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MOTOROLA

MRF1027T1

Advance Information

NPN Silicon Low Noise Transistor

The MRF1027T1 is fabricated utilizing Motorola's latest 12 GHz f_τ discrete bipolar silicon process. It offers 1.0 dB Minimum Noise Figure at V_{CE} = 1.0 V, IC = 1.0 mA and f = 1.0 GHz. The noise performance of the MRF1027T1 at low bias makes this device the ideal choice in high gain, low noise applications. This device is well suited for low–voltage, low–current, front–end applications. It is designed for use in pagers, cellular and cordless phones, and other portable wireless systems.

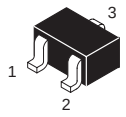
The MRF1027T1 has 9 emitter fingers, with self–aligned and enhanced processing; resulting in a high f_τ, low operating current transistor with reduced parasitics. The MRF1027T1 is fully–ion implanted with gold metallization and nitride passivation for maximum device reliability, performance and uniformity.

- Low Noise Figure, NF_{min} = 1.0 dB (Typ) @1.0 GHz, 3.0 V and 1.0 mA
- High Current Gain–Bandwidth Product, f_τ = 12 GHz @ 3.0 V and 10 mA
- Maximum Stable Gain, 17 dB @ 1.0 GHz, 3.0 V and 8.0 mA
- Output Third Order Intercept, OIP_3 = 23 dBm @ 1.0 GHz, 3.0 V and 10 mA
- Fully Ion–Implanted with Gold Metallization and Nitride Passivation

RF NPN
SILICON TRANSISTOR
f_τ = 12 GHz
NF_{min} = 1.0 dB
I_{CMAX} = 25 mA
V_{CEO} = 5.0 V

SEMICONDUCTOR
TECHNICAL DATA

Pin 1. Base
2. Emitter
3. Collector



PLASTIC PACKAGE
CASE 419
(SC–70, Tape & Reel Only)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	5.0	Vdc
Collector–Base Voltage	V_{CBO}	12	Vdc
Emitter–Base Voltage	V_{EBO}	2.5	Vdc
Power Dissipation @ T_C=75°C Derate Linearly above T_C = 75°C at	$P_{D(max)}$	136 1.82	W mW/°C
Collector Current–Continuous [Note 3]	I_C	25	mA
Maximum Junction Temperature	$T_{J(max)}$	150	°C
Storage Temperature	T_{stg}	–55 to 150	°C

NOTES: 1. Meets Human Body Model (HBM) ≤300 V and Machine Model (MM) ≤75 V.
2. ESD data available upon request.
3. I_C Continuous for MTBF >10 years.

THERMAL CHARACTERISTIC

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction–to–Case	$R_{\theta JC}$	550	°C/W

NOTE: To calculate the junction temperature use $T_J = (P_D \times R_{\theta JC}) + T_C$. The case temperature measured on collector lead adjacent to the package body.

ORDERING INFORMATION

Device	Marking	Package
MRF1027T1	WA	SC–70 Tape & Reel*

*3,000 Units per 8 mm, 7 inch reel.

LIFETIME BUY

LAST ORDER 17SEP00 LAST SHIP 17MAR01

ELECTRICAL CHARACTERISTICS (T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTIC [Note 1]					
Collector–Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	5.0	–	–	Vdc
Collector–Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	12	–	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)CBO}$	2.5	–	–	Vdc
Emitter Cutoff Current (V_{EB} = 1.0 V, I_C = 0)	I_{EBO}	–	–	0.1	μA
Collector Cutoff Current (V_{CB} = 1.0 V, I_E = 0)	I_{CBO}	–	–	0.2	μA
ON CHARACTERISTIC [Note 1]					
DC Current Gain (V_{CE} = 3.0 V, I_C = 3.0 mA)	h_{FE}	100	–	200	–
DYNAMIC CHARACTERISTICS					
Collector–Base Capacitance (V_{CB} = 1.0 V, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.35	–	pF
Current Gain Bandwidth Product (V_{CE} = 3.0 V, I_C = 10 mA, f = 1.0 GHz)	f_τ	–	12	–	GHz
PERFORMANCE CHARACTERISTIC					
Insertion Gain	$\|S_{21}\|^2$				dB
V_{CE} = 1.0 V, I_C = 1.0 mA, f = 1.0 GHz		–	8.0	–	
V_{CE} = 3.0 V, I_C = 3.0 mA, f = 1.0 GHz		–	13	–	
Maximum Stable Gain and/or Maximum Available Gain [Note 2]	MSG, MAG				dB
V_{CE} = 1.0 V, I_C = 1.0 mA, f = 1.0 GHz		–	12	–	
V_{CE} = 3.0 V, I_C = 3.0 mA, f = 1.0 GHz		–	16	–	
Minimum Noise Figure	NF_{min}				dB
V_{CE} = 1.0 V, I_C = 1.0 mA, f = 1.0 GHz		–	1.0	–	
V_{CE} = 3.0 V, I_C = 3.0 mA, f = 1.0 GHz		–	1.1	–	
Associated Gain at Minimum NF	G_{NF}				dB
V_{CE} = 1.0 V, I_C = 1.0 mA, f = 1.0 GHz		–	11	–	
V_{CE} = 3.0 V, I_C = 3.0 mA, f = 1.0 GHz		–	14	–	
Output Power at 1.0 dB Gain Compression [Note 3] (V_{CE} = 3.0 V, I_C = 3.0 mA, f = 1.0 GHz)	P_{1dB}	–	–0.3	–	dBm
Output Third Order Intercept [Note 3] (V_{CE} = 3.0 V, I_C = 3.0 mA, f = 1.0 GHz)	OIP_3	–	22	–	dBm

NOTES: 1. Pulse width ≤300 μs, duty cycle ≤2% pulsed.

2. Maximum Available Gain and Maximum Stable Gain are defined by the K factor as follows:

$$MAG = \left|\frac{S_{21}}{S_{12}}\left(K \pm \sqrt{K^2 - 1}\right)\right|, \text{ if } K > 1, \quad MSG = \left|\frac{S_{21}}{S_{12}}\right|, \text{ if } K < 1$$

3. Z_{in} = 50 Ω and Z_{out} matched for optimum IP3.

Figure 1. Capacitance versus Voltage

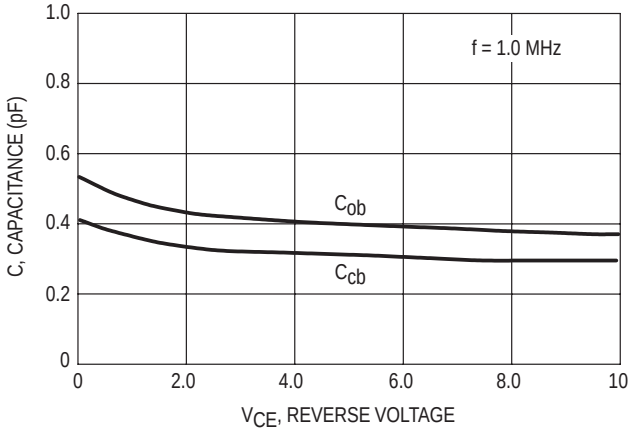


Figure 2. Input Capacitance versus Voltage

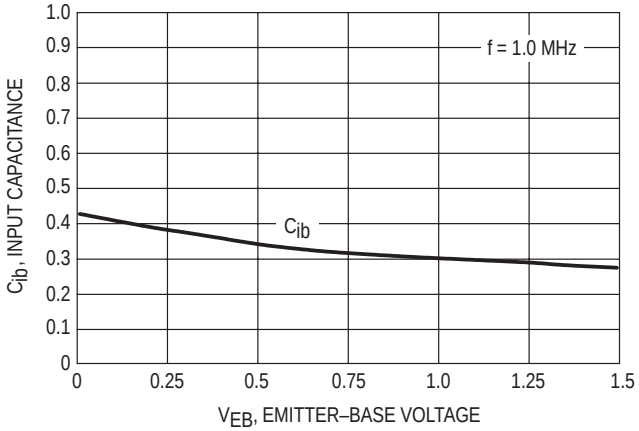


Figure 3. DC Current Gain versus Collector Current

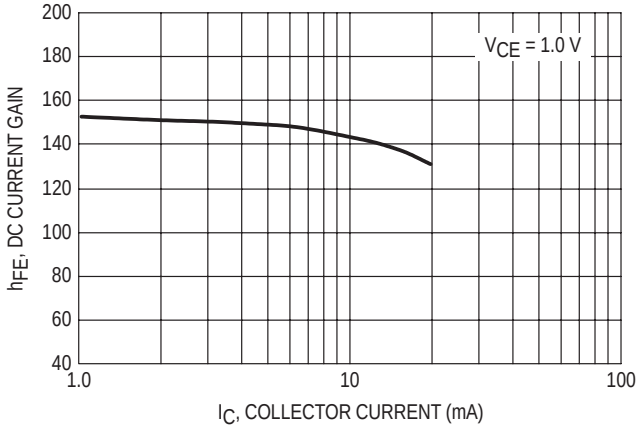


Figure 4. Gain–Bandwidth Product versus Collector Current

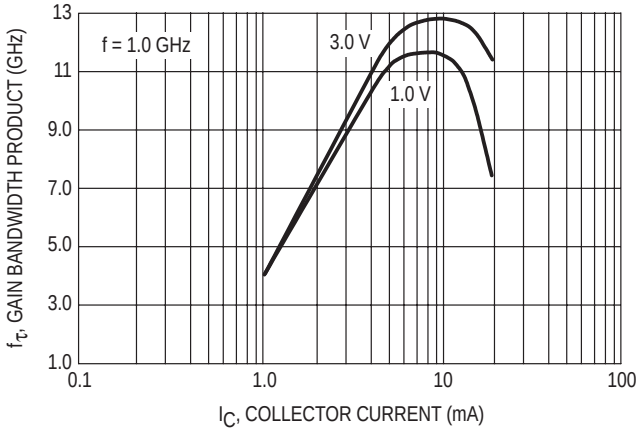


Figure 5. Functional Circuit Schematic

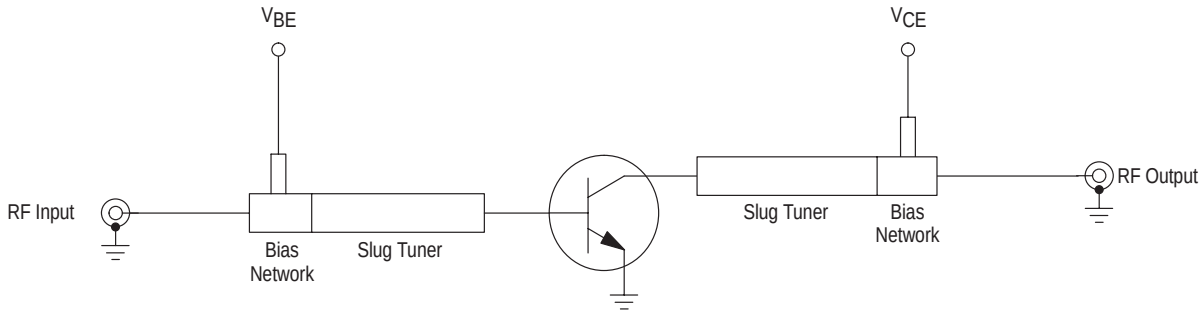


Figure 6. Maximum Stable/Available Gain and Forward Insertion Gain versus Frequency

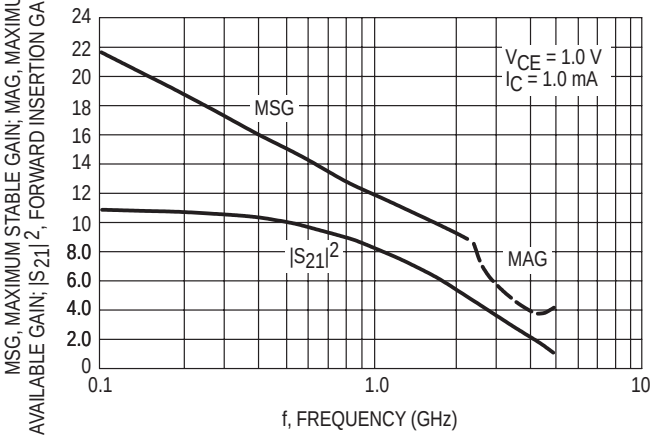


Figure 7. Maximum Stable/Available Gain and Forward Insertion Gain versus Frequency

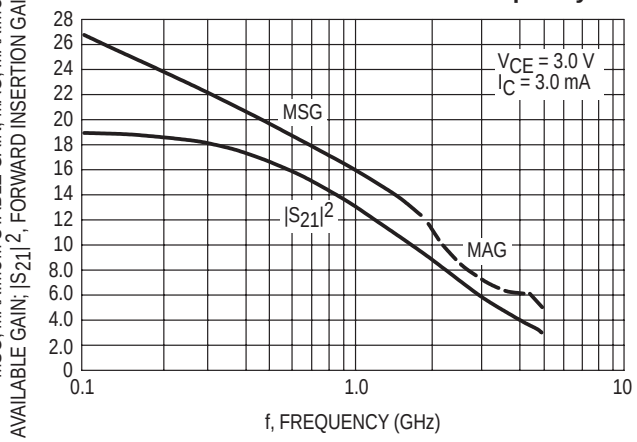


Figure 8. Maximum Stable/Available Gain and Forward Insertion Gain versus Collector Current

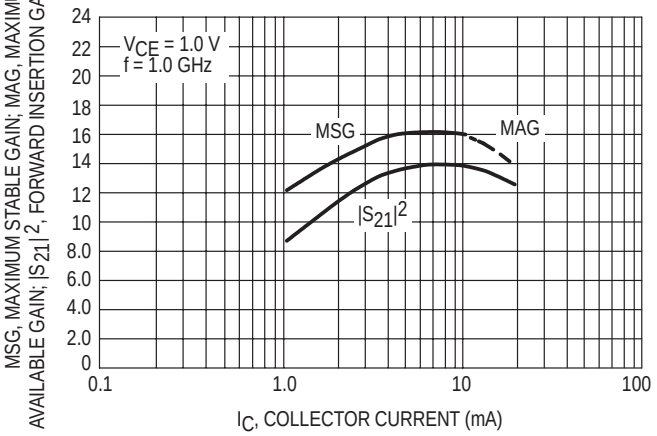


Figure 9. Maximum Stable/Available Gain and Forward Insertion Gain versus Collector Current

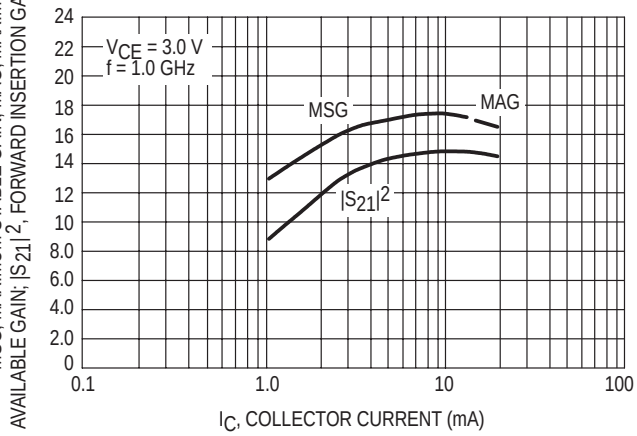


Figure 10. Minimum Noise Figure and Associated Gain versus Frequency

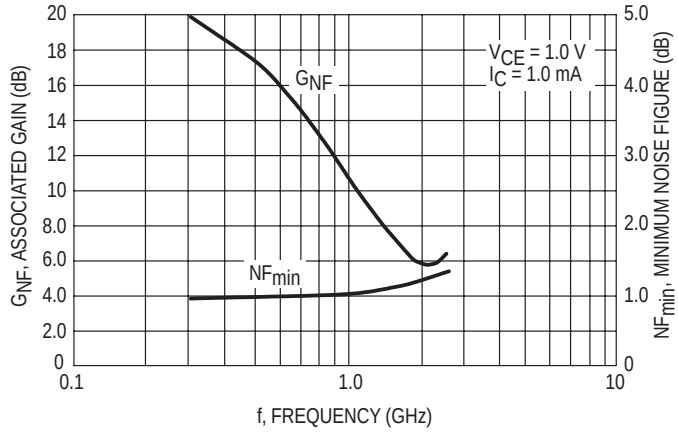


Figure 11. Minimum Noise Figure and Associated Gain versus Frequency

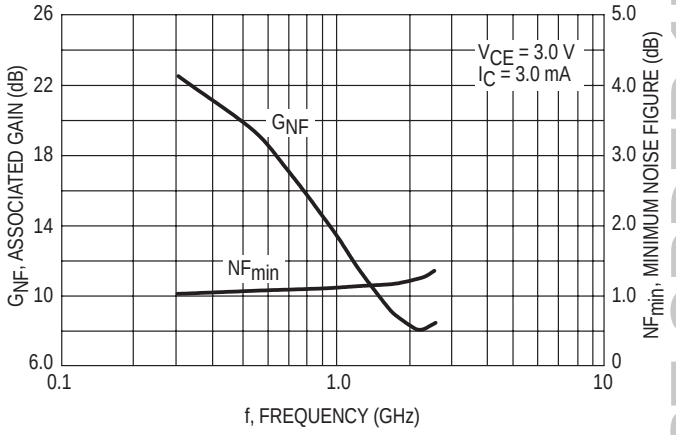


Figure 12. Minimum Noise Figure and Associated Gain versus Collector Current

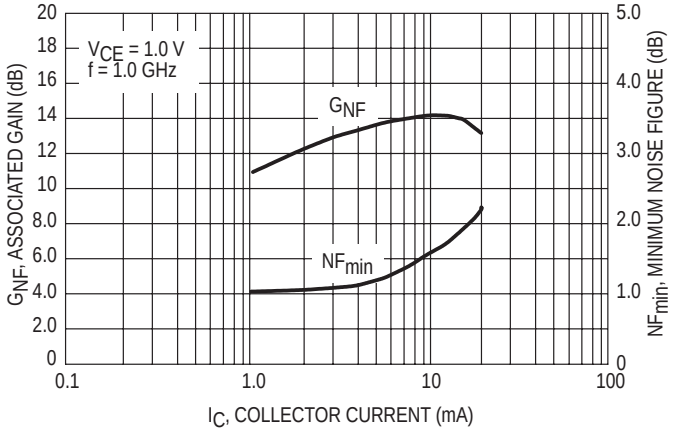


Figure 13. Minimum Noise Figure and Associated Gain versus Collector Current

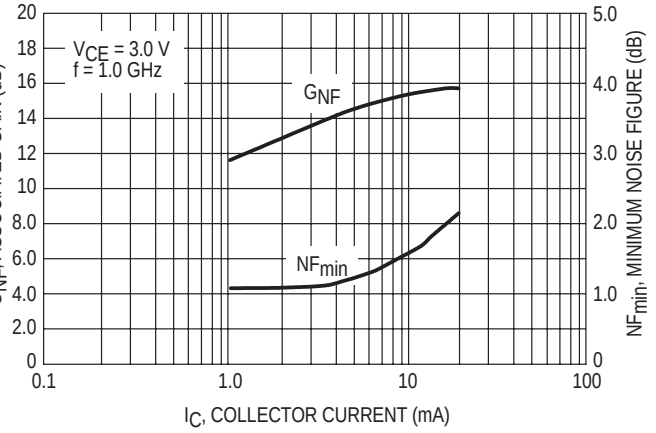


Figure 14. Output Third Order Intercept and Output Power at 1.0 dB Gain Compression versus Collector Current

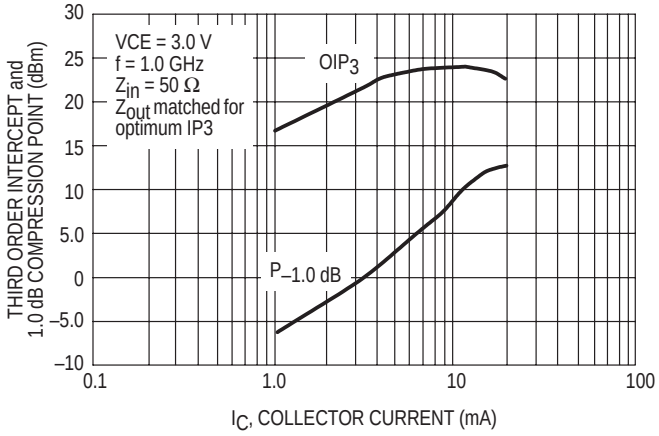


Table 1. Common Emitter S–Parameters

V_{CE} (Vdc)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}		K
			$\|S_{11}\|$	∠ ϕ	$\|S_{21}\|$	∠ ϕ	$\|S_{12}\|$	∠ ϕ	$\|S_{22}\|$	∠ ϕ	
1.0	1.0	0.1	0.971	–7	3.44	173	0.023	85	0.989	–5	0.04
		0.3	0.945	–22	3.35	159	0.067	76	0.965	–14	0.12
		0.5	0.906	–35	3.10	143	0.104	66	0.908	–22	0.27
		0.7	0.803	–47	2.88	131	0.134	59	0.856	–29	0.36
		0.9	0.721	–58	2.71	120	0.157	53	0.797	–35	0.45
		1.0	0.684	–63	2.62	116	0.166	51	0.770	–38	0.49
		1.3	0.576	–78	2.34	101	0.188	45	0.692	–45	0.62
		1.5	0.518	–87	2.19	93	0.200	42	0.649	–50	0.69
		1.8	0.429	–101	1.98	82	0.212	38	0.592	–56	0.81
		2.0	0.386	–112	1.86	75	0.219	37	0.563	–59	0.87
		2.5	0.309	–140	1.63	59	0.232	35	0.491	–69	1.01
		3.0	0.258	–163	1.47	47	0.251	36	0.459	–77	1.09
		3.5	0.238	167	1.33	36	0.276	37	0.445	–85	1.11
		4.0	0.256	142	1.22	26	0.312	38	0.431	–95	1.08
		4.5	0.269	121	1.17	17	0.365	37	0.410	–106	1.03
		5.0	0.305	106	1.09	9	0.417	34	0.411	–118	0.99
	3.0	0.1	0.912	–13	8.89	167	0.022	82	0.964	–9.0	0.11
		0.3	0.809	–36	7.88	145	0.061	70	0.871	–24	0.27
		0.5	0.665	–53	6.52	126	0.086	62	0.737	–33	0.48
		0.7	0.532	–66	5.40	113	0.106	58	0.643	–38	0.62
		0.9	0.432	–77	4.58	103	0.122	56	0.569	–42	0.74
		1.0	0.392	–82	4.25	98	0.130	55	0.543	–44	0.78
		1.3	0.296	–95	3.49	87	0.151	54	0.476	–47	0.90
		1.5	0.247	–103	3.12	81	0.167	53	0.447	–50	0.95
		1.8	0.188	–119	2.70	72	0.189	52	0.410	–54	1.01
		2.0	0.162	–132	2.48	66	0.205	51	0.391	–57	1.03
		2.5	0.145	–170	2.09	54	0.244	49	0.338	–66	1.06
		3.0	0.131	163	1.83	44	0.286	46	0.323	–73	1.06
		3.5	0.150	132	1.64	34	0.327	43	0.314	–82	1.05
		4.0	0.184	115	1.50	26	0.370	39	0.300	–92	1.03
		4.5	0.208	101	1.40	17	0.416	35	0.289	–102	1.01
		5.0	0.245	91	1.322	10	0.461	30	0.286	–115	0.98
	5.0	0.1	0.852	–17	13.06	163	0.022	81	0.938	–12	0.17
		0.3	0.687	–46	10.50	135	0.055	68	0.783	–29	0.39
		0.5	0.510	–62	7.97	117	0.076	62	0.626	–36	0.64
		0.7	0.385	–75	6.27	104	0.093	61	0.535	–39	0.78
		0.9	0.301	–85	5.13	95	0.111	60	0.475	–41	0.87
		1.0	0.269	–89	4.71	92	0.119	60	0.454	–42	0.91
		1.3	0.193	–102	3.78	81	0.145	59	0.406	–44	0.98
		1.5	0.155	–111	3.35	76	0.163	59	0.385	–47	1.01
		1.8	0.114	–132	2.88	68	0.190	57	0.359	–51	1.03
		2.0	0.100	–149	2.63	63	0.207	56	0.343	–54	1.05
		2.5	0.114	168	2.20	52	0.253	52	0.297	–63	1.05
		3.0	0.115	143	1.92	43	0.298	49	0.287	–70	1.05
		3.5	0.147	117	1.71	34	0.342	44	0.280	–80	1.03
		4.0	0.182	105	1.57	25	0.386	40	0.265	–91	1.01
		4.5	0.205	94	1.46	17	0.431	35	0.256	–102	1.00
		5.0	0.242	86	1.38	10	0.474	30	0.251	–115	0.98
3.0	3.0	0.1	0.927	–11	8.88	168	0.018	83	0.968	–7	0.11
		0.3	0.836	–32	8.00	147	0.051	73	0.892	–20	0.26
		0.5	0.704	–47	6.74	129	0.073	64	0.776	–27	0.48
		0.7	0.573	–58	5.65	116	0.091	60	0.694	–32	0.62
		0.9	0.473	–67	4.83	106	0.106	58	0.627	–36	0.73
		1.0	0.432	–71	4.50	102	0.113	58	0.603	–37	0.77
		1.3	0.332	–82	3.72	90	0.133	57	0.542	–40	0.89
		1.5	0.281	–87	3.33	84	0.147	56	0.514	–43	0.94
		1.8	0.213	–98	2.89	75	0.167	55	0.480	–46	0.99
		2.0	0.179	–107	2.66	70	0.181	55	0.462	–49	1.02
		2.5	0.131	–139	2.25	57	0.218	52	0.412	–56	1.05

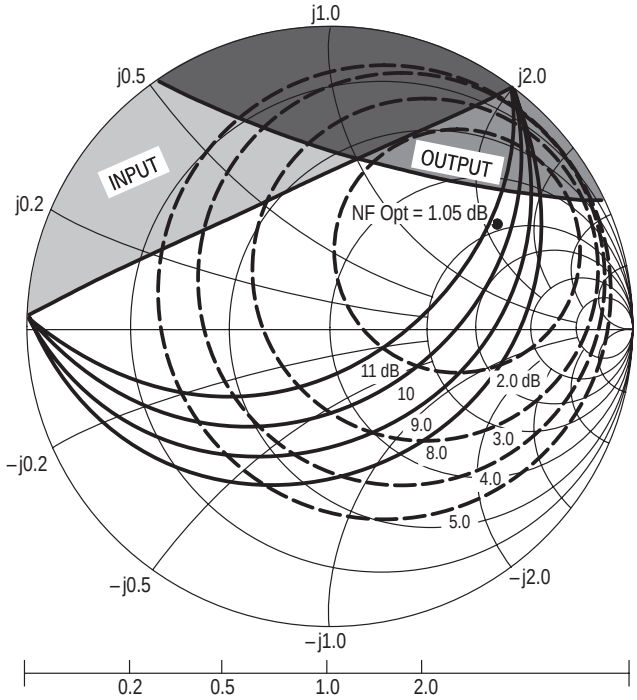
Table 1. Common Emitter S–Parameters (continued)

V_{CE} (Vdc)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}		K
			$\|S_{11}\|$	∠ ϕ	$\|S_{21}\|$	∠ ϕ	$\|S_{12}\|$	∠ ϕ	$\|S_{22}\|$	∠ ϕ	
3.0	3.0	3.0	0.096	–163	1.97	47	0.255	51	0.400	–62	1.05
		3.5	0.092	152	1.76	38	0.294	48	0.394	–70	1.03
		4.0	0.121	126	1.61	29	0.335	44	0.381	–79	1.01
		4.5	0.143	109	1.50	21	0.379	41	0.373	–87	0.98
		5.0	0.180	97	1.42	13	0.424	37	0.370	–98	0.95
	5.0	0.1	0.874	–15	12.93	164	0.018	81	0.952	–10	0.16
		0.3	0.726	–39	10.70	138	0.047	71	0.824	–24	0.38
		0.5	0.557	–54	8.31	120	0.066	65	0.684	–30	0.62
		0.7	0.431	–64	6.62	108	0.083	63	0.602	–33	0.76
		0.9	0.342	–71	5.46	99	0.098	63	0.545	–35	0.86
		1.0	0.308	–74	5.02	95	0.106	63	0.526	–35	0.89
		1.3	0.227	–81	4.05	85	0.129	62	0.482	–37	0.97
		1.5	0.185	–86	3.59	79	0.145	61	0.461	–40	1.00
		1.8	0.132	–94	3.09	71	0.169	60	0.437	–43	1.02
		2.0	0.103	–104	2.83	67	0.185	59	0.423	–45	1.03
		2.5	0.070	–150	2.37	56	0.228	56	0.378	–53	1.04
		3.0	0.050	175	2.06	46	0.270	53	0.371	–60	1.03
		3.5	0.070	120	1.84	37	0.312	49	0.365	–68	1.02
		4.0	0.108	106	1.68	29	0.355	45	0.350	–77	1.00
		4.5	0.131	94	1.57	21	0.399	40	0.343	–86	0.98
		5.0	0.167	86	1.48	14	0.443	35	0.338	–97	0.96
	10	0.1	0.760	–21	19.82	157	0.017	79	0.910	–13	0.26
		0.3	0.539	–50	13.88	126	0.041	70	0.707	–28	0.57
		0.5	0.367	–61	9.71	109	0.058	68	0.573	–30	0.81
		0.7	0.269	–69	7.37	99	0.074	68	0.512	–30	0.91
		0.9	0.206	–73	5.92	91	0.091	68	0.475	–30	0.97
		1.0	0.183	–75	5.39	88	0.100	68	0.465	–31	0.98
		1.3	0.128	–79	4.28	79	0.126	67	0.439	–33	1.02
		1.5	0.097	–81	3.77	75	0.144	66	0.426	–35	1.03
		1.8	0.059	–90	3.22	68	0.170	64	0.409	–39	1.04
		2.0	0.037	–104	2.94	63	0.188	63	0.398	–41	1.04
		2.5	0.043	164	2.46	53	0.234	59	0.359	–49	1.03
		3.0	0.048	126	2.13	45	0.278	55	0.355	–56	1.02
		3.5	0.088	99	1.90	36	0.321	50	0.350	–65	1.00
		4.0	0.123	94	1.73	28	0.365	45	0.334	–75	0.98
		4.5	0.145	86	1.61	21	0.409	41	0.328	–84	0.97
		5.0	0.178	80	1.51	13	0.453	35	0.322	–95	0.95

Table 2. Common–Emitter Noise Parameters

V_{CE} (Vdc)	I_C (mA)	f (GHz)	NF_{min} (dB)	Γ_o		R_N Ω	r_n	G_{NF} (dB)	K
				Magnitude	Angle				
1.0	1.0	0.3	0.95	0.68	10	35	0.69	19.8	0.12
		0.5	0.96	0.68	15	34	0.67	16.8	0.27
		0.7	0.99	0.67	21	33	0.65	14.1	0.36
		0.9	1.01	0.67	28	31	0.62	11.8	0.45
		1.0	1.03	0.66	32	30	0.61	10.8	0.49
		1.5	1.12	0.62	51	25	0.49	7.1	0.69
		2.0	1.21	0.55	74	18	0.35	6.5	0.87
		2.4	1.31	0.47	95	12	0.25	6.7	1.00
	3.0	0.3	1.06	0.58	10	24	0.47	21.8	0.27
		0.5	1.06	0.57	15	23	0.46	18.9	0.48
		0.7	1.06	0.55	20	22	0.44	16.2	0.62
		0.9	1.07	0.53	26	21	0.42	13.9	0.74
		1.0	1.08	0.52	30	20	0.41	12.9	0.78
		1.5	1.14	0.47	50	17	0.35	9.1	0.95
		2.0	1.24	0.40	75	13	0.26	7.4	1.03
		2.4	1.35	0.33	98	10	0.20	7.6	1.06
	5.0	0.3	1.15	0.50	10	21	0.41	22.5	0.39
		0.5	1.16	0.48	14	20	0.40	19.5	0.64
		0.7	1.17	0.46	19	19	0.39	16.9	0.78
		0.9	1.17	0.44	25	19	0.37	14.6	0.87
		1.0	1.18	0.42	28	18	0.36	13.6	0.91
		1.5	1.27	0.36	50	16	0.31	9.8	1.01
		2.0	1.41	0.29	79	12	0.24	8.0	1.05
		2.4	1.57	0.23	108	10	0.19	8.1	1.05
3.0	1.0	0.3	1.01	0.71	10	40	0.80	20.6	0.11
		0.5	1.03	0.71	15	39	0.79	17.5	0.26
		0.7	1.05	0.71	20	38	0.76	14.7	0.35
		0.9	1.06	0.70	26	36	0.72	12.4	0.43
		1.0	1.07	0.70	29	35	0.71	11.3	0.47
		1.5	1.02	0.66	47	29	0.58	7.6	0.67
		2.0	1.06	0.59	68	21	0.43	6.2	0.85
		2.4	1.15	0.52	87	15	0.30	6.9	0.98
	3.0	0.3	1.03	0.64	9	29	0.59	22.5	0.26
		0.5	1.05	0.63	14	29	0.58	19.5	0.48
		0.7	1.06	0.61	19	28	0.56	16.9	0.62
		0.9	1.08	0.60	25	27	0.54	14.6	0.73
		1.0	1.10	0.59	28	26	0.52	13.6	0.77
		1.5	1.14	0.54	46	22	0.44	9.7	0.94
		2.0	1.24	0.49	69	17	0.34	8.1	1.02
		2.4	1.36	0.43	89	13	0.25	8.3	1.04
	5.0	0.3	1.16	0.55	9	24	0.48	23.3	0.38
		0.5	1.16	0.53	13	23	0.47	20.4	0.62
		0.7	1.17	0.52	18	23	0.45	17.7	0.76
		0.9	1.19	0.50	24	22	0.43	15.4	0.86
		1.0	1.20	0.49	27	21	0.42	14.4	0.89
		1.5	1.28	0.43	46	18	0.36	10.5	1.00
		2.0	1.41	0.35	71	14	0.28	8.7	1.03
		2.4	1.56	0.29	94	11	0.22	8.8	1.04
	10	0.3	1.49	0.41	14	20	0.41	24.3	0.57
		0.5	1.49	0.38	15	20	0.40	21.2	0.81
		0.7	1.51	0.36	18	19	0.39	18.5	0.91
		0.9	1.53	0.34	23	19	0.37	16.2	0.97
		1.0	1.54	0.33	27	18	0.37	15.2	0.98
		1.5	1.65	0.26	52	16	0.32	11.2	1.03
		2.0	1.83	0.19	88	13	0.25	9.3	1.04
		2.4	2.02	0.13	123	11	0.22	9.3	1.03

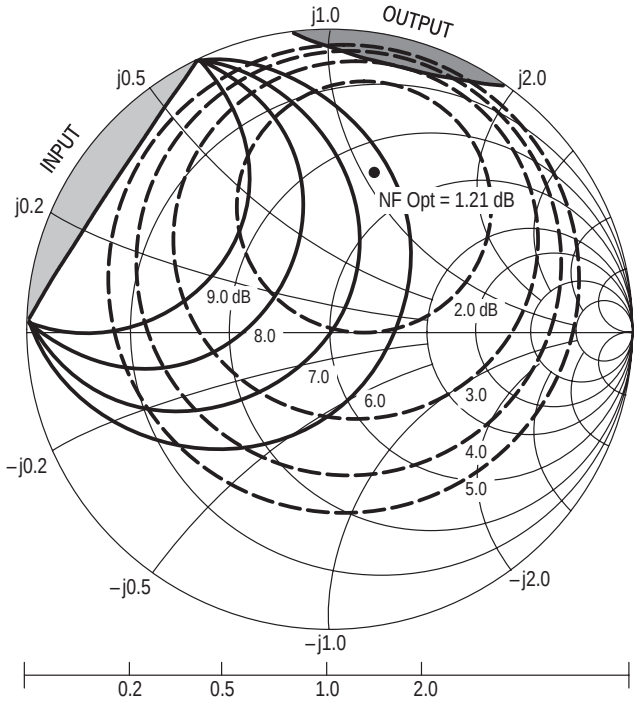
Figure 15. Constant Gain and Noise Figure Contours (f = 1.0 GHz)



V_{CE} = 1.0 V
I_C = 1.0 mA
— Potentially Unstable

f (GHz)	NF Opt (dB)	Γ_o	Rn	K
1.0	1.05	0.66 ∠ 31.5°	30.4	0.49

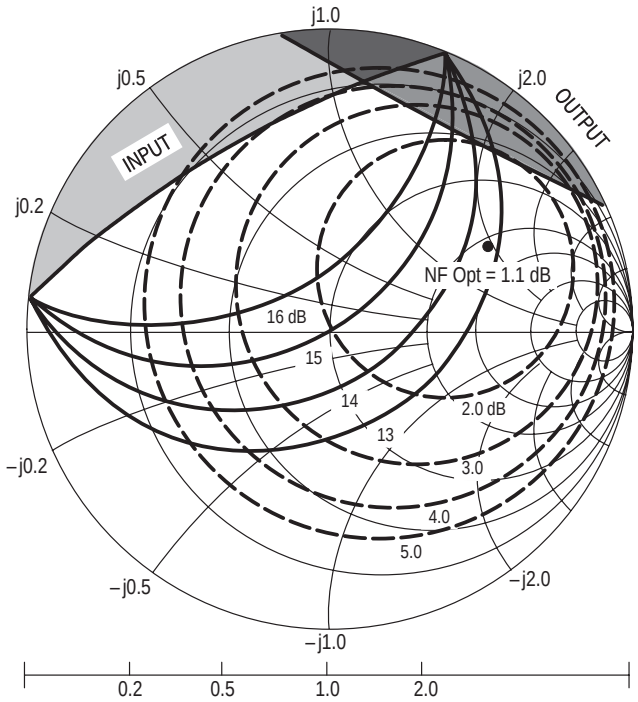
Figure 16. Constant Gain and Noise Figure Contours (f = 2.0 GHz)



V_{CE} = 1.0 V
I_C = 1.0 mA
— Potentially Unstable

f (GHz)	NF Opt (dB)	Γ_o	Rn	K
2.0	1.21	0.55 ∠ 74.1°	17.6	0.87

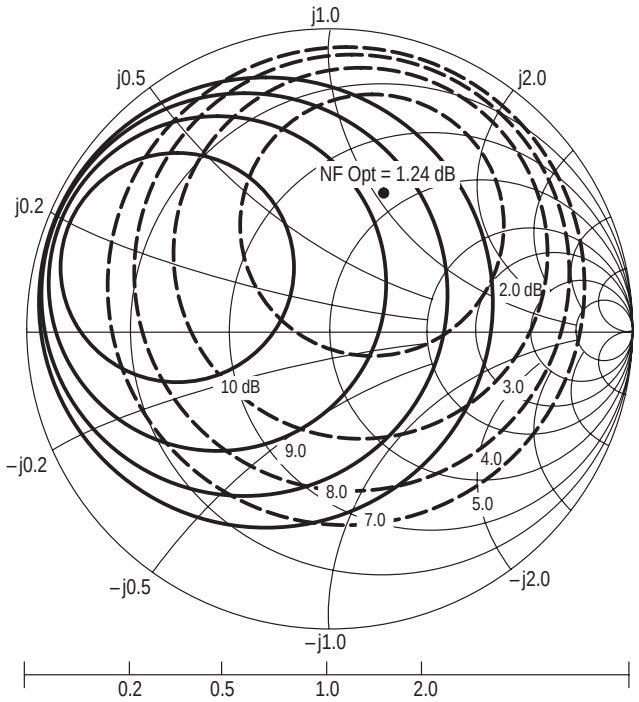
Figure 17. Constant Gain and Noise Figure Contours (f = 1.0 GHz)



V_{CE} = 3.0 V
I_C = 3.0 mA
— Potentially Unstable

f (GHz)	NF Opt (dB)	Γ_o	Rn	K
1.0	1.10	0.59 ∠ 27.9°	26	0.77

Figure 18. Constant Gain and Noise Figure Contours (f = 2.0 GHz)



V_{CE} = 3.0 V
I_C = 3.0 mA
— Potentially Unstable

f (GHz)	NF Opt (dB)	Γ_o	Rn	K
2.0	1.24	0.49 ∠ 68.6°	16.8	1.02

OUTLINE DIMENSIONS

PLASTIC PACKAGE
CASE 419–02
(SC–70)
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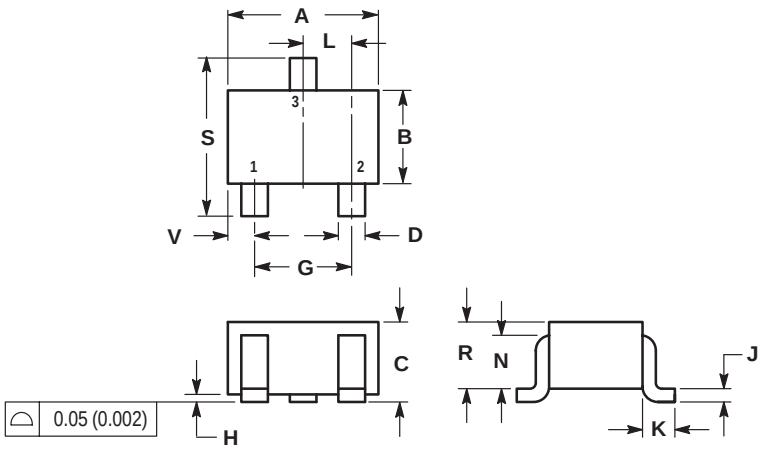

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.035	0.049	0.90	1.25
D	0.012	0.016	0.30	0.40
G	0.047	0.055	1.20	1.40
H	0.000	0.004	0.00	0.10
J	0.004	0.010	0.10	0.25
K	0.017 REF		0.425 REF	
L	0.026 BSC		0.650 BSC	
N	0.028 REF		0.700 REF	
R	0.031	0.039	0.80	1.00
S	0.079	0.087	2.00	2.20
V	0.012	0.016	0.30	0.40

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