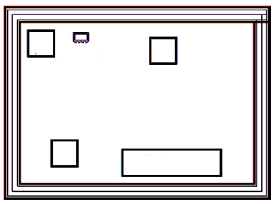
Ultra High Dynamic Range

Monolithic Amplifier Die

PHA-1H-D+

50Ω 0.05 to 6 GHz



The Big Deal

- Ultra High IP3
- Broadband High Dynamic Range without external Matching Components

Product Overview

PHA-1H-D+ (RoHS compliant) is an advanced wideband amplifier die fabricated using E-PHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure. In addition, the PHA-1H-D+ has good input and output return loss over a broad frequency range without the need for external matching components and has demonstrated excellent reliability.

Key Features

Feature	Advantages
Broad Band: 0.05 to 6.0 GHz	Broadband covering primary wireless communications bands: Cellular, PCS, LTE, WiMAX
Extremely High IP3 Versus DC power Consumption 40.4 dBm typical at 2GHz	The PHA-1H-D+ matches industry leading IP3 performance relative to device size and power consumption. The combination of the design and E-PHEMT Structure provides enhanced linearity over a broad frequency range as evidence in the IP3 being typically 20 dB above the P 1dB point. This feature makes this amplifier ideal for use in: • Driver amplifiers for complex waveform up converter paths • Drivers in linearized transmit systems • Secondary amplifiers in ultra High Dynamic range receivers
No External Matching Components Required	Mini-Circuits' PHA-1H-D+ provides good Input and Output Return Loss of 10-23 dB up to 4 GHz without the need for any external matching components
Low Noise Figure: 2.6dB typ. up to 4 GHz 3.4dB typ. up to 6 GHz	A unique feature of the PHA-1H-D+ which separates this design from all competitors is the low noise figure performance in combination with the high IP3 resulting in high dynamic range.
Low Juction Temperature Tj=115°C at 85°C lead temperature and 135°C at 105°C lead temperature	Results in excellent reliability*

* Measured in industry standard SOT-89 package.

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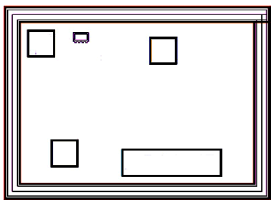


Product Features

- High IP3, 40.4 dBm typ. at 2.4 GHz
- Gain, 13.8 dB typ. at 2 GHz
- High Pout, P1dB 22 dBm typ. at 2 GHz
- Low noise figure, 2.2 dB @2 GHz
- No external matching components required

+RoHS Compliant

The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

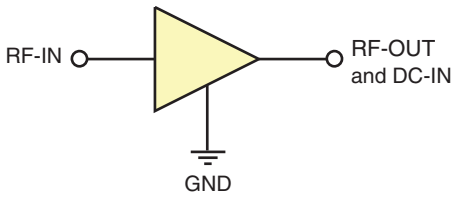
Typical Applications

- Base station infrastructure
- Portable Wireless
- CATV & DBS
- MMDS & Wireless LAN
- LTE

General Description

PHA-1H-D+ (RoHS compliant) is an advanced wideband amplifier die fabricated using E-PHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure.
In addition, the PHA-1H-D+ has good input and output return loss over a broad frequency range without the need for external matching components and has low thermal resistance.

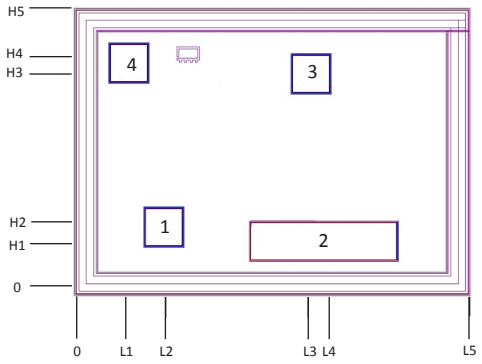
Simplified Schematic and Pad description



Pad#	Function	Description
1	RF-IN	RF input pad. This pad requires the use of an external DC blocking capacitor chosen for the frequency of operation
3	RF-OUT & DC-IN	RF output pad and bias pad. DC voltage is present on this pad, therefore, a DC blocking capacitor is necessary for proper operation. An RF choke is needed to feed DC bias without loss of RF signal due to the bias connection.
2,4	GND	Connections to ground. Bottom of die.

Note: 1. Bond Pad material - Gold
2. Bottom of Die - Gold plated

Bonding Pad Position



Dimensions in µm, Typical

L1	L2	L3	L4	L5	H1	H2	H3	H4	H5	Thickness	Bond pad size
86	156	453	479	750	85	114	422	444	530	750	75 X 75

Electrical Specifications at 25°C, unless noted

Parameter	Condition (GHz)	Vd=5.0V[1]			Units
		Min.	Typ.	Max.	
Frequency range		0.05		6.0	GHz
Gain	0.05		17.7		dB
	0.8		15.9		
	2.0		13.8		
	3.0		12.1		
	4.0		10.9		
	6.0		9.6		
Input return loss	0.05		11.9		dB
	0.8		18.2		
	2.0		12.5		
	3.0		10.8		
	4.0		10.3		
	6.0		8.1		
Output return loss	0.05		14.2		dB
	0.8		22.9		
	2.0		19.7		
	3.0		17.1		
	4.0		15.5		
	6.0		13.7		
Reverse isolation	2.0		19.6		dB
Output power @1 dB compression	0.05		22.1		dBm
	0.8		21.8		
	2.0		22.6		
	3.0		22.2		
	4.0		22.5		
	6.0		22.0		
Output IP3	0.05		39.6		dBm
	0.8		40.6		
	2.0		40.4		
	3.0		40.8		
	4.0		41.4		
	6.0		41.0		
Noise figure	0.5		1.7		dB
	1.0		1.8		
	2.0		2.2		
	3.0		2.4		
	4.0		2.6		
	6.0		3.4		
Device operating voltage		4.8	5.0	5.2	V
Device operating current		—	132	165	mA
Device current variation vs voltage			0.057		mA/mV
Thermal resistance, junction-to-ground lead at 88°C			36.1		°C/W

1. Measured on Mini-Circuits characterization test board TB-313, DUT packaged in industry standard SOT-89 package. See characterization test circuit (Fig. 1)

Absolute Maximum Ratings[2]

Parameter	Ratings
Operating temperature (ground lead)	-40°C to 105°C
Operating current at 5V	210 mA
Power dissipation	1 W
Input power (CW)	24 dBm
DC voltage on RF-Out pad	6 V

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

Characterization Test Circuit

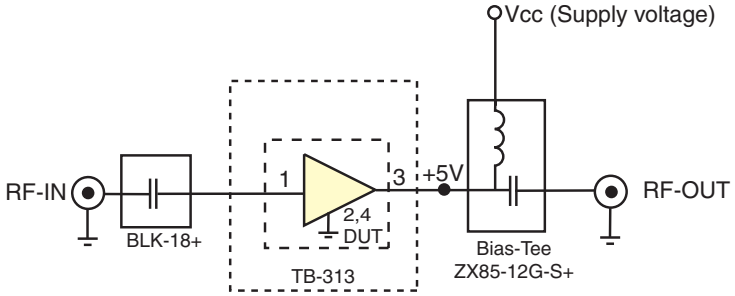
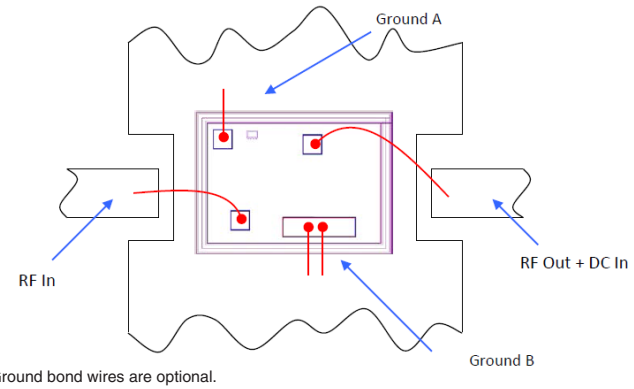


Fig 1. Block Diagram of Test Circuit used for characterization. (DUT, Die packaged in SOT-89 package, soldered on Mini-Circuits Characterization test board TB-313)

Gain, Return loss, Output power at 1dB compression (P1 dB) , output IP3 (OIP3) and noise figure measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:
1. Gain and Return loss: Pin= -25dBm.
Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 5 dBm/tone at output.

Assembly Diagram



Note: Ground bond wires are optional.

Assembly and Handling Procedure

1. Storage
   Dice should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC E-PHEMT amplifier dice are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic protected material, which should be opened in clean room conditions at an appropriately grounded anti-static workstation. Devices need careful handling using correctly designed collets, vacuum pickup tips or sharp antistatic tweezers to deter ESD damage to dice.
3. Die Attach
   The die mounting surface must be clean and flat. Using conductive silver filled epoxy, recommended epoxies are DieMat DM6030HK-PT/H579 or Ablestik 84-1LMISR4. Apply sufficient epoxy to meet required epoxy bond line thickness, epoxy fillet height and epoxy coverage around total die periphery. Parts shall be cured in a nitrogen filled atmosphere per manufacturer's cure condition. It is recommended to use antistatic die pick up tools only.
4. Wire Bonding
   Bond pad openings in the surface passivation above the bond pads are provided to allow wire bonding to the dice gold bond pads. Thermosonic bonding is used with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. Suggested wire is pure gold, 1 mil diameter. Bonds must be made from the bond pads on the die to the package or substrate. All bond wires should be kept as short as low as reasonable to minimize performance degradation due to undesirable series inductance.

Additional Detailed Technical Information

additional information is available on our dash board.

Performance Data	Data Table	
	Swept Graphs	
	S-Parameter (S2P Files) Data Set with and without port extension(.zip file)	
Case Style	Die	
Die Ordering and packaging information	Quantity, Package	Model No.
	Small, Gel - Pak: 5,10,50,100 KGD*	PHA-1H-DG+
	Medium†, Partial wafer: KGD*<5K	PHA-1H-DP+
	Large†, Full Wafer	PHA-1H-DF+
	†*Available upon request contact sales representative*	
	Refer to AN-60-067	
Environmental Ratings	ENV80	

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

ESD Rating**

Human Body Model (HBM): Class 1B (pass 500V) in accordance with ANSI/ESD STM 5.1 - 2001

** Tested in industry standard SOT-89 package.

Additional 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.

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