50 MHz to 350 MHz CASCADEABLE AMPLIFIER

FEATURES

- **High Dynamic Range**
  - **– OIP_3 = 36 dBm**
  - **– NF < 4.5 dB**
- **Single Supply Voltage**
- **High Speed**
  - **– V_S = 3 V to 5 V**
  - **– I_S = Adjustable**
- **Input / Output Impedance**
  - **– 50 Ω**

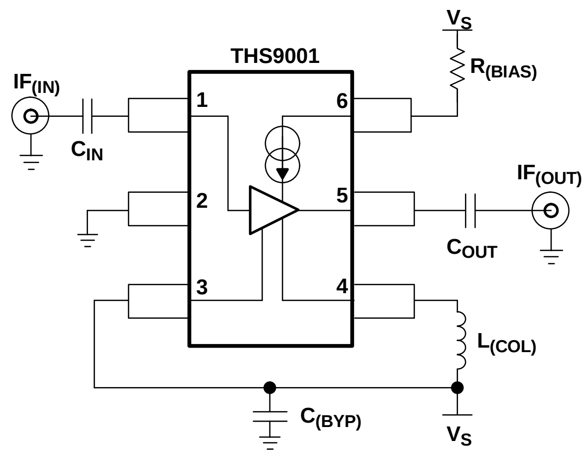
APPLICATIONS

- **IF Amplifier**
  - **– TDMA: GSM, IS-136, EDGE/UWE-136**
  - **– CDMA: IS-95, UMTS, CDMA2000**
  - **– Wireless Local Loop**
  - **– Wireless LAN: IEEE802.11**

DESCRIPTION

The THS9001 is a medium power, cascadeable, gain block optimized for high IF frequencies. The amplifier incorporates internal impedance matching to 50 Ω and achieves greater than 15-dB input and output return loss from 50 MHz to 350 MHz with V_S = 5 V, $R_{(BIAS)}$ = 237 Ω, $L_{(COL)}$ = 470 nH. Design requires only 2 dc-blocking capacitors, 1 power-supply bypass capacitor, 1 RF choke, and 1 bias resistor.

Functional Block Diagram



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

AVAILABLE OPTIONS

PACKAGED DEVICES	PACKAGE TYPE	TRANSPORT MEDIA, QUANTITY
THS9001DBVT	SOT-23-6	Tape and Reel, 250
THS9001DBVR		Tape and Reel, 3000

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature (unless otherwise noted)(1)

		UNIT
Supply voltage, GND to V_S		5.5 V
Input voltage		GND to V_S
Continuous power dissipation		See Dissipation Ratings Table
Maximum junction temperature, T_J		150°C
Maximum junction temperature, continuous operation, long term reliability, T_J(2)		125°C
Storage temperature, T_{stg}		-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds		300°C
ESD Ratings	HBM	2000
	CDM	1500
	MM	100

(1) The absolute maximum ratings under any condition is limited by the constraints of the silicon process. Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) The maximum junction temperature for continuous operation is limited by package constraints. Operation above this temperature may result in reduced reliability and/or lifetime of the device.

DISSIPATION RATING TABLE

PACKAGE	Θ_{JC} (°C/W)	Θ_{JA} (°C/W)	POWER RATING(1)	
			$T_A \leq 25°C$	$T_A = 85°C$
DBV(2)	70.1	216	463 mW	185 mW

(1) Power rating is determined with a junction temperature of 125°C. Thermal management of the final PCB should strive to keep the junction temperature at or below 125°C for best performance.
(2) This data was taken using the JEDEC standard High-K test PCB.

RECOMMENDED OPERATING CONDITIONS

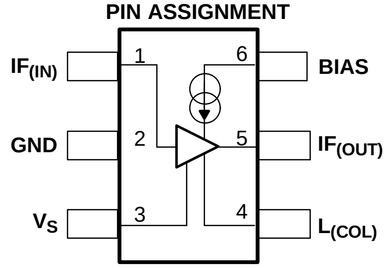
	MIN	NOM	MAX	UNIT
Supply voltage	2.7		5	V
Operating free-air temperature, T_A	-40		85	°C
Supply current		100		mA

ELECTRICAL CHARACTERISTICS

Typical Performance (V_S = 5 V, $R_{(BIAS)}$ = 237 Ω, $L_{(COL)}$ = 470 nH) (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Gain	f = 50 MHz		15.8		dB
	f = 350 MHz		15.0		
OIP_3	f = 50 MHz		35		dBm
	f = 350 MHz		37		
1-dB compression	f = 50 MHz		20.6		dBm
	f = 350 MHz		20.6		
Input return loss	f = 50 MHz		15.4		dB
	f = 350 MHz		16.6		
Output return loss	f = 50 MHz		17		dB
	f = 350 MHz		15		
Reverse isolation	f = 50 MHz		20.7		dB
	f = 350 MHz		20.7		
Noise figure	f = 50 MHz		3.7		dB
	f = 350 MHz		4		

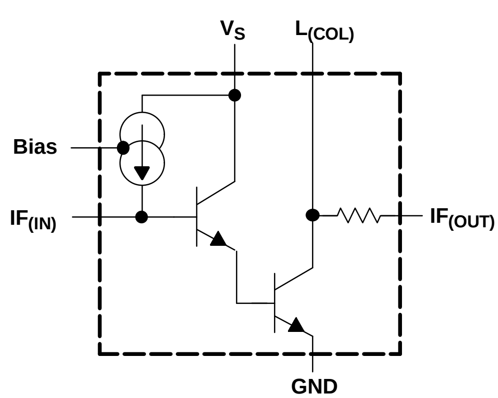
PIN ASSIGNMENT



Terminal Functions

Pin Numbers	Name	Description
1	$IF_{(IN)}$	Signal input
2	GND	Negative power supply input
3	V_S	Positive power supply input
4	$L_{(COL)}$	Output transistor load inductor
5	$IF_{(OUT)}$	Signal output
6	BIAS	Bias current input

SIMPLIFIED SCHEMATIC



TYPICAL CHARACTERISTICS

TABLE OF GRAPHS

		FIGURE
	S21 Frequency response	1
	S22 Frequency response	2
	S11 Frequency response	3
	S12 Frequency response	4
	S21 vs $R_{(Bias)}$	5
	Output power vs Input power	6
	OIP_2 vs Frequency	7
	Noise figure vs Frequency	8
	OIP_3 vs Frequency	9
I_S	Supply current vs $R_{(Bias)}$	10
	S21 Frequency response	11
	S22 Frequency response	12
	S11 Frequency response	13
	S12 Frequency response	14
	Noise figure vs Frequency	15
	OIP_2 vs Frequency	16
	Output power vs Input power	17
	OIP_3 vs Frequency	18

S-Parameters of THS9001 as mounted on the EVM with V_S = 5 V, $R_{(BIAS)}$ = 237 Ω, and $L_{(COL)}$ = 68 nH to 470 nH at room temp.

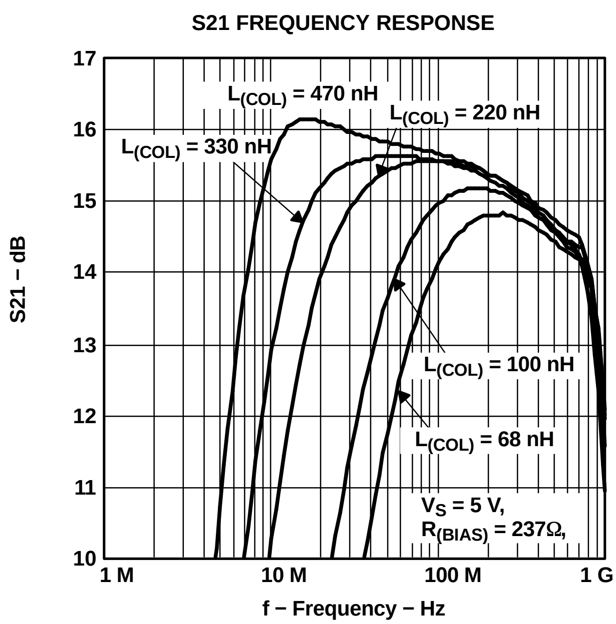


Figure 1.

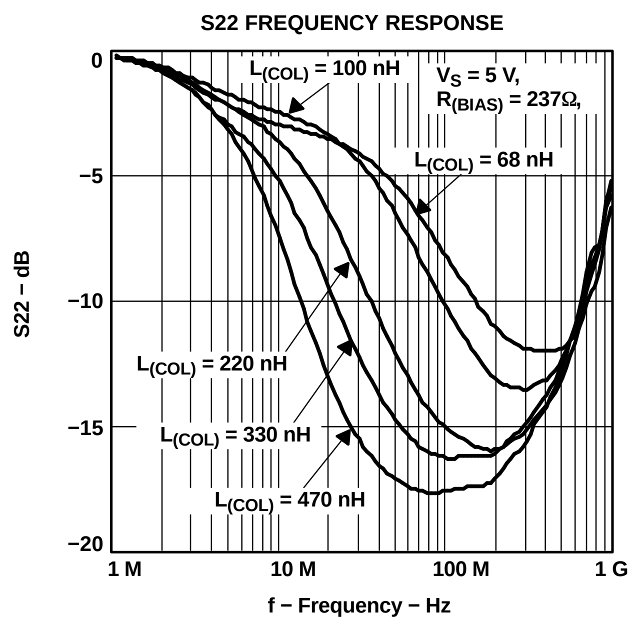


Figure 2.

TYPICAL CHARACTERISTICS (continued)

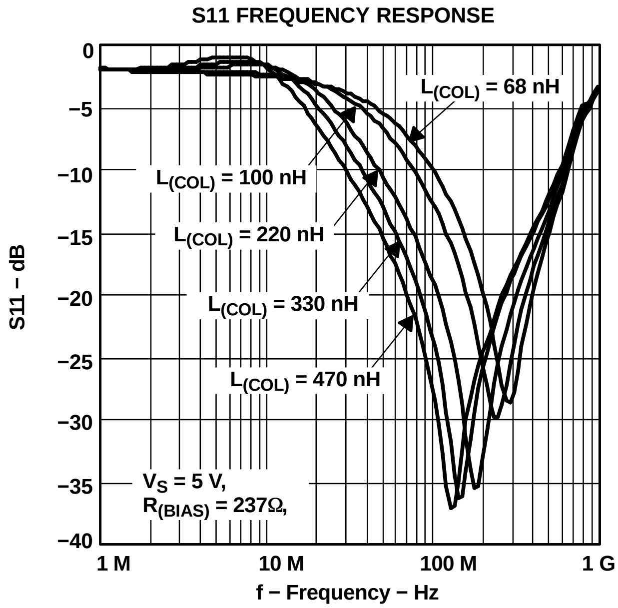


Figure 3.

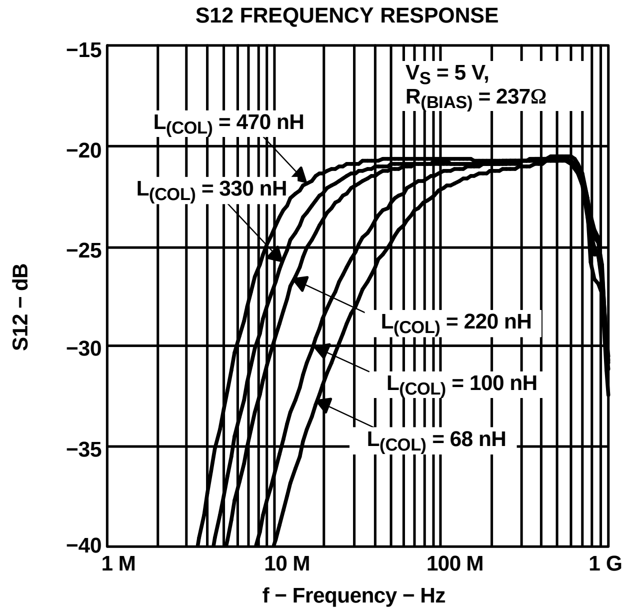


Figure 4.

S-Parameters of THS9001 as mounted on the EVM with V_S = 3 V and 5 V, $R_{(BIAS)}$ = various, and $L_{(COL)}$ = 470 nH at room temp.

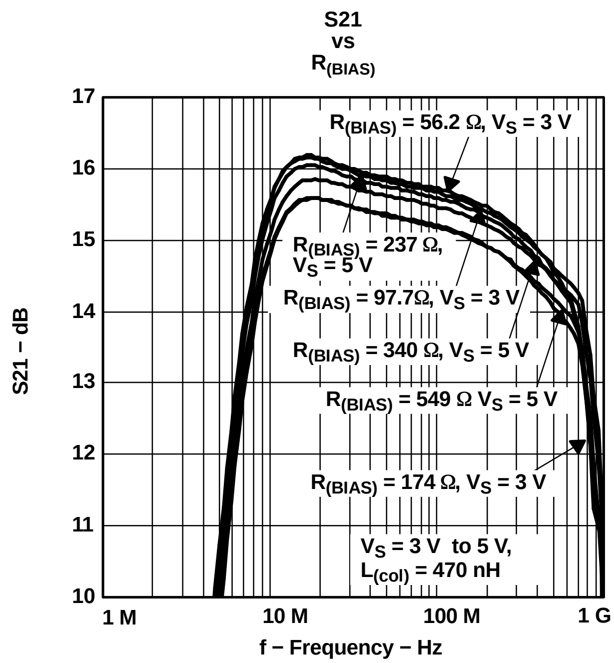


Figure 5.

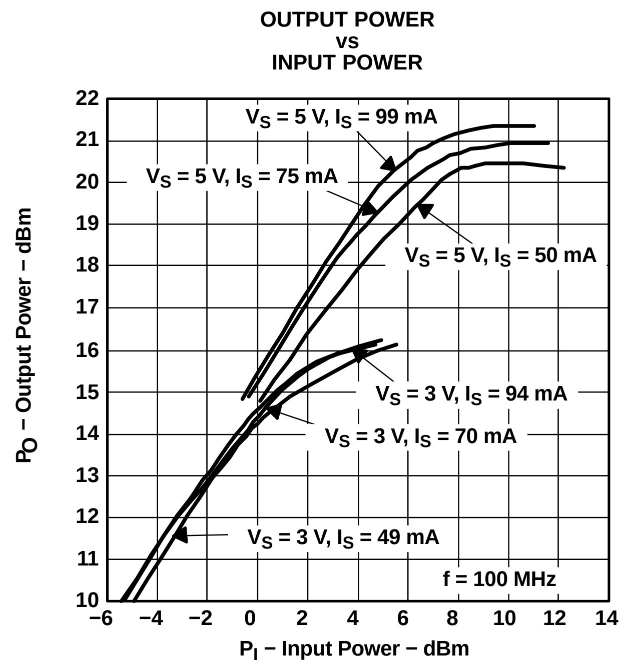


Figure 6.

TYPICAL CHARACTERISTICS (continued)

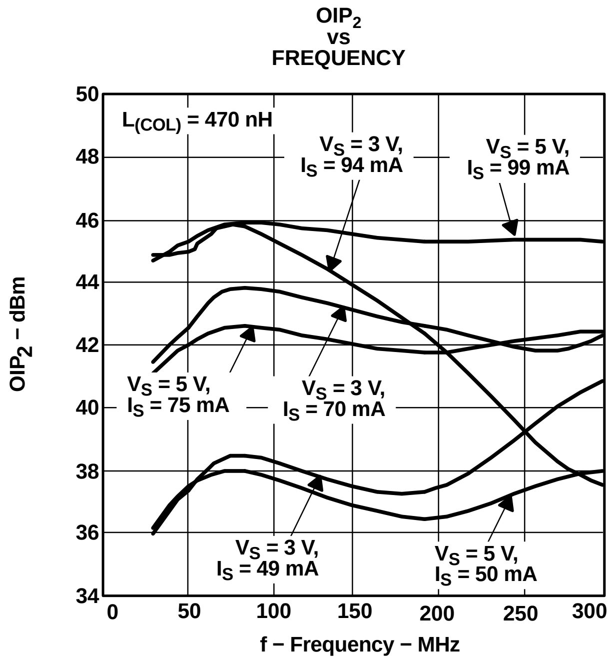


Figure 7.

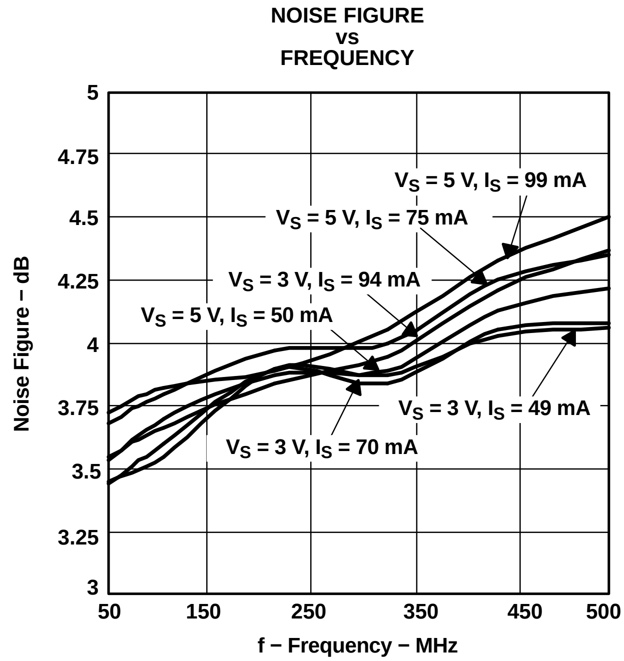


Figure 8.

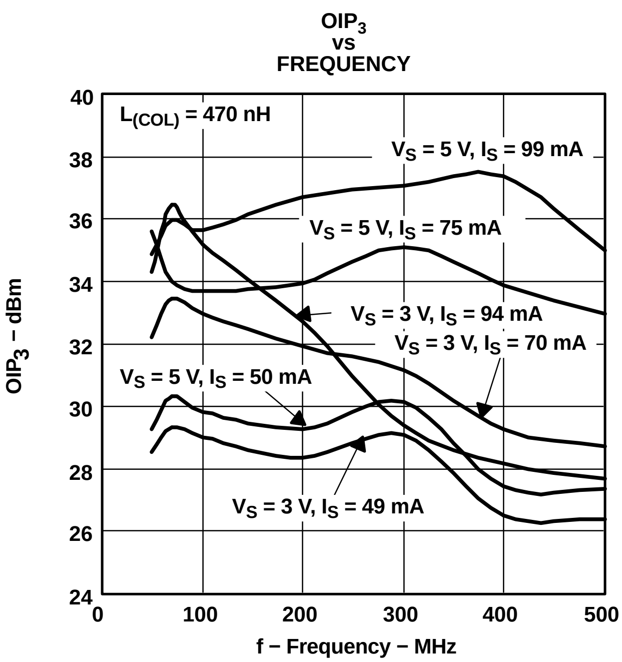


Figure 9.

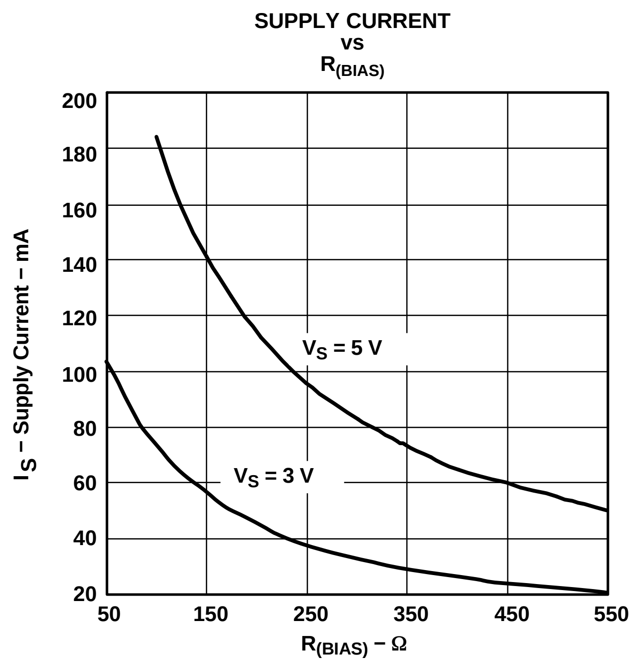


Figure 10.

TYPICAL CHARACTERISTICS (continued)

THS9001 as mounted on the EVM with V_S = 5 V, $R_{(BIAS)}$ = 237 Ω, and $L_{(COL)}$ = 470 nH at 40°C, 25°C, and 85°C.

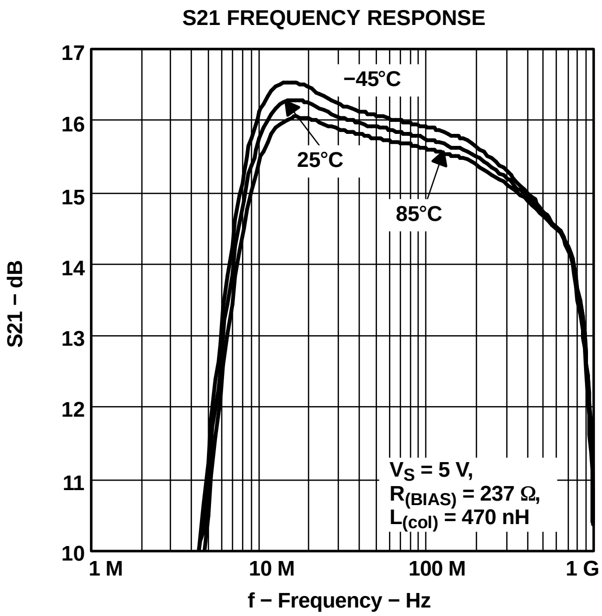


Figure 11.

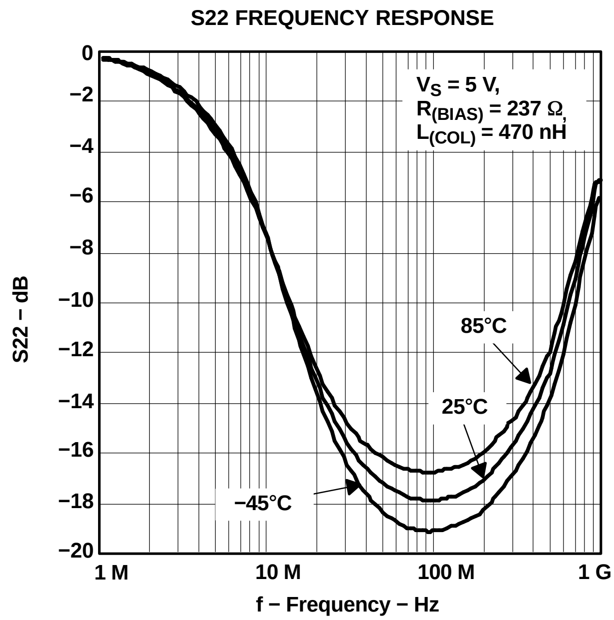


Figure 12.

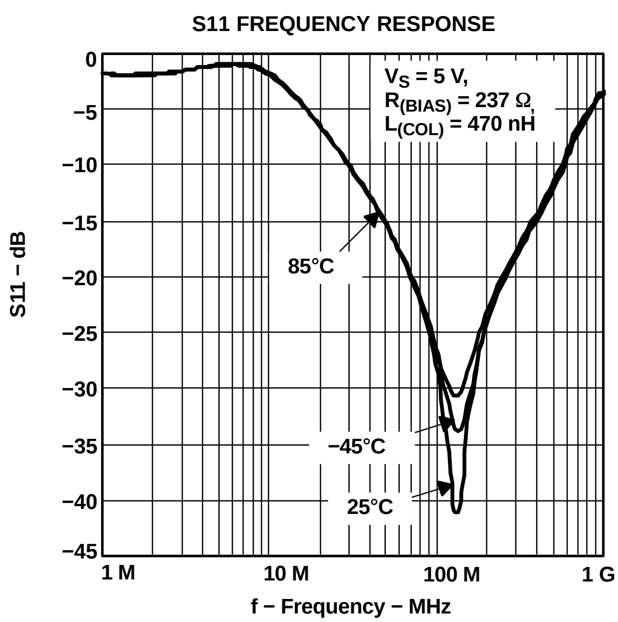


Figure 13.

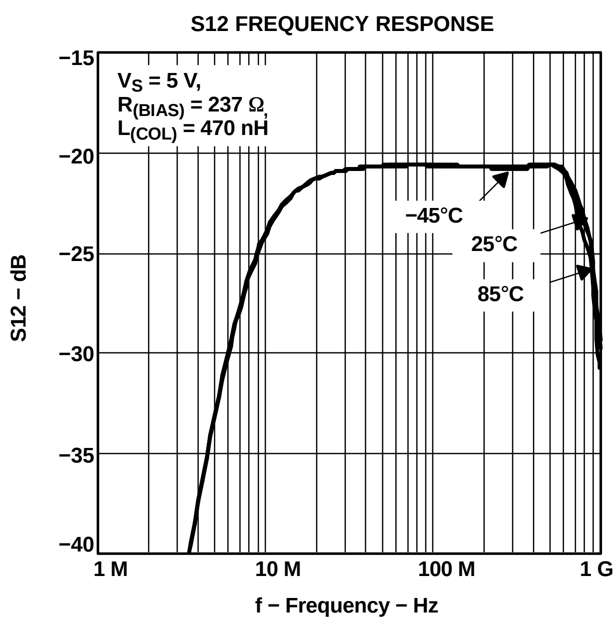


Figure 14.

TYPICAL CHARACTERISTICS (continued)

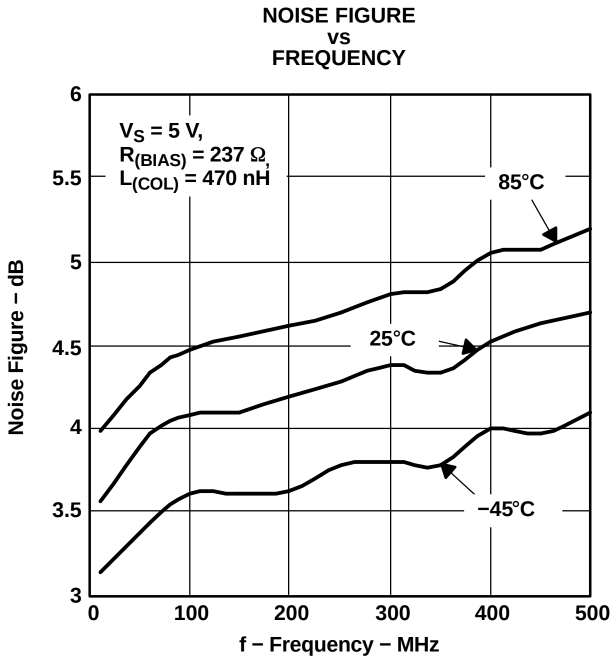


Figure 15.

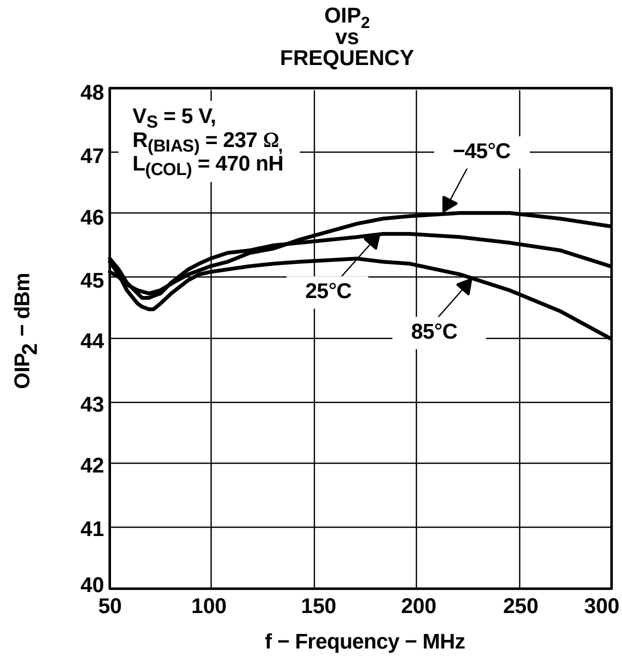


Figure 16.

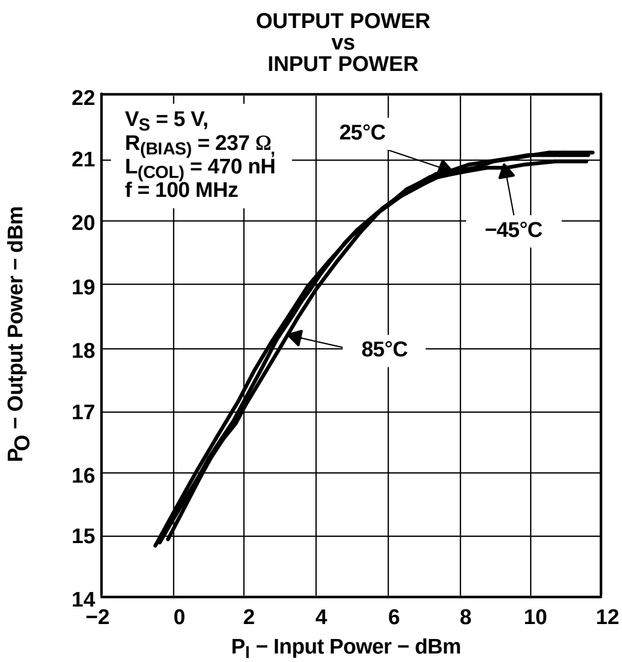


Figure 17.

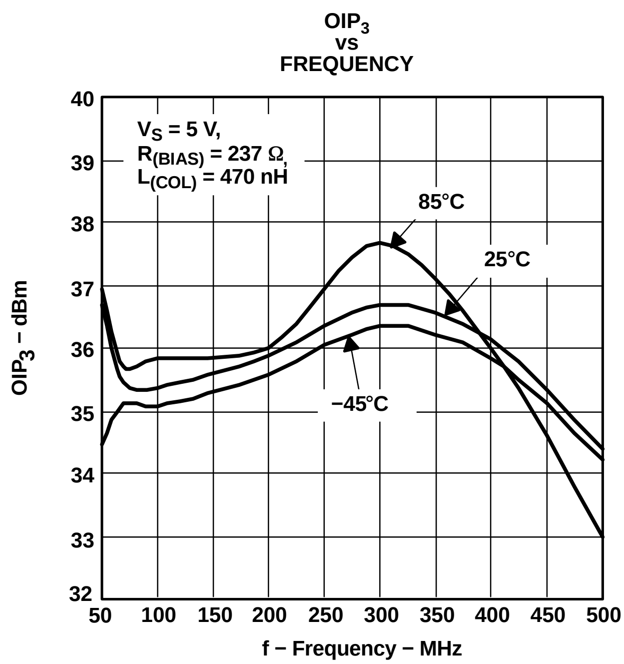


Figure 18.

TYPICAL CHARACTERISTICS

S-Parameters Tables of THS9001 with EVM De-Embedded

V_S = 5 V, $R_{(BIAS)}$ = 237 Ω, $L_{(COL)}$ = 470 nH								
	S21		S11		S22		S12	
Frequency (MHz)	Gain (dB)	Phase (deg)	Gain (dB)	Phase (deg)	Gain (dB)	Phase (deg)	Gain (dB)	Phase (deg)
1.0	-3.5	-165.0	-2.3	-1.1	-2.6	174.8	-64.4	-121.7
5.0	11.7	-127.1	-1.5	-14.9	-2.8	140.4	-32.4	123.0
10.2	15.8	-150.1	-2.2	-42.3	-5.3	99.8	-23.6	79.5
19.7	16.3	-170.8	-6.6	-69.3	-10.7	64.5	-21.1	40.7
50.1	15.9	175.7	-16.2	-90.3	-16.2	33.9	-20.6	14.5
69.7	15.8	171.5	-21.1	-95.4	-16.9	26.4	-20.6	9.4
102.4	15.7	165.7	-32.3	-86.5	-17.1	19.9	-20.6	5.3
150.5	15.6	158.2	-28.0	45.9	-16.8	14.7	-20.7	2.1
198.1	15.5	151.1	-21.9	46.8	-16.2	10.8	-20.7	0.1
246.9	15.3	144.1	-18.9	37.2	-15.3	6.0	-20.7	-1.4
307.6	15.2	135.3	-16.0	27.8	-14.2	-1.8	-20.6	-3.9
362.8	15.0	127.8	-14.2	17.4	-13.3	-9.2	-20.6	-5.9
405.0	14.9	121.9	-12.8	10.9	-12.6	-16.0	-20.6	-8.2
452.2	14.7	115.4	-11.6	3.0	-11.8	-23.9	-20.6	-10.8
504.7	14.5	108.4	-10.3	-6.0	-10.9	-33.0	-20.7	-14.2
563.4	14.4	100.3	-8.9	-17.4	-9.8	-45.2	-20.9	-19.3
595.3	14.2	96.0	-8.2	-23.3	-9.2	-52.2	-21.0	-22.6
664.5	14.1	87.0	-6.7	-36.9	-8.0	-68.3	-21.7	-30.5
702.1	14.0	80.9	-5.9	-44.6	-7.3	-79.1	-22.5	-38.6
741.8	13.9	76.5	-5.1	-54.0	-6.8	-91.4	-24.0	-44.9
828.1	13.5	62.2	-4.3	-76.1	-6.3	-113.2	-26.5	-35.0
874.9	13.0	54.0	-4.1	-84.6	-5.9	-126.0	-27.0	-49.0
924.4	12.8	44.9	-3.6	-93.1	-5.1	-136.8	-28.0	-62.9
976.7	11.6	35.9	-3.5	-104.4	-5.3	-157.8	-34.0	-104.4
1031.9	11.1	33.0	-3.4	-115.7	-5.8	-172.3	-37.1	107.9
1090.3	10.4	29.2	-3.3	-122.0	-5.7	-173.4	-37.8	162.5
1151.9	10.3	22.2	-3.0	-131.3	-4.8	179.4	-31.1	169.5
1217.1	9.7	4.7	-2.9	-142.3	-3.9	161.9	-26.3	137.1
1285.9	8.6	0.7	-2.9	-151.7	-3.6	147.6	-22.7	121.9
1358.6	7.3	-8.3	-2.9	-161.2	-3.4	134.6	-20.6	116.5
1435.5	5.8	-14.5	-3.0	-170.1	-3.2	122.6	-18.8	105.2
1516.6	4.6	-22.7	-3.1	-178.6	-3.2	112.1	-17.2	96.0
1602.4	3.2	-28.4	-3.1	173.2	-3.1	101.7	-15.7	87.0
1693.0	1.5	-38.0	-3.1	165.1	-3.0	92.4	-14.3	79.2
1788.8	-0.5	-47.9	-3.1	157.6	-2.9	83.6	-13.1	68.8
1889.9	-2.5	-51.0	-3.2	148.8	-2.7	74.4	-12.4	56.9
1996.8	-4.1	-49.0	-3.4	139.5	-2.3	65.0	-12.2	48.2

APPLICATION INFORMATION

The THS9001 is a medium power, cascadeable, amplifier optimized for high intermediate frequencies in radios. The amplifier is unconditionally stable and design requires only 2 dc-blocking capacitors, 1 power-supply bypass capacitor, 1 RF choke, and 1 bias resistor. Refer to Figure 24 for circuit diagram.

The THS9001 operates with a power supply voltage ranging from 2.5 V to 5.5 V.

The value of $R_{(BIAS)}$ sets the bias current to the amplifier. Refer to Figure 10. This allows the designer to trade-off linearity versus power consumption. $R_{(BIAS)}$ can be removed without damage to the device.

Component selection of $C_{(BYP)}$, C_{IN}, and C_{OUT} is not critical. The values shown in Figure 24 were used for all the data shown in this data sheet.

The amplifier incorporates internal impedance matching to 50 Ω that can be adjusted for various frequencies of operation by proper selection of $L_{(COL)}$.

Figure 19 shows the s-parameters of the part mounted on the standard EVM with V_S = 5 V, $R_{(BIAS)}$ = 237Ω , and $L_{(COL)}$ = 470 nH. With this configuration, the part is very broadband, and achieves greater than 15-dB input and output return loss from 50 MHz to 325 MHz.

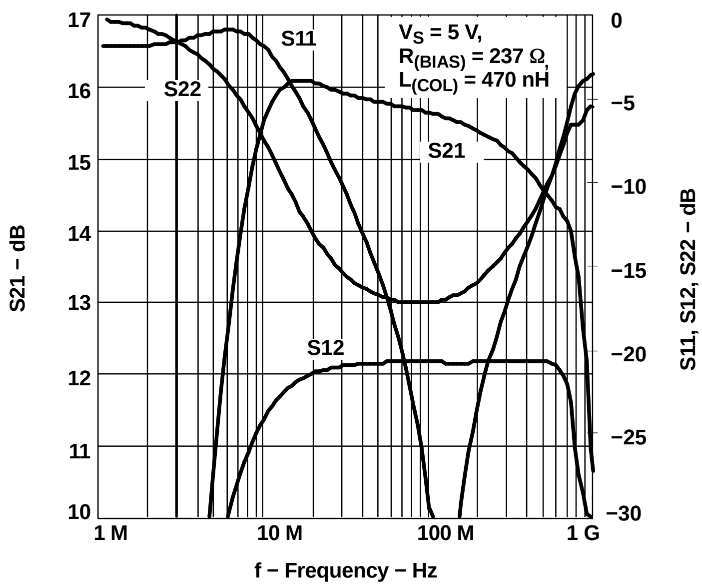


Figure 19. S-Parameters of THS9001 Mounted on the Standard EVM With V_S = 5 V, $R_{(BIAS)}$ = 237 Ω, and $L_{(COL)}$ = 470 nH

APPLICATION INFORMATION (continued)

Figure 20 Shows an example of a single conversion receiver architecture and where the THS9001 would typically be used.

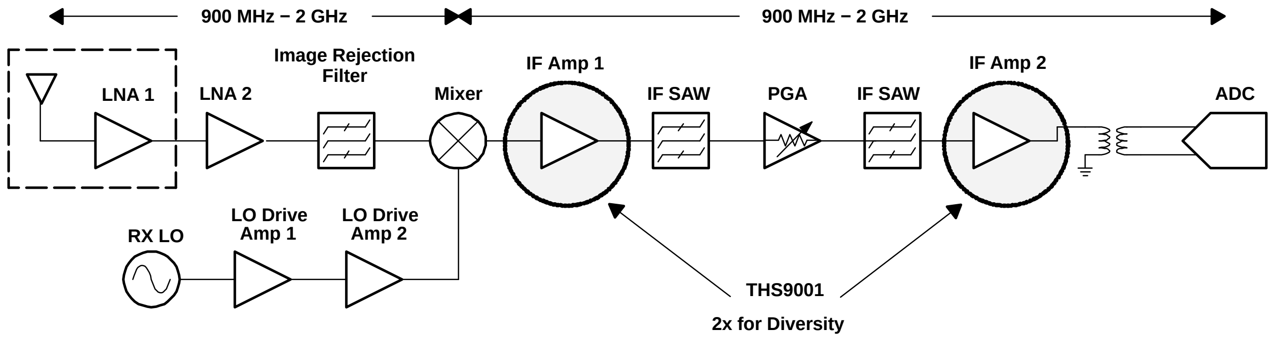


Figure 20. Example Single Conversion Receiver Architecture

Figure 21 shows an example of a dual conversion receiver architecture and where the THS9001 would typically be used.

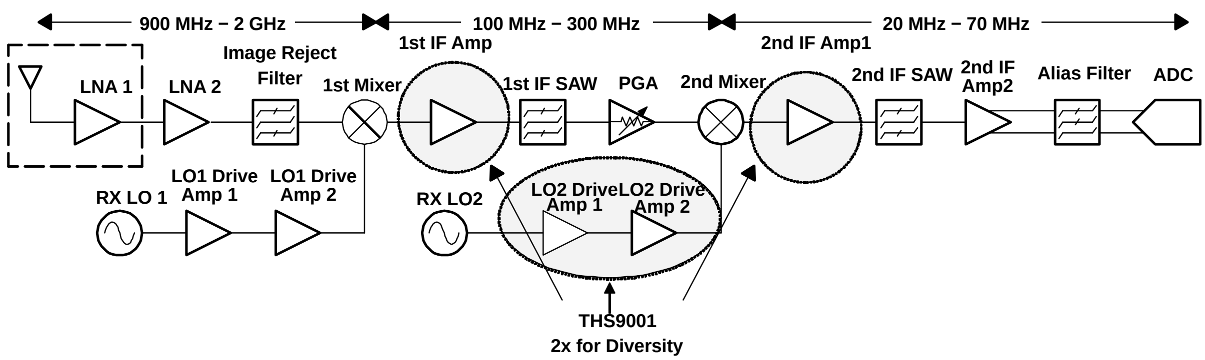


Figure 21. Example Dual Conversion Receiver Architecture

Figure 22 shows an example of a dual conversion transmitter architecture and where the THS9001 would typically be used.

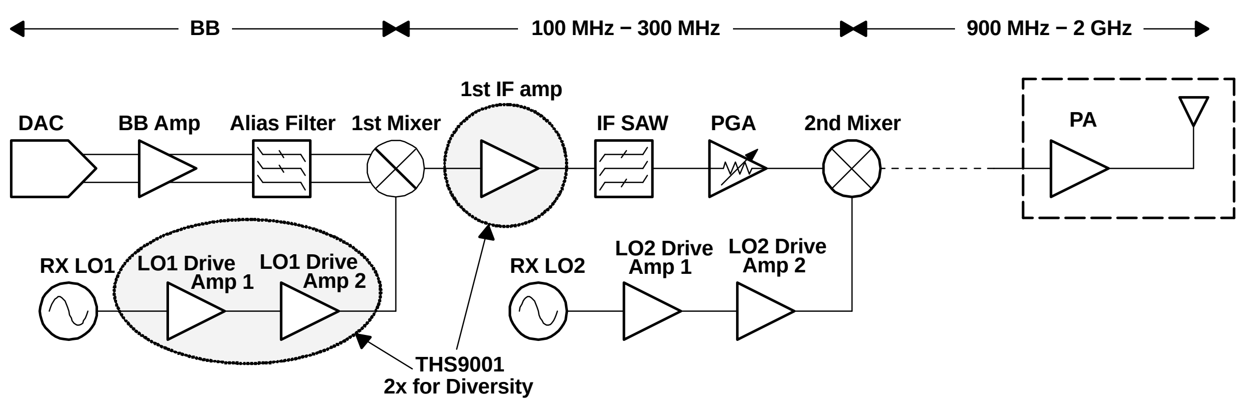
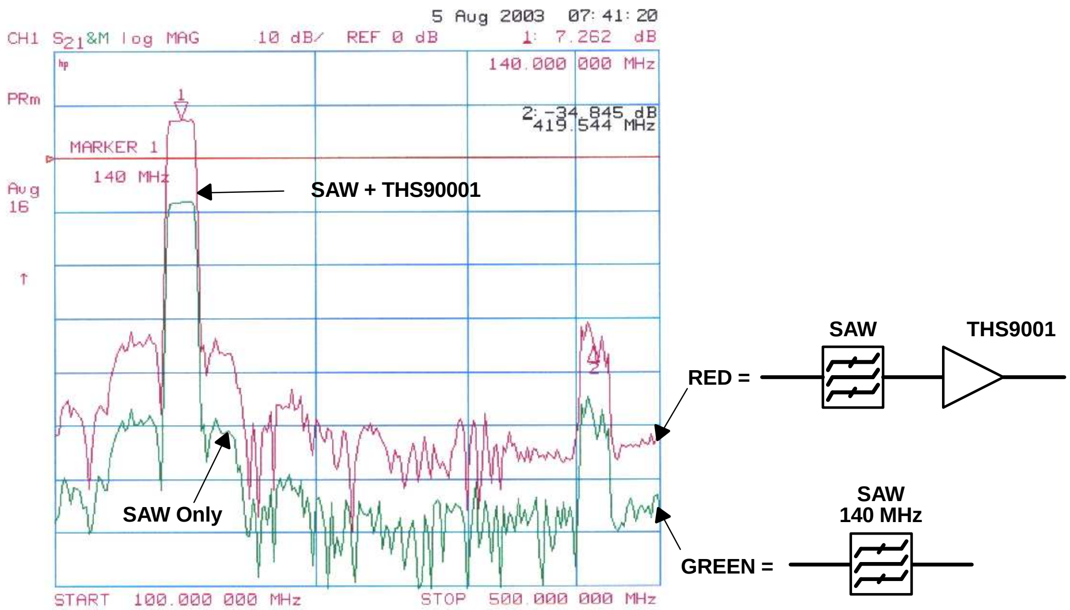


Figure 22. Example Dual Conversion Transmitter Architecture

APPLICATION INFORMATION (continued)

Figure 23 shows the THS9001 and Sawtek #854916 SAW filter frequency response along with the frequency response of the SAW filter alone. The SAW filter has a center frequency of 140 MHz with 10-MHz bandwidth and 8-dB insertion loss. It can be seen that the frequency response with the THS9001 is the same as with the SAW except for a 15-dB gain. The THS9001 is mounted on the standard EVM with V_S = 5 V, $R_{(BIAS)}$ = 237 Ω, and $L_{(COL)}$ = 470 nH. Note the amplifier does not add artifacts to the signal.



140 MHz SAW: Sawtek #854916

Figure 23. Frequency Response of the THS9001 and SAW Filter, and SAW Filter Only

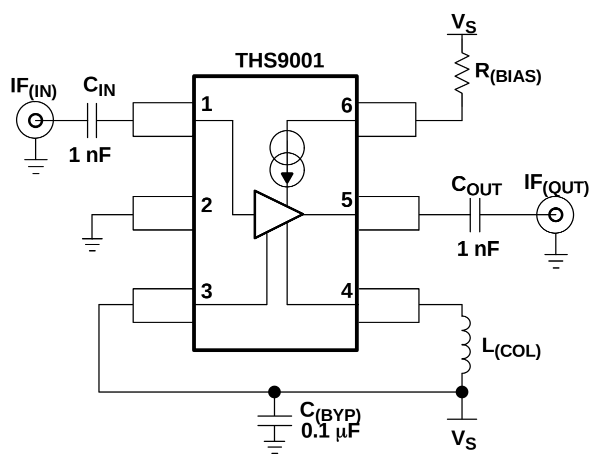


Figure 24. THS9001 Recommended Circuit (Used for all Tests)

APPLICATION INFORMATION (continued)

Evaluation Module

Table 1 is the bill of materials, and Figure 25 and Figure 26 show the EVM layout.

Bill Of Materials

ITEM	DESCRIPTION	REF DES	QTY	PART NUMBER(1)
1	Cap, 0.1 µF, ceramic, X7R, 50 V	C1	1	(AVX) 08055C104KAT2A
2	Cap, 1000 pF, ceramic, NPO, 100 V	C2, C3	2	(AVX) 08051A102JAT2A
3	Inductor, 470 nH, 5%	L1	1	(Coilcraft) 0805CS-471XJBC
4	Resistor, 237 Ω, 1/8 W, 1%	R1	1	(Phycomp) 9C08052A2370FKHFT
5	Open	TR1	1	
6	Jack, banana receptance, 0.25" dia.	J3, J4	2	(SPC) 813
7	Connector, edge, SMA PCB jack	J1, J2	2	(Johnson) 142-0701-801
8	Standoff, 4-40 Hex, 0.625" Length		4	(KEYSTONE) 1808
9	Screw, Phillips, 4-40, .250"		4	SHR-0440-016-SN
10	IC, THS9001	U1	1	(TI) THS9001DBV
11	Board, printed-circuit		1	(TI) EDGE # 6453522 Rev.A

(1) The manufacturer's part numbers are used for test purposes only.

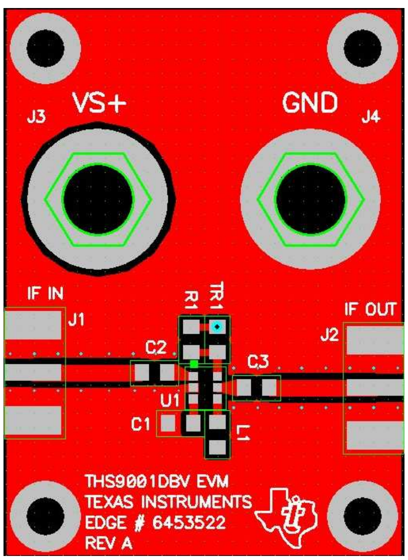


Figure 25. EVM Top Layout

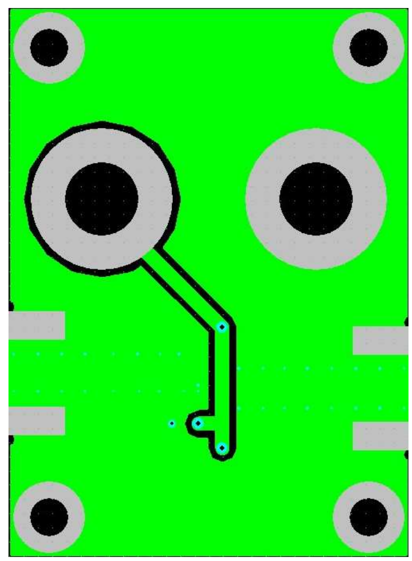


Figure 26. EVM Bottom Layout

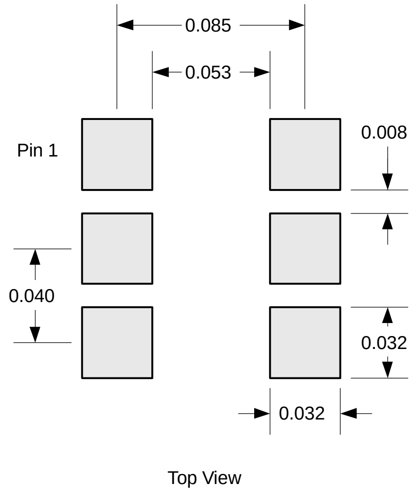


Figure 27. THS9001 Recommended Footprint (dimensions in inches)

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
THS9001DBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
THS9001DBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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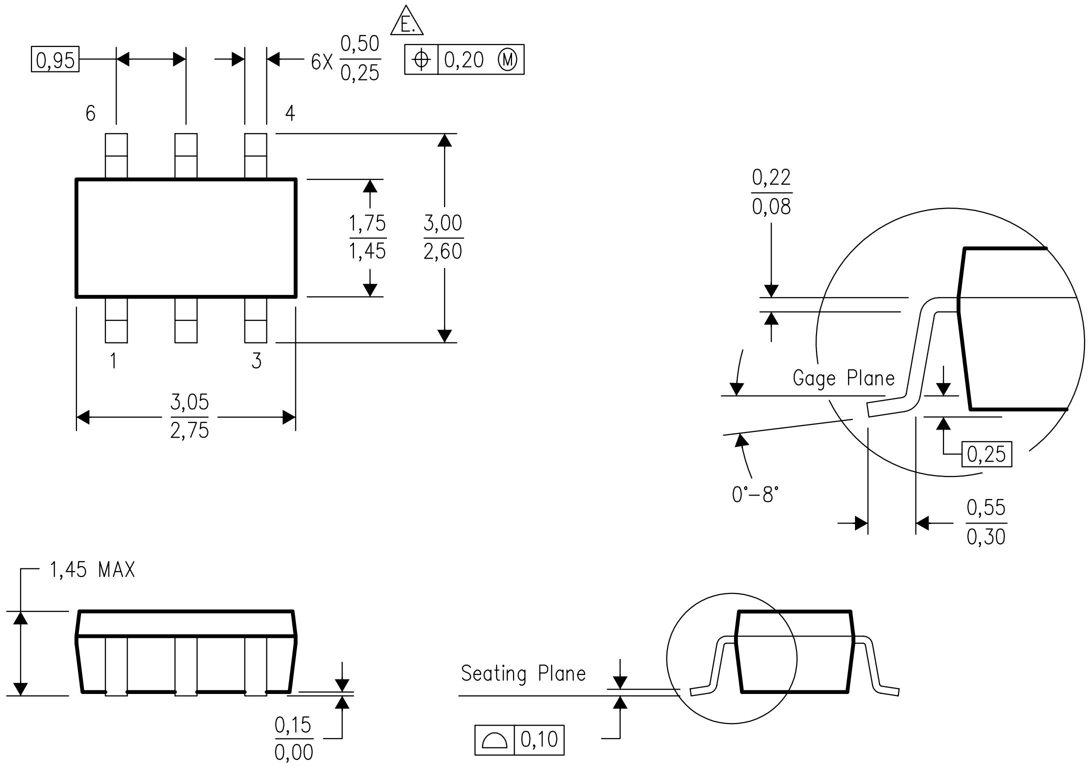
DBV (R-PDSO-G6) PLASTIC SMALL-OUTLINE PACKAGE



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NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
- D. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
- E. Falls within JEDEC MO-178 Variation AB, except minimum lead width.

IMPORTANT NOTICE

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
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