

MOTOROLA
SEMICONDUCTOR
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TECHNICAL DATA

2N5947

The RF Line

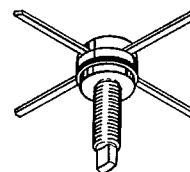
NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed specifically for broadband applications requiring low cross-modulation distortion and low noise figure. Characterized for use in CATV applications. The 2N5947 was formerly the MM8012.

- Low Cross Modulation Distortion —
XM = -57 dB (Max) @ +50 dBmV Output
- Low Noise Figure — @ f = 200 MHz
NF (Narrowband) = 3.8 dB (Typ)
NF (Broadband) = 8.5 dB (Max)
- High Broadband Power Gain —
G_{pe} = 10 dB (Min) @ f = 250 MHz

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON

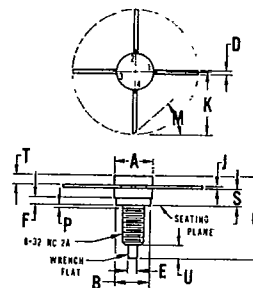


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***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	30	V _{dc}
Collector-Base Voltage	V _{CB}	40	V _{dc}
Emitter-Base Voltage	V _{EB}	3.5	V _{dc}
Collector Current — Continuous	I _C	400	mA _{dc}
Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D	5.0 28.6	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to +200	°C

* Indicates JEDEC Registered Data.



STYLE 1:
 PIN 1. EMITTER
 2. BASE
 3. EMITTER
 4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	15.24	16.51	0.600	0.650
D	0.66	0.88	0.026	0.034
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.10	0.15	0.004	0.006
K	11.17	—	0.440	—
M	45°	NOM	45°	NOM
P	—	1.27	—	0.050
S	2.74	3.35	0.108	0.132
T	1.40	1.78	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244A-01

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Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28 \text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	100	μA
Collector Cutoff Current ($V_{CB} = 20 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	μA
Emitter Cutoff Current ($V_{BE} = 3.5 \text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	100	μA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 75 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$)	h_{FE}	25	—	250	—
Collector-Emitter Saturation Voltage ($I_C = 200 \text{ mA}$, $I_B = 20 \text{ mA}$)	$V_{CE(sat)}$	—	0.2	0.35	Vdc
Base-Emitter Saturation Voltage ($I_C = 200 \text{ mA}$, $I_B = 20 \text{ mA}$)	$V_{BE(sat)}$	—	1.0	1.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (Figure 3) ($I_C = 75 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$, $f = 200 \text{ MHz}$)	f_T	1100	1500	—	MHz
Collector-Base Capacitance (Figure 4) ($V_{CB} = 30 \text{ Vdc}$, $I_E = 0$, $f = 100 \text{ kHz}$)	C_{cb}	—	1.5	4.0	pF
Emitter-Base Capacitance (Figure 4) ($V_{EB} = 0.5 \text{ Vdc}$, $I_C = 0$, $f = 100 \text{ kHz}$)	C_{eb}	—	8.2	12	pF
Small-Signal Current Gain ($I_C = 75 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h_{fe}	25	—	300	—
Collector-Base Time Constant ($I_E = 75 \text{ mA}$, $V_{CB} = 20 \text{ Vdc}$, $f = 31.8 \text{ MHz}$)	τ_b , C_c	2.0	—	20	ps
Noise Figure ($I_C = 50 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$, $f = 200 \text{ MHz}$) (Figure 1) ($I_C = 50 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$, $f = 200 \text{ MHz}$) (1) (Figure 2, 9) ($I_C = 75 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$, $f = 200 \text{ MHz}$) (1) (Figure 2, 9)	NF	— — —	3.8 7.2 7.8	— 8.5 —	dB
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 2) ($I_C = 75 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$, $f = 250 \text{ MHz}$)	G_{pe}	10	11	—	dB
Intermodulation Distortion (Figure 2, 10) ($I_C = 75 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$, $V_{out} = +50 \text{ dBmV}$)	IM	—	-55	-50	dB
Cross Modulation Distortion (Figure 2, 11) ($I_C = 75 \text{ mA}$, $V_{CE} = 20 \text{ Vdc}$, $V_{out} = +50 \text{ dBmV}$)	XM	—	-60	-57	dB

(1) Includes noise figure of post-amplifier and matching pad

FIGURE 4. NARROWBAND FM DRIVER

C1 C2, C3 1.0-20 pF
 C4 C14 C15 1.0-10 pF
 C5 C6 C9 470 pF
 C6 C13 C11 Q001 pF
 C7 C13 0.01 μF
 C12 0.1 pF
 L1 3 Turns AWG #18 1 4" ID
 5.15" ID

L2 11 Turns AWG #18 3 16" ID
 L3 9.3 4 Turns AWG #18 3 16" ID
 1" Long
 Tapped 2.3 4 Turns from Collector to End
 L4 L5 0.43 μH, 50 ohm Choke
 R1 R2 10 Ohms

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FIGURE 3 — CURRENT-GAIN-BANDWIDTH PRODUCT

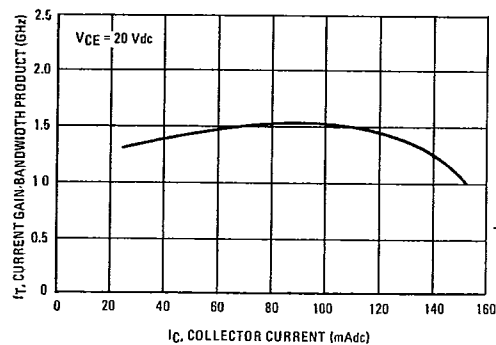


FIGURE 4 — CAPACITANCES

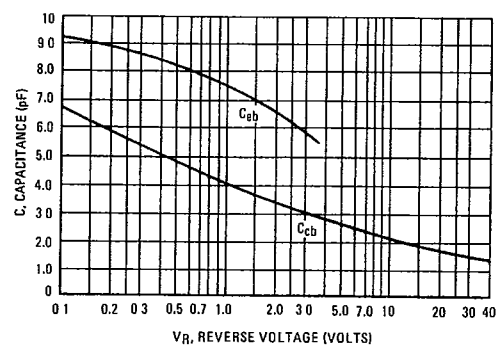


FIGURE 5 — COLLECTOR-EMITTER SATURATION VOLTAGE

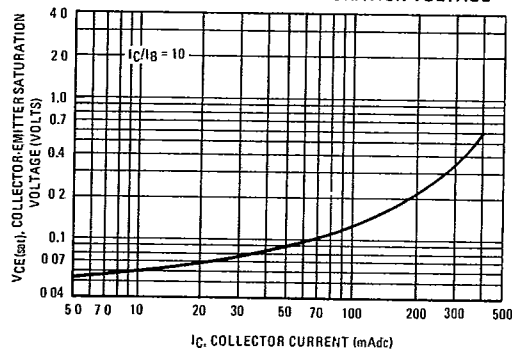


FIGURE 6 — BASE-EMITTER SATURATION VOLTAGE

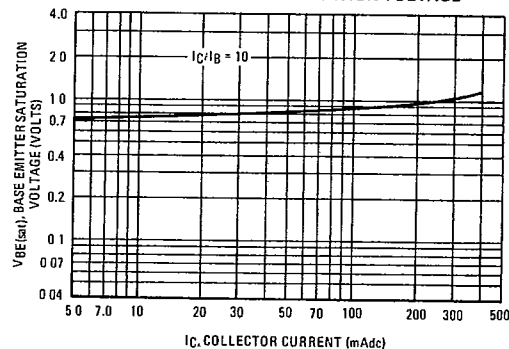


FIGURE 7 — NARROWBAND NOISE FIGURE versus CURRENT

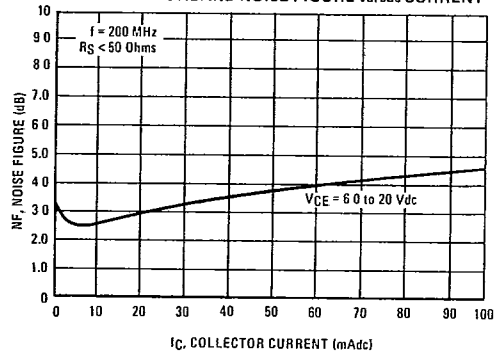
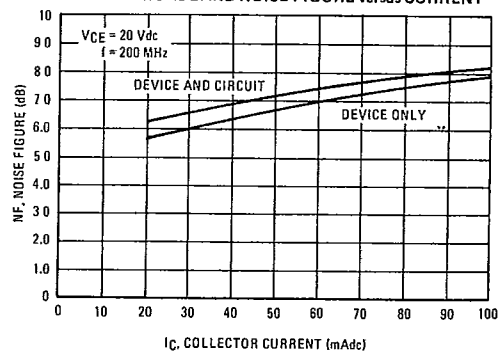


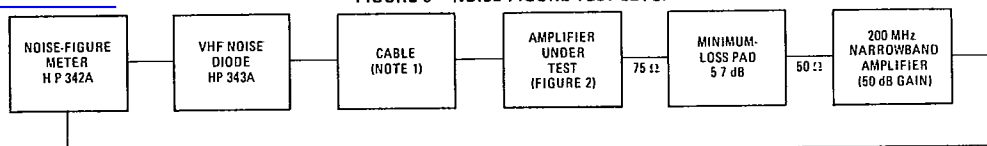
FIGURE 8 — BROADBAND NOISE FIGURE versus CURRENT



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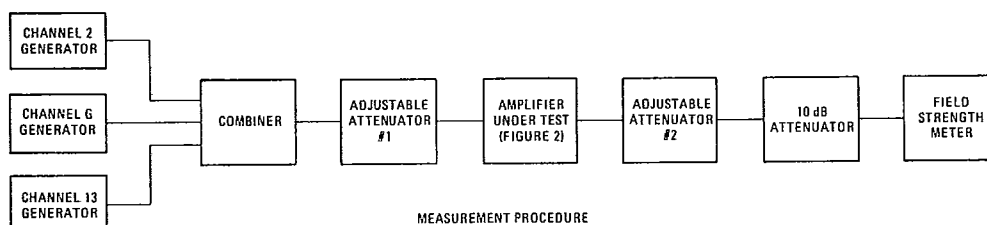
FIGURE 9 - NOISE FIGURE TEST SETUP



NOTE 1. RG 59 CABLE WITH ORIGINAL CENTER CONDUCTOR REPLACED WITH #30 WIRE. OVERALL LENGTH, INCLUDING BNC CONNECTORS, IS A QUARTER-WAVELENGTH AT 200 MHz (APPROX. 11 INCHES). USED TO MATCH IMPEDANCE OF NOISE DIODE TO AMPLIFIER UNDER TEST.

THE NOISE FIGURE OF THE POST-AMPLIFIERS AND MINIMUM LOSS PAD IS 8.4 dB

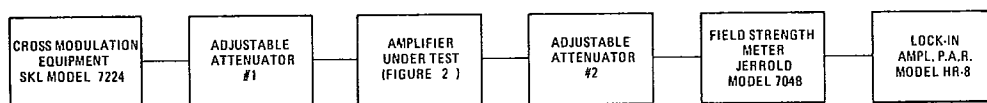
FIGURE 10 - INTERMODULATION DISTORTION TEST SETUP



MEASUREMENT PROCEDURE

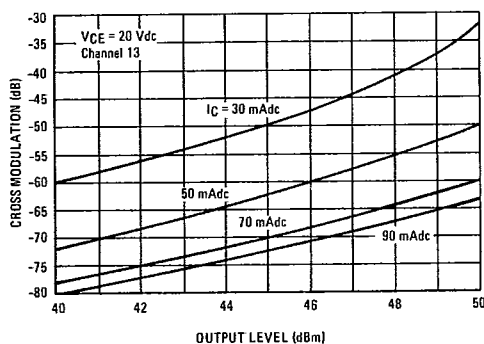
1. ADJUST CHANNEL 2 GENERATOR FOR RATED OUTPUT FROM TEST AMPLIFIER (CHANNELS G & 13 OFF).
2. REPEAT FOR CHANNEL G (2 & 13 OFF) AND CHANNEL 13 (2 & G OFF). NOTE FOR REFERENCE THE FIELD STRENGTH METER READING FOR CHANNEL 13 (2 & G OFF).
3. TURN CHANNEL 13 OFF AND DRIVE THE TEST AMPLIFIER WITH CHANNELS 2 & G. MEASURE THE LEVEL OF INTERMODULATION DISTORTION AT CHANNEL 13 RELATIVE TO THE REFERENCE LEVEL IN STEP 2.

FIGURE 11 - CROSS MODULATION DISTORTION TEST SETUP



MEASUREMENT PROCEDURE

1. ADJUST THE CROSSMODULATION EQUIPMENT FOR +50 dBmV OUTPUT FROM EACH CHANNEL.
2. ADJUST ATTENUATOR #1 FOR THE DESIRED OUTPUT LEVEL FROM THE TEST AMPLIFIER. ADJUST ATTENUATOR #2 TO MAINTAIN THE FIELD STRENGTH METER INPUT AT +10 dBmV.
3. WITH THE FIELD STRENGTH METER SELECT CHANNEL 13. USING THE WAVE ANALYZER MEASURE THE LEVEL OF THE MODULATION ON CHANNEL 13 DUE TO CROSS MODULATION OF CHANNELS 2-12.

FIGURE 12 - CROSS MODULATION DISTORTION
versus OUTPUT LEVELFIGURE 13 - CROSS MODULATION DISTORTION
versus CURRENT