PRELIMINARY DATA SHEET

NEC

NPN EPITAXIAL SILICON TRANSISTOR FOR MICROWAVE HIGH-GAIN AMPLIFICATION

NE699M01

FEATURES

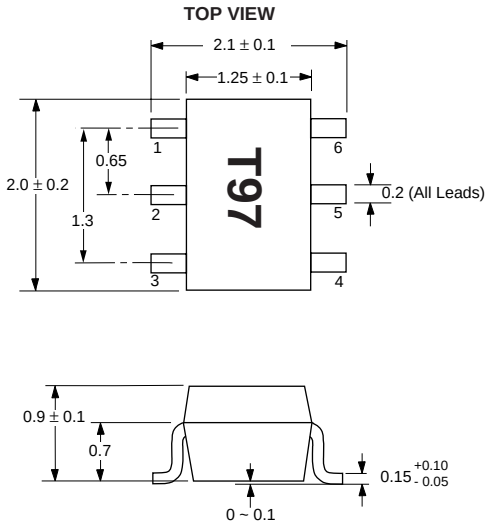
- **HIGH f_T:**
  16 GHz TYP at 2 V, 20 mA
- **LOW NOISE FIGURE:**
  NF = 1.1 dB TYP at 2 GHz
- **HIGH GAIN:**
  $|S_{21E}|^2$ = 14 dB TYP at f = 2 GHz
- **6 PIN SMALL MINI MOLD PACKAGE**
- **EXCELLENT LOW VOLTAGE, LOW CURRENT PERFORMANCE**

DESCRIPTION

The NE699M01 is an NPN high frequency silicon epitaxial transistor (NE687) encapsulated in an ultra small 6 pin SOT-363 package. Its four emitter pins decrease emitter inductance resulting in 3 dB more gain compared to conventional SOT-23 and SOT-143 devices. The NE699M01 is ideal for LNA and pre-driver applications up to 2.4 GHz where low cost, high gain, low voltage and low current are prime considerations.

OUTLINE DIMENSIONS (Units in mm)

PACKAGE OUTLINE M01



PIN CONNECTIONS

1. Emitter	4. Emitter
2. Emitter	5. Emitter
3. Base	6. Collector

Note: Pin 3 is identified with a circle on the bottom of the package.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER PACKAGE OUTLINE			NE699M01 M01		
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**
I_{CBO}	Collector Cutoff Current at V_{CB} = 5 V, I_E = 0	µA			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	µA			0.1
h_{FE}[1]	DC Current Gain at V_{CE} = 2 V, I_C = 20 mA		70		140
f_T	Gain Bandwidth Product at V_{CE} = 2 V, I_C = 20mA, f = 2.0GHz	GHz	13	16	
C_{RE}[2]	Feedback Capacitance at V_{CB} = 2 V, I_E = 0, f = 1 MHz	pF		0.2	0.3
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 2 V, I_C = 20 mA, f = 2.0 GHz	dB	12	14	
NF	Noise Figure at V_{CE} = 2 V, I_C = 3 mA, f = 2.0 GHz	dB		1.1	1.8

Notes:
1. Pulsed measurement, pulse width ≤ 350 µs, duty cycle ≤ 2 %.
2. The emitter terminal should be connected to the ground terminal of the 3 terminal capacitance bridge.

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

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	5
V_{CEO}	Collector to Emitter Voltage	V	3
V_{EBO}	Emitter to Base Voltage	V	2
I_C	Collector Current	mA	30
P_T	Total Power Dissipation	mW	90
T_J	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to +150

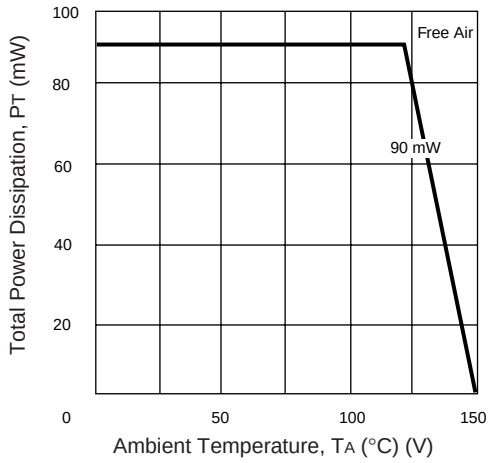
Notes:
1. Operation in excess of any one of these parameters may result in permanent damage.

ORDERING INFORMATION

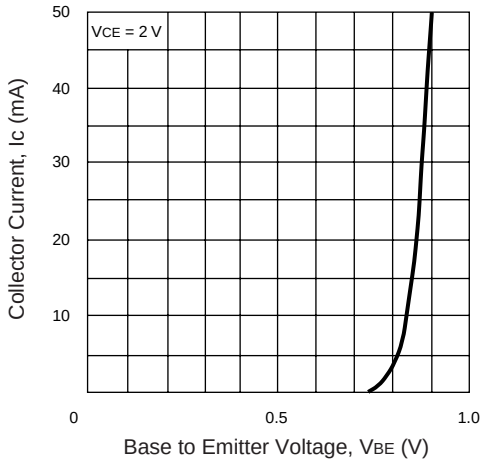
PART NUMBER	QUANTITY	PACKAGING
NE699M01-T1	3000	Tape & Reel

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

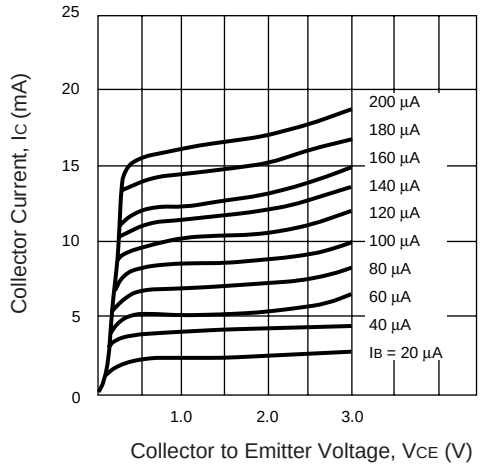
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



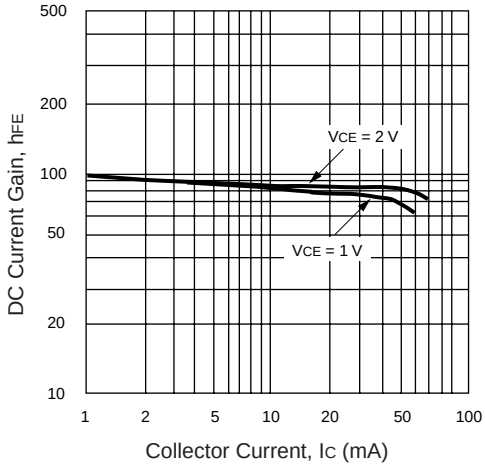
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

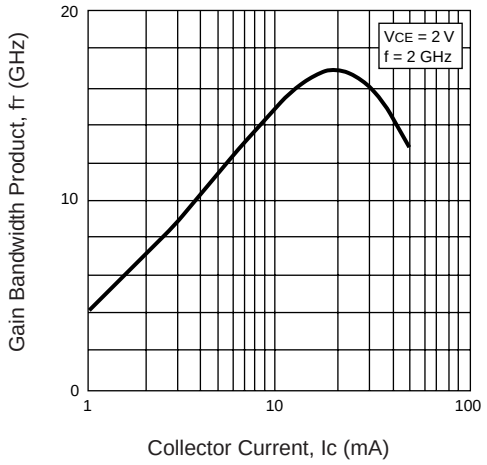


DC CURRENT GAIN vs. COLLECTOR CURRENT

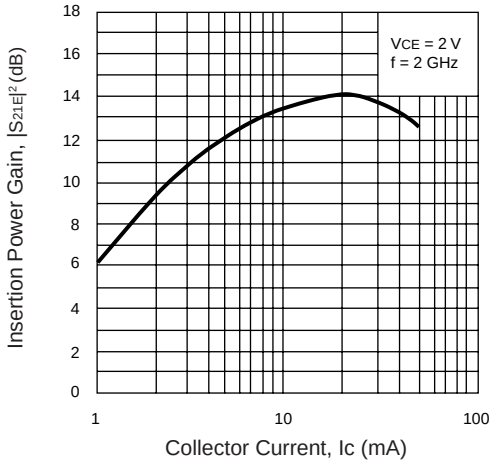


TYPICAL PERFORMANCE CURVES (T_A = 25°C)

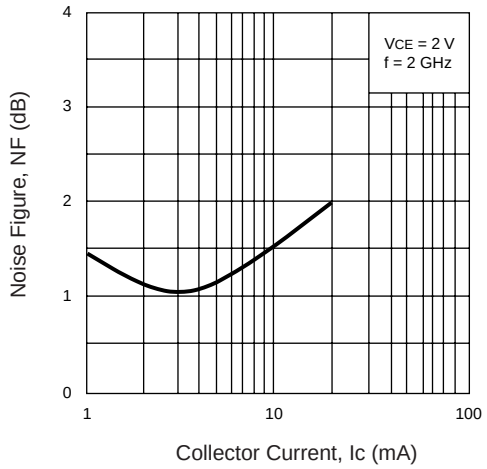
GAIN BANDWIDTH PRODUCT vs. Ic CHARACTERISTICS



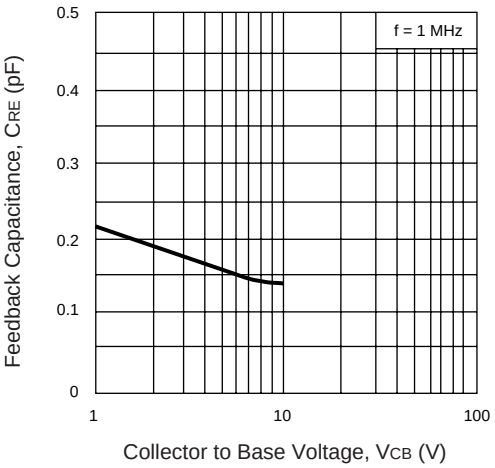
INSERTION POWER GAIN vs. Ic CHARACTERISTICS



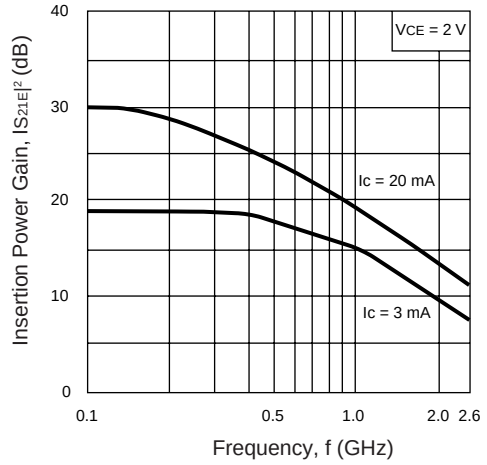
NOISE FIGURE vs. Ic CHARACTERISTICS



FEEDBACK CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



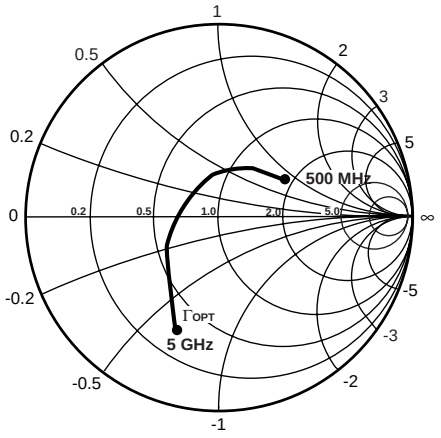
INSERTION POWER GAIN vs. FREQUENCY CHARACTERISTICS



TYPICAL NOISE PARAMETERS (T_A = 25°C)

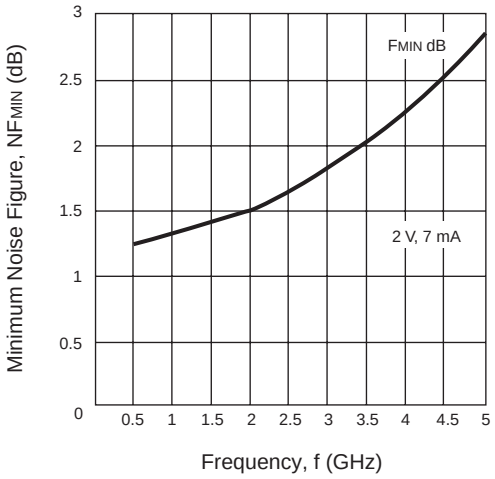
FREQ. (MHz)	NF_{OPT} (dB)	G_A (dB)	Γ_{OPT} MAG	Γ_{OPT} ANG	Rn/50
V_{CE} = 2 V, IC = 7 mA					
0.50	1.25	23.0	0.40	27	0.25
1.00	1.35	19.7	0.32	50	0.34
1.50	1.46	17.0	0.27	70	0.22
2.00	1.55	14.3	0.22	93	0.21
2.50	1.70	12.0	0.18	130	0.17
3.00	1.86	9.8	0.17	160	0.12
4.00	2.30	9.2	0.30	-150	0.08
5.00	2.75	8.2	0.60	-111	0.28

TYPICAL CONSTANT NOISE FIGURE

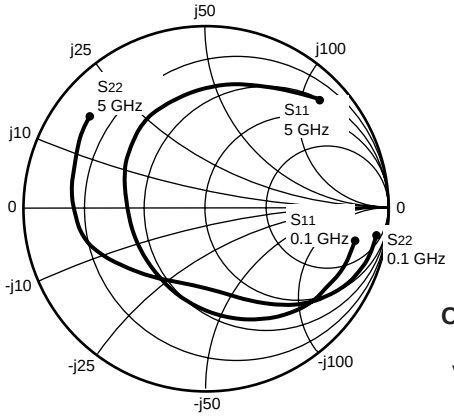


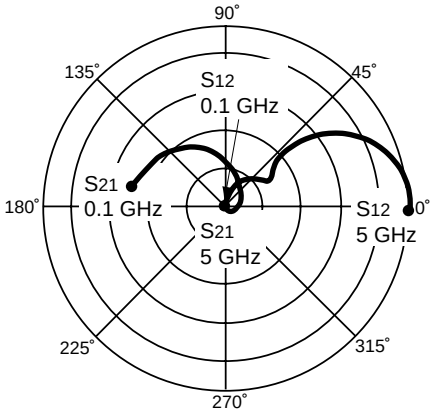
2 V, 7 mA

MINIMUM NOISE FIGURE vs. FREQUENCY



TYPICAL SCATTERING PARAMETERS (T_A = 25°C)





Coordinates in Ohms
Frequency in GHz
V_{CE} = 2 V, I_C = 5 mA

NE699M01
V_{CE} = 2 V, I_C = 1 mA

FREQUENCY	S11		S21		S12		S22		K	MAG[1]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.965	-5.8	3.118	169.3	0.013	82.4	0.990	-4.4	0.17	23.8
0.250	0.957	-16.5	2.957	164.0	0.031	76.7	0.985	-10.5	0.10	19.8
0.400	0.939	-26.7	2.971	155.1	0.049	69.3	0.972	-16.8	0.13	17.8
0.600	0.903	-40.4	2.934	143.5	0.070	59.7	0.947	-24.9	0.17	16.2
0.800	0.856	-54.6	2.871	132.0	0.088	50.0	0.917	-32.8	0.22	15.1
1.000	0.806	-68.8	2.754	120.8	0.102	40.9	0.881	-40.3	0.27	14.3
1.200	0.754	-83.5	2.648	109.7	0.112	32.3	0.844	-47.4	0.33	13.7
1.400	0.708	-98.0	2.503	99.4	0.118	24.3	0.809	-54.0	0.38	13.3
1.600	0.672	-111.7	2.334	89.6	0.119	17.0	0.778	-60.4	0.45	12.9
1.800	0.642	-125.3	2.196	80.6	0.118	10.6	0.752	-66.6	0.51	12.7
2.000	0.623	-137.6	2.045	71.9	0.114	5.1	0.732	-72.7	0.59	12.6
2.500	0.619	-162.8	1.687	53.0	0.095	-4.3	0.706	-87.7	0.83	12.5
3.000	0.637	178.8	1.410	37.3	0.073	-5.0	0.708	-102.9	1.17	10.4
3.500	0.661	164.5	1.179	23.6	0.056	9.0	0.728	-117.2	1.58	8.8
4.000	0.685	152.0	1.000	11.8	0.058	34.6	0.753	-130.2	1.55	8.0
4.500	0.705	139.7	0.851	1.7	0.079	49.5	0.780	-141.1	1.16	7.9
5.000	0.721	126.6	0.735	-7.0	0.109	52.3	0.804	-150.0	0.89	8.3

V_{CE} = 2 V, I_C = 5 mA

FREQUENCY	S11		S21		S12		S22		K	MAG[1]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.844	-11.8	13.310	166.4	0.012	79.5	0.955	-8.7	0.21	30.4
2.500	0.467	162.3	3.441	50.7	0.075	33.4	0.423	-100.4	0.19	26.4
0.400	0.735	-49.7	11.439	140.3	0.041	60.0	0.847	-31.2	0.25	24.5
0.600	0.634	-72.3	10.168	124.9	0.053	49.9	0.751	-42.8	0.35	22.8
0.800	0.546	-93.2	8.857	112.0	0.061	42.4	0.665	-52.0	0.45	21.7
1.000	0.482	-112.5	7.697	101.2	0.065	37.2	0.596	-59.3	0.56	20.7
1.200	0.442	-130.3	6.735	91.9	0.068	33.7	0.541	-65.6	0.66	20.0
1.400	0.422	-146.3	5.939	83.9	0.069	31.6	0.501	-71.3	0.77	19.3
1.600	0.416	-159.8	5.277	76.8	0.070	30.4	0.471	-76.6	0.87	18.8
1.800	0.419	-171.6	4.746	70.2	0.071	30.2	0.450	-81.9	0.96	18.3
2.000	0.429	179.0	4.288	64.2	0.072	30.6	0.436	-87.1	1.04	16.5
2.500	0.467	162.3	3.441	50.7	0.075	33.4	0.423	-100.4	1.19	14.0
3.000	0.503	151.4	2.860	38.7	0.081	37.6	0.435	-113.5	1.24	12.5
3.500	0.534	142.8	2.433	27.7	0.092	41.2	0.465	-125.3	1.21	11.5
4.000	0.560	134.8	2.108	17.3	0.106	43.1	0.503	-135.6	1.12	10.9
0.450	0.716	-55.4	11.128	136.4	0.045	57.4	0.826	-34.4	1.02	10.9
5.000	0.602	115.7	1.636	-2.0	0.143	41.5	0.588	-150.7	0.91	10.6

Note:
1. Gain Calculation:

$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When $K \le 1$, 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°C)

NE699M01
V_{CE} = 2 V, I_C = 7 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.792	-14.7	17.256	164.9	0.012	78.8	0.939	-10.3	0.23	31.6
0.250	0.743	-37.2	15.479	149.9	0.027	67.6	0.882	-24.0	0.23	27.6
0.400	0.658	-58.5	14.101	135.4	0.038	57.9	0.794	-35.7	0.31	25.7
0.600	0.552	-83.5	12.010	119.6	0.048	48.8	0.683	-47.5	0.43	24.0
0.800	0.471	-105.7	10.130	107.1	0.054	43.0	0.593	-56.4	0.55	22.8
1.000	0.421	-125.7	8.616	97.0	0.058	39.5	0.525	-63.4	0.67	21.7
1.200	0.397	-143.6	7.432	88.4	0.061	37.5	0.476	-69.4	0.77	20.9
1.400	0.389	-158.8	6.493	81.0	0.063	36.7	0.440	-74.9	0.87	20.1
1.600	0.393	-171.3	5.738	74.5	0.065	36.5	0.415	-80.1	0.96	19.5
1.800	0.403	178.2	5.137	68.4	0.067	37.0	0.397	-85.5	1.04	17.6
2.000	0.418	170.0	4.634	62.8	0.070	37.6	0.386	-90.7	1.10	16.3
2.500	0.460	155.6	3.710	50.2	0.077	40.2	0.378	-104.1	1.19	14.2
3.000	0.495	146.2	3.086	38.9	0.087	42.5	0.393	-117.0	1.21	12.8
3.500	0.525	138.5	2.630	28.4	0.099	43.9	0.423	-128.4	1.17	11.8
4.000	0.549	131.2	2.287	18.3	0.114	44.0	0.462	-138.0	1.09	11.2
4.500	0.569	122.8	2.015	8.7	0.131	42.8	0.505	-145.7	1.01	11.4
5.000	0.589	113.1	1.790	-0.7	0.150	40.5	0.549	-152.0	0.92	10.8

Note:
1. Gain Calculation:

$$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right).$$ When $K \le 1$, 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