# NBB-302

## CASCADABLE BROADBAND GaAs MMIC AMPLIFIER DC TO 12GHz

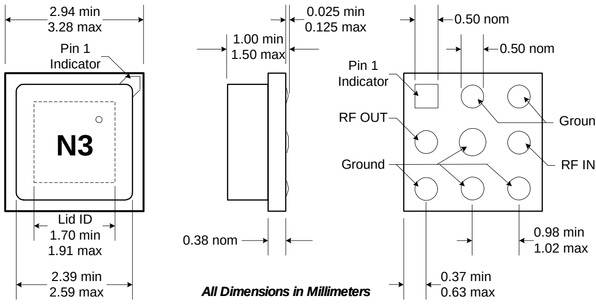
*RoHS Compliant & Pb-Free Product*

## Typical Applications

- Narrow and Broadband Commercial and Military Radio Designs
- Linear and Saturated Amplifiers
- Gain Stage or Driver Amplifiers for MW Radio/Optical Designs (PTP/PMP/LMDS/UNII/VSAT/WLAN/Cellular/DWDM)

## Product Description

The NBB-302 cascadable broadband InGaP/GaAs MMIC amplifier is a low-cost, high-performance solution for general purpose RF and microwave amplification needs. This 50Ω gain block is based on a reliable HBT proprietary MMIC design, providing unsurpassed performance for small-signal applications. Designed with an external bias resistor, the NBB-302 provides flexibility and stability. The NBB-302 is packaged in a low-cost, surface-mount ceramic package, providing ease of assembly for high-volume tape-and-reel requirements. It is available in either packaged or chip (NBB-300-D) form, where its gold metallization is ideal for hybrid circuit designs.

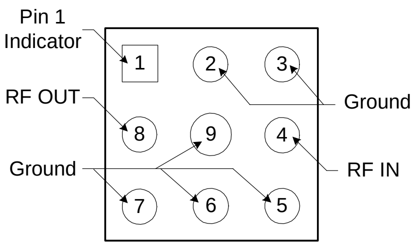


Notes:
1. Solder pads are coplanar to within ±0.025 mm.
2. Lid will be centered relative to frontside metallization with a tolerance of ±0.13 mm.
3. Mark to include two characters and dot to reference pin 1.

**Package Style: MPGA, Bowtie, 3x3, Ceramic**

**Optimum Technology Matching® Applied**

☐ Si BJT
☐ Si Bi-CMOS
☑ InGaP/HBT
☐ GaAs HBT
☐ SiGe HBT
☐ GaN HEMT
☐ GaAs MESFET
☐ Si CMOS
☐ SiGe Bi-CMOS



**Functional Block Diagram**

## Features

- Reliable, Low-Cost HBT Design
- 12.0dB Gain, +13.7dBm P1dB@2GHz
- High P1dB of +14.0dBm@6.0GHz and +11.0dBm@14.0GHz
- Single Power Supply Operation
- 50Ω I/O Matched for High Freq. Use

## Ordering Information

| | |
|---|---|
| NBB-302 | Cascadable Broadband GaAs MMIC Amplifier DC to 12GHz |
| NBB-302-T1 or -T3 | Tape & Reel, 1000 or 3000 Pieces (respectively) |
| NBB-302-E | Fully Assembled Evaluation Board |
| NBB-X-K1 | Extended Frequency InGaP Amp Designer's Tool Kit |

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Greensboro, NC 27409, USA http://www.rfmd.com

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## Absolute Maximum Ratings

| Parameter | Rating | Unit |
|---|---|---|
| RF Input Power | +20 | dBm |
| Power Dissipation | 300 | mW |
| Device Current | 70 | mA |
| Channel Temperature | 200 | °C |
| Operating Temperature | -45 to +85 | °C |
| Storage Temperature | -65 to +150 | °C |

Exceeding any one or a combination of these limits may cause permanent damage.

⚠ **Caution!** ESD sensitive device.

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| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| **Overall** | | | | | $V_D$=+3.9V, $I_{CC}$=50mA, $Z_0$=50Ω, $T_A$=+25°C |
| Small Signal Power Gain, S21 | 12.0 | 13.5 | | dB | f=0.1GHz to 1.0GHz |
| | 11.0 | 13.0 | | dB | f=1.0GHz to 4.0GHz |
| | | 12.5 | | dB | f=4.0GHz to 6.0GHz |
| | 9.0 | 10.5 | | dB | f=6.0GHz to 12.0GHz |
| | | 9.5 (avg.) | | dB | f=12.0GHz to 14.0GHz |
| Gain Flatness, GF | | ±0.6 | | dB | f=0.1GHz to 8.0GHz |
| Input and Output VSWR | | 2.4:1 | | | f=0.1GHz to 4.0GHz |
| | | 2.0:1 | | | f=4.0GHz to 12.0GHz |
| | | 2.8:1 | | | f=12.0GHz to 15.0GHz |
| Bandwidth, BW | | 12.5 | | GHz | BW3 (3dB) |
| Output Power @ -1dB Compression, P1dB | | 13.7 | | dBm | f=2.0GHz |
| | | 14.8 | | dBm | f=6.0GHz |
| | | 11.0 | | dBm | f=14.0GHz |
| Noise Figure, NF | | 5.5 | | dB | f=3.0GHz |
| Third Order Intercept, IP3 | | +23.5 | | dBm | f=2.0GHz |
| Reverse Isolation, S12 | | -15 | | dB | f=0.1GHz to 12.0GHz |
| Device Voltage, $V_D$ | 3.6 | 3.9 | 4.2 | V | |
| Gain Temperature Coefficient, $\delta G_T/\delta T$ | | -0.0015 | | dB/°C | |
| **MTTF versus Temperature @ $I_{CC}$=50mA** | | | | | |
| Case Temperature | | 85 | | °C | |
| Junction Temperature | | 122.9 | | °C | |
| MTTF | | >1,000,000 | | hours | |
| **Thermal Resistance** | | | | | |
| $\theta_{JC}$ | | 194 | | °C/W | $\frac{J_T - T_{CASE}}{V_D \cdot I_{CC}} = \theta_{JC}(°C/Watt)$ |

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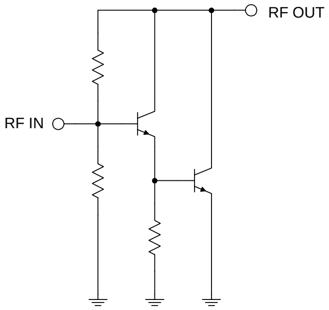
| Pin | Function | Description | Interface Schematic |
|---|---|---|---|
| **1** | **GND** | Ground connection. For best performance, keep traces physically short and connect immediately to ground plane. | |
| **2** | **GND** | Same as pin 1. | |
| **3** | **GND** | Same as pin 1. | |
| **4** | **RF IN** | RF input pin. This pin is NOT internally DC blocked. A DC blocking capacitor, suitable for the frequency of operation, should be used in most applications. DC coupling of the input is not allowed, because this will override the internal feedback loop and cause temperature instability. | |
| **5** | **GND** | Same as pin 1. | |
| **6** | **GND** | Same as pin 1. | |
| **7** | **GND** | Same as pin 1. | |
| **8** | **RF OUT** | RF output and bias pin. Biasing is accomplished with an external series resistor and choke inductor to $V_{CC}$. The resistor is selected to set the DC current into this pin to a desired level. The resistor value is determined by the following equation: $R = \frac{(V_{CC} - V_{DEVICE})}{I_{CC}}$ Care should also be taken in the resistor selection to ensure that the current into the part never exceeds maximum datasheet operating current over the planned operating temperature. This means that a resistor between the supply and this pin is always required, even if a supply near 5.0V is available, to provide DC feedback to prevent thermal runaway. Alternatively, a constant current supply circuit may be implemented. Because DC is present on this pin, a DC blocking capacitor, suitable for the frequency of operation, should be used in most applications. The supply side of the bias network should also be well bypassed. |  |
| **9** | **GND** | Same as pin 1. | |

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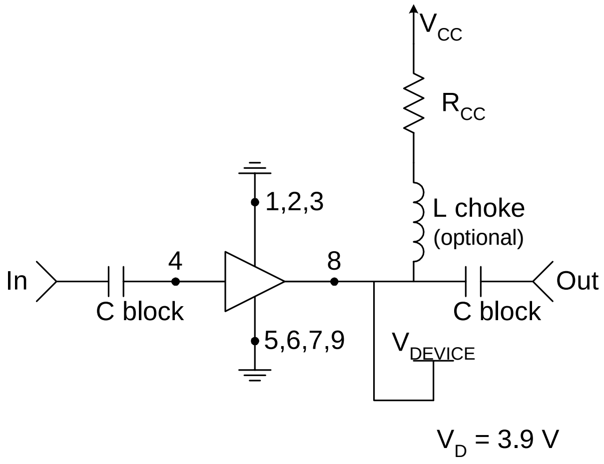
## Typical Bias Configuration

Application notes related to biasing circuit, device footprint, and thermal considerations are available on request.



| Recommended Bias Resistor Values | | | | | | |
|---|---|---|---|---|---|---|
| Supply Voltage, $V_{CC}$ (V) | 5 | 8 | 10 | 12 | 15 | 20 |
| Bias Resistor, $R_{CC}$ (Ω) | 22 | 81 | 122 | 162 | 222 | 322 |

## Application Notes

**Die Attach**

The die attach process mechanically attaches the die to the circuit substrate. In addition, it electrically connects the ground to the trace on which the chip is mounted, and establishes the thermal path by which heat can leave the chip.

**Wire Bonding**

Electrical connections to the chip are made through wire bonds. Either wedge or ball bonding methods are acceptable practices for wire bonding.

**Assembly Procedure**

Epoxy or eutectic die attach are both acceptable attachment methods. Top and bottom metallization are gold. Conductive silver-filled epoxies are recommended. This procedure involves the use of epoxy to form a joint between the backside gold of the chip and the metallized area of the substrate. A 150°C cure for 1 hour is necessary. Recommended epoxy is Ablebond 84-1LMI from Ablestik.

**Bonding Temperature (Wedge or Ball)**

It is recommended that the heater block temperature be set to 160°C±10°C.

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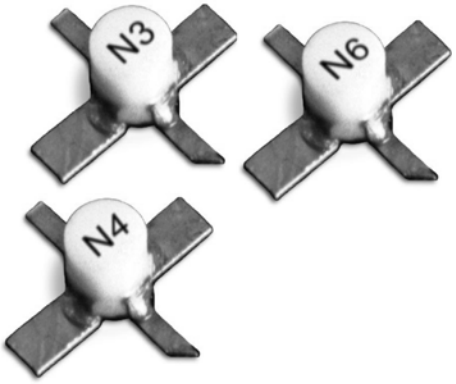
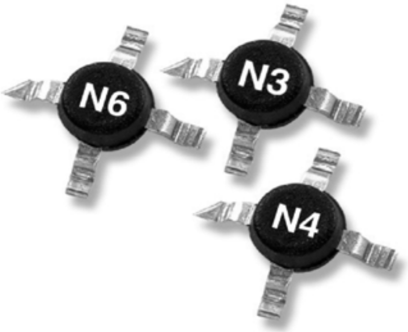
# Extended Frequency InGaP Amplifier Designer's Tool Kit
# NBB-X-K1

This tool kit was created to assist in the design-in of the RFMD NBB- and NLB-series InGap HBT gain block amplifiers. Each tool kit contains the following.

- 5 each NBB-300, NBB-310 and NBB-400 Ceramic Micro-X Amplifiers
- 5 each NLB-300, NLB-310 and NLB-400 Plastic Micro-X Amplifiers
- 2 Broadband Evaluation Boards and High Frequency SMA Connectors
- Broadband Bias Instructions and Specification Summary Index for ease of operation





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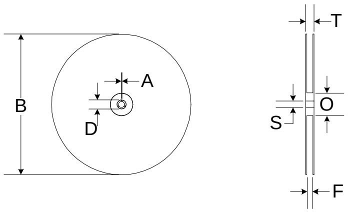
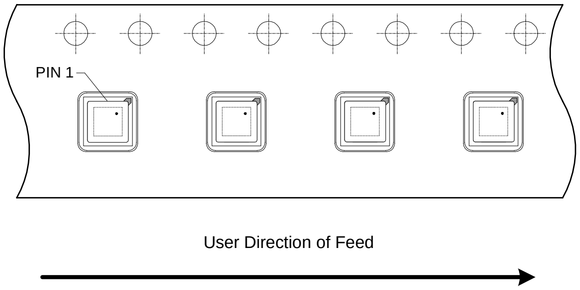
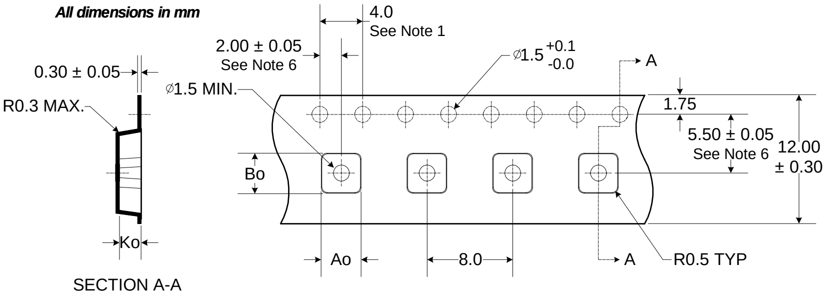
# Tape and Reel Dimensions

All Dimensions in Millimeters



| 330 mm (13") REEL | | | Micro-X, MPGA | |
|---|---|---|---|---|
| | **ITEMS** | **SYMBOL** | **SIZE (mm)** | **SIZE (inches)** |
| **FLANGE** | Diameter | B | 330 +0.25/-4.0 | 13.0 +0.079/-0.158 |
| | Thickness | T | 18.4 MAX | 0.724 MAX |
| | Space Between Flange | F | 12.4 +2.0 | 0.488 +0.08 |
| **HUB** | Outer Diameter | O | 102.0 REF | 4.0 REF |
| | Spindle Hole Diameter | S | 13.0 +0.5/-0.2 | 0.512 +0.020/-0.008 |
| | Key Slit Width | A | 1.5 MIN | 0.059 MIN |
| | Key Slit Diameter | D | 20.2 MIN | 0.795 MIN |





**NOTES:**
1. 10 sprocket hole pitch cumulative tolerance ±0.2.
2. Camber not to exceed 1 mm in 100 mm.
3. Material: PS+C
4. Ao and Bo measured on a plane 0.3 mm above the bottom of the pocket.
5. Ko measured from a plane on the inside bottom of the pocket to the surface of the carrier.
6. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.

Ao = 3.6 MM
Bo = 3.6 MM
Ko = 1.7 MM

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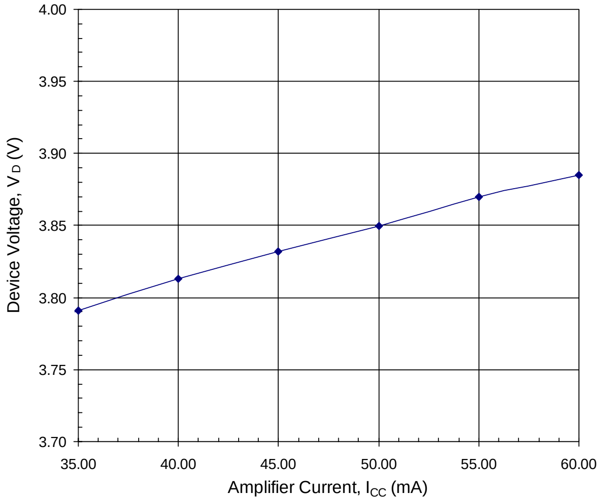
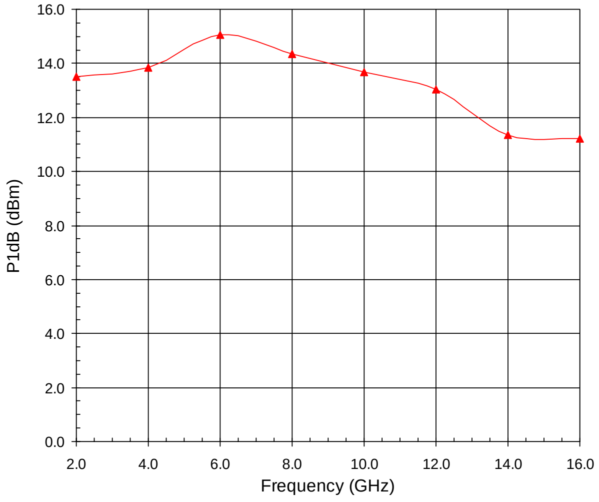
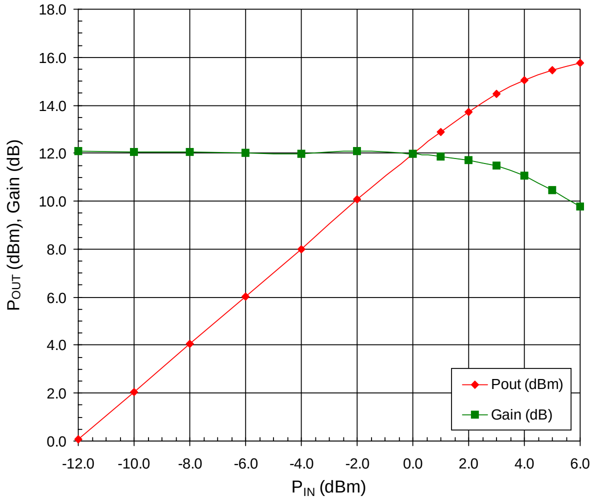


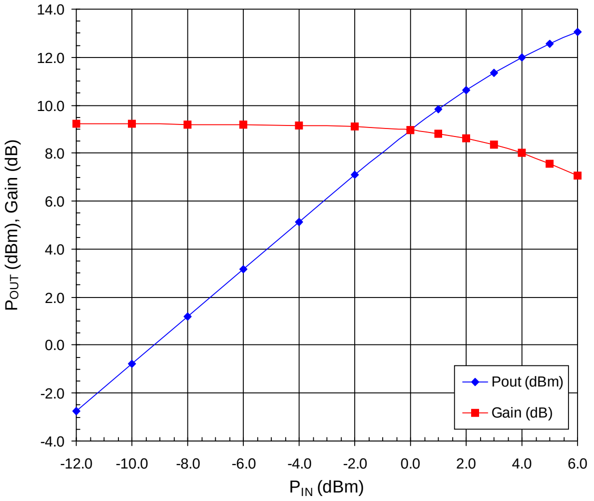
Device Voltage versus Amplifier Current



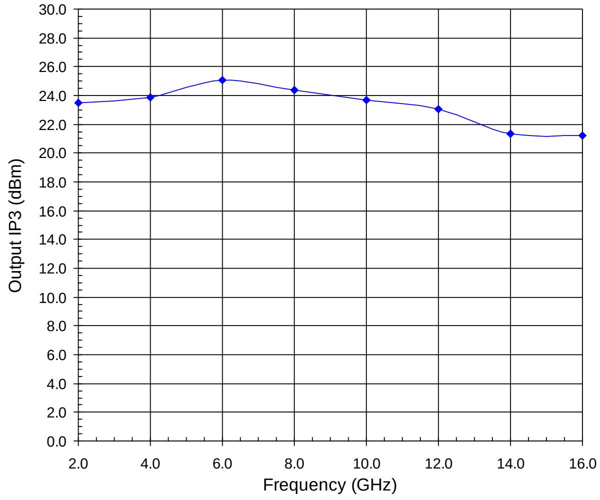
P1dB versus Frequency at +25°C



$P_{OUT}$/Gain versus $P_{IN}$ at 6 GHz



$P_{OUT}$/Gain versus $P_{IN}$ at 14 GHz



Third Order Intercept versus Frequency at +25°C

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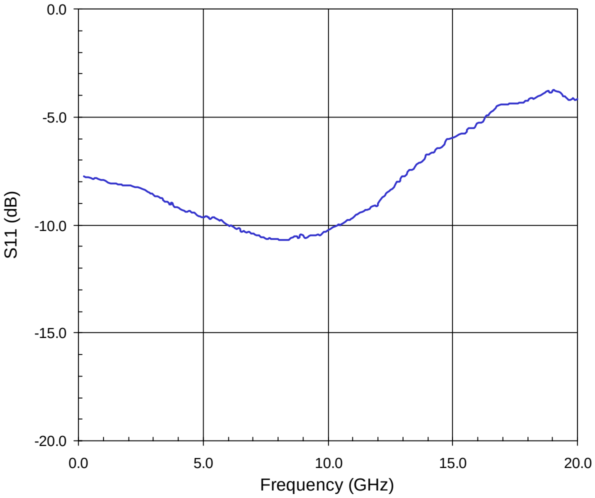
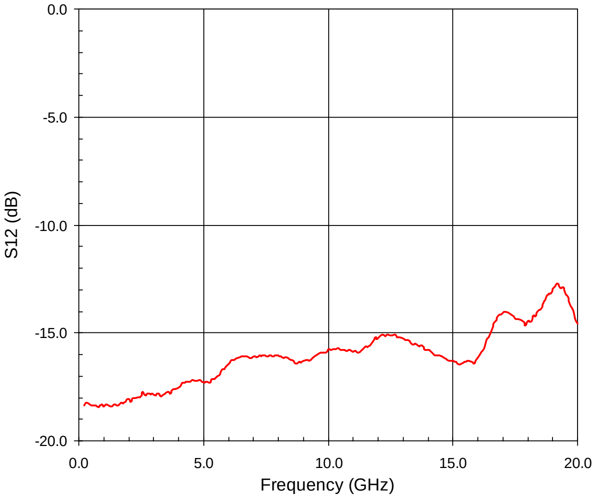
Note: The s-parameter gain results shown below include device performance as well as evaluation board and connector loss variations. The insertion losses of the evaluation board and connectors are as follows:

1GHz to 4GHz=-0.06dB
5GHz to 9GHz=-0.22dB
10GHz to 14GHz=-0.50dB
15GHz to 20GHz=-1.08dB

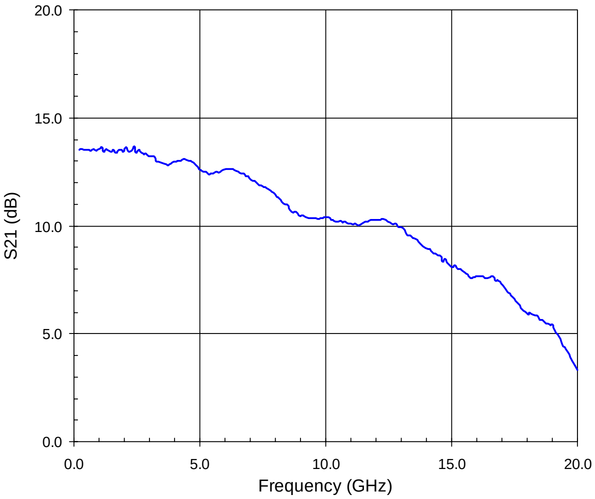
**S11 versus Frequency at +25°C**



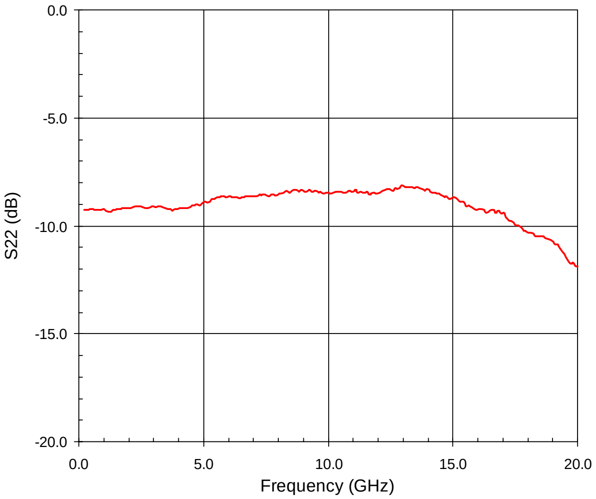
**S12 versus Frequency at +25°C**



**S21 versus Frequency at +25°C**



**S22 versus Frequency at +25°C**



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