

# The RF Line NPN Silicon High-Frequency Transistor

... designed for use in high-gain, low-noise, ultra-linear, tuned and wideband amplifiers. Ideal for use in CATV, MATV, and instrumentation applications.

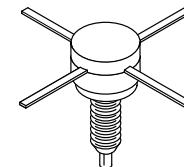
- Low Noise Figure —  
NF = 3.0 dB (Typ) @ f = 500 MHz, IC = 90 mA
- High Power Gain —  
GU(max) = 16.5 dB (Typ) @ f = 500 MHz
- Ion Implanted
- All Gold Metal System
- High fT — 5.5 GHz
- Low Intermodulation Distortion:  
TB3 = -70 dB  
DIN = 125 dB µV
- Nichrome Emitter Ballast Resistors

**MRF587**

NF = 3.0 dB @ 0.5 GHz  
HIGH-FREQUENCY  
TRANSISTOR  
NPN SILICON

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	17	Vdc
Collector-Base Voltage	VCBO	34	Vdc
Emitter-Base Voltage	VEBO	2.5	Vdc
Collector Current — Continuous	IC	200	mAdc
Total Device Dissipation @ TC = 50°C Derate above TC = 50°C	PD	5.0 33	Watts mW/°C
Storage Temperature Range	Tstg	- 65 to +150	°C
Junction Temperature	TJ	200	°C



CASE 244A-01, STYLE 1

## ELECTRICAL CHARACTERISTICS (TC = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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## OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, IB = 0)	V(BR)CEO	17	—	—	Vdc
Collector-Base Breakdown Voltage (IC = 1.0 mAdc, IE = 0)	V(BR)CBO	34	—	—	Vdc
Emitter-Base Breakdown Voltage (IC = 0, IE = 0.1 mAdc)	V(BR)EBO	2.5	—	—	Vdc
Collector Cutoff Current (VCE = 10 Vdc, IE = 0)	ICBO	—	—	50	µAdc

## ON CHARACTERISTICS

DC Current Gain (1) (IC = 50 mAdc, VCE = 5.0 Vdc)	hFE	50	—	200	—
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NOTE:

1. 300 µs pulse on Tektronix 576 or equivalent.

(continued)

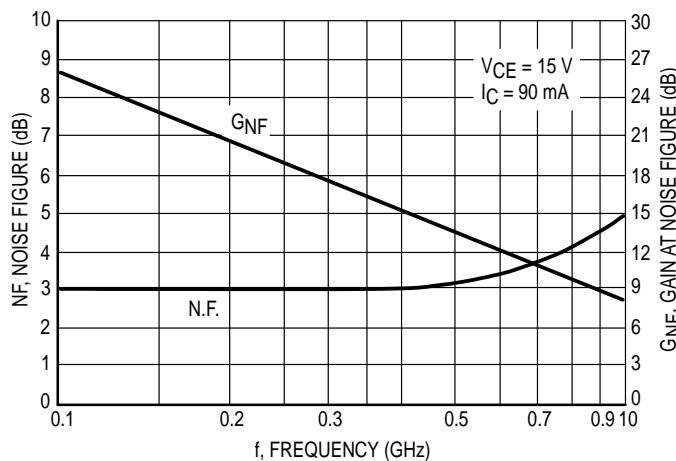
**ELECTRICAL CHARACTERISTICS — continued** ( $T_C = 25^\circ\text{C}$  unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>DYNAMIC CHARACTERISTICS</b>					
Current-Gain — Bandwidth Product (2) ( $I_C = 90 \text{ mA}$ , $V_{CE} = 15 \text{ Vdc}$ , $f = 0.5 \text{ GHz}$ )	$f_T$	—	5.5	—	GHz
Collector-Base Capacitance ( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{cb}$	—	1.7	2.2	pF
<b>FUNCTIONAL TESTS</b>					
Narrowband — Figure 15 ( $I_C = 90 \text{ mA}$ , $V_{CC} = 15 \text{ V}$ , $f = 0.5 \text{ GHz}$ ) Noise Figure Power Gain at Optimum Noise Figure	NF GNF	— 11	3.0 13	4.0 —	dB
Broadband — Figure 16 ( $I_C = 90 \text{ mA}$ , $V_{CC} = 15 \text{ V}$ , $f = 0.3 \text{ GHz}$ ) Noise Figure Power Gain at Optimum Noise Figure	NF GNF	— —	6.3 11	— —	dB
Triple Beat Distortion ( $I_C = 50 \text{ mA}$ , $V_{CC} = 15 \text{ V}$ , $P_{Ref} = 50 \text{ dBmV}$ ) ( $I_C = 90 \text{ mA}$ , $V_{CC} = 15 \text{ V}$ , $P_{Ref} = 50 \text{ dBmV}$ )	TB <sub>3</sub>	—	-70	—	dB
DIN 45004 ( $I_C = 90 \text{ mA}$ , $V_{CC} = 15 \text{ V}$ ) ( $I_C = 90 \text{ mA}$ , $V_{CC} = 15 \text{ V}$ )	DIN	—	125	—	$\text{dB}\mu\text{V}$
Maximum Available Power Gain (3) ( $I_C = 90 \text{ mA}$ , $V_{CE} = 15 \text{ Vdc}$ , $f = 0.5 \text{ GHz}$ )	$G_{Umax}$	—	16.5	—	dB

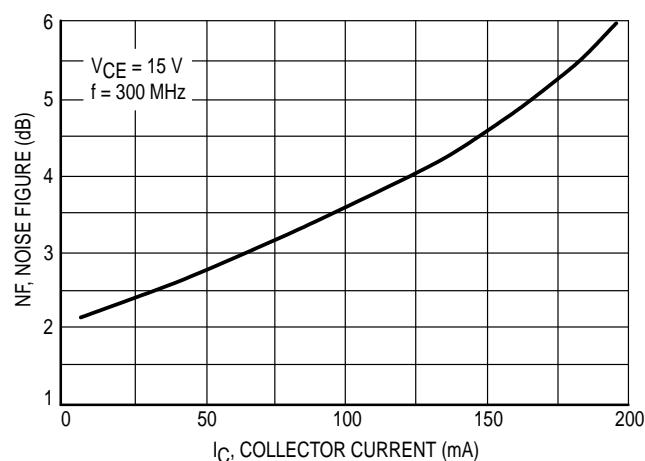
NOTES:

2. Characterized on HP8542 Automatic Network Analyzer

$$3. G_{Umax} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$



**Figure 1. Typical Noise Figure and Associated Gain versus Frequency**



**Figure 2. Noise Figure versus Collector Current**

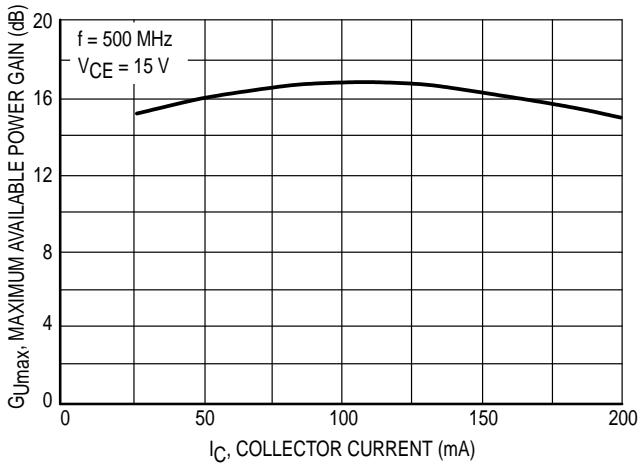


Figure 3.  $G_{U\text{max}}$  versus Collector Current

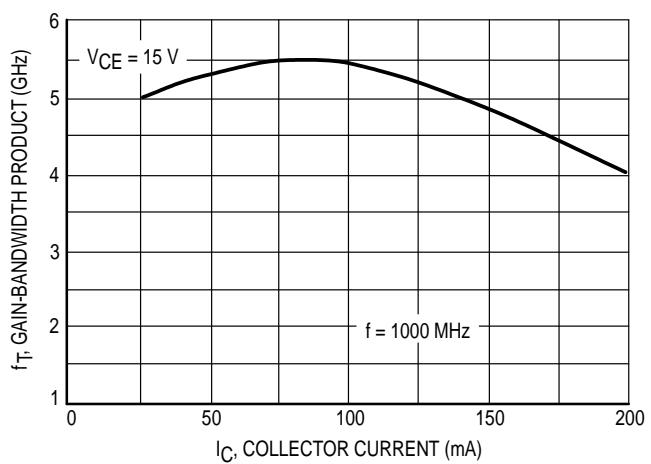


Figure 4. Gain-Bandwidth Product versus Collector Current

### TYPICAL PERFORMANCE

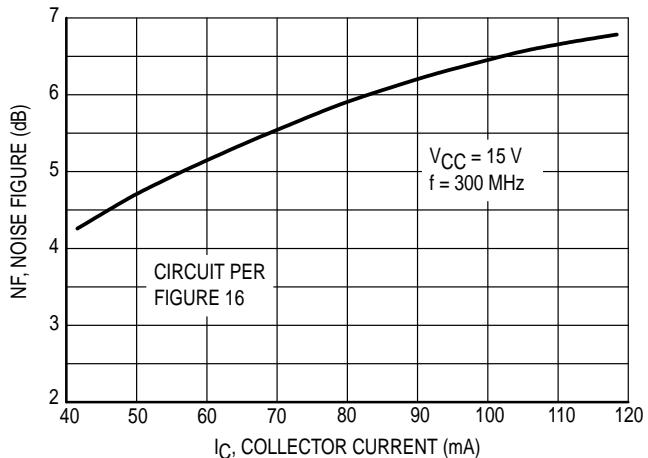


Figure 5. Broadband Noise Figure

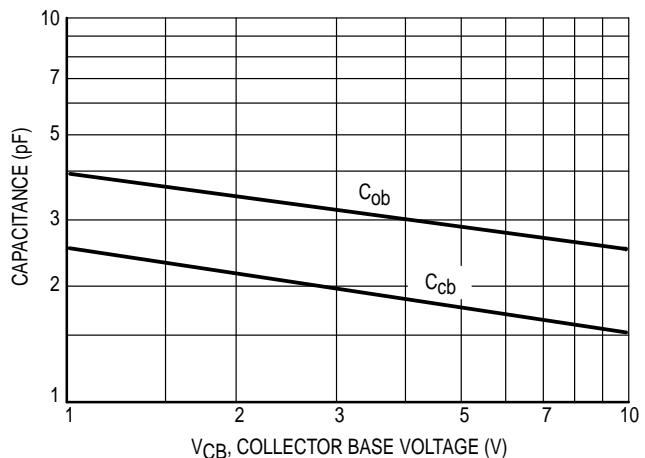


Figure 6. Junction Capacitance versus Voltage

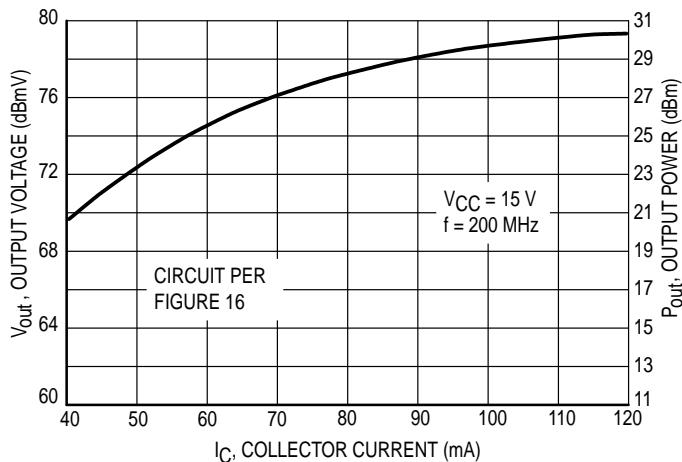


Figure 7. 1.0 dB Compression Point versus Collector Current

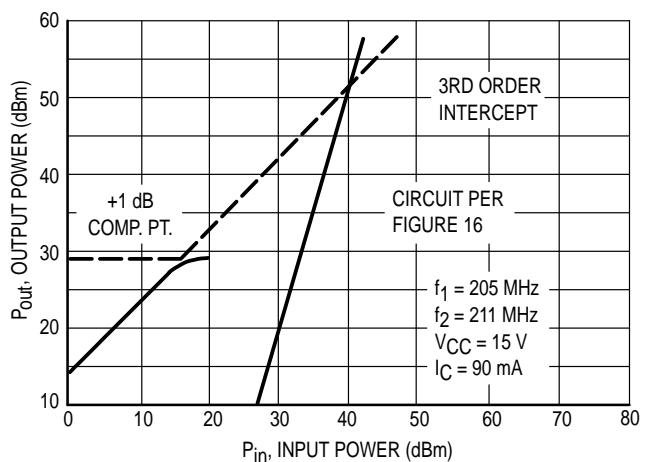
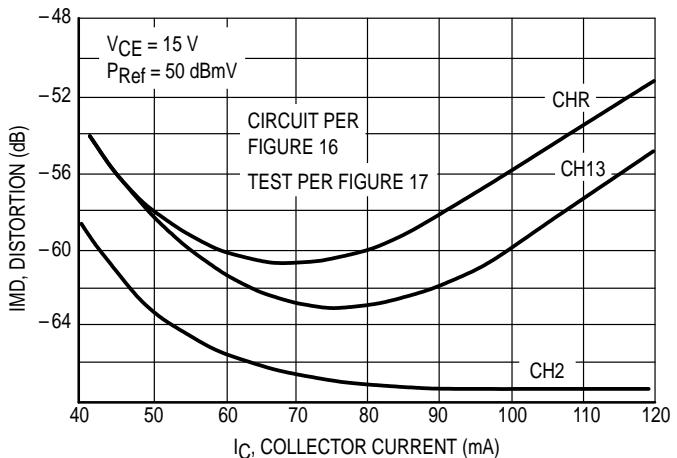
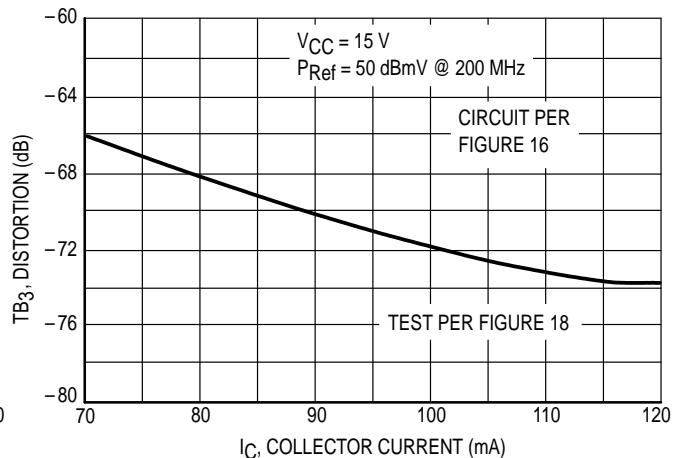


Figure 8. Third Order Intercept Point

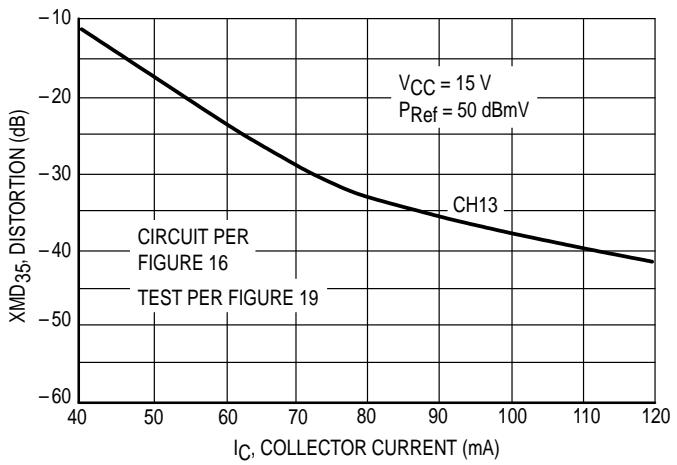
## TYPICAL PERFORMANCE (continued)



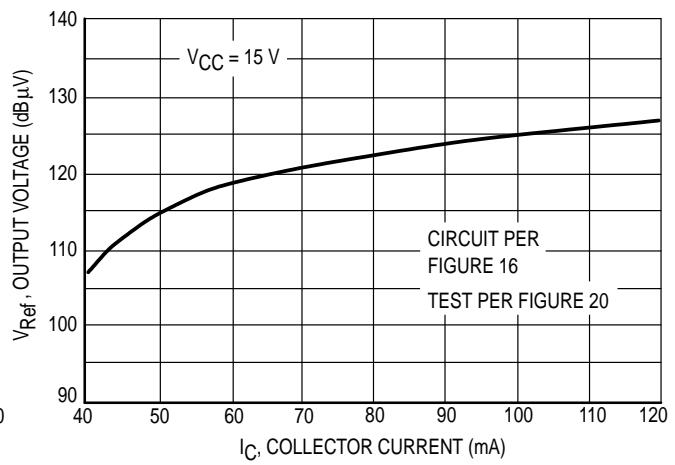
**Figure 9. Second Order Distortion versus Collector Current**



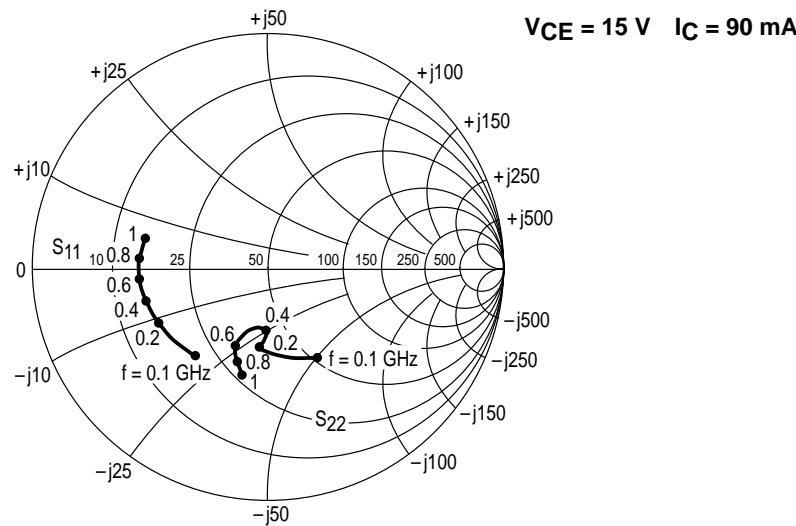
**Figure 10. Triple Beat Distortion versus Collector Current**



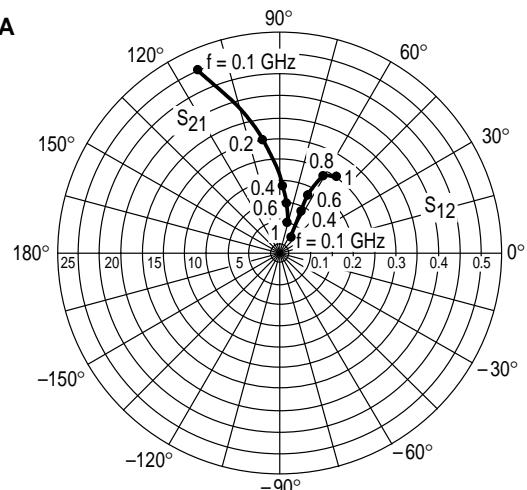
**Figure 11. 35-Channel X-Modulation Distortion versus Collector Current**



**Figure 12. DIN 45004B versus Collector Current**



**Figure 13. Input/Output Reflection Coefficient versus Frequency (GHz)**



**Figure 14. Forward/Reverse Transmission Coefficients versus Frequency (GHz)**

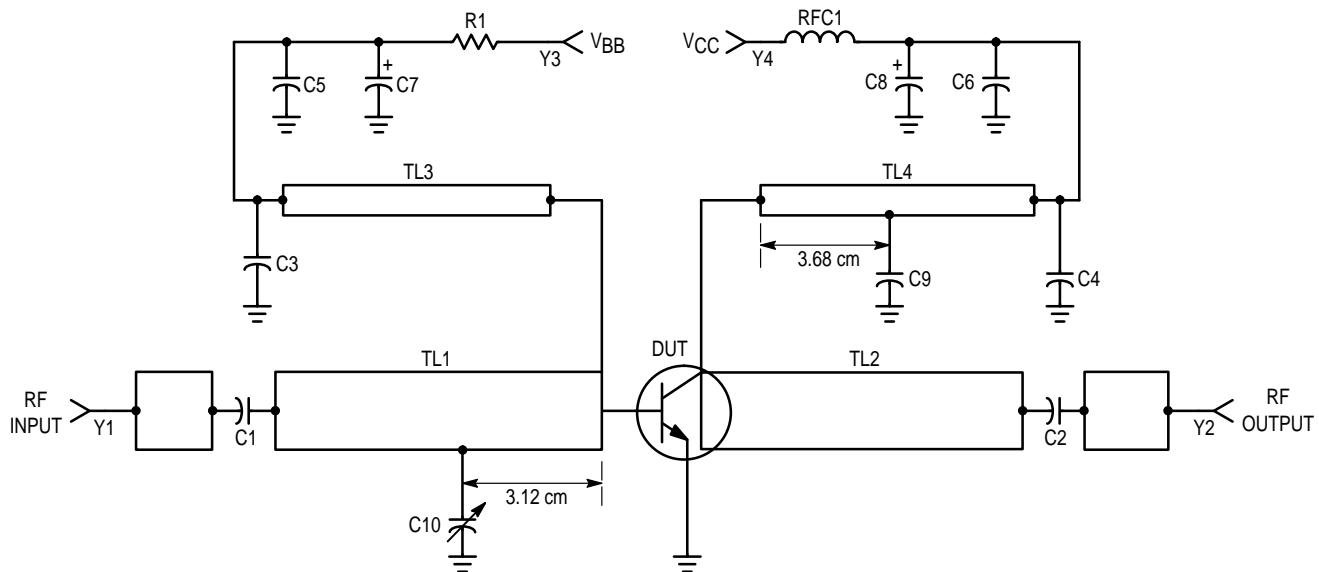
$V_{CE}$ (Volts)	$I_C$ (mA)	$f$ (MHz)	$S_{11}$		$S_{21}$		$S_{12}$		$S_{22}$	
			$ S_{11} $	$\phi$	$ S_{21} $	$\phi$	$ S_{12} $	$\phi$	$ S_{22} $	$\phi$
5.0	30	100	0.56	-131	16.45	113	0.04	45	0.49	-91
		200	0.58	-159	9.42	98	0.06	49	0.38	-116
		400	0.60	-178	5.00	86	0.08	55	0.35	-132
		600	0.64	170	3.61	76	0.11	56	0.38	-138
		800	0.67	162	2.92	67	0.14	55	0.41	-144
		1000	0.70	155	2.55	58	0.17	54	0.44	-152
	60	100	0.53	-141	17.89	110	0.04	50	0.47	-102
		200	0.56	-164	10.05	97	0.05	55	0.39	-126
		400	0.59	178	5.31	85	0.09	60	0.38	-141
		600	0.63	169	3.82	76	0.12	59	0.40	-146
		800	0.66	161	3.09	67	0.15	57	0.44	-153
		1000	0.69	155	2.67	58	0.18	55	0.47	-160
	90	100	0.52	-145	18.26	109	0.04	52	0.47	-106
		200	0.56	-166	10.20	96	0.05	57	0.39	-130
		400	0.59	177	5.38	85	0.09	62	0.39	-144
		600	0.63	168	3.86	76	0.12	60	0.41	-149
		800	0.66	161	3.12	67	0.15	58	0.45	-155
		1000	0.69	155	2.70	58	0.19	55	0.48	-162
10	30	100	0.53	-122	18.36	115	0.04	48	0.50	-75
		200	0.53	-153	10.63	100	0.05	51	0.36	-96
		400	0.55	175	5.71	87	0.08	57	0.33	-112
		600	0.59	173	4.16	78	0.10	58	0.35	-119
		800	0.62	165	3.37	68	0.13	57	0.39	-127
		1000	0.65	158	2.95	59	0.15	55	0.42	-136
	60	100	0.49	-132	20.19	112	0.03	51	0.46	-85
		200	0.51	-158	11.54	99	0.05	57	0.35	-107
		400	0.53	-178	6.12	87	0.08	61	0.33	-123
		600	0.58	171	4.43	78	0.11	60	0.36	-129
		800	0.60	164	3.58	68	0.14	59	0.40	-136
		1000	0.63	157	3.12	60	0.16	57	0.44	-144
	90	100	0.48	-135	20.82	111	0.03	53	0.45	-88
		200	0.50	-160	11.77	98	0.05	59	0.34	-111
		400	0.53	-179	6.22	86	0.08	63	0.33	-126
		600	0.57	171	4.50	78	0.11	62	0.36	-131
		800	0.60	164	3.64	68	0.14	59	0.41	-139
		1000	0.63	157	3.18	60	0.17	57	0.44	-147

(continued)

**Table 1. Common-Emitter S-Parameters**

$V_{CE}$ (Volts)	$I_C$ (mA)	$f$ (MHz)	$S_{11}$		$S_{21}$		$S_{12}$		$S_{22}$	
			$ S_{11} $	$\phi$	$ S_{21} $	$\phi$	$ S_{12} $	$\phi$	$ S_{22} $	$\phi$
15	30	100	0.49	-112	20.34	118	0.04	54	0.51	-52
		200	0.52	-145	11.51	101	0.05	56	0.36	-77
		400	0.48	-164	6.12	87	0.09	63	0.32	-74
		600	0.52	-174	4.19	75	0.12	62	0.32	-90
		800	0.53	177	3.29	68	0.16	61	0.38	-90
		1000	0.53	168	2.76	61	0.20	56	0.47	-90
	60	100	0.45	-122	22.14	115	0.03	56	0.45	-60
		200	0.49	-150	12.24	99	0.05	60	0.33	-86
		400	0.45	-166	6.45	86	0.09	65	0.30	-83
		600	0.50	-175	4.42	75	0.13	63	0.32	-99
		800	0.51	177	3.47	68	0.16	61	0.38	-98
		1000	0.51	168	2.91	62	0.20	55	0.46	-96
	90	100	0.44	-127	22.76	114	0.03	58	0.43	-62
		200	0.48	-152	12.44	98	0.05	62	0.32	-89
		400	0.44	-167	6.55	85	0.09	66	0.29	-85
		600	0.50	-176	4.47	75	0.13	64	0.32	-102
		800	0.51	176	3.51	69	0.17	61	0.38	-100
		1000	0.51	168	2.95	62	0.20	55	0.46	-98

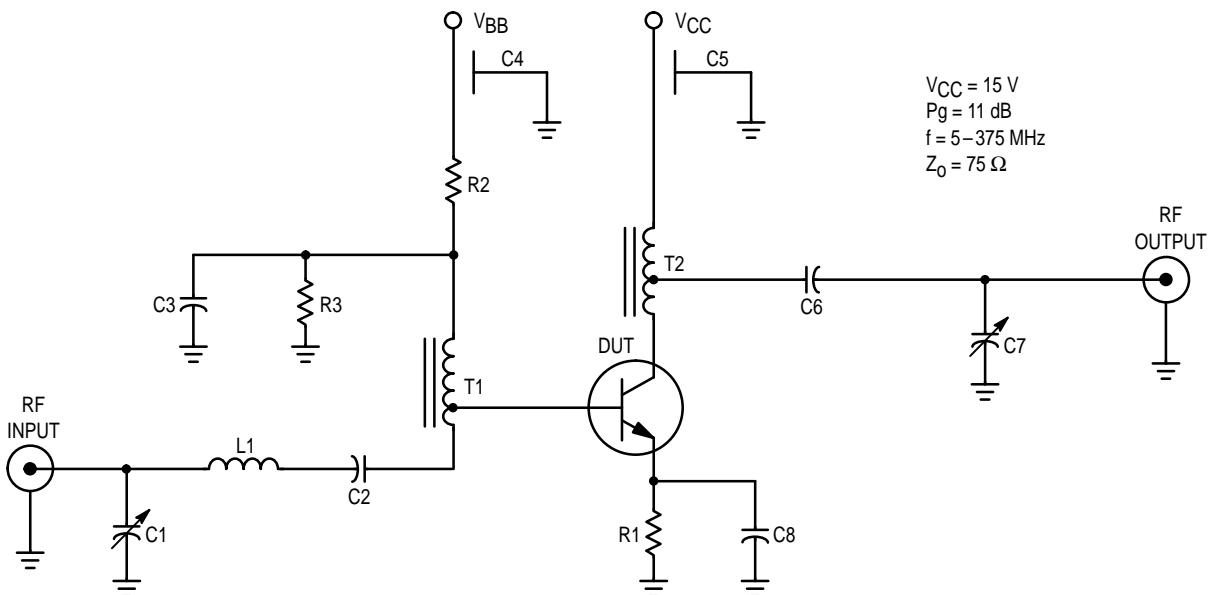
Table 1. Common-Emitter S-Parameters (continued)



C1, C2 — 470 pF Chip (Ceramic)  
C3, C4 — 0.018  $\mu$ F Chip Capacitor  
C5, C6 — 0.1  $\mu$ F Mylar  
C7, C8 — 1.0  $\mu$ F, 25 Vdc Electrolytic  
C9 — 91 pF Mini-Unelco (C9 Taped 3.68 cm from  
Collector Connection on TL4 as shown)  
C10 — 35–45 pF Johanson Ceramic Capacitor, JMC  
5801 or Equivalent (C10 Taped 3.12 cm from  
Base Connection on TL1)

R1 — 2.7 k $\Omega$ , 1-1/2 W  
RFC1 — 0.15  $\mu$ H Molded Choke  
TL1, TL2 —  $Z_0$  = 26  $\Omega$ , 0.0625 TFG as shown in  
Photomaster  
TL3, TL4 —  $\lambda/4$  Microstrip,  $Z_0$  = 100  $\Omega$   
Y1, Y2 — N-Type Connection (Female)  
Y3, Y4 — BNC-Type Connector (Female)  
Board Material — 0.0625" Thick Glass Teflon  $\epsilon_r$  = 2.5

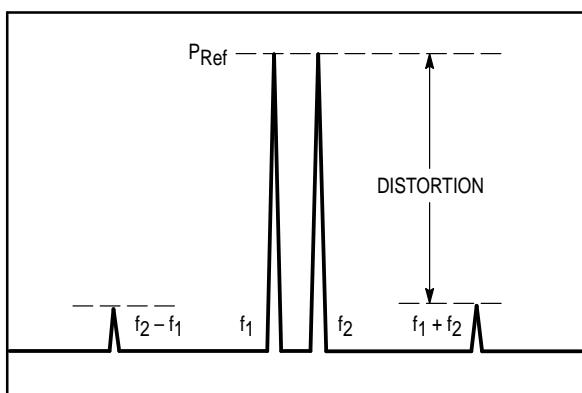
Figure 15. Narrowband Test Fixture Schematic  
500 MHz



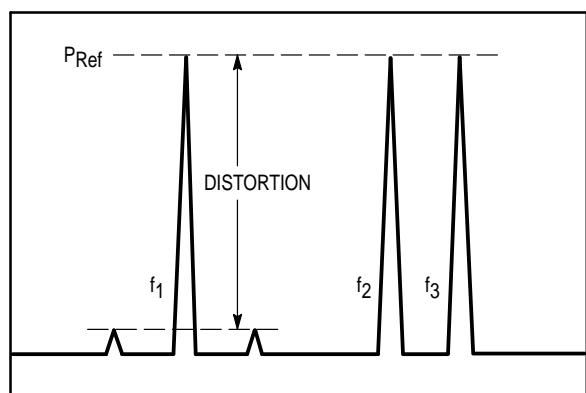
C1, C7 — 0.5–10 pF  
 C2, C6 — 0.001  $\mu$ F  
 C3 — 0.01  $\mu$ F  
 C4, C5 — 0.01  $\mu$ F Feedthru  
 C8 — 12 pF

R1 — 12  $\Omega$  1.0 W (2.0–24  $\Omega$  on each emitter port)  
 R2 — 1.8 k 1/8 W  
 R3 — 2.2 k 1/8 W  
 L1 — 1 Turn 0.012 dia #22 AWG  
 T1(1) — 5 Turns Tapped at 2 Turns, #30 AWG  
 T2(1) — 8 Turns Tapped at 3 Turns, #30 AWG  
 (1) Ferroxcube 135 CT050 3D3 Material

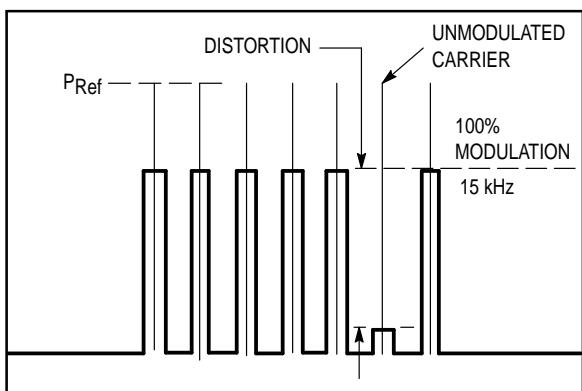
**Figure 16. Broadband Test Circuit Schematic**



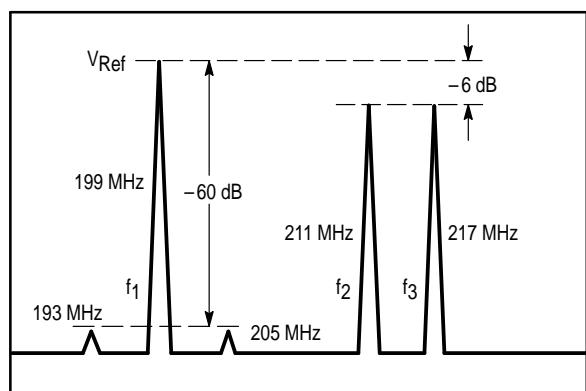
**Figure 17. Second Order Distortion Test**



**Figure 18. Triple Beat Distortion Test**

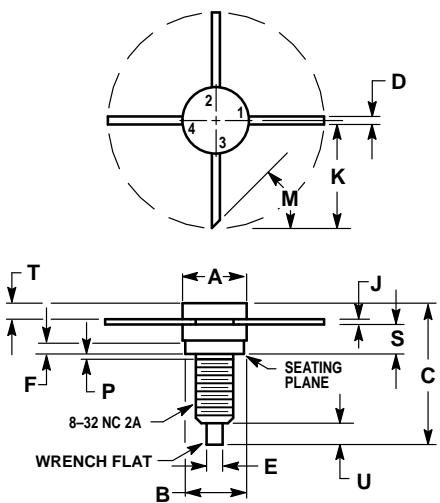


**Figure 19. Cross Modulation Distortion Test**



**Figure 20. DIN 45004B Intermodulation Test**

## PACKAGE DIMENSIONS



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	0.86	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

STYLE 1:  
 PIN 1. Emitter  
 2. Base  
 3. Emitter  
 4. Collector

### CASE 244A-01 ISSUE A

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