MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5947

The RF Line

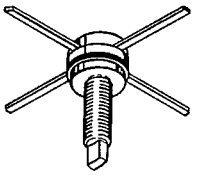
HIGH FREQUENCY TRANSISTOR

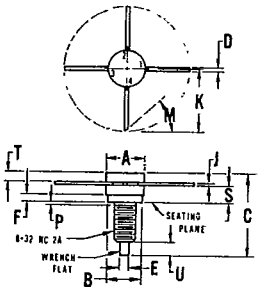
NPN SILICON

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





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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES 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	0.86	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

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current — Continuous	I_C	400	mAdc
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.

2N5947

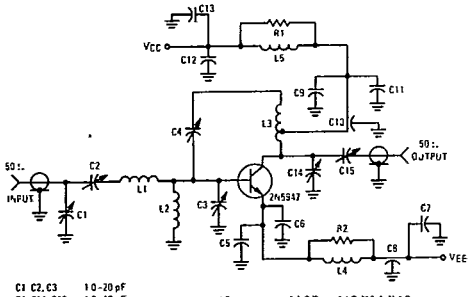
*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3 5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, I_B = 0)	I_{CEO}	–	–	100	μAdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	–	–	10	μAdc
Emitter Cutoff Current (V_{BE} = 3 5 Vdc, I_C = 0)	I_{EBO}	–	–	100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 75 mAdc, V_{CE} = 20 Vdc)	h_{FE}	25	–	250	–
Collector Emitter Saturation Voltage (I_C = 200 mAdc, I_B = 20 mAdc)	$V_{CE(sat)}$	–	0 2	0 35	Vdc
Base-Emitter Saturation Voltage (I_C = 200 mAdc, I_B = 20 mAdc)	$V_{BE(sat)}$	–	1 0	1.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (Figure 3) (I_C = 75 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	f_T	1100	1500	–	MHz
Collector-Base Capacitance (Figure 4) (V_{CB} = 30 Vdc, I_E = 0, f = 100 kHz)	C_{cb}	–	1.5	4 0	pF
Emitter-Base Capacitance (Figure 4) (V_{EB} = 0 5 Vdc, I_C = 0, f = 100 kHz)	C_{eb}	–	8 2	12	pF
Small-Signal Current Gain (I_C = 75 mAdc, V_{CE} = 20 Vdc, f = 1.0 kHz)	h_{fe}	25	–	300	–
Collector-Base Time Constant (I_E = 75 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz)	$r_b C_c$	2.0	–	20	ps
Noise Figure	NF				dB
(I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 200 MHz) (Figure 1)		–	3 8	–	
(I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 200 MHz) (1) (Figure 2, 9)		–	7.2	8 5	
(I_C = 75 mAdc, V_{CE} = 20 Vdc, f = 200 MHz) (1) (Figure 2, 9)		–	7.8	–	
FUNCTIONAL TEST					
Common Emitter Amplifier Power Gain (Figure 2) (I_C = 75 mAdc, V_{CE} = 20 Vdc, f = 250 MHz)	G_{pe}	10	11	–	dB
Intermodulation Distortion (Figure 2, 10) (I_C = 75 mAdc, V_{CE} = 20 Vdc, V_{out} = +50 dBmv)	IM	–	-55	-50	dB
Cross Modulation Distortion (Figure 2, 11) (I_C = 75 mAdc, V_{CE} = 20 Vdc, V_{out} = +50 dBmV)	XM	–	-60	-57	dB

*Indicates JEDEC Registered Data

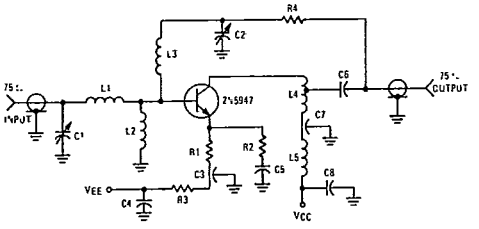
(1) Includes noise figure of post-amplifier and matching pad

FIGURE 1 – NARROWBAND TEST CIRCUIT



C1 C2, C3 10-20 pF
C4 C14 C15 10-10 pF
C5 C8 C9 470 pF
C6 C10 C11 0.001 μF
C7 C13 0.01 μF
C12 0 1 μF
L1 3 Turns AWG #18 1 4" I D 5.16" Long
L2 1 1 2 Turns AWG #18 1 4" I D 3.16 Long
L3 9 3 4 Turns AWG #18 3 16 I D 1" Long Tapped 1 3 4 Turns from Collector End
L4 L5 0 47 μH Molded Choke
R1 R2 10 Ohms

FIGURE 2 – BROADBAND TEST CIRCUIT



C1 C2 0 5-6 0 pF
C3 C7 1500 pF Underwood
C4 C5 C8 0 01 μF
C6 470 pF
L1 3 Turns #20 AWG 5/32" I D
L2 0 84 μH Ohmite Z-235
L3 5 Turns #26 AAG 5/32" I D
L4 #30 AWG Trifilar Wound 1 9 9 Stackpole 57 0385 #11 Toroid
L5 Ferrite Choke 3 Turns #30 on Stackpole 57 0156 Bead
R1 20 Ohms
R2 68 Ohms
R3 150 Ohms
R4 360 Ohms

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FIGURE 3 – CURRENT-GAIN–BANDWIDTH PRODUCT

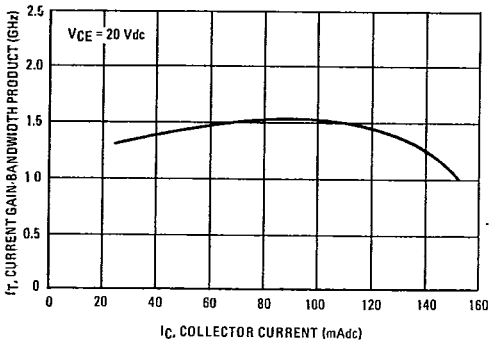

FIGURE 4 – CAPACITANCES

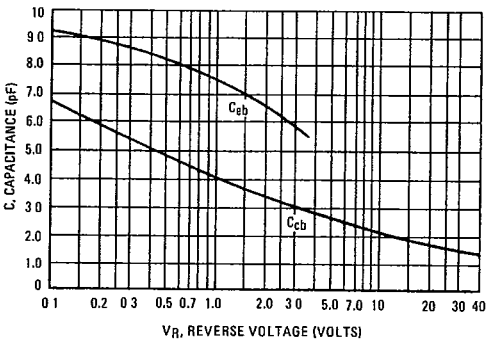

FIGURE 5 – COLLECTOR-EMITTER SATURATION VOLTAGE

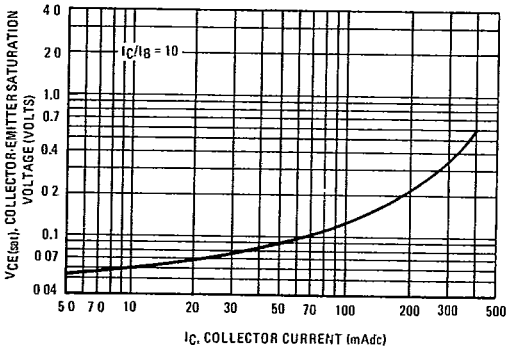

FIGURE 6 – BASE-EMITTER SATURATION VOLTAGE

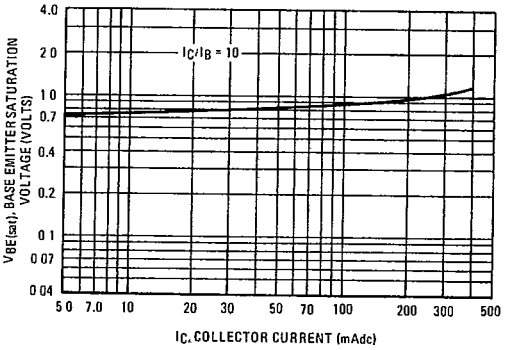

FIGURE 7 – NARROWBAND NOISE FIGURE versus CURRENT

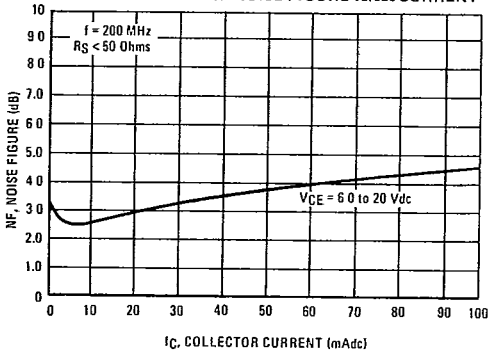

FIGURE 8 – BROADBAND NOISE FIGURE versus CURRENT

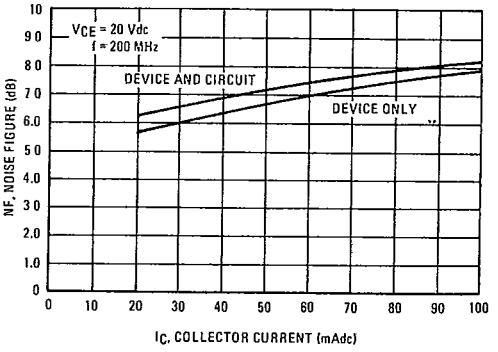

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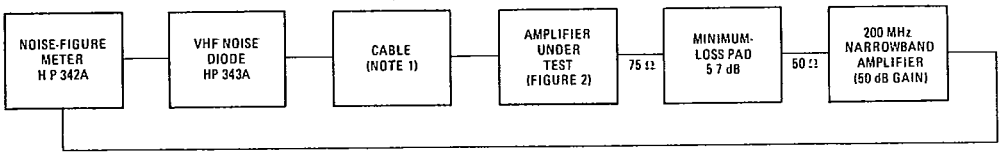
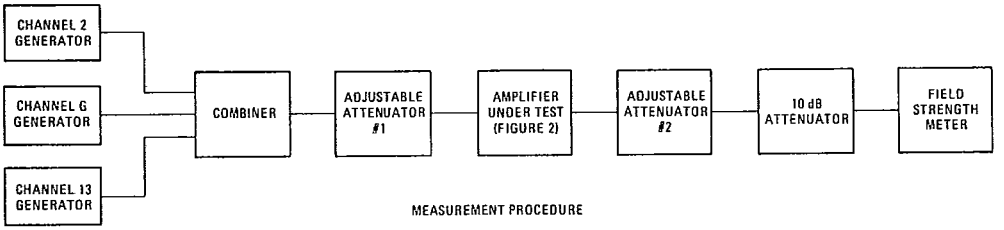
FIGURE 9 – NOISE FIGURE TEST SETUP



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

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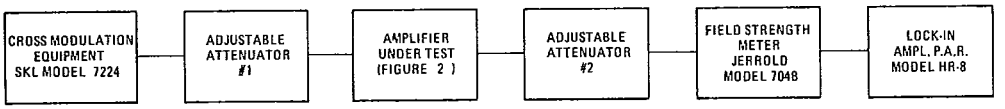
FIGURE 11 – CROSS MODULATION DISTORTION TEST SETUP



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 LEVEL

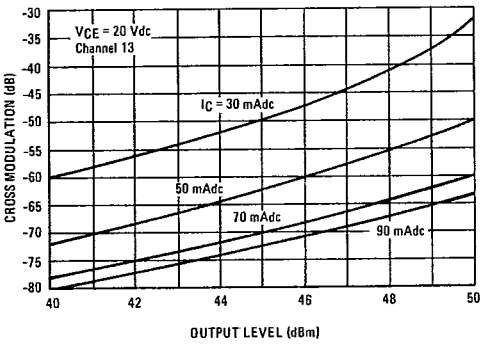


FIGURE 13 – CROSS MODULATION DISTORTION versus CURRENT