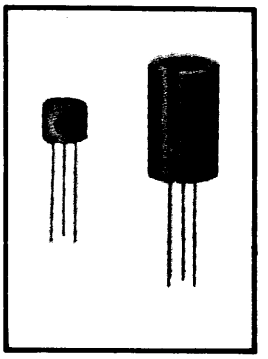
RCA TRANSISTORS
For Industrial Service

2N4068
2N4069

File No. 109

SILICON NPN TRANSISTORS

High-Voltage Types For Wide-Band-Amplifier And Relay-Driver Applications In Critical Industrial Equipment



JEDEC TO-1

RCA-2N4068 and 2N4069* are transistors of the silicon npn type, for use in wide-band-amplifier and relay-driver service in critical industrial applications. These transistors, which differ only in package configuration and dissipation capability, are designed for operation at frequencies up to 100 Mc/s, and feature high breakdown-voltage capabilities, exceptionally low collector-to-base feedback capacitance (2.8 pF typ.), low leakage currents, and low saturation voltages. They also feature an exceptionally linear transfer characteristic, and a high operating-temperature capability.

Both the 2N4068 and 2N4069 utilize a compact, hermetically sealed metal package and have the collector electrode internally connected to the case. The case of the 2N4069 is provided with an integral heat sink of 16-gauge aluminum which gives this transistor twice the dissipation capability of the 2N4068.

* Formerly Dev. Nos. TA-2786 and TA-2787, respectively.
# Registered Trade Mark: Burroughs Corporation.

AMPLIFIER SERVICE

Absolute-Maximum Ratings:

	RCA 2N4068	RCA 2N4069	
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	150	150 max.	volts
EMITTER-TO-BASE VOLTAGE, V_{EBO}	5	5 max.	volts
COLLECTOR CURRENT, I_C	200	200 max.	mA
TRANSISTOR DISSIPATION, P_T:			
At ambient temperatures: up to 25°C	0.5	1 max.	watt
above 25°C	See Fig. 1		
TEMPERATURE RANGE:			
Storage and operating (Junction).	-65 to +175		°C
LEAD TEMPERATURE (During soldering):			
At distances not closer than 1/32" to seating surface for 10 seconds max.	255	255 max.	°C

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APPLICATIONS:

- Distributed amplifiers
- Video amplifiers in TV cameras, camera chains, monitors, oscilloscopes
- Neon-indicator driver circuits
- NIXIE# driver circuits

FEATURES:

- high collector-to-emitter breakdown voltage capability:
  BV_{CEO} = 150 V min., 180 V typ.
- low collector-to-base feedback capacitance:
  C_{cb} = 2.8 pF typ., 3.5 pF max.
- low saturation voltages:
  $V_{CE}(sat)$ = 1 V typ. } I_C = 30 mA,
  $V_{BE}(sat)$ = 0.68 V typ. } I_B = 1 mA
- hermetically sealed 3-lead metal packages – collector internally connected to case
- RCA-2N4069 has integral heat sink for increased dissipation capability

ALFRED NEYE ENATECHNIK

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2N4068, 2N4069 7-66
Supersedes issue dated 2-60

ELECTRICAL CHARACTERISTICS, *at an Ambient Temperature (T_A) of 25° C*

CHARACTERISTICS	SYMBOLS AND UNITS	LIMITS			TEST CONDITIONS			
		RCA 2N4068 2N4069			DC Collector-Voltage V_{CB} or V_{CE}	DC Base Current I_B	DC Collector Current I_C	DC Emitter Current I_E
		Min.	Typ.	Max.	volts	mA	mA	μA
Collector-Cutoff Current	I_{CBO} nA	-	5	50	V_{CB} = 120			0
Collector-to-Emitter Breakdown Voltage	BV_{CEO} volts	150	180	-		0	1	
Emitter-to-Base Breakdown Voltage	BV_{EBO} volts	5	7	-			0	-10
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$ volts	-	1	3		1	30	
Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$ volts	-	0.68	-		1	30	
Static Forward Current-Transfer Ratio	h_{FE}	30	70	-	V_{CE} = 10		30	
Small-Signal Forward Current-Transfer Ratio	h_{fe}	-	80	-	V_{CE} = 10		30	f = 1 kc/s
Gain-Bandwidth Product	f_T Mc/s	50 50	100 100	- -	V_{CE} = 10 V_{CE} = 140		30 2	f = 100 Mc/s
Output Capacitance	C_{cb}△ pF	-	2.8	3.5	V_{CE} = 10		0	f = 1 Mc/s
Thermal Resistance, Junction-to-Case	θ_{J-C} °C/Watt	-	45	60	-	-	-	-
Thermal Resistance, Junction-to-Air	θ_{J-A} °C/Watt	2N4068 = 300 max. 2N4069 = 150 max.			-	-	-	-

△ Three terminal measurement: Lead No. 1 (emitter) and Lead No. 3 (case) connected to guard terminal.

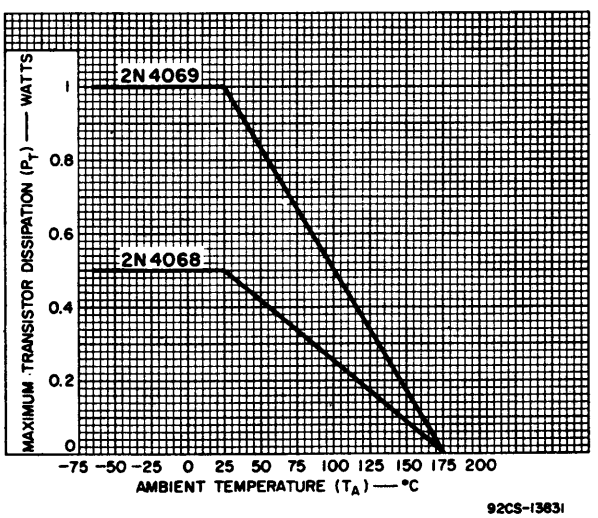


Fig. 1 - Rating Chart for RCA - 2N4068 and 2N4069

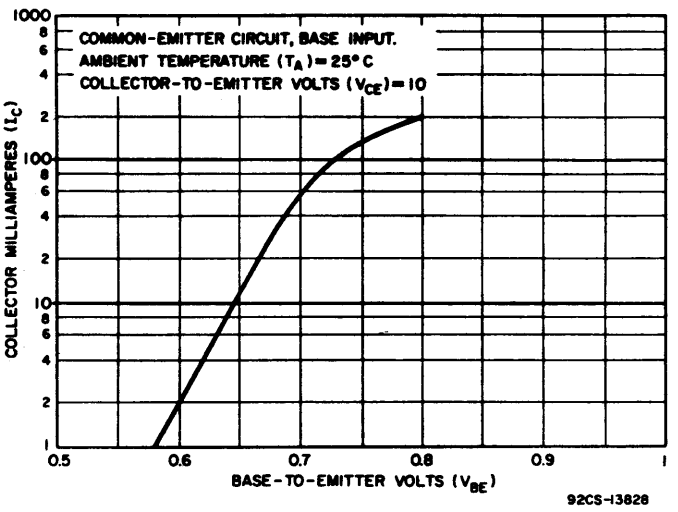


Fig. 2 - Typical Transfer Characteristic for RCA - 2N4068 and 2N4069

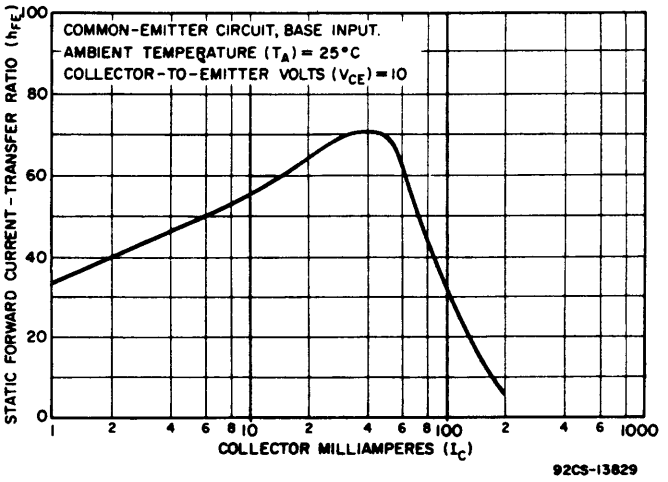


Fig. 3 - Typical Static Forward Current-Transfer Ratio (h_{FE}) Characteristic for RCA-2N4068 and 2N4069

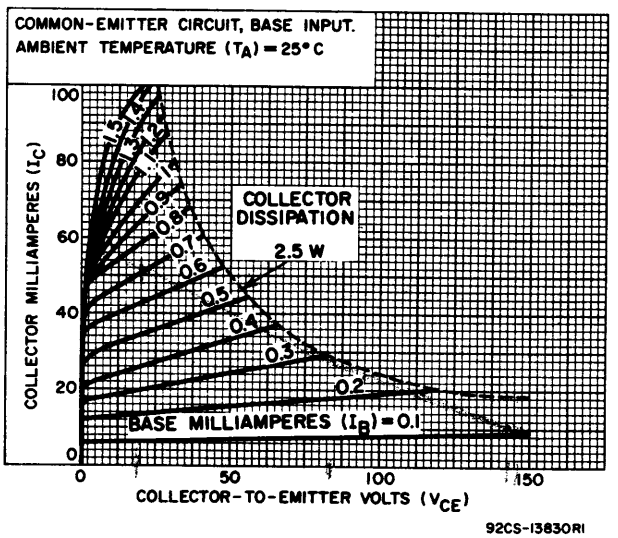


Fig. 4 - Typical Collector Characteristics for RCA-2N4068 and 2N4069

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

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, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

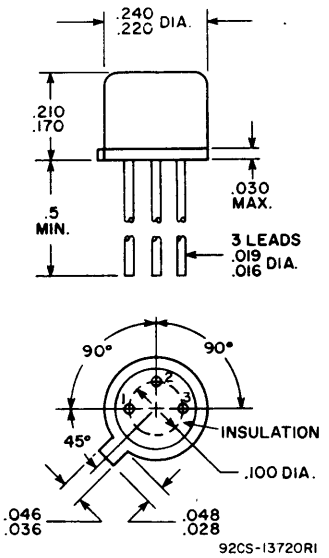
The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment,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

Because the metal shells of these transistors operate at the collector voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

RCA-2N4068 and 2N4069 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

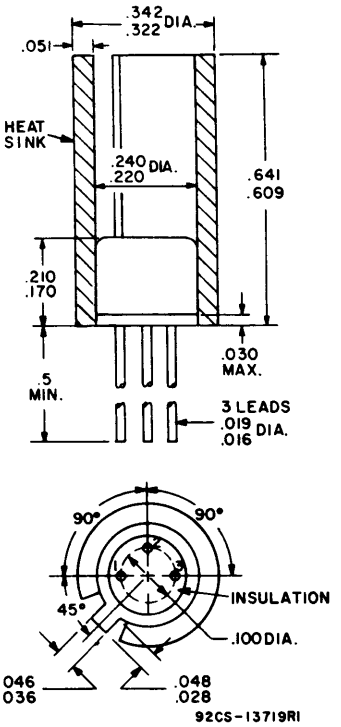
These transistors can be installed in commercially available sockets. Electrical connection to the base and emitter pins may also be made by soldering directly to these pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals. Otherwise the heat of the soldering operation will crack the pin seals and damage the transistor.

DIMENSIONAL OUTLINE FOR RCA-2N4068



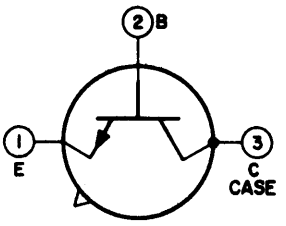
Dimensions in Inches

DIMENSIONAL OUTLINE FOR RCA-2N4069



Dimensions in Inches

TERMINAL DIAGRAM FOR RCA-2N4068 and 2N4069



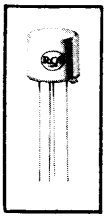
Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector, Case

2N4934
2N4935
2N4936

SILICON N-P-N EPITAXIAL PLANAR TRANSISTORS



JEDEC TO-104

For VHF/UHF Applications in Industrial and Commercial Equipment

RCA-2N4934, 2N4935, and 2N4396* are epitaxial planar transistors of the silicon npn type with characteristics which make them extremely useful as low-noise rf amplifiers at frequencies up to 500 MHz.

These types employ a New Terminal Arrangement in which the emitter and base connections are interchanged to provide maximum isolation between the output (collector) and the input (base) terminals. Although this new basing configuration does not appreciably change the measured device feedback capacitance, it permits the use of external inter-terminal shields to reduce the feedback due to external capacitances, particularly on printed circuit boards. This feature makes it possible to achieve greater circuit stability or higher useable gain per stage in critical circuit designs.

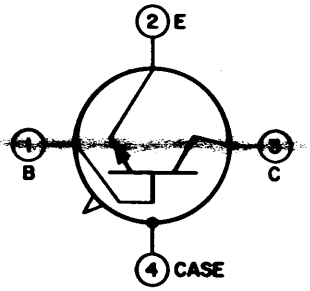
These devices feature very low feedback capacitance, low noise, and high useful power gains in their recommended applications. The high-temperature capability of these silicon devices permits operation up to 200°C.

RCA-2N4934, 2N4935, 2N4936 utilize a hermetically sealed metal case which is electrically isolated from the transistor electrodes. The case is provided with a separate lead which may be grounded to minimize collector-to-base interlead capacitance and coupling to other circuit components.

* Formerly Dev. No's TA7023, TA7024, TA7025, respectively.

FEATURES

- New Terminal Arrangement.....for superior high-frequency performance



1 - Base
2 - Emitter
3 - Collector
4 - Case

Bottom View

- high gain-bandwidth product — f_T = 700 MHz min.
- high unneutralized power gain — G_{pe} = 18 dB min for 2N4934 at 200 MHz; 21 dB min for 2N4935 at 200 MHz; 13 dB min for 2N4936 at 450 MHz
- low noise figure — NF = 3.5 dB max. for 2N4934 at 200 MHz; 3.0 dB max. for 2N4935 at 200 MHz; 4.5 dB max. for 2N4936 at 450 MHz
- very low collector-to-base feedback capacitance — C_{cb} = 0.25 pf max. at 0.1 to 1 MHz
- hermetically sealed TO-104 metal case
- high operating temperature capability to 200°C

Maximum Ratings, *Absolute-Maximum Values:*

	2N4934	2N4935	2N4936	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	40	50	50	max. V
COLLECTOR-TO-EMITTER VOLTAGE, V_{CEO}	30	40	40	max. V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3	3	3	max. V
COLLECTOR CURRENT, I_C	Limited by dissipation			
TRANSISTOR DISSIPATION, P_T:				
At ambient temperatures: Up to 25°C.	200 max.			mW
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 not less than 1/32" from seating surface for 10 seconds max.	265 max.			°C

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Printed in U.S.A.
2N4934 - 2N4936 3-67

ELECTRICAL CHARACTERISTICS, *At Ambient Temperature (T_A) of 25°C:*

CHARACTERISTIC	Symbol	TEST CONDITIONS					LIMITS									UNITS
		Frequency f	DC Collector-to-Base Voltage V_{CB}	DC Collector-to-Emitter Voltage V_{CE}	DC Emitter Current I_E	DC Collector Current I_C	Type 2N4934			Type 2N4935			Type 2N4936			
		MHz	V	V	mA	mA	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current	I_{CBO}	-	15	-	0	-	-	-	10	-	-	10	-	-	10	nA
Collector-to-Base Breakdown Voltage	BV_{CBO}	-	-	-	0	0.001	40	-	-	50	-	-	50	-	-	V
Collector-to-Emitter Breakdown Voltage	BV_{CEO}	-	-	-	I_B=0	1	30	-	-	40	-	-	40	-	-	V
Emitter-to-Base Breakdown Voltage	BV_{EBO}	-	-	-	-0.001	0	3	-	-	3	-	-	3	-	-	V
DC Forward Current-Transfer Ratio	h_{FE}	-	-	8	-	2	40	-	170	60	-	200	60	-	250	-
Magnitude of Small-Signal Forward Current-Transfer Ratio	$\|h_{fe}\|$ [a]	1kHz 100 MHz	- -	8 8	- -	2 2	45 7	- -	195 16	70 7	- -	225 16	70 7	- -	280 16	-
Collector-to-Base Feedback Capacitance	C_{cb} [b]	0.1 to 1	8	-	0	-	-	0.2	0.25	-	0.2	0.25	-	0.2	0.25	pF
Collector-to-Base Time Constant	$r_b'C_c$ [a]	31.9	8	-	-2	-	1	-	8	1	-	6	1	-	6	ps
Small-Signal, Common-Emitter Power Gain in Unneutralized Amplifier Circuit (See Figs. 1 and 4)	G_{pe} [a]	200 450	-	8	-	2	18 -	- -	26 -	21 -	- -	28 -	- 13	- -	- 18	dB
Small-Signal, Common-Emitter Power Gain in Neutralized Amplifier Circuit	G_{pe} [a]	450	-	8	-	2	-	-	-	-	-	-	-	20	-	dB
Measured Noise Figure	NF [a]	200 See Figs. 1 and 2	R_S = 200 Ω [c]	8	-	2	-	-	3.5	-	-	3.0	-	-	-	dB
		450 See Figs. 3 and 4	R_S = 100 Ω [c]	8	-	2	-	-	-	-	-	-	-	-	4.5	

[a] Lead No.4 (case) grounded.

[b] Three-terminal measurement: Lead No.2 (emitter) and lead No.4 (case) connected to guard terminal.

[c] R_S (Source Resistance) is the resistance looking back from the base terminal toward the generator input.

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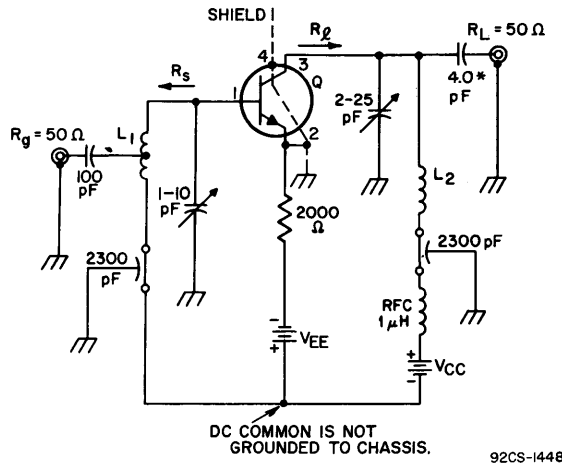


All Capacitance Values in Picofarads

L_1 = 1/2 turn No.14 FORMVAR** wire; center-tapped; total wire length = 2 inches.

L_2 = 1/2 turn No.14 FORMVAR wire; total wire length = 1-1/2 inches

Q = Type 2N4934, 2N4935

Transistor Terminating Resistances

R_s = 200 Ω

R_ℓ = 850 Ω

R_s is the resistance looking back from the base terminal toward the generator input.

R_ℓ is the resistance looking from transistor collector terminal toward the load.

* Effective capacitance between collector and output terminal. The actual capacitor value is 3.3 pF.

** Registered Trade Mark of Shawinidan Products Corp.

Fig. 1 - Unneutralized 200-MHz power gain and noise figure test circuit for 2N4934 and 2N4935.

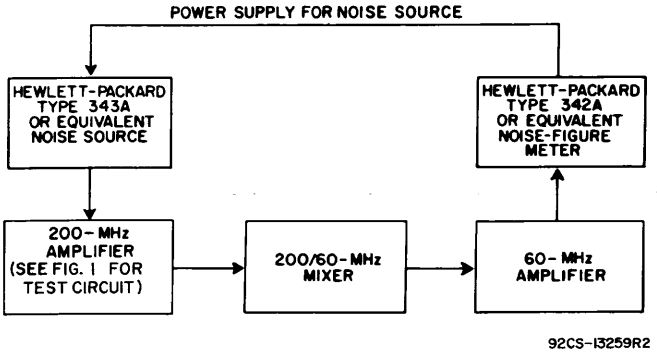


Fig. 2 - Block diagram of noise-figure test circuit for 2N4934 and 2N4935.

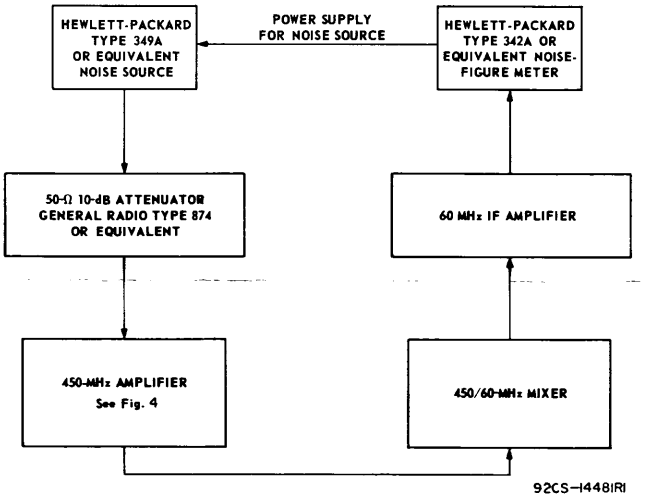
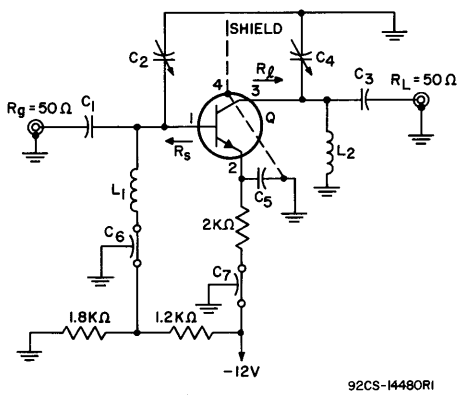


Fig. 3 - Block diagram of noise-figure test circuit for 2N4936.



All capacitors in picofarads

L_1, L_2 - 1/4-inch diameter brass bar 1 inch long

C_1 - Tubular ceramic 7.5 pF, approx. 3/8-inch total lead length

C_2, C_4 - Hammarlund MAC-10 variable air capacitor, or equivalent

C_3 - Button ceramic 1.2 pF, approx. 3/8-inch lead length

C_5 - Leadless ceramic disc capacitor - 50 pF

C_6, C_7 - Button ceramic feed thru capacitor - 50 pF

Q = 2N4936

R_s is the resistance looking back from the base terminal toward the generator input.

R_ℓ is the resistance looking from transistor collector terminal toward the load.

Fig. 4 - Unneutralized 450-MHz power gain and noise figure test circuit for 2N4936.

Typical y-parameter characteristics for 2N4934, 2N4935 and 2N4936 at 200 MHz

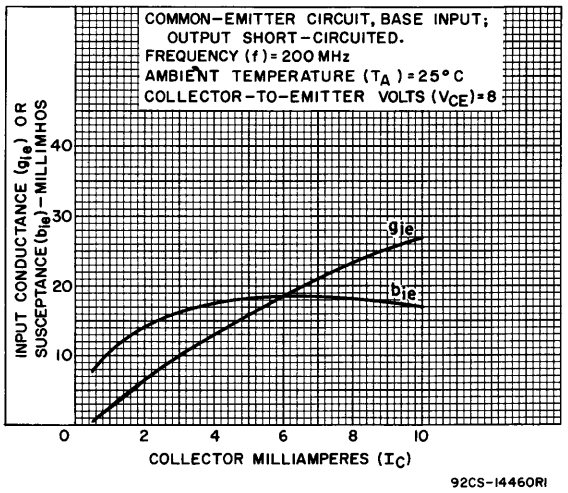


Fig.5 - Y_{ie} vs I_C

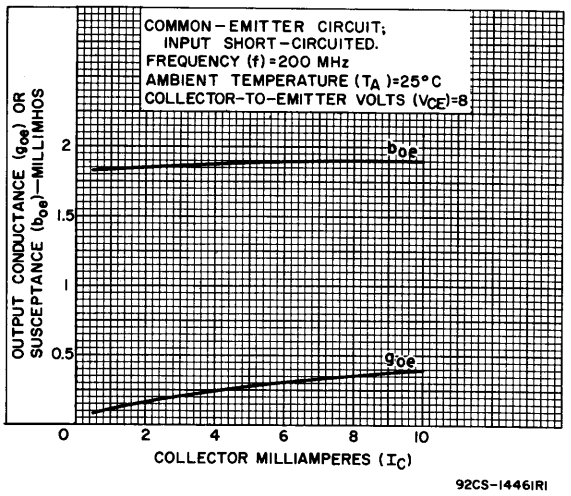


Fig.6 - Y_{oe} vs I_C

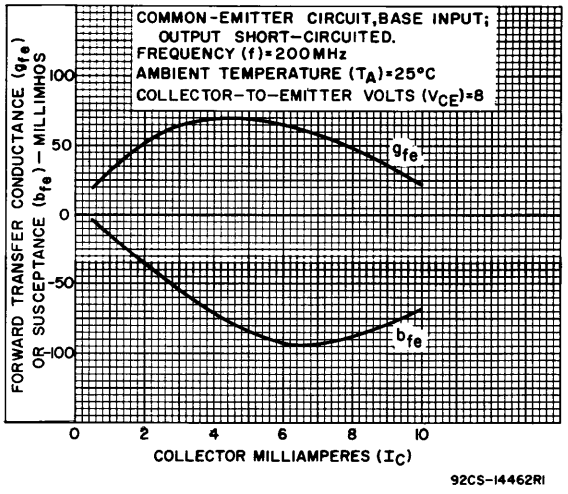


Fig.7 - Y_{fe} vs I_C

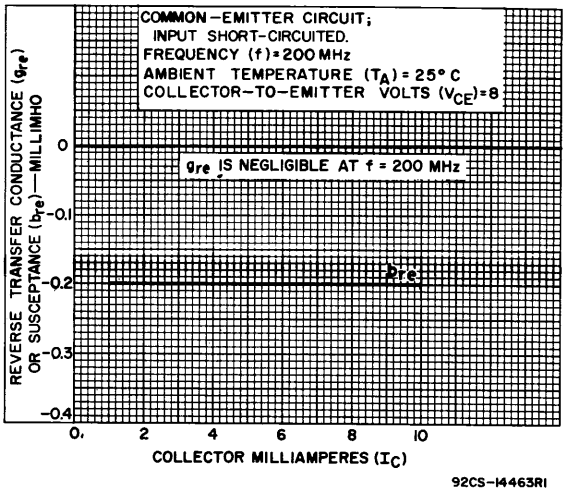


Fig.8 - Y_{re} vs I_C

Typical y-parameter characteristics for 2N4936 at 450 MHz

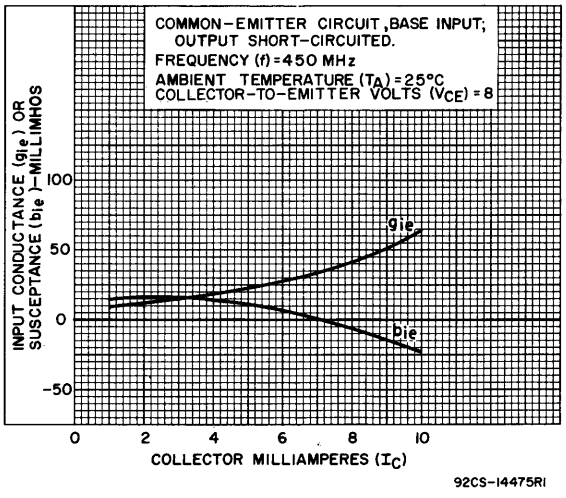


Fig.9 - Y_{ie} vs I_C

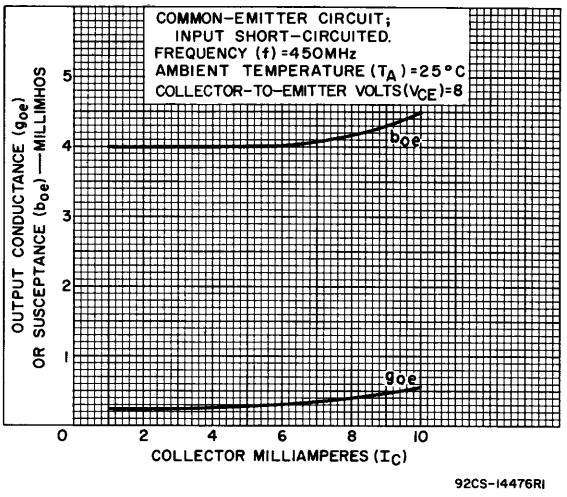


Fig.10 - Y_{oe} vs I_C

Typical y-parameter characteristics for 2N4936 at 450 MHz (cont'd)

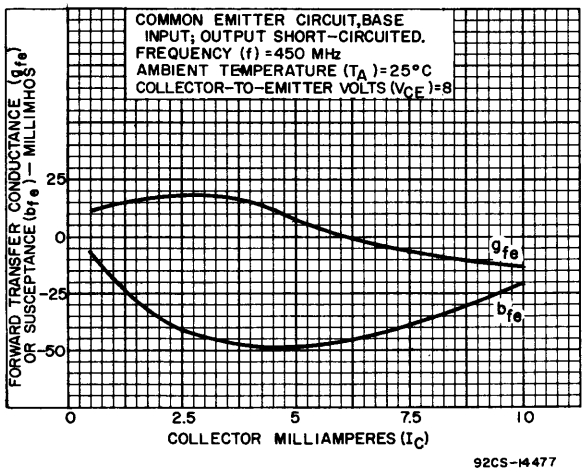


Fig. 11 - Y_{fe} vs I_C

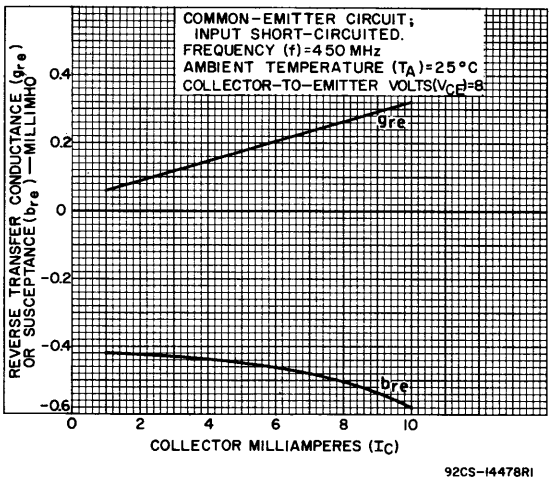


Fig. 12 - Y_{re} vs I_C

Typical y-parameter characteristics for 2N4934, 2N4935 and 2N4936

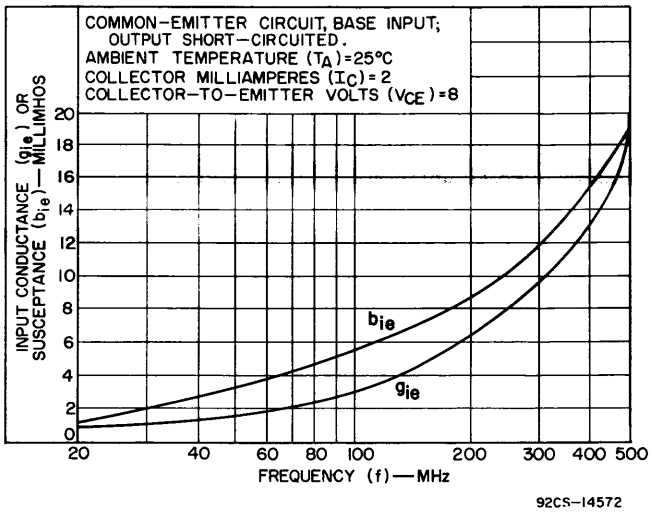


Fig. 13 - Y_{ie} vs f

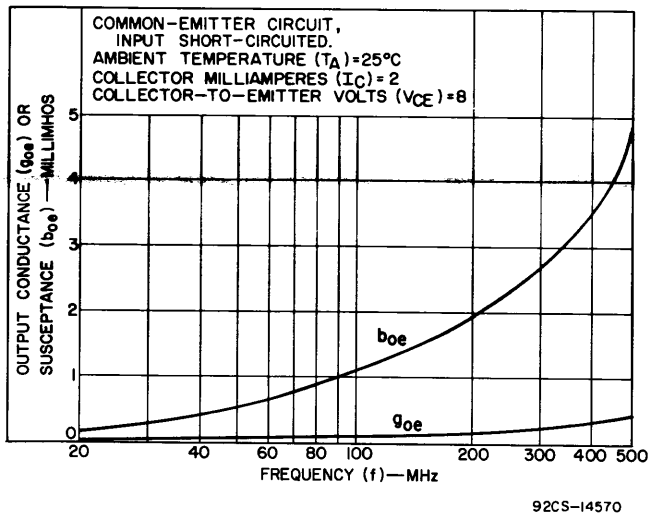


Fig. 14 - Y_{oe} vs f

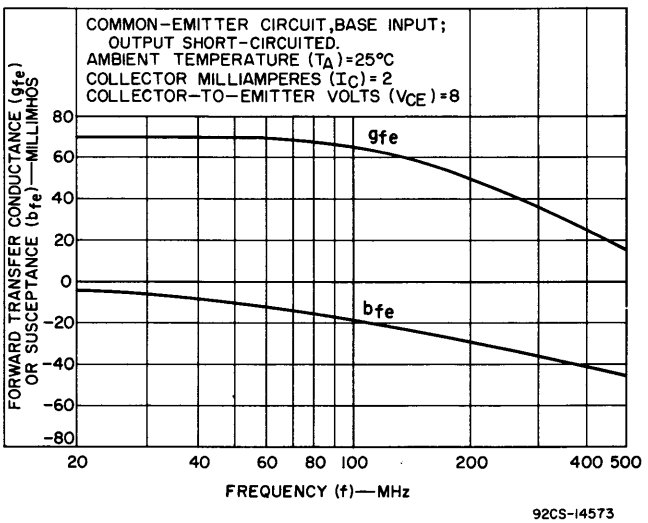


Fig. 15 - Y_{fe} vs f

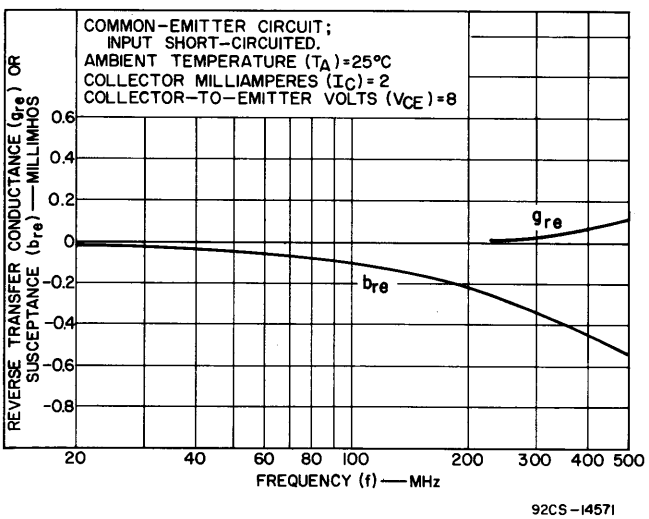


Fig. 16 - Y_{re} vs f

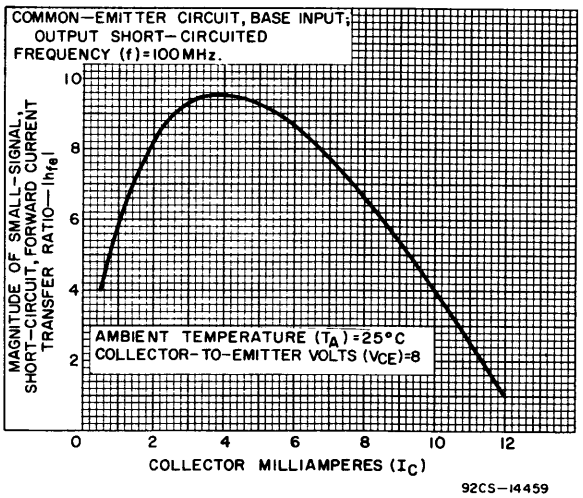
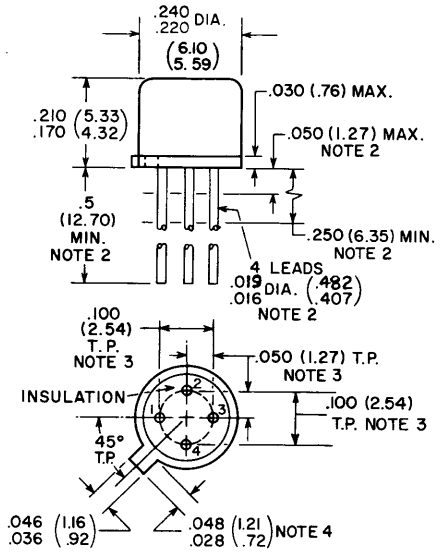


Fig. 17 - Typical small-signal beta characteristic for 2N4934, 2N4935 and 2N4935.

DIMENSIONAL OUTLINE
TO-104



Dimensions in Inches and Millimeters

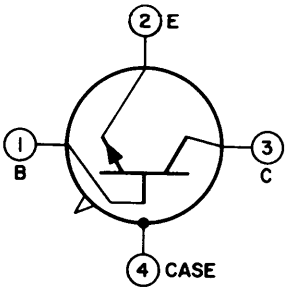
Note 1: *Dimensions in paranthesis are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) + 0.001" (0.025 mm) -0.000" (0.000 mm) below seating plane shall be within 0.007" (0.117 mm) of their true position (location) relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

ATTENTION!
NEW TERMINAL ARRANGEMENT
Bottom View



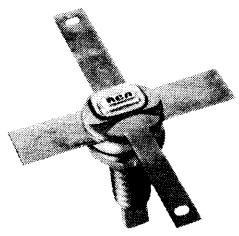
1 - Base
2 - Emitter
3 - Collector
4 - Case

OPERATING CONSIDERATIONS

The flexible leads of the 2N4934, 2N4935 and 2N4936 are usually soldered to the circuit elements. As in the case of any high-frequency semiconductor device, the tips of soldering irons should be grounded, and appropriate precautions should be taken to protect the device against high electric fields.

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

2 m : 15 - 20 W



H-1693

7-W AM, 66-to-88-MHz Emitter-Ballasted Silicon N-P-N Overlay Transistor

For 12.5-V Amplifiers in VHF Communications Equipment

Features

- 7-W min. (carrier) output, 10-dB min. gain at 88 MHz
- 90% min. modulation
- Emitter ballasted
- Infinite VSWR tested at rated output power under full modulation at 66 MHz
- Hermetically sealed stripline ceramic-metal package
- Electrically isolated mounting stud

MAXIMUM RATINGS, *Absolute-Maximum Values:*

* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	65	V
* COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE:			
With base shorted to emitter	$V_{(BR)CES}$	65	V
With base open	$V_{(BR)CEO}$	30	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
* CONTINUOUS COLLECTOR CURRENT	I_C	5	A
* TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 75°C		35.7	W
At case temperatures above 75°C		See Fig.5	
* 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

* In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7.

RCA type 2N5992[a] is an epitaxial silicon n-p-n planar transistor featuring overlay emitter eletrode construction. This device utilizes many separate emitter elements and has individual ballast resistance in each of the emitter sites for stabilization.

The transistor is completely tested for load-mismatch capability at 66 MHz with an infinity-to-one VSWR through all phases under rated power with full modulation.

This device features a hermetic, ceramic-metal package having leads isolated from the mounting stud. These rugged, low-inductance, radial leads are designed for stripline as well as lumped-constant circuits.

[a]Formerly RCA Dev. Type TA7920

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Printed in U.S.A./10-70

ELECTRICAL CHARACTERISTICS, At 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-to-Emitter Cutoff Current: Base-to-emitter shorted	I_{CES}	60	0				–	10[b]	mA
*	Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)CEO}$				0	200[a]	30	–	V
	With base connected to emitter	$V_{(BR)CES}$		0			200[a]	65	–	
*	Emitter-to-Base Breakdown Voltage	$V_{(BR)\ EBO}$			10		0	3.5	–	V
	Thermal Resistance: (Junction-to-Case)	θ_{J-C}						–	3.5	°C/W

[a] Pulsed through a 25-mH inductor; duty factor = 50%.

[b] T_C = 25 to 100°C

DYNAMIC

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS			UNITS
			DC Collector Supply (V_{CC}) V	Output Power (Carrier) P_{OE} W	Frequency (f) - MHz	Min.	Typ.	Max.	
	Power Input	P_{IE}	12.5	7	66 88	– –	0.35 0.5	0.5 0.7	W
*	Power Gain	G_{PE}	12.5	7	66 88	11.5 10	13 11.5	– –	dB
*	Collector Efficiency	η_C	12.5	7	66 88	55 60	60 70	– –	%
	Modulation[c]	m	12.5	7	66 88	90 90	97 95	– –	%
	Load Mismatch[c] (Fig.10)	LM	12.5	7	66	GO/NO GO			
*	Collector-to-Base Capacitance	C_{obo}	12.5 (V_{CB})		1	—	60	70	pF

[c] Input power and collector supply voltage are modulated

*In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7

PERFORMANCE DATA

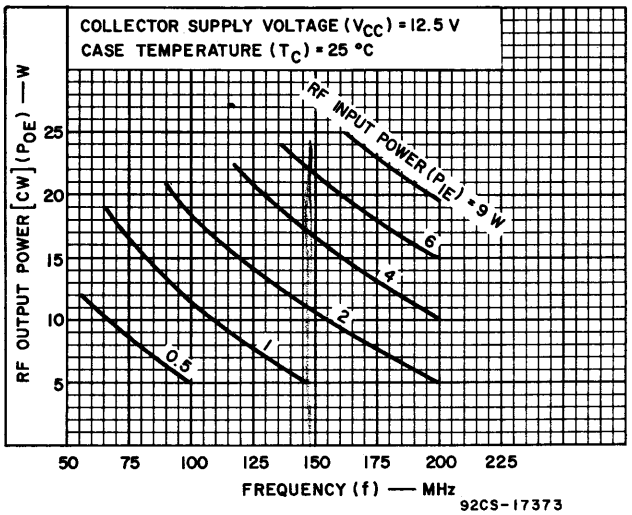


Fig. 1 - RF output power (cw) vs. frequency.

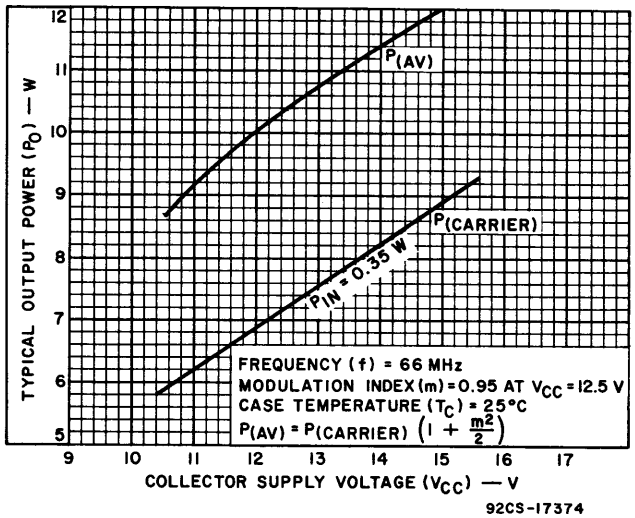


Fig. 2 - Typical output power vs. collector supply voltage.

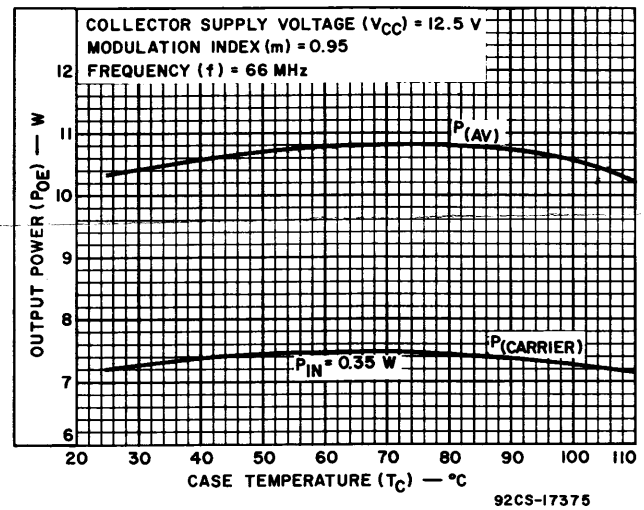


Fig. 3 - Typical output power vs. case temperature.

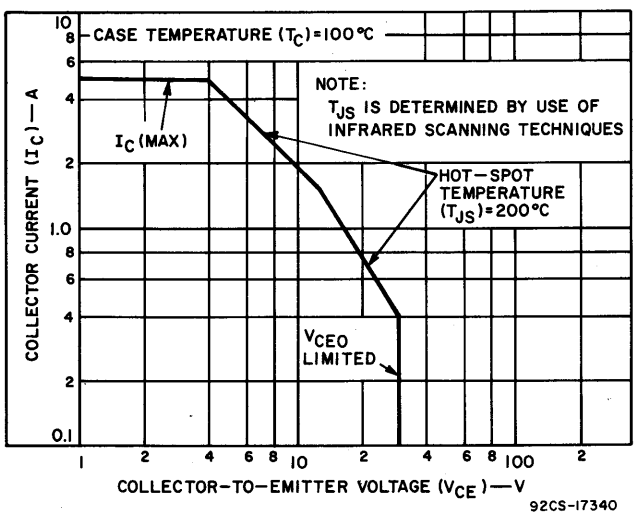


Fig. 4 - Safe area for dc operation.

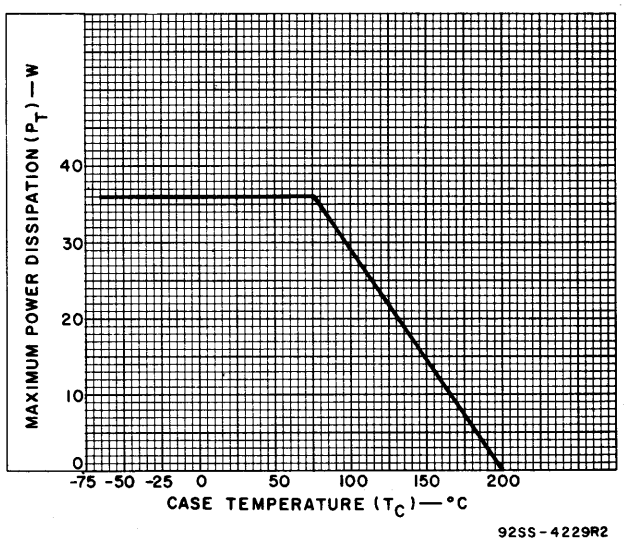


Fig. 5 - RF dissipation derating.

DESIGN DATA

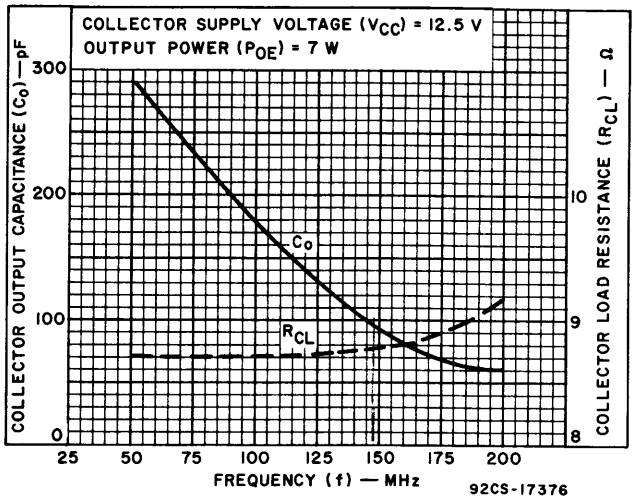


Fig. 6 - Typical large-signal parallel collector load and parallel output capacitance vs. frequency.

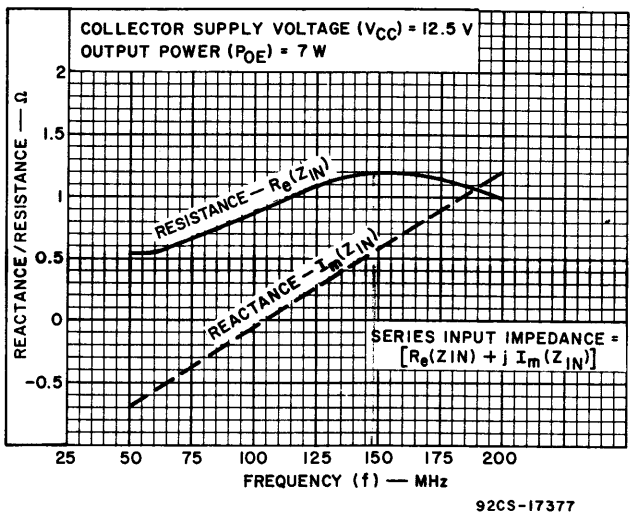


Fig. 7 - Typical large-signal series input impedance vs. frequency.

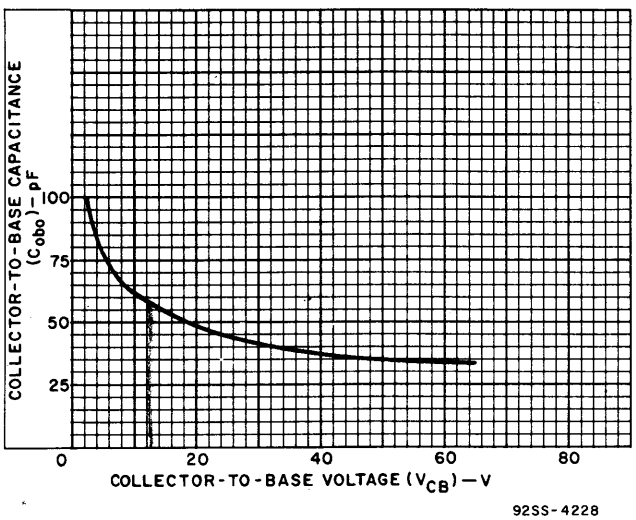
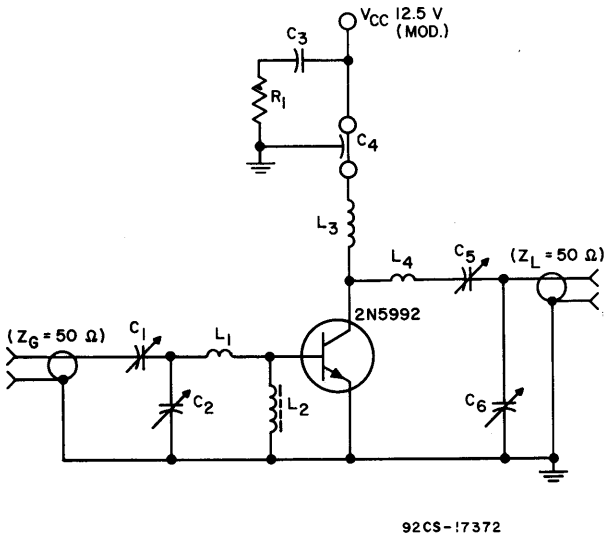


Fig. 8 - Typical collector-to-base capacitance vs. collector-to-base voltage.

APPLICATION DATA



C_1, C_2: 9-180 pF, ARCO 463 or equivalent
C_3: 0.02 μF ceramic
C_4: 0.01 μF feedthrough
C_5, C_6: 5-380 pF, ARCO 465 or equivalent
L_1: 1 turn No. 14 B.T., 1/4-in. I.D., 3/16-in. long
L_2: RFC, Z = 450 Ω, Ferroxcube or equivalent
L_3: 4 turns No. 16 B.T., 1/4-in. I.D., 5/16-in. long
L_4: 2 turns No. 14 B.T., 9/16-in. I.D., 3/8-in. long
R_1: 12Ω, 1/4 watt

Fig. 9 - 66–88-MHz amplifier for measuring output power, power gain, and modulation index.

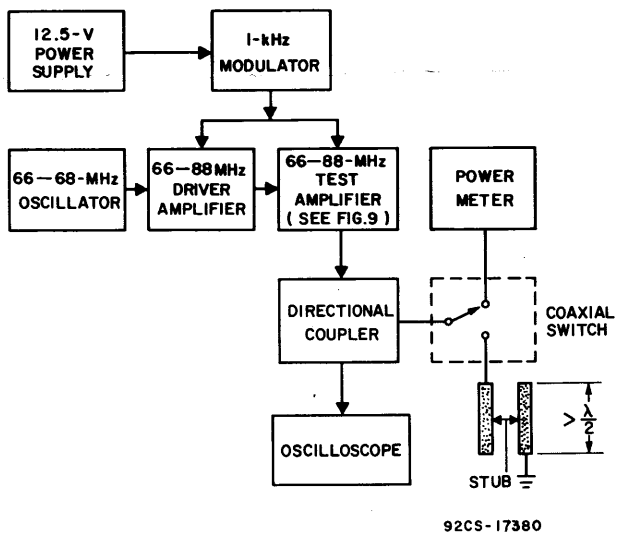


Fig. 10 - Test setup for testing output power, power gain, modulation index, and load-mismatch capability.

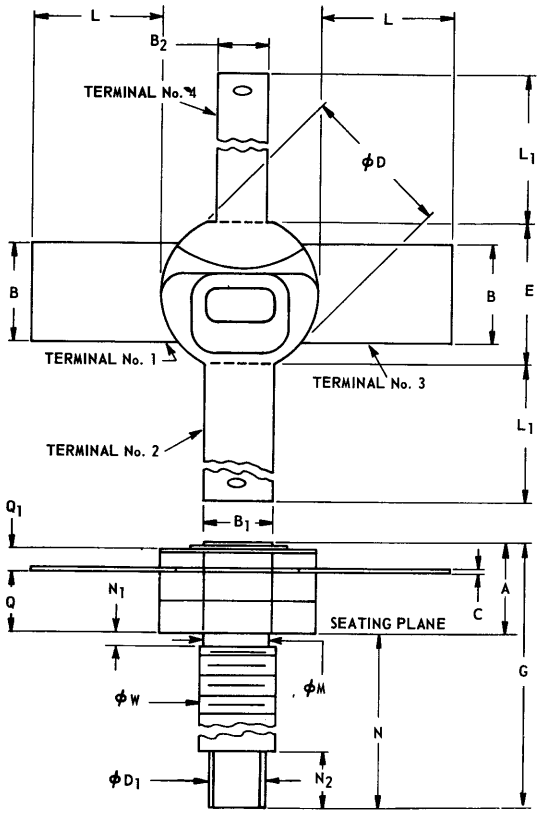
SPECIAL PERFORMANCE DATA

The Infinite load-mismatch capability of the transistor can be demonstrated in the following test:

1. The test setup is shown in Fig. 10.
2. The tuning network is varied through a half wavelength, which effectively varies the load from an open circuit to a short circuit.
3. Operating conditions are as follows: V_{CC} = 12.5 V, rf output power = 7 W under full modulation at 66 MHz.

Care should be taken not to exceed the maximum junction temperature by providing sufficient heatsinking during the above test to prevent device damage or degradation.

DIMENSIONAL OUTLINE



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.150	0.230	3.81	5.84	–
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	3
ϕD	0.305	0.320	7.48	8.12	–
ϕD_1	0.110	0.130	2.80	3.30	1
E	0.275	0.300	6.99	7.62	–
G	0.590	0.705	14.99	17.90	–
L	0.265	0.290	6.74	7.36	–
L_1	0.455	0.510	11.56	12.95	–
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	–
ϕW	0.1399	0.1437	3.531	3.632	2

Millimeter dimensions are derived from original inch dimensions

NOTES:

1. .053 – .064 INCH (1.35 – 1.62 mm) WRENCH FLAT.
2. PITCH DIA. OF 8-32 UNC-2A COATED THREAD. (ASA B1. 1-1960).
3. TYPICAL FOR ALL LEADS
4. LENGTH OF INCOMPLETE OR UNDERCUT THREADS OF ϕ W

92SS-3763R3

TERMINAL CONNECTIONS

Terminals 1, 3 - Emitter

Terminal 2 - Base

Terminal 4 - Collector

WARNING: RCA Type **2N5992** should be handled with care. The ceramic portion of this transistor contains BERYLLIUM OXIDE as a major ingredient. Do not crush, grind, or abrade these portions of the transistor because the dust resulting from such action may be hazardous if inhaled.

18-W, (CW) 88-MHz Emitter-Ballasted Overlay Transistor

Silicon N-P-N Type for 12.5-Volt Applications in VHF Communications Equipment

Features:

- **Emitter-ballasting resistors**
- **Low-inductance radial leads**
- **Hermetically sealed ceramic-metal package**
- **Electrically isolated mounting stud**
- **18 W min. output, 10 dB min. gain at 88 MHz**
- **Infinite load mismatch tested at 66 MHz**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	36	V
*COLLECTOR-TO-EMITTER VOLTAGE:			
With base connected to emitter	$V_{(BR)CES}$	36	V
With base open	V_{CEO}	18	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
*COLLECTOR CURRENT:			
Continuous	I_C	5.0	A
*TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 75°C		35.7	W
At case temperatures above 75°C		See Fig. 9	
*TEMPERATURE RANGE:			
Storage & 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.

RCA type 2N5993[a] is an epitaxial silicon n-p-n planar transistor featuring overlay emitter electrode construction. This device utilizes many separate emitter elements and has individual ballast resistance in each of the emitter sites for stabilization.

The transistor is completely tested for load mismatch capability at 66 MHz with a VSWR of infinity-to-one through all phases under rated power.

This device features a hermetic, ceramic-metal package having leads isolated from the mounting stud. These rugged, low-inductance, radial leads are designed for stripline as well as lumped-constant circuits.

[a]Formerly RCA Dev. Type TA7921.

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NEYE ENATECHNIK

BAUELEMENTE FÜR ELEKTRONIK, OPTOELEKTRONIK + NACHRICHTENTECHNIK

ALFRED NEYE-ENATECHNIK · 2085 Quickborn-Hamburg · Schillerstr. 14 · Telefon Sammel-Nummer 0 41 06/40 22 · Telex 02-13 590
Berlin,Tel. 34 54 65 | Hannover,Tel. 86 48 58 | Düsseldorf,Tel. 66 62 84/85 | Wiesbaden,Tel. 3 93 86 | Stuttgart,Tel. 24 25 35 | München,Tel. 52 79 28

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	I_{CEO}	10			0		–	5.0	mA
*	Collector-to-Base Breakdown Voltage	$V_{(BR)\ CBO}$			0		15	36	–	V
*	Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)\ CEO}$			0		200[a]	18	–	V
	With base connected to emitter	$V_{(BR)\ CES}$		0			200[a]	36	–	
*	Emitter-to-Base Breakdown Voltage	$V_{(BR)\ EBO}$			10			3.5	–	V
	Thermal Resistance Junction-to-Case	$\theta_{J\text{-}C}$						–	3.5	°C/W

[a]Pulsed through a 25-mH inductor; duty factor = 50%.

DYNAMIC

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS			UNITS
			DC Collector Supply (V_{CC}) -Volts	Input Power (P_{IE}) -Watts	Frequency (f) -MHz	MIN.	TYP.	MAX.	
*	Power Output	P_{OE}	12.5	1.0	66	18	20	–	W
				1.75	88	18	20	–	
*	Power Gain	G_{PE}	12.5	1.0	66	12.5	13	–	dB
				1.75	88	10.1	10.6	–	
*	Collector Efficiency	η_C	12.5	1.0	66	65	80	–	%
				1.75	88	65	80	–	
	Load Mismatch (Fig. 11)	LM	12.5	1.0	66	GO/NO GO			
*	Collector-to-Base Capacitance	C_{obo}	12 $I_C = 0$	–	1	–	–	100	pF

*In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7

PERFORMANCE DATA

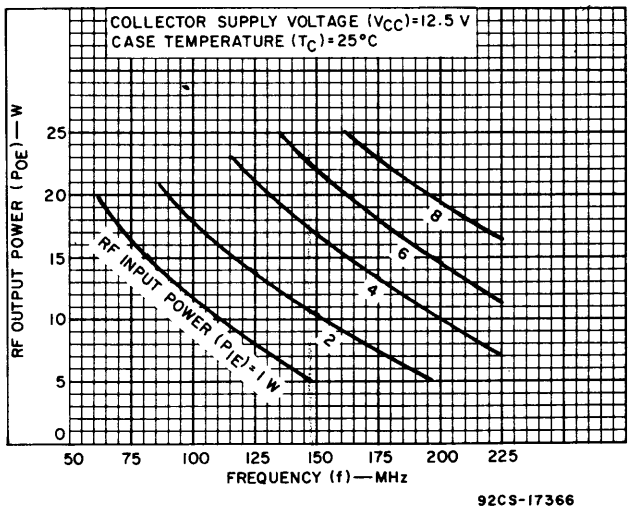


Fig. 1 — RF output power vs. frequency

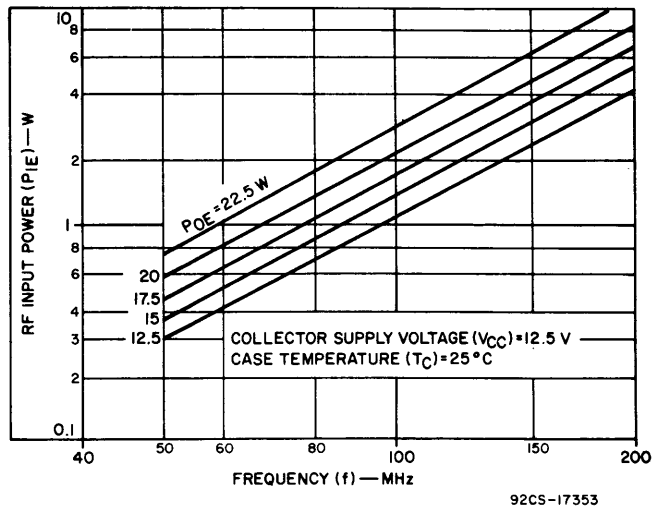


Fig. 2 — RF input power vs. frequency

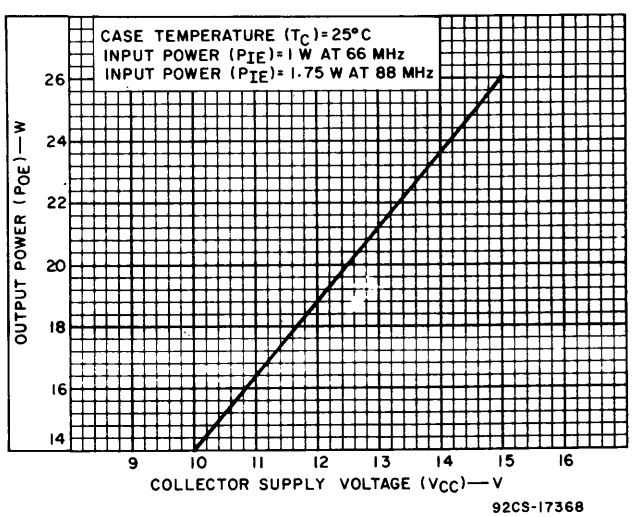


Fig. 3 — Typical output power vs. collector supply voltage (amplifier tuned at V_{CC} = 12.5 V)

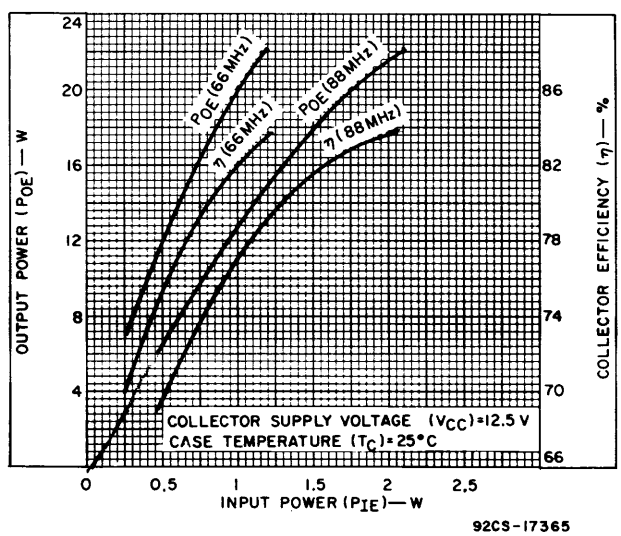


Fig. 4 — Typical output power and collector efficiency vs. input power at 66 and 88 MHz

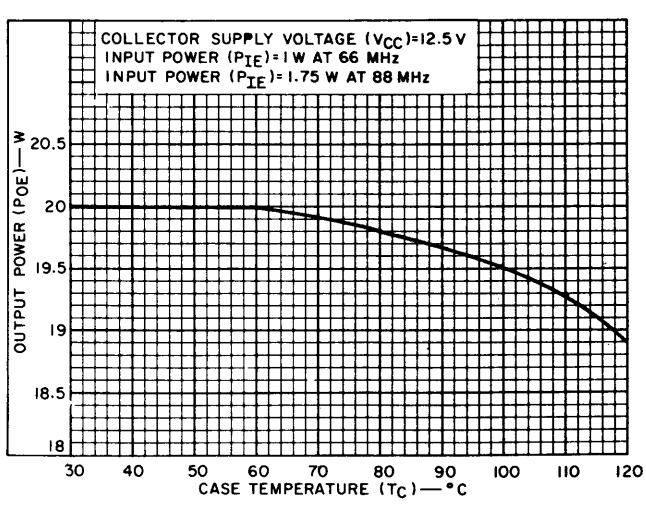


Fig. 5 — Typical output power vs. case temperature

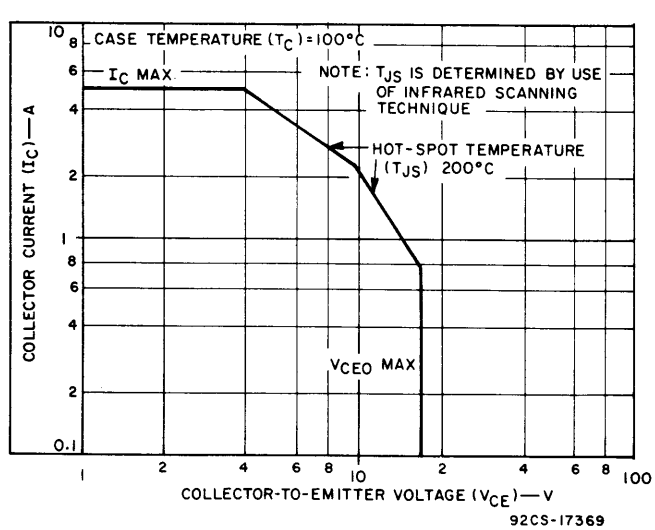


Fig. 6 — Safe area for dc operation

DESIGN DATA

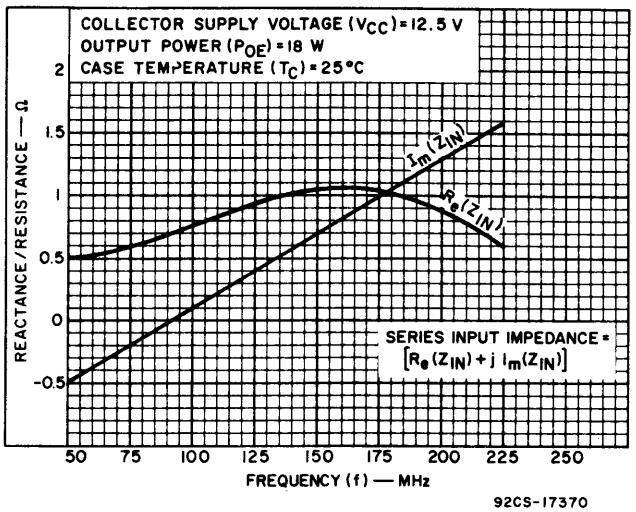


Fig. 7 — Typical large-signal series input impedance vs. frequency

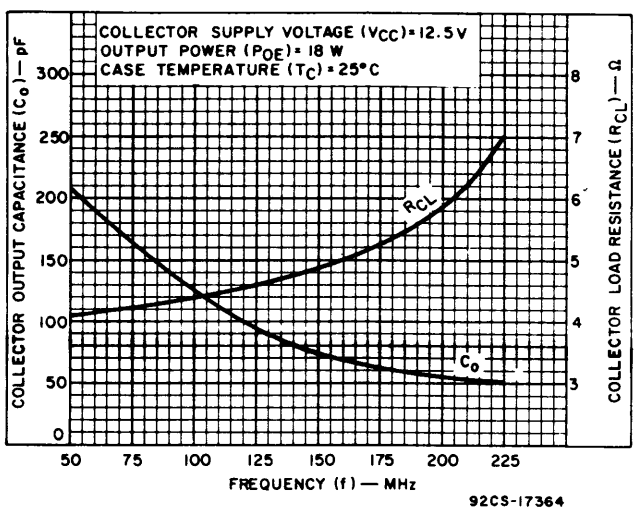


Fig. 8 — Typical large-signal parallel collector load and parallel output capacitance vs. frequency

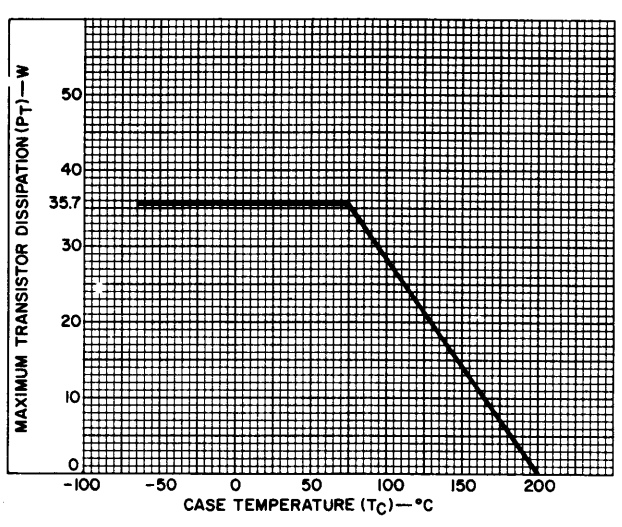
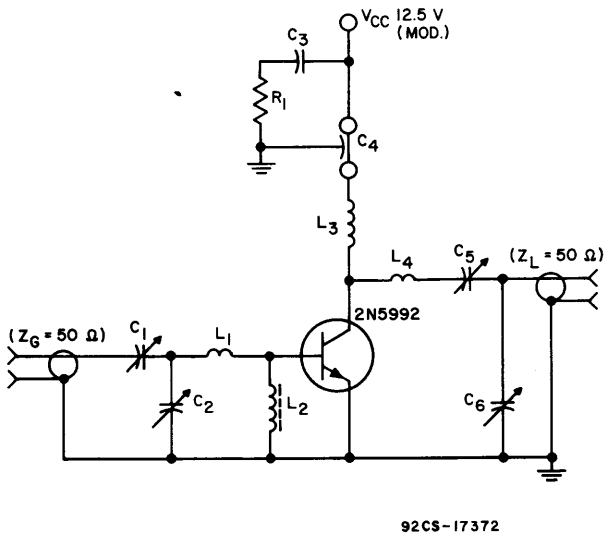


Fig. 9 — RF dissipation derating.

APPLICATION DATA



C_1, C_2: 9–180 pF, ARCO 463 or equivalent
C_3: 0.02 μF ceramic
C_4: 0.01 μF feedthrough
C_5, C_6: 5–380 pF, ARCO 465 or equivalent
L_1: 1 turn No. 14 B.T., 1/4-in. I.D., 3/16-in. long
L_2: RFC, Z = 450 Ω, Ferroxcube or equivalent
L_3: 4 turns No. 16 B.T., 1/4-in. I.D., 5/16-in. long
L_4: 2 turns No. 14 B.T., 9/16-in. I.D., 3/8-in. long
R_1: 12 Ω, 1/4 watt

Fig. 10 – 66-88-MHz amplifier for measuring output power, power gain, and modulation index

SPECIAL PERFORMANCE DATA

The infinite load-mismatch capability of the transistor can be demonstrated in the following test:

1. The test setup is shown in Fig. 11.
2. The tuning stub is varied through a half wavelength, which effectively varies the load from an open circuit to a short circuit.
3. Operating conditions are as follows: V_{CC} = 12.5 V RF input power = 1 W at 66 MHz

Care should be taken not to exceed the maximum junction temperature by providing sufficient heatsinking during the above test to prevent device damage or degradation.

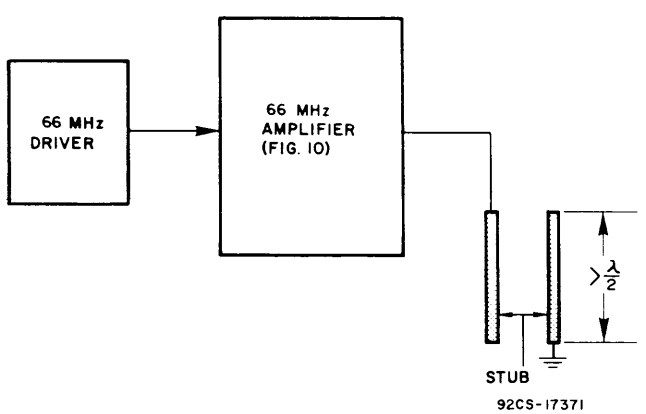
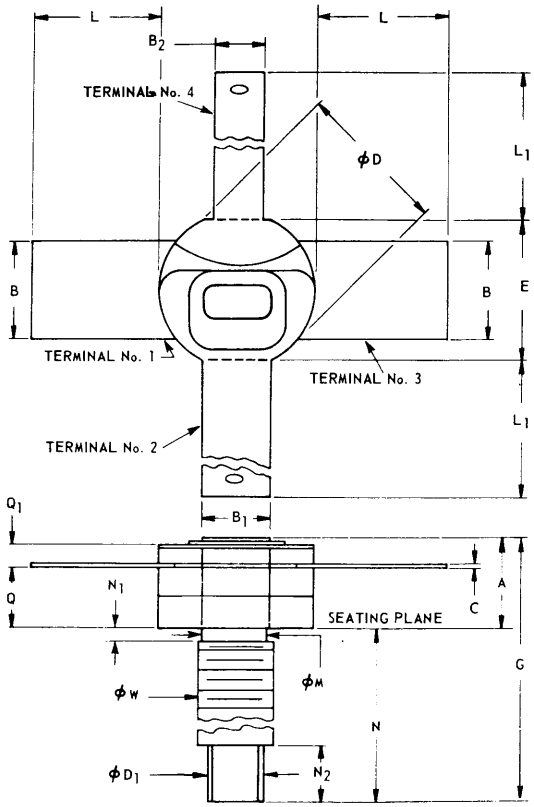


Fig. 11 – Test setup for testing load-mismatch capability

DIMENSIONAL OUTLINE



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.150	0.230	3.81	5.84	–
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	3
ϕD	0.305	0.320	7.48	8.12	–
ϕD_1	0.110	0.130	2.80	3.30	1
E	0.275	0.300	6.99	7.62	–
G	0.590	0.705	14.99	17.90	–
L	0.265	0.290	6.74	7.36	–
L_1	0.455	0.510	11.56	12.95	–
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	–
ϕW	0.1399	0.1437	3.531	3.632	2

Millimeter dimensions are derived from original inch dimensions

NOTES:

1. .053 – .064 INCH (1.35 – 1.62 mm) WRENCH FLAT.
2. PITCH DIA. OF 8-32 UNC-2A COATED THREAD. (ASA B1. 1-1960).
3. TYPICAL FOR ALL LEADS
4. LENGTH OF INCOMPLETE OR UNDERCUT THREADS OF ϕ W

92SS-3163R3

TERMINAL CONNECTIONS

Terminals 1, 3 - Emitter

Terminal 2 - Base

Terminal 4 - Collector

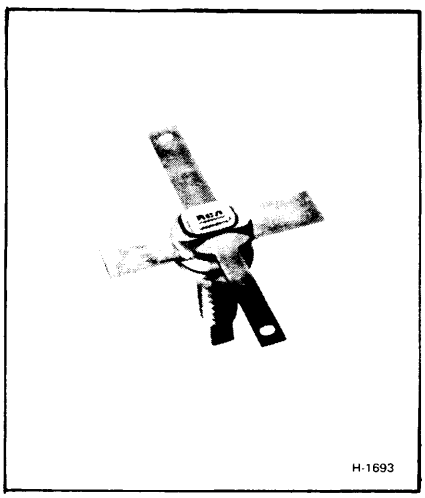
WARNING: RCA Type **2N5993** should be handled with care. The ceramic portion of this transistor contains BERYLLIUM OXIDE as a major ingredient. Do not crush, grind, or abrade these portions of the transistor because the dust resulting from such action may be hazardous if inhaled.

RCA
Solid State
Division

RF Power Transistors

2N5996

File No. 455



15-W, (CW) 175-MHz Emitter-Ballasted Overlay Transistor

Silicon N-P-N Device for 12.5-Volt Applications in VHF Communications Equipment

Features:

- **Emitter-ballasting resistors**
- **Low-inductance radial leads**
- **Hermetically sealed ceramic-metal package**
- **Electrically isolated mounting stud**
- **15-watt min. output at 175 MHz**
- **Infinite load mismatch tested at 175 MHz**

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	$V_{(BR)CEO}$	18	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
***COLLECTOR CURRENT:**			
Continuous	I_C	5.0	A
*TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 75°C		35.7	W
At case temperatures above 75°C		See Fig. 9	
*TEMPERATURE RANGE:			
Storage & 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.

RCA type 2N5996[a] is an epitaxial silicon n-p-n planar transistor featuring overlay emitter electrode construction. This device utilizes many separate emitter elements and has individual ballast resistance in each of the emitter sites for stabilization.

The transistor is completely tested for load mismatch capability at 175 MHz with an infinity-to-one VSWR through all phases under rated power.

This device features a hermetic, ceramic-metal package with leads isolated from the mounting stud. These rugged, low-inductance, radial leads are designed for stripline as well as lumped-constant circuits.

[a]Formerly RCA Dev. Type TA7923

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NEYE ENATECHNIK

BAUELEMENTE FÜR ELEKTRONIK, OPTOELEKTRONIK + NACHRICHTENTECHNIK

ALFRED NEYE-ENATECHNIK · 2085 Quickborn-Hamburg · Schillerstr. 14 · Telefon Sammel-Nummer 0 41 06/40 22 · Telex 02-13 590
Berlin,Tel. 34 54 65 | Hannover,Tel. 86 48 58 | Düsseldorf,Tel. 66 62 84/85 | Wiesbaden,Tel. 3 93 86 | Stuttgart,Tel. 24 25 35 | München,Tel. 52 79 28

10.70/1940-11.70

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 Base-to-Emitter Shorted (T_C = 100°C)	I_{CES}	12.5	0				–	10	mA
	With base open	I_{CEO}	10			0		–	5	
*	Collector-to-Base Breakdown Voltage	$V_{(BR)\ CBO}$			0		15	36	–	V
*	Collector-to-Emitter Breakdown Voltage: With base open	$V_{(BR)\ CEO}$			0		200[a]	18	–	V
	With base connected to emitter	$V_{(BR)\ CES}$		0			200[a]	36	–	
*	Emitter-to-Base Breakdown Voltage	$V_{(BR)\ EBO}$			10		0	3.5	–	V
	Thermal Resistance Junction-to-Case	$\theta_{J\text{-}C}$						–	3.5	°C/W

[a]Pulsed through a 25-mH inductor; duty factor = 50%

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	5.3	175	15	–	W
*	Power Gain	G_{PE}	12.5	5.3	175	4.5	–	dB
*	Collector Efficiency	η_C	12.5	5.3	175	75	–	%
	Load Mismatch (Fig. 11)	LM	12.5	5.3	175	GO/NO GO		
*	Collector-to-Base Capacitance	C_{obo}	12		1	–	100	pF

*In accordance with JEDEC registration data format JS-6 RDF-3/JS-9 RDF-7

PERFORMANCE DATA

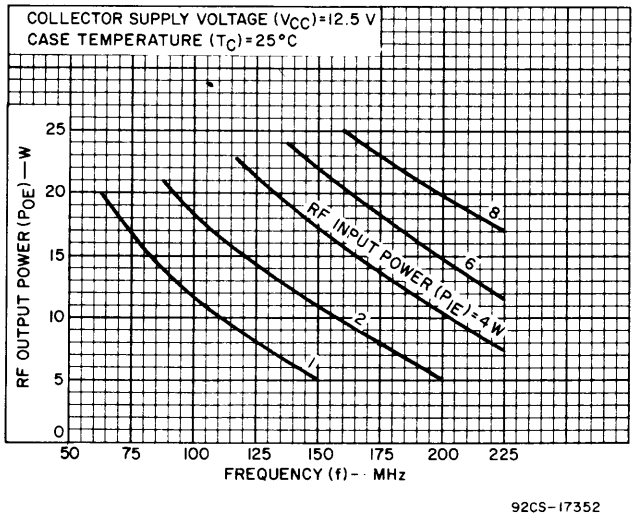


Fig. 1 — Typical rf output power vs. frequency.

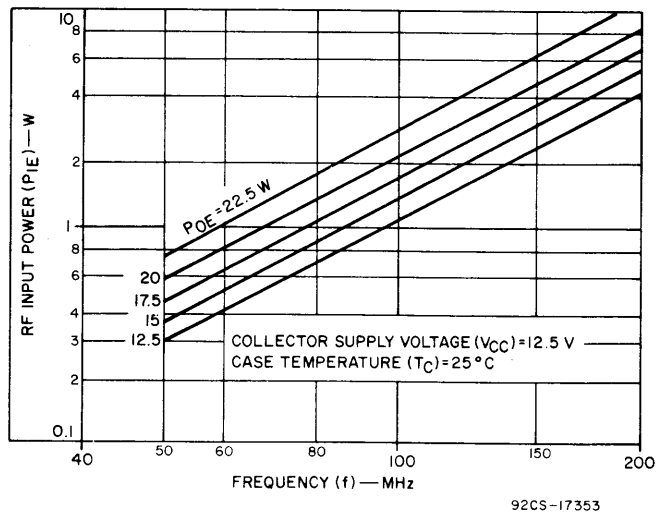


Fig. 2 — Typical rf input power vs. frequency.

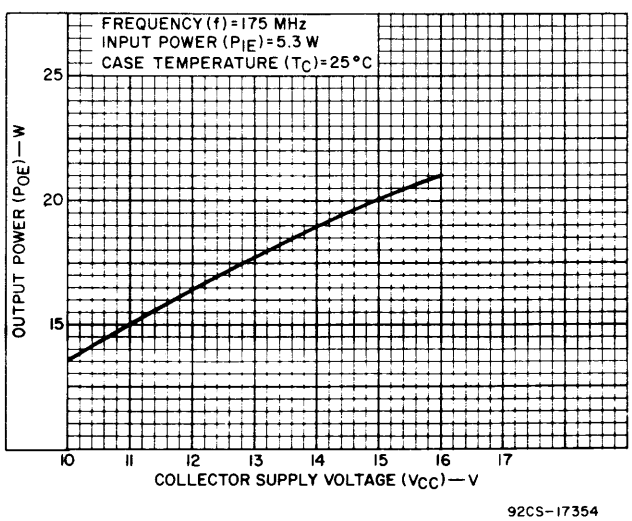


Fig. 3 — Typical output power vs. supply voltage collector (amplifier tuned at V_{CC} = 12.5 V).

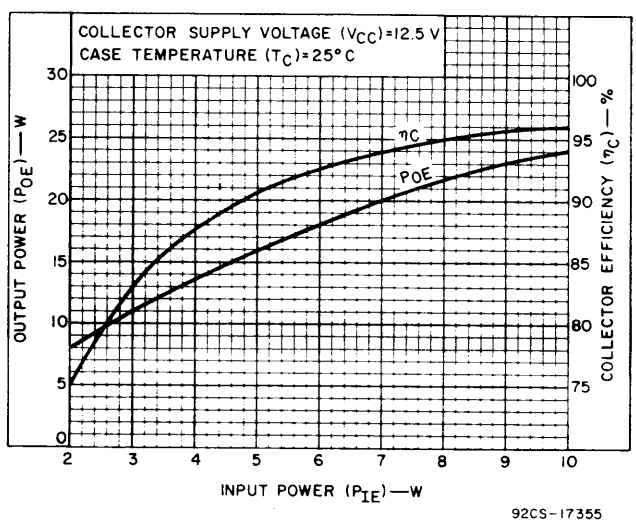


Fig. 4 — Typical output power and collector efficiency vs. input power at 175 MHz.

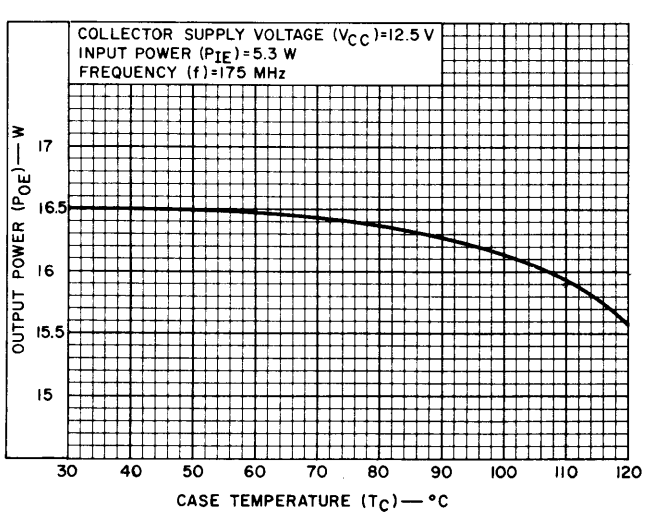


Fig. 5 — Typical output power vs. case temperature.

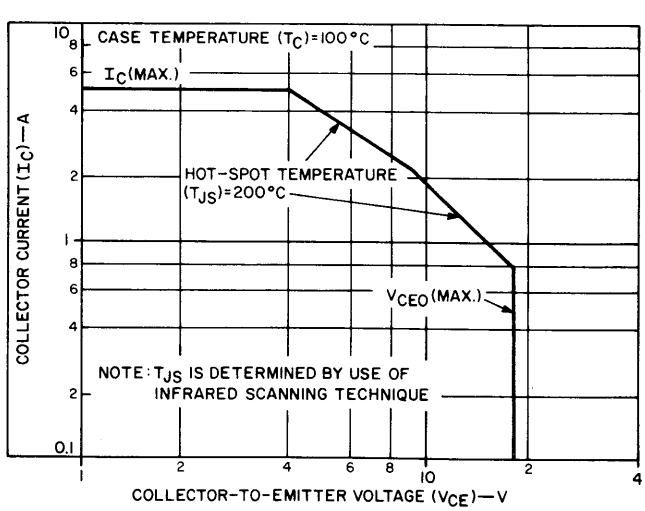


Fig. 6 — Safe area for dc operation.

DESIGN DATA

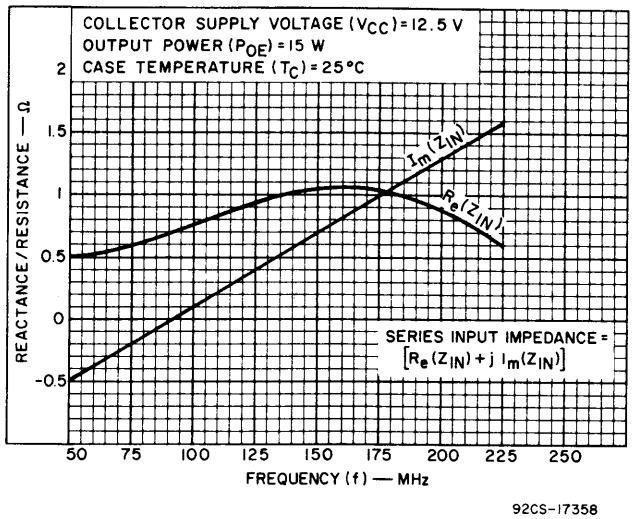


Fig. 7 — Typical large-signal series input impedance vs. frequency.

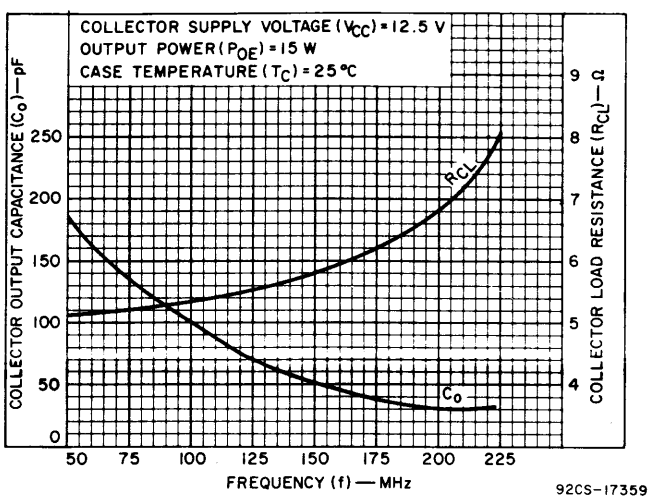


Fig. 8 — Typical large-signal parallel collector load and parallel output capacitance vs. frequency.

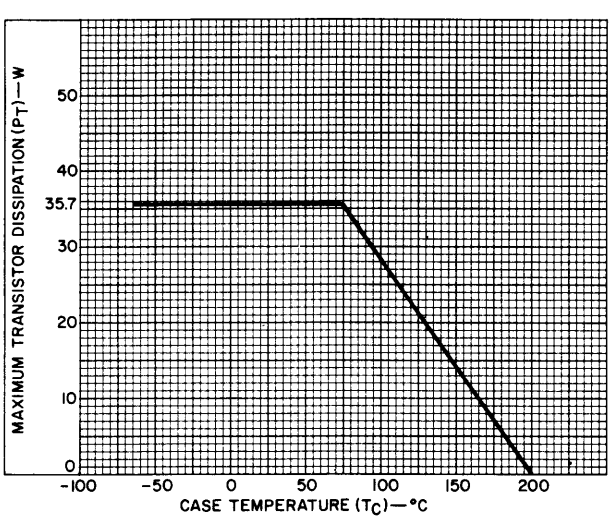
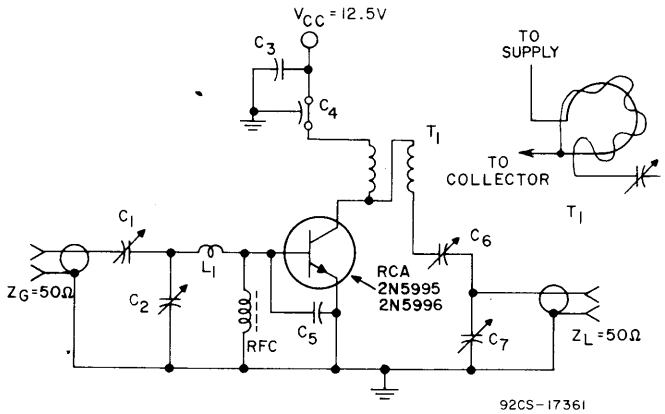


Fig. 9 — RF dissipation derating.

APPLICATION DATA



L_1 - ½ turn No. 14 wire, ¼-in. I.D.
RFC - Z = 450 Ω, Ferroxcube VK-200-09/3B or equivalent
C_1 - 7-100pF, Arco 423 or equivalent
C_2 - 4-40 pF, Arco 422 or equivalent
C_3 - 0.1 μF ceramic
C_4 - 0.001 μF feedthrough
C_5 - 62 pF silver mica
C_6 - 14-150pF, Arco 424 or equivalent
C_7 - 24-200pF, Arco 425 or equivalent
T_1 - Twisted pair of No. 20 enameled wire; 14 turns/in. Formed in a loop 3/8 in. diameter, cross connected (End of one winding connected to beginning of other)

Fig. 10 – 175-MHz amplifier for measuring power output and power gain.

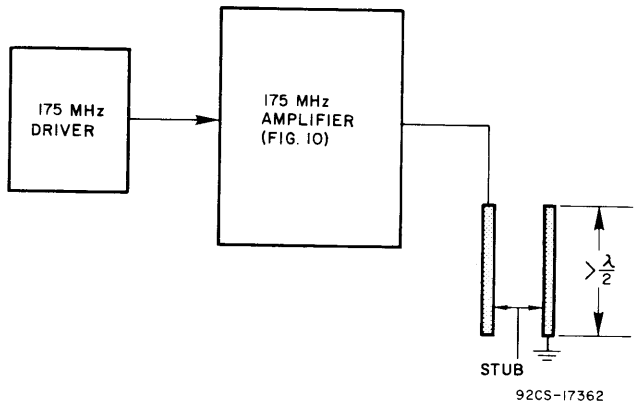


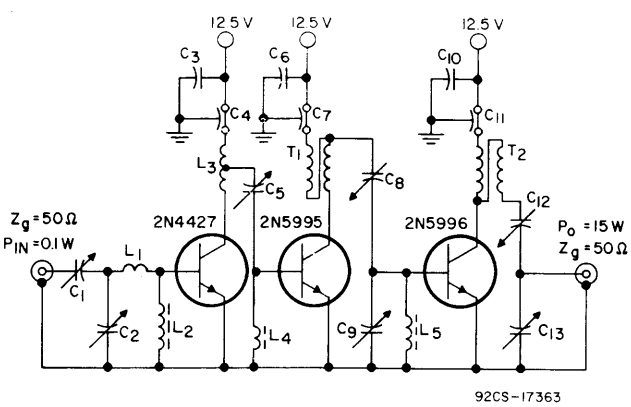
Fig. 11 – Test setup for testing load mismatch capability.

SPECIAL PERFORMANCE DATA

The infinite VSWR load-mismatch capability of the transistor can be demonstrated in the following test:

1. The test setup is shown in Fig. 11.
2. The tuning stub is varied through a half wavelength, which effectively varies the load from an open circuit to a short circuit.
3. Operating conditions are as follows: V_{CC} = 12.5 V, RF input power = 5.3 W.

Care should be taken not to exceed the maximum junction temperature by providing sufficient heatsinking during the above test to prevent device damage or degradation.



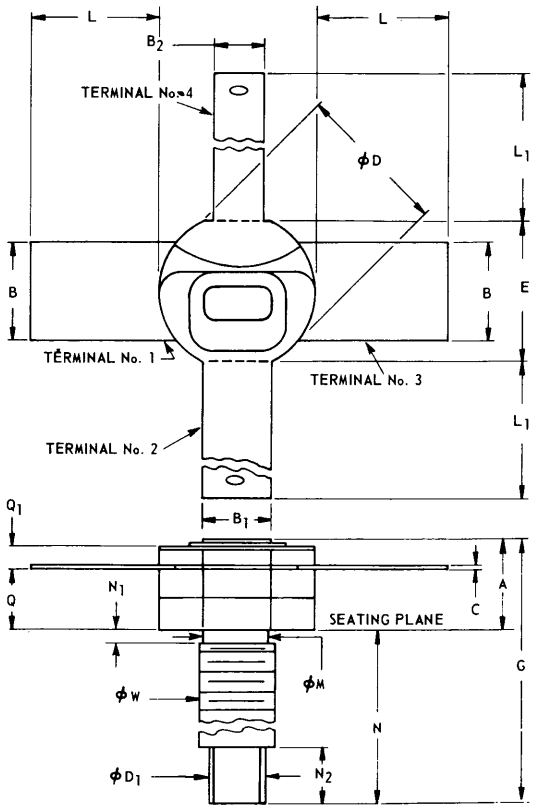
C_1, C_2, C_5: 8-60 pF, ARCO 404 or equivalent
C_3, C_6, C_{10}: 0.05 μF ceramic
C_4, C_7, C_{11}: 0.001 μF feedthrough
C_8, C_9: 7-100 pF, ARCO 423 or equivalent
C_{12}, C_{13}: 14-150 pF, ARCO 424 or equivalent

L_1: 3 turns No. 20 enam. wire, 1/8-in. I.D., 1/4-in. long
L_2: 1 turn No. 20 enam. wire on Ferroxcube bead No. 56-590-65-4A or equivalent
L_3: 5 turns No. 20 B.T., 1/4-in. I.D., 3/8-in. long, tapped 4-1/2 turns from collector
L_4: 3/8-in. loop No. 20 Ferroxcube bead No. 56-590-65-4A or equivalent
L_5: Ferroxcube No. VK-200-09-3B, Z = 450 Ω or equivalent

T_1, T_2: No. 20 enam. wire twisted pair, 14 turns/in., formed into 3/8-in. dia. loop, cross connected

Fig. 12 – Typical 175-MHz amplifier using 2N5996.

DIMENSIONAL OUTLINE



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Millimeter dimensions are derived from original inch dimensions

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2. PITCH DIA. OF 8-32 UNC-2A COATED THREAD. (ASA B1. 1-1960).
3. TYPICAL FOR ALL LEADS
4. LENGTH OF INCOMPLETE OR UNDERCUT THREADS OF ϕ W

92SS-3763R3

TERMINAL CONNECTIONS

Terminals 1, 3 - Emitter

Terminal 2 - Base

Terminal 4 - Collector

WARNING: RCA Type 2N5996 should be handled with care. The ceramic portion of this transistor contains BERYLLIUM OXIDE as a major ingredient. Do not crush, grind, or abrade these portions of the transistor because the dust resulting from such action may be hazardous if inhaled.