MMIC Amplifiers

Product Line Overview

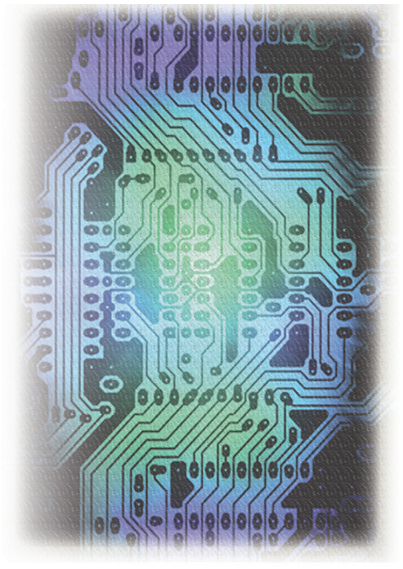
Mini-Circuits®

ISO 9001 ISO 14001 AS 9100 CERTIFIED

www.minicircuits.com

MMIC AMPLIFIERS

CONTENTS



MINI-CIRCUITS

INTRODUCTION

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

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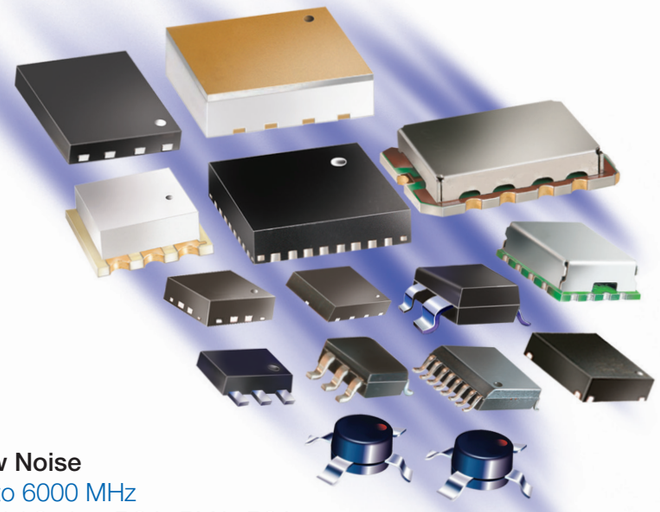
Email: apps@minicircuits.com

AMPLIFIERS

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, MPGA, PHA-11/22

Medium Power
869 to 2170 MHz
Model Series: GVA

Wideband Microwave
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!

AMPLIFIERS

MMIC

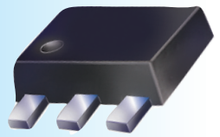
LOW NOISE

40 to 6000 MHz

Overview

Ranging from 40 to 6000 MHz, Mini-Circuits' 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



0.18 x 0.17 x 0.06"
Voltage, 3– 5V
Current, 60 – 116mA
50 & 75Ω

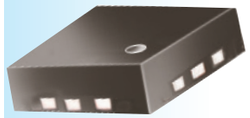
Features

- 40-6000 MHz
- Gain up to 26.5 dB
- P1dB up to +23.2 dBm
- IP3 up to +45 dBm
- NF as low as 0.5 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. 75Ω Models cover primary CATV applications, including GPON, MOCA, and DBS.

Model Family
PMA



3 x 3 x 0.89 mm
Voltage, 3 – 5V
Current, 20 – 158mA

Features

- 50-6000 MHz
- Gain up to 39 dB
- P1dB up to +22.6 dBm
- IP3 up to +40 dBm
- NF as low as 0.38 dB
- F min as low as 0.25 dB*

Advantages

Combining low noise and high IP3, PMA-series amplifiers provide the advantages of both sensitivity and two-tone spur-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

0.05 x 0.09 x 0.04"
Voltage, 3 – 5V
Current, 20 – 80mA

Features

- 50-6000 MHz
- Gain up to 20 dB
- P1dB up to +22 dBm
- IP3 up to +36.8 dBm
- NF as low as 0.75 dB

Advantages

Mini-Circuits' 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.

*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.

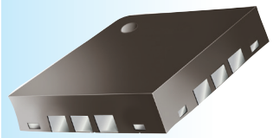
LOW NOISE BYPASS

500 to 5000 MHz

Overview

Mini-Circuits' 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



3 x 3 x 0.89 mm
Voltage, 5V, Current, 82mA
(In Thru Mode)
Internal Bypass Switch
for Large Signals

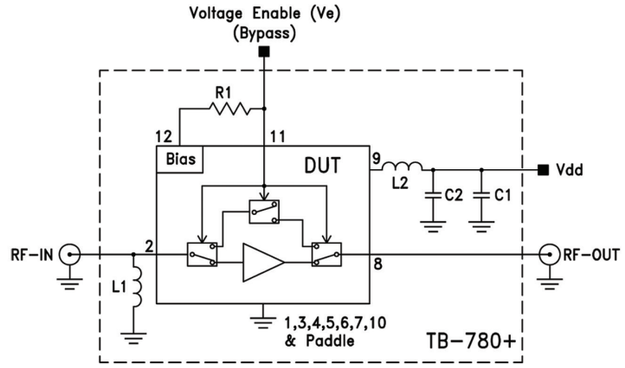
Features

- 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.

Characterization Test Circuit



See data sheet for details.

AMPLIFIERS

MMIC

LOW NOISE TRANSISTOR

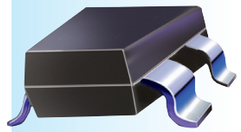
450 to 6000 MHz 50Ω

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.

Model Family

SAV



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

Features

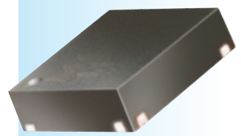
- 450 – 6000 MHz
- Gain up to 23.2 dB
- P1dB up to +19.2 dBm
- IP3 up to +33 dBm
- Ultra low NF as low as 0.5 dB
- F min as low as 0.14 dB

Advantages

Mini-Circuits SAV-series low noise transistor amplifier models come packaged in a tiny SOT-343 (SC-70) style leaded package and may be used as a replacement for Avago ATF-series models[a,b]. **ADS models available.**

Model Family

TAV



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

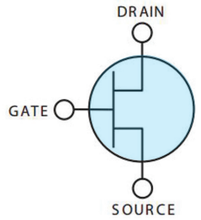
Features

- 450 – 6000 MHz
- Gain up to 23.8 dB
- P1dB up to +19.1 dBm
- IP3 up to +33 dBm
- NF as low as 0.5 dB

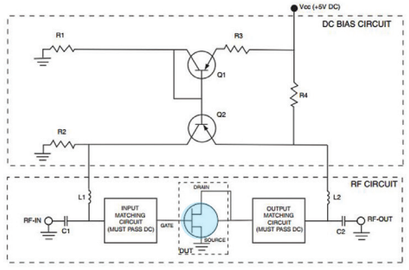
Advantages

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

Simplified Schematic



Recommended Application Active Bias Circuit



See data sheet for details.

* 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.

LOW NOISE MODULES

50 to 3800 MHz

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.

Model Family

RAMP

0.50 x 0.50 x 0.18"
Voltage, 5V
Current, 70mA

Features

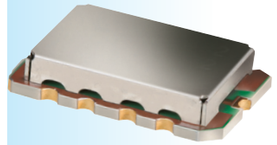
- 50 – 3000 MHz
- Gain up to 22 dB
- P1dB up to +16.5 dBm
- IP3 up to +30 dBm
- NF as low as 1.1 dB

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.

Model Family

TAMP



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

Features

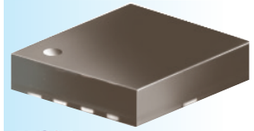
- 400-3600 MHz
- Gain up to 35 dB
- P1dB up to +21.5 dBm
- IP3 up to +36 dBm
- NF as low as 0.55 dB

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.

Model Family

YSF



MSiP

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

Features

- 800 – 3800 MHz
- Gain up to 20 dB
- Ultra-flat gain as flat as ±0.2 dB
- P1dB up to +20.5 dBm
- IP3 up to +37 dBm
- NF as low as 2.5 dB

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™ (MSiP), these models come with integrated matching, bias, and DC blocking all in a single 5x6mm case.

AMPLIFIERS

MMIC

DUAL MATCHED

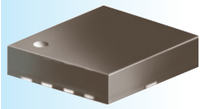
DC to 4000 MHz

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.

Model Family

MERA



6 x 4.9 x 0.9 mm
Voltage, 4.8 – 4.9V
Current, 65 – 80mA

Features

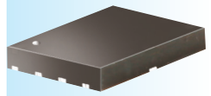
- DC - 4000 MHz
- Gain up to 25 dB
- P1dB up to +19 dBm
- IP3 up to +35 dBm
- NF as low as 2.7 dB

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.

Model Family

MGVA



6 x 4.9 x 0.9 mm
Voltage, 5V
Current, 69 – 82mA

Features

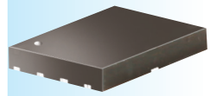
- 40-3000 MHz
- Gain up to 21.4 dB
- P1dB up to +19.6 dBm
- IP3 up to +38 dBm
- NF as low as 3.6 dB

Advantages

Utilizing InGaP HBT technology, MGVA-series models provide high dynamic range and good gain flatness over the 40 to 3000 MHz band. They support 50 and 75Ω applications including Satcom, optical networks, CATV and more.

Model Family

MPGA



6 x 4.9 x 0.9 mm
Voltage, 5V
Current, 63mA

Features

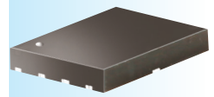
- 40 - 3000 MHz
- Gain up to 14.4 dB
- ±0.5 dB Flatness from 100 – 2000 MHz
- P1dB up to +21 dBm
- IP3 up to + 37.8 dBm
- NF as low as 1.9 dB

Advantages

Fabricated using PHEMT technology, MPGA amplifiers are an ideal choice for applications where low noise figure is a critical requirement. They offer excellent gain flatness, and very high dynamic range for applications including Satcom, optical networks, base station infrastructure and more.

Model Family

PHA-11/22



6 x 4.9 x 0.9 mm
Voltage, 5V
Current, 146mA

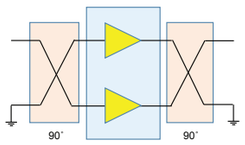
Features

- 50 - 3000 MHz
- Gain up to 16 dB
- P1dB up to +22 dBm
- IP3 up to + 41.5 dBm
- High IP2, up to +78 dBm
- NF as low as 1.9 dB

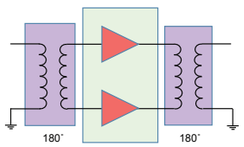
Advantages

Mini-Circuits' PHA-11+ and PHA-22+ dual matched amplifier models are ideal for ultra-high dynamic range applications and are usable in both 50 and 75Ω systems such as CATV, FTTH and more.

Balanced Configuration



Push Pull Configuration



MEDIUM POWER

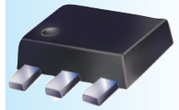
869 to 2170 MHz

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.

Model Family

GVA-91/92+



0.18 x 0.17 x 0.06"
Voltage, 5V
Current, 147mA

Features

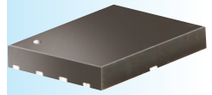
- 869/2170 MHz
- Gain up to 21.2 dB
- P1dB up to +29.5 dBm
- P3dB up to +30.6 dBm
- IP3 up to +43.6 dBm
- PAE up to 50%

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 SOT-89 package with very good thermal performance and excellent repeatability from lot to lot.

Model Family

MGVA-91/92+



6 x 4.9 x 0.9 mm
Voltage, 5V
Current, 290mA

Features

- Balanced design
- Octave bands, 90-4500 MHz
- Gain up to 20 dB
- P1dB up to +28 dBm
- P3dB up to 1W
- IP3 up to +43 dBm

Advantages

Utilizing two well matched dice in balanced configuration, MGVA series models achieve output power up to 1W over wideband with excellent input and output return loss through use of 90˚ hybrids. They offer high IP3 performance and come in a thermally efficient package for high reliability.

AMPLIFIERS

MMIC

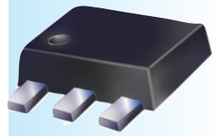
WIDEBAND MICROWAVE

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



0.18 x 0.17 x 0.06"
Voltage, 5V
Current, 52 – 108mA

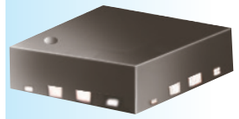
Features

- 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.

Model Family
AVA



3 x 3 x 0.89 mm
Voltage, 5V
Current, 131mA

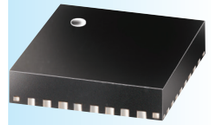
Features

- 5 – 18 GHz
- Gain up to 14.7 dB,
- P1dB up to +19 dBm
- IP3 up to +27 dBm
- NF as low as 4.3 dB
- Excellent isolation, 37 dB

Advantages

High reverse isolation makes the AVA-183A+ an ideal choice for buffering broadband circuits. It is an ideal LO driver amplifier and provides designers system flexibility and margin when integrating cascaded RF components. This model integrates the entire matching network and the majority of the bias circuit inside the package, eliminating the need for complicated external circuits.

Model Family
AVM



5 x 5 x 1 mm
Voltage, 5V
Current, 559mA

Features

- 13 – 26.5 GHz
- Gain up to 14 dB
- Excellent flatness, ± 1 dB
- P1dB up to +27 dBm
- IP3 up to +32.1 dBm
- NF as low as 7.5 dB
- Excellent directivity, 43 dB

Advantages

Model AVM-273-HPK+ supports many applications from 13 to 26.5 GHz with up to 0.5W RF output power. Gain flatness of ±1.0 dB and 58 dB isolation make it an excellent wideband buffer amplifier in P2P radios, military EW and radar, DBS, VSAT and more! Voltage sequencing and DC control module (included) provides the correct voltage sequence, simplifying circuit designs.

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

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

0.06 x 0.18 dia."
Voltage, 3.2 – 5V
Current, 35 – 70mA

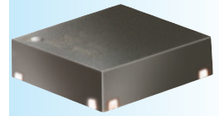
Features

- 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 enclosed in a Micro-X package with excellent thermal stability.

Model Family
LEE



3 x 3 x 0.89 mm
Voltage, 3.5 – 4.9V
Current, 35 – 65mA

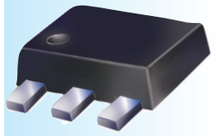
Features

- DC-8000 MHz
- Gain up to 20.8 dB
- P1dB up to +17.3 dBm
- IP3 up to +33 dBm
- NF as low as 2.4 dB

Advantages

LEE-series amplifiers provide super-flat output power across wideband, making them versatile for a wide variety of applications. The 3x3mm MCLP molded plastic package features an exposed metal pad on the bottom allowing excellent heat dissipation and low inductance.

Model Family
GALI



0.18 x 0.17 x 0.06"
Voltage, 3.3 – 5.8V
Current, 16 – 100mA

Features

- DC-8000 MHz
- Gain up to 25.6 dB
- P1dB up to +21.9 dBm
- IP3 up to +38 dBm
- NF as low as 2.4 dB

Advantages

With 24 models offering a variety of combinations of gain, P1dB, noise figure, IP3 and very low DC current, these wideband gain blocks are designed into a SOT-89 package providing low thermal resistance, excellent repeatability and high reliability.

AMPLIFIERS

MMIC

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

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

ULTRA-REL®

Features

- 10 – 6000 MHz
- Gain up to 31.8 dB
- P1dB up to +23.3 dBm
- IP3 up to +36.5 dBm
- NF as low as 0.5 dB

Advantages

A variety of CMA models offers a range of performance attributes to meet your system requirements. Spanning frequencies from 10 to 6000 MHz they support popular application bands including PCS, LTE, WiMAX, satellite IF, and more. CMA amplifiers are bonded to a multilayer LTCC substrate and then hermetically sealed, resulting in low inductance, repeatable performance, and excellent reliability.

Test Description	*Test Method / Process*	*Results*
Hermeticity (fine and gross leak)	MIL-STD-202 Method 112, Cond. C & D	PASS
Acceleration 30K, Y1 Direction	MIL-STD-883 Method 2001, Cond. E	PASS
Vibration 10 – 2000 Hz sine,	MIL-STD-202 Method 204, Cond. D	PASS
Mechanical shock	MIL-STD-202 Method 213 Cond. A	PASS
PIND 20G's @ 130 Hz	MIL-STD-750 Method 2052.2	PASS
Temp Cycle 55C/+125C, 1000 cycles	MIL-STD-202 Method 107	PASS
Autoclave 121C, RH 100%,	JESD22-A102C	PASS
HTOL 1000 hrs., 105C at rated	MIL-STD-202 Method 108, Cond. D	PASS
Bend Test 1000 hrs., 105C at rated	MIL-STD-202 Method 108, Cond. D	PASS
Resistance to soldering heat, 3x reflow, 260C peak	JESD22-B102	PASS
Drop Test	JESD22-B111	PASS
Adhesion Strength	Push Test>10 lb	PASS

HIGH DYNAMIC RANGE

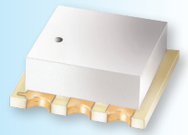
5 to 6000 MHz

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



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

Features

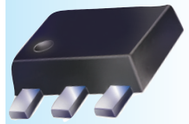
- 500 – 2400 MHz
- Gain up to 15.3 dB
- P1dB up to +23 dBm
- IP3 up to +46.5 dBm
- NF as low as 2.2 dB

Advantages

HXG-series amplifiers provide the unique combination of very high IP3 and surprisingly low noise performance, making them usable as output stage amplifiers and also in receiver front end circuitry. Mini-Circuits System in Package® (MSiP) technology integrates the matching networks with the amplifier in a single, tiny ceramic package, eliminating the need for external matching components.

Model Family

PHA



0.18 x 0.17 x 0.06"
Voltage, 5V
Current, 146mA

Features

- 50 – 6000 MHz
- Gain up to 17.2 dB
- P1dB up to +22 dBm
- IP3 up to +42 dBm
- NF as low as 1.8 dB

Advantages

Mini-Circuits PHA-series models deliver very high IP3 across wide frequency range without the need for external matching components. Industry-leading IP3 performance combined with low power consumption makes these amplifiers ideal for use in driver amplifiers for complex waveform up-converter paths, drivers in linearized transmit systems, and secondary amplifiers in ultra-high dynamic range receivers.

Model Family

LHA

3 x 3 x 0.9mm
Voltage, 5V
Current, 146mA

Features

- 50 – 6000 MHz
- Gain up to 16 dB
- P1dB up to +22.9 dBm
- IP3 up to +40 dBm
- NF as low as 1.8 dB

Advantaes

The LHA-1+ provides ultra-high dynamic range with industry leading IP3 performance and low noise over wideband, supporting a wide variety of applications. This model comes housed in a 3 x 3mm MCLP package with good heat dissipation and low parasitics.

Model Family

HELA

0.30 x 0.40 x 0.10"
Voltage, 12V
Current, 525mA
50 & 75Ω

Features

- 5 – 1000 MHz
- Gain up to 12 dB
- P1dB up to +30 dBm
- IP3 up to +48 dBm
- NF as low as 3.5 dB

Advantages

HELA-series amplifiers are excellent low-cost solutions for reducing intermodulation products in complex, multiple carrier environments such as CATV. Usable in both 50 and 75Ω systems, HELA amplifiers incorporate a pair of amplifiers to provide very high IP3 performance, comparable to that of feed-forward amplifiers, but at significantly lower cost.

AMPLIFIERS

MMIC

DIGITAL VARIABLE GAIN

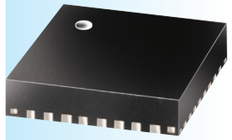
50 to 3000 MHz

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

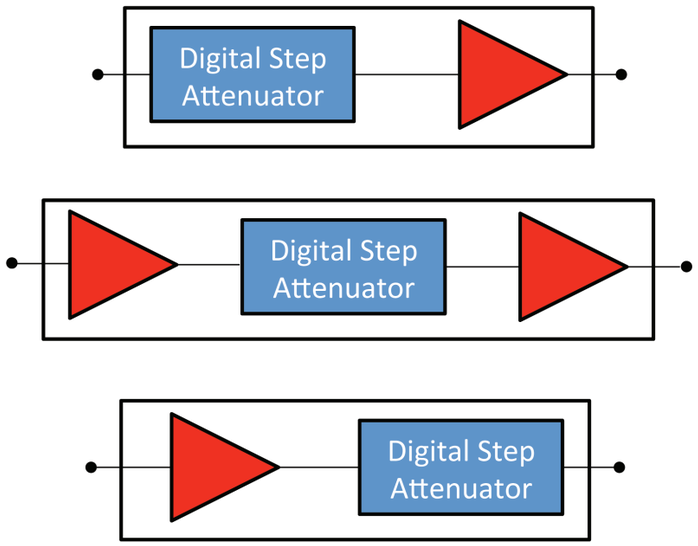
Features

- 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.

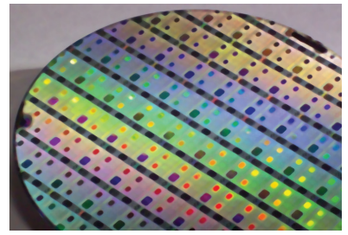
Multiple Configurations Available



SEMICONDUCTOR MATERIALS & PROCESS TECHNOLOGIES

Overview of Semiconductor Materials: GaAs

Material	GaAs
Electron Mobility (cm2/Vs)	5,500 – 7,000
Peak Drift Velocity (107 cm/s)	1.6 – 2.3
Band Gap (eV)	1.4
Frequency Range (GHz)	>75
Gain	Higher
Noise Figure	Good
Production Maturity	6" Wafer



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 <6 GHz

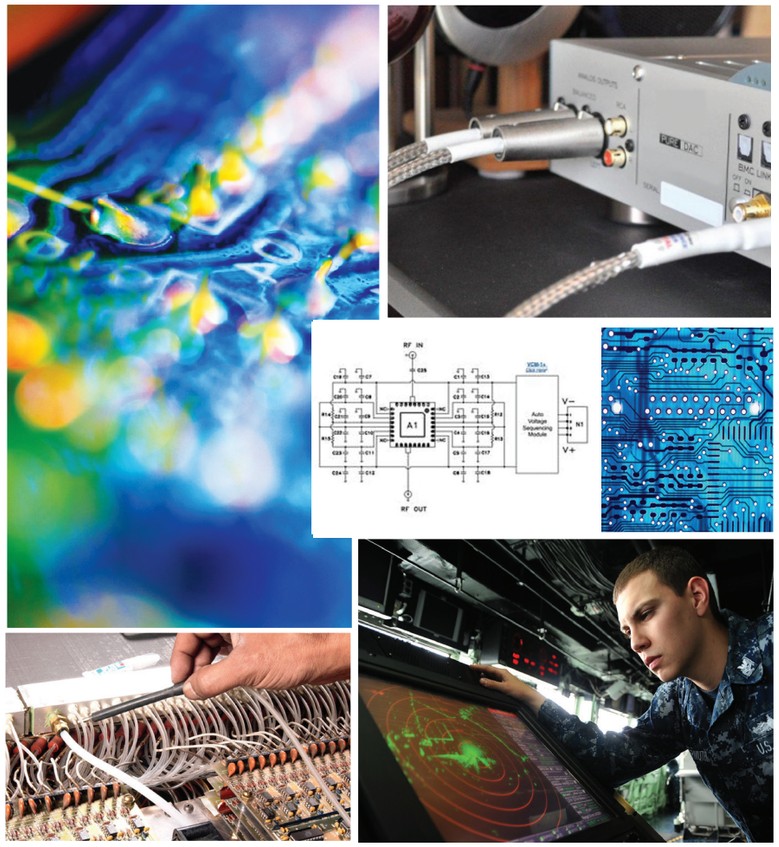
Features

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

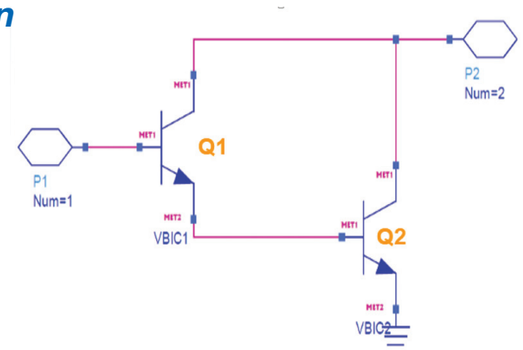
MMIC AMPLIFIERS

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.



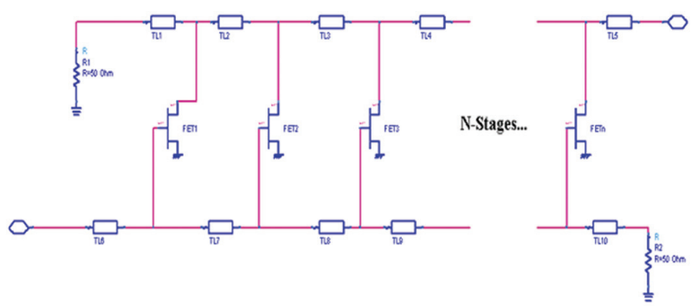
Darlington



Features
- High current gain (β)
- Superior IP3 bandwidth
- Flat gain
- Great impedance match

Applications
- IF gain block
- Multi-purpose driver amplifiers

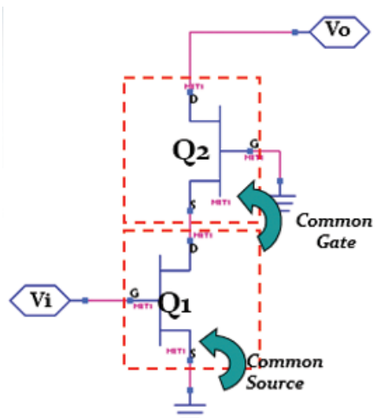
Distributed



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

Applications
- Radars
- Point to point radio
- Test instruments

Cascode



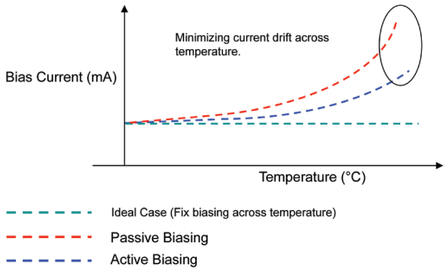
Features
- Improves input-output isolation
- Reduces the Miller effect
- Wide bandwidth
- High gain
- High output impedance
- High supply voltage
- High IP3

Applications
- Low noise amplifiers

QUALITY AND RELIABILITY

Active Biasing

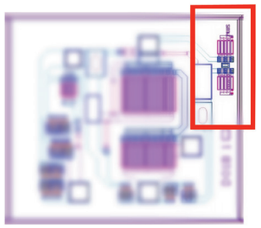
As changes in temperature can cause changes in amplifier characteristics, temperature stability is mandatory to maintain the performance of the amplifier. Mini-Circuits MMIC amplifier designs utilize an active biasing circuit consisting of components that have the same temperature characteristics as 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

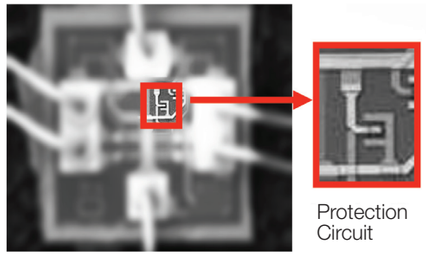
Designed-in ESD protection circuitry provides an alternate, low-resistance path for ESD, reducing current flow to the critical circuit, and improving ESD survivability and product reliability.


Power Clamp Circuit


Diode String

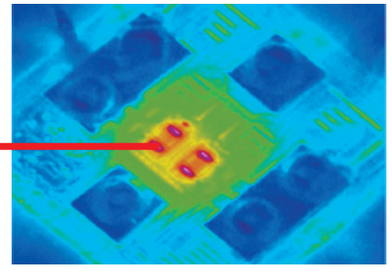
Transient Current Protection Circuit

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.


Protection Circuit

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.

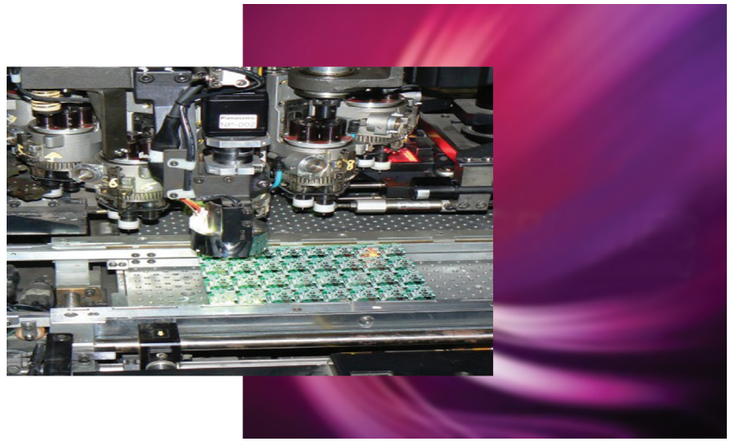


STRINGENT QUALIFICATION

Comprehensive Test and Characterization

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.

- *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	Standard
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)

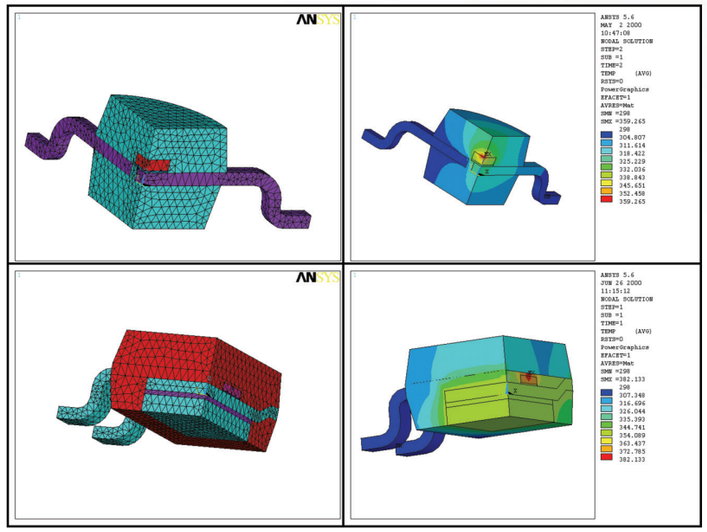
ADVANCED PACKAGING TECHNOLOGY

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.

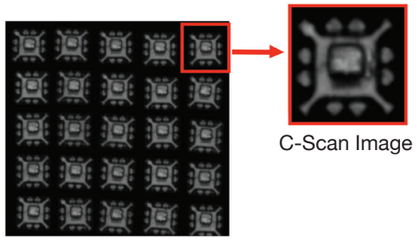
Thermal Conductivity (W/m° K)

Material	Mini-Circuits	Competitors
Mold Compound	1.5	0.88
Conductive Epoxy	45	2.5



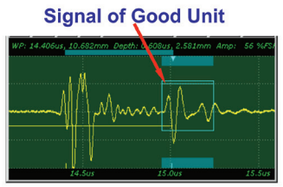
Moisture Sensitivity Level 1

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.



Package without delamination under Scanning Acoustic Microscopy Test

C-Scan Image



A-Scan Image

COMPANION PRODUCTS and OTHER RESOURCES

Companion Products

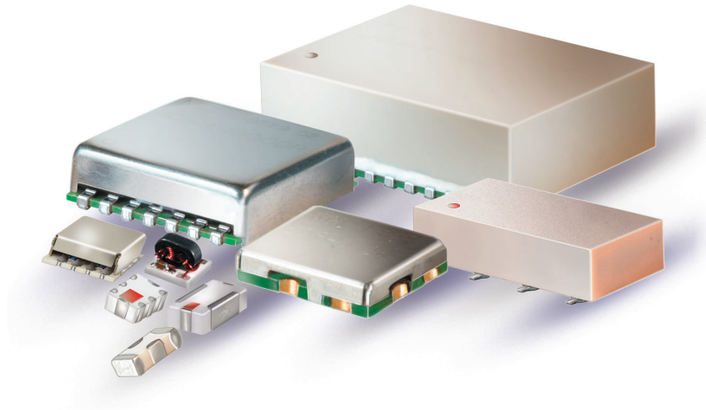
90° Hybrids
- 5 to 8000 MHz
- Power handling up to 15W
- Low phase and amplitude unbalance
- LTCC packages as small as 0805

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 Tees
- 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, Modelitics, these X-parameters 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

FREE X-Parameters-Based Non-Linear Simulation Models for ADS Modelithics®
http://www.modelithics.com/mvp/Mini-Circuits.asp

MMIC Amplifiers

Product Line Overview

Find the Right Model for Your Needs in Seconds!

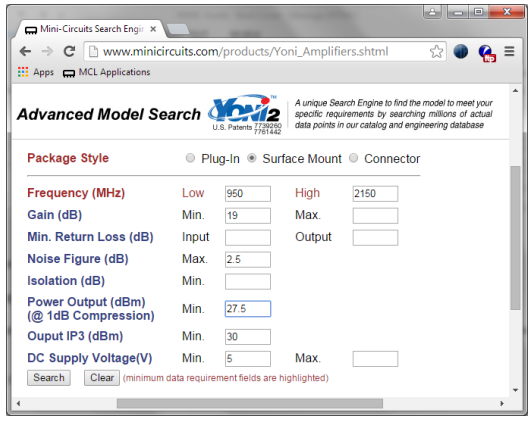
Why waste time searching for a needle in a haystack?

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.

U.S. Patents
7739260, 7761442

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.

Just visit the ***Yoni2***® page for amplifiers at the link below, enter your desired frequency range, performance requirements and click Search. Within seconds, ***Yoni2***® will present a list of components what match your criteria based on how they actually perform across your specific frequency band!



Go to:

www.minicircuits.com/products/Yoni_Amplifiers.shtml

Still didn't find what you're looking for? We may be able to create a custom design especially for you. Reach out to us using the contact information below. We're here to support you!

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