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MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

T-31-01

BFR96
BFRC96
MRF961
MRF962
MRF965

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

The BFR96 series transistors use the same state-of-the-art microwave transistor chip which features fine-line geometry, ion-implanted arsenic emitters and gold top metalization. These transistors are intended for low-to-medium power amplifiers requiring high gain, low noise figure, and low intermodulation distortion. The BFR96 and MRF961 are particularly suitable for broadband MATV/CATV amplifiers. The MRF962 uses a hermetic stripline, ceramic package and is intended for high reliability applications up to 2 GHz. The MRF965 makes an excellent VHF/UHF Class C driver amplifier for several hundred milliwatts power output.

f_T = 4.5 GHz @ 50 mA

HIGH FREQUENCY TRANSISTOR

NPN SILICON

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MAXIMUM RATINGS

Ratings	Symbol	BFRC96 Chip	BFR96 Case 317A-01 Style 2	MRF961 Case 317-01 Style 2	MRF962 Case 303-01 Style 1	MRF965 Case 26-03 Style 1	Unit
		Values					
Collector-Emitter Voltage	V_{CEO}	15	15	15	15	15	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	3.0	3.0	3.0	3.0	Vdc
Collector Current – Continuous	I_C	100	100	100	100	100	mAdc
Total Device Dissipation @ T_C = 100°C(1) Derate above T_C = 100°C	P_D	0.75 T_J = 200°C max	0.5 10	0.5 10	0.75 7.5	0.75 7.5	Watts mW/°C
Storage Temperature	T_{stg}	−65 to +200	−65 to +150	−65 to +150	−65 to +200	−65 to +200	°C

NOTE 1. Case temperature measured on collector lead immediately adjacent to body of package.

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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 = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	–	–	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	–	200	–
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	–	4.5	–	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, Emitter Guarded) BFR96, MRF961, MRF962	C_{cb}	–	1.2	1.5	pF
MRF965		–	1.6	2.0	
FUNCTIONAL TESTS					
Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	NF	–	2.0	–	dB
Maximum Unilateral Gain/Insertion Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) BFR96, MRF965	$G_U(max)$/ $\lvert S_{21}\rvert^2$	–/12	14.5/13	–	dB
MRF961		–/13.5	17/15	–	
MRF962		–/15	20.5/16.5	–	

NOTE 1. $G_U(max) = \dfrac{\lvert S_{21}\rvert^2}{(1-\lvert S_{11}\rvert^2)(1-\lvert S_{22}\rvert^2)}$

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FIGURE 1 – MAXIMUM UNILATERAL GAIN versus FREQUENCY

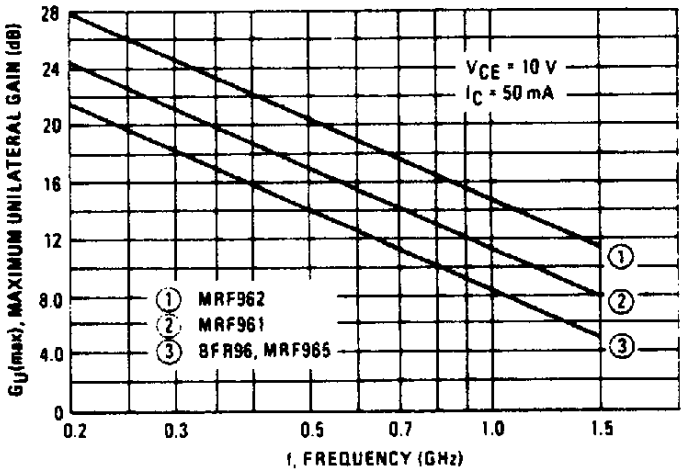

FIGURE 2 – $|S_{21}|^2$ versus FREQUENCY

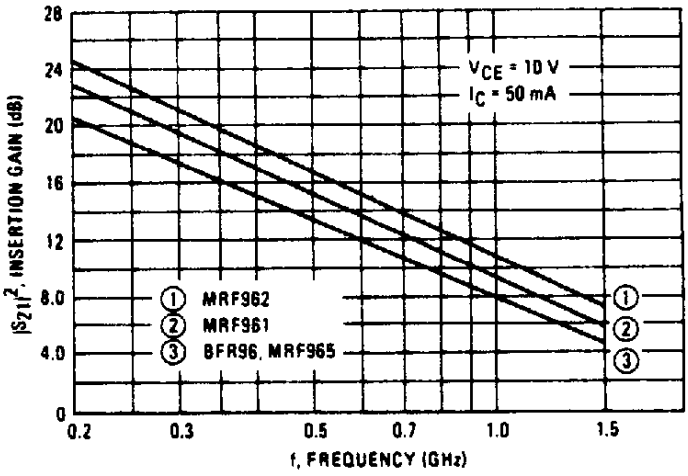

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FIGURE 3 – MAXIMUM UNILATERAL GAIN versus COLLECTOR CURRENT

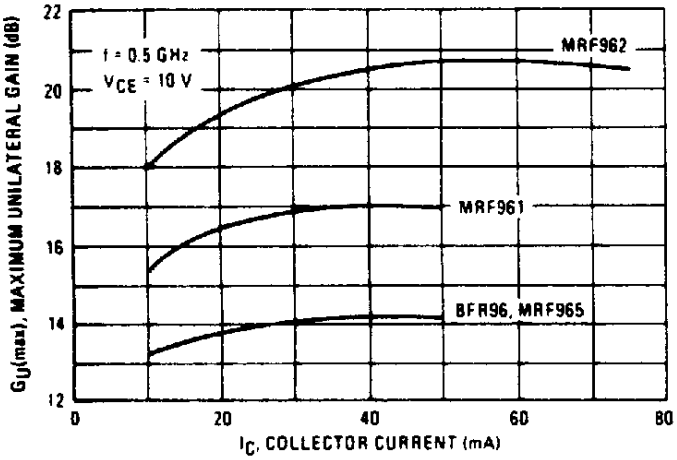


FIGURE 4 – GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

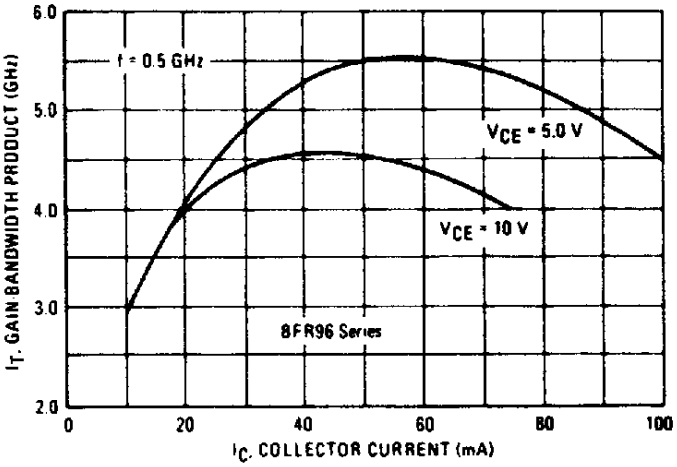


FIGURE 5 – NOISE FIGURE versus FREQUENCY

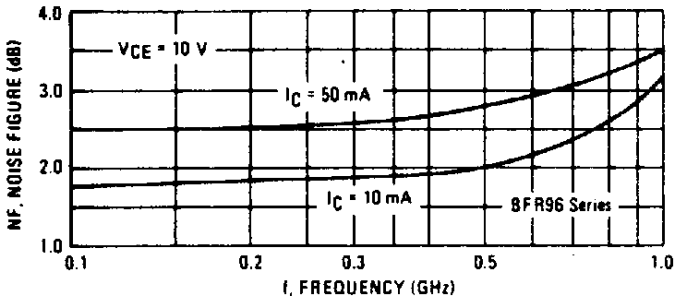


FIGURE 6 – NOISE FIGURE versus COLLECTOR CURRENT

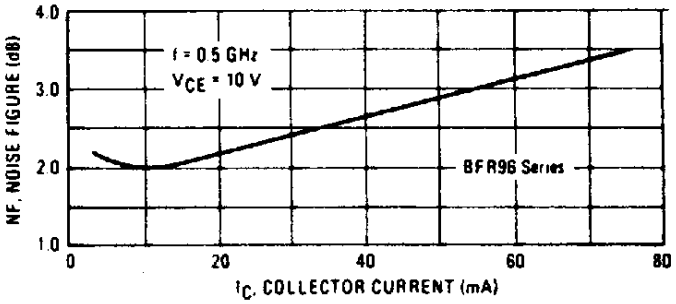


FIGURE 7 – COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE

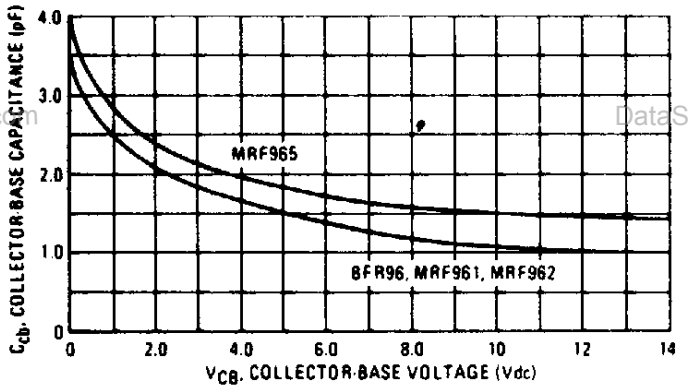


FIGURE 8 – OUTPUT POWER AND EFFICIENCY versus INPUT POWER (MRF965)

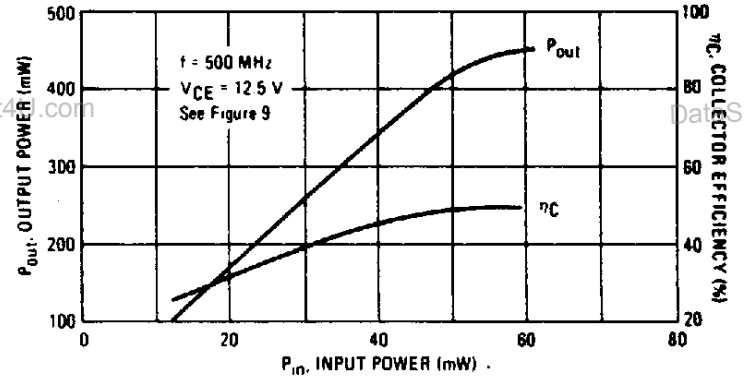
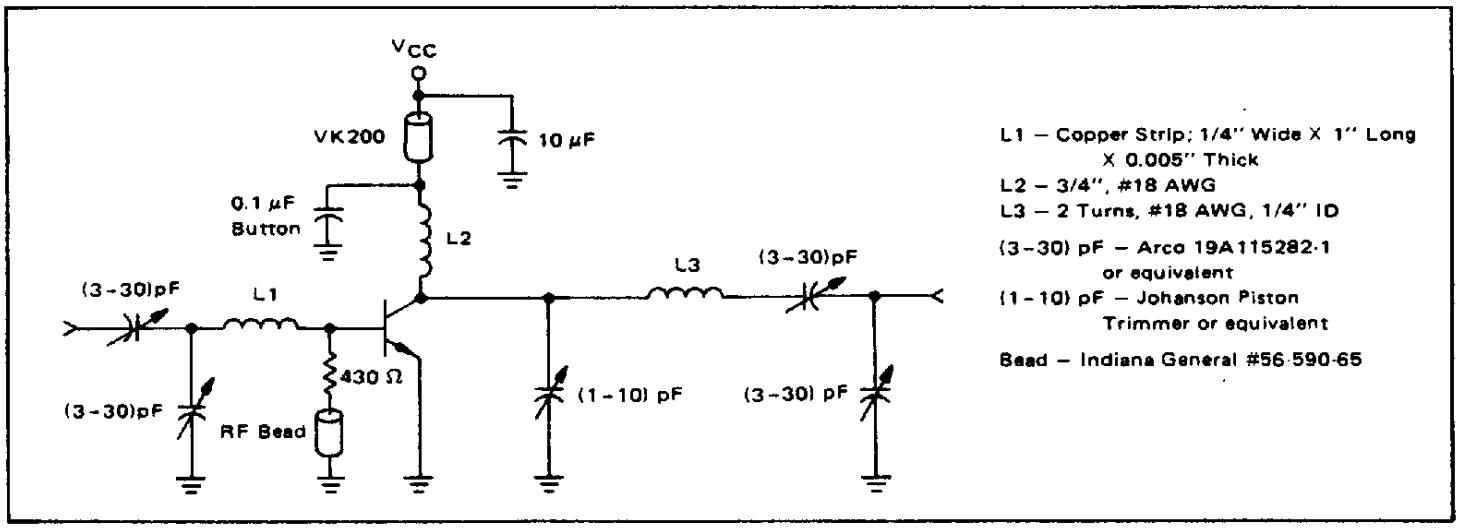


FIGURE 9 – MRF965 CLASS C AMPLIFIER @ 500 MHz, 400 mW



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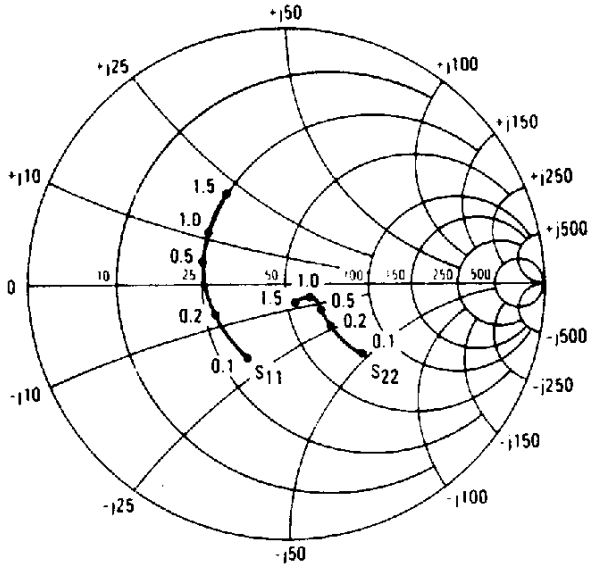
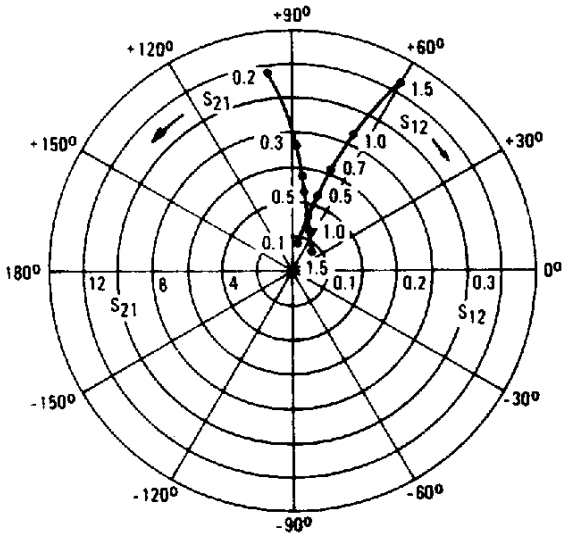
BFR96 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5.0	10	100	0.51	-95	15.04	121	0.047	54	0.58	-48
		300	0.43	-163	5.87	92	0.082	58	0.26	-63
		500	0.46	174	3.61	79	0.120	63	0.19	-63
		700	0.48	162	2.65	68	0.161	63	0.15	-64
		1000	0.48	146	1.92	57	0.220	63	0.12	-79
		1500	0.54	121	1.40	43	0.320	58	0.13	-118
	25	100	0.39	-122	19.41	112	0.037	60	0.42	-68
		300	0.39	-176	6.81	89	0.079	68	0.16	-94
		500	0.42	166	4.11	78	0.129	70	0.10	-103
		700	0.44	156	3.05	69	0.176	68	0.06	-119
		1000	0.44	142	2.20	59	0.244	64	0.06	-159
		1500	0.49	118	1.62	45	0.348	57	0.10	177
	50	100	0.35	-140	21.10	106	0.032	64	0.33	-81
		300	0.38	176	7.11	88	0.081	72	0.13	-116
		500	0.42	162	4.28	78	0.133	72	0.09	-136
		700	0.43	153	3.16	70	0.183	69	0.07	-163
		1000	0.42	140	2.28	60	0.252	65	0.08	165
		1500	0.47	116	1.66	47	0.357	57	0.12	155
10	10	100	0.53	-83	15.96	124	0.039	58	0.65	-36
		300	0.38	-154	6.44	94	0.070	59	0.35	-41
		500	0.41	-179	3.98	81	0.102	64	0.30	-39
		700	0.42	166	2.94	70	0.138	65	0.27	-39
		1000	0.42	151	2.12	60	0.191	66	0.24	-47
		1500	0.49	125	1.50	44	0.278	63	0.22	-72
	25	100	0.38	-104	20.85	115	0.032	60	0.48	-48
		300	0.32	-169	7.54	91	0.070	68	0.23	-48
		500	0.35	170	4.61	80	0.109	71	0.19	-43
		700	0.37	160	3.37	70	0.152	69	0.16	-39
		1000	0.37	146	2.43	61	0.210	67	0.13	-44
		1500	0.43	121	1.73	47	0.304	61	0.10	-74
	50	100	0.33	-119	22.59	109	0.029	63	0.39	-51
		300	0.30	-176	7.74	88	0.069	72	0.19	-47
		500	0.34	166	4.70	79	0.113	73	0.16	-40
		700	0.36	158	3.45	70	0.156	70	0.14	-35
		1000	0.36	144	2.46	61	0.217	66	0.11	-39
		1500	0.42	119	1.75	47	0.310	60	0.08	-72

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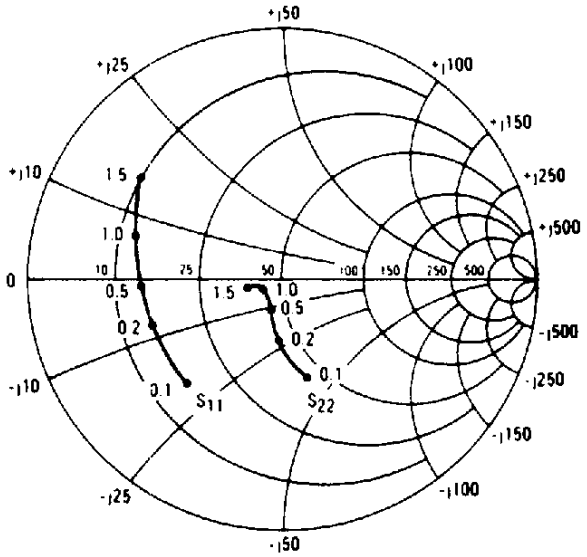
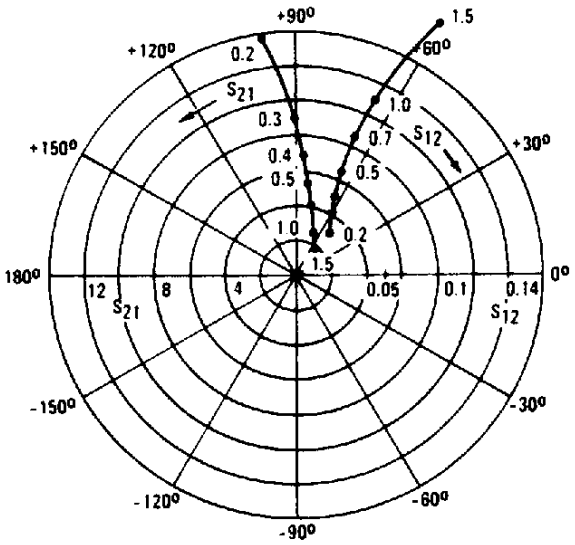
MRF961 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5.0	10	100	0.65	-101	16.61	125	0.047	46	0.61	-56
		300	0.64	-160	6.61	96	0.064	39	0.27	-87
		500	0.66	-178	4.01	83	0.078	45	0.19	-98
		700	0.68	171	2.93	73	0.093	49	0.16	-108
		1000	0.68	160	2.07	63	0.119	53	0.16	-124
		1500	0.72	143	1.43	50	0.158	54	0.21	-141
	25	100	0.60	-129	22.41	115	0.034	44	0.49	-84
		300	0.63	-172	7.94	93	0.049	50	0.26	-132
		500	0.66	174	4.78	83	0.071	58	0.21	-150
		700	0.67	166	3.45	75	0.092	60	0.20	-164
		1000	0.67	156	2.46	66	0.124	61	0.21	-177
		1500	0.71	140	1.73	54	0.173	60	0.24	175
	50	100	0.59	-147	25.12	109	0.025	46	0.42	-104
		300	0.64	-178	8.47	91	0.046	60	0.28	-151
		500	0.67	171	5.05	83	0.070	65	0.26	-167
		700	0.68	164	3.67	75	0.093	65	0.25	-178
		1000	0.67	154	2.60	67	0.128	65	0.26	170
		1500	0.72	138	1.83	56	0.178	62	0.29	163
10	10	100	0.65	-90	17.47	128	0.040	50	0.67	-41
		300	0.61	-154	7.31	97	0.057	41	0.33	-57
		500	0.62	-174	4.46	84	0.069	46	0.25	-58
		700	0.64	175	3.27	74	0.084	50	0.22	-60
		1000	0.64	163	2.33	64	0.106	54	0.20	-72
		1500	0.69	145	1.56	50	0.140	57	0.22	-96
	25	100	0.57	-116	24.36	119	0.030	48	0.51	-62
		300	0.58	-167	8.10	94	0.045	52	0.20	-89
		500	0.61	178	5.43	83	0.070	58	0.14	-97
		700	0.63	169	3.93	75	0.084	60	0.10	-106
		1000	0.62	159	2.78	66	0.112	61	0.09	-124
		1500	0.67	142	1.91	53	0.156	60	0.12	-140
	50	100	0.55	-132	26.97	112	0.024	47	0.40	-73
		300	0.57	-173	9.32	91	0.042	59	0.16	-104
		500	0.60	174	5.58	82	0.064	64	0.11	-115
		700	0.62	167	4.04	74	0.086	64	0.08	-128
		1000	0.61	158	2.85	66	0.115	64	0.08	-149
		1500	0.67	141	1.96	55	0.158	61	0.12	-158

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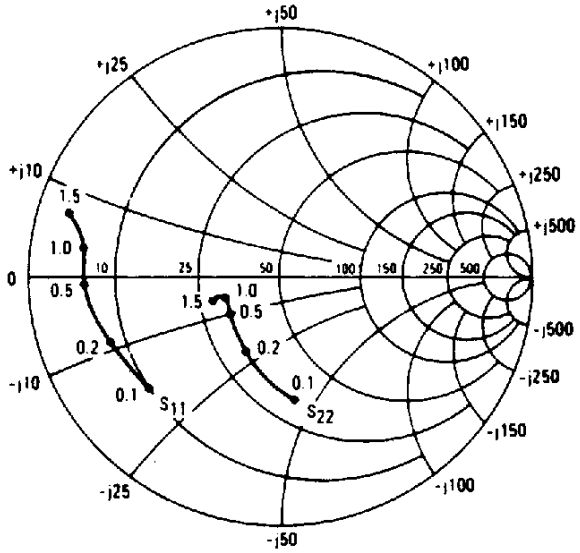
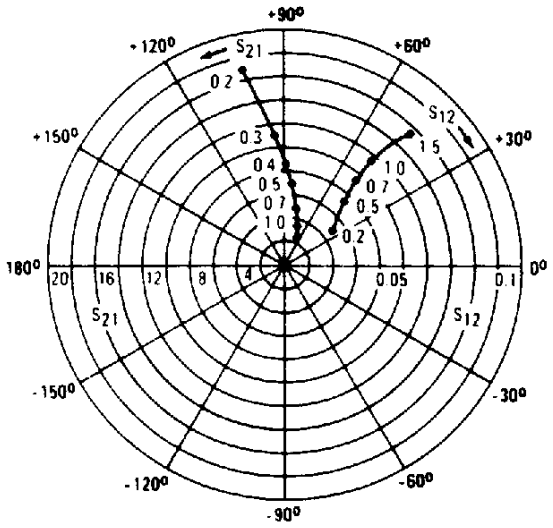
MRF962 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	10	100	0.70	-102	17.42	128	0.044	43	0.65	-57
		300	0.75	-156	7.11	98	0.058	24	0.32	-97
		500	0.78	-170	4.36	86	0.064	25	0.26	-110
		700	0.78	-176	3.16	77	0.071	26	0.23	-117
		1000	0.78	176	2.26	67	0.078	27	0.24	-126
		1500	0.79	167	1.51	54	0.092	29	0.31	-133
	25	100	0.69	-131	24.24	118	0.029	38	0.56	-87
		300	0.77	-167	8.76	95	0.039	32	0.35	-137
		500	0.79	-176	5.26	85	0.046	36	0.32	-150
		700	0.80	178	3.82	78	0.055	40	0.31	-158
		1000	0.79	173	2.72	70	0.067	42	0.32	-164
		1500	0.81	164	1.82	59	0.086	42	0.34	-167
	50	100	0.71	-147	27.72	113	0.021	37	0.53	-107
		300	0.78	-173	9.59	94	0.030	40	0.41	-152
		500	0.81	179	5.72	85	0.038	46	0.39	-163
		700	0.81	176	4.09	78	0.048	50	0.38	-169
		1000	0.81	171	2.89	71	0.061	51	0.38	-175
		1500	0.82	163	1.96	62	0.082	49	0.40	-177
10	10	100	0.71	-92	18.77	131	0.037	47	0.70	-44
		300	0.74	-150	8.09	100	0.051	28	0.34	-69
		500	0.75	-166	5.01	87	0.056	28	0.27	-75
		700	0.76	-174	3.62	78	0.064	28	0.24	-79
		1000	0.76	179	2.58	69	0.071	30	0.24	-88
		1500	0.77	168	1.72	55	0.085	31	0.31	-104
	25	100	0.67	-120	27.10	122	0.027	42	0.57	-68
		300	0.73	-163	10.27	97	0.035	36	0.27	-110
		500	0.76	-174	6.21	86	0.043	39	0.22	-124
		700	0.77	-179	4.48	78	0.051	41	0.20	-132
		1000	0.77	175	3.19	71	0.062	43	0.20	-139
		1500	0.78	166	2.13	59	0.080	42	0.25	-142
	50	100	0.68	-137	31.53	116	0.020	37	0.49	-85
		300	0.74	-169	11.17	95	0.028	40	0.27	-131
		500	0.77	-177	6.69	85	0.037	46	0.24	-144
		700	0.77	178	4.82	78	0.047	48	0.23	-152
		1000	0.77	173	3.42	71	0.059	50	0.23	-158
		1500	0.79	165	2.30	61	0.078	47	0.27	-159

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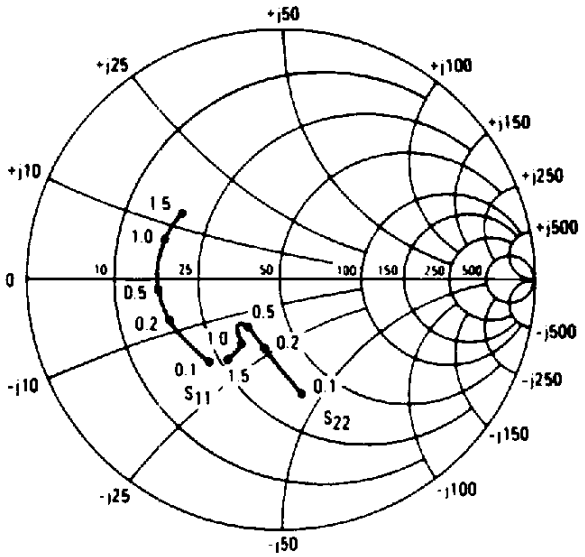
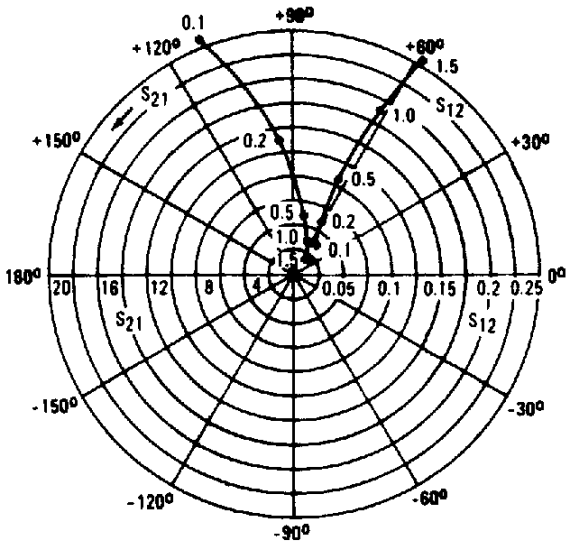
MRF965 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5.0	10	100	0.56	−102	13.87	121	0.054	48	0.58	−62
		300	0.57	−158	5.47	90	0.084	46	0.32	−94
		500	0.56	−169	3.40	77	0.110	52	0.27	−106
		700	0.52	178	2.53	69	0.136	54	0.39	−115
		1000	0.55	167	1.79	57	0.181	56	0.35	−112
		1500	0.54	150	1.27	42	0.242	57	0.43	−122
	25	100	0.48	−129	17.61	112	0.041	51	0.47	−85
		300	0.55	−169	6.38	89	0.076	57	0.30	−125
		500	0.54	−176	3.97	77	0.111	62	0.27	−138
		700	0.50	172	2.94	71	0.114	61	0.30	−143
		1000	0.53	162	2.08	61	0.198	60	0.32	−135
		1500	0.50	146	1.50	47	0.267	57	0.37	−140
	50	100	0.47	−144	19.34	107	0.035	56	0.42	−100
		300	0.55	−173	6.72	87	0.073	63	0.31	−138
		500	0.53	−179	4.17	77	0.112	66	0.29	−150
		700	0.50	168	3.10	71	0.147	64	0.33	−153
		1000	0.53	159	2.19	62	0.206	61	0.32	−146
		1500	0.50	143	1.59	49	0.277	58	0.36	−149
10	10	100	0.56	−92	14.67	123	0.047	50	0.63	−50
		300	0.53	−152	6.00	92	0.077	47	0.34	−73
		500	0.53	−165	3.74	78	0.100	53	0.29	−82
		700	0.49	−177	2.76	70	0.124	56	0.31	−93
		1000	0.52	170	1.96	57	0.166	58	0.38	−94
		1500	0.51	153	1.36	42	0.221	59	0.46	−108
	25	100	0.46	−117	19.10	115	0.036	53	0.49	−68
		300	0.50	−164	7.09	90	0.071	57	0.26	−99
		500	0.49	−172	4.39	78	0.102	62	0.23	−110
		700	0.45	175	3.25	71	0.133	61	0.25	−119
		1000	0.49	164	2.28	60	0.181	61	0.30	−112
		1500	0.47	148	1.61	46	0.246	59	0.37	−120
	50	100	0.42	−131	20.99	110	0.033	56	0.41	−79
		300	0.49	−169	7.46	88	0.069	62	0.24	−111
		500	0.48	−175	4.63	78	0.103	65	0.21	−123
		700	0.45	172	3.40	71	0.136	64	0.25	−129
		1000	0.48	162	2.39	61	0.188	62	0.29	−119
		1500	0.45	146	1.70	48	0.251	59	0.35	−126

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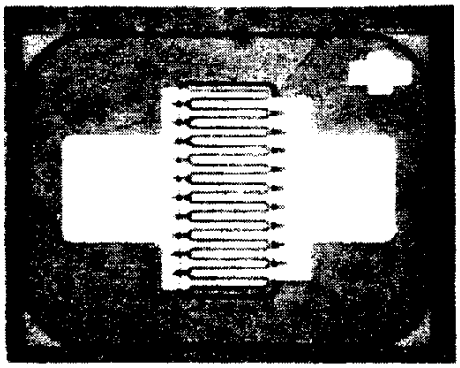

Nominal Chip Size: 0.014" X 0.016" X 0.005"
Front Metalization: Gold
Back Metalization: Gold
Emitter/Base Bond Pad: 2.8 mil Dia.
#Emitter Fingers: 10
#Base Fingers: 11
Emitter Diffusion: Ion-Implanted Arsenic

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