



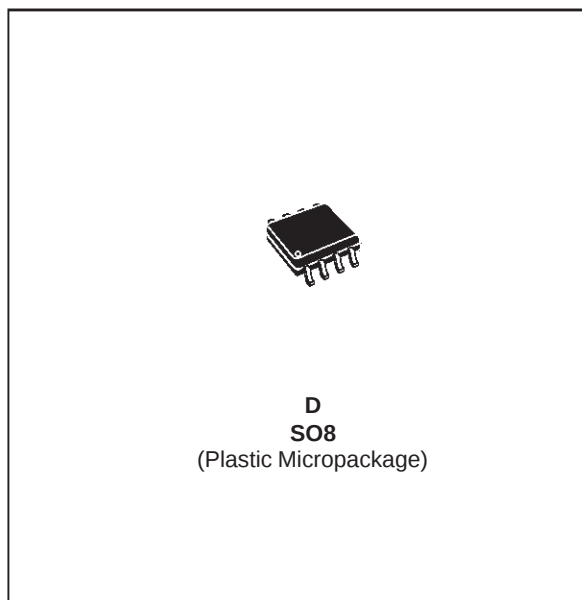
TSH691

LOW COST 40MHz - 1GHz AMPLIFIER

- 28dB GAIN @ 3V @ 450MHz
- +13.5dBm OUTPUT POWER (P1dB)
- BIAS PIN FOR OUTPUT POWER & AMPLIFIER DISABLE
- 50Ω INPUT/OUTPUT MATCHING

DESCRIPTION

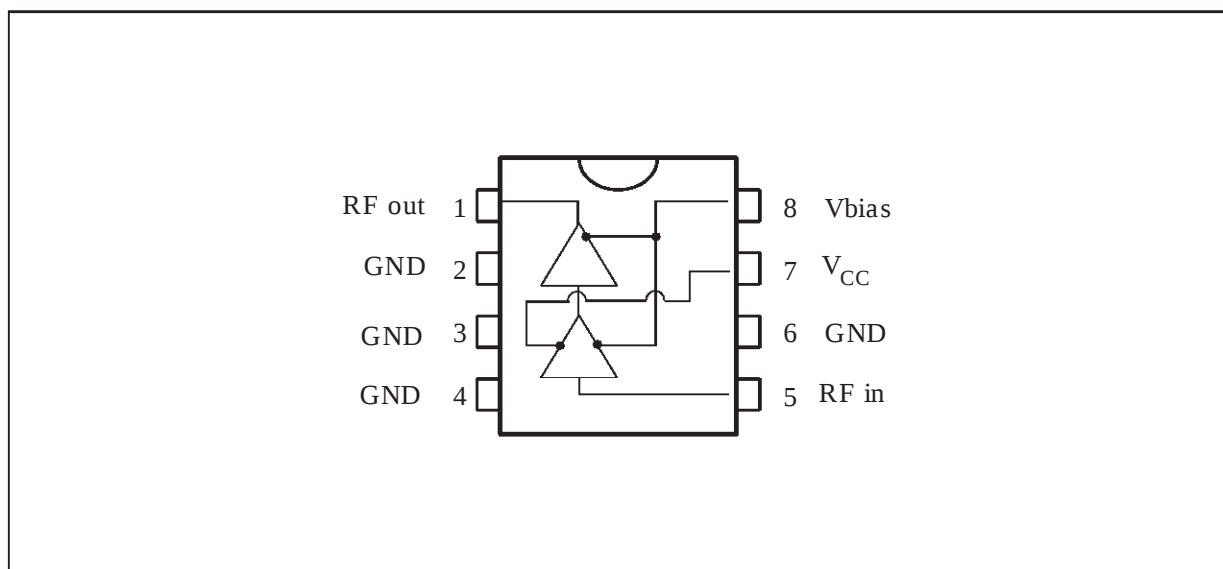
TSH691 is a low cost RF amplifier consisted of 2 stages, designed in advanced bipolar process, featuring high performances. An external bias current adjust allows to tune the output power and also to set the amplifier in power-down mode. The TSH691 is intended to RF consumer equipments in ISM band (remote controls, ASK transmitters) where cost is sensitive



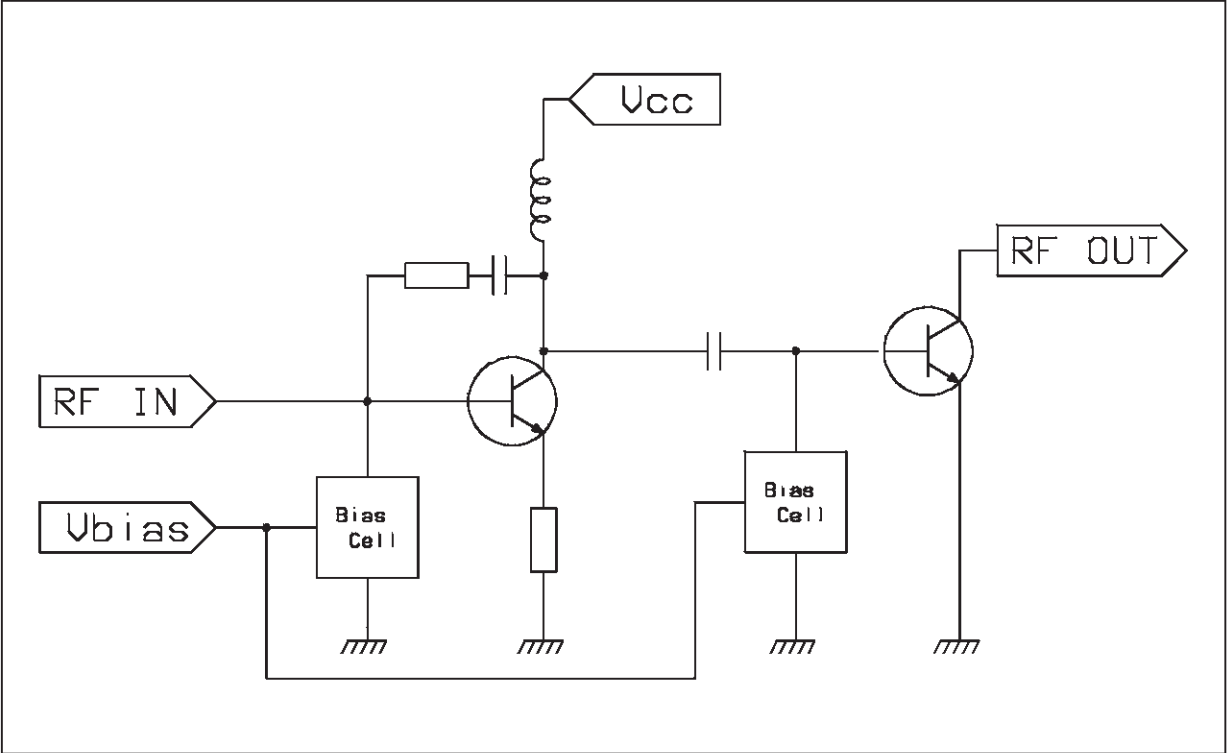
ORDER CODES

Part Number	Temperature Range	Package
		D
TSH691ID	-35, +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	-35 to +85	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
$V_{CC1}, V_{CC2}, V_{bias}$	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

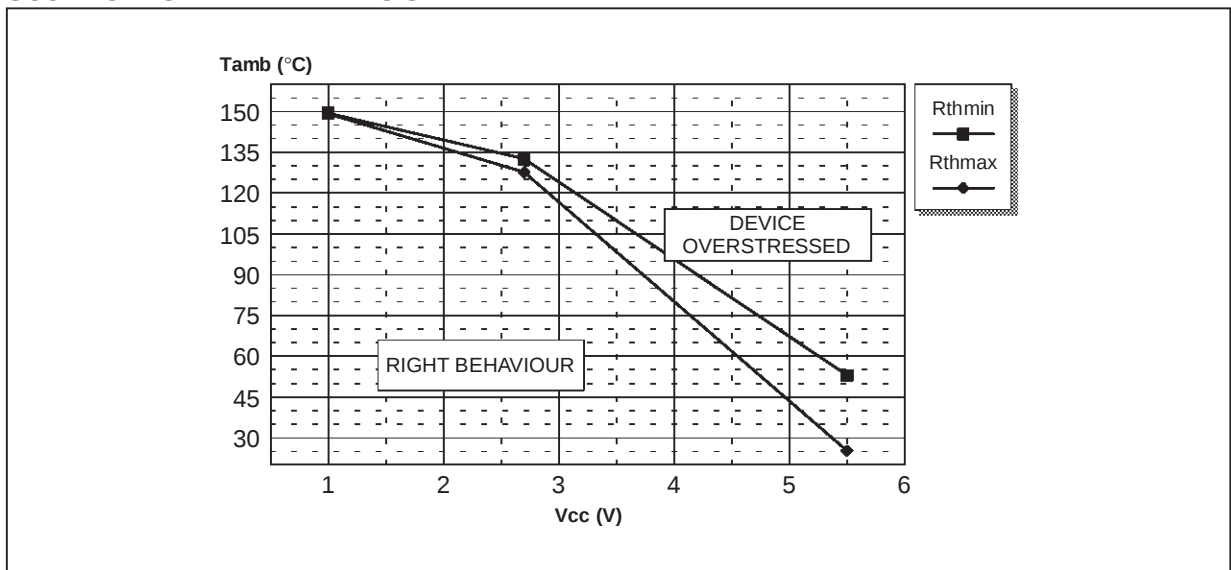
ELECTRICAL CHARACTERISTICS

$T_{amb} = 25^{\circ}\text{C}$, $V_{CC} \text{ \& } V_{bias} = +2.7\text{V}$, $Z_L = 50\Omega$

Parameter	TSH691			Unit
	Min.	Typ.	Max.	
Supply Current		46		mA
S21 ($V_{in} = -20\text{dBm}$, $f = 450\text{MHz}$)	20	23	30	dB
S21 ($V_{in} = -20\text{dBm}$, $f = 900\text{MHz}$)		17		dB
Output Power 1dB Compression ($f = 450\text{MHz}$)		12		dBm
3rd Order Intercept Point ($f = 430\text{MHz}$)		22		dBm
S12 (Reverse Isolation @ $f = 400\text{MHz}$)		-46		dB
S11 (Input Return Loss @ $f = 450\text{MHz}$)		-15		dB
S11 (Input Return Loss @ $f = 900\text{MHz}$)		-10		dB
Noise Figure @ $f = 450\text{MHz}$		4.5		dB
Noise Figure @ $f = 900\text{MHz}$		5.4		dB
$R_{th(j-a)}$ Junction Ambient Thermal Resistance For SO8 Package	140		180	$^{\circ}\text{C/W}$

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

SO8 PACKAGE THERMAL RESISTIVITY



DEFINITION

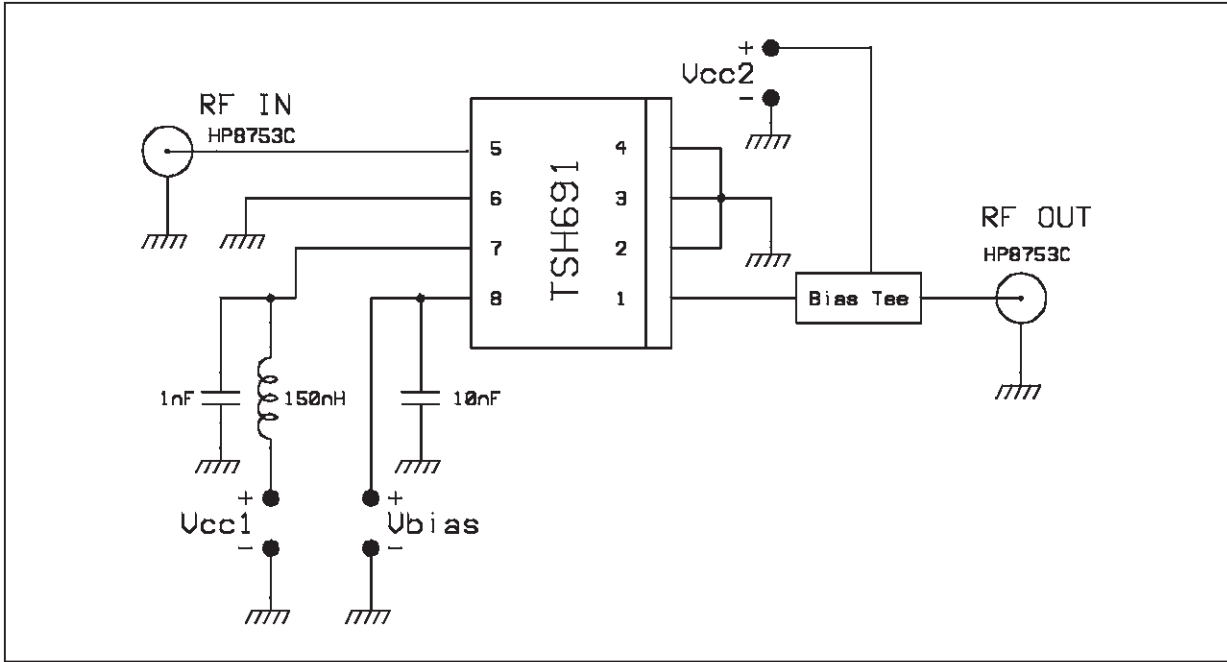
$R_{th(j-a)}$ Junction Ambient Thermal Resistance
 $T_j (^{\circ}\text{C})$ Maximum Die Junction Temperature (~ 150 $^{\circ}\text{C}$)
 $T_{amb} (^{\circ}\text{C})$ Ambient Temperature
 $P_d (\text{W})$ Maximum Dissipated Power ($P_d = 0.75 V_{CC} \cdot I_{CC}$)

REMARKS

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

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

TYPICAL SCATTERING PARAMETERS (Reference waves planes at package leads)



TEST CONDITIONS V_{CC1} , V_{CC2} , $V_{bias} = +2V$, $P_{in} = -40dBm$, $T_{amb} = 25^{\circ}C$

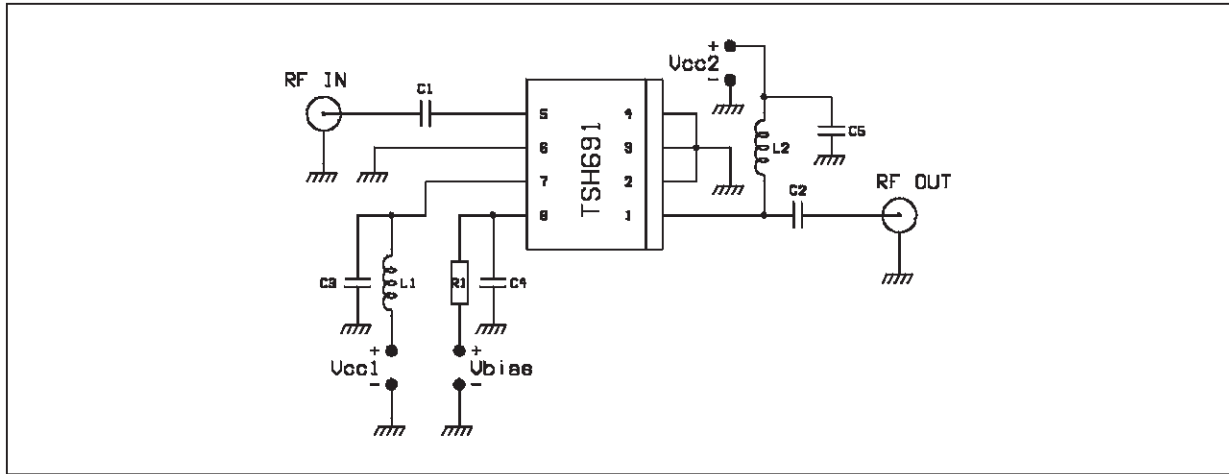
Freq MHz	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
40	0.642	-22.0	6.319	5.0	0.003	-126.5	0.715	-54.7
50	0.615	-25.7	6.406	7.1	0.008	170.7	0.631	-64.7
100	0.537	-41.3	7.643	7.7	0.002	70.1	0.369	-91.3
150	0.490	-55.6	9.353	3.1	0.004	-141.9	0.253	-100.9
200	0.464	-68.0	11.502	-5.7	0.007	-117.3	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} , $V_{bias} = +3V$, $Pin = -40dBm$, $T_{amb} = 25^{\circ}C$

Freq MHz	S11		S21		S12		S22	
	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} , $V_{bias} = +4V$, $Pin = -40dBm$, $T_{amb} = 25^{\circ}C$

Freq MHz	S11		S21		S12		S22	
	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 TSH691 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 series inductor (L2) between the RF output and VCC2 (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 preferred.

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).

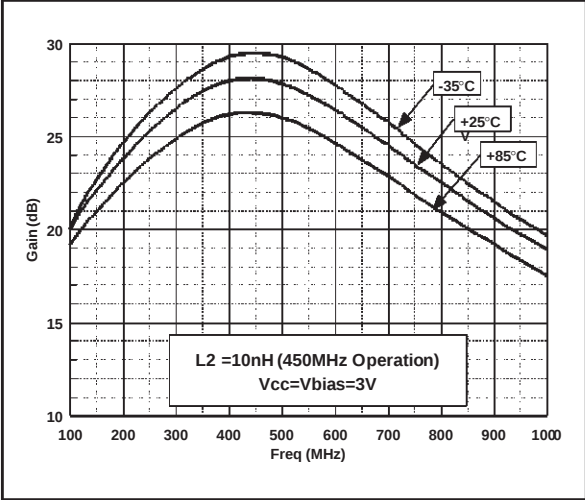
When Vbias is wired to the VCC rail, the current consumption is maximized getting the best linearity (A class Amplifier) whereas biasing to Ground, the IC is set in power down mode.

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.

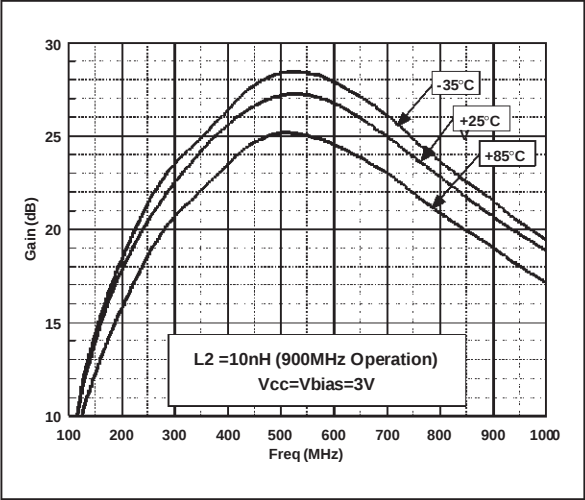
DECOUPLING

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 preferred for RF applications due to the right behaviour in high frequencies while low inductor values (few 10nH) can be printed on board.

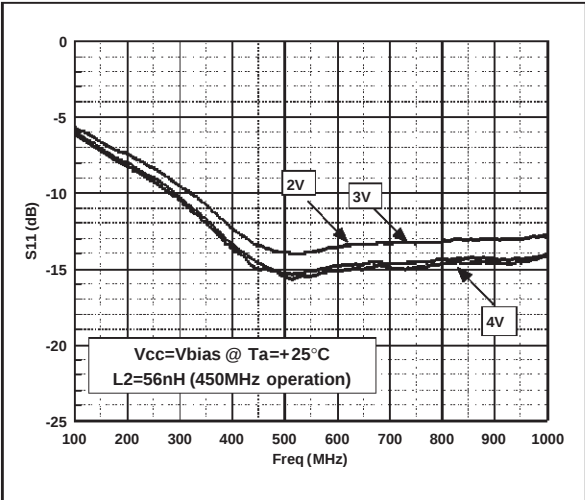
GAIN vs FREQUENCY (450MHz)



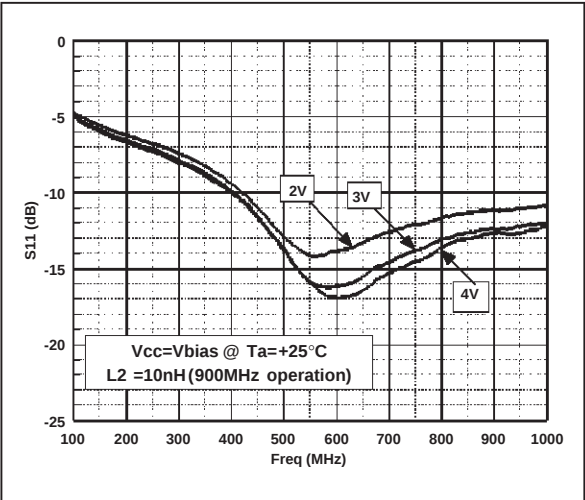
GAIN vs FREQUENCY (900MHz)



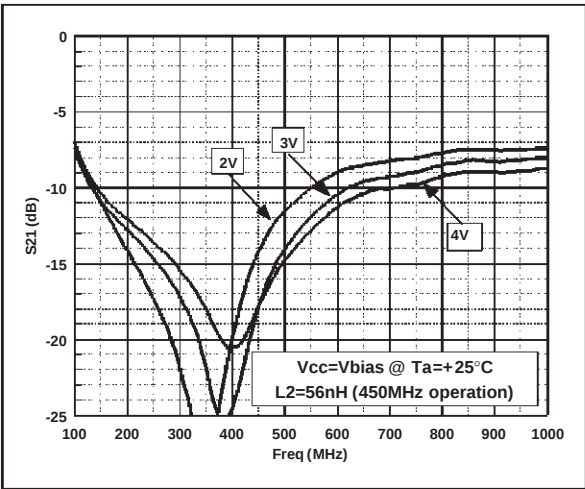
INPUT RETURN LOSS (450MHz)



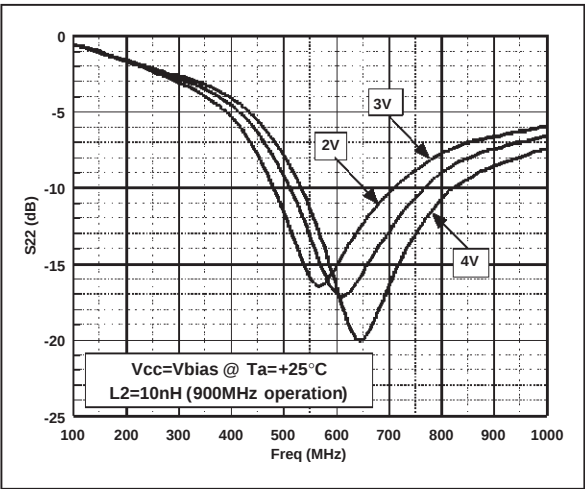
INPUT RETURN LOSS (900MHz)



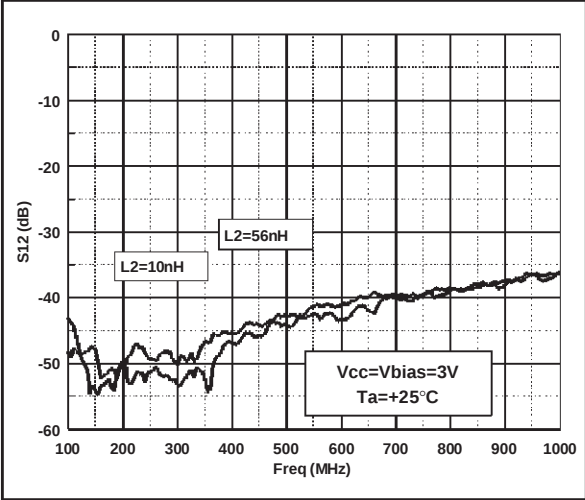
OUTPUT RETURN LOSS (450MHz)



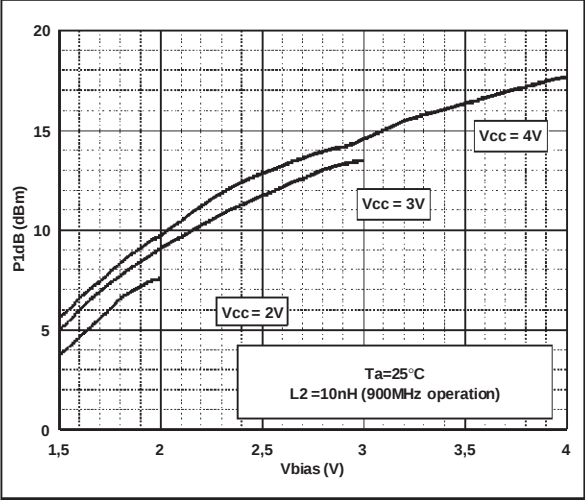
OUTPUT RETURN LOSS (900MHz)



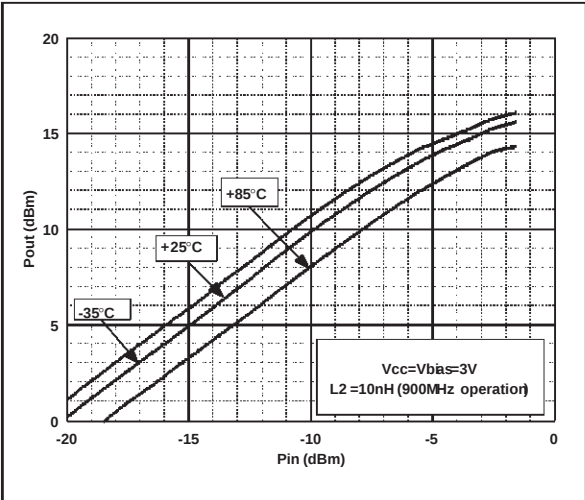
REVERSE ISOLATION vs FREQUENCY



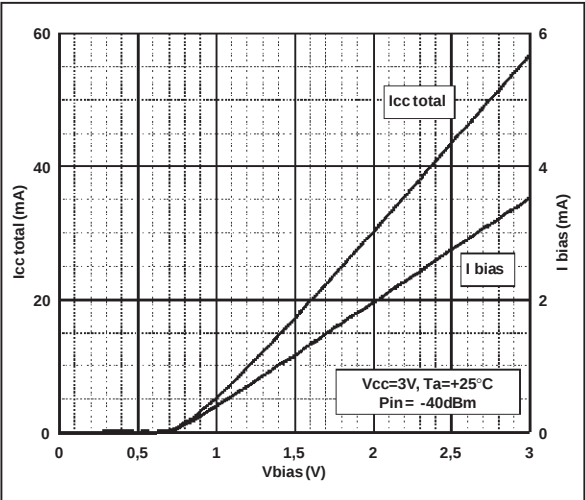
1dB COMPRESSION vs BIAS VOLTAGE

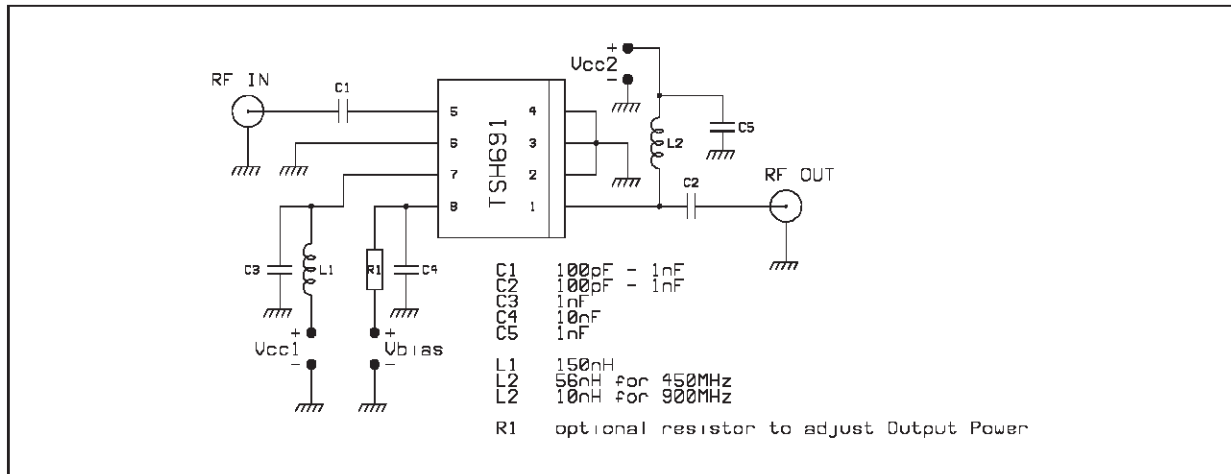
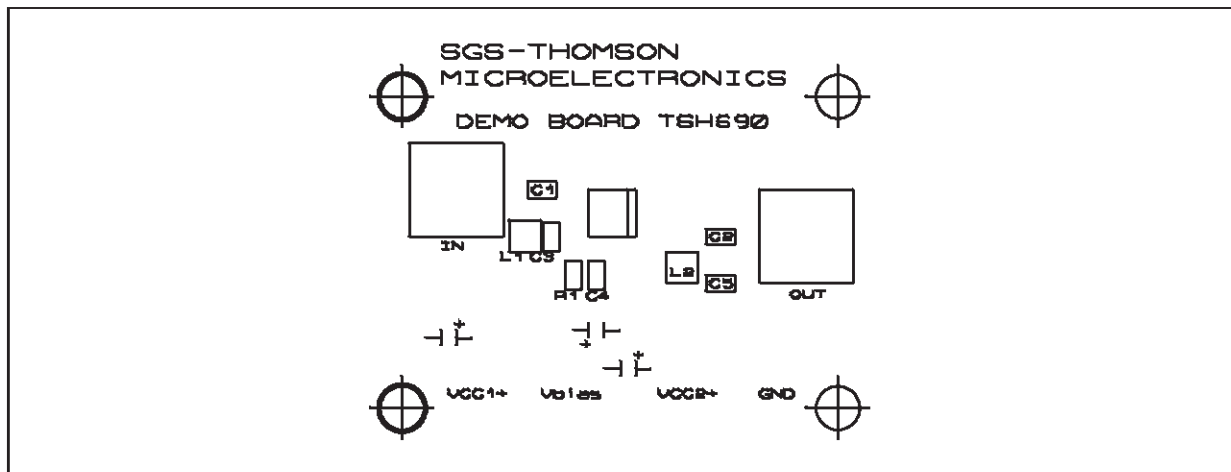
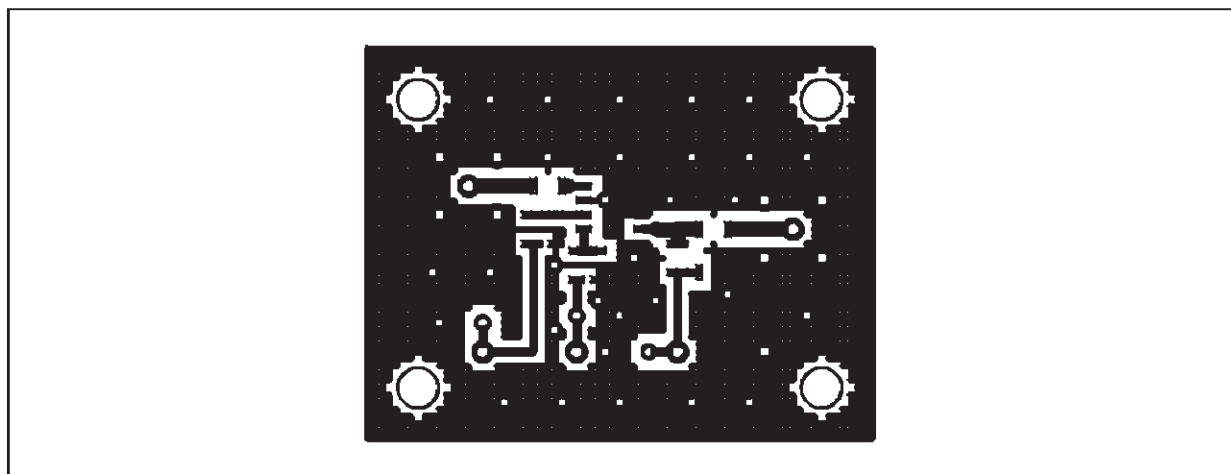


ADMISSION (900MHz)

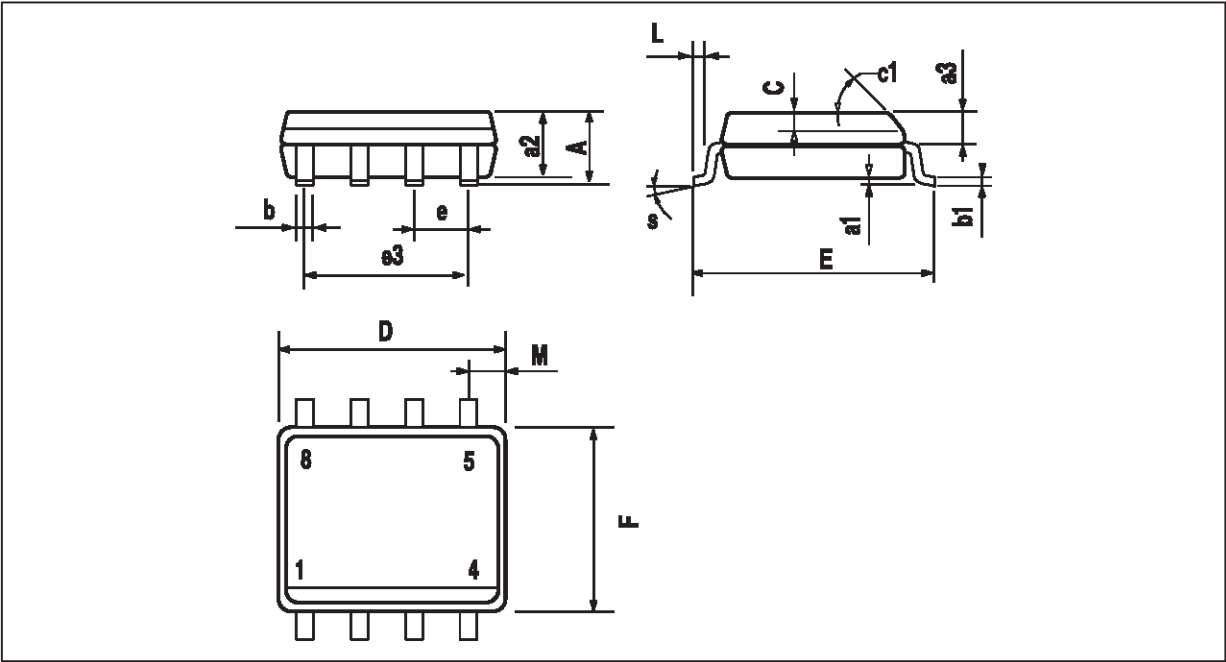


SUPPLY CURRENT vs BIAS VOLTAGE



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)



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.)					

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