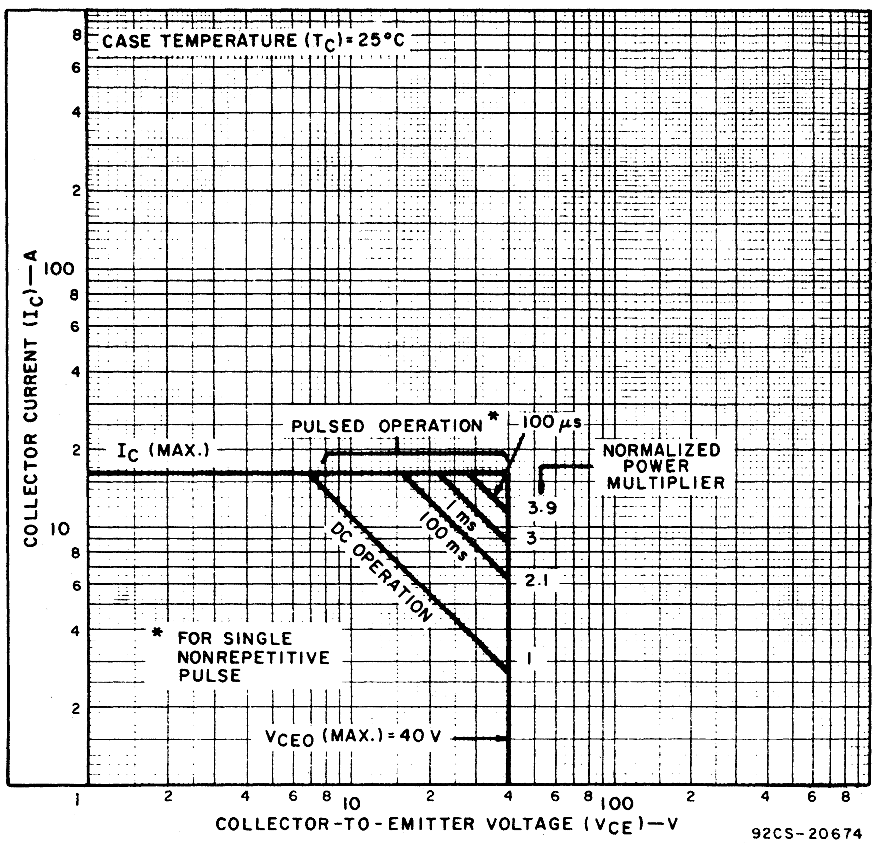


Fig. 13 - Maximum safe area of operation at case temperature of 25°C for 2N6371.

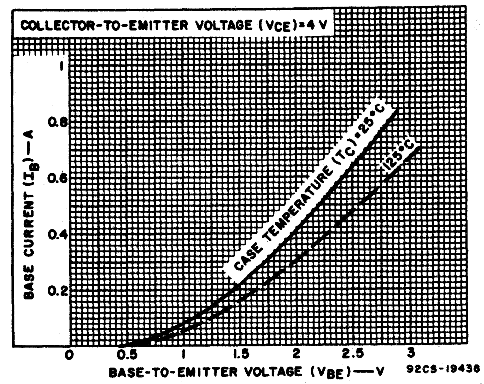


Fig. 14 - Typical input characteristics for 2N6253.

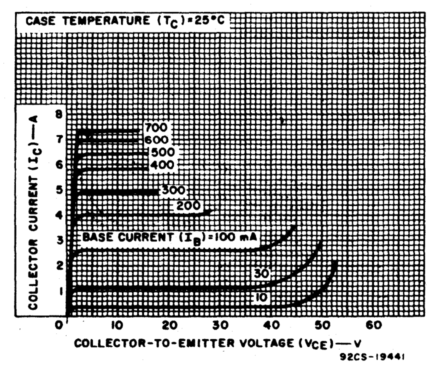


Fig. 15 - Typical output characteristics for 2N6253.

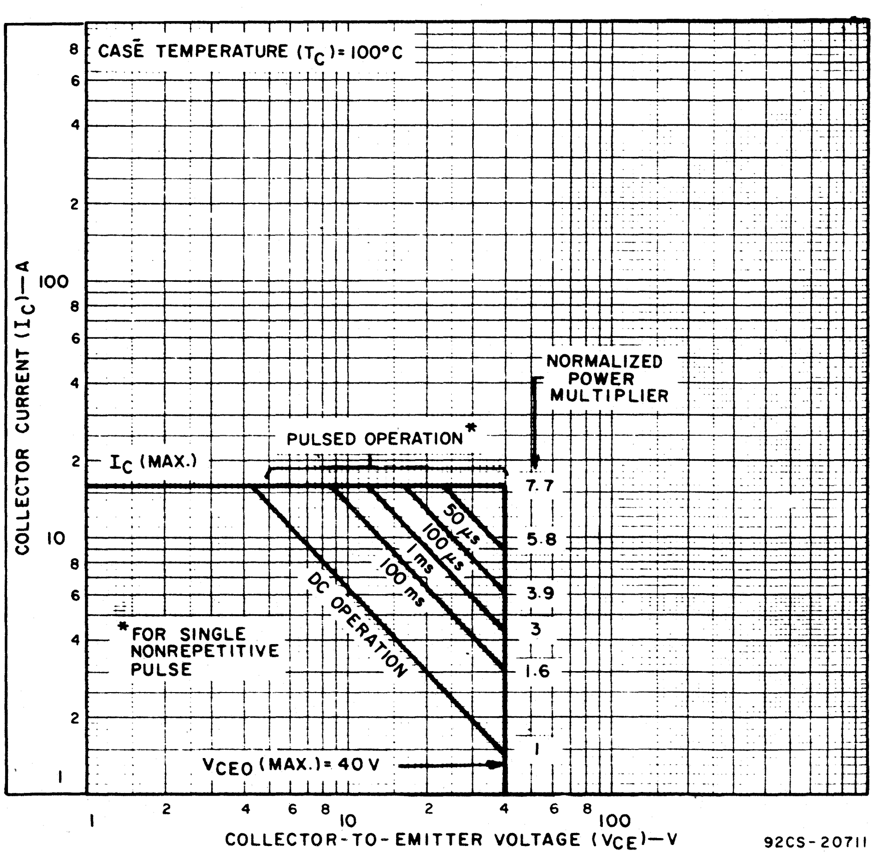


Fig. 16 - Maximum safe area of operation at case temperature of 100°C for 2N6371.

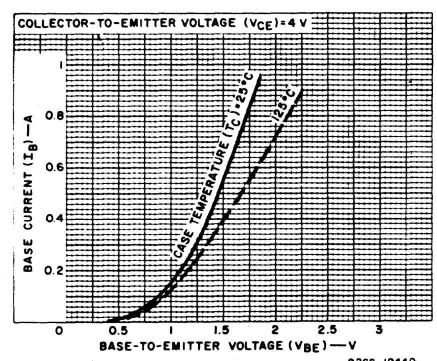


Fig. 17 - Typical input characteristics for 2N6254.

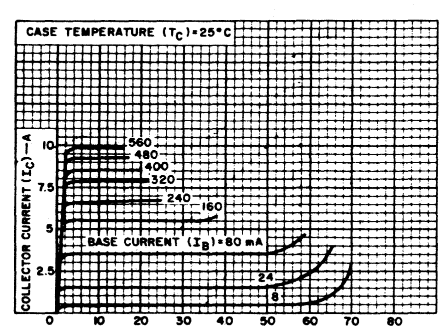


Fig. 18 - Typical output characteristics for 2N6254.

2N3263-2N3266

High-Power, High-Speed, High-Current Silicon N-P-N Power Transistors

Epitaxial Types for Aerospace, Military, and Industrial Applications

RCA-2N3263, 2N3264, 2N3265, and 2N3266● are n-p-n epitaxial silicon power transistors designed for high-reliability aerospace, military, and industrial equipment. Their high current-handling capability and fast switching speed make them desirable in applications where high circuit efficiency is required.

The 2N3263 and 2N3264 are sealed in flat 3/4-inch-diameter packages with radial leads. Types 2N3265 and 2N3266 utilize the JEDEC TO-63 package.

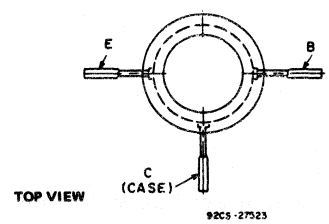
Typical high-speed switching applications for these transistors include switching-control amplifiers, power gates, switching regulators, dc-dc converters, and dc-ac inverters. Other recommended applications include dc-rf amplifiers and power oscillators.

● Formerly RCA Dev. Nos. TA2492, TA2493, TA2494, and TA2495, respectively.

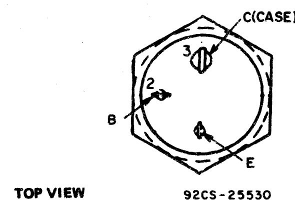
Features:

- Low saturation voltages —
  - 2N3263 and 2N3265
    - $V_{CE}(sat)$ = 0.75 V (max.) at I_C = 15 A
    - $V_{BE}(sat)$ = 1.60 V (max.) at I_C = 15 A
  - 2N3264 and 2N3266
    - V_{CE} (sat) = 1.20 V (max.) at I_C = 15 A
    - V_{BE} (sat) = 1.80 V (max.) at I_C = 15 A
- High reliability and uniformity of characteristics
- High power dissipation
- Fast rise time at high collector current — 0.2 μs at 10 A (typical)

TERMINAL DESIGNATIONS



2N3263, 2N3264 (RADIAL)



2N3265, 2N3266 (JEDEC TO-63)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3264 2N3266	2N3263 2N3265	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With 1.5 volts (V_{BE}) of reverse bias	$V_{CEX}(sus)$	120	150	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω	$V_{CER}(sus)$	80	110	V
* With base open	V_{CEO} (sus)	60	90	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
* COLLECTOR CURRENT	I_C	25	25	A
* BASE CURRENT	I_B	10	10	A
* TRANSISTOR DISSIPATION	P_T	*See Figs. 1 & 2*		
* TEMPERATURE RANGE:				
Storage and operating (Junction)		−65 to +200		°C
LEAD TEMPERATURE (During soldering):				
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230		°C

* In accordance with JEDEC registration data format.

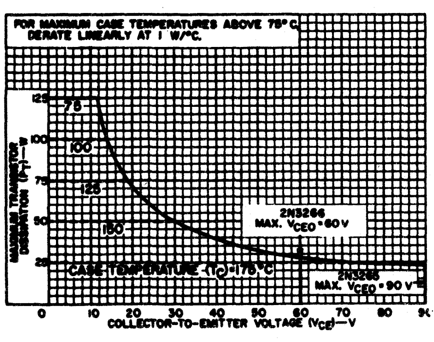


Fig. 1—Rating chart for 2N3265 and 2N3266.

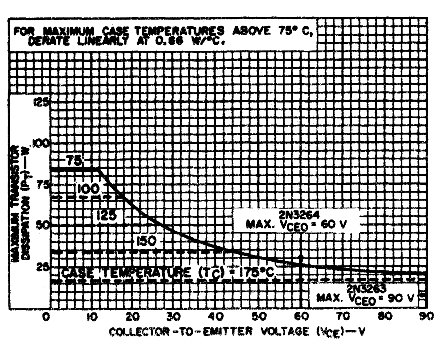


Fig. 2—Rating chart for 2N3263 and 2N3264.

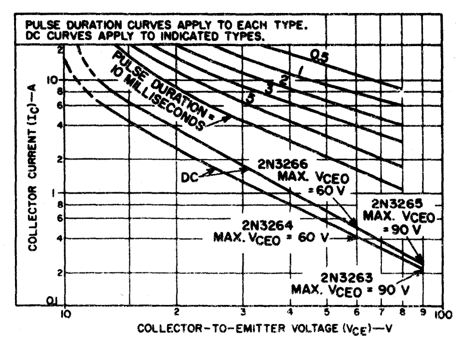


Fig. 3—Safe-operating region as a function of pulse width.

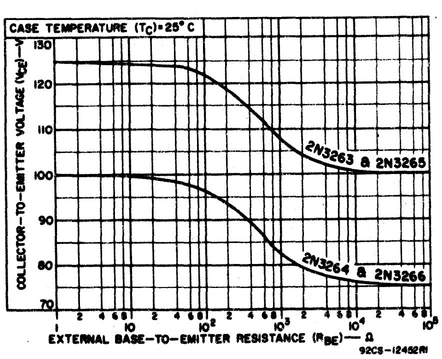


Fig. 4—Typical sustaining voltage vs. base-to-emitter resistance.

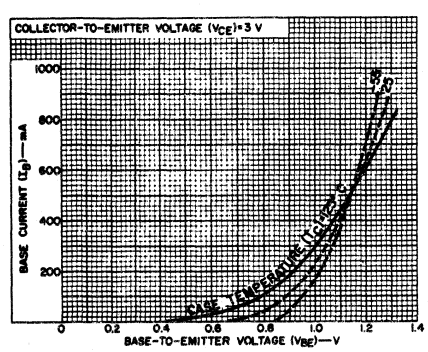


Fig. 5—Typical input characteristics.

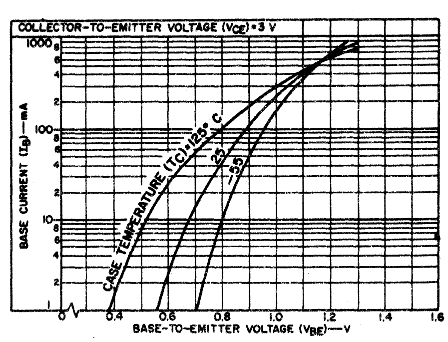


Fig. 6—Typical input characteristics.

2N3263-2N3266

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	V_{EB}	CURRENT A dc I_E	I_B	I_C	LIMITS: 2N3264 2N3266 MIN.	MAX.	2N3263 2N3265 MIN.	MAX.	UNITS
Collector Cutoff Current: With emitter open	I_{CBO}	60			0			–	10	–	–	mA
		80			0			–	–	–	4	
At T_C = 125°C		60			0			–	10	–	–	
		80			0			–	–	–	4	
* With base reverse-biased	I_{CEX}		120	1.5				–	20	–	–	
			150	1.5				–	–	–	20	
* Emitter Cutoff Current:	I_{EBO}			7			0	–	15	–	5	mA
* At T_C = 125°C				7			0	–	15	–	5	
Emitter-to-Base Voltage	V_{EBO}				0.02		0	7	–	7	–	V
Collector-to-Emitter Sustaining Voltage: * With base open	$V_{CEO}(sus)$●					0	0.2	60	–	90	–	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω	$V_{CER}(sus)$●					0	0.2	80	–	110	–	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$●					2	20	–	1.6	–	1	V
						1.2	15	–	1.2	–	0.75	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$●					2	20	–	2.2	–	1.8	V
						1.2	15	–	1.8	–	1.6	
* DC Forward Current Transfer Ratio	h_{FE}●		3				5	35	–	40	–	
*			3				15	20	80	25	75	
			2				15	–	–	20	55	
* Second-Breakdown Collector Current: (See Fig. 3) DC forward-biased	$I_{S/b}$▲	50						700	–	–	–	mA
		75						–	–	350	–	
* Pulsed, forward-biased, t_p = 250 µs		75						13.3	–	13.3	–	A
* Second-Breakdown Energy With base reverse-biased, and R_{BE} = 20Ω, L = 40µH	$E_{S/b}$**			6			10	2	–	2	–	mJ
* Saturated Switching Time: Turn-on (t_d + t_r)	t_{ON}	V_{CC}= 30				1.2♠	15	–	0.5	–	0.5	µs
Storage	t_s					1.2♠	15	–	1.5	–	1.5	
Fall	t_f					1.2♠	15	–	0.5	–	0.5	
* Gain-Bandwidth Product (f = 1 MHz)	f_T		10				3	20	–	20	–	MHz
Collector-to-Base Feedback Capacitance (f = 1 MHz)	C_{ob}	10			0			–	500	–	500	pF
* Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$		10				10	2N3263 2N3264 –	1.5	2N3265 2N3266 –	1	°C/W

* In accordance with JEDEC registration data format.
● Pulsed; pulse duration ≤ 350 µs, duty factor ≤ 2%. CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of test circuit!
▲ $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.
** $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b}$ = 1/2 LI^2, where L is a series load or leakage inductance and I is the collector current.
♠ I_{B_1} = I_{B_2}.

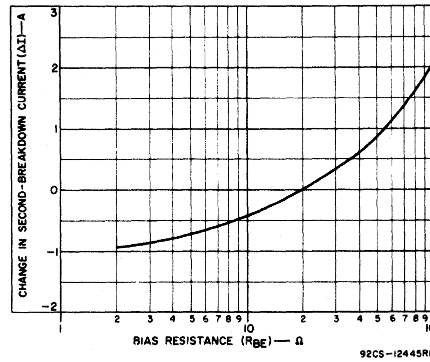


Fig.7—Typical change in $E_{S/b}$ as a function of base-to-emitter resistance.

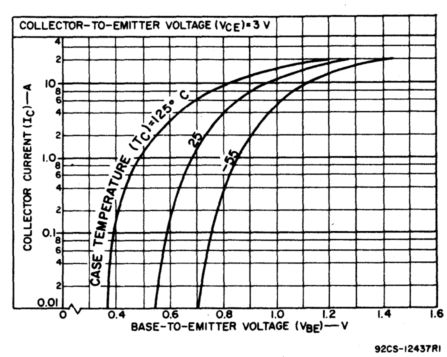


Fig.8—Typical transfer characteristics.

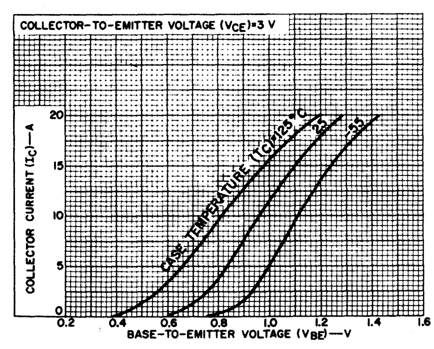


Fig.9—Typical transfer characteristics.

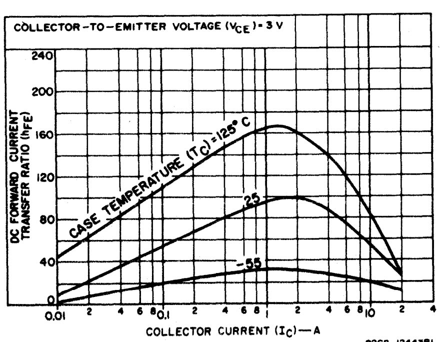


Fig.10—Typical dc beta characteristics (median values).

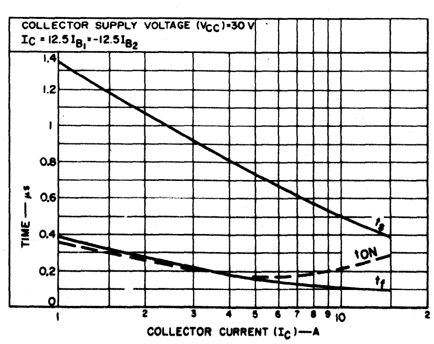


Fig.11—Typical saturated-switching characteristics.

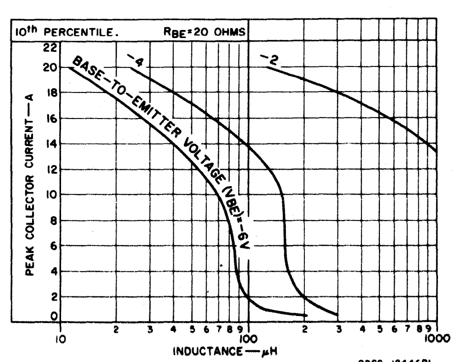


Fig.12—Collector current as a function of inductance (50th percentile).

2N3439; 2N3440; 2N4063; 2N4064; 40385; 40346, V1, V2; 40390; 40412, V1, V2

High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

These RCA types are epitaxial-base silicon n-p-n transistors with high breakdown voltages, high-frequency response, and fast switching speeds. These transistors are intended for industrial, commercial, and military equipment. Typical applications include high-voltage differential and operational amplifiers, high-voltage inverters, and high-voltage, low-current switching and series regulators.

Types 40346, 40346V1, and 40346V2 are especially useful in such devices as neon indicator and NIXIE● driver circuits and in differential and operational amplifiers. Types 40412, 40412V1, and 40412V2 are especially suited for class-A ac/dc audio-amplifier service.

These transistors are supplied in JEDEC TO-39 hermetic packages or in the TO-39 package with factory-attached mounting flange or heat radiator.

●Nixie is a Registered Trademark of Burroughs Corporation, Electronic Components Division, Plainfield, N.J.

Features:

- **High voltage ratings:**
  V_{CBO} = 450 V max. (2N3439, 2N4063)
  = 300 V max. (2N3440, 2N4064)
  $V_{CEO}(sus)$ = 350 V max. (2N3439, 2N4063)
  = 250 V max. (2N3440, 2N4064)
- **Maximum-area-of-operation curves**
- **Low saturation voltages**
- **Planar construction for low noise and low leakage**

Additional Features for 40385:

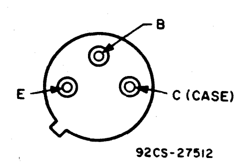
- **High reliability assured by five preconditioning steps**
- **Group A test data in data File 215**

MAXIMUM RATINGS, *Absolute-Maximum Values:*	2N3439 2N4063 40385	2N3440 2N4064 40390	40346 40346V1 40346V2	40412 40412V1 40412V2	
*COLLECTOR-TO-BASE VOLTAGE ...... V_{CBO}	450	300	–	–	V
COLLECTOR-TO-EMITTER VOLTAGE:					
With external base-to-emitter resistance					
(R_{BE}) = 1,000 Ω .... $V_{CER}(sus)$	–	–	175	–	V
= 10,000 Ω .... $V_{CER}(sus)$	–	–	–	250	V
* With base open .... $V_{CEO}(sus)$	350	250	–	–	V
*EMITTER-TO-BASE VOLTAGE .... V_{EBO}	7	7	–	–	V
*CONTINUOUS COLLECTOR CURRENT ... I_C	1	1	1	1	A
*CONTINUOUS BASE CURRENT .... I_B	0.5	0.5	0.5	0.5	A
TRANSISTOR DISSIPATION: P_T					
At case temperature up to 25°C	10	10(2N3440) 10(2N4064)	10(40346) 10(40346V2)	10(40412) 10(40412V2)	W
At free-air temperatures up to 25°C	1(40385)	3.5(40390)	4(40346V1)	4(40412V1)	W
At free-air temperatures up to 50°C	1(2N3439)	1(2N3440)	1(40346)	1(40412)	W
At free-air temperatures above 25°C or 50°C	Derate linearly to 200°C				°C
*TEMPERATURE RANGE:					
Storage & Operating (Junction)	–65 to 200				°C
*LEAD TEMPERATURE (During soldering):					
At distances ≥ 1/32 in (0.79 mm) from seating plane for 10 s max.	255				°C

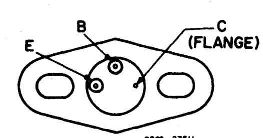
*2N-Series types in accordance with JEDEC registration data

NOTE: P_T value of 10 W at T_C = 25°C and lead temperature of 255°C are registered data for 2N4063 and 2N4064 only.

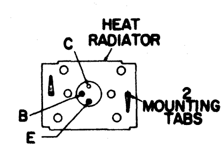
TERMINAL DESIGNATIONS



JEDEC TO-39
2N3439,2N3440,40346
40385,40412



JEDEC TO-39 with Flange
2N4063,2N4064,40346V2,
40412V2



JEDEC TO-39 with Heat Radiator
40390,40346V1,40412V1

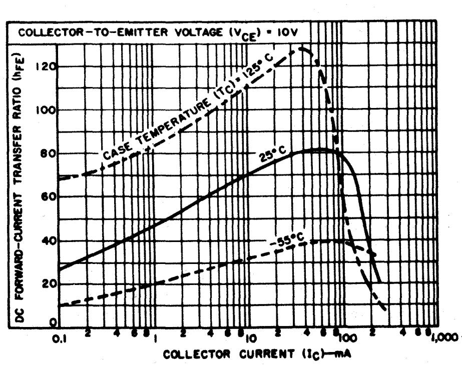


Fig. 1 — Typical dc-beta characteristics for 2N3439, 2N3440, 2N4063, 2N4064 and 40390.

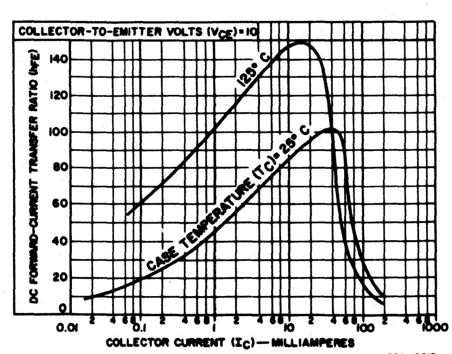


Fig. 2 — Typical dc-beta characteristics for 40346, 40346V1, 40346V2, 40412, 40412V1 and 40412V2.

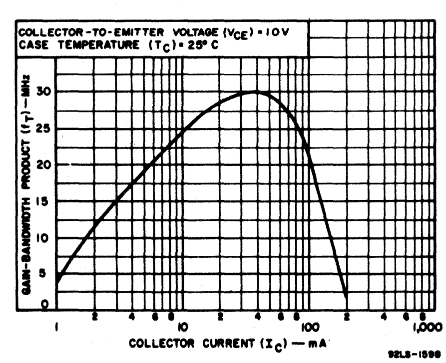


Fig.3—Typical gain-bandwidth product for all types.

2N3439; 2N3440; 2N4063; 2N4064; 40385; 40346, V1, V2; 40390; 40412, V1, V2

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

CHARACTERISTICS	SYMBOL	VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT mA dc I_C	LIMITS 2N3439 2N4063 40385 MIN.	MAX.	2N3440 2N4064 40390 MIN.	MAX.	40346 40346V1 40346V2 MIN.	MAX.	40412 40412V1 40412V2 MIN.	MAX.	UNITS
Collector-Cutoff Current: With base open	I_{CEO}	100	—		—	—	—	—	—	5	—	5	µA
		200			—	—	—	50	—	—	—	—	
		300			—	20	—	—	—	—	—	—	
With base reverse-biased:	I_{CEV}	200	−1.5		—	—	—	—	—	10	—	—	µA
		300	−1.5		—	—	—	500	—	—	—	—	
		450	−1.5		—	500	—	—	—	—	—	—	
At T_C = 150°C		150	−1.5		—	—	—	—	—	—	—	2	mA
		200	−1.5		—	—	—	—	—	1	—	—	
With R = 10,000 ohms	I_{CER}	100			—	—	—	—	—	—	—	1	mA
* Emitter-Cutoff Current	I_{EBO}		−3		—	—	—	—	—	—	—	100	µA
			−4		—	—	—	—	—	5	—	—	
			−6		—	20	—	20	—	—	—	—	
DC Forward-Current Transfer Ratio	h_{FE}	10		2	30	—	—	—	—	—	—	—	
		10		10	—	—	—	—	25	—	—	—	
		10		20	40	160	40	160	—	—	—	—	
		20		30	—	—	—	—	—	—	40	—	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			50	350[a]	—	250[a]	—	—	—	—	—	V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance R_{BE} = 1,000 ohms	$V_{CER}(sus)$			50	—	—	—	—	175[a]	—	—	—	V
R_{BE} = 10,000 ohms	$V_{CER}(sus)$			50	—	—	—	—	—	—	250[a]	—	V
Base-to-Emitter Voltage	V_{BE}	10		10	—	—	—	—	—	1	—	—	V
* Base-to-Emitter Saturation Voltage I_B = 4 mA	$V_{BE}(sat)$			50	—	1.3	—	1.3	—	—	—	—	V
Collector-to-Emitter Saturation Voltage I_B = 1 mA	$V_{CE}(sat)$			10	—	—	—	—	—	0.5	—	0.5	V
* I_B = 4 mA				50	—	0.5	—	0.5	—	—	—	—	V
* Small-Signal Forward-Current Transfer Ratio: f= 5 MHz	h_{fe}	10		10	3	—	3	—	2	—	2	—	
* Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{ob}				—	10	—	10	—	10	—	10	pF
Second-Breakdown Current	$I_{S/b}$	200			—	—	—	—	—	—	50	—	mA
Thermal Resistance: Junction-to-case	$R_{\theta JC}$				—	17.5	—	17.5	15 max. (40346) (40346V2)		15 max. (40412) (40412V2)		°C/W
Junction-to-free air	$R_{\theta JFA}$				—	—	—	—	45 max. (40346V1)		45 max. (40412V1)		°C/W

*2N-Series types in accordance with JEDEC registration data

[a]CAUTION: The sustaining voltages, $V_{CEO}(sus)$ and $V_{CER}(sus)$, MUST NOT be measured on a curve tracer

2N3439; 2N3440; 2N4063; 2N4064; 40385; 40346, V1, V2; 40390; 40412, V1, V2

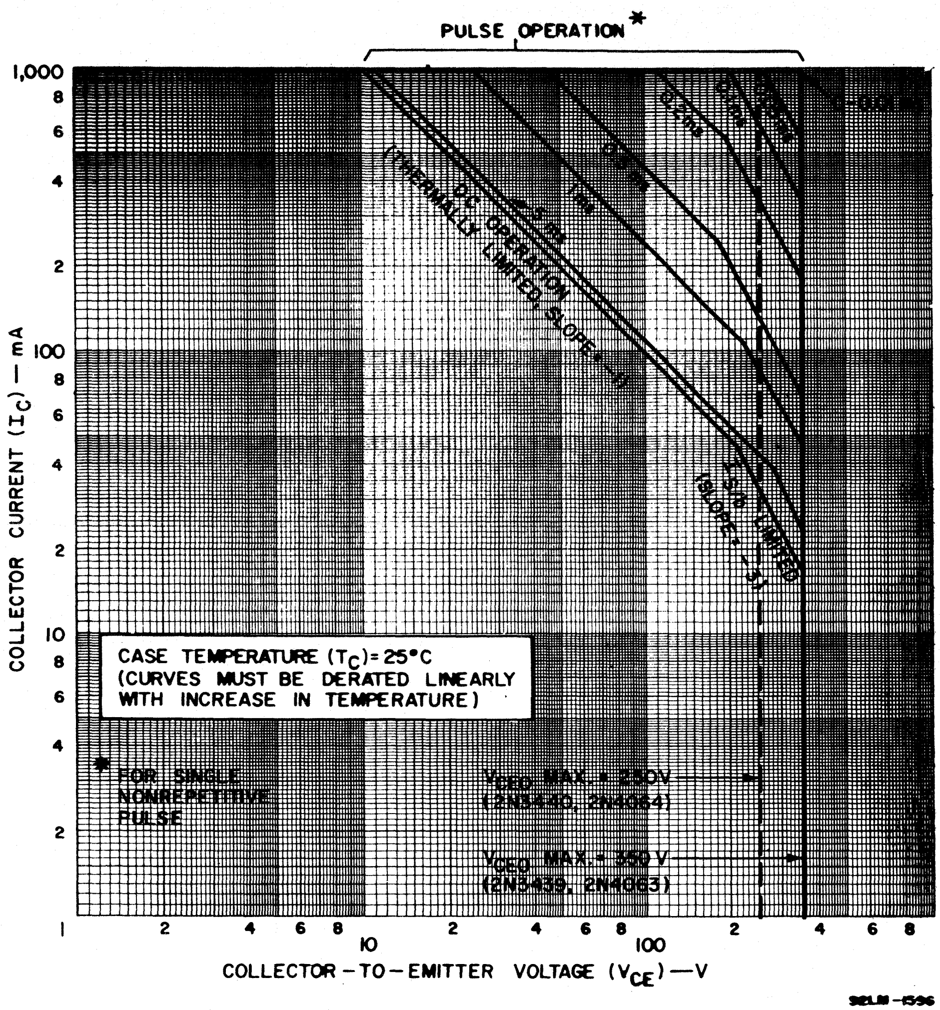


Fig.4—Maximum operating areas for 2N3439,2N3440,2N4063 and 2N4064.

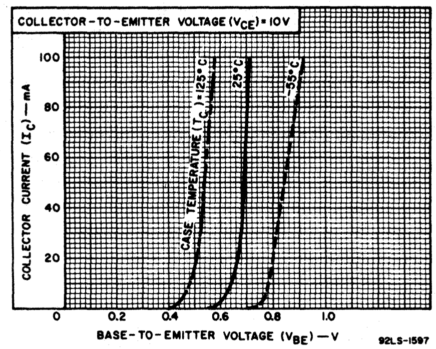


Fig. 5 — Typical transfer characteristics for 2N3439, 2N3440, 2N4063, 2N4064 and 40390.

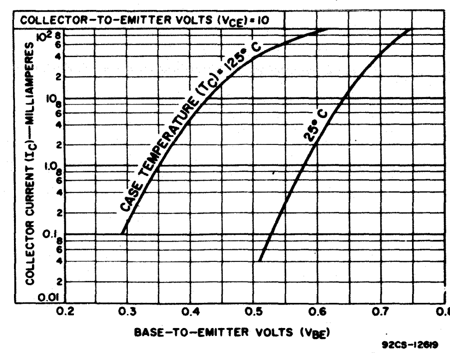


Fig. 6 — Typical transfer characteristics for 40346, 40346V1, 40346V2, 40412, 40412V1 and 40412V2.

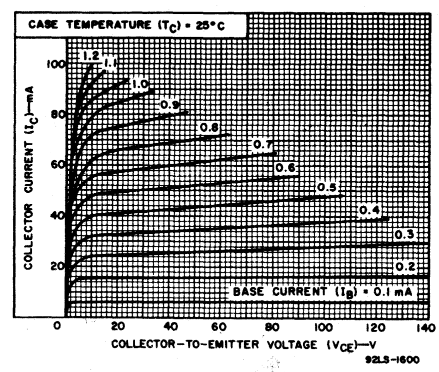


Fig. 7 — Typical output characteristics for 2N3439, 2N3440, 2N4063, 2N4064 and 40390.

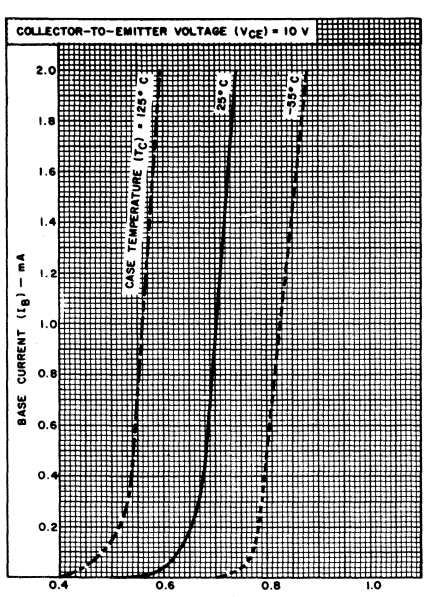


Fig. 8 — Typical input characteristics for 2N3439, 2N3440, 2N4063, 2N4064 and 40390.

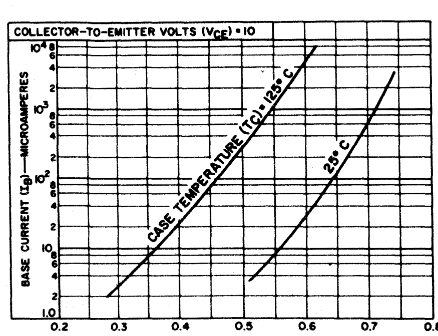


Fig. 9 — Typical input characteristics for 40346, 40346V1, 40346V2, 40412, 40412V1 and 40412V2.

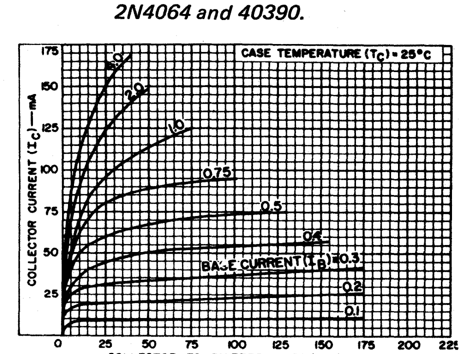


Fig. 10 — Typical output characteristics for 40346, 40346V1, 40346V2, 40412, 40412V1 and 40412V2.

2N3441, 2N6263, 2N6264, 40373, 40912, 40913

Hometaxial-Base Medium-Power Silicon N-P-N Transistors

Rugged Devices for Intermediate Power Applications in Industrial and Commercial Equipment

RCA 2N3441, 2N6263, and 2N6264 are hometaxial-base silicon n-p-n transistors intended for a wide variety of medium to-high power, high-voltage applications. These types are supplied in the JEDEC TO-66 hermetic package.

Types 40373, 40912, and 40913 are the 2N3441, 2N6263, and 2N6264 with factory-attached heat-radiators intended for printed-circuit-board applications.

Features:

- 2N6264: premium type from 2N3441 family
- Maximum safe-area-of-operation curves for dc and pulse operation
- High voltage ratings
- Low saturation voltages
- Thermal-cycling rating curves

Applications:

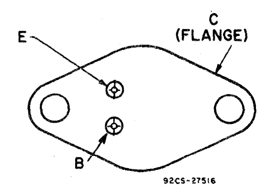
- Series and shunt regulators
- High-fidelity amplifiers
- Power switching circuits
- Solenoid drivers

MAXIMUM RATINGS, *Absolute-Maximum Values:*

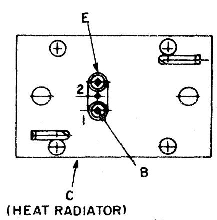
		2N6263 40912	2N3441 40373	2N6264 40913	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	170	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
* With base open	$V_{CEO}(sus)$	120	140	150	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$	130	150	160	V
With base reverse-biased (V_{BE} = -1.5 V)	$V_{CEV}(sus)$	140	160	170	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	3	3	3	A
PEAK COLLECTOR CURRENT		4	4	4	A
*CONTINUOUS BASE CURRENT	I_B	2	2	2	A
TRANSISTOR DISSIPATION:	P_T				
* At case temperature up to 25°C		20 (2N6263)	25 (2N3441)	50 (2N6264)	W
At ambient temperatures up to 25°C		5.8 (40912)	5.8 (40373)	5.8 (40913)	W
* At temperatures above 25°C		Derate linearly to 200°C			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		-65 to 200			°C
*PIN TEMPERATURE (During Soldering):					
At distances ≥1/32 in. (0.8 mm) from seating plane for 10 s max.		235			°C

*In accordance with JEDEC registration data format JS-6 RDF-2

TERMINAL DESIGNATIONS



JEDEC TO-66
2N3441,2N6263,2N6264



JEDEC TO-66 with Heat Radiator
40373,40912,40913

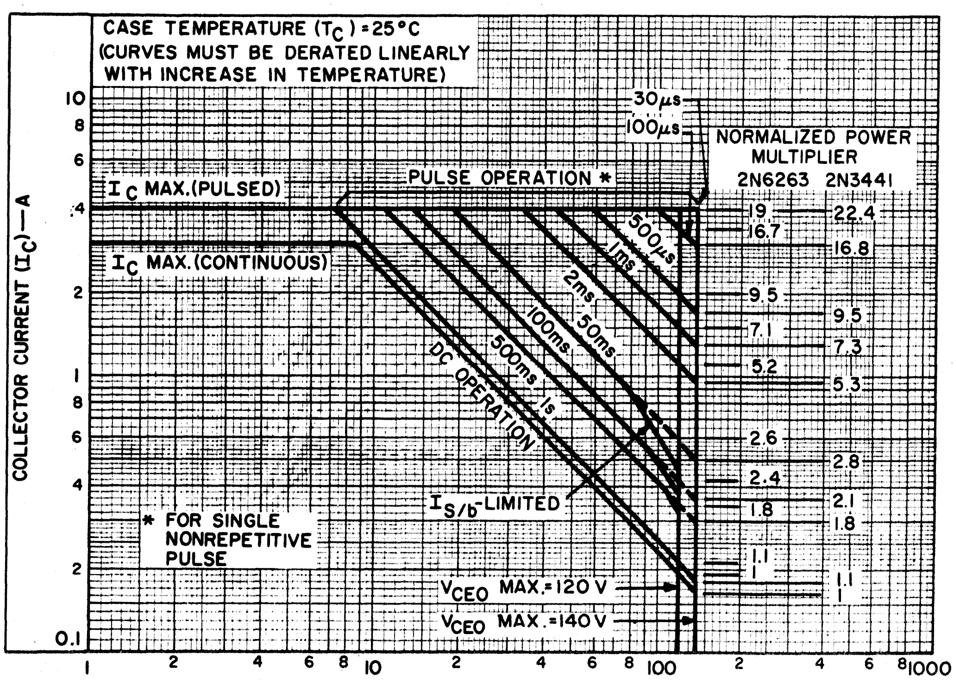


Fig.1—Maximum operating areas for 2N3441 and 2N6263.

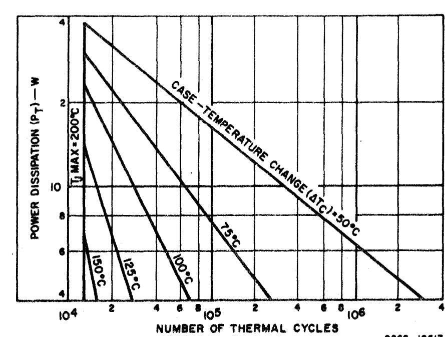


Fig.2—Thermal-cycle rating chart for 2N6264.

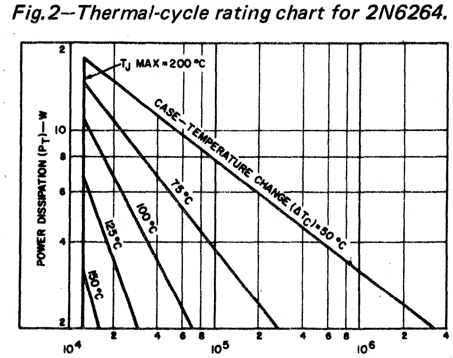


Fig.3—Thermal-cycle rating chart for 2N3441.

2N3441, 2N6263, 2N6264, 40373, 40912, 40913

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6263 40912 Min.	Max.	2N3441 40373 Min.	Max.	2N6264 40913 Min.	Max.	UNITS
Collector-Cutoff Current:												
* With base open	I_{CEO}	100			0	–	5	–	–	–	–	mA
		130			0	–	–	–	–	–	1	
		140			0	–	–	–	100	–	–	
Collector-Cutoff Current: With base-emitter junction reversed biased	I_{CEX}	120	−1.5			–	2*	–	–	–	–	mA
		140	−1.5			–	–	–	5*	–	–	
		140	−1.5			–	–	–	1	–	–	
		150	−1.5			–	–	–	–	–	0.05*	
	I_{CEX} (T_C = 150°C)	120	−1.5			–	10*	–	–	–	–	
		140	−1.5			–	–	–	6*	–	–	
		140	−1.5			–	–	–	5	–	–	
		150	−1.5			–	–	–	–	–	1*	
* Emitter-Cutoff Current	I_{EBO}		−5			–	2	–	–	–	–	mA
			−7			–	–	–	1	–	0.2	
Collector-to-Emitter Sustaining Voltage:[a] * With base open	$V_{CEO}(sus)$			0.1[b]	0	120	–	140	–	150	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1		130	–	150	–	160	–	
With base-emitter junction reversed biased	$V_{CEV}(sus)$		−1.5	0.1		140	–	160	–	170	–	
* DC Forward-Current Transfer Ratio	h_{FE}	2		1[b]		–	–	–	–	20	60	
		2		3[b]		3	–	–	–	5	–	
		4		0.5[b]		20	100	25	100	–	–	
		4		2.7[b]		–	–	5	–	–	–	
Collector-to-Emitter Saturating Voltage	$V_{CE}(sat)$			0.5[b]	0.05	–	1.2*	–	1	–	–	V
				1[b]	0.1	–	–	–	–	–	0.5*	
				2.7[b]	0.9	–	–	–	6*	–	–	
Base-to-Emitter Voltage	V_{BE}	2		1[b]		–	–	–	–	–	1.5*	V
		4		0.5[b]		–	2*	–	1.7	–	–	
		4		2.7[b]		–	–	–	6*	–	–	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 0.4 MHz)	$\|h_{fe}\|$	4		0.5		5	–	5	–	5	–	
Gain-Bandwidth Product	f_T	4		0.2		200	–	200	–	200	–	kHz
* Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		0.1		25	–	–	–	25	–	
		4		0.5		–	–	15	75	–	–	
Forward-Bias Second Breakdown Collector Current, Pulse Duration (non-repetitive) = 1 s	$I_{S/b}$	120				0.167	–	–	–	–	–	A
		120				–	–	–	–	0.417	–	
		120				–	–	0.21	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					8.75 (max.) 2N6263		7 (max.) 2N3441		3.5 (max.) 2N6264		°C/W
Junction-to-Ambient	$R_{\theta JA}$					30 (max.) 40912		30 (max.) 40373		30 (max.) 40913		

*In accordance with JEDEC registration data format (JS-6 RDF-2).

[a]**CAUTION:** The sustaining voltage $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ MUST NOT be measured on a curve tracer.

[b]Pulsed, pulse duration = 300 μs; duty factor ≤ 2 %.

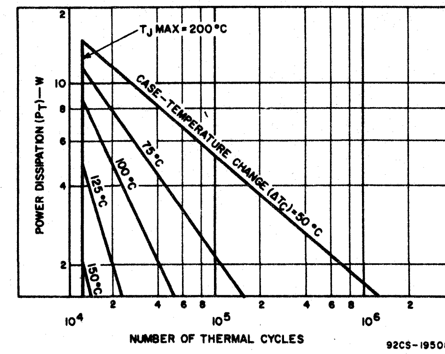


Fig.4—Thermal-cycle rating chart for 2N6263.

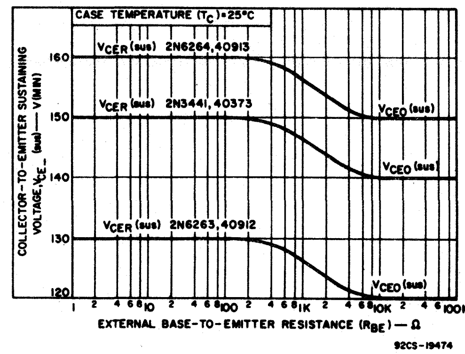


Fig.5—Sustaining voltage vs. base-to-emitter resistance for all types.

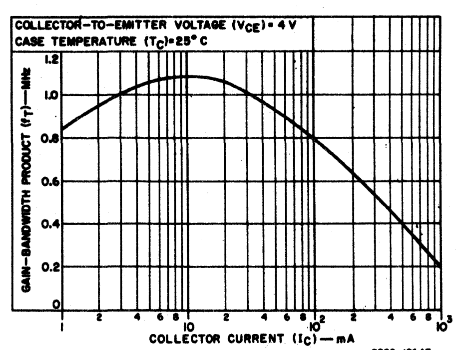


Fig.6—Typical gain-bandwidth product for all types.

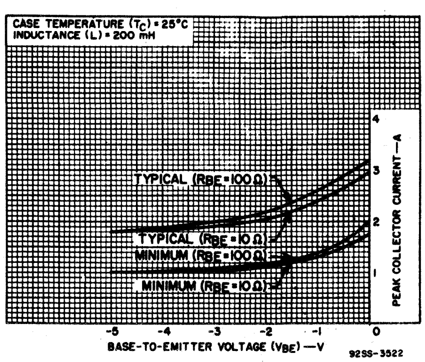


Fig.7—Reverse-bias second-breakdown characteristics for all types.

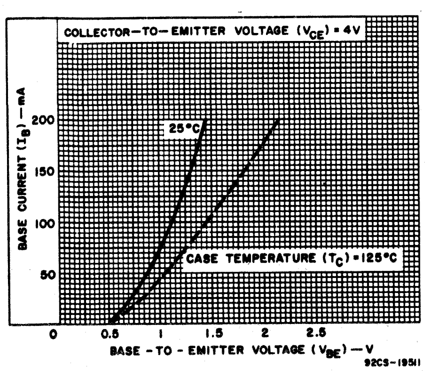


Fig.8—Typical input characteristics for 2N6263 and 40912.

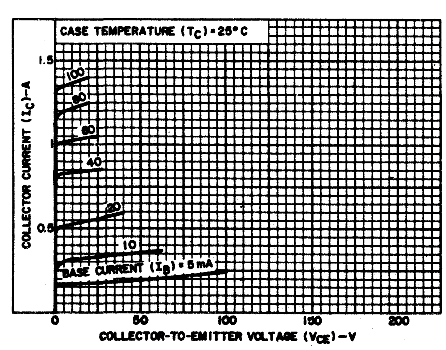


Fig.9—Typical output characteristics for 2N6263 and 40912.

2N3441, 2N6263, 2N6264, 40373, 40912, 40913

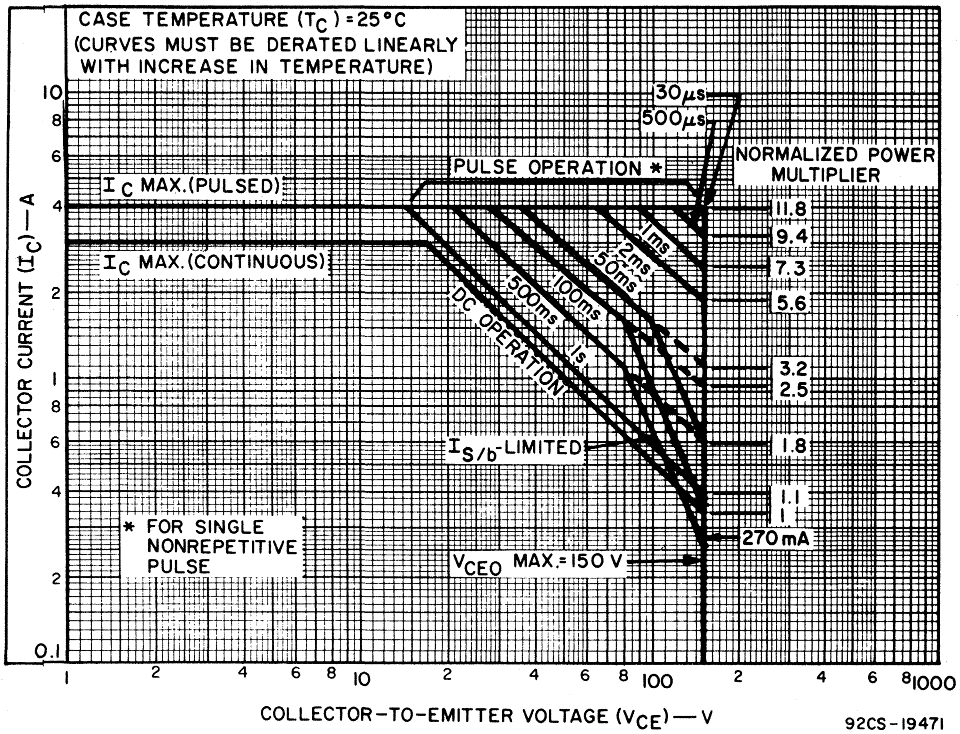


Fig. 10—Maximum operating areas for 2N6264.

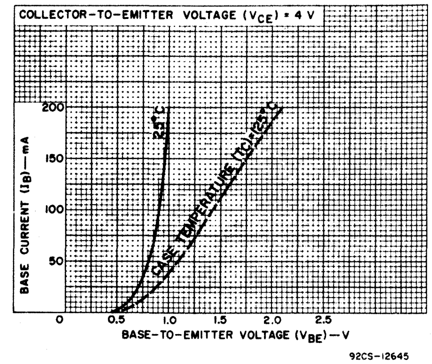


Fig. 11—Typical input characteristics for 2N3441 and 40373.

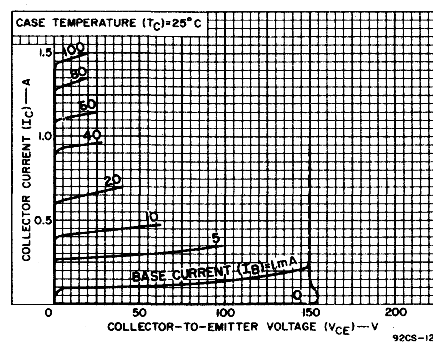


Fig. 12—Typical output characteristics for 2N3441 and 40373.

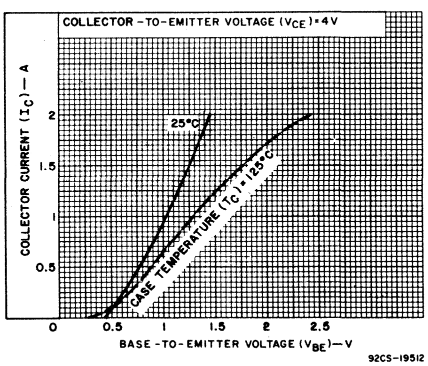


Fig. 13—Typical transfer characteristics for 2N6263 and 40912.

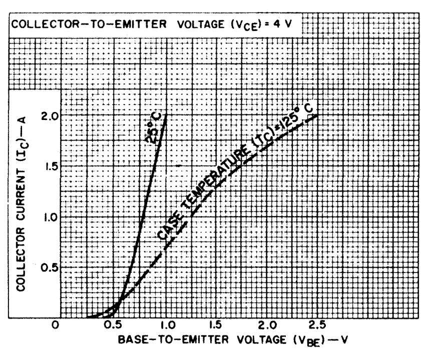


Fig. 14—Typical transfer characteristics for 2N3441 and 40373.

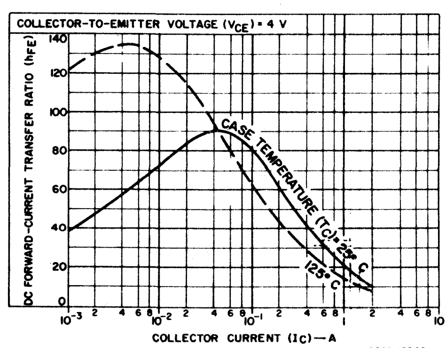


Fig. 15—Typical dc-beta characteristics for 2N3441 and 40373.

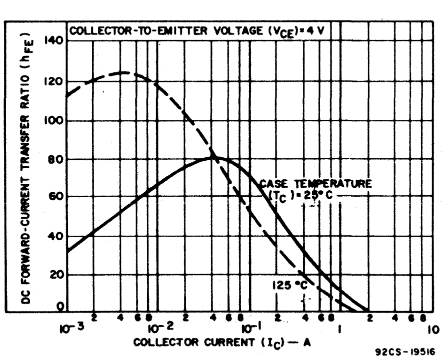


Fig. 16—Typical dc-beta characteristics for 2N6263 and 40912.

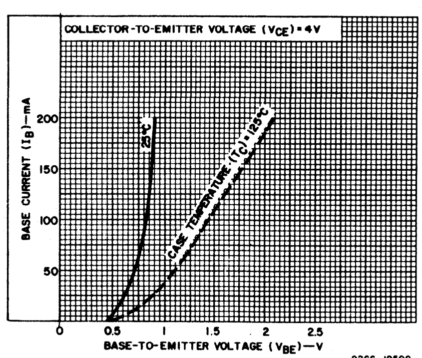


Fig. 17—Typical input characteristics for 2N6264 and 40913.

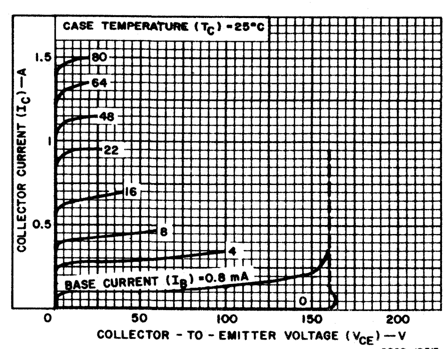


Fig. 18—Typical output characteristics for 2N6264 and 40913.

2N3441, 2N6263, 2N6264, 40373, 40912, 40913

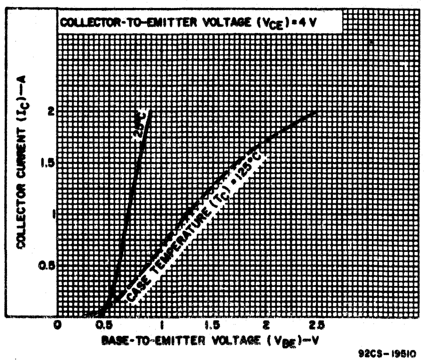


Fig.19—Typical transfer characteristics for 2N6262 and 40913.

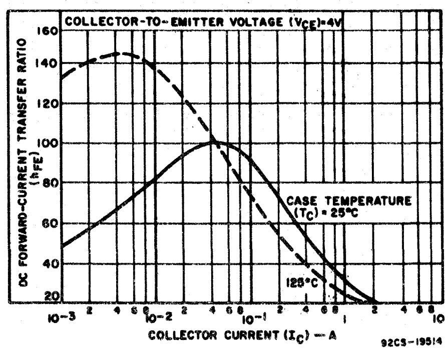


Fig.20—Typical dc-beta characteristics for 2N6264 and 40913.

2N3442, 2N4347, 2N6262

Hometaxial-Base High-Voltage Silicon N-P-N Transistors

Rugged High-Power Devices for Applications in Industrial and Commercial Equipment

RCA 2N3442, 2N4347, and 2N6262 are hometaxial-base, silicon n-p-n transistors intended for a wide variety of high-power, high-voltage applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

These devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage, current, and power.

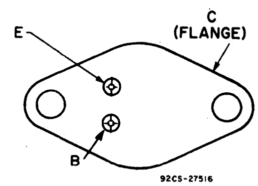
Features:

- **Low saturation voltages**
- **Thermal-cycle rating charts**
- **High dissipation capability – 100 W (2N4347)**
  – 117 W (2N3442)
  – 150 W (2N6262)
- **Maximum area-of-operation curves for dc and pulse operation.**

Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

		2N4347	2N3442	2N6262	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	170	V
COLLECTOR-TO-EMITTER VOLTAGE:					
* With base open	V_{CEO}	120	140	150	V
With reverse bias (V_{BE}) of −1.5 V	V_{CEV}	140*	160	170	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
*COLLECTOR CURRENT:	I_C				
Continuous		5	10	10	A
Peak		10*	15	15	A
*BASE CURRENT:	I_B				
Continuous		3	7	7	A
Peak		8*	–	–	A
*TRANSISTOR DISSIPATION:	P_T				
At case temperature up to 25°C		100	117	150	W
At case temperatures above 25°C			Derate linearly to 200°C		
*TEMPERATURE RANGE:					
Storage & Operating (Junction)			← −65 to +200 →		°C
*PIN TEMPERATURE (During Soldering):					
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		235	235	235	°C

*In accordance with JEDEC registration data format (JS-6, RDF-2).

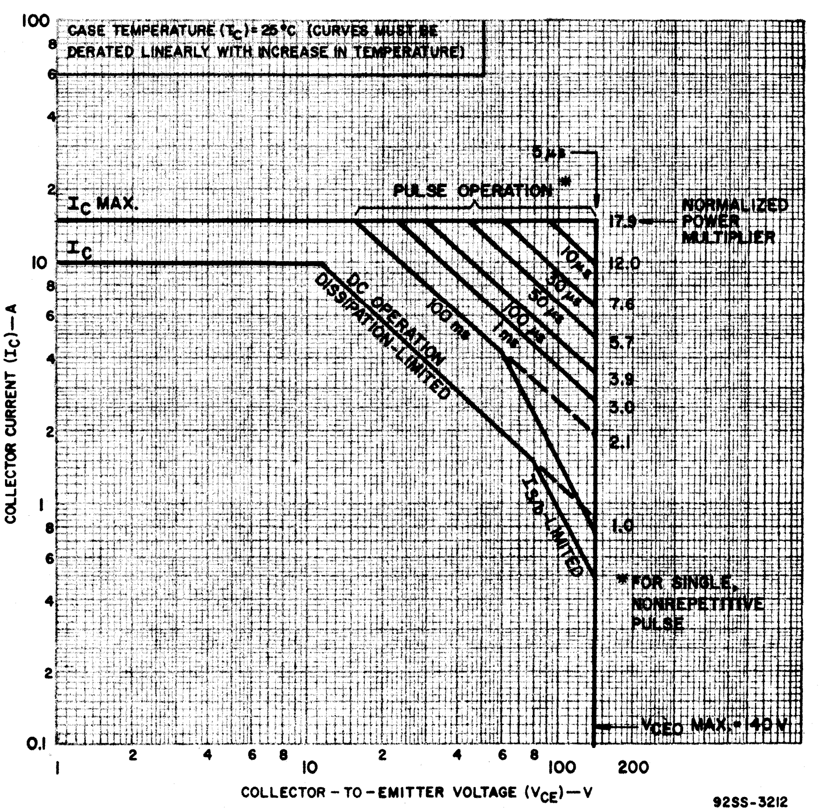


Fig. 1—Maximum operating areas for 2N3442.

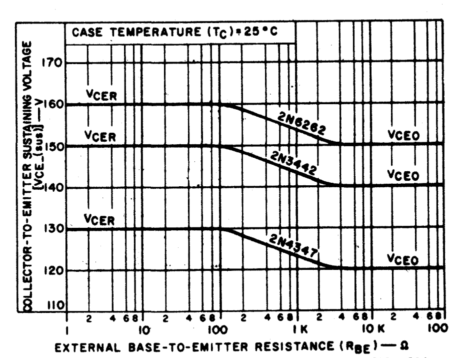


Fig. 2—Sustaining voltage vs. base-to-emitter resistance for all types.

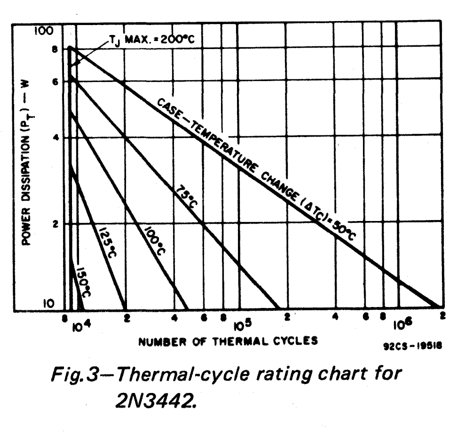


Fig. 3—Thermal-cycle rating chart for 2N3442.

2N3442, 2N4347, 2N6262

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N4347 Min.	Max.	2N3442 Min.	Max.	2N6262 Min.	Max.	UNITS
Collector Cutoff Current: With emitter open (V_{CB} = 140 V)	I_{CBO}					–	–	–	1*	–	1	mA
* With base-emitter junction reverse-biased	I_{CEV}	120	−1.5			–	2	–	–	–	–	mA
		140	−1.5			–	–	–	5	–	–	
		150	−1.5			–	–	–	–	–	0.1	
* With base-emitter junction reverse-biased and T_C = 150°C	I_{CEV}	125	−1.5			–	10	–	–	–	–	mA
		140	−1.5			–	–	–	30	–	–	
		150	−1.5			–	–	–	–	–	2	
* With base open	I_{CEO}	100				–	200	–	–	–	–	mA
		110				–	–	–	–	–	1	
		140				–	–	–	200	–	–	
* Emitter Cutoff Current	I_{EBO}		−7	0		–	5	–	5	–	0.2	mA
* DC Forward Current Transfer Ratio	h_{FE}	2		3[a]		–	–	–	–	20	70	
		2		10[a]		–	–	–	–	5	–	
		4		2[a]		15	60	–	–	–	–	
		4		3[a]		–	–	20	70	–	–	
		4		5[a]		10	–	–	–	–	–	
		4		10[a]		–	–	7.5	–	–	–	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased	$V_{CEV}(sus)$		−1.5	0.1		140	–	160	–	–	–	V
			−1.5	0.2		–	–	–	–	170	–	
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$			0.1		130	–	–	–	–	–	V
				0.2		–	–	150	–	160	–	
* With base open	$V_{CEO}(sus)$			0.2[a]	0	120	–	140	–	–	–	V
				0.2[a]	0	–	–	–	–	150	–	
* Base-to-Emitter Voltage	V_{BE}	2		3[a]		–	–	–	–	–	1	V
		4		3[a]		–	–	1.7	–	–	–	
		4		2[a]		–	2	–	–	–	–	
		4		5[a]		–	3	–	–	–	–	
		4		10[a]		–	–	–	5.7	–	–	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			2[a]	0.2	–	1	–	–	–	–	V
				3[a]	0.3	–	–	–	1	–	0.5	
				5[a]	0.63	–	2	–	–	–	–	
				10[a]	2	–	–	–	5	–	–	
Power Rating Test	PRT	67		1.5		1	–	–	–	–	–	s
		78		1.5		–	–	1	–	–	–	
		100		1.5		–	–	–	–	1	–	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 50 kHz	$\|h_{fe}\|$	4		0.5		40	–	–	–	–	–	
f = 40 kHz	$\|h_{fe}\|$	4		1		–	–	–	–	2	–	
		4		2		–	–	2	–	–	–	
* Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		0.5		40	–	–	–	–	–	
		4		1		–	–	–	–	10	–	
		4		2		–	–	12	72	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.75	–	1.5	–	1.17	°C/W

*In accordance with JEDEC registration data format JS-6 RDF-2

[a]Pulse test; pulse duration = 300 μs, rep. rate = 60 Hz

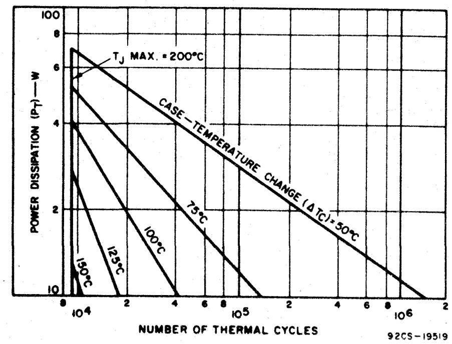


Fig.4—Thermal-cycle rating chart for 2N4347.

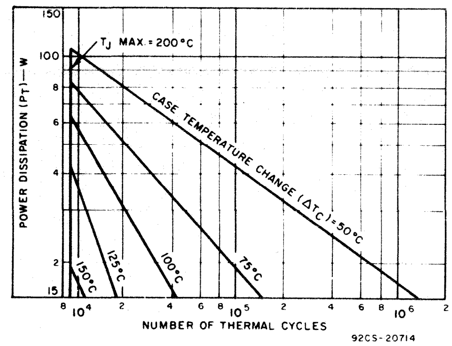


Fig.5—Thermal-cycle rating chart for 2N6262.

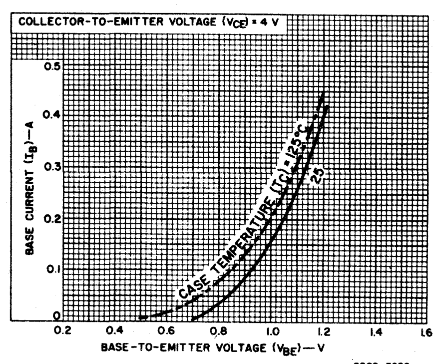


Fig.6—Typical input characteristics for 2N3442.

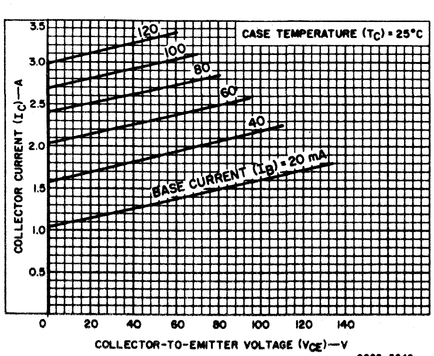


Fig.7—Typical large-signal output characteristics for 2N3442.

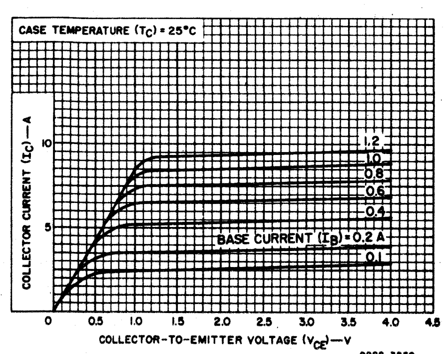


Fig.8—Typical small-signal output characteristics for 2N3442.

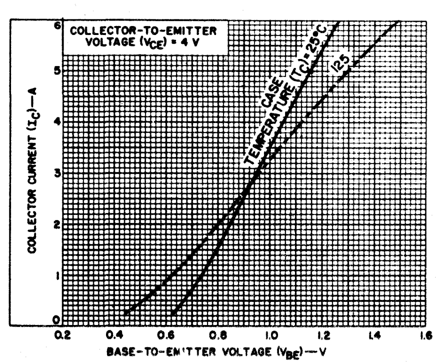


Fig.9—Typical transfer characteristics for 2N3442 and 2N4347.

2N3442, 2N4347, 2N6262

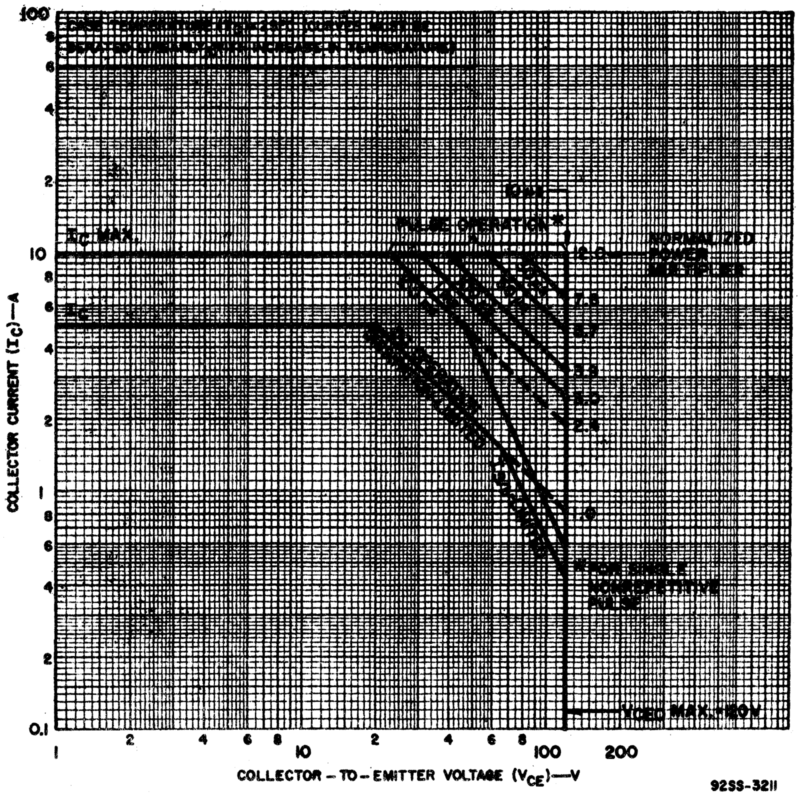


Fig. 10—Maximum operating areas for 2N4347.

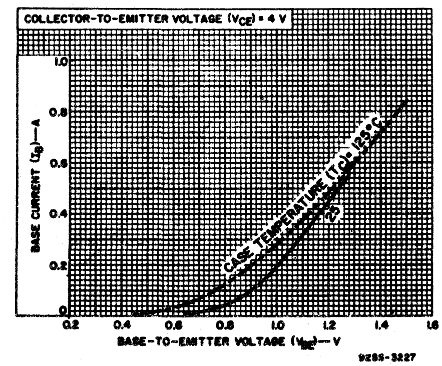


Fig. 11—Typical input characteristics for 2N4347.

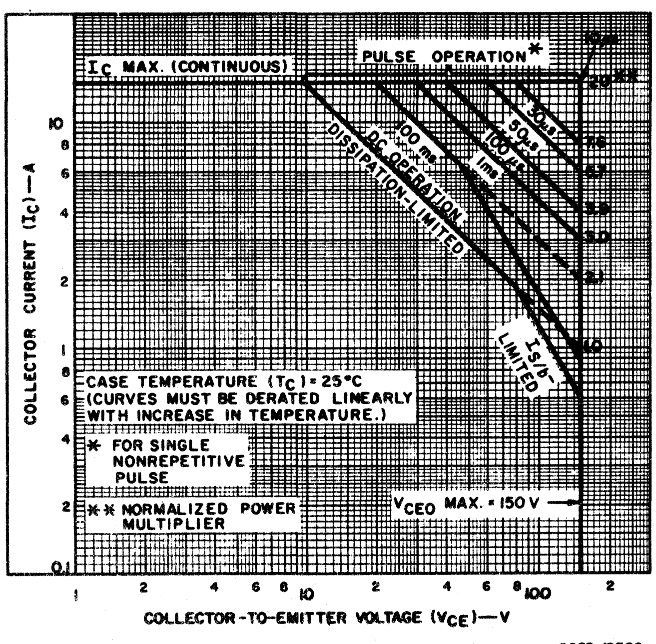


Fig. 12—Maximum operating areas for 2N6262.

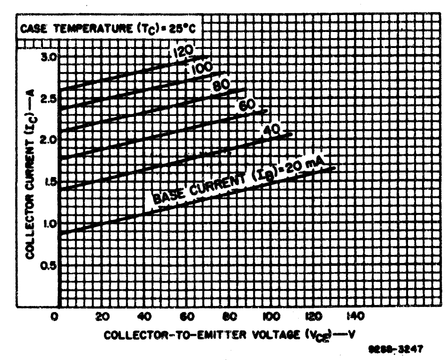


Fig. 13—Typical large-signal output characteristics for 2N4347.

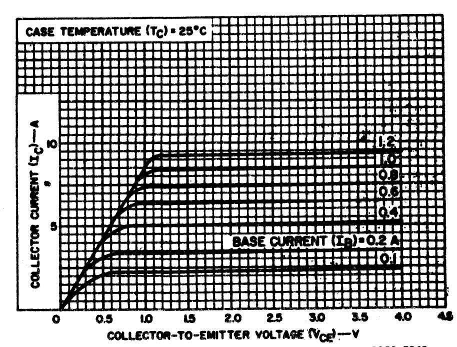


Fig. 14—Typical small-signal output characteristics for 2N4347.

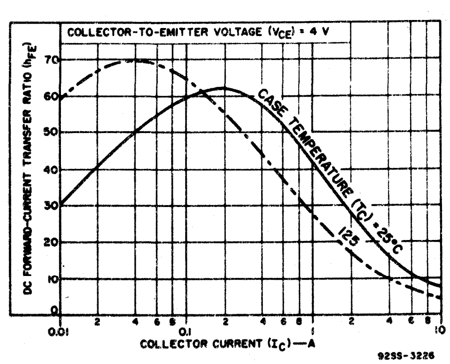


Fig. 15—Typical dc beta characteristics for 2N4347.

2N3442, 2N4347, 2N6262

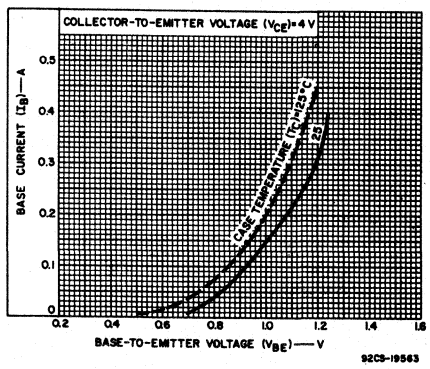


Fig.16—Typical input characteristics for 2N6262.

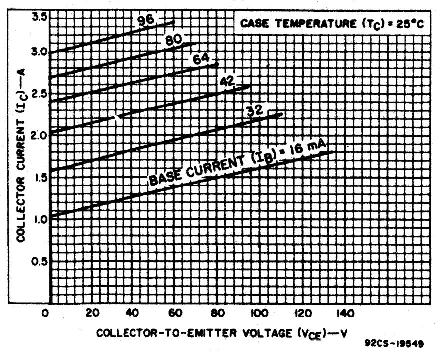


Fig.17—Typical large-signal output characteristics for 2N6262.

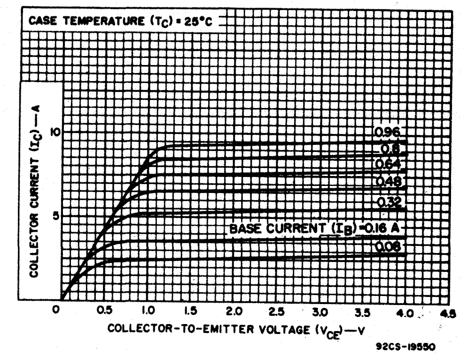


Fig.18—Typical small-signal output characteristics for 2N6262.

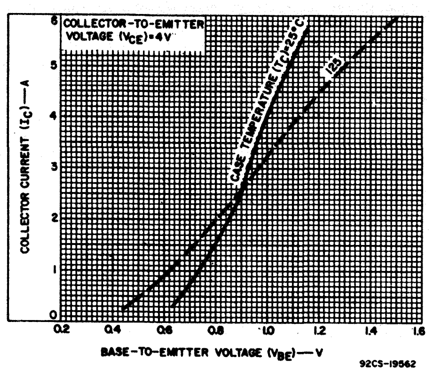


Fig.19—Typical transfer characteristics for 2N6262.

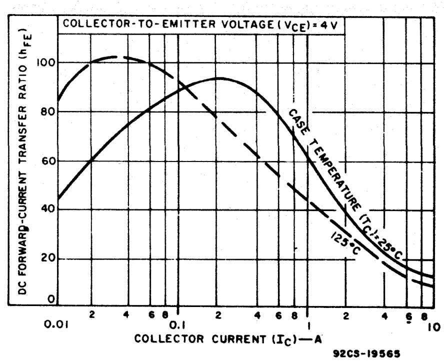


Fig.20—Typical dc beta characteristics for 2N6262.

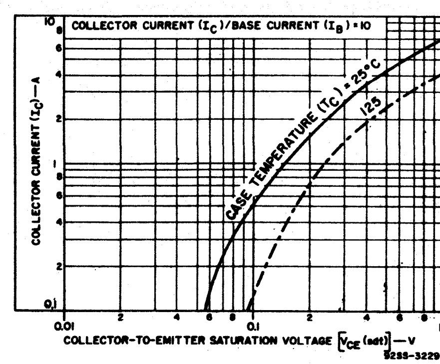


Fig.21—Typical saturation-voltage characteristics for all types.

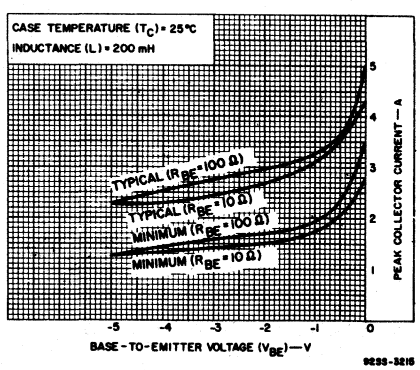


Fig.22—Reverse-bias, second-breakdown characteristics for all types.

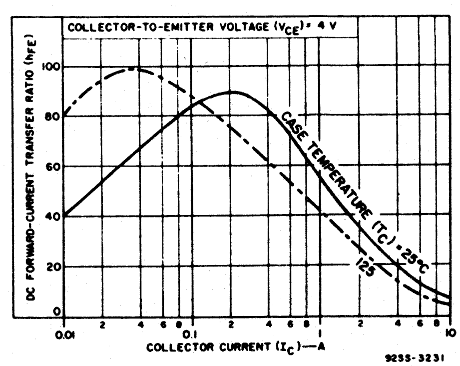


Fig. 23 - Typical dc beta characteristics for 2N3442.

2N3583-2N3585, 2N4240, 40374, 40850

High-Voltage Silicon N-P-N Transistors

For High-Speed Switching, Linear-Amplifier Applications, and Off-Line Switching-Regulator Type Power-Supply Applications

These RCA types are silicon n-p-n transistors with high breakdown voltages and fast switching speeds.

Typical applications for these transistors include high-voltage operational amplifiers, high-voltage switches, switching regulators, converters, inverters, deflection- and hi-fi amplifiers.

These transistors are also intended for a wide variety of applications in ac/dc commercial equipment.

Type 40850 has a voltage capability to be used as push-pull inverters or pulse-width-modulated inverters operating directly off a 240-V line.

In addition type 40850 has a voltage capability to operate as a switching regulator off a 240-V line; for a 20-V line the other types can be used.

Types 2N3583, 2N3584, 2N3585, 2N4240, and 40850 are supplied in hermetic JEDEC TO-66 packages. Type 40374 is a 2N3583 with a factory-attached heat radiator.

Features for JEDEC Types:

- **100-percent tested to assure freedom from second breakdown in both forward- and reverse-bias conditions when operated within specified limits**
- **Economy types for ac/dc circuits**
- **Fast turn-on time at high collector current**

Features for Type 40850:

- **High-voltage ratings for operation from power lines without a step-down transformer**

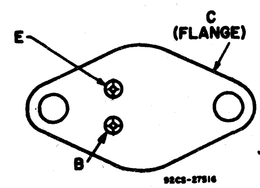
Applications for Type 40850:

- **For use in switching-regulator supplies which feature:**
  - **—A substantial reduction in size and weight due to elimination of the 60-Hz power transformer**
  - **—Operation with a substantial reduction of heat**
- **5-V, off-line supplies with current ratings of 25 A**
- **30-V, off-line supplies with current ratings of 5 A**

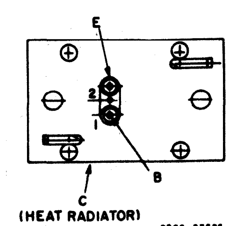
MAXIMUM RATINGS, *Absolute-Maximum Values:*		2N3583	2N3584	2N3585 2N4240	40374	40850	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	375	500	250	450	V
*COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:							
With base open	$V_{CEO}(sus)$	175	250	300	175	300	V
With external base-to-emitter resistance (R_{BE}) ≤ 50Ω	$V_{CER}(sus)$	–	–	–	–	400	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	6	V
*CONTINUOUS COLLECTOR CURRENT	I_C	1	2	2	2	2	A
*PEAK COLLECTOR CURRENT	I_{CM}	5	5	5	5	5	A
*CONTINUOUS BASE CURRENT	I_B	1	1	1	1	1	A
*TRANSISTOR DISSIPATION	P_T						
At case temperature (T_C) = 25°C		35	35	35	–	35	W
At ambient temperature (T_A) = 25°C		–	–	–	5.8	–	W
At case temperatures above 25°C		Derate linearly at 0.2 W/°C					
For other conditions		Derate linearly to 200°C					
*TEMPERATURE RANGE:							
Storage & Operating (Junction)		–65 to 200					°C
*PIN TEMPERATURE:							
1/16 in. (1.58 mm) from seating plane for 10 s max.		235	235	235	235	230	°C

*In accordance with JEDEC registration data format JS-6 RDF-2 (2N3583), JS-6 RDF-1 (2N3584, 2N3585, 2N4240).

TERMINAL DESIGNATIONS



JEDEC TO-66 2N3583, 2N3584, 2N3585, 2N4240, 40850



JEDEC TO-66 with Heat Radiator 40374

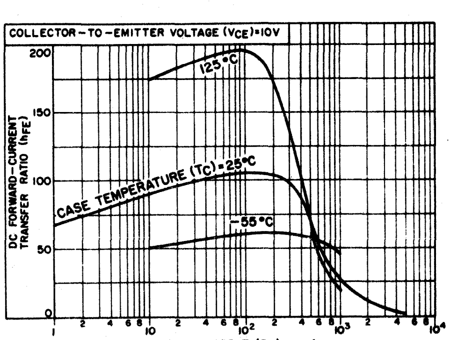


Fig.1—Typical dc beta vs. collector current for 2N3583, 2N4240 and 40374.

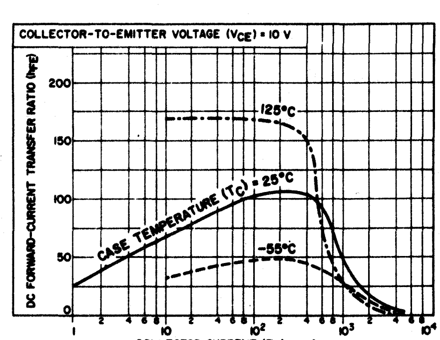


Fig.2—Typical dc beta vs. collector current for 2N3584 and 2N3585.

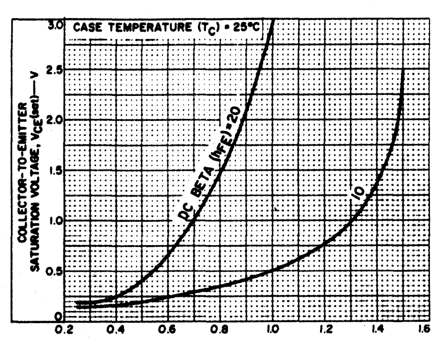


Fig.3—Typical collector-to-emitter saturation voltage vs. current for 2N3584 and 2N3585.

2N3583-2N3585, 2N4240, 40374, 40850

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTICS	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT mA dc I_C	I_E	I_B	LIMITS: 2N3583 40374 MIN.	MAX.	2N3584 MIN.	MAX.	2N3585 MIN.	MAX.	2N4240 MIN.	MAX.	40850 MIN.	MAX.	UNITS
* Collector-Cutoff Current	I_{CEO}	150				0	–	10	–	5	–	5	–	5	–	–	mA
* Collector-Cutoff Current	I_{CEV}	225	−1.5				–	1.0	–	–	–	–	–	–	–	–	mA
		340	−1.5				–	–	–	1.0	–	–	–	–	–	–	
		450	−1.5				–	–	–	–	–	1.0	–	2.0	–	2	
At T_C = 150°C	I_{CEV}	225	−1.5				–	3	–	–	–	–	–	–	–	–	mA
		300	−1.5				–	–	–	3	–	3	–	5.0	–	–	
		450	−1.5				–	–	–	–	–	–	–	–	–	2	
* Emitter-Cutoff Current	I_{EBO}		−6	0			–	5.0	–	0.5	–	0.5	–	0.5	–	–	mA
* DC Forward-Current Transfer Ratio	h_{FE}	2		750[a]			–	–	–	–	–	–	10	100	–	–	
		2		1A[a]			–	–	8	80	8	80	–	–	–	–	
		10		100[a]			40	–	40	–	40	–	40	–	–	–	
		10		750[a]			40	200	–	–	–	–	–	–	25	–	
		10		1A[a]			–	–	–	–	–	–	30	150	–	–	
		10		1A			10	–	25	100	25	100	–	–	–	–	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			200		0	175●	–	250●	–	300●	–	300●	–	300●	–	V
With external base-to-emitter resistance (R_{BE})=200Ω	$V_{CER}(sus)$			200			250●	–	300●	–	400●	–	400●	–	400●	–	V
Emitter-to-Base Voltage	V_{EBO}			0	5		–	–	–	–	–	–	–	–	6	–	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			750[a]		75	–	–	–	–	–	–	–	1.8	–	–	V
				1A[a]		100	–	1.4	–	1.4	–	1.4	–	–	–	–	
				2A[a]		400	–	–	–	–	–	–	–	–	–	2	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			750[a]		75	–	–	–	–	–	–	–	1.0	–	–	V
				1A[a]		125	–	5	–	0.75	–	0.75	–	–	–	–	
				2A[a]		400	–	–	–	–	–	–	–	–	–	2	
Small-Signal Forward Current Transfer Ratio f = 5 MHz	h_{fe}	10		200			3	–	3	–	3	–	3	–	–	–	
* f = 1 kHz		30		100			25	350	–	–	–	–	–	–	–	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio f = 5 MHz	$\|h_{fe}\|$	10		200			2	–	2	–	2	–	3	–	–	–	
Output Capacitance: V_{CB}=10V, f=1 MHz	C_{obo}				0		–	120	–	120	–	120	–	120	–	–	pF
Second-Breakdown Collector Current With base forward-biased**	$I_{S/b}$	100					350	–	350	–	350	–	350	–	–	–	mA
Second-Breakdown Energy with base reverse-biased R_{BE} = 20Ω, L = 100 µH	$E_{S/b}$			2			50	–	200	–	200	–	50	–	–	–	µJ
R_{BE} = 20Ω; L = 100 µH			−4	2A pk			–	–	–	–	–	–	–	–	200	–	µJ
* Saturated Switching Time (V_{CC}=200 V): Rise Time (See Figs. 13 & 16)	t_r			1A		100	–	–	–	3	–	3	–	–	–	–	µs
				750		75	–	–	–	–	–	–	–	0.5	–	–	
* Storage Time (See Figs. 14 & 16)	t_s			1A		100	–	–	–	4	–	4	–	–	–	–	µs
				750		75	–	–	–	–	–	–	–	6	–	–	
Fall Time (See Figs. 15 & 16)	t_f			750		75	–	–	–	–	–	–	–	3	–	–	µs
				1A		100	–	–	–	3	–	3	–	–	–	–	
* Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						5 (Max.) 2N3583		–	5	–	5	–	5	–	5	°C/W
Junction-to-Ambient	$R_{\theta JA}$						70 (Max.) 2N3583		–	70	–	70	–	70	–	–	°C/W
							30 (Max.) 40374		–	–	–	–	–	–	–	–	

* In accordance with JEDEC registration data formal JS-6 RDF-2 (2N3583), JS-6 RDF-1 (2N3584, 2N3585, 2N4240)
● **CAUTION:** The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ **MUST NOT** be measured on a curve tracer.
** Specified value of $I_{S/b}$ for given value of V_{CE} as base voltage is increased from zero in a positive direction.
[a] Pulsed, pulse duration = 300 µs; duty factor ≤ 2%.

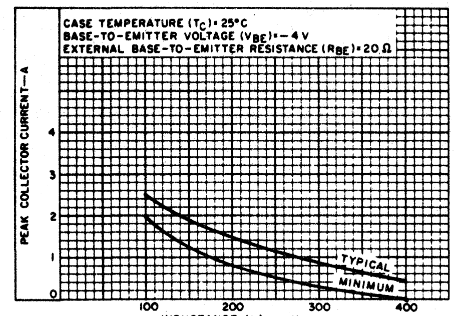


Fig.4—Reverse-bias second breakdown characteristics for 2N3584 and 2N3585.

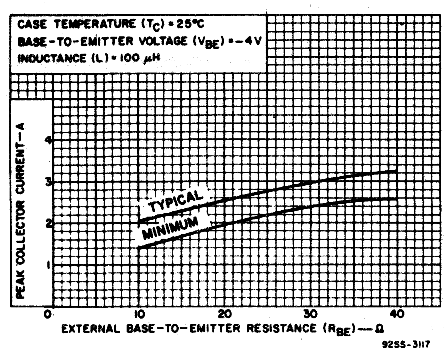


Fig.5—Reverse-bias second breakdown characteristics for 2N3584 and 2N3585.

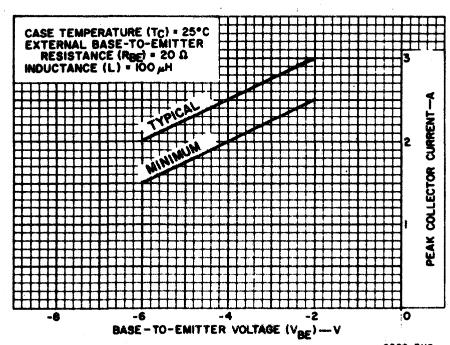


Fig.6—Reverse-bias second breakdown characteristics for 2N3584 and 2N3585.

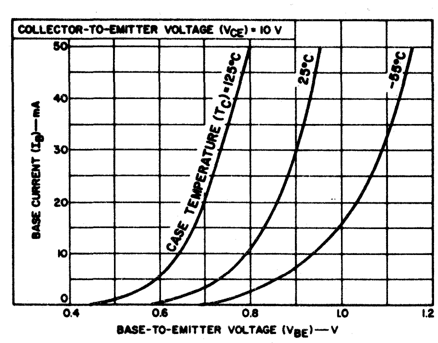


Fig.7—Typical input characteristics for all types.

2N3583-2N3585, 2N4240, 40374, 40850

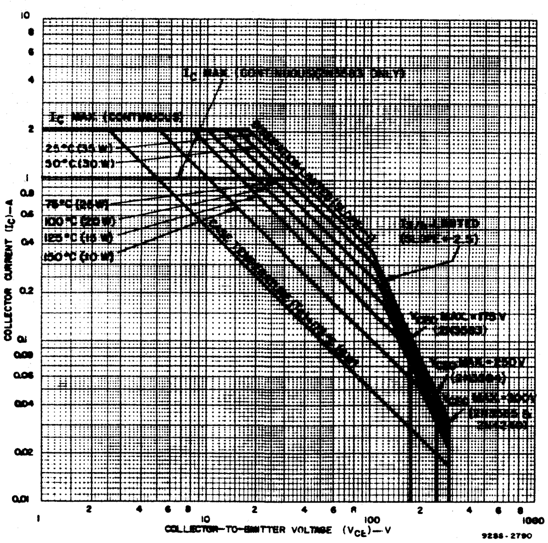


Fig.8—Maximum operating areas for 2N3583, 2N3584, 2N3585, and 2N4240 (pulse conditions).

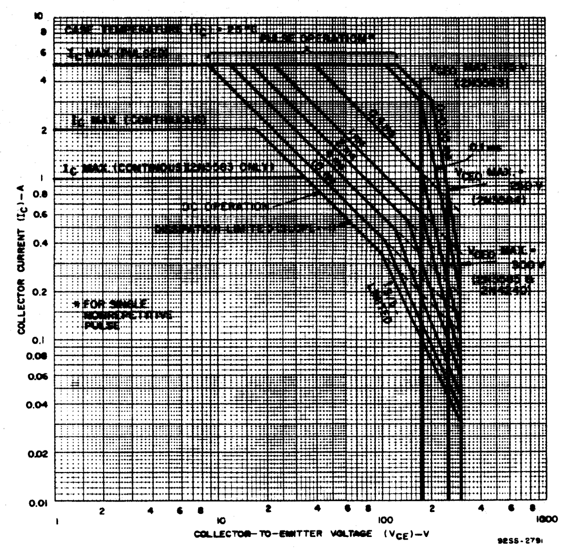


Fig.9—Maximum operating areas for 2N3583, 2N3584, 2N3585, and 2N4240 (dc conditions).

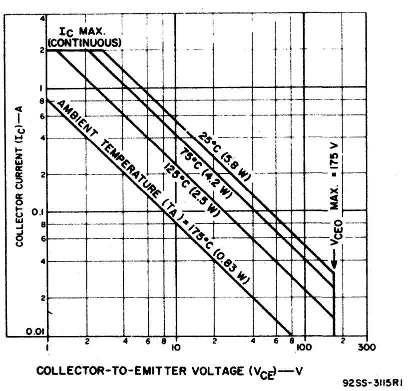


Fig.10—Maximum operating areas for 40374.

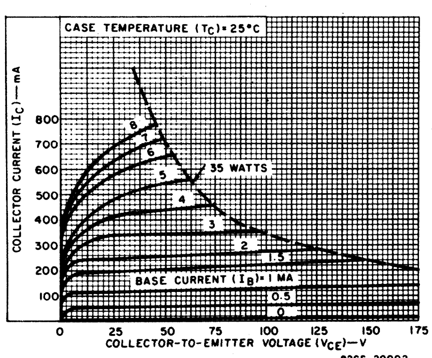


Fig.11—Typical output characteristics for 2N3583 and 40374.

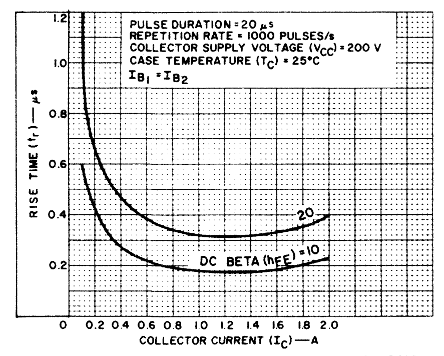


Fig.12—Typical rise time vs. collector current for 2N3584 and 2N3585.

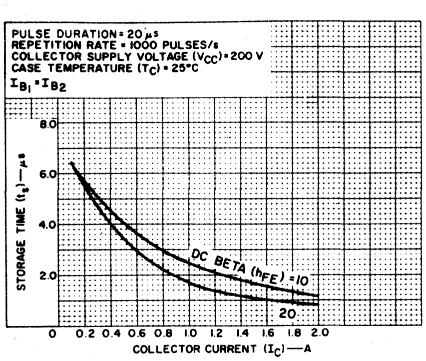


Fig.13—Typical storage time vs. collector current for 2N3584 and 2N3585.

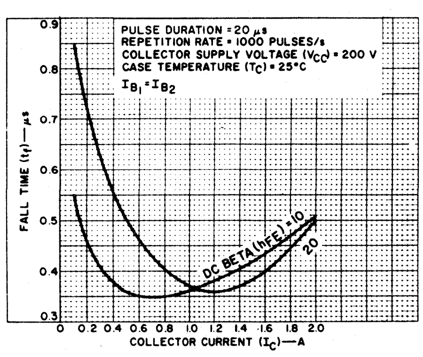


Fig.14—Typical fall time vs. collector current for 2N3584 and 2N3585.

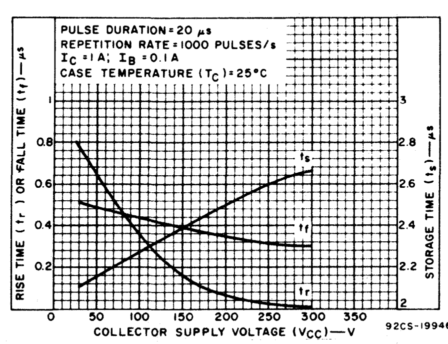


Fig.15—Typical rise time, fall time, and storage time vs. collector supply voltage for 2N3584 and 2N3585.

2N3771, 2N3772, 2N6257, RCS258

Hometaxial-Base High-Power High-Current Transistors

Rugged Silicon N-P-N Devices for Applications in Industrial and Commercial Equipment

Features:
- High dissipation capability
- V_{CEX}(sus) at 3 A = 50 V min. (2N3771, 2N6257) = 90 V min. (2N3772)
- 15-A specification for: h_{FE}, V_{BE}, & V_{CE}(sat) (2N3771, 2N6257)
- 10-A specification for: h_{FE}, V_{BE}, & V_{CE}(sat) (2N3772, RCS258)
- Low saturation voltage with high beta

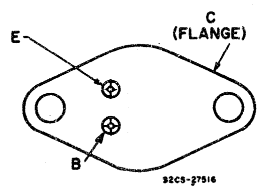
These RCA types are hometaxial base, silicon n-p-n transistors intended for a wide variety of high-power, high-current applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

All devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage, current, and power.

MAXIMUM RATINGS, *Absolute-Maximum Values:*		2N3771	2N3772	2N6257	RCS258	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	100	50	100	V
*COLLECTOR-TO-EMITTER VOLTAGE:						
With −1.5 V (V_{BE}) & R_{BE} = 100Ω	V_{CEX}	50	80	50	80	V
With base open	V_{CEO}	40	60	40	60	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	7	5	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	30	20	20	20	A
*PEAK COLLECTOR CURRENT	I_{CM}	30	30	30	30	A
*CONTINUOUS BASE CURRENT	I_B	7.5	5	5	5	A
*PEAK BASE CURRENT	I_{BM}	15	15	15	15	A
*TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		150	150	150	250	W
At case temperatures above 25°C		Derate linearly to 200°C				
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to 200				°C
*PIN TEMPERATURE (During soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230				

*In accordance with JEDEC registration data format JS-6 RDF-2.

TERMINAL DESIGNATIONS



JEDEC TO-3

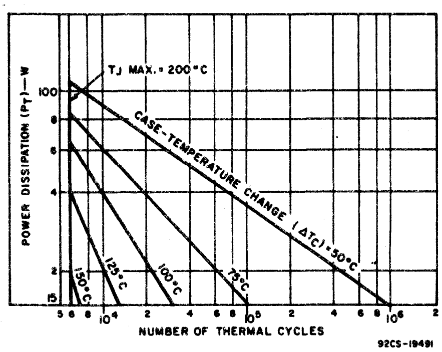


Fig. 1—Thermal-cycle rating chart for 2N3771, 2N3772, and 2N6257.

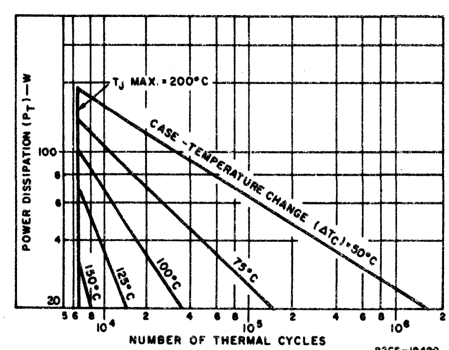


Fig. 2 — Thermal-cycle rating chart for RCS258.

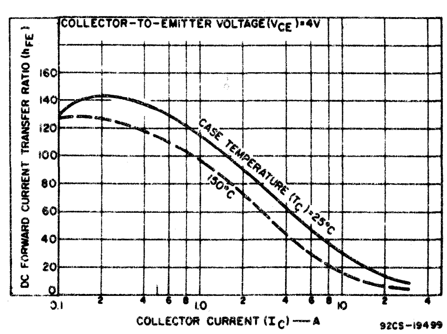


Fig. 3—Typical dc beta characteristics for 2N3771.

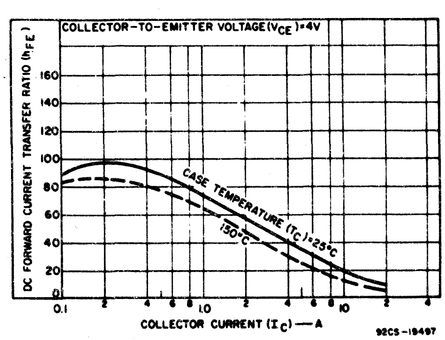


Fig. 4 — Typical dc beta characteristics for 2N3772, 2N6257 and RCS258.

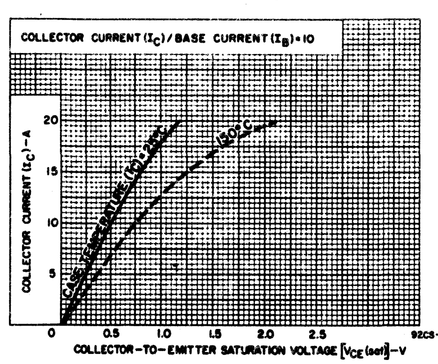


Fig. 5—Typical saturation-voltage characteristics for 2N3771.

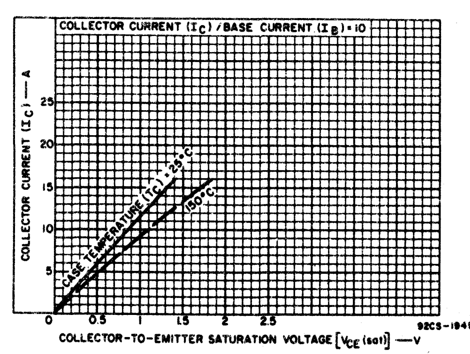


Fig. 6 — Typical saturation-voltage characteristics for 2N3772, 2N6257 and RCS258.

2N3771, 2N3772, 2N6257, RCS258

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25° Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N3771 MIN.	MAX.	2N3772 MIN.	MAX.	2N6257 MIN.	MAX.	RCS258 MIN.	MAX.	UNITS
* Collector-Cutoff Current With emitter open	I_{CBO}	50					–	2*	–	–	–	4	–	–	mA
		100					–	–	–	5*	–	–	–	5	
With base-emitter junction reverse-biased	I_{CEX}		45	–1.5			–	–	–	–	–	4	–	–	mA
			50	–1.5			–	2	–	–	–	–	–	–	
			100	–1.5			–	–	–	5	–	–	–	5	
With base-emitter junction reversed-biased, T_C=150°C	I_{CEX}		30	–1.5			–	10	–	10	–	–	–	–	mA
			45	–1.5			–	–	–	–	–	20	–	–	
			100	–1.5			–	–	–	–	–	–	–	10	
With base open	I_{CEO}		25			0	–	–	–	–	–	10	–	–	mA
			30			0	–	10	–	–	–	–	–	–	
			50			0	–	–	–	10	–	–	–	10	
			60			0	–	–	–	–	–	–	–	–	
* Emitter-Cutoff Current	I_{EBO}			–5	0		–	5	–	–	–	10	–	–	mA
				–7	0		–	–	–	5	–	–	–	5	
* DC Forward Current Transfer Ratio	h_{FE}		4		30[a]		5	–	–	–	–	–	–	–	
			4		20[a]		–	–	5	–	5	–	5	–	
			4		15[a]		15	60	–	–	–	–	–	–	
			4		10[a]		–	–	15	60	–	–	15	60	
			4		8[a]		–	–	–	–	15	75	–	–	
Collector-to-Emitter Sustaining Voltage With base-emitter Junction reversed-biased (R_{BE} = 100Ω)	$V_{CEX}(sus)$			–1.5	0.2[a]		50	–	80	–	50	–	80	–	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$				0.2[a]		45	–	70	–	45	–	70	–	V
* With base open	$V_{CEO}(sus)$				0.2[a]	0	40	–	60	–	40	–	60	–	V
* Base-to-Emitter Voltage	V_{BE}		4		15[a]		–	2.7	–	–	–	–	–	–	V
			4		10[a]		–	–	–	2.2	–	–	–	2.2	
			4		8[a]		–	–	–	–	–	2.2	–	–	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				30[a]	6	–	4	–	–	–	–	–	–	V
					20[a]	4	–	–	–	4	–	4	–	4	
					15[a]	1.5	–	2	–	–	–	–	–	–	
					10[a]	1	–	–	–	1.4	–	–	–	1.4	
					8[a]	0.8	–	–	–	–	–	1.5	–	–	
Second-Breakdown Collector Current With base forward-biased and 1–s nonrepetitive pulse	$I_{S/b}$[b]		60				–	–	2.5	–	–	–	4.2	–	A
			40				3.75	–	–	–	3.75	–	–	–	
Second-Breakdown Energy With base reverse biased and L=40mH, R_{BE}=100Ω	$E_{S/b}$[c]			–1.5	5		500	–	500	–	500	–	500	–	mJ
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 0.05 MHz)	$\|h_{fe}\|$		4		1		4*	16 (Typ)	4*	16 (Typ)	4*	16 (Typ)	4	16 (Typ)	
* Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}		4		1		40	–	40	–	40	–	40	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	1.17	–	1.17	–	1.17	–	0.7	°C/W

*In accordance with JEDEC registration data formal JS-6 RDF-2.

[a] Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz, duty factor ≤ 2%.

[b] $I_{S/b}$ is defined at the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = \frac{1}{2} LI^2$, where L is a series load or leakage inductance and I is the peak collector current.

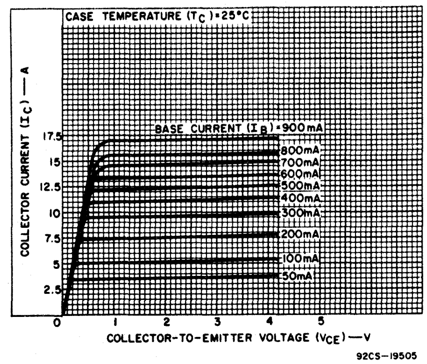


Fig.7—Typical output characteristics for 2N3771.

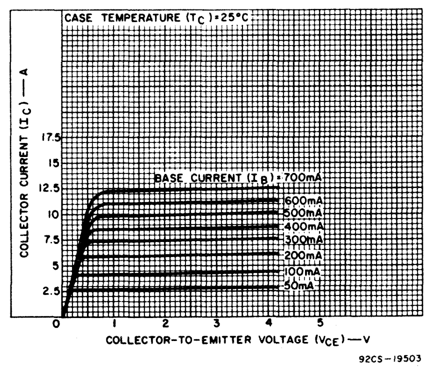


Fig. 8 — Typical output characteristics for 2N3772, 2N6257 and RCS258.

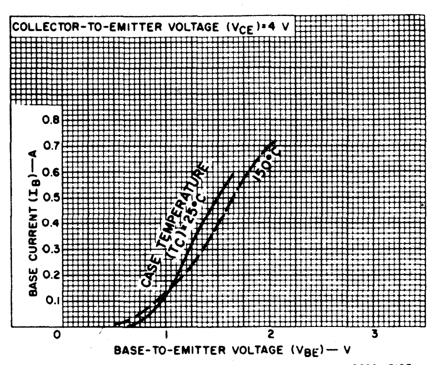


Fig. 9 — Typical input characteristics for 2N3772 and RCS258.

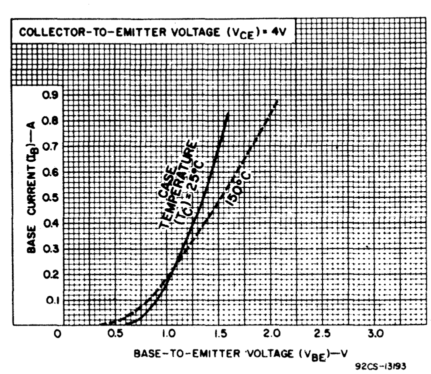


Fig.10—Typical input characteristics for 2N3771 and 2N6257.

2N3771, 2N3772,2N6257, RCS258

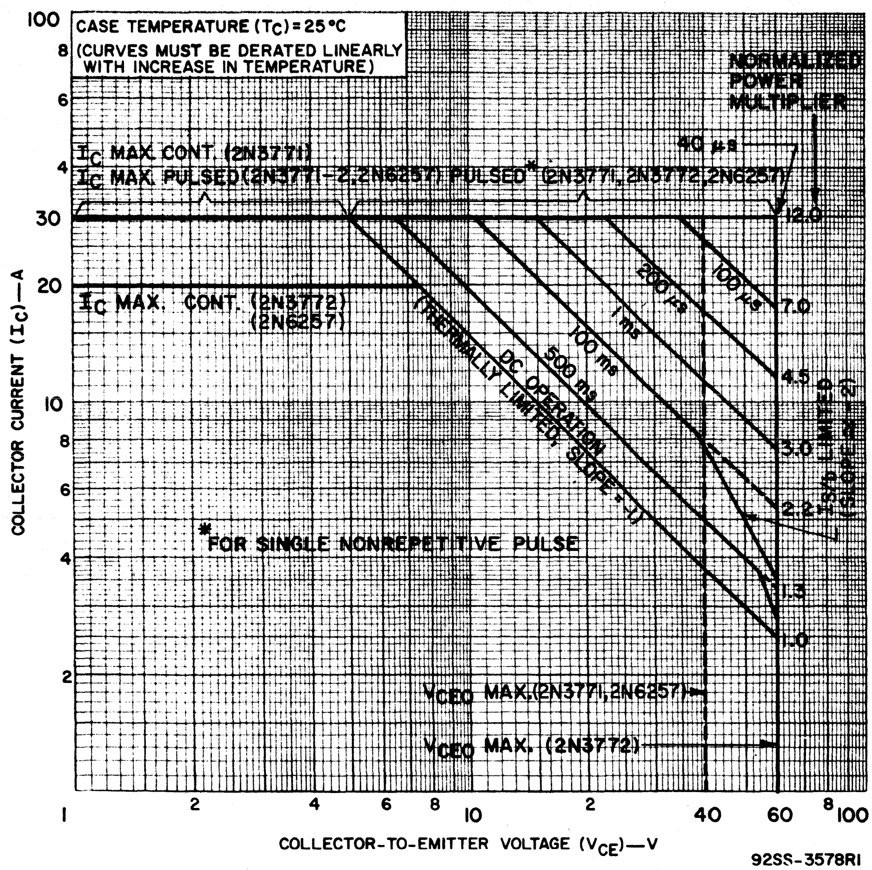


Fig.11—Maximum operating areas for 2N3771, 2N3772, and 2N6257.

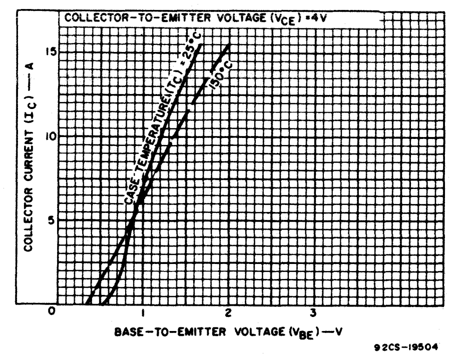


Fig.13—Typical transfer characteristics for 2N3771.

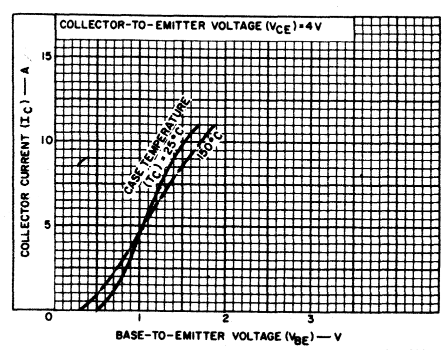


Fig. 14 — Typical transfer characteristics for 2N3772, 2N6257 and RCS258.

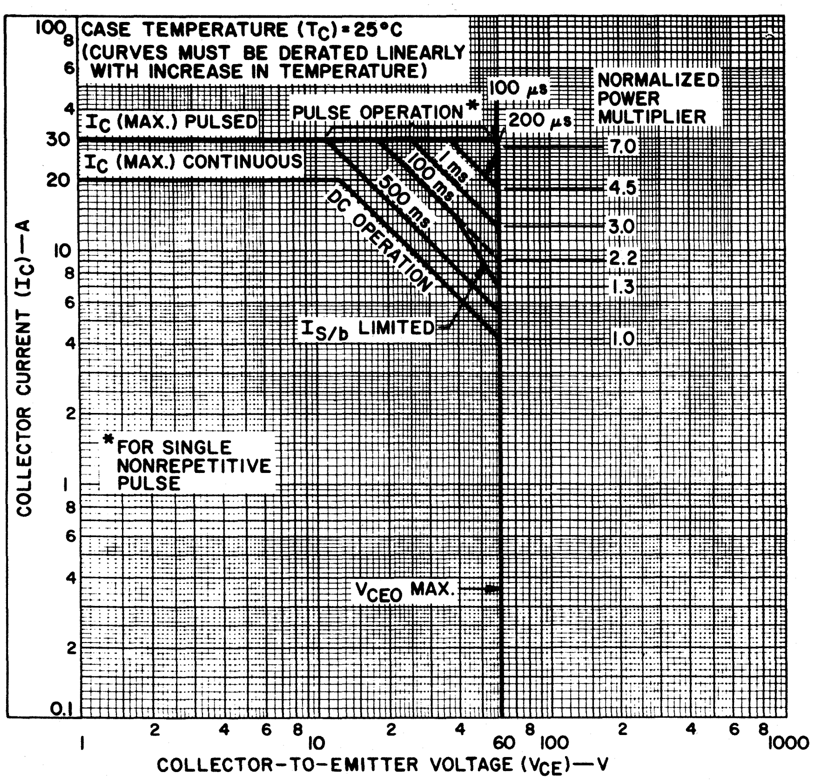


Fig.12—Maximum operating areas for RCS258.

2N3773, 2N4348, 2N6259

Hometaxial-Base, High-Current Silicon N-P-N Transistors

Rugged High-Voltage Devices for Applications in Industrial and Commercial Equipment

These RCA types are hometaxial-base silicon n-p-n transistors intended for a wide variety of high-voltage high-current applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

These devices employ the popular JEDEC TO-3 package; they differ in maximum ratings for voltage, current, and power.

Features:

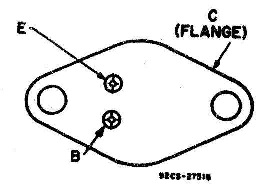
- **High dissipation capability — 120 W (2N4348), 150 W (2N3773), 250 W (2N6259)**
- **5-A specification for h_{FE}, V_{BE}, & $V_{CE}(sat)$ (2N4348)**
- **8-A specification for h_{FE}, V_{BE}, & $V_{CE}(sat)$ (2N3773, 2N6259)**
- **V_{CEX} — 140 V min (2N4348), 160 V min (2N3773) 170 V min (2N6259)**
- **Low saturation voltage with high beta**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N4348	2N3773	2N6259	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	170	V
COLLECTOR-TO-EMITTER VOLTAGE:					
* With base open	V_{CEO}	120	140	150	V
With reverse bias (V_{BE}) of −1.5 V	V_{CEX}	140	160	170	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
*COLLECTOR CURRENT:	I_C				
Continuous		10	16	16	A
Peak		30	30	30	A
*BASE CURRENT:	I_B				
Continuous		4	4	4	A
Peak		15	15	15	A
*TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		120	150	250	W
At case temperatures above 25°C		Derate linearly to 200°C			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		← −65 to +200 →			°C
*PIN TEMPERATURE (During Soldering):					
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		← 230 →			°C

*In accordance with JEDEC registration data format (JS-6, RDF-2).

TERMINAL DESIGNATIONS



JEDEC TO-3

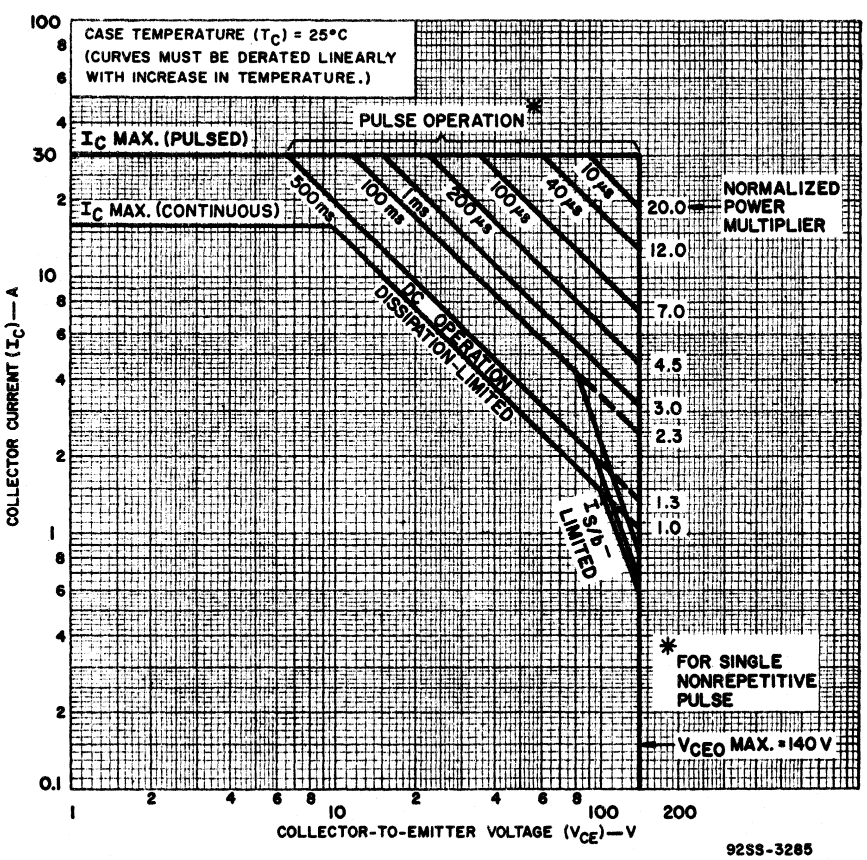


Fig. 1 - Maximum operating areas for 2N3773.

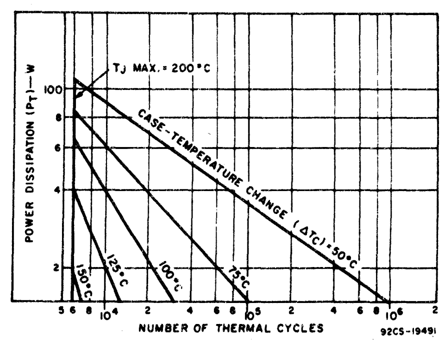


Fig. 2 - Thermal-cycle rating chart for 2N3773.

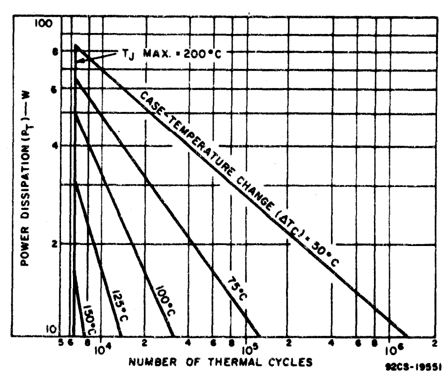


Fig. 3 - Thermal-cycle rating chart for 2N4348.

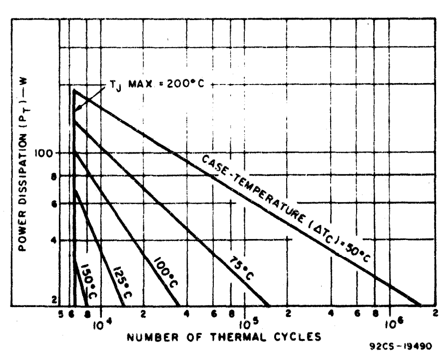


Fig. 4 - Thermal-cycle rating chart for 2N6259.

2N3773, 2N4348, 2N6259

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N4348 Min.	Max.	2N3773 Min.	Max.	2N6259 Min.	Max.	UNITS
* Collector-Cutoff Current: With emitter open, V_{CB}=140 V	I_{CBO}					–	–	–	2	–	–	mA
With base-emitter junction reverse-biased	I_{CEX}	120 140 150	–1.5 –1.5 –1.5			– – –	2 – –	– – –	– 2 –	– – –	– – 0.2	mA
With base-emitter junction reverse-biased and T_C = 150°C	I_{CEX}	120 140 150	–1.5 –1.5 –1.5			– – –	10 – –	– – –	– 10 –	– – –	– – 4	mA
With base open	I_{CEO}	100 120				– –	20 –	– –	– 10	– –	– 2	mA
* Emitter-Cutoff Current	I_{EBO}		–7	0		–	5	–	5	–	2	mA
* DC Forward Current Transfer Ratio	h_{FE}	4 4 2 4 4		5[a] 8[a] 8[a] 10[a] 16[a]		15 – – 10 –	60 – – – –	– 15 – – 5	– 60 – – –	– – 15 – 10	– – 60 – –	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased (R_{BE} = 100Ω)	V_{CEX}(sus)		–1.5	0.1		140	–	160	–	170	–	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}(sus)			0.2[a]		140	–	150	–	160	–	V
* With base open	V_{CEO}(sus)			0.2[a]	0	120	–	140	–	150	–	V
* Base-to-Emitter Voltage	V_{BE}	4 4 2 4		5[a] 8[a] 8[a] 10[a]		– – – –	2 – – 3	– – – –	– 2.2 – –	– – – –	– – 2 –	V
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			5[a] 8[a] 10[a] 16[a]	0.5 0.8 1.25 3.2	– – – –	1 – 2 –	– – – –	– 1.4 – 4	– – – –	– 1 – 2.5	V
Second-Breakdown Collector Current With base forward-biased and 1-s nonrepetitive pulse	$I_{S/b}$[b]	80 100				1.5 –	– –	– 1.5	– –	– 2.5	– –	A
Second-Breakdown Energy With base reverse-biased and L = 40 mH, R_{BE} = 100Ω	$E_{S/b}$[c]		–1.5	2.5		0.125	–	0.125	–	0.125	–	J
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 50 kHz)	$\|h_{fe}\|$	4		1		4	–	4	–	4	–	
* Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		1		40	–	40	–	40	–	
Thermal Resistance Junction-to-Case	$R_{\theta JC}$					–	1.46	–	1.17	–	0.7	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2.

[a] Pulsed; pulse duration = 300μs, rep. rate = 60 Hz.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter base junction forward-biased for transistor operation in the active region.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b}$ = $1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

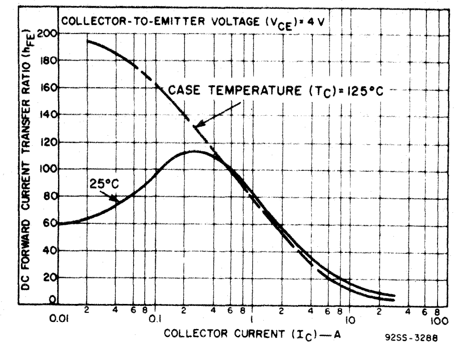


Fig. 5 - Typical dc beta characteristics for 2N3773.

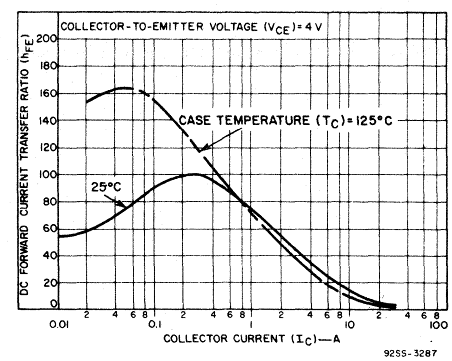


Fig. 6 - Typical dc beta characteristics for 2N4348.

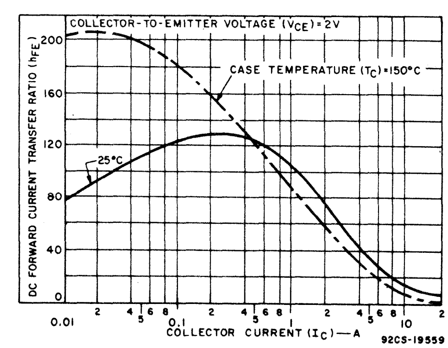


Fig. 7 - Typical dc beta characteristics for 2N6259.

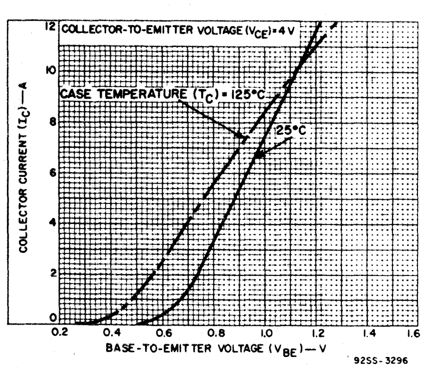


Fig. 8 - Typical transfer characteristics for 2N3773.

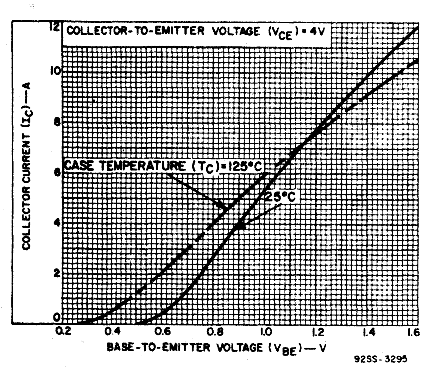


Fig. 9 - Typical transfer characteristics for 2N4348.

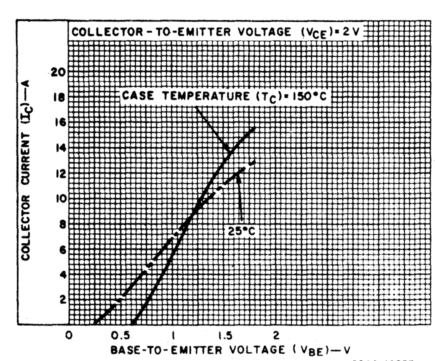


Fig. 10 - Typical transfer characteristics for 2N6259.

2N3773, 2N4348, 2N6259

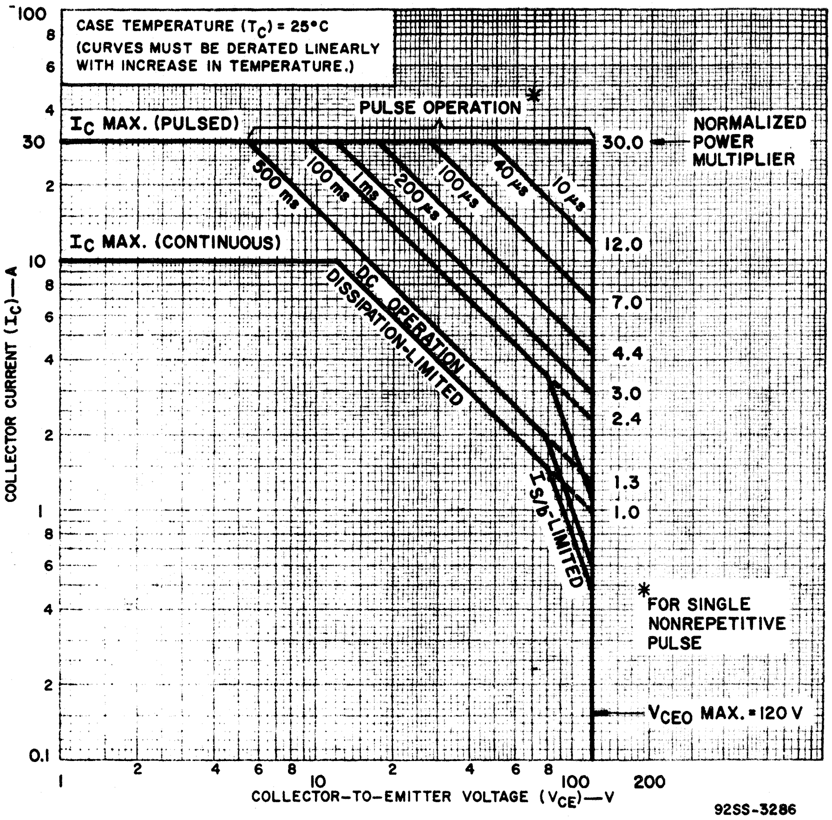


Fig. 11 - Maximum operating areas for 2N4348.

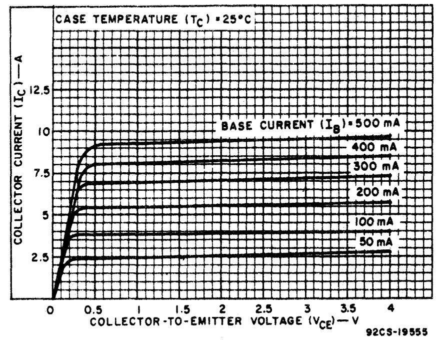


Fig. 12 - Typical output characteristics for 2N3773.

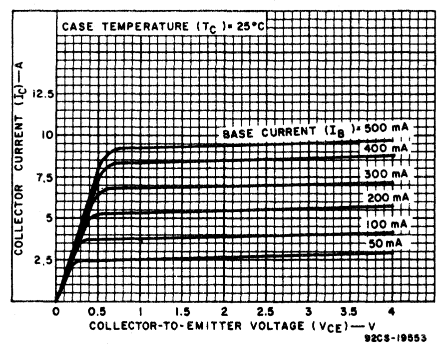


Fig. 13 - Typical output characteristics for 2N4348.

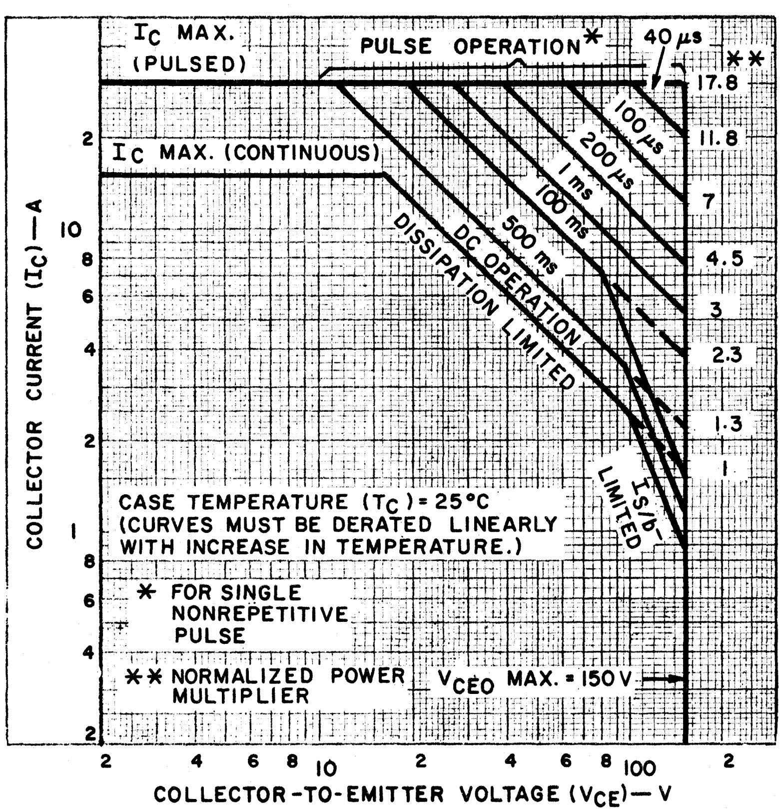


Fig. 14 - Maximum operating areas for 2N6259.

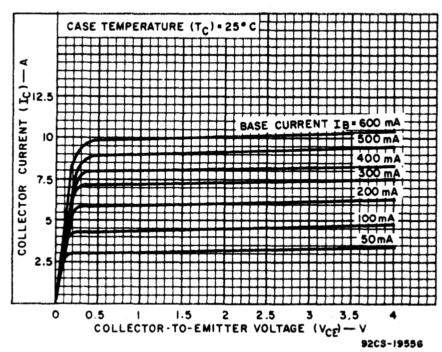


Fig. 15 - Typical output characteristics for 2N6259.

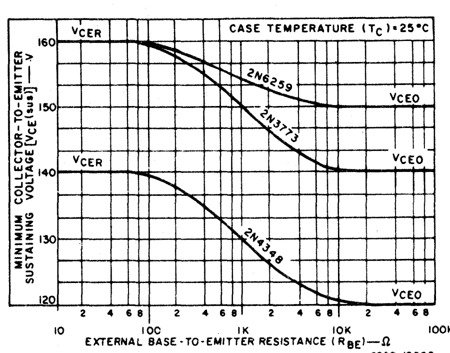


Fig. 16 - Sustaining voltage as a function of base-to-emitter resistance for all types.

2N3773, 2N4348, 2N6259

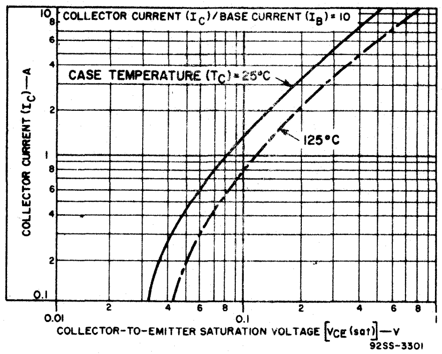


Fig. 17 - Typical saturation-voltage characteristics for 2N3773.

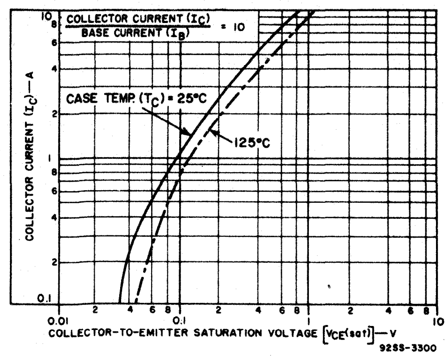


Fig. 18 - Typical saturation-voltage characteristics for 2N4348.

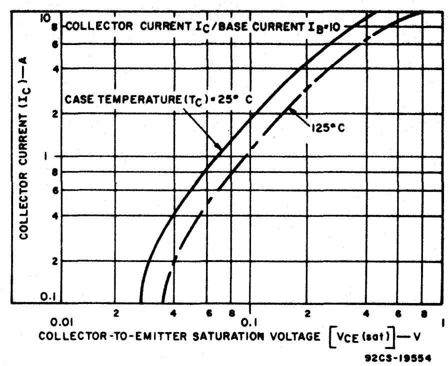


Fig. 19 - Typical saturation-voltage characteristics for 2N6259.

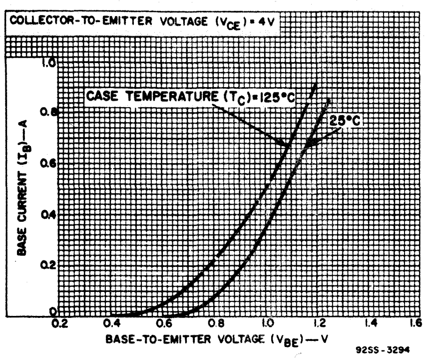


Fig. 20 - Typical input characteristics for 2N3773.

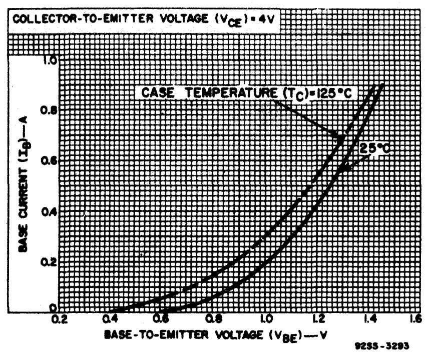


Fig. 21 - Typical input characteristics for 2N4348.

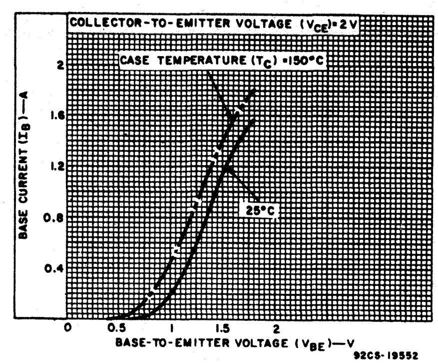


Fig. 22 - Typical input characteristics for 2N6259.

2N3878, 2N3879, 2N5202, 2N6500, 40375

High-Speed, Epitaxial-Collector Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

RCA-2N3878, 2N3879, 2N5202, and 2N6500● are epitaxial silicon n-p-n transistors. The 2N3878 is an amplifier type intended for audio-, ultrasonic-, and radio-frequency circuits. Types 2N3879, 2N5202, and 2N6500 are switching transistors intended for use in high-current, high-speed switching circuits.

Type 40375 is a 2N3878 with a factory-attached heat radiator; it is intended for printed circuit-board applications.

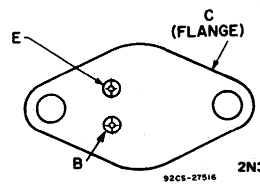
Typical applications for these transistors include: low-distortion power amplifiers, oscillators, switching regulators, series regulators, converters, and inverters.

● Formerly RCA Dev. Type Nos. TA2509, TA2509A, TA7285, and TA8932, respectively.

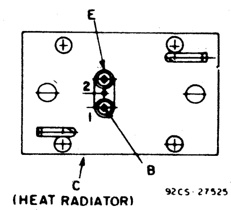
Features:

- Maximum-area-of-operation curves for dc and pulse operation
- Rated for safe operation in both forward- and reverse-bias conditions
- High sustaining voltage
- Total saturated transition time less than 1 μs for 2N3879, 2N5202, and 2N6500

TERMINAL DESIGNATIONS



JEDEC TO-66
2N3878, 2N3879, 2N5202, 2N6500

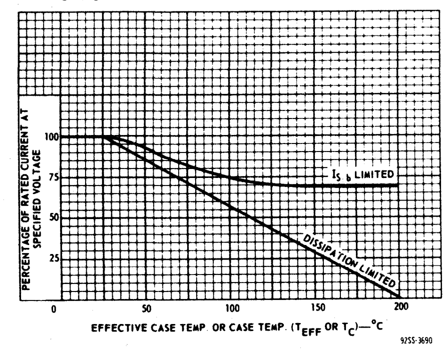


JEDEC TO-66 with Heat Radiator
40375

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3878 40375	2N3879	2N5202	2N6500	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	120	100	120	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 50 Ω	V_{CER}(sus)	65	90	75*	110*	V
With base open	V_{CEO}(sus)	50*	75*	50	90*	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	6	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	4	7	4	4	A
PEAK COLLECTOR CURRENT	I_{CM}	10	10	5	5	A
*CONTINUOUS BASE CURRENT	I_B	4	5	2	3	A
*TRANSISTOR DISSIPATION	P_T					
At case temperature (T_C) = 25°C		35 (2N3878)	35	35	35	W
At case temperatures above 25°C		Derate linearly at 0.2 W/°C				
At ambient temperature (T_A) = 25°C		5.8 (40375)	–	–	–	W
For other conditions		See Figs. 1, 2, 3, and 9				
*TEMPERATURE RANGE:						
Storage & operating (Junction)		-65 to 200				°C
*PIN TEMPERATURE:						
1/32 in. (0.8 mm) from seating plane for 10 s max.		235	235	235	235	°C

* In accordance with JEDEC registration data format JS-6 RDF-2 (2N3878); JS-6 RDF-1 (2N3879, 2N5202, 2N6500).



Note: Use ambient temperature for derating 40375.

Fig. 2 - Dissipation derating for all types.

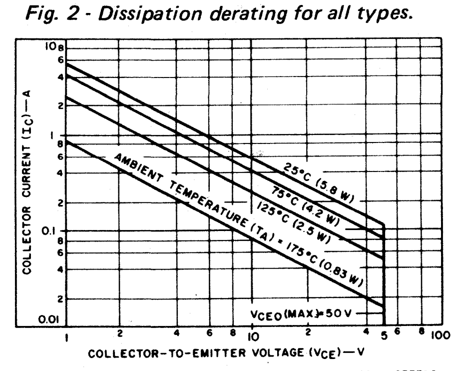


Fig. 3 - Maximum operating areas for 40375.

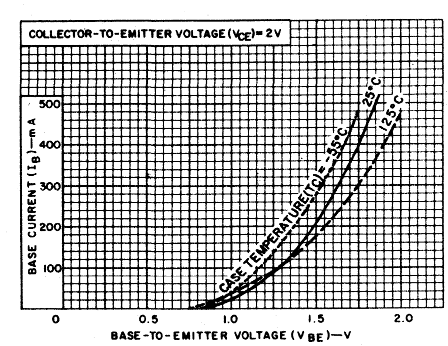


Fig. 4 - Typical input characteristics for all types.

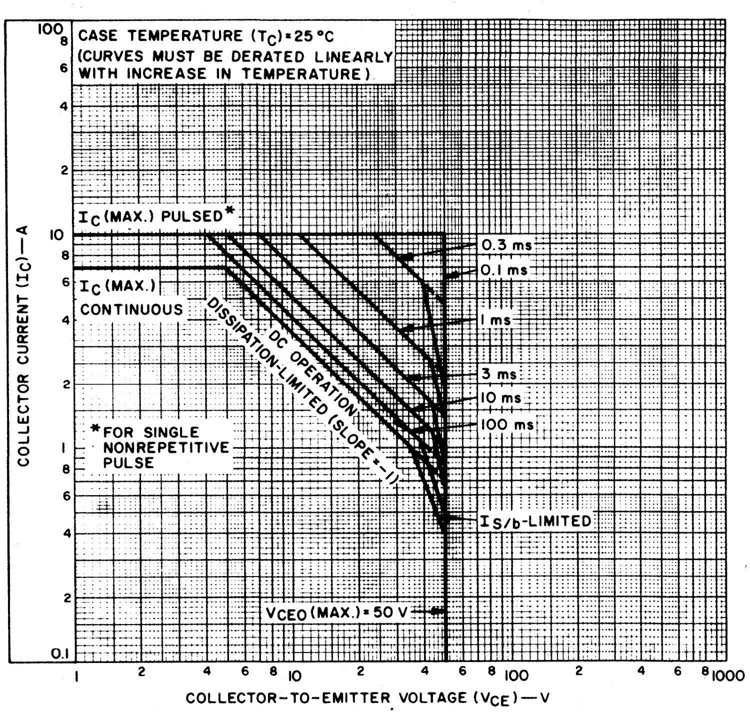


Fig. 1 - Maximum operating areas for 2N3878.

2N3878, 2N3879, 2N5202, 2N6500, 40375

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified:*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc		CURRENT A dc		LIMITS: 2N3878 40375		2N3879		2N5202		2N6500		UNITS
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current: * With base-emitter junction reverse-biased	I_{CEV}	100 110 120	−1.5 0 −1.5			– – –	– – 25	– – –	– – 25	– – –	10 – –	– – –	– 5 –	mA
* With base-emitter junction reverse-biased and T_C = 150°C	I_{CEV}	100 110	−1.5 0			– –	4 –	– –	4 –	– –	10 –	– –	– 10	mA
With base open	I_{CEO}	40 70			0 0	– –	5* –	– –	5 –	– –	– –	– –	– 5	mA
* Emitter Cutoff Current	I_{EBO}		−6 −7			– –	– 10	– –	– 10	– –	10 –	– –	– 25	mA
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$			0.2	0	50*a	–	75*a	–	50a	–	90*a	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$			0.2	0	65a	–	90a	–	75a	–	110a		V
DC Forward-Current Transfer Ratio	h_{FE}	1.2 2 2 2 5 5		4b 0.5b 3b 4b 4b 0.5b		– 40* – 8* 20* 50*	– 200* – – – 200*	– – – 12* 20 40	– – – 100* 80 –	10* – – – – –	100* – – – – –	– – 15* – – –	– – 60* – – –	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			3b 4b	0.3 0.4	– –	– 2	– –	– 1.2	– –	– 1.2	– –	1.5 –	V
* Base-to-Emitter Voltage	V_{BE}	2		4b	–	–	2.5	–	–	–	–	–	–	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			3b 4b	0.3 0.4	– –	– –	– –	– 2	– –	– 2	– –	2.5 –	V
Collector-to-Base Output Capacitance: (f = 1 MHz, V_{CB} = 10 V)	C_{ob}					–	175*		175	–	175	–	175	pF
Second Breakdown Collector Current: With base forward-biased and 1-s nonrepetitive pulse	$I_{S/b}$	40				750	–	500	–	400		400	–	mA
Second-Breakdown Energy: With base reverse-biased and R_{BE} = 50 Ω, V_{BB} = −4 V At L = 50 μH At L = 125 μH	$E_{S/b}$ c					– 1	– –	– 1	– –	0.4 –	– –	– 0.5	– –	mJ
* Magnitude of Common Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: (f = 10 MHz)	$\|h_{fe}\|$	10		0.5		4	–	4	–	6	–	6	–	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: (f = 1 kHz)	h_{fe}	30		0.1		40	–	–	–	–	–	–	–	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					2N3878 –	5	–	5	–	5	–	5	°C/W
Junction-to-ambient	$R_{\theta JA}$					40375 –	30	–	–	–	–	–	–	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2 (2N3878); JS-6 RDF-1 (2N3879, 2N5202, 2N6500).

a CAUTION: Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

b Pulsed, pulse duration = 300 μs, duty factor ⩽ 2 %.

c $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = 1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

TRANSITION AND STORAGE-TIME CHARACTERISTICS FOR SWITCHING TYPES, *At Case Temperature (T_C) = 25°C:*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc	CURRENT A dc		LIMITS: 2N3879		2N5202		2N6500		UNITS
		V_{CC}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Saturated Switching Time Delay time	t_d	30 30 30	3 4 4	0.3a 0.4a 0.8a	– – –	– 40 –	– – –	– – 40	– – –	40 – –	ns
* Rise time	t_r	30 30 30	3 4 4	0.3a 0.4a 0.8a	– – –	– 400 –	– – –	– – 400	– – –	400 – –	ns
* Storage time	t_s	30 30 30	3 4 4	0.3a 0.4a 0.8a	– – –	– 800 –	– – –	– – 1200	– – –	1000 – –	ns
* Fall time	t_f	30 30 30	3 4 4	0.3a 0.4a 0.8a	– – –	– 400 –	– – –	– – 400	– – –	500 – –	ns

* In accordance with JEDEC registration data format (JS-6, RDF-1)

a $I_{B_1} = I_{B_2}$

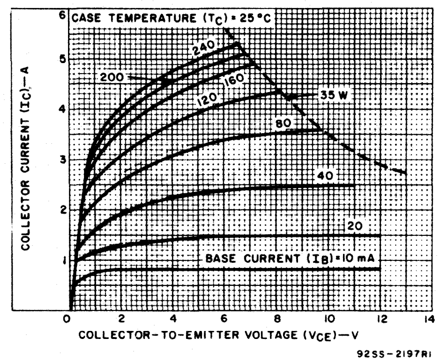


Fig. 5 - Typical output characteristics for 2N3878, 2N3879, 2N5202 and 40375.

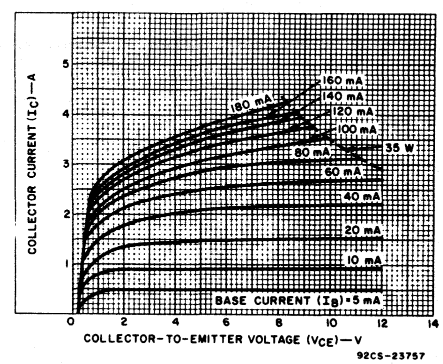


Fig. 6 - Typical output characteristics for 2N6500.

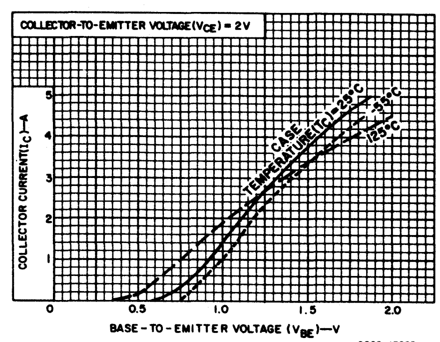


Fig. 7 - Typical transfer characteristics for all types.

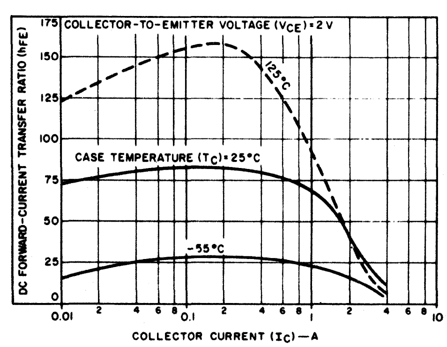


Fig. 8 - Typical dc beta characteristics for 2N6500.

2N3878, 2N3879, 2N5202, 2N6500, 40375

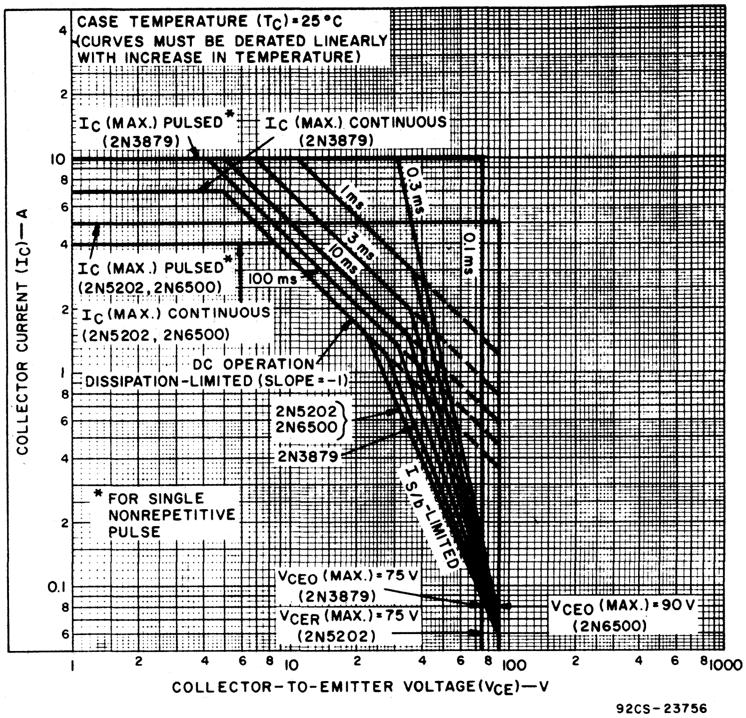


Fig. 9 - Maximum operating areas for 2N3879, 2N5202, and 2N6500.

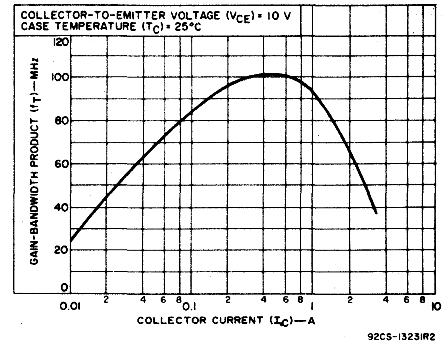


Fig. 10 - Typical gain-bandwidth product for all types.

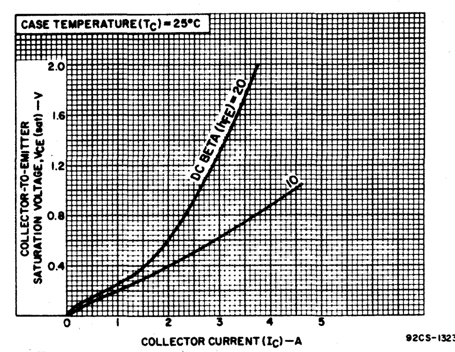


Fig. 11 - Typical saturation-voltage characteristics for 2N3878, and 2N3879.

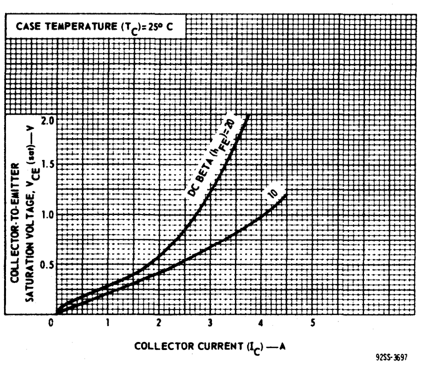


Fig. 12 - Typical saturation-voltage characteristics for 2N5202.

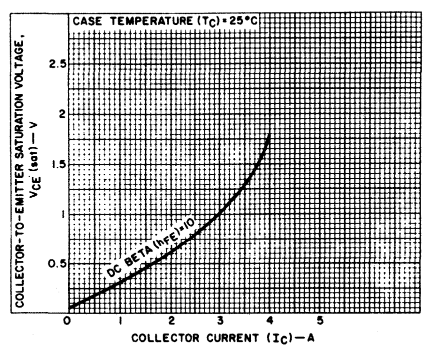


Fig. 13 - Typical saturation-voltage characteristics for 2N6500.

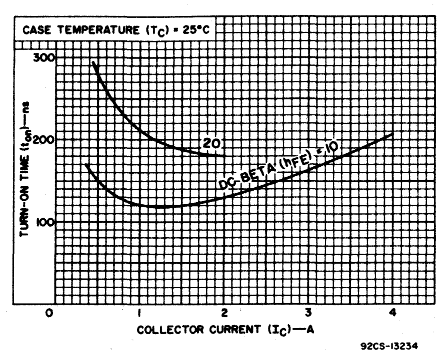


Fig. 14 - Typical turn-on time for 2N3879, 2N5202, and 2N6500.

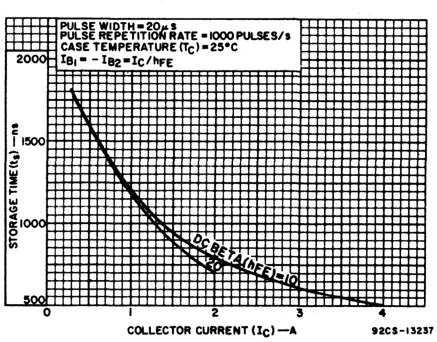


Fig. 15 - Typical storage time for 2N3879, 2N5202, and 2N6500.

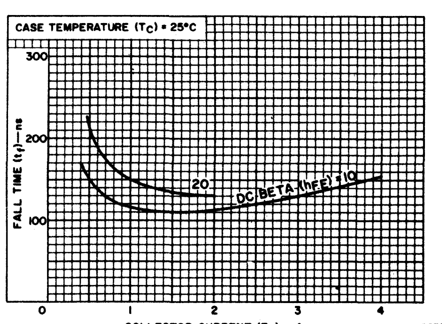


Fig. 16 - Typical fall time for 2N3879, 2N5202, and 2N6500.

2N4036, 2N4037, 2N4314, 40391, 40394, 41503

Medium-Power Silicon P-N-P Planar Transistors

General-Purpose Types for Industrial and Commercial Applications

These RCA types are double-diffused, epitaxial-planar, silicon p-n-p transistors; they differ in breakdown-voltage ratings, leakage-current, and saturation characteristics.

The 2N4036, 2N4037, 2N4314, 40391, and 40394 transistors are intended for a wide variety of small-signal medium-power applications. With a minimum gain-bandwidth product (f_T) of 60 MHz, these devices provide useful gain at high frequencies. In addition, the 2N4036 is useful in high-speed saturated switching applications.

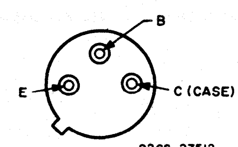
Type 41503 is suitable for low-power, low-cost industrial and audio uses, and may be employed as the p-n-p complement to RCA n-p-n type 41502. (Data for the 41502 are supplied in bulletin File No. 773).

Types 2N4036, 2N4037, 2N4314, and 41503 are supplied in the JEDEC TO-39 hermetic package. The 40391 is a 2N4037 with a factory attached heat radiator, intended for printed-circuit-board applications. Type 40394 is a 2N4037 with a factory-attached diamond-shaped mounting flange.

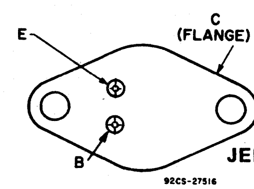
Features:

- 2N4036, 2N4037 are p-n-p complements of 2N2102, 2N3053
- Gain-bandwidth product (f_T) = 60 MHz min.
- High breakdown voltages
- Maximum-area-of-operation curves
- Planar construction provides low noise and low leakage
- Low saturation voltages
- High pulsed beta at high collector current
- Fast switching (2N4036)

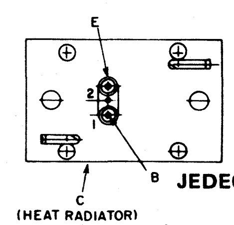
TERMINAL DESIGNATIONS



JEDEC TO-39
2N4036, 2N4037
2N4314, 41503



JEDEC TO-39 with Flange
40394



JEDEC TO-39 with Heat Radiator
40391

MAXIMUM RATINGS, *Absolute Maximum Values:*		2N4036	2N4037 40391, 40394	2N4314	41503	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−90	−60	−90	–	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With 1.5 volts (V_{BE}) of reverse bias	V_{CEV}(sus)	−85	−60	−85	–	V
With external base-to-emitter resistance (R_{BE}) ≤ 200Ω	V_{CER}(sus)	−85	−60	−85	–	V
* With base open	V_{CEO}(sus)	−65	−40	−65	−30	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	−7	−7	−7	−4	V
*COLLECTOR CURRENT	I_C	−1.0	−1.0	−1.0	−1	A
*BASE CURRENT	I_B	−0.5	−0.5	−0.5	−0.5	
*TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		7	7(2N4037)	7	7	W
		–	7(40394)	–	–	W
At free-air temperatures up to 25°C		1	3.5(40391)	1	1	W
		–	1(2N4037, 40394)	–	–	W
At temperatures above 25°C		Derate linearly to 200°C				
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to 200				°C
*LEAD TEMPERATURE (During soldering):						
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		230				°C

* In accordance with JEDEC registration data format (JS-6 RDF-1 2N4036; JS-9 RDF-2 2N4037, 2N4314).

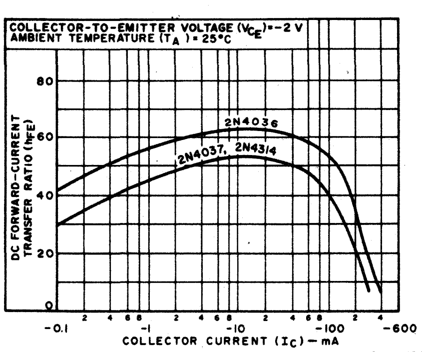


Fig.1—Typical dc-beta characteristics for 2N4036, 2N4037 and 2N4314.

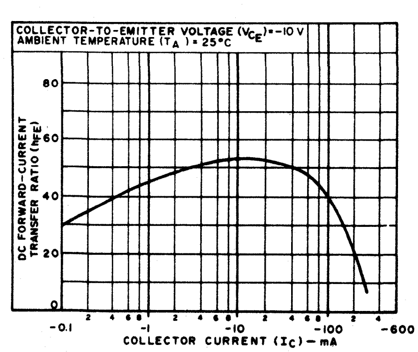


Fig.2—Typical dc-beta characteristic for 41503.

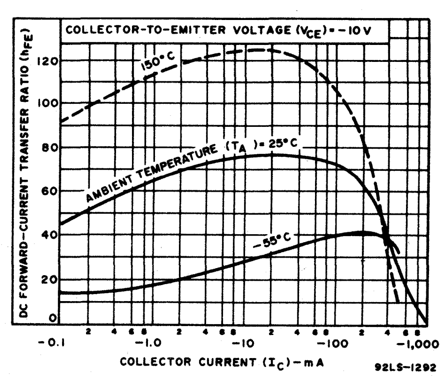


Fig.3—Typical dc beta characteristics for 2N4037 and 2N4314.

2N4036, 2N4037, 2N4314, 40391, 40394, 41503

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT mA dc I_C	LIMITS: 2N4036 MIN.	2N4036 MAX.	2N4037, 40391, 40394 MIN.	2N4037, 40391, 40394 MAX.	2N4314 MIN.	2N4314 MAX.	41503 MIN.	41503 MAX.	UNITS
Collector Cutoff Current: With emitter open	I_{CBO}	−15 −90 −60				– – 	– -0.1● -0.02	– – –	– – -0.25●	– – –	– – -0.25●	– – –	−2 – –	µA mA µA
With base open	I_{CEO}		−30			–	-0.5●	–	-5●	–	-5●	–	–	µA
With base-emitter junction reverse biased	I_{CEX}		−85	1.5		–	-100●	–	–	–	–	–	–	mA
T_C = 150°C	I_{CEX}		−30	1.5		–	-0.1●	–	–	–	–	–	–	mA
Emitter Cutoff Current	I_{EBO}			7 5	0 0	– –	-0.1● -0.02	– –	– -1●	– –	– -1●	– –	– –	mA µA
Collector-to-Base Breakdown Voltage (I_E = 0)	$V_{(BR)CBO}$				-0.1	-90	–	-60●	–	-90●	–	–	–	V
Emitter-to-Base Breakdown Voltage (I_E = -0.1 mA)	$V_{(BR)EBO}$				0	-7	–	-7	–	-7	–	-4	–	V
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse biased	V_{CEV}(sus)			1.5	-100	-85[a]	–	-60[a]	–	-85[a]	–	–	–	V
With external base-to-emitter resistance (R_{BE}) ≤ 200Ω	V_{CER}(sus)				-100	-85[a]	–	-60[a]	–	-85[a]	–	–	–	V
● With base open	V_{CEO}(sus)				-30 -100	– -65[a]	– –	– -40[a]	– –	– -65[a]	– –	-30[a] –	– –	V
● Collector-to-Emitter Voltage (I_B = -15 mA)	V_{CE}(sat)				-150	–	-0.65	–	-1.4	–	-1.4	–	-1.5	V
Base-to-Emitter Voltage	V_{BE}		-10		-150	–	-1.1	–	-1.5●	–	-1.5●	–	-2.5	V
● Base-to-Emitter Voltage (I_B = -15mA)	V_{BE}(sat)				-150	–	-1.4	–	–	–	–	–	–	V
● DC Forward-Current Transfer Ratio	h_{FE}		-2 -10 -10 -10 -10		-150 -0.1 -1.0 -150[b] -500[b]	20 20 – 40 20	200 – – 140 –	– – 15 50 –	– – – 250 –	– – 15 50 –	– – – 250 –	– – – 20 –	– – – – –	
Common-Emitter, Small-Signal Short-Circuit, Forward-Current Transfer Ratio (at f = 20 MHz)	h_{fe}		-10		-50	3	–	3	–	3	–	–	–	
● Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (at f = 20 MHz)	$\|h_{fe}\|$		-10		-50	3	–	3	10	3	10	–	–	
Collector-Base Capacitance (at f = 1 MHz, I_E = 0)	C_{cb}	-10				–	30	–	30●	–	30●	–	30	pF
Input Capacitance	C_{ib}			0.5	0	–	90	–	90	–	90	–	90	pF
● Sat. Switching Time[c] Rise time Storage time Fall time Turn-on time Turn-off time	 t_r t_s t_f t_{on} t_{off}		 -30 -30 -30 -30 -30		 -150 -150 -150 -150 -150	 – – – – –	 70 600 100 110 700	 – – – – –	 – – – – –	 – – – – –	 – – – – –	 – – – – –	 – – – – –	ηs
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					– –	25● –	25 (max.) 2N4037 & 40394		– –	25 –	– –	25 –	°C/W
Junction-to-Ambient	$R_{\theta JA}$					– –	165 –	165 (max.) 2N4037 40394 50 (max.) 40391		– –	165 –	– –	165 –	°C/W

[a]CAUTION: The sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) MUST NOT be measured on a curve tracer.

[b] Pulsed, pulse duration = 300 µs, duty factor ≤ 2%.

●In accordance with JEDEC registration data format (JS-6 RDF-1 2N4036; JS-9 RDF-2 2N4037, 2N4314).

[c]I_{B1} = I_{B2} = 15 mA

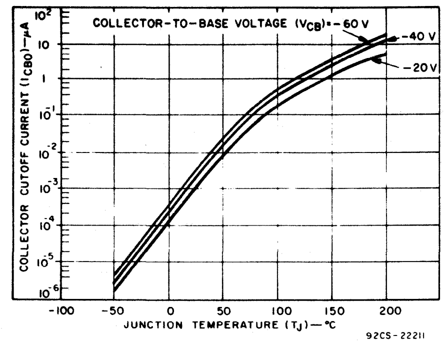


Fig.4—Typical collector-cutoff current vs. junction temperature for 2N4036.

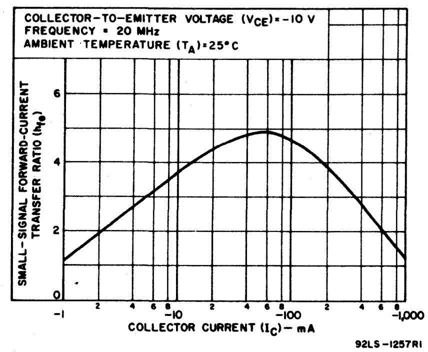


Fig.5—Typical small-signal beta characteristics for all types.

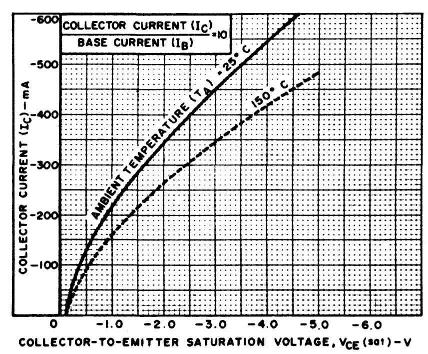


Fig.6—Typical saturation-voltage characteristics for 2N4036.

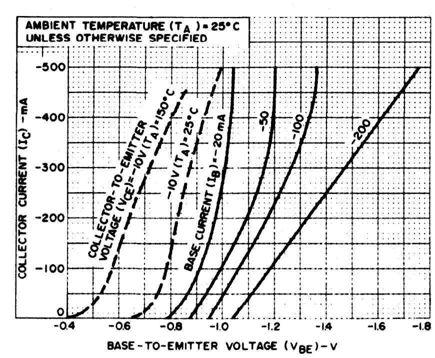


Fig.7—Typical transfer characteristics for 2N4037 and 2N4314.

2N4036, 2N4037, 2N4314, 40391, 40394, 41503

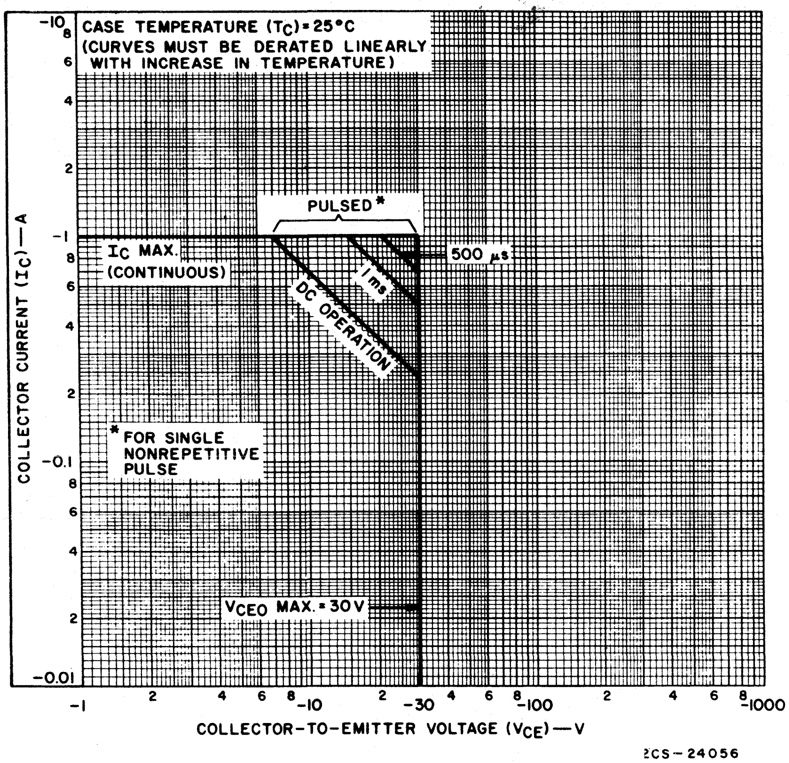


Fig.8—Maximum operating areas.

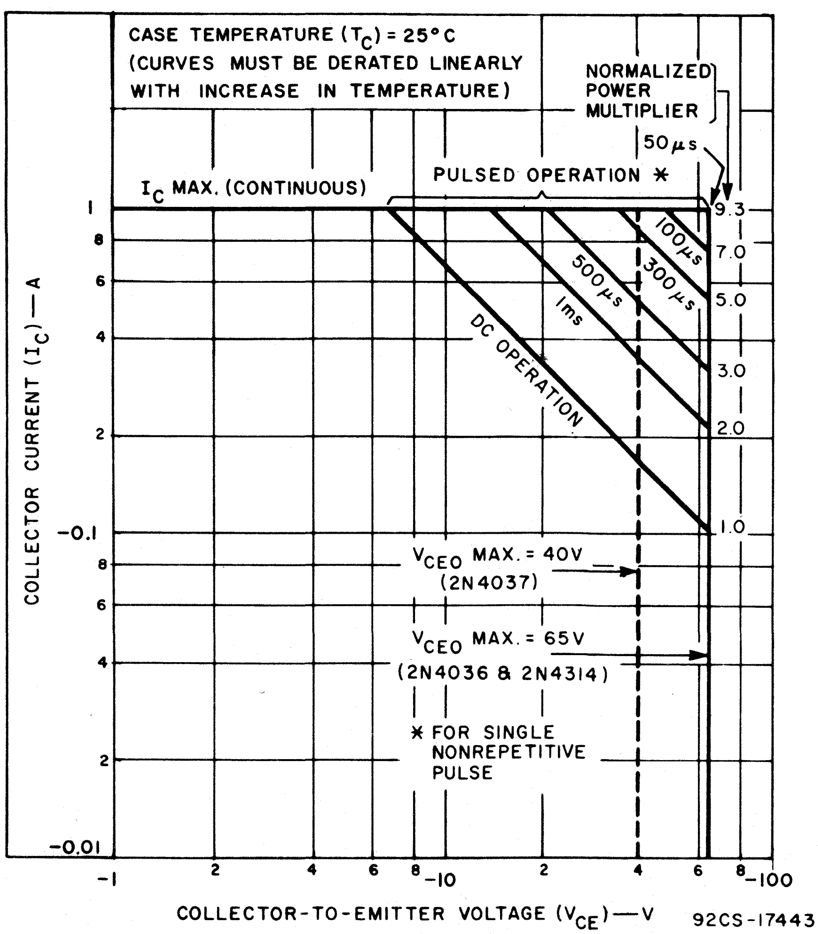


Fig.9—Maximum operating areas for 2N4036, 2N4037, and 2N4314.

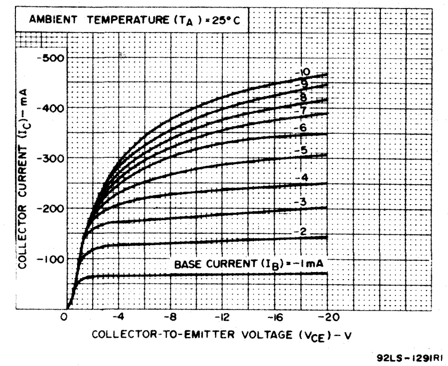


Fig.10—Typical output characteristics for 2N4037 and 2N4314.

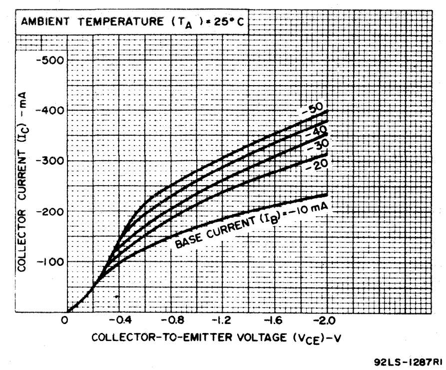


Fig.11—Typical output characteristics for 2N4037 and 2N4314.

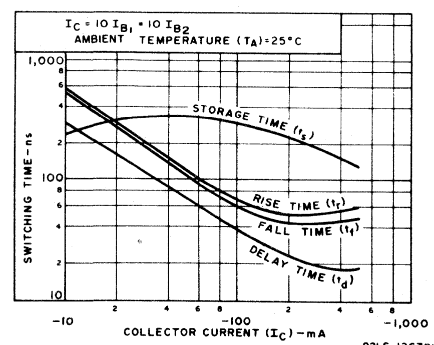


Fig.12—Typical saturated switching times for 2N4036.

2N5038, 2N5039, 2N6354, 2N6496

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistors

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

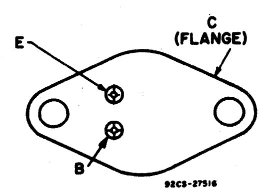
RCA-2N5038, 2N5039, 2N6354, and 2N6496 are epitaxial silicon n-p-n power transistors. They differ in breakdown-voltage ratings, leakage-current, and dc-beta values.

The high current-handling capability of these transistors in conjunction with fast switching speeds make these devices especially sutted for switching-control amplifiers, power gates, switching regulators, converters, and inverters. Other recommended applications include dc-rf amplifiers and power oscillators. These transistors are supplied in the JEDEC TO-3 package.

Features:

- **Maximum operating area curves for dc and pulse operation**
- **$I_{S/b}$-limit line beginning at 28 V**
- **High collector current ratings**
- **High-dissipation capability**
- **Fast switching speeds — Measured at: 5 A, 8 A, 10 A, 12 A levels**

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute Maximum Values:*

		2N5038	2N5039	2N6354	2N6496	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	150	120	150	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With −1.5 volts (V_{BE}) of reverse bias and external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CEX}(sus)	150	120	–	–	V
* With external base-to-emitter resistance (R_{BE}) = 500Ω, L = 7mH	V_{CEX}	–	–	130	–	V
With $R_{BE} \leq 50\Omega$	V_{CER}(sus)	110	95	–	130	V
With base open	V_{CEO}(sus)	90	75	120	110	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	6.5	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	20	20	10	15	A
*PEAK COLLECTOR CURRENT	I_{CM}	30	30	12	–	A
*CONTINUOUS BASE CURRENT	I_B	5	5	5	5	A
*TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C and V_{CE} up to 28 V		140	140	140	140	W
At case temperature of 100°C and V_{CB} of 20 V		80	80	80	80	W
At case temperatures above 25°C		Derate linearly to 200°C				
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to 200				°C
PIN TEMPERATURE (During soldering) At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230				

* In accordance with JEDEC registration data format (JS-6, RDF-1)

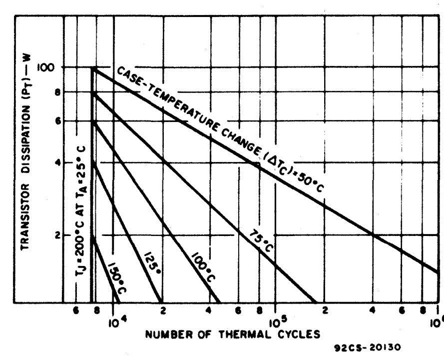


Fig. 2 — Thermal-cycling rating chart for all types.

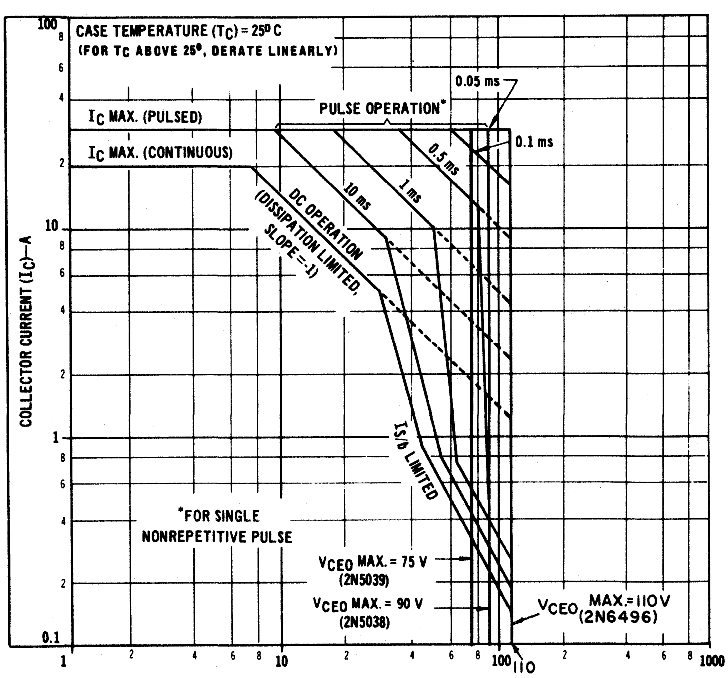


Fig. 1 — Maximum operating areas for 2N5038, 2N5039, 2N6496.

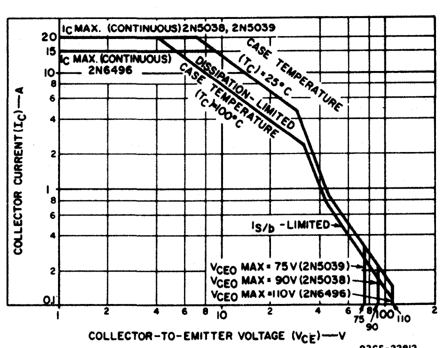


Fig. 3 — Maximum operating areas for 2N5038, 2N5039, 2N6496.

2N5038, 2N5039, 2N6354, 2N6496

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTICS	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		2N5038		2N5039		2N6354		2N6496		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* Collector-Cutoff Current: With emitter open V_{CB} = 150 V	I_{CBO}					–	–	–	–	–	5	–	–	mA
With base open	I_{CEO}	55			0	–	–	–	20	–	–	–	–	mA
		70			0	–	20	–	–	–	–	–	–	
		100				–	–	–	–	–	20	–	–	
* With base-emitter junction reverse-biased	I_{CEV}	110	-1.5			–	–	–	50	–	–	–	–	mA
		130	0			–	–	–	–	–	–	–	20	
		140	-1.5			–	50	–	–	–	–	–	–	
		140	0			–	–	–	–	–	10	–	–	
* At T_C = 150°C		85	-1.5			–	–	–	10	–	–	–	–	
		100	-1.5			–	10	–	–	–	–	–	–	
		130	0			–	–	–	–	–	–	–	25	
* At T_C = 125°C		140	0			–	–	–	–	–	20	–	–	
* Emitter Cutoff Current	I_{EBO}		-5	0		–	5	–	15	–	–	–	–	mA
			-6.5	0		–	–	–	–	–	5	–	–	
			-7	0		–	50	–	50	–	–	–	50	
* DC Forward-Current Transfer Ratio	h_{FE}	2		5[a]		–	–	–	–	20	150	–	–	
*		2		8[a]		–	–	–	–	–	–	12	100	
*		2		10[a]		–	–	–	–	10	100	–	–	
		5		2[a]		50	250	30	250	–	–	–	–	
*		5		10[a]		–	–	20	100	–	–	–	–	
*		5		12[a]		20	100	–	–	–	–	–	–	
* Magnitude of Small-Signal Forward-Current Transfer Ratio: f = 5 MHz	$\|h_{fe}\|$	10		2		12	–	12	–	–	–	12	–	
f = 10 MHz		10		1		–	–	–	–	8	–	–	–	
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$			0.2[a]	0	90[b]	–	75[b]	–	120[b]	–	100[b]	–	V
With base-emitter junction reverse biased and external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CEX}(sus)$		-1.5	0.2	0	150[b]	–	120[b]	–	–	–	–	–	
With R_{BE} ≤ 50Ω				0.2	0	110[b]	–	95[b]	–	–	–	130[b]	–	
≤ 100Ω				0.2		–	–	–	–	130[b]	–	–	–	
Emitter-to-Base Voltage: I_E = 0.05 A	V_{EBO}			0		7	–	7	–	–	–	7	–	V
* = 0.005 A				0		–	–	–	–	6.5	–	–	–	
Base-to-Emitter Voltage	V_{BE}	2		8[a]		–	–	–	–	–	–	–	1.6	V
		5		10[a]		–	–	–	1.8	–	–	–	–	
		5		12[a]		–	1.8	–	–	–	–	–	–	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			8[a]	0.8	–	–	–	–	–	–	–	1.0	V
*				5[a]	0.5	–	–	–	–	–	0.5	–	–	
				10[a]	1.0	–	–	–	1.0	–	1	–	–	
				12[a]	1.2	–	1.0	–	–	–	–	–	–	
*				20[a]	5	–	2.5	–	2.5	–	–	–	–	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			5[a]	0.5	–	–	–	–	–	1.3	–	–	V
				8[a]	0.8	–	–	–	–	–	–	–	2.0	
*				10[a]	1	–	–	–	–	–	2	–	–	
*				20[a]	5	–	3.3	–	3.3	–	–	–	–	
Output Capacitance: V_{CB} = 10V, f = 1 MHz	C_{ob}					–	300	–	300	–	300	–	300	pF
Forward-Bias Second Breakdown Collector Current: t = 1s, nonrepetitive	$I_{S/b}$	25				–	–	–	–	5.5	–	–	–	A
		28				5.0	–	5.0	–	–	–	5.0	–	
		45				0.9	–	0.9	–	–	–	0.9	–	
Second-Breakdown Energy: With base reverse biased, R_{BE} = 51Ω, L = 25µH	$E_{S/b}$		-1	5		–	–	–	–	0.3	–	–	–	mJ
R_B = 20Ω, L = 180µH			-4	13		13	–	13	–	–	–	–	–	
			-4	8		–	–	–	–	–	–	5.7	–	
* Saturated Switching Time (V_{CC} = 30 V, I_{B_1} = I_{B_2}): Rise Time	t_r			5	0.5	–	–	–	–	–	0.3	–	–	µs
				8	0.8	–	–	–	–	–	–	–	0.5	
				10	1.0	–	–	–	0.5	–	1	–	–	
				12	1.2	–	0.5	–	–	–	–	–	–	
* Storage Time	t_{s_1}			5	0.5	–	–	–	–	–	1	–	–	
				8	0.8	–	–	–	–	–	–	–	1.5	
				10	1.0	–	–	–	1.5	–	–	–	–	
				12	1.2	–	1.5	–	–	–	–	–	–	
Storage Time (No Load)	t_{s_2}			0.5	0.5	–	–	–	–	–	2	–	–	
* Fall Time				5	0.5	–	–	–	–	–	0.2	–	–	
				8	0.8	–	–	–	–	–	–	–	0.5	
				10	1.0	–	–	–	0.5	–	–	–	–	
				12	1.2	–	0.5	–	–	–	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	10		10		–	1.25	–	1.25	–	–	–	1.25	°C/W
		20		1		–	–	–	–	–	1.25	–	–	

* In accordance with JEDEC registration data format (JS-6, RDF-1).
[a] Pulsed; pulse duration ≤ 350µs, duty factor = 2%.
[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer.

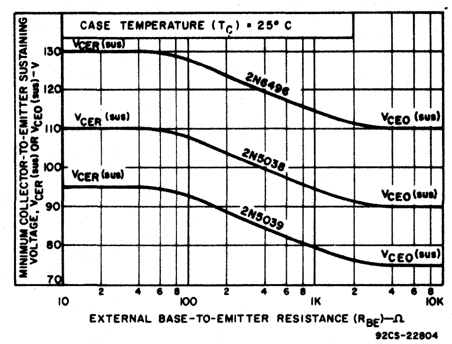


Fig. 4 — Collector-to-emitter sustaining voltage characteristics for 2N5038, 2N5039 and 2N6496.

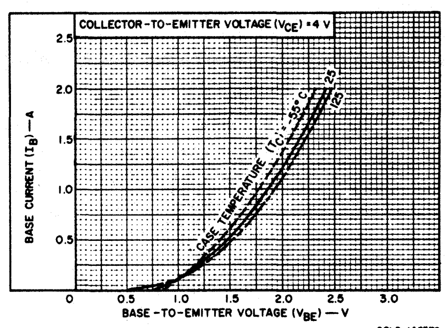


Fig. 5 — Typical input characteristics for 2N5038 and 2N5039.

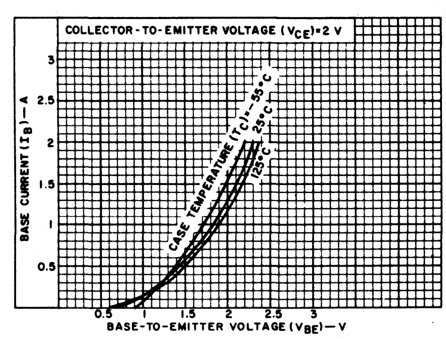


Fig. 6 — Typical input characteristic for 2N6496.

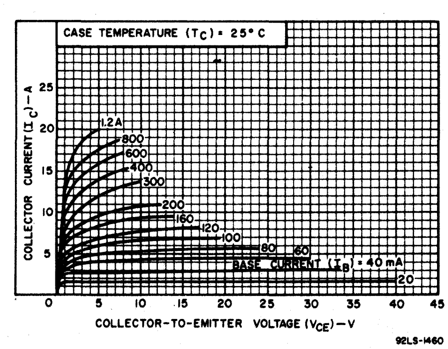


Fig. 7 — Typical output characteristics for 2N5038.

2N5038, 2N5039, 2N6354, 2N6496

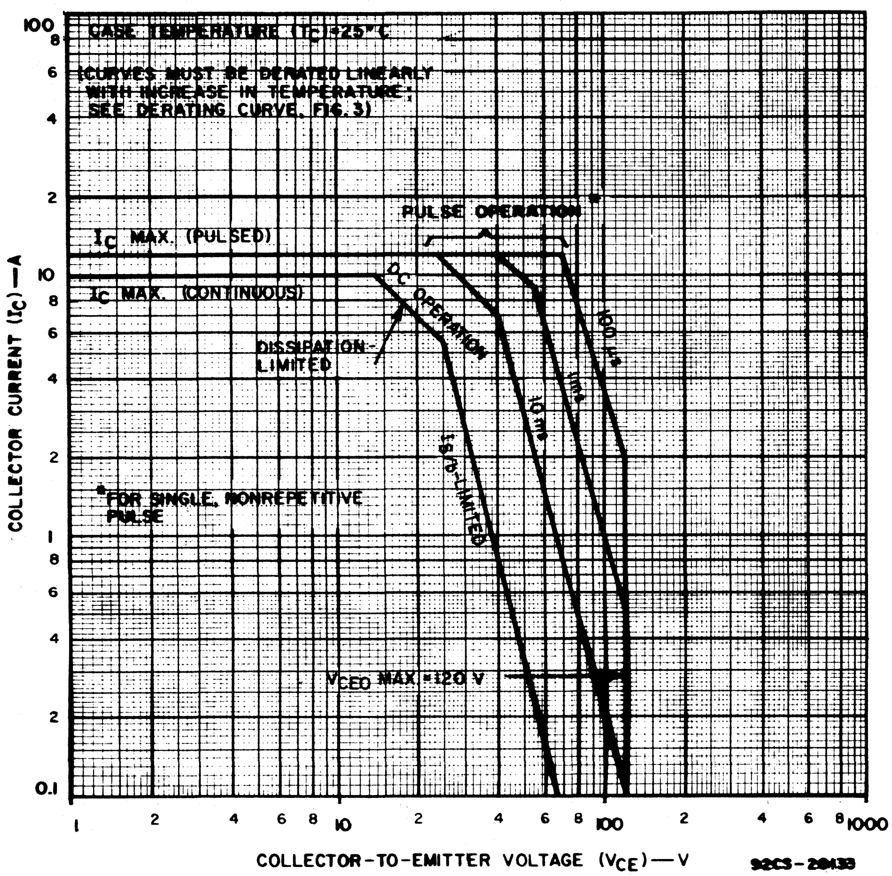


Fig. 8 — Maximum operating areas for 2N6354.

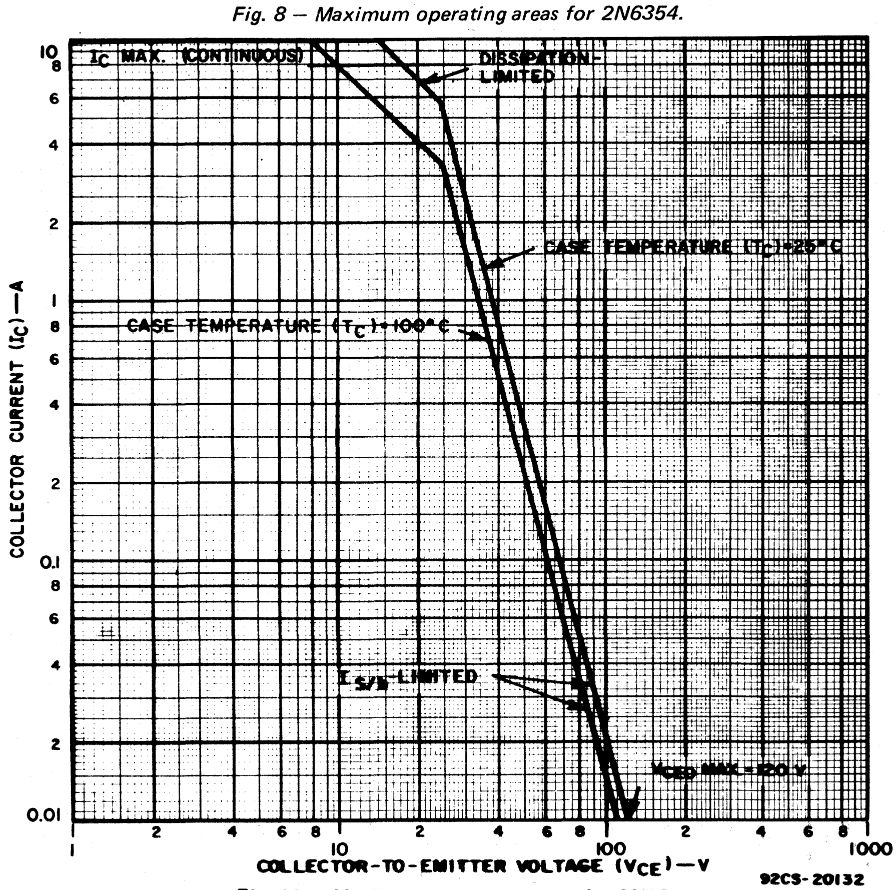


Fig. 11 — Maximum operating areas for 2N6354.

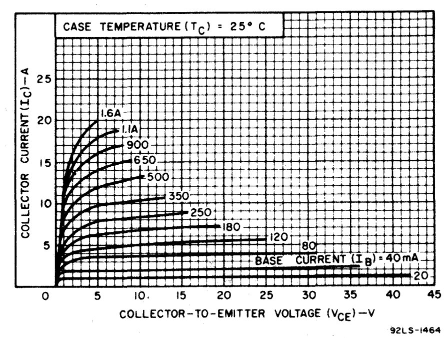


Fig. 9 — Typical output characteristics for 2N5039.

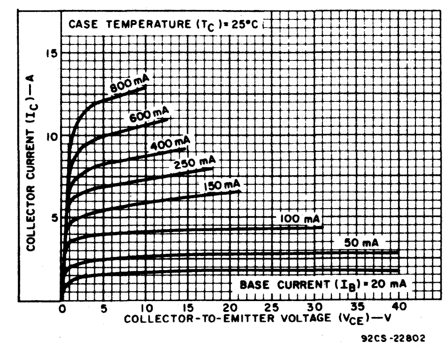


Fig. 10 — Typical output characteristics for 2N6496.

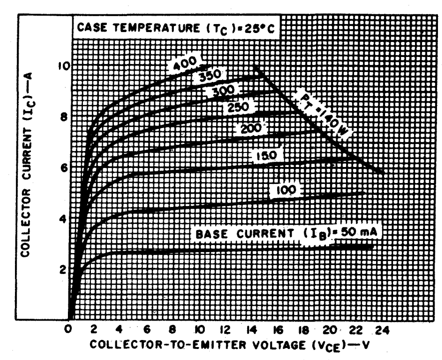


Fig. 12 — Typical output characteristics for 2N6354.

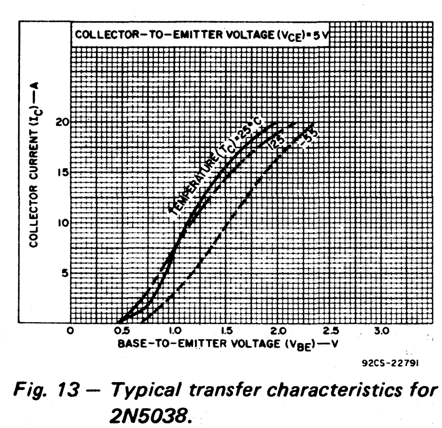


Fig. 13 — Typical transfer characteristics for 2N5038.

2N5038, 2N5039, 2N6354, 2N6496

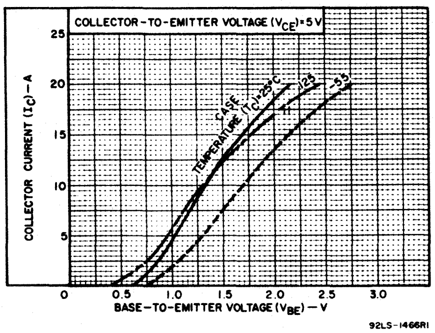


Fig. 14 — Typical transfer characteristics for 2N5039.

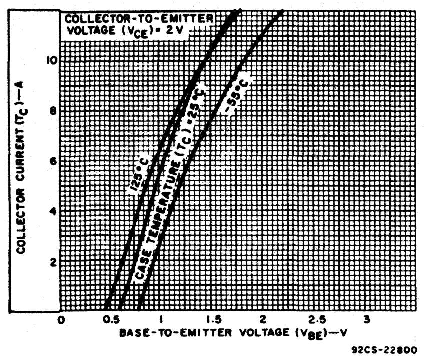


Fig. 15 — Typical transfer characteristics for 2N6496.

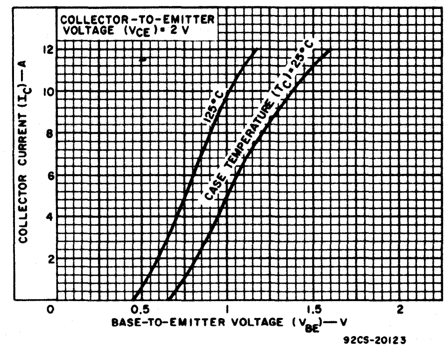


Fig. 16 — Typical transfer characteristics for 2N6354.

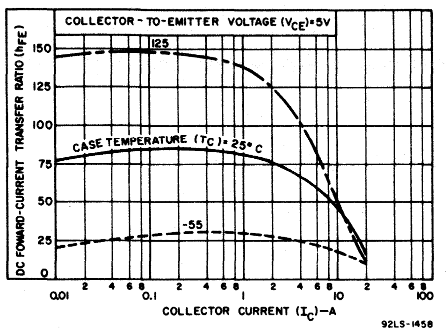


Fig. 17 — Typical dc beta characteristics for 2N5038.

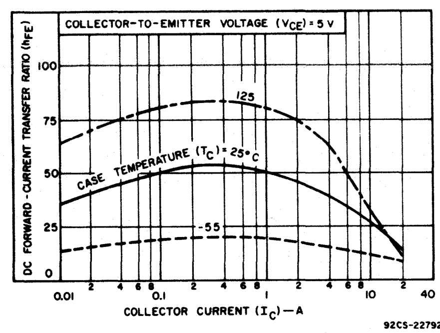


Fig. 18 — Typical dc beta characteristics for 2N5039.

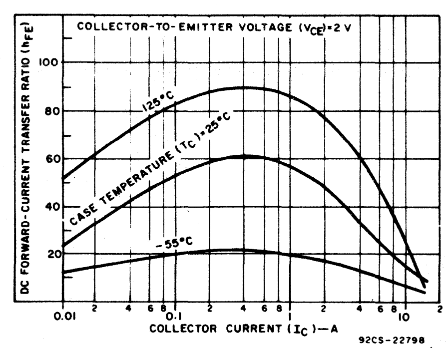


Fig. 19 — Typical dc beta characteristics for 2N6496.

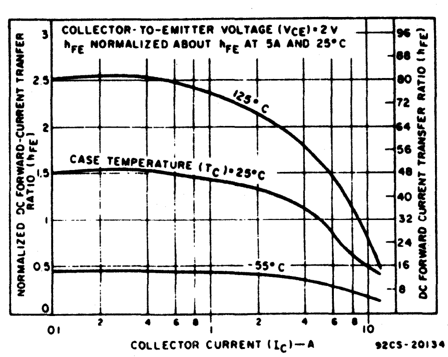


Fig. 20 — Typical normalized dc beta characteristics for 2N6354.

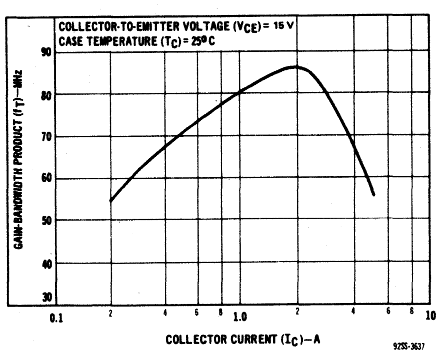


Fig. 21 — Typical gain-bandwidth product for 2N5038, 2N5039, 2N6496.

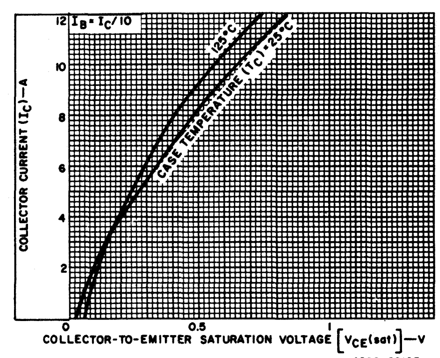


Fig. 22 — Typical saturation voltage characteristics for 2N6354.

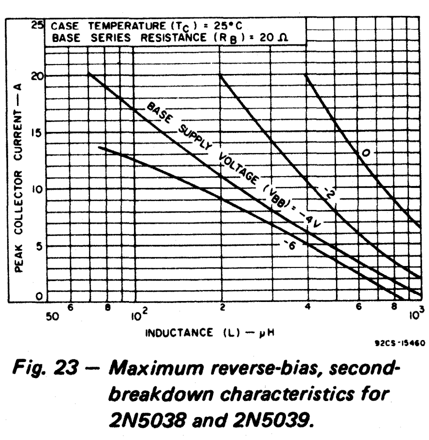


Fig. 23 — Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

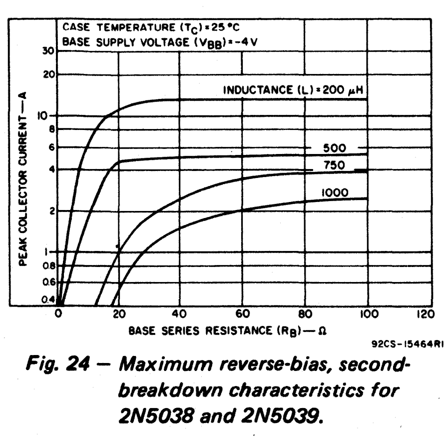


Fig. 24 — Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

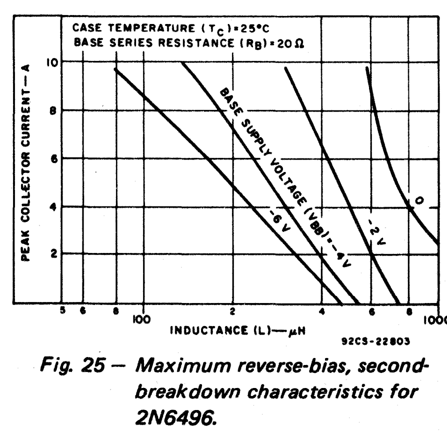


Fig. 25 — Maximum reverse-bias, second-breakdown characteristics for 2N6496.

2N5038, 2N5039, 2N6354, 2N6496

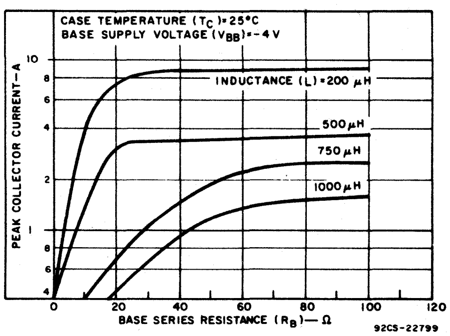


Fig. 26 — Maximum reverse-bias, second-breakdown characteristics for 2N6496.

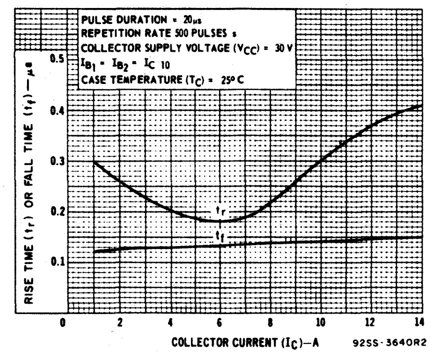


Fig. 27 — Typical rise-time and fall-time characteristics for 2N5038, 2N5039, 2N6496.

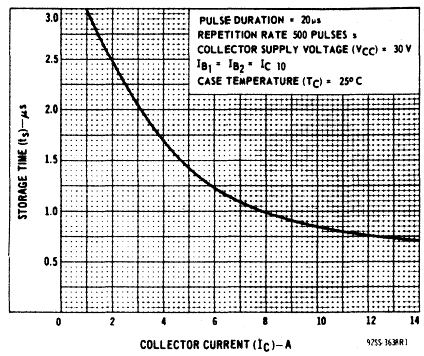


Fig. 28 — Typical storage time characteristics for 2N5038, 2N5039, 2N6496.

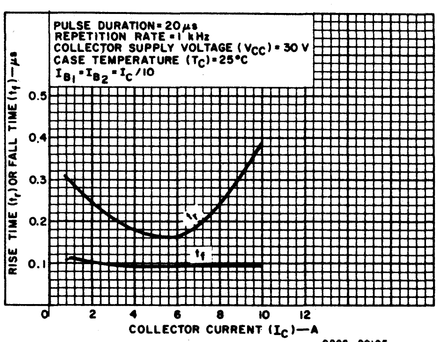


Fig. 29 — Typical rise- and fall-time characteristics for 2N6354.

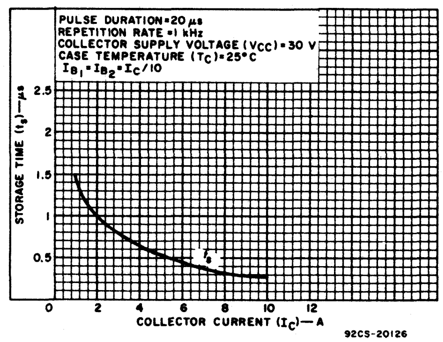


Fig. 30 — Typical storage-time characteristics for 2N6354.

2N5239, 2N5240, 40852

Silicon N-P-N Power Transistors

High-Voltage, High-Power Types for Applications in Industrial and Commercial Service

The RCA-2N5239 and 2N5240 are multiple epitaxial silicon n-p-n power transistors employing a new overlay construction with several emitter sites.

The high breakdown voltage ratings and exceptional second-breakdown capabilities of these transistors make them especially suitable for use in series regulators, power amplifiers, inverters, deflection circuits, switching regulators, and high-voltage bridge amplifiers.

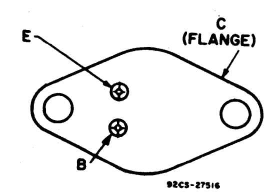
RCA 40852 is selected from RCA's line of silicon power transistors for power-supply applications. Its high-voltage ratings permit operation directly off the power line thereby eliminating the heavy and bulky 60-Hz power transformer.

All of these devices are supplied in the popular JEDEC TO-3 package; they differ in breakdown-voltage and leakage-current values.

Features:
- High voltage ratings
- High power-dissipation ratings
- For switching applications where circuit values and operating conditions require a transistor with a high second breakdown rating ($I_{S/b}$) (limit line begins at 150 V)
- Maximum area-of-operation curves for dc and pulse operation
- High-voltage ratings for operation from power lines without a step-down transformer (40852)

Applications (40852):
- For use in switching-regulator supplies which feature:
  - A substantial reduction in size and weight due to elimination of the 60-Hz power transformer
  - Operation with a substantial reduction of heat
- 5-V, off-line supplies with current ratings of 25, 50, 100, or 200 A
- 30-V, off-line supplies with current ratings of 5, 10, 20, or 40 A

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5239	2N5240	40852	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	300	375	450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
* With base open, V_{CEO}(sus)	225	300	350	V
With external base-to-emitter resistance (R_{BE}) $\leqslant$ 50 Ω, V_{CER}(sus)	250	350	375	V
*EMITTER-TO-BASE VOLTAGE, V_{EBO}	6	6	9	V
*COLLECTOR CURRENT, I_C	5	5	7	A
PEAK COLLECTOR CURRENT, I_{CM}	–	–	10	A
*BASE CURRENT, I_B	2	2	4	A
*TRANSISTOR DISSIPATION, P_T:				
At case temperatures up to 25°C and V_{CE} up to 150 V	100	100	100	W
At case temperatures up to 25°C and V_{CE} above 150 V	See Fig. 6		–	
At case temperatures above 25°C and V_{CE} above 150 V	See Figs. 1 & 6		–	
*TEMPERATURE RANGE:				
Storage & Operating (Junction)	–65 to +200			°C
*PIN TEMPERATURE (During Soldering)				
At distance $\geqslant$ 1/32 in. (0.79 mm) from seating plane for 10 s max	230			°C

*In accordance with JEDEC registration data format (JS-6, RDF-2)

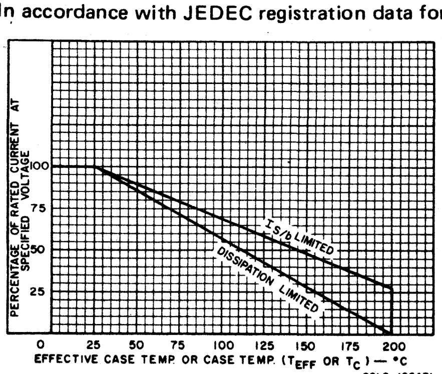


Fig. 1—Dissipation derating curves for all types.

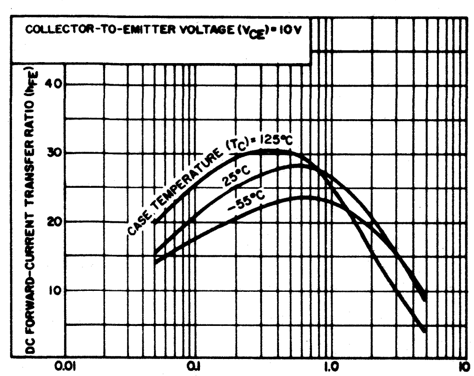


Fig. 2—Typical dc-beta characteristics for all types.

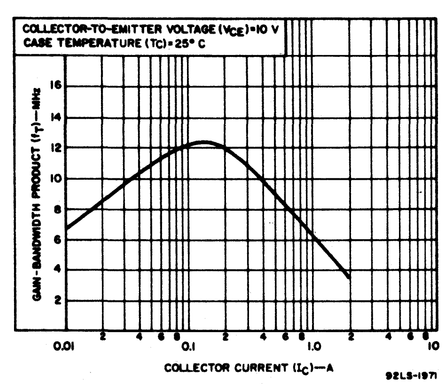


Fig. 3—Typical gain-bandwidth product for all types.

2N5239, 2N5240, 40852

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5239 MIN.	MAX.	2N5240 MIN.	MAX.	40852 MIN.	MAX.	UNITS
* I_{CEO}	200			0	–	5.0	–	2.0	–	–	mA
* I_{CEV}	300	−1.5			–	4.0	–	–	–	–	mA
	375	−1.5			–	–	–	2.0	–	–	
	450	−1.5			–	–	–	–	–	0.5	
I_{CEV} T_C = 125°C	450	−1.5			–	–	–	–	–	5	
I_{CEV} (T_C = 150°C)	300	−1.5			–	5.0	–	3.0	–	–	mA
* I_{EBO}		−5.0	0		–	5.0	–	1.0	–	–	mA
* V_{CEO}(sus)			0.2	0	225[b]	–	300[b]	–	350[b]	–	V
V_{CER}(sus)			0.2	0	250[b]	–	350[b]	–	375[b]	–	V
* V_{EBO}				−0.02	6	–	6	–	–	–	V
				−0.1	–	–	–	–	9	–	
V_{BE}(sat)					–	–	–	–	–	2	V
* V_{BE}	10	–	2.0[a]	–	–	3.0	–	3.0	–	–	V
* V_{CE}(sat)	–	–	2.0[a]	0.25	–	2.5	–	2.5	–	–	V
	–	–	4.5[a]	1.125	–	5	–	5	–	–	
			4[a]	0.8	–	–	–	–	–	3	
h_{FE}	1		1.2[a]		–	–	–	–	12	–	
	10	–	0.4[a]	–	20	80	20	80	–	–	
*	10	–	2.0[a]	–	20	80	20	80	–	–	
*	10	–	4.5[a]	–	5	–	5	–	–	–	
C_{ob} (At 1 MHz) (V_{CB} = 10V, I_E = 0)	–	–	–	–	–	150	–	150	–	–	pF
* $I_{S/b}$ (t_p = I_s)	40				–	–	–	–	2.5	–	A
	150	–	–	–	0.67	–	0.67	–	–	–	
$E_{S/b}$ (R_{BE} = 50 Ω L = 0.2 mH,	–	−4.0	4.0	–	1.6	–	1.6	–	–	–	mJ
L = 100 μH)		−4	3[c]		–	–	–	–	0.45	–	
f_T	10	–	0.2	–	5.0	–	5.0	–	5	–	MHz
* $\|h_{fe}\|$ (at 1 MHz)	10	–	0.2	–	5.0	–	5.0	–	5	–	
* h_{fe} (at 1 kHz)	10	–	4.0	–	20	–	20	–	20	–	
$R_{\theta JC}$	–	–	–	–	–	1.75	–	1.75	–	1.75	°C/W

*In accordance with JEDEC registration data format (JS-6, RDF-2) (2N5239, 2N5240).

[a]Pulsed; pluse duration ≤350 μs, duty factor = 2%.

[b]CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer.

[c]I_{CM}

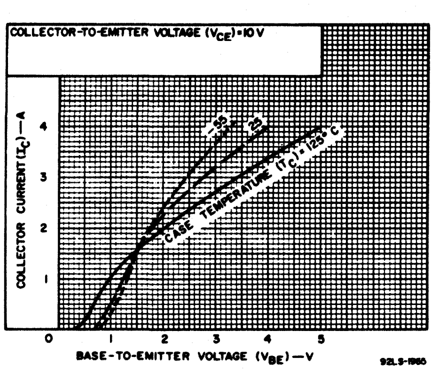


Fig. 4—Typical transfer characteristics for all types.

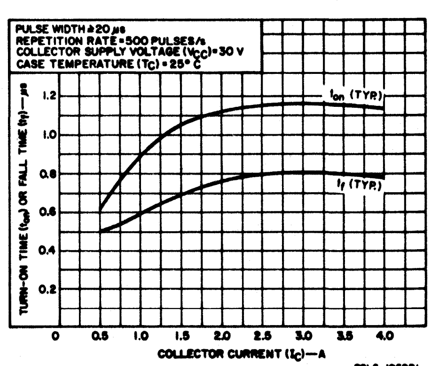


Fig. 5—Saturated switching time (storage) vs. collector current for types 2N5239 & 2N5240.

2N5239, 2N5240, 40852

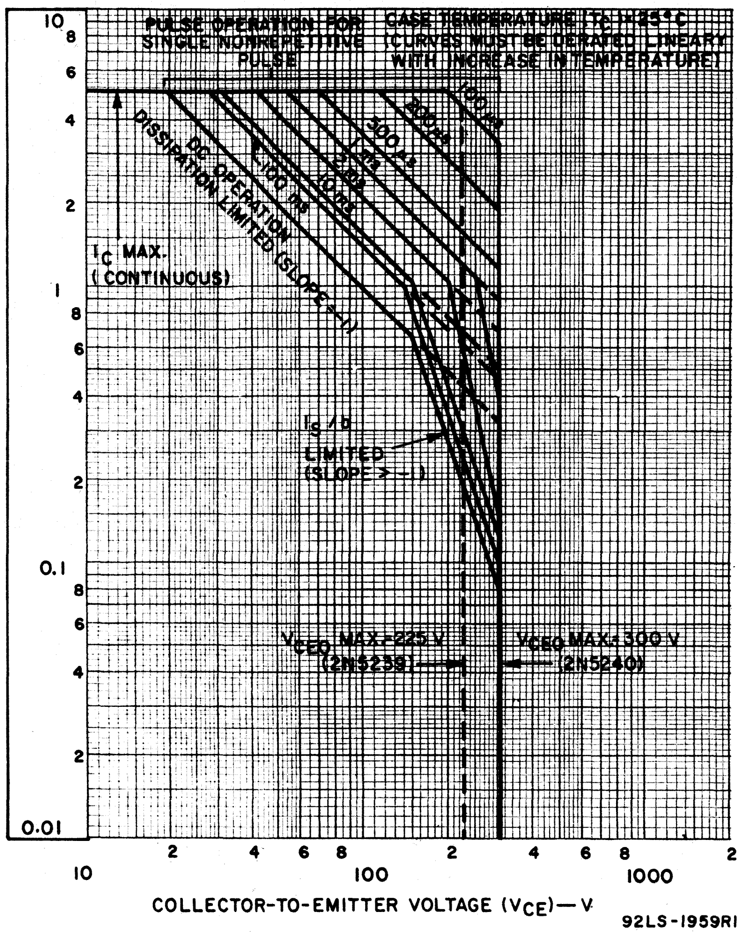


Fig. 6—Maximum operating areas for 2N5239 & 2N5240.

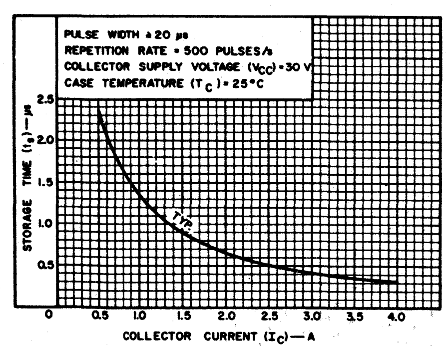


Fig. 7—Saturated switching time (storage) vs. collector current for types 2N5239 & 2N5240.

2N5293-2N5298, 41504, RCA3054

Hometaxial-Base, Silicon N-P-N VERSAWATT Transistors

General-Purpose Types for Medium-Power Switching and Amplifier Applications in Military, Industrial, and Commercial Equipment

Features:

- Low saturation voltage—
  $V_{CE}(sat)$ = 1 V max. at I_C = 0.5 A (2N5293, 2N5294)
  = 1 V max. at I_C = 1 A (2N5295, 2N5296, 41504)
  = 1 V max. at I_C = 1.5 A (2N5297, 2N5298)
- VERSAWATT package (molded-silicone plastic)
- Maximum safe-area-of-operation curves

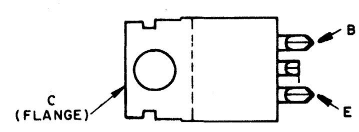
RCA-2N5293, 2N5294, 2N5295, 2N5296, 2N5297, 2N5298, 41504, and RCA3054 are hometaxial-base silicon n-p-n transistors. They are intended for a wide variety of medium-power switching and amplifier applications such as series and shunt regulators, and in driver and output stages of high-fidelity amplifiers. Types 2N5293, 2N5295, and 2N5297 have formed emitter and base leads for easy insertion into TO-66 sockets. Types 2N5294, 2N5296, and 2N5298 are electrically identical to the 2N5293, 2N5295, and 2N5297, respectively, but have straight leads. Types 41504 and RCA3054 are supplied with straight leads.

These plastic power transistors differ in voltage ratings and in the currents at which the parameters are controlled.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

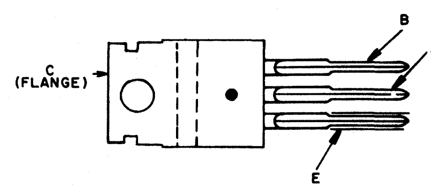
		41504	2N5293 2N5294	2N5295 2N5296	2N5297 2N5298	RCA3054	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	–	80	60	80	90	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:							
With −1.5 volts (V_{BE}) of reverse bias	$V_{CEV}(sus)$	–	80	60	80	90	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	35	75	50	70	60	V
With base open	$V_{CEO}(sus)$	–	70	40	60	55	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	7	5	5	7	V
COLLECTOR CURRENT	I_C	4	4	4	4	4	A
BASE CURRENT	I_B	2	2	2	2	2	A
TRANSISTOR DISSIPATION:	P_T						
At case temperatures up to 25°C		36	36	36	36	36	W
At case temperatures above 25°C			Derate linearly at 0.288				W/°C
At ambient temperatures up to 25°C		1.8	1.8	1.8	1.8	1.8	W
At ambient temperatures above 25°C			Derate linearly at 0.0144				W/°C
TEMPERATURE RANGE:							
Storage and Operating (Junction)			−65 to +150				°C
LEAD TEMPERATURE (During soldering):							
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.			235				°C

TERMINAL DESIGNATIONS



92CS-27520

JEDEC TO-220AA
2N5293, 2N5295, 2N5297



92CS-27519

JEDEC TO-220AB
2N5294, 2N5296, 2N5298, 41504, RCA3054

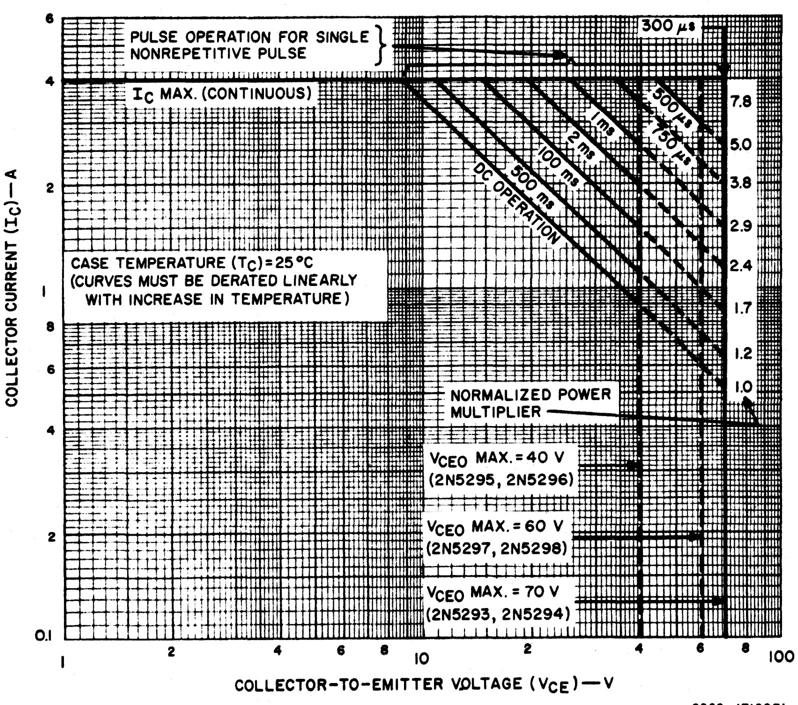


Fig. 1 — Maximum operating areas for 2N5293—2N5298.

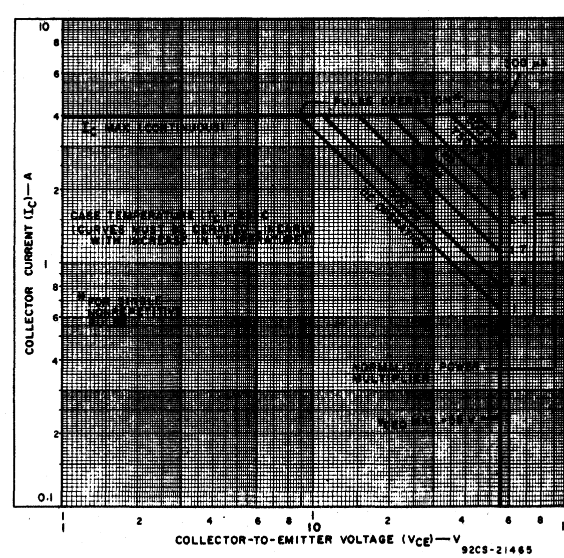


Fig. 2 — Maximum operating areas for RCA3054.

2N5293-2N5298, 41504, RCA3054

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, unless otherwise specified.*

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5293 2N5294 MIN.	MAX.	2N5295 2N5296 MIN.	MAX.	2N5297 2N5298 MIN.	MAX.	41504 MIN.	MAX.	RCA3054 MIN.	MAX.	UNITS
I_{CEV} •	90	-1.5			–	–	–	–	–	–	–	–	–	1	mA
	65	-1.5			–	0.5	–	–	–	0.5	–	–	–	–	
	35	-1.5			–	–	–	2	–	–	–	–	–	–	
I_{CEV} • (T_C = 150°C)	90	-1.5			–	–	–	–	–	–	–	–	–	6	
	65	-1.5			–	3	–	–	–	3	–	–	–	–	
	35	-1.5			–	–	–	5	–	–	–	–	–	–	
I_{CER} (R_{BE} = 100 Ω)	50				–	0.5	–	–	–	0.5	–	–	–	–	mA
	20				–	–	–	–	–	–	–	5	–	–	
I_{CER} (T_C = 150°C)	50				–	2	–	–	–	2	–	–	–	–	mA
I_{EBO}		-7	0		–	1	–	–	–	–	–	–	–	1	mA
		-5	0		–	–	–	1	–	1	–	–	–	–	
		-4	0		–	–	–	–	–	–	–	1	–	–	
h_{FE}[c]	4		0.5		30	120	–	–	–	–	–	–	25	100	
	4		1		–	–	30	120	–	–	25	–	–	–	
	4		1.5		–	–	–	–	20	80	–	–	–	–	
$V_{CEO}(sus)$[c]			0.1	0	70	–	–	–	–	–	–	–	55	–	V
			0.1	0	–	–	40	–	–	–	–	–	–	–	
			0.1	0	–	–	–	–	60	–	–	–	–	–	
$V_{CER}(sus)$[c] (R_{BE} = 100 Ω)			0.1		75	–	–	–	–	–	–	–	–	–	V
			0.1		–	–	50	–	–	–	–	–	–	–	
			0.1		–	–	–	–	70	–	35	–	60	–	
$V_{CEV}(sus)$[c]		-1.5	0.1		80	–	–	–	–	–	–	–	–	–	V
		-1.5	0.1		–	–	60	–	–	–	–	–	–	–	
		-1.5	0.1		–	–	–	–	80	–	–	–	90	–	
V_{BE}[c]	4		0.5		–	1.1	–	–	–	–	–	–	–	1.7	V
	4		1		–	–	–	1.3	–	–	–	1.5	–	–	
	4		1.5		–	–	–	–	–	1.5	–	–	–	–	
$V_{CE}(sat)$[c]			0.5	0.05	–	1	–	–	–	–	–	–	–	1	V
			1	0.05	–	–	–	–	–	–	–	1	–	–	
			1	0.1	–	–	–	1	–	–	–	–	–	–	
			1.5	0.15	–	–	–	–	–	1	–	–	–	–	
f_T	4		0.2		0.8	–	0.8	–	0.8	–	0.8	–	0.8	–	MHz
t_{ON}	V_{CC} = 30		0.5	0.05[a]	–	5	–	–	–	–	–	–	–	–	µs
			1	0.1[a]	–	–	–	5	–	–	–	–	–	–	
			1.5	0.15[a]	–	–	–	–	–	5	–	–	–	–	
t_{OFF}	V_{CC} = 30		0.5	-0.5[a]	–	15	–	–	–	–	–	–	–	–	µs
			1	-0.1[b]	–	–	–	15	–	–	–	–	–	–	
			1.5	-0.15[b]	–	–	–	–	–	15	–	–	–	–	
$R_{\theta JC}$					–	3.5	–	3.5	–	3.5	–	3.5	–	3.5	°C/W
$R_{\theta JA}$					–	70	–	70	–	70	–	70	–	70	°C/W

[a] I_{B1} value (turn-on base current). [b] I_{B2} value (turn-off base current). [c] Pulsed, pulse duration = 300 µs, duty factor = .018.

• I_{CEX} for RCA3054.

2N5293-2N5298, 41504, RCA3054

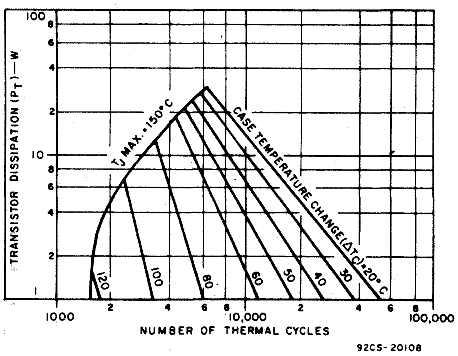


Fig. 3 — Thermal-cycling rating chart for all types.

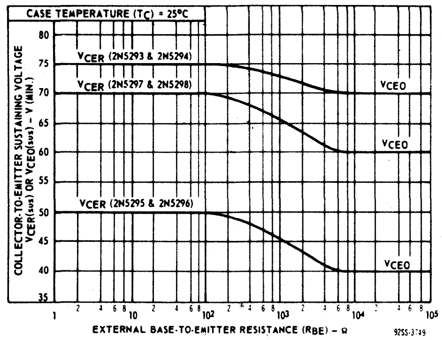


Fig. 4 — Sustaining voltage vs. base-to-emitter resistance for 2N5293–2N5298.

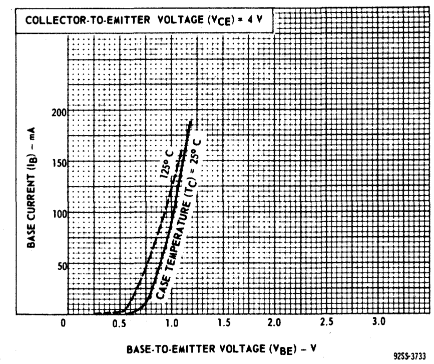


Fig. 5 — Typical input characteristics for 2N5293, 2N5294, and RCA3054.

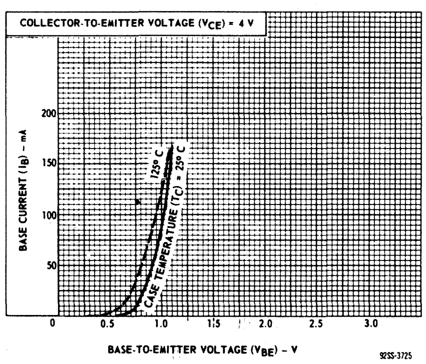


Fig. 6 — Typical input characteristics for 2N5295, 2N5296, and 41504.

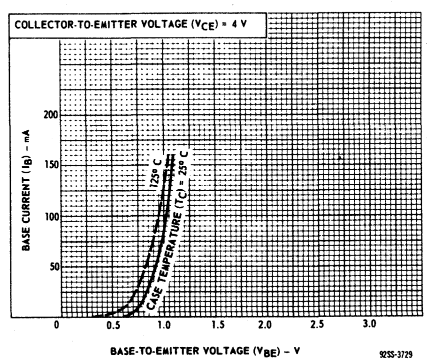


Fig. 7 — Typical input characteristics for types 2N5297 and 2N5298.

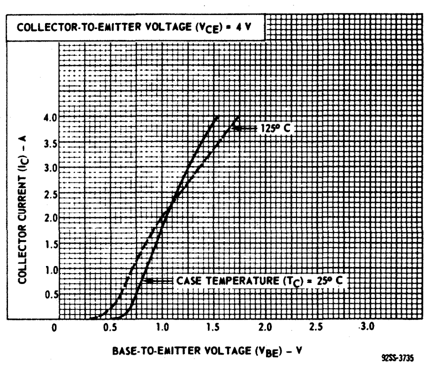


Fig. 8 — Typical transfer characteristics for 2N5293, 2N5294, and RCA3054.

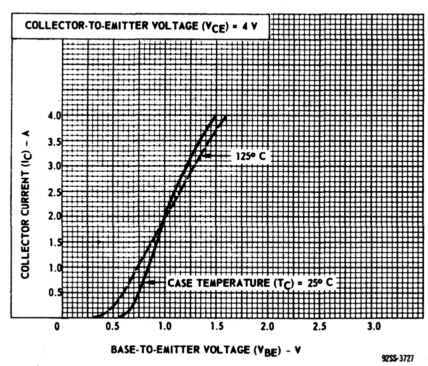


Fig. 9 — Typical transfer characteristics for 2N5295, 2N5296, and 41504.

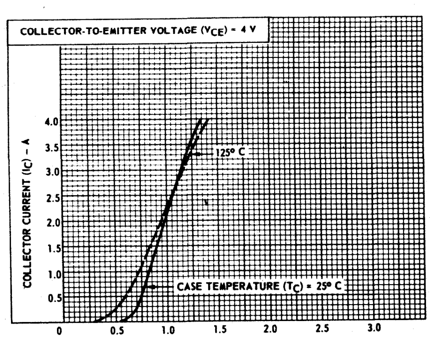


Fig. 10 — Typical transfer characteristics for 2N5297 and 2N5298.

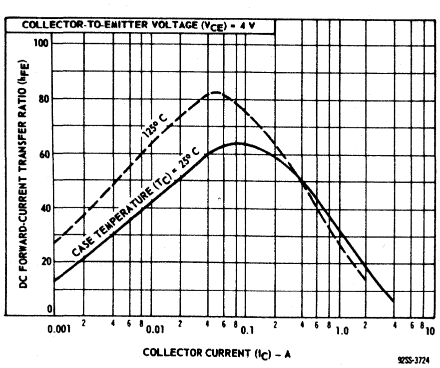


Fig. 11 — Typical dc beta for 2N5293, 2N5294, and RCA3054.

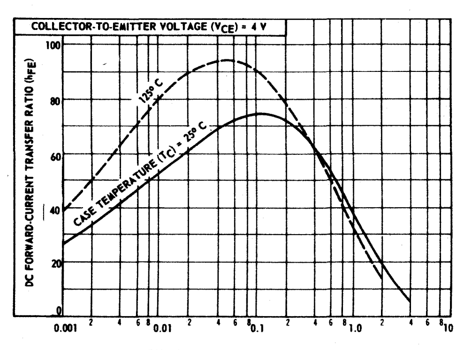


Fig. 12 — Typical dc beta for 2N5295, 2N5296, and 41504.

2N5293-2N5298, 41504, RCA3054

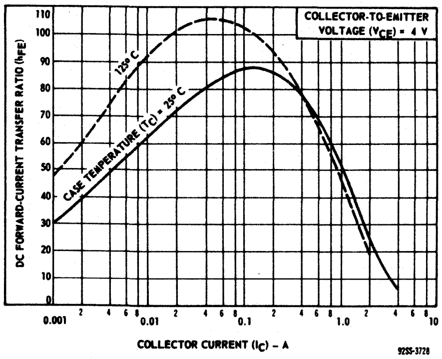


Fig. 13—Typical dc beta for 2N5297 and 2N5298.

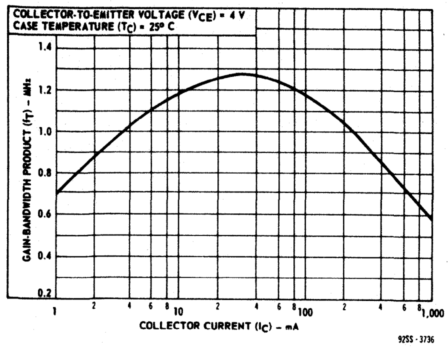


Fig. 14—Typical gain-bandwidth product for 2N5293, 2N5294, and RCA3054.

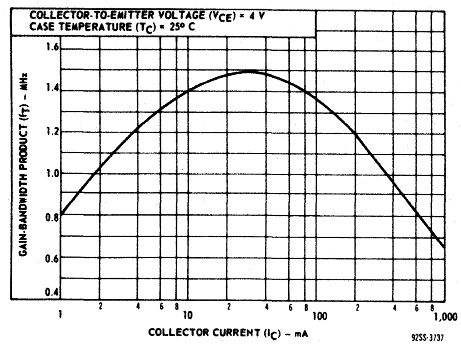


Fig. 15—Typical gain-bandwidth product for 2N5295, 2N5296 and 41504.

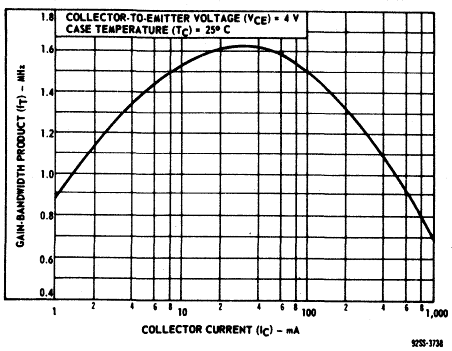


Fig. 16—Typical gain-bandwidth product for 2N5297 and 2N5298.

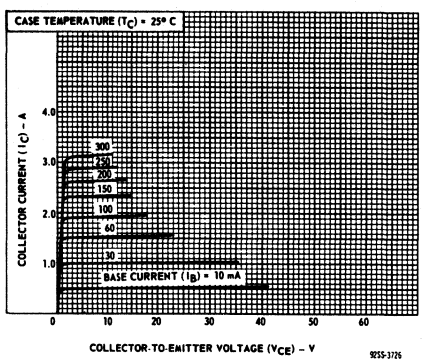


Fig. 17—Typical output characteristics for 2N5293, 2N5294, and RCA3054.

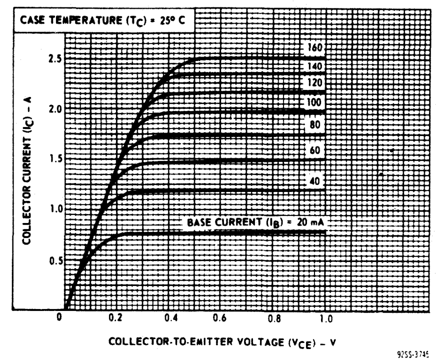


Fig. 18—Typical output characteristics for 2N5295 and 2N5296.

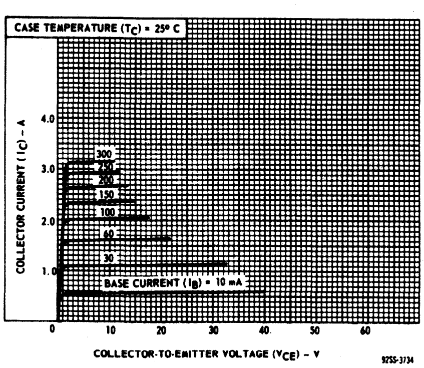


Fig. 19—Typical output characteristics for 2N5295, 2N5296, and 41504.

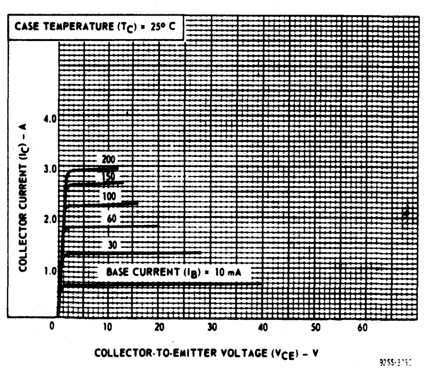


Fig. 20—Typical output characteristics for 2N5297 and 2N5298.

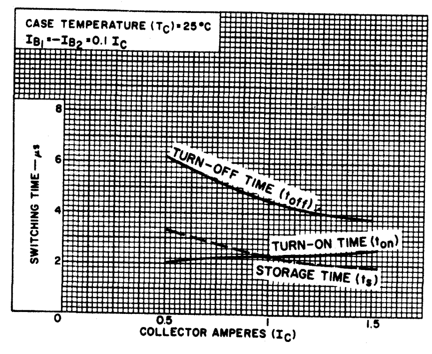


Fig. 21—Typical saturated switching characteristics for 2N5295, 2N5296, and RCA3054.

2N5320-2N5323

Complementary N-P-N & P-N-P Silicon Power Transistors

General-Purpose Types for Small-Signal, Medium-Power Applications

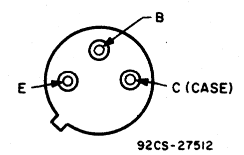
Features:

- 2N5322, 2N5323 P—N—P Complements of: 2N5320, 2N5321
- Maximum safe-area-of-operation curves
- Planar construction for low-noise and low-leakage characteristics
- Low saturation voltage
- High beta at high collector current

RCA-2N5320, 2N5321, 2N5322 and 2N5323 are double-diffused epitaxial-planar silicon power transistors intended for small-signal medium-power applications. The 2N5320 and 2N5321 n-p-n types are actually high-current, high-dissipation versions of the 2N2102 with all of the salinet features of that device. The 2N5322 and 2N5323, p-n-p complements of the 2N5320 and 2N5321, are actually high-current, high-power versions of the 2N4036 with all of its additional outstanding features. (Technical data on the 2N2102 and 2N4036 are shown on pages 29 and 71, respectively).

The devices are supplied in the JEDEC TO-39 hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5321	2N5323	2N5320	2N5322	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	75	-75	100	-100	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With 1.5 volts (V_{BE}) of reverse bias	$V_{CEV}(sus)$	75	-75	100	-100	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	65	-65	90	-90	V
* With base open	$V_{CEO}(sus)$	50	-50	75	-75	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	-5	7	-7	V
* COLLECTOR CURRENT	I_C	2	-2	2	-2	A
* BASE CURRENT	I_B	1	-1	1	-1	A
* TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25° C		10	10	10	10	W
At case temperatures above 25° C		Figs. 2 and 8 Derate linearly at 0.057 W/°C				
* TEMPERATURE RANGE:						
Storage and operating (Junction)		-65 to + 200				°C
* LEAD TEMPERATURE (During soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max		230				°C

*In accordance with JEDEC registration data format (JS-6 RDF-1)

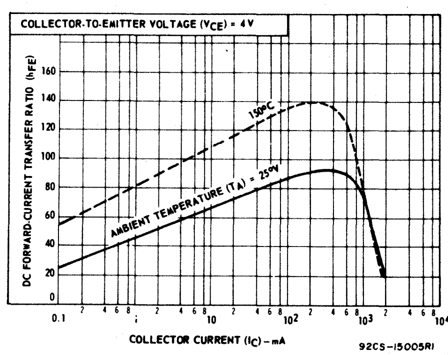


Fig. 1 - Typical static beta characteristics for types 2N5320 and 2N5321.

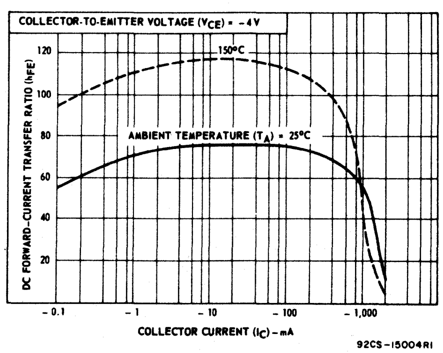


Fig. 3 - Typical static beta characteristics for 2N5322 and 2N5223.

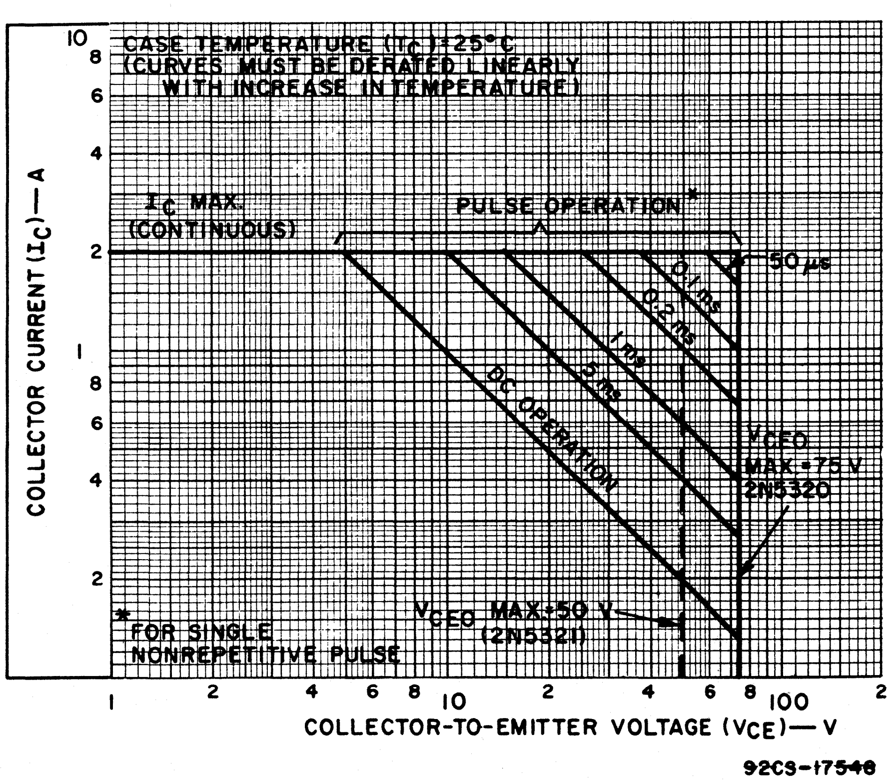


Fig. 2 - Maximum operating areas for 2N5320 and 2N5321.

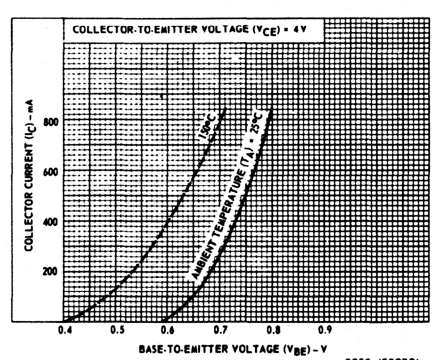


Fig. 4 - Typical transfer characteristics for 2N5320 and 2N5321.

2N5320-2N5323

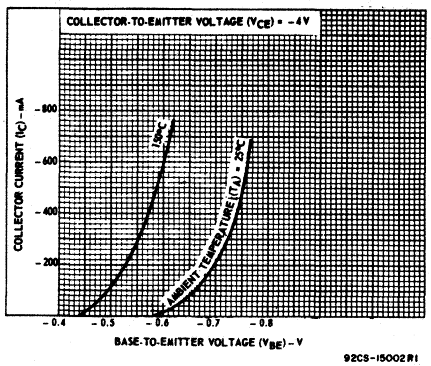


Fig. 5 - Typical transfer characteristics for 2N5322 and 2N5323.

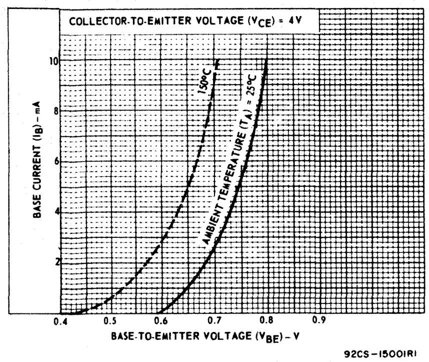


Fig. 6 - Typical input characteristics for 2N5320 and 2N5321.

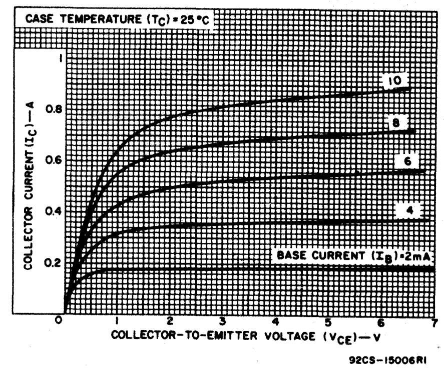


Fig. 7 - Typical output characteristics for 2N5320 and 2N5321.

ELECTRICAL CHARACTERISTICS, ***Case Temperature (T_C) = 25° C Unless Otherwise Specified***

CHARACTERISTIC	Symbol	TEST CONDITIONS DC Voltage V			DC Current mA		LIMITS Type 2N5320		Type 2N5321		Type 2N5322		Type 2N5323		Units
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With base open (I_E = 0)	I_{CBO}	80					-	0.5	-	-	-	-	-	-	µA
		60					-	-	-	5	-	-	-	-	
		-80					-	-	-	-	-	-0.5	-	-	
		-60					-	-	-	-	-	-	-	-5	
* With base-emitter Junction reverse biased	I_{CEX}		100	-1.5			-	0.1	-	-	-	-	-	-	mA
			75	-1.5			-	-	-	0.1	-	-	-	-	
			-100	1.5			-	-	-	-	-	-0.1	-	-	
			-75	1.5			-	-	-	-	-	-	-	-0.1	
T_C=150°C			70	-1.5			-	5	-	-	-	-	-	-	mA
			45	-1.5			-	-	-	5	-	-	-	-	
			-70	1.5			-	-	-	-	-	-5	-	-	
			-45	1.5			-	-	-	-	-	-	-	-5	
* Emitter-Cutoff Current	I_{EBO}			-7	0		-	0.1	-	-	-	-	-	-	mA
				-5	0		-	-	-	0.1	-	-	-	-	
				7	0		-	-	-	-	-	-0.1	-	-	
				5	0		-	-	-	-	-	-	-	-0.1	
				-5	0		-	0.1	-	-	-	-	-	-	µA
				-4	0		-	-	-	0.5	-	-	-	-	
				5	0		-	-	-	-	-	-0.1	-	-	
				4	0		-	-	-	-	-	-	-	-0.5	
Collector-to-Emitter Breakdown Voltage: With base-emitter junction reverse biased	$V_{(BR)CEV}$			-1.5	0.1		100	-	75	-	-	-	-	-	V
				1.5	-0.1		-	-	-	-	-100	-	-75	-	
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}$[a]				100		90	-	65	-	-	-	-	-	V
					-100		-	-	-	-	-90	-	-65	-	
* With base open	$V_{CEO(sus)}$[a]				100	0	75	-	50	-	-	-	-	-	V
					-100	0	-	-	-	-	-75	-	-50	-	
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				500	50	-	0.5	-	0.8	-	-	-	-	V
					-500	-50	-	-	-	-	-	-0.7	-	-1.2	
* Base-to-Emitter Voltage	V_{BE}		4		500		-	1.1	-	1.4	-	-	-	-	V
			-4		-500		-	-	-	-	-	-1.1	-	-1.4	
* DC Forward Current Transfer Ratio	h_{FE}[b] See NOTE		4		500		30	130	40	250	-	-	-	-	
			-4		-500		-	-	-	-	30	130	40	250	
			2		1000		10	-	-	-	-	-	-	-	
			-2		-1000		-	-	-	-	10	-	-	-	
Gain-Bandwidth Product	f_T		4		50		50	-	50	-	-	-	-	-	MHz
			-4		-50		-	-	-	-	50	-	50	-	
* Magnitude of common-emitter, small-signal, short circuit, forward current transfer ratio (f=10 MHz)	$\|h_{fe}\|$		4		50		5	-	5	-	-	-	-	-	
			-4		-50		-	-	-	-	5	-	5	-	

2N5320-2N5323

ELECTRICAL CHARACTERISTICS, (Cont'd)

CHARACTERISTIC	Symbol	TEST CONDITIONS DC Voltage V			DC Current mA		LIMITS Type 2N5320		Type 2N5321		Type 2N5322		Type 2N5323		Units
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Second Breakdown Collector Current[c,e] (With base forward biased)	$I_{S/b}$[d]		50 -35				200 -	- -	200 -	- -	- -285	- -	- -285	- -	mA
* Sat. Switching Time: (See Fig.11.) Turn-on Time	t_{on}		30 -30		500 -500	50 -50	- -	80 -	- -	80 -	- -	- 100	- -	- 100	ns
Turn-off Time	t_{off}		30 -30		500 -500	50 -50	- -	800 -	- -	800 -	- -	- 1000	- -	- 1000	ns
* Thermal Resistance: Junction-to-Case	θ_{J-C}						-	17.5	-	17.5	-	17.5	-	17.5	°C/W
Junction-to-Ambient	θ_{J-A}						-	150	-	150	-	150	-	150	°C/W

[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

[b] Pulsed; pulse duration ≤ 300 μs, duty factor ≤ 0.02.

[c] Safe operating regions for forward-bias operation are shown on pages 4 & 5.

[d] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

[e] Pulsed; 0.4s non-repetitive pulse.

*In accordance with JEDEC registration data format (JS-6 RDF-1)

NOTE: RCA 2N5320, 2N5321, 2N5322, and 2N5323 can be shipped with color dots on the device case to indicate the following ranges of beta values within the beta limits specified for each device.

Color Code	Beta Range	Color Code	Beta Range
Brown	25-38	Green	73-110
Red	33-50	Blue	95-145
Orange	43-65	Violet	125-190
Yellow	56-85	White	165-250

Specific beta distributions or beta matching are available as custom types only on special order. For further details, contact your local RCA Sales office.

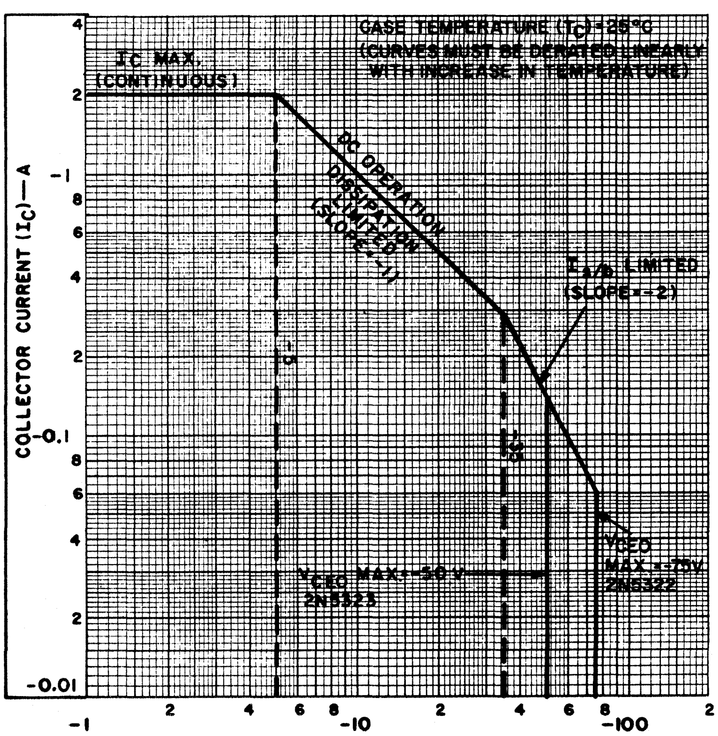


Fig. 8 - Maximum operating areas for 2N5322 and 2N5323.

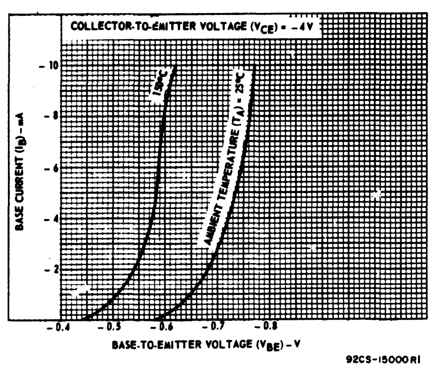


Fig. 9 - Typical input characterisitcs for 2N5322 and 2N5323.

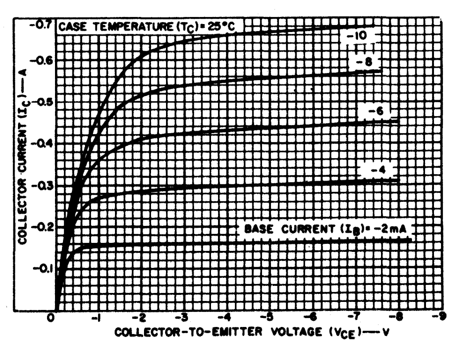


Fig. 10 - Typical output characteristics for 2N5322 and 2N5323.

2N5415, 2N5416, RCS880-RCS882

Silicon P-N-P High-Voltage Transistors

For High-Speed Switching and Linear-Amplifier Applications in Military, Industrial and Commercial Equipment

The RCA-2N5415, 2N5416 and RCS880, RCS881, and RCS882 are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds. All of these types are supplied in the JEDEC TO-39 hermetic package.

These transistors differ primarily in their voltage ratings. Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters; and high-voltage, low-current switching and series regulators.

Features:

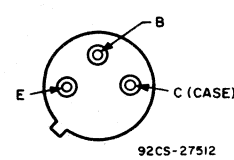
- **2N5415: p-n-p complement of 2N3440**
- **2N5415: p-n-p complement of 2N3439**
- **Maximum safe-area-of-operation curves**
- **High voltage ratings:**
  V_{CBO} = −350 V max. (2N5416)
  $V_{CEO}(sus)$ = −300 V max. (2N5416, RCS882)
  −250 V max. (RCS881)
  −200 V max. (2N5415)
  −150 V max. (RCS880)

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5415	2N5416	RCS880	RCS881	RCS882	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−200	−350	−	−250	−350	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:							
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$	−	−350	−	−	−350	V
* With base open	$V_{CEO}(sus)$	−200	−300	−150	−250	−300	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	−4	−6	−	−4	−6	V
*COLLECTOR CURRENT	I_C	−1	−1	−1	−1	−1	A
*BASE CURRENT	I_B	−0.5	−0.5	−0.5	−0.5	−0.5	A
*TRANSISTOR DISSIPATION:	P_T						
At case temperatures up to 25°C		10	10	7.5	7.5	7.5	W
At case temperatures above 25°C		Derate linearly to 200°C					
At ambient temperatures up to 50°C		1	1	0.75	0.75	0.75	W
At ambient temperatures above 50°C	Derate linearly at	6.7	6.7	5	5	5	mW/°C
*TEMPERATURE RANGE:							
Storage and Operating (Junction)		−65 to +200					°C
*LEAD TEMPERATURE (During soldering):							
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		255					°C

*2N-Series types in accordance with JEDEC registration data format (JS-9 RDF-8)

TERMINAL DESIGNATIONS



JEDEC TO-39

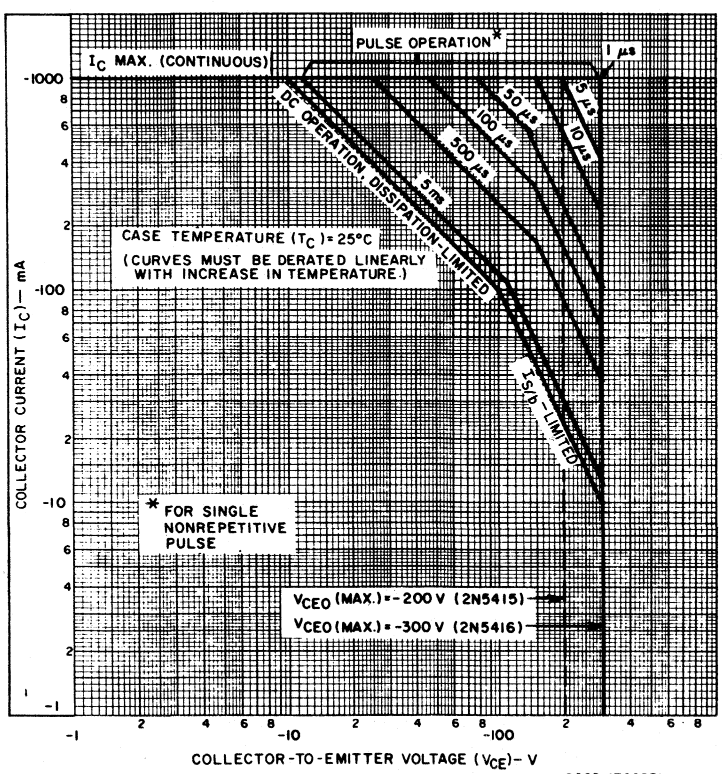


Fig. 1—Maximum safe operating areas for 2N5415 and 2N5416.

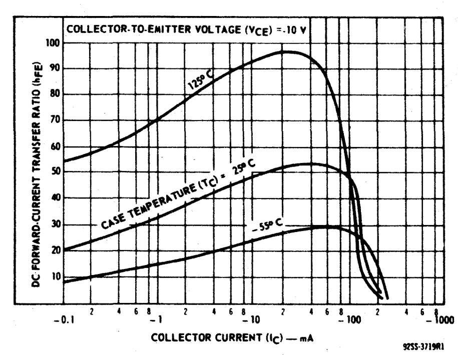


Fig. 2—Typical dc beta characteristics for all types.

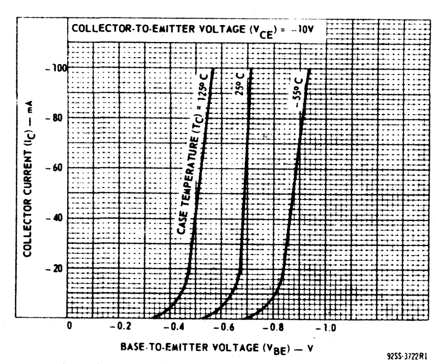


Fig. 3—Typical transfer characteristics for all types.

2N5415, 2N5416, RCS880-RCS882

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C*

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc			CURRENT mA dc		LIMITS 2N5415		2N5416		RCS880		RCS881		RCS882		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}		−250			0	–	–	–	−50	–	–	–	–	–	−50	μA
		−150			0	–	−50	–	–	–	–	–	−50	–	–	
		−100			0	–	–	–	–	–	−50	–	–	–	–	
* I_{CBO}	−280					–	–	–	−50	–	–	–	–	–	−50	μA
	−175					–	−50	–	–	–	–	–	−50	–	–	
I_{CEV}		−300	1.5			–	–	–	−50	–	–	–	–	–	−50	μA
		−200	1.5			–	−50	–	–	–	–	–	−50	–	–	
		−150	1.5							–	−100	–	–	–	–	
* I_{EBO}			6	0		–	–	–	−20	–	–	–	–	–	−20	μA
			4	0		–	−20	–	–	–	−30	–	−20	–	–	
* h_{FE}		−10		−50[b]		–	–	30	120	20	150	–	–	–	–	
		−10		−50[b]		30	150	–	–	–	–	–	–	–	–	
		−10		−35[b]		–	–	–	–	–	–	20	–	20	–	
$V_{CEO}(sus)$				−50	0	−200[a]	–	−300[a]	–	−150[a]	–	−250[a]	–	−300[a]	–	V
$V_{CER}(sus)$ (R_{BE}) = 50 Ω				−50		–	–	−350[a]	–	–	–	–	–	−350[a]	–	V
V_{BE}		−10		−50[b]		–	−1.5	–	−1.5	–	−2.5	–	−1.5	–	−1.5	V
$V_{CE}(sat)$				−50[b]	−5	–	−2.5	–	−2	–	−3.5	–	−3	–	−3	V
* h_{fe} (at 1 kHz)		−10		−5		25	–	25	–	–	–	–	–	–	–	
* $\|h_{fe}\|$ (at 5 MHz)		−10		−10		3	–	3	–	3	–	3	–	3	–	
* $Re(h_{ie})$ (at 1 MHz)		−10		−5		–	300	–	300	–	–	–	300	–	300	Ω
* C_{ib} (at 1 MHz)			5	0		–	75	–	75	–	–	–	75	–	75	pF
* C_{ob} (at 1 MHz)	−10					–	15	–	15	–	–	–	15	–	15	pF
$I_{S/b}$ t_p = 0.4 s nonrep.		−100				−100	–	−100	–	–	–	–	–	–	–	mA
		−75				–	–	–	–	–	–	−100	–	−100	–	
t_p = 0.2 s nonrep.		−75				–	–	–	–	−100	–	–	–	–	–	
$R_{\theta JC}$						–	17.5	–	17.5	–	23.3	–	23.3	–	23.3	°C/W

* 2N-Series types in accordance with JEDEC registration data format (JS-9 RDF-8).

[a] CAUTION: The sustaining voltages V_{CEO}(sus and V_{CER}(sus) MUST NOT be measured on a curve tracer.

[b] Pulsed: Pulse = 300 μs; duty factor ≤2%.

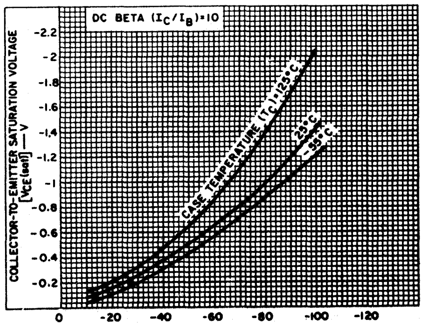


Fig. 4–Typical collector-to-emitter saturation voltage for all types.

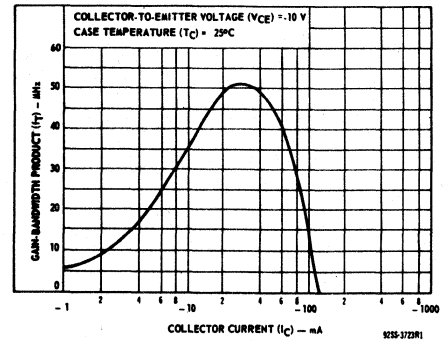


Fig. 5–Typical gain-bandwidth product for all types.

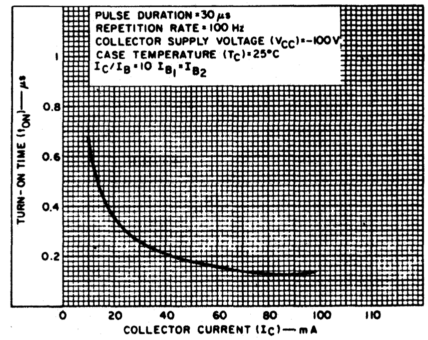


Fig. 6–Typical turn-on time characteristic for 2N5415 and 2N5416.

2N5415, 2N5416, RCS880-RCS882

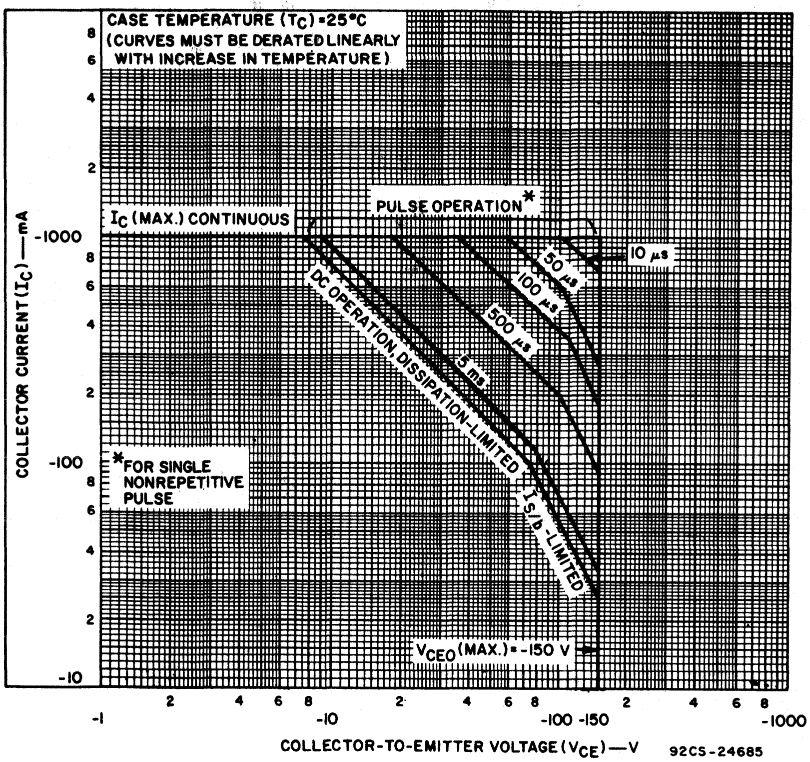


Fig. 7—Maximum safe operating areas for RCS880.

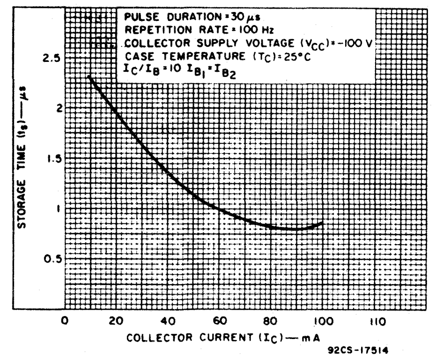


Fig. 8—Typical storage-time characteristic for 2N5415 and 2N5416.

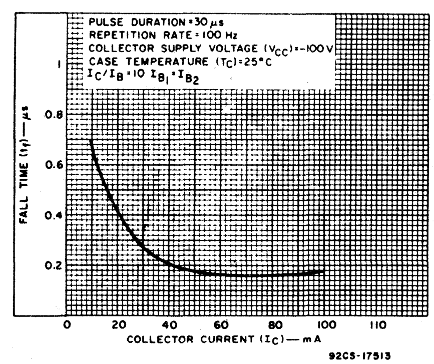


Fig. 10—Typical fall-time characteristic for 2N5415 and 2N5416

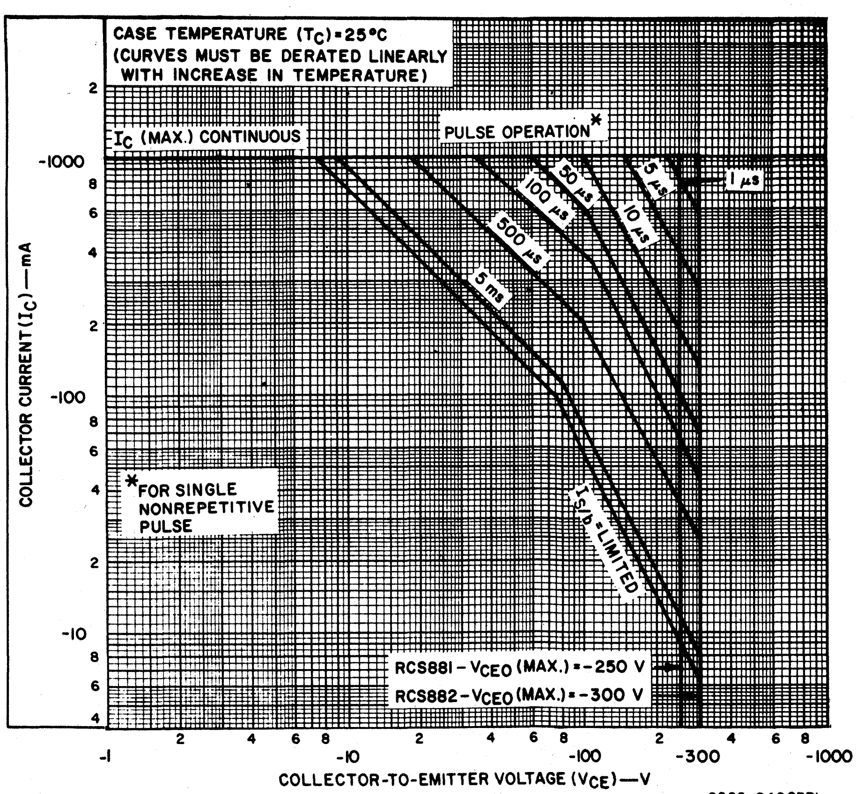


Fig. 9—Maximum safe operating areas for RCS881 and RCS882.

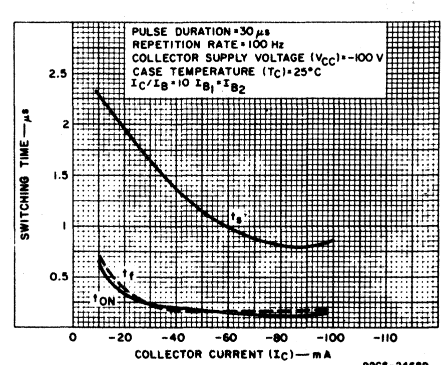


Fig. 11—Typical saturated switching times for RCS880, RCS881 and RCS882.

2N5490-2N5497

Hometaxial-Base, Silicon N-P-N VERSAWATT Transistors

General-Purpose Types for Medium-Power Switching and Amplifier Applications in Military, Industrial, and Commercial Equipment

Features:

- **Low saturation voltage—**
  - $V_{CE}(sat)$ = 1 V max. at I_C = 2 A (2N5490, 2N5491)
  - = 1 V max. at I_C = 2.5 A (2N5492, 2N5493)
  - = 1 V max. at I_C = 3 A (2N5494, 2N5495)
  - = 1 V max. at I_C = 3.5 A (2N5496, 2N5497)
- **VERSAWATT package (molded silicone plastic)**
- **Maximum safe-area-of-operation curves**

RCA-2N5490, 2N5491, 2N5492, 2N5493, 2N5494, 2N5495, 2N5496 and 2N5497* are hometaxial-base silicon n-p-n transistors. They are intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

Types 2N5491, 2N5493, 2N5495, and 2N5497 have formed emitter and base leads for insertion into TO-66 sockets. Types 2N5490, 2N5492, 2N5494, and 2N5496 are electrically identical to the 2N5491, 2N5493, 2N5495, and 2N5497 but have straight leads.

These new plastic power transistors differ in voltage ratings and in the currents at which the parameters are controlled.

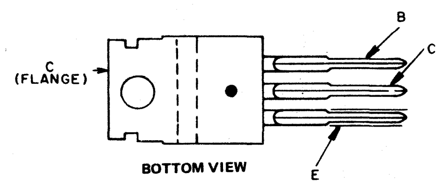
* Formerly RCA Dev. Nos. TA7317, TA7318, TA7315, TA7316, TA7313, TA7314, TA7311, TA7312, respectively.

OPTIONAL LEAD CONFIGURATION

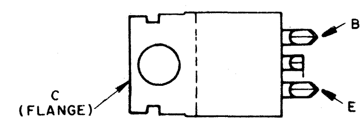
An additional lead forming for printed-circuit-board mounting is also available.

Please submit requirements to your RCA Technical Sales Representative, or write to RCA Low-Frequency Power Marketing, Somerville, N. J. 08876.

TERMINAL DESIGNATIONS



JEDEC TO-220AB
2N5490, 2N5492, 2N5494, 2N5496



JEDEC TO-220AA
2N5491, 2N5493, 2N5495, 2N5497

Maximum Ratings, *Absolute-Maximum Values:*

		2N5490 2N5491 2N5494 2N5495	2N5492 2N5493	2N5496 2N5497	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	75	90	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With -1.5 volts (V_{BE}) of reverse bias	$V_{CEV}(sus)$	60	75	90	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	50	65	80	V
With base open	$V_{CEO}(sus)$	40	55	70	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	V
COLLECTOR CURRENT	I_C	7	7	7	A
BASE CURRENT	I_B	3	3	3	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		50	50	50	W
At ambient temperatures up to 25°C		1.8	1.8	1.8	W
At case temperatures above 25°C		Derate linearly at 0.4 W/°C or see Figs. 2 & 3.			
At ambient temperatures above 25°C		Derate linearly at 0.0144 W/°C			
TEMPERATURE RANGE:					
Storage & Operating (Junction)		← -65 to 150 →			°C
LEAD TEMPERATURE (During Soldering):					
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max		← 235 →			°C

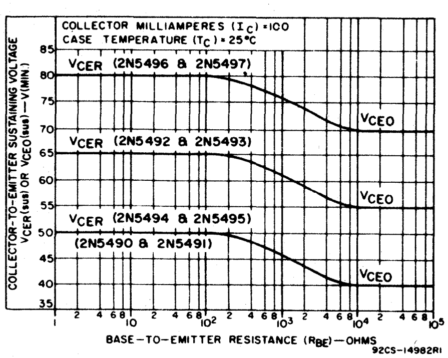


Fig. 1 - Collector-to-emitter sustaining voltage characteristics for 2N5490 through 2N5497 inclusive.

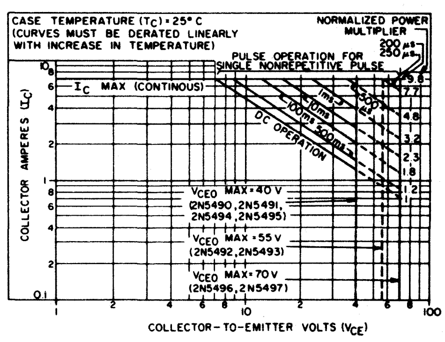


Fig. 2 - Maximum operating areas for 2N5490 through 2N5497 inclusive.

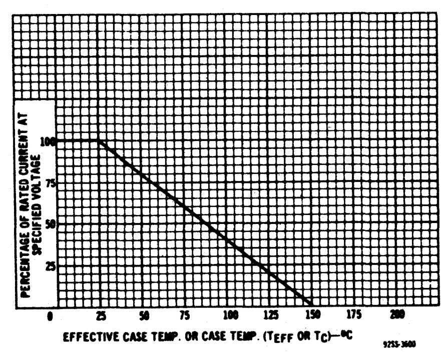


Fig. 3 - Derating curve for 2N5490 through 2N5497 inclusive.

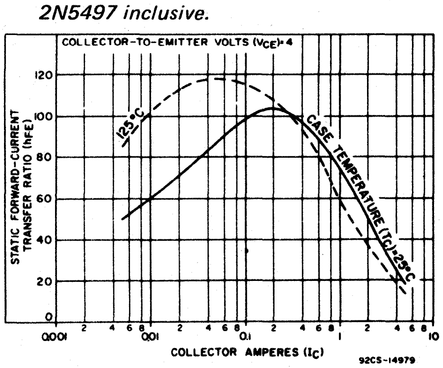


Fig. 4 - Typical static beta characteristics for 2N5496 and 2N5497.

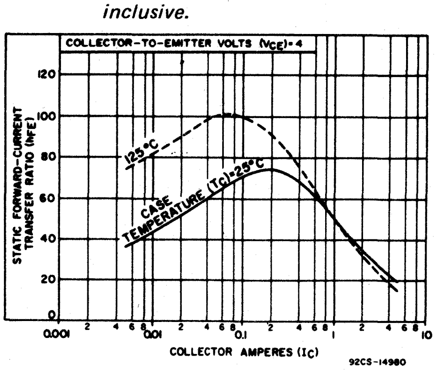


Fig. 5 - Typical static beta characteristics for 2N5494 and 2N5495.

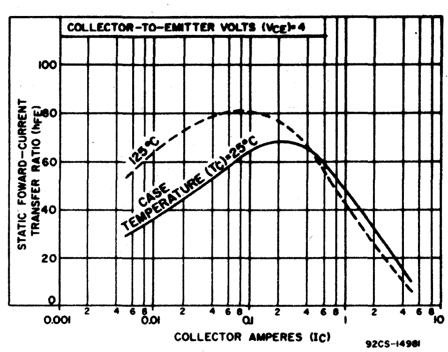


Fig. 6 - Typical static beta characteristics for 2N5490 through 2N5493 inclusive.

2N5490-2N5497

ELECTRICAL CHARACTERISTICS, ***Case Temperature (T_C) = 25°C Unless Otherwise Specified***

Characteristic	Symbol	TEST CONDITIONS: DC Voltage (V) V_{CE}	V_{BE}	DC Current (A) I_C	I_B	LIMITS: Types 2N5496 2N5497 Min.	Max.	Types 2N5494 2N5495 Min.	Max.	Types 2N5492 2N5493 Min.	Max.	Types 2N5490 2N5491 Min.	Max.	Units
Collector-Cutoff Current With base-emitter junction reverse biased	I_{CEV}	85	-1.5			-	1	-	-	-	-	-	-	mA
		55	-1.5			-	-	-	1	-	-	-	-	
		70	-1.5			-	-	-	-	-	1	-	-	
	I_{CEV} (T_C = 150°C)	85	-1.5			-	5	-	-	-	-	-	-	mA
		55	-1.5			-	-	-	5	-	-	-	-	
		70	-1.5			-	-	-	-	-	5	-	-	
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	70				-	0.5	-	-	-	-	-	-	mA
		40				-	-	-	0.5	-	-	-	2	
		55				-	-	-	-	-	0.5	-	-	
	I_{CER} (T_C = 150°C)	70				-	3.5	-	-	-	-	-	-	mA
		40				-	-	-	3.5	-	-	-	5	
		55				-	-	-	-	-	3.5	-	-	
Emitter-Cutoff Current	I_{EBO}		-5			-	1	-	1	-	1	-	1	mA
DC Forward-Current Transfer Ratio	h_{FE}[c]	4		3.5		20	100	-	-	-	-	-	-	
		4		3		-	-	20	100	-	-	-	-	
		4		2.5		-	-	-	-	20	100	-	-	
		4		2		-	-	-	-	-	-	20	100	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$[c]			0.1	0	70	-	40	-	55	-	40	-	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$[c]			0.1		80	-	50	-	65	-	50	-	V
With base-emitter junction reverse biased	$V_{CEV}(sus)$[c]		-1.5	0.1		90	-	60	-	75	-	60	-	V
Base-to-Emitter Voltage	V_{BE}[c]	4		3.5		-	1.7	-	-	-	-	-	-	V
		4		3		-	-	-	1.5	-	-	-	-	
		4		2.5		-	-	-	-	-	1.3	-	-	
		4		2		-	-	-	-	-	-	-	1.1	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$[c]			3.5	0.35	-	1	-	-	-	-	-	-	V
				3	0.3	-	-	-	1	-	-	-	-	
				2.5	0.25	-	-	-	-	-	1	-	-	
				2	0.2	-	-	-	-	-	-	-	1	
Gain-Bandwidth Product	f_T	4		0.5		0.8	-	0.8	-	0.8	-	0.8	-	MHz
Sat. Switching Time: Turn-On	t_{on}	V_{CC} = 30		3.5	0.35[a]	-	5	-	-	-	-	-	-	μs
				3	0.3[a]	-	-	-	5	-	-	-	-	
				2.5	0.25[a]	-	-	-	-	-	5	-	-	
				2	0.2	-	-	-	-	-	-	-	5	
Turn-Off	t_{off}	V_{CC} = 30		3.5	0.35[b]	-	15	-	-	-	-	-	-	μs
				3	0.3[b]	-	-	-	15	-	-	-	-	
				2.5	0.25[b]	-	-	-	-	-	15	-	-	
				2	0.2	-	-	-	-	-	-	-	15	
Thermal Resistance: Junction-to-Case	$\theta_{J\text{-}C}$					-	2.5	-	2.5	-	2.5	-	2.5	°C/W
Junction-to-Ambient	$\theta_{J\text{-}A}$					-	70	-	70	-	70	-	70	°C/W

[a] I_{B1} value (turn-on base current). [b] I_{B2} value (turn-off base current). [c] Pulsed, pulse duration = 300 μs, duty factor = .018.

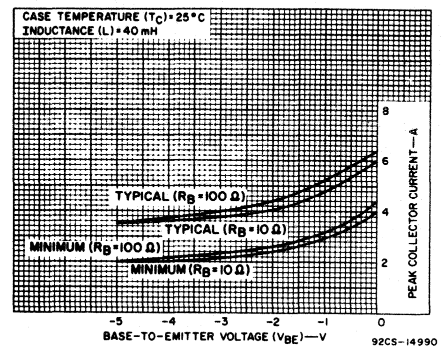


Fig. 7 - Reverse-bias, second-breakdown characteristics for 2N5490 through 2N5497 inclusive.

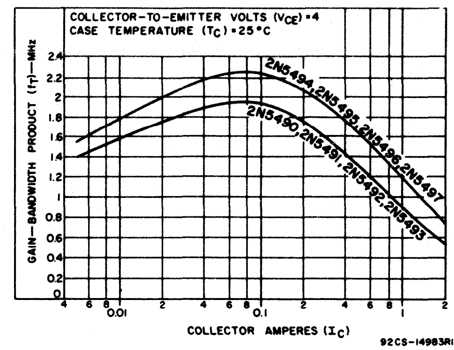


Fig. 8 - Typical gain-bandwidth product for 2N5490 through 2N5497 inclusive.

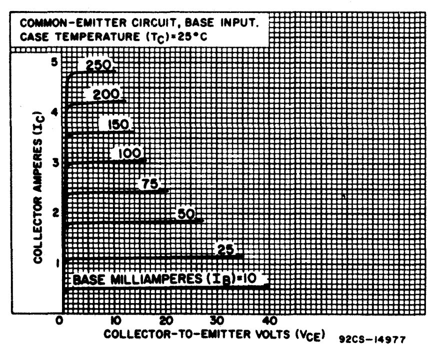


Fig. 9 - Typical output characteristics for 2N5494 through 2N5497 inclusive.

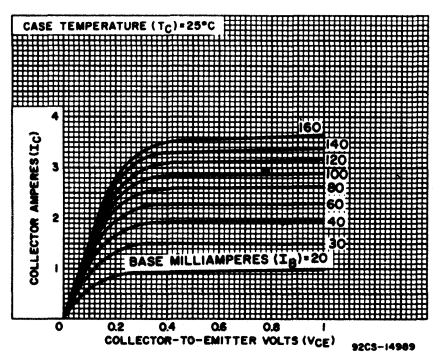


Fig. 10 - Typical output characteristics for 2N5494 and 2N5495.

2N5490-2N5497

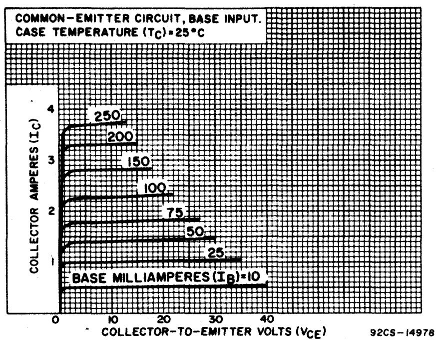


Fig. 11 - Typical output characteristics for 2N5490 through 2N5493 inclusive.

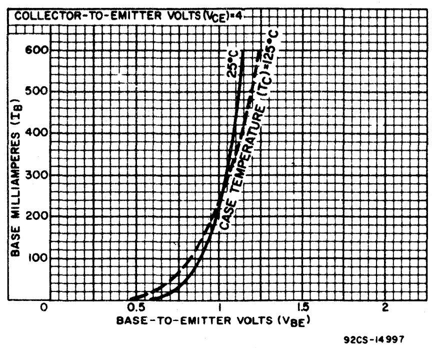


Fig. 12 - Typical input characteristics for 2N5494 through 2N5497 inclusive.

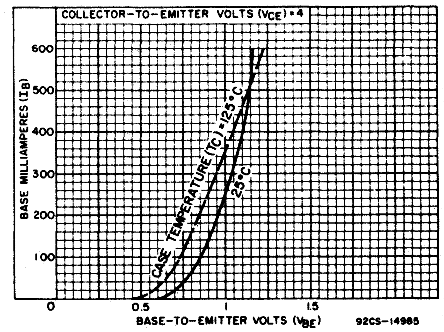


Fig. 13 - Typical input characteristics for 2N5490 through 2N5493 inclusive.

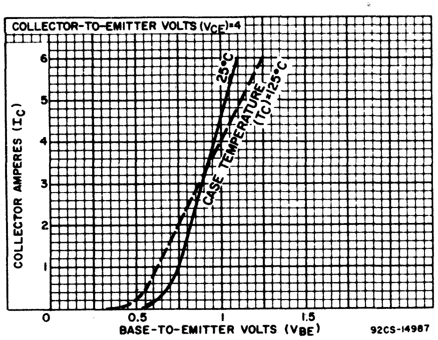


Fig. 14 - Typical transfer characteristics for 2N5494 through 2N5497 inclusive.

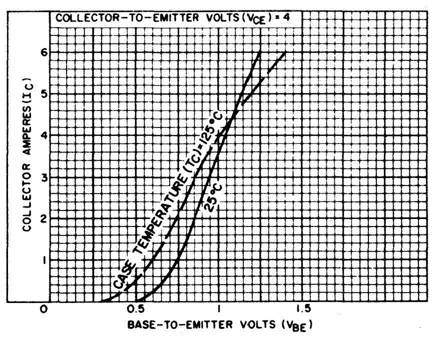


Fig. 15 - Typical transfer characteristics for 2N5490 through 2N5493 inclusive.

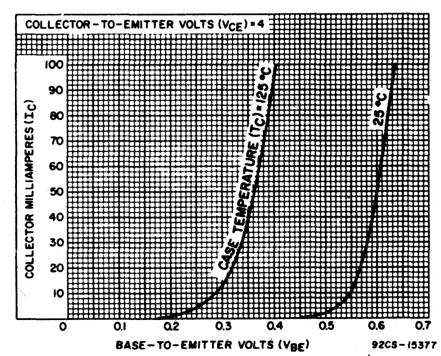


Fig. 16 - Typical transfer characteristics for 2N5490 through 2N5497 inclusive.

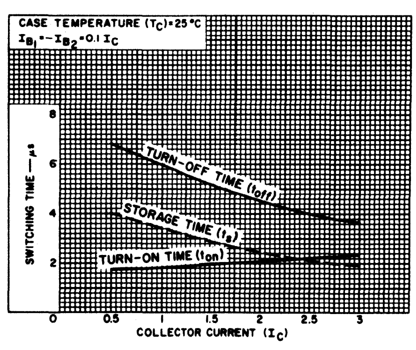


Fig. 17 - Typical saturated switching characteristics for 2N5494 and 2N5495.

2N5575, 2N5578

High-Current, High-Power, Hometaxial-Base Silicon N-P-N Transistors

For Linear and Switching Applications in Military, Commercial, and Industrial Equipment

Features:
- Maximum safe-area-of operation curves
- $I_{S/b}$-limit line beginning at 25 V
- High-current capability
- Low saturation voltage at high beta
- High-dissipation capability
- Low thermal resistance

RCA-2N5575 and 2N5578● are high-current, high-power, hometaxial-base silicon n-p-n transistors. They differ in maximum voltage and current ratings.

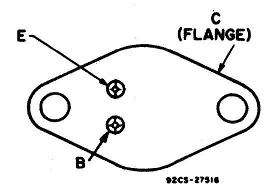
These power transistors are intended for a wide variety of high-current, high-power linear and switching applications such as low- to medium-frequency amplifiers, switching and linear regulators, power-switching circuits, series- or shunt-regulator driver and output stages, dc-to-dc converters, inverters, control circuits, and solenoid (hammer)/relay drivers.

The high-current capability (100-A peak) makes these types particularly suitable for circuit designs that now require several low-current types connected in parallel.

They are supplied in the Modified JEDEC TO-3 package with 0.060-In. Dia. Pins.

● Formerly RCA Dev. Nos. TA7016 and TA7017, respectively.

TERMINAL DESIGNATIONS



Modified JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	Symbol	2N5575	2N5578	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	70	90	V
*COLLECTOR-TO-EMITTER VOLTAGE:				
With base open, sustaining	$V_{CEO}(sus)$	50	70	V
With external base-to-emitter resistance (R_{BE}) = 10 Ω & V_{BE} = −1.5 V	V_{CEX}	70	90	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	8	8	V
*COLLECTOR CURRENT (Continuous)	I_C	80	60	A
*COLLECTOR CURRENT (Peak)		100	80	A
*BASE CURRENT (Continuous)	I_B	20	15	A
*TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C and V_{CE} up to 25 V		300	300	W
At case temperatures of 100°C and V_{CB} of 25 V		150	150	W
At case temperatures up to 25°C and V_{CE} above 25 V		See Fig. 5		
At case temperatures above 25°C and V_{CE} above 25 V		See Figs. 1 & 5		
*TEMPERATURE RANGE:				
Operating (Junction)		−65 to 175		°C
Storage		−65 to 200		°C
*PIN TEMPERATURE (During Soldering):				
At distance ≥ 1/32 in. (0.8 mm) from case for 10 s max.		230		°C

* In accordance with JEDEC registration data format JS-6 RDF-1.

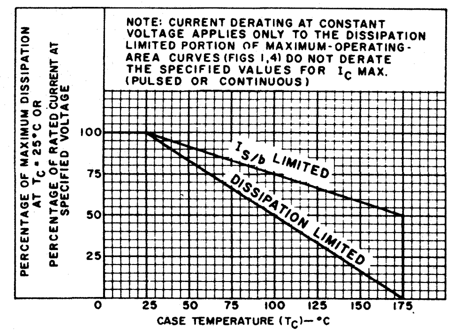


Fig. 1 - Dissipation derating curves for both types.

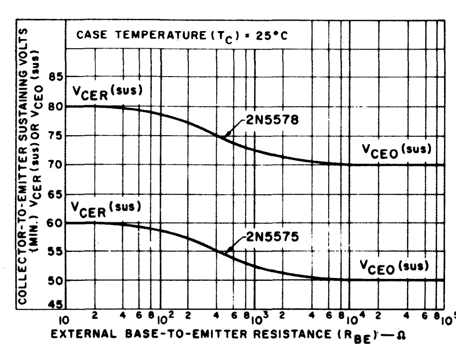


Fig. 2 - Collector-to-emitter sustaining voltage characteristics for both types.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS Voltage V dc V_{CE}	V_{BE}	Current A dc I_C	I_B	LIMITS 2N5575 Min.	Max.	2N5578 Min.	Max.	UNITS
* Collector Cutoff Current: With base-emitter junction reverse-biased	I_{CEV}	60 80	−1.5 −1.5			– –	10 –	– –	– 10	mA
With external base-emitter resistance (R_{BE})=10 Ω	I_{CER}	50 70				– –	10 –	– –	– 10	mA
* With base-emitter junction reverse-biased	I_{CEV} (T_C=150°C)	60 80	−1.5 −1.5			– –	20 –	– –	– 20	mA
* Emitter Cutoff Current	I_{EBO}		−8			–	10	–	10	mA
* Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$			0.2	0	50	–	70	–	
* DC Forward Current Transfer Ratio	h_{FE}[a]	3 4		40[a] 60[a]		– 10	– 40	10 –	40 –	
Collector-to-Emitter Sustaining Voltage: (See Figs. 5 and 6) With base open	$V_{CEO}(sus)$			0.2		50[b]	–	70[b]	–	V
With base-emitter junction reverse-biased, R_{BE}=10 Ω	$V_{CEX}(sus)$		−1.5	0.2		70[b]	–	90[b]	–	V
Base-to-Emitter Voltage	V_{BE}[a]	4 4		40[a] 60[a]		– –	– 3	– –	2.5 –	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$[a]			40[a] 60[a]	4 6	– –	– 2	– –	1.5 –	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$[a]			40[a] 60[a]	4 6	– –	– 3	– –	2.5 –	V
Output Capacitance: (V_{CB} = 10 V)	C_{ob}					–	2000	–	2000	pF
Input Capacitance	C_{ib}		−0.5	0		–	4000	–	4000	pF
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f=0.2 MHz)	$\|h_{fe}\|$	4		10		2	–	2	–	

2N5575, 2N5578

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified (Cont'd.)*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS Voltage V dc		Current A dc		LIMITS 2N5575		2N5578		UNITS
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
* Saturated Switching Time (V_{CC} = 30 V):				40	4	–	–	–	10	μs
Turn-on time	t_{ON}			60	6	–	15	–	–	
Turn-off time	t_{OFF}			40	4	–	–	–	10	
				60	6	–	15	–	–	
Forward-Bias Second-Breakdown Collector Current (t = 1 s)	$I_{S/b}$	25				12	–	12	–	A
Second Breakdown Energy (With base reverse-biased, R_{BE} = 10 Ω, L = 33 mH)	$E_{S/b}$		-1.5	7		0.8	–	0.8	–	J
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$					–	0.5	–	0.5	°C/W

[a]Pulsed; pulse duration ≤ 350 μs, duty factor=0.02.

[b]CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CEX}(sus) MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 5.

*In accordance with JEDEC registration data format JS-6 RDF-1.

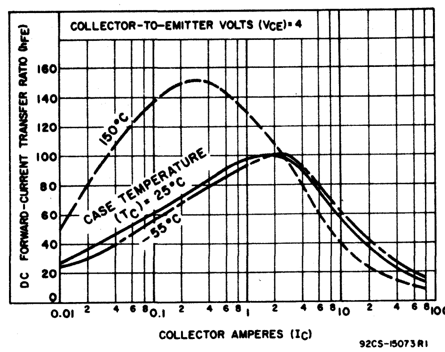


Fig. 3 - Typical dc beta characteristics for 2N5575.

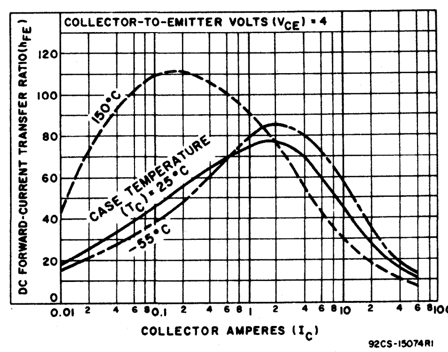


Fig. 4 - Typical dc beta characteristics for 2N5578.

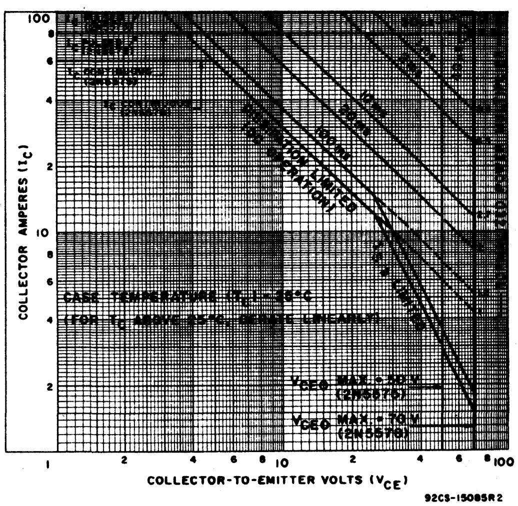


Fig. 5 - Maximum operating areas for both types.

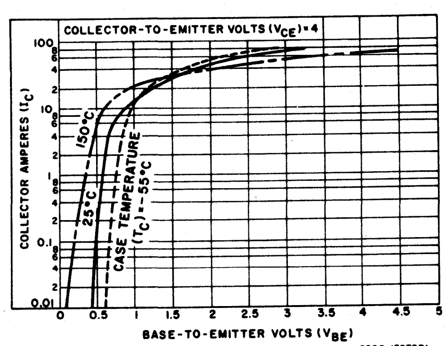


Fig. 6 - Typical transfer characteristics for 2N5575.

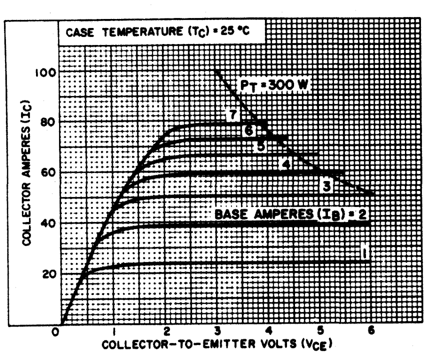


Fig. 7 - Typical output characteristics for 2N5575.

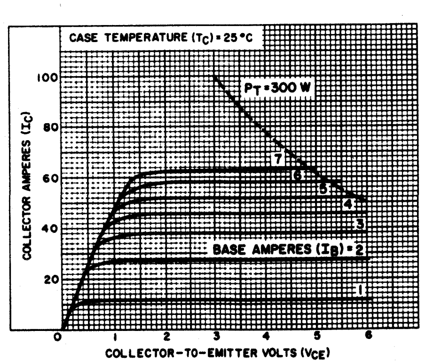


Fig. 8 - Typical output characteristics for 2N5578.

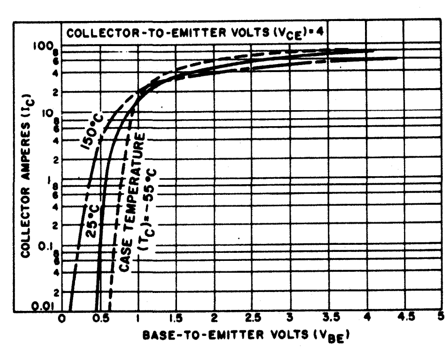


Fig. 9 - Typical transfer characteristics for 2N5578.

2N5575, 2N5578

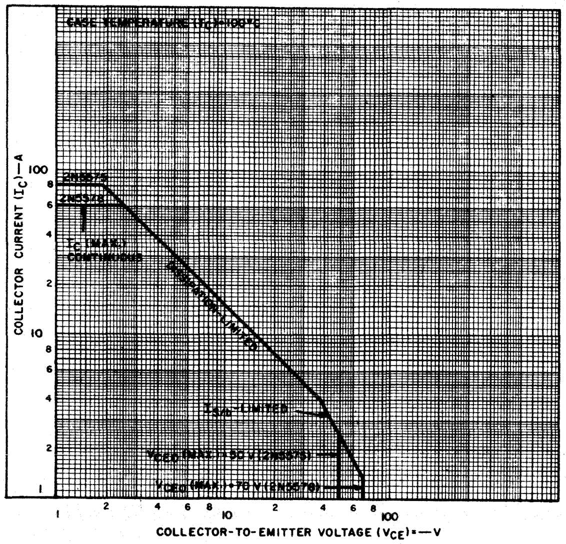


Fig. 10 - Maximum operating areas for both types at $T_C = 100^oC$.

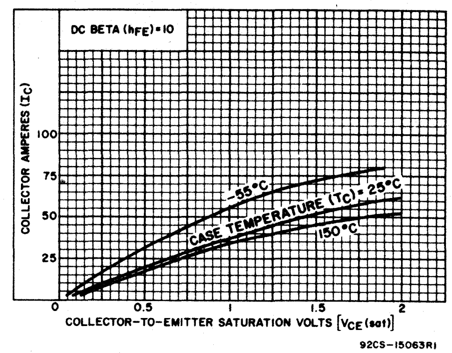


Fig. 11 - Typical saturation voltage characteristics for 2N5575.

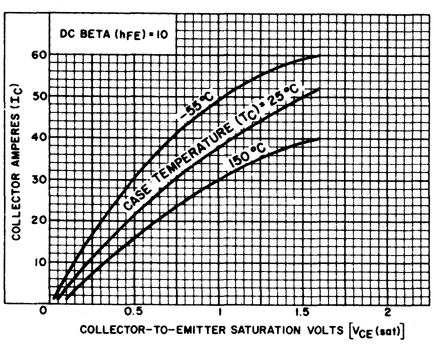


Fig. 12 - Typical saturation voltage characteristics for 2N5578.

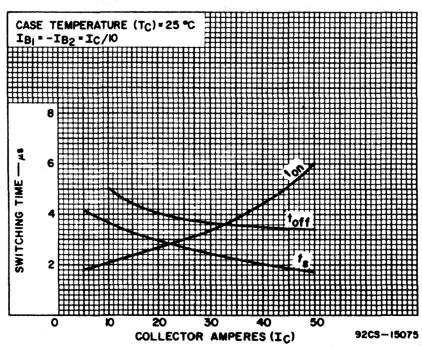


Fig. 13 - Typical saturated switching characteristics for both types.

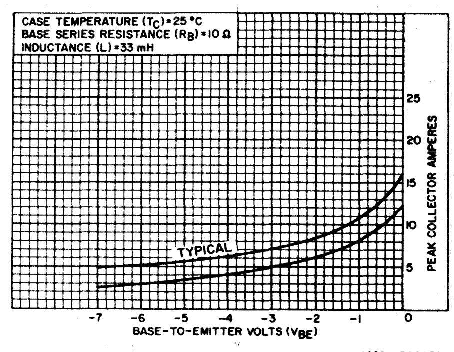


Fig. 14 - Reverse-bias second-breakdown characteristics for both types.

2N5671, 2N5672
SILICON N-P-N POWER TRANSISTORS

High-Current, High-Speed, High-Power Types for Switching and Amplifier Applications

RCA Types 2N5671 and 2N5672▲ are epitaxial silicon n-p-n transistors having high current and high power handling capability and fast switching speed. The 2N5672 is similar to the 2N5671 except that it has higher voltage ratings and lower leakage currents. These devices are especially suitable for switching-control amplifiers, power gates, switching regulators, power-switching circuits, converters, inverters, control circuits. Other recommended applications included DC-RF amplifiers and power oscillators.

They are supplied in the JEDEC TO-3 hermetic steel package.

▲Formerly Dev. Types TA7323 and TA7323A, respectively

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

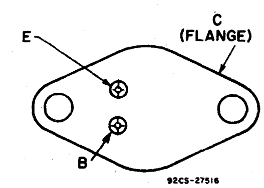
	2N5671	2N5672	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open, $V_{CEO}(sus)$	90	120	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω, $V_{CER}(sus)$	110	140	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω & V_{BE} = -1.5, $V_{CEX}(sus)$	120	150	V
*EMITTER-TO-BASE VOLTAGE, V_{EBO}	7	7	V
*COLLECTOR CURRENT, I_C	30	30	A
*BASE CURRENT, I_B	10	10	A
*TRANSISTOR DISSIPATION, P_T:			
At case temperatures up to 25° C and V_{CE} up to 24 V	140	140	W
At case temperatures up to 25° C and V_{CE} above 24 V	See Fig. 1		
At case temperatures above 25° C and V_{CE} above 24 V	See Figs. 1&2.		
*TEMPERATURE RANGE:			
Storage & Operating (Junction)	-65 to +200		°C
*PIN TEMPERATURE (During Soldering)			
At distances ≥ 1/32 in. from seating plane for 10 s max	230		°C

*In accordance with JEDEC registration data format (JS-6, RFD-1)

Features:

- Maximum Safe-Area-of-Operation Curves . . . $I_{S/b}$ limit line beginning at 24 V
- Fast Turn-On Time . . . t_{on} = 0.5µs max. at I_C = 15 A
- High-Current Capability . . . h_{FE}, $V_{CE}(sat)$, $V_{BE}(sat)$, & V_{BE} measured at I_C = 15 A
- Low $V_{CE}(sat)$ = 0.75 V max.
- High P_T = 140 W max. at T_C = 25° C

TERMINAL DESIGNATIONS



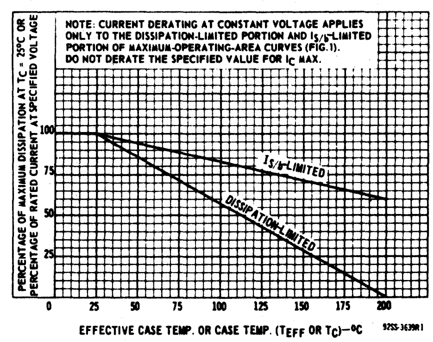


Fig. 2 - Dissipation derating curves for types 2N5671 and 2N5672.

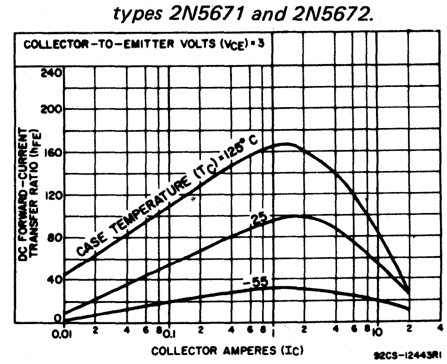


Fig. 3 - Typical dc beta characteristics for types 2N5671 and 2N5672.

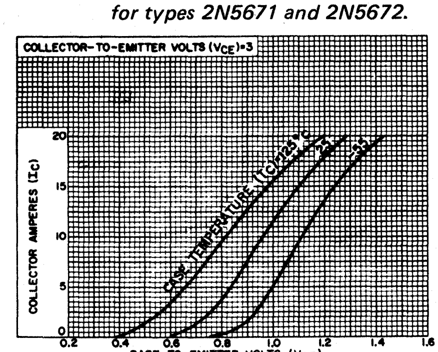


Fig. 4 - Typical transfer characteristics for types 2N5671 and 2N5672.

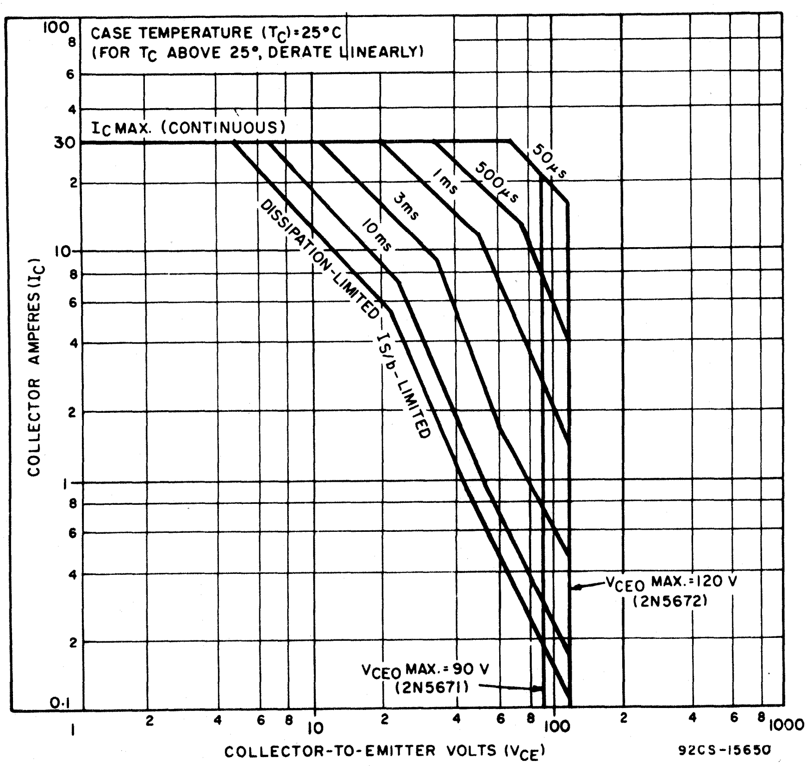


Fig. 1 - Maximum operating areas for types 2N5671 and 2N5672.

2N5671, 2N5672

ELECTRICAL CHARACTERISTICS, ***Case Temperature (T_C) = 25°C Unless Otherwise Specified***

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Voltage (V)			TEST CONDITIONS: DC Current (A)		LIMITS: Type 2N5671		LIMITS: Type 2N5672		UNITS
		V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current	I_{CEO}	–	80	–	–	0	–	10	–	10	mA
*	I_{CEV}	–	110	–1.5	–	–	–	12	–	–	mA
*			135	–1.5	–	–	–	–	–	10	mA
	I_{CEV} (T_C=150° C)	–	100	–1.5	–	–	–	15	–	10	mA
* Emitter-Cutoff Current	I_{EBO}	–	–	–7	0	–	–	10	–	10	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$	–	–	–	0.2	0	90[a]	–	120[a]	–	V
With external base-to-emitter resistance (R_{BE}) ≤50 Ω	$V_{CER}(sus)$	–	–	–	0.2	0	110[a]	–	140[a]	–	V
With base-emitter junction reverse biased & R_{BE} ≤ 50 Ω	$V_{CEX}(sus)$	–	–	–1.5	0.2	–	120[a]	–	150[a]	–	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	–	–	–	15	1.2	–	1.5	–	1.5	V
Base-to-Emitter Voltage	V_{BE}	–	5	–	15	–	–	1.6	–	1.6	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	–	–	–	15	1.2	–	0.75	–	0.75	V
* DC Forward-Current Transfer Ratio	h_{FE}	–	2	–	15	–	20	100	20	100	
		–	5	–	20	–	20	–	20	–	
Second-Breakdown Collector Current[c] With base forward biased	$I_{S/b}$[b]	–	24	–	–	–	5.8[c]	–	5.8[c]	–	A
		–	45	–	–	–	0.9[c]	–	0.9[c]	–	A
Second-Breakdown Energy With base reverse biased R_{BE} = 20 Ω, L = 180 μH	$E_{S/b}$[d]	–	–	–4	15	–	20	–	20	–	mJ
Gain-Bandwidth Product	f_T	–	10	–	2	–	50	–	50	–	MHz
Output Capacitance (At 1 MHz, I_E= 0)	C_{ob}	10	–	–	–	–	–	900	–	900	pF
* Saturated Switching Turn-On Time (Delay Time + Rise Time)	t_{on}	V_{CC}= 30 V	–	–	15	I_{B1}= I_{B2}= 1.2	–	0.5	–	0.5	μs
* Saturated Switching Storage Time	t_s	V_{CC}= 30 V	–	–	15	I_{B1}= I_{B2}= 1.2	–	1.5	–	1.5	μs
* Saturated Switching Fall Time	t_f	V_{CC}= 30 V	–	–	15	I_{B1}= I_{B2}= 1.2	–	0.5	–	0.5	μs
Thermal Resistance (Junction-to-Case)	θ_{J-C}	–	40	–	0.5	–	–	1.25	–	1.25	°C/W

[a]Pulsed; pulse duration ≤ 350 μs, duty factor=0.02.

[b]CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 5.

[c]$I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.

[d]Pulsed; 1-s, non-repetitive pulse.

[e]$E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b}=1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

*In accordance with JEDEC registration data format JS-6 RDF-1.

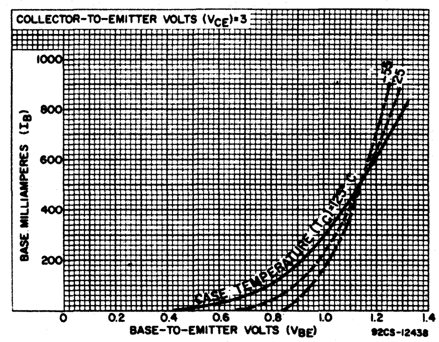


Fig. 5 - Typical input characteristics for types 2N5671 and 2N5672.

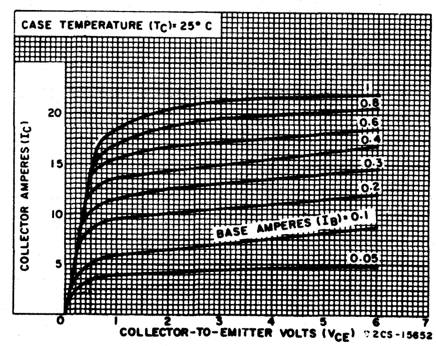


Fig. 6 - Typical output characteristics for types 2N5671 and 2N5672.

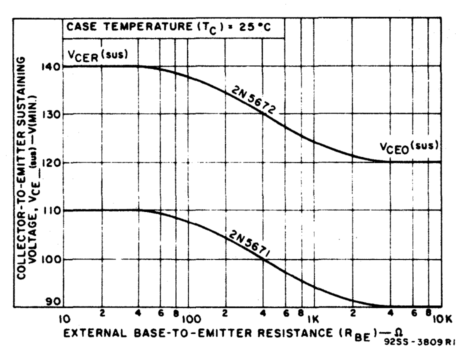


Fig. 7 - Collector-to-emitter sustaining voltage characteristics for types 2N5671 and 2N5672.

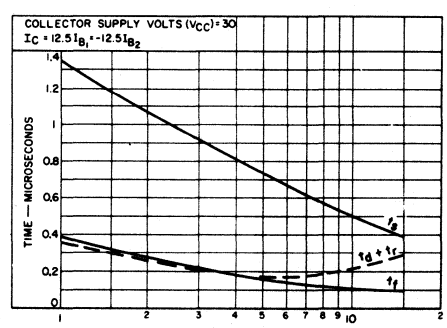


Fig. 8 - Typical saturated switching characteristics for types 2N5671 and 2N5672.

2N5781-2N5786

Silicon N-P-N and P-N-P Epitaxial-Base Complementary-Symmetry Transistors

General-Purpose Types for Switching and Linear-Amplifier Applications

RCA-2N5781, 2N5782, and 2N5783 are epitaxial-base silicon p-n-p transistors - - complements of the hometaxial-base silicon n-p-n types 2N5784, 2N5785, and 2N5786,• respectively.

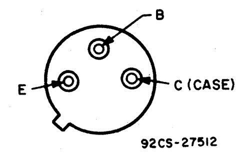
The three types in each family differ primarily in voltage ratings and saturation characteristics.

These transistors are intended for medium-power switching and complementary-symmetry audio amplifier applications.

• Formerly RCA Dev. Types TA7270, TA7271, TA7272, TA7289, TA7290, and TA7291 respectively.

Features:
- Low saturation voltages
- Maximum safe-area-of-operation curves
- Hermetically sealed package
- High gain at high current
- High breakdown voltages

TERMINAL DESIGNATIONS



JEDEC TO-5 or TO-39

These devices are available with either 1½-inch leads (TO-5 package) or ½-inch leads (TO-39 package). The longer-lead versions are specified by suffix "L" after the type number; the shorter-lead versions are specified by suffix "S" after the type number.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		P-N-P: 2N5781♦ / N-P-N: 2N5784	P-N-P: 2N5782♦ / N-P-N: 2N5785	P-N-P: 2N5783♦ / N-P-N: 2N5786	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	80	65	45	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
* With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	80	65	45	V
With base open	$V_{CEO}(sus)$	65	50	40	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	3.5	V
*CONTINUOUS COLLECTOR CURRENT	I_C	3.5	3.5	3.5	A
*CONTINUOUS BASE CURRENT	I_B	1	1	1	A
*TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		10	10	10	W
At ambient temperatures up to 25°C		1	1	1	W
At case temperatures above 25°C ... Derate linearly		0.057 W/°C, or see Fig. 1			
At ambient temperatures above 25°C ... Derate linearly		0.0057			W/°C
*TEMPERATURE RANGE:					
Storage and operating (Junction)		−65 to +200			°C
*LEAD TEMPERATURE (During soldering):					
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230			°C

*In accordance with JEDEC registration data format JS-6 RDF-2.

♦For p-n-p devices, voltage and current values are negative.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5781 p-n-p Min.	Max.	2N5784 n-p-n Min.	Max.	UNITS
	Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	65				–	−10	–	10	μA
	At T_C = 150°C	I_{CER}	65				–	−1	–	1	mA
*	With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CEX}	−75 75	1.5 −1.5			– –	−10 –	– –	– 10	μA
*	At T_C = 150°C	I_{CEX}	−75 75	1.5 −1.5			– –	−1 –	– –	– 1	mA
*	With base open	I_{CEO}	50			0	–	−100	–	100	μA
*	Emitter Cutoff Current	I_{EBO}		−5	0		–	−10	–	10	μA
*	DC Forward-Current Transfer Ratio	h_{FE}	2 2		1[a] 3.2[a]		20 4	100 –	20 4	100 –	
*	Collector-to-Emitter Sustaining Voltage (see Figs, 2 and 3): With base open	$V_{CEO}(sus)$			0.1[a]	0	−65[b]	–	65[b]	–	V
	With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1[a]		−80[b]	–	80[b]	–	V
*	Base-to-Emitter Voltage	V_{BE}	2		1[a]		–	−1.5	–	1.5	V
*	Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case)[c]	$V_{CE}(sat)$			1[a]	0.1	–	−0.5	–	0.5	V
*	Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio[d] f = 4 MHz	$\|h_{fe}\|$	−2		−0.1		2	15	–	–	
	f = 200 kHz	$\|h_{fe}\|$	2		0.1				5	20	
*	Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	2		0.1		25	–	25	–	

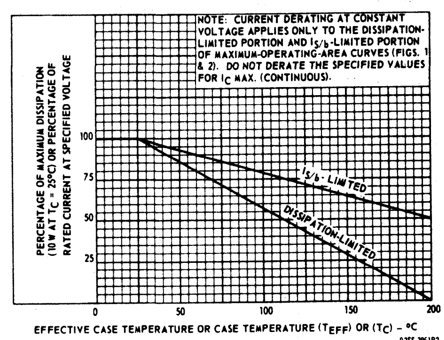


Fig. 1 - Dissipation derating curve for all types.

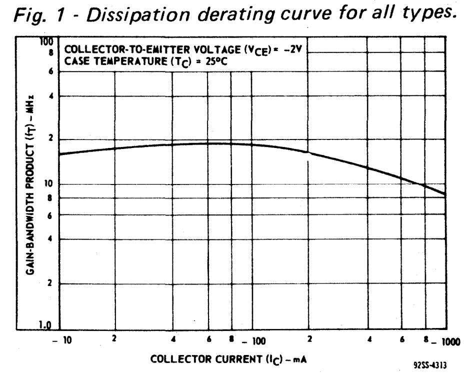


Fig. 2 - Typical gain-bandwidth product for 2N5781, 2N5782, & 2N5783.

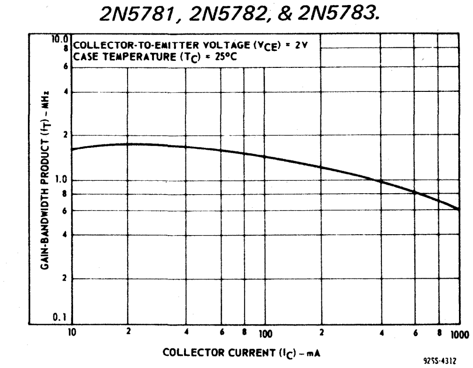


Fig. 3 - Typical gain-bandwidth product for 2N5784, 2N5785, & 2N5786.

2N5781-2N5786

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5781 p-n-p Min.	Max.	2N5784 n-p-n Min.	Max.	UNITS
Saturated Switching Time (V_{CC} = 30 V, I_{B1} = I_{B2}): Turn-on ($t_d + t_r$)	t_{ON}			−1 1	−0.1 0.1	– –	0.5 –	– –	– 5	µs
Turn-off ($t_s + t_f$)	t_{OFF}			−1 1	−0.1 0.1	– –	2.5 –	– –	– 15	µs
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					–	17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	°C/W

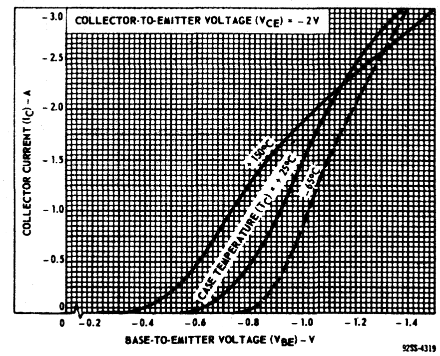


Fig. 4 - Typical transfer characteristics for types 2N5781, 2N5782, 2N5783.

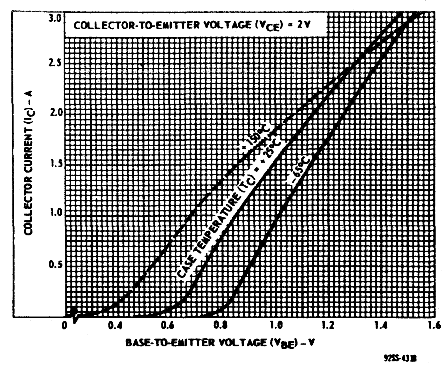


Fig. 5 - Typical transfer characteristics for types 2N5784, 2N5785, 2N5786.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5782 p-n-p Min.	Max.	2N5785 n-p-n Min.	Max.	UNITS
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	50				–	−10	–	10	µA
At T_C = 150°C	I_{CER}	50				–	−1	–	1	mA
* With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CEX}	−60 60	1.5 −1.5			– –	−10 –	– –	– 10	µA
* At T_C = 150°C	I_{CEX}	−60 60	1.5 −1.5			– –	−1 –	– –	– 1	mA
* With base open	I_{CEO}	35			0	–	−100	–	100	µA
* Emitter Cutoff Current	I_{EBO}		−5	0		–	−10	–	10	µA
* DC Forward-Current Transfer Ratio	h_{FE}	2 2		1.2[a] 3.2[a]		20 4	100 –	20 4	100 –	
* Collector-to-Emitter Sustaining Voltage (see Figs. 2 and 3): With base open	$V_{CEO}(sus)$			0.1[a]	0	−50[b]	–	50[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1[a]		−65[b]	–	65[b]	–	V
* Base-to-Emitter Voltage	V_{BE}	2		1.2[a]		–	−1.5	–	1.5	V
* Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case)[c]	$V_{CE}(sat)$			1.2[a] 3.2[a]	0.12 0.8	– –	−0.75 −2	– –	0.75 2	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio[d] f = 4 MHz	$\lvert h_{fe} \rvert$	−2		−0.1		2	15	–	–	
f = 200 kHz	$\lvert h_{fe} \rvert$	2		0.1		–	–	5	20	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	2		0.1		25	–	25	–	
Saturated Switching Time (V_{CC} = 30 V, I_{B1} = I_{B2}): Turn-on ($t_d + t_r$)	t_{ON}			−1 1	−0.1 0.1	– –	0.5 –	– –	– 5	µs
Turn-off ($t_s + t_f$)	t_{OFF}			−1 1	−0.1 0.1	– –	2.5 –	– –	– 15	µs
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2.

[a] Pulsed, pulse duration = 300 µs, duty factor = 1.8%.

[b] ***CAUTION:** Sustaining voltages $V_{CEO}(sus)$, and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.*

♦ For p-n-p devices, voltage and current values are negative.

[c] Lead resistance is critical in this test.

[d] Measured at a frequency where $\lvert h_{fe} \rvert$ is decreasing at approximately 6 dB per octave.

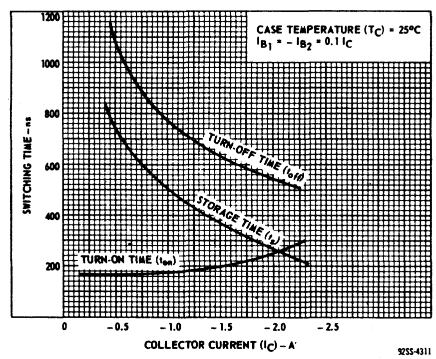


Fig. 6 - Typical saturated switching characteristics for types 2N5781, 2N5782, 2N5783.

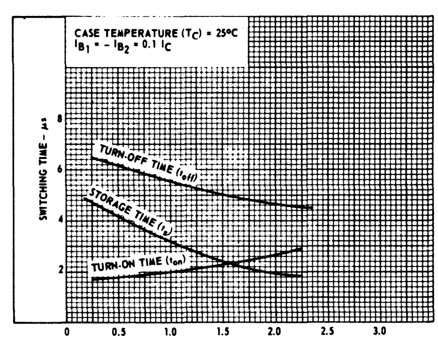


Fig. 7 - Typical saturated switching characteristics for types 2N5784, 2N5785, & 2N5786.

2N5781-2N5786

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5783 p-n-p Min.	Max.	2N5786 n-p-n Min.	Max.	UNITS
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	40				–	–10	–	10	μA
At T_C = 150°C	I_{CER}	40				–	–1	–	1	mA
* With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CEX}	–45 45	1.5 –1.5			– –	–10 –	– –	– 10	μA
* At T_C = 150°C	I_{CEX}	–45 45	1.5 –1.5			– –	–1 –	– –	– 1	mA
* With base open	I_{CEO}	25			0	–	–100	–	100	μA
* Emitter Cutoff Current	I_{EBO}		–3.5	0		–	–10	–	10	μA
* DC Forward-Current Transfer Ratio	h_{FE}	2 2		1.6[a] 3.2[a]		20 4	100 –	20 4	100 –	
* Collector-to-Emitter Sustaining Voltage (see Figs. 2 and 3): With base open	$V_{CEO}(sus)$			0.1[a]	0	–40[b]	–	40[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1[a]		–45[b]	–	45[b]	–	V
* Base-to-Emitter Voltage	V_{BE}	2		1.6[a]		–	–1.5	–	1.5	V
* Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case)[c]	$V_{CE}(sat)$			1.6[a] 3.2[a]	0.16 0.8	– –	–1 –2	– –	1 2	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio[d] f = 4 MHz	$\|h_{fe}\|$	–2		–0.1		2	15	–	–	
f = 200 kHz	$\|h_{fe}\|$	2		0.1		–	–	5	20	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	2		0.1		25	–	25	–	
Saturated Switching Time (V_{CC} = 30 V, I_{B1} = I_{B2}): Turn-on ($t_d + t_r$)	t_{ON}			–1 1	–0.1 0.1	– –	0.5 –	– –	– 5	μs
Turn-off ($t_s + t_f$)	t_{OFF}			–1 1	–0.1 0.1	– –	2.5 –	– –	– 15	μs
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2.

[a] Pulsed, pulse duration = 300 μs, duty factor = 1.8%.

[b] *CAUTION: Sustaining voltages $V_{CEO}(sus)$, and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.*

♦ For p-n-p devices, voltage and current values are negative.

[c] Lead resistance is critical in this test.

[d] Measured at a frequency where $|h_{fe}|$ is decreasing at approximately 6 dB per octave.

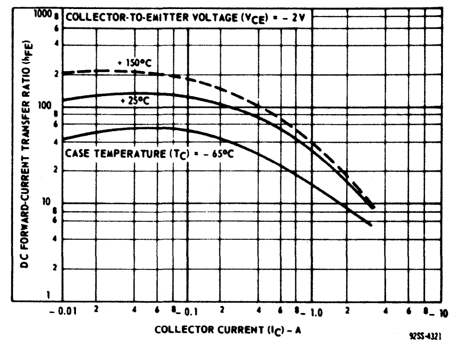


Fig. 8 - Typical dc-beta characteristics for type 2N5781.

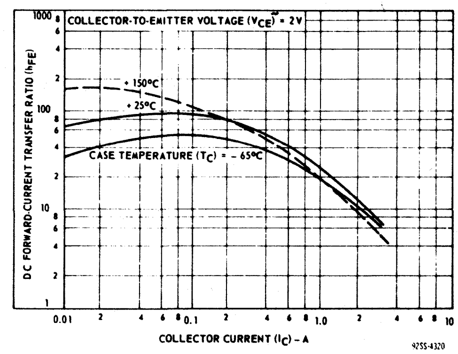


Fig. 9 - Typical dc-beta characteristics for type 2N5784.

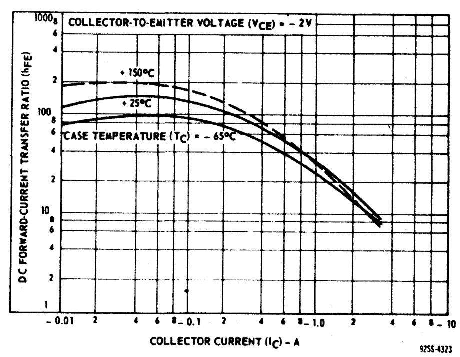


Fig. 10 - Typical dc-beta characteristics for type 2N5782.

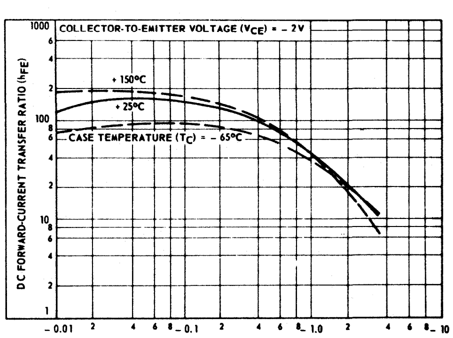


Fig. 11 - Typical dc-beta characteristics for type 2N5783.

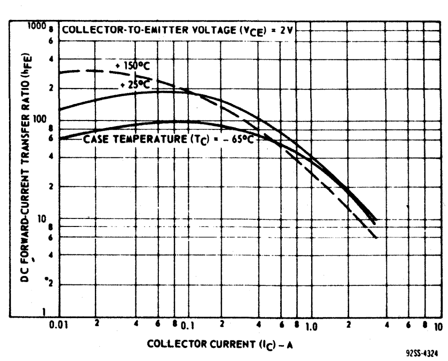


Fig. 12 - Typical dc-beta characteristics for type 2N5786.

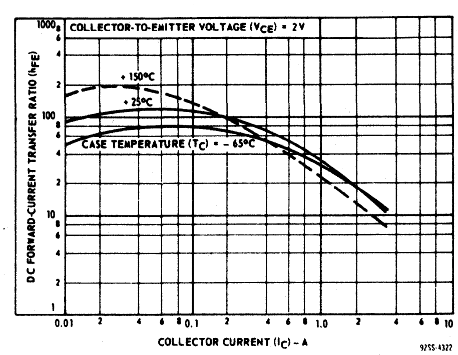


Fig. 13 - Typical dc-beta characteristics for type 2N5785.

2N5781-2N5786

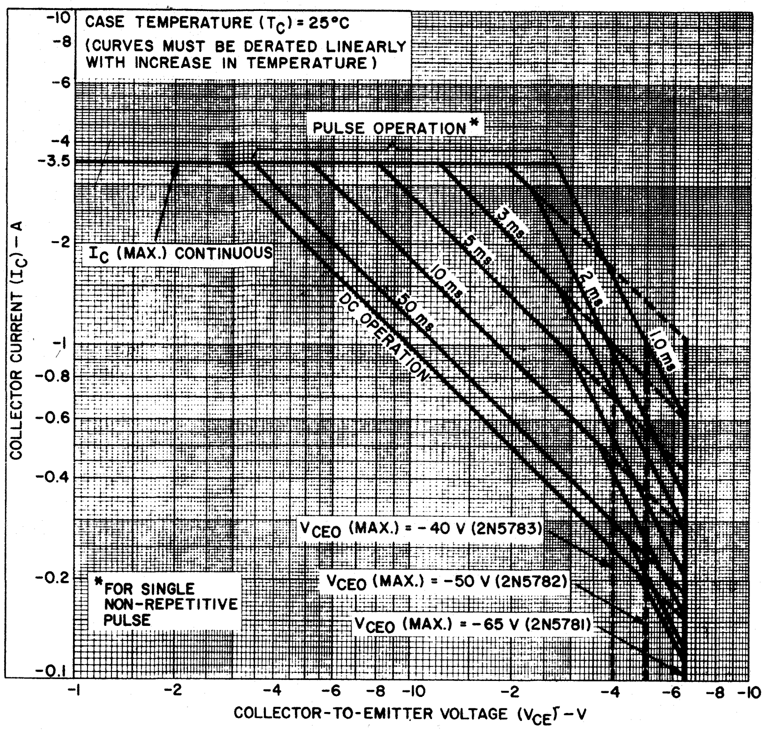


Fig. 14 - Maximum operating areas for types 2N5781, 2N5782, and 2N5783.

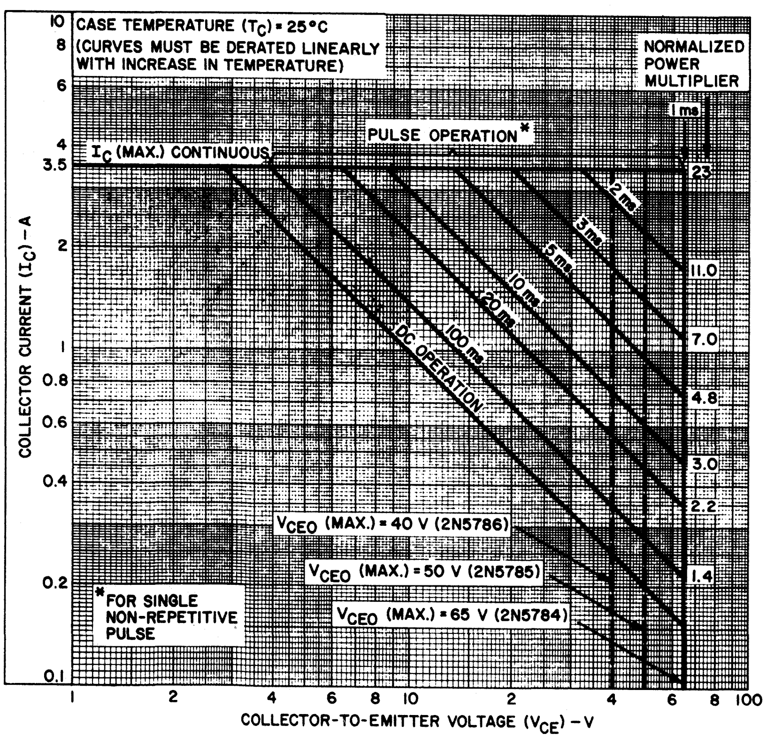


Fig. 15 - Maximum operating areas for types 2N5784, 2N5785, and 2N5786.

2N5838-2N5840

High-Voltage, High-Power Silicon N-P-N Power Transistors

For Switching and Linear Applications in Military, Industrial and Commercial Equipment

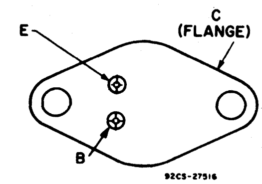
RCA 2N5838, 2N5839 and 2N5840** are epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. These devices employ the popular JEDEC TO-3 package; they differ mainly in voltage, current-gain, and V_{CE}(sat) ratings.

Featuring high breakdown voltage ratings and low-saturation voltage values, the 2N5838, 2N5839 and 2N5840 are especially suitable for use in inverters, deflection circuits, switching regulators, high-voltage bridge amplifiers, ignition circuits, and other high-voltage switching applications.

** Formerly RCA Dev. types TA7513, TA7530, and TA7420 respectively.

Features:
- **Maximum safe-area-of-operation curves**
- **Low saturation voltages**
- **High voltage ratings**
  V_{CER}(sus) = 375 V (2N5840)
  300 V (2N5839)
  275 V (2N5838)
- **High dissipation rating**
  P_T = 100 W

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

	2N5838	2N5839	2N5840	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	275	300	375	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With base open, V_{CEO}(sus)	250	275	350	V
* With reverse bias (V_{BE}) of -1.5 V, V_{CEV}(sus)▲	275	300	375	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω, V_{CER}(sus)	275	300	375	V
*EMITTER-TO-BASE VOLTAGE, V_{EBO}	6	6	6	V
*COLLECTOR CURRENT, I_C				
Continuous	3	3	3	A
Peak	5	5	5	A
*CONTINUOUS BASE CURRENT, I_B	1.5	1.5	1.5	A

	2N5838	2N5839	2N5840	
*TRANSISTOR DISSIPATION, P_T:				
At case temperature up to 25° C and V_{CE} up to 40 V	100	100	100	W
At case temperatures up to 25° C and V_{CE} above 40 V		See Fig. 5		
At case temperatures above 25° C and V_{CE} above 40 V		See Figs. 1 & 5		
*TEMPERATURE RANGE: Storage & Operating (Junction)		-65 to +200		°C
*PIN TEMPERATURE (During Soldering): At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max		230		°C

* In accordance with JEDEC registration data format (JS-6, RDF-1).
▲ Shown as V_{CEX}(sus) in JEDEC Registration Data.

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5838 Min.	2N5838 Max.	2N5839 Min.	2N5839 Max.	2N5840 Min.	2N5840 Max.	UNITS
Collector-Cutoff Current: With base open	I_{CEO}	200 250				- -	2	-	- 2	- -	- 2	mA
* With base-emitter junction reverse biased	I_{CEV}	265 290 360	-1.5 -1.5 -1.5			- - -	5 -	- -	- 2 -	- - -	- - 2	mA
* With base-emitter junction reverse biased, T_C=100°C	I_{CEV} T_C 100 °C	265 290 360	-1.5 -1.5 -1.5			-	8 -	-	- 5	- -	- - 5	mA
* Emitter-Cutoff Current	I_{EBO}		-6			-	1	-	1	-	1	mA
* Collector-to-Emitter Sustaining Voltage: With base open	V_{CEO}(sus)[b]			0.2[a]		250[b]		275[b]	-	350[b]	-	V
* With base-emitter junction reverse biased	V_{CEX}(sus)[b]		-1.5	0.1[a]		275[b]	-	300[b]	-	375[b]	-	V
With external base-to-emitter resistance (R_{BE}) - 50 Ω	V_{CER}(sus)[b]			0.2[a]		275[b]	-	300[b]	-	375[b]	-	V
* Emitter-to-Base Voltage I_E = 0.02 A	V_{EBO}					6	-	6	-	6	-	V
* DC Forward-Current Transfer Ratio	h_{FE}	5 3 2		0.5[a] 2[a] 3[a]		20 - 8	- - 40	20 10 -	- 50 -	20 10 -	- 50 -	
* Base-to-Emitter Saturation Voltage	V_{BE}(sat)			2[a] 3[a]	0.2 0.375	- -	2	-	2 -	- -	2 -	V
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			2[a] 3[a]	0.2 0.375	- -	- 1		1.5	- -	1.5	V
Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{obo}					-	150		150	-	150	pF
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f - 1 MHz)	$\|h_{fe}\|$	10		0.2		5		5	-	5	-	
Forward-Bias, Second-Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$	40				2.5		2.5		2.5	-	A
Second Breakdown[c] Energy (With base reverse biased) R_B = 50 Ω, L = 100 μH	$E_{S/b}$		-4			0.45	-	0.45	-	0.45	-	mJ
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$	10		5			1.75	-	1.75	-	1.75	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-1)
a Pulsed; pulse duration = 350 μs, Duty factor ≤ 2%.
b CAUTION: The sustaining voltages V_{CEO}(sus), V_{CEX}(sus) and V_{CER}(sus), MUST NOT be measured on a curve tracer.

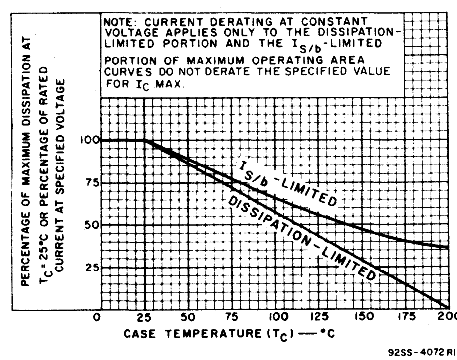


Fig. 1 - Derating curves for all types.

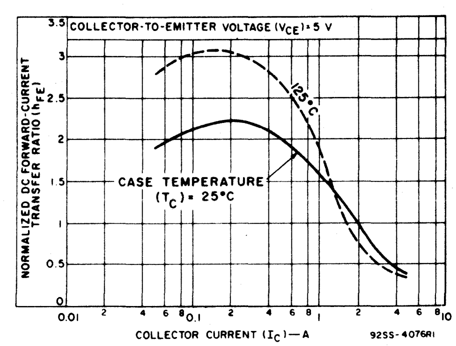


Fig. 2 - Typical normalized dc beta characteristics for all types.

2N5838-2N5840

SWITCHING-TIME CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS						UNITS
		VOLTAGE V dc	CURRENT A dc		2N5838		2N5839		2N5840		
		V_{CC}	I_C	I_B●	Max.	Typ.	Max.	Typ.	Max.	Typ.	
Switching Times: Delay	t_d	200	2	0.2	-	-	-	0.07	-	0.07	μs
			3	0.375	-	0.06				-	
* Rise	t_r	200	2	0.2	-	-	1.5	0.6	1.75	0.6	
			3	0.375	1.5	0.8	-	-	-	-	
* Storage	t_s	200	2	0.2	-	-	3.75	1.75	3.0	1.75	
			3	0.375	3.0	1.0				-	
* Fall	t_f	200	2	0.2	-	-	1.5	0.35	1.5	0.35	
			3	0.375	1.5	0.4	-	-	-	-	

* In accordance with JEDEC registration data format (JS-6 RDF-1). ● $I_{B1} = I_{B2}$ = value shown.

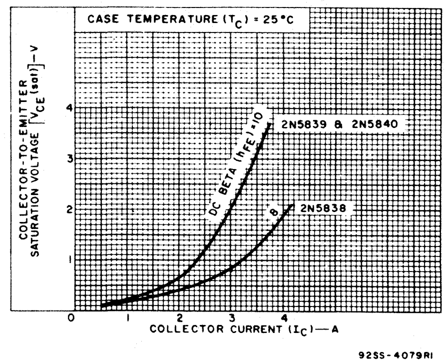


Fig. 3 - Typical saturation voltage characteristics for all types.

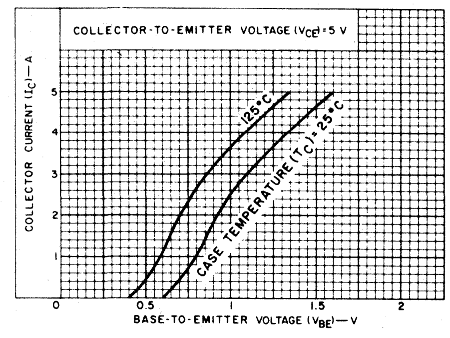


Fig. 4 - Typical transfer characteristics for all types.

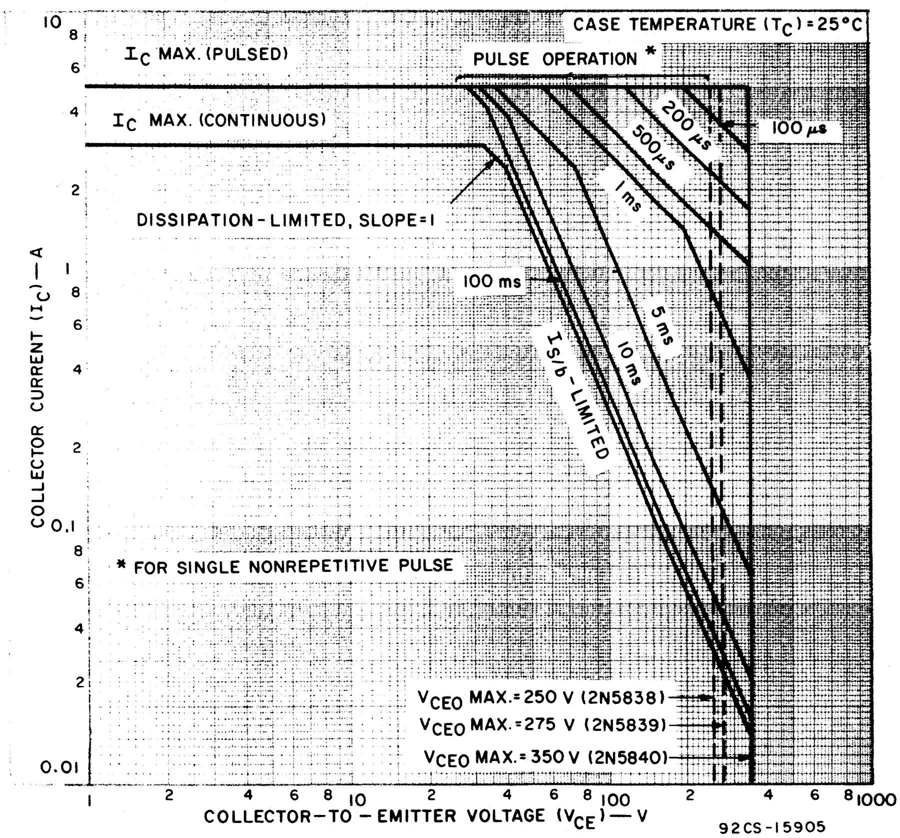


Fig. 5 - Maximum operating areas for all types.

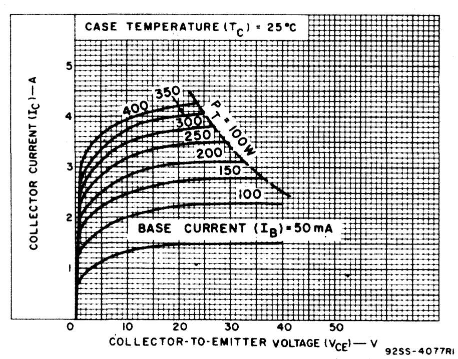


Fig. 6 - Typical output characteristics for all types.

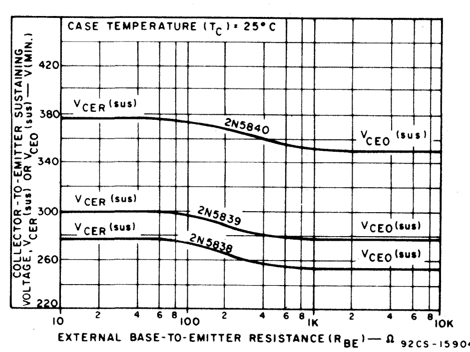


Fig. 7 - Collector-to-emitter sustaining voltage characteristics for all types.

2N5838-2N5840

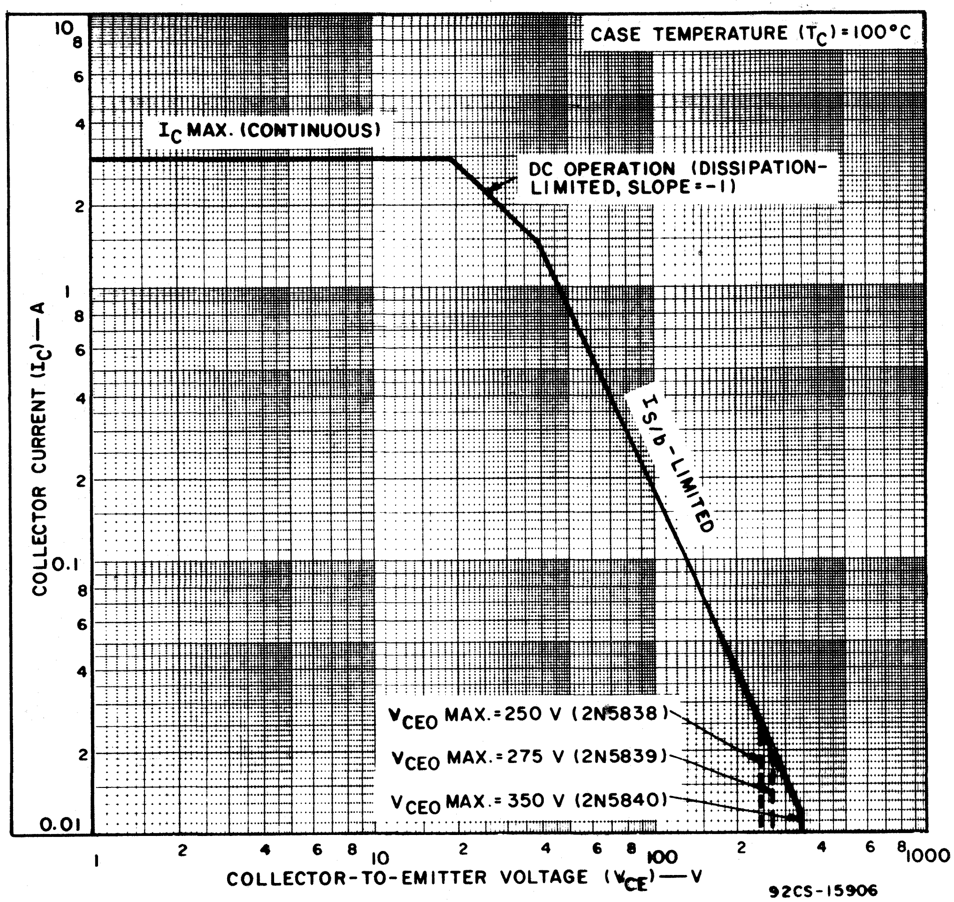


Fig. 8 - Maximum operating areas for all types.

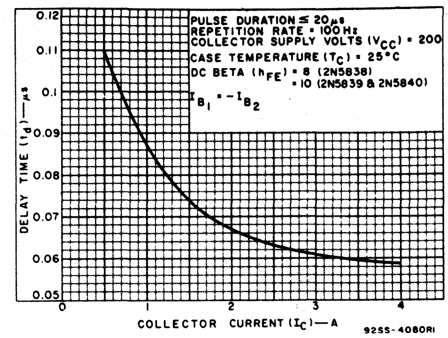


Fig. 9 - Typical delay-time characteristic for all types.

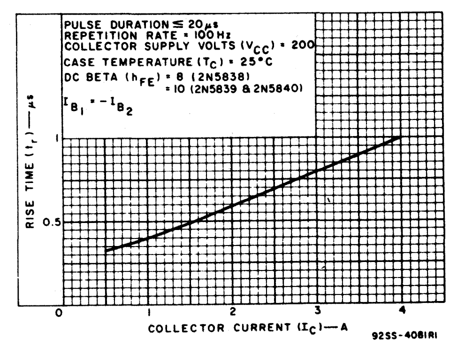


Fig. 10 - Typical rise-time characteristic for all types.

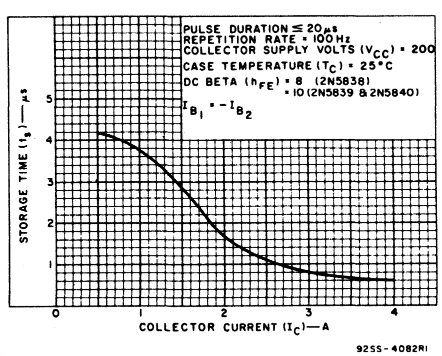


Fig. 11 - Typical storage-time characteristic for all types.

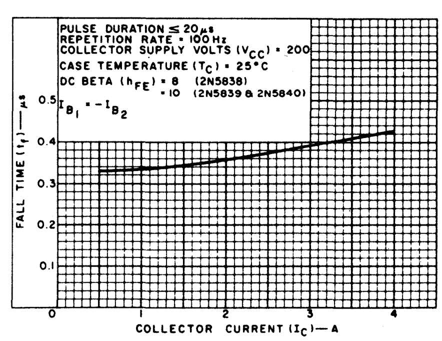


Fig. 12 - Typical fall-time characteristic for all types.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829-40831

Silicon N-P-N and P-N-P Medium-Power Transistors

General-Purpose Types for Switching Applications

RCA-2N5954, -2N5955, and -2N5956 are multiple-epitaxial p-n-p transistors. RCA-2N6372, -2N6373, and -2N6374 are multiple-epitaxial n-p-n transistors. They are complements to 2N5954, 2N5955, and 2N5956.

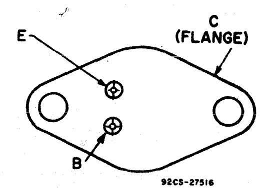
The RCA-2N6465 and 2N6466 are multiple-epitaxial n-p-n transistors. They are complements to the 2N6467, and 2N6468, multiple-epitaxial p-n-p transistors. These devices differ in voltage ratings and in the currents at which the parameters are controlled.

All are supplied in the JEDEC TO-66 package.

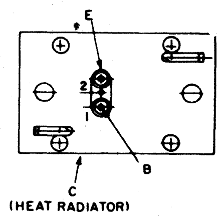
Types 2N5954, 2N5955, and 2N5956 are available with factory-attached heat radiators as RCA types 40829, 40830, and 40831, respectively. The other devices may be obtained with heat radiators on special order. Radiator versions are intended for printed-circuit-board applications, and differ electrically from their basic counterparts only in device dissipation (5.8 W up to 25°C ambient) and thermal resistance (30°C/W max. at T_A = 25°C).

Features:
- **2N5954-2N5956 complements to 2N6372-2N6374**
- **2N6465, 2N6466 complements to 2N6467, 2N6468**
- **Low saturation voltages**
- **Maximum-safe-area-of-operation curves**
- **Thermal-cycle ratings**
- **Hermetically-sealed JEDEC TO-66 package**

TERMINAL DESIGNATIONS



JEDEC TO-66
2N5954-2N5956 2N6372-2N6374, 2N6465-2N6468



JEDEC TO-66 with Heat Raidator
40829, 40830, 40831

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	N-P-N 2N6374 / P-N-P 2N5956♦ 40831♦	2N6373 / 2N5955♦ 40830♦	2N6372 / 2N5954♦ 40829♦	2N6465 / 2N6467♦	2N6466 / 2N6468♦	
*V_{CBO}	50	70	90	110	130	V
*$V_{CEX}(sus)$ V_{BE} = −1.5 V, R_{BE} = 100 Ω	50	70	90	110	130	V
$V_{CER}(sus)$ R_{BE} = 100 Ω	45	65	85	105	125	V
$V_{CEO}(sus)$	40	60	80	100	120	V
*V_{EBO}	5	5	5	5	5	V
*I_C	6	6	6	4	4	A
*I_B	2	2	2	2	2	A
*P_T						
At T_C up to 25°C	40 (2N6374) (2N5956)	40 (2N6373) (2N5955)	40 (2N6372) (2N5954)	40	40	W
At T_A up to 25°C	5.8 (40831)	5.8 (40830)	5.8 (40829)	–	–	W
At T_C above 25°C	Derate linearly to 200°C					
*T_J, T_{stg}	−65 to +200					°C
*T_L At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	+235					°C

***JEDEC types in accordance with JEDEC registration data format JS-6-RDF-2.**
♦For p-n-p devices, voltage and current values are negative.

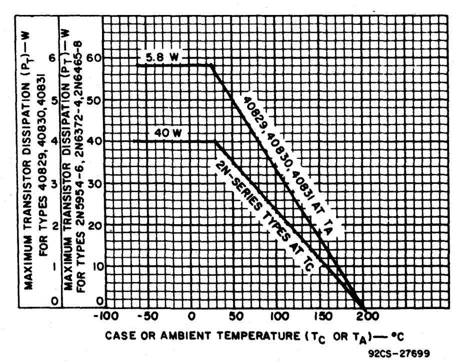


Fig. 1 - Dissipation derating chart for all types.

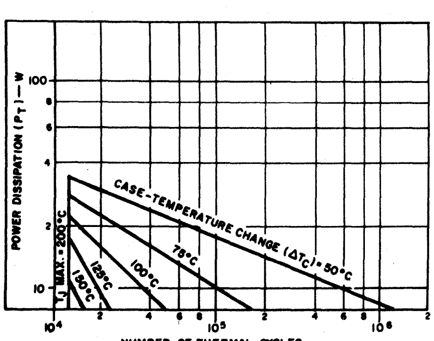


Fig. 2 - Thermal-cycling rating chart for all types.

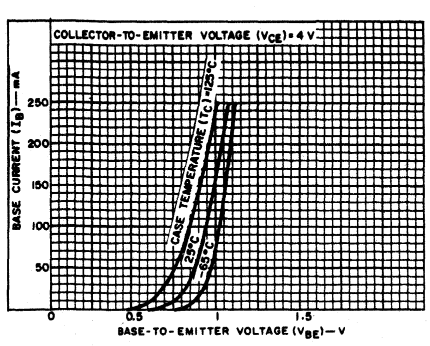


Fig. 3 - Typical input characteristics for 2N5954-56, 2N6372-74 and 40829-31.♦

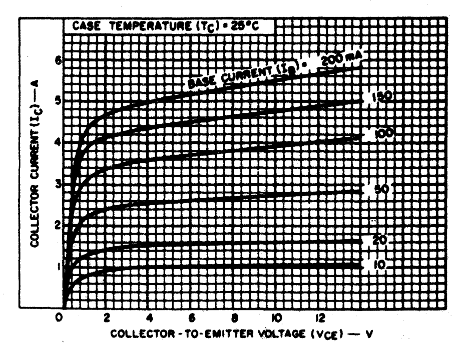


Fig. 4 - Typical output characteristics for 2N5954-56, 2N6372-74 and 40829-31.♦

♦For p-n-p devices, voltage and current values are negative.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829-40831

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS◆ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6374 2N5956◆ 40831◆ Min.	Max.	2N6373 2N5955◆ 40830◆ Min.	Max.	2N6372 2N5954◆ 40829◆ Min.	Max.	UNITS
* I_{CER} R_{BE}=100 Ω	35				–	100	–	–	–	–	μA
	55				–	–	–	100	–	–	
	75				–	–	–	–	–	100	
* I_{CEX} R_{BE}=100 Ω	45	−1.5			–	100	–	–	–	–	μA
	65	−1.5			–	–	–	100	–	–	
	85	−1.5			–	–	–	–	–	100	
* R_{BE}=100 Ω, T_C=150°C	45	−1.5			–	2	–	–	–	–	mA
	65	−1.5			–	–	–	2	–	–	
	85	−1.5			–	–	–	–	–	2	
* I_{CEO}	25				–	1	–	–	–	–	mA
	45				–	–	–	1	–	–	
	65				–	–	–	–	–	1	
* I_{EBO}		−5			–	0.1	–	0.1	–	0.1	mA
* h_{FE}	4		3ª		20	100	–	–	–	–	
	4		2.5ª		–	–	20	100	–	–	
	4		2ª		–	–	–	–	20	100	
	4		6ª		5	–	5	–	5	–	
* V_{CEO}(sus)			0.1ª		40ᵇ	–	60ᵇ	–	80ᵇ	–	V
V_{CER}(sus) R_{BE}=100 Ω			0.1ª		45ᵇ	–	65ᵇ	–	85ᵇ	–	V
V_{CEX}(sus) R_{BE}=100 Ω		−1.5	0.1ª		50ᵇ	–	70ᵇ	–	90ᵇ	–	V
* V_{BE} All types	4		3ª		–	2	–	–	–	–	V
All types	4		2.5ª		–	–	–	2	–	–	
All types	4		2ª		–	–	–	–	–	2	
2N6372-2N6374	4		6ª		–	3	–	3	–	3	
* V_{CE}(sat)			3ª	0.3	–	1	–	–	–	–	V
			2.5ª	0.25	–	–	–	1	–	–	
			2ª	0.2	–	–	–	–	–	1	
* $\|h_{fe}\|$ f=1 MHz 2N6372-2N6374	4		1		4	–	4	–	4	–	
2N5954-56,40829-31	−4		−1		5	–	5	–	5	–	
* h_{fe} f=1 kHz	4		0.5		25	–	25	–	25	–	
$R_{\theta JC}$ 2N5954-56, 2N6372-74					–	4.3	–	4.3	–	4.3	°C/W
$R_{\theta JA}$ 40829-40831					–	30	–	30	–	30	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2 for JEDEC (2N5954-2N5956 2N6372-2N6374 2N6465-2N6468 40829-40831) types.

◆ For p-n-p devices, voltage and current values are negative.

a Pulsed, pulse duration = 300 μs, duty factor = 1.8%.

b *CAUTION: Sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) MUST NOT be measured on a curve tracer.*

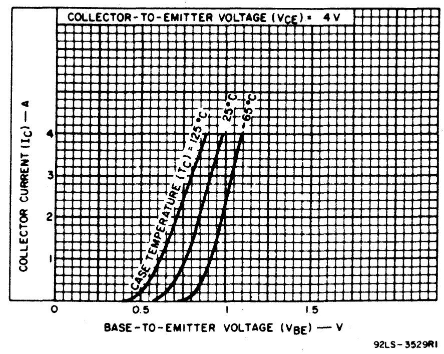


Fig. 5 - Typical transfer characteristics for 2N5954-56, 2N6372-74 and 40829-31.◆

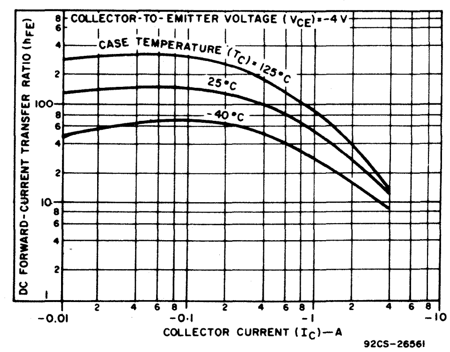


Fig. 6 - Typical dc beta characteristics for 2N6467 and 2N6468.

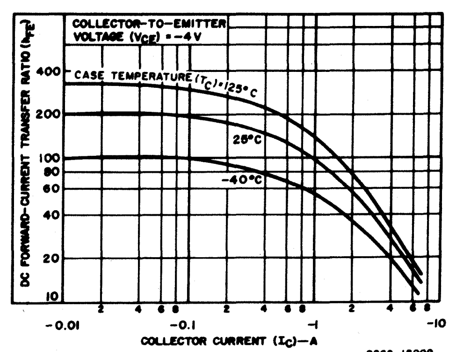


Fig. 7 - Typical dc beta characteristics for 2N5954-2N5956 and 40829-40831.

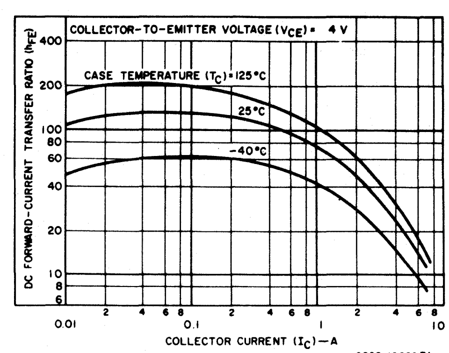


Fig. 8 - Typical dc beta characteristics for 2N6372-2N6374.

◆For p-n-p devices, voltage and current values are negative.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829-40831

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS: 2N6465 2N6467♦ Min.	Max.	2N6486 2N6468♦ Min.	Max.	UNITS
I_{CER}	95				—	100	—	—	μA
R_{BE} = 100 Ω	100				—	—	—	100	
* I_{CEX}	100	−1.5			—	100	—	—	μA
R_{BE} = 100 Ω	120	−1.5			—	—	—	100	
R_{BE} = 100 Ω,	100	−1.5			—	2	—	—	mA
T_C = 150°C	120	−1.5			—	—	—	2	
* I_{CEO}	50				—	1	—	—	mA
	60				—	—	—	1	
* I_{EBO}		−5			—	0.1	—	0.1	mA
* h_{FE}	4		1.5[a]		15	150	15	150	
	4		4[a]		5	—	5	—	
* $V_{CEO}(sus)$			0.1[a]		100[b]	—	120[b]	—	V
$V_{CER}(sus)$ R_{BE} = 100 Ω			0.1[a]		105[b]	—	125[b]	—	V
* $V_{CEX}(sus)$ R_{BE} = 100 Ω		−1.5	0.1[a]		110[b]	—	130[b]	—	V
* V_{BE}	4		1.5[a]		—	2	—	2	V
	4		4[a]		—	3.5	—	3.5	
$V_{CE}(sat)$ All types			1.5[a]	0.15	—	1.2	—	1.2	V
2N6465–2N6466			4[a]	0.8		3*	—	3*	
2N6467–2N6468			−4[a]	−0.8	—	−4*	—	−4*	
* $\|h_{fe}\|$ f = 1 MHz	4		1		5	—	5	—	
* h_{fe} f = 1 kHz	4		0.5		25	—	25	—	
$R_{\theta JC}$					—	4.3	—	4.3	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2.

♦ For p-n-p devices, voltage and current values are negative.

[a] Pulsed, pulse duration = 300 μs, duty factor = 1.8%

[b] *CAUTION: Sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer.*

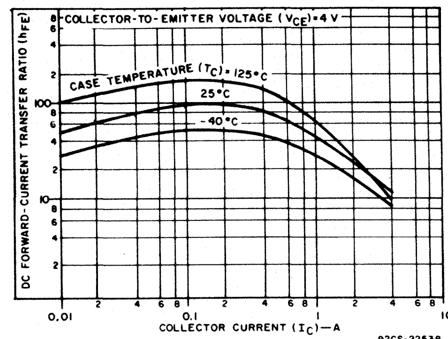


Fig. 9 - Typical dc beta characteristics for 2N6465 and 2N6466.

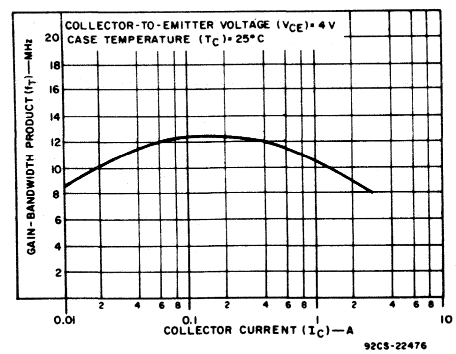


Fig. 10 - Typical gain-bandwidth product for 2N5954-56, 2N6372-74, 2N6467-68, and 40829-31. (For p-n-p devices, voltage and current values are negative.)

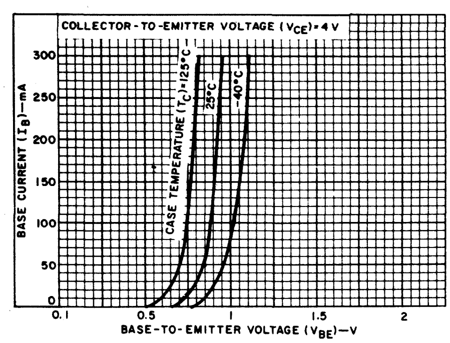


Fig. 11 - Typical input characteristics for 2N6465 and 2N6466.

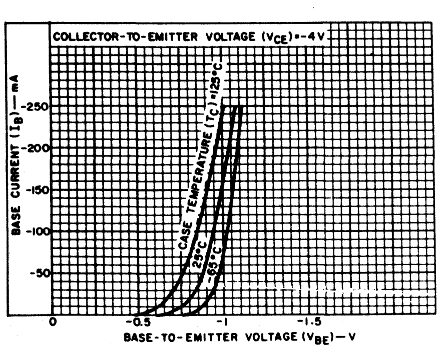


Fig. 12 - Typical input characteristics for 2N6467 and 2N6468.

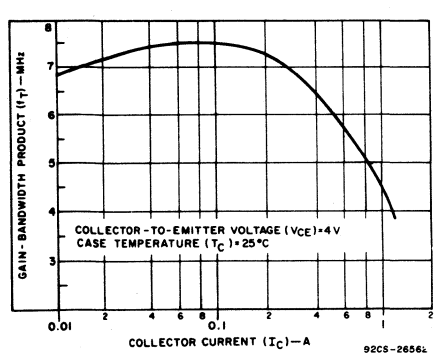


Fig. 13 - Typical gain-bandwidth product for 2N6465 and 2N6466.

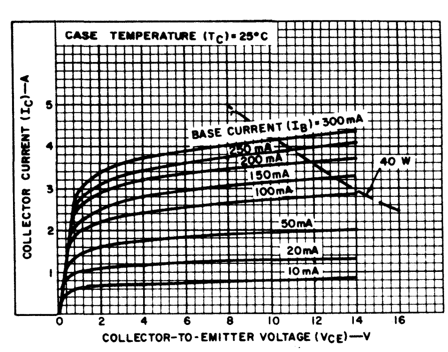


Fig. 14 - Typical output characteristics for 2N6465 and 2N6466.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829-40831

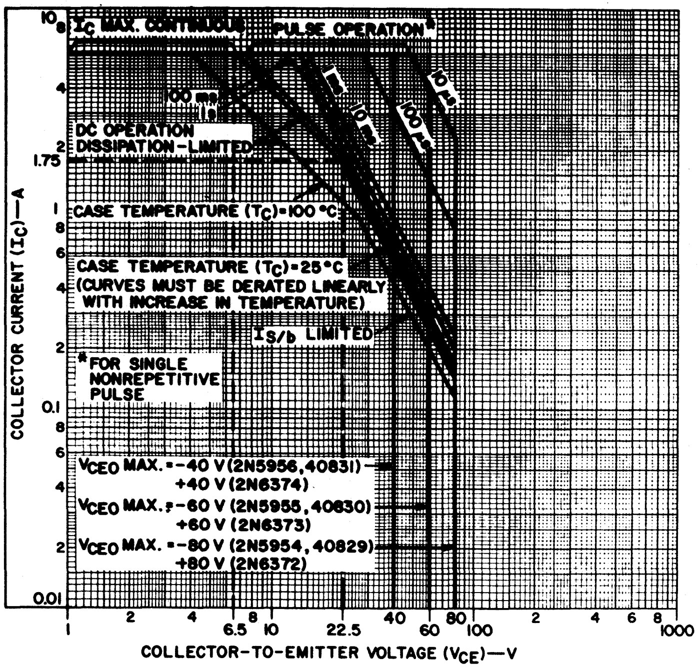


Fig. 15 - Maximum operating areas for 2N5954-56, 2N6372-74, and 40829-31.◆

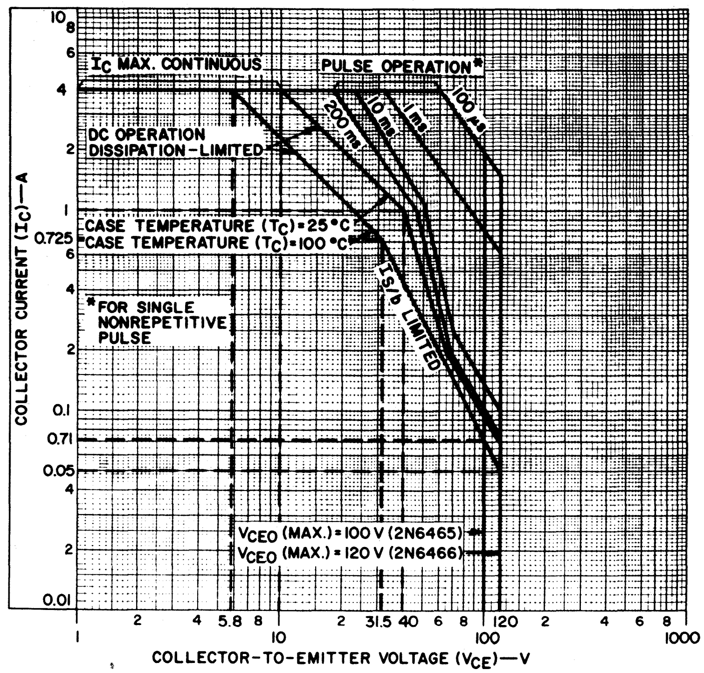


Fig. 16 - Maximum operating areas for 2N6465 and 2N6466.

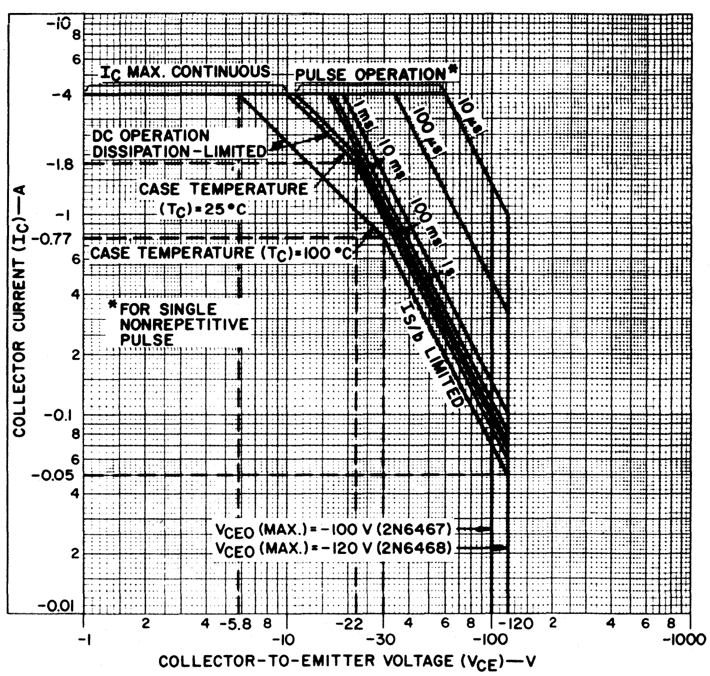


Fig. 17 - Maximum operating areas for 2N6467 and 2N6468.

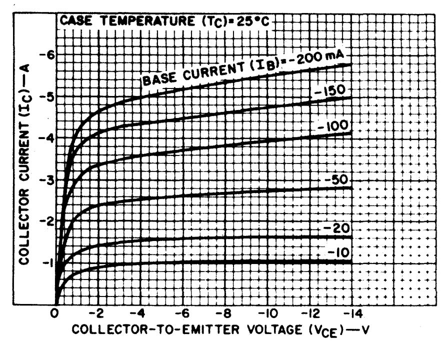


Fig. 18 - Typical output characteristics for 2N6467 and 2N6468.

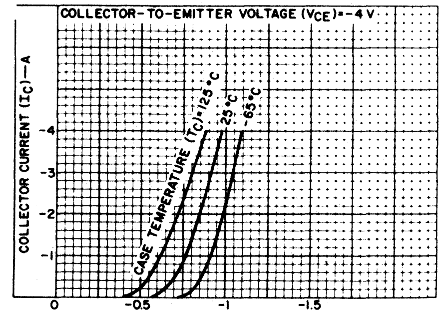


Fig. 19 - Typical transfer characteristics for 2N6467 and 2N6468.

◆For p-n-p devices, voltage and current values are negative.

2N5954-2N5956, 2N6372-2N6374, 2N6465-2N6468, 40829-40831

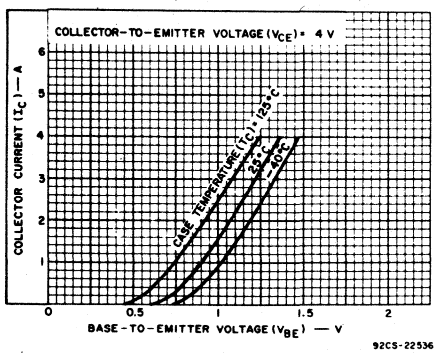


Fig. 20 - Typical transfer characteristics for 2N6465 and 2N6466.

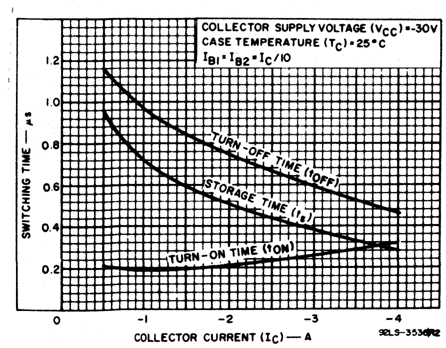


Fig. 21 - Typical saturated switching characteristics for 2N5954-56 and 40829-31.

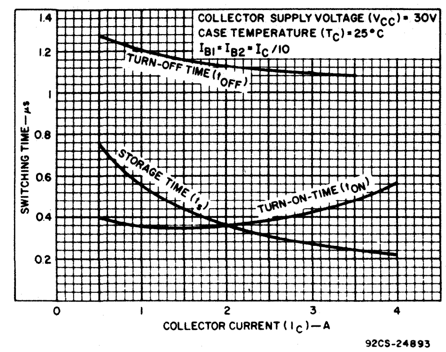


Fig. 22 - Typical saturated switching characteristics for 2N6372-2N6374.

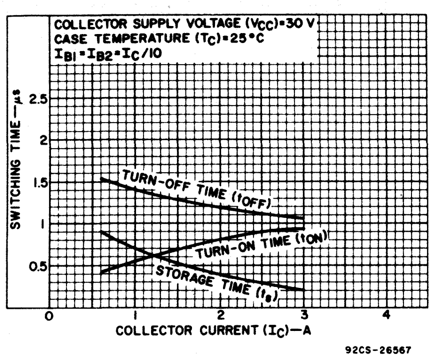


Fig. 23 - Typical saturated switching characteristics for 2N6465 and 2N6466.

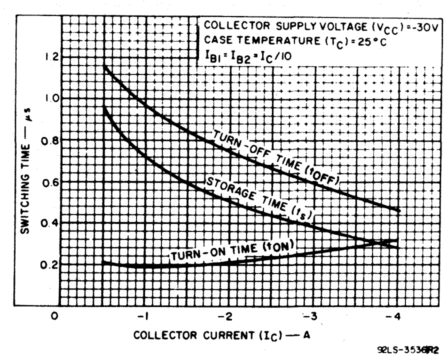


Fig. 24 - Typical saturated switching characteristics for 2N6467 and 2N6468.

2N6032, 2N6033

High-Current, High-Speed, High-Power Transistors

Silicon N-P-N Types

For Switching and Amplifier Applications in Military, Industrial, and Commercial Equipment

RCA Types 2N6032 and 2N6033* are epitaxial silicon n-p-n transistors having high-current and high-power handling capability and fast switching speed. The 2N6033 is similar to the 2N6032; they differ in maximum values for continuous collector current and sustaining voltage.

They are supplied in modified TO-3 hermetic steel packages with 0.60-in. diameter pins.

*Formerly RCA Dev. Types TA7337 and TA7337A, respectively.

Applications:

- Switching-control amplifiers
- Power gates
- Switching regulators
- Power-switching circuits
- Power oscillators
- DC-RF amplifiers
- Converters
- Inverters
- Control circuits

Features:

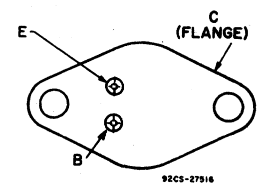
- **Low V_{CE}(sat) = 1.0 V max. at 40 A, 1.3 V max. at 50 A**
- **Maximum Safe-Area-of-Operation Curve... $I_{S/b}$ limit line beginning at 24 V**
- **Fast Storage Time ... t_s = 1.5 μs max at I_C = 40 A (2N6033) 50A (2N6032)**
- **High-Current Capability ... V_{CE}(sat) & V_{BE} measured at I_C = 40 A (2N6033) = 50 A (2N6032)**
- **High P_T (140 W max. at T_C = 25°C)**

MAXIMUM RATINGS, *Absolute Maximum Values:*

		2N6032	2N6033	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With base open	V_{CEO}(sus)	90	120	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω	V_{CER}(sus)	110	140	V
* With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω & V_{BE} = -1.5 V	V_{CEX}(sus)	120	150	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
* CONTINUOUS COLLECTOR CURRENT	I_C	50	40	A
* BASE CURRENT	I_B	10	10	A
* EMITTER CURRENT	I_E	50	40	A
* TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C and V_{CE} up to 24 V		140	140	W
At case temperatures above 25°C		Derate linearly to 200°C		
* TEMPERATURE RANGE:				
Storage & Operating (Junction)		-65 to +200		°C
* PIN TEMPERATURE (During Soldering): At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max		230		°C

*In accordance with JEDEC registration data format JS-6 RDF-1.

TERMINAL DESIGNATIONS



Modified JEDEC TO-3

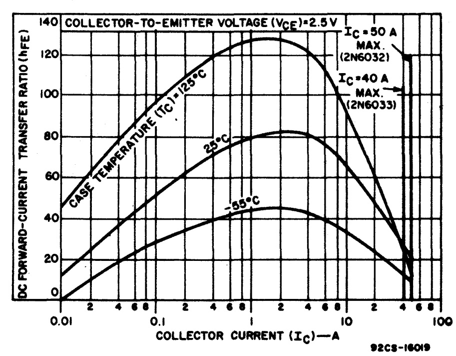


Fig. 2 - Typical dc-beta characteristics for both types.

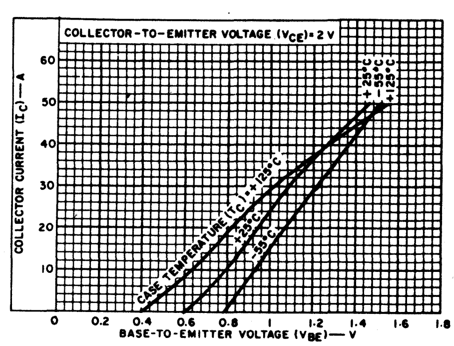


Fig. 3 - Typical transfer characteristics for both types.

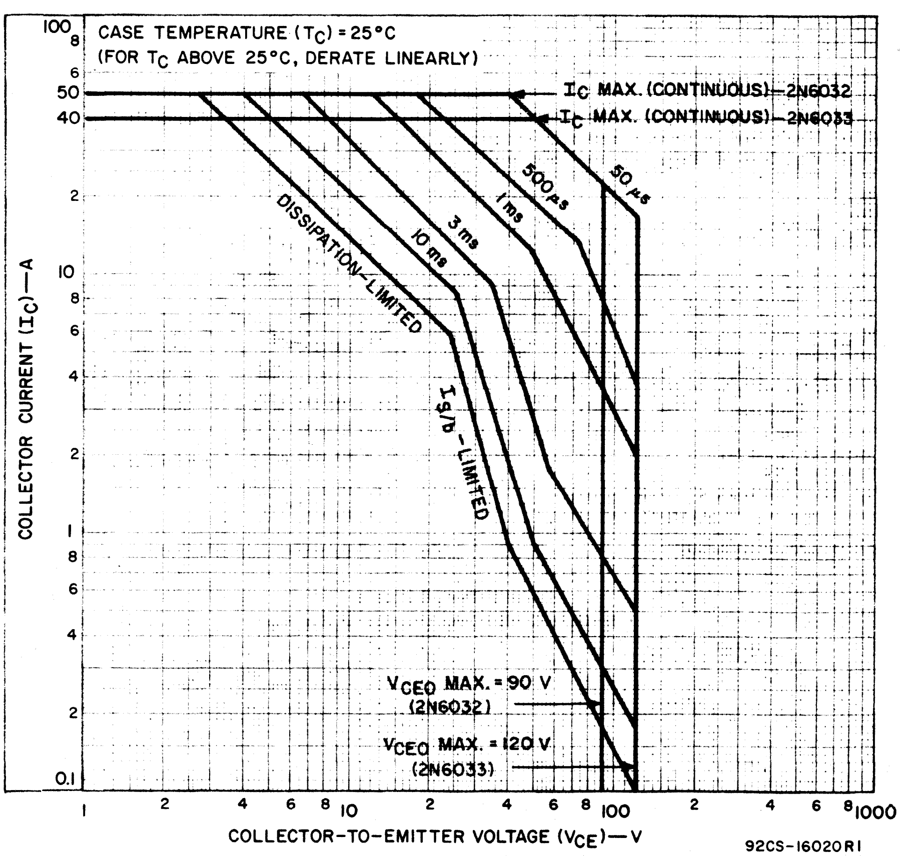


Fig. 1 - Maximum operating areas for both types.

2N6032, 2N6033

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
			VOLTAGE V dc		CURRENT A dc		2N6032		2N6033		
			V_{CE}*	V_{BE}	I_C	I_B	Min.	Max.	Min	Max.	
	Collector-Cutoff Current: With base open	I_{CEO}	80	–	–	0	–	10	–	10	mA
*	With base-emitter junction reverse biased	I_{CEV}	110 135	-1.5 -1.5	– –	– –	– –	12	– –	– 10	mA
	T_C = 150°C	I_{CEV}	100	-1.5	–	–	–	15	–	10	mA
*	Emitter-Cutoff Current	I_{EBO}	–	–	0	–	–	10	–	10	mA
*	Collector-to-Emitter Sustaining Voltage: *(See Figs. 12 & 13)* With base open	V_{CEO}(sus)	–	–	0.2[b]	0	90[a]	–	120[a]	–	V
	With external base to emitter resistance (R_{BE}) ≤ 50 Ω	V_{CER}(sus)	–	–	0.2[b]	0	110[a]	–	140[a]	–	V
	With base-emitter junction reverse biased & R_{BE} ≤ 50 Ω	V_{CEX}(sus)	–	-1.5	0.2[b]	0	120[a]	–	150[a]	–	V
*	Base-to-Emitter Saturation Voltage	V_{BE}(sat)	– –	– –	50[b] 40[b]	5 4	– –	2 –	– –	– 2	V
	Base-to-Emitter Voltage	V_{BE}	2 2	– –	50[b] 40[b]	– –	– –	2 –	– –	– 2	V
*	Collector-to-Emitter Saturation Voltage	V_{CE}(sat)	– –	– –	50[b] 40[b]	5 4	– –	1.3 –	– –	– 1	V
*	DC Forward-Current Transfer Ratio	h_{FE}	2.6 2	– –	50[b] 40[b]	– –	10 –	50 –	– 10	– 50	
	Second-Breakdown Collector Current With base forward biased, t = 1 s nonrepetitive	$I_{S/b}$	24 40	– –	– –	– –	5.8[c] 0.9[c]	– –	5.8[c] 0.9[c]	– –	A
	Second-Breakdown Energy With base reverse biased (L = 310 μH, R_{BE} = 5 Ω)	$E_{S/b}$	–	-4	20	–	62	–	62	–	mJ
*	Magnitude of common-emitter small-signal, short-circuit, forward-current transfer ratio f = 5 MHz	$\lvert h_{fe}\rvert$	10		2		10	–	10	–	
*	Gain-Bandwidth Product f = 5 MHz	f_T	10	–	2	–	50	–	50	–	MHz
	Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{obo}	–	–	–	–	–	800	–	800	pF
	Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$	20	–	2.5	–	–	1.25	–	1.25	°C/W

*In accordance with JEDEC registration format JS-6 RDF-1.

[a] CAUTION: The sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) MUST NOT be measured on a curve tracer.

[b] Pulsed: Pulse duration 300 μs; duty factor ≤ 2%.

SWITCHING TIME CHARACTERISTICS, *Case Temperature (T_C) = 25°C*

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
			VOLTAGE V dc		CURRENT A dc		2N6032		2N6033		
			V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
	Saturated Switching Time: (V_{CC}=30 V, I_{B1} = I_{B2}):										
*	Rise Time	t_r	– –	– –	50 40	5 4	– –	1 —	– –	– 1	μs
*	Storage Time	t_s	– –	– –	50 40	5 4	– –	1.5 –	– –	– 1.5	μs
*	Fall Time	t_f	– –	– –	50 40	5 4	– –	0.5 –	– –	– 0.5	μs

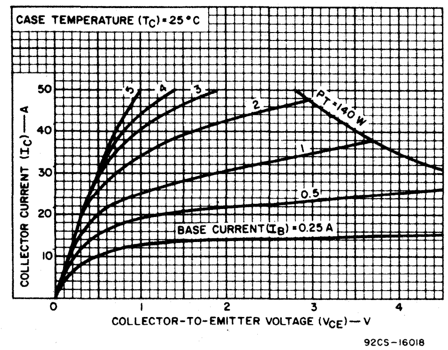


Fig. 4 - Typical output characteristics for both types.

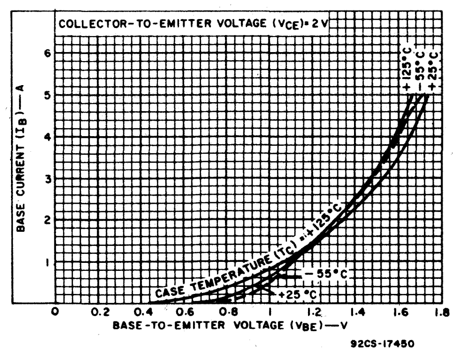


Fig. 5 - Typical input characteristics for both types.

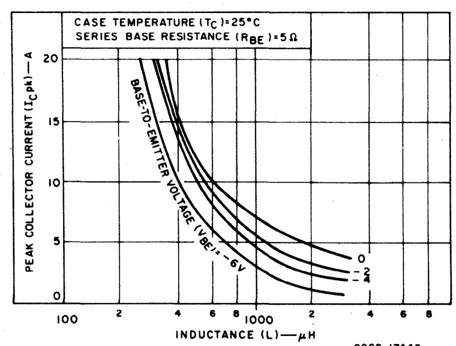


Fig. 6 - Maximum reverse-bias second-breakdown characteristics for both types.

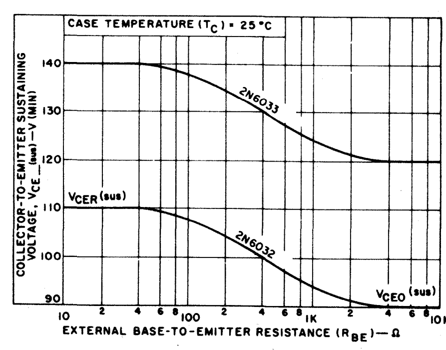


Fig. 7 - Collector-to-emitter sustaining voltage characteristics for both types.

2N6032, 2N6033

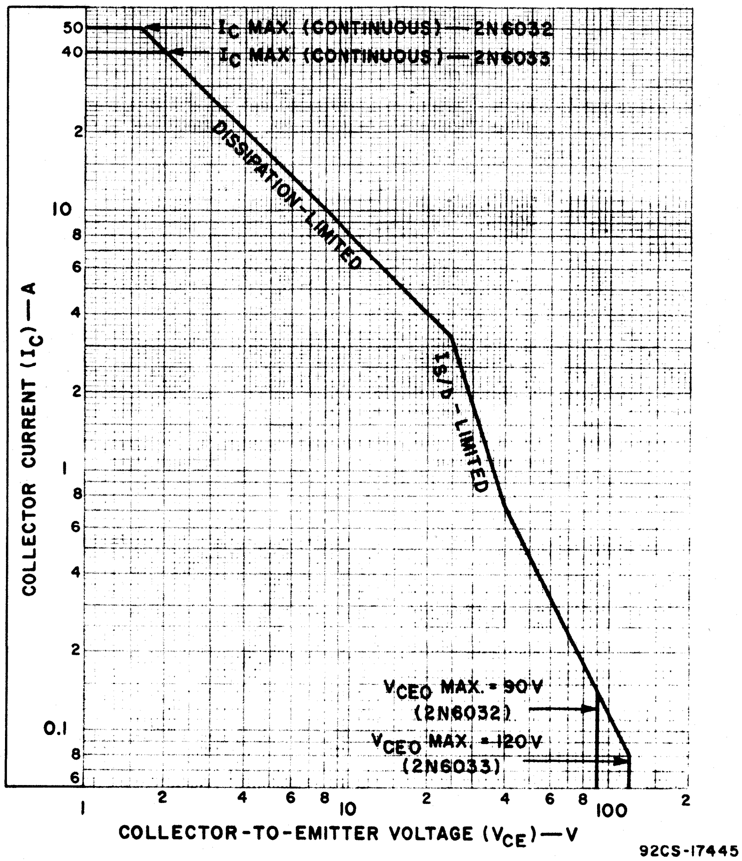


Fig. 8 - Maximum operating areas for both types at case temperature (T_C) = 100°C.

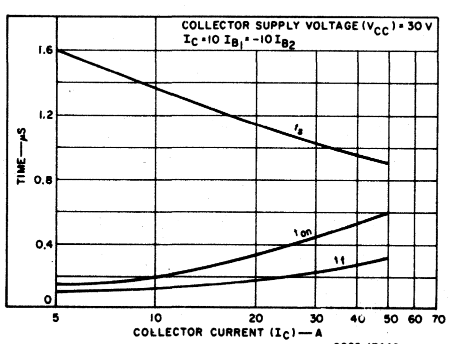


Fig. 9 - Typical saturated switching characteristics for both types.

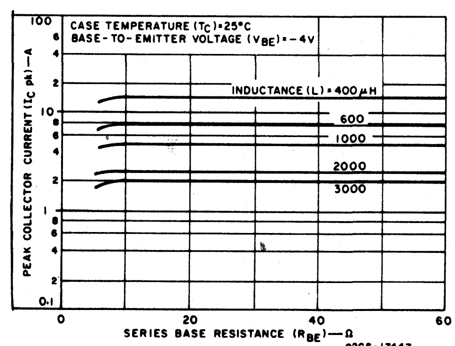


Fig. 10 - Maximum reverse-bias second-breakdown characteristics for both types.

2N6077-2N6079, 40851

High-Voltage, High-Power Silicon N-P-N Transistors

For Switching and Linear Applications

RCA 2N6077, 2N6078, 2N6079 and 40851 are multiple epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. Multiple-epitaxial construction maximizes the volt-ampere characteristic of the device and provides fast switching speeds. Multiple-emitter-site design ensures uniform current flow throughout the structure, which produces a high $I_{S/b}$ and a large safe-operation area.

These devices use the popular JEDEC TO-66 package; they differ mainly in voltage ratings, leakage-current limits, and V_{CE}(sat) ratings.

The 2N6077 is characterized for switching applications with load lines in the active region. These applications include sweep circuits and all circuits using the transistor as an active voltage clamp.

Type 2N6078 is characterized for switching applications with the load line extending into the reverse-bias region. Its voltage ratings make this device useful for switching regulators operating directly from a rectified 110-V or 220-V power line. The unit is rated to take surge currents up to 5 A and maintain saturation.

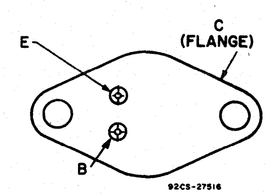
The 2N6079 is characterized for use in inverters operating directly from a rectified 110-V power line. The leakage current is specified at 450 volts; therefore the device can also be used in a series bridge configuration on a 220-V line. The V_{EBO} rating of 9 volts eases requirements on the drive transformer in inverter applications. Storage time, an important factor in the frequency stability of an inverter, is specified in Fig. 11, which shows variation in storage time with variation in load current from zero to maximum (4 A).

The 40851 is characterized for use in switching-regulator power supplies that operate directly from a 120-V or 240-V ac power line.

Features:

- **Maximum safe-area-of-operation curves**
- **Low saturation voltages**
- **High voltage ratings:**
  V_{CER}(sus) = 300 V (2N6077)
  275 V (2N6078)
  375 V (2N6079)
- **High dissipation rating: P_T = 45 W**

TERMINAL DESIGNATIONS



JEDEC TO-66

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

		2N6077	2N6078	2N6079	40851	
•COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	300	275	375	450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With base open	V_{CEO}(sus)	275	250 1	350	350	V
• With reverse bias (V_{BE}) of −1.5 V	V_{CEX}(sus)	300	275	375	–	V
With external base-to-emitter resistance (R_{BE}) ≤50 Ω	V_{CER}(sus)	300	275	375	375	V
•EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	9	9	V
•COLLECTOR CURRENT:	I_C					
Continuous		7	7	7	7	A
Peak		10	10	10	10	A
•CONTINUOUS BASE CURRENT	I_B	4	4	4	4	A
•TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		45	45	45	45	W
At case temperatures above 25°C		Derate linearly to 200°C				
•TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to +200				°C
•PIN TEMPERATURE (During Soldering):						
At distances ≥1/32 in. (0.8 mm) from case for 10 s max.		230				°C

• 2N-Series types in accordance with JEDEC registration data format (JS-6, RDF-1).

2N6077-2N6079, 40851

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS 2N6077			2N6078			2N6079			40851		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Max.	
I_{CEO}	250	−1.5		0	–	–	2	–	–	–	–	–	–	–	–	mA
* I_{CEV}	250	−1.5			–	–	5	–	–	0.05	–	–	–	–	–	mA
	450	−1.5			–	–	–	–	–	–	–	–	0.5	–	0.5	
(T_C = 125°C)	250	−1.5			–	–	8	–	–	0.2	–	–	–	–	–	mA
	450	−1.5			–	–	–	–	–	–	–	–	5	–	5	
* I_{EBO}		−6	0		–	–	1	–	–	1	–	–	–	–	–	mA
		−9	0		–	–	–	–	–	–	–	–	1	–	–	
* V_{CEO}(sus)			0.2^a		275^b	–	–	250^b	–	–	350^b	–	–	350^b	–	V
V_{CER}(sus) (R_{BE} = 50Ω)			0.2^a		300^b	–	–	275^b	–	–	375^b	–	–	375^b	–	V
* V V_{EBO} (I_E = 1 mA)			0		6	–	–	6	–	–	9	–	–	9	–	V
* h_{FE}	1		1.2^a		12	28	70	12	28	70	12	28	50	12	–	
* V_{BE}(sat)			1.2^a	0.2	–	1.0	1.6	–	1.0	1.6	–	1.0	1.6	–	–	V
			3^a	0.6	–	1.2	1.9	–	–	–	–	–	–	–	–	
			4^a	0.8	–	–	–	–	–	–	–	1.3	2	–	2	
			5^a	1	–	–	–	–	1.5	2	–	–	–	–	–	
* V_{CE}(sat)			1.2^a	0.2	–	0.15	0.5	–	0.15	0.5	–	0.15	0.5	–	–	V
			3^a	0.6	–	0.25	1	–	–	–	–	–	–	–	–	
			4^a	0.8	–	–	–	–	–	–	–	0.5	3	–	3	
			5^a	1	–	–	–	–	0.8	3	–	–	–	–	–	
C_{obo} (V_{CB} = 10 V, f = 1 MHz)					–	–	150	–	–	150	–	–	150	–	–	pF
* $\|h_{fe}\|$ (f = 1 MHz)	10		0.2		1	7	–	1	7	–	1	7	–	–	–	
$I_{S/b}$ (Pulse duration (non-repetitive) = 1 s)	50				0.9	–	–	0.9	–	–	0.9	–	–	0.9	–	A
$E_{S/b}$ (R_B = 50Ω, L=100µH)		−4	3●		0.45	–	–	0.45	–	–	0.45	–	–	0.45	–	mj
t_d^c			1.2	0.2	–	0.02	–	–	0.02	–	–	0.02	–	–	–	µs
* t_r^c			1.2	0.2	–	0.3	0.75	–	0.3	0.75	–	0.3	0.75	–	–	µs
* t_s^c			1.2	0.2	–	2.8	5	–	2.8	5	–	2.8	5	–	–	µs
* t_f^c			1.2	0.2	–	0.3	0.75	–	0.3	0.75	–	0.3	0.75	–	–	µs
$R_{\theta JC}$	20		2.25		–	–	3.9	–	–	3.9	–	–	3.9	–	–	°C/W

*2N-series types in accordance with JEDEC registration data format (JS-6, RDF-1).

[a] Pulsed; pulse duration ⩽ 350 µs, Duty factor = 2%.

[b] CAUTION: The sustaining voltages V_{CEO}(sus), and V_{CER}(sus), MUST NOT be measured on a curve tracer.

[c] V_{CC} = 250 V, $I_{B1} = I_{B2}$.

● I_{CM} for 40851

2N6077-2N6079, 40851

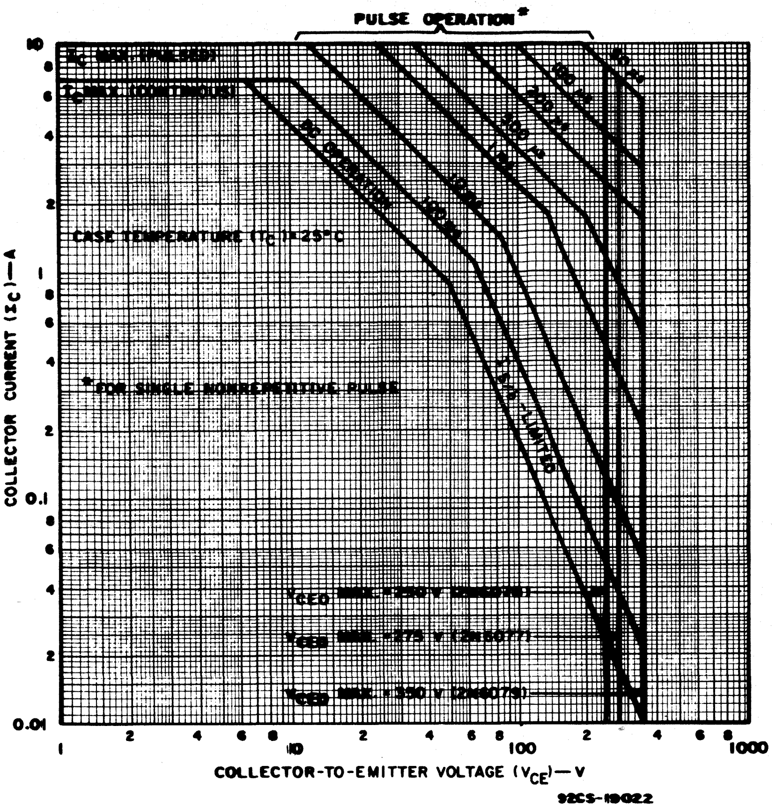


Fig. 1 - Maximum operating areas for all types.

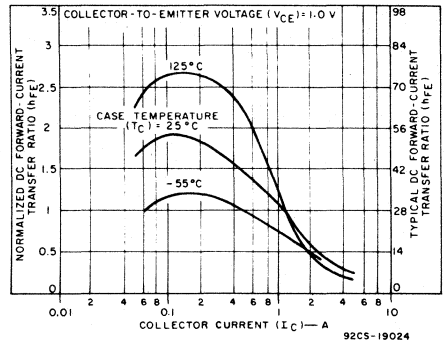


Fig. 2 - Typical normalized dc beta characteristics for all types.

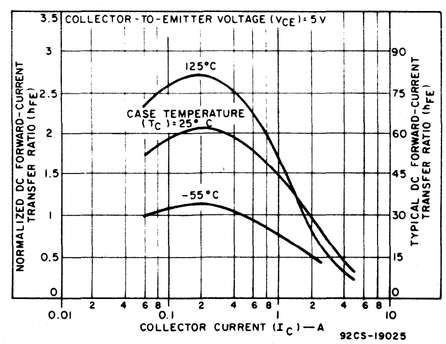


Fig. 3 - Typical normalized dc beta characteristics for all types.

Note (Figs. 2 & 3): To estimate min., max. h_{FE} at any current and temperature, read normalized dc forward-current transfer ratio and multiply by min., max. specifications given in Electrical Characteristics Chart.

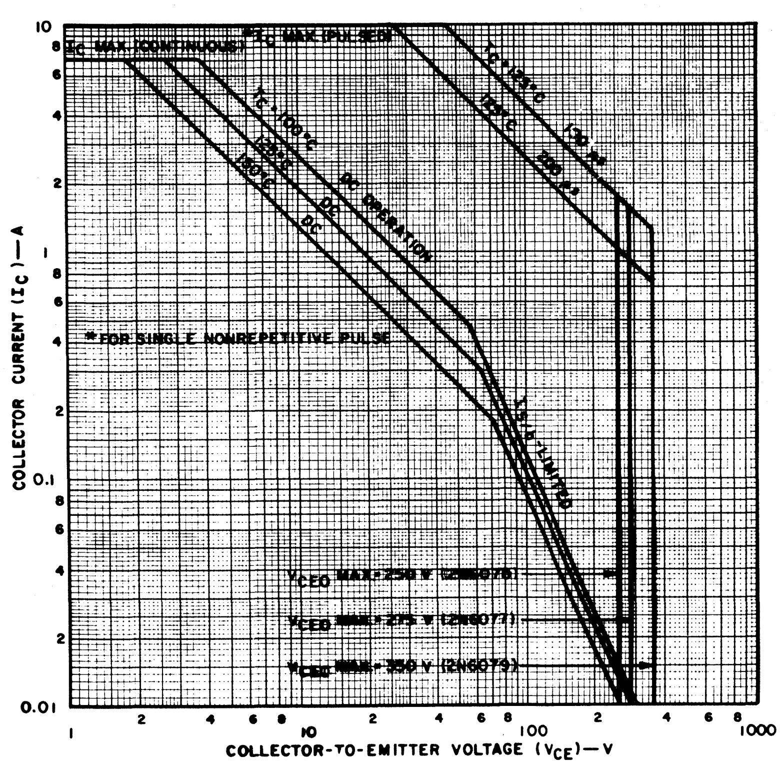


Fig. 4 - Maximum operating areas for all types.

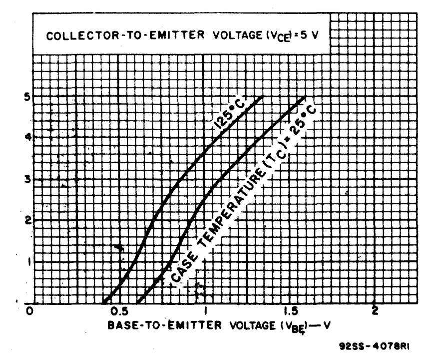


Fig. 5 - Typical transfer characteristics for all types.

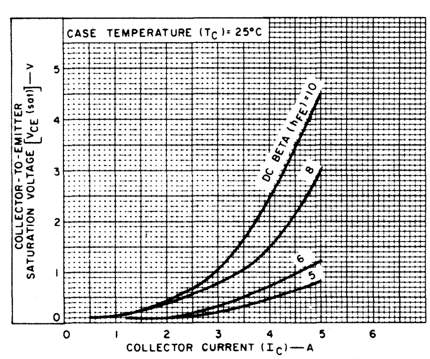


Fig. 6 - Typical saturation voltage characteristics for all types.

2N6077-2N6079, 40851

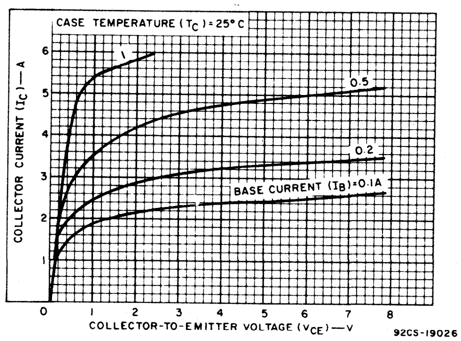


Fig. 7 - Typical output characteristics for all types.

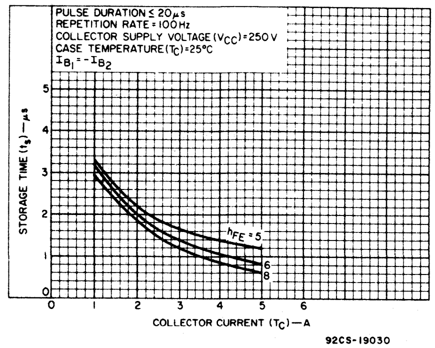


Fig. 8 - Typical storage-time characteristics for all types (with constant forced gain).

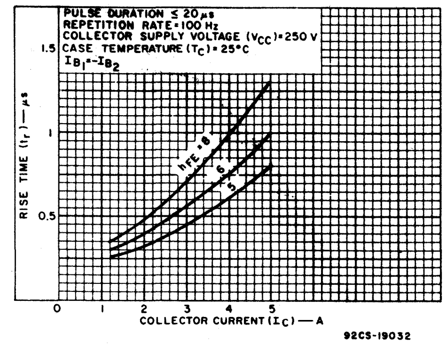


Fig. 9 - Typical rise-time characteristic for all types.

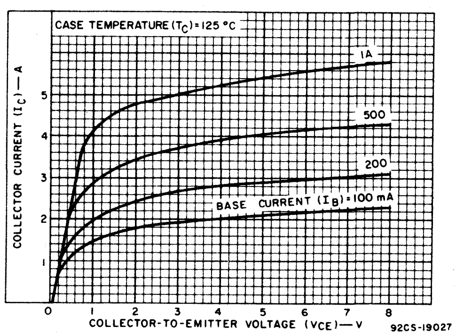


Fig. 10 - Typical output characteristics for all types.

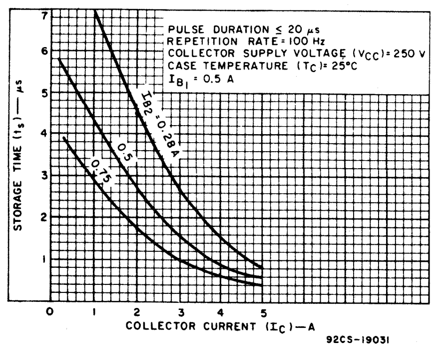


Fig. 11 - Typical storage-time characteristics for all types (with constant-base drives).

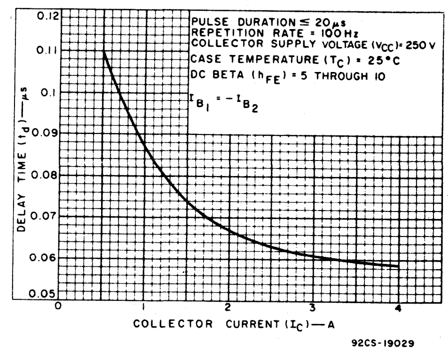


Fig. 12 - Typical delay-time characteristic for all types.

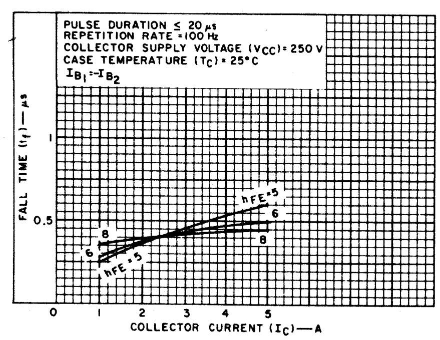


Fig. 13 - Typical fall-time characteristic for all types.

2N6098-2N6103, RCA3055

High-Current, Silicon N-P-N VERSAWATT Transistors

Designed for Medium-Power Linear and Switching Service
in Consumer, Automotive, and Industrial Applications

These RCA types are hometaxial-base silicon n-p-n transistors. Types 2N6098, 2N6100, and 2N6102 have formed emitter and base leads for easy insertion into TO-66 sockets. Types 2N6099, 2N6101, and 2N6103 are electrically identical to the 2N6098, 2N6100, and 2N6102, respectively.

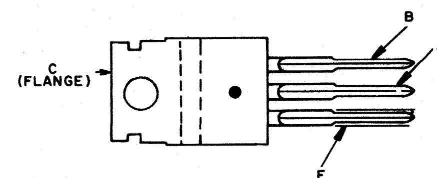
These new VERSAWATT package transistors differ in voltage ratings and in the currents at which the parameters are controlled. They are intended for a wide variety of medium-power switching and linear applications, such as series and shunt regulators, solenoid drivers, motor-speed controls, inverters, and driver and output stages of high-fidelity amplifiers.

OPTIONAL LEAD CONFIGURATION
An additional lead forming for printed-circuit board mounting is also available. Please submit requirements to your RCA Technical Sales Representative, or write to RCA Power Marketing, Somerville, N. J. 08876.

Features:

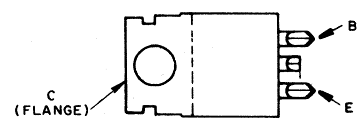
- **Low saturation voltage —**
  $V_{CE}(sat)$ = 1 V max. at I_C = 4 A (2N6098, 2N6099)
  = 1 V max. at I_C = 5 A (2N6100, 2N6101)
  = 1 V max. at I_C = 8 A (2N6102, 2N6103)
- **VERSAWATT package (molded-silicone plastic)**
- **Maximum safe-area-of-operation curves**
- **Thermal-cycle rating curve**

TERMINAL DESIGNATIONS



BOTTOM VIEW 92CS-27519

JEDEC TO-220AB
2N6099, 2N6101, 2N6103



BOTTOM VIEW 92CS-27520

JEDEC TO-220AA
2N6098, 2N6100, 2N6102

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6102 2N6103	2N6098 2N6099	2N6100 2N6101	RCA3055	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	45	70	80	100	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$	45	65	75	70	V
* With base open	$V_{CEO}(sus)$	40	60	70	60	V
With base reverse-biased V_{BE} = −1.5 V	$V_{CEV}(sus)$	—	—	—	90	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	8	8	7	V
*COLLECTOR CURRENT (Continuous)	I_C	16	10	10	15	A
*BASE CURRENT	I_B	4	4	4	4	A
TRANSISTOR DISSIPATION:	P_T					
* At case temperatures up to 25°C		75	75	75	75	W
At ambient temperatures up to 25°C		1.8	1.8	1.8	1.8	W
* At case temperatures above 25°C, derate linearly		0.6				W/°C
At ambient temperatures above 25°C, derate linearly		0.0144				W/°C
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		-65 to 150				°C
*LEAD TEMPERATURE (During Soldering):						
At distance ≥ 1.8 in. (3.17 mm) from case of 10 s max.		235				°C

* 2N-Series types in accordance with JEDEC registration data format JS-6 RDF-2.

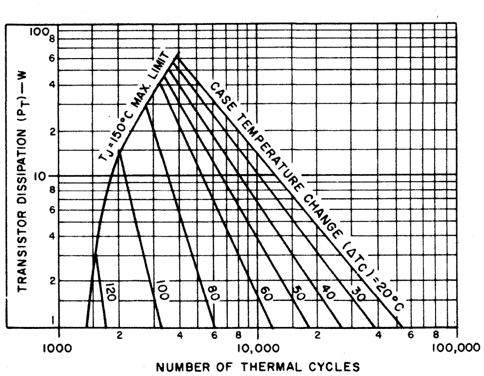


Fig. 1 — Thermal-cycling rating for all types.

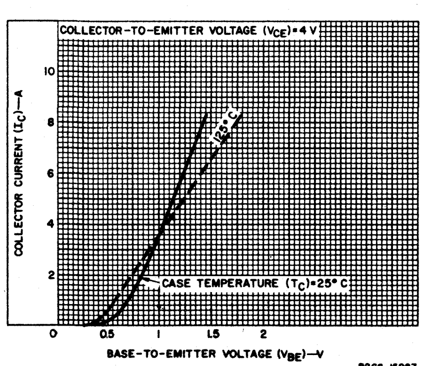


Fig. 2 — Typical transfer characteristics for all types.

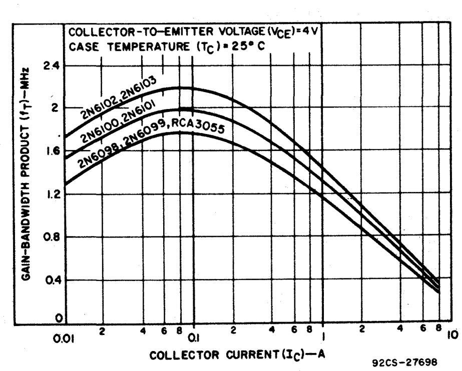


Fig. 3 — Typical gain-bandwidth product for all types.

2N6098-2N6103, RCA3055

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{EB}	CURRENT A dc I_C	I_B	LIMITS: 2N6102 2N6103 MIN.	MAX.	2N6098 2N6099 MIN.	MAX.	2N6100 2N6101 MIN.	MAX.	RCA3055 MIN.	MAX.	UNITS
* I_{CEX}	40	1.5			–	2	–	–	–	–	–	–	mA
	65	1.5			–	–	–	2	–	–	–	–	
	75	1.5			–	–	–	–	–	2	–	–	
	100	1.5			–	–	–	–	–	–	–	5	
* I_{CEX} (T_C = 150°C)	40	1.5			–	10	–	–	–	–	–	–	
	65	1.5			–	–	–	10	–	–	–	–	
	75	1.5			–	–	–	–	–	10	–	–	
	100	1.5			–	–	–	–	–	–	–	30	
* I_{CEO}	30			0	–	2	–	–	–	–	–	0.7	mA
	50			0	–	–	–	2	–	–	–	–	
	60			0	–	–	–	–	–	2	–	–	
* I_{EBO}		5	0		–	1	–	–	–	–	–	–	mA
		7	0		–	–	–	–	–	–	–	5	
		8	0		–	–	–	1	–	1	–	–	
$V_{CER}(sus)$ R_{BE} = 100Ω[a]			0.2		45	–	65	–	75	–	70	–	V
* $V_{CEO}(sus)$[a]			0.2	0	40	–	60	–	70	–	60	–	
$V_{CEV}(sus)$[a]		1.5	0.1		–	–	–	–	–	–	90	–	
* h_{FE}[a]	4		4		–	–	20	80	–	–	20	70	
	4		5		–	–	–	–	20	80	–	–	
	4		8		15	60	–	–	–	–	–	–	
	4		10		–	–	5	–	5	–	5	–	
	4		16		5	–	–	–	–	–	–	–	
* V_{BE}[a]	4		4		–	–	–	1.7	–	–	–	1.8	V
	4		5		–	–	–	–	–	1.7	–	–	
	4		8		–	1.7	–	–	–	–	–	–	
* $V_{CE}(sat)$[a]			4	0.4	–	–	–	–	–	–	–	1.1	V
			10	2	–	–	–	2.5	–	2.5	–	–	
			16	3.2	–	2.5	–	–	–	–	–	–	
$I_{S/b}$[b] ($t \geq 1$ s)	60				–	–	–	–	–	–	1.2	–	A
f_{hfe}	4		1		–	–	–	–	–	–	10	–	kHz
* h_{fe}	4	f=1kHz	0.5		15	–	15	–	15	–	15	120	
* $\|h_{fe}\|$	4	f= 0.1MHz	0.5		8	28	8	28	8	28	2	–	
$R_{\theta JC}$					–	1.67	–	1.67	–	1.67	–	1.67	°C/W
$R_{\theta JA}$					–	70	–	70	–	70	–	70	

*2N-series types in accordance with JEDEC registration data format (JS-6, RDF-2)

[a]Pulsed, pulse duration = 300 μs, duty factor = 0.018

2N6098-2N6103, RCA3055

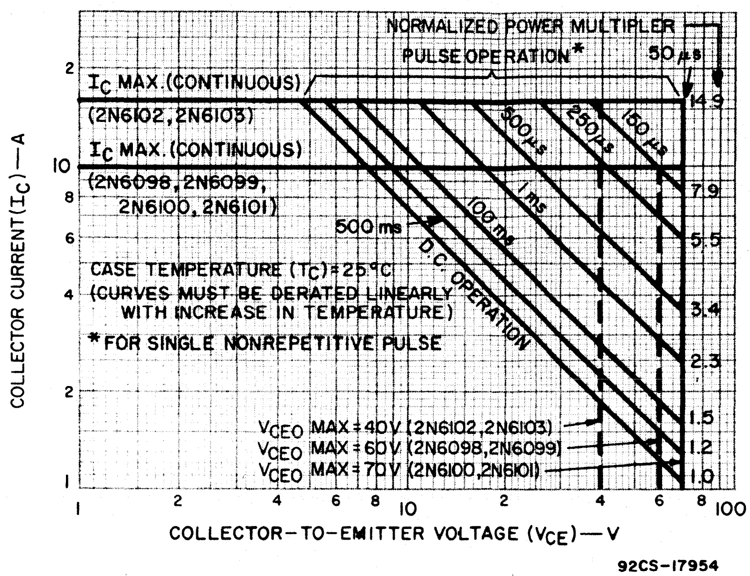


Fig. 4 — Maximum safe operating areas for 2N6098-2N6103, inclusive.

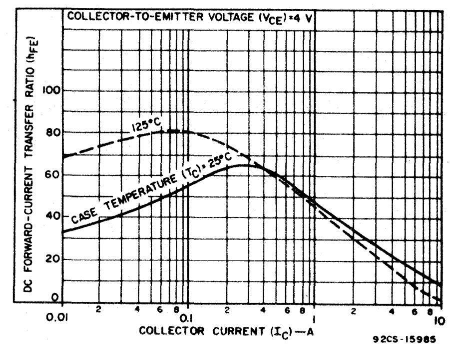


Fig. 5 - Typical dc-beta characteristics for 2N6098, 2N6099, and RCA3055.

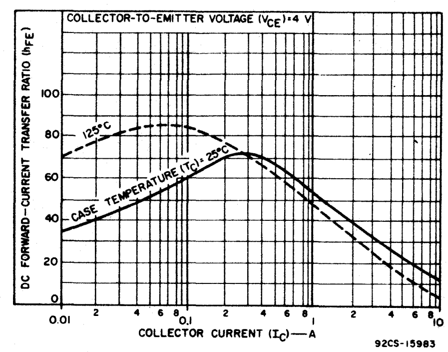


Fig. 6 - Typical dc beta characteristics for 2N6100 and 2N6101.

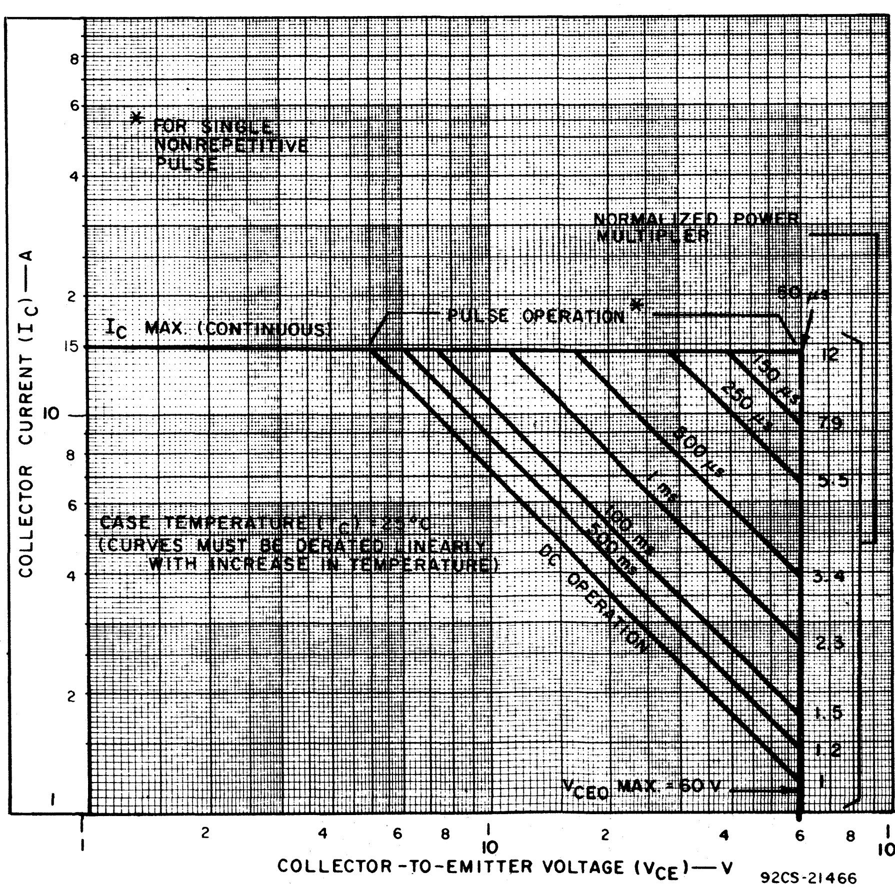


Fig. 7 - Maximum operating areas for RCA3055.

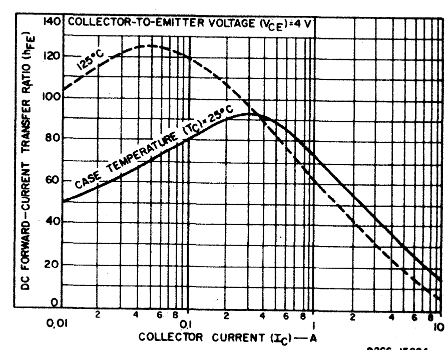


Fig. 8 - Typical dc beta characteristics for 2N6102 and 2N6103.

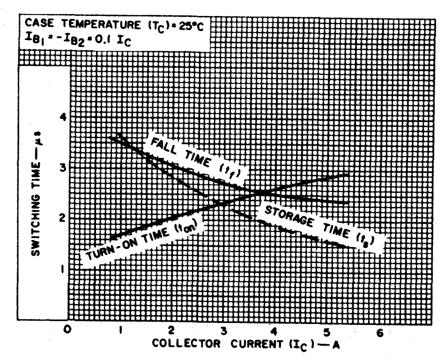


Fig. 9 - Typical saturated switching characteristics for all types.

2N6098-2N6103, RCA3055

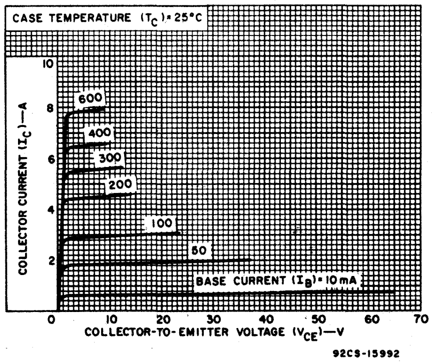


Fig. 10 - Typical output characteristics for 2N6098, 2N6099, and RCA3055.

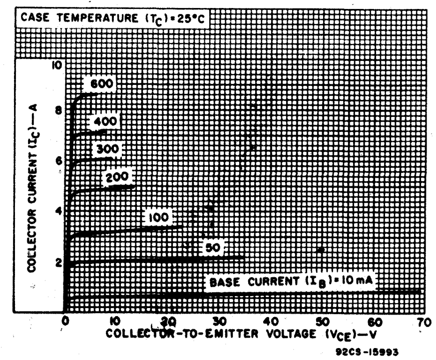


Fig. 11 - Typical output characteristics for 2N6100 and 2N6101.

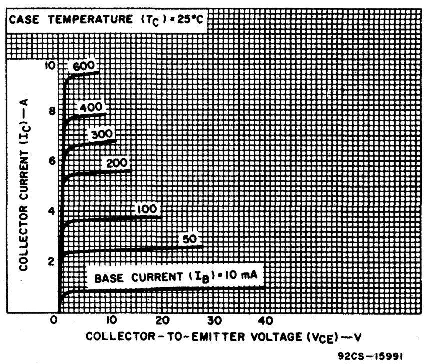


Fig. 12 - Typical output characteristics for 2N6102 and 2N6103.

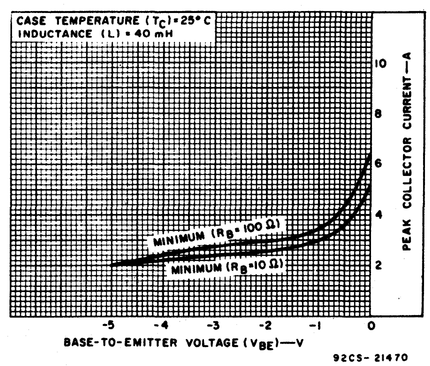


Fig. 13 - Reverse-bias second-breakdown characteristics for all types.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

General-Purpose Medium-Power Types for Switching and Amplifier Applications

RCA 2N6106-2N6111, 2N6288-2N6293, and 2N6473-2N6476, 41500 and 41501 are epitaxial-base silicon transistors supplied in a VERSAWATT package. The 2N6288-2N6293, 2N6473, 2N6474, and 41500 are n-p-n complements of p-n-p types 2N6106-2N6111, 2N6475, 2N6476, and 41501, respectively. All these transistors are intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

The 2N6289, 2N6291, and 2N6293 n-p-n types and 2N6106, 2N6108, and 2N6110 p-n-p devices fit into TO-66 sockets. The remaining types are supplied in the JEDEC TO-220AB straight-lead version of the VERSAWATT package. All of these devices are also available on special order in a variety of lead-form configurations. Detailed information on these and other VERSAWATT outlines is contained in "RCA's Lineup of Power Transistors" (PSP-704).

Features:

- Low saturation voltages
- VERSAWATT package (molded silicone plastic)
- Complementary n-p-n and p-n-p types
- Thermal-cycling ratings
- Maximum safe-area-of-operation curves specified for dc operation

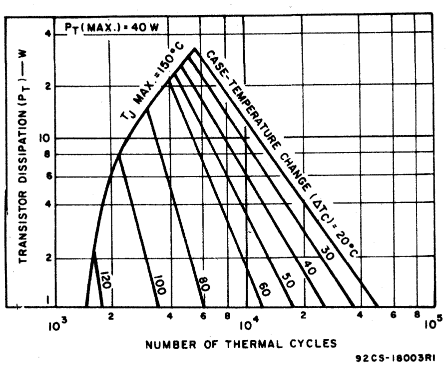
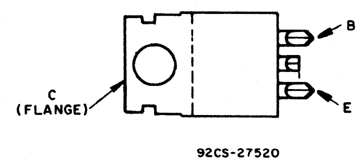
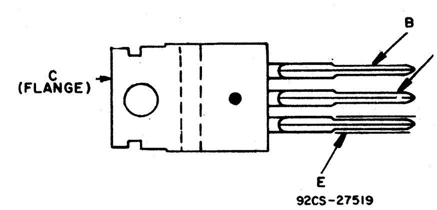


Fig. 1 - Thermal-cycling ratings for all types.

TERMINAL DESIGNATIONS



JEDEC TO-220AA
2N6106, 2N6108, 2N6110
2N6289, 2N6291, 2N6293



JEDEC TO-220AB
2N6107, 2N6109, 2N6111,
2N6288, 2N6290, 2N6292,
2N6473, 2N6474, 2N6475,
2N6476, 41500, 41501

BOTTOM VIEW

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	N-P-N	2N6288 2N6289	2N6290 2N6291	2N6292 2N6293	2N6473	2N6474	41500	
	P-N-P	2N6110♦ 2N6111♦	2N6108♦ 2N6109♦	2N6106♦ 2N6107♦	2N6475♦	2N6476♦	41501♦	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	60	80	110	130	35	V
*COLLECTOR-TO-EMITTER VOLTAGE:								
With external base-supply resistance (R_{BB}) = 100Ω, and base supply voltage (V_{BB}) = 0	V_{CEX}	40	60	80	110	130	35	V
With base open	V_{CEO}	30	50	70	100	120	25	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	5	3	V
*COLLECTOR CURRENT (Continuous)								
At case temperature ⩽ 106°C	I_C	7	7	7	4	4	7	A
*BASE CURRENT (Continuous)								
At case temperature ⩽ 130°C	I_B	3	3	3	2	2	3	A
TRANSISTOR DISSIPATION:	P_T							
At case temperatures up to 25°C		40	40	40	40	40	40	W
* At case temperatures up to 100°C		16	16	16	16	16	16	W
At ambient temperatures up to 25°C		1.8	1.8	1.8	1.8	1.8	1.8	W
At case temperatures above 25°C		Derate linearly at 0.32 W/°C						
* At case temperatures above 100°C		Derate lineraly at 0.32 W/°C						
At ambient temperatures above 25°C		Derate linearly at 0.0144 W/°C						
*TEMPERATURE RANGE:								
Storage and Operating (Junction)		−65 to 150						°C
*LEAD TEMPERATURE (During Soldering):								
At distance ⩾ 1/8 in. (3.17 mm) from case for 10 s max.		235						°C

* 2N-Series types in accordance with JEDEC registration data format (JS-6, RDF-2)

♦For p-n-p devices, voltage and current values are negative

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	CURRENT A dc I_B	LIMITS 2N6288 2N6289 MIN.	2N6288 2N6289 MAX.	2N6110♦ 2N6111♦ MIN.	2N6110♦ 2N6111♦ MAX.	UNITS
Collector-Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	35				–	0.1	–	–0.1	mA
With (R_{BE}) = 100 Ω and T_C = 150°C	I_{CER}	30				–	2	–	–2	mA
* With base-emitter junction reverse-biased	I_{CEX}	37.5	–1.5			–	0.1	–	–0.1	mA
* With base-emitter junction reverse-biased and T_C = 150°C	I_{CEX}	30	–1.5			–	2	–	–2	mA
* With base open	I_{CEO}	20			0	–	1	–	–1	mA
* Emitter-Cutoff Current	I_{EBO}		5	0		–	1	–	–1	mA
* Collector-to-Emitter Sustaining Voltage: With base open	V_{CEO}(sus)			0.1[a]	0	30	–	–30	–	V
With external base-to emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)			0.1		40	–	–40	–	V
* DC Forward Current Transfer Ratio	h_{FE}	4 4		3[a] 7[a]		30 2.3	150 –	30 2.3	150 –	
* Base-to-Emitter Voltage: 2N6288, 2N6289 All Types	V_{BE}	4 4		3[a] 7[a]		– –	1.5 3	– –	– 3	V
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			3[a] 7[a]	0.3 3	– –	1 3.5	– –	–1 –3.5	V
* Common-Emitter, Small-Signal, Forward-Current Transfer Ratio: f = 50 kHz	h_{fe}	4		0.5		20	–	20	–	
Gain-Bandwidth Product: 2N6288-2N6289 2N6110-2N6111	f_T	4 –4		0.5 –0.5		4 –	– –	– 10	– –	MHz
* Magnitude of Common-Emitter, Small-Signal, Forward-Current Transfer Ratio: f = 1 MHz 2N6288-2N6289 2N6110-2N6111	$\|h_{fe}\|$	4 –4		0.5 –0.5		4 –	– –	– 10	– –	
* Collector-to-Base Capacitance: f = 1 MHz, V_{CB} = 10 V	C_{obo}			0		–	250	–	250	pF
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	3.125	–	3.125	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	70	–	70	°C/W

[a]Pulsed: Pulse duration = 300 μs, duty factor = 0.018. ♦For p-n-p devices, voltage and current values are negative.

*In accordance with JEDEC registration data format (JS-6 RDF-2).

CAUTION: The sustaining voltage V_{CER}(sus) MUST NOT be measured on a curve tracer.

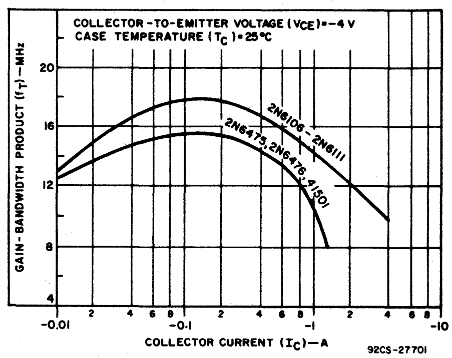


Fig. 2 - Typical gain-bandwidth product for 2N6106–2N6111, 2N6475, 2N6476, and 41501.

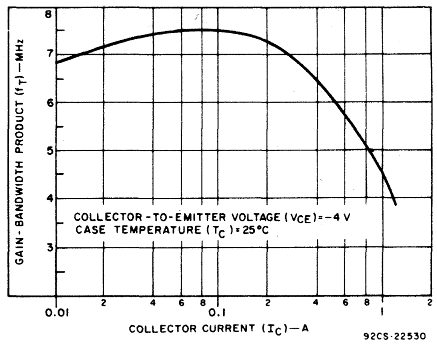


Fig. 3 - Typical gain-bandwidth product for 2N6473 and 2N6474.

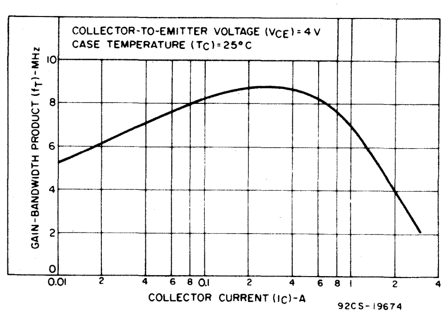


Fig. 4 - Typical gain-bandwidth product for 2N6288–2N6293, and 41500.

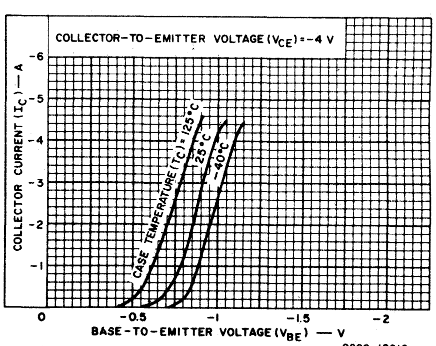


Fig. 5 - Typical transfer characteristics for 2N6106–2N6111.

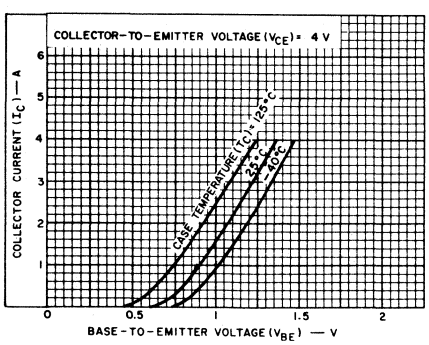


Fig. 6 - Typical transfer characteristics for 2N6473 and 2N6474.

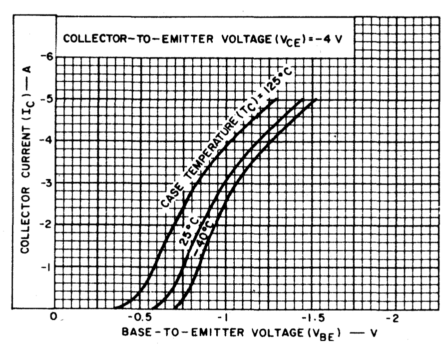


Fig. 7 - Typical transfer characteristics for 2N6475 and 2N6476.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

	CHARACTERISTIC	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6292, 2N6293, 2N6106♦, 2N6107♦ MIN.	MAX.	2N6290, 2N6291, 2N6108♦, 2N6109♦ MIN.	MAX.	UNITS
	I_{CER} (R_{BE} = 100Ω)	75 55				– –	0.1 –	– –	– 0.1	mA
	(T_C = 150°C)	70 50				– –	2 –	– –	– 2	mA
*	I_{CEX}	75 56	−1.5 −1.5			– –	0.1 –	– –	– 0.1	mA
*	(T_C = 150°C)	70 50	−1.5 −1.5			– –	2 –	– –	– 2	mA
*	I_{CEO}	40 60			0 0	– –	– 1	– –	1 –	mA
*	I_{EBO}		−5	0		–	1	–	1	mA
*	V_{CEO}(sus)			0.1[a]	0	70	–	50	–	V
	V_{CER}(sus) (R_{BE} = 100Ω)			0.1		80	–	60	–	V
*	h_{FE}	4 4 4		2[a] 2.5[a] 7[a]		30 – 2.3	150 – –	– 30 2.3	– 150 –	
*	V_{BE} 2N6292, 2N6293 2N6290, 2N6291 All Types	4 4 4		2[a] 2.5[a] 7[a]		– – –	1.5 – 3	– – –	– 1.5 3	V
*	V_{CE}(sat)			2[a] 2.5[a] 7[a]	0.2 0.25 3[a]	– – –	1 – 3.5	– – –	– 1 3.5	V
*	h_{fe} (f = 50 kHz)	4		0.5		20	–	20	–	
	f_T 2N6290 - 2N6293 2N6106 - 2N6109	4 −4		0.5 -0.5		4 10	– –	4 10	– –	MHz
*	$\|h_{fe}\|$ (f = 1 MHz) 2N6290 - 2N6293 2N6106 - 2N6109	4 −4		0.5 -0.5		4 10	– –	4 10	– –	
*	C_{obo} (f = 1 MHz, V_{CB} = 10 V)			0		–	250	–	250	pF
	$R_{\theta JC}$					–	3.125	–	3.125	°C/W
	$R_{\theta JA}$					–	70	–	70	°C/W

[a]Pulsed; pulse duration = 300 μs, duty factor = 0.018.

♦For p-n-p devices, voltage and current values are negative

* In accordance with JEDEC registration data format (JS-6 RDF-2).

CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer.

2N6106-2N6111, 2N6288-2N6293, 2N6473- 2N6476, 41500, 41501

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS♦				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6474 2N6476♦		2N6473 2N6475♦		41500 41501♦		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CER} (R_{BE} = 100Ω)	30				–	–	–	–	–	0.25	mA
	120				–	0.1	–	–	–	–	
	100				–	–	–	0.1	–	–	
(T_C = 100°C)	120				–	2	–	–	–	–	
	100				–	–	–	2	–	–	
I_{CEX}	120	−1.5			–	0.1	–	–	–	–	mA
	100	−1.5			–	–	–	0.1	–	–	
(T_C = 100°C)	120	−1.5			–	2	–	–	–	–	
	100	−1.5			–	–	–	2	–	–	
I_{CEO}	60			0	–	1	–	–	–	–	mA
	50			0	–	–	–	1	–	–	
I_{EBO}		−5	0		–	1	–	1	–	–	mA
		−3	0		–	–	–	–	–	1	
V_{CEO}(sus)			0.1[a]	0	120	–	100	–	25	–	V
V_{CER}(sus) (R_{BE} = 100Ω)			0.1		130	–	110	–	35	–	V
h_{FE}	4		1[a]		–	–	–	–	25	–	
	4		1.5[a]		15	150	15	150	–	–	
	2.5		4[a]		2	–	2	–	–	–	
V_{BE}	4		1[a]		–	–	–	–	–	1.5	V
	4		1.5[a]		–	2	–	2	–	–	
	2.5		4[a]		–	3.5	–	3.5	–	–	
V_{CE}(sat)			1[a]	0.1	–	–	–	–	–	1	V
			1.5[a]	0.15	–	1.2	–	1.2	–	–	
			4[a]	2	–	2.5	–	2.5	–	–	
h_{fe} (f = 50 kHz)	4		0.5		20	–	20	–	20	–	
f_T 41500, 2N6473, 2N6474	4		0.5		4	–	4	–	4	–	MHz
41501, 2N6475, 2N6476	−4		−0.5		10	–	10	–	10	–	
$\|h_{fe}\|$ (f = 1 MHz) 41500, 2N6473, 2N6474	4		0.5		4	–	4	–	4	–	
41501, 2N6475, 2N6476	−4		−0.5		10	–	10	–	10	–	
C_{obo} (f = 1 MHz, V_{CB} = 10 V)			0		–	250	–	250	–	250	pF
$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	°C/W
$R_{\theta JA}$					–	70	–	70	–	70	

[a]Pulsed; pulse duration = 300 μs, duty factor = 0.018. ♦For p-n-p devices, voltage and current values are negative.

*2N-series types in accordance with JEDEC registration data format (JS-6 RDF-2).

CAUTION: The sustaining voltage V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

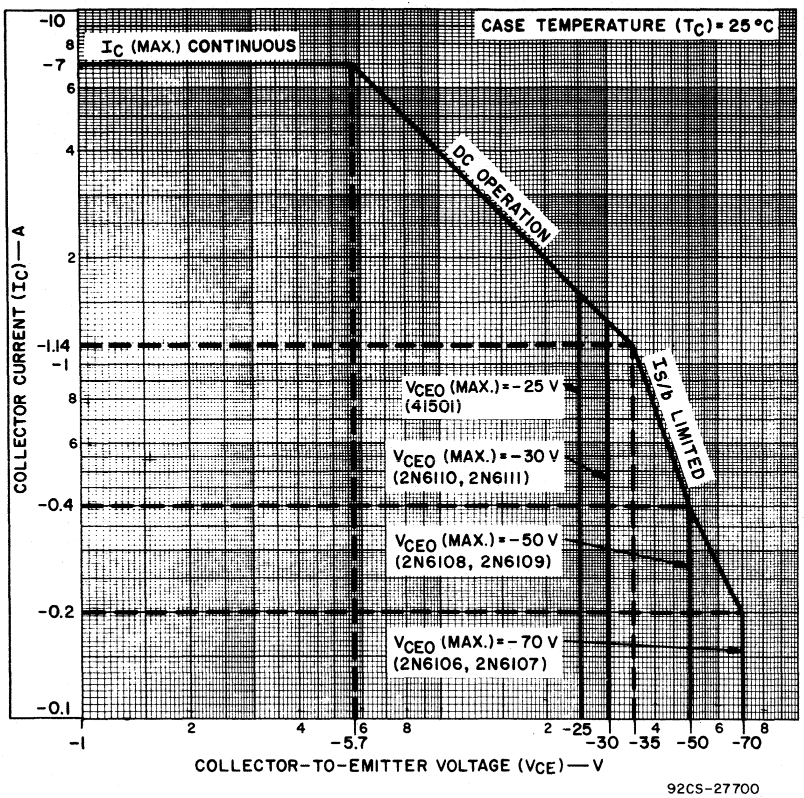


Fig. 8 - Maximum operating areas for 2N6106—2N6111 and 41501.

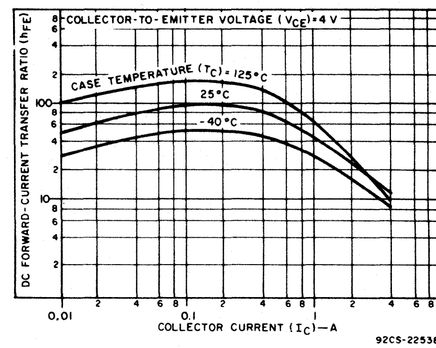


Fig. 9 - Typical dc beta characteristics for 2N6473 and 2N6474.

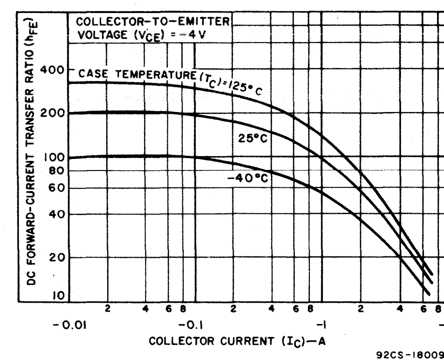


Fig. 10 - Typical dc beta characteristics for 2N6106—2N6111.

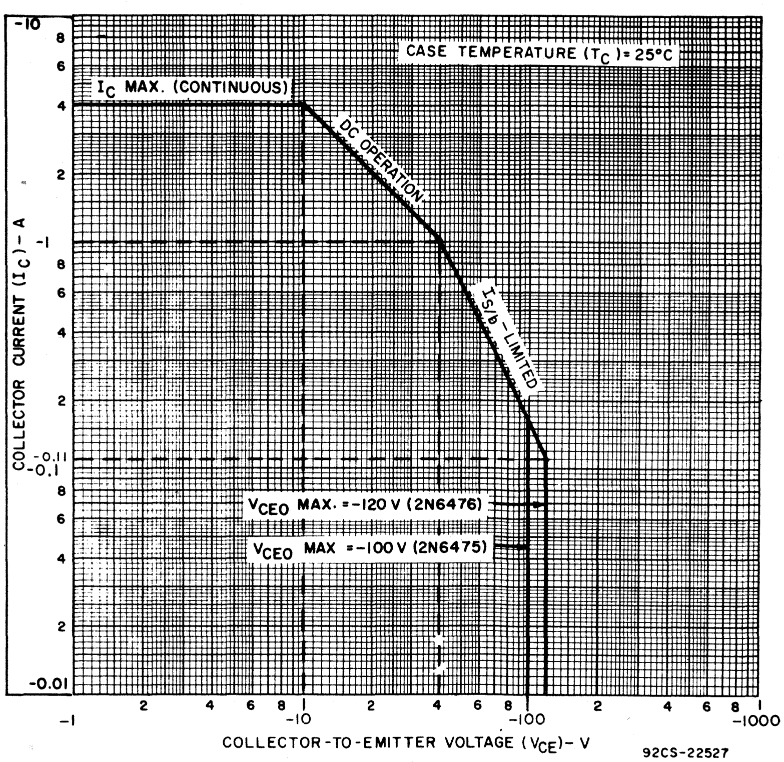


Fig. 11 - Maximum operating areas for 2N6475—2N6476.

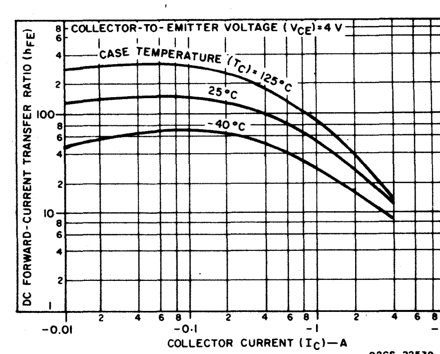


Fig. 12 - Typical dc beta characteristics for 2N6475 and 2N6476.

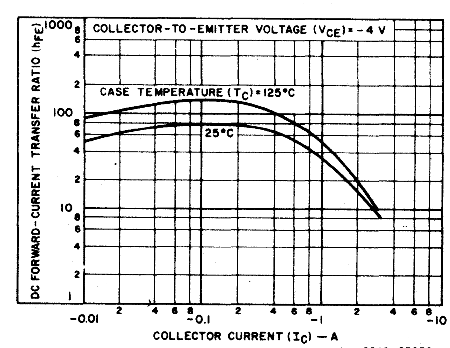


Fig. 13 - Typical dc beta characteristics for 41501.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

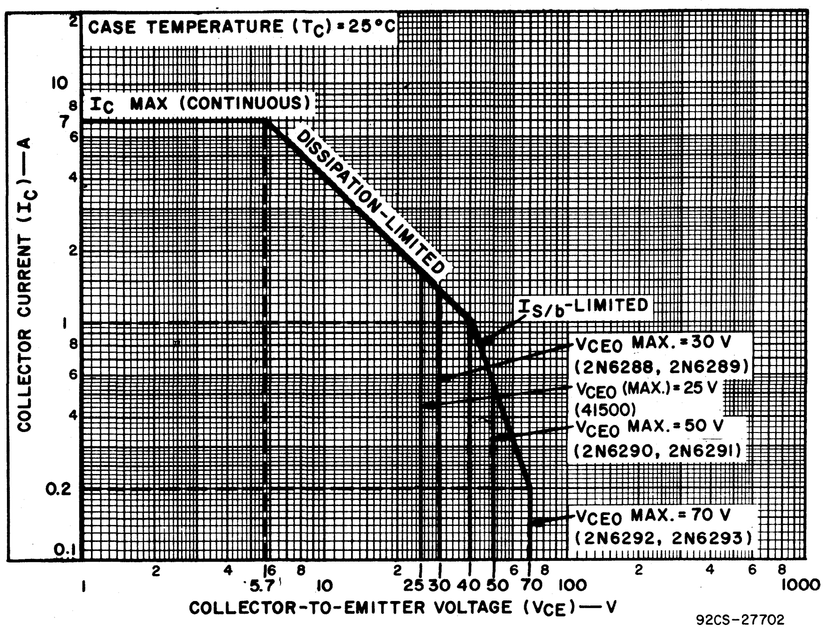


Fig. 14 - Maximum operating areas for 2N6288—2N6293 and 41500.

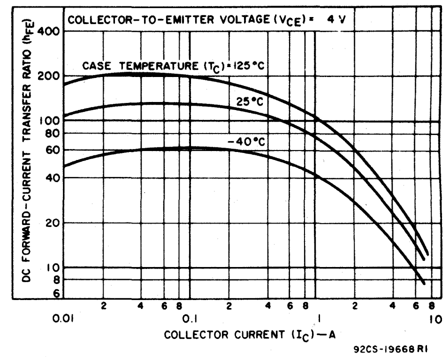


Fig. 15 - Typical dc beta characteristics for 2N6288—2N6293, and 41500.

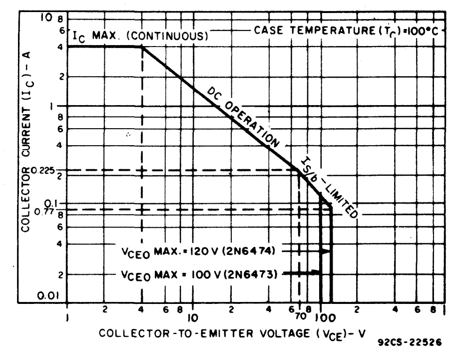


Fig. 16 - Maximum operating areas for 2N6473—2N6474.

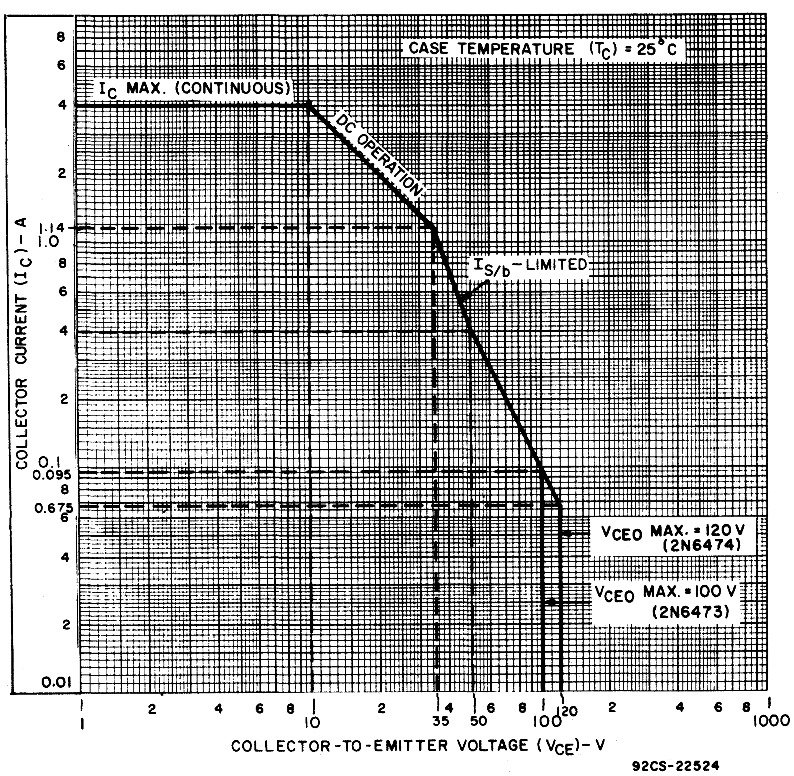


Fig. 17 - Maximum operating areas for 2N6473 and 2N6474.

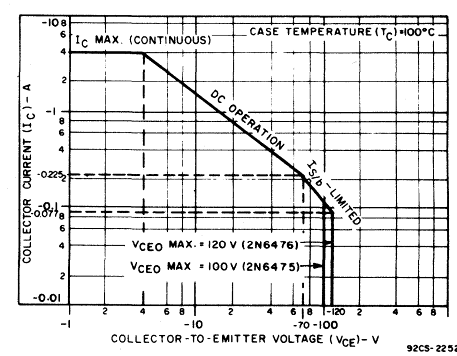


Fig. 18 - Maximum operating areas for 2N6475 and 2N6476.

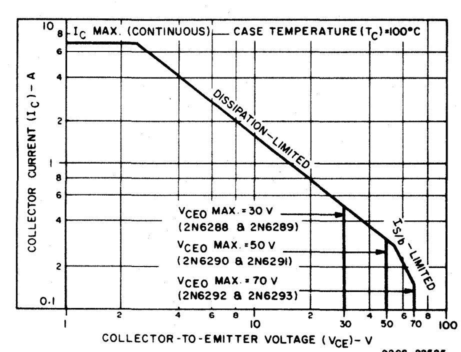


Fig. 19 - Maximum operating areas for 2N6288—2N6293.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476, 41500, 41501

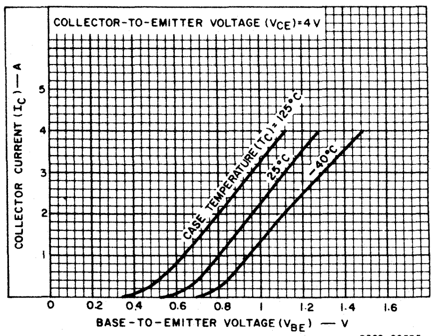


Fig. 20 - Typical transfer characteristics for 2N6288–2N6293, and 41500.

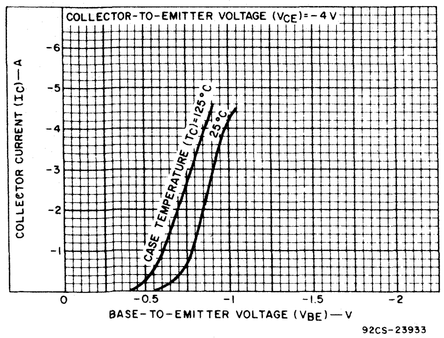


Fig. 21 - Typical transfer characteristics for 41501.

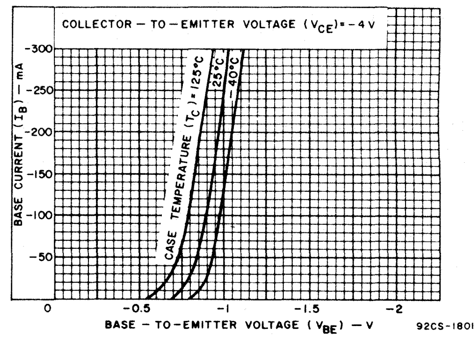


Fig. 22 - Typical input characteristics for 2N6106–2N6111, 2N6475, and 2N6476.

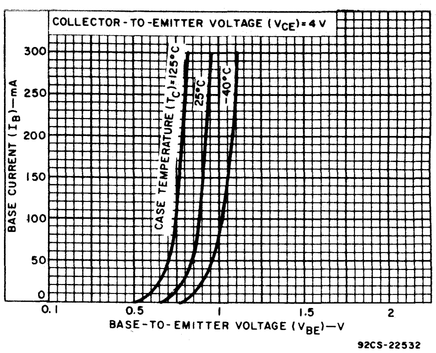


Fig 23 - Typical input characteristics for 2N6473 and 2N6474.

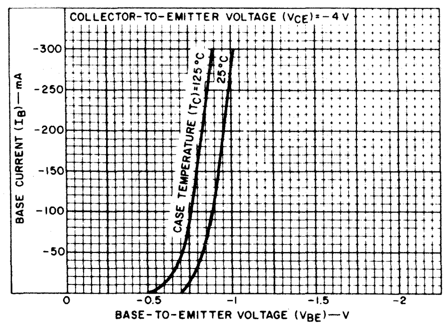


Fig. 24 - Typical input characteristics for 41501.

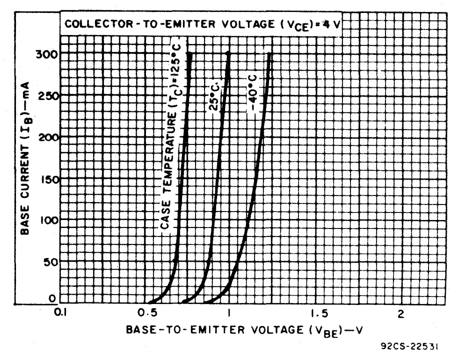


Fig. 25 - Typical input characteristics for 2N6288–2N6293.

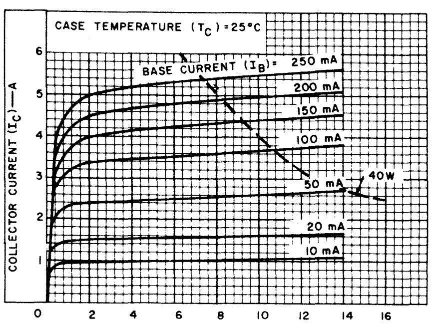


Fig. 26 - Typical output characteristics for 2N6288–2N6293, and 41500.

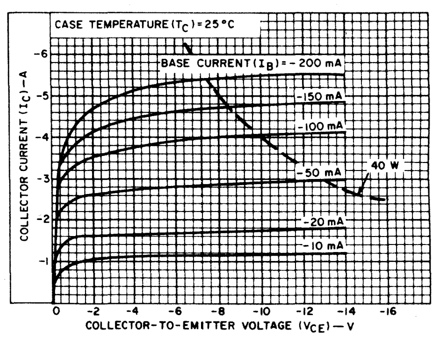


Fig. 27 - Typical output characteristics for 2N6106–2N6111.

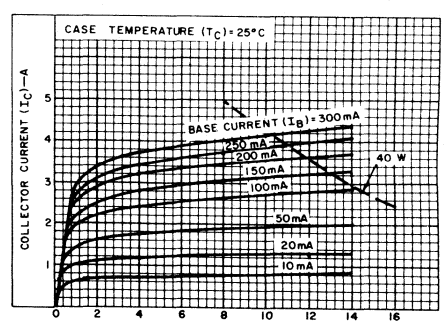


Fig. 28 - Typical output characteristics for 2N6473 and 2N6474.

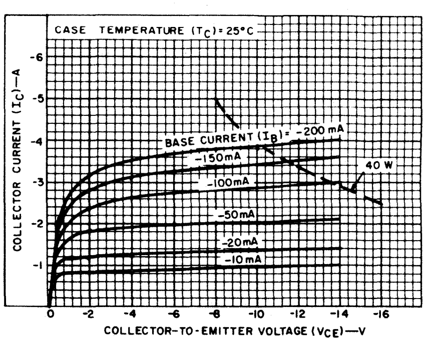


Fig. 29 - Typical output characteristics for 2N6475 and 2N6476.

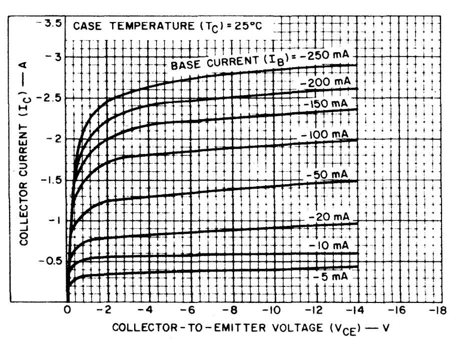


Fig. 30 - Typical output characteristics for 41501.

2N6175-2N6177, 40885-40887, 41505

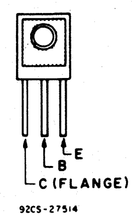
High-Voltage, Medium-Power Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

RCA types 2N6175, 2N6176, 2N6177 and 41505 are silicon n-p-n transistors with high breakdown voltages, high frequency response, and fast switching speeds. They are supplied in the RCA "Plastic TO-5" package. Types 40885, 40886, and 40887 are electrically identical to the 2N6175-2N6177, respectively, but are supplied with factory-attached heat clips.

Typical applications for these devices include TV video output, RGB output, chroma output, TV blanking, solenoid drivers, off-line inverters, regulators, audio output, and electrostatic deflection in display circuits.

TERMINAL DESIGNATIONS



"Plastic TO-5"

NOTE: Terminal designations are the same for all types, including those with heat clips.

Features:

- **Thermal fatigue ratings**
- **High frequency response: f_T = 20 MHz**
- **Maximum area-of-operation curves for DC and pulse operation**
- **Designed to assure freedom from second breakdown in class A, B, and C operation at maximum ratings**
- **High voltage ratings:**
  $V_{CEO}(sus)$ = 350 V max. (2N6177, 40887)
  = 300 V max. (2N6176, 40886)
  = 250 V max. (2N6175, 40885)
  = 200 V max. (41505)
- **Low saturation voltage**

MAXIMUM RATINGS, *Absolute-Maximum Values:*		2N6175 40885	2N6176 40886	2N6177 40887	41505	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	300	350	450	–	V
*COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE	$V_{CEO}(sus)$	250	300	350	200	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	7	V
*COLLECTOR CURRENT	I_C	1.0	1.0	1.0	1.0	A
*BASE CURRENT	I_B	0.5	0.5	0.5	0.5	A
*TRANSISTOR DISSIPATION	P_T					
At case temperatures up to 25°C		20	20	20	20	W
			(2N6175, 2N6176, 2N6177, 41505)			
At case temperatures above 25°C			Derate linearly to 135°C			
At ambient temperatures up to 25°C		0.8	0.8	0.8	0.8	W
			(2N6175, 2N6176, 2N6177, 41505)			
		1.4	1.4	1.4	–	W
			(40885, 40886, 40887)			
At ambient temperatures above 25°C			Derate linearly to 135°C			
For pulse operation			See Figs. 4, 7, 10, and 13			
*TEMPERATURE RANGE:						
Storage & Operating (Junction)			–65 to 135			°C
*LEAD TEMPERATURE (During soldering):						
At distance ≥ 1/16 in. (1.59 mm) from case for 10 s max.			230			°C

*Types 2N6175, 2N6176, and 2N6177 in accordance with JEDEC registration data format JS-9 RDF-8.

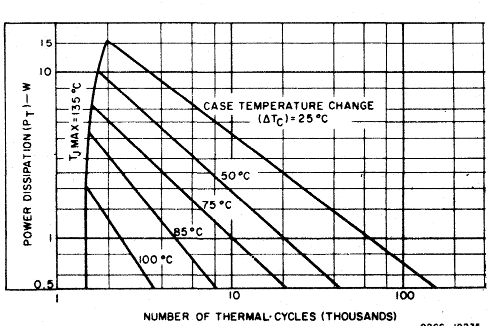


Fig. 1 - Thermal-cycling rating chart for all types.

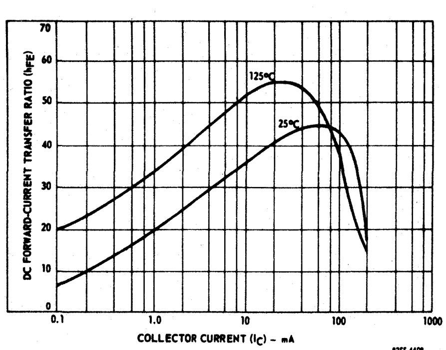


Fig. 2 - Typical dc beta characteristics for all types.

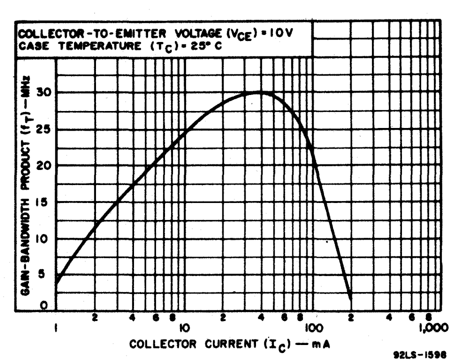


Fig. 3 - Typical gain-bandwidth product for all types.

2N6175-2N6177, 40885-40887, 41505

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CB}	V_{CE}	CURRENT mA dc I_C	I_B	LIMITS 2N6175 40885 MIN.	MAX.	2N6176 40886 MIN.	MAX.	2N6177 40887 MIN.	MAX.	41505 MIN.	MAX.	UNITS
I_{CEO}		300		0	–	–	–	–	–	20	–	–	µA
		200		0	–	50	–	50	–	–	–	–	
* I_{CBO}	360				–	–	–	–	–	20	–	–	
	280				–	–	–	50	–	–	–	–	
	240				–	50	–	–	–	–	–	–	
I_{CEV} (V_{BE} = -1.5 V)		450			–	–	–	–	–	500	–	–	
		300			–	500	–	500	–	–	–	–	
I_{CER} (R_{BE} = 100Ω)		150			–	–	–	–	–	–	–	50	
* I_{EBO} (V_{BE} = -6 V)			0		–	20	–	20	–	20	–	–	µA
h_{FE}		10	50[a]		–	–	–	–	30*	150	20	–	
		10	20[a]		30*	190	30*	150	–	–	–	–	
		10	5[a]		–	–	15	–	15	–	10	–	
		10	1[a]		15	–	–	–	–	–	–	–	
V_{CEO}(sus)			10[a]	0	–	–	–	–	–	–	200[b]	–	V
			50[a]	0	250[b]	–	300[b]	–	350[b]	–	–	–	
V_{BE}(sat)			50[a]	4	–	1.3	–	1.3	–	1.3	–	–	V
V_{CE}(sat)			50[a]	4	–	0.5	–	0.5	–	0.5	–	–	V
			50[a]	5	–	–	–	–	–	–	–	2	
* $V_{(BR)CBO}$			1[a]		300	–	350	–	450	–	–	–	V
$V_{(BR)EBO}$			0	1	–	–	–	–	–	–	7	–	V
* h_{fe} (f = 1 kHz)		10	5		25	–	25	–	25	–	–	–	
* $\|h_{fe}\|$ (f = 3 MHz)		20	20		7	–	7	–	7	–	–	–	
* Re(h_{ie}) (f = 1 MHz)		20	20		–	300	–	–	–	–	–	–	Ω
		10	5		–	–	–	300	–	300	–	–	
* C_{cb} (f = 1 MHz)	20				–	8	–	8	–	8	–	8	pF
$I_{S/b}$ (t = 0.4 s nonrepetitive)		150			133	–	133	–	133	–	–	–	mA
$R_{\theta JC}$					–	5.5	–	5.5	–	5.5	–	5.5	
					(2N6175)		(2N6176)		(2N6177)				
$R_{\theta JA}$					–	138	–	138	–	138	–	138	°C/W
					(2N6175)		(2N6176)		(2N6177)		–	–	
					–	78.6	–	78.6	–	78.6	–	–	
					(40885)		(40886)		(40887)		–	–	

* Types 2N6175, 2N6176, and 2N6177 in accordance with JEDEC registration data format JS-9, RDF-8.

[a] Pulsed; pulse duration = 300 µs; duty factor ≤ 2%.

[b] CAUTION: The sustaining voltage V_{CEO}(sus) MUST NOT be measured on a curve tracer.

2N6175-2N6177, 40885-40887, 41505

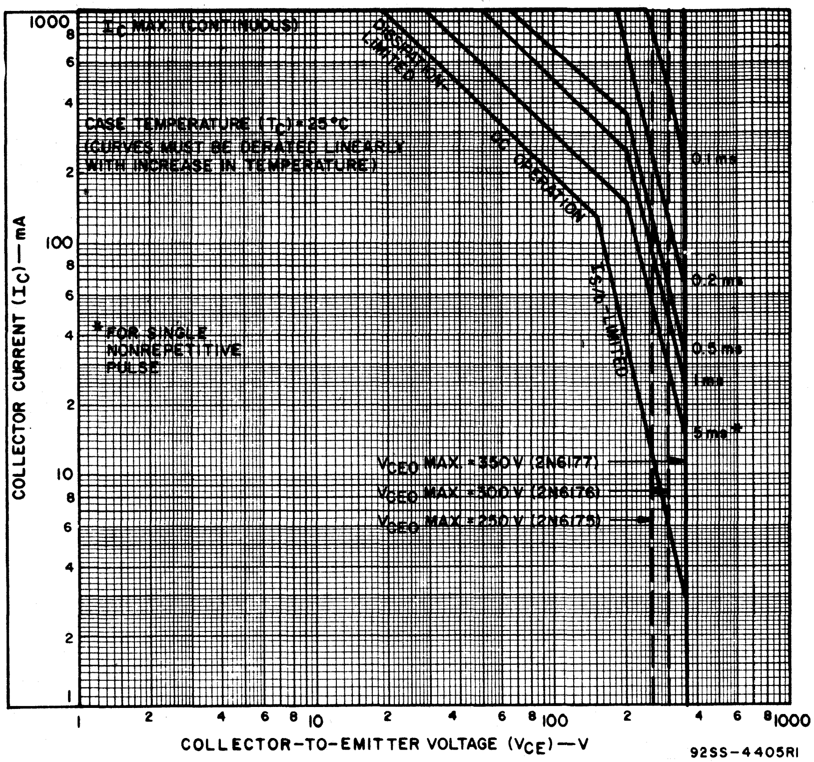


Fig. 4 - Maximum safe-operation-areas for 2N6175, 2N6176, and 2N6177.

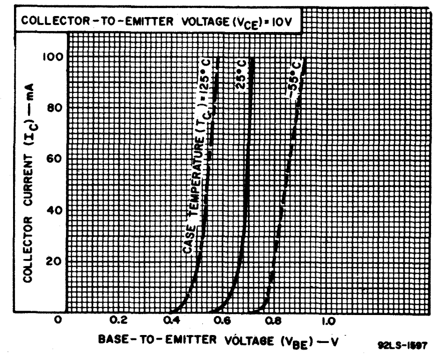


Fig. 5 - Typical transfer characteristics for 2N6175–2N6177 and 40885–40887.

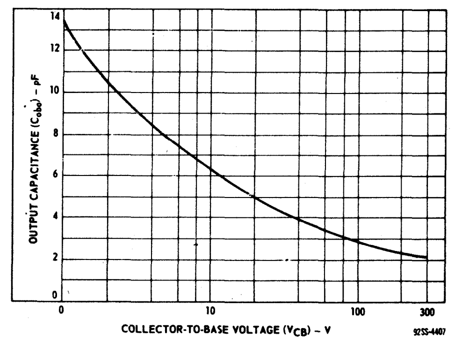


Fig. 6 - Typical output capacitance as a function of collector-to-base voltage for all types.

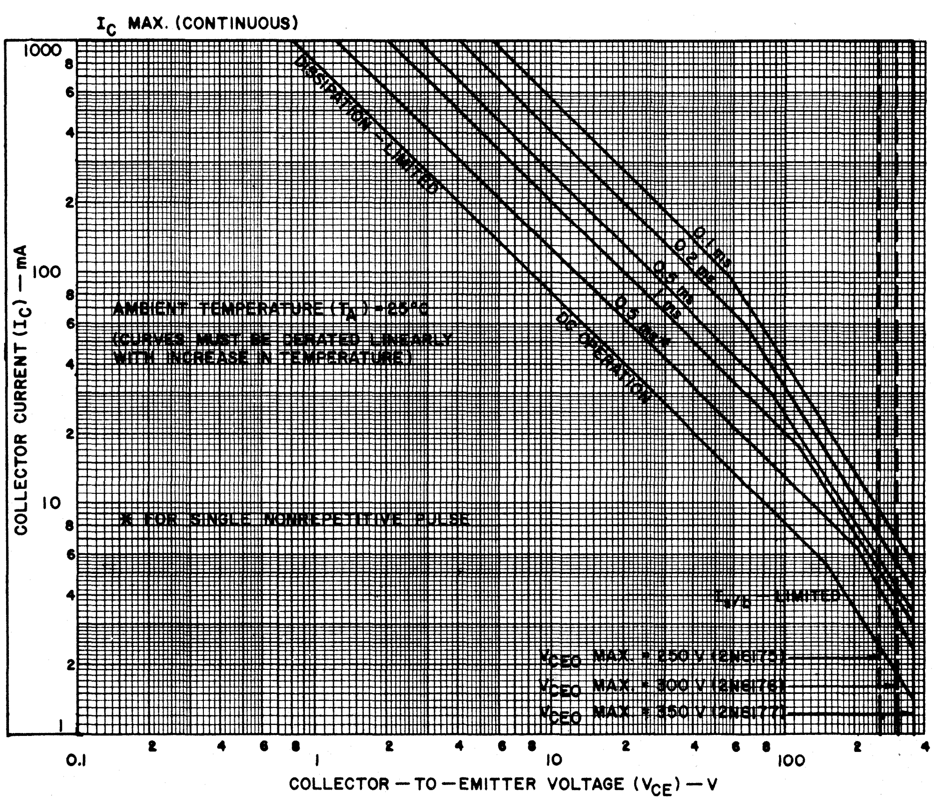


Fig. 7 - Maximum safe area-of-operation at ambient temperature for 2N6175, 2N6176, and 2N6177.

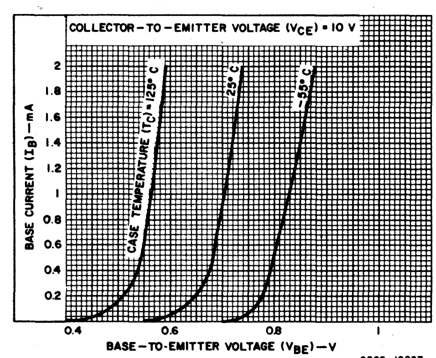


Fig. 8 — Typical input characteristics for 2N6175–2N6177 and 40885–40887.

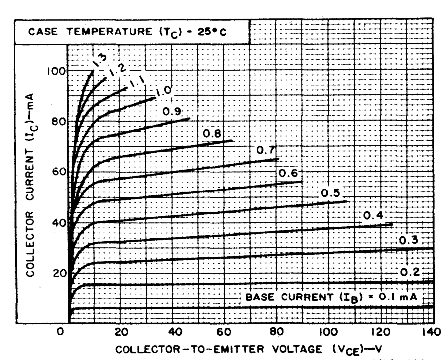


Fig. 9 - Typical output characteristics for 2N6175-2N6177 and 40885-40887.

2N6175-2N6177, 40885-40887, 41505

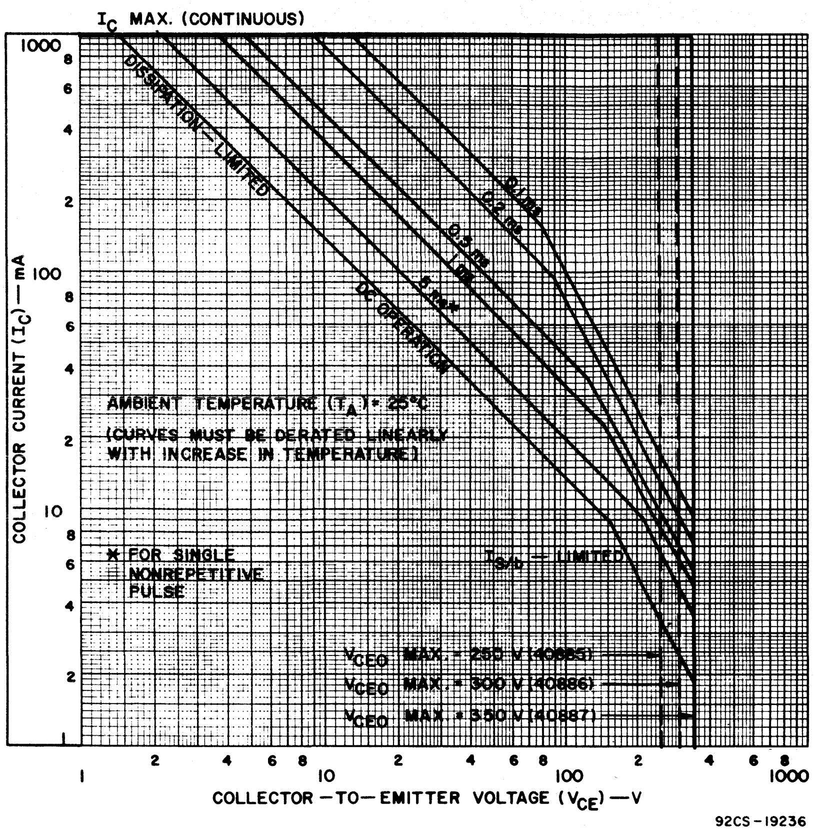


Fig. 10 - Maximum safe area-of-operation for 40885, 40886, and 40887.

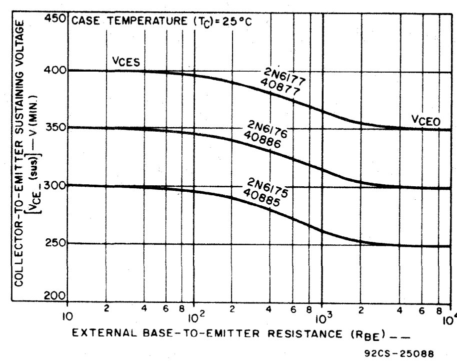


Fig. 11 - Sustaining voltage as a function of base-to-emitter resistance for 2N6175-2N6177 and 40885-40887.

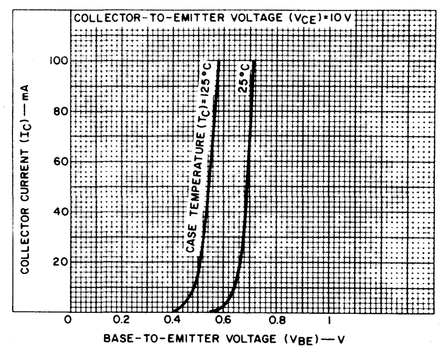


Fig. 12 - Typical transfer characteristics for 41505.

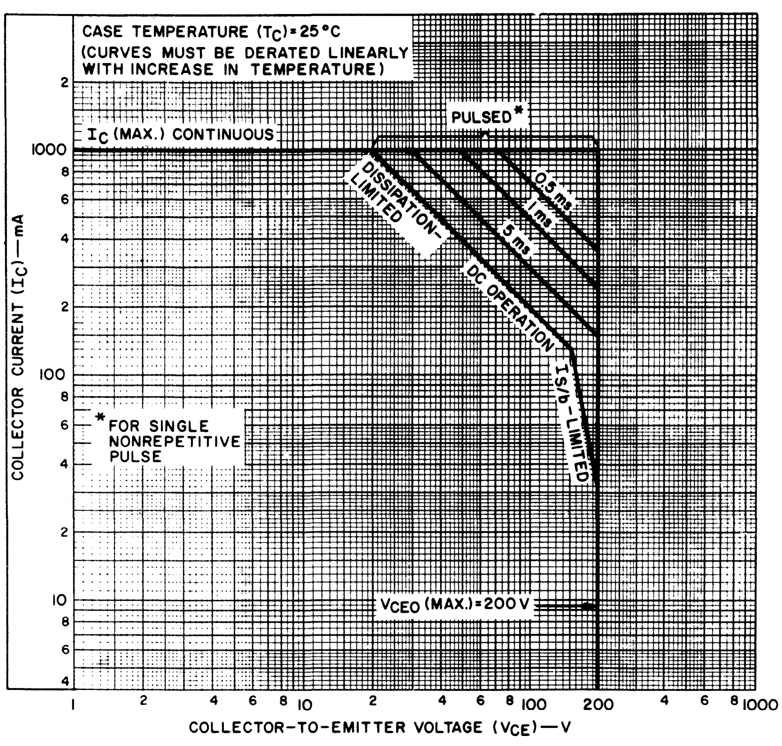


Fig. 13 - Maximum operating areas for 41505.

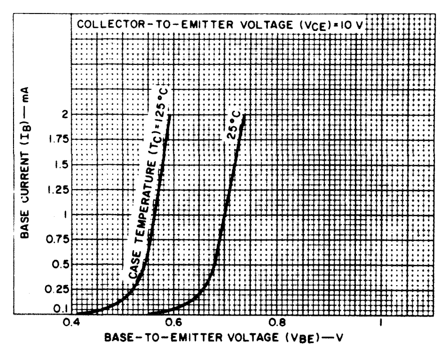


Fig. 14 - Typical input characteristics for 41505.

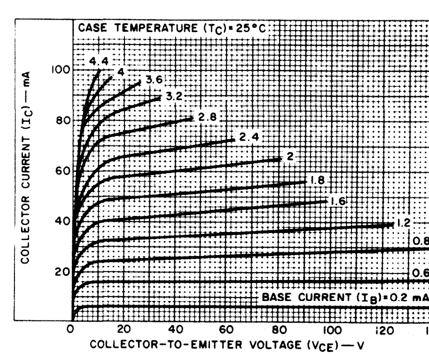


Fig. 15 - Typical output characteristics for 41505.

2N6178-2N6181
Complementary N-P-N/P-N-P Silicon Power Transistors

General-Purpose Types for Large-Signal, Medium-Power Applications

RCA types 2N6178, 2N6179, 2N6180, and 2N6181● are silicon power transistors intended for large-signal, medium-power applications in industrial and commercial equipment.

The 2N6178 and 2N6179 are silicon n-p-n planar types with features similar to the popular 2N2102. Types 2N6180 and 2N6181 (p-n-p complements of the 2N6178 and 2N6179, respectively) are epitaxial-planar devices with features similar to the 2N4036. All these transistors feature higher collector-current ratings and dissipation capability than their 2N2102/2N4036 counterparts.

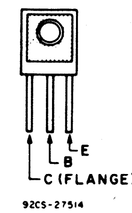
These types are supplied in the "Plastic TO-5" package, which has an insulated mounting hole for ease of mounting and heat sinking.

● Formerly RCA Dev. Nos. TA7554–TA7557, respectively.

Features:

- 2N6180, 2N6181 P–N–P Complements of: 2N6178, 2N6179
- Maximum safe-area-of-operation curves
- Planar construction for low-noise and low-leakage characteristics
- Low saturation voltage (2N6178, 2N6180)
- High beta (2N6179, 2N6181)

TERMINAL DESIGNATIONS



"Plastic TO-5"

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6179	2N6181	2N6178	2N6180	
* V_{CBO}	75	–75	100	–100	V
* V_{CEX}					
V_{BE} = 1.5 V reverse bias	75	–75	100	–100	V
$V_{CER}(sus)$					
R_{BE} = 100 Ω	65	–65	90	–90	V
$V_{CEO}(sus)$	50	–50	75	–75	V
* V_{EBO}	5	–5	7	–7	V
* I_C	2	–2	2	–2	A
* I_B	1	–1	1	–1	A
* P_T:					
$T_C \leqslant$ 25°C	25	25	25	25	W
> 25°C	See Figs.1,2,&7				
$\leqslant$ 100°C	10	10	10	10	W
> 100°C	See Figs.3,4, &7				
* T_J	–65 to 150				°C
* T_L					
During soldering, at distance $\geqslant$ 1/32 in (0.8 mm) from seating plane for 10 s max.	230				°C

* In accordance with JEDEC registration data format JS-6/RDF-1.

N-P-N

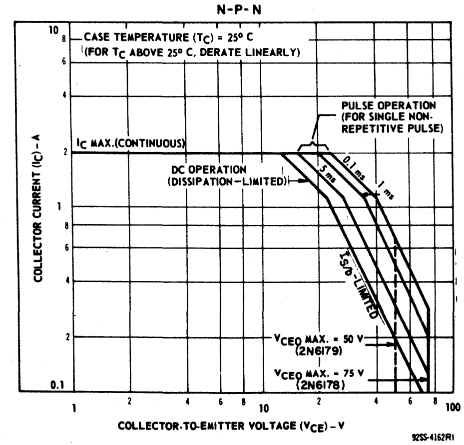


Fig.1 – Maximum operating areas for 2N6178 and 2N6179 at T_C = 25°C.

P-N-P

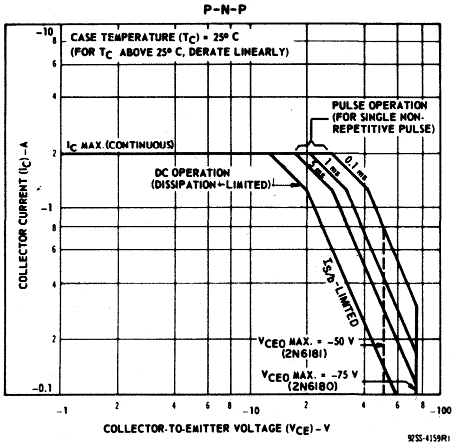


Fig.2 – Maximum operating areas for 2N6180 and 2N6181 at T_C = 25°C.

N-P-N

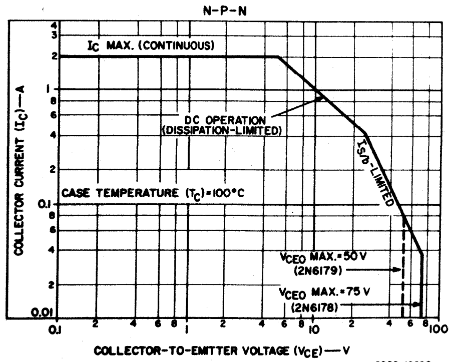


Fig.3 – Maximum operating areas for 2N6178 and 2N6179 at T_C = 100°C.

P-N-P

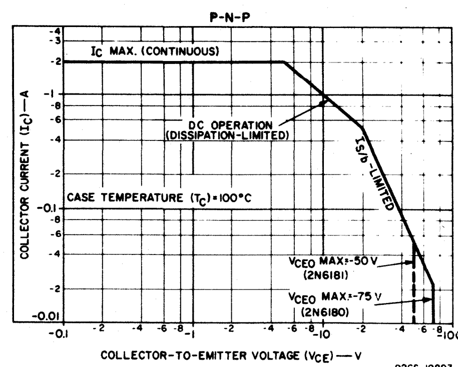


Fig.4 – Maximum operating areas for 2N6180 and 2N6181 at T_C = 100°C.

2N6178-2N6181

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS♦					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		2N6178 2N6180♦		2N6179 2N6181♦		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO} $I_E = 0$	80 60					– –	0.5 –	– –	– 0.5	µA
I_{CEO}		60 45			0 0	– –	1 –	– –	– 1	
* I_{CEV}		100 75	−1.5 −1.5			– –	0.1 –	– –	– 0.1	mA
$T_C = 100°C$		70 45	−1.5 −1.5			– –	0.5 –	– –	– 0.5	
* I_{EBO}			−7 −5	0 0		– –	0.1 –	– –	– 0.1	mA
$V_{(BR)EBO}$ $I_E = 0.1$ A				0		7	–	5	–	V
* $V_{(BR)CEV}$			−1.5	0.1		100	–	75	–	V
* $V_{(BR)CEO}$				100	0	75	–	50	–	V
V_{CER}(sus)[a] $R_{BE} = 100\ \Omega$				100		90	–	65	–	V
V_{CEO}(sus)[a]				100	0	75	–	50	–	V
* V_{CE}(sat) 2N6178 2N6179 2N6180 2N6181				 500 500 −500 −500	 50 50 −50 −50	 – – – –	 0.5 – −0.7 –	 – – – –	 – 0.8 – −1.2	V
* V_{BE}(sat)				500	50	–	1.2	–	1.5	V
C_{obo} f = 1 MHz 2N6178,2N6179 2N6180,2N6181	 10 −10					 12 25	 20 40	 12 25	 20 40	pF
* h_{FE} 2N6179 2N6181 2N6178 2N6180 2N6179 2N6181 2N6178 2N6180		 4 −4 4 −4 4 −4 4 −4		 50 −50 500[b] −500[b] 500[b] −500[b] 1000[b] −1000[b]		 – – 30 30 – – 10 10	 – – 130 150 – – – –	 30 30 – – 40 40 – –	 – – – – 250 250 – –	
$I_{S/b}$ t = 0.4s,nonrep. 2N6178,2N6179 2N6180,2N6181		 50 −50				 200 −150	 – –	 200 −150	 – –	mA
f_T		4		50		50	–	50	–	MHz
* $\|h_{fe}\|$ f = 10 MHz		4		50		5	–	5	–	

* In accordance with JEDEC registration data format JS-6/RDF-1.

♦ For p-n-p devices, voltage and current values are negative.

a CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer.

b Pulsed; pulse duration ≤ 300 µs, duty factor ≤ 0.02.

N-P-N

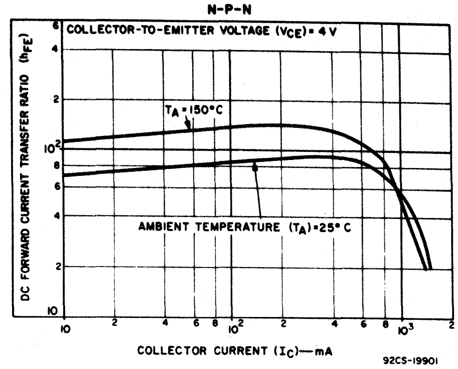


Fig. 5 - Typical dc beta characteristics for 2N6178 and 2N6179.

P-N-P

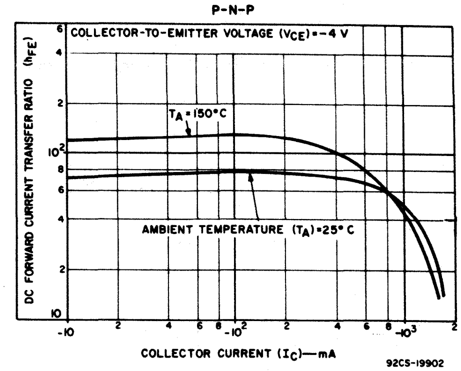


Fig. 6 - Typical dc beta characteristics for 2N6180 and 2N6181.

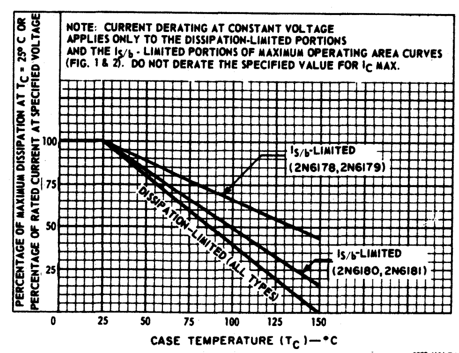


Fig. 7 - Derating curves for all types.

N-P-N

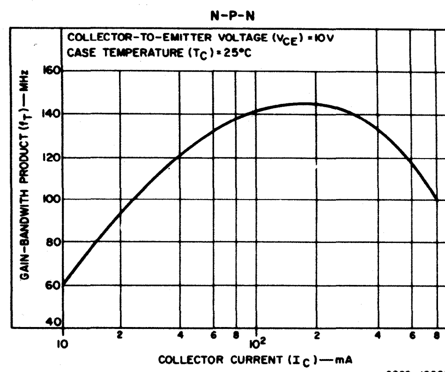


Fig. 8 - Typical gain-bandwidth product for 2N6178 and 2N6179.

2N6178-2N6181

ELECTRICAL CHARACTERISTICS (Cont'd)

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		2N6178 2N6180♦		2N6179 2N6181♦		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
* t_{ON} V_{CC} = 30 V										ns
2N6178,2N6179				500	50	–	80	–	80	
2N6180,2N6181				–500	–50	–	100	–	100	
* t_{OFF} V_{CC} = 30 V										
2N6178,2N6179				500	50	–	800	–	800	
2N6180,2N6181				–500	–50	–	1000	–	1000	
$R_{\theta JC}$						–	5	–	5	°C/W
$R_{\theta JA}$						–	156	–	156	

* In accordance with JEDEC registration data format JS-6/RDF-1.

♦ For p-n-p devices, voltage and current values are negative.

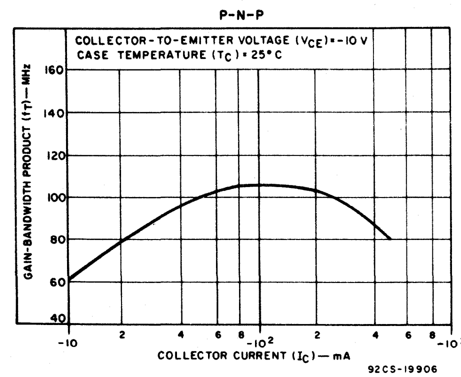


Fig. 9 - Typical gain-bandwidth product for 2N6180 and 2N6181.

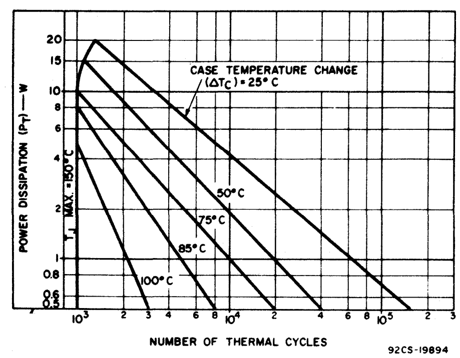


Fig. 10 - Thermal-cycling rating chart for all types.

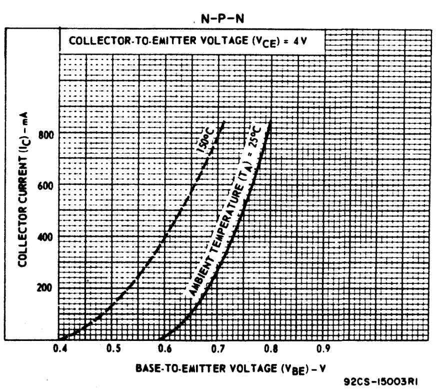


Fig. 11 - Typical transfer characteristics for 2N6178 and 2N6179.

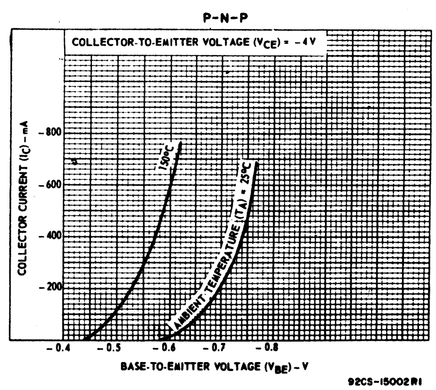


Fig. 12 - Typical transfer characteristics for 2N6180 and 2N6181.

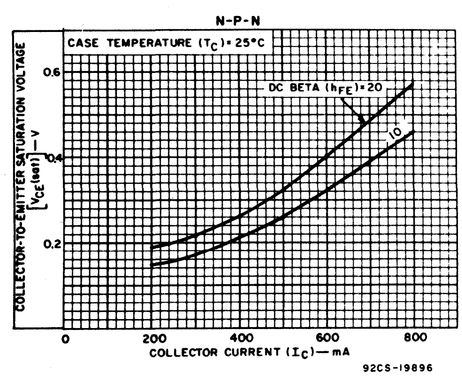


Fig. 13 - Typical saturation-voltage characteristics for 2N6178 and 2N6179.

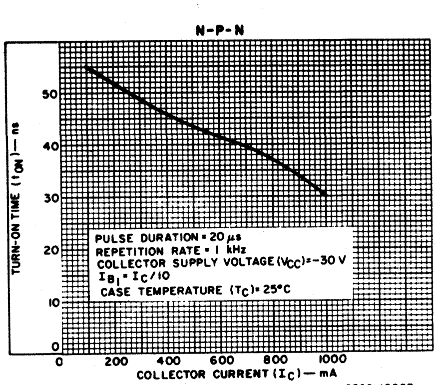


Fig. 14 - Typical turn-on time for 2N6178 and 2N6179.

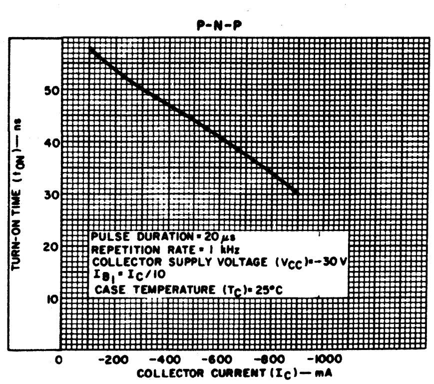


Fig. 15 - Typical turn-on time for 2N6180 and 2N6181.

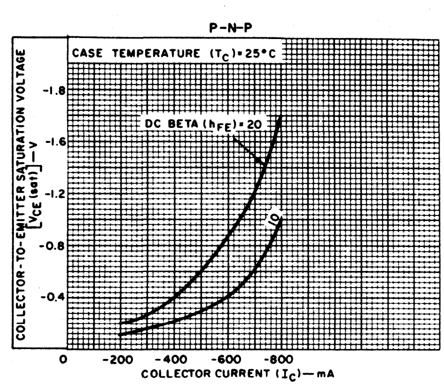


Fig. 16 - Typical saturation-voltage characteristics for 2N6180 and 2N6181.

2N6178-2N6181

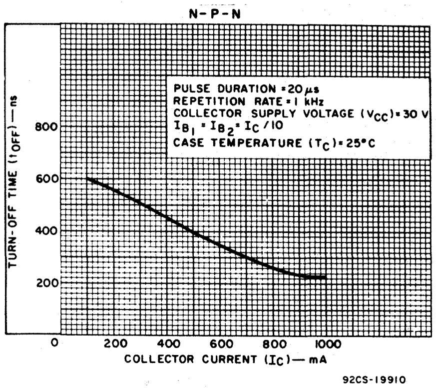


Fig. 17 - Typical turn-off time for 2N6178 and 2N6179.

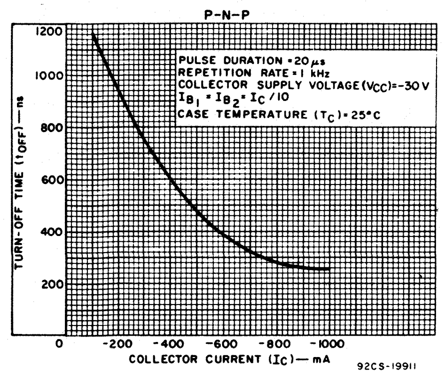


Fig. 18 - Typical turn-off time for 2N6180 and 2N6181.

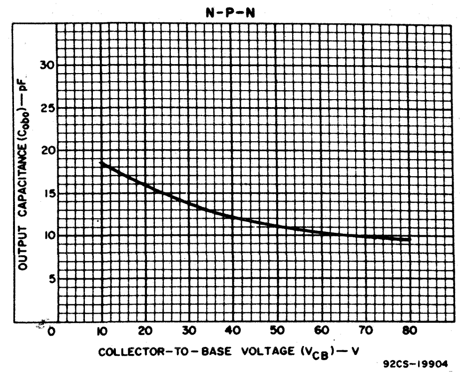


Fig. 19 - Typical output capacitance as a function of collector-to-base voltage for 2N6178 and 2N6179.

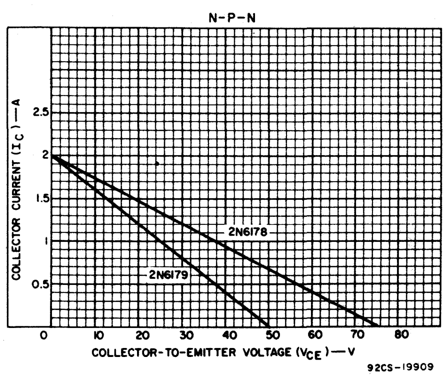


Fig. 20 - Maximum operating conditions, resistive-load switching between saturation and cutoff for 2N6178 and 2N6179.

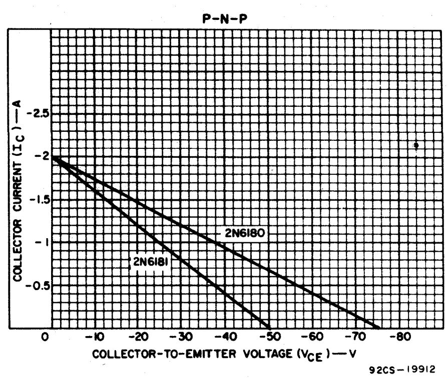


Fig. 21 - Maximum operating conditions, resistive-load switching between saturation and cutoff for 2N6180 and 2N6181.

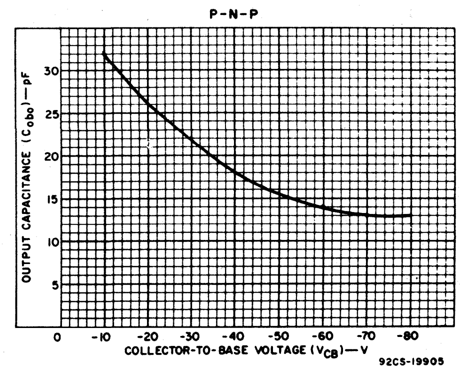


Fig. 22 - Typical output capacitance as a function of collector-to-base voltage for 2N6180 and 2N6181.

2N6211-2N6214

High-Voltage Medium-Power Silicon P-N-P Transistors

For Switching and Amplifier Applications
In Military, Industrial, and Commercial Equipment

Features:

- **High voltage ratings:**
  $V_{CEO}(sus)$ = −400 V max. (2N6214)
  = −350 V max. (2N6213)
  = −300 V max. (2N6212)
  = −225 V max. (2N6211)
- **Large safe-operating area**
- **Complements to 2N3585 transistor family**
- **Thermal-cycling rating**

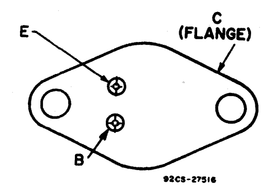
RCA types 2N6211, 2N6212, 2N6213, and 2N6214• are epitaxial silicon p-n-p transistors with high breakdown-voltage ratings and fast switching speeds. They are supplied in the popular JEDEC TO-66 package; they differ in breakdown-voltage ratings and leakage-current values.

• Formerly RCA Dev. Nos. TA7719, TA7410, TA8330, and TA8331, respectively.

Applications:

- **Power-Switching Circuits**
- **Switching Regulators**
- **Converters**
- **Inverters**
- **High-Fidelity Amplifiers**

TERMINAL DESIGNATIONS



JEDEC TO-66

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6211	2N6212	2N6213	2N6214	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−275	−350	−400	−450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With base open	$V_{CEO}(sus)$	−225	−300	−350	−400	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$	−250	−325	−375	−425	V
* With base-emitter junction reverse-biased (V_{BE} = 1.5 V)	$V_{CEX}(sus)$	−275	−350	−400	−450	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	−6	−6	−6	−6	V
*COLLECTOR CURRENT (Continuous)	I_C	−2	−2	−2	−2	A
*BASE CURRENT (Continuous)	I_B	−1	−1	−1	−1	A
TRANSISTOR DISSIPATION:	P_T					
* At case temperatures up to 100°C and V_{CE} up to 50 V		20	20	20	20	W
At case temperatures up to 25°C and V_{CE} up to 40 V		35	35	35	35	W
At case temperatures up to 25°C and V_{CE} above 40 V			See Fig. 1			
At case temperatures above 25°C			Derate linearly to 200°C			
*TEMPERATURE RANGE:						
Storage & Operating (Junction)			−65 to 200			°C
*LEAD TEMPERATURE (During Soldering):						
At distance ≥ 1/32 in. (0.8 mm) from case for 10s max.			230			°C

*In accordance with JEDEC registration data format (JS-6 RDF-1)

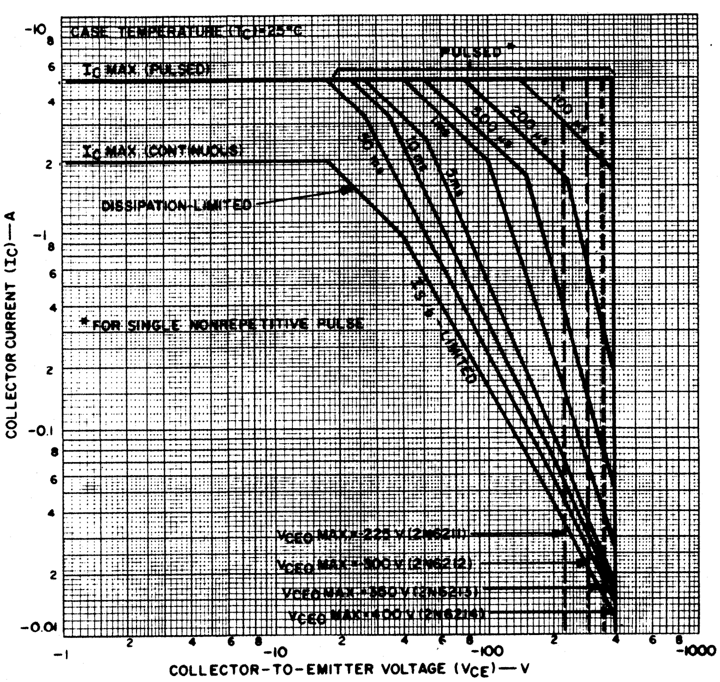


Fig. 1 - Maximum operating areas for all types.

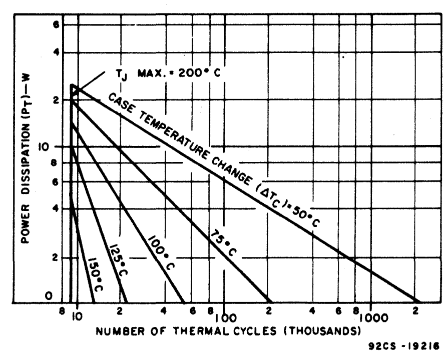


Fig. 2 - Thermal-cycling rating chart for all types.

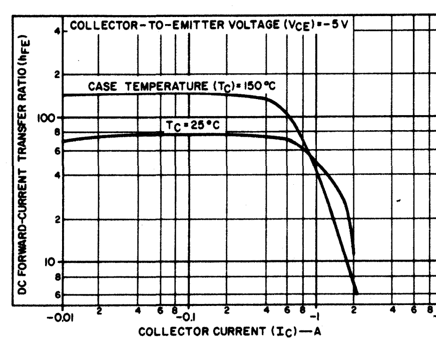


Fig. 3 - Typical dc beta characteristic for all types.

2N6211-2N6214

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS Voltage V dc V_{CE}	V_{BE}	Current A dc I_C	I_B	LIMITS 2N6211 Min.	2N6211 Max.	2N6212 Min.	2N6212 Max.	2N6213 Min.	2N6213 Max.	2N6214 Min.	2N6214 Max.	UNITS
Collector-Cutoff Current: With base open	I_{CEO}	−150			0	–	−5	–	−5	–	−5	–	−5	mA
• With base-emitter junction reverse-biased	I_{CEV}	−250	1.5			–	−0.5	–	–	–	–	–	–	mA
		−315	1.5			–	–	–	−0.5	–	–	–	–	mA
		−360	1.5			–	–	–	–	–	−0.5	–	–	mA
		−410	1.5			–	–	–	–	–	–	–	−1	mA
• With base-emitter junction reverse biased and T_C = 100°C	I_{CEV}	−250	1.5			–	−5	–	–	–	–	–	–	mA
		−315	1.5			–	–	–	−5	–	–	–	–	mA
		−360	1.5			–	–	–	–	–	−5	–	–	mA
		−410	1.5			–	–	–	–	–	–	–	−10	mA
• Emitter-Cutoff Current	I_{EBO}		6	0		–	−1	–	−0.5	–	−0.5	–	−0.5	mA
• DC Forward-Current Transfer Ratio	h_{FE}	−2.8		-1^a		10	100	–	–	–	–	–	–	
		−3.2		-1^a		–	–	10	100	–	–	–	–	
		−4		-1^a		–	–	–	–	10	100	–	–	
		−5		-1^a		–	–	–	–	–	–	10	100	
• Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			-0.2^a	0	−225	–	−300	–	−350	–	−400	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$			-0.2^a		−250	–	−325	–	−375	–	−425	–	V
With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CEX}(sus)$		1.5	-0.2^a		275	–	−350	–	−400	–	−450	–	V
• Emitter-to-Base Voltage	V_{EBO}				0.5 mA	–	–	−6	–	−6	–	−6	–	V
					1 mA	−6				–	–	–	–	V
• Emitter-to-Base Saturation Voltage	$V_{BE}(sat)$			-1^a	−0.125	–	−1.4	–	−1.4	–	−1.4	–	−1.4	V
• Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			-1^a	−0.125	–	1.4	–	−1.6	–	−2	–	−2.5	V
Output Capacitance (f = 1 MHz)	C_{obo}	−10 (V_{CB})				–	220	–	220	–	220	–	220	pF
Second-Breakdown Collector Current (Base forward-biased)	$I_{S/b}$	−40				−0.875	–	−0.875	–	−0.875	–	−0.875	–	A
• Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 5 MHz)	$\|h_{fe}\|$	−10		−0.2		4	–	4	–	4	–	4	–	
• Saturated Switching Times: Rise time	t_r	V_{CC} = −200 V		−1	I_{B1} & I_{B2} −0.125	–	0.6	–	0.6	–	0.6	–	0.6	μs
Storage time	t_s	V_{CC} = −200 V		−1	I_{B1} & I_{B2} −0.125	–	2.5	–	2.5	–	2.5	–	2.5	μs
Fall time	t_f	V_{CC} = −200 V		−1	I_{B1} & I_{B2} −0.125	–	0.6	–	0.6	–	0.6	–	0.6	μs
Thermal Resistance (Junction-to-case)	$R_{\theta JC}$	−10		−1		–	5	–	5	–	5	–	5	°C/W

• In accordance with JEDEC registration data format JS-6 RDF-1.

[a]Pulsed, pulse duration = 300 μs; duty factor ≤ 2%.

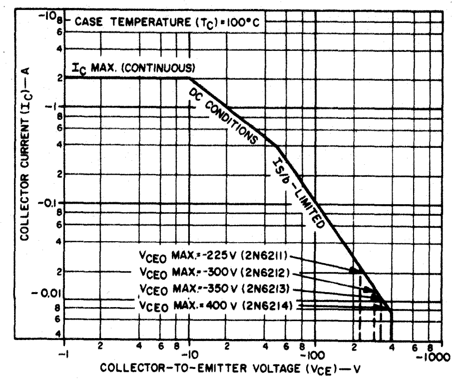


Fig. 4 - Maximum operating areas for all types.

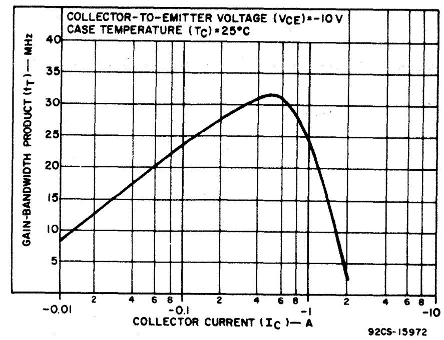


Fig. 5 - Typical gain-bandwidth product for all types.

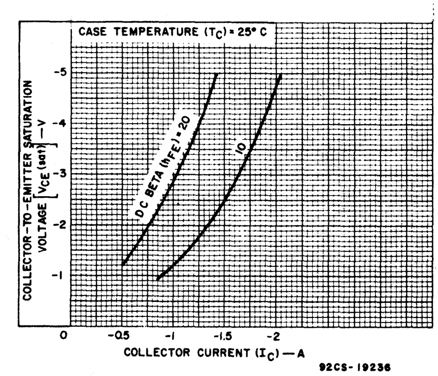


Fig. 6 - Typical saturation-voltage characteristics for all types.

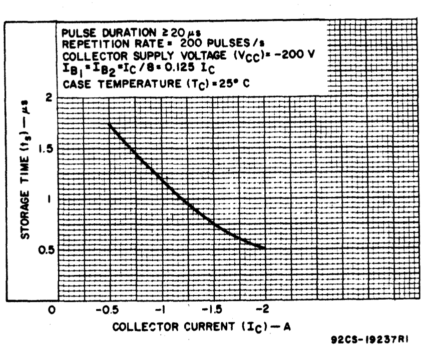


Fig. 7 - Typical storage-time characteristic for all types.

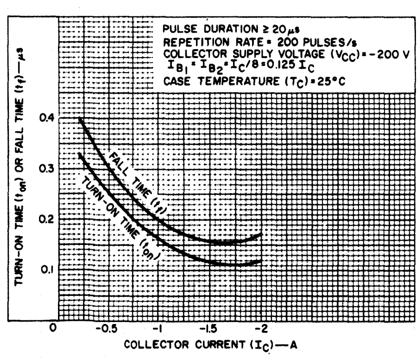


Fig. 8 - Typical turn-on time and fall-time characteristics for all types.

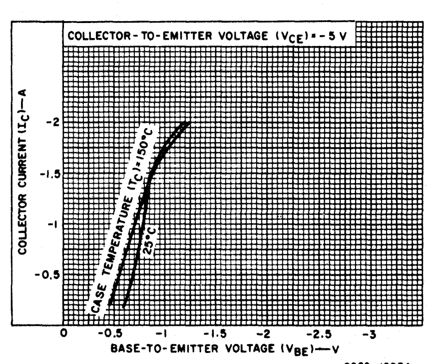


Fig. 9 - Typical transfer characteristics for all types.

2N6246, 2N6247, 2N6248, 2N6469, 2N6470, 2N6471, 2N6472

Silicon N-P-N and P-N-P Epitaxial-Base High-Power Transistors

General-Purpose Types for Switching and Linear-Amplifier Applications

RCA-2N6246, 2N6247, 2N6248, and 2N6469▲ are epitaxial-base silicon p-n-p transistors featuring high gain at high current. RCA-2N6470, 2N6471, and 2N6472● are epitaxial-base silicon n-p-n transistors. They may be used as complements to the 2N6469, 2N6246, and 2N6247, respectively. All of these devices have a dissipation capability of 125 watts at case temperatures up to 25°C. They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the JEDEC TO-3 package.

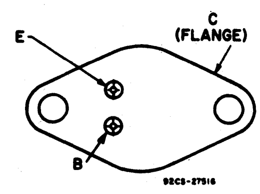
▲ Formerly RCA Dev. Nos. TA7281, TA7280, TA7279, and TA8724, respectively.

● Formerly RCA Dev. Nos. TA8726, TA8443, and TA8442, respectively.

Features:

- **High dissipation capability: 125 W at 25°C**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**
- **Hermetically sealed JEDEC TO-3 package**
- **High gain at high current**
- **Thermal-cycling rating curve**

TERMINAL DESIGNATIONS



JEDEC TO-3

Maximum Ratings, *Absolute-Maximum Values:*

		N-P-N: 2N6470 / P-N-P: 2N6469♦	N-P-N: 2N6471 / P-N-P: 2N6246♦	N-P-N: 2N6472 / P-N-P: 2N6247♦	P-N-P: 2N6248♦	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	70	90	110	V
COLLECTOR-TO-EMITTER VOLTAGE:						
* With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	50	70	90	110	V
With base open	V_{CEO}	40	60	80	100	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
*CONTINUOUS COLLECTOR CURRENT	I_C	15	15	15	10	A
*CONTINUOUS BASE CURRENT	I_B	5	5	5	5	A
*TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		125	125	125	125	W
At case temperatures above 25°C		← Derate linearly 200°C →				
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to +200 →				°C
*PIN TEMPERATURE (During Soldering):						
At distances ≥ 1/32" (0.8 mm) from seating plane for 10 s max.		← +235 →				°C

* In accordance with JEDEC registration data format (JS-6 RDF-2).

♦ For p-n-p devices, voltage and current values are negative.

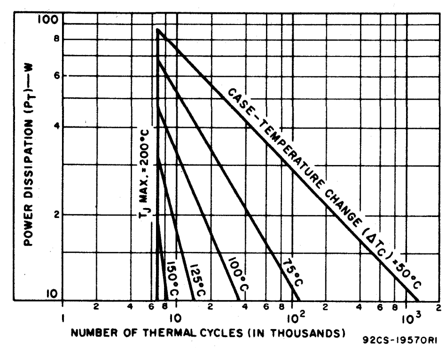


Fig. 1 - Thermal-cycling rating chart for all types.

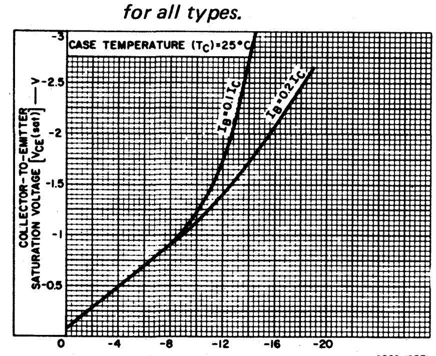


Fig. 2 - Typical collector-to-emitter saturation-voltage characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

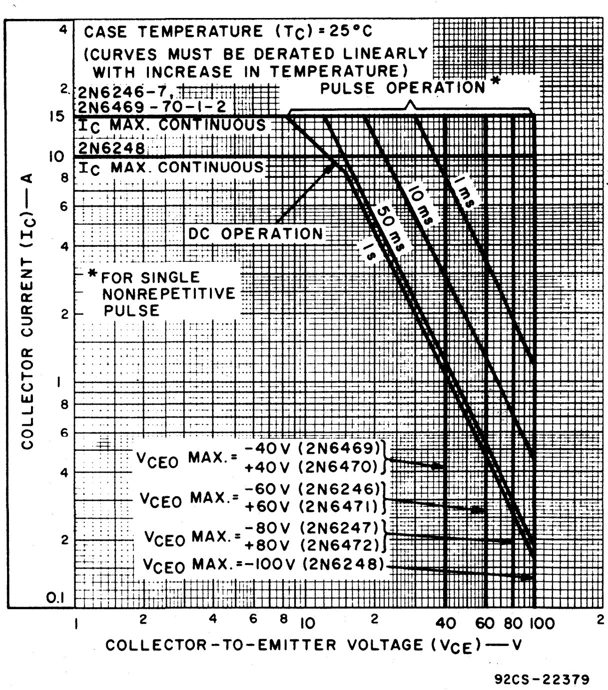


Fig. 3 - Maximum operating areas for all types.♦

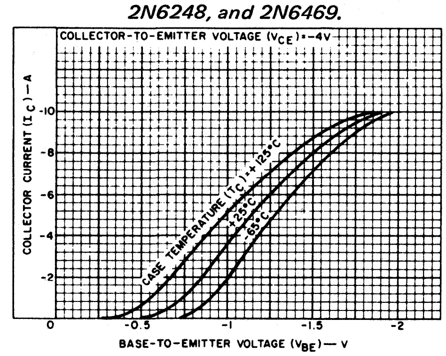


Fig. 4 - Typical transfer characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

♦For p-n-p devices, voltage and current values are negative.

2N6246, 2N6247, 2N6248, 2N6469, 2N6470, 2N6471, 2N6472

ELECTRICAL CHARACTERISTICS FOR N-P-N TYPES, *At case temperature (T_C) = 25°C unless otherwise specified*

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS						UNITS
			VOLTAGE V dc	CURRENT A dc		2N6470		2N6471		2N6472		
			V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
	Collector-Cutoff Current: With external base-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	35			–	500	–	–	–	–	µA
			55			–	–	–	500	–	–	
			75			–	–	–	–	–	500	
*	With base-emitter junction reverse-biased V_{BE} = −1.5 V	I_{CEX}	45			–	500	–	–	–	–	µA
			65			–	–	–	500	–	–	
			85			–	–	–	–	–	500	
*	With reverse bias, V_{BE} = −1.5 V, and T_C = 150°C	I_{CEX}	40			–	5	–	–	–	–	mA
			60			–	–	–	5	–	–	
			80			–	–	–	–	–	5	
*	With base open	I_{CEO}	20		0	–	1	–	–	–	–	mA
			30		0	–	–	–	1	–	–	
			40		0	–	–	–	–	–	1	
*	Emitter-Cutoff Current: V_{BE} = −5 V	I_{EBO}		0		–	1	–	1	–	1	mA
*	DC Forward-Current Transfer Ratio	h_{FE}	4	5[a]		20	150	20	150	20	150	
			4	15[a]		5	–	5	–	5	–	
*	Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$		0.2	0	40[b]	–	60[b]	–	80[b]	–	V
	With external base-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$		0.2		50[b]	–	70[b]	–	90[b]	–	V
*	Base-to-Emitter Voltage	V_{BE}	4	5[a]		–	1.3	–	1.3	–	1.3	V
			4	15[a]		–	3.5	–	3.5	–	3.5	
*	Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$		5[a]	0.5	–	1.3	–	1.3	–	1.3	V
				15[a]	5	–	3.5	–	3.5	–	3.5	
*	Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio: f = 1 MHz	$\|h_{fe}\|$	4	1		5	–	5	–	5	–	
*	Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 kHz	h_{fe}	4	1		25	–	25	–	25	–	
	Thermal Resistance: Junction-to-case	$R_{\theta JC}$				–	1.4	–	1.4	–	1.4	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-2).

[a] Pulsed; pulse duration ≐ 300 µs, duty factor = 1.8%.

[b] *CAUTION: Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.*

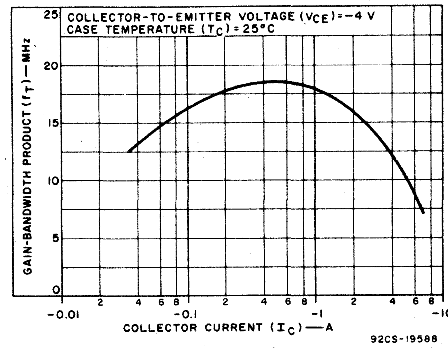


Fig. 5 - Typical gain-bandwidth product as a function of collector current for 2N6246, 2N6247, 2N6248, and 2N6469.

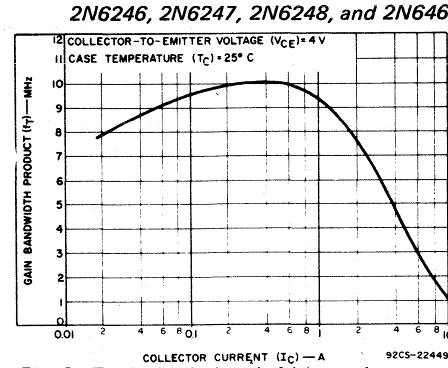


Fig. 6 - Typical gain-bandwidth product as a function of collector current for 2N6470, 2N6471 and 2N6472.

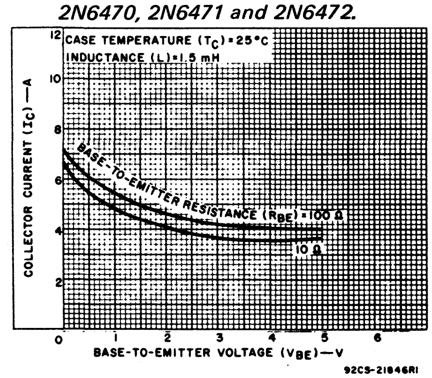


Fig. 7 - Minimum reverse-bias second-breakdown characteristics for all types. (Values for p-n-p types are negative).

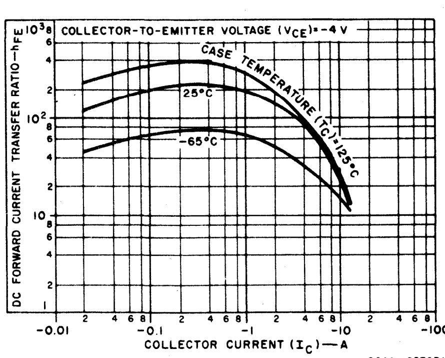


Fig. 8 - Typical dc beta characteristics for 2N6246, 2N6247, and 2N6469.

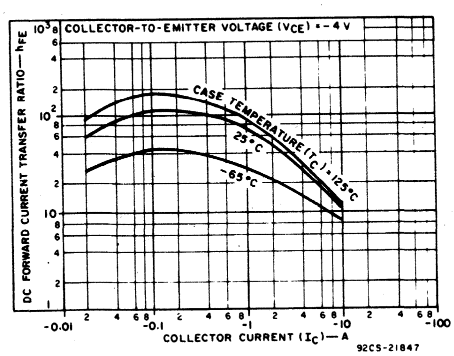


Fig. 9 - Typical dc beta characteristics for 2N6248.

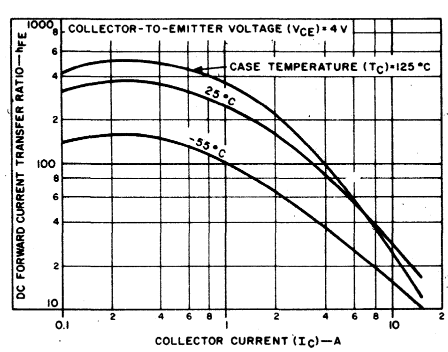


Fig. 10 - Typical dc beta characteristics for 2N6470, 2N6471, and 2N6472.

2N6246, 2N6247, 2N6248, 2N6469, 2N6470, 2N6471, 2N6472

ELECTRICAL CHARACTERISTICS FOR P-N-P TYPES, *At case temperature (T_C) = 25°C unless otherwise specified*

SYMBOL	TEST CONDITIONS				LIMITS				TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6469		2N6246		VOLTAGE V dc		CURRENT A dc		2N6247		2N6248		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER} (R_{BE}) = 100 Ω	−35 −55				– –	−200 –	– –	– −200	−75 −95				– –	−200 –	– –	– −200	μA
* I_{CEX}	−45 −65	1.5 1.5			– –	−200 –	– –	– −200	−85 −100	1.5 1.5			– –	−200 –	– –	– −200	μA
* T_C = 150°C	−45 −55	1.5 1.5			– –	−5 –	– –	– −5	−70 −90	1.5 1.5			– –	−5 –	– –	– −5	mA
* I_{CEO}	−20 −30			0 0	– –	−1 –	– –	– −1	−40 −50			0 0	– –	−1 –	– –	– −1	mA
* I_{EBO}		5		0	–	−5	–	−5		5		0	–	−1	–	−1	mA
* h_{FE}	 −4 −4 −4		 −5[a] −7[a] −15[a]		 20 – 5	 150 – –	 – 20 5	 – 100 –	−4 −4 −4 −4		−5[a] −6[a] −10[a] −15[a]		– 20 – 5	– 100 – –	20 – 5 –	100 – – –	
* $V_{CEO}(sus)$			−0.2	0	−40[b]	–	−60[b]	–			−0.2	0	−80[b]	–	−100[b]	–	V
$V_{CER}(sus)$			−0.2		−50[b]	–	−70[b]	–			−0.2		−90[b]	–	−110[b]	–	V
* V_{BE}	−4 −4		−15[a] −7[a]		– ·	−3.5 –	– –	– −2	−4 −4		−6[a] −5[a]		– –	−1.8 –	– –	– −1.8	V
* $V_{CE}(sat)$			−5[a] −7[a] −15[a] −15[a]	−0.5 −0.7 −5 −3	– – – –	−1.3 – −3.5 –	– – – –	– −1.3 – −2.5			−5[a] −6[a] −15[a] −10[a]	−0.5 −0.6 −4 −2	– – – –	– −1.3 −3.5 –	– – – –	−1.3 – – −3.5	V
* $\|h_{fe}\|$ f = 2 MHz	−4		−1		5	–	5	–	−4		−1		5	–	5	–	
* h_{fe} f = 1 kHz	−4		−1		25	–	25	–	−4		−1		25	–	25	–	
$R_{\theta JC}$					–	1.4	–	1.4					–	1.4	–	1.4	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-2).

[a] Pulsed; pulse duration = 300 μs, duty factor = 1.8%.

[b] *CAUTION: CAUTION: Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. (See Fig. 22)*

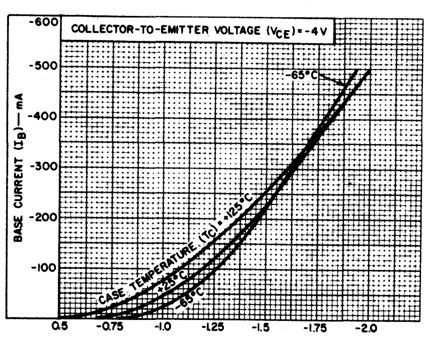


Fig. 11 - Typical input characteristics for 2N6246, 2N6247, and 2N6449.

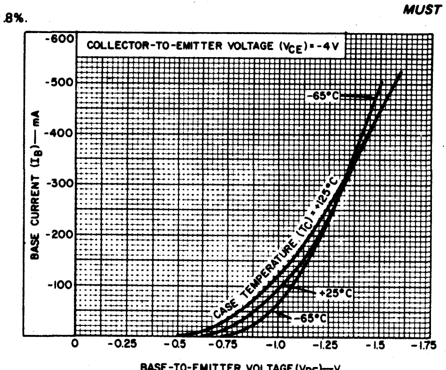


Fig. 12 - Typical input characteristics for 2N6248.

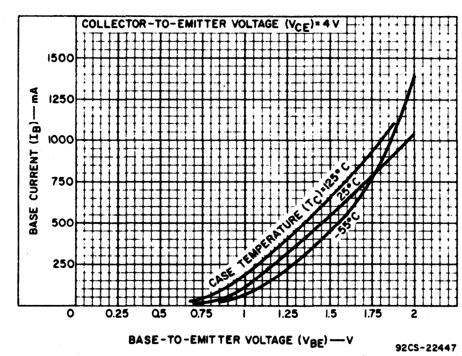


Fig. 13 - Typical input characteristics for 2N6470, 2N6471, and 2N6472.

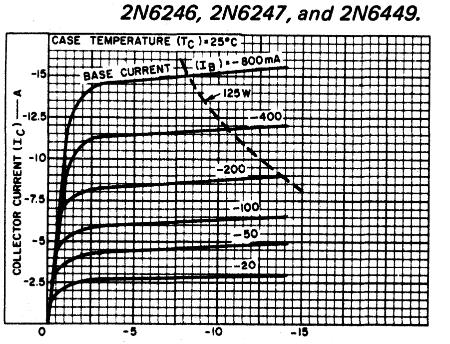


Fig. 14 - Typical output characteristics for 2N6246, 2N6247, and 2N6469.

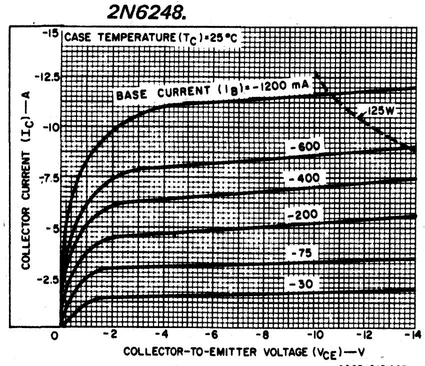


Fig. 15 - Typical output characteristics for 2N6248.

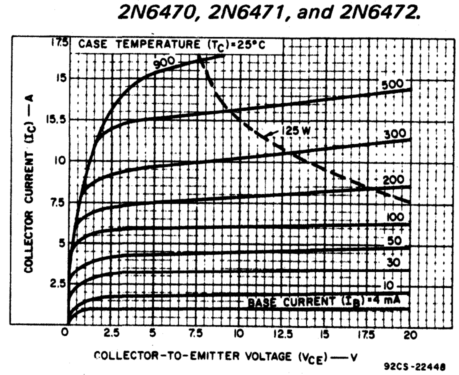


Fig. 16 - Typical output characteristics for 2N6470, 2N6471, and 2N6472.

2N6246, 2N6247, 2N6248, 2N6469, 2N6470, 2N6471, 2N6472

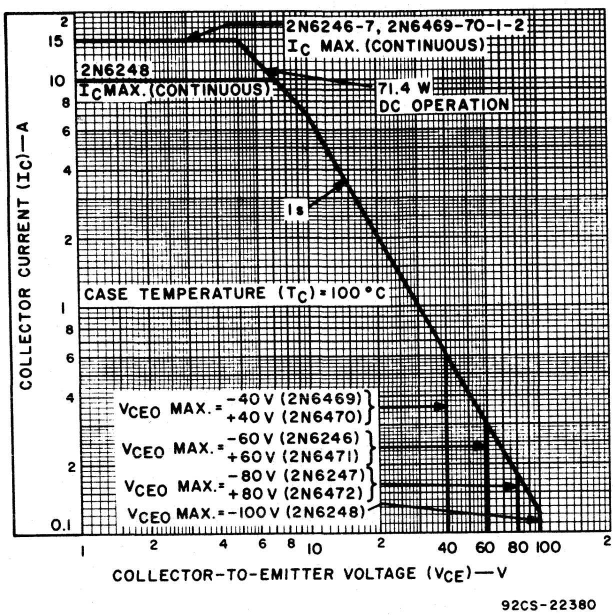


Fig. 17 - Maximum operating areas for all types.♦

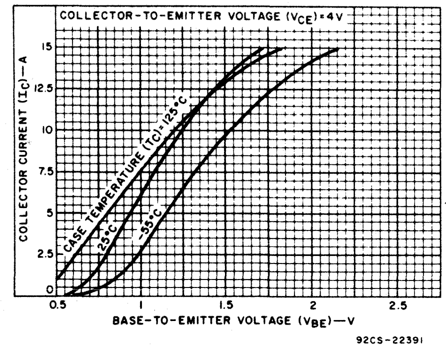


Fig. 18 - Typical transfer characteristics for 2N6470, 2N6471, and 2N6472.

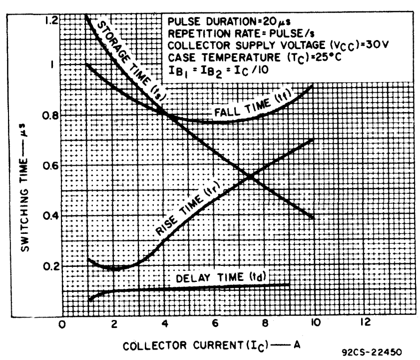


Fig. 19 - Typical saturated switching characteristics for 2N6470, 2N6471, and 2N6472.

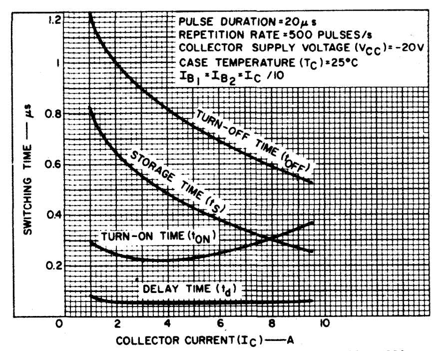


Fig. 20 - Typical saturated switching characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

♦For p-n-p devices, voltage and current values are negative.

2N6249-2N6251, 40854

450-V, 30-A, 175-W Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

RCA-2N6269, 2N6250, 2N6251, and 40854 are multiple epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. Multiple-epitaxial construction maximizes the volt-ampere characteristic of the device and provides fast switching speeds. Multiple-emitter-site design assures uniform current flow throughout the structure, which produces a high $I_{S/b}$ and a large safe-operation area.

These devices use the popular JEDEC TO-3 package; they differ mainly in voltage ratings, leakage-current limits, and V_{CE}(sat) ratings.

The exceptional second-breakdown capabilities and high voltage-breakdown ratings make these transistors especially suitable for off-line inverters, switching regulators, motor controls, and deflection circuit applications.

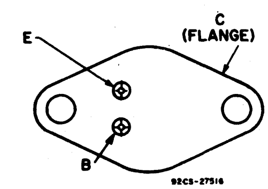
The high gain and high $E_{S/b}$ energy-handling capability of the 2N6249 make it an excellent choice for motor-control applications in which large winding inductances are encountered and high surge currents are required to start the motor.

The high breakdown voltages, low saturation voltages, and fast-switching capability of the 2N6250 and 2N6251 make them especially suitable for inverter circuits operating directly off the rectified 115-V power line or a bridge configuration operating from the rectified 220-V line.

Features:

- **High voltage ratings:**
  V_{CBO}=450 V (2N6251, 40854)
  375 V (2N6250)
  300 V (2N6249)
- **High dissipation rating: P_T = 175 W**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**

TERMINAL DESIGNATIONS



JEDEC TO-3

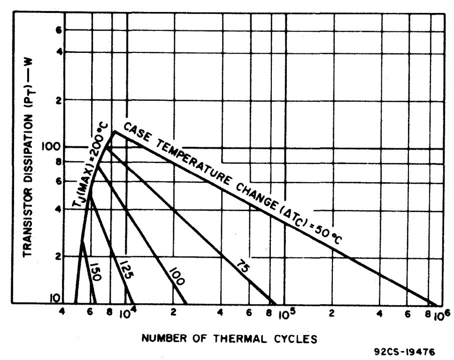


Fig. 1 - Thermal-cycle rating chart for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6249	2N6250	2N6251	40854	
*COLLECTOR-TO-BASE Voltage	V_{CBO}	300	375	450	450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With base open	V_{CEO}(sus)	200	275	350	300	V
* With reverse bias (V_{BE}) = 0 V (with base-emitter shorted)	V_{CEX}(sus)	225	300	375	–	V
With external base-to-emitter resistance (R_{BE}) $\leq 50\Omega$	V_{CER}(sus)	225	300	375	325	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
COLLECTOR CURRENT:	I_C					
* Continuous		10	10	10	15	A
Peak		30	30	30	30	A
*CONTINUOUS BASE CURRENT	I_B	10	10	10	10	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C and V_{CE} up to 30 V		175	175	175	175	W
At case temperatures up to 25°C and V_{CE} above 30 V		Derate linearly at 1°C/W				
*TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to +200				°C
*PIN TEMPERATURE (During Soldering):						
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max		230				°C

*2N-Series types in accordance with JEDEC registration data format (JS-6, RDF-1).

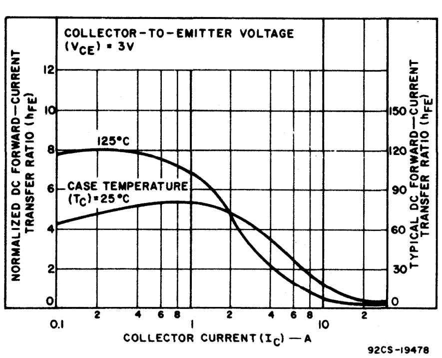


Fig. 2 - Typical normalized dc beta characteristics for all types.

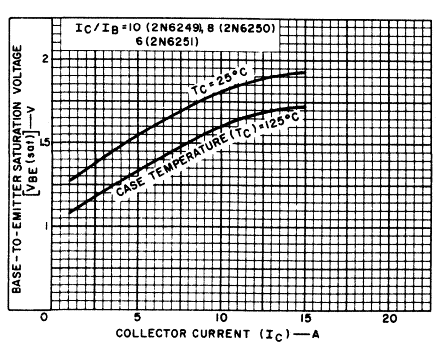


Fig. 3 - Typical base-to-emitter saturation voltage characteristics for all types.

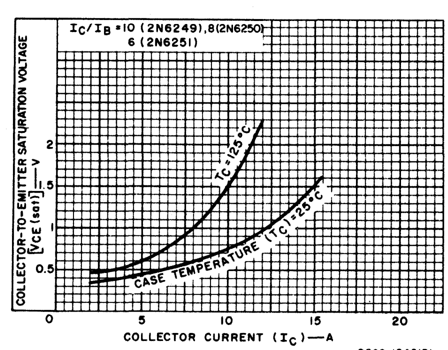


Fig. 4 - Typical collector-to-emitter saturation voltage characteristics for all types.

2N6249-2N6251, 40854

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified.*

CHARACTERISTIC	TEST CONDITIONS: DC VOLTAGE (V) V_{CE}	DC VOLTAGE (V) V_{BE}	DC CURRENT (A) I_C	DC CURRENT (A) I_B	2N6249 MIN.	2N6249 TYP.	2N6249 MAX.	2N6250 MIN.	2N6250 TYP.	2N6250 MAX.	2N6251 MIN.	2N6251 TYP.	2N6251 MAX.	40854 MIN.	40854 TYP.	40854 MAX.	UNITS
I_{CEO}	150			0	–	–	5	–	–	–	–	–	–	–	–	–	mA
	225			0	–	–	–	–	–	5	–	–	–	–	–	–	
	300			0	–	–	–	–	–	–	–	–	5	–	–	–	
* I_{CEV}	225	−1.5			–	–	5	–	–	–	–	–	–	–	–	–	
	300	−1.5			–	–	–	–	–	5	–	–	–	–	–	–	
	375	−1.5			–	–	–	–	–	–	–	–	5	–	–	–	
	450	−1.5			–	–	–	–	–	–	–	–	–	–	–	1	
* I_{CEV} T_C = 125°C	225	−1.5			–	–	10	–	–	–	–	–	–	–	–	–	
	300	−1.5			–	–	–	–	–	10	–	–	–	–	–	–	
	375	−1.5			–	–	–	–	–	–	–	–	10	–	–	–	
	450	−1.5			–	–	–	–	–	–	–	–	–	–	–	10	
* I_{EBO}		−6			–	–	1	–	–	1	–	–	1	–	–	–	mA
* V_{CEO}(sus)			0.2		200[b]	–	–	275[b]	–	–	350[b]	–	–	300[b]	–	–	V
V_{CER}(sus) R_{BE} = 50 Ω			0.2		225[b]	–	–	300[b]	–	–	375[b]	–	–	325[b]	–	–	V
* V_{EBO} I_E = 1 mA					6	–	–	6	–	–	6	–	–	–	–	–	V
I_E = 5 mA					–	–	–	–	–	–	–	–	–	6	–	–	
* h_{FE}	3		10[a]		10	–	50	–	–	–	–	–	–	–	–	–	
	3		10[a]		–	–	–	8	–	50	–	–	–	–	–	–	
	3		10[a]		–	–	–	–	–	–	6	–	50	–	–	–	
	4		10[a]		–	–	–	–	–	–	–	–	–	8	–	–	
* V_{BE}(sat)			10[a]	1	–	–	2.25	–	–	–	–	–	–	–	–	–	V
			10[a]	1.25	–	–	–	–	–	2.25	–	–	–	–	–	–	
			10[a]	1.67	–	–	–	–	–	–	–	–	2.25	–	–	–	
			16[a]	3.2	–	–	–	–	–	–	–	–	–	–	–	3	
* V_{CE}(sat)			10[a]	1	–	–	1.5	–	–	–	–	–	–	–	–	–	V
			10[a]	1.25	–	–	–	–	–	1.5	–	–	–	–	–	–	
			10[a]	1.67	–	–	–	–	–	–	–	–	1.5	–	–	–	
			16[a]	3.2	–	–	–	–	–	–	–	–	–	–	–	3	
* $\|h_{fe}\|$ f = 1 MHz	10		1		2.5	8	–	2.5	8	–	2.5	8	–	2.5	8	–	
* $I_{S/b}$ t_p = 1s nonrep.	30				5.8	–	–	5.8	–	–	5.8	–	–	5.8	–	–	A
* $E_{S/b}$ R_B = 50 Ω, L = 50 µH		−4	10[c]		2.5	–	–	2.5	–	–	2.5	–	–	2.5	–	–	mJ
* t_r V_{CC} = 200 V, $I_{B1} = I_{B2}$			10	1	–	0.8	2	–	–	–	–	–	–	–	–	–	µs
			10	1.25	–	–	–	–	0.8	2	–	–	–	–	–	–	
			10	1.67	–	–	–	–	–	–	–	0.8	2	–	–	–	
* t_s V_{CC} = 200 V, $I_{B1} = I_{B2}$			10	1	–	1.8	3.5	–	–	–	–	–	–	–	–	–	
			10	1.25	–	–	–	–	1.8	3.5	–	–	–	–	–	–	
			10	1.67	–	–	–	–	–	–	–	1.8	3.5	–	–	–	
* t_f V_{CC} = 200 V, $I_{B1} = I_{B2}$			10	1	–	0.5	1	–	–	–	–	–	–	–	–	–	
			10	1.25	–	–	–	–	0.5	1	–	–	–	–	–	–	
			10	1.67	–	–	–	–	–	–	–	0.5	1	–	–	–	
$R_{\theta JC}$	10		5		–	–	1	–	–	1	–	–	1	–	–	1	°C/W

* 2N-Series types in accordance with JEDEC registration data format (JS-6 RDF-1.)

[a] Pulsed; pulse duration ≤350 µs, duty factor = 2%.

[b] CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) MUST NOT be measured on a curve tracer.

[c] I_{CM} (40854)

2N6249-2N6251, 40854

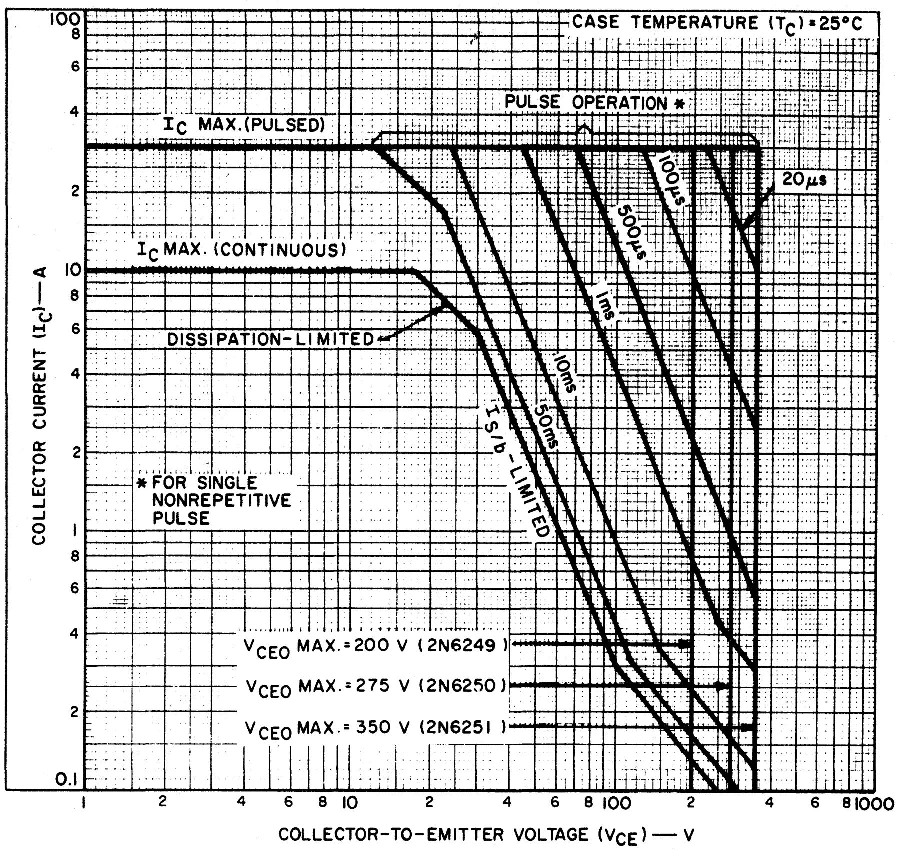


Fig. 5 — Maximum operating areas for 2N6249 — 2N6251.

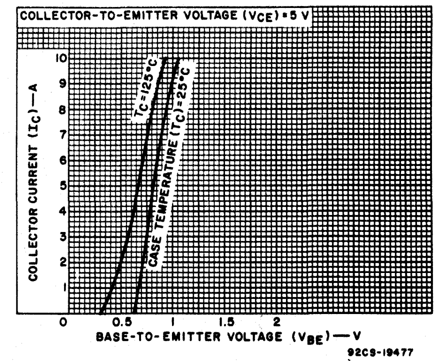


Fig. 6 - Typical transfer characteristics for 2N6249, 2N6250 and 2N6251.

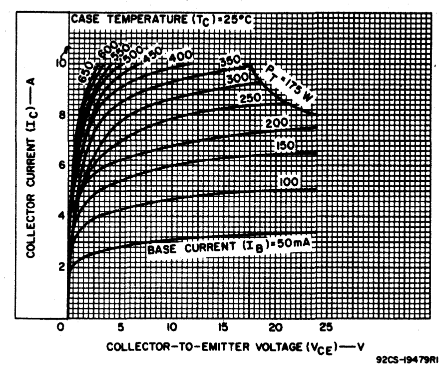


Fig. 7 - Typical output characteristics for all types.

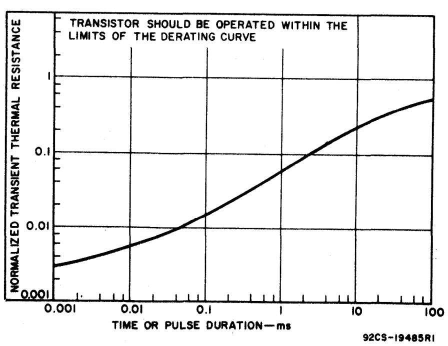


Fig. 8 - Typical thermal response characteristics for all types.

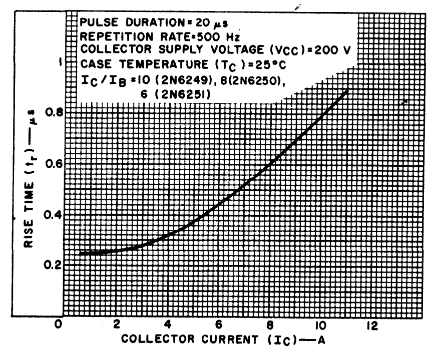


Fig. 9 - Typical rise-time characteristic for 2N6249—2N6251.

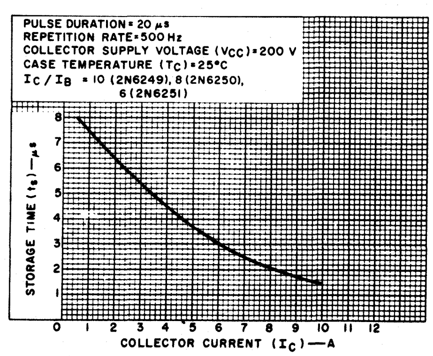


Fig. 10 - Typical storage-time characteristics for 2N6249—2N6251 (with constant forced gain).

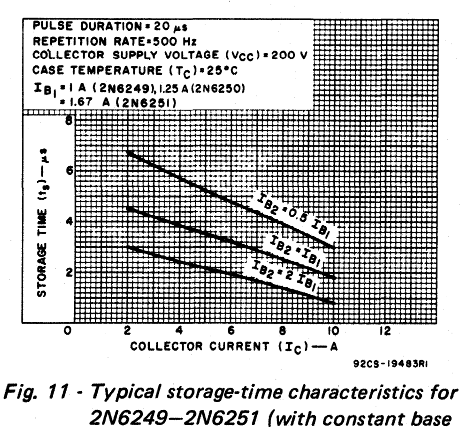


Fig. 11 - Typical storage-time characteristics for 2N6249—2N6251 (with constant base drive).

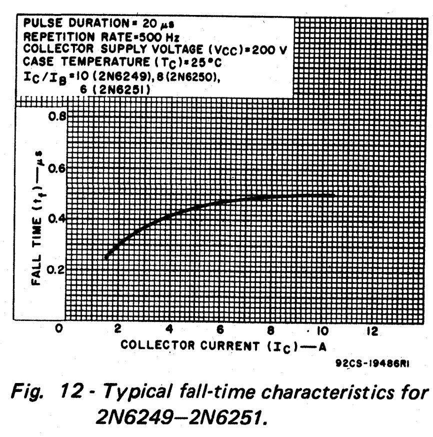


Fig. 12 - Typical fall-time characteristics for 2N6249—2N6251.

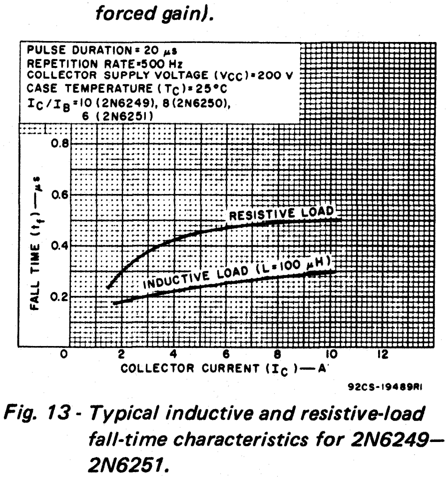


Fig. 13 - Typical inductive and resistive-load fall-time characteristics for 2N6249—2N6251.

2N6249-2N6251, 40854

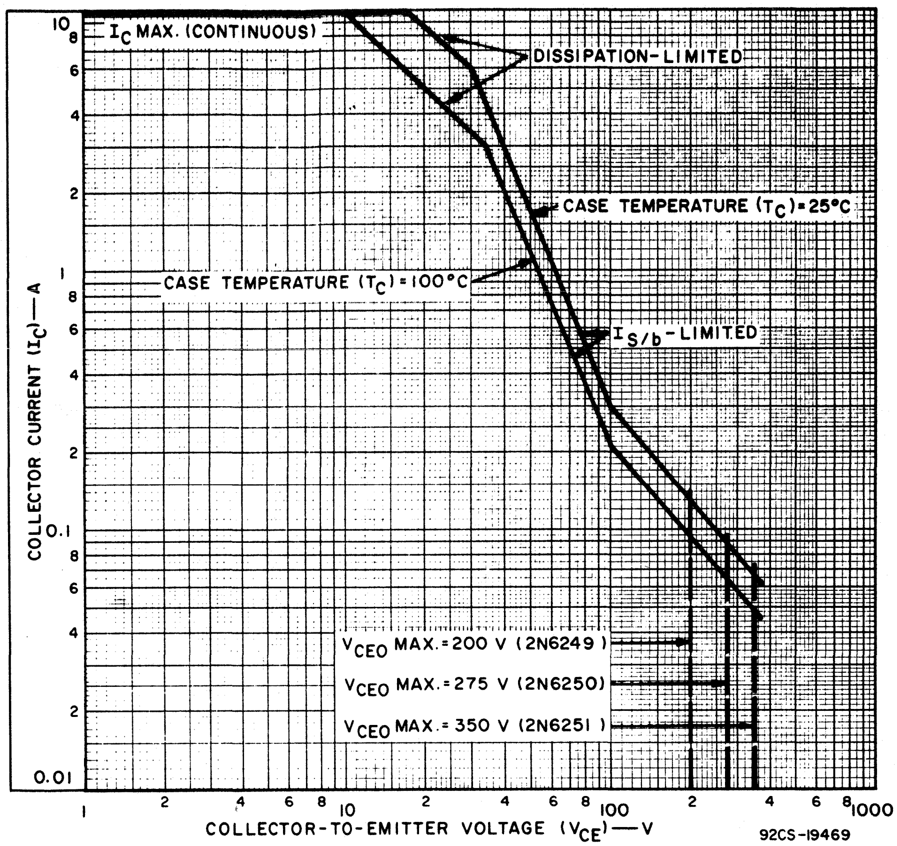


Fig. 14 - Maximum operating areas for 2N6249—2N6251.

2N6306-2N6308, RCS579
High-Voltage, High-Current Silicon N-P-N Power-Switching Transistors

For Off-Line Power Supplies and Other High-Voltage Switching Applications

The RCA-2N6306, 2N6307, 2N6308, and RCS579 are epitaxial silicon n-p-n power transistors with pi-nu construction. They are hermetically sealed in a steel JEDEC TO-3 package, and differ mainly in voltage ratings, saturation voltage, and beta characteristics. The exceptional second-breakdown and high voltage ratings, together with the high gain, low saturation voltage and fast-switching capability of this series of devices, make them particularly suitable for inverter circuits operating directly off the rectified 120-volt power line or in a bridge configuration operating from the rectified 240-volt line.

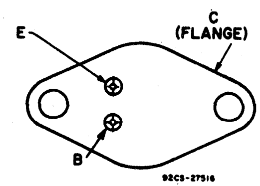
Features:

- **Fast Switching Speed**
- **High Voltage Ratings: V_{CER} = 350 V to 450 V**
- **High Gain at I_C = 3 A**
- **Thermal-Cycling Rating Chart**

Applications:

- **Off-Line Power Supplies**
- **High-Voltage Inverters**
- **Switching Regulators**
- **Motor Controls**

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCS579	2N6306	2N6307	2N6308	
* V_{CBO}	500	500	600	700	V
$V_{CER(sus)}$					
R_{BE} = 50 Ω	400	350	400	450	V
* $V_{CEO(sus)}$	250	250	300	350	V
* V_{EBO}	6	8	8	8	V
* I_C	8	8	8	8	A
* I_{CM}	16	16	16	16	A
* I_B	4	4	4	4	A
* P_T					
T_C up to 25°C	125	125	125	125	W
T_C above 25°C	Derate linearly to 200°C				
* T_{stg}, T_J	−65 to +200				°C
* T_L					
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235				°C

*2N-Series types in accordance with JEDEC registration data format (JS-6 RDF-1)

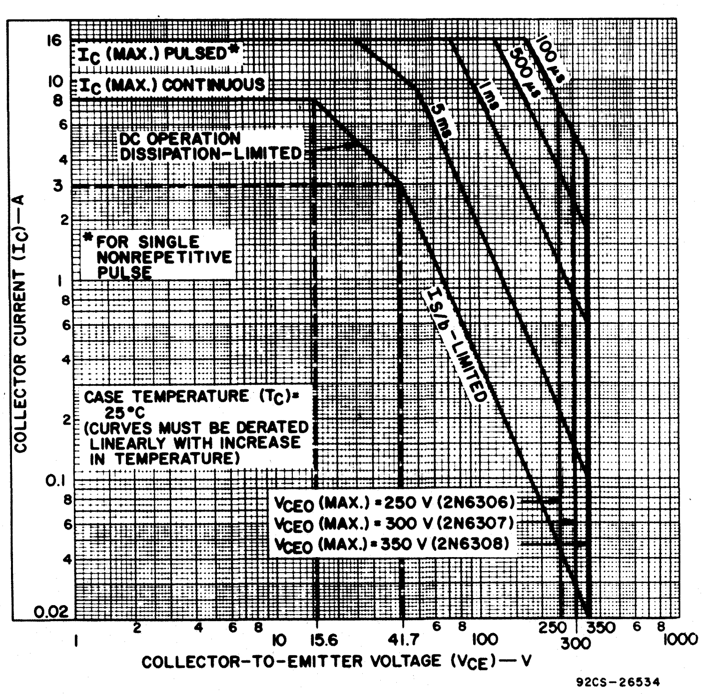


Fig. 1 - Maximum operating areas for 2N6306—2N6308.

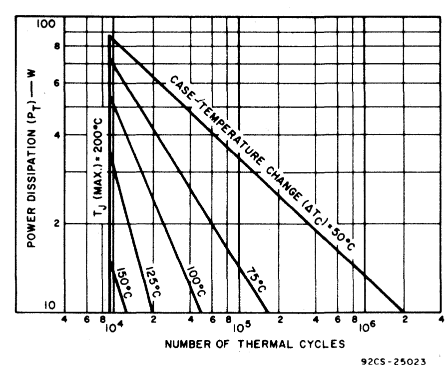


Fig. 2 - Thermal-cycling rating chart for all types.

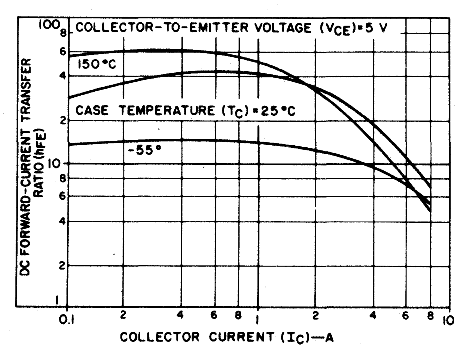


Fig. 3 - Typical dc beta characteristics for all types.

2N6306-2N6308, RCS579

ELECTRICAL CHARACTERISTICS, *T_C - 25°C Unless Otherwise Specified.*

CHARACTERISITC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS 2N6306		2N6307		2N6308		RCS579		UNITS
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	250			0	–	0.5	–	–	–	–	–	0.5	
	300			0	–	–	–	0.5	–	–	–	–	
	350			0	–	–	–	–	–	0.5	–	–	
* I_{CEV}	500	−1.5			–	0.5	–	–	–	–	–	0.5	
	600	−1.5			–	–	–	0.5	–	–	–	–	mA
	700	−1.5			–	–	–	–	–	0.5	–	–	
* T_C = 150°C	450	−1.5			–	2.5	–	–	–	–	–	2.5	
	550	−1.5			–	–	–	2.5	–	–	–	–	
	650	−1.5			–	–	–	–	–	2.5	–	–	
* I_{EBO}		−6	0		–	–	–	–	–	–	–	2	mA
		−8	0		–	1	–	1	–	1	–	–	
* $V_{CEO}(sus)$			0.1[a]	0	250	–	300	–	350	–	250	–	V
$V_{CER}(sus)$ R_{BR} = 50 Ω			0.1[b]		350	–	400	–	450	–	400	–	V
V_{EBO} I_E = 1 mA			0		–	–	–	–	–	–	6	–	V
* h_{FE}	5		3[a]		15	75	15	75	12	60	12	–	
	5		8[a]		4	–	4	–	3	–	3	–	
* V_{BE}	5		3[a]		–	1.3	–	1.3	–	1.5	–	1.5	V
* $V_{BE}(sat)$			8[a]	2	–	2.3	–	2.3	–	–	–	–	V
			8[a]	2.67	–	–	–	–	–	2.5	–	2.5	
* $V_{CE}(sat)$			3[a]	0.6	–	0.8	–	1	–	1.5	–	1.5	
			8[a]	2	–	5	–	5	–	–	–	–	V
			8[a]	2.67	–	–	–	–	–	5	–	5	
* $\|h_{fe}\|$ * f = 1 MHz	10		0.3		5	–	5	–	5	–	5	–	
* $E_{S/b}$ L = 40 mH R_{BB} = 3kΩ		−1.5	3		180	–	180	–	180	–	180	–	mJ
$I_{S/s}$ t_p = 1 s, nonrep.	40				3.15	–	3.15	–	3.15	–	3.15	–	A
* C_{obo} V_{CB} = 10 V, f = 0.1 MHz					–	250	–	250	–	250	–	250	pF
* t_r V_{CC} = 125 V			3	0.6	–	0.6	–	0.6	–	0.6	–	0.6	
* t_s V_{CC} = 125 V t_p = 25 μs			3	+0.6	–	1.6	–	1.6	–	1.6	–	+0.6	
				−1.5								−1.5	μs
t_p = 5 μs				+0.6	–	0.8	–	0.8	–	0.8	–	–	
			3	−1.5									
* t_f				+0.6	–	0.4	–	0.4	–	0.4	–	+0.6	
V_{CC} = 125 V			3	−1.5								−1.5	
$R_{\theta JC}$					–	1.4	–	1.4	–	1.4	–	1.4	°C/W

* 2N-Series types in accordance with JEDEC registration data fomat (JS-6, RDF-1).

[a] Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltage $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. $V_{CEO}(sus)$ should be measured by the pulse method (Note "a").

2N6306-2N6308, RCS579

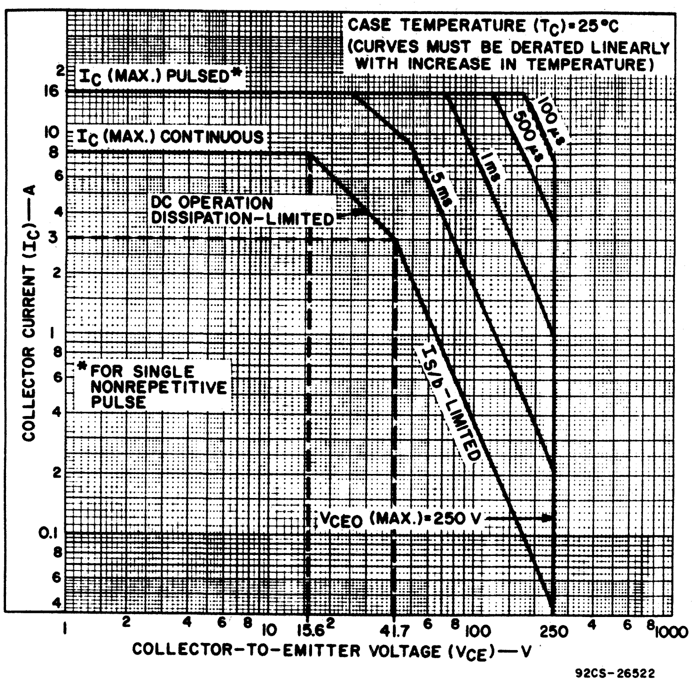


Fig. 4 - Maximum operating areas for RCS579.

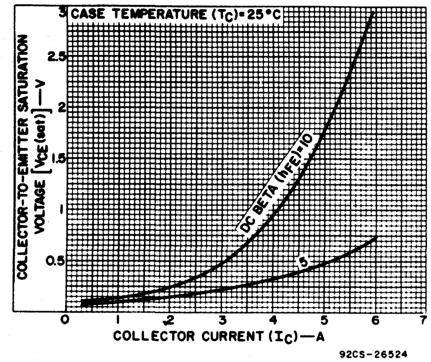


Fig. 5 - Typical collector-to-emitter saturation-voltage characteristics for all types.

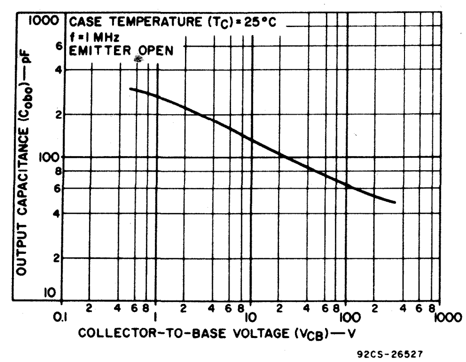


Fig. 6 - Typical output capacitance for all types.

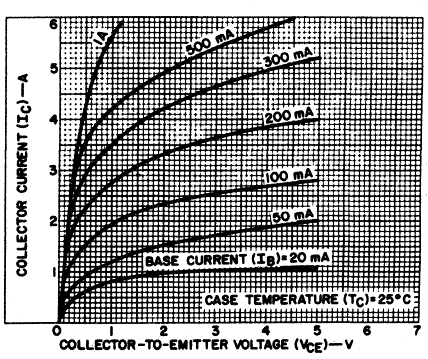


Fig. 7 - Typical output characteristics for all types.

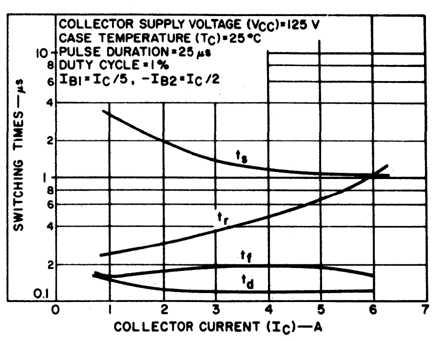


Fig. 8 - Typical saturated-switching-time characteristics for all types.

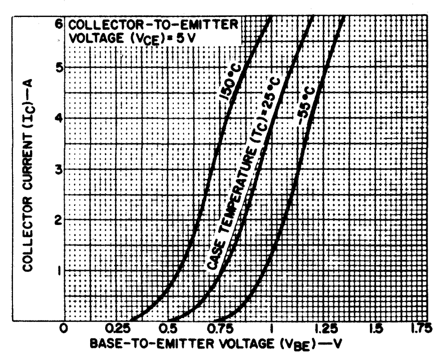
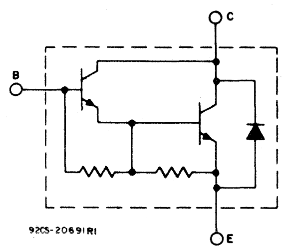


Fig. 9 - Typical transfer characteristics for all types.

2N6383-2N6385, 2N6055, 2N6056, RCA1000, RCA1001
8- and 10-Ampere N-P-N Darlington Power Transistors

For Use as Output Devices in Switching and Amplifier Applications
40-60-80 Volts, 90-100 Watts

The RCA devices are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The double epitaxial construction of these devices provides good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.



Schematic diagram for all types.

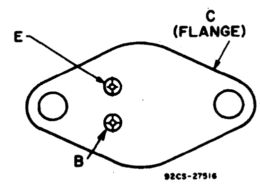
Features:

- Operation from IC without predriver
- Low leakage at high temperature
- High reverse-second-breakdown capability

Applications:

- Power switching
- Audio amplifiers
- Series and shunt regulators
- Hammer drivers

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6385	2N6384	2N6383	2N6055	2N6056	RCA1000	RCA1001	
*V_{CBO}	80	60	40	60	80	60	80	V
V_{CER}(sus) R_{BE} = 100 Ω	80	60	40	60	80	–	–	V
*V_{CEO}(sus)	80	60	40	60	80	60	80	V
V_{CEV}(sus) V_{BE} = −1.5 V	–	–	–	60	80	–	–	V
*V_{CEX} V_{BE} = −1.5 V, R_{BB} = 100 Ω	80	60	40	–	–	–	–	V
*V_{EBO}	5	5	5	5	5	5	5	V
*I_C	10	10	10	8	8	8	8	A
I_{CM}	15	15	15	16	16	15	15	A
*I_B	0.25	0.25	0.25	0.12	0.12	0.1	0.1	mA
*P_T T_C ≤ 25°C	100	100	100	100	100	90	90	W
T_C > 25°C	Derate linearly to 200°C							
*T_{stg}, T_J	−65 to +200							°C
*T_L At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235							°C

*2N-Series types in accordance with JEDEC registration data format JS-6 RDF-2.

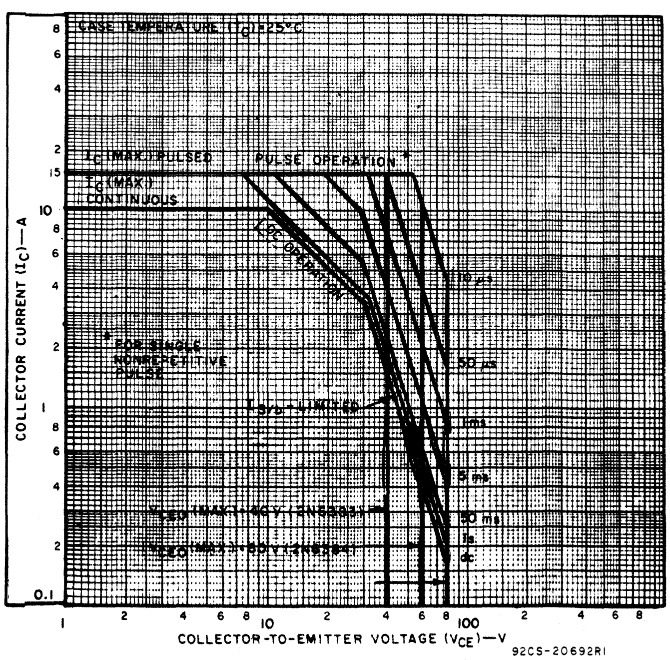


Fig. 1 – Maximum operating area for 2N6383–2N6385.

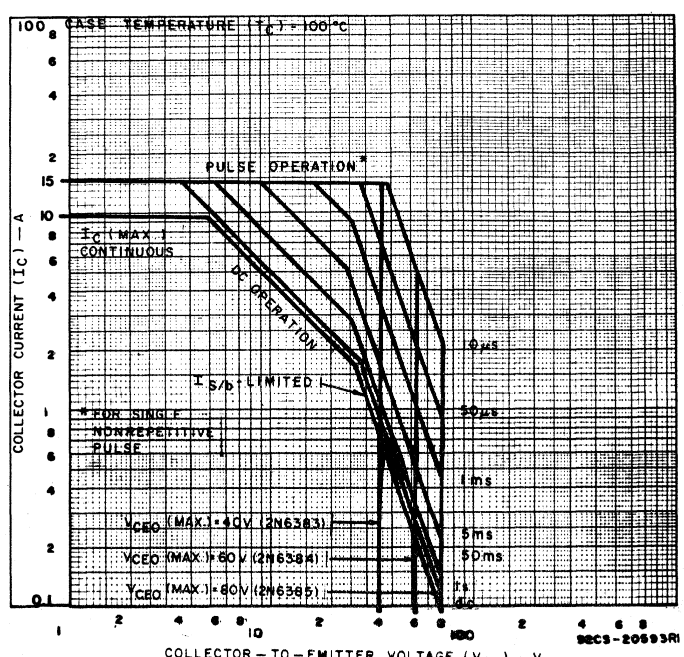


Fig. 2 – Maximum operating area for 2N6383 – 2N6385 at T_C = 100°C.

2N6383-2N6385, 2N6055, 2N6056, RCA10000, RCA1001

ELECTRICAL CHARACTERISTICS, *At Case Temperature, T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{EB}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6385 MIN.	MAX.	2N6384 MIN.	MAX.	2N6383 MIN.	MAX.	UNITS
* I_{CEO}	80				0	–	1	–	–	–	–	
	60				0	–	–	–	1	–	–	
	40				0	–	–	–	–	–	1	
* I_{CEV}	80		−1.5			–	0.3	–	–	–	–	
	60		−1.5			–	–	–	0.3	–	–	
	40		−1.5			–	–	–	–	–	0.3	mA
T_C = 150°C	80		−1.5			–	3	–	–	–	–	
	60		−1.5			–	–	–	3	–	–	
	40		−1.5			–	–	–	–	–	3	
* I_{EBO}		5		0		–	5	–	5	–	5	mA
* $V_{CEO}(sus)$				0.2[a]	0	80	–	60	–	40	–	
* $V_{CER}(sus)$ R_{BE} = 100 Ω				0.2[a]		80	–	60	–	40	–	V
$V_{CEV}(sus)$			−1.5	0.2[a]		80	–	60	–	40	–	
* h_{FE}	3			5[a]		1000	20,000	1000	20,000	1000	20,000	
	3			10[a]		100	–	100	–	100	–	
* V_{BE}	3			5[a]		–	2.8	–	2.8	–	2.8	V
	3			10[a]		–	4.5	–	4.5	–	4.5	
* $V_{CE}(sat)$				5[a]	0.01[a]	–	2	–	2	–	2	V
				10[a]	0.1[a]	–	3	–	3	–	3	
V_F				−10		–	4	–	4	–	4	
* h_{fe} f = 1 kHz	5			1		1000	–	1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	5			1		20	–	20	–	20	–	
* C_{obo} f = 1 MHz	V_{CB} = 10				I_E=0	–	200	–	200	–	200	pF
$E_{S/b}$[b] L = 12 mH, R_{BE} = 100 Ω			−1.5	4.5		120	–	120	–	120	–	mJ
$I_{S/b}$ t = 1 s, non rep.	75					0.22	–	–	–	–	–	
	55					–	–	0.55	–	–	–	A
	30					3.33	–	3.33	–	3.33	–	
$R_{\theta JC}$						–	1.75	–	1.75	–	1.75	°C/W

a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

b $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2LI^2$ where L is a series load or leakage inductance, and I is the peak collector current.

* 2N-Series types in accordance with JEDEC registration data format JS-6 RDF-2.

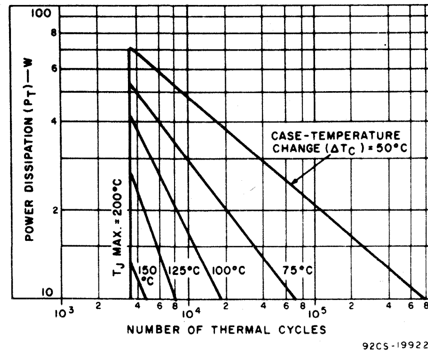


Fig. 3 - Thermal-cycling rating chart for 2N6055—2N6056, 2N6383—2N6385.

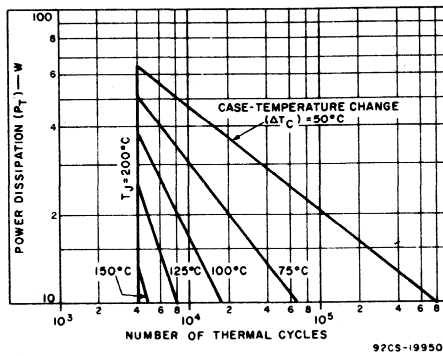


Fig. 4 - Thermal-cycling rating chart for RCA1000, RCA1001.

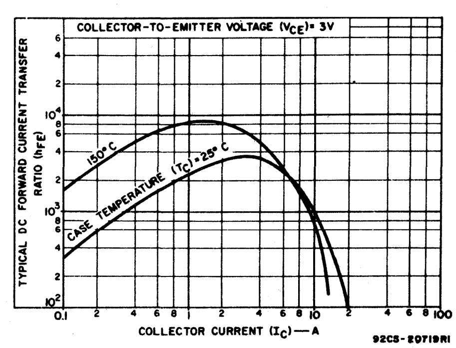


Fig. 5 - Typical dc beta characteristics for all types.

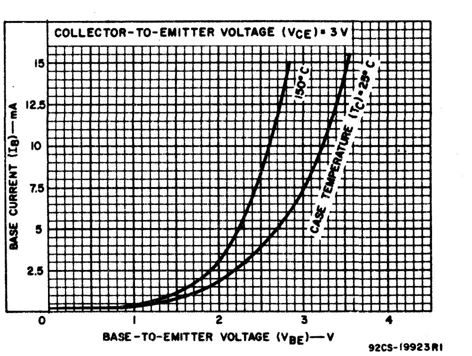


Fig. 6 - Typical input characteristics for 2N6383—2N6385, 2N6055, 2N6056.

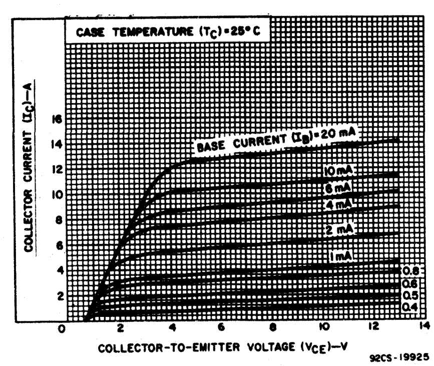


Fig. 7 - Typical output characteristics for 2N6383—2N6385, 2N6055, 2N6056.

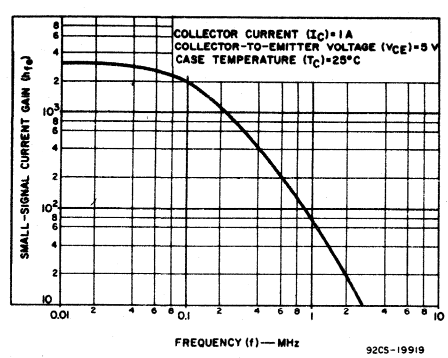


Fig. 8 - Typical small-signal gain for all types.

2N6383-2N6385, 2N6055, 2N6056, RCA1000, RCA1001

ELECTRICAL CHARACTERISTICS, *At Case Temperature, T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS DC VOLTAGE V			TEST CONDITIONS DC CURRENT A			LIMITS 2N6055		2N6056		RCA1000		RCA1001		UNITS
	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	30					0	–	0.5	–	–	–	0.5	–	–	mA
	40					0	–	–	–	0.5	–	–	–	0.5	
I_{CER}	60						–	–	–	–	–	1	–	–	
R_{BE} = 1 kΩ	80						–	–	–	–	–	–	–	1	
I_{CER}	60						–	–	–	–	–	5	–	–	mA
R_{BE} = 1 kΩ, T_C = 150°C	80						–	–	–	–	–	–	–	5	
I_{CEX}	60		−1.5				–	0.5	–	–	–	–	–	–	mA
	80		−1.5				–	–	–	0.5	–	–	–	–	
I_{CEX}	60		−1.5				–	5	–	–	–	–	–	–	
T_C = 150°C	80		−1.5				–	–	–	5	–	–	–	–	
* I_{EBO}		5		0			–	2	–	2	–	2	–	2	mA
* h_{FE}	3			8[a]			100	–	100	–	–	–	–	–	
	3			4[a]			750	18,000	750	18,000	750	–	750	–	
	3			3[a]			–	–	–	–	1000	–	1000	–	
$V_{(BR)CEO}$				0.1[a]	0		–	–	–	–	60	–	80	–	V
$V_{CEO}(sus)$				0.1[a]			60[a]	–	80[a]	–	–	–	–	–	
$V_{CER}(sus)$ R_{BE} = 100 Ω				0.1[a]			60[a]	–	80[a]	–	–	–	–	–	V
$V_{CEX}(sus)$			−1.5	0.1[a]			60[a]	–	80[a]	–	–	–	–	–	
* $V_{CE}(sat)$				3[a]		0.012	–	–	–	–	–	2	–	2	V
				4[a]		0.016	–	2	–	2	–	–	–	–	
				8[a]		0.04	–	–	–	–	–	4	–	4	
				8[a]		0.08	–	3	–	3	–	–	–	–	
* V_{BE}	3			3[a]			–	–	–	–	–	2.5	–	2.5	V
	3			4[a]			–	2.8	–	2.8	–	–	–	–	
$V_{BE}(sat)$				8[a]		0.08	–	4	–	4	–	–	–	–	
* $\|h_{fe}\|$ f = 1 MHz	3			3			4	–	4	–	–	–	–	–	
* C_{obo} f = 0.1 MHz, V_{CB} = 10 V					0		–	200	–	200	–	–	–	–	pF
* h_{fe} f = 1 kHz	3			3			300	–	300	–	–	–	–	–	
$E_{S/b}$[b] L = 12 mH, R_{BE} = 100 Ω			−1.5	5			150	–	150	–	–	–	–	–	mJ
$I_{S/b}$ t = 1 s, non rep.	33.3						3	–	3	–	–	–	–	–	A
	40						–	–	2	–	–	–	–	–	
$R_{\theta JC}$							–	1.75	–	1.75	–	1.94	–	1.94	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2.

[a] Pulsed: Pulse duration = 300 μs, duty factor = 2%

[b] $E_{/Sb}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2LI^2$, where L is a series load or leakage inductance and I is the peak collector current.

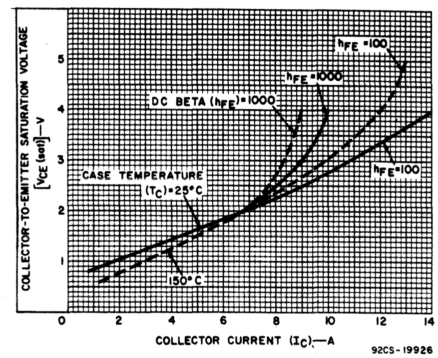


Fig. 9 - Typical saturation characteristics for 2N6055, 2N6056, RCA1000, RCA1001.

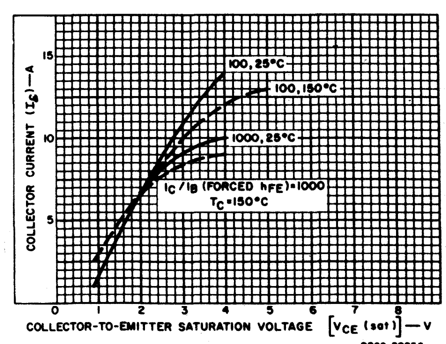


Fig. 10 - Typical saturation characteristics for 2N6383—2N6385.

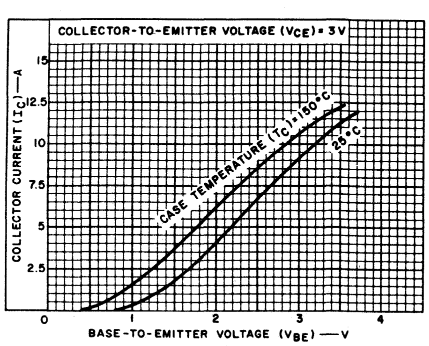


Fig. 11 - Typical transfer characteristics for 2N6383—2N6385. 2N6055, 2N6056.

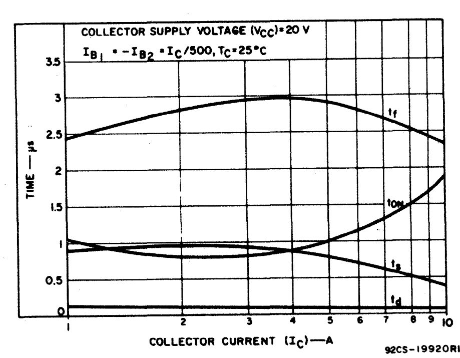


Fig. 12 - Typical saturated switching-time characteristics for 2N6383—2N6385, 2N6055, 2N6056.

2N6383-2N6385, 2N6055, 2N6056, RCA1000, RCA1001

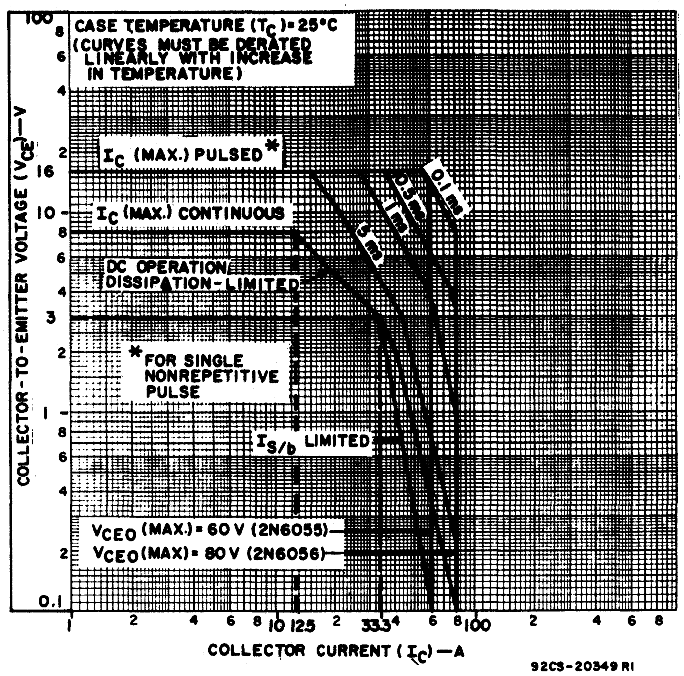


Fig. 13 — Maximum operating areas for 2N6055 and 2N6056.

2N6386-2N6388, RCA120-RCA122
8- and 10-Ampere N-P-N Darlington Power Transistors

60-80-100 Volts, 65 Watts

These RCA devices are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The double epitaxial construction of these transistors provides good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB straight-lead version of the VERSAWATT package. Optional lead configurations are available upon request. For information, contact your nearest RCA Sales Office.

The 2N6386, 2N6387, and 2N6388 are complementary to the RCA8203, RCA8203A and RCA8203B Technical data for RCA8203, RCA8203A and RCA8203B are given in RCA Bulletin File No. 835.

The RCA120 and RCA121 are n-p-n complements of the RCA125 and RCA 126 described in RCA data bulletin File 841.

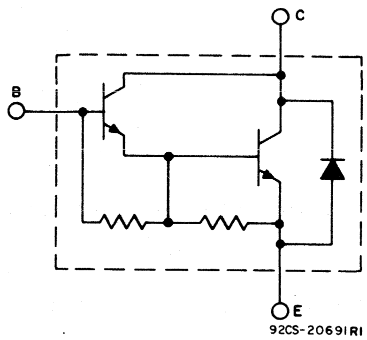


Fig. 1 - Schematic diagram for all types.

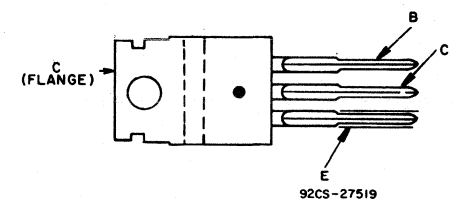
Features:

- Operates from IC without predriver
- Low leakage at high temperature
- High reverse second-breakdown capability

Applications:

- Power switching
- Hammer drives
- Series and shunt regulators
- Audio amplifiers

TERMINAL DESIGNATIONS



BOTTOM VIEW
JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6386	2N6387	2N6388	RCA120	RCA121	RCA122	
* V_{CBO}	40	60	80	60	80	100	V
V_{CER}(sus) R_{BE} = 100 Ω	40	60	80	60	80	100	V
V_{CEO}(sus)	40	60	80	60	80	100	V
* V_{CEV}(sus) V_{BE} = −1.5 V	40	60	80	60	80	100	V
* V_{EBO}	5	5	5	5	5	5	V
* I_C	8	10	10	8	8	8	A
I_{CM}	15	15	15	10	10	10	A
* I_B	0.25	0.25	0.25	0.25	0.25	0.25	A
* P_T $T_C \leq 25°C$	65	65	65	65	65	65	W
$T_C > 25°C$	Derate linearly to 150°C						
* T_{stg}, T_J	−65 to +150						°C
* T_L At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235						°C

* 2N- Series types in accordance with JEDEC registration data format JS-6 RDF-2.

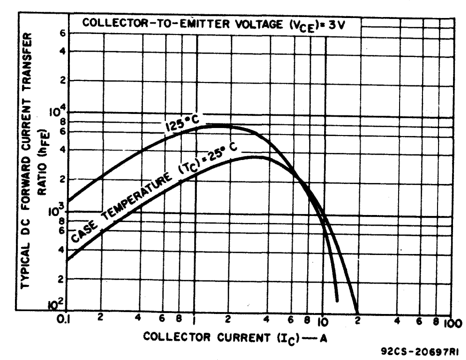


Fig. 2 - Typical dc beta characteristics for 2N6386–2N6388.

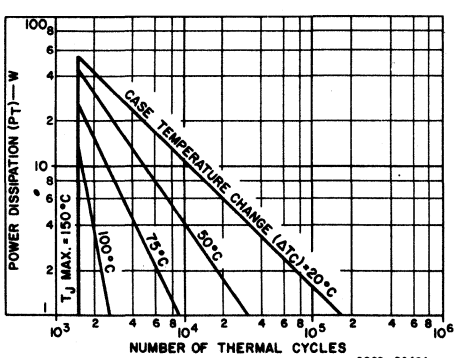


Fig. 3 - Thermal-cycling rating chart for 2N6386–2N6388.

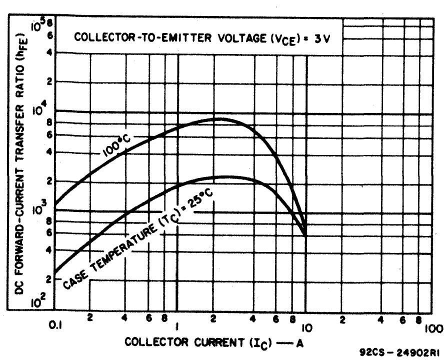


Fig. 4 - Typical dc beta characteristics for RCA120–RCA122.

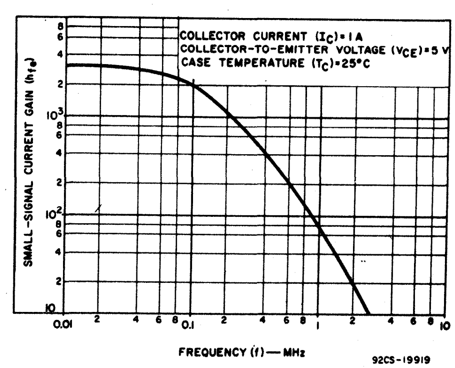


Fig. 5 - Typical small-signal gain for all types.

2N6386-2N6388, RCA120-RCA122

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6386 MIN.	MAX.	2N6387 MIN.	MAX.	2N6388 MIN.	MAX.	UNITS
* I_{CEO}	80			0	–	–	–	–	–	1	
	60			0	–	–	–	1	–	–	
	40			0	–	1	–	–	–	–	
* I_{CEV}	80	−1.5			–	–	–	–	–	0.3	
	60	−1.5			–	–	–	0.3	–	–	mA
	40	−1.5			–	0.3	–	–	–	–	
T_C = 125°C	80	−1.5			–	–	–	–	–	3	
	60	−1.5			–	–	–	3	–	–	
	40	−1.5			–	3	–	–	–	–	
* I_{EBO}		5	0		–	5	–	5	–	5	mA
* V_{CEO}(sus)			0.2[a]	0	40	–	60	–	80	–	
V_{CER}(sus) R_{BE} = 100 Ω			0.2[a]		40	–	60	–	80	–	V
V_{CEV}(sus)		−1.5	0.2[a]		40	–	60	–	80	–	
* h_{FE}	3		3[a]		1000	20,000	–	–	–	–	
	3		5[a]		–	–	1000	20,000	1000	20,000	
	3		8[a]		100	–	–	–	–	–	
	3		10[a]		–	–	100	–	100	–	
* V_{BE}	3		3[a]		–	2.8	–	–	–	–	
	3		5[a]		–	–	–	2.8	–	2.8	V
	3		8[a]		–	4.5	–	–	–	–	
	3		10[a]		–	–	–	4.5	–	4.5	
* V_{CE}(sat)			3[a]	0.006[a]	–	2	–	–	–	–	
			5[a]	0.01[a]	–	–	–	2	–	2	V
			8[a]	0.08[a]	–	3	–	–	–	–	
			10[a]	0.1[a]	–	–	–	3	–	3	
V_F			−8[a]		–	4	–	–	–	–	V
			−10[a]		–	–	–	4	–	4	
* h_{fe} f = 1 kHz	5		1		1000	–	1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	20	–	
* C_{ob} V_{CB} = 10 V, f = 1 MHz					–	200	–	200	–	200	pF
$E_{S/b}$ L = 12 mH R_{BE} = 100 Ω		−1.5	4.5		120	–	120	–	120	–	mJ
$I_{S/b}$ t = 1 s, nonrep.	25				2.6	–	2.6	–	2.6	–	A
$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.
* In accordance with JEDEC registration data format JS-6 RDF-2.

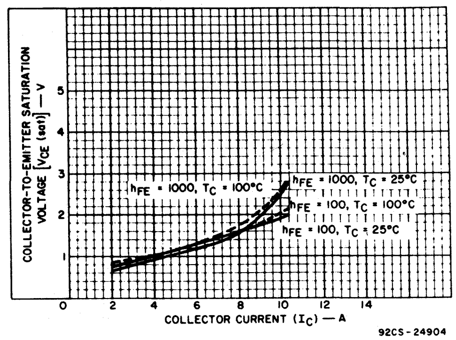


Fig. 6 - Typical saturation characteristics for RCA120–RCA122.

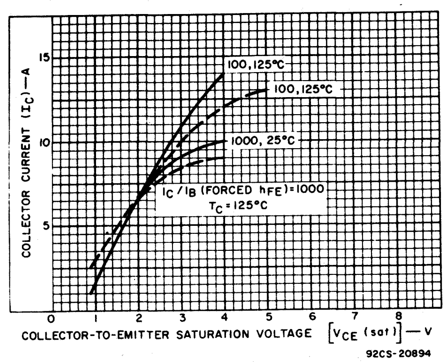


Fig. 7 - Typical saturation characteristics for 2N6386–2N6388.

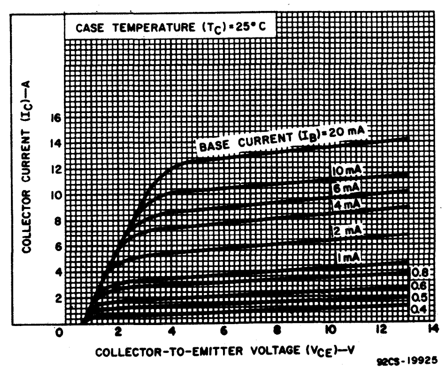


Fig. 8 - Typical output characteristics for 2N6386-2N6388.

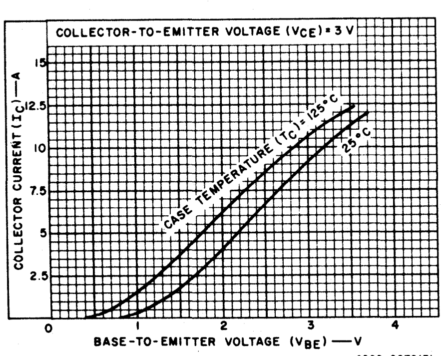


Fig. 9 - Typical transfer characteristics for 2N6386–2N6388.

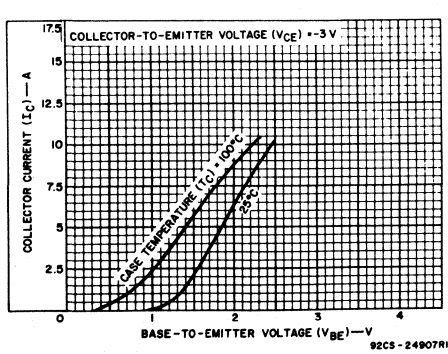


Fig. 10 - Typical transfer characteristics for RCA120–RCA122.

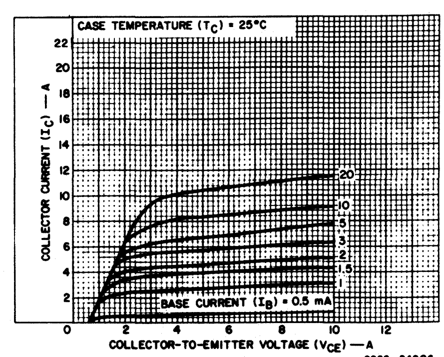


Fig. 11 - Typical output characteristics for RCA120-RCA122.

2N6386-2N6388, RCA120-RCA122

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		RCA120		RCA121		RCA122		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CBO} I_E=0	60 80 100				– – –	0.2 – –	– – –	– 0.2 –	– – –	– – 0.2	mA
I_{CEO}	30 40 50			0 0 0	– – –	0.5 – –	– – –	– 0.5 –	– – –	– – 0.5	mA
I_{EBO}		−5	0		–	3	–	3	–	3	mA
V_{CEO}(sus)			0.2[a]	0	60	–	80	–	100	–	V
h_{FE}	3 3		3[a] 0.5[a]		1000 500	– –	1000 500	– –	1000 500	– –	
V_{BE}	3		3[a]		–	2.5	–	2.5	–	2.5	V
V_{CE}(sat)			3[a] 5[a]	0.012 0.02	– –	2 3	– –	2 3	– –	2 3	V
h_{fe} f=1 kHz	5		1		1000	–	1000	–	1000	–	
$\|h_{fe}\|$ f=1 MHz	5		1		20	–	20	–	20	–	
C_{obo} V_{CB}=10 V, f=1 MHz					–	200	–	200	–	200	pF
$E_{S/b}$ L=12 mH, R_{BE}=100 Ω		−1.5	4.5		120	–	120	–	120	–	mJ
$I_{S/b}$ t=0.5 s, nonrep.	25				2.6	–	2.6	–	2.6	–	A
$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

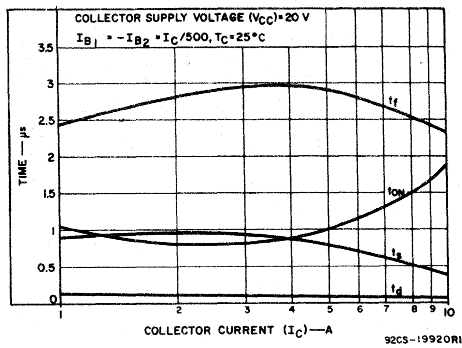


Fig. 12 - Typical saturated switching-time characteristics for 2N6386–2N6388.

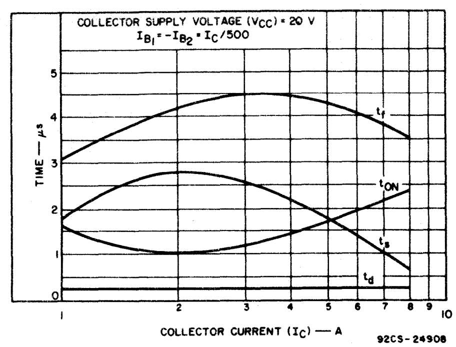


Fig. 13 - Typical saturated switching characteristics for RCA120–RCA122.

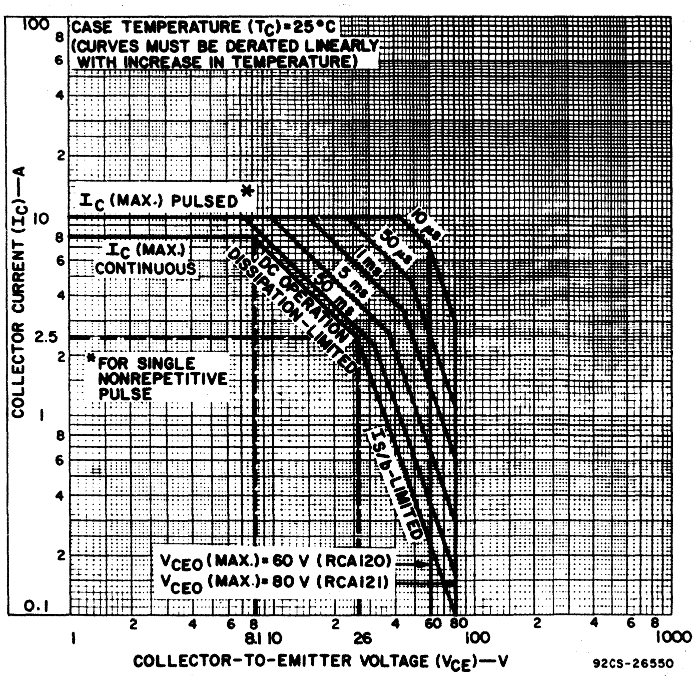


Fig. 14 - Minimum operating areas for RCA120 and RCA121 at T_C = 25°C.

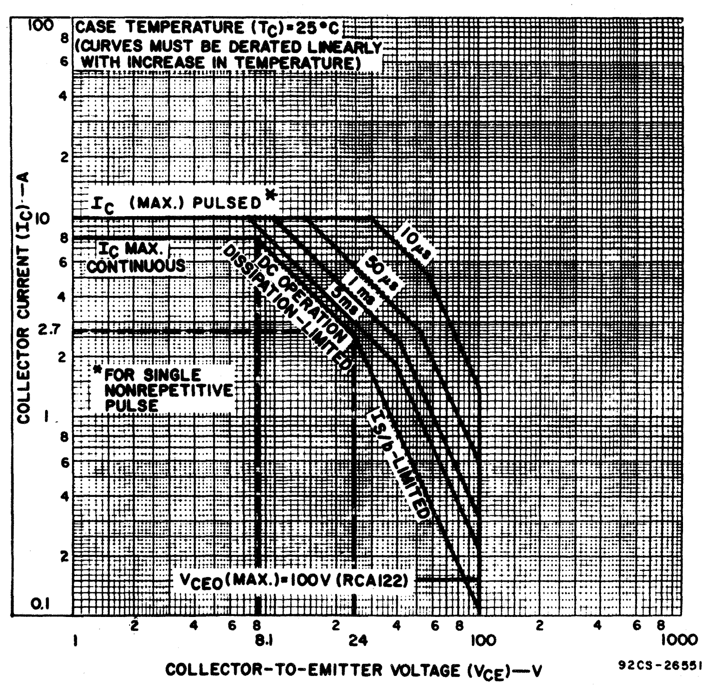


Fig. 15 - Maximum operating areas for RCA122 at T_C = 25°C.

2N6386-2N6388, RCA120-RCA122

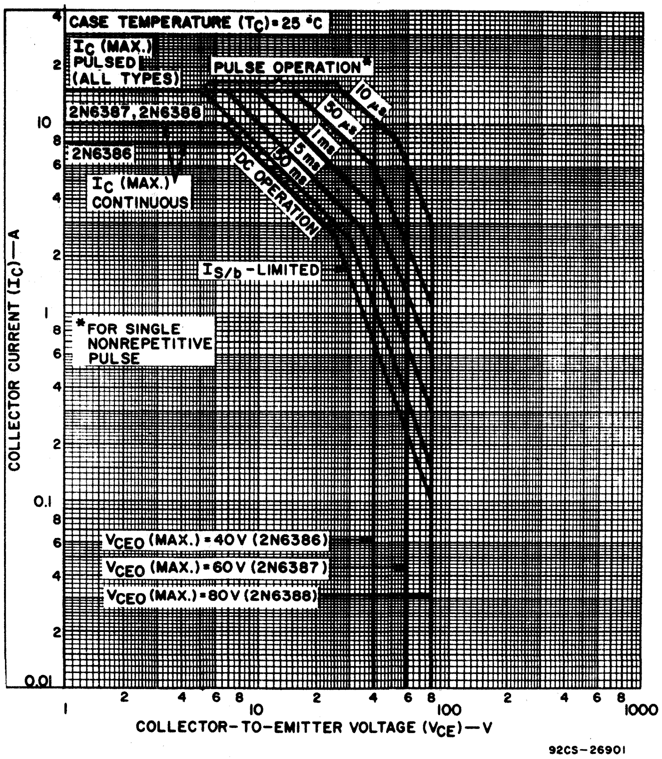


Fig. 16 - Maximum operating areas for 2N6386—2N6388.

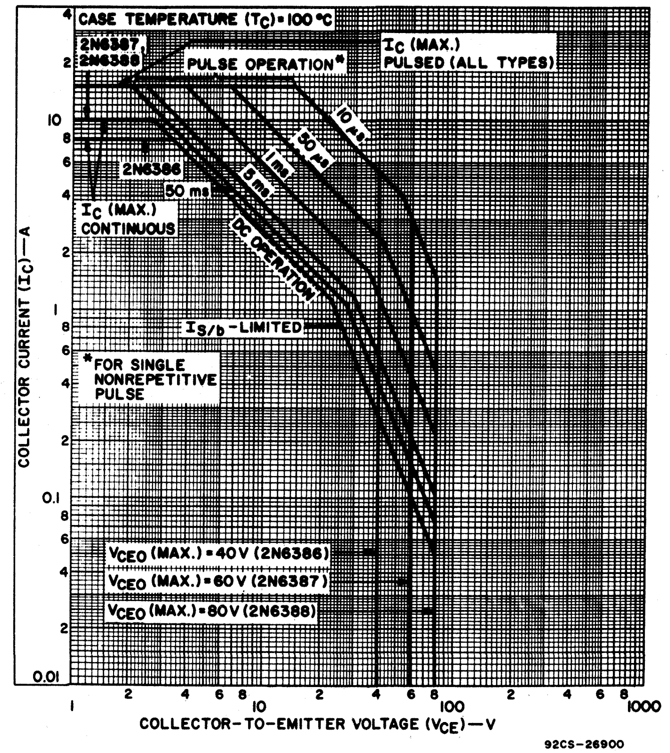
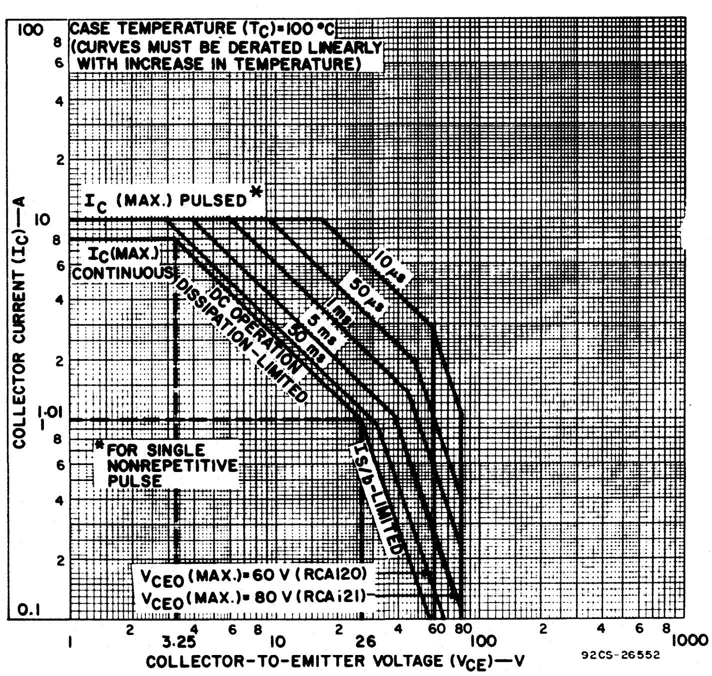


Fig. 17 - Maximum operating areas for 2N6386—2N6388 at T_C = 100°C.



ig. 18 - Maximum operating areas for RCA120 and RCA121 at T_C = 100°C.

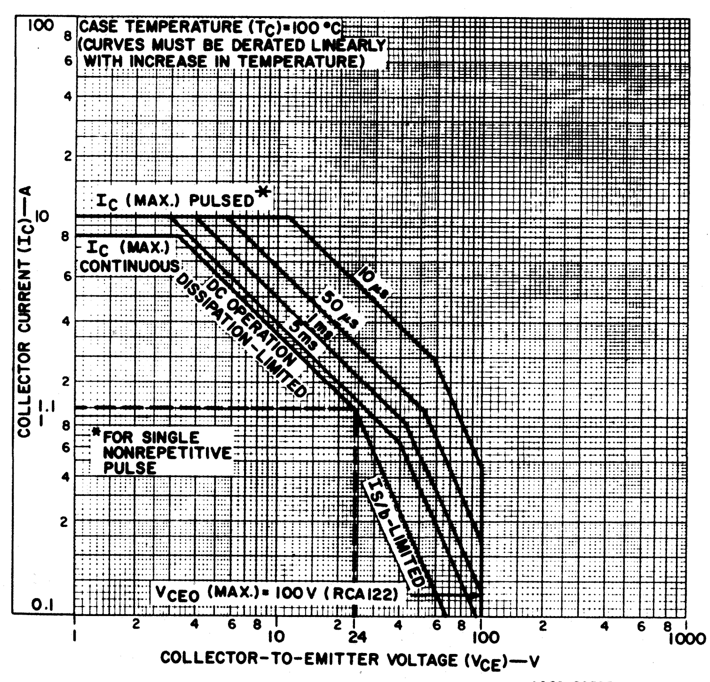


Fig. 19 - Maximum operating areas for RCA122 at T_C = 100°C.

2N6477, 2N6478, RCA3441, RCA6263

Hometaxial-Base, Medium-Power Silicon N-P-N Transistors

Designed for Medium-Power Linear and Switching Service in Consumer, Automotive, and Industrial Applications

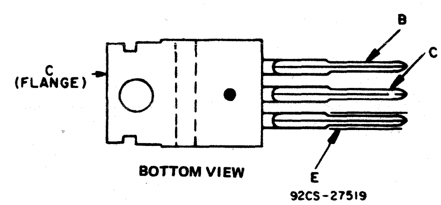
Features:
- Maximum safe-area-of-operation curves
- Low saturation voltages
- High dissipation ratings
- Thermal-cycling rating curves

Applications:
- Series and shunt regulators
- High-fidelity amplifiers
- Power switching circuits
- Solenoid drivers
- Vertical output stages in color and B/W TV

RCA 2N6477 and 2N6478 are hometaxial-base silicon n-p-n transistors intended for a wide variety of medium-to-high power, high-voltage applications. These devices, which are voltage extensions of the 2N5298 family, are especially useful in vertical output stages in color and black-and-white TV. The units differ in voltage ratings and in the currents at which parameters are controlled.

RCA3441 and RCA6263 are silicon n-p-n transistors intended for a wide variety of high-current applications. The hometaxial-base construction of these devices renders them highly resistant to second breakdown over a wide range of operating conditions. The VERSAWATT case has a proven thermal-cycling capability. This capability is assured by real-time quality controls in our manufacturing locations. All these types are supplied in the JEDEC TO-220AB straight-lead version of the package. They are also available on special order in a variety of lead-form configurations. Two popular variations have leads formed to fit TO-66 sockets (specify formed lead No. 6201) or printed-circuit boards (specify formed lead No. 6207). Detailed information on these and other VERSAWATT outlines may be obtained from your RCA Sales Office.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6477	2N6478	RCA6263	RCA3441	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	140	160	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	120	140	120	140	V
With base open	$V_{CEO}(sus)$	130	150	130	150	V
With base reverse-biased V_{BE} = −1.5 V	$V_{CEV}(sus)$	140	160	140	160	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	2.5	2.5	3	3	A
PEAK COLLECTOR CURRENT		4	4	4	4	A
CONTINUOUS BASE CURRENT	I_B	1	1	2	2	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		50	50	36	36	W
		Derate linearly to 150°C				
At case temperatures above 25°C		1.8	1.8	—	—	W
		Derate linearly at 0.0144		—	—	W/°C
TEMPERATURE RANGE:						
Storage and Operating (Junction)				−65 to 150		°C
PIN TEMPERATURE (During Soldering):						
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.				235		°C

• 2N- Series types in accordance with JEDEC registration data format JS-6 RDF-2.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS 2N6477		2N6478		UNITS
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
* Collector-Cutoff Current: With base open	I_{CEO}	80 100			0 0	– –	2 –	– –	– 2	mA
With base-emitter junction reverse-biased	I_{CEV}	130 150	−1.5 −1.5			– –	2 –	– –	– 2	mA
At T_C = 150°C	I_{CEV}	120 140	−1.5 −1.5			– –	10 –	– –	– 10	mA
* Emitter-Cutoff Current	I_{EBO}		−5	0		–	2	–	2	mA
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.1[a]	0	120	–	140	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1[a]		130	–	150	–	V
With base-emitter junction reverse-biased	$V_{CEV}(sus)$		−1.5	0.1[a]		140	–	160	–	V
* DC Forward-Current Transfer Ratio	h_{FE}	4 4		1[a] 2.5[a]		25 5	150 –	25 5	150 –	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			1[a] 2.5[a]	0.1 0.5	– –	1 2	– –	1 2	V
* Base-to-Emitter Voltage	V_{BE}	4 4		1[a] 2.5[a]		– –	1.8 3	– –	1.8 3	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: f = 40 kHz	$\|h_{fe}\|$	4		0.5		5	–	5	–	
Gain-Bandwidth Product	f_T	4		0.5		200	–	200	–	kHz
* Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: f = 1 kHz	h_{fe}	4		0.1		25	–	25	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	2.5	–	2.5	°C/W
Junction-to-Ambient	$R_{\theta JC}$					–	70	–	70	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-2). [a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

CAUTION: The sustaining voltage $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ MUST NOT be measured on a curve tracer.

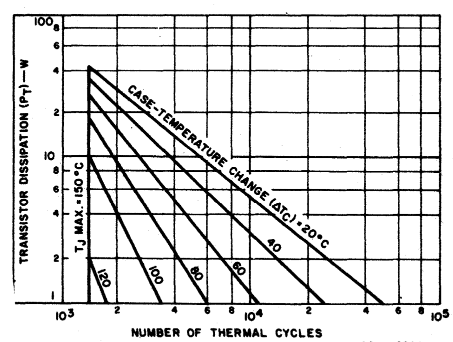


Fig. 1 - Thermal-cycling rating chart for 2N6477, 2N6478.

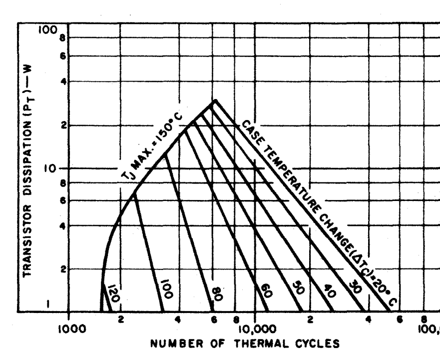


Fig. 2 - Thermal-cycling rating chart for RCA3441, RCA6263.

2N6477, 2N6478, RCA3441, RCA6263

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT A dc		RCA6263		RCA3441		
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
Collector-Cutoff Current: With base open	I_{CEO}	100 120				0 0	– –	5 –	– –	– 5	mA
With base-emitter junction reverse-biased	I_{CEX}	120 140		−1.5 −1.5			– –	5 –	– –	– 5	
At T_C = 150°C	I_{CEX}	120 140		−1.5 −1.5			– –	10 –	– –	– 10	
Emitter-Cutoff Current	I_{EBO}		5		0		–	2	–	2	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$				0.1[a]	0	120	–	140	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				0.1[a]		130	–	150	–	
With base-emitter junction reverse-biased	$V_{CEV}(sus)$			−1.5	0.1[a]		140	–	160	–	
DC Forward-Current Transfer Ratio	h_{FE}	4			0.5[a]		20	150	20	150	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				0.5[a]	0.05[a]	–	1.2	–	1.2	V
Base-to-Emitter Voltage	V_{BE}	4			0.5[a]		–	2	–	2	V
Gain-Bandwidth Product	f_T	4			0.2		200	–	200	–	kHz
Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	4			0.1		25	–	25	–	
Forward-Bias Second Breakdown Collector Current[b] (t ≥ 1 s)	$I_{S/b}$	120					0.3	–	0.3	–	A
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	3.5	–	3.5	°C/W
Junction-to-Ambient	$R_{\theta JA}$						–	70	–	70	

[a]Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[b]Pulsed: 1-second non-repetitive pulse.

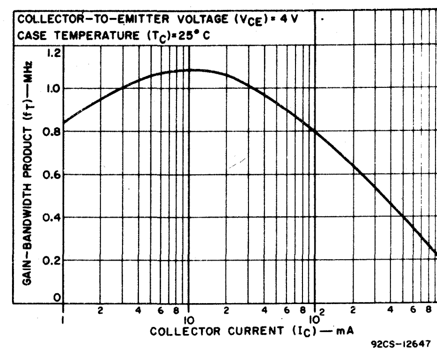


Fig. 3 - Typical gain-bandwidth product for all types.

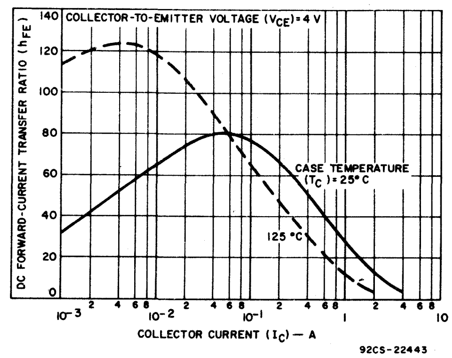


Fig. 4 - Typical dc beta characteristics for 2N6477.

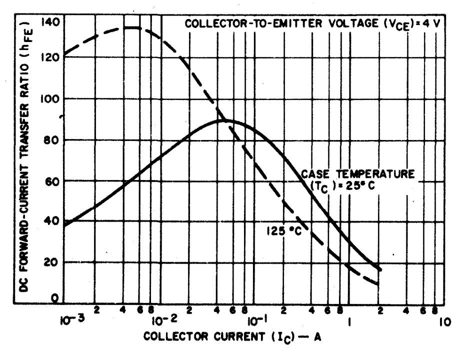


Fig. 5 - Typical dc beta characteristics for 2N6478.

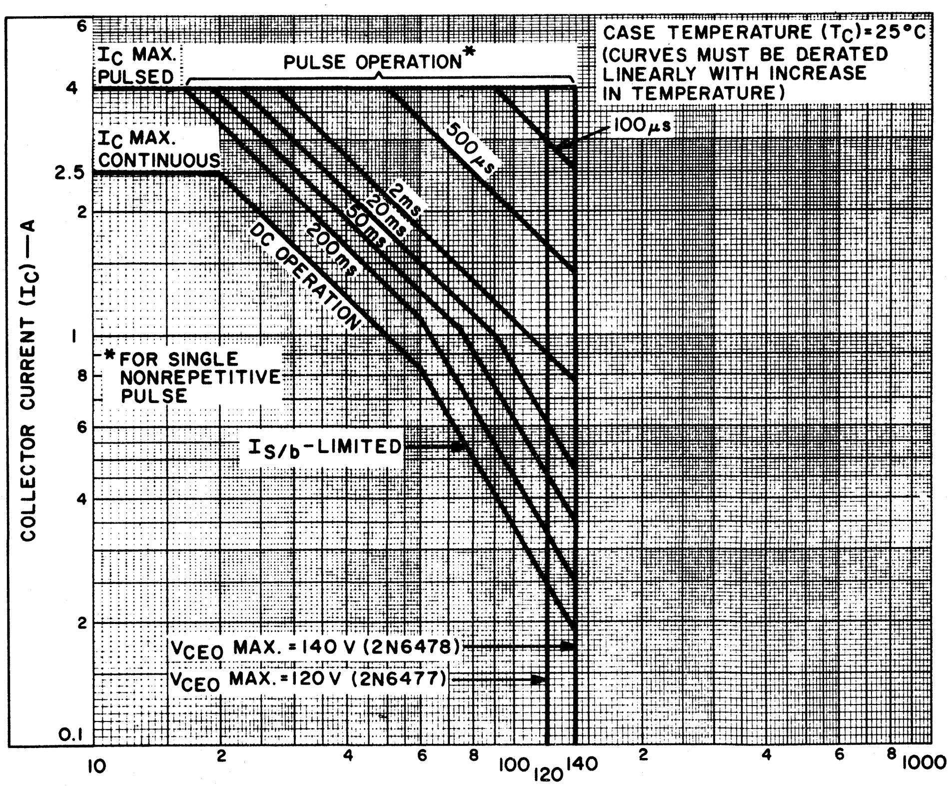


Fig. 6 - Maximum operating areas for 2N6477 and 2N6478.

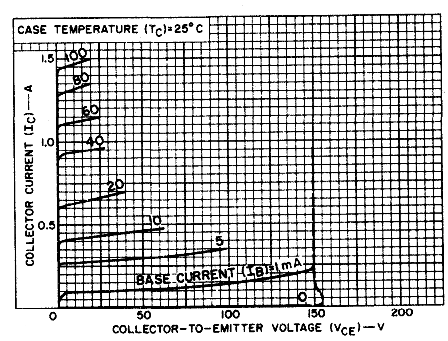


Fig. 7 - Typical output characteristics for 2N6478 and RCA3441.

2N6477, 2N6478, RCA3441, RCA6263

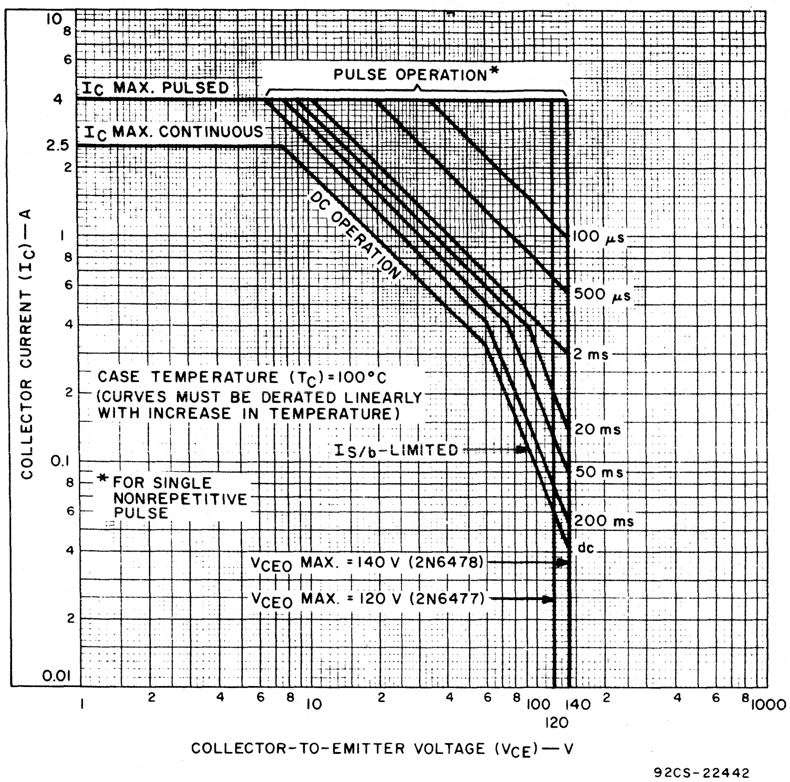


Fig. 8 - Maximum operating areas for 2N6477 and 2N6478.

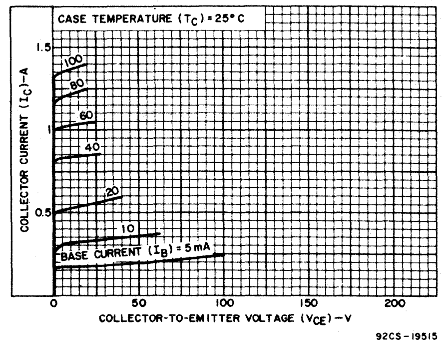


Fig. 9 - Typical output characteristics for 2N6477 and RCA6263.

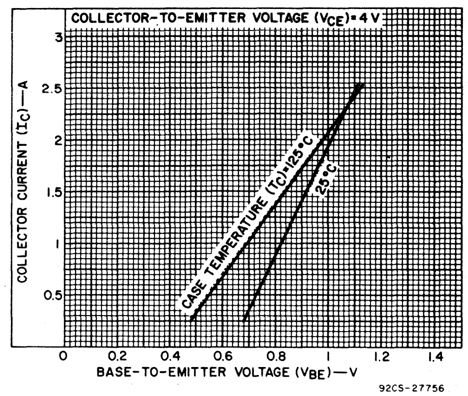


Fig. 10 - Typical transfer characteristics for 2N6477 and 2N6478.

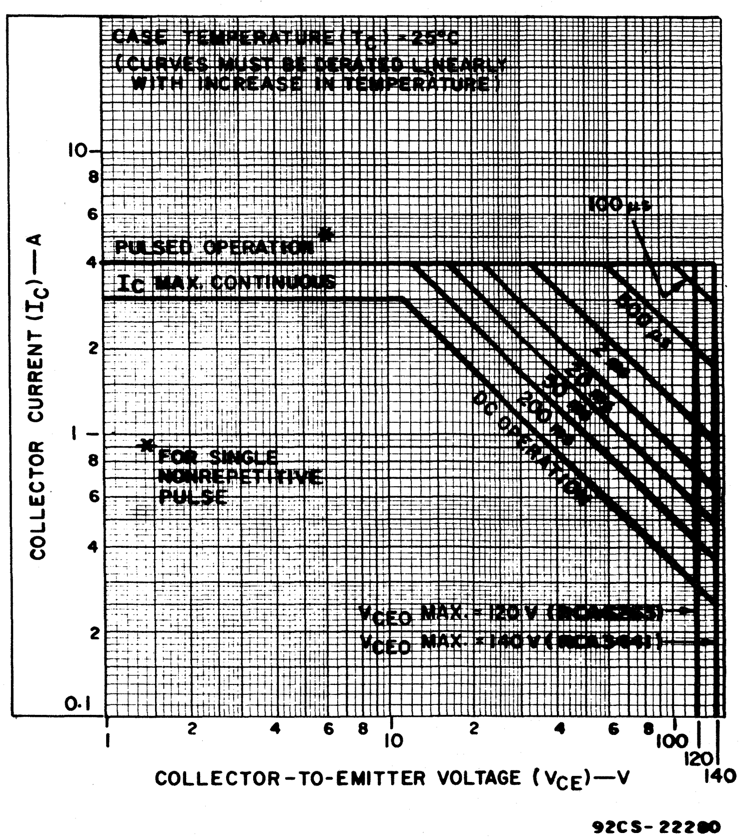


Fig. 11 - Maximum operating areas for RCA3441, RCA6263.

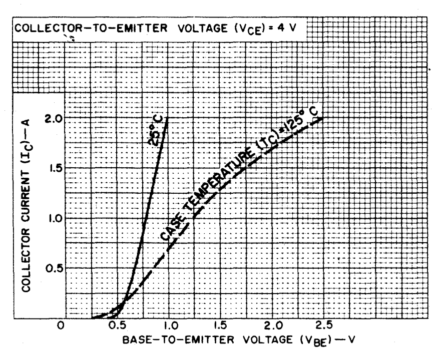


Fig. 12 - Typical transfer characteristics for RCA3441.

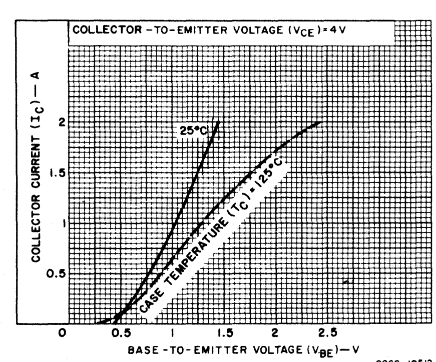


Fig. 13 - Typical transfer characteristics for RCA6263.

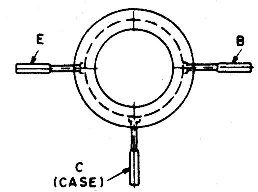
2N6479-2N6482

Radiation-Hardened Silicon N-P-N Power Transistors

Epitaxial-Planar Types for Aerospace and Military Applications

Rated for Operation in Radiation Environments with Cumulative Neutron Fluence Levels to 1 x 10^{14} Neutrons/cm^2 and Gamma Intensity to 1 x 10^8 Rad(Si)/s

TERMINAL DESIGNATIONS



TOP VIEW

92CS-27523

RADIAL

RCA types 2N6479, 2N6480, 2N6481, and 2N6482• are epitaxial silicon n-p-n planar power-switching transistors. They are designed for aerospace applications in which they might be subjected to extreme neutron and gamma-ray exposure.

The 2N6479, 2N6480, 2N6481, and 2N6482 are intended for use in 5-to-10 ampere high-frequency power inverter service. Types 2N6479 and 2N6481 differ from types 2N6480 and 2N6482, respectively, in voltage and power ratings. In types 2N6479 and 2N6480, the collector is isolated from the case.

• Formerly RCA Dev. Nos. TA8007, TA8007B, TA8100, and TA8100B, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6479	2N6480	2N6481	2N6482	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	100	100	100	100	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
* With external base-to-emitter resistance (R_{BE}) ≤ 100 Ω	$V_{CER}(sus)$	80	100	80	100	V
With base open	$V_{CEO}(sus)$	60	80	60	80	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
* CONTINUOUS COLLECTOR CURRENT	I_C	12	12	12	12	A
* PEAK COLLECTOR CURRENT		25	25	25	25	A
* CONTINUOUS BASE CURRENT	I_B	5	5	5	5	A
* TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		87	87	117	117	W
At case temperatures above 25°C		See Figs. 1, 3, and 11				
* TEMPERATURE RANGE:						
Storage and Operating (Junction)		-65 to +200				°C
* TERMINAL TEMPERATURE (During Soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230				°C

* In accordance with JEDEC registration data format JS-6 RDF-1.

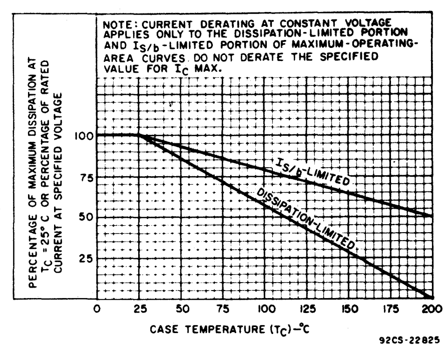


Fig. 1 - Derating curves for all types.

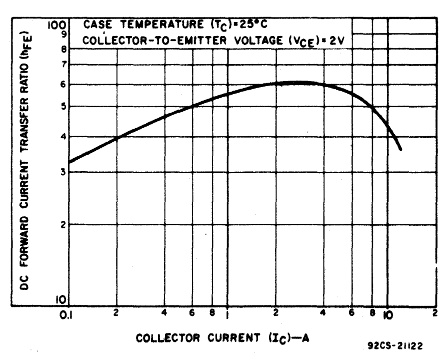


Fig. 2 - Typical dc beta characteristic for all types.

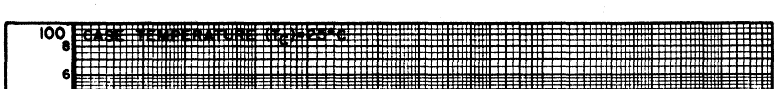


Fig. 3 - Maximum operating areas for 2N6479 and 2N6480.

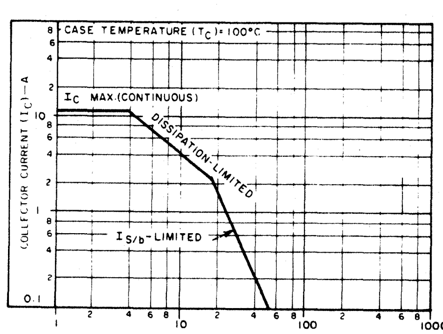


Fig. 4 - Maximum operating area for 2N6479 and 2N6480 at 100°C case temperature.

2N6479-2N6482

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*
PRE-RADIATION

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{EB}	CURRENT A dc I_B	I_C	LIMITS 2N6479 2N6481 MIN.	MAX.	2N6480 2N6482 MIN.	MAX.	UNITS
Collector Cutoff Current: With emitter open, V_{CB} = 100 V	I_{CBO}					–	1	–	1	mA
With base shorted	I_{CES}	60				–	200	–	200	µA
* With base-emitter junction reverse-biased	I_{CEV}	100	0			–	1	–	1	mA
* At T_C = 100°C	I_{CEV}	60	0			–	1	–	1	mA
* Emitter Cutoff Current	I_{EBO}		6			–	2	–	2	mA
Emitter-to-Base Voltage: I_E = 2 mA	V_{EBO}					6	–	6	–	V
Collector-to-Emitter Sustaining Voltage: * With base open	$V_{CEO}(sus)$				0.2[a]	60[b]	–	80[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				0 2	80[b]	–	100[b]	–	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			1.2	12[a]	–	0.75	–	0.75	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			1.2	12[a]	–	1.5	–	1.5	V
* DC Forward Current Transfer Ratio	h_{FE}	2			12[a]	20	300	20	300	
Second Breakdown Collector Current: With base forward-biased, t = 1 s	$I_{S/b}$	12				7.3	-	7.3	-	A
Second Breakdown Energy: With base reverse-biased, R_{BE} = 100 Ω, L = 100 µH	$E_{S/b}$**				5	1.25	-	1.25	-	mJ
* Saturated Switching Time (V_{CC} = 30 V, I_{B1} = I_{B2}): Rise	t_r			1.2	12	-	400	-	400	ns
Storage	t_s			1.2	12	-	800	-	800	ns
Fall	t_f			1.2	12	-	200	-	200	ns
* Magnitude of Common Emitter Small-Signal Short Circuit Forward Current Transfer Ratio: f = 10 MHz	$\lvert h_{fe} \rvert$	5			1	10	-	10	-	
Collector-to-Base Feedback Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{ob}					–	400	–	400	pF
						2N6479 2N6480		2N6481 2N6482		
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	10			5	–	2	–	1.5	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-1.
[a] Pulsed; pulse duration ≤ 350 µs, duty factor ≤ 2%.
[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

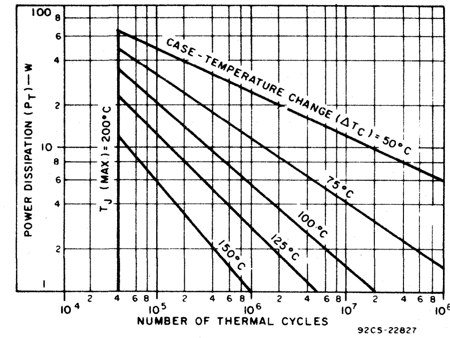


Fig. 5 - Thermal-cycling rating chart for 2N6479 and 2N6480.

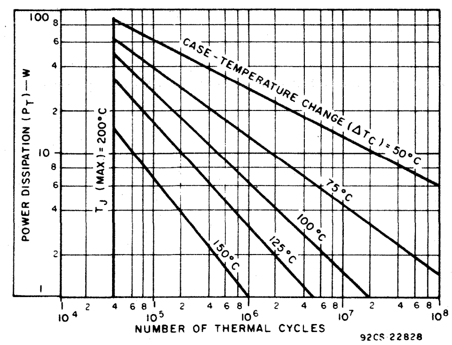


Fig. 6 - Thermal-cycling rating chart for 2N6481 and 2N6482.

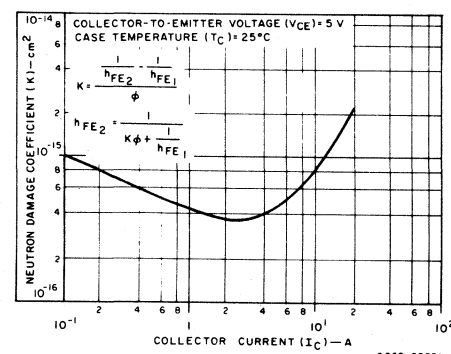


Fig. 7 - Typical 1-MeV-equivalent neutron damage coefficient as a function of collector current for all types.

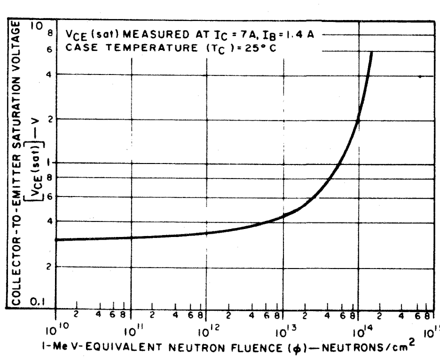


Fig. 8 - Typical collector-to-emitter saturation voltage as a function of 1-MeV-equivalent neutron fluence for all types.

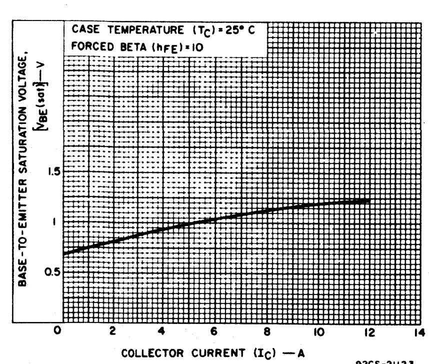


Fig. 9 - Typical base-to-emitter saturation voltage characteristic for all types.

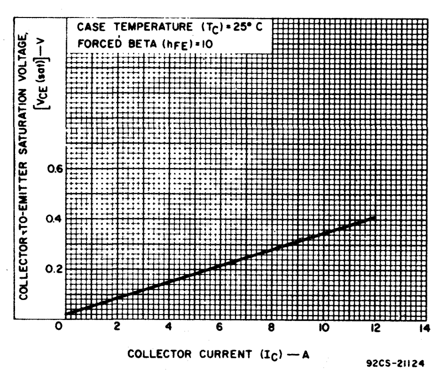


Fig. 10 - Typical collector-to-emitter saturation voltage characteristic for all types.

2N6479-2N6482

POST-NEUTRON-RADIATION ELECTRICAL CHARACTERISTICS
AFTER EXPOSURE TO 5 x 10^{13} NEUTRONS/cm^2 (1 MeV equiv.), *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS		UNITS
		VOLTAGE V dc		CURRENT A dc		For all Types		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	
* Collector Cutoff Current: With base-emitter junction reverse-biased	I_{CEV}	100	0			–	1.2	mA
* Emitter Cutoff Current	I_{EBO}		−5			–	2.2	mA
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.2 0.2	0.05 0.05	80[b] 60[c]	– –	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			7[a]	1.4	–	1.5	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			7[a]	1.4	–	1.5	V
* DC Forward Current Transfer Ratio	h_{FE}	5		7[a]		12	–	
Magnitude of Common Emitter, Small-Signal Short Circuit Forward Current Transfer Ratio: Ratio (f = 10 MHz)	$\|h_{fe}\|$	5		1		10	–	
* Damage Constant	K▲					–	9 x 10^{-16}	

* In accordance with JEDEC registration data format JS-6 RDF-1.

a Pulsed; pulse duration ≤ 350 μs, duty factor ≤ 2%.

b For types 2N6480, 2N6482.

c For types 2N6479, 2N6481.

▲Damage constant $K = \dfrac{\dfrac{1}{h_{FE_2}} - \dfrac{1}{h_{FE_1}}}{\phi}$

Where h_{FE_1} = Beta prior to exposure
h_{FE_2} = Beta after exposure
ϕ = Neutron fluence (1 MeV equiv.)
Knowing K, h_{FE_2} may be calculated for other fluences using the relationship:

$$h_{FE_2} = \frac{1}{K\phi + \frac{1}{h_{FE_1}}}$$

TYPICAL CHARACTERISTIC DURING GAMMA EXPOSURE FOR DOSE RATES OF LESS THAN 1 x 10^8 RAD(Si)/sec

CHARACTERISTIC	SYMBOL	TEST CONDITIONS		LIMITS	UNITS
		VOLTAGE – V dc		For all Types	
		V_{CB}	V_{BE}	TYPICAL	
Collector-to-Base Charge Generation Constant	(C)	20	0	5x10^{-8}	Coulomb / Rad

The charge generated in the depletion region of a transistor is proportional to the volume of the depletion region, the total dose, and the energy of the gamma radiation.

The primary base-collector photo current [$I_{pp(base)}$] = (C)$\dot{\gamma}$, where $\dot{\gamma}$ is the gamma dose rate in Rad(Si)/s.

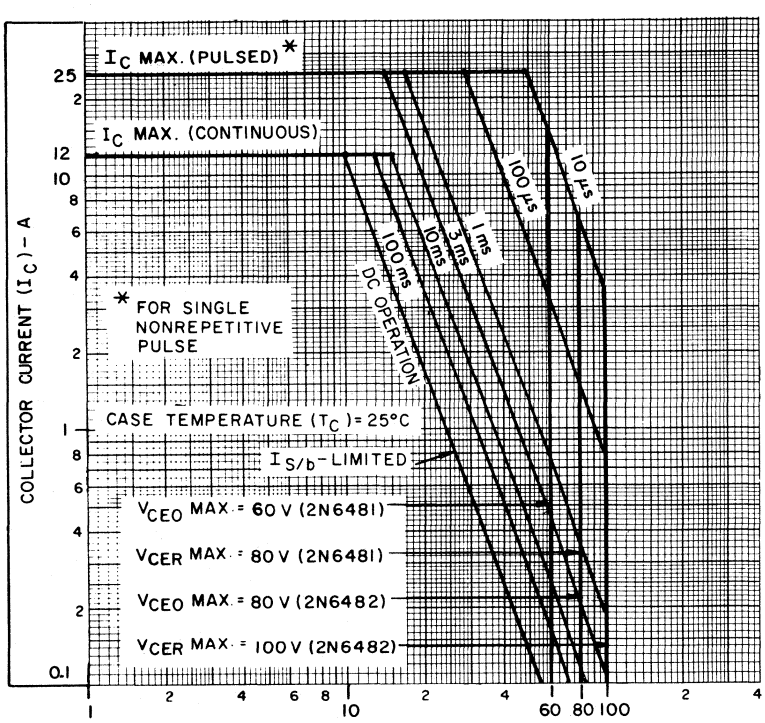


Fig. 11 - Maximum operating areas for 2N6481 and 2N6482.

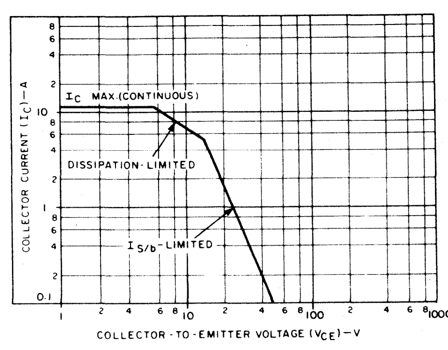


Fig. 12 - Maximum operating area for 2N6481 and 2N6482.

2N6486-2N6491

15-A, 75-W, Silicon N-P-N and P-N-P Epitaxial-Base VERSAWATT Transistors

Complementary Pairs for General-Purpose Switching and Amplifier Applications

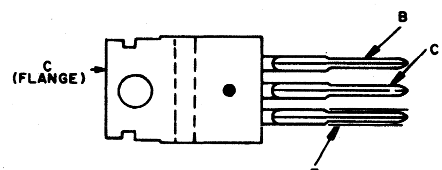
Features:
- **Thermal-cycling ratings**
- **Maximum safe-area-of-operation curves**
- **Color-coded packages of molded-silicone plastic:**
  Green — p-n-p (2N6489, 2N6490, 2N6491)
  Gray — n-p-n (2N6486, 2N6487, 2N6488)

RCA-2N6486–2N6491●, inclusive, are epitaxial-base silicon transistors. The 2N6486, 2N6487, and 2N6488 are n-p-n complements of p-n-p types 2N6489, 2N6490, and 2N6491, respectively. All these devices are intended for a wide variety of medium-power switching and amplifier applications, and are particularly useful in high-fidelity amplifiers utilizing complementary-symmetry circuits.

● Formerly RCA Dev. Nos. TA8325, TA8324, TA8323, TA8328, TA8327, and TA8326, respectively.

These devices are supplied in the RCA VERSAWATT package in color-coded molded-silicone plastic; the 2N6489–2N6491 (p-n-p) devices are green, and the 2N6486–2N6488 (n-p-n) devices are gray. All are regularly supplied in the JEDEC TO-220AB straight-lead version of the package. They are also available on special order in a variety of lead-form configurations.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		N-P-N: 2N6486 P-N-P: 2N6489♦	2N6487 2N6490♦	2N6488 2N6491♦	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	70	90	V
COLLECTOR-TO-EMITTER VOLTAGE:					
* With 1.5 volts (V_{BE}) of reverse bias, and external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CEX}	50	70	90	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	45	65	85	V
With base open	V_{CEO}	40	60	80	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	V
* CONTINUOUS COLLECTOR CURRENT	I_C	15	15	15	A
* CONTINUOUS BASE CURRENT	I_B	5	5	5	A
* TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		75	75	75	W
At ambient temperatures up to 25°C		1.8	1.8	1.8	W
At case temperatures above 25°C		Derate linearly 0.6			W/°C
At ambient temperatures above 25°C		Derate linearly 0.0144			W/°C
* TEMPERATURE RANGE:					
Storage and operating (Junction)		−65 to +150			°C
* LEAD TEMPERATURE (During soldering): At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.		235			°C

* In accordance with JEDEC registration data format JS-6 RDF-2.

♦ For p-n-p devices, voltage and current values are negative.

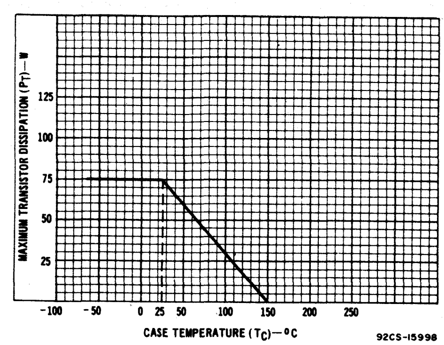


Fig. 1 - Derating chart for all types.

ELECTRICAL CHARACTERISTICS, *At case temperature (T_C) = 25°C unless otherwise specified*

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURR. A dc I_C	LIMITS 2N6486 2N6489♦ Min.	Max.	2N6487 2N6490♦ Min.	Max.	2N6488 2N6491♦ Min.	Max.	UNITS
	Collector-Cutoff Current: With external base-emitter resistance (R_{BE}) = 100Ω	I_{CER}	35 55 75			– – –	500 – –	– – –	– 500 –	– – –	– – 500	μA
*	With base-emitter junction reverse biased and external base-to-emitter resistance (R_{BE}) = 100Ω	I_{CEX}	45 65 85	−1.5 −1.5 −1.5		– – –	500 – –	– – –	– 500 –	– – –	– – 500	μA
*	At T_C = 150°C	I_{CEX}	40 60 80	−1.5 −1.5 −1.5		– – –	5 – –	– – –	– 5 –	– – –	– – 5	mA
*	With base open	I_{CEO}	20 30 40			– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
*	Emitter-Cutoff Current	I_{EBO}		−5	0	–	1	–	1	–	1	mA
*	DC Forward-Current Transfer Ratio	h_{FE}	4 4		5[a] 15[a]	20 5	150 –	20 5	150 –	20 5	150 –	
*	Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$			0.2	40[b]	–	60[b]	–	80[b]	–	V
	With external base-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$			0.2	45[b]	–	65[b]		85[b]	–	V
	With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CEX}(sus)$		−1.5	0.2	50[b]	–	70[b]	–	90[b]	–	V
*	Base-to-Emitter Voltage	V_{BE}	4 4		5[a] 15[a]	– –	1.3 3.5	– –	1.3 3.5	– –	1.3 3.5	V
*	Collector-to-Emitter Saturation Voltage — I_B = 0.5 A; I_B = 5 A	$V_{CE}(sat)$			5[a] 15[a]	– –	1.3 3.5	– –	1.3 3.5	– –	1.3 3.5	V
*	Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio: f = 1 MHz	$\|h_{fe}\|$	4		1	5	–	5	–	5	–	
*	Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		1	25	–	25	–	25	–	
	Thermal Resistance: Junction-to-case	$R_{\theta JC}$				–	1.67	–	1.67	–	1.67	°C/W
	Junction-to-ambient	$R_{\theta JA}$				–		–	70	–	70	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-2).

[a] Pulsed; pulse duration = 300 μs, duty factor = 1.8%

[b] *CAUTION: Sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer. (See Fig. 19)*

♦ For p-n-p devices, voltage and current values are negative.

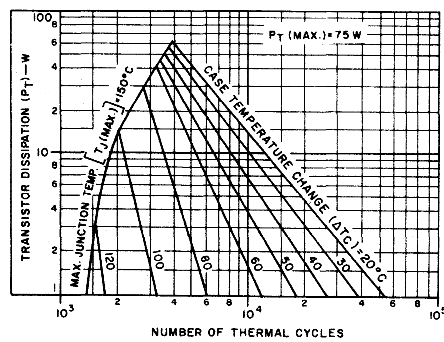


Fig. 2 - Thermal-cycling rating chart for all types.

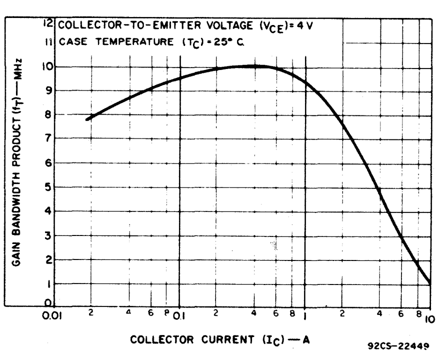


Fig. 3 - Typical gain-bandwidth product as a function of collector current for all types.♦

♦ For p-n-p devices, voltage and current values are negative.

2N6486-2N6491

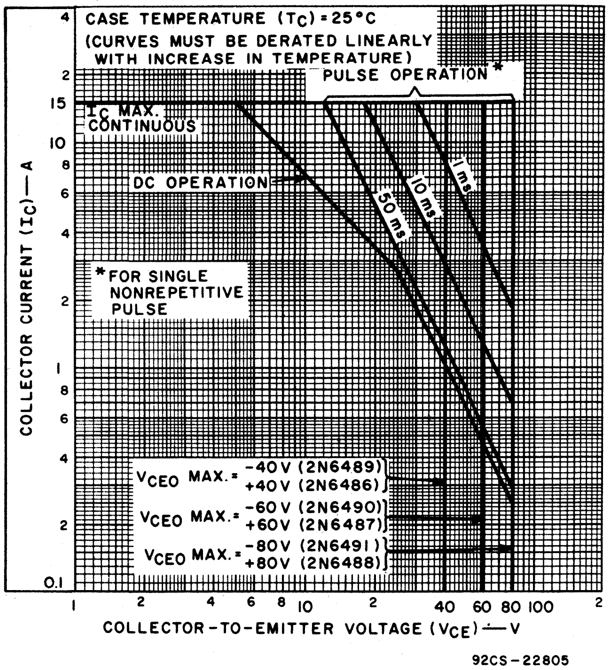


Fig. 4 - Maximum operating areas for all types.◆

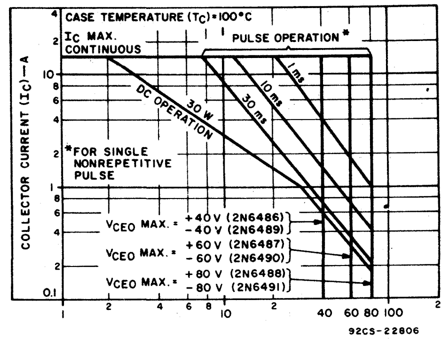


Fig. 5 - Maximum operating areas for all types.◆

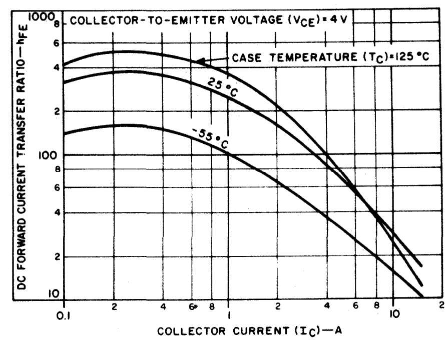


Fig. 6 - Typical dc beta characteristics for 2N6486, 2N6487, and 2N6488.

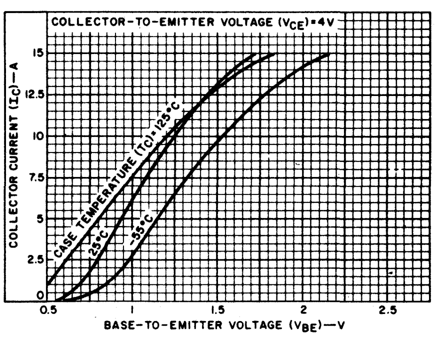


Fig. 7 - Typical transfer characteristics for all types.◆

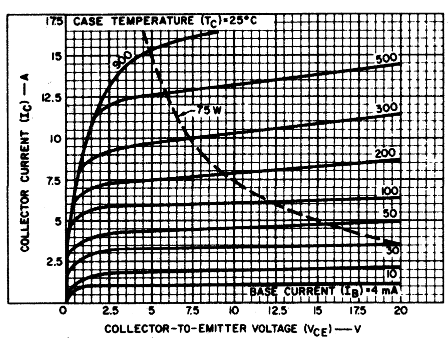


Fig. 8 - Typical output characteristics for all types.◆

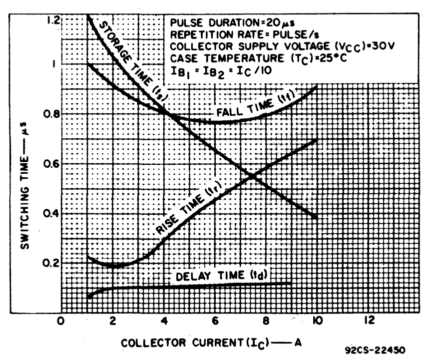


Fig. 9 - Typical saturated switching characteristics for 2N6486, 2N6487, and 2N6488.

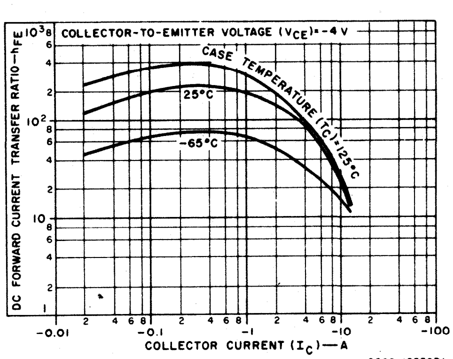


Fig. 10 - Typical dc beta characteristics for 2N6489, 2N6490, 2N6491.

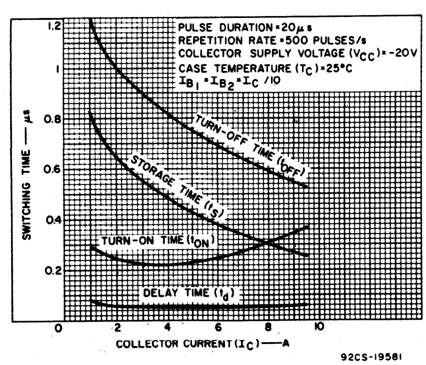


Fig. 11 - Typical saturated switching characteristics for 2N6489, 2N6490, and 2N6491.

◆ For p-n-p devices, voltage and current values are negative.

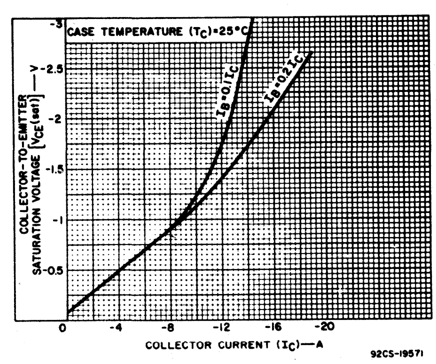


Fig. 12 - Typical collector-to-emitter saturation-voltage characteristics for all types.

2N6510-2N6514

High-Voltage, High-Current Silicon N-P-N Power-Switching Transistors

For Switching Applications in Industrial Commercial and Military Equipment

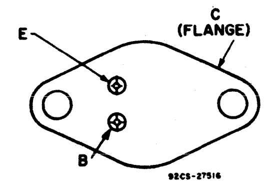
Features:
- Fast switching speed
- Epitaxial pi-nu construction
- Hermetic steel package—JEDEC TO-3
- Maximum-safe-area-of-operation curves
- Thermal-cycling rating chart

The RCA-2N6510, -2N6511, -2N6512, -2N6513, and -2N6514● are epitaxial silicon n-p-n power transistors with pi-nu construction. They are especially designed for use in electronic ignition circuits and other applications requiring high-voltage, high-energy, and fast-switching-speed capability.

These devices are hermetically sealed in a steel JEDEC TO-3 package. They differ from each other in breakdown-voltage ratings, leakage, and beta characteristics.

●Formerly RCA Dev. Nos. TA8847D, TA8847A, TA8847B, TA8847C, and TA8847E, respectively.

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6510	2N6511	2N6512	2N6513	2N6514	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	300	350	400	350	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:							
With external base-to-emitter resistance R_{BE} = 50 Ω	$V_{CER}(sus)$	250	300	350	400	350	V
* With base open	$V_{CEO}(sus)$	200	250	300	350	300	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	6	V
*CONTINUOUS COLLECTOR CURRENT	I_C	7	7	7	7	7	A
*CONTINUOUS BASE CURRENT	I_B	3	3	3	3	3	A
*EMITTER CURRENT	I_E	10	10	10	10	10	A
*TRANSISTOR DISSIPATION:	P_T						
At case temperatures up to 25°C		120	120	120	120	120	W
At case temperatures above 25°C		See Figs. 1 and 2.					
*TEMPERATURE RANGE:							
Storage and Operating (Junction)		-65 to +200					°C
*PIN TEMPERATURE (During Soldering):							
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230					°C

*In accordance with JEDEC registration data format JC-25 RDF-1.

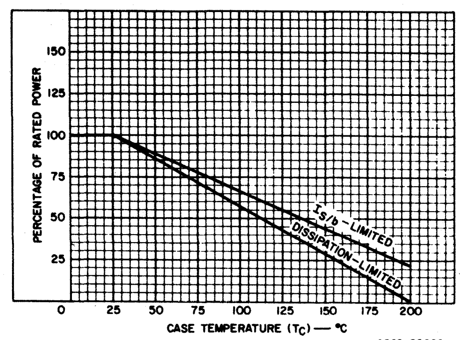


Fig. 2 - Derating curve for all types.

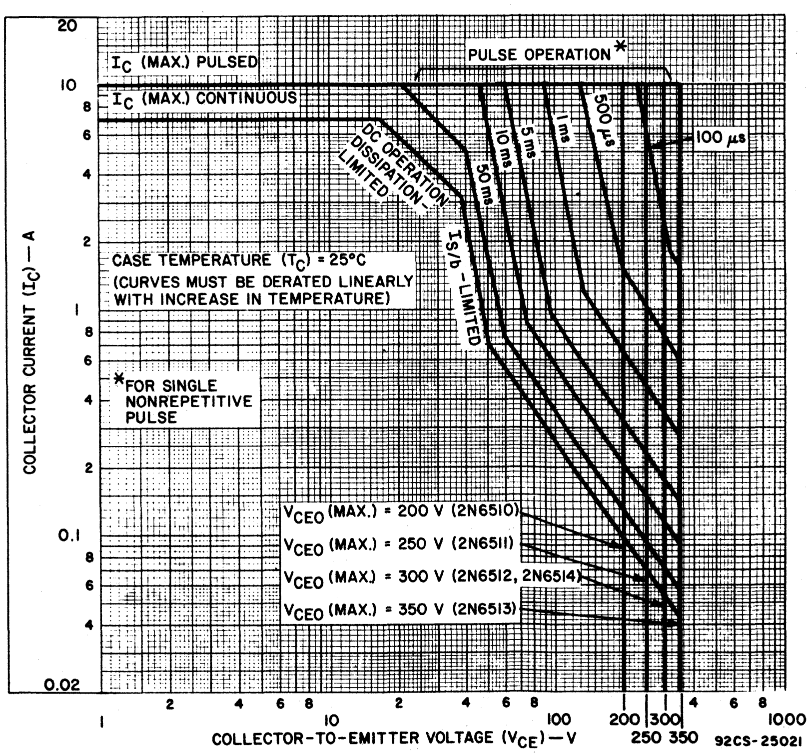


Fig. 1 - Maximum operating areas for all types.

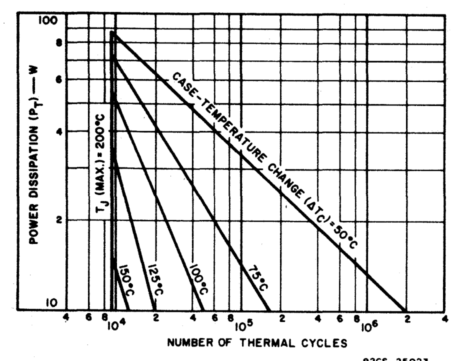


Fig. 3 - Thermal-cycling rating chart for all types.

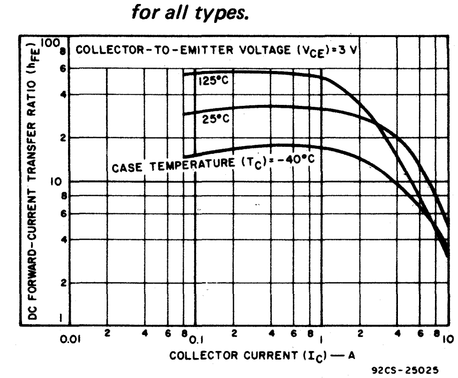


Fig. 4 - Typical dc beta characteristic for all types.

2N6510-2N6514

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6512 2N6514 Min.	Typ.	Max.	2N6513 Min.	Typ.	Max.	UNITS
Collector-Cutoff Current: With base open	I_{CEO}	250 300				— —	— —	5 —	— —	— —	— 5	mA
* With base-emitter junction reverse biased	I_{CEV}	350 400	−1.5 −1.5			— —	— —	5 —	— —	— —	— 5	mA
* With base-emitter junction reverse biased, T_C = 100°C	I_{CEV}	350 400	−1.5 −1.5			— —	— —	10 —	— —	— —	— 10	mA
* Emitter-Cutoff Current	I_{EBO}		−6			—	—	3	—	—	3	mA
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.2		300[b]	—	—	350[b]	—	—	V
With external base-to-emitter resistance: R_{BE} = 50 Ω	$V_{CER}(sus)$			0.2		350[b]	—	—	400[b]	—	—	V
* Emitter-to-Base Voltage: I_E = 3 mA	V_{EBO}					6	—	—	6	—	—	V
* DC Forward-Current Transfer Ratio: 2N6512, 2N6513 2N6514	h_{FE}	3 3		4[a] 5[a]		10 10	— —	50 50	10 —	— —	50 —	
* Base-to-Emitter Saturation Voltage: 2N6512, 2N6513 2N6514	$V_{BE}(sat)$			4[a] 5[a]	0.8 1	— —	— —	1.7 1.7	— —	— —	1.7 —	V
* Collector-to-Emitter Saturation Voltage: 2N6512, 2N6513 2N6514 All types	$V_{CE}(sat)$			4[a] 5 7	0.8 1 3	— — —	— — 1.5	1.5 1.5 2.5	— — —	— — 1.5	1.5 — 2.5	V
* Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{obo}					100	—	200	100	—	200	pF
* Magnitude of Common Emitter, Small-Signal Short-Circuit, Forward-Current Transfer Ratio: f = 1 MHz	$\|h_{fe}\|$	10		1		3	—	9	3	—	9	MHz
* Forward-Bias, Second-Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$	38 200				3.16 0.1	— —	— —	3.16 0.1	— —	— —	A
* Switching Time:[c] (V_{CC} = 200 V, I_{B1} = I_{B2}): Delay Time: 2N6512, 2N6513 2N6514	t_d			4 5	0.8 1	— —	0.1 0.1	0.2 0.2	— —	0.1 —	0.2 —	μs
Rise Time: 2N6512, 2N6513 2N6514	t_r			4 5	0.8 1	— —	0.7 0.7	1.5 1.5	— —	0.7 —	1.5 —	μs
Storage Time: 2N6512, 2N6513 2N6514	t_s			4 5	0.8 1	— —	3 3	5 5	— —	3 —	5 —	μs
Fall Time: 2N6512, 2N6513 2N6514	t_f			4 5	0.8 1	— —	0.5 0.5	1.5 1.5	— —	0.5 —	1.5 —	μs
* Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	20		5		—	—	1.46	—	—	1.46	°C/W

* Minimum and maximum values and test conditions in accordance with JEDEC registration data format JC-25 RDF-1.

[a] Pulsed; pulse duration = 300 μs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

[c] See Figs. 10 and 11.

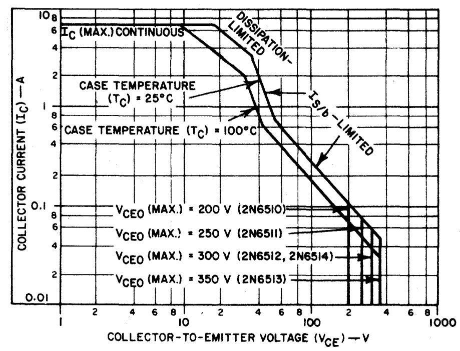


Fig. 5 - Maximum operating areas for all types at 25°C and 100°C.

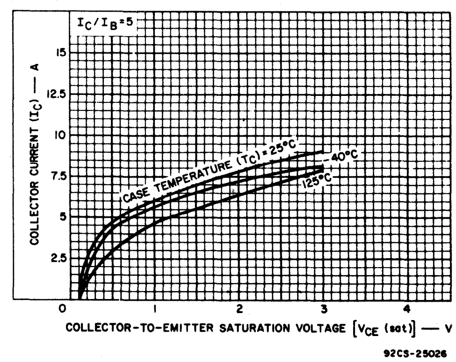


Fig. 6 - Typical collector-to-emitter saturation-voltage characteristics for all types.

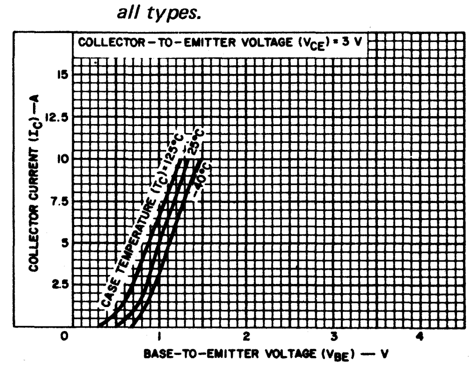


Fig. 7 - Typical transfer characteristics for all types.

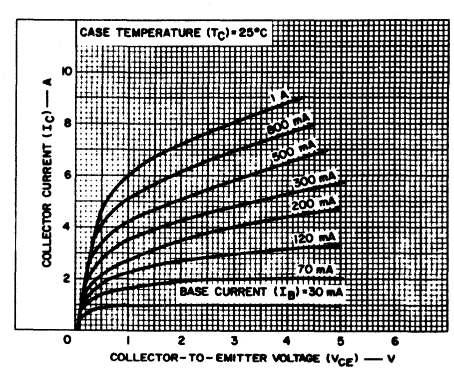


Fig. 8 - Typical output characteristics for all types.

2N6510-2N6514

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc		TEST CONDITIONS CURRENT A dc		LIMITS 2N6510			LIMITS 2N6511			UNITS
		V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	150 200				– –	– –	5 –	– –	– –	– 5	mA
* With base-emitter junction reverse biased	I_{CEV}	250 300	−1.5 −1.5			– –	– –	5 –	– –	– –	– 5	mA
* With base-emitter junction reverse biased, T_C = 100°C	I_{CEV}	250 300	−1.5 −1.5			– –	– –	10 –	– –	– –	– 10	mA
* Emitter-Cutoff Current	I_{EBO}		−6			–	–	3	–	–	3	mA
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.2		200[b]	–	–	250[b]	–	–	V
With external base-to-emitter resistance: R_{BE} = 50 Ω	$V_{CER}(sus)$			0.2		250[b]	–	–	300[b]	–	–	V
* Emitter-to-Base Voltage: I_E = 3 mA	V_{EBO}					6	–	–	6	–	–	V
* DC Forward-Current Transfer Ratio	h_{FE}	3 3		3[a] 4[a]		10 –	– –	50 –	– 10	– –	– 50	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			3[a] 4[a]	0.6 0.8	– –	– –	1.7 –	– –	– –	– 1.7	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			3[a] 4[a] 7[a]	0.6 0.8 3	– – –	– – 1.5	1.5 – 2.5	– – –	– – 1.5	– 1.5 2.5	V
* Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{obo}					100	–	200	100	–	200	pF
* Magnitude of Common Emitter, Small-Signal Short-Circuit, Forward-Current Transfer Ratio: f = 1 MHz	$\|h_{fe}\|$	10		1		3	–	9	3	–	9	MHz
* Forward-Bias, Second-Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$	38 200				3.16 0.1	– –	– –	3.16 0.1	– –	– –	A
* Switching Time:[c] (V_{CC} = 200 V, I_{B1} = I_{B2}): Delay Time	t_d			3 4	0.6 0.8	– –	0.1 –	0.2 –	– –	– 0.1	– 0.2	µs
Rise Time	t_r			3 4	0.6 0.8	– –	0.7 –	1.5 –	– –	– 0.7	– 1.5	µs
Storage Time	t_s			3 4	0.6 0.8	– –	3 –	5 –	– –	– 3	– 5	µs
Fall Time	t_f			3 4	0.6 0.8	– –	0.5 –	1.5 –	– –	– 0.5	– 1.5	µs
* Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	20		5		–	–	1.46	–	–	1.46	°C/W

* Minimum and maximum values and test conditions in accordance with JEDEC registration data format JC-25 RDF-1.

[a] Pulsed; pulse duration = 300 µs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 11.

[c] See Figs. 8-10.

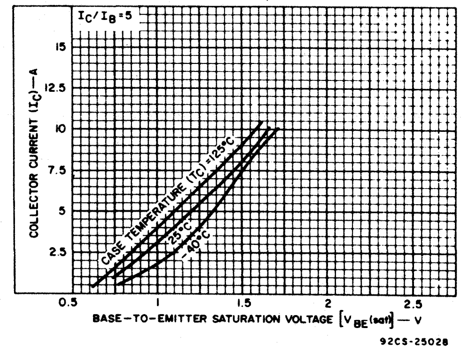


Fig. 9 - Typical base-to-emitter saturation-voltage characteristics for all types.

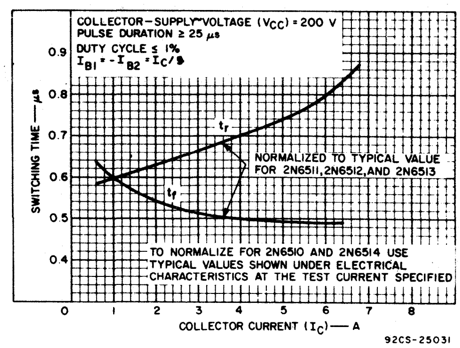


Fig. 10 - Typical rise- and fall-time characteristics for all types.

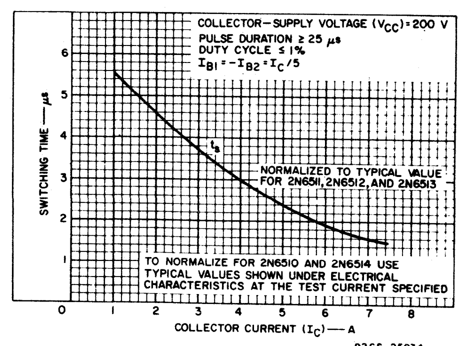


Fig. 11 - Typical storage-time characteristic for all types.

2N6530-2N6533

8-Ampere N-P-N Darlington Power Transistors

80, 100, 120 Volts, 60 Watts
Gain of 1000 at 5 A (2N6530, 2N6532)
Gain of 1000 at 3 A (2N6533)
Gain of 500 at 3 A (2N6531)

Features:
- **Operate from IC without predriver**
- **Low leakage at high temperature**
- **High reverse second-breakdown capability**

Applications:
- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

The RCA-2N6530, 2N6531, 2N6532, and 2N6533● are monolithic n-p-n silicon Darlington transistors designed for power applications at low and medium frequencies. The double epitaxial construction of these devices provides good forward and reverse second-breakdown characteristics. Their high gain allows them to be driven directly from integrated circuits.

● Formerly RCA Dev. Nos. TA8904C, TA8904D, TA8904B, and TA8904A, respectively.

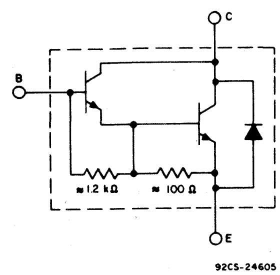
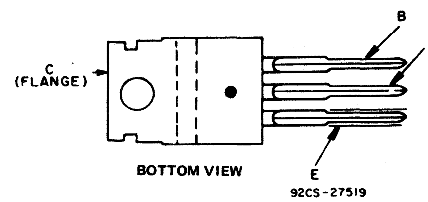


Fig. 1 - Schematic diagram for all types.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6530	2N6531	2N6532	2N6533	
$^*V_{CBO}$	80	100	100	120	V
$V_{CER}(sus)$					
$R_{BE} = 100\ \Omega$	80	100	100	120	V
$V_{CEO}(sus)$	80	100	100	120	V
$^*V_{CEV}(sus)$					
$V_{BE} = -1.5$ V	80	100	100	120	V
$^*V_{EBO}$	5	5	5	5	V
$^*I_C$	8	8	8	8	A
I_{CM}	15	15	15	15	A
$^*I_B$	0.25	0.25	0.25	0.25	A
$^*P_T$					
Up to 25°C	65	65	65	65	W
Above 25°C	See Fig. 2				
$^*T_J$, T_{stg}	−65 to +150				°C
$^*T_L$					
At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

* In accordance with JEDEC registration data format JS-6, RDF-4.

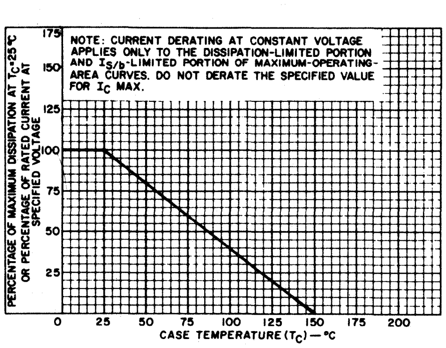


Fig. 2 - Dissipation derating curve for all types.

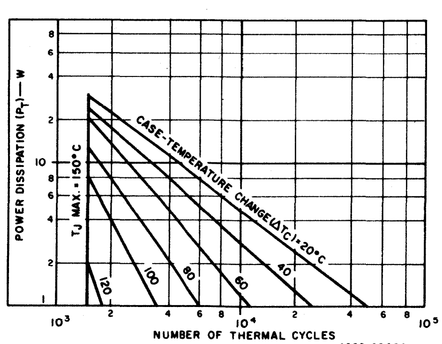


Fig. 3 - Thermal-cycling rating chart for all types.

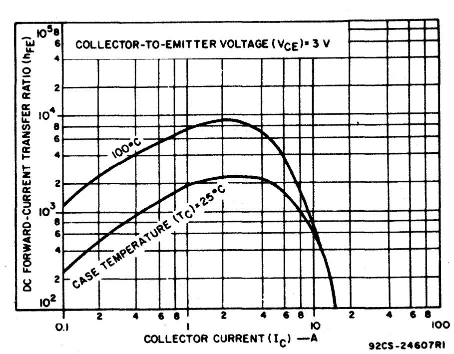


Fig. 4 - Typical dc beta characteristics for all types.

2N6530-2N6533

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc		TEST CONDITIONS CURRENT A dc		LIMITS 2N6530		LIMITS 2N6531		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	80 100			0 0	– –	1 –	– –	– 1	
* I_{CEV}	80 100	−1.5 −1.5			– –	0.5 –	– –	– 0.5	mA
* T_C = 125°C	80 100	−1.5 −1.5			– –	5 –	– –	– 5	
I_{EBO}		−5	0		–	5	–	5	mA
* h_{FE}	3 3 3		5[a] 3[a] 8[a]		1,000 – 100	10,000 – 5,000	– 500 100	– 10,000 5,000	
V_{CEO}(sus)			0.2	0	80[b]	–	100[b]	–	
V_{CER}(sus) R_{BE} = 100 Ω			0.2		80[b]	–	100[b]	–	V
* V_{CEV}(sus)		−1.5	0.2		80[b]	–	100[b]	–	
V_{BE}	3 3 3		5[a] 3[a] 8[a]		– – –	2.8 – 4.5*	– – –	– 2.8 4.5*	V
V_{CE}(sat)			3[a] 5[a] 8[a]	0.006 0.01 0.08	– – –	– 2 3*	– – –	3 – 3*	V
V_F			5[a] 8[a]		– –	– 5	– –	4 –	V
h_{fe} f = 1 kHz	5		1		1,000	–	1,000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	
C_{obo} V_{CB} = 10 V f = 1 MHz					–	200	–	200	pF
* $I_{S/b}$ t = 0.5 s, nonrep.	24				2.7	–	2.7	–	A
$E_{S/b}$ L = 12 mH R_{BE} = 100 Ω		−1.5	4.5		120	–	120	–	mJ
$R_{\theta JC}$					–	1.92	–	1.92	°C/W

* In accordance with JEDEC registration data format JS-6, RDF-4.

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

[b] *CAUTION:* Sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) *MUST NOT* be measured on a curve tracer.

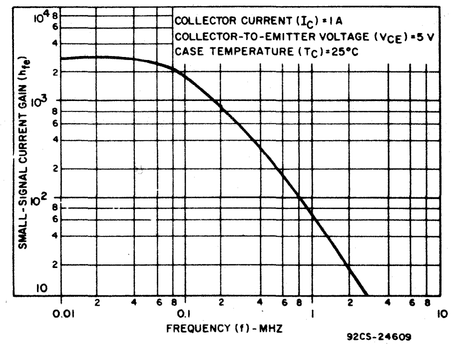


Fig. 5 - Typical small-signal current gain for all types.

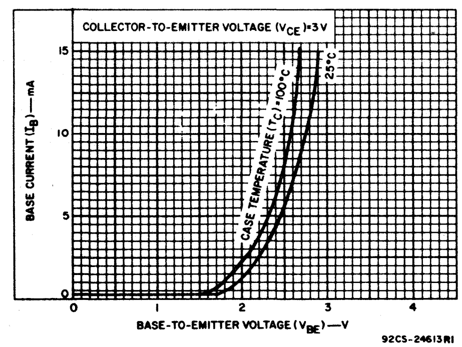


Fig. 6 - Typical input characteristics for all types.

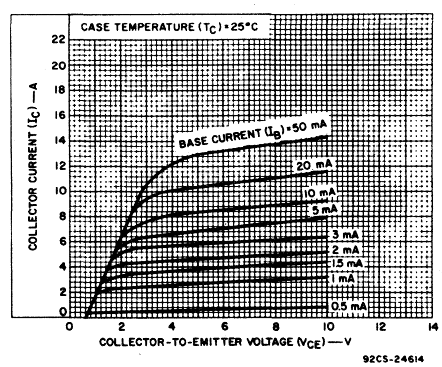


Fig. 7 - Typical output characteristics for all types.

2N6530-2N6533

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6532		2N6533		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	120 100			0 0	– –	– 1	– –	1 –	mA
* I_{CEV}	120 100	−1.5 −1.5			– –	– 0.5	– –	0.5 –	mA
* T_C = 125°C	120 100	−1.5 −1.5			– –	– 5	– –	5 –	mA
I_{EBO}		−5	0		–	5	–	5	mA
* h_{FE}	3 3 3		3[a] 5[a] 8[a]		– 1,000 100	– 10,000 5,000	1,000 – 100	10,000 – 5,000	
V_{CEO}(sus)			0.2	0	100[b]	–	120[b]	–	V
V_{CER}(sus) R_{BE} = 100 Ω			0.2		100[b]	–	120[b]	–	V
* V_{CEV}(sus)		−1.5	0.2		100[b]	–	120[b]	–	V
V_{BE}	3 3 3		3[a] 5[a] 8[a]		– – –	– 2.8 4.5*	– – –	2.8 – 4.5*	V
V_{CE}(sat)			3[a] 5[a] 8[a]	0.006 0.01 0.08	– – –	– 2 3*	– – –	2 – 3*	V
V_F			5[a] 8[a]		– –	– 5	– –	4 –	V
h_{fe} f = 1 kHz	5		1		1,000	–	1,000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	
C_{obo} V_{CB} = 10 V f = 1 MHz					–	200	–	200	pF
* $I_{S/b}$ t = 0.5 s, nonrep.	24				2.7	–	2.7	–	A
$E_{S/b}$ L = 12 mH R_{BE} = 100 Ω		−1.5	4.5		120	–	120	–	mJ
$R_{\theta JC}$					–	1.92	–	1.92	°C/W

* In accordance with JEDEC registration data format JS-6, RDF-4.

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

[b] *CAUTION:* Sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) *MUST NOT* be measured on a curve tracer.

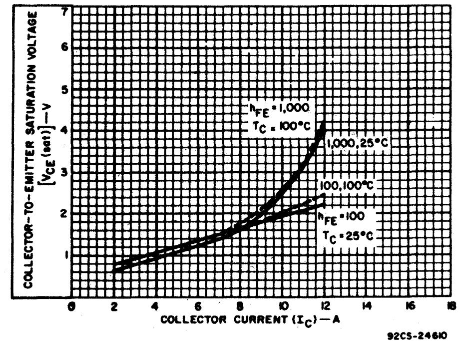


Fig. 8 - Typical saturation characteristics for all types.

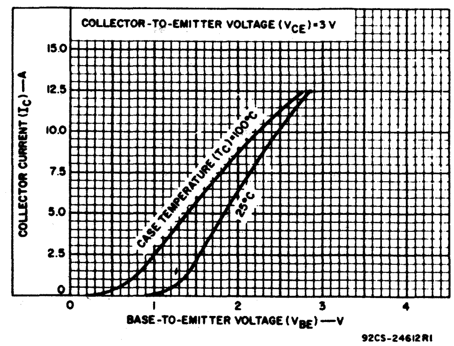


Fig. 9 - Typical transfer characteristics for all types.

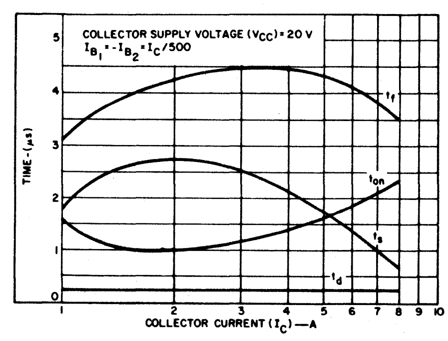


Fig. 10 - Typical saturated switching-time characteristics for all types.

2N6530-2N6533

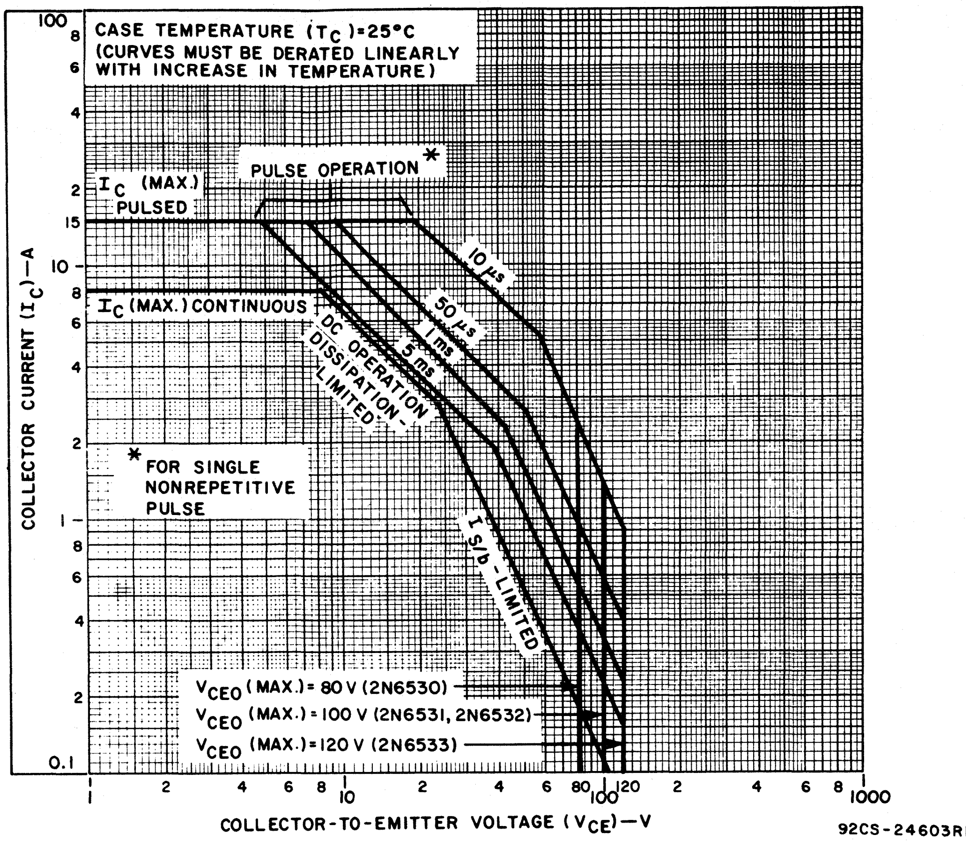


Fig. 11 - Maximum operating areas for all types at case temperature of 25°C.

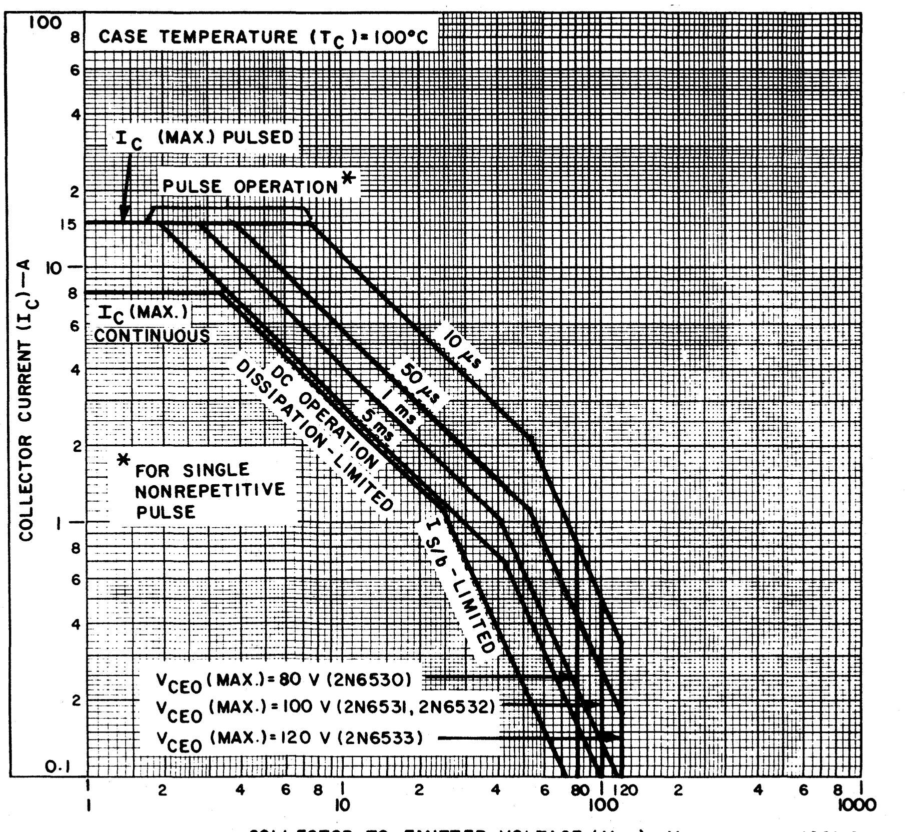


Fig. 12 - Maximum operating areas for all types at case temperature of 100°C.

2N6534-2N6537
8-Ampere N-P-N Darlington Power Transistors

80, 100, 120 Volts, 36 Watts
Gain of 1000 at 5 A (2N6534, 2N6536)
Gain of 1000 at 3 A (2N6537)
Gain of 500 at 3 A (2N6535)

The RCA-2N6534, 2N6535, 2N6536, and 2N6537● are monolithic n-p-n silicon Darlington transistors designed for power applications at low and medium frequencies. The double epitaxial construction of these devices provides good forward and reverse second-breakdown characteristics. Their high gain allows them to be driven directly from integrated circuits.

These transistors are supplied in JEDEC TO-66 hermetic packages.

● Formerly RCA Dev. Nos. TA8941C, TA8941D, TA8941B, and TA8941A, respectively.

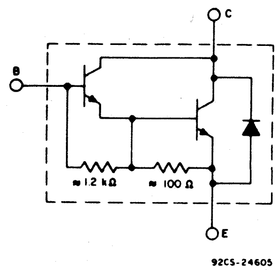


Fig. 1 - Schematic diagram for all types.

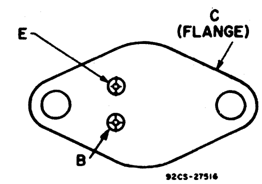
Features:

- Operate from IC without predriver
- Low leakage at high temperature
- High reverse second-breakdown capability

Applications:

- Power switching ■ Audio amplifiers
- Hammer drivers ■ Series and shunt regulators

TERMINAL DESIGNATIONS



JEDEC TO-66

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6534	2N6535	2N6536	2N6537	
*V_{CBO}	80	100	100	120	V
$V_{CER}(sus)$ R_{BE} = 100 Ω	80	100	100	120	V
$V_{CEO}(sus)$	80	100	100	120	V
*$V_{CEV}(sus)$ V_{BE} = −1.5 V	80	100	100	120	V
*V_{EBO}	5	5	5	5	V
*I_C	8	8	8	8	A
I_{CM}	15	15	15	15	A
*I_B	0.25	0.25	0.25	0.25	A
*P_T Up to 25°C	36	36	36	36	W
Above 25°C	See Fig. 2				
*T_{stg}	−65 to +200				°C
*T_J	−65 to +150				°C
*T_L At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

* In accordance with JEDEC registration data format JS-6, RDF-4.

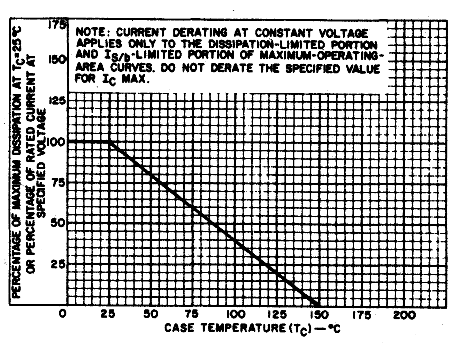


Fig. 2 - Dissipation derating curve for all types.

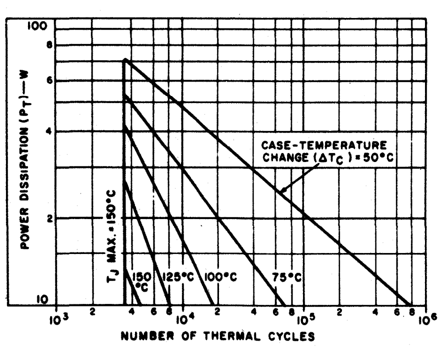


Fig. 3 - Thermal-cycling rating chart for all types.

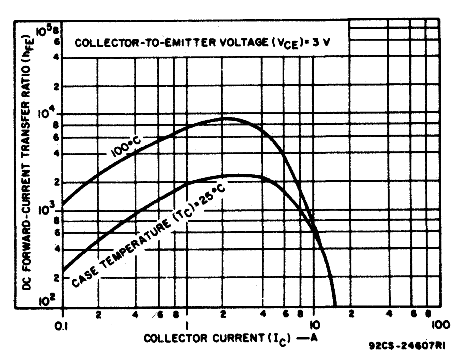


Fig. 4 - Typical dc beta characteristics for all types.

2N6534-2N6537

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6534 Min.	Max.	2N6535 Min.	Max.	UNITS
I_{CEO}	80 100			0 0	– –	1 –	– –	– 1	
* I_{CEV}	80 100	−1.5 −1.5			– –	0.5 –	– –	– 0.5	mA
* T_C = 150°C	80 100	−1.5 −1.5			– –	5 –	– –	– 5	
I_{EBO}		−5	0		–	5	–	5	mA
* h_{FE}	3 3 3		5[a] 3[a] 8[a]		1,000 – 100	10,000 – 5,000	– 500 100	– 10,000 5,000	
V_{CEO}(sus)			0.2	0	80[b]	–	100[b]	–	
V_{CER}(sus) R_{BE} = 100 Ω			0.2		80[b]	–	100[b]	–	V
* V_{CEV}(sus)		−1.5	0.2		80[b]	–	100[b]	–	
V_{BE}	3 3 3		5[a] 3[a] 8[a]		– – –	2.8 – 4.5*	– – –	– 2.8 4.5*	V
V_{CE}(sat)			3[a] 5[a] 8[a]	0.006 0.01 0.08	– – –	– 2 3*	– – –	3 – 3*	V
V_F			5[a] 8[a]		– –	– 5	– –	4 –	V
h_{fe} f = 1 kHz	5		1		1,000	–	1,000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	
C_{obo} V_{CB} = 10 V f = 1 MHz					–	200	–	200	pF
* $I_{S/b}$ t = 1 s, nonrep.	34				1.06	–	1.06	–	A
$E_{S/b}$ L = 12 mH R_{BE} = 100 Ω		−1.5	4.5		120	–	120	–	mJ
$R_{\theta JC}$					–	3.5	–	3.5	°C/W

* In accordance with JEDEC registration data format JS-6, RDF-4.

a Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

b *CAUTION:* Sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) ***MUST NOT*** be measured on a curve tracer.

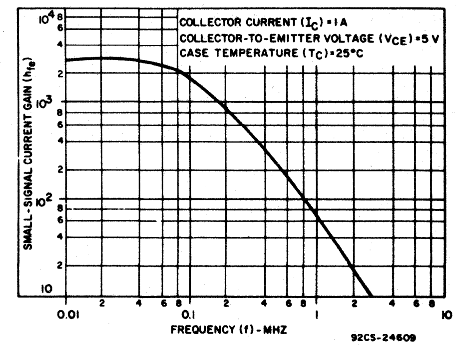


Fig. 5 - Typical small-signal current gain for all types.

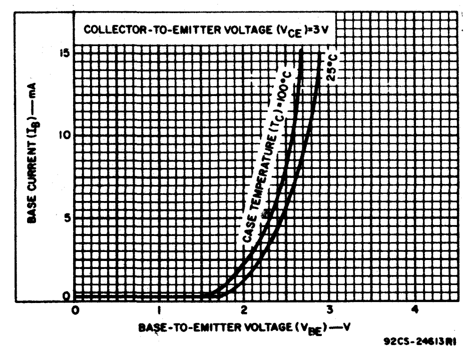


Fig. 6 - Typical input characteristics for all types.

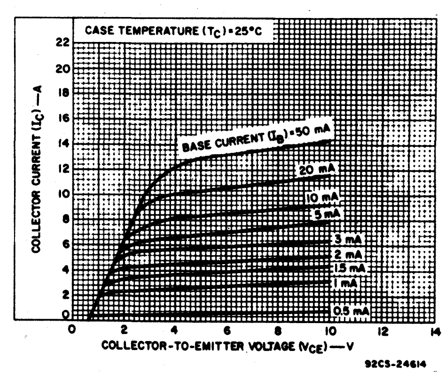


Fig. 7 - Typical output characteristics for all types.

2N6534-2N6537

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6536		2N6537		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	120 100			0 0	– –	– 1	– –	1 –	
* I_{CEV}	120 100	−1.5 −1.5			– –	– 0.5	– –	0.5 –	mA
* T_C = 150°C	120 100	−1.5 −1.5			– –	– 5	– –	5 –	
I_{EBO}		−5	0		–	5	–	5	mA
* h_{FE}	3 3 3		3[a] 5[a] 8[a]		– 1,000 100	– 10,000 5,000	1,000 – 100	10,000 – 5,000	
V_{CEO}(sus)			0.2	0	100[b]	–	120[b]	–	
V_{CER}(sus) R_{BE} = 100 Ω			0.2		100[b]	–	120[b]	–	V
* V_{CEV}(sus)		−1.5	0.2		100[b]	–	120[b]	–	
V_{BE}	3 3 3		3[a] 5[a] 8[a]		– – –	– 2.8 4.5*	– – –	2.8 – 4.5*	V
V_{CE}(sat)			3[a] 5[a] 8[a]	0.006 0.01 0.08	– – –	– 2 3*	– – –	2 – 3*	V
V_F			5[a] 8[a]		– –	– 5	– –	4 –	V
h_{fe} f = 1 kHz	5		1		1,000	–	1,000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	
C_{obo} V_{CB} = 10 V f = 1 MHz					–	200	–	200	pF
* $I_{S/b}$ t = 1 s, nonrep.	34				1.06	–	1.06	–	A
$E_{S/b}$ L = 12 mH R_{BE} = 100 Ω		−1.5	4.5		120	–	120	–	mJ
$R_{\theta JC}$					–	3.5	–	3.5	°C/W

* In accordance with JEDEC registration data format JS-6, RDF-4.

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

[b] *CAUTION:* Sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEV}(sus) *MUST NOT* be measured on a curve tracer.

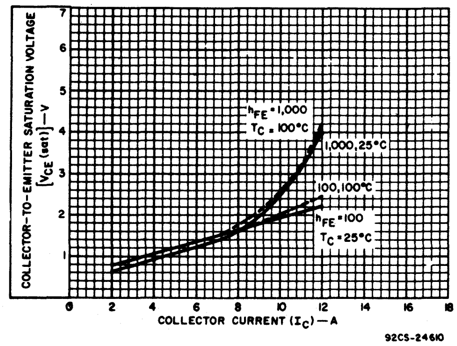


Fig. 8 - Typical saturation characteristics for all types.

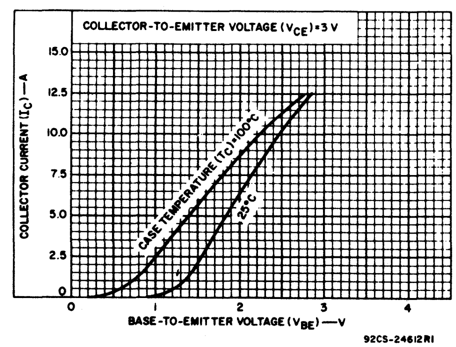


Fig. 9 - Typical transfer characteristics for all types.

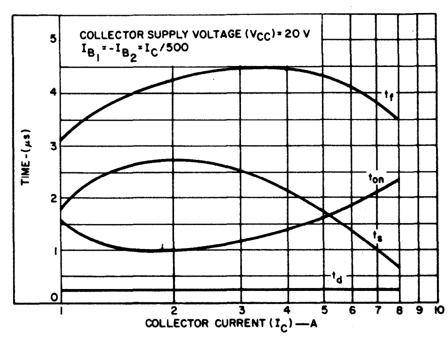


Fig. 10 - Typical saturated switching-time characteristics for all types.

2N6534-2N6537

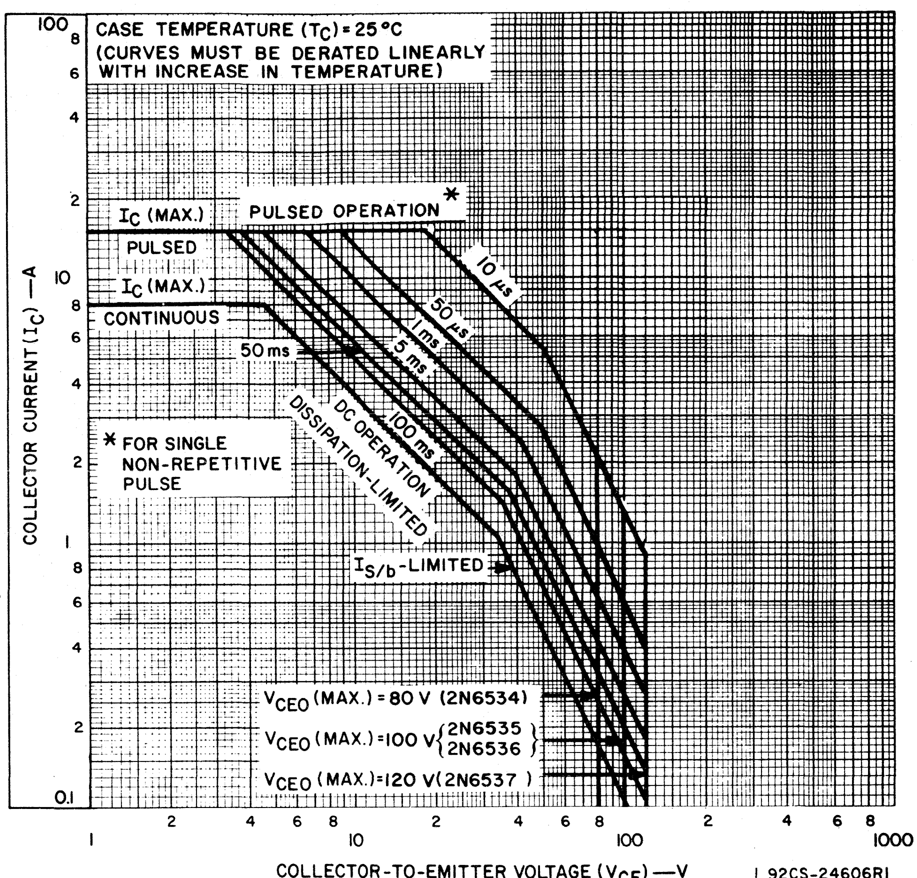
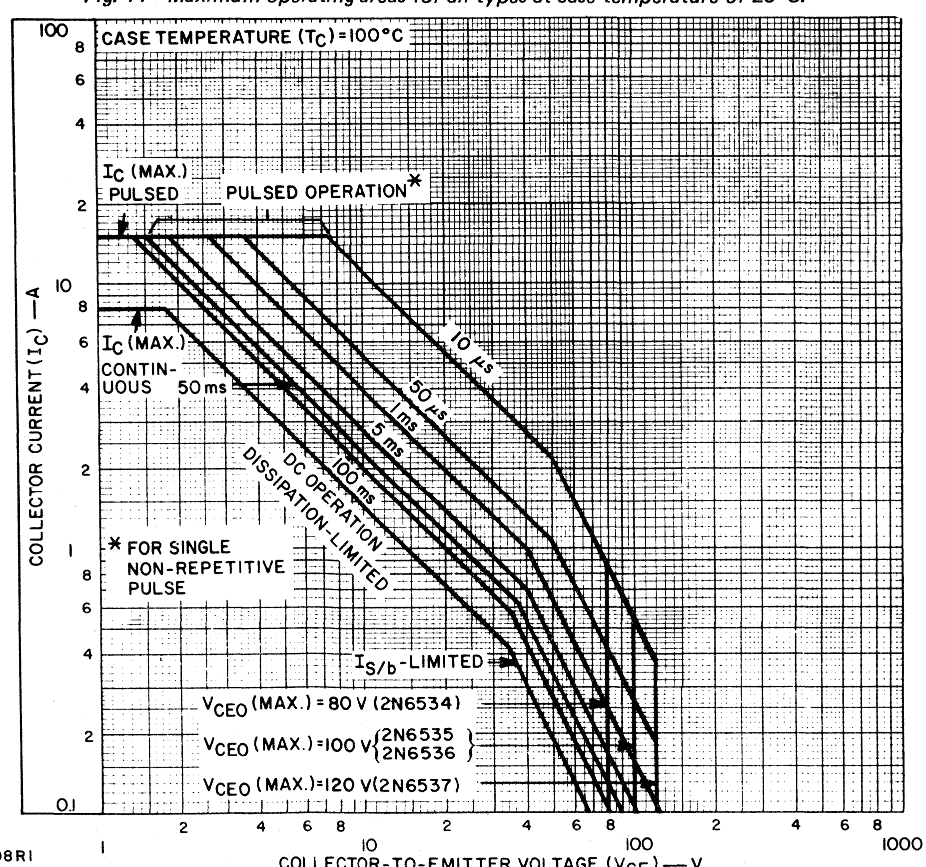


Fig. 11 - Maximum operating areas for all types at case temperature of 25°C.



92CS-24608R1

Fig. 12 - Maximum operating areas for all types at case temperature of 100°C.

40871, 40872

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

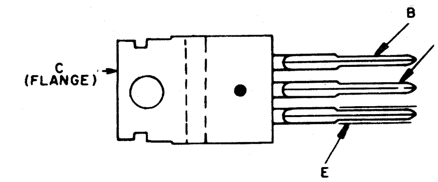
General-Purpose Types for Medium-Power Switching and Amplifier Service in Consumer, Automotive, and Industrial Applications

Features:

- Low saturation voltage
- VERSAWATT package
- Maximum safe-operating-area curves
- Thermal-cycling ratings

RCA-40871 is an epitaxial-base silicon n-p-n transistor. RCA-40872, is an epitaxial-base p-n-p transistor. These devices are intended for a wide variety of medium-power switching and amplifier applications, such as switching regulators and inverters and driver and output stages of high-fidelity amplifiers. These plastic power transistors are supplied in the JEDEC TO-220AB VERSAWATT package.

TERMINAL DESIGNATIONS



BOTTOM VIEW 92CS-27519

JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		N-P-N 40871 / P-N-P 40872*	
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	120	V
With base open	$V_{CEO}(sus)$	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	V
COLLECTOR CURRENT (Continuous)	I_C	7	A
BASE CURRENT (Continuous)	I_B	3	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		40	W
At ambient temperatures up to 25°C		1.8	W
At case temperatures above 25°C		Derate linearly at 0.32W/°C	
At ambient temperatures above 25°C		Derate linearly at 0.0144 W/°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 150	°C
LEAD TEMPERATURE (During Soldering):			
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.		235	°C

* For p-n-p device, voltage and current values are negative.

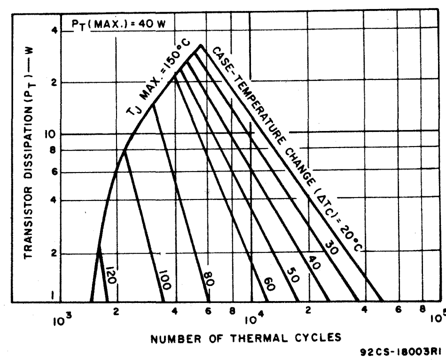


Fig. 1 - Thermal-cycling ratings for both types.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C, Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{EB}	CURRENT A dc I_C	I_B	LIMITS 40871 40872* MIN.	MAX.	UNITS
Collector-Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	110				–	1	mA
Emitter-Cutoff Current	I_{EBO}		5	0		–	1	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.1	0	100	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.1		120	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4 4 4		1[a]		50	250	
Base-to-Emitter Voltage	V_{BE}	4 4 4		1[a]		– – –	1.5 – –	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			1[a]	0.1	–	1.0	V
Gain-Bandwidth Product	f_T	4		0.5		4	–	MHz
Thermal Resistance: Junction-to-Case Junction-to-Ambient	$R_{\theta JC}$ $R_{\theta JA}$					–	3.125 70	°C/W

* For p-n-p devices, voltage and current values are negative.

[a] Pulsed: Pulse duration = 300 μs, duty factor = 0.018.

CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

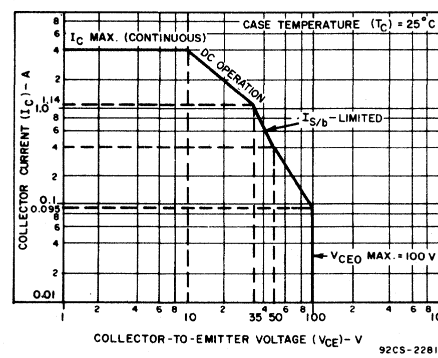


Fig. 2 - Maximum operating areas for 40871.

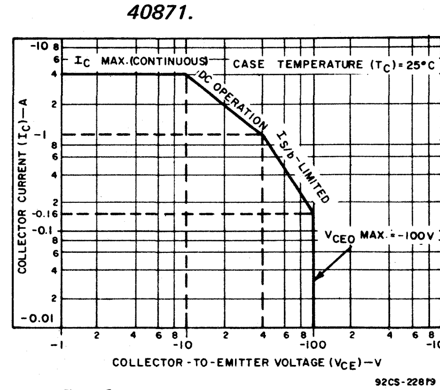


Fig. 3 - Maximum operating areas for 40872.

40871, 40872

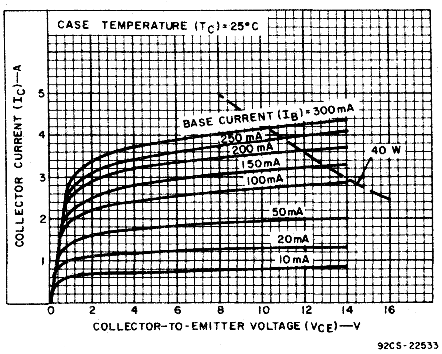


Fig. 4 - Typical output characteristics for 40871.

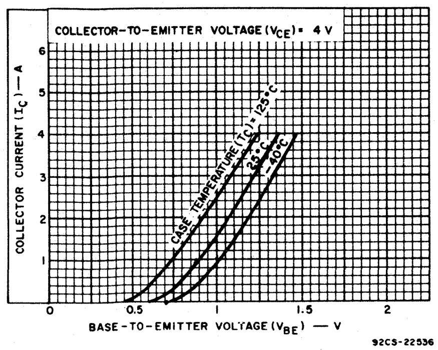


Fig. 5 - Typical transfer characteristics for 40871.

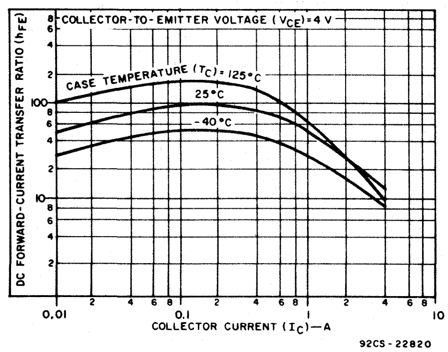


Fig. 6 - Typical dc beta characteristics for 40871.

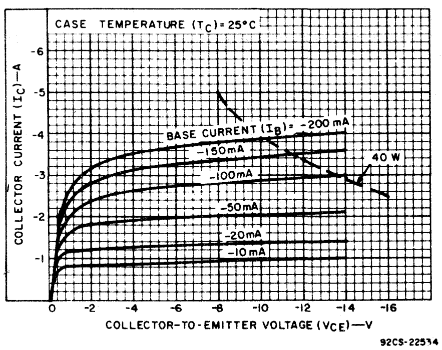


Fig. 7 - Typical output characteristics for 40872.

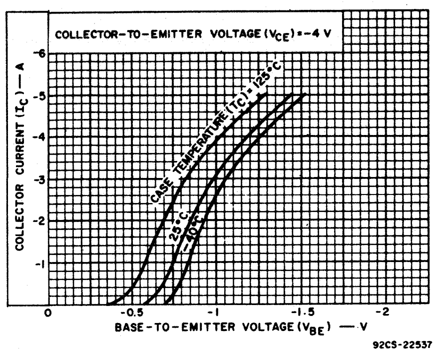


Fig. 8 - Typical transfer characteristics for 40872.

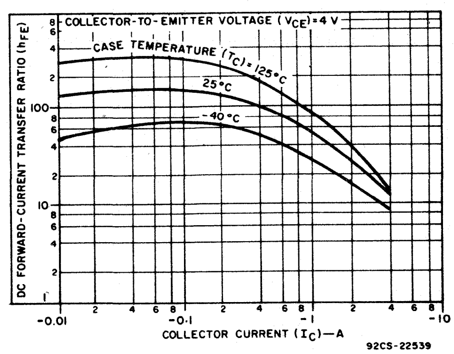


Fig. 9 - Typical dc beta characteristics for 40872.

BD142

Hometaxial-Base, High-Power Silicon N-P-N Transistor

Rugged General-Purpose Device For Commercial Use

The RCA-BD142 is a hometaxial-base diffused-junction silicon n-p-n transistor intended for a wide variety of intermediate-power and high-power applications. It is especially suited for use in audio and inverter circuits at 12 volts.

The BD142 is supplied in a JEDEC TO-3 hermetic steel package.

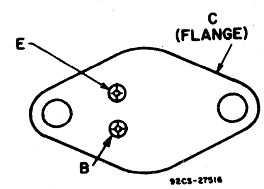
Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers
- 12-V audio and inverter circuits

Features:

- Maximum-safe-area-of-operation curves
- Low saturation voltage
- High dissipation rating
- Thermal-cycling rating curve

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open	$V_{CEO}(sus)$	45	V
With base reverse bias $V_{BE} = -1.5$ V	$V_{CEV}(sus)$	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	15	A
CONTINUOUS BASE CURRENT	I_B	7	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		117	W
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235	°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified.*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc			CURRENT A dc		LIMITS		UNITS
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	
Collector Cutoff Current: With base-emitter junction reverse-biased	I_{CEV}	40		−1.5			–	2	mA
Emitter Cutoff Current	I_{EBO}		7				–	1	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$				0.2	0	45	–	V
With base-emitter junction reverse-biased	$V_{CEV}(sus)$			−1.5	0.1		50	–	V
DC Forward Current Transfer Ratio	h_{FE}	4			4[a]		12.5	160	
Base-to-Emitter Voltage	V_{BE}	4			4[a]		–	1.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				4[a]	0.4	–	1.1	V
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4			1		10	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 0.4 MHz)	$\|h_{fe}\|$	4			1		2	–	
Gain-Bandwidth Product	f_T				1		800	–	kHz
Forward-Bias Second-Breakdown Collector Current (t ≥ 1 s)	$I_{S/b}$	39					3	–	A
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	1.5	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 2%.

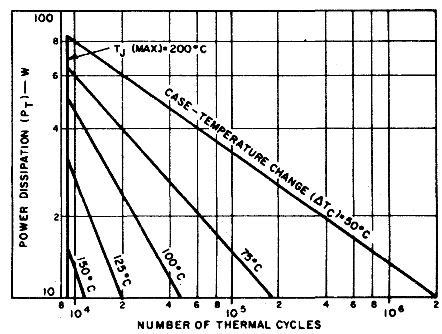


Fig. 1 — Thermal-cycling rating chart.

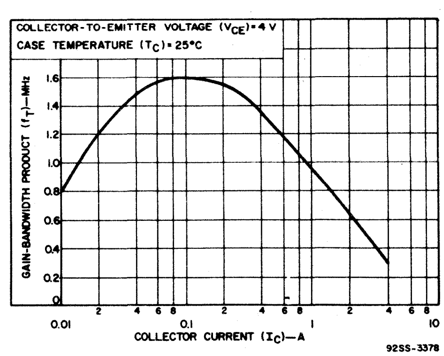


Fig. 2 — Typical gain-bandwidth product.

BD142

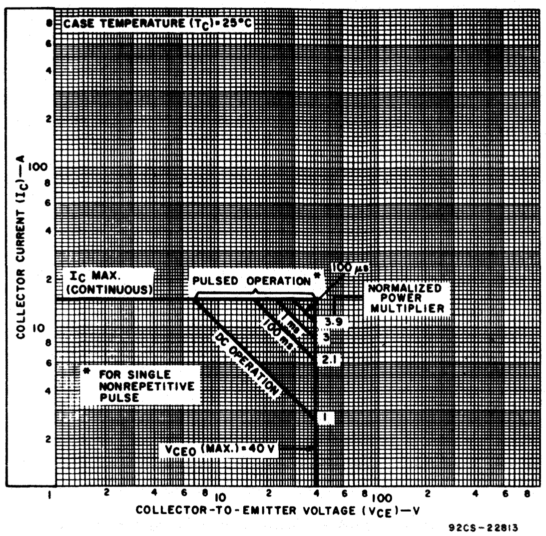


Fig. 3 — Maximum safe area of operation.

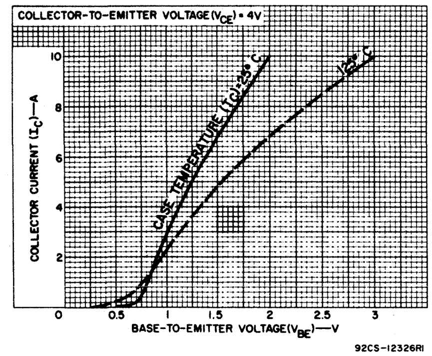


Fig. 4 — Typical transfer characteristics.

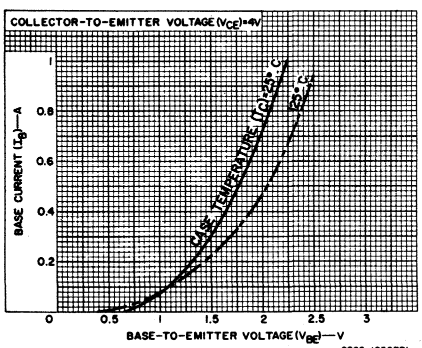


Fig. 5 — Typical input characteristics.

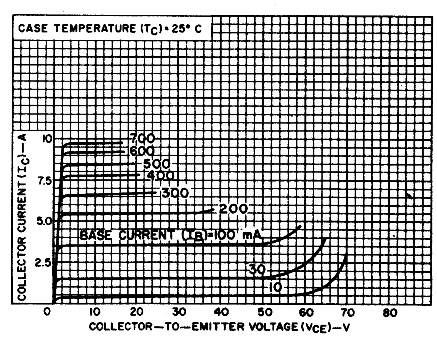


Fig. 6 — Typical output characteristics.

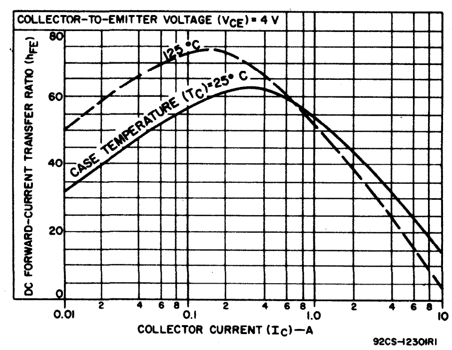


Fig. 7 — Typical dc beta characteristics.

BD181, BD182, BD183

Hometaxial-Base, High-Power Silicon N-P-N Transistors

Rugged, Broadly Applicable Devices For Commercial Use

RCA-BD181, BD182 and BD183 are silicon n-p-n transistors intended for a wide variety of high-power applications. The hometaxial-base construction of these devices renders them highly resistant to second breakdown over a wide range of operating conditions.

These transistors are supplied in a JEDEC TO-3 hermetic steel package.

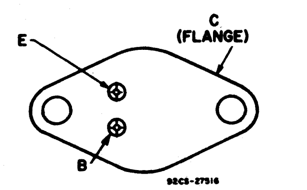
Applications:

- **Series and shunt regulators**
- **High-fidelity amplifiers**
- **Power-switching circuits**
- **Solenoid drivers**

Features:

- **Maximum safe-area-of-operation curves**
- **Low saturation voltages**
- **High dissipation ratings**
- **Thermal-cycling rating curves**

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD181	BD182	BD183	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	70	85	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	55	70	85	V
With base open	$V_{CEO}(sus)$	45	60	80	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	15	15	15	A
CONTINUOUS BASE CURRENT	I_B	7	7	7	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		117	117	117	W
At case temperatures above 25°C		← See Fig. 2 →			
TEMPERATURE RANGE:					
Storage and Operating (Junction)		← −65 to +200 →			°C
PIN TEMPERATURE (During Soldering):					
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		← 235 →			°C

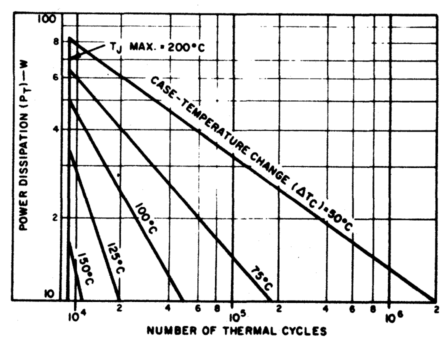


Fig. 1 — Thermal cycling rating chart for all types.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc				CURRENT A dc		LIMITS: BD181		BD182		BD183		UNITS
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector-Cutoff Current: With emitter open and T_C = 200°C	I_{CBO}	45 60 80					0 0 0	– – –	2 – –	– – –	– 5 –	– – –	– – 5	mA
With base-emitter junction reverse-biased	I_{CEX}		45 60 80		−1.5 −1.5 −1.5			 – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
Emitter-Cutoff Current	I_{EBO}			7				–	5	–	5	–	5	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$					0.2[a]	0	45	–	60	–	80	–	V
With external base-to-emitter resistance (R_{BE})=100 Ω	$V_{CER}(sus)$					0.2[a]		55	–	70	–	85	–	V
DC Forward Current Transfer Ratio	h_{FE}		4 4			4[a] 3[a]		– 20	– 70	20 –	70 –	– 20	– 70	
Base-to-Emitter Voltage	V_{BE}		4 4			3[a] 4[a]		– –	1.5 –	– –	– 1.5	– –	1.5 –	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					4[a] 3[a]	0.4[a] 0.3[a]	– –	– 1	– –	1 –	– –	– 1	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 0.4 MHz)	$\|h_{fe}\|$		4			1		2	–	2	–	2	–	
Gain-Bandwidth Product	f_T					1		800	–	800	–	800	–	kHz
Common-Emitter, Short-Circuit, Small-Signal, Forward Current Transfer Ratio Cutoff Frequency	f_{hfe}		4			0.3		15	–	15	–	15	–	kHz
Forward-Bias Second Breakdown Collector Current (t ⩾ 1 s)	$I_{S/b}$		30					3.95	–	3.95	–	3.95	–	A
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$							–	1.5	–	1.5	–	1.5	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

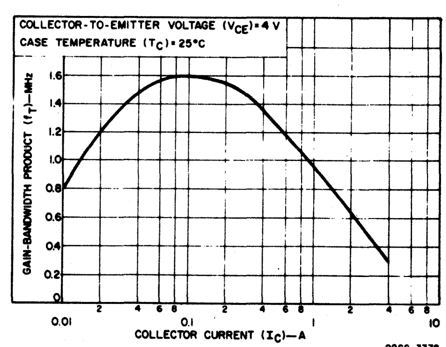


Fig. 2 — Typical gain-bandwidth product for all types.

BD181, BD182, BD183

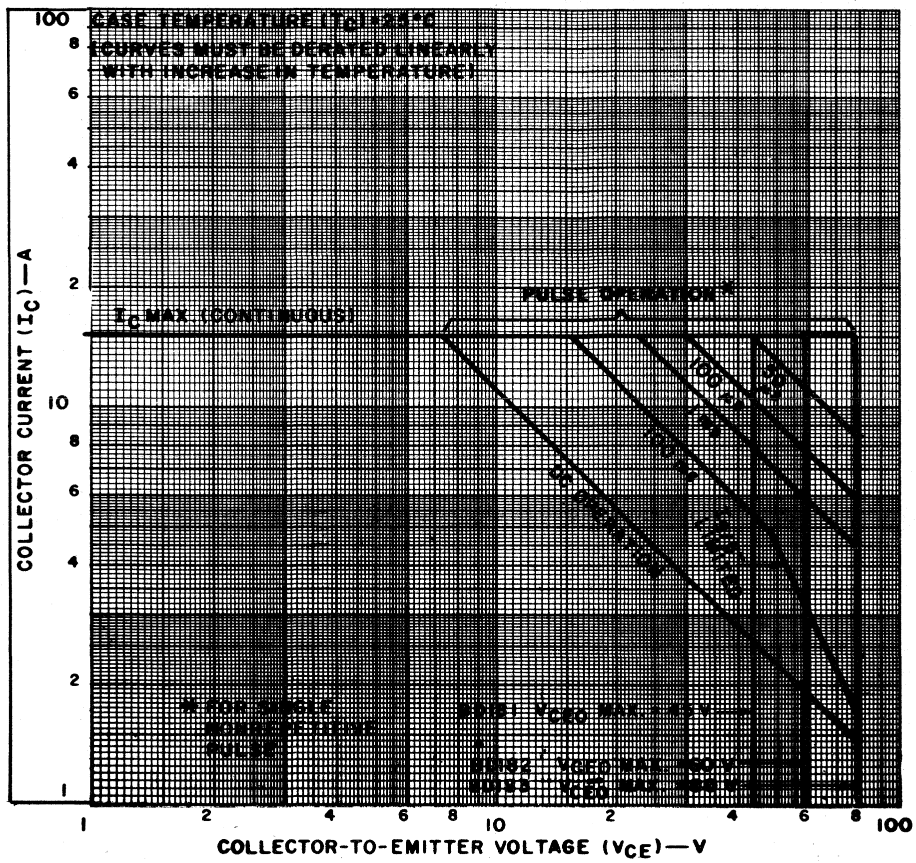


Fig. 3 — Maximum operating areas for all types.

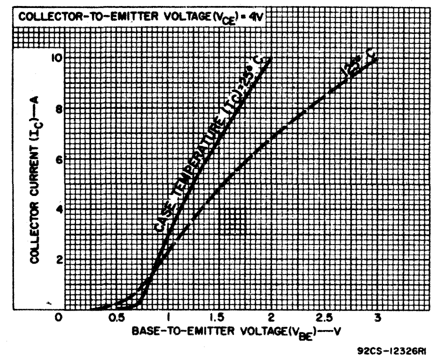


Fig. 4 — Typical transfer characteristics for all types.

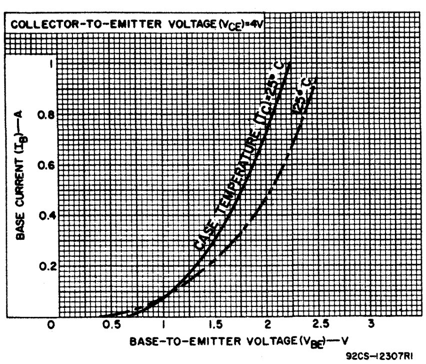


Fig. 5 — Typical input characteristics for BD182.

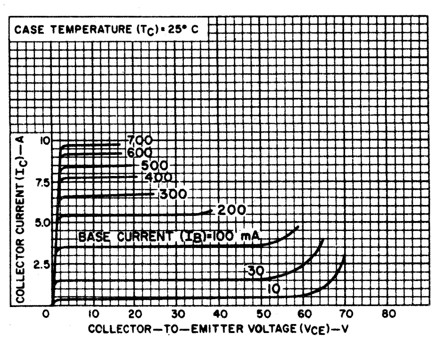


Fig. 6 — Typical output characteristics for BD182.

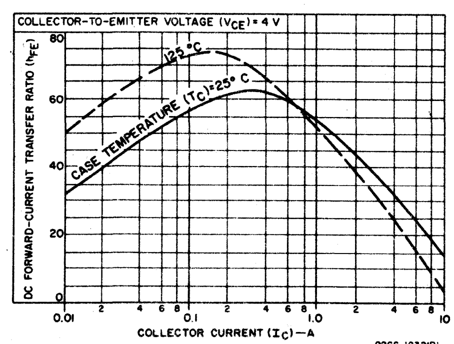


Fig. 7 — Typical dc-beta characteristics for BD182.

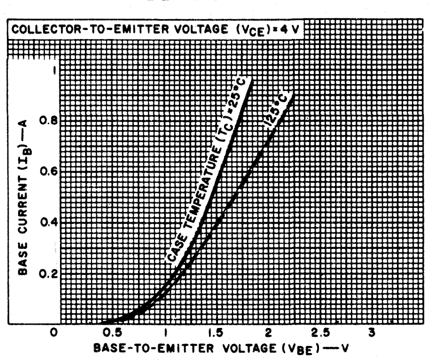


Fig. 8 — Typical input characteristics for BD181 and BD183.

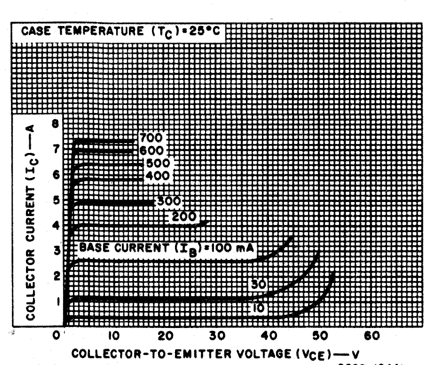


Fig. 9 — Typical output characteristics for BD181 and BD183.

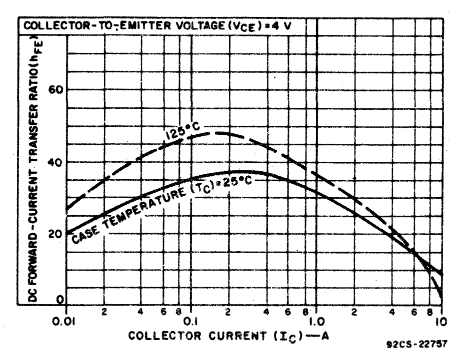


Fig. 10 — Typical dc-beta characteristics for BD181 and BD183.

BD239, BD239A, BD239B, BD239C, BD240, BD240A, BD240B, BD240C

Epitaxial-Base Silicon N-P-N and P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

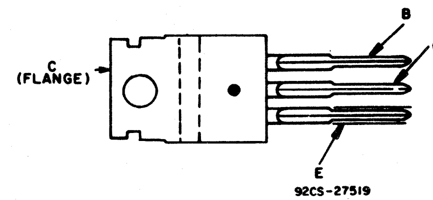
Features:

- **30 W at 25°C case temperature**
- **4-A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 200 mA**

These RCA devices are epitaxial-base silicon n-p-n and p-n-p transistors; they differ only in their voltage ratings. These transistors are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD240-series p-n-p power transistors are complements of the n-p-n devices in the BD239 series.

All these transistors are supplied in the JEDEC TO-220AB straight-lead version of the VERSAWATT package. Optional lead configurations are available upon request. For information, contact your nearest RCA International Sales Office.

TERMINAL DESIGNATIONS



BOTTOM VIEW
JEDEC TO-220 AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD239 BD240♦	BD239A BD240A♦	BD239B BD240B♦	BD239C BD240C♦	
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	4	4	4	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		30	30	30	30	W
At ambient temperatures up to 25°C .		2	2	2	2	W
At case temperatures above 25°C		Derate linearly to 150°C				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

♦ For p-n-p devices, voltage and current values are negative.

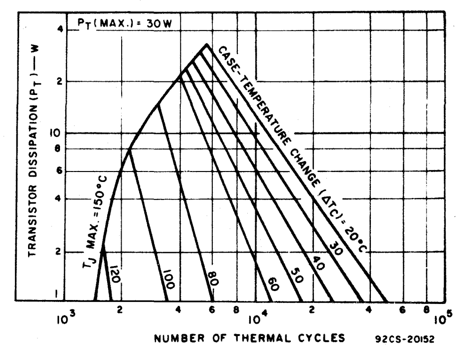


Fig. 1 — Thermal-cycling ratings for all types.

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BD239 BD240♦ MIN.	MAX.	BD239A BD240A♦ MIN.	MAX.	BD239B BD240B♦ MIN.	MAX.	BD239C BD240C♦ MIN.	MAX.	UNITS
Collector Cutoff Current: With base open	I_{CEO}	−30			0	–	−0.3	–	−0.3	–	–	–	–	mA
		−60			0	–	–	–	–	–	−0.3	–	−0.3	mA
With base-to-emitter junction short-circuited	I_{CES}	−45	0			–	−0.2	–	–	–	–	–	–	mA
		−60	0			–	–	–	0.2	–	–	–	–	mA
		−80	0			–	–	–	–	–	−0.2	–	–	mA
		−100	0			–	–	–	–	–	–	–	−0.2	mA
Emitter Cutoff Current	I_{EBO}		5	0		–	−1	–	−1	–	−1	–	−1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			−0.03[a]	0	−45	–	−60	–	−80	–	−100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	−4		−0.2[a]		40	–	40	–	40	–	40	–	
		−4		−1[a]		15	–	15	–	15	–	15	–	
Base-to-Emitter Voltage	V_{BE}	−4		−1[a]		–	−1.3	–	−1.3	–	−1.3	–	−1.3	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			−1[a]	−0.2	–	−0.7	–	−0.7	–	−0.7	–	−0.7	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	−10		0.2		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	−10		0.2		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	4.17	–	4.17	–	4.17	–	4.17	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	°C/W

♦ For p-n-p devices, voltage and current values are negative.
[a]Pulsed: Pulse duration = 300 μs, duty factor = 2%.

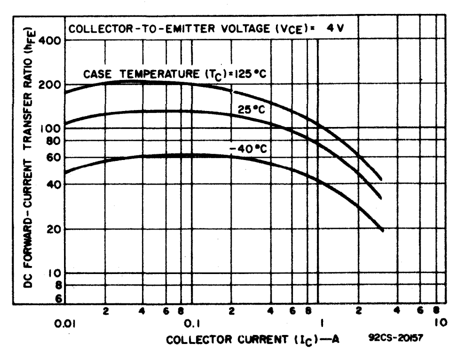


Fig. 2 — Typical dc beta characteristics for BD239-series types.

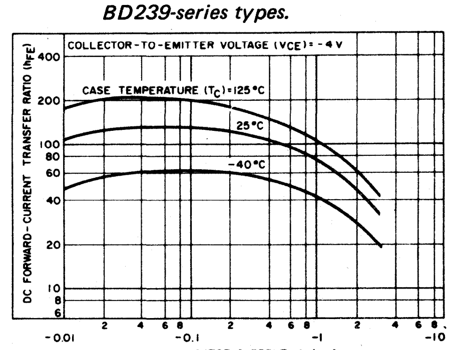


Fig. 3 — Typical dc beta characteristics for BD240-series types.

BD239, BD239A, BD239B, BD239C, BD240, BD240A, BD240B, BD240C

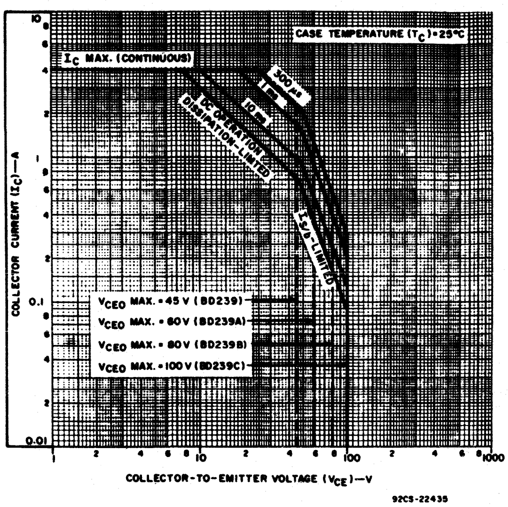


Fig. 4 — Maximum safe operating areas for BD239-series types.

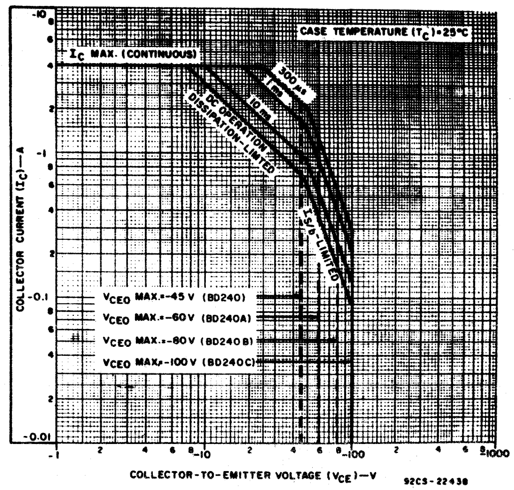


Fig. 5 — Maximum safe operating areas for BD240-series types.

BD241, BD241A, BD241B, BD241C, BD242, BD242A, BD242B, BD242C
Epitaxial-Base Silicon N-P-N and P-N-P VERSAWATT Transistors

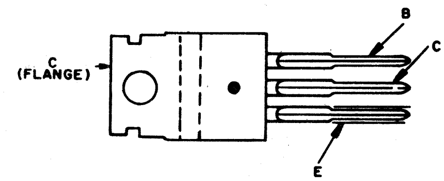
For Power-Amplifier and High-Speed-Switching Applications

These RCA devices are epitaxial-base silicon n-p-n and p-n-p transistors; they differ only in their voltage ratings. These transistors are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD242-series p-n-p power transistors are complements of the n-p-n devices in the BD241 series.

All these transistors are supplied in the JEDEC TO-220AB straight-lead version of the VERSAWATT package. Optional lead configurations are available upon request. For information, contact your nearest RCA International Sales Office.

Features:
- **40 W at 25°C case temperature**
- **5-A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 500 mA**

TERMINAL DESIGNATIONS



BOTTOM VIEW
JEDEC TO-220 AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD241 BD242♦	BD241A BD242A♦	BD241B BD242B♦	BD241C BD242C♦	
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	5	5	5	5	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		40	40	40	40	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C		Derate linearly to 150°C				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

♦ For p-n-p devices, voltage and current values are negative.

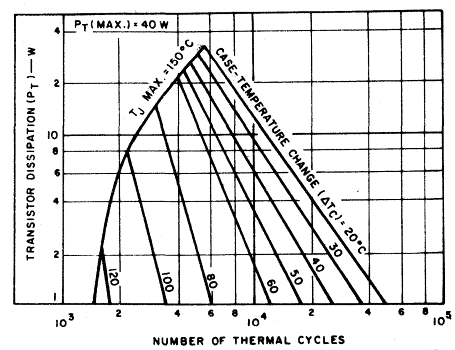


Fig. 1 — Thermal-cycling ratings for all types.

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BD241 BD242♦ MIN.	MAX.	BD241A BD242A♦ MIN.	MAX.	BD241B BD242B♦ MIN.	MAX.	BD241C BD242C♦ MIN.	MAX.	UNITS
Collector Cutoff Current: With base open	I_{CEO}	30			0	–	0.3	–	0.3	–	–	–	–	mA
		60			0	–	–	–	–	–	0.3	–	0.3	mA
With base-to-emitter junction short-circuited	I_{CES}	45	0			–	0.2	–	–	–	–	–	–	mA
		60	0			–	–	–	0.2	–	–	–	–	mA
		80	0			–	–	–	–	–	0.2	–	–	mA
		100	0			–	–	–	–	–	–	–	0.2	mA
Emitter Cutoff Current	I_{EBO}		−5	0		–	1	–	1	–	1	–	1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			0.03[a]	0	45	–	60	–	80	–	100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4		1[a]		25	–	25	–	25	–	25	–	
		4		3[a]		10	–	10	–	10	–	10	–	
Base-to-Emitter Voltage	V_{BE}	4		3[a]		–	1.8	–	1.8	–	1.8	–	1.8	V
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			3[a]	0.6	–	1.2	–	1.2	–	1.2	–	1.2	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	10		0.5		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	10		0.5		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	–	3.125	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	°C/W

[a]Pulsed: Pulse duration = 300 μs, duty factor = 2%.

♦ For p-n-p devices, voltage and current values are negative.

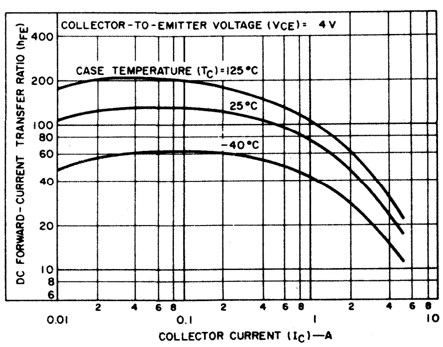


Fig. 2 — Typical dc beta characteristics for BD241-series types.

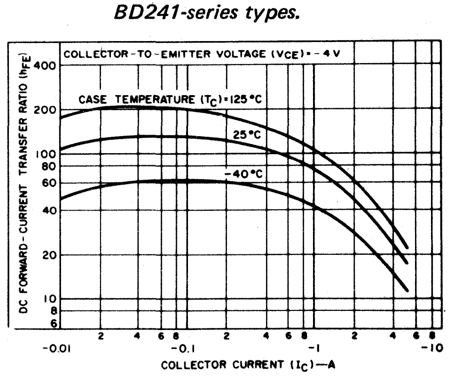


Fig. 3 — Typical dc beta characteristics for BD242-series types.

BD241, BD241A, BD241B, BD241C, BD242, BD242A, BD242B, BD242C

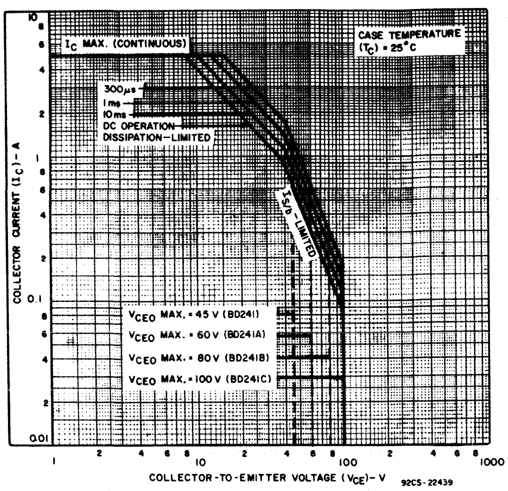


Fig. 4 — Maximum safe operating areas for BD241-series types.

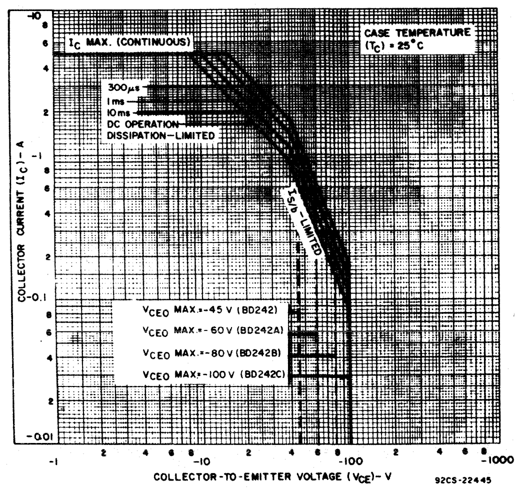


Fig. 5 — Maximum safe operating areas for BD242-series types.

BD243A, BD243B BD243C, BD244, BD244A BD244B, BD244C

Epitaxial-Base Silicon N-P-N and P-N-P VERSAWATT Transistors

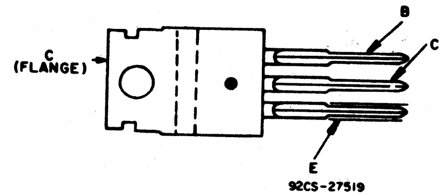
For Power-Amplifier and High-Speed-Switching Applications

Features:
- **65 W at 25°C case temperature**
- **7-A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 500 mA**

These RCA devices are epitaxial-base silicon n-p-n and p-n-p transistors; they differ only in their voltage ratings. These transistors are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD244-series p-n-p power transistors are complements of the n-p-n devices in the BD243 series.

All these transistors are supplied in the JEDEC TO-220AB straight-lead version of the VERSAWATT package. Optional lead configurations are available upon request. For information, contact your nearest RCA International Sales Office.

TERMINAL DESIGNATIONS



BOTTOM VIEW
JEDEC TO-220 AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD243 BD244♦	BD243A BD244A♦	BD243B BD244B♦	BD243C BD244C♦	
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	4	4	4	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		30	30	30	30	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C			Derate linearly to 150°C			
TEMPERATURE RANGE:						
Storage & Operating (Junction)		←	−65 to 150		→	°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		←	235		→	°C

♦ For p-n-p devices, voltage and current values are negative.

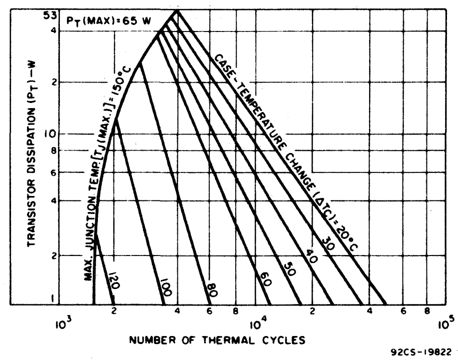


Fig. 1 — Thermal-cycling ratings for all types.

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BD243 BD244♦ MIN.	MAX.	BD243A BD244A♦ MIN.	MAX.	BD243B BD244B♦ MIN.	MAX.	BD243C BD244C♦ MIN.	MAX.	UNITS
Collector Cutoff Current: With base open	I_{CEO}	30			0	–	0.7	–	0.7	–	–	–	–	mA
		60			0	–	–	–	–	–	0.7	–	0.7	
With base-to-emitter junction short-circuited	I_{CES}	45	0			–	0.4	–	–	–	–	–	–	
		60	0			–	–	–	0.4	–	–	–	–	
		80	0			–	–	–	–	–	0.4	–	–	
		100	0			–	–	–	–	–	–	–	0.4	
Emitter Cutoff Current	I_{EBO}		−5	0		–	1	–	1	–	1	–	1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			0.03[a]	0	45	–	60	–	80	–	100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4		0.3[a]		30	–	30	–	30	–	30	–	
		4		3[a]		15	–	15	–	15	–	15	–	
Base-to-Emitter Voltage	V_{BE}	4		6[a]		–	2	–	2	–	2	–	2	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			6[a]	1	–	1.5	–	1.5	–	1.5	–	1.5	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	10		0.5		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	10		0.5		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	–	1.92	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	°C/W

[a]Pulsed: Pulse duration = 300 μs, duty factor = 2%.   ♦ For p-n-p devices, voltage and current values are negative.

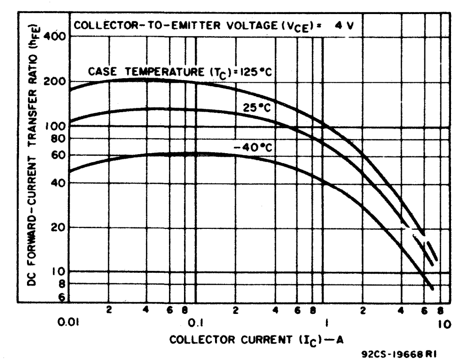


Fig. 2 — Typical dc beta characteristics for BD243-series types.

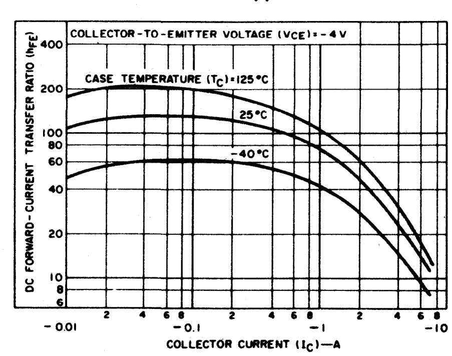


Fig. 3 — Typical dc beta characteristics for BD244-series types.

BD243A, BD243B, BD243C, BD244, BD244A, BD244B, BD244C

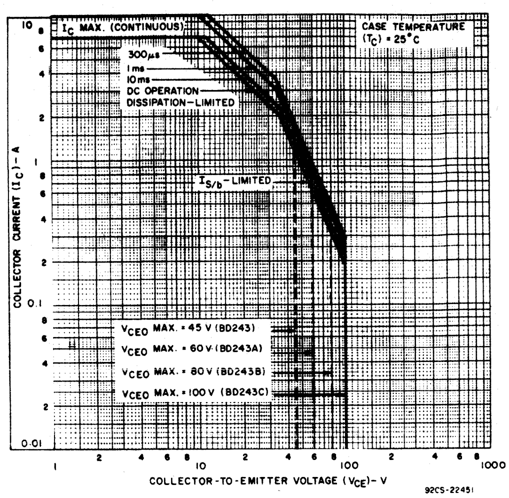


Fig. 4 — Maximum safe operating areas for BD243-series types.

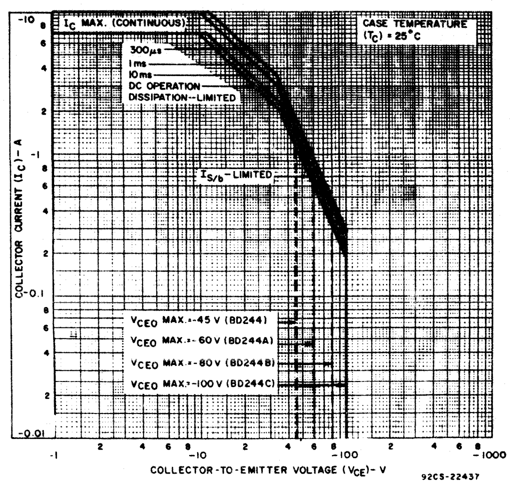


Fig. 5 — Maximum safe operating areas for BD244-series types.

BD277

7-A, 70-W, Epitaxial-Base, Silicon P-N-P VERSAWATT Transistor

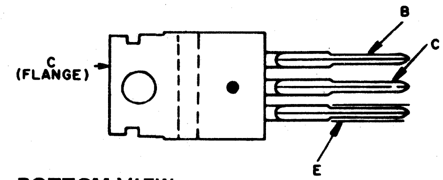
For Applications in Series and Shunt Regulators

Features:
- Thermal-cycling ratings
- Maximum-safe-area-of-operation curve
- Low saturation voltage
- VERSAWATT package (molded silicone plastic)
- High power-dissipation capability

Type BD277 is an epitaxial-base silicon p-n-p transistor supplied in the JEDEC TO-220AB straight-lead VERSAWATT package. It is also available in the TO-220AA package (leads formed to fit a TO-66 socket); to order this version, specify formed lead No. 6201.

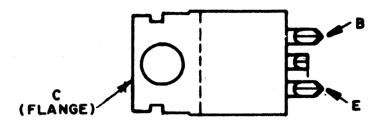
The BD277 is useful in series regulators and shunt regulators because of its low saturation voltage and high power-dissipation capability. It is also useful as a replacement for germanium p-n-p transistors in many applications.

TERMINAL DESIGNATIONS



BOTTOM VIEW

TO-220AB



BOTTOM VIEW

TO-220AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	−45	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	−45	V
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EBO}	−4	V
COLLECTOR CURRENT (Continuous)	I_C	−7	A
BASE CURRENT (Continuous)	I_B	−3	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		70	W
At case temperatures above 25°C		Derate linearly at 0.56 W/°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 150	°C
LEAD TEMPERATURE (During Soldering):			
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.		235	°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless specified otherwise*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc			CURRENT A dc			LIMITS		UNITS
		V_{CE}	V_{CB}	V_{EB}	I_C	I_B	I_E	MIN.	MAX.	
Collector Cutoff Current: With emitter open	I_{CBO}		−45				0	–	−0.1	mA
With emitter open and T_C = 150°C			−40				0	–	−2.0	
With base open	I_{CEO}	−30				0		–	−1.0	
Emitter Cutoff Current: With collector open	I_{EBO}			−4	0			–	−1.0	mA
Collector-to-Emitter Breakdown Voltage. With base open	$V_{(BR)CEO}$				−0.1*	0		−45	–	V
Base-to-Emitter Voltage	V_{BE}	−2			−1.75*			–	1.2	V
DC Forward-Current Transfer Ratio	h_{FE}	−2			−1.75*			30	150	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				−1.75*	−0.1		–	−0.5	V
Gain-Bandwidth Product	f_T	−4			−0.5			10	–	MHz
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$							–	1.78	°C/W
Junction-to-Ambient	$R_{\theta JA}$							–	70	

* Pulsed: Pulse duration = 300 μs, duty factor ≤ 2%.

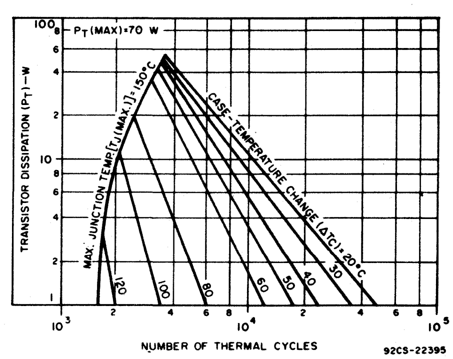


Fig. 1 — Thermal-cycling ratings.

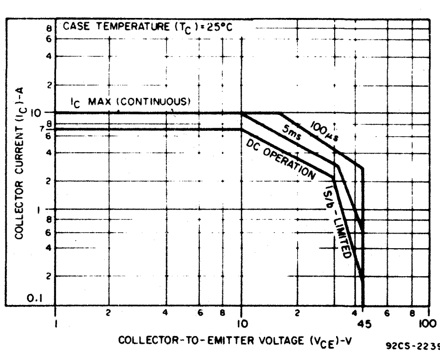


Fig. 2 — Maximum operating area.

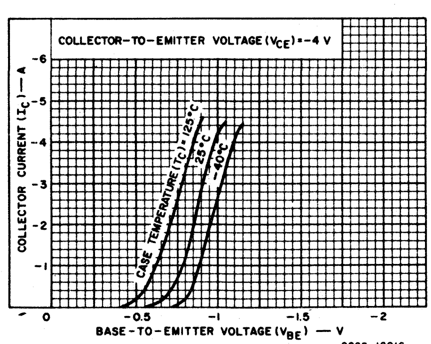


Fig. 3 — Typical transfer characteristics.

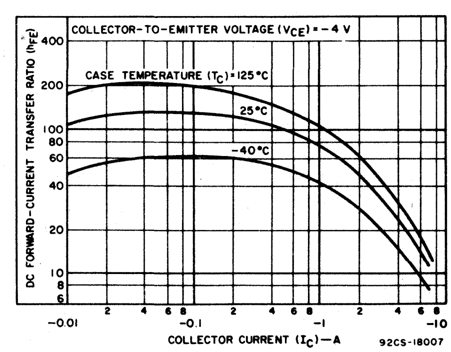


Fig. 4 — Typical dc beta characteristics.

BD278, BD278A

High-Current Silicon N-P-N VERSAWATT Transistor

For Medium-Power Linear and Switching Service in Consumer, Automotive, and Industrial Applications

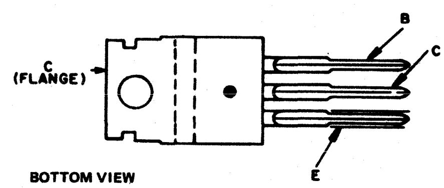
The RCA BD278 and BD278A are hometaxial-base silicon n-p-n transistors supplied in the JEDEC TO-220AB straight-lead VERSAWATT package. They are also available in the TO-220AA package (leads formed to fit a TO-66 socket); to order this version, specify formed lead No. 6201.

These transistors are intended for a wide variety of medium-power switching and linear applications such as series regulators, solenoid drivers, motor-speed controls, inverters, output stages for high-fidelity amplifiers, and power supply and vertical-deflection circuits for monochrome and color TV.

Features:

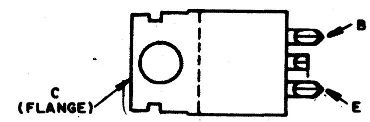
- **Low saturation voltage:** $V_{CE}(sat)$ = 1 V max. at I_C = 4 A
- **VERSAWATT package (molded-silicon plastic)**
- **Maximum-safe-area-of-operation curve**
- **Thermal-cycling rating curve**

TERMINAL DESIGNATIONS



BOTTOM VIEW 92CS-27519

JEDEC TO-220AB



BOTTOM VIEW 92CS-27520

JEDEC TO-220AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD278	BD278A	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	70	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$	55	70	V
With base open	$V_{CEO}(sus)$	45	60	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	V
COLLECTOR CURRENT (Continuous)	I_C	10	10	A
BASE CURRENT	I_B	4	4	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C		75	75	W
At ambient temperatures up to 25°C		1.8	1.8	W
At case temperatures above 25°C, derate linearly		0.6	0.6	W/°C
At ambient temperatures above 25°C, derate linearly		0.0144	0.0144	W/°C
TEMPERATURE RANGE:				
Storage & Operating (Junction)		—— −65 to 150 ——		°C
LEAD TEMPERATURE (During Soldering):				
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.		—— 235 ——		°C

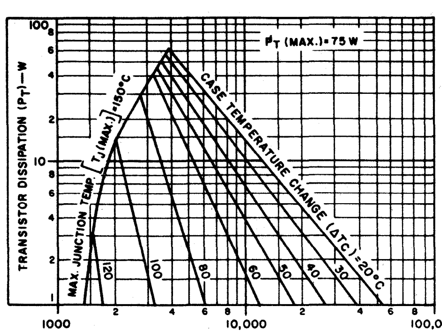


Fig. 1 – Thermal-cycling ratings.

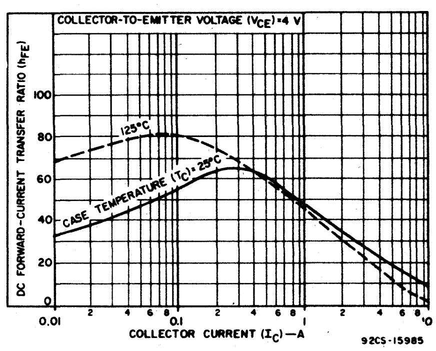


Fig. 2 – Typical dc beta characteristics.

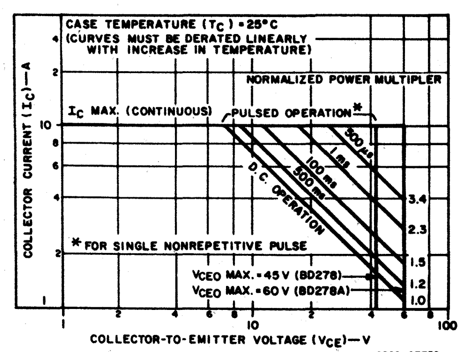


Fig. 3 – Maximum safe operating area.

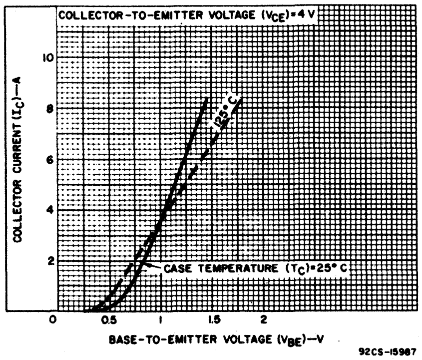


Fig. 4 – Typical transfer characteristics.

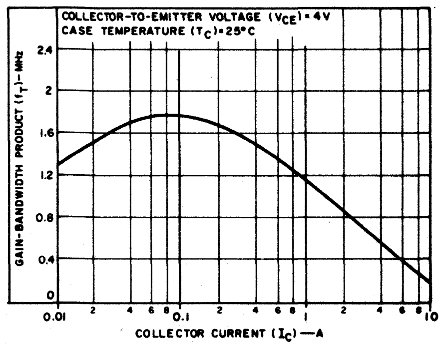


Fig. 5 – Typical gain bandwidth product.

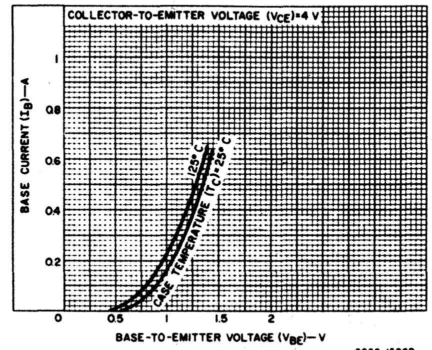


Fig. 6 – Typical input characteristics.

BD278, BD278A

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc		TEST CONDITIONS CURRENT A dc		LIMITS BD278		LIMITS BD278A		UNITS
		V_{CE}	V_{EB}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base-to-emitter junction reverse-biased	I_{CEX}	55 70	1.5 1.5			– –	2 –	– –	– 2	mA
With base-to-emitter junction reverse-biased and T_C = 150°C	I_{CEX}	50 65	1.5 1.5			– –	10 –	– –	– 10	mA
With base open	I_{CEO}	30 45			0 0	– –	2 –	– –	– 2	
Emitter Cutoff Current	I_{EBO}		5			–	5	–	5	mA
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 100Ω[a]	$V_{CER}(sus)$			0.2		55	–	70	–	V
With base open[a]	$V_{CEO}(sus)$			0.2	0	45	–	60	–	V
DC Forward-Current Transfer Ratio[a]	h_{FE}	4		4		15	75	15	75	
Base-to-Emitter Voltage[a]	V_{BE}	4		4		–	1.8	–	1.8	V
Collector-to-Emitter Saturation Voltage[a]	$V_{CE}(sat)$			4	0.4	–	1	–	1	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		0.5		15	–	15	–	
Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 0.1 MHz)	h_{fe}	4		0.5		8	28	8	28	
Forward-Bias Second-Breakdown Collector Current (t= 0.5 s)	$I_{S/b}$	40				1.87	–	1.87	–	A
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.67	–	1.67	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	70	–	70	°C/W

[a] Pulsed, pulse duration = 300μs, duty factor = 0.018

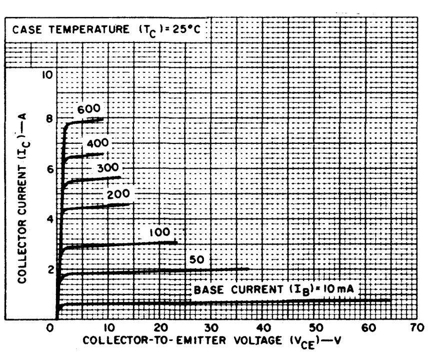


Fig. 7 — Typical output characteristics.

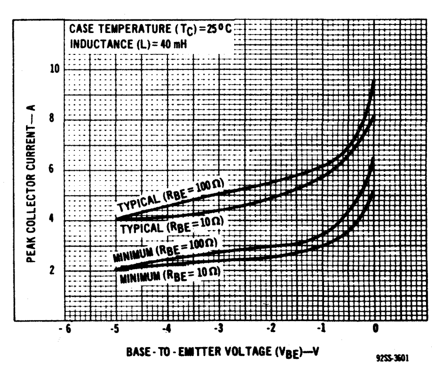


Fig. 8 — Reverse-bias second-breakdown characteristics.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D, BDX34, BDX34A, BDX34B, BDX34C

10-Ampere N-P-N and P-N-P Darlington Power Transistors

40-60-80-100-120 Volts, 70 Watts

Gain of 750 at 4 A (BDX33, BDX33A, BDX34, BDX34A)
Gain of 750 at 3 A (BDX33B, BDX33C, BDX33D, BDX34B, BDX34C)

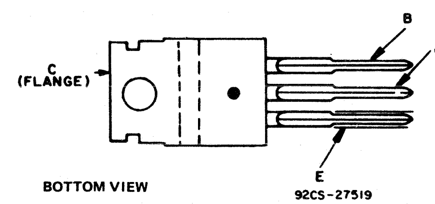
These RCA devices are monolithic silicon n-p-n and p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The BDX33, BDX33A, BDX33B, and BDX33C n-p-n transistors are complementary to the BDX34, BDX34A, BDX34B, and BDX34C p-n-p devices.

All these transistors are supplied in the JEDEC TO-220AB package.

Features:
- Operates from IC without predriver
- Low leakage at high temperature
- High reverse second-breakdown capability

Applications:
- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BDX33 BDX34	BDX33A BDX34A	BDX33B BDX34B	BDX33C BDX34C ♦	BDX33D	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	45	60	80	100	120	V
COLLECTOR-TO-EMITTER VOLTAGE:							
With external base-to-emitter resistance (R_{BE}) = 100Ω, sustaining	$V_{CER}(sus)$	45	60	80	100	120	V
With base open, sustaining	$V_{CEO}(sus)$	45	60	80	100	120	V
With base reverse-biased V_{BE} = −1.5 V	$V_{CEX}(sus)$	45	60	80	100	120	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	10	10	10	10	10	A
CONTINUOUS BASE CURRENT	I_B	0.25	0.25	0.25	0.25	0.25	A
TRANSISTOR DISSIPATION:	P_T						
At case temperatures up to 25°C		70	70	70	70	70	W
At case temperatures above 25°C				Derate linearly 0.56			W/°C
TEMPERATURE RANGE:							
Storage and Operating (Junction)				−65 to + 150			°C
LEAD TEMPERATURE (During Soldering):							
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.				235			°C

♦ For p n p devices, voltage and current values are negative.

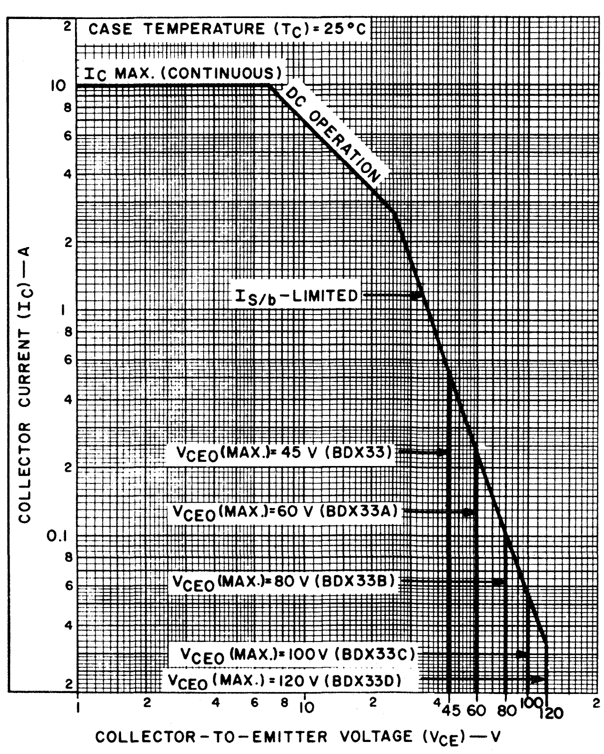


Fig. 1 — Maximum operating areas for BDX33-series types.

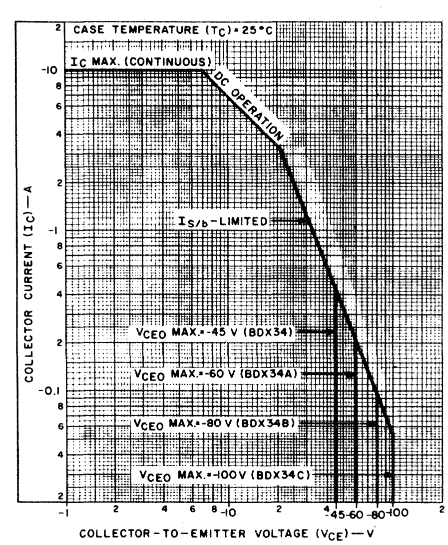


Fig. 2 — Maximum operating areas for BDX34-series types.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D, BDX34, BDX34A, BDX34B, BDX34C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc			TEST CONDITIONS♦ CURRENT A dc		LIMITS BDX33 BDX34♦		BDX33A BDX34A♦		BDX33B BDX34B♦		BDX33C BDX34C♦		BDX33D BDX33D♦		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} With base open		60			0	–	–	–	–	–	–	–	–	–	0.5	mA
		50			0	–	–	–	–	–	–	–	0.5	–	–	
		40			0	–	–	–	–	–	0.5	–	–	–	–	
		30			0	–	–	–	0.5	–	–	–	–	–	–	
		20			0	–	0.5	–	–	–	–	–	–	–	–	
I_{CEO} T_C = 100°C		60			0	–	–	–	–	–	–	–	–	–	10	
		50			0	–	–	–	–	–	–	–	10	–	–	
		40			0	–	–	–	–	–	10	–	–	–	–	
		30			0	–	–	–	10	–	–	–	–	–	–	
		20			0	–	10	–	–	–	–	–	–	–	–	
I_{CBO}	120					–	–	–	–	–	–	–	–	–	1	
	100					–	–	–	–	–	–	–	1	–	–	
	80					–	–	–	–	–	1	–	–	–	–	
	60					–	–	–	1	–	–	–	–	–	–	
	45					–	1	–	–	–	–	–	–	–	–	
I_{CBO} T_C = 100°C	120					–	–	–	–	–	–	–	5	–	–	
	100					–	–	–	–	–	–	–	–	–	5	
	80					–	–	–	–	–	5	–	–	–	–	
	60					–	–	–	5	–	–	–	–	–	–	
	45					–	5	–	–	–	–	–	–	–	–	
I_{EBO}			–5	0		–	10	–	10	–	10	–	10	–	10	mA
$V_{CEO}(sus)$				0.1[a]	0	–	–	–	–	–	–	–	–	120	–	V
				0.1[a]	0	–	–	–	–	–	–	100	–	–	–	
				0.1[a]	0	45	–	60	–	80	–	–	–	–	–	
$V_{CER}(sus)$ (R_{BE}) = 100Ω				0.1[a]		–	–	–	–	–	–	–	–	120	–	
				0.1[a]		–	–	–	–	–	–	100	–	–	–	
				0.1[a]		45	–	60	–	80	–	–	–	–	–	
$V_{CEV}(sus)$			–1.5	0.1[a]		–	–	–	–	–	–	–	–	120	–	
			–1.5	0.1[a]		–	–	–	–	–	–	100	–	–	–	
			–1.5	0.1[a]		45	–	60	–	80	–	–	–	–	–	
h_{FE}		3		3[a]		–	–	–	–	750	–	750	–	750	–	
		3		4[a]		750	–	750	–	–	–	–	–	–	–	
V_{BE}		3		3[a]		–	–	–	–	–	2.5	–	2.5	–	2.5	V
		3		4[a]		–	2.5	–	2.5	–	–	–	–	–	–	
$V_{CE}(sat)$				3[a]	0.006	–	–	–	–	–	2.5	–	2.5	–	2.5	V
				4[a]	0.008	–	2.5	–	2.5	–	–	–	–	–	–	
V_F				8		–	4	–	4	–	4	–	4	–	4	V
h_{fe} f = 1 kHz		5		1		1000	–	1000	–	1000	–	1000	–	1000	–	
h_{fe} f = 1.0 MHz		5		1		20	–	20	–	20	–	20	–	20	–	
$E_{S/b}$[b] R_{BE} = 100Ω L = 12 mH, types BDX33 types			1.5	4.5		120	–	120	–	120	–	120	–	120	–	mJ
L = 3 mH, BDX34 types			1.5	4.5		30	–	30	–	30	–	30	–	30	–	
$I_{S/b}$ tp = 0.5 s nonrep. BDX33 types		25				2.8	–	2.8	–	2.8	–	2.8	–	2.8	–	A
		36				1	–	1	–	1	–	1	–	1	–	
BDX34 types		–20				–3.5	–	–3.5	–	–3.5	–	–3.5	–	–3.5	–	
		–33				–1	–	–1	–	–1	–	–1	–	–1	–	
$R_{\theta JC}$						–	1.78	–	1.78	–	1.78	–	1.78	–	1.78	°C/W

♦ For p-n-p devices, voltage and current values are negative.
[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%
[b] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

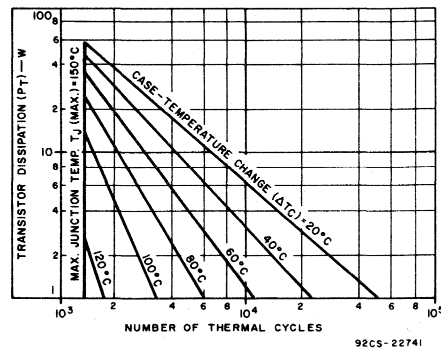


Fig. 3 — Thermal-cycling rating chart for all types.

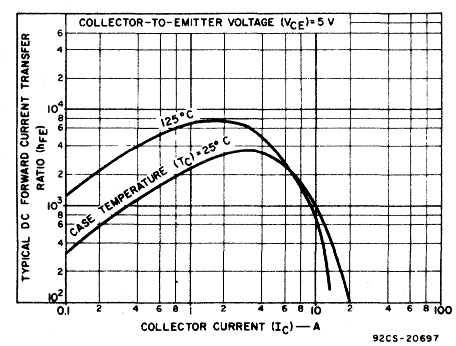


Fig. 4 — Typical dc-beta characteristics for BDX33-series types.

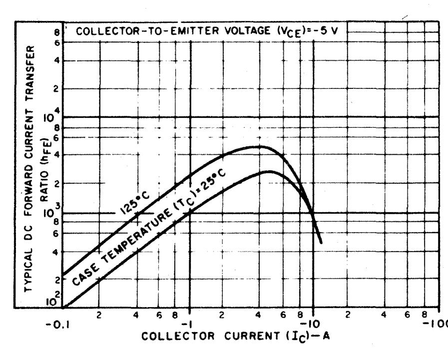


Fig. 5 — Typical dc-beta characteristics for BDX34-series types.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D, BDX34, BDX34A, BDX34B, BD34C

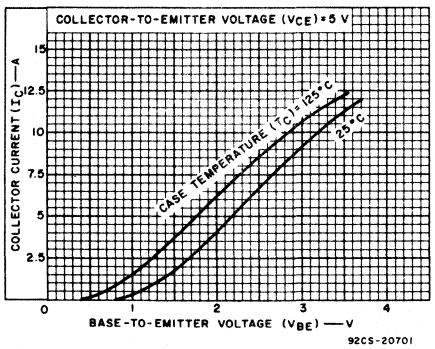


Fig. 6 – Typical transfer characteristics for BDX33-series types.

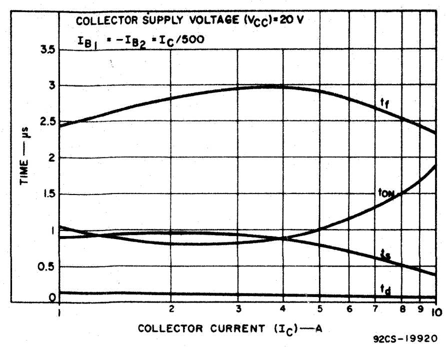


Fig. 7 – Typical saturated switching-time characteristics for BDX33-series types.

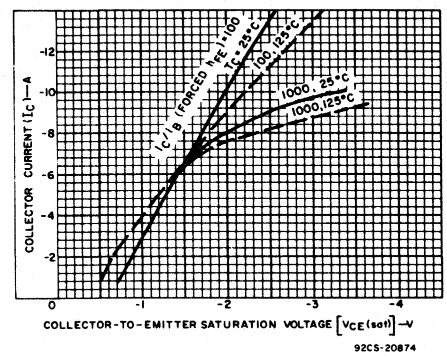


Fig. 8 – Typical saturation characteristics for BDX34-series types.

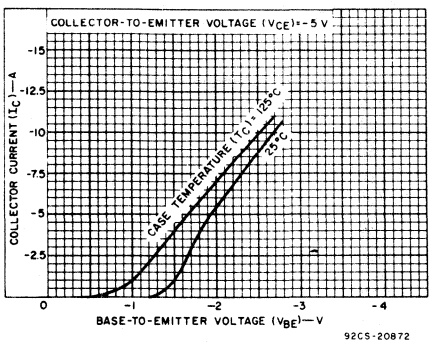


Fig. 9 – Typical transfer characteristics for BDX34-series types.

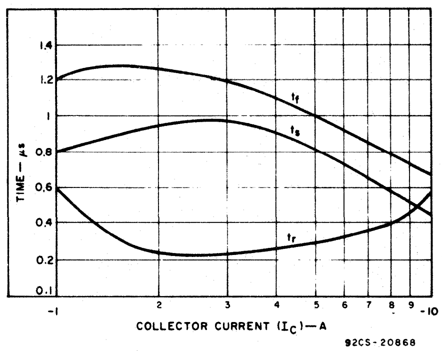


Fig. 10 – Typical saturated switching-time characteristics for BDX34-series types.

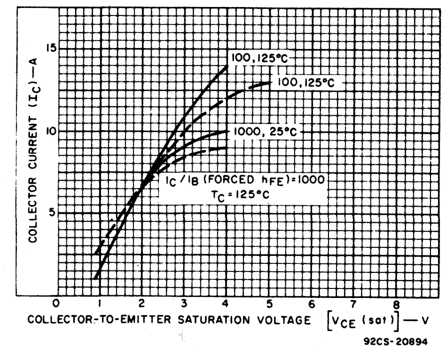


Fig. 11 – Typical saturation characteristics for BDX33-series types.

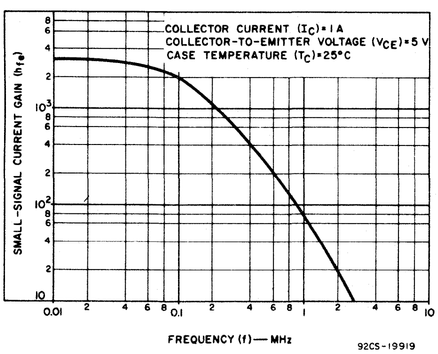


Fig. 12 – Typical small-signal gain for BDX33-series types.

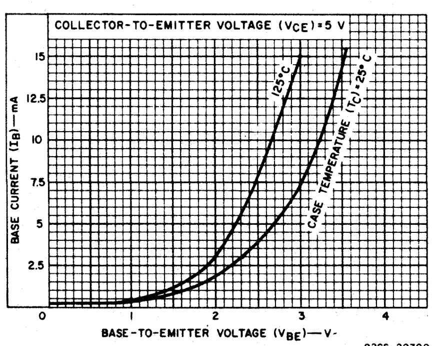


Fig. 13 – Typical input characteristics for BDX33-series types.

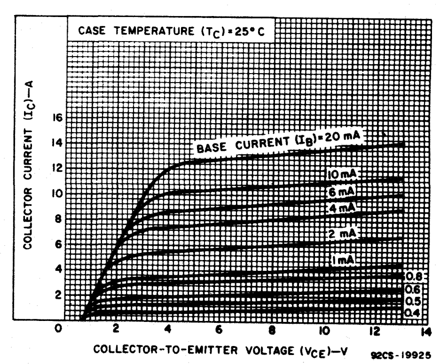


Fig. 14 – Typical output characteristics for BDX33-series types.

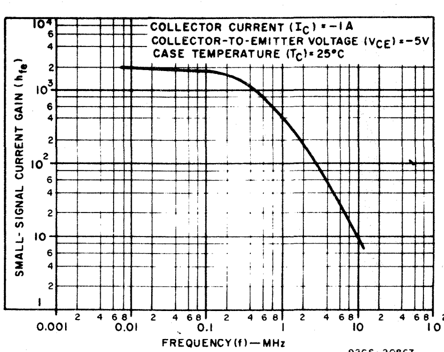


Fig. 15 – Typical small-signal gain for BDX34-series types.

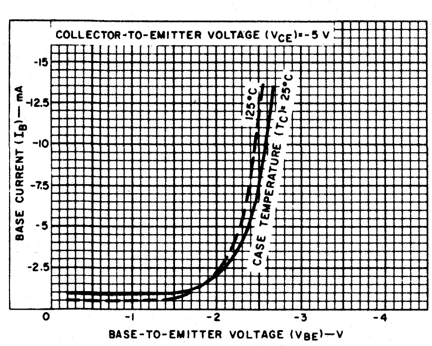


Fig. 16 – Typical input characteristics for BDX34-series types.

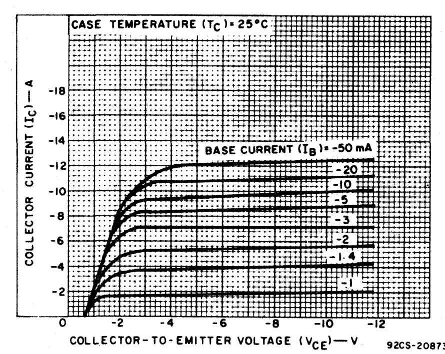


Fig. 17 – Typical output characteristics for BDX34-series types.

BDX83, BDX83A, BDX83B, BDX83C (Preliminary Data)
15-Ampere N-P-N Darlington Power Transistors

40-60-80-100 Volts, 125 Watts Gain of 1000 at 5 Amperes

Features:
- Operates from IC without predriver
- Low leakage at high temperature
- High reverse second-breakdown capability

Applications:
- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

The RCA-BDX83, BDX83A, BDX83B, and BDX83C are monolithic silicon Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The BDX83-series types are supplied in the JEDEC TO-3 hermetic steel package.

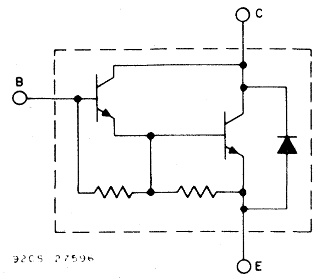
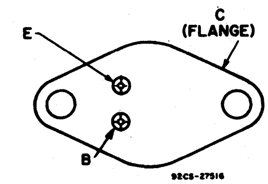


Fig. 1 — Schematic diagram for all types.

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX83	BDX83A	BDX83B	BDX83C	
V_{CBC}	45	60	80	100	V
$V_{CEO}(sus)$	45	60	80	100	V
V_{EBO}	5	5	5	5	V
I_C	10	10	10	10	A
I_{CM}	15	15	15	15	A
I_B	0.25	0.25	0.25	0.25	A
P_T					
$T_C \leqslant 25°C$	125	125	125	125	W
$T_C > 25°C$	Derate linearly at 0.714 W/°C				
T_{stg}, T_J	–65 to +200				°C
T_L					
At distances $\geqslant$ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235				°C

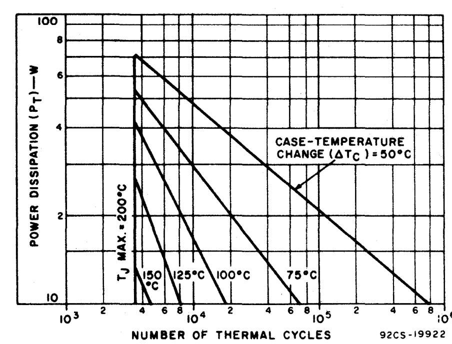


Fig. 3 — Thermal-cycling rating chart for all types.

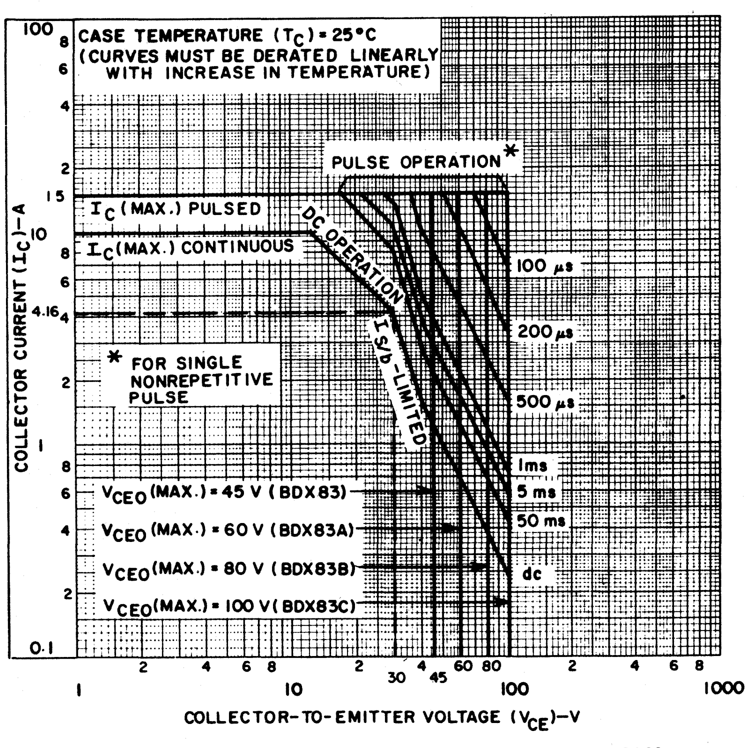


Fig. 2 — Maximum operating area for all types.

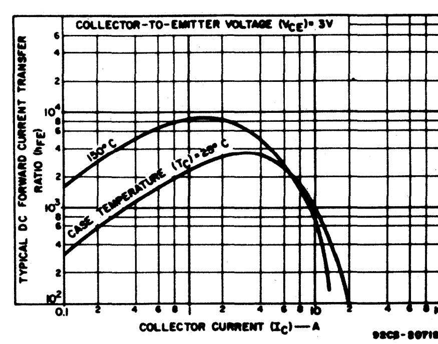


Fig. 4 — Typical dc-beta characteristics for all types.

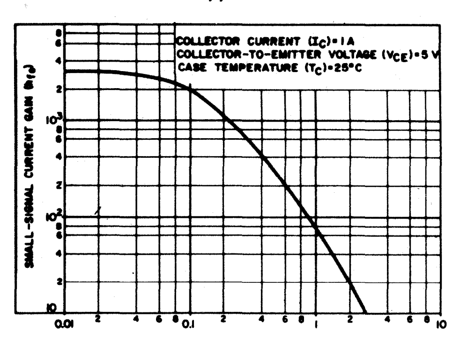


Fig. 5 — Typical small-signal gain for all types.

BDX83, BDX83A, BDX83B, BDX83C (Preliminary Data)

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARAC-TERISTIC SYMBOL	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX83		BDX83A		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	20				0	–	1	–	–	
	30				0	–	–	–	1	
I_{CEV}	45		−1.5			–	0.5	–	–	
	60		−1.5			–	–	–	0.5	mA
T_C = 150°C	45		−1.5			–	3	–	–	
	60		−1.5			–	–	–	3	
I_{EBO}		5		0		–	5	–	5	mA
V_{CEO}(sus)				0.1[a]	0	45	–	60	–	V
h_{FE}	3			1[a]		750	–	750	–	
	3			5[a]		1000	–	1000	–	
	3			10[a]		250	–	250	–	
V_{BE}	3			5[a]		–	2.8	–	2.8	V
	3			10[a]		–	4.5	–	4.5	
V_{CE}(sat)				5[a]	0.01[a]	–	2	–	2	V
V_F				−10		–	4	–	4	
h_{fe} f = 1 kHz	5			1		1000	–	1000	–	
$\|h_{fe}\|$ f = 1 MHz	5			1		20	–	20	–	
$E_{S/b}$[b] L = 12 mH, R_{BE} = 100 Ω			−1.5	4.5		120	–	120	–	mJ
$I_{S/b}$ t = 1 s, non rep.	45					1.2	–	–	–	
	60					–	–	0.66	–	A
	30					4.16	–	4.16	–	
$R_{\theta JC}$						–	1.4	–	1.4	°C/W

[a]Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[b]$E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b}$ = ½LI^2 where L is a series load or leakage inductance, and I is the peak collector current.

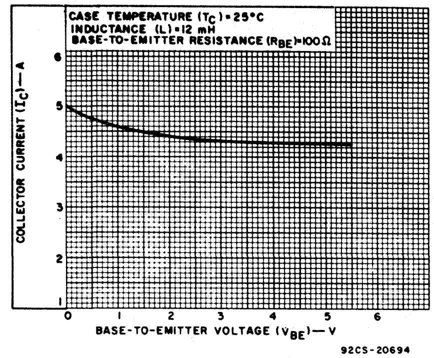


Fig. 6 – Minimum values of reverse-bias second-breakdown characteristic ($E_{S/b}$) for all types.

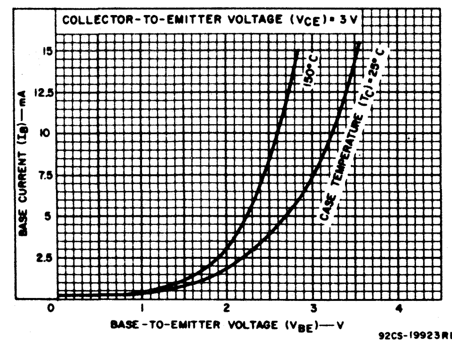


Fig. 7 – Typical input characteristics for all types.

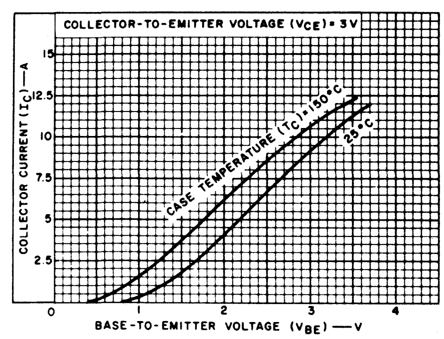


Fig. 8 – Typical transfer characteristics for all types.

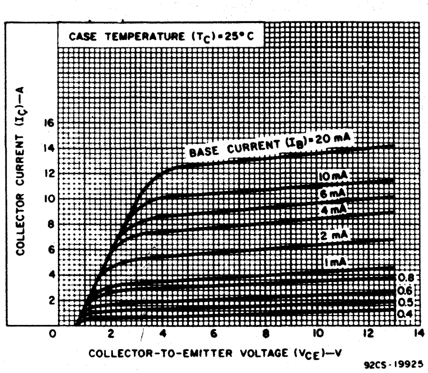


Fig. 9 – Typical output characteristics for all types.

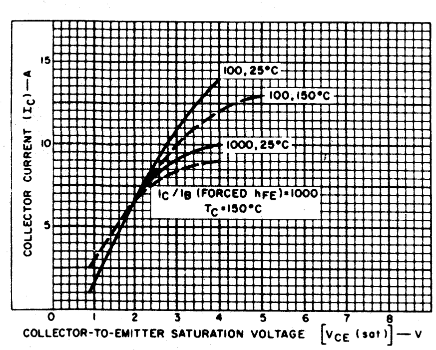


Fig. 10 – Typical saturation characteristics for all types.

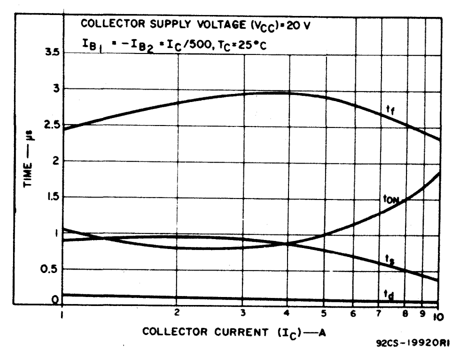


Fig. 11 – Typical saturated switching time characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C (Preliminary Data)

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc			TEST CONDITIONS CURRENT A dc		LIMITS BDX83B		LIMITS BDX83C		UNITS
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	40				0	–	1	–	–	mA
	50				0	–	–	–	1	
I_{CEV}	80		−1.5			–	0.5	–	–	
	100		−1.5			–	–	–	0.5	
T_C = 150°C	80		−1.5			–	3	–	–	
	100		−1.5			–	–	–	3	
I_{EBO}		5		0		–	5	–	5	mA
$V_{CEO(sus)}$				0.1[a]	0	80	–	100	–	V
h_{FE}	3			1[a]		750	–	750	–	
	3			5[a]		1000	–	1000	–	
	3			10[a]		250	–	250	–	
V_{BE}	3			5[a]		–	2.8	–	2.8	V
	3			10[a]		–	4.5	–	4.5	
$V_{CE(sat)}$				5[a]	0.01[a]	–	2	–	2	V
V_F				−10		–	4	–	4	
h_{fe} f = 1 kHz	5			1		1000	–	1000	–	
$\|h_{fe}\|$ f = 1 MHz	5			1		20	–	20	–	
$E_{S/b}$[b] L = 12 mH, R_{BE} = 100 Ω			−1.5	4.5		120	–	120	–	mJ
$I_{S/b}$ t = 1 s, non rep.	80					0.36	–	–	–	A
	100					–	–	0.25	–	
	30					4.16	–	4.16	–	
$R_{\theta JC}$						–	1.4	–	1.4	°C/W

[a]Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[b]$E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = ½LI^2$ where L is a series load or leakage inductance, and I is the peak collector current.

BDY29
(Preliminary Data)
Hometaxial-Base, High-Power High-Current Transistor

Rugged Silicon N-P-N Devices for Applications
in Industrial and Commercial Equipment

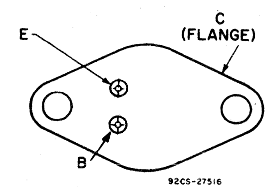
Features:

- High dissipation capability
- High V_{CEX} ratings
- 15-A specification for h_{FE} and $V_{CE}(sat)$
- Low saturation voltage with high beta

The RCA-BDY29 is a hometaxial-base silicon, n-p-n transistor intended for a wide variety of high-power high-current applications. Typical applications for the BDY29 include power-switching circuits, audio amplifiers, series- and shunt-regulators, driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

The device is supplied in the popular JEDEC TO-3 package.

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	100	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With −1.5 V (V_{BE}) & R_{BE} = 100 Ω	V_{CEX}	90	V
With base open	V_{CEO}	75	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	30	A
PEAK COLLECTOR CURRENT	I_{CM}	30	A
CONTINUOUS BASE CURRENT	I_B	7.5	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		220	W
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
PIN TEMPERATURE (During soldering):			
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BDY29 Min.	Max.	UNITS
Collector Cutoff Current: With emitter open	I_{CBO}	100					–	1	mA
With base-emitter junction reverse-biased	I_{CEX}		100	−1.5			–	1	mA
With base-emitter junction reverse-biased & T_C = 150°C	I_{CEX}		100	−1.5			–	10	mA
With base open	I_{CEO}		60			0	–	2	mA
Emitter Cutoff Current	I_{EBO}			−7	0		–	2	mA
DC Forward Current Transfer Ratio	h_{FE}		2		15[a]		15	60	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased (R_{BE}) = 100 Ω	$V_{CEX}(sus)$			−1.5	0.2		90	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				0.2		85	–	V
With base open	$V_{CEO}(sus)$				0.2	0	75	–	V
Base-to-Emitter Voltage	V_{BE}		4		30[a]		–	3.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				15[a]	1.5	–	1.2	V
Second-Breakdown Collector Current: With base forward-biased and 1-s, nonrepetitive pulse	$I_{S/b}$[b]		60				3.66	–	A
Second-Breakdown Engergy: With base reverse-biased and L = 40 mH, R_{BE} = 100 Ω	$E_{S/b}$[c]			−1.5	5		500	–	mJ
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 0.05 MHz	$\|h_{fe}\|$		4		1		4	16 (Typ.)	
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 1 kHz	h_{fe}		4		1		40	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	0.8	°C/W

[a] Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz; duty factor ≤ 2%.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = 1/2LI^2$, where L is a series load or leakage inductance and I is the peak collector current.

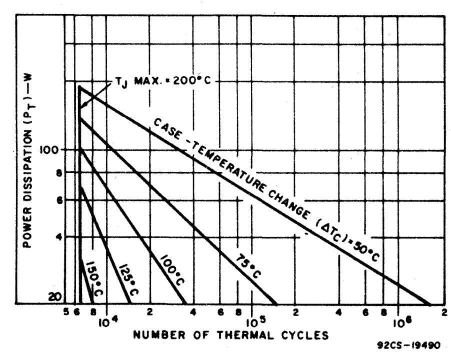


Fig. 1 — Thermal-cycling rating chart.

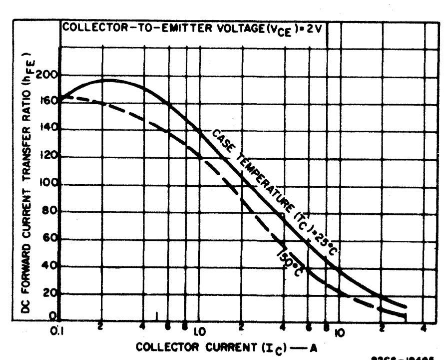


Fig. 2 — Typical dc beta characteristics.

BDY29
(Preliminary Data)

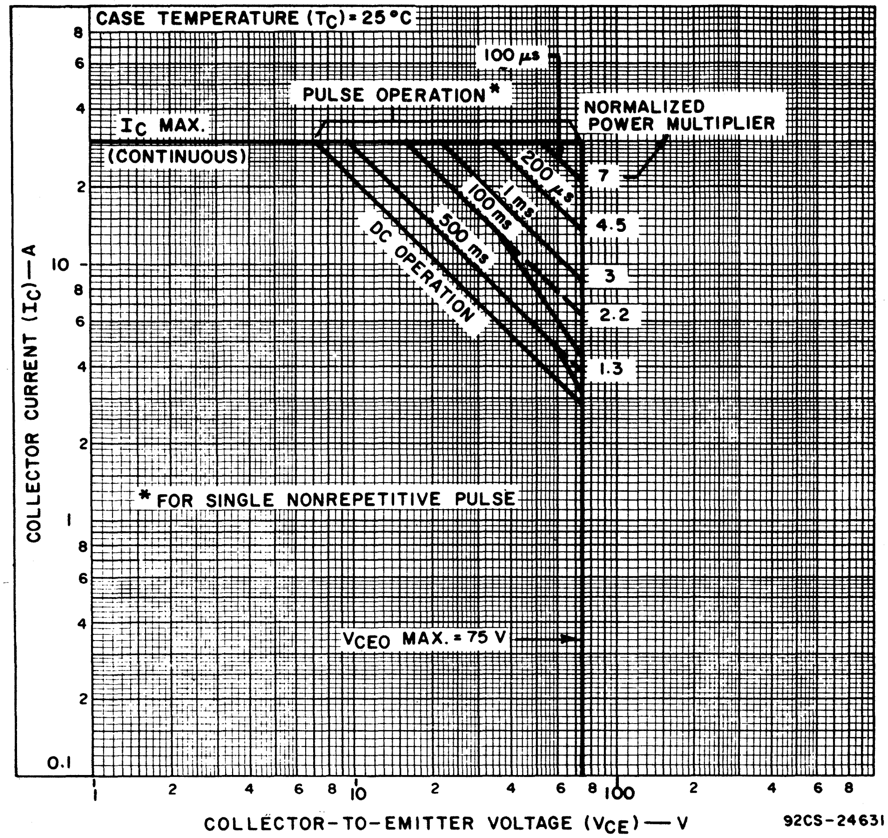


Fig. 3 — Maximum operating areas.

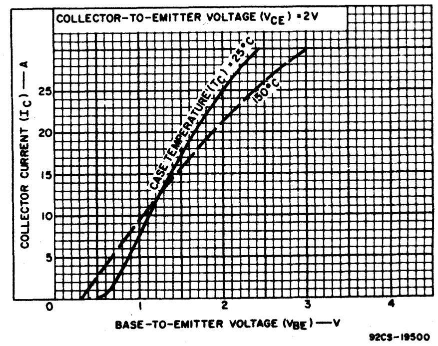


Fig. 4 — Typical transfer characteristics.

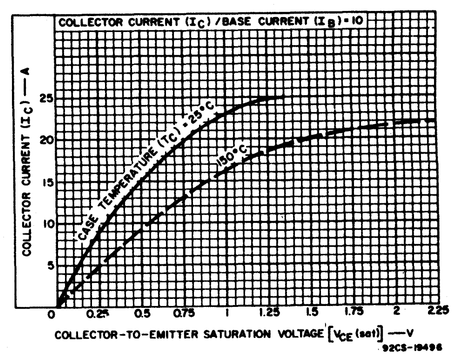


Fig. 5 — Typical saturation-voltage characteristics.

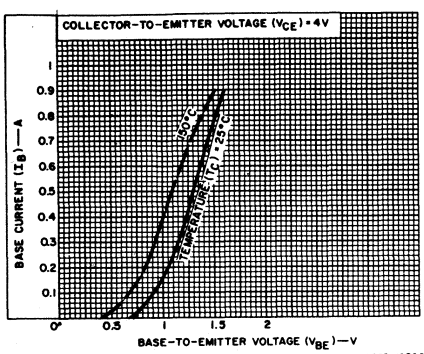


Fig. 6 — Typical input characteristics.

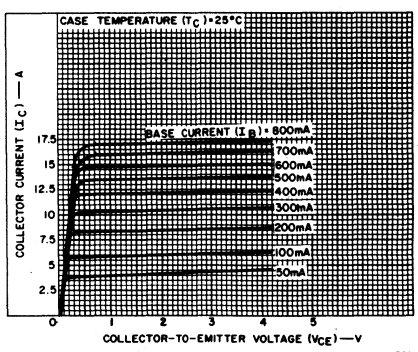


Fig. 7 — Typical output characteristics.

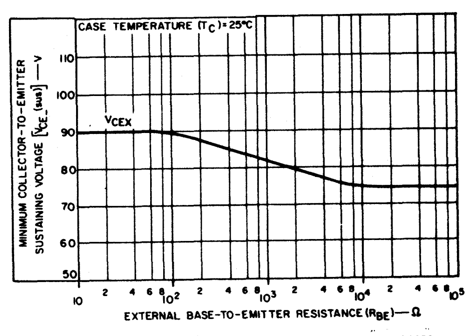


Fig. 8 — Sustaining voltage vs. base-to-emitter resistance.

BDY37

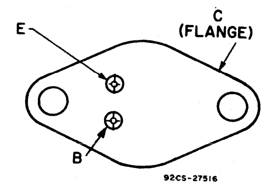
Hometaxial-Base High-Current Silicon N-P-N Transistor

Rugged High-Voltage Device for Applications in Industrial and Commercial Equipment

Features:
- High dissipation capability — 150 W
- 8-A specification for h_{FE}, V_{BE}, and $V_{CE}(sat)$
- V_{CEX} — 160 V min.
- Low saturation voltage with high beta

The RCA-BDY 37 is a hometaxial-base silicon n-p-n transistor intended for a wide variety of high-voltage high-current applications. Typical applications include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service. The BDY 37 employs the popular JEDEC TO-3 package.

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	160	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	140	V
With reverse bias (V_{BE}) of −1.5 V	V_{CEX}	160	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
COLLECTOR CURRENT:			
Continuous	I_C	16	A
Peak	I_{CM}	30	A
BASE CURRENT:			
Continuous	I_B	4	A
Peak	I_{BM}	15	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		150	W
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to +200	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		230	°C

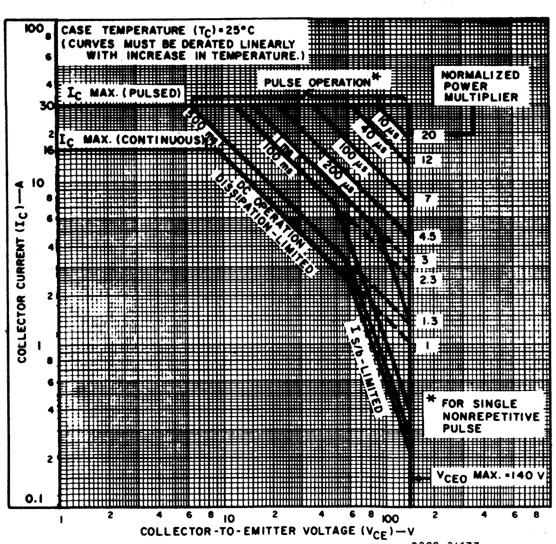


Fig. 1 — Maximum operating areas.

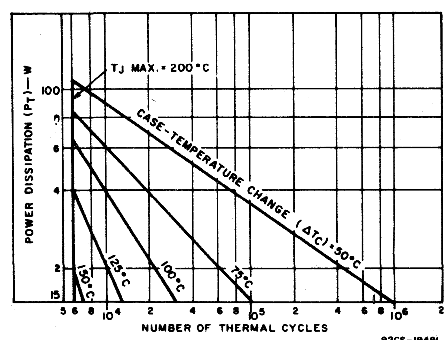


Fig. 2 — Thermal-cycling rating chart.

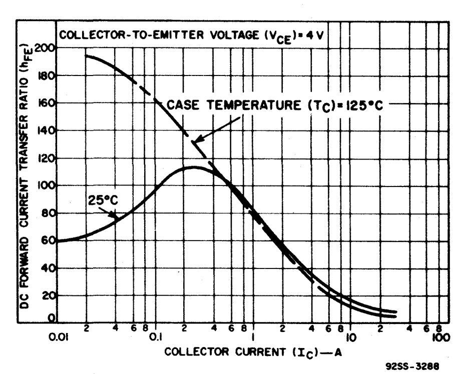


Fig. 3 — Typical dc beta characteristics.

BDY37

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc				CURRENT A dc			LIMITS BDY37		UNITS
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	
Collector-Cutoff Current: With emitter open	I_{CBO}	140					0		–	2	mA
With base-emitter junction reverse-biased	I_{CEX}		140		−1.5				–	2	mA
With base-emitter junction reverse-biased and T_C = 150°C	I_{CEX}		140		−1.5				–	10	mA
With base open	I_{CEO}		120					0	–	10	mA
Emitter-Cutoff Current	I_{EBO}			7		0			–	5	mA
DC Forward-Current Transfer Ratio	h_{FE}		4			8[a]			15	60	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased (R_{BE} = 100 Ω)	$V_{CEX}(sus)$				−1.5	0.1			160	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$					0.2[a]			150	–	V
With base open	$V_{CEO}(sus)$					0.2[a]		0	140	–	V
Base-to-Emitter Voltage	V_{BE}		4			8[a]			–	2.2	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					8[a]		0.8	–	1.4	V
Second-Breakdown Collector Current: With base forward-biased and 1-s nonrepetitive pulse	$I_{S/b}$[b]		60						2.5	–	A
Second-Breakdown Energy: With base reverse-biased and L = 40 mH, R_{BE} = 100 Ω	$E_{S/b}$[c]				−1.5	2.5			0.125	–	J
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 50 kHz)	$\|h_{fe}\|$		4			1			4	–	
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}		4			1			40	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$								–	1.17	°C/W

[a] Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz, duty factor ≤ 2%.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.

[c] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = 1/2LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

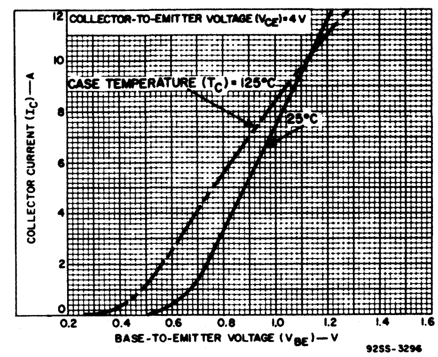


Fig. 4 — Typical transfer characteristics.

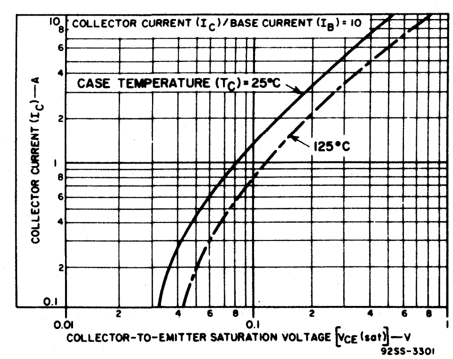


Fig. 5 — Typical staturation-voltage characteristics.

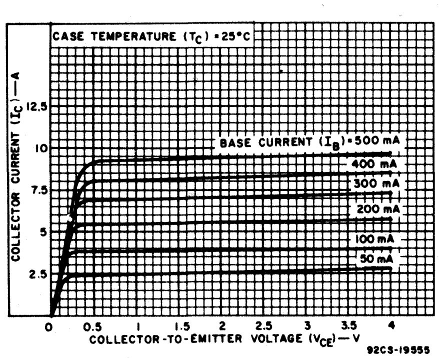


Fig. 6 — Typical output characteristics.

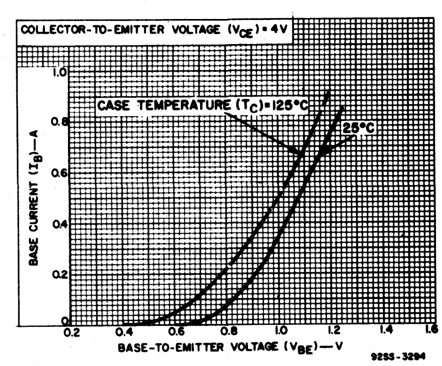


Fig. 7 — Typical input characteristics.

BDY71

Hometaxial-Base, Medium-Power Silicon N-P-N Transistors

For Intermediate-Power Applications in Industrial and Commercial Equipment

The RCA-BDY71 is a hometaxial-base silicon n-p-n transistor intended for a wide variety of medium- to high-power applications. It is supplied in the JEDEC TO-66 hermetic package.

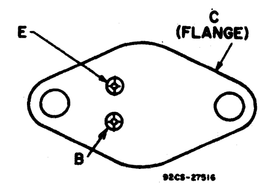
Applications:

- Power switching circuits
- Series- and shunt-regulator driver and output stages
- High-fidelity amplifiers
- Solenoid drivers

Features:

- Maximum safe-area-of-operation curves for dc and pulse operation
- $V_{CEV}(sus)$ = 90 V min
- Low saturation voltage: $V_{CE}(sat)$ = 1.0 V at I_C = 0.5 A

TERMINAL DESIGNATIONS



JEDEC TO-66

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BDY71	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	90	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	55	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$	60	V
With base reverse-biased (V_{BE} = -1.5 V)	$V_{CEV}(sus)$	90	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	A
CONTINUOUS BASE CURRENT	I_B	2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperature up to 25°C		29	W
At temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
PIN TEMPERATURE (During Soldering):			
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235	°C

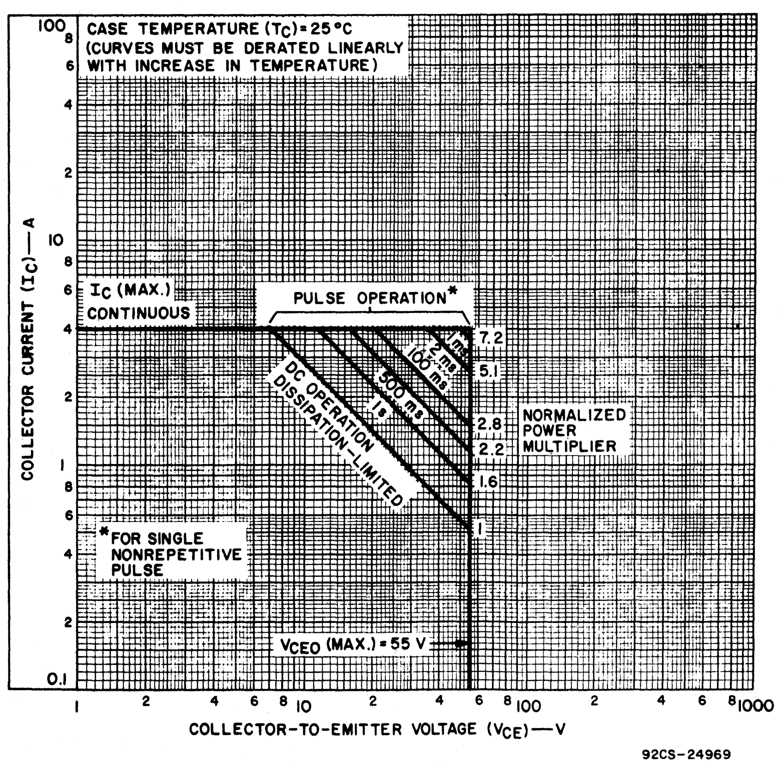


Fig. 1 — Maximum operating areas for BDY71.

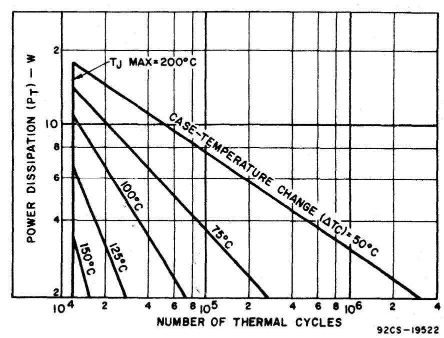


Fig. 2 — Thermal-cycling rating chart.

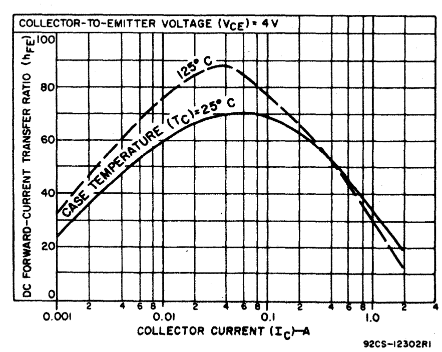


Fig. 3 — Typical dc beta characteristics.

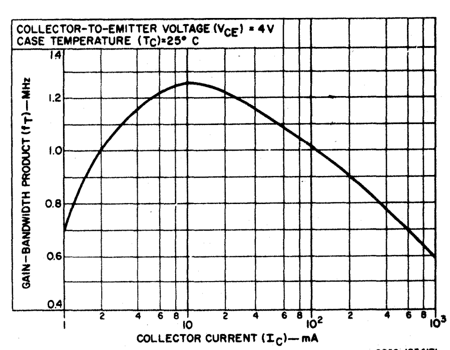


Fig. 4 — Typical gain-bandwidth product.

BDY71

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BDY71 Min.	Max.	UNITS
Collector-Cutoff Current: With base open	I_{CEO}	30			0	–	0.5	mA
With base-emitter junction reverse-biased	I_{CEX}	90	−1.5			–	1	mA
at T_C = 150°C	I_{CEX}	90	−1.5			–	6	mA
Emitter-Cutoff Current	I_{EBO}		−7		0	–	1	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.1[a]	0	55	–	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$			0.1[a]		60	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4 4		3[a] 0.5[a]		5 80	– 200	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			0.5[a] 3[a]	0.05[a] 1[a]	– –	1 6	V
Base-to-Emitter Voltage	V_{BE}	4		0.5		–	1.7	V
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio Cutoff Frequency	f_{hfe}	4		0.1		0.03	–	MHz
Gain-Bandwidth Product: f = 0.4 MHz	f_T			0.2		800	–	kHz
Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio: f = 1 kHz	h_{fe}	4		0.1		25	–	
Forward-Bias Second Breakdown Collector Current: t = 1-s nonrepetitive	$I_{S/b}$	55				525	–	mA
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					6.3	–	°C/W

[a]Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

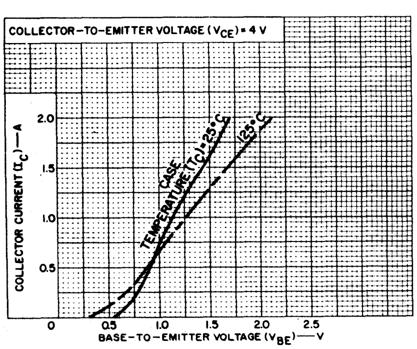


Fig. 5 — Typical transfer characteristics.

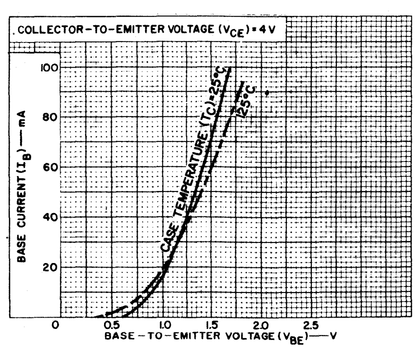


Fig. 6 — Typical input characteristics.

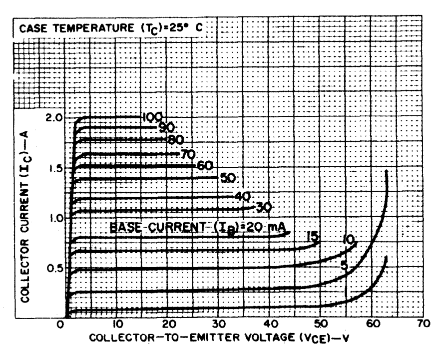


Fig. 7 — Typical output characteristics.

BFT19, BFT19A, BFT19B (Preliminary Data)

High-Voltage Silicon P-N-P Transistors

For High-Speed Switching and Linear-Amplifier Applications in Military, Industrial and Commercial Equipment

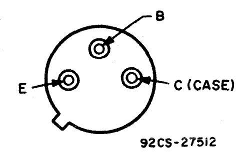
Features:

- Maximum safe-area-of-operation curves
- High voltage ratings:
  V_{CBO} = −400 V max. (BFT19B); −300 V max. (BFT19A); −200 V max. (BFT19)
  $V_{CEO}(sus)$ = −350 V max. (BFT19B); −250 V max. (BFT19A); −150 V max. (BFT19)

RCA-BFT19, BFT19A, and BFT19B are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds. These transistors differ in their voltage ratings. They are supplied in the JEDEC TO-39 hermetic package.

Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters, and high-voltage, low-current switching and series regulators.

TERMINAL DESIGNATIONS



JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BFT19	BFT19A	BFT19B	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−200	−300	−400	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With base open	$V_{CEO}(sus)$	−150	−250	−350	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	−200	−300	−400	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	−5	−5	−5	V
COLLECTOR CURRENT (Continuous)	I_C	−1	−1	−1	A
BASE CURRENT (Continuous)	I_B	−0.5	−0.5	−0.5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		5	5	5	W
At case temperatures above 25°C		Derate linearly to 200°C			
At ambient temperatures up to 25°C		1	1	1	W
At ambient temperatures above 25°C		Derate linearly at 5.7 mW/°C			
TEMPERATURE RANGE:					
Storage and Operating (Junction)		← −65 to 200 →			°C
PIN TEMPERATURE (During Soldering):					
At distance ⩾ 1/32 in. (0.8 mm) from case for 10 s max.		← 255 →			°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS						UNITS
		VOLTAGE V dc			CURRENT mA			BFT19		BFT19A		BFT19B		
		V_{CB}	V_{CE}	V_{EB}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With emitter open	I_{CBO}	−100 −200 −300					0 0 0	– – –	−100 – –	– – –	– −100 –	– – –	– – −100	μA
Emitter-Cutoff Current	I_{EBO}			−5	0			–	−100	–	−100	–	−100	μA
DC Forward-Current Transfer Ratio	h_{FE}		−10 −10 −10		−10 −30 −50			20 25 20	– – –	20 25 20	– – –	20 25 20	– – –	
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$				−10		0	−150[a]	–	−250[a]	–	−350[a]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				−10			−200[a]	–	−300[a]	–	−400[a]	–	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$				−30		−3	–	−1.8	–	−1.8	–	−1.8	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				−10 −30		−1 −3	– –	−1 −2.5	– –	−1 −2.5	– –	−1 −2.5	V
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (at 1 kHz)	h_{fe}		−10		−5			25	–	25	–	25	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio (at 5 MHz)	$\|h_{fe}\|$		−10		−30			5	–	5	–	5	–	
Common-Base, Short-Circuit, Input Capacitance (at 1 MHz)	C_{ib}			−5	0			–	75	–	75	–	75	pF
Output Capacitance (at 1 MHz)	C_{ob}	−10				0		–	15	–	15	–	15	pF
Second-Breakdown Collector Current: With base forward biased	$I_{S/b}$	−100						−50	–	−50	–	−50	–	mA
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$							–	35	–	35	–	35	°C/W

[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

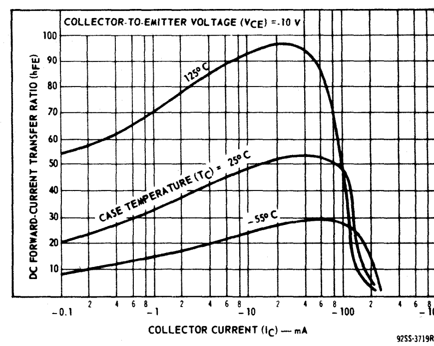


Fig. 1 — Typical dc beta characteristics.

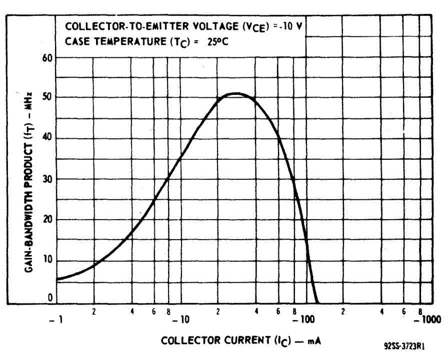


Fig. 2 — Typical gain-bandwidth product.

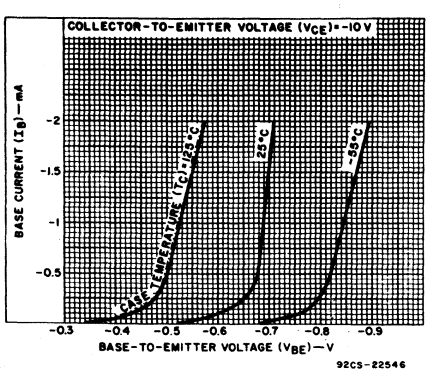


Fig. 3 — Typical input characteristics.

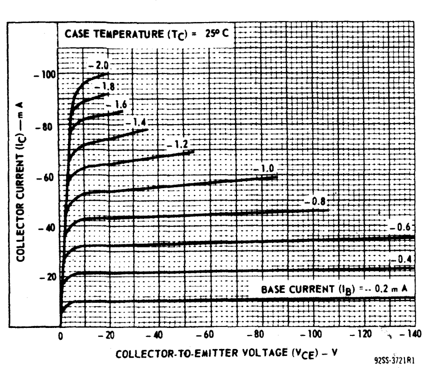


Fig. 4 — Typical output characteristics.

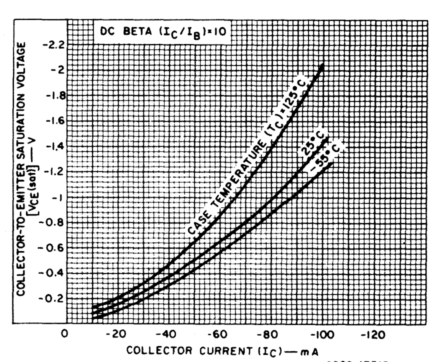


Fig. 5 — Typical collector-to-emitter saturation voltage.

BFT19, BFT19A, BFT19B
(Preliminary Data)

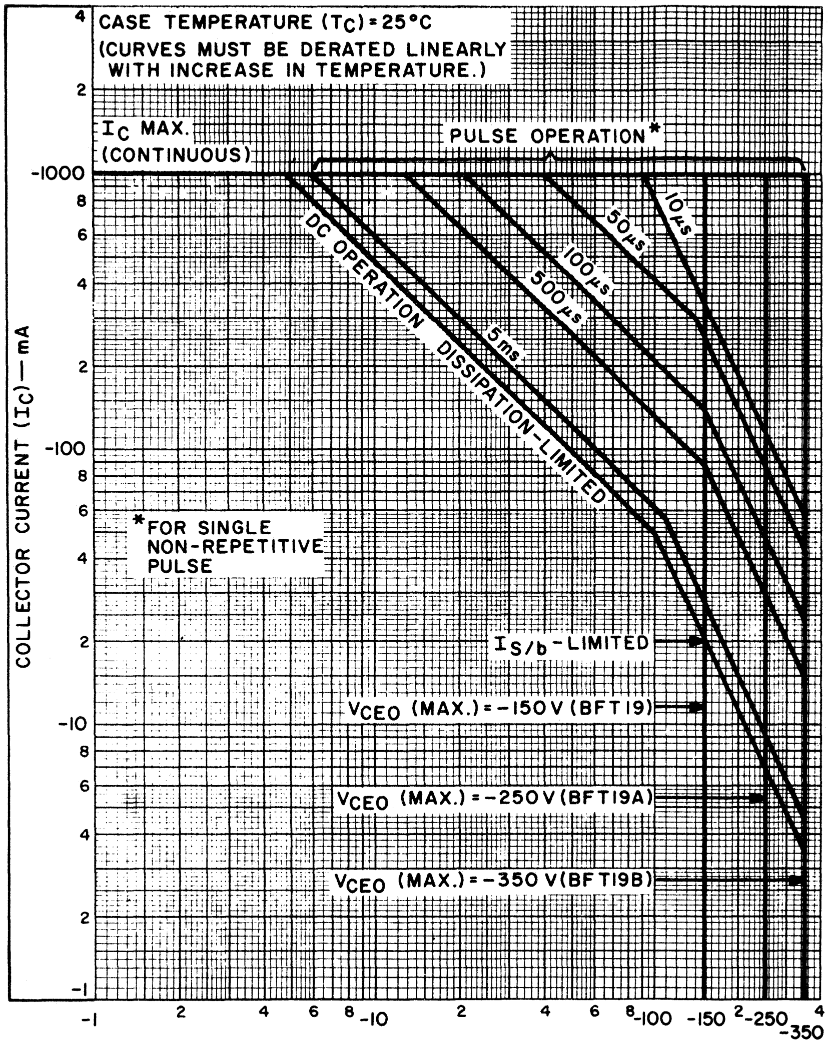


Fig. 6 — Maximum operating areas for all types.

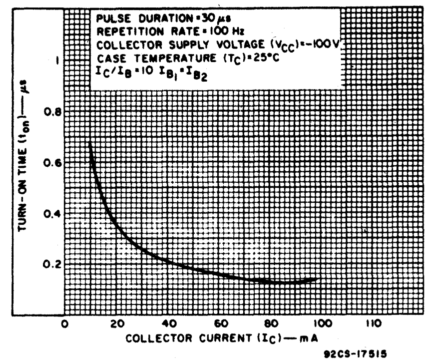


Fig. 7 — Typical turn-on time characteristics.

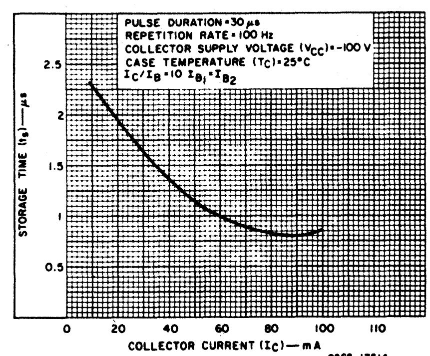


Fig. 8 — Typical storage-time characteristic.

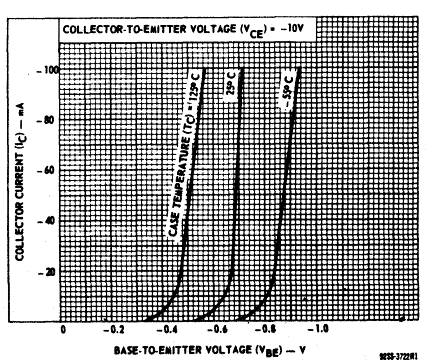


Fig. 9 — Typical transfer characteristics.

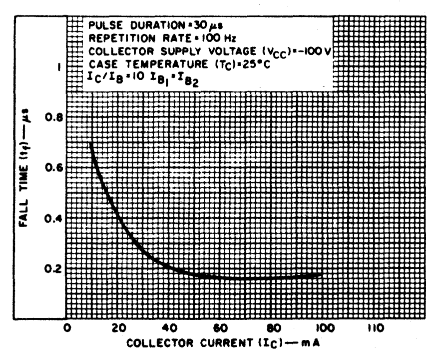


Fig. 10 — Typical fall-time characteristic.

BFT28, BFT28A, BFT28B, BFT28C, (Preliminary Data)

High-Voltage Silicon P-N-P Transistors

For High-Speed Switching and Linear-Amplifier Applications in Military, Industrial and Commercial Equipment

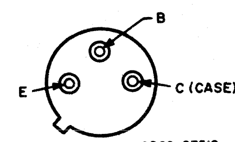
Features:

- Maximum safe-area-of-operation curves
- High voltage ratings:
  V_{CBO} = –150 V max. (BFT 28); –200 V max. (BFT28A); –250 V max. (BFT 28 B); –300 V max. (BFT28C)
  $V_{CEO}(sus)$ = –100 V max. (BFT 28); –150 V max. (BFT28A); –200 V max. (BFT28B); –250 V max. (BFT28C)

The RCA-BFT28, BFT28A, BFT28B and BFT28C are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds. They are supplied in the JEDEC TO-39 hermetic package.

These transistors differ primarily in their voltage ratings. Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters; and high-voltage, low-current switching and series regulators.

TERMINAL DESIGNATIONS



JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BFT28	BFT28A	BFT28B	BFT28C	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	–150	–200	–250	–300	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	–150	–200	–250	–300	V
With base open	$V_{CEO}(sus)$	–100	–150	–200	–250	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	–4	–4	–4	–4	V
COLLECTOR CURRENT	I_C	–1	–1	–1	–1	A
BASE CURRENT	I_B	–0.5	–0.5	–0.5	–0.5	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C		5	5	5	5	W
At case temperatures above 25°C		Derate linearly to 200°C				
At ambient temperatures up to 50°C		1	1	1	1	W
At ambient temperatures above 50°C ..... Derate linearly at		5.7	5.7	5.7	5.7	mW/°C
TEMPERATURE RANGE:						
Storage and Operating (Junction)		–65 to +200				°C
LEAD TEMPERATURE (During soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		255				°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS								UNITS
		VOLTAGE V dc			CURRENT mA dc		BFT28		BFT28A		BFT28B		BFT28C		
		V_{CB}	V_{CE}	V_{EB}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With emitter open	I_{CBO}	–50					–	–1	–	–	—	—	—	—	μA
		–75					–	–	–	–1	–	–	–	–	μA
		–150					–	—	—	—	–	–5	–	–5	μA
Emitter-Cutoff Current	I_{EBO}			–4	0		–	–100	–	–100	–	–100	–	–100	μA
DC Forward-Current Transfer Ratio	h_{FE}		–10		–10[c]		20	–	20	–	20	–	20	–	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$				–10	0	–100[a]	–	–150[a]	–	–200[a]	–	–250[a]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				–10		–150[a]	–	–200[a]	–	–250[a]	–	–300[a]	–	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$				–30[c]	–3	–	–1.5	–	–1.5	–	–1.5	–	–1.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				–10[c]	–1	–	–0.6	–	–0.6	–	–5	–	–5	V
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 kHz	h_{fe}		–10		–5		25	–	25	–	25	–	25	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: f = 5 MHz	$\lvert h_{fe} \rvert$		–10		–30		5	–	5	–	5	–	5	–	
Common-Base, Short-Circuit, Input Capacitance: f = 1 MHz	C_{ib}			–5	0		–	75	–	75	–	75	–	75	pF
Output Capacitance: f = 1 MHz	C_{ob}	–10					–	15	–	15	–	15	–	15	pF
Forward-Bias, Second-Breakdown Collector Current: 0.4-s non-repetitive pulse	$I_{S/b}$[b]		–80				–62.5	–	–62.5	–	–62.5	–	–62.5	–	mA
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	35	–	35	–	35	–	35	°C/W

[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

[b] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.

[c] Pulsed, pulse duration = 300 μs; duty factor ≤ 2%.

BFT28, BFT28A, BFT28B, BFT28C
(Preliminary Data)

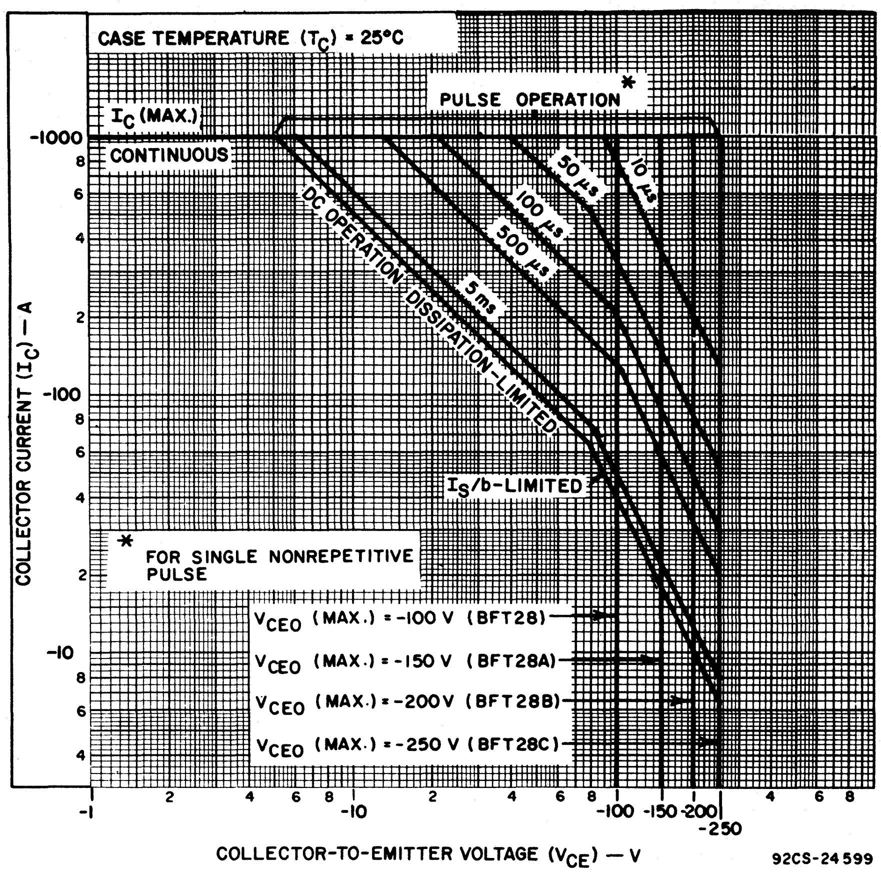


Fig. 1 — Maximum safe operating areas.

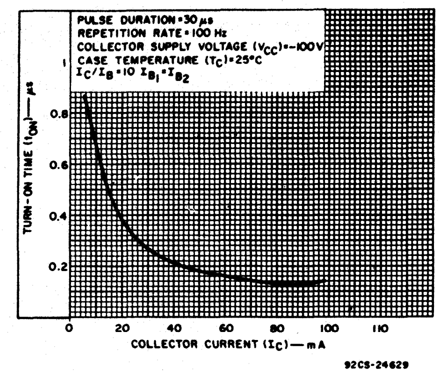


Fig. 2 — Typical turn-on time characteristic for all types.

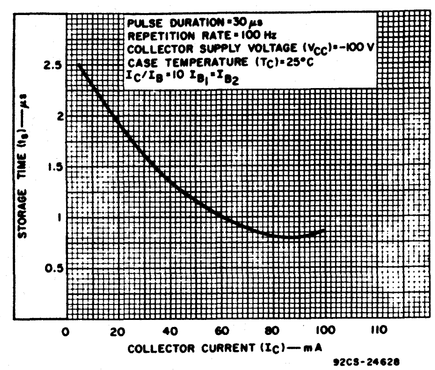


Fig. 3 — Typical storage-time characteristic for all types.

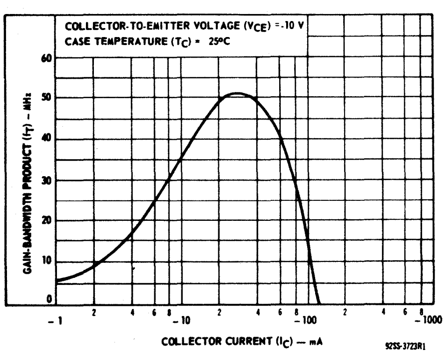


Fig. 4 — Typical gain-bandwidth product for all types.

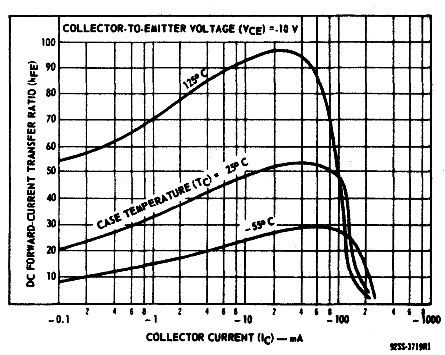


Fig. 5 — Typical dc beta characteristics for all types.

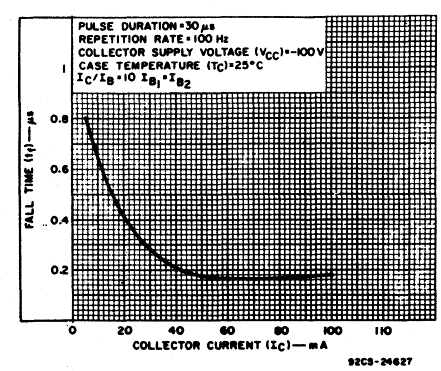


Fig. 6 — Typical fall-time characteristic for all types.

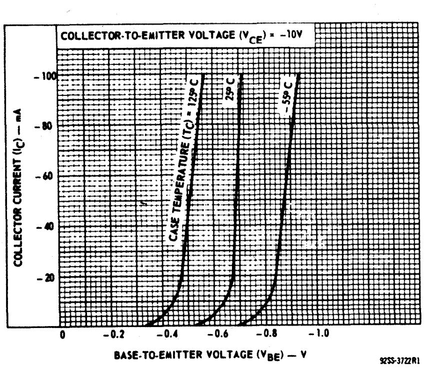


Fig. 7 — Typical transfer characteristics for all types.

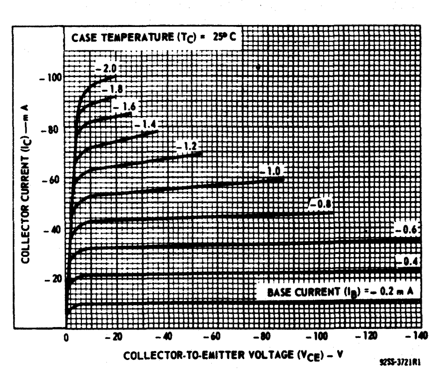


Fig. 8 — Typical output characteristics for all types.

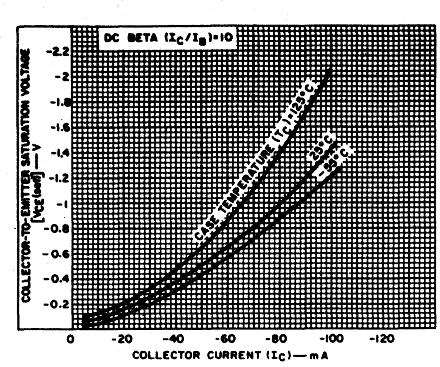


Fig. 9 — Typical collector-to-emitter saturation voltage for all types.

BU106

Epitaxial-Base Silicon N-P-N Transistor

For Horizontal Deflection for Small-Screen Black-and-White TV

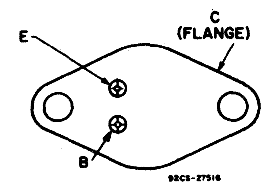
Features:

- Maximum safe-area-of-operation curves
- Low saturation voltages
- High voltage ratings
- High dissipation rating

BU106 is a silicon n-p-n transistor with a pi-nu epitaxial-layer construction. This device is supplied in a JEDEC TO-3 hermetic package. The BU106 is primarily intended for use in horizontal-deflection output stages in small-screen black-and-white television receivers.

This transistor is supplied in the JEDEC TO-3 hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	325	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open	$V_{CEO}(sus)$	140	V
With base reverse-biased (V_{BE}) between −2 V ~ 8 V	$V_{CEV}(sus)$	325	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	8	V
CONTINUOUS COLLECTOR CURRENT	I_C	7	A
PEAK COLLECTOR CURRENT		10	A
CONTINUOUS BASE CURRENT	I_B	4	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C and V_{CE} up to 40 V		75	W
At case temperatures up to 25°C and V_{CE} above 40 V		See Fig. 3	
At case temperatures above 25°C		Derate linearly to 200°C	
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
PIN TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS		UNITS
		VOLTAGE V dc			CURRENT A dc			BU106		
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	I_E	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	100				0		–	2	mA
With base-emitter junction reverse-biased	I_{CEV}	325		−1.5				–	2	
With base-emitter junction reverse-biased and T_C = 100°C		325		−1.5				–	5	
Emitter-Cutoff Current	I_{EBO}		8		0			–	10	mA
Collector-to-Emitter Sustaining Voltage (See Figs. 4 and 5): With base open	$V_{CEO}(sus)$				0.1[a]	0		140	–	V
With base-emitter junction reverse-biased	$V_{CEV}(sus)$			−2	0.05[a]			325	–	
Emitter-to-Base Voltage	V_{EBO}				0.01			8	–	V
DC Forward-Current Transfer Ratio	h_{FE}	5			4[a]			8	–	
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$				4[a]	0.5		–	1.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				4[a]	0.5		–	5	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	10			0.2			3	–	
Common Base Output Capacitance (f = 1 MHz)	C_{ob}	V_{CB} = 10					0	150	–	pF
Forward-Bias Second Breakdown Collector Current (1-s non-repetitive pulse)	$I_{S/b}$	40						1.85	–	A
Switching Time: Storage (V_{CC} = 40 V)	t_s				4	0.5[c]		–	3	µs
Turn-off (V_{CC} = 40 V)	t_{OFF}	2			0.1			–	1.5	
Thermal Resistance Junction-to-Case	$R_{\theta JC}$	10			5			–	2.34	°C/W

[a] Pulsed; pulse duration ≤ 350 µs, Duty factor = 2%.

[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$, and $V_{CEV}(sus)$, MUST NOT be measured on a curve tracer.

[c] I_{B1} = I_{B2} = value shown.

[d] Turn-off is measured when V_{CE} has reached a value of 2 V and I_C has decreased to 100 mA.

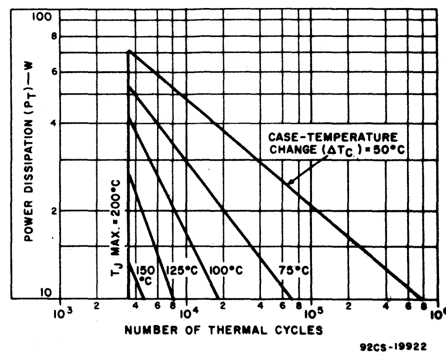


Fig. 1 — Thermal-cycling rating chart.

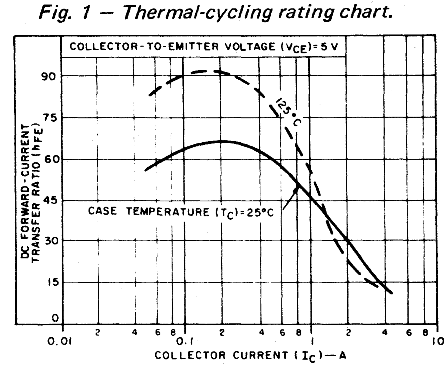


Fig. 2 — Typical dc beta characteristics.

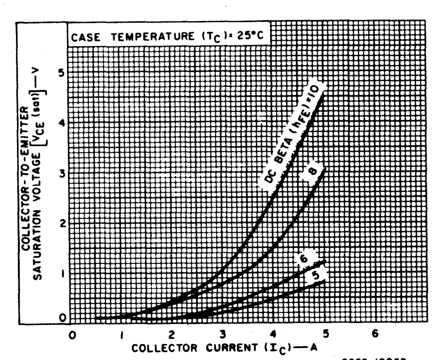


Fig. 3 — Typical saturation voltage characteristics.

BU106

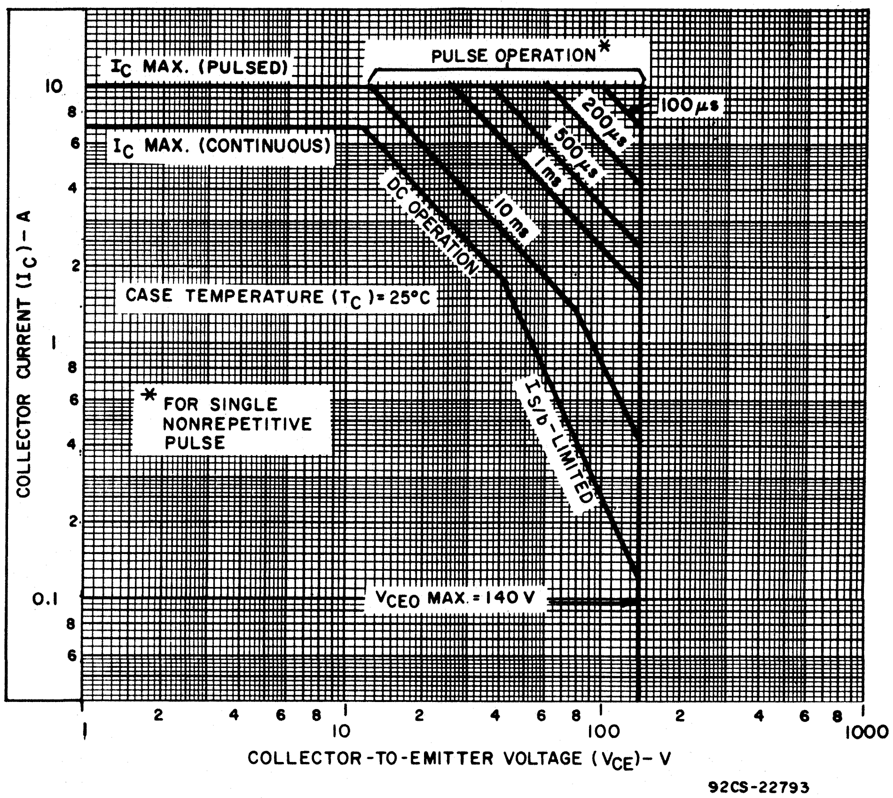


Fig. 4 — Maximum operating areas.

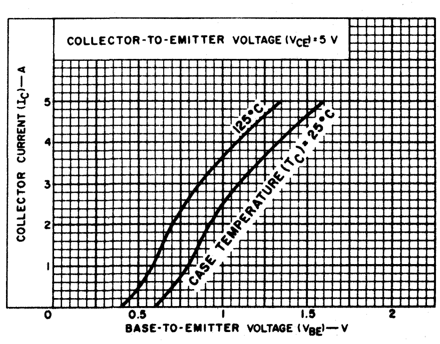


Fig. 5 — Typical transfer characteristics.

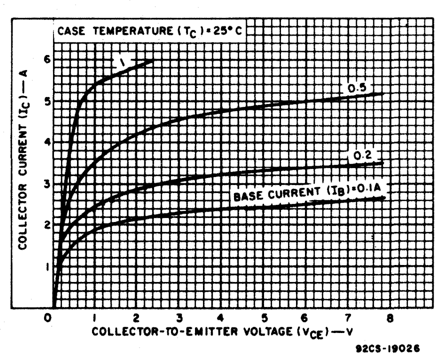


Fig. 6 — Typical output characteristics.

BU126, BU133

High-Voltage, Power-Switching Silicon N-P-N Transistors

TV Colour/Monochrome Receiver Power Supplies –90° and 110° Deflection Angles

Features:

- **Fast switching speed**
- **Hermetic steel package – JEDEC TO-3**
- **Epitaxial pi-nu construction**

The RCA-BU126 and BU133 are silicon epitaxial-collector n-p-n power switching transistors intended for use in switched-mode power supplies of 90° and 110° colour and black-and-white TV receivers.

These devices are hermetically sealed in a steel JEDEC TO-3 package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BU126	BU133	
V_{CES}	750	750	V
V_{CEV}			
$V_{BE} = -1.5$ V	750	750	V
$V_{CEO(sus)}$	300	250	V
V_{EBO}	6	6	V
I_C	3	3	A
I_{CM}	6	6	A
I_B	2	2	A
P_T			
Up to 25°C	80	80	W
Above 25°C	Derate linearly to 200°C		
T_J, T_{stg}	–65 to 200		°C
T_L			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235		°C

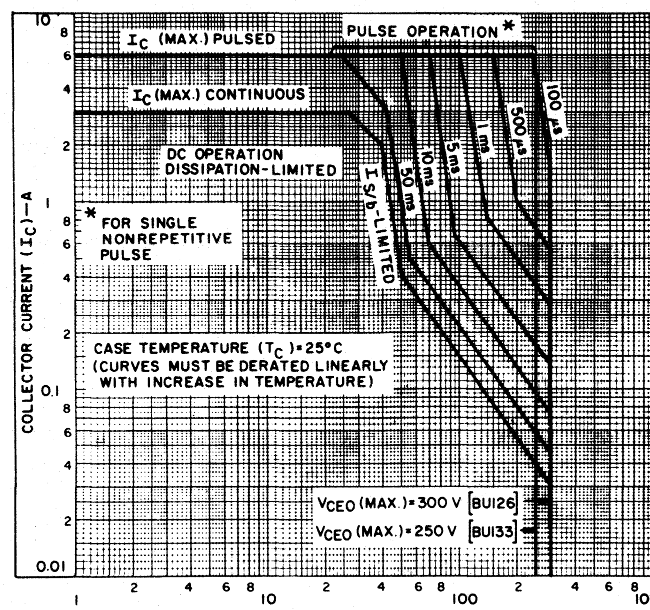


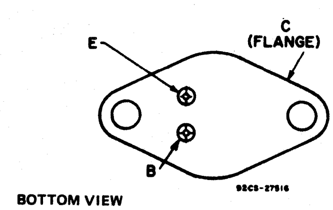
Fig. 1 — Maximum operating areas for BU126, BU133.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BU126		BU133		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CES}	750	0			–	500	–	500	µA
T_C = 125°C	750	0			–	2	–	2	mA
I_{EBO}		–6			–	5	–	5	mA
h_{FE}	5		1a		15	60	15	80	
$V_{CEO(sus)}$			0.1[a]	0	300[b]	–	250[b]	–	V
$V_{BE(sat)}$			4[a]	1	–	1.5	–	1.5	V
$V_{CE(sat)}$			2.5[a] 4[a]	0.25 1	– –	10 5	– –	10 5	V
$I_{S/b}$ t = 1 s nonrep.	40 200				2 50	– –	2 50	– –	V mA
f_T	10		0.2		3.5 typ.		3.5 typ.		MHz
t_s V_{CC} = 50 V			2.5	0.25[c]	1.5 typ.	2.4	1.5 typ.	2.4	µs
t_f V_{CC} = 50 V[d]			2.5	0.25[c]	0.5 typ.	0.9	0.5 typ.	0.9	µs
$R_{\theta JC}$					–	2.18	–	2.18	°C/W

[a] Pulsed: pulse duration = 300 µs, rep. rate = 50 Hz, duty factor = 2%
[b] CAUTION: The sustaining voltage $V_{CEO(sus)}$ MUST NOT be measured on a curve tracer.
[c] $I_{B_1} = I_{B_2}$
[d] Fall-time characteristics measured in a typical switched-mode power supply show an average value of 0.16 µs.

TERMINAL DESIGNATIONS



JEDEC TO-3

BUX16, BUX16A, BUX16B, BUX16C

High-Voltage, High-Power Silicon N-P-N Power Transistor

For Switching and Linear Applications in Industrial, and Commercial Equipment

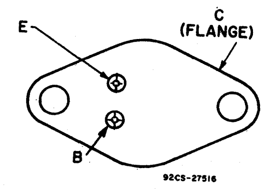
The RCA BUX16-series devices are multiple epitaxial silicon n-p-n power transistors employing a new overlay construction with several emitter sites. All devices employ the popular JEDEC TO-3 package; they differ in breakdown-voltage, leakage-current, and current-gain values.

The high breakdown-voltage ratings and exceptional second-breakdown capabilities of these transistors make them especially suitable for use in series regulators, power amplifiers, inverters, deflection circuits, switching regulators, and high-voltage bridge amplifiers.

Features:

- **High voltage ratings: V_{CER}(sus) up to 400 V, $R_{BE} \leq 50\ \Omega$; V_{CEO}(sus) up to 350 V**
- **High power dissipation rating: P_T = 100 W at V_{CE} = 135 V, T_C = 25°C**
- **For switching applications where circuit values and operating conditions require a transistor with a high second breakdown rating ($I_{S/b}$) (limit line begins at 135 V)**
- **Maximum area-of-operation curves for dc and pulse operation**

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BUX16	BUX16A	BUX16B	BUX16C	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	325	375	425	V
COLLECTOR-TO-EMITTER VOLTAGE:						
With base reverse-biased (V_{BE}) = −1.5 V	V_{CEV}	250	325	375	425	V
With external base-to-emitter resistance (R_{BE}) ≤50 Ω	V_{CER}(sus)	225	300	350	400	V
With base open	V_{CEO}(sus)	200	250	300	350	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
CONTINUOUS COLLECTOR CURRENT	I_C	5	5	5	5	A
CONTINUOUS BASE CURRENT	I_B	2	2	2	2	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C and V_{CE} up to 135 V		100	100	100	100	W
At case temperatures up to 25°C and V_{CE} above 135 V		See Fig. 1				
At case temperatures above 25°C		Derate linearly to 200°C				
TEMPERATURE RANGE:						
Storage and operating (Junction)		−65 to 200				°C
PIN TEMPERATURE (During soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	230				°C

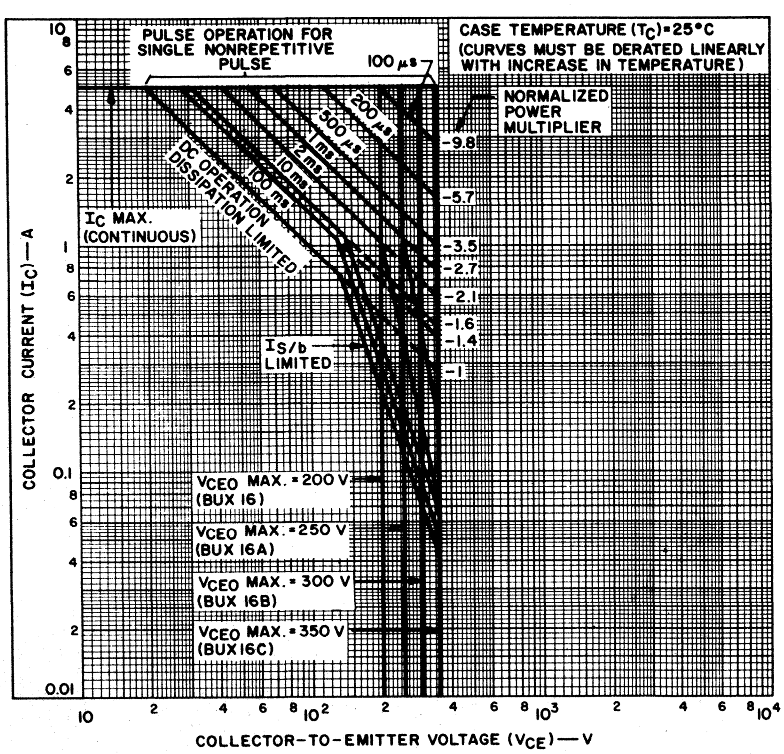


Fig. 1 — Maximum operating areas for all types.

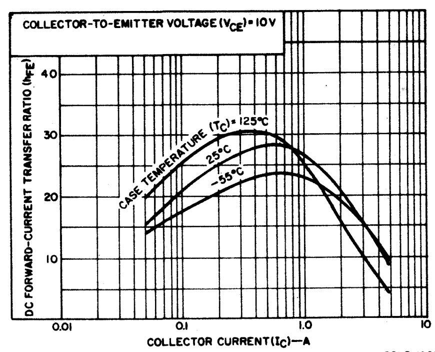


Fig. 2 — Typical dc beta vs. collector current for all types.

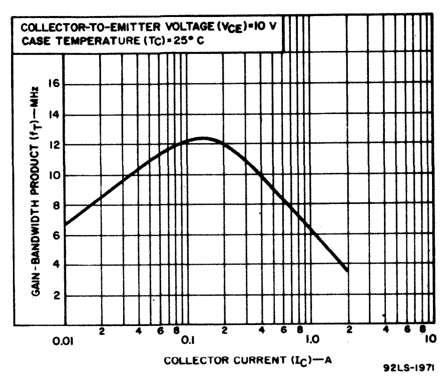


Fig. 3 — Typical gain-bandwidth product vs. collector current for all types.

BUX16, BUX16A, BUX16B, BUX16C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc		TEST CONDITIONS CURRENT A dc		LIMITS BUX16		BUX16A		BUX16B		BUX16C		UNITS
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With base reverse-biased	I_{CEV}	250	−1.5	–	–	–	5	–	–	–	–	–	–	mA
		325	−1.5	–	–	–	–	–	5	–	–	–	–	
		375	−1.5	–	–	–	–	–	–	–	2	–	–	
		425	−1.5	–	–	–	–	–	–	–	–	–	2	
With base reverse-biased T_C = 150°C	I_{CEV}	250	−1.5	–	–	–	8	–	8	–	3	–	3	
With base open	I_{CEO}	175	–	–	0	–	5	–	2	–	–	–	–	
		250	–	–	0	–	–	–	–	–	5	–	2	
Emitter Cutoff Current: V_{EB} = 5 V	I_{EBO}	–	–	0	–	–	5	–	5	–	2	–	2	mA
Collector-to-Emitter Sustaining Voltage[a] With base open	$V_{CEO}(sus)$	–	–	0.2	0	200	–	250	–	300	–	350	–	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω	$V_{CER}(sus)$	–	–	0.2	–	225	–	300	–	350	–	400	–	
Emitter-to-Base Voltage	V_{EBO}	–	–	0	0.02	6	–	6	–	6	–	6	–	V
DC Forward-Current Transfer Ratio	h_{FE}	10	–	0.4[b]	–	15	130	15	130	15	130	15	130	
		10	–	2[b]	–	15	–	15	–	12	–	12	–	
		10	–	4.5[b]	–	5	–	5	–	5	–	5	–	
Base-to-Emitter Voltage	V_{BE}	10	–	2[b]	–	–	3	–	3	–	3	–	3	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	–	–	2[b]	0.25	–	2.5	–	2.5	–	2.5	–	2.5	V
		–	–	4.5[b]	1.125	–	5	–	5	–	5	–	5	
Gain-Bandwidth Product	f_T	10	–	0.2	–	5	–	5	–	5	–	5	–	MHz
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio[c] (at 1 MHz)	$\|h_{fe}\|$	10	–	0.2	–	5	–	5	–	5	–	5	–	
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (at 1 kHz)	h_{fe}	10	–	4	–	20	–	20	–	20	–	20	–	
Output Capacitance (at 1 MHz): V_{CB} = 10 V, I_E = 0	C_{obo}	–	–	–	–	–	150	–	150	–	150	–	150	pF
Second-Breakdown Collector Current[d]: (With base forward-biased) Pulse duration (nonrepetitive) = 1 s	$I_{S/b}$	135	–	–	–	0.75	–	0.75	–	0.75	–	0.75	–	A
Second-Breakdown Energy[e]: (With base reverse-biased) L = 150 μH, R_{BE} = 50 Ω	$E_{S/b}$	–	−4	4	–	1.2	–	1.2	–	1.2	–	1.2	–	mJ
Thermal Resistance: Junction-to-case	$R_{\theta JC}$	–	–	–	–	–	1.75	–	1.75	–	1.75	–	1.75	°C/W

[a] *CAUTION:* Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ *MUST NOT* be measured on a curve tracer.
[b] Pulsed, pulse duration ≤ 350 μs, duty factor = 2%.
[c] Measured at a frequency where $|h_{fe}|$ is decreasing at approximately 6 dB per octave.
[d] $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.
[e] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias connections. $E_{S/b}$ = ½ LI^2 where L is a series load or leakage inductance, and I is the peak collector current.

BUX16, BUX16A, BUX16B, BUX16C

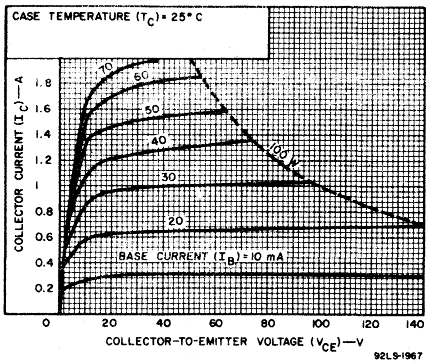


Fig. 4 — Typical output characteristics for all types.

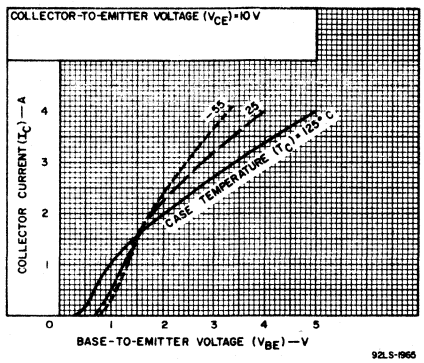


Fig. 5 — Typical transfer characteristics for all types.

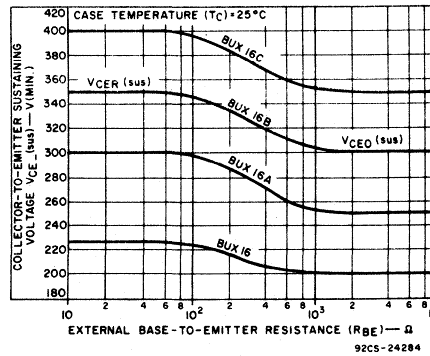


Fig. 6 — Sustaining voltage vs base-to-emitter resistance for all types.

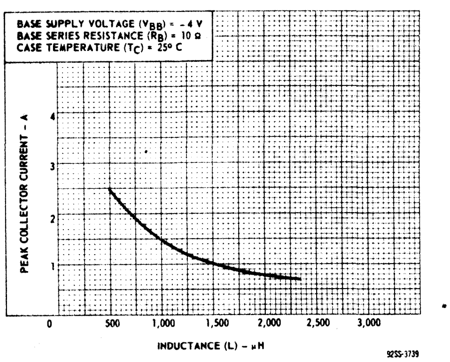


Fig. 7 — Typical reverse-bias, second-breakdown characteristic for all types.

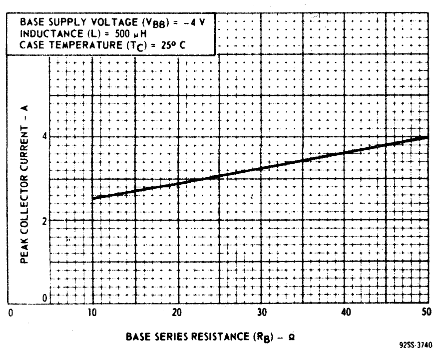


Fig. 8 — Typical reverse-bias, second-breakdown characteristic for all types.

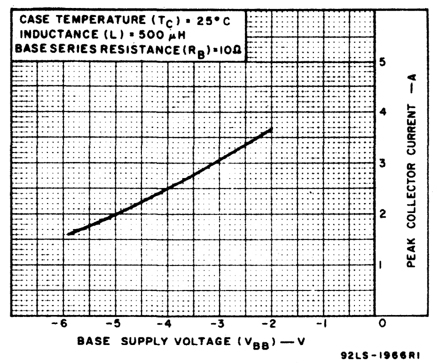


Fig. 9 — Typical reverse-bias, second-breakdown characteristic for all types.

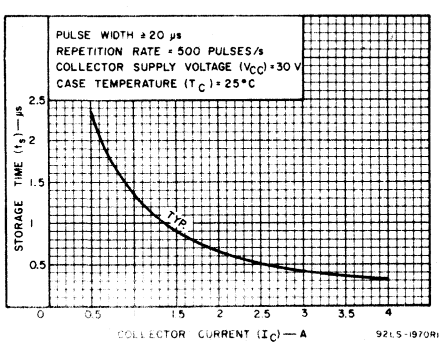


Fig. 10 — Saturated switching time (storage) vs. collector current for all types.

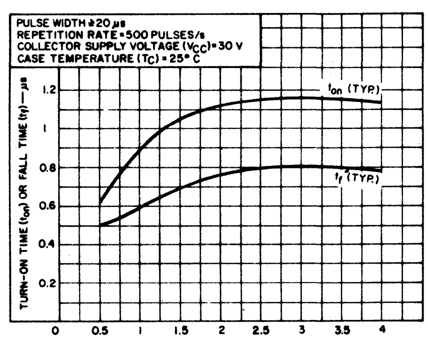


Fig. 11 — Saturated switching times (turn-on and fall) vs. collector current for all types.

BUX17, BUX17A, BUX17B, BUX17C (Preliminary Data)

Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

The RCA-BUX17, BUX17A, BUX17B, and BUX17C are multiple epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. Multiple-epitaxial construction maximizes the volt-ampere characteristic of the device and provides fast switching speeds. Multiple-emitter-site design assures uniform current flow throughout the structure, which produces a high $I_{S/b}$ and a large safe-operation area.

These devices use the popular JEDEC TO-3 package; they differ mainly in voltage ratings and leakage-current limits.

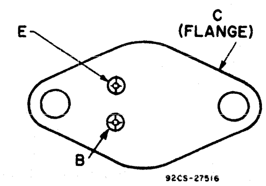
The exceptional second-breakdown capabilities and high voltage-breakdown ratings make these transistors especially suitable for off-line inverters, switching regulators, motor controls, and deflection-circuit applications.

The high breakdown voltages, low saturation voltages, and fast-switching capability of these devices make them especially suitable for inverter circuits operating directly off the rectified 115-V power line or in a bridge configuration operating from the rectified 220-V line.

Features:

- **High voltage ratings:**
  V_{CBO} = 250 V (BUX17)
  = 350 V (BUX17A)
  = 400 V (BUX17B)
  = 450 V (BUX17C)
- **High dissipation rating: P_T = 150 W**
- **Low saturation voltages**
- **Maximum safe-area-of-operation curves**

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BUX17	BUX17A	BUX17B	BUX17C	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	350	400	450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With base open	$V_{CEO}(sus)$	150	250	300	350	V
With reverse bias (V_{BE}) = 0 V (with base-emitter shorted)	$V_{CEX}(sus)$	250	350	400	450	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω	$V_{CER}(sus)$	175	275	325	375	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
COLLECTOR CURRENT:						
Continuous	I_C	10	10	10	10	A
Peak	I_{CM}	30	30	30	30	A
CONTINUOUS BASE CURRENT	I_B	10	10	10	10	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C and V_{CE} up to 30 V		150	150	150	150	W
At case temperatures up to 25°C and V_{CE} above 30 V		See Fig. 1				
At case temperatures above 25°C		Derate linearly to 200°C				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		−65 to +200				°C
PIN TEMPERATURE (During soldering):						
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		230				°C

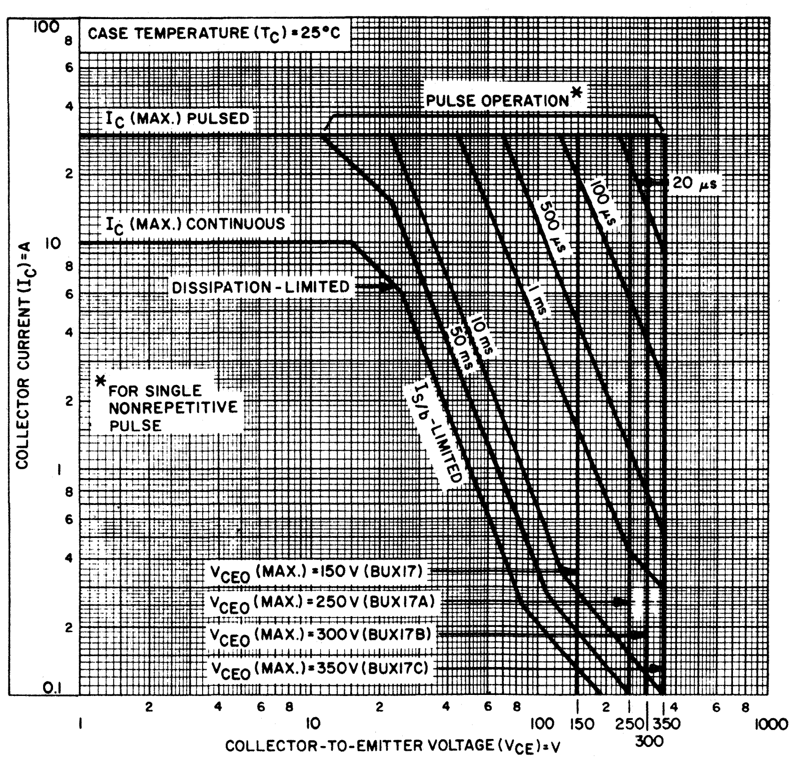


Fig. 1 — Maximum operating areas for all types.

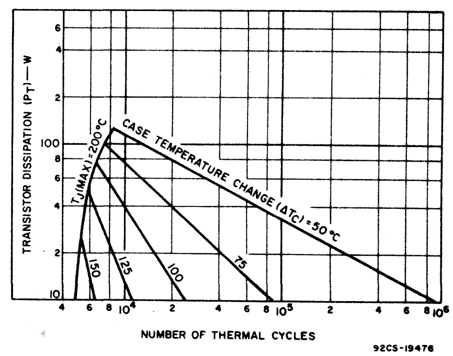


Fig. 2 — Thermal-cycling rating chart for all types.

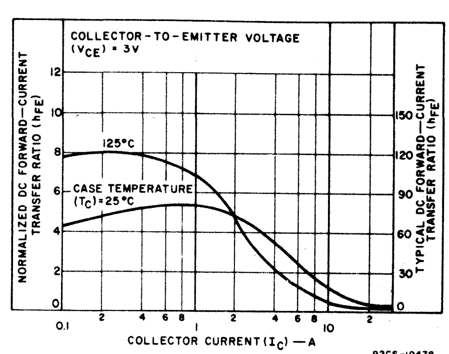


Fig. 3 — Typical normalized dc beta characteristics for all types.

BUX17, BUX17A, BUX17B, BUX17C (Preliminary Data)

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BUX17		BUX17A		BUX17B		BUX17C		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 50 Ω	I_{CER}	175				–	10	–	–	–	–	–	–	mA
		275				–	–	–	10	–	–	–	–	
		325				–	–	–	–	–	10	–	–	
		375				–	–	–	–	–	–	–	10	
With base-emitter junction reverse-biased	I_{CEV}	250	−1.5			–	10	–	–	–	–	–	–	
		350	−1.5			–	–	–	10	–	–	–	–	
		400	−1.5			–	–	–	–	–	5	–	–	
		450	−1.5			–	–	–	–	–	–	–	5	
At T_C = 125°C		250	−1.5			–	20	–	–	–	–	–	–	
		350	−1.5			–	–	–	20	–	–	–	–	
		400	−1.5			–	–	–	–	–	10	–	–	
		450	−1.5			–	–	–	–	–	–	–	10	
Emitter Cutoff Current	I_{EBO}		−6	0		–	2	–	2	–	2	–	2	mA
DC Forward-Current Transfer Ratio	h_{FE}	3		4[a]		20	–	20	–	15	–	15	–	
		3		8		–	–	–	–	7	–	7	–	
		3		10[a]		7	–	7	–	–	–	–	–	
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$			0.2[a]		150[b]	–	250[b]	–	300[b]	–	350[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$			0.2[a]		175[b]	–	275[b]	–	325[b]	–	375[b]	–	
Base-to-Emitter Voltage	V_{BE}	3		8[a]		–	–	–	–	–	3.5	–	3.5	V
		3		10[a]		–	4	–	4	–	–	–	–	
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			8[a]	1.5	–	–	–	–	–	2	–	2	V
				10[a]	2	–	3	–	3	–	–	–	–	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			8[a]	1.5		–	–	–	–	3	–	3	V
				10[a]	2	–	2	–	2	–	–	–	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 MHz	$\|h_{fe}\|$	10		1		2.5	8	2.5	8	2	8	2.5	8	
Forward-bias Second Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$	25				6	–	6	–	6	–	6	–	A
Second-Breakdown Energy: With base reverse-biased, and R_{BE} = 50 Ω, L = 40 µH	$E_{S/b}$		−4	10		2	–	2	–	2	–	2	–	mJ
Saturated Switching Time (V_{CC}= 200 V, I_{B1} = I_{B2}): Turn-on (t_d + t_r)	t_{ON}			8	1.5	–	–	–	–	–	2	–	2	µs
				10	2	–	2	–	2	–	–	–	–	
Storage	t_s			8	1.5	–	–	–	–	–	3.5	–	3.5	
				10	2	–	3.5	–	3.5	–	–	–	–	
Fall	t_f			8	1.5	–	–	–	–	–	1	–	1	
				10	2	–	1	–	1	–	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.17	–	1.17	–	1.17	–	1.17	°C/W

[a]Pulsed; pulse duration ≤ 350 µs, duty factor = 2%.

[b]CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.

BUX17, BUX17A, BUX17B, BUX17C (Preliminary Data)

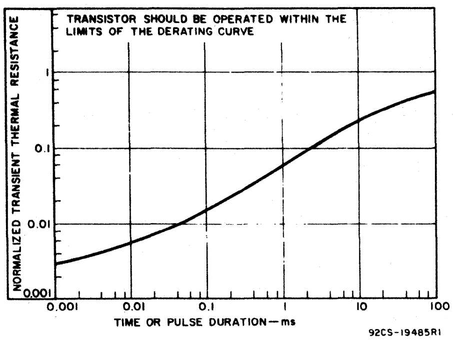


Fig. 4 — Typical thermal response characteristics for all types.

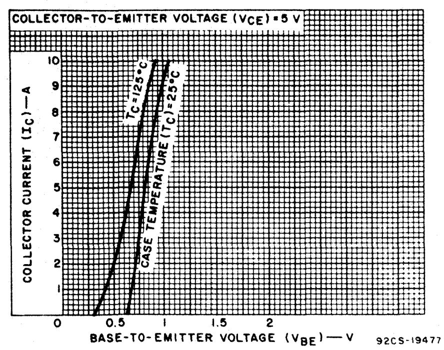


Fig. 5 — Typical transfer characteristics for all types.

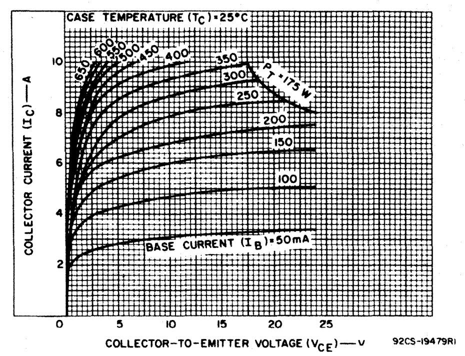


Fig. 6 — Typical output characteristics for all types.

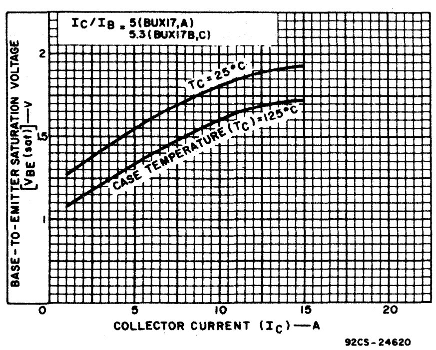


Fig. 7 — Typical base-to-emitter saturation-voltage characteristics for all types.

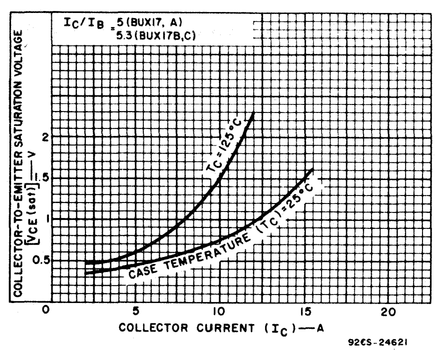


Fig. 8 — Typical collector-to-emitter saturation-voltage characteristics for all types.

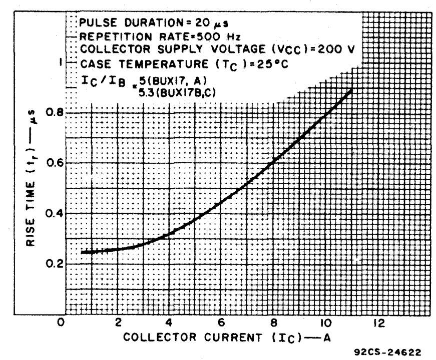


Fig. 9 — Typical rise-time characteristics for all types.

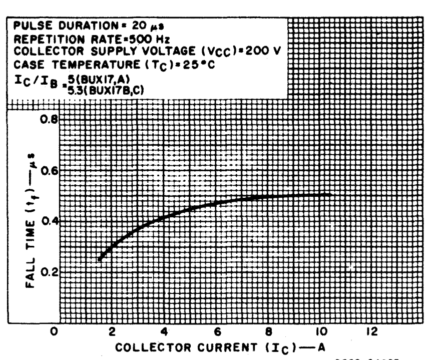


Fig. 10 — Typical fall-time characteristic for all types.

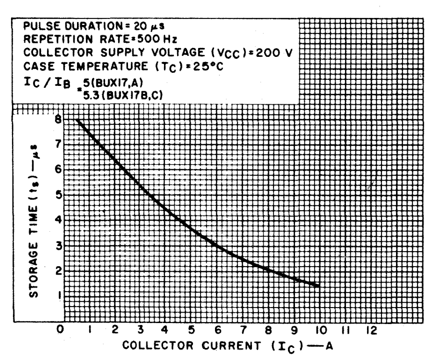


Fig. 12 — Typical inductive- and resistive-load fall-time characteristics for all types.

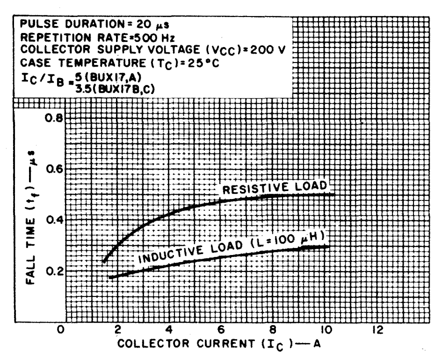


Fig. 11 — Typical storage-time characteristics for all types (with constant forced gain).

BUX18, BUX18A, BUX18B, BUX18C

High-Voltage, High-Current, Silicon N-P-N Power Switching Transistors

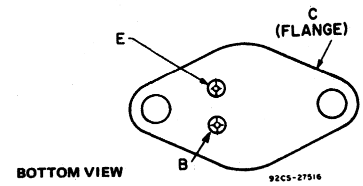
For Off-Line Switching Applications

The RCA-BUX18, BUX18A, BUX18B, and BUX18C are epitaxial silicon n-p-n power-switching transistors with pi-nu construction. They are intended for use in off-line power supplies and for other applications in which a combination of high-current-handling capability, ruggedness, and fast switching speed is required. The devices are hermetically sealed in a steel JEDEC TO-3 package, and differ from each other in collector voltage ratings.

Features:

- **Fast switching speed**
- **Hermetic steel package—JEDEC TO-3**
- **Epitaxial pi-nu construction**

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BUX18	BUX18A	BUX18B	BUX18C	
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGES:						
With reverse bias, $V_{BE} = -1.5$ V	$V_{CEV}(sus)$	300	450	600	750	
With external base-to-emitter resistance ($R_{BE} = 100\Omega$)	$V_{CER}(sus)$	250	325	375	425	V
With base open	$V_{CEO}(sus)$	200	275	325	375	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
CONTINUOUS COLLECTOR CURRENT	I_C	8	8	8	8	A
PEAK COLLECTOR CURRENT	I_{CM}	12	12	12	12	A
CONTINUOUS BASE CURRENT	I_B	2	2	2	2	A
PEAK BASE CURRENT	I_{BM}	3	3	3	3	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		120	120	120	120	W
At case temperatures above 25°C		Derate linearly at 0.68 W/°C				
TEMPERATURE RANGE:						°C
Storage and Operating (Junction)		−65 to +200				°C
LEAD TEMPERATURE (During Soldering):						
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		235				°C

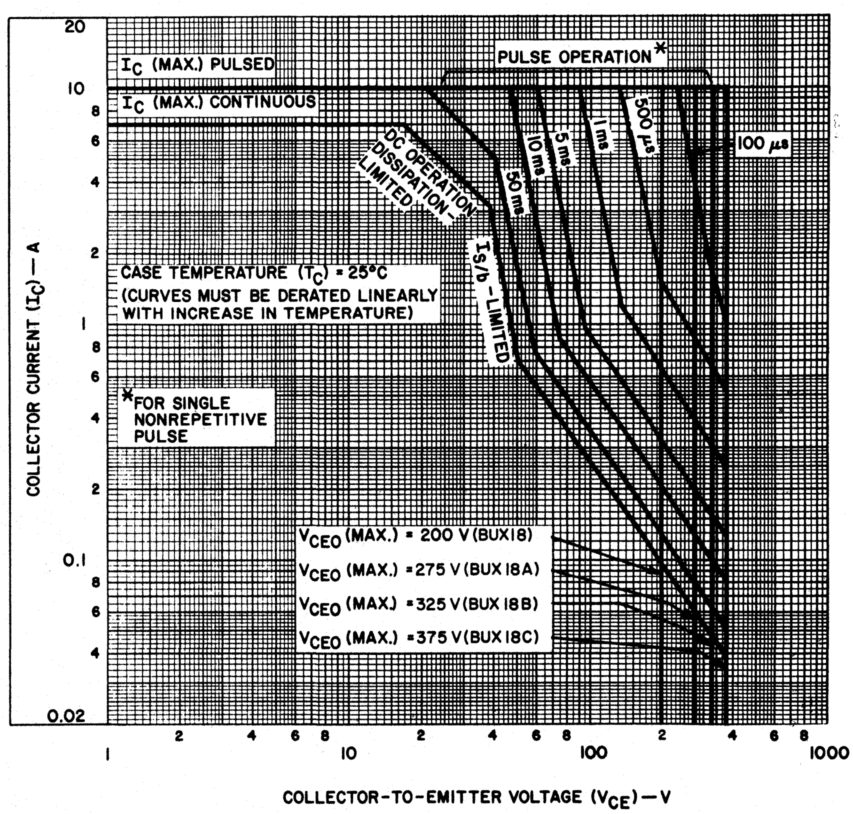


Fig. 1 — Maximum operating areas for all types.

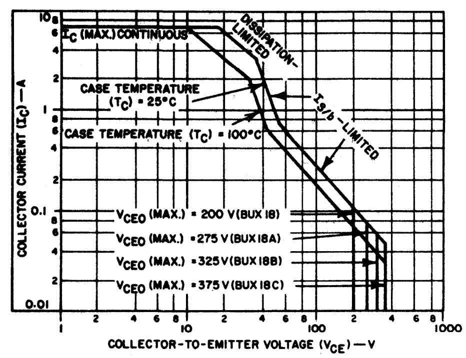


Fig. 2 — Maximum operating areas for all types at 25°C and 100°C.

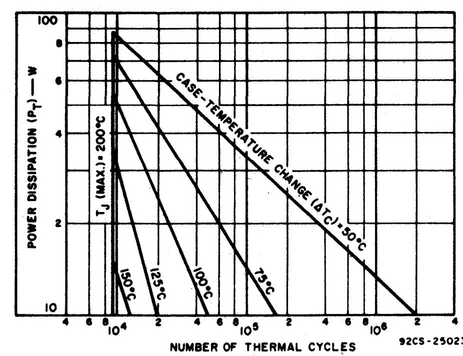


Fig. 3 — Thermal-cycling rating chart for all types.

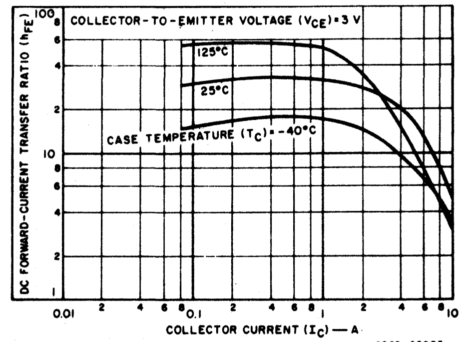


Fig. 4 — Typical dc beta characteristic for all types.

BUX18, BUX18A, BUX18B, BUX18C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified.*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BUX18		BUX18A		BUX18B		BUX18C		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	200				–	3	–	–	–	–	–	–	mA
		275				–	–	–	3	–	–	–	–	
		325				–	–	–	–	–	3	–	–	
		400				–	–	–	–	–	–	–	3	
With base-to-emitter junction reverse-biased	I_{CEV}	300	−1.5			–	0.5	–	–	–	–	–	–	
		450	−1.5			–	–	–	0.5	–	–	–	–	
		600	−1.5			–	–	–	–	–	0.5	–	–	
		750	−1.5			–	–	–	–	–	–	–	0.5	
With base-to-emitter junction reverse-biased, and T_C = 100°C		300	−1.5			–	10	–	–	–	–	–	–	
		450	−1.5			–	–	–	10	–	–	–	–	
		600	−1.5			–	–	–	–	–	10	–	–	
		750	−1.5			–	–	–	–	–	–	–	10	
Emitter Cutoff Current	I_{EBO}		−6	0		–	3	–	3	–	3	–	3	mA
Emitter Cutoff Voltage	V_{EBO}			0	0.003	6	–	6	–	6	–	6	–	V
DC Forward-Current Transfer Ratio	h_{FE}	3		4[a]		–	–	–	–	10	–	10	–	
		3		5[a]		–	–	7	–	–	–	–	–	
		3		6[a]		7	–	–	–	–	–	–	–	
		5		1[a]		15	100	15	100	15	100	15	100	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.2	0	200[b]	–	275[b]	–	325[b]	–	375[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$			0.2		250[b]	–	325[b]	–	375[b]	–	425[b]	–	
Forward-Biased Second-Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$	38				3.16	–	3.16	–	3.16	–	3.16	–	A
		200				0.1	–	0.1	–	0.1	–	0.1	–	
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			6[a]	1.2	–	2.5	–	–	–	–	–	–	V
				5[a]	1	–	–	–	2.5	–	–	–	–	
				4[a]	0.8	–	–	–	–	–	2.5	–	2.5	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			6[a]	1.2	–	1.5	–	–	–	–	–	–	V
				5[a]	1	–	–	–	1.5	–	–	–	–	
				4[a]	0.8	–	–	–	–	–	1.5	–	1.5	
Reverse-Bias Second-Breakdown Energy: R_{BE} = 3 kΩ, L = 40 µH	$E_{S/b}$		−1.5	3		180	–	180	–	180	–	180	–	mJ
Saturated Switching Time (I_{B1} = I_{B2}): Storage	t_s	V_{CC}= 200 V		4	0.8	–	2	–	2	–	2	–	2	µs
Fall	t_f	V_{CC} = 200 V		4	0.8	–	0.6	–	0.6	–	0.6	–	0.6	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.46	–	1.46	–	1.46	–	1.46	°C/W

[a] Pulsed, pulse duration = 300 µs, duty factor ≤ 2%.

[b] CAUTION: Sustaining Voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ MUST NOT be measured on a curve tracer.

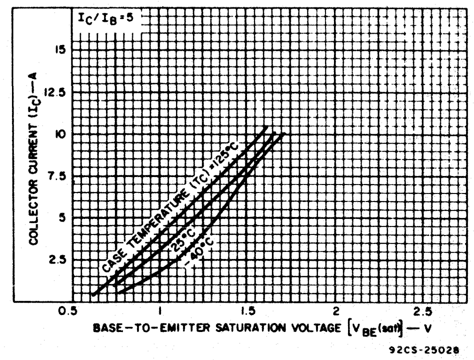


Fig. 5 — Typical collector-to-emitter saturation-voltage characteristics for all types.

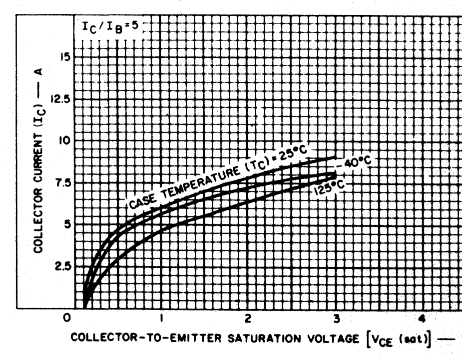


Fig. 6 — Typical base-to-emitter saturation-voltage characteristics for all types.

BUX66, BUX66A, BUX66B, BUX66C, BUX67, BUX67A, BUX67B, BUX67C
High-Voltage Silicon N-P-N and P-N-P Transistors

For High-Speed Switching and Linear-Amplifier Applications

The RCA-BUX66-series types are silicon p-n-p transistors; the RCA-BUX67-series types are silicon n-p-n transistors. All of these devices feature high breakdown voltage and fast switching speeds. They are intended for a wide variety of applications in ac/dc commercial equipment.

Typical applications include high-voltage operational and linear amplifiers, high-voltage switches, switching regulators, converters, and inverters.

The BUX66, BUX66A, BUX66B, and BUX66C are p-n-p complements to the n-p-n types BUX67, BUX67A, BUX67B, and BUX67C. All are supplied in the JEDEC TO-66 hermetic package.

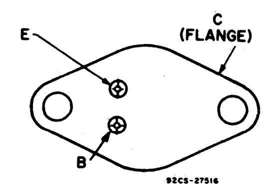
Features:
- **High voltage ratings:**
- **Large safe-operating area**
- **Thermal-cycling rating**
- **100-percent tested to assure freedom from second breakdown in both forward- and reverse-bias conditions when operated within specified limits**
- **Economy types for ac/dc circuits**
- **Fast turn-on time at high collector current**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX66♦ BUX67	BUX66A♦ BUX67A	BUX66B♦ BUX67B	BUX66C♦ BUX67C	
V_{CBO}	200	300	350	400	V
$V_{CEV}(sus)$ $V_{BE} = -1.5$ V	200	300	350	400	V
$V_{CER}(sus)$ $R_{BE} = 100\ \Omega$	175	275	325	375	V
$V_{CEO}(sus)$	150	250	300	350	V
V_{EBO}	6	6	6	6	V
I_C	2	2	2	2	A
I_{CM}	5	5	5	5	A
I_B	1	1	1	1	A
P_T Up to 25°C	35	35	35	35	W
Above 25°C, Derate linearly	0.2	0.2	0.2	0.2	W/°C
T_J, T_{stg}		−65 to 200			°C
T_L At distance 1/16 in. (1.58 mm) from seating plane for 10 s max.	235	235	235	235	°C

♦For p-n-p devices, voltage and current values are negative.

TERMINAL DESIGNATIONS



JEDEC TO-66

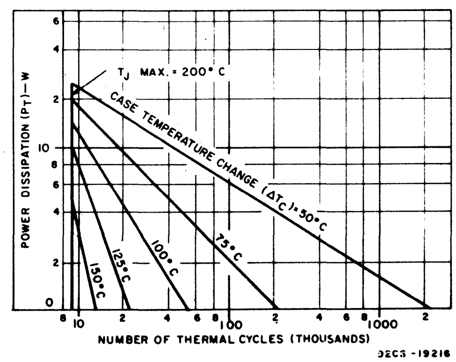


Fig. 1 — Thermal-cycling rating chart for BUX66-series types.

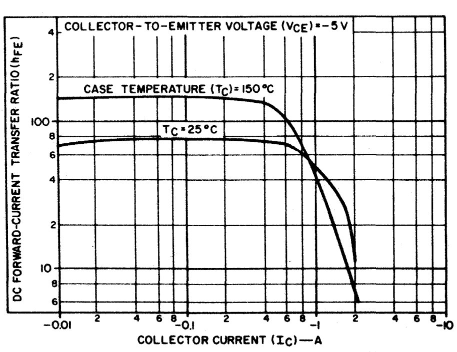


Fig. 2 — Typical dc beta characteristics for BUX66-series types.

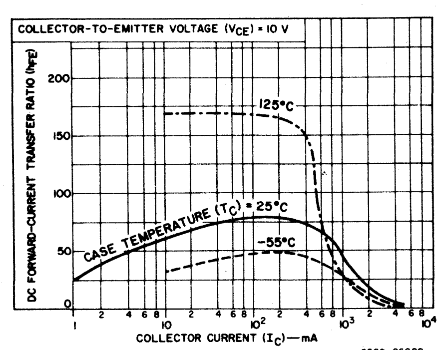


Fig. 3 — Typical dc beta characteristics for BUX67-series types.

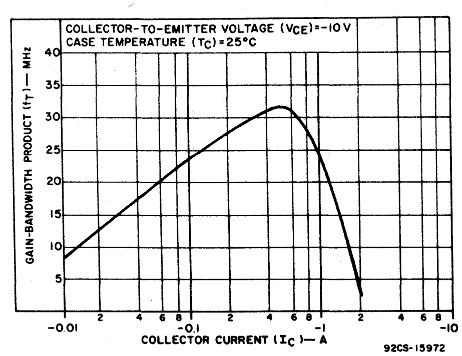


Fig. 4 — Typical gain-bandwidth product for BUX66-series types.

BUX66, BUX66A, BUX66B, BUX66C, BUX67, BUX67A, BUX67B, BUX67C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BUX66♦ BUX67 Min.	Max.	BUX66A♦ BUX67A Min.	Max.	BUX66B♦ BUX67B Min.	Max.	BUX66C♦ BUX67C Min.	Max.	UNITS
I_{CEO}	150			0	–	10	–	10	–	–5	–	–5	
I_{CEX}	200	–1.5			–	8	–	–	–	–	–	–	
	300	–1.5			–	–	–	8	–	–	–	–	
	350	–1.5			–	–	–	–	–	–8	–	–	
	400	–1.5			–	–	–	–	–	–	–	–8	mA
T_C = 100°C	200	–1.5			–	10	–	–					
	300	–1.5			–	–	–	10					
	350	–1.5			–	10	–	–	–	–10	–	–	
	400	–1.5			–	–	–	10	–	–	–	–10	
I_{EBO}		–6	0		–	1	–	1	–	1	–	1	mA
h_{FE}	5		1[a]		10	150	10	150	10	150	10	150	
$V_{CEO(sus)}$			0.2[a]	0	150[c]	–	250[c]	–	–300[c]	–	–350[c]	–	
$V_{CER(sus)}$ R_{BE} = 50 Ω			0.2		175[c]	–	275[c]	–	–325[c]	–	–375[c]	–	V
$V_{BE(sat)}$			1[a]	0.15	–	1.5	–	1.5	–	–1.5	–	–1.5	V
$V_{CE(sat)}$			1[a]	0.15	–	2.5	–	2.5	–	–2.5	–	–2.5	V
C_{obo} V_{CB} = 10 V f = 1 MHz BUX67 Types			0		–	120	–	120	–	220	–	220	pF
BUX66 Types			0		–	200	–	200	–	220	–	220	
$I_{S/b}$ t = 1 s, nonrep.	40				875	–	875	–	–875	–	–875	–	mA
$E_{S/b}$ L = 100 µH R_{BE} = 20 Ω		–4			50	–	200	–	200	–	50	–	µJ
$\lvert h_{fe} \rvert$ f = 5 MHz BUX67 Types	10		0.2		2	–	2	–	2	–	2	–	
BUX66 Types	–10		–0.2		4	–	4	–	4	–	4	–	
t_r V_{CC} = 200 V BUX67 Types			1	0.1[b]	–	3	–	3	–	3	–	3	
BUX66 Types			–1	–0.10[b]	–	0.6	–	0.6	–	0.6	–	0.6	
t_s V_{CC} = 200 V BUX67 Types			1	0.1[b]	–	4	–	4	–	4	–	4	µs
BUX66 Types			–1	–0.10[b]	–	2.5	–	2.5	–	2.5	–	2.5	
t_f V_{CC} = 200 V BUX67 Types			1	0.1[b]	–	3	–	3	–	3	–	3	
BUX66 Types			–1	–0.10[b]	–	0.6	–	0.6	–	0.6	–	0.6	
$R_{\theta JC}$						5	–	5	–	5	–	5	°C/W

[a] Pulsed: Pulse duration = 300 µs; duty factor ≤ 2%. [b] $I_{B1} = I_{B2}$ ♦For p-n-p devices, voltage and current values are negative.

[c] Sustaining voltages, $V_{CEO(sus)}$ and $V_{CER(sus)}$ MUST NOT be measured on a curve tracer.

BUX66, BUX66A, BUX66B, BUX66C, BUX67, BUX67A, BUX67B, BUX67C

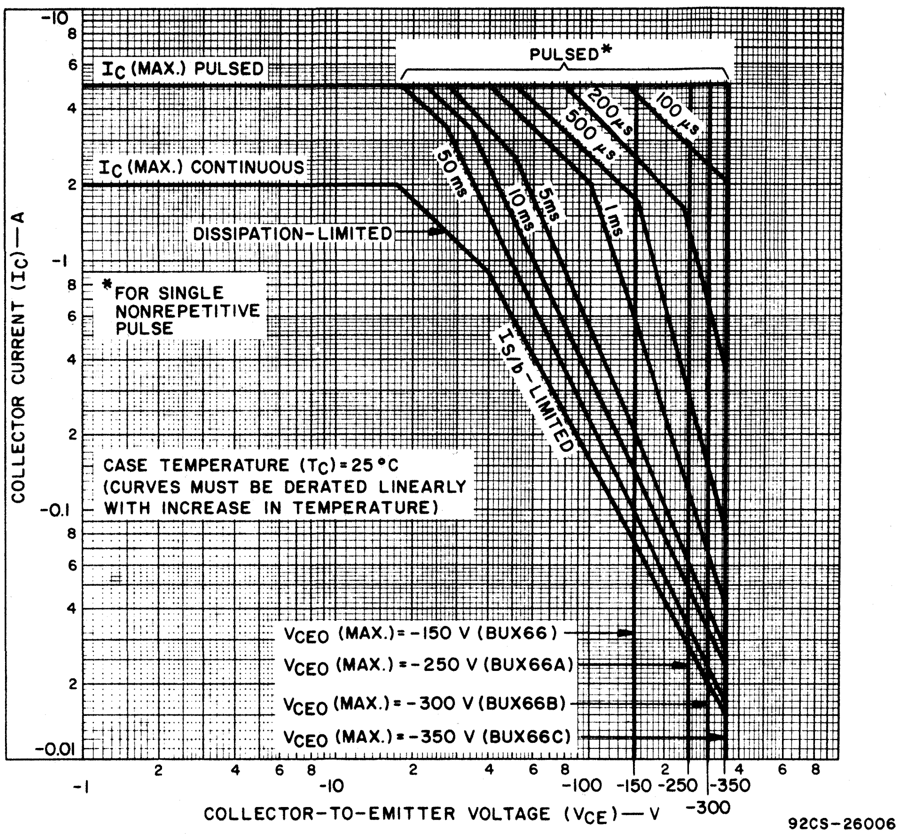


Fig. 5 — Maximum operating areas for BUX66-series types.

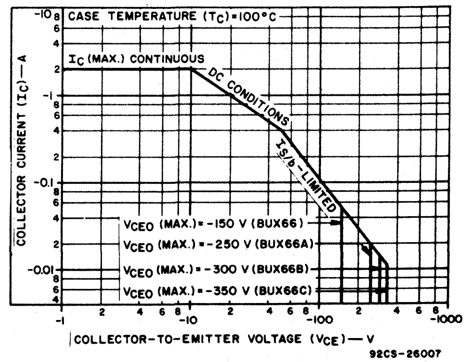


Fig. 7 — Maximum operating areas for BUX66-series at $T_C = 100°C$.

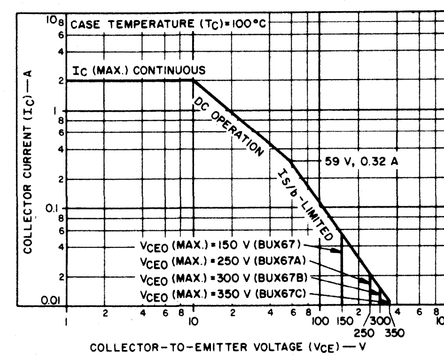


Fig. 8 — Maximum operating areas for BUX67-series at $T_C = 100°C$.

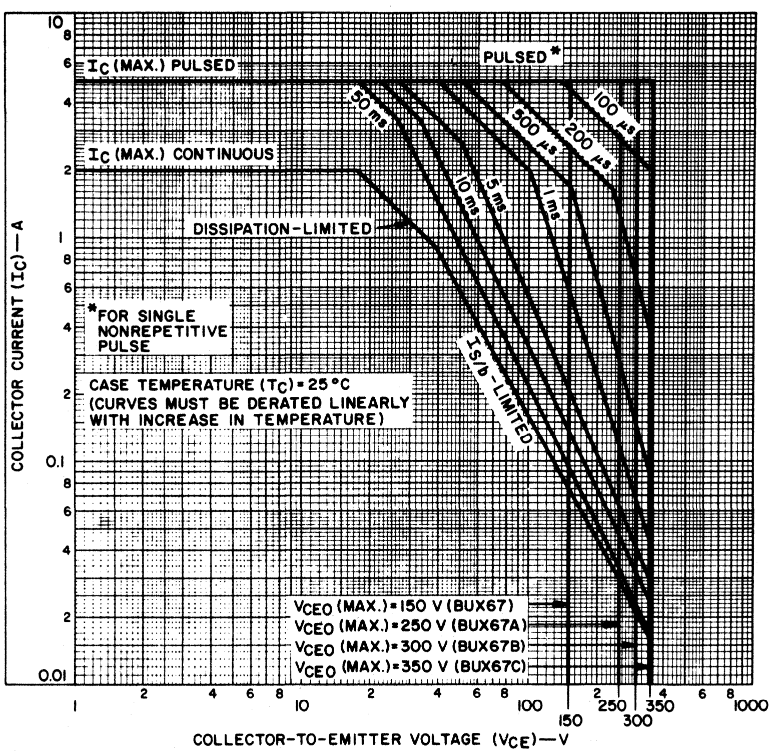


Fig. 6 — Maximum operating areas for BUX67-series types at $T_C = 25°C$.

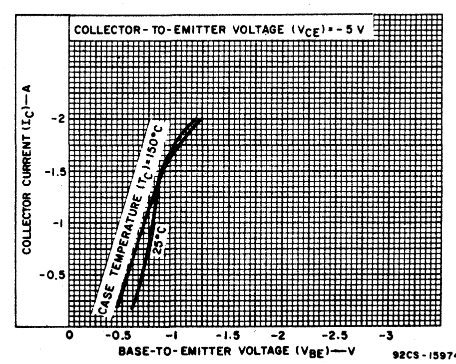


Fig. 9 — Typical transfer characteristics for BUX66-series types.

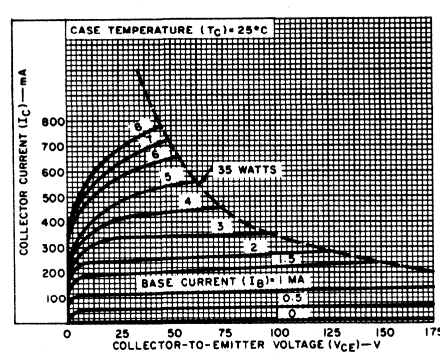


Fig. 10 — Typical output characteristics for BUX67-series types.

BUX66, BUX66A, BUX66B, BUX66C, BUX67, BUX67A, BUX67B, BUX67C

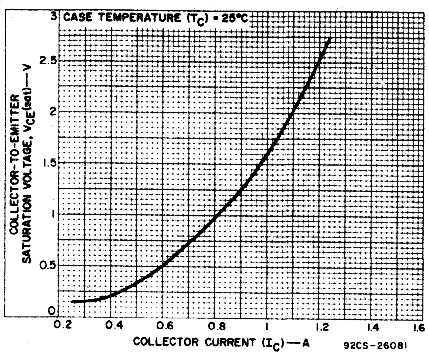


Fig. 11 — Typical saturation-voltage characteristic for BUX67-series types.

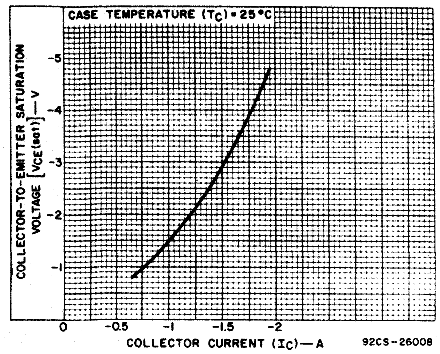


Fig. 12 — Typical saturation-voltage characteristic for BUX66-series types.

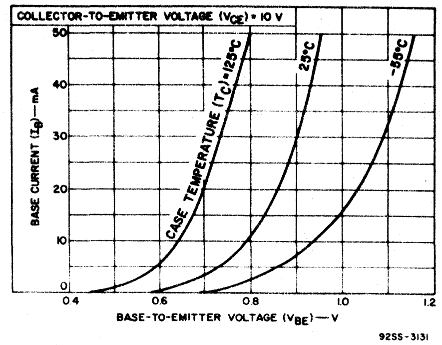


Fig. 13 — Typical input characteristics for BUX67-series types.

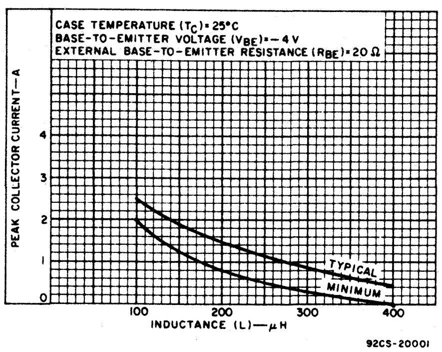


Fig. 14 — Reverse-bias second-breakdown characteristics for BUX67-series types.

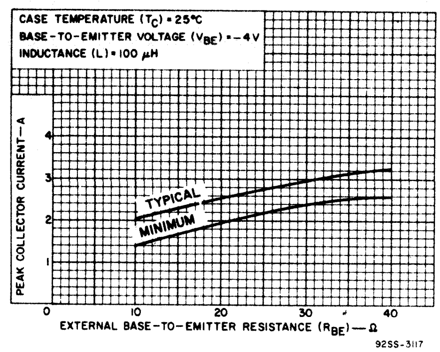


Fig. 15 — Reverse-bias second-breakdown characteristics for BUX67-series types.

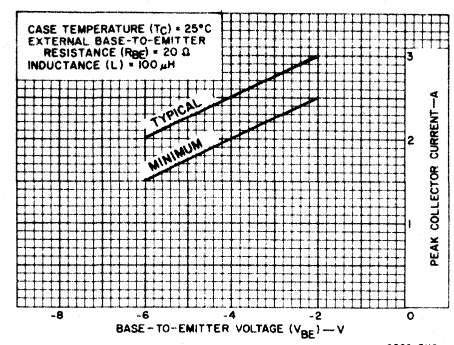


Fig. 16 — Reverse-bias second-breakdown characteristics for BUX67-series types.

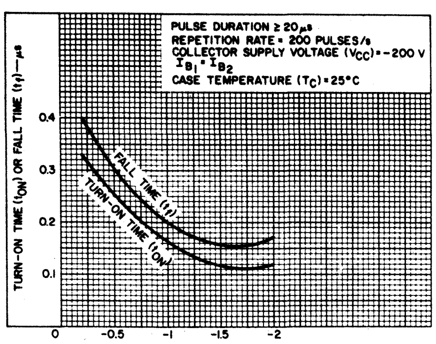


Fig. 17 — Typical turn-on time and fall-time characteristics for BUX66-series types.

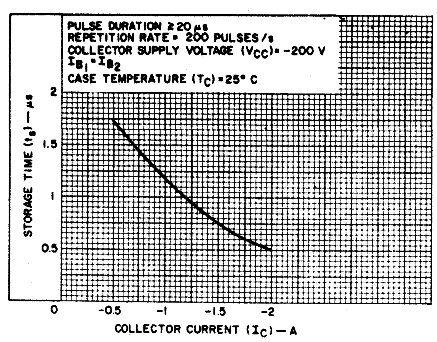


Fig. 18 — Typical storage-time characteristic for BUX66-series types.

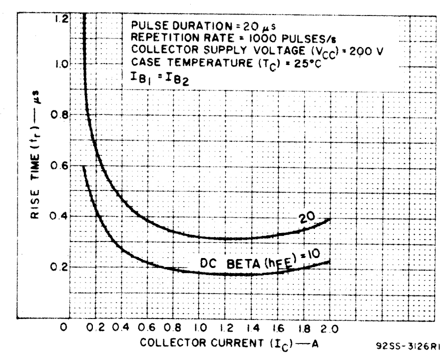


Fig. 19 — Typical rise time vs. collector current for BUX67-series types.

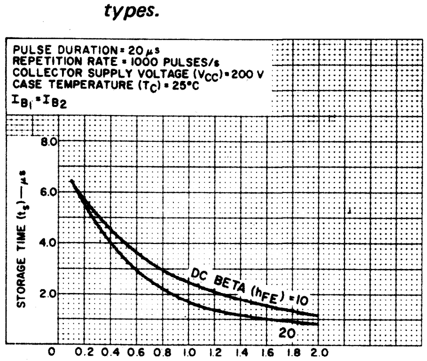


Fig. 20 — Typical storage time vs. collector current for BUX67-series types.

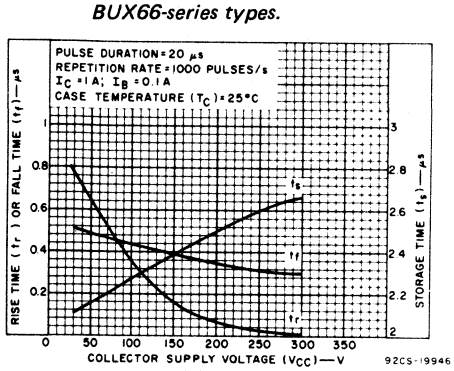


Fig. 21 — Typical rise time, fall time, and storage time vs. collector supply voltage for BUX67-series types.

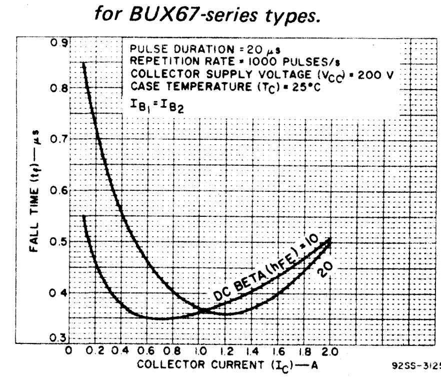


Fig. 22 — Typical fall time vs. collector current for BUX67-series types.

RCA8203, A, B; RCA125, RCA126

8- and 10-Ampere P-N-P Darlington Power Transistors

40-60-80 Volts, 65 Watts
Gain of 1000 at 5 A (RCA8203A, RCA8203B)
Gain of 1000 at 3 A (RCA8203, RCA125, RCA126)
Gain of 500 at −0.75 A (RCA125, RCA126)

Features:

- Operates from IC without predriver
- High reverse second-breakdown capability

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

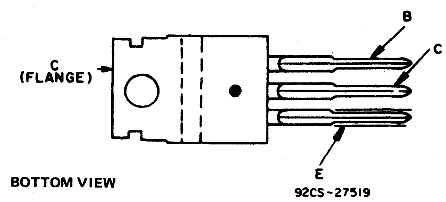
These RCA devices are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The RCA8203, RCA8203A and RCA 8203B are complementary to the 2N6386, 2N6387, and 2N6388. Technical data for 2N6386 — 2N6388 are given in RCA Bulletin File No. 610.

The RCA125 and RCA126 are p-n-p complements of the RCA120 and RCA-121 described in File No. 840.

These devices are supplied in the JEDEC TO-220AB straight-lead version of the VERSAWATT package. Optional lead configurations are available upon request. For information, contact your nearest RCA Sales Office.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

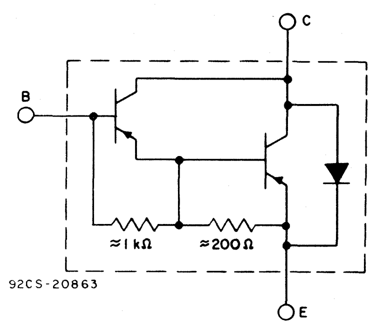


Fig. 1 — Schematic diagram for all types.

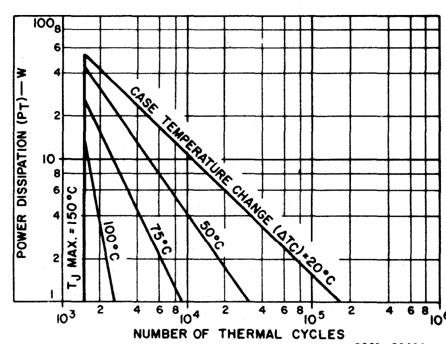


Fig. 2 - Thermal-cycling rating chart for all types.

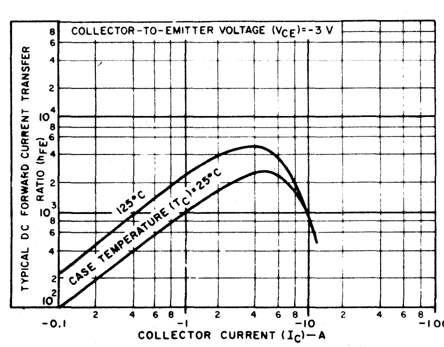


Fig. 3 - Typical dc beta characteristics for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA8203B	RCA8203A	RCA8203	RCA125	RCA126	
V_{CBO}	−80	−60	−40	−60	−80	V
$V_{CER}(sus)$						
R_{BE} = 100 Ω	−80	−60	−40	–	–	V
$V_{CEO}(sus)$	−80	−60	−40	−60	−80	V
$V_{CEV}(sus)$						
V_{BE} = −1.5 V	−80	−60	−40	–	–	V
V_{EBO}	−5	−5	−5	−5	−5	V
I_C	−10	−10	−8	−8	−8	A
I_{CM}	−15	−15	−15	−15	−15	A
I_B	−0.25	−0.25	−0.25	−0.25	−0.25	A
P_T						
$T_C \leq 25°C$	65	65	65	65	65	W
$T_C > 25°C$	Derate linearly to 150°C					
T_{stg}, T_J	−65 to +150					°C
T_L						
At distance ≥ 1/8 in. (3.17 mm) from case for 20 s max.	235					°C

RCA8203, A, B; RCA125, RCA126

ELECTRICAL CHARACTERISTICS, *At Case Temperature, T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS RCA8203B		RCA8203A		RCA8203		RCA125		RCA126		UNITS
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}	–80			0	–	–1	–	–	–	–	–	–	–	–	
	–60			0	–	–	–	–1	–	–	–	–	–	–	
	–40			0	–	–	–	–	–	–1	–	–	–	–0.5	
	–30			0	–	–	–	–	–	–	–	–0.5	–	–	mA
I_{CEV}	–80	1.5			–	–0.3	–	–	–	–	–	–	–	–	
	–60	1.5			–	–	–	–0.3	–	–	–	–	–	–	
	–40	1.5			–	–	–	–	–	–0.3	–	–	–	–	
T_C = 125°C	–80	1.5			–	–3	–	–	–	–	–	–	–	–	
	–60	1.5			–	–	–	–3	–	–	–	–	–	–	
	–40	1.5			–	–	–	–	–	–3	–	–	–	–	
I_{EBO}		5	0		–	–10	–	–10	–	–10	–	–10	–	–10	mA
V_{CEO}(sus)			–0.05		–	–	–	–	–	–	–60	–	–80	–	
			–0.2[a]	0	–80	–	–60	–	–40	–	–	–	–	–	
V_{CER}(sus) R_{BE} = 100 Ω			–0.2[a]		–80	–	–60	–	–40	–	–	–	–	–	V
V_{CEV}(sus		1.5	–0.2[a]		–80	–	–60	–	–40	–	–	–	–	–	
h_{FE}	–3		–0.75[a]		–	–	–	–	–	–	500	–	500	–	
	–3		–3[a]		–	–	–	–	1000	20,000	1000	–	1000	–	
	–3		–5[a]		1000	20,000	1000	20,000	–	–	–	–	–	–	
	–3		–8[a]		–	–	–	–	100	–	–	–	–	–	
	–3		–10[a]		100	–	100	–	–	–	–	–	–	–	
V_{BE}	–3		–3[a]		–	–	–	–	–	–2.8	–	–2.5	–	–2.5	
	–3		–5[a]		–	–2.8	–	–2.8	–	–	–	–	–	–	V
	–3		–8[a]		–	–	–	–	–	–4.5	–	–	–	–	
	–3		–10[a]		–	–4.5	–	–4.5	–	–	–	–	–	–	
V_{CE}(sat)			–3[a]	–0.006[a]	–	–	–	–	–	–2	–	–	–	–	
			–3[a]	–0.012[a]	–	–	–	–	–	–	–	–2	–	–2	
			–5[a]	–0.01[a]	–	–2	–	–2	–	–	–	–	–	–	
			–5[a]	–0.02[a]	–	–	–	–	–	–	–	–4	–	–4	V
			–8[a]	–0.08[a]	–	–	–	–	–	–3	–	–	–	–	
			–10[a]	–0.1[a]	–	–3	–	–3	–	–	–	–	–	–	
V_F			8[a]		–	–	–	–	–	4	–	–	–	–	V
			10[a]		–	4	–	4	–	–	–	–	–	–	
h_{fe} f = 1 kHz	–5		–1		1000	–	1000	–	1000	–	1000	–	1000	–	
$\|h_{fe}\|$ f = 1 MHz	–5		–1		20	–	20	–	20	–	20	–	20	–	
$E_{s/b}$ L = 3 mH, R_{BE} = 100 Ω		1.5	–4.5		30	–	30	–	30	–	–	–	–	–	mJ
$I_{S/b}$ t = 1 s nonrep.	–20				–3.2	–	–3.2	–	–3.2	–	–3.2	–	–3.2	–	A
t_{ON} R_L = 20 Ω V_{CC} = –20 V			–3	I_{B1} = –0.012 I_{B2} = 0.012							1 (typ.)		1 (typ.)		µs
t_{OFF} R_L = 20 Ω V_{CC} = –20 V			–3	I_{B1} = –0.012 I_{B2} = 0.012							3 (typ.)		3 (typ.)		
$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	–	1.92	–	1.92	°C/W

[a] Pulsed: Pulse duration = 300 µs, duty factor ⩽2%.

RCA8203, A, B; RCA125, RCA126

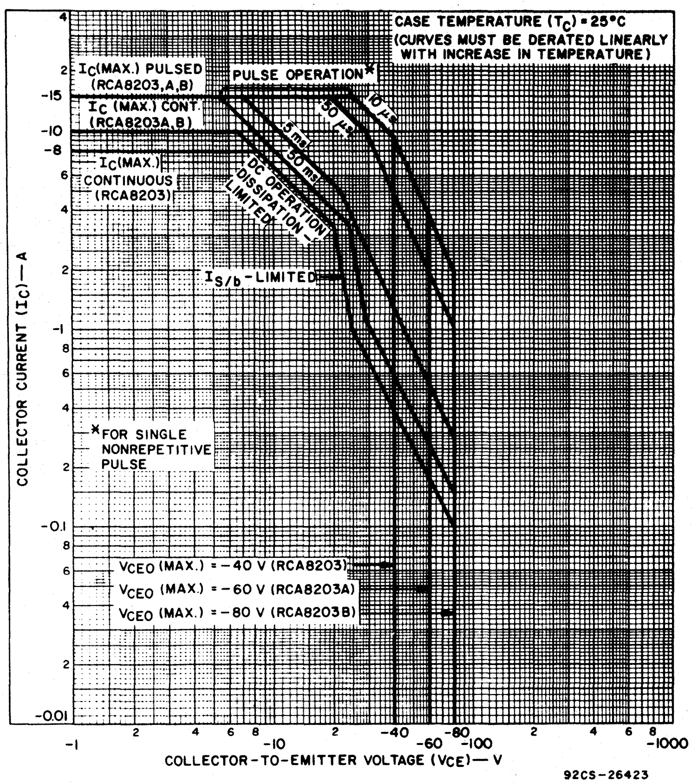


Fig. 4 - Maximum operating areas for RCA8203, RCA8203A, RCA8203B.

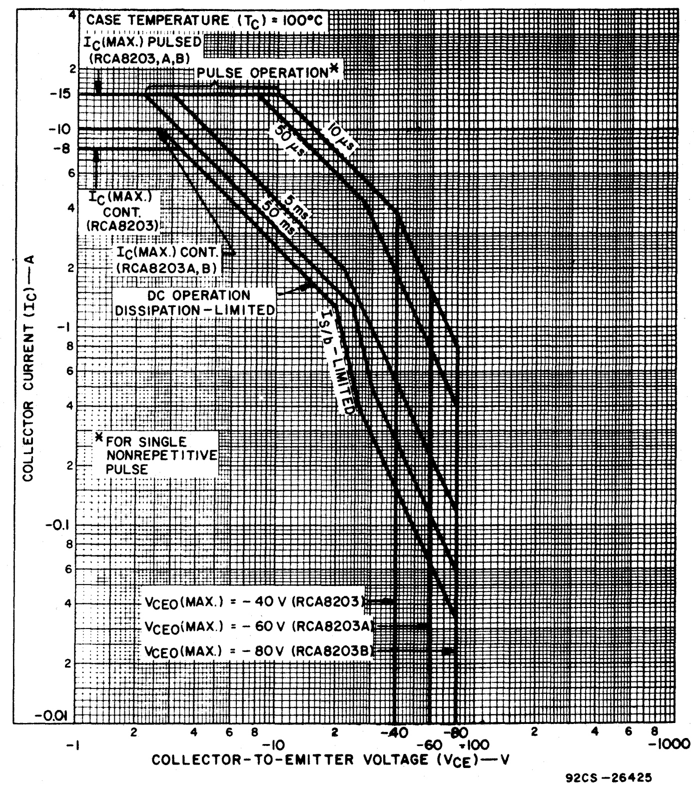


Fig. 5 - Maximum operating areas for RCA8203, RCA8203A, RCA8203B at $T_C = 100^oC$.

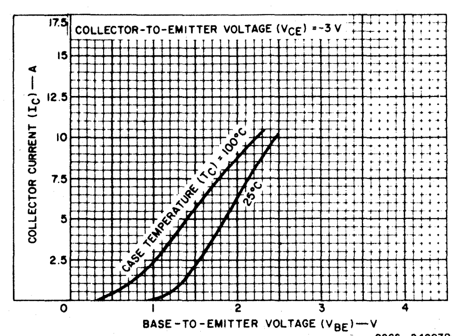


Fig. 7 - Typical transfer characteristics for RCA8203, RCA8203A, RCA8203B.

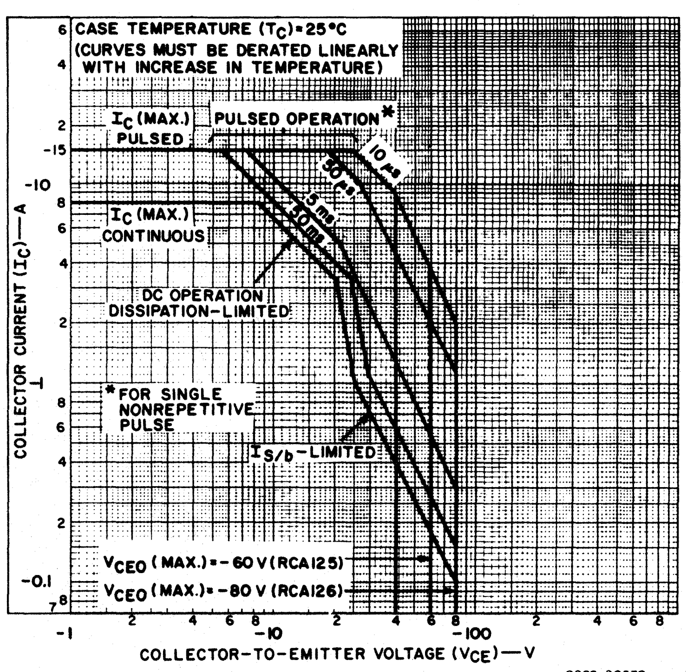


Fig. 6 - Maximum operating areas for RCA125, RCA126.

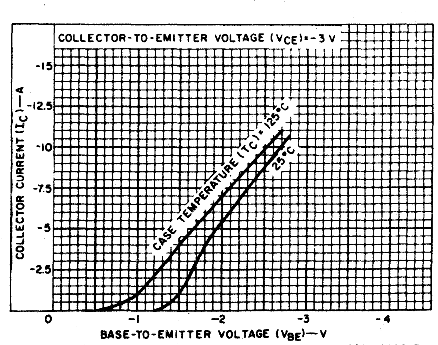


Fig. 8 - Typical transfer characteristics for RCA125, RCA126.

RCA8203, A, B; RCA125, RCA126

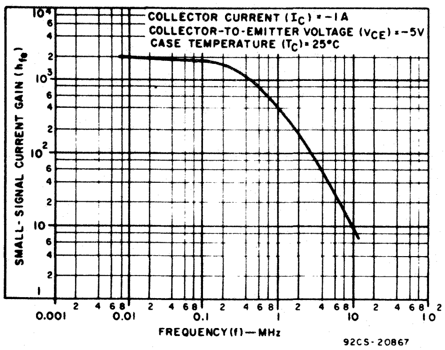


Fig. 9 - Typical small-signal gain for all types.

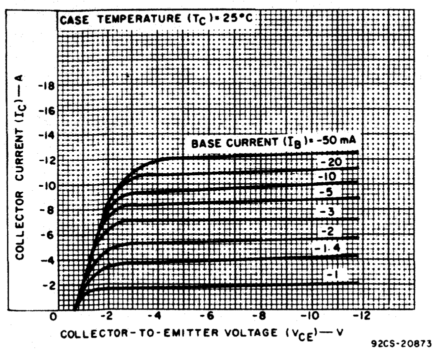


Fig. 10 - Typical output characteristics for all types.

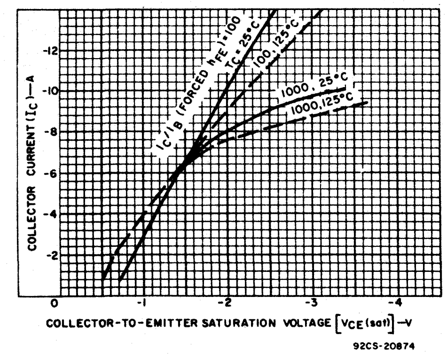


Fig. 11 - Typical saturation characteristics for RCA8203, RCA8203A, RCA8203B.

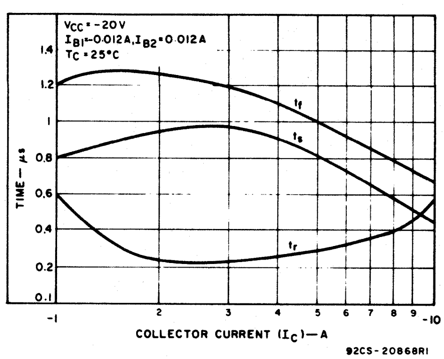


Fig. 12 - Typical saturated switching-time characteristics for all types.

RCA8350, A, B
10-Ampere P-N-P Darlington Power Transistors

40-60-80 Volts, 70 Watts
Gain of 1000 at 5 A

The RCA8350, RCA8350A and RCA8350B● are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. They are complementary to the 2N6383, 2N6384, and 2N6385.

● Formerly RCA Dev. Nos. TA8351, TA8488, and TA8350, respectively.

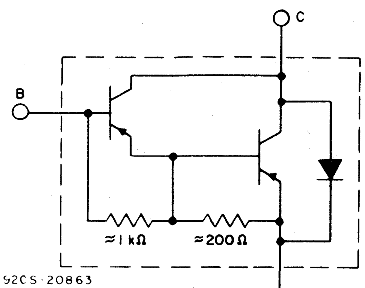


Fig. 1 — Schematic diagram for all types.

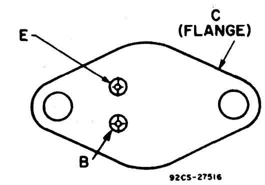
Features:

- Operates from IC without predriver
- High reverse second-breakdown capability

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA8350B	RCA8350A	RCA8350	
V_{CBO}	−80	−60	−40	V
$V_{CER}(sus)$				
R_{BE} = 100 Ω	−80	−60	−40	V
$V_{CEO}(sus)$	−80	−60	−40	V
$V_{CEV}(sus)$				
V_{BE} = −1.5 V	−80	−60	−40	V
V_{EBO}	−5	−5	−5	V
I_C	−10	−10	−10	A
I_{CM}	−15	−15	−15	A
I_B	−0.25	−0.25	−0.25	A
P_T				
$T_C \leq 25^oC$	70	70	70	W
$T_C > 25^oC$	Derate linearly to 150 °C			
T_{stg}, T_J	−65 to +150			°C
T_L				
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235			°C

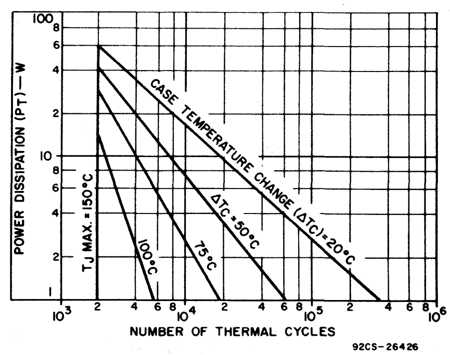


Fig. 2 - Thermal-cycling rating chart for all types.

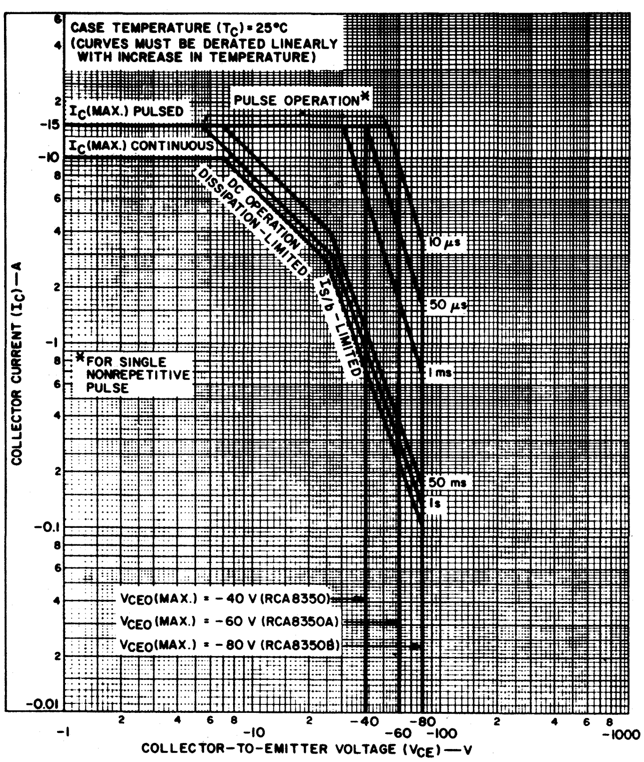


Fig. 3 - Maximum operating areas for all types.

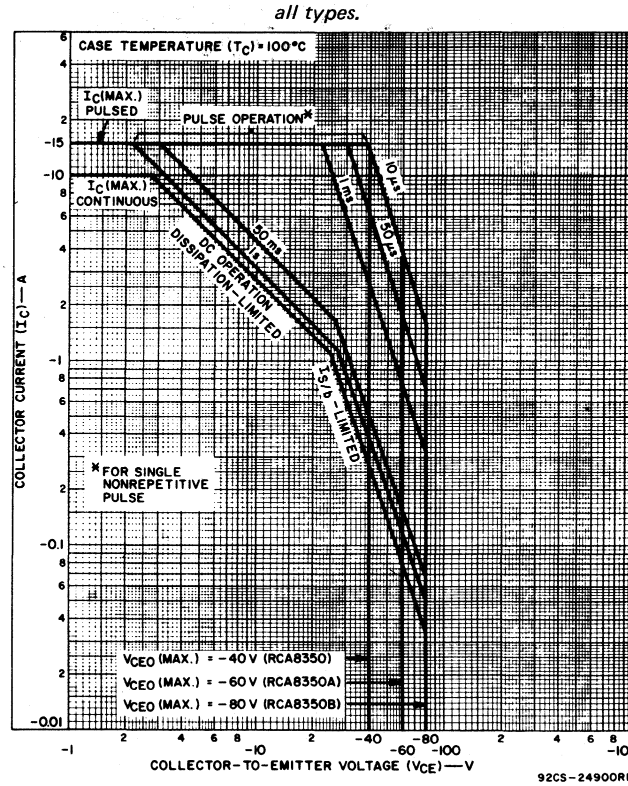


Fig. 4 - Maximum operating areas for all types at $T_C = 100^oC$.

RCA8350, A, B

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS RCA8350B MIN.	MAX.	RCA8350A MIN.	MAX.	RCA8350 MIN.	MAX.	UNITS
I_{CEO}	−80 −60 −40			0 0 0	– – –	−1 – –	– – –	– −1 –	– – –	– – −1	mA
I_{CEV}	−80 −60 −40	1.5 1.5 1.5			– – –	−0.3 – –	– – –	– −0.3 –	– – –	– – −0.3	
T_C = 150°C	−80 −60 −40	1.5 1.5 1.5			– – –	−3 – –	– – –	– −3 –	– – –	– – −3	
I_{EBO}		5	0		–	−10	–	−10	–	−10	mA
V_{CEO}(sus)			−0.2[a]	0	−80	–	−60	–	−40	–	
V_{CER}(sus) R_{BE} = 100 Ω			−0.2[a]		−80	–	−60	–	−40	–	V
V_{CEV}(sus)		1.5	−0.2[a]		−80	–	−60	–	−40	–	
h_{FE}	−3 −3		−5[a] −10[a]		1000 100	20,000 –	1000 100	20,000 –	1000 100	20,000 –	
V_{BE}	−3 −3		−5[a] −10[a]		– –	−2.8 −4.5	– –	−2.8 −4.5	– –	−2.8 −4.5	V
V_{CE}(sat)			−5[a] −10[a]	−0.01[a] −0.1[a]	– –	−2 −3	– –	−2 −3	– –	−2 −3	V
V_F			10[a]		–	4	–	4	–	4	V
h_{fe} f = 1 kHz	−5		−1		1000	–	1000	–	1000	–	
$\|h_{fe}\|$ f = 1 MHz	−5		−1		20	–	20	–	20	–	
$E_{S/b}$ L = 3 mH, R_{BE} = 100 Ω		1.5	−4.5		30	–	30	–	30	–	mJ
$I_{S/b}$ t = 1 s, nonrep.	−35 −25				−1 −2.8	– –	−1 −2.8	– –	−1 −2.8	– –	A
$R_{\theta JC}$					–	1.75	–	1.75	–	1.75	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

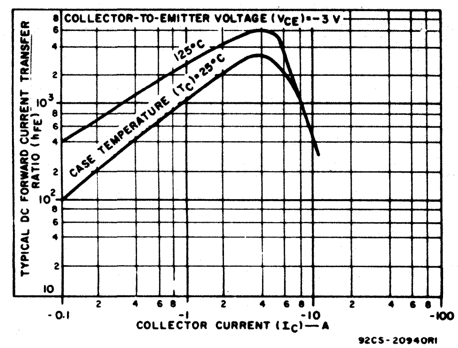


Fig. 5 - Typical dc beta characteristics for all types.

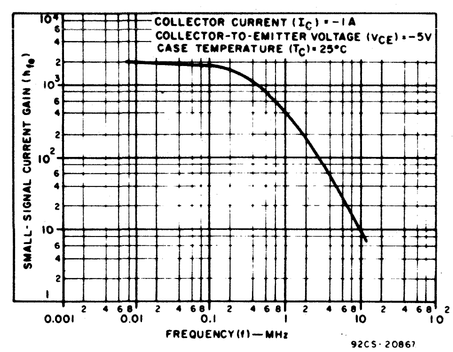


Fig. 6 - Typical small-signal gain for all types.

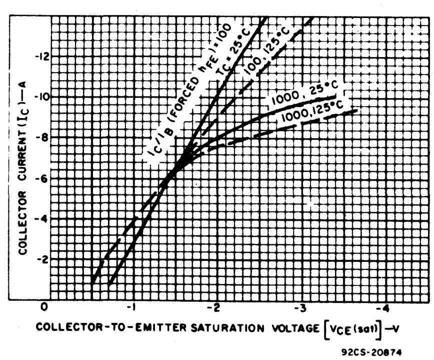


Fig. 7 - Typical saturation characteristics for all types.

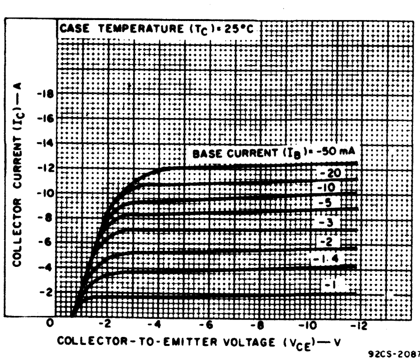


Fig. 8 - Typical output characteristics for all types.

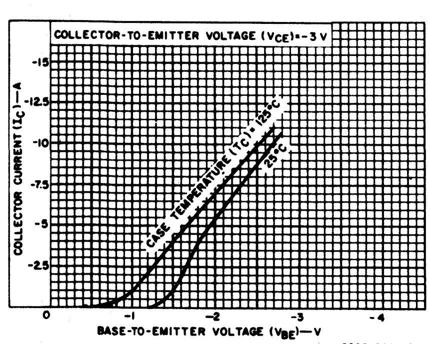


Fig. 9 - Typical transfer characteristics for all types.

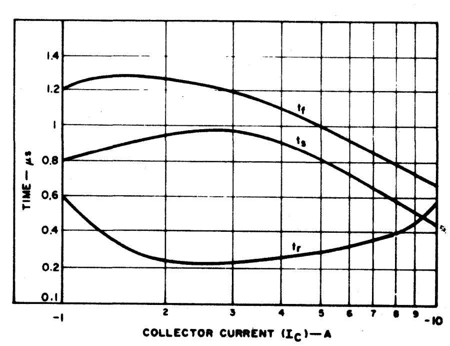


Fig. 10 - Typical saturated switching-time characteristics for all types.

RCP111, RCP113, RCP115, RCP117 Series

High-Voltage, Medium-Power Silicon N-P-N Power Transistors

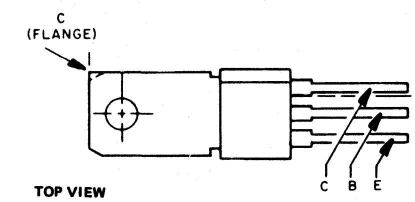
For TV Video Output and Linear-Amplifier Applications

Features:

- Thermal-cycling ratings
- Maximum safe-area-of-operation curves
- High gain-bandwidth product: f_T = 80 MHz typ.

The RCP111-, RCP113, RCP115-, and RCP117-series power transistors are double-diffused, epitaxial-collector silicon n-p-n transistors with planar junctions and field-shield construction. These transistors are designed especially for TV applications such as RGB output, chroma output, and video output. They are also suitable for use in regulators, audio output and amplifier circuits, and electrostatic deflection in display circuits. The devices are supplied in the JEDEC TO-202AB VERSATAB molded plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-202AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		RCP111D RCP113D	RCP111C RCP113C	RCP111B RCP113B	RCP111A RCP113A	RCP115B RCP117B	RCP115 RCP117	
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:								
With base open	$V_{CEO}(sus)$	350	300	250	200	250	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	7	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	150	150	150	150	150	150	mA
CONTINUOUS BASE CURRENT	I_B	50	50	50	50	50	50	mA
TRANSISTOR DISSIPATION:	P_T							
At case temperatures up to 25°C		6.25	6.25	6.25	6.25	6.25	6.25	W
At ambient temperatures up to 25°C		1.56	1.56	1.56	1.56	1.56	1.56	W
For pulse operation		See Fig. 3						
TEMPERATURE RANGE:								
Storage & Operating (Junction)		−65 to 150						°C
LEAD TEMPERATURE (During Soldering):								
At distances ≥ 1/16 in. (1.39 mm) from case for 10 s max.		230						°C

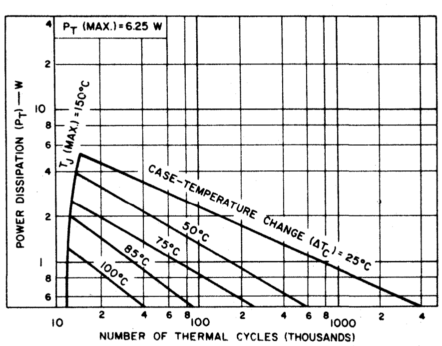


Fig. 1 — Thermal-cycling rating chart for all types.

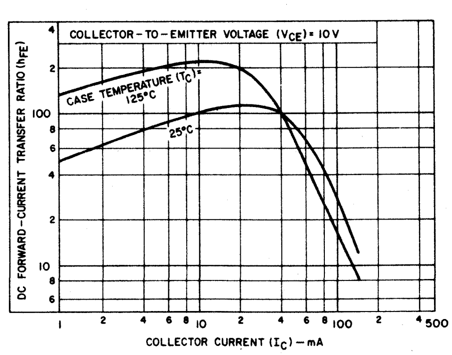


Fig. 2 — Typical dc beta characteristics for all types.

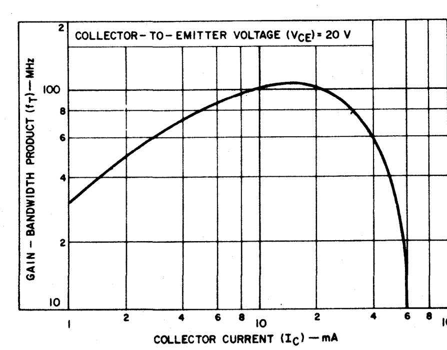


Fig. 3 — Typical gain-bandwidth product for all types.

RCP111, RCP113, RCP115, RCP117 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature, T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc			CURRENT mA dc		LIMITS RCP111A RCP113A		RCP111B RCP113B		RCP111C RCP113C		RCP111D RCP113D		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CBO}	350					–	–	–	–	–	–	–	1	μA
	300					–	–	–	–	–	1	–	–	
	250					–	–	–	1	–	–	–	–	
	200					–	1	–	–	–	–	–	–	
I_{CEO}		250			0	–	–	–	–	–	–	–	5	μA
		200			0	–	–	–	–	–	5	–	–	
		175			0	–	–	–	5	–	–	–	–	
		150			0	–	5	–	–	–	–	–	–	
I_{EBO}			6	0		–	10	–	10	–	10	–	10	μA
h_{FE}		10		25[a]		50	300	50	300	50	300	50	300	
RCP111 Series		10		1[a]		25	–	25	–	25	–	25	–	
RCP113 Series		10		25[a]		30	150	30	150	30	150	30	150	
		10		1[a]		15	–	15	–	15	–	15	–	
$V_{CEO}(sus)$[b]				20[a]	0	200	–	250	–	300	–	350	–	V
V_{BE}		10		25[a]		–	0.8	–	0.8	–	0.8	–	0.8	V
$V_{(BR)EBO}$ (I_E = 1 mA)				0		7	–	7	–	7	–	7	–	V
$V_{CE}(sat)$				25[a]	2.5	–	1	–	1	–	1	–	1	V
$\|h_{fe}\|$ (f = 20 MHz)		20		15		4 (typ.)		(4 typ.)		4 (typ.)		4 (typ.)		
f_T		20		15		80 (typ.)		80 (typ.)		80 (typ.)		80 (typ.)		MHz
$I_{S/b}$ (t = 0.05 s)		100				100	–	100	–	100	–	100	–	mA
C_{cb} (I_E = 0)	20			25		–	2.25	–	2.25	–	2.25	–	2.25	pF
$R_{\theta JC}$						–	20	–	20	–	20	–	20	°C/W
$R_{\theta JA}$						–	80	–	80	–	80	–	80	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽2%.

[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.

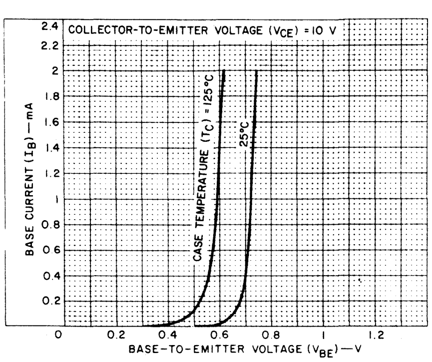


Fig. 4 — Typical input characteristics for all types.

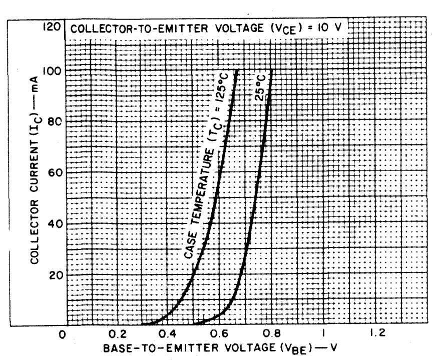


Fig. 5 — Typical transfer characteristics for all types.

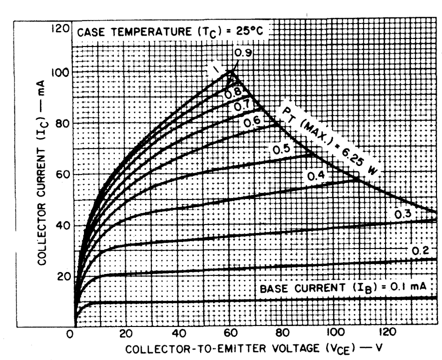


Fig. 6 — Typical output characteristics for all types.

RCP111, RCP113, RCP115, RCP117 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature, T_C = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT mA dc I_C	I_B	LIMITS: RCP115A MIN.	MAX.	RCP115B MIN.	MAX.	RCP117A MIN.	MAX.	RCP117B MIN.	MAX.	UNITS
I_{CBO}	250					–	–	–	50	–	–	–	50	µA
	100					–	50	–	–	–	50	–	–	
I_{CEO}		175			0	–	–	–	100	–	–	–	100	µA
		70			0	–	100	–	–	–	100	–	–	
h_{FE}		10		25[a]		50	–	50	–	20	–	20	–	
		10		1[a]		10	–	10	–	10	–	10	–	
$V_{CEO}(sus)$[b]				20[a]	0	100	–	250	–	100	–	250	–	V
V_{BE}		10		25[a]		–	1.5	–	1.5	–	1.5	–	1.5	V
$V_{(BR)EBO}$ (I_E = 1 mA)				0		5	–	5	–	5	–	5	–	V
$V_{CE}(sat)$				25[a]	5	–	2	–	2	–	2	–	2	V
$\|h_{fe}\|$ (f = 20 MHz)		20		15		4 (typ.)		4 (typ.)		4 (typ.)		4 (typ.)		
f_T		20		15		80 (typ.)		80 (typ.)		80 (typ.)		80 (typ.)		MHz
$I_{S/b}$ (t = 0.05 s)		75				130	–	130	–	130	–	130	–	mA
C_{cb} (I_E = 0)		20		25		–	2.25	–	2.25	–	2.25	–	2.25	pF
$R_{\theta JC}$						–	20	–	20	–	20	–	20	°C/W
$R_{\theta JA}$						–	80	–	80	–	80	–	80	°C/W

[a] Pulsed, pulse duration = 300 µs, duty factor ≤2%.

[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.

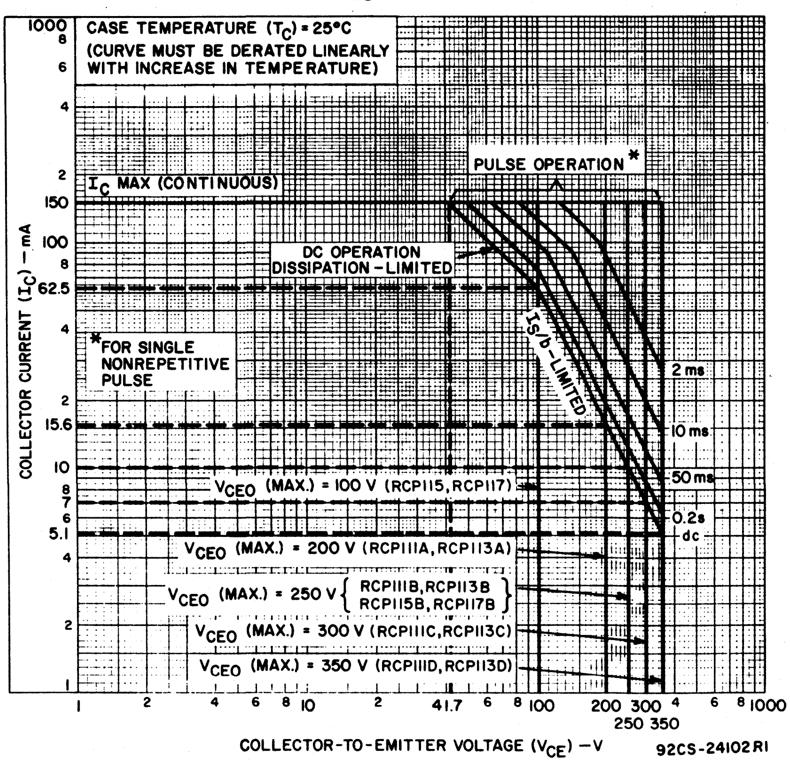


Fig. 7 — Maximum operating areas for all types.

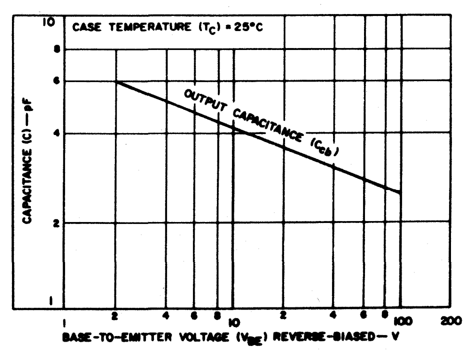


Fig. 8 — Typical junction capacitance vs. reverse-bias base-to-emitter voltage.

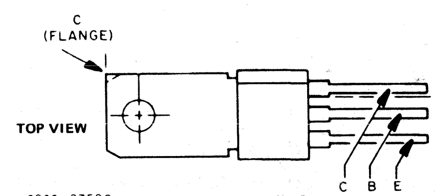
RCP131, RCP133, RCP135, RCP137 Series
High-Voltage, Medium-Power Silicon N-P-N Power Transistors

For TV Video Output, Horizontal Driver, and Linear-Amplifier Applications

Features:
- Thermal-cycling ratings
- Maximum safe-area-of-operation curves
- High gain-bandwidth product: f_T = 30 MHz min.

The RCP131-, RCP133-, RCP135-, and RCP137-series devices are double-diffused, epitaxial-collector silicon n-p-n power transistors with planar junctions and field-shield construction. These transistors are designed especially for TV applications such as horizontal driver, chroma output, and video output. They are also suitable for use in regulators, audio output and amplifier circuits, and electrostatic deflection in display circuits. The devices are supplied in the VERSATAB JEDEC TO-202AB, plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCP131A RCP133A	RCP131B RCP133B	RCP131C RCP133C	RCP131D RCP133D	RCP135 RCP137	RCP135B RCP137B	
V_{CEO}(sus)	200	250	300	350	100	250	V
V_{EBO}	7	7	7	7	5	5	V
I_C	1	1	1	1	1	1	A
I_B	0.5	0.5	0.5	0.5	0.5	0.5	A
P_T:							
$T_C \leq 25°C$	10	10	10	10	10	10	W
$T_A \leq 25°C$	1.75	1.75	1.75	1.75	1.75	1.75	W
For pulse operation	See Fig. 1						
T_{stg}, T_J	−65 to 150						°C
T_L: During soldering at distance ≥ 1/16 in. (1.39 mm) from case for 10 s max.	230						°C

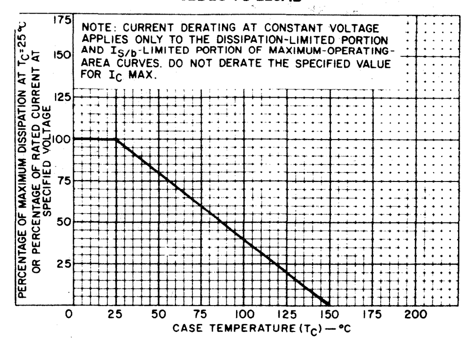


Fig. 2—Dissipation derating curve at case temperature for all types.

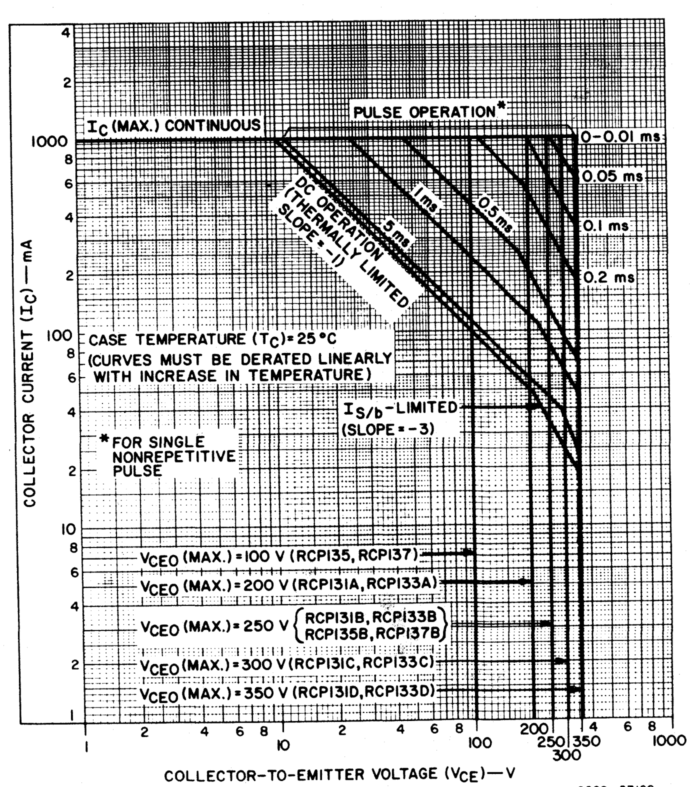


Fig. 1—Maximum operating areas for all types.

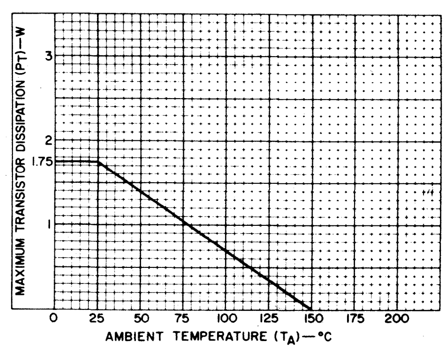


Fig. 3—Dissipation derating curve at ambient temperature for all types.

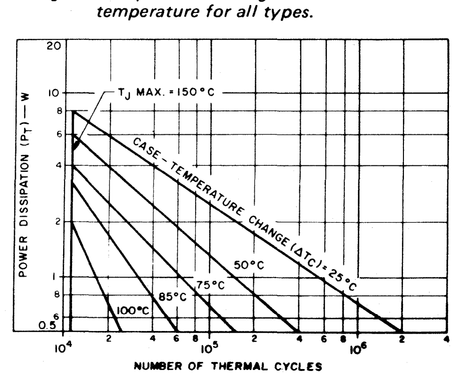


Fig. 4—Thermal-cycling rating chart for all types.

RCP131, RCP133, RCP135, RCP137 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc			CURRENT mA dc		LIMITS: RCP131A, RCP133A, RCP131C, RCP133C, RCP135, RCP137		LIMITS: RCP131B, RCP133B, RCP131D, RCP133D, RCP135B, RCP137B		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO} (I_E = 0)										
RCP131A, RCP133A	200					–	5	–	–	μA
RCP131B, RCP133B	250					–	–	–	5	μA
RCP131C, RCP133C	300					–	5	–	–	μA
RCP131D, RCP133D	350					–	–	–	5	μA
RCP135, RCP137	100					–	50	–	–	μA
RCP135B, RCP137B	250					–	–	–	50	μA
I_{CEO}										
RCP131A, RCP133A		150			0	–	10	–	–	μA
RCP131B, RCP133B		175			0	–	–	–	10	μA
RCP131C, RCP133C		200			0	–	10	–	–	μA
RCP131D, RCP133D		250			0	–	–	–	10	μA
RCP135, RCP137		70			0	–	100	–	–	μA
RCP135B, RCP137B		175			0	–	–	–	100	μA
I_{EBO} (RCP131, RCP133-series only)			–6	0		–	10	–	10	μA
h_{FE}										
RCP131-series		10		50[a]		50	300	50	300	
RCP133-series		10		50[a]		30	150	30	150	
RCP135-series		10		50[a]		50	–	50	–	
RCP137-series		10		50[a]		20	–	20	–	
V_{CEO}(sus)										
RCP131A, RCP133A				20[a]	0	200[b]	–	–	–	V
RCP131B, RCP133B				20[a]	0	–	–	250[b]	–	V
RCP131C, RCP133C				20[a]	0	300[b]	–	–	–	V
RCP131D, RCP133D				20[a]	0	–	–	350[b]	–	V
RCP135, RCP137				20[a]	0	100[b]	–	–	–	V
RCP135B, RCP137B				20[a]	0	–	–	250[b]	–	V
V_{BE}										
RCP131, RCP133-series		10		50[a]		–	1	–	1	V
RCP135, RCP137-series		10		50[a]		–	1.5	–	1.5	V
$V_{(BR)EBO}$ (I_E = 1 mA)										
RCP131, RCP133-series				0		7	–	7	–	V
RCP135, RCP137-series				0		5	–	5	–	V
V_{CE}(sat)										
RCP131, RCP133-series				50[a]	5	–	1	–	1	V
RCP135, RCP137-series				50[a]	5	–	5	–	5	V
$\lvert h_{fe} \rvert$ (f = 3 MHz)		20		20		10	–	10	–	
f_T		20		20		30	–	30	–	MHz
$I_{S/b}$ (t = 0.4 s)		100				100	–	100	–	mA
C_{ob} (f = 1 MHz)		20				–	8	–	8	pF
$R_{\theta JC}$						–	12.5	–	12.5	°C/W
$R_{\theta JA}$						–	71.4	–	71.4	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

[b] CAUTION: Sustaining voltage, V_{CEO}(sus), MUST NOT be measured on a curve tracer.

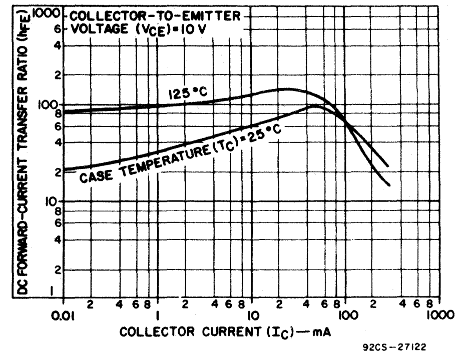


Fig. 5 - Typical dc beta characteristics for all types.

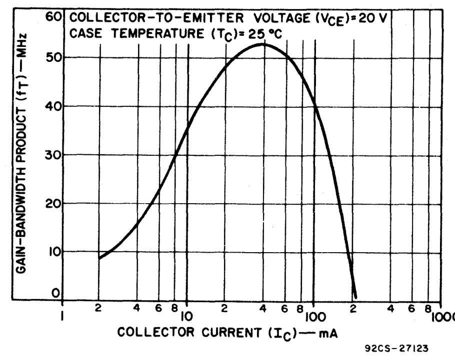


Fig. 6 - Typical gain-bandwidth product for all types.

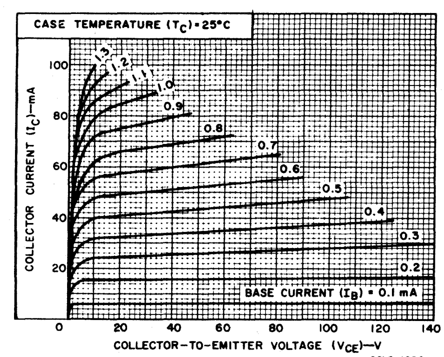


Fig. 7 - Typical output characteristics for all types.

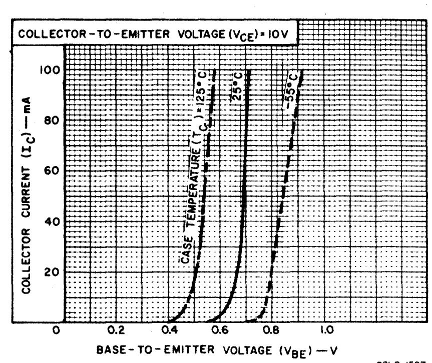


Fig. 8 - Typical transfer characteristics for all types.

RCP700, RCP702, RCP704, RCP706 Series RCP701, RCP703, RCP705, RCP707 Series

General-Purpose, Medium- Power Silicon N-P-N and P-N-P Planar Transistors

The RCA-RCP700-, RCP702-, RCP704-, and RCP706-series power transistors are double-diffused, epitaxial-planar silicon p-n-p transistors. The RCA-RCP701-, RCP703-, RCP 705-, and RCP707-series power transistors are double-diffused, epitaxial-planar silicon n-p-n transistors.

All of these devices are intended for a wide variety of large-signal, general-purpose applications such as complementary vertical deflection, TV sound output, regulators, and driver and output stages of audio amplifiers.

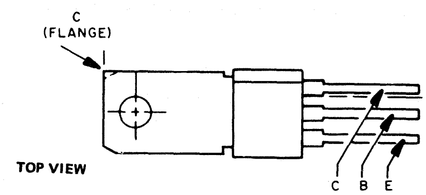
The RCP700-, RCP702-, RCP704-, and RCP706-series types are p-n-p complements of the n-p-n devices in the RCP701, RCP703, RCP705, and RCP707 series.

These are supplied in the JEDEC TO-202AB molded plastic package.

Features

- Maximum safe-area-of-operation curves specified for dc operation
- Planar construction for low noise and low leakage
- High gain at high current
- Fast switching time
- Thermal-cycling ratings
- Types in RCP700, RCP702, RCP704, and RCP706 series are p-n-p complements of n-p-n types in RCP701, RCP703, RCP705, and RCP707 series

TERMINAL DESIGNATIONS



JEDEC TO-202AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCP700D RCP702D RCP701D RCP703D	RCP700C RCP702C RCP701C RCP703C	RCP700B RCP702B RCP701B RCP703B	RCP700A RCP702A RCP701A RCP703A	RCP704B RCP706B RCP705B RCP707B	RCP704♦ RCP706♦ RCP705 RCP707	
V_{CBO}	125	105	85	55	85	45	V
$V_{CEO}(sus)$	100	80	60	40	60	30	V
V_{EBO}			5				V
I_C			2				A
I_B			1				A
P_T:							
$T_C \leq 25^oC$			10				W
$T_C > 25^oC$			Derate linearly 0.08 W/°C				
$T_A \leq 25^oC$			1.75				W
$T_A > 25^oC$			Derate linearly 0.014 W/°C				
T_{stg}, T_J			−65 to 150				°C
T_L At distance 1/8 in.(3.17 mm) from case for 10 s max.			230				°C

♦ For p-n-p devices, voltage and current values are negative.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*
RCP700 and RCP702 Series, P-N-P Types

CHARAC-TERISTIC SYMBOL	TEST CONDITIONS					LIMITS								UNITS
	VOLTAGE V dc			CURRENT A dc		RCP700A RCP702A		RCP700B RCP702B		RCP700C RCP702C		RCP700D RCP702D		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} I_E=0	−50 −70					– –	−0.5 –	– –	– −0.5	– –	−0.5 –	– –	– −0.5	μA
I_{CEO}		−30 −45			0 0	– –	−100 –	– –	– −100	– –	−100 –	– –	– −100	μA
I_{CEV}		−55 −85	1.5 1.5			– –	−100 –	– –	– −100	– –	−100 –	– –	– −100	μA
I_{EBO}			5	0		–	−100	–	−100	–	−100	–	−100	μA
h_{FE} RCP700 series RCP702 series Both series		 −4 −4 −4		 −0.5[a] −0.5[a] −1[a]		 50 30 10	 250 150 –	 50 30 10	 250 150 –	 50 30 10	 250 150 –	 50 30 10	 250 150 –	
$V_{CEO}(sus)$[b]				−0.1[a]	0	−40	–	−60	–	−80	–	−100	–	V
$V_{BE}(sat)$				−0.5[a]	−0.05	–	−1.2	–	−1.2	–	−1.2	–	−1.2	V
V_{BE}		−4		−0.5[a]		–	−1.1	–	−1.1	–	−1.1	–	−1.1	V
$V_{CE}(sat)$				−0.5[a]	−0.05	–	−0.8	–	−0.8	–	−0.8	–	−0.8	V
$\|h_{fe}\|$ f=10 MHz		−4		−0.05		5	–	5	–	5	–	5	–	
f_T		−4		−0.05		50	–	50	–	50	–	50	–	MHz
$I_{S/b}$ With base forward biased		−35 −50				−285 –	– –	– −150	– –	−150	–	−150	–	mA
C_{obo} f=1 MHz	−10					20	40	20	40	20	40	20	40	pF
t_{ON}	(V_{CC}) −30			0.5	I_{B_1}=−0.05 I_{B_2}=0.05	–	100	–	100	–	100	–	100	ns
t_{OFF}	(V_{CC}) −30			0.5	I_{B_1}=−0.05 I_{B_2}=0.05	–	1000	–	1000	–	1000	–	1000	ns
$R_{\theta JC}$ $R_{\theta JA}$						– –	12.5 71.4	– –	12.5 71.4	– –	12.5 71.4	– –	12.5 71.4	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%. [b] *CAUTION:* Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.

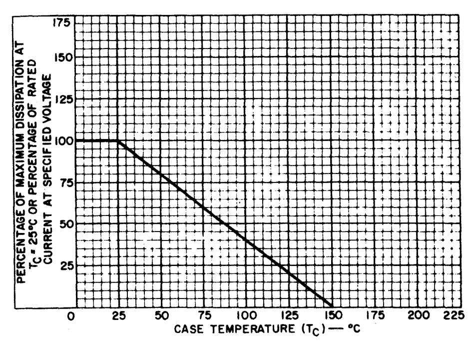


Fig. 1 - Dissipation derating curve for all types.

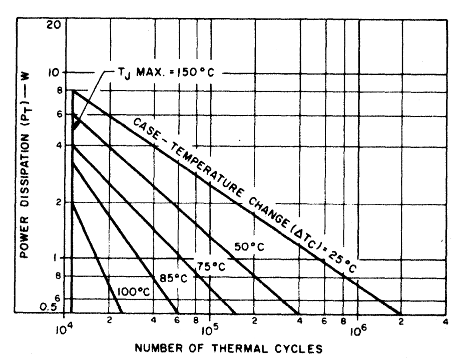


Fig. 2 - Thermal-cycling rating chart for all types.

RCP700, RCP702, RCP704, RCP706 Series
RCP701, RCP703, RCP705, RCP707 Series

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*
RCP704, RCP705, RCP706, RCP707 Series N-P-N and P-N-P Types
RCP704 and RCP706 Series RCP705 and RCP707 Series

CHARAC-TERISTIC SYMBOL	TEST CONDITIONS♦					LIMITS								UNITS
	VOLTAGE V dc			CURRENT A dc		RCP704 RCP706		RCP704B RCP706B		RCP705 RCP707		RCP705B RCP707B		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} $I_E=0$	-40 -70					– –	-5 –	– –	– -5	– –	5 –	– –	– 5	μA
I_{CEO}		-22 -45			0 0	– –	-1000 –	– –	– -1000	– –	1000 –	– –	– 1000	μA
I_{CEV}		-45 -85	-1.5 -1.5			– –	-1000 –	– –	– -1000	– –	1000 –	– –	– 1000	μA
I_{EBO}			-5	0		–	-100	–	-100	–	100	–	100	μA
h_{FE} RCP704 RCP705 series RCP706 RCP707 series		 -4 -4		 -0.5[a] -0.5[a]		 50 20	 – –	 50 20	 – –	 50 20	 – –	 50 20	 – –	
$V_{CEO}(sus)$[b]				-0.1[a]	0	-30	–	-60	–	30	–	60	–	V
$V_{BE}(sat)$				-0.5[a]	-0.05	–	-1.6	–	-1.6	–	1.6	–	1.6	V
V_{BE}		-4		-0.5[a]		–	-1.5	–	-1.5	–	1.5	–	1.5	V
$V_{CE}(sat)$				-0.5[a]	-0.05	–	-1.2	–	-1.2	–	1.2	–	1.2	V
$\|h_{fe}\|$ f=10 MHz		-4		-0.05		5	–	5	–	5	–	5	–	
f_T		-4		-0.05		50	–	50	–	50	–	50	–	MHz
$I_{S/b}$ With base forward biased		 -20 -50				 -500 –	 – –	 – -200	 – –	 500 –	 – –	 – 120	 – –	mA
C_{obo} f=1 MHz	-10					20	40	20	40	8	20	8	20	pF
t_{ON}	(V_{CC}) -30			0.5	I_{B_1}=-0.05 I_{B_2}=0.05	–	100	–	100	–	80	–	80	ns
t_{OFF}	(V_{CC}) -30			0.5	I_{B_1}=-0.05 I_{B_2}=0.05	–	1000	–	1000	–	800	–	800	ns
$R_{\theta JC}$ $R_{\theta JA}$						– –	12.5 71.4	– –	12.5 71.4	– –	12.5 71.4	– –	12.5 71.4	°C/W

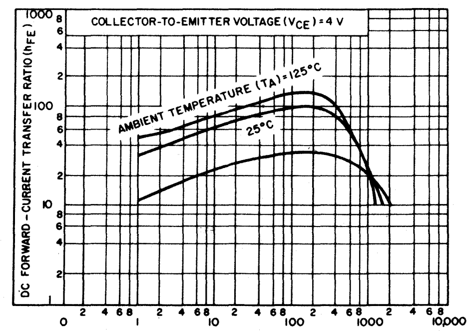


Fig. 3 - Typical static beta characteristics for RCP701, RCP703, RCP705, RCP707-series types.

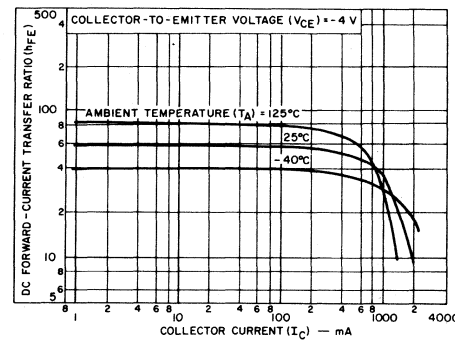


Fig. 4 - Typical static beta characteristics for RCP700, RCP702, RCP704, RCP706-series types.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*
RCP701 and RCP703 Series, N-P-N Types

CHARAC-TERISTIC SYMBOL	TEST CONDITIONS					LIMITS								UNITS
	VOLTAGE V dc			CURRENT A dc		RCP701A RCP703A		RCP701B RCP703B		RCP701C RCP703C		RCP701D RCP703D		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} $I_E=0$	50 70					– –	0.5 –	– –	– 0.5	– –	0.5 –	– –	– 0.5	μA
I_{CEO}		30 45			0 0	– –	100 –	– –	– 100	– –	100 –	– –	– 100	μA
I_{CEV}		55 85	-1.5 -1.5			– –	100 –	– –	– 100	– –	100 –	– –	– 100	μA
I_{EBO}			-5	0		–	100	–	100	–	100	–	100	μA
h_{FE} RCP701 series RCP703 series Both series		 4 4 4		 0.5[a] 0.5[a] 1[a]		 50 30 10	 250 150 –	 50 30 10	 250 150 –	 50 30 10	 250 150 –	 50 30 10	 250 150 –	
$V_{CEO}(sus)$[b]				0.1[a]	0	40	–	60	–	80	–	100	–	V
$V_{BE}(sat)$				0.5[a]	0.05	–	1.2	–	1.2	–	1.2	–	1.2	V
V_{BE}		4		0.5[a]		–	1.1	–	1.1	–	1.1	–	1.1	V
$V_{CE}(sat)$				0.5[a]	0.05	–	0.8	–	0.8	–	0.8	–	0.8	V
$\|h_{fe}\|$ f=10 MHz		4		0.05		5	–	5	–	5	–	5	–	
f_T		4		0.05		50	–	50	–	50	–	50	–	MHz
$I_{S/b}$ With base forward biased		 20 50				 500 –	 – –	 – 200	 – –	200	–	200	–	mA
C_{obo} f=1 MHz	10					8	20	8	20	8	20	8	20	pF
t_{ON}	(V_{CC}) 30			0.5	I_{B_1}=0.05 I_{B_2}=-0.05	–	80	–	80	–	80	–	80	ns
t_{OFF}	(V_{CC}) 30			0.5	I_{B_1}=0.05 I_{B_2}=-0.05	–	800	–	800	–	800	–	800	ns
$R_{\theta JC}$ $R_{\theta JA}$						– –	12.5 71.4	– –	12.5 71.4	– –	12.5 71.4	– –	12.5 71.4	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.
[b] *CAUTION:* Sustaining voltage, $V_{CEO}(sus)$, MUST NOT be measured on a curve tracer.
♦ For p-n-p devices, voltage and current values are negative.

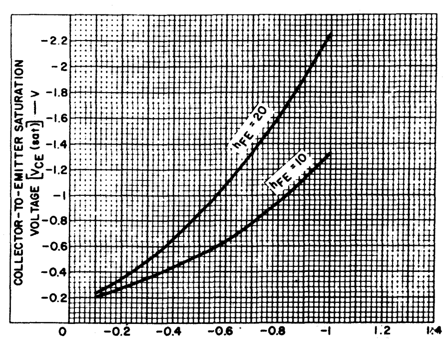


Fig. 5 - Typical saturation-voltage characteristics for RCP700, RCP702, RCP704, RCP706-series types.

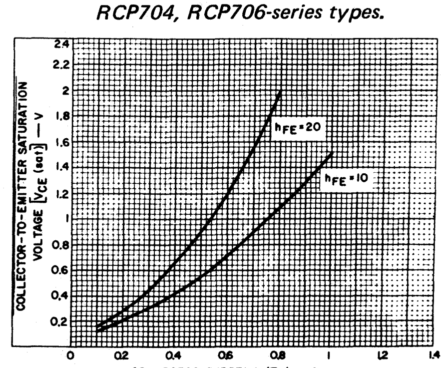


Fig. 6 - Typical saturation-voltage characteristics for RCP701, RCP703, RCP705, RCP707-series types.

RCP700, RCP702, RCP704, RCP706 Series
RCP701, RCP703, RCP705, RCP707 Series

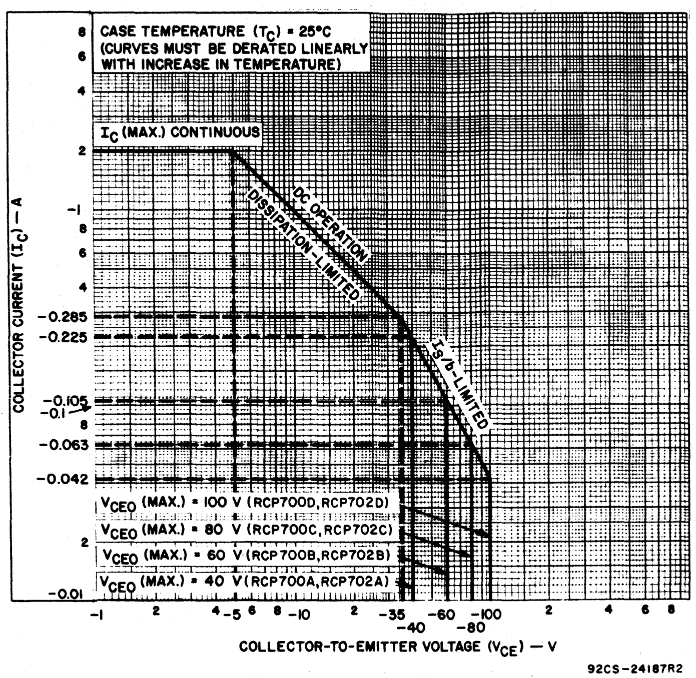


Fig. 7 - Maximum operating areas for RCP700-series and RCP702-series types.

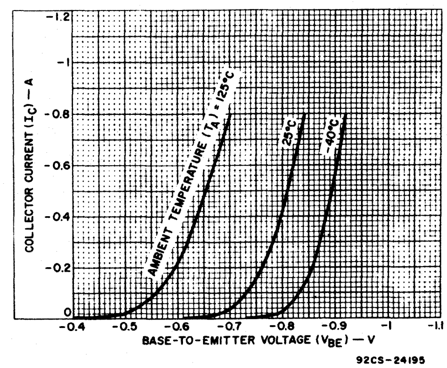


Fig. 8 - Typical transfer characteristics for RCP700, RCP702, RCP704, RCP706-series types.

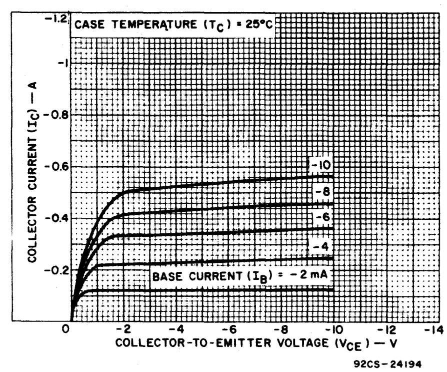


Fig. 9 - Typical output characteristics for RCP700, RCP702, RCP704, RCP706-series types.

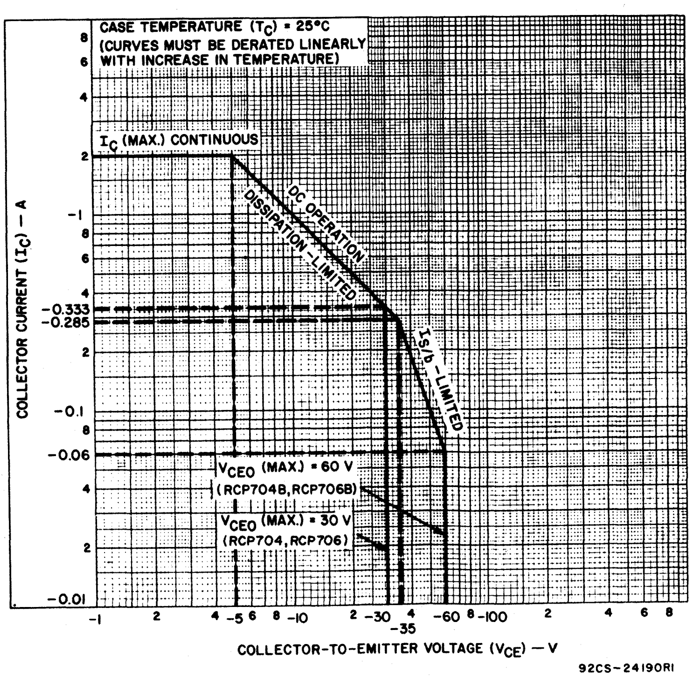


Fig. 10 - Maximum operating areas for RCP704-series and RCP706-series types.

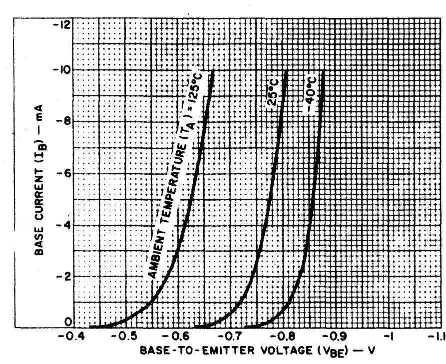


Fig. 11 - Typical input characteristics for RCP700, RCP702, RCP704, RCP706-series types.

RCP700, RCP702, RCP704, RCP706 Series
RCP701, RCP703, RCP705, RCP707 Series

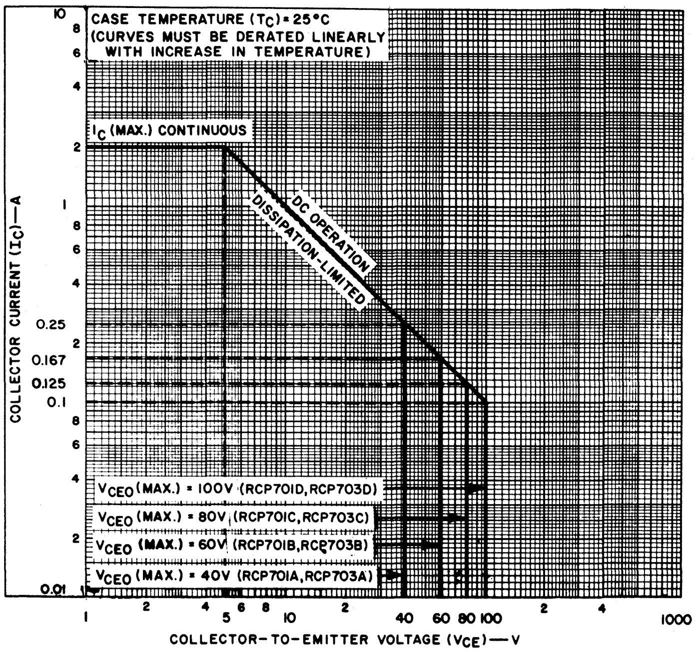


Fig. 12 - Maximum operating areas for RCP701-series and RCP703-series types.

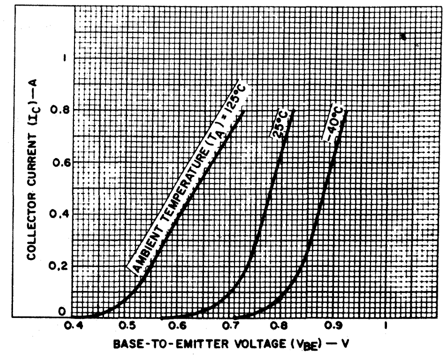


Fig. 13 - Typical transfer characteristics for RCP701, RCP703, RCP705, RCP707-series types.

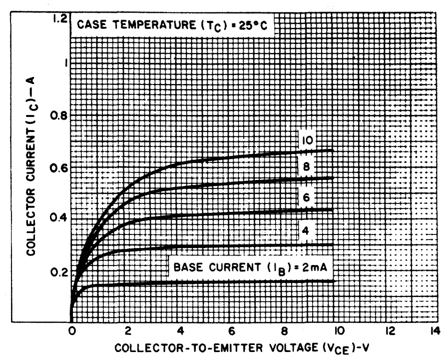


Fig. 14 - Typical output characteristics for RCP701, RCP703, RCP705, RCP707-series types.

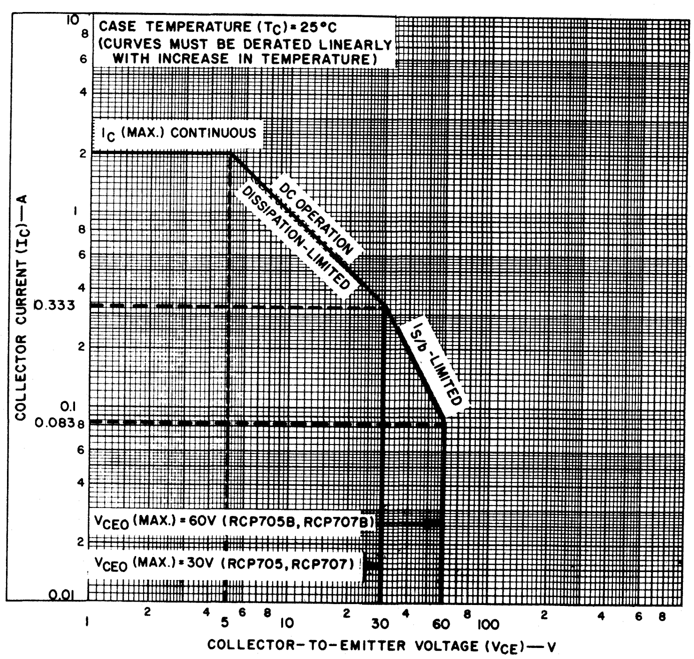


Fig. 15 - Maximum operating areas for RCP705-series and RCP707-series types.

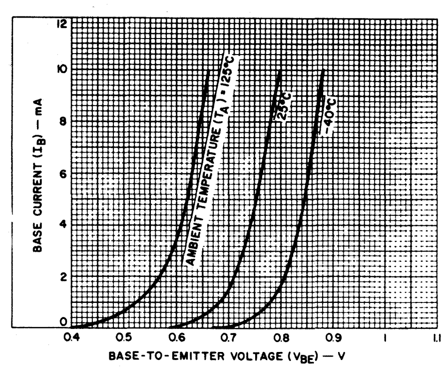


Fig. 16 - Typical input characteristics for RCP701, RCP703, RCP705, RCP707-series types.

RCA Equivalents of Popular Industry Types

Hometaxial-Base VERSAWATT Types (JEDEC TO-220AB Plastic Package)

Type No.	Polarity	I_C (A)	P_T (W)	$V_{CEO}(sus)$ (V)	h_{FE}/@ I_C (A)	f_T (MHz)	Complementary Type	Data File No.
RCA29/SDH	n-p-n	4	36	40	40 min./0.2	0.8	–	792
RCA29A/SDH	n-p-n	4	36	60	40 min./0.2	0.8	–	792
RCA29B/SDH	n-p-n	4	36	80	40 min./0.2	0.8	–	792
RCA29C/SDH	n-p-n	2.5	50	100	40 min./0.2	0.8	–	792
RCA31/SDH	n-p-n	4	36	40	25 min./1	0.8	–	793
RCA31A/SDH	n-p-n	4	36	60	25 min./1	0.8	–	793
RCA31B/SDH	n-p-n	4	36	80	25 min./1	0.8	–	793
RCA31C/SDH	n-p-n	2.5	50	100	25 min./1	0.8	–	793
RCA41/SDH	n-p-n	16	75	40	30 min./0.3	0.8	–	794
RCA41A/SDH	n-p-n	10	75	60	30 min./0.3	0.8	–	794
RCA41B/SDH	n-p-n	10	75	80	30 min./0.3	0.8	–	794

Epitaxial-Base VERSAWATT Types (JEDEC TO-220AB Plastic Package)

RCA29	n-p-n	3	30	40	15-150/1	3	RCA30	583
RCA29A	n-p-n	3	30	60	15-150/1	3	RCA30A	583
RCA29B	n-p-n	3	30	80	15-150/1	3	RCA30B	583
RCA29C	n-p-n	3	30	100	15-150/1	3	RCA30C	583
RCA30	p-n-p	−3	30	−40	15-150/−1	3	RCA29	584
RCA30A	p-n-p	−3	30	−60	15-150/−1	3	RCA29A	584
RCA30B	p-n-p	−3	30	−80	15-150/−1	3	RCA29B	584
RCA30C	p-n-p	−3	30	−100	15-150/−1	3	RCA29C	584
RCA31	n-p-n	5	40	40	10-50/3	3	RCA32	585
RCA31A	n-p-n	5	40	60	10-50/3	3	RCA32A	585
RCA31B	n-p-n	5	40	80	10-50/3	3	RCA32B	585
RCA31C	n-p-n	5	40	100	10-50/3	3	RCA32C	585
RCA32	p-n-p	−5	40	−40	10-50/−3	3	RCA31	586
RCA32A	p-n-p	−5	40	−60	10-50/−3	3	RCA31A	586
RCA32B	p-n-p	−5	40	−80	10-50/−3	3	RCA31B	586
RCA32C	p-n-p	−5	40	−100	10-50/−3	3	RCA31C	586
RCA41	n-p-n	7	65	40	15-150/3	3	RCA42	587
RCA41A	n-p-n	7	65	60	15-150/3	3	RCA42A	587
RCA41B	n-p-n	7	65	80	15-150/3	3	RCA42B	587
RCA41C	n-p-n	7	65	100	15-150/3	3	RCA42C	587
RCA42	p-n-p	−7	65	−40	15-150/−3	3	RCA41	588
RCA42A	p-n-p	−7	65	−60	15-150/−3	3	RCA41A	588
RCA42B	p-n-p	−7	65	−80	15-150/−3	3	RCA41B	588
RCA42C	p-n-p	−7	65	−100	15-150/−3	3	RCA41C	588

Epitaxial-Base Hermetic Types (JEDEC TO-66 Package)

RCS29	n-p-n	3	30	40	15-150/1	3	RCS30	880
RCS29A	n-p-n	3	30	60	15-150/1	3	RCS30A	880
RCS29B	n-p-n	3	30	80	15-150/1	3	RCS30B	880
RCS29C	n-p-n	3	30	100	15-150/1	3	RCS30C	880
RCS30	p-n-p	−3	30	−40	15-150/−1	3	RCS29	881
RCS30A	p-n-p	−3	30	−60	15-150/−1	3	RCS29A	881
RCS30B	p-n-p	−3	30	−80	15-150/−1	3	RCS29B	881
RCS30C	p-n-p	−3	30	−100	15-150/−1	3	RCS29C	881
RCS31	n-p-n	5	40	40	10-50/3	3	RCS32	882
RCS31A	n-p-n	5	40	60	10-50/3	3	RCS32A	882
RCS31B	n-p-n	5	40	80	10-50/3	3	RCS32B	882
RCS31C	n-p-n	5	40	100	10-50/3	3	RCS32C	882
RCS32	p-n-p	−5	40	−40	10-50/−3	3	RCS31	883
RCS32A	p-n-p	−5	40	−60	10-50/−3	3	RCS31A	883
RCS32B	p-n-p	−5	40	−80	10-50/−3	3	RCS31B	883
RCS32C	p-n-p	−5	40	−100	10-50/−3	3	RCS31C	883

High-Voltage Hermetic Types (JEDEC TO-3 Package)

RCA410	n-p-n	7	125	200	30-90/1	4	–	509
RCA411	n-p-n	7	125	300	30-90/1	2.5	–	510
RCA413	n-p-n	7	125	325	20-80/0.5	4	–	511
RCA423	n-p-n	7	125	325	30-90/1	4	–	512
RCA431	n-p-n	7	125	325	15-35/2.5	4	–	513

Power Transistors for Audio-Frequency Applications°

Type No.	Polarity	I_C (A)	P_T (W)	$V_{CEO}(sus)$ (V)	$h_{FE}/@I_C$ (A)	V_{BE} (V)	$V_{CE}(sat)$ (V)	f_T (MHz)	$I_{S/b}$ (A)	Complementary Type	Package	Data Sheet File No.
RCA1A01	n-p-n	1	5	70	40-200/10 mA	1	1.4	120	–	–	TO-39	651
RCA1A02	p-n-p	–1	7	–50	30-200/-0.1 mA	–0.8	–	60	–	–	TO-39	651
RCA1A05	p-n-p	–1	5	–75*	50-250/-0.15	–1.4	–0.8	60	–0.1	RCA1A06	TO-39	651
RCA1A06	n-p-n	1	5	75*	50-250/0.15	1.4	0.8	120	0.077	RCA1A05	TO-39	651
RCA1A07	n-p-n	1	5	40	50-250/3 mA	1.3	1	120	–	RCA1A08	TO-39	651
RCA1A08	p-n-p	–1	7	–40	70-250/-50 mA	–1.4	–1.4	60	–0.12	RCA1A07	TO-39	651
RCA1A09	n-p-n	1	10	175	20-100/10 mA	0.9	0.5	15	0.065	RCA1A10	TO-39	651
RCA1A10	p-n-p	–1	10	–175	40-250/-10 mA	–0.8	–2	15	–0.04	RCA1A09	TO-39	651
RCA1A11	n-p-n	1	10	175	40-250/1 mA	0.7	–	15	–	–	TO-39	651
RCA1A15	n-p-n	1	10	100	20-100/10 mA	1	1	15	0.2	RCA1A16	TO-39	651
RCA1A16	p-n-p	–1	10	–100	40-250/-10 mA	–1	–1	15	–0.2	RCA1A15	TO-39	651
RCA1A17	n-p-n	1	5	90	40-200/10 mA	1	1.4	120	–	–	TO-39	651
RCA1A18	n-p-n	1	7	10	40-250/10 mA	0.78	1	120	–	RCA1A19	TO-39	651
RCA1A19	p-n-p	–1	7	–10	40-250/-10 mA	–0.78	–1	60	–	RCA1A18	TO-39	651
RCA1A03	n-p-n	2	10	95*	70-300/0.3	1.4	0.8	50	0.2	RCA1A04	TO-39	651
RCA1A04	p-n-p	–2	10	–95*	70-300/-0.3	–1.4	–0.8	50	–0.285	RCA1A03	TO-39	651
RCA1E02	n-p-n	2	35	175	30-150/0.3	1	–	–	0.4	RCA1E03	TO-66	653
RCA1E03	p-n-p	–2	35	–175	30-150/-0.3	–1	–	–	–0.25	RCA1E02	TO-66	653
RCA1C03	n-p-n	4	40	100	50-250/1	1.5	1	4	1	RCA1C04	TO-220AB	652
RCA1C04	p-n-p	–4	40	–100	50-250/-1	–1.5	–1	10	–1	RCA1C03	TO-220AB	652
RCA1C12	n-p-n	4	40	120	40-250/1	1.2	–	4	0.66	RCA1C13	TO-220AB	652
RCA1C13	p-n-p	–4	40	–120	40-250/-1	–1.2	–	10	–0.66	RCA1C12	TO-220AB	652
RCA1C10	n-p-n	7	40	40	50-250/1.5	1.5	1	4	2	RCA1C11	TO-220AB	642
RCA1C11	p-n-p	–7	40	–40	50-250/-1.5	–1.5	–1	10	–2	RCA1C10	TO-220AB	642
RCA1B04	n-p-n	7	150	200	15-75/2	–	2	5	1.25	–	TO-3	649
RCA1B05	n-p-n	7	150	250	15-75/2	1.75	2	5	1.07	–	TO-3	650
RCA1B06	n-p-n	7	150	100	10-50/4	2	2	5	1.87	–	TO-3	648
RCA1B09	n-p-n	7	150	250	40 min./2	1	1	5	1.875	–	TO-3	908
RCA1C05	n-p-n	7	40	50	20-120/3	1.5	1	4	2	RCA1C06	TO-66	644
RCA1C06	p-n-p	–7	40	–50	20-120/-3	–1.5	–1	10	–2	RCA1C05	TO-66	644
RCA1C14	n-p-n	7	50	40	20-70/3	1.4	1	0.8	1.25	–	TO-66	643
RCA1C07	n-p-n	10	75	65	20-120/4	1.5	1	5	2.5	RCA1C08	TO-66	646
RCA1C08	p-n-p	–10	75	–65	20-120/-4	–1.5	–1	5	–2.5	RCA1C07	TO-66	646
RCA1C09	n-p-n	10	75	65	20-120/4	1.5	1	0.8	1.87	–	TO-66	645
RCA1B01	n-p-n	15	115	95*	20-70/4	1.4	1	0.8	1.95	–	TO-3	647
40311	n-p-n	0.7	5	30	70-350/50 mA	1	–	100	–	–	TO-39	78
40314	n-p-n	0.7	5	40	70-350/50 mA	1	1.4	100	–	40319	TO-39	78
40317	n-p-n	0.7	5	40	40-200/10 mA	1	–	–	–	–	TO-39	78
40319	p-n-p	–0.7	5	–40	35-200/-50 mA	–1	–1.4	100	–	40314	TO-39	78
40362	p-n-p	–0.7	5	–70*	35-200/-50 mA	–	–1.4	100	–	–	TO-39	78
40406	p-n-p	–0.7	1	–50	30-200/-0.1 mA	–0.8	–	100	–	40407	TO-39	219
40407	n-p-n	0.7	1	50	40-200/1 mA	0.8	–	100	–	40406	TO-39	219
40408	n-p-n	0.7	1	90	40-200/10 mA	1	1.4	100	–	–	TO-39	219
40409	n-p-n	0.7	3	90*	50-250/0.15	1	1.4	100	–	40410	TO-39/rad.	219
40410	p-n-p	–0.7	3	–90*	50-250/-0.15	–1	–1.4	100	–	40409	TO-39/rad.	219
40537	p-n-p	–0.7	5	55*	50-300/-50 mA	–1.1	–1.8	100	–	–	TO-39	302
40538	p-n-p	–0.7	5	–55*	15-90/-0.5	–2.7	–2	100	–	40539	TO-39	302
40539	n-p-n	0.7	5	55*	15-90/0.5	2.7	2	100	–	40538	TO-39	303
40321	n-p-n	1	5	300*	25-200/20 mA	2	2	–	–	–	TO-39	78
40327	n-p-n	1	5	300*	40-250/20 mA	2	2	–	–	–	TO-39	78
40412	n-p-n	1	10	250*	40 min./30 mA	–	–	–	0.05	–	TO-39	211
40313	n-p-n	2	35	300*	40-250/0.1	1.5	–	–	0.15	–	TO-66	78
40318	n-p-n	2	35	300*	50 min./0.5	1.5	–	–	0.1	–	TO-66	78
40322	n-p-n	2	35	300*	75 min./0.5	–	–	–	0.1	–	TO-66	78
40310	n-p-n	4	29	35	20-120/1	1.4	–	0.75	–	–	TO-66	78
40312	n-p-n	4	29	60*	20-120/1	1.4	–	0.75	–	–	TO-66	78
40316	n-p-n	4	29	40*	20-120/1	1.4	–	0.75	–	–	TO-66	78
40324	n-p-n	4	29	35	10-120/1	1.4	–	0.75	–	–	TO-66	78
40631	n-p-n	4	36	45*	20-70/2	1.5	1	–	–	–	TO-220AA	358
40325	n-p-n	15	117	35	12-60/8	2	1.5	–	–	–	TO-3	78
40363	n-p-n	15	115	70*	20-70/4	1.8	1.1	0.7	–	–	TO-3	78
40411	n-p-n	30	150	90*	35-100/4	1.2	0.8	100	–	–	TO-3	219

*V_{CER}

° In order of collector-current (I_C) rating

CH2102, CH2270, CH2405, CH3053, CH3439, CH3440, CH4036, CH4037, CH5262, CH5320-CH5323, CH6479

Unmounted and Unencapsulated N-P-N and P-N-P Silicon Power Transistor Chips

Features:

- **Prepared and tested for use in hybrid circuits**
- **h_{FE} ratings from 30 to 50 (min.)**
- **I_{CBO} leakage ratings in the 10 μA to 1 mA range**
- **V_{CEO} ratings up to 90 V on planar transistor chips; up to 325 V on passivated mesa types**
- **I_C up to 12 A (CH6479)**

The transistor chip families described in this bulletin are selected from the broad line of RCA discrete power transistors. Known also as pellets or dies, these chips represent the essential electronic portion of the transistor. They are especially suited for direct mounting on a heat sink in hybrid circuits. The n-p-n and p-n-p types can be used either singly or in complementary-pair configurations for large-signal medium-power applications.

All of the chip families shown are double-diffused epitaxial types. Six of the families are of planar construction; the other is of a passivated mesa construction. The oxide layer that results from conventional planar processing protects the planar types. The junctions and surfaces of the mesa transistor chips are protected by deposited glass-passivated coverings.

Aluminum has been deposited at the base and emitter electrodes of all the transistor chips for ease of bonding. The base and emitter bonding areas on each chip will accommodate up to a 0.003-inch (0.076-mm)-diameter bond wire except for the CH6479 which will accommodate a 0.010-inch (0.254-mm) wire. Either thermo-compression or ultrasonic bonding can be used to attach gold wires to these electrodes; aluminum wires can also be bonded by conventional ultrasonic techniques.

The collector contact, which is on the underside of the chip, has been metallized with gold for all of the chips except CH6479. For all of the chips, the collector can be attached directly to a heat sink by adhesive or by gold-silicon or gold-germanium eutectic bonding methods.

The CH6479, because of its large size, must be mounted on a heat sink made of material with thermal expansion coefficient close to that of silicon; suitable materials are molybdenum or beryllium oxide. A special cleaning step is required in mounting the CH6479.

All of the chips must be mounted in an inert or reduced atmosphere. The chips must not be subjected to more than 400°C for a maximum of 1 minute. Because of the specially prepared surfaces of the chips (except as noted for the CH6479), etching of the pellets or the use of flux is not recommended.

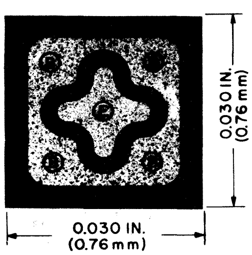
The chips are supplied in plastic containers. Each chip is securely held in a recessed partition of the container by a clear plastic cover that also protects the surface from dust and abrasion. For additional protection, the container is sealed in a clear plastic bag. If the sealed shipping container is opened or broken, ruptured, punctured, or damaged in any way, the chips must be stored at a temperature of not more than 40°C and a relative humidity of not more than 50% in a clean, dust-free environment. If the sealed shipping container is damaged on receipt as described above, the product should be immediately returned to RCA.

These unmounted and unencapsulated chips are tested electrically and visually inspected to meet the specifications shown on the following pages. Written notification of non-conformance to such specifications must be made to RCA within 90 days of the date of the shipment by RCA. RCA assumes no responsibility for chips which have been subjected to further processing, such as, but not limited to, lead-bonding or pellet-mounting operations.

RCA has the right to change the chip design and processing without notification.

Assistance in determining proper mounting and bonding procedures is available from RCA.

2N2102 Family (n-p-n)



Ⓑ 4 Base Bonding Areas 0.008 in. (0.20 mm) diameter

Ⓔ Emitter Bonding Area 0.008 in. (0.20 mm) diameter

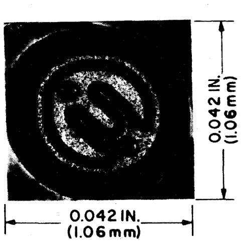
CH2102 CH2270 CH2405 CH3053

RCA-CH2102, CH2270, CH2405, and CH3053 are double-diffused n-p-n epitaxial planar transistor chips similar to RCA-2N2102, 2N2270, 2N2405. and 2N3053 transistors, respectively. They can be used either singly or in complementary-pair configurations with RCA p-n-p chips CH4036 and CH4037 for large-signal medium-power applications.

ELECTRICAL CHARACTERISTICS, at Chip Temperature = 25°C

Characteristic	Symbol	Test Conditions: Voltage V dc		Current mA dc		Limits: CH2102		CH2270		CH2405		CH3053		Units
		V_{CB}	V_{CE}	I_C	I_E	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current	I_{CBO}	60					10		10		10		10	μA
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.01	5		5		5		5		V
Collector-to-Emitter Sustaining Voltage: Base open[a]	$V_{CEO(sus)}$			20		60		45		90		30		V
DC Forward-Current Transfer Ratio[b]	h_{FE}		10	150		50		50		50		50		

2N3439 Family (n-p-n)



Ⓑ Base Bonding Area 0.005 in. (0.13 mm) diameter

Ⓔ Emitter Bonding Area 0.005 in. (0.13 mm) diameter

CH3439 CH3440

RCA-CH3439 and CH3440 are passivated mesa n-p-n transistor chips similar to those used in RCA-2N3439 and 2N3440 high-voltage transistors. Because of their high breakdown voltages, good high-frequency response, and fast switching speeds, these transistor chips can be used in high-voltage differential and operational amplifiers, high-voltage inverters and high-voltage, low-current switching regulators.

ELECTRICAL CHARACTERISTICS, at Chip Temperature = 25°C

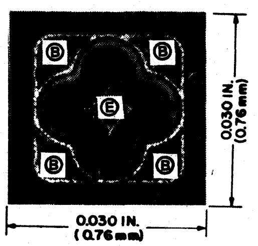
Characteristic	Symbol	Test Conditions: Voltage V dc		Current mA dc		Limits: CH3439		CH3440		Units
		V_{CB}	V_{CE}	I_C	I_E	Min.	Max.	Min.	Max.	
Collector Cutoff Current	I_{CBO}	200					20		50	μA
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.02	5		5		V
Collector-to-Emitter Sustaining Voltage: Base open[a]	$V_{CEO(sus)}$			20		325		250		V
DC Forward-Current Transfer Ratio[b]	h_{FE}		10	20		30		30		

[a]CAUTION: This voltage MUST NOT be measured on a curve tracer. [b]Pulse tested; 2% duty factor, less than or equal to 300 μs duration.

CH2102, CH2270, CH2405, CH3053, CH3439, CH3440, CH4036, CH4037, CH5262, CH5320-CH5323, CH6479

Unmounted and Unencapsulated N-P-N and P-N-P Silicon Power Transistor Chips (Cont'd)

2N4036 Family (p-n-p)



Ⓑ 4 Base Bonding Areas 0.008 in. (0.20 mm) diameter

Ⓔ Emitter Bonding Area 0.008 in. (0.20 mm) diameter

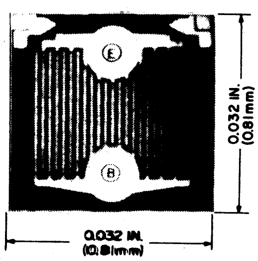
CH4036 CH4037

RCA-CH4036 and CH4037 are double-diffused p-n-p epitaxial planar transistor chips similar to RCA-2N4036 and 2N4037 transistors. Their high-voltage ratings and heat-dissipating ability make them ideal for amplifying large signals at a medium power level. They can be used singly or as complements of RCA n-p-n chips CH2102, CH2270, CH2405, and CH3053.

ELECTRICAL CHARACTERISTICS, at Chip Temperature = 25°C

Characteristic	Symbol	Test Conditions				Limits				Units
		Voltage V dc		Current mA dc		CH4036		CH4037		
		V_{CB}	V_{CE}	I_C	I_E	Min.	Max.	Min.	Max.	
Collector Cutoff Current	I_{CBO}	-60					-10		-10	μA
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				-0.01	-6.5		-6.6		V
Collector-to-Emitter Sustaining Voltage: Base open [a]	$V_{CEO(sus)}$			-20		-65		-40		V
DC Forward-Current Transfer Ratio [b]	h_{FE}		-10	-150		35		35		

2N5262 Family (n-p-n)



Ⓑ Base Bonding Areas 0.005 in. (0.13 mm) diameter

Ⓔ Emitter Bonding Area 0.005 in. (0.13 mm) diameter

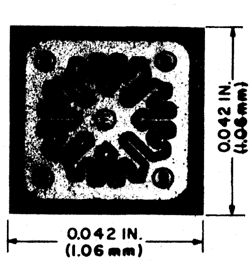
CH5262

RCA-CH5262 is a double-diffused n-p-n epitaxial planar transistor chip similar to the RCA-2N5262 transistor. Its high speed and high current capability make it ideal for use in driving magnetic systems and in other applications requiring the switching of high currents through inductive loads.

ELECTRICAL CHARACTERISTICS, at Chip Temperature = 25°C

Characteristic	Symbol	Test Conditions				Limits		Units
		Voltage V dc		Current mA dc		CH5262		
		V_{CB}	V_{CE}	I_C	I_E	Min.	Max.	
Collector Cutoff Current	I_{CBO}	60					10	μA
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.01	5		V
Collector-to-Emitter Sustaining Voltage: Base open [a]	$V_{CEO(sus)}$			10		35		V
DC Forward-Current Transfer Ratio [b]	h_{FE}		6	100		30		

2N5320 Family (n-p-n)



Ⓑ 4 Base Bonding Areas 0.008 in. (0.20 mm) diameter

Ⓔ Emitter Bonding Area 0.008 in. (0.20 mm) diameter

CH5320 CH5321

RCA-CH5320 and CH5321 are double-diffused n-p-n epitaxial planar transistor chips similar to RCA-2N5320 and 2N5321 transistors. They can be used singly or as complements of RCA p-n-p chips CH5322 and CH5323.

ELECTRICAL CHARACTERISTICS, at Chip Temperature = 25°C

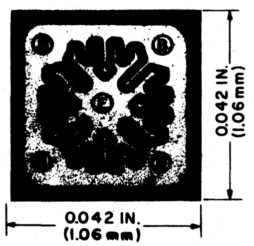
Characteristic	Symbol	Test Conditions				Limits				Units
		Voltage V dc		Current mA dc		CH5320		CH5321		
		V_{CB}	V_{CE}	I_C	I_E	Min.	Max.	Min.	Max.	
Collector Cutoff Current	I_{CBO}	60					10		10	μA
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.01	5		5		V
Collector-to-Emitter Sustaining Voltage: Base open [a]	$V_{CEO(sus)}$			20		80		55		V
DC Forward-Current Transfer Ratio [b]	h_{FE}		10	250		30		30		

[a] CAUTION: This voltage MUST NOT be measured on a curve tracer. [b] Pulse tested; 2% duty factor, less than or equal to 300 μs duration.

CH2102, CH2270, CH2405, CH3053, CH3439, CH3440, CH4036, CH4037, CH5262, CH5320-CH5323, CH6479

Unmounted and Unencapsulated N-P-N and P-N-P Silicon Power Transistor Chips (Cont'd)

2N5323 Family (p-n-p)



Ⓑ 4 Base Bonding Areas 0.008 in. (0.20 mm) diameter

Ⓔ Emitter Bonding Area 0.008 in. (0.20 mm) diameter

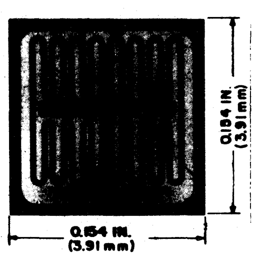
CH5322 CH5323

RCA-CH5322 and CH5323 are double-diffused p-n-p epitaxial planar transistor chips similar to RCA-2N5322 and 2N5323 transistors. They can be used singly or as complements of RCA n-p-n chips CH5320 and CH5321 for amplifying large signals at a medium power level.

ELECTRICAL CHARACTERISTICS, at Chip Temperature = 25°C

Characteristic	Symbol	Test Conditions				Limits				Units
		Voltage V dc		Current mA dc		CH5322		CH5323		
		V_{CB}	V_{CE}	I_C	I_E	Min.	Max.	Min.	Max.	
Collector Cutoff Current	I_{CBO}	-60					-10		-10	μA
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				-0.01	-5		-5		V
Collector-to-Emitter Sustaining Voltage: Base open [a]	$V_{CEO(sus)}$			-20		-80		-55		V
DC Forward-Current Transfer Ratio [b]	h_{FE}		-10	-250		30		30		

2N6479 Family (n-p-n)



Ⓑ Base Bonding Area 0.013 in. (0.33 mm) x 0.091 in. (2.31 mm)

Ⓔ Emitter Bonding Area 0.013 in. (0.33 mm) x 0.091 in. (2.31 mm)

CH6479

RCA-CH6479 is a double-diffused n-p-n epitaxial planar transistor chip similar to the RCA-2N6479 transistor. Radiation hardening makes this type suitable for aerospace applications, and high-switching speeds make it ideal for use in high-speed inverters, switching regulators, and military hybrid applications.

ELECTRICAL CHARACTERISTICS, at Chip Temperature = 25°C

Characteristic	Symbol	Test Conditions				Limits		Units
		Voltage V dc		Current mA dc		CH6479		
		V_{CB}	V_{CE}	I_C	I_E	Min.	Max.	
Collector Cutoff Current	I_{CBO}	100					1	mA
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				1	5		V
Collector-to-Emitter Sustaining Voltage: Base open [a]	$V_{CEO(sus)}$			25		60		V
DC Forward-Current Transfer Ratio [b]	h_{FE}		2	500		40		

CH6479 Chip Special Clean-Up Schedule:

Before eutectic mounting, the CH6479 chip must be etched for 30 seconds in a 10% (by volume) electronic-grade hydrofluoric acid solution at 25°C ± 5°C with agitation. Normal precautions for using hydrofluoric acid should be observed. The chip must then be dried and mounted within 8 hours.

[a]CAUTION: This voltage MUST NOT be measured on a curve tracer. [b]Pulse tested; 2% duty factor, less than or equal to 300 μs duration.

CHIP INSPECTION INFORMATION

Each lot is inspected to a 2.5% AQL (cumulative) according to Mil Std. 105 using 20 times magnification. The following defects determine the inspection criteria:

Foreign matter adhering to the base and emitter bond areas.

Improperly cut pellets that include a portion of another pellet.

Bridging by the metallization which causes a short.

Blistering, lifting or absence of the aluminum metallization.

Fractures or edges within 0.0005 in. (0.013) mm of the base collector junction.

Severed base-contact rings that isolate all the bonding pads and most of the base area.

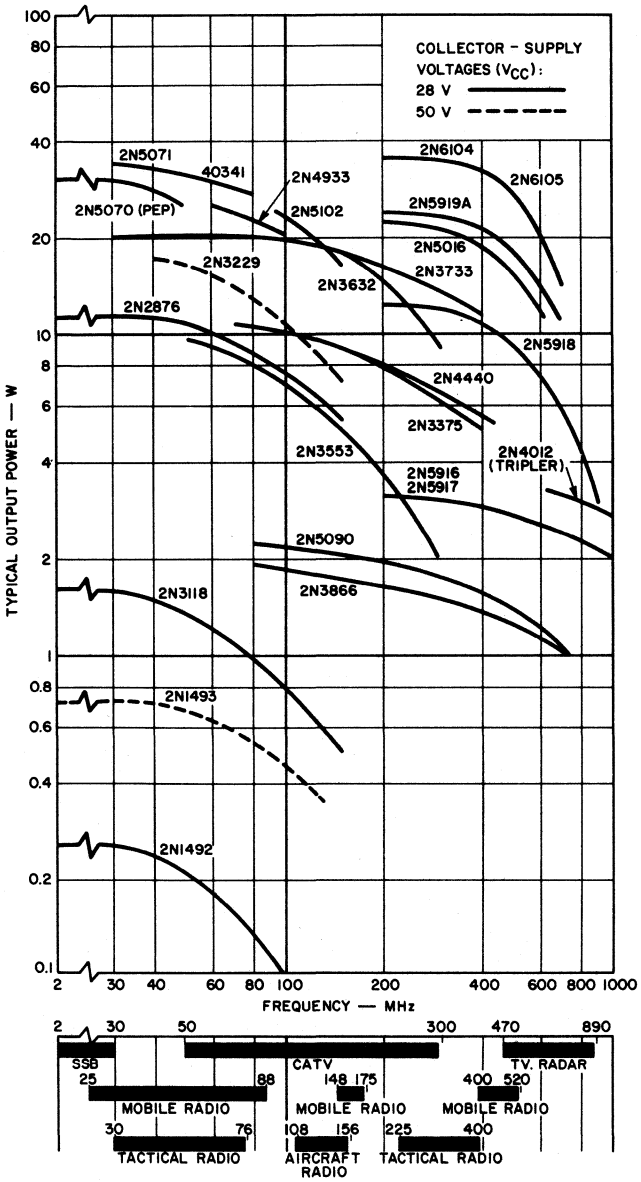
Oxide missing from the junction area.

RF/Microwave Power Transistors

Page

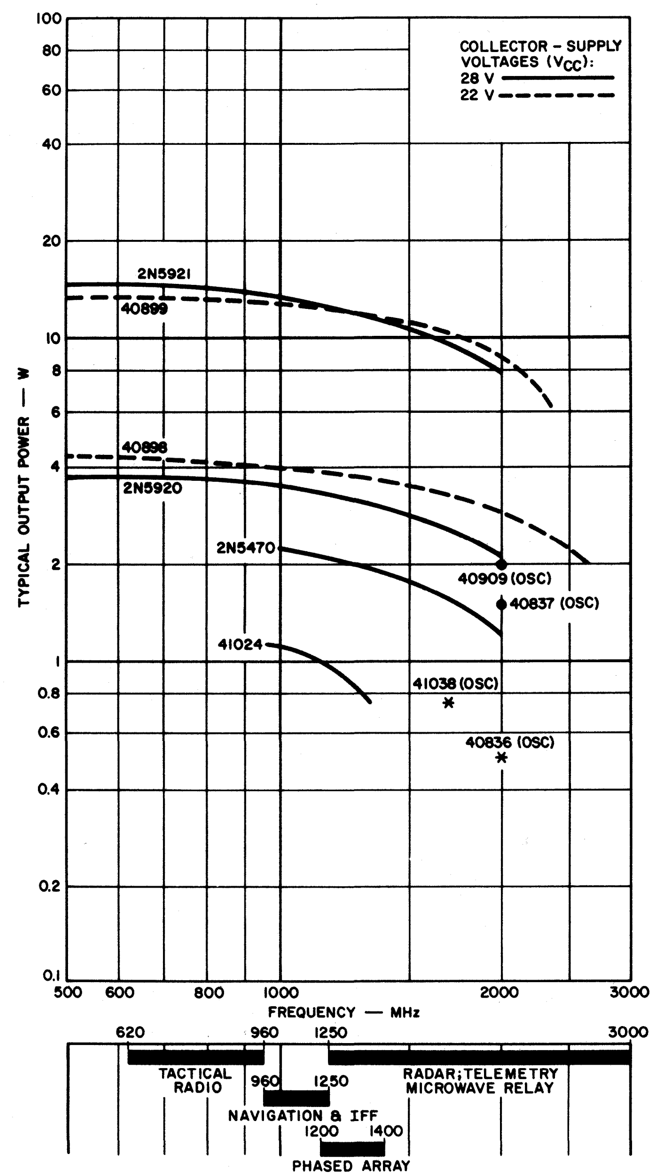
POWER-FREQUENCY CURVES

RF Power Transistors for Operation at 28 V or 50 V



92CM-24934R1

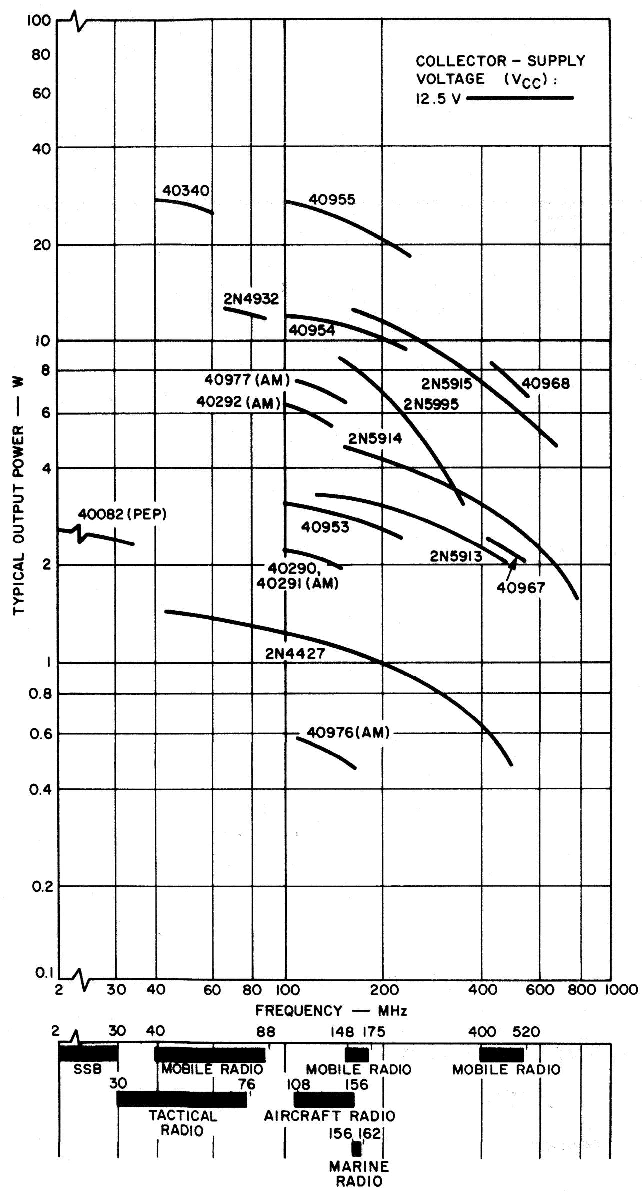
RF Power Transistors for Operation at 22 V or 28 V



92CM-24935R1

POWER-FREQUENCY CURVES (CONT'D)

RF Power Transistors for Operation at 12.5 V



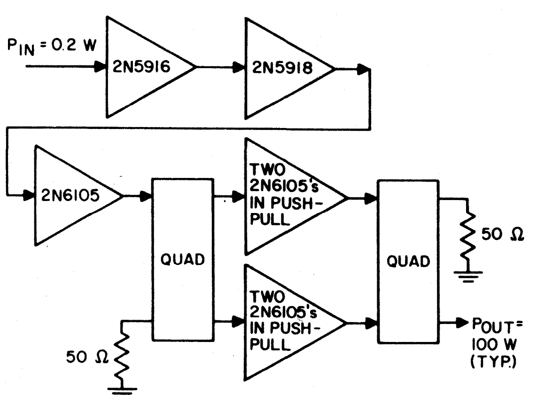
Application Information

Types For Microwave Applications

Type	Operating Frequency (GHz)	Min. Output Power (W)	Collector-Supply Voltage (V)	Min. Power Gain (dB)	Collector Efficiency (%)	Package Type
Lead						
41024	1	1	28	5	35	TO-39
41038	1.68	0.75	20	(OSC)	20	TO-46
Coaxial						
40836	2	0.5	21	(OSC)	20	TO-215AA
2N5470	2	1	28	5	30	TO-215AA
40837	2	1.25	28	(OSC)	20	TO-215AA
2N5920	2	2	28	10	40	TO-215AA
40909	2	2	25	(OSC)	20	TO-201AA
2N5921	2	5	28	7	40	TO-201AA
40898	2.3	2	22	7	35	TO-215AA
40899	2.3	6	22	6	35	TO-201AA

Types For UHF Military Applications

Type	Operating Frequency (MHz)	Min. Output Power (W)	Collector-Supply Voltage (V)	Min. Power Gain (dB)	Package Type
2N3866	400	1	28	10	TO-39
2N5916	400	2	28	10	TO-216AA
2N5917	400	2	28	10	HF-31
2N5918	400	10	28	8	TO-216AA
2N5919A	400	16	28	6	TO-216AA
2N6104	400	30	28	5	HF-32
2N6105	400	30	28	5	TO-216AA



BLOCK DIAGRAM OF A 100-WATT 225-400 MHz AMPLIFIER.

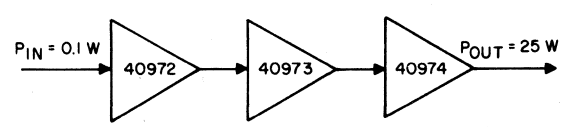
92CS-24929

Types For UHF Mobile-Radio Applications

Type	Operating Frequency (MHz)	Min. Output Power (W)	Collector-Supply Voltage (V)	Min. Power Gain (dB)	Package Type
40964	470	0.4	12	6	TO-39
40965	470	0.5	12	7	TO-39
2N5914	470	2	12.5	7	TO-216AA
40967	470	2	12.5	7	HF-44
40968	470	6	12.5	4.8	HF-44
2N5915	470	6	12.5	4.8	TO-216AA

Types For VHF Mobile-Radio Applications

Type	Operating Frequency (MHz)	Min. Output Power (W)	Collector-Supply Voltage (V)	Min. Power Gain (dB)	Package Type
2N4427	175	1	12	10	TO-39
40280	175	1	13.5	9	TO-39
2N5913	175	1.75	12.5	12.4	TO-39
40972	175	1.75	12.5	12.4	TO-39
40281	175	4	13.5	6	TO-60
2N5995	175	7	12.5	9.7	TO-216AA
40973	175	10	12.5	7.6	HF-44
40282	175	12	13.5	4.8	TO-60
40974	175	25	12.5	4.5	HF-44

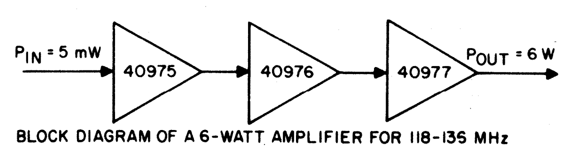


BLOCK DIAGRAM OF A 25-WATT AMPLIFIER FOR 148-175 MHz MOBILE APPLICATION.

92CS-24932

Types For Aircraft-Radio Applications

Type	Operating Frequency (MHz)	Min. Output Power (W)	Collector-Supply Voltage (V)	Min. Power Gain (dB)	Package Type
40975	118–136	0.05	12.5	10	TO-39
40976	118–136	0.5	12.5	10	TO-39
40977	118–136	6	12.5	10.8	HF-44
40290	118–136	2	12.5	6	TO-39
40291	118–136	2	12.5	6	TO-60
40292	118–136	6	12.5	4.8	TO-60
2N5102	118–136	15	24	4	TO-60

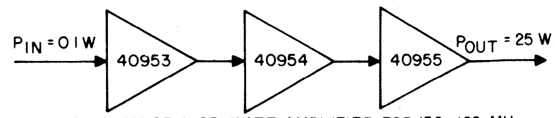


BLOCK DIAGRAM OF A 6-WATT AMPLIFIER FOR 118-136 MHz AIRCRAFT-RADIO APPLICATION.

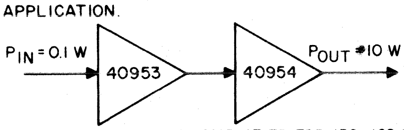
92CS-24930

Types For Marine-Radio Applications

Type	Operating Frequency (MHz)	Min. Output Power (W)	Collector-Supply Voltage (V)	Min. Power Gain (dB)	Package Type
40953	156	1.75	12.5	12.4	TO-39
40954	156	10	12.5	7.6	HF-44
40955	156	25	12.5	4.5	HF-44



BLOCK DIAGRAM OF A 25-WATT AMPLIFIER FOR 156–162 MHz MARINE APPLICATION.

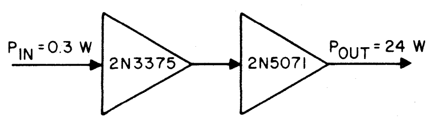


BLOCK DIAGRAM OF A 10-WATT AMPLIFIER FOR 156–162 MHz MARINE APPLICATION.

92CS-24933

Types For Single-Sideband Applications and For Military Communications

Type	Operating Frequency (MHz)	Min. Output Power (W)	Collector-Supply Voltage (V)	Min. Power Gain (dB)	Package Type
40082	30	2.5(PEP)	12.5	10	TO-39
40936	30	20(PEP)	28	13	TO-60
2N5070	30	25(PEP)	28	13	TO-60
2N5071	76	24	24	9	TO-60



BLOCK DIAGRAM OF A 24-WATT AMPLIFIER FOR 30–76 MHz OPERATION.

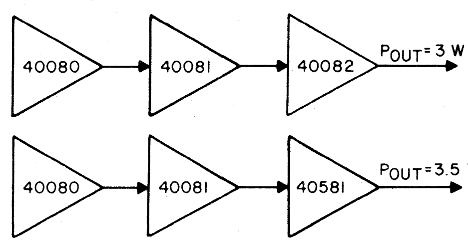
92CS-24928

Types For CATV/MATV and Small-Signal Low-Noise Applications

Type	Operating Frequency (MHz)	Noise Figure (dB)	Collector-to-Emitter Voltage (V)	Min. Power Gain (dB)	Package Type
2N918	60	6	6	13	TO-72
2N3478	200	4.5	6–15	11.5	TO-72
2N5179	200	4.5	6	15	TO-72
40894	200	3	12	15	TO-72
40895	200	–	12	15	TO-72
40896	200	–	12	15	TO-72
2N3600	200	4.5	15	17	TO-72
40897	200	–	12	18	TO-72
40915	450	2.5	10	14	TO-72
2N2857	450	4.5	6	12.5	TO-72
2N3839	450	3.9	6	12.5	TO-72
2N5109	200	3	15	11	TO-39
40608	200	3	15	11	TO-39
2N6389	890	6	10	15	TO-72
41039	200	3.2	15	8	TO-39

Types For CB-Radio Applications

Type	Frequency (MHz)	Min. Output Power (W)	Collector-Supply Voltage (V)	Package Type
40080	27	0.1	12	TO-5
40081	27	0.4	12	TO-5
40082†	27	3.0	12	TO-39
40581†	27	3.5	12	TO-39



BLOCK DIAGRAMS OF 3-WATT AND 3.5-WATT OSCILLATOR/AMPLIFIER CHAIN FOR CB-RADIO APPLICATIONS.

92CS-24926

† Available with flange

RCA Radiation-Tolerant Types

Typical Data:

Parent Type	Environmental Level A*				
	Test Conditions			P_{OUT} (W)	
	Frequency (MHz)	V_{CC} (V)	P_{IN} (W)	Pre-A	Post-A
2N5071	76	24	3.0	23.6	19.1
2N5016	225	28	5.0	21.8	20.4
2N3375	175	28	0.25	2.2	1.97
2N5470	2000	28	0.30	1.02	0.92
	Devices unbiased during radiation				

Data showing effect of radiation at the following environmental levels are available upon request, for a wide range of transistors.

*A. Neutron Fluence: 1.2×10^{14} n/cm^2; gamma dose: 1.5×10^7 rads.

B. Neutron Fluence: 5.7×10^{13} n/cm^2; gamma dose: 1.5×10^7 rads.

C. Gamma Dose: 1.5×10^7 rads.

2N918 2N3600

SILICON N-P-N EPITAXIAL PLANAR TRANSISTORS

For VHF Applications In Military, Communications, and Industrial Equipment

Features:

- high gain-bandwidth product
- hermetically sealed four-lead package
- low leakage current
- high 200-MHz power gain

2N3600

- low noise figure
  NF = 4.5 dB max. at 200 MHz
- low collector-to-base time constant
  $r_b'C_c$ = 15 ps max.
- high power gain as neutralized amplifier
  G_{pe} = 17 dB min. at 200 MHz

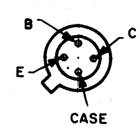
MAXIMUM RATINGS, Absolute-Maximum Values:

	2N918	2N3600		
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	30	30	max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15	15	max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3	3	max.	V
COLLECTOR CURRENT, I_C	50	*	max.	mA
TRANSISTOR DISSIPATION, P_T:				
For operation with heat sink:				
At case temperatures** — up to 25°C	300	300	max.	mW
At case temperatures** — above 25°C	Derate at 1.71 mW/°C			

	2N918	2N3600		
For operation at ambient temperatures:				
At ambient temperatures — up to 25°C	200	200	max.	mW
At ambient temperatures — above 25°C	Derate at 1.14 mW/°C			
TEMPERATURE RANGE:				
Storage and Operating (Junction)	-65 to +200			°C
LEAD TEMPERATURE (During Soldering):				
At distances ≥ 1/16 inch from seating surface for 60 seconds max.	300	300	max.	°C

* Limited by transistor dissipation.
** Measured at center of seating surface.

TERMINAL DESIGNATIONS



JEDEC TO-72

92CS-27513

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS: Ambient Temperature T_A (°C)	Frequency f (MHz)	DC Collector-to-Base Voltage V_{CB} (V)	DC Collector-to-Emitter Voltage V_{CE} (V)	DC Emitter-to-Base Voltage V_{EB} (V)	DC Emitter Current I_E (mA)	DC Collector Current I_C (mA)	DC Base Current I_B (mA)	LIMITS: Type 2N918 Min.	Type 2N918 Typ.	Type 2N918 Max.	Type 2N3600 Min.	Type 2N3600 Typ.	Type 2N3600 Max.	Units
Collector-Cutoff Current	I_{CBO}	25 150		15 15			0 0			- -	- -	0.01 1	- -	- -	0.01 1	μA μA
Collector-to-Base Breakdown Voltage	BV_{CBO}	25					0	0.001		30	-	-	30	-	-	V
Collector-to-Emitter Sustaining Voltage	$BV_{CEO}(sus)$	25						3	0	15	-	-	15	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0.01	0		3	-	-	3	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25						10	1	-	-	0.4	-	-	0.4	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	25						10	1	-	-	1	-	-	1	V
Static Forward Current-Transfer Ratio	h_{FE}	25			1			3		20	-	-	20	-	150	
Small-Signal Forward Current-Transfer Ratio[a]	h_{fe}	25	100 100 1 kHz		10 6 6			4 5 2		6 - -	- - -	- - -	- 8.5 40	- - -	- 15 200	
Common-Base Output Capacitance[b]	C_{ob}	25	0.1 to 1	10 0			0 0			- -	- -	1.7 3	- -	- -	- -	pF pF
Collector-to-Base Feedback Capacitance[b]	C_{cb}	25	0.1 to 1	10			0			-	-	-	-	-	1	pF
Common-Base Input Capacitance[c]	C_{ib}	25	0.1 to 1			0.5		0		-	-	2	-	1.4	-	pF
Collector-to-Base Time Constant[a]	$r_b'C_c$	25	40 31.9	6 6				2 5		- -	15 -	- -	- 4	- -	- 15	ps ps
Small-Signal Power Gain in Neutralized Common-Emitter Amplifier Circuit[a]	G_{pe}	25	200		12 6			6 5		15 -	21 -	- -	- 17	- -	- 24	dB dB
Small-Signal Power Gain in Unneutralized Common-Emitter Amplifier Circuit[a]	G_{pe}	25	200		10			5		-	13	-	-	-	-	dB
Power Output in Common-Emitter Oscillator Circuit[c] (See Fig.5)	P_o	25	≥ 500	10			12			30	-	-	20	-	-	mW
Nose Figure[a]	NF	25	200		6			1.5		-	-	-	-	-	4.5	dB
Noise Figure[a,d]	NF	25	60		6			1		-	-	6	-	-	3	dB

[a] Lead No.4 (case) grounded.
[b] Three-terminal measurement of the collector-to-base capacitance with the case and emitter leads connected to the guard terminal.
[c] Lead No.4 (case) floating.
[d] Generator Resistance (R_g) = 400 ohms.

2N1491-2N1493

SILICON N-P-N PLANAR TRANSISTORS

VHF Amplifier & Oscillator Service

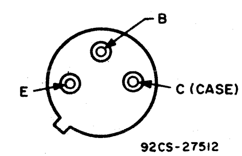
Features:

- **High V_{CB} Ratings – up to 100 V**
- **High Transistor-Dissipation Ratings – up to 3 watts**
- **High Typical f_T at I_C = 25 mA – up to 380 MHz**
- **High Typical Power Gain at 70 MHz – up to 12 db at 500-mW output**
- **JEDEC TO-39 Package**

Maximum Ratings, ***Absolute-Maximum Values:***

		2N1491	2N1492	2N1493	
COLLECTOR-TO-BASE VOLTAGE . . .	V_{CBO}	30	60	100	max. V
COLLECTOR-TO-EMITTER VOLTAGE:					
With emitter-to-base reverse biased. .	V_{CEV}	30	60	100	max. V
EMITTER-TO-BASE VOLTAGE.	V_{EBO}	1	2	4.5	max. V
COLLECTOR CURRENT	I_C	500	500	500	max. mA
EMITTER CURRENT		500	500	500	max. mA
TRANSISTOR DISSIPATION, See *Fig.3:*	P_T				
Operation in free air:					
Ambient temperature = 25° C . . .		0.5	0.5	0.5	max. W
Ambient temperature = 100° C. . .		0.25	0.25	0.25	max. W
Operation with heat sink:					
Case temperature = 25° C		3	3	3	max. W
Case temperature = 100° C.		1.5	1.5	1.5	max. W
AMBIENT TEMPERATURE RANGE:					
Operating and storage			−65 to +175		°C

TERMINAL DESIGNATIONS



JEDEC TO-39

ELECTRICAL CHARACTERISTICS, *Ambient Temperature = 25° C*

Characteristics	Symbol	TEST CONDITIONS: DC Collector Voltage (volts) V_{CB}	DC Collector Voltage (volts) V_{CE}	DC Collector Current (mA)	DC Emitter Current (mA)	LIMITS: Type 2N1491 Min.	Type 2N1491 Max.	Type 2N1492 Min.	Type 2N1492 Max.	Type 2N1493 Min.	Type 2N1493 Max.	Units
Collector Breakdown Voltage	BV_{CBO}			0.1	0	30		60		100		volts
Collector Cutoff Current	I_{CBO}	12			0		10		10		10	μA
Emitter Cutoff Current	I_{EBO}		V_{EB} 0.5	0			100		100		100	μA
Collector-to-Base Capacitance	C_{ob}	30			0		5		5		5	pF
Small-Signal Current Transfer Ratio: at 1 KHz	h_{fe}		20	15		15	200	15	200	15	200	
Power Gain at 70 MHz Power Output (mW) See *Fig.11* = 10 = 100 = 500	PG	20 30 50			−15 −15 −25	13		13		10		dB dB dB
Thermal Resistance Junction-to-case	R_T						50		50		50	°C/W

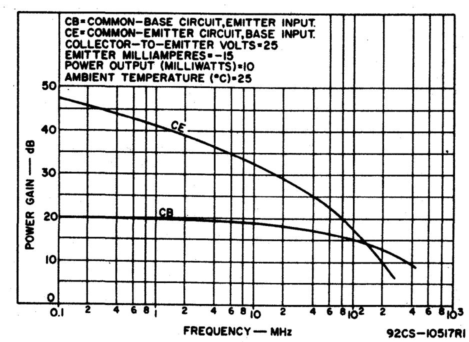


Fig. 1 - Performance characteristics.

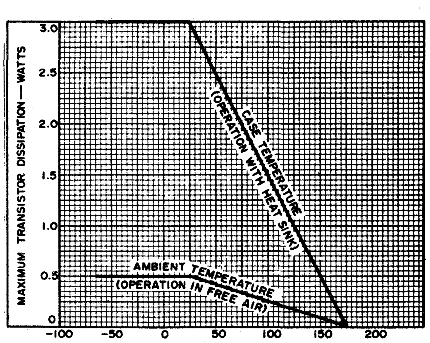


Fig. 2 - Dissipation derating graph.

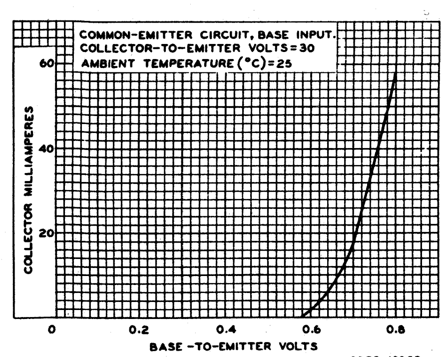


Fig. 3 - Typical characteristics.

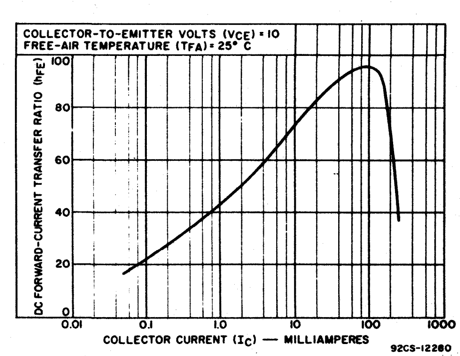


Fig. 4 - Typical dc beta characteristics.

2N2631, 2N2876
SILICON N-P-N PLANAR TRANSISTORS

For Large-Signal, High-Power, VHF Applications in Military and Industrial Communications Equipment

Features:

- High Power Output, Unneutralized (P_{OUT}):
  - 10 w min. at 50 Mc, 3 w min. at 150 Mc } 2N2876
  - 7.5 w min. at 50 Mc, 3 w min. at 150 Mc } 2N2631
- High Voltage Ratings:
  - V_{CBO} = 80 volts max.
  - V_{CEO} = 60 volts max.
- 100 per cent tested to assure freedom from second breakdown in class A operation at maximum ratings

RCA-2N2876 Features:

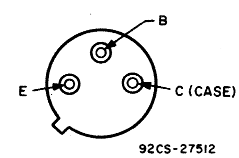
- Low Thermal Resistance (θ_{J-C})— high-thermal-conductivity ceramic insulation between collector and mounting stud
- Isolated Stud Package:
  - all three electrodes electrically isolated from case —for design flexibility
  - heavy copper mounting stud—for effective contact with heat sink
  - pin terminals arranged on a .200" pin-circle diameter —fit commercially available sockets

Maximum Ratings, *Absolute-Maximum Values:*

	2N2876	2N2631	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	80	80	max. volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open, V_{CEO}	60	60	max. volts
With V_{BE} = -1.5 volts, V_{CEV}	80	80	max. volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4	4	max. volts
COLLECTOR CURRENT, I_C	2.5	1.5	max. amp
TRANSISTOR DISSIPATION, P_T:			
At case temperatures up to 25°C	17.5	8.75	max. watts
At case temperatures above 25°C	Derate linearly 100mw/°C	Derate linearly 50 mw/°C	

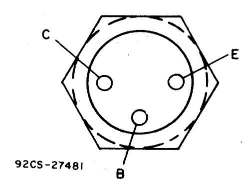
	2N2876	2N2631		
TEMPERATURE RANGE:				
Storage	-65to+200	-65to+200		°C
Operating (Junction)	-65to+200	-65to+200		°C
LEAD TEMPERATURE (During soldering):				
At distances ≥ 1/32" from ceramic wafer for 10 sec. max.	230	-	max.	°C
At distances ≥ 1/32" from seating surface for 10 sec. max.	-	230	max.	°C

TERMINAL DESIGNATIONS



2N2631

JEDEC TO-39



2N2876

JEDEC TO-60

ELECTRICAL CHARACTERISTICS *Case Temperature = 25° C Unless Otherwise Specified*

Characteristic	Symbol	TEST CONDITIONS: DC Collector Volts V_{CB}	DC Collector Volts V_{CC}	DC Base Volts V_{BE}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS 2N2876 Min.	2N2876 Max.	2N2631 Min.	2N2631 Max.	Units
Collector-Cutoff Current	I_{CBO}	30			0			-	0.1	-	0.1	µa
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.5	80	-	80	-	volts
Collector-to-Emitter Breakdown Voltage (Sustaining)	$BV_{CEO}(sus)$					0	500*	60	-	60	-	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEV}			-1.5			0.1	80	-	80	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4	-	4	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					300	1.5 amp	-	-	-	1	volt
						500	2.5 amp	-	1	-	-	volt
Feedback Capacitance (Measured at 140 Kc)	$C_{b'c}$	30			0			-	20	-	20	pf
RF Power Output, Unneutralized	P_{out}											
Measured at 50 Mc			28				500	10[a]	-	-	-	watts
50 Mc			28				375	-	-	7.5[b]	-	watts
150 Mc			28				275	3[b]	-	3[b]	-	watts
Gain-Bandwidth Product	f_T		28				250	200 (typ.)		200 (typ.)		Mc
Base Spreading Resistance (Measured at 400 Mc)	$r_{bb'}$		28				250	6.0 (typ.)		6.0 (typ.)		ohms
Collector-to-Case Capacitance	C_c							-	6	-	-	pf

* Pulsed. Pulse duration ≤ 5 µsec; duty factor ≤ 1%.
[a] For P_{IN} = 2 watts.
[b] For P_{IN} = 1 watt.

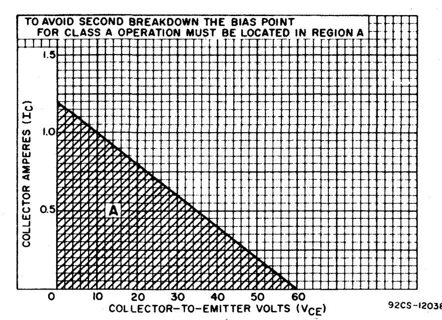


Fig. 1 - Region of safe operation (without second breakdown) in class A service for type 2N2876.

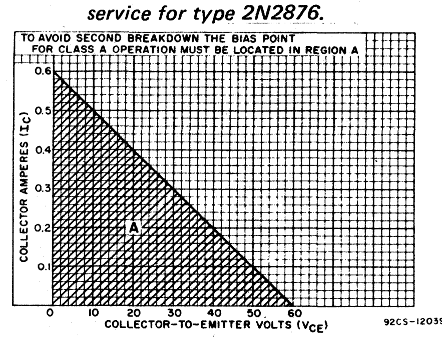


Fig. 2 - Region of safe operation (without second breakdown) in class A service for type 2N2631.

2N2857

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

For UHF Applications in Industrial and Military Equipment

Features:

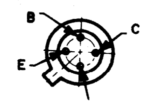
- high gain-bandwidth product— f_T = 1000 MHz min.
- high converter (450-to-30 MHz) gain— G_c = 15 dB typ. for circuit bandwidth of approximately 2 MHz
- high power gain as neutralized amplifier— G_{pe} = 12.5 dB min. at 450 MHz for circuit bandwidth of 20 MHz
- high power output as uhf oscillator— P_o = {30 mW min., 40 mW typ. at 500 MHz; 20 mW typ., at 1 GHz}
- low device noise figure— NF = {4.5 dB max. as 450 MHz amplifier; 7.5 dB typ. as 450-to-30 MHz converter}
- low collector-to-base time constant — $r_b'C_c$ = 7 ps typ.
- low collector-to-base feedback capacitance— C_{cb} = 0.6 pF typ.

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	30 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	2.5 max.	V
COLLECTOR CURRENT, I_C	40 max.	mA
TRANSISTOR DISSIPATION, P_T:		
At case temperatures* up to 25° C.	300 max.	mW
At case temperatures* above 25° C.	Derate at 1.72	mW/°C
At ambient temperatures up to 25°C	200 max.	mW
At ambient temperatures above 25°C	Derate at 1.14	mW/°C
TEMPERATURE RANGE:		
Storage and Operating (Junction)	-65 to +200	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/32 inch from seating surface for 10 seconds max	265 max.	°C

* Measured at center of seating surface.

TERMINAL DESIGNATIONS



JEDEC TO-72

ELECTRICAL CHARACTERISTICS, *At an Ambient Temperature, T_A = 25° C, Unless Otherwise Specified*

Characteristic	Symbol	Frequency f	TEST CONDITIONS: DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Base Current I_B	DC Collector Current I_C	LIMITS Type 2N2857 Min.	Typ.	Max.	Units
		MHz	V	V	V	mA	mA	mA				
Collector-Cutoff Current	I_{CBO}	T_A = 25°C T_A = 150°C	15 15			0 0			-	-	10 1.0	nA µA
Collector-to-Base Breakdown Voltage	BV_{CBO}					0		0.001	30	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}						0	3	15	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					-0.01		0	2.5	-	-	V
Static Forward-Current Transfer Ratio	h_{FE}			1				3	30	-	150	
Small-Signal Forward-Current Transfer Ratio	h_{fe}	0.001[c] 100[c]		6 6				2 5	50 10	- -	220 19	
Collector-to-Base Feedback Capacitance	C_{cb}	0.1 to 1[b]	10			0			-	0.6	1.0	pF
Input Capacitance	C_{ib}	0.1 to 1[a]			0.5			0	-	1.4	-	pF
Collector-to-Base Time Constant	$r_b'C_c$	31.9[c]	6			-2			4	7	15	ps
Small-Signal, Common-Emitter Power Gain in Neutralized Amplifier Circuit	G_{pe}	450[c]		6				1.5	12.5	-	19	dB
Power Output as Oscillator	P_o	≥ 500[a]	10			-12			30	-	-	mW
UHF Device Noise Figure	NF	450[c,d,f]		6				1.5	-	3.8	4.5	dB
UHF Measured Noise Figure	NF	450[c,d]		6				1.5	-	-	5.0	dB
VHF Device Noise Figure	NF	60[b,d]		6				1	-	2.2	-	dB

[a] Fourth lead (case) not connected

[b] Three-terminal measurement: Lead No.1 (Emitter) and lead No.4 (Case) connected to guard terminal.

[c] Fourth lead (case) grounded.

[d] Generator resistance, R_g = 50 ohms.

[e] Generator resistance, R_g = 400 ohms.

[f] Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test circuit (0.25 dB) and the contribution of the following stages in the test set-up (0.25 dB).

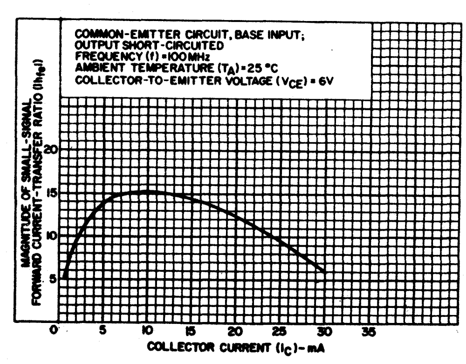


Fig. 1 - Small-signal beta characteristic for type 2N2857.

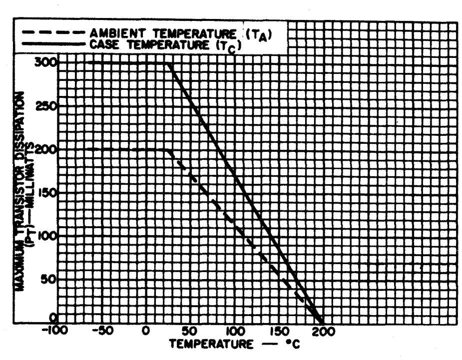


Fig. 2 - Rating chart for type 2N2857.

2N3118

SILICON N-P-N PLANAR TRANSISTOR

For Large-Signal VHF Class-C and Small-Signal VHF Class-A Amplifier Service

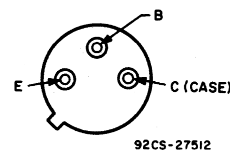
Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Emitter Voltage:		
Reverse bias (V_{CEX})		
For V_{BE} = -1.5 volts.	85 max.	volts
With base open (V_{CEO})	60 max.	volts
Emitter-to-Base Voltage (V_{EBO}). .	4 max.	volts
Collector Current (I_C).	0.5 max.	ampere
Transistor Dissipation (P_T):		
At case temperatures up to 25° C	4 max.	watts
At free-air temperatures up to 25° C	1 max.	watt
At temperatures above 25° C	See *Fig.1*	
Temperature Range:		
Storage	-65 to +200	°C
Operating (Junction).	-65 to +200	°C

Features:

- High power dissipation — 4 watts at case temperature of 25° C
- High output power — Class-C service; 28-volt operation: 1 watt minimum at 50 Mc; 0.4 watt minimum at 150 Mc
- High collector-to-emitter voltage ratings — V_{CEX} = 85 volts; V_{CEO} = 60 volts
- High gain-bandwidth product — 380 Mc typical
- High power gain — Class-A service, neutralized: 25 db at 50 Mc, 200 mw output

TERMINAL DESIGNATIONS



JEDEC TO-5

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS: Case Temperature (T_C) °C	Frequency Mc	DC Collector-to-Base Voltage (volts) V_{CB}	DC Collector-to-Emitter Voltage (volts) V_{CE}	DC Emitter-to-Base Voltage (volts) V_{EB}	DC Collector Current (ma) I_C	DC Emitter Current (ma) I_E	DC Base Current (ma) I_B	LIMITS Min.	LIMITS Max.	Units
Collector-Cutoff Current	I_{CBO}	25(T_{FA})▲ 150(T_{FA})▲		30 30				0 0			0.1 100	μa μa
Emitter-to-Base Breakdown Voltage	BV_{EBO}	25					0	0.1		4		volts
Collector-to-Emitter Breakdown Voltage (Sustaining)	BV_{CEO}(sus)	25					10 pulsed□		0	60		volts
Reverse Collector-to-Emitter Breakdown Voltage	BV_{CEX}	25				1.5	0.1			85		volts
Feedback Capacitance	$C_{b'c}$	25	1	28			0				6	pf
$r_{bb'}$ $C_{b'c}$ Product	$r_{bb'}C_{b'c}$	25	50		28		25				60	psec
DC Forward-Current Transfer Ratio□	h_{FE}	25			28		25			50	275	
Small-Signal Forward-Current Transfer Ratio	h_{fe}	25	50		28		25			5		
Real Part of Short-Circuit Input Impedance	$h_{ie(real)}$	25	50		28		25			25	75	ohms
Real Part of Short-Circuit Output Impedance	$1/Y_{22(real)}$	25	50		28		25			500	1000	ohms
Output Power Class-C Service P_{in} = 0.1 watt (with heat sink)	P_{OUT}	25 25	50 150		28 28					1.0 0.4		watt watt
Power Gain Class-A Service P_{out} = 0.2 watt (with heat sink)	PG	25	50		28		25			18		db

▲ T_{FA} = free-air temperature □ Pulse duration, 300 μsec; duty factor, less than 1.8%

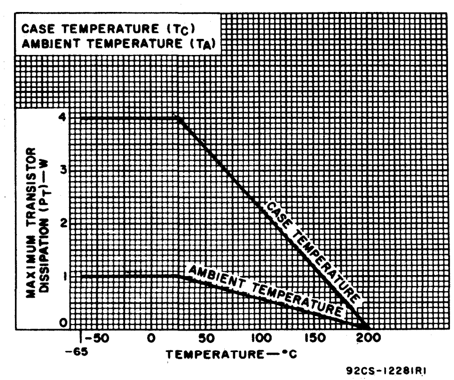


Fig. 1 - Rating chart.

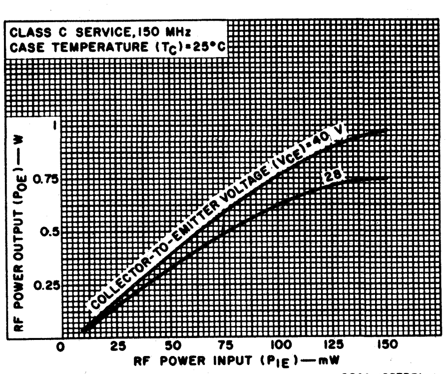


Fig. 2 - Power output as a function of power input at 150 Mc.

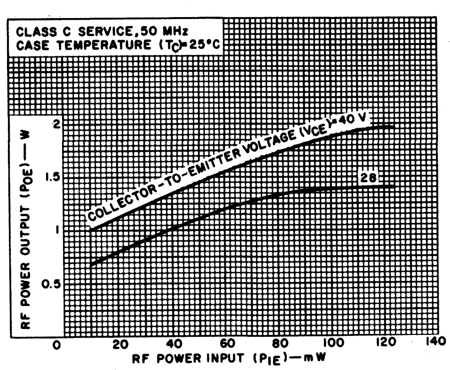


Fig. 3 - Power output as a function of power input at 50 Mc.

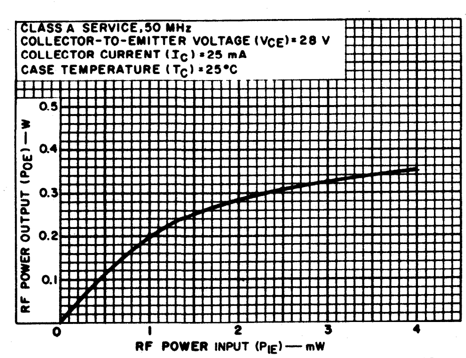


Fig. 4 - Power output as a function of power input at 50 Mc and 25 mA.

2N3119

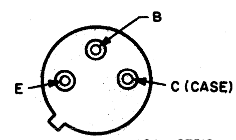
High-Power Silicon N-P-N Planar Transistor

For Switching and Pulse-Amplifier Applications

Features:

- **High voltage ratings:** V_{CEX} = 100 V, V_{CEO} = 80 V
- **Fast rise time:** 10 ns with 50-V pulse, 1-KΩ load
- **High power dissipation:** 4 W at T_C = 25° C

TERMINAL DESIGNATIONS



JEDEC TO-5

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	100	V
COLLECTOR-TO-EMITTER VOLTAGE:			
* With base open	V_{CEO}	80	V
With base-emitter junction reverse-biased (V_{BE} = −1.5 V)	V_{CEX}	100	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
*COLLECTOR CURRENT:	I_C		
Continuous		0.5	A
*TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25° C		4	W
At free-air temperatures up to 25° C		1	W
At temperatures above 25° C		See Fig. 1	
*TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to +200	°C
*LEAD TEMPERATURE (During soldering):			
At 1/16 in. ± 1/32 in. (1.59 mm ± 0.8 mm) from seating plane for 10 s max.		255	°C

*In accordance with JEDEC registration data format

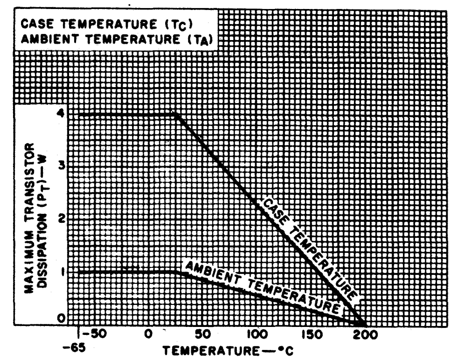


Fig. 1 - Rating chart.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25° C unless otherwise specified.*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTS V_{CB}	DC COLLECTOR VOLTS V_{CE}	DC EMITTER VOLTS V_{BE}	DC CURRENT (MILLIAMPERES) I_E	DC CURRENT (MILLIAMPERES) I_B	DC CURRENT (MILLIAMPERES) I_C	LIMITS MIN.	LIMITS MAX.	UNITS
* Collector-Cutoff Current At T_{FA} = 25° C = 150° C	I_{CBO}	60 60			0 0			– –	50 50	nA μA
* Reverse Collector Current	I_{CEV}		60	−1.5				–	0.2	μA
* Emitter-Cutoff Current (At T_{FA} = 25° C)	I_{EBO}			−3			0	–	100	nA
* Base Current	I_B		60	−1.5				–	0.2	μA
* Collector-to-Emitter Breakdown Voltage (Sustaining)	$BV_{CEO}(sus)$					0	10•	80	–	V
* Reverse Collector-to-Emitter Breakdown Voltage	BV_{CEX}			−1.5			0.10	100	–	V
* Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.10	100	–	V
* Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.10		0	4	–	V
* DC Forward-Current Transfer Ratio	h_{FE}		10 10• 10•				10 100 250	40 50 20	– 200 –	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					10	100	–	0.5	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$					10	100	–	1.1	V
* Base-to-Emitter Voltage (Pulsed)	V_{BE}		10•				100	–	1.1	V
Feedback Capacitance (At 1 Mc)	$C_{b'c}$	28					0	–	6	pF
* Common-Base Output Capacitance (at 1 mC)	C_{ob}	28					0	–	6	pF
* Gain-Bandwidth Product (At 50 Mc)	f_T		28				25	250	–	Mc
* Pulse-Amplifier Delay + Rise Time	$t_d + t_r$		V_{CC} = 80				10	–	20	ns
Sat. Switch Turn-On Time (delay time + rise time)	t_{on}		V_{CC} = 28			I_{B1} = 10	100	–	40	ns
Sat. Switch Turn-Off Time (storage time + fall time)	t_{off}		V_{CC} = 28			I_{B2} = −10	100	–	700	ns
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$							–	44	°C/W

*In accordance with JEDEC registration data format

•Pulsed; pulse duration = 300 μsec; duty factor = 1.8%

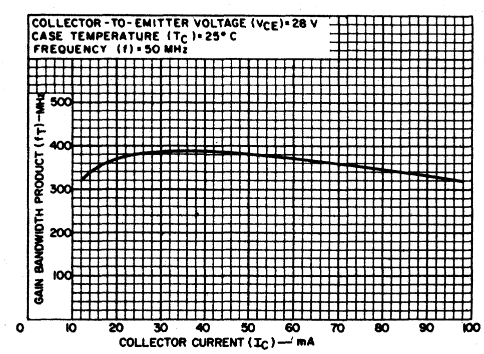


Fig. 2 - Typical gain-bandwidth product characteristic.

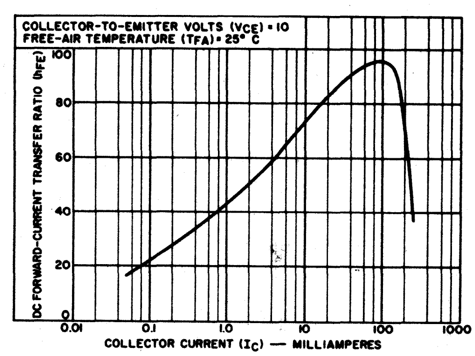


Fig. 3 - Typical dc beta characteristic.

2N3229

SILICON N-P-N PLANAR TRANSISTOR

For Large-Signal, High-Power, VHF Applications in Military and Industrial Communications Equipment

Features:

- **High Power Output, Unneutralized (P_{OUT}):**
  15 w min. at 50 Mc
  5 w min. at 150 Mc
- **High Voltage Ratings:**
  V_{CBO} = 105 volts max.
  V_{CEV} = 105 volts max.
  V_{CEO} = 60 volts max.
- **100 per cent tested to assure freedom from second breakdown in class-A operation at maximum ratings**
- **Low Thermal Resistance (θ_{J-C})—**
  high thermal-conductivity ceramic insulation between collector and mounting stud
- **Isolated Stud Package:**
  all three electrodes electrically isolated from case—for design flexibility
  heavy copper mounting stud—for effective contact with heat sink
  pin terminals arranged on a .200" pin-circle diameter—fit commercially available sockets

Maximum Ratings, *Absolute-Maximum Values:*

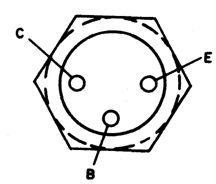
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	105 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With base open, V_{CEO}	60 max.	volts
With V_{BE} = -1.5 volts, V_{CEV}	105 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4 max.	volts
COLLECTOR CURRENT, I_C	2.5 max.	amperes
TRANSISTOR DISSIPATION, P_T:		
At case temperatures up to 25° C.	17.5 max.	watts
At case temperatures above 25° C.	Derate linearly 100 mw/°C	
TEMPERATURE RANGE:		
Storage	-65 to 200	°C
Operating (Junction)	-65 to 200	°C
LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/32" from ceramic wafer for 10 sec. max.	230 max.	°C

ELECTRICAL CHARACTERISTICS *Case Temperature = 25° C Unless Otherwise Specified*

Characteristic	Symbol	TEST CONDITIONS: DC Collector Volts V_{CB}	V_{CE}	DC Base Volts V_{BE}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS Min.	Max.	Units
Collector-Cutoff Current	I_{CBO}	30			0			-	0.1	μa
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.5	105	-	volts
Collector-to-Emitter Breakdown Voltage (Sustaining)	$BV_{CEO(sus)}$					0	500*	60	-	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEV}			-1.5			0.1	105	-	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4	-	volts
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$					500	2.5 amp	-	1	volt
Feedback Capacitance (Measured at 140 Kc)	$C_{b'c}$	30			0			-	20	pf
RF Power Output, Unneutralized	P_{out}									
Measured at 50 Mc			50				550	15[a]	-	watts
150 Mc			50				250	5[b]	-	watts
Gain-Bandwidth Product	f_T		28				250	200(typ.)		Mc
Base-Spreading Resistance (Measured at 400 Mc)	$r_{bb'}$		28				250	6.0(typ.)		ohms
Collector-to-Case Capacitance	C_c							-	6	pf

* Pulsed. Pulse duration ≤ 5 μsec; duty factor ≤ 1%.
[a] For P_{IN} = 2 watts
[b] For P_{IN} = 1 watt

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

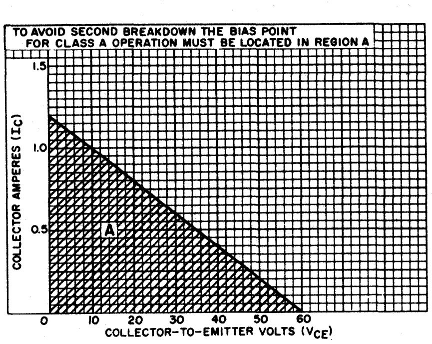


Fig. 1 - Region of safe operation (without second breakdown) in class A service.

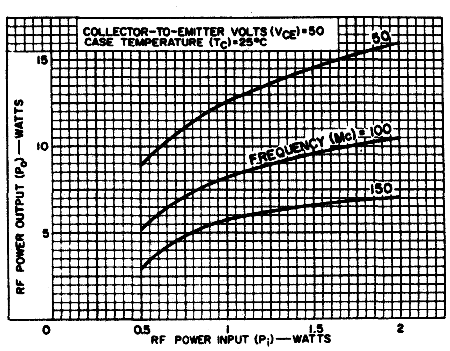


Fig. 2 - Typical operation characteristics.

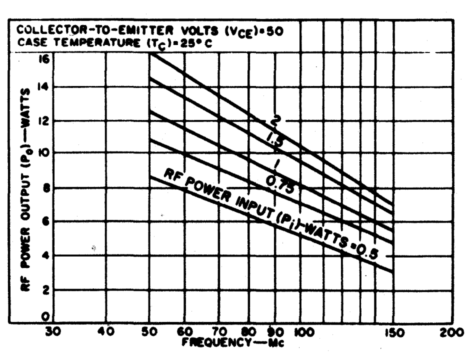


Fig. 3 - Typical operation characteristics.

2N3262

SILICON N-P-N PLANAR TRANSISTOR

For High-Voltage, High-Speed Switching and Pulse-Amplifier Applications

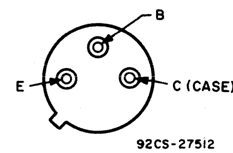
Features:

- High Voltage Ratings —
- Fast Rise Time at High Collector Currents— 20 nsec rise time (max.) at 1 ampere
- High Power Dissipation —
- Low Collector to Emitter Saturation Voltage at High Collector Currents— 0.6 volts (max.) at 1 ampere

Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage, V_{CBO}	100 max.	volts
Collector-to-Emitter Voltage		
Reverse bias, V_{CEX} For V_{EB} = 1.5 volts	100 max.	volts
With base open (sustaining voltage), V_{CEO}(sus)	80 max.	volts
Emitter-to-Base Voltage, V_{EBO}	4 max.	volts
Collector Current, I_C	1.5 max.	amperes
Transistor Dissipation, P_T:		
At case temperatures up to 25° C	8.75 max.	watts
At case temperatures above 25° C	Derate linearly (50 mw/°C) to 175° C	
At free-air temperatures up to 25° C	1 max.	watt
At free-air temperatures above 25° C	Derate linearly (5.71 mw/°C) to 175° C	
Temperature Range:		
Storage	-65 to +200	°C
Operating (Junction)	-65 to +200	°C
Lead Temperature:		
1/16" ± 1/32" from seating surface for 10 sec. max.	230	°C

TERMINAL DESIGNATIONS



JEDEC TO-39

Electrical Characteristics, *Case Temperature = 25° C Unless Otherwise Specified.*

Characteristic	Symbol	TEST CONDITIONS: DC Collector Volts V_{CB}	V_{CE}	DC Emitter Volts V_{EB}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS Min.	Max.	Units
Collector-Cutoff Current at T_{FA} = 25° C	I_{CBO}	30			0				0.1	μa
Emitter-Cutoff Current	I_{EBO}			3			0		100	μa
Collector-to-Emitter Sustaining Voltage with External Base-to-Emitter Resistance (R_{BE}) = 10 ohms	V_{CER}(sus)						500*	90		volts
Collector-to-Emitter Sustaining Voltage	V_{CEO}(sus)					0	500*	80		volts
Reverse Collector-to-Emitter Breakdown Voltage	BV_{CEX}			1.5			0.25	100		volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4		volts
Base-to-Emitter Saturation Voltage	V_{BE}(sat)					100	1000		1.4	volts
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)					100	1000		0.6	volts
DC Forward Current Transfer Ratio	h_{FE}		4				500	40		
Input Capacitance (at 1 Mc)	C_{ib}			3			0		300	pf
Feedback Capacitance (at 1 Mc)	$C_{b'c}$	28					0		20	pf
Pulse-Amplifier Rise Time	t_r		V_{cc}=80				25		20	nsec
Sat. Switch Turn-On Time— Delay Time + Rise Time	t_{on}		28		I_{B1}=I_{B2} =100		1000		40	nsec
Sat. Switch Turn-Off Time— Storage + Fall Time	t_{off}		28		I_{B1}=I_{B2} = 100				750	nsec
Forward Current Transfer Ratio (at 50 Mc)	h_{fe}		28				100	3		

* Pulsed; pulse duration = 15 μsec; duty factor = 0.15%.

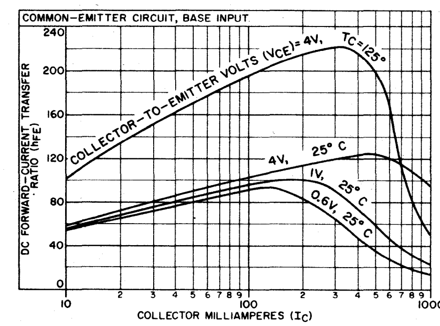


Fig. 1 - DC forward-current transfer ratio as a function of collector current.

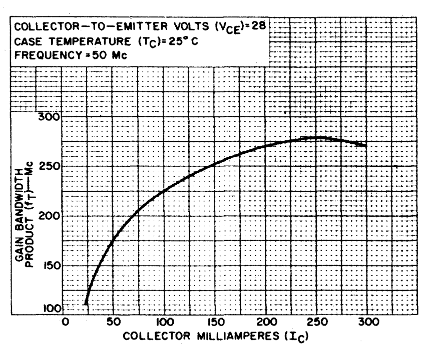


Fig. 2 - Gain-bandwidth product as a function of collector current.

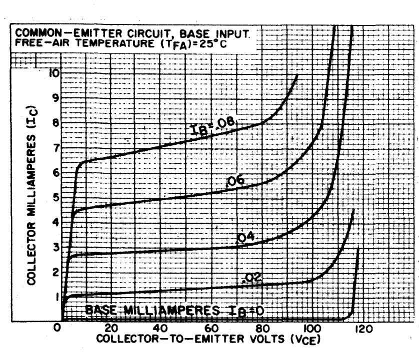


Fig. 3 - Typical transfer characteristics.

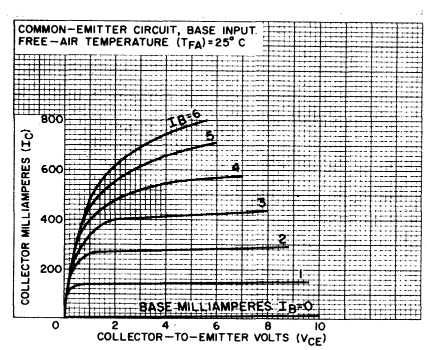


Fig. 4 - Typical small-signal transfer characteristics.

2N3375, 2N3553, 2N3632 , 40665, 40666
SILICON N-P-N OVERLAY TRANSISTORS

For VHF-UHF Applications

Maximum Ratings, *Absolute-Maximum Values:*

		2N3553	2N3375 40666	2N3632 40665	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	65	65	V
COLLECTOR-TO-EMITTER VOLTAGE:					
With base open	V_{CEO}	40	40	40	V
With $V_{BE} = -1.5V$	V_{CEV}	65	65	65	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	4	4	V
COLLECTOR CURRENT:					
Peak		1.0	1.5	3.0	A
Continuous	I_C	0.33	0.5	1.0	A
TRANSISTOR DISSIPATION	P_T				
At case temperatures up to 25° C		7.0	11.6	23	W

At case temperature above 25° C. Derate linearly to 0 watts at 200° C

	2N3553 2N3375 2N3632 40666 40665	
TEMPERATURE RANGE: Storage & Operating (Junction)	-65 to 200	°C
LEAD TEMPERATURE (During soldering): At distances ≥ 1/32 in. (.793 mm) from insulating wafer (TO-60 package) or from seating plane (TO-39 package) for 10 s max	230	°C

Features:

- **High Power Output, Class-C Amplifier:**

TYPE	400 MHz	260 MHz	175 MHz	100 MHz
2N3632 40665		10 W Typ.	13.5 W Min.	
2N3553		2.5 W Typ.	2.5 W Min.	
2N3375 40666	3 W Min.			7.5 W Min.

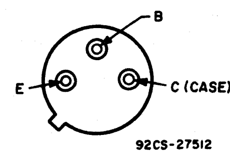
- **High Power Output, Oscillator:**
  2.5W (Typ.) at 500 MHz, (2N3375)
  1.5W (Typ.) at 500 MHz, (2N3553)
- **High Voltage Ratings**
- **Internally Grounded Emitter Types (40665 and 40666) available.**

ELECTRICAL CHARACTERISTICS: *At Case Temperature (T_C) = 25°C*

Characteristic	Symbol	TEST CONDITIONS: DC Collector Volts V_{CB}	DC Collector Volts V_{CE}	DC Base Volts V_{BE}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS: 40665 2N3632 Min.	Max.	2N3553 Min.	Max.	40666 2N3375 Min.	Max.	Units
Collector-Cutoff Current	I_{CEO}		30			0		-	0.25	-	0.1	-	0.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$				0		0.1	-	-	-	-	65	-	V
					0		0.3	-	-	65	-	-	-	
					0		0.5	65	-	-	-	-	-	
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$					0	0 to 200[a]	40[b]	-	40[b]	-	40[b]	-	V
	$V_{(BR)CEV}$			−1.5			0 to 200[a]	65[b]		65[b]		65[b]	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.1		0	-	-	4	-	4	-	V
					0.25		0	4	-	-	-	-	-	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					100	500	-	1	-	-	-	1	V
						50	250	-	-	-	1	-	-	
Collector-to-Base Capacitance Measured at 1 MHz	C_{obo}	30			0		-	-	20	-	10	-	10	pF
RF Power Output Amplifier, Unneutralized At 100 MHz	P_{OE}		28					-	-	-	-	7.5[c]	-	W
175 MHz			28					13.5[e]	-	2.5[g]	-	-	-	
260 MHz			28					10[f]	(typ.)	-	-	-	-	
400 MHz			28					-	-	-	-	3[d]	-	
Gain-Bandwidth Product	f_T		28				100	-	-	500	(typ.)	-	-	MHz
			28				150	400	(typ.)	-		500	(typ.)	
Base-Spreading Resistance Measured at 100 MHz	$r_{bb'}$		28				100	-	-	12.0	(typ.)	-	-	ohms
200 MHz			28				250	6.5	(typ.)	-	-	-	-	
400 MHz			28				250	-	-	-	-	10.0	(typ.)	

[a]Pulsed through an inductor (25 mH); duty factor = 50%.
[b]Measured at a current where the breakdown voltage is a minimum.
[c]For P_{IE} = 1.0 W; minimum efficiency = 65%.
[d]For P_{IE} = 1.0 W; minimum efficiency = 40%.
[e] For P_{IE} = 3.5 W; minimum efficiency = 70%.
[f] For P_{IE} = 3.0 W; typical efficiency = 60%.
[g]For P_{IE} = 1/4 W; minimum efficiency = 50%.

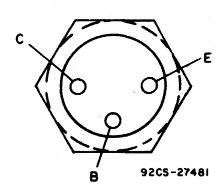
TERMINAL DESIGNATIONS



LEAD 1 - EMITTER
LEAD 2 - BASE
LEAD 3 - COLLECTOR, CASE

2N3553

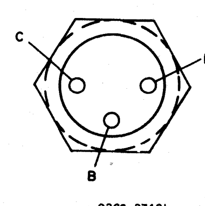
JEDEC TO-39



PIN 1 - EMITTER
PIN 2 - BASE
PIN 3 - COLLECTOR
STUD - NO CONNECTION

2N3632
2N3375

JEDEC TO-60



PIN 1 - EMITTER, CASE
PIN 2 - BASE
PIN 3 - COLLECTOR
STUD - EMITTER

40666
40665

JEDEC TO-60

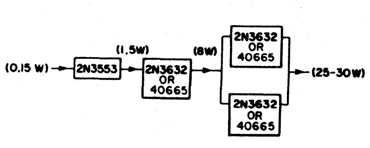


Fig. 1 - Typical 175-MHz amplifier chain for P_{OE} of 25 to 30 years.

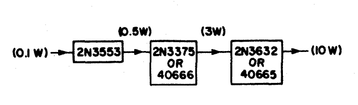


Fig. 2 - Typical 260-MHz amplifier chain for P_{OE} of 10 watts.

All the pins of the 2N3632 and 2N3375 are electrically isolated from the case. In the 40665 and 40666 (variants of types 2N3632 and 2N3375, respectively), the emitter is connected internally to the case.

2N3375, 2N3553, 2N3632, 40665, 40666

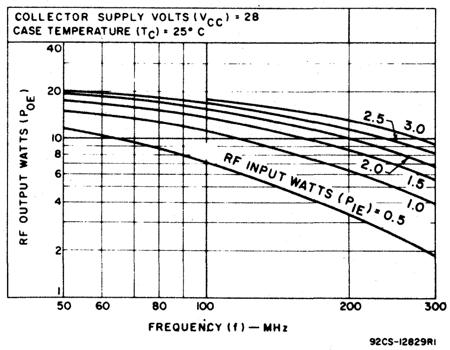


Fig. 3 - Power output as a function of frequency for 2N3632 and 40665.

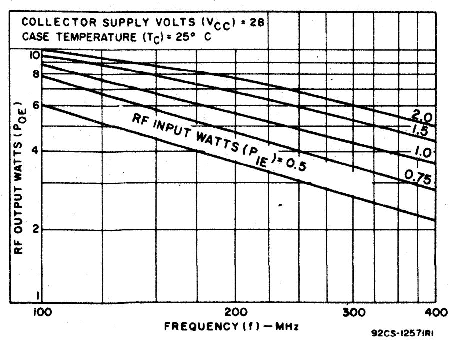


Fig. 4 - Power output as a function of frequency for 2N3375 and 40666.

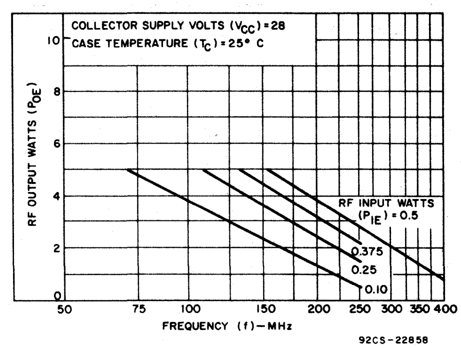


Fig. 5 - Power output as a function of frequency for type 2N3553.

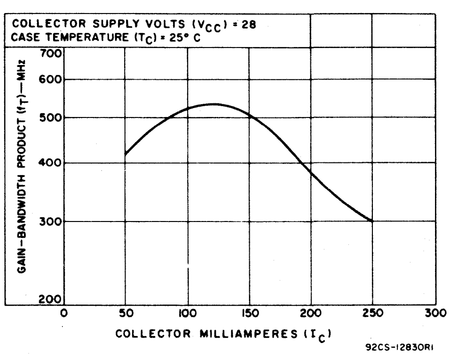


Fig. 6 - Gain-bandwidth product as a function of collector current for types 2N3632 and 40665.

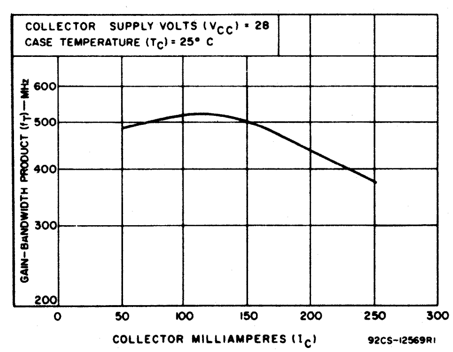


Fig. 7 - Gain-bandwidth product as a function of collector current for types 2N3375 and 40666.

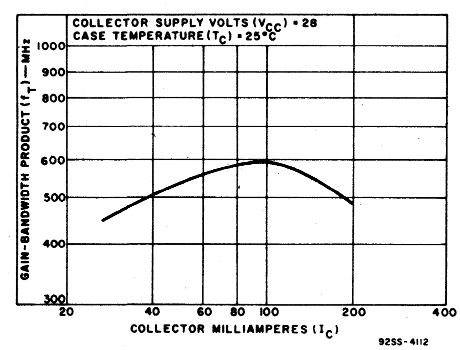


Fig. 8 - Gain-bandwidth product as a function of collector current for 2N3553.

2N3478

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

For VHF/UHF Applications in Industrial and Commercial Equipment

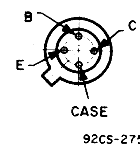
Features:

- high gain-bandwidth product – f_T = 900 MHz typ.
- low noise figure NF = 5 dB typ. at 470 MHz; 4.5 dB max. at 200 MHz; 2.5 dB typ. at 60 MHz
- high unneutralized power gain G_{pe} = 11.5 dB min. at 200 MHz
- hermetically sealed four-lead package
- all active elements insulated from case
- low collector-to-base feedback capacitance, C_{cb} 0.7 pF max.

Maximum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage, V_{CBO} . . . . . 30 max. V
Collector-to-Emitter Voltage, V_{CEO} . . . . . 15 max. V
Emitter-to-Base Voltage, V_{EBO} . . . . . 2 max. V
Collector Current, I_C . . . . . limited by dissipation
Transistor Dissipation, PT:
  at ambient temperatures } up to 25° C . . . . . 200 max. mW
  } above 25° C . . . . . See *Fig. 1*
Temperature Range:
  Storage and Operating (Junction) −65 to 200 °C
Lead Temperature (During Soldering):
  At distances not closer than 1/32" to seating surface for 10 seconds max. . . . . . 265 max. °C

TERMINAL DESIGNATIONS



JEDEC TO-72

ELECTRICAL CHARACTERISTICS, *At an Ambient Temperature (T_A) of 25° C*

Characteristics	Symbols	TEST CONDITIONS: Frequency f (MHz)	DC Collector-to-Base Voltage V_{CB} (V)	DC Collector-to-Emitter Voltage V_{CE} (V)	DC Emitter Current I_E (mA)	DC Collector Current I_C (mA)	LIMITS Type 2N3478 Min.	Typ.	Max.	Units
Collector-Cutoff Current	I_{CBO}		1		0		–	–	0.02	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0	0.001	30	–	–	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0.001	15	–	–	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				-0.001	0	2	–	–	V
Static Forward-Current Transfer Ratio	h_{FE}			8		2	25	–	150	
Magnitude of Small-Signal Forward-Current Transfer Ratio	h_{fe} [a]	100		8		2	7.5	9	16	
Collector-to-Base Feedback Capacitance	C_{cb} [b]	1	10		0		–	–	1	pF
Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit	G_{pe} [a]	200		8		2	11.5	–	17	dB
Small-Signal, Common-Emitter Power Gain in Neutralized Amplifier Circuit	G_{pe} [a, c]	470		6		1.5	–	12	–	dB
UHF Noise Figure	NF [a, c]	470		6		1.5	–	5	–	dB
VHF Noise Figure	NF [a]	200		8		2	–		4.5	dB
	NF [a, d]	60		8		1	–	2.5	–	dB

[a] Fourth lead (case) grounded.
[b] C_{cb} is a three terminal measurement of the collector-to-base capacitance with the emitter and case connected to the guard terminal.
[c] Source Resistance, R_s = 50 ohms.
[d] Source Resistance, R_s = 400 ohms.

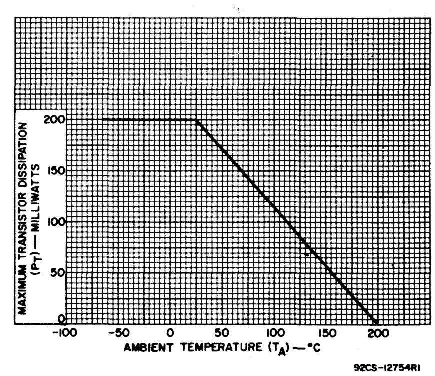


Fig. 1 - Rating chart for type 2N3478

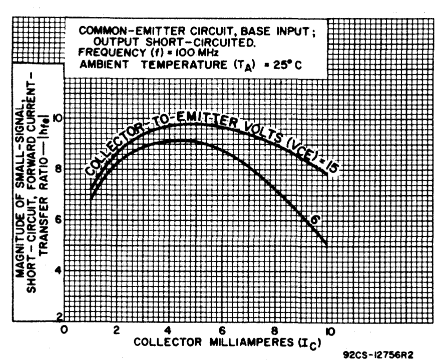


Fig. 2 - Typical small-signal beta characteristics for type 2N3478

2N3733

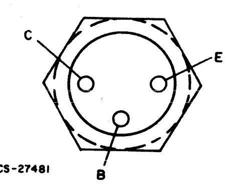
10-W, 400-Mc Silicon N-P-N Overlay Transistor

For Large-Signal, High-Power VHF/UHF Applications

Features:

- **High power output, unneutralized Class C amplifier:**
  at 400 Mc — 10 W min.
  at 260 Mc — 14.5 W typ.
- **High voltage ratings:**
  V_{CBO} = 65 V max.
  V_{CEV} = 65 V max.
  V_{CEO} = 40 V max.
- **100 per cent tested to assure freedom from second breakdown for operation in Class A applications**
- **Low thermal resistance**

TERMINAL DESIGNATIONS



JEDEC TO-60

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base-emitter junction reverse-biased (V_{BE} = -1.5 V)	V_{CEV}	65	V
*With base open	V_{CEO}	40	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
*COLLECTOR CURRENT:			
Continuous	I_C	1	A
Peak		3	A
*CONTINUOUS BASE CURRENT	I_B	1	A
*TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		23	W
At case temperatures above 25°C		Derate linearly to 0 watts at 200°C	
*TEMPERATURE RANGE:			
Storage and operating (junction)		-65 to 200	°C
*LEAD TEMPERATURE (During soldering):			
At distances ⩾ 1/32 in. (0.8 mm) from insulating wafer for 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT mA dc I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
* Collector Cutoff Current: With base open	I_{CEO}		30			0		-	0.25	mA
With base-emitter junction reverse-biased	I_{CEV}		65	-1.5				-	5	mA
At T_C = 200°C			30	-1.5				-	10	mA
With emitter open	I_{CBO}	65						-	0.5	mA
* Emitter Cutoff Current	I_{EBO}			-4				-	0.25	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$				0		0.5	65	-	V
Collector-to-Emitter Breakdown Voltage: With base-emitter junction reverse-biased	$V_{(BR)CEV}$			-1.5			0 to 200●	65**	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.25		0	4	-	V
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$					0	200	40	-	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$						200	40	-	V
* DC Forward Current Transfer Ratio	h_{FE}		5 5				1 0.25	5 10	- 150	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					200	1000	-	1	V
* Base-Emitter Voltage	V_{BE}		5				1000	-	1.5	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 100 Mc)	$\|h_{fe}\|$		28 28				250 250	2.5* 4.0 (typ.)	-	
* Collector-to-Base Capacitance (f = 0.1 to 1 Mc)	C_{ob}	28					250	-	25	pF
* Available Amplifier Signal Input Power P_o = 10 W, Z_G = 50 Ω, f = 400 Mc	P_i							-	4	W
* Collector Circuit Efficiency P_o = 10 W, Z_G = 50 Ω, f = 400 Mc	η_C							45	-	%
Base-Spreading Resistance Measured at 200 Mc	$r_{bb'}$		28				250	6.5 (typ.)		Ω
Collector-to-Case Capacitance	C_s							-	6	pF
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$							-	7.5	°C/W

●Pulsed through an inductor (25 mH); duty factor = 50%

**Measured at a current where the breakdown voltage is a minimum

*In accordance with JEDEC registration data

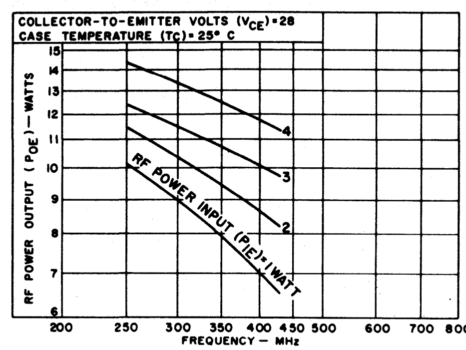


Fig. 1 - Power output as a function of frequency

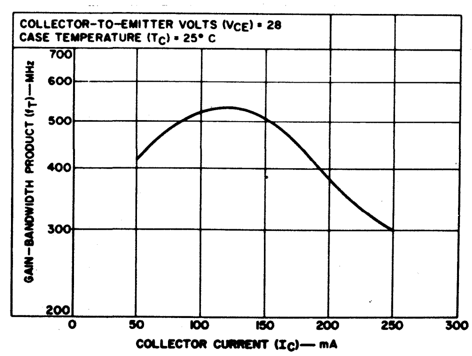


Fig. 2 - Gain-bandwidth product as a function of collector current.

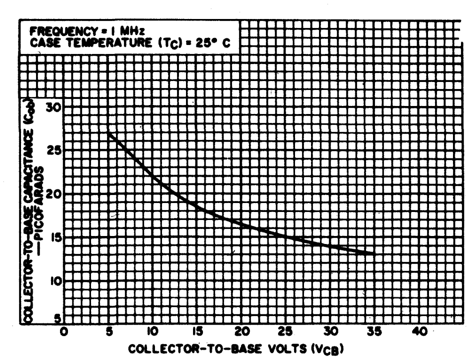


Fig. 3 - Variation of collector-to-base capacitance.

2N3839

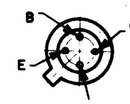
SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

For Low-Noise UHF Applications in Industrial and Military Equipment

Features:

- very low device noise figure — NF = 3.4 dB max. as 450-MHz amplifier
- high gain-bandwidth product — f_T = 1000 MHz min.
- high converter (450-to-30 MHz) gain — G_c = 15 dB typ. for circuit bandwidth of approximately 2 MHz
- high power gain as neutralized amplifier — G_{pe} = 12.5 dB min. at 450 MHz for circuit bandwidth of 20 MHz
- high power output as UHF oscillator — P_o = 30 mW min., 40 mW typ. at 500 MHz = 20 mW typ. at 1 GHz
- low collector-to-base time constant — $r_b'C_c$ = 7 ps typ.
- low collector-to-base feedback capacitance — C_{cb} = 0.6 pF typ.

TERMINAL DESIGNATIONS



JEDEC TO-72

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	30 max.	V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	15 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	2.5 max.	V
COLLECTOR CURRENT, I_C	40 max.	mA
TRANSISTOR DISSIPATION, P_T:		
For operation with heat sink:		
At case temperatures** up to 25°C	300 max.	mW
At case temperatures** above 25°C	Derate at 1.72 mW/°C	
For operation at ambient temperatures:		
At ambient temperatures up to 25°C	200 max.	mW
At ambient temperatures above 25°C	Derate at 1.14 mW/°C	
TEMPERATURE RANGE:		
Storage and Operating (Junction)	-65 to +200	°C
LEAD TEMPERATURE (During Soldering):		
At distances ≥ 1/32 inch from seating surface for 10 seconds max.	265 max.	°C

ELECTRICAL CHARACTERISTICS

CHARACTERISTICS	SYMBOL	TEST CONDITIONS: FREQUENCY f (MHz)	DC COLLECTOR-TO-BASE VOLTAGE V_{CB} (V)	DC COLLECTOR-TO-EMITTER VOLTAGE V_{CE} (V)	DC EMITTER-TO-BASE VOLTAGE V_{EB} (V)	DC EMITTER CURRENT I_E (mA)	DC BASE CURRENT I_B (mA)	DC COLLECTOR CURRENT I_C (mA)	LIMITS TYPE 2N3839 Min.	Typ.	Max.	UNITS
Collector-Cutoff Current T_A = 25°C	I_{CBO}		15			0			-	-	10	nA
T_A = 150°C			15			0			-	-	1.0	µA
Collector-to-Base Breakdown Voltage	BV_{CBO}					0		0.001	30	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}						0	3	15	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					0.01		0	2.5	-	-	V
Static Forward Current-Transfer Ratio	h_{FE}			1				3	30	-	150	
Small-Signal Forward Current-Transfer Ratio	h_{fe}	0.001[c]		6				2	50	-	220	
		100[c]		6				5	10	-	20	
Collector-to-Base Feedback Capacitance	C_{cb}	0.1 to 1.0[b]	10			0			-	0.6	1.0	pF
Input Capacitance	C_{ib}	0.1 to 1.0			0.5			0	-	1.4	-	pF
Collector-to-Base Time Constant	$r_b'C_c$	31.9[c]	6			-2			1	7	15	ps
Small-Signal, Common-Emitter Power Gain in Neutralized Amplifier Circuit	G_{pe}	450[c]		6				1.5	12.5	-	19	dB
Power Output as Oscillator	P_o	≥500[a]	10			-12			30	-	-	mW
UHF Measured Noise Figure	NF	450[c,d]		6				1.5	-	-	3.9	dB
UHF Device Noise Figure	NF	450[c,d,f]		6				1.5	-	-	3.4	dB
VHF Measured Noise Figure	NF	60[c,e]		6				1	-	2	-	dB

[a] Lead No.4 (case) not connected.

[b] 3-terminal measurement with emitter and case connected to guard terminal.

[c] Lead No.4 (case) grounded.

[d] Generator resistance, R_g = 50 ohms.

[e] Generator resistance, R_g = 400 ohms.

[f] Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test circuit (0.25 dB) and the contribution of the following stages in the test setup (0.25 dB).

2N3866

Silicon N-P-N Overlay Transistor

High-Gain Driver for VHF/UHF Applications in Military and Industrial Communications Equipment

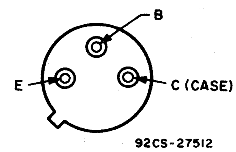
Features

- High Power Gain, Unneutralized Class C Amplifier
  - 1 W output at 400 MHz (10 dB gain)
  - 1 W output at 250 MHz (15 dB gain)
  - 1 W output at 175 MHz (17 dB gain)
  - 1 W output at 100 MHz (20 dB gain)
- Low Output Capacitance
  C_{obo} = 3 pF max.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

* COLLECTOR-TO-BASE VOLTAGE . . .	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 10Ω.	V_{CER}	55	V
* With base open	V_{CEO}	30	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
* CONTINUOUS COLLECTOR CURRENT	I_C	0.4	A
* CONTINUOUS BASE CURRENT	I_B	0.4	A
* TRANSISTOR DISSIPATION	P_T		
At case temperature up to 25°C		5	W
At case temperatures above 25°C . . .		See Fig. 2	
* TEMPERATURE RANGE:			
Storage & Operating (Junction).		–65 to +200	°C
* LEAD TEMPERATURE			
At distances ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		230	°C

TERMINAL DESIGNATIONS



JEDEC TO-39

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS DC Voltage (V) V_{CE}	V_{EB}	DC Current (mA) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
* Collector-Cutoff Current: Base-emitter junction reverse biased	I_{CEX}	55	1.5				–	0.1	mA
T_C = 200°C		30	1.5				–	0.1	mA
Base open	I_{CEO}	28			0		–	20	μA
* Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	55	–	V
* Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				0	5	30	–	V
With base connected to emitter through 10-ohm resistor	$V_{(BR)CER}$		0			5	55	–	V
* Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
* Emitter-Cutoff Current	I_{EBO}		3.5				–	0.1	mA
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				20	100	–	1.0	V
* DC Forward-Current Transfer Ratio	h_{FE}	5 5				360 50	5 10	– 200	
Thermal Resistance: (Junction-to-Case)	$\theta_{J\text{-}C}$						–	35	°C/W

DYNAMIC

TEST & CONDITIONS	SYMBOL	FREQUENCY MHz	LIMITS MINIMUM	MAXIMUM	UNITS
Power Output (V_{CC} = 28 V): P_{IE} = 0.1 W	P_{OE}	400	1.0	–	W
Large-Signal Common-Emitter Power Gain (V_{CC} = 28 V): P_{IE} = 0.1 W	G_{PE}	400	10	–	dB
* Collector Efficiency (V_{CC} = 28 V): P_{IE} = 0.1 W, P_{OE} = 1 W, Source Impedance = 50Ω	η_C	400	45	–	%
* Magnitude of Common-Emitter, Small Signal, Short-Circuit Forward-Current Transfer Ratio I_C = 50 mA, V_{CE} = 15 V	$\|h_{fe}\|$	200	2.5	–	
* Available Amplifier Signal Input Power, P_{OE} = 1 W, Source Impedance = 50Ω	P_i	400	–	0.1	W
* Common-Base Output Capacitance (V_{CB} = 28 V)	C_{obo}	1	–	3	pF

* In accordance with JEDEC registration data format JS-6 RDF-3

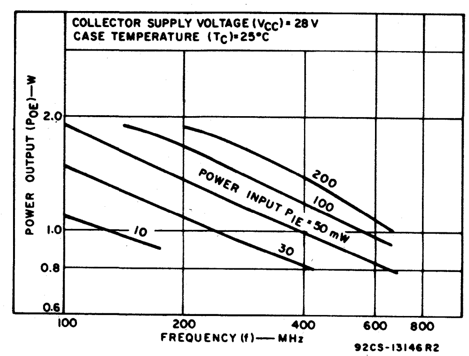


Fig. 1 - Power output as a function of frequency.

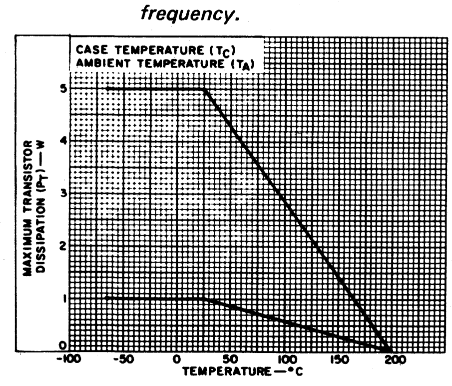


Fig. 2 - Dissipation derating curve.

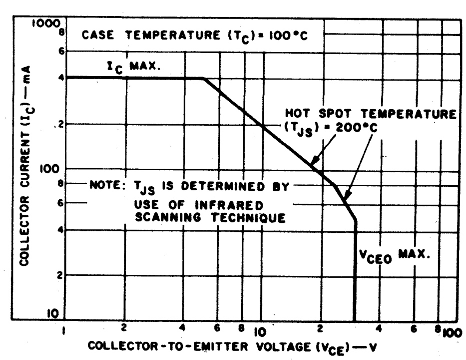


Fig. 3 - Safe area for dc operation.

2N4012

High-Power Silicon N-P-N Overlay Transistor

For Applications as a Frequency Multiplier Into the UHF or L-Band Range

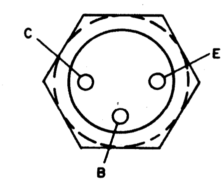
Features

- 2.5 W output with 4 dB conversion gain (min.) as tripler to 1 GHz
- 3 W output with 4.8 dB conversion gain (typ.) as doubler to 800 MHz
- High voltage ratings
- Freedom from second breakdown

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	40	V
With V_{BE} = −1.5 volts	V_{CEV}	65	V
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT	I_C	1.5	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		11.6	W
At case temperatures above 25°C		See Fig. 5	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to +200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from insulating wafer for 10 s max.		230	°C

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

ELECTRICAL CHARACTERISTICS, Case Temperature = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS		UNITS
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0		–	0.1	mA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0		0.1	65	–	volts
Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0	0 to 200[a]	40[b]	–	volts
	BV_{CEV}			-1.5			0 to 200[a]	65[b]	–	volts
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4	–	volts
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					100	500	–	1	volt
Collector-to-Base Capacitance	C_{ob}	30			0			–	10	pF
RF Power Output Tripler At 1002 Mc/s Doubler At 800 Mc/s	P_{OUT}		28 28					2.5[c] 3.0[d] (typ.)		watts
Gain-Bandwidth Product	f_T		28				150	500 (typ.)		Mc/s
Collector-to-Base Cutoff Frequency[e]	f_c		28				0	25 (typ.)		Gc/s

a Pulsed through an inductor (25 mH); duty factor = 50%.
b Measured at a current where the breakdown voltage is a minimum.
c For P_{IN} = 1.0 W; at 334 Mc/s; minimum collector efficiency = 25%.
d For P_{IN} = 1.0 W; at 400 Mc/s; typical collector efficiency = 35%.
e Cutoff frequency is determined from Q measurement at 210 Mc/s. The cutoff frequency of the collector-to-base junction of the transistor, f_c = Q x 210 Mc/s.

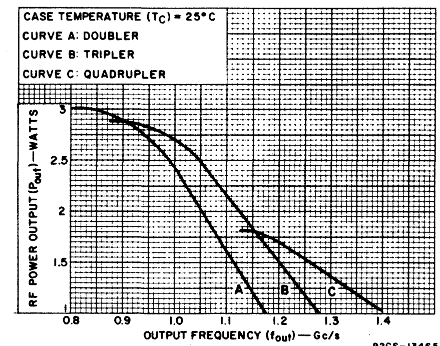


Fig. 1 - Output power as a function of output frequency.

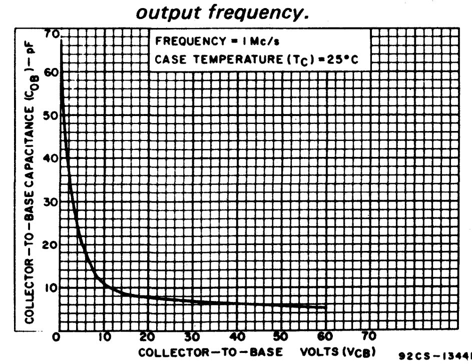


Fig. 2 - Collector-to-base capacitance as a function of collector-to-base voltage.

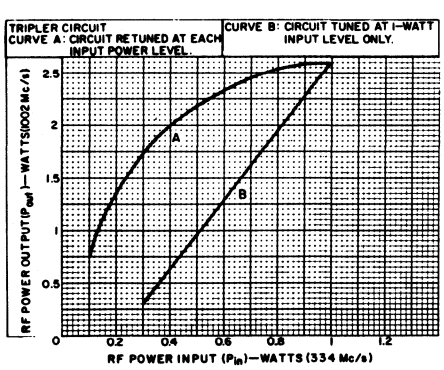


Fig. 3 - Power output as a function of power input.

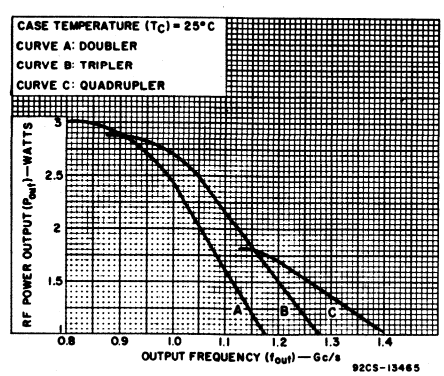


Fig. 4 - Power output as a function of collector supply voltage

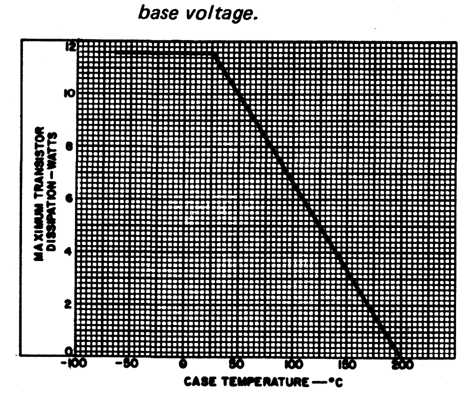


Fig. 5 - Dissipation derating curve.

2N4427

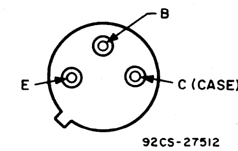
Silicon N-P-N Overlay Transistor

High-Gain Driver for VHF-UHF

Features:

- 1 W output with 10 dB gain (min.) at 175 MHz V_{CC} = 12 V
- 0.4 W output with 5 dB gain (typ.) at 470 MHz V_{CC} = 12 V

TERMINAL DESIGNATIONS



JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	V
* COLLECTOR-TO-EMITTER VOLTAGE: With base open	V_{CEO}	20	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	2	V
* CONTINUOUS COLLECTOR CURRENT	I_C	0.4	A
* CONTINUOUS BASE CURRENT	I_B	0.4	A
* TRANSISTOR DISSIPATION: At case temperatures up to 100°C	P_T	2	W
* TEMPERATURE RANGE: Storage & Operating (Junction)		−65 to 200	°C
* LEAD TEMPERATURE (During soldering): At distances ≥ 1/32 in. (0.8 mm) from insulating wafer for 10 s max.		230	°C

* In accordance with JEDEC registration data format JS-6 RDF-3.

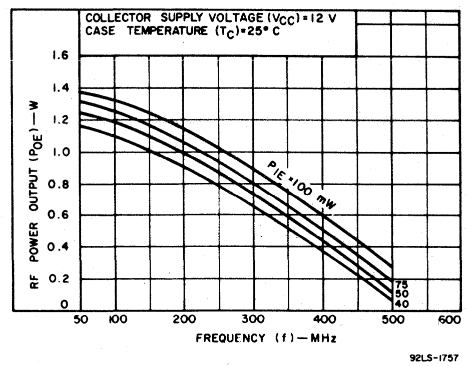


Fig. 1 - Power output as a function of frequency.

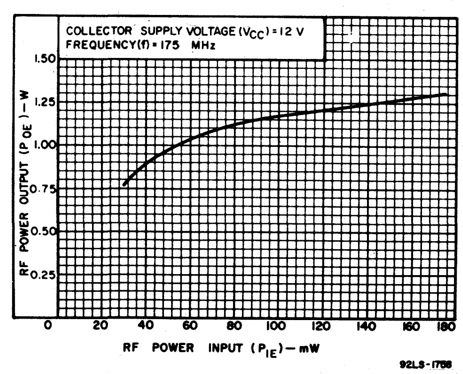


Fig. 2 - Power output as a function of power input at 175 MHz.

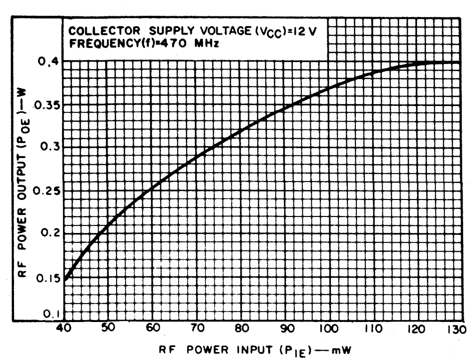


Fig. 3 - Power output as a function of power input at 470 MHz.

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C.

Characteristic	Symbol	TEST CONDITIONS: DC Voltage (V)				DC Current (mA)			Limits		Units
		V_{BE}	V_{EB}	V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
* Collector-Cutoff Current: With base open	I_{CEO}				12		0		–	0.02	mA
With base-emitter junction reverse-biased	I_{CEV}	−1.5			40				–	0.1	mA
T_C = 150°C	I_{CEV}	−1.5			12				–	5	mA
* Emitter-Cutoff Current	I_{EBO}		2						–	0.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$					0		0.1	40	–	V
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$						0	5	20	–	V
With external base-to-emitter resistance (R_{BE}) = 10Ω	$V_{CER}(sus)$							5	40	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$					0.1		0	2	–	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$						20	100	–	0.5	V
* DC Forward Current Transfer Ratio	h_{FE}				5 5			360 100	5 10	– 200	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 200 MHz)	$\|h_{fe}\|$				15			50	2.5	–	
* Collector-to-Base Capacitance (f = 1 MHz)	C_{ob}			12		0			–	4	pF
RF Power Output Class C Amplifier, Unneutralized (f = 175 MHz, P_{IE} = 0.1 W, η_C ≥ 50%)	P_{OE}			12 (V_{CC})					1	–	W
* Available Amplifier Signal Input Power (f = 175 MHz, P_{OE} = 1 W, Z_{IN} = 50 Ω)	P_i			12 (V_{CC})					–	0.1	W
* Collector Efficiency (f = 175 MHz, P_{OE} = 1 W, Z_{IN} = 50 Ω)	η_C			12 (V_{CC})					50	–	%
Thermal Resistance Junction-to-Case	$R_{\theta JC}$								–	50	°C/W

* In accordance with JEDEC registration data format JS–6 RDF–3.

2N4440

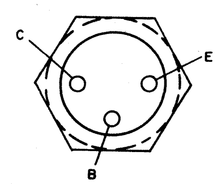
Silicon N-P-N Overlay Transistor

For Class A, B, or C VHF/UHF
Military and Industrial Communications Equipment

Features:

- 5 W output min. at 400 MHz
- 6.5 W output typ. at 225 MHz

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
*COLLECTOR-TO-EMITTER VOLTAGE:			
With base-emitter junction reverse-biased (V_{BE}) = -1.5 V	V_{CEV}	65	V
* With base open	V_{CEO}	40	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
*CONTINUOUS COLLECTOR CURRENT	I_C	1.5	A
*CONTINUOUS BASE CURRENT	I_B	0.2	A
*TRANSISTOR DISSIPATION▲:	P_T		
At case temperatures up to 25°C		11.6	W
At case temperatures above 25°C		See Fig. 2	
*TEMPERATURE RANGE:			
Storage and operating (junction)		-65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from insulating wafer for 10 s max		230	°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT mA dc I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
* Collector Cutoff Current: With base open	I_{CEO}		30			0		-	0.1	
With base-emitter junction reverse-biased	I_{CEV}		65	-1.5				-	1	mA
At T_C = 200°C			30	-1.5				-	5	
* Emitter Cutoff Current	I_{EBO}			-4				-	0.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$				0		0.1	65	-	V
Collector-to-Emitter Breakdown Voltage: With base-emitter junction reverse-biased	$V_{(BR)CEV}$			-1.5			0 to 200•	65**	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.1		0	4	-	V
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$					0	200•	40	-	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$						200•	40	-	
* DC Forward Current Transfer Ratio	h_{FE}		5 5				1350 125	3 10	- 200	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					50	250	-	1	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 100 MHz)	$\|h_{fe}\|$		28				125	4• 5 (typ.)	-	
* Collector-to-Base Capacitance (f = 1 MHz)	C_{ob}	28					125	-	12	pF
* Available Amplifier Signal Input Power (P_o = 5 W, Z_G = 50Ω, f = 400 MHz)	P_i							-	1.7	W
* Collector Circuit Efficiency (P_o = 5 W, Z_G = 50Ω, f = 400 MHz)	η_C							45	-	%
Base-Spreading Resistance Measured at 200 MHz	r_{bb}'		28				250	10 (typ.)		Ω
Collector-to-Case Capacitance	C_s							-	6	pF
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$							-	15	°C/W

•Pulsed through an inductor (25 mH); duty factor=50%
**Measured at a current where the breakdown voltage is a minimum
*In accordance with JEDEC registration data.

▲Secondary breakdown considerations limit maximum dc operating conditions. . .contact your RCA Representative for specific data.

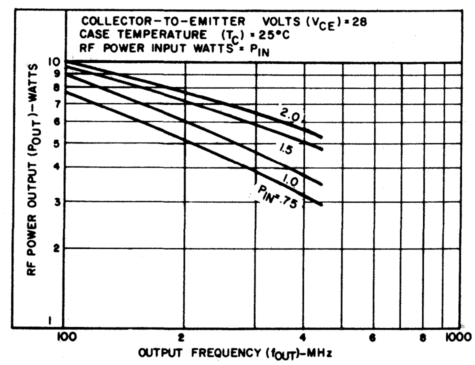


Fig. 1 - Typical power output as a function of frequency.

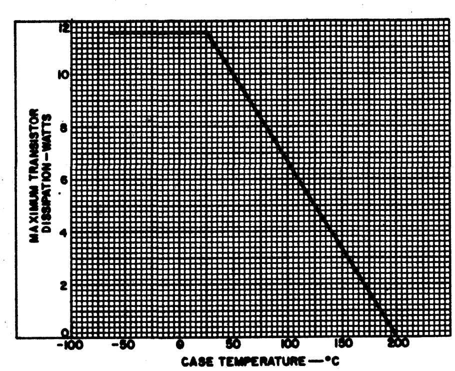


Fig. 2 - Dissipation derating chart.

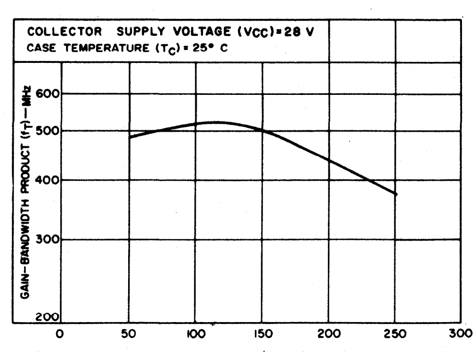


Fig. 3 - Typical gain-bandwidth product as a function of collector current.

2N4932, 2N4933
SILICON N-P-N "overlay" TRANSISTORS

For International VHF Mobile and Portable Communication, 66 to 88 MHz

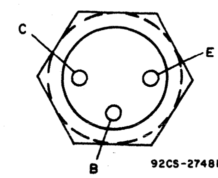
Features:

Operation From a Power Supply of –
13.5 volts (2N4932)
24 volts (2N4933)

Power Output (Min.) at 88 MHz
12 watts (2N4932)
20 watts (2N4933)

Load Protection
High Voltage Ratings

TERMINAL DESIGNATIONS



JEDEC TO-60

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

	Symbol	2N4932	2N4933	Units
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	70	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open	V_{CEO}	25	35	V
With V_{BE} = −1.5V	V_{CEV}	50	70	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4.0		V
COLLECTOR CURRENT:				
Peak		10		A
Continuous	I_C	3.3		A
RF INPUT POWER	P_{in}			
At 88 MHz		3.5		W
TRANSISTOR DISSIPATION	P_T			
At case temperatures up to 25° C		70		W
TEMPERATURE RANGE:				
Storage & Operating (Junction)		−65 to 200		°C
LEAD TEMPERATURE (During soldering):				
At distances ≥ 1/32 in. from insulating wafer for 10 s max.		230		°C

ELECTRICAL CHARACTERISTICS FOR 2N4932
Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS						Limits		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		15			0			1.0	mA
	I_{CBO}	40			0				10	mA
Collector-to-Emitter Breakdown Voltage	$V_{CEV}(sus)$			−1.5			200[a]	50		V
	$V_{CEO}(sus)$					0	200[a]	25		V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				10		0	4		V
Collector-to-Base Capacitance	C_{ob}	15			0				120	pF
RF Power Output	P_{out}							12[c]		W

ELECTRICAL CHARACTERISTICS FOR 2N4933
Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS						Limits		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)					
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		30			0			1.0	mA
	I_{CBO}	50			0				10	mA
Collector-to-Emitter Breakdown Voltage	$V_{CEV}(sus)$			−1.5			200[a]	70		V
	$V_{CEO}(sus)$					0	200[a]	35		V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				10		0	4		V
Collector-to-Base Capacitance	C_{ob}	30			0				85	pF
RF Power Output	P_{out}							20[b]		W

[a] Pulsed through an inductor (25mH), duty factor = 50%
[b] For P_{in} = 3.5 W, at 88 MHz; V_{cc} = 24V, minimum efficiency = 70%
[c] For P_{in} = 3.5 W, at 88 MHz; V_{cc} = 13.5V, minimum efficiency = 70%

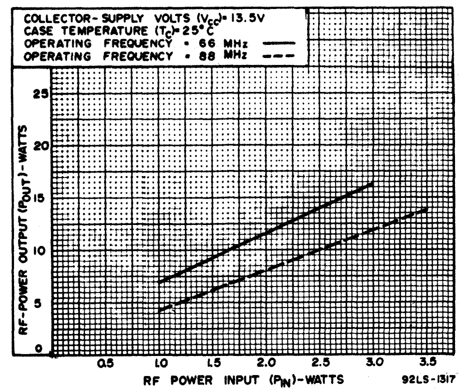


Fig. 1 - Typical power output as a function of power input for the 2N4932.

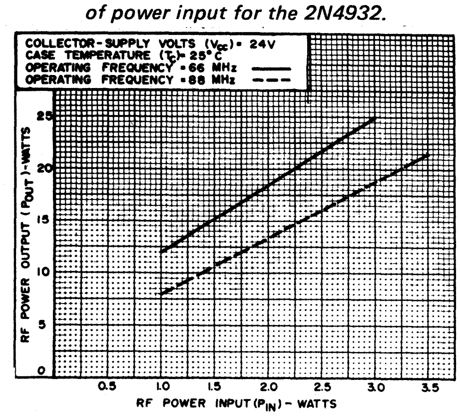


Fig. 2 - Typical power output as a function of power input for the 2N4933.

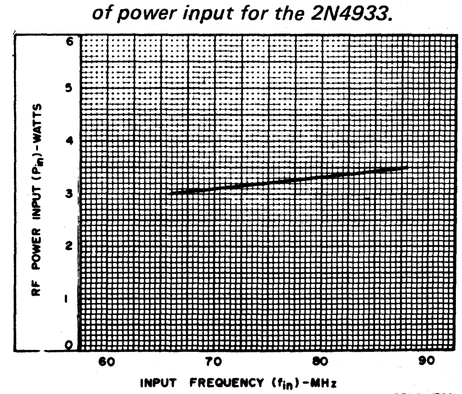


Fig. 3 - Input derating curve.

2N5016

High-Power Silicon N-P-N Overlay Transistor

For VHF/UHF Communications Equipment

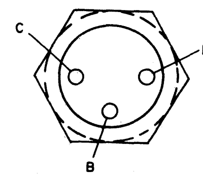
Features:

- For class B or C vhf/uhf military and industrial communications
- 15 W output (min.) at 400 MHz
- 23 W output (typ.) at 225 MHz
- Emitter grounded to case

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base-emitter junction reverse-biased, V_{BE} = −1.5 V	V_{CEV}	65	V
With external base-to-emitter resistance, R_{BE} = 30 Ω	V_{CER}	40	V
* With base open	V_{CEO}	30	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
*CONTINUOUS COLLECTOR CURRENT	I_C	4.5	A
*CONTINUOUS BASE CURRENT	I_B	1.5	A
*TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 50°C		30	W
At case temperatures above 50°C		See Fig. 1	
*TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
*LEAD TEMPERATURE (During soldering):			
At distances ≥1/32 in. (0.8 mm) from insulating wafer for 10 s max.		230	°C

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C*

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR OR BASE VOLTAGE – V: V_{CB}	V_{CE}	V_{BE}	DC CURRENT mA: I_E	I_B	I_C	LIMITS: MIN.	MAX.	UNITS
Collector-Cutoff Current With base open	I_{CEO}		30			0		–	10	mA
* With base-emitter junction reverse-biased	I_{CEV}		60	-1.5				–	10	mA
* T_C = 150°C	I_{CEV}		30	-1.5				–	10	mA
* Emitter Cutoff Current V_{BE} = 4 V	I_{EBO}							–	5	mA
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$					0	200[a]	30	–	V
* With external base-to-emitter resistance (R_{BE}) = 30 Ω	$V_{CER}(sus)$					0	200[a]	40	–	V
With base-emitter junction reverse-biased	$V_{CEV}(sus)$			-1.5			200[a]	65	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				5		0	4	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					400	2000	–	1	V
* DC Forward Current Transfer Ratio	h_{FE}		4 4				4500 500	3 10	– 200	
Thermal Resistance: Junction-to-Case	$R_{\theta J\text{-}C}$							–	5	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	MIN.	MAX.	UNITS
* Available Amplifier Signal Input Power (P_{OE} = 15 W, Z_{IN} = 50 Ω, V_{CC} = 28 V, f = 400 MHz)	P_i							–	5	W
* Collector Efficiency (P_{IE} = 5 W, P_{OE} = 15 W, Z_L = 50 Ω, f = 400 MHz)	η_C							50	–	%
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 400 MHz)	$\lvert h_{fe} \rvert$		15				500	1.25	–	
Gain-Bandwidth Product	f_T		15				500	600 (typ.)		MHz
* Collector-to-Base Capacitance (f = 1 MHz)	C_{ob}	30			0			–	25	pF

TYPICAL APPLICATION INFORMATION

CHARACTERISTIC	SYMBOL	V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	MIN.	MAX.	UNITS
RF Power Output Amplifier, Unneutralized At 225 MHz 400 MHz	P_{OE}		28 28					23[b] (typ.) 15[c]	 –	W
Dynamic Input Impedance at 400 MHz	Z_{IN}		28					2.5 + j5 (typ.)[c]		Ω

[a]Pulsed through an inductor (25 mH); duty factor = 50%.
[b]For P_{IE} = 5.0 W; minimum efficiency = 60%.
[c]For P_{IE} = 5.0 W; minimum efficiency = 50%.
*In accordance with JEDEC registration data.

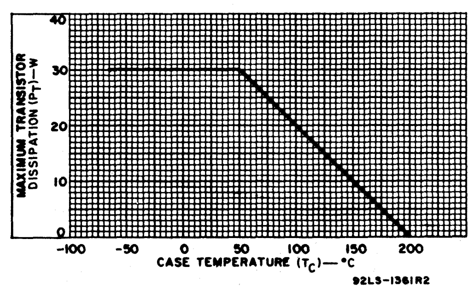


Fig. 1 - Dissipation derating curve.

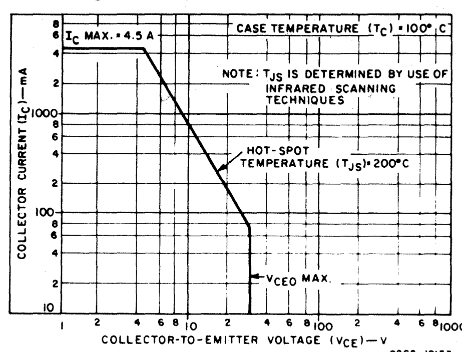


Fig. 2 - Safe area for dc operation.

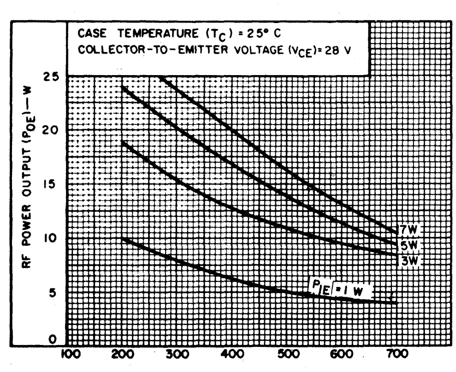


Fig. 3 - Typical power output as a function of frequency.

2N5070

Silicon N-P-N Overlay Transistor

For High-Frequency Single-Sideband Communications Equipment

Features:

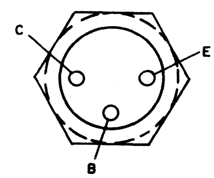
- Suitable for class A or class B amplifiers
- 25 W PEP output min. at 30 MHz with
  gain: 13 dB
  η: 40% min.,
  IMD: 30 dB max.
- Low thermal resistance

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base-emitter junction reverse-biased (V_{BE}) = −1.5 V	V_{CEV}	65	V
With external base-to-emitter resistance (R_{BE}) = 5Ω	V_{CER}	40	V
* With base open	V_{CEO}	30	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
*COLLECTOR CURRENT:	I_C		
Continuous		3.3	A
Peak		10	A
*CONTINUOUS BASE CURRENT	I_B	1	A
*TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		70	W
At case temperatures above 25°C		See Fig. 2	
*TEMPERATURE RANGE:			
Storage and operating (junction)		-65 to 200	°C
*LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from insulating wafer for 10 s max.		230	°C

*In accordance with JEDEC registration data

TERMINAL DESIGNATIONS



JEDEC TO-60

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25° C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT mA dc I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
* Collector Cutoff Current: With base-emitter junction reverse-biased	I_{CEV}		60	-1.5				–	10	mA
At T_C = 150° C	I_{CEV}		60	-1.5				–	10	mA
With emitter open	I_{CBO}		60		0			–	10	mA
With base open	I_{CEO}		30			0		–	5	mA
* Emitter Cutoff Current	I_{EBO}			4				–	10	mA
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased	V_{CEV}(sus)			-1.5			200[a]	65	–	V
* With base open	V_{CEO}(sus)					0	200[a]	30	–	V
* With external base-to-emitter resistance (R_{BE}) = 5Ω	V_{CER}(sus)						200[a]	40	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				10			4	–	V
* DC Forward Current Transfer Ratio	h_{FE}		5 5				3000 1000	10 20	100 –	
* Magnitude of Common-Emitter Small-Signal Short-Circuit Forward Current Transfer Ratio (f = 50 MHz)	$\|h_{fe}\|$		15				1000	2	–	
* Output Capacitance (f = 1 MHz)	C_{ob}	30			0			–	85	pF
* Available Amplifier Signal Input Power Z_G = 50Ω, P_o = 25 W(PEP) f_1 = 30 MHz, f_2 = 30.001 MHz	P_i							–	1.25 PEP	W
* Intermodulation Distortion Z_G = 50Ω, P_o = 25 W(PEP) f_1 = 30 MHz, f_2 = 30.001 MHz	IMD							–	30	dB
* Collector Efficiency Z_G = 50Ω, P_o = 25 W(PEP) f_1 = 30 MHz, f_2 = 30.001 MHz	η_C							40	–	%
Thermal Resistance Junction-to-Case	$R_{\theta JC}$							–	2.5	°C/W

*In accordance with JEDEC registration data format
[a]Pulsed through a 25-mH inductor; duty factor = 50%

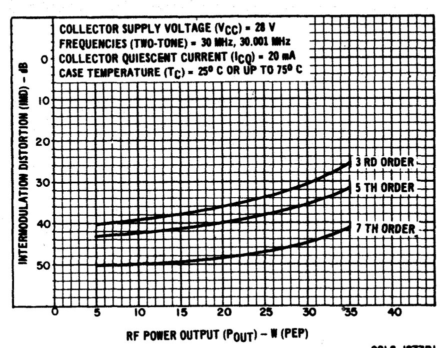


Fig. 1 - Typical intermodulation distortion as a function of rf power output.

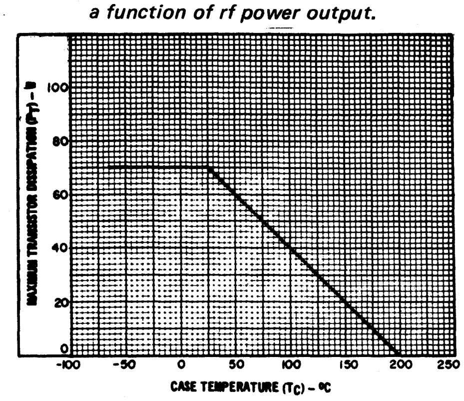


Fig. 2 - Dissipation derating chart.

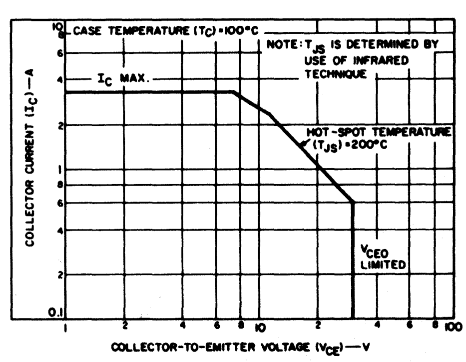


Fig. 3 - Safe operation with dc forward bias.

2N5071

24-W (CW), 76-MHz Emitter-Ballasted Overlay Transistor

Silicon N-P-N Device for 24-Volt Applications in VHF Communications Equipment

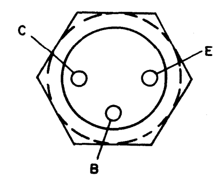
Features:

- For class B or class C amplifiers
- For 24-V FM (30 to 76 MHz) communications
- 24 W output at 76 MHz with 9 dB gain (Min.)
- Low thermal resistance

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
*COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}	30	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
*COLLECTOR CURRENT:			
Continuous	I_C	3.3	A
Peak		10	A
*CONTINUOUS BASE CURRENT	I_B	1	A
*TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		70	W
*TEMPERATURE RANGE:			
Storage and operating (junction)		−65 to 200	°C
*LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from insulating wafer for 10 s max.		230	°C

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

STATIC

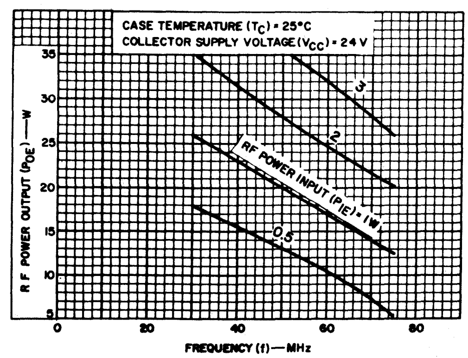
CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage-V V_{CB}	V_{CE}	DC Base Voltage-V V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
* Collector-Cutoff Current:	I_{CEV}		60	−1.5				–	10	mA
At T_C = 150°C			60	−1.5				–	10	
With base open	I_{CEO}		30			0		–	5	
With emitter open	I_{CBO}	60						–	10	
* Emitter-Cutoff Current	I_{EBO}			4				–	10	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$				0		200[a]	65	–	V
* Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				0		200[a]	30	–	V
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$					0	200[a]	30	–	V
With external base-to-emitter resistance (R_{BE}) = 5 Ω	$V_{CER}(sus)$						200[a]	40	–	
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$					10	0	4	–	V
* DC Forward Current Transfer Ratio	h_{FE}		5				3 A	10	100	
			5				1 A	20	–	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$							–	2.5	°C/W

[a]Pulsed through a 25-mH inductor; duty factor = 50%; repetition rate ≥ 60 Hz.

DYNAMIC

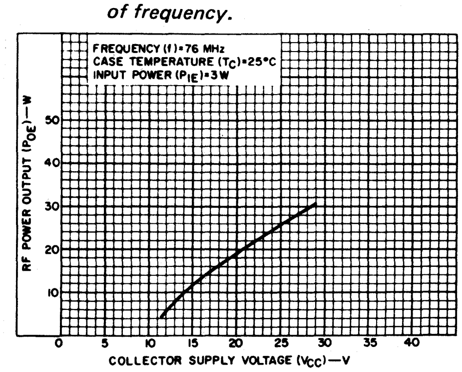
CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC})—V	Input Power (P_{IE})—W	Frequency (f) · MHz	LIMITS MIN.	MAX.	UNITS
Power Output	P_{OE}	24	3	76	24	–	W
Power Gain	G_{PE}	24	3	76	9	–	dB
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio	$\lvert h_{fe} \rvert$	V_{CE} = 15 V, I_C = 1A		50	2	–	
* Available Amplifier Signal Input Power	P_i	Source impedance (Zg) = 50	P_{OE} = 24 W	76	–	3	W
* Collector Efficiency	η_C	24	3	76	60	–	%
Load Mismatch	LM	24	1.2	30	GO/NO GO VSWR = 3:1		
* Collector-to-Base Capacitance	C_{obo}	V_{CB} = 30 V	–	1	–	85	pF

* In accordance with JEDEC registration data



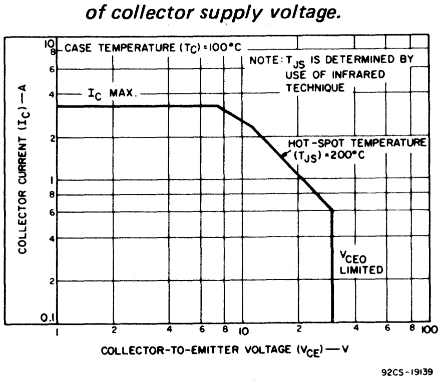
92LS-1836R2

Fig. 1 - Typical output power as a function of frequency.



92CS-19159

Fig. 2 - Typical output power as a function of collector supply voltage.



92CS-19139

Fig. 3 - Safe area for dc operation.

2N5090

High-Power Silicon N-P-N Overlay Transistor

High-Gain Type for Class A, B, or C Operation in VHF/UHF Circuits

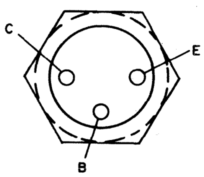
Features:

- Maximum safe-area-of-operation curve
- 1.2 W (min.) output at 400 MHz (7.8 dB gain)
- 1.6 W (typ.) output at 175 MHz (12 dB gain)
- Hermetic stud-type package
- All electrodes isolated from stud

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10Ω	V_{CER}	55	V
* With base open	V_{CEO}	30	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
*CONTINUOUS COLLECTOR CURRENT	I_C	0.4	A
*CONTINUOUS BASE CURRENT	I_B	0.4	A
*TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 100°C		4	W
At case temperatures above 100°C		Derate linearly at 0.04 W/°C	
*TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to +200	°C
*LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/16 in. (1.58 mm) from insulating wafer for 10 s max.		230	°C

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage-V V_{CE}	DC Base Voltage-V V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
* Collector-Cutoff Current: With base open	I_{CEO}	28			0		–	0.02	mA
With base-emitter junction reverse-biased	I_{CEV}	55	−1.5				–	0.1	mA
With base-emitter junction reverse-biased & T_C = 200°C	I_{CEV}	30	−1.5				–	5	mA
* Emitter-Cutoff Current	I_{EBO}		3.5				–	0.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	55	–	V
* Collector-to-Emitter Sustaining Voltage: With base-open	$V_{CEO}(sus)$				0	5	30	–	V
With external base-to-emitter resistance (R_{BE}) = 10Ω	$V_{CER}(sus)$					5	55[a]	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				20	100	–	1.0	V
* DC Forward-Current Transfer Ratio	h_{FE}	5 5				360 50	5 10	– 200	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	25	°C/W

[a]Pulsed through a 25-mH inductor; duty factor = 0.05%.

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage V	Output Power (P_{OE}) W	Input Power (P_{IE}) W	Collector Current (I_C) mA	Frequency (f) MHz	LIMITS MIN.	MAX.	UNITS
Power Output (Class C amplifier, unneutralized)	P_{OE}	V_{CC} = 28		0.2		400	1.2	–	W
Gain-Bandwidth Product	f_T	V_{CE} = 15			50		500	–	MHz
* Magnitude of Common Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio	$\lvert h_{fe} \rvert$	V_{CE} = 15			50		2.5	–	
* Available Amplifier Signal Input Power	P_i		1.2			400	–	0.2	W
* Collector Efficiency	η_C		1.2				45	–	%
* Collector-to-Base Capacitance	C_{obo}	V_{CB} = 30				1	–	3.5	pF

*In accordance with JEDEC registration data format JS-6 RDF-3.

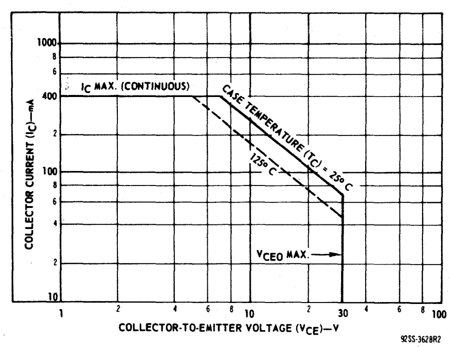


Fig. 1 - Safe area for dc operation.

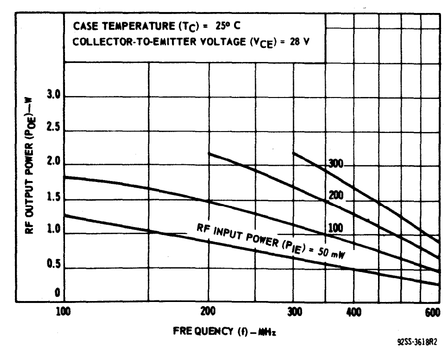


Fig. 2 - Typical output power as a function of frequency.

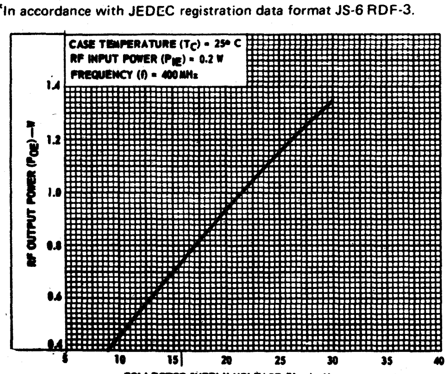


Fig. 3 - Typical output power as a function of collector supply voltage.

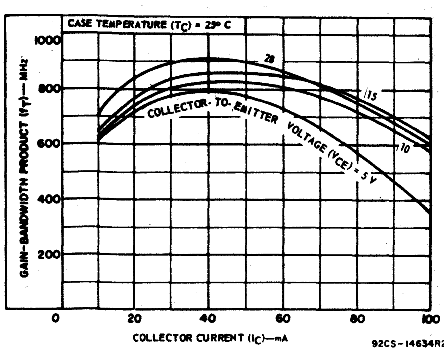


Fig. 4 - Typical gain-bandwidth product as a function of collector current.

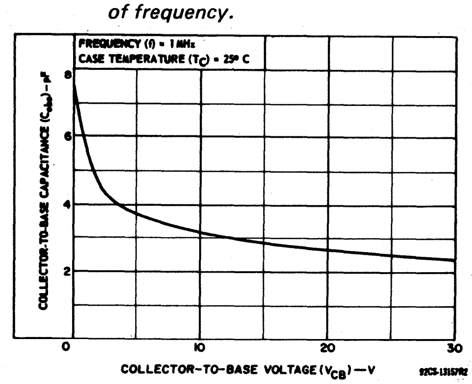


Fig. 5 - Typical variation of collector-to-base capacitance with collector-to-base voltage.

2N5102

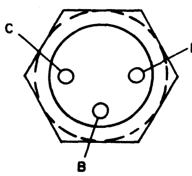
SILICON N-P-N "overlay" TRANSISTOR

High-Power Device for Class-C, AM Operation in VHF Circuits

Features:

- 15 Watts Output Min. at 136 MHz
- For 24-Volt Aircraft Communication
- Complete Load Mismatch Protection
- High Voltage Ratings
- Case Connected to Emitter

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = − 1.5 volts	V_{CEV}	100	V
With external base-to-emitter resistance R_{BE} = 5 Ω	V_{CER}	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT:			
Peak		10	A
Continuous	I_C	3.3	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		70	W
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max		230	°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc: V_{CB}	V_{CE}	V_{BE}	CURRENT mA dc: I_E	I_B	I_C	LIMITS: MIN.	MAX.	UNITS
* Collector Cutoff Current: With base-emitter junction reverse biased	I_{CEV}		83	−1.5				–	20	mA
* At T_C = 150°C	I_{CEV}		30	−1.5				–	10	mA
With external base-to-emitter resistance (R_{BE}) = 5 Ω	I_{CER}		50					–	10	mA
* Emitter Cutoff Current	I_{EBO}			−4				–	10	mA
* Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse biased	$V_{CEV}(sus)$			−1.5			600[a]	100	–	V
With external base-to-emitter resistance (R_{BE}) = 5 Ω	$V_{CER}(sus)$						200[a]	50	–	V
With base open	$V_{CEO}(sus)$					0	200[a]	35	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				10		0	4	–	V
* DC Forward Current Transfer Ratio	h_{FE}		4 4				3 A 0.5 A	10 10	– 100	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 150 MHz)	$\|h_{fe}\|$		24				500	1	–	
* Output Capacitance (f = 1 MHz)	C_{ob}	30			0			–	85	pF
* Available Amplifier Signal Input Power[b] (P_o = 15 W, Z_G = 50 Ω, f = 136 MHz)	P_i							–	6	W
* Collector Circuit Efficiency (P_{IE} = 6 W, Z_G = 50 Ω, f = 136 MHz)	η_C							70	–	%
Modulation (f = 118 MHz)	M		24 (V_{CC})					80	–	%
Load Mismatch (f = 118 MHz)	LM		24 (V_{CC})				1100	Will not be damaged		
Dynamic Input Impedance (P_{IE} = 6 W, f = 150 MHz)	Z_{IN}		24 (V_{CC})					1.7 + j 2.6 (typ)		Ω
Thermal Resistance (Junction to Case)	$R_{\theta JC}$							–	2.5	°C/W

*In accordance with JEDEC registration data.

[a] Pulsed through a 9-mH inductor; duty factor = 50%.

[b] Unmodulated carrier.

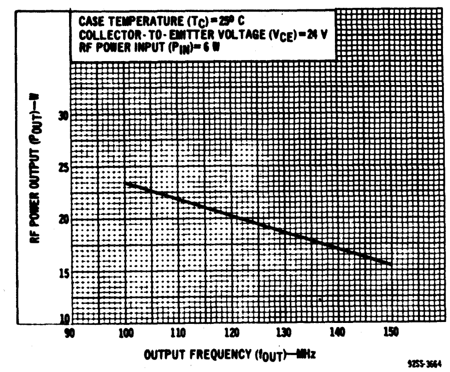


Fig. 1 - Typical power output as a function of frequency.

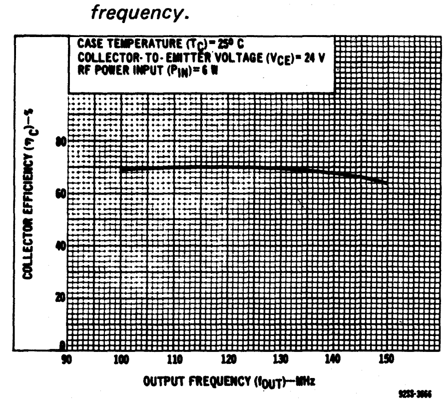


Fig. 2 - Typical collector efficiency as a function of output frequency.

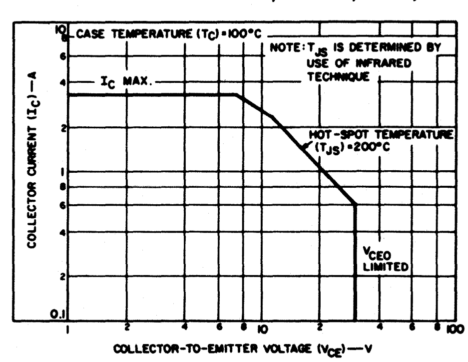


Fig. 3 - Safe operation area with dc forward bias.

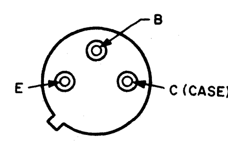
2N5109

Silicon N-P-N Overlay Transistor

High Gain for Line Amplifiers in CATV and MATV Equipment

Features:
- High gain-bandwidth product
- Large dynamic range
- Low distortion
- Low noise

TERMINAL DESIGNATION



JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	V
COLLECTOR-TO-EMITTER VOLTAGE:			
* With base open	V_{CEO}	20	V
With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	40	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	3	V
* CONTINUOUS COLLECTOR CURRENT	I_C	0.4	A
* CONTINUOUS BASE CURRENT	I_B	0.4	A
* TRANSISTOR DISSIPATION:	P_T		
At case temperature up to 75°C		2.5	W
* TEMPERATURE RANGE:			
Storage and operating (Junction)		-65 to +200	°C
* LEAD TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from the seating plane for 10 s max		230	°C

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR OR BASE VOLTAGE – V				DC CURRENT (mA)			LIMITS		UNITS
		V_{CB}	V_{BE}	V_{CE}	V_{EB}	I_E	I_B	I_C	MIN.	MAX.	
Collector-Cutoff Current: With base open	I_{CEO}			15			0		–	20	μA
* With base-emitter junction reverse-biased	I_{CEV}		-1.5	35					–	5	mA
* T_C = 150°C			-1.5	15					–	5	mA
* Emitter-Cutoff Current	I_{EBO}				3				–	0.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$					0		0.1	40	–	V
* Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$[a]							5	40	–	V
With base open	$V_{CEO}(sus)$						0	5	20	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$					0.1		0	3	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$						10	100	–	0.5	V
* Collector-to-Base Capacitance (f = 1 MHz)	C_{cb}	15				0			–	3.5	pF
* DC Forward-Current Transfer Ratio	h_{FE}			15 5				50 360	40 5	120 –	
Small-Signal Common-Emitter Forward Current Transfer Ratio (f = 200 MHz)	h_{fe}			15 15 15				25 50 100	4.8 6 4.8	– – –	
* Magnitude of Common-Emitter Small-Signal Forward Current Transfer Ratio (f = 200 MHz)	$\|h_{fe}\|$			15				50	6	–	
* Available Amplifier Signal Input Power (P_{out} = 1.26 mW, Source Impedance = 50 Ω, f = 200MHz)	P_i	15 (V_{CC})						50	–	0.1	mW
* Voltage Gain, Wideband, 50 to 216 MHz	G_{VE}			15				50	11		dB
Cross Modulation @ 54 dBmV[b] Output	CM			15				50	–57 (typ.)		dB
Power Gain, Narrowband (f = 200 MHz, P_{IN} = –10 dBm)	G_{PE}			15				10	11		dB
Noise Figure (f = 200 MHz)	NF			15				10	3 (typ.)		dB

[a]Pulsed through a 25 mH inductor; duty factor = 50%

[b] O dBmV = 1 millivolt

* In accordance with JEDEC registration data

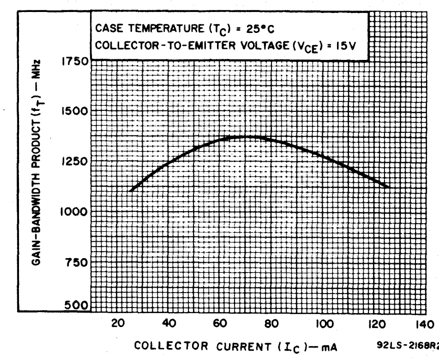


Fig. 1 - Gain-bandwidth product as a function of collector current.

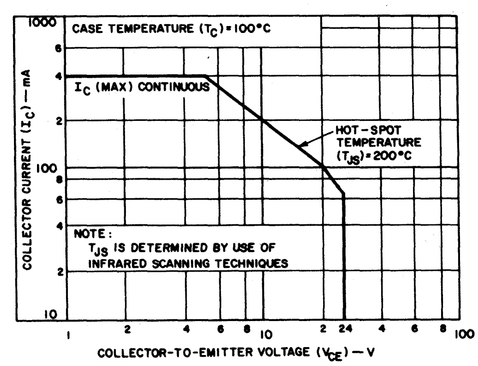


Fig. 2 - Maximum operating area.

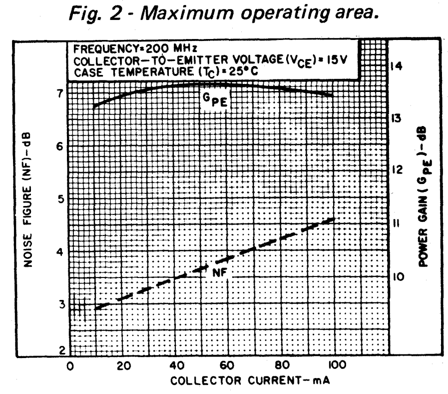


Fig. 3 - Power gain and noise figure as a function of collector current.

2N5179

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

For UHF Applications in Military, Communications, and Industrial Equipment

Features:

- **high gain-bandwidth product — 1000MHz min.**
- **hermetically sealed TO-72 four-lead metal package**
- **low leakage current**
- **high power gain as neutralized amplifier — G_{pe} = 15dB min. at 200MHz**
- **high power output as UHF oscillator — 20mW typ. at 500MHz**
- **low noise figure — NF = 4.5dB max. at 200MHz**
- **low collector-to-base time constant — $r_b'C_c$ = 14ps max.**
- **high reliability — production lots of RCA-2N5179 are subjected to and meet the minimum mechanical, environmental, and life-test requirements of the basic MILITARY specification MIL-S-19500. See Fig. 2 for a description of the Group A and Group B Tests.**

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE, V_{CBO} .... 20 max. V

COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO} .... 12 max. V

EMITTER-TO-BASE VOLTAGE, V_{EBO} .... 2.5 max. V

COLLECTOR CURRENT, I_C ...... 50 max. mA

TRANSISTOR DISSIPATION, P_T:

For operation with heat sink:

At case temperatures** { up to 25°C ... 300 max. mW; above 25°C ... Derate at 1.71mW/°C

For operation at ambient temperatures:

At ambient temperatures { up to 25°C ... 200 max. mW; above 25°C ... Derate at 1.14mW/°C

TEMPERATURE RANGE:

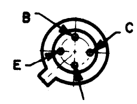
Storage and Operating (Junction) . −65 to +200 °C

LEAD TEMPERATURE (During Soldering):

At distances ≥ 1/32″ from seating surface for 10 seconds max. ..... 265 max. °C

** Measured at center of seating surface.

TERMINAL DESIGNATIONS



JEDEC TO-72

ELECTRICAL CHARACTERISTICS

Characteristics	Symbols	TEST CONDITIONS: Ambient Temp. T_A	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Collector Current I_C	DC Base Current I_B	LIMITS Type 2N5179 Min.	Typ.	Max.	Units
		°C	MHz	V	V	V	mA	mA	mA				
Collector-Cutoff Current	I_{CBO}	25 150		15 15			0 0			- -	- -	0.02 1	μA μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$	25					0	0.001		20	-	-	V
Collector-to-Emitter Sustaining Voltage	$V_{CEO}(sus)$	25						3	0	12	-	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$	25					−0.01	0		2.5	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	25						10	1	-	-	0.4	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$	25						10	1	-	-	1	V
Static Forward Current-Transfer Ratio	h_{FE}	25			1			3		25	70	250	
Magnitude of Small-Signal Forward Current-Transfer Ratio[a]	$\|h_{fe}\|$	25	100 1 kHz		6 6			5 2		9 25	14 90	20 300	
Collector-to-Base Feedback Capacitance[b]	C_{cb}	25	0.1 to 1	10			0			-	0.7	1	pF
Common-Base Input Capacitance[c]	C_{ib}	25	0.1 to 1			0.5		0		-	-	2	pF
Collector-to-Base Time Constant[a]	$r_b'C_c$	25	31.9	6				2		3	7	14	ps
Small-Signal Power Gain in Neutralized Common-Emitter Amplifier Circuit[a]	G_{pe}	25	200		12			5		15	21	-	dB
Power Output in Common-Emitter Oscillator Circuit[c]	P_o	25	>500	10			−12			20	-	-	mW
Noise Figure[a]	NF	25	200		6			1.5		-	3	4.5	dB

[a] Lead No.4(case) grounded; R_g = 125Ω

[b] Three-terminal measurement of the collector-to-base capacitance with the case and emitter leads connected to the guard terminal.

[c] Lead No. 4 (case) floating.

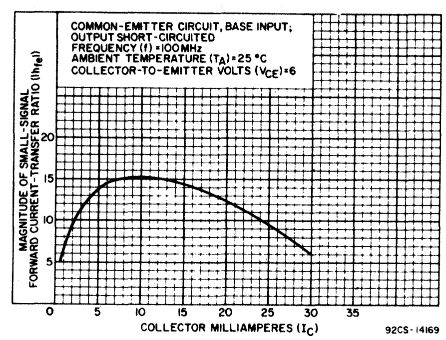
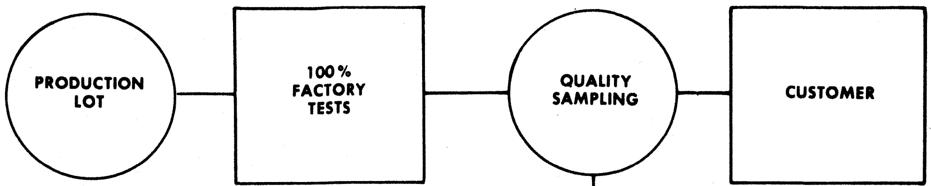


Fig. 1-Small-signal beta characteristics for type 2N5179.

2N5179



ITEM	TEST DESCRIPTION	LTPD
GROUP A TESTS		
Subgroup 1.	Visual and Mechanical Examination	5%
Subgroup 2.	Electrical	10%
GROUP B TESTS		
Subgroup 1.	Physical Dimensions	20%
Subgroup 2.	Solderability, Temperature Cycling, Thermal Shock, Moisture Resistance	20%
Subgroup 3.	Shock, Vibration Fatigue, Vibration Variable Frequency, Constant Acceleration	20%
Subgroup 4.	Terminal Strength	20%
Subgroup 5.	Salt Atmosphere	20%
Subgroup 6.	High-Temperature Life, Non-Operating (T_A = 200°C)	λ = 10%
Subgroup 7.	Steady-State-Operation Life (P_D = 300mW, T_A = 25°C)	λ = 10%

Fig. 2 - Group A and Group B Quality Sampling Tests.

2N5180

Silicon N-P-N Epitaxial Planar Transistor

For VHF Applications in Industrial and Commercial Equipment

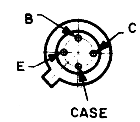
Features:
- High gain-bandwidth product
- Low noise figure
- High unneutralized power gain
- Hermetically sealed four-lead metal package
- All active elements insulated from case
- Low collector-to-base feedback

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	30	V
*COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}	15	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	2	V
*CONTINUOUS COLLECTOR CURRENT	I_C	limited by dissipation	
*TRANSISTOR DISSIPATION:	P_T		
At ambient temperatures up to 25°C		180	mW
At ambient temperatures above 25°C		See Fig.2	
*TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 175	°C
*LEAD TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		265	°C

* Measured at center of seating surface.

TERMINAL DESIGNATIONS



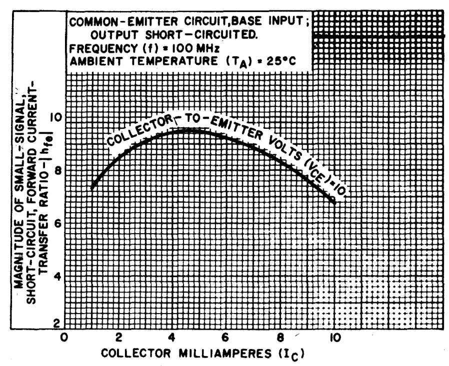
92CS-27513

JEDEC TO-72

ELECTRICAL CHARACTERISTICS, at T_A = 25°C

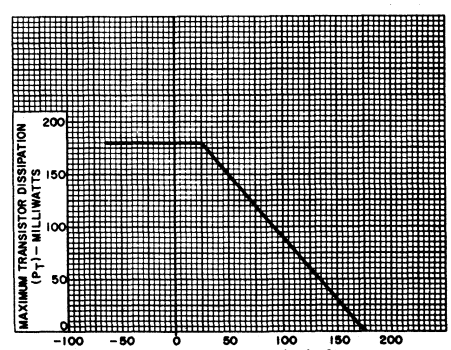
Characteristics	Symbols	TEST CONDITIONS: Frequency f (MHz)	DC Collector-to-Base Voltage V_{CB} (V)	DC Collector-to-Emitter Voltage V_{CE} (V)	DC Emitter Current I_E (mA)	DC Collector Current I_C (mA)	LIMITS Type 2N5180 Min.	Typ.	Max.	Units
* Collector-Cutoff Current	I_{CBO}		8		0		-	-	0.5	μA
* Collector-to-Base Breakdown Voltage	BV_{CBO}				0	0.001	30	-	-	V
* Collector-to-Emitter Breakdown Voltage	BV_{CEO}					0.001	15	-	-	V
* Emitter-to-Base Breakdown Voltage	BV_{EBO}				-0.001	0	2	-	-	V
* Static Forward-Current Transfer Ratio	h_{FE}			8		2	20	-	200	
* Magnitude of Small-Signal Forward-Current Transfer Ratio	$\|h_{fe}\|^a$	100		8		2	6.5	9	17	
* Collector-to-Base Feedback Capacitance	$C_{cb}{}^b$	0.1 to 1	8		0		-	-	1	pF
* Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit	$G_{PE}{}^a$	200		10		2	12	-	19	dB
VHF Noise Figure	NF^a $NF^{a,c}$	200 60		8 8		2 1	-	- 2.5	4.5	dB dB
* Collector-Base Time Constant	$r_b'C_c$	31.9	8		-2		2	–	16	ps
* Real Part of Common-Emitter Small-Signal Short-Circuit Input Impedance	$R_e(h_{ie})$	200		10		2	60	–	240	Ω
* Bandwidth	BW	200		10		2	650	–	1700	MHz

[a]Fourth lead (case) grounded.
[b]C_{cb} is a three terminal measurement of the collector-to-base capacitance with the emitter and case connected to the guard terminal.
[c]Source Resistance, R_s=400 ohms.
* In accordance with JEDEC registration data format JS-9 RDF-1.



92CS-14785

Fig. 1 - Typical small-signal beta characteristics for 2N5180.



92CS 14777

Fig. 2 - Rating chart for 2N5180.

2N5470

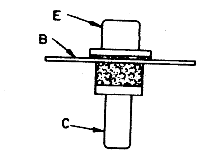
Silicon N-P-N Overlay Transistor

For UHF/Microwave Power Amplifiers, Microwave Fundamental-Frequency Oscillators, and Frequency Multipliers

Features:

- **1-W output with 5-dB gain (min.) at 2 GHz**
- **2-W output with 10-dB gain (typ.) at 1 GHz**
- **Ceramic-metal hermetic package with low inductance and low parasitic capacitances**

TERMINAL DESIGNATIONS



JEDEC TO-215AA

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	55	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
PEAK COLLECTOR CURRENT		0.4	A
CONTINUOUS COLLECTOR CURRENT	I_C	0.2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25 °C		3.5	W
At case temperatures above 25 °C		See Fig. 2.	
TEMPERATURE RANGE:			
Storage and operating (junction)		−65 to +200	°C

ELECTRICAL CHARACTERISTICS *At Case Temperature (T_C) = 25 °C*

CHARACTERISTICS	SYMBOL	TEST CONDITIONS: DC Collector Voltage (V)		DC Current (mA)			LIMITS		UNITS
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CES}		50		0		–	1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	50	–	V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$					5	50	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	–	1.0	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{cb}	30		0			–	3.0	pF
RF Power Output (Common-Base Amplifier): At 2 GHz[a] At 1 GHz[b]	P_{OB}	28 28					1.0 2.0 (typ.)	–	W W
RF Power Output (Common-Base Oscillator): At 2 GHz	P_{OB}	24				80	0.3 (typ.)		W

[a]For P_{IB} = 0.316 W; minimum efficiency = 30%
[b]For P_{IB} = 0.20 W; typical efficiency = 50%

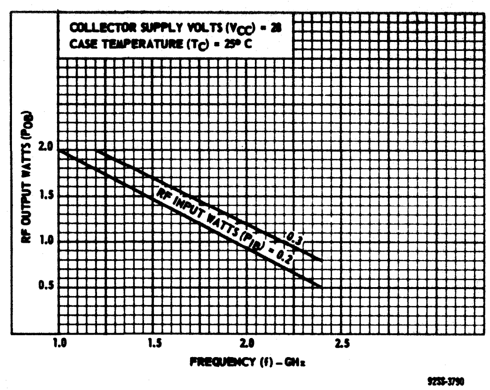


Fig. 1 - Typical output power as a function of frequency for common-base power amplifier.

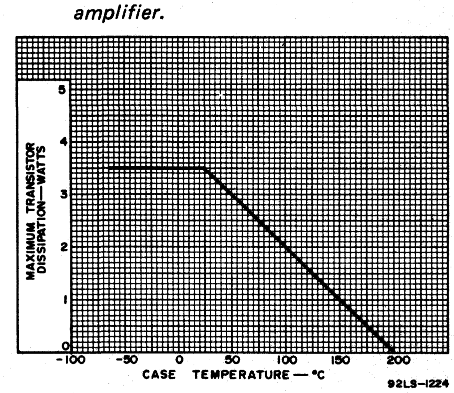


Fig. 2 - Dissipation derating curve.

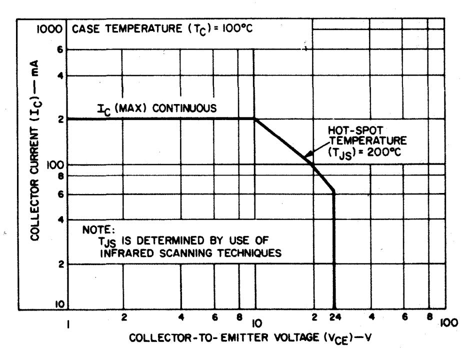


Fig. 3 - Maximum operating area for forward-bias operation.

2N5913

Silicon N-P-N Overlay Transistor

12.5-Volt, High-Gain Type for Class-C Amplifiers in VHF/UHF Communications Equipment

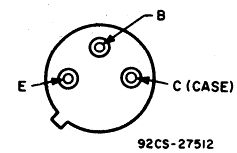
Features:

- High Power Gain, High Power Output . . .
  - At 12.5 V:
    - 2-W (typ.) output at 470 MHz (7-dB gain)
    - 2-W (typ.) output at 250 MHz (9-dB gain)
    - 2-W (typ.) output at 175 MHz (13-dB gain)
  - At 8 V:
    - 1.5-W (typ.) output at 470 MHz (4.8-dB gain)
    - 1.5-W (typ.) output at 250 MHz (7.0-dB gain)
    - 1.5-W (typ.) output at 175 MHz (10-dB gain)

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

* COLLECTOR-TO-BASE VOLTAGE. V_{CBO}	36	V
COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE:		
With base shorted to emitter . . . . $V_{(BR)CES}$	36	V
* With base open . . . . $V_{(BR)CEO}$	14	V
* EMITTER-TO-BASE VOLTAGE . . . V_{EBO}	3.5	V
* CONTINUOUS COLLECTOR CURRENT . . . . I_C	0.33	A
* TRANSISTOR DISSIPATION: . . . . . P_T		
At case temperatures up to 75°C. .	3.5	W
At case temperatures above 75°C .	Derate at 0.0028 W/°C	
* TEMPERATURE RANGE:		
Storage & Operating (Junction) . .	-65 to +200	°C
* LEAD TEMPERATURE:		
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max. .	230	°C

TERMINAL DESIGNATIONS



JEDEC TO-39

ELECTRICAL CHARACTERISTICS ***Case Temperature (T_C) = 25°C Unless Otherwise Specified***

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Voltage (V) V_{CE}	V_{EB}	DC Current (mA) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
* Collector-Cutoff Current									
Base Connected to Emitter	I_{CES}	12.5			0			1.0[b]	mA
Base Open	I_{CEO}	10			0			0.3	mA
* Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.5	36	–	V
* Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				0	25[a]	14	–	V
With base connected to emitter	$V_{(BR)CES}$		0			25[a]	36	–	V
* Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.5		0	3.5	–	V
Thermal Resistance: (Junction-to-Case)	θ_{J-C}						–	35.7	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%.

[b] T_C = 100°C.

DYNAMIC

TEST & CONDITIONS	SYMBOL	FREQUENCY MHz	LIMITS MINIMUM	TYPICAL	UNITS
Power Output (V_{CC} = 12.5 V): P_{IE} = 0.1 W	P_{OE}	175	1.75		W
* Large-Signal Common-Emitter Power Gain (V_{CC}=12.5 V): P_{IE} = 0.1 W	G_{PE}	175	12.4		dB
* Collector Efficiency (V_{CC} = 12.5 V): P_{IE} = 0.1 W	η_C	175	50		%
* Common-Base Output Capicatance V_{CB} = 12 V	C_{obo}	1	15 (max.)		pF

* In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7.

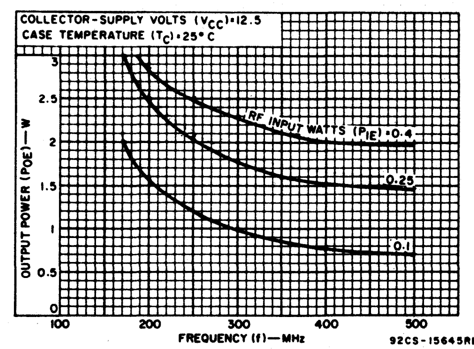


Fig. 1 - Typical power output as a function of frequency.

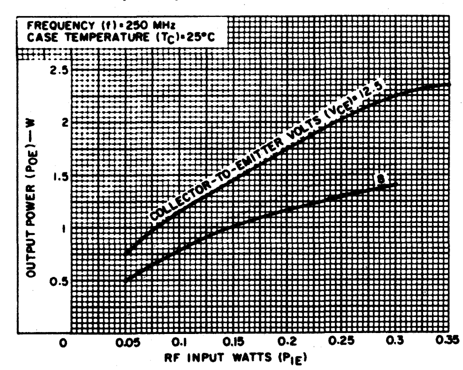


Fig. 2 - Typical power output as a function of power input at 250 MHz.

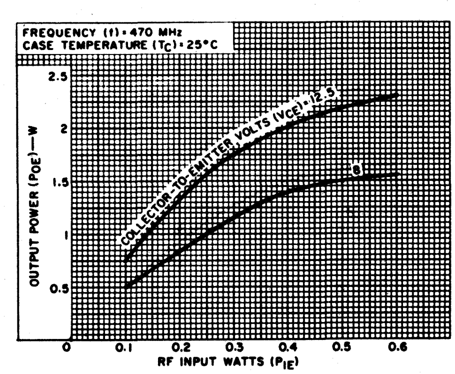


Fig. 3 - Typical power output as a function of power input at 470 MHz.

2N5914, 2N5915

High-Power Silicon N-P-N Overlay Transistors

12.5-Volt, High-Power Types For Class-C Amplifiers in VHF/UHF Communications Equipment

Features:

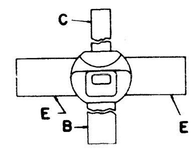
- Low inductance radial leads – particularly useful for strip-line circuits
- Hermetically sealed ceramic-metal package
- Electrically isolated mounting stud
- 6 watts minimum output from 2N5915 amplifier at 470 MHz
- 7-dB gain from 2N5914 driver at 470 MHz

MAXIMUM RATINGS, ***Absolute-Maximum Values:***

		2N5914	2N5915	
● COLLECTOR-TO-BASE BREAKDOWN VOLTAGE	$V_{(BR)CBO}$	36	36	V
● COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE:				
With base connected to emitter	$V_{(BR)CES}$	36	36	V
With base open	$V_{(BR)CEO}$	14	14	V
● EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	3.5	V
● COLLECTOR CURRENT:				
Continuous.	I_C	0.5	1.5	A

		2N5914	2N5915	
● TRANSISTOR DISSIPATION: . . .	P_T			
At case temperatures up to 75°C		5.7	10.7	W
At case temperatures above 75°C		See Fig. 3		
● TEMPERATURE RANGE:				
Storage & Operating (Junction) . .		-65 to +200°C		
● CASE TEMPERATURE (During soldering):				
For 10 s max.		230		°C

TERMINAL DESIGNATIONS



JEDEC TO-216AA

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

Static

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTS V_{CE}	DC BASE VOLTS V_{BE}	DC CURRENT mA I_E	I_B	I_C	LIMITS 2N5914 MIN.	2N5914 MAX.	2N5915 MIN.	2N5915 MAX.	UNITS
●	Collector-Cutoff Current	I_{CEO}	10			0		–	0.3	–	1.0	mA
●	Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.5	36	–	–	–	V
							1.0	–	–	36	–	
●	Collector-to-Emitter Breakdown voltage: With base open	$V_{(BR)CEO}$			0		25ᵃ	14	–	–	–	V
							75ᵃ	–	–	14	–	
	With base connected to emitter	$V_{(BR)CES}$		0			25ᵃ	36	–	–	–	
							75ᵃ	–	–	36	–	
●	Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.5		0	3.5	–	–	–	V
					1.0		0	–	–	3.5	–	

ᵃ Pulsed through a 25-mH inductor; duty factor = 50%

Dynamic

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC}) – Volts	Input Power (P_{IE}) – Watts	Frequency (f) – MHz	LIMITS 2N5914 MIN.	2N5914 TYP.	2N5915 MIN.	2N5915 TYP.	UNITS
●	Power Output	P_{OE}	12.5	0.4	470	2.0		–		W
				2.0		–		6		
●	Power Gain	G_{PE}	12.5	0.4	470	7		–		dB
				2.0		–		4.8		
●	Collector Efficiency	η_C	12.5	0.4	470	65		–		%
				2.0		–		65		
	Load Mismatch	LM	12.5	2N5914 0.4, 2N5915 2	470	GO/NO GO				
●	Collector-to-Base Capacitance	C_{obo}	12, I_C = 0		1	–	15 (max.)	–	30 (max.)	pF
	Gain-Bandwidth Product	f_T	12, I_C = 200 mA				900	–		MHz
			12, I_C = 300 mA			–			800	

● In accordance with JEDEC registration data fromat JS-6 RDF-3/JS-9 RDF-7

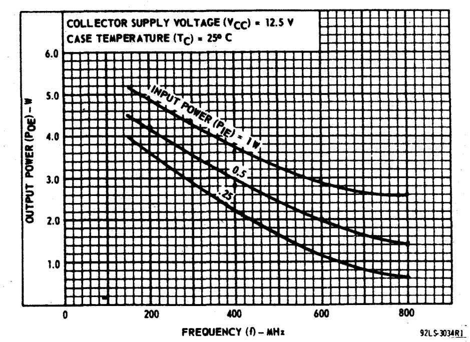


Fig. 1 - Typical output power as a function of frequency for 2N5914.

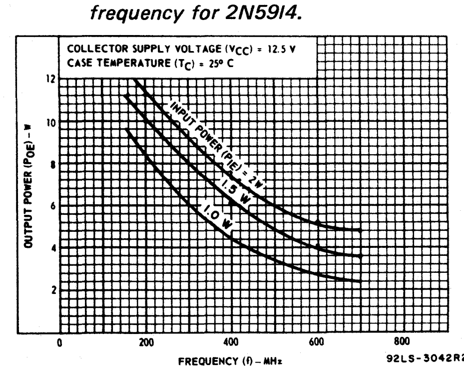


Fig. 2 - Typical output power as a function of frequency for 2N5915.

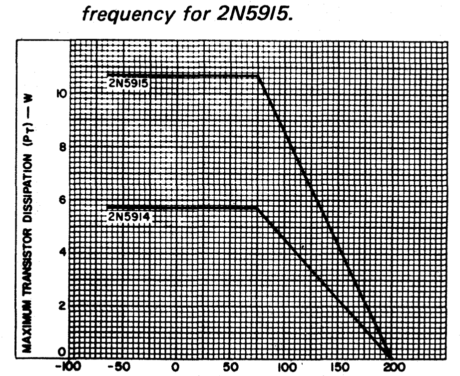


Fig. 3 - Dissipation derating for 2N5914 and 2N5915.

2N5916, 2N5917

High-Gain Silicon N-P-N Overlay Transistors

For VHF/UHF Communications Equipment

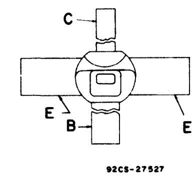
Features:

- Radial leads for microstripline circuits
- 2 watts (min.) output at 400 MHz (10-dB gain)
- 2 watts (typ.) output at 1 GHz (5-dB gain)
- Low-inductance, ceramic-metal hermetic packages
- All electrodes isolated from stud

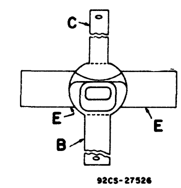
MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5916 2N5917	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
*COLLECTOR-TO-EMITTER VOLTAGE With base open	V_{CEO}	24	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
*CONTINUOUS COLLECTOR CURRENT	I_C	0.2	A
*TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 100°C		4	W
At case temperatures above 100°C		Derate linearly at 0.04 W/°C	
*TEMPERATURE RANGE:			
Storage & Operating (Junction)		–65 to +200	°C
* CASE TEMPERATURE (During soldering):			
For 10 s max		230	°C

TERMINAL DESIGNATIONS



JEDEC TO-216AA



RCA HF-31

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

STATIC

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage V_{CE}	DC Base Voltage V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS MIN.	LIMITS MAX.	UNITS
*	Collector-to-Emitter Cutoff Current: Base-emitter junction shorted	I_{CES}	30^b	0				–	1	mA
*	Collector-to-Emitter Breakdown Voltage:	$V_{(BR)CES}$		0			5^a	55	–	V
	With base open	$V_{(BR)CEO}$					5^a	24	–	V
*	Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
	Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	–	0.5	V
	Thermal Resistance: (Junction-to-Case)	θ_{J-C}						–	25	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%

[b] Case temperature = 100°C

DYNAMIC

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC}) – V	Output Power (P_{OE}) – W	Input Power (P_{IE}) – W	Frequency (f) – MHz	LIMITS MIN.	LIMITS MAX.	UNITS
*	Power Output	P_{OE}	28		0.2	400	2.0	–	W
*	Power Gain	G_{PE}	28	2		400	10	–	dB
*	Collector Efficiency	η_C	28		0.2	400	50	–	%
*	Collector – Base Capacitance	C_{cb}	30(V_{CB})			1	–	4.5	pF

* In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7.

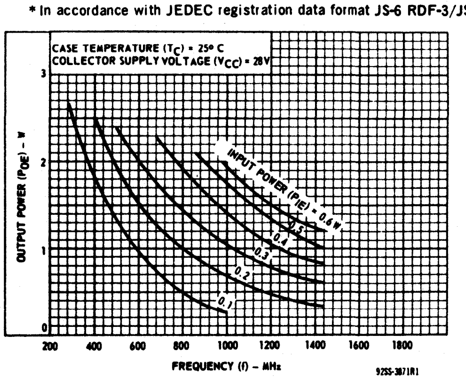


Fig. 1 - Typical power output as a function of frequency (for both types).

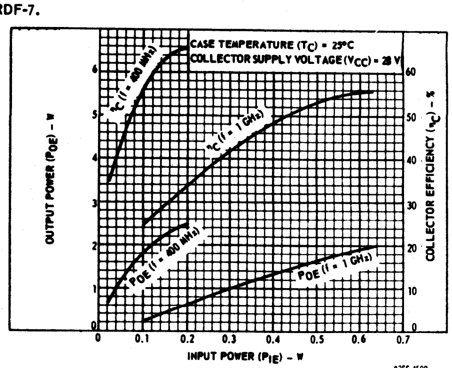


Fig. 2 - Typical power output and collector efficiency as a function of power input (for both types).

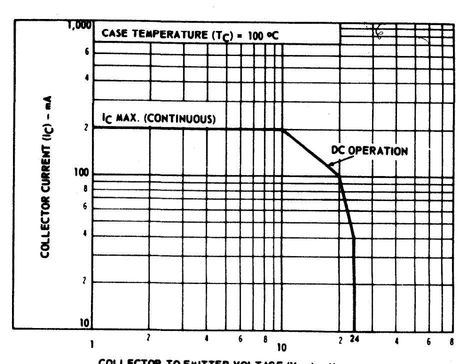


Fig. 3 - Safe operating area, for dc operation (for both types).

2N5918

10-W, 400-MHz High-Gain Silicon N-P-N Emitter-Ballasted Overlay Transistor

For VHF/UHF Communications Equipment

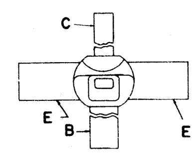
Features:

- 10 W output at 400 MHz (8 dB min. gain)
- Emitter-ballasting resistors
- Broadband performance (225—400 MHz)
- Low-inductance, ceramic-metal hermetic package
- All electrodes isolated from stud
- Radial leads for stripline circuits

MAXIMUM RATINGS, *Absolute-Maximum Values.*

* COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	30	V
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
* CONTINUOUS COLLECTOR CURRENT	I_C	0.75	A
* TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 75°C		10	W
At case temperatures above 75°C		Derate linearly at 0.08 W/°C	
* TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to +200	°C
* CASE TEMPERATURE (During soldering):			
For 10 s max.		230	°C

TERMINAL DESIGNATIONS



92CS-27527

JEDEC TO-216AA

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

STATIC

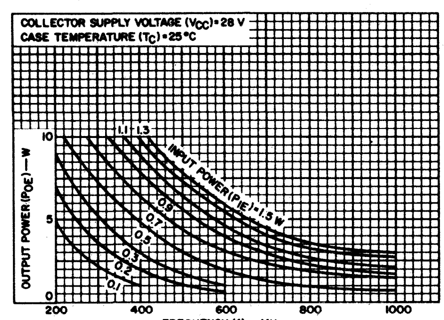
CHARACTERISTIC	SYMBOL	DC Collector Voltage V_{CE}	DC Base Voltage V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS MIN.	LIMITS MAX.	UNITS
* Collector-to-Emitter Cutoff Current: Base-emitter junction shorted	I_{CES}	30	0				–	5	mA
* Collector-to-Emitter Breakdown Voltage:	$V_{(BR)CES}$		0			100[a]	60	–	V
With base open	$V_{(BR)CEO}$					100[a]	30	–	V
* Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			1		0	4	–	V
Thermal Resistance: (Junction-to-Case)	$\theta_{J\text{-}C}$						–	12.5	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%

DYNAMIC

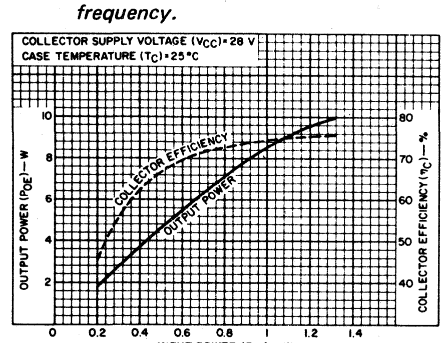
CHARACTERISTIC	SYMBOL	DC Collector Supply (V_{CC})—V	Output Power (P_{OE})—W	Input Power (P_{IE})—W	Frequency (f)—MHz	LIMITS MIN.	LIMITS MAX.	UNITS
* Power Output	P_{OE}	28		1.59	400	10	–	W
* Power Gain	G_{PE}	28	10		400	8	–	dB
* Collector Efficiency	η_C	28	10		400	60	–	%
* Collector-to-Base Output Capacitance	C_{obo}	30(V_{CB})			1	–	13	pF

* In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7.



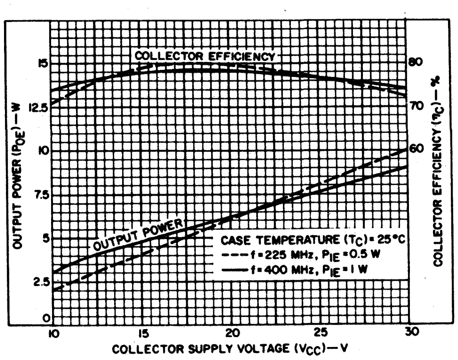
92CS-17197

Fig. 1 - Typical output power as a function of frequency.



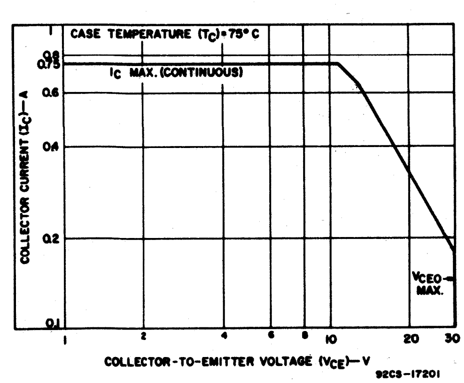
92CS-17198

Fig. 2 - Typical output power or collector efficiency as a function of input power at 400 MHz.



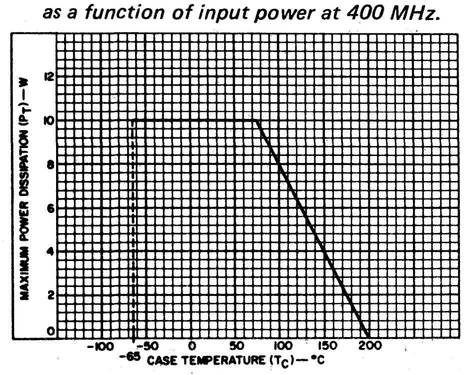
92CS-17199

Fig. 3 - Typical output power or collector efficiency as a function of collector supply voltage.



92CS-17201

Fig. 4 - Maximum operating area for dc operation.



92CS-17202

Fig. 5 - Dissipation derating curve for rf class C operation.

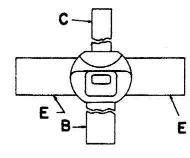
2N5919A

16-W, 400-MHz, Silicon N-P-N Emitter-Ballasted Overlay Transistor

For Large-Signal VHF/UHF Amplifiers—
Provide Overdrive Capability of 20-W Output

Features:
- 6-dB gain (min.) at 400 MHz with 16 watts (min.) output
- Integral emitter-ballasting resistors
- Broadband performance (225-400 MHz)
- Low-inductance, ceramic-metal, hermetic package
- Radial leads for microstripline circuits
- All electrodes isolated from the stud

TERMINAL DESIGNATIONS



JEDEC TO-216AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-EMITTER VOLTAGE: With base open	V_{CEO}	30	V
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
*CONTINUOUS COLLECTOR CURRENT	I_C	4.5	A
*TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 75°C		25	W
At case temperatures above 75°C		Derate at 0.2	W/°C
*TEMPERATURE RANGE: Storage & Operating (Junction)		–65 to +200	°C
*CASE TEMPERATURE (During soldering): For 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage-V V_{CE}	DC Base Voltage-V V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
* Collector-to-Emitter Cutoff Current: With base connected to emitter	I_{CES}	30	0				–	10	mA
* Collector-to-Emitter Breakdown Voltage: With base connected to emitter	$V_{(BR)CES}$		0			200[a]	65	–	V
With base open	$V_{(BR)CEO}$					200[a]	30	–	
* Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			5		0	4	–	V
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$							5.0	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%.

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC})-V	Input Power (P_{IE})-W	Output Power (P_{OE})-W	Frequency (f)—MHz	LIMITS MIN.	MAX.	UNITS
Output Power	P_{OE}	28	4.0		400	16	–	W
* Overdrive Objective Test		28	7.0		400	20		
* Power Gain	G_{PE}	28		16	400	6	–	dB
* Collector Efficiency	η_C	28	4.0		400	65	–	%
* Collector-to-Base Output Capacitance	C_{obo}	30 (V_{CB})			1	–	22	pF

* In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7.

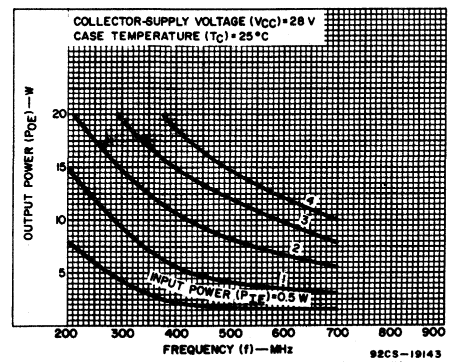


Fig. 1 - Typical output power as a function of frequency.

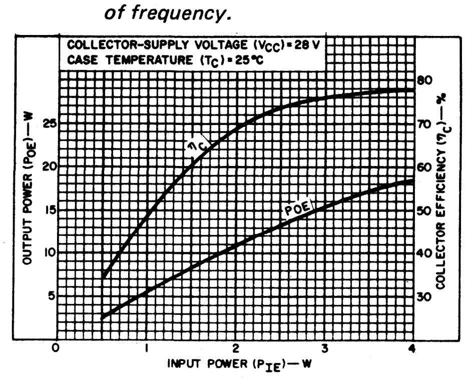


Fig. 2 - Typical output power and collector efficiency as a function of input power.

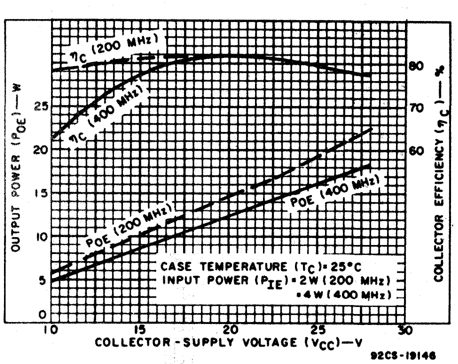


Fig. 3 - Typical output power and collector efficiency as a function of collector-supply voltage.

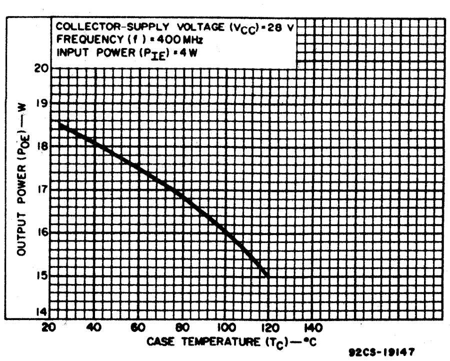


Fig. 4 - Typical output power as a function of case temperature.

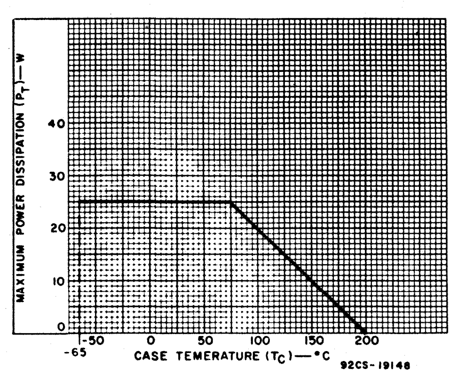


Fig. 5 - Dissipation-derating curve for class C operation.

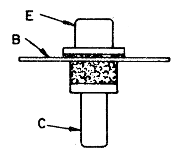
2N5920

2-W, 2-GHz, Emitter-Ballasted Silicon N-P-N Overlay Transistor

For UHF/Microwave Power Amplifiers, Microwave Fundamental-Frequency Oscillators and Frequency-Multipliers

Features:
- 2-W output with 10-dB gain (min.) at 2 GHz
- 3-W output with 12-dB gain (typ.) at 1 GHz
- Ceramic-metal hermetic package with low inductance and low parasitic capacitances
- Stable common-base operation
- For coaxial, microstripline, & lumped-constant circuit applications
- Integral emitter-ballasting resistors

TERMINAL DESIGNATIONS



92CS-27521

JEDEC TO-215AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
* COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 10 Ω, sustaining	$V_{CER}(sus)$	50	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
* DC COLLECTOR CURRENT (CONTINUOUS)	I_C	0.25	A
* TRANSISTOR DISSIPATION:	P_T		
At case temperature up to 75°C		3.5	W
At case temperatures above 75°C, derate linearly		0.028	W/°C
For point of measurement of temperature (on collector terminal), see dimensional outline.			
* TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
* CASE TEMPERATURE (During Soldering):			
For 10 s max.		230	°C

* In accordance with JEDEC registration data format (JS-6-RDF-3/JS-9-RDF-7).

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C, unless otherwise specified.*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR OR BASE VOLTAGE (V) V_{CE}	V_{BE}	DC CURRENT (mA) I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
• Collector-Cutoff Current	I_{CES}	45	0				–	2	mA
At T_C = 100°C		50	0				–	3	
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		5	50	-	V
• Collector-to-Emitter Breakdown Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{(BR)CER}$					5[a]	50	-	V
• Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	-	1	V
Thermal Resistance: (Junction-to-collector terminal)	$R_{\theta JCT}$	10				100	-	30	°C/W

[a] Pulsed test, 50% duty factor.

DYNAMIC

CHARACTERISTIC	SYMBOL	POWER INPUT P_{IB}(W)	POWER OUTPUT P_{OB}(W)	SUPPLY VOLTAGE V_{CC}(V)	FREQUENCY (f) GHz	LIMITS MIN.	MAX.	UNITS
Power Output (See Fig. 5)	P_{OB}	0.2		28	2	2		W
• Power Gain	G_{PB}	0.2	2.0	28	2	10		dB
• Collector Efficiency	η_C	0.2	2.0	28	2	40		%
• Collector-to-Base Capacitance	C_{obo}			30(V_{CB})	1MHz		3	pF

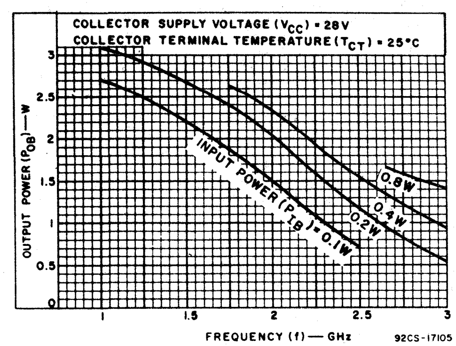


Fig. 1 - Typical output power as a function of frequency for common-base amplifier.

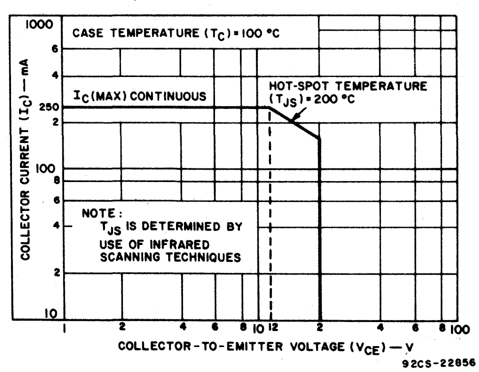


Fig. 2 - Maximum operating area for forward-bias operation.

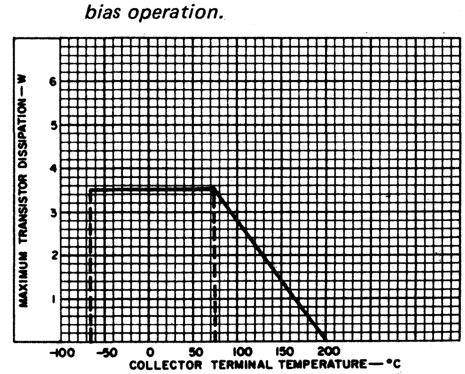


Fig. 3 - Temperature derating of power dissipation of the 2N5920.

2N5921

5-W,2-GHz,Emitter-Ballasted Silicon N-P-N Overlay Transistor

For UHF/Microwave Power Amplifiers, Microwave Fundamental-Frequency Oscillators and Frequency Multipliers

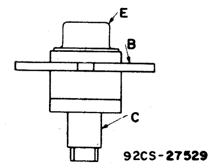
Features:

- 5-W output with 5.5-dB gain (typ.) at 2.3 GHz
- 5-W output with 7-dB gain (min.) at 2 GHz
- 10-W output with 11-dB gain (typ.) at 1.2 GHz
- Integral emitter-ballasting resistors
- Ceramic-metal hermetic package with low inductance and low parasitic capacitances
- Beryllium oxide ceramic for low thermal-resistance path between collector stud & base flange
- Stable common-base operation
- For coaxial, microstripline, & lumped-constant circuit applications

MAXIMUM RATINGS, *Absolute-Maximum Values:*

* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
* COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	50	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
* DC COLLECTOR CURRENT (CONTINUOUS)	I_C	0.7	A
TRANSISTOR DISSIPATION:	P_T		
* At case temperatures up to 25°C		14.5	W
* At case temperatures above 25°C, derate linearly		0.083	W/°C
* TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to + 200	°C
* CASE TEMPERATURE (During soldering):			
For 10 s max.		230	°C

TERMINAL DESIGNATIONS



JEDEC TO-201AA

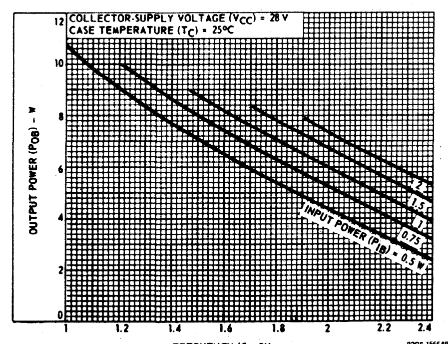


Fig. 1 - Typical output power as a function of frequency.

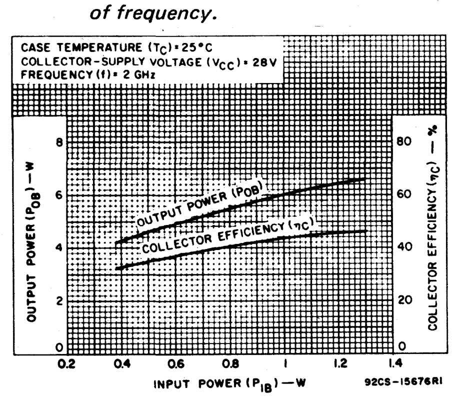


Fig. 2 - Typical power output or collector efficiency as a function of power input at 2 GHz.

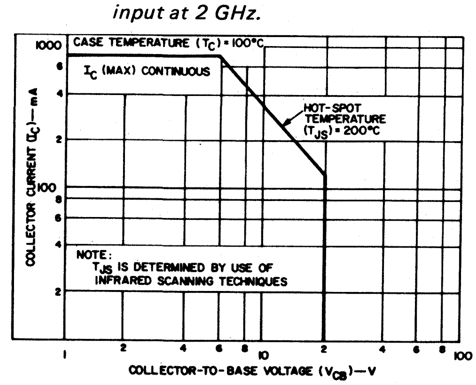


Fig. 3 - Safe operating area for dc operation.

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C, unless otherwise specified.*

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector or Base Voltage (V) V_{CE}	V_{BE}	DC Current (mA) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
Collector-Cutoff Current	I_{CES}	45	0				–	2	mA
* Collector-Cutoff Current	I_{CES} (T_C = 100°C)	45	0				–	5	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		5	50	–	V
* Collector-to-Emitter Breakdown Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{(BR)CER}$					10	50	–	V
* Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)				20	100	–	1	V
Thermal Resistance: (Junction-to-Flange)	$R_{\theta JF}$						–	12	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: Frequency (f) – GHz	DC Collector Supply Voltage (V_{CC}) – V	LIMITS Min.	Max.	UNITS
Output Power P_{IB} = 1 W	P_{OB}	2	28	5	–	W
* Power Gain P_{OB} = 5 W	G_{PB}	2	28	7	–	dB
* Collector Efficiency P_{OB} = 5 W	η_C	2	28	40	–	%
* Collector-to-Base Capacitance V_{CB} = 30 V	C_{obo}	1 MHz	–	–	8.5	pF

*In accordance with JEDEC registration data format (JS-6-RDF-3/JS-9-RDF-7).

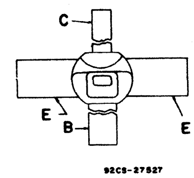
2N5995

7-W, (CW) 175-MHz Silicon N-P-N Overlay Transistor

For 12.5-Volt Applications in VHF Communications Equipment

Features:
- Low-inductance radial leads
- Hermetically sealed ceramic-metal package
- Electrically isolated mounting stud
- 7 watt (min.) output at 175 MHz
- 9.7 dB (min.) gain at 175 MHz
- Infinite load mismatch tested at 175 MHz

TERMINAL DESIGNATIONS



TO-216AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	36	V
*COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE:			
With base connected to emitter	$V_{(BR)CES}$	36	V
With base open	$V_{(BR)CEO}$	14	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
*COLLECTOR CURRENT: Continuous	I_C	1.5	A
*TRANSISTOR DISSIPATION: At case temperatures up to 75°C	P_T	10.7	W
*TEMPERATURE RANGE: Storage & Operating (Junction)		-65 to +200	°C
*CASE TEMPERATURE (During soldering): For 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS		UNITS
		DC Collector Voltage-V	DC Base Voltage-V	DC Current mA					
		V_{CE}	V_{BE}	I_E	I_B	I_C	MIN.	MAX.	
* Collector-Cutoff Current With base open	I_{CEO}	10			0		–	2.5	mA
With base connected to emitter	I_{CES}	12.5	0				–	5[b]	mA
* Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		5	36	–	V
* Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$			0		75[a]	14	–	V
With base connected to emitter	$V_{(BR)CES}$		0			75[a]	36	–	V
* Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			2		0	3.5	–	V
Thermal Resistance (Junction-to-Case)	θ_{J-C}						–	11.7	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50% [b] T_C = 100°C

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS		UNITS
		DC Collector Supply (V_{CC}) -Volts	Input Power (P_{IE}) -Watts	Frequency (f) -MHz	MIN.	MAX.	
* Power Output	P_{OE}	12.5	0.75	175	7	–	W
* Power Gain	G_{PE}	12.5	0.75	175	9.7	–	dB
* Collector Efficiency	η_C	12.5	0.75	175	65	–	%
Load Mismatch	LM	12.5	0.75	175	GO/NO GO		
* Collector-to-Base Capacitance	C_{ob}	12	–	1	–	80	pF

* In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7

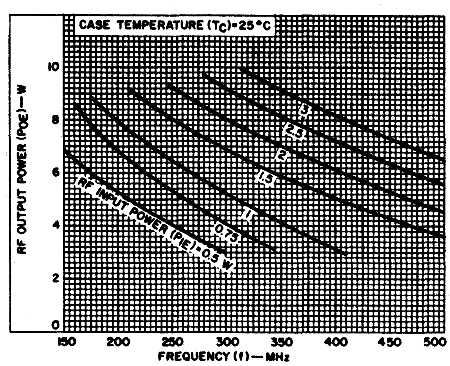


Fig. 1 - Typical rf output power as a function of frequency.

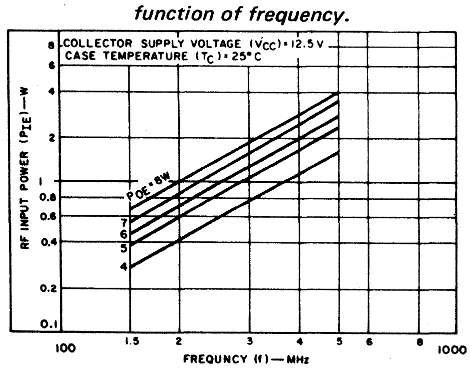


Fig. 2 - Typical rf input power as a function of frequency.

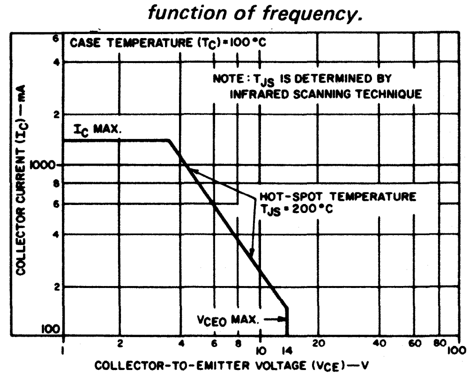


Fig. 3 - Safe area for dc operation.

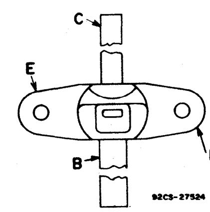
2N6104, 2N6105

30-W 400-MHz Broadband Emitter-Ballasted Silicon N-P-N Overlay Transistors

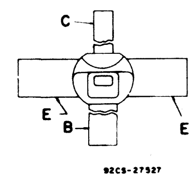
Features:

- 5-dB gain (min.) at 400 MHz with 30 watts (min.) output
- Emitter-ballasting resistors
- Broadband performance (225-400 MHz)
- Low-inductance ceramic-metal hermetic package
- Radial leads for microstripline circuits
- All electrodes isolated from the stud (2N6105)
- Flange is emitter lead (2N6104)

TERMINAL DESIGNATIONS



2N6104
RCA HF-32



2N6105
JEDEC TO-216AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

* COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	30	V
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
* CONTINUOUS COLLECTOR CURRENT	I_C	4.5	A
* TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 75° C		36	W
At case temperatures above 75° C		Derate linearly at 0.288	W/°C
* TEMPERATURE RANGE:			
Storage & Operating (Junction)		− 65 to +200	°C
* CASE TEMPERATURE (During soldering):			
For 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C unless otherwise specified*

STATIC

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS DC Voltage V V_{CE}	V_{BE}	DC Current mA I_E	I_C	LIMITS MIN.	MAX.	UNITS
*	Collector-to-Emitter Cutoff Current: Base connected to emitter, T_C=55°C	I_{CES}	30	0			–	10	mA
*	Collector-to-Emitter Breakdown Voltage: With base connected to emitter	$V_{(BR)CES}$		0		200[a]	65	–	V
	With base open	$V_{(BR)CEO}$				200[a]	30	–	V
*	Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			5	0	4	–	V
	Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						3.5	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%.

DYNAMIC

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS DC Collector Supply (V_{CC})-V	Input Power (P_{IE})-W	Output Power (P_{OE})-W	Frequency (f)—MHz	LIMITS Min.	Max.	UNITS
	Output Power	P_{OE}	28	9.5		400	30	–	W
	Overdrive Test	P_{OEO}	28	12.0		400	34	–	W
*	Power Gain	G_{PE}	28		30	400	5	–	dB
*	Collector Efficiency	η_C	28	9.5		400	65	–	%
*	Collector-to-Base Output Capacitance	C_{obo}	30 (V_{CB})			1	–	35	pF

*In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7.

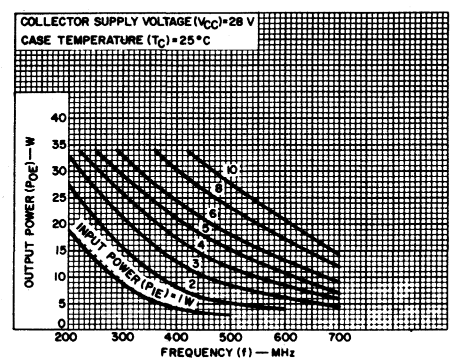


Fig. 1 - Typical output power as a function of frequency for both types.

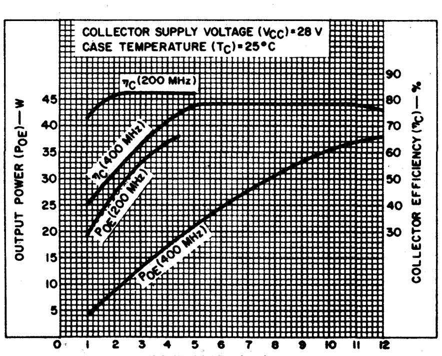


Fig. 2 - Typical output power and collector efficiency as a function of input power for both types.

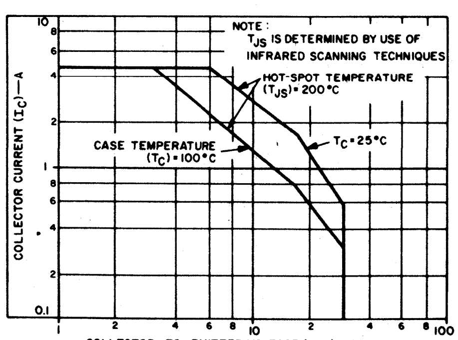


Fig. 3 - Safe area for dc operation for both types.

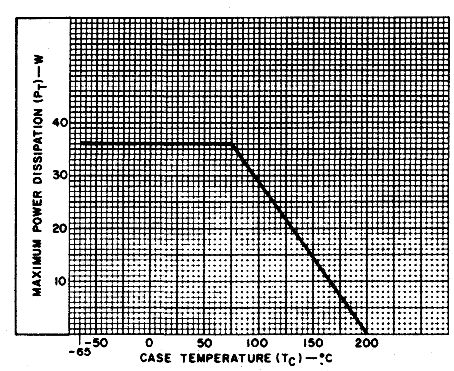


Fig. 4 - Dissipation derating for class C operation for both types.

2N6389

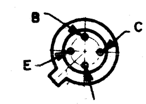
UHF/MATV Low-Noise Silicon N-P-N Transistor

For High-Gain Small-Signal Applications in UHF TV RF Amplifiers and UHF MATV Amplifiers

Features:

- **Low noise figure:**
  NF = 3 dB (typ.) at 450 MHz, 1.5 mA
  = 4 dB (typ.) at 890 MHz, 1.5 mA
  = 6 dB (typ.) at 890 MHz, 10 mA
- **High gain (tuned, unneutralized):**
  G_{PE} = 15 dB (min.) at 890 MHz
- **High gain-bandwidth product**
- **Large dynamic range**
- **Low distortion**
- **Low collector-base capacitance**

TERMINAL DESIGNATION



92CS-27513

JEDEC TO-72

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	20	V
*COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}	12	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	2.5	V
*COLLECTOR CURRENT (Continuous)	I_C	40	mA
*TRANSISTOR DISSIPATION:	P_T		
At ambient temperatures up to 25°C		200	mW
At ambient temperatures above 25°C		Derate linearly at 1.14 mW/°C	
*TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200° C	
*LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/16 in. (1.59 mm) from seating plane for 60 s max.		300° C	

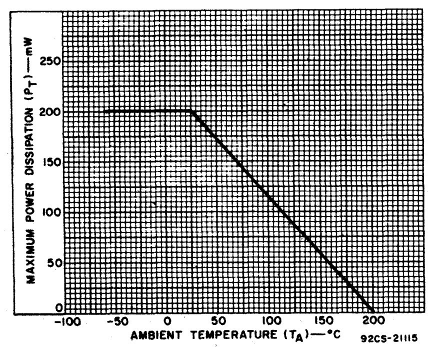


Fig. 1 - Power dissipation as a function of ambient temperature.

ELECTRICAL CHARACTERISTICS, *At Ambient Temperature (T_A) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	CURRENT mA dc I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
STATIC									
* Collector Cutoff Current	I_{CBO}	15		0				20	nA
* Emitter Cutoff Current	I_{EBO}	(V_{EB}) 1				0		1	µA
* Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.001	20		V
* Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$				0	3	12		V
* Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.01		0	2.5		V
* DC Forward Current Transfer Ratio	h_{FE}		1			3	25	250	
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$							880	°C/W
DYNAMIC									
Device Noise Figure: f = 890 MHz = 890 MHz = 450 MHz	NF	10 10 10				1.5 10 1.5	 – –	4(typ.) 6(typ.) 3(typ.)	dB
Small-Signal Common-Base Power Gain (f = 890 MHz)	G_{PB}	10				10	15	–	dB
* Small-Signal, Short Circuit Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}		1			3	25	250	
* Magnitude of Small-Signal Short Circuit Forward Current Transfer Ratio (f = 200 MHz)	$\lvert h_{fe} \rvert$		10			1.5	5	15	
* Collector-to-Base Time Constant (f = 31.9 MHz)	$r_b'C_c$	10		1.5			1	15	ps
* Collector-to-Base Capacitance (f = 1 MHz)	C_{cb}	10		0			0.4	0.55	pF

* In accordance with JEDEC registration data format JS-9 RDF-1.

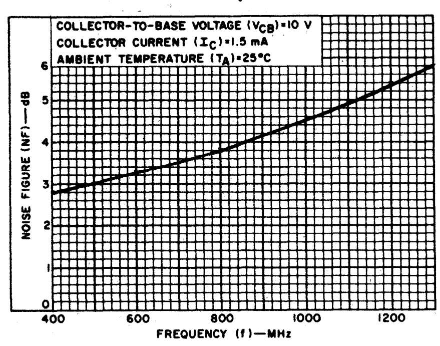


Fig. 2 - Typical common-base noise figure as a function of frequency.

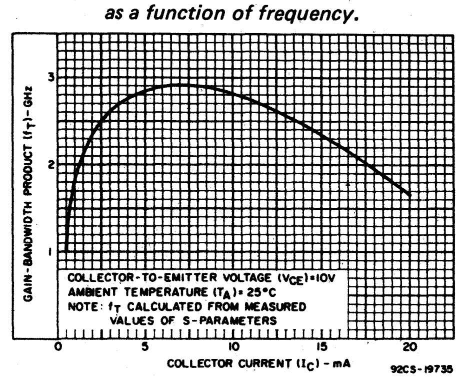


Fig. 3 - Gain-bandwidth product as a function of collector current.

40080-40082, 40446, 40581, 40582

Silicon N-P-N Planar Transistors

For Class C Operation in 27-MHz "CB" Circuits

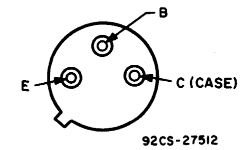
Features:

- OSCILLATOR: 40080 (TO-5)
- DRIVER: 40081 (TO-5)
- OUTPUT: 40082, 40581 (TO-39) 40446, 40582 (TO-39 + Flange)

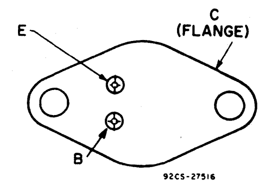
MAXIMUM RATINGS, *Absolute-Maximum Values:*

		40080	40081	40082 40581	40446 40582	
COLLECTOR-TO-EMITTER VOLTAGE:						
With V_{BE} = −0.5 volts	V_{CEV}	–	60	60	60	V
With base open	V_{CEO}	30	–	–	–	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	–	2.0	2.5	2.5	V
PEAK COLLECTOR CURRENT		0.25	0.25	1.5	1.5	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		–	2.0	5.0	10	W
At free-air temperatures up to 25°C		0.5	–	–	–	W
At case temperatures above 25°C		← See Fig. 1 →				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to 200 →				°C
LEAD TEMPERATURE (During soldering):						
At distances ≥ 1/32 in. (0.8 mm) from insulating wafer for 10s max		← 230 →				°C

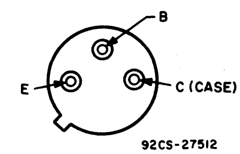
TERMINAL DESIGNATION



40082
40581
JEDEC TO-39



40582
40446
JEDEC TO-39
(FLANGE)



40080
40081
JEDEC TO-5

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTAGE V			DC EMITTER OR BASE VOLTAGE V	DC CURRENT mA			LIMITS: 40080		40081		40581 40582 40082 40446		UNITS
		V_{CB}	V_{CE}	V_{CC}	V_{BE}	I_C	I_E	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector-to-Emitter Voltage:	V_{CEO}					10		0	30	–	–	–	–	–	V
	V_{CEV}				−0.5 −0.5	100μA 500μA			–	–	60	–	60	–	V
Emitter-to-Base Voltage:	V_{EBO}					0 0	500μA 500μA		–	–	2.0	–	2.5	–	V
Collector-Cutoff Current	I_{CBO}	15 15 15					0 0 0		–	10	–	10	–	10	μA
Collector-to Base Capacitance: (Measured at 1 MHz)	C_{ob}		30 30 30							6		6		20	pF
RF Power Output: Oscillator (f = 27 MHz)	P_{OUT}			12		32			100		–	–	–	–	mW
Driver (f = 27 MHz, P_{IN} = 75 mW)	P_{OUT}			12		85			–	–	400		–	–	mW
Output Amplifier (f = 27 MHz, P_{IN} = 350 mW)	P_{OUT}			12		415							3.0 (min.) [40082, 40446]		W
				12		415							3.5 (min.) [40581, 40582]		W
Junction-to-Case Thermal Resistance:	$R_{\theta JC}$								350[a] (max.)		87.5 (max.)		17.5 (max.) [40446, 40582] 35 (max.) [40082, 40581]		°C/W

[a]Junction-to-Ambient Thermal Resistance, $R_{\theta JA}$

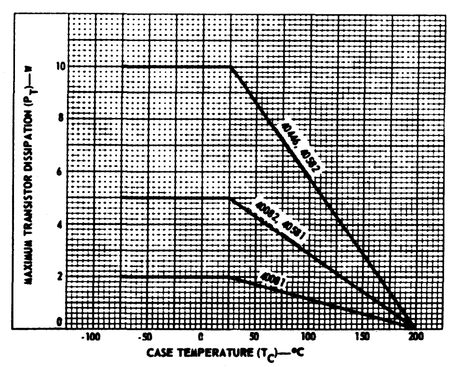


Fig. 1 - Dissipation derating curves.

TYPICAL C.B. TRANSMITTER PERFORMANCE (V_{CC} = 13.8 V)

STAGE	RCA TYPE	NO MODULATION: I_C mA	RF P_{OUT} W	100% MODULATION: I_C mA	RF P_{OUT} W
Oscillator	40080	15	–	15	–
Driver	40081	55	–	50	–
Output	40082, 40581 40446, or 40582	330	3.5[a]	330	4.8 (typ.)

[a]Adjusted for maximum legal power output.

40280-40282

1,4,& 12-W, 175-MHz Overlay Transistors

Silicon N-P-N Devices for High-Power VHF Amplifier Service

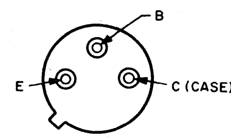
Features:

- Suitable for low-voltage supplies (13.5 V)
- High output power at 175 MHz, unneutralized class C amplifier
- High efficiency at 175 MHz
- Low input impedance

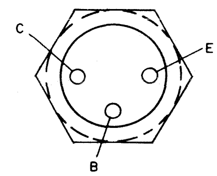
MAXIMUM RATINGS, *Absolute-Maximum Values:*

		40280	40281	40282	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	36	36	36	V
COLLECTOR-TO-EMITTER VOLTAGE:					
With base open	V_{CEO}	18	18	18	V
With V_{BE} = −1.5V......	V_{CEV}	36	36	36	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	4	4	V
COLLECTOR CURRENT. .	I_C	0.5	1	2	A
TRANSISTOR DISSIPATION P_T					
At case temperatures up to 25°C		7.0	11.6	23.2	W
At case temperatures above 25°C.........		Derate linearly to 0 watts at 200°C			
TEMPERATURE RANGE:					
Storage & Operating (Junction)		−65 to 200			°C
LEAD TEMPERATURE (During soldering):					
At distances ≥1/32 in. (0.8 mm) from insulating wafer (TO-60) package or from seating plane (TO-39 package) for 10 s max.		230			°C

TERMINAL DESIGNATIONS



40280
JEDEC TO-39



40281, 40282
JEDEC TO-60

ELECTRICAL CHARACTERISTICS *At Case Temperature (T_C) = 25 °C*

Characteristics	Symbol	TEST CONDITIONS						LIMITS						Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)			Type 40280		Type 40281		Type 40282		
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current	I_{CEO}		15			0		–	100	–	100	–	250	µA
Collector-to-Base Breakdown Voltage	BV_{CBO}				0 0		0.25 0.50	36 –	– –	36 –	– –	– 36	– –	V V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.10 0.25		0 0	4 –	– –	4 –	– –	– 4	– –	V V
Collector-to-Emitter Breakdown Voltage	BV_{CEV}			−1.5			200[a]	36	–	36	–	36	–	V
Collector-to-Emitter Sustaining Voltage	$V_{CEO}(sus)$					0	200[a]	18	–	18	–	18	–	V
Real Part of Common-Emitter High Frequency Input Impedance (At f = 175 MHz)	hie (real)		13.5 13.5 13.5				100 400 800	10 (typ.) – –	 – –	– 7 (typ.) –	– –	– – 5 (typ.)	– – 	Ω Ω Ω
RF Power Output: As Class-C Amplifier, Unneutralized (At f = 175 MHz)	P_{OUT}		13.5					1[b]	–	4[c]	–	12[b]	–	W
Gain-Bandwidth Product	f_T		13.5 13.5 13.5				100 400 800	550 (typ.) – –	 – –	– 400 (typ.) –	– –	– – 350 (typ.)	– – 	MHz MHz MHz
Collector-to-Base Capacitance (At f = 1 MHz)	C_{ob}	13.5			0			–	15	–	22	–	45	pF
Collector-to-Case Capacitance	C_s							–	–	–	5	–	5	pF
Thermal Resistance Junction-to-Case	Θ_{J-C}							–	25	–	15	–	7.5	°C/W

[a] Pulsed through an inductor (25 mH); duty factor = 50%.

[b] For P_{IN} = 0.125 w; minimum efficiency = 60%.

[c] For P_{IN} = 1.0 W; minimum efficiency = 70%.

[d] For P_{IN} = 4.0 W; minimum efficiency = 80%.

TYPICAL RF POWER OUTPUT vs. RF POWER INPUT
175-MHz Operation

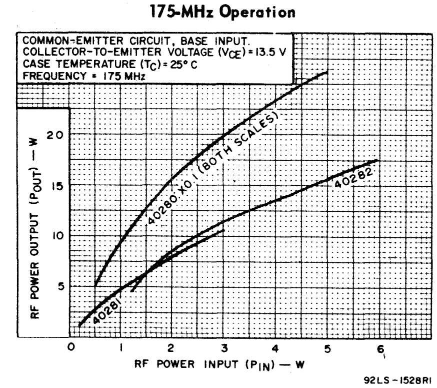


Fig. 1

40290-40292
SILICON N-P-N "overlay" TRANSISTORS

For Low Supply Voltage, High Power Output, Amplitude Modulated, VHF Class-C Amplifier Service in Aircraft, Military, and Industrial Communications Equipment

Features:

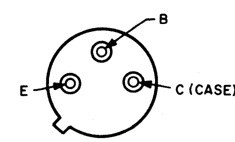
- High carrier output power as 135 Mc Class-C amplifier with 12.5 volt collector supply voltage
  40290 — 2 watts (min.) at P_{IN} = 0.5 watt
  40291 — 2 watts (min.) at P_{IN} = 0.5 watt
  40292 — 6 watts (min.) at P_{IN} = 2.0 watts
- 100% testing of all transistors performed to assure excellent upward modulation characteristics
- High collector efficiency at 135 Mc
- All electrodes isolated from case (40291 and 40292)

Maximum Ratings, *Absolute-Maximum Values:*

	40290	40291	40292	
COLLECTOR-TO-EMITTER VOLTAGE:				
With V_{BE} = -1.5 volts, V_{CEX}	50	50	50	volts
At f = 100 Mc, V_{CEV}(RF)	90	90	90	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4	4	4	volts
COLLECTOR CURRENT, I_C	0.5	0.5	1.25	amperes
TRANSISTOR DISSIPATION, P_T:				
At case temperatures up to 25° C.	7.0	11.6	23.2	watts
At case temperatures above 25° C.	Derate linearly to 0 watts at 200° C			

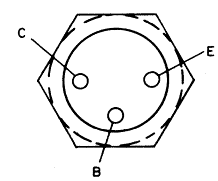
	40290 40291 40292	
TEMPERATURE RANGE:		
Storage	-65 to 200°C	
Operating (Junction)	-65 to 200°C	
PIN OR LEAD TEMPERATURE (During soldering): At distances ≥ 1/32 from insulating wafer (TO-60 package) or from seating plane (TO-39 package) for 10 seconds maximum	230	°C

TERMINAL DESIGNATIONS



40290

JEDEC TO-39



40291, 40292

JEDEC TO-60

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Volts V_{CB}	V_{CE}	DC Base Volts V_{BE}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS: Type 40290 Min.	Max.	Type 40291 Min.	Max.	Type 40292 Min.	Max.	UNITS
Collector Cutoff Current	I_{CEO}		15			0		–	100	–	100	–	250	µa
Emitter-to-Base Breakdown Voltage	BV_{EBO}				0.1		0	4.0	–	4.0	–	–	–	Volts
					0.25		0	–	–	–	–	4.0	–	Volts
Collector-to-Emitter Breakdown Voltage	BV_{CEX}			−1.5			200[a]	50	–	50	–	50	–	Volts
Real Part of Common-Emitter Input Impedance (At f = 135 Mc)	$h_{ie(real)}$		12.5				100	12(Typ.)		12(Typ.)		–	–	ohms
			12.5				400	–	–	–	–	6.5(Typ.)		ohms
RF Carrier Power Output: As Class-C Amplifier, (At f = 135 Mc)	P_{OUT}		12.5					2.0[c]	–	2.0[c]	–	6.0[d]	–	watts
Gain-Bandwidth Product	f_T		12.5				100	500(Typ.)		500(Typ.)		–	–	Mc
			12.5				400	–	–	–	–	300(Typ.)		Mc
Collector-to-Base Capacitance (At f = 1 Mc)	C_{ob}	12.5			0			–	17	–	17	–	30	pf
Collector-to-Case Capacitance	C_s							–	–	–	6.0	–	6.0	pf
Thermal Resistance (Junction-to-Case)	$\theta_{J\text{-}C}$							–	25	–	15	–	7.5	°C/W

[a] Pulsed through an inductor (25 mh); R_{BE} = 39 ohms; duty factor = 50%.
[b] At frequencies of 100 Mc or higher.
[c] For P_{IN} = 0.5 w; minimum efficiency = 70%.
[d] For P_{IN} = 2.0 w; minimum efficiency = 70%.

40340, 40341

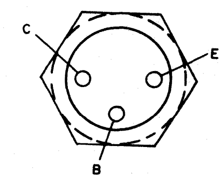
High-Power 50-MHz Emitter-Ballasted Silicon N-P-N Overlay Transistors

For 13.5-V and 24-V Applications in Mobile Communications Equipment

Features:

- **Emitter ballasting resistors**
- **13.5 V–25 W min. power output, 7 dB min. gain (40340)**
- **24 V–30 W min. power output, 10 dB min. gain (40341)**
- **Emitter connected to case**
- **Infinite load mismatch tested at 50 MHz**

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		40340	40341	
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open	V_{CEO}	25	35	V
With base-emitter junction reverse-biased (V_{BE}) = −1.5 volts	V_{CEV}	60	70	V
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	70	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4.0	4.0	V
PEAK COLLECTOR CURRENT		10	10	A
CONTINUOUS COLLECTOR CURRENT	I_C	3.3	3.3	A
TRANSISTOR DISSIPATION	P_T			
At case temperatures up to 25°C		70	70	W
TEMPERATURE (Operating junction)	T_J	200	200	°C

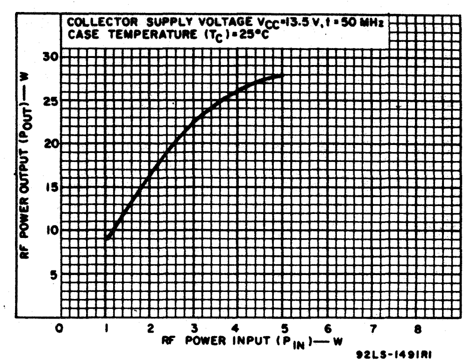


Fig. 1 - Typical performance of type 40340 in a common-emitter amplifier.

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage (V) V_{CB}	V_{CE}	DC Base Voltage (V) V_{BE}	DC Current (mA) I_E	I_C	LIMITS 40340 Min.	Max.	40341 Min.	Max.	UNITS
Collector-Cutoff Current: With base open	I_{CEO}		30				–	–	–	1.0	mA
			15				–	1.0	–	–	
With emitter open	I_{CBO}	50					–	–	–	10	
		40					–	10	–	–	
Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$					200[a]	25	–	35	–	V
With base-emitter junction reverse biased, and external base-to-emitter resistance (R_{BE}) = 20 Ω	$V_{(BR)CEV}$			−1.5		200[a]	60	–	70	–	
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				10		4	–	4	–	V
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$						2.5		2.5		°C/W

[a]Pulsed through a 25-mH inductor; duty factor = 50%.

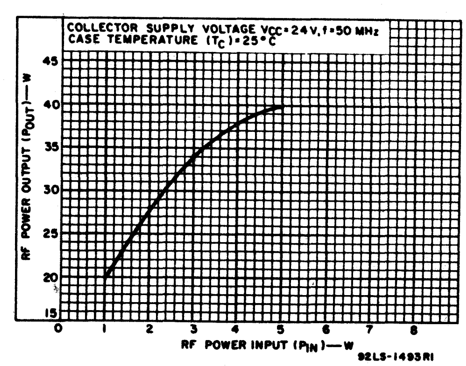


Fig. 2 - Typical performance of type 40341 in a common-emitter amplifier.

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC})–V	Input Power (P_{IE})–W	Frequency (f) - MHz	LIMITS 40340 Min.	Max.	40341 Min.	Max.	UNITS
Power Output	P_{OE}	13.5	5	50	25	–	–	–	W
		24	3	50	–	–	30	–	
Power Gain	G_{PE}	13.5	5	50	7	–	–	–	dB
		24	3	50	–	–	10	–	
Collector Efficiency	η_C	13.5	5	50	60	–	–	–	%
		24	3	50	–	–	60	–	
Load Mismatch	LM	13.5	5	50	GO/NO GO				
		24	3	50					
Collector-to-Base Capacitance	C_{obo}	V_{CB} = 30		1	–	–	–	85	pF
		V_{CB} = 15		1	–	120	–	–	

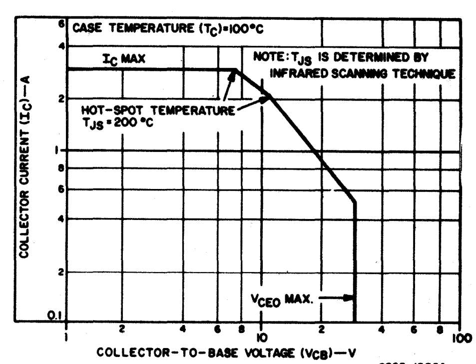


Fig. 3 - Safe area for dc operation.

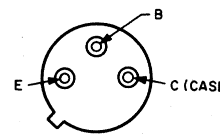
40608
SILICON N-P-N "overlay" TRANSISTOR

For Class A Wide-Band CATV and MATV Applications

Features:

- High Gain-Bandwidth Product
- Low Cross-Modulation

TERMINAL DESIGNATIONS



JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	V
COLLECTOR-TO-EMITTER VOLTAGE: With external base-to-emitter resistance, (R_{BE}) = 100Ω	V_{CER}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	2	V
COLLECTOR CURRENT	I_C	0.4	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25°C		3.5	W
At case temperatures above 25°C		See *Fig. 1.*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to +200	°C
LEAD TEMPERATURE (During soldering): At distances ≥ 1/32 in. (0.79 mm) from seating plane for 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, *Case Temperature* = 25° C

Characteristic	Symbol	Test Conditions: DC Collector Volts V_{CB}	V_{CE}	DC Current (mA) I_E	I_B	I_C	Limits Min.	Max.	Units
Collector-Cutoff Current	I_{CEO}		20		0			100	µA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	40		V
Collector-to-Emitter Voltage (Sustaining)	$V_{CER}(sus)$					50[a]	40		V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	2		V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	50		1.0	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{ob}	30		0				3.0	pF
Gain-Bandwidth Product	f_T		15			50	700		MHz
DC Forward-Current Transfer Ratio	h_{FE}		15			50	35	120	
Voltage Gain	VG		15			50	11		dB
Cross Modulation @46 dBmV	CM		15			50	−57 (Typ.)		dB

[a] Pulsed through an inductor (20 mH); duty factor = 50%; R_{BE} = 100 Ω.

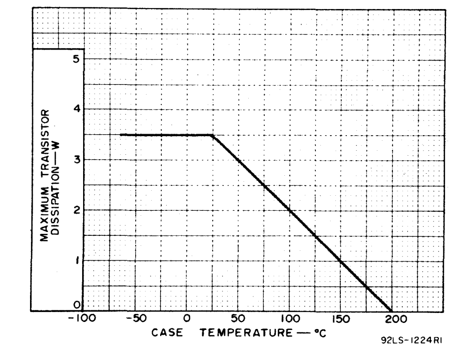


Fig. 1 - Dissipation derating curve.

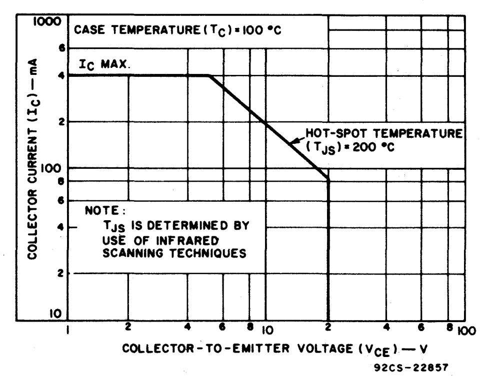


Fig. 2 - Safe area for dc operation.

40637A

Silicon N-P-N Epitaxial Planar Transistor

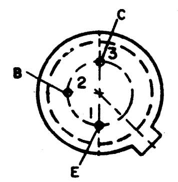
For Frequency-Multiplier Service in Mobile, Marine, and Sonobuoy VHF Transmitters

Features:
- High transistor dissipation rating (P_T) = 2 W max.
- Low output capacitance (C_{ob}) = 4 pF max.
- Hermetically sealed JEDEC TO-18 package

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With base-emitter junction short-circuited	V_{CES}	36	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperature up to 25°C		2	W
At case temperature above 25°C		See Fig. 1	
At ambient temperature up to 25°C		0.75	W
At ambient temperature above 25°C		See Fig. 1	
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During Soldering):			
At distances ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		265	°C

TERMINAL DESIGNATIONS



TO-18

ELECTRICAL CHARACTERISTICS, *at Ambient Temperature (T_A) = 25°C*

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS Voltage V dc		Current mA dc		LIMITS		UNITS
		V_{CE}	V_{BE}	I_E	I_C	MIN.	MAX.	
Collector Cutoff Current: With base-emitter junction short-circuited	I_{CES}	12	0	–	–	–	0.5	mA
Collector-to-Emitter Breakdown Voltage: With base-emitter junction short-circuited	$V_{(BR)CES}$	–	0	–	5	36	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$	–	–	−0.1	0	3.5	–	V
Thermal Resistance: Junction-to-case	$R_{\theta JC}$	–	–	–	–	–	87.5	°C/W
Junction-to-ambient	$R_{\theta JA}$	–	–	–	–	–	233	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE Vdc	FREQ. MHz	POWER mW		LIMITS		UNITS
		V_{CC}	f	P_{IE}	P_{OE}	MIN.	MAX.	
Output Power as a Frequency Doubler	P_{OE}	12	78(f_{IN}) 156(f_{OUT})	37	–	100	–	mW
Efficiency as a Frequency Doubler	η	12	78(f_{IN}) 156(f_{OUT})	–	100	18	–	%
Collector-to-Base Capacitance	C_{ob}	12 (V_{CB})	0.1 to 1	–	–	–	4	pF

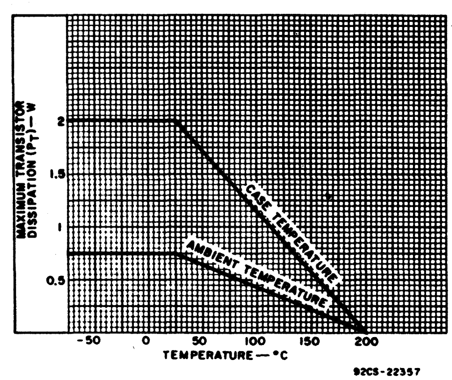


Fig. 1 - Dissipation derating curves.

40836, 40837

High-Frequency Overlay Power Transistors

For Oscillators And Amplifiers In UHF/Microwave Equipment

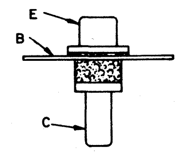
Features:

- 0.5 W (min.) oscillator output at 2.0 GHz (40836)
- 1.25 W (min.) oscillator output at 2.0 GHz (40837)
- Ceramic-metal hermetic coaxial package with low inductances and low parasitic capacitances
- Emitter connected to flange (for increased internal feedback) for higher efficiency at S-band frequencies in Colpitts oscillator circuits
- For coaxial, stripline, and lumped-constant circuits

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		40836	40837	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	50	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	50	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	3.5	V
DC COLLECTOR CURRENT (CONTINUOUS)	I_C	0.2	0.275	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 75°C		2.5	4.15	W
TEMPERATURE RANGE:				
Storage and Operating (Junction)		← −65 to +200 →		°C

TERMINAL DESIGNATIONS



JEDEC TO-215AA

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C*

Static

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTAGE (V) V_{CE}	DC CURRENT (mA) I_E	I_B	I_C	LIMITS 40836 MIN.	MAX.	40837 MIN.	MAX.	UNITS
Collector-Cutoff Current	I_{CES}	45		0		–	1	–	2	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$		0 0		0.1 1	50 –	– –	– 50	– –	V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$				5	50	–	50	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$		0.1		0	3.5	–	3.5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			10 20	100 200	– –	1 –	– –	– 1	V
Thermal Resistance: (Junction-to-Collector Terminal)	$R_{\theta JCT}$					–	50	–	30	°C/W

Dynamic

CHARACTERISTIC	SYMBOL	POWER OUTPUT (P_{OB})–W	SUPPLY VOLTAGE (V_{CC})–V	FREQUENCY GHz	LIMITS 40836 MIN.	TYP.	40837 MIN.	TYP.	UNITS
Common-Collector Oscillator Output Power	P_{OB}		21 28	2 2	0.5 –	0.65 –	– 1.25	– 1.35	W
Oscillator Circuit Efficiency	η_o	0.5 1.25	21 28	2 2	20 –	– –	– 20	– –	%
Collector-to-Base Capacitance	C_{obo}		30(V_{CB})	1 MHz	3.0 (Max.)		3.0 (Max.)		pF

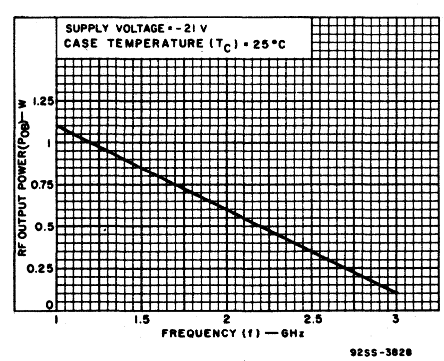


Fig. 1 - Typical power output as a function of frequency for grounded collector power oscillator for 40836.

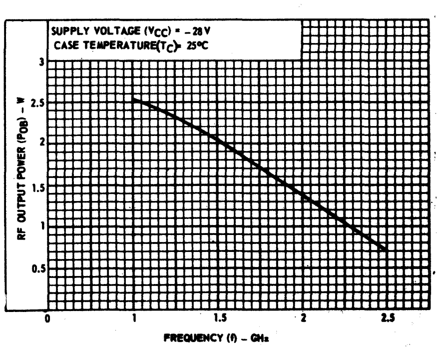


Fig. 2 - Typical power output as a function of frequency for grounded collector power oscillator for 40837.

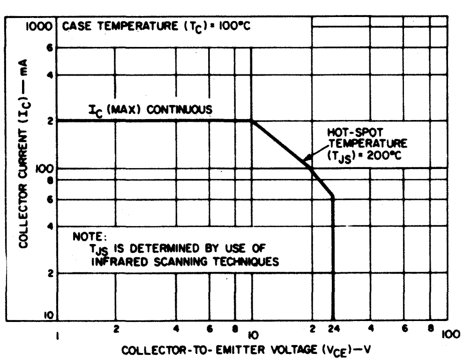


Fig. 3 - Maximum operating area for forward-bias operation for type 40836.

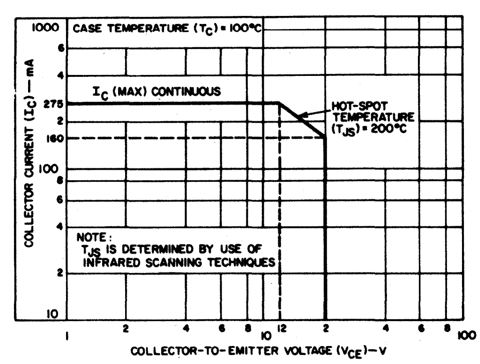


Fig. 4 - Maximum operating area for forward-bias operation for type 40837.

40894-40897

High - Frequency Silicon N-P-N Transistors

For TV-Tuner, FM and AM/FM "Front-End", and IF Amplifier, Oscillator, and Converter Service

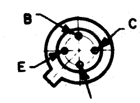
Features:

- **High gain-bandwidth products:**
  f_T = 1200 MHz typ. for tuner types
  = 800 MHz typ. for if-amplifier types
- **Very low collector-to-base feedback capacitance:**
  C_{cb} = 0.7 pF typ. for 40894, 40895
- **Low noise figure:**
  3 dB typ. at 200 MHz for rf amplifier type
- **High power gain as neutralized amplifier:**
  G_{PE} = 15 dB min. at 200 MHz (40894)
- **High power output as uhf oscillator:**
  P_{OE} = 20 mW typ. at 500 MHz (40896)
- **Low noise figure:**
  NF = 4.5 dB max. at 200 MHz (40894)
- **Low collector-to-base time constant:**
  $r_b'C_c$ = 14 ps max.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}	12	V
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	20	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	2.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	50	mA
TRANSISTOR DISSIPATION	P_T		
With heat sink, at case temperatures up to 25°C		300	mW
With heat sink, at case temperatures above 25°C		Derate linearly 1.71	mW/°C
At ambient temperatures up to 25°C		200	mW
At ambient temperatures above 25°C		Derate linearly 1.14	mW/°C
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to +200	°C
CASE TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating surface for 10 seconds max.		265	°C

TERMINAL DESIGNATIONS



JEDEC TO-72

ELECTRICAL CHARACTERISTICS at Ambient Temperature (T_A) = 25°C unless otherwise specified

CHARACTERISTICS	SYMBOLS	TEST CONDITIONS: FREQUENCY MHz	DC COLLECTOR OR EMITTER VOLTAGE V			DC CURRENT mA			LIMITS: TYPE 40894 RF AMPLIFIER			TYPE 40895 MIXER			TYPE 40896 OSCILLATOR			TYPE 40897 IF AMPLIFIER			UNITS
			V_{CB}	V_{CE}	V_{EB}	I_E	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}		15			0			-	-	0.02	-	-	0.02	-	-	0.02	-	-	0.02	µA
T_A = 150°C	I_{CBO}		15			0			-	-	1	-	-	1	-	-	1	-	-	1	µA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$					0	0.001		20	-	-	20	-	-	20	-	-	20	-	-	V
Collector-to-Emitter Sustaining Voltage	$V_{CEO}(sus)$						3	0	15	-	-	15	-	-	15	-	-	15	-	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$					0.01	0		2.5	-	-	2.5	-	-	2.5	-	-	2.5	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$						10	1	-	-	0.4	-	-	0.4	-	-	0.4	-	-	0.4	V
Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$						10	1	-	-	1	-	-	1	-	-	1	-	-	1	V
Static Forward Current-Transfer Ratio	h_{FE}			6			1		50	80	250	40	70	250	27	50	250	70	120	250	
Magnitude of Common-Emitter, Small-Signal Short-Circuit, Forward Current Transfer Ratio[a]	$\|h_{fe}\|$	100 1 kHz		6 6			5 2		9 25	14 90	20 300	9 25	14 90	20 300	9 25	14 90	20 300	9 25	14 90	20 300	
Collector-to-Base Feedback Capacitance[b]	C_{cb}	0.1 to 1	10			0			-	0.7	1	-	0.7	1	-	0.7	1	-	0.7	1	pF
Common-Base Input Capacitance[c]	C_{ib}	0.1 to 1			0.5		0		-	-	2	-	-	2	-	-	2	-	-	2	pF
Collector-to-Base Time Constant[a]	$r_b'C_c$	31.9	6				2		3	7	14	3	7	14	3	7	14	3	7	14	ps
Small-Signal Power Gain in Neutralized Common-Emitter Amplifier Circuit[a]	G_{PE}	10.7 200		12 12			5 5		- 15	- 21	- -	- 15	- 21	- -	- 15	- 21	- -	18 -	25 -	- -	dB
Noise Figure[a]	NF	200		6			1.5		-	3	4.5	-	-	-	-	-	-	-	-	-	dB

[a] Lead No. 4 (case) grounded; R_g = 125Ω

[b] Three-terminal measurement of the collector-to-base capacitance with the case and emitter leads connected to the guard terminal.

[c] Lead No. 4 (case) floating.

40898, 40899

6- and 2-W, 2.3-GHz Emitter-Ballasted Silicon N-P-N Overlay Transistors

For Microwave Power Amplifiers, Fundamental- Frequency Oscillators, and Frequency Multipliers

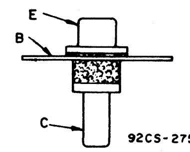
Features:

- Designed for 20- to 24-V equipment
- Emitter-ballasting resistors
- 6-W output with 6-dB gain (min.) at 2.3 GHz, 22 V — 40899
- 2-W output with 7-dB gain (min.) at 2.3 GHz, 22 V — 40898
- Stable common-base operation
- Ceramic-metal hermetic packages with low inductances and low parasitic capacitances
- For coaxial, microstripline, and lumped-constant circuit applications

MAXIMUM RATINGS, *Absolute-Maximum Values:*

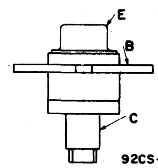
		40898	40899	
COLLECTOR-TO-BASE VOLTAGE:	V_{CBO}	45	45	V
COLLECTOR-TO-EMITTER VOLTAGE: With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	45	45	V
EMITTER-TO-BASE VOLTAGE:	V_{EBO}	3.5	3.5	V
CONTINUOUS COLLECTOR CURRENT:	I_C	0.35	1.5	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 75°C		4.15	14.8	W
At case temperatures above 75°C, derate linearly		0.033	0.118	W/°C
TEMPERATURE RANGE: Storage & Operating (Junction)		−65 to +200		°C
CASE TEMPERATURE (During soldering): For 10 s max (See Soldering Instructions on page 7.)		230		°C

TERMINAL DESIGNATIONS



RCA-40898

JEDEC TO-215AA



RCA-40899

JEDEC TO-201AA

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC VOLTAGE V: V_{CE}	DC CURRENT mA: I_E	I_B	I_C	LIMITS 40898 MIN.	40898 MAX.	40899 MIN.	40899 MAX.	UNITS
Collector-Cutoff Current	I_{CES}	40				–	2	–	2	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$		0		5	45	–	45	–	V
Collector-to-Emitter Breakdown Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{(BR)CER}$				10	45	–	45	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$		0.1		0	3.5	–	3.5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			10 20	100 100	– –	1 –	– –	– 1	V
Thermal Resistance: (Junction-to-Collector-Terminal)	$R_{\theta JCT}$						30	–	8.5	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: INPUT POWER (P_{IB})-W	OUTPUT POWER (P_{OB})-W	SUPPLY VOLTAGE (V_{CC})-V	FREQUENCY (f)-GHz	LIMITS 40898 MIN.	40898 MAX.	40899 MIN.	40899 MAX.	UNITS
Output Power	P_{OB}	0.4 1.5		22 22	2.3 2.3	2.0 –	– –	– 6.0	– –	W
Power Gain	G_{PB}	0.4 1.5	2 6	22 22	2.3 2.3	7.0 –	– –	– 6.0	– –	dB
Collector Efficiency	η_C	0.4 1.5	2 6	22 22	2.3 2.3	35 –	– –	– 35	– –	%
Collector-to-Base Capacitance	C_{obo}			30 (V_{CB})	1 MHz	–	4	–	11.5	pF

TYPICAL APPLICATION INFORMATION

CIRCUIT & FREQUENCY	SEE FIG.	SUPPLY VOLTAGE (V_{CC})-V	40898 INPUT POWER (P_{IB})-W	40898 OUTPUT POWER (P_{OB})-W	40899 INPUT POWER (P_{IB})-W	40899 OUTPUT POWER (P_{OB})-W
Coaxial-Line 2.3-GHz Amplifier	17 21	22 22	0.4 –	2.1 –	– 1.5	– 6.5
Coaxial-Line 1.2-GHz Amplifier	21	22	–	–	1	13.5
Lumped-Constant 1-GHz Amplifier	19	22	0.21	3.8	–	–
Lumped-Constant 2-GHz Oscillator	18	22		0.75	–	–

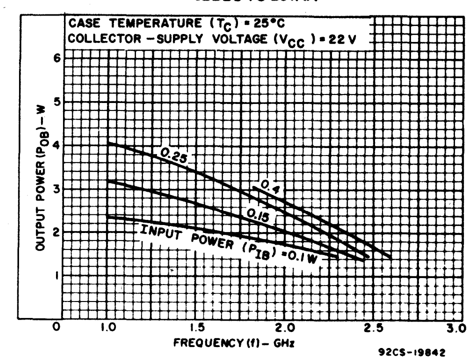


Fig. 1 - Typical output power as a function of frequency for type 40898.

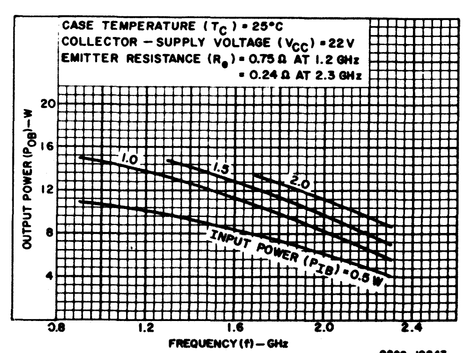


Fig. 2 - Typical output power as a function of frequency for type 40899.

40909

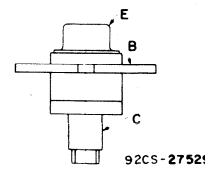
2-W, 2-GHz Emitter-Ballasted Silicon N-P-N Overlay Transistor

For Microwave Fundamental-Frequency Oscillators

Features:

- Emitter-ballasting resistors
- 2-W (min.) output at 2 GHz
- 4-W (typ.) output at 1 GHz
- Emitter connected to flange (for increased internal feedback) for higher efficiency at S-band frequencies in Colpitts oscillator circuits
- Beryllium-oxide ceramic for low thermal resistance between collector stud and emitter flange
- For coaxial, stripline, and lumped-constant circuit applications

TERMINAL DESIGNATIONS



JEDEC TO-201AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
COLLECTOR-TO-EMITTER VOLTAGE: With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
CONTINUOUS DC COLLECTOR CURRENT	I_C	0.7	A
TRANSISTOR DISSIPATION	P_T		
At case temperature up to 75°C		10.4	W
At case temperatures above 75°C derate linearly		0.083	W/°C
TEMPERATURE RANGE: Storage & Operating (Junction)		−65 to 200	°C
CASE TEMPERATURE (During soldering): For 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C unless otherwise specified.

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage (V) V_{CE}	DC Current (mA) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
Collector-Cutoff Current	I_{CES}	45				-	2	mA
	I_{CES} (T_C = 100°C)	45				-	5	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$		0		5	50	-	V
Collector-to-Emitter Breakdown Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{(BR)CER}$				10	50	-	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$		0.1		0	3.5	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			20	100	-	1	V
Thermal Resistance: (Junction to Collector-Stud)	$R_{\theta JCT}$					-	10	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: Frequency (f) – GHz	DC Emitter Supply Voltage (V_{EE}) – V	LIMITS Min.	Max.	UNITS
Oscillator Output Power	P_O	2	25	2.0	-	W
Oscillator Circuit Efficiency	η	2	25	20	-	%
Collector-to-Base Capacitance V_{CB} = 30 V	C_{obo}	1 MHz	-	-	8.5	pF

TYPICAL APPLICATION INFORMATION

Application	Collector Current (I_C) – mA	DC Emitter Supply Voltage (V_{EE}) – V	Output Power (P_O) – W
2-GHz Oscillator	400	25	2.5
1-GHz Oscillator	400	25	4.0

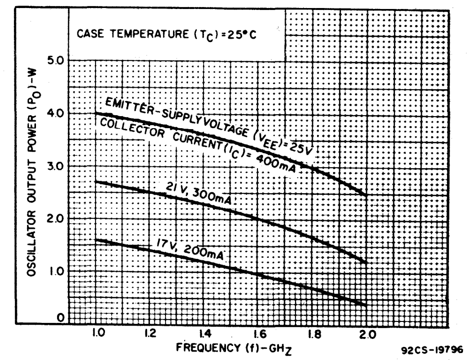


Fig. 1 - Typical oscillator output power as a function of frequency.

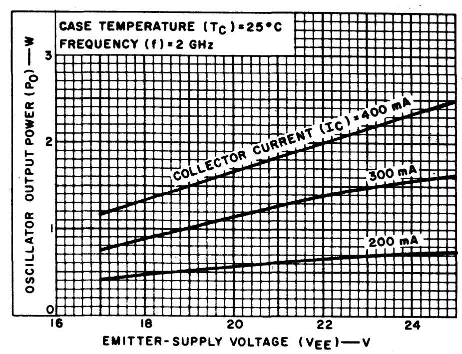


Fig. 2 - Typical 2-GHz oscillator output power as a function of emitter-supply voltage.

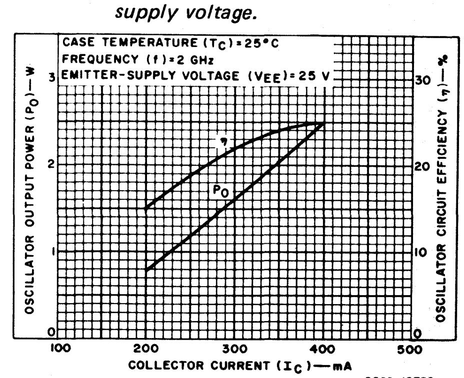


Fig. 3 - Typical oscillator output power and circuit efficiency as a function of collector current.

40915

0.2-to-1.4-GHz Low-Noise Silicon N-P-N Transistor

For High-Gain Small-Signal Applications

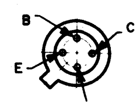
Features:
- **Low noise figure:**
  NF = 2.5 dB (max.) with 11 dB gain at 450 MHz
  = 3.0 dB (typ.) at 890 MHz
  = 4.5 dB (typ.) at 1.3 GHz
- **High gain (tuned, unneutralized):**
  G_{PE} = 14 dB (min.) at 450 MHz
  = 6.5 dB (typ.) at 1.3 GHz
- **High gain-bandwidth product**
- **Large dynamic range**
- **Low distortion**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

Collector-to-Base Voltage	V_{CBO}	35	V
Collector-to-Emitter Voltage	V_{CEO}	15	V
Emitter-to-Base Voltage	V_{EBO}	3.5	V
Collector Current (Continuous)	I_C	40	mA

Transistor Dissipation: P_T
At ambient temperatures up to 25°C .... 200 mW
At ambient temperatures above 25°C .... Derate linearly at 1.14 mW/°C
Temperature Range:
Storage and Operating (Junction) .... −65 to +200 °C

TERMINAL DESIGNATIONS



92CS-27513

JEDEC TO-72

ELECTRICAL CHARACTERISTICS at Ambient Temperature (T_A) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTAGE (V) V_{CB}	V_{CE}	DC CURRENT (mA) I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
STATIC									
Collector Cutoff Current	I_{CBO}	10		0			–	20	nA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.01	35	–	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$				0	0.1	15	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.01		0	3.5	–	V
DC Forward-Current Transfer Ratio	h_{FE}		10			3	20	–	–
Thermal Resistance: (Junction-to-Ambient)	$R_{\theta JA}$						–	880	°C/W
DYNAMIC									
Device Noise Figure (f = 450 MHz)	NF		10			1.5	–	2.5	dB
Small-Signal Common-Emitter Power Gain (f = 450 MHz) Unneutralized Amplifier	G_{PE}		10			1.5	14	–	dB
At minimum noise figure	G_{PE}		10			1.5	11.0	–	dB
Collector-to-Base Output Capacitance (f = 1 MHz)	C_{obo}	10		0			–	1.0	pF

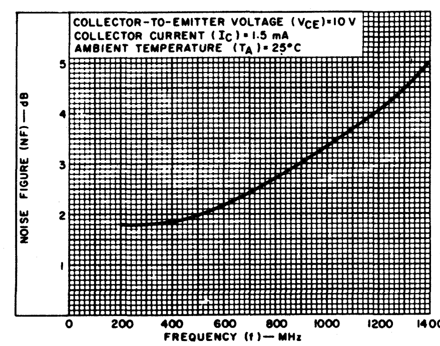


Fig. 1 - Typical noise figure as a function of frequency.

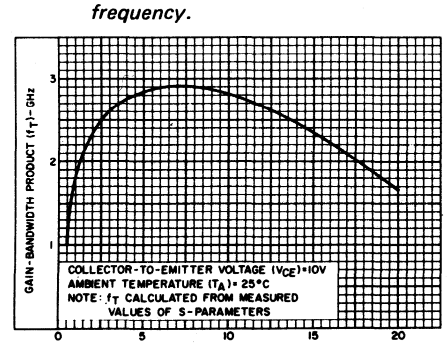


Fig. 2 - Gain-bandwidth product as a function of collector current.

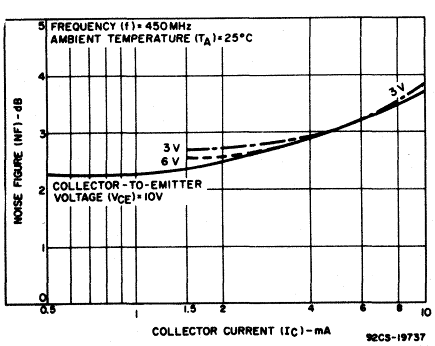


Fig. 3 - Typical noise figure as a function of collector current.

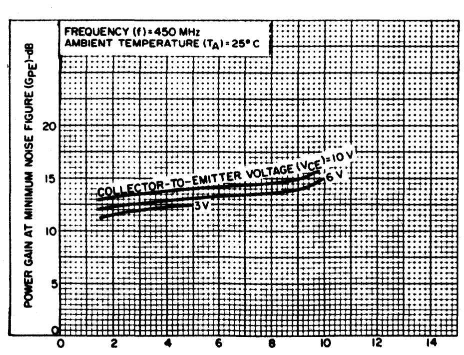


Fig. 4 - Typical power gain (at minimum noise figure) as a function of collector current.

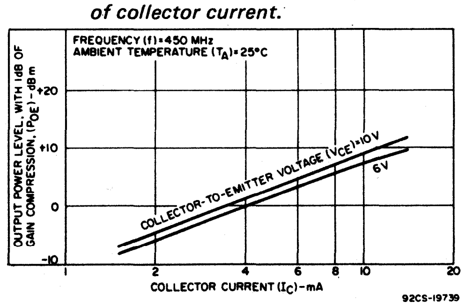


Fig. 5 - Typical output power level (with 1 dB of gain compression) as a function of collector current.

40936

20-W(PEP) Emitter-Ballasted Overlay Transistor

For 2- to-30-MHz Single-Sideband Linear Amplifier Applications

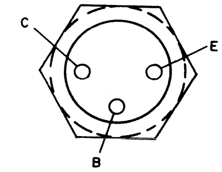
Features:

- **For class A or class B amplifier service**
- **Integral emitter-ballasting resistors**
- **20 W(PEP) output (min.) at 30 MHz with: gain = 13 dB (min.); collector efficiency = 40% (min.); intermodulation distortion = –30 dB (max.)**
- **Low-Thermal-Resistance Package**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = –1.5 V	V_{CEV}	65	V
With external base-to-emitter resistance R_{BE} = 5 Ω	V_{CER}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT:			
Peak		10	A
Continuous	I_C	3.3	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 75°C		50	W
At case temperatures above 75°C		Derate linearly at 0.4 W/°C.	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		–65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.787 mm) from insulating wafer for 10 s max		230	°C

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTAGE (V) V_{CB}	V_{CE}	DC BASE VOLTAGE (V) V_{BE}	DC CURRENT (mA) I_E	I_C	LIMITS MIN.	MAX.	UNITS
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse biased	V_{CEV}(sus)			–1.5		200[a]	65	–	V
With external base-to-emitter resistance (R_{BE})=5Ω	V_{CER}(sus)					200[a]	40	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				20		4	–	V
Collector-to-Emitter Cutoff Current	I_{CEO}		30				–	5.0	mA
Collector-to-Base Cutoff Current	I_{CBO}	60					–	10	mA
Collector-to-Base Capacitance (f = 1 MHz)	C_{obo}	30					–	85	pF
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	2.5	°C/W

[a]Pulsed through an inductor (25 mH); duty factor = 50%.

DYNAMIC (30-MHz Single-Sideband Amplifier)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR SUPPLY VOLTAGE (V) V_{CC}	OUTPUT POWER W(PEP) P_{OE}	FREQUENCY (MHz) f	DC CURRENT (mA) I_C	LIMITS MIN.	MAX.	UNITS
RF Input Power: Average	P_{IE}	28	10	30	20	–	0.5	W
Peak envelope (PEP)	P_{IE}	28	20	30	20	–	1.0	W
Power Gain	G_{PE}	28	20	30	20	13	–	dB
Collector Efficiency	η_C	28	20	30	20	40	–	%
Intermodulation Distortion*	IMD	28	20	30	20	–	-30	dB

*Referenced to either of the two tones, and without the use of feedback to enhance linearity.

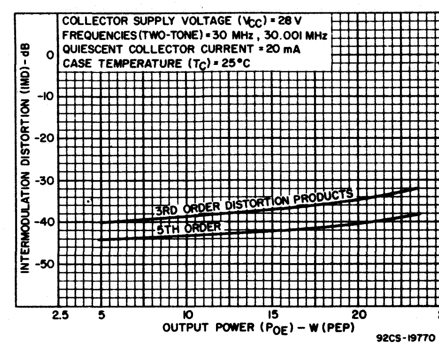


Fig. 1 - Typical intermodulation distortion as a function of output power.

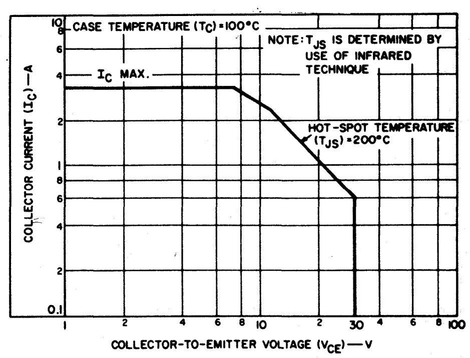


Fig. 2 - Maximum operating area for forward-bias operation.

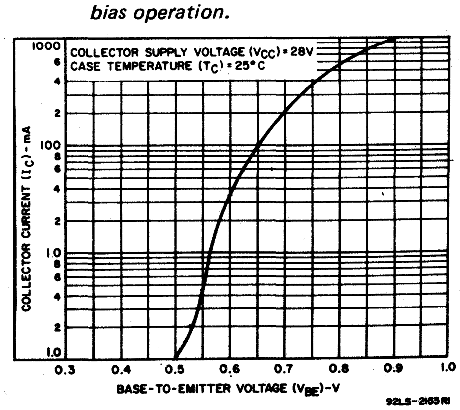


Fig. 3 - Typical transfer characteristic.

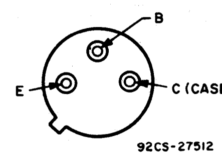
40953-40955

1.75-, 10-, and 25-W, 156-MHz Silicon N-P-N Overlay Transistors

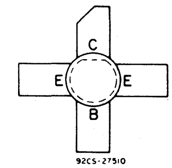
For High-Power VHF Amplifiers

Features:
- Designed for vhf marine transmitters
- 25 W (min.) output at 156 MHz (12.5-V supply)
- Infinite VSWR load-tested at constant input power, f = 156 MHz, V_{CC} = 15.5 V (40955)

TERMINAL DESIGNATIONS



40953
JEDEC TO-39



40954
40955
RCA HF-44

MAXIMUM RATINGS, *Absolute Maximum Values:*

		40953	40954	40955	
COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE:					
With base shorted to emitter	$V_{(BR)CES}$	36	36	36	V
With base open	$V_{(BR)CEO}$	14	14	14	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	3.5	3.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.33	4.5	5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 75°C		3.5	25	35.7	W
At case temperatures above 75°C, derate linearly		0.028	0.2	0.286	W/°C
TEMPERATURE RANGE:					
Storage and operating (Junction)			–65 to +200		°C
LEAD TEMPERATURE (During soldering):					
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.			230		°C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS DC Voltage V V_{CE}	V_{EB}	DC Current mA I_E	I_B	I_C	LIMITS 40953 MIN.	MAX.	40954 MIN.	MAX.	40955 MIN.	MAX.	UNITS
Collector-Cutoff Current: Base connected to emitter	I_{CES}	12.5			0		–	1	–	10	–	10	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				0	25[a]	14	–	–	–	–	–	V
					0	200	–	–	14	–	14	–	V
With base connected to emitter	$V_{(BR)CES}$		0			25[a]	36	–	–	–	–	–	V
						200	–	–	36	–	36	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.5		0	3.5	–	–	–	–	–	V
				5		0	–	–	3.5	–	3.5	–	V
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$						–	35.7	–	5	–	3.5	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%.

DYNAMIC

TEST & CONDITIONS	SYMBOL	DC COLLECTOR SUPPLY VOLTAGE (V_{CC}) – V	FREQUENCY (f)-MHz	LIMITS 40953 MIN.	MAX.	40954 MIN.	MAX.	40955 MIN.	MAX.	UNITS
Power Output: P_{IE} = 0.1 W (40953) 1.75 W (40954) 9 W (40955)	P_{OE}	12.5	156	1.75	–	10	–	25	–	W
Large-Signal Common-Emitter Power Gain: P_{OE}=1.75 W (40953) 10 W (40954) 25 W (40955)	G_{PE}	12.5	156	12.4	–	7.6	–	4.5	–	dB
Collector Efficiency: P_{OE} = 1.75 W (40953) 10 W (40954) 25 W (40955)	η_C	12.5	156	50	–	60	–	60	–	%
Collector-to-Base Output Capacitance	C_{obo}	12.5 (V_{CB})	1	–	15	–	30	–	80	pF

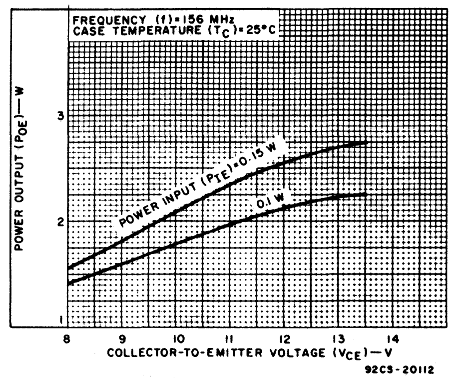


Fig. 1 - Typical power output as a function of supply-voltage at 156 MHz for type 40953.

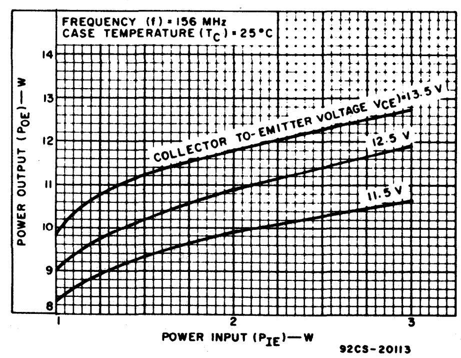


Fig. 2 - Typical power output as a function of power input at 156 MHz for type 40954.

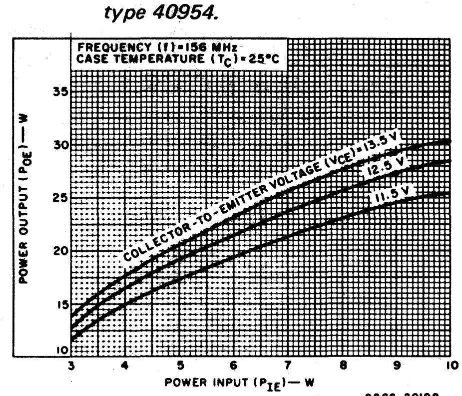


Fig. 3 - Typical power output as a function of power input at 156 MHz for type 40955.

40964, 40965

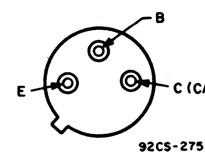
Silicon N-P-N Overlay Transistors

High-Gain Devices for Class C VHF/UHF Multiplier and Amplifier Service

Features:

- **High power gain:**
  6 dB (min.) up to f = 470 MHz (40964 tripler)
  7 dB (min.) at f = 470 MHz (40965 amplifier)

TERMINAL DESIGNATIONS



JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	36	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 33Ω	$V_{CER(sus)}$	36	V
With base open	$V_{CEO(sus)}$	14	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	2	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		3.5	W
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max		230	°C

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS Voltage V dc	Current mA dc			LIMITS 40964 40965		UNITS
		V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}	10		0		–	0.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$		0			36	–	V
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO(sus)}$			0	5[a]	14	–	V
With external base-to-emitter resistance (R_{BE}) = 33Ω	$V_{CER(sus)}$				5[a]	36	–	
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$		0.1		0	2	–	V
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$					–	50	°C/W

[a]Pulsed through a 25-mH inductor; duty factor = 50%.

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS Collector Supply (V_{CC}) - V dc	Input Power (P_{IE}) - W	Frequency (f) - MHz	LIMITS 40964 Min.	40964 Typ.	40965 Min.	40965 Typ.	UNITS
Power Output	P_{OE}	12	0.1	156.7-470	0.4	0.44	–	–	W
				470	–	–	0.5	0.55	
		8	0.1	156.7-470	–	0.33	–	–	
				470	–	–	–	0.33	
Power Gain	G_{PE}	12	0.1	156.7-470	6	6.4	–	–	dB
				470	–	–	7	7.4	
		8	0.1	156.7-470	–	5.2	–	–	
				470	–	–	–	5.2	
Collector Efficiency	η_C	12	0.1	156.7-470	25	–	–	–	%
				470	–	–	40	–	
		8	0.1	156.7-470	–	25	–	–	
				470	–	–	–	40	
Collector-to-Base Capacitance	C_{obo}	V_{CB} = 12 V, I_C = 0	–	1	–	5 (max.)	–	5 (max.)	pF
Gain-Bandwidth Product	f_T	V_{CE} = 12 V, I_C = 50 mA	–	–	–	700	–	700	MHz

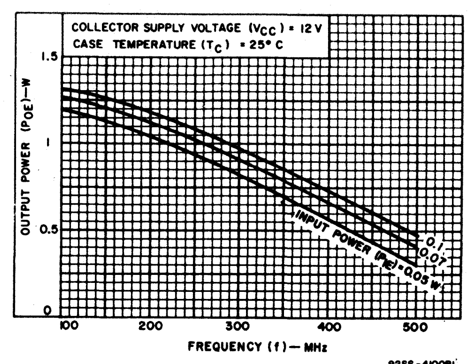


Fig. 1 - Typical power output as a function of frequency for 40965.

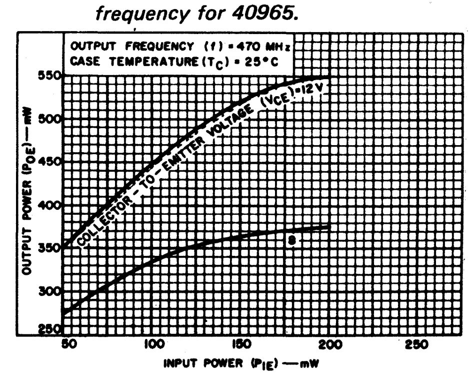


Fig. 2 - Typical power output as a function of power input for 40964.

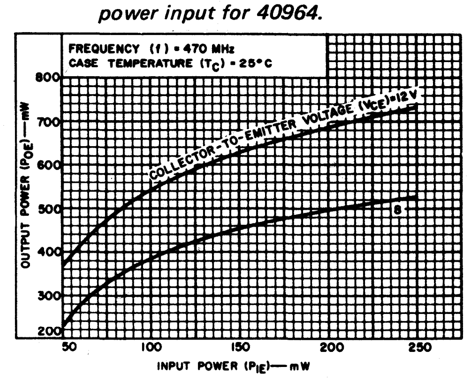


Fig. 3 - Typical power output as a function of power input for 40965.

40972-40974

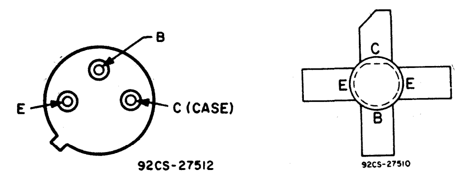
1.75-, 10-, and 25-W, 175-MHz Silicon N-P-N Overlay Transistors

For High-Power VHF Amplifiers

Features:

- Designed for vhf mobile transmitters
- 25 W (min.) output at 175 MHz (V_{CC} = 12.5 V)
- Infinite VSWR load-tested at constant input power, f = 175 MHz, V_{CC} = 15.5 V (40974)

TERMINAL DESIGNATIONS



40972 JEDEC TO-39

40973 40974 RCA HF-44

MAXIMUM RATINGS, *Absolute Maximum Values:*

		40972	40973	40974	
COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE:					
With base shorted to emitter	$V_{(BR)CES}$	36	36	36	V
With base open	$V_{(BR)CEO}$	14	14	14	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	3.5	3.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.33	4.5	5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 75°C		3.5	25	35.7	W
At case temperatures above 75°C, derate linearly		0.028	0.2	0.286	W/°C
TEMPERATURE RANGE:					
Storage and operating (Junction)			−65 to +200		°C
LEAD TEMPERATURE (During soldering):					
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.			230		°C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS						UNITS
		Voltage V dc		Current mA dc			40972		40973		40974		
		V_{CE}	V_{EB}	I_E	I_B	I_C	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: Base connected to emitter	I_{CES}	12.5	0		0		–	1	–	10	–	10	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.5	36	–	36	–	36	–	V
Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				0	25[a]	14	–	–	–	–	–	V
					0	200	–	–	14	–	14	–	
With base connected to emitter	$V_{(BR)CES}$		0			25[a]	36	–	–	–	–	–	
						200	–	–	36	–	36	–	
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.5		0	3.5	–	–	–	–	–	V
				5		0	–	–	3.5	–	3.5	–	
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$						–	35.7	–	5	–	3.5	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%.

DYNAMIC

TEST & CONDITIONS	SYMBOL	DC COLLECTOR SUPPLY VOLTAGE (V_{CC}) – V	FREQUENCY (f)-MHz	LIMITS						UNITS
				40972		40973		40974		
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Output Power: P_{IE} = 0.1 W (40972) 1.75 W (40973) 9 W (40974)	P_{OE}	12.5	175	1.75	–	10	–	25	–	W
Large-Signal Common-Emitter Power Gain: P_{OE} = 1.75 W (40972) 10 W (40973) 25 W (40974)	G_{PE}	12.5	175	12.4	–	7.6	–	4.5	–	dB
Collector Efficiency: P_{OE} = 1.75 W (40972) 10 W (40973) 25 W (40974)	η_C	12.5	175	50	–	60	–	60	–	%
Collector-to-Base Output Capacitance	C_{obo}	12.5 (V_{CB})	1	–	15	–	30	–	80	pF

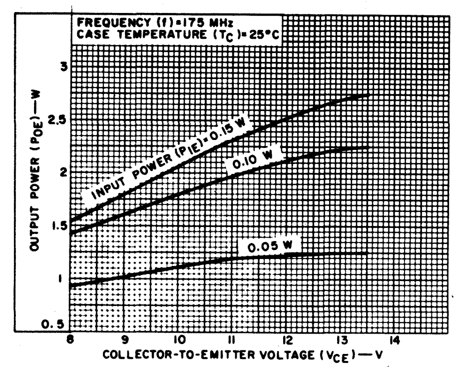


Fig. 1 - Typical output power as a function of supply voltage for RCA-40972.

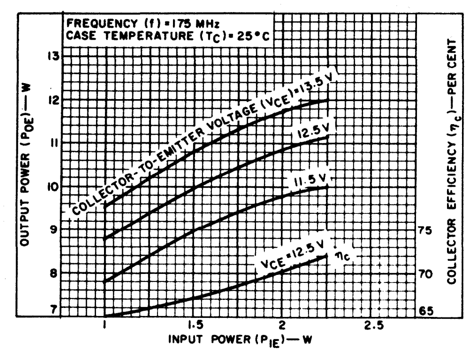


Fig. 2 - Typical output power and collector efficiency as a function of input power for RCA-40973.

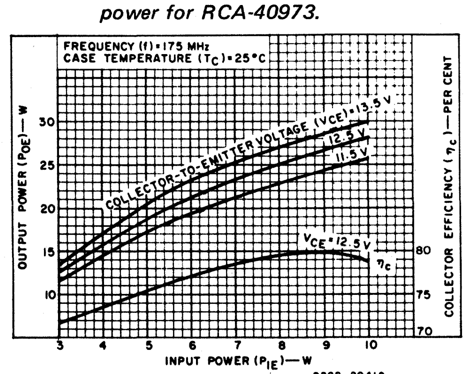


Fig. 3 - Typical output power and collector efficiency as a function of input power for RCA-40974.

40975-40977

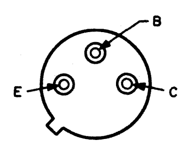
0.05-, 0.5-, and 6-W, 118-136-MHz Silicon N-P-N Overlay Transistors

For High-Power VHF Amplifiers

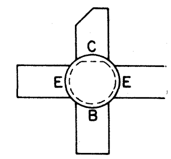
Features:

- Designed for vhf aircraft transmitters
- 6 W (min.) output at 118 MHz (12.5-V supply)
- Infinite VSWR load-tested at constant input power, f = 118 MHz, V_{CC} = 25 V (40977)

TERMINAL DESIGNATIONS



40975
40976
JEDEC TO-39



40977
RCA HF-44

MAXIMUM RATINGS, *Absolute Maximum Values:*

		40975	40976	40977	
COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE:					
With base shorted to emitter	$V_{(BR)CES}$	55	60	60	V
With base open	$V_{(BR)CEO}$	30	30	30	V
EMITTER-TO-BASE VOLTAGE.	V_{EBO}	3.5	3.5	3.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.4	0.5	5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 75°C		3.5	5	25	W
At case temperatures above 75°C, derate linearly		0.028	0.04	0.2	W/°C
TEMPERATURE RANGE:					
Storage and operating (Junction)			–65 to +200		°C
LEAD TEMPERATURE (During soldering):					
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.			230		°C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

STATIC

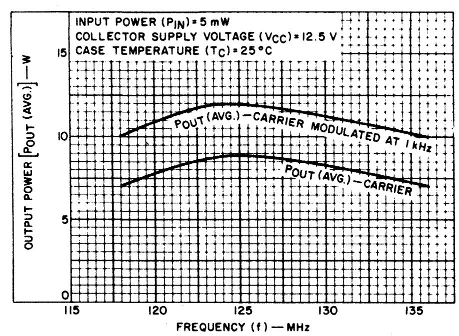
CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Voltage V: V_{CE}	V_{EB}	DC Current mA: I_E	I_B	I_C	LIMITS: 40975 MIN.	40975 MAX.	40976 MIN.	40976 MAX.	40977 MIN.	40977 MAX.	UNITS
Collector Cutoff Current: Base connected to emitter	I_{CES}	12.5	0				–	0.1	–	1	–	10	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				0	5	30	–	30	–	–	–	V
					0	200[a]	–	–	–	–	30	–	
With base connected to emitter	$V_{(BR)CES}$		0			5	55	–	60	–	–	–	
			0			200[a]	–	–	–	–	60	–	
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.5		0	3.5	–	3.5	–	–	–	V
				5		0	–	–	–	–	3.5	–	
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$						–	35.7	–	25	–	5	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%.

DYNAMIC

TEST & CONDITIONS	SYMBOL	DC COLLECTOR SUPPLY VOLTAGE (V_{CC}) – V	FREQUENCY (f) – MHz	LIMITS: 40975 MIN.	40975 MAX.	40976 MIN.	40976 MAX.	40977 MIN.	40977 MAX.	UNITS
Power Output: P_{IE} = 0.005 W (40975)	P_{OE}	12.5	118	0.05	–	–	–	–	–	W
0.05 W (40976)		12.5		–	–	0.5	–	–	–	
0.5 W (40977)		12.5		–	–	–	–	6	–	
1.2 W (40977)		25		–	–	–	–	22[b]	–	
Large-Signal Common-Emitter Power Gain: P_{OE} = 0.05 W (40975), 0.5 W (40976), 6 W (40977)	G_{PE}	12.5	118	10	–	10	–	10.8	–	dB
Collector Current: P_{OE} = 0.05 W (40975), 0.5 W (40976), 6 W (40977)	I_C	12.5	118	–	60	–	140	–	950	mA
Collector Efficiency: P_{OE} = 6 W (40977)	η_C	25	118	–	–	–	–	55	–	%
Collector-to-Base Output Capacitance	C_{obo}	12.5 (V_{CB})	1	–	4	–	15	–	30	pF

[b] Pulsed Input: Rep. rate = 1 kHz
Envelope shape = Square wave
Duty factor = 50%



92CS-24884

Fig. 1 - Power output as a function of frequency.

41024

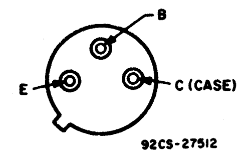
1-W, 1-GHz Silicon N-P-N Overlay Transistor

High-Gain Device for Class B- or C- Operation in UHF Circuits

Features:

- **1-watt output min. at 1 GHz (5 dB gain)**
- **For sonde applications**
  0.3-watt output typ. at 1.68 GHz (V_{CC} = 20 V)

TERMINAL DESIGNATIONS



JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	55	V
With base open	V_{CEO}	24	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.4	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		3.5	W
At case temperatures above 25°C		See Fig. 1	
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230	°C

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: Voltage V dc		Current mA dc			LIMITS		UNITS
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector Cutoff Current: With base open	I_{CEO}		15		0		–	20	μA
With base connected to emitter	I_{CES}		50				–	1	
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	55	–	V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$					5	55	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	–	0.5	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{ob}	30		0			–	3.0	pF
Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (Measured at 200 MHz)	$\|h_{fe}\|$		15			50	6.0	–	
RF Power Output Common Emitter Amplifier at 1 GHz	P_{OUT}		28				1[a]	–	W

[a]For P_{IN} = 0.316 W, minimum efficiency = 35%.

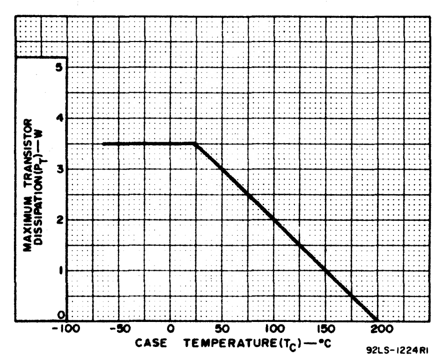


Fig. 1 - Derating curve.

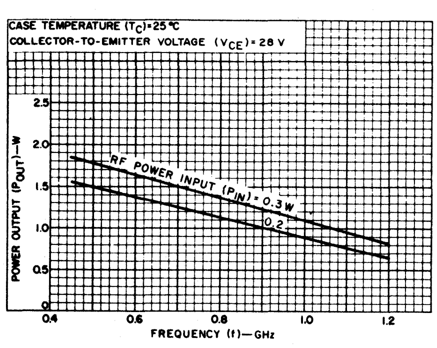


Fig. 2 - Typical power output vs. frequency.

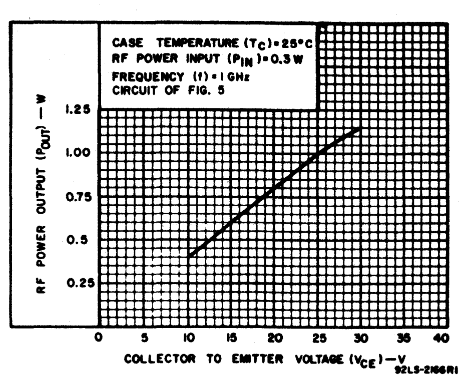


Fig. 3 - Typical rf power output as a function of collector-to-emitter voltage.

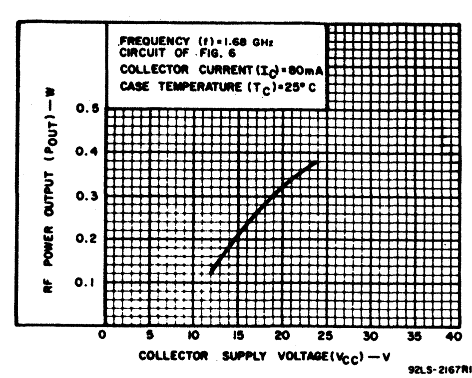


Fig. 4 - Typical oscillator power output as a function of collector supply voltage.

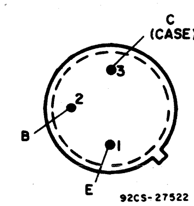
41038

750-mW, 1.68-GHz Oscillator Transistor

Features:

- Emitter-ballasting resistors
- 750-mW oscillator power at 1.68 GHz (20 V)
- Collector connected to case
- For coaxial, stripline, and lumped-element circuits

TERMINAL DESIGNATIONS



TO-46

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}		45	V
COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}		21	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}		3.5	V
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 100°C			3.1	W
At case temperatures above 100°C		Derate at	0.031	W/°C
TEMPERATURE RANGE:				
Storage and Operating (Junction)			−65 to 200	°C

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

Static

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT mA dc I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
Collector Cutoff Current	I_{CES}	40	0		0		–	2	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		5	45	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	32	°C/W

Dynamic

CHARACTERISTIC	SYMBOL	POWER OUTPUT (P_{OB})–W	SUPPLY VOLTAGE (V_{CC})–V	FREQUENCY GHz	LIMITS MIN.	MAX.	UNITS
Common-Collector Oscillator Output Power	P_{OB}		20	1.68	0.75	–	W
Oscillator Circuit Efficiency	η_O	0.75	20	1.68	20	–	%
Collector-to-Base Capacitance	C_{obo}		30(V_{CB})	1 MHz	–	4	pF

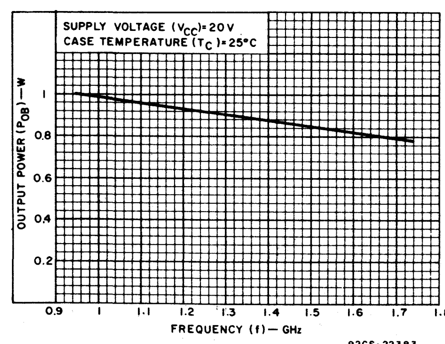


Fig. 1 - Typical output power as a function of frequency for 41038 oscillator.

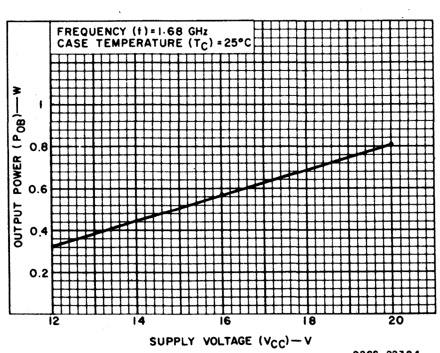


Fig. 2 - Typical output power as a function of supply voltage for 41038 oscillator.

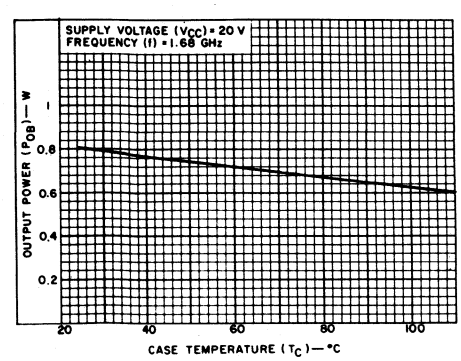


Fig. 3 - Typical output power as a function of case temperature for 41038 oscillator.

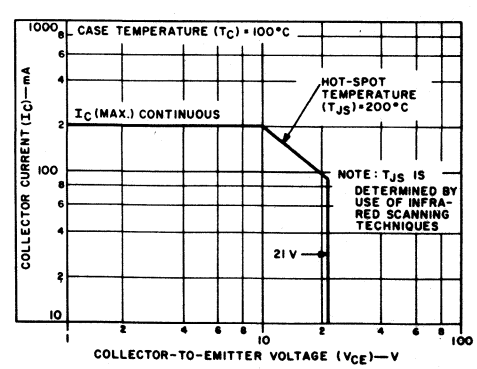


Fig. 4 - Maximum operating area for forward-biased operation.

41039

Silicon N-P-N Overlay Transistor

For VHF Broadband Amplifiers in CATV and MATV Equipment

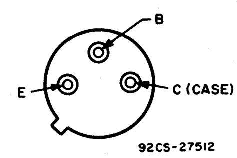
Features:

- **Low Device Noise Figure:**
  - **200-MHz narrow-band (30 mA) = 3 dB max.**
  - **60-MHz narrow-band (30 mA) = 2.2 dB max.**
  - **50-250-MHz broadband = 6.5 dB typ.**
- **High Gain:**
  - **G_{PE} (200 MHz, 30 mA) = 15 dB min.**
  - **G_{VE} (50-250 MHz, broadband) = 10 dB typ.**
  - **f_T (30 mA) = 1.8 GHz min.**
- **Low Distortion:**
  - **Cross-modulation (40 dBmV, 17 V, 60 mA) = −67 dB typ.**
  - **IMD (50 dBmV, 17 V, 60 mA) = −55 dB typ.**
- **Collector-to-Base Time Constant:**
  - **(f = 31.9 MHz) = 7.0 ps typ.**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	25	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.25	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 75°C		2.5	W
At case temperatures above 75°C ... Derate linearly at		0.02	W/°C
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230	°C

TERMINAL DESIGNATIONS



JEDEC TO-39

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS DC Voltage V		DC Current mA			LIMITS		UNITS
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	18			0		–	100	μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		1	40	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$				0	20	25	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	–	0.25	V
DC Forward-Current Transfer Ratio	h_{FE}		15			50	60	350	
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$						–	50	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS DC Voltage V		DC Current mA			LIMITS		UNITS
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Small-Signal, Common-Emitter Power Gain (f = 200 MHz)	G_{PE}		15			30	15	–	dB
Noise Figure (Measured) (f = 200 MHz)	NF		15			30	–	3.2[a]	dB
Wideband Voltage Gain (f = 50-250 MHz)	G_{VE}		17			60	9.5	–	dB
12-Channel Cross Modulation Distortion (f = 50-250 MHz; output level = 40 dBmV)	CMD		17			60	−62	–	dB
Gain-Bandwidth Product (f = 200 MHz)	f_T		15 15			30 60	1.8 2	– –	GHz
Collector-to-Base Capacitance (f = 1 MHz)	C_{obo}	30					–	2.5	pF

[a] Because of insertion loss of input test circuit, device noise figure is approximately 0.2 dB less than measured.

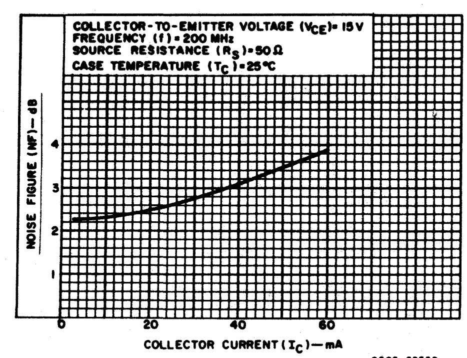


Fig. 1 - Typical measured narrow-band noise figure as a function of collector current.

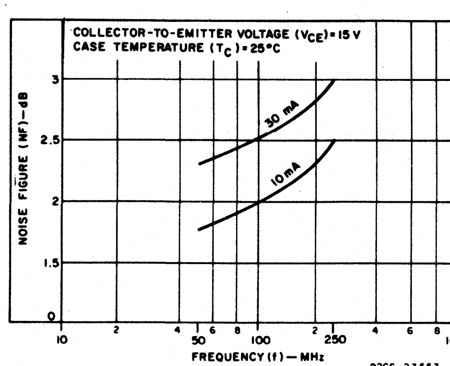


Fig. 2 - Typical measured narrow-band noise figure as a function of frequency.

Power Hybrid Circuits

HC2000H, HC2500
Multi-Purpose 7-Ampere Operational Amplifiers

Linear Amplifiers for Applications in Industrial and Commercial Equipment

The RCA-HC2000H and HC2500 hybrid-circuit operational amplifiers are designed for operation from either single or split power supplies at output currents up to 7 amperes and power outputs up to 100 watts. These versatile amplifiers are recommended for servoamplifiers, audio power amplifiers, driven inverters, power operational amplifiers, deflection amplifiers, solenoid drivers, voltage regulators, and similar linear-amplifier power applications. They are supplied in a metal hermetic package.

The HC2000H and HC2500 employ a quasi-complementary-symmetry output stage with hometaxial-base output transistors. They feature low distortion, with a maximum total harmonic distortion of 0.5 per cent over a bandwidth of 30 kHz at a power output of 60 watts and a typical intermodulation distortion of less than 1 per cent at rms power outputs from 0.2 to 70 watts. At an rms output of 50 milliwatts, the HC2500 has an exceptionally low typical intermodulation distortion of only 0.06 per cent.

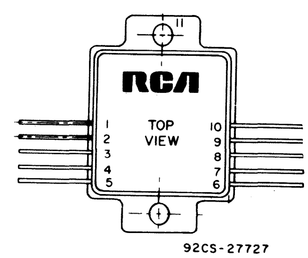
The HC2000H includes a load-line limiting network that provides protection against short-circuit loads and against high-energy transients when the amplifier is used to drive inductive loads. Both circuits also feature adjustable idling current and direct coupling to the load.

High-reliability versions of the HC2000H are also available for use in aerospace, military, and critical industrial applications. These types are screened to four reliability levels (/1, /2, /3, and /4) that approximate the reliability classes of MIL-STD-750. These slash-series types are the electronic industry's first series of high-reliability high-power hybrid-circuit op-amps.

Features:

- Bandwidth: 30 kHz at 60 W
- High power output: up to 100 W(rms)
- High output current: 7A (peak)
- Low IMD and THD
- Adjustable idling current
- Stability with resistive or reactive loads
- Single or split power supply (30 to 75 V, single, ± 15 to ± 37.5, split)
- Class AB output stage (HC2500) Class B output state (HC2000H)
- Direct coupling to load
- Built-in load-line-limiting circuit to protect amplifiers from accidentally short-circuited output terminals (HC2000H)
- Reactive-load fault protection (HC2000H)
- Socket available
- Rugged package with heavy leads
- Light weight: 100 grams

TERMINAL DESIGNATION



92CS-27727

HC2000H, HC2500

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	HC2000H HC2500
V_S: Between leads 1 & 10	75 V
I_{OM}	7 A
P_T: Per Output Device	See Figs. 3 & 4
T_{stg}	−55 to +125°C
T_J	−55 to +150°C
T_L (During Soldering): At distance ≥1/8 in. (3.17 mm) from case for 10 s max.	235°C
ϕL (Min): At distance ≥0.075 (1.91 mm) from case	0.04 in. (1.02 mm)

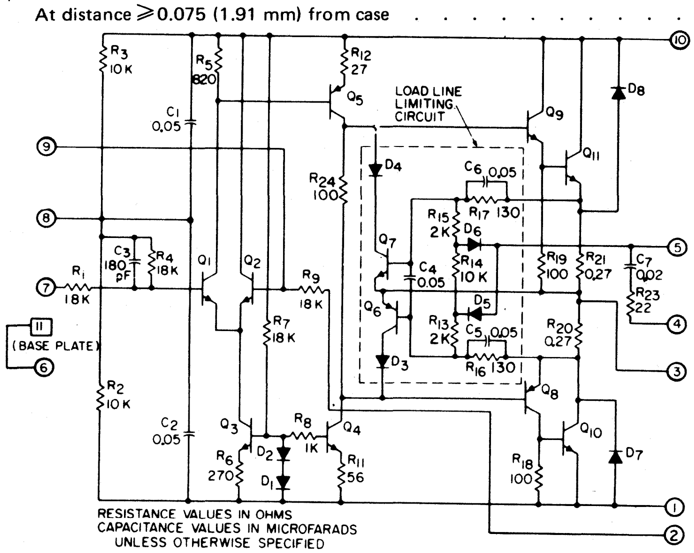


Fig. 1 — Schematic diagram of type HC2000H operational amplifier.

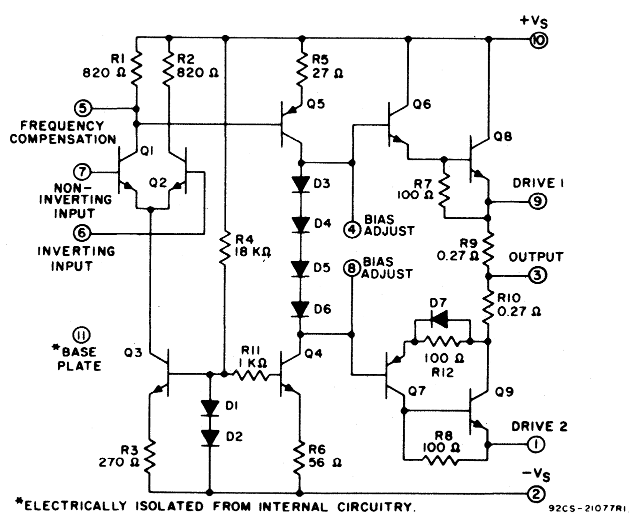


Fig. 2 — Schematic diagram of type HC2500 operational amplifier.

HC2000H, HC2500

COMPARISON CHART

TYPE	IM DIST.	OUTPUT PROTECTION NETWORK	OPERATING MODE	FREQUENCY COMPENSATION	COMMUTATING DIODES
HC2500	0.06% @ 50 mW	NO	CLASS AB	CAPACITOR ON SIGNAL TERMINALS	NO
HC2000H	0.6% @ 200 mW	YES	CLASS B	LC FILTER ON OUTPUT	YES

HC2000H

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	V_S –V	f –kHz	P_O –W	R_L –Ω	MIN.	TYP.	MAX.	
$\frac{V_{OUT}}{V_{IN}}$ Open-Loop	±37.5	4	25	4	–	2000	–	
Closed-Loop	±37.5	1	1	4	26	30	–	
Z_{IN} Measured between leads 7 & 8	–	–	–	–	16	18	–	kΩ
I_O	±37.5	–	–	–	15	–	30	mA
V_{IO} Measured between leads 4 & 5	±37.5	–	–	4	0	±30	±250	mV
V_{OUT}	±37.5	1	100	4	28	32	–	V
f_H (See Fig.9)	±37.5	–	1	4	43	–	–	kHz
THD (See Fig. 10)	±37.5	1	60	4	–	0.4	0.5	%
I_S (See Fig. 12)	±37.5	1	–	0	±2	–	±3.85	A
S/N Z_G = 600 Ω	±37.5	–	–	–	–	78	–	dB
SR (Unity gain, I_{OM} = 4A)	±37.5	1	100	4	5	–	–	V/μs
$R_{\theta JC}$ Per Output Device (See Figs. 3 & 4)	–	–	–	–	–	–	2	°C/W

HC2500

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C and Supply Voltage (V_S) = ±37.5 V*

CHARACTERISTIC	REFERENCE FIG. NO.	TEST CONDITIONS				LIMITS			UNITS
		SPECIAL NOTES	FREQ. (f)–kHz	OUTPUT POWER (P_O)–W	LOAD RESIST. (R_L)–Ω	MIN.	TYP.	MAX.	
V_{offset}		Measured Pin 3 to Gnd	–	–	4	–	–	±250	mV
I_o		Idling Current < 1 mA	–	–	Open	–	–	±30	mA
V_{OUT}		Peak dc voltage	0	200	4	28	–	–	V
f_H			–	1	4	43	–	–	kHz
THD	21		1	60	4	–	0.3	0.5	%
A_{CL}			1	1	4	31	32	–	
$R_{\theta JC}$	3, 4		–	–	–	–	–	2	°C/W

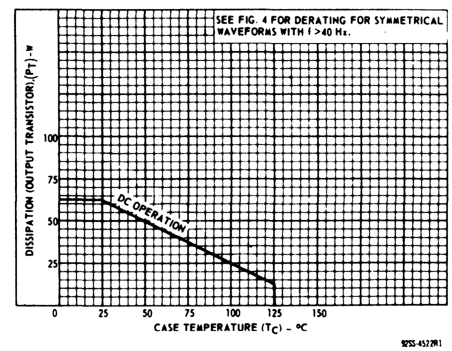


Fig. 3 — Dissipation (dc) derating curve for each output transistor for both types.

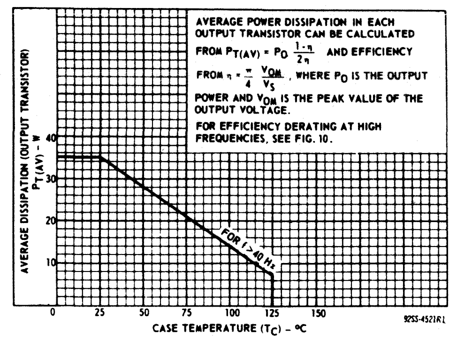


Fig. 4 — Dissipation (average) derating curve for each output transistor (for symmetrical wave-forms with f >40 Hz) for both types.

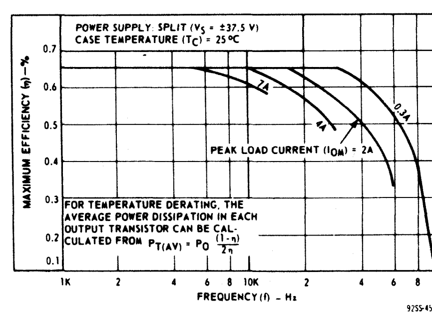


Fig. 5 — Maximum efficiency vs. frequency for several values of peak load current for both types.

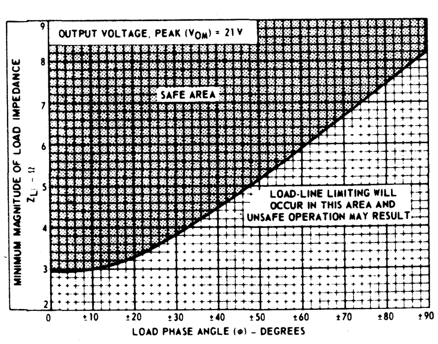


Fig. 6 — Minimum load impedance vs. load phase angle and safe area of operation for both types.

HC2000H, HC2500

HC2500

ELECTRICAL CHARACTERISTICS (Cont'd)

Typical Values (for Design Guidance), *At Case Temperature (T_C) = 25°C and Supply Voltage (V_S) = ±37.5*

CHARACTERISTIC	REFERENCE FIG. NO.	TEST CONDITIONS				LIMITS			UNITS
		SPECIAL NOTES	FREQ. (f)–kHz	OUTPUT POWER (P_O)–W	LOAD RESIST. (R_L)–Ω	MIN.	TYP.	MAX.	
A_{OL}	16	Idling current = 50 mA	1	25	4	–	70	–	dB
V_{IO}			–	0	Open	–	±10	–	mV
I_{IO}			–	0	Open	–	7	–	μA
I_{IB}			–	0	Open	–	20	–	μA
R_{CM}			0.005	0	Open	–	1	–	MΩ
V_{ICR}			0.5	100	4	–	32	–	V
CMRR			0.005	0	Open	–	50	–	dB
V_{RR}			0.06	0	4	–	30	–	dB
IMD	20	Idling current = 50 mA	–	0.05	4	–	0.06	–	%
SR	24	A_{CL} = 2, C_c = 100 pF	0.5 Square Wave	–	4	–	4.3	–	V/μs
ΔI_i	23	25°C to 100°C	–	–	4	–	1	–	mA/°C

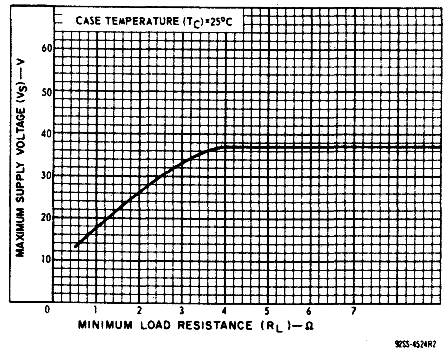


Fig. 7 — Maximum allowable supply voltage vs. load resistance for HC2000H.

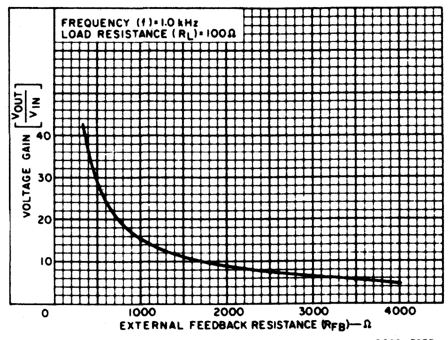


Fig. 8 — Closed-loop voltage gain vs. external feedback resistance for HC2000H.

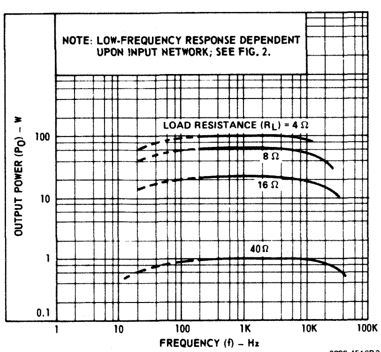


Fig. 9 — Output power vs. frequency for HC2000H.

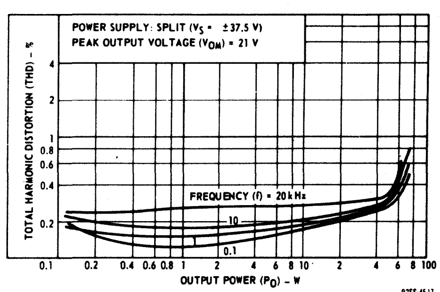


Fig. 10 — Total harmonic distortion with split power supply for HC2000H.

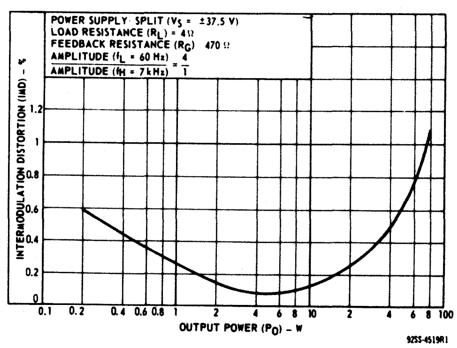


Fig. 11 — Intermodulation distortion with split supply and 4-ohm load for HC2000H.

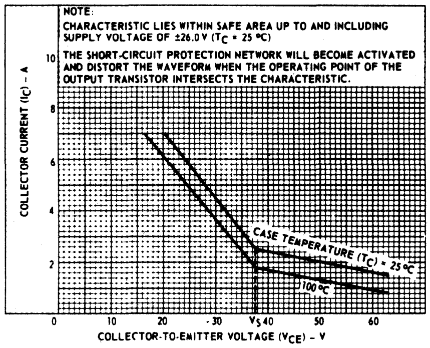


Fig. 12 — Characteristics of built-in load-line-limiting circuit for HC2000H.

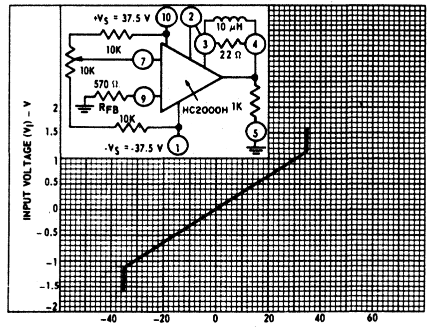


Fig. 13 — Gain linearity characteristics for HC2000H.

HC2000H, HC2500

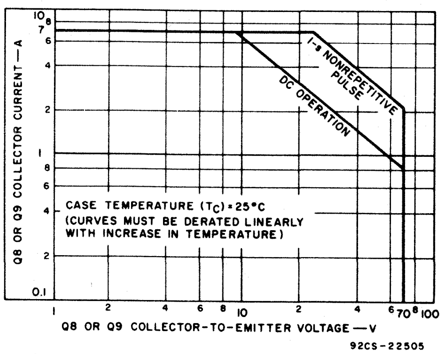


Fig. 14 — Maximum operating area for HC2500.

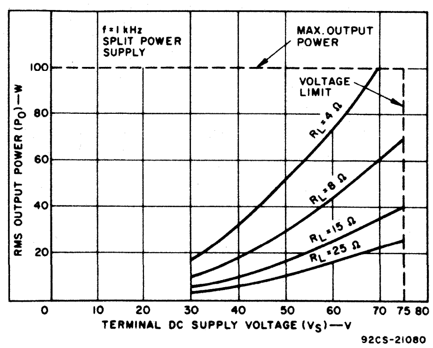


Fig. 15 — Output power as a function of supply voltage, with various values of load resistance, for symmetrical sine-wave operation for HC2500.

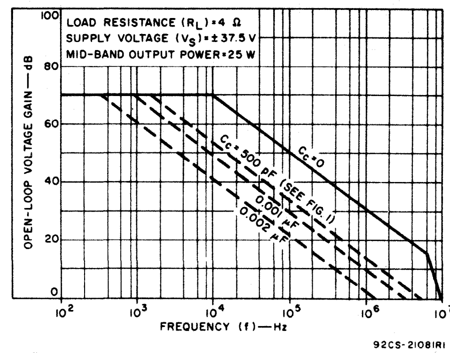


Fig. 16 — Typical open-loop voltage gain vs. frequency for HC2500.

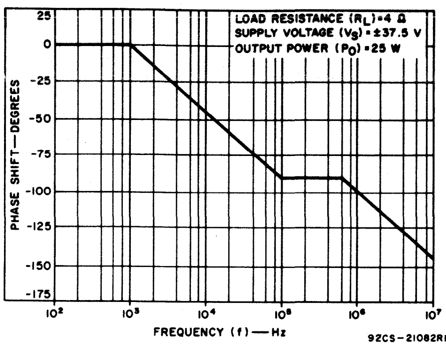


Fig. 17 — Typical open-loop phase shift vs. frequency for HC2500.

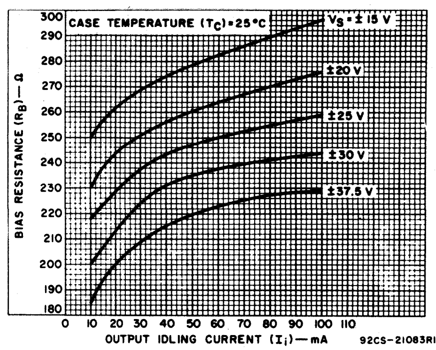


Fig. 18 — Bias resistor value vs. output idling current (I_i) for HC2500.

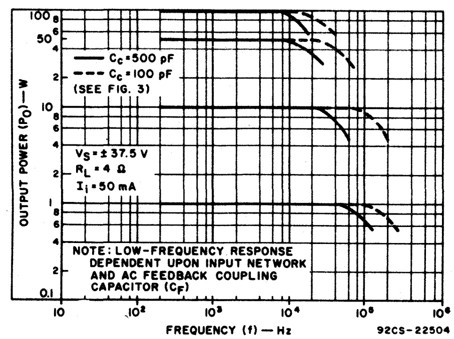


Fig. 19 — Output power vs. frequency for HC2500.

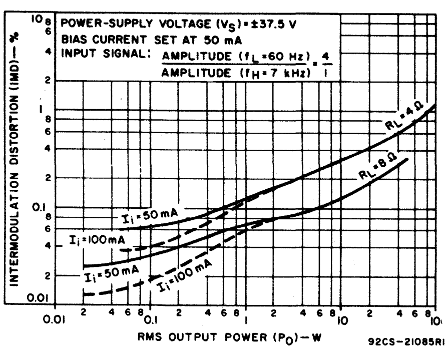


Fig. 20 — Typical intermodulation distortion vs. rms output power for HC2500.

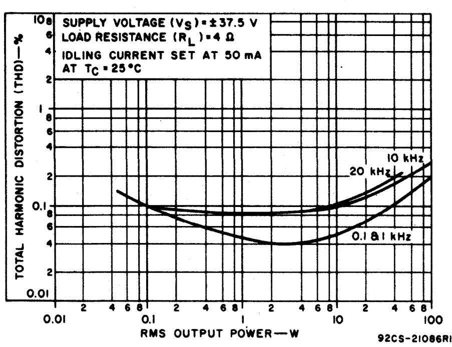


Fig. 21 — Typical harmonic distortion vs. rms output power for HC2500.

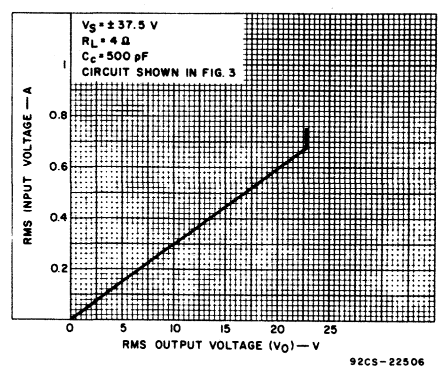


Fig. 22 — Input sensitivity for HC2500.

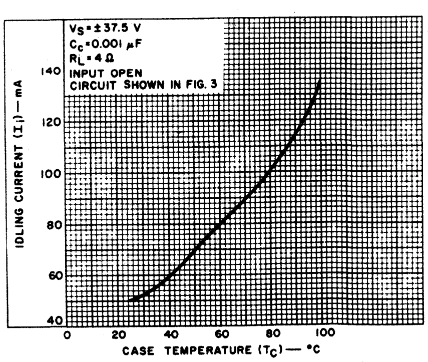


Fig. 23 — Typical idling-current drift for HC2500.

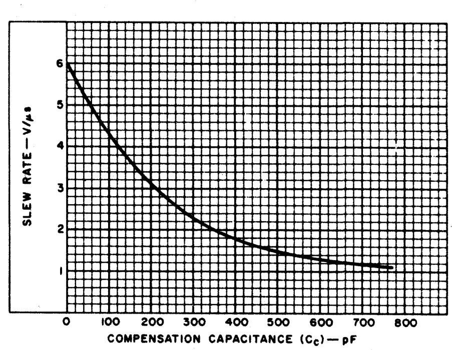


Fig. 24 — Typical slew rate vs. value of compensation capacitor C_C for HC2500.

Thyristor and Rectifier Type-Number Systems

In January 1974, a system of coded type numbers was adopted for all non-JEDEC RCA triacs, silicon controlled rectifiers (SCR's), rectifiers, and diacs. The type number for JEDEC devices, i.e., devices registered with the Joint Electron Devices Engineering Council of the Electronic Industries Association (EIA), consists of the prefix "1N" (for diodes) or "2N" (for thyristors) followed by a number. EIA assigns these type numbers sequentially, and they provide no information on device features and capabilities.

The type numbers for non-JEDEC RCA thyristors, rectifiers, and diacs consist of an alpha-numeric code that immediately identifies the basic type of device and provides information on significant device features. The basic product type is indicated by the initial letter in the type-number designation, i.e., T = triacs, S = SCR or ITR, G = gate-turn-off SCR (GTO), and D = rectifier or diac. The numbers following the initial letter indicate device current ratings, type of package, and electrical variants within a series. The suffix letter(s) define the voltage rating of the device.

Sixteen suffix letters are used to represent specific voltage ratings in the range from 15 to 1000 volts. Combinations of these letters can be used to indicate voltage ratings that differ from the sixteen basic values. (For example, the suffix DF is used for a voltage rating of 450 volts; i.e., D + F = 400 + 50 = 450 volts.)

The charts shown below provide a detailed explanation of the new type number codes.

Graphic Representation of Rectifier and Diac Numbering System

D 1 1 0 0 A

- **D** — Indicates Rectifier or Diac
- **1** — Indicates Type: 1 = Standard; 2 = Fast Recovery; 3 = Diac
- **1** — Indicates Package: 1 = DO-1; 2 = DO-15; 3 = TO-1; 4 = DO-4; 5 = DO-5; 6 = DO-26; 7 = DO-26 Insulated
- **00** — Indicates Average Current Rating I_O (00 indicates $I_O < 1$ A)
- **A** — Voltage Designation: Q = 15 V; U = 25 V; Y = 30 V; F = 50 V; A = 100 V; G = 150 V; B = 200 V; H = 250 V; C = 300 V; D = 400 V; E = 500 V; M = 600 V; S = 700 V; N = 800 V; T = 900 V; P = 1000 V

Graphic Representation of Thyristor Numbering System

T 2 3 0 0 A

- **T** — Indicates Type: T = Triac; S = SCR; G = GTO
- **23** — Indicates Broad Generic Classification on basis of $I_{T(RMS)}$ Rating
- **0** — Identifies Package Variants
- **0** — Identifies Electrical Variants
- **A** — Voltage Designation (as shown at left)

$I_{T(RMS)}$ Ratings (A)	Standard Devices	Fast-Turnoff Devices
0 - 2.5	00 - 09	10 - 19
2.5 - 10	20 - 29	30 - 39
10 - 15	40 - 49	50 - 59
15 - 40	60 - 69	70 - 79
>40	80 - 89	90 - 99

(NOTE: The first five digits, e.g., T2300, provide the basic device series designation.)

Triacs

Page

Triac Product Matrix

RCA Triacs		Modified TO-5				Mod. TO-5 With Heat Radiator				TO-66		TO-66 With Heat Radiator
STANDARD												
$I_{T(RMS)}$		2.5A	2.5A	2.5A	2.5A	2.5A	2.5A	2.5A	2.5A	6A	15A	6A
I_{TSM} (60 Hz)		25A	25A	25A	25A	25A	25A	25A	25A	100A	100A	100A
$V_{DROM}(V)$	50	T2300F	T2301F	T2302F	T2303F	T2310F	T2311F	T2312F	T2313F			
	100	T2300A	T2301A	T2302A	2N5754	T2310A	T2311A	T2312A	T2313A			
	200	T2300B	T2301B	T2302B	2N5755	T2310B	T2311B	T2312B	T2313B	T2700B	T4700B	T2710B
	400	T2300D	T2301D	T2302D	2N5756	T2310D	T2311D	T2312D	T2313D	T2700D	T4700D	T2710D
	450											
	600				2N5757				T2313M			
	800											
$I_{GT}(mA)$	I+, III−	3	4	10	25	3	4	10	25	25	30	25
	I−, III+	3	4	10	40	3	4	10	40	40	80	40
$V_{GT}(V)$	All Modes	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.5	2.2
	Page No.	316	316	316	319	316	316	316	319	326	338	326
ZERO VOLTAGE SWITCH												
$V_{DROM}(V)$	100				T2306A				T2316A			
	200				T2306B				T2316B	T2706B	T4706B	T2716B
	400				T2306D				T2316D	T2706D	T4706D	T2716D
	450											
	600											
$I_{GT}(mA)$	I+, III+				45				45	45	45	45
$V_{GT}(V)$	I+, III+				1.5				1.5	1.5	1.5	1.5
	Page No.				349				349	349	349	349
400-HZ OPERATION												
$I_{T(RMS)}$				0.5A	0.5A							
$V_{DROM}(V)$	200			T2304B	T2305B							
	400			T2304D	T2305D							
$I_{GT}(mA)$	I+, III−			10	25							
	I−, III+			10	40							
$V_{GT}(V)$	All Modes			2.2	2.2							
	Page No.			322	322							

RCA Triacs		TO-220AB VERSAWATT					Press-Fit			Stud		
STANDARD												
$I_{T(RMS)}$		6A	6A	8A	8A	ISOWATT* 8A		10A	15A		10A	10A
I_{TSM} (60 Hz)		60A	80A	100A	100A	100A		100A	100A		100A	100A
$V_{DROM}(V)$	100					T2850A						
	200	T2500B	T2801B	T2800B	T2802B	T2850B		2N5567	2N5571		2N5569	2N5573
	300		T2801C	T2800C	T2802C							
	400	T2500D	T2801D	T2800D	T2802D	T2850D		2N5568	2N5572		2N5570	2N5574
	500		T2801E	T2800E	T2802E							
	600			T2800M	T2802M			T4101M	T4100M		T4111M	T4110M
	800											
$I_{GT}(mA)$	I+, III−	25	80	25	50	25		25	50		25	50
	I−, III+	60	–	60	–	60		40	80		40	80
$V_{GT}(V)$	All Modes	2.5	4.0▲	2.5	2.5▲	2.5		2.5	2.5		2.5	2.5
	Page No.	324	328	328	328	328		331	331		331	331
ZERO VOLTAGE SWITCH												
$V_{DROM}(V)$	100											
	200	T2506B			T2806B	T2856B		T4107B	T4106B		T4117B	T4116B
	400	T2506D			T2806D	T2856D		T4107D	T4106D		T4117D	T4116D
	450											
	600							T4107M	T4106M		T4117M	T4116M
$I_{GT}(mA)$	I+, III+	45			45	45		45	45		45	45
$V_{GT}(V)$	I+, III+	1.5			1.5	1.5		1.5	1.5		1.5	1.5
	Page No.	349			349	349		349	349		349	349
400-HZ OPERATION												
$I_{T(RMS)}$							6A	10A	15A	6A	10A	15A
$V_{DROM}(V)$												
	200						T4105B	T4104B	T4103B	T4115B	T4114B	T4113B
	400						T4105D	T4104D	T4103D	T4115D	T4114D	T4113D
$I_{GT}(mA)$	I+, III−						50	50	50	50	50	50
	I−, III+						80	80	80	80	80	80
$V_{GT}(V)$	All Modes						2.5	2.5	2.5	2.5	2.5	2.5
	Page No.						335	335	335	335	335	335

* ISOWATT — Mounting tab electrically isolated from electrodes   ▲ I+, III− only

Triac Product Matrix (continued)

RCA Triacs		Isolated Stud		Press-Fit: With flex. leads, encap. on iso-lated-stud		Press-Fit: Isolated on TO-3 flange		Press-Fit: With flex. leads, encap., isolated on TO-3 flange		Press-Fit		Stud		
STANDARD	$I_{T(RMS)}$	10A	15A	10A	15A	10A	15A	10A	15A	30A	40A	30A		40A
	I_{TSM}(60 Hz)	100A	100A	100A	100A	100A	100A	100A	100A	300A	300A	300A		300A
	V_{DROM}(V) 100													
	200	T4121B	T4120B	T4131B	T4130B	T4141B	T4140B	T4152B	T4150B	T6401B	2N5441	T6411B		2N5444
	400	T4121D	T4120D	T4131D	T4130D	T4141D	T4140D	T4151D	T4150D	T6401D	2N5442	T6411D		2N5445
	450													
	600	T4121M	T4120M	T4131M	T4130M	T4141M	T4140M	T4151M	T4150M	T6401M	2N5443	T6411M		2N5446
	800										T6400N			T6410N
	I_{GT}(mA) I+, III−	25	50	25	50	25	50	25	50	50	50	50		50
	I−, III+	40	80	40	80	40	80	40	80	80	80	80		80
	V_{GT}(V) All Modes	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5		2.5
	Page No.	331	331	337	337	337	337	337	337	340	340	340		340
ZERO VOLTAGE SWITCH	V_{DROM}(V) 100													
	200	T4127B	T4126B							T6407B	T6406B	T6417B		T6416B
	400	T4127D	T4126D							T6407D	T6406D	T6417D		T6416D
	450													
	600	T4127M	T4126M							T6407M	T6406M	T6417M		T6416M
	I_{GT}(mA) I+, III+									45	45	45		45
	V_{GT}(V) I+, III+									1.5	1.5	1.5		1.5
	Page No.	349	349							349	349	349		349
400-HZ OPERATION	$I_{T(RMS)}$									25A	25A	25A	25A	40A
	V_{DROM}(V) 200									T6405B	T6404B	T6415B	2N5806	T6414B
	400									T6405D	T6404D	T6415D	2N5807	T6414D
	500												2N5808	
	600												2N5809	
	I_{GT}(mA) I+, III−									80	80	80	80	80
	I−, III+									120	120	120	150•	120
	V_{GT}(V) All Modes									3	3	3	2.5▼	3
	Page No.									344	344	344	340	344

• 80 A for I− mode. ▼4 V for III+ mode.

RCA Triacs		Isolated Stud		Press-Fit: With flex. leads, encap. on iso-lated-stud		Press-Fit: Isolated on TO-3 flange		Press-Fit: With flex. leads, encap., isolated on TO-3 flange		Overmold Stud		Overmold Isolated Stud	
STANDARD	$I_{T(RMS)}$	30A	40A	30A	40A	30A	40A	30A	40A	60A	80A	60A	80A
	I_{TSM} (60 Hz)	300A	300A	300A	300A	300A	300A	300A	300A	600A	850A	600A	850A
	V_{DROM}(V) 100												
	200	T6421B	T6420B	T6431B	T6430B	T6441B	T6440B	T6451B	T6450B	T8411B	T8410B	T8421B	T8420B
	400	T6421D	T6420D	T6431D	T6430D	T6441D	T5440D	T6451D	T6450D	T8411D	T8410D	T8421D	T8420D
	450												
	600	T6421M	T6420M	T6431M	T6430M	T6441M	T6440M	T6451M	T6450M	T8411M	T8410M	T8421M	T8420M
	800		T6420N		T6430N		T6440N		T6450N				
	I_{GT}(mA) I+, III−	50	50	50	50	50	50	50	50	75	75	75	75
	I−, III+	80	80	80	80	80	80	80	80	150	150	150	15
	V_{GT}(V) All Modes	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.8	2.5	2.8	2.5
	Page No.	340	340	337	337	337	337	337	337	346	346	346	346
ZERO VOLTAGE SWITCH	V_{DROM}(V) 100												
	200	T6427B	T6426B										
	400	T6427D	T6426D										
	450												
	600	T427M	T6426M										
	I_{GT}(mA) I+, III+	45	45										
	V_{GT}(V) I+, III+	1.5	1.5										
	Page No.	349	349										

RCA Triac Direct-Replacement Guide

Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type
BTR0205	TRANS	T2700B	BTU0530	TRANS	2N5574	IT18	HUTSON	T2850A	PT48	HUTSON	2N5568
BTR0210	TRANS	T2700B	BTU0540	TRANS	2N5574	IT26	HUTSON	T2850B	PT56	HUTSON	T4101M
BTR0220	TRANS	T2700B	BTU0550	TRANS	T4110M	IT28	HUTSON	T2850B	PT58	HUTSON	T4101M
BTR0230	TRANS	T2700D	BTU0560	TRANS	T4110M	IT36	HUTSON	T2850D	PT66	HUTSON	T4101M
BTR0240	TRANS	T2700D	BTU0605	TRANS	T6411B	IT38	HUTSON	T2850D	PT68	HUTSON	T4101M
BTR0305	TRANS	T2700B	BTU0610	TRANS	T6411B	IT46	HUTSON	T2850D	PT110	HUTSON	2N5567
BTR0310	TRANS	T2700B	BTU0620	TRANS	T6411B	IT48	HUTSON	T2850D	PT115	HUTSON	2N5571
BTR0320	TRANS	T2700B	BTU0630	TRANS	T6411D	L2001M3	ECC	T2300B	PT125/130	HUTSON	T6401B
BTR0330	TRANS	T2700D	BTU0640	TRANS	T6411D	L2001M4	ECC	T2300B	PT140	HUTSON	2N5441
BTR0340	TRANS	T2700D	BTU0650	TRANS	T6411M	L2001M5	ECC	T2301B	PT210	HUTSON	2N5567
BTR0405	TRANS	T4700B	BTU0660	TRANS	T6411M	L2001M7	ECC	T2302B	PT215	HUTSON	2N5571
BTR0410	TRANS	T4700B	BTV0405	TRANS	T4121B	L4001M3	ECC	T2300D	PT225/230	HUTSON	T6401B
BTR0420	TRANS	T4700B	BTV0410	TRANS	T4121B	L4001M4	ECC	T2300D	PT240	HUTSON	2N5441
BTR0430	TRANS	T4700D	BTV0420	TRANS	T4121B	L4001M5	ECC	T2301D	PT310	HUTSON	2N5568
BTR0440	TRANS	T4700D	BTV0430	TRANS	T4121D	L4001M7	ECC	T2302D	PT315	HUTSON	2N5572
BTS0305	TRANS	2N5567	BTV0440	TRANS	T4121D	MAC35-1	MOT	T6401B	PT325/330	HUTSON	T6401D
BTS0310	TRANS	2N5567	BTV0450	TRANS	T4121M	MAC35-2	MOT	T6401B	PT340	HUTSON	2N5442
BTS0320	TRANS	2N5567	BTV0460	TRANS	T4121M	MAC35-3	MOT	T6401B	PT410	HUTSON	2N5568
BTS0330	TRANS	2N5568	BTX0505	TRANS	T4120B	MAC35-4	MOT	T6401B	PT415	HUTSON	2N5572
BTS0340	TRANS	2N5568	BTX0510	TRANS	T4120B	MAC35-5	MOT	T6401D	PT425/430	HUTSON	T6401D
BTS0350	TRANS	T4101M	BTX0520	TRANS	T4120B	MAC35-6	MOT	T6401D	PT440	HUTSON	2N5442
BTS0360	TRANS	T4101M	BTX0530	TRANS	T4120D	MAC35-7	MOT	T6401M	PT510	HUTSON	T4111M
BTS0405	TRANS	2N5567	BTX0540	TRANS	T4120D	MAC36-1	MOT	T6411B	PT515	HUTSON	T4100M
BTS0410	TRANS	2N5567	BTX0550	TRANS	T4120M	MAC36-2	MOT	T6411B	PT525/530	HUTSON	T6401M
BTS0420	TRANS	2N5567	BTX0560	TRANS	T4120M	MAC36-3	MOT	T6411B	PT540	HUTSON	2N5443
BTS0430	TRANS	2N5568	BTX0605	TRANS	T6421B	MAC36-4	MOT	T6411B	PT610	HUTSON	T4111M
BTS0440	TRANS	2N5568	BTX0610	TRANS	T6421B	MAC36-5	MOT	T6411D	PT615	HUTSON	T4100M
BTS0450	TRANS	T4101M	BTX0620	TRANS	T6421B	MAC36-6	MOT	T6411D	PT625/630	HUTSON	T6401M
BTS0460	TRANS	T4101M	BTX0630	TRANS	T6421D	MAC36-7	MOT	T6411M	Q2001MS2	ECC	T2302B
BTS0505	TRANS	2N5571	BTX0640	TRANS	T6421D	MAC37-1	MOT	T6401B	Q2001M2	ECC	2N5755
BTS0510	TRANS	2N5571	BTX0650	TRANS	T6421M	MAC37-2	MOT	T6401B	Q2003P	ECC	T2800B
BTS0520	TRANS	2N5571	BTX0660	TRANS	T6421M	MAC37-3	MOT	T6401B	Q2004	ECC	T4120B
BTS0530	TRANS	2N5572	BTX94-400	PHIL	T6411D	MAC37-4	MOT	T6401B	Q2006L4	ECC	T2850B
BTS0540	TRANS	2N5572	BTX94-500	PHIL	T6411M	MAC37-5	MOT	T6401D	Q2008	ECC	T4121B
BTS0550	TRANS	T4100M	BTX94-600	PHIL	T6411M	MAC37-6	MOT	T6401D	Q2015	ECC	T4120B
BTS0560	TRANS	T4100M	HB26	HUTSON	2N5755	MAC37-7	MOT	T6401M	Q2025	ECC	T6421B
BTS0605	TRANS	2N5441	HB46	HUTSON	2N5756	MAC38-1	MOT	T6411B	Q2040	ECC	T6420B
BTS0610	TRANS	2N5441	HL03SC	HUTSON	T2301A	MAC38-2	MOT	T6411B	Q4001MS2	ECC	T2302D
BTS0620	TRANS	2N5441	HL03SD	HUTSON	T2301A	MAC38-3	MOT	T6411B	Q4001M2	ECC	2N5756
BTS0630	TRANS	2N5442	HL03SG	HUTSON	T2302A	MAC38-4	MOT	T6411B	Q4004	ECC	T4121D
BTS0640	TRANS	2N5442	HL03SS	HUTSON	T2300A	MAC38-5	MOT	T6411D	Q4004L4	ECC	T2850D
BTS0650	TRANS	2N5443	HL13SC	HUTSON	T2301A	MAC38-6	MOT	T6411D	Q4006	ECC	T4121D
BTS0660	TRANS	2N5443	HL13SD	HUTSON	T2301A	MAC38-7	MOT	T6411M	Q4006L4	ECC	T2850D
BTU0305	TRANS	2N5569	HL13SG	HUTSON	T2302A	MAC40688	MOT	T6420B	Q4008	ECC	T4121D
BTU0310	TRANS	2N5569	HL13SS	HUTSON	T2300A	MAC40689	MOT	T6420B	Q4010	ECC	T4121D
BTU0320	TRANS	2N5569	HL23SC	HUTSON	T2301B	MAC40690	MOT	T6420B	Q4015	ECC	T4120D
BTU0330	TRANS	2N5570	HL23SD	HUTSON	T2301B	NL-C40A	NAT	2N3680	Q4025	ECC	T6421D
BTU0340	TRANS	2N5570	HL23SG	HUTSON	T2302B	PT06	HUTSON	2N5567	Q4040	ECC	T6420D
BTU0350	TRANS	T4111M	HL23SS	HUTSON	T2300B	PT08	HUTSON	2N5567	Q5006L4	ECC	T2850D
BTU0360	TRANS	T4111M	HL33SC	HUTSON	T2301D	PT010	HUTSON	2N5567	Q5008	ECC	T4121M
BTU0405	TRANS	2N5569	HL33SD	HUTSON	T2301D	PT015	HUTSON	2N5571	Q5010	ECC	T4121M
BTU0410	TRANS	2N5569	HL33SG	HUTSON	T2302D	PT16	HUTSON	2N5567	Q4015	ECC	T4120M
BTU0420	TRANS	2N5569	HL33SS	HUTSON	T2300D	PT18	HUTSON	2N5567	Q5025	ECC	T6421M
BTU0430	TRANS	2N5570	HL43SC	HUTSON	T2301D	PT025/030	HUTSON	T6401B	Q5040	ECC	T6420M
BTU0440	TRANS	2N5570	HL43SD	HUTSON	T2301D	PT26	HUTSON	2N5567	Q6008	ECC	T4121M
BTU0450	TRANS	T4111M	HL43SG	HUTSON	T2302D	PT28	HUTSON	2N5567	Q6010	ECC	T4121M
BTU0460	TRANS	T4111M	HL43SS	HUTSON	T2300D	PT36	HUTSON	2N5568	Q6015	ECC	T4120M
BTU0505	TRANS	2N5573	IT06	HUTSON	T2850A	PT38	HUTSON	2N5568	Q6025	ECC	T6421M
BTU0510	TRANS	2N5573	IT08	HUTSON	T2850A	PT040	HUTSON	2N5441	Q6040	ECC	T6420M
BTU0520	TRANS	2N5573	IT16	HUTSON	T2850A	PT46	HUTSON	2N5568	Q8025	ECC	T6420N

RCA Triac Direct-Replacement Guide (Cont'd)

Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type
Q8040	ECC	T6420N	SC245B	GE	2N5569	TIC22	TI	2N5569
SC35A	GE	2N5569	SC245B2	GE	T4121B	TIC23	TI	2N5570
SC35B	GE	2N5569	SC245D	GE	2N5570	TIC250B	TI	T6401B
SC35D	GE	2N5570	SC245D2	GE	T4121D	TIC250D	TI	T6401D
SC35F	GE	2N5569	SC245E	GE	T4111M	TIC250E	TI	T6401M
SC36A	GE	2N5567	SC245E2	GE	T4121M	TIC250M	TI	T6401M
SC36B	GE	2N5567	SC246B	GE	2N5567	TIC252B	TI	T6411B
SC36D	GE	2N5568	SC246D	GE	2N5568	TIC252D	TI	T6411D
SC36F	GE	2N5567	SC246E	GE	T4101M	TIC252E	TI	T6411M
SC40A	GE	2N5569	SC250B	GE	2N5573	TIC252M	TI	T6411M
SC40B	GE	2N5569	SC250B2	GE	T4120B	TIC260B	TI	T6401B
SC40B2	GE	T4121B	SC250D	GE	2N5574	TIC260D	TI	T6401D
SC40D	GE	2N5570	SC250D2	GE	T4120D	TIC260E	TI	T6401M
SC40D2	GE	T4121D	SC250E	GE	T4110M	TIC260M	TI	T6401M
SC40E	GE	T4111M	SC250E2	GE	T4120M	TIC262B	TI	T6411B
SC40E2	GE	T4121M	SC251B	GE	2N5571	TIC262D	TI	T6411D
SC40F	GE	2N5569	SC251D	GE	2N5571	TIC262E	TI	T6401M
SC41A	GE	2N5567	SC251E	GE	T4100M	TIC262M	TI	T6401M
SC41B	GE	2N5567	SPT06	HUTSON	2N5569	TIC270B	TI	2N5441
SC41D	GE	2N5568	SPT08	HUTSON	2N5569	TIC270D	TI	2N5442
SC41E	GE	T4101M	SPT010	HUTSON	2N5569	TIC270E	TI	2N5443
SC41F	GE	2N5567	SPT015	HUTSON	2N5573	TIC270M	TI	2N5443
SC45A	GE	2N5569	SPT16	HUTSON	2N5569	TIC272B	TI	2N5444
SC45B	GE	2N5569	SPT18	HUTSON	2N5569	TIC272D	TI	2N5445
SC45B2	GE	T4121B	SPT025/030	HUTSON	T6411B	TIC272E	TI	2N5446
SC45D	GE	2N5570	SPT26	HUTSON	2N5569	TIC272M	TI	2N5446
SC45D2	GE	T4121D	SPT28	HUTSON	2N5569	6T06	HUTSON	T2700B
SC45E	GE	T4111M	SPT36	HUTSON	2N5570	6T08	HUTSON	T4700B
SC45E2	GE	T4121M	SPT38	HUTSON	2N5570	6T16	HUTSON	T2700B
SC45	GE	2N5569	SPT040	HUTSON	2N5444	6T18	HUTSON	T4700B
SC46A	GE	2N5567	SPT46	HUTSON	2N5570	6T26	HUTSON	T2700B
SC46B	GE	2N5567	SPT48	HUTSON	2N5570	6T28	HUTSON	T4700B
SC46D	GE	2N5568	SPT56	HUTSON	T4111M	6T36	HUTSON	T2700D
SC46E	GE	T4101M	SPT58	HUTSON	T4111M	6T38	HUTSON	T4700D
SC46F	GE	2N5567	SPT68	HUTSON	T4111M	6T46	HUTSON	T2700D
SC50A	GE	2N5573	SPT110	HUTSON	2N5569	6T48	HUTSON	T4700D
SC50B	GE	2N5573	SPT115	HUTSON	2N5573			
SC50B2	GE	T4120B	SPT125/130	HUTSON	T6411B			
SC50D	GE	2N5574	SPT140	HUTSON	2N5444			
SC50D2	GE	T4120D	SPT210	HUTSON	2N5569			
SC50E	GE	2N5573	SPT215	HUTSON	2N5573			
SC50E	GE	T4110M	SPT225/230	HUTSON	T6411B			
SC50E2	GE	T4120M	SPT240	HUTSON	2N5444			
SC50F	GE	2N5573	SPT310	HUTSON	2N5570			
SC50A	GE	2N5571	SPT315	HUTSON	2N5574			
SC51B	GE	2N5571	SPT325/330	HUTSON	T6411D			
SC51D	GE	2N5572	SPT340	HUTSON	2N5445			
SC51E	GE	T4100M	SPT410	HUTSON	2N5570			
SC51F	GE	2N5571	SPT415	HUTSON	2N5574			
SC141B	GE	T2800B	SPT425/430	HUTSON	T6411D			
SC141D	GE	T2800D	SPT440	HUTSON	2N5445			
SC240B	GE	2N5569	SPT510	HUTSON	T4111M			
SC240B2	GE	T4121B	SPT515	HUTSON	T4110M			
SC240D	GE	2N5570	SPT525/530	HUTSON	T6411M			
SC240D2	GE	T4121D	SPT540	HUTSON	2N5446			
SC240E	GE	T4111M	SPT610	HUTSON	T4111M			
SC240E2	GE	T4121M	SPT615	HUTSON	T4110M			
SC241B	GE	2N5567	SPT625/630	HUTSON	T6411M			
SC241D	GE	2N5568	TIC20	TI	2N5567			
SC241E	GE	T4101M	TIC21	TI	2N5568			

T2300, T2301, T2302, T2310, T2311, T2312 Series

2.5-A Sensitive-Gate Silicon Triacs

Mod. TO-5 and Mod. TO-5 with Heat Radiator Packages For AC Power Switching

The RCA-T2300, T2301, T2302, T2310, T2311, T2312 series triacs are gate-controlled full-wave silicon ac switches that are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

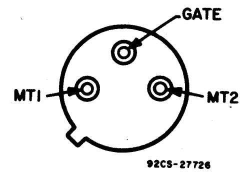
The T2310, T2311, and T2312 series are the same as the T2300, T2301, and T2302 series, respectively, but have factory-attached heat radiators and are intended for printed-circuit-board applications.

The gate sensitivity of these triacs permits the use of economical transistorized control circuits and enhances their use in low-power phase-control and load-switching applications.

Features:

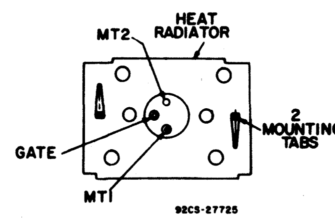
- **Very high gate sensitivity—3, 4, and 10 mA**
- **di/dt capability—100 A/μs**
- **Shorted-emitter, center-gate design**
- **Low switching losses**
- **Low on-state voltage at high current levels**

TERMINAL CONNECTIONS



T2300
T2301
T2302
Series

Modified TO-5



T2310
T2311
T2312
Series

Mod. TO-5 with Heat Radiator

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies Up to 50/60 Hz and with Resistive or Inductive Load

3 mA Gate	T2300F	T2300A	T2300B	T2300D	
4 mA Gate	T2301F	T2301A	T2301B	T2301D	
10 mA Gate	T2302F	T2302A	T2302B	T2302D	
3 mA Gate	T2310F	T2310A	T2310B	T2310D	
4 mA Gate	T2311F	T2311A	T2311B	T2311D	
10 mA Gate	T2312F	T2312A	T2312B	T2312D	
V_{DROM}▲					
Gate open, T_J=−40 to 100°C	50	100	200	400	V
$I_{T(RMS)}$ (θ = 360°):					
T_C = 70°C	2.5				A
T_A = 25°C	1.9				A
For other conditions	See Figs. 2,3,4,5				
I_{TSM}:					
For one cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$:					
60 Hz (sinusoidal)	25				A
50 Hz (sinusoidal)	21				A
For more than one cycle of applied principal voltage	See Figs. 6,7				
di/dt:					
V_D = V_{DROM}, I_{GT} = 50 mA, t_r = 0.1 μs	100				A/μs
I^2t [At T_C shown for $I_{T(RMS)}$]:					
t = 20 ms	4.3				A^2s
= 2.5 ms	2				A^2s
= 0.5 ms	1				A^2s
For other time values	See Fig. 7				
I_{GTM}●:					
For 1 μs max.	1				A
P_{GM}:					
Peak (For 1 μs max., I_{GTM} ⩽ 1 A(peak)	10				W
$P_{G(AV)}$:					
T_C = 60°C	0.15				W
T_A = 25°C	0.05				W
T_{stg}■	−40 to 150				°C
T_C■	−40 to 100				°C
T_T■: During soldering for 10 s maximum at distance ⩾ 1/16 in. (1.58 mm) from seating plane	225				°C

▲ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
● For either polarity of gate voltage (V_G) with reference to main terminal 1.
■ For temperature measurement reference point, see Dimensional Outlines.

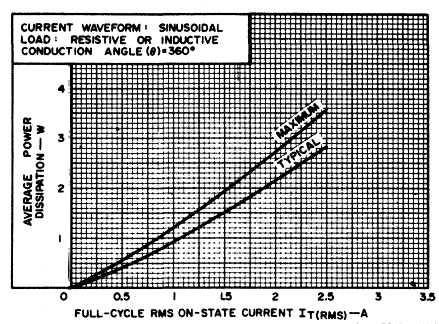


Fig. 1—Power dissipation vs. on-state current.

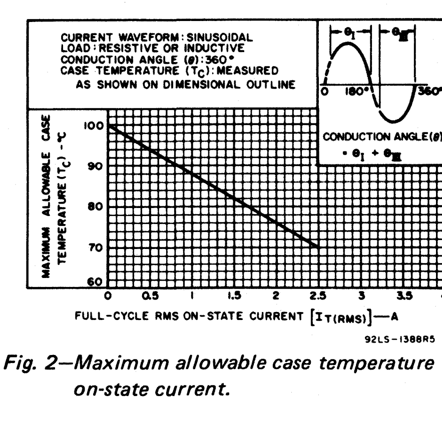


Fig. 2—Maximum allowable case temperature vs. on-state current.

T2300, T2301, T2302, T2310 T2311, T2312 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified Min.	Typ.	Max.	UNITS
I_{DROM}▲: Gate open, T_J=100°C, V_{DROM}=Max.rated value	–	0.2	0.75	mA
V_{TM}▲: i_T=10 A(peak), T_C=25°C	–	1.7	2.2	V
I_{HO}▲: *(See Figs. 9 & 10)* Gate open, Initial principal current=150 mA (dc), v_D=12 V, T_C=25°C				
(T2300, T2301, T2310, T2311 series)	–	2	5	mA
(T2302, T2312 series)	–	7	15	mA
dv/dt (Commutating)▲: v_D=V_{DROM}, $I_{T(RMS)}$=2.5 A, commutating di/dt=0.95 A/ms, gate unenergized, T_C=100°C	0.5	–	–	V/μs
dv/dt (Off-state)▲: v_D=V_{DROM}, exponential voltage rise, gate open,				
T_C= 90°C (T2300, T2301, T2310, T2311 series)	3	5	–	V/μs
T_C=100°C (T2302, T2312 series)	6	10	–	V/μs
I_{GT}▲●: *(See Figs. 13 & 14)* v_D=12 V dc, R_L=30 Ω, T_C=25°C				
Mode / V_{MT2} / V_G				
I⁺ positive positive				
T2300, T2310 series	–	1	3	mA
T2301, T2311 series	–	1	4	mA
T2302, T2312 series	–	3.5	10	mA
III⁻ negative negative				
T2300, T2310 series	–	1	3	mA
T2301, T2311 series	–	1	4	mA
T2302, T2312 series	–	3.5	10	mA
I⁻ positive negative				
T2300, T2310 series	–	2	3	mA
T2301, T2311 series	–	2	4	mA
T2302, T2312 series	–	7	10	mA
III⁺ negative positive				
T2300, T2310 series	–	2	3	mA
T2301, T2311 series	–	2	4	mA
T2302, T2312 series	–	7	10	mA
V_{GT}▲●: *(See Fig. 15)*				
v_D=12 V dc, R_L=30 Ω, T_C=25°C	–	1	2.2	V
v_D=V_{DROM}, R_L=125 Ω, T_C=100°C	0.15	–	–	V
t_{gt}: v_D=V_{DROM}, I_{GT}=60 mA, t_r=0.1 μs, i_T=10 A(peak), T_C=25°C	–	1.8	2.5	μs
$R_{\theta JC}$: Steady-state	–	–	8.5	°C/W
$R_{\theta JA}$	–	–	150	°C/W

▲For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

●For either polarity of gate voltage (V_G) with reference to main terminal 1.

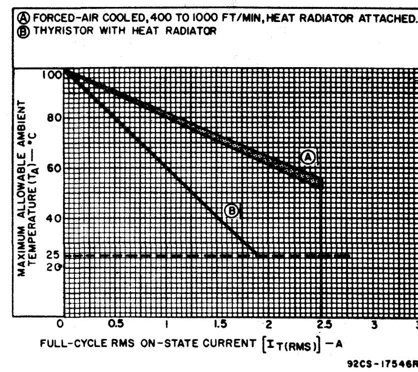


Fig. 3—Maximum allowable ambient temperature vs. on-state current for T2310, T2311, T2312 series.

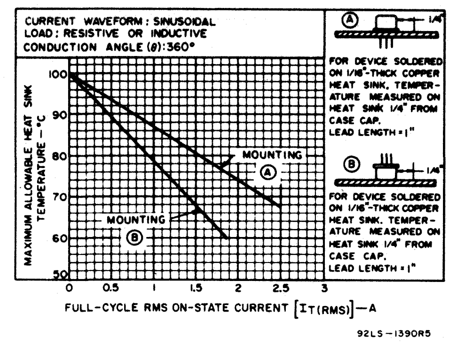


Fig. 4—Maximum allowable heat-sink temperature vs. on-state current for T2300, T2301, T2302 series.

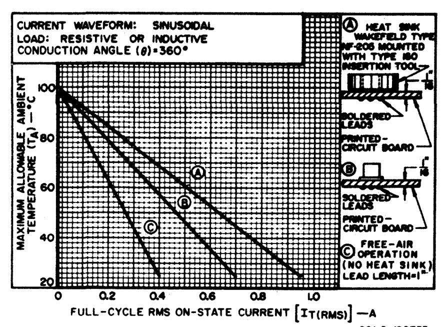


Fig. 5—Maximum allowable ambient temperature vs. on-state current for T2302 series.

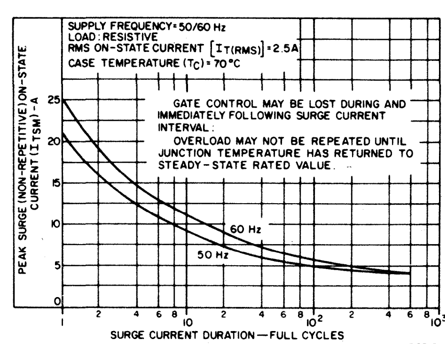


Fig. 6—Peak surge on-state current vs. surge-current duration.

T2300, T2301, T2302, T2310, T2311, T2312 Series

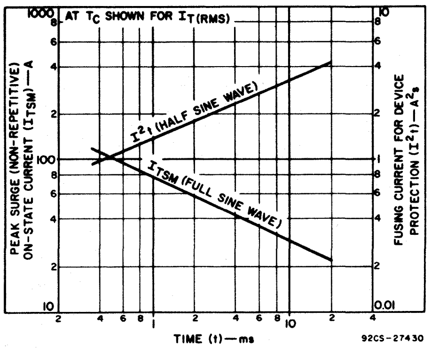


Fig. 7—Peak surge on-state current and fusing current vs. time.

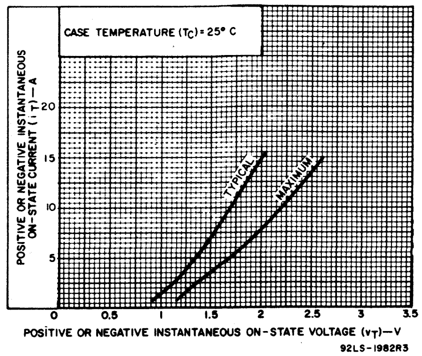


Fig. 8—On-state current vs. on-state voltage for all standard series.

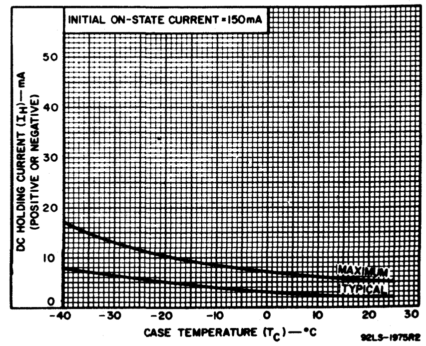


Fig. 9—DC holding current (positive or negative) vs. case temperature for T2300, T2301, T2310, T2311 series.

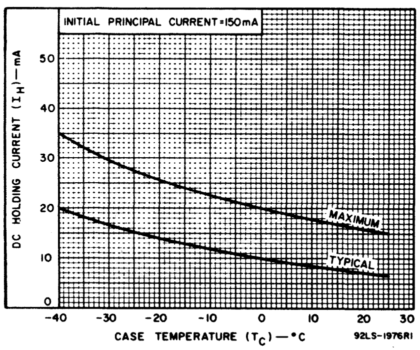


Fig. 10—DC holding current (positive or negative) vs. case temperature for T2302, T2312 series.

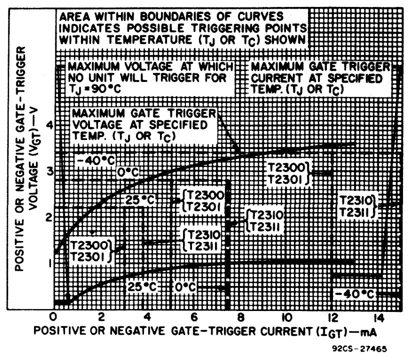


Fig. 11—Gate-trigger voltage vs. gate-trigger current for T2300, T2301, T2310, T2311 series.

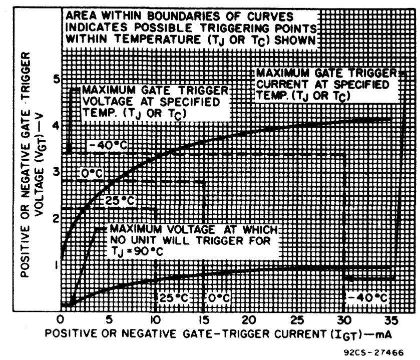


Fig. 12—Gate-trigger voltage vs. gate-trigger current for T2302, T2312 series.

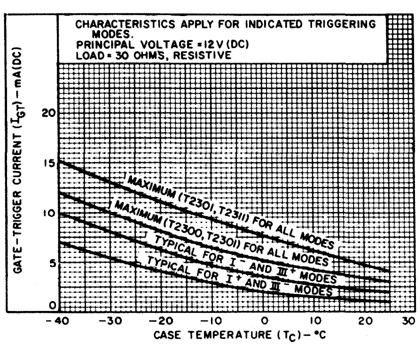


Fig. 13—Gate-trigger current vs. case temperature for T2300, T2301.

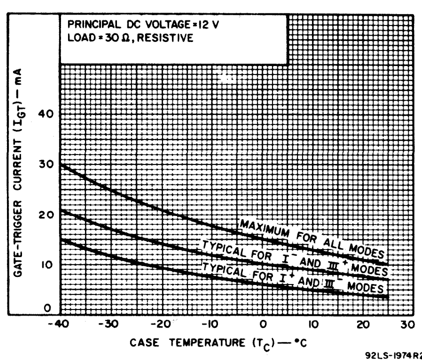


Fig. 14—Gate-trigger current vs. case temperature for T2302, T2312 series.

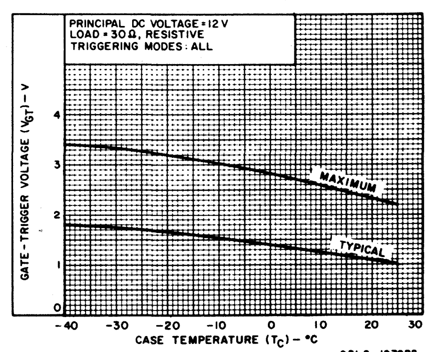


Fig. 15—Gate-trigger voltage vs. case temperature.

T2303 (2N5754-2N5757), T2313 Series

2.5-A Silicon Triacs

Modified TO-5 and Modified TO-5 with Heat Radiator Packages For AC power Switching Applications

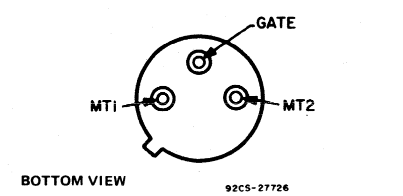
The RCA-T2303 and T2313 series triacs are gate-controlled full-wave silicon ac switches that are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages.

The T2303 (2N5754-57) series types employ a hermetic modified TO-5 package. The T2313 series types employ a hermetic modified TO-5 with a factory-attached heat radiator package.

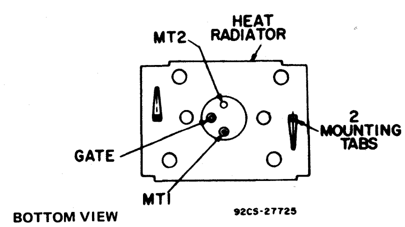
Features:

- Gate sensitivity −25 mA
- di/dt capability −100 A/μs
- Shorted-emitter, center-gate design
- Low switching losses
- Low-on-state voltage at high current levels

TERMINAL CONNECTIONS



T2303 (2N5754–57) Series



T2313 Series

MAXIMUM RATINGS, *Absolute-Maximum Values:*

For operation with sinusoidal supply voltage at frequencies up to 50/60 Hz and with resistive or inductive load

	T2303F T2313F	2N5754 T2313A	2N5755 T2313B	2N5756 T2313D	2N5757 T2313M	
*V_{DROM}▲:						
Gate open, T_J = −65 to 100°C	50	100	200	400	600	V
$I_{T(RMS)}$ (θ = 360°C):						
* T_C = 70°C (T2303 series)			2.5			A
T_A = 25°C (T2313 series)			1.9			A
For other conditions			See Figs. 2,3,4			
I_{TSM}:						
For one cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$:						
* 60 Hz (sinusoidal)			25			A
50 Hz (sinusoidal)			21			A
For more than one cycle of applied principal voltage			See Figs. 5,6			
di/dt:						
$V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 μs			100			A/μs
I^2t [At T_C shown for $I_{T(RMS)}$]:						
t = 20 ms			4.3			A^2s
t = 2.5 ms			2			A^2s
t = 0.5 ms			1			A^2s
For other time values			See Fig. 6			
*I_{GTM}●:						
For 1 μs max. (See Fig. 9)			1			A
P_{GM}:						
Peak (For 1 μs max., $I_{GTM} \leq$ 1 A (peak), (See Fig. 9)			10			W
*$P_{G(AV)}$ − T_C = 70°C			0.15			W
T_A = 25°C			0.05			W
*T_{stg}■			−65 to 150			°C
*T_C■			−65 to 100			°C
T_T■:						
During soldering for 10 s maximum at distance ≥ 1/16 in. (1.58 mm) from seating plane			225			°C

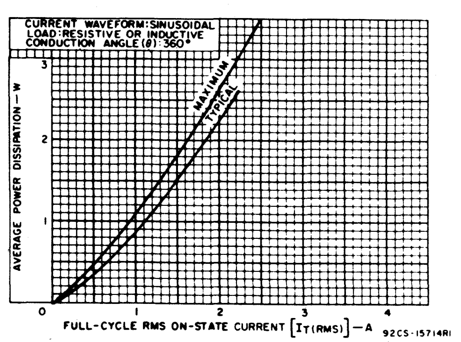


Fig. 1 — Power dissipation vs. on-state current.

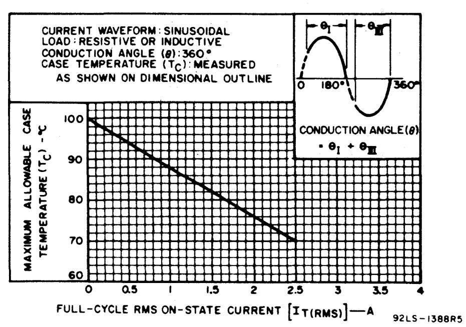


Fig. 2 — Maximum allowable case temperature vs. on-state current.

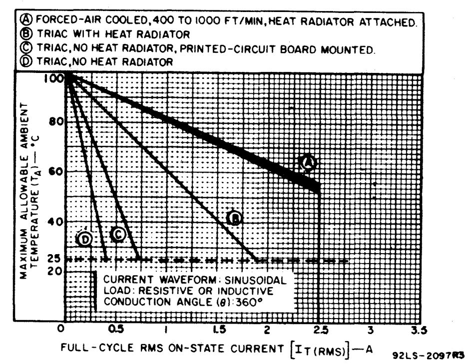


Fig. 3 — Maximum allowable ambient temperature vs. on-state current.

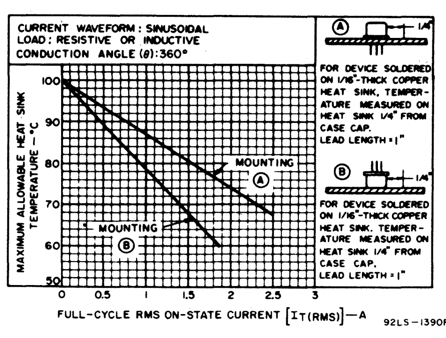


Fig. 4 — Maximum allowable heat-sink temperature vs. on-state current.

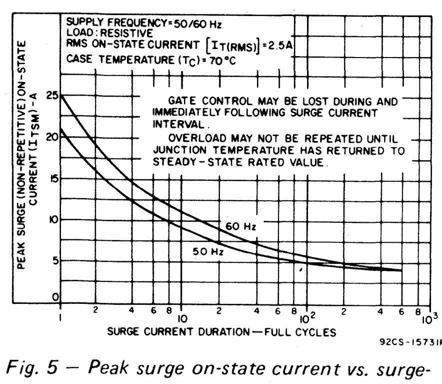


Fig. 5 — Peak surge on-state current vs. surge-current duration.

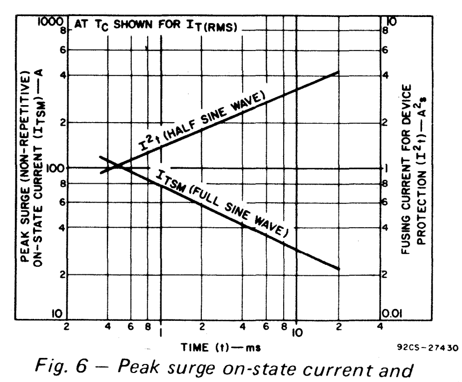


Fig. 6 — Peak surge on-state current and fusing current vs. time.

T2303 (2N5754-2N5757), T2313 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTICS	LIMITS			UNITS
	For All Types Except as Specified			
	MIN.	MAX.	MIN.	
* I_{DROM}▲: Gate open, T_J = 100°C, V_{DROM} = Max. rated value	—	0.2	0.75	mA
V_{TM}▲:				V
i_T = 10 A (peak), T_C = 25°C	–	2.2	2.6	V
* i_T = 3.5 A (peak), T_C = 25°C	–	–	1.8	V
I_{HO}▲: (See Fig. 7) Gate open, Initial principal current = 150 mA (dc), v_D = 12 V				mA
T_C = 25°C	–	6	35	mA
= −65°C	–	20	82*	mA
dv/dt (Commutating)▲: v_D = V_{DROM}, $I_{T(RMS)}$ = 2.5 A commutating di/dt = 0.95 A/ms, gate unenergized, T_C = 70°C	0.5	–	–	V/μs
* dv/dt (Off-State)▲: v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C:	10	100	–	V/μs
I_{GT}▲●: (See Fig. 10)				mA
v_D = 12 V dc, R_L = 30Ω, T_C = 25°C				
Mode / V_{MT2} / V_G				
I^+ positive positive	–	5	25	mA
III^- negative negative	–	5	25	mA
I^- positive negative	–	10	40	mA
III^+ negative positive	—	10	40	mA
v_D = 12 V dc, R_L = 30Ω, T_C = −65°C				
Mode / V_{MT2} / V_G				
I^+ positive positive	–	30	60*	mA
III^- negative negative	–	30	60*	mA
I^- positive negative	–	40	100*	mA
III^+ negative positive	–	40	100*	mA
V_{GT}▲●: (See Fig. 11)				V
v_D = 12 V dc, R_L = 30Ω, T_C = 25°C	–	0.9	2.2	V
= −65°C	–	1.5	3*	V
v_D = V_{DROM}, R_L = 125Ω, T_C = 100°C	0.2	–	–	V
t_{gt}: v_D = V_{DROM}, I_{GT} = 60 mA, t_r = 0.1 μs, i_T = 10 A (peak) T_C = 25°C	–	1.8	2.5	μs
* $R_{\theta JC}$: Steady-State	–	–	8.5	°C/W
$R_{\theta JA}$: Steady-State	–	–	150	°C/W

* In accordance with JEDEC registration data format (JS-14, RDF-2– filed for the JEDEC (2N-Series) types.

▲ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

● For either polarity of gate voltage (V_G) with reference to main terminal 1.

T2303 (2N5754-2N5757), T2313 Series

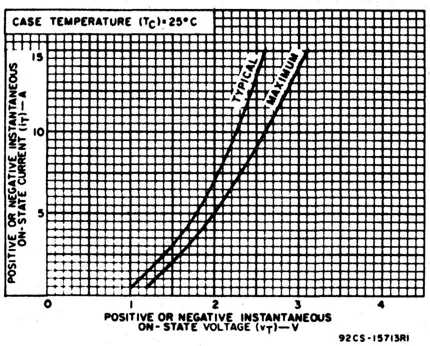


Fig. 7 — On-state current vs. on-state voltage.

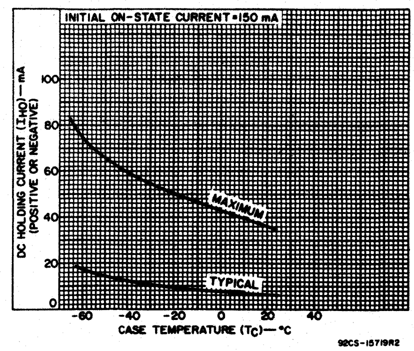


Fig. 8 — DC holding current (positive or negative) vs. case temperature.

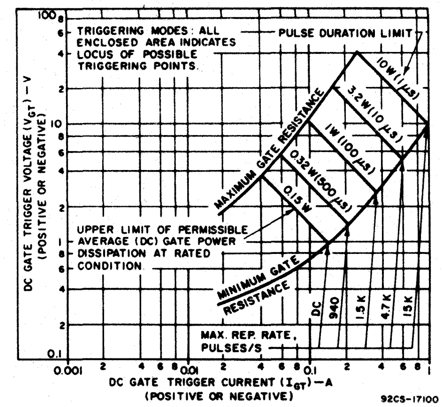


Fig. 9 — Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

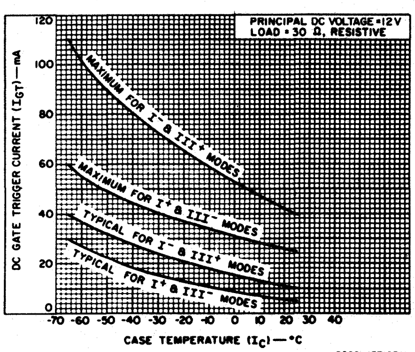


Fig. 10 — DC gate-trigger current vs. case temperature.

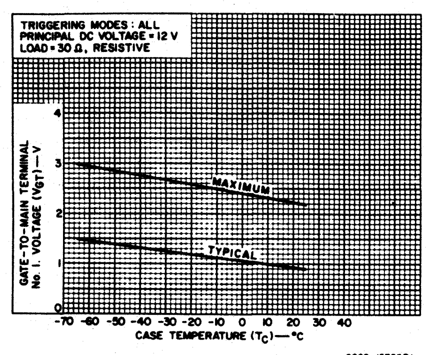


Fig. 11 — DC gate-trigger voltage vs. case temperature.

T2304, T2305 Series

400-Hz,0.5-A Sensitive-Gate Silicon Triacs

For Control-Systems Application in Airborne and Ground-Support Type Equipment

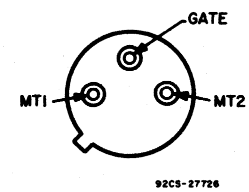
RCA T2304- and T2305-series triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

These triacs are intended for operation up to 400 Hz with resistive or inductive loads and nominal line voltages of 115 and 208 V RMS sine wave and repetitive peak off-stage voltages of 200 V and 400 V.

The high gate sensitivity of these triacs permits the use of economical transistorized or integrated control circuits and enhances their use in low-power phase control and load-switching applications.

Features:
- **High gate sensitivity, I_{GT} = 10/40 mA max.**
- **di/dt capability = 100 A/μs**
- **Commutating dv/dt capability characterized at 400 Hz**
- **Shorted-Emitter Design**

TERMINAL CONNECTIONS



Modified JEDEC TO-5

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 400 Hz and with Resistive or Inductive Load.

	Symbol	T2304B / T2305B	T2304D / T2305D	Units
REPETITIVE PEAK OFF-STATE VOLTAGE:*				
Gate open, T_J = -50 to 100°C	V_{DROM}	200	400	V
RMS ON-STATE CURRENT (Conduction angle = 360°):	$I_{T(RMS)}$			
Case temperature (T_C) = 90°C		0.5		A
Ambient temperature (T_A) = 25°C, without heat sink		0.4		A
For other conditions		See Figs. 2 & 3		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}			
For one cycle of applied principal voltage, T_C = 90°C				
400 Hz (sinusoidal)		50		A
60 Hz (sinusoidal)		25		A
50 Hz (sinusoidal)		21		A
For more than one cycle of applied principal voltage		See Fig. 4		
RATE-OF-CHANGE OF ON-STATE CURRENT: $V_{DM} = V_{DROM}$, I_{GT} = 60 mA, t_r = 0.1 μs	di/dt	100		A/μs
FUSING CURRENT (for triac protection): T_J = -50 to 100°C, t = 1.25 to 10 ms	I^2t	2		A^2s
PEAK GATE-TRIGGER CURRENT:■ For 1 μs (max.) (See Fig. 10)	I_{GTM}	1		A
GATE POWER DISSIPATION:				
PEAK (For 1 μs max., (See Fig. 10)	P_{GM}	10		W
AVERAGE (At T_C = 60°C)	$P_{G(AV)}$	0.15		W
(At T_A = 25°C, without heat sink)	$P_{G(AV)}$	0.05		W
TEMPERATURE RANGE:▲				
Storage	T_{stg}	-50 to 150		°C
Operating (Case)	T_C	-50 to 100		°C
LEAD TEMPERATURE (During soldering): At distances ≥ 1/16 in. (1.58 mm) from the case for 10 s max.	T_L	225		°C

* For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see Dimensional Outline.

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS T2304 Series Min.	Typ.	Max.	T2305 Series Min.	Typ.	Max.	UNITS
Peak Off-State Current:♦ Gate open, T_J = 100°C, V_{DROM} = Max. rated value	I_{DROM}	-	0.2	0.75	-	0.2	0.75	mA
Maximum On-State Voltage:♦ For i_T = 10 A (peak), T_C = 25°C	V_{TM}	-	1.7	2.2	-	1.7	2.2	V
DC Holding Current:♦ Gate open, Initial principal current = 150 mA (DC), v_D = 12 V, T_C = 25°C	I_{HO}	-	7	15	-	15	30	mA
For other case temperatures		See Figs. 8 & 9						
Critical Rate-of-Rise of Commutation Voltage:♦ For $v_D = V_{DROM}$, $I_{T(RMS)}$ = 0.5 A, commutating di/dt = 1.8 A/ms, gate unenergized, T_C = 90°C	dv/dt	1	4	-	1	4	-	V/μs
Critical Rate-of-Rise of Off-Stage Voltage:♦ For $v_D = V_{DROM}$, exponentail voltage rise, gate open, T_C = 100°C	dv/dt	10	100	-	10	100	-	V/μs
DC Gate-Trigger Current:♦ (Mode / V_{MT2} / V_G)	I_{GT}							mA
For v_D = 12 V (DC), — I⁺ / positive / positive		-	3.5	10	-	5	25	
R_L = 30 Ω — III⁻ / negative / negative		-	3.5	10	-	5	25	
T_C = 25°C — I⁻ / positive / negative		-	7	10	-	10	40	
III⁺ / negative / positive		-	7	10	-	10	40	
For other case temperatures		See Figs. 11 & 12						
DC Gate-Trigger Voltage:♦† For v_D = 12 V (DC), R_L = 30Ω, T_C = 25°C	V_{GT}	-	1	2.2	-	1	2.2	V
For other case temperatures		See Fig. 13						
For $v_D = V_{DROM}$, R_L = 125Ω, T_C = 100°C		0.15	-	-	0.15	-	-	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For $v_D = V_{DROM}$, I_{GT} = 60 mA, t_r = 0.1 μs, i_T = 10 A (peak), T_C = 25°C (See Fig. 16)	t_{gt}	-	1.8	-	2.5	1.8	2.5	μs
Thermal Resistance, Junction-to-Case:	θ_{J-C}	-	-	8.5	-	-	8.5	°C/W

♦ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
† For either polarity of gate voltage (V_G) with reference to main terminal 1.

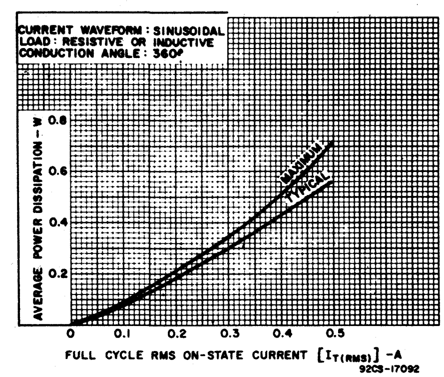


Fig. 1—Power dissipation vs. on-state current.

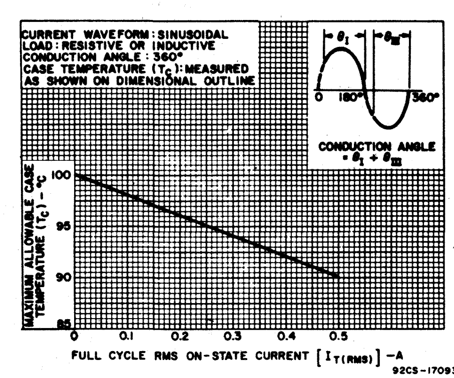


Fig. 2—Maximum allowable case temperature vs. on-state current.

T2304, T2305 Series

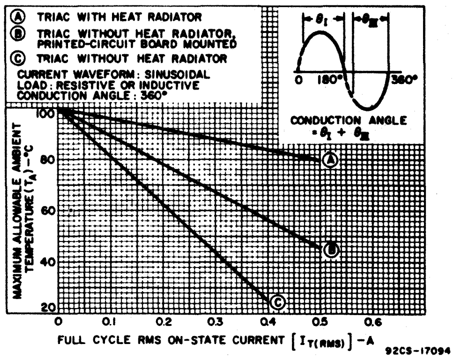


Fig. 3—Maximum allowable ambient temperature vs. on-state current for the package/mounting options of these triacs.

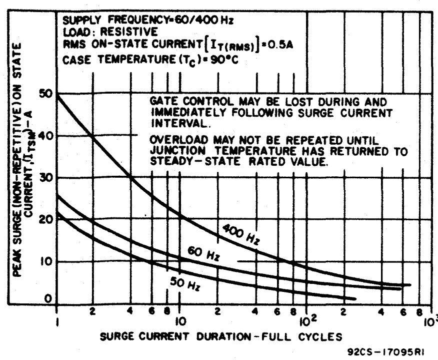


Fig. 4—Peak surge on-state current vs. surge-current duration.

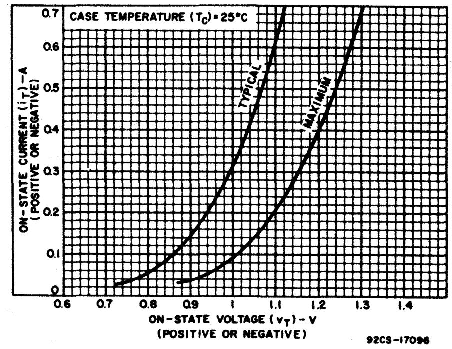


Fig. 5—On-state current vs. on-state voltage (steady-state condition).

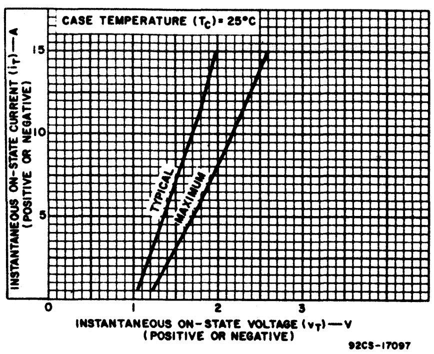


Fig. 6—On-state current vs. on-state voltage (surge condition).

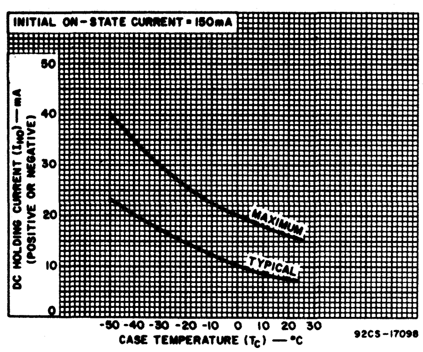


Fig. 7—DC holding current vs. case temperature for T2304 series.

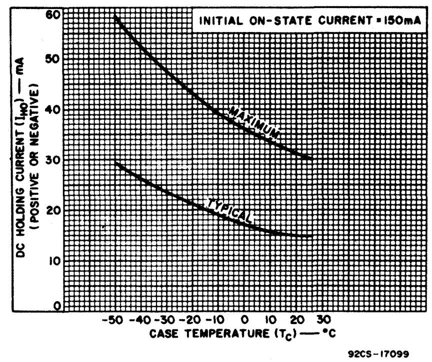


Fig. 8—DC holding current vs. case temperature for T2305 series.

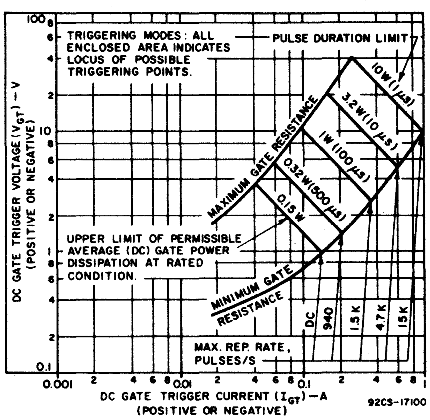


Fig. 9—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

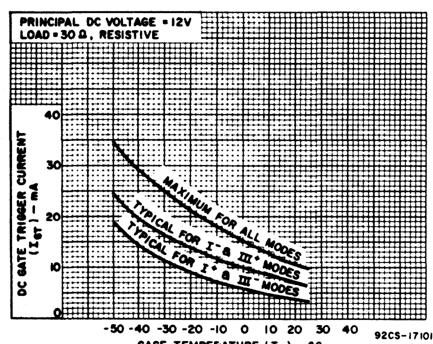


Fig. 10—DC gate-trigger current vs. case temperature for T2304 series.

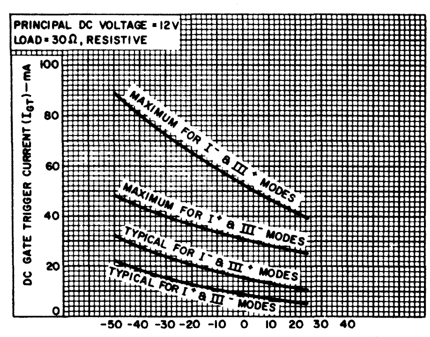


Fig. 11—DC gate-trigger current vs. case temperature for T2305 series.

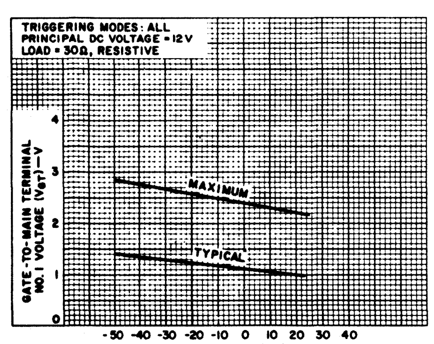


Fig. 12—DC gate-trigger voltage vs. case temperature.

T2500 Series

6-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

Features:
- 60-A Peak Surge Full-Cycle Current Ratings
- Shorted-Emitter, Center-Gate Design
- Package Design Facilitates Mounting on a Printed-Circuit Board
- Low Switching Losses
- Low Thermal Resistance

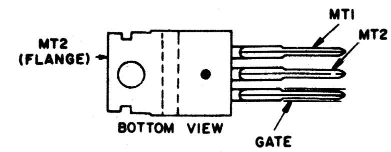
Types T2500B and T2500D* are gate-controlled full-wave silicon triacs utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, heating controls, relay replacement, solenoid drivers, static switching, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 6 amperes at a T_C of 80°C and repetitive off-state voltage ratings of 200 volts and 400 volts, respectively.

These triacs employ the plastic JEDEC TO-220-AB package.

*Formerly RCA Dev. Nos. TA8504 and TA8505.

TERMINAL CONNECTIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

Rating	Symbol	T2500B	T2500D	Units
REPETITIVE PEAK OFF-STATE VOLTAGE:•				
Gate open, T_J = −65 to 100°C	V_{DROM}	200	400	V
RMS ON-STATE CURRENT (Conduction angle = 360°):	$I_{T(RMS)}$			
Case temperature T_C = 80°C		6		A
For other conditions		See Fig. 2		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}			
For one cycle of applied principal voltage, T_C = 80°C				
60 Hz (sinusoidal)		60		A
50 Hz (sinusoidal)		50		A
For more than one cycle of applied principal voltage		See Fig. 3		
RATE OF CHANGE OF ON-STATE CURRENT:				
$V_{DM} = V_{DROM}$, I_{GT} = 200 mA, tr = 0.1 μs	di/dt	70		A/μs
FUSING CURRENT (for Triac Protection):				
T_C = −65 to 100°C, t = 1.25 to 10 ms	I^2t	18		A^2s
PEAK GATE-TRIGGER CURRENT:■				
For 10 μs max; see Fig. 10	I_{GTM}	4		A
GATE POWER DISSIPATION:				
Peak (For 1 μs max., $I_{GTM} \leq 4$ A; see Fig. 6)	P_{GM}	16		W
AVERAGE	$P_{G(AV)}$	0.2		W
TEMPERATURE RANGE:▲				
Storage	T_{stg}	−65 to 150		°C
Operating (Case)	T_C	−65 to 100		°C
TERMINAL TEMPERATURE (During soldering):				
For 10 s max. (terminals and case)	T_T	225		°C

• For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see *Dimensional Outline.*

ELECTRICAL CHARACTERISTICS at Maximum Ratings unless otherwise specified, and at indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS T2500B MIN.	T2500B TYP.	T2500B MAX.	T2500D MIN.	T2500D TYP.	T2500D MAX.	UNITS
Peak Off-State Current:* Gate Open, V_{DROM} = Max. rated value At T_J = 100°C	I_{DROM}	–	0.1	2	–	0.1	2	mA
Maximum On-State Voltage:* For i_T = 30 A (peak) and T_C = 25°C	V_{TM}	–	1.7	2	–	1.7	2	V
DC Holding Current:* Gate Open Initial principal current = 150 mA (dc) At T_C = 25°C	I_{HO}	–	15	30	–	15	30	mA
For other case temperatures		See Fig. 5.						
Critical Rate of Rise of Commutation Voltage:*♦ For $v_D = V_{DROM}$, $I_{T(RMS)}$ = 6 A, Commutating di/dt = 3.2 A/ms, and gate unenergized At T_C = 80°C	dv/dt	4	10	–	4	10	–	V/μs
Critical Rate of Rise of Off-State Voltage:* For $v_D = V_{DROM}$, exponential voltage rise, and gate open At T_C = 100°C	dv/dt	100	300	–	75	250	–	V/μs
For other case temperatures		See Fig.9						
DC Gate-Trigger Current:*† For v_D = 12 V (dc), R_L = 12 Ω T_C = 25°C, and specified triggering mode:	I_{GT}							mA
I+ Mode (V_{MT2} positive, V_G positive)		–	10	25	–	10	25	
III− Mode (V_{MT2} negative, V_G negative)		–	15	25	–	15	25	
I− Mode (V_{MT2} positive, V_G negative)		–	20	60	–	20	60	
III+ Mode (V_{MT2} negative, V_G positive)		–	30	60	–	30	60	
For other case temperatures		See Figs. 7 and 8						

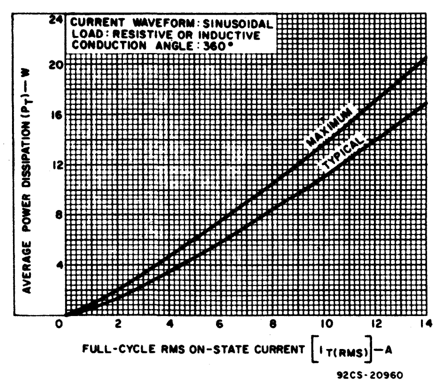


Fig. 1—Power dissipation vs. on-state current.

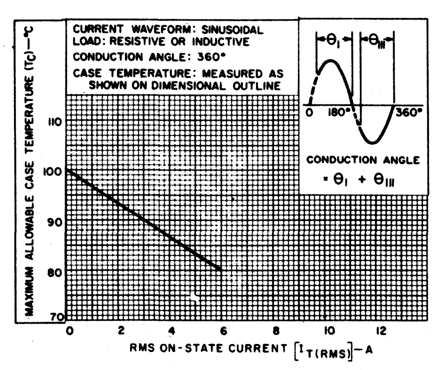


Fig. 2—Allowable case temperature vs. on-state current.

T2500 Series

ELECTRICAL CHARACTERISTICS at Maximum Ratings unless otherwise specified, and at indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS T2500B MIN.	T2500B TYP.	T2500B MAX.	T2500D MIN.	T2500D TYP.	T2500D MAX.	UNITS
DC Gate-Trigger Voltage:*†								
For v_D = 12 V (dc) and R_L = 12 Ω								
At T_C = 25 °C	V_{GT}	–	1.25	2.5	–	1.25	2.5	V
For other case temperatures	V_{GT}	See Fig.9						V
For v_D = V_{DROM} and R_L = 125 Ω								
At T_C = 100 °C	V_{GT}	0.2	–	–	0.2	–	–	V
Gate-Controlled Turn-On Time (Delay Time + Rise Time): For v_D = V_{DROM}, I_{GT} = 160 mA, rise time = 0.1 μs, and i_T = 10 A (peak) At T_C = 25°C (See Fig. 11)	t_{gt}	–	1.6	2.5	–	1.6	2.5	μs
Thermal Resistance:								
Junction-to-Case	$R_{\theta JC}$	–	–	2.7	–	–	2.7	°C/W
Junction-to-Ambient	$R_{\theta JA}$	–	–	60	–	–	60	°C/W

*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

†For either polarity of gate voltage (V_G) with reference to main terminal 1.

♦Variants of these devices having dv/dt characteristics selected specifically for inductive loads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.

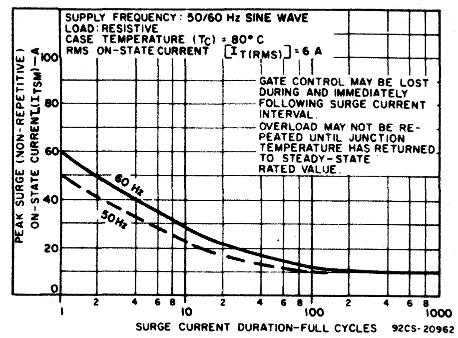


Fig. 3—Peak surge on-state current vs. surge-current duration.

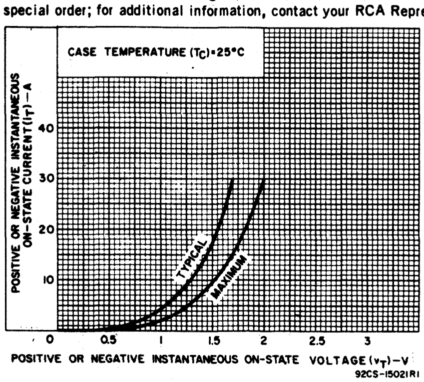


Fig. 4—On-state current vs. on-state voltage.

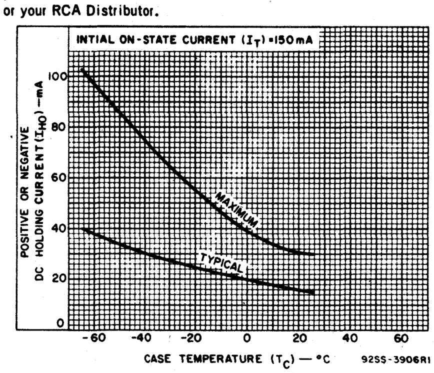


Fig. 5—DC holding current for either direction of on-state current vs. case temperature.

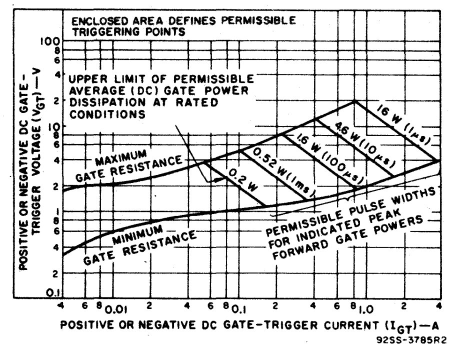


Fig. 6—Gate-pulse characteristics for all triggering modes.

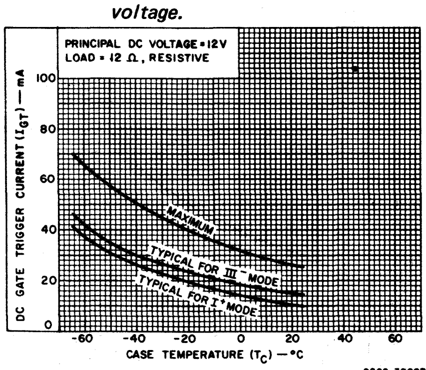


Fig. 7—DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

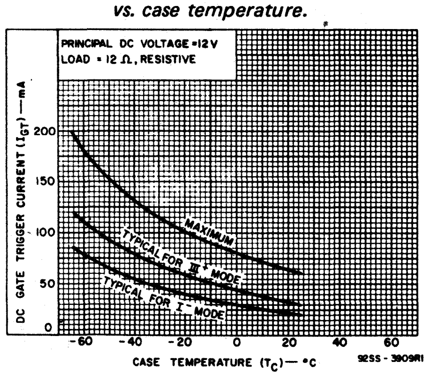


Fig. 8—DC gate-trigger current (for I^- and III^+ triggering modes) vs. temperature.

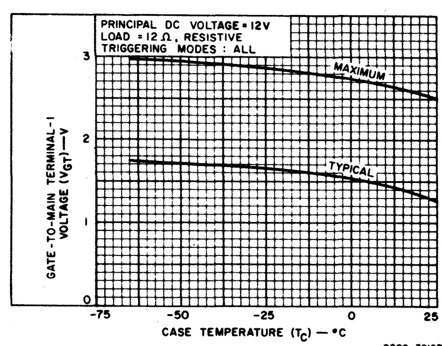


Fig. 9—DC gate-trigger voltage vs. case temperature.

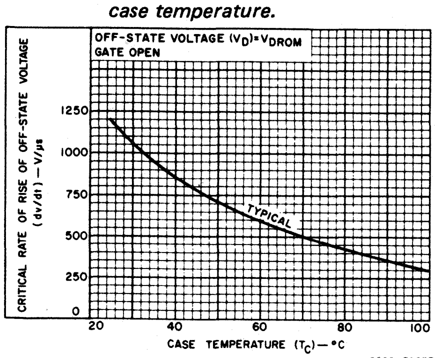


Fig. 10—Critical rate of rise of off-state voltage vs. case temperature.

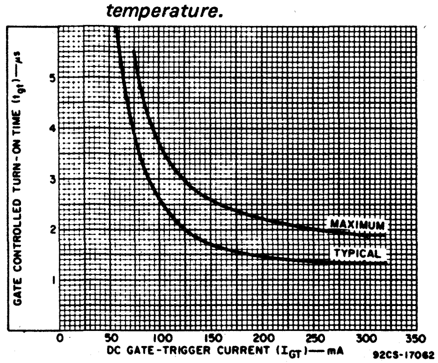


Fig. 11—Typical turn-on time vs. gate-trigger current.

T2700, T2710 Series

6-A Silicon Triacs

For Power-Control and Power-Switching Applications

RCA T2700- and T2710-series devices are gate-controlled full-wave silicon triacs. They are intended for the control of ac loads in applications such as heating controls, motor controls, light dimmers, and power switching systems.

These triacs are designed to switch from an off-state to an on-state condition for either polarity of applied voltage with positive or negative triggering voltages to the gate.

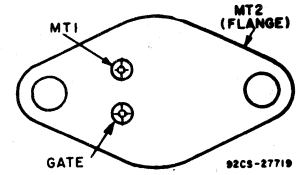
Features:

- **Shorted-emitter construction . . . contains an internally diffused resistor between gate and Main Terminal 1**
- **Center gate construction . . . provides rapid uniform gate-current spreading for faster turn-on with substantially reduced heating effects**

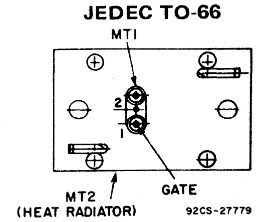
T2700B and T2700D are hermetically sealed types having an on-state current rating of 6 amperes at a case temperature of +75°C and repetitive off-state voltage ratings of 200 volts and 400 volts, respectively.

The T2700 series types employ the hermetic JEDEC TO-66 package. The T2710 series employ the hermetic TO-66 with a factory attached heat-radiator package.

TERMINAL CONNECTIONS



JEDEC TO-66



JEDEC TO-66 With Heat Radiator

Maximum Ratings, *Absolute-Maximum Values:*

For Operation with Sinusoidal Supply Voltage at Frequencies of 50/60 Hz, and with Resistive or Inductive Load

	T2700B / T2710B	T2700D / T2710D	
REPETITIVE PEAK OFF-STATE VOLTAGE♠, V_{DROM}:			
Gate Open, For T_J = −65 to +100 °C	200	400	V
RMS ON-STATE CURRENT, $I_{t(rms)}$:			
For case temperature (T_C) of +75 °C and a conduction angle of 360°	6	6	A
For ambient temperatures (T_A) up to +100 °C and a conduction angle of 360°	See Fig. 3.		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT, I_{TSM}:			
For one cycle of applied principal voltage, T_C = 75°C			
60 Hz (sinusoidal)	100	100	A
50 Hz (sinusoidal)	85	85	A
For more than one full cycle of applied voltage	See Fig. 4.		
RATE OF CHANGE OF ON-STATE CURRENT:			
$V_{DM} = V_{DROM}$, I_{GT} = 200 mA, tr = 0.1 μs di/dt	100		A/μs
FUSING CURRENT (for triac protection, I^2t:			
T_J = −65 to 100°C, t = 1.25 to 10 ms	50	50	A^2s
PEAK GATE-TRIGGER CURRENT■, I_{GTM}:			
For 1 μs max.	4	4	A
GATE POWER DISSIPATION:■			
PEAK, P_{GM} For 1 μs max. and $I_{GTM} \leq$ 4 A (peak)......	16	16	W
AVERAGE, $P_{G(AV)}$	0.2	0.2	W
TEMPERATURE RANGE♦:			
Storage	−65 to +150		°C
Operating (case)	−65 to +100		°C

♠For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■For either polarity of gate voltage (V_{GT}) with reference to main terminal 1.

♦For information on the reference point of temperature measurement, see *Dimensional Outline.*

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified
(For Definitions of Terms and Symbols, See Page 6)

CHARACTERISTIC	SYMBOL	LIMITS T2700B Min.	Typ.	Max.	T2710B Min.	Typ.	Max.	T2700D Min.	Typ.	Max.	T2710D Min.	Typ.	Max.	UNITS
Peak Off-State Current:* Gate Open At T_J = +100 °C and V_{DROM} = Max. rated value	I_{DROM}	–	0.1	4	–	0.1	1.2	–	0.2	4	–	0.2	1.2	mA
Maximum On-State Voltage:* For i_T = 30A (peak) and T_C = +25 °C	V_{TM}	–	1.8	2.25	–	1.8	2.25	–	1.8	2.25	–	1.8	2.25	V
DC Holding Current:* Gate Open Initial principal current = 150 mA (DC) At T_C = +25 °C	I_{HO}	–	15	30	–	15	30	–	15	30	–	15	30	mA
For other case temperatures		See Fig. 6.												
Critical Rate of Rise of Commutation Voltage:*♠ For $V_D = V_{DROM}$, $I_{t(rms)}$ = 6 A, commutating di/dt = 3.2 A/ms, and gate unenergized At T_C = +75 °C	dv/dt	3	10	–	–	–	–	3	10	–	–	–	–	V/μs
$I_{t(rms)}$ and T_A specified by curve A of Fig. 3		–	–	–	3	10	–	–	–	–	3	10	–	
$I_{t(rms)}$ and T_A specified by curve B of Fig. 3		–	–	–	4	12	–	–	–	–	4	12	–	
Critical Rate of Rise of Off-State Voltage:* For $V_D = V_{DROM}$, exponential voltage rise, and gate open At T_C = +100 °C	dv/dt	30	150	–	30	150	–	20	100	–	20	100	–	V/μs
DC Gate-Trigger Current:*† For V_D = 12 volts (DC), R_L = 12 Ω T_C = +25 °C, and specified triggering mode: I+ Mode: positive V_{MT2}, positive V_{GT}	I_{GT}	–	15	25	–	15	25	–	15	25	–	15	25	mA
III− Mode: negative V_{MT2}, negative V_{GT}		–	15	25	–	15	25	–	15	25	–	15	25	
I− Mode: positive V_{MT2}, negative V_{GT}		–	25	40	–	25	40	–	25	40	–	25	40	
III+ Mode: negative V_{MT2}, positive V_{GT}		–	25	40	–	25	40	–	25	40	–	25	40	
For other case temperatures		See Fig. 8 & 9.												
DC Gate-Trigger Voltage:*† For V_D = 12 volts (DC) and R_L = 12 Ω At T_C = +25 °C	V_{GT}	–	1	2.2	–	1	2.2	–	1	2.2	–	1	2.2	V
For other case temperatures		See Fig. 10.												
For $V_D = V_{DROM}$ and R_L = 125 Ω At T_C = +100 °C		0.2	–	–	0.2	–	–	0.2	–	–	0.2	–	–	

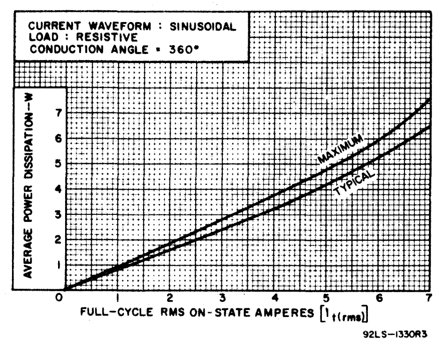


Fig. 1—Power dissipation vs. on-state current.

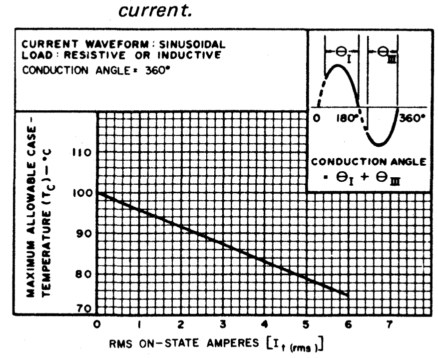


Fig. 2—Allowable case temperature vs. on-state current.

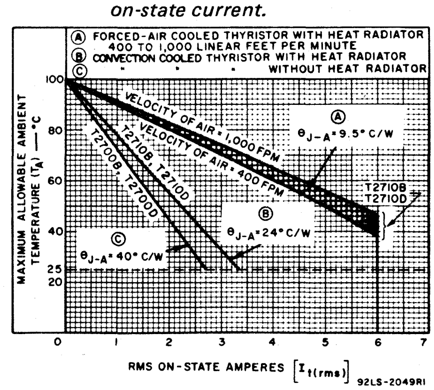


Fig. 3—Maximum allowable ambient temperature vs. on-state current.

T2700, T2710 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified
(For Definitions of Terms and Symbols, See Page 6)

CHARACTERISTIC	SYMBOL	LIMITS												UNITS
		T2700B			T2710B			T2700D			T2710D			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For $V_D = V_{DROM}$ and $I_{GT} = 80$ mA, 0.1 μs rise time, and $i_T = 10$ A (peak) At $T_C = +25\,^{\circ}C$	t_{gt}	–	2.2	–	–	2.2	–	–	2.2	–	–	2.2	–	μs
Thermal Resistance: Junction-to-Case (Steady-State)		–	–	4	–	–	–	–	–	4	–	–	–	
Junction-to-Case (Transient)	θ_{J-C}	See Fig. 11.												$^{\circ}C/W$
Junction-to-Ambient	θ_{J-A}	–	–	–	See Fig. 3.			–	–	–	See Fig. 3.			

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
†For either polarity of gate voltage (V_{GT}) with reference to main terminal 1.
♦Variants of these devices having dv/dt characteristics selected specifically for inductive loads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.

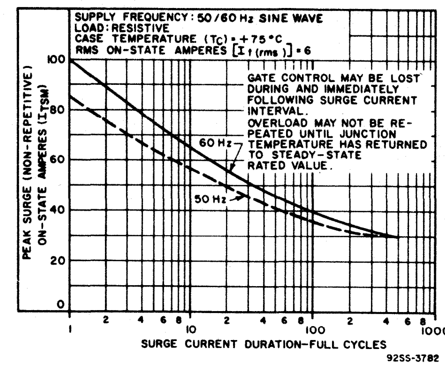


Fig. 4–Peak surge on-state current vs. surge-current duration.

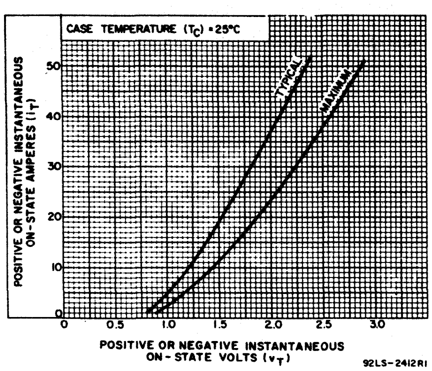


Fig. 5–On-state current vs. on-state voltage.

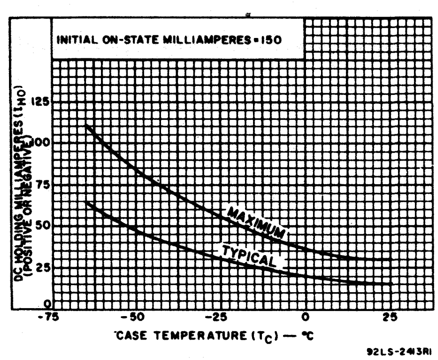


Fig. 6–DC holding current for either direction of on-state current vs. case temperature.

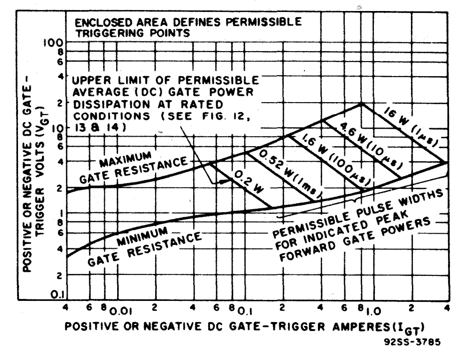


Fig. 7–Gate-pulse characteristics for all triggering modes.

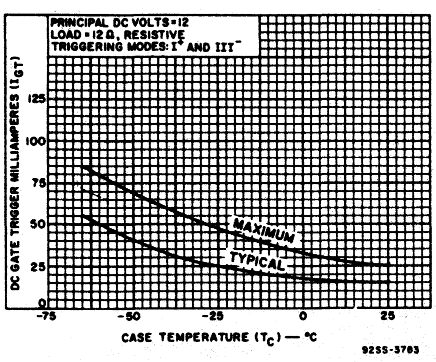


Fig. 8–DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

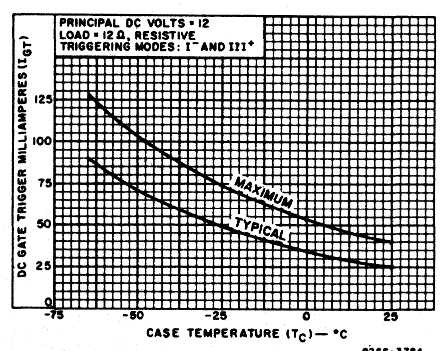


Fig. 9–DC gate-trigger current (for I^- and III^+ triggering modes) vs. case temperature.

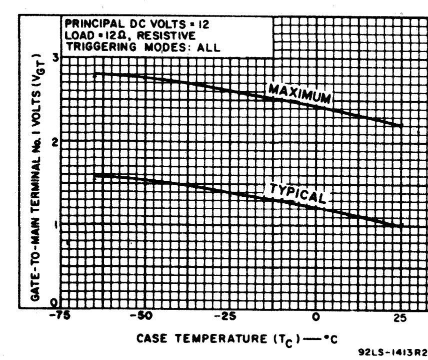


Fig. 10–DC gate-trigger voltage vs. case temperature.

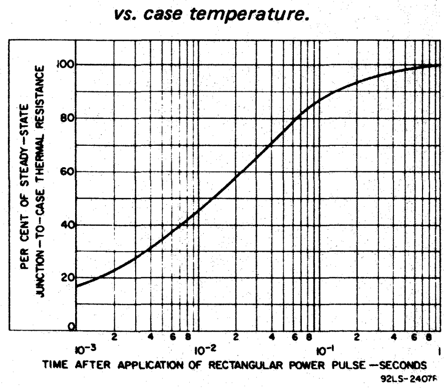


Fig. 11–Transient thermal resistance (junction-to-case vs. time).

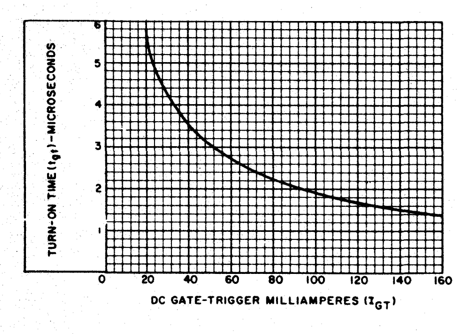


Fig. 12–Typical turn-on time vs. gate-trigger current.

T2800, T2801, T2802 , T2850 Series

6-A and 8-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

Features:

- **80-A and 100-A Peak Surge Full-Cycle Current Ratings**
- **Glass Passivated Junctions**
- **Short-Emitter Center-Gate Design**
- **Low Switching Losses**
- **Low Thermal Resistance**
- **Package Design Facilitates Mounting on a Printed-Circuit Board**

Additional Features for T2850 Series:

- **Internal Isolation**
- **Package Suitable for Direct Mounting on Heat Sink**

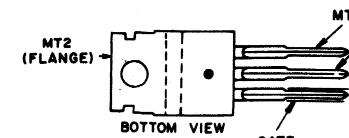
These RCA triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

The T2801 and T2802 series triacs are characterized for I^+, III^- gate triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

All series employ the plastic JEDEC TO-220AB package. The T2850-series package has three leads that are electrically isolated from the mounting flange. Because of this internal isolation, the triac can be mounted directly on a heat sink, without any insulating hardware; therefore heat transfer is improved and heat-sink size can be reduced.

TERMINAL CONNECTIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal-Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

		–	T2800B	T2800C	T2800D	T2800E	T2800M	
		–	T2802B	T2802C	T2802D	T2802E	T2802M	
		–	T2801B	T2801C	T2801D	T2801E	–	
		T2850A	T2850B	–	T2850D	–	–	
REPETITIVE PEAK OFF-STATE VOLTAGE:●								
Gate open, T_J = –65 to 100°C	V_{DROM}	100	200	300	400	500	600	V
RMS ON-STATE CURRENT (Conduction angle = 360°):	$I_{T(RMS)}$							
Case Temperature								
T_C = 80°C (T2800, T2802, T2850 series)		8						A
= 80°C (T2801 series only)		6						A
For other conditions		See Fig. 3						
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}							
For one cycle of applied principal voltage								
60 Hz (sinusoidal), T_C=80°C (T2800, T2802, T2850 series)		100						A
50 Hz (sinusoidal) T_C=80°C (T2800, T2802, T2850 series)		85						A
60 Hz (sinusoidal), T_C=80°C (T2801 series only)		80						A
50 Hz (sinusoidal), T_C=80°C (T2801 series only)		65						A
For more than one cycle of applied principal voltage		See Fig. 4, 5						
RATE OF CHANGE OF ON-STATE CURRENT:								
$v_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs	di/dt	70						A/μs
FUSING CURRENT (for triac protection):								
At T_C shown for $I_{T(RMS)}$:								
t = 20 ms								
T2800, T2802, T2850		55						A^2s
T2801		35						A^2s
= 2.5 ms								
T2800, T2802, T2850		28						A^2s
T2801		18						A^2s
= 0.5 ms								
T2800, T2802, T2850		16						A^2s
T2801		10						A^2s
PEAK GATE-TRIGGER CURRENT:■								
For 1 μs max. See Fig. 11	I_{GTM}	4						A
GATE POWER DISSIPATION:								
Peak (for 1 μs max., I_{GTM} ≤ 4 A, See Fig. 11	P_{GM}	16						W
AVERAGE (T2800, T2802, T2802 series)	$P_{G(AV)}$	0.35						W
AVERAGE (T2850 series)	$P_{G(AV)}$	0.2						W
TEMPERATURE RANGE:▲								
Storage	T_{stg}	–65 to 150						°C
Operating (Case)	T_C	–65 to 100						°C
TERMINAL TEMPERATURE (During soldering):								
For 10 s max. (terminals and case)	T_T	225						°C

●For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲For temperature measurement reference point, see Dimensional Outline.

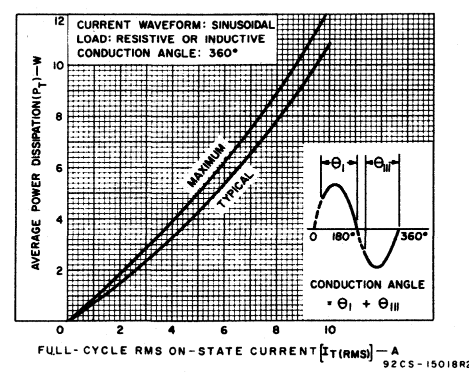


Fig. 1 — Power dissipation vs. on-state current for T2800, T2802, T2850 series.

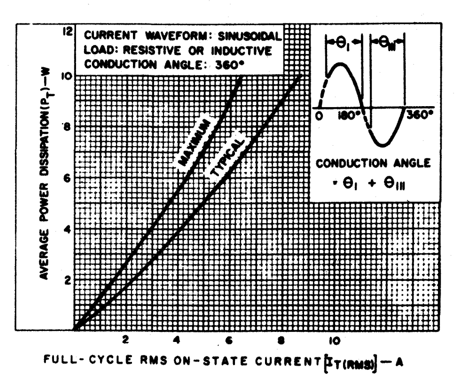


Fig. 2 — Power dissipation vs. on-state current for T2801 series.

T2800, T2801, T2802 , T2850 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTICS	SYMBOL	LIMITS For All Types Except as Specified MIN.	TYP.	MAX.	UNITS
Peak Off-State Current:● Gate open, T_J = 100°C, V_{DROM} = Max. rated value	I_{DROM}	–	0.1	2	mA
Maximum On-State Voltage:● (See Fig. 6, 7) For i_T = 30 A (peak), T_C = 25°C (T2800, T2802, T2850 series	v_{TM}	–	1.7	2	V
(T2801 series)		–	2	3	
DC Holding Current:● Gate open, Initial principal current = 150 mA (dc) v_D = 12 V, T_C = 25°C, T2800, T2850 series	I_{HO}	–	15	30	mA
T2801 series		–	100	–	
T2802 series		–	20	60	
For other case temperatures		See Fig. 8, 9, 10			
Critical Rate-of-Rise of Commutation Voltage:●▲ For v_D = V_{DROM}, $I_{T(RMS)}$ = 8 A, commutating di/dt = 4.3 A/ms, gate unenergized, T_C = 80°C (T2800, T2802, T2850 series)	dv/dt	4	10	–	V/µs
For v_D = V_{DROM}, $I_{T(RMS)}$ = 6 A, commutating di/dt = 4.3 A/ms, gate unenergized, T_C = 80°C (T2801 series)		2	10	–	
Critical Rate-of-Rise of Off-State Voltage:● For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C: T2850A	dv/dt	125	350	–	V/µs
T2800B, T2802B, T2850B		100	300	–	
T2800C, T2802C		85	275	–	
T2800D, T2802D, T2850D		75	250	–	
T2800E, T2802E		65	225	–	
T2800M, T2802M		60	200	–	
T2801B		50	300	–	
T2801C		40	275	–	
T2801D		30	250	–	
T2801E		20	225	–	
DC Gate-Trigger Current:●■ For v_D = 12 V (dc) R_L = 12Ω T_C = 25°C; Mode V_{MT2} V_G; I^+ positive positive T2800, T2850 series	I_{GT}	–	10	25	mA
T2801 series		–	25	80	
T2802 series		–	25	50	
III^- negative negative T2800, T2850 series		–	15	25	
T2801 series		–	25	80	
T2802 series		–	25	50	
I^- positive negative T2800, T2850 series only		–	20	60	
III^+ negative positive T2800, T2850 series only		–	30	60	
For other case temperatures		See Fig. 12, 13, 14			
DC Gate-Trigger Voltage:●■ For v_D = 12 V (dc), R_L = 12Ω, T_C = 25°C T2800, T2802, T2850 series	V_{GT}	–	1.25	2.5	V
T2801 series		–	1.5	4	
For other case temperatures		See Fig. 15, 16			
For v_D = V_{DROM}, R_L = 125Ω, T_C = 100°C		0.2	–	–	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For v_D = V_{DROM}, I_{GT} = 80 mA, t_r = 0.1 µs, i_T = 10 A (peak), T_C = 25°C (T2800, T2802, T2850 series)	t_{gt}	–	1.6	2.5	µs
(T2801 series)		–	2.2	–	
Thermal Resistance: Junction-to-Case (T2800, T2801, T2802 series)	$R_{\theta JC}$	–	–	2.2	°C/W
(T2850 series)		–	–	3.1	
Junction-to-Ambient	$R_{\theta JA}$	–	–	60	

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ Variants of these devices having dv/dt characteristics selected specifically for inductive loads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.

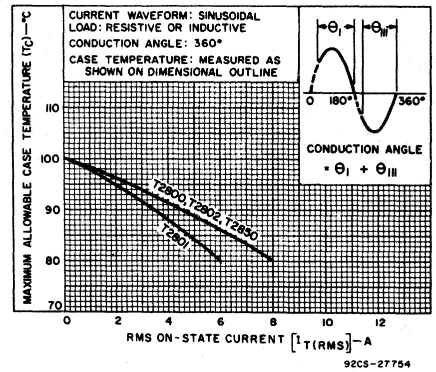


Fig. 3 — Maximum allowable case temperature vs. on-state current.

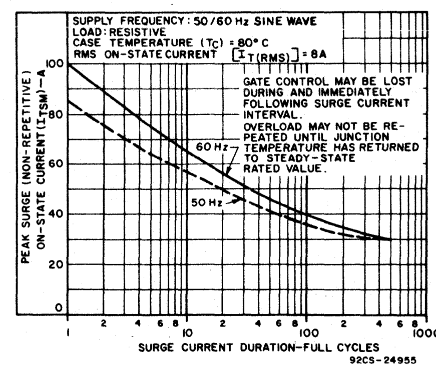


Fig. 4 — Peak surge on-state current vs. surge current duration for T2800, T2802, T2850 series.

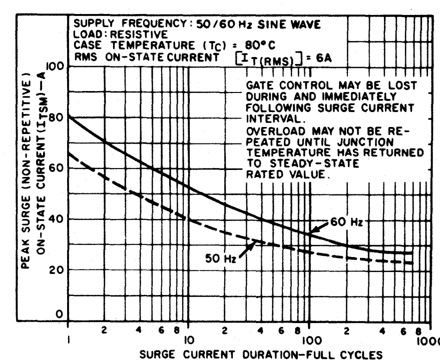


Fig. 5 — Peak surge on-state current vs. surge current duration for T2801 series.

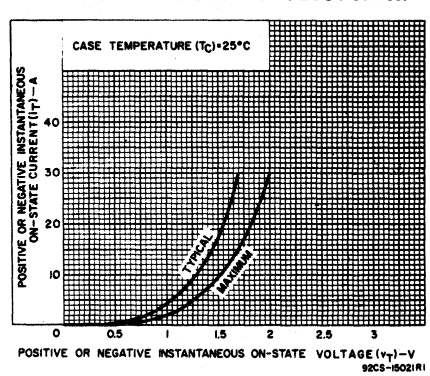


Fig. 6 — On-state current vs. on-state voltage for T2800, T2802, T2850 series.

T2800, T2801, T2802 , T2850 Series

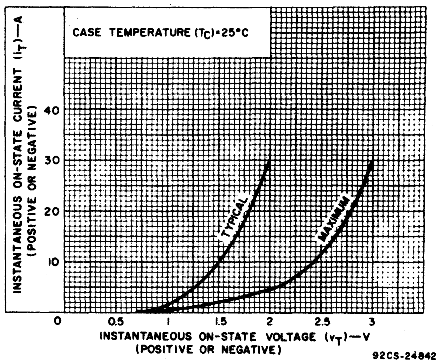


Fig. 7 — On-state current vs. on-state voltage for T2801 series.

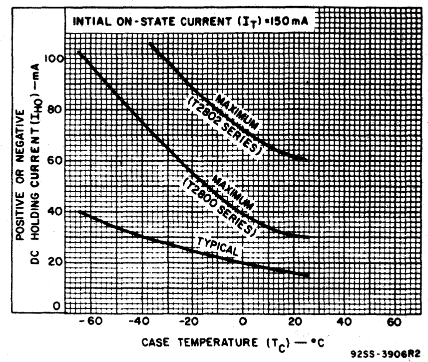


Fig. 8 — DC holding current vs. case temperature for T2800, T2802.

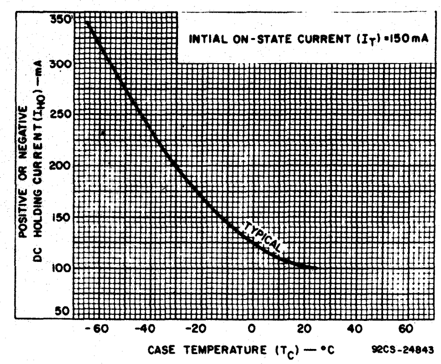


Fig. 9 — DC holding current vs. case temperature for T2801 series.

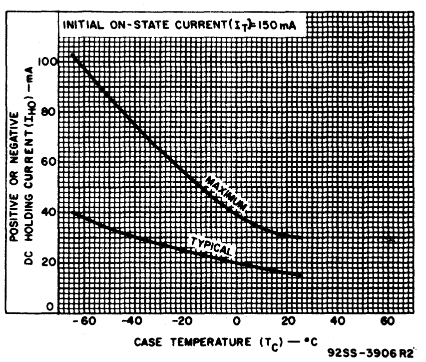


Fig. 10 — DC holding current vs. case temperature for T2850 series.

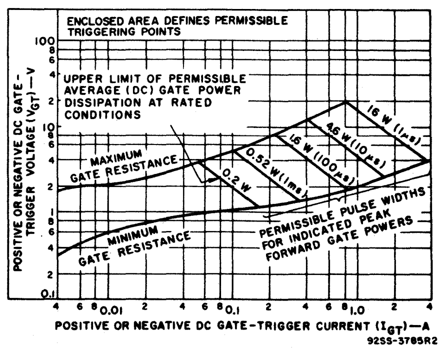


Fig. 11 — Gate pulse characteristics for all triggering modes for all series.

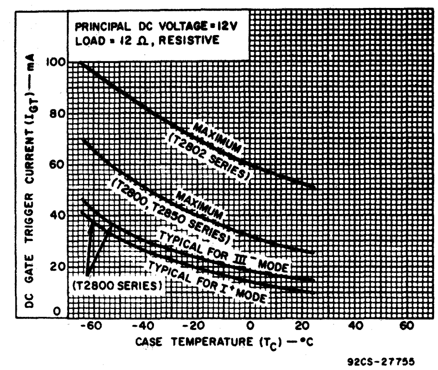


Fig. 12 — DC gate-trigger current (for 1^+ and III^- triggering modes) vs. case temperature for T2800, T2802,T2850 series.

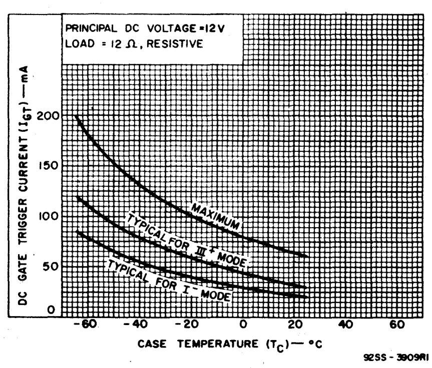


Fig. 13 — DC gate-trigger current (for 1^- and III^+ triggering modes) vs. case temperature for T2800, T2802, T2850 series.

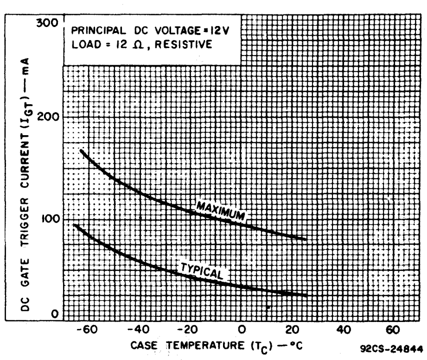


Fig. 14 — DC gate-trigger current (for 1^+ and III^- triggering modes) vs. case temperature for T2801 series.

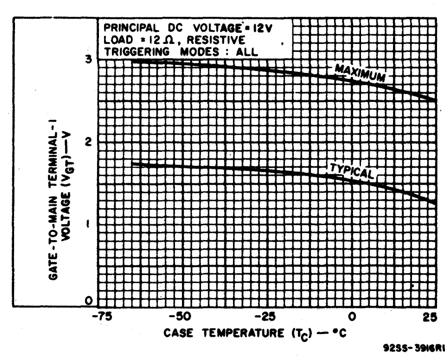


Fig. 15 — DC gate-trigger voltage vs. case temperature for T2800, T2802, T2850 series.

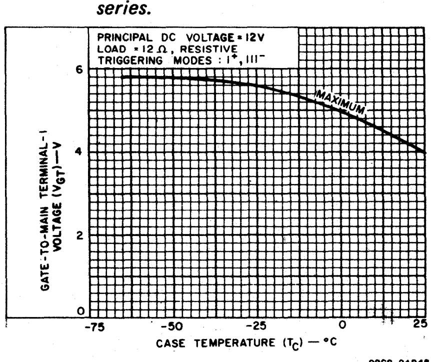


Fig. 16 — DC gate-trigger voltage vs. case temperature for T2801 series.

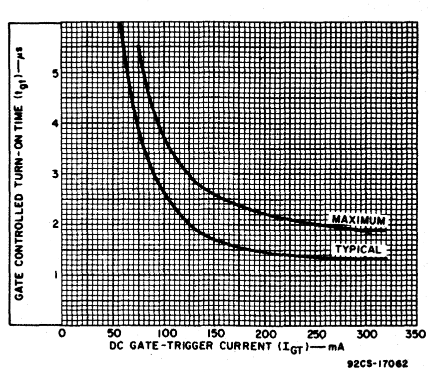


Fig. 17 — Turn-on time vs. gate-trigger current for T2800, T2802, T2850 series.

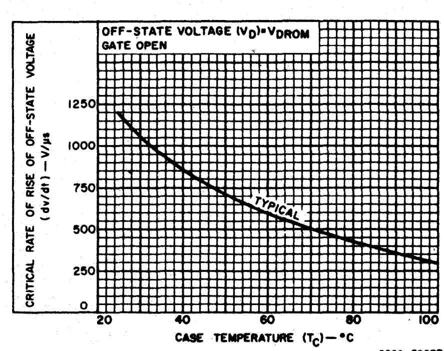


Fig. 18 — Typical critical rate-of-rise of off-state voltage vs. case temperature for all series.

T4100 (2N5567-2N5570, T4100M); T4101 (2N5571-2N5574, T4101M) Series

10-A and 15-A Silicon Triacs

For General Purpose AC Power Switching

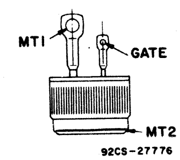
Features:
- di/dt Capability = 150 A/μs
- Shorted-Emitter, Center-Gate Design
- Low Switching Losses
- Low On-State Voltage at High Current Levels
- Low Thermal Resistance

These RCA triacs are gate-controlled, full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

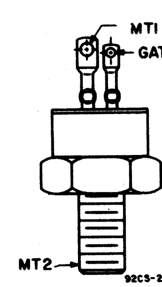
These triacs are intended for control of ac loads in applications such as heating controls, motor controls, arc-welding equipment, light dimmers, and power switching systems.

Types 2N5567, 2N5568, 2N5571, 2N5572, T4100M, and T4101M employ a press-fit package. Types 2N5569, 2N5570, 2N5573, 2N5574, T4110M, T4111M employ a stud package. Types T4120B, T4120D, T4120M, T4121B, T4121D, and T4121M employ an isolated-stud package.

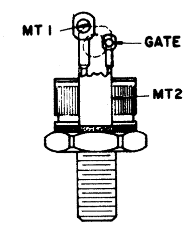
TERMINAL CONNECTIONS



Press-Fit Types



Stud Types



Isolated-Stud Types

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

		2N5567 2N5569 2N5571 2N5573 T4120B T4121B	2N5568 2N5570 2N5572 2N5574 T4120D T4121D	T4100M T4110M T4120M T4101M T4111M T4121M	
*REPETITIVE PEAK OFF-STATE VOLTAGE:●					
Gate open, T_J = −65 to 100°C	V_{DROM}	200	400	600	V
*RMS ON-STATE CURRENT (Conduction angle = 360°):					
Case temperature	$I_{T(RMS)}$				
T_C = 85°C (2N5567, 68, 69, 70, T4101M, T4111M, T4121B, D, M)			10		A
= 80°C (2N5571, 72, 73, 74, T4100M, T4110M Press-fit & stud types)			15		A
= 75°C (T4120B, D, M — Isolated-stud types)			15		A
For other conditions			See Fig. 3, 4		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}				
For one cycle of applied principal voltage, T_C as above					
• 60 Hz (sinusoidal)			100		A
50 Hz (sinusoidal)			85		A
For more than one cycle of applied principal voltage			See Fig. 5, 6		
RATE-OF-CHANGE OF ON-STATE CURRENT:					
$V_{DM} = V_{DROM}$, I_{GT} = 160 mA, t_r = 0.1 μs	di/dt		150		A/μs
FUSING CURRENT (for Triac Protection):					
At T_C shown for $I_{T(RMS)}$	I^2t				
t = 20 ms			55		A^2s
= 2.5 ms			28		A^2s
= 0.5 ms			16		A^2s
PEAK GATE-TRIGGER CURRENT:■					
For 1 μs max., See Fig. 11	I_{GTM}		4		A
*GATE POWER DISSIPATION:					
PEAK (For 1 μs max., $I_{GTM} \leq$ 4 A, See Fig. 11	P_{GM}		16		W
AVERAGE	$P_{G(AV)}$		0.5		W
*TEMPERATURE RANGE:▲					
Storage	T_{stg}		−65 to 150		°C
Operating (Case)	T_C		−65 to 100		°C
*TERMINAL TEMPERATURE (During soldering):					
For 10 s max. (terminals and case)	T_T		225		°C
STUD TORQUE:	τ_s				
Recommended			35		in-lb
Maximum (DO NOT EXCEED)			50		in-lb

* In accordance with JEDEC registration data format (JS-14, RDF 2) filed for the JEDEC (2N-Series) types.
● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see Dimensional Outline.

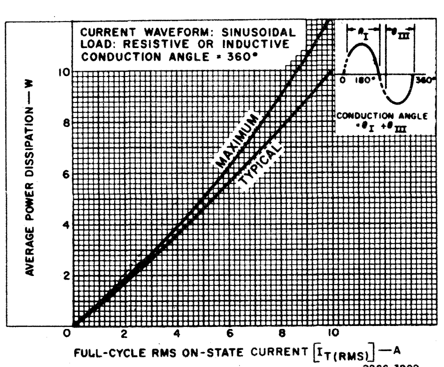


Fig. 1 — Power dissipation vs. on-state current for all 10-A triacs.

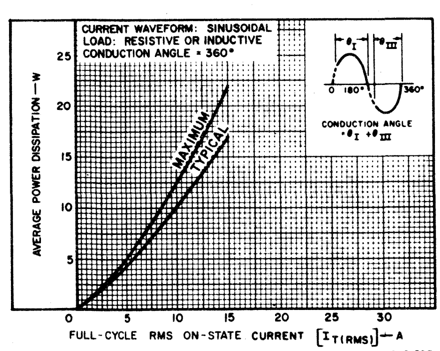


Fig. 2 — Power dissipation vs. on-state current for all 15-A triacs.

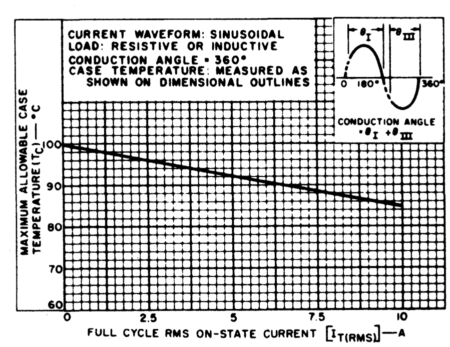


Fig. 3 — Maximum allowable case temperature vs. on-state current for all 10-A triacs.

T4100 (2N5567-2N5570, T4100M); T4101 (2N5571-2N5574, T4101M) Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Indicated*

CHARACTERISTICS	SYMBOL	LIMITS MIN.	TYP.	MAX.	UNITS
Peak Off-State Current:♠ Gate open, T_J = 100°C, V_{DROM} = Max. rated value	I_{DROM}	–	0.1	2*	mA
Maximum On-State Voltage:♠ For i_T = 14 A (peak), T_C = 25°C (2N5567, 68, 69, 70, T4101M, T4111M, T4121 series)	V_{TM}	–	1.35	1.65*	mA
= 21 A (peak), T_C = 25°C (2N5571, 72, 73, 74, T4100M, T4110M, T4120 series)		–	1.4	1.8*	
DC Holding Current:♠ Gate open, Initial principal current = 500 mA (DC), v_D = 12 V: 2N5567, 68, 69, 70, T4101M, T4111M, T4121 series: T_C = 25°C	I_{HO}	–	15	30	mA
T_C = −65°C		–	75	200*	
2N5571, 72, 73, 74, T4100M, T4110M, T4120 series: T_C = 25°C		–	20	75	
T_C = −65°C		–	75	300*	
For other case temperature		See Fig. 9 & 10			
Critical Rate-of-Rise of Commutation Voltage:♠ For v_D = V_{DROM}, $I_{T(RMS)}$ = 10 A, commutating di/dt = 5.4 A/ms, gate unenergized, T_C = 85°C 2N5567, 68, 69, 70, T4101M, T4111M, T4121 series	dv/dt	2*	5	–	V/μs
For v_D = V_{DROM}, $I_{T(RMS)}$ = 15 A, commutating di%dt = 8 A/ms, gate unenergized, T_C = 80°C (2N5571, 72, 73, 74, T4100M, T4110M – Press-fit & stud types)		2*	10	–	
= 75°C (T4120B, D, M – Isolated-stud)		2	10	–	
Critical Rate-of-Rise of Off-State Voltage:♠ For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C: 2N5567, 2N5569, T4121, 2N5571, 2N5573, T4120B	dv/dt	30*	150	–	V/μs
2N5568, 2N5570, T4121D, 2N5572, 2N5574, T4120D		20*	100	–	
T4101M, T4111M, T4121M, T4100M, T4110M, T4120M		10	75	–	
DC Gate-Trigger Current:♠♦ For v_D = 12 V (DC), R_L = 30Ω, T_C = 25°C; Mode V_{MT2} V_G; I+ positive positive: All 10-A triacs	I_{GT}	–	10	25	mA
All 15-A triacs		–	20	50	
III− negative negative: All 10-A triacs		-	10	25	
All 15-A triacs		–	20	50	
I− positive negative: All 10-A triacs		–	20	40	
All 15-A triacs		–	35	80	
III+ negative positive: All 10-A triacs		–	20	40	
All 15-A triacs		–	35	80	
For v_D = 12 V (DC), R_L = 30Ω, T_C = −65°C; Mode V_{MT2} V_G; I+ positive positive: All 10-A triacs		–	45	100*	
All 15-A triacs		–	75	150*	
III− negative negative: All 10-A triacs		–	45	100*	
All 15-A triacs		–	75	150*	
I− positive negative: All 10-A triacs		–	80	150*	
All 15-A triacs		–	100	200*	
III+ negative positive: All 10-A triacs		–	80	150*	
All 15-A triacs		–	100	200*	
For other case temperatures		See Fig. 12, 13, 14, & 15			
DC Gate-Trigger Voltage:♠♦ For v_D = 12 V(DC), R_L = 30Ω: T_C = 25°C	V_{GT}	–	1	2.5	V
T_C = −65°C		–	2	4*	
For other case temperatures		See Fig. 16 & 17			
For v_D = V_{DROM}, R_L = 125Ω, T_C = 100°C		0.2	–	–	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For v_D = V_{DROM}, I_{GT} = 160 mA, t_r = 0.1 μs, i_T = 15 A (peak) All 10-A triacs, i_T = 25 A (peak) All 15-A triacs, T_C = 25°C	t_{gt}	–	1.6	2.5	μs
Thermal Resistance: Junction-to-Case: Steady-State	θ_{J-C}	–	–	1*	°C/W
Transient		See Fig. 20			
Junction-to-Isolated Hex (Stud, see Dim. Outline): Steady-State	θ_{J-IH}	–	–	1.1	

* In accordance with JEDEC registration data format (JS-14, RDF 2) filed for the JEDEC (2N-Series) types.
♠ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
♦ For either polarity of gate voltage (V_G) with reference to main terminal 1.

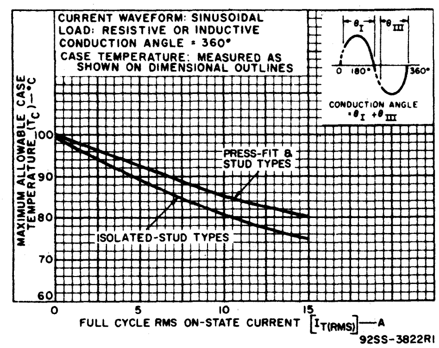


Fig. 4 — Maximum allowable case temperature vs. on-state current for all 15-A triacs.

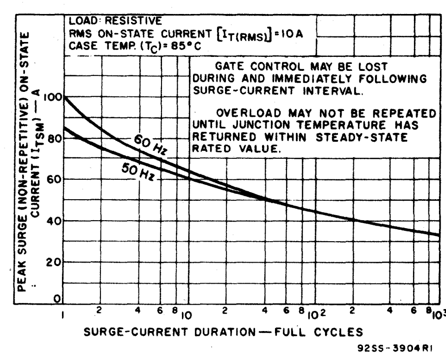


Fig. 5 — Peak surge on-state current vs. surge current duration for all 10-A triacs.

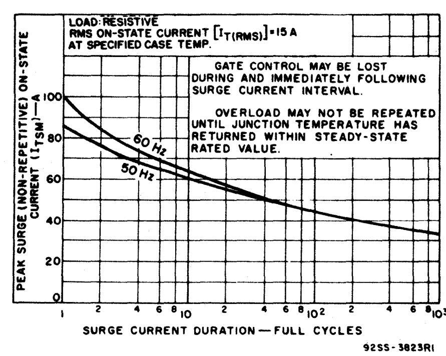


Fig. 6 — Peak surge on-state current vs. surge current duration for all 15-A triacs.

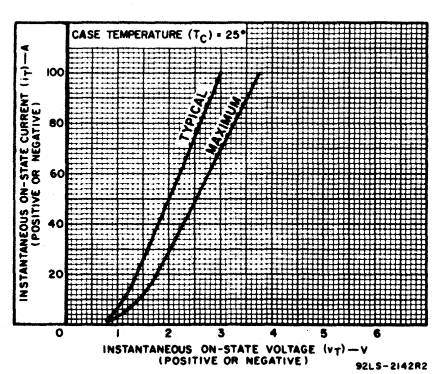


Fig. 7 — On-state current vs. on-state voltage for all 10-A triacs.

T4100 (2N5567-2N5570 , T4100M);
T4101 (2N5571-2N5574 , T4101M) Series

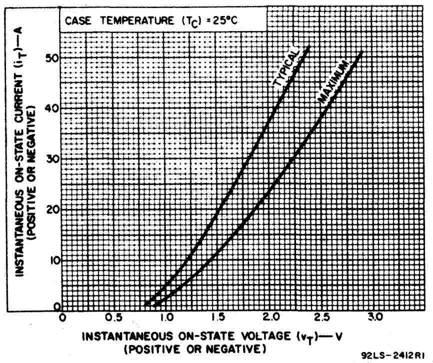


Fig. 8 – On-state current vs. on-state voltage for all 15-A triacs.

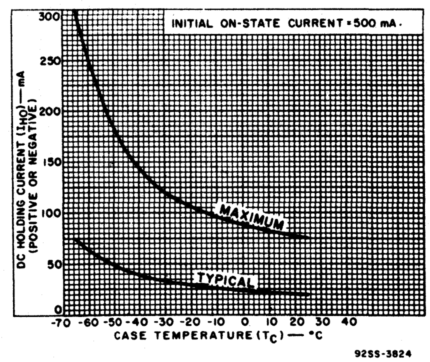


Fig. 9 – DC holding current vs. case temperature for all 10-A triacs.

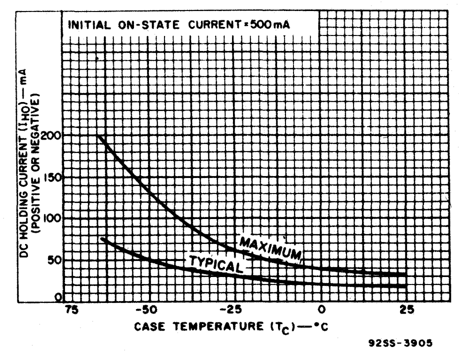


Fig. 10 – DC holding current vs. case temperature for all 15-A triacs.

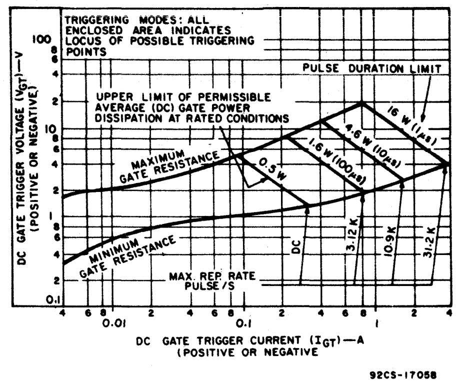


Fig. 11 – Gate trigger characteristics and limiting conditions for determination of permissible gate trigger pulses for all triacs.

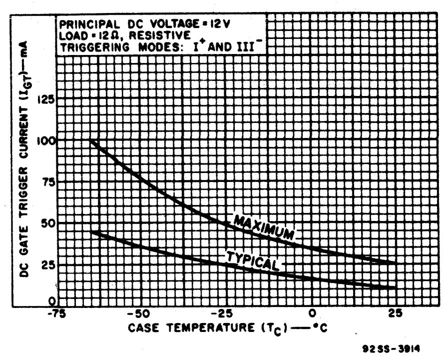


Fig. 12 – DC gate-trigger current vs. case temperature (I+ & III− modes) for all 10-A triacs.

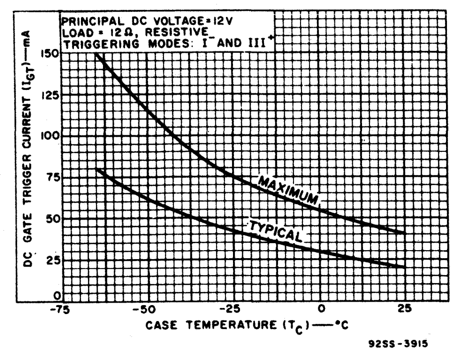


Fig. 13 – DC gate-trigger current vs. case temperature (I− & III+ modes) for all 10-A triacs.

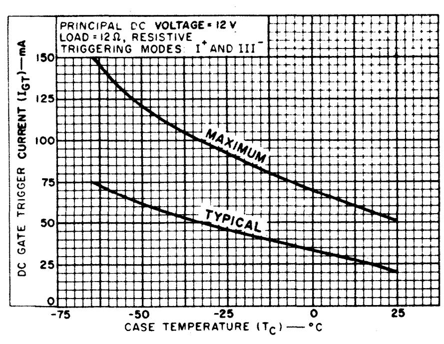


Fig. 14 – DC gate-trigger current vs. case temperature (I+ & III− modes) for all 15-A triacs.

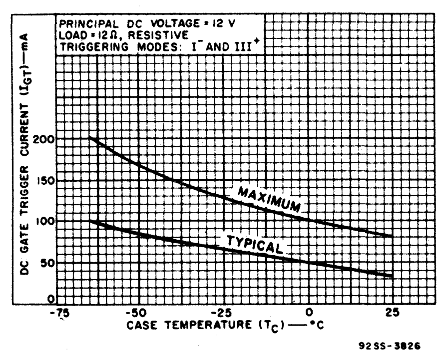


Fig. 15 – DC gate-trigger current vs. case temperature (I− & III+ modes) for all 15-A triacs.

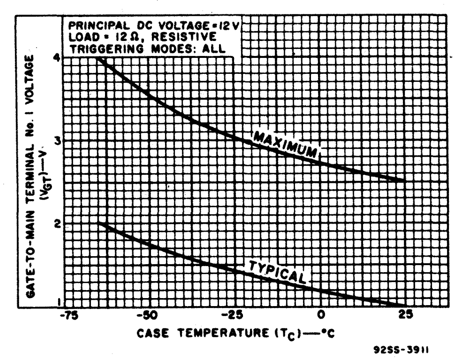


Fig. 16 – DC gate-trigger voltage vs. case temperature for all 10-A triacs.

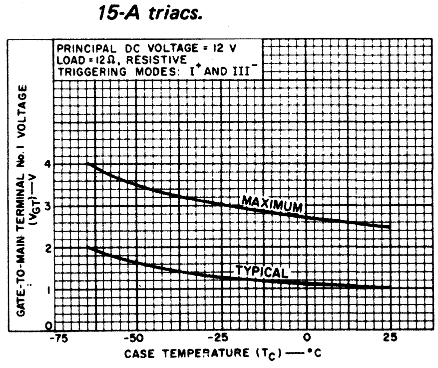


Fig. 17 – DC gate-trigger voltage vs. case temperature for all 15-A triacs.

T4100 (2N5567-2N5570 , T4100M); T4101 (2N5571-2N5574 , T4101M) Series

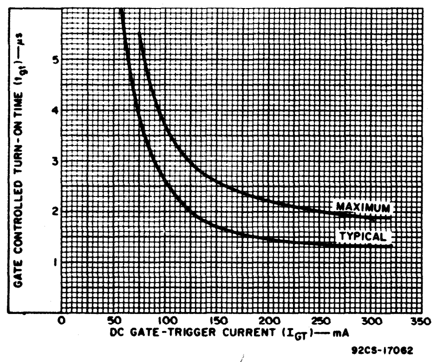


Fig. 18 — Turn-on time vs. gate trigger current for all types.

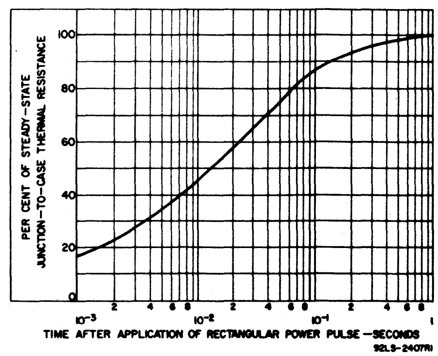


Fig. 19 — Transient junction-to-case thermal resistance vs. time for all triacs.

WARNING:
The RCA isolated-stud package thyristors should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient. Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

T4103-T4105, T4113-T4115 Series

400-Hz, 6,10, & 15-A Silicon Triacs

For Control-Systems Application in Airborne and Ground-Support Type Equipment

Features:

- di/dt capability = 150 A/μs
- Shorted-emitter center-gate design
- Commutating dv/dt capability characterized at 400 Hz

These RCA triacs are gate-controlled full-wave silicon ac switches.

The devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

They are intended for operation up to 400 Hz with resistive or inductive loads and nominal line voltages of 115 and 208 V RMS sine wave and repetitive peak off-state voltages of 200 V and 400 V.

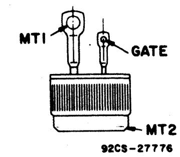
These triacs exhibit commutating voltage (dv/dt) capability at high commutating current (di/dt). They can also be used in 60-Hz applications where high commutating capability is required.

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 400 Hz and with Resistive or Inductive Load.

		T4103B T4113B T4104B T4114B T4105B T4115B	T4103D T4113D T4104D T4114D T4105D T4115D	
REPETITIVE PEAK OFF-STATE VOLTAGE:*	V_{DROM}			
Gate open, T_J = −50 to 100°C		200	400	V
RMS ON-STATE CURRENT (Conduction angle = 360°):	$I_{T(RMS)}$			
Case temperature				
T_C = 90°C (T4105B, T4105D, T4115B, T4115D)		6		A
= 85°C (T4104B, T4104D, T4114B, T4114D)		10		A
= 80°C (T4103B, T4103D, T4113B, T4113D)		15		A
For other conditions		*See Fig.* 2		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}			
For one cycle of applied principal voltage, T_C as above				
400 Hz (sinusoidal)		200		A
60 Hz (sinusoidal)		100		A
50 Hz (sinusoidal)		85		A
For more than one cycle of applied principal voltage		See Fig. 3		
RATE-OF-CHANGE OF ON-STATE CURRENT:	di/dt			
V_{DM} = V_{DROM}, I_{GT} = 160 mA, t_r = 0.1 μs		150		A/μs
FUSING CURRENT (for triac protection):				
T_J = −50 to 100°C, t = 1.25 to 10 ms	I^2t	30		A^2s
PEAK GATE-TRIGGER CURRENT:▪	I_{GTM}			
For 1 μs max., *(See Fig. 7)*		4		A
GATE POWER DISSIPATION:				
PEAK (For 1 μs max., I_{GTM} ≤ 4 A. See Fig. 6)	P_{GM}	16		W
AVERAGE	$P_{G(AV)}$	0.2		W
TEMPERATURE RANGE:▲				
Storage	T_{stg}	-50 to 150		°C
Operating (Case)	T_C	-50 to 100		°C
TERMINAL TEMPERATURE (During soldering):				
For 10 s max. (terminals and case)	T_T	225		°C
STUD TORQUE: τ_s				
Recommended		35		in-lb
Maximum (DO NOT EXCEED)		50		in-lb

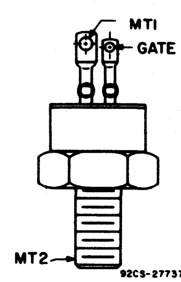
* For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
▪ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see Dimensional Outline.

TERMINAL CONNECTIONS



T4103 Series
T4104 Series
T4105 Series

Press-fit



T4113 Series
T4114 Series
T4115 Series

Stud

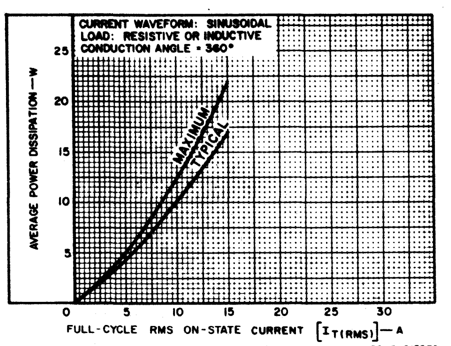


Fig. 1—Power dissipation vs. on-state current.

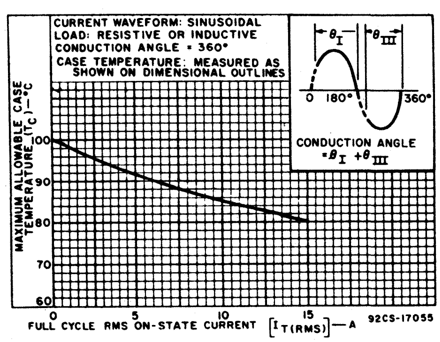


Fig. 2—Maximum allowable case temperature vs. on-state current.

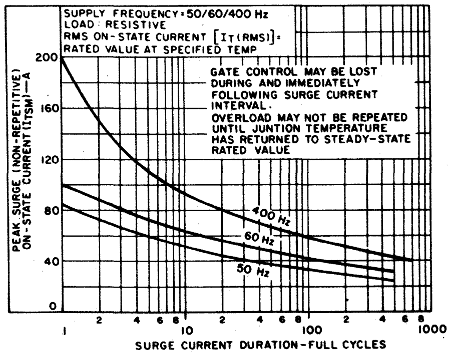


Fig. 3—Peak surge on-state current vs. surge-current duration.

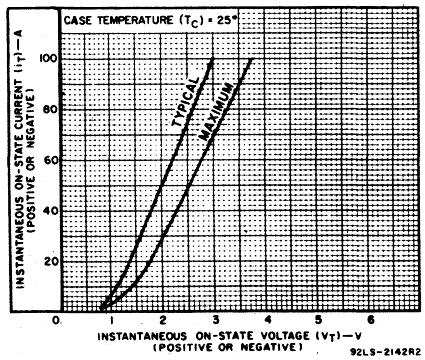


Fig. 4—On-state current vs. on-state voltage.

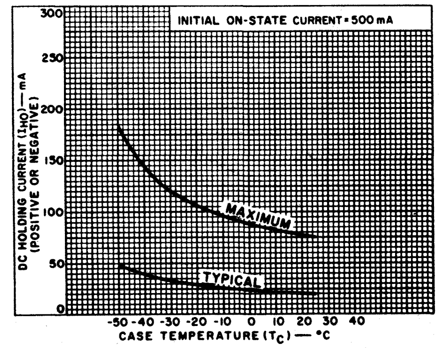


Fig. 5—DC holding current vs. case temperature.

T4103-T4105, T4113-T4115 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS ALL TYPES Min.	Typ.	Max.	UNITS
Peak Off-State Current:♠ Gate open, T_J = 100°C, V_{DROM} = Max. rated value	I_{DROM}	-	0.1	2	mA
Maximum On-State Voltage:♠ For i_T = 21 A (peak), T_C = 25 °C.	V_{TM}	–	1.4	1.8	V
DC Holding Current:♠ Gate open, Initial principal current = 500 mA (DC), v_D = 12 V, T_C = 25° C.	I_{HO}	–	20	75	mA
For other case temperatures			See Fig. 5		
Critical Rate-of-Rise of Commutation Voltage:♠ For v_D = V_{DROM}, $I_{T(RMS)}$ = rated value, gate unenergized	dv/dt				V/μs
Commutating di/dt = 21.4 A/ms, T_C = 90° C T4105B, T4105D, T4115B, T4115D		5	10	–	
Commutating di/dt = 36 A/ms, T_C = 85° C T4104B, T4104D, T4114B, T4114D		5	10	–	
Commutating di/dt = 53.3 A/ms, T_C = 80° C T4103B, T4103D, T4113B, T4113D		5	10	–	
Critical Rate-of-Rise of Off-State Voltage:♠ For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100° C.	dv/dt	30	150	–	V/μs
DC Gate-Trigger Current:♠† For v_D = 12 V (DC), R_L = 30 Ω, and T_C = 25 °C — Mode I^+: V_{MT2} positive, V_G positive	I_{GT}	–	20	50	mA
Mode III^-: V_{MT2} negative, V_G negative		–	20	50	
Mode I^-: V_{MT2} positive, V_G negative		–	35	80	
Mode III^+: V_{MT2} negative, V_G positive		–	35	80	
For other case temperatures.			See Figs. 7 & 8		
DC Gate-Trigger Voltage:♠† For v_D = 12 V(DC), R_L = 30Ω, T_C = 25°C.	V_{GT}	–	1	2.5	V
For other case temperatures.			See Fig. 9		
For v_D = V_{DROM}, R_L = 125Ω, T_C = 100°C		0.2	–	–	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For v_D = V_{DROM}, I_{GT} = 160mA, t_r = 0.1 μs, i_T = 25A (peak), T_C = 25°C	t_{gt}	–	1.6	2.5	μs
Thermal Resistance Steady-State (Junction-to-Case)	θ_{J-C}	–	–	1	°C/W
Transient (Junction-to-Case).			See Fig. 11		
Steady-State (Junction-to-Ambient).	θ_{J-A}	–	–	33	°C/W

♠ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

† For either polarity of gate voltage (V_G) with reference to main terminal 1.

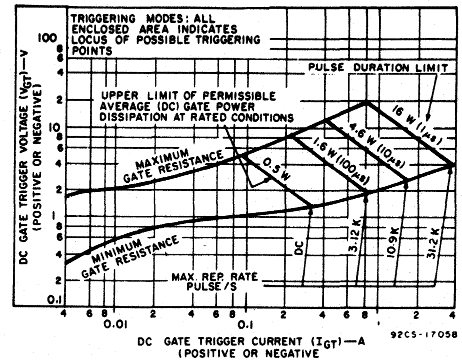


Fig. 6—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

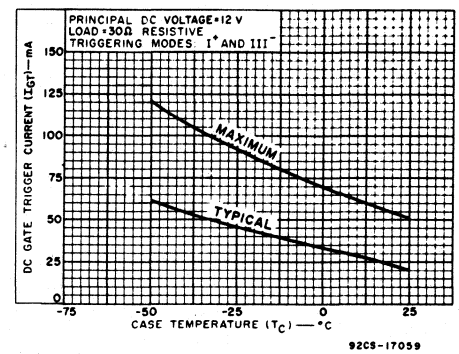


Fig. 7—DC gate-trigger current vs. case temperature. (I^+ and III^- modes).

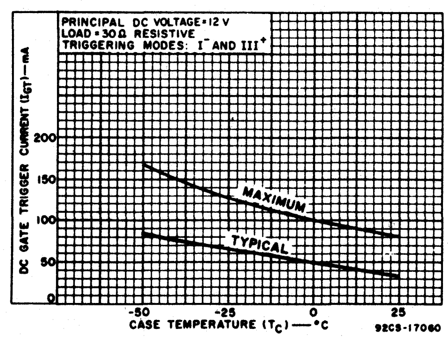


Fig. 8—DC gate-trigger current vs. case temperature. (I^- and III^+ modes).

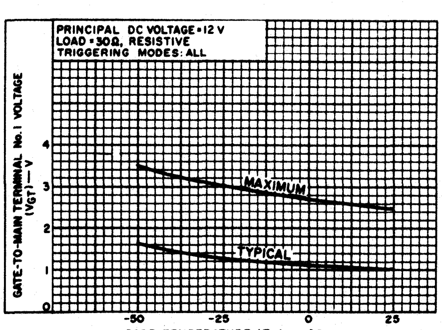


Fig. 9—DC gate-trigger voltage vs. case temperature.

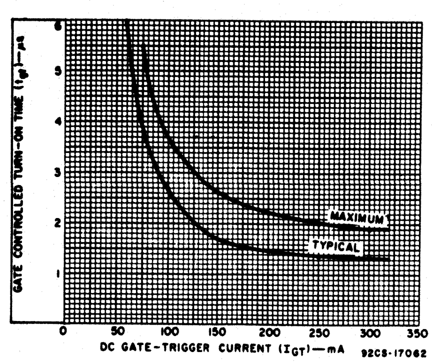


Fig. 10—Turn-on time vs. gate-trigger current.

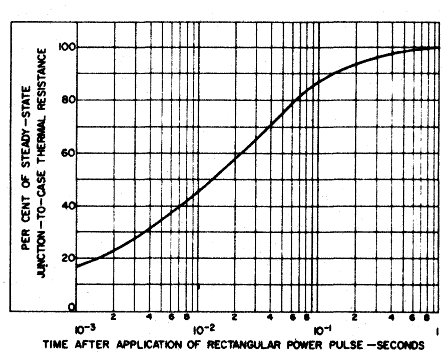


Fig. 11—Transient thermal resistance vs. time (junction-to-case).

T4130, T4131, T4140, T4141, T4150, T4151, T6430, T6431, T6440, T6441, T6450, T6451 Series

10-, 15-, 30-, and 40-A Silicon Triacs

For Phase-Control and Load-Switching Applications

Features:

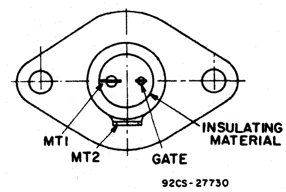
- 3-kV rms encapsulant (HYPOT) breakdown voltage
- Flame-resistant encapsulant (self-extinguishing)
- Rugged packages
- Standard RCA triac features

These RCA triacs are gate-controlled, full wave ac switches. They are designed to switch from an off-state to an on state for either polarity of applied voltage with positive or negative gate triggering voltages.

The T4130, T4140, and T4150 series have current ratings of 15 amperes. The T4131, T4141, and T4151 series have current ratings of 10 amperes. The T6430, T6440, and T6450 series have current ratings of 40 amperes. The T6431, T6441, and T6451 series have current ratings of 30 amperes. Triacs in each series have voltage ratings of 200, 400, and 600 volts. In addition, the 40-A T6430, T6440, and T6450 series also include 800-volt types.

The T4130, T4131, T6430, and T6431 series employ a press-fit package with flexible leads, encapsulated on an isolated stud.

TERMINAL CONNECTIONS



Press-Fit, Isolated on TO-3 Flange

T4140 T6440
T4141 T6441

10-A Triacs — T4131, T4141, and T4151 Series — Electrical and Mechanical Data

Type No.	Rep. Peak Off-State Voltage V_{DROM} (V)	On-State Current I_T (RMS) (A)	T_C (°C)	Package (Press-fit)	Wire Size MT 1&2 Gage No.	Wire Size Gate Gage No.	Wire Insulation Thickness MT 1&2 in. (mm)	Wire Insulation Thickness Gate in. (mm)	Refer to Bulletin File No.*
T4131B T4131D T4131M	200 400 600	10	85	With flex.leads, encap.on isolated-stud	14	22	0.031 (0.787)	0.016 (0.406)	457
T4141B T4141D T4141M	200 400 600	10	85	Isolated on TO-3 flange	–	–	–	–	457
T4151B T4151D T4151M	200 400 600	10	85	With flex.leads, encap.,isolated on TO-3 flange	14	22	0.031 (0.787)	0.016 (0.406)	457
15-A Triacs — T4130, T4140, and T4150 Series — Electrical and Mechanical Data									
T4130B T4130D T4130M	200 400 600	15	75	With flex.leads, encap.on isolated-stud	14	22	0.031 (0.787)	0.016 (0.406)	458
T4140B T4140D T4140M	200 400 600	15	75	Isolated on TO-3 flange	–	–	–	–	458
T4150B T4150D T4150M	200 400 600	15	75	With flex.leads, encap.,isolated on TO-3 flange	14	22	0.031 (0.787)	0.016 (0.406)	458
30-A Triacs — T6431, T6441, and T6451 Series — Electrical and Mechanical Data									
T6431B T6431D T6431M	200 400 600	30	55	With flex.leads, encap.on isolated-stud	12	22	0.034 (0.863)	0.016 (0.406)	459
T6441B T6441D T6441M	200 400 600	30	55	Isolated on TO-3 flange	–	–	–	–	459
T6451B T6451D T6451M	200 400 600	30	55	With flex.leads, encap.,isolated on TO-3 flange	12	22	0.034 (0.863)	0.016 (0.406)	459
40-A Triacs — T6430, T6440, and T6450 Series — Electrical and Mechanical Data									
T6430B T6430D T6430M T6430N	200 400 600 800	40	60	With flex.leads, encap. on isolated-stud	12	22	0.034 (0.863)	0.016 (0.406)	593
T6440B T6440D T6440M T6440N	200 400 600 800	40	60	Isolated on TO-3 flange	–	–	–	–	593
T6450B T6450D T6450M T6450N	200 400 600 800	40	60	With flex.leads, encap.,isolated on TO-3 flange	12	22	0.034 (0.863)	0.016 (0.406)	593

* Electrical characteristics and ratings given in these bulletins also apply to the types listed in this chart.

FLEXIBLE-LEAD (TERMINAL) CONNECTIONS

Flexible-Lead (Insulation) Color	Terminal
Yellow	Gate
Red	Main Terminal No. 1
Black	Main Terminal No. 2

Note: Terminals are identified by color code only. Position of the flexible leads (relative to terminals of the device) leaving the encapsulant is random.

Press-Fit, Encapsulated on Isolated-Stud with Flexible Leads

T4130 T6430
T4131 T6431

Press-Fit, Encapsulated, Isolated on TO-3 Flange with Flexible Leads

T4150 T6450
T4151 T6451

WARNING: The ceramic used in these packages contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

The T4140, T4141, T6440, and T6441 series employ a press-fit package, isolated on a TO-3 flange. The T4150, T4151, T6450, and T6451 series employ a press-fit package with flexible leads encapsulated on an isolated TO-3 flange.

T4700 Series

15-Ampere Silicon Triacs

For Low-Power Phase-Control and Load-Switching Applications

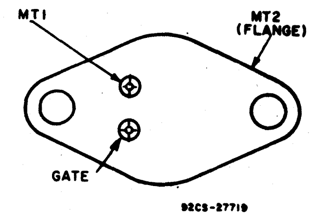
Features:
- di/dt Capability = 150 A/μs
- Shorted-Emitter, Center-Gate Design
- Low Switching Losses
- Low On-State Voltage at High Current Levels
- Low Thermal Resistance

RCA T4700B and T4700D* are gate-controlled full-wave ac silicon switches. They are designed to switch from an off-state to a conducting state for either polarity of applied voltage with positive or negative gate triggering.

These devices are intended for the control of ac loads in applications such as space heater, oven and furnace controls, motor controls, and lamp loads.

*Formerly Dev. Types TA2834 and TA2835, respectively.

TERMINAL CONNECTIONS



BOTTOM VIEW

JEDEC TO-66

MAXIMUM RATINGS, *Absolute-Maximum Values:*

For Operation with 50/60-Hz, Sinusoidal Supply Voltage and Resistive or Inductive Load

		T4700B	T4700D	
REPETITIVE PEAK OFF-STATE VOLTAGE:■				
Gate Open	V_{DROM}	200	400	V
RMS ON-STATE CURRENT:				
T_C = 70°C, conduction angle = 360°	$I_{T(RMS)}$	15		A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}			
For one full cycle of applied principal voltage 60 Hz (sinusoidal), T_C = 70°C		100		A
For one full cycle of applied principal voltage (50-Hz, sinusoidal), T_C = 70°C		85		A
For more than one full cycle of applied voltage		See Fig. 3		
PEAK GATE-TRIGGER CURRENT:				
For 1 μs max.	I_{GTM}	4		A
RATE OF CHANGE OF ON-STATE CURRENT:				
$V_D = V_{DROM}$, I_{GT} = 200 mA, tr = 0.1 μs	di/dt	150		A/μs
FUSING CURRENT (for triac protection):				
T_J = −40 to 100°C, t = 1.25 to 10 ms	I^2t	50		A^2s
GATE POWER DISSIPATION:				
Peak● (for 1 μs max. and I_{GTM} = ≤ 4 A)	P_{GM}	16		W
Average (averaging time = 10 ms max.)	$P_{G(AV)}$	0.45		W
TEMPERATURE RANGE:▲				
Storage	T_{stg}	−40 to 150		°C
Operating (Case)	T_C	−40 to 100		°C
PIN TEMPERATURE (During soldering):				
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	225		°C

■ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
● For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, *see Dimensional Outline.*

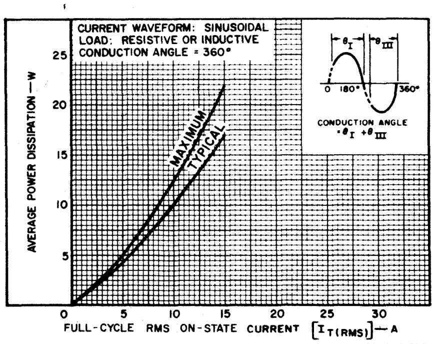


Fig. 1—Power dissipation curve.

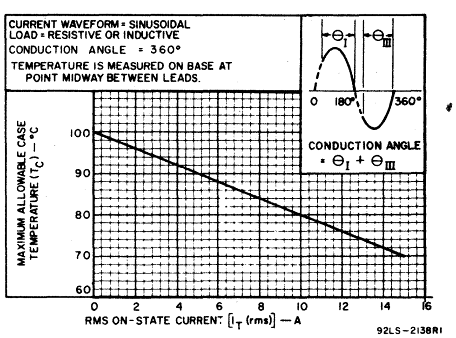


Fig. 2—Conduction rating chart (case temperature).

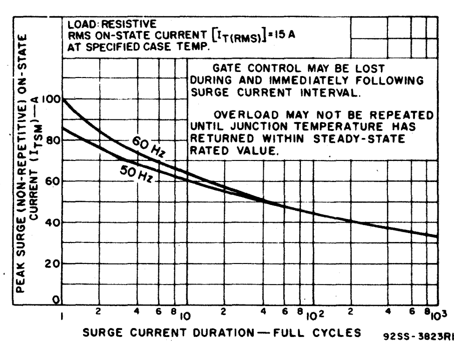


Fig. 3—Surge current rating chart.

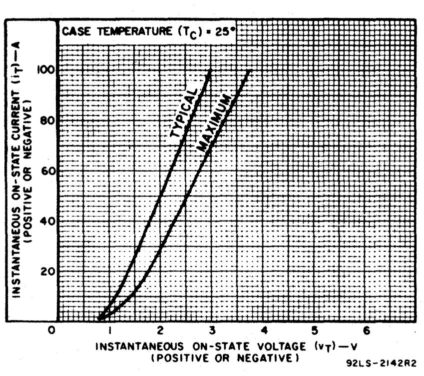


Fig. 4—On-state characteristics for either direction of principal current.

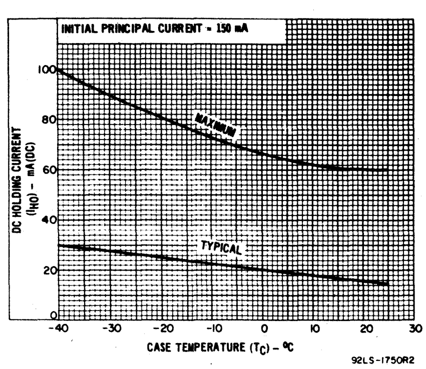


Fig. 5—DC holding current characteristics for either direction of principal current.

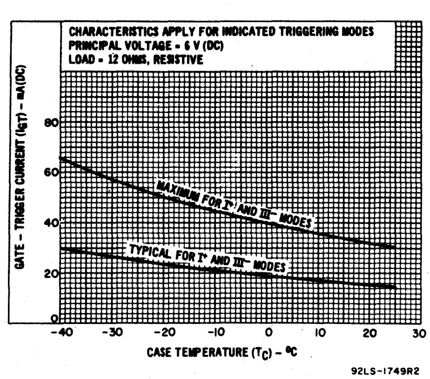


Fig. 6—DC gate-trigger current characteristics for I^+ and III^- modes.

T4700 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTICS	TRIAC TYPES						UNITS
	T4700B			T4700D			
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Off-State Current♣, I_{DROM}							
Gate open							
At T_j = +100° C and V_{DROM} = Max. rated value	–	0.2	4	–	0.2	4	mA
Instantaneous On-State Voltage♣, v_T							
For i_T = 30 A (peak) and T_C = +25° C.	–	1.6	2.0	–	1.6	2.0	V(peak)
DC Holding Current♣, I_{HO}:							
Gate Open							
Initial principal current = 150 mA (dc)							
At T_C = +25° C.	–	15	60	–	15	60	mA(dc)
For other case temperatures.		See Fig. 5			See Fig.5		
Critical Rate of Applied Commutating Voltage♣,							
Commutating dv/dt:							
For v_D = V_{DROM}, $I_{T(RMS)}$ = 15 A, commutating di/dt = 8 A/ms, and gate unenergized							
At T_C = +70° C.	2	10	–	2	10	–	V/μs
Critical Rate of Rise of Off-State Voltage♣,							
Critical dv/dt:							
For v_D = V_{DROM}, exponential voltage rise, gate open							
At T_C = +100° C.	30	150	–	20	100	–	V/μs
DC Gate-Trigger Current♣ ■, I_{GT}							
For v_D = 6 volts (dc), R_L = 12 ohms, T_C = +25° C, and Specified Triggering Mode:							
I+ Mode: V_{T2} is positive, V_G is positive. . .	–	15	30	–	15	30	mA(dc)
I- Mode: V_{T2} is positive, V_G is negative. . .	–	35	80	–	35	80	mA(dc)
III+ Mode: V_{T2} is negative, V_G is positive. . .	–	35	80	–	35	80	mA(dc)
III- Mode: V_{T2} is negative, V_G is negative. . .	–	15	30	–	15	30	mA(dc)
For other case temperatures.		See Figs. 6 & 7			See Figs. 6 & 7		
DC Gate-Trigger Voltage♣ ■, V_{GT}:							
For v_D = 6 volts (dc) and R_L = 12 ohms							
At T_C = +25° C.	–	1	2.5	–	1	2.5	V(dc)
For other case temperatures.		See Fig. 8			See Fig. 8		
For v_D = V_{DROM} and R_L = 125 ohms							
At T_C = +100° C.	0.2	–	–	0.2	–	–	V(dc)
Gate-Controlled Turn-On Time, t_{gt}							
(Delay Time + Rise Time)							
For v_D = V_{DROM}, I_{GT} = 160 mA, 0.1 μs rise time, and i_T = 25 A (peak)							
At T_C = +25° C.	–	1.6	2.5	–	1.6	2.5	μs
Thermal Resistance, Junction to case,							
$R_{\theta JC}$	–	–	1.3	–	–	1.3	°C/W

♣For either polarity of main terminal 2 voltage (V_{T2}) with reference to main terminal 1.

■For either polarity of gate voltage (V_G) with reference to main terminal 1.

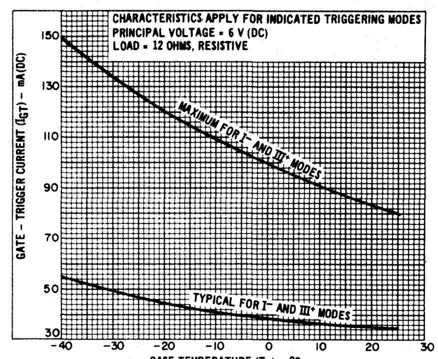


Fig. 7—DC gate-trigger current characteristics for I^- and III^+ modes.

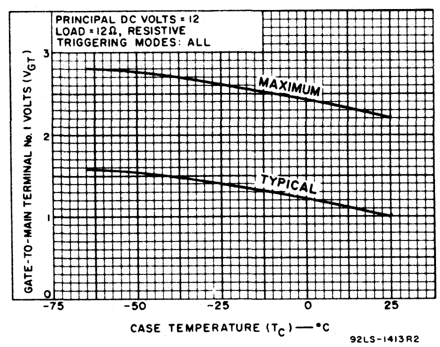


Fig. 8—DC gate-trigger voltage characteristics.

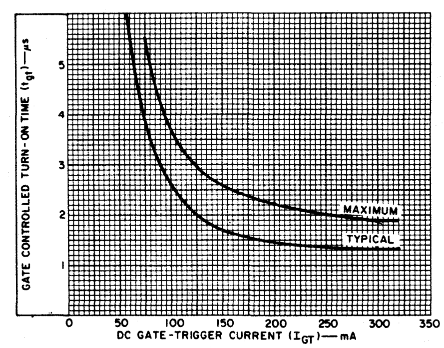


Fig. 9—Turn-on time vs. gate-trigger current.

T6400, T6401, T6410, T6411, T6415, T6420, T6421 Series (Includes 2N5441-2N5446, 2N5806-2N5809)

25-A, 30-A, and 40-A Silicon Triacs

For General Purpose AC Power Switching Application
All 30-A and 40-A Triacs

For Control-Systems Application in Airborne and Ground Support Type Equipment
25-A, 400-Hz Triacs (2N5806-2N5809)

Features:

- di/dt Capability = 100 A/μs
- Shorted-Emitter, Center-Gate Design
- Low Switching Losses
- Low On-State Voltage at High Current Levels
- Low Thermal Resistance

Additional Features for the 2N5806-2N5809:

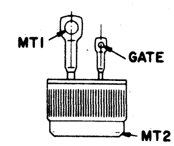
- Available in JAN or JANTX Screening
- Commutating dv/dt capability Characterized at 400 Hz

These RCA triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

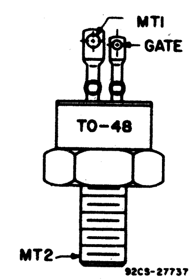
These triacs are intended for control of ac loads in applications such as heating controls, motor controls, arc-welding equipment, light dimmers, and power switching systems. They can also be used in air-conditioning and photocopying equipment.

Types 2N5441-43 T6400N, and T6401 series employ a press-fit package. Types 2N5444-46, 2N5806-09, T6410N, and T6411 series employ a stud package. T6420 series and T6421 series employ an isolated-stud package.

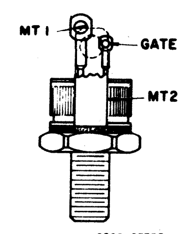
TERMINAL CONNECTIONS



Press-Fit Types



Stud Types



Isolated-Stud Types

MAXIMUM RATINGS, *Absolute-Maximum Values: For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/400 Hz and with Resistive or Inductive Load.*

40-A		2N5441	2N5442	–	2N5443	T6400N	
		2N5444	2N5445	–	2N5446	T6410N	
		T6420B	T6420D	–	T6420M	T6420N	
30-A		T6401B	T6401D	–	T6401M	–	
		T6411B	T6411D	–	T6411M	–	
		T6421B	T6421D	–	T6421M	–	
25-A		2N5806	2N5807	2N5808	2N5809	–	
•REPETITIVE PEAK OFF-STATE VOLTAGE:●	V_{DROM}						
Gate open, T_J = –65 to 110°C		200	400	500	600	800	V
RMS ON-STATE CURRENT (Conduction angle = 360°):	$I_{T(RMS)}$						
Case temperature							
• T_C = 70°C (2N5441-43, T6400N—Press-fit types)				40			A
= 65°C (2N5444-46, T6410N—Stud types)				40			A
= 60°C (T6420 series – Isolated-stud types)				40			A
= 65°C (T6401 series – Press-fit types)				30			A
= 60°C (T6411 series – Stud types)				30			A
= 55°C (T6421 series – Isolated-stud types)				30			A
= 80°C (2N5806-2N5809 – Stud types)				25			A
For other conditions				See Figs. 4, 5, 6			
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}						
For one cycle of applied principal voltage, T_C as above							
• 60 Hz (sinusoidal - 30-A & 40-A types)				300			A
50 Hz (sinusoidal - 30-A & 40-A types)				265			A
400 Hz (sinusoidal - 25-A types)				370			A
• 60 Hz (sinusoidal - 25-A types)				200			A
50 Hz (sinusoidal - 25-A types)				170			A
For more than once cycle of applied principal voltage				See Figs. 7, 8, 9			
RATE OF CHANGE OF ON-STATE CURRENT:	di/dt						
$V_{DM} = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs				100			A/μs
FUSING CURRENT (For Triac Protection):	I^2t						
[At T_C shown for $I_{T(RMS)}$]:							
t = 20 ms (30-A & 40-A types)				500			A^2s
= 2.5 ms (30-A & 40-A types)				250			A^2s
= 0.5 ms (30-A & 40-A types)				145			A^2s
= 20 ms (25-A types)				240			A^2s
= 2.5 ms (25-A types)				110			A^2s
=0.5 ms (25-A types)				65			A^2s
•PEAK GATE-TRIGGER CURRENT:■	I_{GTM}						
For 1 μs max., See Fig. 15 (30-A and 40-A types only)				12			A
•GATE POWER DISSIPATION:							
PEAK (For 10 μs max., $I_{GTM} \leq$ 4 A, –30-A & 40-A types)	P_{GM}			40			W
–25-A types)	P_{GM}			10			W
AVERAGE (30-A & 40-A types)	$P_{G(AV)}$			0.75			W
(25-A types, t = 16.6 ms)	$P_{G(AV)}$			0.5			W
•TEMPERATURE RANGE:▲							
Storage (30-A & 40-A types)	T_{stg}			–65 to 150			°C
(25-A types)	T_{stg}			–55 to 125			°C
Operating (Case) – 40-A types	T_C			–65 to 110			°C
– 30-A types	T_C			–65 to 100			°C
– 25-A types	T_C			–40 to 115			°C
•TERMINAL TEMPERATURE:	T_T						
During soldering for 10 s max. (terminals and case)							
30-A & 40-A types				225			°C
25-A types				260			°C
STUD TORQUE:	τ_s						
Recommended				35			in-lb
				0.4			kgf-m
Maximum (DO NOT EXCEED)				50			in-lb
				0.57			kgf-m

• In accordance with JEDEC registration data format (JS-14, RDF 2) filed for the JEDEC (2N-Series) types.
● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see Dimensional Outline.

T6400, T6401, T6410, T6411, T6415, T6420, T6421 Series (Includes 2N5441-2N5446,2N5806-2N5809)

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTICS	SYMBOL	LIMITS MIN.	TYP.	MAX.	UNITS
Peak Off-State Current:♣					
Gate open, V_{DROM} = Max. rated value					
T_J = 110°C, (40-A types)	I_{DROM}	–	0.2	4*	mA
= 100°C, (30-A types)		–	0.2	4	
= 115°C, (25-A types)		–	0.2	2*	
Maximum On-State Voltage:♣					
For i_T = 100 A (peak), T_C = 25°C, (40-A types)	V_{TM}	–	1.7	2	V
For i_T = 56 A (peak), T_C = 25°C, (40-A types)		–	1.5	1.85*	
For i_T = 100 A (peak), T_C = 25°C, (30-A types)		–	2.1	2.5	
= 35 A (peak), pulse width ≤ 1 ms, duty cycle ≤ 2%, I_G = 150 mA, T_C = 25°C (25-A types)		–	1.3	1.6*	
DC Holding Current:♣					
Gate open, Initial principal current = 500 mA (dc), v_D = 12V:					
T_C = 25°C (30-A & 40-A types)	I_{HO}	–	25	60	mA
= 25°C (25-A types)		–	30	75	
= −65°C (40-A types)		–	–	100*	
= −40°C (25-A types)		–	45	100*	
For other case temperatures		See Figs. 13 & 14			
Critical Rate of Rise of Commutation Voltage:♣					
v_D = V_{DROM}, $I_{T(RMS)}$ = 40 A, commutating di/dt = 22 A/ms, gate unenergized,	dv/dt				V/μs
T_C= 70°C (40-A, Press-fit types)		5*	30	–	
= 65°C (40-A, Stud-types)		5*	30	–	
= 60°C (40-A, Isolated-stud types)		5*	30	–	
v_D = V_{DROM}, $I_{T(RMS)}$ = 30 A, commutating di/dt = 16 A/ms, gate unenergized,					
T_C= 65°C (30-A, Press-fit types)		3	20	–	
= 60°C (30-A, Stud types)		3	20	–	
= 55°C, (30-A, Isolated-stud types)		3	20	–	
v_D = V_{DROM}, $I_{T(RMS)}$ = 25 A, commutating di/dt = 88 A/ms, gate unenergized					
T_C = 80°C (25-A, Stud types)		5	–	–	
Critical Rate-of-Rise of Off-State Voltage:♣					
For v_D = V_{DROM}, exponential voltage rise, gate open	dv/dt				V/μs
T_C = 110°C (40-A types):					
2N5441, 2N5444, T6420B		50*	200	–	
2N5442, 2N5445, T6420D		30*	150	–	
2N5443, 2N5446, T6420M		20*	100	–	
T6400N, T6410N, T6420N		10*	75	–	
T_C = 100°C (30-A types):					
T6401B, T6411B, T6421B		40	200	–	
T6401D, T6411D, T6421D		25	150	–	
T6401M, T6411M, T6421M		20	100	–	
T_C = 115°C (25-A types)		20	100	–	
DC Gate-Trigger Current:♣♦					
v_D = 12 V (dc) R_L = 30Ω T_C = 25°C	I_{GT}				mA
Mode V_{MT2} V_G					
I+ positive positive (40-A & 30-A types)		–	15	50	
(25-A types)		–	20	80	
III− negative negative (40-A & 30-A types)		–	20	50	
(25-A types)		–	50	80	
II− positive negative (40-A & 30-A types)		–	30	80	
(25-A types)		–	80	80	
III+ negative positive (40-A & 30-A types)		–	40	80	
(25-A types)		–	100	150	
v_D = 12 V (dc) R_L = 30Ω T_C = −65°C					
Mode V_{MT2} V_G					
I+ positive positive (40-A types only)		–	–	125*	
III− negative negative (40-A types only)		–	–	125*	
I− positive negative (40-A types only)		–	–	240*	
III+ negative positive (40-A types only)		–	–	240*	
v_D = 12 V (dc) R_L = 25Ω T_C = 40°C					
Mode V_{MT2} V_G					
I+ positive positive (25-A types only)		–	32	120	
III− negative negative (25-A types only)		–	98	120	
I− positive negative (25-A types only)		–	–	170	
III+ negative positive (25-A types only)		–	–	–	
DC Gate-Trigger Voltage:♣♦					
v_D = 12 V (dc), R_L = 30Ω,	V_{GT}				V
T_C = 25°C (30-A & 40-A types)		–	1.35	2.5	
= −65°C (40-A types only)		–	1.8	3.4*	
For other case temperatures		See Fig. 20			
v_D = V_{DROM}, R_L = 125Ω, T_C = 110°C (40-A types)		0.2	–	–	
= 100°C (30-A types)		0.2	–	–	

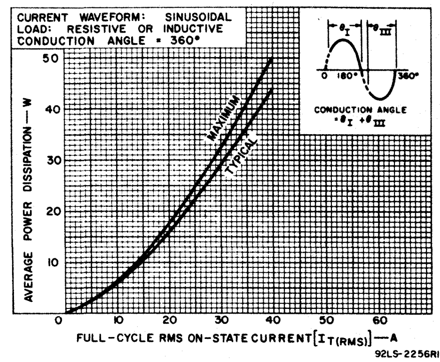


Fig. 1 — Power dissipation vs. on-state current for 2N5441-46, T6400N, T6410N, T6420 series.

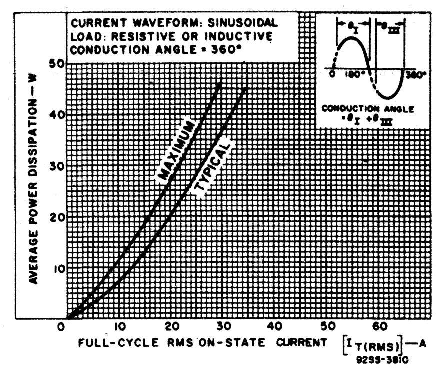


Fig. 2 — Power dissipation vs. on-state current for T6401, T6411, T6421 series.

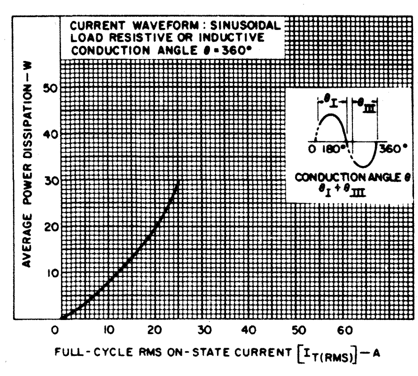


Fig. 3 — Power dissipation vs. on-state current for 2N5806-2N5809.

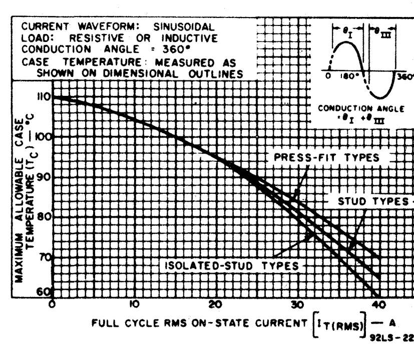


Fig. 4 — Maximum allowable case temperature vs. on-state current for 2N5441-46, T6400N, T6410N, T6420 series.

T6400, T6401, T6410, T6411, T6415, T6420, T6421 Series (Includes 2N5441-2N5446, 2N5806-2N5809)

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTICS	SYMBOL	LIMITS			UNITS
		MIN.	TYP.	MAX.	
DC Gate-Trigger Voltage: ♣♦					
v_D = 12 V (dc), R_L = 25Ω					
Triggering Modes I⁺, III⁻, I⁻ (25-A types), T_C = 25°C	V_{GT}	–	2	2.5	V
= −40°C		–	2.6	4*	
Triggering Modes III⁺ (25-A types), T_C = 25°C		–	3	4	
v_D = 12 V (dc), R_L = 1 kΩ,					
Triggering Modes I⁺, III⁻, I⁻ (25-A types): T_C = 115°C		0.15	–	–	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time)	t_{gt}				μs
v_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs, i_T = 60 A (peak), T_C = 25°C (40-A types)		–	1.7	3	
v_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs, i_T = 45 A (peak), T_C = 25°C (30-A types)		–	1.7	3	
v_D = V_{DROM}, I_{GT} = 150 mA, t_r = 0.1 μs, i_T = 60 A (peak), T_C = 25°C (25-A types)		–	1.6	–	
Thermal Resistance, Junction-to-Case: Steady-State	$R_{\theta JC}$				°C/W
Press-fit types		–	–	0.8*	
Stud types		–	–	0.9*	
Stud types (25-A types only)		–	1	1.23*	
Isolated-stud types		–	–	1	
Transient (Press-fit & stud types)		See Fig. 24			
Thermal Resistance, Junction-to-Ambient Steady-State (25-A types only)	$R_{\theta JA}$	–	–	50*	

* In accordance with JEDEC registration data format (JS-14, RDF 2) field for the JEDEC (2N-Series) types.
♣ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
♦ For either polarity of gate voltage (V_G) with reference to main terminal 1.

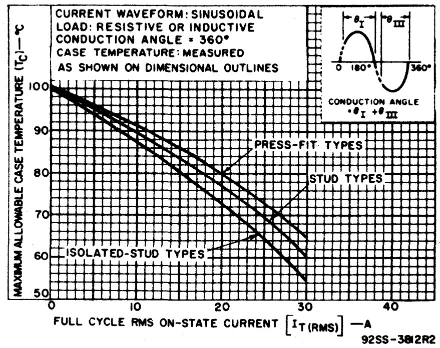


Fig. 5 — Maximum allowable case temperature vs. on-state current for T6401, T6411, T6421 series.

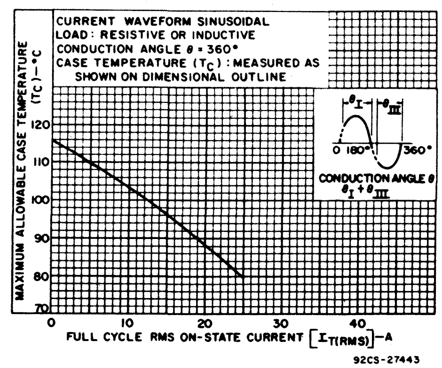


Fig. 6 — Maximum allowable case temperature vs. on-state current for 2N5806-2N5809.

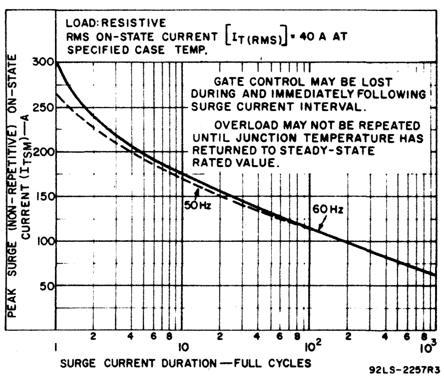


Fig. 7 — Peak surge on-state current vs. surge current duration for 2N5441-46, T6400N, T6410N, T6420 series.

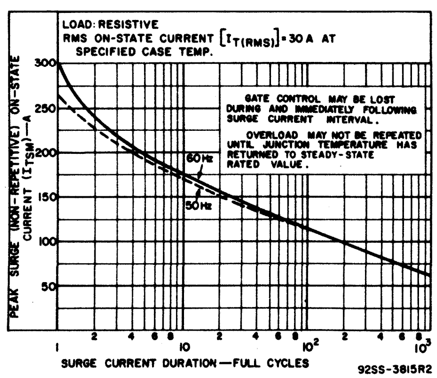


Fig. 8 — Peak surge on-state current vs. surge current duration for T6401, T6411, T6421 series.

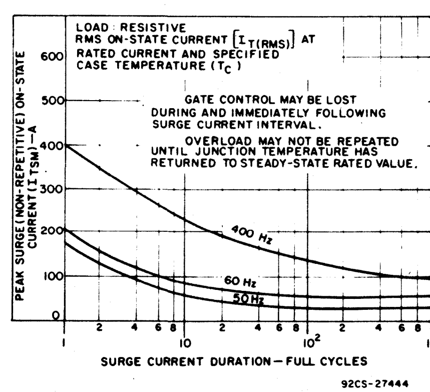


Fig. 9 — Peak surge on-state current vs. surge current duration for 2N5806-2N5809.

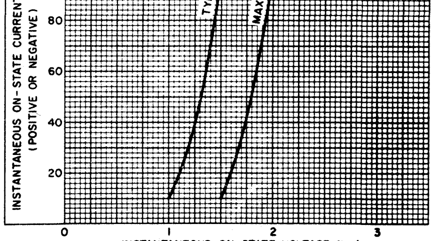


Fig. 10 — On-state current vs. on-state voltage for 2N5441-46, T6400N, T6410N, T6420 series.

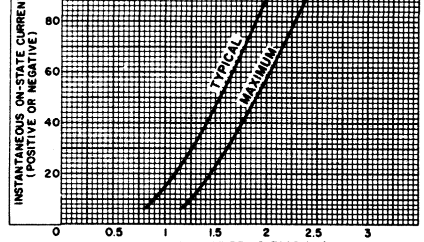


Fig. 11 — On-state current vs. on-state voltage for T6401, T6411, T6421 series.

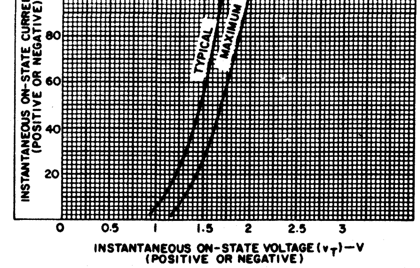


Fig. 12 — On-state current vs. on-state voltage for 2N5806-2N5809.

T6400, T6401, T6410, T6411, T6415, T6420, T6421 Series (Includes 2N5441-2N5446, 2N5806-2N5809)

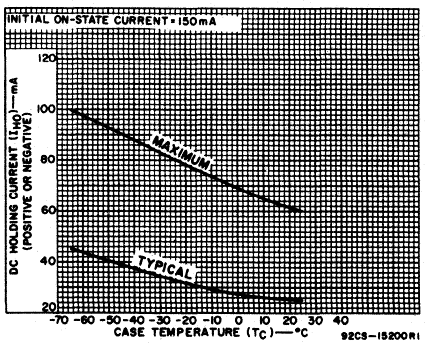


Fig. 13 – DC holding current vs. case temperature for 2N5441-46, T6400N, T6410N, T6420, T6401, T6411, T6421 series.

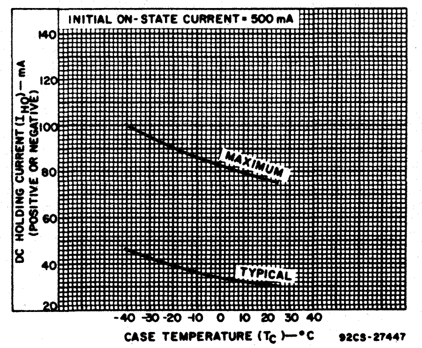


Fig. 14 – DC holding current vs. case temperature for 2N5806-2N5809 series.

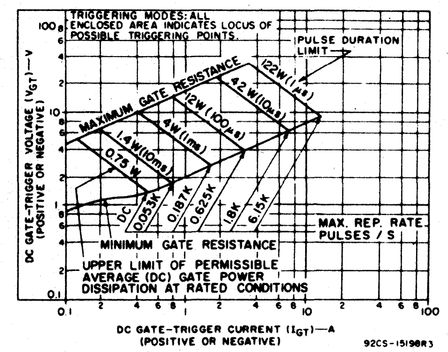


Fig. 15 – Gate-trigger characteristics and limiting conditions for determination of permissable gate-trigger pulses for 2N5441-46, T6400N, T6410N, T6420, T6401, T6411, T6421 series.

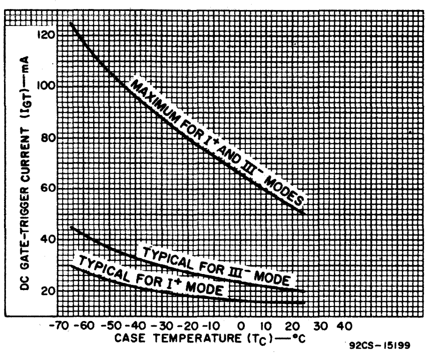


Fig. 16 – DC gate-trigger current vs. case temperature (I^+ & III^- modes) for 2N5441-46, T6400N, T6410N, T6420, T6401, T6411, T6421 series.

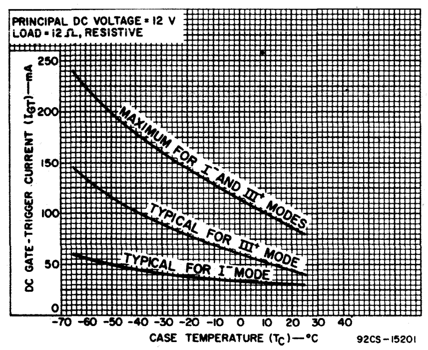


Fig. 17 – DC gate-trigger current vs. case temperature (I^- & III^+ modes) for 2N5441-46, T6400N, T6410N, T6420, T6401, T6411, T6421 series.

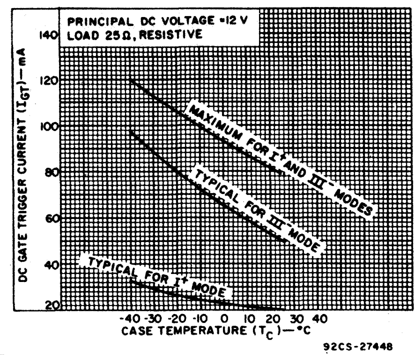


Fig. 18 – DC gate-trigger current vs. case temperature (I^+ & III^- modes) for 2N5806-2N5809.

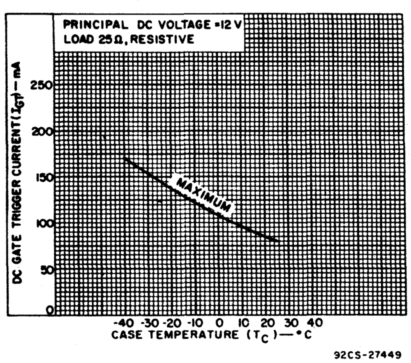


Fig. 19 – DC gate-trigger current vs. case temperature (I^- mode) for 2N5806-2N5809.

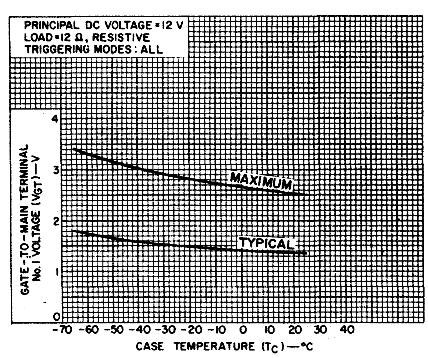


Fig. 20 – DC gate-trigger voltage vs. case temperature for 2N5441-46, T6400N, T6410N, T6420, T6401, T6411, T6421 series.

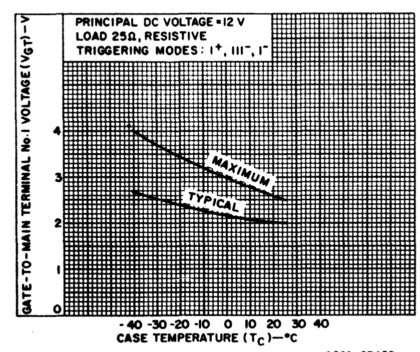


Fig. 21 – DC gate-trigger voltage vs. case temperature for 2N5806-2N5809.

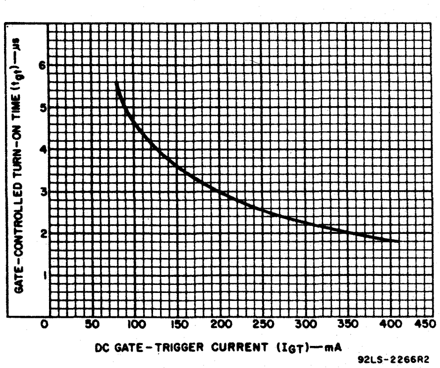


Fig. 22 – Turn-on time vs. gate-trigger current for 2N5441-46, T6400N, T6410N, T6420, T6401, T6411, T6421 series.

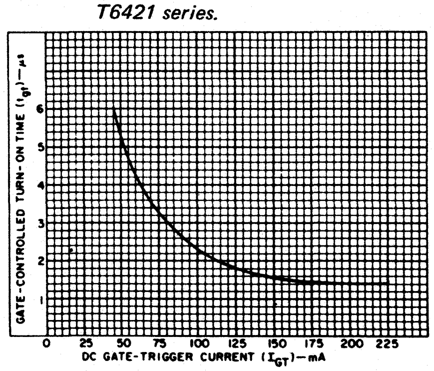


Fig. 23 – Typical turn-on time vs. gate-trigger current for 2N5806-2N5809.

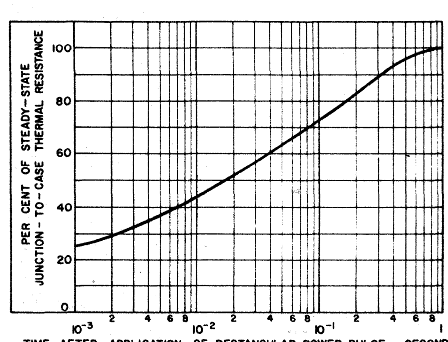


Fig. 24 – Transient junction-to-case thermal resistance vs. time for press-fit and stud types.

T6404, T6405, T6414, T6415 Series

400-Hz, 25 & 40-A Silicon Triacs

For Control-Systems Application in Airborne and Ground-Support Type Equipment

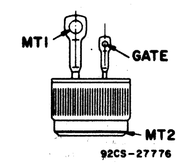
These RCA triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

They are intended for operation at 400 Hz with resistive or inductive loads and nominal line voltages of 115 and 208 V RMS sine wave and repetitive peak off-state voltages of 200 V and 400 V.

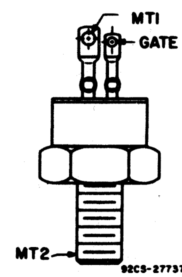
These triacs exhibit commutating voltage (dv/dt) capability at high commutating current (di/dt). They can also be used in 60-Hz applications where high commutating capability is required.

Features:
- **RMS On-State Current –**
  $I_{T(RMS)}$ = 25A: T6405 and T6415 Series
  = 40A: T6404 and T6414 Series
- **Commutating dv/dt Capability Characterized at 400 Hz**
- **Shorted-Emitter Center-Gate Design**
- **di/dt Capability = 100 A/µs**

TERMINAL CONNECTIONS



T6404 Series
T6405 Series
Press-fit



T6414 Series
T6415 Series
Stud

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at 400 Hz and with Resistive or Inductive Load.

		T6404B T6405B T6414B T6415B	T6404D T6405D T6414D T6415D	
REPETITIVE PEAK OFF-STATE VOLTAGE:*	V_{DROM}			
Gate open, T_J = –50 to 110° C		200	400	V
RMS ON-STATE CURRENT (Conduction Angle = 360°):	$I_{T(RMS)}$			
Case temperature				
T_C = 85° C (T6405 Series)		25		A
80° C (T6415 Series)		25		A
70° C (T6404 Series)		40		A
65° C (T6414 Series)		40		A
For other conditions		See Fig. 2		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}			
For one cycle of applied principal voltage, T_C as above				
400 Hz (sinusoidal)		600		A
60 Hz (sinusoidal)		300		A
50 Hz (sinusoidal)		265		A
For more than one cycle of applied principal voltage		See Fig. 3		
RATE-OF-CHANGE OF ON-STATE CURRENT:	di/dt			
$V_{DM} = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 µs		100		A/µs
FUSING CURRENT (for Triac Protection):	I^2t			
T_J = –50 to 110° C, t = 1.25 to 10 ms		270		A^2s
PEAK GATE-TRIGGER CURRENT:■	I_{GTM}			
For 1 µs max. *(See Fig. 7)*		12		A
GATE POWER DISSIPATION:				
Peak (For 10 µs max., $I_{GTM} \leq$ 4 A (peak), *(See Fig. 7)*	P_{GM}	42		W
Average	$P_{G(AV)}$	0.75		W
TEMPERATURE RANGE:▲				
Storage	T_{stg}	–50 to 150		°C
Operating (Case)	T_C	–50 to 110		°C
TERMINAL TEMPERATURE (During soldering):	T_T			
For 10 s max. (terminals and case)		225		°C
STUD TORQUE:	τ_s			
Recommended		35		in.-lb
Maximum (DO NOT EXCEED)		50		in.-lb

* For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲ For temperature measurement reference point, see Dimensional Outline.

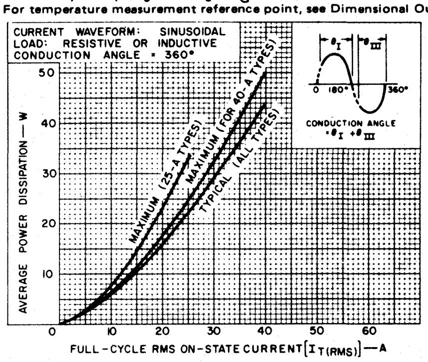


Fig. 1—Power dissipation vs. on-state current.

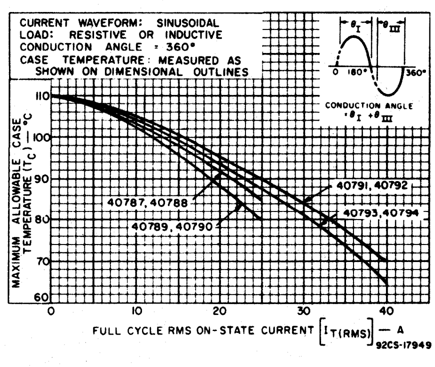


Fig. 2—Maximum allowable case temperature vs. on-state current.

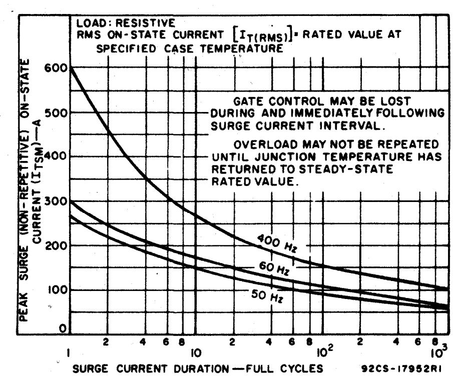


Fig. 3—Peak surge on-state current vs. surge current duration.

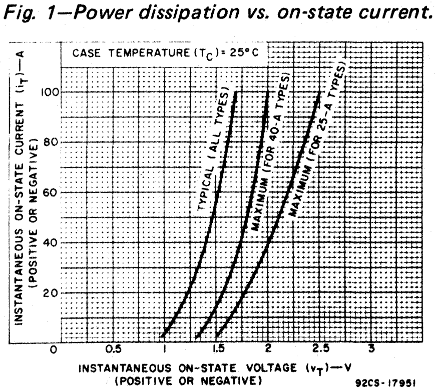


Fig. 4—On-state current vs. on-state voltage.

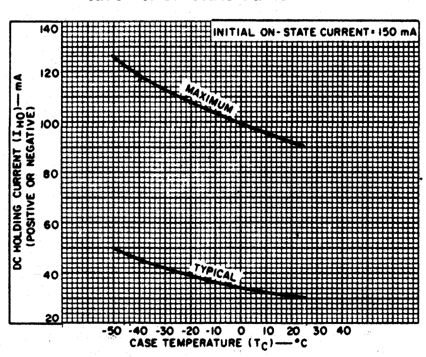


Fig. 5—DC holding current vs. case temperature.

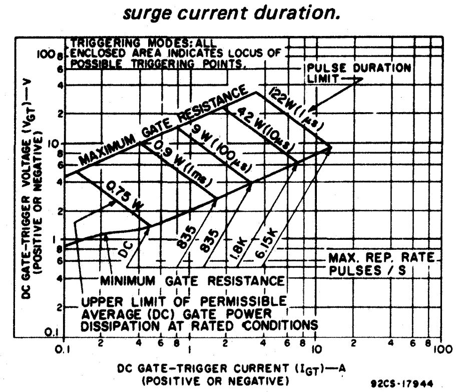


Fig. 6—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

T6404, T6405, T6414, T6415 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS Min.	Typ.	Max.	UNITS
Peak Off-State Current:♠ Gate open, T_J = 110° C, V_{DROM} = Max. rated value	I_{DROM}	–	0.2	4	mA
Maximum On-State Voltage:♠ For i_T = 100 A (peak), T_C = 25° C: T6405 & T6415 Series T6404 & T6414 Series	V_{TM}	– –	1.7 1.7	2.5 2	V
DC Holding Current:♠ Gate open, Initial principal current = 500 mA (DC), v_D = 12 V, T_C = 25° C For other case temperatures	I_{HO}	–	30 See Fig. 5	90	mA
Critical Rate-of-Rise of Commutation Voltage:♠ For v_D = V_{DROM}, $I_{T(RMS)}$ = rated value, gate unenergized, Commutating di/dt = 88 A/ms T_C = 85° C (T6405 Series) = 80° C (T6415 Series) Commutating di/dt = 141 A/ms T_C = 70° C (T6404 Series) = 65° C (T6414 Series)	dv/dt	2 2 2 2	– – – –	– – – –	V/μs
Critical Rate-of-Rise of Off-State Voltage:♠ For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 110° C: T6405 & T6415 Series T6404 & T6414 Series	dv/dt	30 50	150 200	– –	V/μs
DC Gate-Trigger Current:♠† For v_D = 12 V (DC), R_L = 30 Ω, T_C = 25° C Mode / V_{MT2} / V_G: I⁺ positive positive III⁻ negative negative I⁻ positive negative III⁺ negative positive For other case temperatures	I_{GT}	– – – –	20 50 80 80 See Figs. 7& 8	80 80 120 120	mA
DC Gate-Trigger Voltage:♠† For v_D = 12 V(DC), R_L = 30 Ω, T_C = 25° C For other case temperatures For v_D = V_{DROM}, R_L = 125 Ω, T_C = 110° C	V_{GT}	– 0.2	2 See Fig. 9 –	3 –	V
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For v_D = V_{DROM}, I_{GT} = 150 mA, t_r = 0.1 μs, i_T = 60 A (peak), T_C = 25° C (See Fig. 10)	t_{gt}	–	1.6	2.5	μs
Thermal Resistance, Junction-to-Case: Steady-State Press-fit types Stud Transient (Press-fit & stud types)	$θ_{J-C}$	– –	– – See Fig. 12	0.8 0.9	°C/W

♠ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
† For either polarity of gate voltage (V_G) with reference to main terminal 1.

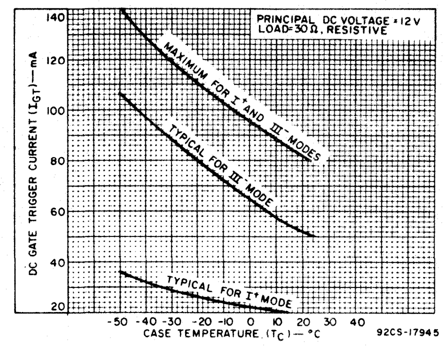


Fig. 7—DC gate-trigger current vs. case temperature (I⁺ and III⁻ modes).

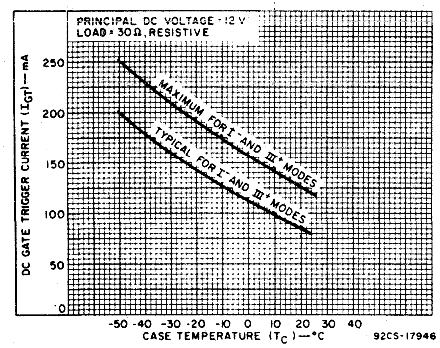


Fig. 8—DC gate-trigger current vs. case temperature (I⁻ and III⁺ modes).

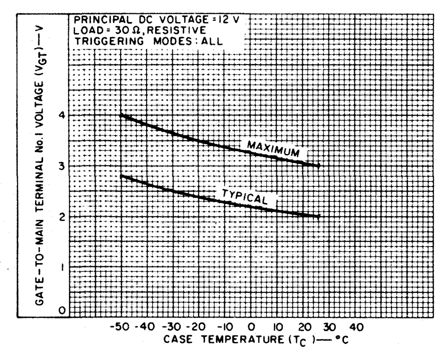


Fig. 9—DC gate-trigger voltage vs. case temperature.

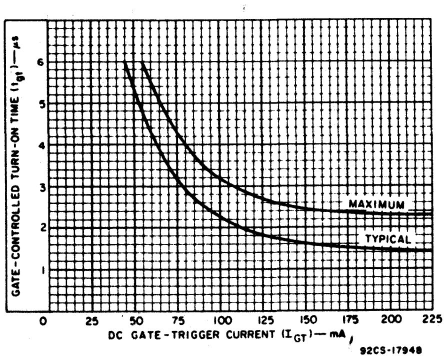


Fig. 10—Turn-on time vs. gate-trigger current.

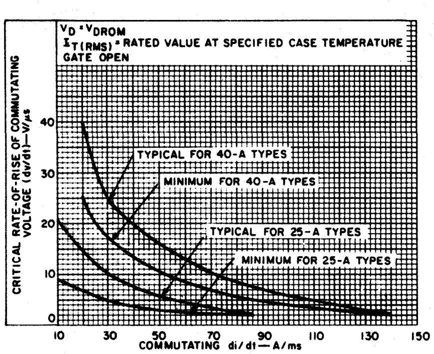


Fig. 11—Commutating voltage vs. commutating current.

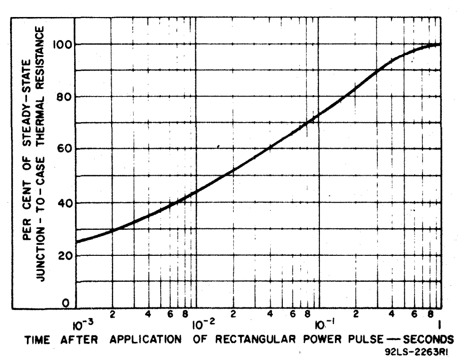


Fig. 12—Transient junction-to-case thermal resistance vs. time.

T8410, T8411, T8420, T8421 Series

60-A and 80-A Silicon Triacs

Stud and Isolated-Stud "Overmolded" Packages
For General Purpose AC Power Switching

The RCA T8410, T8411, T8420, and T8421 series triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. The T8410 and T8420 series, are 80-A triacs, the T8411 and T8421 series are 60-A triacs.

These triacs are intended for control of ac loads in applications such as heating controls, motor controls, arc-welding equipment, light dimmers, and power switching systems. They can also be used in airconditioning and photocopying equipment.

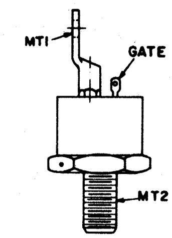
The T8410 and T8411 series employ a stud "overmolded" package. The T8420 and T8421 series employ an isolated-stud "overmolded" package.

The T8410 and T8420 series replaces the former RCA-T8440 and T8450 series.

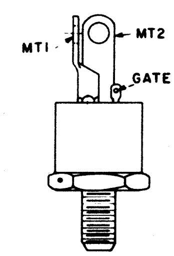
Features:

- di/dt Capability = 300 A/μs
- Shorted-Emitter Center-Gate Design
- Low Switching Losses
- Low On-State Voltage at High Current Levels
- Low Thermal Resistance
- 2.5 kV RMS Isolation (Isolated-Stud Types)

TERMINAL CONNECTIONS



Stud "overmolded" types



Isolated-Stud "overmolded" types

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies Up to 50/60 Hz and with Resistive or Inductive Load.

	T8410B T8420B T8411B T8421B	T8410D T8420D T8411D T8421D	T8410M T8420M T8411M T8421M	
V_{DROM}▲:				
Gate open, T_J = −40 to 110°C	200	400	600	V
$I_{T(RMS)}$ (θ = 360°):				
T_C = 70°C (T8410 series – Stud types)	—	80	—	A
= 65°C (T8420 series – Isolated-Stud types)	—	80	—	A
= 80°C (T8411 series – Stud types)	—	60	—	A
= 75°C (T8421 series – Isolated-Stud types)	—	60	—	A
For other conditions	—	See Figs. 2 & 3	—	
I_{TSM}:				
For one cycle of applied principal voltage				
60 Hz (sinusoidal), $I_{T(RMS)}$ and T_C as above for T8410, 20 series	—	850	—	A
50 Hz (sinusoidal), $I_{T(RMS)}$ and T_C as above for T8410, 20 series	—	725	—	A
60 Hz (sinusoidal), $I_{T(RMS)}$ and T_C as above for T8411, 21 series	—	700	—	A
50 Hz (sinusoidal), $I_{T(RMS)}$ and T_C as above for T8411, 21 series	—	600	—	A
For more than one cycle of applied principal voltage	—	See Figs. 4 & 5	—	
di/dt:				
$V_{DM} = V_{DROM}$, I_{GT} = 300 mA, t_r = 0.1 μs	—	300	—	A/μs
I^2t: [At T_C shown for $I_{T(RMS)}$]:				
t = 20 ms				
T8410, T8420 series	—	4000	—	A^2s
T8411, T8421 series	—	2700	—	A^2s
t = 2.5 ms				
T8410, T8420 series	—	2000	—	A^2s
T8411, T8421 series	—	1350	—	A^2s
t = 0.5 ms				
T8410, T8420 series	—	1150	—	A^2s
T8411, T8421 series	—	800	—	A^2s
I_{GTM}●:				
For 10 μs max. (See Fig. 9)	—	7	—	A
P_{GM}:				
Peak (For 10 μs max., $I_{GTM} \leq$ 7 A (peak), (See Fig. 9)	—	42	—	W
$P_{G(AV)}$	—	0.75	—	W
T_{stg}	—	−40 to 150	—	°C
T_C	—	−40 to 110	—	°C
T_T■:				
During soldering for 10 ms maximum (terminals and case)	—	225	—	°C
τ_s:				
Recommended	—	125	—	in-lb
	—	1.44	—	kgf-m
Maximum (DO NOT EXCEED)	—	150	—	in-lb
	—	1.73	—	kgf-m

▲For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
●For either polarity of gate voltage (V_G) with reference to main terminal 1.
■For temperature measurement reference point, see Dimensional Outline.

WARNING: The ceramic of the isolated stud package contains beryllium oxide. Do not crush, grind, or abrade this part because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

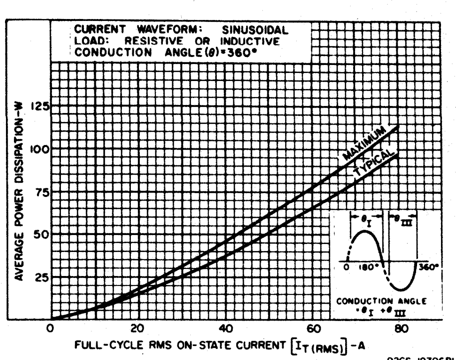


Fig. 1 – Power dissipation vs. on-state current for T8410, T8420, T8411, and T8421 series.

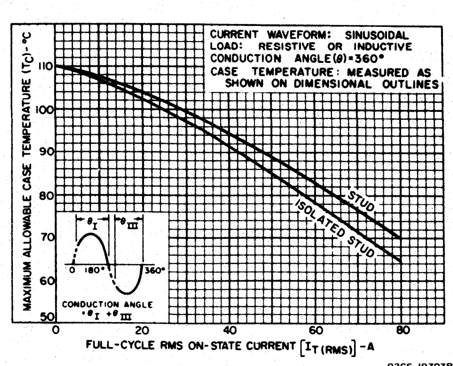


Fig. 2 – Maximum allowable case temperature vs. on-state current for T8410 and T8420 series.

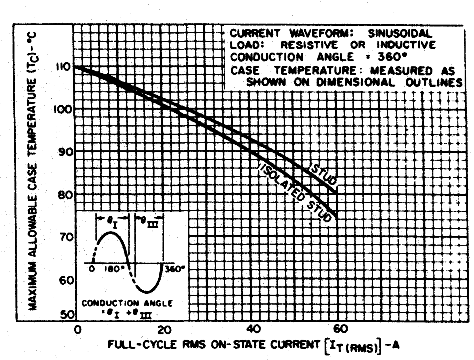


Fig. 3 – Maximum allowable case temperature vs. on-state current for T8411 and T8421 series.

T8410, T8411, T8420, T8421 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}▲: Gate open, T_J = 110°C, V_{DROM} = Max. rated value	–	0.4	4	mA
V_{TM}▲:				V
i_T = 200 A (peak), T_C = 25°C	–	1.75	2	
i_T = 100 A (peak), T_C = 25°C	–	1.55	1.8	
I_{HO}▲: Gate open, Initial principal current = 500 mA (dc), v_D = 12 V				mA
T_C = 25°C	–	40	60	
= –40°C	–	–	85	
For other case temperatures — See Fig. 8				
dv/dt (Commutating)▲:				V/µs
v_D = V_{DROM}, $I_{T(RMS)}$ = 80 A, commutating di/dt = 42 A/ms, gate unenergized				
T_C = 70°C (Stud types – T8410 series)	3	10	–	
= 65°C (Isolated-stud types – T8420 series)	3	10	–	
v_D = V_{DROM}, $I_{T(RMS)}$ = 60 A, commutating di/dt = 32 A/ms, gate unenergized				
T_C = 80°C (Stud types – T8411 series)	3	10	–	
= 75°C (Isolated-stud types – T8421 series)	3	10	–	
dv/dt (Off-State)▲: v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 110°C:				V/µs
T8410B, T8420B, T8411B, T8421B	50	200	–	
T8410D, T8420D, T8411D, T8421D	30	150	–	
T8410M, T8420M, T8411M, T8421M	20	100	–	
I_{GT}▲●:				mA
v_D = 12 V dc, R_L = 30Ω, T_C = 25°C				
Mode — V_{MT2} — V_G				
I^+ — positive — positive	–	20	75	
III^- — negative — negative	–	40	75	
I^- — positive — negative	–	40	150	
III^+ — negative — positive	–	100	150	
v_D = 12 V dc, R_L = 30Ω, T_C = –40°C				
Mode — V_{MT2} — V_G				
I^+ — positive — positive	–	35	150	
III^- — negative — negative	–	80	150	
I^- — positive — negative	–	100	400	
III^+ — negative — positive	–	280	400	
For other case temperatures — See Figs. 10 & 11				
V_{GT}▲●: v_D = 12 V dc, R_L = 30Ω, T_C = 25°C	–	1.35	2.5	V
For other case temperatures — See Fig. 12				
t_{gt}: v_D = V_{DROM}, I_{GT} = 300 mA, t_r = 0.1 µs, T_C = 25°C,				µs
i_T = 85 A(peak) (T8411, T8421 series)	–	1.2	2.5	
=112 A(peak) (T8410, T8420 series)	–	1.2	2.5	
$R_{\theta JC}$: Steady-State				°C
Stud types	–	–	0.35	
Isolated-stud types	–	–	0.4	
Transient — See Fig. 14				

▲ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
● For either polarity of gate voltage (V_G) with reference to main terminal 1.
■ For temperature measurement reference point, see Dimensional Outline.

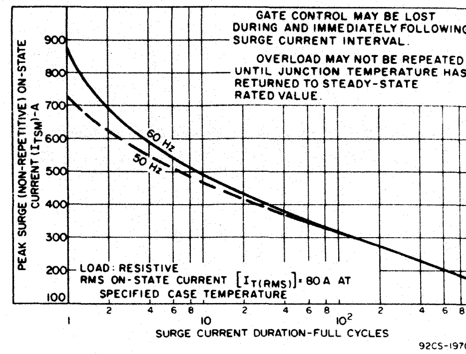


Fig. 4 — Peak surge on-state current vs. surge current duration for T8410 and T8420 series.

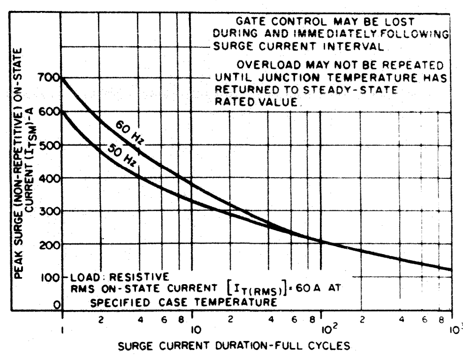


Fig. 5 — Peak surge on-state current vs. surge current duration for T8411 and T8421 series.

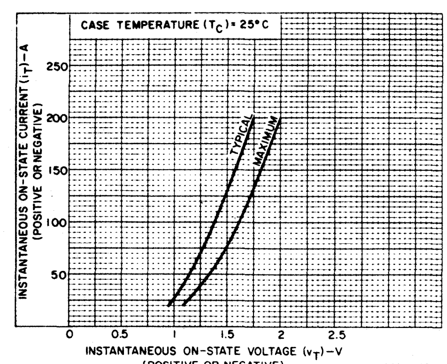


Fig. 6 — On-state current vs. on-state voltage for T8410 and T8420 series.

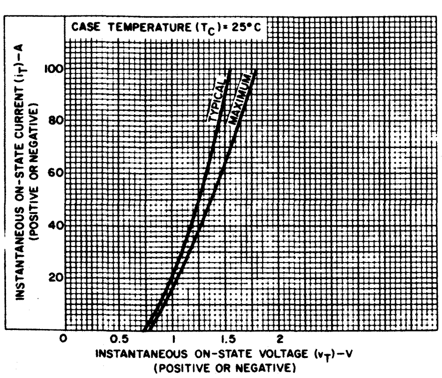


Fig. 7 — On-state current vs. on-state voltage for T8411 and T8421 series.

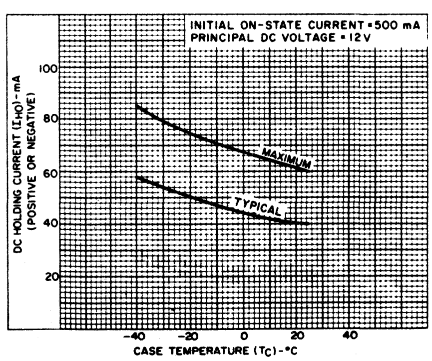


Fig. 8 — DC holding current vs. case temperature for all series.

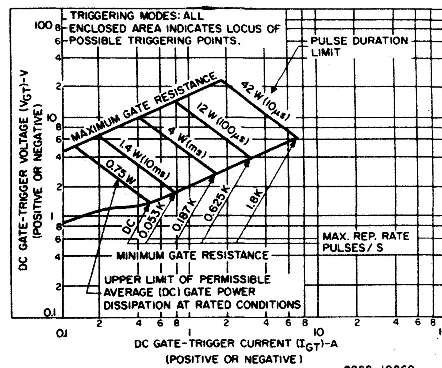


Fig. 9 — Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses for all series.

T8410, T8411, T8420, T8421 Series

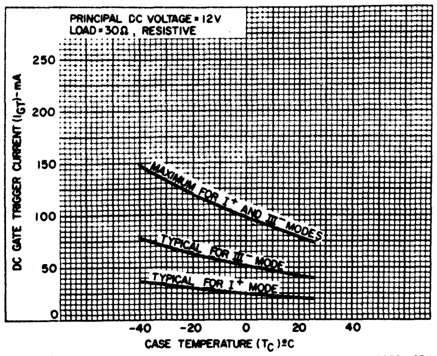


Fig. 10 — DC gate-trigger current vs. case temperature (I^+ and III^- modes) for all series.

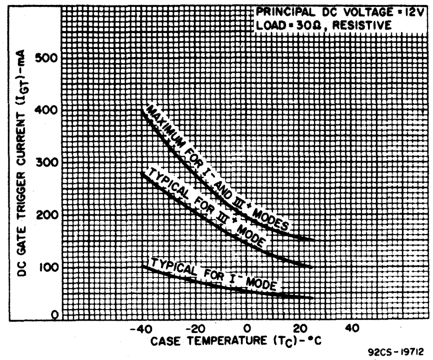


Fig. 11 — DC gate-trigger current vs. case temperature (I^- and III^+ modes) for all series.

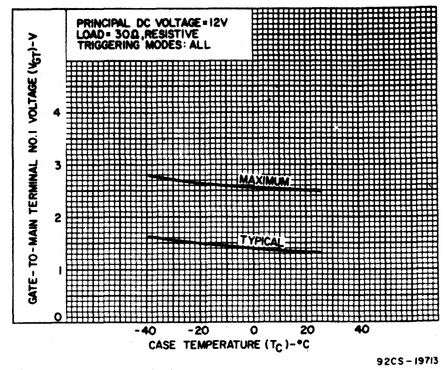


Fig. 12 — DC gate-trigger voltage vs. case temperature for all series.

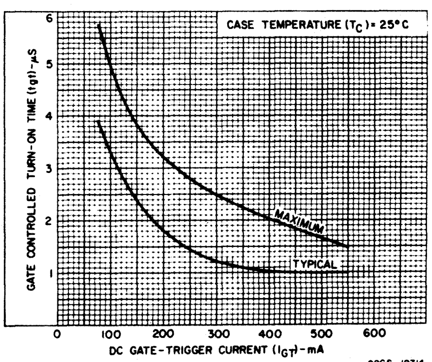


Fig. 13 — Turn-on time vs. gate-trigger current for all series.

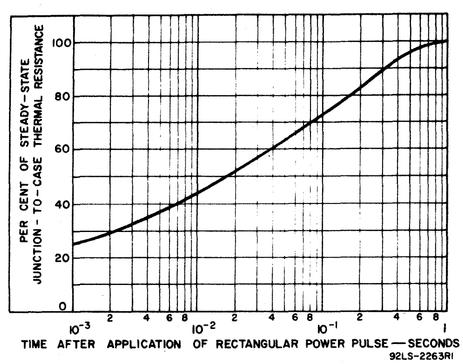


Fig. 14 — Transient junction-to-case thermal resistance vs. time for all series.

Zero-Voltage-Switched Types

2.5-40 A, 100-600 V Silicon Triacs for Use With IC Zero-Voltage Switches

For Power-Control and Switching Applications at 50-60 Hz with RCA-CA3058, CA3059, or CA3079 IC as Trigger Circuits

The triacs listed below are gate-controlled full-wave ac switches intended for load-control applications. They are especially useful in ac circuits for heating controls (proportional or on-off), lamp switching, motor switching, and a wide variety of other power-control applications.

These devices have gate characteristics which assure that an RCA-CA3058, CA3059, or CA3079 integrated circuit can supply sufficient drive current to trigger them over their full operating-temperature range (−40°C to +85°C).

The RCA-CA3058, CA3059, and CA3079 are monolithic silicon integrated-circuit zero-voltage switches which can operate directly from the ac line. They are designed to drive the triac gate directly and provide the gating signal at zero-voltage crossings for minimum radio-frequency interference.

These triacs have rms on-state current ratings that range from 2.5 to 40 amperes, and repetitive off-state voltage ratings from 100 to 600 volts. They are supplied in a variety of packages.

Technical information on RCA-CA3058, CA3059, and CA3079 is contained in bulletin File No. 490. For detailed application information, see Application Note ICAN-6182, "Features and Application of RCA Integrated-Circuit Zero-Voltage Switches".

RATINGS AND CHARACTERISTICS

All types, at case temperature (T_C) = 25°C, I^+ and III^+ triggering modes,▲ I_{GT} = 45 mA max., V_{GT} = 1.5 V max.

Type No.	Rep. Peak Off-State Voltage V_{DROM} (V)	RMS On-State Current $I_{T(RMS)}$ at Case Temp. (A)	(°C)	Typ. DC Holding Current at 25°C, I_{HO} (mA)	Package	Additional Data Shown in Bulletin File No.*
T2306A	100	2.5	70	6	Mod. TO-5	414
T2306B	200	2.5	70	6		414
T2306D	400	2.5	70	6		414
T2316A	100	2.5	70	6	Mod. TO-5 on Heat Radiator	414
T2316B	200	2.5	70	6		414
T2316D	400	2.5	70	6		414
T2506B	200	6	80	15	TO-220AB	615
T2506D	400	6	80	15		615
T2706B	200	6	75	15	TO-66	351
T2706D	400	6	75	15		351
T2716B	200	6	75	15	TO-66 with Heat Radiator	351
T2716D	400	6	75	15		351
T2806B	200	8	80	15	TO-220AB	364
T2806D	400	8	80	15		364
T2856B	200	8	75	15	Isolated-Tab TO-220AB	540
T2856D	400	8	75	15		540
T4106B	200	15	80	20	Press-fit	458
T4106D	400	15	80	20		458
T4106M	600	15	80	20		458
T4107B	200	10	85	15	Press-fit	457
T4107D	400	10	85	15		457
T4107M	600	10	85	15		457
T4116B	200	15	80	20	Stud	458
T4116D	400	15	80	20		458
T4116M	600	15	80	20		458
T4117B	200	10	85	15	Stud	457
T4117D	400	10	85	15		457
T4117M	600	10	85	15		457
T4126B	200	15	75	20	Isolated Stud	458
T4126D	400	15	75	20		458
T4126M	600	15	75	20		458
T4127B	200	10	85	15	Isolated Stud	457
T4127D	400	10	85	15		457
T4127M	600	10	85	15		457
T6406B	200	40	70	45	Press-fit	593
T6406D	400	40	70	45		593
T6406M	600	40	70	45		593
T6407B	200	30	65	25	Press-fit	459
T6407D	400	30	65	25		459
T6407M	600	30	65	25		459
T6416B	200	40	65	25	Stud	593
T6416D	400	40	65	25		593
T6416M	600	40	65	25		593
T6417B	200	30	60	25	Stud	459
T6417D	400	30	60	25		459
T6417M	600	30	60	25		459
T6426B	200	40	60	25	Isolated Stud	593
T6426D	400	40	60	25		593
T6426M	600	40	60	25		593
T6427B	200	30	55	25	Isolated Stud	459
T6427D	400	30	55	25		459
T6427M	600	30	55	25		459

▲ A triac driven directly from the output terminal of the CA3058, CA3059, or CA3079 should be characterized for operation in the I^+ or III^+ triggering mode, i.e., with positive gate current (current flows into the gate for both polarities of the applied ac voltage).

* Except for gate characteristics, data in these bulletins also apply to the types listed in this chart.

Silicon Controlled Rectifiers (SCR's)

Page

SCR Product Matrix

RCA SCR's	TO-8	TO-66							TO-66 With Heat Rad.		Low Profile Mod. TO-5
$I_{T(RMS)}$	2A	5A	FTO* 5A	FTO* 5A	FTO* 5A	FTO* 5A	FTO* 5A	FTO* 5A	5A	FTO* 5A	7A
I_{TSM} (60 Hz)	60A	60A	80A	80A	80A	75A(IPM)	80A	80A	80A	80A	100A
V_{DROM} V_{RROM} (V) 15											
25											
30											
50											
100					S3704A					S3714A	
150											
200	2N3528	2N3228		S3700B	S3704B				S2710B	S3714B	S2600B
250											
300											
400	2N3529	2N3525		S3700D	S3704D				S2710D	S3714D	S2600D
500			S3706E								
600	2N4102	2N4101	S3705M	S3700M	S3704M	S3701M			S2710M	S3714M	S2600M
700					S3704S		S3702S			S3714S	
750								S3703SF			
800											
I_{GT}(mA)	15	15	30	40	40	35	45	40	15	40	15
V_{GT}(V)	2	2	4	3.5	3.5	4	4	4	2	3.5	1.5
Page No.	361	361	373	370	370	372	373	373	361	370	364

* FTO – Fast Turn-Off

RCA SCR's	TO-5 With Heat Rad.	TO-5 With Heat Spreader	TO-220 AB VERSAWATT						Stud		TO-3
$I_{T(RMS)}$	3.3A	7A	4A	4A	4A	8A	10A	12	16	FTO* ◆ 10A	12.5
I_{TSM} (60 Hz)	100A	100A	35A	35A	35A	100A	100A	125	160	90A	200A
V_{DROM} V_{RROM} (V) 15			S2060Q	S2061Q	S2062Q						
25											
30			S2060Y	S2061Y	S2062Y						
50			S2060F	S2061F	S2062F	S122F	S2800F	2N6394	2N6400		
100			S2060A	S2061A	S2062A	S122A	S2800A	2N6395	2N6401		2N3668
150											
200	S2610B	S2620B	S2060B	S2061B	S2062B	S122B	S2800B	2N6396	2N6402	S5210B	2N3669
250											
300			S2060C	S2061C	S2062C	S122C	S2800C	S6000C	S6100C		
400	S2610D	S2620D	S2060D	S2061D	S2062D	S122D	S2800D	2N6397	2N6403	S5210D	2N3670
500			S2060E	S2061E	S2062E	S122E	S2800E	S6000E	S6100E		
600	S2610M	S2620M	S2060M	S2061M	S2062M	S122M	S2800M	2N6398	2N6404	S5210M	2N4103
700						S122S	S2800S	S6000S	S6100S		
750											
800											
I_{GT}(mA)	15	15	0.2	0.5	2	25	15	30	30	40	40
V_{GT}(V)	1.5	1.5	0.8	0.8	0.8	1.5	1.5	1.5	1.5	3.5	2
Page No.	364	364	358	358	358	367	367	384	384	382	379

* FTO – Fast Turn-Off ◆Check availability in Europe, the Middle East, and Africa.

RCA SCR's	Press–Fit		Stud		Isolated Stud		Press-Fit: With flex.leads, encap. on isolated stud		Press-Fit: Isolated on TO-3 flange		Press-Fit: With flex.leads, encap., isolated on TO-3 flange	
$I_{T(RMS)}$	20A	35A	20A	35A	20A	35A	20A	35A	20A	35A	20A	35A
I_{TSM} (60 Hz)	200A	350A	200A	350A	200A	350A	200A	350A	200A	350A	200A	350A
V_{DROM} V_{RROM} (V) 15												
25												
30												
50												
100	S6200A	2N3870	S6210A	2N3896	S6220A	S6420A	S6230A	S6430A	S6240A	S6440A	S6250A	S6450A
150												
200	S6200B	2N3871	S6210B	2N3897	S6220B	S6420B	S6230B	S6430B	S6240B	S6440B	S6250B	S6450B
250												
300												
400	S6200D	2N3872	S6210D	2N3898	S6220D	S6420D	S6230D	S6430D	S6240D	S6440D	S6250D	S6450D
500												
600	S6200M	2N3873	S6210M	2N3899	S6220M	S6420M	S6230M	S6430M	S7240M	S6440M	S6250M	S6450M
700												
750												
800		S6400N		S6410N		S6420N		S6430N		S6440N		S6450N
I_{GT}(mA)	15	40	15	40	15	40	15	40	15	40	15	40
V_{GT}(V)	2	2	2	2	2	2	2	2	2	2	2	2
Page No.	387	387	387	391	391	391	390	390	390	390	390	390

♠ VERSAWATT

SCR Product Matrix (cont'd)

RCA SCR's	TO-48				
	16A	25A	Pulse Modulator 35A	FTO* 35A	FTO* 35A
$I_{T(RMS)}$	16A	25A	35A	35A	35A
I_{TSM} (60 Hz)	125A	150A	150A	180A	250A
V_{DROM} V_{RROM}(V) 15					
25	2N1842A	2N681			
30					
50	2N1843A	2N682			2N3654
100	2N1844A	2N683		2N3650	2N3655
150	2N1845A	2N684			
200	2N1846A	2N685		2N3651	2N3656
250	2N1847A	2N686			
300	2N1848A	2N687		2N3652	2N3657
400	2N1849A	2N688		2N3653	2N3658
500	2N1850A	2N689			
600		2N690	S6493M	S7410M	S7412M
700					
750					
800					
I_{GT}(mA)	45	25	80	180	180
V_{GT}(V)	3.5	3	2	3	2
Page No.	394	394	397	399	399

* FTO – Fast Turn-Off

ITR Product Matrix

For Horizontal-Deflection Circuits

RCA ITR's*	TO-220AB VERSAWATT			
	Trace	Commutating (Retrace)	Trace	Commutating (Retrace)
$I_{T(RMS)}$	8A	8A	8A	8A
I_{TSM} (60 Hz)	90A	90A	90A	90A
V_{DROM}(V) 300				
400				
450			S3902DF	
500				
550				
600		S3901M		
650	S3900MF	S3901MF		S3903MF
700	S3900S	S3901S		
750	S3900SF			
I_{GT}(mA)	30	45		
V_{GT}(V)	4	4		
Page No.	376	376	376	376

* Integrated Thyristor/Rectifiers

GTO Product Matrix

RCA GTO's*		TO-3		
$I_{T(DC)}$		8.5A	8.5A	8.5A
I_{TSM} (60 Hz)		50A	50A	50A
V_{DRXM}(V)	100	G5001A	G5002A	G5003A
	200	G5001B	G5002B	G5003B
	400	G5001D	G5002D	G5003D
	600	G5001M	G5002M	G5003M
Turn-on Time	t_d	1μs	1.5μs	1.5μs
t_{gt}	t_r	1μs	1.5μs	1.5μs
Turn-off Time	t_s	1μs	3μs	10μs
t_q	t_f	1μs	3μs	10μs
	Page No.	356	356	356

*Gate-turn-off SCR's

RCA SCR Direct-Replacement Guide

Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type
BTY87-800R	PHIL	S6410N	C122F	GE	S2800A	CS35-02N	CRL	2N3896	NL-C35G	NAT	2N684
BTY91-800R	PHIL	S6410N	C122G	GE	S2800B	CS35-05M	CRL	2N3870	NL-C35H	NAT	2N686
BTY87-400R	PHIL	2N3898	C122Y	GE	S2800A	CS35-05N	CRL	2N3896	NL-C35M	NAT	2N690
BTY87-500R	PHIL	2N3899	C140A	GE	2N3650	CS35-1M	CRL	2N3870	NL-C36A	NAT	2N1844A
BTY87-600R	PHIL	2N3899	C140B	GE	2N3651	CS35-1N	CRL	2N3896	NL-C36B	NAT	2N1846A
BTY87-800R	PHIL	S6410N	C140C	GE	2N3652	CS35-2M	CRL	2N3871	NL-C36C	NAT	2N1848A
BTY91-400R	PHIL	2N3898	C140D	GE	2N3653	CS35-2N	CRL	2N3897	NL-C36D	NAT	2N1849A
BTY91-500R	PHIL	2N3899	C140F	GE	2N3654	CS35-4M	CRL	2N3872	NL-C36E	NAT	2N1850A
BTY91-600R	PHIL	2N3899	C141A	GE	2N3655	CS35-4N	CRL	2N3898	NL-C36G	NAT	2N1845A
BTY91-800R	PHIL	S6410N	C141B	GE	2N3656	CS35-6M	CRL	2N3873	NL-C36H	NAT	2N1847A
C20A	GE	S6200A	C141C	GE	2N3657	CS35-6N	CRL	2N3899	NL-C40B	NAT	2N3651
C20B	GE	S6200B	C141D	GE	2N3658	EC106A1	ECC	S2060A	NL-C40C	NAT	2N3652
C20C	GE	S6200D	C141F	GE	2N3654	EC106B1	ECC	S2060B	NL-C40D	NAT	2N3654
C20D	GE	S6200D	C220U	GE	S6210A	EC106M1	ECC	S2060M	NL-C40E	NAT	S7410M
C20F	GE	S6200A	C220A	GE	S6210A	EC107A1	ECC	S2061A	NL-C40G	NAT	2N3651
C20U	GE	S6200A	C220A2	GE	S6220A	EC107B1	ECC	S2061B	NL-C40H	NAT	2N3652
C22A	GE	S6210A	C220B	GE	S6210B	EC107M1	ECC	S2061M	NL-570M	NAT	2N690
C22B	GE	S6210B	C220B2	GE	S6220B	IR140A	IR	2N3650	PS08	HUTSON	S6200A
C22C	GE	S6210D	C220C	GE	S6210D	IR140B	IR	2N3651	PS18	HUTSON	S6200A
C22D	GE	S6210D	C220C2	GE	S6220D	IR140C	IR	2N3652	PS020	HUTSON	S6200A
C22F	GE	S6210A	C220D	GE	S6210D	IR140D	IR	2N3653	PS28	HUTSON	S6200B
C22U	GE	S6210A	C220D2	GE	S6220D	IR140F	IR	2N3654	PS035	HUTSON	2N3870
C34A2	GE	2N3650	C220E	GE	S6210M	IR141A	IR	2N3655	PS38	HUTSON	S6200D
C34B2	GE	2N3651	C220E2	GE	S6220M	IR141B	IR	2N3656	PS48	HUTSON	S6200D
C34C2	GE	2N3652	C220F	GE	S6210A	IR141C	IR	2N3657	PS58	HUTSON	S6200M
C34D2	GE	2N3653	C220F2	GE	S6220A	IR141D	IR	2N3658	PS68	HUTSON	S6200M
C34E2	GE	S7410M	C220U2	GE	S6220A	IR141F	IR	2N3654	PS120	HUTSON	S6200M
C34F2	GE	2N3650	C222A	GE	S6200A	MCR1718-5	MOT	2N3653	PS135	HUTSON	2N3870
C35A	GE	2N683	C222B	GE	S6200B	MCR1718-6	MOT	2N3653	PS220	HUTSON	S6200B
C35B	GE	2N685	C222C	GE	S6200D	MCR1718-7	MOT	S7410M	PS235	HUTSON	2N3871
C35C	GE	2N687	C222D	GE	S6200D	MCR1718-8	MOT	S7410M	PS320	HUTSON	S6200D
C35C	GE	2N688	C222E	GE	S6200M	MCR3818-1	MOT	S6200A	PS335	HUTSON	2N3872
C35E	GE	2N689	C222F	GE	S6200A	MCR3818-3	MOT	S6200A	PS420	HUTSON	S6200D
C35F	GE	2N682	C222U	GE	S6200A	MCR3818-5	MOT	S6200D	PS435	HUTSON	2N3872
C35G	GE	2N684	CS5-2T	CRL	2N3228	MCR3818-7	MOT	S6200M	PS520	HUTSON	S6200M
C35H	GE	2N686	CS5-4T	CRL	2N3525	MCR3835-1	MOT	2N3870	PS535	HUTSON	2N3873
C35M	GE	2N690	CS5-5.5T	CRL	2N4101	MCR3835-2	MOT	2N3870	PS620	HUTSON	S6200M
C35U	GE	2N681	CS10-02M	CRL	S6200A	MCR3835-3	MOT	2N3870	PS635	HUTSON	2N3873
C36A	GE	2N1844A	CS10-02N	CRL	S6210A	MCR3835-4	MOT	2N3871	RTS0202	TRAN	S6200A
C36B	GE	2N1846A	CS10-05M	CRL	S6200A	MCR3835-5	MOT	2N3872	RTS0205	TRAN	S6200A
C36C	GE	2N1848A	CS10-05N	CRL	S6210A	MCR3835-6	MOT	2N3872	RTS0210	TRAN	S6200A
C36D	GE	2N1849A	CS10-1M	CRL	S6200A	MCR3835-7	MOT	2N3873	RTS0220	TRAN	S6200B
C36E	GE	2N1850A	CS10-1N	CRL	S6210A	MCR3835-8	MOT	2N3873	RTS0230	TRAN	S6200D
C36F	GE	2N1843A	CS10-2M	CRL	S6200B	MCR3918-1	MOT	S6210A	RTS0240	TRAN	S6200D
C36G	GE	2N1845A	CS10-2N	CRL	S6210B	MCR3918-3	MOT	S6210A	RTS0250	TRAN	S6200M
C36H	GE	2N1847A	CS10-4M	CRL	S6200D	MCR3918-5	MOT	S6210D	RTS0260	TRAN	S6200M
C36U	GE	2N1842A	CS10-4N	CRL	S6210D	MCR3918-7	MOT	S6210M	RTS0502	TRAN	S6200A
C40A	GE	2N3650	CS10-6M	CRL	S6200M	MCR3935-1	MOT	2N3896	RTS0505	TRAN	S6200A
C40B	GE	2N3651	CS10-6N	CRL	S6210D	MCR3935-2	MOT	2N3896	RTS0510	TRAN	S6200A
C40C	GE	2N3652	CS20-05M	CRL	S6200A	MCR3935-3	MOT	2N3896	RTS0520	TRAN	S6200B
C40D	GE	2N3653	CS20-05N	CRL	S6210A	MCR3935-4	MOT	2N3897	RTS0530	TRAN	S6200D
C40E	GE	S7410M	CS20-1M	CRL	S6200A	MCR3935-5	MOT	2N3898	RTS0540	TRAN	S6200D
C40F	GE	2N3650	CS20-1N	CRL	S6210A	MCR3935-6	MOT	2N3898	RTS0550	TRAN	S6200M
C40G	GE	2N3651	CS20-2M	CRL	S6200B	MCR3935-7	MOT	2N3898	RTS0602	TRAN	S6200A
C40H	GE	2N3652	CS20-2N	CRL	S6210B	MCR3935-8	MOT	2N3899	RTS0605	TRAN	S6200A
C40U	GE	2N3650	CS20-4M	CRL	S6200D	NL-C35A	NAT	2N683	RTS0610	TRAN	S6200A
C122A	GE	S2800A	CS20-4N	CRL	S6210D	NL-C35B	NAT	2N685	RTS0620	TRAN	S6200B
C122B	GE	S2800B	CS20-6M	CRL	S6200M	NL-C35C	NAT	2N687	RTS0630	TRAN	S6200D
C122C	GE	S122C	CS20-6N	CRL	S6210M	NL-C35D	NAT	2N688	RTS0640	TRAN	S6200D
C122D	GE	S2800D	CS35-02M	CRL	2N3870	NL-C35E	NAT	2N689	RTS0650	TRAN	S6200M

RCA SCR Direct-Replacement Guide (Cont'd)

Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type	Other Mfg. Type	Mfg.	RCA Type
RTS0660	TRAN	S6200M	S2010G	ECC	S6200B	SPS520	HUTSON	S6210M
RTU0102	TRAN	S6210A	S2010H	ECC	S6210B	SPS620	HUTSON	S6210M
RTU0105	TRAN	S6210A	S2016B	ECC	S6220B	TC106A	TI	S2060A
RTU0110	TRAN	S6210A	S2016G	ECC	S6200B	TC106B	TI	S2060B
RTU0120	TRAN	S6210B	S2016H	ECC	S6210B	TC106C	TI	S2060C
RTU0130	TRAN	S6210D	S2025G	ECC	2N3871	TC106D	TI	S2060D
RTU0140	TRAN	S6210D	S2025H	ECC	2N3897	TC106F	TI	S2060F
RTU0150	TRAN	S6210M	S2035G	ECC	2N3871	TC106Y	TI	S2060Y
RTU0160	TRAN	S6210M	S2035H	ECC	2N3897	TIC116A	TI	S2800A
RTU0202	TRAN	2N3896	S4006B	ECC	S6220D	TIC116B	TI	S2800B
RTU0205	TRAN	2N3896	S4006G	ECC	S6200D	TIC116C	TI	S122C
RTU0210	TRAN	2N3896	S4006H	ECC	S6210D	TIC116D	TI	S122D
RTU0220	TRAN	2N3897	S4008B	ECC	S6220D	TIC116F	TI	S122A
RTU0230	TRAN	2N3898	S4008G	ECC	S6200D	10RC10A	IR	2N1844A
RTU0240	TRAN	2N3898	S4008H	ECC	S6210D	10RC10AS24	IR	2N3650
RTU0250	TRAN	S6410N	S4010B	ECC	S6220D	10RC20A	IR	2N1846A
RTU0260	TRAN	S6410N	S4010H	ECC	S6210D	10RC20AS24	IR	2N3650
RTU0602	TRAN	2N3896	S4016B	ECC	S6220D	10RC30A	IR	2N1848A
RTU0605	TRAN	2N3896	S4016G	ECC	S6200D	10RC30AS24	IR	2N3651
RTU0610	TRAN	2N3896	S4016H	ECC	S6210D	10RC40A	IR	2N1849A
RTU0620	TRAN	2N3897	S4025G	ECC	2N3872	10RC40AS24	IR	2N3652
RTU0630	TRAN	2N3898	S4025H	ECC	2N3898	10RC50A	IR	2N1850A
RTU0640	TRAN	2N3898	S4035G	ECC	2N3872	10RC50AS24	IR	S7410M
RTU0650	TRAN	2N3899	S4035H	ECC	2N3898	10RC60AS24	IR	S7410M
RTU0660	TRAN	2N3899	S6003RS2	ECC	S2060M	16RC10A	IR	2N683
RTU0705	TRAN	2N3896	S6003RS3	ECC	S2061M	16RC20A	IR	2N685
RTU0710	TRAN	2N3896	S6006B	ECC	S6220M	16RC20AS24	IR	2N3651
RTU0720	TRAN	2N3897	S6006G	ECC	S6200M	16RC30A	IR	2N687
RTU0730	TRAN	2N3898	S6006H	ECC	S6210M	16RC30AS24	IR	2N3652
RTU0740	TRAN	2N3898	S6008B	ECC	S6220M	16RC40A	IR	2N688
RTU0750	TRAN	2N3899	S6008G	ECC	S6200M	16RC40AS24	IR	2N3653
RTU0760	TRAN	2N3899	S6008H	ECC	S6210M	16RC50A	IR	2N689
S0525G	ECC	2N3870	S6010B	ECC	S6220M	16RC50AS24	IR	S7410M
S1003RS2	ECC	S2060A	S6010G	ECC	S6200M	16RC60A	IR	2N690
S1003RS3	ECC	S2061A	S6010H	ECC	S6210M	16RC60AS24	IR	S7410M
S1006B	ECC	S6220A	S6016B	ECC	S6220M	2N1842	SCR	2N1842A
S1006G	ECC	S6200A	S6016G	ECC	S6200M	2N1843	SCR	2N1843A
S1006H	ECC	S6210A	S6016H	ECC	S6210M	2N1844	SCR	2N1844A
S1008B	ECC	S6220A	S6025G	ECC	2N3873	2N1845	SCR	2N1845A
S1008G	ECC	S6200A	S6025H	ECC	2N3899	2N1846	SCR	2N1846A
S1008H	ECC	S6210A	S6035G	ECC	2N3873	2N1847	SCR	2N1847A
S1010B	ECC	S6220A	S6035H	ECC	2N3899	2N1848	SCR	2N1848A
S1010G	ECC	S6200A	S8025C	ECC	S6410N	2N1849	SCR	2N1849A
S1010H	ECC	S6210A	S8025D	ECC	S6420N	2N1850	SCR	2N1850A
S1016B	ECC	S6220A	S8025G	ECC	S6400N			
S1016G	ECC	S6200A	S8025H	ECC	S6410N			
S1016H	ECC	S6210A	S8035G	ECC	S6400N			
S1025G	ECC	2N3870	S8035H	ECC	S6410N			
S1025H	ECC	2N3896	SPS08	HUTSON	S6210A			
S1035G	ECC	2N3870	SPS18	HUTSON	S6210A			
S1035H	ECC	2N3896	SPS020	HUTSON	S6210A			
S2003RS2	ECC	S2060B	SPS28	HUTSON	S6210B			
S2003RS3	ECC	S2061B	SPS38	HUTSON	S6210D			
S2006B	ECC	S6220B	SPS48	HUTSON	S6210D			
S2006G	ECC	S6200B	SPS58	HUTSON	S6210M			
S2006H	ECC	S5210B	SPS68	HUTSON	S6210M			
S2008B	ECC	S6220B	SPS120	HUTSON	S6210A			
S2008G	ECC	S6200B	SPS220	HUTSON	S6210B			
S2008H	ECC	S6210B	SPS320	HUTSON	S6210D			
S2010B	ECC	S6220B	SPS420	HUTSON	S6210D			

G5001,G5002,G5003 Series
8.5-A Gate-Turn-Off (GTO) Silicon Controlled Rectifiers

For High-, Medium-, and Low-Frequency Power-Switching Applications

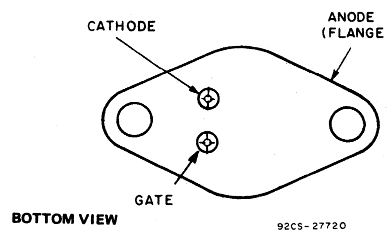
Features:

- **Turn-off capability at gate terminal**
- **Operating temperature range to 125°C**

The RCA-G5001, G5002, and G5003 series devices are gate-turn-off silicon controlled rectifiers (GTO's). GTO devices employ the same basic four-layer, three-junction regenerative semiconductor structure and exhibit a pulse turn-on capability similar to that of conventional silicon controlled rectifiers (SCR's). GTO devices, however, differ from conventional SCR's in that they can be turned off by application of a negative voltage to the gate terminal.

The G5001, G5002, and G5003 series gate-turn-off SCR's employ the popular JEDEC TO-3 hermetic package. The three series of devices differ in their gate-controlled turn-on and turn-off capabilities and peak reverse gate-voltage ratings. The types in each series differ in their off-state voltage ratings. The suffix letter indicates the voltage (V_{DRXM}) rating for each type.

TERMINAL DESIGNATIONS



JEDEC TO-3

MAXIMUM RATINGS, *Absolute-Maximum Values:*	G5001A G5002A G5003A	G5001B G5002B G5003B	G5001C G5002C G5003C	G5001D G5002D G5003D	G5001E G5002E G5003E	G5001M G5002M G5003M	
V_{RROM}	50	50	50	50	50	50	V
V_{DRXM}: R_{GK} = 1000 Ω	100	200	300	400	500	600	V
V_{GRRM}: G5001 series	70						V
G5002 series	70						V
G5003 series	50						V
I_{TGQM}	15						A
I_T (T_C = 75°C)	8.5						A
I_{TSM}: For one full cycle of applied principal voltage, 60 Hz (sinusoidal), T_C = 75°C	50						A
50 Hz (sinusoidal), T_C = 75°C	40						A
I^2t: T_J = –40 to 125°C, t = 1 to 8.3 ms	10						A^2s
P_D (T_C = 25°C)	50						W
I_{GM}	3						A
P_{GRM}	25						W
T_{stg}▲	–40 to 150						°C
T_C▲	–40 to 125						°C
T_L: At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	250						°C

▲ For temperature measurement reference point, see Dimensional Outline.

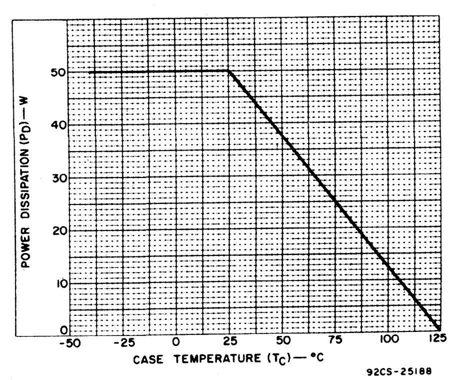


Fig. 1 — Dissipation vs. case temperature.

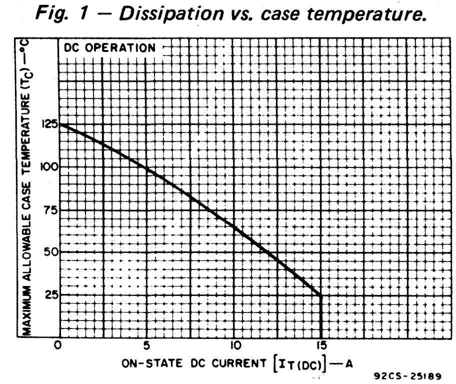


Fig. 2 — Maximum allowable case temperature vs. on-state dc current.

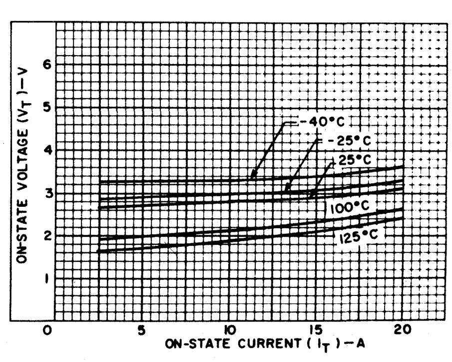


Fig. 3 — Maximum on-state voltage vs. maximum on-state current.

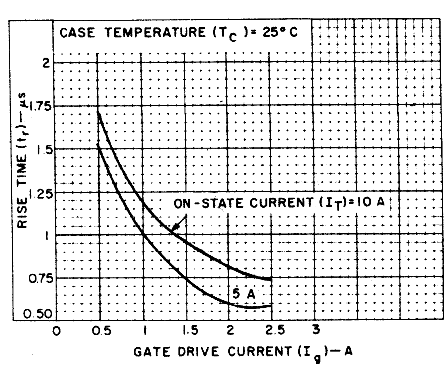


Fig. 4 — Rise time vs. gate-drive current.

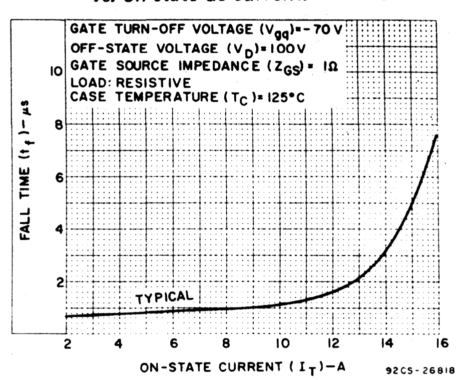


Fig. 5 — Fall time vs. on-state current for G5001 series.

G5001,G5002,G5003 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and T_C = 25°C Unless Otherwise Specified

CHARACTERISTIC	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED MIN.	TYP.	MAX.	UNITS
I_{DRXM}: $V_D = V_{DRXM}$, R_{GK} = 1000 Ω, T_C = 125°C	–	–	2	mA
I_{RROM}: $V_R = V_{RROM}$, T_C = 125°C	–	–	2	mA
I_{GRRM}: $V_{GR} = V_{GRRM}$	–	–	300	μA
V_T: For I_T = 5 A, T_J = 100°C	–	1.5	2	V
For other conditions	See Fig. 3			V
I_{GT}: V_D = 12 V (dc), R_L = 6.5 Ω, T_C = 25°C	–	–	160	mA
V_{GT}: V_D = 12 V (dc), R_L = 6.5 Ω, T_C = 25°C	–	–	2.5	V
I_L: V_D = 40 V, I_G = 200 mA, tp = 50 μs	–	500	800	mA
dv/dt: $V_D = V_{DRXM}$ value, V_G = –5 V, Exponential rise, T_C = 125°C	500	–	–	V/μs
t_{gt} (t_{ON}): $t_{gt} = t_d + t_r$; V_D = 100 V, I_T = 5 A, I_g = 1 A; G5001 series	–	–	t_d = 1, t_r = 1	μs
G5002 series	–	–	t_d = 1, t_r = 2	μs
G5003 series	–	–	t_d = 1, t_r = 2	μs
t_{gq} (t_{OFF}): $t_{gq} = t_s + t_f$; V_D = 100 V for all "A" types, 200 V for all "B","C","D","E", and"M" types, I_T = 5 A, Z_{GS} = 1 Ω, resistive load, T_C = 125°C: G5001 series (V_{gq} = –70 V)			t_s = 1, t_f = 1	μs
G5002 series (V_{gq} = –70 V)			t_s = 1.5, t_f = 2	μs
G5003 series (V_{gq} = –50 V)			t_s = 5, t_f = 5	μs
$R_{\theta JC}$▲	–	–	2	°C/W

▲ For temperature measurement reference point, see Dimensional Outline.

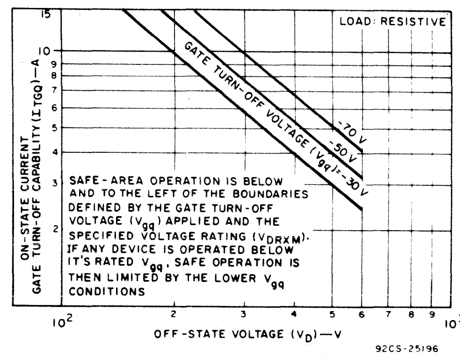


Fig. 6 — On-state current gate turn-off capability vs. off-state voltage.

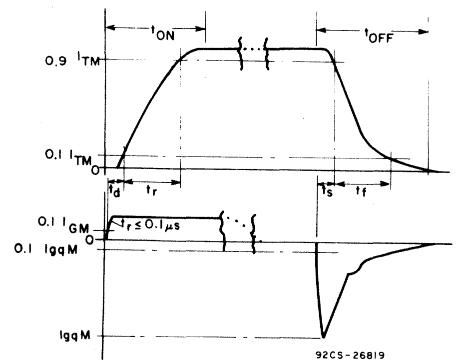


Fig. 7 — Relationship between anode current (on-state), gate-drive current, and time showing reference points for definition of t_{gt} (t_{ON}) and t_{gq} (t_{OFF}).

S2060, S2061, S2062 Series

4-A Sensitive-Gate Silicon Controlled Rectifiers

For Power Switching and Control Applications

The S2060, S2061, and S2062 series● are sensitive-gate silicon controlled rectifiers designed for switching ac and dc currents. These SCR's are divided into the three different series according to gate sensitivity. The types within each series differ in their voltage ratings; the voltage ratings are identified by suffix letters in the type designations.

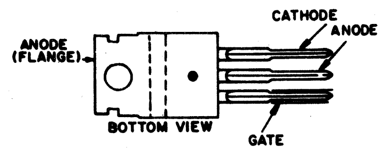
These thyristors have microampere gate-current requirements which permit operation with low-level logic circuits. They can be used for lighting, power-switching, and motor-speed controls, and for gate-current amplification for driving larger SCR's.

All types in each series utilize the JEDEC TO-220AB package. Upon request, each type is available in either of two variants of the TO-220AB package. For information on these package variations, contact the RCA Sales Office in your locale.

● Formerly the RCA106, RCA107, and RCA108 series.

Features:
- Microampere gate sensitivity
- Minimum gate current specified for the S2062 series
- 600-V capability
- 4-A (rms) on-state current ratings
- 35-A peak surge capability
- Glass-passivated chip for stability
- Low thermal resistances
- Surge capability curve

TERMINAL CONNECTIONS



92CS-27721

JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		Suffix Letter Q	Y	F	A	B	C	D	E	M	
NON-REPETITIVE PEAK REVERSE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 110°C	V_{RSXM}	25	50	75	125	250	400	500	600	700	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 110°C	V_{DSXM}										
REPETITIVE PEAK REVERSE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 110°C	V_{RRXM}	15	30	50	100	200	300	400	500	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 110°C	V_{DRXM}										

Rating	Symbol	Value	Units
ON-STATE CURRENT: Conduction angle = 180°, T_C = 85°C			
Average ac value	$I_{T(AV)}$	2.5	A
RMS value	$I_{T(RMS)}$	4	A
DC operation	$I_{T(DC)}$	2.75	A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT: For one cycle of applied principal voltage, T_C = 85°C	I_{TSM}		
60 Hz (sinusoidal)		35	A
50 Hz (sinusoidal)		28	A
60 Hz (sinusoidal)	I_{TSM}	35	A
For more than one cycle of applied principal voltage		See Fig. 5	
PEAK GATE CURRENT (t = 10 μsec)	I_{GM}	0.2	A
PEAK GATE REVERSE VOLTAGE	V_{RGM}	6	V
RATE OF CHANGE OF ON-STATE CURRENT: V_{DM} = V_{DROM}, I_{GT} = 1 mA, t_r = 0.5 μs, T_C = 110°C	di/dt	100	A/μs
FUSING CURRENT (for SCR protection): T_J = −40 to 110°C, t = 1 to 8.3 ms	I^2t	2.6	A^2s
GATE POWER DISSIPATION:			
PEAK FORWARD (for 10 μs max.)	P_{GM}	0.5	W
AVERAGE (averaging time = 10 ms max.)	$P_{G(AV)}$	0.1	W
TEMPERATURE RANGE:			
Storage	T_{stg}	-40 to +150	°C
Operating (case)*	T_C	-40 to +110	°C
TERMINAL TEMPERATURE (During soldering): For 10 s max.	T_T	250	°C

*Temperature measuring point is shown in the dimensional outline.

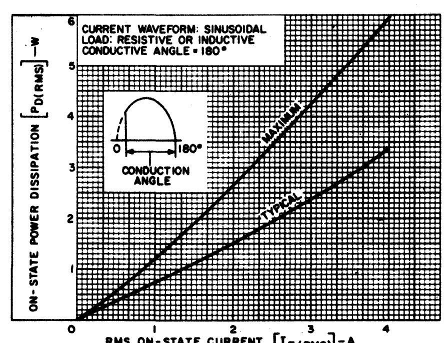


Fig. 1—Power dissipation vs. rms-on-state current for all series.

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED MIN.	TYP.	MAX.	UNITS
PEAK OFF-STATE CURRENT: Forward, V_D = V_{DRXM}, R_{GK} = 1000 Ω	I_{DRXM}				μA
T_C = 25°C		–	0.1	10	
T_C = 110°C		–	10	100	
Reverse, V_R = V_{RRXM}, R_{GK} = 1000 Ω	I_{RRXM}				
T_C = 25°C		–	0.1	10	
T_C = 100°C		–	10	100	
INSTANTANEOUS ON-STATE VOLTAGE: For i_T = 4 A and T_C = 25°C (See Fig. 7)	v_T	–	1.25	2.2	V
DC GATE TRIGGER CURRENT: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C:	I_{GT}				μA
S2060 Series		–	–	200	
S2061 Series		–	–	500	
S2062 Series		100	–	2000	
For other case temperatures		See Figs. 10,11,12			
DC GATE TRIGGER VOLTAGE: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	V_{GT}	–	0.5	0.8	V
For other case temperatures		See Fig. 14			
INSTANTANEOUS HOLDING CURRENT: R_{GK} = 1000 Ω, V_D = 12 V, $I_{T(INITIAL)}$ = 50 mA, T_C = 25°C:	i_H				mA
S2060 Series		–	1.7	3	
S2061 Series		–	3.9	6	
S2062 Series		–	6	10	

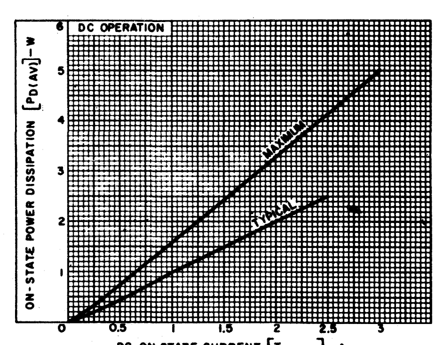


Fig. 2—Power dissipation vs. dc on-state current for all series.

S2060, S2061, S2062 Series

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED MIN.	TYP.	MAX.	UNITS
LATCHING CURRENT: R_{GK} = 1000 Ω, V_D = 12 V, T_C = 25°C:					
S2060 Series (I_{GT} = 200 μA)	i_L	–	1.8	4	mA
S2061 Series (I_{GT} = 500 μA)		–	2.5	8	
S2062 Series (I_{GT} = 2000 μA)		–	8	12	
CRITICAL RATE OF RISE OF OFF-STATE VOLTAGE: V_D = V_{DRXM}, R_{GK} = 1000 Ω, Exponential rise, T_C = 110°C	dv/dt	5	8	–	V/μs
GATE-CONTROLLED TURN-ON TIME: V_D = V_{DRXM}, i_T = 1 A, R_{GK} = 1000 Ω, I_{GT} = 1 mA, rise time = 0.1 μs, T_C = 25°C	t_{gt}	–	1.7	2.5	μs
CIRCUIT COMMUTATED TURN-OFF TIME: V_D = V_{DRXM}, i_T = 1 A, R_{GK} = 1000 Ω, Pulse Duration = 50 μs, dv/dt = 5 V/μs, di/dt = −10 A/μs, I_{GT} = 1 mA at turn on, T_C = 110°C	t_q	–	30	100	μs
THERMAL RESISTANCE: Junction-to-Case*	$R_{\theta JC}$	–	–	3.5	°C/W
Junction-to-Ambient	$R_{\theta JA}$	–	–	60	

* Temperature measuring point is shown in the dimensional outline.

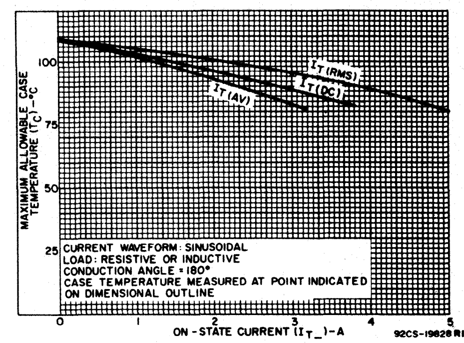


Fig. 3—Maximum allowable case temperature vs. on-state current for all series.

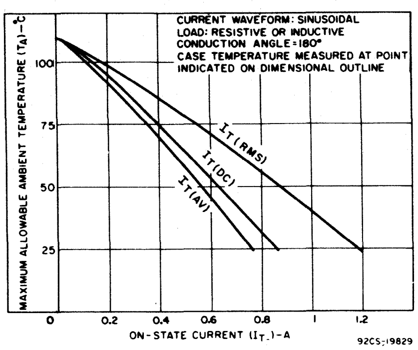


Fig. 4—Maximum allowable ambient temperature vs. on-state current for all series.

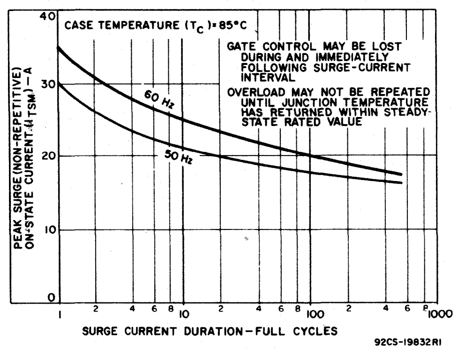


Fig. 5—Peak surge on-state current vs. surge-current duration for all series.

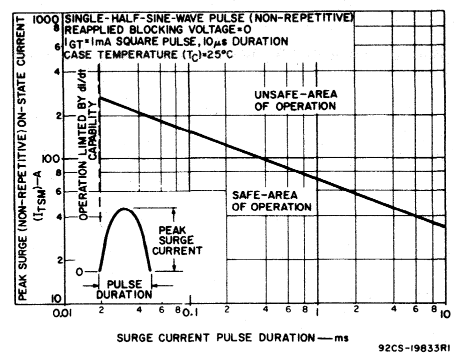


Fig. 6—Surge capability without reapplied blocking voltage for all series.

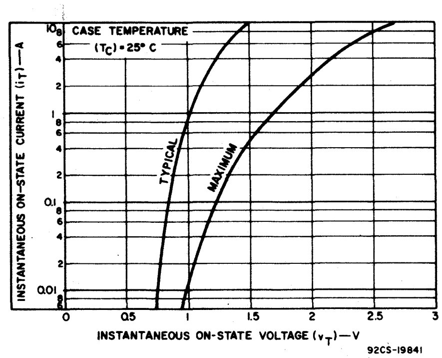


Fig. 7—Instantaneous on-state current vs. on-state voltage for all series.

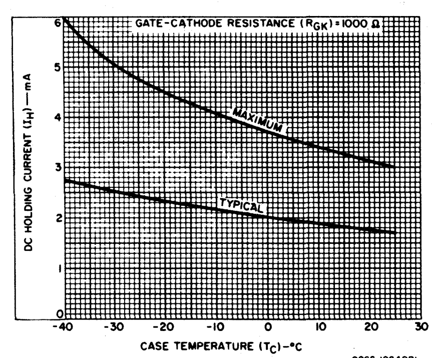


Fig. 8—DC holding current vs. case temperature for the S2060 series.

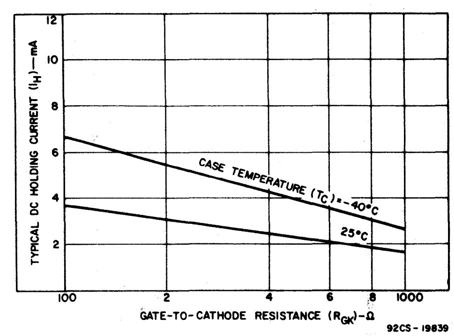


Fig. 9—DC holding current vs. gate-cathode resistance for the S2060 series.

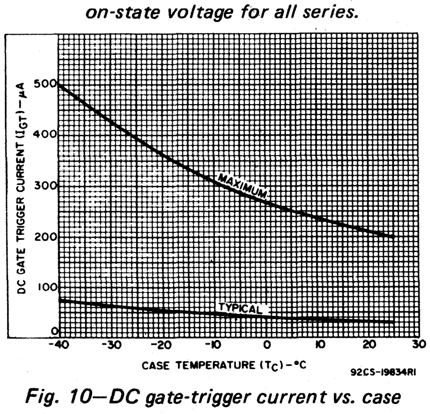


Fig. 10—DC gate-trigger current vs. case temperature for S2060 series.

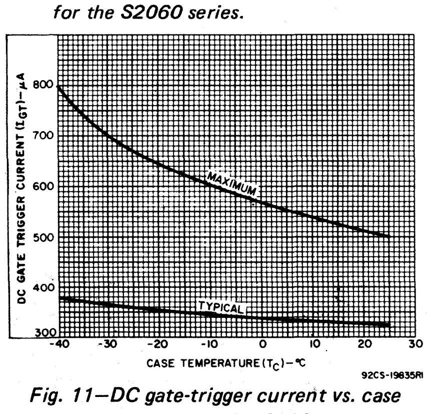


Fig. 11—DC gate-trigger current vs. case temperature for S2061 series.

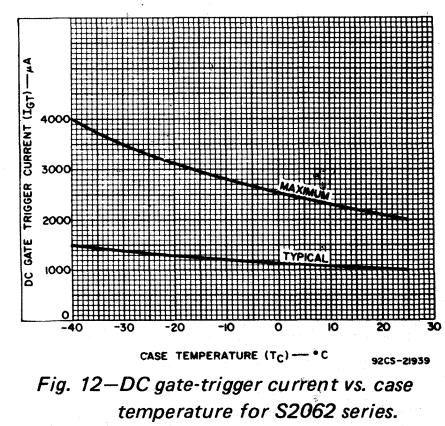


Fig. 12—DC gate-trigger current vs. case temperature for S2062 series.

S2060, S2061, S2062 Series

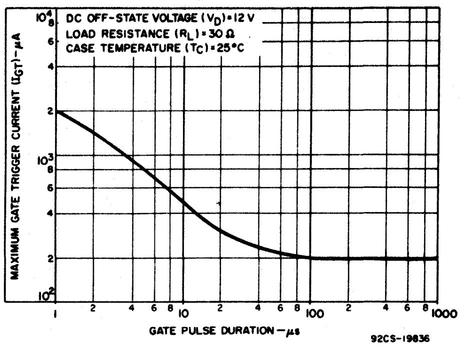


Fig. 13—Maximum gate-trigger current vs. gate-pulse duration for types in the S2060 series.

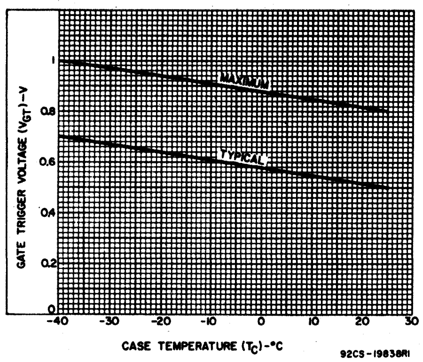


Fig. 14—Gate-trigger voltage vs. case temperature for all series.

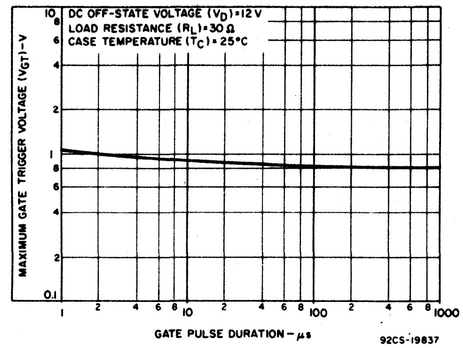


Fig. 15—Maximum gate-trigger voltage vs. gate pulse duration for types in the S2060 series.

S2200(2N3528, 2N3529,2N4102), S2710, S2700(2N3228,2N3525,2N4101, Series

5-A Silicon Controlled Rectifiers

For Low-Cost Power-Control and Power-Switching Applications

RCA 2N3228*, 2N3525*, 2N4101*, and 2N3528•, 2N3529•, and 2N4102• are all-diffused, three-junction, silicon controlled-rectifiers (SCR's) intended for use in power-control and power-switching applications.

Types 2N3228, 2N3525, and 2N4101 use the JEDEC TO-66 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 5 amperes (rms value) at a case temperature of 75°C.

* Formerly Dev. Types TA1222, TA1225, and TA2773, respectively.

• Formerly Dev. Types TA2597, TA2617, and TA2774, respectively.

Types 2N3528, 2N3529, and 2N4102 use the JEDEC TO-8 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 2 amperes (rms value) at an ambient temperature of 25°C.

S2710B, S2710D, and S2710M are all-diffused, three-junction silicon controlled-rectifiers having integral heat radiators. They are variants of the 2N3228, 2N3525, and 2N4101, respectively.*

FEATURES

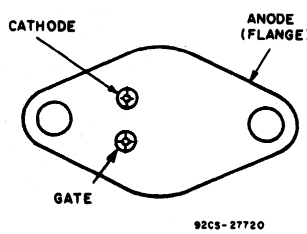
- Designed especially for high-volume systems
- Readily adaptable for printed-circuit boards and metal heat sinks
- Low switching losses
- High di/dt and dv/dt capabilities
- Shorted emitter gate-cathode construction
- Forward and reverse gate dissipation ratings
- All-diffused construction – assures exceptional uniformity and stability of characteristics
- Direct-soldered internal construction – assures exceptional resistance to fatigue
- Symmetrical gate-cathode construction – provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- All-welded construction and hermetic sealing
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- Low thermal resistance

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load

RATINGS	CONTROLLED-RECTIFIER TYPES						UNITS
	2N3228 S2710B	2N3525 S2710B	2N4101 S2710M	2N3528	2N3529	2N4102	
Transient Peak Reverse Voltage (Non-Repetitive), v_{RM}(non-rep)	330	660	700	330	660	700	volts
Peak Reverse Voltage (Repetitive), v_{RM}(rep)	200	400	600	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), v_{FBOM}(rep)	200	400	600	200	400	600	volts
Forward Current:							
For case temperature (T_C) of + 75°C, and unit mounted on heat sink–							
Average DC value at a conduction angle of 180°, I_{FAV}	3.2	3.2	3.2	—	—	—	amperes
RMS value, I_{FRMS}	5.0	5.0	5.0	—	—	—	amperes
For other conditions, See Fig. 2							
For free-air temperature (T_{FA}) of 25°C, and with no heat sink employed–							
Average DC value at a conduction angle of 180°, I_{FAV}	1.7	1.7	1.7	1.3	1.3	1.3	amperes
RMS value, I_{FRMS}	—	—	—	2.0	2.0	2.0	amperes
For other conditions, See Figs. 3 & 4							
Peak Surge Current, i_{FM}(surge):							
For one cylce of applied principal voltage,							
60 Hz (sinusoidal), T_C = 75°C		60			60		amperes
50 Hz (sinusoidal), T_C = 75°C		50			50		amperes
For more than one cycle of applied voltage		See Fig. 5			See Fig. 5		
Fusing Current (for SCR protection): T_J = −40 to 100°C, t = 1 to 8.3 ns, I^2t		15			15		ampere² second
Rate of Change of Forward Current, di/dt		200			200		amperes/ microsecond
V_{FB} = v_{BOO}(min. value)							
I_{GT} = 200mA, 0.5 μs rise time							
Gate Power*:							
Peak, Forward or Reverse, for 10 μs duration, P_{GM} (See Figs. 7 and 9)		13			13		watts
Average, P_{GAV}		0.5			0.5		watt
Temperature:							
Storage, T_{stg}		−40 to +125			−40 to +125		°C
Operating (Case), T_C		−40 to +100			−40 to +100		°C

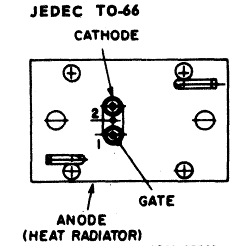
*Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

TERMINAL CONNECTIONS



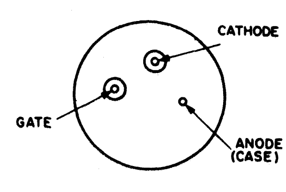
BOTTOM VIEW

JEDEC TO-66



BOTTOM VIEW

TO-66 with Heat Radiator



BOTTOM VIEW

JEDEC TO-8

S2200(2N3528, 2N3529, 2N4102), S2710, S2700(2N3228, 2N3525, 2N4101), Series

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES									UNITS
	2N3228, 2N3528 S2710B			2N3525, 2N3529 S2710D			2N4101, 2N4102 S2710M			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Breakover Voltage, v_{BOO}: At T_C = +100°C	200	—	—	400	—	—	600	—	—	volts
Peak Blocking Current, at T_C = +100°C: Forward, I_{FBOM} $V_{FBO}{}^{P}$ = v_{BOO}(min. value)	—	0.10	1.5	—	0.20	3.0	—	0.40	4.0	mA
Reverse, I_{RBOM} $V_{RBO}{}^{P}$ = v_{RM}(rep) value	—	0.05	0.75	—	0.10	1.5	—	0.20	2.0	mA
Forward Voltage Drop, v_F At a Forward Current of 30 amperes and a T_C = +25°C	—	2.15	2.8	—	2.15	2.8	—	2.15	2.8	volts
DC Gate-Trigger Current, I_{GT} At T_C = +25°C (See Fig. 9)	—	8	15	—	8	15	—	8	15	mA(dc)
Gate-Trigger Voltage, V_{GT} At T_C = +25°C (See Fig. 9)	—	1.2	2.0	—	1.2	2.0	—	1.2	2.0	volts(dc)
Holding Current, i_{HOO} At T_C = +25°C	—	10	20	—	10	20	—	10	20	mA
Critical Rate of Applied Forward Voltage, Critical dv/dt V_{FB} = v_{BOO}(min. value), exponential rise, T_C = +100°C	10	200	—	10	200	—	10	200	—	volts/ microsecond
Turn-On Time, t_{on}, (Delay Time + Rise Time) V_{FB} = v_{BOO}(min. value), i_F = 4.5 amperes, I_{GT} = 200mA, 0.1 μs rise time, T_C = +25°C	0.75	1.5	—	0.75	1.5	—	0.75	1.5	—	microseconds
Turn-Off Time, t_{off}. i_F = 2 amperes, 50 μs pulse width, dv_{FB}/dt = 20 v/μs, di_r/dt = 30 A/μs, I_{GT} = 200mA, T_C = +75°C	—	15	50	—	15	50	—	15	50	microseconds

	2N3228, 2N3525, 2N4101			2N3528, 2N3529, 2N4102			
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Thermal Resistance: Junction-to-case	—	—	4	—	—	5	°C/W
Junction-to-ambient	—	—	40	—	—	40	°C/W
	S2710 series			—	—	—	°C/W
Junction-to-Ambient	—	—	28	—	—	—	

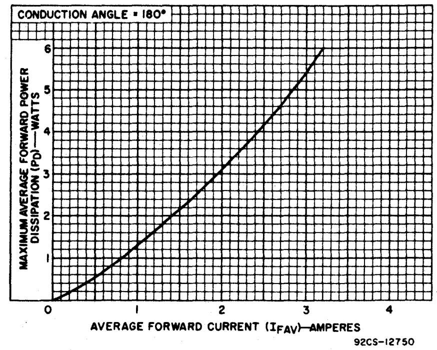


Fig. 1—Power dissipation chart for all types.

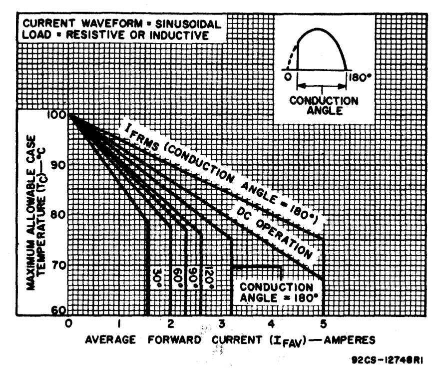


Fig. 2—Rating chart (case temperature) for types 2N3228, 2N3525, and 2N4101.

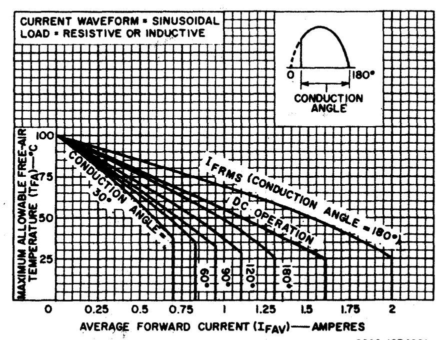


Fig. 3—Rating chart (free-air temperature) for types 2N3528, 2N3529, and 2N4102.

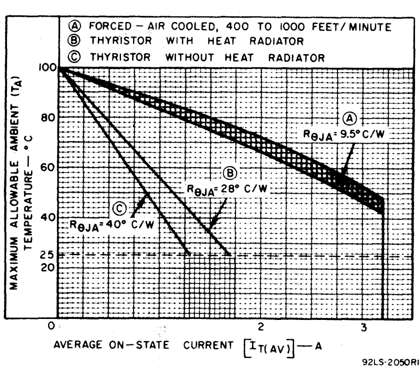


Fig. 4—Maximum allowable ambient temperature vs. on-state current for S2710 series only.

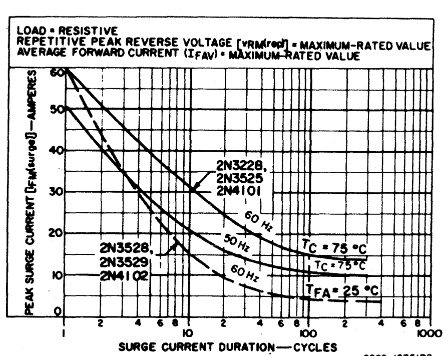


Fig. 5—Surge-current rating chart.

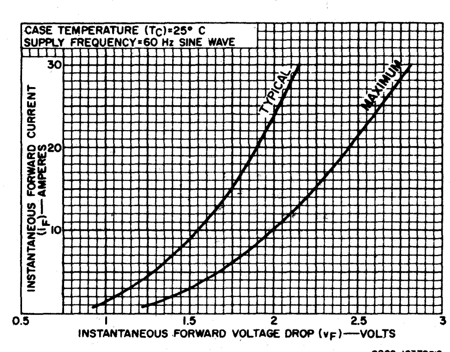


Fig. 6—Forward characteristics for all types.

S2200(2N3528, 2N3529, 2N4102), S2710, S2700(2N3228, 2N3525, 2N4101), Series

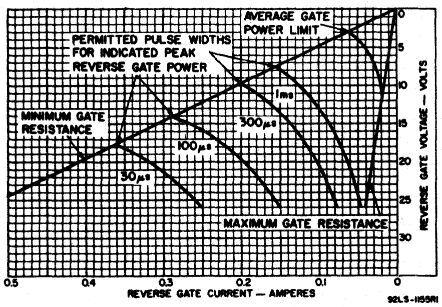


Fig. 7—Reverse gate characteristics.

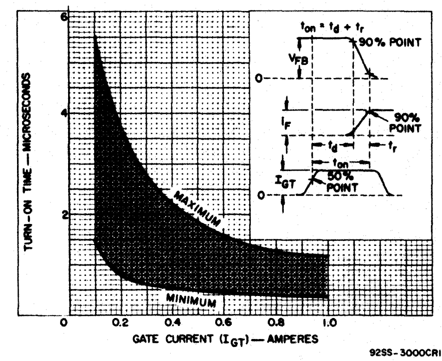


Fig. 8—Turn-on time characteristics.

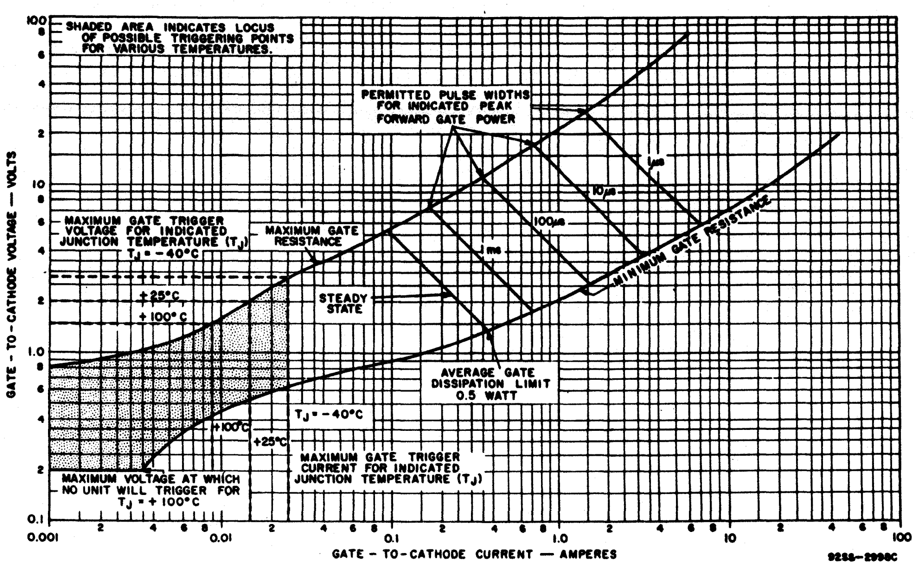


Fig. 9—Forward gate characteristics.

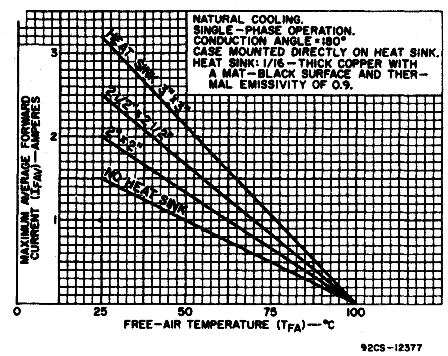


Fig. 10—Operation guidance chart for types 2N3228, 2N3525, and 2N4101.

S2600, S2610, S2620 Series

7-Ampere "Low-Profile" Silicon Controlled Rectifiers

For Power Switching, Power Control, Power Crowbar, and Ignition Applications

The S2600, S2610, and S2620 series are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) for capacitor-discharge ignition systems, high-voltage generators, and power-switching and control applications. They may be used in capacitor-discharge ignition systems (battery or magneto types) for internal combustion engines, electronic igniters, and high-voltage generators. Other uses are power-control and power-switching circuits.

The S2600B, S2600D, and S2600M have a three-lead low-profile package (similar to the JEDEC TO-5). The S2610B, S2610D, and S2610M have integral heat radiators. The S2620B, S2620D, and S2620M have integral heat spreaders.

Features:

- Forward and reverse gate ratings
- All-diffused center gate construction
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- High pulse-current capability for capacitor-discharge ignition circuits
- High dv/dt capability
- Low switching losses
- Low thermal resistance
- Sub-cycle surge capability curve

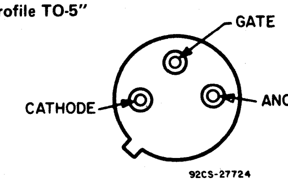
MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with Resistive or Inductive Load.

		S2600B S2610B S2620B	S2600D S2610D S2620D	S2600M S2610M S2620M	
NON-REPETITIVE PEAK REVERSE VOLTAGE•: Gate open	V_{RSOM}	250	500	700	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE:•: Gate open	V_{DSOM}	250	500	700	V
REPETITIVE PEAK REVERSE VOLTAGE•: Gate open	V_{RROM}	200	400	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE•: Gate open	V_{DROM}	200	400	600	V
RMS ON-STATE CURRENT (Conduction angle = 180°)	$I_{T(RMS)}$		See Figs. 2-6		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT: For one cycle of applied principal voltage	I_{TSM}				
60 Hz (sinusoidal)		100	100	100	A
50 Hz (sinusoidal)		85	85	85	A
For more than one cycle of applied principal voltage			See Fig. 7		
PEAK REPETITIVE ON-STATE CURRENT† (See Fig. 16): Duty factor = 0.1%, T_C = 75°C, Pulse duration = 5 µs (min.), 20 µs (max.)	I_{TRM}	100	100	100	A
RATE OF CHANGE OF ON-STATE CURRENT: $V_{DM} = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.5 µs	di/dt		200		A/µs
FUSING CURRENT (for SCR protection): T_J = −65 to 100°C, t = 1 to 8.3 ms	I^2t		40		A^2s
NON-REPETITIVE SUB-CYCLE SURGE CURRENT: T_C = 25°C, single pulse, I_{GT} = 50 mA, 10 µs square pulse			See Fig. 20		
GATE POWER DISSIPATION▲: PEAK FORWARD (for 1 µs max.)	P_{GM}	40	40	40	W
PEAK REVERSE	P_{RGM}		See Fig. 14		
AVERAGE (averaging time = 10 ms, max.)	$P_{G(AV)}$	0.5	0.5	0.5	W
TEMPERATURE RANGE♦: Storage	T_{stg}		-65 to +150		°C
Operating (case)	T_C		-65 to +100		°C
LEAD TEMPERATURE (During soldering)■: For 10 s max. for case or leads			225		°C

† When rms current exceeds 4 amperes (maximum rating for the anode lead), connection must be made to the case.
•These values do not apply if there is a positive gate signal. Gate must be open, terminated, or have negative bias.
▲Any values of peak gate current or peak gate voltage that yield the maximum gate power are permissible.
♦For information on the reference point of temperature measurement, see dimensional outlines.
■When these devices are soldered directly to the heat sink, a 60/40 solder should be used. Case heating time should be a minimum . . . sufficient to allow the solder to flow freely.

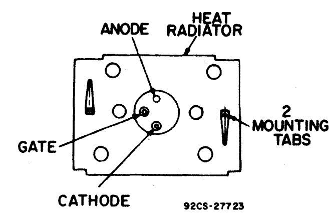
TERMINAL CONNECTIONS

"Low-Profile TO-5"



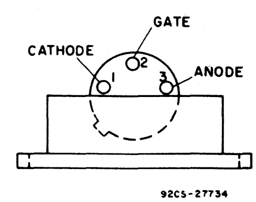
BOTTOM VIEW
S2600 Series

"Low-Profile TO-5" with Heat Radiator



BOTTOM VIEW
S2610 Series

"Low-Profile TO-5" with Heat Spreader



S2620 Series

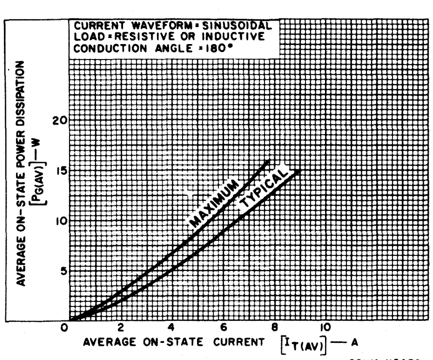


Fig. 1—Power dissipation vs. on-state current.

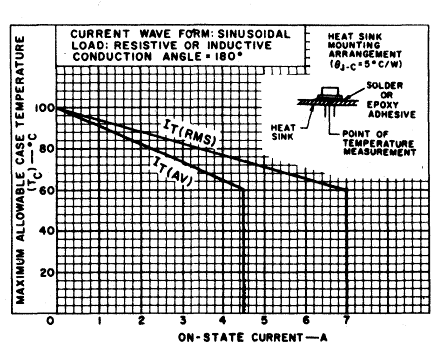


Fig. 2—Maximum allowable case temperature vs. on-state current for S2600 series.

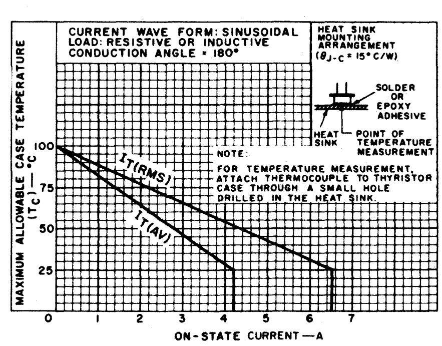


Fig. 3—Maximum allowable case temperature vs. on-state current for S2600 series.

S2600, S2610, S2620 Series

ELECTRICAL CHARACTERISTICS, *At maximum ratings and at indicated case temperature (T_C) unless otherwise specified*

CHARACTERISTIC	SYMBOL	LIMITS S2600 Series MIN.	S2600 Series TYP.	S2600 Series MAX.	S2610 Series S2620 Series MIN.	S2610 Series S2620 Series TYP.	S2610 Series S2620 Series MAX.	UNITS
PEAK OFF-STATE CURRENT: (Gate Open, T_C = +100°C) FORWARD, V_D = V_{DROM}	I_{DOM}	–	0.1	0.5	–	0.2	1.5	mA
REVERSE, V_R = V_{RROM}	I_{ROM}	–	0.05	0.5	–	0.1	1.5	
INSTANTANEOUS ON-STATE VOLTAGE: For i_T = 30 A and T_C = +25°C	v_T	–	1.9	2.6	–	1.9	2.6	V
DC GATE TRIGGER CURRENT: V_D = 12 V (DC), R_L = 30 Ω, T_C = +25°C	I_{GT}	–	6	15	–	6	15	mA
For other case temperatures		See Fig. 12						
DC GATE TRIGGER VOLTAGE: V_D = 12 V (DC), R_L = 30 Ω, T_C = +25°C	V_{GT}	–	0.65	1.5	–	0.65	1.5	V
For other case temperatures		See Fig. 13						
INSTANTANEOUS HOLDING CURRENT: Gate Open and T_C = +25°C	i_{HO}	–	9	20	–	9	20	mA
For other case temperatures		See Fig. 10						
CRITICAL RATE-OF-RISE OF OFF-STATE VOLTAGE: V_D = V_{DROM}, Exponential rise, T_C = +100°C (See Fig. 3)	dv/dt	20	200	–	20	200	–	V/μs
GATE CONTROLLED TURN-ON TIME: V_D = V_{DROM}, i_T = 4.5 A, I_{GT} = 200 mA, 0.1 μs rise time, T_C = +25°C (See Fig. 15)	t_{gt}	–	1	2	1	2	–	μs
CIRCUIT COMMUTATED TURN-OFF TIME: V_D = V_{DROM}, i_T = 2 A, Pulse Duration = 50 μs, dv/dt = 20V/μs, di/dt = -30A/μs, I_{GT} = 200 mA at turn on, T_C = +75°C	t_q	–	15	50	–	15	50	μs
THERMAL RESISTANCE: Junction-to-Case	$R_{\theta JC}$	–	–	5	–	–	5	°C/W
Junction-to-Ambient (See dimensional outlines)	$R_{\theta JA}$	–	–	120	–	–	30 (S2610 Series)	
Junction-to-Heat Spreader (See dimensional outline)	$R_{\theta JHS}$	–	–	–	–	–	7 (S2620 Series)	

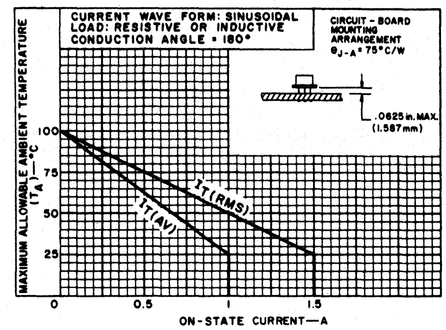


Fig. 4—Maximum allowable ambient temperature vs. on-state current for S2600 series.

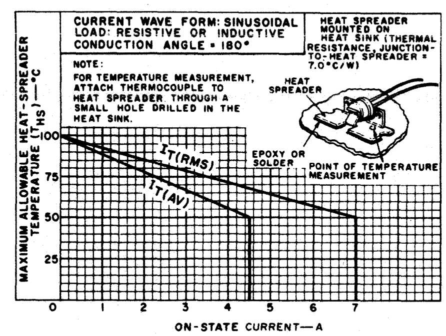


Fig. 5—Maximum allowable heat-spreader temperature vs. on-state current for S2620 series.

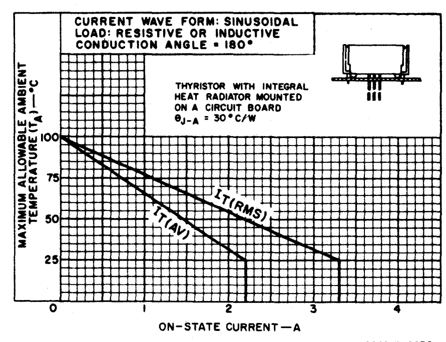


Fig. 6—Maximum allowable ambient temperature vs. on-state current for S2610 series.

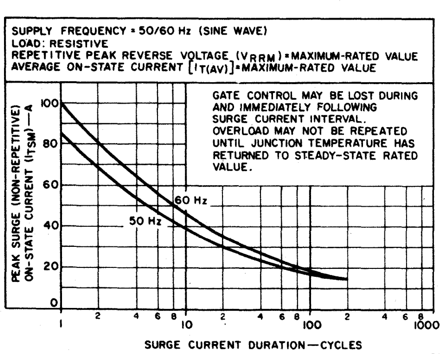


Fig. 7—Peak surge on-state current vs. surge-current duration for all types.

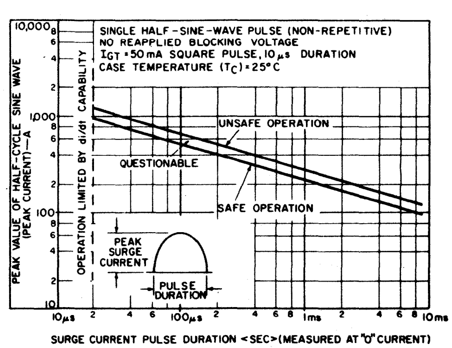


Fig. 8—Sub-cycle surge capability.

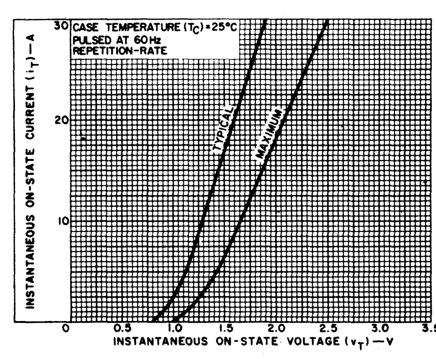


Fig. 9—Instantaneous on-state current vs. on-state voltage for all types.

S2600, S2610, S2620 Series

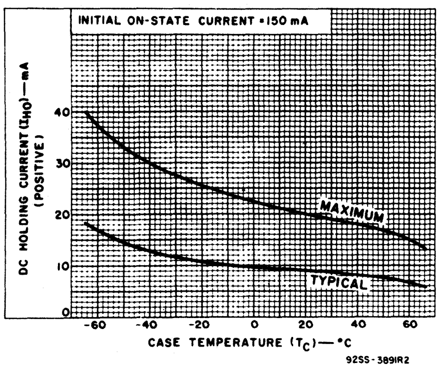


Fig. 10—DC holding current (positive) vs. case temperature.

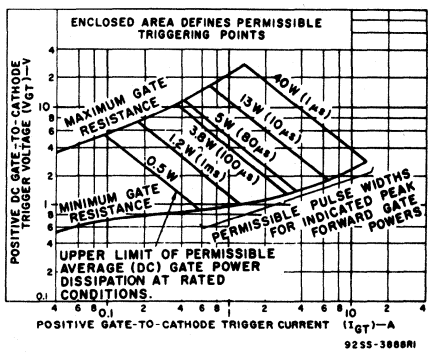


Fig. 11—Gate-pulse characteristics for forward-triggering mode.

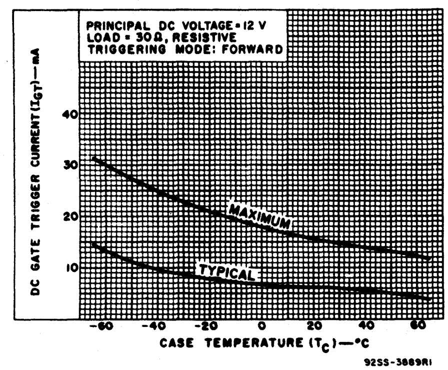


Fig. 12—DC gate-trigger current (forward) vs. case temperature.

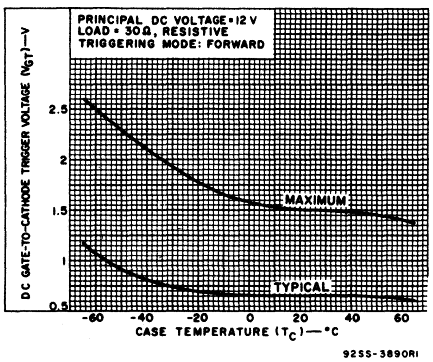


Fig. 13—DC gate-trigger voltage vs. case temperature.

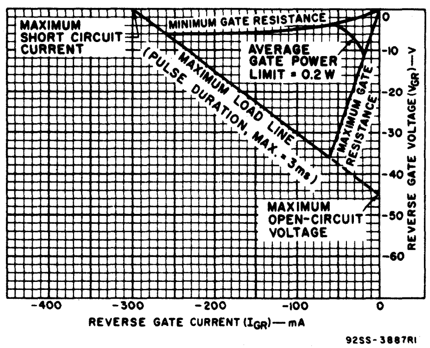


Fig. 14—Reverse-gate voltage vs. reverse-gate current.

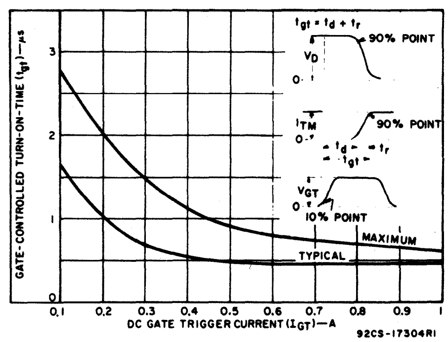


Fig. 15—Gate controlled turn-on time (t_{gt}) vs. gate-trigger current.

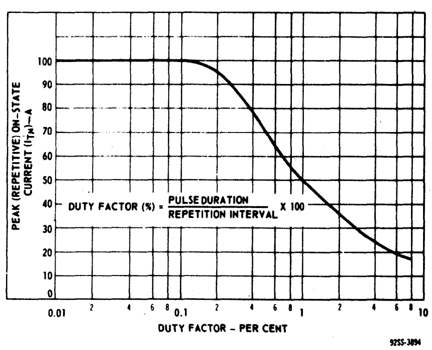


Fig. 16—Derating curve for peak pulse current (repetitive) vs. duty factor for the ignition circuit.

S122, S2800 Series

8-A and 10-A Silicon Controlled Rectifiers

For Power Switching, Power Control, and Ignition Applications

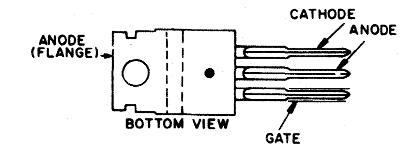
The RCA-S122 and RCA-S2800 series types are medium-power silicon controlled rectifiers (reverse-blocking triode thyristors) designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state regardless of gate-voltage polarity.

The plastic TO-220AB package provides easy package mounting and low thermal resistance, allowing operation at high case temperatures and permitting reduced heat-sink size. These SCR's can be used in lighting and motor-speed controls, capacitor-discharge ignition circuits, high-voltage generators, automotive applications, and power-switching systems.

Features:

- High dv/dt capability
- Glass-passivated chip
- Low on-state voltage at high current levels
- Shorted-emitter gate-cathode construction
- Low thermal resistance
- Center-gate construction

TERMINAL CONNECTIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

<table>
<tr><th></th><th>S122F
S2800F</th><th>S122A
S2800A</th><th>S122B
S2800B</th><th>S122C
S2800C</th><th>S122D
S2800D</th><th>S122E
S2800E</th><th>S122M
S2800M</th><th>S122S
S2800S</th><th></th></tr>
<tr><td>V_{RSOM}▲, V_{DSOM}▲</td><td>75</td><td>125</td><td>250</td><td>375</td><td>500</td><td>600</td><td>700</td><td>800</td><td>V</td></tr>
<tr><td>V_{RROM}▲, V_{DROM}▲</td><td>50</td><td>100</td><td>200</td><td>300</td><td>400</td><td>500</td><td>600</td><td>700</td><td>V</td></tr>
<tr><td>$I_{T(RMS)}$ (T_C = 75°C, θ = 180°) - S122 series</td><td colspan="8">8</td><td>A</td></tr>
<tr><td>- S2800 series</td><td colspan="8">10</td><td>A</td></tr>
<tr><td>I_{TSM}
For one full cycle of applied principal voltage 400 Hz</td><td colspan="8">200</td><td>A</td></tr>
<tr><td>60 Hz</td><td colspan="8">100</td><td>A</td></tr>
<tr><td>50 Hz</td><td colspan="8">85</td><td>A</td></tr>
<tr><td>For more than one full cycle of applied principal voltage</td><td colspan="8">See Fig. 4</td><td></td></tr>
<tr><td>di/dt
V_D = V_{DROM}, I_{GT} = 80 mA, t_r = 0.5 μs</td><td colspan="8">100</td><td>A/μs</td></tr>
<tr><td>I^2t
T_J = −65 to 100°C; t = 1 to 8.3 ms</td><td colspan="8">40</td><td>A^2s</td></tr>
<tr><td>P_{GM}● (for 10 μs max.)</td><td colspan="8">16</td><td>W</td></tr>
<tr><td>P_{RGM}●</td><td colspan="8">See Fig. 10</td><td></td></tr>
<tr><td>$P_{G(AV)}$● (averaging time = 10 ms max.)</td><td colspan="8">0.5</td><td>W</td></tr>
<tr><td>T_{stg}■</td><td colspan="8">−65 to +150</td><td>°C</td></tr>
<tr><td>T_C■</td><td colspan="8">−65 to +100</td><td>°C</td></tr>
<tr><td>T_T
During soldering for 10 s maximum (terminal and case)</td><td colspan="8">250</td><td>°C</td></tr>
</table>

▲These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
● Any values of peak gate current or peak gate voltage which result in an equal or lower power are permissible.
■ For information on the reference point of temperature measurement, see Dimensional Outline.

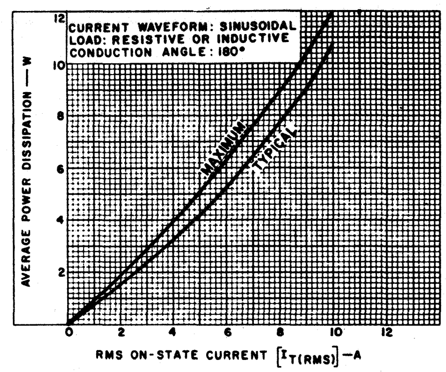


Fig. 1 — Power dissipation vs. on-state current for all types.

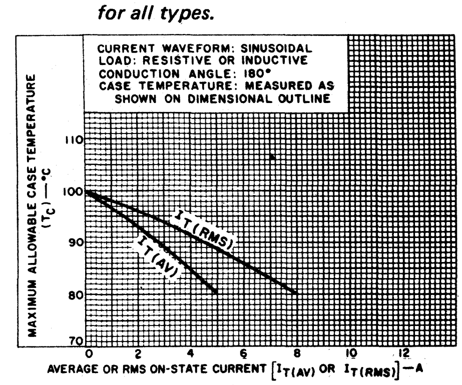


Fig. 2 — Maximum allowable case temperature vs. on-state current for S122 series.

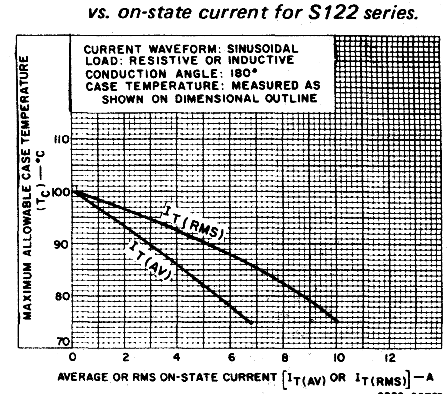


Fig. 3 — Maximum allowable case temperature vs. on-state current for S2800 series.

ELECTRICAL CHARACTERISTICS,
At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS For All Types Except as Specified MIN.	TYP.	MAX.	UNITS
I_{DOM} or I_{ROM} V_D = V_{DROM} or V_R = V_{RROM}, T_C = +100°C	–	0.1	2	mA
V_T See Fig. 5 & 6 i_T = 16 A, T_C = 25°C (S122 series) = 30 A, T_C = 25°C (S2800 series)	– –	1.45 1.7	1.83 2	V
I_{GT} See Fig. 11 & 12 V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C (S122 series) V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C (S2800 series)	– –	18 8	25 15	mA
V_{GT} V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C For other case temperatures	–	0.9 See Fig. 13	1.5	V
I_{HO} T_C = 25°C (S122 series) T_C = 25°C (S2800 series) For other case temperatures	– –	20 10 See Fig. 7 & 8	30 20	mA

S122 , S2800 Series

ELECTRICAL CHARACTERISTICS,
At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	MIN.	TYP.	MAX.	
dv/dt $V_D = V_{DROM}$ Exponential voltage rise, $T_C = 100°C$ S122 series	10	100	–	V/µs
S2800F	100	–	–	V/µs
S2800A	75	–	–	V/µs
S2800B	50	–	–	V/µs
S2800C	40	–	–	V/µs
S2800D	30	–	–	V/µs
S2800E	25	–	–	V/µs
S2800M	20	–	–	V/µs
S2800S	15	–	–	V/µs
t_{gt} See Fig. 16 $V_D = V_{DROM}$, $i_T = 4.5$ A, $i_T = 2$ A $I_{GT} = 80$ mA, 0.1 µs rise time $T_C = +25°C$	–	1.6	2.5	µs
t_q $V_D = V_{DROM}$, $i_T = 2$ A, $t_p = 50$ µs dv/dt = 200 V/µs, di/dt = –10 A/µs $I_{GT} = 200$ mA at t_{ON}, $T_C = +75°C$	–	10	35	µs
$R_{\theta JC}$	–	–	2	°C/W
$R_{\theta JA}$	–	–	60	°C/W

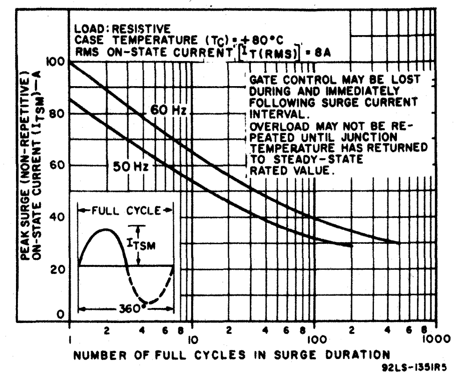


Fig. 4 — Allowable peak surge on-state current vs. surge duration for all types.

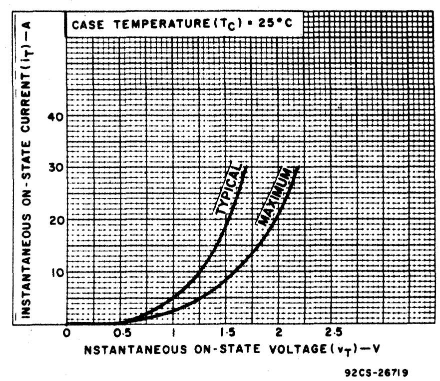


Fig. 5 — Instantaneous on-state current vs. on-state voltage for S122 series.

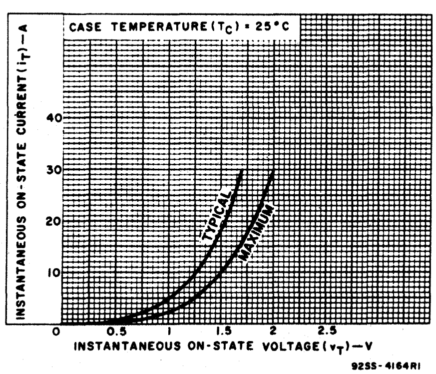


Fig. 6 — Instantaneous on-state current vs. on-state voltage for S2800 series.

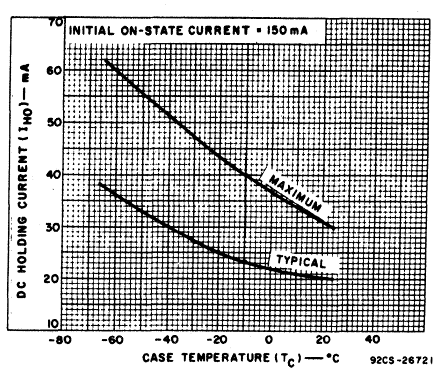


Fig. 7 — Holding current vs. case temperature for S122 series.

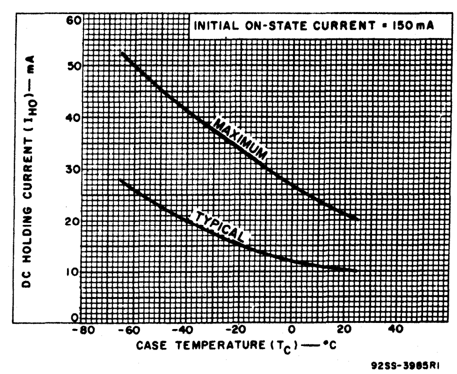


Fig. 8 — Holding current vs. case temperature for S2800 series.

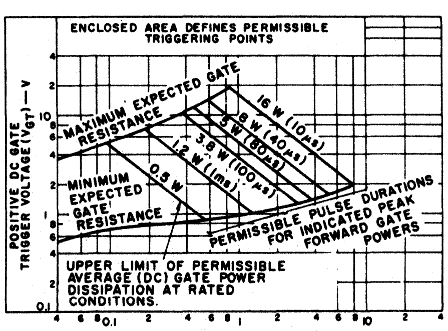


Fig. 9 — Typical forward-biased gate characteristics for all types.

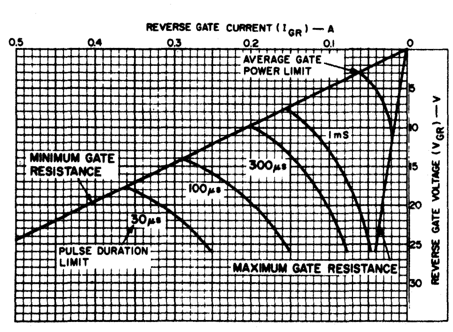


Fig. 10 — Reverse gate voltage vs. reverse gate current for all types.

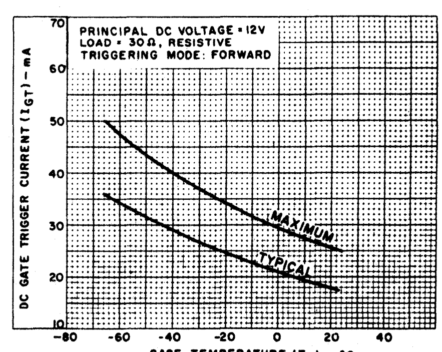


Fig. 11 — DC gate-trigger current vs. case temperature for S122 series.

S122, S2800 Series

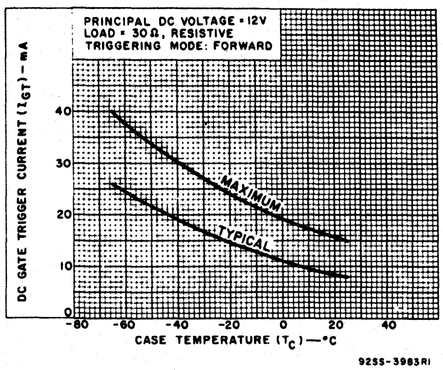


Fig. 12 – DC gate-trigger current vs. case temperature for S2800 series.

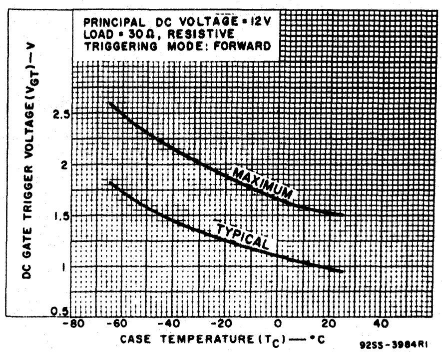


Fig. 13 – DC gate-trigger voltage vs. case temperature for all types.

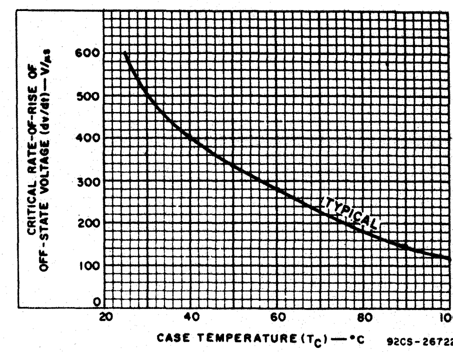


Fig. 14 – Critical rate-of-rise of off-state voltage vs. case temperature for S122 series.

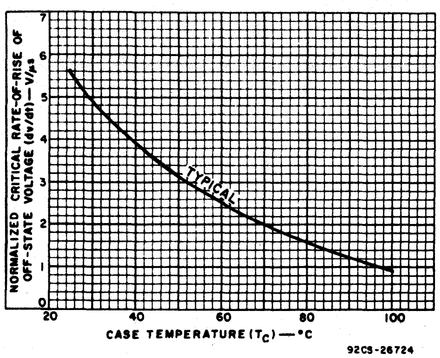


Fig. 15 – Normalized critical rate of rise of off-state voltage vs. case temperature for S2800 series.

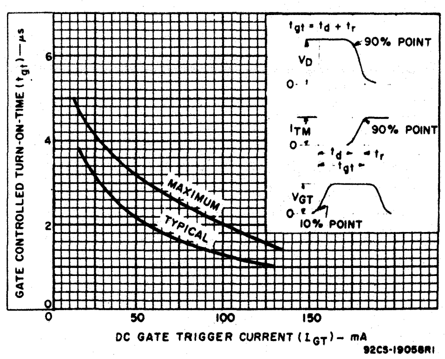


Fig. 16 – Gate-controlled turn-on time vs. gate trigger current for all types.

S3700, S3704, S3714 Series

5-A Silicon Controlled Rectifiers

For Inverter Applications

The RCA-S3700, S3704, and S3714-series types are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) designed for inverter applications such as ultrasonics, choppers, regulated power supplies, induction heaters, cycloconverters, and fluorescent lighting. These types may be used at frequencies up to 25 kHz.

The S3700 and S3704 series employ a hermetic JEDEC TO-66 package. The S3714 series employs a TO-66 with heat radiator package.

Features

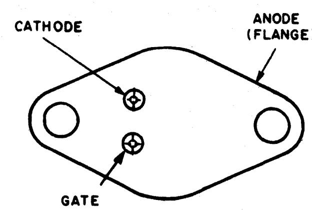
- **Fast turn-off time-8 µs max.**
- **High di/dt and dv/dt capabilities**
- **Shorted-emitter gate-cathode construction . . .contains an internally diffused resistor between gate and cathode**
- **Center gate construction. . . .provides rapid uniform gate-current spreading for faster turn-on with substantially reduced heating effects**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

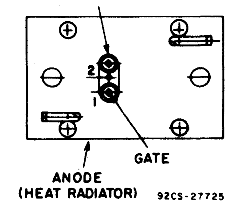
		S3704A / S3714A	S3700B / S3704B / S3714B	S3700D / S3704D / S3714D	S3700M / S3704M / S3714M	S3704S / S3714S	
NON-REPETITIVE PEAK REVERSE VOLTAGE:■ Gate Open	V_{RSOM}	150	300	500	700	800	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE:■ Gate Open	V_{DSOM}	150	300	500	700	800	V
REPETITIVE PEAK REVERSE VOLTAGE:■ Gate Open	V_{RROM}	100	200	400	600	700	V
REPETITIVE PEAK OFF-STATE VOLTAGE:■ Gate Open	V_{DROM}	100	200	400	600	700	V
ON-STATE CURRENT: T_C = 60°C, conduction angle = 180°: RMS	$I_{T(RMS)}$	← 5 →					A
Average	$I_{T(AV)}$	← 3.2 →					A
For other conditions		← See Figs. 3, 4 →					
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT: For one full cycle of applied principal voltage, T_C = 60°C	I_{TSM}						
60 Hz (sinusoidal)		← 80 →					A
50 Hz (sinusoidal)		← 65 →					A
For more than one full cycle of applied principal voltage		← See Fig. 5 →					
RATE OF CHANGE OF ON-STATE CURRENT $V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 µs	di/dt	← 200 →					A/µs
FUSING CURRENT (for SCR protection): T_J = −40 to 100°C, t = 1 to 8.3 ms	I^2t	← 25 →					A
GATE POWER DISSIPATION:● Peak Forward (for 10 µs max., See Fig. 7)	P_{GM}	← 13 →					W
Peak Reverse (for 10 µs max., See Fig. 8)	P_{RGM}	← 13 →					W
Average (averaging time = 10 ms max.)	$P_{G(AV)}$	← 0.5 →					W
TEMPERATURE RANGE:▲ Storage	T_{stg}	← −40 to 150 →					°C
Operating (Case)	T_C	← −40 to 100 →					°C
PIN TEMPERATURE (During soldering): At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	← 225 →					°C

■ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
▲ For temperature measurement reference point, *see Dimensional Outline.*

TERMINAL CONNECTIONS



BOTTOM VIEW
JEDEC TO-66



BOTTOM VIEW
JEDEC TO-66 with Heat Radiator

ELECTRICAL CHARACTERISTICS
At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES Except as Specified MIN.	TYP.	MAX.	UNITS
Peak Off-State Current: (Gate open, T_C = 100°C) Forward Current (I_{DOM}) at $V_D = V_{DROM}$	I_{DOM}	–	0.5	3	mA
Reverse Current (I_{ROM}) at $V_R = V_{RROM}$	I_{ROM}	–	0.3	1.5	mA
Instantaneous On-State Voltage: i_T = 30 A (peak), T_C = 25°C	v_T	–	2.2	3	V
For other conditions			See Fig. 6		
Instantaneous Holding Current: Gate open, T_C = 25°C	i_{HO}	–	20	50	mA
Critical Rate of Rise of Off-State Voltage: $V_D = V_{DROM}$, exponential voltage rise, Gate open, T_C = 80°C	dv/dt	100	250	–	V/µs
DC Gate Trigger Current: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	I_{GT}	–	15	40	mA
For other conditions			See Fig. 7		
DC Gate Trigger Voltage: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	V_{GT}	–	1.8	3.5	V
For other conditions			See Fig. 7		
Gate Controlled Turn-On Time: (Delay Time + Rise Time) For $V_{DX} = V_{DROM}$, I_{GT} = 300 mA, t_r = 0.1 µs, I_T = 2 A (peak), T_C = 25°C (See Fig. 10)	t_{gt}	–	0.7	–	µs
Circuit Commutated Turn-Off Time: $V_{DX} = V_{DROM}$, i_T = 2 A, pulse duration = 50 µs, dv/dt = 100 V/µs, −di/dt = −10 A/µs, I_{GT} = 100 mA, V_{GT} = 0 V (at turn-off), T_C = 80°C (See Fig. 13)	t_q				µs
S3700 series		–	4	6	µs
S3704, S3714 series		–	4	8	µs
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	–	4	8	°C/W
Junction-to-Ambient	$R_{\theta JA}$	–	–	40	°C/W

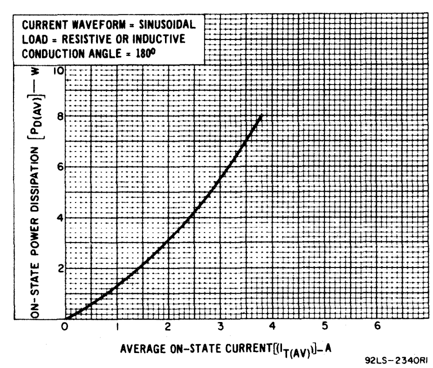


Fig. 1—Power dissipation vs. average on-state current.

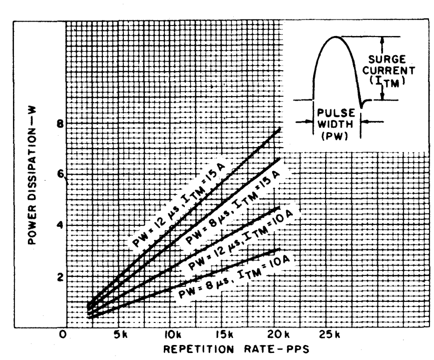


Fig. 2—Dissipation vs. repetition rate.

S3700, S3704, S3714 Series

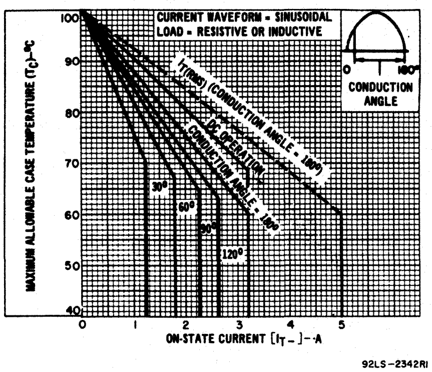


Fig. 3—Maximum allowable case temperature vs. on-state current.

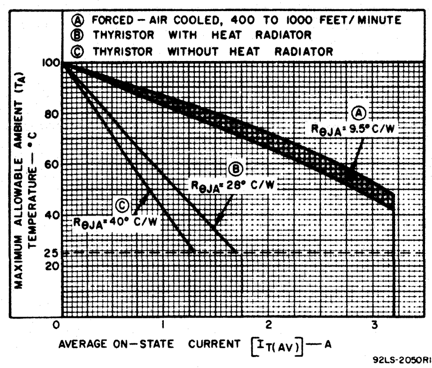


Fig. 4—Maximum allowable ambient temperature vs. average on-state current.

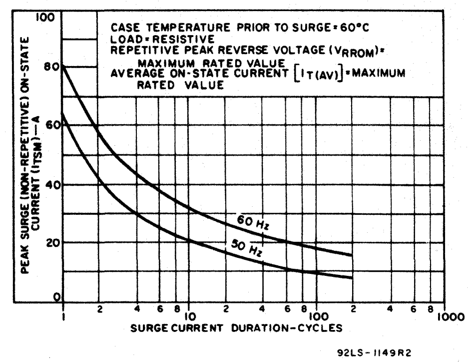


Fig. 5—Peak surge on-state current vs. surge-current duration.

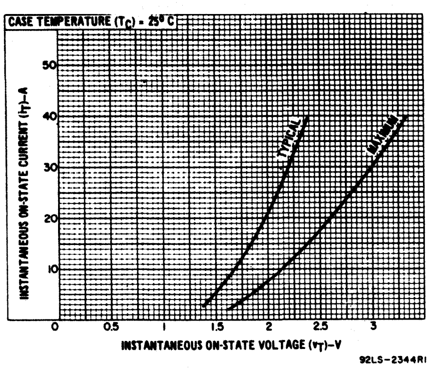


Fig. 6—Instantaneous on-state current vs. on-state voltage.

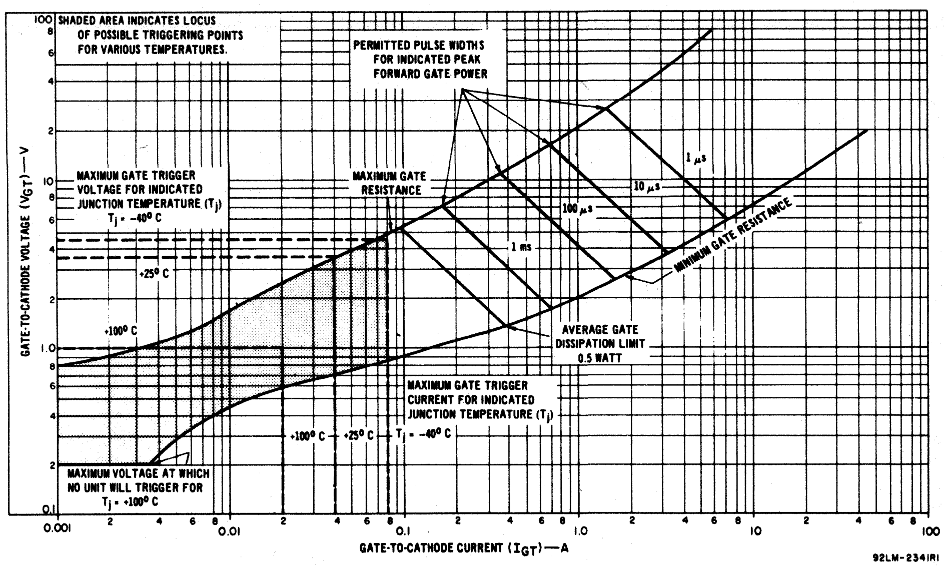


Fig. 7—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

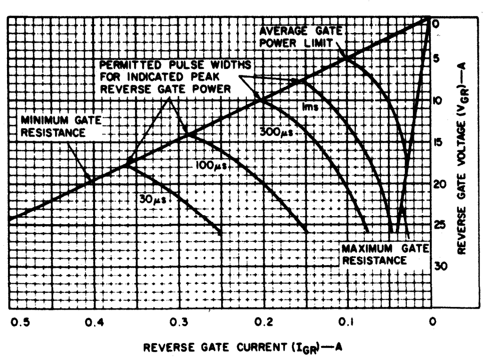


Fig. 8—Reverse-gate voltage vs. reverse-gate current.

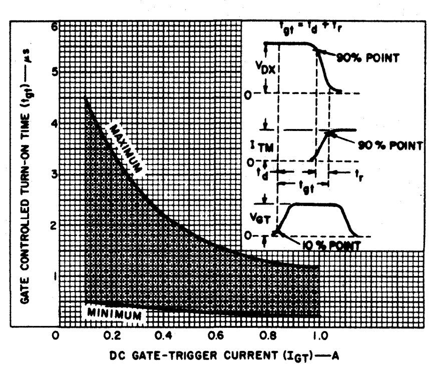


Fig. 9—Turn-on time vs. gate-trigger current.

S3701M

5-Ampere Silicon Controlled Rectifier

For Applications in Pulse Power Supplies To Drive GaAs Laser Diodes

Type S3701M is a silicon controlled rectifier intended for use in circuits which generate pulses to drive injection laser diodes.

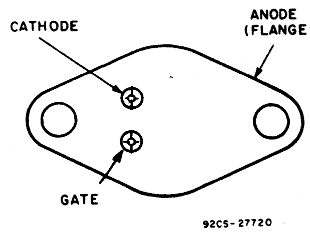
The S3701M SCR is designed for the good current-spreading and delay-time characteristics necessary to provide high-peak-current pulses to drive the laser diode. An additional significant characteristic of this device is its well controlled holding current, which assures operation only at currents sufficiently high to meet the circuit requirements.

The S3701M SCR employs a hermetic JEDEC TO-66 package.

Features:

- **High peak-current capability**
- **Good current-spreading attributes**
- **Symmetrical gate-cathode construction for uniform current density, rapid electrical conduction, and efficient heat dissipation**
- **Controlled minimum holding current**
- **Hermetic construction**
- **Low thermal resistance**

TERMINAL CONNECTIONS



BOTTOM VIEW

JEDEC TO-66

MAXIMUM RATINGS, *Absolute-Maximum Values:*
Case temperature (T_C) = 25°C, unless otherwise specified

REPETITIVE PEAK OFF-STATE VOLTAGE:			
Gate open	V_{DROM}	600	V
RMS ON-STATE CURRENT (Conduction angle = 180°)	$I_{T(RMS)}$	5	A
REPETITIVE PEAK ON-STATE CURRENT (0.2 µs Pulse Width):	I_{PM}		
Free-air cooling, f = 500 Hz		75	A
Free-air cooling, f = 5000 Hz		40	A
Infinite heat sink, f = 10,000 Hz		40	A
Infinite heat sink, f = 1,000 Hz		75	A
GATE POWER DISSIPATION:			
PEAK (For 10 µs pulse)	P_{GM}	25	W
TEMPERATURE RANGE:			
Storage	T_{stg}	-40 to 125°C	
Operating (Case)	T_C	-40 to 100°C	
TERMINAL TEMPERATURE (During soldering):	T_T		
For 10 s max. (terminals and case)		225	°C

ELECTRICAL CHARACTERISTICS
At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS		UNITS
		Min.	Max.	
Peak Off-State Current: Gate open, $v_D = V_{DROM}$, T_C = 25°C	I_{DROM}	–	0.65	mA
T_C = 75°C		–	1.2	
DC Gate-Trigger Current: T_C = 25°C	I_{GT}	–	35	mA
DC Gate-Trigger Voltage: T_C = 25°C	V_{GT}	–	4	V
DC Holding Current: Gate open, T_C = 25°C	I_{HO}	15	–	mA
T_C = 75°C		10	–	
Critical Rate-of-Rise of Off-State Voltage: For $v_D = V_{DROM}$, exponential voltage rise, gate open, T_C = 75°C	dv/dt	200	–	V/µs
Source Voltage for Functional Test (See Fig. 2): I_p = 75A, C = 0.022µF, R_s = 2Ω, f = 60Hz, pulse duration = 0.2µs, T_C = 25°C	V_s	–	550	V
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	–	7	°C/W
Junction-to-Ambient	$R_{\theta JA}$	–	40	

S3702S, S3703SF, D2101S, D2103S, D2103SF, S3705M, S3706E, D2600M, D2601E, D2601M

SCR's and Rectifiers for Horizontal-Deflection Circuits

For Large-Screen Color TV

The RCA SCR's S3702S, S3702SF, S3705M, and S3706E and the RCA rectifiers D2101S, D2103S D2103SF, D2600M, D2601E, and D2601M are designed for use in horizontal output circuits.

The S3703SF silicon controlled rectifier and the D2102SF silicon rectifier are designed to act as a bipolar switch that controls horizontal yoke current during the beam trace interval. The S3702S silicon controlled rectifier and the D2103S silicon rectifier act as the commutating switch to initiate trace-retrace switching and control yoke current during retrace.

The D2101S silicon rectifier may be used as a clamp to protect the circuit components from excessively high transient voltages which may be generated as a result of arcing in the picture tube or in a high-voltage rectifier tube.

To facilitate direct connection across each silicon controlled rectifier, S3702S and S3702SF, the anode connections of silicon rectifiers D2103S and D2103SF are reversed as compared to that of a normal power-supply rectifier diode.

The S3705M silicon controlled rectifier and the D2601M silicon rectifier are designed to act as a bipolar switch that controls horizontal yoke current during the beam trace interval. The S3706E silicon controlled rectifier and the D2601E silicon rectifier act as the commutating switch to initiate trace-retrace switching and control yoke current during retrace.

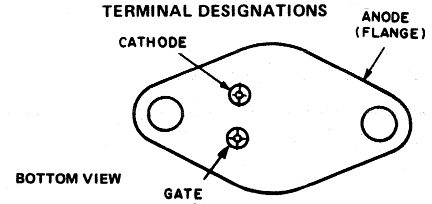
The D2600M silicon rectifier may be used as a clamp to protect the circuit components from excessively high transient voltages which may be generated as a result of arcing in the picture tube or in a high-voltage rectifier tube.

The SCR's employ a hermetic JEDEC TO-66 package. The rectifier types D2101S D2103S, and D2103SF employ a hermetic JEDEC TO-1 package. The rectifier types D2600M, D2601E, and D2601M employ a hermetic JEDEC DO-26 package.

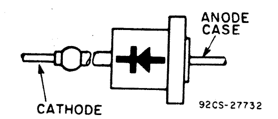
Features:

- **Operation from supply voltages between 150 and 270 V (nominal)**
- **Ability to handle high beam current; average 1.6 mA dc**
- **Ability to supply as much as 5 mJ to 8 mJ of stored energy to the deflection yoke, which is sufficient for 29-mm-neck picture tubes operated at 29 kV or 31 kV (nominal value)**
- **Highly reliable circuit which can also be used as a low-voltage power supply**

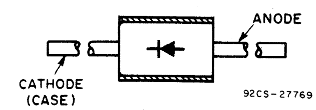
TERMINAL DESIGNATIONS



JEDEC TO-3



JEDEC DO-1



JEDEC DO-26

SILICON CONTROLLED RECTIFIERS
MAXIMUM RATINGS, *Absolute-Maximum Values:*

		S3703SF	S3705M	S3702S	S3706E	
		TRACE SCR		COMMUTATING SCR		
NON-REPETITIVE PEAK OFF-STATE VOLTAGE:●						
Gate Open	V_{DSOM}	800*	700*	750*	600*	V
REPETITIVE PEAK REVERSE VOLTAGE:●						
Gate Open	V_{RROM}	25	25	25	25	V
REPETITIVE PEAK OFF-STATE VOLTAGE:●						
Gate Open	V_{DROM}	750	600	700	500	V
ON-STATE CURRENT						
T_C = 60°C, 60 Hz sine wave, conduction angle = 180°:						
RMS	$I_{T(RMS)}$	5	5	5	5	A
Average DC	$I_{T(AV)}$	3.2	3.2	3.2	3.2	A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}					
For one full cycle of applied principal voltage						
60 Hz (sinusoidal), T_C = 60°C		80	80	80	80	A
50 Hz (sinusoidal), T_C = 60°C		65	65	65	65	A
For one-half sine wave, 3 ms pulse width		130	150	130	150	A
RATE OF CHANGE OF ON-STATE CURRENT:						
$V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 μs	di/dt	200				A/μs
FUSING CURRENT (for SCR protection):						
T_J = −40 to 80°C, t = 1 to 10 ms	I^2t	20				A^2s
GATE POWER DISSIPATION:■	P_{GM}					
Peak (forward or reverse) for 10 μs duration, max.						
negative gate bias = −35 V (S3703SF, S3705M)		25				W
= −10 V (S3702S, S3706E)		25				W
TEMPERATURE RANGE:▲						
Storage	T_{stg}	−40 to 150				°C
Operating (Case)	T_C	−40 to 80				°C
PIN TEMPERATURE (During soldering)						
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	225				°C

* Protection against transients above these values induced by arcing or other causes must be provided.
● These values do not apply if there is a positive gate signal, Gate must be open or negatively biased.
■ Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted, provided that the maximum reverse gate bias (as specified) is not exceeded.
▲ For temperature measurement reference point, see Dimension Outline.

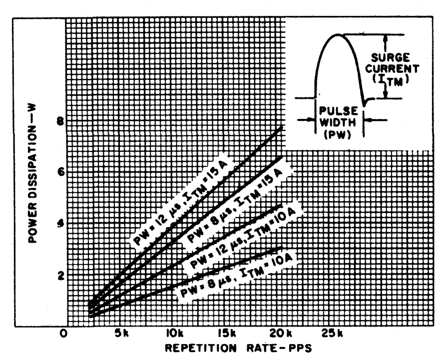


Fig. 1 — Dissipation vs. repetition rate for S3702S and S3702SF.

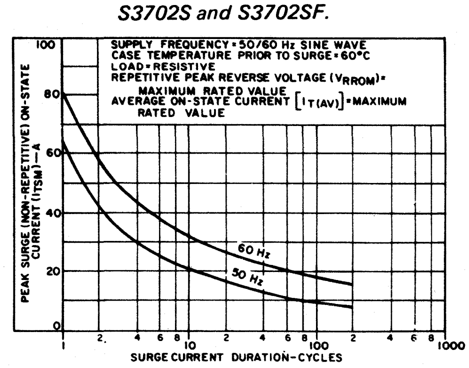


Fig. 2 — Peak surge on-state current vs. surge current duration for S3705M and S3706E.

S3702S, S3703SF, D2101S, D2103S, D2103SF, S3705M, S3706E, D2600M, D2601E, D2601M

SILICON CONTROLLED RECTIFIERS

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTIC	SYMBOL	LIMITS				UNITS
		S3703SF S3705M TRACE SCR.		S3702S S3706E COMMUT. SCR		
		TYP.	MAX.	TYP.	MAX.	
Peak Forward Off-State Current: Gate open, $V_D = V_{DROM}$, $T_C = 85°C$	I_{DOM}	0.5	1.5	0.5	1.5	mA
Instantaneous On-State Voltage: i_T = 30 A (peak), $T_C = 25°C$	v_T	2.2	3	2.2	3	V
Critical Rate-of-Rise of Off-State Voltage: $V_D = V_{DROM}$, exponential voltage rise, Gate open, $T_C = 70°C$ S3702S	dv/dt	–	–	700 (min.) $(dv/dt)_3$		V/µs
S3706E	dv/dt	175 (min.)		1000 (min.) $(dv/dt)_2$		V/µs
DC Gate Trigger Current: V_D = 12 V (dc), $R_L = 30\,\Omega$, $T_C = 25°C$	I_{GT}	15	32	15	45	mA
DC Gate Trigger Voltage: V_D = 12 V (dc), $R_L = 30\,\Omega$, $T_C = 25°C$	V_{GT}	1.8	4	1.8	4	V
Circuit Commutated Turn-Off Time:♦ $T_C = 70°C$, minimum negative gate bias during turn-off time = −20 V (S3703SF, S3705M) and −2.5 V (S3702S, S3706E), rate of reapplied voltage (dv/dt) = 175 V/µs S3703S	t_q	–	2.4	–	–	µs
S3705M	t_q	–	2.5	–	–	µs
= 400 V/µs S3702S	t_q	–	–	–	4.2	µs
S3706E	t_q	–	–	–	4.5	µs
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	–	4	–	4	°C/W

♦ This parameter, the sum of reverse recovery time and gate recovery time, is measured from the zero crossing of current to the start of the reapplied voltage. Knowledge of the current, the reapplied voltage, and the case temperature is necessary when measuring t_q. In the worst conditions (high line, zero-beam, off-frequency, minimum auxiliary load, etc.) turn-off time must not fall below the given values. Turn-off time increases with temperature; therefore, case temperature must not exceed 70°C,

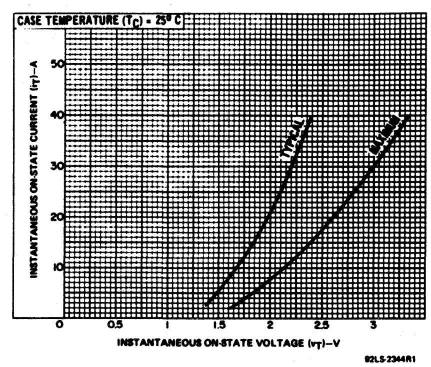


Fig. 3 — Instantaneous on-state current vs. on-state voltage for S3702S and S3703SF.

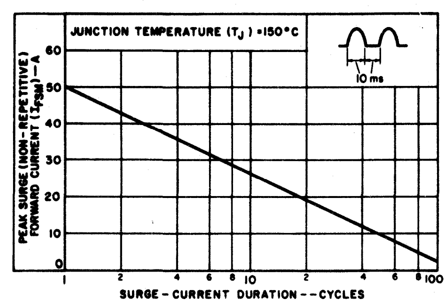


Fig. 4 — Peak surge (non-repetitive) forward current vs. surge-current duration for D2101S, D2103S, and D2103SF.

SILICON RECTIFIERS

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		D2103SF	D2601M	D2103S	D2601E	D2101S	D2600M	
		TRACE		COMMUTATING		CLAMP		
REVERSE VOLTAGE:**								
Repetitive Peak	V_{RRM}	750	600	700	500	700	600	V
Non-Repetitive Peak●●	V_{RSM}	800	700	800	600	800	700	V
FORWARD CURRENT (operating in 15 kHz deflection circuit):								
RMS	$I_{F(RMS)}$	3■■	1.9■■	3■■	1.6■■	1**	0.5**	A
Peak Surge (Non-Repetitive)●●	I_{FSM}	70♦♦	70♦♦	70♦♦	70♦♦	30♦♦	30♦♦	A
Peak (Repetitive)	I_{FRM}	7	6.5	12	6	0.5	0.5	A
TEMPERATURE RANGE								
Storage	T_{stg}	−30 to 150						°C
Operating (Case)	T_C	−30 to 80						°C
LEAD TEMPERATURE (During Soldering):▲▲								
For 10 s maximum	T_L	225						°C

** For ambient temperatures up to 45°C.

●● For a maximum of 3 pulses, each less than 10 µs duration, during any 64-µs period.

■■ Maximum current rating applies only if the rectifier is properly mounted to maintain junction temperature below 150°C.

♦♦ See Figs. 4 & 5 for I_{FSM} value for 60 Hz.

▲▲ At distances no closer to rectifier body than points A and B on outline drawing.

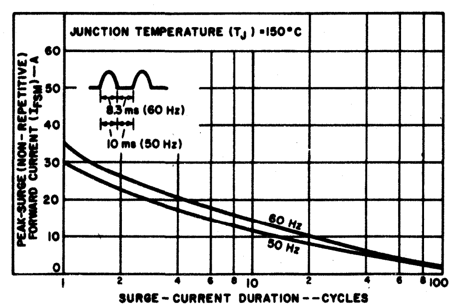


Fig. 5 — Peak-surge (non-repetitive) forward current vs. surge-current duration for D2600M, D2601E, and D2601M.

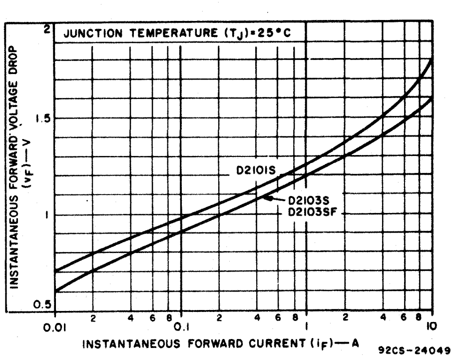


Fig. 6 — Forward-voltage drop vs. forward current for D2101S, D2103S, and D2103SF.

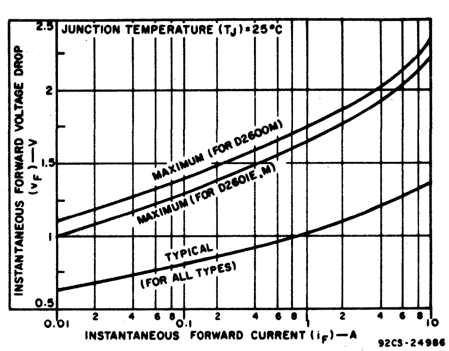


Fig. 7 — Forward-voltage drop vs. forward current for D2600M, D2601E, and D2601M.

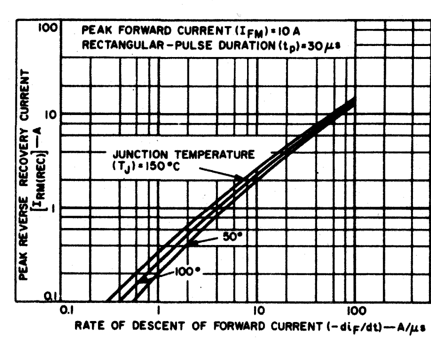


Fig. 8 — Typical peak reverse-recovery current vs. rate of descent of forward current for all rectifiers.

S3702S, S3703SF, D2101S, D2103S, D2103SF, S3705M, S3706E, D2600M, D2601E, D2601M

SILICON RECTIFIERS

ELECTRICAL CHARACTERISTICS,

CHARACTERISTIC	SYMBOL	LIMITS: D2103SF, D2601M TRACE; D2103S, D2601E COMMUT. — MAXIMUM	LIMITS: D2101S, D2600M CLAMP — MINIMUM	UNITS
Reverse Current: *Static* For V_{RRM} = max. rated value, I_F = 0, T_C = 25°C	I_{RM}	10	10	μA
For V_R = 500 V, T_C = 100°C.	I_{RM}	250	250	μA
Instantaneous Forward Voltage Drop: At i_F = 4 A, T_A = 25°C (See Fig. 6, 7)	v_F	1.4 (D2103SF, D2103S)	1.5 (D2101S)	V
		1.9 (D2601M, D2601E)	2 (D2600M)	
Reverse Recovery Time: At I_{FM} = 3.14 A, $-di_F/dt$ = −10 A/μs, pulse duration = 0.94 μs, T_C = 25°C	t_{rr}	0.5 (D2103SF, D2103S)	0.7 (D2101S)	μs
At I_{FM} = 20 A, $-di_F/dt$ = −20 A/μs, pulse duration = 2.8 μs, T_C = 25°C		0.5 (D2601M, D2601E)	0.7 (D2600M)	
In Tektronix type "S" plug-in unit (or equivalent): At I_F = 20 mA, I_R = 1 mA, T_C = 25°C		1.2	1.5	
Peak Forward Voltage Drop (at turn-on): In Tektronic type "S" plug-in unit (or equivalent): At I_F = 20 mA, T_C = 25°C	$V_{F(pk)}$	5	6	V
Thermal Resistance (Junction-to-Case)▲	$R_{\theta JC}$	10 (D2103SF, D2103S)	10 (D2101S)	°C/W
Thermal Resistance (Junction-to-Lead)▲ (See Fig. 11)	$R_{\theta JL}$	45 (D2601M, D2601E)	45 (D2600M)	°C/W

▲ Measured at point as indicated on Dimensional Outline.
♦ Measured on anode lead 1/8 in. (3.18 mm) from case.

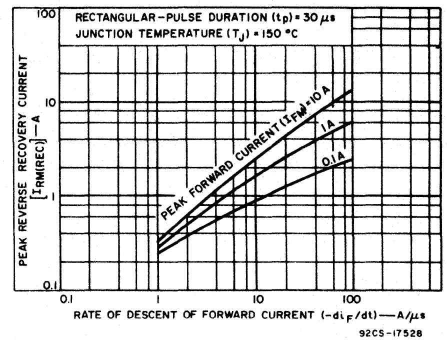


Fig. 9 — Typical peak reverse-recovery current vs. rate of descent of forward-current for all rectifiers.

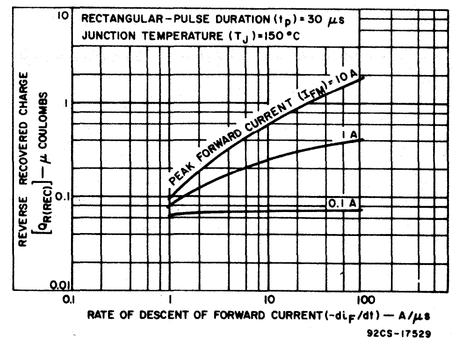


Fig. 10 — Typical reverse-recovered charge vs. rate of descent of forward current for all rectifiers.

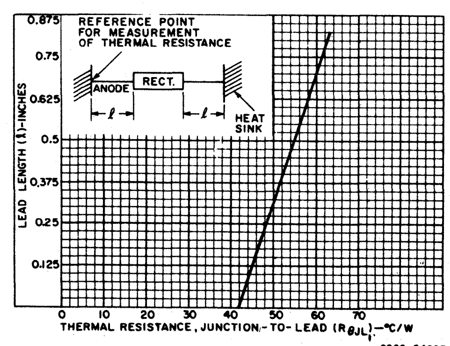


Fig. 11 — Junction-to-lead thermal resistance vs. lead length for D2600M, D2601E, and D2601M.

S3900, S3901, S3902DF, S3903MF Series

Monolithic Integrated Thyristor/Rectifiers (ITR's) for TV Horizontal-Deflection Circuits

Color and Monochrome

The RCA-S3900- and S3901-series and the S3902DF and S3903MF integrated thyristor/rectifiers are all-diffused power monolithic circuits that incorporate a silicon controlled rectifier and a silicon rectifier on a common pellet. The S3900-series and S3902DF types are used as bipolar switches to control horizontal yoke current during the beam trace interval; the S3901-series and S3903MF types are used as commutating switches to initiate trace-retrace switching.

The S3900 and S3901-series ITR's are designed for use in color TV circuits. Devices in the S3900 series are capable of supplying 8 mJ of stored energy to the deflection yoke; this is sufficient for 29-mm-neck and 35-mm-neck color picture tubes operated at a nominal value of 31 kV.

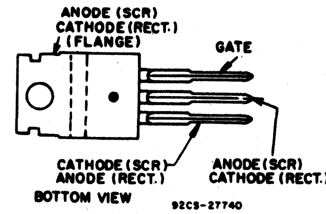
The S3902DF and S3903MF types are intended for use in black-and-white TV circuits. The S3903DF ITR is capable of supplying 3 mJ of stored energy to the deflection yoke; this is sufficient for 29-mm-neck monochrome tubes operated at 19 kV nominal value.

All types in these four series are supplied in the JEDEC TO-220AB package. The plastic used in this package is a flame-retardant material.

Features:

- Operation from nominal supply voltages between:
  - 100 V and 240 V – S3902DF, S3903MF
  - 140 V and 270 V – S3900, S3901 Series
- Ability to handle high beam current:
  - 1 mA dc (avg.) – S3902DF, S3903MF
  - 1.6 mA dc (avg.) – S3900, S3901 Series
- Ability to supply stored energy to the deflection yoke, as much as:
  - 3 mJ for 19 kV (nom.) monochrome tubes – S3902DF
  - 8 mJ for 31 kV (nom.) color TV tubes – S3900 Series
- Highly reliable circuit which can also be used as a low-voltage power supply

TERMINAL CONNECTIONS



JEDEC TO-220AB

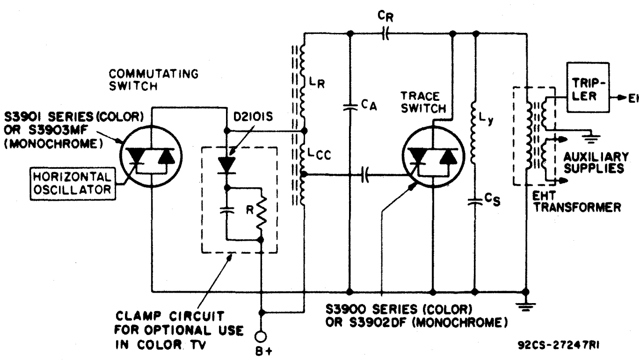


Fig. 1 – Simplified schematic diagram of horizontal output circuit.

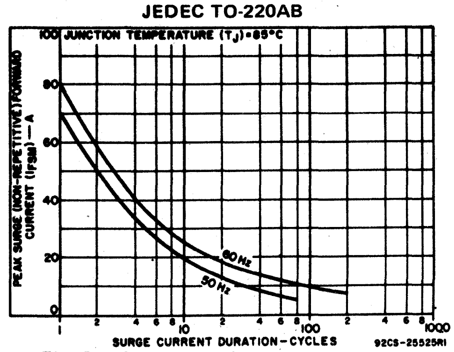


Fig. 2 – Peak surge forward current vs. surge-current duration for rectifier unit of ITR (all types).

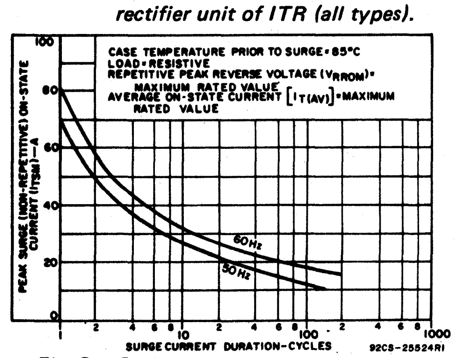


Fig. 3 – Peak surge on-state current vs. surge-current duration for SCR unit of ITR (all types).

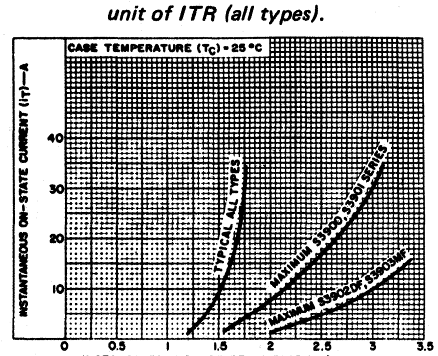


Fig. 4 – Instantaneous on-state current vs. on-state voltage for SCR unit of ITR (all types).

ITR's FOR COLOR TELEVISION

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TRACE			COMMUTATING			
	S3900MF	S3900S	S3900SF	S3901M	S3901MF	S3901S	
V_{DSOM}:*• $T_C = 85^oC$	700	750	800	650	700	750	V
V_{RROM}:• $T_C = 85^oC$	4	4	4	4	4	4	V
V_{DROM}:• $T_C = 85^oC$	650	700	750	600	650	700	V
CURRENT: $T_C = 60^oC$, 50 Hz sine wave, $\theta = 180^o$:							
Rectifier Unit:							
I_o	3						A
$I_{F(RMS)}$	4.5						A
SCR Unit:							
$I_{T(AV)}$	5						A
$I_{T(RMS)}$	8						A
I_{TSM}: For one full cycle of applied principal voltage:							
60 Hz (sinusoidal), T_C=85°C:							
Rectifier Unit, I_{FSM}	80						A
SCR Unit, I_{TSM}	80						A
50 Hz (sinusoidal), T_C=85°C:							
Rectifier Unit, I_{FSM}	70						A
SCR Unit, I_{TSM}	70						A
For more than one full cycle of applied principal voltage	See Figs. 2 and 3						
For one-half sine wave, t_p=3 ms:							
Rectifier Unit, I_{FSM}	150						A
SCR Unit, I_{TSM}	150						A

S3900, S3901, S3902DF, S3903MF Series

ITR's FOR COLOR TELEVISION

MAXIMUM RATINGS, *Absolute-Maximum Values:* **(Cont'd)**

	TRACE: S3900MF, S3900S, S3900SF — COMMUTATING: S3901M, S3901MF, S3901S	
di/dt: $V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 µs	200	A/µs
I^2t (For ITR protection): T_J = −40 to 85°C, t = 1 to 10 ms	30	A^2s
P_{GM}:■ Forward or reverse for 10 µs duration, max. negative gate bias = −10 V	25	W
T_{stg}:▲	−40 to 150	°C
T_C:▲	−40 to 85	°C
T_T (During soldering): At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.	225	°C

*Protection against transients above these values induced by arcing or other causes must be provided.

•These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

■Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted, provided that the maximum reverse gate bias (as specified) is not exceeded.

▲For temperature measurement reference point, see Dimensional Outline.

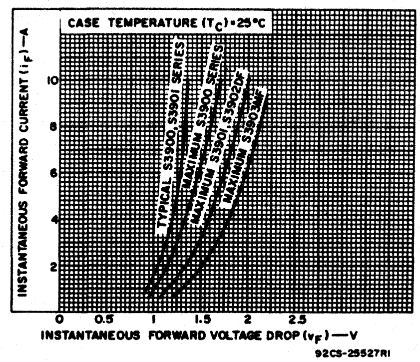


Fig. 5 — Instantaneous forward current vs. forward voltage drop for rectifier unit of ITR (all types).

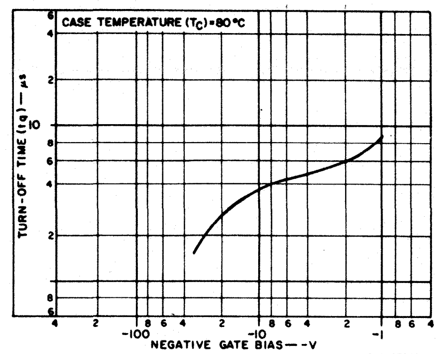


Fig. 6 — Typical turn-off time vs. gate bias for S3900-series types.

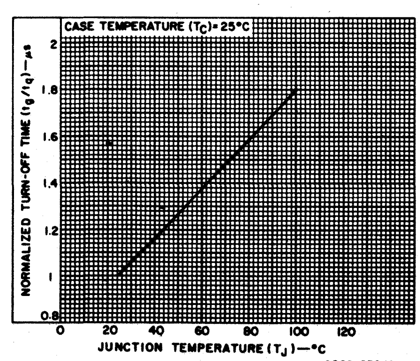


Fig. 7 — Normalized turn-off time vs. junction temperature for S3900- and S3901-series types.

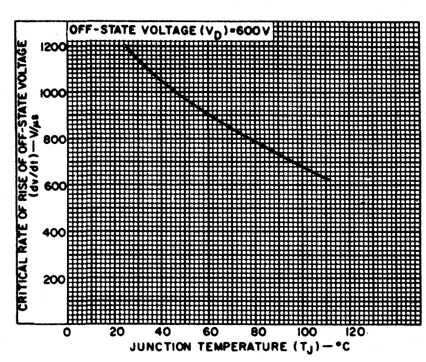


Fig. 8 — Typical dv/dt vs. junction temperature for S3900- and S3901-series types.

ELECTRICAL CHARACTERISTICS FOR ITR's FOR COLOR-TELEVISION CIRCUITS
At Maximum Ratings and at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	LIMITS				UNITS
	S3900 Series TRACE ITR		S3901 Series COMMUTATING ITR		
	TYP.	MAX.	TYP.	MAX.	
I_{DOM}: $V_D = V_{DROM}$, T_C = 85°C	0.5	1.5	0.5	1.5	mA
V_T: SCR Unit: i_T = 30 A (See Fig. 4)	1.75	3	1.75	3	V
V_F: Rectifier Unit: i_F = 10 A (See Fig. 5)	1.35	1.7	1.35	2	V
dv/dt: $V_D = V_{DROM}$, T_C = 85°C, V_G = −2.5 V min. (S3901 Series)	175 (min.)		1000 (min.) $(dv/dt)_2$		V/µs
I_{GT}: V_D = 12 V dc, R_L = 30 Ω	15	40	15	45	mA
V_{GT}: V_D = 12 V dc, R_L = 30 Ω	1.8	4	1.8	4	V
t_q: ♦ T_C = 80°C, Minimum negative gate bias = −20 V (S3900 Series) = −2.5 V (S3901 Series); dv/dt = 175 V/µs (S3900 Series)	–	2.4	–	–	µs
dv/dt = 400 V/µs (S3901 Series)	–	–	–	4.2	µs

S3900, S3901, S3902DF, S3903MF Series

ELECTRICAL CHARACTERISTICS FOR ITR's FOR COLOR-TELEVISION CIRCUITS (Cont'd)
At Maximum Ratings and at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	LIMITS				UNITS
	S3900 Series TRACE ITR		S3901 Series COMMUTATING ITR		
	TYP.	MAX.	TYP.	MAX.	
t_{rr}: Rectifier Unit: I_{FM} = 10 A, $-di_F/dt$ = −10 A/μs, t_p = 3 μs	0.5	0.7	0.5	0.7	μs
V_{FM} (At t_g): Rectifier Unit: I_{FM} = 1 A	8	13	–	–	V
$R_{\theta JC}$ ▲	–	2.5	–	2.5	°C/W

♦ Turn-off time increases with temperature; therefore, case temperature must not exceed the level indicated.

▲ Measured at point indicated on Dimensional Outline.

ITR's FOR MONOCHROME TELEVISION

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TRACE S3902DF	COMMUTATING S3903MF	
V_{DSOM}: * • T_C = 85°C	500	700	V
V_{RROM}: • T_C = 85°C	4	4	V
V_{DROM}: • T_C = 85°C	450	650	V
CURRENT:			
T_C = 60°C, 50 Hz sine wave, θ = 180°:			
Rectifier Unit:			
I_o	3		A
$I_{F(RMS)}$	4.5		A
SCR Unit:			
$I_{T(AV)}$	5		A
$I_{T(RMS)}$	8		A
I_{TSM}:			
For one full cycle of applied principal voltage:			
60 Hz (sinusoidal), T_C = 85°C:			
Rectifier Unit, I_{FSM}	80		A
SCR Unit, I_{TSM}	80		A
50 Hz (sinusoidal), T_C = 85°C:			
Rectifier Unit, I_{FSM}	70		A
SCR Unit, I_{TSM}	70		A
For more than one full cycle of applied principal voltage	See Figs. 2 and 3		
For one-half sine wave, t_p = 3 ms:			
Rectifier Unit, I_{FSM}	150		A
SCR Unit, I_{TSM}	150		A
di/dt:			
$V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 μs	200		A/μs
I^2t (For ITR protection):			
T_J = −40 to 85°C, t = 1 to 10 ms	30		A^2s
P_{GM}: ■			
Forward or reverse for 10 μs duration, max. negative gate bias = −10 V	25		W
T_{stg}: ▲	−40 to 150		°C
T_C: ▲	−40 to 85		°C
T_T (During soldering):			
At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.	225		°C

*Protection against transients above these values induced by arcing or other causes must be provided.

•These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

■Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted, provided that the maximum reverse gate bias (as specified) is not exceeded.

▲For temperature measurement reference point, see Dimensional Outline.

ELECTRICAL CHARACTERISTICS FOR ITR's FOR MONOCHROME-TELEVISION CIRCUITS
At Maximum Ratings and at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	LIMITS				UNITS
	S3902DF TRACE ITR		S3903MF COMMUTATING ITR		
	TYP.	MAX.	TYP.	MAX.	
I_{DOM}: $V_D = V_{DROM}$, T_C = 85°C	0.5	1.5	0.5	1.5	mA
v_T: SCR Unit: i_T = 10 A (See Fig. 4)	1.75	3	1.75	3	V
v_F: Rectifier Unit: i_F = 4 A (See Fig. 5)	1.35	1.6	1.35	1.8	V
dv/dt: $V_D = V_{DROM}$, T_C = 85°C, V_G = −2.5 V min. (S3903MF)	120 (min.)		700 (min.) $(dv/dt)_2$		V/μs
I_{GT}: V_D = 12 V dc, R_L = 30 Ω	15	40	15	45	mA
V_{GT}: V_D = 12 V dc, R_L = 30 Ω	1.8	4	1.8	4	V
t_q: ♦ T_C = 80°C, Minimum negative gate bias = −20 V (S3902DF) = −2.5 V (S3903MF), dv/dt = 120 V/μs (S3902DF)	–	3	–	–	μs
dv/dt = 400 V/μs (S3903 Series)	–	–	–	5	μs
t_{rr}: Rectifier Unit: I_{FM} = 3.14 A, $-di_F/dt$ = −10 A/μs, t_p = 0.94 μs	0.3	0.5	0.3	0.5	μs
V_{FM} (At t_g): Rectifier Unit: I_{FM} = 1 A	8	13	–	–	V
$R_{\theta JC}$ ▲	–	2.5	–	2.5	°C/W

♦ Turn-off time increases with temperature; therefore, case temperature must not exceed the level indicated.

▲ Measured at point indicated on Dimensional Outline.

S4000(2N3668-2N3670,2N4103) Series

12.5-A Silicon Controlled Rectifiers

For Low-Cost Power-Control and Power-Switching Applications

RCA 2N3668*, 2N3669*, 2N3670*, and 2N4103* are all-diffused, three-junction, silicon controlled-rectifiers (SCR's). They are intended for use in power-control and power-switching applications requiring a blocking voltage capability of up to 600 volts and a forward-current capability of 12.5 amperes (rms value) or 8 amperes (average value) at a case temperature of 80°C.

The 2N3668 is designed for low-voltage power supplies, the 2N3669 for direct operation from 120-volt line supplies, the 2N3670 for direct operation from 240-volt line supplies, and the 2N4103 for high-voltage power supplies.

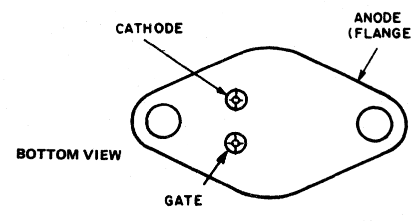
The 2N3668, 2N3669, 2N3670 and 2N4103 SCR's employ the hermetic JEDEC TO-3 package.

*Formerly Dev. Types TA2621, TA2598, TA2618, and TA2775, respectively.

Features:

- Low switching losses
- High di/dt and dv/dt capabilities
- Shorted emitter gate-cathode construction
- Forward and reverse gate dissipation ratings
- Designed especially for high-volume systems
- All-diffused construction – assures exceptional uniformity and stability of characteristics
- Direct-soldered internal construction – assures exceptional resistance to fatigue
- Symmetrical gate-cathode construction – provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- All-welded construction and hermetic sealing
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- Low thermal resistance

TERMINAL DESIGNATIONS



JEDEC TO-3

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load

RATINGS	CONTROLLED-RECTIFIER TYPES				UNITS
	2N3668	2N3669	2N3670	2N4103	
Transient Peak Reverse Voltage (Non-Repetitive), v_{RM}(non-rep)	150	330	660	700	volts
Peak Reverse Voltage (Repetitive), v_{RM}(rep)	100	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), v_{FBOM}(rep)	100	200	400	600	volts
Forward Current:					
For case temperature (T_C) of +80° C					
Average DC value at a conduction angle of 180°, I_{FAV}	8	8	8	8	amperes
RMS value, I_{FRMS}	12.5	12.5	12.5	12.5	amperes
For other conditions, (See Fig. 4)					
Peak Surge Current, i_{FM}(surge):					
For one cycle of applied voltage	200	200	200	200	amperes
For one cycle of applied principal voltage					
60 Hz (sinusoidal), T_C = 80°C	200	200	200	200	amperes
50 Hz (sinusoidal), T_C = 80°C	170	170	170	170	amperes
For more than one cycle of applied voltage	See Fig. 2	See Fig. 2	See Fig. 2	See Fig. 2	
Fusing Current (for SCR protection):					
T_J = −40 to 100°C, t = 1 to 8.3 ms, I^2t	170	170	170	170	ampere² second
Rate of Change of Forward Current, di/dt V_{FB} = v_{BOO}(min. value) I_{GT} = 200mA, 0.5 μs rise time	200	200	200	200	amperes/ microsecond
Gate Power*:					
Peak, Forward or Reverse, for 10 μs duration, P_{GM} (See Figs. 5 and 6)	40	40	40	40	watts
Average, P_{GAV}	0.5	0.5	0.5	0.5	watt
Temperature:					
Storage, T_{stg}●	-40 to +125	-40 to +125	-40 to +125	-40 to +125	°C
Operating (Case), T_C	-40 to +100	-40 to +100	-40 to +100	-40 to +100	°C

* Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

● Temperature reference point is within 1/8 in. (3.17 mm) of the center of the underside of unit.

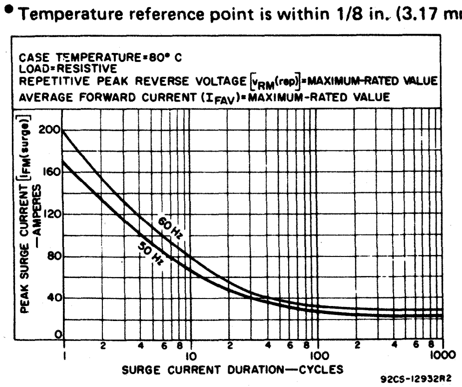


Fig. 1 – Peak surge current vs. surge current duration.

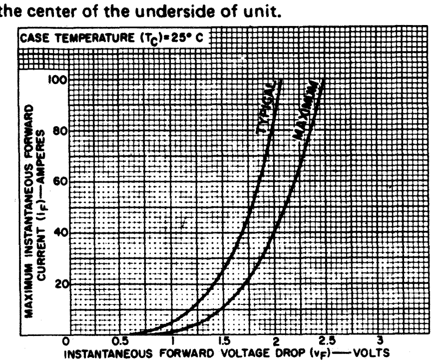


Fig. 2 – Instantaneous forward current vs. instantaneous forward voltage drop.

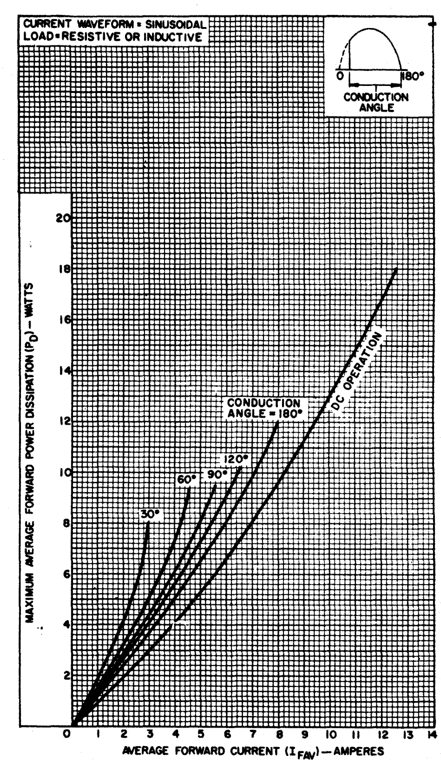


Fig. 3 – Power dissipation vs. forward current.

S4000(2N3668-2N3670,2N4103) Series

ELECTRICAL CHARACTERISTICS

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES												UNITS
	2N3668			2N3669			2N3670			2N4103			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Repetitive Blocking Voltage, V_{DROM} At T_C = +100°C	100	–	–	200	–	–	400	–	–	600	–	–	volts
Peak Blocking Current, at T_C = +100°C: Forward, I_{DOM} $V_D = V_{DROM}$	–	0.2	2	–	0.25	2.5	–	0.3	3	–	0.35	4	mA
Reverse, I_{ROM} $V_R = V_{RROM}$	–	0.05	1	–	0.1	1.25	–	0.2	1.5	–	0.3	3	mA
Forward Voltage Drop, v_F At a Forward Current of 25 amperes and a T_C = +25°C (See Fig. 2)	–	1.5	1.8	–	1.5	1.8	–	1.5	1.8	–	1.5	1.8	volts
DC Gate-Trigger Current, I_{GT}: At T_C = +25°C (See Fig. 5)	1	20	40	1	20	40	1	20	40	1	20	40	mA(dc)
Gate-Trigger Voltage, V_{GT}: At T_C = +25°C (See Fig. 5)	–	1.5	2	–	1.5	2	–	1.5	2	–	1.5	2	volts (dc)
Holding Current, i_{HOO}: At T_C = +25°C	0.5	25	50	0.5	25	50	0.5	25	50	0.5	25	50	mA
Critical Rate of Applied Forward Voltage, Critical dv/dt V_{FB} = v_{BOO}(min.value), exponential rise, T_C = +100°C	10	100	–	10	100	–	10	100	–	10	100	–	volts/ microsecond
Turn-On Time, t_{on}, (Delay Time + Rise Time) V_{FB} = v_{BOO}(min. value), i_F = 8 amperes, I_{GT} = 200mA, 0.1 μs rise time, T_C = +25°C (See waveshapes of Fig. 3)	0.75	1.25	–	0.75	1.25	–	0.75	1.25	–	0.75	1.25	–	microseconds
Turn-Off Time, t_{off}, (Reverse Recovery Time + Gate Recovery Time) i_F = 8 amperes, 50 μs pulse width, dv_{FB}/dt = 20 v/μs, di_r/dt = 30 A/μs, I_{GT} = 200mA, T_C = +80°C	–	20	50	–	20	50	–	20	50	–	20	50	microseconds
Thermal Resistance, Junction-to-Case	–	–	1.7	–	–	1.7	–	–	1.7	–	–	1.7	°C/W

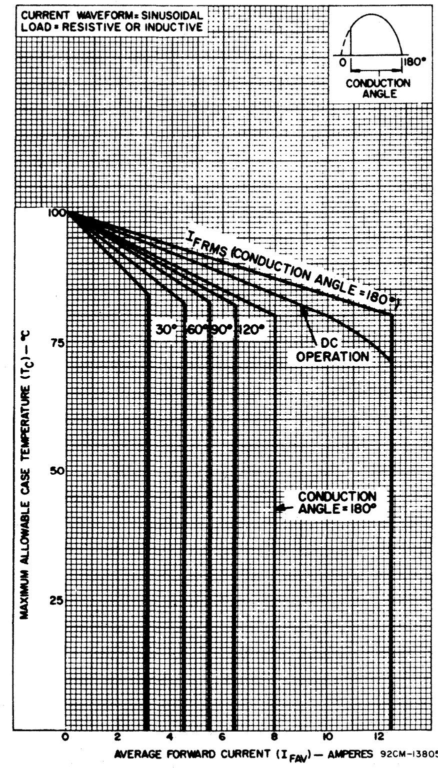


Fig. 4 — Maximum allowable case temperature vs. average forward current.

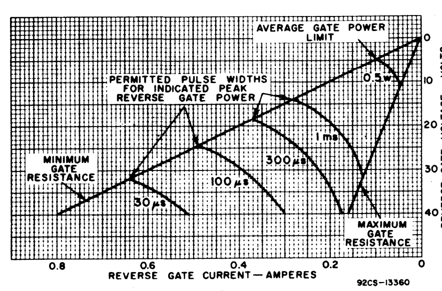


Fig. 6 — Reverse gate characteristics.

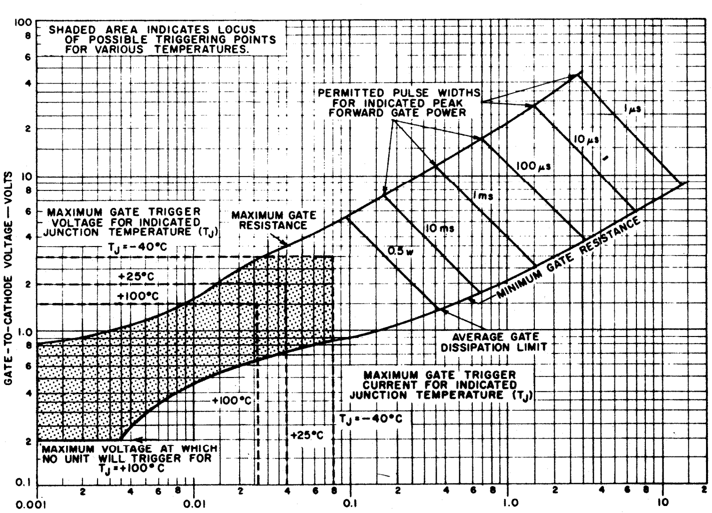


Fig. 5 — Forward gate characteristics.

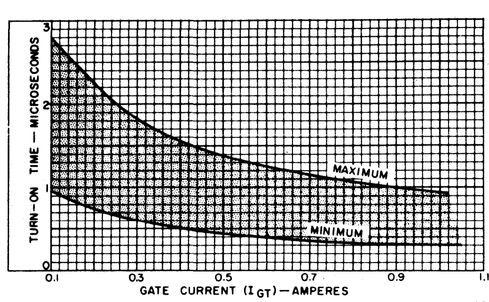


Fig. 7 — Turn-on time vs. gate current.

S4000(2N3668-2N3670, 2N4103) Series

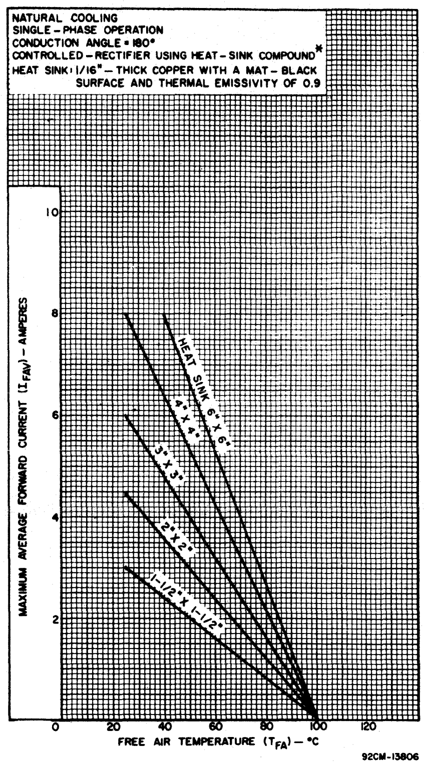


Fig. 8 — Natural-cooling operation guidance chart.

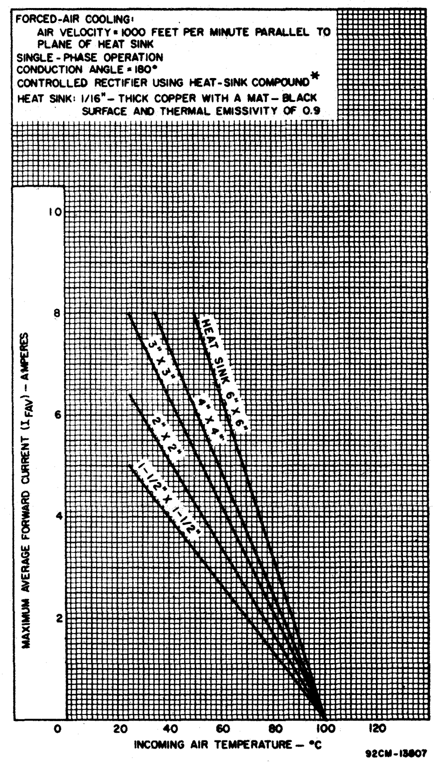


Fig. 9 — Forced-air cooling operation guidance chart.

*Dow Corning 340 Silicon Heat Sink Compound, or Equivalent.

S5210 Series

10-A Silicon Controlled Rectifiers

For Inverter Applications

RCA-S5210-series types are all-diffused, silicon controlled rectifiers designed for high-frequency power-switching applications such as inverters, switching regulators, and high-current pulse applications. These types may be used at frequencies up to 25 kHz.

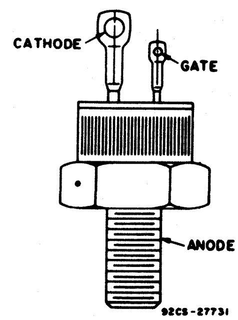
Features:
- **Fast turn-off time — 8 µs max.**
- **High di/dt and dv/dt capabilities**
- **Shorted-emitter gate-cathode construction ... contains an internally diffused resistor between gate and cathode**
- **Low thermal resistance**
- **Center gate construction ... provides rapid uniform gate-current spreading for faster turn-on with substantially reduced heating effects**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		S5210B	S5210D	S5210M	
NON-REPETITIVE PEAK REVERSE VOLTAGE:• Gate Open	V_{RSOM}	200	400	600	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE:• Gate Open	V_{DSOM}	250	500	700	V
REPETITIVE PEAK REVERSE VOLTAGE:• Gate Open	V_{RROM}	200	400	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE:• Gate Open	V_{DROM}	200	400	600	V
ON-STATE CURRENT: T_C = 85°C, conduction angle = 180°:					
RMS	$I_{T(RMS)}$		10		A
Average	$I_{T(AV)}$		6.3		A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT: For one full cycle of applied principal voltage 60 Hz (sinusoidal)	I_{TSM}		90		A
RATE OF CHANGE OF ON-STATE CURRENT: $V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 µs	di/dt		200		A/µs
FUSING CURRENT (for SCR protection): T_J = −40 to 100°C, t = 1 to 8.3 ms	I^2t		35		A^2s
GATE POWER DISSIPATION:▪					
Peak Forward (for 10 µs max.)	P_{GM}		13		W
Average (averaging time = 10 ms max.)	$P_{G(AV)}$		0.5		W
TEMPERATURE RANGE:▲					
Storage	T_{stg}		−40 to 150		°C
Operating (Case)	T_C		−40 to 100		°C
TERMINAL TEMPERATURE (During Soldering): For 10 s max. (terminals and case)	T_T		225		°C
STUD TORQUE:	τ_s				
Recommended			35		in-lb
Maximum (DO NOT EXCEED)			50		in-lb

•These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
▪Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
▲For temperature measurement reference point, see Dimensional Outline.

TERMINAL DESIGNATIONS



1/4 — 28-Thread Stud Package

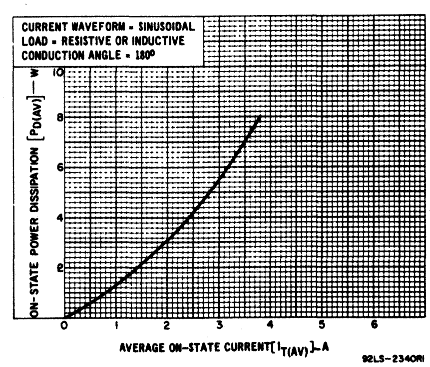


Fig. 1 — Power dissipation vs. average on-state current.

ELECTRICAL CHARACTERISTICS
At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES Except as Specified			UNITS
		Min.	Typ.	Max.	
Peak Off-State Current: (Gate open, T_C = 100°C) Forward Current (I_{DOM}) at $V_D = V_{DROM}$	I_{DOM}	–	–	3	mA
Reverse Current (I_{ROM}) at $V_R = V_{RROM}$	I_{ROM}	–	–	3	mA
Instantaneous On-State Voltage: i_T = 30 A (peak), T_C = 25°C	v_T	–	2.2	3	V
For other conditions			(See Fig.3)		
Instantaneous Holding Current: Gate open, T_C = 25°C	i_{HO}	–	20	50	mA
Critical Rate of Rise of Off-State Voltage $V_D = V_{DROM}$, exponential voltage rise, Gate open, T_C = 80°C	dv/dt	100	250	–	V/µs
DC Gate Trigger Current: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	I_{GT}	–	15	40	mA
DC Gate Trigger Voltage: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	V_{GT}	–	1.8	3.5	V
Gate Controlled Turn-On Time: (Delay Time + Rise Time) For $V_{DX} = V_{DROM}$, I_{GT} = 300 mA, t_r = 0.1 µs, I_T = 2 A (peak), T_C = 25°C (See Fig. 4)	t_{gt}	–	0.7	–	µs
Circuit Commutated Turn-Off Time: $V_{DX} = V_{DROM}$, i_T = 10 A, pulse duration = 50 µs, dv/dt = 100 V/µs, −di/dt = −10 A/µs, I_{GT} = 100 mA, V_{GT} = 0 V (at turn-off), T_C = 80°C	t_q	–	–	8	µs
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	–	–	1.5	°C/W

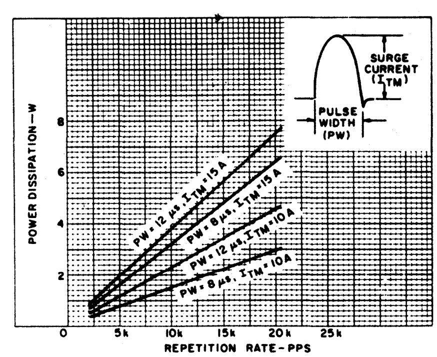


Fig. 2 — Dissipation vs. repetition rate.

S5210 Series

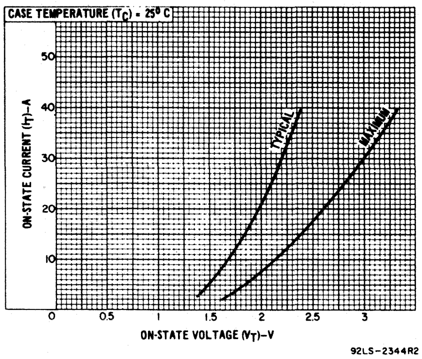


Fig. 3 – Instantaneous on-state vs. on-state voltage.

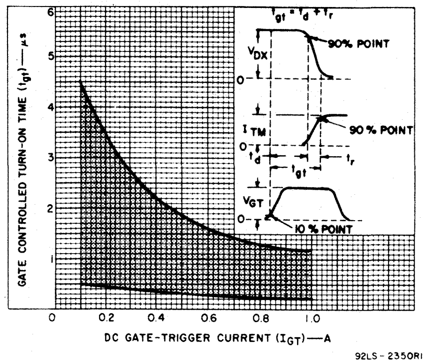


Fig. 4 – Turn-on time vs. gate-trigger current.

S6000 (2N6394-2N6398; S6000C, S6000E, S6000S) S6100 (2N6400-2N6404; S6100C, S6100E, S6100S) Series

12-A and 16-A Silicon Controlled Rectifiers

For Power Switching, Power Control, and Ignition Applications

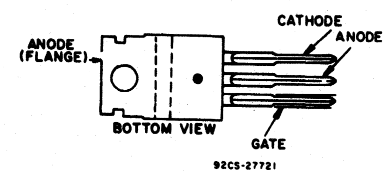
The RCA-2N6394 to 2N6398, inclusive, and 2N6400 to 2N6404, inclusive, and the S6000C, S6000E, S6000S, S6100C, S6100E, and S6100S are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state.

The TO-220AB package provides easy package mounting and low thermal resistance, allowing operation at high case temperatures and permitting reduced heatsink size. These SCR's can be used in lighting and motor-speed control, capacitor-discharge ignition circuits, high-voltage generators, automotive applications, and power-switching systems.

Features:

- High dv/dt capability
- Low thermal resistance
- Shorted-emitter center gate design
- Low on-state voltage at high current levels
- Glass passivated junctions

TERMINAL CONNECTIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6394 2N6400	2N6395 2N6401	2N6396 2N6402	S6000C S6100C	2N6397 2N6403	S6000E S6100E	2N6398 2N6404	S6000S S6100S	
*V_{RSOM}▲	75	125	250	350	450	550	650	750	V
V_{DSOM}▲	75	125	250	350	450	550	650	750	V
*V_{RROM}▲	50	100	200	300	400	500	600	700	V
*V_{DROM}▲	50	100	200	300	400	500	600	700	V
$I_{T(RMS)}$ θ = 180°C									
T_C = 90°C – 2N6394-98, S6000 series	12								A
T_C = 100°C – 2N6400-04, S6100 series	16								A
I_{TSM}: For one full cycle of applied principal voltage									
60-Hz† – 12-A types	125♦								A
16-A types	160								A
50-Hz† – 12-A types	105								A
– 16-A types	135								A
For more than one full cycle of applied principal voltage	See Fig. 7, 8								
di/dt									
$V_D = V_{DROM}$, I_{GT} = 80 mA, t_r = 0.1 μs	100								A/μs
I^2t:									
T_J = −40 to 125°C,									
t = 1 to 8.3 ms – 12-A types	65								A^2s
16-A types	100								A^2s
P_{GM}●:									
Peak forward for 10 μs max.	16♠								W
Peak reverse	See Fig. 13								
*$P_{G(AV)}$●:									
Averaging time = 8 ms maximum	0.5								W
I_{GM}: (forward)	2								A
*T_{stg}■	−40 to 150								°C
*T_C■	−40 to 125								°C
T_T: During soldering for 10 s maximum (terminal and case)	250								°C

* In accordance with JEDEC registration data format (JS-22, RDF-1) filed for the JEDEC (2N series) types.
▲ These values do not apply if there is a positive gate signal, Gate must be open or negatively biased.
† At maximum rated $I_{T(RMS)}$.
♦ JEDEC registered value is 100 A at T_C = 90°C.
● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
♠ JEDEC registered value is 10 W.
■ For temperature measurement reference point, see Dimensional Outline.

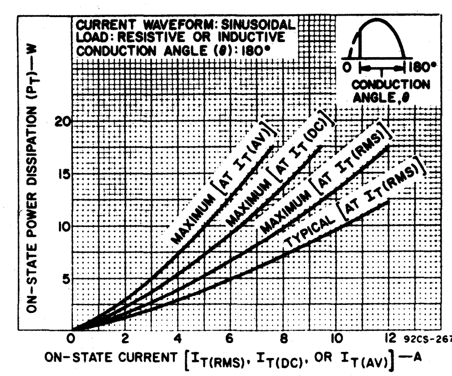


Fig. 1 — On-state power dissipation vs. on-state current for 2N6394-98, S6000 series.

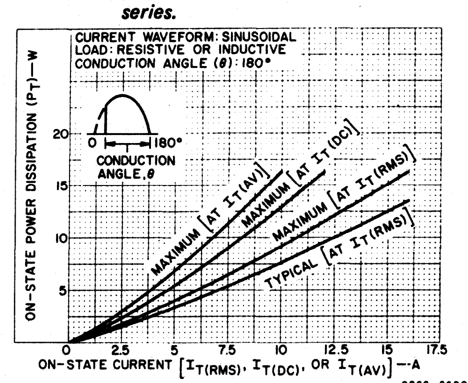


Fig. 2 — On-state power dissipation vs. on-state current for 2N6400-04, S6100 series.

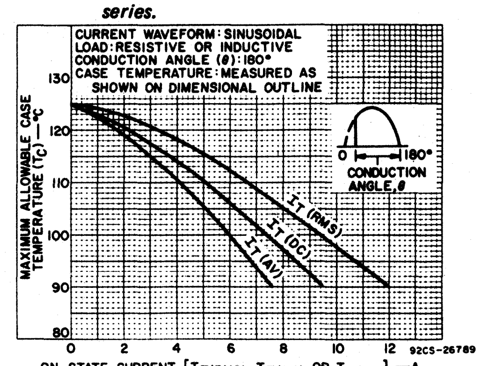


Fig. 3 — Maximum allowable case temperature vs. on-state current for 2N6394-98, S6000 series.

S6000 (2N6394-2N6398; S6000C, S6000E, S6000S) S6100 (2N6400-2N6404; S6100C, S6100E, S6100S) Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTIC	LIMITS For All Types MIN.	TYP.	MAX.	UNITS
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, T_C = 125°C	–	0.1	2*	mA
v_T: (See Fig. 9, 10) i_T = 24 A (peak), T_C = 25°C (12-A types)	–	1.7	2.2*	V
= 32 A (peak), T_C = 25°C (16-A types)	–	1.4	1.7*	V
I_{HO}: (See Fig. 11) T_C = 25°C	–	10	35	mA
T_C = −40°C	–	–	60*	mA
dv/dt: $V_D = V_{DROM}$, exponential voltage rise, T_C = 125°	50	–	–	V/μs
I_{GT}: (See Fig. 14) V_D = 12 V (dc), R_L = 50Ω, T_C = 25°C	–	8	30	mA
V_D = 12 V (dc), R_L = 50Ω, T_C = −40°C	–	–	60*	mA
V_{GT}: (See Fig. 15) V_D = 12 V (dc), R_L = 50Ω, T_C = 25°C	–	0.7	1.5	V
V_D = 12 V (dc), R_L = 50Ω, T_C = −40°C	–	–	2.5*	V
V_{GRD}: $V_D = V_{DROM}$, T_C = 125°C	0.2	–	–	V
t_{gt}: $V_D = V_{DROM}$, i_T = 24 A (peak), I_{GT} = 200 mA, t_r = 0.02 μs, T_C = 25°C	–	–	2*	μs
t_q: Rectangular Pulse $V_D = V_{DROM}$, $i_T = I_{T(RMS)}$, pulse duration = 50 μs, dv/dt = 50 V/μs, −di/dt = −10 A/μs, I_{GT} = 80 mA at turn-on, V_R = 20 V minimum, V_{GK} = 0 V at turn-off, T_C = 75°C	–	35	75	μs
$R_{\theta JC}$	–	–	2*	°C/W
$R_{\theta JA}$	–	–	50*	°C/W

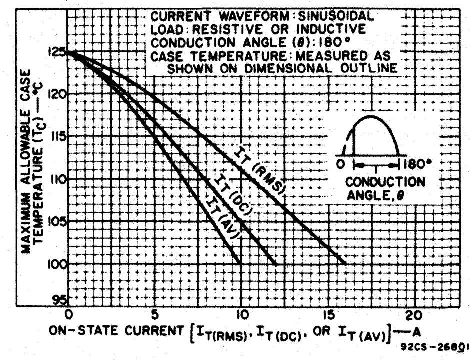


Fig. 4 — Maximum allowable case temperature vs. on-state current for 2N6400-04, S6100 series.

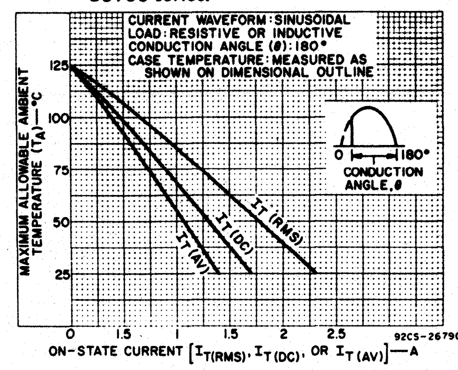


Fig. 5 — Maximum allowable ambient temperature vs. on-state current — no heat sinking for 2N6394-98, S6000 series.

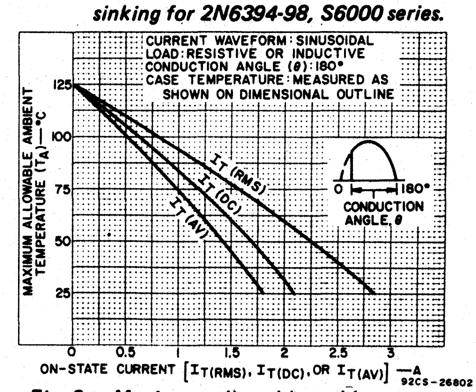


Fig. 6 — Maximum allowable ambient temperature vs. on-state current — no heat sinking for 2N6400-04, S6100 series.

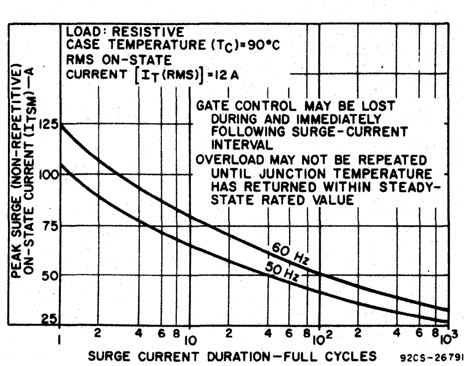


Fig. 7 — Allowable peak surge on-state current vs. surge duration for 2N6394-2N6398 and S6000 series.

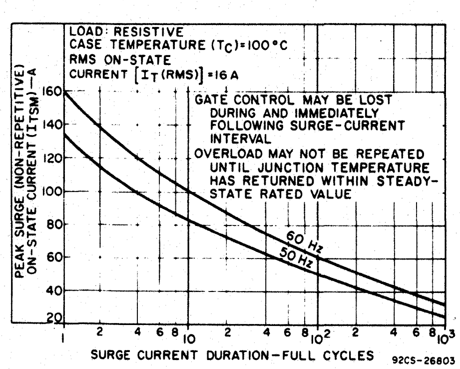


Fig. 8 — Allowable peak surge on-state current vs. surge duration for 2N6400-2N6404 and S6100 series.

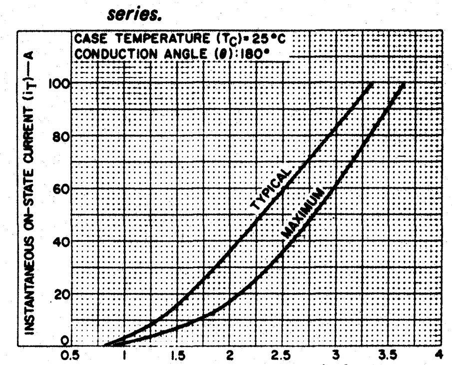


Fig. 9 — Instantaneous on-stage current vs. instantaneous on-state voltage for 2N6394—2N6398 and S6000 series.

S6000 (2N6394-2N6398; S6000C, S6000E, S6000S) S6100 (2N6400-2N6404; S6100C, S6100E, S6100S) Series

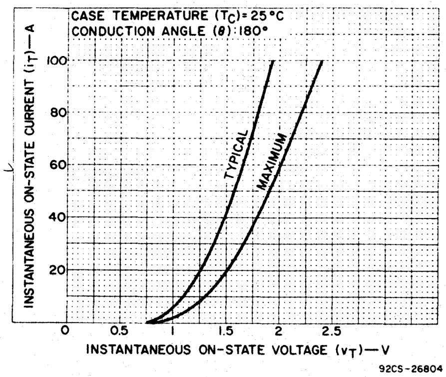


Fig. 10 — Instantaneous on-state current vs. instantaneous on-state voltage for 2N6400—2N6404 and S6100 series.

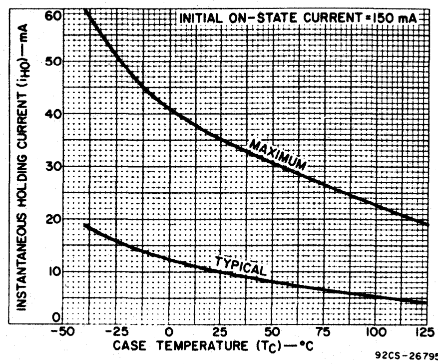


Fig. 11 — Instantaneous holding current vs. case temperature for all types.

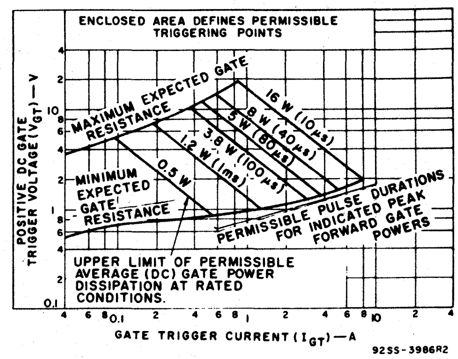


Fig. 12 — Gate trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses for all types.

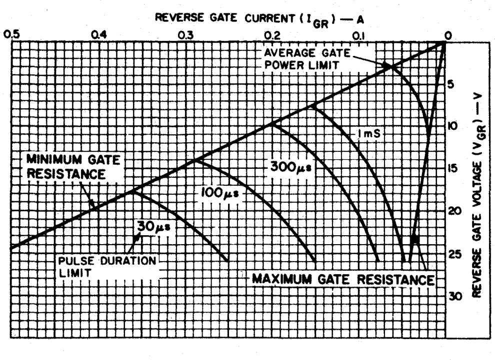


Fig. 13 — Reverse gate characteristics for all types.

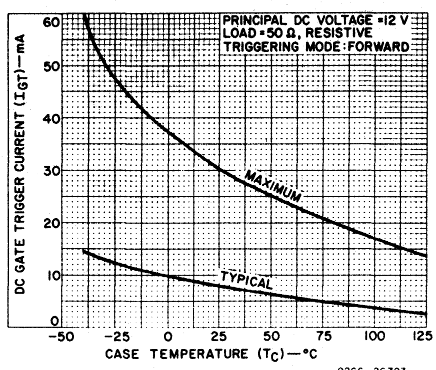


Fig. 14 — DC gate trigger current vs. case temperature for all types.

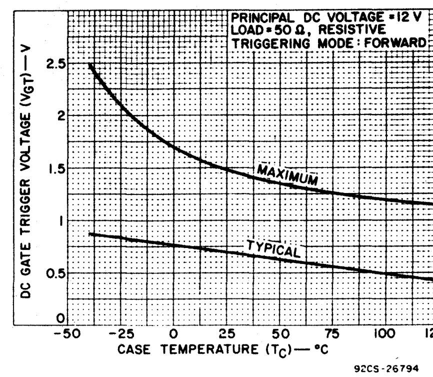


Fig. 15 — DC gate trigger voltage vs. case temperature for all types.

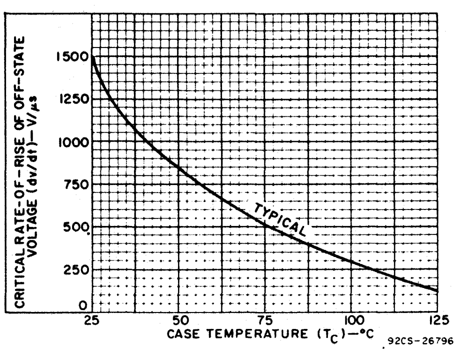


Fig. 16 — Critical rate of rise of off-state voltage vs. case temperature for all types.

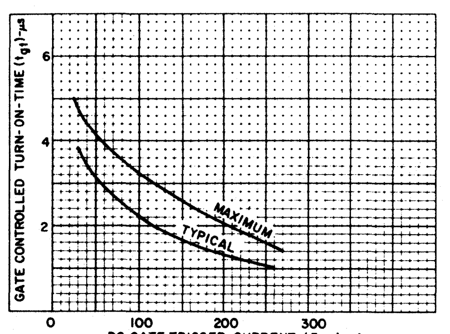


Fig. 17 — Typical gate-controlled turn-on time vs. gate trigger current for all types.

S6200, S6210, S6220 Series

20-Ampere Silicon Controlled Rectifiers

Press-Fit, Stud, and Isolated-Stud Packages

These RCA types are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) designed for power switching and voltage regulator applications and for heating, lighting and motor speed-control circuits.

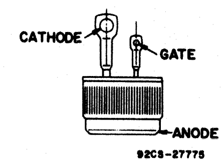
These SCRs have an RMS on-state current rating ($I_{T\,[RMS]}$) of 20 A and have voltage ratings (V_{DROM}) of 100, 200, 400, and 600 volts.

The S6200 SCR series employs a hermetic press-fit package, the S6210 series employs a hermetic stud package, and the S6220 series employs a hermetic isolated-stud package.

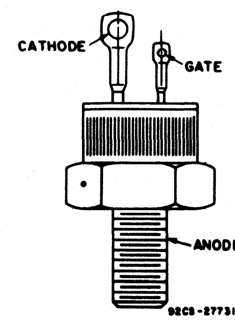
Features:
- Low switching losses
- High di/dt and dv/dt capabilities
- Shorted-emitter gate-cathode construction
- Forward and reverse gate dissipation ratings
- All-diffused construction—assures exceptional uniformity and stability of characteristics
- Symmetrical gate-cathode construction—provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- Low leakage currents, both forward and reverse
- Low forward voltage drop at high current levels
- Low thermal resistance

MAXIMUM RATINGS, *Absolute-Maximum Values:*		S6200A S6210A S6220A	S6200B S6210B S6220B	S6200D S6210D S6220D	S6200M S6210M S6220M	
NON-REPETITIVE PEAK REVERSE VOLTAGE						
Gate Open	V_{RSOM}	150	250	500	700	V
NON-REPETITIVE PEAK FORWARD VOLTAGE						
Gate Open	V_{DSOM}	150	250	500	700	V
REPETITIVE PEAK REVERSE VOLTAGE						
Gate Open	V_{RROM}	100	200	400	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE						
Gate Open	V_{DROM}	100	200	400	600	V
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:						
For one cycle of applied principal voltage $T_C = 75°C$	I_{TSM}					
50-Hz, (sinusoidal)		170				A
60-Hz, (sinusoidal)		200				A
For more than one full cycle of applied principal voltage		See Fig. 3				
ON-STATE CURRENT:						
For case temperature (T_C) = 75° C, conduction angle of 180°						
Average DC value	$I_{T(AV)}$	12.5				A
RMS value	$I_{T(RMS)}$	20				A
RATE-OF-CHANGE OF ON-STATE CURRENT:						
$V_{DM} = V_{(BO)O}$, I_{GT} = 200 mA, t_r = 0.5 μs	di/dt	200				A/μs
FUSING CURRENT (for SCR protection):						
T_J = −65 to 100°C, t = 1 to 8.3 ms	I^2t	170				A^2s
GATE POWER DISSIPATION:						
PEAK FORWARD (for 10 μs max.)	P_{GM}	40				W
AVERAGE (averaging time = 10 ms, max.)	$P_{G(AV)}$	0.5				W
PEAK REVERSE	P_{RGM}	See Fig. 10				
TEMPERATURE RANGE:						
Storage		−65 to 150				°C
Operating (Case)		−65 to 100				°C
Soldering (10 s max. for terminals)		225				°C

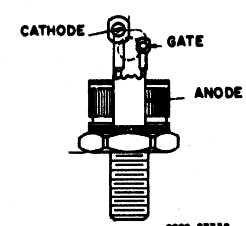
TERMINAL CONNECTIONS



Press-Fit Types



Stud Types



Isolated-Stud Types

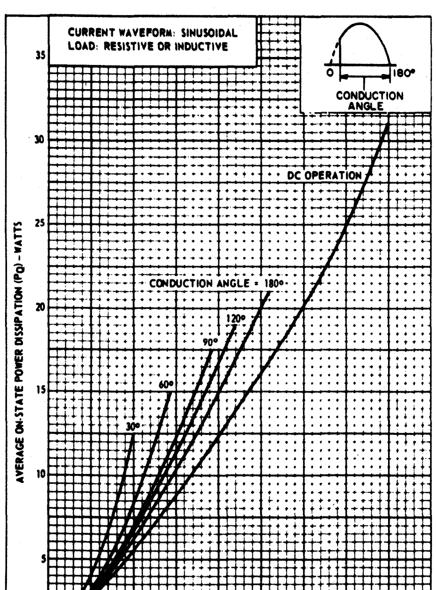


Fig. 1 —Power dissipation vs. on-state current.

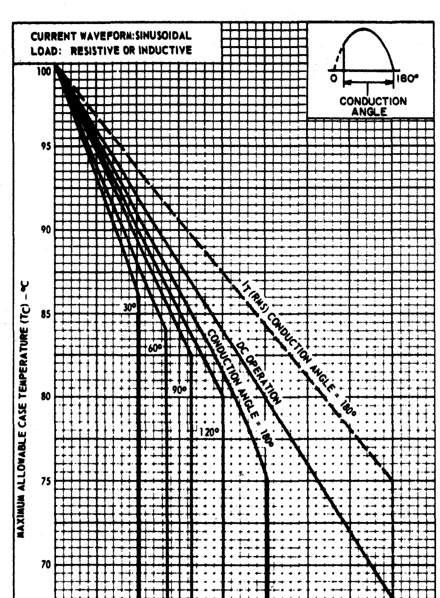


Fig. 2 —Maximum allowable case temperature vs. average forward current for stud and press-fit.

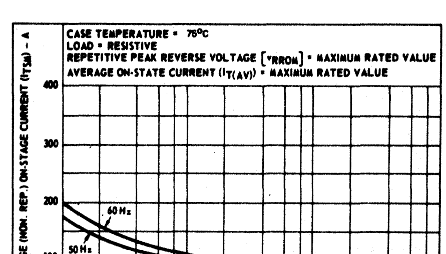


Fig. 3 —Peak surge on-state current vs. surge current duration.

S6200, S6210, S6220 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS – ALL TYPES Min.	Typ.	Max.	UNITS
Instantaneous Forward Breakover Voltage: (Gate open, T_C = 100 °C)					
S6200A, S6210A, S6220A	$v_{(BO)O}$	100	–	–	V
S6200B, S6210B, S6220B		200	–	–	
S6200D, S6210D, S6220D		400	–	–	
S6200M, S6210M, S6220M		600	–	–	
Peak Off-State Current: (Gate open, T_C = 100 °C)					
Forward, $V_{DO} = V_{DROM}$	I_{DOM}	–	0.2	3	mA
Reverse, $V_{RO} = V_{RROM}$	I_{RROM}	–	0.1	2	
Instantaneous On-State Voltage: For i_T = 100 A, T_C = 25 °C	v_T	–	1.9	2.4	V
DC Gate Trigger Current: V_D = 12 V (DC), R_L = 30 Ω, T_C = 25 °C	I_{GT}	–	8	15	mA
At other case temperatures			See Fig. 8		
DC Gate Trigger Voltage: V_D = 12 V (DC), R_L = 30 Ω, T_C = 25 °C	V_{GT}		1.1	2	V
At other case temperatures			See Fig. 9		
Instantaneous Holding Current: Gate open, T_C = 25 °C	I_{HO}		9	20	mA
At other case temperatures			See Fig. 6		
Critical Rate-of-Rise of Off-State Voltage: ($V_{DO} = v_{(BO)O}$ Min. value, Exponential rise, T_C = 100°C)	dv/dt				V/μs
S6200A, S6200D, S6210A, S6210D, S6220A, S6220D		10	100	–	
S6200B, S6210B, S6220B		10	150	–	
S6200M, S6210M, S6220M		10	75	–	
Gate Controlled Turn-On Time: $V_D = v_{(BO)O}$ Min. value, i_T = 30 A, I_{GT} = 200 mA, 0.1 μs rise time, T_C = 25°C See Fig. 11	t_{gt}	–	2	–	μs
Circuit Commutated Turn-Off Time: $V_D = V_{F(BO)O}$ Min. value, i_T = 18 A, Pulse Duration = 50 μs, **dv/dt = 20 V/μs, di/dt = –30 A/μs, T_C = 75°C**	t_q	–	20	40	μs
Thermal Resistance:					
Junction-to-Case **(press-fit, stud packages)**	$R_{\theta JC}$	–	–	1.2	°C/W
Junction-to-Isolated Stud **(Isolated-stud package)**	$R_{\theta JIS}$	–	–	1.4	

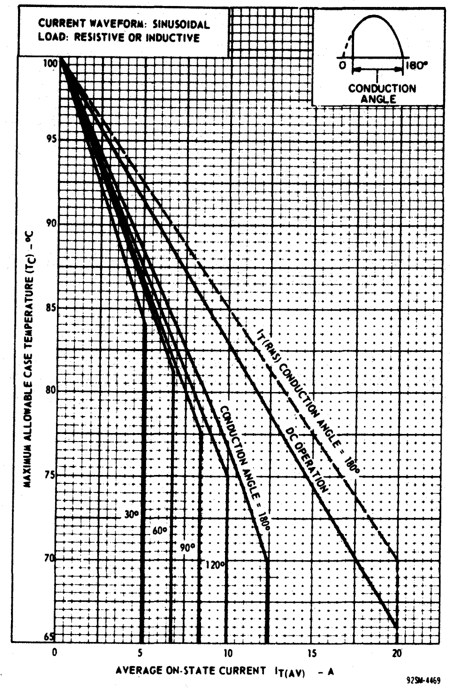


Fig. 4 – Maximum allowable case temperature vs. average forward current for isolated stud.

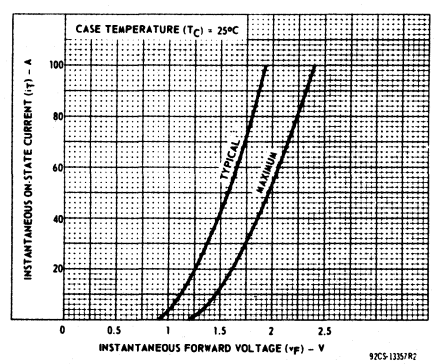


Fig. 5 – Instantaneous on-state current vs. on-state voltage.

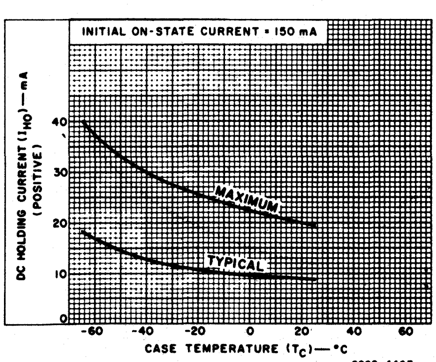


Fig. 6 – DC holding current vs. case temperature.

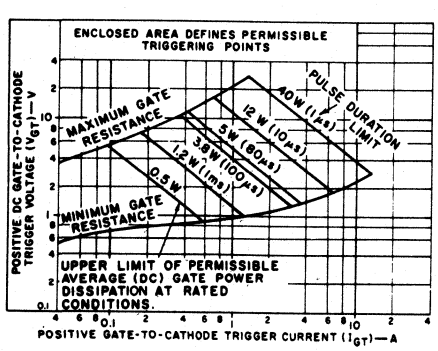


Fig. 7 – Typical forward-biased gate trigger characteristics.

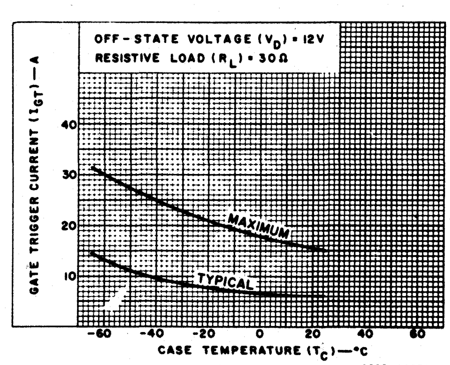


Fig. 8 – DC gate-trigger current (forward) vs. case temperature.

S6200, S6210, S6220 Series

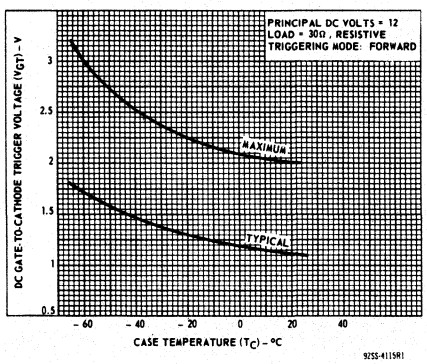


Fig. 9 – DC gate-trigger voltage vs. case temperature.

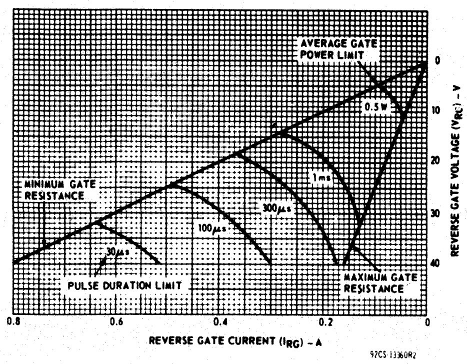


Fig. 10 – Reverse gate voltage vs. reverse gate current.

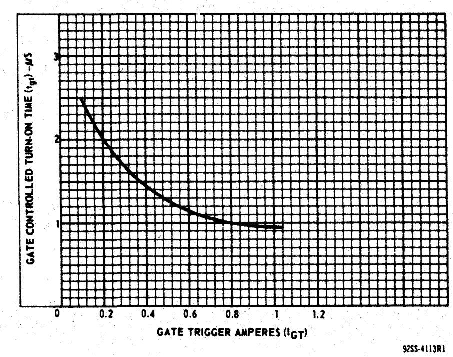


Fig. 11 – Gate controlled turn-on time (t_{gt}) vs. gate-trigger current.

S6230, S6240, S6250, S6430, S6440, S6450 Series

20- and 35-A Silicon Controlled Rectifiers

For General-Purpose Phase-Control Applications

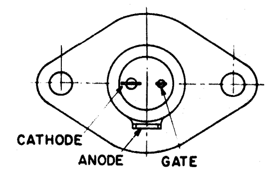
These RCA silicon controlled rectifiers (reverse-blocking triode thyristors) are designed for general-purpose phase-control applications.

The S6230, S6240, and S6250 series have current ratings of 20 amperes. SCR's in each series have voltage ratings of 100, 200, 400, and 600 volts. The S6430, S6440, and S6450 series have current ratings of 35 amperes. SCR's in each series have voltage ratings of 100, 200, 400, 600, and 800 volts.

The S6230 and S6430 series employ a press-fit package with flexible leads, encapsulated on an isolated stud. The S6240 and S6440 series employ a press-fit package isolated on a TO-3 flange. The S6250 and S6450 series employ a press-fit package with flexible leads, encapsulated on an isolated TO-3 flange.

Features:
- **3-kV rms encapsulant (HYPOT) breakdown voltage**
- **Flame-resistant encapsulant (self-extinguishing)**
- **Rugged packages**
- **Standard RCA SCR features**

TERMINAL CONNECTIONS



92CS-27729

S6240 **S6440**

FLEXIBLE-LEAD (TERMINAL) CONNECTIONS

Flexible-Lead (Insulation) Color	Terminal
White	Gate
Red	Cathode
Black	Anode

Note: Terminals are identified by color code only. Position of the flexible leads (relative to terminals of the device) leaving the encapsulant is random.

Press-Fit with Flexible Leads, Encapsulated on Isolated-Stud

S6230 **S6430**

Press-Fit with Flexible Leads, Encapsulated, Isolated on TO-3 Flange

S6250 **S6450**

WARNING: The ceramic used in these packages contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

20-A SCR's – S6230, S6240, and S6250 Series Electrical and Mechanical Data

Type No.	Rep. Peak Off-State Voltage V_{DROM} (V)	On-State Current I_T (RMS) (A)	T_C (°C)	Package (Press-fit)	Wire Size: Cathode Anode Gage No.	Wire Size: Gate Gage No.	Wire Insulation Thickness: Cathode Anode in. (mm)	Wire Insulation Thickness: Gate in. (mm)	Refer to Bulletin File No.*
S6230A S6230B S6230D S6230M	100 200 400 600	20	70	With flex.leads, encap. on isolated-stud	14	22	0.031 (0.787)	0.016 (0.406)	418
S6240A S6240B S6240D S6240M	100 200 400 600	20	70	Isolated on TO-3 flange	–	–	–	–	418
S6250A S6250B S6250D S6250M	100 200 400 600	20	70	With flex.leads, encap., isolated on TO-3 flange	14	22	0.031 (0.787)	0.016 (0.406)	418

35-A SCR's – S6430, S6440, and S6450 Series Electrical and Mechanical Data

S6430A S6430B S6430D S6430M S6430N	100 200 400 600 800	35	65	With flex.leads, encap. on isolated-stud	12	22	0.034 (0.863)	0.016 (0.406)	578
S6440A S6440B S6440D S6440M S6440N	100 200 400 600 800	35	65	Isolated on TO-3 flange	–	–	–	–	578
S6450A S6450B S6450D S6450M S6450N	100 200 400 600 800	35	65	With flex.leads, encap., isolated on TO-3 flange	12	22	0.034 (0.863)	0.016 (0.406)	578

* Electrical characteristics and ratings given in these bulletins also apply to the types listed in this chart.

S6400(2N3870-2N3873;S6400N) S6410(2N3896-2N3899; S6410N) S6420 Series

35-A Silicon Controlled Rectifiers

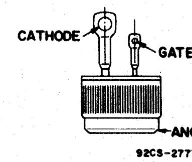
Features:
- High di/dt and dv/dt capabilities
- Low on-state voltage at high current levels
- Low thermal resistance
- Shorted-emitter center-gate construction

These RCA types are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) designed for power switching, power control, and voltage regulator applications and for heating, lighting, and motor speed-control circuits.

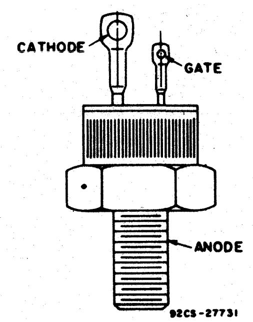
The 2N3870-73 and S6400N employ a hermetic press-fit package.

The 2N3896-99 and S6410N employ a hermetic stud package. The S6420 series employ a hermetic isolated-stud package.

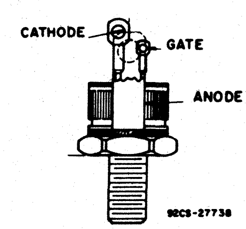
TERMINAL CONNECTIONS



Press-Fit Types



Stud Types



Isolated-Stud Types

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3870 2N3896 S6420A	2N3871 2N3897 S6420B	2N3872 2N3898 S6420D	2N3873 2N3899 S6420M	S6400N S6410N S6420N	
•NON-REPETITIVE PEAK REVERSE VOLTAGE▲ Gate Open	V_{RSOM}	150	330	660	700	900	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE▲ Gate Open	V_{DSOM}	150	330	660	700	900	V
•REPETITIVE PEAK REVERSE VOLTAGE▲ Gate Open	V_{RROM}	100	200	400	600	800	V
•REPETITIVE PEAK OFF-STATE VOLTAGE▲ Gate Open	V_{DROM}	100	200	400	600	800	V
ON-STATE CURRENT: T_C = 65°C♦, conduction angle = 180°:							
RMS	$I_{T(RMS)}$			35			A
• Average	$I_{T(AV)}$			22			A
For other conditions				See Figs. 2 & 4			
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT: For one full cycle of applied principal voltage, T_C = 65°C	I_{TSM}						
• 60 Hz (sinusoidal)				350			A
50 Hz (sinusoidal)				300			A
For more than one full cycle of applied principal voltage				See Fig. 3			
RATE OF CHANGE OF ON-STATE CURRENT $V_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.5 μs	di/dt			200			A/μs
FUSING CURRENT (for SCR protection): T_J = -40 to 100°C, t = 1 to 8.3 ms	I^2t			300			A^2s
GATE POWER DISSIPATION●:							
Peak Forward (for 10 μs max., See Fig. 7)	P_{GM}			40			W
Peak Reverse	P_{RGM}			See Fig. 8			
Average (averaging time = 10 ms max.)	$P_{G(AV)}$			0.5			W
•TEMPERATURE RANGE■:							
Storage	T_{stg}			-40 to 125			°C
Operating (Case)	T_C			-40 to 100			°C
TERMINAL TEMPERATURE (During soldering): For 10 s max. (terminals and case)	T_T			225			°C

* In accordance with JEDEC registration data filed for the JEDEC (2N-series) types.
▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
♦ T_C = 60° for isolated-stud package types.
● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
■ Temperature measurement point is shown on the DIMENSIONAL OUTLINE.

WARNING: The ceramic of the isolated stud package contains beryllium oxide. Do not crush, grind, or abrade this part because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

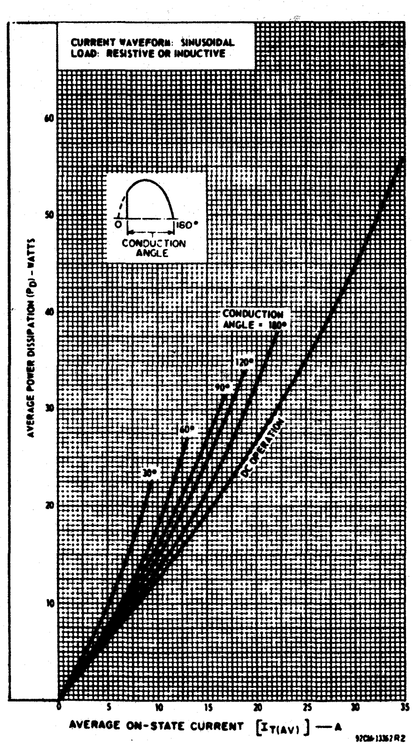


Fig.1 — Power dissipation vs. on-state current.

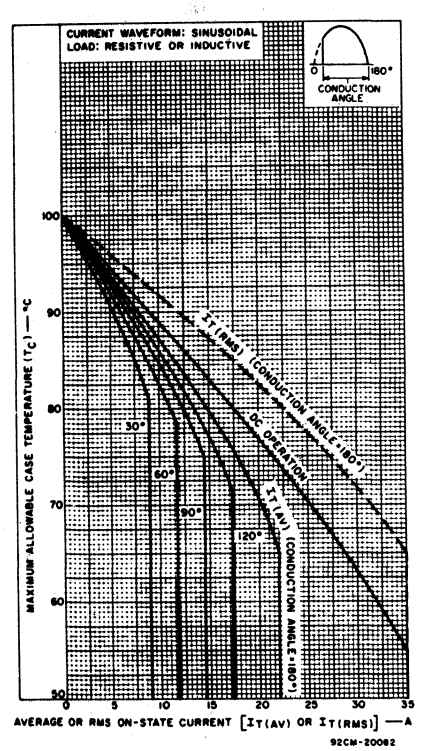


Fig.2 — Maximum allowable case temperature vs. on-state current for press-fit and stud types.

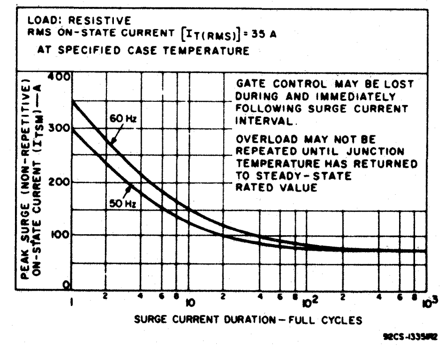


Fig.3 — Peak surge on-state current vs. surge current duration.

S6400(2N3870-2N3873;S6400N) S6410(2N3896-2N3899; S6410N) S6420 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES Unless Otherwise Specified MIN.	TYP.	MAX.	UNITS
Peak Off-State Current: (Gate open, T_C = 100°C) Forward Current (I_{DOM}) at V_D = V_{DROM} Reverse Current (I_{ROM}) at V_R = V_{RROM}	I_{DOM} or I_{ROM}				mA
2N3870, 2N3896, S6420A		–	0.2	2*	
2N3871, 2N3897, S6420B		–	0.25	2.5*	
2N3872, 2N3898, S6420D		–	0.3	3*	
2N3873, 2N3899, S6420M, S6400N, S6410N, S6420N		–	0.35	4*	
Instantaneous On-State Voltage: i_T = 69 A (peak), T_C = 25°C	v_T	–	–	1.85*	V
i_T = 100 A (peak), T_C = 25°C		–	1.7	2.1	
DC Gate Trigger Voltage: V_D = 12 V (dc), R_L = 30 Ω, T_C = -40°C	V_{GT}	–	1.5	.3*	V
V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C		–	1.1	2	
For other case temperatures			See Fig. 10		
DC Gate Trigger Current: V_D = 12 V (dc), R_L = 30 Ω, T_C = -40°C	I_{GT}	–	46	80*	mA
V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C		1	25	40	
For other case temperatures			See Fig. 9		
Instantaneous Holding Current: Gate open, T_C = 25°C	i_{HO}	0.5	30	70	mA
For other case temperatures			See Fig. 6		
Gate Controlled Turn-On Time: (Delay Time + Rise Time) For V_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs, I_T = 30 A (peak), T_C = 25°C	t_{gt}	–	1.25	2	μs
Circuit Commutated Turn-Off Time: V_D = V_{DROM}, i_T = 18 A, pulse duration = 50 μs, dv/dt = 20 V/μs, -di/dt = -30 A/μs, I_{GT} = 200 mA, T_C = 80°C	t_q	–	20	40	μs
Critical Rate of Rise of Off-State Voltage: V_D= V_{DROM}, exponential voltage rise, Gate open, T_C = 100°C	dv/dt	10	100	–	V/μs
Thermal Resistance, Junction-to-Case: Steady-State Press-fit & stud types	$R_{\theta JC}$	–	–	0.9*	°C/W
Isolated-stud types		–	–	1	

*In accordance with JEDEC registration data filed for the JEDEC (2N-series) types.

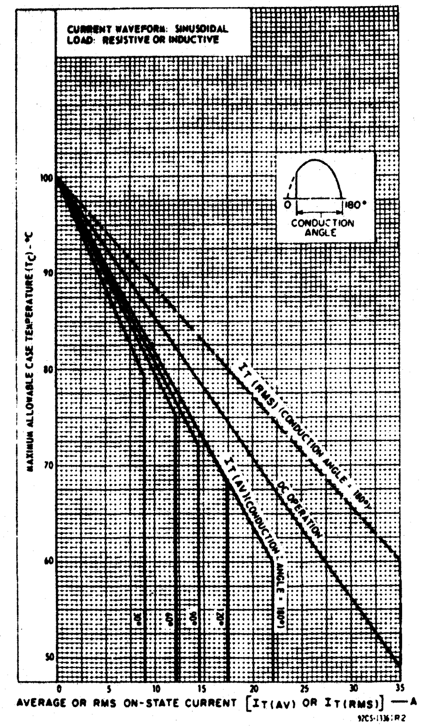


Fig.4 — Maximum allowable case temperature vs. on-state current for isolated-stud types.

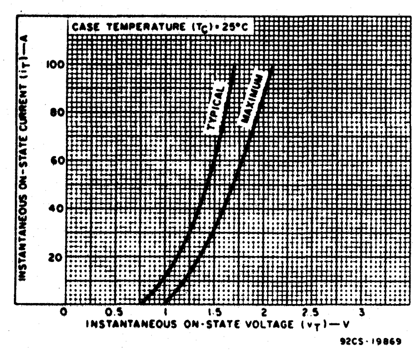


Fig.5 — Instantaneous on-state current vs. on-state voltage.

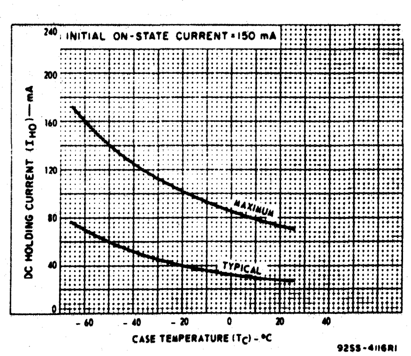


Fig.6 — DC holding current vs. case temperature.

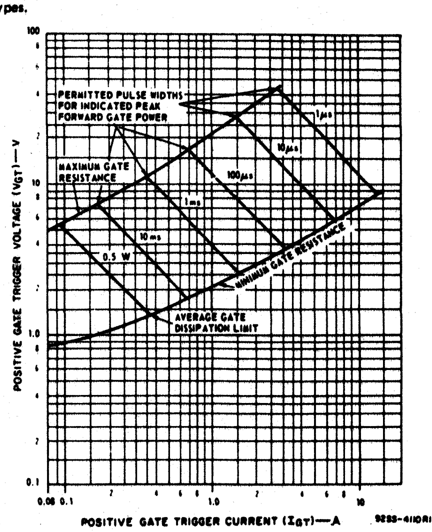


Fig.7 — Gate pulse characteristics for forward triggering mode.

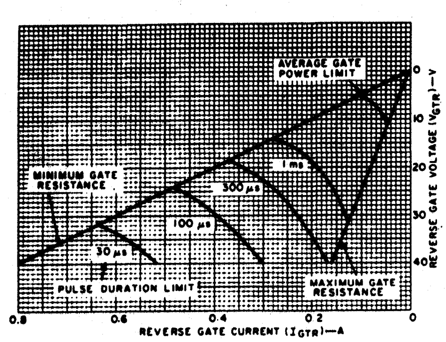


Fig.8 — Reverse gate voltage vs. reverse gate current.

S6400(2N3870-2N3873;S6400N) S6410(2N3896-2N3899; S6410N) S6420 Series

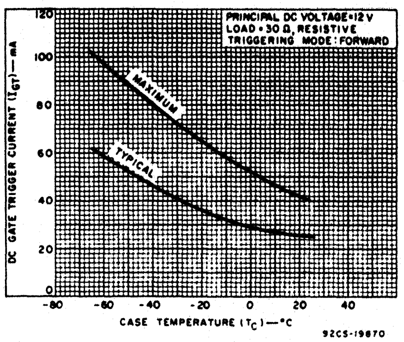


Fig.9 — DC gate trigger current (forward) vs. case temperature.

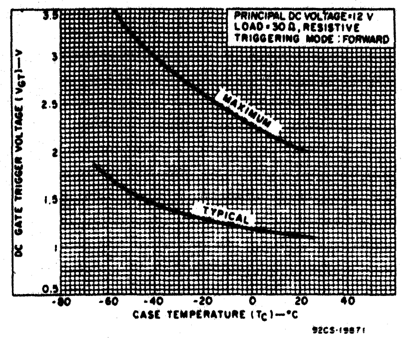


Fig.10 — DC gate trigger voltage (forward) vs. case temperature.

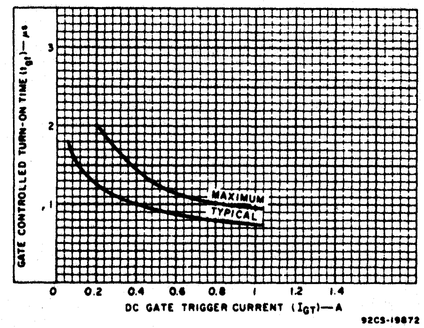


Fig.11 — Gate-controlled turn-on time vs. gate trigger current.

S6431(2N681-2N690) S6432(2N1842A-2N1850A) Series

16-A and 25-A Silicon Controlled Rectifiers for Power-Control and Power-Switching Applications

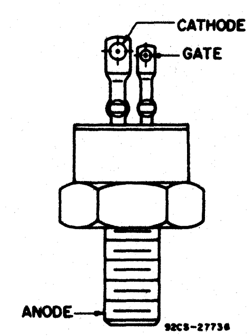
The RCA 2N681-2N690 and the 2N1842A-2N1850A are all-diffused silicon controlled rectifiers (reverse-blocking triode thrysistors) designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state.

These SCR's employ a hermetic JEDEC TO-48 package.

Features:

- **High di/dt capability**
- **Low on-state voltage at high current levels**
- **Low thermal resistance**
- **Shorted-emitter center-gate construction**.

TERMINAL CONNECTIONS



JEDEC TO-48

MAXIMUM RATINGS, *Absolute-Maximum Values:*	2N681 2N1842A	2N682 2N1845A	2N683 2N1844A	2N684 2N1845A	2N685 2N1846A	2N686 2N1847A	2N687 2N1848A	2N688 2N1849A	2N689 2N1850A	2N690 –	
*V_{RSOM}▲	35	75	150	225	300	350	400	500	600	700	V
*V_{RROM}▲	25	50	100	150	200	250	300	400	500	600	V
*V_{DROM}▲	25	50	100	150	200	250	300	400	500	600	V
$I_{T(RMS)}$ (θ = 180°):											
T_C = 80°C, (2N1842A-2N1850A)					16						A
= 65°C, (2N681-2N690)					25						A
*$I_{T(AV)}$ (θ = 180°):											
T_C = 80°C (2N1842A-2N1850A)					10						A
= 65°C (2N681-2N690)					16						A
I_{STM}: For one full cycle of applied principal voltage											
* 60Hz† (2N1842A-2N1850A)					125						A
* 60Hz♠ (2N681-2N690)					150						A
50Hz† (2N1842A-2N1850A)					115						A
50Hz♠ (2N681-2N690)					140						A
For more than one full cycle of applied principal voltage					See Figs. 3, 4						
di/dt: $V_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.5 μs					200						A/μs
I^2t [at T_C shown for $I_{T(RMS)}$]:											
t = 10 ms (2N1842A-2N1850A)					68						A^2s
(2N681-2N690)					100						A^2s
= 1 ms (2N1842A-2N1850A)					32						A^2s
(2N681-2N690)					46						A^2s
*P_{GM}●:					5						W
*$P_{G(AV)}$●:					0.5						W
*I_{GM}					2						A
*V_{GM}					10						V
*V_{GRM}					5						V
*T_{stg}■ (2N1842A-2N1850A)					−65 to 125						°C
(2N681-2N690)					−65 to 150						°C
*T_C■					−65 to 125						°C
T_T: During soldering for 10 s maximum (terminal and case)					225						°C
τ_s: Recommended					35						in-lb
					0.4						kgf-m
Maximum (DO NOT EXCEED)					50						in-lb
					0.57						kgf-m

* In accordance with JEDEC registration data.
▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
† At $I_{T(RMS)}$ = 16 A and T_C = 80°C
♠ At $I_{T(RMS)}$ = 25 A and T_C = 65°C
● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
■ For temperature measurement reference point, see Dimensional Outline.

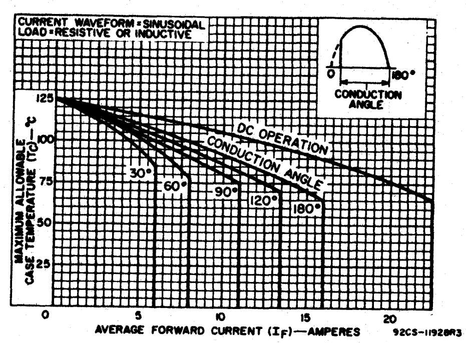


Fig. 1 — Maximum allowable case temperature vs. on-state current for 2N681 - 2N690.

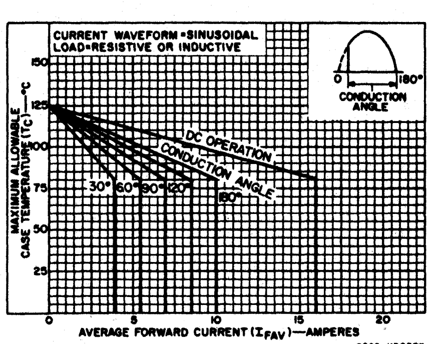


Fig. 2 — Maximum allowable case temperature vs. on-state current for 2N1842A-2N1850A.

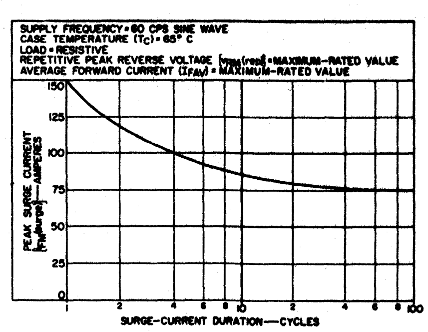


Fig. 3 — Peak surge on-state current vs. surge duration for 2N681-2N690.

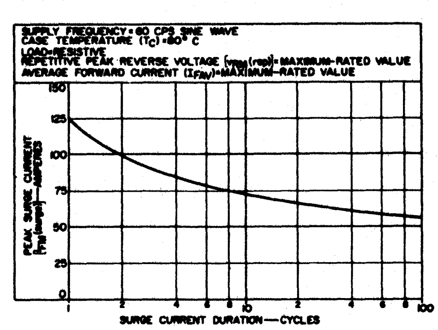


Fig. 4 — Peak surge on-state current vs. surge duration for 2N681-2N690.

S6431(2N681-2N690) S6432 (2N1842A-2N1850A) Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTIC	LIMITS 2N681-2N690 MIN.	TYP.	MAX.	2N1842A-2N1850A MIN.	TYP.	MAX.	UNITS
• I_{DROM} or I_{RROM}:							
$V_D = V_{DROM}$ or $V_R = V_{RROM}$, T_C = 125°C:							
2N681, 2N682, 2N683, 2N684	–	–	6.5	–	–	–	mA
2N685	–	–	6	–	–	–	mA
2N686	–	–	5.5	–	–	–	mA
2N687	–	–	5	–	–	–	mA
2N688	–	–	4	–	–	–	mA
2N689	–	–	3	–	–	–	mA
2N690	–	–	2.5	–	–	–	mA
$V_D = V_{DROM}$ or V_{RROM}, T_C = 80°C:							
2N1842A	–	–	–	–	–	22.5	mA
2N1843A	–	–	–	–	–	19	mA
2N1844A	–	–	–	–	–	12.5	mA
2N1845A	–	–	–	–	–	6.5	mA
2N1846A	–	–	–	–	–	6	mA
2N1847A	–	–	–	–	–	5.5	mA
2N1848A	–	–	–	–	–	5	mA
2N1849A	–	–	–	–	–	4	mA
2N1850A	–	–	–	–	–	3	mA
• v_T:							
i_T = 30 A (peak), T_C = 25°C	–	–	–	–	–	2.5	V
= 50 A (peak), T_C = 25°C	–	–	2	–	–	–	V
$v_{T(AV)}$:							
$I_T = I_{T(RMS)}$ = T_C = 65°C	–	–	0.86	–	–	–	V
= 80°C	–	–	–	–	–	1.2	V
i_{HO}:							
T_C = 125°C	–	15	–	–	8	–	mA
I_{GT}:							
T_C = 125°C	–	–	25	–	–	4.5	mA
V_D = 12 V (dc), R_L = 50Ω, T_C = 25°C	–	–	80*	–	–	150*	mA
• V_{GT}:							
V_D = 12 V (dc), R_L = 50Ω, T_C = –65 to 125°C	–	–	3	–	–	–	V
= 125°C	0.25	–	–	0.25	–	–	V
= –40°C	–	–	–	–	–	3.5	V
= –65°C	–	–	–	–	–	3.7	V
= 100°C	–	–	–	0.3	–	–	V
$R_{\theta JC}$	–	–	2	–	–	2	°C/W

*In accordance with JEDEC registration data.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

S6431(2N681-2N690) S6432(2N1842A-2N1850A) Series

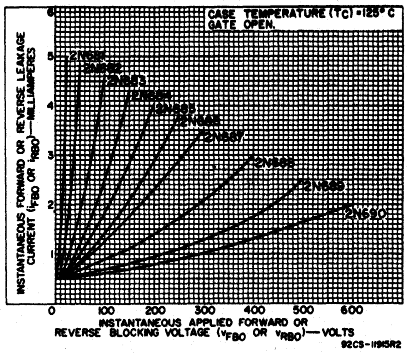


Fig. 5 — Typical peak off-state current or peak reverse current vs. off-state or reverse voltage for 2N681-2N690.

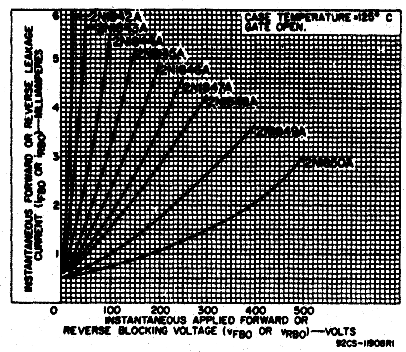


Fig. 6 — Typical peak off-state current or peak reverse current vs. off-state or reverse voltage for 2N1842A-2N1850A.

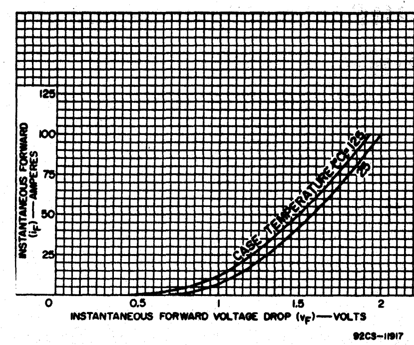


Fig.7 — Typical on-state current vs. instantaneous on-state voltage for 2N681—2N690.

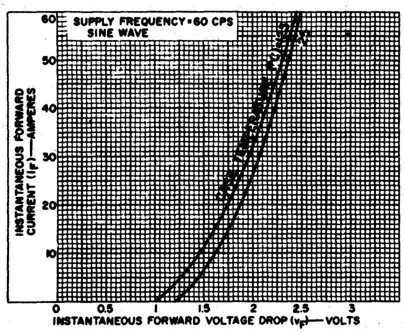


Fig.8 — Typical on-state current vs. instantaneous on-state voltage for 2N1842A—2N1850A.

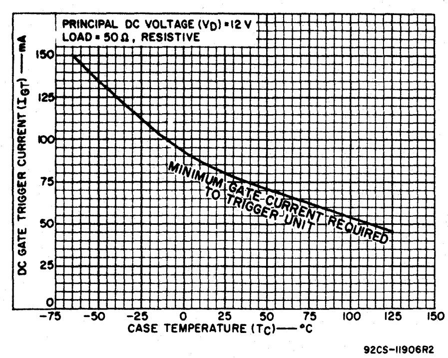


Fig. 9 — DC gate-trigger current vs. case temperature for 2N1842A-2N1850A.

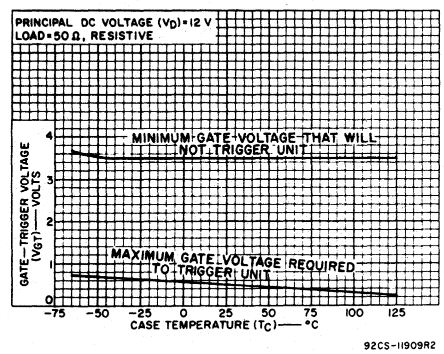


Fig. 10 — DC gate-trigger voltage vs. case temperature for 2N1842A-2N1850A.

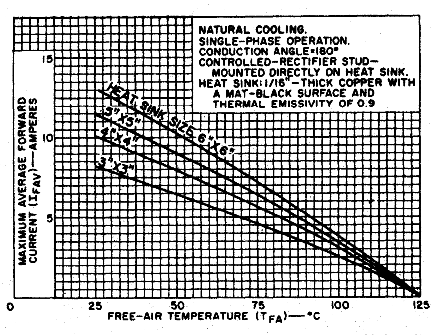


Fig.11 — Average on-state forward current vs. ambient temperature for 2N681—2N690.

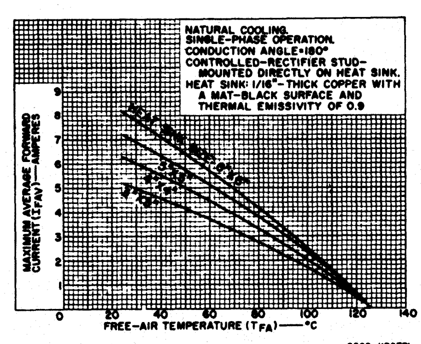


Fig.12 — Average on-state forward current vs. ambient temperature for 2N1842A—2N1850A.

S6493M

Silicon Controlled Rectifier for High-Current Pulse Applications

The RCA-S6493M* is an all-diffused silicon controlled rectifier (reverse-blocking triode thyristor) designed especially for use in radar pulse modulators, inverters, switching regulators, and other applications requiring a large ratio of peak to average current.

It is especially constructed for rapid spread of forward current over the full junction area to achieve a high rate of change of forward current (di/dt) capability and low switching dissipation.

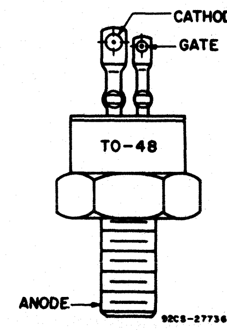
The S6493M employs a hermetic JEDEC TO-48 package.

*Formerly RCA Type No. S6431M.

Features:

- Up to 900 A peak pulse on-state current
- 30 W maximum average dissipation
- On-state current of 35 A (rms value)
- Shorted-emitter center-gate design

TERMINAL CONNECTIONS



JEDEC TO-48

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{RSOM}▲	700	V
V_{DSOM}▲	700	V
V_{RROM}▲	600	V
V_{DROM}▲	600	V
$I_{T(RMS)}$ (T_C = 65°C, θ = 180°)	35	A
$I_{TM(pulse)}$:		
T_C = 65°C, See Figs. 1 and 2	900	A
I^2t:		
T_J = −65 to 125°C, t = 1 to 8.3 ms	2000	A^2s
$P_{D(AV)}$ (T_C = 65°C, See Fig. 3)	30	W
P_{GM}●:		
Peak (forward or reverse) for 10 μs maximum, See Fig. 4	40	W
$P_{G(AV)}$●:		
Averaging time = 10 ms maximum	1	W
T_{stg}■	−65 to 150	°C
T_C■	−65 to 125	°C
T_T:		
During soldering for 10 s maximum (terminals and case)	225	°C
τ_s:		
Recommended	35	in-lbf
	0.4	kgf-m
Maximum (DO NOT EXCEED)	50	in-lbf
	0.57	kgf-m

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
■ For temperature measurement reference point, *see Dimensional Outline.*

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS			UNITS
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: V_D = V_{DROM} or V_R = V_{RROM}, T_C = 125°C	–	2	10	mA
$V_{T(I)}$ $I_{TM(pulse)}$ = 600 A, t = 2 μs, T_C = 65°C (See Fig. 7)	–	–	19	V
I_{HO}: T_C = 25°C	0.5	20	70	mA
dv/dt: V_D = V_{DROM}, exponential voltage rise, T_C = 125°C	20	50	–	V/μs
I_{GT} (T_C = 25°C), See Fig.4	1	25	80	mA
V_{GT} (T_C = 25°C), See Fig.4	–	1.1	2	V
t_{gt}: V_D = V_{DROM}, i_T = 30 A (peak), I_{GT} = 200 mA, t_r = 0.1 μs, T_C = 25°C	–	1.25	–	μs
t_q: Rectangular Pulse V_{DX} = V_{DROM}, i_T 18 A, pulse duration = 50 μs, dv/dt = 20 V/μs, – di/dt = −30 A/μs, I_{GT} = 200 mA at turn-on, T_C = 80°C	15	20	40	μs
$R_{\theta JC}$	–	–	2	°C/W

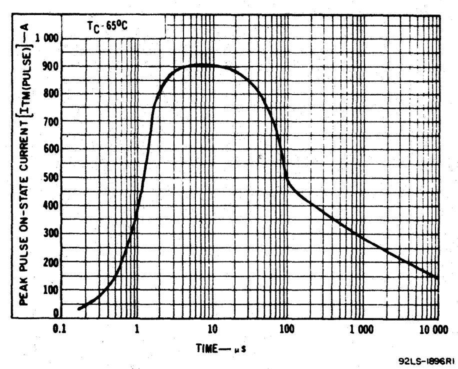


Fig.1 — Peak pulse on-state current vs. time.

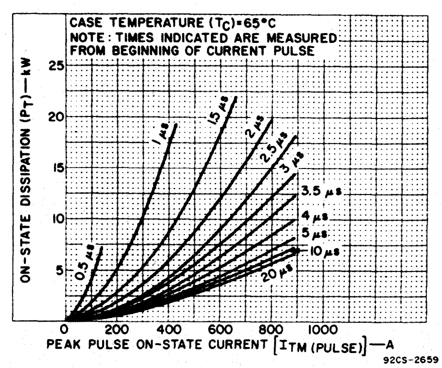


Fig.2 — On-state dissipation vs. peak pulse on-state current and time.

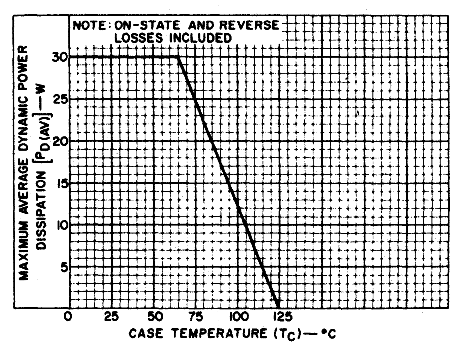


Fig.3 — Dissipation derating curve.

S6493M

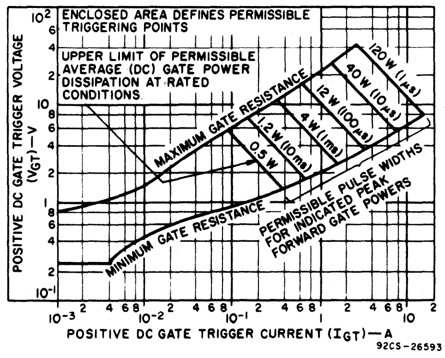


Fig.4 — Forward-bias gate-trigger characteristics and limiting conditions for determination of premissible gate-trigger pulses.

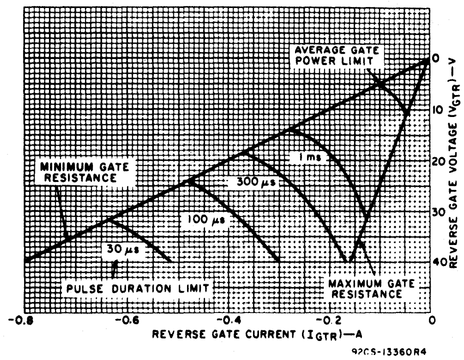


Fig.5 — Reverse bias gate-trigger characteristics.

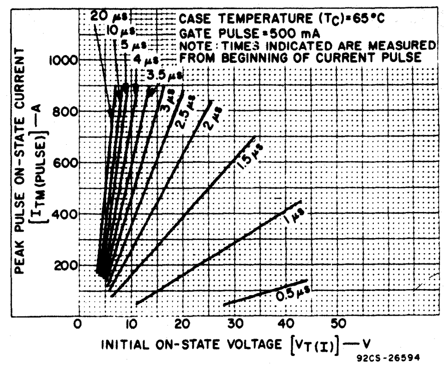


Fig.6 — Initial on-state voltage characteristics.

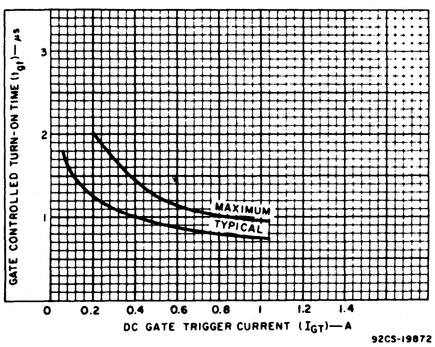


Fig.7 — Gate-controlled turn-on time vs. gate trigger current.

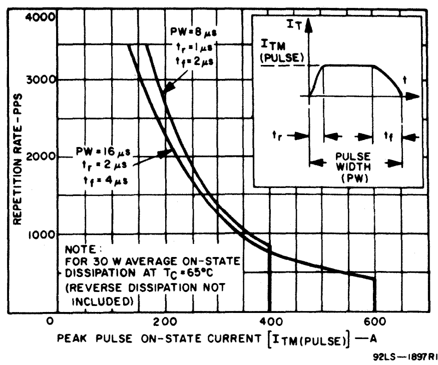


Fig.8 — Peak pulse on-state current as a function of repetition rate, rectangular pulse.

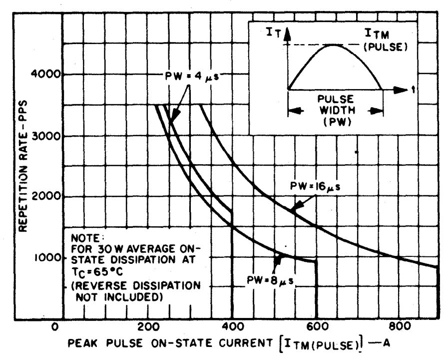


Fig.9 — Peak pulse on-state current as a function of repetition rate, half sine wave pulse.

S7410 (2N3650-2N3653; S7410M) S7412 (2N3654-2N3658; S7412M) Series

35-A Silicon Controlled Rectifiers

For Inverter Applications

RCA-2N3650 to 2N3658, inclusive, and the S7410M* and S7412M● are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) intended for high-speed switching applications such as power inverters, switching regulators, and high-current pulse applications. They feature fast turn-off, high dv/dt, and high di/dt characteristics and may be used at frequencies up to 25 kHz.

This SCR series has forward and reverse off-state voltage ratings of 50, 100, 200, 300, and 400 volts. Types S7410M and S7412M has a forward and reverse off-state voltage rating of 600 volts.

These SCR's employ a hermetic JEDEC TO-48 package.

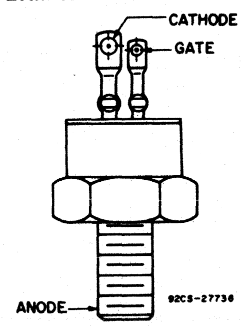
● Formerly RCA Type No. S7432M.

* Formerly RCA Type No. S7430M.

Features

- **Fast turn-off time — 10 μs to 15 μs max.**
- **High di/dt and dv/dt capabilities**
- **Shorted-emitter center gate design**
- **Low thermal resistance**

TERMINAL CONNECTIONS



JEDEC TO-48

MAXIMUM RATINGS, *Absolute-Maximum Values:*	2N3654	2N3650 2N3655	2N3651 2N3656	2N3652 2N3657	2N3653 2N3658	S7410M S7412M	
* V_{RSOM}▲	75	150	300	400	500	700	V
V_{DSOM}▲	75	150	300	400	500	700	V
* V_{RROM}▲	50	100	200	300	400	600	V
* V_{DROM}▲	50	100	200	300	400	600	V
$I_{T(RMS)}$ (T_C = 40°C, θ = 180°)				35			A
* $I_{T(AV)}$ (T_C = 40°C, θ = 180°)				25			A
* I_{TSM}: Peak rectangular pulse, t_p = 5 ms, t_r = 50 μs max.				180			A
* di/dt: V_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs				400			A/μs
I^2t: T_J = −65 to 120°C, t = 1 to 8.3 ms				165			A^2s
* P_{GM}●: Peak (forward or reverse) for 10 μs maximum, See Fig. 6)				40			W
* $P_{G(AV)}$●: Averaging time = 10 ms maximum				1			W
* T_{stg}■				−65 to 150			°C
* T_C■				−65 to 120			°C
T_T: During soldering for 10 s maximum (terminal and case)				225			°C
τ_s: Recommended				35			in-lbf
				0.4			kgf-m
Maximum (DO NOT EXCEED)				50			in-lbf
				0.57			kgf-m

* In accordance with JEDEC registration data format (JS-14, RDF-1) filed for the JEDEC (2N series) types.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

■ For temperature measurement reference point, see Dimensional Outline.

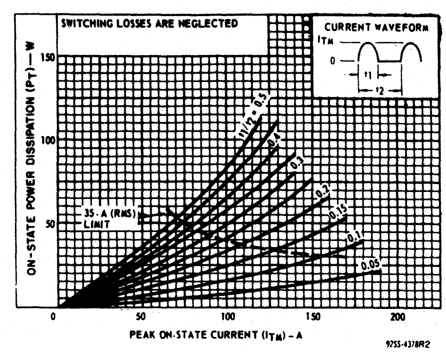


Fig. 1 - Maximum allowable case temperature as a function of on-state current.

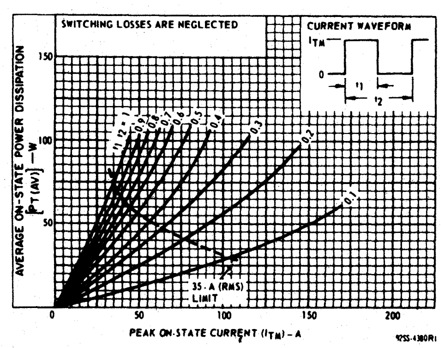


Fig. 2 - Maximum allowable case temperature as a function of on-state current.

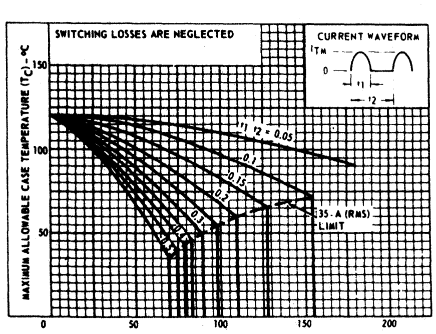


Fig. 3 - Peak surge on-state current as a function of surge duration.

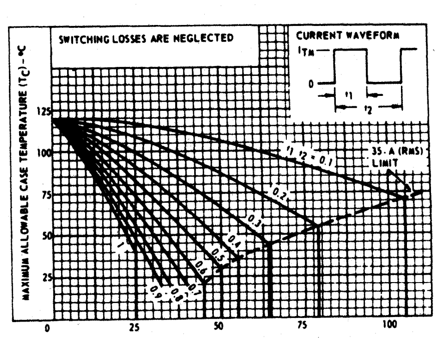


Fig. 4 - Peak surge on-state current as a function of surge duration.

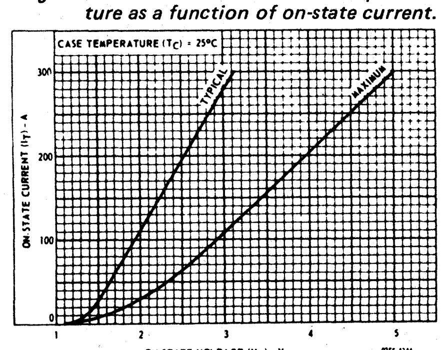


Fig. 5 - Maximum allowable case-temperature as a function of peak on-state current.

S7410 (2N3650-2N3653; S7410M) S7412 (2N3654-2N3658; S7412M) Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = 120°C$				
2N3654, 2N3655, 2N3656, S7412M	–	2	6*	mA
2N3657	–	2	5.5*	
2N3658	–	2	4*	
v_T: i_T = 25 A (peak), $T_C = 25°C$	–	1.5	2.05*	V
i_{HO}: $T_C = 25°C$	–	75	150	mA
$T_C = -65°C$	–	150	350*	
* dv/dt: $V_D = V_{DROM}$, exponential voltage rise, $T_C = 120°C$	200	–	–	V/μs
I_{GT}: V_D = 6 V (dc), R_L = 4 Ω, $T_C = 25°C$	–	80	180	mA
V_D = 6 V (dc), R_L = 2 Ω, $T_C = -65°C$	–	150	500*	
V_{GT}: V_D = 6 V (dc), R_L = 4 Ω, $T_C = 25°C$	–	1.5	3	V
* V_D = 6 V (dc), R_L = 200 Ω, $T_C = 120°C$	0.25	–	–	
V_D = 6 V (dc), R_L = 2 Ω, $T_C = -65°C$	–	2	4.5*	
* tq: Rectangular Pulse: $V_{DX} = V_{DROM}$, i_T = 10 A, pulse duration = 50 μs, dv/dt = 200 V/μs, –di/dt = 5 A/μs, I_{GT} = 200 mA at turn-on, V_{RX} = 15 V minimum, V_{GK} = 0 V at turn-off, $T_C = 120°C$	–	–	15	μs
Sinusoidal Pulse: $V_{DX} = V_{DROM}$, i_T = 100 A, pulse duration = 2 μs, dv/dt = 200 V/μs, V_{RX} = 30 V minimum, V_{GK} = 0 at turn-off, $T_C = 115°C$	–	–	15	
$R_{\theta JC}$	–	0.85	1.7*	°C/W

* In accordance with JEDEC registration data format (JS-14, RDF-1) filed for the JEDEC (2N series) types.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

● Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

■ For temperature measurement reference point, see Dimensional Outline.

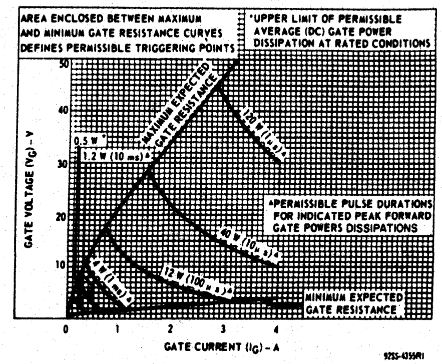


Fig.6 – Typical forward-biased gate characteristics.

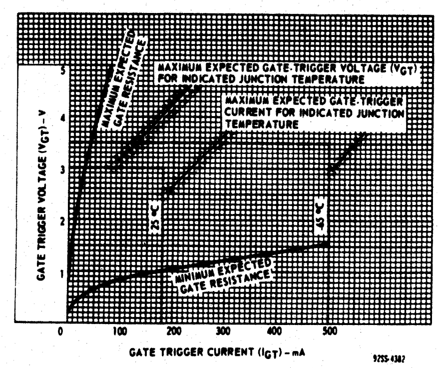


Fig.7 – Typical gate-trigger characteristics.

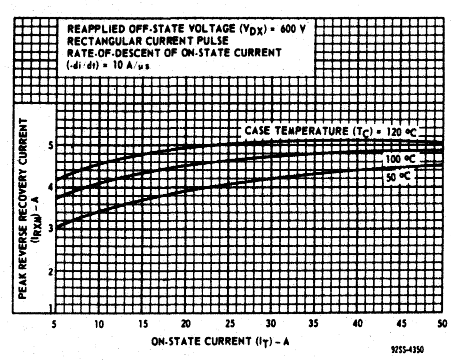


Fig.8 – Typical variation of peak reverse-recovery current with on-state current (rectangular pulse).

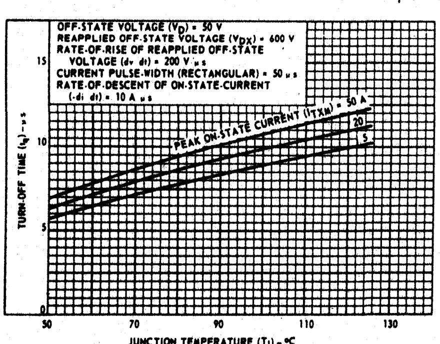


Fig.9 – Typical variation of turn-off time with junction temperature (rectangular pulse).

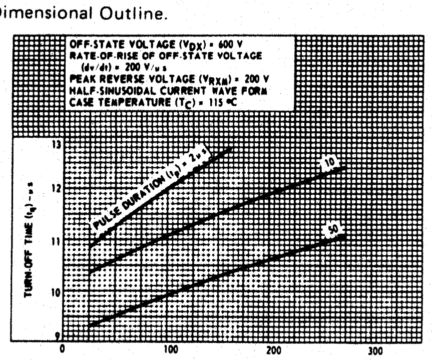


Fig.10 – Typical variation of turn-off time with peak on-state current (half-sine-wave pulse).

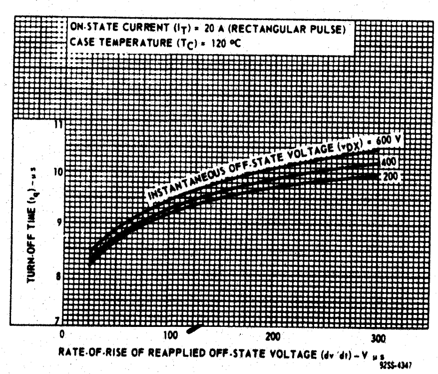


Fig.11 – Typical variation of turn-off time with rate-of-rise of reapplied off-state voltage (rectangular pulse).

Diacs

D3202Y, D3202U

Silicon Bidirectional Diacs

Plastic-Packaged Two-Terminal Trigger Devices for Applications in Military, Industrial, and Commercial Equipment

Features:

- **For critical triggering applications requiring narrow breakover voltage range (29-35V)—D3202Y**
- **Typical breakover voltage: $V_{(BO)}$ = 32 V**
- **Low breakover current (at breakover voltage): $I_{(BO)}$ = 25 μA max.**
- **High peak pulse current capability**
- **Breakover voltage symmetry:**
  $|+V_{(BO)}|-|-V_{(BO)}|$ = ±3 V max.

RCA D3202Y (45411)* and D3202U (45412)* are all-diffused, three-layer, two-terminal devices in an axial-lead plastic package designed specifically for triggering thyristors. Both units exhibit bidirectional negative-resistance characteristics.

These diacs are intended for use in thyristor phase-control circuits for lamp-dimming, universal-motor speed control, and heat controls. Their small size and plastic package of high insulation resistance make these diacs especially suitable for applications in which high packing densities are employed.

*Number in parentheses is a former RCA type number.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

DEVICE DISSIPATION:
- At case temperature up to 40°C .... 1 W
- At case temperatures above 40°C ... Derate 0.016 W/°C

TEMPERATURE RANGE:
- Storage .... −40 to +150 °C
- Operating (Junction) .... −40 to +100 °C

LEAD TEMPERATURE (During Soldering)
- At distance ≥ 1/16 in. (1.59 mm) from case for 10 s max. .... 240 °C

ELECTRICAL CHARACTERISTICS: At Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	LIMITS D3202Y MIN.	D3202Y MAX.	D3202U MIN.	D3202U MAX.	UNITS
Breakover Voltage (Forward or Reverse)	$V_{(BO)}$		29	35	25	40	V
Breakover Voltage Symmetry	$\lvert +V_{(BO)}\rvert - \lvert -V_{(BO)}\rvert$		–	±3	–	±3	V
Peak Output Current	i_{pk}	V_{SUPPLY} = 30 V_{RMS}, C_T = 0.1 μF, R_L = 20 Ω	190	–	190	–	mA
Peak Breakover Current	$I_{(BO)}$	At breakover voltage	–	25	–	25	μA
Dynamic Breakback Voltage	$\lvert \Delta V\pm \rvert$	V_{SUPPLY} = 30 V_{RMS}, C_T = 0.1 μF, R_L = 20 Ω	9	–	9	–	V
Thermal Impedance Junction-to-ambient	$I_{\theta JA}$		–	60	–	60	°C/W

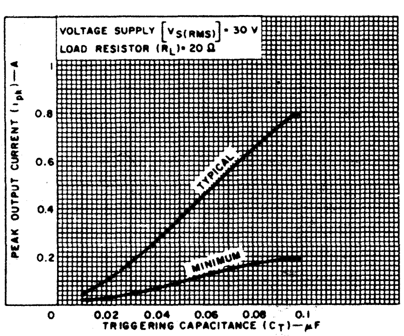


Fig.1 — Peak output current vs. triggering capacitance.

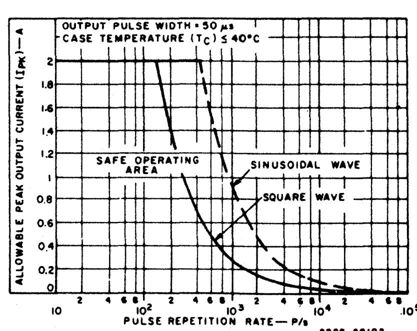


Fig.2 — Peak output-current derating curves.

Silicon Rectifiers

Rectifier Product Matrix

Standard Types

RCA Rectifiers		Modified TO-1 (2-lead)	DO-1				DO-26				DO-15	
I_O		0.25A	0.75A ◆	0.75A ◆	1A ◆	1A	0.75A ◆	0.75A ◆ Insulated	1A	1A Insulated	1A	1.5A
I_{FSM}		30A	15A	15A	35A	35A	35A	35A	50A	50A	30A	50A
$V_{RRM}(V)$	50			1N536		1N2858A					D1201F	1N5391
	100	D1300A	1N440B	1N537		1N2859A					D1201A	1N5392
	200	D1300B	1N441B	1N538		1N2860A	1N3193	1N3253	1N5211	1N5215	D1201B	1N5393
	300		1N442B	1N539		1N2861A						1N5394
	400	D1300D	1N443B	1N540	1N1763A	1N2862A	1N3194	1N3254	1N5212	1N5216	D1201D	1N5395
	500		1N444B	1N1095	1N1764A	1N2863A						1N5396
	600		1N445B	1N547		1N2864A	1N3195	1N3255	1N5213	1N5217	D1201M	1N5397
	800						1N3196	1N3256	1N5214	1N5218	D1201N	1N5398
	1000							1N3563			D1201P	1N5399
	Page No.	405	405	405	405	405	405	406	406	406	405	405

Standard Type (cont'd)

RCA Rectifiers		DO-4		DO-5	
I_O		6A	12A	20A	40A
I_{FSM}		160A	240A	350A	800A
$V_{RRM}(V)$	50	1N1341B	1N1199A	1N248C	1N1183A
	100	1N1342B	1N1200A	1N249C	1N1184A
	200	1N1344B	1N1202A	1N250C	1N1186A
	300	1N1345B	1N1203A	1N1195A	1N1187A
	400	1N1346B	1N1204A	1N1196A	1N1188A
	500	1N1347B	1N1205A	1N1197A	1N1189A
	600	1N1348B	1N1206A	1N1198A	1N1190A
	800				
	1000				
	Page No.	406	406	406	406

Types For Horizontal-Deflection Circuits

RCA Rectifiers	DO-26			DO-1		DO-15
I_O	0.5* ◆	1.6* ◆	1.9*	–	–	1A
I_{FSM}	30A	70A	70A	70A	30A	50A
Trace			D2601M	D2103SF		D2201M
Commutating		D2601E		D2103S		D2201M
Linearity						D2201B
Regulator						D2201B
Clamp	D2600M				D2101S	
Page No.	408	408	408	408	408	408

*$I_{F(RMS)}$ value

Fast-Recovery Types

RCA Rectifier		DO-26	DO-15	DO-4				DO-5			
I_O		1A	1A	6A	6A ◆	12A	12A ◆	20A	20A ◆	30A	40A
I_{FSM}		35A	50A	75A	125A	150A	250A	225A	300A	300A	700A
$V_{RRM}(V)$	50	D2601F	D2201F	1N3879	D2406F	1N3889	D2412F	1N3899	D2520F	1N3909	D2540F
	100	D2601A	D2201A	1N3880	D2406A	1N3890	D2412A	1N3900	D2520A	1N3910	D2540A
	200	D2601B	D2201B	1N3881	D2406B	1N3891	D2412B	1N3901	D2520B	1N3911	D2540B
	300			1N3882	D2406C	1N3892	D2412C	1N3902	D2520C	1N3912	
	400	D2601D	D2201D	1N3883	D2406D	1N3893	D2412D	1N3903	D2520D	1N3913	D2540D
	500										
	600	D2601M	D2201M		D2406M		D2412M		D2520M		D2540M
	800	D2601N	D2201N								
	1000										
Reverse Recovery Time t_{rr}											
	Typ.	200 ns.	200 ns.	–	200 ns.	–	200 ns.	–	200 ns.	–	200 ns.
	Max.	500 ns.	500 ns.	200 ns.	350 ns.	200 ns.	350 ns.	200 ns.	350 ns.	200 ns.	350 ns.
	Page No.	408	408	408	408	408	408	409	409	409	408

◆Check availability in Europe, the Middle East, and Africa.

Rectifiers

RCA TYPE	Forward Current: Av. I_o A	Forward Current: Surge I_{FSM} A	Forward Current: Temp.-T_A °C	Package	Voltage V_{RRM} V	Temp. Range Operating °C	Voltage Drop: V_F V	Voltage Drop: I_o A
STANDARD RECTIFIERS with Lead-Type Packages								
D11 types								
1N440B	0.75	15	50	DO-1	100	-65 to 165	1.5	■
1N441B	0.75	15	50		200	-65 to 165	1.5	■
1N442B	0.75	15	50		300	-65 to 165	1.5	■
1N443B	0.75	15	50		400	-65 to 165	1.5	■
1N444B	0.65	15	50		500	-65 to 150	1.5	■
1N445B	0.65	15	50		600	-65 to 150	1.5	■
1N536	0.75	15	50	DO-1	50	-65 to 165	1.1	0.5
1N537	0.75	15	50		100	-65 to 165	1.1	0.5
1N538	0.75	15	50		200	-65 to -165	1.1	0.5
1N539	0.75	15	50		300	-65 to 165	1.1	0.5
1N540	0.75	15	50		400	-65 to 165	1.1	0.5
1N1095	0.75	15	50		500	-65 to 165	1.2	0.5
1N547	0.75	15	50		600	-65 to 165	1.2	0.5
1N1763A	1	35	75	DO-1	400	-65 to 135	1.2	1
1N1764A	1	35	75		500	-65 to 135	1.2	1
1N2858A	1	35	75	DO-1	50	-65 to 135	1.2	1
1N2859A	1	35	75		100	-65 to 135	1.2	1
1N2860A	1	35	75		200	-65 to 135	1.2	1
1N2861A	1	35	75		300	-65 to 135	1.2	1
1N2862A	1	35	75		400	-65 to 135	1.2	1
1N2863A	1	35	75		500	-65 to 135	1.2	1
1N2864A	1	35	75		600	-65 to 135	1.2	1
D12 Types								
D1201F	1	30	75	DO-15	50	-65 to 175	1.1	1
D1201A	1	30	75		100	-65 to 175	1.1	1
D1201B	1	30	75		200	-65 to 175	1.1	1
D1201D	1	30	75		300	-65 to 175	1.1	1
D1201M	1	30	75		400	-65 to 175	1.1	1
D1201N	1	30	75		800	-65 to 175	1.1	1
D1201P	1	30	75		1000	-65 to 175	1.1	1
1N5391	1.5	50	70	DO-15	50	-65 to 170	1.4	1.5
1N5392	1.5	50	70		100	-65 to 170	1.4	1.5
1N5393	1.5	50	70		200	-65 to 170	1.4	1.5
1N5394	1.5	50	70		300	-65 to 170	1.4	1.5
1N5395	1.5	50	70		400	-65 to 170	1.4	1.5
1N5396	1.5	50	70		500	-65 to 170	1.4	1.5
1N5397	1.5	50	70		600	-65 to 170	1.4	1.5
1N5398	1.5	50	70		800	-65 to 170	1.4	1.5
1N5399	1.5	50	70		1000	-65 to 170	1.4	1.5
D13 types								
D1300A	0.25	30	65	TO-1 (2-Lead)	100	-65 to 125	1	0.25
D1300B	0.25	30	65		200	-65 to 125	1	0.25
D1300D	0.25	30	65		400	-65 to 125	1	0.25
D16 types								
1N3193	0.75	35	75	DO-26	200	-65 to 100	1.2	0.5
1N3194	0.75	35	75		400	-65 to 100	1.2	0.5
1N3195	0.75	35	75		600	-65 to 100	1.2	0.5
1N3196	0.5	35	75		800	-65 to 100	1.2	0.5

■ At full load current

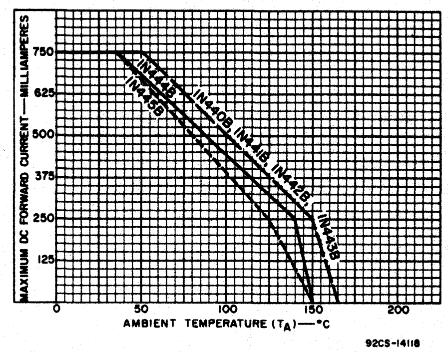


Fig. 1 — Maximum average forward current vs. ambient temperature for 1N440B–1N445B.

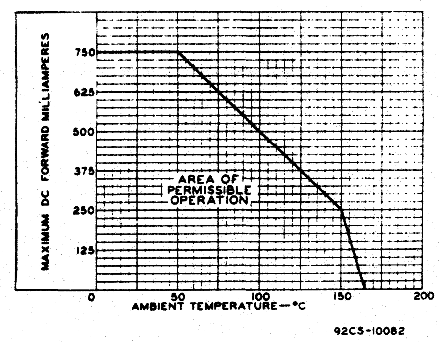


Fig. 2 — Maximum average forward current vs. ambient temperature for 1N536–1N540, 1N547, and 1N1095.

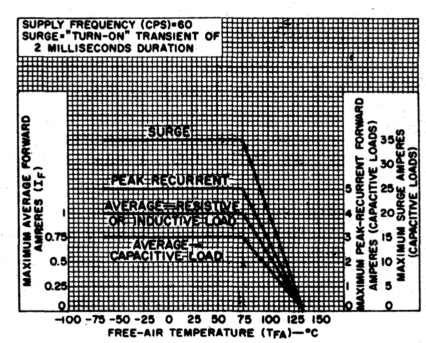


Fig. 3 — Maximum average forward current/ peak recurrent/surge current vs. ambient temperature for 1N1763A, 1N1764A, and 1N2858A–1N2864A.

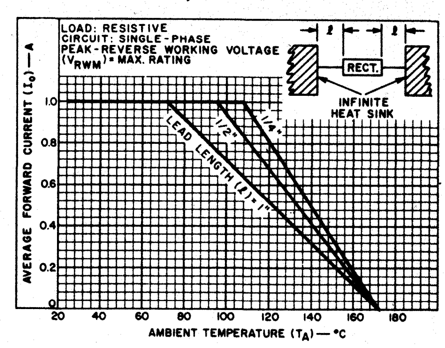


Fig. 4 — Maximum average forward current vs. ambient temperature for D1201 series.

Rectifiers (Cont'd)

RCA TYPE	Forward Current Av. I_o A	Surge I_{FSM} A	Temp.-T_A °C	Package	Voltage V_{RRM} V	Temp. Range Operating °C	Voltage Drop v_F V	I_o A
STANDARD RECTIFIERS with Lead-Type Packages (continued)								
D16 types (cont'd)								
1N5211	1	50	75	DO-26	200	-65 to 175	1.2	1
1N5212	1	50	75		400	-65 to 175	1.2	1
1N5213	1	50	75		600	-65 to 175	1.2	1
1N5214	0.75	50	75		800	-65 to 175	1.2	1
D17 types								
1N3253	0.75	35	75	DO-26	200	-65 to 100	1.2	0.5
1N3254	0.75	35	75		400	-65 to 100	1.2	0.5
1N3255	0.75	35	75		600	-65 to 100	1.2	0.5
1N3256	0.5	35	75		800	-65 to 100	1.2	0.5
1N3563	0.4	35	75		1000	-65 to 100	1.2	0.5
1N5215	1	50	75	DO-26	200	-65 to 175	1.2	1
1N5216	1	50	75		400	-65 to 175	1.2	1
1N5217	1	50	75		600	-65 to 175	1.2	1
1N5218	0.75	50	75		800	-65 to 175	1.2	1
STANDARD RECTIFIERS with Stud-Type Packages‡								
D14 types								
1N1341B	6	160	150	DO-4	50	-65 to 200	0.65■	6
1N1342B	6	160	150		100	-65 to 200	0.65■	6
1N1344B	6	160	150		200	-65 to 200	0.65■	6
1N1345B	6	160	150		300	-65 to 200	0.65■	6
1N1346B	6	160	150		400	-65 to 200	0.65■	6
1N1347B	6	160	150		500	-65 to 200	0.65■	6
1N1348B	6	160	150		600	-65 to 200	0.65■	6
D15 types								
1N1199A	12	240	150	DO-4	50	-65 to 200	0.55■	12
1N1200A	12	240	150		100	-65 to 200	0.55■	12
1N1202A	12	240	150		200	-65 to 200	0.55■	12
1N1203A	12	240	150		300	-65 to 200	0.55■	12
1N1204A	12	240	150		400	-65 to 200	0.55■	12
1N1205A	12	240	150		500	-65 to 200	0.55■	12
1N1206A	12	240	150		600	-65 to 200	0.55■	12
1N248C	20	350	150	DO-4	50	-65 to 175	0.6■	20
1N249C	20	350	150		100	-65 to 175	0.6■	20
1N250C	20	350	150		200	-65 to 175	0.6■	20
1N1195A	20	350	150		300	-65 to 175	0.6■	20
1N1196A	20	350	150		400	-65 to 175	0.6■	20
1N1197A	20	350	150		500	-65 to 175	0.6■	20
1N1198A	20	350	150		600	-65 to 175	0.6■	20
1N1183A	40	800	150	DO-4	50	-65 to 200	0.65■	40
1N1184A	40	800	150		100	-65 to 200	0.65■	40
1N1186A	40	800	150		200	-65 to 200	0.65■	40
1N1187A	40	800	150		300	-65 to 200	0.65■	40
1N1188A	40	800	150		400	-65 to 200	0.65■	40
1N1189A	40	800	150		500	-65 to 200	0.65■	40
1N1190A	40	800	150		600	-65 to 200	0.65■	40

‡ Reverse-polarity versions available

■ At full cycle average

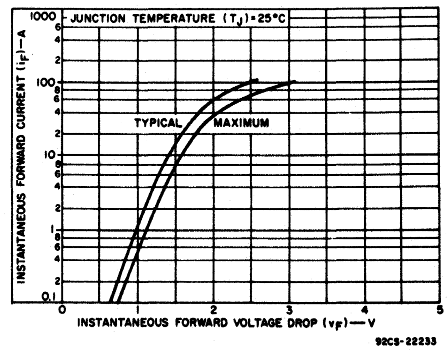


Fig. 5 – Forward current vs. forward voltage drop for D2406 series.

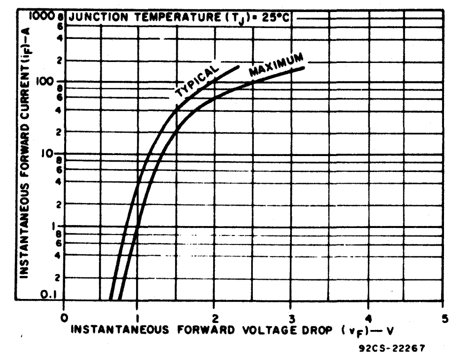


Fig. 6 – Forward current vs. forward voltage drop for D2412 series.

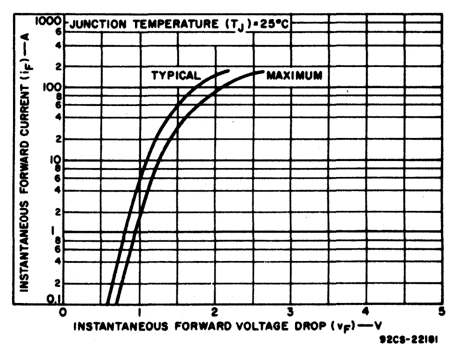


Fig. 7 – Forward current vs. forward voltage drop for D2520 series.

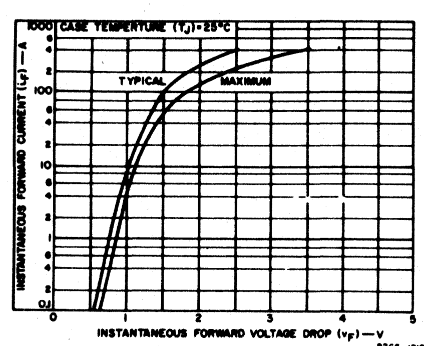


Fig. 8 – Forward current as a function of forward voltage drop for D2540 series.

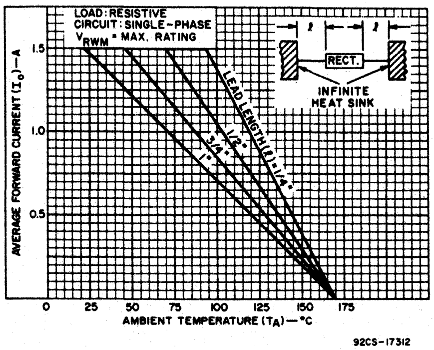


Fig. 9 — Average-forward-current vs. ambient temperature for 1N5391—1N5399 for several lead lengths.

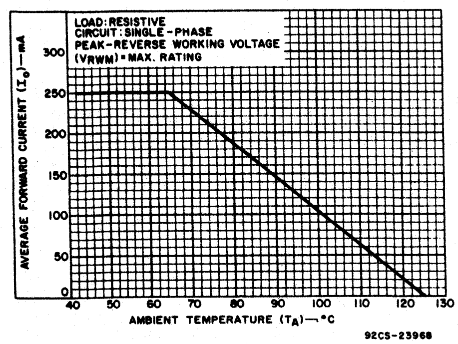


Fig. 10 — Maximum average-forward-current vs. ambient temperature for D1300 series.

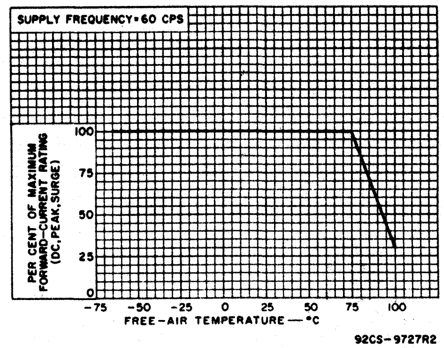


Fig. 11 — Maximum average forward current/ peak recurrent/surge current vs. ambient temperature for 1N3193—1N3196, 1N3253—1N3256, and 1N3563.

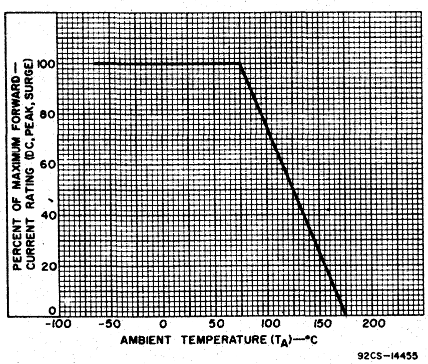


Fig. 12 — Maximum average forward/peak recurrent/surge current vs. ambient temperature for 1N5211—1N5218.

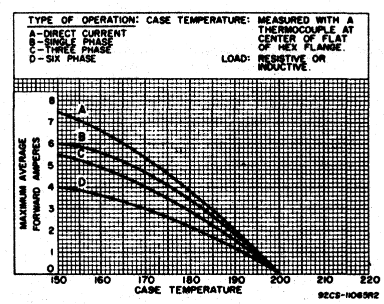


Fig. 13 — Maximum average forward current vs. case temperature for 1N1341B, 1N1342B, 1N1344B—1N1348B.

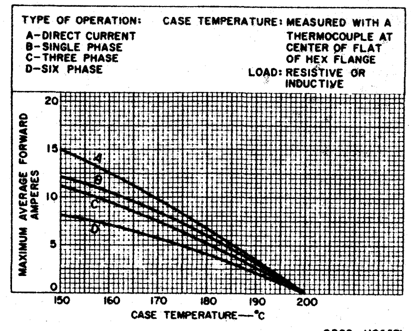


Fig. 14 — Maximum average forward current vs. case temperature for 1N1199A, 1N1200A, 1N1202A—1N1206A.

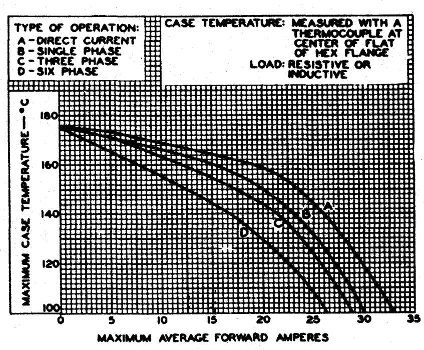


Fig. 15 — Maximum average forward current vs. case temperature for 1N248C, 1N250C, 1N1195A—1198A.

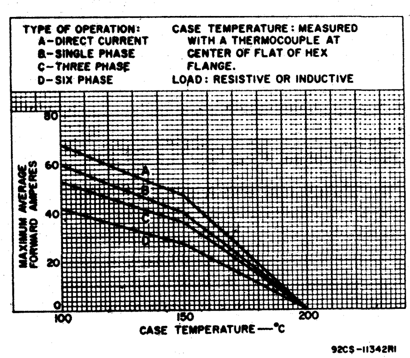


Fig. 16 — Maximum average forward current vs. case temperature for 1N1183A, 1N1184A, 1N1186A—1N1190A.

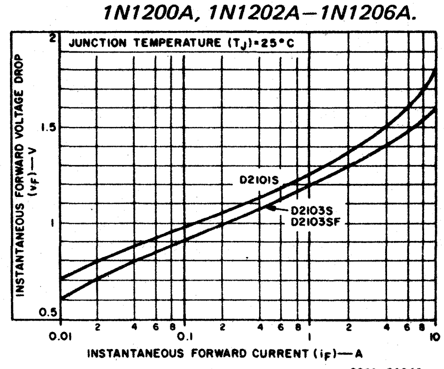


Fig. 17 — Forward-voltage drop vs. forward current for D2101S, D2103S, and D2103SF.

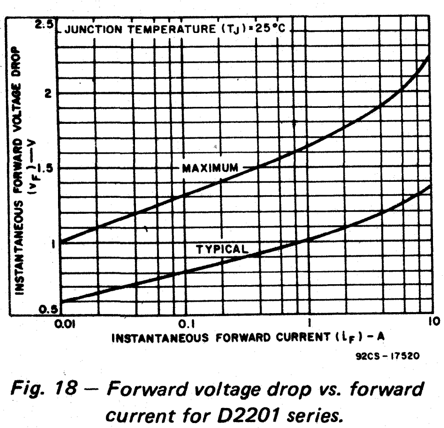


Fig. 18 — Forward voltage drop vs. forward current for D2201 series.

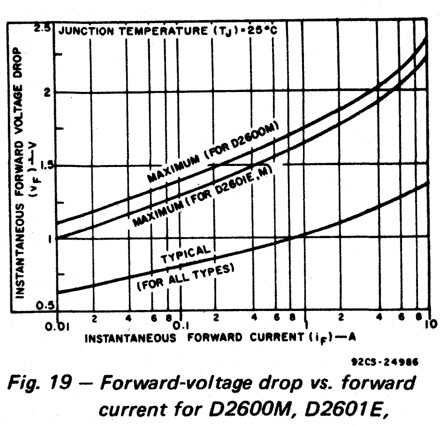


Fig. 19 — Forward-voltage drop vs. forward current for D2600M, D2601E, and D2601M.

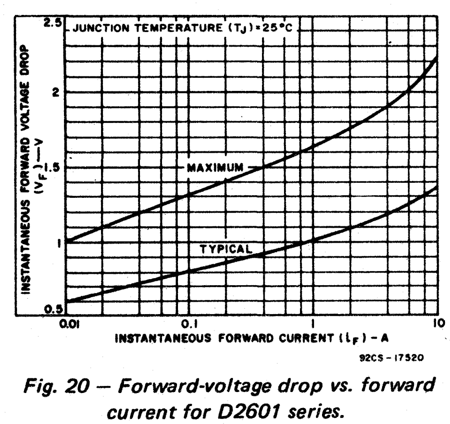


Fig. 20 — Forward-voltage drop vs. forward current for D2601 series.

Rectifiers (Cont'd)

RCA TYPE	Forward Current RMS $I_{F(RMS)}$ A	Forward Current Av. I_o A	Forward Current Surge I_{FSM} A	Forward Current Surge Temp.-T_A °C	Package	Voltage V_{RRM} V	Temp. Range Operating °C	Voltage Drop v_F V	Voltage Drop i_F A	Rev. Recovery Time t_{rr} µs	Rev. Recovery Time I_{FM} A	Rev. Recovery Time T_C °C
FAST-RECOVERY RECTIFIERS with Lead-Type Packages												
D21 types												
D2103SF	3	–	70	150●●	DO-1	750	-30 to 150	1.4	4	0.5	3.14	25
D2103S	3	–	70	150●●	DO-1	700	-30 to 150	1.4	4	0.5	3.14	25
D2101S	1	–	30	45	DO-1	700	-30 to 80	1.5	4	0.7	3.14	25

●● Junction Temperature

D22 types

RCA TYPE	$I_{F(RMS)}$ A	I_o A	I_{FSM} A	Temp.-T_A °C	Package	V_{RRM} V	Operating °C	v_F V	i_F A	t_{rr} µs	I_{FM} A	T_C °C
D2201F	1.5	1	50●	100■	DO-15	50	-40 to 150	1.9	4	0.5	3.14	25
D2201A	1.5	1	50●	100■	DO-15	100	-40 to 150	1.9	4	0.5	3.14	25
D2201B	1.5	1	50●	100■	DO-15	200	-40 to 150	1.9	4	0.5	3.14	25
D2201D	1.5	1	50●	100■	DO-15	400	-40 to 150	1.9	4	0.5	3.14	25
D2201M	1.5	1	50●	100■	DO-15	600	-40 to 150	1.9	4	0.5	3.14	25
D2201N	1.5	1	50●	100■	DO-15	800	-40 to 150	1.9	4	0.5	3.14	25

● At Junction Temperature (T_J) = 150 °C ■ Lead Temperature

D26 types

RCA TYPE	$I_{F(RMS)}$ A	I_o A	I_{FSM} A	Temp.-T_A °C	Package	V_{RRM} V	Operating °C	v_F V	i_F A	t_{rr} µs	I_{FM} A	T_C °C
D2600M	0.5	–	30	45	DO-26	600	-40 to 80	2	4	0.7	20	25
D2601E	1.6	–	70	150●	DO-26	500	-40 to 150	1.9	4	0.5	20	25
D2601M	1.9	–	70	150●	DO-26	600	-40 to 150	1.9	4	0.5	20	25
D2601F	1.5	1	35♦	100■	DO-26	50	-40 to 150	1.9	4	0.5	20	25
D2601A	1.5	1	35♦	100■	DO-26	100	-40 to 150	1.9	4	0.5	20	25
D2601B	1.5	1	35♦	100■	DO-26	200	-40 to 150	1.9	4	0.5	20	25
D2601D	1.5	1	35♦	100■	DO-26	400	-40 to 150	1.9	4	0.5	20	25
D2601M	1.5	1	35♦	100■	DO-26	600	-40 to 150	1.9	4	0.5	20	25
D2601N	1.5	1	35♦	100■	DO-26	800	-40 to 150	1.9	4	0.5	20	25

FAST-RECOVERY RECTIFIERS with Stud Packages ‡

D24 types

RCA TYPE	$I_{F(RMS)}$ A	I_o A	I_{FSM} A	Temp.-T_A °C	Package	V_{RRM} V	Operating °C	v_F V	i_F A	t_{rr} µs	I_{FM} A	T_C °C
D2406F	9	6	125	100	DO-4	50	-40 to 150	1.4	6	0.35	19	25
D2406A	9	6	125	100	DO-4	100	-40 to 150	1.4	6	0.35	19	25
D2406B	9	6	125	100	DO-4	200	-40 to 150	1.4	6	0.35	19	25
D2406C	9	6	125	100	DO-4	300	-40 to 150	1.4	6	0.35	19	25
D2406D	9	6	125	100	DO-4	400	-40 to 150	1.4	6	0.35	19	25
D2406M	9	6	125	100	DO-4	600	-40 to 150	1.4	6	0.35	19	25
1N3879	9	6	75	100	DO-4	50	-65 to 150	1.4	6	0.20	1	25
1N3880	9	6	75	100	DO-4	100	-65 to 150	1.4	6	0.20	1	25
1N3881	9	6	75	100	DO-4	200	-65 to 150	1.4	6	0.20	1	25
1N3882	9	6	75	100	DO-4	300	-65 to 150	1.4	6	0.20	1	25
1N3883	9	6	75	100	DO-4	400	-65 to 150	1.4	6	0.20	1	25
D2412F	18	12	250	100	DO-4	50	-40 to 150	1.4	12	0.35	38	25
D2412A	18	12	250	100	DO-4	100	-40 to 150	1.4	12	0.35	38	25
D2412B	18	12	250	100	DO-4	200	-40 to 150	1.4	12	0.35	38	25
D2412C	18	12	250	100	DO-4	300	-40 to 150	1.4	12	0.35	38	35
D2412D	18	12	250	100	DO-4	400	-40 to 150	1.4	12	0.35	38	25
D2412M	18	12	250	100	DO-4	600	-40 to 150	1.4	12	0.35	38	25
1N3889	18	12	150	100	DO-4	50	-65 to 150	1.4	12	0.20	1	25
1N3890	18	12	150	100	DO-4	100	-65 to 150	1.4	12	0.20	1	25
1N3891	18	12	150	100	DO-4	200	-65 to 150	1.4	12	0.20	1	25
1N3892	18	12	150	100	DO-4	300	-65 to 150	1.4	12	0.20	1	25
1N3893	18	12	150	100	DO-4	400	-65 to 150	1.4	12	0.20	1	25

♦ At Junction Temperature (T_J) = 165 °C ■ Lead Temperature ● Junction Temperature

‡ Reverse-polarity versions available

Rectifiers (Cont'd)

RCA TYPE	Forward Current RMS $I_{F(RMS)}$ A	Av. I_o A	Surge I_{FSM} A	Temp.-T_C °C	Package	Voltage V_{RRM} V	Temp. Range Operating °C	Voltage Drop v_F V	i_F A	Rev. Recovery Time t_{rr} µs	I_{FM} A	T_C °C
FAST-RECOVERY RECTIFIERS with Stud Packages (cont'd)												
D25 types												
D2520F	30	20	300	100		50	-40 to 150	1.4	20	0.35	63	25
D2520A	30	20	300	100		100	-40 to 150	1.4	20	0.35	63	25
D2520B	30	20	300	100		200	-40 to 150	1.4	20	0.35	63	25
D2520C	30	20	300	100		300	-40 to 150	1.4	20	0.35	63	25
D2520D	30	20	300	100		400	-40 to 150	1.4	20	0.35	63	25
D2520M	30	20	300	100		600	-40 to 150	1.4	20	0.35	63	25
1N3899	30	20	225	100	DO-5	50	-65 to 150	1.4	20	0.20	1	25
1N3900	30	20	225	100		100	-65 to 150	1.4	20	0.20	1	25
1N3901	30	20	225	100		200	-65 to 150	1.4	20	0.20	1	25
1N3902	30	20	225	100		300	-65 to 150	1.4	20	0.20	1	25
1N3903	30	20	225	100		400	-65 to 150	1.4	20	0.20	1	25
1N3909	45	30	300	100		50	-65 to 150	1.4	30	0.20	1	25
1N3910	45	30	300	100		100	-65 to 150	1.4	30	0.20	1	25
1N3911	45	30	300	100	DO-5	200	-65 to 150	1.4	30	0.20	1	25
1N3912	45	30	300	100		300	-65 to 150	1.4	30	0.20	1	25
1N3913	45	30	300	100		400	-65 to 150	1.4	30	0.20	1	25
D2540F	60	40	700	165		50	-40 to 150	1.8	100	0.35	125	25
D2540A	60	40	700	165		100	-40 to 150	1.8	100	0.35	125	25
D2540B	60	40	700	165	DO-5	200	-40 to 150	1.8	100	0.35	125	25
D2540D	60	40	700	165		400	-40 to 150	1.8	100	0.35	125	25
D2540M	60	40	700	165		600	-40 to 150	1.8	100	0.35	125	25

‡ Reverse-polarity versions available

Bridge Rectifiers

CR401 SERIES ♦

Fin-mounted, single-phase, full-wave types.

RCA Type No.	Average DC Output Current (A)	Average DC Output Voltage (V)	RMS Supply Voltage (V)
CR401	18	200	222
CR402	18	400	444
CR403	18	800	888
CR404	34	200	222
CR405	34	400	444
CR406	34	800	888
CR407	70	200	222
CR408	70	400	444
CR409	70	800	888

CR501 SERIES

Fin-mounted, three-phase, full-wave types.

CR501	24	300	222
CR502	24	600	444
CR503	46	300	222
CR504	46	600	444
CR505	92	300	222
CR506	92	600	444

♦Check availability in Europe, the Middle East, and Africa.

High-Voltage Rectifier Assemblies

CR101 SERIES—Data Sheet File No. 84 ♦

Rugged high-voltage rectifier stacks with integral R-C voltage-equalizing networks. Diffused-junction RCA rectifier cells are employed.

RCA Type No.	Maximum Peak Reverse Voltage—V		Average (DC) Forward Current[c]—mA		Peak Surge Current[d]—A	Max. Reverse Current—mA (Dynamic[e])
	Repetitive[a]	Non—Repetitive[b]	T_A = 60°C	T_A = 100°C		
CR101	1200	1440	850	350	15	0.3
CR102	2000	2400	825	325	15	0.3
CR103	3000	3600	725	300	15	0.3
CR104	4000	4800	625	275	15	0.3
CR105	5000	6000	625	275	15	0.3
CR106	6000	7200	575	225	15	0.3
CR107	7000	8400	550	210	15	0.3
CR108	8000	9600	550	210	15	0.3
CR109	9000	10800	550	210	15	0.3
CR110	10000	12000	550	210	15	0.3

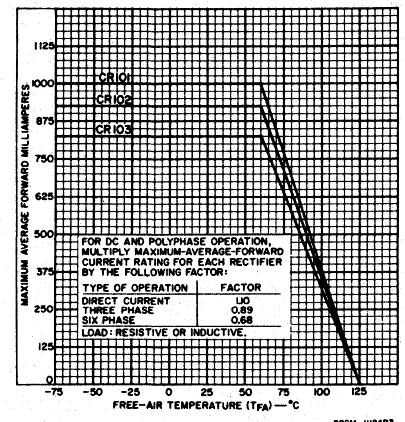


Fig. 21 — Maximum average forward current vs. ambient temperature for CR101, CR102, and CR103.

CR201 SERIES—Data Sheet File No. 86 ♦

Compact high-voltage rectifier stacks with cells precisely matched for internal voltage equalization. Diffused-junction RCA rectifier cells are employed.

CR201	1500	1800	400	155	10	0.1
CR203	3000	3600	400	155	10	0.1
CR204	4500	5400	400	155	10	0.1
CR206	6000	7200	400	155	10	0.1
CR208	8000	9600	400	155	10	0.1
CR210	10000	12000	400	155	10	0.1
CR212	12000	14400	400	155	10	0.1

[a] This value is also the maximum dc blocking voltage.

[b] At free-air temperatures from 60°C to 125°C, for maximum duration of 5 milliseconds.

[c] The RMS supply current in half-wave rectifier service is 1.57 times the specified average (DC) forward current.

[d] For one cycle, 60-Hz, sine wave. Superimposed on device operating within the maximum specified voltage, current, and temperature ratings and may be repeated after sufficient time has elapsed for the device to return to the presurge thermal-equilibrium conditions.

* Maximum reverse current average over one complete cycle and for operation at the maximum ratings.

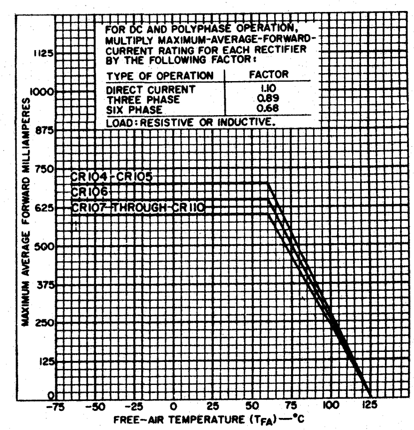


Fig. 22 — Maximum average forward current vs. ambient temperature for CR104—CR110.

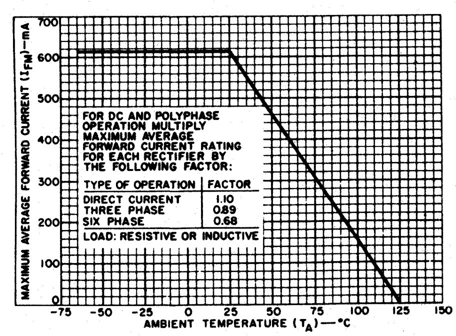


Fig. 23 — Maximum average forward current vs. ambient temperature for CR201 series.

CR273 SERIES ♦

DIRECT PLUG-IN TUBE REPLACEMENT TYPES

Encapsulated Plug-In Package (4-Pin Bayonet Base)
Operating-Temperature Range: —50 to +60°C

RCA Type No.	Peak Reverse Voltage (kV)	Average Current (A)	Peak Current (A)	Type(s) Replaced	Data Sheet File No.
CR273/8008	10	1.25	5.0	8008	100
CR274/872A	10	1.25	5.0	872, 872A	102
CR275/866A/3B28/3B25	10	0.25	1.0	866, 866A, 3B28, 3B25	104

These high-voltage types are direct replacements for the mercury vapor and gas rectifier tubes indicated.

♦Check availability in Europe, the Middle East, and Africa.

High-Voltage Rectifier Assemblies (Cont'd)

CR301 SERIES—Data Sheet File No. 60 ♦

Fin-mounted high-voltage rectifier stacks with integral R-C voltage-equalizing networks. Diffused-junction RCA rectifier cells are employed.

RCA Type No.	Maximum Peak Reverse Voltage—V		Average (DC) Forward Current[c]—mA		Peak Surge Current[d]—A	Max. Reverse Current—mA (Dynamic[e])
	Repetitive[a]	Non-Repetitive[b]	T_A = 50°C	T_A = 100°C		
CR301	2400	2880	5	2.5	250	1.5
CR302	3600	4320	5	2.5	250	1.5
CR303	4800	5760	5	2.5	250	1.5
CR304	6000	7200	5	2.5	250	1.5
CR305	7200	8640	5	2.5	250	1.5
CR306	8400	10080	5	2.5	250	1.5
CR307	9600	11520	5	2.5	250	1.5
CR311	2400	2880	9	4.5	250	1.5
CR312	3600	4320	9	4.5	250	1.5
CR313	4800	5760	9	4.5	250	1.5
CR314	6000	7200	9	4.5	250	1.5
CR315	7200	8640	9	4.5	250	1.5
CR316	8400	10080	9	4.5	250	1.5
CR317	9600	11520	9	4.5	250	1.5
CR321	2400	2880	12	6	400	1.5
CR322	3600	4320	12	6	400	1.5
CR323	4800	5760	12	6	400	1.5
CR324	6000	7200	12	6	400	1.5
CR325	7200	8640	12	6	400	1.5
CR331	2400	2880	17	8.5	400	1.5
CR332	3600	4320	17	8.5	400	1.5
CR333	4800	5760	17	8.5	400	1.5
CR334	6000	7200	17	8.5	400	1.5
CR335	7200	8640	17	8.5	400	1.5
CR341	2400	2880	23	11.5	850	1.5
CR342	3600	4320	23	11.5	850	1.5
CR343	4800	5760	23	11.5	850	1.5
CR344	6000	7200	23	11.5	850	1.5
CR351	2400	2880	35	17.5	850	1.5
CR352	3600	4320	35	17.5	850	1.5
CR353	4800	5760	35	17.5	850	1.5
CR354	6000	7200	35	17.5	850	1.5

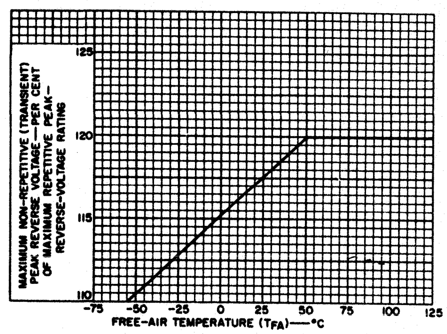


Fig. 24 — Derating curve for CR301–CR307, CR311–CR317, CR321–CR325, CR331–CR335, CR341–CR344, CR351–CR354.

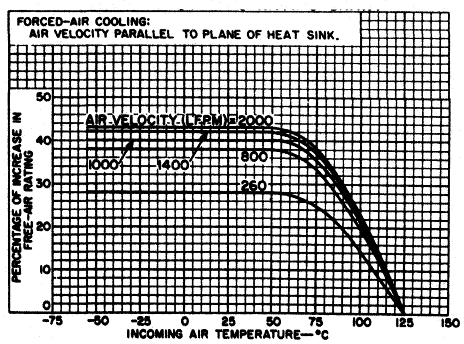


Fig. 25 — Forced-air cooling derating curve for CR301–CR307, CR311–CR317, CR321–CR325, CR331–CR335, CR341–CR344, CR351–CR354.

CR601 SERIES ♦

HIGH VOLTAGE STACKS — For Military and Industrial Use

CR601	2400	2640	5		250	1
CR602	4000	4400	5		250	1.5
CR603	6000	6600	5		250	1.5

[a]This value is also the maximum dc blocking voltage.

[b]At free-air temperatures from 50°C to 125°C, for maximum duration of 5 milliseconds.

[c]The RMS supply current in half-wave rectifier service is 1.57 times the specified average (DC) forward current.

[d]For one cycle, 60-Hz, sine wave. Superimposed on device operating within the maximum specified voltage, current and temperature ratings and may be repeated after sufficient time elapsed for the device to return to the presurge thermal-equilibrium conditions.

[e]Maximum reverse current averaged over one complete cycle and for operation at the maximum ratings.

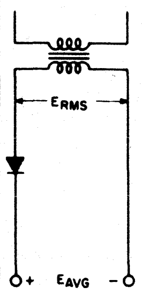
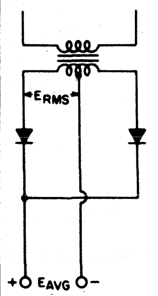
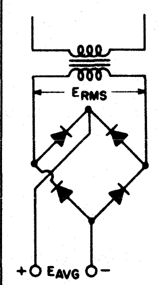
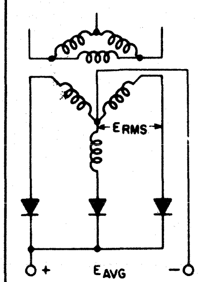
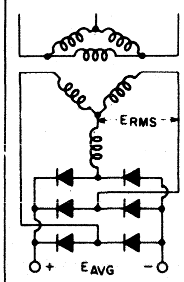
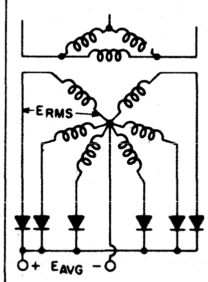
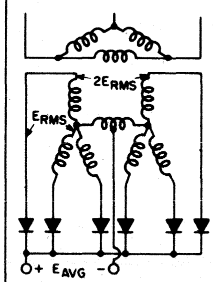
♦Check availability in Europe, the Middle East, and Africa.

Designers' Guide For Rectifier Circuits

To Determine Value of Parameter in Column I (Row 7-14), Multiply Value of Parameter in Column II by Factor Shown in Column III*.

ROW	COLUMN I			COLUMN II	
1	SAMPLE CALCULATION Required: Single-phase, center-tapped, full-wave rectifier, resistive load (Column III, ASA Circuit No. 2) DC output voltage (E_{AVG}) = 2000 volts DC output current (I_{AVG}) = 13 amperes Rectifier Device Parameters (per unit)— PRV = $E_{AVG} \times 3.14 = 2000 \times 3.14 = 6280$ volts (Row 9) $I_{FAV} = I_{AVG} \times 0.500 = 13 \times 0.500 = 6.5$ amperes (Row 10) $I_{RMS} = I_{AVG} \times 0.785 = 13 \times 0.785 = 10.2$ amperes (Row 11) $I_{PEAK} = I_{AVG} \times 1.57 = 13 \times 1.57 = 20.4$ amperes (Row 12) Transformer Requirement (secondary volts per leg)— E_{RMSsec} = PRV / 2.82 = 6280 / 2.82 = 2220 volts (Row 9) Ripple Percentage for this circuit = 48% (Row 14) This chart is intended as an aid in selecting the proper RCA rectifier device. It is emphasized that many critical power-supply-design parameters are not included in this Table. For example: transformer impedance, circuit protective elements, transient and cooling considerations, available space, and other important design factors must be resolved.			Type of Circuit	
2				Primary	
3				Secondary	
4				Waveform of output voltage to circuit	
5				Waveform of current through rectifier legs	
6				Number of rectifier elements in circuit	
7	RMS DC volts output (E_{RMS})		=	Average DC voltage output (E_{AVG})	X
8	Peak DC volts output (E_{PEAK})		=	Average DC voltage output (E_{AVG})	X
9	Peak reverse volts per rectifier element (PRV)		=	Average DC voltage output (E_{AVG})	X
			=	RMS secondary volts per transformer leg (E_{RMSsec})	X
			=	RMS secondary volts line-to-line (E_{L-L})	X
10	Average DC output current per rectifier element (I_{FAV})		=	Average DC output current (I_{AVG})	X
11	RMS current per rectifier element (I_{RMS})	Resistive Load	=	Average DC output current (I_{AVG})	X
		Inductive Load	=	Average DC output current (I_{AVG})	X
12	Peak current per rectifier element (I_{PEAK})	Resistive Load	=	Average DC output current (I_{AVG})	X
		Inductive Load	=	Average DC output current (I_{AVG})	X
13	Ratio: Peak to average current per element	Resistive Load			
		Inductive Load			
14	% Ripple = $\left(\frac{\text{RMS Ripple}}{\text{Average Output Volts}}\right) \times 100$				

*Assumes zero forward drop and zero reverse current in rectifier elements and no AC line or source reactance.

COLUMN III							ROW
Single-Phase Half-Wave ASA Circuit No. 1*	Single-Phase Center-Tapped Full-Wave ASA Circuit No. 2*	Single-Phase Full-Wave Bridge ASA Circuit No. 21*	Three-Phase Y Half-Wave ASA Circuit No. 3*	Three-Phase Y Full-Wave Bridge ASA Circuit No. 23*	Six-Phase Star (Three-Phase Diametric) ASA Circuit No. 9*	Three-Phase Double Y and Interphase Transformer ASA Circuit No. 45*	1
							2
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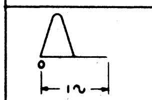
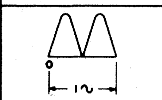
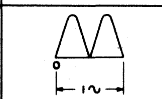
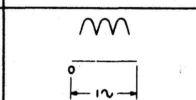
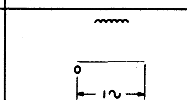
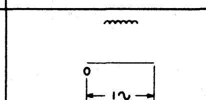
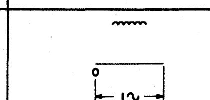
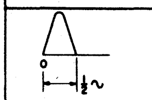
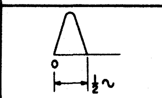
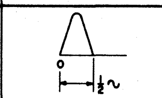
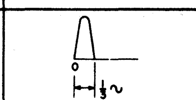
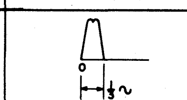
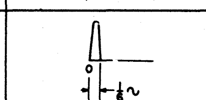
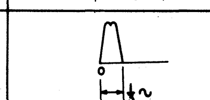
							4
							5
1	2	4	3	6	6	6	6
1.57	1.11	1.11	1.02	1.00	1.00	1.00	7
3.14	1.57	1.57	1.21	1.05	1.05	1.05	8
3.14	3.14	1.57	2.09	1.05	2.42	2.09	9
1.41	2.82	1.41	2.45	2.45	2.83	2.45	
1.41	1.41	1.41	1.41	1.41	1.41	1.41 (DIAMETRIC)	
1.00	0.500	0.500	0.333	0.333	0.167	0.167	10
1.57	0.785	0.785	0.587	0.579	0.409	0.293	11
—	0.707	0.707	0.578	0.578	0.408	0.289	
3.14	1.57	1.57	1.21	1.05	1.05	0.525	12
—	1.00	1.00	1.00	1.00	1.00	0.500	
3.14	3.14	3.14	3.63	3.15	6.30	3.15	13
—	2.00	2.00	3.00	3.00	6.00	3.00	
121	48	48	18.3	4.3	4.3	4.3	14

* ASA Standard Publication No. C34.1—1958.

High-Reliability Power Devices

High-Reliability Power Devices

Solid-state devices classified as high-reliability types have come to be primarily associated with military and aerospace applications. In many ways, this association is misleading because the commercial equipment market is probably the largest user of high-reliability products, but not necessarily by that label. Military and aerospace agencies, however, have been largely responsible for establishment of comprehensive published reliability specifications and standards which have been accepted by the solid-state industry. MIL standards dominate the procedures used to specify high-reliability solid-state devices and represent a common reference point frequently used by commercial users to define their requirements.

Military and aerospace requirements for high-reliability solid-state devices are extremely large and diverse, not only in terms of performance, operating conditions, and reliability, but also in terms of logistics and procurement. As a result of these requirements, the military services have jointly developed specifications and standards under which most military end-use solid-state devices are procured. To simplify procurement, logistics, and the development of reliability data, MIL specs are not issued for the full spectrum of devices manufactured; rather, they are restricted to those devices for which significant need is demonstrated and are specified so that the device can have as wide applicability as possible. Although the limits for operating conditions may exceed those required for some applications, they simplify procurement and assure a supply of devices for the majority of military equipment. These standards also cover a wide range of requirements for the manufacturer on such things as:

(a) The procedure and requirements for a manufacturer to become certified to manufacture MIL-spec parts.
(b) The requirements for qualifying parts.
(c) Product-assurance provisions in such areas as quality control, inspection procedures, personnel training, cleanliness, failure analysis, and documentation.
(d) Test methods and procedures.
(e) Marking and identification of product.
(f) Preservation and packing.

JAN, JANTX, AND JANTXV SOLID-STATE DEVICES

The major military specification used for the procurement of standard solid-state devices by the military is MIL-S-19500, which covers devices such as discrete transistors, thyristors, and diodes.

MIL-S-19500 is the specification for the familiar "JAN"-type solid-state device. Detailed electrical specifications are prepared as needed by the three military services and coordinated by the Defense Electronic Supply Center. At present, approximately five hundred detailed electrical specifications are included in the MIL-S-19500 system.

Three levels of reliability, JAN, TX, and TXV, are defined by MIL-S-19500. Devices designated as JAN types receive lot screening only and are the least expensive. Devices designated as TX receive some 100-per-cent screening (primarily burn-in) and a tight lot-sampling plan. Not all detailed specifications include TX requirements. Devices designated as TXV are tested the same as TX devices; however, they receive an additional visual inspection prior to sealing the package. Only a few detailed specifications include TXV testing.

Fig. 1 shows the processing requirements specified by MIL-S-19500 for JAN, JANTX, and JANTXV solid-state power devices.

The Defense Electronic Supply Center maintains a "Qualified Products List" of all vendors qualified to produce devices in accordance with MIL-S-19500. This list is published periodically and is available to manufacturers of military equipment. NASA, to date, has not been a heavy user of MIL-S-19500, preferring instead to procure devices to their own specifications.

RCA offers a number of solid-state power devices that have been qualified as JAN, JANTX, and/or JANTXV devices in accordance with MIL-S-19500.

Table I shows the wide product line of JAN, JANTX, and JANTXV military-specification solid-state power devices available from RCA for high-reliability applications in military, aerospace, and critical industrial usage. These devices, which include power transistors, rf power transistors, and silicon controlled rectifiers (SCR's), are processed in accordance with the MIL-S-19500 general specifications. MIL-STD-750 test methods are used as required by the individual military detail specification. This table lists the individual MIL-S-19500 specification number for each family of devices

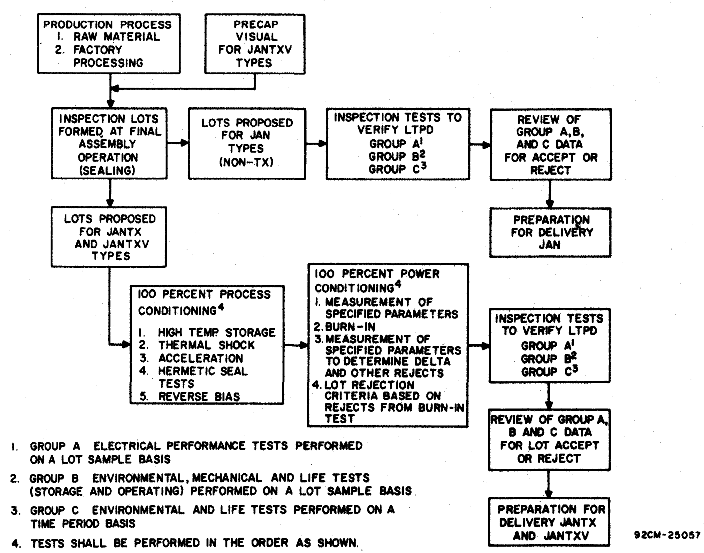


Fig. 1 — Order of procedure diagram for JAN, JANTX, and JANTXV solid-state devices.

TABLE I — RCA JAN, JANTX, and JANTXV Solid-State Power Devices

Parent Type	Military Specification Type	MIL-S-19500/*
	POWER TRANSISTORS	
	Hometaxial-Base Types	
2N1479	JAN2N1479	207
2N1480	JAN2N1480	207
2N1481	JAN2N1481	207
2N1482	JAN2N1482	207
2N1483	JAN2N1483, JANTX2N1483	180
2N1484	JAN2N1484, JANTX2N1484	180
2N1485	JAN2N1485, JANTX2N1485	180
2N1486	JAN2N1486, JANTX2N1486	180
2N1487	JAN2N1487	208
2N1488	JAN2N1488	208
2N1489	JAN2N1489	208
2N1490	JAN2N1490	208
2N3055	JAN2N3055, JANTX2N3055	407
2N3441	JAN2N3441, JANTX2N3441	369
2N3442	JAN2N3442	370
2N3771	JAN2N3771, JANTX2N3771	413
2N3772	JAN2N3772, JANTX2N3772	413

*MIL-S-19500 specifications can be obtained from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pa. 19120.

TABLE I — RCA JAN, JANTX, and JANTXV Solid-State Power Devices (cont'd)

Parent Type	Military Specification Type	MIL-S-19500/*
	POWER TRANSISTORS (Cont'd)	
	High-Voltage Types	
2N3584	JAN2N3584, JANTX2N3584, JANTXV2N3584	384
2N3585	JAN2N3585, JANTX2N3585, JANTXV2N3585	384
2N6211	JAN2N6211, JANTX2N6211	461
2N6212	JAN2N6212, JANTX2N6212	461
2N6213	JAN2N6213, JANTX2N6213	461
2N3439	JAN2N3439, JANTX2N3439	368
2N3440	JAN2N3440, JANTX2N3440	368
2N5415	JAN2N5415, JANTX2N5415	485
2N5416	JAN2N5416, JANTX2N5416	485
2N5838	JAN2N5838, JANTX2N5838	487
2N5839	JAN2N5839, JANTX2N5839	487
2N5840	JAN2N5840, JANTX2N5840	487
	High-Speed Types	
2N5038	JAN2N5038, JANTX2N5038, JANTXV2N5038	439
2N5039	JAN2N5039, JANTX2N5039, JANTXV2N5039	439
2N5671	JAN2N5671, JANTX2N5671	488
2N5672	JAN2N5672, JANTX2N5672	488
	RF POWER TRANSISTORS	
2N918	JAN2N918, JANTX2N918	301
2N1493	JAN2N1493	247
2N2857	JAN2N2857, JANTX2N2857	343
2N3375	JAN2N3375, JANTX2N3375	341
2N3553	JAN2N3553, JANTX2N3553	341
2N4440	JAN2N4440, JANTX2N4440	341
2N3866	JAN2N3866, JANTX2N3866	398
2N5071	JAN2N5071, JANTX2N7071	442
2N5109	JAN2N5109, JANTX2N5109	453
	SILICON CONTROLLED RECTIFIERS (SCR's)	
2N682	JAN2N682, JANTX2N682	108
2N683	JAN2N683, JANTX2N683	108
2N685	JAN2N685, JANTX2N685	108
2N687	JAN2N687, JANTX2N687	108
2N688	JAN2N688, JANTX2N688	108
2N689	JAN2N689, JANTX2N689	108
2N690	JAN2N690, JANTX2N690	108

*MIL-S-19500 specifications can be obtained from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pa. 19120.

TABLE II — LTPD sampling plans 1/ 2/ 3/

Minimum size of sample to be tested to assure, with a 90 percent confidence, that a lot having percent-defective equal to the specified LTPD will not be accepted (single sample).

Max. Percent Defective (LTPD) or λ	20	15	10	7	5	3	2	1.5	1	0.7	0.5	0.3
Acceptance Number (c) (r = c + 1)	Minimum Sample Sizes (For device-hours required for life test, multiply by 1000)											
0	11 (0.46)	15 (0.34)	22 (0.23)	32 (0.16)	45 (0.11)	76 (0.07)	116 (0.04)	153 (0.03)	231 (0.02)	328 (0.02)	461 (0.01)	767 (0.007)
1	18 (2.0)	25 (1.4)	38 (0.94)	55 (0.65)	77 (0.46)	129 (0.28)	195 (0.18)	258 (0.14)	390 (0.09)	555 (0.06)	778 (0.045)	1296 (0.027)
2	25 (3.4)	34 (2.24)	52 (1.6)	75 (1.1)	105 (0.78)	176 (0.47)	266 (0.31)	354 (0.23)	533 (0.15)	759 (0.11)	1065 (0.080)	1773 (0.045)
3	32 (4.4)	43 (3.2)	65 (2.1)	94 (1.5)	132 (1.0)	221 (0.62)	333 (0.41)	444 (0.31)	668 (0.20)	953 (0.14)	1337 (0.10)	2226 (0.062)
4	38 (5.3)	52 (3.9)	78 (2.6)	113 (1.8)	158 (1.3)	265 (0.75)	398 (0.50)	531 (0.37)	798 (0.25)	1140 (0.17)	1599 (0.12)	2663 (0.074)
5	45 (6.0)	60 (4.4)	91 (2.9)	131 (2.0)	184 (1.4)	308 (0.85)	462 (0.57)	617 (0.42)	927 (0.28)	1323 (0.20)	1855 (0.14)	3090 (0.085)
6	51 (6.6)	68 (4.9)	104 (3.2)	149 (2.2)	209 (1.6)	349 (0.94)	528 (0.62)	700 (0.47)	1054 (0.31)	1503 (0.22)	2107 (0.155)	3509 (0.093)
7	57 (7.2)	77 (5.3)	116 (3.5)	166 (2.4)	234 (1.7)	390 (1.0)	589 (0.67)	783 (0.51)	1178 (0.34)	1680 (0.24)	2355 (0.17)	3922 (0.101)
8	63 (7.7)	85 (5.6)	128 (3.7)	184 (2.6)	258 (1.8)	431 (1.1)	648 (0.72)	864 (0.54)	1300 (0.36)	1854 (0.25)	2599 (0.18)	4329 (0.108)
9	69 (8.1)	93 (6.0)	140 (3.9)	201 (2.7)	282 (1.9)	471 (1.2)	709 (0.77)	945 (0.58)	1421 (0.38)	2027 (0.27)	2842 (0.19)	4733 (0.114)
10	75 (8.4)	100 (6.3)	152 (4.1)	218 (2.9)	306 (2.0)	511 (1.2)	770 (0.80)	1025 (0.60)	1541 (0.40)	2199 (0.28)	3082 (0.20)	5133 (0.120)

1/ Sample sizes are based upon the Poisson exponential binomial limit.
2/ The minimum quality (approximate AQL) required to accept (on the average) 19 of 20 lots is shown in parenthesis for information only.
3/ This sampling plan is derived from Table C-1 in Appendix C of MIL-S-19500.

RCA NON-JAN TYPE SOLID-STATE DEVICES

Many solid-state devices are not covered by military specifications, either because they are too new or are not used in sufficient quantities. Many of these devices offer the most recent technological advances or have special performance characteristics which offer advantages to the designer of high-reliability equipment. RCA cooperates with the users of such devices in establishment of high-reliability specifications patterned after MIL standards, which allow these designs to be approved for use in military and aerospace systems, as well as commercial equipment. If the use warrants, these specifications may be submitted by RCA, or the user, to the cognizant military specification agency as candidates for MIL approval as a standard type.

Most procurements of solid-state devices for military systems are made by the equipment contractor from the MIL-STD parts list as awards are received for electronic equipment. Some military and aerospace programs, because of their size, duration, or special requirements (Minuteman and Apollo are two examples), require that special specifications and process methods, or even special production lines, be established and tailored to the particular functional, reliability, and economic needs of the program. RCA Solid State Division has frequently used the resources of its laboratories, production facilities, and expert technical staff to contribute to the success of such programs.

All RCA high-reliability solid-state power devices are processed in accordance with the provisions of MIL-S-19500. These provisions include the following items:

1. A clearly defined procedure for the conversion of a customer specification into an RCA internal specification with built-in safeguards to assure the customer that the delivered parts meet or exceed his specification requirements.
2. A formalized personnel training and testing program which assures that each operation is performed correctly.
3. A complete inspection of incoming materials, utilities, and work in process using on-site facilities such as scanning-electron-microscope and X-ray equipment.
4. Maintenance of cleanliness in work areas.
5. Rigorous control over changes in design, materials, and processes with documentation kept in active files for a minimum of three years.
6. Tool and test equipment maintenance and calibration in strict accordance with MIL-C-45662, "Calibration System Requirements."
7. A quality-assurance program in accordance with MIL-Q-9858, "Quality Program Requirements."

The *Lot Sampling* plans used for RCA high-reliability solid-state power devices, as defined by MIL-S-19500 and MIL-STD 105D, are shown in Tables II, III, and IV. Detailed processing and screening requirements for RCA high-reliability power transistors, thyristors (triacs and SCR's), and rf power transistors are described in the following paragraphs.

TABLE III — Sample Size Code Letters*

Lot or batch size			General inspection levels I	II	III
2	to	8	A	A	B
9	to	15	A	B	C
16	to	25	B	C	D
26	to	50	C	D	E
51	to	90	C	E	F
91	to	150	D	F	G
151	to	280	E	G	H
281	to	500	F	H	J
501	to	1200	G	J	K
1201	to	3200	H	K	L
3201	to	10000	J	L	M
10001	to	35000	K	M	N
35001	to	150000	L	N	P
150001	to	500000	M	P	Q
500001	and	over	N	Q	R

* Derived from Table I of MIL-STD-105D

TABLE IV — Single Sampling Plans for Normal Inspection*

Acceptable Quality Levels (normal inspection); each cell gives Ac Re.

Sample size code letter	Sample size	0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25
A	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↓	↓	1 2
B	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3
C	5	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4
D	8	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6
E	13	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8
F	20	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11
G	32	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15
H	50	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22
J	80	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑
K	125	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑
L	200	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑
M	315	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑
N	500	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑
P	800	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑
Q	1250	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑	↑
R	2000	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑	↑	↑

↓ = Use first sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100 percent inspection.
↑ = Use first sampling plan above arrow.

Ac = Acceptance number.
Re = Rejection number.

* Derived from Table II-A of MIL-STD-105D

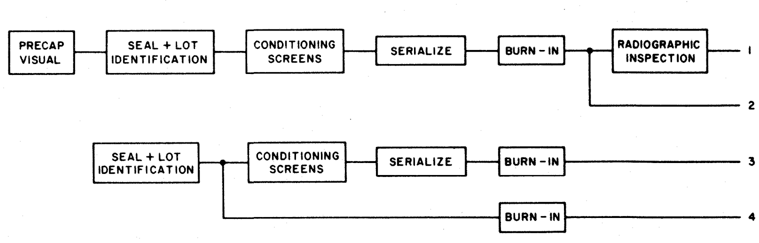


Fig. 2 — Process-flow chart for four reliability levels of RCA high-reliability power transistors.

Power Transistors

In addition to JAN, JANTX, and JANTXV types, high-reliability selections of all RCA power transistors can be obtained on a custom basis. Such power transistors are subjected to high-reliability preconditioning and screening in accordance with the Group A, B, and C Sampling Tests as specified in MIL-STD-750 or special customer requirements. These power transistors can be supplied to four basic reliability levels. The preconditioning and screening for Level 1 is the same as that for JANTXV devices and, in addition, includes X-ray inspection. Level 2 corresponds directly to the JANTXV level. Level 3 devices are equivalent to JANTX devices. For RCA Level 4 devices, the preconditioning consists of burn-in only.

Fig. 2 shows the basic processing steps required for RCA high-reliability power transistors for each reliability level, and Table V lists the screening tests to which these devices are subjected. Tables VI, VII, and VIII list the Groups A, B, and C Sampling Tests and the test methods specified by MIL-STD-750.

Thyristors (Triacs and SCR's)

RCA high-reliability thyristors that are subjected to high-reliability preconditioning and screening in accordance with the Group A, B, and C Sampling Tests as specified in MIL-STD-750 or special customer requirements can be obtained on a custom basis. These thyristors can be supplied to four basic reliability levels that are approximately equivalent to, or exceed, the reliability classes (JAN, JANTX, JANTXV) defined by MIL-S-19500.

Fig. 3 shows the basic processing steps required for RCA high-reliability thyristors for each reliability level, and Table IX lists the screening tests to which these devices are subjected. Tables X, XI, and XII list the Groups A, B, and C Sampling Tests and the test methods specified by MIL-STD-750.

RF Power Transistors

In addition to the prescribed screening requirements, RCA maintains a general Quality Assurance Program for high-reliability rf transistors which include the following functions:

1. A system for controlling the conversion of a customer specification into an internal RCA specification which assures complete compliance with customer requirements. Also, this system provides for control of documentation regarding changes in design, processes, materials, and electrical characteristics. All processes, work instructions, and quality inspections are clearly defined and documented.
2. Maintenance of test equipment and tools kept in strict compliance with MIL-C-45662, "Calibration System Requirements."
3. Quality Inspection in accordance with MIL-I-45208. Specifically, this program incorporates the following quality inspections:
   (a) A thorough inspection of incoming raw parts and materials.
   (b) Wafer-processing visual inspection and bond-pull tests to check metallization-to-wafer adherence.

TABLE V – Screening Tests for RCA High-Reliability Power Transistors

Test	Conditions	MIL-STD-750 Method	MIL-STD-750 Conditions	Screening Levels 1	2	3	4
1. Precap Visual		2072		X	X		
2. Seal and Lot Identification				X	X	X	X
3. High Temp Storage	24 hrs at 200°C			X	X	X	
4. Temperature Cycling	10 cycles	1051	C	X	X	X	
5. Acceleration	Y_1 direction	2006		X	X	X	
6. Fine Leak		1071	G or H	X	X	X	
7. Gross Leak		1071	A,C,D or F	X	X	X	
8. Reverse Bias	24 hrs at 150°C	1039	A	X	X	X	
9. Serialize				X	X	X	
10. Pre Burn-in Electrical				X	X	X	
11. Burn-in	168 hrs at 25°C	1039	B	X	X	X	X
12. Post Burn-in Electrical				X	X	X	
13. Final Electrical				X	X	X	X
14. Radiographic Inspection		2076		X			
15. External Visual		2071		X	X	X	

Specific test conditions and limits determined by each type of transistor.

TABLE VI – Group A Inspections (power transistors)

Subgroup	Test	MIL-STD-750 Method
1	Visual & Mech Examination	2071
2	BV_{CEO}, BV_{CER}, or BV_{CEX}	3011
	I_{CEO}, I_{CER}, or I_{CEX}	3041
	I_{EBO}	3061
3	h_{FE}	3076
	$V_{CE(sat)}$	3071
	V_{BE}	3066
4	h_{FE}	3306
	C_{obo}	3236
	t_{on}	3251
	t_{off}	3251
5	150°C I_{CEX}	3041
	−65°C h_{FE}	3076

TABLE VII – Group B Inspections (power transistors)

Subgroup	Test	MIL-STD-750 Method
1	Physical dimensions	2066
2	Solderability	2026
	Temperature Cycling	1051
	Moisture Resistance	1021
3	Shock	2016
	Vibration, Variable Frequency	2056
	Constant Accleration	2066
4	Safe Operating Area	3051
5	High Temperature Life	1031
6	Steady-State Operation Life	1026

TABLE VIII – Group C Inspections (power transistors)

Subgroup	Test	MIL-STD-750 Method
1	Barometric Pressure	1001
2	Salt Atmosphere	1041

TABLE X – Group A Tests (triacs and SCR's)

Subgroup	Test	MIL-STD-750 Method
1	Visual	2071
2	Forward blocking current	4206.1
2	Reverse blocking current	4211.1
3	High-temp. forward blocking current	
3	High-temp. reverse blocking current	
3	High-temp. gate-trigger voltage or gate-trigger current	4221.1
3	Exponential rate of voltage rise	4231.2
4	Gate-trigger voltage or gate-trigger current at 25°C	
4	Gate-controlled turn-on time	4223
4	Circuit-commutated turn-off time	4224
4	Gate-controlled turn-off time	4225
4	Forward "on" voltage	4226.1
4	Holding current	4201.2

TABLE IX – Screening Test for High-Reliability Thyristors

Test	Condition	MIL-STD-750 Method	MIL-STD-750 Conditions	Screening Levels 1	2	3	4
1. Precap visual	20 power			X			
2. Seal and lot identification				X	X	X	X
3. High-temperature Storage	24 hrs. at 150°C	1031		X	X		
4. Temperature cycling	Low temperature per device	1051	F	X	X		
5. Acceleration	Y_1 direction	2006		X	X		
6. Hermeticity-fine leak		1071	H	X	X	X	
7. Hermeticity-gross leak		1071	D	X	X		
8. Serialize				X			
9. Preburn-in electrical-record				X			
10. Preburn-in electrical					X	X	X
11. Burn-in	24 to 168 hrs.; 100°C to 125°C			X	X	X	X
12. Post burn-in electrical					X	X	X
13. Post burn-in electrical-record Δ's				X			
14. Final electrical				X	X		
15. Hermeticity-fine leak				X	X		
16. Hermeticity-gross leak				X			
17. Radiographic		2076		X			
18. External visual		2071		X			

TABLE XI – Group B Tests (triacs and SCR's)

Test	MIL-STD-750 Method
Reverse gate current	4219
Surge current	4066
Temperature cycling	1051
Thermal shock (glass strain)	1056
Terminal strength	2036
Moisture resistance	1021
AC blocking voltage	–

TABLE XII – Group C Tests (triacs and SCR's)

Subgroup	Test	MIL-STD-750 Method
1	Physical dimensions	2066
2	Shock	2016
2	Vibration, variable-frequency	2056
2	Constant acceleration	2006
3	Barometric pressure	1001
4	Salt atmosphere	1041
5	Solderability	2026
6	Intermittent life	–

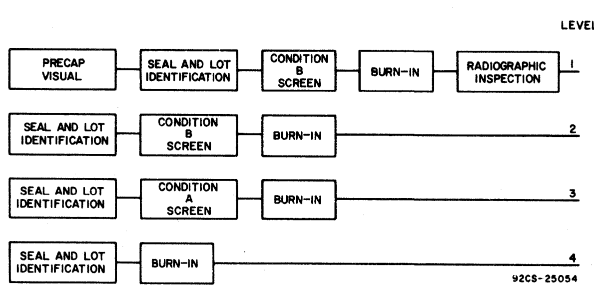


Fig. 3 – Basic processing and screening required for RCA high-reliability triacs and SCR's.

(c) Pellet visual inspection after wafer dicing (SEM inspection of pellets when required by purchase order).
(d) Package-assembly visual inspection.
(e) In-process bond-pull test to monitor pellet-to-package adherence.
(f) In-process bond-puller test to monitor integrity of bond-wire contact.
(g) Precap visual inspection
(h) Package cap-seal visual inspection.
(i) Hermeticity (fine and gross) leak-test audit performed after 100% testing.
(j) Group A electrical-test audit performed after 100% testing.
(k) Completed-unit external visual inspection.
(l) Group B reliability test sampling from parent types in accordance with MIL-STD-750 test methods.

4. Quality-control sampling procedure in accordance with MIL-STD-105 and MIL-S-19500.
5. Thorough records kept on all inspections. All data kept on active file for a minimum of 3 years.

RCA HR-Series RF Power Transistors — RCA HR-series types are high-reliability rf and microwave power transistors intended for applications in aerospace, military, and industrial equipment. These transistors are supplied to three screening levels (/1, /2, /3) which meet the electrical mechanical, and environmental test, methods, and procedures established for power transistors in MIL-STD-750. Table XIII defines these reliability levels in terms of system-application usage.

TABLE XIII — Reliability Levels for RCA High-Reliability RF and Microwave Transistors

Level	Application	Description
/1	Satellite and Aerospace	For devices intended for applications in which maintenance and replacement are extremely difficult or impossible, and Reliability is imperative.
/2	Military and Industrial (For example in Airborne Electronics)	For devices intended for applications in which maintenance and replacement can be performed, but are difficult and expensive.
/3	Military and Industrial (For example in Ground Based Electronics)	For devices intended for applications in which replacement can readily be accomplished.

RCA can provide on request SEM (Scanning Electron Microscope) inspection photographs to NASA-Goddard Specification GSFC-S-311-P-12A for each wafer lot tested to level /1. Precap Visual Inspection is conducted in conformance with Method 2072 of MIL-STD-750.

The product-flow diagram shown in Fig. 4 lists a summary of processing, screening, tests, and sampling procedures followed in the manufacture of these transistors.

Table XIV provides detailed information for the screening tests included in the product-flow diagram. Table XV gives pre-burn-in and post-burn-in electrical tests and delta limits for critical test parameters.

TABLE XIV — Description of Total Lot Screening for HR-Series rf power transistors*

Test	Conditions	MIL-STD-750 or -202 Method	Cond.	Screening Levels• /1	/2	/3
Wafer Lot Identification	—	—	—	X	—	—
SEM Inspection	—	GSFC-S-311-P-12A■		S	—	—
Precap Visual	—	2072	—	X	X	—
Seal and Lot Identification	—	—	—	X	X	X
Stabilization Bake	24 hrs min at 200°C	—	—	X	X	X
Temperature Cycling	10 cycles	1051/107C	—	X	X	X
Centrifuge	20,000G, Y_1 direction	2006	—	X	X	X
Fine Leak	—	112	CIII	X	X	X
Gross Leak	—	112	A or B	X	X	X
HTRB (High-Temperature Reverse Bias)	80% V_{CB}, 150°C min	—	—	X	X	X
Serialize	—	—	—	X	X	X
Pre-Burn-in Electrical	See detail Specification			X	X	X
Burn-In	See detail Specification			X	X	X
Post-Burn-in Electrical	See detail Specification			X	X	X
Final Group A	See detail Specification			X	X	X

* Data on specific HR-Series types given in following pages show test conditions and limits.
• x = 100% Testing; S = Sample of 5 (random selection from each wafer); — = not performed.
■ This specification, which was written by NASA Goddard Space Flight Center, is the industry standard.

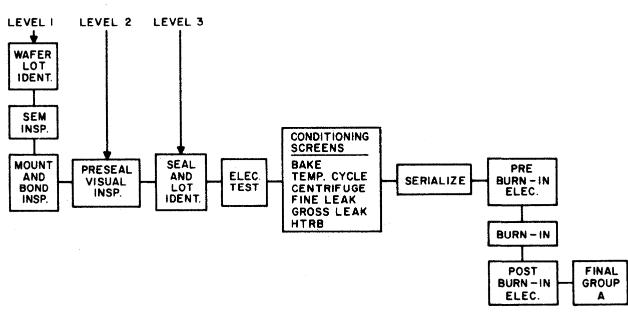


Fig. 4 — Product Flow Diagram for RCA HR-Series rf power transistors (See Tables XIV and XV for additional details).

TABLE XV — Burn-In Test Measurements

Test	MIL-STD-750 Method	Conditions & Limits	Symbol	Δ Limits
Collector cutoff current	3041	Per Detailed Electrical Specification	—	100% of pre-burn-in value or 10% of Group -A Limit whichever is greater
Forward-current transfer ratio	3076		h_{FE}	± 20% of pre-burn-in value
Power output	—		P_{out}	

When ordering HR-series types, the appropriate reliability level should be indicated by addition of the suffix /1, /2, or /3 to the type number. For example, the 2N6265 processed to level /3 requirements should be marked HR2N6265/3.

The parameters listed in Table XV are tested before and after burn-in, and the data are recorded for all devices in the lot. The parameters measured shall not have changed during burn-in from the initial value by more than the specified delta (Δ) limit or beyond the end-point limits given in Table XV.

All devices that exceed these limits are removed from the inspection lot, and the quality removed are noted in the lot history. If the quantity removed after burn-in exceeds 10 percent of the devices subjected to burn-in, the entire lot is rejected.

RCA Premium- and Ultra-High Reliability RF Power Transistors — RCA also supplies several transistors referred to as premium- or ultra-high-reliability types. Processing and screening requirements and ratings and electrical characteristics for these transistors are included in the technical data for these types at the end of this section.

Technical Data — Significant electrical ratings and characteristics and special features of RCA HR-series rf power transistors and premium- and ultra-high reliability rf power transistors are given in the data charts on the following pages.

HR2N2857

Silicon N-P-N Epitaxial Planar Transistor

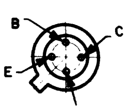
For UHF Applications in Industrial and Military Equipment

The RCA-HR2N2857 is a high-reliability version of the RCA-2N2857. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N2857 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N2857 transistor in RCA data bulletin file No. 61.

Features:

- **High gain-bandwidth product — f_T = 1000 MHz min.**
- **High converter (450-to-30-MHz) gain — G_c = 15 dB typ. for circuit bandwidth of approximately 2 MHz**
- **High power gain as neutralized amplifier — G_{pe} = 12.5 dB min. at 450 MHz for circuit bandwidth of 20 MHz**
- **High power output as uhf oscillator — P_o = {30 mW min., 40 mW typ. at 500 MHz; 20 mW typ., at 1 GHz}**
- **Low device noise figure — NF = {4.5 dB max. as 450 MHz amplifier; 7.5 dB typ. as 450-to-30-MHz converter}**
- **Low collector-to-base time constant — $r_b' C_c$ = 7 ps typ.**
- **Low collector-to-base feedback capacitance — C_{cb} = 0.6 pF typ.**

TERMINAL DESIGNATIONS



92CS-27513

JEDEC TO-72

I. MAXIMUM RATINGS, ***Absolute-Maximum Values:***

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	30	V
COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}	15	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	2.5	V
COLLECTOR CURRENT	I_C	40	mA
TRANSISTOR DISSIPATION:	P_T		
At case temperature up to 25° C		300	mW
At case temperatures above 25° C		Derate at 1.72	mW/°C
At ambient temperatures up to 25° C		200	mW
At ambient temperatures above 25° C		Derate at 1.14	mW/°C
TEMPERATURE RANGE:			
Storage and operating (Junction)		−65 to +200	°C
LEAD TEMPERATURE (During Soldering):			
At distances ≥ 1/32 in. from seating surface for 10 s max.		265	°C

II. GROUP A TESTS, ***at Ambient Temperature (T_A) = 25° C***

CHARACTERISTIC	Symbol	TEST CONDITIONS: Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter-to-Base Voltage V_{EB}	DC Emitter Current I_E	DC Base Current I_B	DC Collector Current I_C	LIMITS Min.	LIMITS Max.	Units
		MHz	V	V	V	mA	mA	mA	Min.	Max.	
• Collector Cutoff Current	I_{CBO}		15			0			–	10	nA
Collector-to-Base Breakdown Voltage	BV_{CBO}					0		0.001	30	–	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}						0	3	15	–	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}					−0.01		0	2.5	–	V
• Static Forward Current Transfer Ratio	h_{FE}			1				3	30	150	
Small-Signal Forward Current Transfer Ratio	h_{fe}	0.001[c] 100[c]		6 6				2 5	50 10	220 19	
Collector-to-Base Feedback Capacitance	C_{cb}	0.1 to 1[b]	10			0			–	1.0	pF
Collector-to-Base Time Constant	$r_b' C_c$	31.9[c]	6			−2			4	15	ps
Small-Signal Common-Emitter Power Gain in Neutralized Amplifier Circuit	G_{pe}	450[c]		6				1.5	12.5	19	dB
Power Output as Oscillator	P_o	≥500[a]	10			−12			30	–	mW
UHF Device Noise Figure	NF	450[c, d, f]		6				1.5	–	4.5	dB
UHF Measured Noise Figure	NF	450[c, d]		6				1.5	–	5.0	dB

[a] Fourth lead (case) not connected.
[b] Three-terminal measurement: Lead No. 1 (Emitter) and lead No. 4 (Case) connected to guard terminal.
[c] Fourth lead (case) grounded.
[d] Generator resistance R_g = 50 ohms.
[e] Generator resistance R_g = 400 ohms.
[f] Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test circuit (0.25 dB) and the contribution of the following stages in the test setup (0.25 dB).

•Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C

V_{CB} = 15 V

P_T = 0.2 W

HR2N3375

Silicon N-P-N Overlay Transistor

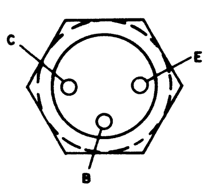
For VHF/UHF Applications

The RCA-HR2N3375 is a high-reliability version of the RCA-2N3375. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N3375 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N3375 transistor in RCA data bulletin file No. 386.

Features:

- **7.5 W (MIN) output at 100 MHz Class C**
- **3.0 W (MIN) output at 400 MHz Class C**
- **2.5 W (Typ) output at 500 MHz, Oscillator**
- **High Voltage Ratings**
- **Hermetic stud-type package**
- **All electrodes isolated from stud**

TERMINAL DESIGNATIONS



JEDEC TO-60

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter voltage $V_{BE} = -1.5$ V	V_{CEV}	65	V
With base open	V_{CEO}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.5	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		11.6	W
At case temperatures above 25°C	Derate linearly at	0.066	W/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
LEAD TEMPERATURE (During soldering):			
At distances ⩾ 1/16 in. (1.58 mm) from insulating wafer for 10 s max.		230	°C

II. GROUP A TESTS. At Case Temperature (T_C) = 25°C.

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Volts		DC Base Volts	DC Current (Milliamperes)			LIMITS		UNITS
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
* Collector-Cutoff Current	I_{CEO}		30			0		–	.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$				0		0.1	65	–	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$					0	0 to 200[a]	40[b]	–	V
	$V_{(BR)CEV}$			−1.5			0 to 200[a]	65[b]	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.1		0	4	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					100	500	–	1	V
* DC Forward Current Transfer Ratio	h_{FE}		5				150	10	–	

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Volts		DC Base Volts	DC Current (Milliamperes)			LIMITS		UNITS
		V_{CB}	V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
Collector-to-Base Capacitance Measured at 1 MHz	C_{obo}	30			0			–	10	pF
RF Power Output Amplifier, Unneutralized At 100 MHz	P_{OE}		28					7.5[c]	–	W
400 MHz			28					3.0[d]	–	

[a] Pulsed through an inductor (25 mH); duty factor = 50%.
[b] Measured at a current where the breakdown voltage is a minimum.
[c] For P_{IE} = 1.0 W; minimum efficiency 65%.
[d] For P_{IE} = 1.0 W minimum efficiency 40%.
* Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25°C
V_{CB} = 30 V
P_T = 2.6 W

HR2N3553

Silicon N-P-N Overlay Transistor

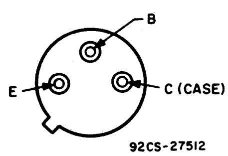
For VHF/UHF Applications

The RCA-HR2N3553 is a high-reliability version of the RCA-2N3553. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N3553 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N3553 transistor in RCA data bulletin file No. 386.

Features:

- **2.5 W (MIN) output at 175 MHz, Class C Amplifier**
- **1.5 W (Typ) output at 500 MHz, Oscillator**
- **High Voltage Ratings**

TERMINAL DESIGNATIONS



JEDEC TO-39

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter voltage $V_{BE} = -1.5$ V	V_{CEV}	65	V
With base open	V_{CEO}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.33	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		7	W
At case temperatures above 25°C	Derate linearly at	0.04	W/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		230	°C

II. GROUP A TESTS. At Case Temperature (T_C) = 25°C.

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Volts V_{CB}	V_{CE}	DC Base Volts V_{BE}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
* Collector-Cutoff Current	I_{CEO}		30			0		–	.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$				0		0.3	65	–	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$					0	0 to 200[a]	40[b]	–	V
	$V_{(BR)CEV}$			−1.5			0 to 200[a]	65[b]	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				0.1		0	4	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					50	250	–	1	V
* DC Forward Current Transfer Ratio	h_{FE}		5				150	10	–	

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Volts V_{CB}	V_{CE}	DC Base Volts V_{BE}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
Collector-to-Base Capacitance Measured at 1 MHz	C_{obo}	30			0			–	10	pF
RF Power Output Amplifier, Unneutralized At 175 MHz	P_{OE}		28					2.5[c]		W

[a] Pulsed through an inductor (25 mH); duty factor = 50%.
[b] Measured at a current where the breakdown voltage is a minimum.
[c] For P_{IE} = 2.5 W; minimum efficiency = 50%.
*Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25°C
V_{CE} = 30 V
P_T = 1 W

HR2N3632

Silicon N-P-N Overlay Transistor

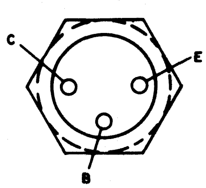
For VHF Applications

The RCA-HR2N3632 is a high-reliability version of the RCA-2N3632. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N3632 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N3632 transistor in RCA data bulletin file No. 386.

Features:

- **13.5 W (MIN) output at 175 MHz Class C**
- **10.0 W (Typ) output at 260 MHz Class C**
- **High Voltage Ratings**
- **Hermetic stud-type package**
- **All electrodes isolated from stud**

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter voltage V_{BE} = −1.5 V	V_{CEV}	65	V
With base open	V_{CEO}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
CONTINUOUS COLLECTOR CURRENT	I_C	1.0	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		23	W
At case temperatures above 25°C	Derate linearly at	0.13	W/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/16 in (1.58 mm) from insulating wafer for 10 s max.		230	°C

II. GROUP A TESTS. At Case Temperature (T_C) = 25°C.

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Volts V_{CB}	V_{CE}	DC Base Volts V_{BE}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
Collector-Cutoff Current	I_{CEO}		30			0		–	0.25	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$				0		0.5	65	–	V
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$					0	0 to 200[a]	40[b]	–	V
	$V_{(BR)CEV}$			−1.5			0 to 200[a]	65[b]	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$				.25		0	4	–	V.
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					100	500	–	1	V
* DC Forward Current Transfer Ratio	h_{FE}		5				300	10	–	

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Volts V_{CB}	V_{CE}	DC Base Volts V_{BE}	DC Current (Milliamperes) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
Collector-to-Base Capacitance Measured at 1 MHz	C_{obo}	30			0			–	20	pF
RF Power Output Amplifier, Unneutralized At 175 MHz	P_{OE}		28					13.5[c]		W
260 MHz			28					10[d]		

[a] Pulsed through an inductor (25 mH); duty factor = 50%.
[b] Measured at a current where the breakdown voltage is a minimum.
[c] For P_{IE} = 3.5 W; minimum efficiency = 70%.
[d] For P_{IE} = 3.0 W; typical efficiency = 60%.
* Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25°C
V_{CB} = 30 V
P_T = 2.6 W

HR2N3866

Silicon N-P-N Overlay Transistor

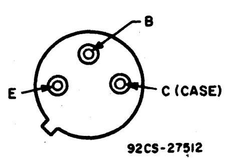
High-Gain Driver for VHF/UHF Applications in Military and Industrial Communications Equipment

The RCA-HR2N3866 is a high-reliability version of the RCA-2N3866. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N3866 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N3866 transistor in RCA data bulletin file No. 80.

Features:

- **High power gain, unneutralized Class C amplifier**
  - **1-W output at 400 MHz (10-dB gain)**
  - **1-W output at 250 MHz (15-dB gain)**
  - **1-W output at 175 MHz (17-dB gain)**
  - **1-W output at 100 MHz (20-dB gain)**
- **Low output capacitance**
  - **C_{obo} = 3 pF max.**

TERMINAL DESIGNATIONS



JEDEC TO-39

I. MAXIMUM RATINGS, ***Absolute-Maximum Values:***

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10 Ω	V_{CER}	55	V
With base open	V_{CEO}	30	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.4	A
CONTINUOUS BASE CURRENT	I_B	0.4	A
TRANSISTOR DISSIPATION:	P_T		
At case temperature up to 25° C		5	W
At case temperatures above 25° C		Derate at 0.0286	W/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
LEAD TEMPERATURE:			
At distances ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		230	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS DC VOLTAGE (V) V_{CE}	V_{EB}	DC CURRENT (mA) I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
Collector Cutoff Current: Base-emitter junction reverse biased	I_{CEX}	55	1.5				–	0.1	mA
* Base open	I_{CEO}	28			0		–	20	μA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	55	–	V
Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				0	5	30	–	V
With base connected to emitter through 10-ohm resistor	$V_{(BR)CER}$		0			5	55	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Emitter-Cutoff Current	I_{EBO}		3.5				–	0.1	mA
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				20	100	–	1.0	V
* DC Forward-Current Transfer Ratio	h_{FE}	5				50	10	200	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	35	°C/W

DYNAMIC

TEST AND CONDITIONS	SYMBOL	FREQUENCY MHz	LIMITS MIN.	MAX.	UNITS
Power Output (V_{CC} = 28 V): P_{IE} = 0.1 W	P_{OE}	400	1.0	–	W
Large-Signal Common-Emitter Power Gain (V_{CC} = 28 V): P_{IE} = 0.1 W	G_{PE}	400	10	–	dB
Collector Efficiency (V_{CC} = 28 V): P_{IE} = 0.1 W, P_{OE} = 1 W, Source Impedance = 50 Ω	η_C	400	45	–	%
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: I_C = 50 mA, V_{CE} = 15 V	$\lvert h_{fe}\rvert$	200	2.5	–	
Available Amplifier Signal Input Power, P_{OE} = 1 W, Source Impedance = 50 Ω	P_i	400	–	0.1	W
Common-Base Output Capacitance (V_{CB} = 28 V)	C_{obo}	1	–	3	pF

*Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C
V_{CB} = 28 V
P_T = 1 W

HR2N5071

24-W (CW), 76-MHz Emitter- Ballasted Overlay Transistor

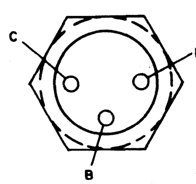
Silicon N-P-N Device for 24-Volt Applications in VHF Communications Equipment

The RCA-HR2N5071 is a high-reliability version of the RCA-2N5071. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N5071 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N5071 transistor in RCA data bulletin file No. 269.

Features:

- For class B or class C amplifiers
- For 24-V FM (30 to 76 MHz) communications
- 24 W output at 76 MHz with 9 dB gain (Min.)
- Low thermal resistances

TERMINAL DESIGNATIONS



JEDEC TO-60

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}	30	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT:			
Continuous	I_C	3.3	A
Peak		10	A
CONTINUOUS BASE CURRENT	I_B	1	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		70	W
At case temperatures above 25°C	Derates linearly at	0.4	W/°C
TEMPERATURE RANGE:			
Storage and operating (junction)		–65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from insulating wafer for 10 s max.		230	°C

II. GROUP A TESTS. At Case Temperature (T_C) = 25°C.

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage-V V_{CB}	V_{CE}	DC Base Voltage-V V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
Collector-Cutoff Current:										
* With base open	I_{CEO}		30			0		–	5	mA
With emitter open	I_{CBO}	60						–	10	
Collector to Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$					0	200[a]	30	–	V
With external base-to-emitter resistance (R_{BE}) = 5 Ω	$V_{CER}(sus)$						200[a]	40	–	
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$					10	0	4	–	V
* DC Forward Current Transfer Ratio	h_{FE}		5				1 A	20	–	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$							–	2.5	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC})–V	Input Power (P_{IE})–W	Frequency (f) - MHz	LIMITS MIN.	MAX.	UNITS
Power Output	P_{OE}	24	3	76	24	–	W
Power Gain	G_{PE}	24	3	76	9	–	dB
Available Amplifier Signal Input Power	P_i	Source impedance (Zg) = 50	P_{OE} = 24 W	76	–	3	W
Collector Efficiency	η_C	24	3	76	60	–	%
Load Mismatch	LM	24	1.2	30	GO/NO GO VSWR = 3:1		
Collector-to-Base Capacitance	C_{obo}	V_{CB} = 30 V	–	1	–	85	pF

[a]Pulsed through a 25-mH inductor; duty factor = 50%; repetition rate > 60 Hz.
*Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25°C
V_{CB} = 28 V
P_T = 2.6 W

HR2N5090

High-Power Silicon N-P-N Overlay Transistor

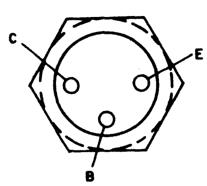
High-Gain Type for Class A, B, or C Operation in VHF/UHF Circuits

The RCA-HR2N5090 is a high-reliability version of the RCA-2N5090. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N5090 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N5090 transistor in RCA data bulletin file No. 270.

Features:

- **Maximum-safe-area-of-operation curve**
- **1.2-W (min.) output at 400 MHz (7.8-dB gain)**
- **1.6-W (typ.) output at 175 MHz (12-dB gain)**
- **Hermetic stud-type package**
- **All electrodes isolated from stud**

TERMINAL DESIGNATIONS



JEDEC TO-60

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10 Ω	V_{CER}	55	V
With base open	V_{CEO}	30	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.4	A
CONTINUOUS BASE CURRENT	I_B	0.4	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 100° C		4	W
At case temperatures above 100° C		Derate linearly at 0.04	W/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
LEAD TEMPERATURE (During Soldering):			
At distances ≥ 1/16 in. (1.58 mm) from insulating wafer for 10 s max.		230	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTAGE V V_{CE}	DC BASE VOLTAGE V V_{BE}	DC CURRENT mA I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
• Collector Cutoff Current: With base open	I_{CEO}	28			0		–	0.02	mA
With base-emitter junction reverse-biased	I_{CEV}	55	−1.5				–	0.1	mA
Emitter Cutoff Current	I_{EBO}		3.5			0	–	0.1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	55	–	V
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$				0	5	30	–	V
With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$					5	55[a]	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				20	100	–	1.0	V
• DC Forward-Current Transfer Ratio	h_{FE}	5				50	10	200	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	25	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR VOLTAGE V	OUTPUT POWER (P_{OE}) W	INPUT POWER (P_{IE}) W	COLLECTOR CURRENT (I_C) mA	FREQUENCY (f) MHz	LIMITS MIN.	MAX.	UNITS
Power Output (Class C amplifier, unneutralized)	P_{OE}	V_{CC} = 28		0.2		400	1.2	–	W
Gain-Bandwidth Product	f_T	V_{CE} = 15			50		500	–	MHz
Magnitude of Common Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio	$\|h_{fe}\|$	V_{CE} = 15			50		2.5	–	
Available Amplifier Signal Input Power	P_i		1.2			400	–	0.2	W
Collector Efficiency	η_C		1.2				45	–	%
Collector-to-Base Capacitance	C_{obo}	V_{CB} = 30				1	–	3.5	pF

[a] Pulse through a 25-mH inductor; duty factor = 0.05.

• Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C

V_{CB} = 28 V

P_T = 1.75 W

HR2N5470

Silicon N-P-N Overlay Transistor

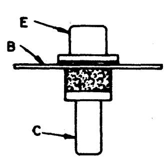
For UHF/Microwave Power Amplifiers, Microwave Fundamental-Frequency Oscillators, and Frequency Multipliers

The RCA-HR2N5470 is a high-reliability version of the RCA-2N5470. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N5470 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N5470 transistor in RCA data bulletin file No. 350.

Features:

- **1-W output with 5-dB gain (min.) at 2 GHz**
- **2-W output with 10-dB gain (typ) at 1 GHz**
- **Ceramic-metal hermetic package with low inductance and low parasitic capacitances**

TERMINAL DESIGNATIONS



92CS-27521

JEDEC TO-215AA

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10 Ω	V_{CER}	55	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
PEAK COLLECTOR CURRENT		0.4	A
CONTINUOUS COLLECTOR CURRENT	I_C	0.2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25° C		3.5	W
At case temperatures above 25° C		Derate at 0.02	W/°C
TEMPERATURE RANGE:			
Storage and operating (Junction)		−65 to +200	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage (V)		DC Current (mA)			LIMITS		UNITS
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
* Collector Cutoff Current	I_{CES}		50				–	1	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		0.1	55	–	V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$					5	55	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	–	1.0	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{cb}	30		0			–	3.0	pF
RF Power Output (Common-Base Amplifier): At 2 GHz[a]	P_{OB}	28					1.0	–	W
* Forward Current Transfer Ratio	h_{FE}		5			50	30	150	

[a] For P_{IB} = 0.316 W; minimum efficiency = 30%.
* Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C
V_{CB} = 15 V
P_T = 1 W

HR2N5916

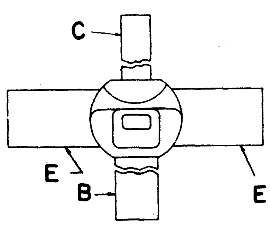
High-Gain Silicon N-P-N Overlay Transistor

For VHF/UHF Communications Equipment

The RCA-HR2N5916 is a high-reliability version of the RCA-2N5916. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N5916 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N5916 transistor in RCA data bulletin file No. 425.

Features:

- **Radial leads for microstripline circuits**
- **2-W (min.) output at 400 MHz (10-dB gain)**
- **2-W (typ.) output at 1 GHz (5-dB gain)**
- **Low-inductance, ceramic-metal hermetic package**
- **All electrodes isolated from stud**



92CS-27527

JEDEC TO-216AA

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	24	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.2	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 100° C		4	W
At case temperatures above 100° C		Derate linearly at 0.04	W/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
CASE TEMPERATURE (During Soldering):			
For 10 s max.		230	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage V_{CE}	DC Base Voltage V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
• Collector-to-Emitter Cutoff Current: Base-emitter junction shorted	I_{CES}	30	0				–	1	mA
Collector-to-Emitter Breakdown Voltage:	$V_{(BR)CES}$		0			5ª	55	–	V
With base open	$V_{(BR)CEO}$					5ª	24	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	–	0.5	V
• Forward Current Transfer Ratio	h_{FE}	5				50	30	150	
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$						–	25	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC}) – V	Output Power (P_{OE}) – W	Input Power (P_{IE}) – W	Frequency (f) – MHz	LIMITS Min.	Max.	UNITS
Power Output	P_{OE}	28		0.2	400	2.0	–	W
Power Gain	G_{PE}	28	2		400	10	–	dB
Collector Efficiency	η_C	28		0.2	400	50	–	%
Collector-Base Capacitance	C_{cb}	30 (V_{CB})			1	–	4.5	pF

ª Pulsed through a 25-mH inductor; duty factor = 50%

• Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C

V_{CB} = 16 V

P_T = 1.3 W

HR2N5918

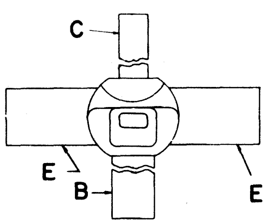
10-W, 400-MHz High-Gain Silicon N-P-N Emitter-Ballasted Overlay Transistor

For VHF/UHF Communications Equipment

The RCA-HR2N5918 is a high-reliability version of the RCA-2N5918. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N5918 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N5918 transistor in RCA data bulletin file No. 448.

Features:

- **10-W output at 400 MHz (8-dB min. gain)**
- **Emitter-ballasting resistors**
- **Broadband performance (225–400 MHz)**
- **Low-inductance ceramic-metal hermetic package**
- **All electrodes isolated from stud**
- **Radial leads for stripline circuits**



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JEDEC TO-216AA

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	30	V
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
CONTINUOUS COLLECTOR CURRENT	I_C	0.75	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 75° C		10	W
At case temperatures above 75° C		Derate linearly at 0.08	W/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
CASE TEMPERATURE (During Soldering):			
For 10 s max.		230	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage V_{CE}	DC Base Voltage V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
* Collector-to-Emitter Cutoff Current: Base-emitter junction shorted	I_{CES}	30	0				–	5	mA
Collector-to-Emitter Breakdown Voltage:	$V_{(BR)CES}$		0			100[a]	60	–	V
With base open	$V_{(BR)CEO}$					100[a]	30	–	
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			1		0	4	–	V
* Forward Current Transfer Ratio	h_{FE}	4				500	10	200	
Thermal Resistance, (Junction to Case)	$R_{\theta JC}$						–	12.5	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC}) – V	Output Power (P_{OE}) – W	Input Power (P_{IE}) – W	Frequency (f) – MHz	LIMITS Min.	Max.	UNITS
Power Output	P_{OE}	28		1.59	400	10	–	W
Power Gain	G_{PE}	28	10		400	8	–	dB
Collector Efficiency	η_C	28	10		400	60	–	%
Collector-to-Base Output Capacitance	C_{obo}	30 (V_{CB})			1	–	13	pF

[a]Pulsed through a 25-mH inductor; duty factor = 50%.

*Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C

V_{CB} = 28 V

P_T = 2.4 W

HR2N5919A

16-W, 400-MHz, Silicon N-P-N Emitter-Ballasted Overlay Transistor

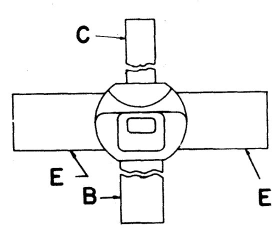
Overdrive Capability of 20 W Output

The RCA-HR2N5919A is a high-reliability version of the RCA-2N5919A. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N5919A are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N5919A transistor in RCA data bulletin file No. 505.

Features:

- 6-dB gain (min.) at 400 MHz with 16-W (min.) output
- Integral emitter-ballasting resistors
- Broadband performance (225–400 MHz)
- Low-inductance ceramic-metal hermetic package
- Radial leads for microstripline circuits
- All electrodes isolated from the stud

TERMINAL DESIGNATIONS



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JEDEC TO-216AA

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	30	V
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
CONTINUOUS COLLECTOR CURRENT	I_C	4.5	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 75° C		25	W
At case temperatures above 75° C		Derate at 0.2	W/°C
TEMPERATURE RANGE:			
Storage and operating (Junction)		−65 to +200	°C
CASE TEMPERATURE (During Soldering):			
For 10 s max.		230	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage-V V_{CE}	DC Base Voltage-V V_{BE}	DC Current mA I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
• Collector-to-Emitter Cutoff Current: With base connected to emitter	I_{CES}	30	0				–	10	mA
Collector-to-Emitter Breakdown Voltage: With base connected to emitter	$V_{(BR)CES}$		0			200[a]	65	–	V
With base open	$V_{(BR)CEO}$				0	200[a]	30	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			5		0	4	–	V
• Forward Current Transfer Ratio	h_{FE}	4				500	10	200	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	5.0	°C/W

[a]Pulsed through a 25-mH inductor; duty factor = 50%

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC})-V	Input Power (P_{IE})-W	Output Power (P_{OE})-W	Frequency (f) MHz	LIMITS Min.	Max.	UNITS
Output Power	P_{OE}	28	4.0		400	16	–	W
Overdrive Objective Test	P_{OE}	28	7.0		400	20	–	W
Power Gain	G_{PE}	28		16	400	6	–	dB
Collector Efficiency	η_C	28	4.0		400	65	–	%
Collector-to-Base Output Capacitance	C_{obo}	30 (V_{CB})			1	–	22	pF

•Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C

V_{CB} = 28 V

P_T = 2.6 W

HR2N5920

2-W, 2-GHz, Emitter-Ballasted Silicon N-P-N Overlay Transistor

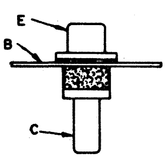
For UHF/Microwave Power Amplifiers, Microwave Fundamental-Frequency Oscillators, and Frequency Multipliers

The RCA-HR2N5920 is a high-reliability version of the RCA-2N5920. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N5920 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N5920 transistor in RCA data bulletin file No. 440.

Features:

- **2-W output with 10-dB gain (min.) at 2 GHz**
- **3-W output with 12-dB gain (typ.) at 1 GHz**
- **Ceramic-metal hermetic package with low inductance and low parasitic capacitances**
- **Stable common-base operation**
- **For coaxial, microstripline, and lumped-constant circuit applications**
- **Integral emitter-ballasting resistors**

TERMINAL DESIGNATIONS



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JEDEC TO-215AA

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10 Ω, sustaining	$V_{CER}(sus)$	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
DC COLLECTOR CURRENT (Continuous)	I_C	0.25	A
TRANSISTOR DISSIPATION:	P_T		
At case temperature up to 75° C		3.5	W
At case temperatures above 75° C, derate linearly		0.028	W/° C
For point of measurement of temperature (on collector terminal), see dimensional outline.			
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
CASE TEMPERATURE (During Soldering):			
For 10 s max.		230	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector or Base Voltage (V)		DC Current (mA)			LIMITS		UNITS
		V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
* Collector Cutoff Current	I_{CES}	45	0				–	2	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		1	50	–	V
Collector-to-Emitter Breakdown Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{(BR)CER}$					5	50	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100	–	1	V
* Forward Current Transfer Ratio	h_{FE}	5				100	20	200	
Thermal Resistance (Junction-to-collector terminal)	$R_{\theta JCT}$						–	30	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	POWER INPUT P_{IB}(W)	POWER OUTPUT P_{OB}(W)	SUPPLY VOLTAGE V_{CC}(V)	FREQUENCY (f) GHz	LIMITS Min.	LIMITS Max.	UNITS
Power Output	P_{OB}	0.2		28	2	2	–	W
Power Gain	G_{PB}	0.2	2.0	28	2	10	–	dB
Collector Efficiency	η_C	0.2	2.0	28	2	40	–	%
Collector-to-Base Capacitance	C_{obo}			30 (V_{CB})	1 MHz		3	pF

*Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C

V_{CB} = 15 V

P_T = 2 W

HR2N5921

5-W, 2-GHz, Emitter-Ballasted Silicon N-P-N Overlay Transistor

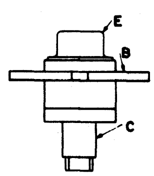
For UHF/Microwave Power Amplifiers, Microwave Fundamental-Frequency Oscillators, and Frequency Multipliers

The RCA-HR2N5921 is a high-reliability version of the RCA-2N5921. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N5921 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N5921 transistor in RCA data bulletin file No. 427.

Features:

- **5-W output with 5.5-dB gain (typ.) at 2.3 GHz**
- **5-W output with 7-dB gain (min.) at 2 GHz**
- **10-W output with 11-dB gain (typ.) at 1.2 GHz**
- **Integral emitter-ballasting resistors**
- **Ceramic-metal hermetic package with low inductance and low parasitic capacitances**

TERMINAL DESIGNATIONS



92CS-27529

JEDEC TO-201AA

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10 Ω	V_{CER}	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
DC COLLECTOR CURRENT (Continuous)	I_C	0.7	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25° C		14.5	W
At case temperatures above 25° C, derate linearly		0.083	W/°C
TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to +200	°C
CASE TEMPERATURE (During Soldering):			
For 10 s max.		230	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector or Base Voltage (V) V_{CE}	V_{BE}	DC Current (mA) I_E	I_B	I_C	LIMITS Min.	Max.	UNITS
* Collector Cutoff Current	I_{CES}	45	0				–	2	mA
Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		5	50	–	V
Collector-to-Emitter Breakdown Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{(BR)CER}$					10	50	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				20	100	–	1	V
* Forward Current Transfer Ratio	h_{FE}	5				500	20	200	
Thermal Resistance (Junction-to-Flange)	$R_{\theta JF}$						–	12	°C/W

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: Frequency (f) – GHz	DC Collector Supply Voltage (V_{CC}) – V	LIMITS Min.	Max.	UNITS
Output Power P_{IB} = 1 W	P_{OB}	2	28	5	–	W
Power Gain P_{OB} = 5 W	G_{PB}	2	28	7	–	dB
Collector Efficiency P_{OB} = 5 W	η_C	2	28	40	–	%
Collector-to-Base Capacitance V_{CB} = 30 V	C_{obo}	1 MHz	–	–	8.5	pF

*Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_C = 125° C
V_{CB} = 8 V
P_T = 3.2 W

HR2N6105

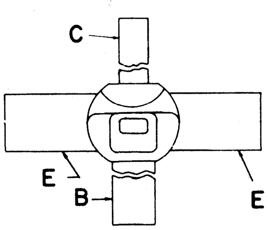
30-W, 400-MHz Broadband Emitter-Ballasted Silicon N-P-N Overlay Transistor

The RCA-HR2N6105 is a high-reliability version of the RCA-2N6105. It is specially processed and screened for high reliability in accordance with the basic schedules outlined earlier in the discussion of Processing and Screening of HR-Series High-Reliability Transistors. The maximum ratings, specific electrical (Group A) tests and test limits, and the burn-in conditions for the HR2N6105 are shown below. The basic electrical-characteristics curves and test conditions and the mechanical details for this device are the same as those given for the basic 2N6105 transistor in RCA data bulletin file No. 504.

Features:

- **5-dB gain (min.) at 400 MHz with 30 watts (min.) output**
- **Emitter-ballasting resistors**
- **Broadband performance (225—400 MHz)**
- **Low-inductance ceramic-metal hermetic package**
- **Radial leads for microstripline circuits**
- **All electrodes isolated from the stud**

TERMINAL DESIGNATIONS



92CS-27527

JEDEC TO-216AA

I. MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	30	V
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
CONTINUOUS COLLECTOR CURRENT	I_C	4.5	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 75° C		36	W
At case temperatures above 75° C		Derate linearly at 0.288	W/°C
TEMPERATURE RANGE:			
Storage and operating (Junction)		−65 to +200	°C
CASE TEMPERATURE (During Soldering):			
For 10 s max.		230	°C

II. GROUP A TESTS, at Case Temperature (T_C) = 25° C

STATIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Voltage V		DC Current mA		LIMITS		UNITS
		V_{CE}	V_{BE}	I_E	I_C	Min.	Max.	
* Collector-to-Emitter Cutoff Current: Base connected to emitter	I_{CES}	30	0			–	10	mA
Collector-to-Emitter Breakdown Voltage: With base connected to emitter	$V_{(BR)CES}$		0		200[a]	65	–	V
With base open	$V_{(BR)CEO}$				200[a]	30	–	V
Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			5	0	4	–	V
* Forward Current Transfer Ratio	h_{FE}	4			500	10	200	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						3.5	°C/W

[a]Pulsed through a 25-mH inductor; duty factor = 50%.

DYNAMIC

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Supply (V_{CC}) – V	Input Power (P_{IE}) – W	Output Power (P_{OE}) – W	Frequency (F) – MHz	LIMITS Min.	Max.	UNITS
Output Power	P_{OE}	28	9.5		400	30	–	W
Overdrive Test	P_{OEO}	28	12.0		400	34	–	W
Power Gain	G_{PE}	28		30	400	5	–	dB
Collector Efficiency	η_C	28	9.5		400	65	–	%
Collector-to-Base Output Capacitance	C_{obo}	30 (V_{CB})			1	–	35	pF

*Recorded before and after burn-in for each device (serialized).

III. BURN-IN CONDITIONS

T_A = 25° C

V_{CB} = 28 V

P_T = 2.6 W

40279

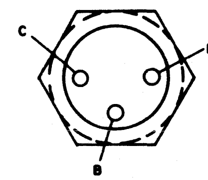
Ultra-High-Reliability High-Power UHF-VHF Transistor

Features:

- **Ultra-High Reliability**
- **Complete Qualification Testing**

The RCA-40279 is the ultra-high reliability version of the RCA-2N3375 epitaxial silicon N-P-N planar transistor intended for class-A, -B, or -C amplifier, frequency multiplier, or oscillator operation. This device is subjected to special preconditioning tests for selection in ultra-high-reliability, large-signal, high-power, VHF-UHF applications in Space, Military, and Industrial communications equipment.

TERMINAL DESIGNATIONS



92CS-27481

JEDEC TO-60

RF SERVICE, Maximum Ratings (Absolute-Maximum Values)

Collector-To-Base Voltage, V_{CBO}	65	volts
Collector-To-Emitter Voltage:		
With base open, V_{CEO}	40	volts
With V_{BE} = -1.5 volts, V_{CEV}	65	volts
Emitter-To-Base Voltage, V_{EBO}	4	volts
Collector Current, I_C	1.5	amps.
Transistor Dissipation, P_T:		
At T_C up to 25°C	11.6	watts
At T_C above 25°C	Derate linearly to 0 watts at 200°C	
Temperature Range:		
Storage	-65 to 200	°C
Operating (Junction)	-65 to 200	°C
Lead Temperature (During soldering):		
At distances 1/32" from insulating wafer for 10 sec. max.	230	°C

RELIABILITY TESTING

Electrically, the RCA-40279 is similar to the RCA-2N3375; the exception being the 40279 I_{CEO} is 100 nanoamperes maximum. In addition to Preconditioning and Group A tests, a Qualification Approval test series (Group B Tests) is performed on a semi-annual basis. All units are tested to assure freedom from second breakdown in Class-A applications.

Preconditioning (100 Per Cent Testing of Each Transistor)

1. Serialization
2. Record I_{CEO}, h_{FE}, V_{CE}(sat)
3. Temperature Cycling-Method 102A of MIL-STD-202, 5 cycles, -65°C +200°C
4. Bake, 72 hours minimum, +200°C
5. Constant Acceleration-Method 2006 of MIL-STD-750, 10, 000G, Y_1 and Y_2 axes
6. Record I_{CEO}, h_{FE}, V_{CE}(sat)
7. Reverse Bias Age, T_A = 150°C, V_{CB} = 28 V, t = 168 hours

*8. Record I_{CEO}, h_{FE}, V_{CE}(sat)

9. Power Age, T_A = 25°C, V_{CB} = 28 V, t = 500 hours, P_D = 2.6 W, free air

*10. Record I_{CEO}, h_{FE}, V_{CE}(sat) at 168 hours and 500 hours

11. Helium Leak, 1 x 10^{-8} cc/sec. max.
12. Methanol Bomb, 70 psig, 18 to 24 hours
13. X-Ray, RCA spec. 1750326
14. Record Subgroups 2 and 3 of Group A Tests

* Delta criteria after 168 hours Reverse Bias Age and after 168 hours and 500 hour Power Age

ΔI_{CEO}	+100% or +10 nanoamperes whichever is greater
Δh_{FE}	±30%
ΔV_{CE}(sat)	±0.1 V

Group A Tests

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	CONDITIONS	LTPD	SYMBOL	LIMITS MIN.	LIMITS MAX.	UNITS
	Subgroup 1		10				
2071	Visual and Mechanical Examination	–	–	–	–	–	–
	Subgroup 2		5				
3036D	Collector-To-Emitter Cutoff Current	V_{CE} = 30 V, I_B = 0	–	I_{CEO}	–	100	namps
3001D	Collector-To-Base Breakdown Voltage	I_C = 100μa, I_E = 0	–	BV_{CBO}	65	–	Volts
3026D	Emitter-To-Base Breakdown Voltage	I_E = 100μa, I_C = 0	–	BV_{EBO}	4	–	Volts
3011D	Collector-To-Emitter Breakdown Voltage	I_C = 0 to 200 ma (Inductive) I_B = 0	–	BV_{CEO}	40	–	Volts
3011A	Collector-To-Emitter Breakdown Voltage	I_C = 0 to 200 ma (inductive) V_{BE} = -1.5 V	–	BV_{CEV}	65	–	Volts
3071	Collector-To-Emitter Saturation Voltage	I_C = 500 ma, I_B = 100 ma	–	V_{CE}(sat)	–	1	Volt
3076	Forward Current Transfer Ratio	I_C = 150 ma V_{CE} = 5 V	–	h_{FE}	10	–	
	Subgroup 3		5				
3236	Output Capacitance	f = 140 Kc, V_{CB} = 30 V, I_E = 0	–	C_{ob}	–	10	pf
	R.F. Power Output (Min. Eff. = 65%)	V_{CE} = 28 V P_i = 1 W, f = 100 mc	–	P_{OUT}	7.5	–	Watts
	R.F. Power Output (Min. Eff. = 40%)	V_{CE} = 28 V, P_i = 1 W, f = 400 mc	–	P_{OUT}	3	–	Watts
	Subgroup 4		15				
3036D	Collector Cutoff Current	T_A = 150°C ± 3°C, V_{CB} = 30 V, I_E = 0	–	I_{CBO}	–	100	μamp.
3076	Forward Current Transfer Ratio	T_A = 150°C ± 3°C, I_C = 150 ma, V_{CE} = 5 V	–	h_{FE}	–	200	–

40279

Group B Tests

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	CONDITIONS	LTPD*	SYMBOL	LIMITS MIN.	MAX.	UNITS
	Subgroup 1 (10 samples)	–	7	–	–	–	–
2066	Physical Dimensions	TO-60	–	–	–	–	–
202/102A	Temperature Cycle	5~, -65°C, 200°C	–	–	–	–	–
1056B	Thermal Shock	0°C, 100°C	–	–	–	–	–
1021	Moisture Resistance	Omit lead fatigue	–	–	–	–	–
2036D	Torque-To-Stud	1 minute, 12 inch pounds	–	–	–	–	–
	Subgroup 2 (10 samples)		7				
2016	Impact Shock	500G, 5 blows X_1, Y_1, Z_1, 1 msec.	–	–	–	–	–
2046	Vibration Fatigue	–	–	–	–	–	–
2056	Vibration Var. Freq.	–	–	–	–	–	–
	Subgroup 3 (10 samples)		7				
2026	Solderability	–	–	–	–	–	–
1066	Dew Point	25°C, -65°C read I_{CEO}	–	–	–	–	–
1001	Barometric Pressure	100,000 ft. read I_{CEO}	–	–	–	–	–
	Subgroup 4 (25 samples)		7				
1031	Storage Life	200°C, 1000 hr	–	–	–	–	–
2006	Constant Acceleration	20,000G, Y_1, Y_2	–	–	–	–	–
	Subgroup 5 (25 samples)		7				
1026	Operating Life	1000 hrs T_C = 140°C, V_{CB} = 28 V, P_D = 4 W	–	–	–	–	–
	End Points Subgroups 1, 2, 3, 4, 5						
3036D	Collector-Cutoff Current	V_{CE} = 30, I_B = 0	–	I_{CEO}	–	1	μamp
3011A	Collector-To-Emitter Breakdown Voltage	I_C = 0 to 200 ma (inductive) V_{BE} = –1.5 V	–	BV_{CEV}	60	–	Volts
	R.F. Power Output	f = 100 mc, V_{CE} = 28 V, P_i = 1 W	–	P_{OUT}	6.5	–	Watts
3076	Forward Current Transfer Ratio	I_C = 150 ma, V_{CE} = 5 V	–	h_{FE}	9	–	–
3026D	Emitter-To-Base Breakdown Voltage	I_E = 100 μa, I_C = 0	–	BV_{EBO}	3.5	–	Volts

* Acceptance/Rejection Criteria of Group B tests: For an LTPD plan of 7% the total sample size is 80 for which the maximum number of rejects allowed is 2. Acceptance is also subject to a maximum of one (1) reject per Subgroup.

Group B tests are performed once every six months as part of Qualification Approval.

40294

ULTRA-HIGH-RELIABILITY SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

For UHF Applications in Critical Aerospace and Military Equipment

RCA-40294 is an ultra-high-reliability double-diffused, epitaxial planar transistor of the silicon NPN type for low-noise amplifier, mixer, and oscillator applications at frequencies up to 500 MHz (common-emitter configuration), and up to 1200 MHz (common-base configuration).

This transistor is electrically and mechanically like RCA-2N2857, but is specially processed, preconditioned, and tested for critical aerospace and military applications.

The 40294 utilizes a hermetically sealed JEDEC TO-72 package. All active transistor elements are insulated from the case, which may be grounded by a fourth lead in applications requiring shielding of the device.

The curves of Typical Characteristics shown in the technical bulletin for RCA-2N2857 also apply for RCA-40294.

Features:

- **Meets performance requirements of TX2N2857 MIL-S-19500/343 USAF, 7 March 1966**
- **Extra-rigorous control and inspection of all parts, materials, and internal assemblies before sealing**
- **100% thermal and mechanical preconditioning after sealing**
- **complete electrical and mechanical QUALITY CONFORMANCE test program**
- **100% RELIABILITY ASSURANCE testing**
- **100% PERFORMANCE-REQUIREMENTS testing**
- **100% Noise Figure and Power Gain Tests at 450 MHz**
- **high gain-bandwidth product — f_T = 1000 MHz min.**
- **very low Device Noise Figure — NF = 4.5 dB max. at 450 MHz**
- **high power gain as neutralized amplifier — G_{pe} = 12.5 dB min. at 450 MHz for circuit bandwidth of 20 MHz**
- **high power output as uhf oscillator — P_o = 30 mW min. at 500 MHz**
- **low collector-to-base time constant — $r_b'C_c$ = 15 ps max.**

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE, V_{CBO} . . 30 max. V

COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO} 15 max. V

EMITTER-TO-BASE VOLTAGE, V_{EBO} . . . . . 2.5 max. V

COLLECTOR CURRENT, I_C . . . . 40 max. mA

TRANSISTOR DISSIPATION, P_T:

For operation with heat sink:

At case temperatures* up to 25°C . . . . 300 max. mW

At case temperatures* above 25°C . . . . . . Derate at 1.72 mW/°C

For operation in free air:

At ambient temperatures up to 25°C . . . . 200 max. mW

At ambient temperatures above 25°C . . . . . . Derate at 1.14 mW/°C

TEMPERATURE RANGE:

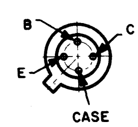
Storage and Operating (Junction) . . . . -65 to +200 °C

LEAD TEMPERATURE (During soldering):

At distances ≥ 1/32 inch from seating surface for 10 seconds maximum. . . . 265 max. °C

* Measured at center of seating surface.

TERMINAL DIAGRAM



92CS-27513

JEDEC TO-72

TABLE I
GROUP A TESTS

Sub-group	Lot Tolerance Per Cent Defective	Characteristic Test	Symbol	MIL-STD 750 Reference Test Method	TEST CONDITIONS: Ambient Temperature T_A (°C)	Frequency f (MHz)	DC Collector-to-Base Voltage V_{CB} (V)	DC Collector-to-Emitter Voltage V_{CE} (V)	DC Collector Current I_C (mA)	DC Emitter Current I_E (mA)	DC Base Current I_B (mA)	LIMITS RCA 40294 Min.	Max.	Units
1	5	Visual and Mechanical Examination	--	2071	--	--	--	--	--	--	--	--	--	
2	3	Collector-Cutoff Current	I_{CBO}	3036 Bias Condition D	25±3	--	15			0		--	10	nA
		Collector-Cutoff Current	I_{CES}	3041 Bias Condition C	25±3	--		16				--	100	nA
		Collector-to-Base Breakdown Voltage	BV_{CBO}	3001 Test Condition D	25±3	--			0.001	0		30	--	V
		Collector-to-Emitter Breakdown Voltage	$BV_{CEO(sus)}$	3011 Test Condition D	25±3	--			3*		0	15	--	V
		Emitter-to-Base Breakdown Voltage	BV_{EBO}	3026 Test Condition D	25±3	--			0	-0.001		2.5	--	V
		Base-to-Emitter Voltage	V_{BE}	3066 Test Condition A	25±3	--			10		1	--	1	V
		Collector-to-Emitter Voltage	V_{CE}	3071	25±3	--			10		1	--	0.4	V
		Static Forward Current-Transfer Ratio	h_{FE}	3076	25±3	--		1	3			30	150	
3	10	Small-Signal Power Gain▲	G_{pe}		25±3	450		6	1.5			12.5	19	dB
		Device Noise Figure◆: Generator Resistance (R_G) = 50 Ω	NF		25±3	450		6	1.5			--	4.5	dB
		Measured Noise Figure Generator Resistance R_G = 50Ω	NF		25±3	450		6	1.5			--	5.0	dB
		Collector-to-Base Time Constant▲	$r_b'C_c$		25±3	31.9		6		-2		4	15	ps
		Oscillator Power Output	P_o		25±3	≥500	10			-12		30	--	mW
		Collector-to-Base Feedback Capacitance ●	C_{cb}		25±3	≥0.1 ≤1	10			0		--	1	pF
4	10	Static Forward Current Transfer Ratio (Low Temperature)	h_{FE}	3076	-55±3	--		1	3			10	--	
		Collector-Cutoff Current (High Temperature)	I_{CBO}	3036 Bias Condition D	150^{+0}_{-5}	--	15			0		--	1	µA
		Small-Signal, Short Circuit Forward Current-Transfer Ratio▲	h_{fe}	3206	25±3	0.001		6	2			50	220	
		Magnitude of Small-Signal, Short-Circuit Forward Current Transfer Ratio▲	$\lvert h_{fe} \rvert$	3206	25±3	100		6	5			10	19	

* Pulse Test

▲ Lead No. 4 (Case) Grounded

◆ Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test amplifier and the contribution of the following stages in the test setup.

● Three-terminal measurement with emitter and case leads guarded.

40294

TABLE II

GROUP B TESTS

Subgroup	Test	MIL-STD 750 Reference	Lot Tolerance Per Cent Defective %	INITIAL AND ENDPOINT CHARACTERISTICS TESTS: Characteristic Test	MIL-STD 750 Reference	Test Conditions	RCA-40294 Initial Values Min.	Initial Values Max.	End Point Values Min.	End Point Values Max.	Units
1	PHYSICAL DIMENSIONS (See Dimensional Outline Drawing on page 7)	2066	20	--	--	--	--	--	--	--	
2	SOLDERABILITY Solder Temp. = 260±5°C	2026	10	I_{CBO}	3036D	T_A =25±3 °C V_{CB}=15 V	--	10	--	10	nA
	TEMPERATURE-CYCLING TEST (Condition C)	1051									
	THERMAL-SHOCK TEST: $T_{min} = 0^{+5}_{-0}$ °C $T_{max} = 100^{+0}_{-5}$ °C	1056 Test Condition A		h_{FE}	3076	T_A =25±3 °C V_{CE}=1 V I_C=3 mA	30	150	30	150	
	MOISTURE-RESISTANCE TEST	1021									
3	SHOCK TEST: NON-OPERATING 1500 G's, 0.5 ms 5 blows each in X_1, Y_1, Y_2, and Z_1 planes	2016	10	I_{CBO}	3036D	T_A =25±3 °C V_{CB}=15 V	--	10	--	10	nA
	VIBRATION FATIGUE TEST: NON-OPERATING 60 ±20 Hz, 20 G's	2046		h_{FE}	3076	T_A =25±3°C V_{CE}=1 V I_C=3 mA	30	150	30	150	
	VIBRATION VARIABLE-FREQUENCY TEST	2056									
	CONSTANT-ACCELERATION TEST: 20,000 G's	2006									
4	TERMINAL STRENGTH TEST	2036 Test Condition E	20	Helium Leak Test	MIL-STD 202 Method 112 Condition C Procedure III A		--	--	--	10^{-8}	atm cm^3/s
				Bubble Test	MIL-STD 202 Condition A	T_A=150°C (min.) 1 minute					
5	SALT-ATMOSPHERE TEST	1041	20	I_{CBO}	3036D	T_A =25±3 °C V_{CB}=15 V	--	10	--	10	nA
				h_{FE}	3076	T_A =25±3°C V_{CE}=1 V I_C=3 mA	30	150	30	150	
6	HIGH-TEMPERATURE LIFE TEST (NON-OPERATING): T_A =200±10°C Duration=1000 hrs.	1031	λ= 7%	I_{CBO}	3036D	T_A =25±3° C V_{CB}=15 V	--	10	--	20	nA
				h_{FE}	3076	T_A =25±3 °C V_{CE}=1 V I_C=3 mA	30	150	24	180	
7	STEADY-STATE OPERATION LIFE TEST: Common-Base Circuit T_A =25±3° C V_{CB}=12.5±0.5 V PT=200 mW Duration=1000 hrs.	1026	λ= 7%	I_{CBO}	3036D	T_A=25±3 °C V_{CB}=15 V	--	10	--	20	nA
				h_{FE}	3076	T_A =25±3 °C V_{CE}=1 V I_C=3 mA	30	150	24	180	•

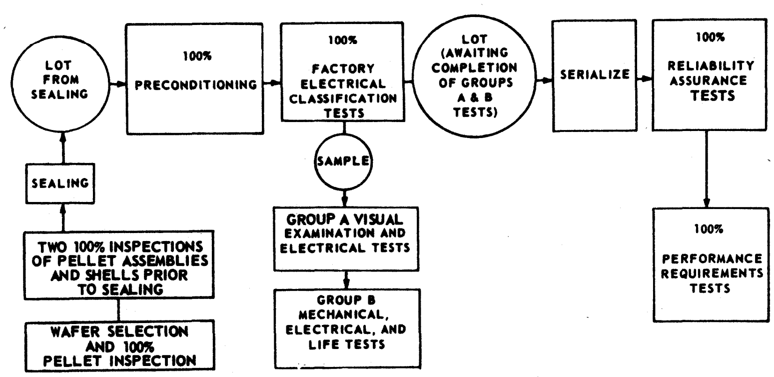


Fig. 1 - High-Reliability Testing Process Flow Diagram

TABLE III 100% PRECONDITIONING
BEFORE FACTORY, QUALITY, RELIABILITY-ASSURANCE AND PERFORMANCE REQUIREMENTS TESTS

STABILIZATION BAKE	48 hours minimum at 200° C
TEMPERATURE CYCLING (PER MIL-STD-750 METHOD 1051, COND. C)	5 complete cycles from -65° C to +200° C, each including 15 minutes at -65° C, 15 minutes at +200° C, and 5 minutes at 25° C
HELIUM-LEAK TEST (PER MIL-STD-202, METHOD 112 COND. C, PROC.IIIA). . . .	Leakage may not exceed 10^{-8} atm cc/s
BUBBLE TEST (PER MIL-STD-202, METHOD 112 COND. A)	150° C minimum, 1 minute, ethylene glycol
CONSTANT-ACCELERATION (CENTRIFUGE) TEST (PER MIL-STD-750, METHOD 2006). .	20,000 G's; Y_1 plane, 1 minute

40294

TABLE IV

100% RELIABILITY ASSURANCE TEST

THE CUMULATIVE REJECTS OF TABLES IV AND V SHALL NOT EXCEED 10% OF THE LOT

Test	MIL-STD 750 Reference	INITIAL AND ENDPOINT CHARACTERISTICS TESTS				
		Characteristic Test	RCA-40294 Initial Value	RCA-40294 Endpoint Value	MIL-STD 750 Reference	Test Conditions
POWER BURN-IN: Common-Base Circuit T_A =25±3°C V_{CB}=12.5±0.5 V P_T=200 mW Duration=340 hours	1026	ΔI_{CBO}	10 max. nA	Δ= ±5 nA	3036 Bias Condition D	T_A =25±3 °C V_{CB}=15 V
		Δh_{FE}	30 min. 150 max.	Δ=±15%	3076	T_A =25±3 °C V_{CE}=1 V I_C=3 mA

TABLE V

100% PERFORMANCE REQUIREMENTS TESTS

THE CUMULATIVE REJECTS OF TABLES IV AND V SHALL NOT EXCEED 10% OF THE LOT

Test	Symbol	MIL-STD 750 Reference	TEST CONDITIONS: Ambient Temperature T_A	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	LIMITS RCA 40294 Min.	LIMITS RCA 40294 Max.	Units
			°C	MHz	V	V	mA	mA	mA	Min.	Max.	
Collector-Cutoff Current	I_{CBO}	3036 Bias Condition D	25±3	--	15			0		--	10	nA
Collector-Cutoff Current	I_{CES}	3041 Bias Condition C	25±3	--		16				--	100	nA
Collector-to-Base Breakdown Voltage	BV_{CBO}	3001 Test Condition D	25±3	--			0.001	0		30	--	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO} (sus)	3011 Test Condition D	25±3	--			3*		0	15	--	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	3026 Test Condition D	25±3	--			0	−0.001		2.5	--	V
Base-to-Emitter Voltage	V_{BE}	3066 Test Condition A	25±3	--			10		1	--	1	V
Collector-to-Emitter Voltage	V_{CE}	3071	25±3	--			10		1	--	0.4	V
Static Forward Current-Transfer Ratio	h_{FE}	3076	25±3	--		1	3			30	150	
Device Noise Figure▲: Generator Resistance (R_G)=50 Ohms	NF	--	25±3	450		6	1.5			--	4.5	dB
Measured Noise Figure Generator Resistance R_G = 50Ω ▲	NF		25±3	450		6	1.5			--	5.0	dB
Visual Examination (External) Under 20-Power Magnification		Examine leads, header, and shell for visual defects.										

* Pulse Test

▲ Lead No. 4 (Case) Grounded

40296

Ultra-High-Reliability Silicon N-P-N Epitaxial Planar Transistor

For UHF Applications in Critical Aerospace and Military Equipment

RCA-40296 is an ultra-high-reliability double-diffused, epitaxial planar transistor of the silicon n-p-n type for low-noise amplifier, mixer, and oscillator applications at frequencies up to 500 MHz (common-emitter configuration), and up to 1200 MHz (common-base configuration).

This transistor is electrically and mechanically like RCA-2N2857, but is specially processed, preconditioned, and tested for critical aerospace and military applications.

The 40296 utilizes a hermetically sealed JEDEC TO-72 package. All active transistor elements are insulated from the case, which may be grounded by a fourth lead in applications requiring shielding of the device.

The curves of Typical Characteristics shown in the technical bulletin for RCA-2N2857 also apply for RCA-40296.

Features:

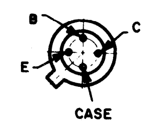
- **Meets performance requirements of TX2N2857 MIL-S-19500/343 USAF, 7 March 1966**
- **Extra-rigorous control and inspection of all parts, materials, and internal assemblies before sealing**
- **100% thermal and mechanical preconditioning after sealing**
- **Complete electrical and mechanical QUALITY CONFORMANCE test program**
- **100% RELIABILITY ASSURANCE testing**
- **100% PERFORMANCE-REQUIREMENTS testing**
- **100% noise figure and power gain tests at 450 MHz**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}	15	V
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	30	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	2.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	40	mA
TRANSISTOR DISSIPATION	P_T		
With heat sink, at case* temperatures up to 25°C		300	mW
With heat sink, at case* temperatures above 25°C		Derate linearly 1.72	mW/°C
At ambient temperatures up to 25°C		200	mW
At ambient temperatures above 25°C		Derate linearly 1.14	mW/°C
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to +200	°C
CASE TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating surface for 10 seconds max.		265	°C

*Measured at center of seating surface.

Terminal Diagram



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JEDEC TO-72

TABLE I
GROUP A TESTS

Sub-group	Lot Tolerance Per Cent Defective	Characteristic Test	Symbol	MIL-STD 750 Reference Test Method	TEST CONDITIONS: Ambient Temperature T_A	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Collector Current I_C	DC Emitter Current I_E	DC Base Current I_B	LIMITS RCA 40296 Min.	Max.	Units
					°C	MHz	V	V	mA	mA	mA	Min.	Max.	
1	5	Visual and Mechanical Examination	--	2071	--	--	--	--	--	--	--	--	--	
2	3	Collector-Cutoff Current	I_{CBO}	3036 Bias Condition D	25±3	--	15			0		--	10	nA
		Collector-Cutoff Current	I_{CES}	3041 Bias Condition C	25±3	--		16				--	100	nA
		Collector-to-Base Breakdown Voltage	BV_{CBO}	3001 Test Condition D	25±3	--			0.001	0		30	--	V
		Collector-to-Emitter Breakdown Voltage	BV_{CEO} (sus)	3011 Test Condition D	25±3	--			3*		0	15	--	V
		Emitter-to-Base Breakdown Voltage	BV_{EBO}	3026 Test Condition D	25±3	--			0	0.001		2.5	--	V
		Base-to-Emitter Voltage	V_{BE}	3066 Test Condition A	25±3	--			10		1	--	1	V
		Collector-to-Emitter Voltage	V_{CE}	3071	25±3	--			10		1	--	0.4	V
		Static Forward Current-Transfer Ratio	h_{FE}	3076	25±3	--		1	3			30	150	
3	10	Small-Signal Power Gain▲	G_{pe}		25±3	450		6	1.5			11.5	16.5	dB
		Device Noise Figure◆: Generator Resistance (R_G) = 50 Ω	NF		25±3	450		6	1.5			--	3.4	dB
		Measured Noise Figure Generator Resistance R_G = 50Ω	NF		25±3	450		6	1.5				4.2	dB
		Collector-to-Base Time Constant▲	$r_b'C_c$		25±3	31.9		6		-2		4	15	ps
		Oscillator Power Output	P_o		25±3	≥500	10			-12		30	--	mW
		Collector-to-Base Feedback Capacitance ●	C_{cb}		25±3	≥0.1 ≤1	10			0		--	1	pF
4	10	Static Forward Current Transfer Ratio (Low Temperature)	h_{FE}	3076	-55±3	--		1	3			10	--	
		Collector-Cutoff Current (High Temperature)	I_{CBO}	3036 Bias Condition D	150^{+0}_{-5}	--	15			0		--	1	μA
		Small-Signal, Short Circuit Forward Current-Transfer Ratio▲	h_{fe}	3206	25±3	0.001		6	2			50	220	
		Magnitude of Small-Signal, Short-Circuit Forward Current Transfer Ratio▲	$\|h_{fe}\|$	3206	25±3	100		6	5			10	20	

Notes to Table I:

- * Pulse Test
- ▲ Lead No. 4 (Case) Grounded
- ◆ Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test amplifier and the contribution of the following stages in the test setup.
- ● Three-terminal measurement with emitter and case leads guarded grounded.

40296

TABLE II
GROUP B TESTS

Subgroup	Test	MIL-STD 750 Reference	Lot Tolerance Per Cent Defective %	INITIAL AND ENDPOINT CHARACTERISTICS TESTS: Characteristic Test	MIL-STD 750 Reference	Test Conditions	RCA-40296 Initial Values Min.	Initial Values Max.	End Point Values Min.	End Point Values Max.	Units
1	PHYSICAL DIMENSIONS (See Dimensional Outline Drawing on page 7)	2066	20	--	--	--	--	--	--	--	
2	SOLDERABILITY Solder Temp. = 260±5°C	2026	10	I_{CBO}	3036D	T_A =25±3°C V_{CB}=15 V	--	10	--	10	nA
	TEMPERATURE-CYCLING TEST (Condition C)	1051									
	THERMAL-SHOCK TEST: $T_{min} = 0^{+5}_{-0}$ °C $T_{max} = 100^{+0}_{-5}$ °C	1056 Test Condition A		h_{FE}	3076	T_A =25±3°C V_{CE}=1 V I_C=3 mA	30	150	30	150	
	MOISTURE-RESISTANCE TEST	1021									
3	SHOCK TEST: NON-OPERATING 1500 G's, 0.5 ms 5 blows each in X_1, Y_1, Y_2, and Z_1 planes	2016	10	I_{CBO}	3036D	T_A =25±3°C V_{CB}=15 V	--	10	--	10	nA
	VIBRATION FATIGUE TEST: NON-OPERATING 60 ±20 Hz, 20 G's	2046		h_{FE}	3076	T_A =25±3°C V_{CE}=1 V I_C=3 mA	30	150	30	150	
	VIBRATION: VARIABLE-FREQUENCY TEST	2056									
	CONSTANT-ACCELERATION TEST: 20,000 G's	2006									
4	TERMINAL STRENGTH TEST	2036 Test Condition E	20	Helium Leak Test	MIL-STD 202 Method 112 Condition C Procedure III A		--	--	--	10^{-8}	atm cm^3/s
				Bubble Test	MIL-STD 202 Condition A	T_A=150°C min. 1 minute					
5	SALT-ATMOSPHERE TEST	1041	20	I_{CBO}	3036D	T_A =25±3°C V_{CB}=15 V	--	10	--	10	nA
				h_{FE}	3076	T_A =25±3°C V_{CE}=1 V I_C=3 mA	30	150	30	150	
6	HIGH-TEMPERATURE LIFE TEST (NON-OPERATING): T_A =200±10°C Duration=1000 hrs.	1031	λ= 7%	I_{CBO}	3036D	T_A =25±3°C V_{CB}=15 V	--	10	--	20	nA
				h_{FE}	3076	T_A =25±3°C V_{CE}=1 V I_C=3 mA	30	150	24	180	
7	STEADY-STATE OPERATION LIFE TEST: Common-Base Circuit T_A =25±3°C V_{CB}=12.5±0.5 V P_T=200 mW Duration=1000 hrs.	1026	λ= 7%	I_{CBO}	3036D	T_A =25±3°C V_{CB}=15 V	--	10	--	20	nA
				h_{FE}	3076	T_A =25±3°C V_{CE}=1 V I_C=3 mA	30	150	24	180	

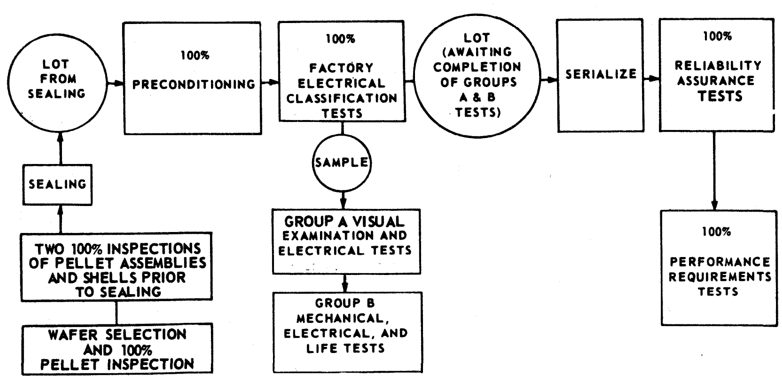


Fig. 1 - High-Reliability Testing Process Flow Diagram

TABLE III 100% PRECONDITIONING
BEFORE FACTORY, QUALITY, RELIABILITY-ASSURANCE AND PERFORMANCE REQUIREMENTS TESTS

STABILIZATION BAKE	48 hours minimum at 200° C
TEMPERATURE CYCLING (PER MIL-STD-750 METHOD 1051, COND. C)	5 complete cycles from -65° C to +200° C, each including 15 minutes at -65° C, 15 minutes at +200° C, and 5 minutes at 25° C
HELIUM-LEAK TEST (PER MIL-STD-202, METHOD 112 COND. C, PROC.IIIA)	Leakage may not exceed 10^{-8} atm cc/s
BUBBLE TEST (PER MIL-STD-202, METHOD 112 COND. A)	150° C minimum, 1 minute, ethylene glycol
CONSTANT-ACCELERATION (CENTRIFUGE) TEST (PER MIL-STD-750, METHOD 2006)	20,000 G's; Y_1 plane, 1 minute

TABLE IV

100% RELIABILITY ASSURANCE TEST

THE CUMULATIVE REJECTS OF TABLES IV AND V SHALL NOT EXCEED 10% OF THE LOT

Test	MIL-STD 750 Reference	INITIAL AND ENDPOINT CHARACTERISTICS TESTS: Characteristic Test	RCA-40296: Initial Value	RCA-40296: Endpoint Value	MIL-STD 750 Reference	Test Conditions
POWER BURN-IN: Common-Base Circuit T_A =25±3°C V_{CB}=12.5±0.5 V P_T=200 mW Duration=340 hours	1026	ΔI_{CBO}	10 max. nA	Δ= ±5 nA	3036 Bias Condition D	T_A =25±3°C V_{CB}=15 V
		Δh_{FE}	30 min. 150 max.	Δ=±15%	3076	T_A =25±3°C V_{CE}=1 V I_C=3 mA

TABLE V

100% PERFORMANCE REQUIREMENTS TESTS

THE CUMULATIVE REJECTS OF TABLES IV AND V SHALL NOT EXCEED 10% OF THE LOT

Test	Symbol	MIL-STD 750 Reference	TEST CONDITIONS: Ambient Temperature T_A (°C)	Frequency f (MHz)	DC Collector-to-Base Voltage V_{CB} (V)	DC Collector-to-Emitter Voltage V_{CE} (V)	DC Collector Current I_C (mA)	DC Emitter Current I_E (mA)	DC Base Current I_B (mA)	LIMITS RCA 40296 Min.	Max.	Units
Collector-Cutoff Current	I_{CBO}	3036 Bias Condition D	25±3	--	15			0		--	10	nA
Collector-Cutoff Current	I_{CES}	3041 Bias Condition C	25±3	--		16				--	100	nA
Collector-to-Base Breakdown Voltage	BV_{CBO}	3001 Test Condition D	25±3	--			0.001	0		30	--	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO} (sus)	3011 Test Condition D	25±3	--			3*		0	15	--	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	3026 Test Condition D	25±3	--			0	0.001		2.5	--	V
Base-to-Emitter Voltage	V_{BE}	3066 Test Condition A	25±3	--			10		1	--	1	V
Collector-to-Emitter Voltage	V_{CE}	3071	25±3	--			10		1	--	0.4	V
Static Forward Current-Transfer Ratio	h_{FE}	3076	25±3	--		1	3			30	150	
Device Noise Figure▲: Generator Resistance (R_G)=50 Ohms (See Fig. 3 for Test Circuit)	NF	--	25±3	450		6	1.5			--	3.9	dB
Visual Examination (External) Under 20-Power Magnification		Examine leads, header, and shell for visual defects.										

* Pulse Test

▲ Lead No. 4 (Case) Grounded

40305-40307

High-Reliability, High-Power UHF-VHF Transistors

RCA-40305, 40306, and 40307 are high-reliability variants of RCA-2N3553, 2N3375, and 2N3632 epitaxial silicon n-p-n overlay transistors. They are intended for Class-A, -B, or -C amplifier, frequency multiplier, or oscillator operation.

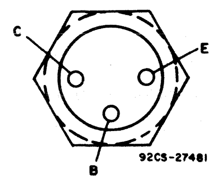
RCA types 40305, 40306, and 40307 are electrically similar to RCA-2N3553, 2N3375, and 2N3632 respectively; but they differ in that they have substantially lower collector-cutoff current. I_{CEO} for the 40305 and 40306 is 100 nanoamperes maximum and I_{CEO} for the 40307 is 250 nanoamperes maximum.

These devices are subjected to special preconditioning tests for selection in high-reliability, large-signal, high-power, VHF-UHF applications in Space, Military, and Industrial communications equipment.

FEATURES

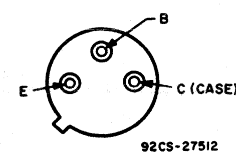
- High-Reliability Assured By Seven (7) Preconditioning Steps
- Data Recorded Before and After "Power-Age Test" and Held to Critical Delta Criteria
- High Voltage Ratings — V_{CEV} = 65 volts max. V_{CBO} = 65 volts max. V_{CEO} = 40 volts max.
- 100 Per-Cent Tested to Assure Freedom from Second Breakdown for Operation in Class-A Applications
- High Power Output, P_{OUT}, Unneutralized Class-C Amplifier —
  - At 400 Mc, 3 w min. (40306)
  - 175 Mc: 13.5 w min. (40307); 2.5 w min. (40305)
  - 100 Mc, 7.5 w min. (40306)

TERMINAL DIAGRAMS



(40306, 40307)

JEDEC TO-60



(40305)

JEDEC TO-39

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	40305	40306	40307	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	65	65	65	volts
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open, V_{CEO}	40	40	40	volts
With V_{BE} = -1.5 volts, V_{CEV}	65	65	65	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	4	4	4	volts
COLLECTOR CURRENT, I_C	1.0	1.5	3.0	amperes
TRANSISTOR DISSIPATION, P_T[▲]:				
At case temperatures up to 25°C	7.0	11.6	23	watts

	40305 40306 40307	
At case temperatures above 25°C	Derate linearly to 0 watts at 200°C	
TEMPERATURE RANGE:		
Storage	-65 to 200	°C
Operating (Junction)	-65 to 200	°C
PIN OR LEAD TEMPERATURE (During soldering):		
At distances ≥ 1/32" from insulating wafer (TO-60 package) or from seating plane (TO-39 package) for 10 sec. max.	230	°C

▲Secondary breakdown considerations limit maximum DC operating conditions—contact your RCA representative for specific data.

Group A Tests

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	SYMBOL	CONDITIONS	LTPD	LIMITS 40305 Min.	40305 Max.	40306 Min.	40306 Max.	40307 Min.	40307 Max.	UNITS
	Subgroup 1			10							
2071	Visual and Mechanical Examination	-	-	-	-	-	-	-	-	-	-
	Subgroup 2			5							
3041D	Collector-To-Emitter Cutoff Current	I_{CEO}	V_{CE} = 30 V, I_B = 0	-	-	0.1	-	0.1	-	0.25	μamp
3001D	Collector-To-Base Breakdown Voltage	BV_{CBO}	I_C = 300 μa, I_E = 0	-	65	-	-	-	-	-	volts
			I_C = 100 μa, I_E = 0	-	-	-	65	-	-	-	volts
			I_C = 500 μa, I_E = 0	-	-	-	-	-	65	-	volts
3026D	Emitter-To-Base Breakdown Voltage	BV_{EBO}	I_E = 100 μa, I_C = 0	-	4	-	4	-	-	-	volts
			I_E = 250 μa, I_C = 0	-	-	-	-	-	4	-	volts
3011D	Collector-To-Emitter Breakdown Voltage	BV_{CEO}	I_C = 0 to 200 ma[a], I_B = 0	-	40[b]	-	40[b]	-	40[b]	-	volts
3011A	Collector-To-Emitter Breakdown Voltage	BV_{CEX}	I_C = 0 to 200 ma[a], V_{BE} = -1.5 V	-	65[b]	-	65[b]	-	65[b]	-	volts
3071	Collector-To-Emitter Saturation Voltage	$V_{CE}(sat)$	I_C = 250 ma, I_B = 50 ma	-	-	1	-	-	-	-	volts
			I_C = 500 ma, I_B = 100 ma	-	-	-	-	1	-	1	volts
3076	Forward Current Transfer Ratio	h_{FE}	I_C = 150 ma, V_{CE} = 5 V	-	10	-	10	-	-	-	
			I_C = 300 ma, V_{CE} = 5 V	-	-	-	-	-	10	-	
	Subgroup 3			5							
3236	Open Circuit Output Capacitance	C_{ob}	f = 1 Mc, V_{CB} = 30 V, I_E = 0	-	-	10	-	10	-	20	pf
	R. F. Power Output	P_{OUT}	V_{CE} = 28 V, P_{IN} = 0.25 watt, f = 175 Mc, Min. Effic. = 50%	-	2.5	-	-	-	-	-	watts
			V_{CE} = 28 V, P_{IN} = 1 watt, f = 100 Mc, Min. Effic. = 65%	-	-	-	7.5	-	-	-	watts
			V_{CE} = 28 V, P_{IN} = 3.5 watts, f = 175 Mc, Min. Effic. = 70%	-	-	-	-	-	13.5	-	watts
			V_{CE} = 28 V, P_{IN} = 1 watt, f = 400 Mc, Min. Effic. = 40%	-	-	-	3	-	-	-	watts
	Subgroup 4			15							
3036D	Collector Cutoff Current	I_{CBO}	T_A = 150°C ± 3°C, V_{CB} = 30 V, I_E = 0	-	-	100	-	100	-	250	μamp
3076	Forward Current Transfer Ratio	h_{FE}	T_A = 150°C ± 3°C, I_C = 150 ma, V_{CE} = 5 V	-	-	200	-	200	-	-	
			T_A = 150°C ± 3°C, I_C = 300 ma, V_{CE} = 5 V	-	-	-	-	-	-	200	

[a] Pulsed through an inductor (25 mh); duty factor = 50%.

[b] Measured at a current where the breakdown voltage is a minimum.

Preconditioning (100 Per-Cent Testing of Each Transistor)

1. Helium Leak, 1 x 10^{-8} cc/sec. max.
2. Temperature Cycling-Method 102A of MIL-STD-202, 3 cycles, -65° C to +200° C
3. Methanol Bomb, 70 psig, 16 hours minimum
4. Bake, 72 hours minimum, +200° C
5. Constant Acceleration-Method 2006 of MIL-STD-750, 10,000 G, Y_1 axis
6. Serialization
7. Record I_{CEO}, h_{FE}, $V_{CE}(sat)$
8. Power Age, T_A = 25°C, V_{CB} = 28 V, t = 168 hours, free air
   P_D(40305) = 1 watt
   P_D(40306, 40307) = 2.6 watts
9. * Record I_{CEO}, h_{FE}, $V_{CE}(sat)$
10. X-Ray Inspection, RCA Spec. 1750326
11. Record Subgroups 2 and 3 of Group A Tests.

* Delta criteria after 168 hours Power Age

I_{CEO}	40305, 40306	+100% or +10 nanoamperes whichever is greater
I_{CEO}	40307	+100% or +25 nanoamperes whichever is greater
h_{FE}		±30%
$V_{CE}(sat)$		±0.1 V

40414

High-Reliability Silicon N-P-N Epitaxial Planar Transistor

For UHF Applications in Industrial and Military Equipment

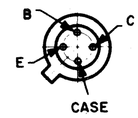
RCA-40414 is a double-diffused epitaxial planar transistor of the silicon n-p-n type. It is extremely useful in low-noise-amplifier, oscillator, and converter applications at frequencies up to 500 MHz in the common-emitter configuration, and up to 1200 MHz in the common-base configuration.

The 40414 is electrically and mechanically like the RCA-2N2857, but each shipment of the RCA-40414 is accompanied by a certified summary of the results of the Group A Electrical Tests and the Group B Environmental Tests shown in Tables I and II, respectively. The Test Data Summary and Certification shown in the Specimen Copy on page 5 are the results of the acceptance tests for the production lot from which the shipment is made.

RCA-40414 utilizes a hermetically sealed 4-lead JEDEC TO-72 package. All active elements of the transistor are insulated from the case, which may be grounded by means of the fourth lead in applications requiring shielding of the device.

The curves of Typical Characteristics shown in the Technical Bulletin for RCA-2N2857 also apply for RCA-40414.

Terminal Diagram



92CS-27513

JEDEC TO-72

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE	V_{CEO}	15	V
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	30	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	2.5	V
CONTINUOUS COLLECTOR CURRENT	I_C	40	mA
TRANSISTOR DISSIPATION	P_T		
At case temperatures* up to 25°C		300	mW
At case temperatures* above 25°C		Derate linearly 1.71	mW/°C
At ambient temperatures up to 25°C		200	mW
At ambient temperatures above 25°C		Derate linearly 1.14	mW/°C
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to +200	°C
CASE TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. (0.8 mm) from seating surface for 10 seconds max.		265	°C

* Measured at center of seating surface.

TABLE I – GROUP A TESTS

Sub-group	Lot Tolerance Per Cent Defective	Characteristic Test	Symbol	MIL-STD 750 Reference Test Method	TEST CONDITIONS: Ambient Temperature T_A	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Collector Current I_C	DC Emitter Current I_E	LIMITS RCA 40414 Min.	Max.	Units
					°C	MHz	V	V	mA	mA			
1	10	Visual and Mechanical Examination	--	2071	--	--	--	--	--	--	--	--	
2	5	Collector-Cutoff Current	I_{CBO}	3036 Bias Condition D	25±3	--	15			0	--	10	nA
		Collector-to-Base Breakdown Voltage	BV_{CBO}	3001 Test Condition D	25±3	--			0.001	0	30	--	V
		Collector-to-Emitter Breakdown Voltage	BV_{CEO} (sus)	3011 Test Condition D	25±3	--			3*	$I_B = 0$	15	--	V
		Emitter-to-Base Breakdown Voltage	BV_{EBO}	3026 Test Condition D	25±3	--			0	-0.01	2.5	--	V
		Static Forward Current-Transfer Ratio	h_{FE}	3076	25±3	--		1	3		30	150	
3	15	Small-Signal Power Gain▲	G_{pe}		25±3	450		6	1.5		12.5	19	dB
		Device Noise Figure⊗ Generator Resistance $(R_G) = 50\ \Omega$	NF		25±3	450		6	1.5		--	4.5	dB
		Measured Noise Figure: Generator Resistance $(R_G) = 50\ \Omega$▲	NF		25±3	450		6	1.5		--	5.0	dB
		Collector-to-Base Time Constant▲	$r_b'C_c$		25±3	31.9	6		2		4	15	ps
		Oscillator Power Output (See Fig.4 for Test Circuit)	P_o		25±3	≥500	10			-12	30	--	mW
		Collector-to-Base Feedback Capacitance●	C_{cb}		25±3	≥ 0.1 ≤ 1	10			0	--	1	pF

Features:

- High gain-bandwidth product: f_T = 1000 MHz min.
- High converter (450-to-30 MHz) gain: G_c = 15 dB typ. for circuit bandwidth of approximately 2 MHz
- High power gain as neutralized amplifier: G_{PE} = 12.5 dB min. at 450 MHz for circuit bandwidth of 20 MHz
- High power output as uhf oscillator:

  P_{OE} = 30 mW min., 40 mW typ. at 500 MHz; 20 mW typ., at 1 GHz

- Low device noise figure:

  NF = 4.5 dB max. as 450 MHz amplifier; 7.5 dB typ., as 450-to-30 MHz converter

- Low collector-to-base time constant: $r_b'C_c$ = 7 ps typ.
- Low collector-to- base feedback capacitance: C_{cb} = 0.6 pF typ.

40414

TABLE I – GROUP A TESTS (Cont'd)

Sub-group	Lot Toler-ance Per Cent Defect-ive	Characteristic Test	Symbol	MIL-STD 750 Reference Test Method	TEST CONDITIONS: Ambient Temperature T_A	Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Collector Current I_C	DC Emitter Current I_E	LIMITS RCA 40414 Min.	Max.	Units
					°C	MHz	V	V	mA	mA			
4	15	Static Forward Current Transfer Ratio (Low Temperature)	h_{FE}	3076	-55 ±3	--		1	3		10	--	
		Collector-Cutoff Current (High Temperature)	I_{CBO}	3036 Bias Condition D	150 $^{+0}_{-5}$	--	15			0	--	1	µA
		Small-Signal, Short Circuit Forward Current-Transfer Ratio▲	h_{fe}	3206	25±3	0.001		6	2		50	220	
		Magnitude of Small-Signal, Short-Circuit Forward Current-Transfer Ratio▲	$\|h_{fe}\|$	3206	25±3	100		6	5		10	19	

* Pulse Test

▲Lead No.4 (Case) Grounded

●Three-terminal measurement with emitter and case leads guarded.

◆Device noise figure is approximately 0.5 dB lower than the measured noise figure. The difference is due to the insertion loss at the input of the test amplifier and the contribution of the following stages in the test setup.

TABLE II – GROUP B TESTS

Subgroup	Test	MIL-STD 750 Reference	Lot Tolerance Per Cent Defective %	Characteristic Test	MIL-STD 750 Reference	Test Conditions	RCA-40414 Initial Values Min.	Initial Values Max.	End Point Values Min.	End Point Values Max.	Units
1	PHYSICAL DIMENSIONS (See Dimensional Outline Drawing on page 6)	2066	20	--	--	--	--	--	--	--	
2	SOLDERABILITY Without Aging	2026	20	I_{CBO}	3036D	T_A = 25 ± 3°C, V_{CB} = 15 V	--	10	--	30	nA
	TEMPERATURE-CYCLING TEST (Condition C)	1051									
	THERMAL-SHOCK TEST: $T_{min} = 0^{+5}_{-0}$ °C, $T_{max} = 100^{+0}_{-5}$ °C	1056 Test Condition A		h_{FE}	3076	T_A = 25 ± 3°C, V_{CE} = 1 V, I_C = 3 mA	30	150	18	--	
	MOISTURE-RESISTANCE TEST	1021									
3	SHOCK TEST: NON-OPERATING 1500 G's, 0.5 ms 5 blows each in X_1, Y_1, Y_2 and Z_1 planes	2016	20	I_{CBO}	3036D	T_A = 25 ± 3°C, V_{CB} = 15 V	--	10	--	30	nA
	VIBRATION FATIGUE TEST: NON-OPERATING 60 ± 20 Hz, 20 G's	2046									
	VIBRATION VARIABLE-FREQUENCY TEST	2056		h_{FE}	3076	T_A = 25 ± 3°C, V_{CE} = 1 V, I_C = 3 mA	30	150	18	--	
	CONSTANT-ACCELERATION TEST: 20,000 G's	2006									
4	TERMINAL STRENGTH TEST	2036 Test Condition E	20	--	--	--	--	--	--	--	
				--	--	--	--	--	--	--	
5	SALT-ATMOSPHERE TEST	1041	20	I_{CBO}	3036D	T_A = 25 ± 3°C, V_{CB} = 15 V	--	10	--	30	nA
				h_{FE}	3076	T_A = 25 ± 3°C, V_{CE} = 1 V, I_C = 3 mA	30	150	18	--	
6	HIGH-TEMPERATURE LIFE TEST (NON-OPERATING): T_A = 200 ± 10°C, Duration = 1000 hrs.	1031	λ = 10%	I_{CBO}	3036D	T_A = 25 ± 3°C, V_{CB} = 15 V	--	10	--	30	nA
				h_{FE}	3076	T_A = 25 ± 3°C, V_{CE} = 1 V, I_C = 3 mA	30	150	18	--	
7	STEADY-STATE OPERATION LIFE TEST: Common-Base Circuit T_A = 25 ± 3°C, V_{CB} = 12.5 ± 0.5 V, P_T = 200 mW, Duration = 1000 hrs.	1026	λ = 10%	I_{CBO}	3036D	T_A = 25 ± 3°C, V_{CB} = 15 V	--	10	--	30	nA
				h_{FE}	3076	T_A = 25 ± 3°C, V_{CE} = 1 V, I_C = 3 mA	30	150	18	--	

40577

High-Reliability VHF Power Transistor

High-Gain Device for Class A or C Operation in VHF Circuits

RCA–40577* is a high-reliability variant of the RCA–2N3118, a triple-diffused transistor. It is especially processed for high reliability. It is intended for Class A and C amplifier, frequency multiplier or oscillator operation in high-reliability, large-signal, high-power VHF applications in Space, Military, and Industrial communications equipment.

High reliability is assured by eight preconditioning steps, including drift temperature measurements after the High Temperature Reverse Bias and Power Age tests. The 40577 also features complete qualification and lot acceptance testing.

*Formerly RCA-Dev. No. TA7079

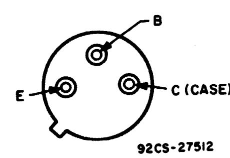
- 8 Preconditioning Steps
- Complete Qualification and Lot Acceptance Testing
- 1.0 Watt Output Min. at 50 MHz
- 0.4 Watt Output Min. at 150 MHz

RATINGS

Maximum Ratings, ***Absolute-Maximum Values:***

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE} = −1.5 volts	V_{CEV}	85	V
With base open	V_{CEO}	60	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT	I_C	0.5	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		3	W
At free-air temperatures up to 25° C		0.5	W
At case temperatures above 25° C		See *Fig.4*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max.		230	°C

Terminal Diagram



JEDEC TO-5

Preconditioning (100 Per Cent Testing of Each Transistor)

1. Serialization
2. Record I_{CBO}, h_{FE}
3. Temperature Cycling-Method 107B, Cond. C of MIL-STD-202, 5 cycles, −65° C to 200° C
4. Bake, 72 hours minimum, 200° C
5. Constant Acceleration-Method 2006 of MIL-STD-750, 10,000g, Y_1 and Y_2 axes
6. X-Ray
7. Record I_{CBO}, h_{FE}
8. Reverse Bias Age, T_A = 175° C, V_{CB} = 60 V, t = 96 hours
9. [d] Record I_{CBO}, h_{FE}.
10. Power Age, T_A = 25° C, V_{CB} = 28 V, t = 340 hours, P_T = 1 W, free air
11. [d] Record I_{CBO}, h_{FE} at 340 hours
12. Helium Leak, 1 x 10^{-7} cc/sec. max.
13. Gross Leak, MIL-STD-202, Method 112
14. Record Subgroups 2 and 3 of Group A Tests

[d] Delta criteria after 96 hours Reverse Bias Age and 340 hours Power Age.

ΔI_{CBO}	+100% or +5 nanoamperes whichever is greater
Δh_{FE}	±20%

Definitions

Delta (Δ): Delta shall be determined by subtracting the parameter value measured before application of stress from the value measured after the application of stress.

Group A Tests

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	CONDITIONS	LTPD	SYMBOL	LIMITS Min.	LIMITS Max.	UNITS
	Subgroup 1		10				
2071	Visual and Mechanical Examination	–	–	–	–	–	–
	Subgroup 2		5				
3036D	Collector-Cutoff Current	V_{CB} = 30V, I_E = 0	–	I_{CBO}	–	10	nA
3001D	Collector-to-Emitter Breakdown Voltage	I_C = 100 µA, V_{BE} = −1.5 V	–	BV_{CEV}	85[g]	–	volts
3026D	Emitter-to-Base Breakdown Voltage	I_E = 100 µA, I_C = 0	–	BV_{EBO}	4	–	volts
3011D	Collector-to-Emitter Breakdown Voltage	I_C = 10 mA[f] I_B = 0	–	V_{CEO}	60[g]	–	volts
3076	DC Forward-Current Transfer Ratio	I_C = 100 mA, V_{CE} = 5V	–	h_{FE}	50	275	
	Subgroup 3		5				
3236	Output Capacitance	f = 0.1 to 1.0 MHz, V_{CB}=28V, I_E = 0	–	C_{ob}	–	6.0	pF
	Power Output	f = 50 MHz, V_{CE} = 28V Pin = 0.1 W	–	P_{OUT}	1.0	–	watts
	RF Power Output (Min. Eff. = 45%)	V_{CE} = 28 V, P_{IN} = 0.1 W f = 150 MHz	–	P_{OUT}	0.4	–	watts
3306	Small-Signal Forward-Current Transfer Ratio	I_C = 25 mA, V_{CE} = 28 V f = 50 MHz	–	h_{fe}	–	5.0	
	Subgroup 4		15				
3036D	Collector-Cutoff Current	T_A = 150° C, V_{CB} = 30 V	–	I_{CBO}	–	5	µA
3201	Input Impedance	V_{CE} = 28 V, I_C = 25 mA f = 50 MHz	–	h_{ie}	25	75	ohms
3231	Output Admittance	V_{CE} = 28 V, I_C = 25 mA f = 50 MHz	–	Y_{22}	1	2	mmho

[f] Pulsed through an inductor (25 µH); duty factor = 50%.

[g] Measured at a current where the breakdown voltage is a minimum.

40577

Group B Tests[h]

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	CONDITIONS
	Subgroup 1	(13 Samples)
2066	Physical Dimensions	JEDEC TO-5 Pkg.
	Subgroup 2	(13 Samples)
2026	Solderability	Omit aging, Dwell time = 10 s ± 1 s
1051	Thermal Shock (Temp. Cycling)	Test Condition C
1056	Thermal Shock (Glass Strain)	Test Condition B
	Seal (Leak Rate)	Method 112 of MIL-STD-202 Test Cond. C, procedure III; Test Cond. A for gross leaks
1021	Moisture Resistance	
	Subgroup 3	(13 Samples)
2016	Shock	1,500 g, 0.5 ms, 5 blows each orientation: X_1, Y_1, Y_2, Z_1
2046	Vibration Fatigue	Nonoperating
2056	Vibration Var. Freq.	–
2006	Constant Acceleration	20,000 G Y_1, Y_2
	Subgroup 4	(13 Samples)
2036	Terminal Strength (Lead Fatique)	Test Cond. E
	Subgroup 5	(13 Samples)
1041	Salt Atmosphere	
	Subgroup 6	(25 Samples)
1031	High Temperature Life (Non-operating)	$T_{storage}$ = 200° C t = 1000 hrs.
	Subgroup 7	(25 Samples)
1026	Steady-State Operation	P_T = 1.5 W, T_C = 100° C t = 1000 hrs. V_{CB} = 40 V

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	CONDITIONS	SYMBOL	LIMITS		UNITS
				Min.	Max.	
	End Points **Subgroups (2, 3, 5, 6)**					
3036D	Collector Base Cutoff Current	V_{CB} = 30 V, I_E = 0	I_{CBO}		1.0	μA
3001D	Collector Base Breakdown Voltage	V_{BE} = −1.5 V, I_C= 100 μA	BV_{CEV}	80		
3076	DC Forward-Current Transfer Ratio	I_C =100 mA, V_{CE} = 5 V	h_{FE}	35	325	–

[h]Acceptance/Rejection Criteria of Group B tests: For an LTPD plan of 7% the total sample size is 115 for which the maximum number of rejects allowed is 4. Acceptance is also subject to a maximum of one (1) reject per Sub-group. Group B tests are performed on each lot for Qualification or Lot Acceptance.

[i]Pulsed through an inductor (25 mH); duty factor = 50%.

[k]Measured at a current where the breakdown voltage is a minimum.

40578

High-Reliability Silicon N-P-N Epitaxial Planar Transistor

High-Gain Device for Class A,B, or C Operation in VHF-UHF Circuits

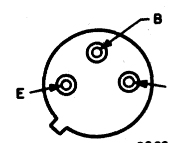
- 8 Preconditioning Steps
- Complete Qualification and Lot Acceptance Testing
- High Power Gain, Unneutralized Class C Amplifier
  At 400 MHz, 1 W output with 10 dB gain (min.)
  250 MHz, 1 W output with 15 dB gain (typ.)
  175 MHz, 1 W output with 17 dB gain (typ.)
  100 MHz, 1 W output with 20 dB gain (typ.)

RCA–40578* is a high-reliability variant of the RCA–2N3866, an epitaxial n-p-n planar transistor of "overlay" emitter electrode construction. It is especially processed for high reliability. It is intended for Class A, B, and C amplifier, frequency multiplier, or oscillator operation in high-reliability, driver or pre-driver stages, VHF-UHF applications in Space, Military, and Industrial communications equipment.

High reliability is assured by eight preconditioning steps, including drift temperature measurements after the High Temperature Reverse Bias and Power Age tests. The 40578 also features complete qualification and lot acceptance testing.

* Formerly RCA–Dev. No. TA7080

TERMINAL CONNECTIONS



JEDEC
TO-39

RATINGS

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance R_{BE} = 10 ohms	V_{CER}	55	V
With base open	V_{CEO}	30	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
COLLECTOR CURRENT	I_C	0.4	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		5	W
At free-air temperatures up to 25° C		1.0	W
TEMPERATURE RANGE:			
Storage & Operating (Junction)		–65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from seating plane for 10 s max.		230	°C

Preconditioning (100 Per Cent Testing of Each Transistor)

1. Serialization
2. Record I_{CEO}, h_{FE}
3. Temperature Cycling-Method 107B Cond. C of MIL-STD-202, 5 cycles, –65° C to 200° C
4. Bake, 72 hours minimum, 200° C
5. Constant Acceleration-Method 2006 of MIL-STD-750, 10,000g, Y_1 and Y_2 axes
6. X-Ray
7. Record I_{CEO}, h_{FE}
8. Reverse Bias Age, T_A = 200° C, V_{CB} = 50 V, t = 96 hours
9. [d] Record I_{CEO}, h_{FE}
10. Power Age, T_A = 25° C, V_{CB} = 28 V, t = 340 hours, P_T = 1 W, free air
11. [d] Record I_{CEO}, h_{FE}, V_{CE} at 340 hours
12. Helium Leak, 1 x 10^{-7} cc/sec. max.
13. Gross Leak, MIL-STD-202, Method 112
14. Record Subgroups 2 and 3 of Group A Tests

[d] Delta criteria after 96 hours Reverse Bias Age and 340 hours Power Age

ΔI_{CEO}	+100% or +20 nanoamperes whichever is greater
Δh_{FE}	±20%

Definitions

Delta (Δ): Delta shall be determined by subtracting the parameter value measured before application of stress from the value measured after the application of stress.

Group A Tests

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	CONDITIONS	LTPD	SYMBOL	LIMITS		UNITS
					Min.	Max.	
	Subgroup 1		10				
2071	Visual and Mechanical Examination	–	–	–	–	–	–
	Subgroup 2		5				
3041D	Collector-Cutoff Current	V_{CE} = 28 V	–	I_{CEO}	–	100	nA
3001D	Collector-to-Base Breakdown Voltage	I_C = 100 µA	–	BV_{CBO}	55	–	volts
3026D	Emitter-to-Base Breakdown Voltage	I_E = 100 µA	–	BV_{EBO}	3.5	–	volts
3011D	Collector-to-Emitter Breakdown Voltage	I_C = 0 to 5 mA[f]	–	BV_{CEO}	30[g]	–	volts
3011B	Collector-to-Emitter Breakdown Voltage	I_C = 0 to 5 mA[f], R_{BE} = 10 Ω	–	BV_{CER}	55[g]	–	volts
3071	Collector-to-Emitter Saturation Voltage	I_C = 100 mA, I_B = 20 mA	–	$V_{CE}(sat)$	–	1	volt
3076	DC Forward-Current Transfer Ratio	I_C = 100 mA, V_{CE} = 5 V	–	h_{FE}	10	–	–
	Subgroup 3		5				
3236	Output Capacitance	V_{CB} = 30 V	–	C_{ob}	–	3.0	pF
3261	Extrapolated Unity Gain Frequency	I_C = 50 mA, V_{CE} = 15 V, f = 200 MHz	–	f_T	500	–	MHz
	RF Power Output (Min. Eff. = 45%)	V_{CE} = 28 V, P_{IN} = .1 W, f = 400 MHz	–	P_{OUT}	1.0	–	watts
	Subgroup 4		15				
3036D	Collector-Cutoff Current	T_A = 150° C ± 3° C, V_{CB} = 30 V	–	I_{CBO}	–	100	µA
3076	DC Forward-Current Transfer Ratio	T_A = –55° C ± 3° C, I_C = 100 mA, V_{CE} = 5 V	–	h_{FE}	5	–	–

[f] Pulsed through an inductor (25 µH); duty factor = 50%.
[g] Measured at a current where the breakdown voltage is a minimum.

40578

Group B Tests

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	CONDITIONS
	Subgroup 1	(13 Samples)
2066	Physical Dimensions	
	Subgroup 2	(13 Samples)
2026	Solderability	
1051	Thermal Shock (Temp. Cycling)	Test Condition C
1056	Thermal Shock (Glass Strain)	Test Condition B
2036	Terminal Strength (Tension)	Test Condition A, weight = 5 lbs. time = 15 s each terminal
	Seal (Leak Rate)	Method 112 of MIL-STD-202 Test Cond. C, procedure IIIa, Test Cond. A for gross leaks
1021	Moisture Resistance	10^{-8} cc/s
	Subgroup 3	(13 Samples)
2016	Shock	1,500 g, 0.5 ms, 5 blows each orientation: X_1, Y_1, Z_1, (15 blows total)
2046	Vibration Fatigue	Nonoperating
2056	Vibration Var. Freq.	–
2006	Constant Acceleration	20,000 G Y_1, Y_2
	Subgroup 4	(13 Samples)
2036E	Terminal Strength (Lead Fatigue)	
	Subgroup 5	(13 Samples)
1041	Salt Atmosphere	
	Subgroup 6	(25 Samples)
1031	High Temperature Life (Nonoperating)	$T_{storage}$ = 200° C
	Subgroup 7	(25 Samples)
1026	Steady-State Operation	T_{FA} = 25° C t = 1000 hrs. P_T = 1 W, V_{CB} = 28 V free air, no heat sink

TEST METHOD PER MIL-STD-750	EXAMINATION OR TEST	CONDITIONS	SYMBOL	LIMITS Min.	LIMITS Max.	UNITS
	End Points Subgroups (2, 3, 5, 6, 7)					
3041D	Collector-to-Emitter Cutoff Current	V_{CE} = 28 V	I_{CEO}	–	1.0	μA
3011B	Collector-to-Emitter Breakdown Voltage	I_C = 5 mA (Inductive)[i] R_{BE} = 10	BV_{CER}	50[k]	–	volts
	RF Power Output (Min. Eff. = 45%)	V_{CE} = 28 V, P_{IN} = 0.1 W, f = 400 MHz	P_{OUT}	0.95	–	watts
3076	DC Forward-Current Transfer Ratio	I_C = 100 mA V_{CE} = 5 V	h_{FE}	9	–	–
3026D	Emitter-to-Base Breakdown Voltage	I_E = 100 mA	BV_{EBO}	3.0	–	volts

[h] Acceptance/Rejection Criteria of Group B tests: For an LTPD plan of 7% the total sample size is 115 for which the maximum number of rejects allowed is 4. Acceptance is also subject to a maximum of one (1) reject per Sub-group. Group B tests are performed on each lot for Qualification or Lot Acceptance.

[i] Pulsed through an inductor (25 mH); duty factor = 50%.

[k] Measured at a current where the breakdown voltage is a minimum.

40605

"Premium" High-Reliability Type

SILICON N-P-N "overlay" TRANSISTOR

For Class-A,-B, or -C Service in VHF/UHF Military, Industrial, and Commercial Equipment

RCA-40605* is an epitaxial silicon n-p-n planar transistor featuring "overlay" emitter electrode construction. It is intended for class-A, -B, or -C amplifier, frequency multiplier, and oscillator service in VHF/UHF equipment.

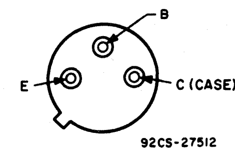
Premium high-reliability type 40605 is identical to RCA-2N3553 but is preconditioned and tested for use in critical aerospace and industrial equipment.

*Formerly RCA Dev. Type No. TA7361.

FEATURES:

- **High Power Output**
  - Class-C Amplifier . . . 2.5-W (min.) at 175 MHz
  - Oscillator . . . 1.5-W (typ.) at 500 MHz

TERMINAL DIAGRAM



JEDEC TO-39

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65 V
COLLECTOR-TO-EMITTER VOLTAGE:		
With -1.5 volts (V_{BE}) of reverse bias & external base-to-emitter resistance (R_{BE}) = 33 Ω	V_{CEX}	65 V
With base open	V_{CEO}	40 V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4 V
CONTINUOUS COLLECTOR CURRENT . .	I_C	0.33 A
PEAK COLLECTOR CURRENT	I_{Cpk}	1 A
TRANSISTOR DISSIPATION:	P_T	
At case temperatures up to 25°C		7 W
At case temperatures above 25°C derate linearly at		0.04 W/°C
At ambient temperatures up to 25°C . . .		1 W
At ambient temperatures above 25°C derate linearly at		5.71 mW/°C
TEMPERATURE RANGE:		
Storage & Operating (Junction)		-65 to +200°C
LEAD TEMPERATURE (During Soldering):		
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230°C

Lot Acceptance Data

Conditioning Screens (100% Testing, see Table I) a) Attributes Data on Burn-In b) Attributes Data on Radiographic Inspection c) Variables Data on Burn-In	
Group A (Lot Sampling, see Table II) a) Variables Data	**Group B** (Lot Sampling, see Table III) a) Attributes Data (From a member of the family)

Table 1. Description of Total Lot Screening – 100% Testing

TEST	CONDITIONS	MIL-STD-750		MIL-STD-202	
		METHOD	CONDITIONS	METHOD	CONDITIONS
1. Lot identification	–	–	–	–	–
2. Pre-seal visual inspection	In accordance with RCA's RFT-701 (See note 1)	–	–	–	–
3. Temp. cycling	5 cycles	1051	C	–	–
4. High Temp. storage	72 hrs. min. at T_A = 200° C	–	–	–	–
5. Acceleration	20,000 g min.; Y_1 direction only	2006	–	–	–
6. Fine leak	–	–	–	112	C
7. Gross leak	Fluorocarbon bubble test (See note 2)	–	–	–	–
8. Serialize	–	–	–	–	–
9. Pre burn-in electrical	See Table 1 A	–	–	–	–
10. Burn-in	(See note 3)	–	–	–	–
11. Post burn-in electrical	Delta requirements See table 1 A	–	–	–	–
12. Radiographic inspection	–	–	–	–	–

Note 1: Complete title of RFT-701 is: "General Reliability Specifications of RCA RF Power Transistors".

Note 2: Immersed in fluorochemical FC 78 at 65 psig for 4 hrs, unit is than placed in fluorochemical FC 48 at 80° C (nominal) and observed for bubbles.

Note 3: Burn-in tests:
Reverse bias age – all transistors shall be operated for 96 hrs at T_A = 150° C, V_{CB} = 50 V
Power age – all transistors shall be operated for 340 hrs at T_A = 25° C ± 3° C, V_{CB} = 30 V, P_T = 1 W.

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Table 1A. Pre Burn-In & Post Burn-In Tests and Delta (Δ) Limits

TEST	SYMBOL	MIL-STD-750		LIMITS		UNITS
		METHOD	CONDITIONS	MIN.	MAX.	
Collector-Cutoff Current	I_{CEO}	3041	V_{CE} = 30 V, bias cond. D	–	0.1	μA
DC Forward-Current Transfer Ratio	h_{FE}	3076	V_{CE} = 5 V, I_C = 150 mA pulsed	15	150	–

Delta (Δ) Limits:

I_{CEO} and h_{FE} of Table 1A shall be retested after each burn-in test and the data recorded for all devices in the lot. The tests measured shall not have changed during each burn-in test from the initial value by more than the specified amount as follows:

ΔI_{CEO} = ± 100% or 10 nA, whichever is greater
Δh_{FE} = ± 20%

All transistors that exceed the delta (Δ) limits or the limits of Table 1A after each burn-in test shall be removed from the lot and the quantity removed shall be recorded in the lot history.

Table II. Group A Electrical Sampling Inspection

EXAMINATION OR TEST	MIL-STD-750		LTPD	SYMBOL	LIMITS		UNITS
	METHOD	CONDITIONS			MIN.	MAX.	
Subgroup 1			10				
Visual and Mechanical Examination	2071	–	–	–	–	–	–
Subgroup 2			5				
Collector-Cutoff Current	3041D	V_{CE} = 30 V, I_B = 0	–	I_{CEO}	–	100	nA
Collector-to-Base Breakdown Voltage	3001D	I_C = 0.3 mA	–	$V_{(BR)CBO}$	65	–	V
Emitter-to-Base Breakdown Voltage	3026D	I_E = 0.1 mA	–	$V_{(BR)EBO}$	4	–	V
Collector-to-Emitter Breakdown Voltage	3011D See Fig. 2.	I_C = 200 mA[a]	–	$V_{(BR)CEO}$	40[b]	–	V
Collector-to-Emitter Breakdown Voltage	3011B See Fig. 2.	I_C = 200 mA[a], V_{BE} = -1.5 V, R_{BE} = 33 Ω	–	$V_{(BR)CEX}$	65[b]	–	V
Collector-to-Emitter Saturation Voltage	3071	I_C = 250 mA, I_B = 50 mA	–	V_{CE} (sat)	–	1	V
DC Forward-Current Transfer Ratio	3076	I_C = 150 mA, V_{CE} = 5 V	–	h_{FE}	15	150	–
Subgroup 3			5				
Output Capacitance	3236	V_{CB} = 30 V, I_C = 0	–	C_{obo}	–	10	pF
Extrapolated Unity Gain Frequency	3261	I_C = 125 mA, V_{CE} = 28 V, f = 100 MHz	–	f_T	350	–	MHz
RF Power Output (Min. Eff. = 50%)	See Fig. 3.	V_{CE} = 28 V, P_{IE} = 0.25 W, f = 175 MHz	–	P_{OE}	2.5	–	W
Subgroup 4			15				
Collector-Cutoff Current	3036D	T_A = 150° C ± 3° C, V_{CB} = 30 V	–	I_{CBO}	–	100	μA
DC Forward-Current Transfer Ratio	3076	T_A = -55° C ± 3° C, I_C = 150 mA, V_{CE} = 5 V	–	h_{FE}	10	–	–

[a] Pulsed through a 25 mH inductor; duty factor = 50%

[b] Measured at a current where the breakdown voltage is a minimum

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Table III. Group B Environmental Sampling Inspection

EXAMINATION OR TEST	MIL-STD-750 METHOD	MIL-STD-750 CONDITIONS	LTPD	SYMBOL	LIMITS MIN.	LIMITS MAX.	UNITS
Subgroup 1			20				
Physical Dimensions	2066	–		–	–	–	–
Subgroup 2			15				
Solderability	2026	–		–	–	–	–
Thermal Shock (Temp. Cycling)	1051	Test Condition C		–	–	–	–
Thermal Shock (Glass Strain)	1056	Test Condition B		–	–	–	–
Seal (Leak Rate)	–	Method 112 of MIL-STD-202 Test Cond. C, procedure III a		–	–	1×10^{-7}	atm cc/s
		For Gross Leaks, Refer to Note 1 in Lot Screening sequence		–	–	–	–
Moisture Resistance	1021	–		–	–	–	–
End Points:							
Collector-Cutoff Current	3041D	V_{CE} = 30 V, I_B = 0		I_{CEO}	–	100	nA
Collector-to-Emitter Breakdown Voltage	3011D See Fig. 2.	I_C = 200 mA[a]		$V_{(BR)CEO}$	40	–	V
DC Forward-Current Transfer Ratio	3076	I_C = 150 mA, V_{CE} = 5 V		h_{FE}	12	–	–
RF Power Output (Min. Eff = 50%)	See Fig. 3	V_{CE} = 28 V, P_{IE} = 0.25 W, f = 175 MHz		P_{OE}	2.5	–	W
Subgroup 3			15				
Shock	2016	1,500 g, 0.5 ms, 5 blows each orientation: X_1, Y_1, Z_1, Y_2,(15 blows total)		–	–	–	–
Vibration Fatigue	2046	Nonoperating		–	–	–	–
Vibration, Variable Frequency	2056	–		–	–	–	–
Constant Acceleration	2006	20,000 g Y_1, Y_2		–	–	–	–
End Points: (Same as Subgroup 2)							
Subgroup 4			15				
Terminal Strength (Lead Fatigue)	2036E	–		–	–	–	–
Subgroup 5			15				
Salt Atmosphere	1041	–		–	–	–	–
Subgroup 6							
High Temperature Life (Nonoperating)		T_{stg} = +200° C, t = 1000 hrs.	–	–	–	–	–
End Points:							
Collector-Cutoff Current	3041D	V_{CE} = 30 V, I_B = 0	–	I_{CEO}	–	1	μA
Collector-to-Emitter Breakdown Voltage	3011D See Fig. 2.	I_C = 200 mA[a]	–	$V_{(BR)CEO}$	40	–	V
DC Forward-Current Transfer Ratio	3076	I_C = 150 mA, V_{CE} = 5 V	–	h_{FE}	12	–	–
RF Power Output (Min. Eff. = 50%)	See Fig. 3	V_{CE} = 28 V, P_{IE} = 0.25 W, f = 175 MHz	–	P_{OE}	2.3	–	W

[a] Pulsed through a 25 μH inductor; duty factor = 50%

40606

High-Reliability Silicon N-P-N Overlay Transistor

For Large-Signal, High-Power VHF/UHF Applications in Military and Industrial Communications Equipment

Features:

- **High power output, unneutralized class C amplifier**
- **High voltage ratings**
- **100 per cent tested to assure freedom from second breakdown for operation in class A applications**
- **All three electrodes electrically isolated from case for design flexibility**

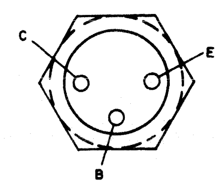
RCA-40606 is an epitaxial silicon n-p-n planar transistor. This device is intended for class A, B, C amplifier, frequency multiplier, or oscillator operation. The device was developed for vhf/uhf applications.

The transistor employs the overlay concept in emitter-electrode design — an emitter electrode consisting of many microscopic areas connected together through the use of a diffused-grid structure and an overlay of metal which is applied on the silicon wafer by means of a photo-etching technique. This arrangement provides the very high emitter periphery-to-emitter area ratio required for high efficiency at high frequencies.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base-emitter junction reverse-biased (V_{BE} = -1.5 V)	V_{CEV}	65	V
With base open	V_{CEO}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT	I_C	3	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25°C		23	W
At case temperatures above 25°C		Derate linearly to 0 watts at 200°C	
TEMPERATURE RANGE:			
Storage and operating (junction)		-65 to 200	°C
TEMPERATURE (During soldering):			
At distances ⩾ 1/32 in. (0.8 mm) from insulating wafer for 10 s max.		230	°C

TERMINAL CONNECTIONS



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JEDEC TO-60

RELIABILITY SPECIFICATIONS:

Lot Acceptance Data

Conditioning Screens (100% Testing, see Table I) (a) Attributes Data on Burn-In	(b) Attributes Data on Radiographic Inspection	(c) Variables Data on Burn-In
Group A (Lot Sampling, see Table II) (a) Variables Data	**Group B** (Lot Sampling, see Table III) (a) Attributes Data (From a member of the family)	

Table 1. Description of Total Lot Screening — 100% Testing

TEST	CONDITIONS	MIL-STD-750		LIMITS		UNITS
		METHOD	CONDITIONS	MIN.	MAX.	
1. Read: Collector-to-Emitter Current	V_{CE} = 30 V, I_B = 0	–	–	–	250	nA
DC Forward-Current Transfer Ratio	I_C = 300 mA, V_{CE} = 5 V	–	–	10	–	
2. Temp. Cycling	5 cycles, –65°C to +200°C	1051C	–	–	–	
3. High-Temp. Storage	T_A = 200°C, t = 72 hrs.	–	–	–	–	
4. Acceleration	20,000 g; Y_1, Y_2	2006	–	–	–	
5. Helium Leak		–	–	–	–	
6. Gross Leak	Ethylene Glycol, Temp. = 150°C, t = 15 s min.	–	–	–	–	
7. Serialization		–	–	–	–	
8. Radiographic Inspection		–	–	–	–	
9. Read and Record: Collector-to-Emitter Current	V_{CE} = 30 V, I_B = 0	–	–	–	250	nA
DC Forward-Current Transfer Ratio	I_C = 300 mA, V_{CE} = 5 V	–	–	10	–	
10. Reverse-Bias Age	T_A = 150°C, V_{CB} = 50 V, t = 96 hrs.	–	–	–	–	
11. Read and Record Reverse-Bias End Points	See Table 1A.	–	–	–	–	
12. Power Age	T_A = 25°C, V_{CB} = 30 V, t = 340 hrs. P_D = 2.6 W free air Interim down period = 168 hrs.	–	–	–	–	
13. Read and Record Power-Age End Points	See Table 1A.	–	–	–	–	
14. Read and Record Subgroups 2, 3 of Group A; Sample Subgroup 4 of Group A		–	–	–	–	

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Table 1A. Power Age and Reverse-Bias Age

TEST	SYMBOL	MIL-STD-750		LIMITS		UNITS
		METHOD	CONDITIONS	MIN.	MAX.	
Collector-Cutoff Current	I_{CEO}	3041	V_{CE} = 30 V, I_B = 0	–	250	nA
DC Forward-Current Transfer Ratio	h_{FE}	3076	V_{CE} = 5 V, I_C = 300 mA pulsed	10	–	–

Delta (Δ) Limits:

I_{CEO} and h_{FE} of Table 1A shall be retested after each burn-in test and the data recorded for all devices in the lot. The tests measured shall not have changed during each burn-in test from the initial value by more than the specified amount as follows:

ΔI_{CEO} = ± 100% or 25 nA, whichever is greater

Δh_{FE} = ± 20%

All transistors that exceed the delta (Δ) limits or the limits of Table 1A after each burn-in test shall be removed from the lot and the quantity removed shall be recorded in the lot history.

Table II. Group A Electrical Sampling Inspection

EXAMINATION OR TEST	MIL-STD-750		LTPD	SYMBOL	LIMITS		UNITS
	METHOD	CONDITIONS			MIN.	MAX.	
Subgroup 1			10				
Visual and Mechanical Examination	2071	–	–	–	–	–	–
Subgroup 2			5				
Collector-Cutoff Current	3041D	V_{CE} = 30 V, I_B = 0	–	I_{CEO}	–	250	nA
Collector-to-Base Breakdown Voltage	3001D	I_C = 0.5 mA, I_E = 0	–	$V_{(BR)CBO}$	65	–	V
Emitter-to-Base Breakdown Voltage	3026D	I_E = 0.25 mA, I_C = 0	–	$V_{(BR)EBO}$	4	–	V
Collector-to-Emitter Breakdown Voltage	3011D	I_C = 200 mA[a], I_B = 0	–	$V_{(BR)CEO}$	40[b]	–	V
Collector-to-Emitter Breakdown Voltage	3011A	I_C = 200 mA[a], V_{BE} = -1.5 V, R_{BE} = 33 Ω	–	$V_{(BR)CEV}$	65[b]	–	V
Collector-to-Emitter Saturation Voltage	3071	I_C = 500 mA, I_B = 100 mA	–	V_{CE} (sat)	–	1	V
DC Forward-Current Transfer Ratio	3076	I_C = 300 mA, V_{CE} = 5 V	–	h_{FE}	10	–	–
Second Breakdown Collector Current	–	V_{CE} = 28 V, t = 1 s pulse	–	$I_{S/b}$	0.33	–	A
Subgroup 3			5				
Output Capacitance	3236	V_{CB} = 30 V, I_B = 0	–	C_{obo}	–	20	pF
Common-Emitter, Small-Signal Short Circuit Forward Current Transfer Ratio	–	I_C = 250 mA, V_{CE} = 28 V, f = 100 MHz	–	h_{fe}	2.4	–	–
RF Power Output (Min. Eff. = 45%)	See Fig. 3.	V_{CE} = 28 V, P_{IE} = 4 W, f = 400 MHz	–	P_{OE}	10	–	W
Subgroup 4			15				
Collector-Cutoff Current	3036D	T_A = 150° C ± 3° C, V_{CE} = 30 V	–	I_{CBO}	–	250	μA
DC Forward-Current Transfer Ratio	3076	T_A = -55° C ± 3° C, I_C = 300 mA, V_{CE} = 5 V	–	h_{FE}	10	–	–

[a] Pulsed through a 25 mH inductor; duty factor = 50%

[b] Measured at a current where the breakdown voltage is a minimum

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Table III. Group B Environmental Sampling Inspection

EXAMINATION OR TEST	MIL-STD-750 METHOD	MIL-STD-750 CONDITIONS	LTPD	SYMBOL	LIMITS MIN.	LIMITS MAX.	UNITS
Subgroup 1			20				
Physical Dimensions	2066	–		–	–	–	–
Subgroup 2			15				
Solderability	2026	–		–	–	–	–
Thermal Shock (Temp. Cycling)	1051	5 cycles −65°C to +200°C		–	–	–	–
Seal (Leak Rate)	1071			–	–	1×10^{-7}	atm cc/s
Terminal Strength	2036			–	–	–	–
Moisture Resistance	1021	–		–	–	–	–
End Points:							
Collector-Cutoff Current	3041D	V_{CE} = 30 V, I_B = 0		I_{CEO}	–	250	nA
Collector-to-Emitter Breakdown Voltage	3011D	I_C = 200 mA[a], I_B = 0		$V_{(BR)CEO}$	40	–	V
DC Forward-Current Transfer Ratio	3076	I_C = 300 mA, V_{CE} = 5 V		h_{FE}	10	–	–
RF Power Output (Min. Eff = 45%)	See Fig. 3	V_{CE} = 28 V, P_{IE} = 4 W, f = 400 MHz		P_{OE}	10	–	W
Subgroup 3			15				
Shock	2016	500 g, 1.0 ms, 5 blows each orientation: X_1, Y_1, Z_1, Y_2, (20 blows total)		–	–	–	–
Vibration Fatigue	2046	Nonoperating		–	–	–	–
Vibration, Variable Frequency	2056	–		–	–	–	–
Constant Acceleration	2006	20,000 g Y_1, Y_2		–	–	–	–
End Points: (Same as Subgroup 2)							
Subgroup 6							
High Temperature Life (Nonoperating)	1031	T_{stg} = +200° C, t = 1000 hrs.	–	–	–	–	–
End Points:							
Collector-Cutoff Current	3041D	V_{CE} = 30 V, I_B = 0	–	I_{CEO}	–	2.5	μA
Collector-to-Emitter Breakdown Voltage	3011D	I_C = 200 mA[a], I_B = 0	–	$V_{(BR)CEO}$	40	–	V
DC Forward-Current Transfer Ratio	3076	I_C = 300 mA, V_{CE} = 5 V	–	h_{FE}	9	–	–
RF Power Output (Min. Eff. = 45%)		V_{CE} = 28 V, P_{IE} = 4 W, f = 400 MHz	–	P_{OE}	10	–	W
Subgroup 7							
Operating Life							
Steady-State DC	1026	V_{CB} = 28 V, P_D = 4 W, T_A = 170°C	–	–	–	–	
End Points: (Same as Subgroup 6)							

[a] Pulsed through a 25 μH inductor; duty factor = 50%

HC2000H/... Series

High-Reliability Multi-Purpose 7-Ampere Operational Amplifier

For Aerospace, Military, and Critical Industrial Applications

The RCA-HC2000H "Slash" (/) Series types are complete solid-state hybrid operational amplifiers in metal hermetic packages, especially designed for critical applications in aerospace, military, and industrial equipment. These types are electrically and mechanically interchangeable with the RCA-HC2000H, but are specially processed and tested to meet the aerospace and military electrical, environmental, and physical test methods and procedures established for microelectronic devices in MIL-STD-883.

These units can be supplied to four screening levels; the number following the slash (/) mark in the type designation, e.g. HC2000H/1, indicates the screening level employed by RCA to achieve the quality and reliability commensurate with the intended application. A description of these levels (/1, /2, /3, and /4) is given in Table 1.

Types HC2000H/. . . employ a quasi-complementary-symmetry class B output circuit with built-in load-fault protection and hometaxial output transistors. They can be operated from single or split power supplies.

These amplifiers are recommended for the following applications: servo amplifiers (ac, dc, PWM); deflection amplifiers; power operational amplifiers; audio amplifiers; voltage regulators; and driven inverters.

Features:

- **30-kHz bandwidth at 60 W**
- **High output power: up to 100 W (rms)**
- **High output current: 7 A (peak)**
- **Built-in load-line limiting to protect amplifier from short-circuit at output terminals**
- **Stability with resistive or reactive loads**
- **Reactive-load fault protection**
- **Single or split power supply (30 to 75 V, total)**
- **Provision for feedback control**
- **Direct coupling to load**
- **Class B output stage**
- **Rugged package with heavy leads**
- **Light weight: 100 grams**
- **Low crossover distortion**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

SUPPLY VOLTAGE:
Between leads 1 & 10 .... 75 V
OUTPUT CURRENT (PEAK) .... 7 A
TOTAL DISSIPATION:
Per Output Device .... See Fig. 2 & 3
TEMPERATURE RANGE:
Storage .... −55 to +125°C
Output-Transistor Junction .... −55 to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance ⩾ 1/8 in. (3.17 mm) from case for 10 s max. .... 235°C

LEAD-BENDING RADIUS (MIN.)
At distance ⩾ 0.075 (1.91 mm) from case .... 0.04 in. (1.02 mm)

TOTAL POWER DISSIPATION
(per each output device):

AVERAGE POWER DISSIPATION IN EACH OUTPUT TRANSISTOR CAN BE CALCULATED FROM $P_{T(AV)} = P_O \frac{1-\eta}{2\eta}$ **AND EFFICIENCY FROM** $\eta = \frac{\pi}{4} \frac{V_{OM}}{V_S}$**, WHERE** P_O **IS THE OUTPUT POWER AND** V_{OM} **IS THE PEAK VALUE OF THE OUTPUT VOLTAGE.**

FOR EFFICIENCY DERATING AT HIGH FREQUENCIES, SEE FIG. 10

Table 1 — Descriptions of RCA Screening Levels

RCA Level	Approximates MIL-STD-883	Application	Description
/1	Class A with Condition B Precap Visual Inspection	Aerospace and Missiles	For devices intended for use where maintenance and replacement are impossible and reliability is imperative
/2	Class A with Condition B Precap Visual Inspection. Centrifuge and Radiographic Inspection Omitted	Aerospace and Missiles	For devices intended for use where maintenance and replacement are extremely difficult or impossible and reliability is imperative
/3	Class B	Military and Industrial; For example, in Airborne Electronics	For devices intended for use where maintenance and replacement can be performed but are difficult and expensive
/4	Class C	Military and Industrial; For example, in Ground-Based Electronics	For devices intended for use where replacement can readily be accomplished

Reliability Testing

- **Examinations and tests performed in accordance with MIL-STD-883, "Test Methods and Procedures for Microelectronics"**
- **Total Lot Screening (100% testing) "Group A" (electrical) and "Group B" (environmental) sampling test program**
- **Choice of 4 distinct screening levels**
- **Internal visual (precap) inspection performed on all 4 screening levels in accordance with Method 2017 of MIL-STD-883**

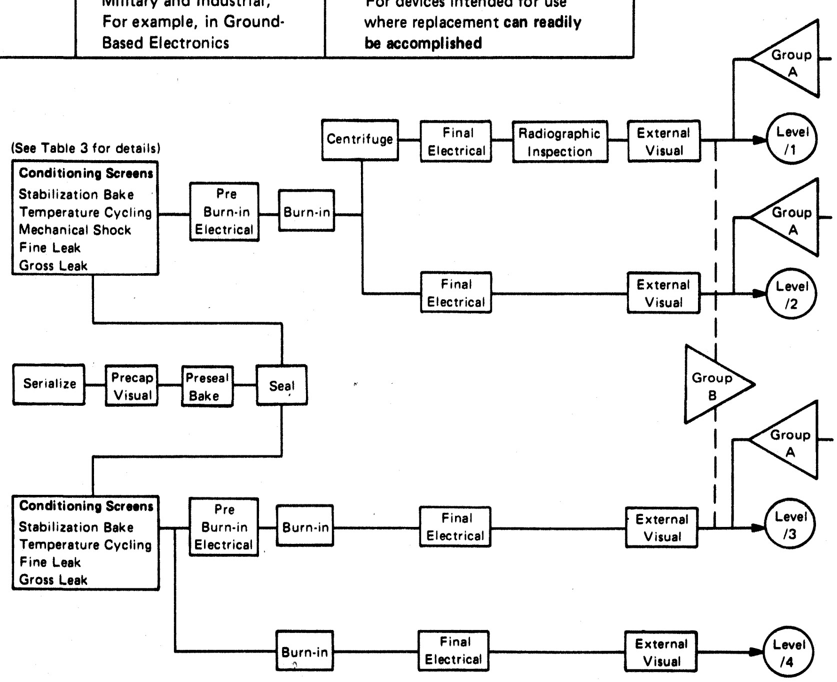

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Fig. 1 — Total lot screening.

HC2000H/... Series

Table 2 – Lot Acceptance Data

	Levels	Included With Order	On Request
Conditioning Screens (100% Testing; see Table 3)			
a) Final electrical test data	/1, /2, /3, /4	√	–
b) Radiographic inspection	/1	√	–
c) Pre-burn-in electrical test data	/1, /2	–	√
d) Precap visual by customer's inspector	/1, /2	–	√
Group A (Lot Sampling; see Table 7)	/1, /2, /3	–	√
Group B (Lot Sampling; see Table 8)	/1, /2, /3	–	√

Note: If several shipments are made from a specific production lot, Group A and B data will be supplied for only the first shipment.

Table 3 – Description of Total Lot Screening (X indicates 100-per-cent testing)

Test	Conditions	MIL-STD-883		Screening Levels			
		Method	Conditions	/1	/2	/3	/4
1. Serialize	–	–	–	X	X	X	X
2. Precap Visual	–	2017	–	X	X	X	X
	Semiconductor Die	2010	–	X	X	X	X
3. Preseal Bake	2 hrs. min. at 150°C min.			X	X	X	X
4. Seal	–	–	–	X	X	X	X
5. Stabilization Bake	16 hrs. at 150°C min.	1008	C	X	X	X	X
6. Temperature Cycling	10 cycles	1010	C	X	X	X	X
7. Mechanical Shock	5 pulses, Y1 direction	2002	B	X	X		
8. Centrifuge	Y1 direction only	2001	1500 g	X			
9. Fine Leak	–	1014	A	X	X	X	X
10. Gross Leak	–	1014	C	X	X	X	X
11. Pre-Burn-In Electrical	See Table 4	–	–	X	X	X	
12. Burn-In (Accelerated thermal fatigue)	4 hrs. See Fig. 17	–	–	X	X	X	X
13. Final Electrical							
25°C	See Table 6	–	–	X	X	X	X
–55 and +125°C	See Table 6	–	–	X	X		
14. Radiographic Inspection	X2, Y2, Z1	2012	–	X			
15. External Visual	–	2009	–	X	X	X	X

Table 4 – Pre-Burn-In Electrical Tests at case temperature (T_C) = 25°C

Characteristic	Symbol	Test Conditions					Limits		Units
		Supply Voltage (V_S)-V	Freq. (f)-kHz	Output Power (P_O)-W	Load Resist. (R_L)-Ω	Test Circuit (Fig.)	Min.	Max.	
Open-Loop Voltage Gain	$\frac{V_{OUT}}{V_{IN}}$	±37.5	1	25	4	16	2400	–	V/V
Bandwidth	f_H	±37.5	–	1	4	19	43	–	kHz
Quiescent Current	I_Q	±37.5	–	–	–	18	–	±30	mA
Offset Voltage	V_{offset}	±37.5	–	–	4	18	–	±250	mV
Maximum Voltage Swing	V_{OUT}	±26	1	100	4	19	±28	–	V
Short-Circuit Current	I_S	±37.5	1	–	0.5	19	–	±3.5	A

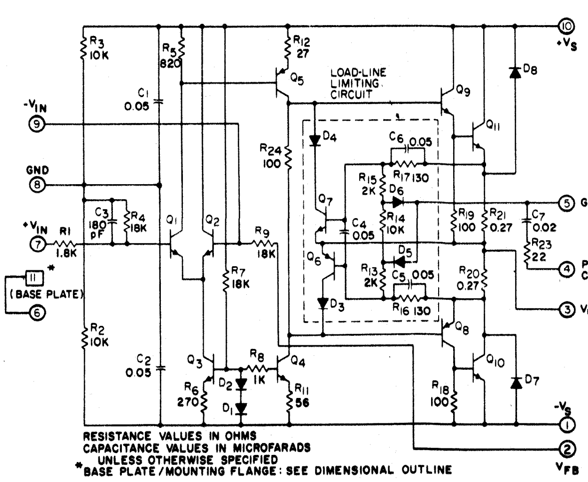
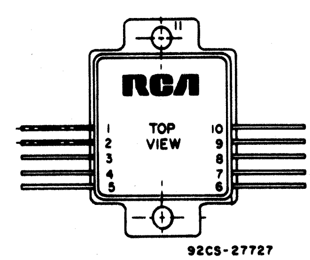


Fig. 2 – Schematic diagram of type HC2000H/. . . power hybrid circuit operational amplifier.

TERMINAL CONNECTIONS



Pin No.		Connection
1	$-V_S$	Negative supply voltage
2	V_{FB}	Feedback voltage
3	V_{OUT}	Output voltage
4	PC	Phase compensation
5	GND	Ground
6	BP	Base plate (internal connection)
7	$+V_{IN}$	Non-inverting input
8	GND	Ground
9	$-V_{IN}$	Inverting input
10	$+V_S$	Positive supply voltage

HC2000H/... Series

Table 5 – Characteristics not Measured in Screening Procedures

Characteristic	Symbol	Test Condition: Supply Voltage (V_S) - V	Limits: Max.	Limits: Typical	Units
Signal-to-Noise Ratio (Source impedance 600 Ω)	S/N	±37.5	–	+78	dB
Thermal Resistance per output device (junction-to-case)	$R_{\theta JC}$	–	2	–	°C/W
Common-Mode Input Voltage Range		–	–	$+V_S - 5$ V $-V_S + 5$ V	V

Table 6 – Final Electrical Tests (Post-Burn-in)

Characteristic	Symbol	Supply Voltage (V_S)-V	Freq. (f)-kHz	Output Power (P_O)-W	Load Resist. (R_L)-Ω	Test Circuit (Fig.)	Minimum −55°C	Minimum +25°C	Minimum +125°C	Maximum −55°C	Maximum +25°C	Maximum +125°C	Units
Open-Loop Voltage Gain	V_{OUT}/V_{IN}	±37.5	1	25	4	16	2000	2400	2000*	–	–	–	V/V
Closed-Loop Voltage Gain	V_{OUT}/V_{IN}	±37.5	1	1	4	19	26	26	26	–	–	–	V/V
Bandwidth	f_H	±37.5	–	1	4	19	–	43	–	–	–	–	kHz
Quiescent Current	I_O	±37.5	–	–	–	18	–	–	–	–	±30	–	mA
Offset Voltage	V_{offset}	±37.5	–	–	4	18	–	–	–	±350	±250	±350	mV
Total Harmonic Distortion	THD	±37.5	1	60	4	19	–	–	–	–	0.5	–	%
Maximum Voltage Swing	V_{OUT}	±37.5	1	100	4	19	24	28	24*	–	–	–	V
Short-Circuit Current	I_S	±26	1	–	0.5	19	–	–	–	–	3.5	–	A
Input Impedance	Z_{IN}	±37.5	–	–	–	15	–	16	–	–	–	–	kΩ
Slew Rate	SR	±37.5	1	100	4	19	–	5	–	–	–	–	V/µs
Maximum Power	P_{max}	±37.5	1	100	4	19	72	100	72*	–	–	–	W

* Pulse test; duration < 500 ms.

Table 7 – Group A Electrical Sampling Inspection MIL-M-38510 A

LTPD ● (applies to all characteristics below)

Screening Level	/1, /2			/3, /4		
Temp °C	−55	+25	+125	−55	+25	+125
LTPD	7%	5%	7%	10%	5%	10%

Characteristic	Symbol	Test Circuit (Fig.)	Minimum −55°C	Minimum +25°C	Minimum +125°C	Maximum −55°C	Maximum +25°C	Maximum +125°C	Units
Open-Loop Voltage Gain	V_{OUT}/V_{IN}	16	2000	2400	2000*	–	–	–	V/V
Closed-Loop Voltage Gain	V_{OUT}/V_{IN}	19	26	26	26	–	–	–	V/V
Bandwidth	f_H	19	–	43	–	–	–	–	kHz
Quiescent Current	I_O	18	–	–	–	–	±30	–	mA
Offset Voltage	V_{offset}	18	–	–	–	±350	±250	±350	mV
Total Harmonic Distortion	THD	19	–	–	–	–	0.5	–	%
Maximum Voltage Swing	V_{OUT}	19	24	28	24*	–	–	–	V
Short-Circuit Current	I_S	19	–	–	–	–	3.5	–	A
Input Impedance	Z_{IN}	15	–	16	–	–	–	–	kΩ
Slew Rate	SR	19	–	5	–	–	–	–	V/µs
Maximum Power	P_{max}	19	72	100	72*	–	–	–	W

● Lot Tolerance Percent Defectives

* Pulse test; duration < 500 ms

HC2000H/... Series

Table 8 – Group B Environmental Sampling Inspection

Subgroup	Test	MIL-STD-883		Lot Tolerance % Defectives	
		Reference	Conditions	Levels /1, /2	Levels /3, /4
1	Visual and Mechanical and Marking Permanency	2008	Test Cond. B 10X mag.	10	15
	Physical Dimensions	2008	Test Cond. A per Dimen. Outline		
2	Solderability	2003	Temperature 230 ± 5°C	10	15
3	Temperature Cycling	1010	Test Cond. C, 25 cycles		
4	Mechanical Shock	2002	Test Cond. B,0.5 ms,5 blows Y1 direction only	10	15
	Constant Acceleration	2001	Test Level 1500 g Y1 direction only		
5	Lead Fatigue	2004	Test Cond. B, per Fig. 20	10	15
	Fine Leak	1014	Test Cond. A, 5 x 10^{-7} min.		
	Gross Leak	1014	Test Cond. C		
6	High Temp. Storage	1008	Test Cond. C, 1000 hrs.	7	15
7	Operating Life	1005	T_A=25°C, 1000 hrs. Test Circuit—see Fig. 17	7	10
8	Bond Strength	2011	Test Cond. D	10 devices ≤ 1% def.	10 devices ≤ 1% def.

Table 9 – Group B Electrical Test Limits

Characteristic	Symbol	Test Circuit (Fig.)	Limits		Units
			Min.	Max.	
Offset Voltage	V_{offset}	18	–275	+275	mV
Maximum Power	P_{max}	19	90	–	W
Voltage Gain (Open Loop)	$\frac{V_{out}}{V_{in}}$	16	2000	–	V/V
Total Harmonic Distortion	THD	19	–	0.6	%
Short-Circuit Current	I_S	19	±1.5	±4.0	A

Appendix

Page

General Characteristics, Test Circuits, and Waveforms

POWER TRANSISTORS

Dissipation Derating Chart

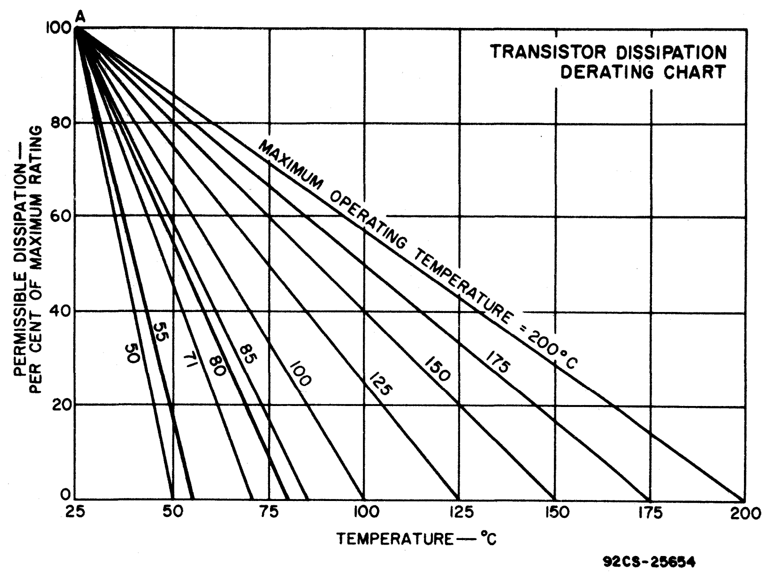


Fig.1 — Dissipation derating chart for silicon power transistors operated at temperatures above 25°C.

For many transistors, the maximum value of dissipation is specified for ambient, case, or mounting-flange temperatures up to 25°C, and must be reduced linearly for higher temperatures. For such types, the chart above can be used to determine maximum permissible dissipation values at particular temperature conditions above 25°C. (This chart cannot be assumed to apply to types other than those for which it is specified that the maximum allowable dissipation is derated linearly to zero at the maximum allowable operating temperature, T_J (max.).) The curves show the permissible percentage of the maximum dissipation ratings as a function of ambient or case temperature. Individual curves are plotted for maximum operating temperatures of 50, 55, 75, 80, 85, 100, 125, 150, 175, and 200°C. If the maximum operating temperature of a transistor is some other value, a new curve can be drawn from point A in the figure to the desired temperature value on the abscissa. To use the chart, it is necessary to know the maximum dissipation rating and the maximum operating temperature for a given transistor. The calculation involves only two steps:

1. A vertical line is drawn at the desired operating temperature value on the abscissa to intersect the curve representing the maximum operating temperature for the transistor.

2. A horizontal line drawn from this intersection point to the ordinate establishes the permissible percentage of the maximum dissipation at the given temperature.

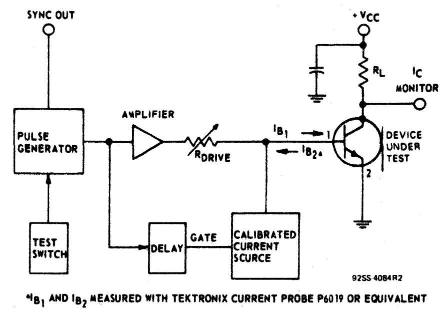
The following example illustrates the calculation of the maximum permissible dissipation for transistor type 2N1487 at a case temperature of 100°C. This type has a maximum dissipation rating of 75 watts at a case temperature of 25°C, and a maximum permissible case-temperature rating of 200°C.

1. A perpendicular line is drawn from the 100-degree point on the abscissa to the 200-degree curve.

2. Projection of this point to the ordinate shows a percentage of 57.5.

Therefore, the maximum permissible dissipation for the 2N1487 at a case temperature of 100°C is 0.575 times 75, or approximately 43 watts.

Switching-Time Measurements



* For p-n-p types, direction of currents and polarities of voltages are reversed.

Fig.2 — Circuit used to measure switching times.

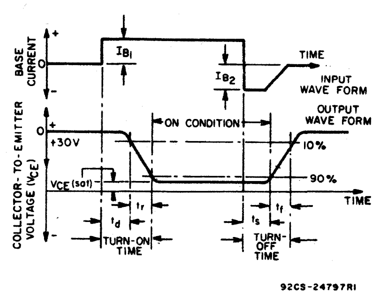


Fig.3 — Oscilloscope display for measurement of switching times.

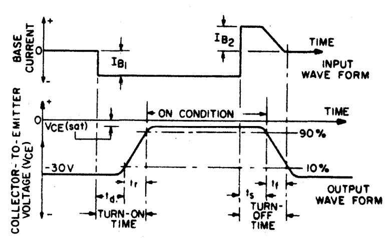
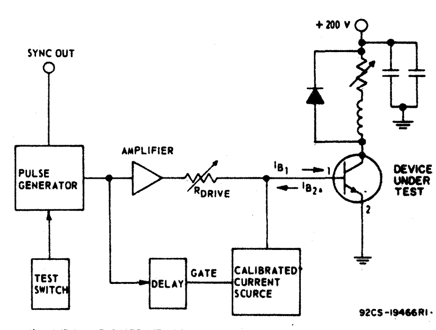


Fig.4 — Oscilloscope display for measurement of switching times for p-n-p types.



* For p-n-p types, direction of currents and polarities of voltages are reversed.

Fig.5 — Circuit used to measure inductive-load switching times.

POWER TRANSISTORS (Cont'd)

Breakdown (Sustaining) Voltage Tests

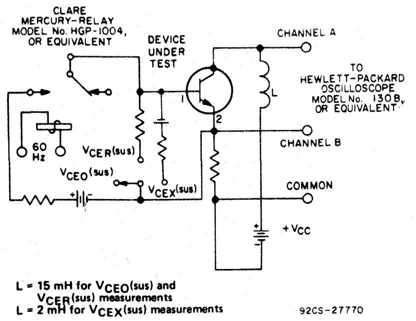


Fig.6 — Basic configuration used to measure sustaining voltage $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for n-p-n power transistors.

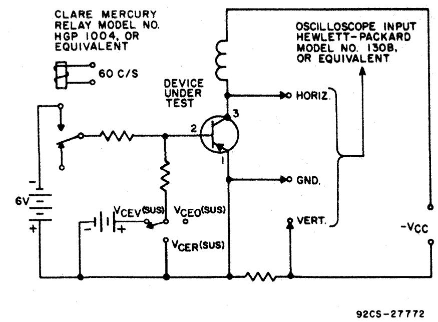


Fig.8 — Basic circuit configuration used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ for p-n-p power transistors.

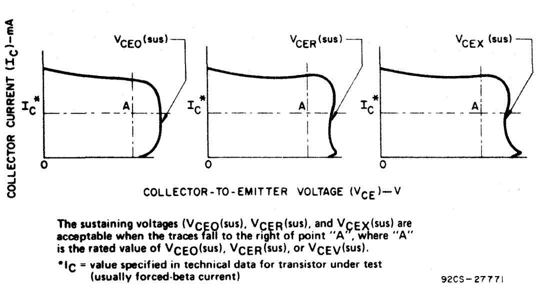


Fig.7 — Oscilloscope display for measurement of sustaining voltages of n-p-n power transistors.

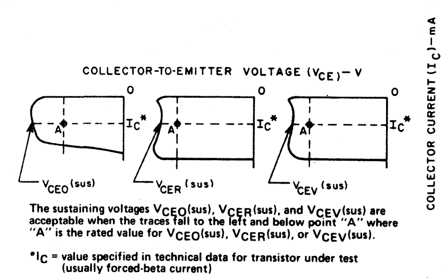


Fig.9 — Oscilloscope display for measurement of sustaining voltages of p-n-p power transistors.

Inductive Load-Switching Measurements

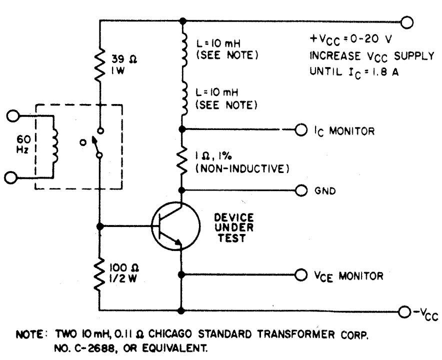


Fig.10 — Circuit for measuring inductive-load switching for all types.

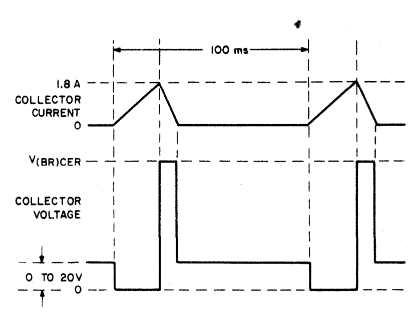


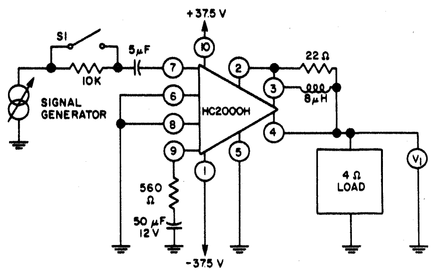
Fig.11 — Inductive-load switching voltage and current waveforms .

HC2000H POWER HYBRID OPERATIONAL AMPLIFIER TEST CIRCUITS

PROCEDURE FOR MEASUREMENT OF COMMON-MODE INPUT IMPEDANCE

a) Insert unit
b) Apply ±37.5 V
c) Close S1
d) Adjust signal generator for 1 V on voltmeter V1
e) Open S1
f) Read voltmeter V1
g) Input impedance = (10 k)x $\frac{V1}{1-V1}$

Note: Circuit under test must have a heat sink so that $T_C \approx 25°C$, unless otherwise noted.

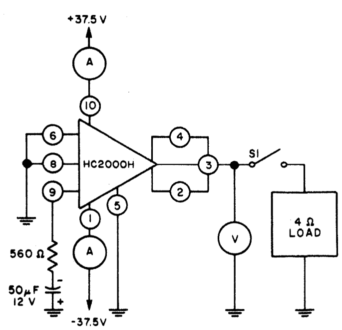


92CS-24277

Fig. 12 — Circuit for measurement of common-mode input impedance.

PROCEDURE FOR MEASUREMENT OF OFFSET VOLTAGE AND QUIESCENT CURRENT

A = DC ammeter 100 mA range
V = DC voltmeter ± 250 mV range
a) Close S1
b) Insert unit
c) Apply ± 37.5 V
d) Read offset voltage on voltmeter. Change polarity if required.
e) Open S1
f) Read positive and negative quiescent current on ammeter.



92CS-24280

Fig. 13 — Circuit for measurement of offset voltage and quiescent current.

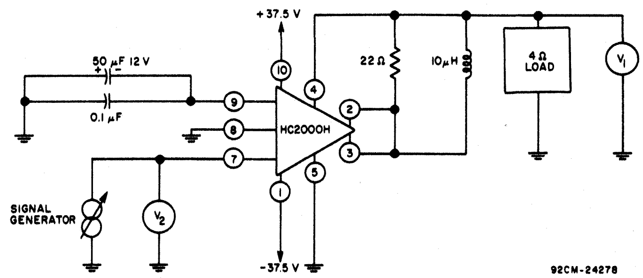
HC2000H

TERMINAL CONNECTIONS

Pin No.	Connection	
1	$-V_S$	Negative supply voltage
2	V_{FB}	Feedback voltage
3	V_{OUT}	Output voltage
4	PC	Phase compensation
5	GND	Ground
6	BP	Base plate (internal connection)
7	$+V_{IN}$	Non-inverting input
8	GND	Ground
9	$-V_{IN}$	Inverting input
10	$+V_S$	Positive supply voltage

PROCEDURE FOR MEASUREMENT OF OPEN-LOOP GAIN

a) Insert unit
b) Apply ± 37.5 V
c) Set generator at 1 kHz and adjust until V1 = 10 V rms
d) Read V2
e) Open-loop gain = V1/V2



92CM-24278

Fig. 14 — Circuit for measurement of open-loop gain.

PROCEDURE FOR MEASUREMENT OF CLOSED-LOOP VOLTAGE GAIN

a) Insert unit
b) Adjust signal generator to 1 kHz, V2 = 0
c) Apply ± 37.5 V
d) Adjust signal generator for 2 V rms on voltmeter V1
e) Read voltmeter V2
f) Voltage gain = $\frac{V1}{V2}$

PROCEDURE FOR MEASUREMENT OF TOTAL HARMONIC DISTORTION

a) Adjust signal generator for 15.5 V rms on V1
b) Adjust distortion analyzer. Record the meter reading as Total Harmonic Distortion (THD).

PROCEDURE FOR MEASUREMENT OF MAXIMUM VOLTAGE SWING AND MAXIMUM POWER

a) Adjust signal generator for maximum output on scope No. 1 with no clipping. Read peak voltage as maximum voltage swing.
b) Read V1
c) Maximum power = $\frac{V1^2}{4}$

PROCEDURE FOR MEASUREMENT OF SHORT-CIRCUIT CURRENT

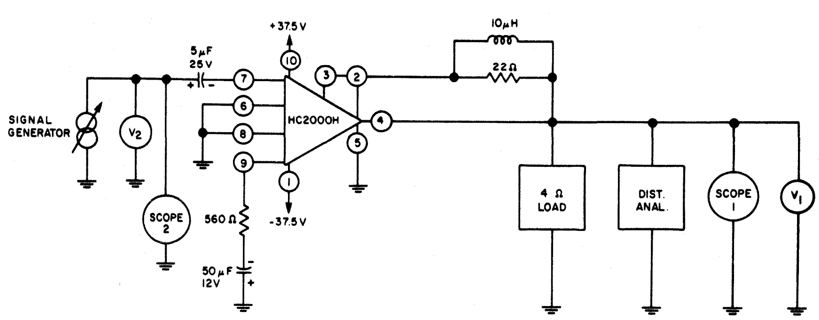
a) Lower power supply to ± 26 V
b) Momentarily replace 4-ohm load with 0.5-ohm load
c) Scope No. 1 must show symmetrical square wave of less than ± 1.75 V

PROCEDURE FOR MEASUREMENT OF BANDWIDTH

a) Raise power supply to ± 37.5 V
b) Adjust signal generator at 43 kHz to 2 V rms on V1
c) Adjust distortion analyzer and verify that THD < 0.5%

PROCEDURE FOR MEASUREMENT OF SLEW RATE

a) Replace signal generator with square-wave generator.
b) Adjust generator for 500 Hz and V1 = 40 V peak-to-peak.
c) Read time required for swing from peak to peak.
d) Slew rate = $\frac{40\ V}{\text{Measured time}}$



92CM-24281

Fig. 15 — Circuit for measurement of closed-loop voltage gain, total harmonic distortion, maximum voltage swing, maximum power, short-circuit current, bandwidth, and slew-rate.

HC2500 POWER HYBRID OPERATIONAL AMPLIFIER TEST CIRCUITS

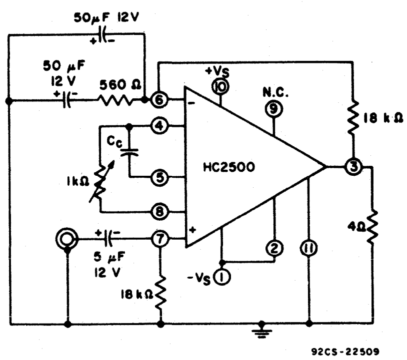
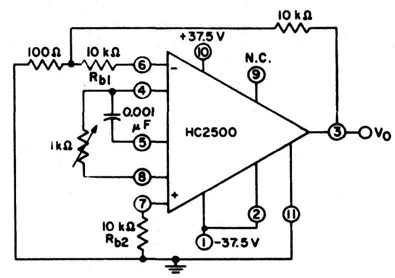


Fig. 16 — Test circuit for open-loop gain and phase response.



$V_{IO} = -\frac{V_O}{100}$ with R_{b1} and R_{b2} shorted

$I_{IO} = -\frac{V_O}{100\,R_{b2}}$

$I_{Ib} = \frac{\pm V_O}{100\,R_{b2}}$ with R_{b1} shorted

92CS-22510

Fig. 17 — Test circuit for input offset voltage and current test.

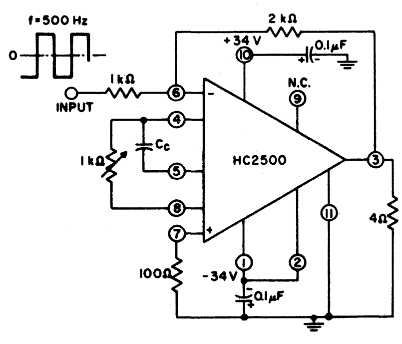
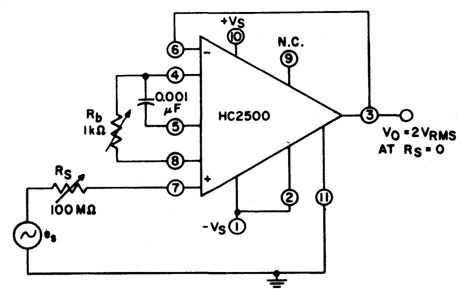


Fig. 18 — Circuit used to test slew rate.



$R_{CM} = 9\,R_S$ with series resistance (R_S) increased from zero until output voltage (V_O) is reduced by 10%.

92CS-22512

Fig. 19 — Test circuit for measuring common-mode input resistance.

HC2500
TERMINAL CONNECTIONS

Pin No.		Connection
1		Drive 2
2	$-V_S$	Negative supply voltage
3	V_{OUT}	Output Voltage
4		Bias adjust
5		Frequency compensation
6	$-V_{IN}$	Inverting input
7	$+V_{IN}$	Noninverting input
8		Bias adjust
9		Drive 1
10	$+V_S$	Positive supply voltage
11	BP	Base plate (electrically isolated from internal circuitry)

THYRISTORS
Voltage-Current Characteristics

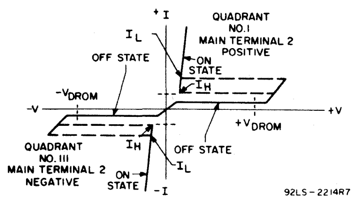


Fig.20 — Principal voltage-current characteristic for a triac.

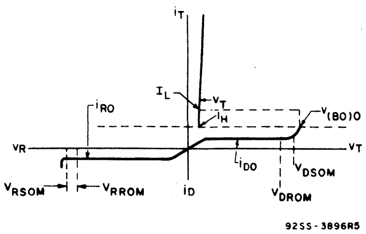


Fig.21 — Principal voltage-current characteristic for a conventional SCR.

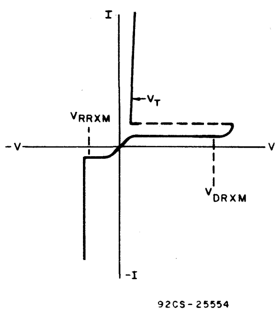


Fig.22 — Anode-cathode voltage-current characteristic for a gate-turn-off SCR (GTO).

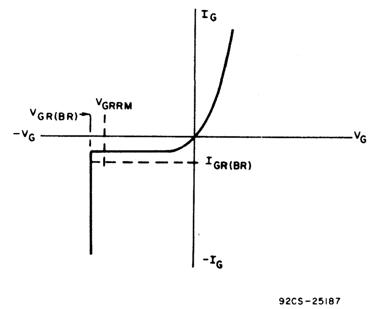


Fig. 23 - Gate-cathode voltage-current characteristic for a gate-turn-off SCR (GTO).

Critical Rate of Rise of On-State Current (di/dt)

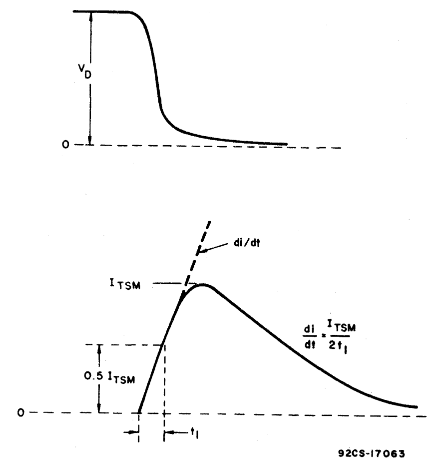


Fig.24 — Rate of change of on-state current with time (defining di/dt) for a triac.

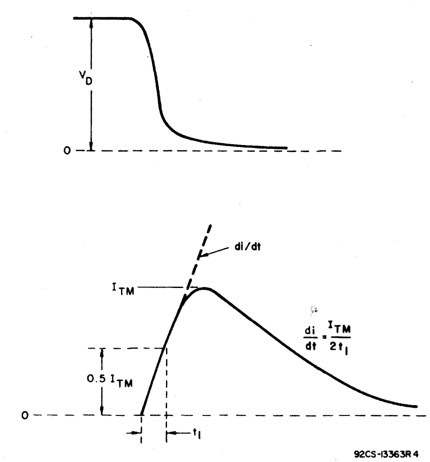


Fig.25 — Rate of change of on-state current with time (defining di/dt) for an SCR.

Critical Rate of Rise of Off-State Voltage (Static and Commutating dv/dt)

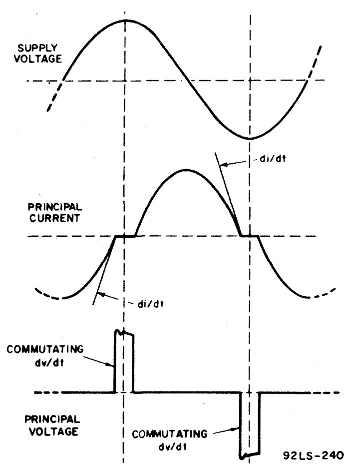


Fig.26 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt) for a triac.

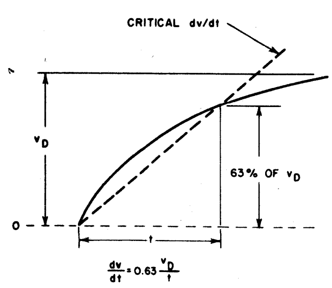


Fig.27 — Rate of rise of off-state voltage with time (defining critical dv/dt) for general-purpose SCR's, gate-turn-off SCR's, and triacs.

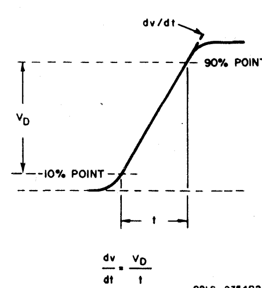


Fig.28 — Rate of rise of off-state voltage with time (defining dv/dt) for an inverter SCR.

THYRISTORS (Cont'd)

Subcycle Surge-Current Test for SCR's

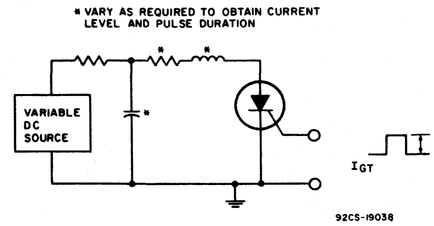


Fig.29 — Sub-cycle surge capability test circuit.

Turn-On-Time Waveforms

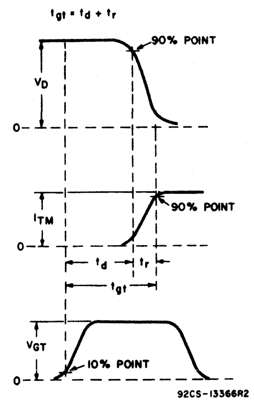


Fig.30 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}) for triacs and SCR's.

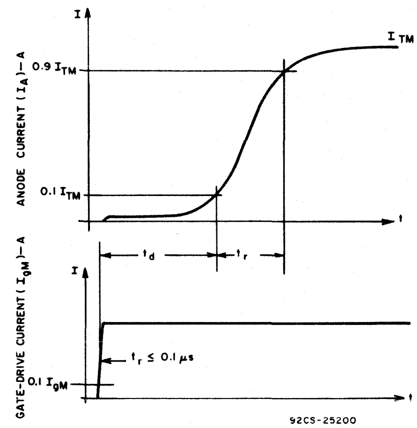


Fig.31 — Relationship between anode current (on-state), gate drive current, and time showing reference points for definition of gate controlled turn-on time (t_{gt}) for gate-turn-off SCR's.

Turn-Off-Time Test Circuits and Waveforms for SCR's

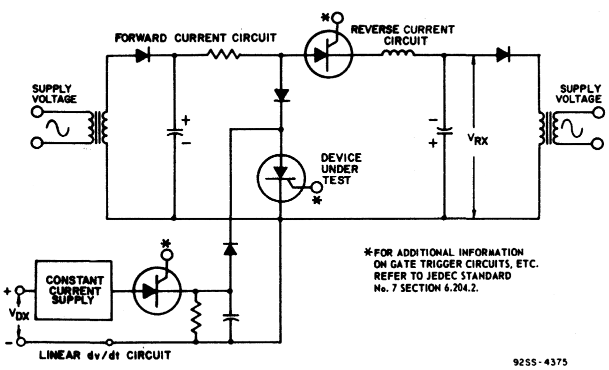


Fig. 32 - Circuit used to measure turn-off time (t_q) rectangular pulse.

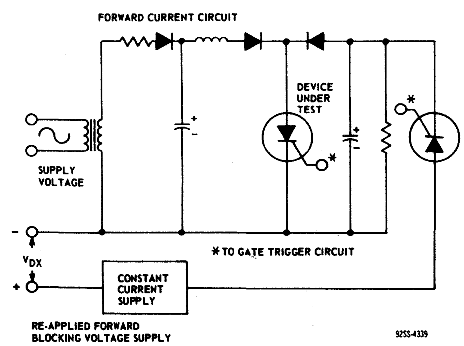


Fig.33 — Circuit used to measure turn-off time (t_q) half-sine wave pulse.

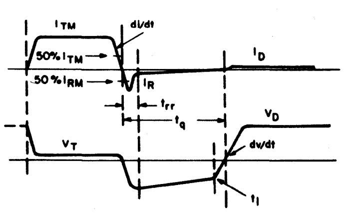


Fig.34 — Relationship between instantaneous on-state current and voltage showing reference points for definition of circuit commutated turn-off time (t_q) for general-purpose SCR's (rectangular pulse).

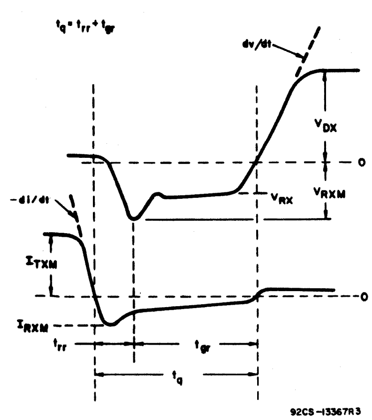


Fig.35 — Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points defining turn-off time (t_q) for inverter SCR's (rectangular pulse).

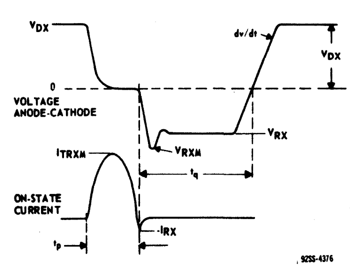


Fig.36 — Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points for specification of turn-off time (t_q) for an inverter SCR (half-sine-wave pulse).

THYRISTORS (Cont'd)

Switching-Time Waveforms for Gate-Turn-Off SCR's

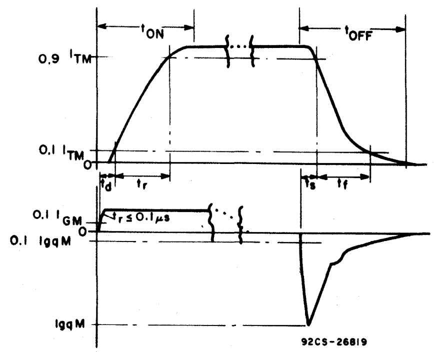


Fig.37 – Relationship between anode current (on-state), gate-drive current, and time showing reference points for definition of t_{gt} (t_{ON}) and t_{gq} (t_{OFF}).

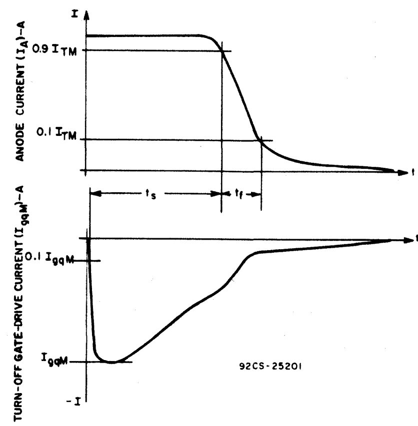
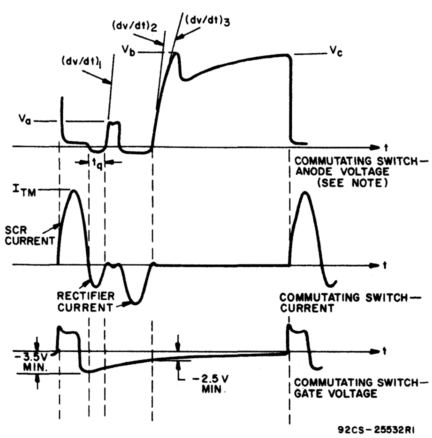


Fig.38 – Relationship between anode current (on-state), turn-off gate-drive current, and time showing reference points for definition of gate-controlled turn-off time (t_{gq}).

Switching Waveforms for Deflection-Circuit ITR's



NOTE: "Commutating Switch-Anode Voltage" oscilloscope display has been modified graphically to show the measurement points of dv/dt more effectively.

Fig.39 – Oscilloscope display of commutating switching ITR's showing circuit-commutated turn-off time (t_q).

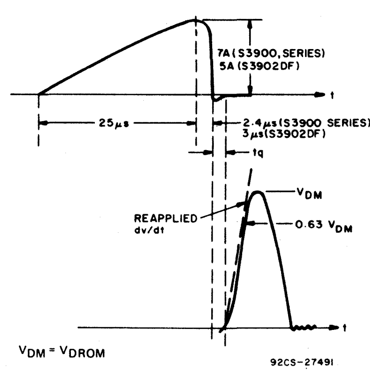


Fig.40 – Oscilloscope display of trace switching ITR's (S3900 Series, S3902DF) showing circuit-commutated turn-off time (t_q).

Notes for Figs. 39 and 40

Circuit-commutated turn-off time (t_q), the sum of reverse recovery time and gate recovery time, is measured from the zero crossing of current to the start of the reapplied voltage. Knowledge of the current, the reapplied voltage, and the case temperature is necessary when measuring t_q. In the worst conditions (high line, zero beam, off-frequency, minimum auxiliary load, etc), turn-off time must not fall below the given values. Turn-off time increases with temperature, therefore, case temperature must not exceed 75°C for all types.

THYRISTORS (Cont'd)

Reverse-Recovery-Time Measurements for Rectifier Unit of ITR

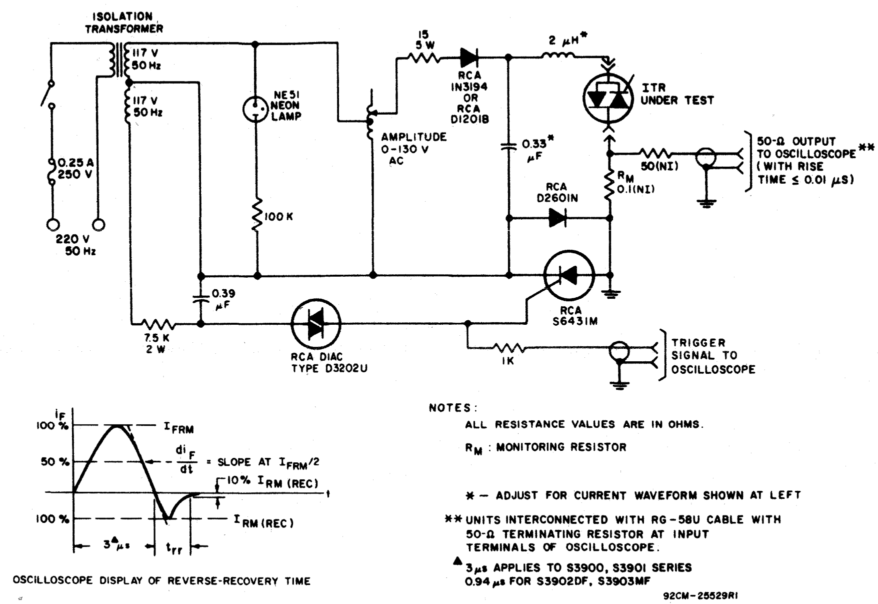


Fig.41 – Test circuit (pulsed sine wave) oscilloscope display for measurement of reverse-recovery time for rectifier unit of ITR.

Peak Forward-Voltage Measurements for Rectifier Unit of ITR

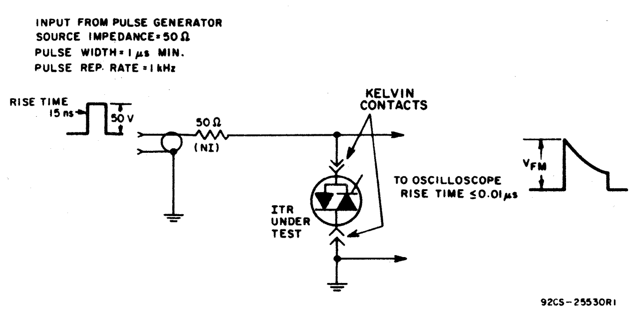


Fig.42 – Test circuit for measurement of peak forward voltage drop at turn-on for rectifier unit of ITR.

DIACS

Voltage-Current Characteristic

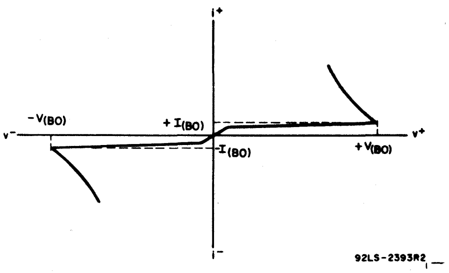


Fig.43 — Voltage-current characteristic for a diac.

Switching Measurements

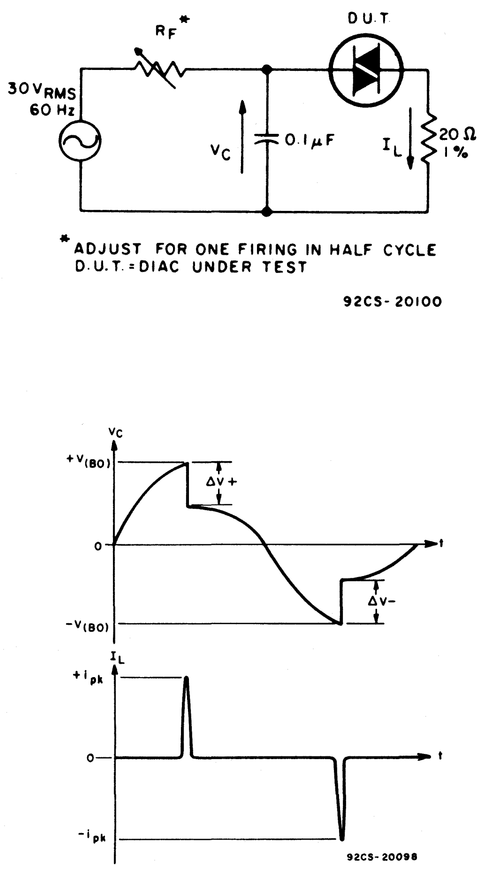


Fig.44 — Circuit and waveforms used to measure diac characteristics.

RECTIFIERS

Reverse-Recovery-Measurements

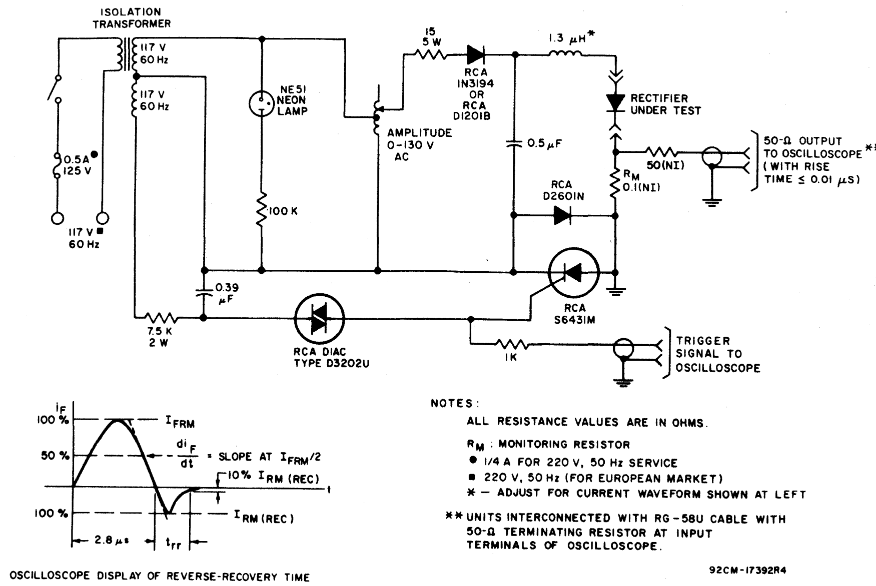


Fig.45 — Test circuit (pulsed sine wave) for measurement of reverse-recovery time.

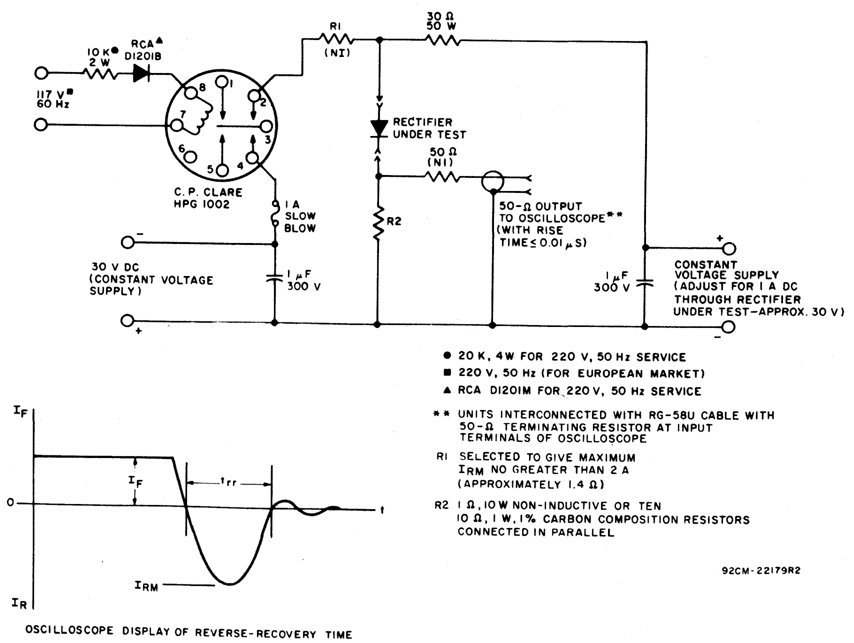
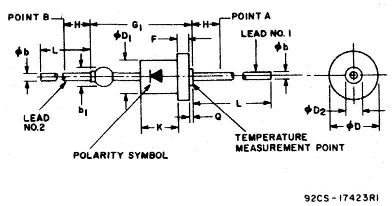


Fig.46 — Test circuit (pulsed dc) for measurement of reverse-recovery time.

Dimensional Outlines

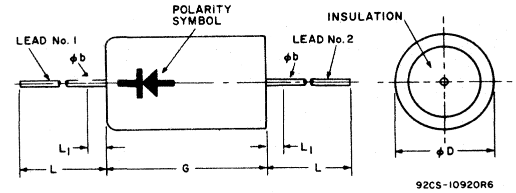
DO-1



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
φb	0.027	0.035	0.69	0.89	2
b_1	–	0.125	–	3.18	1
φD	0.360	0.400	9.14	10.16	
$φD_1$	0.245	0.280	6.22	7.11	
$φD_2$	–	0.200	–	5.08	
F	–	0.075	–	1.91	
G_1	–	0.725	–	18.42	
H	0.5	–	12.7	–	
K	0.220	0.260	5.59	6.60	
L	1.000	1.625	25.40	41.28	
Q	–	0.025	–	0.64	

NOTES:
1. Dimensions to allow for pinch or seal deformation anywhere along tubulation (optional).
2. Diameter to be controlled from free end of lead to within 0.188 inch (4.78 mm) from the point of attachment to the body. Within the 0.188 inch (4.78 mm) dimension, the diameter may vary to allow for lead finishes and irregularities.

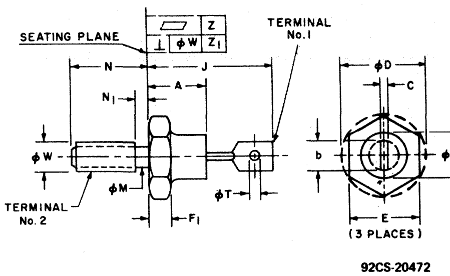
DO-26



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
φb	0.027	0.039	0.69	0.99	
φD	0.220	0.260	5.59	6.60	1
G	0.344	0.410	8.74	10.41	1
L	1.400	–	35.56	–	
L_1	–	0.080	–	2.03	2

NOTES:
1. Package contour optional within cylinder of diameter, φD, and length, G. Slugs, if any, shall be included within this cylinder but shall not be subject to the minimum limit of φD.
2. Lead diameter not controlled in this zone to allow for flash, lead-finish build up, and minor irregularities other than slugs.

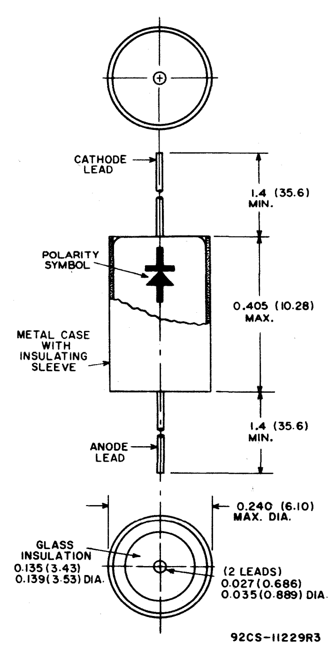
DO-4



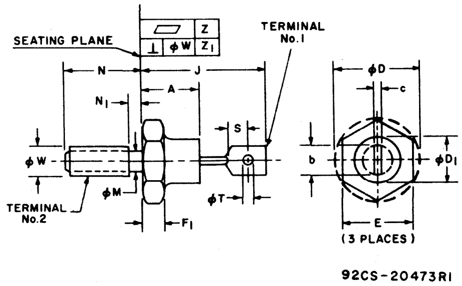
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	–	0.405	–	10.28	
b	–	0.250	–	6.35	2
c	0.020	0.065	0.51	1.65	
φD	–	0.505	–	12.82	
$φD_1$	0.265	0.424	6.74	10.76	
E	0.423	0.438	10.75	11.12	
F_1	0.075	0.175	1.91	4.44	1
J	0.600	0.800	15.24	20.32	
φM	0.163	0.189	4.15	4.80	
N	0.422	0.453	10.72	11.50	
N_1	–	0.078	–	1.98	
φT	0.060	0.095	1.53	2.41	
φW	10-32 UNF-2A		10-32 UNF-2A		3
Z	–	0.002	–	0.050	
Z_1	–	0.006	–	0.152	

NOTES:
1: Chamfer or undercut on one or both sides of hexagonal base is optional.
2: Angular orientation and contour of Terminal No. 1 is optional.
3: φW is pitch diameter of coated threads. REF: Screw Thread Standards for Federal Services, Handbook H 28 Part I. Recommended torque: 15 inch-pounds.

DO-26 With Insulating Sleeve



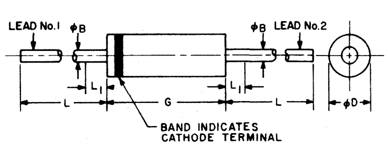
DO-5



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	–	0.450	–	11.43	
b	–	0.375	–	9.52	
c	0.030	0.080	0.77	2.03	
φD	–	0.794	–	20.16	
$φD_1$	–	0.667	–	16.94	
E	0.669	0.688	17.00	17.47	
F_1	0.115	0.200	2.93	5.08	
J	0.750	1.000	19.05	25.40	
φM	0.220	0.249	5.59	6.32	
N	0.422	0.453	10.72	11.50	
N_1	–	0.090	–	2.28	
S	0.156	–	3.97	–	
φT	0.140	0.175	3.56	4.44	
φW	1/4-28 UNF 2A		1/4-28 UNF 2A		1
Z	–	0.002	–	0.050	
Z_1	–	0.006	–	0.152	

NOTE
1: φW is pitch diameter of coated threads. REF: Screw-Thread Standards for Federal Services, Handbook H 28 Part I. Recommended torque: 30 inch-pounds.

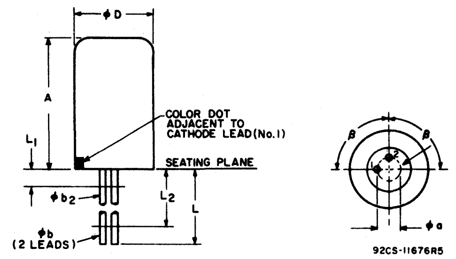
DO-15



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
φb	0.027	0.035	0.686	0.889
φD	0.104	0.140	2.64	3.56
G	0.230	0.300	5.84	7.62
L	1.000	–	25.40	–
L_1*	–	0.050	–	1.27

*Within this zone the diameter may vary to allow for lead finishes and irregularities.

Mod. TO-1 2-Lead

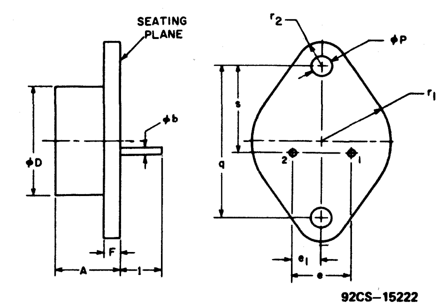


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
φa	0.061	0.081	1.55	2.06	
A	–	0.410	–	10.41	
φb	–	0.021	–	0.533	1
φb2	0.016	0.019	0.406	0.483	1
φD	–	0.240	–	6.10	
L	1.500	–	38.10	–	1
L1	–	0.05	–	1.27	
L2	0.25	–	6.35	–	1
β	90° NOMINAL				

NOTE:

1. ϕb_2 applies between L_1 and L_2. ϕb applies between L_2 and 1.5 in. (38.10 mm) from seating plane. Diameter is uncontrolled in L_1 and beyond 1.5 in. (38.10 mm) from seating plane.

TO-3

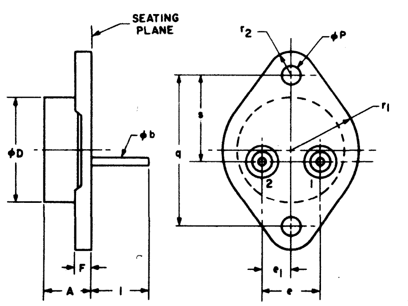


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.35	11.43	
φb	0.038	0.043	0.97	1.09	2
φD		0.875		22.23	
e	0.420	0.440	10.67	11.18	
e1	0.205	0.225	5.21	5.72	
F		0.135		3.43	
l	0.312		7.92		2
φP	0.151	0.161	3.84	4.09	
q	1.177	1.197	29.90	30.40	
r1		0.525		13.34	
r2		0.188		4.78	
s	0.655	0.675	16.64	17.15	1

NOTES:

1. These dimensions should be measured at points 0.050 in. (1.27 mm) to 0.055 in. (1.40 mm) below seating plane. When gage is not used, measurement will be made at seating plane.
2. Two pins.

MODIFIED TO-3 (2N5575, 2N5578)



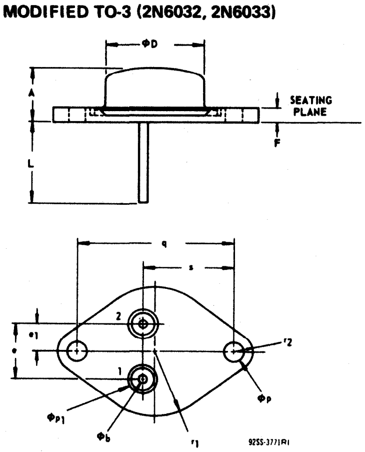
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.300	0.350	7.62	8.89	
φb	0.059	0.061	1.50	1.55	2
φD		0.800		20.32	
e	0.420	0.440	10.67	11.18	
e1	0.205	0.225	5.21	5.72	
F		0.114		2.90	
l	0.440	0.470	11.18	11.94	2
φp	0.151	0.161	3.84	4.09	
q	1.177	1.197	29.90	30.40	
r1		0.525		13.34	
r2		0.188		4.78	
s	0.655	0.675	16.64	17.15	1

NOTES:

1. THESE DIMENSIONS SHOULD BE MEASURED AT POINTS 0.050" (1.27 mm) TO 0.055" (1.40 mm) BELOW SEATING PLANE. WHEN GAGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.
2. TWO LEADS.

92CS-17432

MODIFIED TO-3 (2N6032, 2N6033)

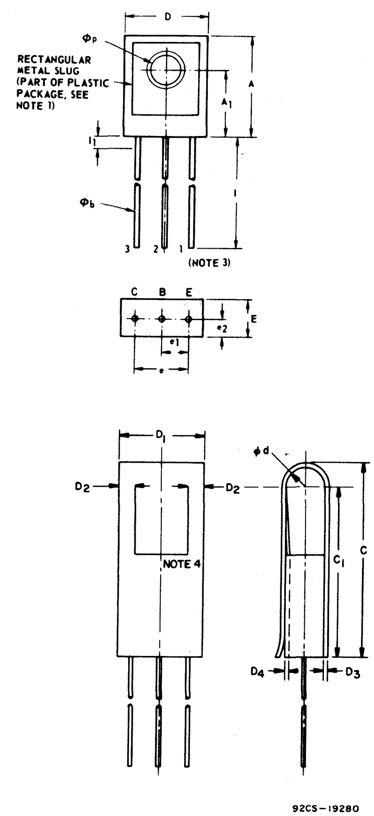


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.416	0.450	10.57	11.43	
φb	0.059	0.62	1.499	1.575	
φD	0.750	0.771	19.05	19.583	
e	0.420	0.440	10.67	11.18	
e1	0.205	0.225	5.21	5.72	
F	0.100	0.114	2.54	2.89	
L	0.595	0.625	15.12	15.87	1
φp	0.151	0.161	3.84	4.09	
φp1	0.200	0.285	5.08	7.239	2
q	1.177	1.197	29.90	30.40	
r1	–	0.525	–	13.34	
r2	–	0.188	–	4.78	
s	0.655	0.675	16.64	17.15	

NOTES:

1. Two pins.
2. Clearance holes for both pins should be 0.285 in. (7.24 mm) min. dia.

PLASTIC PACKAGES
PLASTIC TO-5 AND PLASTIC TO-5 WITH HEAT CLIP



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.385	0.395	9.78	10.03	
A1	0.251	0.261	6.37	6.63	
φb	0.016	0.019	0.41	0.48	2
C	0.858		21.79		
C1	0.750		19.05		
D	0.305	0.315	7.75	8.00	
D1	0.300		7.62		
D2	0.070		1.77		
D3	0.0329		0.813		
D4	0.021	0.041	0.533	1.04	
φd	0.073	0.077	1.85	1.95	
E	0.145	0.155	3.68	3.94	
e	0.195	0.205	4.95	5.21	
e1	0.095	0.105	2.41	2.67	
e2	0.070	0.080	1.78	2.03	
ℓ	0.725	0.745	18.41	18.91	
ℓ1	0.125	0.250	3.17	6.35	
φp	0.112	0.118	2.84	2.99	

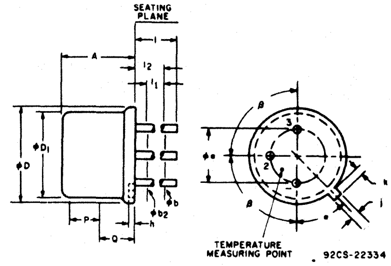
NOTE 1: To attach to heat-sink, use a 4-40 binding-head screw and a No. 4 flat washer. The recommended screw torque (for even distribution of mounting pressure and optimum thermal contact) is 6 in.-lb.

NOTE 2: Three leads. Leads are pretinned to the ℓ_1 dimension.

NOTE 3: Lead numbering from right to left with rectangular metal slug facing observer.

NOTE 4: Tab to be sheared through and set inward as shown.

TO-39/TO-5



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕa	0.190	0.210	4.83	5.33	
A	0.240	0.260	6.10	6.60	
ϕb	0.016	0.021	0.406	0.533	2
ϕb2	0.016	0.019	0.406	0.483	2
ϕD	0.350	0.370	8.89	9.40	
ϕD1	0.305	0.335	8.00	8.51	
h	0.009	0.041	0.229	1.04	
j	0.028	0.034	0.711	0.864	
k	0.029	0.040	0.737	1.02	3
L (long lead)	1.500		38.10		2
L (short lead)	0.500		12.70		2
l_1		0.050		1.27	2
l_2	0.250		6.35		2
P	0.100		2.54		1
Q					4
α	45° NOMINAL				
β	90° NOMINAL				

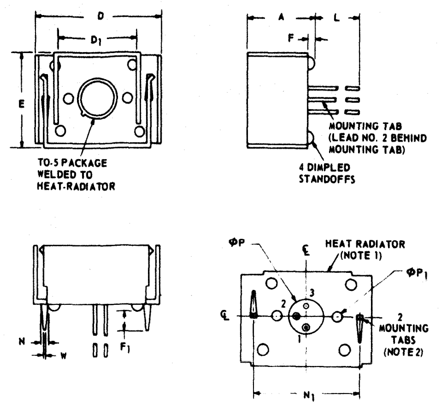
Note 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed 0.010 in. (0.254 mm).

Note 2: (Three leads) ϕb_2 applies between l_1 and l_2. ϕb applies between l_2 and l. Diameter is uncontrolled in l_1.

Note 3: Measured from maximum diameter of the actual device.

Note 4: Details of outline in this zone optional.

TO-39/TO-5 with Heat Radiator

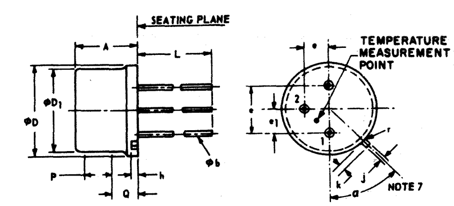


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.630	–	16.00	
D	1.205	1.235	30.61	31.37	
D1	0.775	0.785	19.69	19.93	
E	0.875	0.905	22.22	22.99	
F	0.040	0.055	1.02	1.40	
F1	0.160	0.195	4.06	4.95	
L (long lead)	1.410	–	35.81	–	
L (short lead)	0.410	–	10.41	–	
ϕP	0.295	0.305	7.493	7.747	
ϕP1	0.093	0.095	2.362	2.413	
N	0.048	0.062	1.21	1.57	
N1	0.998	1.002	25.349	25.450	3
W	0.048	0.052	1.219	1.320	

NOTES:

1. 0.035 C.R.S., finish—electroless nickel plate.
2. Recommended hole size for printed-circuit board is 0.070 in. (1.78 mm) dia.
3. Measured at bottom of heat-radiator. 92CS-22335

"Low-Profile TO-5"



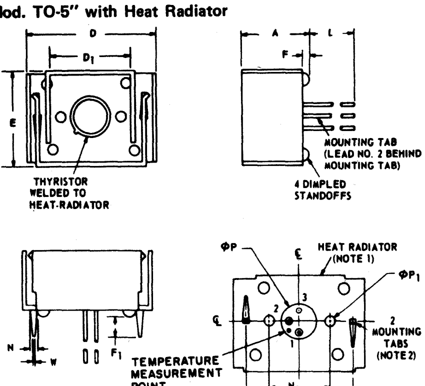
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.160	.180	4.06	4.57	
ϕb	.017	.021	.432	.533	2
ϕD	.355	.366	9.017	9.296	
ϕD1	.323	.335	8.204	8.51	
e	.190	.210	4.83	5.33	
e1	.100 TRUE POSITION		2.54 TRUE POSITION		4,5
h	.015	.035	.381	.889	
j	.028	.035	.711	.889	5
k	.029	.045	.737	1.14	3,5
L	.985	1.015	25.02	25.78	2
P	.100		2.54		1
Q					6
r		.007		.179	
α	42°	48°			5,7

NOTES:

1. This zone is controlled for automatic handling. The variation in actual diameter within the zone shall not exceed .012 in. (.279 mm).
2. (Three Leads) ϕ b applies between seating plane and 1.015 in. (25.78 mm).
3. Measured from maximum diameter of the actual device.
4. Leads having maximum diameter .021 in. (.533 mm) measured at the seating plane of the device shall be within .007 in. (.178 mm) of their true positions relative to the maximum-width tab.
5. The device may be measured by direct methods or by the gage and gaging procedure described on gage drawing GS-1 of JEDEC publication 12E, May 1964.
6. Details of outline in this zone optional.
7. Tab centerline.

92SS-3901R1

"Mod. TO-5" with Heat Radiator

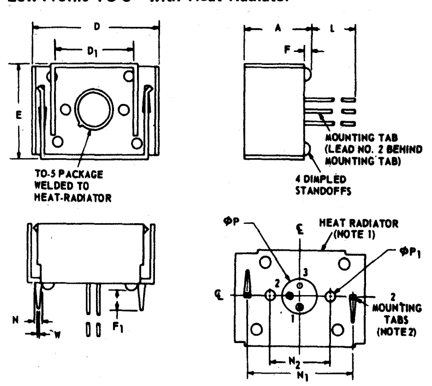


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	.630	–	16.00	
D	1.205	1.235	30.61	31.37	
D1	.745	.755	18.923	19.177	
E	.875	.905	22.22	22.99	
F	.040	.055	1.02	1.40	
F1	.170	.225	4.32	5.72	
L	.920	–	23.37	–	
ϕP	.295	.305	7.493	7.747	
ϕP1	.093	.095	2.362	2.413	
N	.048	.062	1.21	1.57	
N1	.998	1.002	25.349	25.450	3
N2	.687	.689	17.45	17.50	3
W	.048	.052	1.219	1.320	

NOTES: 92LM-2109R1

1. 0.035 C.R.S., finish: electroless nickel plate
2. Recommended hole size for printed-circuit board is 0.070 in. (1.78 mm) dia.
3. Measured at bottom of heat radiator

"Low-Profile TO-5" with Heat Radiator



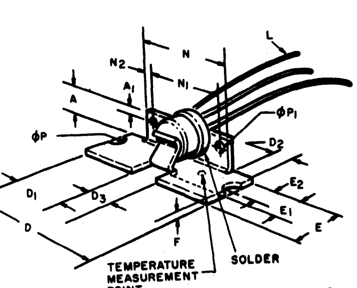
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	.630	–	16.00	
D	1.205	1.235	30.61	31.37	
D1	.745	.755	18.923	19.177	
E	.875	.905	22.22	22.99	
F	.040	.055	1.02	1.40	
F1	.170	.225	4.32	5.72	
L	.885	–	22.48	–	
ϕP	.295	.305	7.493	7.747	
ϕP1	.093	.095	2.362	2.413	
N	.048	.062	1.21	1.57	
N1	.998	1.002	25.349	25.450	3
N2	.687	.689	17.45	17.50	3
W	.048	.052	1.219	1.320	

NOTES:

1. 0.035 C.R.S., finish: electroless nickel plate
2. Recommended hole size for printed-circuit board is 0.070 in. (1.78 mm) dia.
3. Measured at bottom of heat-radiator

92SS-3900R1

"Low-Profile TO-5" with Heat Spreader

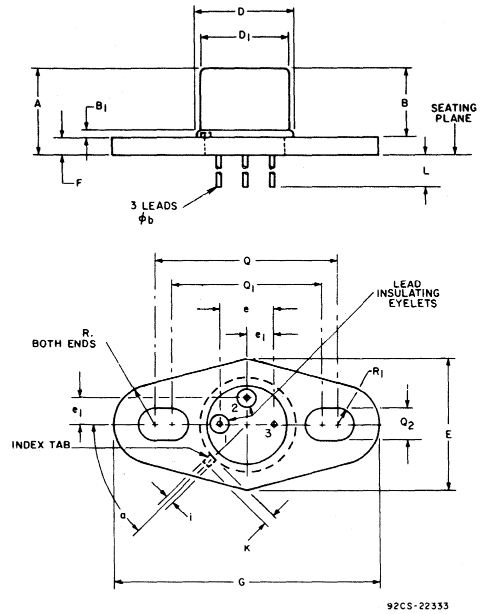


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.22		5.58		
A1	0.75		19.05		
D	1.0		25.4		
D1	0.406		10.31		
D2	0.14	0.16	3.55	4.06	
D3	0.188		4.77		
E	0.40		10.16		
E1	0.32		8.12		
E2	0.156		3.96		
F	0.02		0.05		
L	0.95	—	24.13	–	1
N	0.69	0.71	17.52	18.03	
N1	0.55		13.97		
N2	0.75		19.05		
○ P	0.072 Rad.		1.83 Rad.		
○ P1	0.094 Dia.		2.39 Dia.		2

NOTES:

1. Min. length, 3 leads.
2. Two holes.

TO-39/TO-5 with Flange

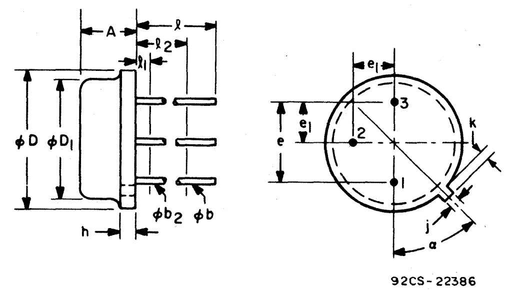


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.328	–	8.33	
B	0.240	0.260	6.10	6.60	
B_1	0.009	0.125	0.229	3.18	
ϕb	0.016	0.019	0.406	0.483	
D	0.335	0.370	8.51	9.40	
D_1	0.305	0.335	7.75	8.51	
E	0.495	0.505	12.57	12.83	
e	0.200 T.P.		5.08 T.P.		1
e_1	0.100 T.P.		2.54 T.P.		1
F	0.062	0.068	1.57	1.74	
G	0.995	1.005	25.27	25.53	
i	0.028	0.034	0.711	0.864	
k	0.029	0.045	0.737	1.14	
L long lead	1.430	–	36.32	–	
L short lead	0.430	–	10.92	–	
Q	0.685	0.691	17.40	17.55	
Q_1	0.559	0.565	14.20	14.35	
Q_2	0.128	0.132	3.25	3.35	
R	0.156 T.P.		3.96 T.P.		1
R_1	0.064	0.066	1.63	1.67	
α	45° T.P.				1, 2

NOTES:

1. True position.
2. Tab centerline.

TO-46

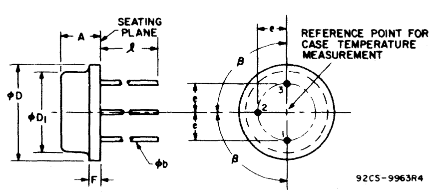


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.065	0.085	1.65	2.16	
ϕb	0.016	0.021	0.406	0.533	1
ϕb_2	0.012	0.019	0.305	0.483	1
ϕD	0.209	0.230	5.31	5.84	
ϕD_1	0.178	0.195	4.52	4.95	
e	0.100 T.P.		2.54 T.P.		2
e_1	0.050 T.P.		1.27 T.P.		2
h		0.040		1.02	
j	0.036	0.046	0.914	1.17	
k	0.028	0.048	0.711	1.22	4
ℓ	0.500		12.70		1
ℓ_1		0.050		1.27	1
ℓ_2	0.250		6.35		1
α	45° T.P.		45° T.P.		3, 5

NOTES:

1. (THREE LEADS) ϕb_2 APPLIES BETWEEN ℓ_1 AND ℓ_2. ϕb APPLIES BETWEEN ℓ_2 AND 0.5 IN. (12.70 MM) FROM SEATING PLANE. DIAMETER IS UNCONTROLLED IN ℓ_1 AND BEYOND 0.5 IN. (12.70 MM) FROM SEATING PLANE.
2. MAXIMUM DIAMETER LEADS AT A GAGING PLANE 0.054 IN. (1.37 MM) + 0.001 IN. (0.025 MM) - 0.000 IN. (0.000 MM) BELOW SEATING PLANE TO BE WITHIN 0.007 IN. (0.178 MM) OF THEIR POSITION RELATIVE TO MAXIMUM-WIDTH TAB AND TO THE MAXIMUM 0.230 IN. (5.84 MM) DIAMETER MEASURED WITH A SUITABLE GAGE. WHEN GAGE IS NOT USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.
3. INDEX TAB FOR VISUAL ORIENTATION ONLY.
4. MEASURED FROM MAXIMUM DIAMETER OF THE ACTUAL DEVICE.
5. TAB CENTERLINE.

TO-8

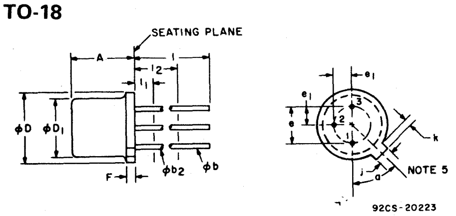


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.270	0.330	6.86	8.38	–
ϕb	0.027	0.033	0.686	0.838	1
ϕD	0.550	0.650	13.97	16.51	–
ϕD_1	0.444	0.524	11.28	13.31	–
e	0.136	0.146	3.45	3.71	–
F	–	0.115	–	2.92	–
ℓ	0.360	0.440	9.14	11.18	1
β	90 NOMINAL				

NOTE:

1. Three leads.

TO-18

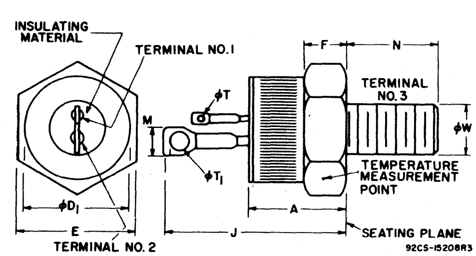


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.170	0.210	4.32	5.33	
ϕb	0.016	0.021	0.406	0.533	1
ϕb_2	0.016	0.019	0.406	0.483	1
ϕD	0.209	0.230	5.31	5.84	
ϕD_1	0.178	0.195	4.52	4.95	
e	0.100 T.P.		2.54 T.P.		2, 4
e_1	0.050 T.P.		1.27 T.P.		2, 4
F		0.030		0.762	
j	0.036	0.046	0.914	1.17	4
k	0.028	0.048	0.711	1.22	3
l	0.500		12.70		1
l_1		0.050		1.27	1
l_2	0.250		6.35		1
α	45° T.P.				5

NOTES:

1. (Three leads) ϕb_2 applies between l_1 and l_2. ϕb applies between l_2 and 0.5 in. (12.70 mm) from seating plane. Diameter is uncontrolled in l_1 and beyond 0.5 in. (12.70 mm) from seating plane.
2. Leads having maximum diameter 0.019 in. (0.483 mm) measured in gaging plane 0.054 in. (1.37 mm) + 0.001 in. (0.025 mm) – 0.00 in. (0.00 mm) below the seating plane of the device shall be within 0.007 in. (0.178 mm) of their true positions relative to a maximum-width tab.
3. Measured from maximum diameter of the actual device.
4. The device may be measured by direct methods or by the gage and gaging procedure described on gage drawing GS-2.
5. Tab centerline.

TO-48



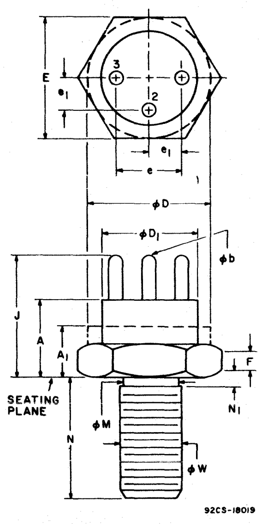
NOTE

1. ϕW is pitch diameter of coated threads.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.330	0.505	8.4	12.8	–
ϕD_1	–	0.544	–	13.81	–
E	0.544	0.562	13.82	14.28	–
F	0.113	0.200	2.87	5.08	–
J	0.950	1.100	24.13	27.94	–
M	0.215	0.225	5.46	5.71	–
N	0.422	0.453	10.72	11.50	–
ϕT	0.058	0.068	1.47	1.73	–
ϕT_1	0.138	0.148	3.51	3.75	–
ϕW	1/4-28 UNF-2A		1/4-28 UNF-2A		1

REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I. Recommended Torque: 25 inch-pounds.

TO-60



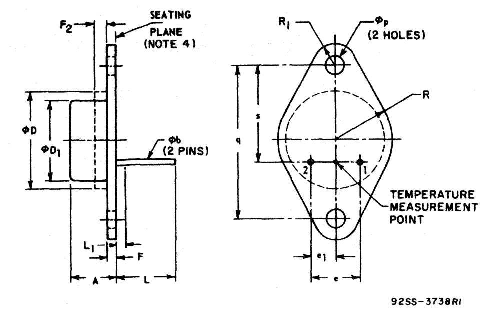
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	0.215	0.320	5.46	8.13	
A_1	–	0.165	–	4.19	2
φb	0.030	0.046	0.762	1.17	4
φD	0.360	0.437	9.14	11.10	2
$φD_1$	0.320	0.360	8.13	9.14	
E	0.424	0.437	10.77	11.10	
e	0.185	0.215	4.70	5.46	
e_1	0.090	0.110	2.29	2.79	
F	0.090	0.135	2.29	3.43	1
J	0.355	0.480	9.02	12.19	
φM	0.163	0.189	4.14	4.80	
N	0.375	0.455	9.53	11.56	
N_1	–	0.078	–	1.98	
φW	0.1658	0.1697	4.212	4.310	3, 5

MILLIMETER DIMENSIONS ARE DERIVED FROM ORIGINAL INCH DIMENSIONS

NOTES:

1. Dimension does not include sealing flanges
2. Package contour optional within dimensions specified
3. Pitch diameter – 10-32 UNF 2A thread (coated)
4. Pin spacing perimts insertion in any socket having a pin-circle diameter of 0.200 in. (5.08 mm) and contacts which will accommodate pins with a diameter of 0.030 in. (0.762 mm) min., 0.046 in. (1.17 mm) max.
5. The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

TO-66

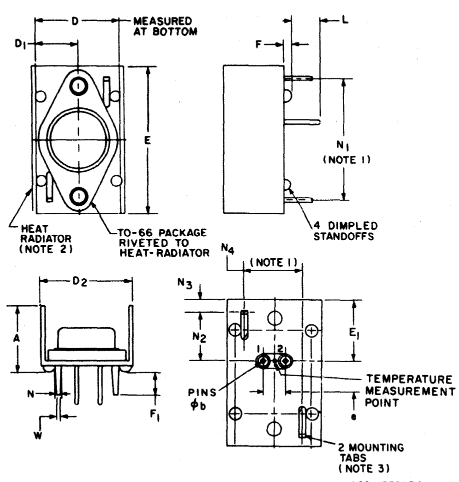


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	0.250	0.340	6.35	8.64	
φb	0.028	0.034	0.711	0.863	
φD	–	0.620	–	15.75	1
$φD_1$	0.470	0.500	11.94	12.70	
e	0.190	0.210	4.83	5.33	2
e_1	0.093	0.107	2.36	2.72	2
F_1	0.050	0.075	1.27	1.91	
F_2	–	0.050	–	1.27	1
L	0.360	–	9.14	–	
L_1	–	0.050	–	1.27	3
φp	0.142	0.152	3.61	3.86	
q	0.958	0.962	24.33	24.43	
R	–	0.350	–	8.89	
R_1	–	0.145	–	3.68	
s	0.570	0.590	14.48	14.99	

NOTES:

1. Body contour is optional within zone defined by φD and F_2.
2. These dimensions should be measured at points 0.050 in. (1.27 mm) to 0.055 in. (1.40 mm) below seating plane. When gage is not used, measurement will be made at seating plane.
3. φb applies between L_1 and L. Diameter is uncontrolled in L_1.
4. The seating plane of header shall be flat within 0.001 in. (0.025 mm) concave to 0.004 in. (0.10 mm) convex inside a 0.520 in. (13.21 mm) diameter circle on the center of the header and flat within 0.001 in (0.025 mm) concave to 0.006 in. (0.15 mm) convex overall.

TO-66 with Heat Radiator

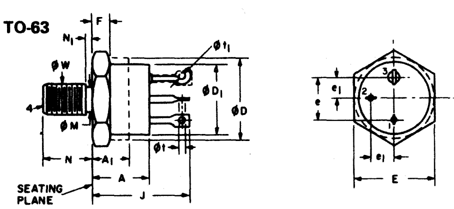


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	–	0.620	–	15.75	
φb	0.028	0.034	0.711	0.864	
D	0.750	0.760	19.05	19.30	
D_1	0.370	0.385	9.40	9.78	
D_2	0.820	0.920	20.83	23.37	
E	1.297	1.327	32.94	33.70	
E_1	0.546	0.566	13.87	14.37	
e	0.190	0.210	4.83	5.33	
F	0.30	0.55	7.62	13.97	
F_1	0.175	0.210	4.44	5.33	
L	0.270	–	6.86	–	
N	0.052	0.065	1.32	1.65	
N_1	1.098	1.102	27.89	27.99	1
N_2	0.448	0.452	11.38	11.47	
N_3	0.099	0.113	0.25	0.29	
N_4	0.498	0.502	12.65	12.75	
W	0.048	0.060	1.22	1.52	

NOTES:

1. Measured at bottom of heat radiator.
2. 0.035 in. (0.889) C.R.S., tin plated.
3. Recommended hole size for printed-circuit board is 0.070 in. (1.778) dia.

TO-63



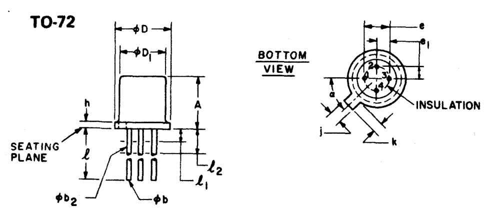
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	0.480	0.535	12.19	13.59	
A_1	–	0.300	–	7.62	2
φD	0.775	0.875	19.69	22.23	2
$φD_1$	0.745	0.775	18.92	19.69	
E	0.855	0.875	21.72	22.23	
e	0.485	0.515	12.32	13.08	5
e_1	0.240	0.260	6.10	6.60	5
F	0.090	0.167	2.29	4.24	1
J	0.937	1.030	23.80	26.16	
φM	0.278	0.312	7.06	7.92	
N	0.460	0.495	11.68	12.57	
N_1	–	0.105	–	2.67	
φt	0.060	0.105	1.52	2.67	
$φt_1$	0.060	0.105	1.52	2.67	4
φW	0.2806	0.2854	7.127	7.249	3

NOTES:

92CS-20225

1. DIMENSION DOES NOT INCLUDE SEALING FLANGES.
2. PACKAGE CONTOUR OPTIONAL WITHIN DIMENSIONS SPECIFIED.
3. PITCH DIAMETER - THREAD 5/16-24 UNF-2A (COATED). REFERENCE (SCREW THREAD STANDARDS FOR FEDERAL SERVICES - HANDBOOK H-28).
4. THIS TERMINAL CAN BE FLATTENED AND PIERCED OR HOOK TYPE.
5. POSITION OF LEADS IN RELATION TO THE HEXAGON IS NOT CONTROLLED.

TO-72



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	0.170	0.210	4.32	5.33	
φb	0.016	0.021	0.406	0.533	2
$φb_2$	0.016	0.019	0.406	0.483	2
φD	0.209	0.230	5.31	5.84	
$φD_1$	0.178	0.195	4.52	4.95	
e	0.100 T.P.		2.54 T.P.		4
e1	0.050 T.P.		1.27 T.P.		4
h		0.030		0.762	
j	0.036	0.046	0.914	1.17	
k	0.028	0.048	0.711	1.22	3
l	0.500		12.70		2
l_1		0.050		1.27	2
l_2	0.250		6.35		2
α	45° T.P.		45° T.P.		4, 6

92CS-17444RI

Note 1: (Four leads). Maximum number leaus omitted in this outline, "none" (0). The number and position of leads actually present are indicated in the product registration. Outline designation determined by the location and minimum angular or linear spacing of any two adjacent leads.

Note 2: (All leads) $φb_2$ applies between l_1 and l_2. φb applies between l_2 and 0.50 in. (12.70 mm) from seating plane. Diameter is uncontrolled in l_1 and beyond 0.50 in. (12.70 mm) from seating plane.

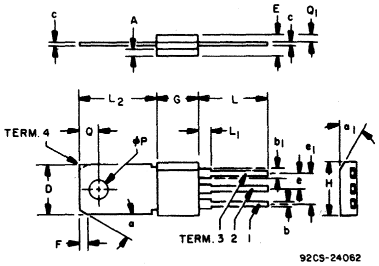
Note 3: Measured from maximum diameter of the product.

Note 4: Leads having maximum diameter 0.019 in. (0.484 mm) measured in gaging plane 0.054 in. (1.37 mm) +0.001 in. (0.025 mm) – 0.000 (0.000 mm) below the seating plane of the product shall be within 0.007 in. (0.178 mm) of their true position relative to a maximum width tab.

Note 5: The product may be measured by direct methods or by gage.

Note 6: Tab centerline.

TO-202AB
RCP Plastic Package (VERSATAB)

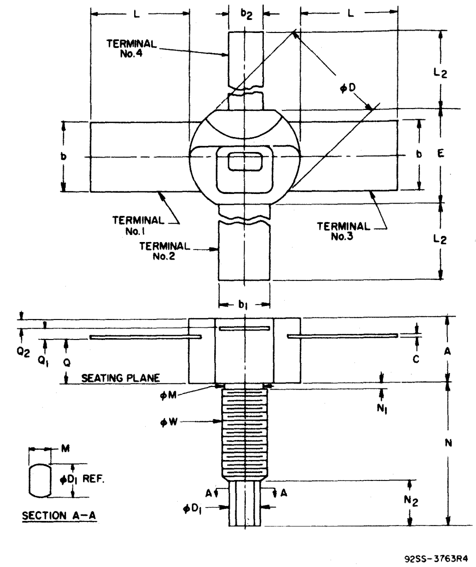


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.05	–	1.270	1
b	0.023	0.029	0.584	0.736	
b_1	0.045	0.055	1.143	1.397	1
c	0.018	0.026	0.457	0.660	
D	0.305	0.325	7.747	8.255	
E	0.130	0.150	3.302	3.810	
e	0.095	0.105	2.413	2.667	
e_1	0.190	0.210	4.826	5.334	
F	–	0.08	–	2.032	1
G	0.230	0.250	5.842	6.350	
H	0.330	0.370	8.382	9.398	
L	0.400	0.450	10.16	11.43	
L_1	–	0.100	–	2.54	1,2
L_2	0.540	0.580	13.71	14.73	
ϕP	0.123	0.127	3.124	3.225	
Q	0.120	0.130	3.048	3.302	
Q_1	0.039	0.050	0.990	1.270	
α	–	35°	–	35°	1
α_1	–	50°	–	50°	1

NOTES:

1. Package contour optional within dimensions specified.
2. Lead dimensions uncontrolled in this zone.
3. Chamfer on tab optional.
4. Controlling dimensions: inch.

TO-216AA



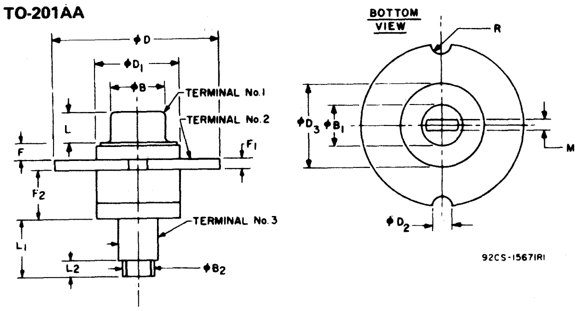
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.150	0.230	3.81	5.84	–
b	0.195	0.205	4.953	5.207	–
b_1	0.135	0.145	3.429	3.683	–
b_2	0.095	0.105	2.413	2.667	–
C	0.004	0.010	0.102	0.254	3
ϕD	0.305	0.320	7.75	8.12	5
ϕD_1	0.110	0.130	2.80	3.30	1
E	0.275	0.300	6.99	7.62	5
L	0.265	0.290	6.74	7.36	–
L_2	0.455	0.510	11.56	12.95	–
M	0.053	0.064	1.35	1.62	–
ϕM	0.120	0.163	3.05	4.14	–
N	0.425	0.470	10.80	11.93	–
N_1	–	0.078	–	1.98	4
N_2	0.110	0.150	2.80	3.81	–
Q	0.120	0.170	3.05	4.31	–
Q_1	0.025	0.045	0.64	1.14	–
Q_2	–	–	–	–	5
ϕW	–	–	–	–	2

MILLIMETER DIMENSIONS ARE DERIVED FROM ORIGINAL INCH DIMENSIONS

NOTES:

1. 0.053 - 0.064 INCH (1.35 - 1.62 mm) WRENCH FLAT.
2. PITCH DIA. OF 8-32 UNC-2A COATED THREADS (REF: UNITED SCREW THREADS ANS B1.1 - 1960). THE APPLIED TORQUE SHOULD NOT EXCEED 5 IN.-LBS. CLAMPING FORCES MUST BE APPLIED ONLY TO THE FLAT SURFACES OF THE STUD.
3. TYPICAL FOR ALL LEADS.
4. LENGTH OF INCOMPLETE OR UNDERCUT THREADS OF ϕW.
5. BODY CONTOUR OPTIONAL WITHIN Q_2, ϕD, AND E.

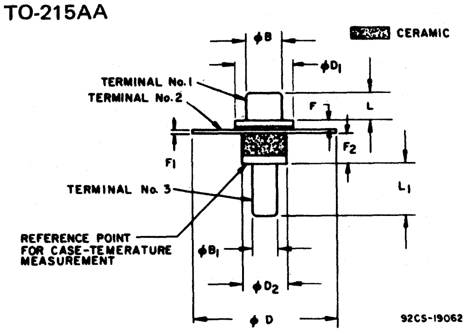
TO-201AA



SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
ϕB	0.165	0.175	4.19	4.44
ϕB_1	0.115	0.125	2.92	3.17
ϕB_2	0.090	0.110	2.29	2.79
ϕD	0.495	0.505	12.57	12.83
ϕD_1	0.245	0.255	6.22	6.48
ϕD_2	0.055	0.065	1.39	1.65
ϕD_3	0.245	0.255	6.22	6.48
F	0.045	0.060	1.14	1.52
F_1	0.025	0.035	0.63	0.88
F_2	0.145	0.175	3.68	4.44
L	0.095	0.115	2.41	2.92
L_1	0.165	0.195	4.19	4.95
L_2	0.040	0.060	1.02	1.52
M	0.045	0.055	1.14	1.39
R	0.027	0.033	0.68	0.83

MILLIMETER DIMENSIONS ARE DERIVED FROM ORIGINAL INCH DIMENSIONS

TO-215AA



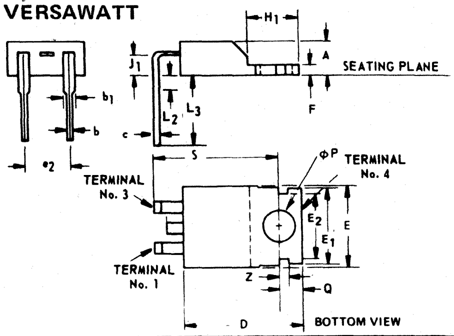
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕB	0.118	0.122	2.997	3.098	1
ϕB_1	0.090	0.094	2.286	2.387	2
ϕD	0.497	0.503	12.624	12.776	3
ϕD_1	0.180	NOM.	4.57	NOM.	
ϕD_2	0.162	NOM.	4.11	NOM.	
F	0.028	0.039	0.71	0.99	
F_1	0.009	0.011	0.229	0.279	
F_2	0.114	0.126	2.90	3.20	
L	0.098	0.104	2.49	2.64	
L_1	0.179	0.191	4.55	4.85	

NOTES:

1. Silver or KOVAR*
2. Solid silver
3. Gold-plated KOVAR

*Trademark, Westinghouse Electric Corp.

TO-220AA VERSAWATT

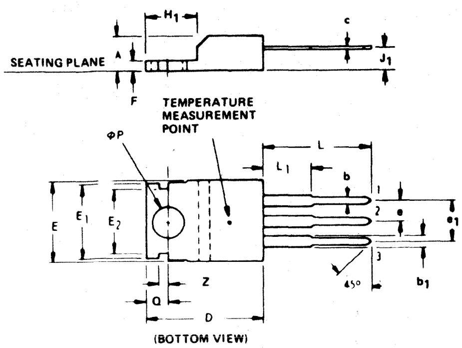


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	–
b	0.020	0.045	0.51	1.14	–
b_1	0.045	0.070	1.14	1.77	–
c	0.015	0.025	0.38	0.63	–
D	0.560	0.625	14.23	15.87	–
E	0.380	0.420	9.66	10.66	1
E_1	0.365	0.385	9.28	9.77	–
E_2	0.300	0.320	7.62	8.12	–
e_2	0.190	0.210	4.83	5.33	2
F	0.045	0.055	1.14	1.39	–
H_1	0.230	0.270	5.85	6.85	1
J_1	0.080	0.115	2.04	2.92	–
L_2	–	0.050	–	1.27	–
L_3	0.360	0.422	9.15	10.71	–
ϕP	0.139	0.147	3.531	3.733	–
Q	0.100	0.120	2.54	3.04	–
S	0.580	0.610	14.74	15.49	–
Z	0.040	0.060	1.02	1.52	–

92CS-17990R2

NOTES:
1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.050 – 0.055 in. (1.270 – 1.397 mm) below seating plane.

TO-220AB VERSAWATT

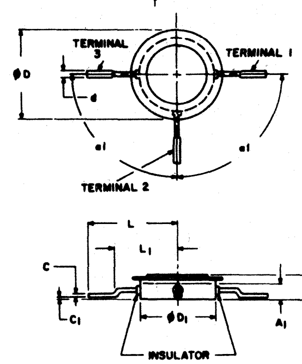


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	–
b	0.020	0.045	0.51	1.14	–
b_1	0.045	0.070	1.14	1.77	–
c	0.015	0.025	0.38	0.63	–
D	0.560	0.625	14.23	15.87	–
E	0.380	0.420	9.66	10.66	1
E_1	0.365	0.385	9.28	9.77	–
E_2	0.300	0.320	7.62	8.12	–
e	0.090	0.110	2.29	2.79	2
e_1	0.190	0.210	4.83	5.33	2
F	0.045	0.055	1.14	1.39	–
H_1	0.230	0.270	5.85	6.85	1
J_1	0.080	0.115	2.04	2.92	–
L	0.500	0.562	12.70	14.27	–
L_1	–	0.250	–	6.35	–
ϕP	0.139	0.147	3.531	3.733	–
Q	0.100	0.120	2.54	3.04	–
Z	0.040	0.060	1.02	1.52	–

92SS-17991R2

NOTES:
1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.250 – 0.255 in. (6.350 – 6.477 mm) from case.

RADIAL PACKAGE

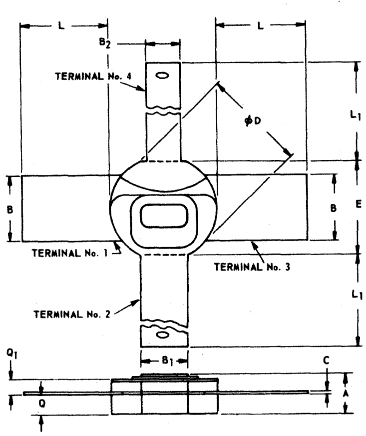


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.200	–	5.08	
A_1	–	0.125	–	3.17	1
C	0.015	0.019	0.38	0.48	
C_1	–	0.015	–	0.38	
ϕD	–	0.710	–	18.03	
ϕD_1	0.615	0.690	15.62	17.52	1
d	0.042	0.046	1.06	1.16	
L	–	0.705	–	17.90	
L_1	–	0.510	–	12.95	
α_1	90° ± 2°		90° ± 2°		

92CS-20224

NOTE:
1. CONTROLLED AREA OF THE DIAMETER DOES NOT INCLUDE THE BRAZED AREA AROUND THE CERAMIC AND TERMINAL 2.

HF-31



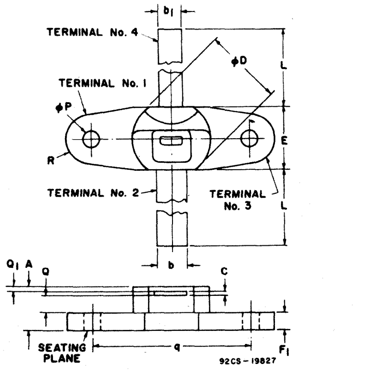
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.090	0.135	2.29	3.42	–
B	0.195	0.205	4.96	5.20	–
B_1	0.135	0.145	3.43	3.68	–
B_2	0.095	0.105	2.42	2.66	–
C	0.004	0.010	0.11	0.25	1
ϕD	0.305	0.320	7.48	8.12	–
E	0.275	0.300	6.99	7.62	–
L	0.265	0.290	6.74	7.36	–
L_1	0.455	0.510	11.56	12.95	–
Q	0.055	0.070	1.40	1.77	–
Q_1	0.025	0.045	0.64	1.14	–

MILLIMETER DIMENSIONS ARE DERIVED FROM ORIGINAL INCH DIMENSIONS

NOTE: 1. TYPICAL FOR ALL LEADS

92SS-4462 R1

HF-32

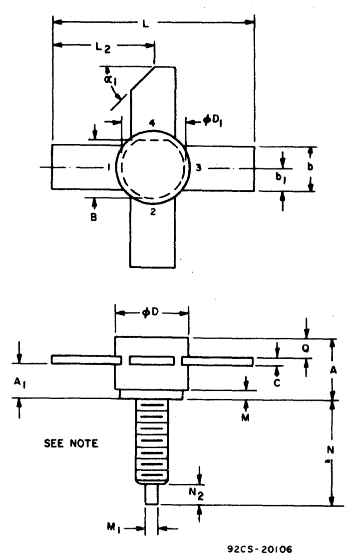


SYMBOL	INCHES		MILIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.160	0.210	4.07	5.33	
b	0.135	0.145	3.429	3.683	
b_1	0.095	0.105	2.413	2.667	
c	0.004	0.010	0.102	0.254	1
ϕD	0.305	0.320	7.75	8.12	
E	0.275	0.300	6.99	7.62	
F_1	0.057	0.067	1.448	1.701	
L	0.455	0.510	11.56	12.95	
ϕP	0.115	0.125	2.921	3.175	
Q	0.085	0.105	2.16	2.66	
Q_1	–	–	–	–	2
q	0.590	0.610	14.99	15.49	
R	0.115	0.125	2.921	3.175	

MILLIMETER DIMENSIONS ARE DERIVED FROM ORIGINAL INCH DIMENSIONS

NOTES: 1. TYPICAL TWO LEADS.
2. BODY CONTOUR OPTIONAL WITHIN Q_1, ϕ D, AND E.

HF-44

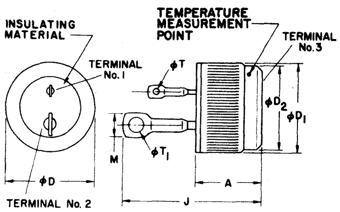


SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.250	0.275	6.35	6.98
A_1	0.163	0.173	4.141	4.394
B	0.299	0.307	7.595	7.797
b	0.221	0.229	5.614	5.816
b_1	0.110	0.115	2.794	2.921
C	0.0045	0.006	0.113	0.152
ϕD	0.370	0.390	9.40	9.90
ϕD_1	0.320	0.330	8.128	8.382
L	1.040	1.055	26.42	26.79
L_2	0.520	0.530	13.208	13.462
M	0.070	0.080	1.778	2.032
M_1	0.055	0.065	1.397	1.651
N	0.455	0.475	11.56	12.06
N_2	0.100	0.130	2.54	3.30
Q	0.085	0.095	2.159	2.413
α_1	45° NOM.		45° NOM.	

MILLIMETER DIMENSIONS ARE DERIVED FROM ORIGINAL INCH DIMENSIONS

NOTE: PITCH DIA. OF 8-32 UNC-2A COATED THREAD (ASA B1. 1-1960)

Press-Fit
6-, 10-, and 15-A Triacs; 20- and 35-A SCR's

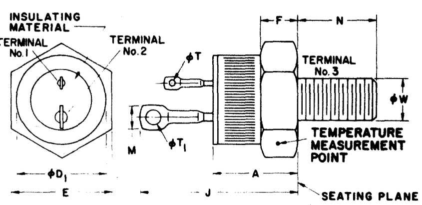


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.380	–	9.65	
ϕ D	0.501	0.510	12.73	12.95	
ϕ D_1	–	0.505	–	12.83	1
ϕ D_2	0.465	0.475	11.81	12.07	
J	–	0.750	–	19.05	
M	–	0.155	–	3.94	
ϕ T	0.058	0.068	1.47	1.73	
ϕ T_1	0.080	0.090	2.03	2.29	

NOTE 1: Outer diameter of knurled surface.

92CS-23134

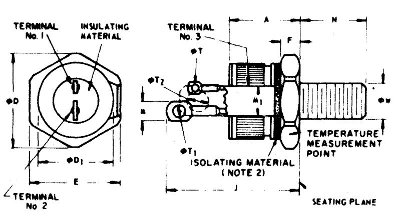
Stud 6-, 10, and 15-A Triacs; 20- and 35-A SCR's



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.330	0.505	8.40	12.80	
ϕ D_1	–	0.544	–	13.81	
E	0.544	0.562	13.82	14.28	
F	0.113	0.200	2.87	5.08	
J	–	0.950	–	24.13	
M	–	0.155	–	3.94	
N	0.422	0.453	10.72	11.50	
ϕ T	0.058	0.068	1.47	1.73	
ϕ T_1	0.080	0.090	2.03	2.29	
ϕ W	1/4-28 UNF-2A		1/4-28 UNF-2A		1

NOTE. 1. ϕW is pitch diameter of coated threads.
REF: Screw-Thread Standards for Federal Services, Handbook H28,
Part I. Recommended Torque: 35 in-lbf (0.4 kg f-m)
Maximum Torque: 50 in-lb (0.57 kg f-m)

Isolated-Stud 6-, 10-, and 15-A Triacs; 20- and 35-A SCR's



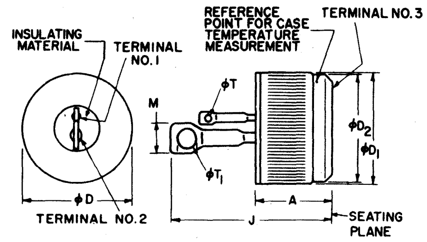
92CS-23133

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.673	–	17.09	
ϕ D	0.604	0.614	15.34	15.59	
ϕ D_1	0.501	0.505	12.72	12.82	
E	0.551	0.557	13.99	14.14	
F	0.175	0.185	4.44	4.69	
J	–	1.055	–	26.79	
M	–	0.155	–	3.94	
M_1	0.200	0.210	5.08	5.33	
N	0.422	0.452	10.72	11.48	
ϕ T	0.058	0.068	1.47	1.73	
ϕ T_1	0.080	0.090	2.03	2.29	
ϕ T_2	0.138	0.148	3.50	3.75	
ϕ W	1/4-28 UNF-2A		1/4-28 UNF-2A		1

NOTES:

1. ϕW is pitch diameter of coated threads.
REF: Screw-Thread Standards for Federal Services, Handbook H28,
Part I. Recommended Torque: 35 in-lbf (0.4 kg f-m)
Maximum Torque: 50 in-lb (0.57 kg f-m)
2. Isolating material (ceramic) between hex (stud) and terminal No. 3 is beryllium oxide. Minimum isolation breakdown voltage is 2100 V rms for 1 minute duration.

Press-Fit
25-, 30-, and 40-A Triacs

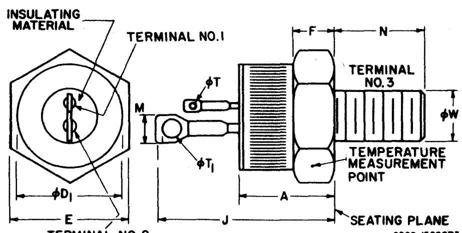


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.380	–	9.65	–
ϕD	0.501	0.510	12.73	12.95	–
ϕD_1	–	0.505	–	12.83	1
ϕD_2	0.465	0.475	11.81	12.07	–
J	0.825	1.000	20.95	25.40	–
M	0.215	0.225	5.46	5.71	–
ϕT	0.058	0.068	1.47	1.73	–
ϕT_1	0.138	0.148	3.51	3.75	–

NOTE:
1. Outer diameter of knurled surface.

92CS-15207R3

Stud 25-, 30-, and 40-A Triacs



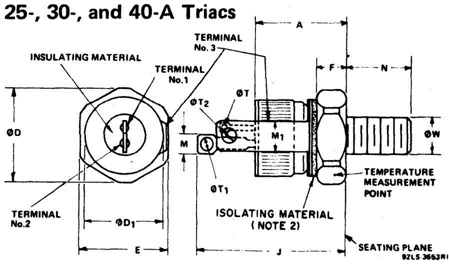
92CS-15208R3

NOTE
1. ϕW is pitch diameter of coated threads.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.330	0.505	8.4	12.8	–
ϕD_1	–	0.544	–	13.81	–
E	0.544	0.562	13.82	14.28	–
F	0.113	0.200	2.87	5.08	–
J	0.950	1.100	24.13	27.94	–
M	0.215	0.225	5.46	5.71	–
N	0.422	0.453	10.72	11.50	–
ϕT	0.058	0.068	1.47	1.73	–
ϕT_1	0.138	0.148	3.51	3.75	–
ϕW .	1/4-28 UNF-2A		1/4-28 UNF-2A		1

NOTE
1. ϕW is pitch diameter of coated threads.
REF: Screw-Thread Standards for Federal Services, Handbook H28,
Part I. Recommended Torque: 35 in-lbf (0.4 kg f-m)
Maximum Torque: 50 in-lb (0.57 kg f-m)

Isolated-Stud 25-, 30-, and 40-A Triacs



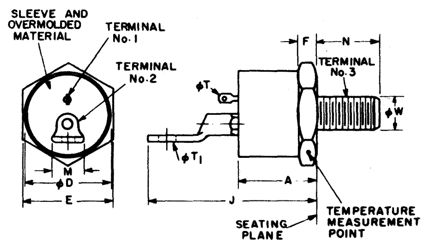
92LS-3663R1

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	0.673	–	17.09	–
ϕD	0.604	0.614	15.34	15.59	–
ϕD_1	0.501	0.505	12.72	12.82	–
E	0.551	0.557	13.99	14.14	–
F	0.175	0.185	4.44	4.69	–
J	–	1.298	–	32.96	–
M	0.210	0.230	5.33	5.84	–
M_1	0.200	0.210	5.08	5.33	–
N	0.422	0.452	10.72	11.48	–
ϕT	0.058	0.068	1.47	1.73	–
ϕT_1	0.125	0.165	3.18	4.19	–
ϕT_2	0.138	0.148	3.50	3.75	–
ϕW	¼-28 UNF-2 A		¼-28 UNF-2 A		1

NOTES:

1. ϕW is pitch diameter of coated threads.
REF: Screw-Thread Standards for Federal Services, Handbook H28,
Part I. Recommended Torque: 35 in-lbf (0.4 kg f-m)
Maximum Torque: 50 in-lb (0.57 kg f-m)
2. Isolating material (ceramic) between hex (stud) and terminal No. 3 is beryllium oxide. Minimum isolation breakdown voltage is 2100 V rms for 1 minute duration.

Overmold
Stud 60-A and 80-A Triacs

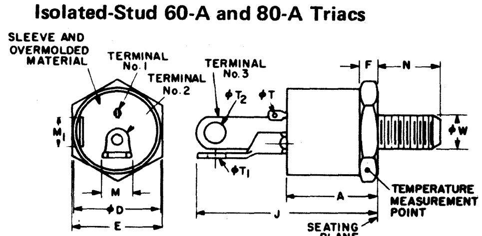


SYMBOL	INCHES		MILLIMETERS		NOTE
	MIN.	MAX.	MIN.	MAX.	
A	0.7	0.8	17.78	20.32	
ϕD	0.9	1.1	22.86	27.94	
E	1.050	1.060	26.67	26.92	
F	0.175	0.192	4.44	4.88	
J	–	1.75	–	44.45	
M	0.37	0.39	9.40	9.91	
N	0.73	0.77	18.54	19.56	
ϕT	0.060	0.065	1.52	1.65	
ϕT_1	0.19	0.21	4.83	5.33	
ϕW	½–20	NF–2A	½–20	NF–2A	1

1. ϕW is pitch diameter of coated threads. REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I. Recommended torque: 125 in-lb (1.44 kgf-m). Maximum torque: 150 in-lb (1.73 kgf-m).

92CM-26729

Overmold
Isolated-Stud 60-A and 80-A Triacs



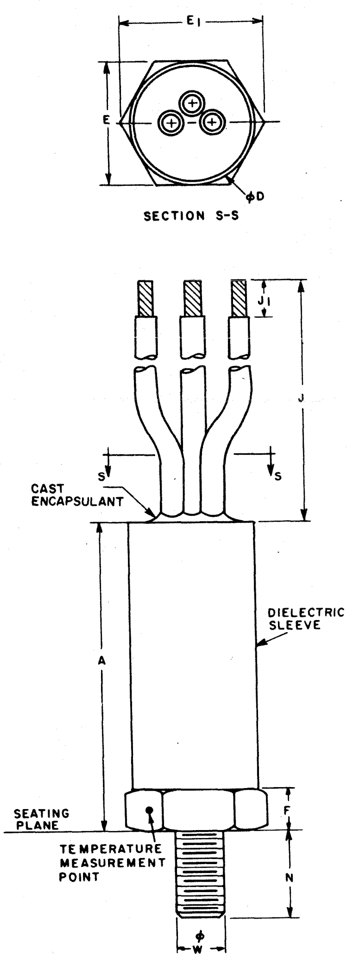
92CM-26728

SYMBOL	INCHES		MILLIMETERS		NOTE
	MIN.	MAX.	MIN.	MAX.	
A	0.8	1.0	20.32	25.4	
ϕD	0.9	1.1	22.86	27.94	
E	1.050	1.060	26.67	26.92	
F	0.175	0.192	4.44	4.88	
J	–	1.9	–	48.26	
M	0.37	0.39	9.40	9.91	
M_1	0.37	0.39	9.40	9.91	
N	0.73	0.77	18.54	19.56	
ϕT	0.060	0.065	1.52	1.65	
ϕT_1	0.19	0.21	4.83	5.33	
ϕT_2	0.19	0.21	4.83	5.33	
ϕW	½–20	NF–2A	½–20	NF–2A	1

1. ϕW is pitch diameter of coated threads. REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I. Recommended torque: 125 in-lb (1.44 kgf-m). Maximum torque: 150 in-lb (1.73 kgf-m).
2. Isolating material (ceramic) between hex (stud) and terminal No. 3 is beryllium oxide.

WARNING: The ceramic used in these packages contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

Press-Fit with Flexible Leads, Encapsulated on Isolated-Stud

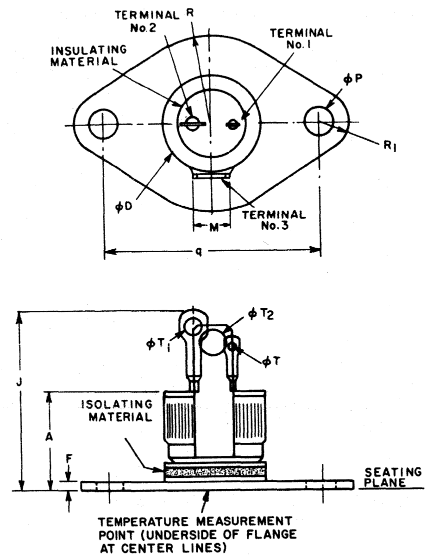


Symbol	INCHES		MILLIMETERS		Note
	Min.	Max.	Min.	Max.	
A	1.498	1.622	38.05	41.20	
ϕD	0.619	0.629	15.72	15.98	
E	0.677	0.683	17.20	17.35	
E_1	0.745	0.755	18.92	19.17	
F	0.117	0.123	2.97	3.12	
J	–	6.500	–	165.10	
J_1	0.125	0.500	3.17	12.70	
N	0.430	0.450	10.92	11.43	
ϕW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

Note 1: ϕW is pitch diameter of coated threads.
Ref.: Screw-Thread Standard for Federal Services Handbook H28, Part I.
Recommended torque: 35 in.-lbf (0.4 kgf m).

92CM-26375

Press-Fit, Isolated on TO-3 Flange

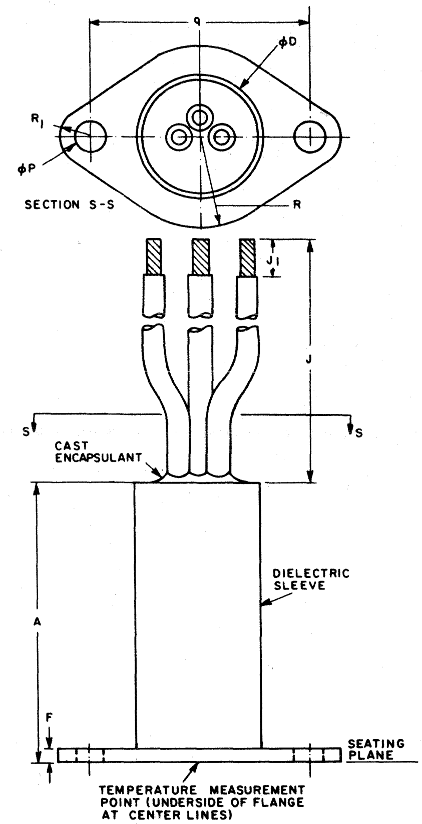


Symbol	INCHES		MILLIMETERS		Note
	Min.	Max.	Min.	Max.	
A	–	0.635	–	16.13	
ϕD	0.501	0.505	12.72	12.83	
F	0.060	0.065	1.52	1.65	
J	–	1.015	–	25.78	
M	0.200	0.210	5.08	5.33	
q	1.184	1.190	30.07	30.22	
ϕP	0.152	0.159	3.86	4.04	
R	0.497	0.503	12.62	12.77	
R_1	0.169	0.176	4.29	4.47	
ϕT	0.060	0.065	1.52	1.65	
$ϕT_1$	0.083	0.087	2.11	2.21	
$ϕT_2$	0.138	0.148	3.50	3.76	

92CM-26377R1

WARNING: The ceramic used in these packages contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

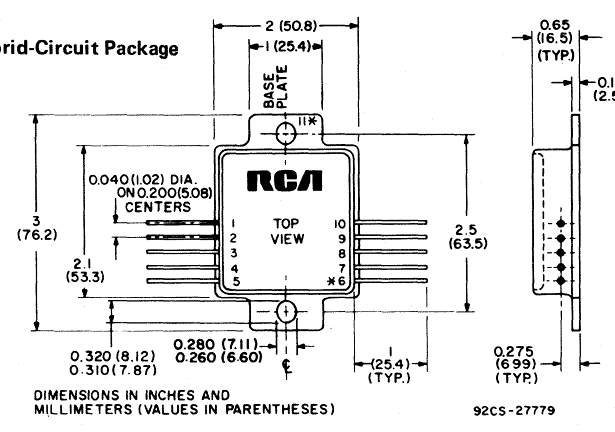
Press-Fit with Flexible Leads, Encapsulated, Isolated on TO-3 Flange



Symbol	INCHES		MILLIMETERS	
	Min.	Max.	Min.	Max.
A	1.470	1.535	37.34	38.99
ϕD	0.619	0.629	15.72	15.98
F	0.060	0.065	1.52	1.65
J	–	6.500	–	165.10
J_1	0.125	0.500	3.17	12.70
q	1.184	1.190	30.07	30.22
ϕP	0.152	0.159	3.86	4.04
R	0.497	0.503	12.62	12.77
R_1	0.169	0.176	4.29	4.47

92CM-26376

Hybrid-Circuit Package

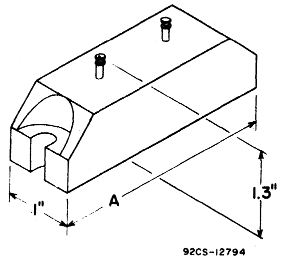


DIMENSIONS IN INCHES AND MILLIMETERS (VALUES IN PARENTHESES)

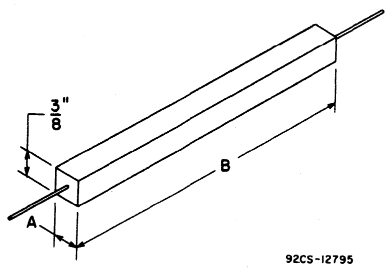
92CS-27779

*For HC2000H, Terminal 11 is internally connected to Terminal 6.
For HC2500, Terminal 11 is electrically isolated from internal circuitry.

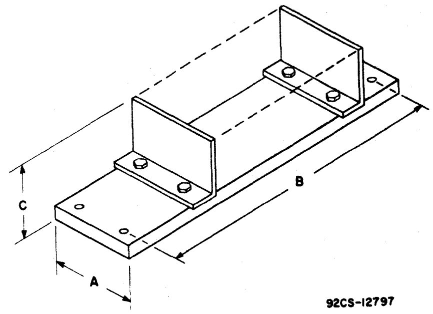
HIGH-VOLTAGE AND BRIDGE RECTIFIER ASSEMBLIES



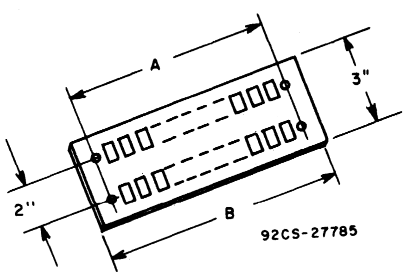
RCA Type No.	Dimensions Inches
	A
CR101	2-3/8
CR102	2-3/8
CR103	2-3/8
CR104	3-1/4
CR105	3-1/4
CR106	4-1/2
CR107	4-1/2
CR108	4-1/2
CR109	5-1/2
CR110	5-1/2



RCA Type No.	Dimensions Inches	
	A	B
CR201	3/8	2
CR203	3/8	3-1/2
CR204	3/8	4-1/2
CR206	3/4	3-1/2
CR208	3/4	3-1/2
CR210	3/4	4-1/2
CR212	3/4	4-1/2



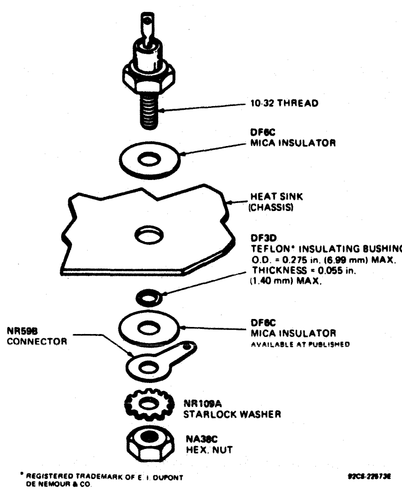
RCA Type No.	Dimensions Inches		
	A	B	C
CR301	2-1/4	5-1/4	2
CR302	2-1/4	7	2
CR303	2-1/4	8-3/4	2
CR304	2-1/4	10-1/2	2
CR305	2-1/4	12-1/4	2
CR306	2-1/4	14	2
CR307	2-1/4	15-3/4	2
CR311	2-1/4	5-1/4	2
CR312	2-1/4	7	2
CR313	2-1/4	8-3/4	2
CR314	2-1/4	10-1/2	2
CR315	2-1/4	12-1/4	2
CR316	2-1/4	14	2
CR317	2-1/4	15-3/4	2
CR321	3	7-1/8	3-3/8
CR322	3	9-1/2	3-3/8
CR323	3	11-7/8	3-3/8
CR324	3	14-1/4	3-3/8
CR325	3	16-5/8	3-3/8
CR331	3	7-1/8	3-3/8
CR332	3	9-1/2	3-3/8
CR333	3	11-7/8	3-3/8
CR334	3	14-1/4	3-3/8
CR335	3	16-5/8	3-3/8
CR341	5-1/2	7-11/16	5-3/8
CR342	5-1/2	10-1/4	5-3/8
CR343	5-1/2	12-13/16	5-3/8
CR344	5-1/2	15-3/8	5-3/8
CR351	5-1/2	7-11/16	5-3/8
CR352	5-1/2	10-1/4	5-3/8
CR353	5-1/2	12-13/16	5-3/8
CR354	5-1/2	15-3/8	5-3/8
CR401	2-1/4	5-1/4	2
CR402	2-1/4	5-1/4	2
CR403	2-1/4	8-3/4	2
CR404	3	7-1/8	3-3/8
CR405	3	7-1/8	3-3/8
CR406	3	11-7/8	3-3/8
CR407	5-1/2	7-11/16	5-3/8
CR408	5-1/2	7-11/16	5-3/8
CR409	5-1/2	12-13/16	5-3/8
CR501	2-1/4	7	2
CR502	2-1/4	7	2
CR503	3	9-1/2	3-3/8
CR504	3	9-1/2	3-3/8
CR505	5-1/2	10-1/4	5-3/8
CR506	5-1/2	10-1/4	5-3/8



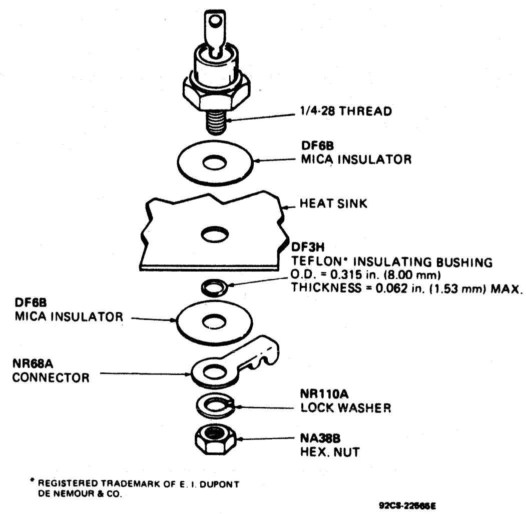
RCA Type No.	Dimensions Inches	
	A	B
CR601	13-3/8	13-7/8
CR602	13-3/8	13-7/8
CR603	20	20-1/2

Suggested Hardware and Mounting Arrangements

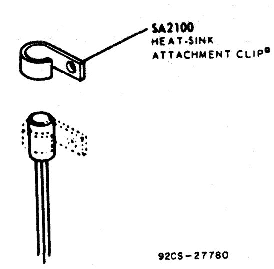
DO-4



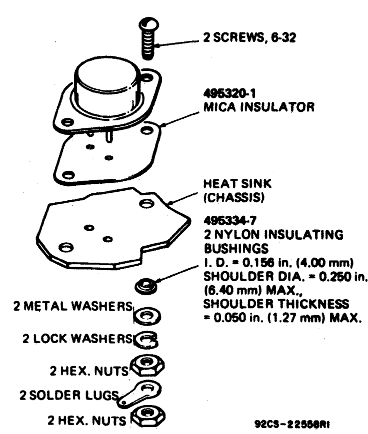
DO-5



TO-1



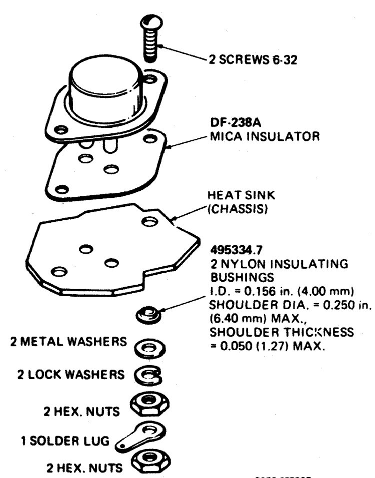
TO-3



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 12 in.-lbs. (0.14 kgf m).

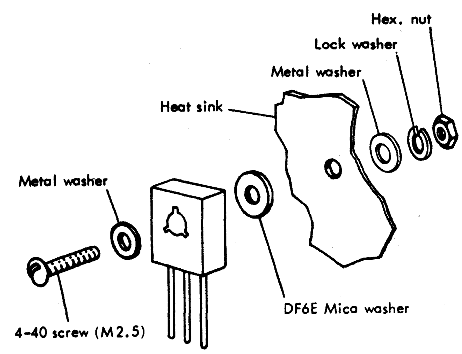
Note: Maximum torque applied to mounting flange is 12 in-lb (0.14 kgf-m).

MODIFIED TO-3



Note: Maximum torque applied to mounting flange is 12 in-lb (0.14 kgf-m).

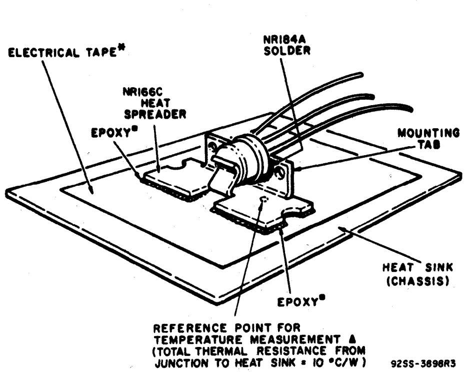
PLASTIC TO-5



Recommended torque (for even distribution of mounting pressure and optimum thermal contact): 6 lbs. in (0.07 kgf-m).

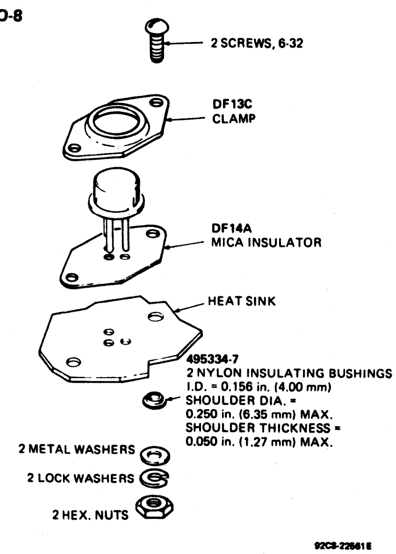
92CS-27783

"LOW - Profile TO-5" with Heat Spreader



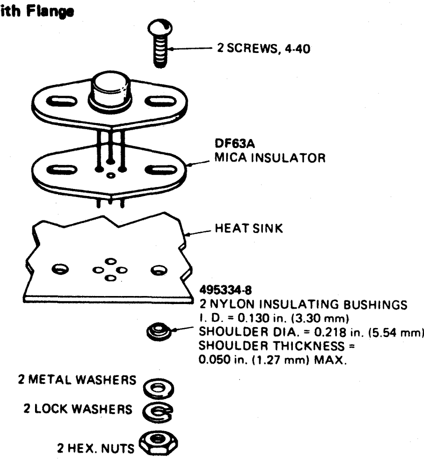
- * Scotch brand electrical tape No.27 (thermo setting one side), Minnesota Mining & Mfg. Co., St Paul, Minnesota, or equivalent.
- ■ An epoxy such as Hysol Epoxy Patch Kit 6C, Hysol Corporation, Olean, N. Y. 14761, or equivalent.
- ▲ For heat-sink temperature measurement, the thermocouple (wire no larger than AWG No. 26) should be inserted in a small, shallow hole drilled in (but not through) the heat sink at the indicated temperature reference point.

TO-8



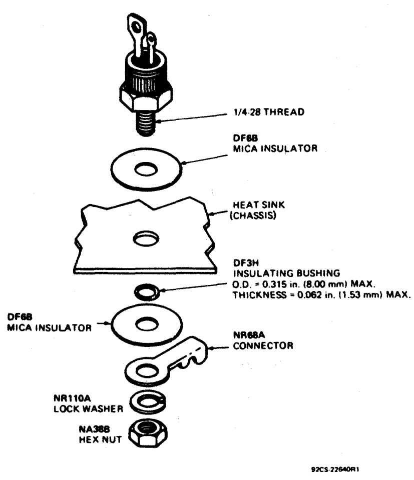
Note: Maximum torque applied to mounting flange is 12 in-lb (0.14 kgf-m).

TO-39/TO-5 With Flange

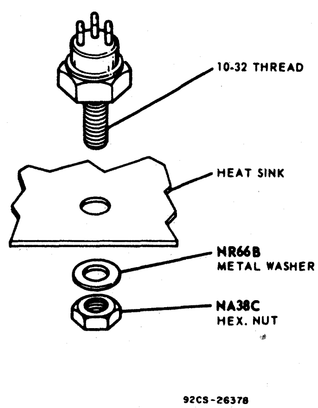


Note: Maximum torque applied to mounting flange is 8 in-lb (0.09 kgf-m).

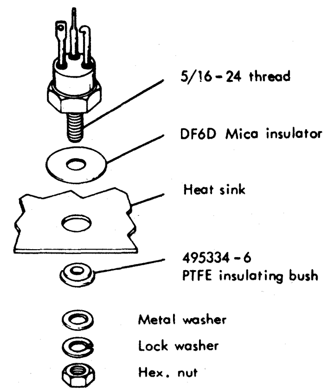
TO-48



TO-60



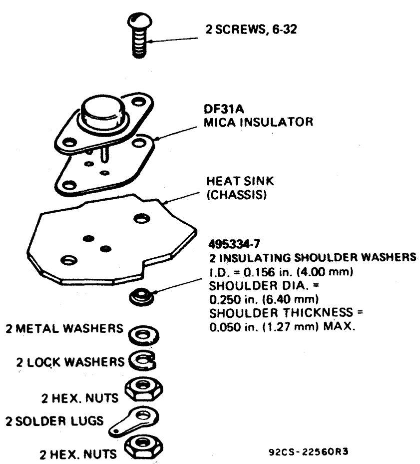
TO-63



Maximum torque: 30 lbf in (0.35 kgf m)

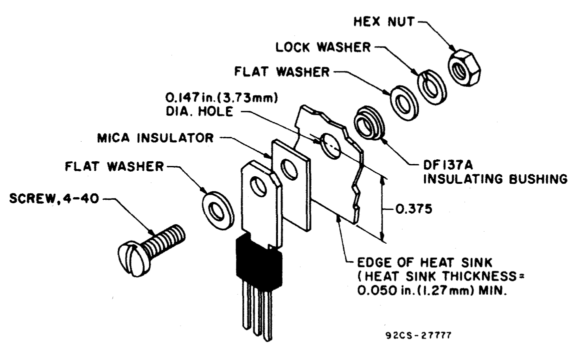
92CS-27781

TO-66

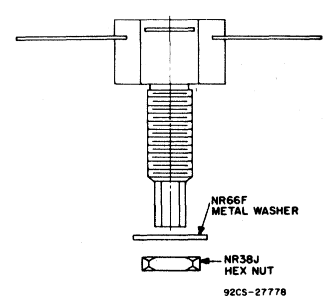


NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 12 in. lb. (0.14 kgf m)

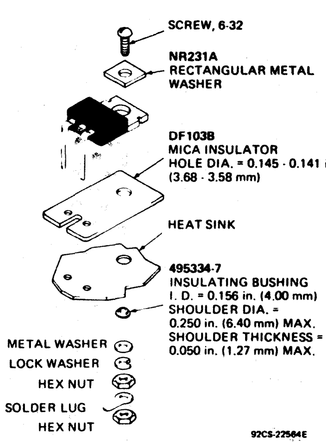
TO-202AB



TO-216AA

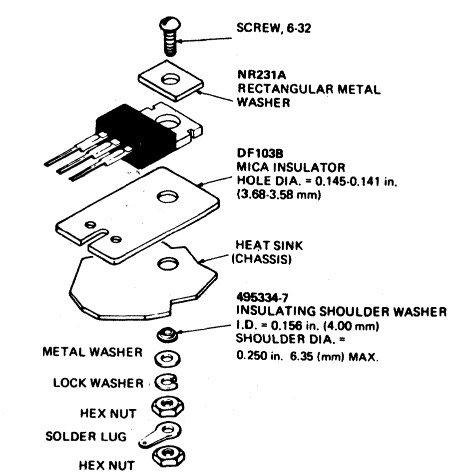


TO-220AA



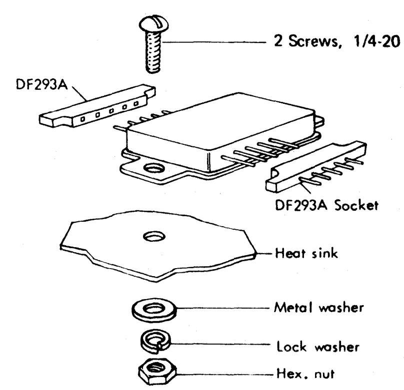
Note: Maximum torque applied to mounting flange is 8 in-lb (0.09 kgf-m).

TO-220AB



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in.-lb. (0.09 kgf-m)

Power Hybrid Circuit Package

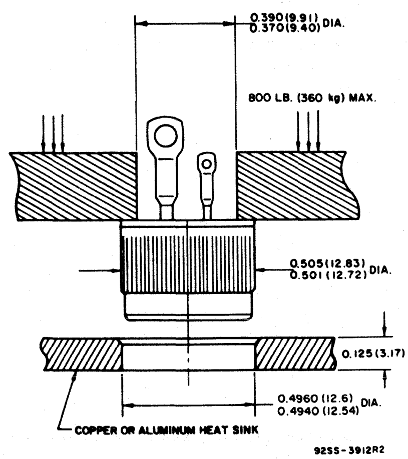


Note: Maximum torque applied to mounting flange is 24 in-lb (0.3 kgf-m).

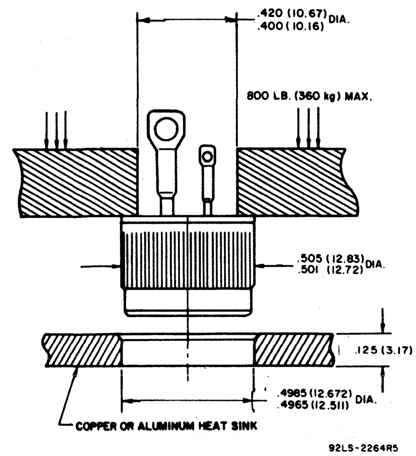
DF293A is a socket to enable simple connection of this module

92CS-27782

Press-Fit (PF-1)
6-, 10-, and 15-A Triacs, 20- and 35-A SCR's

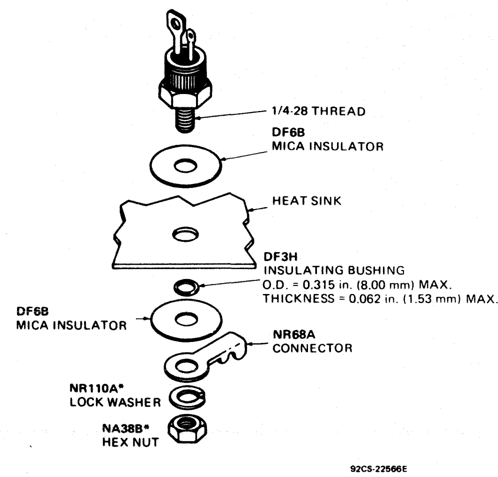


Press-Fit (PF-2)
25-, 30-, and 40-A Triacs



NOTE: Dimensions in parentheses are in millimeters.

Stud and Isolated-Stud
Triacs and SCR's except 60- and 80-A Triacs



* Only hardware required for isolated-stud package

Case-to-Heat Sink Thermal Resistance for Different Mounting Arrangements—Triacs and SCR's except 60- and 80-A Triacs

Package	Type of Mounting Employed	Thermal Resistance-°C/W
Press-Fit	Press-fitted into heat sink. Minimum required thickness of heat sink = 1/8 in. (3.17 mm).	0.5
	Soldered directly to heat sink. (60-40 solder which has a melting point of 188°C should be used. Heating time should be sufficient to cause solder to flow freely).	0.1 to 0.35

Case-to-Heat Sink Thermal Resistance for Different Mounting Arrangements—Triacs and SCR's except 60- and 80-A Triacs

Package	Type of Mounting Employed	Resistance-°C/W
Stud & Isolated-Stud	Directly mounted on heat sink with or without the use of heat-sink compound.	0.6
Stud	Mounted on heat sink with a 0.004 to 0.006 in. (0.102 to 0.152 mm) thick mica insulating washer used between unit and heat sink.	
	Without heat sink compound	2.5
	With heat sink compound	1.5

Press-Fit
Triacs and SCR's except 60- and 80-A Triacs

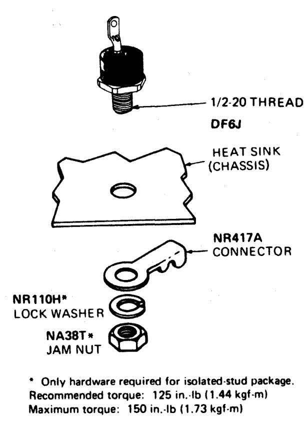
MOUNTING CONSIDERATIONS

Mounting of press-fit package types depends upon an interference fit between the thyristor case and the heat sink. As the thyristor is forced into the heat-sink hole, metal from the heat sink flows into the knurl voids of the thyristor case. The resulting close contact between the heat sink and the thyristor case assures low thermal and electrical resistances.

A recommended mounting method, Press-Fit (PF-1) or Press-Fit (PF-2), shows press-fit knurl and heat-sink hole dimensions. If these dimensions are maintained, a "worst-case" condition of 0.0085 in. (0.2159 mm) interference fit will allow press-fit insertion below the maximum allowable insertion force of 800 pounds. A slight chamfer in the heat-sink hole will help center and guide the press-fit package properly into the heat sink. The insertion tool should be a hollow shaft having an inner diameter of 0.380 ± 0.010 in. (9.65 ± 0.254 mm) for PF-1 package, and 0.410 ± 0.010 in. (10.41 ± 0.254 mm) for PF-2 package and an outer diameter of 0.500 in (12.70 mm). These dimensions provide sufficient clearance for the leads and assure that no direct force will be applied to the glass seal of the thyristor.

The press-fit package is not restricted to a single mounting arrangement; direct soldering and the use of epoxy adhesives have been successfully employed. The press-fit case is tin-plated to facilitate direct soldering to the heat sink. A 60-40 solder should be used and heat should be applied only long enough to allow the solder to flow freely.

Overmold
Stud and Isolated-Stud
60- and 80-A Triacs



* Only hardware required for isolated-stud package.
Recommended torque: 125 in.-lb (1.44 kgf-m)
Maximum torque: 150 in.-lb (1.73 kgf-m)

92CS-22843R1

Case-to-Heat Sink Thermal Resistance for Different Mounting Arrangements – 60- and 80-A Triacs

Package	Type of Mounting Employed	Resistance-°C/W
Stud	Directly mounted on heat sink with or without the use of heat sink compound	0.05 to 0.15
Isolated Stud		

Application Note Abstracts

Power Transistors

AN-3065 . . . . 12 pages
Silicon Transistors for High-Voltage Applications
Several applications for n-p-n high-voltage silicon transistors featuring high-frequency response, fast switching speeds, and low cost are discussed (RCA types 2N3583, 2N3584, 2N3585, 2N3439 and 2N3440). The applications include a series voltage regulator, a switching regulator, inverters, a magnetic deflection circuit, a line-operated audio amplifier, and an operational amplifier.

AN-3565 . . . . 4 pages
A 100-Watt, 18-KHz Inverter Using RCA-2N5202 Silicon Power Transistors
A two-transistor, two transformer inverter that demonstrates the excellent switching capabilities of the RCA-2N5202 power transistor is described.

AN-4124 . . . . 8 pages
Handling and Mounting of RCA Molded-Plastic Transistors and Thyristors
Detailed guidelines for handling and mounting plastic-packaged RCA power transistors and thyristors are given. Types of packages and suggested mounting hardware to accommodate various mounting arrangements are described. Recommendations are made for handling packages during the forming of leads. Various mounting arrangements, thermal considerations, and cleaning methods are described. This information is intended to supplement the data on electrical characteristics, safe operating area, and performance capabilities in the technical bulletin for each type of plastic-packaged transistor or thyristor.

AN-4509 . . . . 8 pages
Compact 5-Volt Power Supplies Using High-Voltage Power Transistors
The use of low-cost, industrial-type, high voltage power transistors and fast-recovery rectifiers to achieve size and weight reductions and efficiency improvements in 5-volt dc power supplies with output currents of 50 amperes or more are discussed. The supplies described, like those used in high-reliability aerospace applications, use switching rather than dissipating regulators to eliminate the need for a 60-Hz power transformer and heat sinks for the transsistors. A complete switching-regulator power supply is described in detail.

AN-4558 . . . . .12pages
A regulated constant-voltage power supply that uses integrated circuits and a rugged hometaxial-base transistor to attain high output-power capability is described. A 20-volt, 3-ampere supply that uses a single RCA-2N3055 pass transistor is described in detail; the discussion includes circuit descriptions, operating characteristics, component specifications, and suggestions for layout and construction. Thermal-fatigue effects and safe operating conditions for power transistors are considered. Guidance is provided for those who may want to develop a similar circuit.

AN-4573 . . . . 6 pages
Testing for Forward-Bias Second Breakdown in Power Transistors
The design of a non-destructive forward-bias second-breakdown test facility that determines the forward-bias second-breakdown safe-operating locus for power transistors is described. Detailed schematic diagrams of test circuits that can be used to test devices with collector-current ratings up to 2.5 amperes and sustaining collector-to-emitter voltage [V_{CEO}(sus)] ratings up to 300 volts, or with ratings to 5 amperes and 100 volts, are given.

AN4612 . . . . 4 pages
Thermal-Cycling Rating System for Silicon Power Transistors
The basic causes of thermal fatigue in silicon power transistors are analyzed, and a rating chart that makes it possible for a circuit designer to avoid such failures during the operating life of his equipment is described. Examples are provided on the use of this chart to determine the transistor operating conditions required to assure a desired thermal-cycling capability and to determine whether the thermal-cycling capability is adequate for the requirements of a given application.

AN-4673 . . . . 6 pages
A 750-Watt Three-Phase Frequency Converter
A frequency converter with an output frequency ranging from 380 Hz to 1250 Hz that delivers up to 750 watts of three-phase power at 120 or 208 volts rms is described. The circuit, useful in military equipment that uses three phase, 400-Hz power, and industrial plants and laboratories that require power at a variety of low frequencies, makes use of a three-phase bridge inverter supplied from a rectified line; the input can be single-phase or three-phase, 120 volts or 208 volts, at any frequency from 47 Hz to 1250 Hz. The RCA-2N5805 power transistor is used in the circuit.

AN-4783 . . . . 8 pages
Thermal-Cycling Ratings of Power Transistors
A testing program used to determine the capability of the design of an RCA-2N3055 power transistor to withstand thermal cycling over a wide range of operating conditions is described. A sufficient number of tests were performed to verify a rating chart that can be applied by an equipment designer to any practical operating condition. The discussion covers a brief description of thermal fatigue, a method of "scaling the environment" to determine the proper test conditions, specialized test equipment and techniques that assure that the proper stresses were applied to the transistor, and the test results and predicted-capability chart for the transistor.

AN-6145 . . . . 8 pages
A Test Set for Nondestructive Safe-Area Measurements Under High-Voltage, High-Current Conditions
The determination of the safe-operating area of power transistors at high volt/ampere products under pulsed and repetitive-pulsed conditions, nondestructively, is made possible by the test set described in this Note. System philosophy, design, construction, and operation are detailed.

AN-6163 . . . . 12 pages
Quantitative Measurement of Thermal-Cycling Capability of Silicon Power Transistors
This Note discusses the methods used to test the thermal-cycling capability of power transistors. A brief description of thermal fatigue, application requirements, and rating charts is given. A detailed discussion of the practical design and construction of thermal-cycling racks is also included along with actual test conditions for various power transistor types. Acceleration factors, failure indicators, failure mechanisms, and real-time control of thermal-cycling capability of factory products are discussed. Some information is also given on hermetic versus plastic-package thermal-cycling reliability.

AN-6195 . . . . 8 pages
A Switching Regulator Using An RCA p-n-p Power Darlington Transistor
A 20-kHz switching regulator that employs an RCA8350B, a p-n-p Darlington transistor, and that operates from a 28-volt supply is described. The regulator has a regulated output between 4 and 16 volts dc and features overload protection that limits the current to about 11 amperes. The regulator does not operate at a fixed clock frequency, but is free-running.

AN-6215 . . . . 6 pages
Interpretation of Voltage Ratings for Transistors
The basic voltage-breakdown mechanisms of power transistors and the relationship of these mechanisms to external circuits are described—transistor voltage breakdown is a function of both individual device characteristics and associated circuits. The mechanisms described are used to explain the various types of voltage ratings used by transistor manufacturers.

AN-6249 . . . . 6 pages
Real-Time Controls of Silicon Power-Transistor Reliability
This Note compares the traditional, classical approach to the reliability-assurance testing of power transistors with a newer classification of testing: Real-Time Control, RTC. The classical approach is commonly referred to as Group B, and involves a series of mechanical, environmental, and life stress tests. RTC involves a continuous, systematic evaluation and control in "real time" of basic, potential failure mechanisms. It is an important supplement to a total program of reliability assurance.

AN-6272 . . . . 6 pages
Characteristics of RCA Monolithic Power Darlingtons
The design and application of RCA monolithic power Darlington transistors is described. The Darlington circuit has been in use for some time in applications where high beta is needed, but has only recently been available as a monolithic device. The RCA Power Darlington series 2N6385 consists of n-p-n circuits that can be driven directly from an integrated circuit and that operate at currents up to 10 amperes and voltages ranging from 40 to 80 volts.

Application Note Abstracts (cont'd)

AN-6281 . . . . 6 pages
Accurate Measurement of Sustaining Voltage of Power Transistors — A Pulsed-Breakdown Test Set
Several techniques for the measurement of the primary (sustaining) breakdown voltage of power transistors are in common use today. The characteristics and limitations of these test methods frequently make rapid and accurate sustaining-voltage readings on power transistors difficult or impossible. The test set described in this Note fills the need for accurate, laboratory-type, sustaining-voltage measuring equipment, although circuitry used in the test set design may be adapted to high-speed testing equipment as well. A complete parts list and calibration sequence are given.

AN-6297 . . . . 2 pages
Biasing Circuit for the Output Stage of a Power Amplifier — The V_{BE} Multiplier
A biasing circuit, the V_{BE} multiplier, for the output stage of a power amplifier is described. The V_{BE} multiplier provides proper bias for the output transistors of the amplifier under all operating conditions.

AN-6320 . . . . 8 pages
Radiation-Hardness Capability of RCA Silicon Power Transistors
The types of radiation damage that might be experienced by a power device and the tests used to determine the design most effective in preventing these types of damage are described.

AN-6330 . . . . 12 pages
A Safe-Area Rating System for Power Inverters Handling Capacitive and Inductive Loads
Although transistor power inverters have classically been evaluated with resistive loads, the reliability of practical inverters often depends on inductive and capacitive loads and associated starting transient considerations. This Note describes a safe-area rating system for transistors and relates this system to self-excited single-transformer, self-excited double transformer, and driven inverters operating into resistive, capacitive, and inductive loads under both steady-state and starting conditions.

AN-6400 . . . . 16 pages
Operating Conditions Experienced by Transistors in TV Horizontal-Deflection Circuits
This Note is a compilation of equations used to calculate the operating conditions experienced by the output transistor in various types of deflection circuits, circuits that provide horizontal (line) deflection of the electron beam in TV picture tubes employing magnetic deflection yokes. The circuits treated include direct-drive circuits and those in which taps and auxiliary windings on the flyback transformer are employed to provide impedance transformation and yoke voltage reduction. Derivations of the various equations, the simplified as well as the rigorous forms, are provided in Appendixes. Relationships for calculating the "worst case" voltage conditions are given. Operating conditions as measured in experimental circuits are compared with those calculated by means of the equations provided in this Note.

AN-6432 . . . . 8 pages
2-Kilowatt Stepped Sine-Wave Inverter
Recent advances in high-power semiconductor technology, complemented by the capabilities of existing digital integrated circuits, have made possible the economical design of a stepped sine-wave inverter in the multikilowatt range. This Note describes the use of the 2N5578 power transistor in a 2-kilowatt, 60-Hz, stepped sine-wave inverter.

RF/Microwave Power Transistors

AN-3749 . . . . 6 pages
40-Watt Peak-Envelope-Power Transistor Amplifier for AM Transmitters in the Aircraft Band (118 to 136 MHz)
A broadband amplifier for use in AM transmitters operating in the aircraft communication band (118 to 136 MHz) is described. The uncomplicated design of the unit leaves ample room for adaptation to specific needs. The amplifier is capable of delivering peak envelope power of 40 watts at a modulation of 95 per cent with a collector voltage of 12.5 volts dc. Unmodulated drive of 5 milliwatts is required at the input. The overall efficiency of the amplifier is 48 to 53 per cent and the envelope distortion is less than 5 per cent for an amplitude modulation of 95 per cent.

AN-3755 . . . . 12 pages
UHF Power Generation Using RF Power Transistors
The use of rf power transistors in high-power generating sources that employ multiple transistors, pulse operation, and broadband power amplifiers is discussed. Operational principles for and design approaches to, these applications are presented, and practical and reliability aspects are discussed.

AN-3764 . . . . 12 pages
Microwave Amplifiers and Oscillators Using the RCA-2N5470 Power Transistor
The capabilities and some of the uses of the 2N5470 power transistor in the uhf/microwave amplifiers and oscillators that are the essential building blocks for solid-state microwave, radiosonde, and S-band telemetry equipment are discussed. Device and package construction and reliability considerations are described, along with large and small-signal operation at microwave frequencies. Detailed designs and performance data are given for practical circuits incorporating the 2N5470.

AN-4025 . . . . 6 pages
The Use of Coaxial-Package Transistors in Microstripline Circuits
The design, construction, and performance of two microstripline circuits employing 2N5470 coaxial transistors is described. One circuit is a 1.5-GHz amplifier that can provide 1.5 watts of output power with 8 dB of power gain at 50 per cent collector efficiency; the second circuit is a 2-GHz amplifier that can provide 1.2 watts of output power with 6-dB of power gain at 40 per cent collector efficiency. Microstrip or stripline amplifier circuits employing the 2N5470 coaxial-package transistor can have thermal and electrical performance capabilities equal to those coaxial-line circuits.

AN-4421 . . . . 12 pages
16- and 25-Watt Broadband Power Amplifiers Using RCA-2N5918, 2N5919A, and 2N6105 UHF/Microwave Power Transistors
General design considerations for broadband rf amplifiers are discussed. The design of a 2N5919A amplifier that provides a constant power output of 16 watts with gain variation within 1 dB over a bandwidth of 225 to 400 MHz is also discussed. The 2N5918, 2N5919A, and 2N6105, which feature the stripline package, are examples of improved rf power transistors designed specifically for use in high-power broadband amplifiers operating in this range.

AN-4774 . . . . 4 pages
Hotspotting in RF Power Transistors
"Hotspotting", a localized heating effect that results from local current concentrations in the active areas of a transistor, is discussed. The effect can produce catastrophic thermal runaway, long-term deterioration of performance of a transistor during linear operation (class A or AB), when the device is operated with high collector-supply voltage, or when it is operated into a high load VSWR, even though the dissipation is within the limit set by the classical junction-to-case thermal resistance. Hotspot thermal resistance, $\theta_{JS\text{-}C}$, a parameter that can be used in reliability predictions, particularly for devices involved in linear or mismatch service, is examined.

AN-6010 . . . . 12 pages
Characteristics and Broadband (225 to 400 MHz) Applications of the RCA-2N6104 and 2N6105 UHF Power Transistors
This Note describes basic performance characteristics and specific circuit design details related to the application of the 2N6104 and 2N6105 transistors in broadband uhf power amplifiers intended for use over the frequency band from 225 to 400 MHz. The circuit designs shown in this Note employ 2N6105 transistors; however, equivalent performance can be achieved when 2N6104 transistors are used provided that adequate consideration is given to the mechanical differences of the package.

AN-6084 . . . . 8 pages
High-Power Transistor Microwave Oscillators
This Note describes an approach to the design of transistor microwave power oscillators that may be considered an extension of the more familiar technique used in the design of large-signal class C power amplifiers. The approach has resulted in the design of L- and S-band power sources that provide 1 to 10 watts of output power. These high efficiency power sources exhibit low residual FM noise and very good frequency stability, and are adaptable to voltage-tuning and phase-locking techniques.

AN-6126 . . . . 6 pages
60- and 100-Watt Broadband (225-to-400 MHz) Push-Pull RF Amplifiers Using RCA-2N6105 VHF/UHF Power Transistors
The use of 2N6105 transistors in push-pull rf power amplifiers designed for operation over the frequency range from 225 MHz to 400 MHz is described. The design and performance of a basic single-stage push-pull amplifier and the use of combined pairs of this basic circuit to obtain higher output-power levels are explained. An improved version of the basic push-pull circuit is also described.

Application Note Abstracts (cont'd)

AN-6291 . . . . 6 pages
Microwave Transistor Oscillators
Bipolar-transistor oscillators are important components in many communications, test, and military systems. These transistor sources, which feature low residual FM noise, very good frequency stability, and a capability for voltage tuning and phase locking, are available in a wide range of options: fundamental oscillators, frequency doublers, and frequency multipliers. Power outputs range from the milliwatt level to much higher power levels. Bipolar oscillators are less sensitive to spurious modes than IMPATT and TRAPATT diode oscillators. In addition, bipolar devices are rapidly developing a history of high reliability in this frequency range. Therefore, emphasis is placed in this Note on current L- and S-band transistor oscillator techniques.

Power Hybrid Circuits

AN-4483 . . . . 6 pages
General Application Considerations for the RCA-HC2000H Hybrid Linear Power Amplifier
This Note briefly describes the RCA HC-2000H hybrid linear amplifier and discusses such operating considerations as dc and ac power dissipation, efficiency as a function of frequency, protection against excessive load variations and reactive loads, and heat-sink requirements.

Thyristors (SCR's and Triacs)

AN-3469 . . . . 12 pages
Application of RCA Silicon Controlled Rectifiers to the Control of Universal Motors
Typical electric-motor control circuits are discussed along with the characteristics of universal motors. Schematic diagrams of the circuits are given and the advantages and limitations of each circuit are discussed. Speed control by use of phase-angle variations is described.

AN-3551 . . . . 6 pages
Circuit Factor Charts for RCA Thyristor Applications
In the design of circuits using thyristors, it is often necessary to determine the specific values of peak, average, and rms current flowing through the device. This Note contains charts that show several current ratios as functions of conduction and firing angles for some SCR and triac circuits. Examples are given of the use of these charts in the design of half-wave, full-wave ac, full-wave dc, and three-phase half-wave circuits using RCA thyristors. Current and voltage waveforms for the various circuits are included, as are curves of per-cent ripple in load current and voltage.

AN-3659 . . . . 6 pages
Application of RCA Silicon Rectifiers to Capacitive Loads
This Note describes a simplified rating system that allows designers to calculate the characteristics of capacitive-load rectifier circuits quickly and accurately. The effect of the addition of a series limiting resistance to such circuits and the importance of the ratio of the limiting resistance to capacitive reactance are described; curves of rectifier current ratios are presented as functions of the effective ratio. Typical design examples are given, and output-ripple considerations are discussed.

AN-3697 . . . . 8 pages
Triac Power-Control Applications
This Note describes triac operating characteristics and provides guidance in the use of triacs in specific applications: incandescent lamp controls, light-activated controls, motor controls, heat controls, and a proportional integral-cycle control.

AN-3778 . . . . 6 pages
Light Dimmers Using Triacs
A simple, inexpensive light-dimmer circuit that contains a diac, triac, and RC charge-control network is described. The use of the diac to trigger the triac in light-dimming circuits is explained. The basic light-control circuit is introduced and its operation described. In addition, the components added to improve circuit performance are discussed. Three complete circuits and parts lists are shown for 120-volt, 60-Hz operation and 240-volt, 50/60-Hz operation. Mechanical details involved in building the circuits are discussed, and a trouble-shooting chart is included.

AN-3822 . . . . 6 pages
Thermal Considerations in Mounting of RCA Thyristors
Three simple rules to aid the designer in determining heat-sink specifications for a given application are provided. Power dissipation and heat-sink area, the mounting of thyristors on heat-sinks, typical heat-sink configurations, and chassis-mounted heat-sinks are discussed.

AN-3886 . . . . 6 pages
AC Voltage Regulators Using Thyristors
This Note describes a basic ac-voltage regulating technique using thyristors that prevents ac rms or dc voltage from fluctuating more than ±3 percent in spite of wide variations in input line voltage. Load voltage can also be held within ±3 percent of a desired value despite variations in load impedance through the use of a voltage-feedback technique. The voltage regulator described can be used in photocopying machines, light dimmers, dc power supplies, and motor controllers (to maintain fixed speed under fixed load conditions).

AN-4124 . . . . 8 pages
Handling and Mounting of RCA Molded-Plastic Transistors and Thyristors
Detailed guidelines for handling and mounting plastic-packaged RCA power transistors and thyristors are given. Types of packages and suggested mounting hardware to accommodate various mounting arrangements are described. Recommendations are made for handling packages during the forming of leads. Various mounting arrangements, thermal considerations, and cleaning methods are described. This information is intended to supplement the data on electrical characteristics, safe operating area, and performance capabilities in the technical bulletin for each type of plastic-packaged transistor or thyristor.

AN-4242 . . . . 16 pages
A Review of Thyristor Characteristics and Applications
This Note describes the operation, ratings, characteristics and typical applications of thyristors. The basic operation of a thyristor is explained by use of a two-transistor anology. The significance of voltage and temperature ratings is pointed out. Thyristor gate characteristics, switching behavior, and triggering techniques are described. Use of thyristors in typical power-control applications is discussed.

AN-4537 . . . . 8 pages
Thyristor Control of Incandescent Traffic-Signal Lamps
This Note discusses the use of thyristors in the control of traffic signals. The thyristor most applicable to this application is the triac, which can carry the electrical power required for incandescent traffic-light bulbs, yet can be gated by the low-power signals from electronic control timers or monitoring computers. In addition, the triac is able to handle the large transient currents that result from cold filament turn-on (inrush) and filament rupture (flash-over). Triac operation, stresses on triacs in operation with incandescent lamps, and a number of triac circuits for control of incandescent lamps in traffic signal applications are discussed.

AN-4745 . . . . 6 pages
Analysis and Design of Snubber Networks for dv/dt Suppression in Thyristor Circuits
When a triac is used to control an inductive load, voltages with high rates of change (dv/dt) can be generated that can cause a non-gated turn-on of the triac. The result is a loss of control of power to the load. The simplest method of suppressing this dv/dt stress is to place a series RC network across the main terminals of the triac. The design of this network, commonly called a snubber network, must take into account the peak voltage that can be allowed in the circuit and the maximum dv/dt stress that the device can withstand. This Note analyzes the RC network design and contains graphs that allow a designer to select a snubber to fit a given application.

AN-6054 . . . . 6 pages
Triac Power Controls for Three-Phase Systems
The growing demand for solid-state switching of ac power in heating controls and other industrial applications has resulted in the increasing use of triac circuits in the control of three-phase power. This Note explains a basic approach to the design of triac control circuits for use in the switching of three-phase power. The basic design rules employed in this approach are outlined, an integrated-circuit zero-voltage switch specifically intended for use in triac triggering is briefly described, and the necessity for, and methods of isolation of, the dc logic circuitry in power controls for three-phase systems are pointed out. Recommended configurations are then shown for power-control circuits intended for use with both inductive and resistive balanced three-phase loads, and the specific design requirements for each type of loading condition are discussed.

Application Note Abstracts (cont'd)

AN-6069 . . . . 8 pages
Solid-State Approaches to Cooking-Range Control

As a result of decreasing semiconductor costs, advanced system-cost analysis by appliance manufacturers, and increased consumer consciousness, various solid-state range-control designs can be applied in today's applicance market. This Note presents various solid-state design approaches available to the range-control designer.

AN-6141 . . . . 6 pages
Power Switching Using Solid-State Relays

Solid-state relays make use of a semiconductor device for control of ac or dc power. Since, in most ac applications, the semiconductor element chosen for power control is the triac, this Note describes the triac as a power-switching element. Advantages and disadvantages of the active element over the electro-mechanical relay are discussed in general terms. Basic parameters, such as surge in-rush capability, transient-voltage ratings, suppression network, turn-off consideration and the different modes of triac gating are also discussed. AC power control is covered by various circuit designs for ON/OFF control, zero-voltage switching, and line-voltage isolation.

ICAN-6182 . . . . 28 pages
Features and Applications of RCA Integrated-Circuit Zero - Voltage Switches (CA3058, CA3059 and CA3079

RCA-CA3058, CA3059 and CA3079 zero-voltage switches are monolithic integrated circuits designed primarily for use as trigger circuits for thyristors in ac power-control and power-switching applications. These integrated-circuit switches operate from ac input voltages of 24, 120, 208 to 230, or 277 volts at 50, 60, or 400 Hz. Zero-voltage switches trigger the thyristors at zero-voltage points in the supply-voltage cycle. Consequently, transient load-current surges and radio-frequency interferance are substantially reduced. Zero-voltage switches also reduce the rate of change of on-state current (di/dt) in the thyristor being triggered and can be adapted for use in a variety of control functions by use of an internal differential comparator to detect the difference between two externally developed voltages.

AN-6286 . . . . 8 pages
Latching, Gate-Trigger Circuits Using Thyristors for Machine Control Applications

This Note describes a variety of approaches to the development of a solid-state, latching gate drive for the control of ac loads; the solid-state device used is the thyristor. The solid-state circuits described have fewer undesirable characteristics than electro-mechanical devices and are smaller and lighter.

AN-6288 . . . . 2 pages
Thyristors in Capacitive Discharge (CD) Ignition Systems

This Note describes the requirements of small-engine ignition systems (those deriving electrical energy from a flywheel alternator system), automotive or battery-powered systems, and the ac line-operated igniters. The merits of both capacitive and inductive systems are compared. Both systems are described in terms of performance and limitations. Practical circuits are shown.

AN-6456 . . . . 12 pages
Characteristics and Applications of RCA Fast-Switching ASCR's

Silicon controlled rectifiers (SCR's) used in applications such as inverters, choppers, and radar pulse modulators at switching frequencies up to 30 kHz require high di/dt and dv/dt capabilities and very short turn-on and turn-off times. This Note explains SCR characteristics required for fast-switching applications, describes a new type of fast-switching SCR, the asymmetrical silicon controlled rectifier (ASCR), and discusses the application of this new type of SCR in induction cooking ranges.

AN-6457 . . . . 20 pages
Characteristics and Applications of RCA Gate-Turn-Off Silicon Controlled Rectifiers

This Note provides basic information on the theory, special operating considerations, and applications of GTO devices with particular attention given to the RCA G5001, G5002, and G5003 series of 8.5-ampere types. First, GTO devices are compared with conventional silicon controlled rectifiers (SCR's) and power transistors. The basic theory of operation of GTO silicon controlled rectifiers is then explained, and significant ratings and characteristics for these devices are discussed. Guidance is also provided on the use of GTO's in circuit applications, and a number of typical applications are examined.

BR = Bridge rectifier
D = Diac
GTO= Gate-turn-off SCR
ITR = Integrated thyristor/rectifier
PH = Power hybrid circuit
PT = Power transistor
R = Rectifier
RA = Rectifier assembly
RF = RF/microwave transistor
SCR = Silicon controlled rectifier
TRI = Triac

*JAN-type versions also available.

RCA
Solid State

·TRANSISTORS·TRANSISTORS·TRANSISTORS·TRANSISTORS·TRANSISTORS·TRANSISTORS

·HIGH-REL TYPES·HIGH-REL TYPES·HIGH-REL TYPES·HIGH-REL TYPES·HIGH-REL TYPES