Over 170 Models from DC to 26.5 GHz

With over 170 different MMIC amplifier models covering frequency bands from DC to 26.5 GHz, chances are Mini-Circuits has your application covered. Utilizing GaAs semiconductor materials and PHEMT and InGaP HBT process technologies, our designs offer a very wide variety of performance characteristics to meet your needs including low noise, flat gain, ultra-wideband, digital variable gain, and more. With packages as small as 0.08 x 0.05”, our amplifiers can satisfy extremely tight space requirements, and our ultra-reliable, hermetically sealed ceramic designs stand up to the most extreme operating conditions.

This guide will provide you with a complete overview of our MMIC amplifier product line and also highlight some of the key differences in design approach between Mini-Circuits MMIC amplifiers and typical products on the market. As one of the few suppliers in the industry who own and manage their own packaging facilities, Mini-Circuits is able to provide the highest quality, most consistent, and most reliable products to our customers.

From here, we invite you to visit minicircuits.com and use Yoni2, our patented search engine that lets you search our entire engineering database by performance criteria to find the models that meet your requirements. You’ll also find complete specs for individual models, free samples of selected products, high accuracy simulation models, and everything you need to make an informed decision about the right amplifier for your needs.

We’re always here to support you. Get in touch with our applications team to discuss any questions or special requirements you might have. We hope this product guide provides a helpful reference for your work, and we thank you for your interest in Mini-Circuits MMIC amplifiers!

Sincerely,

Harvey Kaylie
Mini-Circuits CEO and Founder
Contact: Mini-Circuits Applications
Email: apps@minicircuits.com

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**MMIC AMPLIFIER FAMILIES**

- **Low Noise**
  - 40 to 6000 MHz
  - Model Series: PGA, PMA, PSA

- **Low Noise Bypass**
  - 500 to 5000 MHz
  - Model Series: TSS

- **Low Noise Transistor**
  - 450 to 6000 MHz
  - Model Series: SAV, TAV

- **Low Noise Modules**
  - 50 to 3800 MHz
  - Model Series: RAMP, TAMP, YSF

- **Dual Matched for Push-Pull Applications**
  - DC to 4000 MHz
  - Model Series: MERA, MGVA, MPGVA, PHA-11/22

- **Medium Power**
  - 869 to 2170 MHz
  - Model Series: GVA

- **Wideband Microwaves**
  - DC to 26.5 GHz
  - Model Series: GVA, AVA, AVM

- **Wideband Fixed Current**
  - DC to 8000 MHz
  - Model Series: ERA, LEE, GALI

- **Hi-Rel Ceramic**
  - 10 to 6000 MHz
  - Model Series: CMA

- **High Dynamic Range**
  - 5 to 6000 MHz
  - Model Series: HXG, PHA, LHA, HELA

- **Digital Variable Gain**
  - 50 to 3000 MHz
  - Model Series: DVGA

**SELECTED APPLICATIONS**

- Point to Point Radio
- SATCOM
- Cellular
- Portable Wireless
- PCS
- LTE
- WiMAX
- GPS
- Wireless Base Station Systems
- UHF/VHF
- CATV
- Multi-Band Receivers
- Test and Measurement
- Instrumentation
- Military EW
- Avionics Systems
- Radar
- Isolation Amplifiers
- Balanced Amplifiers
- Optical Networks
- And More!

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LOW NOISE

40 to 6000 MHz

Overview
Ranging from 40 to 6000 MHz, Mini-Circuit’s low noise MMIC amplifier model families provide noise figures as low as 0.38 dB, making them ideal for sensitive receiver applications. Our selection provides various combinations of gain, P1dB, IP3, power consumption and size to meet a wide range of system requirements.

Model Family
PGA

Features
- 40-6000 MHz
- Gain up to 26.5 dB
- P1dB up to +23.2 dBm
- IP3 up to +45 dBm
- NF as low as 0.38 dB
- F min as low as 0.25 dB

Advantages
PGA models are ideal for use in driver amplifiers for complex waveform up-converter paths, drivers in linearized transit systems, and secondary amplifiers in ultra-high dynamic range receivers. They cover primary CATV applications, including GPON, MOCA, and DBS.

*Defined as minimum noise figure when amplifier load is optimized for the best complex match possible. Refer to Application Note AN60-040 on our website.

Model Family
PMA

Features
- 50-6000 MHz
- Gain up to 39 dB
- P1dB up to +22.6 dBm
- IP3 up to +40 dBm
- NF as low as 0.5 dB

Advantages
Combining low noise and high IP3, PMA-series amplifiers provide the advantages of both sensitivity and two-tone spurious-free dynamic range, along with on-chip active bias circuits, making them ideal for use in low noise Receiver Front End, among other applications.

Model Family
PSA

Features
- 50-6000 MHz
- Gain up to 20 dB
- P1dB up to +23 dBm
- IP3 up to +36.8 dBm
- NF as low as 0.75 dB

Advantages
Mini-Circuit’s PSA-series amplifiers are designed specifically for applications which require linear performance, particularly wideband, advanced digital communications systems such as LTE as well as critical IF amplifier applications.

LOW NOISE BYPASS

500 to 5000 MHz

Overview
Mini-Circuit’s low noise bypass amplifier TSS-53LNB+ features an internal switchable bypass circuit to protect the LNA in the presence of high power signals, minimize noise distortion and extend the usable dynamic range up to +48 dBm in bypass mode. It provides very flat gain from 500 MHz to 5 GHz and comes housed in a tiny 3x3mm MCLP package with very low operating power requirements.

Model Family
TSS

Features
- 500 – 5000 MHz
- Gain up to 22.8 dB
- ±0.7 dB flatness over 700-2100 MHz
- P1dB up to +21 dBm
- +34 dBm IP3 in thru mode
- +48 dBm IP3 in bypass mode
- NF as low as 1.2 dB

Advantages
It’s outstanding combination of performance characteristics makes the TSS-53LNB+ a candidate for many high-performance applications such as wireless base station receivers and test and measurement systems. In addition, it’s flat gain over very wide frequency range supports broadband and multi-band usage, ideal for carrier aggregation in LTE-Advanced (LTE-A) systems, for example.
LOW NOISE TRANSISTOR
450 to 6000 MHz  50Ω

Overview
To allow designers the flexibility to develop their own bias and matching circuits to meet their specific application requirements, Mini-Circuits offers a selection of tiny surface mount transistors with ultra-low noise, high IP3 and wide bandwidth to use in a variety of Low Noise Amplifier designs. Manufactured using PHEMT technology, these models operate on a single positive supply voltage with a range of current consumption ratings. They’re available from stock in both leaded and leadless packages for low cost. Covering frequencies from 450 to 6000 MHz, they offer versatile solutions for many applications including cellular, telecom, instrumentation and other wideband applications.

Features
• 450 – 6000 MHz
• Gain up to 23.2 dB
• P1dB up to +19.2 dBm
• IP3 up to +33 dBm
• Ultra low NF as low as 0.5 dB
• F min as low as 0.14 dB

Advantages
TAV-series models come housed in a tiny leadless package with exposed metal pad on the bottom for superior heat dissipation.

Recommended Application
Active Bias Circuit

* For band specific, drop-in modules, and as an alternative to designing circuits, please refer to Mini-Circuits TAMP- and RAMP-series models which are based on SAV/TAV PHEMTs and include all DC blocking, bias, matching and stabilization circuitry, without the need for any external components.

a. Suitability for model replacement within a particular system must be determined by and is solely the responsibility of the customer based on, among other things, electrical performance criteria, stimulus conditions, application, compatibility with other components and environmental conditions and stresses.

b. Avago ATF-series is used for identification and comparison purposes only.

MINICIRCUITS
ISO 9001  ISO 14001  AS 9100
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Model Family
SAV

Overview
- 0.09 x 0.09 x 0.04" 
- Voltage, 3V
- Current, 15 – 60mA

Model Family
TAV

Overview
- 3 x 3 x 0.89mm
- Voltage, 3V
- Current, 15 – 60mA

Model Family
RAMP

Overview
- 0.5 x 0.5 x 0.18" 
- Voltage, 5V
- Current, 70mA

Model Family
TAMP

Overview
- 0.59 x 0.39 x 0.12" 
- Voltage, 5V
- Current, 20 – 120mA

Model Family
YSF

Overview
- 6 x 4.9 x 0.9 mm
- Voltage, 5V
- Current, 118mA

Overview
To simplify circuit design and provide turnkey solutions for ensuring low system sensitivity in demanding applications, Mini-Circuits offers a variety of low noise amplifier modules with integrated bias, matching and stability circuits in a single package. These models achieve outstanding noise figure performance with various combinations of gain, dynamic range and output power to meet your requirements for applications from 50 to 3800 MHz.

Advantages
- Mini-Circuits’ RAMP-33LN+ utilizes advanced PHEMT technology to achieve low noise and high IP3 over the full bandwidth from 50 to 3000 MHz, supporting a wide variety of applications requiring moderate output power and low distortion. 1.1 dB noise figure enables low sensitivity for receiver applications, while +30 dBm IP3 performance can improve spurious free dynamic range. It comes housed in a rugged metal case providing excellent shielding from nearby circuitry.

Advantages
- The TAMP-series of LNA modules provides a variety of models with different combinations of low noise, gain, IP3 and output power to meet your system requirements. They provide excellent input and output matching without any external elements and come housed in metal packages providing ruggedness and shielding.

Advantages
With models providing gain up to 20 dB and as flat as ±0.2 dB, the YSF family is ideal for any application where consistent performance across frequency is a critical requirement. Housed in a Mini-Circuits System in Package™ (MSP), these models come with integrated matching, bias, and DC blocking all in a single 5x6mm case.

See data sheet for details.
## DUAL MATCHED
### DC to 4000 MHz

**Overview**
Mini-Circuits offers a broad selection of dual-matched MMIC amplifiers for use in balanced and push-pull amplifier applications. These models include two well-matched dice in a single package making them excellent solutions for suppression of unwanted second harmonics and to achieve very high dynamic range. With designs based on both InGaP HBT and PHEMT technologies, our selection offers a variety of performance features for different needs.

### Advantages
Based on InGaP HBT technology, MERA-series amplifiers offer bandwidths as wide as DC to 4000 MHz with high gain, high dynamic range and good gain flatness, supporting applications from UHF/VHF to cellular and more.

### Features
- **6 x 4.9 x 0.9 mm**
- **Voltage, 4.8 – 4.9V**
- **Current, 65 – 85mA**

- DC - 4000 MHz
- Gain up to 25 dB
- P1dB up to +19 dBm
- IP3 up to +35 dBm
- NF as low as 2.7 dB

### Model Family
- **MERA**

### Model Family
- **MGVA**

### Model Family
- **MPGA**

### Model Family
- **PHA-11/22**

### balanced Configuration
![Balanced Configuration](Image)

### Push Pull Configuration
![Push Pull Configuration](Image)

---

## MEDIUM POWER
### 869 to 2170 MHz

**Overview**
For applications requiring high output power and high Power Added Efficiency (PAE), Mini-Circuits’ GVA-91+ and GVA-92+ amplifiers are capable of delivering 1W and ½ W output power, respectively, and PAE up to 50%. These models employ matching circuits for targeted application bands. Mini-Circuits has also developed a design using two matched GVA-91+ and -92+ dice in balanced configuration enabling outstanding amplifier performance up to 1W over octave bands from 90 up to 4500 MHz and providing medium power capability for a range of wideband applications.

### Advantages
With high Power Added Efficiency, GVA power amplifiers deliver high output power with low DC power consumption. They come housed in an industry standard SO-89 package with very good thermal performance and excellent repeatability from lot to lot.

### Features
- **0.18 x 0.17 x 0.065”**
- **Voltage, 5V**
- **Current, 146mA**

- 869/2170 MHz
- Gain up to 21.2 dB
- P1dB up to +29.5 dBm
- IP3 up to +43.6 dBm
- PAE up to 50%

### Model Family
- **GVA-91/92+**

### Model Family
- **MGVA-91/92+**

### Model Family
- **MPGA-91/92+**

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**WIDEBAND MICROWAVE**

DC to 26.5 GHz

**Overview**

Covering applications from DC up to 26.5 GHz, our selection of wideband fixed voltage MMIC amplifiers covers an extremely wide range of applications from DC to 26.5 GHz. With a variety of models offering different performance features including flat gain, high linearity, and output power up to 1/2W, chances are we have a model that meets your requirements. They all operate on a single +5V supply and come in packages as small as 3x3mm.

**Model Family**

- **GVA**
- **AVA**
- **AVM**

**Features**

- DC – 12000 MHz
- Gain up to 24 dB
- P1dB up to +20.5 dBm
- IP3 up to +42 dBm
- NF as low as 3.7 dB

**Advantages**

- Mini-Circuits’ GVA-series amplifiers provide wideband performance* with excellent gain flatness and high dynamic range, making them suitable candidates for wideband applications such as advanced digital communications systems and LTE.

**WIDEBAND FIXED CURRENT**

DC to 8000 MHz

**Overview**

To support systems where constant current is a requirement, Mini-Circuits offers over 60 fixed current MMIC amplifier models off the shelf with wideband performance in a variety of case styles. Covering applications from DC to 8000 MHz with a range of performance characteristics to meet different system needs, these models make excellent solutions for replacements in legacy systems and any design operating on fixed current power supply.

**Model Family**

- **ERA**
- **LEE**
- **GALI**

**Features**

- DC – 8000 MHz
- Gain up to 24.4 dB
- P1dB up to +18.4 dBm
- IP3 up to +36.5 dBm
- NF as low as 2.2 dB

**Advantages**

- Mini-Circuits’ ERA-series amplifiers cover applications from DC up to 8 GHz. They are unconditionally stable, transient protected and come encased in a Micro-X package with excellent thermal stability.

*GVA-91+ and GVA-92+ specified from 869 to 2170 MHz; application circuits for different bandwidths available.
HI-REL CERAMIC
10 to 6000 MHz

Overview
Mini-Circuits’ CMA-series ceramic MMIC amplifiers offer ultra-low noise, high IP3, high gain, and outstanding flatness in a tiny (3 x 3 x 1.14mm) ceramic, hermetically sealed package. Performance qualified to meet MIL requirements for gross leak, fine leak, thermal shock, mechanical shock, vibration, acceleration, and HTOL, these amplifiers provide ultra-high reliability in extreme operating environments.

Model Family
CMA

Overview

0.12 x 0.12 x 0.05”
Voltage, 3 – 5V
Current, 55 – 158mA

Ultra-High
Reliability
and Power Consumption

Features
• 10 – 6000 MHz
• Gain up to 31.8 dB
• NF as low as 2.2 dB
• IP3 up to +36.5 dBm

Adventages
• NF as low as 0.5 dB
• IP3 up to +36.5 dBm
• P1dB up to +23 dBm

Test Description
Hermeticity (fine and gross leak)
Acceleration 30K, Y1 Direction
Vibration 10 – 2000 Hz sine
Mechanical shock 20G’s @ 130 Hz
PIND 25G’s @ 130 Hz
Temp Cycle 55°C to 125°C, 1000 cycles
Autoclave 121°C, RH 100%
HTOL 1000 hrs., 105°C at rated
Bend Test 1000 hrs., 105°C at rated
Resistance to soldering heat
3x reflow, 260°C peak
Drop Test
Adhesion Strength

Test Method / Process
MIL-STD-202 Method 112, Cond. C & D
MIL-STD-202 Method 204, Cond. D
MIL-STD-202 Method 213, Cond. A
MIL-STD-750 Method 2052.2
MIL-STD-202 Method 107
JESD22-A102C
MIL-STD-202 Method 108, Cond. D
JESD22-B102
JESD22-B111
Push Test>10 lb

Results
PASS
PASS
PASS
PASS
PASS
PASS
PASS
PASS
PASS

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HIGH DYNAMIC RANGE
5 to 6000 MHz

Overview
Mini-Circuits’ high dynamic range amplifiers deliver industry-leading dynamic range with OIP3 performance as high as +48 dBm. This translates into extremely linear performance in multi-carrier and complex signal environments. Supporting both 50 and 75Ω systems with a range of supply voltages, these models provide outstanding combinations of intercept point and power consumption for low cost compared to similar products on the market.

Model Family
HXG

Overview

0.25 x 0.27 x 0.09*
Voltage, 5V
Current, 144mA

Ultra-High Dynamic Range

Features
• 500 – 2400 MHz
• Gain up to 15.3 dB
• NF as low as 2.2 dB

Adventages
• NF as low as 1.8 dB
• IP3 up to +42 dBm
• P1dB up to +22.9 dBm

Test Description
Hermeticity (fine and gross leak)
Acceleration 30K, Y1 Direction
Vibration 10 – 2000 Hz sine
Mechanical shock 20G’s @ 130 Hz
PIND 25G’s @ 130 Hz
Temp Cycle 55°C to 125°C, 1000 cycles
Autoclave 121°C, RH 100%
HTOL 1000 hrs., 105°C at rated
Bend Test 1000 hrs., 105°C at rated
Resistance to soldering heat
3x reflow, 260°C peak
Drop Test
Adhesion Strength

Test Method / Process
MIL-STD-202 Method 112, Cond. C & D
MIL-STD-202 Method 204, Cond. D
MIL-STD-202 Method 213, Cond. A
MIL-STD-750 Method 2052.2
JESD22-A102C
MIL-STD-202 Method 108, Cond. D
JESD22-B102
JESD22-B111
Push Test>10 lb

Results
PASS
PASS
PASS
PASS
PASS
PASS
PASS
PASS
PASS

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**DIGITAL VARIABLE GAIN**

50 to 3000 MHz

**Overview**

Mini-Circuits’ DVGA-series digitally controlled variable gain amplifiers integrate an amplifier with a digital step attenuator in a single, 5 x 5mm package. They provide gain as high as 30 dB and 31.5 dB gain control in 0.5 dB steps using 6-bit serial or parallel control interfaces. The step attenuators used in DVGA amplifiers are produced using a unique combination CMOS process on silicon, offering the performance of GaAs with the advantages of conventional CMOS devices. They are immune to latch-up and provide ±0.1 dB attenuation accuracy enabling very precise gain control.

**Model Family**

**DVGA**

- 5 x 5 x 1 mm
- Voltage, 3-5V
- Current, 71 – 159mA

**Features**

- 50 - 3000 MHz
- Gain up to 29.5 dB
- 31.5 dB gain control (0.5 dB steps)
- P1dB up to +23.2 dBm
- IP3 up to +35.7 dBm
- NF as low as 3.1 dB

**Advantages**

Combining medium and high gain with a wide range of gain control makes DVGA models ideal building blocks for any RF chain where level setting control is required in a small space.

---

**SEMICONDUCTOR MATERIALS & PROCESS TECHNOLOGIES**

**Overview of Semiconductor Materials: GaAs**

<table>
<thead>
<tr>
<th>Material</th>
<th>GaAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron Mobility (cm2/Vs)</td>
<td>5,500 – 7,000</td>
</tr>
<tr>
<td>Peak Drift Velocity (107 cm/s)</td>
<td>1.6 – 2.3</td>
</tr>
<tr>
<td>Band Gap (eV)</td>
<td>1.4</td>
</tr>
<tr>
<td>Frequency Range (GHz)</td>
<td>&gt;75</td>
</tr>
<tr>
<td>Gain</td>
<td>Higher</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>Good</td>
</tr>
<tr>
<td>Production Maturity</td>
<td>6” Wafer</td>
</tr>
</tbody>
</table>

**Why GaAs?**

- High electron mobility enables high frequencies and fast switching performance
- Intrinsic GaAs is semi-insulating, making it an ideal substrate for stripline and high Q passives
- Large band gap (1.4 eV) enables higher power operation
- Radiation hardness means GaAs is well accepted for both space and military applications
- Commercial availability in 6” wafer makes it suitable for mass production
- GaAs is widely accepted as the superior technology for the production of high-frequency, high power and low noise products

**Overview of Process Technologies**

**GaAs PHEMT**

0.5/0.25/0.15µm

- E-mode and D-mode

**Products**

- Low noise amplifiers
- High linearity gain block
- Distributed amplifiers
- mmWave power amplifiers

**Features**

- High transition frequency (Ft)
- Low noise up to mmWave
- E-Mode (single supply)
- High linearity
- High power density
- Great power and efficiency
- Low standby current
- May operate as low as 1.2V

**GaAs InGaP HBT**

2 /1µm

**Products**

- High linearity gain block
- Power amplifiers <8 GHz

**Features**

- High current gain
- High power density
- Single supply
- Consistent product performance
- Proven technology for gain block and medium power amplifiers.
CIRCUIT ARCHITECTURES

Our MMIC amplifier designs employ a range of different circuit topologies to give our customers a wide variety of choices to meet their system requirements. Whether the goal is to achieve wideband performance, high dynamic range, ultra-low noise or other critical performance characteristics, the right circuit architecture allows our design engineers to strike the ideal balance of parameters for your needs.

**Darlington**

- **Features**
  - High current gain ($\beta$)
  - Superior IP3 bandwidth
  - Flat gain
  - Great impedance match

- **Applications**
  - IF gain block
  - Multi-purpose driver amplifiers

**Distributed**

- **Features**
  - Broadband performance
  - Good impedance match
  - Flat gain
  - Excellent isolation

- **Applications**
  - Radars
  - Point to point radio
  - Test instruments

**Cascode**

- **Features**
  - Improves input-output isolation
  - Reduces the Miller effect
  - Wide bandwidth
  - High gain
  - High output impedance
  - High supply voltage
  - High IP3

- **Applications**
  - Low noise amplifiers
QUALITY AND RELIABILITY

Active Biasing
As changes in temperature can cause changes in amplifier characteristics, temperature stability is mandatory to maintain the performance of the amplifier. Mini-Circuits MMIC amplifier designs utilize an active biasing circuit consisting of components that have the same temperature characteristics as the amplifier to improve temperature stability. RF signals are isolated from the active biasing circuit, preventing degradation in RF performance.

Protection Circuitry
ESD Protection Circuit
Designed-in ESD protection circuitry provides an alternate, low-resistance path for ESD, reducing current flow to the critical circuit, and improving ESD survivability and product reliability.

Transient Current Protection Circuit
Voltage spikes may cause permanent damage to MMIC amplifiers. Built-in transient current protection circuitry prevents damage caused by voltage spikes without degrading the amplifier’s RF performance.

Junction Temperature Measurement
We also measure and monitor MMIC amplifier junction temperature using embedded temperature sensing diodes near the transistor junction on every design and every production wafer to ensure we provide the highest quality and reliability in our amplifiers.

Stringent Qualification
Mini-Circuits uses state-of-the-art RF measurement equipment to characterize and qualify our MMIC amplifier designs. Characterization and qualification testing such as S-parameter testing, power testing, noise figure testing, IP3 testing, and load and source pull testing allow our designers to validate every amplifier design’s performance and provide comprehensive performance analysis for each model.

Comprehensive Test and Characterization
- S-parameter test
- Power test
- Noise figure test
- IP3 test
- Load / source pull test

Our amplifiers undergo extensive and stringent qualification testing to ensure every unit delivers the quality you expect and reliability you can count on.

Test
- High Temperature Operating Life Test (HTOL) JEDEC Standard, JESD22A-108
- Moisture Sensitivity Test (Level 1) JEDEC Standard, J-STD-020
- Temperature Cycle Test MIL-STD-883, Method 1010
- Autoclave Test JEDEC Standard, JESD22-A102
- High Temperature Storage Test JEDEC Standard, JESD22-A103
- Scanning Acoustic Microscope Test JEDEC Standard, J-STD-020C
- Humidity Test MIL-STD-202F Method 103B
- Solderability Test JEDEC Standard, JESD22-B102
- Lead Integrity Test MIL-STD-883, Method 2004
- Whisker Growth Test JEDEC Standard, JESD22-A121
- ESD Sensitivity Test ANSI/ESD-STM5.1-2007 (HBM) STM5.2-1999 (MM)
ADVANCED PACKAGING TECHNOLOGY

Thermal Management
At Mini-Circuits, we know temperature has a direct impact on the operating performance and reliability of amplifiers. During material selection, we use mold compound, lead frame materials and package designs with excellent heat dissipation properties that improve product performance and long-term reliability.

### Moisture Sensitivity Level 1
Our proprietary package design meets MSL Level 1 standards and eliminates the risk of package delamination, ensuring long-term product reliability under all operating and assembly conditions.

### Thermal Conductivity (W/m°C)

<table>
<thead>
<tr>
<th>Material</th>
<th>Mini-Circuits</th>
<th>Competitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mold Compound</td>
<td>1.5</td>
<td>0.88</td>
</tr>
<tr>
<td>Conductive Epoxy</td>
<td>45</td>
<td>2.5</td>
</tr>
</tbody>
</table>

**C-Scan Image**

**A-Scan Image**

**Package without delamination under Scanning Acoustic Microscopy Test**

**Signal of Good Unit**

**Companion Products and OTHER RESOURCES**

**Companion Products**

#### 90° Hybrids
- 5 to 8000 MHz
- Power handling up to 15W
- Low phase and amplitude unbalance
- LTCC packages as small as 0805

#### Baluns
- 4 kHz to 18 GHz
- LTCC packages as small as 0805
- Insertion loss as low as 0.5 dB
- Low phase* and amplitude unbalance “relative to 180°”

#### Bias TEs
- 0.1 to 10000 MHz
- Isolation up to 44 dB
- Insertion loss as low as 0.35 dB
- VSWR as low as 1.05:1

#### Limiters
- 0.2 to 8200 MHz
- Input powers from +5 to +37 dBm
- Response time as fast as 2ns
- Hi-rel ceramic packages available

#### LTCC Filters
- DC to 18.3 GHz
- Low pass, high pass, band pass, and diplexers
- Sharp rejection
- Ceramic packages as small as 0603

**Extensive Application Notes**
As part of our commitment to providing you with best in class product information and application support, our online library of application notes contains over 40 articles with detailed technical information regarding uses of many of our amplifier models in different systems and operating environments.

Go to:

www.minicircuits.com/applications/application_notes.html

You can also request an application note specifically for the work you’re doing by reaching out to us at apps@minicircuits.com.

We’re here to support you!

**Advanced Simulation Models**

Mini-Circuits has always provided customers with free S-Parameters for all models to support performance modeling and simulation over linear power domains. To allow designers to accurately model the complete linear and non-linear performance of their designs, Mini-Circuits now provides **free X-Parameters®** for three of our most popular MMIC amplifiers: PHA-1+, GVA-62+, and GVA-63+.

Made possible through our partnership with modeling and measurement specialists, Modelithics, this advanced capability is ideal for use in systems with complex waveforms like LTE, OFDM and QAM, as well as for prediction of power compression, non-linear distortion, and other behaviors elusive to conventional simulations.

Made possible through our partnership with modeling and measurement specialists, Modelithics, these X-parameter models enable faster, more comprehensive feasibility assessments and more rapid transition from prototype simulations to working designs. For more information...

Go to:

http://www.minicircuits.com/products/x_parameters.shtml
Find the Right Model for Your Needs in Seconds!

Why waste time searching for a needle in a haystack?

Instead of combing through tables and datasheets of hundreds of possible amplifier options for the one that fits your requirements, visit minicircuits.com and use Yoni2®, our patented RF product search engine.

Yoni2® searches thousands of actual test data points from our entire database of catalog models and non-catalog engineering designs for the amplifiers that meet or exceed your criteria.

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