

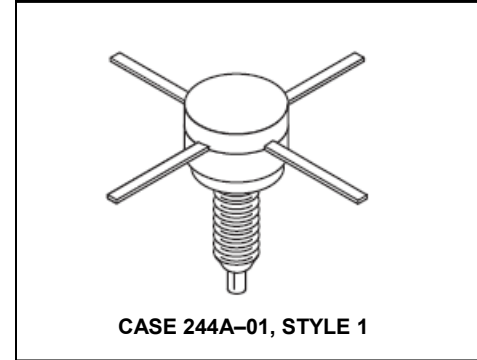
## The RF Line NPN Silicon High Frequency Transistor Noise Figure 3.0 dB@ 500MHz

Rev. V1

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

- Low noise figure —  
NF = 3.0 dB (typ.) @ f = 500 MHz, I<sub>C</sub> = 90 mA
- High power gain —  
G<sub>U(max)</sub> = 16.5 dB (typ.) @ f = 500 MHz
- Ion implanted
- All gold metal system
- High f<sub>T</sub> — 5.5 GHz
- Low intermodulation distortion:  
TB<sub>3</sub> = -70 dB  
DIN = 125 dB μV
- Nichrome emitter ballast resistors

### Product Image



### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V <sub>CEO</sub>	17	Vdc
Collector-Base Voltage	V <sub>CBO</sub>	34	Vdc
Emitter-Base Voltage	V <sub>EBO</sub>	2.5	Vdc
Collector Current — Continuous	I <sub>C</sub>	200	mAdc
Total Device Dissipation @ T <sub>C</sub> = 50°C Derate above T <sub>C</sub> = 50°C	P <sub>D</sub>	5.0 33	Watts mW/°C
Storage Temperature Range	T <sub>stg</sub>	- 65 to +150	°C
Junction Temperature	T <sub>J</sub>	200	°C

### ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (I <sub>C</sub> = 5.0 mAdc, I <sub>B</sub> = 0)	V <sub>(BR)CEO</sub>	17	—	—	Vdc
Collector-Base Breakdown Voltage (I <sub>C</sub> = 1.0 mAdc, I <sub>E</sub> = 0)	V <sub>(BR)CBO</sub>	34	—	—	Vdc
Emitter-Base Breakdown Voltage (I <sub>C</sub> = 0, I <sub>E</sub> = 0.1 mAdc)	V <sub>(BR)EBO</sub>	2.5	—	—	Vdc
Collector Cutoff Current (V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0)	I <sub>CBO</sub>	—	—	50	μAdc

### ON CHARACTERISTICS

DC Current Gain (1) (I <sub>C</sub> = 50 mAdc, V <sub>CE</sub> = 5.0 Vdc)	h <sub>FE</sub>	50	—	200	—
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NOTE:

1. 300 μs pulse on Tektronix 576 or equivalent.

(continued)

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### ELECTRICAL CHARACTERISTICS — continued (T<sub>C</sub> = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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### DYNAMIC CHARACTERISTICS

Current–Gain — Bandwidth Product (2) (I <sub>C</sub> = 90 mA, V <sub>CE</sub> = 15 Vdc, f = 0.5 GHz)	f <sub>T</sub>	—	5.5	—	GHz
Collector–Base Capacitance (V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz)	C <sub>cb</sub>	—	1.7	2.2	pF

### FUNCTIONAL TESTS

Narrowband — Figure 15 (I <sub>C</sub> = 90 mA, V <sub>CC</sub> = 15 V, f = 0.5 GHz) Noise Figure Power Gain at Optimum Noise Figure	NF G <sub>NF</sub>	— 11	3.0 13	4.0 —	dB
Broadband — Figure 16 (I <sub>C</sub> = 90 mA, V <sub>CC</sub> = 15 V, f = 0.3 GHz) Noise Figure Power Gain at Optimum Noise Figure	NF G <sub>NF</sub>	— —	6.3 11	— —	dB
Triple Beat Distortion (I <sub>C</sub> = 50 mA, V <sub>CC</sub> = 15 V, P <sub>Ref</sub> = 50 dBmV) (I <sub>C</sub> = 90 mA, V <sub>CC</sub> = 15 V, P <sub>Ref</sub> = 50 dBmV)	TB <sub>3</sub>	—	-70	—	dB
DIN 45004 (I <sub>C</sub> = 90 mA, V <sub>CC</sub> = 15 V) (I <sub>C</sub> = 90 mA, V <sub>CC</sub> = 15 V)	DIN	—	125	—	dBμV
Maximum Available Power Gain (3) (I <sub>C</sub> = 90 mA, V <sub>CE</sub> = 15 Vdc, f = 0.5 GHz)	G <sub>Umax</sub>	—	16.5	—	dB

### NOTES:

2. Characterized on HP8542 Automatic Network Analyzer

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

## The RF Line NPN Silicon High Frequency Transistor Noise Figure 3.0 dB@ 500MHz

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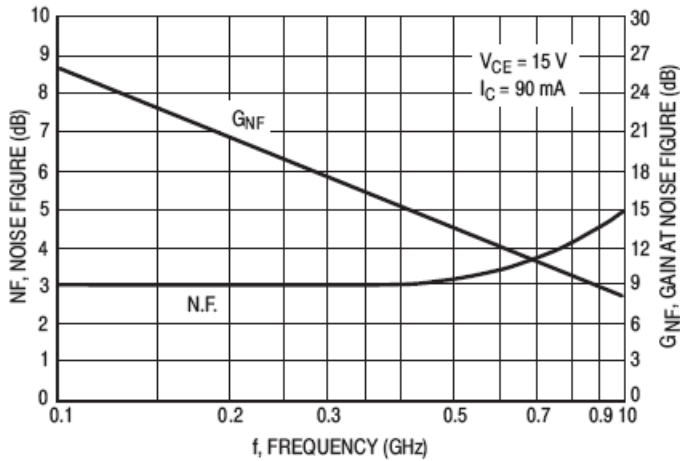


Figure 1. Typical Noise Figure and Associated Gain versus Frequency

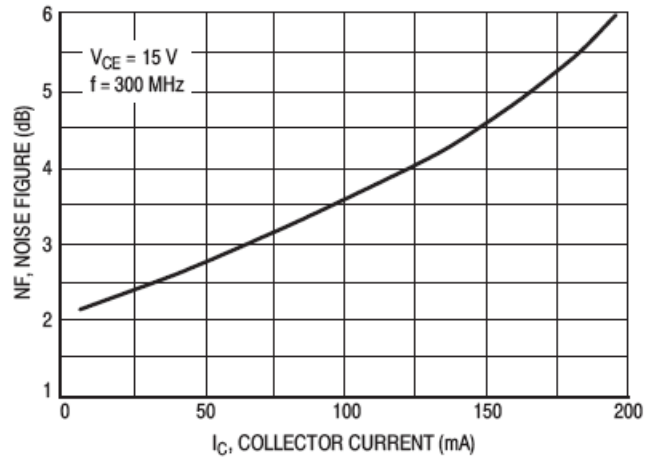


Figure 2. Noise Figure versus Collector Current

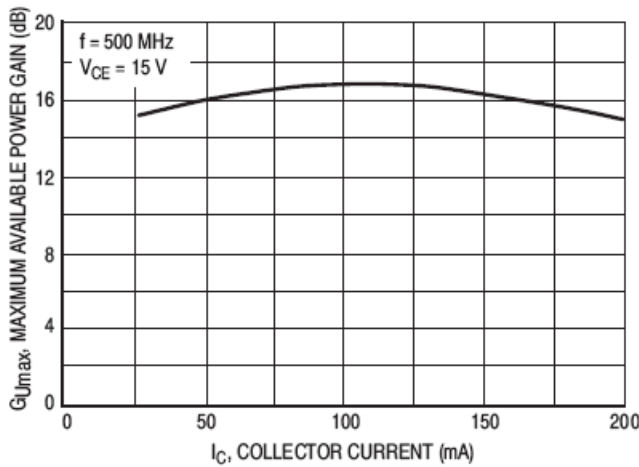


Figure 3.  $G_{Ummax}$  versus Collector Current

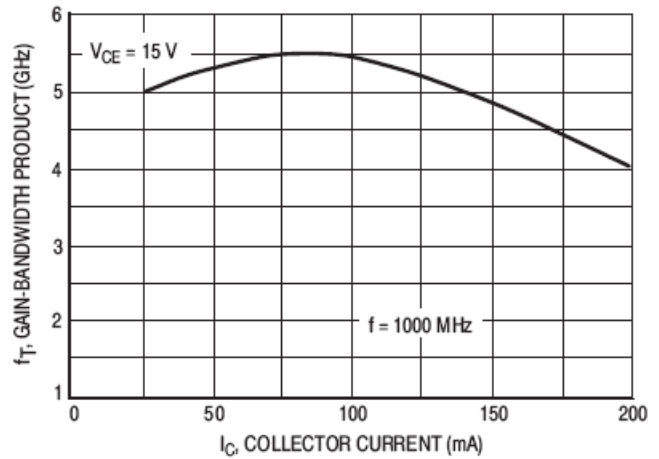


Figure 4. Gain-Bandwidth Product versus Collector Current

## TYPICAL PERFORMANCE

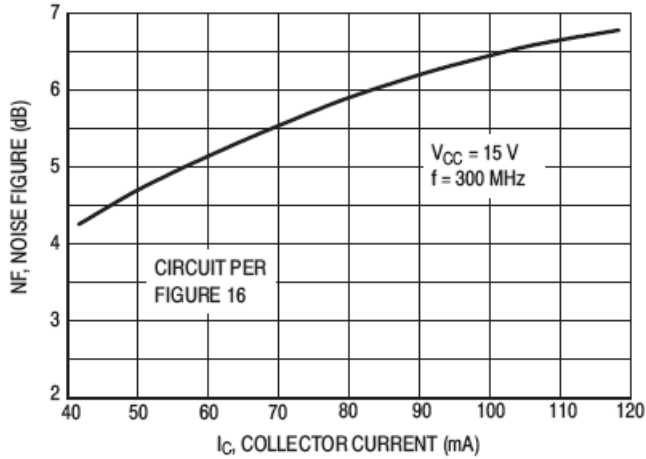


Figure 5. Broadband Noise Figure

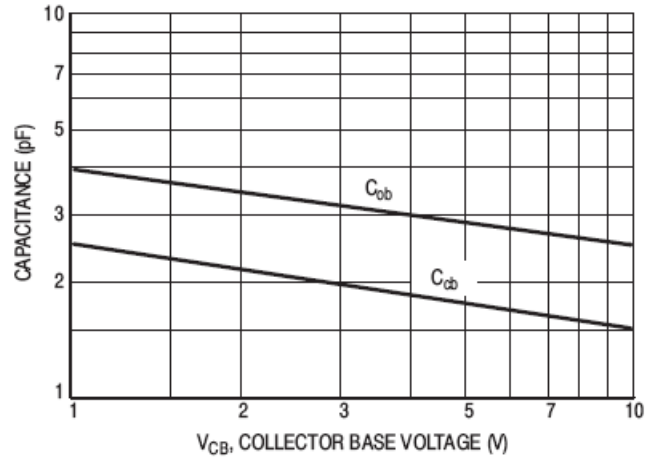


Figure 6. Junction Capacitance versus Voltage

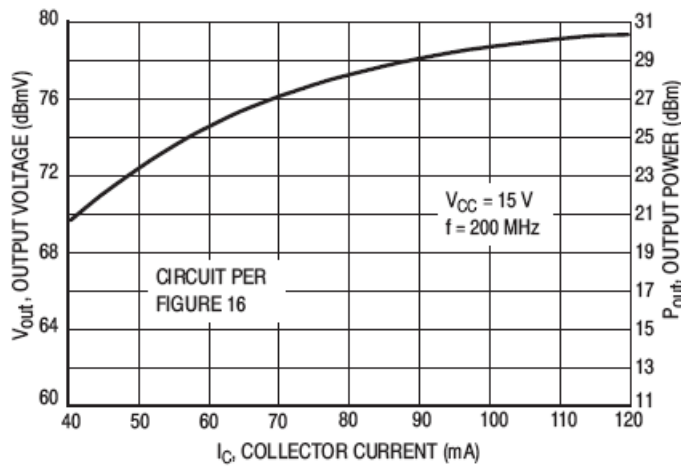


Figure 7. 1.0 dB Compression Point versus Collector Current

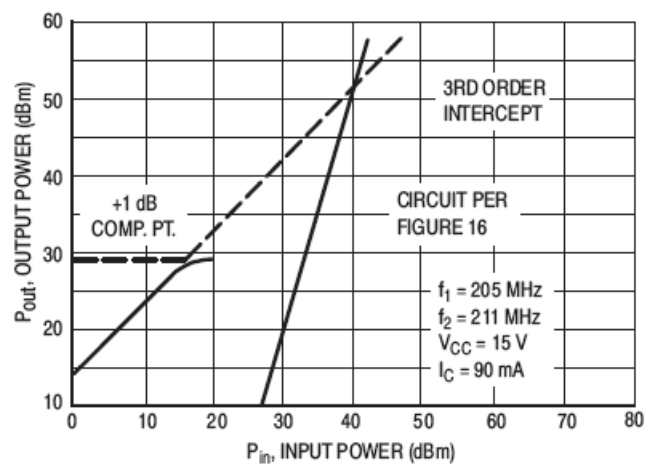


Figure 8. Third Order Intercept Point

TYPICAL PERFORMANCE (continued)

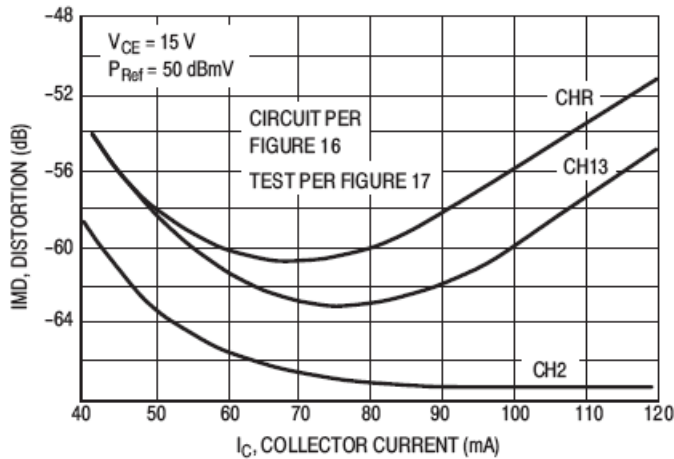


Figure 9. Second Order Distortion versus Collector Current

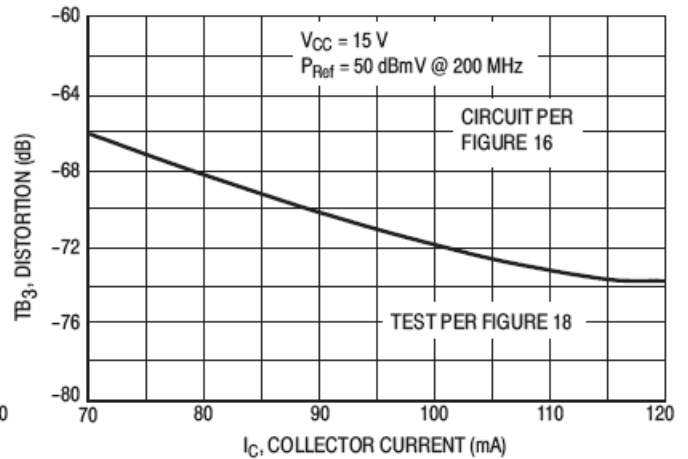


Figure 10. Triple Beat Distortion versus Collector Current

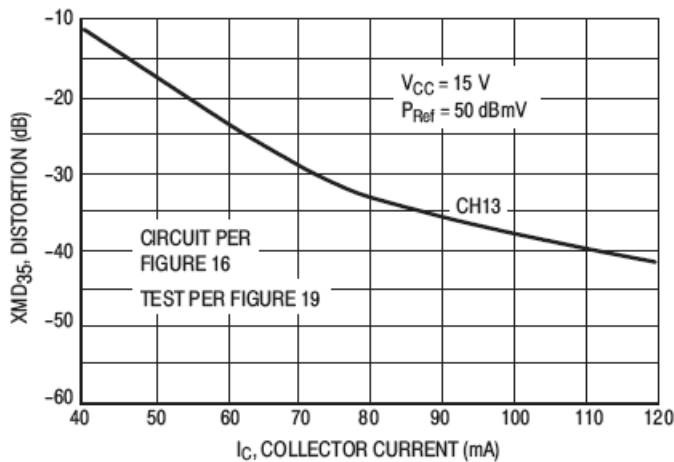


Figure 11. 35-Channel X-Modulation Distortion versus Collector Current

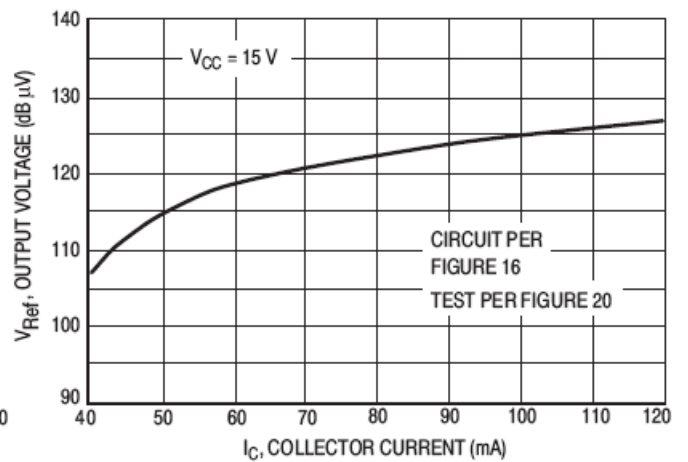


Figure 12. DIN 45004B versus Collector Current

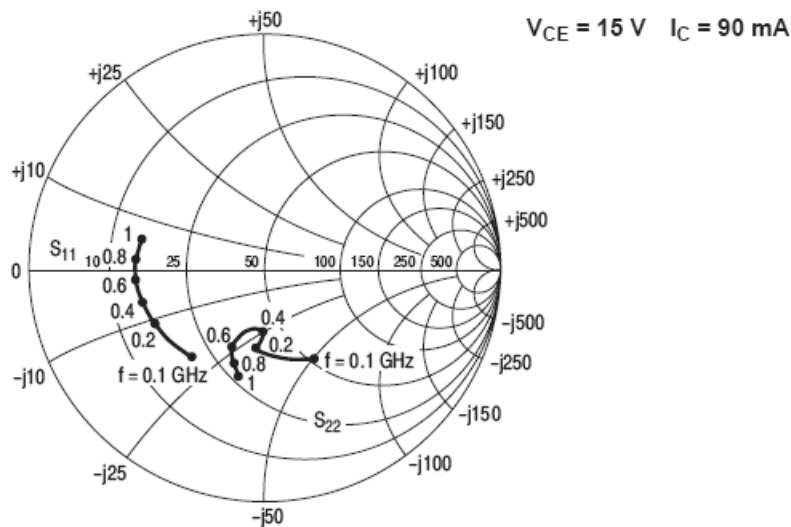


Figure 13. Input/Output Reflection Coefficient versus Frequency (GHz)

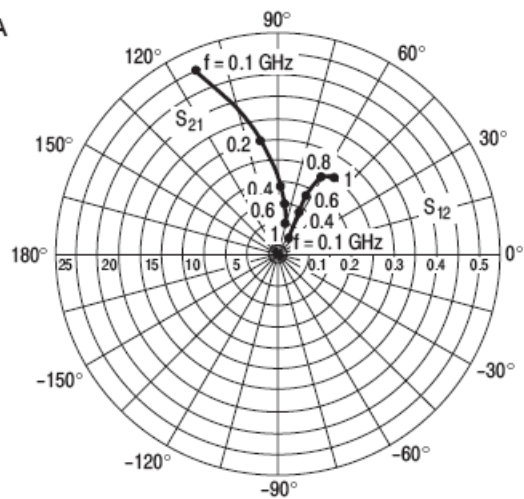


Figure 14. Forward/Reverse Transmission Coefficients versus Frequency (GHz)

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**Noise Figure 3.0 dB@ 500MHz**

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V <sub>CE</sub> (Volts)	I <sub>C</sub> (mA)	f (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		
			S <sub>11</sub>	∠ φ	S <sub>21</sub>	∠ φ	S <sub>12</sub>	∠ φ	S <sub>22</sub>	∠ φ	
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
	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**

**The RF Line NPN Silicon High Frequency Transistor**  
**Noise Figure 3.0 dB@ 500MHz**

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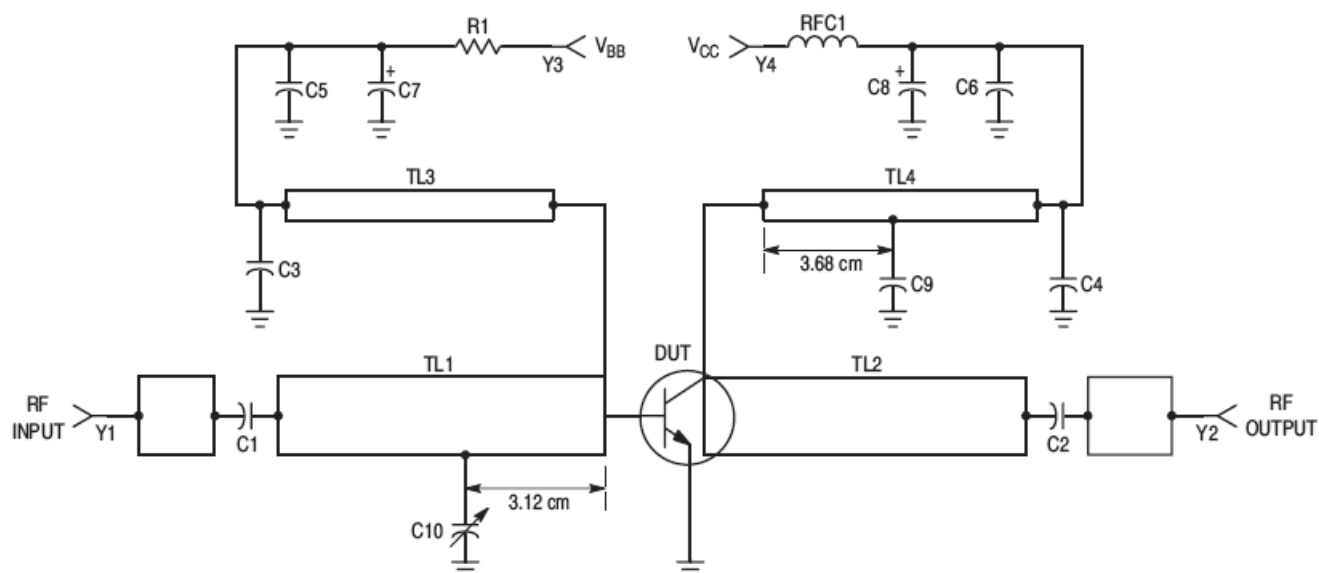
V <sub>CE</sub> (Volts)	I <sub>C</sub> (mA)	f (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
			S <sub>11</sub>	∠φ	S <sub>21</sub>	∠φ	S <sub>12</sub>	∠φ	S <sub>22</sub>	∠φ
15	30	100	0.49	-112	20.34	118	0.04	54	0.51	-52
		200	0.52	-145	11.51	101	0.05	56	0.36	-77
		400	0.48	-164	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)



## The RF Line NPN Silicon High Frequency Transistor Noise Figure 3.0 dB@ 500MHz

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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**

The RF Line NPN Silicon High Frequency Transistor  
Noise Figure 3.0 dB@ 500MHz

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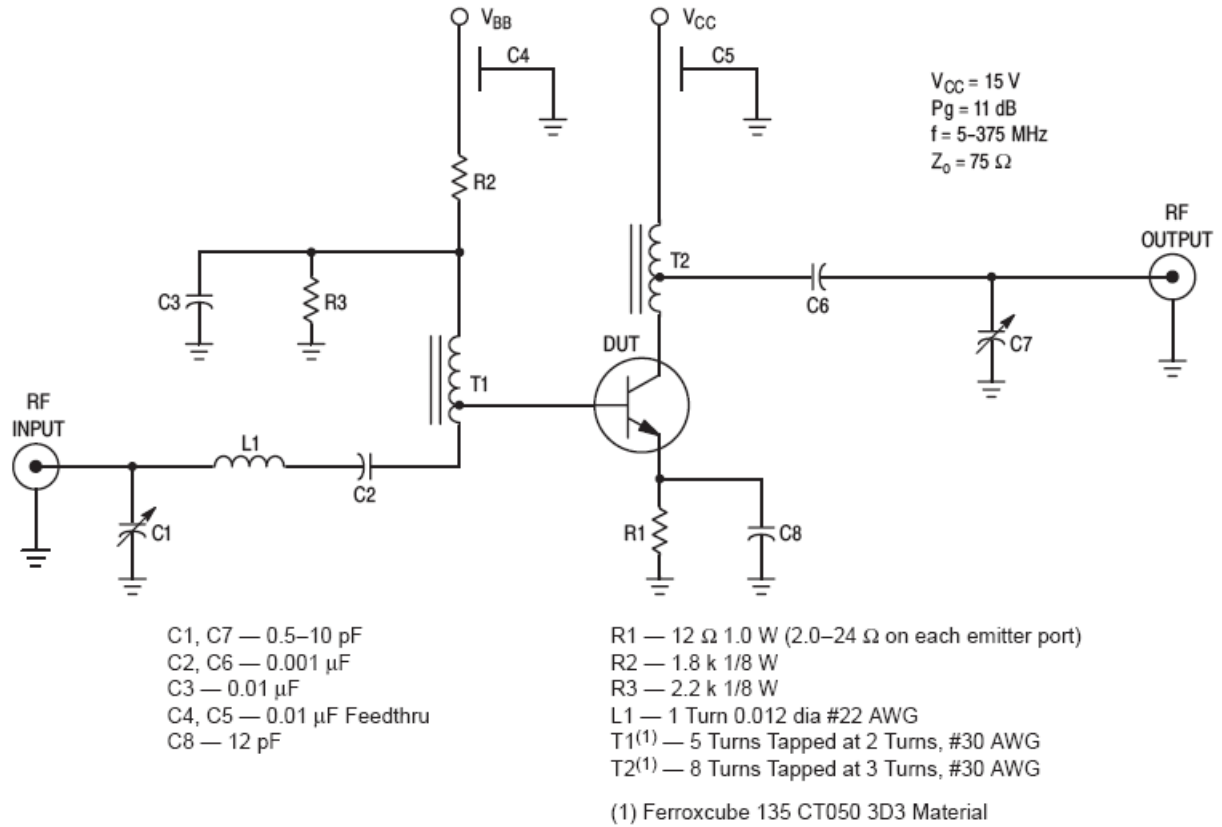


Figure 16. Broadband Test Circuit Schematic

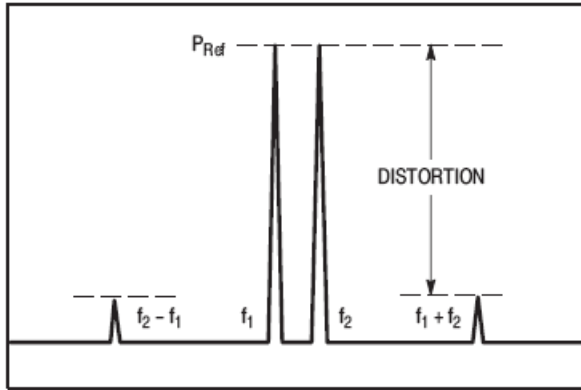


Figure 17. Second Order Distortion Test

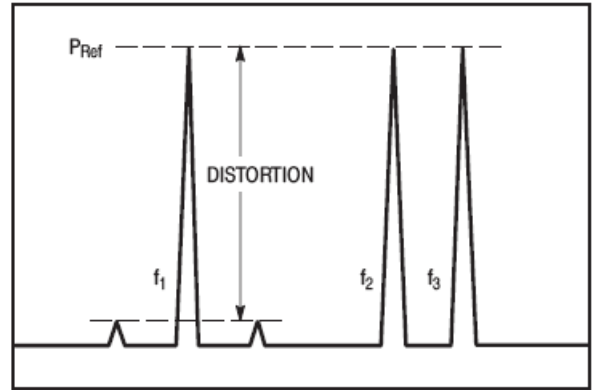


Figure 18. Triple Beat Distortion Test

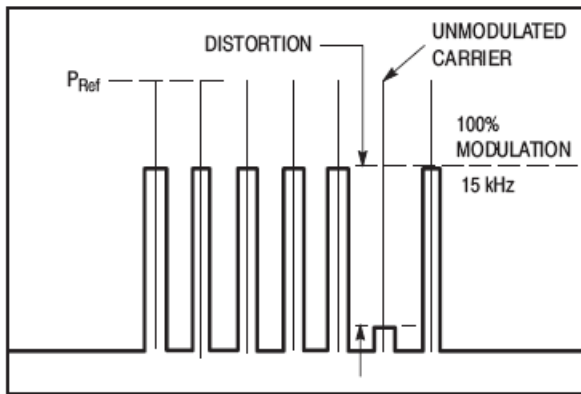


Figure 19. Cross Modulation Distortion Test

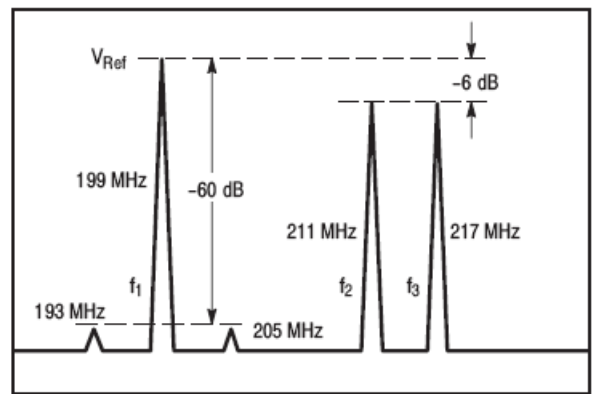
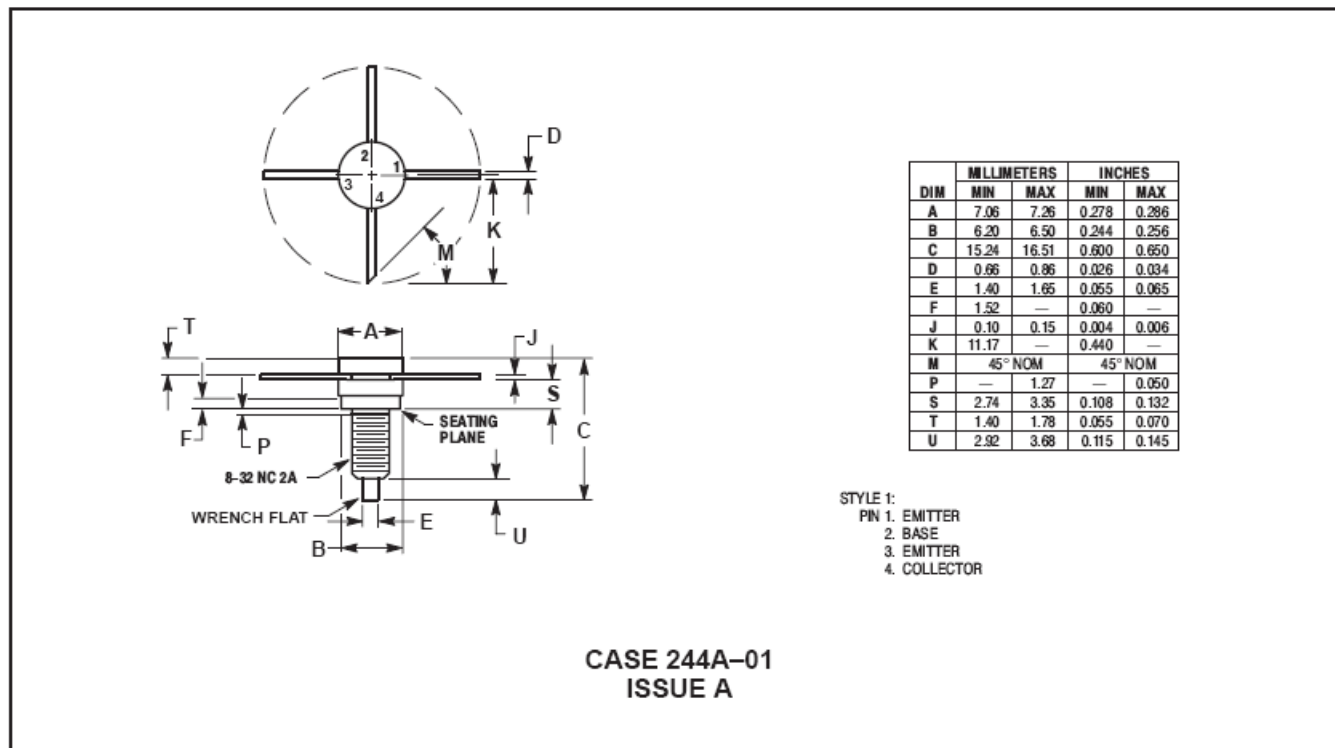


Figure 20. DIN 45004B Intermodulation Test

## PACKAGE DIMENSIONS



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