The RF Line

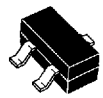
NPN Silicon High-Frequency Transistor

MMBR901LT1, T3
MPS901 MRF901
MRF9011LT1

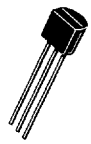
Designed primarily for use in high–gain, low–noise small–signal amplifiers for operation up to 2.5 GHz. Also usable in applications requiring fast switching times.

- High Current–Gain — Bandwidth Product
- Low Noise Figure @ f = 1.0 GHz —
  $NF_{(matched)}$ = 1.8 dB (Typ) (MRF9011LT1)
  = 1.9 dB (Typ) (MMBR901LT1, T3)
- High Power Gain —
  $G_{pe(matched)}$ = 13.5 dB (Typ) @ f = 1.0 GHz (MRF9011LT1)
  = 12.0 dB (Typ) @ f = 1.0 GHz (MMBR901LT1, T3)
- Guaranteed RF Parameters (MRF9011LT1)
- Surface Mounted SOT–23 & SOT–143 Offer Improved RF Performance
  Lower Package Parasitics
  High Gain
- Available in tape and reel packaging options:
  T1 suffix = 3,000 units per reel
  T3 suffix = 10,000 units per reel

I_C = 30 mA
SURFACE MOUNTED
HIGH–FREQUENCY
TRANSISTOR
NPN SILICON

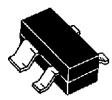


CASE 318–08, STYLE 6
SOT–23
LOW PROFILE, MMBR901LT1, T3



CASE 29–04, STYLE 2
TO–226AA (TO–92)
MPS901

CASE 317–01, STYLE 2
MRF901



CASE 318A–05, STYLE 1
SOT–143
LOW PROFILE, MRF9011LT1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	15	Vdc
Collector–Base Voltage	V_{CBO}	25	Vdc
Emitter–Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	30	mAdc
Power Dissipation @ T_C = 75°C (1) MMBR901LT1, T3; MRF9011LT1	$P_{D(max)}$	0.300	Watt
Derate above 25°C		4.00	mW/°C
Total Device Dissipation @ T_C = 75°C (1) MPS901	P_D	300	mW
Derate above 75°C		4.0	mW/°C
Total Device Dissipation @ T_C = 75°C (1) MRF901	P_D	0.375	Watt
Derate above 75°C		5.0	mW/°C
Storage Temperature Range All	T_{stg}	−55 to +150	°C
Maximum Junction Temperature	$T_{J(max)}$	150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Storage Temperature	T_{stg}	150	°C
Thermal Resistance, Junction to Case MRF901	$R_{\theta JC}$	200	°C/W
MRF9011LT1, MMBR901LT1, T3		250	

DEVICE MARKING

MRF9011LT1 = 01	MMBR901LT1, T3 = 7A

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

REV 7

ELECTRICAL CHARACTERISTICS (T_A = 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)		$V_{(BR)CEO}$	15	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)		$V_{(BR)CBO}$	25	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)		$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc)	MMBR901LT1, T3 MRF9011LT1, MPS901, MRF901	h_{FE}	50 30	— 80	200 200	—
DYNAMIC CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	MRF9011LT1 MPS901, MRF901	f_T	— —	3.8 4.5	— —	GHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	MRF9011LT1 MPS901 MRF901	C_{cb}	— — —	0.55 0.50 0.40	1.0 1.0 1.0	pF
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	MRF9011LT1	G_{NFmin}	—	13.5	—	dB
Minimum Noise Figure (Figure 3) (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	MRF9011LT1	NF_{min}	—	1.8	—	dB
Insertion Gain in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	MRF9011LT1	$\|S_{21}\|^2$	9.0	10.2	—	dB
Minimum Noise Figure (Figure 3) (V_{CE} = 6.0 Vdc, I_C = 5.0 mA, f = 1.0 GHz) (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	MMBR901LT1, T3	NF_{min}	—	1.9	—	dB
Minimum Noise Figure (Figure 3) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 900 MHz)	MPS901	NF_{min}	—	2.4	—	dB
Minimum Noise Figure (Figure 3) (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 GHz)	MRF901	NF_{min}	—	2.0	2.5	dB
SMALL–SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = 10 Vdc, I_C = 5.0 mAdc, f = 1.0 GHz)	MMBR901LT1	C_{obo}	—	—	1.0	pF
Common–Emitter Amplifier Gain (V_{CC} = 6.0 Vdc, I_C = 5.0 mAdc, f = 1.0 GHz)	MMBR901LT1	G_{pe}	—	12	—	dB

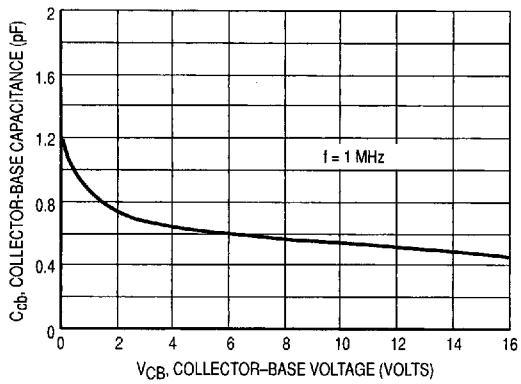


Figure 1. Collector–Base Capacitance versus Collector–Base Voltage

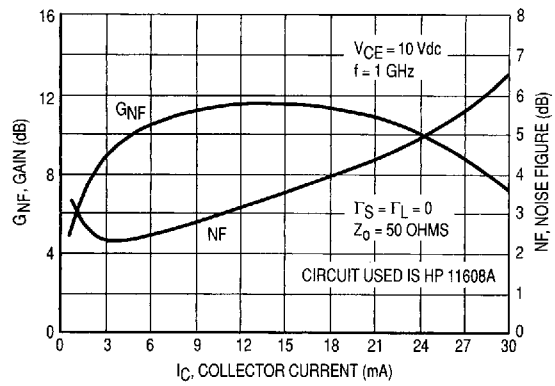


Figure 2. Gain and Noise Figure versus Collector Current

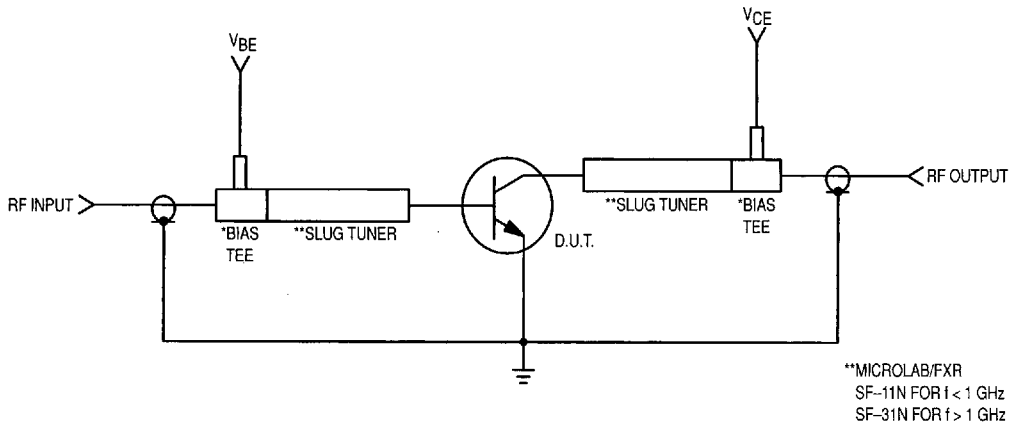


Figure 3. MRF9011LT1 Functional Circuit Schematic

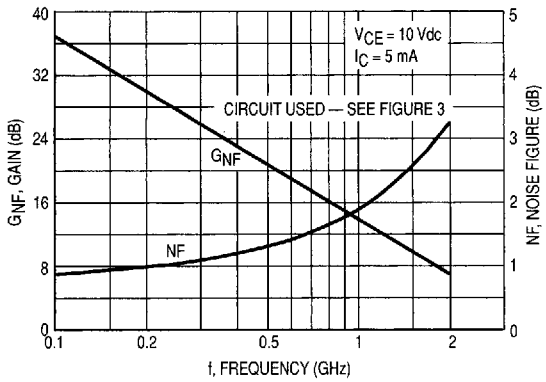


Figure 4. Gain and Noise Figure versus Frequency

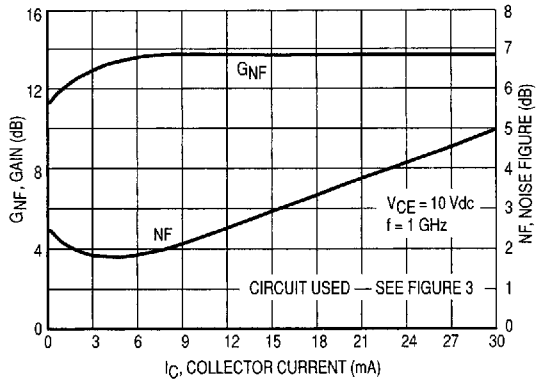


Figure 5. Gain and Noise Figure versus Collector Current

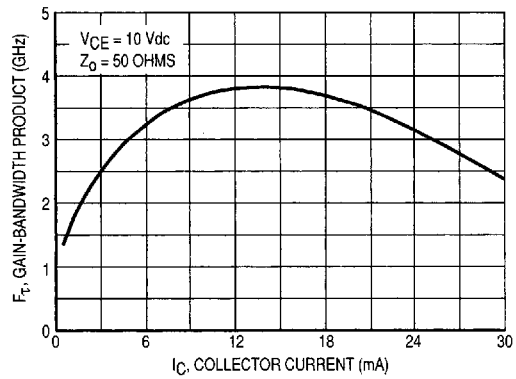


Figure 6. Gain–Bandwidth Product versus Collector Current

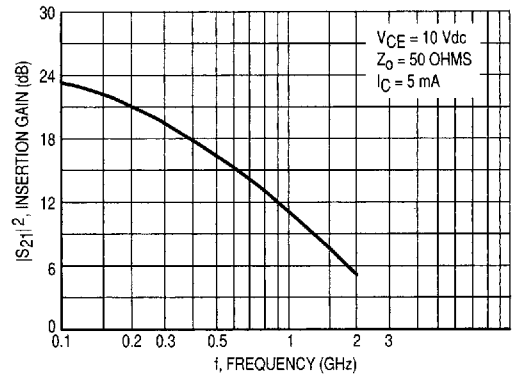


Figure 7. Insertion Gain versus Frequency

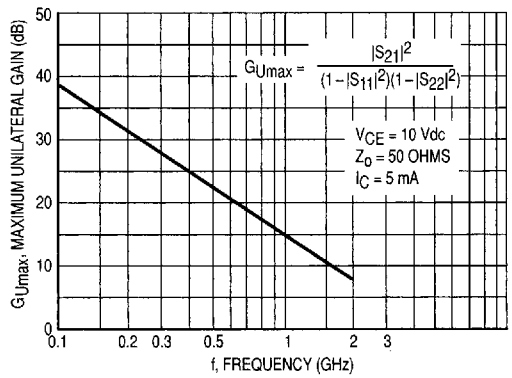


Figure 8. Maximum Unilateral Gain versus Frequency

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	5.0	100	0.85	−41	13.64	153	0.03	65	0.93	−17
		200	0.78	−76	10.77	134	0.05	54	0.80	−29
		500	0.71	−131	6.10	102	0.08	35	0.55	−42
		1000	0.66	−169	3.22	77	0.08	33	0.45	−48
		2000	0.60	152	1.65	47	0.11	46	0.47	−63
	10	100	0.72	−59	20.01	145	0.03	62	0.87	−23
		200	0.70	−100	14.31	123	0.04	49	0.67	−36
		500	0.66	−150	7.03	94	0.06	38	0.44	−43
		1000	0.63	179	3.57	73	0.07	45	0.37	−46
		2000	0.58	147	1.79	46	0.11	57	0.41	−60
	15	100	0.65	−75	23.44	138	0.02	57	0.81	−27
		200	0.66	−118	15.56	116	0.04	46	0.59	−38
		500	0.65	−159	7.10	90	0.05	42	0.40	−40
		1000	0.63	174	3.57	71	0.06	52	0.35	−43
		2000	0.59	144	1.77	45	0.11	62	0.40	−58
	20	100	0.61	−89	24.32	133	0.02	51	0.77	−28
		200	0.66	−130	15.11	111	0.03	43	0.55	−35
		500	0.66	−166	6.68	88	0.04	46	0.41	−34
		1000	0.65	171	3.32	69	0.06	56	0.39	−39
		2000	0.61	143	1.65	43	0.10	65	0.44	−56
	30	100	0.63	−132	13.18	118	0.02	47	0.72	−15
		200	0.68	−157	7.07	104	0.02	44	0.66	−16
		500	0.69	−177	3.23	90	0.03	55	0.62	−24
		1000	0.70	165	1.78	71	0.05	65	0.59	−38
		2000	0.66	138	0.93	42	0.09	79	0.62	−62
10	5.0	100	0.85	−38	13.67	155	0.03	70	0.93	−14
		200	0.80	−71	10.97	136	0.05	56	0.83	−24
		500	0.70	−126	6.35	104	0.07	37	0.60	−35
		1000	0.65	−166	3.39	78	0.07	36	0.51	−40
		2000	0.58	154	1.74	48	0.10	50	0.54	−55
	10	100	0.75	−55	20.12	147	0.02	66	0.88	−19
		200	0.71	−94	14.60	125	0.04	50	0.72	−30
		500	0.65	−145	7.33	96	0.05	39	0.50	−35
		1000	0.62	−177	3.74	74	0.06	46	0.45	−38
		2000	0.57	149	1.88	47	0.10	60	0.49	−53
	15	100	0.68	−68	23.53	140	0.02	61	0.85	−22
		200	0.67	−110	15.90	119	0.03	49	0.65	−31
		500	0.64	−155	7.45	92	0.04	42	0.47	−32
		1000	0.62	177	3.74	71	0.06	53	0.44	−35
		2000	0.58	146	1.90	45	0.09	65	0.50	−51
	20	100	0.64	−79	24.77	135	0.02	56	0.81	−23
		200	0.64	−122	15.81	114	0.03	46	0.62	−29
		500	0.64	−161	7.10	89	0.04	46	0.48	−28
		1000	0.62	174	3.53	79	0.05	56	0.46	−33
		2000	0.59	145	1.75	44	0.09	68	0.53	−50
	30	100	0.61	−114	16.25	123	0.01	48	0.79	−15
		200	0.63	−147	9.10	107	0.02	49	0.71	−15
		500	0.65	−172	4.22	90	0.03	53	0.66	−22
		1000	0.66	168	2.27	71	0.05	63	0.63	−33
		2000	0.63	140	1.15	41	0.08	79	0.67	−53

Table 1. MRF9011LT1 Common Emitter S–Parameters

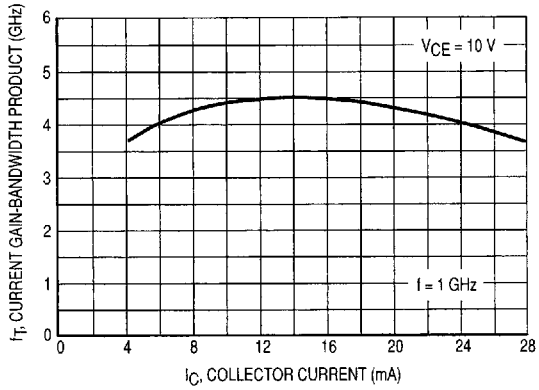


Figure 9. Current Gain–Bandwidth Product versus Collector Current

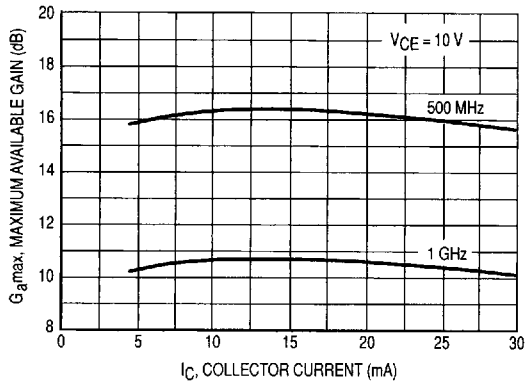


Figure 10. Maximum Available Gain versus Collector Current

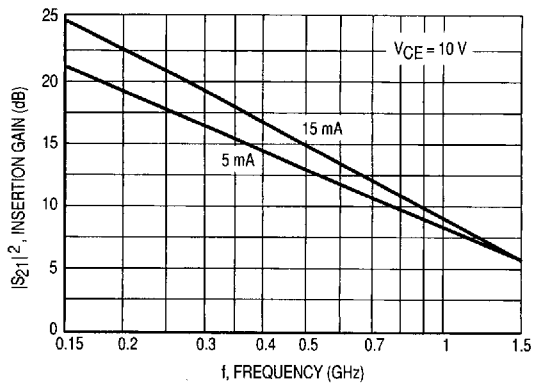


Figure 11. $|S_{21}|^2$ versus Frequency

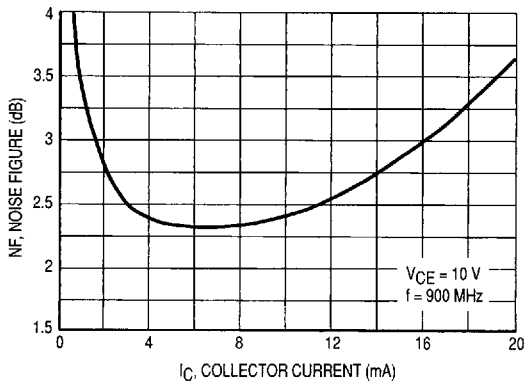


Figure 12. Noise Figure versus Collector Current

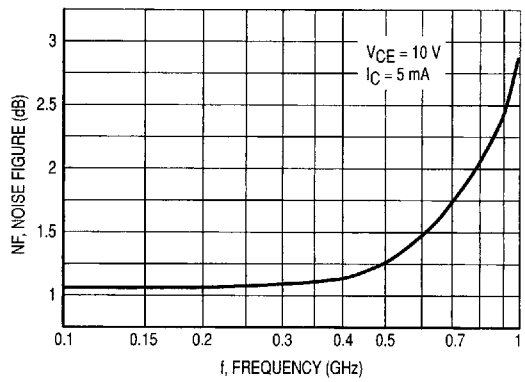


Figure 13. Noise Figure versus Frequency

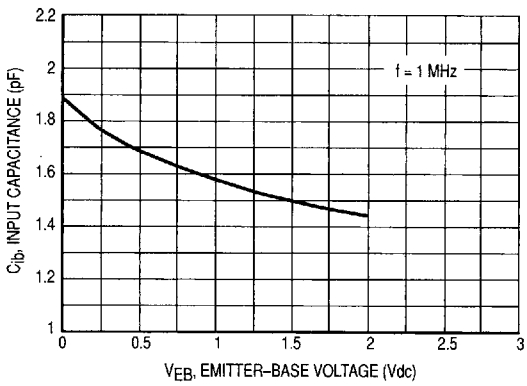


Figure 14. Input Capacitance versus Emitter–Base Voltage

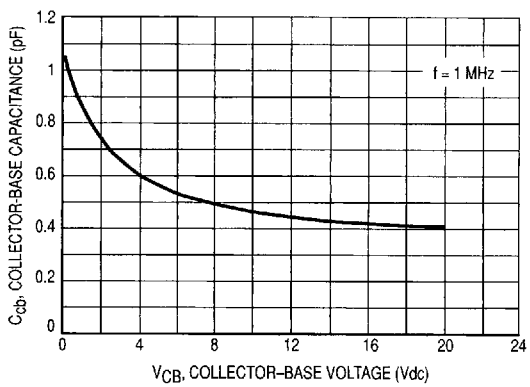


Figure 15. Collector–Base Capacitance versus Collector–Base Voltage

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	5.0	100	0.76	−35	9.42	142	0.03	67	0.85	−18
		200	0.60	−63	7.98	122	0.05	58	0.70	−26
		500	0.28	−127	4.79	84	0.09	55	0.53	−35
		1000	0.27	148	2.71	50	0.15	51	0.42	−51
		1500	0.43	113	2.02	23	0.21	42	0.28	−79
	10	100	0.57	−51	14.80	131	0.03	65	0.75	−22
		200	0.36	−87	10.80	108	0.04	62	0.60	−26
		500	0.18	−151	5.23	77	0.08	62	0.48	−31
		1000	0.25	136	2.86	47	0.15	55	0.39	−48
		1500	0.42	109	2.12	22	0.22	42	0.25	−75
	15	100	0.42	−67	17.80	123	0.02	66	0.69	−22
		200	0.26	−105	11.50	101	0.04	66	0.56	−23
		500	0.17	−169	5.27	74	0.08	66	0.47	−28
		1000	0.26	131	2.86	46	0.15	57	0.39	−47
		1500	0.43	108	2.12	21	0.22	44	0.25	−73
	20	100	0.33	−82	18.66	117	0.02	67	0.66	−21
		200	0.22	−120	11.54	98	0.03	68	0.55	−21
		500	0.17	−171	5.16	72	0.08	67	0.48	−27
		1000	0.28	129	2.80	45	0.15	58	0.40	−45
		1500	0.45	107	2.07	19	0.22	45	0.27	−71
	25	100	0.28	−103	18.11	113	0.02	68	0.64	−20
		200	0.22	−138	11.03	95	0.03	70	0.55	−19
		500	0.20	169	4.94	71	0.08	68	0.50	−25
		1000	0.32	128	2.68	43	0.15	60	0.42	−44
		1500	0.49	106	1.98	17	0.22	47	0.30	−71
	30	100	0.31	−127	16.10	109	0.02	67	0.64	−16
		200	0.28	−156	9.69	93	0.03	70	0.57	−16
		500	0.28	160	4.32	69	0.07	70	0.53	−25
		1000	0.39	125	2.37	41	0.14	63	0.46	−44
		1500	0.55	104	1.73	15	0.21	51	0.34	−72

Table 2. MPS901 Common Emitter S–Parameters, V_{CE} = 5.0 V

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
10	5.0	100	0.79	−33	9.36	144	0.03	68	0.88	−15
		200	0.63	−58	7.97	124	0.04	58	0.74	−22
		500	0.28	−117	4.87	86	0.07	57	0.60	−31
		1000	0.23	153	2.80	53	0.13	56	0.50	−46
		1500	0.38	116	2.09	26	0.19	48	0.38	−69
	10	100	0.60	−48	14.87	132	0.02	66	0.79	−18
		200	0.39	−79	11.06	110	0.03	63	0.65	−21
		500	0.16	−135	5.38	79	0.07	64	0.56	−28
		1000	0.20	138	2.97	50	0.13	59	0.47	−44
		1500	0.37	111	2.21	25	0.20	49	0.36	−66
	15	100	0.46	−61	18.20	124	0.02	66	0.74	−18
		200	0.28	−94	11.94	102	0.03	66	0.62	−19
		500	0.14	−154	5.45	76	0.07	67	0.55	−26
		1000	0.22	131	2.97	48	0.13	61	0.48	−42
		1500	0.38	109	2.21	24	0.20	50	0.36	−64
	20	100	0.37	−72	19.38	119	0.02	67	0.71	−17
		200	0.23	−105	11.97	99	0.03	68	0.61	−18
		500	0.14	−172	5.36	74	0.07	69	0.56	−24
		1000	0.23	128	2.91	47	0.13	62	0.48	−41
		1500	0.40	108	2.16	22	0.20	51	0.37	−64
	25	100	0.32	−86	19.40	115	0.02	68	0.70	−16
		200	0.22	−119	11.67	97	0.03	69	0.61	−16
		500	0.19	−176	5.28	74	0.06	70	0.57	−23
		1000	0.26	127	2.82	46	0.13	63	0.50	−41
		1500	0.43	107	2.09	21	0.19	53	0.40	−63
	30	100	0.29	−103	18.29	112	0.02	68	0.70	−14
		200	0.22	−135	10.86	95	0.03	70	0.62	−15
		500	0.20	165	4.82	72	0.06	72	0.59	−22
		1000	0.31	125	2.63	44	0.12	66	0.53	−41
		1500	0.47	106	1.95	19	0.19	55	0.43	−64

Table 3. MPS901 Common Emitter S–Parameters, V_{CE} = 10 V

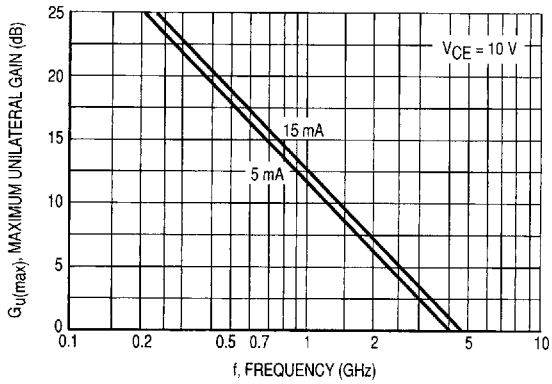


Figure 16. Maximum Unilateral Gain versus Frequency

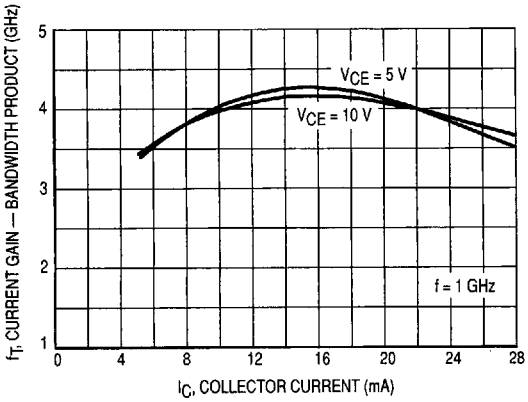


Figure 17. Current Gain — Bandwidth Product versus Collector Current

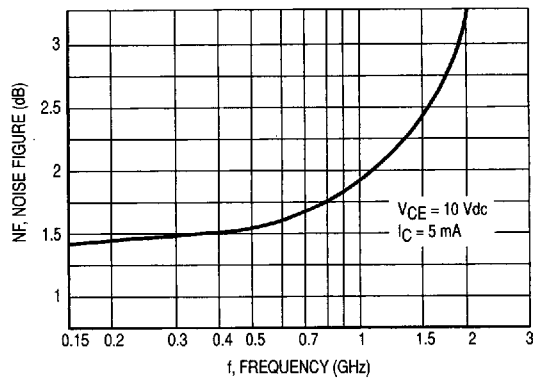


Figure 18. Noise Figure versus Frequency

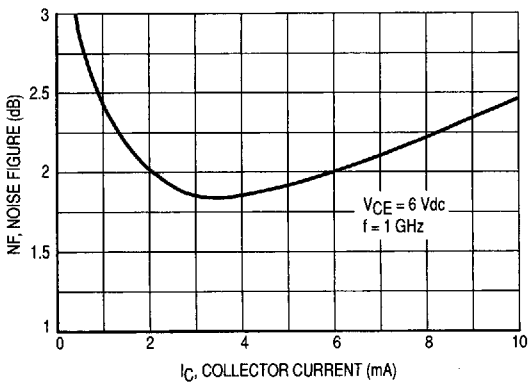


Figure 19. Noise Figure versus Collector Current

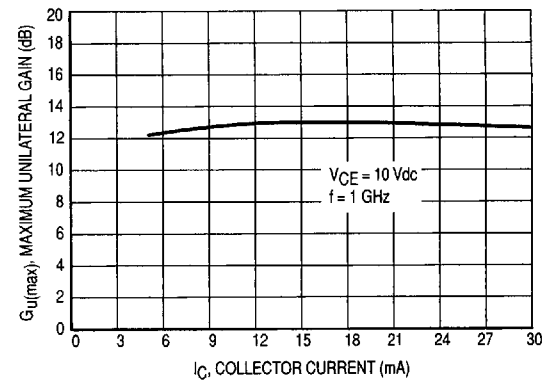


Figure 20. Maximum Unilateral Gain versus Collector Current

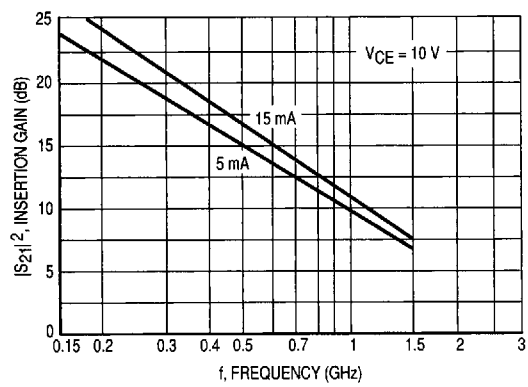


Figure 21. $|S_{21}|^2$ versus Frequency

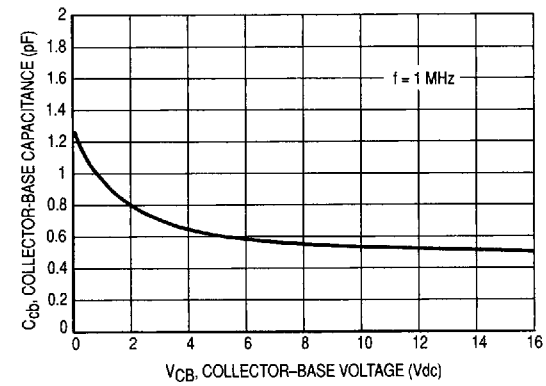


Figure 22. Collector–Base Capacitance versus Collector–Base Voltage

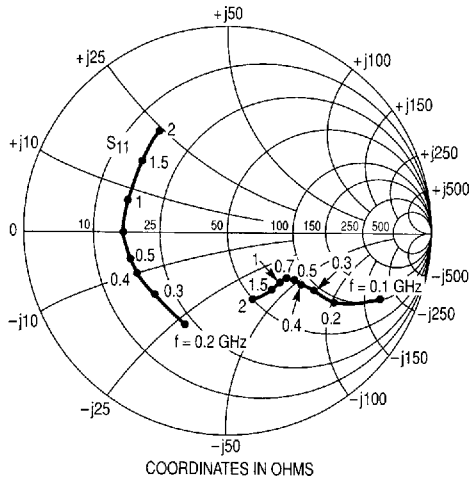


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Figure 23. Input and Output Reflection Coefficients versus Frequency (V_{CE} = 10 V, I_C = 15 mA)

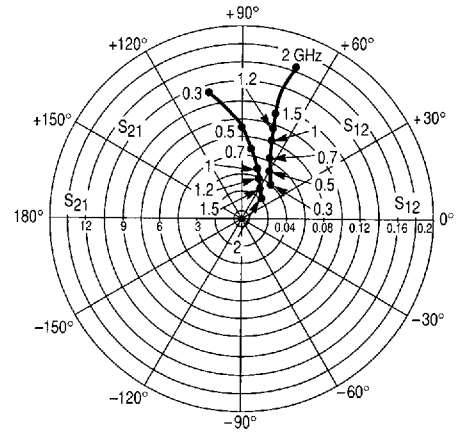


Figure 24. Forward/Reverse Transmission Coefficients versus Frequency (V_{CE} = 10 V, I_C = 15 mA)

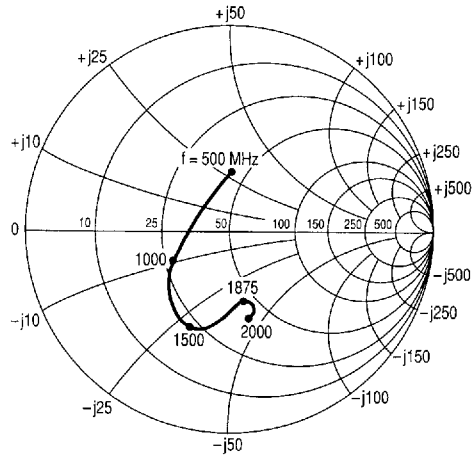
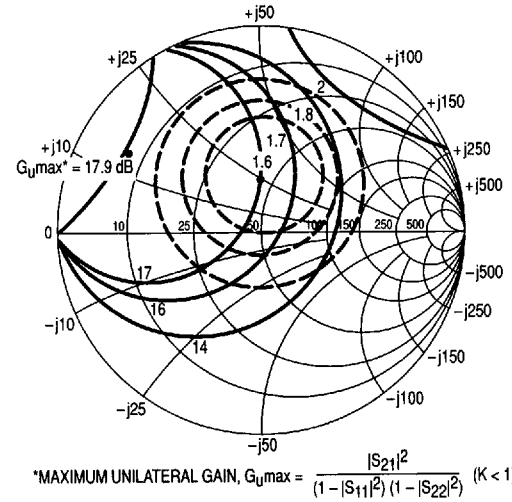
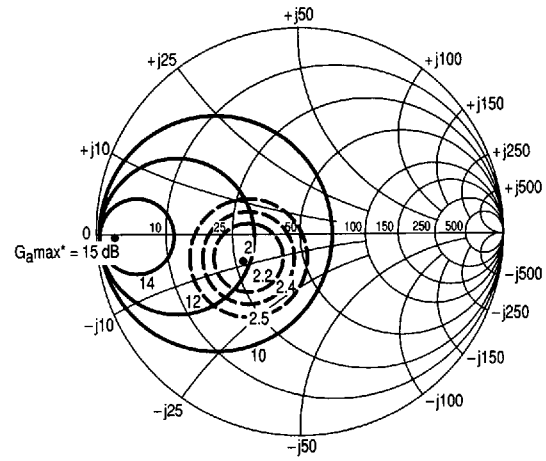


Figure 25. Source Impedance (Γms) for Optimum Noise Figure versus Frequency (V_{CE} = 10 V, I_C = 5.0 mA)



*MAXIMUM UNILATERAL GAIN, $G_u max = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$ (K < 1)

Figure 26. Constant Gain and Noise Figure Contours (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 500 MHz)



*MAXIMUM AVAILABLE GAIN, $G_a max = \frac{|S_{21}|}{|S_{12}|}(K \pm \sqrt{K^2-1})$ (K > 1)

Figure 27. Constant Gain and Noise Figure Contours (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	5.0	100	0.71	−38	11.30	153	0.03	68	0.92	−17
		200	0.62	−75	9.48	133	0.05	55	0.76	−29
		500	0.54	−141	5.40	100	0.07	43	0.48	−44
		1000	0.53	178	2.93	76	0.09	48	0.40	−56
		2000	0.59	130	1.51	48	0.16	62	0.35	−85
	10	100	0.57	−58	16.95	145	0.03	63	0.85	−23
		200	0.51	−103	12.61	123	0.04	53	0.64	−35
		500	0.52	−161	6.24	93	0.06	50	0.38	−45
		1000	0.52	166	3.24	73	0.09	61	0.33	−54
		2000	0.59	125	1.66	47	0.17	67	0.29	−84
	15	100	0.48	−75	20.08	139	0.02	61	0.80	−27
		200	0.47	−121	13.89	117	0.04	53	0.57	−38
		500	0.53	−170	6.44	91	0.05	56	0.34	−44
		1000	0.53	162	3.33	72	0.09	66	0.31	−52
		2000	0.60	123	1.70	46	0.18	68	0.28	−82
	20	100	0.44	−88	21.62	136	0.02	60	0.76	−28
		200	0.47	−132	14.33	114	0.03	54	0.53	−38
		500	0.53	−175	6.45	89	0.05	60	0.32	−41
		1000	0.53	159	3.31	70	0.09	68	0.31	−50
		2000	0.61	122	1.69	45	0.18	70	0.28	−80
	30	100	0.43	−112	21.45	130	0.02	58	0.72	−28
		200	0.50	−148	13.38	109	0.03	57	0.51	−33
		500	0.57	178	5.82	86	0.05	65	0.35	−34
		1000	0.57	156	2.99	68	0.08	73	0.35	−46
		2000	0.65	121	1.50	42	0.18	74	0.33	−78

Table 4. MRF901 Common Emitter S–Parameters, V_{CE} = 5.0 V

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
10	5.0	100	0.73	−35	11.32	154	0.03	69	0.93	−14
		200	0.63	−69	9.69	135	0.05	57	0.79	−25
		500	0.53	−135	5.65	101	0.07	43	0.54	−38
		1000	0.51	−177	3.11	77	0.08	50	0.47	−48
		2000	0.57	132	1.58	48	0.14	66	0.41	−75
	10	100	0.59	−52	17.06	147	0.02	64	0.87	−19
		200	0.52	−95	13.06	125	0.04	54	0.69	−30
		500	0.49	−156	6.58	95	0.05	51	0.45	−37
		1000	0.50	170	3.44	74	0.08	62	0.41	−45
		2000	0.57	126	1.75	47	0.16	70	0.36	−72
	15	100	0.51	−66	20.36	141	0.02	63	0.83	−22
		200	0.47	−112	14.48	119	0.03	54	0.63	−31
		500	0.50	−166	6.81	92	0.05	57	0.41	−35
		1000	0.50	164	3.54	72	0.08	67	0.39	−43
		2000	0.58	124	1.78	46	0.16	72	0.35	−70
	20	100	0.47	−78	22.08	138	0.02	61	0.80	−23
		200	0.46	−123	15.07	116	0.03	55	0.60	−30
		500	0.50	−171	6.84	90	0.05	60	0.40	−32
		1000	0.51	162	3.51	71	0.08	69	0.39	−41
		2000	0.59	123	1.77	45	0.17	73	0.35	−68
	30	100	0.44	−98	22.70	133	0.02	59	0.76	−23
		200	0.47	−139	14.47	111	0.03	55	0.57	−27
		500	0.53	−177	6.33	87	0.04	65	0.43	−28
		1000	0.54	158	3.26	69	0.07	74	0.43	−39
		2000	0.62	122	1.61	42	0.16	77	0.39	−68

Table 5. MRF901 Common Emitter S–Parameters, V_{CE} = 10 V