

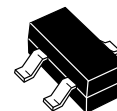
# The RF Line NPN Silicon High-Frequency Transistors

Designed for low noise, wide dynamic range front-end amplifiers and low-noise VCO's. Available in a surface-mountable plastic packages. This Motorola series of small-signal plastic transistors offers superior quality and performance at low cost.

- High Gain-Bandwidth Product  
 $f_T = 8.0 \text{ GHz (Typ) @ 50 mA}$
- Low Noise Figure  
 $NF_{\min} = 1.6 \text{ dB (Typ) @ } f = 1.0 \text{ GHz (MRF5711LT1, MRF571)}$
- High Gain  
 $G_{NF} = 17 \text{ dB (Typ) @ 30 mA/500 MHz (MMBR571LT1)}$
- High Power Gain  
 $G_{pe} \text{ (matched)} = 13.5 \text{ dB (Typ) (MRF5711LT1)}$
- State-of-the-Art Technology  
Fine Line Geometry  
Ion-Implanted Arsenic Emitters  
Gold Top Metallization and Wires  
Silicon Nitride Passivation
- Available in tape and reel packaging options:  
T1 suffix = 3,000 units per reel

**MMBR571LT1**  
**MRF571**  
**MRF5711LT1**

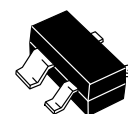
**$I_C = 80 \text{ mA}$**   
**LOW NOISE**  
**HIGH-FREQUENCY**  
**TRANSISTORS**



**CASE 318-08, STYLE 6**  
**SOT-23**  
**LOW PROFILE**  
**MMBR571LT1**



**CASE 317-01, STYLE 2**  
**MACRO-X**  
**MRF571**



**CASE 318A-05, STYLE 1**  
**SOT-143**  
**LOW PROFILE**  
**MRF5711LT1**

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CEO}$	10	Vdc
Collector-Base Voltage	$V_{CBO}$	20	Vdc
Emitter-Base Voltage	$V_{EBO}$	3.0	Vdc
Collector Current — Continuous	$I_C$	80	mA
Total Device Dissipation @ $T_{\text{case}} = 75^\circ\text{C}$ MMBR571LT1, MRF5711LT1 Derate linearly above $T_{\text{case}} = 75^\circ\text{C}$ @	$P_{D(\text{max})}$	0.33 4.44	W mW/°C
Total Device Dissipation (1) @ $T_C = 75^\circ\text{C}$ Derate above $75^\circ\text{C}$ MRF571	$P_D$	0.58 7.73	Watts mW/°C
Operating and Storage Temperature	$T_{\text{stg}}$	-55 to +150	°C

## THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Thermal Resistance, Junction to Case MRF5711LT1, MMBR571LT1	$R_{\theta JC}$	225	°C/W
Thermal Resistance, Junction to Case MRF571	$R_{\theta JC}$	130	°C/W
Maximum Junction Temperature	$T_{J\text{max}}$	150	°C

## DEVICE MARKING

MMBR571LT1 = 7X	MRF5711LT1 = 02
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## NOTE:

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

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

Characteristic	Symbol	Min	Typ	Max	Unit
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**OFF CHARACTERISTICS**

Collector–Emitter Breakdown Voltage ( $I_C = 1.0\text{ mA}$ , $I_B = 0$ )	$V_{(BR)CEO}$	10	12	—	Vdc
Collector–Base Breakdown Voltage ( $I_C = 0.1\text{ mA}$ , $I_E = 0$ )	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter–Base Breakdown Voltage ( $I_E = 50\ \mu\text{Adc}$ , $I_C = 0$ )	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current ( $V_{CB} = 8.0\text{ Vdc}$ , $I_E = 0$ )	$I_{CBO}$	—	—	10	$\mu\text{Adc}$

**ON CHARACTERISTICS**

DC Current Gain ( $I_C = 30\text{ mAdc}$ , $V_{CE} = 5.0\text{ Vdc}$ )	$h_{FE}$	50	—	300	—
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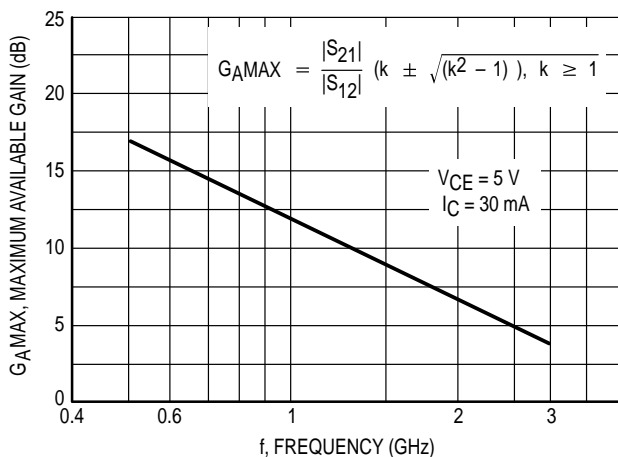
**DYNAMIC CHARACTERISTICS**

Collector–Base Capacitance ( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ ) ( $V_{CB} = 6.0\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )	MMBR571LT1 MRF5711LT1, MRF571	$C_{cb}$	—	0.7 0.75	1.0 1.0	pF
Current Gain–Bandwidth Product ( $V_{CE} = 5.0\text{ Vdc}$ , $I_C = 50\text{ mAdc}$ , $f = 1.0\text{ GHz}$ ) ( $V_{CE} = 8.0\text{ Vdc}$ , $I_C = 50\text{ mAdc}$ , $f = 1.0\text{ GHz}$ )	MMBR571LT1 MRF5711LT1, MRF571	$f_T$	—	8.0 8.0	—	GHz

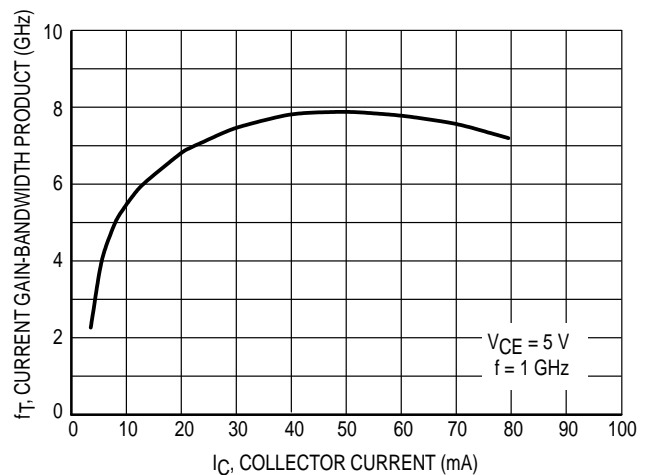
**FUNCTIONAL TESTS**

Gain @ Noise Figure ( $I_C = 10\text{ mAdc}$ , $V_{CE} = 6.0\text{ Vdc}$ )	MRF571 MRF571	$f = 0.5\text{ GHz}$ $f = 1.0\text{ GHz}$	$G_{NF}$	— 10	16.5 12	—	dB
Noise Figure ( $I_C = 10\text{ mAdc}$ , $V_{CE} = 6.0\text{ Vdc}$ )	MRF571 MRF571	$f = 0.5\text{ GHz}$ $f = 1.0\text{ GHz}$ $f = 2.0\text{ GHz}$	NF	— — —	1.0 1.5 2.8	— 2.0 —	dB
Gain @ Noise Figure ( $I_C = 10\text{ mAdc}$ , $V_{CE} = 5.0\text{ Vdc}$ )  ( $I_C = 10\text{ mA}$ , $V_{CE} = 6.0\text{ Vdc}$ )	MMBR571LT1 MRF5711LT1	$f = 0.5\text{ GHz}$ $f = 1.0\text{ GHz}$ $f = 1.0\text{ GHz}$	$G_{NF}$	— — —	16.5 10.5 13.5	— — —	dB
Noise Figure ( $I_C = 10\text{ mAdc}$ , $V_{CE} = 5.0\text{ Vdc}$ )  ( $I_C = 10\text{ mAdc}$ , $V_{CE} = 6.0\text{ Vdc}$ )	MMBR571LT1 MRF5711LT1	$f = 0.5\text{ GHz}$ $f = 1.0\text{ GHz}$ $f = 1.0\text{ GHz}$	NF	— — —	2.0 2.6 2.2	— — —	dB
Noise Figure ( $V_{CE} = 6.0\text{ V}$ , $I_C = 10\text{ mA}$ , $f = 1.0\text{ GHz}$ )	MRF5711LT1		$NF_{min}$	—	1.6	—	dB
Power Gain in 50 $\Omega$ System ( $V_{CE} = 6.0\text{ V}$ , $I_C = 10\text{ mA}$ , $f = 1.0\text{ GHz}$ )	MRF5711LT1		$ S_{21} ^2$	9.0	10	—	dB

**TYPICAL CHARACTERISTICS**  
**MMBR571LT1**

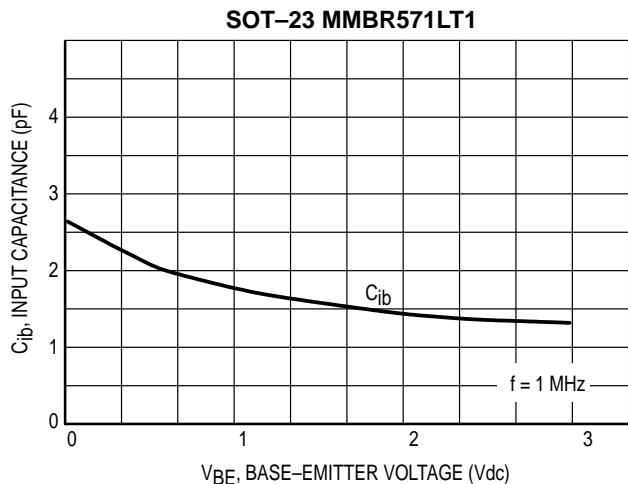


**Figure 1. Maximum Available Gain versus Frequency**

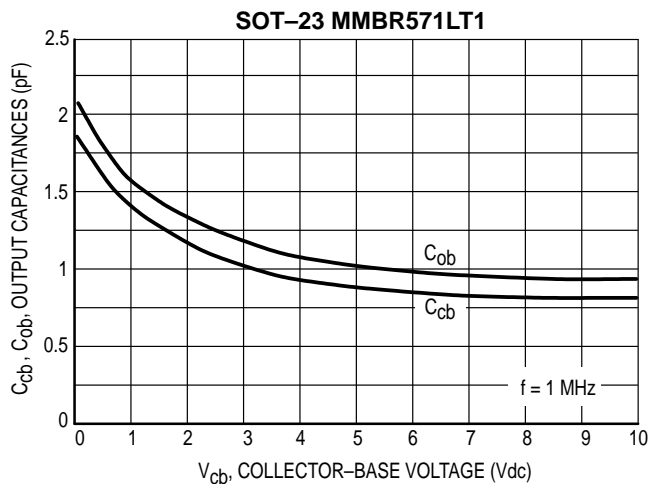


**Figure 2. Current Gain–Bandwidth versus Collector Current @ 1.0 GHz**

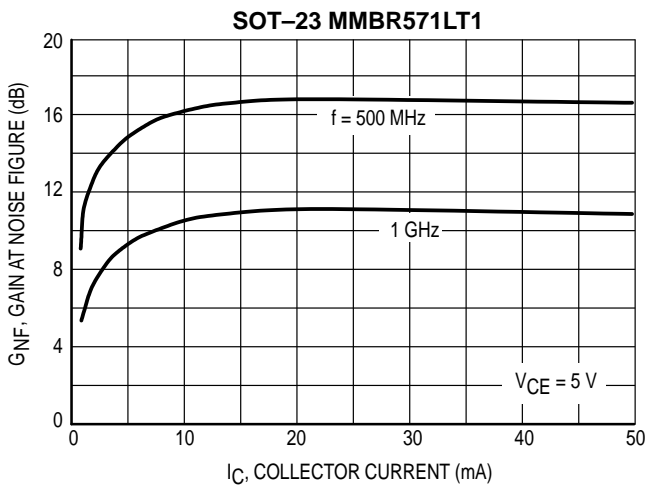
**TYPICAL CHARACTERISTICS**  
**MMBR571LT1**



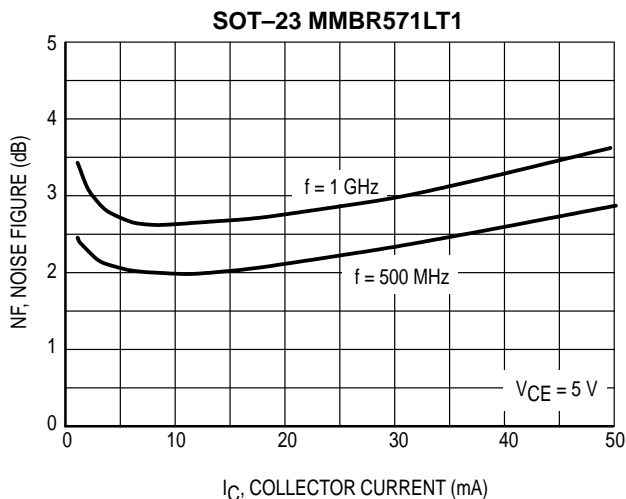
**Figure 3. Input Capacitance versus Emitter Base Voltage**



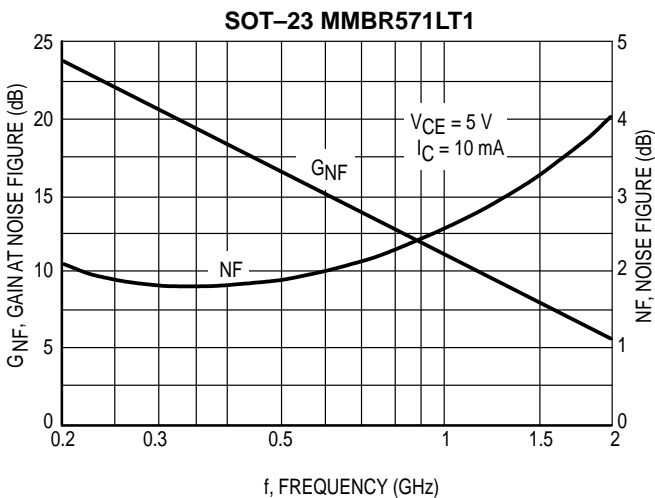
**Figure 4. Output Capacitances versus Collector-Base Voltage**



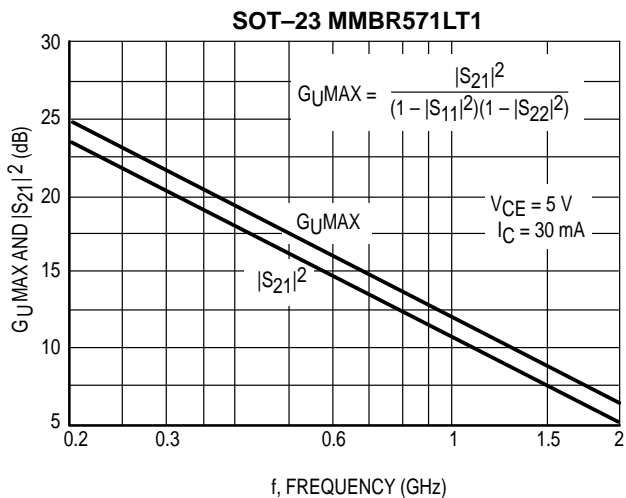
**Figure 5. Gain at Noise Figure versus Collector Current**



**Figure 6. Noise Figure versus Collector Current**

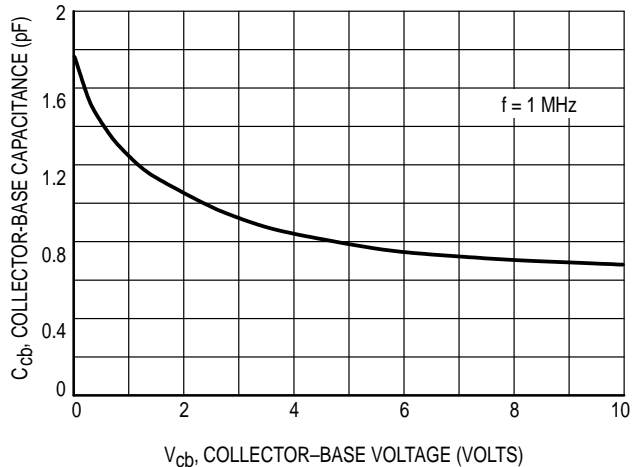


**Figure 7. Gain at Noise Figure and Noise Figure versus Frequency**

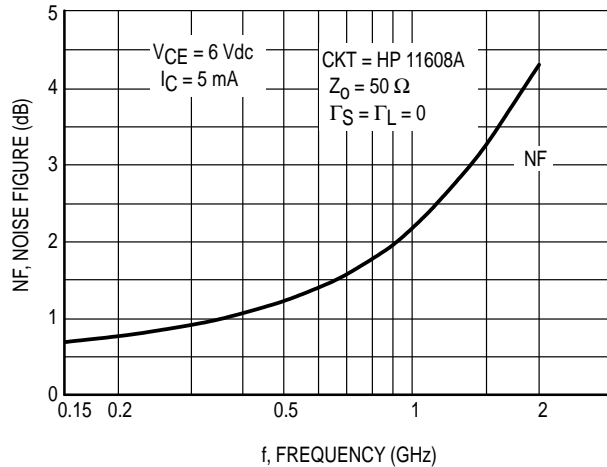


**Figure 8. Maximum Unilateral Gain and Insertion Gain versus Frequency**

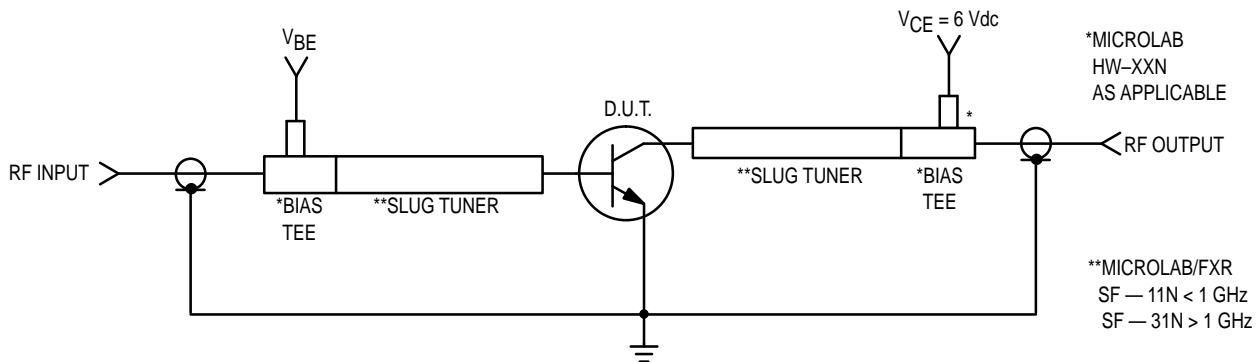
**TYPICAL CHARACTERISTICS**  
**MRF5711LT1**



**Figure 9. Collector-Base Capacitance versus Collector-Base Voltage**

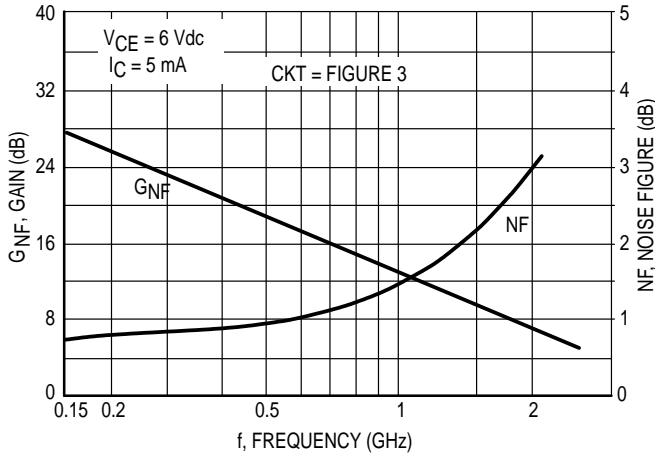


**Figure 10. 50  $\Omega$  Noise Figure versus Frequency**

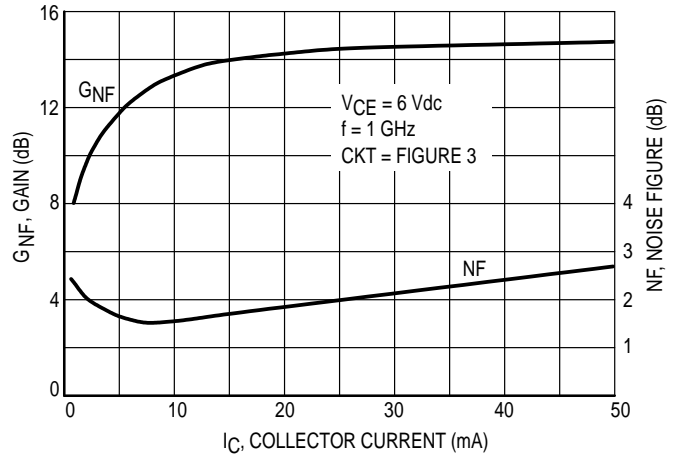


**Figure 11. Functional Circuit Schematic**

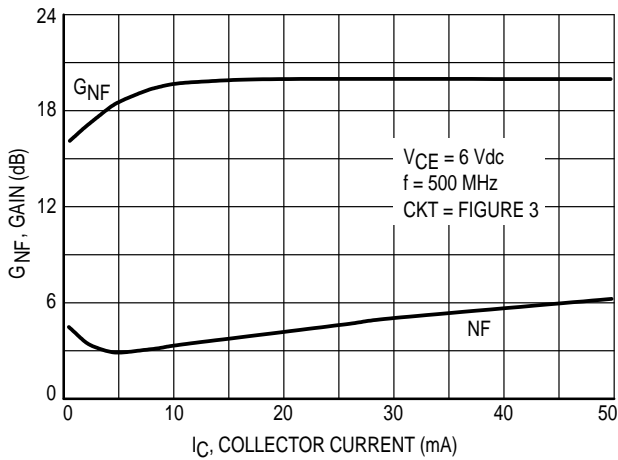
**TYPICAL CHARACTERISTICS**  
**MRF5711LT1**



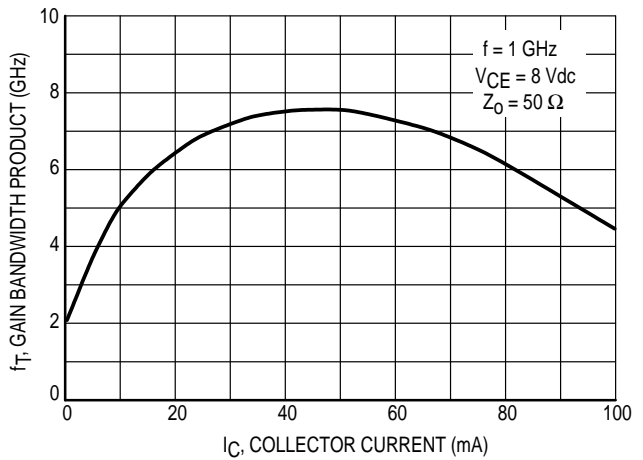
**Figure 12. Gain and Noise Figure versus Frequency**



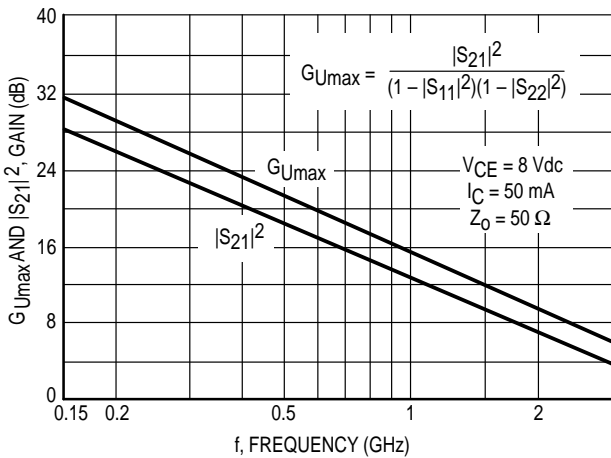
**Figure 13. Gain and Noise Figure versus Collector Current**



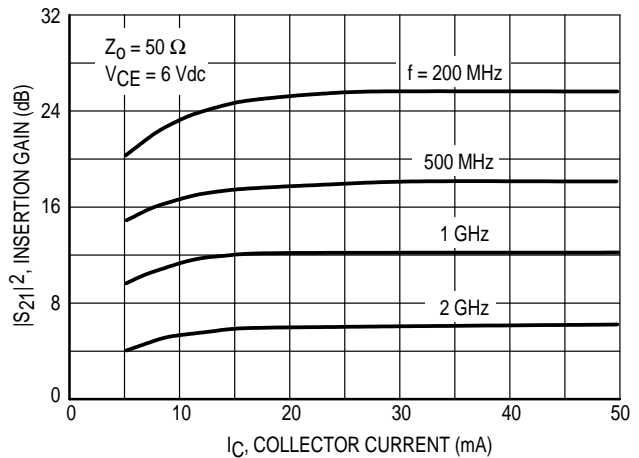
**Figure 14. Gain and Noise Figure versus Collector Current**



**Figure 15. Gain Bandwidth Product versus Collector Current**



**Figure 16.  $G_{Umax}$  and  $|S_{21}|^2$  versus Frequency**



**Figure 17. Insertion Gain versus Collector Current**

MMBR571LT1

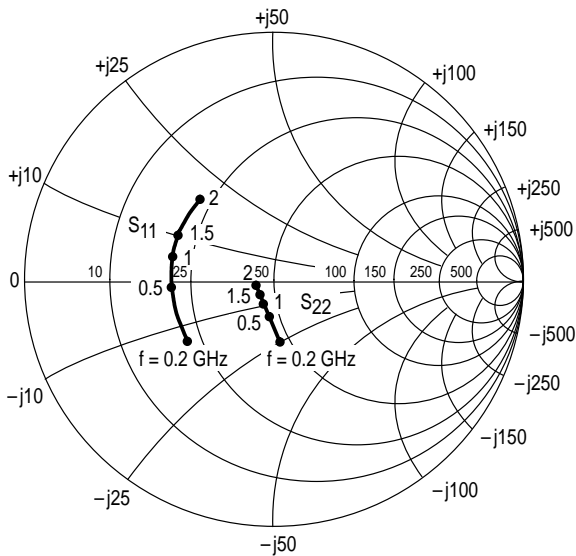


Figure 18. Input/Output Reflection Coefficients versus Frequency  
 $V_{CE} = 5.0 \text{ V}$ ,  $I_C = 30 \text{ mA}$

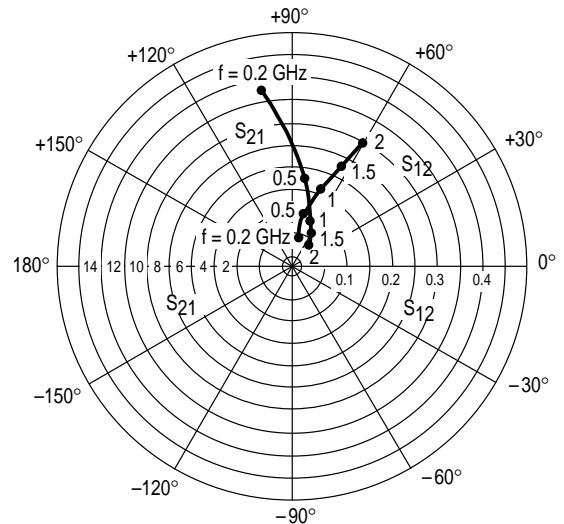
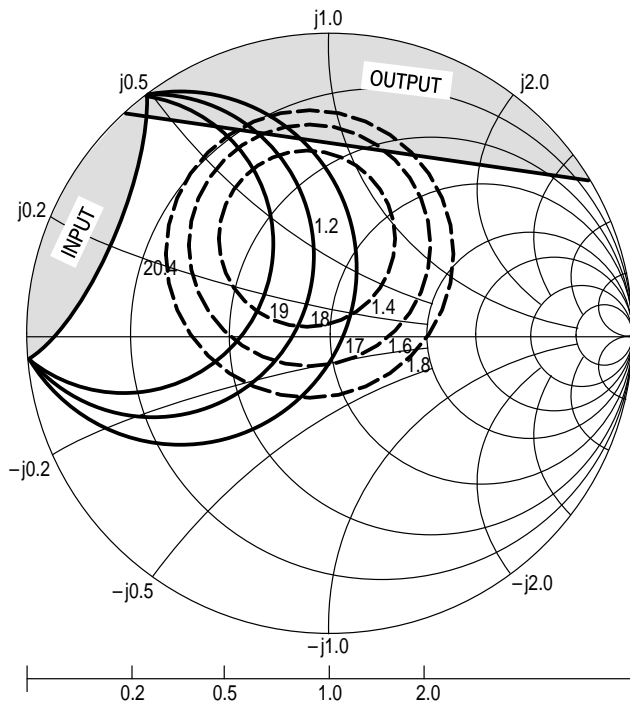


Figure 19. Forward/Reverse Transmission Coefficients versus Frequency  
 $V_{CE} = 5.0 \text{ V}$ ,  $I_C = 30 \text{ mA}$

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	5.0	200	0.68	-82	8.41	126	0.07	53	0.61	-45
		500	0.52	-142	4.62	93	0.10	46	0.35	-60
		1000	0.50	179	2.57	72	0.14	53	0.26	-71
		1500	0.51	161	1.82	57	0.19	58	0.24	-77
		2000	0.52	143	1.48	45	0.24	59	0.22	-86
	15	200	0.46	-125	13.65	108	0.05	60	0.35	-73
		500	0.43	-169	6.03	86	0.09	66	0.17	-94
		1000	0.44	168	3.20	72	0.16	67	0.14	-111
		1500	0.45	152	2.21	58	0.22	64	0.11	-118
		2000	0.46	137	1.80	48	0.29	59	0.10	-131
	30	200	0.42	-148	14.79	102	0.04	68	0.26	-87
		500	0.41	-177	6.31	84	0.09	72	0.14	-115
		1000	0.42	165	3.35	71	0.16	70	0.12	-135
		1500	0.44	151	2.29	59	0.23	65	0.11	-144
		2000	0.44	135	1.84	48	0.30	60	0.10	-157
	50	200	0.41	-159	15.14	98	0.04	73	0.21	-96
		500	0.42	179	6.38	83	0.09	75	0.13	-124
		1000	0.43	163	3.35	70	0.16	71	0.12	-143
		1500	0.44	148	2.32	58	0.23	66	0.10	-151
		2000	0.45	134	1.84	48	0.30	60	0.09	-163

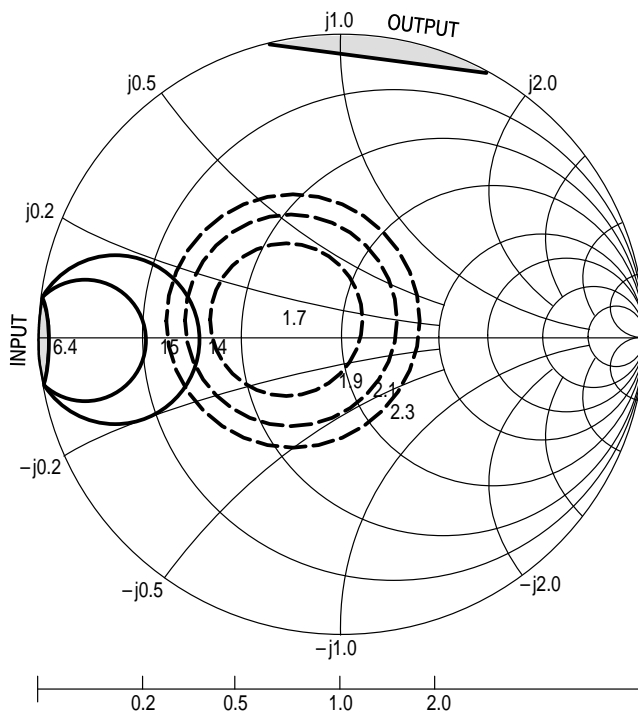
Table 1. MMBR571LT1 Common Emitter S-Parameters



$V_{CE} = 5\text{ V}$   
 $I_C = 10\text{ mA}$   
 □ = Area of Instability

f (GHz)	NF OPT	$\Gamma_{MS}$ NF OPT	Rn	K
0.5	1.20 dB	$0.36 \angle 104^\circ$	7	0.63

**Figure 20. MRF5711LT1 Constant Gain and Noise Figure Contours (f = 0.5 GHz)**



$V_{CE} = 5\text{ V}$   
 $I_C = 10\text{ mA}$   
 □ = Area of Instability

f (GHz)	NF OPT	$\Gamma_{MS}$ NF OPT	Rn	K
1.0	1.70 dB	$0.20 \angle 162^\circ$	8	0.94

**Figure 21. MRF5711LT1 Constant Gain and noise Figure Contours (f = 1.0 GHz)**

V <sub>CE</sub> (Vdc)	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
6.0	5.0	200	0.79	-90	10.9	128	0.06	46	0.70	-45
		500	0.72	-144	5.7	96	0.08	28	0.42	-66
		1000	0.69	-177	3.0	75	0.09	28	0.31	-77
		1500	0.66	164	2.0	59	0.10	32	0.34	-89
		2000	0.65	147	1.6	47	0.12	38	0.32	-94
	10	200	0.72	-115	15.2	118	0.05	41	0.55	-66
		500	0.69	-160	6.9	92	0.06	34	0.30	-92
		1000	0.67	174	3.6	74	0.08	42	0.21	-108
		1500	0.64	159	2.4	60	0.10	46	0.23	-114
		2000	0.64	143	1.8	49	0.12	50	0.20	-116
	50	200	0.67	-159	20	102	0.02	48	0.33	-111
		500	0.67	179	8.2	85	0.04	58	0.33	-142
		1000	0.66	174	3.8	72	0.07	65	0.21	-158
		1500	0.63	151	2.7	61	0.10	64	0.22	-158
		2000	0.58	138	2.1	51	0.14	62	0.17	-165
8.0	5.0	200	0.80	-87	11.1	130	0.06	47	0.71	-42
		500	0.72	-141	5.9	97	0.08	30	0.44	-60
		1000	0.70	-177	3.1	75	0.09	28	0.33	-68
		1500	0.66	166	2.1	60	0.10	32	0.35	-80
		2000	0.61	149	1.6	47	0.12	39	0.35	-85
	10	200	0.72	-113	15.6	119	0.05	42	0.56	-61
		500	0.68	-159	7.2	92	0.06	34	0.31	-82
		1000	0.66	175	3.7	74	0.08	41	0.21	-92
		1500	0.64	160	2.5	61	0.09	47	0.23	-101
		2000	0.60	144	2.0	49	0.13	50	0.21	-103
	50	200	0.66	-156	20.9	103	0.02	48	0.31	-101
		500	0.65	-179	8.6	85	0.04	58	0.19	-128
		1000	0.64	164	4.3	72	0.07	65	0.16	-144
		1500	0.61	153	2.9	61	0.10	65	0.17	-142
		2000	0.58	137	2.3	51	0.13	64	0.14	-145

Table 2. MRF5711LT1 Common Emitter S-Parameters



TYPICAL CHARACTERISTICS  
MRF571

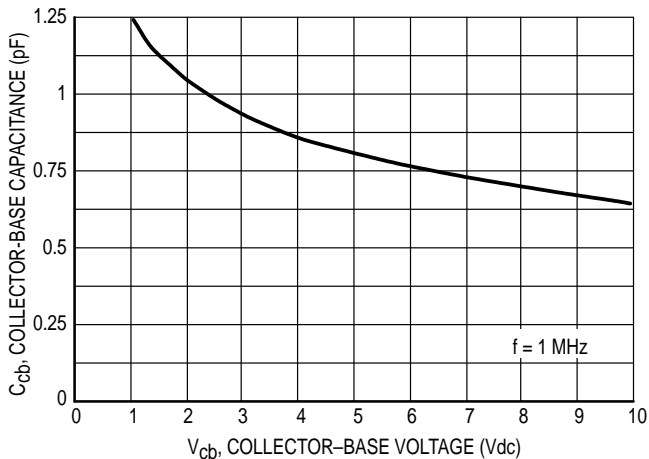


Figure 22. C<sub>cb</sub>, Collector-Base Capacitance versus Voltage

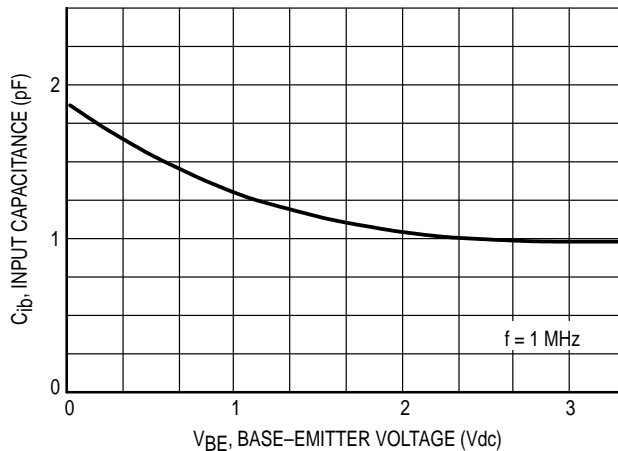


Figure 23. C<sub>ib</sub>, Input Capacitance versus Emitter Base Voltage

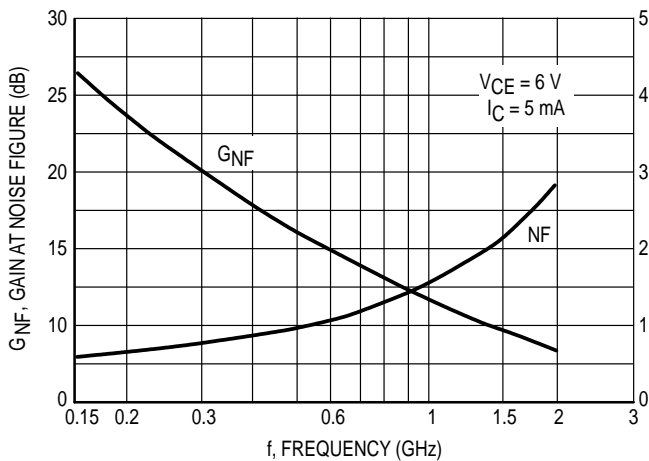


Figure 24. Gain at Noise Figure and Noise Figure versus Frequency

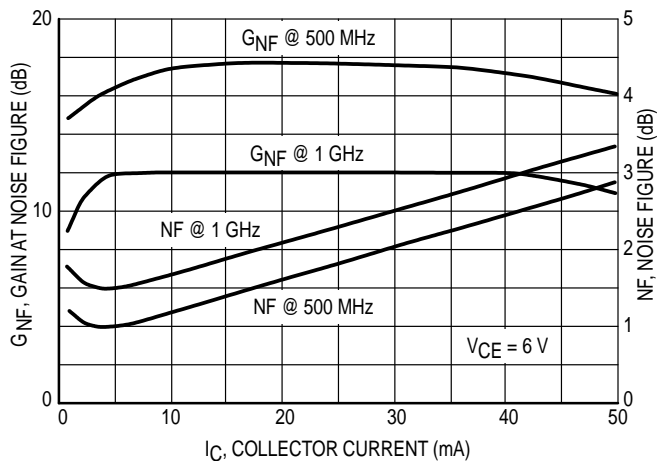
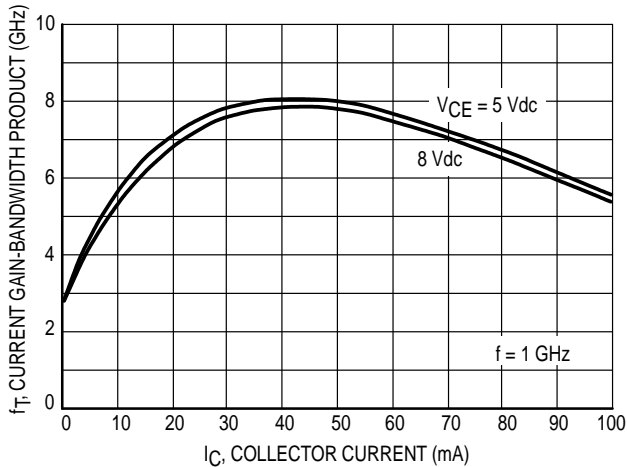
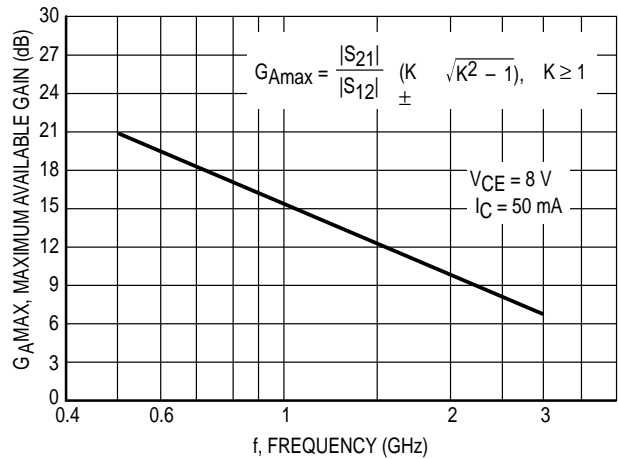


Figure 25. Gain at Noise Figure and Noise Figure versus Collector Current

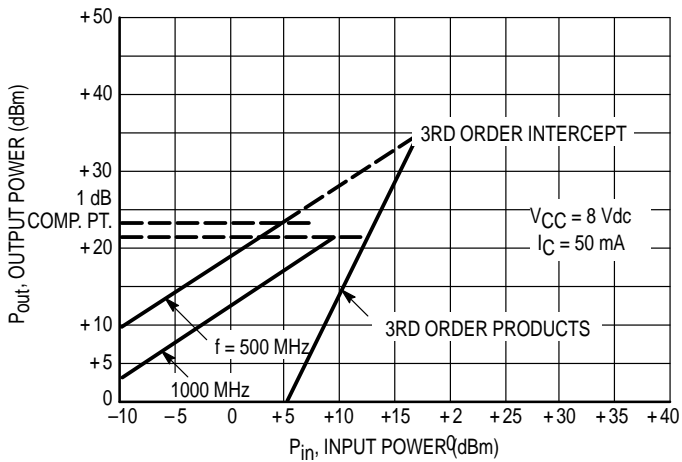
## TYPICAL CHARACTERISTICS MRF571



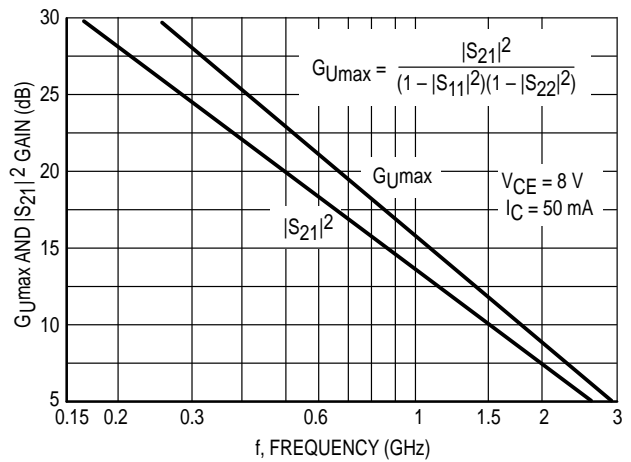
**Figure 26.  $f_T$ , Current Gain–Bandwidth Product versus Collector Current**



**Figure 27.  $G_{Amax}$ , Maximum Available Gain versus Frequency**



**Figure 28. 1.0 dB Compression Point and Third Order Intercept**



**Figure 29.  $G_{Umax}$  and  $|S_{21}|^2$  versus Frequency**

MRF571

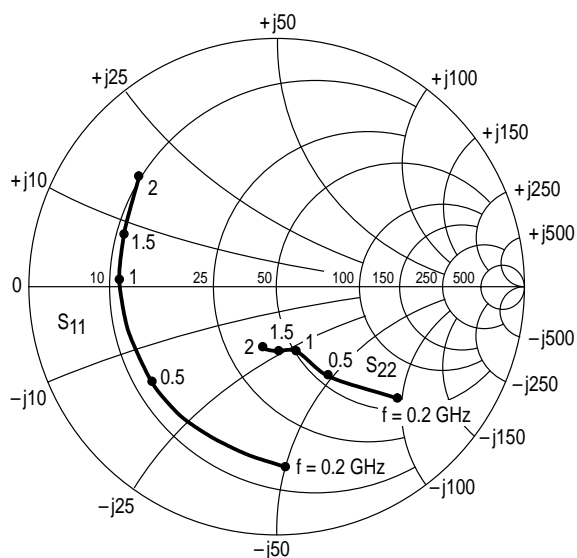


Figure 30. Input/Output Reflection Coefficients versus Frequency (GHz)  
 VCE = 6.0 V, IC = 5.0 mA

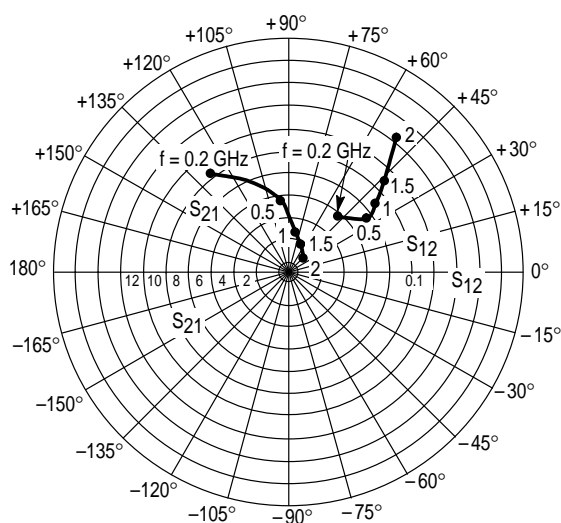
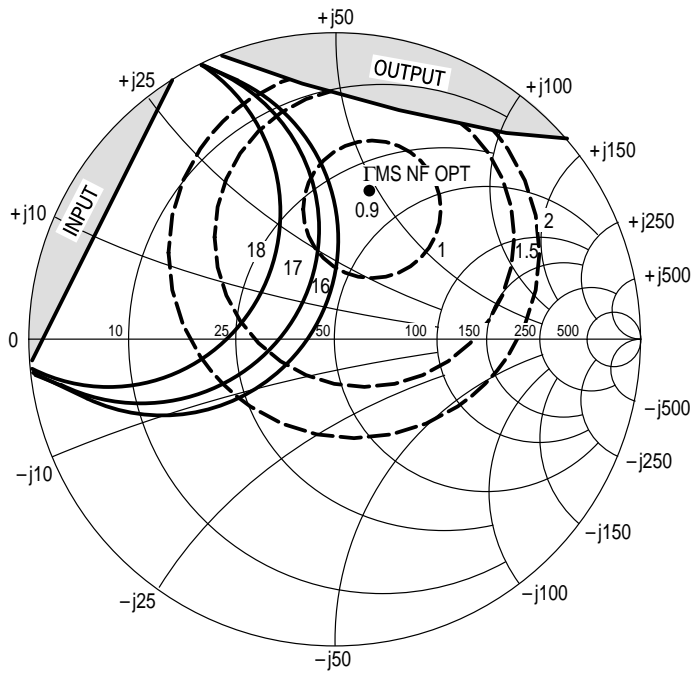


Figure 31. Forward/Reverse Transmission Coefficients versus Frequency (GHz)  
 VCE = 6.0 V, IC = 5.0 mA

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠ φ	S21	∠ φ	S12	∠ φ	S22	∠ φ
6.0	5	200	0.74	-86	10.5	129	0.06	48	0.69	-42
		500	0.62	-143	5.5	97	0.08	33	0.41	-59
		1000	0.61	178	3.0	78	0.09	37	0.28	-69
		1500	0.65	158	2.0	62	0.11	44	0.26	-88
		2000	0.70	140	1.6	51	0.14	51	0.27	-99
	10	200	0.64	-111	15	118	0.04	44	0.53	-59
		500	0.58	-160	6.9	93	0.06	42	0.27	-77
		1000	0.59	168	3.7	77	0.09	52	0.16	-91
		1500	0.63	151	2.5	64	0.12	56	0.16	-113
		2000	0.67	134	2.0	53	0.16	57	0.16	-118
	50	200	0.56	-160	20.4	102	0.02	57	0.27	-98
		500	0.57	176	8.4	86	0.05	67	0.14	-130
		1000	0.60	156	4.4	75	0.09	70	0.11	-164
		1500	0.62	152	2.9	64	0.13	68	0.13	-175
		2000	0.66	127	2.4	53	0.18	62	0.11	-178
8.0	5	200	0.75	-83	10.7	129	0.06	49	0.71	-39
		500	0.62	-140	5.1	98	0.08	34	0.43	-54
		1000	0.60	-179	3.7	78	0.09	38	0.31	-62
		1500	0.64	159	2.1	62	0.10	45	0.29	-80
		2000	0.69	141	1.7	52	0.13	52	0.29	-91
	10	200	0.64	-99	15.1	120	0.05	46	0.54	-60
		500	0.52	-152	7.1	94	0.07	45	0.32	-75
		1000	0.52	170	3.7	76	0.10	54	0.15	-82
		1500	0.52	150	2.5	62	0.13	56	0.16	-108
		2000	0.57	133	2.0	51	0.18	55	0.16	-107
	50	200	0.52	-153	19.6	102	0.03	56	0.28	-92
		500	0.52	178	8.1	86	0.05	67	0.16	-98
		1000	0.56	157	4.1	73	0.10	70	0.06	-130
		1500	0.54	139	2.8	62	0.13	68	0.11	-146
		2000	0.59	126	2.2	52	0.19	63	0.10	-137

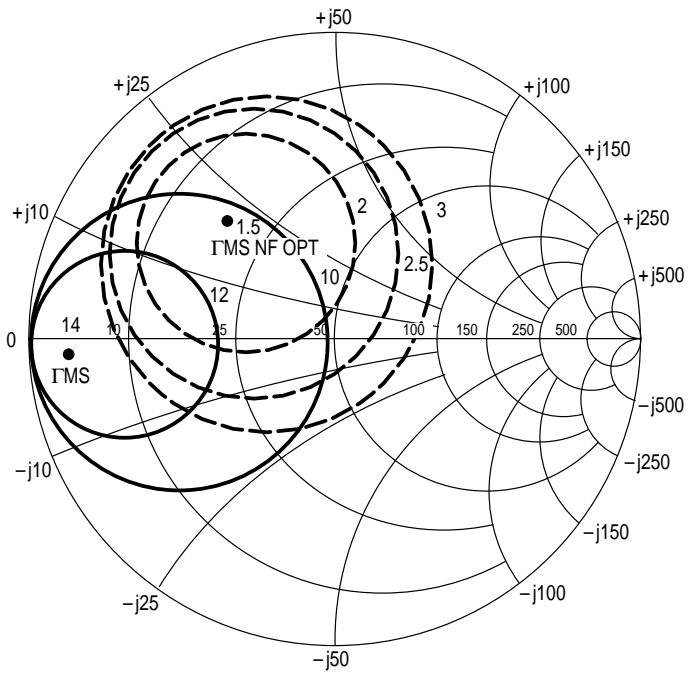
Table 3. MRF571 Common Emitter S-Parameters



$V_{CE} = 6.0 \text{ V}$ ,  $I_C = 5.0 \text{ mA}$   
 $f = 500 \text{ MHz}$   
 [Shaded Area] — REGION OF INSTABILITY

f (GHz)	NF OPT (dB)	Rn ( $\Omega$ )	NF50 $\Omega$ (dB)
0.5	0.9	9.3	1.3

$\Gamma_{MS}$ NF OPT	K
$0.49 \angle 74^\circ$	0.58

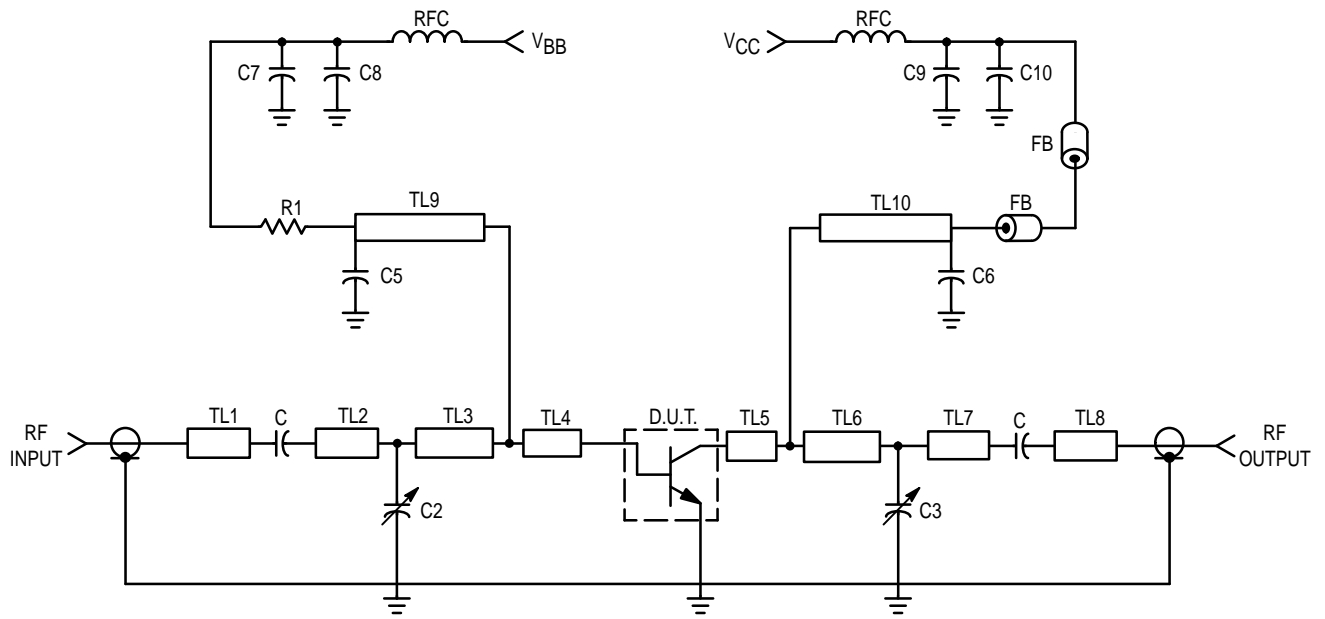


$V_{CE} = 6.0 \text{ V}$ ,  $I_C = 5.0 \text{ mA}$   
 $f = 1.0 \text{ GHz}$

f (GHz)	NF OPT (dB)	Rn ( $\Omega$ )	NF50 $\Omega$ (dB)	$\Gamma_{MS}$ NF OPT
1.0	1.5	7.5	2.2	$0.48 \angle 134^\circ$

$\Gamma_{MS}$	$\Gamma_{ML}$
$0.89 \angle -179^\circ$	$0.81 \angle 66^\circ$

Figure 32. MRF571 Constant Gain and Noise Figure Contours

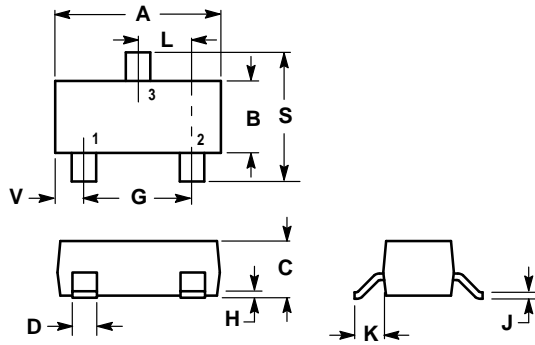


C1, C4, C5, C6, C8, C9 — 100 pF Chip Capacitor  
 C2, C3 — 0.8–8.0 pF Johanson Capacitor  
 C7, C10 — 10  $\mu$ F Tantalum Capacitor  
 R1 — 1.0 kOhms Res.  
 RFC — VK-200, Ferroxcube  
 FB — Ferrite Bead, Ferroxcube 56-590-65/3B  
 Board Material — 0.0625" Glass Teflon,  $\epsilon_r = 2.55$

TL1, TL7, TL8 — Microstrip 0.162" x 0.600"  
 TL2 — Microstrip 0.162" x 1.060"  
 TL3 — Microstrip 0.162" x 0.700"  
 TL4, TL5 — Microstrip 0.162" x 0.440"  
 TL6 — Microstrip 0.162" x 1.140"  
 TL8, TL9 — Microstrip 0.020" x 2.130"

**Figure 33. MRF571 Test Circuit Schematic**

## PACKAGE DIMENSIONS



**NOTES:**

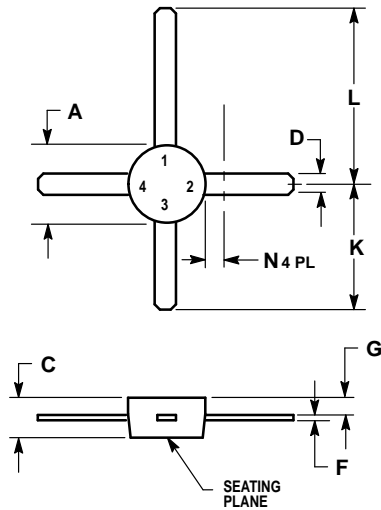
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1102	0.1197	2.80	3.04
B	0.0472	0.0551	1.20	1.40
C	0.0350	0.0440	0.89	1.11
D	0.0150	0.0200	0.37	0.50
G	0.0701	0.0807	1.78	2.04
H	0.0005	0.0040	0.013	0.100
J	0.0034	0.0070	0.085	0.177
K	0.0140	0.0285	0.35	0.69
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.1039	2.10	2.64
V	0.0177	0.0236	0.45	0.60

**STYLE 6:**

- PIN 1: BASE  
 2. EMITTER  
 3. COLLECTOR

**CASE 318-08  
 ISSUE AF  
 MMR571LT1**



**NOTES:**

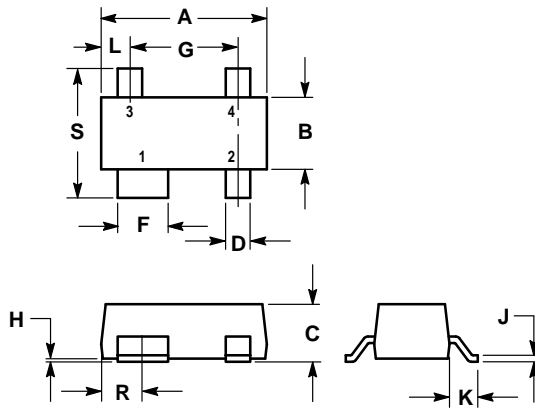
1. DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.080	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

**STYLE 2:**

- PIN 1: COLLECTOR  
 2. EMITTER  
 3. BASE  
 4. EMITTER

**CASE 317-01  
 ISSUE E  
 MRF571**




- NOTES:  
 4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 5. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.04	0.110	0.120
B	1.20	1.39	0.047	0.055
C	0.84	1.14	0.033	0.045
D	0.39	0.50	0.015	0.020
F	0.79	0.93	0.031	0.037
G	1.78	2.03	0.070	0.080
H	0.013	0.10	0.0005	0.004
J	0.08	0.15	0.003	0.006
K	0.46	0.60	0.018	0.024
L	0.445	0.60	0.0175	0.024
R	0.72	0.83	0.028	0.033
S	2.11	2.48	0.083	0.098

- STYLE 1:  
 PIN 1. COLLECTOR  
 2. EMITTER  
 3. EMITTER  
 4. BASE

**CASE 318A-05  
 ISSUE R  
 MRF5711LT1**

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