MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MMBR521LT1*
MRF521
MRF5211LT1

*Motorola Preferred Device

The RF Line
PNP Silicon
High-Frequency Transistor

I_C = −70 mA
HIGH-FREQUENCY
TRANSISTOR
PNP SILICON

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 GHz (Typ) @ I_C = −35 mAdc (MMBR521LT1)
  f_T = 4.2 GHz (Typ) @ I_C = −50 mAdc (MRF521, MRF5211LT1)
- Low Noise Figure @ f = 1.0 GHz —
  $NF_{(matched)}$ = 2.5 dB (Typ) (MMBR521LT1)
  $NF_{(matched)}$ = 2.8 dB (Typ) (MRF521, MRF5211LT1)
- High Power Gain — $G_{pe\ (matched)}$ = 11 dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-23 (MMBR521LT1) & SOT-143 (MRF5211LT1) Offer Improved RF Performance
  Lower Package Parasitics
  Higher Gain

CASE 317-01, STYLE 1
MRF521

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

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)
MMBR521LT1

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°C, MMBR521LT1 Derate above T_C = 75°C MRF5211LT1	P_D	312 315	mW
Collector Current — Continuous	I_C	−70	mA
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Thermal Resistance, Junction to Case (1) MRF521 MMBR521LT1, MRF5211LT1	$R_{\theta JC}$	 200 240	°C/W
Thermal Resistance, Junction to Ambient MRF521 MMBR521LT1, MRF5211LT1	$R_{\theta JA}$	 355 395	°C/W

DEVICE MARKING

MMBR521L = 7M	MRF5211 = 04

NOTE:
1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package. For case temperatures above +75°C: $P_{DISP(max)} = (T_{Jmax} - T_C) / R_{\theta JC}$

Preferred devices are Motorola recommended choices for future use and best overall value

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)		$V_{(BR)CEO}$	−10	−12	—	Vdc
Collector-Base Breakdown Voltage (I_C = −0.1 mAdc, I_E = 0)		$V_{(BR)CBO}$	−20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −50 μAdc, I_C = 0)		$V_{(BR)EBO}$	−2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = −8.0 Vdc, I_E = 0)		I_{CBO}	—	—	−10	μAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = −30 mAdc, V_{CE} = −5.0 Vdc)		h_{FE}	25	—	125	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = −6.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	1.0	1.5	pF
Current Gain — Bandwidth Product		f_T				GHz
(V_{CE} = −8.0 V, I_C = −35 mA, f = 1.0 GHz)	MMBR521LT1		—	3.4	—	
(V_{CE} = −8.0 V, I_C = −50 mA, f = 1.0 GHz)	MRF5211LT1		—	4.2	—	
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure		G_{NFmin}				dB
(V_{CE} = −6.0 V, I_C = −5.0 mA, f = 500 MHz)	MMBR521LT1		13	15	—	
(V_{CE} = −6.0 V, I_C = −5.0 mA, f = 1.0 GHz)	MMBR521LT1		8.0	10	—	
(V_{CE} = −6.0 V, I_C = −5.0 mA, f = 1.0 GHz)	MRF5211LT1		10	11	—	
Noise Figure — Minimum		NF_{min}				dB
(V_{CE} = −6.0 V, I_C = −5.0 mA, f = 500 MHz)	MMBR521LT1		—	1.5	2.5	
(V_{CE} = −6.0 V, I_C = −5.0 mA, f = 1.0 GHz)	MMBR521LT1		—	2.5	3.5	
(V_{CE} = −6.0 V, I_C = −5.0 mA, f = 1.0 GHz)	MRF5211LT1		—	2.8	3.5	

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TYPICAL CHARACTERISTICS
MMBR521LT1, MRF521, MRF5211LT1

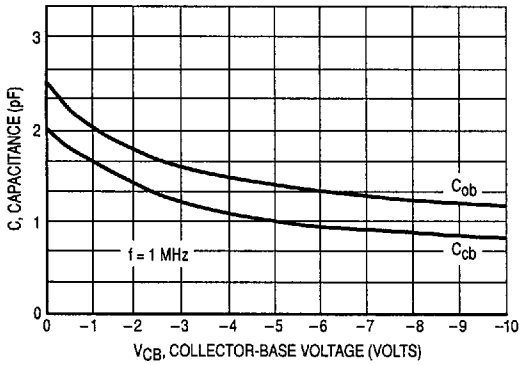

Figure 1. Junction Capacitance versus Voltage

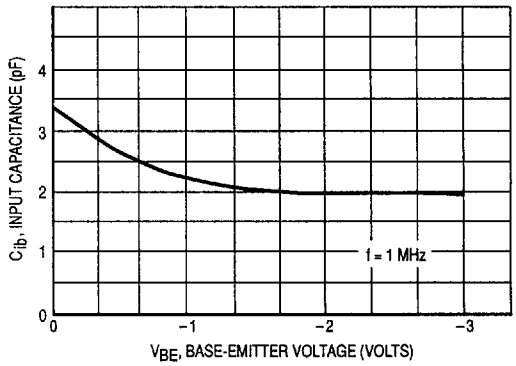

Figure 2. Input Capacitance versus Voltage

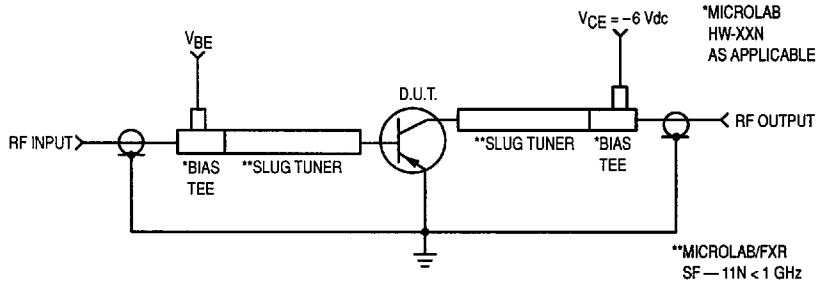

Figure 3. Functional Circuit Schematic

TYPICAL CHARACTERISTICS
MMBR521LT1

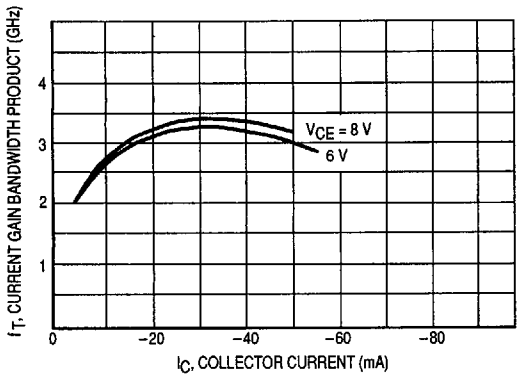

Figure 4. Current Gain Bandwidth Product versus Collector Current

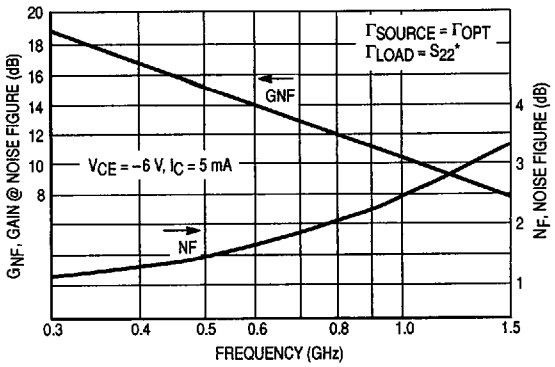

Figure 5. Noise Figure & Gain @ Noise Figure versus Frequency

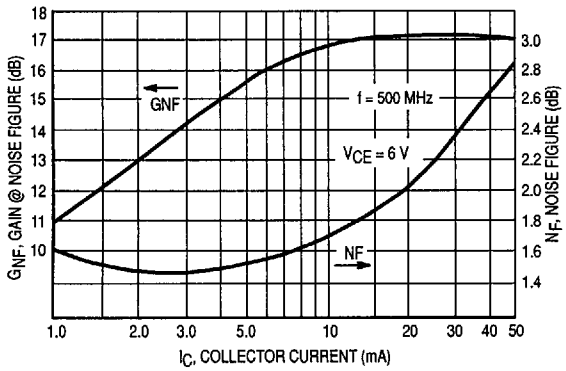

Figure 6. Noise Figure & Gain @ Noise Figure versus Collector Current

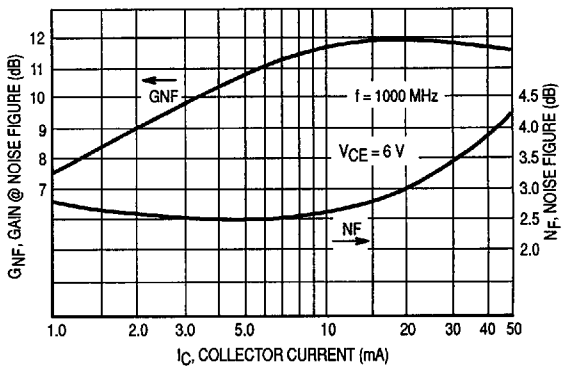

Figure 7. Noise Figure & Gain @ Noise Figure versus Collector Current

TYPICAL CHARACTERISTICS
MRF5211LT1

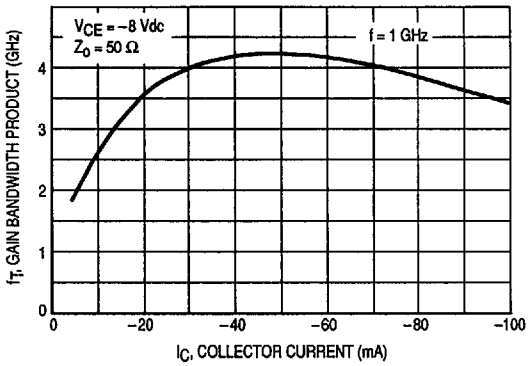

Figure 8. Gain-Bandwidth Product versus Current

GAIN AND NOISE FIGURE versus FREQUENCY

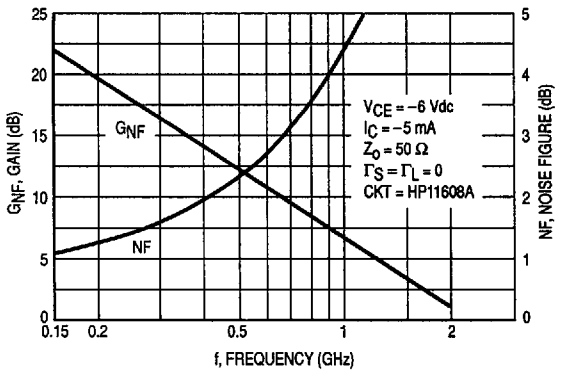

Figure 9. 50 Ohm System

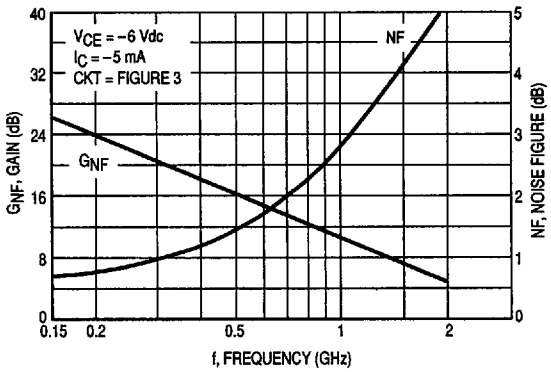

Figure 10. Tuned Circuit

GAIN AND NOISE FIGURE versus CURRENT

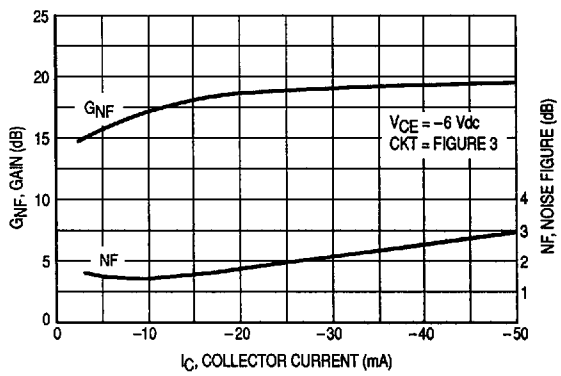

Figure 11. Tuned Circuit — Frequency 500 MHz

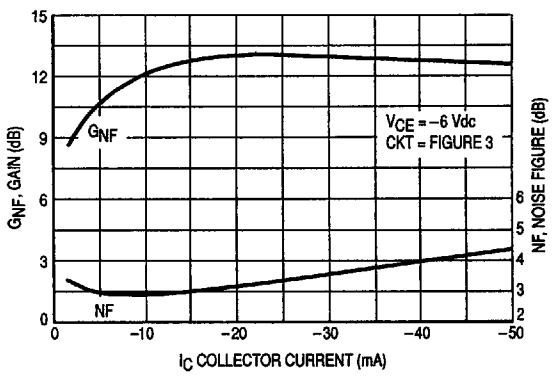

Figure 12. Tuned Circuit — Frequency 1.0 GHz

TYPICAL CHARACTERISTICS — continued
MRF5211LT1

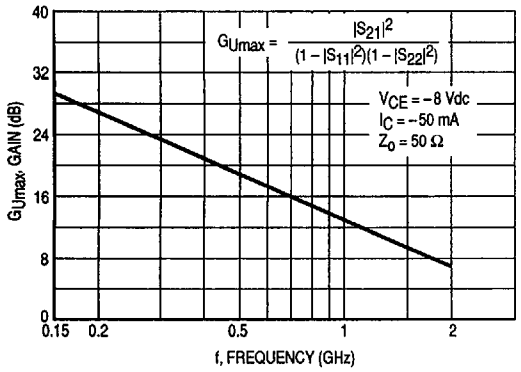

Figure 13. G_{Umax} versus Current

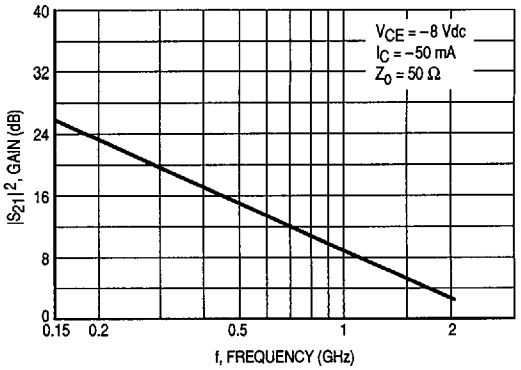

Figure 14. Insertion Gain versus Frequency

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V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
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	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	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_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
−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

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
−6.0	−5.0	200	0.75	−116	7.6	117	0.06	36	0.59	−42
		500	0.75	−164	3.9	86	0.07	28	0.42	−51
		1000	0.74	165	2.0	63	0.08	37	0.37	−64
		1500	0.75	144	1.3	45	0.09	53	0.39	−85
		2000	0.74	124	1.0	32	0.14	61	0.43	−101
	−10	200	0.71	−138	10.7	109	0.04	37	0.45	−54
		500	0.72	−175	4.7	82	0.06	40	0.29	−61
		1000	0.72	148	2.4	63	0.08	55	0.20	−73
		1500	0.72	140	1.6	47	0.11	63	0.28	−94
		2000	0.71	122	1.2	34	0.16	61	0.31	−108
	−50	200	0.71	−172	12.9	100	0.02	59	0.26	−77
		500	0.72	170	5.3	78	0.05	68	0.15	−88
		1000	0.72	152	2.7	62	0.09	71	0.13	−99
		1500	0.72	136	1.8	46	0.13	70	0.17	−116
		2000	0.71	118	1.4	63	0.18	63	0.20	−123
−8.0	−5.0	200	0.77	−107	8.3	119	0.06	40	0.64	−38
		500	0.74	−163	4.1	88	0.07	28	0.45	−46
		1000	0.74	167	2.2	64	0.07	39	0.40	−58
		1500	0.74	146	1.4	47	0.08	54	0.42	−79
		2000	0.73	126	1.1	33	0.13	62	0.45	−95
	−10	200	0.69	−133	11.5	111	0.04	39	0.49	−49
		500	0.71	−172	5.1	83	0.05	41	0.32	−55
		1000	0.71	161	2.6	64	0.07	56	0.28	−64
		1500	0.71	142	1.7	48	0.10	64	0.30	−85
		2000	0.70	123	1.3	34	0.15	63	0.33	−98
	−50	200	0.67	−171	13.2	99	0.02	59	0.25	−70
		500	0.70	171	5.8	81	0.04	67	0.17	−74
		1000	0.69	151	2.9	62	0.08	72	0.15	−82
		1500	0.70	136	2.0	38	0.12	70	0.17	−100
		2000	0.68	117	1.5	33	0.17	63	0.20	−109

Table 3. MRF521 Common Emitter S-Parameters