

**MOTOROLA**  
**SEMICONDUCTOR**  
**TECHNICAL DATA**

The RF Line  
**PNP Silicon**  
**High-Frequency Transistors**

... 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 —  $f_T = 4.2$  GHz (Typ) @  $I_C = -50$  mAdc
- Low Noise Figure (at  $f = 1$  GHz —  $NF_{(matched)} = 2.8$  dB (Typ)
- High Power Gain —  $G_{pe}$  (matched) = 11 dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance  
Lower Package Parasitics  
Higher Gain
- Tape and Reel Packaging Options

**MRF521**  
**MRFC521**  
**MRF522**  
**MRF524**  
**MRF5211L**

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$I_C = -50$  mA  
**HIGH FREQUENCY**  
**TRANSISTORS**  
**PNP SILICON**

MAXIMUM RATINGS	Symbol	MRFC521	MRF521	MRF522	MRF524	MRF5211L	Unit
		Chip	Macro-X Case 317-01 Style 2	Case 303-01 Style 1	Case 20-03 Style 10 (TO-72)	Case 318A-05 Style 1 (SOT-143) Low Profile	
Collector-Emitter Voltage	$V_{CEO}$	-10	-10	-10	-10	-10	Vdc
Collector-Base Voltage	$V_{CBO}$	-20	-20	-20	-20	-20	Vdc
Emitter-Base Voltage	$V_{EBO}$	-2.5	-2.5	-2.5	-2.5	-2.5	Vdc
Maximum Junction Temperature	$T_{Jmax}$	-200	150	200	200	150	°C
Collector Current — Continuous	$I_C$	-50	-70	-50	-50	-70	mA
Total Device Dissipation (at $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$ )	$P_D$	—	—	—	0.2 1.14	0.58 4.64	Watts mW/°C
Total Device Dissipation (at $T_C = 75^\circ\text{C}$ Derate above $75^\circ\text{C}$ (Note 1))	$P_D$	0.75 —	0.75 10	0.62 5	—	0.58 7.7	Watts mW/°C
Storage Temperature	$T_{stg}$	-65 to +200	-65 to +150	-65 to +200	-65 to +200	-65 to +150	°C

**THERMAL CHARACTERISTICS**

Characteristic	Symbol	MRFC521	MRF521	MRF522	MRF524	MRF5211L	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	—	—	—	870	216	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	—	100	200	—	130	°C/W

**DEVICE MARKING**

MRF5211 = 04

**ELECTRICAL CHARACTERISTICS**

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

Collector-Emitter Breakdown Voltage ( $I_C = -1$ 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 ( $I_E = -50$ $\mu$ Adc, $I_C = 0$ )	$V_{(BR)EBO}$	-2.5	—	—	Vdc
Collector Cutoff Current ( $V_{CB} = -8$ Vdc, $I_E = 0$ )	$I_{CBO}$	—	—	-10	$\mu$ Adc

1 Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package

(continued)



# MRF521 Series

MOTOROLA SC (XSTRS/R F) 46E D 6367254 0094728 T MOT6

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

Characteristic	Symbol	Min	Typ	Max	Unit	
<b>ON CHARACTERISTICS</b>						
DC Current Gain ( $I_C = -30\text{ mA}$ , $V_{CE} = -5\text{ Vdc}$ )	$h_{FE}$	25	—	125	—	
<b>DYNAMIC CHARACTERISTICS</b>						
Collector-Base Capacitance ( $V_{CB} = -6\text{ Vdc}$ , $I_E = 0$ , $f = 1\text{ MHz}$ )	Figure 1 $C_{cb}$	—	1	1.5	$\mu\text{F}$	
Current Gain — Bandwidth Product ( $V_{CE} = -8\text{ Vdc}$ , $I_C = -50\text{ mA}$ , $f = 1\text{ GHz}$ )	Figure 7 $f_T$	—	4.2	—	GHz	
<b>FUNCTIONAL TESTS</b>						
Power Gain at Minimum Noise Figure ( $V_{CE} = -6\text{ V}$ , $I_C = -5\text{ mA}$ , $f = 500\text{ MHz}$ ) ( $V_{CE} = -6\text{ V}$ , $I_C = -5\text{ mA}$ , $f = 1\text{ GHz}$ )	Figure 6 MRF524 MRF521/522/5211L	$G_{NFmin}$	9 10	— 11	— —	dB
Noise Figure — Minimum ( $V_{CE} = -6\text{ V}$ , $I_C = -5\text{ mA}$ , $f = 500\text{ MHz}$ ) ( $V_{CE} = -6\text{ V}$ , $I_C = -5\text{ mA}$ , $f = 1\text{ GHz}$ )	Figure 6 MRF524 MRF521/522/5211L	$NF_{min}$	— —	— 2.8	2.5 3.5	dB

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## TYPICAL CHARACTERISTICS

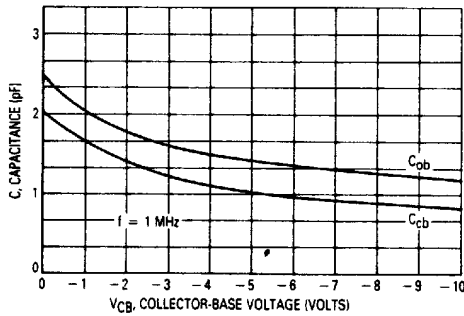


Figure 1. Junction Capacitance versus Voltage

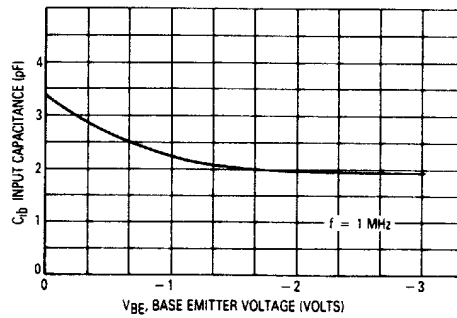


Figure 2. Input Capacitance versus Voltage

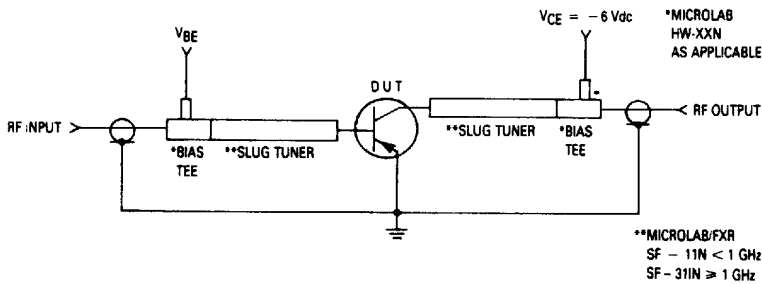


Figure 3. Functional Circuit Schematic

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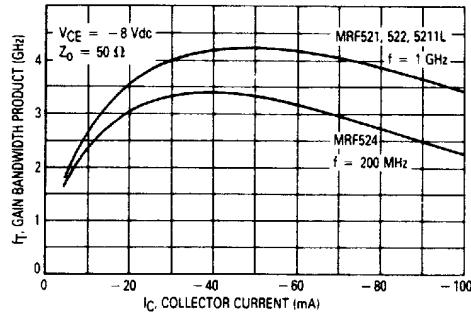


Figure 4. Gain-Bandwidth Product versus Current

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GAIN AND NOISE FIGURE VERSUS FREQUENCY

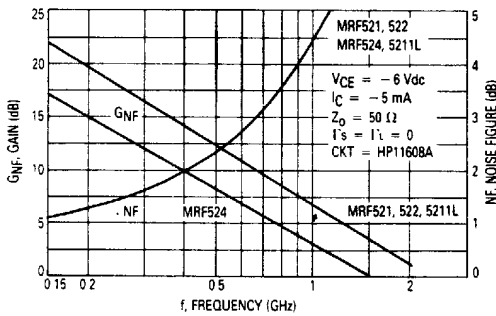


Figure 5. 50 Ohm System

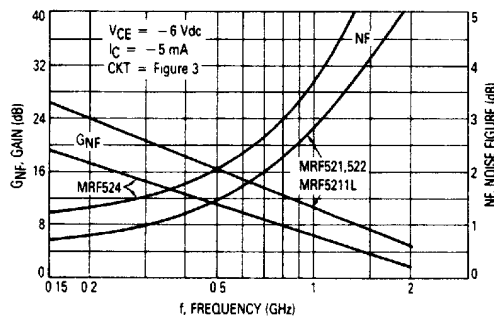


Figure 6. Tuned Circuit

GAIN AND NOISE FIGURE VERSUS CURRENT

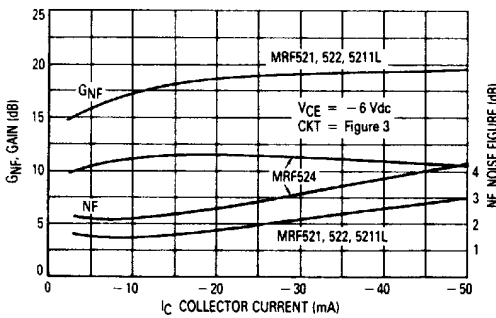


Figure 7. Tuned Circuit — Frequency 500 MHz

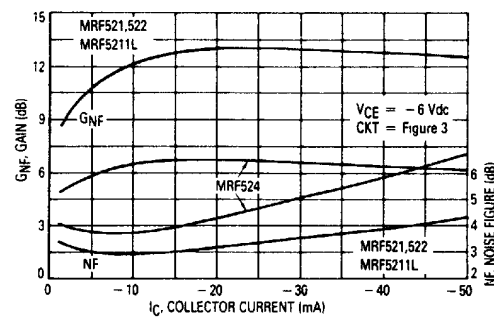


Figure 8. Tuned Circuit — Frequency 1 GHz

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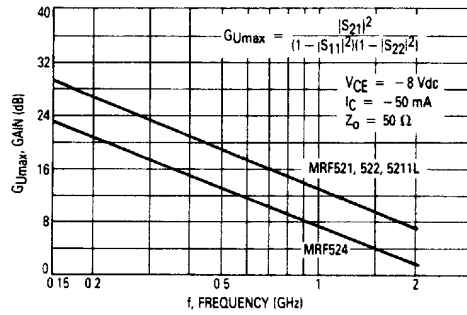


Figure 9. GUmmax versus Current

MRF521 COMMON EMITTER S-PARAMETERS

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠φ
-6	-5	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	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	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	-5	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	38	0.12	70	0.17	-100
		2000	0.68	117	1.5	33	0.17	63	0.20	-109

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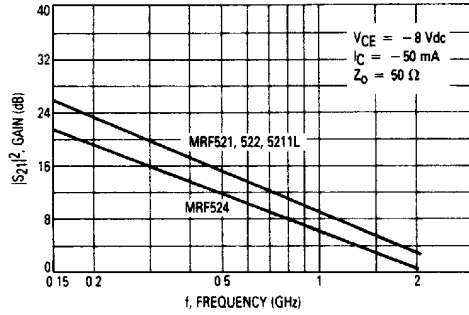


Figure 10. Insertion Gain versus Frequency

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**MRF522 COMMON EMITTER S-PARAMETERS**

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠φ
-6	-5	200	0.77	-113	7.5	120	0.06	34	0.60	-40
		500	0.80	-157	3.9	90	0.07	18	0.42	-51
		1000	0.83	-177	2	70	0.07	14	0.36	-63
		1500	0.84	-164	1.3	52	0.06	17	0.37	-88
		2000	0.88	-153	1	39	0.06	27	0.41	-106
	-10	200	0.77	-138	10.4	112	0.04	32	0.47	-56
		500	0.82	-168	4.9	88	0.05	25	0.28	-65
		1000	0.85	-173	2.5	71	0.05	31	0.23	-77
		1500	0.86	-163	1.7	56	0.06	39	0.26	-100
		2000	0.88	-153	1.3	45	0.07	47	0.30	-112
	-50	200	0.81	-169	13.2	104	0.02	43	0.30	-88
		500	0.84	-177	5.8	85	0.03	53	0.17	-112
		1000	0.87	-166	3	71	0.04	63	0.13	-130
		1500	0.87	-158	2	57	0.06	65	0.19	-138
		2000	0.90	-149	1.5	47	0.08	66	0.21	-142
-8	-5	200	0.80	-109	8	121	0.06	36	0.64	-39
		500	0.81	-153	4.1	92	0.07	20	0.43	-46
		1000	0.83	-179	2.1	72	0.07	15	0.38	-58
		1500	0.85	-168	1.4	55	0.06	18	0.39	-80
		2000	0.87	-157	1.1	43	0.06	28	0.42	-95
	-10	200	0.76	-133	11.1	113	0.04	33	0.49	-52
		500	0.80	-167	5.3	89	0.05	25	0.28	-60
		1000	0.83	-174	2.7	71	0.05	31	0.23	-69
		1500	0.85	-163	1.8	57	0.06	38	0.27	-91
		2000	0.87	-153	1.4	46	0.07	46	0.30	-105
	-50	200	0.76	-160	14.4	105	0.02	44	0.30	-86
		500	0.80	-178	6.4	85	0.03	52	0.16	-110
		1000	0.84	-164	3.2	70	0.04	62	0.16	-125
		1500	0.85	-154	2.1	55	0.06	64	0.16	-140
		2000	0.88	-145	1.7	45	0.08	62	0.19	-141

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**MRF524 COMMON EMITTER S-PARAMETERS**

VCE (Vdc)	Ic (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠φ
-6	-5	200	0.42	-98	5.8	109	0.07	57	0.65	-26
		400	0.29	-143	3.5	84	0.10	58	0.54	-29
		600	0.27	-175	2.5	71	0.13	60	0.50	-33
		800	0.27	166	2	60	0.17	61	0.47	-42
		1000	0.25	147	1.7	49	0.21	61	0.47	-49
	-10	200	0.28	-111	7.3	100	0.06	64	0.54	-28
		400	0.21	-152	4.1	81	0.10	64	0.46	-28
		600	0.20	-179	2.9	69	0.14	63	0.41	-32
		800	0.20	167	2.3	59	0.19	61	0.39	-41
		1000	0.18	149	1.9	49	0.22	58	0.41	-47
	-50	200	0.15	-136	8.1	92	0.06	73	0.42	-26
		400	0.13	-172	4.4	77	0.12	70	0.36	-25
		600	0.15	166	3.1	66	0.17	65	0.33	-28
		800	0.15	159	2.4	56	0.21	60	0.32	-38
		1000	0.13	143	2	47	0.25	55	0.32	-45
-8	-5	200	0.45	-93	6.1	109	0.06	57	0.67	-25
		400	0.30	-137	3.7	86	0.09	58	0.57	-27
		600	0.27	-167	2.6	72	0.12	60	0.51	-32
		800	0.26	174	2.1	61	0.15	60	0.49	-40
		1000	0.23	155	1.8	51	0.19	60	0.50	-47
	-10	200	0.28	-100	7.5	101	0.06	65	0.57	-25
		400	0.18	-139	4.3	82	0.10	65	0.49	-26
		600	0.17	-171	3	70	0.13	64	0.45	-30
		800	0.16	174	2.3	60	0.18	61	0.43	-39
		1000	0.13	153	2	50	0.21	58	0.44	-45
	-50	200	0.14	-107	8.3	94	0.06	72	0.47	-23
		400	0.10	-155	4.6	78	0.11	70	0.42	-23
		600	0.10	172	3.2	67	0.16	66	0.39	-26
		800	0.10	163	2.5	57	0.20	61	0.37	-36
		1000	0.09	144	2	47	0.24	57	0.37	-42

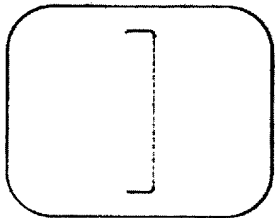
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**MRF5211L COMMON EMITTER S-PARAMETERS**

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	∠φ	S21	∠φ	S12	∠φ	S22	∠φ
-6	-5	200	0.82	-114	7.9	118	0.07	35	0.59	-46
		500	0.81	-158	4	88	0.08	21	0.40	-54
		1000	0.79	175	2	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	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	-5	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	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	53	0.08	67	0.18	-126
		2000	0.70	139	1.5	42	0.11	68	0.19	-127

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**CHIP TOPOGRAPHY**



Nominal Chip Size: 0.015" x 0.016" x 0.005"  
 Front Metallization: Gold  
 Back Metallization: Gold  
 Emitter Base Bond Pad: 2.2 x 2.2 mil  
 #Emitter Fingers: 22  
 #Base Fingers: 23  
 Emitter Diffusion: Ion-Implanted Arsenic