

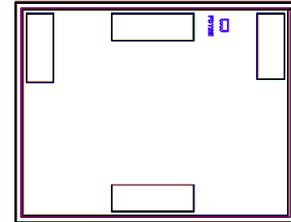
# Ultra High Dynamic Range Monolithic Amplifier Die

## PHA-13HLN-D+

50Ω     1MHz to 1 GHz

### The Big Deal

- Ultra-High IP3, +43 dBm typ.
- Medium Power, +28.7dBm typ.
- Excellent Noise Figure, 1.1 dB typ.
- Operates over +3 to +8V DC



### Product Overview

PHA-13HLN-D+ (RoHS compliant) is an advanced wideband amplifier Die fabricated using E-PHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure. In addition, the PHA-13HLN-D+ has good input and output return loss over a broad frequency range.

### Key Features

| Feature                                                                    | Advantages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Broad Band: 1MHz to 1 GHz                                                  | Broadband covering primary wireless communications bands: Cellular, VHF, UHF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Extremely High IP3<br>38.4 dBm typical at 1MHz<br>43 dBm typical at 0.5GHz | The PHA-13HLN-D+ matches industry leading IP3 performance relative to device size and power consumption. The combination of the design and E-PHEMT Structure provides enhanced linearity over a broad frequency range as evidence in the IP3 being approximately 15 dB above the P1dB point. This feature makes this amplifier ideal for use in: <ul style="list-style-type: none"><li>• Driver amplifiers for complex waveform up converter paths</li><li>• Drivers in linearized transmit systems</li><li>• Secondary amplifiers in ultra-High Dynamic range receivers</li></ul> |
| Low Noise Figure: 1.1dB at 0.5 GHz                                         | Enables lower system noise figure performance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| High P1dB<br>28.7 dBm at 0.5 GHz                                           | High P1dB, High OIP3, Low NF results in a very dynamic range preventing amplifier saturation under strong interfering signals.<br>It can also be used to drive mixers requiring high drive                                                                                                                                                                                                                                                                                                                                                                                         |
| Unpackaged Die                                                             | Enables the user to integrate the amplifier directly into hybrids                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |



# Ultra High Dynamic Range Monolithic Amplifier Die

## PHA-13HLN-D+

50Ω 1MHz to 1 GHz

### Product Features

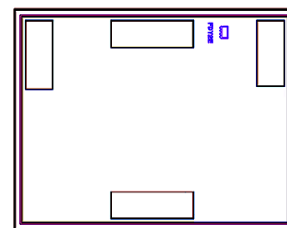
- High IP3, 43 dBm typ. at 0.5GHz
- Gain, 22.7 dB typ. at 0.5GHz
- High Pout, P1dB 28.7 dBm typ. at 0.5GHz
- Low noise figure, 1.1 dB at 0.5GHz
- Operates over +3 to +8V DC

### Typical Applications

- Base station infrastructure
- CATV
- Cellular

### General Description

PHA-13HLN-D+ (RoHS compliant) is an advanced wideband amplifier Die fabricated using E-PHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure. In addition, the PHA-13HLN-D+ has good input and output return loss over a broad frequency range.

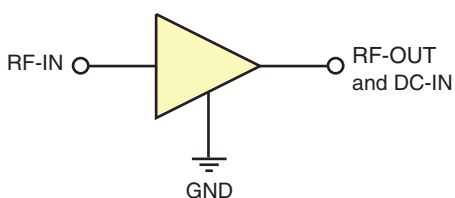


#### +RoHS Compliant

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

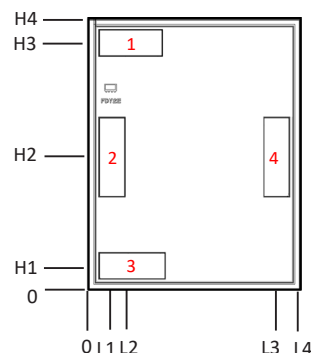
Ordering Information: Refer to Last Page

### Simplified Schematic and Pad description



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

### Bonding Pad Position



Dimensions in μm, Typical

| L1   | L2    | L3    | L4  | H1   | H2    | H3    | H4   | Thickness | Pad#1 Ground Size | Pad#3 Ground Size | RF In & RF Out + DC Pad |
|------|-------|-------|-----|------|-------|-------|------|-----------|-------------------|-------------------|-------------------------|
| 85.5 | 160.5 | 704.5 | 790 | 85.5 | 495.2 | 924.5 | 1010 | 100       | 240 X 90          | 230 x 90          | 90 x 290                |

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



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REV. OR  
M166553  
PHA-13HLN-D+  
WP/RS/CP  
180320  
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Electrical Specifications<sup>1,2</sup> at 25°C, unless noted

| Parameter                                                                                        | Condition (GHz) | Vd=8V <sup>1</sup> |        |      | Vd=5V <sup>1</sup> |        |      | Vd=3V <sup>1</sup> | Units |
|--------------------------------------------------------------------------------------------------|-----------------|--------------------|--------|------|--------------------|--------|------|--------------------|-------|
|                                                                                                  |                 | Min.               | Typ.   | Max. | Min.               | Typ.   | Max. |                    |       |
| Frequency Range                                                                                  |                 | 1                  |        | 1000 | 1                  |        | 1000 | 1-1000             | MHz   |
| Gain                                                                                             | 1               |                    | 25.0   |      |                    | 24.6   |      | 23.7               | dB    |
|                                                                                                  | 20              |                    | 24.3   |      |                    | 24.0   |      | 23.3               |       |
|                                                                                                  | 250             |                    | 23.0   |      |                    | 22.8   |      | 22.1               |       |
|                                                                                                  | 500             |                    | 22.7   |      |                    | 22.4   |      | 21.5               |       |
|                                                                                                  | 1000            |                    | 20.4   |      |                    | 20.1   |      | 18.7               |       |
| Input Return Loss                                                                                | 1               |                    | 10.8   |      |                    | 10.3   |      | 9.4                | dB    |
|                                                                                                  | 20              |                    | 15.8   |      |                    | 15.4   |      | 14.6               |       |
|                                                                                                  | 250             |                    | 16.7   |      |                    | 17.5   |      | 17.9               |       |
|                                                                                                  | 500             |                    | 17.5   |      |                    | 17.4   |      | 14.7               |       |
|                                                                                                  | 1000            |                    | 10.5   |      |                    | 10.2   |      | 7.9                |       |
| Output Return Loss                                                                               | 1               |                    | 11.2   |      |                    | 11.3   |      | 11.0               | dB    |
|                                                                                                  | 20              |                    | 18.8   |      |                    | 19.1   |      | 21.5               |       |
|                                                                                                  | 250             |                    | 17.7   |      |                    | 17.7   |      | 20.2               |       |
|                                                                                                  | 500             |                    | 29.4   |      |                    | 23.9   |      | 20.0               |       |
|                                                                                                  | 1000            |                    | 9.0    |      |                    | 8.9    |      | 7.8                |       |
| Reverse isolation                                                                                | 500             |                    | 26.3   |      |                    | 26.1   |      | 25.7               | dB    |
| Output Power @ 1 dB compression                                                                  | 1               |                    | 26.2   |      |                    | 21.3   |      | 15.1               | dBm   |
|                                                                                                  | 20              |                    | 27.3   |      |                    | 23.0   |      | 16.9               |       |
|                                                                                                  | 250             |                    | 28.4   |      |                    | 24.4   |      | 19.5               |       |
|                                                                                                  | 500             |                    | 28.7   |      |                    | 24.5   |      | 19.5               |       |
|                                                                                                  | 1000            |                    | 27.4   |      |                    | 24.2   |      | 18.7               |       |
| Output IP3 <sup>2</sup>                                                                          | 1               |                    | 38.4   |      |                    | 37.0   |      | 30.6               | dBm   |
|                                                                                                  | 20              |                    | 41.7   |      |                    | 40.2   |      | 33.3               |       |
|                                                                                                  | 250             |                    | 43.5   |      |                    | 40.2   |      | 33.4               |       |
|                                                                                                  | 500             |                    | 43.0   |      |                    | 39.0   |      | 32.3               |       |
|                                                                                                  | 1000            |                    | 42.2   |      |                    | 36.4   |      | 28.6               |       |
| Noise Figure                                                                                     | 1               |                    | 3.0    |      |                    | 3.1    |      | 3.0                | dB    |
|                                                                                                  | 20              |                    | 1.2    |      |                    | 1.2    |      | 1.1                |       |
|                                                                                                  | 250             |                    | 1.1    |      |                    | 0.9    |      | 0.9                |       |
|                                                                                                  | 500             |                    | 1.1    |      |                    | 1.0    |      | 1.0                |       |
|                                                                                                  | 1000            |                    | 1.4    |      |                    | 1.2    |      | 1.3                |       |
| Device Operating Voltage                                                                         |                 |                    | 8.0    |      |                    | 5.0    |      | 3.0                | V     |
| Device Operating Current                                                                         |                 | —                  | 234.1  | —    |                    | 138.9  |      | 71.2               | mA    |
| Device Current Variation vs. Temperature <sup>3</sup>                                            |                 |                    | -100.6 |      |                    | 21.7   |      | 30.3               | μA/°C |
| Device Current Variation vs Voltage                                                              |                 |                    | 0.0155 |      |                    | 0.0338 |      | 0.0338             | mA/mV |
| Thermal Resistance, junction-to-ground lead<br>Junction-to-ground lead at 85°C stage temperature |                 |                    | 23.3   |      |                    | 23.3   |      | 23.3               | °C/W  |

1. Measured on Mini-Circuits Characterization test board. Die packaged in industry standard SOT-89 package and soldered on TB-969-13HLN+. See Characterization Test Circuit (Fig. 1)

2. Tested at Pout= 0 dBm / tone.

3. (Current at 85°C — Current at -45°C)/130

Absolute Maximum Ratings<sup>4</sup>

| Parameter                           | at 8V                                                                                                             | at 3V&5V                                                                                                        |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Operating Temperature (ground lead) | -40°C to 95°C                                                                                                     | -40°C to 105°C                                                                                                  |
| Power Dissipation <sup>5</sup>      | 3.3W                                                                                                              | 3.3W                                                                                                            |
| Input Power (CW)                    | +21 dBm (5 minutes max) <sup>6</sup><br>+10 dBm (continuous) for 1-10 MHz<br>+11 dBm (continuous) for 10-1000 MHz | +21 dBm (5 minutes max) <sup>6</sup><br>+6 dBm (continuous) for 1-10 MHz<br>+8 dBm (continuous) for 10-1000 MHz |
| DC Voltage on Pad 4                 | 10V                                                                                                               | 10V                                                                                                             |

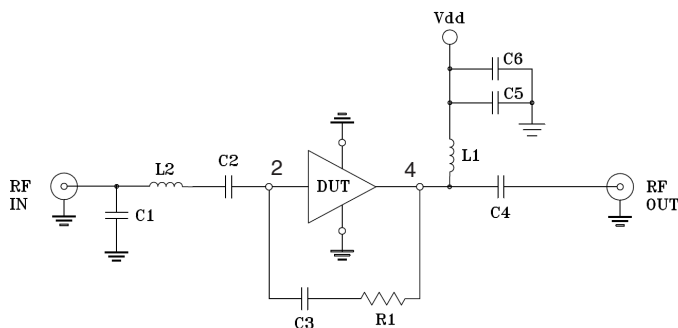
4. Permanent damage may occur if any of these limits are exceeded.

Electrical maximum ratings are not intended for continuous normal operation.

5. Up to 85°C, derate linearly to 2.5W at 95°C.

6. Up to 85°C, derate linearly to +18 dBm at 95°C.

Characterization Test / Recommended Application Circuit

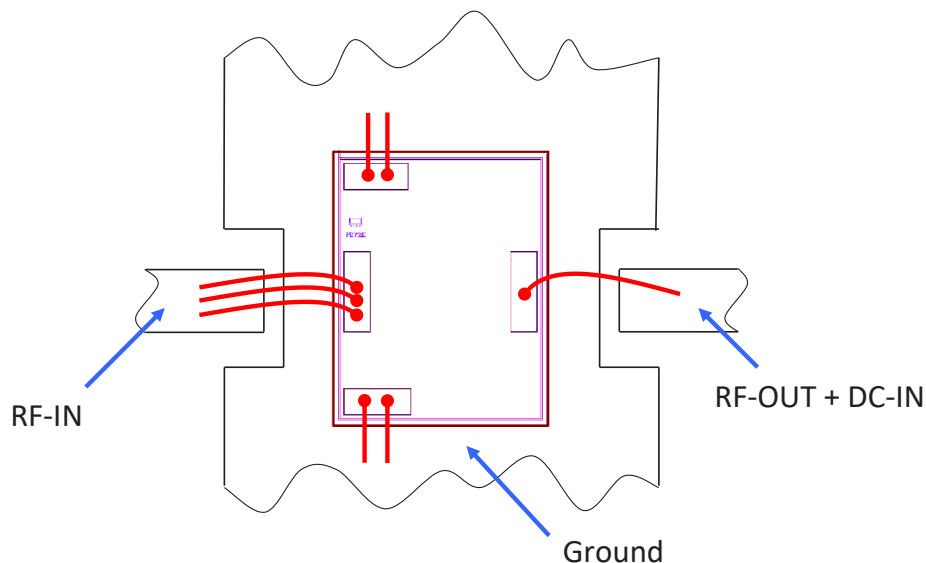


| Components | Size | Value         | Manufacturer | P/N               |
|------------|------|---------------|--------------|-------------------|
| C1         | 0402 | 1.5 pF        | Murata       | GRM1555C1H1R5CZ01 |
| C2         | 0603 | 2.2 uF        |              | GRM188R61C225KE15 |
| C3         | 0402 | 0.1uF         |              | GRM155R71C104KA88 |
| C4         | 0603 | 2.2 uF        |              | GRM188R61C225KE15 |
| C5         | 0402 | 1000 pF       |              | GRM1555C1H102JA01 |
| C6         | 0805 | 10 uF         |              | GRM21BR61C106KE15 |
| L1         | 1210 | 15 uH         | Coilcraft    | LQH32DN150K53L    |
| L2         | 0603 | 5.1 nH        |              | 0603CS-5N1XJL     |
| R1         | 0402 | 1500 $\Omega$ | Koa          | RK73H1ET1501F     |

**Fig 1.** Block Diagram of Test Circuit used for characterization. (DUT, Die packaged in SOT-89 package, soldered on Mini-Circuits Characterization test board TB-969-13HLN+) Gain, Return loss, Output power at 1dB compression (P1 dB) , output IP3 (OIP3) and noise figure measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:  
1. Gain and Return loss: Pin= -25dBm.  
Output IP3 (OIP3): Two tones, spaced 0.5 MHz apart, 0 dBm/tone at output.

## Assembly Diagram



## Assembly and Handling Procedure

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

additional information is available on our dash board.

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

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

\*\* Tested in industry standard SOT-89 package.

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*Typical Performance Data***NOTE: Use PDF Bookmarks to view DATA at required conditions****Definitions:**

Input Return Loss = -S11 (dB)

Gain(Power Gain) = S21 (dB)

Reverse Isolation = -S12 (dB)

Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 8.00V, Id = 238.6mA @ Temperature = +25°C

| FREQ  | Gain  | Isolation | Input<br>Return<br>Loss | Output<br>Return<br>Loss | Stability |         | IP-3<br>Output | 1dB<br>Comp.<br>Output | Noise<br>Figure |
|-------|-------|-----------|-------------------------|--------------------------|-----------|---------|----------------|------------------------|-----------------|
| (MHz) | (dB)  | (dB)      | (dB)                    | (dB)                     | K         | Measure | (dBm)          | (dBm)                  | (dB)            |
| 1     | 24.97 | 29.26     | 11.12                   | 11.36                    | 1.07      | 0.54    | 43.13          | 26.04                  | 2.87            |
| 3     | 25.28 | 28.80     | 14.51                   | 23.20                    | 1.06      | 0.57    | 43.39          | 26.30                  | 1.84            |
| 5     | 25.24 | 28.59     | 15.09                   | 37.21                    | 1.05      | 0.57    | 43.52          | 26.50                  | 1.49            |
| 7     | 25.15 | 28.36     | 15.28                   | 32.70                    | 1.04      | 0.56    | 43.54          | 26.43                  | 1.52            |
| 9     | 25.03 | 28.12     | 15.40                   | 26.52                    | 1.03      | 0.55    | 43.68          | 26.69                  | 1.35            |
| 10    | 24.96 | 27.99     | 15.46                   | 24.99                    | 1.03      | 0.54    | 43.84          | 26.67                  | 1.29            |
| 20    | 24.32 | 27.03     | 15.66                   | 18.71                    | 1.01      | 0.50    | 43.63          | 27.35                  | 1.26            |
| 30    | 23.90 | 26.52     | 15.88                   | 17.14                    | 1.01      | 0.46    | 44.41          | 27.81                  | 1.22            |
| 40    | 23.67 | 26.28     | 16.02                   | 16.47                    | 1.02      | 0.45    | 44.60          | 27.92                  | 1.11            |
| 50    | 23.53 | 26.14     | 16.09                   | 16.24                    | 1.02      | 0.44    | 44.46          | 28.03                  | 1.10            |
| 60    | 23.43 | 26.05     | 16.15                   | 16.10                    | 1.03      | 0.43    | 44.51          | 28.15                  | 1.13            |
| 70    | 23.37 | 26.00     | 16.14                   | 16.00                    | 1.03      | 0.43    | 45.52          | 28.16                  | 1.09            |
| 80    | 23.33 | 25.98     | 16.25                   | 16.00                    | 1.03      | 0.43    | 44.90          | 28.15                  | 1.08            |
| 90    | 23.29 | 25.96     | 16.27                   | 16.00                    | 1.03      | 0.43    | 45.41          | 28.23                  | 1.07            |
| 100   | 23.27 | 25.95     | 16.33                   | 16.09                    | 1.03      | 0.43    | 45.47          | 28.23                  | 1.09            |
| 150   | 23.20 | 25.93     | 16.55                   | 16.58                    | 1.04      | 0.44    | 45.59          | 28.42                  | 1.10            |
| 200   | 23.15 | 25.96     | 16.82                   | 17.39                    | 1.04      | 0.46    | 45.52          | 28.43                  | 1.07            |
| 250   | 23.09 | 26.00     | 17.15                   | 18.41                    | 1.05      | 0.48    | 44.98          | 28.52                  | 1.02            |
| 300   | 23.03 | 26.05     | 17.48                   | 20.08                    | 1.05      | 0.50    | 45.79          | 28.76                  | 1.04            |
| 350   | 22.97 | 26.12     | 17.78                   | 22.35                    | 1.06      | 0.52    | 45.52          | 28.67                  | 1.06            |
| 400   | 22.89 | 26.21     | 18.14                   | 25.60                    | 1.06      | 0.54    | 45.26          | 28.89                  | 1.08            |
| 450   | 22.78 | 26.32     | 18.31                   | 30.40                    | 1.07      | 0.57    | 44.89          | 28.79                  | 1.09            |
| 500   | 22.64 | 26.48     | 18.35                   | 29.28                    | 1.08      | 0.61    | 44.15          | 28.87                  | 1.14            |
| 550   | 22.36 | 26.78     | 17.64                   | 23.27                    | 1.11      | 0.66    | 44.60          | 28.68                  | 1.13            |
| 600   | 22.23 | 27.30     | 15.25                   | 22.28                    | 1.16      | 0.75    | 44.48          | 28.60                  | 1.15            |
| 650   | 22.09 | 27.12     | 15.31                   | 25.68                    | 1.14      | 0.72    | 45.14          | 28.87                  | 1.13            |
| 700   | 22.11 | 27.15     | 15.69                   | 20.08                    | 1.14      | 0.71    | 45.40          | 28.86                  | 1.14            |
| 750   | 21.97 | 27.35     | 15.56                   | 16.87                    | 1.15      | 0.72    | 45.32          | 28.77                  | 1.17            |
| 800   | 21.76 | 27.63     | 15.08                   | 14.65                    | 1.17      | 0.74    | 44.99          | 28.56                  | 1.19            |
| 850   | 21.47 | 27.99     | 14.38                   | 12.90                    | 1.20      | 0.76    | 44.83          | 28.41                  | 1.21            |
| 900   | 21.08 | 28.47     | 13.48                   | 11.41                    | 1.25      | 0.79    | 44.34          | 27.99                  | 1.27            |
| 950   | 20.51 | 29.15     | 12.33                   | 10.10                    | 1.33      | 0.82    | 43.25          | 27.34                  | 1.27            |
| 1000  | 19.64 | 30.16     | 10.86                   | 9.00                     | 1.48      | 0.87    | 41.51          | 26.46                  | 1.30            |
| 1050  | 18.27 | 31.71     | 9.19                    | 8.30                     | 1.80      | 0.94    | 40.54          | 25.41                  | 1.36            |
| 1100  | 16.71 | 33.41     | 7.59                    | 8.58                     | 2.36      | 1.03    | 40.36          | 25.66                  | 1.47            |
| 1150  | 16.85 | 33.15     | 6.66                    | 10.83                    | 2.34      | 1.12    | 43.50          | 26.64                  | 1.55            |
| 1200  | 18.23 | 31.71     | 6.46                    | 16.08                    | 1.88      | 1.16    | 45.12          | 27.62                  | 1.64            |

Note: Test data of Die packaged in industry standard SOT-89 package

## Typical Performance Data

## Definitions:

Input Return Loss = -S11 (dB)

Gain(Power Gain) = S21 (dB)

Reverse Isolation = -S12 (dB)

Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 7.60V, Id = 226.05mA @ Temperature = +25°C

| FREQ  | Gain  | Isolation | Input<br>Return<br>Loss | Output<br>Return<br>Loss | Stability |         | IP-3<br>Output | 1dB<br>Comp.<br>Output | Noise<br>Figure |
|-------|-------|-----------|-------------------------|--------------------------|-----------|---------|----------------|------------------------|-----------------|
| (MHz) | (dB)  | (dB)      | (dB)                    | (dB)                     | K         | Measure | (dBm)          | (dBm)                  | (dB)            |
| 1     | 24.96 | 29.26     | 11.07                   | 11.38                    | 1.07      | 0.55    | 43.10          | 25.53                  | --              |
| 3     | 25.26 | 28.80     | 14.41                   | 23.26                    | 1.06      | 0.57    | 43.46          | 25.78                  | --              |
| 5     | 25.22 | 28.59     | 14.97                   | 37.86                    | 1.05      | 0.57    | 43.53          | 25.85                  | --              |
| 7     | 25.13 | 28.36     | 15.16                   | 32.77                    | 1.04      | 0.56    | 43.64          | 26.06                  | --              |
| 9     | 25.01 | 28.12     | 15.31                   | 26.50                    | 1.03      | 0.55    | 43.77          | 26.05                  | --              |
| 10    | 24.94 | 27.99     | 15.41                   | 24.97                    | 1.03      | 0.54    | 43.90          | 26.02                  | 1.25            |
| 20    | 24.31 | 27.02     | 15.65                   | 18.68                    | 1.01      | 0.49    | 44.32          | 26.89                  | 1.22            |
| 30    | 23.88 | 26.51     | 15.89                   | 17.12                    | 1.01      | 0.46    | 45.14          | 27.37                  | 1.18            |
| 40    | 23.65 | 26.27     | 16.07                   | 16.43                    | 1.02      | 0.45    | 45.96          | 27.49                  | 1.07            |
| 50    | 23.52 | 26.12     | 16.19                   | 16.22                    | 1.02      | 0.44    | 45.11          | 27.60                  | 1.07            |
| 60    | 23.42 | 26.05     | 16.24                   | 16.08                    | 1.03      | 0.43    | 44.75          | 27.73                  | 1.09            |
| 70    | 23.36 | 26.00     | 16.21                   | 15.96                    | 1.03      | 0.43    | 45.60          | 27.72                  | 1.05            |
| 80    | 23.31 | 25.97     | 16.27                   | 15.96                    | 1.03      | 0.43    | 45.45          | 27.80                  | 1.06            |
| 90    | 23.28 | 25.94     | 16.33                   | 15.97                    | 1.03      | 0.43    | 45.41          | 27.80                  | 1.05            |
| 100   | 23.26 | 25.93     | 16.40                   | 16.05                    | 1.03      | 0.43    | 45.66          | 27.78                  | 1.07            |
| 150   | 23.19 | 25.92     | 16.65                   | 16.54                    | 1.04      | 0.44    | 45.38          | 27.98                  | 1.07            |
| 200   | 23.14 | 25.94     | 16.92                   | 17.33                    | 1.04      | 0.46    | 45.30          | 28.08                  | 1.05            |
| 250   | 23.08 | 25.98     | 17.24                   | 18.34                    | 1.05      | 0.47    | 44.94          | 28.07                  | 0.99            |
| 300   | 23.02 | 26.03     | 17.53                   | 19.96                    | 1.05      | 0.50    | 45.92          | 28.32                  | 1.02            |
| 350   | 22.96 | 26.10     | 17.87                   | 22.18                    | 1.05      | 0.52    | 45.19          | 28.23                  | 1.03            |
| 400   | 22.87 | 26.19     | 18.25                   | 25.24                    | 1.06      | 0.54    | 45.13          | 28.46                  | 1.04            |
| 450   | 22.77 | 26.30     | 18.37                   | 29.27                    | 1.07      | 0.57    | 45.06          | 28.44                  | 1.05            |
| 500   | 22.62 | 26.46     | 18.40                   | 28.25                    | 1.08      | 0.61    | 44.24          | 28.42                  | 1.06            |
| 550   | 22.34 | 26.76     | 17.67                   | 22.86                    | 1.11      | 0.66    | 44.88          | 28.32                  | 1.07            |
| 600   | 22.21 | 27.28     | 15.28                   | 21.80                    | 1.16      | 0.75    | 45.02          | 28.19                  | 1.09            |
| 650   | 22.08 | 27.10     | 15.35                   | 25.29                    | 1.14      | 0.72    | 45.58          | 28.44                  | 1.11            |
| 700   | 22.10 | 27.12     | 15.73                   | 20.06                    | 1.13      | 0.71    | 46.05          | 28.44                  | 1.10            |
| 750   | 21.96 | 27.32     | 15.60                   | 16.89                    | 1.15      | 0.72    | 45.93          | 28.46                  | 1.15            |
| 800   | 21.75 | 27.59     | 15.12                   | 14.67                    | 1.17      | 0.74    | 45.83          | 28.26                  | 1.17            |
| 850   | 21.46 | 27.95     | 14.42                   | 12.93                    | 1.20      | 0.76    | 45.64          | 28.03                  | 1.19            |
| 900   | 21.07 | 28.43     | 13.53                   | 11.43                    | 1.25      | 0.79    | 45.32          | 27.63                  | 1.24            |
| 950   | 20.51 | 29.09     | 12.38                   | 10.12                    | 1.32      | 0.82    | 43.99          | 27.13                  | 1.23            |
| 1000  | 19.64 | 30.09     | 10.90                   | 9.01                     | 1.47      | 0.87    | 42.06          | 26.27                  | 1.31            |
| 1050  | 18.29 | 31.63     | 9.22                    | 8.29                     | 1.78      | 0.94    | 41.29          | 25.21                  | 1.34            |
| 1100  | 16.75 | 33.31     | 7.60                    | 8.53                     | 2.31      | 1.03    | 41.71          | 25.44                  | 1.41            |
| 1150  | 16.88 | 33.05     | 6.68                    | 10.72                    | 2.30      | 1.12    | 44.01          | 26.37                  | 1.49            |
| 1200  | 18.24 | 31.62     | 6.47                    | 15.79                    | 1.85      | 1.15    | 44.52          | 27.17                  | 1.57            |

Note: Test data of Die packaged in industry standard SOT-89 package

*Typical Performance Data***Definitions:**

Input Return Loss = -S11 (dB)

Gain(Power Gain) = S21 (dB)

Reverse Isolation = -S12 (dB)

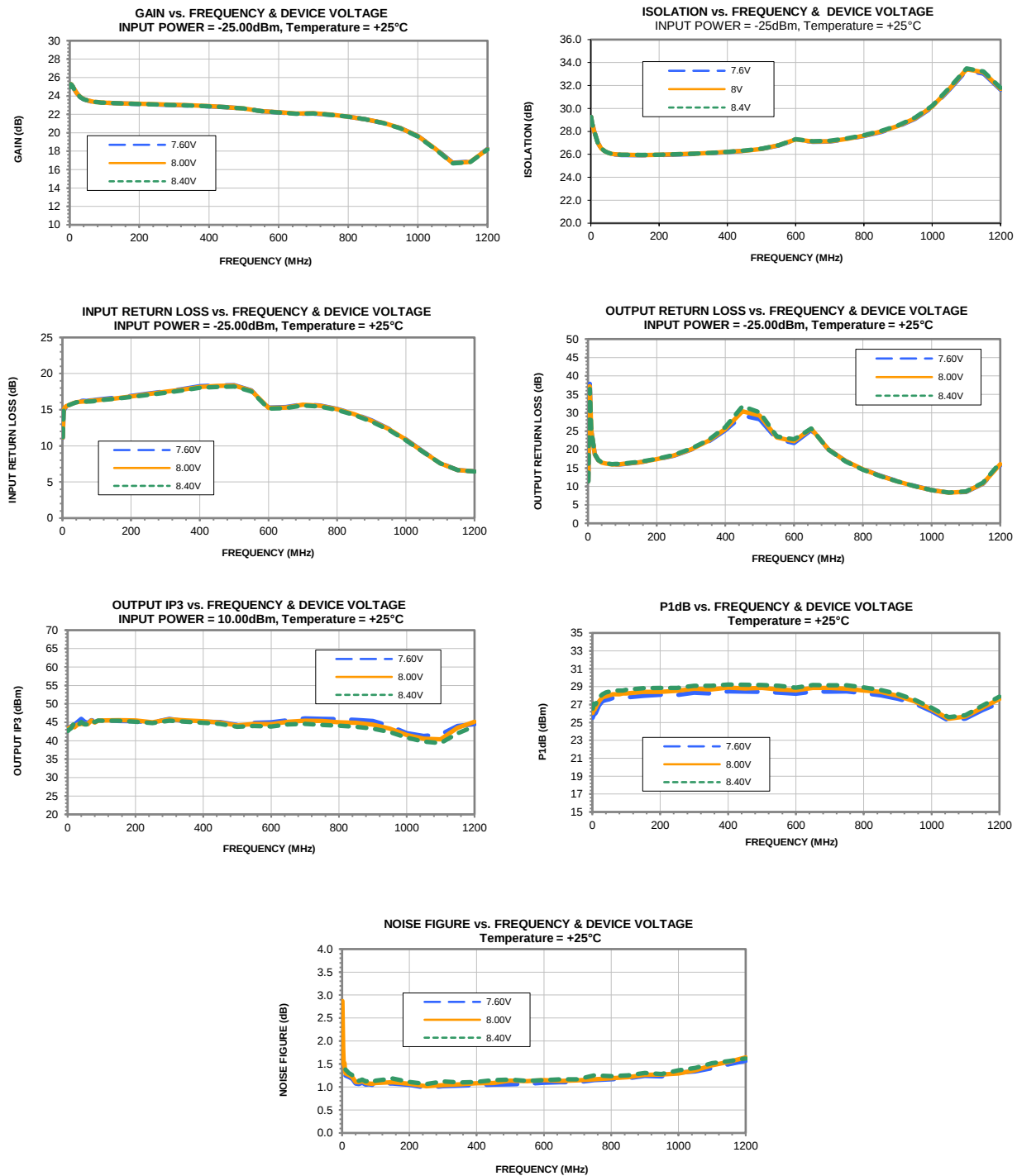
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 8.40V, Id = 250.07mA @ Temperature = +25°C

| FREQ  | Gain  | Isolation | Input<br>Return<br>Loss | Output<br>Return<br>Loss | Stability |         | IP-3<br>Output | 1dB<br>Comp.<br>Output | Noise<br>Figure |
|-------|-------|-----------|-------------------------|--------------------------|-----------|---------|----------------|------------------------|-----------------|
| (MHz) | (dB)  | (dB)      | (dB)                    | (dB)                     | K         | Measure | (dBm)          | (dBm)                  | (dB)            |
| 1     | 24.97 | 29.26     | 11.21                   | 11.35                    | 1.07      | 0.54    | 42.64          | 26.53                  | --              |
| 3     | 25.28 | 28.80     | 14.66                   | 23.16                    | 1.07      | 0.57    | 42.99          | 26.80                  | --              |
| 5     | 25.23 | 28.59     | 15.21                   | 36.45                    | 1.06      | 0.56    | 43.07          | 27.11                  | --              |
| 7     | 25.14 | 28.36     | 15.40                   | 32.60                    | 1.05      | 0.56    | 43.18          | 27.06                  | --              |
| 9     | 25.02 | 28.12     | 15.51                   | 26.58                    | 1.04      | 0.55    | 43.25          | 27.05                  | --              |
| 10    | 24.95 | 27.99     | 15.55                   | 25.02                    | 1.03      | 0.54    | 43.33          | 27.03                  | 1.38            |
| 20    | 24.31 | 27.02     | 15.68                   | 18.79                    | 1.01      | 0.50    | 44.85          | 27.80                  | 1.31            |
| 30    | 23.89 | 26.53     | 15.85                   | 17.22                    | 1.01      | 0.47    | 44.04          | 28.15                  | 1.26            |
| 40    | 23.65 | 26.29     | 16.02                   | 16.55                    | 1.02      | 0.45    | 45.07          | 28.34                  | 1.17            |
| 50    | 23.52 | 26.15     | 16.10                   | 16.34                    | 1.02      | 0.44    | 44.45          | 28.44                  | 1.13            |
| 60    | 23.42 | 26.06     | 16.08                   | 16.20                    | 1.03      | 0.44    | 44.41          | 28.49                  | 1.16            |
| 70    | 23.36 | 26.01     | 16.12                   | 16.08                    | 1.03      | 0.43    | 45.31          | 28.56                  | 1.12            |
| 80    | 23.32 | 25.99     | 16.13                   | 16.08                    | 1.03      | 0.43    | 45.03          | 28.57                  | 1.14            |
| 90    | 23.28 | 25.97     | 16.17                   | 16.09                    | 1.03      | 0.44    | 45.48          | 28.57                  | 1.11            |
| 100   | 23.26 | 25.96     | 16.27                   | 16.19                    | 1.03      | 0.44    | 45.39          | 28.64                  | 1.14            |
| 150   | 23.19 | 25.95     | 16.49                   | 16.68                    | 1.04      | 0.45    | 45.42          | 28.83                  | 1.19            |
| 200   | 23.14 | 25.97     | 16.75                   | 17.50                    | 1.04      | 0.46    | 45.15          | 28.85                  | 1.11            |
| 250   | 23.08 | 26.01     | 17.07                   | 18.54                    | 1.05      | 0.48    | 44.81          | 28.86                  | 1.06            |
| 300   | 23.02 | 26.06     | 17.36                   | 20.25                    | 1.05      | 0.50    | 45.44          | 29.09                  | 1.12            |
| 350   | 22.96 | 26.13     | 17.69                   | 22.61                    | 1.06      | 0.52    | 45.17          | 29.10                  | 1.10            |
| 400   | 22.88 | 26.22     | 18.04                   | 26.11                    | 1.06      | 0.55    | 44.88          | 29.24                  | 1.11            |
| 450   | 22.77 | 26.33     | 18.16                   | 31.75                    | 1.07      | 0.58    | 44.55          | 29.22                  | 1.15            |
| 500   | 22.63 | 26.50     | 18.21                   | 30.10                    | 1.08      | 0.61    | 43.76          | 29.20                  | 1.16            |
| 550   | 22.34 | 26.80     | 17.52                   | 23.57                    | 1.11      | 0.66    | 43.99          | 29.10                  | 1.14            |
| 600   | 22.21 | 27.33     | 15.16                   | 22.78                    | 1.16      | 0.76    | 43.85          | 28.90                  | 1.15            |
| 650   | 22.08 | 27.15     | 15.22                   | 25.73                    | 1.14      | 0.72    | 44.40          | 29.18                  | 1.17            |
| 700   | 22.10 | 27.18     | 15.58                   | 19.96                    | 1.14      | 0.71    | 44.57          | 29.16                  | 1.17            |
| 750   | 21.96 | 27.38     | 15.45                   | 16.76                    | 1.15      | 0.72    | 44.28          | 29.17                  | 1.25            |
| 800   | 21.74 | 27.66     | 14.96                   | 14.57                    | 1.17      | 0.74    | 44.03          | 28.93                  | 1.23            |
| 850   | 21.45 | 28.03     | 14.26                   | 12.83                    | 1.21      | 0.76    | 43.78          | 28.63                  | 1.26            |
| 900   | 21.05 | 28.53     | 13.37                   | 11.35                    | 1.26      | 0.79    | 43.28          | 28.18                  | 1.30            |
| 950   | 20.48 | 29.21     | 12.24                   | 10.07                    | 1.34      | 0.82    | 42.34          | 27.52                  | 1.28            |
| 1000  | 19.60 | 30.23     | 10.77                   | 9.00                     | 1.49      | 0.87    | 40.80          | 26.64                  | 1.36            |
| 1050  | 18.23 | 31.79     | 9.13                    | 8.34                     | 1.82      | 0.94    | 39.74          | 25.59                  | 1.42            |
| 1100  | 16.68 | 33.49     | 7.56                    | 8.67                     | 2.39      | 1.04    | 39.34          | 25.82                  | 1.52            |
| 1150  | 16.82 | 33.23     | 6.65                    | 11.00                    | 2.37      | 1.12    | 42.00          | 26.89                  | 1.57            |
| 1200  | 18.19 | 31.80     | 6.44                    | 16.45                    | 1.90      | 1.16    | 43.95          | 27.88                  | 1.62            |

Note: Test data of Die packaged in industry standard SOT-89 package

## Typical Performance Curves



Note: Test data of Die packaged in industry standard SOT-89 package



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<br>Ambient Environment | Refer to Individual Model Data Sheet |
| Storage Environment   | 20° to 35° C and 40 to 60% humidity<br>(In Factory Shipped Package)      | Individual Model Data Sheet          |