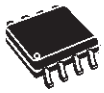
TSH690

40MHz to 1GHz AMPLIFIER

- 1.5V to 5V OPERATING VOLTAGE
- 28dB GAIN @ 3V @ 450MHz
- 20dB GAIN @ 3V @ 900MHz
- +13.5dBm OUTPUT POWER (P1dB)
- BIAS PIN FOR CURRENT ADJUST & AMPLIFIER DISABLE
- ADJUSTABLE OUTPUT POWER
- 50Ω INPUT/OUTPUT MATCHING
- FULLY GUARANTEED AT 2.7V



D
SO8
(Plastic Micropackage)

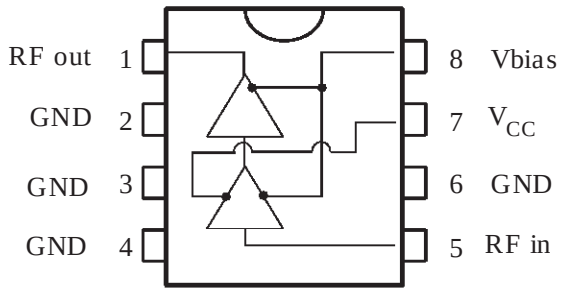
DESCRIPTION

TSH690 is a wide band RF amplifier, consisted of 2 stages, designed in advanced bipolar process featuring 28dB gain and +13.5dBm output power at 450MHz under 3V. The pin 8 allows an external bias current adjust to tune the output power and also to set the amplifier in power-down mode. This powerful amplifier is dedicated to equip secured RF data transmitters as antenna drivers in ISM band (reliable RF meter-reading systems, secured Remote Controls, Cordless Telephones, ...)

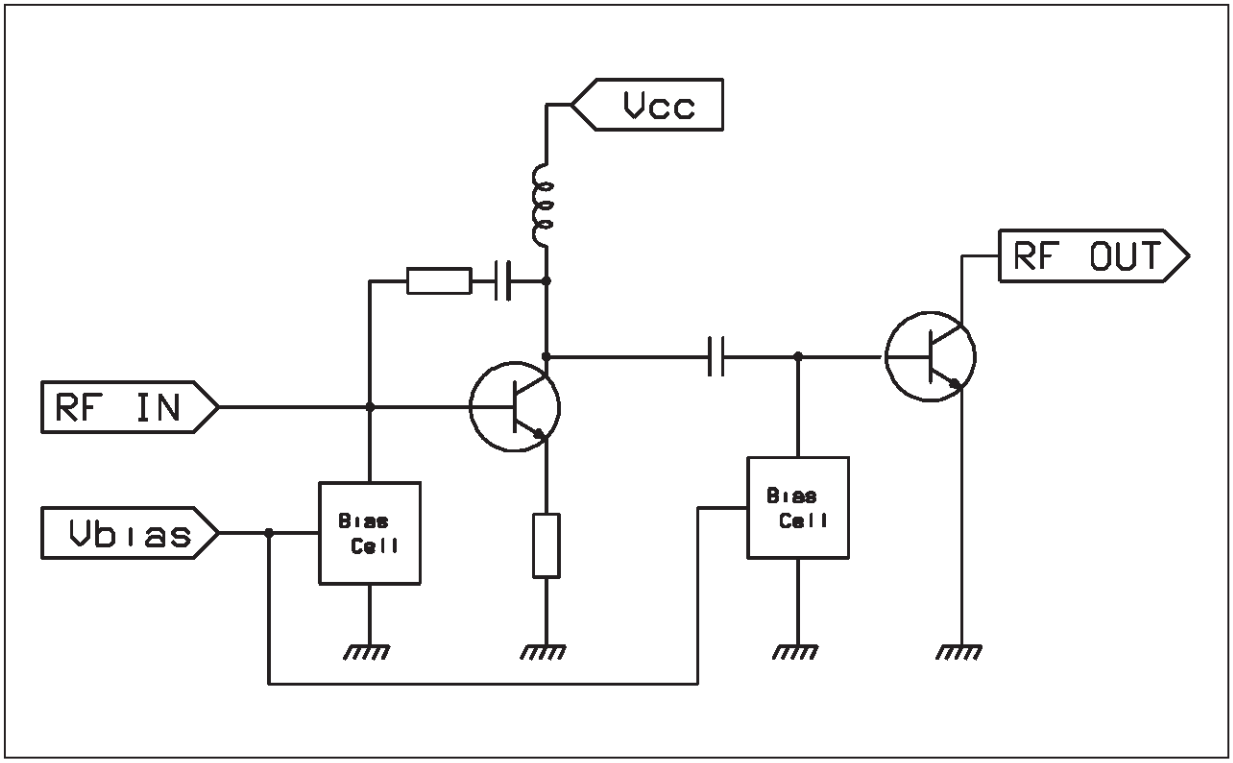
ORDER CODES

Part Number	Temperature Range	Package
		D
TSH690ID	-40, +85°C	•

PIN CONNECTIONS (top view)



SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC1}, V_{CC2}, V_{bias}	Supply Voltages & Bias Voltage	5.5	V
RF in	RF Input Power	+10	dBm
RF out	RF Output Power	+21	dBm
T_{oper}	Operating Free Air Temperature Range	-40 to +85	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{CC1}, V_{CC2}	Supply Voltages	1.5 to 5	V
V_{bias}	Bias Voltage	0 to 6	V
RF_{sr}	RF Signal Range	40 to 1000	MHz

ESD SENSITIVE DEVICE

Handling Precautions Required

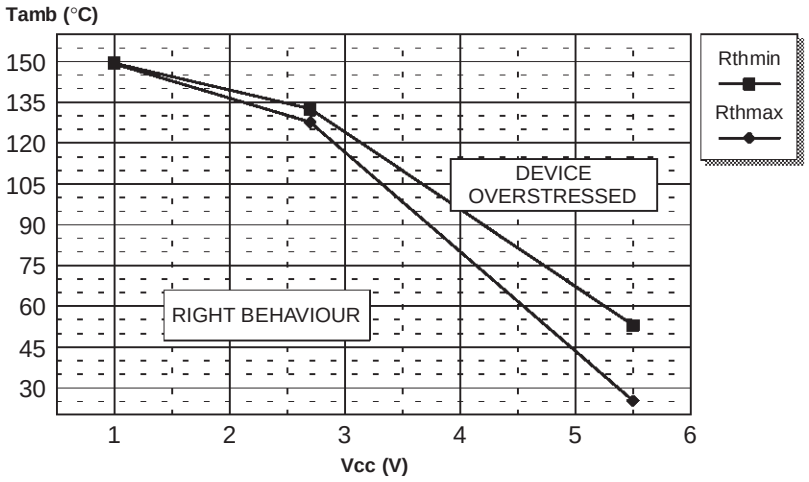
ELECTRICAL CHARACTERISTICS

T_{amb} = 25°C, V_{CC} & V_{bias} = +2.7V, Z_L = 50Ω

Parameter	TSH690			Unit
	Min.	Typ.	Max.	
Supply Current	40	46		mA
S21 (V_{in} = -20dBm, f = 450MHz)	20	23	30	dB
S21 (V_{in} = -20dBm, f = 900MHz)		17		dB
Output Power 1dB Compression (f = 450MHz)	8	12		dBm
3rd Order Intercept Point (f = 430MHz)	16	22		dBm
S12 (Reverse Isolation @ f = 400MHz)		-46		dB
S11 (Input Return Loss @ f = 450MHz)	-10	-15		dB
S11 (Input Return Loss @ f = 900MHz)		-10		dB
Noise Figure @ f = 450MHz		4.5		dB
Noise Figure @ f = 900MHz		5.4		dB
$R_{th(j-a)}$ Junction Ambient Thermal Resistance For SO8 Package	140		180	°C/W

All parameters with min. or max. figures are 100% tested.

SO8 PACKAGE THERMAL RESISTIVITY



DEFINITION

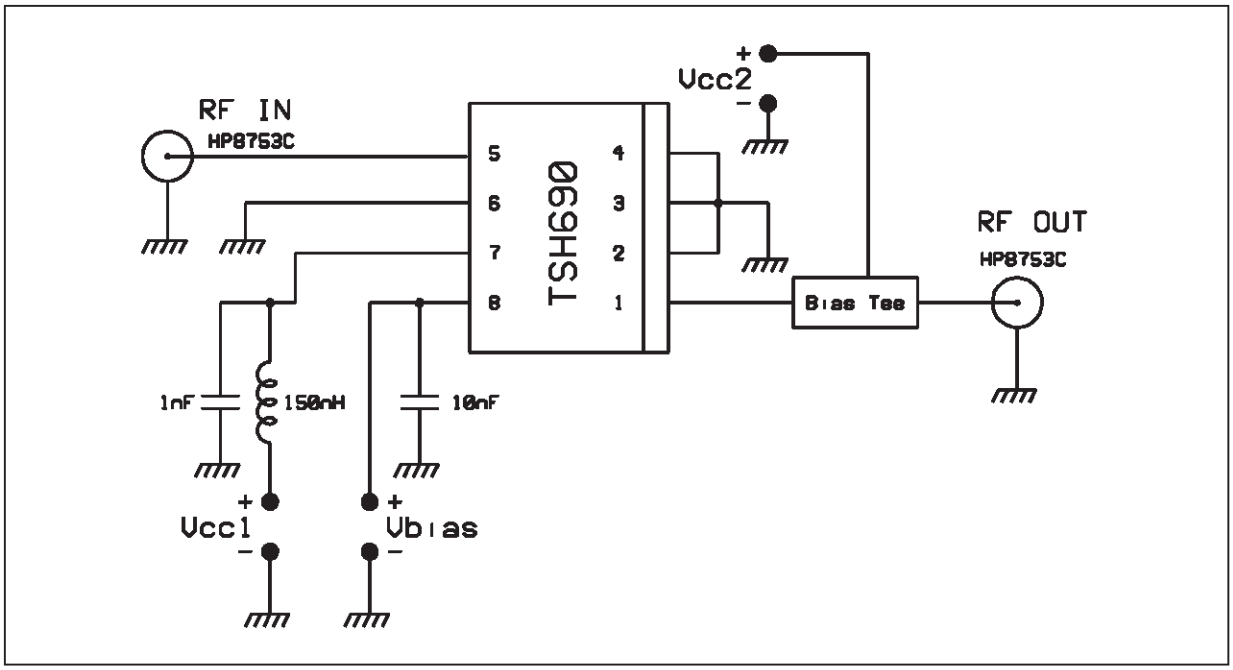
$R_{th(j-a)}$ Junction Ambient Thermal Resistance
T_j (°C) Maximum Die Junction Temperature (~ 150°C)
T_{amb} (°C) Ambient Temperature
P_d (W) Maximum Dissipated Power (P_d = 0.75 V_{CC} • I_{CC})

REMARKS

The right behaviour is obtained when the following equation is fulfilled.

$$T_j - T_{amb} = P_d \bullet R_{th(j-a)}$$

TYPICAL SCATTERING PARAMETERS (Reference waves planes at package leads)



TEST CONDITIONS V_{CC1}, V_{CC2}, V_{bias} = +2V, Pin = -40dBm, T_{amb} = 25°C

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
40	0.642	-22.0	6.319	5.0	0.003	-126.5	0.715	-54.7
50	0.615	-25.7	6.406	7.1	0.008	170.7	0.631	-64.7
100	0.537	-41.3	7.643	7.7	0.002	70.1	0.369	-91.3
150	0.490	-55.6	9.353	3.1	0.004	-141.9	0.253	-100.9
200	0.464	-68.0	11.502	-5.7	0.007	-117.3	0.202	-100.9
250	0.428	-79.0	13.856	-18.0	0.003	162.3	0.203	-92.7
300	0.413	-92.1	16.229	-33.4	0.005	142.1	0.209	-87.6
350	0.373	-101.5	18.019	-51.2	0.008	101.4	0.263	-89.4
400	0.334	-106.7	19.110	-70.1	0.008	115.2	0.326	-99.7
450	0.312	-111.5	19.159	-90.3	0.008	169.9	0.382	-112.1
500	0.290	-112.5	18.154	-108.0	0.008	111.5	0.395	-122.9
550	0.302	-114.5	16.778	-124.8	0.010	92.1	0.425	-130.0
600	0.324	-118.2	15.075	-140.5	0.015	93.6	0.424	-139.6
650	0.335	-122.9	13.482	-153.6	0.011	109.6	0.427	-150.8
700	0.349	-129.6	11.992	-165.5	0.011	101.7	0.425	-159.0
750	0.368	-135.0	10.750	-177.2	0.019	82.4	0.414	-169.5
800	0.366	-142.1	9.453	173.4	0.011	79.5	0.413	-177.8
850	0.373	-147.9	8.598	165.0	0.015	60.2	0.432	176.2
900	0.374	-154.1	7.783	155.8	0.013	89.7	0.438	166.4
950	0.381	-159.0	7.117	146.7	0.017	111.3	0.447	160.8
1000	0.377	-165.8	6.500	138.9	0.013	82.2	0.462	155.1

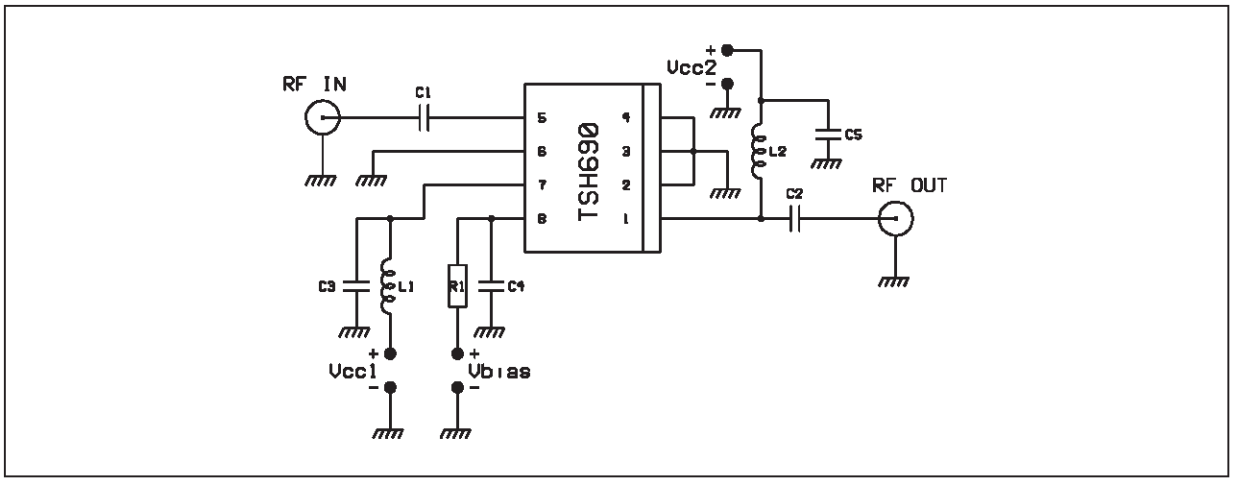
TEST CONDITIONS V_{CC1}, V_{CC2}, V_{bias} = +3V, Pin = -40dBm, T_{amb} = 25°C

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
40	0.616	-23.3	9.237	6.2	0.002	-135.8	0.733	-56.9
50	0.595	-27.0	9.402	7.9	0.005	-169.5	0.651	-67.7
100	0.513	-43.4	11.263	6.5	0.006	-153.8	0.381	-101.7
150	0.470	-57.7	13.566	0.9	0.006	94.5	0.227	-119.1
200	0.436	-71.1	16.434	-8.6	0.007	155.8	0.156	-117.5
250	0.402	-82.2	19.416	-21.3	0.007	154.1	0.134	-100.3
300	0.382	-95.0	22.265	-36.6	0.005	7.2	0.135	-75.7
350	0.343	-103.3	24.337	-53.7	0.008	40.6	0.193	-78.0
400	0.302	-109.7	25.564	-71.8	0.010	125.9	0.269	-86.1
450	0.279	-114.8	25.594	-91.2	0.008	167.1	0.316	-100.6
500	0.271	-114.0	24.292	-108.3	0.011	120.2	0.356	-111.0
550	0.280	-116.1	22.527	-124.7	0.013	101.0	0.396	-119.3
600	0.306	-119.8	20.511	-140.1	0.005	89.9	0.404	-131.3
650	0.315	-125.5	18.282	-153.2	0.006	107.2	0.400	-142.6
700	0.330	-131.1	16.311	-165.1	0.007	78.9	0.406	-151.6
750	0.333	-136.2	14.604	-177.1	0.012	84.5	0.398	-160.4
800	0.343	-142.5	12.860	173.6	0.017	76.0	0.399	-170.5
850	0.346	-148.0	11.668	165.1	0.014	90.8	0.411	-178.8
900	0.354	-155.1	10.579	156.0	0.018	75.6	0.413	170.9
950	0.347	-159.6	9.652	147.0	0.013	66.6	0.439	165.2
1000	0.355	-166.2	8.775	139.2	0.018	75.3	0.459	157.3

TEST CONDITIONS V_{CC1}, V_{CC2}, V_{bias} = +4V, Pin = -40dBm, T_{amb} = 25°C

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
40	0.614	-23.1	11.023	6.9	0.002	107.6	0.726	-54.4
50	0.590	-27.4	11.248	7.9	0.003	-111.3	0.646	-65.1
100	0.508	-44.6	13.262	4.5	0.004	-47.0	0.366	-97.6
150	0.465	-59.9	15.736	-2.0	0.006	-62.5	0.206	-110.4
200	0.429	-72.0	18.727	-11.5	0.003	97.7	0.130	-104.3
250	0.396	-83.4	21.837	-24.2	0.002	-135.5	0.108	-78.6
300	0.371	-94.7	24.804	-39.3	0.009	154.7	0.136	-56.7
350	0.335	-103.8	26.854	-56.0	0.006	135.2	0.191	-64.3
400	0.295	-109.9	28.077	-73.6	0.003	139.7	0.262	-75.2
450	0.275	-114.8	28.113	-92.5	0.010	97.0	0.321	-85.8
500	0.265	-114.8	26.710	-109.4	0.007	111.8	0.335	-98.2
550	0.282	-117.0	24.831	-125.5	0.007	93.8	0.389	-108.5
600	0.296	-120.3	22.620	-140.8	0.007	110.0	0.393	-121.0
650	0.314	-124.7	20.235	-154.1	0.005	85.1	0.402	-131.7
700	0.321	-131.5	18.081	-166.2	0.010	93.2	0.388	-143.9
750	0.334	-135.8	16.178	-178.0	0.012	106.1	0.390	-153.8
800	0.339	-143.8	14.235	172.5	0.010	74.1	0.377	-162.4
850	0.348	-149.4	12.941	164.1	0.014	57.9	0.392	-170.4
900	0.340	-157.5	11.693	154.9	0.014	80.2	0.402	179.5
950	0.352	-161.0	10.670	145.7	0.006	87.4	0.409	171.4
1000	0.341	-166.8	9.683	137.6	0.016	50.0	0.433	163.3

Figure 1 : Typical 300MHz-1000MHz Biasing Circuit



APPLICATIONS INFORMATION

CIRCUIT DESCRIPTION

The TSH690 is 50Ω input/output internally matched from 300MHz to 1000MHz. Due to its open-collector structure, the output RF port must be tied to Vcc2. The pin 8 allows a bias current adjust to set the output power and the gain. The circuit is packaged in SO8 for thermal dissipation considerations.

MATCHING

Within the 300-1000MHz band, although the circuit is matched, the output return loss can be improved by adding a serial inductor (L2) between the RF output and V_{CC2} (56nH @ 450MHz and 10nH @ 900MHz). Below 300MHz, using the S-parameters matrix, specific input/output matching networks can be calculated to maximize electrical performances.

DC BLOCKING

Because input/output are respectively internal/external biased, DC blocks (C1, C2) are recommended on both RF ports to guarantee a DC isolation from the next cells. Above 500MHz, 100pF is suggested whereas below, 1nF is better and far below (less than 100MHz), 10nF is prefered.

BIASING

The amplifier can operate in the range of 1.5V to 5V and offers a bias current adjust function (Vbias pin) which enables the trimming of the RF output power (AB class Amplifier) by tuning a series variable resistor (Rbias).

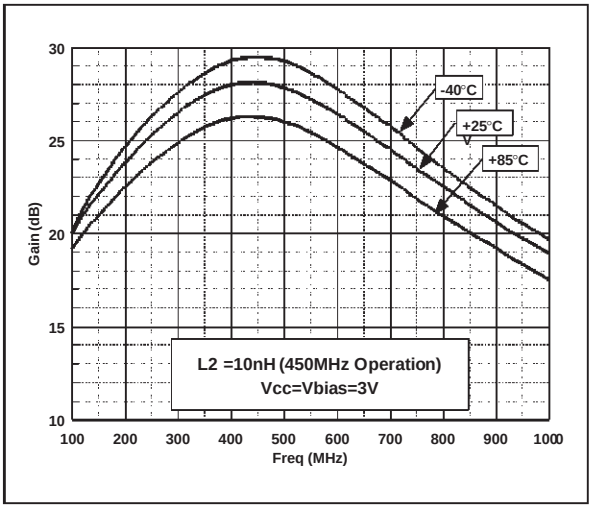
When Vbias is wired to the Vcc rail, the current consumption is maximized getting the best linearity (A class Amplifier) whereas biasing to Ground, the IC is set in power down mode.

For higher supply voltage than 4V to reach high output power, the serial resistor (R1) is strongly recommended to increase the efficiency of the amplifier and therefore reduce the thermal dissipation of the circuit.

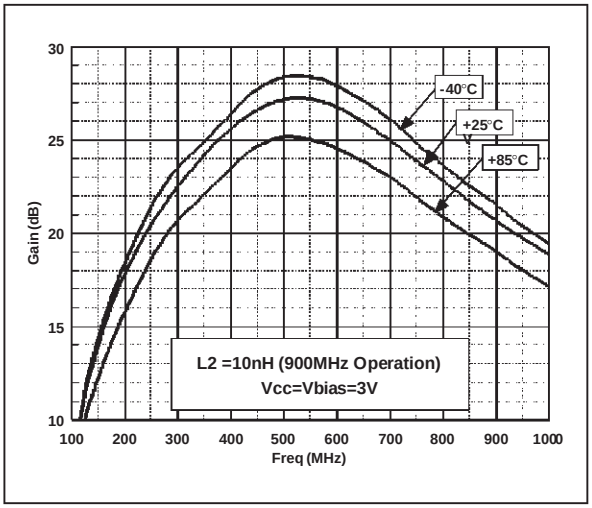
DECOUPLING

As with any RF devices, the supply voltage decoupling must be done carefully using a 1nF bypass capacitor (C3, C5) placed as close as possible to the device pins and could be also improved by adding a 150nH RF choke inductance (L1). Concerning the Vbias pin, a 10nF decoupling capacitor (C4) is recommended while placing on board is not critical. Note that Surface Mounted Devices (SMD) components are prefered for RF applications due to the right behaviour in high frequencies while low inductor values (few 10nH) can be printed on board.

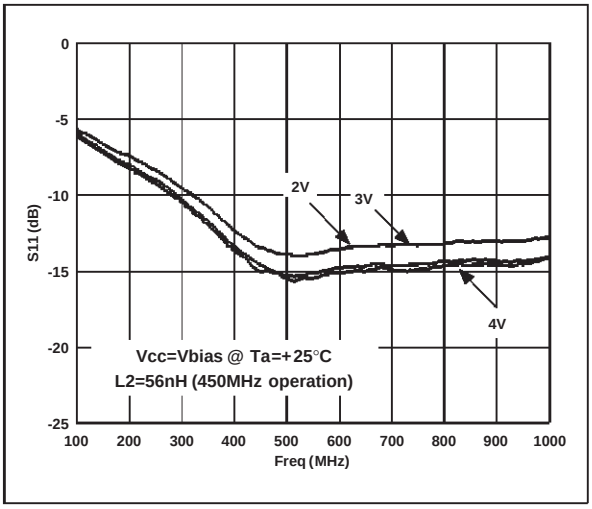
GAIN vs FREQUENCY (450MHz)



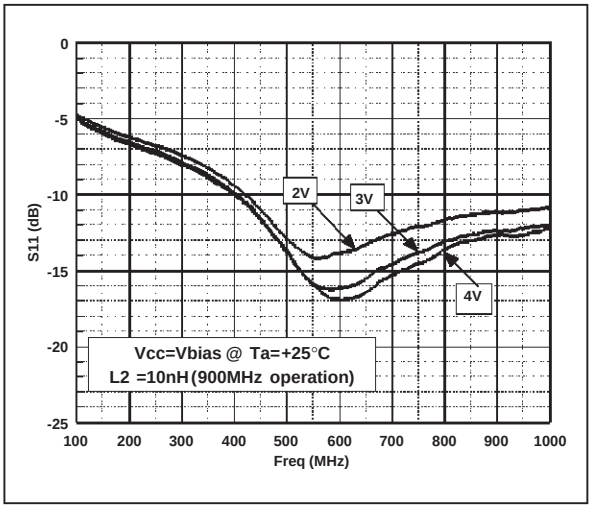
GAIN vs FREQUENCY (900MHz)



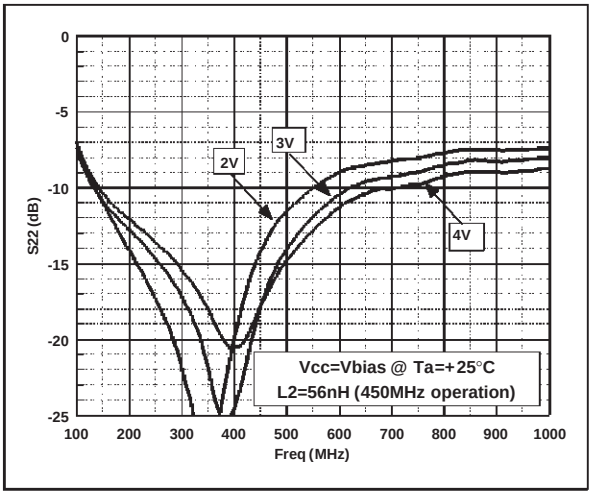
INPUT RETURN LOSS (450MHz)



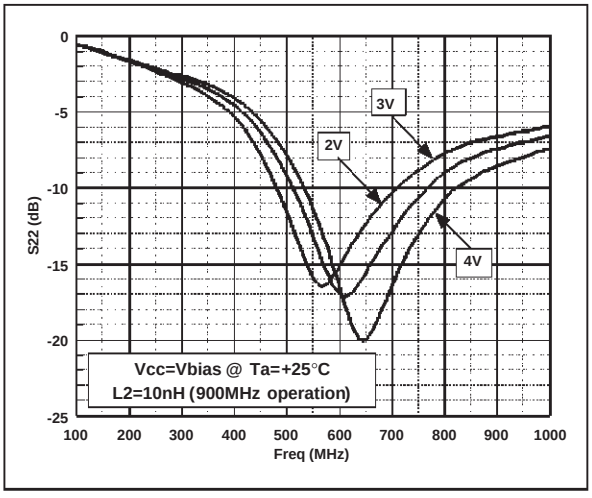
INPUT RETURN LOSS (900MHz)



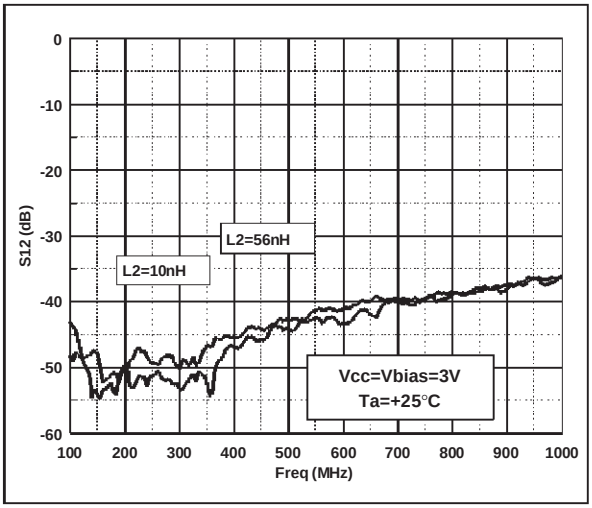
OUTPUT RETURN LOSS (450MHz)



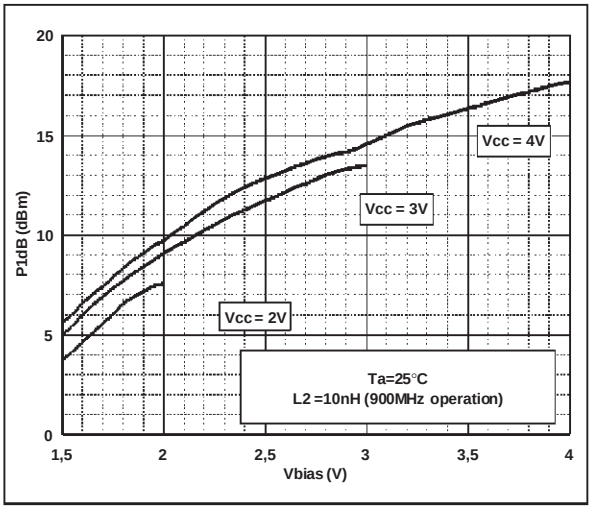
OUTPUT RETURN LOSS (900MHz)



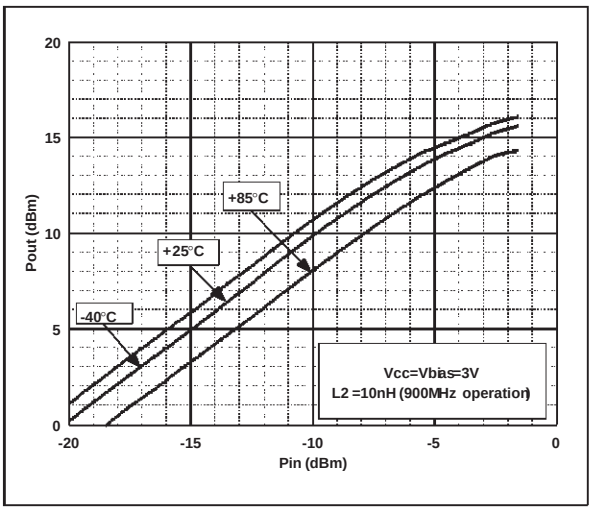
REVERSE ISOLATION vs FREQUENCY



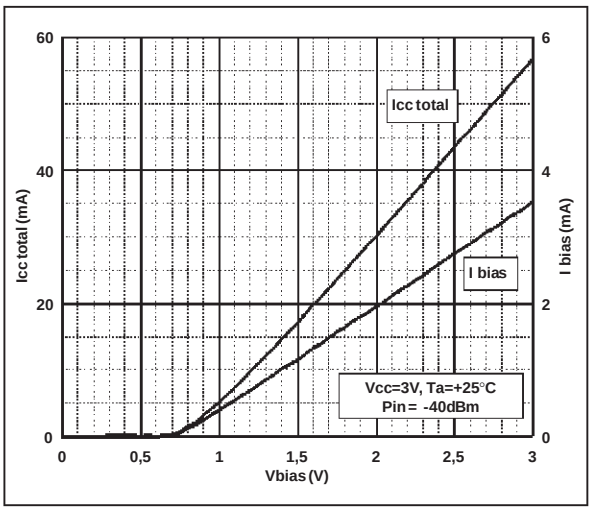
1dB COMPRESSION vs BIAS VOLTAGE



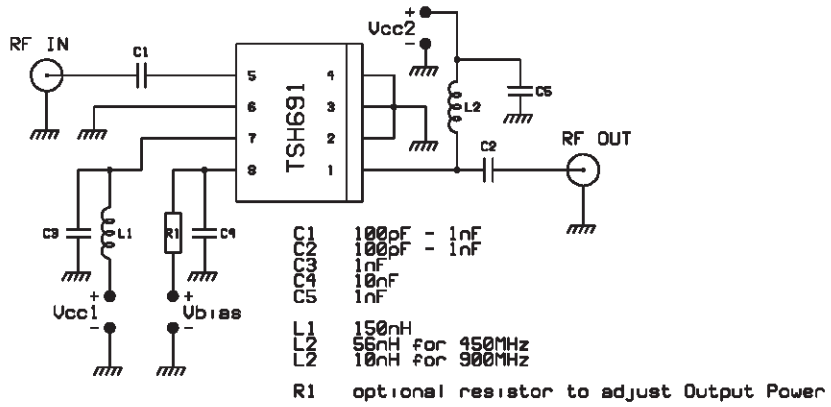
ADMISSION (900MHz)



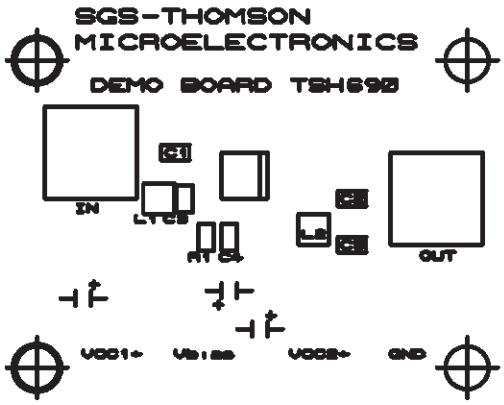
SUPPLY CURRENT vs BIAS VOLTAGE



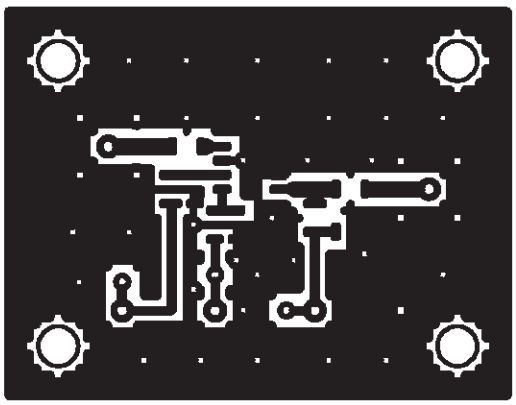
DEMONSTRATION BOARD : Diagram for 300MHz - 1000MHz operation



DEMONSTRATION BOARD : Silk Screen

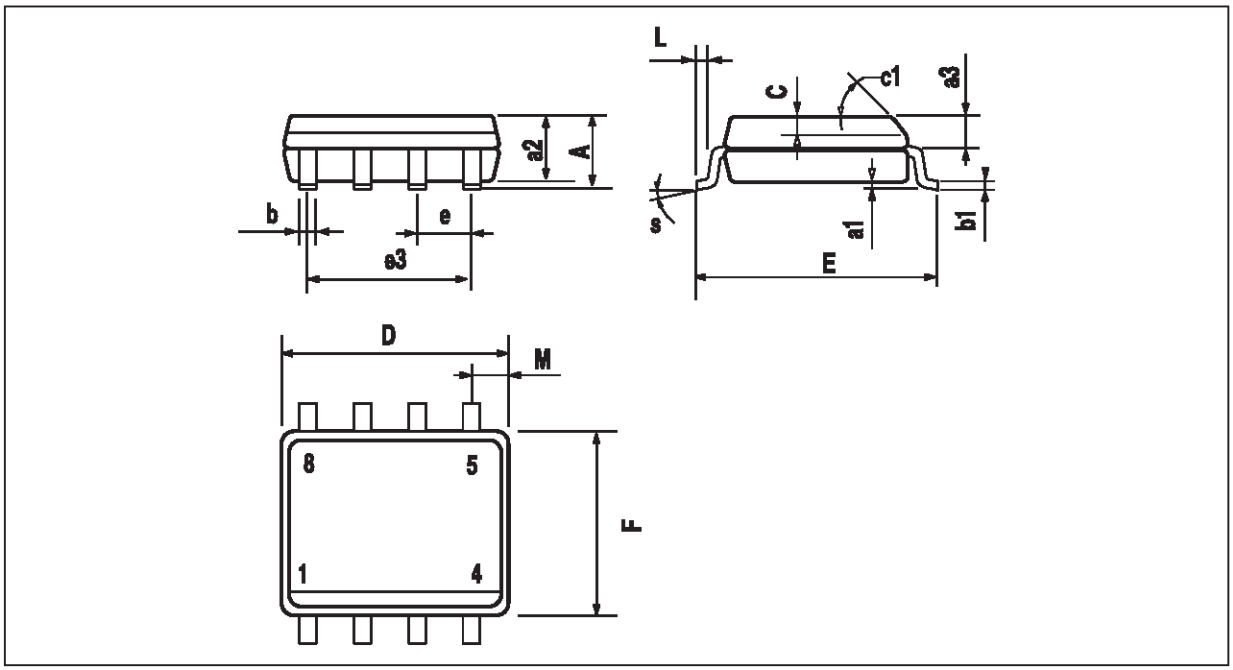


DEMONSTRATION BOARD : Printed Circuit Board (available on request)



PACKAGE MECHANICAL DATA

8 PINS - PLASTIC MICROPACKAGE (SO)



PM-SO16.EPS

Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

SO16.TBL

ORDER CODE :