

The RF Line
NPN Silicon
Low Noise, High-Frequency
Transistors

2

... designed for use in high gain, low noise small-signal amplifiers. This series features excellent broadband linearity and is offered in a variety of packages.

- Fully Implanted Base and Emitter Structure
- 18 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal
- Tape and Reel Packaging Options Available

MAXIMUM RATINGS

Ratings	Symbol	MRF951	MMBR951L	MRF9511L	Unit
Collector-Emitter Voltage	V_{CE0}	10	10	10	Vdc
Collector-Base Voltage	V_{CB0}	20	20	20	Vdc
Emitter-Base Voltage	V_{EB0}	1.5	1.5	1.5	Vdc
Power Dissipation ⁽¹⁾ $T_A = 25^\circ\text{C}$	P_D	1.0	0.2	0.2	Watts
Collector Current — Continuous ⁽²⁾	I_C	100	100	100	mA
Maximum Junction Temperature	T_{Jmax}	150	150	150	$^\circ\text{C}$
Storage Temperature	T_{stg}	-65 to +150	-65 to +150	-65 to +150	$^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	625	625	$^\circ\text{C/W}$

DEVICE MARKING

MRF9511L = 11

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS⁽³⁾					
Collector-Emitter Breakdown Voltage ($I_C = 0.1\text{ mA}, I_B = 0$)	$V_{(BR)CEO}$	10	13	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}, I_E = 0$)	$V_{(BR)CBO}$	20	25	—	Vdc
Emitter Cutoff Current ($V_{EB} = 1\text{ V}, I_C = 0$)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current ($V_{CB} = 10\text{ V}, I_E = 0$)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS⁽³⁾					
DC Current Gain ($V_{CE} = 6\text{ V}, I_C = 5\text{ mA}$)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 10\text{ V}, I_E = 0, f = 1\text{ MHz}$)	C_{cb}	—	0.45	—	pF
Current Gain ⁽⁴⁾ — Bandwidth Product ($V_{CE} = 8\text{ V}, I_C = 30\text{ mA}, f = 1\text{ GHz}$)	f_T	—	8	—	GHz

NOTES: 1. To calculate the junction temperature use $T_J = P_D \times R_{\theta JA} + T_{AMBIENT}$.
 2. I_C — Continuous (MTBF = 10 years).
 3. Pulse width = 300 μs , duty cycle = 2% pulsed.

MRF951
MMBR951L
MRF9511L

$I_C = 100\text{ mA}$
LOW NOISE
HIGH FREQUENCY
TRANSISTORS



CASE 317-01, STYLE 2
 MACRO-X
 MRF951



CASE 318-07, STYLE 6
 SOT-23
 LOW PROFILE
 MMBR951L



CASE 318A-05, STYLE 1
 SOT-143
 LOW PROFILE
 MRF9511L

MRF951, MMR951L, MRF9511L

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	MRF951			MRF9511L			MMBR951L			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Insertion Gain ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 2\text{ GHz}$)	$ S_{21} ^2$	—	14.5	—	—	14.5	—	—	12.5	—	dB
Maximum Unilateral Gain ⁽¹⁾ ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 2\text{ GHz}$)	GU_{max}	—	17	—	—	17	—	—	14	—	dB
Noise Figure — Minimum ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 2\text{ GHz}$)	NF _{MIN.}	—	1.3	—	—	1.3	—	—	1.3	—	dB
Associated Gain at Minimum NF ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 2\text{ GHz}$)	G _{NF}	—	14	—	—	14	—	—	13	—	dB
Noise Figure — 50 Ohm Source ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	NF _{50Ω}	—	1.9	2.8	—	1.9	2.8	—	1.9	2.8	dB

NOTE: 1. Maximum Unilateral Gain is $GU_{max} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

2

TYPICAL CHARACTERISTICS

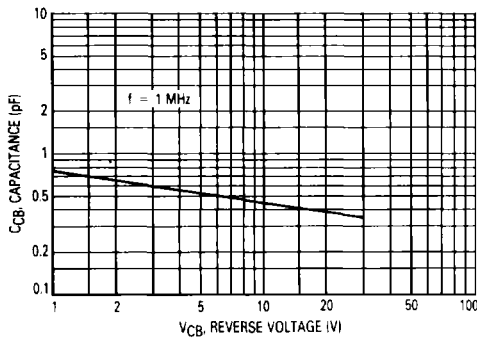


Figure 1. Collector-Base Capacitance versus Voltage

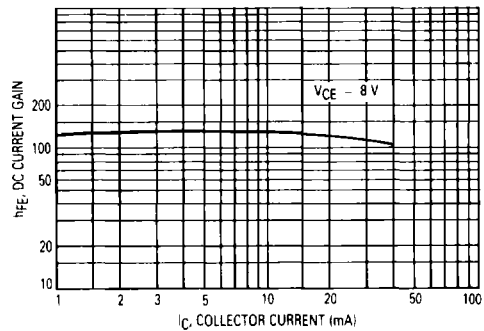


Figure 2. DC Current Gain versus Collector Current

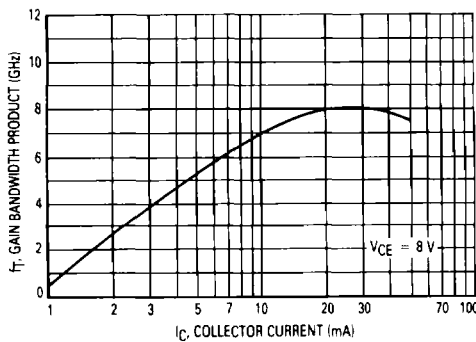


Figure 3. Gain Bandwidth Product versus Collector Current

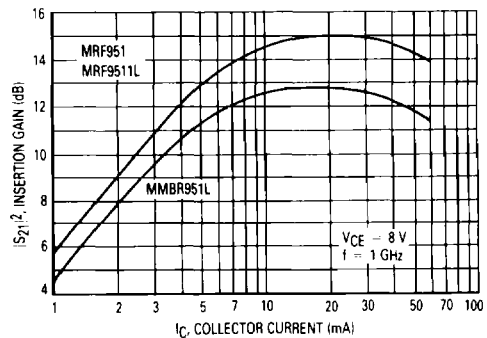


Figure 4. Insertion Gain versus Collector Current

MRF951, MMBR951L, MRF9511L

TYPICAL FORWARD INSERTION GAIN AND MAXIMUM UNILATERAL GAIN versus FREQUENCY

2

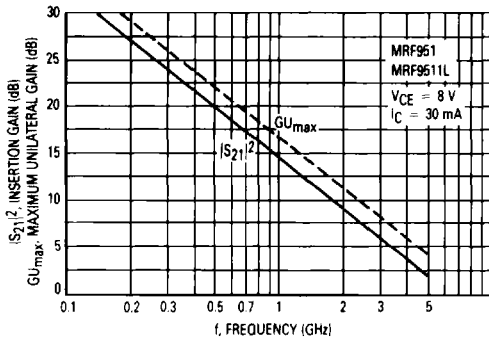


Figure 5. MRF951, MRF9511L

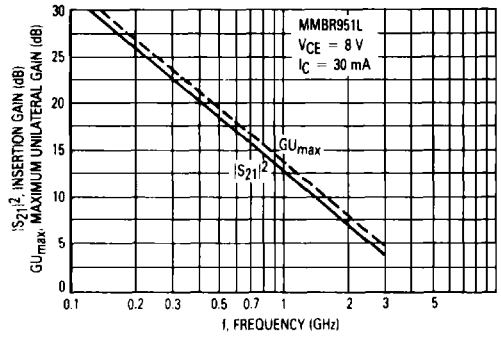


Figure 6. MMBR951L

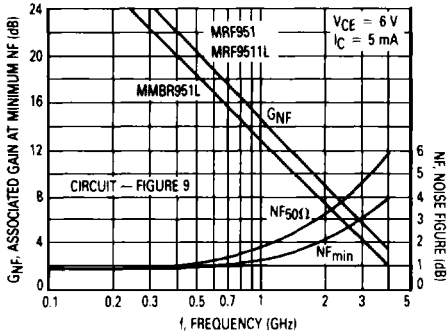


Figure 7. Typical Noise Figure and Associated Gain versus Frequency

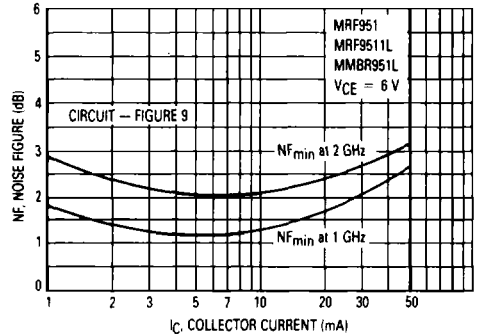


Figure 8. Typical Noise Figure versus Collector Current

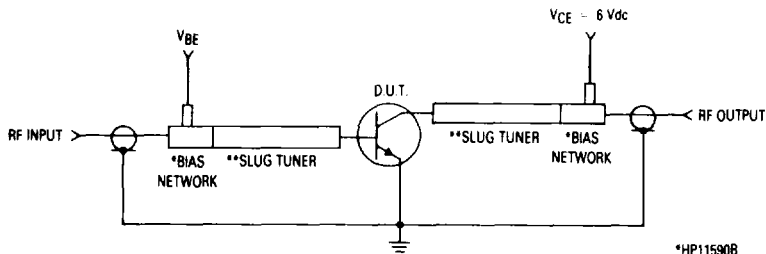


Figure 9. Functional Circuit Schematic

*HP11590B
**MICROLAB-FXR
SF - 11N < 1 GHz
SF - 311N ≥ 1 GHz

MRF951, MMBR951L, MRF9511L

MRF951
TYPICAL COMMON EMITTER S-PARAMETERS

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠φ
6	5	100	0.81	-36	13.89	156	0.03	72	0.94	-17
		500	0.58	-122	7.23	105	0.07	42	0.55	-46
		1000	0.53	-165	4.06	78	0.08	41	0.42	-57
		1500	0.54	172	2.78	61	0.10	44	0.40	-67
		2000	0.55	155	2.13	46	0.12	47	0.40	-79
		2500	0.56	140	1.74	32	0.15	48	0.41	-92
		3000	0.59	127	1.46	21	0.18	47	0.43	-105
		3500	0.61	115	1.28	9	0.22	44	0.45	-119
		4000	0.62	104	1.13	-1	0.26	40	0.48	-132
		10	100	0.67	-41	22.99	147	0.02	67	0.86
	500		0.50	-85	8.94	97	0.05	49	0.41	-53
	1000		0.48	-34	4.75	75	0.08	54	0.31	-61
	1500		0.49	163	3.26	60	0.11	55	0.29	-71
	2000		0.51	148	2.47	46	0.14	53	0.30	-83
	2500		0.52	135	2.03	34	0.17	50	0.31	-97
	3000		0.55	123	1.72	22	0.20	46	0.34	-109
	3500		0.56	112	1.50	11	0.24	41	0.36	-122
	4000		0.59	101	1.33	1	0.28	37	0.39	-135
	20		100	0.52	-77	32.50	137	0.02	62	0.75
		500	0.46	-96	10.00	92	0.05	60	0.30	-56
		1000	0.47	172	5.20	73	0.08	63	0.24	-63
		1500	0.48	156	3.50	59	0.11	61	0.24	-74
		2000	0.49	143	2.70	46	0.15	57	0.24	-86
		2500	0.51	131	2.20	34	0.18	52	0.26	-100
		3000	0.53	121	1.90	23	0.22	47	0.29	-112
		3500	0.55	110	1.60	13	0.25	41	0.31	-125
		4000	0.57	100	1.40	3	0.28	35	0.34	-137
		30	100	0.45	-95	36.80	132	0.02	64	0.68
	500		0.46	-170	10.20	89	0.04	65	0.27	-55
	1000		0.47	169	5.30	72	0.08	66	0.22	-62
1500	0.48		154	3.60	58	0.11	63	0.22	-73	
2000	0.50		142	2.80	45	0.15	58	0.23	-86	
2500	0.51		132	2.30	36	0.18	54	0.25	-97	
3000	0.53		119	1.90	23	0.22	47	0.28	-113	
3500	0.55		109	1.60	12	0.25	41	0.30	-125	
4000	0.57		99	1.50	2	0.29	35	0.33	-137	
60	100		0.41	-129	38.90	123	0.01	63	0.58	-40
	500	0.49	-35	9.70	86	0.04	71	0.26	-44	
	1000	0.50	164	4.90	70	0.07	71	0.24	-53	
	1500	0.52	151	3.30	56	0.11	67	0.24	-66	
	2000	0.53	140	2.50	43	0.15	61	0.26	-79	
	2500	0.55	128	2.10	31	0.18	56	0.28	-94	
	3000	0.57	118	1.70	21	0.21	50	0.31	-108	
	3500	0.59	108	1.50	10	0.25	44	0.33	-121	
	4000	0.61	98	1.30	0	0.29	38	0.36	-134	

(continued)

2

MRF951, MMBR951L, MRF9511L

MRF951
TYPICAL COMMON EMITTER S-PARAMETERS (continued)

V _{CE} (V _{dc})	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
8	5	100	0.82	-34	13.71	157	0.03	74	0.94	-16
		500	0.59	-119	7.35	106	0.07	42	0.57	-44
		1000	0.52	-162	4.14	78	0.08	41	0.44	-54
		1500	0.52	174	2.86	61	0.10	46	0.41	-65
		2000	0.54	156	2.19	46	0.12	48	0.41	-76
		2500	0.55	141	1.78	32	0.15	50	0.42	-90
		3000	0.58	128	1.49	21	0.18	48	0.45	-103
		3500	0.59	116	1.31	9	0.22	45	0.47	-116
	4000	0.62	104	1.15	-1	0.26	41	0.50	-129	
	10	100	0.68	-50	23.16	148	0.02	67	0.86	-24
		500	0.49	-142	9.19	98	0.05	50	0.43	-49
		1000	0.47	-177	4.87	75	0.07	54	0.33	-56
		1500	0.48	164	3.33	60	0.10	56	0.32	-66
		2000	0.50	149	2.56	46	0.13	54	0.32	-77
		2500	0.51	136	2.08	34	0.16	52	0.34	-91
		3000	0.54	124	1.76	23	0.20	48	0.36	-103
		3500	0.55	113	1.54	11	0.23	43	0.38	-117
	4000	0.58	103	1.36	1	0.27	39	0.41	-129	
	20	100	0.53	-73	32.78	138	0.02	65	0.76	-32
		500	0.45	-160	10.25	92	0.04	60	0.33	-50
		1000	0.45	174	5.33	73	0.07	62	0.27	-57
		1500	0.46	161	3.96	62	0.10	61	0.26	-65
		2000	0.48	144	2.74	46	0.14	57	0.27	-79
		2500	0.50	132	2.24	34	0.17	54	0.29	-93
		3000	0.52	121	1.90	23	0.21	48	0.31	-106
		3500	0.54	111	1.66	12	0.24	42	0.33	-118
	4000	0.56	101	1.48	3	0.28	37	0.36	-131	
	30	100	0.45	-90	37.27	132	0.01	62	0.70	-36
		500	0.45	-102	10.50	90	0.04	65	0.30	-48
		1000	0.45	170	5.41	72	0.07	66	0.25	-55
		1500	0.47	155	3.66	58	0.11	64	0.25	-66
		2000	0.48	142	2.81	46	0.14	59	0.26	-78
		2500	0.50	131	2.27	34	0.18	55	0.27	-92
		3000	0.52	120	1.93	23	0.21	49	0.30	-105
		3500	0.54	110	1.69	12	0.25	43	0.32	-118
	4000	0.56	100	1.50	2	0.28	38	0.35	-131	
60	100	0.42	-124	38.02	124	0.01	63	0.60	-35	
	500	0.49	-106	9.54	87	0.04	70	0.31	-38	
	1000	0.50	165	4.92	70	0.07	71	0.29	-47	
	1500	0.51	152	3.36	57	0.10	68	0.29	-60	
	2000	0.52	140	2.55	44	0.14	62	0.30	-74	
	2500	0.54	129	2.08	32	0.17	58	0.32	-88	
	3000	0.56	118	1.76	21	0.21	52	0.34	-102	
	3500	0.58	108	1.53	10	0.24	46	0.37	-116	
4000	0.61	98	1.35	0	0.28	40	0.39	-129		

MRF951, MMBR951L, MRF9511L

MMBR951L COMMON EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠φ
6	5	100	0.82	-36.6	14.0	153	0.04	44.7	0.88	-18.2
		500	0.50	-119	6.6	104	0.07	48.2	0.52	-40
		1000	0.39	-162	3.5	81	0.11	55	0.43	-43
		2000	0.32	150	1.9	57	0.21	66	0.42	-50
		3000	0.36	110	1.4	40	0.31	66	0.40	-67
	10	100	0.66	-54	22.6	142	0.03	60	0.78	-29
		500	0.38	-138	7.8	96	0.07	55	0.40	42
		1000	0.32	-176	4.0	78	0.13	71	0.34	-47
		2000	0.26	142	2.2	57	0.22	70	0.36	-46
		3000	0.31	105	1.6	41	0.32	64	0.33	-62
	20	100	0.49	-76	30	131	0.01	85	0.67	37
		500	0.32	-153	8.3	92	0.08	76	0.34	-39
		1000	0.29	175	4.3	77	0.11	67	0.29	-44
		2000	0.24	137	2.3	57	0.24	71	0.32	-48
		3000	0.28	102	1.6	42	0.34	63	0.29	-60
	30	100	0.40	-94	33	125	0.03	87	0.58	-42
		500	0.30	-162	8.4	90	0.07	84	0.31	-35
		1000	0.29	170	4.3	76	0.12	80	0.27	-39
		2000	0.24	134	2.3	56	0.23	71	0.33	48
		3000	0.30	101	1.6	41	0.35	66	0.30	-60
	60	100	0.38	-126	31	116	0.03	74	0.49	37
		500	0.37	-176	7.3	77.6	0.05	84	0.34	-26
		1000	0.36	163	3.7	73.4	0.12	84	0.34	-37
		2000	0.33	130	2.0	52	0.22	78	0.37	-48
3000		0.38	98	1.4	37	0.34	69	0.34	-62	
8	5	100	0.83	-35	13.9	154	0.04	92	0.90	19
		500	0.51	-117	6.7	104	0.08	51	0.55	-38
		1000	0.38	160	3.6	82	0.10	72	0.44	-42
		2000	0.31	151	1.9	58	0.20	73	0.46	-47
		3000	0.35	110	1.4	41	0.32	71	0.43	-63
	10	100	0.67	-52	23	143	0.02	96	0.81	-28
		500	0.37	-135	7.9	97	0.07	64	0.43	-38
		1000	0.30	-173	4.1	80	0.11	78	0.37	41
		2000	0.25	143	2.2	57	0.21	74	0.38	-47
		3000	0.30	105	1.6	42	0.31	67	0.34	-60
	20	100	0.51	-72	30	131	0.02	68	0.68	-35
		500	0.31	-150	8.5	92	0.07	75	0.36	-36
		1000	0.28	177	4.3	77	0.13	76	0.32	-39
		2000	0.23	138	2.3	57	0.22	72	0.35	45
		3000	0.27	103	1.6	42	0.31	64	0.31	58
	30	100	0.42	-87	33	125	0.02	71	0.61	-38
		500	0.31	-159	8.6	90	0.07	71	0.33	-33
		1000	0.27	172	4.4	76	0.11	74	0.32	-39
		2000	0.23	135	2.3	57	0.22	73	0.34	-42
		3000	0.28	102	1.6	41	0.31	65	0.33	-55
	60	100	0.39	-119	32	117	0.02	31	0.52	-31
		500	0.36	-174	7.4	87	0.06	84	0.37	-25
		1000	0.35	164	3.8	74	0.11	78	0.35	-33
		2000	0.32	131	2.0	53	0.22	81	0.42	-41
3000		0.37	100	1.4	38	0.33	70	0.40	-62	

MRF951, MMBR951L, MRF9511L

MRF9511L TYPICAL COMMON EMITTER S-PARAMETERS

V _{CE} (V _{dC})	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
6	5	100	0.81	-48	13.69	152	0.04	66	0.88	-22
		500	0.67	-122	7.58	92	0.07	41	0.57	-50
		1000	0.61	-157	4.65	76	0.09	40	0.45	-62
		1500	0.57	86	2.87	70	0.10	44	0.42	-71
		2000	0.54	156	2.14	60	0.12	52	0.42	-75
		2500	0.55	121	1.72	51	0.14	57	0.40	-86
		3000	0.57	121	1.48	44	0.17	59	0.39	-97
		3500	0.65	110	1.28	38	0.21	60	0.37	-112
	4000	0.67	100	1.14	33	0.24	54	0.38	-130	
	10	100	0.71	-56	24.07	149	0.03	66	0.86	-28
		500	0.60	-143	9.47	101	0.05	46	0.41	-62
		1000	0.56	-176	4.97	81	0.07	51	0.30	-73
		1500	0.53	167	3.35	69	0.10	57	0.31	-78
		2000	0.50	148	2.54	60	0.13	63	0.30	-78
		2500	0.52	132	2.02	52	0.16	63	0.29	-89
		3000	0.54	116	1.75	45	0.19	61	0.29	-78
		3500	0.60	106	1.53	39	0.22	60	0.26	-115
	4000	0.64	97	1.35	34	0.26	57	0.28	-133	
	20	100	0.59	-80	33.51	138	0.02	61	0.75	-38
		500	0.56	-159	10.39	95	0.04	54	0.31	-69
		1000	0.54	175	5.36	79	0.07	62	0.23	-79
		1500	0.51	161	3.58	68	0.10	66	0.25	-82
		2000	0.49	142	2.75	60	0.13	68	0.25	-80
		2500	0.52	128	2.18	52	0.16	66	0.23	-91
		3000	0.53	112	1.88	45	0.20	63	0.23	-99
		3500	0.60	103	1.65	39	0.24	62	0.21	-117
	4000	0.63	95	1.46	34	0.27	57	0.22	-137	
	30	100	0.54	-97	37.48	133	0.02	57	0.67	-43
		500	0.56	166	10.60	93	0.04	59	0.27	-70
		1000	0.54	171	5.45	78	0.07	68	0.21	-80
		1500	0.51	158	3.62	67	0.10	69	0.24	-81
		2000	0.50	140	2.73	60	0.13	70	0.23	-79
		2500	0.52	126	2.19	51	0.17	68	0.23	-90
		3000	0.53	111	1.89	45	0.20	64	0.23	-97
		3500	0.60	102	1.65	38	0.24	62	0.20	-115
	4000	0.63	94	1.47	33	0.27	58	0.22	-136	
	60	100	0.54	-128	36.66	123	0.01	57	0.56	-43
		500	0.60	-177	8.97	89	0.03	67	0.27	-50
		1000	0.59	166	4.62	75	0.06	73	0.25	-59
		1500	0.56	153	3.05	64	0.09	75	0.29	-68
		2000	0.55	136	2.29	56	0.13	76	0.30	-71
		2500	0.57	125	1.85	48	0.16	74	0.29	-83
		3000	0.59	110	1.59	42	0.20	69	0.30	-92
		3500	0.65	102	1.41	36	0.23	67	0.27	-108
	4000	0.69	93	1.22	31	0.27	62	0.29	-130	

(continued)

MRF951, MMBR951L, MRF9511L

MRF9511L
TYPICAL COMMON EMITTER S-PARAMETERS (continued)

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠φ
8	5	100	0.84	-36	14.65	158	0.03	72	0.94	-18
		500	0.68	-120	7.79	110	0.07	42	0.58	-48
		1000	0.60	-161	4.32	86	0.08	41	0.44	-60
		1500	0.56	88	2.95	71	0.10	45	0.44	-68
		2000	0.53	157	2.19	60	0.11	53	0.44	-71
		2500	0.55	140	1.76	51	0.14	58	0.42	-82
		3000	0.56	122	1.50	44	0.17	60	0.42	-92
		3500	0.63	112	1.33	39	0.18	62	0.38	-107
	4000	0.68	105	1.18	33	0.21	63	0.36	-125	
	10	100	0.73	-53	24.04	150	0.02	68	0.87	-26
		500	0.60	-140	9.68	101	0.05	46	0.43	-58
		1000	0.55	-174	5.10	82	0.07	52	0.32	-66
		1500	0.52	169	3.42	69	0.09	58	0.33	-72
		2000	0.49	149	2.59	61	0.12	63	0.33	-73
		2500	0.51	133	2.06	52	0.15	63	0.32	-83
		3000	0.53	116	1.78	45	0.19	63	0.32	-91
		3500	0.64	109	1.60	38	0.20	62	0.28	-108
	4000	0.67	101	1.39	34	0.23	60	0.29	-131	
	20	100	0.61	-76	33.76	139	0.02	60	0.76	-36
		500	0.56	-157	10.72	96	0.04	54	0.32	-63
		1000	0.53	176	5.53	79	0.07	62	0.29	-70
		1500	0.50	162	3.69	68	0.10	66	0.27	-75
		2000	0.48	143	2.79	60	0.13	68	0.27	-74
		2500	0.51	129	2.22	52	0.16	68	0.26	-84
		3000	0.52	112	1.92	46	0.19	65	0.26	-91
		3500	0.59	104	1.75	40	0.21	64	0.24	-109
	4000	0.63	98	1.54	35	0.24	59	0.25	-131	
	30	100	0.57	-89	37.35	134	0.02	58	0.71	-40
		500	0.55	-163	10.82	94	0.04	57	0.29	-63
		1000	0.53	128	5.54	78	0.07	65	0.24	-69
		1500	0.50	159	3.69	67	0.10	69	0.26	-73
		2000	0.49	141	2.77	59	0.13	70	0.27	-71
		2500	0.51	127	2.23	51	0.16	69	0.26	-82
		3000	0.52	112	1.93	45	0.19	66	0.26	-89
		3500	0.61	106	1.68	40	0.21	64	0.21	-110
	4000	0.66	97	1.51	34	0.24	60	0.23	-130	
	60	100	0.55	-122	34.92	126	0.01	52	0.59	-37
		500	0.59	-175	8.71	91	0.03	65	0.33	-42
		1000	0.58	167	4.52	76	0.06	73	0.30	-53
		1500	0.55	154	3.04	65	0.09	75	0.34	-62
2000		0.54	138	2.28	56	0.12	77	0.35	-66	
2500		0.57	125	1.82	48	0.16	76	0.34	-78	
3000		0.59	110	1.56	42	0.19	72	0.35	-88	
3500		0.66	104	1.28	36	0.22	70	0.32	-105	
4000	0.70	95	1.14	32	0.26	66	0.32	-132		

2