PRELIMINARY DATA SHEET

NEC

NPN EPITAXIAL SILICON TRANSISTOR FOR MICROWAVE HIGH-GAIN AMPLIFICATION

NE698M01

FEATURES

- **HIGH f_T:**
  17 GHz TYP at 2 V, 7 mA
- **LOW NOISE FIGURE:**
  NF = 1.1 dB TYP at f = 2 GHz, 2 V, 1 mA
- **HIGH GAIN:**
  $|S_{21E}|^2$ = 15.5 dB TYP at f = 2 GHz
- **6 PIN SMALL MINI MOLD PACKAGE**
- **EXCELLENT LOW VOLTAGE, LOW CURRENT PERFORMANCE**

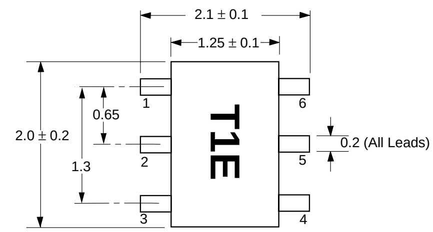
DESCRIPTION

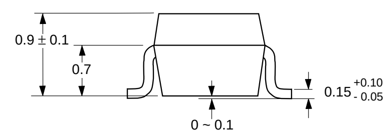
The NE698M01 is an NPN high frequency silicon epitaxial transistor (NE686) encapsulated in an ultra small 6 pin SOT-363 package. Its four emitter pins decrease emitter inductance resulting in 3 dB more gain compared to conventional SOT-23 and SOT-143 devices. The NE698M01 is ideal for LNA and pre-driver 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

TOP VIEW





PIN CONNECTIONS

1. Emitter
2. Emitter
3. Base
4. Emitter
5. Emitter
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			NE698M01 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 = 7 mA		70		140
f_T	Gain Bandwidth Product at V_{CE} = 2 V, I_C=7mA, f = 2.0GHz	GHz		17	
C_{RE}[2]	Feedback Capacitance at V_{CB} = 2 V, I_E=0, f=1 MHz	pF		0.1	0.15
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 2 V, I_C = 7 mA, f = 2.0 GHz	dB	13	15.5	
NF	Noise Figure at V_{CE} = 2 V, I_C = 1 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	10
P_T	Total Power Dissipation	mW	30
T_J	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to +150

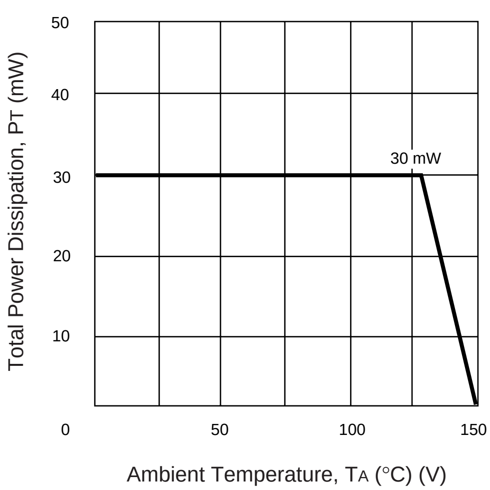
Notes:
1. Operation in excess of any one of these parameters may result in permanent damage.

ORDERING INFORMATION

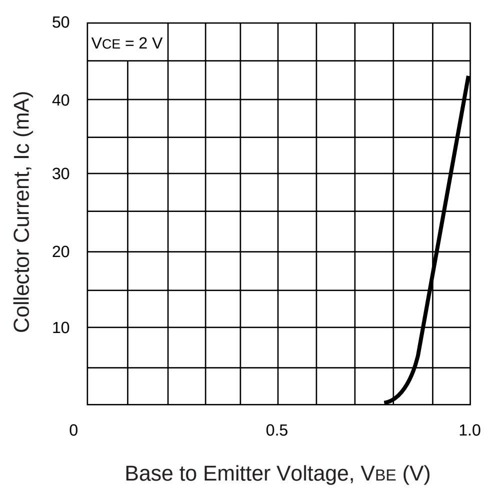
PART NUMBER	ORDER MULTIPLE	PACKAGING
NE698M01-T1	3000	Tape & Reel

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

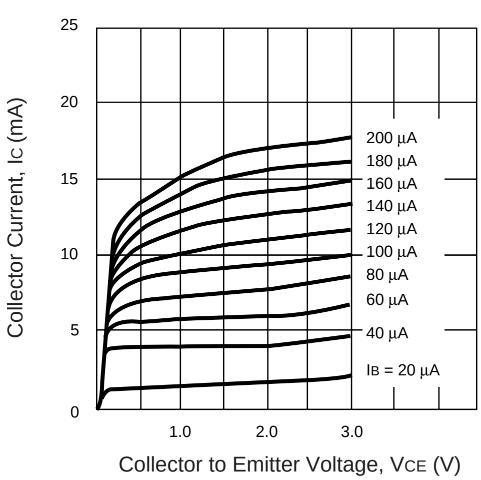
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



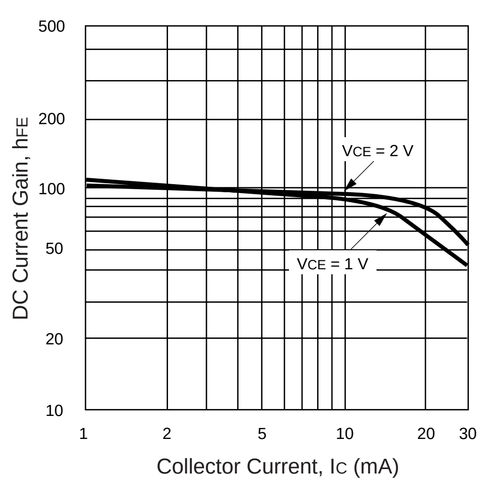
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

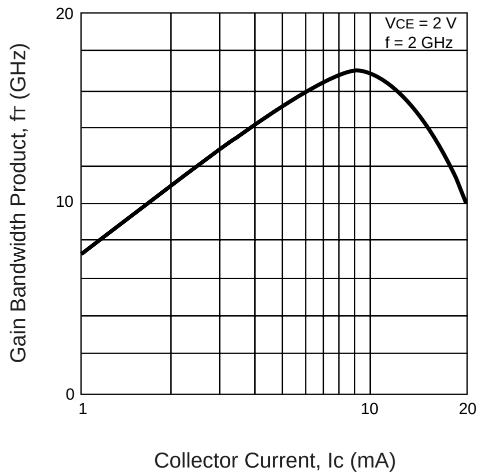


DC CURRENT GAIN vs. COLLECTOR CURRENT

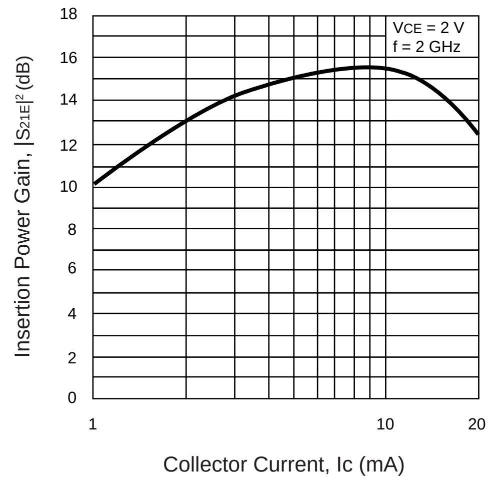


TYPICAL PERFORMANCE CURVES (T_A = 25°C)

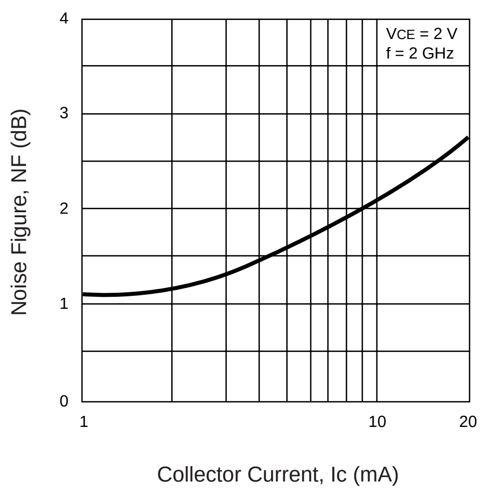
GAIN BANDWIDTH PRODUCT vs. Ic CHARACTERISTICS



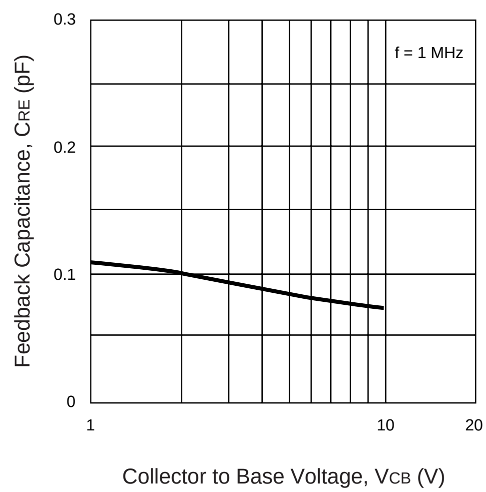
INSERTION POWER GAIN vs. Ic CHARACTERISTICS



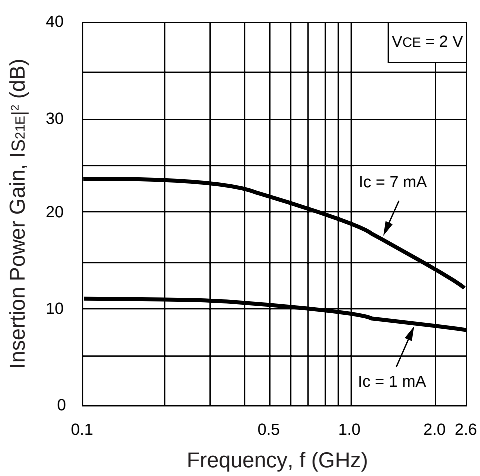
NOISE FIGURE vs. Ic CHARACTERISTICS



FEEDBACK CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



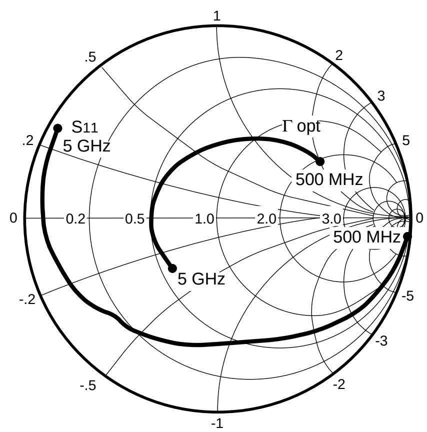
INSERTION POWER GAIN vs. FREQUENCY CHARACTERISTICS



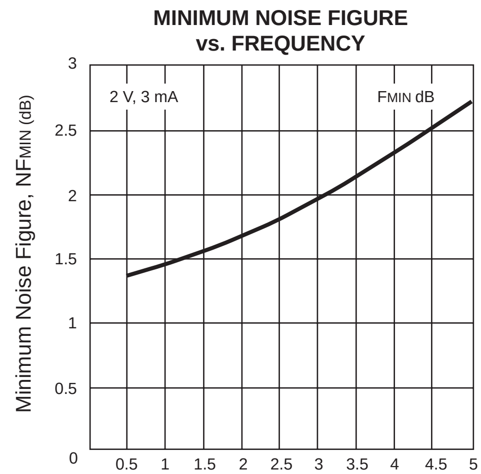
TYPICAL NOISE PARAMETERS (TA = 25°C)

FREQ. (GHz)	NFOPT (dB)	GA (dB)	ΓOPT MAG	ΓOPT ANG	Rn/50
VCE = 2 V, IC = 3 mA					
0.50	1.37	22	0.61	27	0.94
1.00	1.45	19	0.58	37	0.49
1.50	1.56	16.6	0.55	45	0.67
2.00	1.67	14.6	0.51	53	0.56
2.50	1.80	13.2	0.47	62	0.45
3.00	1.95	12.2	0.40	82	0.34
4.00	2.30	10.9	0.34	159	0.14
5.00	2.70	10.2	0.34	-134	0.31

TYPICAL OPTIMUM NOISE MATCH (ΓOPT)



(2 V, 3 mA)



TYPICAL SCATTERING PARAMETERS (T_A = 25°C)

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

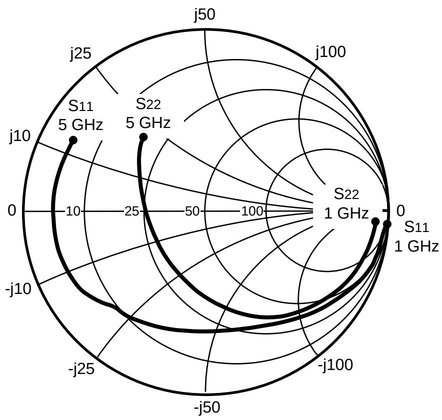
FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
f (MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
100	0.963	-3.9	2.863	171.7	0.006	82.8	0.987	-2.7	0.21	26.7
250	0.962	-10.0	2.880	167.7	0.015	80.1	0.989	-8.2	0.11	22.8
400	0.953	-16.1	2.893	161.3	0.024	75.5	0.984	-13.0	0.12	20.8
600	0.934	-24.2	2.886	152.6	0.035	68.8	0.973	-19.5	0.16	19.2
800	0.907	-32.4	2.893	143.7	0.045	61.8	0.957	-26.0	0.21	18.1
1000	0.874	-40.6	2.852	134.7	0.054	55.1	0.938	-32.5	0.27	17.3
1200	0.838	-49.2	2.823	126.0	0.061	48.8	0.919	-39.0	0.31	16.7
1400	0.799	-57.6	2.758	117.5	0.066	42.6	0.897	-45.5	0.37	16.2
1600	0.758	-66.2	2.685	108.9	0.070	36.6	0.875	-52.0	0.43	15.9
1800	0.715	-75.3	2.629	100.5	0.071	31.1	0.853	-58.4	0.50	15.7
2000	0.668	-84.6	2.573	92.0	0.071	26.1	0.834	-64.7	0.58	15.6
2500	0.587	-107.1	2.279	72.5	0.063	17.7	0.797	-80.0	0.84	15.6
3000	0.533	-131.1	2.035	54.6	0.050	19.5	0.780	-94.4	1.23	13.2
3500	0.518	-154.4	1.772	38.0	0.042	38.7	0.785	-107.6	1.56	11.9
4000	0.532	-175.9	1.534	23.4	0.052	63.3	0.800	-119.2	1.25	11.7
4500	0.561	165.6	1.324	10.7	0.077	72.0	0.821	-129.3	0.83	12.3
5000	0.592	149.7	1.146	-0.5	0.108	71.1	0.841	-138.1	0.58	10.3

Note:
1. Gain Calculations:

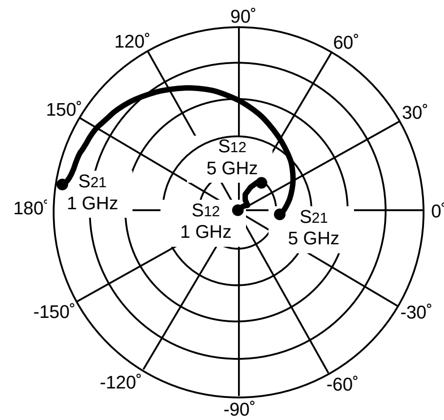
$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When K ≤ 1, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|}$, $\Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2 V, I_C = 3 mA)



V_{CE} = 2 V, I_C = 3 mA

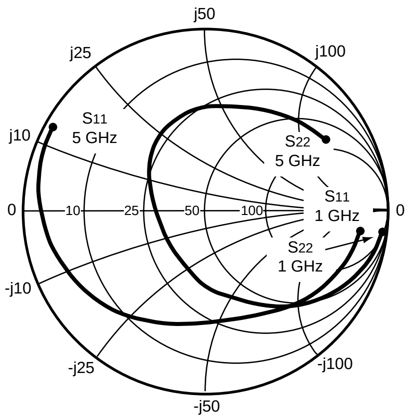
FREQUENCY	S11		S21		S12		S22		K	MAG[1]
f (MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
100	0.910	-5.49	7.711	170.42	0.006	85.31	0.983	-4.58	0.15	31.2
200	0.903	-12.15	7.507	165.89	0.012	79.32	0.975	-8.86	0.15	28.0
300	0.886	-18.46	7.391	159.88	0.017	74.51	0.962	-13.10	0.19	26.3
400	0.867	-23.84	7.277	153.86	0.022	71.17	0.949	-17.19	0.21	25.1
500	0.844	-29.82	7.211	148.01	0.027	67.27	0.932	-21.20	0.24	24.2
600	0.818	-35.35	7.024	142.43	0.031	63.60	0.913	-24.97	0.28	23.5
700	0.789	-40.72	6.842	136.76	0.035	59.99	0.893	-28.57	0.33	22.9
800	0.758	-46.19	6.679	131.59	0.038	56.72	0.873	-31.93	0.37	22.4
900	0.727	-51.33	6.479	126.49	0.041	53.71	0.853	-35.20	0.41	21.9
1000	0.696	-56.23	6.281	121.67	0.044	51.05	0.833	-38.24	0.45	21.6
1200	0.632	-66.19	5.923	112.11	0.047	46.49	0.796	-44.05	0.54	21.0
1400	0.573	-75.35	5.541	103.48	0.050	43.02	0.763	-49.33	0.64	20.5
1600	0.519	-84.27	5.162	95.39	0.051	40.54	0.735	-54.29	0.74	20.1
1800	0.465	-93.54	4.858	87.66	0.051	39.26	0.711	-59.16	0.85	19.8
2000	0.421	-102.59	4.554	80.30	0.051	38.93	0.692	-63.82	0.96	19.5
2200	0.387	-112.30	4.244	73.46	0.051	39.56	0.679	-68.35	1.06	17.7
2400	0.355	-122.55	3.999	66.73	0.051	41.72	0.667	-73.12	1.16	16.5
2600	0.331	-133.20	3.771	60.20	0.051	44.53	0.659	-77.85	1.25	15.7
2800	0.317	-144.52	3.554	53.94	0.052	48.11	0.656	-82.78	1.30	15.1
3000	0.309	-156.20	3.363	47.78	0.054	52.26	0.655	-87.66	1.31	14.6
3500	0.328	177.03	2.911	33.02	0.065	60.65	0.668	-100.67	1.19	13.9
4000	0.383	156.43	2.518	19.22	0.082	64.68	0.692	-113.87	0.98	14.9
4500	0.451	142.11	2.167	6.57	0.104	64.38	0.723	-126.63	0.77	13.2
5000	0.527	130.35	1.864	-4.78	0.126	61.60	0.737	-136.90	0.64	11.7

Note:
1. Gain Calculations:

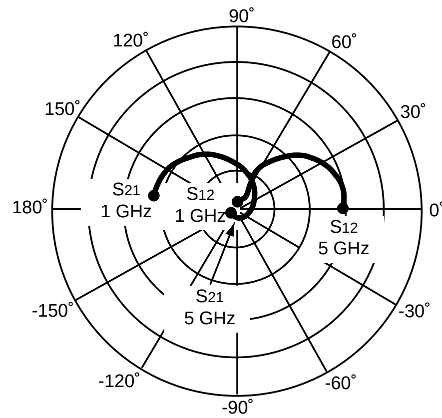
$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When K ≤ 1, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}S_{21}|}$, $\Delta = S_{11}S_{22} - S_{21}S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



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



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

FREQUENCY	S11		S21		S12		S22		K	MAG[1]
f (MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
100	0.852	-6.7	11.171	169.3	0.006	80.8	0.969	-4.3	0.29	32.8
250	0.828	-18.7	10.993	159.7	20.014	76.4	0.954	-12.3	0.21	28.9
400	0.786	-29.4	10.602	149.3	0.021	69.7	0.922	-19.1	0.27	27.0
600	0.713	-42.9	9.916	136.3	0.029	62.0	0.871	-27.3	0.37	25.3
800	0.629	-55.3	9.125	124.3	0.035	55.7	0.816	-34.3	0.48	24.1
1000	0.548	-66.7	8.319	113.7	0.039	51.0	0.765	-40.4	0.59	23.3
1200	0.478	-77.8	7.580	104.1	0.042	47.9	0.722	-45.9	0.70	22.5
1400	0.415	-88.4	6.906	95.6	0.044	45.9	0.686	-50.9	0.82	21.9
1600	0.364	-99.1	6.311	87.7	0.046	44.9	0.658	-55.9	0.93	21.4
1800	0.321	-110.6	5.807	80.3	0.047	45.2	0.636	-60.8	1.03	19.9
2000	0.289	-122.1	5.355	73.5	0.048	46.0	0.621	-65.7	1.12	18.4
2500	0.253	-151.7	4.432	57.8	0.052	51.3	0.604	-78.2	1.26	16.2
3000	0.266	-177.8	3.752	43.6	0.060	57.1	0.610	-90.8	1.25	15.0
3500	0.305	163.3	3.214	30.5	0.072	61.1	0.634	-103.1	1.12	14.4
4000	0.355	149.1	2.781	18.4	0.088	62.7	0.665	-114.1	0.95	15.0
4500	0.406	138.1	2.426	7.1	0.108	61.9	0.701	-123.7	0.78	13.5
5000	0.451	128.3	2.135	-3.3	0.130	59.6	0.735	-132.1	0.63	12.2

Note:
1. Gain Calculations:

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

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)

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

FREQUENCY	S11		S21		S12		S22		K	MAG[1]
f (MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
100	0.803	-8.4	14.546	168.7	0.006	81.2	0.965	-5.5	0.27	34.0
250	0.776	-22.1	13.446	157.1	0.014	75.0	0.942	-13.4	0.25	30.0
400	0.718	-34.6	12.779	145.1	0.020	67.6	0.898	-20.6	0.33	28.0
600	0.629	-49.7	11.594	131.0	0.027	60.5	0.834	-28.6	0.45	26.3
800	0.538	-63.2	10.364	118.7	0.032	55.3	0.773	-35.2	0.58	25.1
1000	0.457	-75.5	9.221	108.2	0.036	51.7	0.721	-40.6	0.71	24.1
1200	0.388	-87.6	8.246	98.8	0.038	49.9	0.679	-45.5	0.83	23.3
1400	0.332	-99.4	7.407	90.6	0.040	49.3	0.647	-50.1	0.95	22.7
1600	0.289	-111.4	6.694	83.1	0.042	49.7	0.623	-54.6	1.05	20.7
1800	0.255	-124.4	6.100	76.2	0.044	50.9	0.606	-59.3	1.14	19.2
2000	0.234	-137.5	5.591	69.7	0.046	52.3	0.595	-64.1	1.20	18.1
2500	0.227	-168.7	4.593	54.6	0.053	57.1	0.585	-76.6	1.26	16.3
3000	0.258	168.0	3.869	40.9	0.064	61.1	0.598	-89.6	1.20	15.1
3500	0.305	152.0	3.304	28.2	0.077	63.0	0.624	-102.0	1.07	14.7
4000	0.359	140.6	2.856	16.3	0.094	63.0	0.658	-113.2	0.91	14.8
4500	0.408	131.3	2.491	5.4	0.114	61.2	0.695	-123.0	0.75	13.4
5000	0.453	122.8	2.191	-4.9	0.135	58.4	0.730	-131.5	0.62	12.1

Note:
1. Gain Calculations:

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