MMIC SURFACE MOUNT

Low Noise Bypass Amplifier TSS2-53LNB+

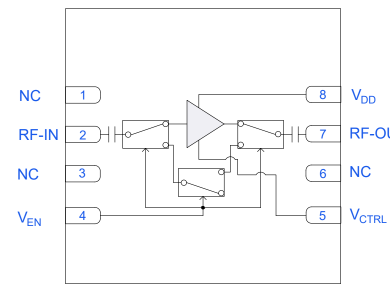
50Ω 500 to 5000 MHz

THE BIG DEAL

- Wideband, 500 to 5000MHz
- Very Fast Bypass Switching
- Low Noise Figure, Typ. 1.2dB
- High Gain, Typ. 21.7dB
- High IP3 in Bypass, Typ. +47 dBm
- Minimal External Circuitry
- 2x2mm 8-lead QFN-Style Package

Generic photo used for illustration purposes only

FUNCTIONAL DIAGRAM



APPLICATIONS

- 5G MIMO and Back Haul Radio Systems
- Test and Measurement Equipment
- Radar, EW, and ECM Defense Systems

PRODUCT OVERVIEW

Mini-Circuits' TSS2-53LNB+ is an advanced low noise amplifier, fabricated using E-pHEMT technology and offering extremely high dynamic range over a broad frequency range. It has integrated switches enabling users to bypass the amplifier during high signal conditions. In addition, the TSS2-53LNB+ provides excellent input and output return loss over a broad frequency range using minimal external matching components. It is enclosed in a compact 2x2mm 8-lead QFN-style package with ground paddle for good thermal performance.

KEY FEATURES

Features	Advantages
Wideband, 500 to 5000MHz	Ideal for a wide range of receiver applications including defense, communication, and test and measurement equipment. Effective for broadband or multi-band applications. Just one, cost-efficient model required for multiple frequency usage.
Minimal External Matching	Minimizes the need for external matching networks, simplifying circuit designs and enabling the amplifier to operate over multiple bands in a single application circuit.
High Dynamic Range	Low noise figure and high IP3 enable minimal signal degradation in active mode and enhanced linearity in bypass mode under high signal conditions.
Internal Bypass Switch Feature	Unique design handles low to high signal levels with minimal noise distortion.
Built-in DC Blocking Cap at RF-Out Port & Separate pads for RF-Out & V_{DD}	Simplifies biasing and eliminates need for bias-tee at output.
Compact Size, 2x2x0.9mm	Saves space in dense system layouts. Low inductance, repeatable transitions, and excellent thermal contact.

Low Noise Bypass Amplifier TSS2-53LNB+

50Ω 500 to 5000 MHz

ELECTRICAL SPECIFICATIONS[1] AT +25°C, Zo = 50Ω AND V_{DD} = +5V; V_{CTRL} TIED TO V_{EN} THROUGH 3.92KΩ RESISTOR UNLESS NOTED OTHERWISE

Parameter	Condition (MHz)	Amplifier-ON V_{EN} = +5V			Units
		Min.	Typ.	Max.	
Frequency Range		500		5000	MHz
Noise Figure	500		1.3		dB
	1000		1.1		
	2000		1.2		
	3000		1.3		
	4000		1.3		
	5000		1.3		
Gain	500		22.6		dB
	1000		22.5		
	2000		21.7		
	3000		20.6		
	4000		19.6		
	5000		18.6		
Input Return Loss	500		16.1		dB
	1000		15.5		
	2000		14.0		
	3000		11.5		
	4000		11.9		
	5000		15.4		
Output Return Loss	500		12.7		dB
	1000		14.0		
	2000		22.4		
	3000		14.8		
	4000		12.8		
	5000		10.4		
Output Power at 1dB Compression (OP1dB)	500		+19.6		dBm
	1000		+19.4		
	2000		+19.0		
	3000		+18.8		
	4000		+19.2		
	5000		+18.3		
Output Third-Order Intercept Point (P_{OUT} = 0dBm/Tone)	500		+28.7		dBm
	1000		+31.6		
	2000		+29.3		
	3000		+31.2		
	4000		+28.9		
	5000		+25.0		
Device Operating Voltage (V_{DD})		+4.75	+5.0	+5.25	V
Device Operating Current (I_{DD}) [2]			80	94	mA
Enable Voltage (V_{EN})		+4.5	+5.0	+5.5	V
Enable Current (I_{EN})			2.0		mA
Control Voltage (V_{CTRL})			+1.5		V
Control Current (I_{CTRL})			0.9		mA
DC Current (I_{DD}) Variation vs. Temperature [3]			-77		µA/°C
DC Current (I_{DD}) Variation vs. Voltage [4]			0.002		mA/mV

1. Tested on Mini-Circuits Characterization Test/Evaluation Board TB-TSS2-53LNBC+.
2. Current at P_{IN} = -25dBm. Increases to 96mA at P1dB.
3. ((Currentat +85°C) – (Currentat -45°C)) / (+130°C)
4. ((Currentat +5.25V) - (Currentat +4.75V))/(+5.25V - +4.75V)

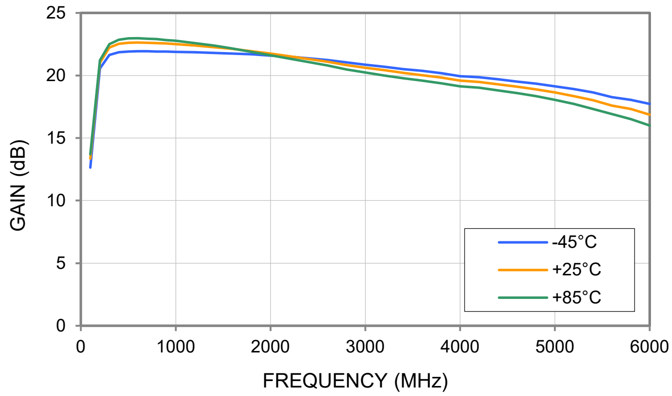
ELECTRICAL SPECIFICATIONS[5] AT +25°C, Zo = 50Ω AND V_{DD} = +5V; V_{CTRL} TIED TO V_{EN} THROUGH 3.92KΩ RESISTOR UNLESS NOTED OTHERWISE

Parameter	Condition (MHz)	Amplifier-Bypass V_{EN} = 0V			Units
		Min.	Typ.	Max.	
Frequency Range		500		5000	MHz
Gain	500		-0.7		dB
	1000		-0.7		
	2000		-0.9		
	3000		-1.0		
	4000		-1.0		
	5000		-0.9		
Input Return Loss	500		23.7		dB
	1000		16.4		
	2000		11.2		
	3000		11.1		
	4000		13.9		
	5000		18.2		
Output Return Loss	500		21.2		dB
	1000		15.7		
	2000		11.6		
	3000		12.1		
	4000		16.0		
	5000		18.4		
Input Power at 1dB Compression (IP1dB)	500		+34.4		dBm
	1000		+34.5		
	2000		+29.1		
	3000		+29.9		
	4000		+29.8		
	5000		+30.1		
Output Third-Order Intercept Point (P_{OUT} = 0dBm/Tone)	500		+47.0		dBm
	1000		+46.8		
	2000		+42.6		
	3000		+38.3		
	4000		+39.4		
	5000		+39.1		
Device Operating Voltage (V_{DD})			+5.0		V
Device Operating Current (I_{DD})			2		mA
Enable Voltage (V_{EN})		0	—	0.5	V
Enable Current (I_{EN})			0		mA
Control Voltage (V_{CTRL})			0		V
Control Current (I_{CTRL})				0.012	μA

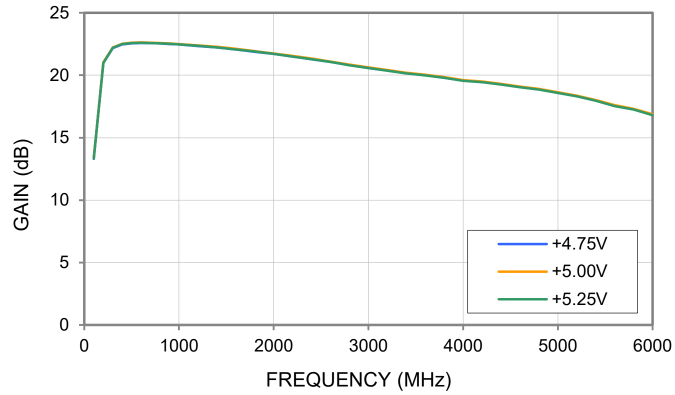
5. Tested on Mini-Circuits Characterization Test/Evaluation Board TB-TSS2-53LNBC+.

TYPICAL PERFORMANCE GRAPHS
LNA MODE

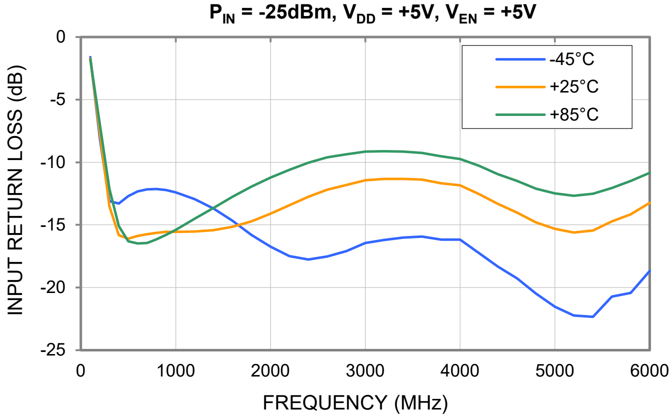
GAIN vs. TEMPERATURE
P_{IN} = -25dBm, V_{DD} = +5V, V_{EN} = +5V



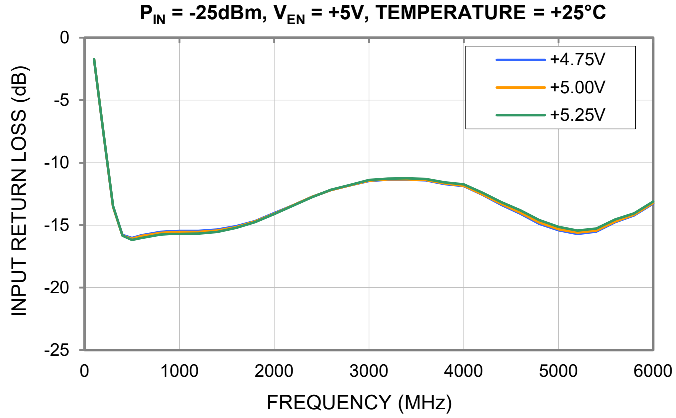
GAIN vs. DEVICE VOLTAGE
P_{IN} = -25dBm, V_{EN} = +5V, TEMPERATURE = +25°C



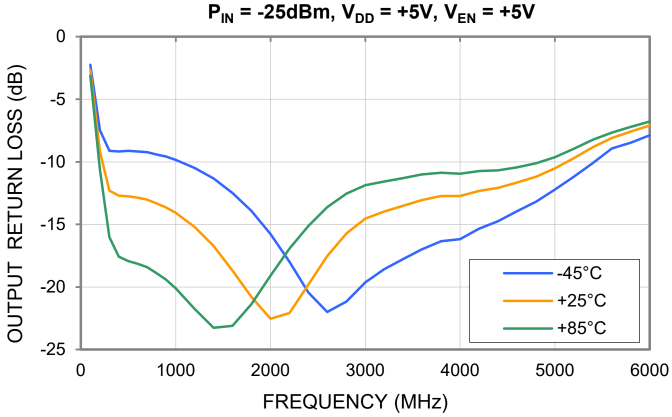
INPUT RETURN LOSS vs. TEMPERATURE
P_{IN} = -25dBm, V_{DD} = +5V, V_{EN} = +5V



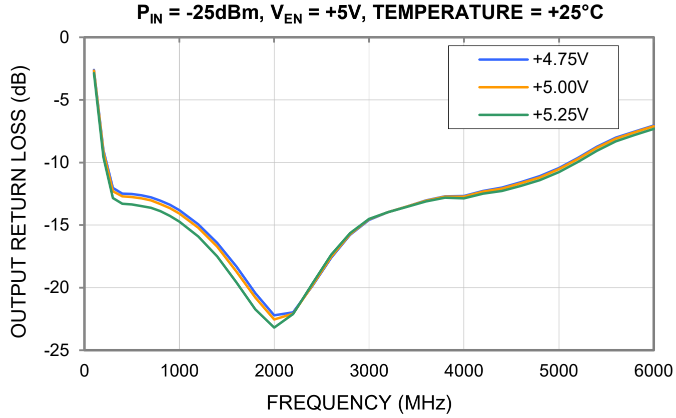
INPUT RETURN LOSS vs. DEVICE VOLTAGE
P_{IN} = -25dBm, V_{EN} = +5V, TEMPERATURE = +25°C



OUTPUT RETURN LOSS vs. TEMPERATURE
P_{IN} = -25dBm, V_{DD} = +5V, V_{EN} = +5V

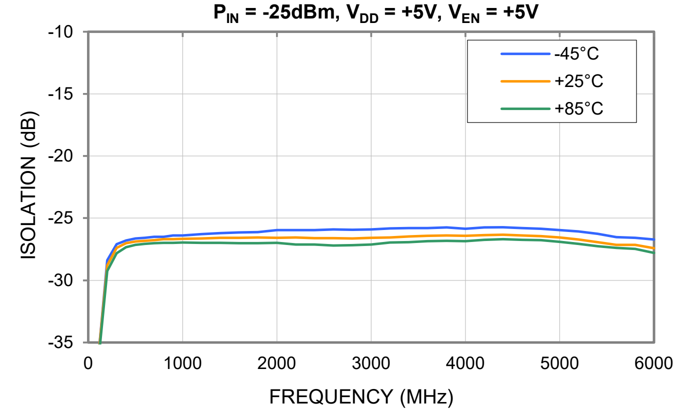


OUTPUT RETURN LOSS vs. DEVICE VOLTAGE
P_{IN} = -25dBm, V_{EN} = +5V, TEMPERATURE = +25°C

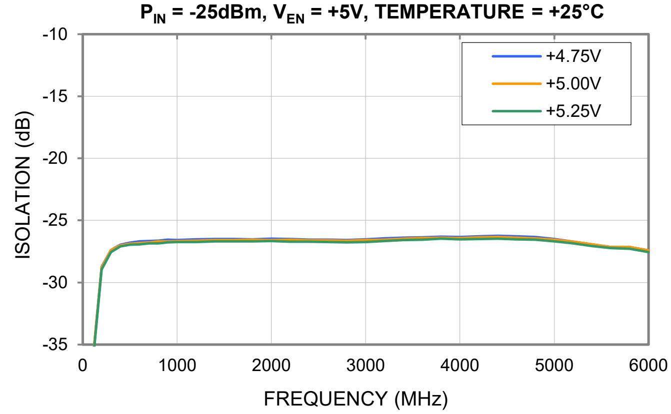


TYPICAL PERFORMANCE GRAPHS
LNA MODE

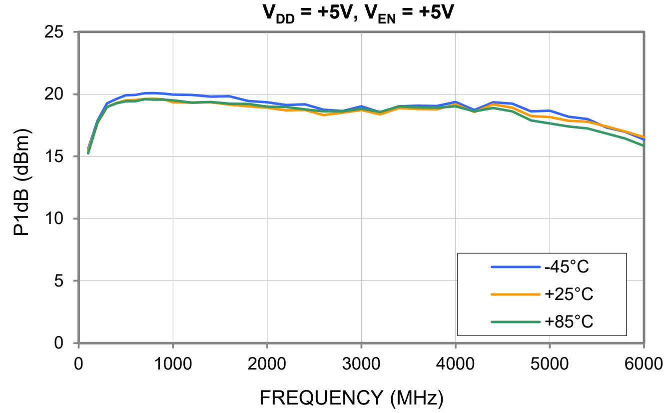
ISOLATION vs. TEMPERATURE
P_{IN} = -25dBm, V_{DD} = +5V, V_{EN} = +5V



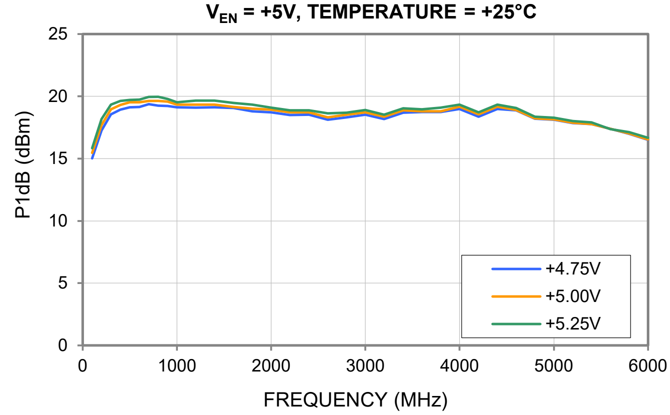
ISOLATION vs. DEVICE VOLTAGE
P_{IN} = -25dBm, V_{EN} = +5V, TEMPERATURE = +25°C



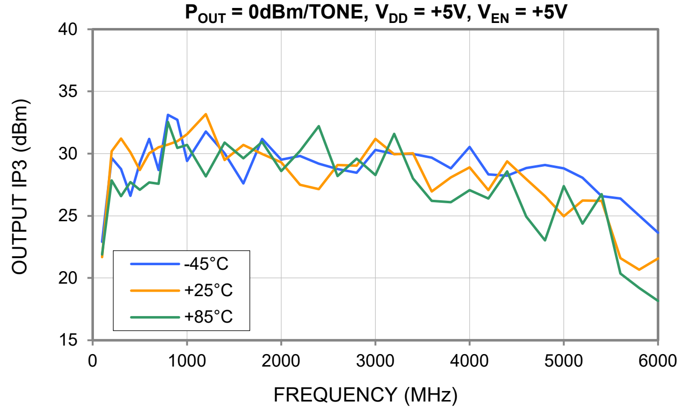
P1dB vs. TEMPERATURE
V_{DD} = +5V, V_{EN} = +5V



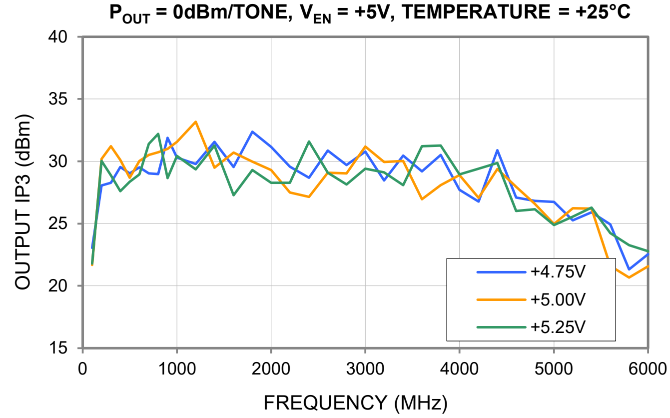
P1dB vs. DEVICE VOLTAGE
V_{EN} = +5V, TEMPERATURE = +25°C



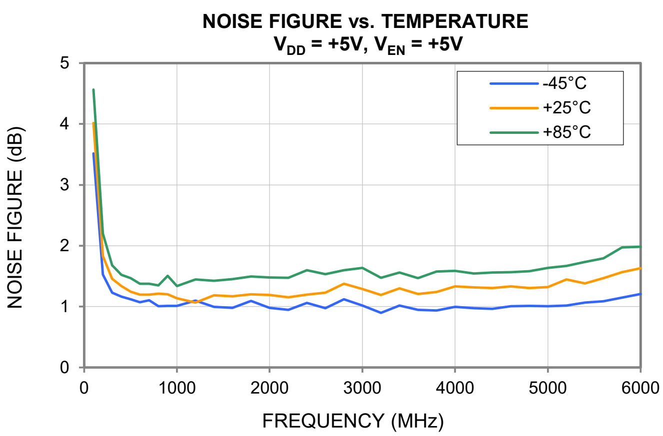
OUTPUT IP3 vs. TEMPERATURE
P_{OUT} = 0dBm/TONE, V_{DD} = +5V, V_{EN} = +5V

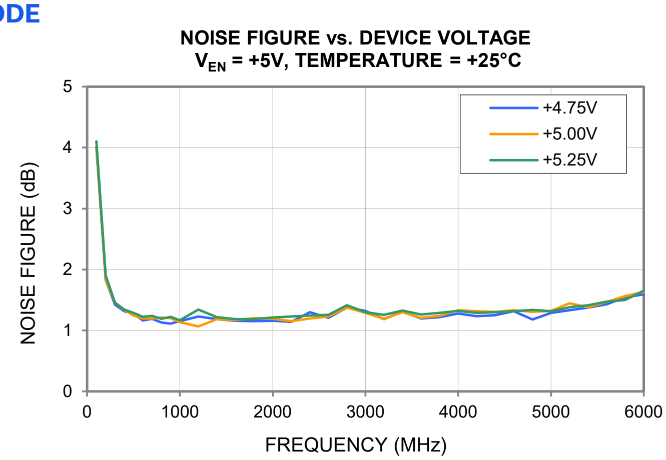


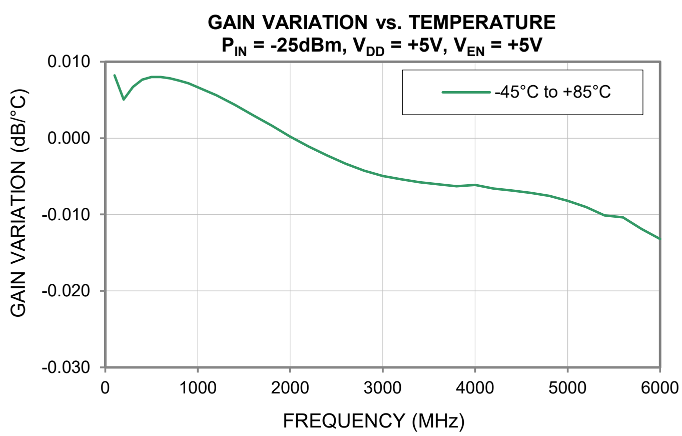
OUTPUT IP3 vs. DEVICE VOLTAGE
P_{OUT} = 0dBm/TONE, V_{EN} = +5V, TEMPERATURE = +25°C



TYPICAL PERFORMANCE GRAPHS
LNA MODE

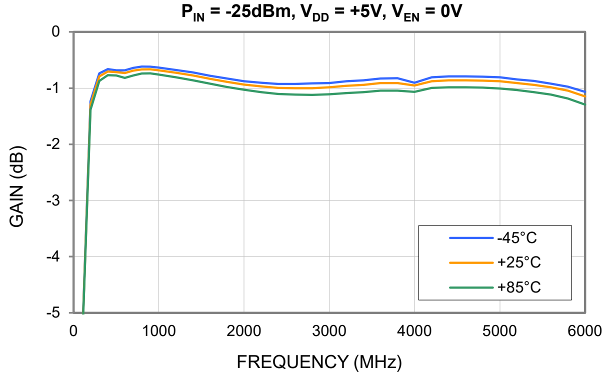




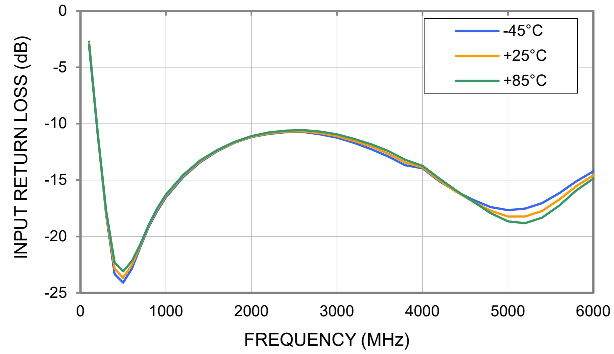


TYPICAL PERFORMANCE GRAPHS
BYPASS MODE

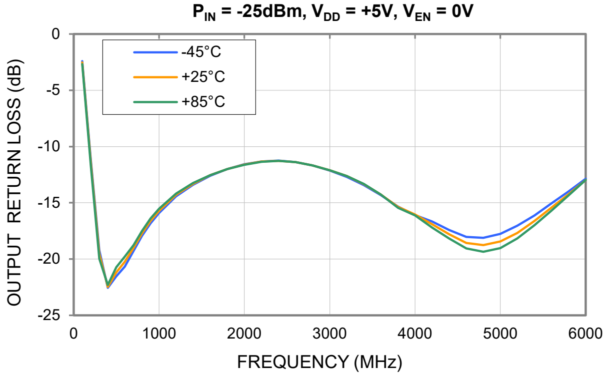
GAIN vs. TEMPERATURE
P_{IN} = -25dBm, V_{DD} = +5V, V_{EN} = 0V



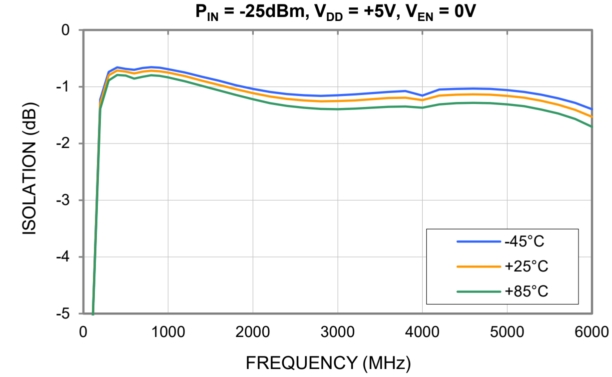
INPUT RETURN LOSS vs. TEMPERATURE
P_{IN} = -25dBm, V_{DD} = +5V, V_{EN} = 0V



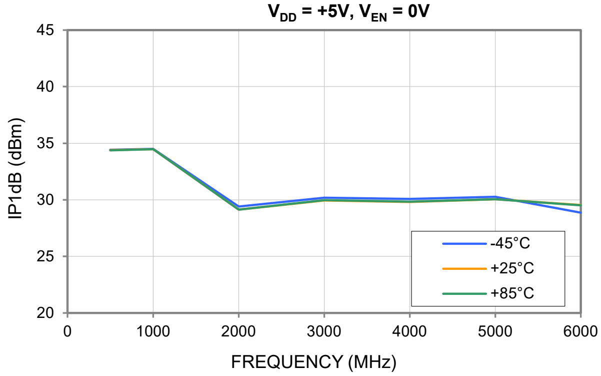
OUTPUT RETURN LOSS vs. TEMPERATURE
P_{IN} = -25dBm, V_{DD} = +5V, V_{EN} = 0V



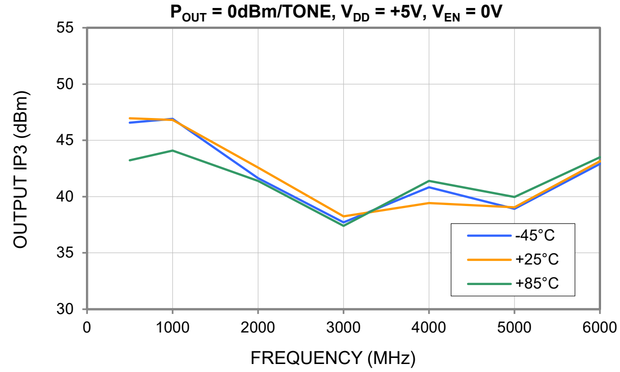
ISOLATION vs. TEMPERATURE
P_{IN} = -25dBm, V_{DD} = +5V, V_{EN} = 0V



INPUT P1dB vs. TEMPERATURE
V_{DD} = +5V, V_{EN} = 0V



OUTPUT IP3 vs. TEMPERATURE
P_{OUT} = 0dBm/TONE, V_{DD} = +5V, V_{EN} = 0V



ABSOLUTE MAXIMUM RATINGS[6]

Parameter		Ratings
Operating Temperature (ground lead)		-45°C to 85°C
Storage Temperature		-65°C to 150°C
Total Power Dissipation		0.7W
Input Power	Amplifier-ON	+19dBm
	Amplifier-Bypass	+29dBm
DC Voltage V_{DD}		+7.0V
DC Voltage V_{EN}		+7.0V
DC Voltage V_{CTRL}		+7.0V
DC Voltage on RF-OUT		+15.0V

6. Permanent damage may occur if any of these limits are exceeded. Electrical maximum ratings are not intended for continuous normal operation.

ENABLE VOLTAGE (V_{EN})

	Min.	Typ.	Max.	Units
Amplifier-ON	+4.5	+5.0	+5.5	V
Amplifier-Bypass	0	—	+0.5	V

THERMAL RESISTANCE

Parameter	Ratings
Thermal Resistance (Θ_{jc})[7]	53.8°C/W

7. Θ_{jc}= (Hot Spot Temperature on Die - Temperature at Ground Lead)/Dissipated Power

ESD RATING

	Class	Voltage Range	Reference Standard
Human Body Model (HBM)	1A	250V to <500V	ANSI/ESDA/JEDEC JS-001-2017
Charged Device Model (CDM)	C3	>1000V	JESD22-C101F

ESD HANDLING PRECAUTION: This device is designed to be Class 1A for HBM. Static charges may easily produce potentials higher than this with improper handling and can discharge into DUT and damage it. As a preventive measure Industry standard ESD handling precautions should be used at all times to protect the device from ESD damage.

MSL RATING

Moisture Sensitivity: MSL1 in accordance with IPC/JEDEC J-STD-020E /JEDEC J-STD-033C

SWITCHING SPECIFICATIONS (RISE/FALL TIME)

Parameter		Min.	Typ.	Max.	Units
Amplifier ON to Bypass	OFF TIME (50% Control to 10% RF)	-	39	-	ns
	FALL TIME (90% to 10% RF)	-	12	-	
Amplifier Bypass to ON	ON TIME (50% Control to 90% RF)	-	650	-	ns
	RISE TIME (10% to 90% RF)	-	250	-	
Control Voltage Leakage		-	+49	-	mV

Low Noise Bypass Amplifier TSS2-53LNB+

50Ω 500 to 5000 MHz

FUNCTIONAL DIAGRAM

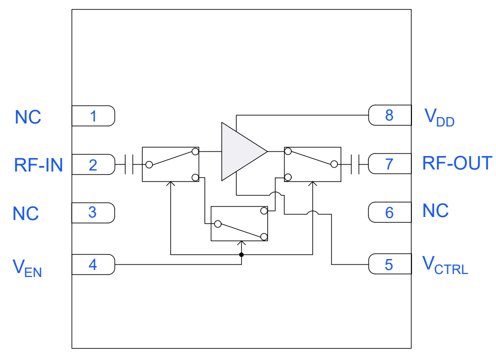


Figure 1. TSS2-53LNB+ Functional Diagram

PAD DESCRIPTION

Function	Pad Number	Application Description (Refer to Figure 2)
RF-IN	2	RF-Input pad. Connect to Ground Via L1.
RF-OUT	7	RF-Output pad. No external DC blocking capacitor required.
V_{CTRL}	5	Voltage Control pad. Voltage level on this pad sets the I_{DD}. May be tied to V_{EN} through a fixed resistor.
V_{EN}	4	Voltage Enable Pad. Voltage level on this pad determines if the Amplifier is on or bypassed.
V_{DD}	8	Supply Voltage Pad. Connect to V_{DD} via L2.
Ground	Paddle	Connects to ground.
NC	1,3,6	No internal connection. Recommended to be grounded.

CHARACTERIZATION TEST CIRCUIT

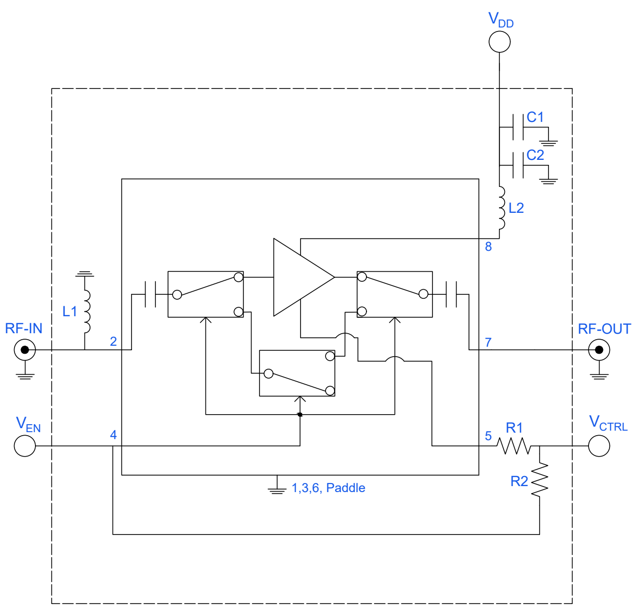


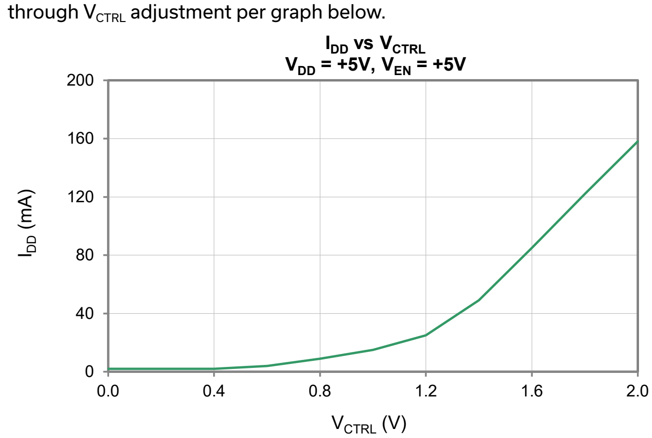
Figure 2. DUT soldered on Mini-Circuits Characterization Test Board: TB-TSS2-53LNBC+.

Electrical Parameters and Conditions

Gain, Return Loss, Output Power at 1dB Compression (P1dB), Output IP3 (OIP3) and Noise Figure measured using N5242A PNA-X Microwave Network Analyzer.

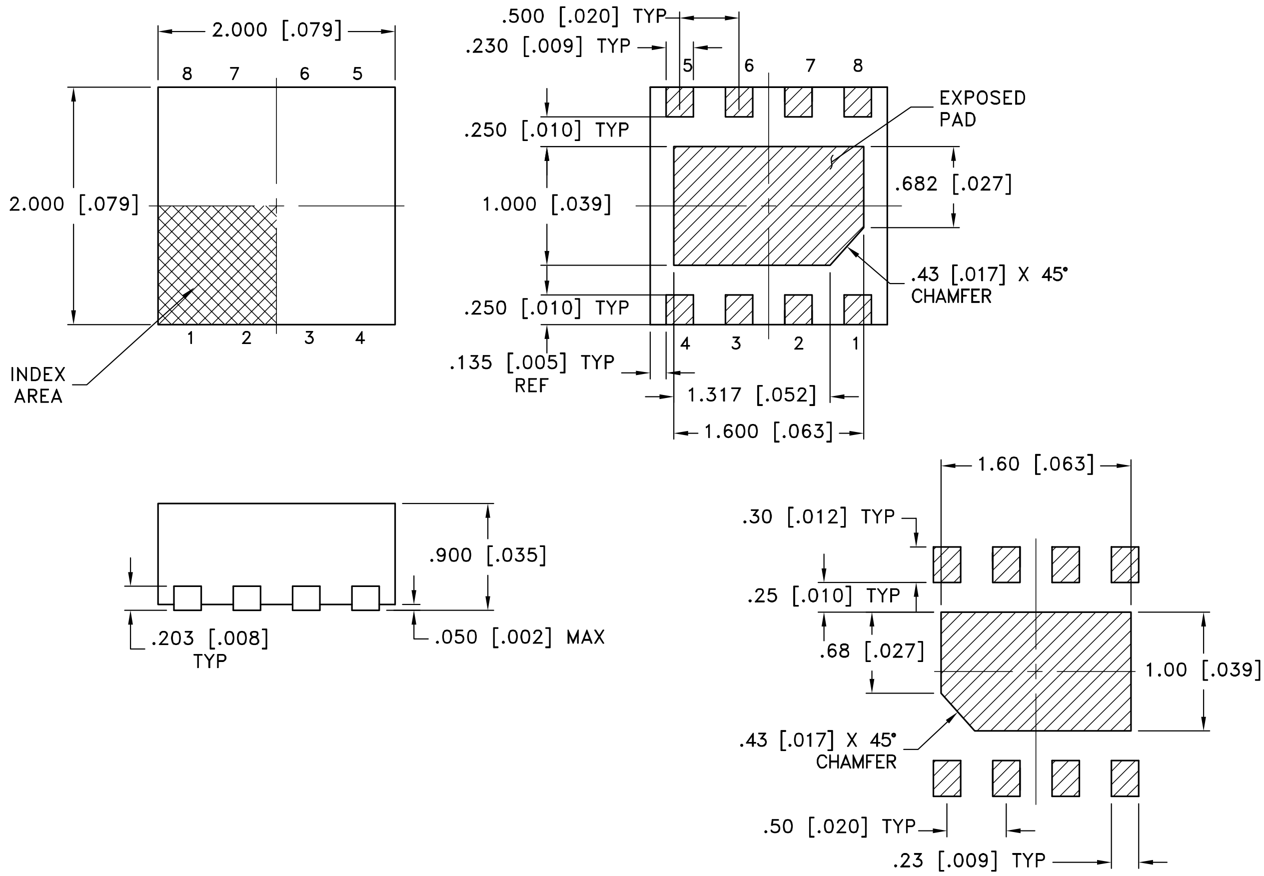
Conditions:

1. Gain and Return Loss: P_{IN}= -25dBm
2. Output IP3 (OIP3): Two tones, spaced 1MHz apart, 0dBm/tone at output.
3. Switching Time: P_{IN}=-25dBm at 500MHz. V_{EN}=4.5, 5.0, 5.5V at 10kHz. V_{DD} =4.75, 5.0 and 5.25V. V_{CTRL} and V_{EN} are tied together per Figure 2.
4. If V_{CTRL} and V_{EN} are tied together, apply +5V (typical) to V_{EN} only. After that, a value of +1.5V will be seen at V_{CTRL}.
5. If V_{CTRL} is used independently of V_{EN}, then R2 must be removed and connection between V_{CTRL} and V_{EN} shall be left opened. Furthermore, R1 0Ω resistor shall be replaced with a 3.92KΩ resistor. This allows for current control of the amplifier through V_{CTRL} adjustment per graph below.



Component	Value	Size	Part Number	Manufacturer
L1	47nH	0402	LL1005-FHL47NJ	Toko
L2	56nH	0402	0402HPH-56NXGLW	Coilcraft
C1	0.1µF	0402	GRM155R71C04KA88D	Murata
C2	10pF	0402	GJM1555C1H100JB01	Murata
R1	0Ω	0402	RK73Z1ETTP	Koa Speer
R2	3.92KΩ	0402	RK73H1ETTP3921F	Koa Speer

CASE STYLE DRAWING

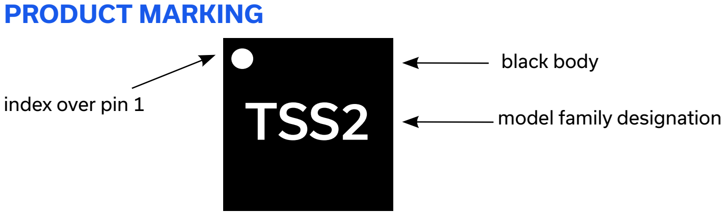


DENOTES METALLIZATION

Suggested Layout

Weight: .011 grams
Dimensions are in mm [inches]. Tolerances: 3 Pl.±.0.050[0.002] mm [Inches]

PRODUCT MARKING



Marking may contain other features or characters for internal lot control

Low Noise Bypass Amplifier TSS2-53LNB+

50Ω 500 to 5000 MHz

ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASH BOARD

CLICK HERE

Performance Data & Graphs	Data Graphs S-Parameter (S2P Files) Data Set (.zip file)
Case Style	MC3007 Plastic package, exposed paddle, Lead Finish: Matte-Tin
RoHs Status	Compliant
Tape & Reel **Standard quantities available on reel**	F66 7″ reels with 20, 50, 100, 200, 500,1K or 2K devices
Suggested Layout for PCB Design	PL-760
Evaluation Board	TB-TSS2-53LNBC+
Environmental Ratings	ENV12T2