MMIC DIE

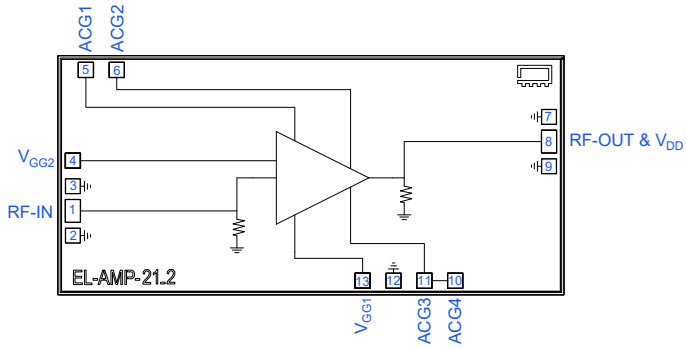
# Medium Power Amplifier AVA-223MP-D+

50Ω 100 kHz to 22 GHz Wideband Amplifier

## THE BIG DEAL

- Wide Bandwidth 100 kHz to 22 GHz
- High Saturated Output Power, Typ. +27.7 dBm
- High OIP3, Typ. +37.9 dBm
- Low Noise Figure, Typ. 3.1 dB
- Positive Gain Slope from 4 to 22 GHz

## FUNCTIONAL DIAGRAM




SEE ORDERING INFORMATION ON THE LAST PAGE

## APPLICATIONS

- Test and Measurement Equipment
- 5G MIMO and Back Haul Radio
- Satellite Communication
- Radar, EW, and ECM Defense Systems

## PRODUCT OVERVIEW

Mini-Circuits' AVA-223MP-D+ is a wideband, high dynamic range, MMIC amplifier fabricated on a GaAs pHEMT process with high output power and broadband gain. Operating from 100 kHz to 22 GHz, this amplifier features typical +25.9 dBm P1dB, +27.7 dBm $P_{SAT}$, 3.1 dB NF, and +37.9 dBm OIP3. This device is matched to 50Ω and measures only 3.28 x 1.55 mm.

## KEY FEATURES

| Features | Advantages |
|---|---|
| Wide Bandwidth: 100 kHz to 22 GHz | Supports a variety of broadband and narrowband applications without the need to reconfigure circuitry. |
| High Dynamic Range<br>- Noise Figure: 3.1 dB<br>- Output IP3: +37.9 dBm<br>- Output P1dB: +25.9 dBm | Low noise figure, high IP3 and high P1dB make this ideal for use in high dynamic range receivers. |
| Positive Gain Slope from 4 to 22 GHz | Positive gain slope acts as equalization to counteract loss from other components in the signal chain as frequency increases. |
| Unpackaged Die | Suitable for chip and wire hybrid assemblies. |

# Medium Power Amplifier AVA-223MP-D+

50Ω 100 kHz to 22 GHz Wideband Amplifier

## ELECTRICAL SPECIFICATIONS[1] AT +25°C, $V_{DD}$ = +10 V, $V_{GG2}$ = +3.5 V, AND $Z_O$ = 50Ω UNLESS NOTED OTHERWISE

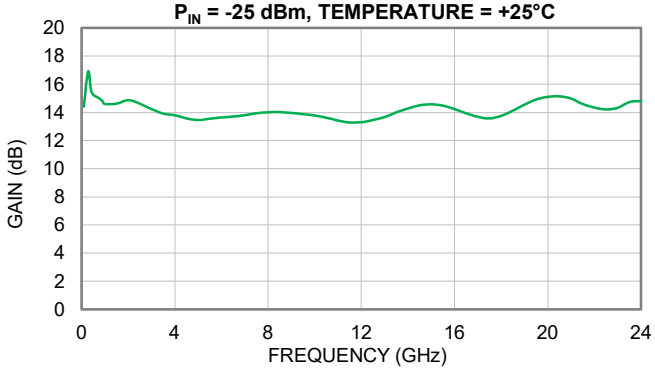
| Parameter | Condition (GHz) | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Frequency Range | | 0.0001 | | 22 | GHz |
| Gain | 0.1[2] | | 16.1 | | dB |
| | 5 | | 13.4 | | |
| | 10 | | 13.7 | | |
| | 15 | | 14.5 | | |
| | 22 | | 14.5 | | |
| Input Return Loss | 0.1[2] | | 20 | | dB |
| | 5 | | 18 | | |
| | 10 | | 17 | | |
| | 15 | | 19 | | |
| | 22 | | 14 | | |
| Output Return Loss | 0.1[2] | | 20 | | dB |
| | 5 | | 19 | | |
| | 10 | | 17 | | |
| | 15 | | 20 | | |
| | 22 | | 12 | | |
| Isolation | 0.1-22 | | 41.4 | | dB |
| Output Power at 1 dB Compression (P1dB) | 0.1[2] | | +26.2 | | dBm |
| | 5 | | +27.0 | | |
| | 10 | | +25.9 | | |
| | 15 | | +25.4 | | |
| | 22 | | +23.2 | | |
| Output Power at Saturation ($P_{SAT}$)[3] | 0.1[2] | | +27.1 | | dBm |
| | 5 | | +29.6 | | |
| | 10 | | +27.7 | | |
| | 15 | | +28.4 | | |
| | 22 | | +25.4 | | |
| Output Third-Order Intercept (OIP3) ($P_{OUT}$ = +16 dBm/Tone) | 0.1[2] | | +38.4 | | dBm |
| | 5 | | +41.0 | | |
| | 10 | | +37.9 | | |
| | 15 | | +37.5 | | |
| | 22 | | +30.1 | | |
| Noise Figure | 2 | | 5.3 | | dB |
| | 5 | | 3.2 | | |
| | 10 | | 3.1 | | |
| | 15 | | 3.2 | | |
| | 22 | | 4.4 | | |
| Device Operating Voltage ($V_{DD}$) | | +9 | +10 | +11 | V |
| Gate Voltage ($V_{GG1}$) | | -2.0 | -0.8 | -0.6 | V |
| Gate Voltage ($V_{GG2}$)[4] | | +3.25 | +3.5 | +3.75 | V |
| Device Operating Current ($I_{DD}$)[5] | | 250 | 300 | | mA |
| Gate Current ($I_{GG1}$) | | | 0.2 | | mA |
| Gate Current ($I_{GG2}$) | | | 1.4 | | mA |
| Device Current Variation vs. Temperature[6] | | | -157.7 | | µA/°C |
| Device Current Variation vs. Voltage[7] | | | +0.8 | | µA/mV |

1. Tested on Mini-Circuits Die Characterization Test Board. See Figure 3. Loss de-embedded to the RF input and output wire bonds of the device.
2. Tested on AVA-223MP-D+ Modified Die Application Circuit. See Figure 4. Loss de-embedded to the RF input and output wire bonds of the device.
3. Defined as output power at which change is 0.1 per 1 dB change in input power.
4. $V_{GG2}$ should be set to +3.5 V for optimal performance. It is not recommended to operate $V_{GG2}$ outside of the specified range.
5. Current at $P_{IN}$ = -25 dBm. Increases to 380 mA at $P_{SAT}$.
6. (Current at +85°C - Current at -45°C)/(+85°C - -45°C)
7. (Current at +11 V - Current at +9 V)/(+11 V - +9 V)

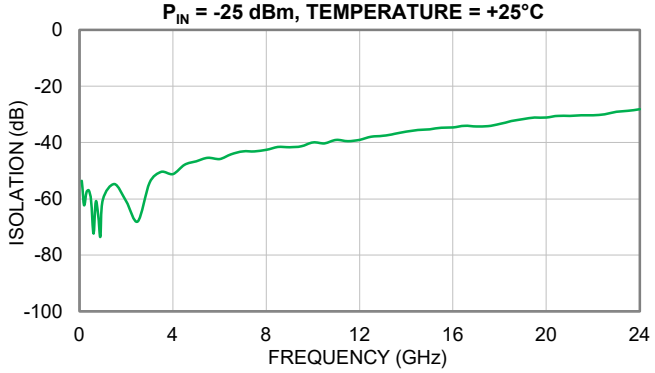
## TYPICAL PERFORMANCE GRAPHS

Note: Data was taken at $V_{DD}$ = +10 V and $V_{GG2}$ = +3.5 V. At +25°C, $V_{GG1}$ has been adjusted to achieve $I_{DD}$ = 300 mA. For over voltage and temperature data, see AVA-223MP+.

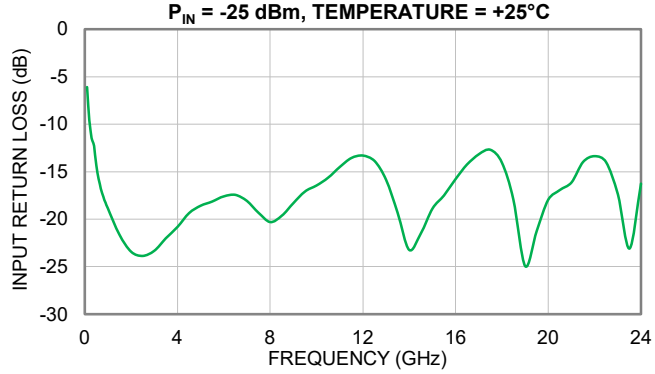
**GAIN vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



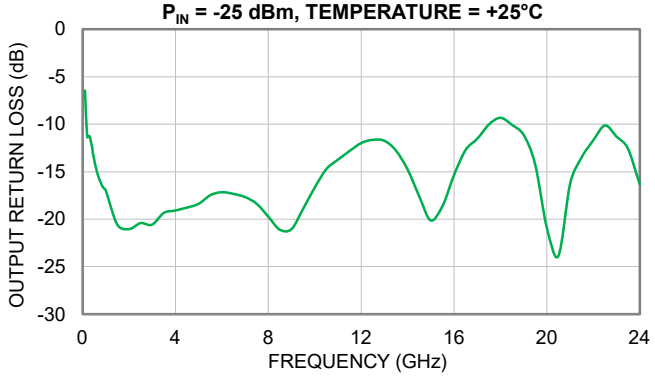

**ISOLATION vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



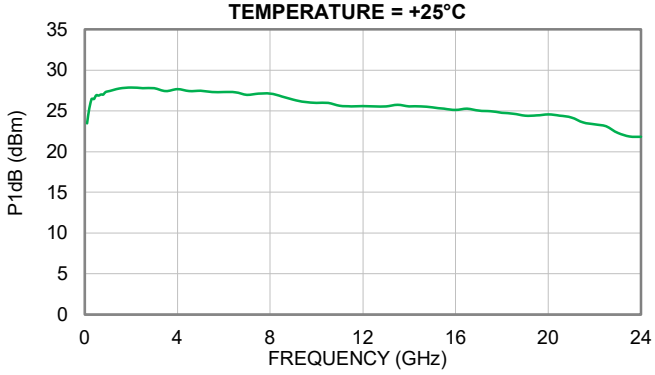

**INPUT RETURN LOSS vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



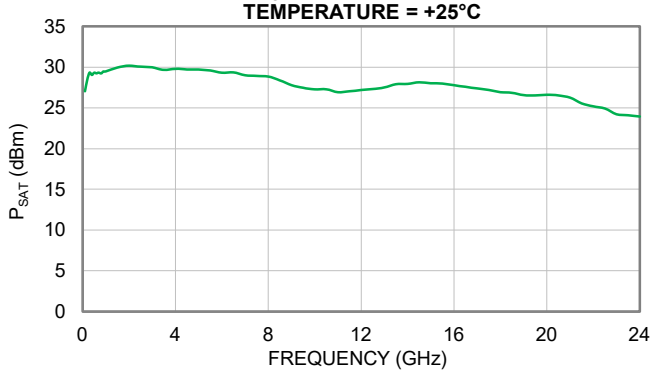

**OUTPUT RETURN LOSS vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**




**P1dB vs. FREQUENCY**
**TEMPERATURE = +25°C**



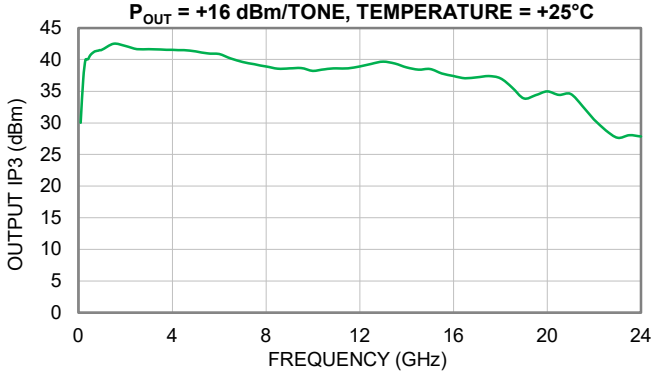

**$P_{SAT}$ vs. FREQUENCY**
**TEMPERATURE = +25°C**



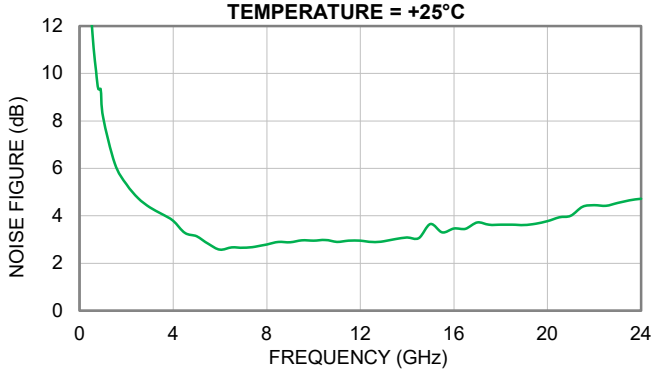
## TYPICAL PERFORMANCE GRAPHS

Note: Data was taken at $V_{DD}$ = +10 V and $V_{GG2}$ = +3.5 V. At +25°C, $V_{GG1}$ has been adjusted to achieve $I_{DD}$ = 300 mA. For over voltage and temperature data, see AVA-223MP+.

**OUTPUT IP3 vs. FREQUENCY**
**$P_{OUT}$ = +16 dBm/TONE, TEMPERATURE = +25°C**



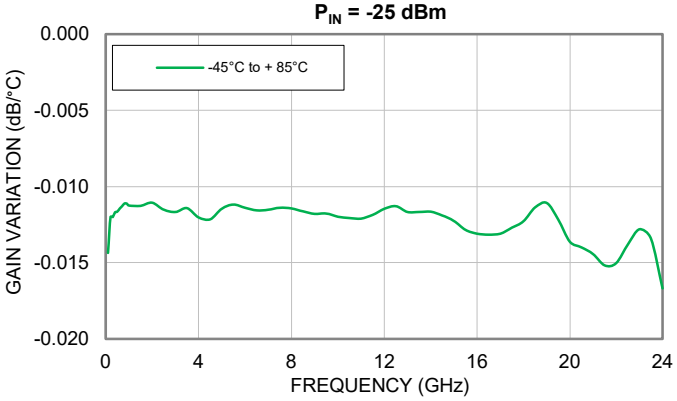

**NOISE FIGURE vs. FREQUENCY**
**TEMPERATURE = +25°C**



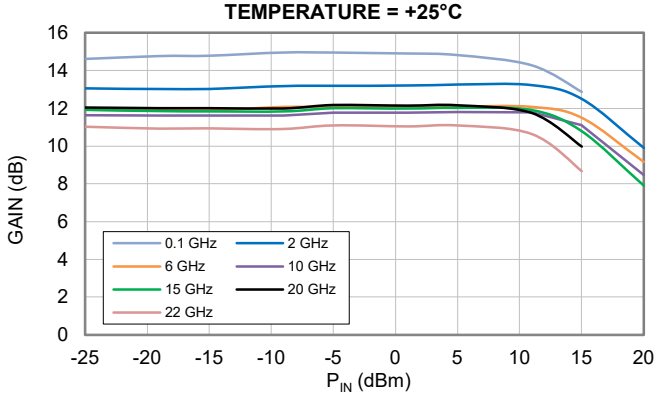
## TYPICAL PERFORMANCE GRAPHS

Note: All data taken in this section represents the Die attached in a 5x5mm 32-Lead QFN-style package and measured on Mini-Circuits Characterization Test Board TB-AVA-223MPC+. Data was taken at $V_{DD}$ = +10 V and $V_{GG2}$ = +3.5 V. At +25°C, $V_{GG1}$ has been adjusted to achieve $I_{DD}$ = 300 mA.

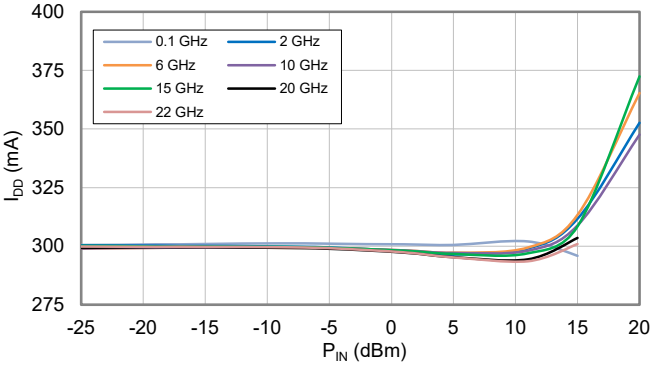
**GAIN VARIATION vs. TEMPERATURE**
**$P_{IN}$ = -25 dBm**



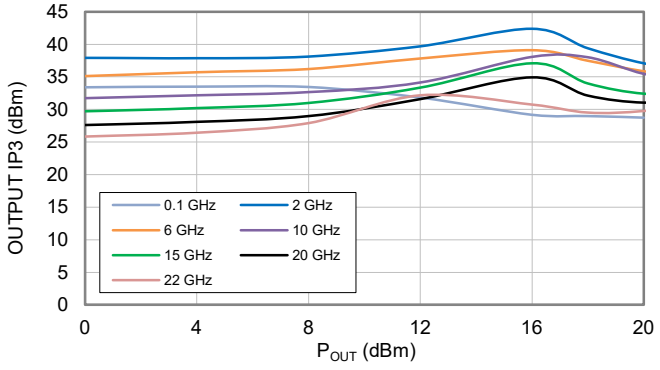

**GAIN vs. $P_{IN}$**
**TEMPERATURE = +25°C**




**$I_{DD}$ vs. $P_{IN}$**
**TEMPERATURE = +25°C**




**OIP3 vs. $P_{OUT}$**
**TEMPERATURE = +25°C**



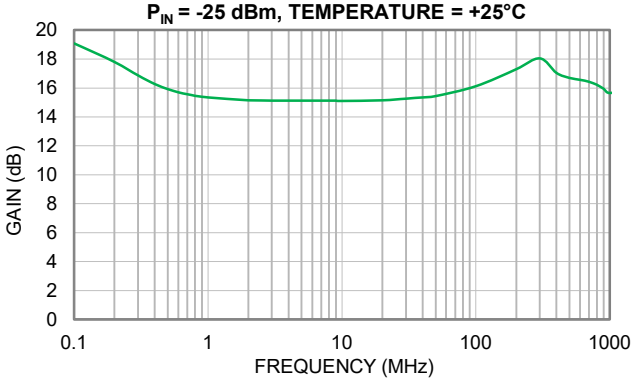
# Medium Power Amplifier AVA-223MP-D+

50Ω 100 kHz to 22 GHz Wideband Amplifier

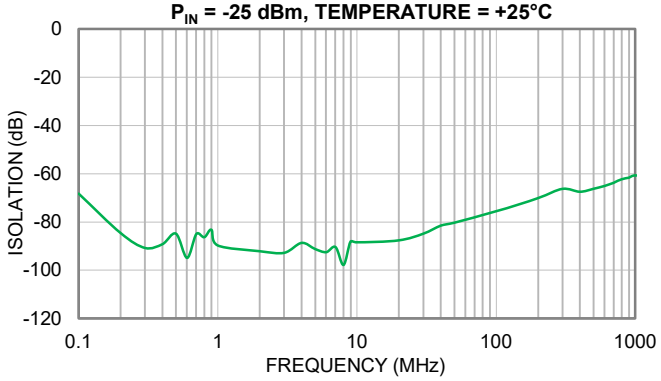
## TYPICAL PERFORMANCE GRAPHS

Note: All data taken in this section represents the die measured on modified Mini-Circuits Die Characterization Test Board using external bias tee (Figure 4). Data was taken at $V_{DD}$ = +10 V and $V_{GG2}$ = +3.5 V. At +25°C, $V_{GG1}$ has been adjusted to achieve $I_{DD}$ = 300 mA.

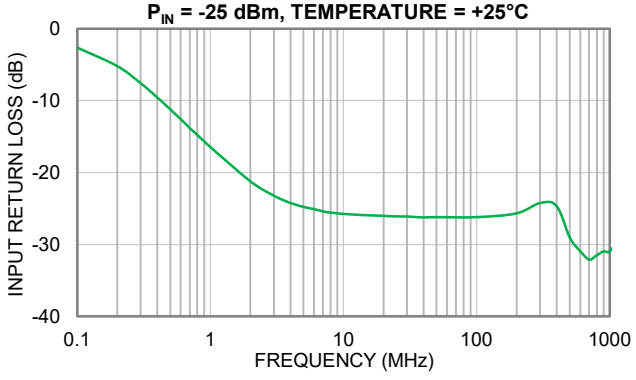
**GAIN vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



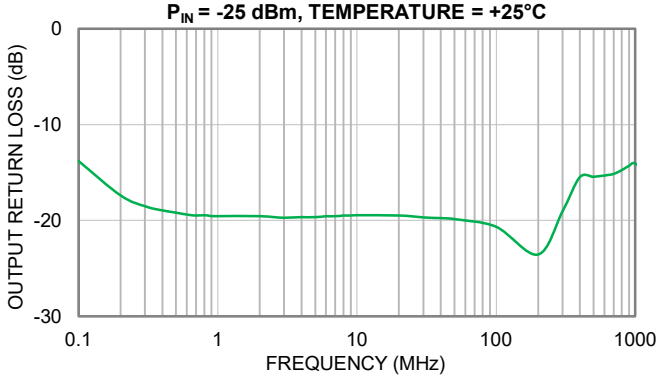

**ISOLATION vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



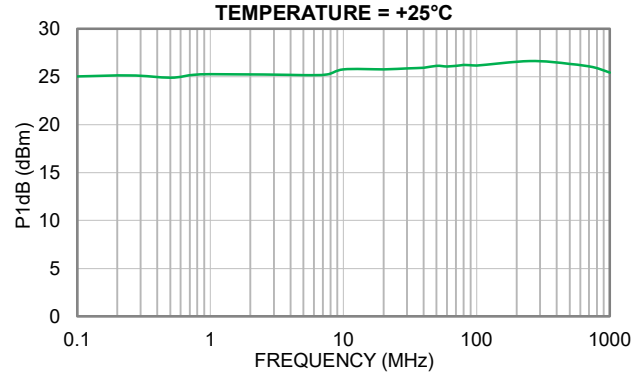

**INPUT RETURN LOSS vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



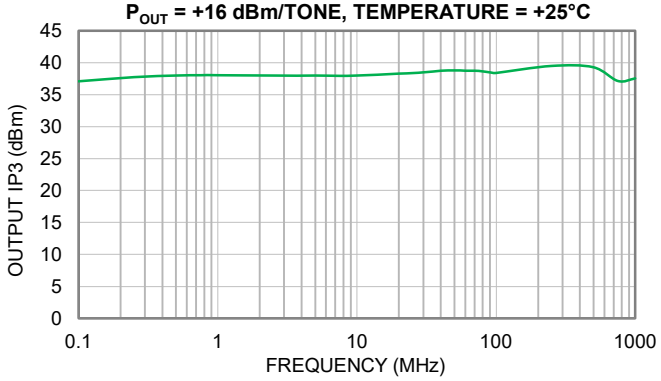

**OUTPUT RETURN LOSS vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**




**P1dB vs. FREQUENCY**
**TEMPERATURE = +25°C**




**OUTPUT IP3 vs. FREQUENCY**
**$P_{OUT}$ = +16 dBm/TONE, TEMPERATURE = +25°C**



## ABSOLUTE MAXIMUM RATINGS[8]

| Parameter | Ratings |
|---|---|
| Operating Temperature[9] | -45°C to +85°C |
| Storage Temperature[10] | -65°C to +150°C |
| Total Power Dissipation | 6.38 W |
| Junction Temperature[11] | +175°C |
| Input Power (CW), $V_{DD}$ = +10 V | +22 dBm |
| DC Voltage on RF-OUT & $V_{DD}$ | +14 V |
| DC Voltage on RF-IN | +6 V |
| DC Gate Voltage on $V_{GG1}$ | -3 V < $V_{GG1}$ < 0 V |
| DC Gate Voltage on $V_{GG2}$ | +5 V |
| DC Drain Current $I_{DD}$ | 500 mA |
| DC Gate Current $I_{GG1}$ | 1 mA |
| DC Gate Current $I_{GG2}$ | 10 mA |

8. Permanent damage may occur if any of these limits are exceeded.
9. Bottom of Die.
10. For die shipped in Gel-Pak see ENV-80 (limited by packaging).
11. Hot spot temperature on top of die.

## THERMAL RESISTANCE

| Parameter | Ratings |
|---|---|
| Thermal Resistance ($\Theta_{JC}$)[12] | 14.1°C/W |

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

## ESD RATING[13]

| | Class | Voltage Range | Reference Standard |
|---|---|---|---|
| HBM | 1B | 500 V < 1000 V | ANSI/ESDA/JEDEC JS-001-2023 |
| CDM | C3 | > 1000 V | ANSI/ESDA/JEDEC JS-002-2022 |

ESD HANDLING PRECAUTION: This device is designed to be Class 1B for HBM. Static charges may easily produce potentials higher than this with improper handling and can discharge into DUT and damage it. As a preventive measure Industry standard ESD handling precautions should be used at all times to protect the device from ESD damage.

13. ESD measured in 5x5 mm 32-Lead QFN-style package.

# Medium Power Amplifier AVA-223MP-D+

50Ω 100 kHz to 22 GHz Wideband Amplifier

## FUNCTIONAL DIAGRAM

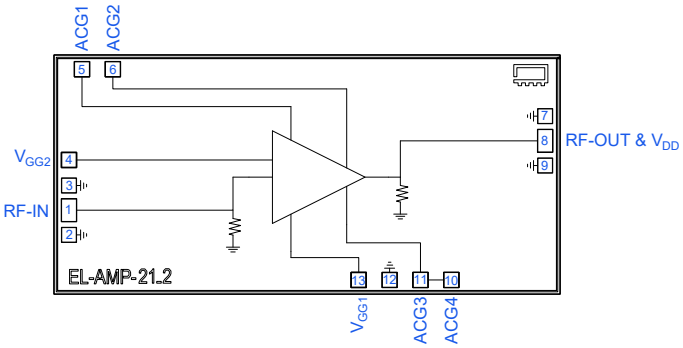



Figure 1. AVA-223MP-D+ Functional Diagram

## PAD DESCRIPTION

| Function | Pad Number | Description (Refer to Fig 3) |
|---|---|---|
| RF-IN | 1 | RF-IN pad connects to RF Input port. |
| RF-OUT & $V_{DD}$ | 8 | RF-OUT & $V_{DD}$ pad connects to RF-Output port and voltage input port, $V_{DD}$. |
| $V_{GG1}$ | 13 | DC Input pad connects to voltage input port, $V_{GG1}$. |
| $V_{GG2}$ | 4 | DC Input pad connects to voltage input port, $V_{GG2}$. |
| ACG1 | 5 | ACG1 pad connects to AC ground port 1. |
| ACG2 | 6 | ACG2 pad connects to AC ground port 2. |
| ACG3 | 11 | ACG3 pad connects to AC ground port 3. ACG3 pad connected to ACG4 on die. |
| ACG4 | 10 | ACG4 pad connects to AC ground port 4. ACG4 pad connected to ACG3 on die. |
| GND | 2, 3, 7, 9, 12, & Bottom of Die | Connected to die backside through vias. Bond wires to ground are optional. |

## DIE OUTLINE: inches [mm], Typical

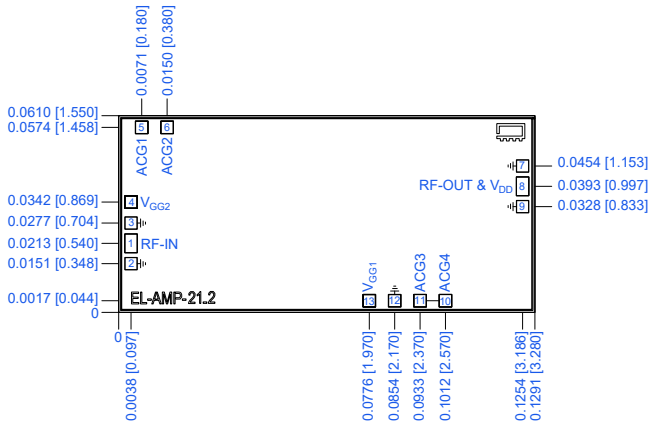



Figure 2. AVA-223MP-D+ Die Outline

## DIMENSIONS: inches [mm], Typical

| | |
|---|---|
| **Die Size** | 0.1291 x 0.0610 [3.280 x 1.550] |
| **Die Thickness** | 0.0040 [0.100] |
| **Bond Pad Sizes:** | |
| **Pads 1, 8** | 0.0039 x 0.0059 [0.100 x 0.150] |
| **Pads 2-7, 9-13** | 0.0039 x 0.0039 [0.100 x 0.100] |
| **Plating (Pads & Bottom of Die)** | Gold |

## EVALUATION BOARD

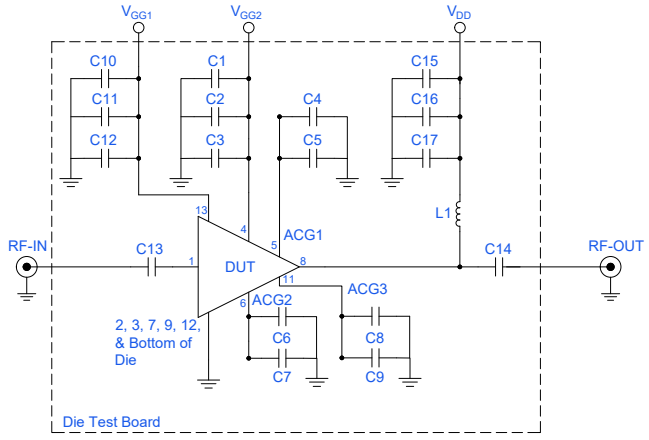



**Figure 3. AVA-223MP-D+ Evaluation and Application Circuit**

**Electrical Parameters and Conditions**
Gain, Return Loss, Output Power at 1 dB Compression (P1dB), Output Power at Saturation ($P_{SAT}$), Output IP3 (OIP3), and Noise Figure measured using N5245B PNA-X Microwave Network Analyzer.

Conditions:
1. Gain and Return Loss: $P_{IN}$ = -25 dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, +16 dBm/Tone at output.

Note: ACG3 and ACG4 are connected internally and can be bonded to interchangeably as needed.

**Power ON/Power OFF Sequence[14]**
Caution: Permanent damage to the device will occur if the Power ON and Power OFF sequences are not followed.

**POWER ON:**
1) Set $V_{GG1}$ = -2 V. Apply $V_{GG1}$.
2) Set $V_{GG2}$ = +3.5 V. Apply $V_{GG2}$.
3) Set $V_{DD}$ = +10 V. Apply $V_{DD}$.
4) Increase $V_{GG1}$ to obtain the desired $I_{DD}$ as shown in specification table.
5) Apply RF Signal.

**POWER OFF:**
1) Turn off RF Signal.
2) Adjust $V_{GG1}$ to -2 V.
3) Turn off $V_{DD}$.
4) Turn off $V_{GG2}$.
5) Turn off $V_{GG1}$.

14. $V_{GG2}$ may be derived from $V_{DD}$ using a resistive divider, zener diode, or equivalent circuit. If $V_{GG2}$ is derived from $V_{DD}$, it may be applied simultaneously with $V_{DD}$.

| Component | Value | Size | Part Number | Manufacturer |
|---|---|---|---|---|
| C5, C6, C8, C12 | 100 pF | 0.022 x 0.022 in | MA4M3100 | MACOM |
| C3, C17 | 100 pF | 0603 | GRM1885C1H101GA01D | Murata |
| C2, C4, C9, C11, C16 | 0.01 µF | 0402 | GRM155R71E103KA01D | Murata |
| C13, C14 | 30 pF | 0201 | P21BN300M5S | DLI |
| C1, C7, C10, C15 | 4.7 µF | 1812 | C4532X7S2A475K230KB | TDK Corp |
| L1 | 0.22 µH | 0.2 x 0.15 in | CCM19T40-002 | Piconics |

# Medium Power Amplifier AVA-223MP-D+

50Ω 100 kHz to 22 GHz Wideband Amplifier

## EVALUATION AND APPLICATION CIRCUIT

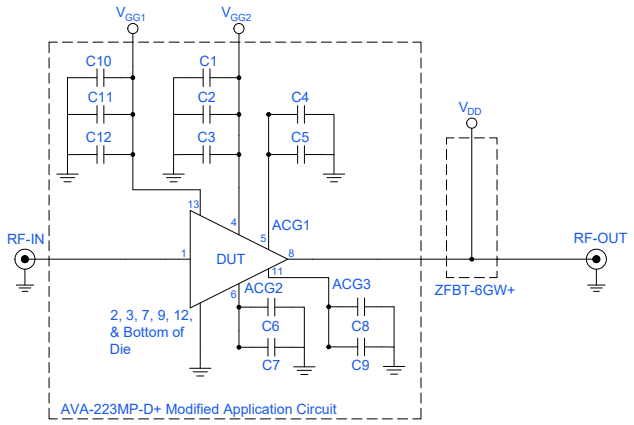



**Figure 4. AVA-223MP-D+ Low Frequency Evaluation and Application Circuit**

**Electrical Parameters and Conditions**
Gain and Return Loss measured using P5022A Vector Network Analyzer.

Output Power at 1 dB Compression (P1dB) measured using Mini-Circuits' PWR-4GHS Power Sensor.

Output IP3 (OIP3) measured using MXA N9020A Signal Analyzer.

Conditions:
1. Gain and Return Loss: $P_{IN}$ = -25 dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, +16 dBm/tone at output.

| Component | Value | Size | Part Number | Manufacturer |
|---|---|---|---|---|
| C5, C6, C8, C12 | 100 pF | 0.022 x 0.022 in | MA4M3100 | MACOM |
| C3 | 100 pF | 0603 | GRM1885C1H101GA01D | Murata |
| C2, C4, C9, C11 | 0.01 µF | 0402 | GRM155R71E103KA01D | Murata |
| C1, C7, C10 | 4.7 µF | 1812 | C4532X7S2A475K230KB | TDK Corp |

## ASSEMBLY DIAGRAM

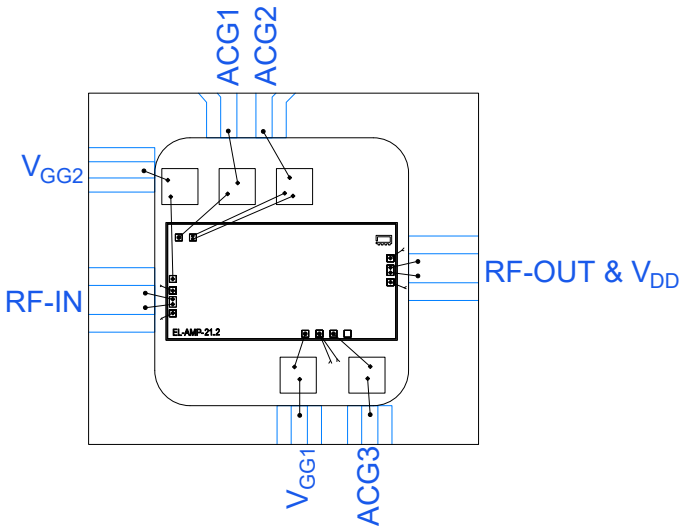



**Figure 5. AVA-223MP-D+ Assembly Diagram**

- Bond wire diameter: 1 mil
- Bond wire lengths from die pad to PCB at RF-IN & RF-OUT & $V_{DD}$: 20 mils ± 2 mils
- Bond wire lengths from die pad to capacitor near $V_{GG1}$: 22 mils ± 2 mils
- Bond wire lengths from die pad to capacitor near $V_{GG2}$: 48 mils ± 2 mils
- Bond wire lengths from die pad to capacitor near ACG1: 35 mils ± 2 mils
- Bond wire lengths from die pad to capacitor near ACG2: 52 mils ± 2 mils
- Bond wire lengths from die pad to capacitor near ACG3: 22 mils ± 2 mils
- Typical gap from die edge to PCB edge: 3 mils
- PCB thickness and material: 8 mils Rogers 4003 (Thickness: 1 oz copper on each side). Die is mounted in a cut-out of the PCB, directly onto the brass baseplate using high thermal conductivity silver-sintering epoxy.

## ASSEMBLY AND HANDLING PROCEDURE

1. Storage
   Die should be stored in a dry nitrogen purged desiccator or equivalent.
2. ESD Precautions
   MMIC pHEMT amplifier die are susceptible to electrostatic and mechanical damage. Die are supplied in anti-static protected material, which should be opened only in clean room conditions at an appropriately grounded anti-static workstation.
3. Die Handling and Attachment
   Devices require careful handling using tools appropriate for manipulating semiconductor chips. It is recommended to handle the chips along the edges with a custom designed collet. The surface of the chips should not be touched with a vacuum collet, tweezers, or fingers. The die mounting surface must be clean and flat. Using conductive silver-filled epoxy, apply sufficient adhesive to meet the required bond line thickness, fillet height and coverage around the total periphery of the device. The recommended epoxy is ATROX Sintering 800HT5 or equivalent. Parts should be cured in a nitrogen-filled atmosphere per manufacturer's recommended cure profile.
4. Wire Bonding
   Openings in the surface passivation above the gold bond pads are provided to allow wire bonding to the die. Thermosonic bonding is recommended with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. The suggested interconnect is pure gold, 1 mil diameter wire. Bonds are recommended to be made from the bond pads on the die to the package or substrate. All bond wire length and bond wire height should be kept as short as possible, unless specified by design, to minimize performance degradation due to undesirable series inductance.

# Medium Power Amplifier AVA-223MP-D+

50Ω 100 kHz to 22 GHz Wideband Amplifier

## ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASHBOARD CLICK HERE

| | | |
|---|---|---|
| **Performance Data & Graphs** | Data<br>Graphs<br>S-Parameter (S2P Files) Data Set (.zip file) | |
| **Case Style** | Die | |
| **RoHS Status** | Compliant | |
| **Die Ordering and Packaging Information** | Quantity, Package | Model No. |
| | Gel - Pak: 5, 10, or 50 KGD* | AVA-223MP-DG+ |
| | Medium†, Partial wafer: KGD*<464 | AVA-223MP-DP+ |
| | Full wafer† | AVA-223MP-DF+ |
| | †Available upon request contact sales representative. Refer to AN-60-067 | |
| **Die Marking** | EL-AMP-21_2 | |
| **Environmental Ratings** | ENV80 | |

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

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-Circuits' applicable established test performance criteria and measurement instructions.

C. The parts covered by this specification document are subject to Mini-Circuits' standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/terms/viewterm.html

D. Mini-Circuits does not warrant the accuracy or completeness of the information, text, graphics and other items contained within this document and same are provided as an accommodation and on an as is basis, with all faults.

E. Purchasers of this part are solely responsible for proper storing, handling, assembly and processing of known good die (KGD) (including, without limitation, proper ESD preventative measures, die preparation, die attach, wire bonding and related assembly and test activities), and Mini-Circuits assumes no responsibility therefor or for environmental effects on KGD.

F. Mini-Circuits and the Mini-Circuits logo are registered trademarks of Scientific Components Corporation d/b/a Mini-Circuits. All other third-party trademarks are the property of their respective owners. A reference to any third-party trademark does not constitute or imply any endorsement, affiliation, sponsorship, or recommendation by any such third-party of Mini-Circuits or its products.

## *Typical Performance Data*

**NOTE: Use PDF Bookmarks to view DATA at required conditions**

**Definitions:**

Input Return Loss = S11 (dB)
Gain(Power Gain) = S21 (dB)
Isolation = S12 (dB)
Output Return Loss = S22 (dB)

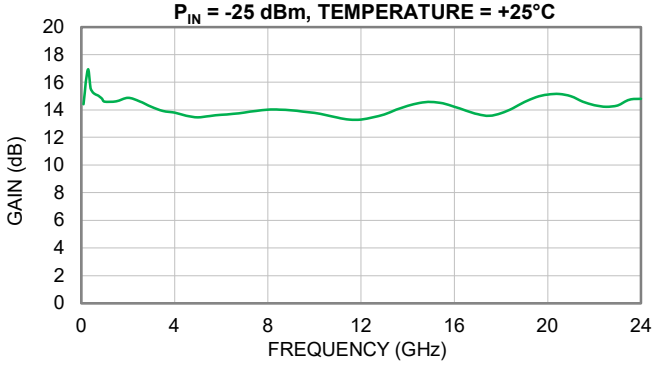
TEST CONDITIONS: $V_{GG1}$ = -0.77 V, $I_{GG1}$ = 0.22 mA , $V_{GG2}$ = +3.5 V, $I_{GG2}$ = 1.42 mA, $V_{DD}$ = +10 V, $I_{DD}$ = 303 mA @ Temperature = +25°C

| FREQ | Gain | Isolation | Input Return Loss | Output Return Loss | Stability | | IP-3 Output $P_{OUT}$ = +10 dBm | IP-3 Output $P_{OUT}$ = +16 dBm | 1dB Comp. Output | $P_{SAT}$ Output | Noise Figure |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (GHz) | (dB) | (dB) | (dB) | (dB) | K | Measure | (dBm) | (dBm) | (dBm) | (dBm) | (dB) |
| 0.1 | 14.4 | -53.6 | -6.1 | -6.5 | 46.3 | 1.0 | 34.6 | 30.0 | 23.5 | 27.1 | 21.7 |
| 0.2 | 16.0 | -62.2 | -9.6 | -11.3 | 116.5 | 1.0 | 37.6 | 36.9 | 25.3 | 28.4 | 18.3 |
| 0.3 | 16.9 | -57.6 | -11.4 | -11.2 | 59.4 | 1.0 | 37.0 | 40.0 | 26.4 | 29.3 | 15.4 |
| 0.4 | 15.6 | -57.0 | -12.3 | -12.4 | 63.8 | 1.0 | 37.3 | 40.0 | 26.5 | 29.0 | 13.6 |
| 0.5 | 15.3 | -60.5 | -14.3 | -13.8 | 100.2 | 1.0 | 37.0 | 40.7 | 26.9 | 29.3 | 12.3 |
| 0.6 | 15.1 | -72.4 | -15.7 | -14.8 | 400.5 | 1.0 | 36.8 | 41.1 | 26.9 | 29.3 | 11.1 |
| 0.7 | 15.1 | -60.9 | -16.8 | -15.6 | 108.4 | 1.0 | 36.6 | 41.3 | 27.0 | 29.3 | 10.1 |
| 0.8 | 14.9 | -65.6 | -17.6 | -16.3 | 186.7 | 1.0 | 36.9 | 41.4 | 27.0 | 29.2 | 9.3 |
| 0.9 | 14.8 | -73.5 | -18.3 | -16.7 | 473.3 | 1.0 | 36.7 | 41.5 | 27.3 | 29.5 | 9.3 |
| 1.0 | 14.6 | -60.3 | -18.9 | -17.0 | 105.5 | 1.0 | 36.2 | 41.5 | 27.4 | 29.5 | 8.1 |
| 1.5 | 14.6 | -54.8 | -21.6 | -20.6 | 56.1 | 1.0 | 37.7 | 42.5 | 27.8 | 30.0 | 6.2 |
| 2.0 | 14.9 | -60.9 | -23.4 | -21.1 | 109.7 | 1.0 | 37.7 | 42.2 | 27.9 | 30.2 | 5.3 |
| 2.5 | 14.6 | -68.0 | -23.9 | -20.4 | 257.4 | 1.0 | 37.2 | 41.7 | 27.8 | 30.0 | 4.7 |
| 3.0 | 14.2 | -54.3 | -23.3 | -20.6 | 55.2 | 1.0 | 37.0 | 41.7 | 27.8 | 30.0 | 4.4 |
| 3.5 | 13.9 | -50.4 | -22.0 | -19.3 | 36.7 | 1.0 | 36.7 | 41.6 | 27.4 | 29.7 | 4.1 |
| 4.0 | 13.8 | -51.2 | -20.8 | -19.1 | 40.5 | 1.0 | 36.4 | 41.5 | 27.7 | 29.8 | 3.8 |
| 4.5 | 13.6 | -47.9 | -19.3 | -18.8 | 28.5 | 1.0 | 36.7 | 41.5 | 27.4 | 29.7 | 3.3 |
| 5.0 | 13.4 | -46.6 | -18.6 | -18.4 | 25.0 | 1.0 | 36.9 | 41.3 | 27.5 | 29.7 | 3.1 |
| 5.5 | 13.6 | -45.5 | -18.1 | -17.5 | 21.6 | 1.0 | 35.9 | 41.0 | 27.3 | 29.6 | 2.8 |
| 6.0 | 13.6 | -45.8 | -17.6 | -17.2 | 22.4 | 1.0 | 36.0 | 40.9 | 27.3 | 29.3 | 2.6 |
| 6.5 | 13.7 | -44.2 | -17.4 | -17.3 | 18.5 | 1.0 | 35.8 | 40.2 | 27.3 | 29.4 | 2.7 |
| 7.0 | 13.8 | -43.1 | -18.1 | -17.7 | 16.4 | 1.0 | 35.6 | 39.6 | 27.0 | 29.0 | 2.6 |
| 7.5 | 13.9 | -43.1 | -19.3 | -18.4 | 16.4 | 1.0 | 34.6 | 39.3 | 27.1 | 28.9 | 2.7 |
| 8.0 | 14.0 | -42.6 | -20.3 | -19.7 | 15.4 | 1.0 | 34.5 | 38.9 | 27.1 | 28.8 | 2.8 |
| 8.5 | 14.0 | -41.6 | -19.6 | -21.1 | 13.8 | 1.0 | 34.6 | 38.6 | 26.8 | 28.4 | 2.9 |
| 9.0 | 14.0 | -41.6 | -18.3 | -21.0 | 14.0 | 1.0 | 33.3 | 38.6 | 26.4 | 27.8 | 2.9 |
| 9.5 | 13.9 | -41.3 | -17.1 | -18.9 | 13.6 | 1.0 | 33.7 | 38.7 | 26.1 | 27.5 | 3.0 |
| 10.0 | 13.8 | -40.0 | -16.5 | -16.7 | 11.7 | 1.0 | 33.6 | 38.2 | 26.0 | 27.3 | 2.9 |
| 10.5 | 13.6 | -40.3 | -15.6 | -14.7 | 12.2 | 1.0 | 33.5 | 38.5 | 26.0 | 27.3 | 3.0 |
| 11.0 | 13.4 | -39.0 | -14.5 | -13.7 | 10.7 | 1.0 | 33.3 | 38.6 | 25.6 | 26.9 | 2.9 |
| 11.5 | 13.3 | -39.5 | -13.6 | -12.8 | 11.4 | 1.0 | 33.2 | 38.6 | 25.6 | 27.0 | 2.9 |
| 12.0 | 13.3 | -39.0 | -13.3 | -12.0 | 10.7 | 1.0 | 33.0 | 38.9 | 25.6 | 27.2 | 3.0 |
| 12.5 | 13.5 | -38.0 | -13.9 | -11.6 | 9.4 | 1.0 | 32.9 | 39.3 | 25.6 | 27.3 | 2.9 |
| 13.0 | 13.7 | -37.6 | -15.9 | -11.7 | 9.0 | 1.0 | 32.7 | 39.7 | 25.6 | 27.5 | 2.9 |
| 13.5 | 14.0 | -36.9 | -19.3 | -12.7 | 8.2 | 1.0 | 32.3 | 39.4 | 25.8 | 27.9 | 3.0 |
| 14.0 | 14.3 | -36.1 | -23.2 | -14.8 | 7.5 | 1.0 | 31.7 | 38.8 | 25.6 | 27.9 | 3.1 |
| 14.5 | 14.5 | -35.6 | -21.5 | -17.6 | 7.0 | 1.0 | 31.1 | 38.4 | 25.6 | 28.1 | 3.1 |
| 15.0 | 14.6 | -35.3 | -18.9 | -20.1 | 6.8 | 1.0 | 31.3 | 38.5 | 25.4 | 28.0 | 3.7 |
| 15.5 | 14.5 | -34.8 | -17.5 | -18.6 | 6.4 | 1.0 | 30.7 | 37.8 | 25.3 | 28.0 | 3.3 |
| 16.0 | 14.2 | -34.6 | -15.8 | -15.3 | 6.4 | 1.0 | 30.4 | 37.4 | 25.1 | 27.8 | 3.5 |
| 16.5 | 13.9 | -34.1 | -14.3 | -12.7 | 6.0 | 1.0 | 30.9 | 37.1 | 25.3 | 27.6 | 3.5 |
| 17.0 | 13.7 | -34.3 | -13.2 | -11.5 | 6.3 | 1.0 | 28.2 | 37.2 | 25.0 | 27.4 | 3.7 |
| 17.5 | 13.6 | -34.2 | -12.7 | -10.0 | 6.1 | 0.9 | 30.1 | 37.4 | 25.0 | 27.2 | 3.6 |
| 18.0 | 13.8 | -33.4 | -14.0 | -9.3 | 5.5 | 0.9 | 28.8 | 37.1 | 24.8 | 26.9 | 3.6 |
| 18.5 | 14.1 | -32.4 | -17.9 | -10.1 | 4.9 | 0.9 | 28.1 | 35.6 | 24.7 | 26.9 | 3.6 |
| 19.0 | 14.6 | -31.7 | -24.9 | -11.1 | 4.4 | 0.9 | 29.5 | 33.9 | 24.4 | 26.6 | 3.6 |
| 19.5 | 14.9 | -31.2 | -21.2 | -14.3 | 4.2 | 1.0 | 31.1 | 34.4 | 24.4 | 26.5 | 3.7 |
| 20.0 | 15.1 | -31.1 | -18.0 | -20.9 | 4.2 | 1.0 | 30.2 | 35.0 | 24.6 | 26.6 | 3.8 |
| 20.5 | 15.1 | -30.5 | -16.9 | -23.9 | 3.9 | 1.0 | 30.7 | 34.4 | 24.4 | 26.5 | 3.9 |
| 21.0 | 15.0 | -30.5 | -16.1 | -16.3 | 3.9 | 1.0 | 29.3 | 34.6 | 24.2 | 26.2 | 4.0 |
| 21.5 | 14.6 | -30.3 | -14.0 | -13.5 | 3.9 | 1.0 | 30.5 | 32.7 | 23.6 | 25.6 | 4.4 |
| 22.0 | 14.3 | -30.3 | -13.4 | -11.7 | 3.9 | 1.0 | 30.5 | 30.5 | 23.4 | 25.2 | 4.4 |
| 22.5 | 14.2 | -29.9 | -14.0 | -10.1 | 3.7 | 0.9 | 28.3 | 28.8 | 23.1 | 24.9 | 4.4 |
| 23.0 | 14.3 | -29.1 | -17.4 | -11.3 | 3.5 | 0.9 | 29.4 | 27.6 | 22.3 | 24.2 | 4.5 |
| 23.5 | 14.7 | -28.7 | -23.1 | -12.6 | 3.3 | 0.9 | 28.3 | 28.0 | 21.9 | 24.1 | 4.6 |
| 24.0 | 14.8 | -28.2 | -16.2 | -16.3 | 3.1 | 1.0 | 26.8 | 27.8 | 21.8 | 24.0 | 4.7 |

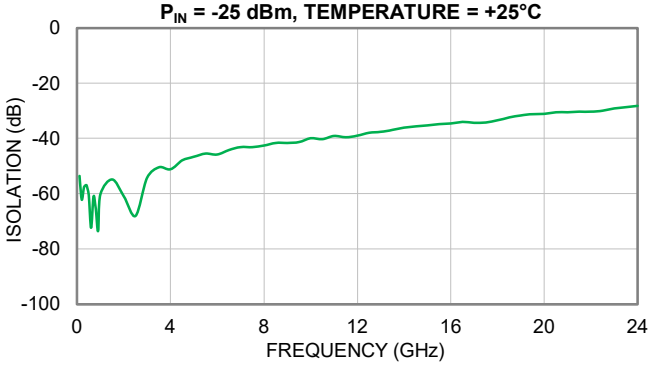
## *Typical Performance Curves*

Note: Data was taken at $V_{DD}$ = +10 V and $V_{GG2}$ = +3.5 V. At +25°C, $V_{GG1}$ has been adjusted to achieve $I_{DD}$ = 300 mA. For over voltage and temperature data, see AVA-223MP+.

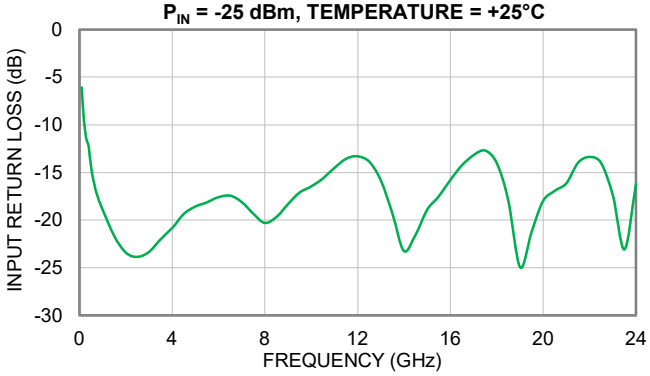
**GAIN vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



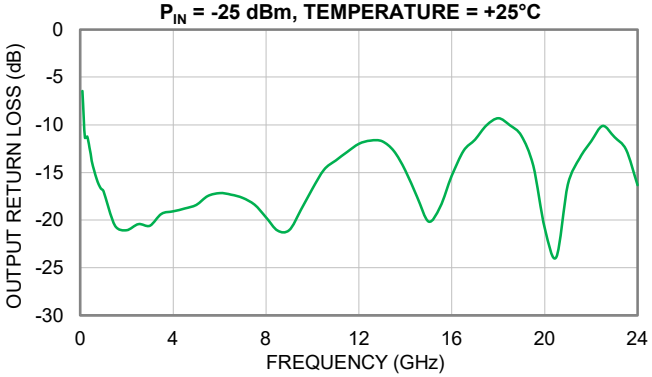

**ISOLATION vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



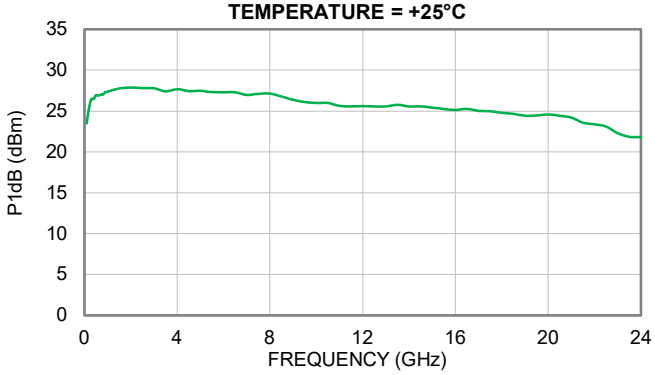

**INPUT RETURN LOSS vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



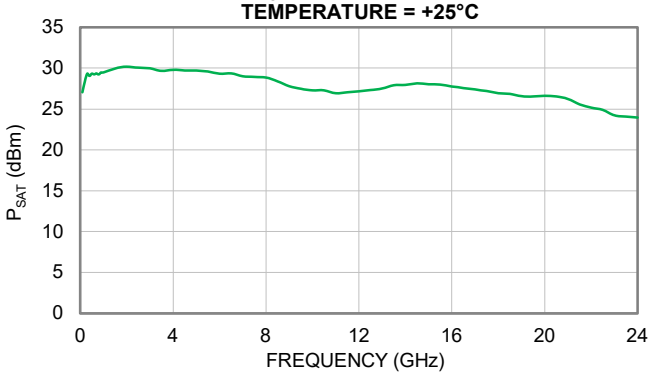

**OUTPUT RETURN LOSS vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**




**P1dB vs. FREQUENCY**
**TEMPERATURE = +25°C**



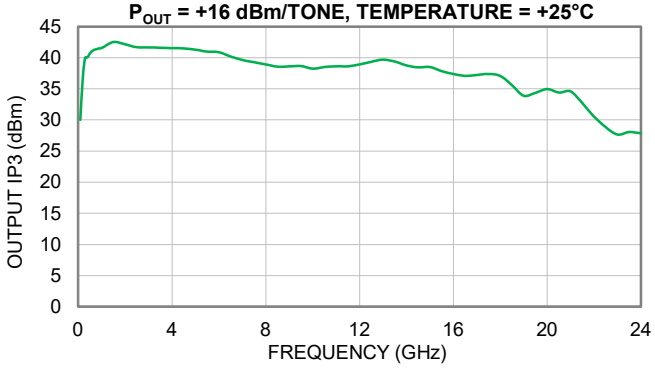

**$P_{SAT}$ vs. FREQUENCY**
**TEMPERATURE = +25°C**



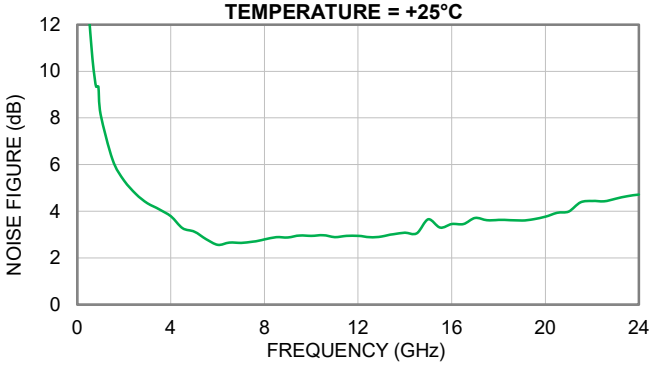
## *Typical Performance Curves*

Note: Data was taken at $V_{DD}$ = +10 V and $V_{GG2}$ = +3.5 V. At +25°C, $V_{GG1}$ has been adjusted to achieve $I_{DD}$ = 300 mA. For over voltage and temperature data, see AVA-223MP+.

**OUTPUT IP3 vs. FREQUENCY**
**$P_{OUT}$ = +16 dBm/TONE, TEMPERATURE = +25°C**

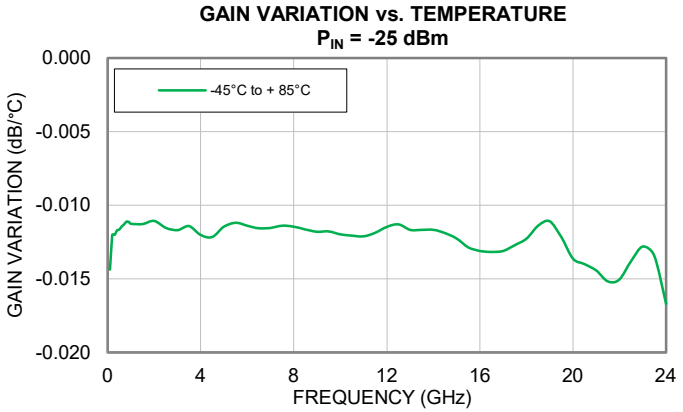


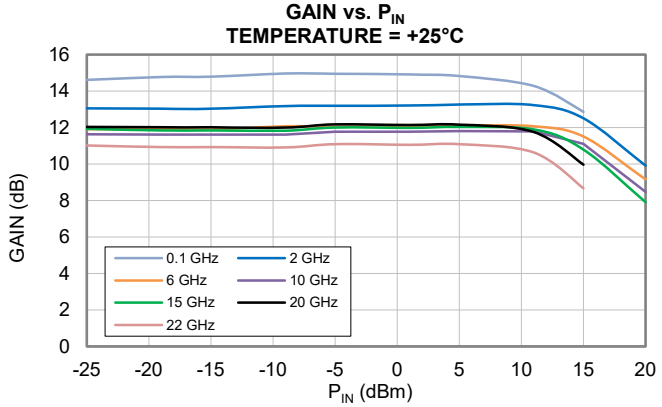

**NOISE FIGURE vs. FREQUENCY**
**TEMPERATURE = +25°C**

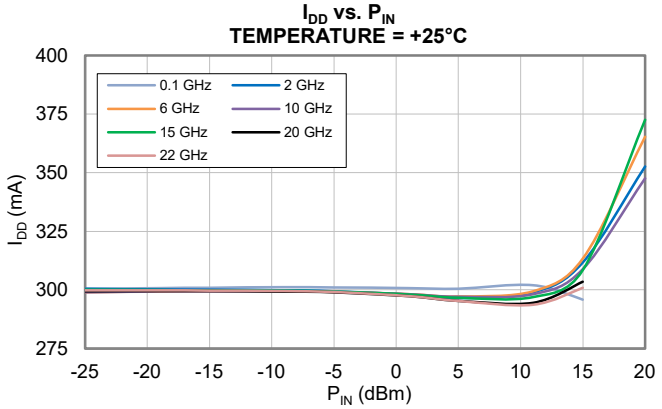


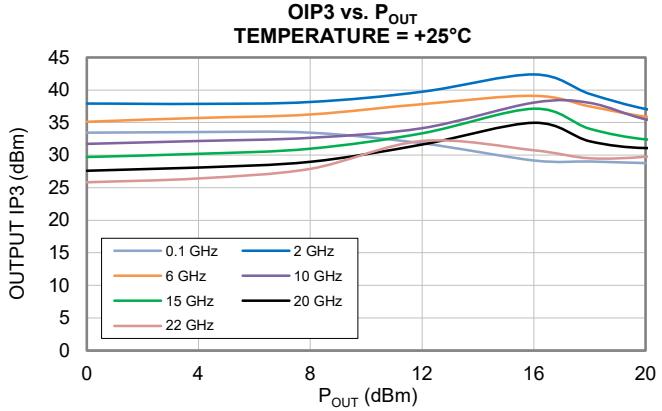
## *Typical Performance Curves*

Note: All data taken in this section represents the Die attached in a 5x5mm 32-Lead QFN-style package and measured on Mini-Circuits Characterization Test Board TB-AVA-223MPC+. Data was taken at $V_{DD}$ = +10 V and $V_{GG2}$ = +3.5 V. At +25°C, $V_{GG1}$ has been adjusted to achieve $I_{DD}$ = 300 mA.



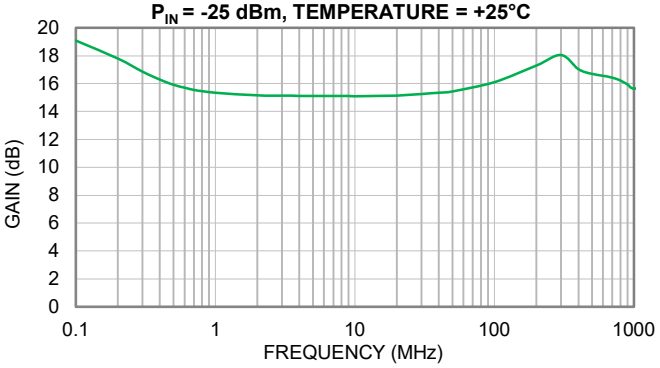



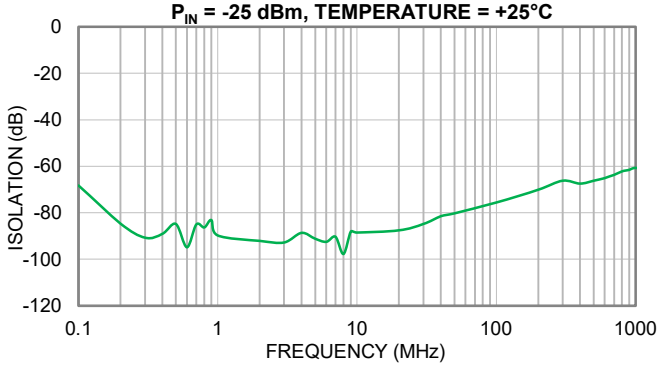
## *Typical Performance Curves*

Note: All data taken in this section represents the die measured on modified Mini-Circuits Die Characterization Test Board using external bias tee (Figure 4). Data was taken at $V_{DD}$ = +10 V and $V_{GG2}$ = +3.5 V. At +25°C, $V_{GG1}$ has been adjusted to achieve $I_{DD}$ = 300 mA.

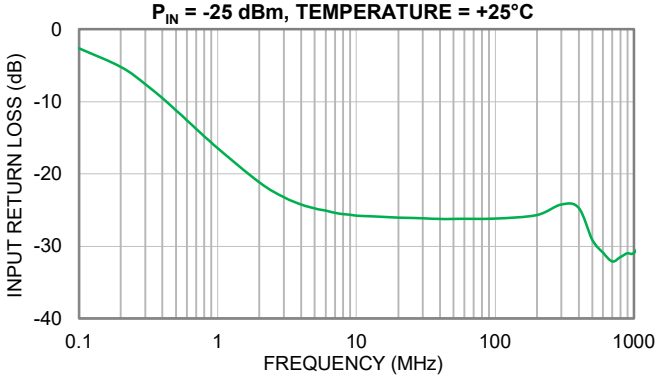
**GAIN vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



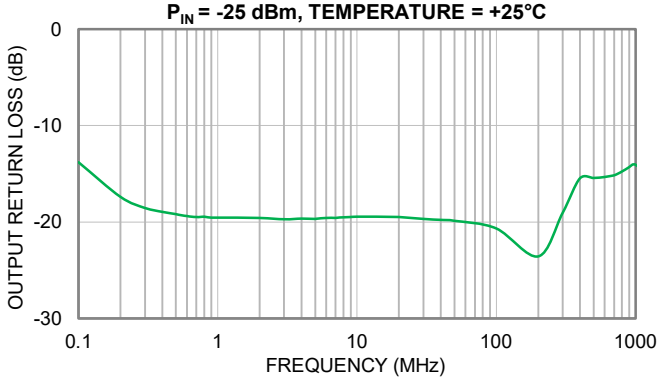

**ISOLATION vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



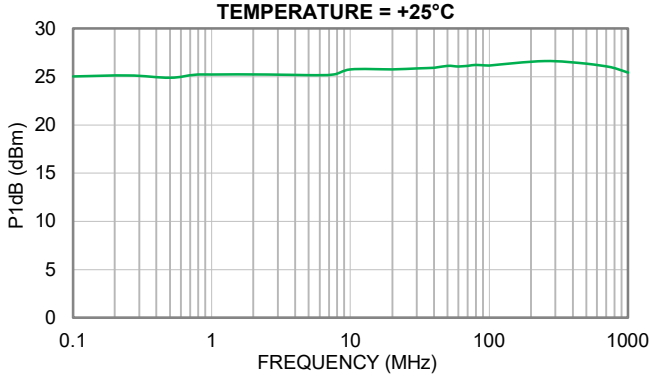

**INPUT RETURN LOSS vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**



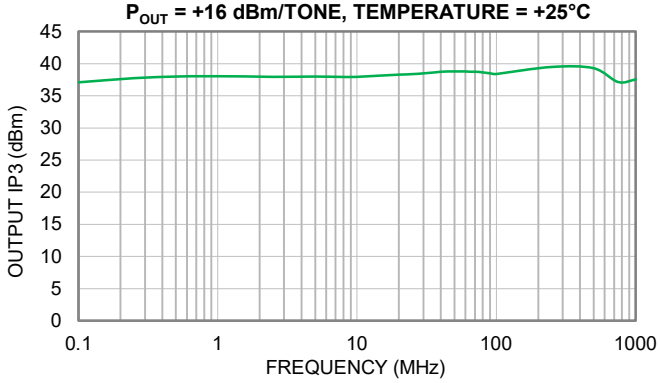

**OUTPUT RETURN LOSS vs. FREQUENCY**
**$P_{IN}$ = -25 dBm, TEMPERATURE = +25°C**




**P1dB vs. FREQUENCY**
**TEMPERATURE = +25°C**




**OUTPUT IP3 vs. FREQUENCY**
**$P_{OUT}$ = +16 dBm/TONE, TEMPERATURE = +25°C**



Mini-Circuits

# Environmental Specifications ENV80

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

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


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