MMIC DIE

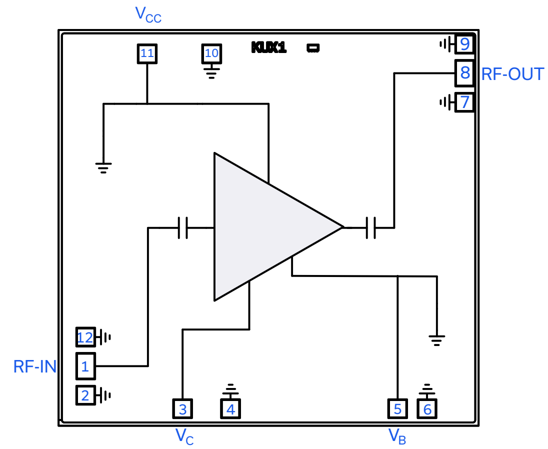
Wideband Amplifier LVA-6183PN-D+

50Ω 6 to 18 GHz Ultra-Low Phase Noise

THE BIG DEAL

- Wide Bandwidth, 6 to 18 GHz
- Ultra-Low Phase Noise, Typ. -165 dBc/Hz @ 10 kHz Offset
- Output P1dB, Typ. +19.3 dBm
- Output IP3, Typ. +28.9 dBm

FUNCTIONAL DIAGRAM



SEE ORDERING INFORMATION ON THE LAST PAGE

APPLICATIONS

- Test and Measurement
- Radar, EW, and ECM Defense Systems
- 5G MIMO and Backhaul Radio Systems
- Signal Distribution Networks

PRODUCT OVERVIEW

Mini-Circuits' LVA-6183PN-D+ is an ultra-low phase noise distributed MMIC amplifier die fabricated on a GaAs HBT process. Operating from 6 to 18 GHz, this amplifier features high dynamic range and ultra-low phase noise along with 19.5 dB gain, +19.3 dBm P1dB, +28.9 dBm OIP3, and 4.1 dB noise figure. The LVA-6183PN-D+ is ideal for use with low noise signal sources and highly sensitive transceiver signal chains for commercial, industrial, and defense applications.

KEY FEATURES

Features	Advantages
Wide Bandwidth: 6 to 18 GHz	Supports a broad variety of applications including Test and Measurement Equipment, 5G Microwave Radio, Radar, and Electronic Warfare Systems.
Ultra-Low Phase Noise: -165 dBc/Hz @ 10 kHz Offset	Preserves signal quality by providing amplification with minimal degradation in system phase noise.
High Dynamic Range: • +19.3 dBm P1dB • 19.5 dB Gain	The MMIC amplifier's unique combination of ultra-low phase noise, high output IP3, high gain, and low noise figure enables optimum performance in sensitive high dynamic range receivers.
Unpackaged Die	Enables integration into hybrid chip and wire assemblies.

REV. A
ECO-025575
LVA-6183PN-D+
MCL NY
250530

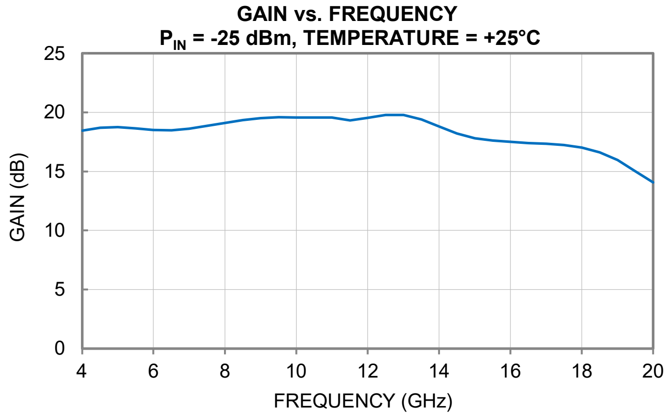
ELECTRICAL SPECIFICATIONS[1] AT +25°C, V_{CC} = +6 V, V_C = +6 V, V_B = +5.4 V, AND Zo = 50Ω UNLESS NOTED OTHERWISE

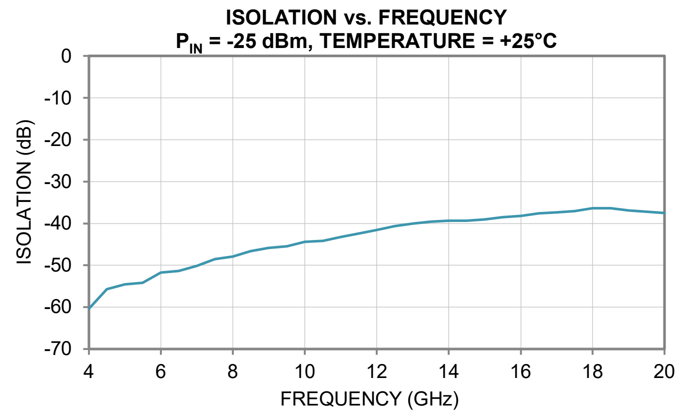
Parameter	Frequency (GHz)	Min.	Typ.	Max.	Units
Frequency Range		6		18	GHz
Additive Phase Noise[2]	6		-165		dBc/Hz
Gain	6		18.5		dB
	9		19.4		
	12		19.5		
	15		17.8		
	18		17.1		
Input Return Loss	6		9		dB
	9		11		
	12		11		
	15		8		
	18		17		
Output Return Loss	6		12		dB
	9		14		
	12		20		
	15		13		
	18		20		
Isolation	6-18		42.6		dB
Output Power at 1dB Compression (P1dB)	6		+20.0		dBm
	9		+20.1		
	12		+19.3		
	15		+17.4		
	18		+15.4		
Output Power at 3dB Compression (P3dB)	6		+22.5		dBm
	9		+21.9		
	12		+20.9		
	15		+19.6		
	18		+18.1		
Output Third-Order Intercept Point (P_{OUT} = 0 dBm/Tone)	6		+29.6		dBm
	9		+29.1		
	12		+28.9		
	15		+27.2		
	18		+24.5		
Input Third-Order Intercept Point (P_{OUT} = 0 dBm/Tone)	6		+11.1		dBm
	9		+9.7		
	12		+9.4		
	15		+9.4		
	18		+7.4		
Noise Figure[3]	6		4.6		dB
	9		4.3		
	12		4.1		
	15		4.9		
	18		5.7		
Device Operating Voltage (V_{CC})			+6		V
Device Operating Current (I_{CC})[4]			123		mA
Collector Voltage (V_C)			+6		V
Collector Current (I_C)			7.5		mA
Base Voltage (V_B)[5]			+5.4		V
Base Current (I_B)			12.4		mA
Device Current Variation Vs. Temperature[6]			12.2		uA/°C
Device Current Variation Vs. Voltage[7]			-0.0044		mA/mV

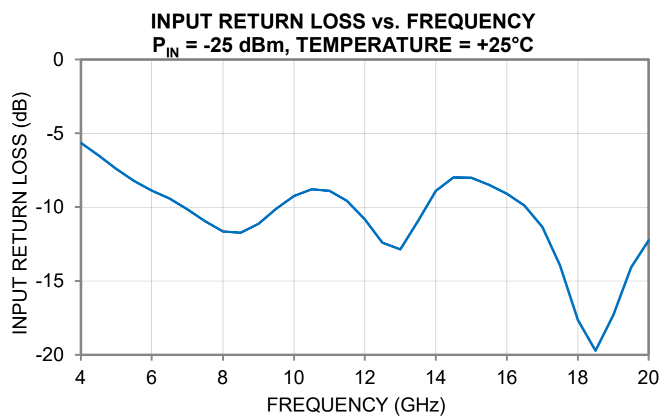
1. Tested on Mini-Circuits Die Characterization Test Board. See Figure 3. Board loss de-embedded.
2. P_{IN} = +3 dBm and Offset Frequency = 10 kHz
3. Electrical specifications were measured on packaged model LVA-6183PN+ on its Mini-Circuits Characterization Test Board TB-LVA-6183PNC.
4. Current at P_{IN} = -25 dBm. Current increases to 180 mA at P3dB.
5. 50Ω series resistor may be used to create V_B = +5.4 V from available +6 V source.
6. (Current at +105°C – Current at -45°C)/(+150°C)
7. (Current at +6.25 V – Current at +5.75 V) / (+6.25 V - +5.75 V)

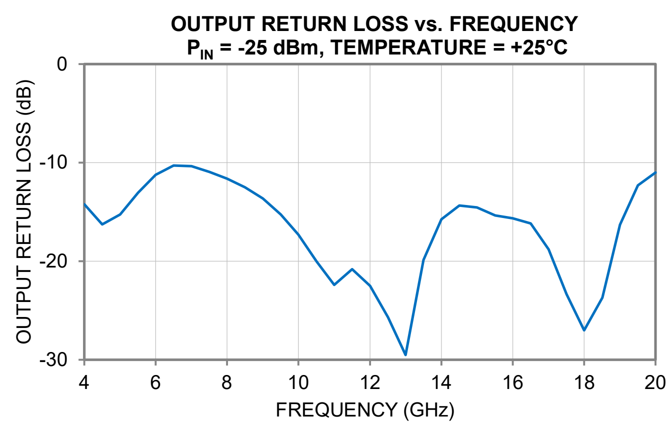
TYPICAL PERFORMANCE GRAPHS

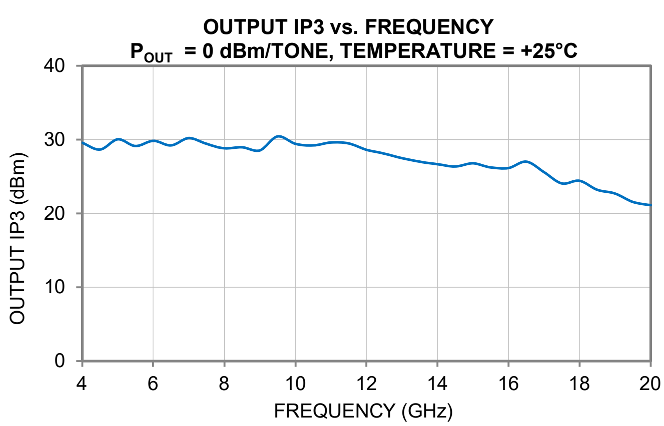
Note: The following data was taken on the Mini-Circuits Die Characterization Test Board (Figure 3). All data taken at nominal conditions V_{CC} = +6 V, V_C = +6 V, and V_B = +5.4 V unless noted otherwise. For over voltage data, see LVA-6183PN+.

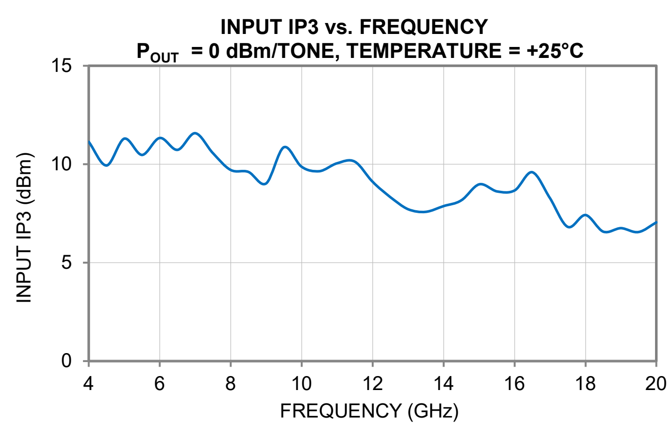












TYPICAL PERFORMANCE GRAPHS

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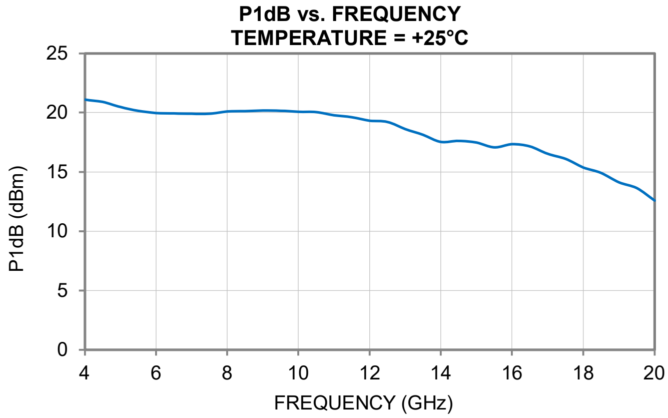
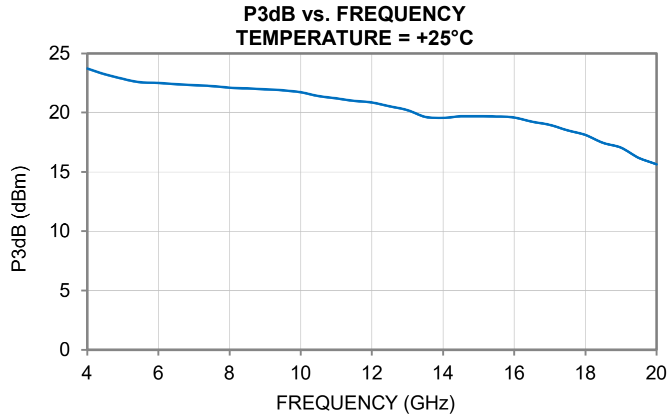
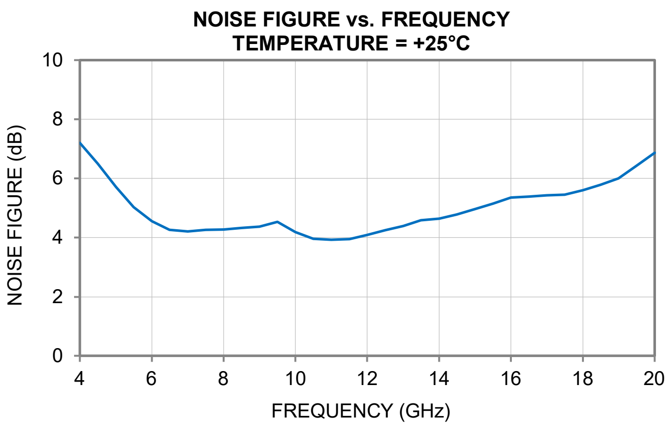


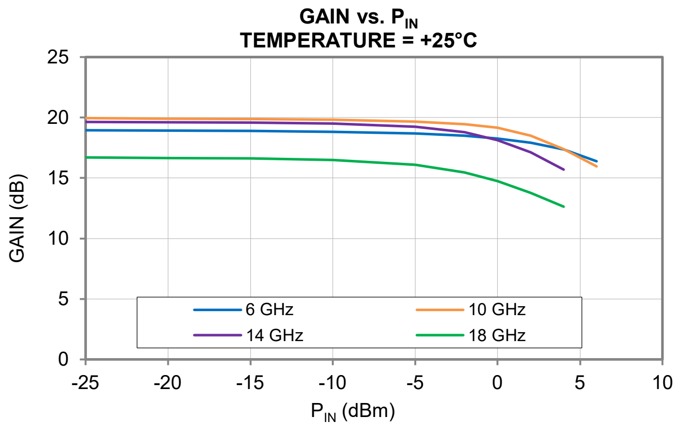


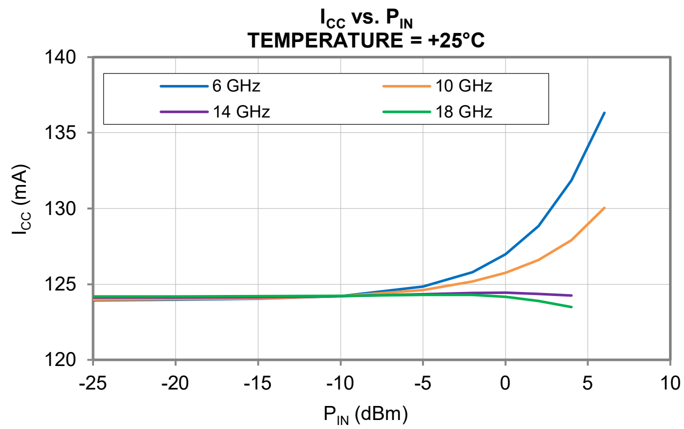
Note: All data taken in this section represents the Die attached in a 4x4 mm 24-Lead QFN-style package and measured on Mini-Circuits Characterization Test Board TB-LVA-6183PNC+. All data taken at nominal conditions V_{CC} = +6 V, V_C = +6 V, and V_B = +5.4 V unless noted otherwise. For over voltage data, see LVA-6183PN+.

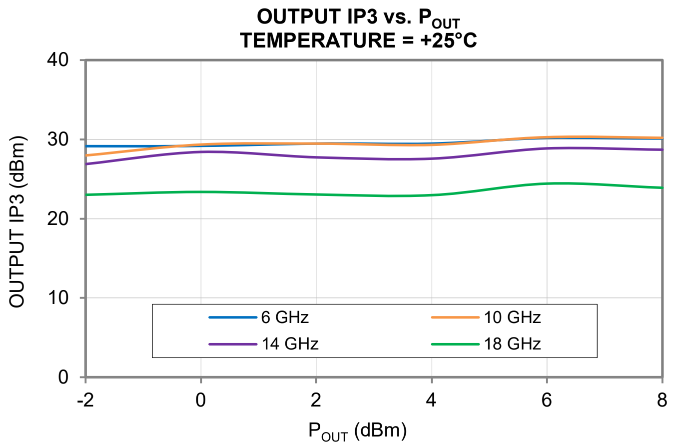


TYPICAL PERFORMANCE GRAPHS

Note: All data taken in this section represents the Die attached in a 4x4 mm 24-Lead QFN-style package and measured on Mini-Circuits Characterization Test Board TB-LVA-6183PNC+. All data taken at nominal conditions V_{CC} = +6 V, V_C = +6 V, and V_B = +5.4 V unless noted otherwise.

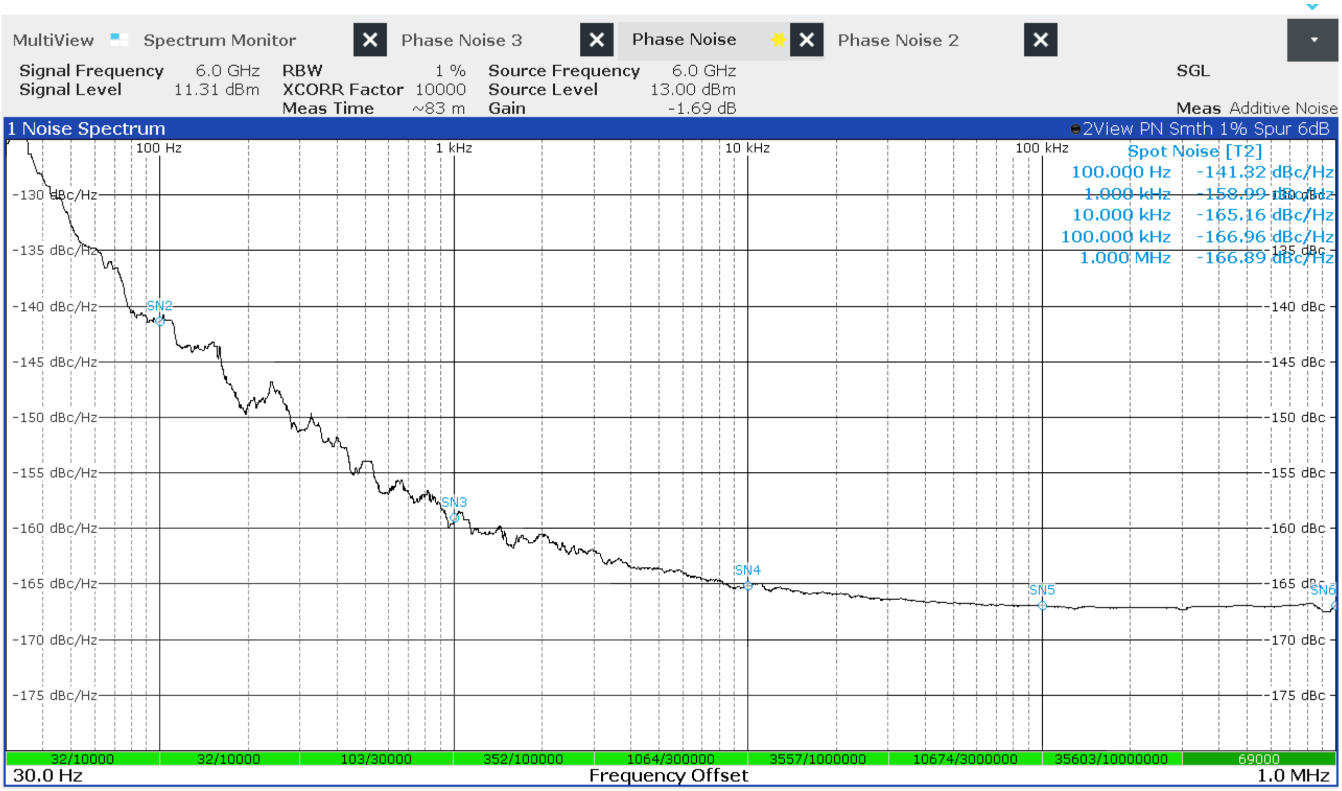






ADDITIVE PHASE NOISE VS. OFFSET FREQUENCY

(RF Frequency = 6 GHz, RF Input Power = +3 dBm)
Data measured on TB-LVA-6183PNC+



ABSOLUTE MAXIMUM RATINGS[8]

Parameter	Ratings
Operating Temperature[9]	-45°C to +105°C
Storage Temperature[10]	-65°C to +150°C
Total Power Dissipation	1.27 W
Junction Temperature[11]	+150°C
Input Power (CW), V_{CC} = +6 V, V_C = +6 V, V_B = +5.4 V	+25 dBm
DC Voltage on V_{CC}	+11 V
Current I_{CC}	170 mA
DC Voltage on V_C	+11 V
Current I_C	15 mA
DC Voltage on V_B	+11 V
Current I_B	30 mA

8. Permanent damage may occur if any of these limits are exceeded. Maximum ratings are not intended for continuous normal operation.
9. Bottom of die.
10. For die shipped in Gel-Pak see ENV80 (limited by packaging).
11. Peak temperature on top of die.

THERMAL RESISTANCE

Parameter	Ratings
Thermal Resistance (Θ_{JC})[12]	35.3°C/W

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

ESD RATING[13]

	Class	Voltage Range	Reference Standard
HBM	1C	1000 V to < 2000 V	ANSI/ESDA/JEDEC JS-001-2017
CDM	C3	≥ 1000 V	JESD22-C101F

ESD HANDLING PRECAUTION: This device is designed to be Class 1C 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.

13. Tested in 4x4 mm 24-Lead QFN-style package.

FUNCTIONAL DIAGRAM

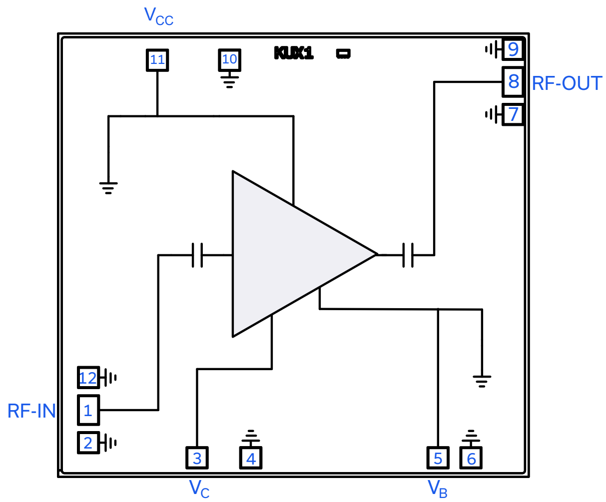


Figure 1. LVA-6183PN-D+ Functional Diagram

PAD DESCRIPTION

Function	Pad #	Application Description (Refer to Figure 3)
RF-IN	1	RF-IN Pad connects to RF-Input port.
RF-OUT	8	RF-OUT Pad connects to RF-Output port.
V_{CC}	11	DC Input Pad connects to supply voltage input port.
V_C	3	DC Input Pad connects to collector voltage input port.
V_B	5	DC Input Pad connects to base voltage input port.
GND	2, 4, 6-7, 9-10, 12, & Bottom of Die	Connected to die backside through vias. Bondwires to ground are optional.

DIE OUTLINE: inches [mm], Typical

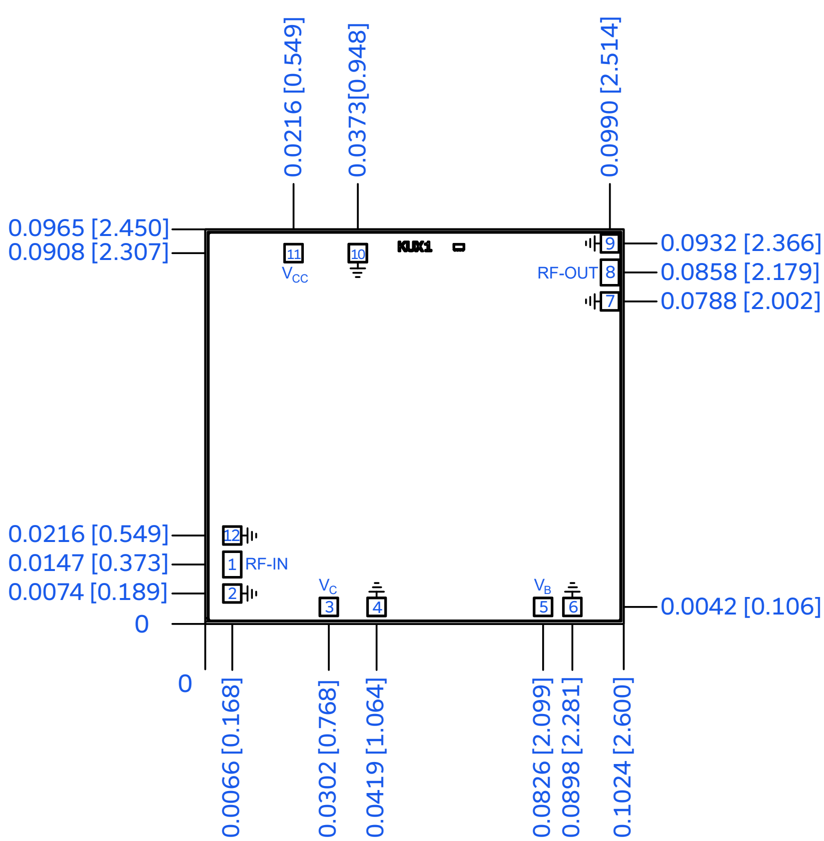


Figure 2. LVA-6183PN-D+ Die Outline

DIMENSIONS: inches [mm], Typical

Die Size	0.1024 x 0.0965 [2.600 x 2.450]
Die Thickness	0.0040 [0.100]
Bond Pad Sizes:	
Pad 1 & 8	0.0043 x 0.0061 [0.108 x 0.155]
Pads 2-7, 9-12	0.0043 x 0.0043 [0.108 x 0.108]
Plating (Pads & Bottom of Die)	Gold

CHARACTERIZATION BOARD

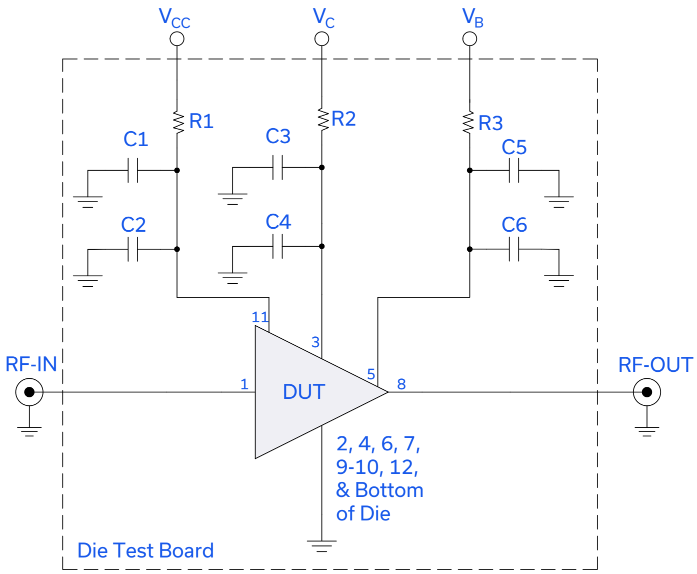


Figure 3. LVA-6183PN-D+ Characterization and Application Circuit

Electrical Parameters and Conditions
Gain, Return Loss, Output Power at 1dB Compression (P1dB), Output IP3 (OIP3), and Noise Figure measured using N5245A 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.

Power ON/Power OFF Sequence
Caution: Permanent damage to the device will occur if the Power ON and Power OFF sequences are not followed.

Power ON:
1) Set V_{CC} = +6 V.
2) Set V_C = +6 V.
3) Set V_B = +5.4 V.
4) Turn on V_{CC}, V_C, and V_B.
5) Apply RF signal.

Power OFF:
1) Turn off RF signal.
2) Turn off V_{CC}, V_C, and V_B.

Component	Value	Size	Part Number	Manufacturer
C1, C3, C5	0.1 µF	0402	GRM155R71H104KE14J	Murata
C2, C4, C6	100 pF	0402	GRM1555C1H101JA01D	Murata
R1, R2, R3[14]	0Ω	0402	RK73Z1ETTP	KOA Speer

14. R3 can be swapped for a 50Ω resistor to create V_B = +5.4 V from available +6 V source.

ASSEMBLY DIAGRAM

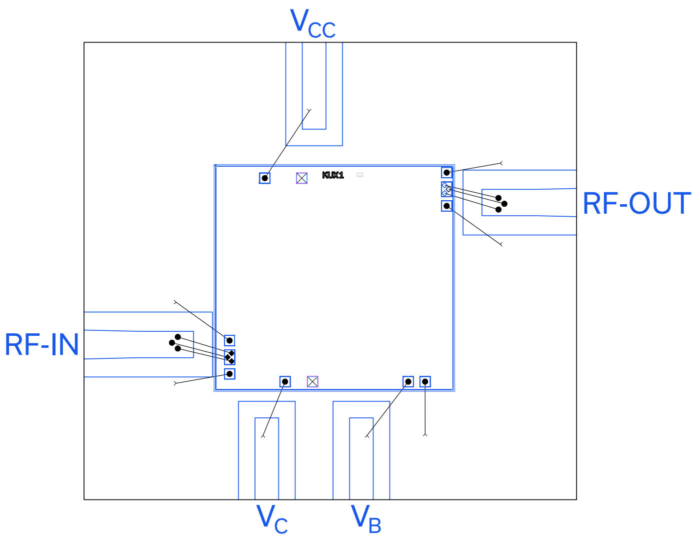


Figure 4. LVA-6183PN-D+ Assembly Diagram

Refer to the table in Figure 3 for more details on the passive components.

- Bond wire diameter: 1 mil
- Bond wire lengths from Die Pad to PCB at RF-IN & RF-OUT ports: 23 ± 2 mils
- Typical Gap from Die edge to PCB edge: 3 mils
- PCB thickness and material: 6.6 mil RO4350B (Thickness: 1 oz copper on each side).

ASSEMBLY AND HANDLING PROCEDURE

1. Storage
   Die should be stored in a dry nitrogen purged desiccator or equivalent.
2.  ESD Precautions
   MMIC HBT amplifier die are susceptible to electrostatic and mechanical damage. Die are supplied in anti-static protected material, which should be opened only in clean room conditions at an appropriately grounded anti-static workstation.
3. Die Handling and Attachment
   Devices require careful handling using tools appropriate for manipulating semiconductor chips. It is recommended to handle the chips along the edges with a custom designed collet. The die mounting surface must be clean and flat. Using conductive silver-filled epoxy, apply sufficient adhesive to meet the required bond line thickness, fillet height and coverage around the total periphery of the device. The recommended epoxy is Atrox 800HT5 Sintering or equivalent. Parts should be cured in a nitrogen-filled atmosphere per manufacturer's recommended cure profile.
4. Wire Bonding
   Openings in the surface passivation above the gold bond pads are provided to allow wire bonding to the die. Thermosonic bonding is recommended with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. The suggested interconnect is pure gold, 1 mil diameter wire. Bonds are recommended to be made from the bond pads on the die to the package or substrate. All bond wire length and bond wire height should be kept as short as possible, unless specified by design, to minimize performance degradation due to undesirable series inductance.

ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASH BOARD CLICK HERE

Performance Data	Table Graphs S-Parameter (S2P Files) Data Set (.zip file)	
Case Style	Die	
RoHS Status	Compliant	
Die Ordering and Packaging Information	Quantity, Package	Model No.
	Gel - Pak: 5, 10, or 50 KGD*	LVA-6183PN-DG+
	Medium†, Partial wafer: KGD*<380	LVA-6183PN-DP+
	Full wafer†	LVA-6183PN-DF+
	†Available upon request contact sales representative. Refer to AN-60-067	
Die Marking	KUX1	
Environmental Ratings	ENV80	

* Known Good Die ("KGD") means that the die in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such die fall within a predefined range. While DC testing is not definitive, it does provide a high degree of confidence that die are capable of meeting typical RF electrical parameters specified by Mini-Circuits.

Typical Performance Data

NOTE: Use PDF Bookmarks to view DATA at required conditions

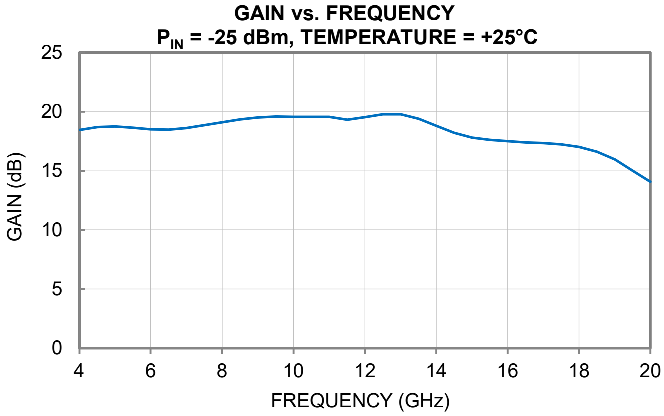
Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

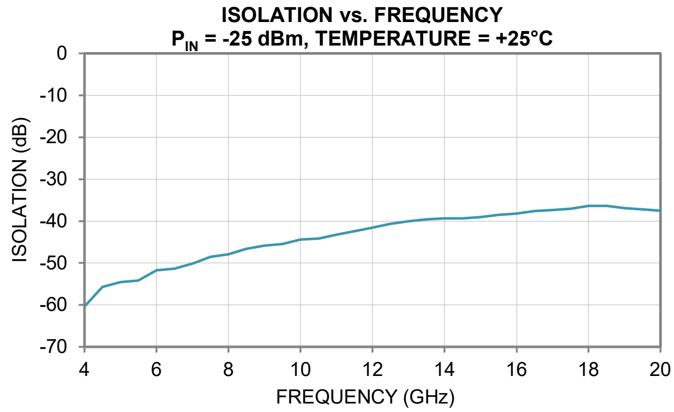
TEST CONDITIONS: V_{CC} = +6 V; V_C = +6 V; V_B = +5.4 V , I_{CC} = 123 mA, I_C = 7.38 mA, I_B = 12.21 mA @ Temperature = +25°C

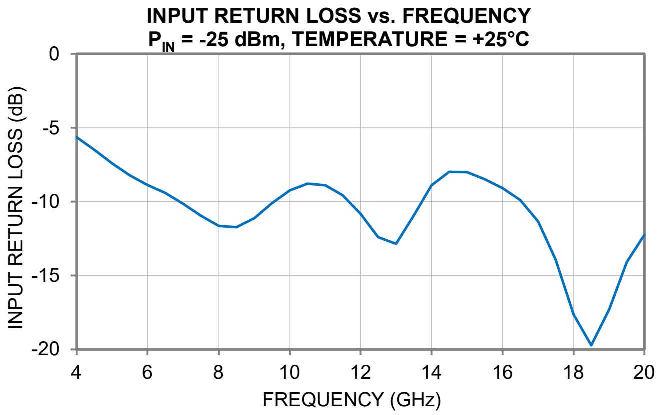
FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	IP-3 Input	1dB Comp. Output	3dB Comp. Output	Noise Figure
(GHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
4.00	18.4	-60.4	-5.6	-14.2	47.4	1.2	29.6	11.1	21.1	23.7	7.2
4.50	18.7	-55.7	-6.5	-16.2	29.4	1.2	28.6	9.9	20.9	23.2	6.5
5.00	18.8	-54.6	-7.4	-15.2	26.9	1.1	30.0	11.3	20.5	22.8	5.7
5.50	18.6	-54.2	-8.2	-13.1	26.8	1.1	29.1	10.5	20.1	22.5	5.0
6.00	18.5	-51.8	-8.9	-11.2	20.7	1.0	29.8	11.3	20.0	22.5	4.6
6.50	18.5	-51.4	-9.4	-10.3	19.9	1.0	29.2	10.7	19.9	22.4	4.3
7.00	18.6	-50.1	-10.1	-10.3	17.4	1.0	30.2	11.6	19.9	22.3	4.2
7.50	18.9	-48.5	-11.0	-10.9	14.5	1.0	29.4	10.5	19.9	22.2	4.3
8.00	19.1	-48.0	-11.6	-11.6	13.7	1.0	28.8	9.7	20.1	22.1	4.3
8.50	19.4	-46.7	-11.7	-12.5	11.7	1.0	29.0	9.6	20.1	22.0	4.3
9.00	19.5	-45.8	-11.1	-13.6	10.5	1.0	28.5	9.0	20.2	22.0	4.4
9.50	19.6	-45.4	-10.1	-15.3	9.9	1.1	30.4	10.9	20.2	21.9	4.5
10.00	19.6	-44.4	-9.2	-17.3	8.8	1.1	29.4	9.9	20.1	21.7	4.2
10.50	19.6	-44.2	-8.8	-20.0	8.6	1.1	29.2	9.6	20.0	21.4	4.0
11.00	19.6	-43.3	-8.9	-22.4	7.8	1.1	29.6	10.0	19.8	21.2	3.9
11.50	19.3	-42.4	-9.6	-20.8	7.5	1.1	29.5	10.1	19.6	21.0	3.9
12.00	19.5	-41.6	-10.8	-22.5	6.9	1.1	28.6	9.1	19.3	20.9	4.1
12.50	19.8	-40.7	-12.4	-25.7	6.3	1.0	28.1	8.3	19.2	20.5	4.3
13.00	19.8	-40.0	-12.9	-29.5	5.9	1.0	27.5	7.7	18.6	20.2	4.4
13.50	19.4	-39.6	-10.9	-19.9	5.7	1.1	27.0	7.6	18.1	19.6	4.6
14.00	18.8	-39.4	-8.9	-15.8	5.6	1.1	26.7	7.9	17.5	19.6	4.6
14.50	18.2	-39.3	-8.0	-14.4	5.8	1.1	26.3	8.2	17.6	19.7	4.8
15.00	17.8	-39.0	-8.0	-14.6	5.8	1.1	26.8	9.0	17.5	19.7	5.0
15.50	17.6	-38.5	-8.5	-15.4	5.8	1.1	26.2	8.6	17.1	19.7	5.1
16.00	17.5	-38.2	-9.1	-15.7	5.8	1.1	26.2	8.7	17.3	19.6	5.4
16.50	17.4	-37.6	-9.9	-16.2	5.6	1.1	27.0	9.6	17.2	19.2	5.4
17.00	17.3	-37.4	-11.4	-18.8	5.8	1.1	25.6	8.3	16.5	19.0	5.4
17.50	17.2	-37.0	-14.0	-23.3	5.9	1.0	24.1	6.8	16.1	18.5	5.4
18.00	17.0	-36.4	-17.6	-27.0	5.8	1.0	24.4	7.4	15.4	18.1	5.6
18.50	16.6	-36.4	-19.7	-23.7	6.2	1.0	23.2	6.6	14.9	17.4	5.8
19.00	16.0	-36.9	-17.3	-16.3	7.0	1.0	22.7	6.7	14.1	17.0	6.0
19.50	15.0	-37.2	-14.1	-12.3	7.7	1.0	21.6	6.5	13.6	16.2	6.4
20.00	14.1	-37.5	-12.2	-11.0	8.4	1.0	21.1	7.0	12.6	15.6	6.9

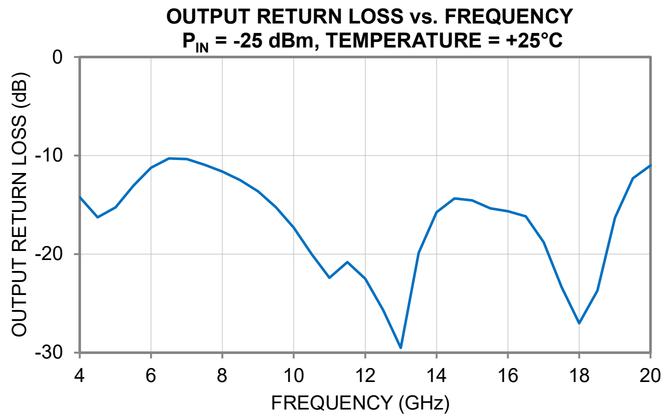
Typical Performance Curves

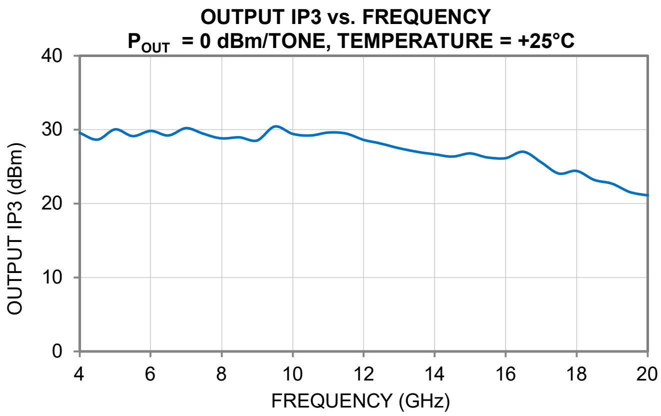
Note: The following data was taken on the Mini-Circuits Die Characterization Test Board (Figure 3). All data taken at nominal conditions V_{CC} = +6 V, V_C = +6 V, and V_B = +5.4 V unless noted otherwise. For over voltage data, see LVA-6183PN+.

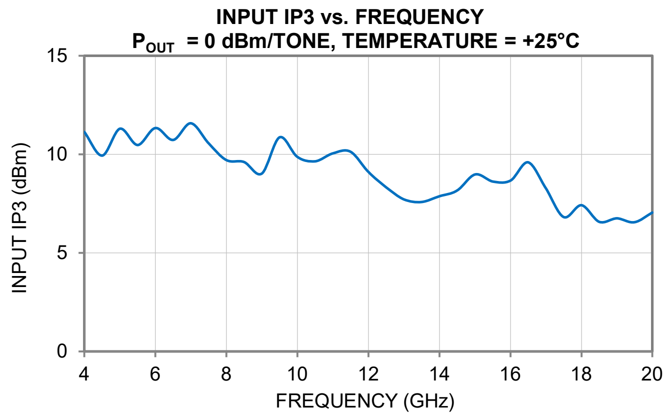






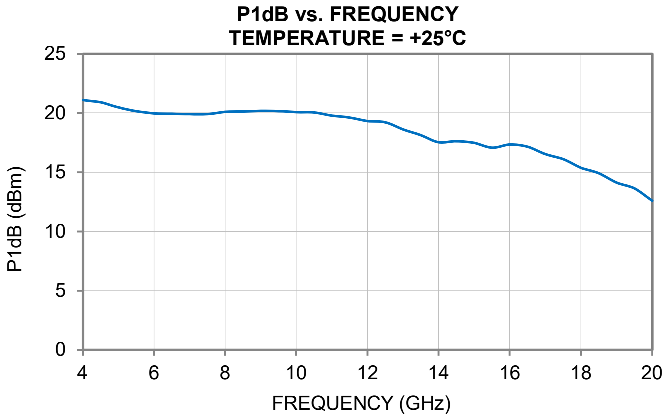


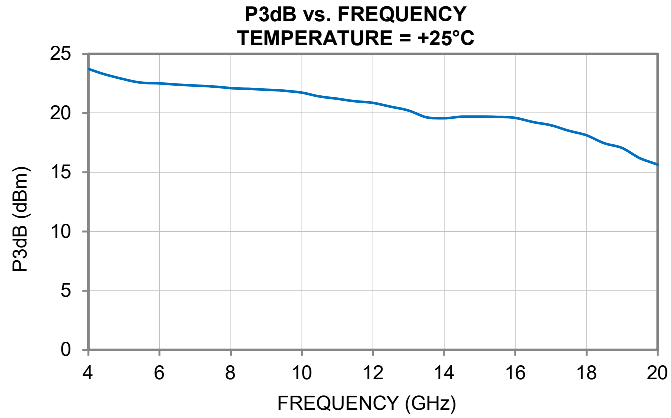




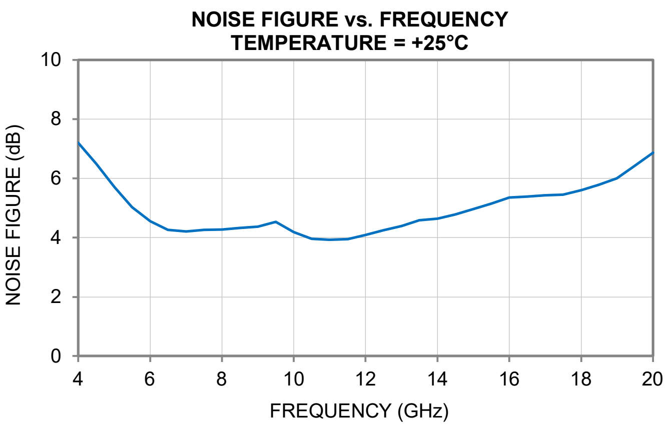
Typical Performance Curves

Note: The following data was taken on the Mini-Circuits Die Characterization Test Board (Figure 3). All data taken at nominal conditions V_{CC} = +6 V, V_C = +6 V, and V_B = +5.4 V unless noted otherwise. For over voltage data, see LVA-6183PN+.



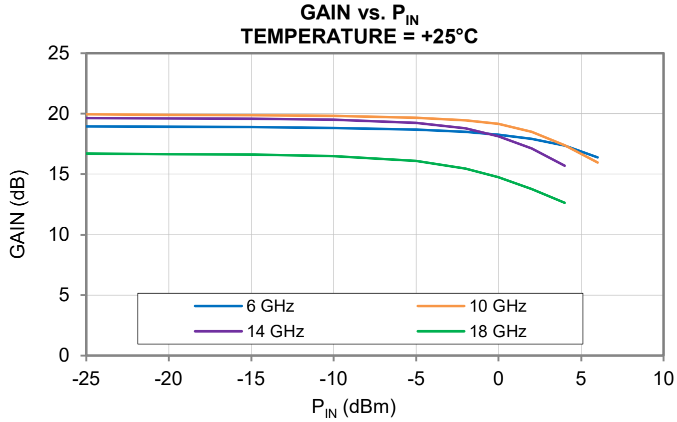


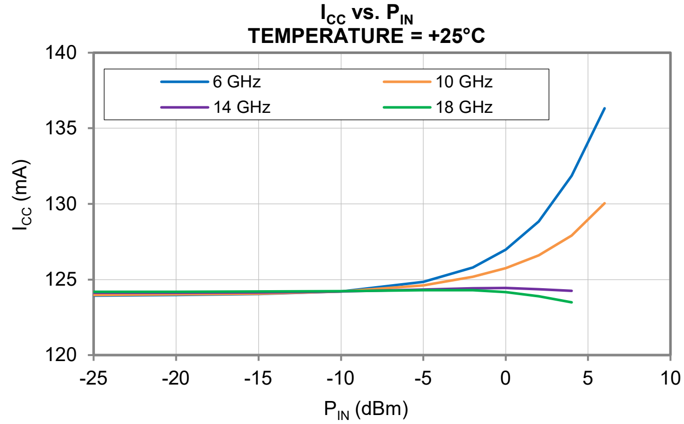
Note: All data taken in this section represents the Die attached in a 4x4 mm 24-Lead QFN-style package and measured on Mini-Circuits Characterization Test Board TB-LVA-6183PNC+. All data taken at nominal conditions V_{CC} = +6 V, V_C = +6 V, and V_B = +5.4 V unless noted otherwise. For over voltage data, see LVA-6183PN+.

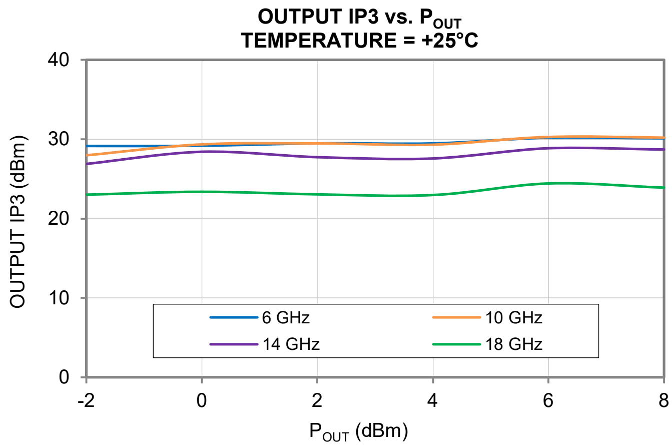


Typical Performance Curves

Note: All data taken in this section represents the Die attached in a 4x4 mm 24-Lead QFN-style package and measured on Mini-Circuits Characterization Test Board TB-LVA-6183PNC+. All data taken at nominal conditions V_{CC} = +6 V, V_C = +6 V, and V_B = +5.4 V unless noted otherwise.







Typical Performance Curves

(RF Frequency = 6 GHz, RF Input Power = +3 dBm)

Data measured on TB-LVA-6183PNC+

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-40° to 85° C or -40° to 105° C or -55° to 105° C or -45° to 105° C Ambient Environment	Refer to Individual Model Data Sheet
Storage Environment (Die)	-65° to 150°C	Individual Model Data Sheet
Storage Environment(Packaging)	-40° to 70°C and 40 to 60% humidity (In Factory Shipped Package)	