

**MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA**

**MRF586
MRF587**

Designer's Data Sheet

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The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS



... 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, I_C = 90 mA
- High Power Gain —
G_{U(max)} = 16.5 dB (Typ) @ f = 500 MHz
- Ion Implanted
- All Gold Metal System
- High f_T — 4.5 GHz MRF586
5.5 GHz MRF587
- Low Intermodulation Distortion:
TB₃ = -70 dB
DIN = 125 dB μV
- Nichrome Emitter Ballast Resistors.

NF = 3.0 dB @ 0.5 GHz

**HIGH FREQUENCY
TRANSISTORS**

NPN SILICON

MAXIMUM RATINGS		MRF586  Case 79-04 Style 1	MRF587  Case 244A-01 Style 1	Unit
Ratings	Symbol	Values		Unit
Collector-Emitter Voltage	V _{CEO}	17	17	V _{dc}
Collector-Base Voltage	V _{CBO}	34	34	V _{dc}
Emitter-Base Voltage	V _{EBO}	2.5	2.5	V _{dc}
Collector Current — Continuous	I _C	200	200	mA _{dc}
Total Device Dissipation @ T _C = 50°C Derate above T _C = 50°C	P _D	2.5 17	5.0 33	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to +200	-65 to +150	°C
Junction Temperature	T _J	200	200	°C

MRF586, MRF587

MOTOROLA SC (XSTRS/R F) 4E D ■ 6367254 0094795 3 ■ MOT6

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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 5.0 mA, I _B = 0)	V _{(BR)CEO}	17	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 1.0 mA, I _E = 0)	V _{(BR)CBO}	34	—	—	Vdc
Emitter-Base Breakdown Voltage (I _C = 0, I _E = 0.1 mA)	V _{(BR)EBO}	2.5	—	—	Vdc
Collector Cutoff Current (V _{CB} = 10 Vdc, I _E = 0)	I _{CBO}	—	—	50	μAdc

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ON CHARACTERISTICS

DC Current Gain (1) (I _C = 50 mA, V _{CE} = 5.0 Vdc)	h _{FE}	50	—	200	—
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DYNAMIC CHARACTERISTICS

Current-Gain — Bandwidth Product (2) (I _C = 90 mA, V _{CE} = 15 Vdc, f = 0.5 GHz)	MRF586	f _T	—	4.5	—	GHz
	MRF587		—	5.5	—	
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{cb}	—	1.7	2.2	pF

FUNCTIONAL TESTS

Narrow Band — Figure 23 (I _C = 90 mA, V _{CC} = 15 V, f = 0.5 GHz) Noise Figure Power Gain at Optimum Noise Figure	MRF586	NF	—	3.0	4.0	dB
	MRF587	G _{NF}	9.0	11.0	—	
			11.0	13.0	—	
Broad Band — Figures 24 and 25 (I _C = 90 mA, V _{CC} = 15 V, f = 0.3 GHz) Noise Figure Power Gain at Optimum Noise Figure	MRF586	NF	—	5.5	—	dB
	MRF587		—	6.3	—	
	MRF586	G _{NF}	—	10.0	—	
	MRF587		—	11.0	—	
Triple Beat Distortion (I _C = 50 mA, V _{CC} = 15 V, P _{Ref} = 50 dBmV) (I _C = 90 mA, V _{CC} = 15 V, P _{Ref} = 50 dBmV)	MRF586	TB ₃	—	-65	—	dB
	MRF587		—	-70	—	
DIN 45004 (I _C = 90 mA, V _{CC} = 15 V) (I _C = 90 mA, V _{CC} = 15 V)	MRF586	DIN	—	120	—	dBμV
	MRF587		—	125	—	
Maximum Available Power Gain (3) (I _C = 90 mA, V _{CE} = 15 Vdc, f = 0.5 GHz)	MRF586	G _{Umax}	—	14.5	—	dB
	MRF587		—	16.5	—	

NOTES

- 300 μs pulse on Tektronix 576 or equivalent
- Characterized on HP8542 Automatic Network Analyzer
- $G_{Umax} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

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FIGURE 1 — TYPICAL NOISE FIGURE AND ASSOCIATED GAIN versus FREQUENCY

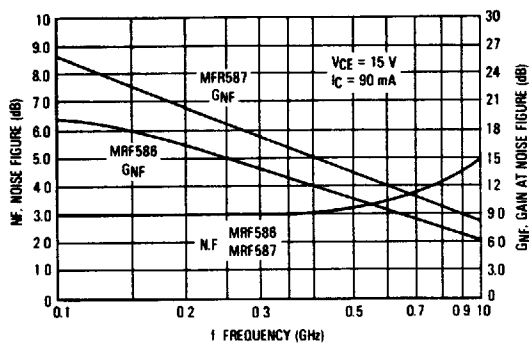


FIGURE 2 — NOISE FIGURE versus COLLECTOR CURRENT

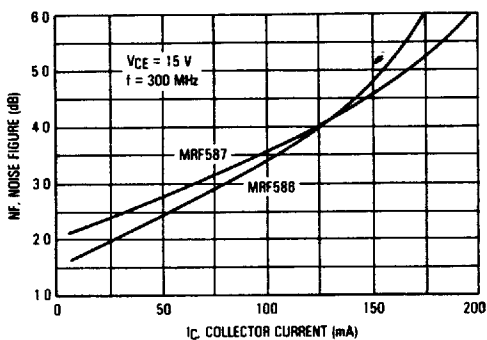


FIGURE 3 — G_{Umax} versus COLLECTOR CURRENT

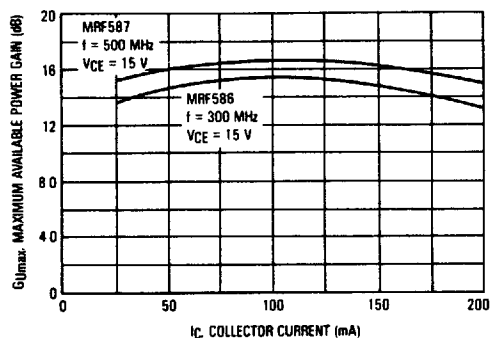
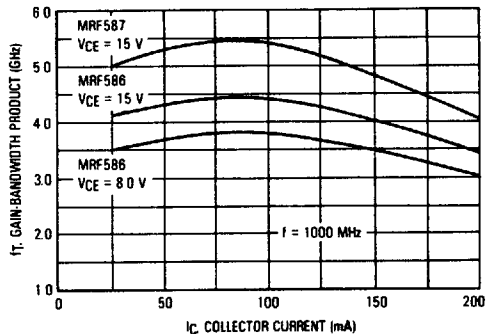


FIGURE 4 — GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT



MRF586 TYPICAL PERFORMANCE

FIGURE 5 — BROADBAND NOISE FIGURE MRF586

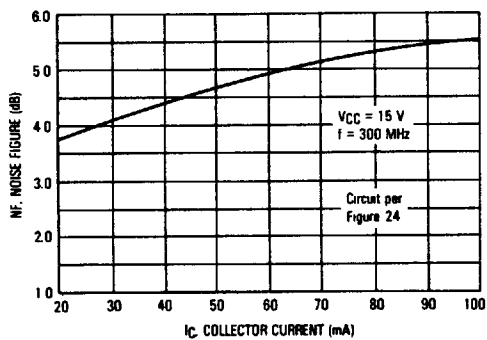
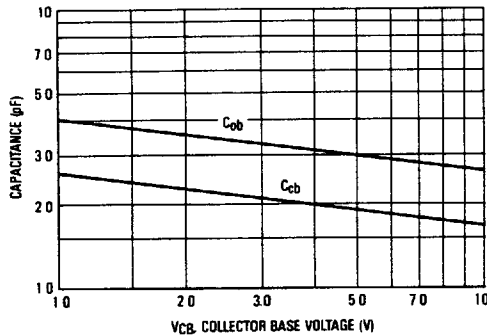


FIGURE 6 — JUNCTION CAPACITANCE versus VOLTAGE MRF586



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FIGURE 7 — 1.0 dB COMPRESSION POINT versus COLLECTOR CURRENT
MRF586

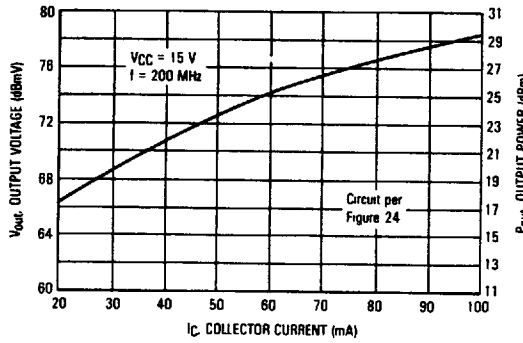


FIGURE 8 — THIRD ORDER INTERCEPT POINT
MRF586

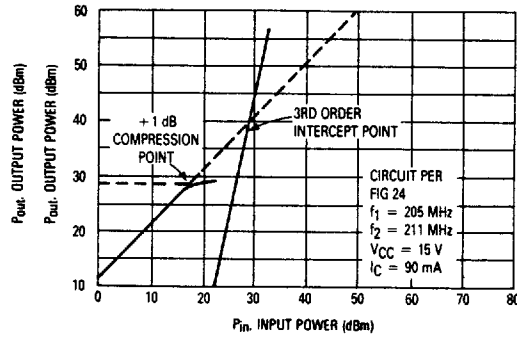


FIGURE 9 — SECOND ORDER DISTORTION versus COLLECTOR CURRENT
MRF586

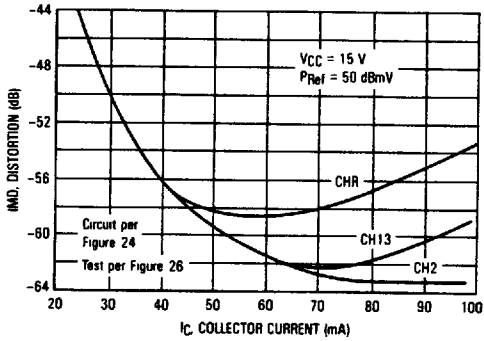


FIGURE 10 — TRIPLE BEAT DISTORTION versus COLLECTOR CURRENT
MRF586

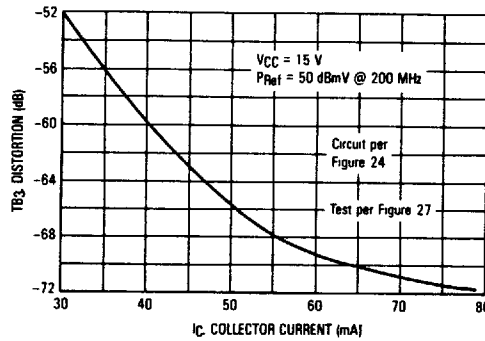


FIGURE 11 — 35-CHANNEL X-MODULATION DISTORTION versus COLLECTOR CURRENT
MRF586

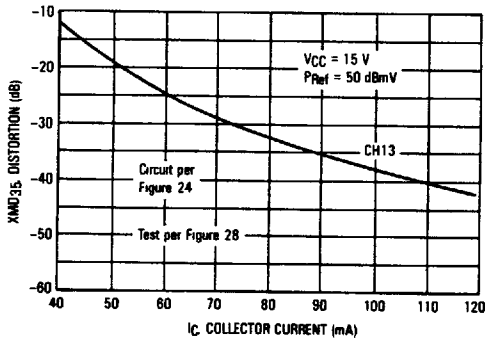
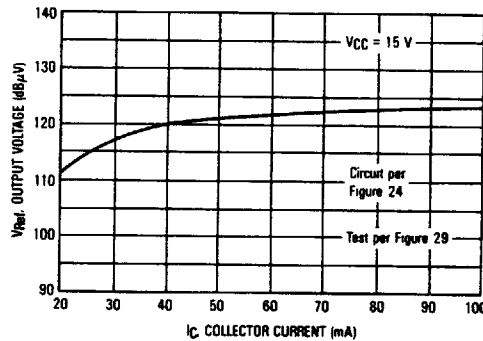


FIGURE 12 — DIN45004B versus COLLECTOR CURRENT
MRF586



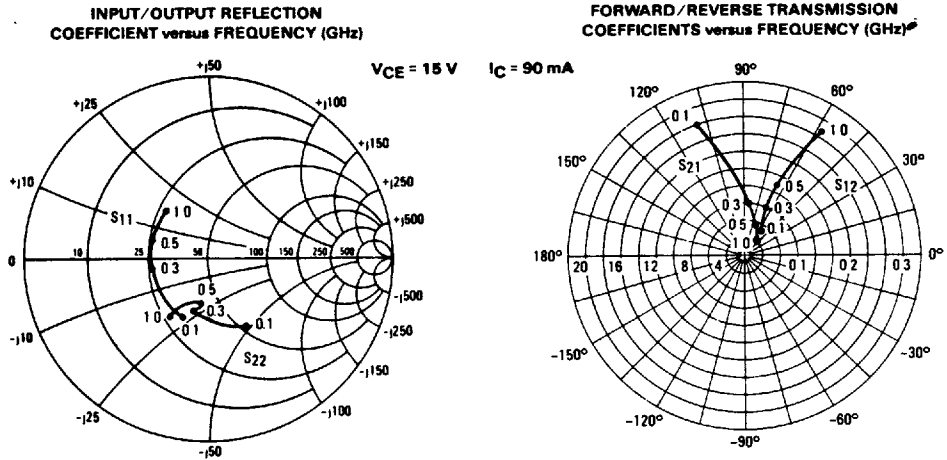
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FIGURE 13 — MRF586 COMMON-EMITTER S-PARAMETERS

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VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠φ
5.0	30	100	0.42	-122	13.45	109	0.05	54	0.45	-74
		300	0.39	-175	5.10	84	0.09	58	0.30	-105
		500	0.41	162	3.11	71	0.16	60	0.32	-125
		1000	0.42	131	1.68	47	0.28	56	0.38	-138
	60	100	0.39	-131	14.35	106	0.05	56	0.41	-84
		300	0.37	180	5.27	83	0.11	62	0.28	-130
		500	0.39	158	3.22	72	0.17	62	0.32	-134
		1000	0.39	127	1.75	49	0.29	55	0.36	-144
	90	100	0.39	-134	14.45	106	0.05	56	0.42	-87
		300	0.38	176	5.27	82	0.11	60	0.33	-132
		500	0.39	155	3.19	70	0.16	59	0.37	-136
		1000	0.36	120	1.70	43	0.28	49	0.45	-143
10	30	100	0.41	-112	14.40	111	0.05	55	0.48	-63
		300	0.35	-170	5.51	85	0.10	60	0.28	-100
		500	0.37	164	3.35	72	0.15	61	0.32	-109
		1000	0.38	132	1.79	47	0.26	58	0.40	-125
	60	100	0.37	-119	15.35	109	0.05	58	0.43	-70
		300	0.33	-174	5.76	84	0.10	62	0.26	-103
		500	0.35	160	3.50	73	0.16	62	0.31	-117
		1000	0.36	128	1.88	49	0.27	57	0.37	-130
	90	100	0.36	-123	15.68	107	0.05	57	0.44	-77
		300	0.33	180	5.78	83	0.10	61	0.32	-117
		500	0.34	154	3.44	70	0.15	59	0.39	-122
		1000	0.31	118	1.84	43	0.25	51	0.49	-133
15	30	100	0.42	-107	14.72	111	0.05	55	0.49	-58
		300	0.33	-167	5.64	85	0.09	60	0.28	-92
		500	0.35	166	3.48	73	0.14	61	0.32	-102
		1000	0.37	133	1.82	47	0.25	59	0.40	-119
	60	100	0.37	-112	15.90	109	0.05	57	0.45	-64
		300	0.31	-171	5.90	85	0.10	63	0.26	-100
		500	0.33	162	3.60	73	0.15	63	0.30	-108
		1000	0.35	130	1.92	48	0.27	58	0.38	-124
	90	100	0.37	-114	16.04	109	0.05	56	0.45	-67
		300	0.31	-173	5.96	84	0.10	61	0.30	-108
		500	0.32	155	3.56	70	0.15	61	0.35	-114
		1000	0.33	120	1.84	45	0.25	55	0.44	-127

MRF587 TYPICAL PERFORMANCE

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FIGURE 14 — BROADBAND NOISE FIGURE
MRF587

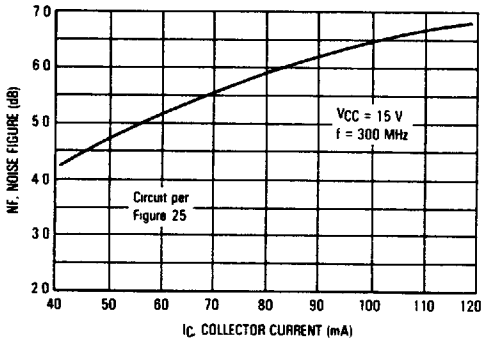


FIGURE 15 — JUNCTION CAPACITANCE versus VOLTAGE
MRF587

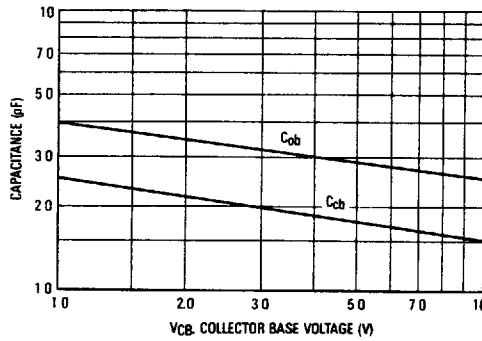


FIGURE 16 — 1 0 dB COMPRESSION POINT versus
COLLECTOR CURRENT
MRF587

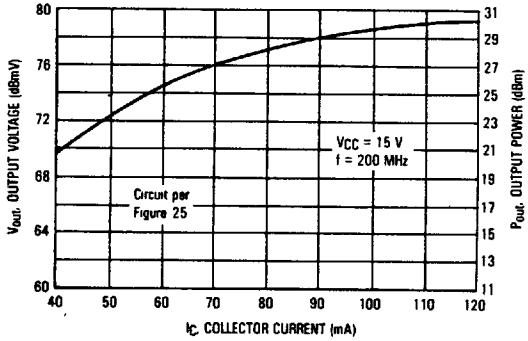
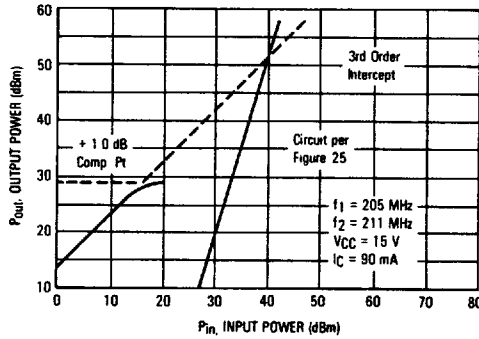


FIGURE 17 — THIRD ORDER INTERCEPT POINT
MRF587



MRF587 TYPICAL PERFORMANCE (continued)

FIGURE 18 — SECOND ORDER DISTORTION versus COLLECTOR CURRENT
MRF587

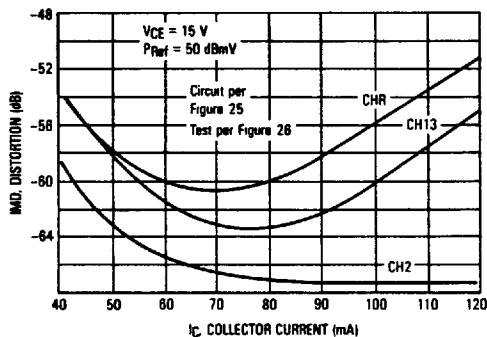


FIGURE 19 — TRIPLE BEAT DISTORTION versus COLLECTOR CURRENT
MRF587

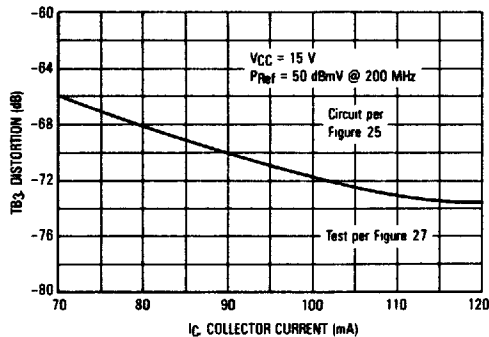


FIGURE 20 — 36-CHANNEL X-MODULATION DISTORTION versus COLLECTOR CURRENT
MRF587

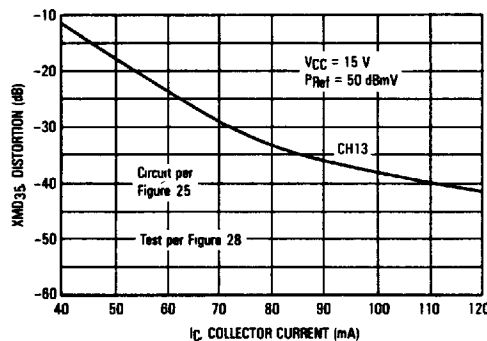
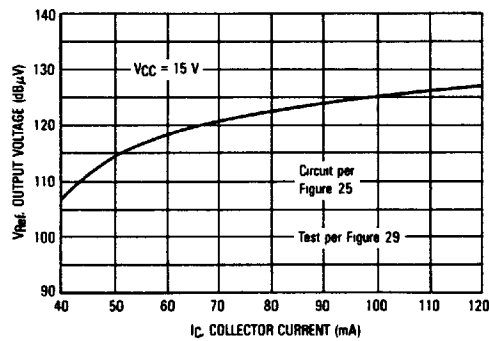


FIGURE 21 — DIN 45004B versus COLLECTOR CURRENT
MRF587



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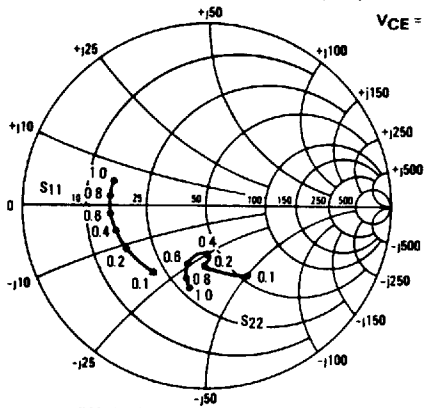
MOTOROLA SC (XSTRS/R F) 46E D 6367254 0094801 5 MOT6

FIGURE 22 — MRF587 COMMON-EMITTER S-PARAMETERS

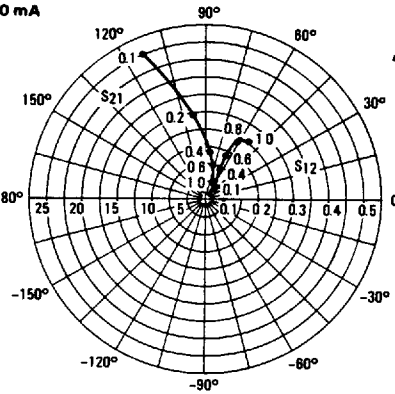
INPUT/OUTPUT REFLECTION
COEFFICIENT versus FREQUENCY (GHz)

FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY (GHz)

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VCE = 15 V IC = 90 mA



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VCE (Volts)	IC (mA)	Freq (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠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	-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
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	22.78	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

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FIGURE 23 — MRF586/587 NARROW BAND TEST FIXTURE SCHEMATIC
500 MHz

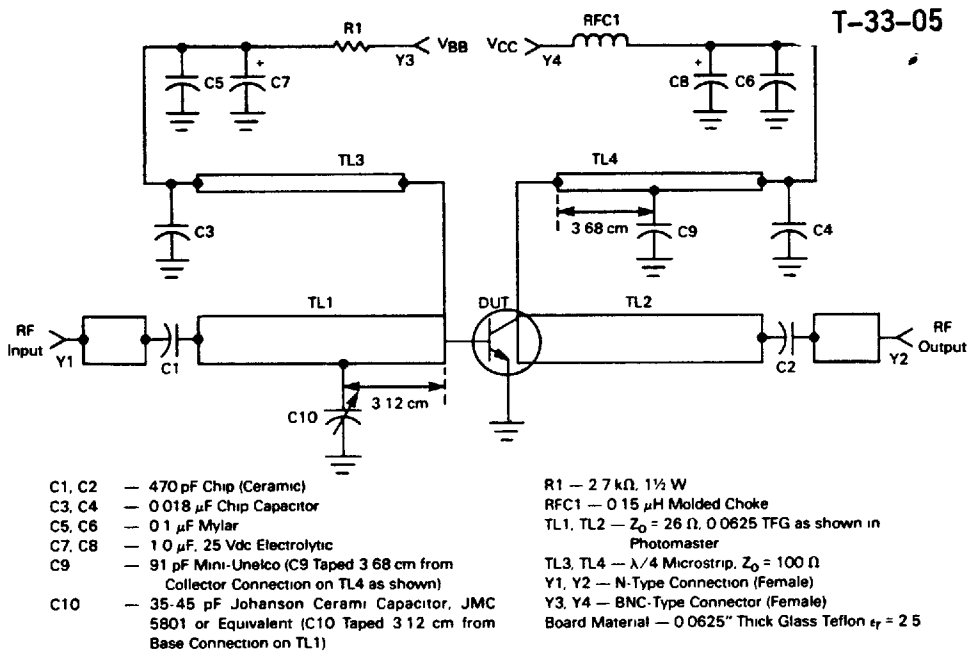


FIGURE 24 — MRF586 BROADBAND TEST CIRCUIT SCHEMATIC

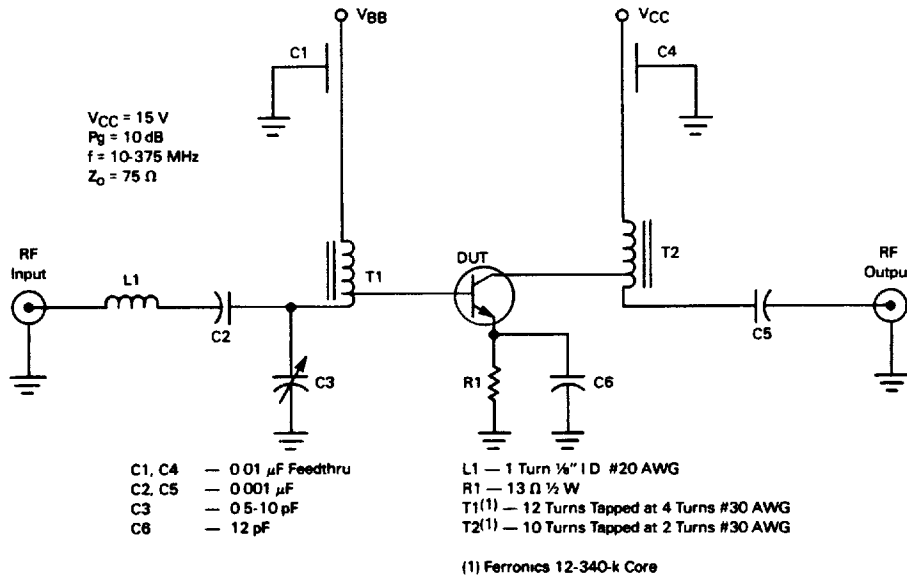
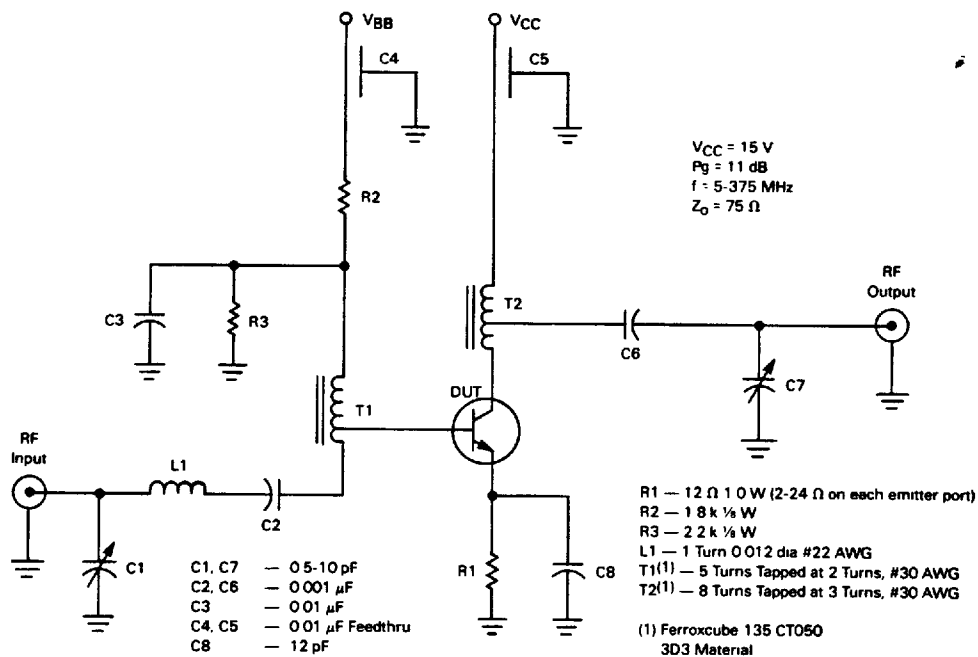


FIGURE 25 — MRF587 BROADBAND TEST CIRCUIT SCHEMATIC

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FIGURE 26 — SECOND ORDER DISTORTION TEST

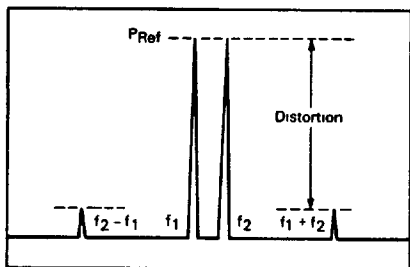


FIGURE 27 — TRIPLE BEAT DISTORTION TEST

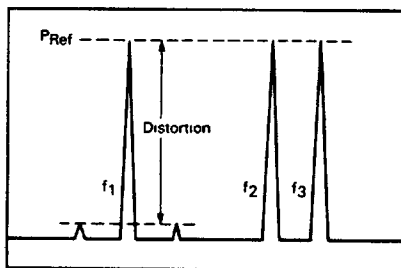


FIGURE 28 — CROSSMODULATION DISTORTION TEST

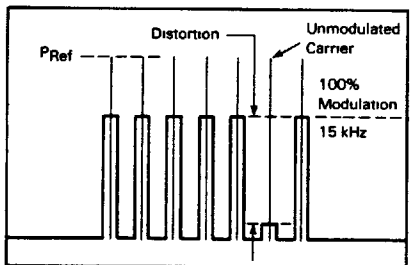


FIGURE 29 — DIN 45004B INTERMODULATION TEST

