MMIC SURFACE MOUNT

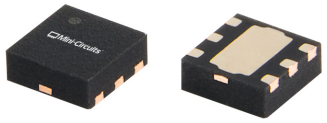
Monolithic Amplifier

LEE1-39+

50Ω DC to 7000 MHz

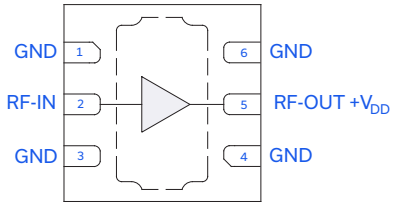
THE BIG DEAL

- Low Noise Figure, Typ. 2.3 dB
- High Gain, Typ. 18.4 dB
- High OIP3, Typ. +22.3 dBm
- High P1dB, Typ. +11.9 dBm
- Low Operating Current, 35 mA at +3.6 V
- 1.5x1.5 mm 6-Lead QFN-Style Package



Generic photo used for illustration purposes only

FUNCTIONAL DIAGRAM (TOP VIEW)



APPLICATIONS

- Satellite Communications
- 5G MIMO and Backhaul MW Radio Systems
- Radar, EW and ECM Defense Systems

PRODUCT OVERVIEW

The LEE1-39+ is high-linearity gain block amplifier in a low-cost surface mount package, fabricated using an InGaP/GaAs HBT semiconductor process. Operating from DC to 7000 MHz, this amplifier features high dynamic range with typical 2.3 dB noise figure, 18.4 dB gain, +11.9 dBm P1dB, and +22.3 dBm OIP3 at 4 GHz. This combination of performance makes it ideal for sensitive, high dynamic range receiver applications. The LEE1-39+ is a current driven device consuming only 35 mA at +3.6 V supply, is well matched to 50Ω, and comes in a small, low-profile 1.5x1.5 mm QFN-style package for ease of integration into dense circuit board layouts.

KEY FEATURES

Features	Advantages
Low Power Consumption, Typ. 35 mA at +3.6 V	At only 35 mA, this amplifier is ideal for applications with limited available power or densely packed applications where thermal and power management is critical.
High Dynamic Range • Noise Figure, Typ. 2.3 dB • OIP3, Typ. +22.3 dBm • P1dB, Typ. +11.9 dBm	The LEE1-39+ offers low noise figure and good linearity making this gain block amplifier ideal for use as a secondary stage amplifier in ultra-high dynamic range receivers.
1.5x1.5 mm 6-Lead QFN-Style Package	Very small footprint saves space in dense PCB layouts while providing low inductance, repeatable transitions, and excellent thermal contact with the PCB. Industry standard packaging allows for ease of assembly in high volume manufacturing processes.
No External Matching Components Required	The LEE1-39+ has good input and output return loss up to 6 GHz, eliminating the need for any external matching components while demonstrating excellent reliability.

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ELECTRICAL SPECIFICATIONS[1] AT +25°C, I_{DD} = 35 mA, UNLESS NOTED OTHERWISE

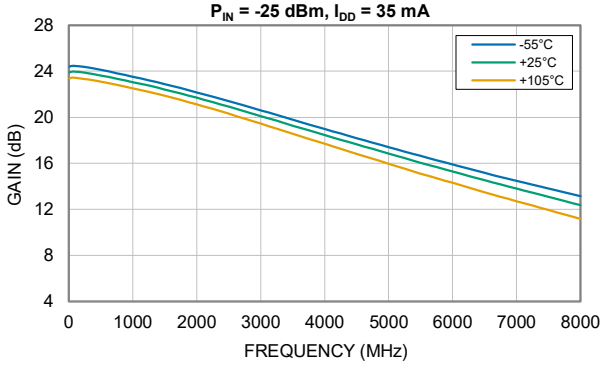
Parameter	Frequency (MHz)	Min.	Typ.	Max.	Units
Frequency Range		DC[6]		7000	MHz
Gain	10	22.5	23.9		dB
	1000	21.6	23.0		
	2000	20.3	21.7		
	4000	17.2	18.4		
	6000	13.5	15.2		
	7000	11.3	13.7		
Input Return Loss	10		25		dB
	1000		19		
	2000		15		
	4000		12		
	6000		9		
	7000		8		
Output Return Loss	10		21		dB
	1000		17		
	2000		14		
	4000		11		
	6000		11		
	7000		10		
Isolation	10 - 7000		22		dB
Output Power at 1 dB Compression (P1dB)	10		+12.8		dBm
	1000		+11.5		
	2000		+11.5		
	4000		+11.9		
	6000		+10.6		
	7000		+9.8		
Output Power at 3 dB Compression (P3dB)	10		+14.2		dBm
	1000		+13.1		
	2000		+12.8		
	4000		+13.3		
	6000		+12.3		
	7000		+11.7		
Output Third-Order Intercept Point (P_{OUT} = 0 dBm/Tone)	10		+24.3		dBm
	1000		+24.0		
	2000		+23.2		
	4000		+22.3		
	6000		+22.0		
	7000		+21.7		
Noise Figure	10		2.0		dB
	1000		2.1		
	2000		2.1		
	4000		2.3		
	6000		2.8		
	7000		3.1		
Device Operating Voltage (V_{DD})[2]		+3.1	+3.6	+3.9	V
Device Operating Current (I_{DD})[3]			35		mA
Device Voltage Variation vs. Temperature[4]			-2.5		mV/°C
Device Voltage Variation vs. Current[5]			3.571		mV/mA

1. Tested on Mini-Circuits Characterization Test Board MB-225-39C+. See Figure 2. Board loss de-embedded to the device.
2. Operating Voltage applied to device LEE1-39+.
3. Current at P_{IN} = -25 dBm.
4. (Voltage at +105°C - Voltage at -55°C) / (+105°C - -55°C)
5. (Voltage at 42 mA - Voltage at 28 mA) / (42 mA- 28 mA)
6. Low frequency cut off determined by external coupling capacitors.

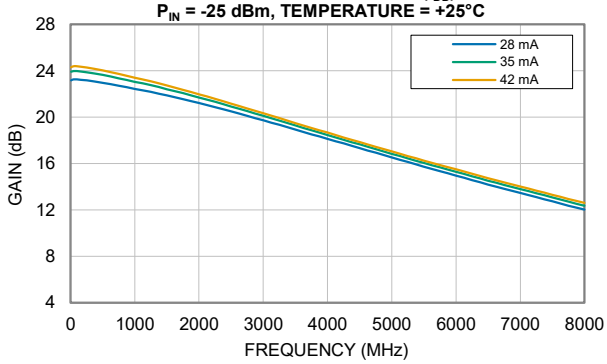
TYPICAL PERFORMANCE GRAPHS

Note: The following data was taken on the Mini-Circuits Characterization Test Board MB-225-39C+ (Figure 2).

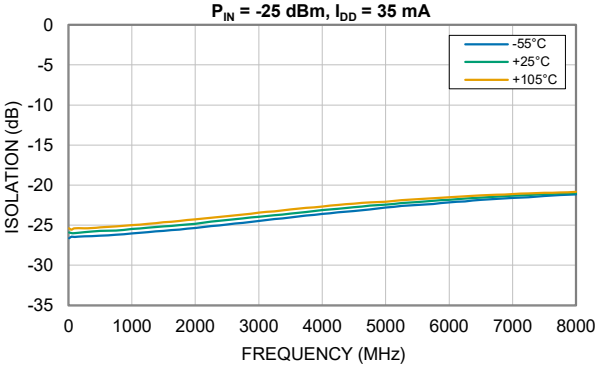
GAIN vs. TEMPERATURE
P_{IN} = -25 dBm, I_{DD} = 35 mA



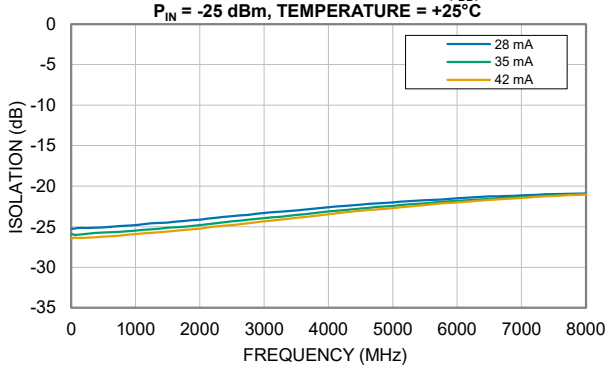
GAIN vs. DEVICE CURRENT (I_{DD})
P_{IN} = -25 dBm, TEMPERATURE = +25°C



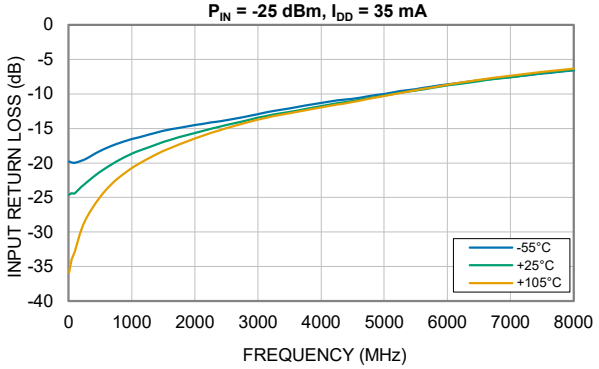
ISOLATION vs. TEMPERATURE
P_{IN} = -25 dBm, I_{DD} = 35 mA



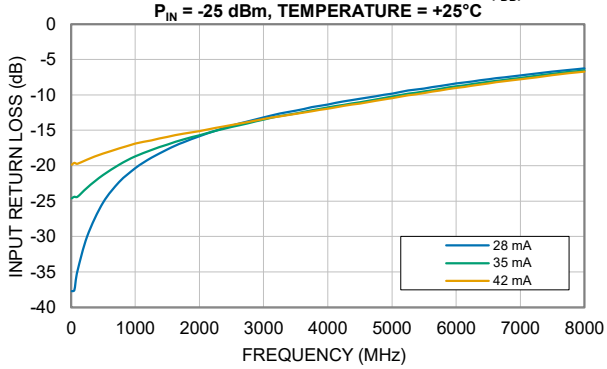
ISOLATION vs. DEVICE CURRENT (I_{DD})
P_{IN} = -25 dBm, TEMPERATURE = +25°C



INPUT RETURN LOSS vs. TEMPERATURE
P_{IN} = -25 dBm, I_{DD} = 35 mA



INPUT RETURN LOSS vs. DEVICE CURRENT (I_{DD})
P_{IN} = -25 dBm, TEMPERATURE = +25°C



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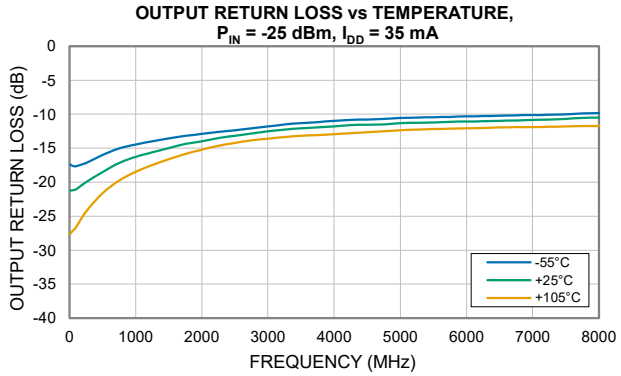
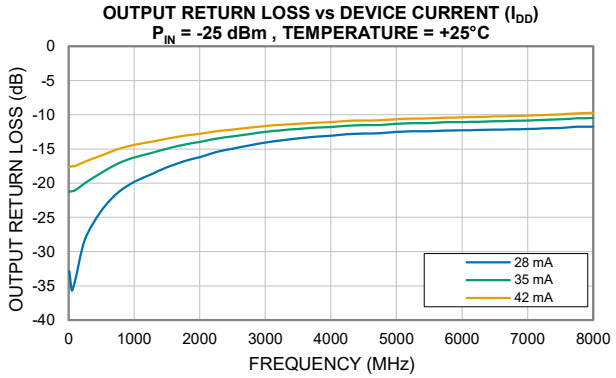
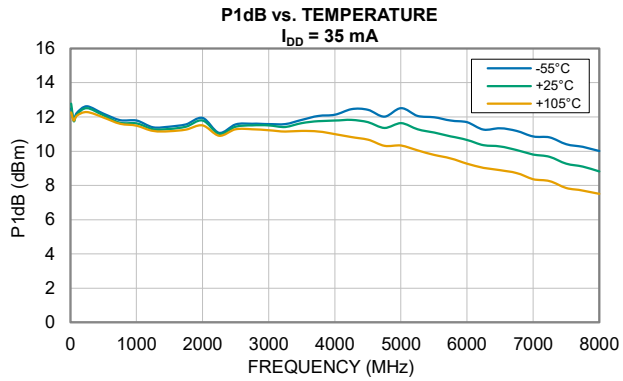
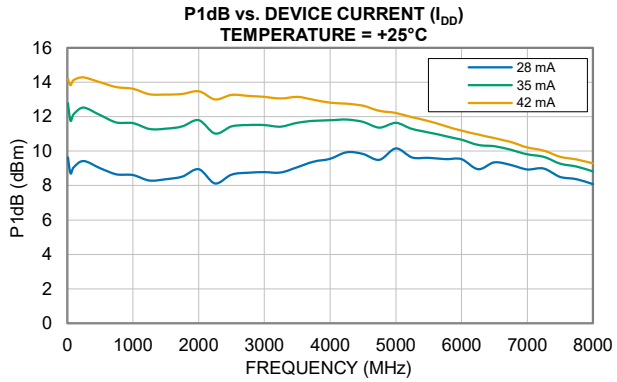
TYPICAL PERFORMANCE GRAPHS

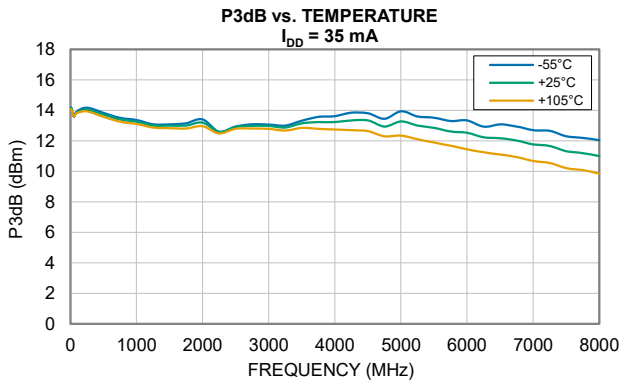
Note: The following data was taken on the Mini-Circuits Characterization Test Board MB-225-39C+ (Figure 2).

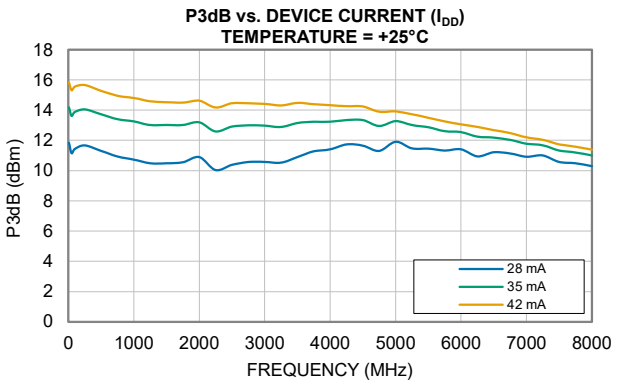












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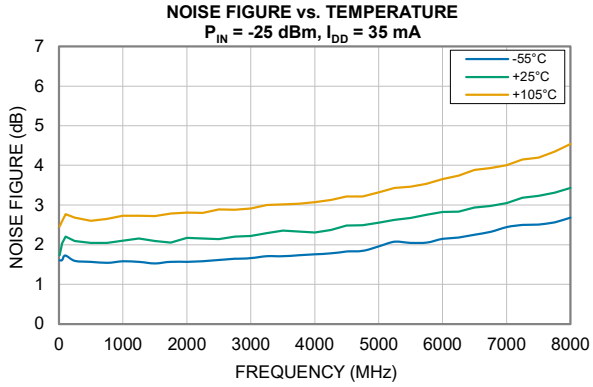

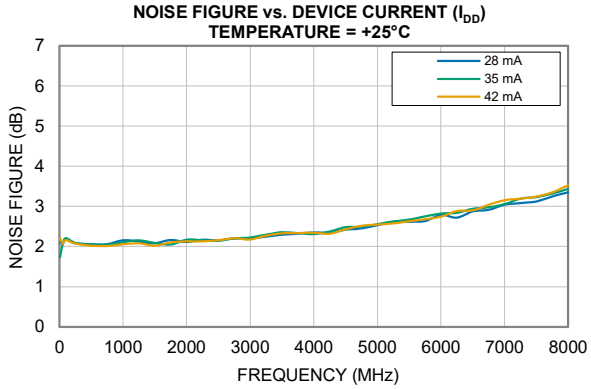

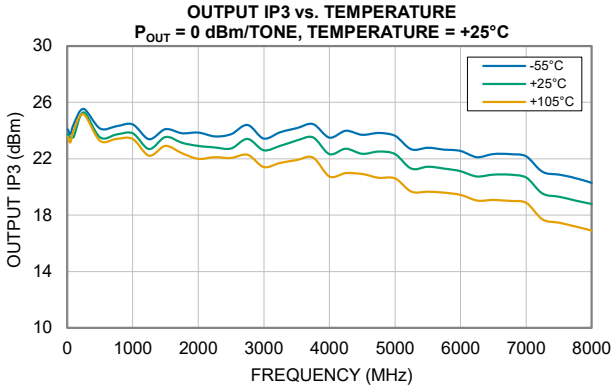

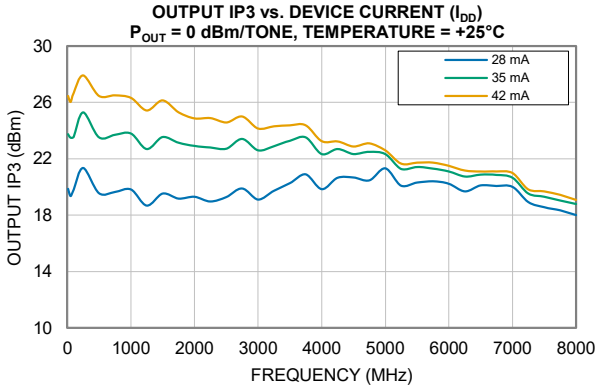

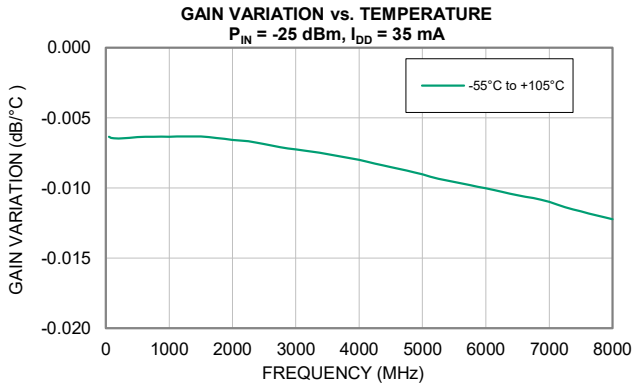

ABSOLUTE MAXIMUM RATINGS[7]

Parameter	Ratings
Operating Temperature	-55°C to +105°C
Storage Temperature	-65°C to +150°C
Junction Temperature[8]	+150°C
Total Power Dissipation	0.43 W
Input Power (CW), I_{DD} = 35 mA	+13 dBm
DC Voltage at V_{DD}	+4 V
DC Current I_{DD}	60 mA

7. Permanent damage may occur if any of these limits are exceeded. Maximum ratings are not intended for continuous normal operation.
8. Peak temperature on top of Die.

THERMAL RESISTANCE

Parameter	Ratings
Thermal Resistance (Θ_{JC})[9]	104.3°C/W

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

ESD RATING

	Class	Voltage Range	Reference Standard
HBM	1A	250 V to < 500 V	ANSI/ESDA/JEDEC JS-001-2023
CDM	C3	> 1000 V	ANSI/ESDA/JEDEC JS-002-2022

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

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FUNCTIONAL DIAGRAM (TOP VIEW)

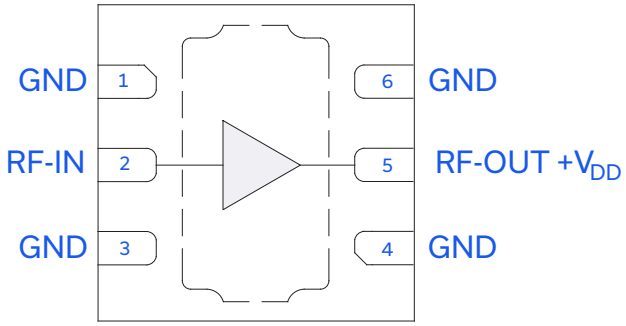

Figure 1. LEE1-39+ Functional Diagram

PAD DESCRIPTION

Function	Pad Number	Description (Refer to Fig 2)
RF-IN	2	RF-IN Pad connects to RF Input port.
RF-OUT+V_{DD}	5	RF-OUT Pad connects to RF Output port. V_{DD} is applied via external bias tee.
GND	1, 3, 4, 6 & Paddle	Connects to ground.

CHARACTERIZATION TEST BOARD

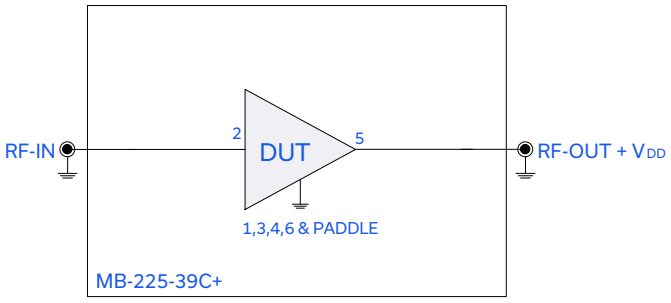

Figure 2. LEE1-39+ Characterization Circuit

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} = -25 dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 0 dBm/Tone at output.
3. I_{DD} = 35 mA at V_{DD} = +3.6 V Typ.

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EVALUATION BOARD

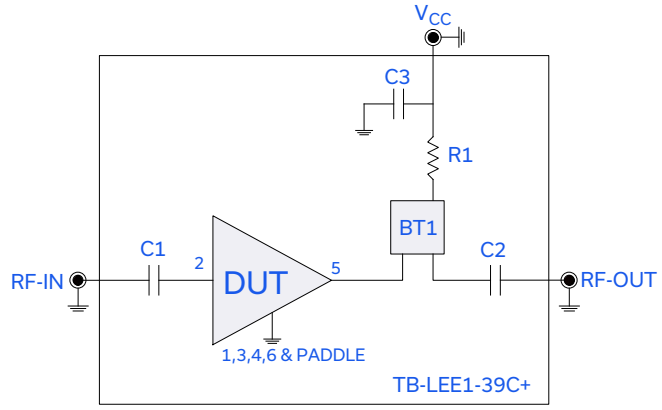


Figure 3. LEE1-39+ Evaluation Circuit

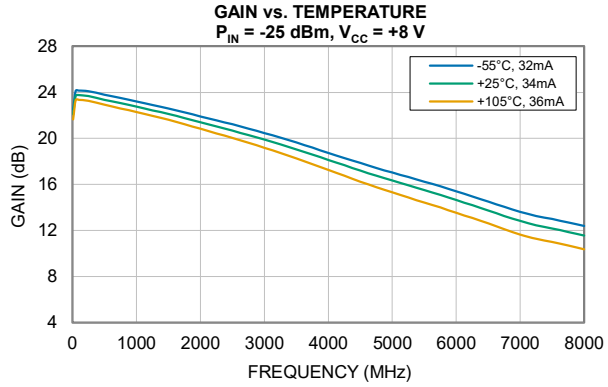
Electrical Parameters and Conditions
Gain, Return Loss, Output Power at 1dB Compression (P1dB), Output IP3 (OIP3), and Noise Figure measured using N5242A PNA-X microwave network analyzer.

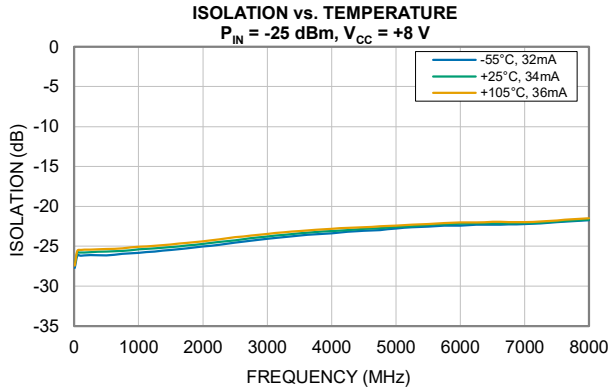
Conditions:
1. Gain and Return Loss: P_{IN} = -25 dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 0 dBm/Tone at output.
3. V_{CC} = +8 V

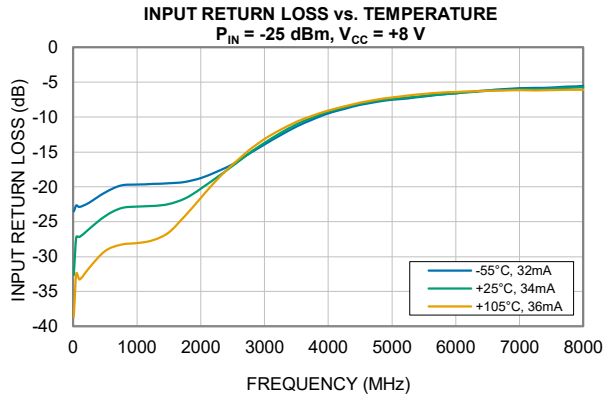
Component	Value	Size	Part Number	Manufacturer
C1, C2	2.4 nF	0402	GRM1557U1A242JA1D	Murata
C3	0.1 µF	0805	GCM21BR91H104KA37L	Murata
R1	130Ω, 0.5W	1210	RK73H2ETTD1300F	KOA Speer
BT1	-	3.8x3.8 mm	TCBT-123+	Mini-Circuits

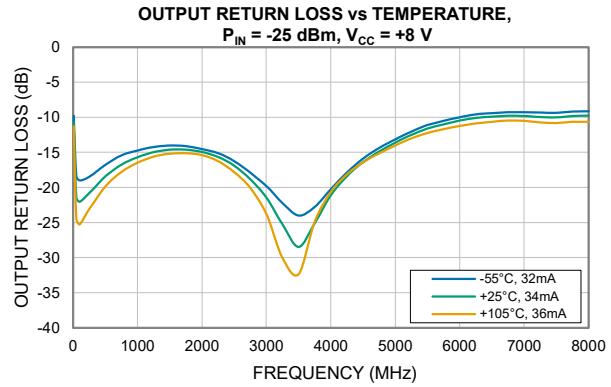
TYPICAL PERFORMANCE GRAPHS

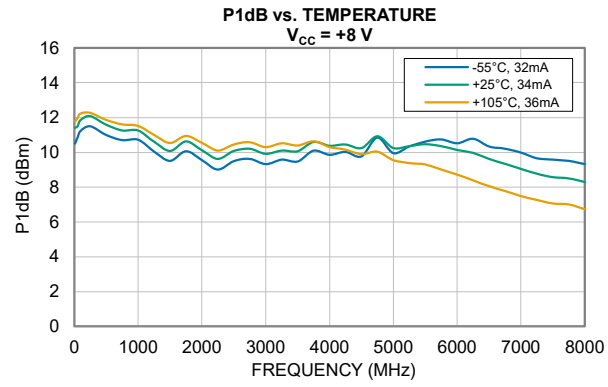
Note: The following data was taken on the Mini-Circuits Evaluation Board TB-LEE1-39C+ (Figure 3).

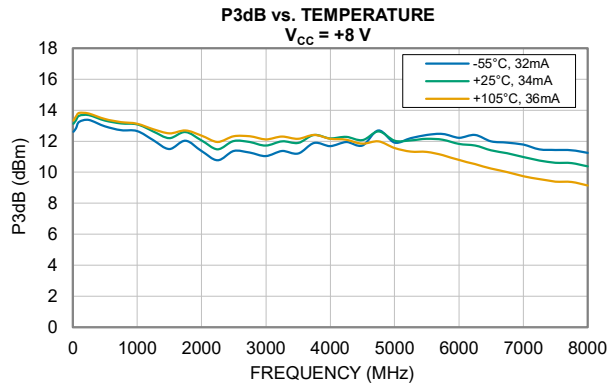












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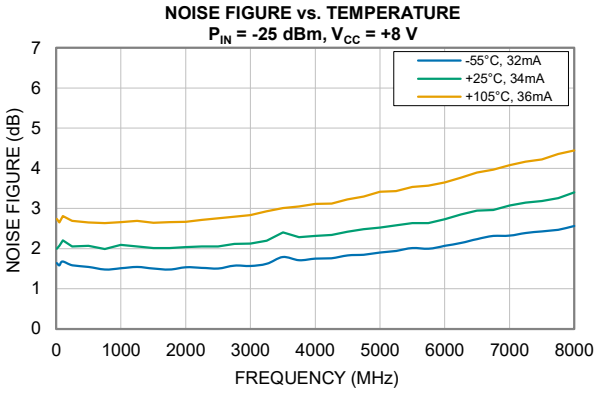

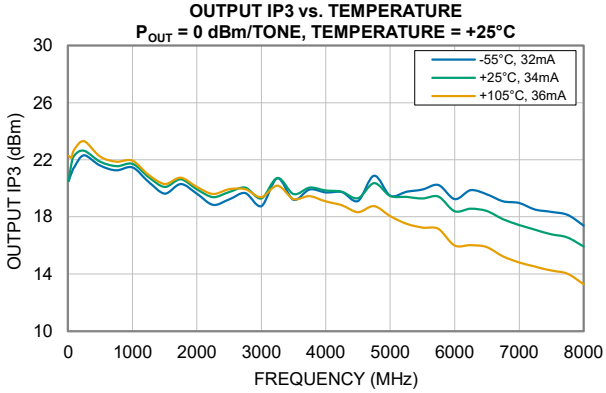

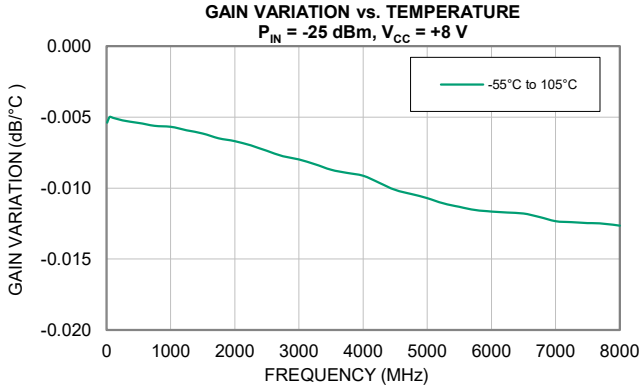

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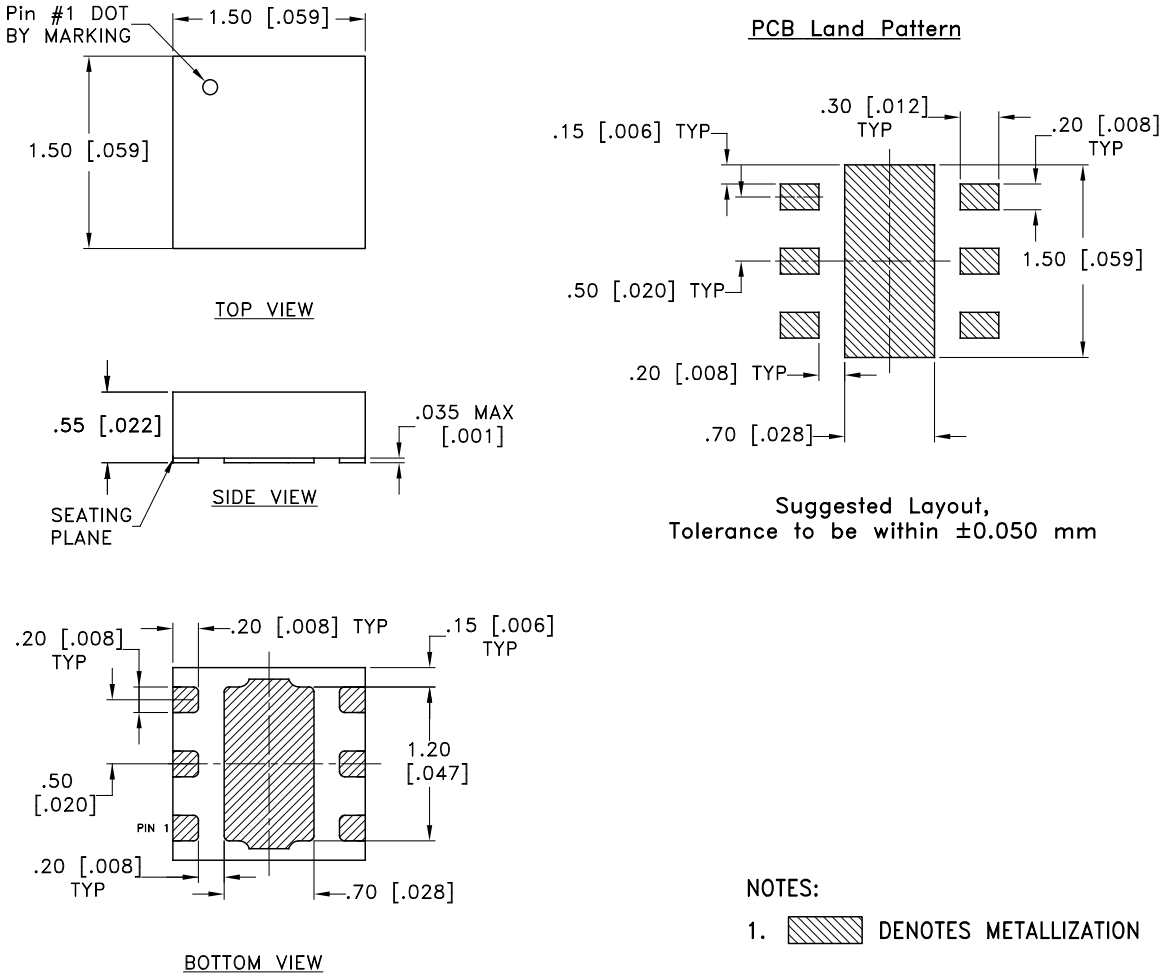
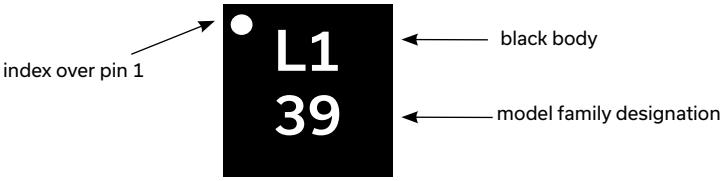
CASE STYLE DRAWING



Weight: 0.0036 grams
Dimensions are in mm [inches]. Tolerances: 2Pl. ±0.05 mm [0.002 inches].

PRODUCT MARKING



Marking may contain other features or characters for internal lot control

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ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASHBOARD CLICK HERE

Performance Data & Graphs	Data Graphs S-Parameter (S2P Files) Data Set (.zip file)
Case Style	KC3011 Plastic package, exposed paddle, Lead Finish: Nickel Palladium Gold
RoHS Status	Compliant
Tape & Reel **Standard quantities available on reel**	F66 7" reels with 20, 50, 100, 200, 500, 1000, 2000, or 3000 devices
Suggested Layout for PCB Design	PL-851
Evaluation Board	TB-LEE1-39C+ Gerber File
Environmental Ratings	ENV08T1

NOTES

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the standard terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/terms/viewterm.html