RCA
Solid State
Division

RF Power Transistors

2N5109

JEDEC TO-39 H-1381

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**

RCA-2N5109* is an epitaxial silicon n-p-n planar transistor employing "overlay" emitter electrode construction. It is especially designed to provide large dynamic range, low distortion, and low noise as a wideband amplifier into the vhf range.

A high gain-bandwidth product over a wide range of collector current makes the 2N5109 ideally suited for such applications as CATV and MATV line amplifiers and low-noise linear amplifiers.

*Formerly RCA Dev. No. TA2800.

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
At case temperature above 75°C		See Fig. 10	
* 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

* In accordance with JEDEC registration data

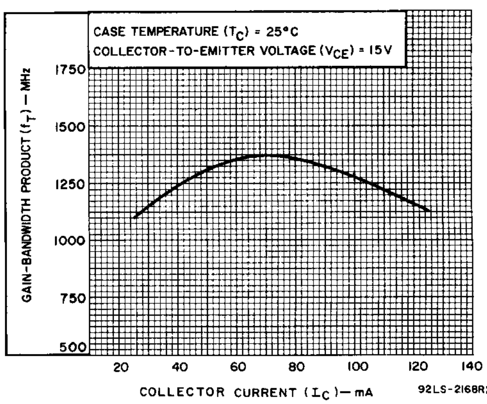


Fig. 1—Gain-bandwidth vs. collector current for type 2N5109.

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC COLLECTOR OR BASE VOLTAGE – V V_{CB}	V_{BE}	V_{CE}	V_{EB}	DC CURRENT (mA) I_E	I_B	I_C	LIMITS MIN.	MAX.	UNITS
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 (See Fig. 9) (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 (See Fig. 8.)	G_{VE}			15				50	11		dB
Cross Modulation @ 54 dBmV[b] Output (See Fig. 14.)	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) (See Fig. 9.)	NF			15				10	3 (typ.)		dB

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

[b] 0 dBmV = 1 millivolt

* In accordance with JEDEC registration data

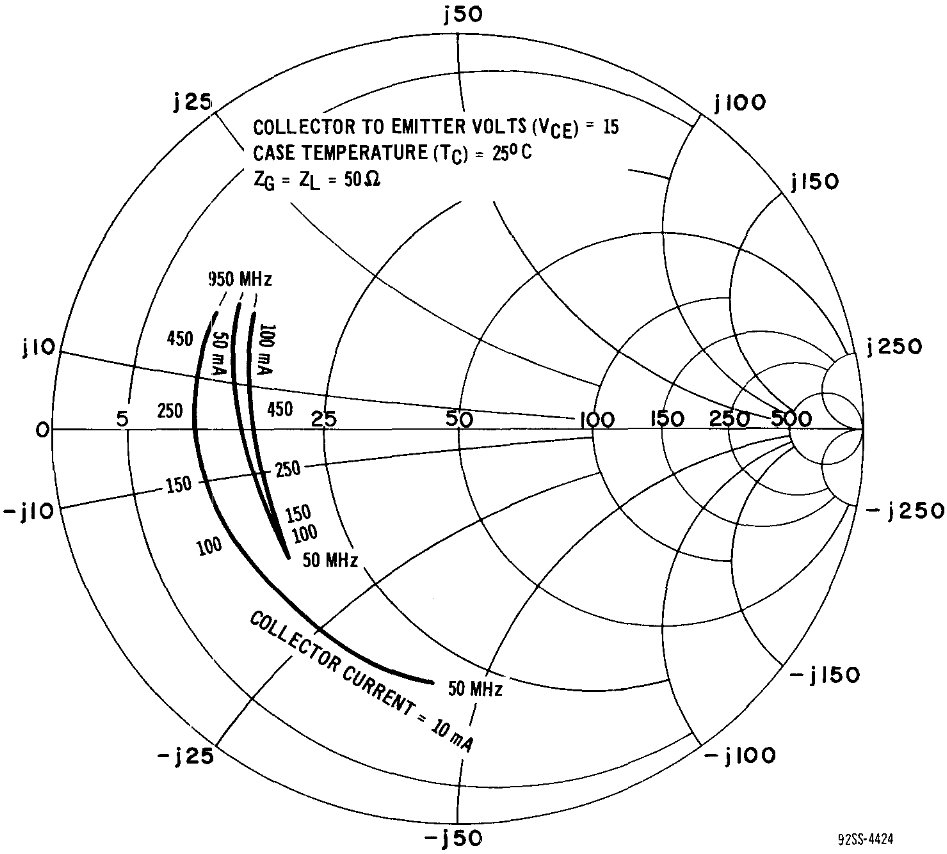


Fig.2—Input reflection coefficient (S'_{11e}) vs. frequency for type 2N5109.

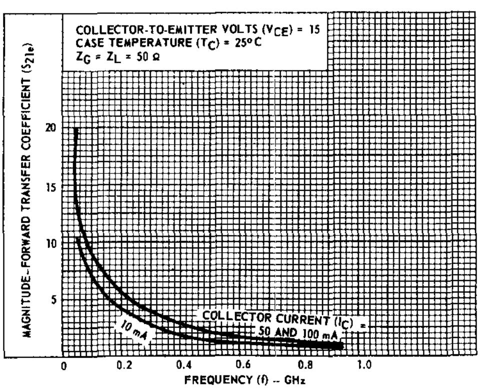


Fig.3—Magnitude of common-emitter forward transfer coefficient (S_{21e}) vs. frequency for type 2N5109.

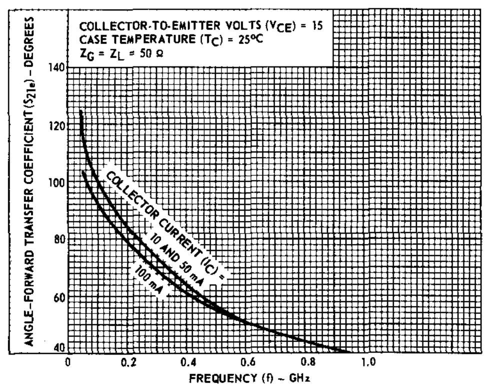


Fig.4—Angle of common-emitter forward transfer coefficient (S_{21e}) vs. frequency for type 2N5109.

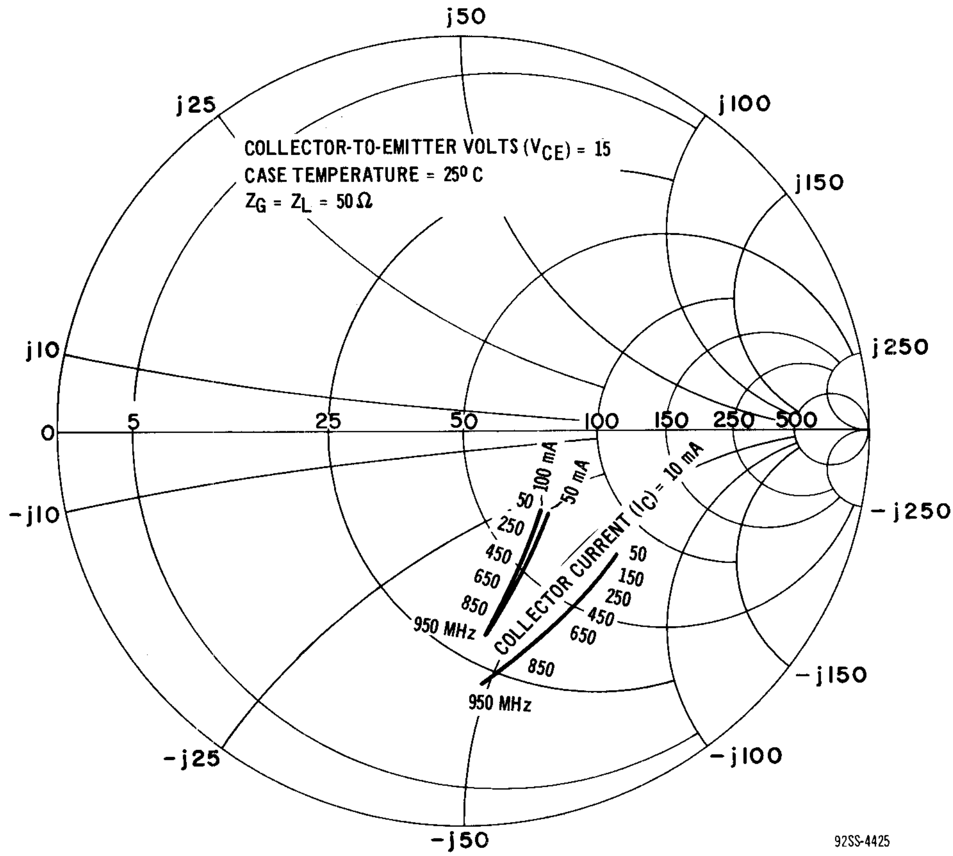


Fig.5—Output reflection coefficient (S_{22e}) vs. frequency for type 2N5109.

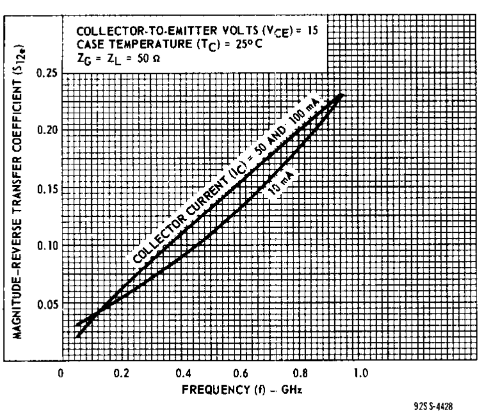


Fig.6—Magnitude of common-emitter, reverse transfer coefficient (S_{12e}) for type 2N5109.

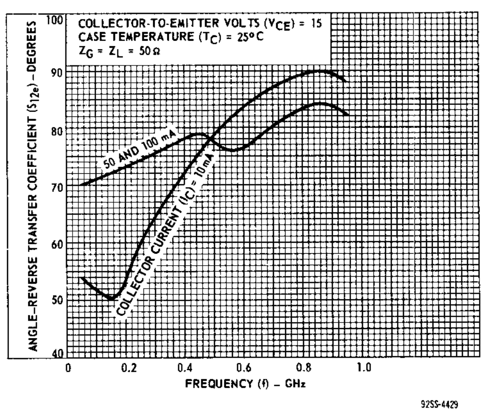
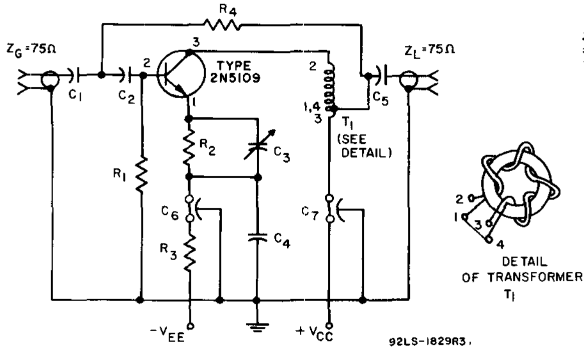
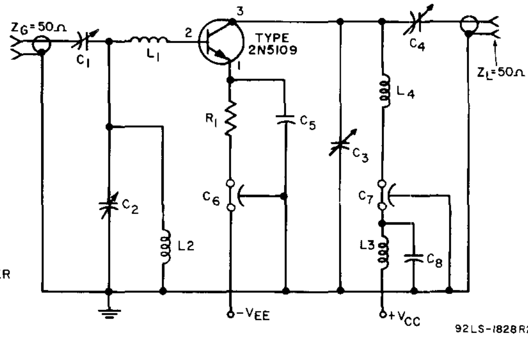


Fig.7—Angle of common-emitter reverse transfer coefficient (S_{12e}) vs. frequency for type 2N5109.



C_1, C_2, C_5: 0.002 μF, disc ceramic
C_3: 8–60 pF, ARCO 404, or equivalent
C_4: 0.03 μF, disc ceramic
C_6, C_7: 1,500 pF, feedthrough
R_1: 390 Ω, 1/2W, carbon
R_2: 6.8 Ω, 1/2W, carbon
R_3: 330Ω, 1 W, carbon
R_4: 270Ω, 1/2 W, carbon
T_1: 4 turns No. 30 wire bifilar wound on "Indiana General" Core No. CF-102-Q1, or equivalent

Fig.8—RF amplifier for voltage-gain testing of type 2N5109.



C_1, C_2, C_3: 1.0–30 pF, mica trimmer, ARCO or equivalent
C_4: 1.0–20 pF disc ceramic
C_5: 10,000 pF disc ceramic
C_6, C_7: 1,000 pF disc ceramic
C_8: 0.01 μF disc ceramic
L_1: 4-1/2 turns, No. 22 wire, 3/16 in. (4.76 mm) I.D.
L_4: 3-1/2 turns, No. 22 wire, 3/16 in. (4.76 mm) I.D.
L_2, L_3: 0.82 μH RFC
R_1: 240 Ω, 2 W, carbon

Fig.9—200-MHz amplifier for power-gain and noise-figure testing of type 2N5109.

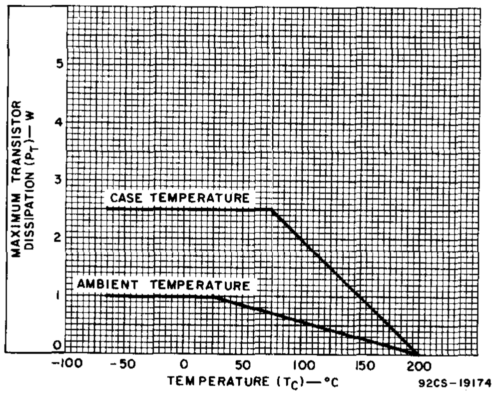


Fig.10—Dissipation derating curve for type 2N5109.

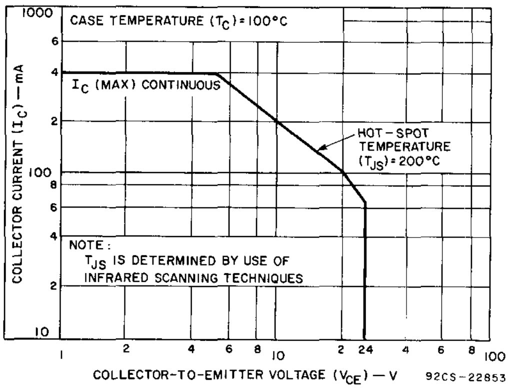


Fig. 11-Maximum operating area for type 2N5109.

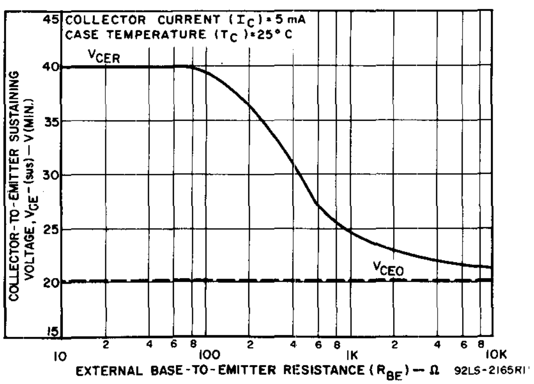


Fig. 12—Sustaining voltage vs. base-to-emitter resistance for type 2N5109.

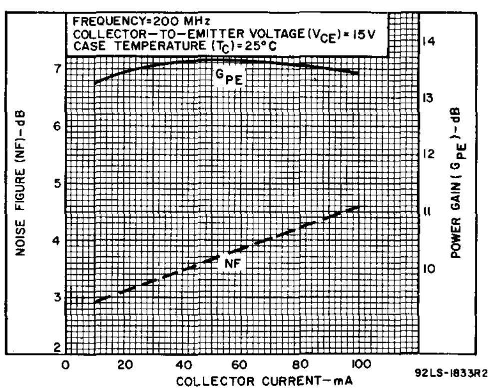
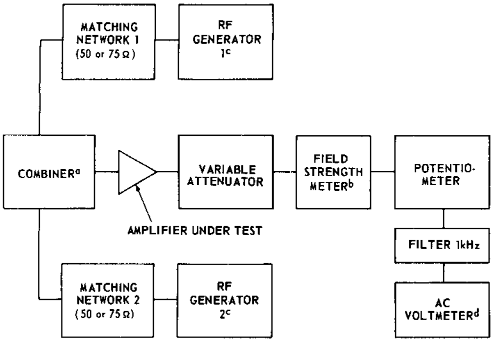


Fig. 13—Power gain and noise figure vs. collector current for type 2N5109.



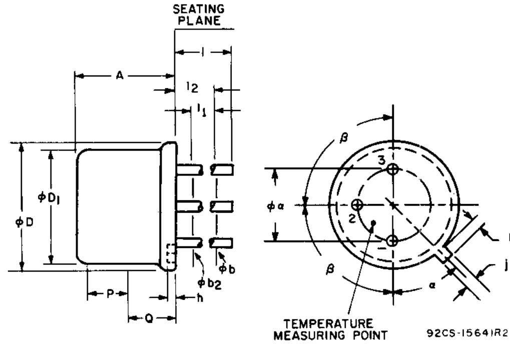
a Provides 20 db isolation between generators
b 50–220 MHz with detector output
c Hewlett–Packard HP 608 D or equivalent
d Ballantine 861 or equivalent

Fig. 14–Test set-up for measuring cross modulation in type 2N5109.

CROSS-MODULATION TEST PROCEDURE:

1. Set up equipment as shown in Fig. 14.
2. Set generator 1 to 150 MHz modulated 30% by 1,000 Hertz, and tune field strength meter to 150 MHz.
3. Adjust output level of generator 1 to give rated output from the amplifier under test.
4. Adjust potentiometer and AC voltmeter for a convenient level. This level then corresponds to 100% cross modulation.
5. Remove modulation. Readjust output level of generator 1 if necessary, to obtain the AC voltmeter "100% level". Do not readjust generator 1 during the following steps.
6. Set generator 2 to 210 MHz modulated 30% by 1,000 Hertz and tune field strength meter to 210 MHz.
7. Adjust output level of generator 2 to give rated output of the amplifier; i.e., the AC voltmeter indicates the " 100% level".
8. Tune field strength meter to 150 MHz CW and read the AC voltmeter (a change of the AC voltmeter scale may be necessary).
9. Calculate percentage of cross modulation by comparing the reading of step 8 to the "100% level".

DIMENSIONAL OUTLINE
JEDEC No. TO-39



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	0.315	0.335	8.00	8.51	
h	0.009	0.125	0.229	1.04	
j	0.028	0.034	0.711	0.318	
k	0.029	0.040	0.737	1.02	3
l	0.500		12.70		2
l1		0.050		1.27	2
l2	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 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.

Note 3: Measured from maximum diameter of the actual device.

Note 4: Details of outline in this zone optional.

TERMINAL CONNECTIONS

Lead No.1 – Emitter
Lead No.2 – Base
Lead No.3 – Collector
Case – Collector