

## Variable Gain Amplifier with Analog Control 400 - 2700 MHz

Rev. V1

### Features

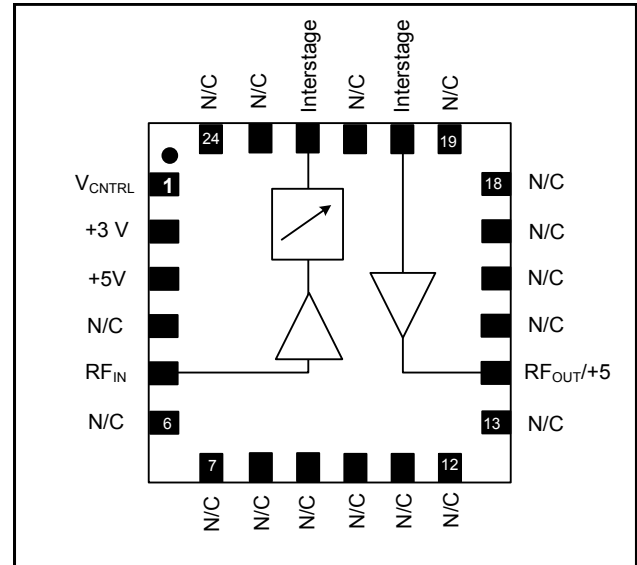
- Wide Frequency Range
- +42 dBm Output IP3
- 25.5 dB Gain at 2140 MHz
- 26.5 dB Attenuation Range
- Lead-Free 4 mm, 24-Lead PQFN Package
- RoHS\* Compliant and 260°C Reflow Compatible

### Description

The MAAM-009320 is a variable gain amplifier with 26.5 dB of gain control at 2.14 GHz. It has good input IP3 performance over the full attenuation range. External matching components are used to set the center frequency and achieve the return loss performance. The analog control is accomplished through a single control pin of 0 to +3V.

The 4 mm PQFN package is RoHS compliant and compatible with reflow temperatures to 260°C. Applications include transceivers for cellular infrastructure.

### Functional Schematic



### Pin Configuration<sup>3</sup>

| Pin No. | Function           | Pin No. | Function               |
|---------|--------------------|---------|------------------------|
| 1       | V <sub>CNTRL</sub> | 13      | N/C                    |
| 2       | +3V                | 14      | RF <sub>OUT</sub> /+5V |
| 3       | +5V                | 15      | N/C                    |
| 4       | N/C                | 16      | N/C                    |
| 5       | RF <sub>IN</sub>   | 17      | N/C                    |
| 6       | N/C                | 18      | N/C                    |
| 7       | N/C                | 19      | N/C                    |
| 8       | N/C                | 20      | Interstage             |
| 9       | N/C                | 21      | N/C                    |
| 10      | N/C                | 22      | Interstage             |
| 11      | N/C                | 23      | N/C                    |
| 12      | N/C                | 24      | N/C                    |
|         |                    | 25      | Paddle <sup>4</sup>    |

3. For optimum RF performance, all N/C's should be terminated to ground.
4. The exposed pad centered on the package bottom must be connected to RF and DC ground.

### Ordering Information<sup>1,2</sup>

| Part Number        | Package                |
|--------------------|------------------------|
| MAAM-009320-TR3000 | 3000 piece reel        |
| MAAM-009320-001SMB | Sample Board, 2140 MHz |

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

\* Restrictions on Hazardous Substances, European Union Directive 2002/95/EC.

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### Electrical Specifications<sup>5,6,7</sup>: Freq. = 2140 MHz, T<sub>A</sub> = +25°C, Z<sub>0</sub> = 50 Ω

| Parameter   | Units | Min. | Typ.   | Max. |
|---|-------|------|--------|------|
| Gain  | dB    | 24   | 25.5   | —    |
| Noise Figure  | dB    | —    | 3.0    | —    |
| Input Return Loss   | dB    | —    | 13     | —    |
| Output Return Loss  | dB    | —    | 12     | —    |
| Output P1dB   | dBm   | —    | 28     | —    |
| Output IP3<br>P <sub>out</sub> = +9 dBm per tone SCL, 1 MHz spacing | dBm   | 40   | 42     | —    |
| Attenuation Range   | dB    | 25   | 26.5   | —    |
| Attenuation Control   | V     | —    | 0 to 3 | —    |
| Small Signal Current  | mA    | —    | 231    | 300  |

- Contact M/A-COM Technology Solutions' Application Engineering Department for performance and tuning at other frequencies within frequency range.
- Typical performance at no attenuation, V<sub>cntrl</sub> = 0V.
- Typical small signal currents are 76 mA for stage 1 and 155 mA for stage 3.

### Absolute Maximum Ratings<sup>8,9</sup>

| Parameter                               | Absolute Maximum |
|---|------------------|
| Input Power                             | +6 dBm           |
| Voltage (all DC pins)                   | 6 volts          |
| Storage Temperature                     | -55°C to +150°C  |
| Case Temperature                        | -40°C to +85°C   |
| Junction Temp, Stage 1 <sup>10,11</sup> | 150°C            |
| Junction Temp, Stage 3 <sup>10,12</sup> | 160°C            |

- Exceeding any one or combination of these limits may cause permanent damage to this device.
- M/A-COM Technology Solutions does not recommend sustained operation near these survivability limits.
- Junction Temperature (T<sub>J</sub>) = T<sub>A</sub> + Θ<sub>jc</sub> \* ((V \* I) - (P<sub>OUT</sub> - P<sub>IN</sub>))
- Stage 1 typical thermal resistance (Θ<sub>jc</sub>) = 106.5° C/W
- Stage 3 typical thermal resistance (Θ<sub>jc</sub>) = 68.6° C/W

### Handling Procedures

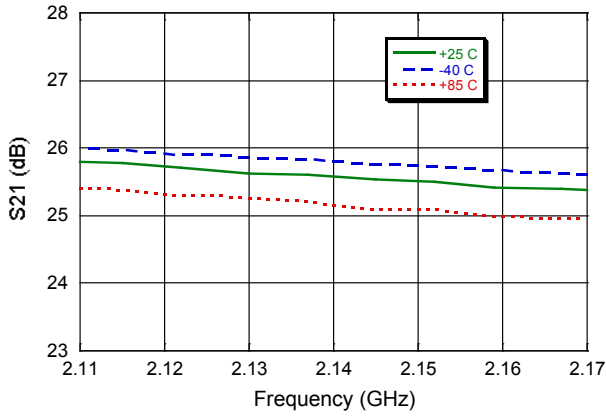
Please observe the following precautions to avoid damage:

### Static Sensitivity

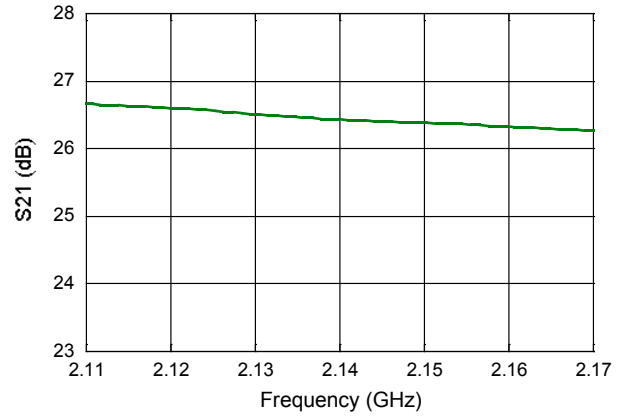
Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these class 1A devices.

**Typical Performance Curves:**

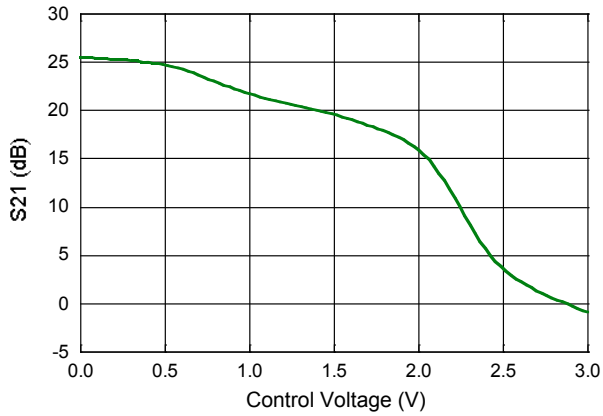
**Gain,  $V_{ctrl} = 0V$**



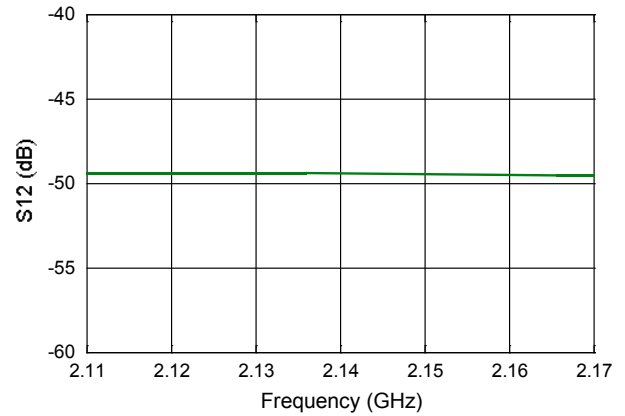
**Attenuation Range**



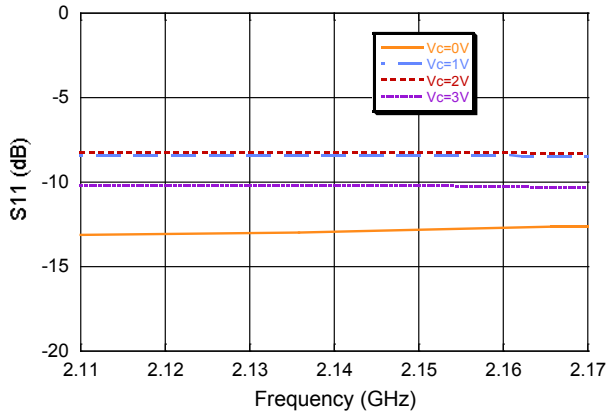
**Gain vs. Control Voltage**



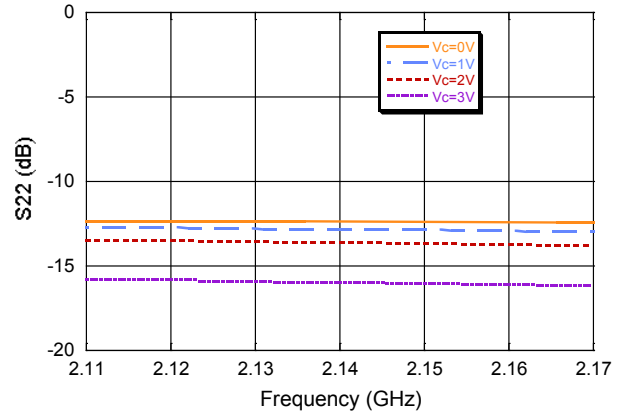
**Reverse Isolation,  $V_{ctrl} = 0V$**



**Input Return Loss**

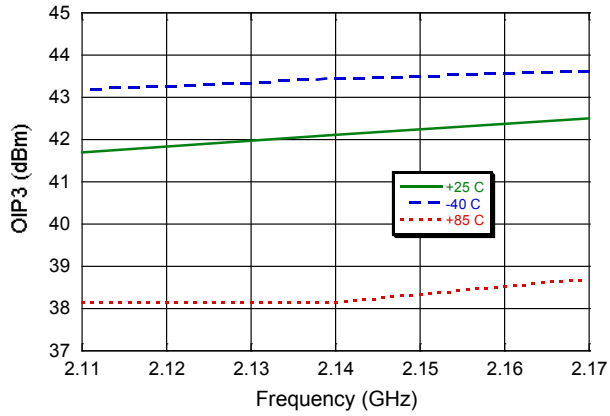


**Output Return Loss**

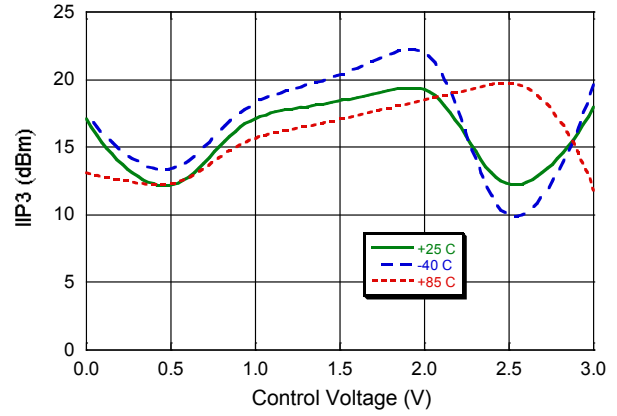


**Typical Performance Curves:**

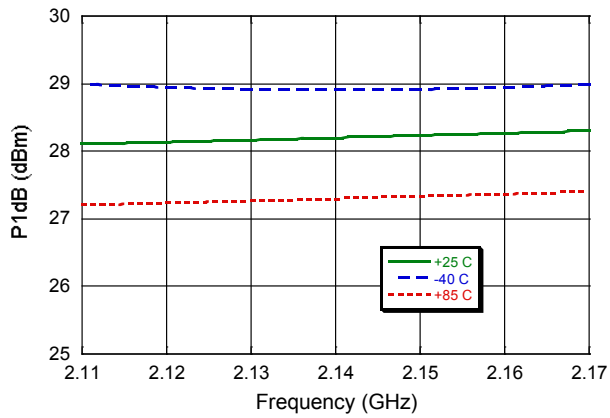
**Output IP3, Vcntrl = 0V**



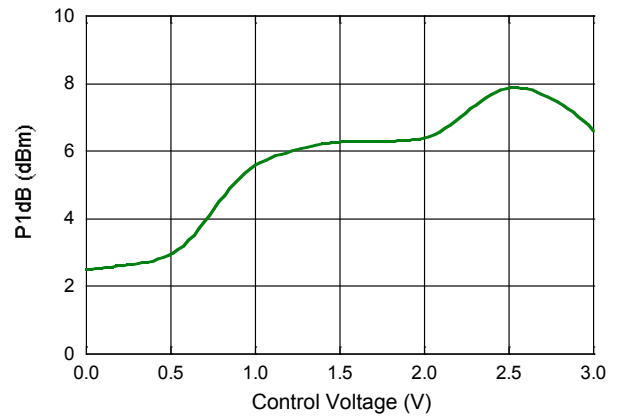
**Input IP3 vs. Control Voltage**



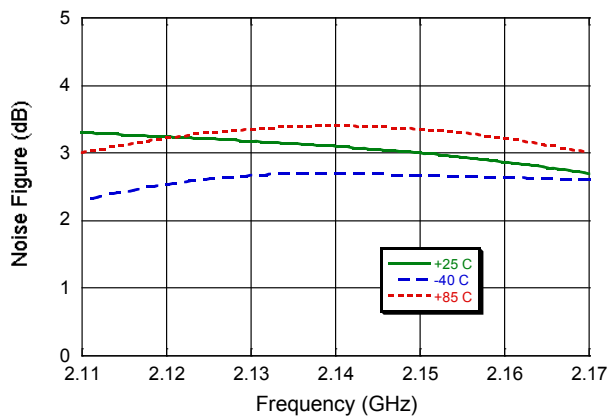
**Output P1dB, Vcntrl = 0V**



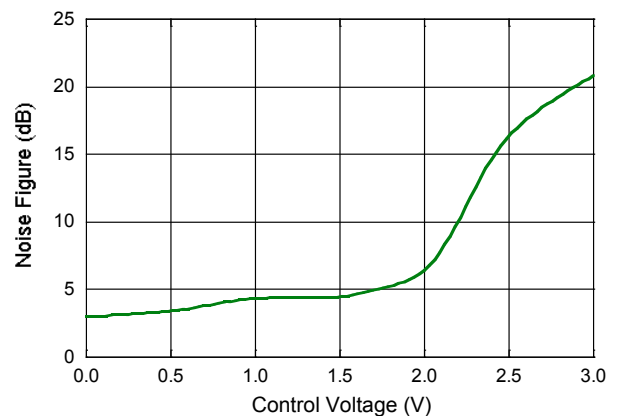
**Input P1dB vs. Control Voltage**



**Noise Figure, Vcntrl = 0V**



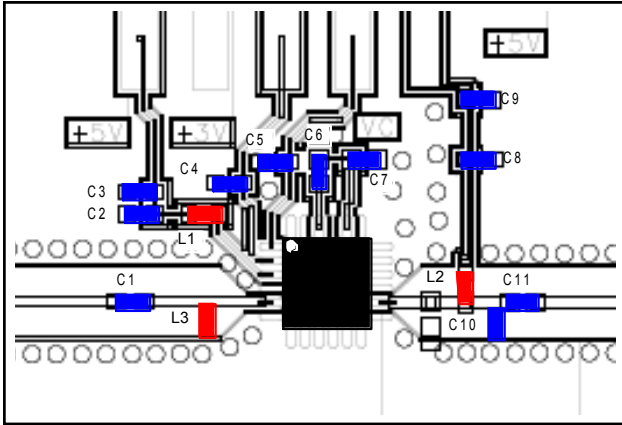
**Noise Figure vs. Control Voltage**



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Rev. V1

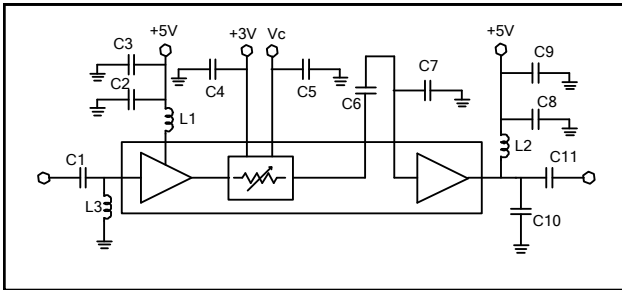
### 2140 MHz PCB Layout



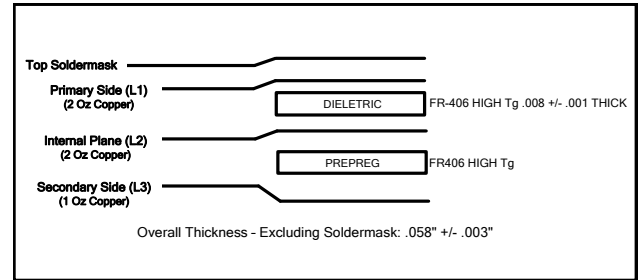
### Parts List

| Part           | Value   | Case Style |
|----------------|---------|------------|
| C1             | 68 pF   | 0402       |
| C2, C4, C5, C8 | 1000 pF | 0402       |
| C3, C9         | 0.1 μF  | 0402       |
| C6             | 12 pF   | 0402       |
| C7             | 2.2 pF  | 0402       |
| C10            | 1.5 pF  | 0402       |
| C11            | 39 pF   | 0402       |
| L1             | 39 nH   | 0402       |
| L2             | 7.5 nH  | 0402       |
| L3             | 3.9 nH  | 0402       |

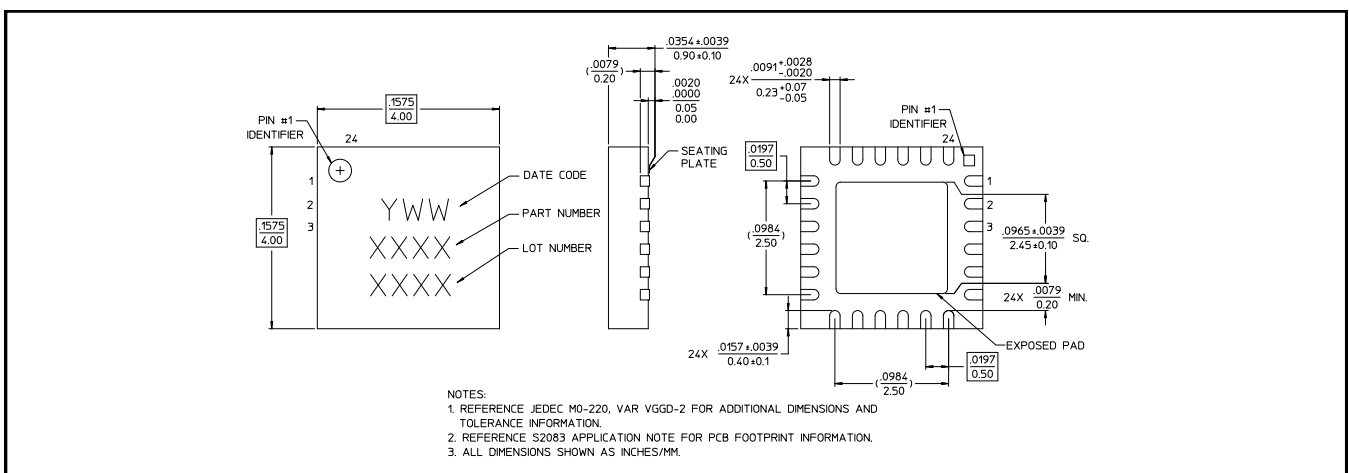
### 2140 MHz Schematic



### Cross Section View



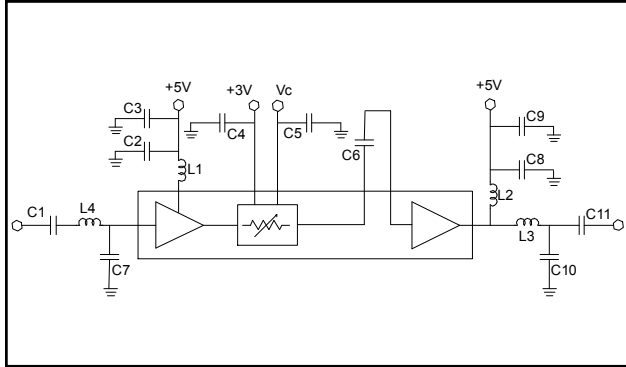
### Lead Free 4 mm 24-Lead PQFN †



† Reference Application Note M538 for lead-free solder reflow recommendations.  
 Meets JEDEC moisture sensitivity level 1 requirements.  
 Plating is 100% matte tin over copper.

## 400 MHz Applications Section

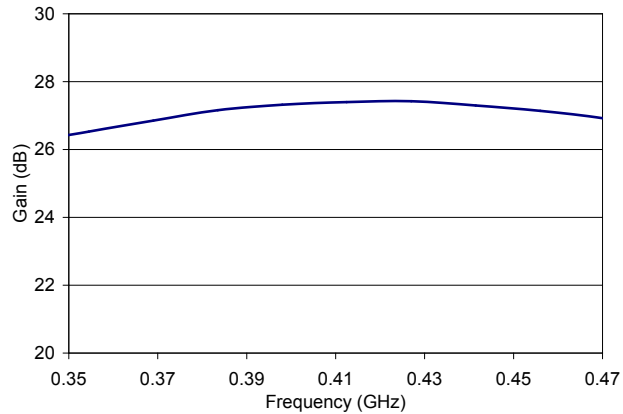
### Schematic



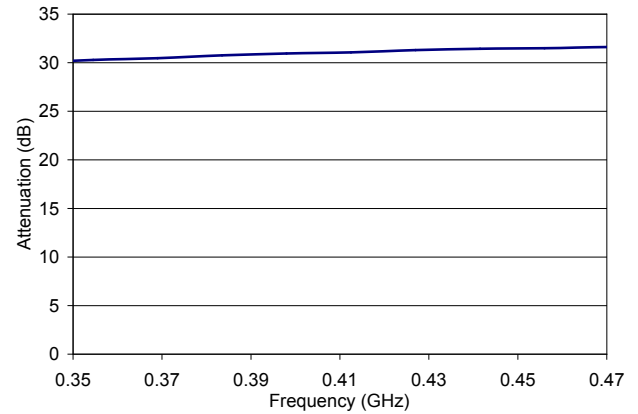
### Parts List

| Part           | Value       | Case Style |
|----------------|-------------|------------|
| C1, C11        | 39 pF       | 0402       |
| C2, C4, C5, C8 | 1000 pF     | 0402       |
| C3, C9         | 0.1 $\mu$ F | 0402       |
| C6             | 4.7 pF      | 0402       |
| C7             | 4 pF        | 0402       |
| C10            | 18 pF       | 0402       |
| L1             | 39 nH       | 0402       |
| L2             | 7.5 nH      | 0402       |
| L3             | 3.9 nH      | 0402       |
| L4             | 12 nH       | 0402       |

**Gain, Vcntrl = 0V**

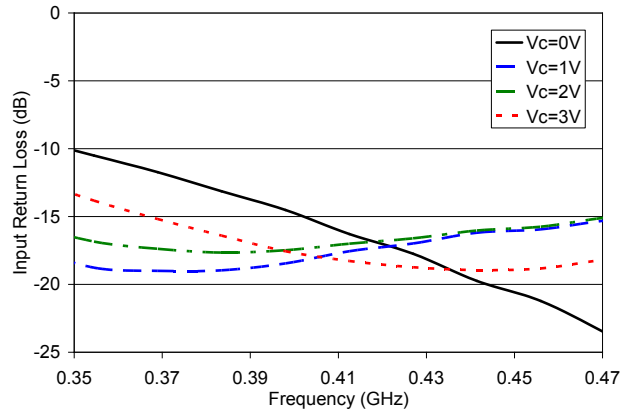


**Attenuation Range**

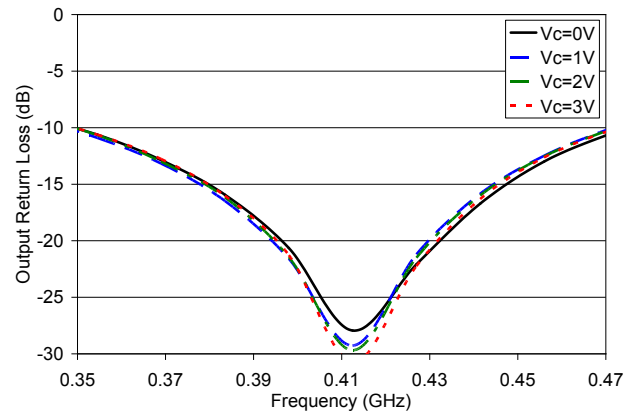


## 400 MHz Applications Section

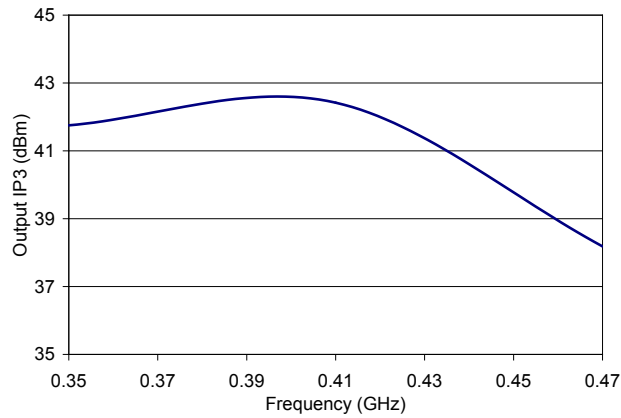
**Input Return Loss**



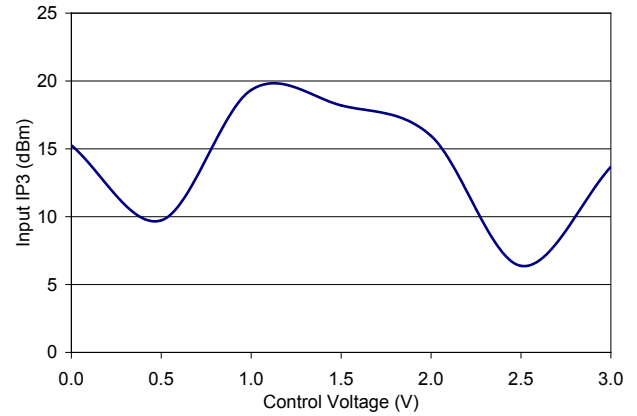
**Output Return Loss**



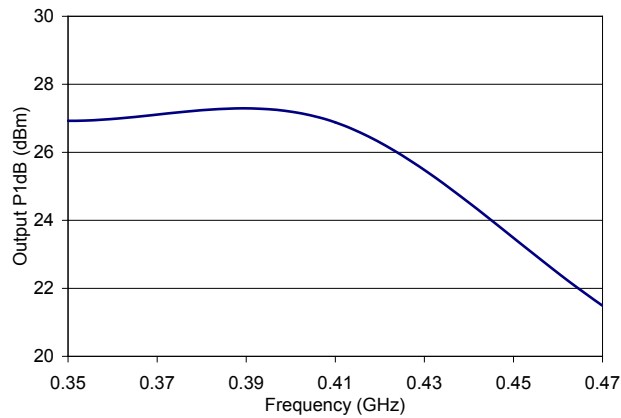
**Output IP3, Vcntrl = 0V**



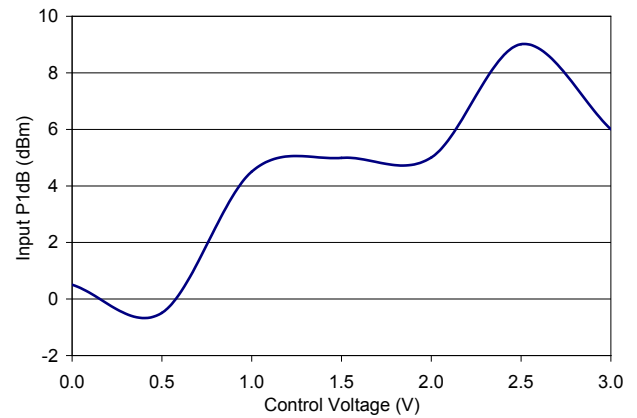
**Input IP3 vs. Control Voltage**



**Output P1dB, Vcntrl = 0V**

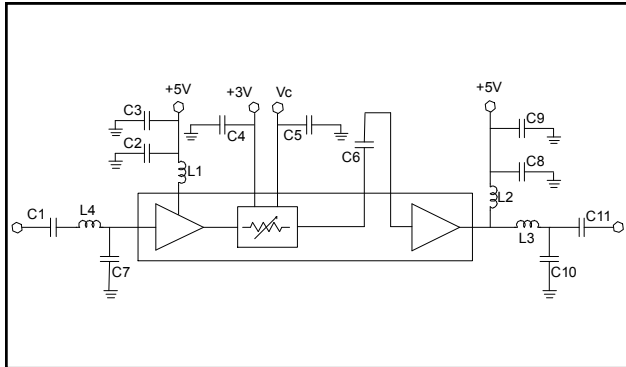


**Input P1dB vs. Control Voltage**



## 850 MHz Applications Section

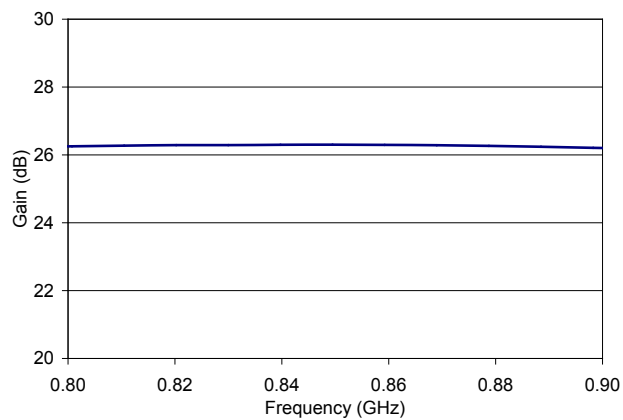
### Schematic



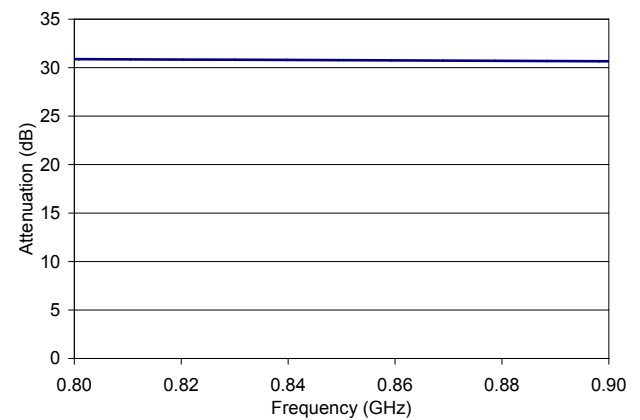
### Parts List

| Part           | Value       | Case Style |
|----------------|-------------|------------|
| C1, C11        | 39 pF       | 0402       |
| C2, C4, C5, C8 | 1000 pF     | 0402       |
| C3, C9         | 0.1 $\mu$ F | 0402       |
| C6             | 4.7 pF      | 0402       |
| C7             | 1.2 pF      | 0402       |
| C10            | 6.8 pF      | 0402       |
| L1             | 39 nH       | 0402       |
| L2             | 7.5 nH      | 0402       |
| L3             | 1 nH        | 0402       |
| L4             | 10 nH       | 0402       |

**Gain, Vcntrl = 0V**



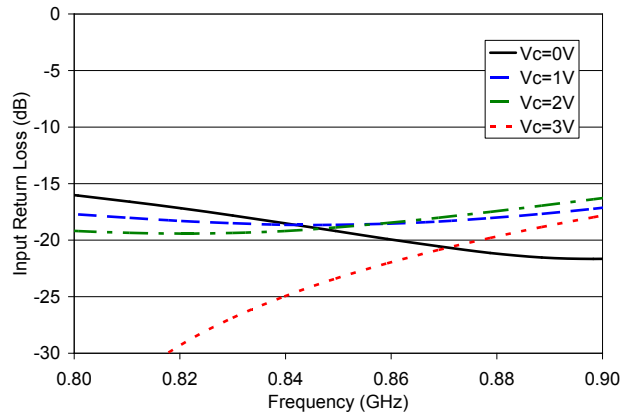
**Attenuation Range**



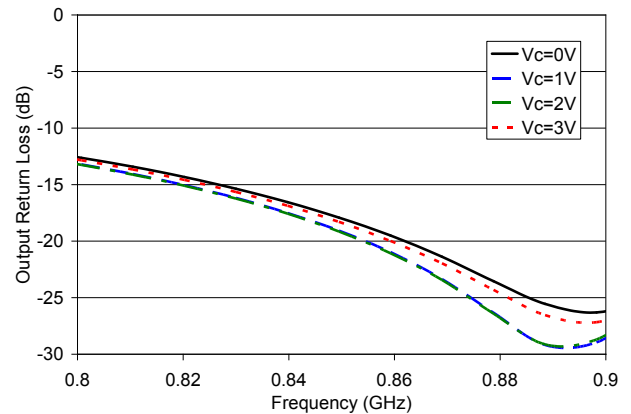


### 850 MHz Applications Section

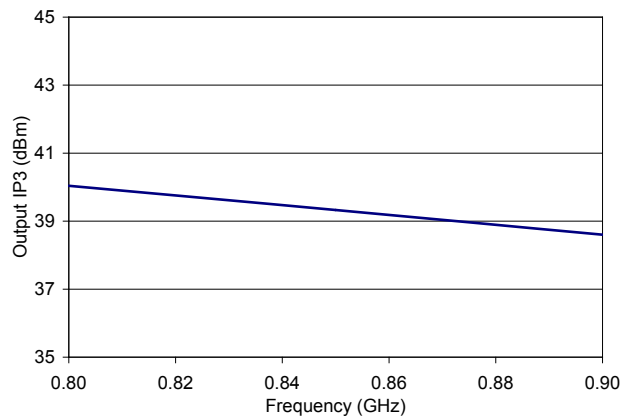
**Input Return Loss**



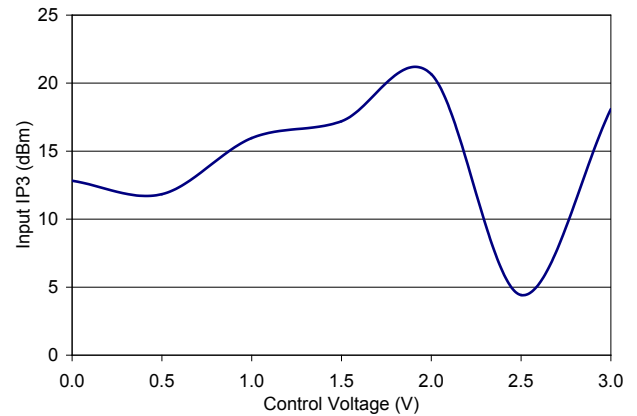
**Output Return Loss**



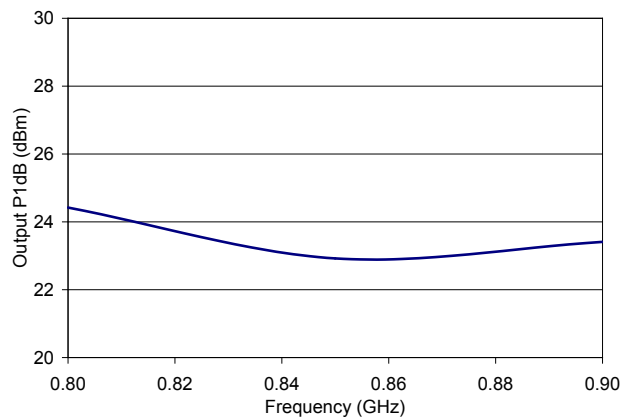
**Output IP3, Vctrl = 0V**



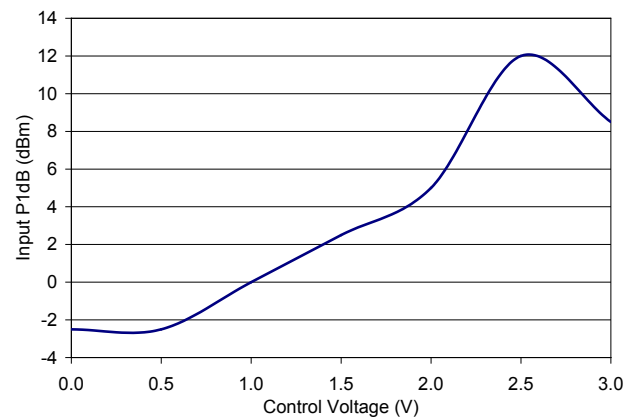
**Input IP3 vs. Control Voltage**



**Output P1dB, Vctrl = 0V**

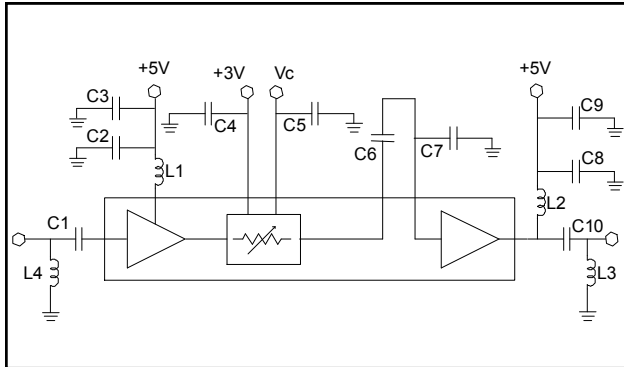


**Input P1dB vs. Control Voltage**



## 2600 MHz Applications Section

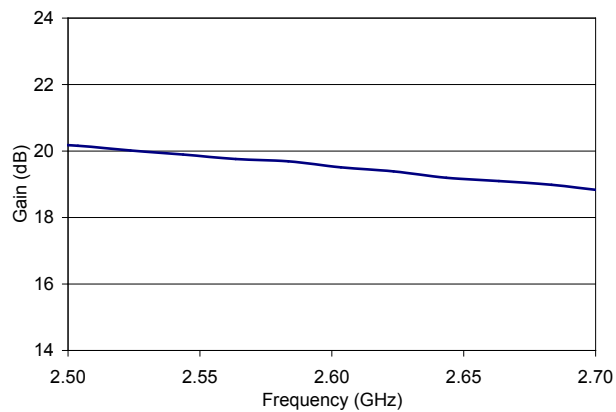
### Schematic



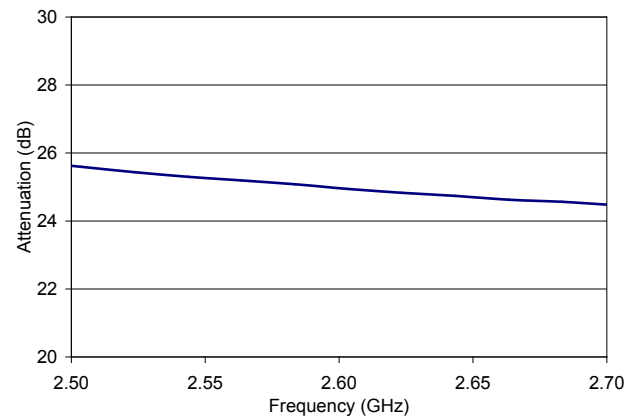
### Parts List

| Part           | Value       | Case Style |
|----------------|-------------|------------|
| C1             | 3.9 pF      | 0402       |
| C2, C4, C5, C8 | 1000 pF     | 0402       |
| C3, C9         | 0.1 $\mu$ F | 0402       |
| C6             | 6.8 pF      | 0402       |
| C7             | 1.2 pF      | 0402       |
| C10            | 1 pF        | 0402       |
| L1             | 39 nH       | 0402       |
| L2             | 7.5 nH      | 0402       |
| L3             | 1.8 nH      | 0402       |
| L4             | 3.9 nH      | 0402       |

**Gain, Vcntrl = 0V**

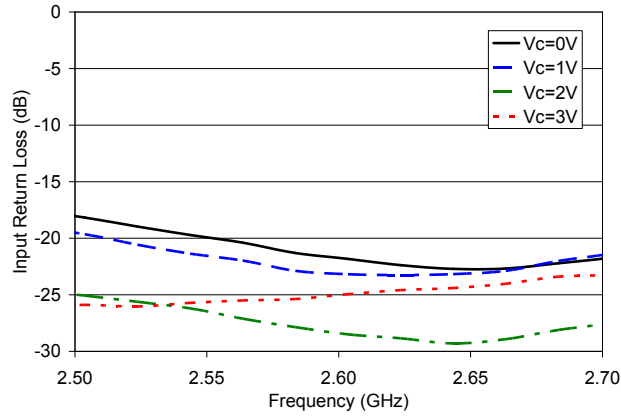


**Attenuation Range**

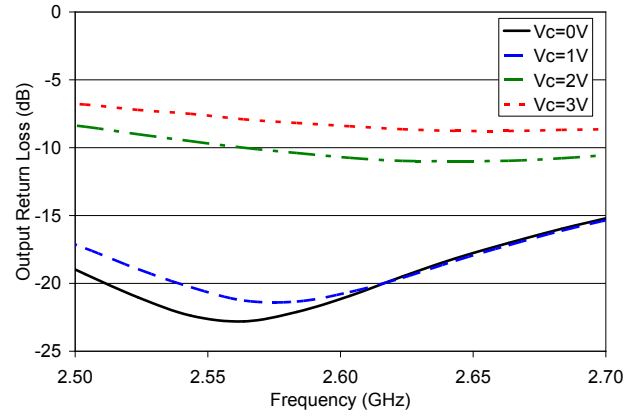


### 2600 MHz Applications Section

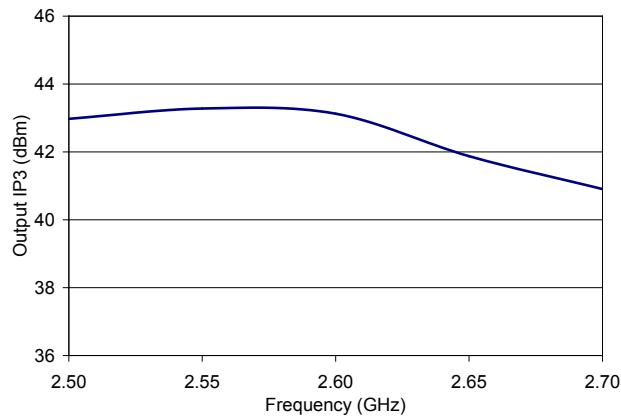
**Input Return Loss**



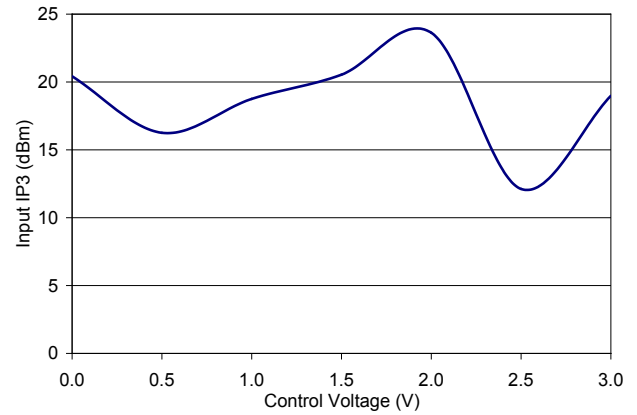
**Output Return Loss**



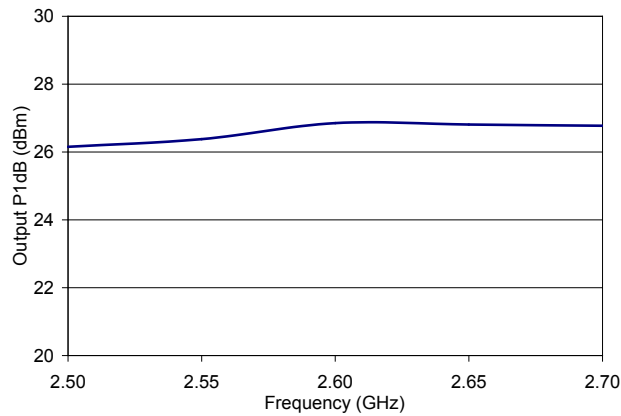
**Output IP3, Vcntrl = 0V**



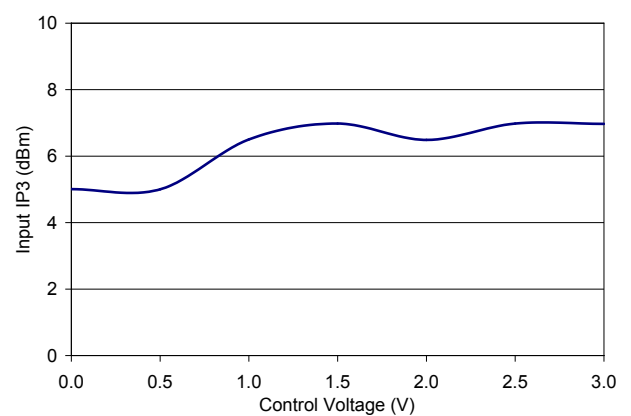
**Input IP3 vs. Control Voltage**



**Output P1dB, Vcntrl = 0V**



**Input P1dB vs. Control Voltage**



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