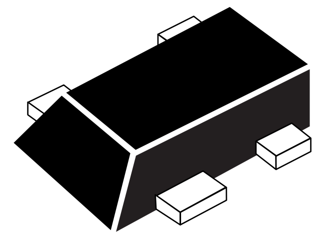
CEL

NPN SILICON HIGH FREQUENCY TRANSISTOR

NE661M04

FEATURES

- **HIGH GAIN BANDWIDTH:** f_T = 25 GHz
- **HIGH POWER GAIN:** $|S_{21E}|^2$ = 17 dB TYP at 2 GHz
- **LOW NOISE FIGURE:** NF = 1.2 dB at 2 GHz
- **HIGH MAXIMUM STABLE GAIN:** 22 dB @ 2 GHz
- **NEW LOW PROFILE M04 PACKAGE:**
  SOT-343 footprint, with a height of just 0.59 mm.
  Flat Lead Style for better RF performance.



M04

DESCRIPTION

NEC's NE661M04 is fabricated using NEC's UHS0 25 GHz f_T wafer process. With a typical transition frequency of 25 GHz the NE661M04 is usable in applications from 100 MHz to 10 GHz. The NE661M04 provides excellent low voltage/low current performance.

NEC's new low profile/flat lead style "M04" package is ideal for today's portable wireless applications. The NE661M04 is an ideal choice for LNA and oscillator requirements in all mobile communication systems.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

		PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE	NE661M04 2SC5507 M04			
	SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**
DC	I_{CBO}	Collector Cutoff Current at V_{CE} = 5 V, I_E = 0	µA			0.1
DC	I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	µA			0.1
DC	h_{FE}	Forward Current Gain[2] at V_{CE} = 2 V, I_C = 5 mA		50	70	100
RF	f_T	Gain Bandwidth at V_{CE} = 3 V, I_C = 10 mA, f = 2 GHz	GHz	20	25	
RF	MSG	Maximum Stable Gain[4] at V_{CE} = 2 V, I_C = 5 mA, f = 2 GHz	dB		22	
RF	$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 2 V, I_C = 5 mA, f = 2 GHz	dB	14	17	
RF	NF	Noise Figure at V_{CE} = 2 V, I_C = 2 mA, f = 2 GHz, $Z_{IN} = Z_{OPT}$	dB		1.2	1.5
RF	P1dB	Output Power at 1 dB compression point at V_{CE} = 2 V, I_C = 5 mA, f = 2 GHz	dBm		5	
RF	IP_3	Third Order Intercept Point at V_{CE} = 2 V, I_C = 5 mA, f = 2 GHz	dBm		15	
RF	Cre	Feedback Capacitance[3] at V_{CB} = 2 V, I_C = 0, f = 1 MHz	pF		0.08	0.12

Notes:

1. Electronic Industrial Association of Japan.
2. Pulsed measurement, pulse width ≤ 350 µs, duty cycle ≤ 2 %.
3. Capacitance is measured by capacitance meter (automatic balance bridge method) when emitter pin is connected to the guard pin.
4. $MSG = \left|\frac{S_{21}}{S_{12}}\right|$

ABSOLUTE MAXIMUM RATINGS[1] (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	15
V_{CEO}	Collector to Emitter Voltage	V	3.3
V_{EBO}	Emitter to Base Voltage	V	1.5
I_C	Collector Current	mA	12
P_T	Total Power Dissipation	mW	39
T_J	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to +150

Note:
1. Operation in excess of any one of these parameters may result in permanent damage.

THERMAL RESISTANCE

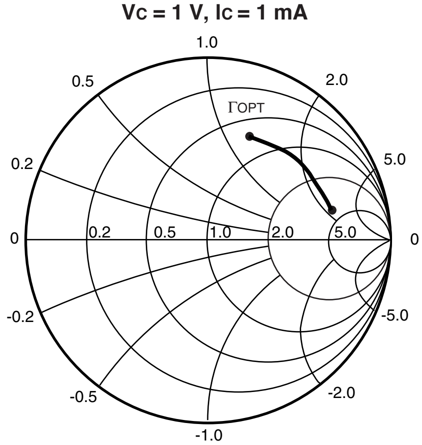
ITEM	SYMBOL	VALUE	UNIT
Junction to Case Resistance	$R_{th\ j\text{-}c}$	240	°C/W
Junction to Ambient Resistance	$R_{th\ j\text{-}a}$	650	°C/W

TYPICAL NOISE PARAMETERS (T_A = 25˚C)

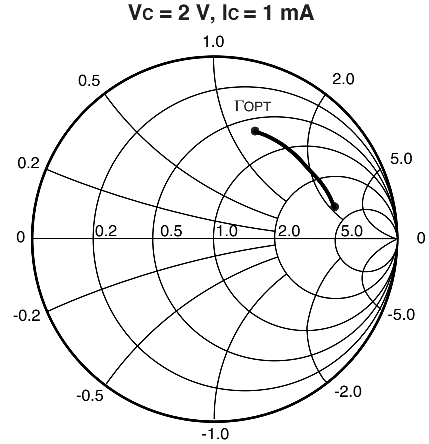
FREQ. (GHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50
V_C = 1 V, I_C = 1 mA					
0.50	1.08	21.40	0.67	13	0.60
0.90	1.13	18.90	0.64	31	0.64
1.00	1.14	18.40	0.64	33	0.64
1.50	1.20	15.70	0.63	43	0.64
2.00	1.29	14.20	0.62	50	0.62
2.50	1.40	13.20	0.61	59	0.55
3.00	1.55	12.50	0.60	67	0.45
V_C = 2 V, I_C = 1 mA					
0.50	1.12	21.70	0.69	13	0.57
0.90	1.15	19.50	0.66	26	0.56
1.00	1.16	19.10	0.65	30	0.55
1.50	1.23	16.50	0.64	37	0.69
2.00	1.32	14.70	0.64	46	0.68
2.50	1.45	13.90	0.63	60	0.55
3.00	1.60	13.30	0.62	69	0.52
V_C = 2 V, I_C = 5 mA					
0.50	1.69	27.41	0.41	14	0.60
0.90	1.70	23.80	0.41	30	0.64
1.00	1.70	23.00	0.41	34	0.64
1.50	1.72	20.24	0.40	40	0.64
2.00	1.75	17.93	0.39	47	0.62
2.50	1.79	16.77	0.38	55	0.55
3.00	1.85	16.30	0.36	64	0.45

TYPICAL OPTIMAL NOISE MATCHING (T_A = 25˚C)

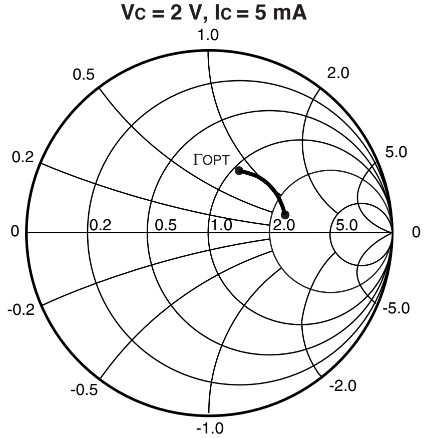
Vc = 1 V, Ic = 1 mA



Vc = 2 V, Ic = 1 mA

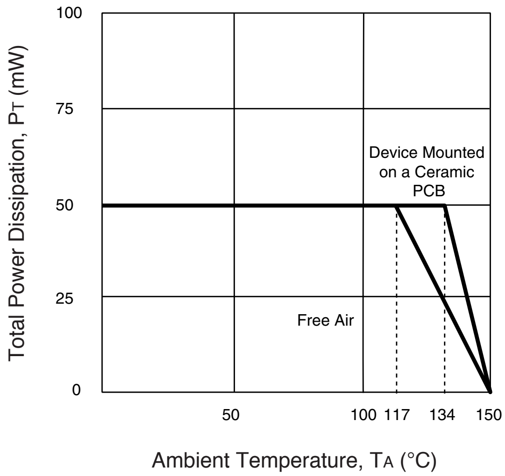


Vc = 2 V, Ic = 5 mA

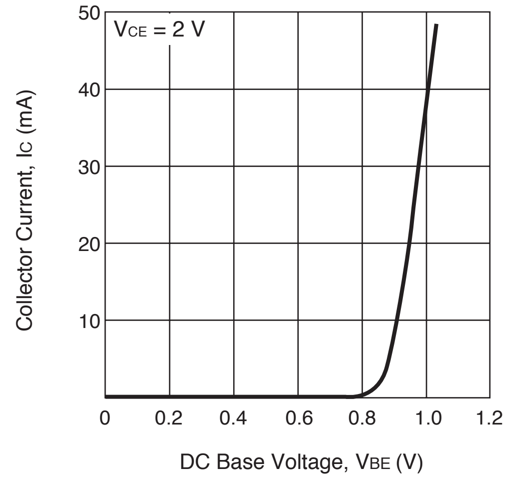


TYPICAL PERFORMANCE CURVES ($T_A = 25°C$)

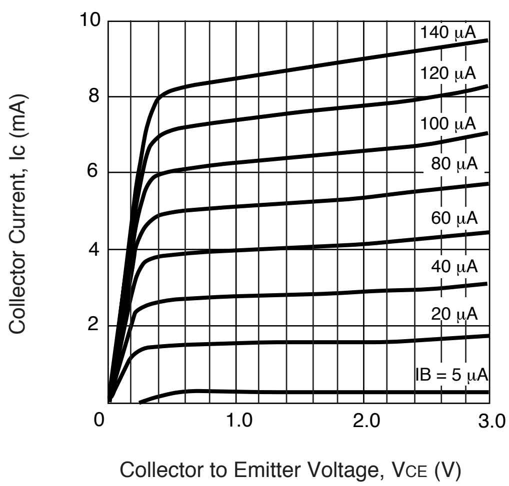
DC POWER DERATING CURVES



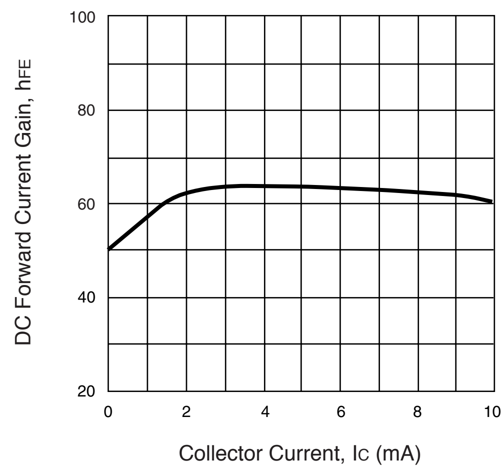
COLLECTOR CURRENT vs. DC BASE VOLTAGE



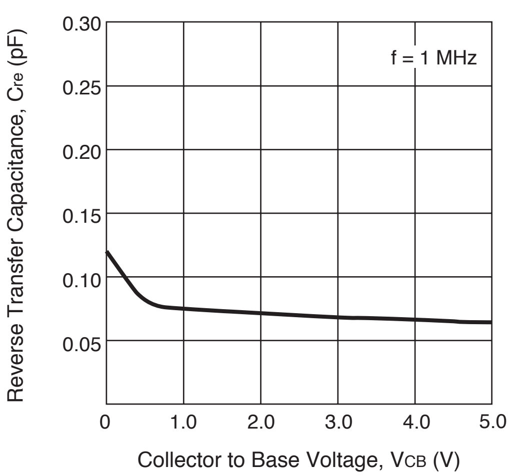
COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE



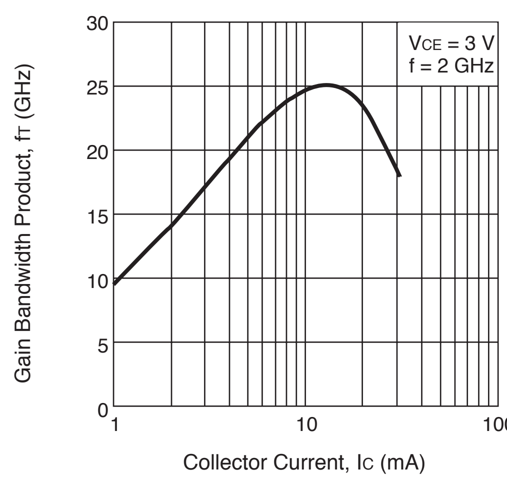
FORWARD CURRENT GAIN vs. COLLECTOR GAIN



REVERSE TRANSFER CAPACITANCE vs. COLLECTOR BASE VOLTAGE

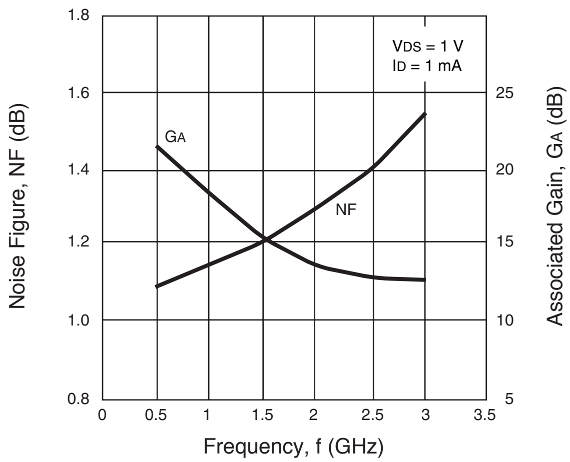


GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

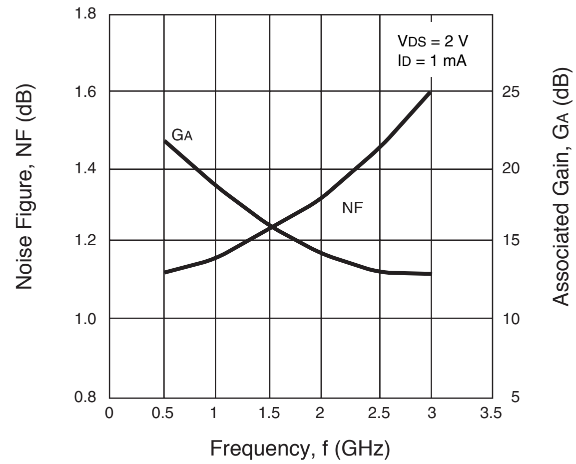


TYPICAL PERFORMANCE CURVES (T_A = 25°C)

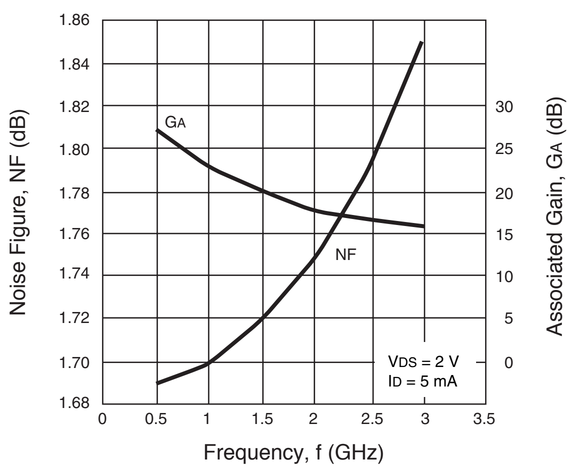
NOISE FIGURE vs. FREQUENCY



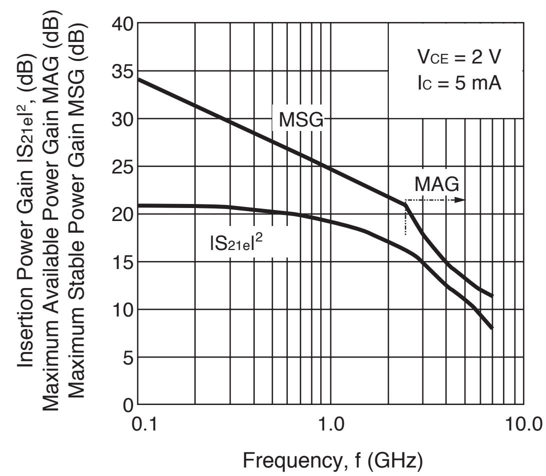
NOISE FIGURE vs. FREQUENCY



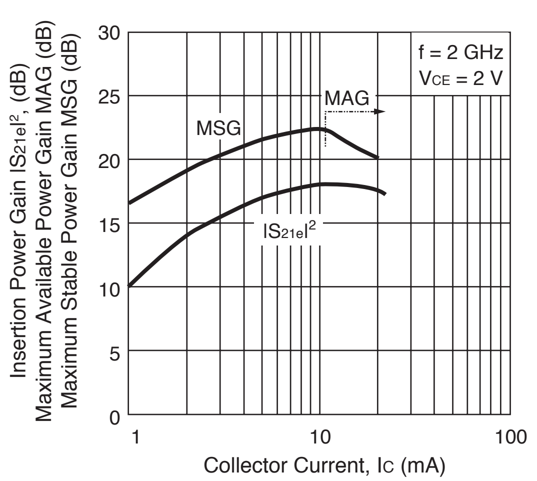
NOISE FIGURE vs. FREQUENCY



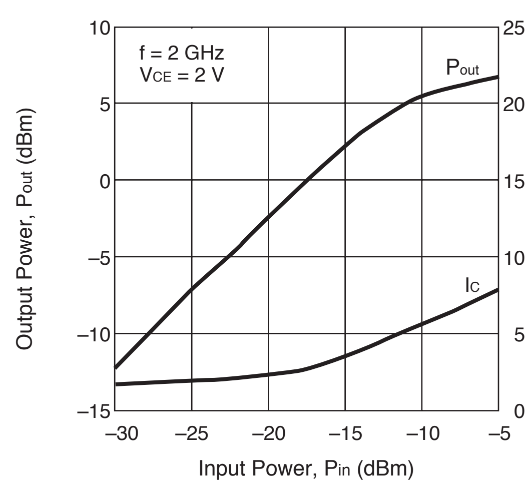
INSERTION POWER GAIN, MAXIMUM AVAILABLE POWER GAIN, MAXIMUM STABLE POWER GAIN vs. FREQUENCY



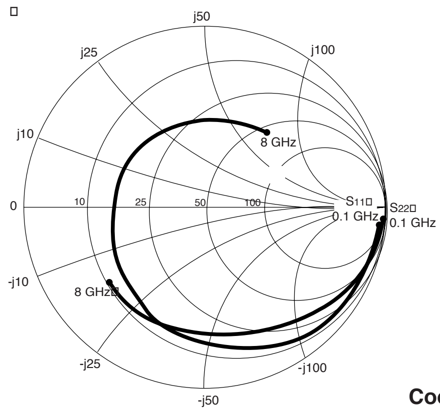
INSERTION POWER GAIN, MAXIMUM AVAILABLE POWER GAIN, MAXIMUM STABLE POWER GAIN vs. COLLECTOR CURRENT

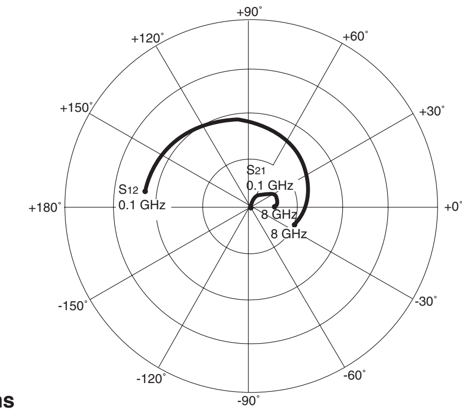


OUTPUT, COLLECTOR CURRENT vs. INPUT POWER



TYPICAL SCATTERING PARAMETERS ($T_A = 25^\circ C$)





Coordinates in Ohms
Frequency in GHz
(V_{CE} = 1 V, I_C = 1 mA)

V_C = 1 V, I_C = 1 mA

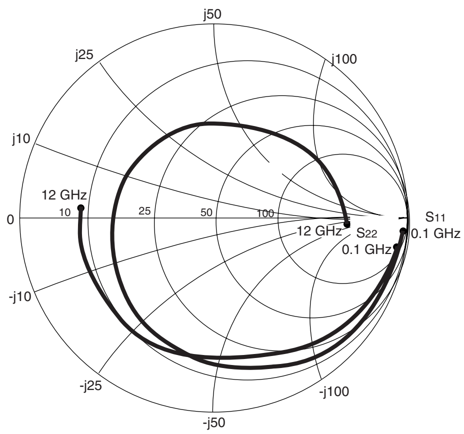
FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.10	0.944	-4.3	2.912	172.0	0.005	84.9	0.991	-4.3	0.15	27.53
0.20	0.943	-8.0	2.868	171.3	0.009	77.9	0.970	-7.6	0.22	24.88
0.30	0.941	-11.9	2.845	168.3	0.013	75.1	0.955	-10.2	0.22	23.30
0.40	0.939	-15.4	2.837	164.2	0.017	73.0	0.943	-12.8	0.23	22.21
0.50	0.935	-19.2	2.845	160.7	0.021	70.8	0.935	-15.2	0.22	21.37
0.70	0.930	-26.7	2.807	153.5	0.028	66.3	0.922	-19.9	0.22	20.00
1.00	0.916	-37.4	2.734	144.1	0.038	59.6	0.906	-26.7	0.22	18.57
1.50	0.862	-55.4	2.614	126.2	0.051	46.5	0.850	-37.3	0.39	17.08
2.00	0.807	-72.7	2.526	110.8	0.061	36.2	0.821	-46.6	0.49	16.16
2.50	0.755	-89.4	2.337	96.3	0.068	26.8	0.794	-55.1	0.61	15.38
3.00	0.693	-106.9	2.236	82.4	0.071	18.3	0.768	-62.8	0.75	14.96
3.50	0.636	-124.7	2.095	68.9	0.072	10.7	0.744	-70.1	0.92	14.61
4.00	0.585	-143.5	1.977	55.6	0.071	4.5	0.723	-77.2	1.11	12.45
5.00	0.515	178.7	1.746	30.4	0.066	-2.9	0.696	-91.7	1.53	9.96
6.00	0.489	143.2	1.521	6.9	0.061	-1.9	0.689	-106.9	1.89	8.49
7.00	0.480	109.3	1.325	-14.4	0.066	0.9	0.688	-119.9	2.05	7.22
8.00	0.495	75.6	1.155	-34.5	0.076	2.0	0.679	-131.9	2.04	5.98

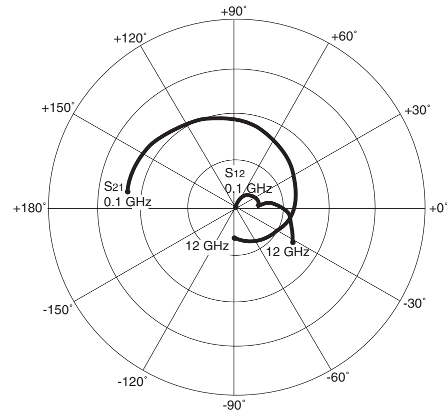
Note:
1. Gain Calculation:

$$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right).$$ When $K \leq 1$, MAG is undefined and MSG values are used. $$MSG = \frac{|S_{21}|}{|S_{12}|},\quad K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|},\quad \Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)





Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2 V, I_C = 1 mA)

V_C = 2 V, I_C = 1 mA

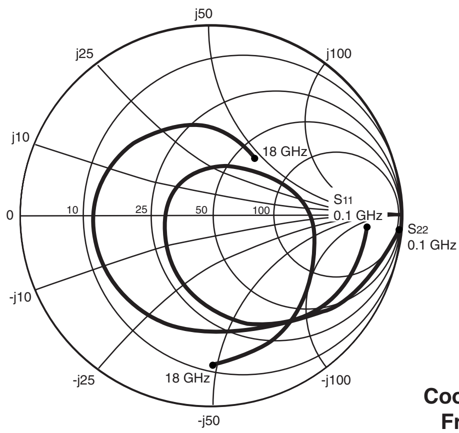
FREQUENCY (GHz)	S_{11} MAG	S_{11} ANG	S_{21} MAG	S_{21} ANG	S_{12} MAG	S_{12} ANG	S_{22} MAG	S_{22} ANG	K	MAG[1] (dB)
0.10	0.946	-4.2	2.929	172.1	0.005	84.2	0.992	-4.2	0.16	28.12
0.20	0.945	-7.7	2.882	171.5	0.008	76.7	0.971	-7.4	0.25	25.51
0.30	0.943	-11.6	2.860	168.6	0.012	74.8	0.956	-10.0	0.24	23.91
0.40	0.941	-14.9	2.853	164.6	0.015	72.6	0.944	-12.4	0.25	22.79
0.50	0.938	-18.6	2.861	161.2	0.018	70.6	0.937	-14.7	0.24	21.95
0.70	0.933	-25.9	2.825	154.2	0.025	66.5	0.924	-19.3	0.23	20.61
1.00	0.921	-36.3	2.756	145.0	0.033	60.4	0.909	-25.9	0.23	19.19
1.50	0.869	-53.9	2.643	127.4	0.045	47.8	0.856	-36.2	0.40	17.72
2.00	0.816	-70.7	2.563	112.3	0.053	38.1	0.829	-45.2	0.50	16.82
2.50	0.765	-87.0	2.377	98.0	0.059	29.2	0.805	-53.4	0.62	16.05
3.50	0.647	-121.6	2.142	70.9	0.063	14.4	0.759	-68.1	0.94	15.33
3.00	0.703	-104.1	2.281	84.2	0.062	21.3	0.781	-60.9	0.76	15.65
4.00	0.593	-139.9	2.027	57.7	0.062	9.4	0.740	-75.2	1.14	12.87
5.00	0.518	-177.4	1.799	32.7	0.057	4.6	0.716	-89.6	1.58	10.51
6.00	0.485	147.0	1.573	9.1	0.056	8.2	0.711	-104.7	1.86	9.10
7.00	0.472	112.6	1.372	-12.2	0.064	11.0	0.711	-117.7	1.89	7.86
8.00	0.483	78.3	1.197	-32.2	0.078	10.5	0.704	-129.7	1.82	6.62
9.00	0.541	49.9	1.039	-51.0	0.098	4.2	0.700	-142.3	1.56	5.85
10.00	0.604	28.4	0.914	-67.6	0.120	-3.8	0.697	-154.8	1.30	5.53
11.00	0.653	10.2	0.821	-84.2	0.144	-15.4	0.698	-169.7	1.07	5.90
12.00	0.691	-7.9	0.734	-101.2	0.168	-29.3	0.693	173.1	0.96	6.41

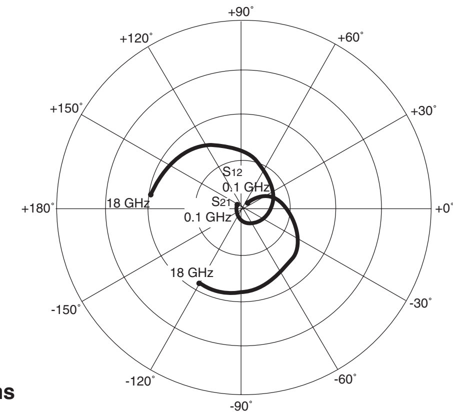
Note:
1. Gain Calculation:

$$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right).$$ When K ≤ 1, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|}$, $\Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS ($T_A = 25^\circ C$)





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V_C = 2 V, I_C = 5 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.10	0.823	-5.3	10.113	172.3	0.004	81.5	0.979	-5.1	0.27	34.04
0.20	0.816	-11.4	9.907	167.9	0.008	75.6	0.954	-9.1	0.32	31.13
0.30	0.807	-17.0	9.734	163.0	0.011	72.1	0.933	-12.5	0.34	29.55
0.40	0.797	-22.0	9.571	158.1	0.014	70.1	0.916	-15.5	0.34	28.41
0.50	0.784	-27.2	9.433	153.3	0.017	67.9	0.902	-18.5	0.35	27.54
0.70	0.757	-37.1	9.037	144.0	0.022	63.3	0.873	-23.9	0.37	26.18
1.00	0.710	-51.0	8.386	131.4	0.029	57.0	0.836	-31.3	0.43	24.69
1.50	0.592	-71.5	7.208	111.1	0.036	47.3	0.748	-41.2	0.67	23.00
2.00	0.498	-89.6	6.429	95.0	0.042	41.5	0.704	-49.1	0.83	21.77
2.50	0.417	-106.7	5.446	80.7	0.046	37.6	0.672	-55.9	0.98	20.73
3.00	0.345	-124.2	4.809	67.8	0.050	34.7	0.649	-62.1	1.11	17.80
3.50	0.289	-143.0	4.283	55.9	0.054	32.2	0.631	-68.0	1.23	16.15
4.00	0.249	-163.9	3.862	44.7	0.058	30.0	0.619	-74.1	1.30	14.95
5.00	0.221	153.2	3.218	23.5	0.067	25.3	0.606	-87.3	1.37	13.17
6.00	0.235	117.2	2.732	3.3	0.078	19.5	0.614	-101.9	1.35	11.92
7.00	0.255	84.3	2.369	-15.7	0.090	11.9	0.621	-114.5	1.31	10.86
8.00	0.298	53.7	2.074	-33.9	0.101	3.5	0.622	-125.8	1.30	9.84
9.00	0.371	32.9	1.834	-51.5	0.114	-5.1	0.625	-138.3	1.20	9.31
10.00	0.439	18.4	1.657	-67.9	0.130	-13.2	0.624	-150.4	1.08	9.33
11.00	0.497	5.3	1.521	-85.1	0.149	-23.8	0.625	-165.1	0.93	10.10
12.00	0.547	-9.8	1.395	-103.4	0.167	-36.4	0.622	178.1	0.83	9.22
13.00	0.597	-26.5	1.269	-121.9	0.185	-50.4	0.606	162.0	0.76	8.37
14.00	0.648	-42.6	1.147	-140.2	0.193	-64.4	0.575	146.0	0.76	7.73
15.00	0.693	-53.5	1.041	-158.0	0.204	-77.1	0.522	127.4	0.77	7.08
16.00	0.732	-64.5	0.963	-176.4	0.221	-91.0	0.488	106.8	0.71	6.39
17.00	0.758	-77.4	0.864	163.2	0.230	-107.7	0.434	79.8	0.77	5.75
18.00	0.787	-89.6	0.756	144.0	0.230	-122.4	0.368	52.7	0.88	5.16

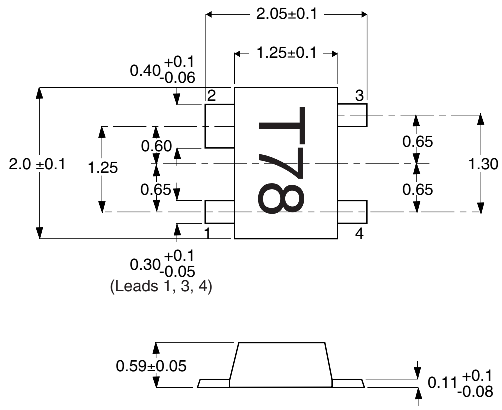
Note:
1. Gain Calculation:

$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When $K \leq 1$, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}S_{21}|}$, $\Delta = S_{11}S_{22} - S_{21}S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

OUTLINE DIMENSIONS (Units in mm)

PACKAGE OUTLINE M04



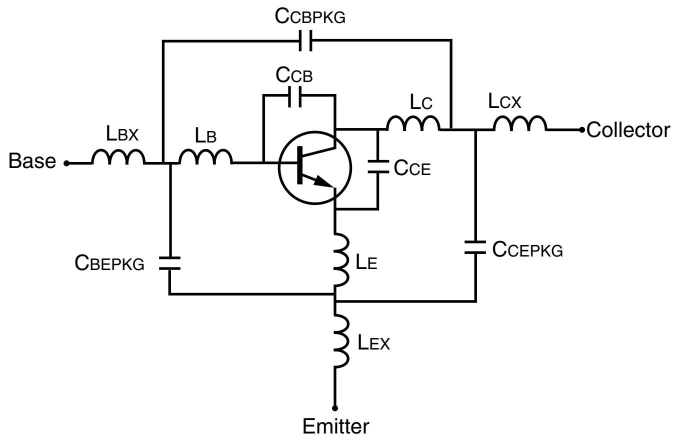
PIN CONNECTIONS
1. Emitter
2. Collector
3. Emitter
4. Base

ORDERING INFORMATION

PART NUMBER	QUANTITY	PACKAGING
NE661M04-T2-A	3000	Tape & Reel

NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

Parameters	Q1	Parameters	Q1
IS	2.2e-18	MJC	0.33
BF	120	XCJC	1
NF	1	CJS	0
VAF	39.7	VJS	0.75
IKF	0.21	MJS	0
ISE	4.64e-14	FC	0.5
NE	2.09	TF	2e-12
BR	10	XTF	20
NR	1.004	VTF	10
VAR	1.9	ITF	0.1
IKR	0.1	PTF	200
ISC	1.1e-11	TR	1e-11
NC	41	EG	1.11
RE	3.5	XTB	0
RB	14	XTI	3
RBM	14	KF	0
IRB	0.004	AF	1
RC	8		
CJE	0.3e-12		
VJE	0.5		
MJE	0.33		
CJC	0.001e-12		
VJC	0.75		

(1) Gummel-Poon Model

ADDITIONAL PARAMETERS

Parameters	NE661M04
C_{CB}	0.08e-12
C_{CE}	0.1e-12
L_B	0.93e-9
L_C	0.6e-9
L_E	0.2e-9
C_{CBPKG}	0.001e-12
C_{CEPKG}	0.25e-12
C_{BEPK}	0.2e-12
L_{BX}	0.2e-9
L_{CX}	0.2e-9
L_{EX}	0.05e-9

MODEL RANGE
Frequency: 0.1 to 18 GHz
Bias: V_{CE} = 0.5 V to 2.5 V, I_C = 1 mA to 7 mA
Date: 02/2002

CEL California Eastern Laboratories

4590 Patrick Henry Drive
Santa Clara, CA 95054-1817
Telephone: (408) 919-2500
Facsimile: (408) 988-0279

Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL's understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

<table>
<tr><th rowspan="1">Restricted Substance per RoHS</th><th>Concentration Limit per RoHS (values are not yet fixed)</th><th colspan="2">Concentration contained in CEL devices</th></tr>
<tr><td rowspan="2">Lead (Pb)</td><td rowspan="2">< 1000 PPM</td><td>-A</td><td>-AZ</td></tr>
<tr><td>Not Detected</td><td>(*)</td></tr>
<tr><td>Mercury</td><td>< 1000 PPM</td><td colspan="2">Not Detected</td></tr>
<tr><td>Cadmium</td><td>< 100 PPM</td><td colspan="2">Not Detected</td></tr>
<tr><td>Hexavalent Chromium</td><td>< 1000 PPM</td><td colspan="2">Not Detected</td></tr>
<tr><td>PBB</td><td>< 1000 PPM</td><td colspan="2">Not Detected</td></tr>
<tr><td>PBDE</td><td>< 1000 PPM</td><td colspan="2">Not Detected</td></tr>
</table>

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.