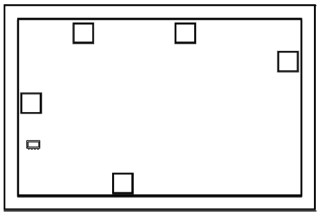
*Low Noise, High IP3*

# Monolithic Amplifier Die **PMA-545G1-D+**

50Ω 0.4 to 2.2 GHz



## The Big Deal

- High Gain, 31.3 dB
- Low Noise Figure, 1.0 dB
- High IP3, 34-36 dBm

## Product Overview

Mini-Circuits' PMA-545G1-D+ is a E-PHEMT based Low Noise MMIC Amplifier die operating from 0.4 to 2.2 GHz with a unique combination of low noise high gain and high IP3 making this amplifier ideal for sensitive receiver applications. This design operates on a single +5V supply and is internally matched to 50 Ohms.

## Key Features

| Feature | Advantages |
|---|---|
| High Gain: 26-32 dB | Incorporating multiple stages of amplification, the PMA-545G1-D+ provides high gain reducing cost and real estate. |
| Ultra Low Noise: 1.0 dB at 0.9 GHz | Excellent Noise Figure, measured in a 50 Ohm environment – without any external matching. When combined with high gain of this design, it suppresses second stage NF contribution. |
| High IP3: +35 dBm IP3 at 0.9 GHz | Combining Low Noise and High IP3 makes this MMIC amplifier ideal for Low Noise Receiver Front End (RFE) giving the user advantages at both ends of the dynamic range: sensitivity & two-tone IM dynamic range. |
| Output Power: +23 dBm at 0.9 GHz | The PMA-545G1-D+ maintains consistent output power capability over the full operating temperature range making it ideal to be used in remote applications such as LNB's as the L Band driver stage. |
| Internally Matched: 9-18 dB return loss | No external matching elements required to achieve the advertized noise and output power over the full band. |
| Max Input Power<br>+25 dBm | Ruggedized design operates up to input powers often seen at Receiver inputs. |
| High Reliability | Low, small signal operating current of 160 mA nominal maintains junction temperatures typically below 123°C at 85°C at bottom of die. |
| Unpackaged Die | Enables user to integrate the amplifier directly into hybrids |

*Low Noise, High IP3*

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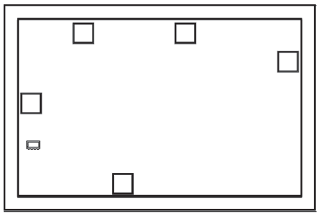


## Product Features

- High Gain, 31.3 dB typ. at 0.9 GHz
- Ultra Low Noise Figure, 1.0 dB typ. at 0.9 GHz
- High IP3, 34.6 dBm typ. 0.9 GHz
- Output Power, up to +23dBm typ. at 0.9 GHz
- Single Positive Supply Voltage, 5V

***+RoHS Compliant***

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

*Ordering Information: Refer to Last Page*

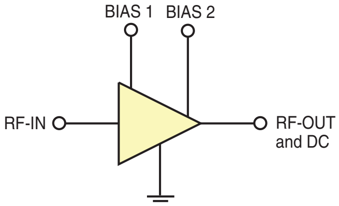
## Typical Applications

- Cellular
- ISM
- GSM
- WCDMA
- LTE
- GPS

## General Description

PMA-545G1-D+ is a high dynamic range, low noise, high IP3, high output power, monolithic amplifier die. Manufactured using E-PHEMT* technology enables it to work with a single positive supply voltage. Unconditionally stable over the operating frequency.

### Simplified Schematic and Pad description



| Bonding Pad | **Description** *(See Application Circuit, Fig. 1)* |
|---|---|
| RF-IN | RF input pad (connected to RF-IN via C1) |
| RF-OUT & DC | RF output pad (connected to RF-OUT via blocking external cap C2, and Supply voltage Vs via RF Choke L2) |
| BIAS 1 | Connect to Vs |
| BIAS 2 | Connect to Vs via L1 |
| GROUND | Connected to ground |

*Enhancement mode Pseudomorphic High Electron Mobility Transistor.

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

## Electrical Specifications[1] at 25°C, Vd=5V, Zo=50Ω *(refer to characterization circuit)*

| Parameter | Condition (GHz) | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Frequency Range | | 0.4 | | 2.2 | GHz |
| DC Voltage (Vd) | | 4.8 | 5.0 | 5.2 | V |
| DC Current | | 117 | 158 | 186 | mA |
| Noise Figure | 0.4 | — | 1.2 | — | dB |
| | 0.9 | — | 1.0 | — | |
| | 1.2 | — | 1.0 | — | |
| | 1.6 | — | 1.1 | — | |
| | 2.2 | — | 1.3 | — | |
| Gain | 0.4 | — | 32.0 | — | dB |
| | 0.9 | — | 31.3 | — | |
| | 1.2 | — | 31.1 | — | |
| | 1.6 | — | 29.9 | — | |
| | 2.2 | — | 25.8 | — | |
| Input Return Loss | 0.4 | | 15.8 | | dB |
| | 0.9 | | 9.4 | | |
| | 1.2 | | 10.0 | | |
| | 1.6 | | 12.9 | | |
| | 2.2 | | 18.1 | | |
| Output Return Loss | 0.4 | | 16.9 | | dB |
| | 0.9 | | 17.3 | | |
| | 1.2 | | 17.0 | | |
| | 1.6 | | 16.3 | | |
| | 2.2 | | 14.9 | | |
| Output IP3 | 0.4 | | 34.5 | | dBm |
| | 0.9 | | 34.6 | | |
| | 1.2 | | 36.1 | | |
| | 1.6 | | 36.6 | | |
| | 2.2 | | 35.4 | | |
| Output Power @ 1 dB compression[2] | 0.4 | — | 22.2 | — | dBm |
| | 0.9 | — | 23.3 | — | |
| | 1.2 | — | 23.4 | — | |
| | 1.6 | — | 23.7 | — | |
| | 2.2 | — | 23.5 | — | |
| DC Current Variation vs. Voltage | | | 0.034 | | mA/mV |
| Thermal Resistance | | | 40 | | °C/W |

1. Measured on Mini-Circuits die Characterization test board.
   See Characterization Test Circuit (Fig. 1)
2. Current increases at P1dB.

## Absolute Maximum Ratings[3,5]

| Parameter | Ratings |
|---|---|
| Operating Temperature[4] | -40°C to 85°C |
| Channel Temperature | 150°C |
| DC Voltage (Pads Bias, RF-OUT & DC) | 6V |
| Power Dissipation | 1.35W |
| Input Power | 25dBm |

3. Permanent damage may occur if any of these limits are exceeded.
   These maximum ratings are not intended for continuous normal operation.
4. Defined with reference to ground pad temperature.
5. Measured in industry standard 8-lead 3x3 MCLP package.

## Characterization Test Circuit

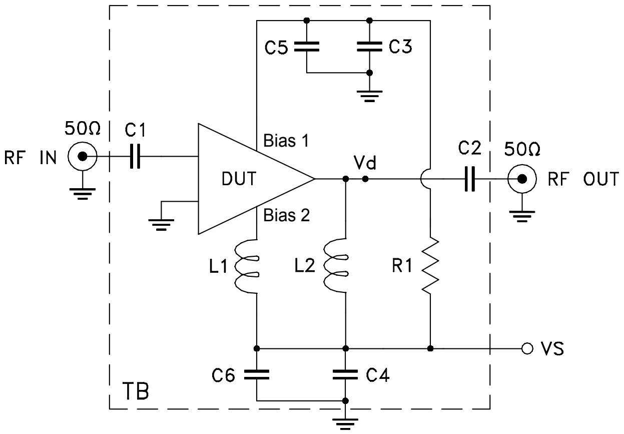
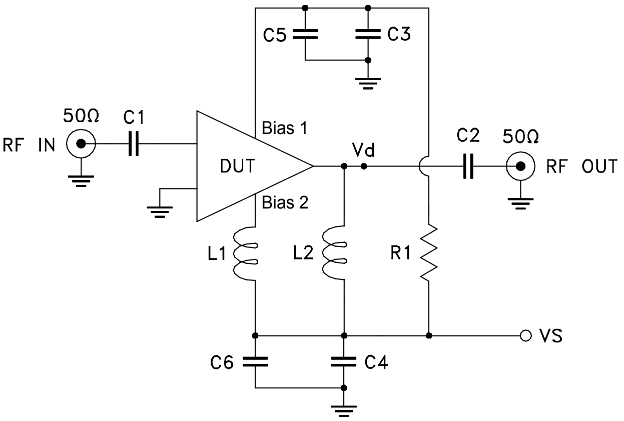


**Fig 1.** Block Diagram of Test Circuit used for characterization. Gain, Output power at 1dB compression (P1dB), Output IP3 (OIP3), Noise Figure are measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:
1. Gain: Pin=-25 dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 0 dBm/tone at output.
3. Vs adjusted for 5V at device (Vd), compensating loss of bias tee.

## Recommended Application Circuit



| Component | Description |
|---|---|
| **DUT** | **PMA-545G1-D+ Die** |
| **C1, C2, C5, C6** | **100 pF** |
| **C3, C4** | **1μF** |
| **R1** | **0 Ω** |
| **L1** | **36 nH** |
| **L2** | **47 nH** |

## Die Layout

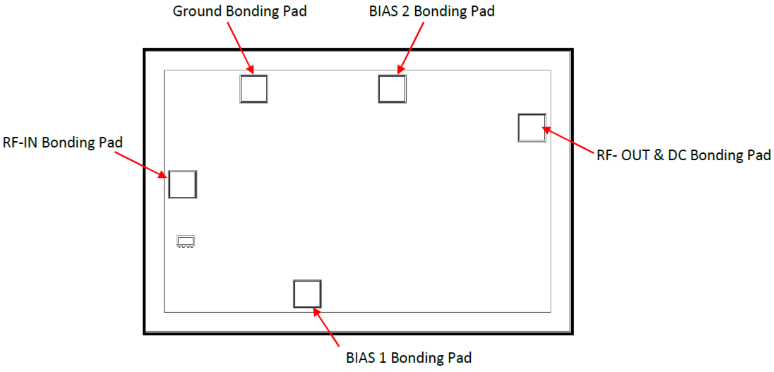


Fig 2. Die Layout

## Bonding Pad Position

(Dimensions in μm, Typical)

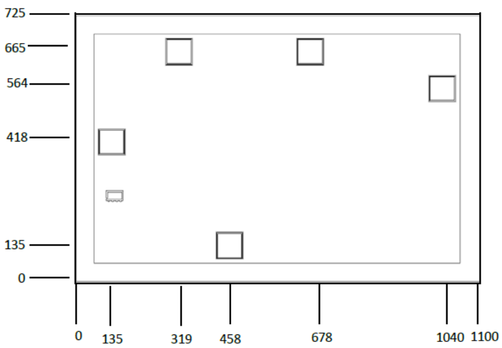


Fig 3. Bonding Pad Positions

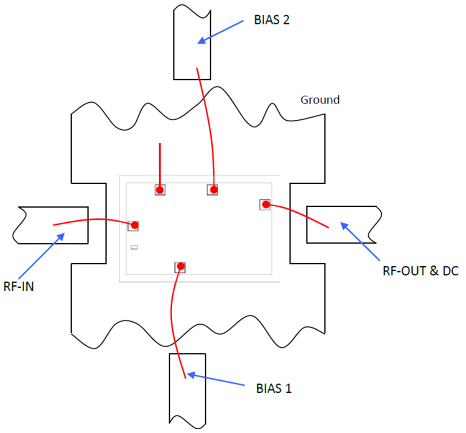
## Critical Dimensions

| Parameter | Values |
|---|---|
| Die Thickness, μm | 100 |
| Die Width, μm | 725 |
| Die Length, μm | 1100 |
| Bond Pad Size, μm | 75 x 75 |

## Assembly and Handling Procedure

1. Storage
   Dice should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC Gallium Arsenide (GaAs) 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.

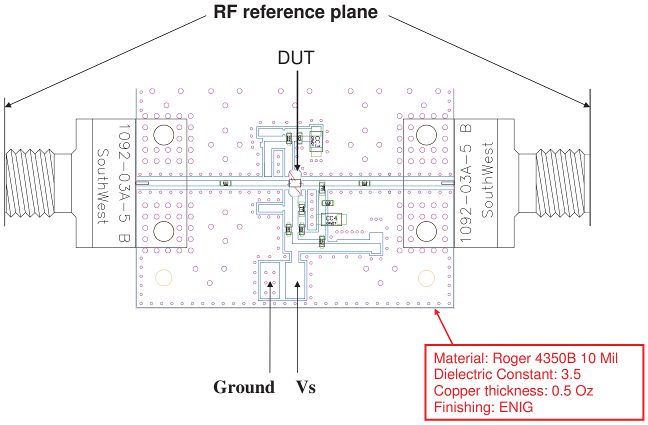
## Assembly Diagram



### Recommended Wire Length, Typical

| Wire | Wire Length (mm) | Wire Loop Height (mm) |
|---|---|---|
| RF-IN, RF-OUT & DC | 0.8 | 0.15 |
| BIAS 1, BIAS 2 | 1.2 | 0.15 |
| GROUND | 0.50 | 0.15 |

### RF Reference Plane - No port extension



Material: Roger 4350B 10 Mil
Dielectric Constant: 3.5
Copper thickness: 0.5 Oz
Finishing: ENIG

## 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.<br>Small, Gel - Pak: 10,50,100 KGD* — PMA-545G1-DG+<br>Medium†, Partial wafer: KGD*<1655 — PMA-545G1-DP+<br>Large†, Full Wafer — PMA-545G1-DF+<br>†*Available upon request contact sales representative*<br>Refer to AN-60-067 |
| **Environmental Ratings** | ENV-80 |

*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 (500 to <1000V) in accordance with ANSI/ESD STM 5.1 - 2001

** Tested in industry standard 3x3mm, 8-lead, MCLP package.

### Additional Notes

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