MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF521
MRFC521
MRF522
MRF524
MRF5211,L

HIGH FREQUENCY
TRANSISTORS
PNP SILICON

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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 @ 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
- Available In Both Standard Profile (MRF5211) and Low Profile (MRF5211L)
- Tape and Reel Packaging Options

MAXIMUM RATINGS (Note 1)		MRFC521 Chip	MRF521 Macro-X Case 317-01 Style 2	MRF522 Case 303-01 Style 1	MRF524 Case 20-03 Style 10 (TO-72)	MRF5211,L Case 318B-03 Style 1 (SOT-143)	
Ratings	**Symbol**	**Values**					**Unit**
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 @ T_A = 25°C Derate above 25°C	P_D	— —	— —	— —	0.2 1.14	0.58 4.64	Watts mW/°C
Total Device Dissipation @ T_C = 75°C Derate above 75°C (Note 2)	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							
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
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 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 8 Vdc, I_E = 0)	I_{CBO}	—	—	10	μAdc

Notes 1. Voltages and currents for PNP transistors are given for magnitude information only. Polarity is assumed to be opposite that of an NPN transistor.
2. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

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

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TYPICAL CHARACTERISTICS

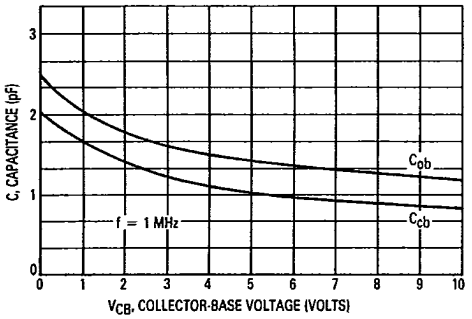

Figure 1. Junction Capacitance versus Voltage

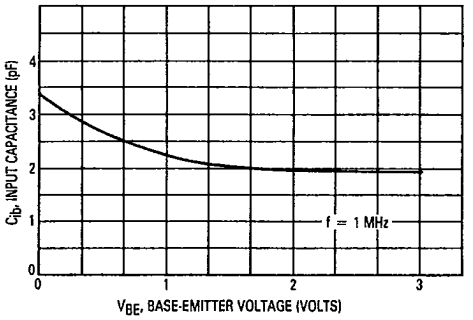

Figure 2. Input Capacitance versus Voltage

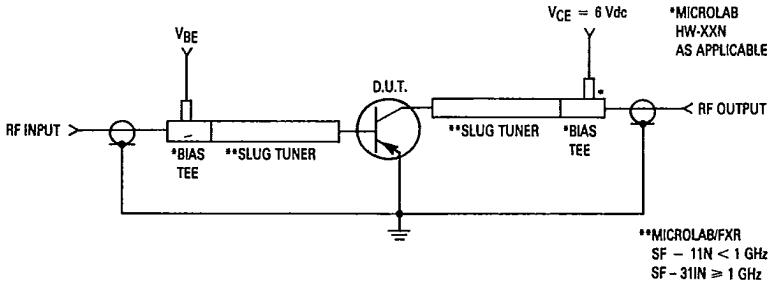

Figure 3. Functional Circuit Schematic

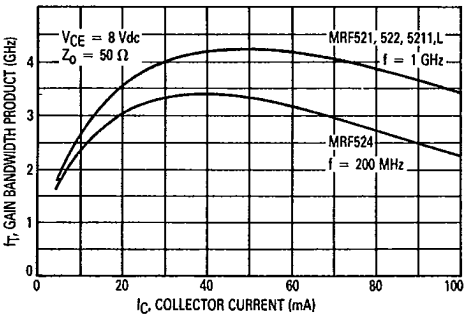

Figure 4. Gain-Bandwidth Product versus Current

GAIN AND NOISE FIGURE VERSUS FREQUENCY

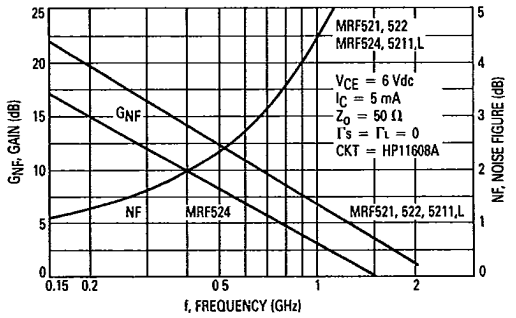

Figure 5. 50 Ohm System

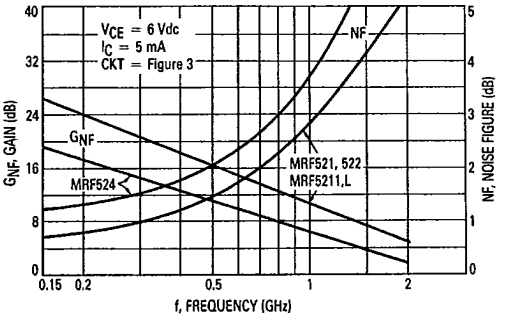

Figure 6. Tuned Circuit

GAIN AND NOISE FIGURE VERSUS CURRENT

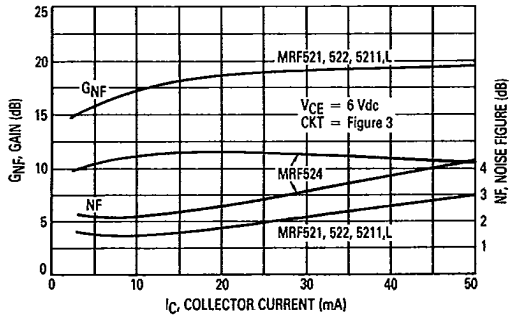

Figure 7. Tuned Circuit — Frequency 500 MHz

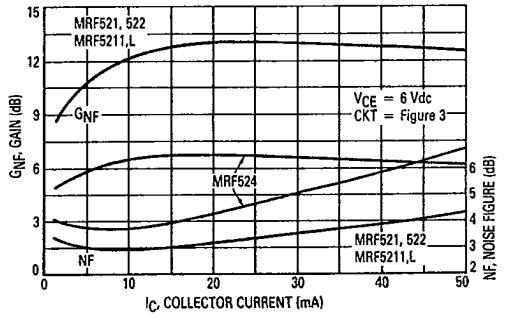

Figure 8. Tuned Circuit — Frequency 1 GHz

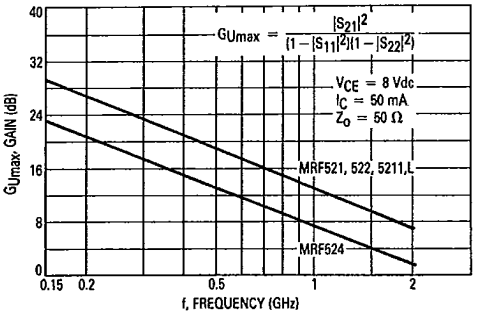

Figure 9. G_{Umax} versus Current

MRF521 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	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

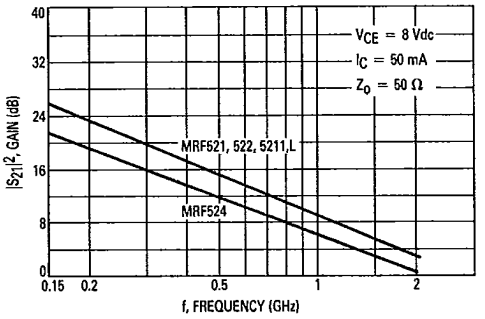

Figure 10. Insertion Gain versus Frequency

MRF522 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	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

MRF524 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	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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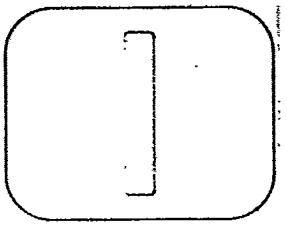
MRF5211,L COMMON EMITTER S-PARAMETERS

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	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

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