

# The RF Line

## PNP Silicon

### High-Frequency Transistor

Designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

- High Current Gain-Bandwidth Product —  
 $f_T = 3.4 \text{ GHz (Typ) @ } I_C = -35 \text{ mAdc (MMBR521LT1)}$   
 $f_T = 4.2 \text{ GHz (Typ) @ } I_C = -50 \text{ mAdc (MRF5211LT1)}$
- Low Noise Figure @  $f = 1.0 \text{ GHz}$  —  
 $NF(\text{matched}) = 2.5 \text{ dB (Typ) (MMBR521LT1)}$   
 $NF(\text{matched}) = 2.8 \text{ dB (Typ) (MRF5211LT1)}$
- High Power Gain —  $G_{pe}(\text{matched}) = 11 \text{ dB (Typ)}$
- Guaranteed RF Parameters
- Surface Mounted SOT-23 (MMBR521LT1) & SOT-143 (MRF5211LT1)  
 Offer Improved RF Performance  
 Lower Package Parasitics  
 Higher Gain
- Available in tape and reel packaging options:  
 T1 suffix = 3,000 units per reel

#### MAXIMUM RATINGS

Ratings	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CEO}$	-10	Vdc
Collector-Base Voltage	$V_{CBO}$	-20	Vdc
Emitter-Base Voltage	$V_{EBO}$	-2.5	Vdc
Power Dissipation (1) $T_C = 75^\circ\text{C}$ , Derate linearly above $T_C = 75^\circ\text{C}$ @ All	$P_{D(\text{max})}$	0.333 4.44	W mW/°C
Collector Current — Continuous	$I_C$	-70	mA
Maximum Junction Temperature	$T_{J\text{max}}$	150	°C
Storage Temperature All	$T_{\text{stg}}$	-55 to +150	°C

#### THERMAL CHARACTERISTICS

Ratings	Symbol	Value	Unit
Thermal Resistance, Junction to Case (MMBR521LT1, MRF5211LT1)	$R_{\theta JC}$	225	°C/W

#### DEVICE MARKING

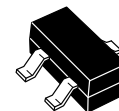
MMBR521LT1 = 7M	MRF5211LT1 = 04
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#### NOTE:

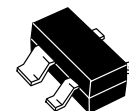
1. Case Temperature is measured on the collector lead closest to the package. For case temperatures above  $+75^\circ\text{C}$ :  $P_{\text{DISP}(\text{max})} = (T_{J\text{max}} - T_C) / R_{\theta JC}$

**MMBR521LT1**  
**MRF5211LT1**

$I_C = -70 \text{ mA}$   
**HIGH-FREQUENCY**  
**TRANSISTOR**  
**PNP SILICON**



**CASE 318-08, STYLE 6**  
**SOT-23**  
**LOW PROFILE**  
**(TO-236AA/AB)**  
**MMBR521LT1**



**CASE 318A-05, STYLE 1**  
**SOT-143**  
**LOW PROFILE**  
**MRF5211LT1**

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
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 ( $I_E = -50\text{ }\mu\text{A}$ , $I_C = 0$ )	$V_{(BR)EBO}$	-2.5	—	—	Vdc
Collector Cutoff Current ( $V_{CB} = -8.0\text{ Vdc}$ , $I_E = 0$ )	$I_{CBO}$	—	—	-10	$\mu\text{A}$
<b>ON CHARACTERISTICS</b>					
DC Current Gain ( $I_C = -30\text{ mA}$ , $V_{CE} = -5.0\text{ Vdc}$ )	$h_{FE}$	25	—	125	—
<b>DYNAMIC CHARACTERISTICS</b>					
Collector–Base Capacitance ( $V_{CB} = -6.0\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )	$C_{cb}$	—	1.0	1.5	pF
Current Gain — Bandwidth Product ( $V_{CE} = -8.0\text{ V}$ , $I_C = -35\text{ mA}$ , $f = 1.0\text{ GHz}$ ) ( $V_{CE} = -8.0\text{ V}$ , $I_C = -50\text{ mA}$ , $f = 1.0\text{ GHz}$ )	$f_T$	—	3.4 4.2	—	GHz
			MMBR521LT1 MRF5211LT1		
<b>FUNCTIONAL TESTS</b>					
Power Gain at Minimum Noise Figure ( $V_{CE} = -6.0\text{ V}$ , $I_C = -5.0\text{ mA}$ , $f = 500\text{ MHz}$ ) ( $V_{CE} = -6.0\text{ V}$ , $I_C = -5.0\text{ mA}$ , $f = 1.0\text{ GHz}$ ) ( $V_{CE} = -6.0\text{ V}$ , $I_C = -5.0\text{ mA}$ , $f = 1.0\text{ GHz}$ )	$G_{NFmin}$	13 8.0 10	15 10 11	—	dB
			MMBR521LT1 MMBR521LT1 MRF5211LT1		
Noise Figure — Minimum ( $V_{CE} = -6.0\text{ V}$ , $I_C = -5.0\text{ mA}$ , $f = 500\text{ MHz}$ ) ( $V_{CE} = -6.0\text{ V}$ , $I_C = -5.0\text{ mA}$ , $f = 1.0\text{ GHz}$ ) ( $V_{CE} = -6.0\text{ V}$ , $I_C = -5.0\text{ mA}$ , $f = 1.0\text{ GHz}$ )	$NF_{min}$	—	1.5 2.5 2.8	2.5 3.5 3.5	dB
			MMBR521LT1 MMBR521LT1 MRF5211LT1		

**TYPICAL CHARACTERISTICS**

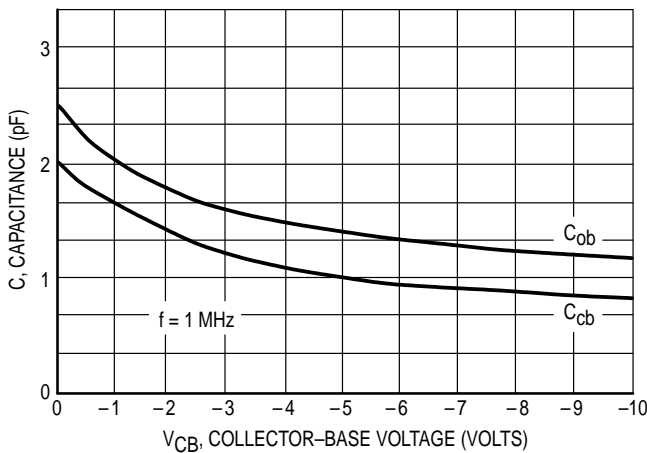


Figure 1. Junction Capacitance versus Voltage

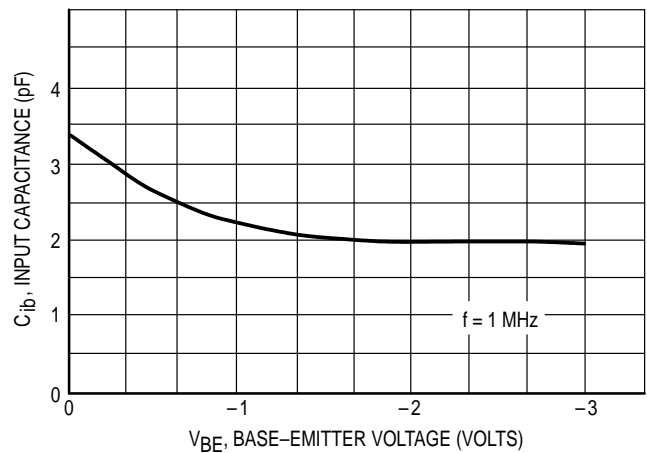


Figure 2. Input Capacitance versus Voltage

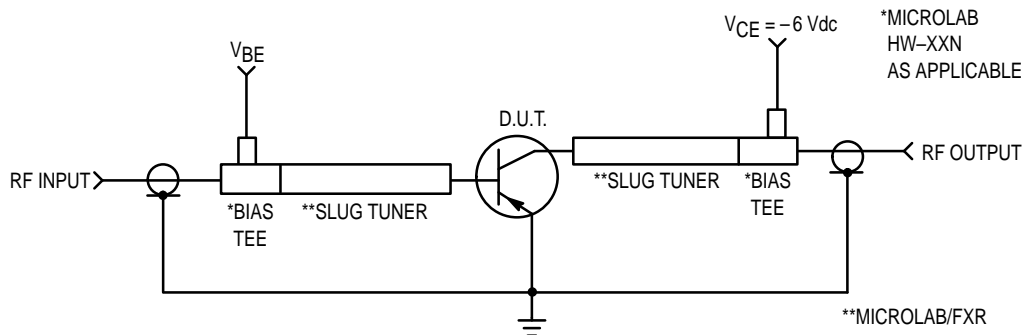
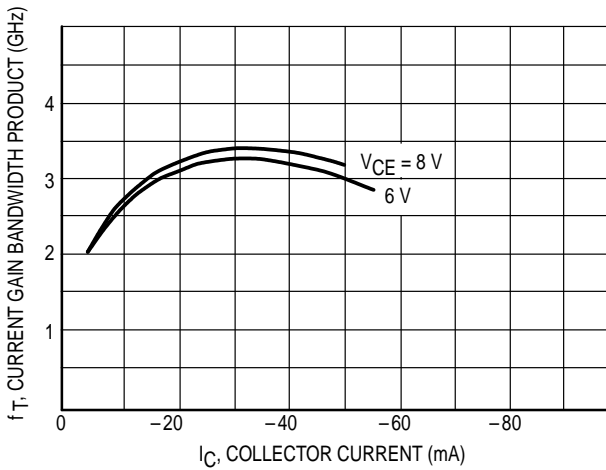
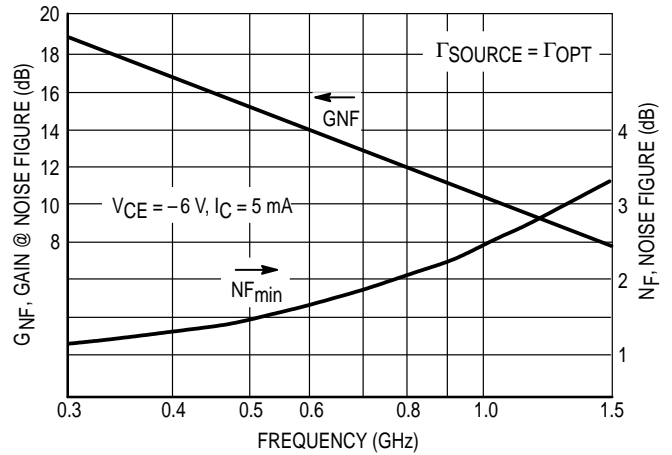


Figure 3. Functional Circuit Schematic

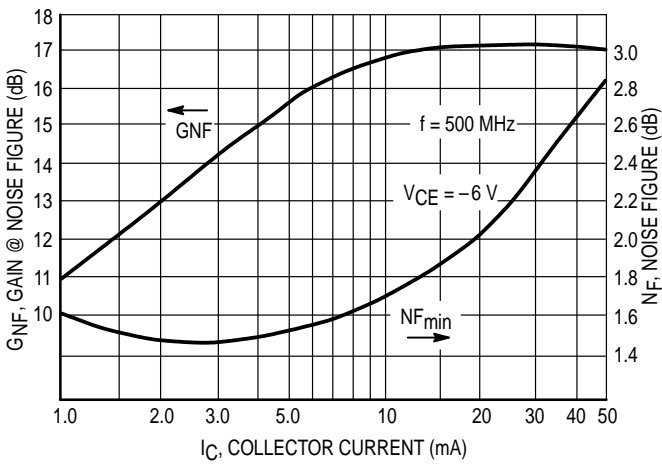
**TYPICAL CHARACTERISTICS  
MMBR521LT1**



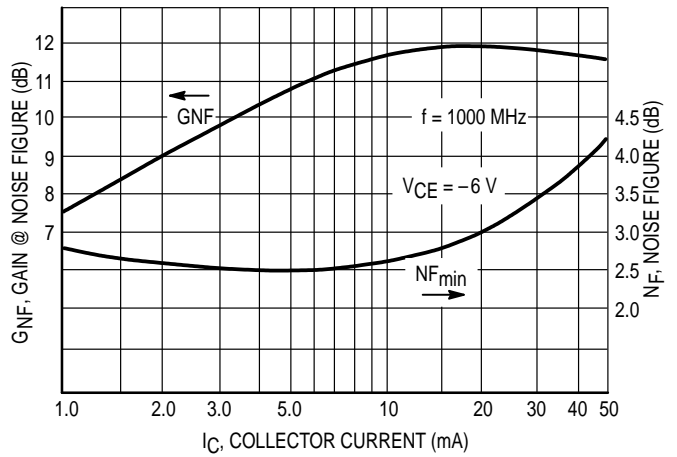
**Figure 4. Current Gain Bandwidth Product versus Collector Current**



**Figure 5. Minimum Noise Figure & Gain @ Noise Figure versus Frequency**



**Figure 6. Minimum Noise Figure & Gain @ Noise Figure versus Collector Current**



**Figure 7. Minimum Noise Figure & Gain @ Noise Figure versus Collector Current**

## TYPICAL CHARACTERISTICS MRF5211LT1

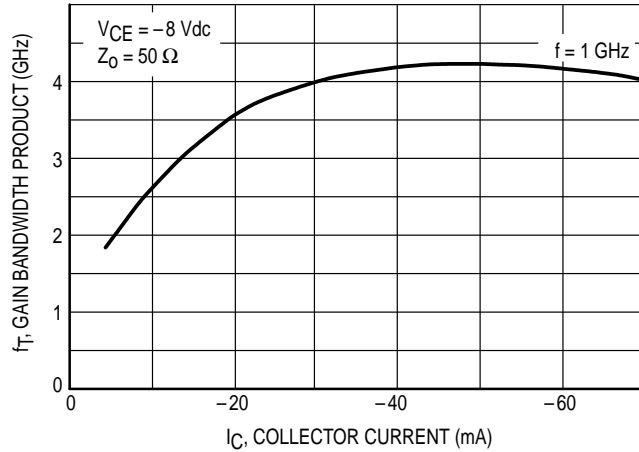


Figure 8. Gain–Bandwidth Product versus Current

### GAIN AND NOISE FIGURE versus FREQUENCY

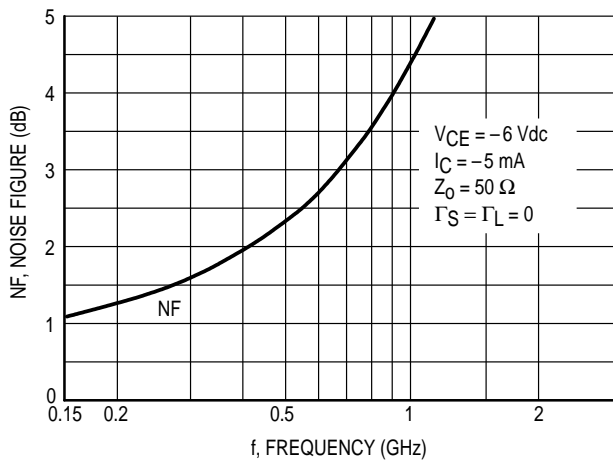


Figure 9. 50 Ohm Noise Figure

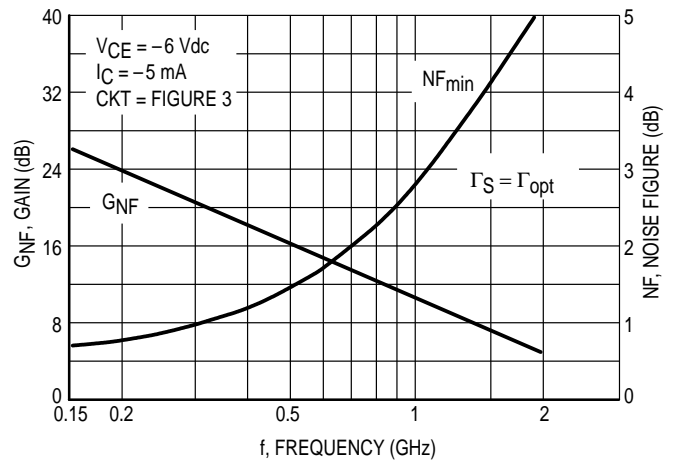


Figure 10. Tuned Circuit

### GAIN AND NOISE FIGURE versus CURRENT

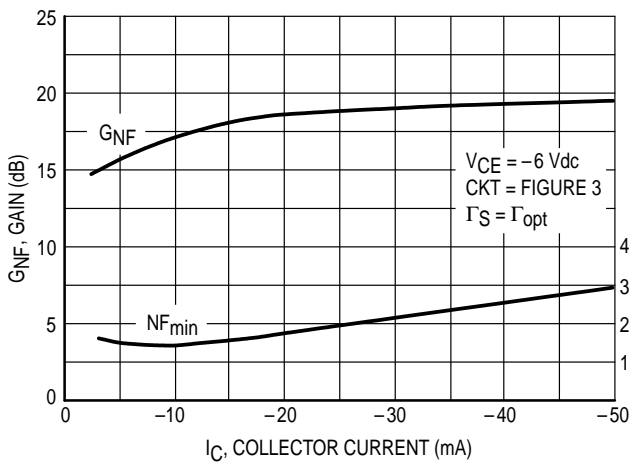


Figure 11. Tuned Circuit — Frequency 500 MHz

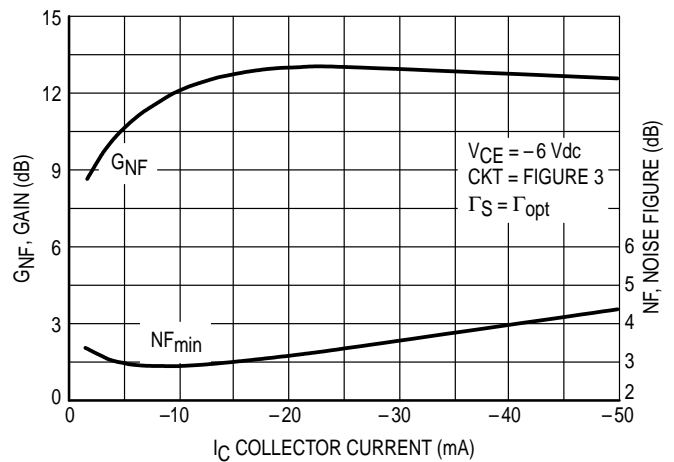


Figure 12. Tuned Circuit — Frequency 1.0 GHz

TYPICAL CHARACTERISTICS — continued  
MRF5211LT1

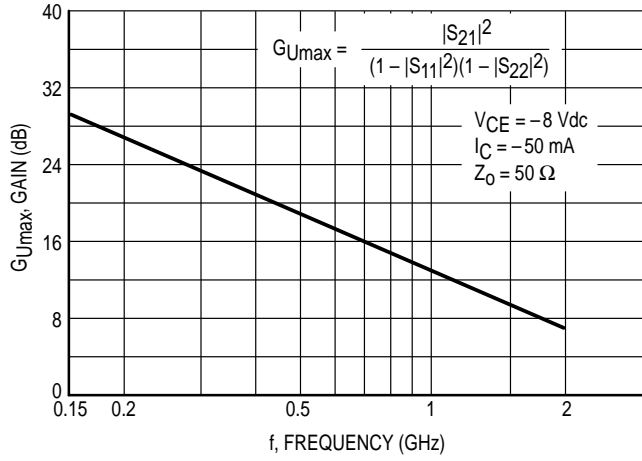


Figure 13.  $G_{Umax}$  versus Current

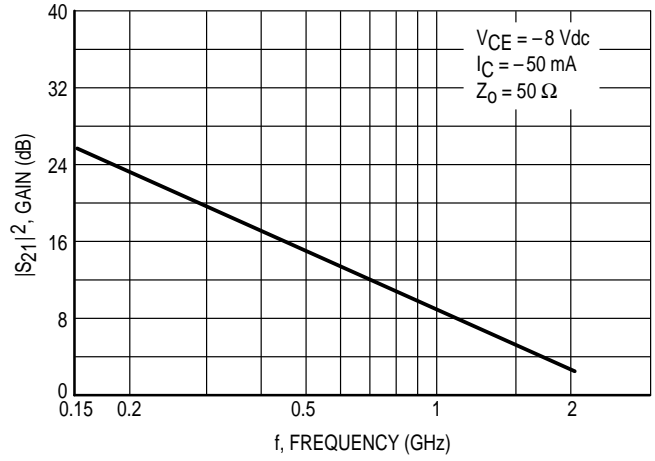


Figure 14. Insertion Gain versus Frequency

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	5	100	0.754	-67	11.453	141	0.040	59	0.818	-24	
		300	0.683	-132	6.106	105	0.065	39	0.549	-37	
		500	0.667	-157	3.954	89	0.071	39	0.472	-40	
		700	0.660	-171	2.890	78	0.078	44	0.452	-44	
		900	0.656	179	2.294	69	0.085	50	0.449	-49	
		1000	0.654	175	2.086	65	0.091	53	0.451	-52	
		1500	0.641	158	1.442	48	0.130	64	0.480	-66	
		2000	0.672	140	1.108	36	0.188	69	0.466	-79	
		2500	0.681	124	0.917	26	0.261	66	0.483	-94	
		3000	0.681	110	0.793	18	0.343	60	0.493	-110	
	3500	0.686	96	0.716	13	0.426	52	0.500	-126		
	4000	0.683	84	0.674	9	0.503	43	0.502	-143		
	4500	0.678	73	0.653	6	0.568	34	0.503	-160		
	5000	0.669	64	0.653	3	0.620	24	0.507	-176		
	10	10	100	0.632	-92	16.621	131	0.032	55	0.694	-33
			300	0.618	-149	7.460	98	0.050	47	0.417	-41
			500	0.618	-168	4.671	85	0.061	53	0.358	-44
			700	0.616	-178	3.392	76	0.076	58	0.346	-47
			900	0.615	173	2.672	68	0.092	62	0.347	-52
			1000	0.613	170	2.429	64	0.100	63	0.352	-55
			1500	0.601	155	1.677	48	0.150	66	0.382	-68
			2000	0.633	138	1.294	36	0.208	66	0.371	-80
			2500	0.642	124	1.078	25	0.273	62	0.391	-94
			3000	0.646	110	0.929	16	0.346	56	0.408	-109
	3500	0.656	98	0.827	10	0.422	49	0.421	-124		
	4000	0.662	86	0.756	4	0.494	41	0.431	-141		
	4500	0.664	75	0.709	1	0.554	32	0.442	-158		
	5000	0.664	66	0.683	-3	0.609	24	0.455	-174		
	50	50	100	0.547	-149	21.107	115	0.017	63	0.441	-43
			300	0.606	-174	7.891	90	0.037	68	0.260	-42
500			0.616	177	4.811	80	0.058	73	0.239	-44	
700			0.616	171	3.480	72	0.080	73	0.242	-48	
900			0.616	165	2.746	65	0.102	73	0.248	-54	
1000			0.615	163	2.479	61	0.113	72	0.255	-57	
1500			0.606	150	1.717	46	0.169	69	0.293	-71	
2000			0.643	135	1.327	33	0.229	65	0.289	-82	
2500			0.654	122	1.097	22	0.292	60	0.315	-96	
3000			0.662	108	0.940	13	0.359	54	0.337	-110	
3500	0.672	96	0.825	6	0.427	47	0.356	-126			
4000	0.680	84	0.743	1	0.493	39	0.373	-142			
4500	0.682	74	0.688	-2	0.551	31	0.391	-159			
5000	0.679	64	0.658	-5	0.601	22	0.409	-175			
10	5	100	0.792	-59	11.498	144	0.036	62	0.848	-21	
		300	0.681	-123	6.513	108	0.061	41	0.598	-32	
		500	0.652	-150	4.278	91	0.068	40	0.518	-36	
		700	0.639	-166	3.142	80	0.073	44	0.496	-39	
		900	0.631	-177	2.491	71	0.081	49	0.489	-44	
		1000	0.628	179	2.264	67	0.086	53	0.492	-46	
		1500	0.616	161	1.560	50	0.120	64	0.514	-58	
		2000	0.644	142	1.199	37	0.171	69	0.500	-70	
		2500	0.654	126	0.985	26	0.238	68	0.516	-83	
		3000	0.661	111	0.843	18	0.314	63	0.523	-98	
3500	0.670	98	0.749	12	0.399	56	0.529	-113			
4000	0.672	85	0.690	8	0.479	47	0.528	-129			
4500	0.671	73	0.656	5	0.549	38	0.524	-146			
5000	0.665	63	0.649	3	0.609	28	0.523	-162			
10	10	100	0.666	-80	17.255	135	0.030	58	0.738	-28	
		300	0.596	-141	8.143	101	0.047	48	0.465	-37	
		500	0.587	-162	5.139	87	0.059	53	0.404	-38	
		700	0.581	-174	3.741	78	0.072	58	0.388	-41	
		900	0.578	177	2.947	70	0.086	61	0.387	-45	
		1000	0.577	174	2.670	66	0.095	63	0.389	-48	
		1500	0.565	158	1.856	50	0.139	66	0.413	-60	
		2000	0.596	140	1.431	38	0.191	66	0.402	-70	
		2500	0.608	126	1.177	26	0.253	64	0.420	-82	
		3000	0.619	112	1.008	17	0.319	59	0.434	-96	
3500	0.632	99	0.886	9	0.393	52	0.444	-110			
4000	0.644	87	0.797	3	0.465	44	0.453	-126			
4500	0.652	75	0.732	-1	0.532	36	0.457	-143			
5000	0.654	65	0.694	-4	0.589	28	0.465	-159			

Table 1. MMBR521LT1 Common Emitter S-Parameters

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	0.82	-114	7.9	118	0.07	35	0.59	-46
		500	0.81	-158	4.0	88	0.08	21	0.40	-54
		1000	0.79	175	2.0	67	0.08	21	0.37	-68
		1500	0.76	158	1.3	50	0.07	30	0.43	-82
		2000	0.74	143	1.0	38	0.08	47	0.47	-95
	-10	200	0.78	-137	10.6	109	0.05	32	0.43	-63
		500	0.79	-168	4.9	84	0.06	28	0.26	-75
		1000	0.77	169	2.5	66	0.06	39	0.24	-87
		1500	0.74	155	1.6	50	0.08	49	0.29	-97
		2000	0.71	140	1.2	39	0.10	55	0.32	-106
	-50	200	0.77	-167	13.1	99	0.02	45	0.26	-108
		500	0.77	176	5.7	80	0.04	57	0.18	-132
		1000	0.76	161	2.8	65	0.06	65	0.17	-142
		1500	0.73	149	1.9	51	0.08	67	0.19	-137
		2000	0.70	136	1.4	40	0.12	65	0.20	-137
-8.0	-5.0	200	0.82	-109	8.1	119	0.07	36	0.62	-43
		500	0.80	-154	4.2	90	0.08	22	0.42	-52
		1000	0.78	175	2.2	67	0.08	22	0.38	-65
		1500	0.75	159	1.4	50	0.07	31	0.43	-78
		2000	0.72	143	1.0	37	0.09	43	0.46	-89
	-10	200	0.77	-132	11.2	110	0.05	33	0.45	-61
		500	0.77	-167	5.2	86	0.06	29	0.27	-70
		1000	0.76	169	2.6	67	0.06	39	0.25	-81
		1500	0.73	155	1.7	51	0.07	49	0.29	-90
		2000	0.70	140	1.3	39	0.10	54	0.31	-98
	-50	200	0.75	-164	14.2	100	0.02	43	0.26	-101
		500	0.76	178	6.1	82	0.04	55	0.17	-121
		1000	0.75	163	3.1	67	0.06	64	0.15	-131
		1500	0.72	151	2.0	53	0.08	67	0.18	-126
		2000	0.70	139	1.5	42	0.11	68	0.19	-127

Table 2. MRF5211LT1 Common Emitter S-Parameters

## 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 AE**

**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. 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 J**

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