

## GRF4001

### BROADBAND LNA / LINEAR DRIVER 0.1 to 6 GHz

#### FEATURES

- Flexible Bias Voltage and Current
- Internally Matched to 50  $\Omega$
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package

#### Reference: 3.3 V / 45 mA / 2.5 GHz

- Gain: 15.5 dB
- OIP3: 30.5 dBm
- OP1dB: 16.5 dBm
- Evaluation Board Noise Figure: 0.9 dB

#### APPLICATIONS

- Linear Driver Amplifier
- Small Cells and Cellular Repeaters
- Distributed Antenna Systems
- First Stage LNA
- Microwave Backhaul
- C-Band Amplifiers
- Low Voltage Radios

#### DESCRIPTION

The GRF4001 is a broadband low noise gain block designed for small cell, wireless infrastructure and other high-performance applications. It exhibits outstanding broadband noise figure (NF), linearity and return losses over 0.1 to 6 GHz with a single match.

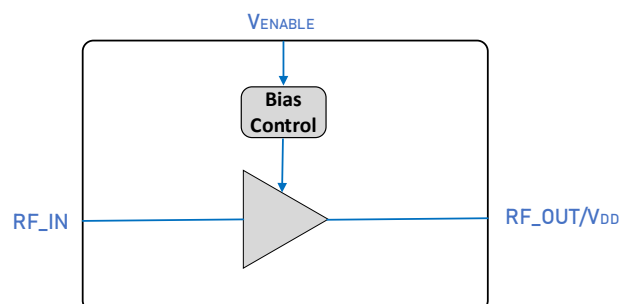
Configured as a first stage LNA, linear driver or cascaded gain block, GRF4001 offers high levels of reuse both within a design and across platforms. The device is typically operated from a supply voltage ( $V_{DD}$ ) of 3.3 volts with a selectable  $I_{DDQ}$  range of 10 to 50 mA for optimal efficiency and linearity.  $V_{DD} > 3.6$  volts is not recommended for applications below 700 MHz.

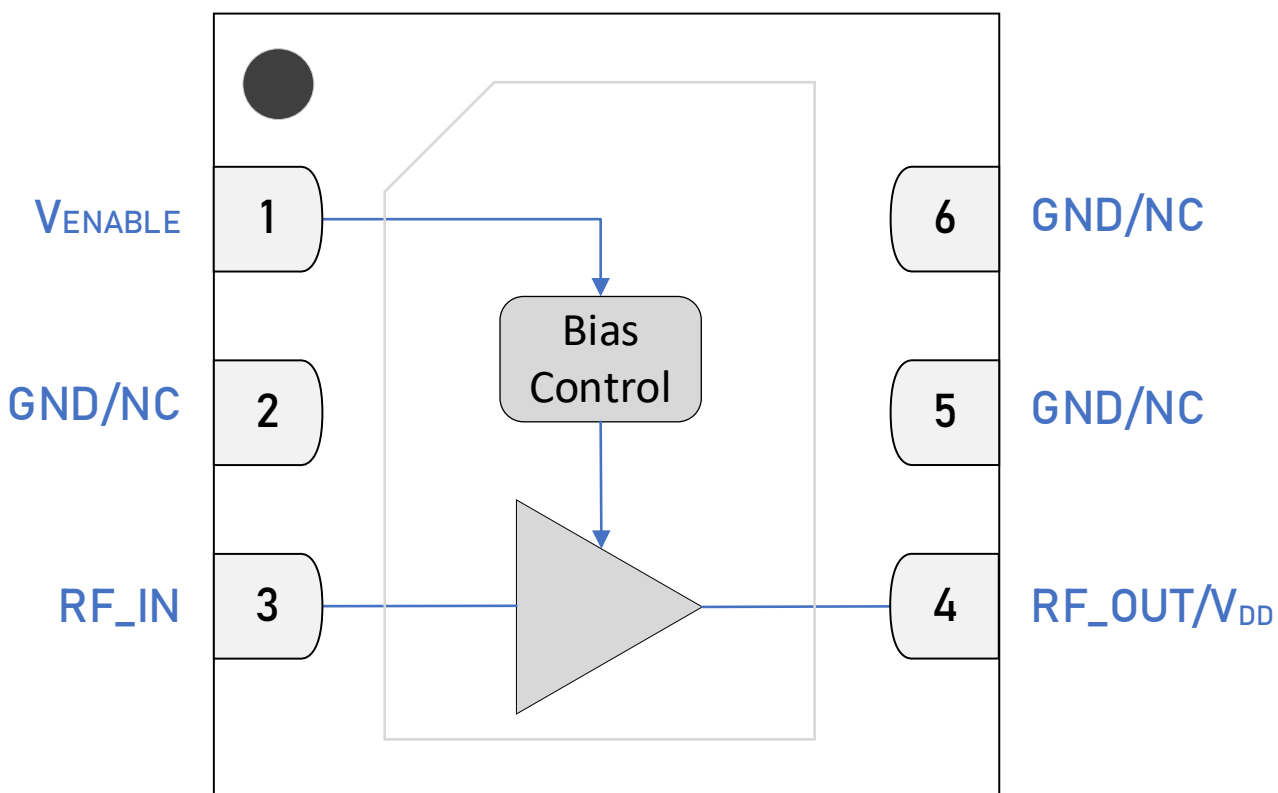
The GRF4001 is internally matched to 50  $\Omega$  at the input and output ports, needing only external DC blocks and a bias choke on the output.

Please consult with the GRF applications engineering team for custom tuning/evaluation board data and S-parameters.

Additional tunes can be found on the GRF4001 "Custom Tunes" product page: [GRF4001 Custom Tunes](#)

#### BLOCK DIAGRAM





1.5 x 1.5 mm DFN-6 Pin Out (Top View)

## Pin Assignments

| Pin      | Name                   | Description          | Note                                                                                                                                                                                                                      |
|----------|------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1        | V <sub>ENABLE</sub>    | Enable Voltage Input | V <sub>ENABLE</sub> and series resistor set I <sub>DDQ</sub> . V <sub>ENABLE</sub> ≤ 0.2 volts disables device. On die pull-down resistor will turn the device off if this node is allowed to float.                      |
| 2, 5, 6  | GND/NC                 | Ground or No Connect | No internal connection to die. We recommend connecting these pins to ground.                                                                                                                                              |
| 3        | RF_IN                  | LNA RF Input         | Internally matched to 50 Ω. An external DC blocking capacitor must be used.                                                                                                                                               |
| 4        | RF_OUT/V <sub>DD</sub> | LNA RF Output        | Internally matched to 50 Ω. V <sub>DD</sub> must be applied through a choke to this pin.                                                                                                                                  |
| PKG BASE | GND                    | Ground               | Provides DC and RF ground for LNA, as well as thermal heat sink. Recommend multiple 8 mil vias beneath the package for optimal RF and thermal performance. Refer to evaluation board top layer graphic on schematic page. |

## Absolute Ratings

| Parameter                                                   | Symbol          | Min. | Max. | Unit |
|-------------------------------------------------------------|-----------------|------|------|------|
| Supply Voltage                                              | $V_{DD}$        | 0    | 6    | V    |
| RF Input Power: Load VSWR < 2:1, $V_{DD} = 5$ V.            | $P_{IN\ MAX}$   |      | 17   | dBm  |
| Operating Temperature (package base).                       | $T_{PKG\ BASE}$ | -40  | 105  | °C   |
| Maximum Channel Temperature (MTTF > 10 <sup>6</sup> hours). | $T_{MAX}$       |      | 170  | °C   |
| Maximum Dissipated Power                                    | $P_{DISS\ MAX}$ |      | 300  | mW   |

## Electrostatic Discharge

|                  |     |     |  |   |
|------------------|-----|-----|--|---|
| Human Body Model | HBM | 250 |  | V |
|------------------|-----|-----|--|---|

## Storage

|                            |           |     |     |    |
|----------------------------|-----------|-----|-----|----|
| Storage Temperature        | $T_{STG}$ | -65 | 150 | °C |
| Moisture Sensitivity Level | MSL       |     | 1   | -- |



**Caution! ESD Sensitive Device.**

**Exceeding Absolute Maximum Rating conditions may cause permanent damage.**

Note: For additional information, please refer to [Package Manufacturing Information | Guerrilla RF \(guerrilla-rf.com\)](#)



All Guerrilla RF products are provided in RoHS compliant lead (Pb)-free packaging requiring no exemptions. Additional information for this topic can be found at this link - [Environmental and Restricted Substance Statement Library](#)

## Recommended Operating Conditions

| Parameter                            | Symbol          | Specification |      |      | Unit     | Condition                                                                                   |
|--------------------------------------|-----------------|---------------|------|------|----------|---------------------------------------------------------------------------------------------|
|                                      |                 | Min.          | Typ. | Max. |          |                                                                                             |
| Supply Voltage                       | $V_{DD}$        | 1.8           | 3.3  | 6    | V        |                                                                                             |
| Operating Temperature (package base) | $T_{PKG\ BASE}$ | -40           |      | 105  | °C       |                                                                                             |
| RF Frequency Range                   | $F_{RF}$        | 0.1           | 2.5  | 3.8  | GHz      | Typical application schematic with external matching components ( <b>notes 1 &amp; 2</b> ). |
| RF_IN Port Impedance                 | $Z_{RF\_IN}$    |               | 50   |      | $\Omega$ |                                                                                             |
| RF_OUT Port Impedance                | $Z_{RF\_OUT}$   |               | 50   |      | $\Omega$ |                                                                                             |

**Note 1:** Operation outside of this range is supported by using different custom tunes. Examples of other optimized tunes can be found here: [GRF4001 Custom Tunes](#)

**Note 2:** Contact the Guerrilla RF applications team for guidance on optimizing the tuning of the device for alternative bands.

## Nominal Operating Parameters – General

The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.1 to 6 GHz tuning set.  $V_{DD} = 3.3\text{ V}$ ,  $F_{TEST} = 2.5\text{ GHz}$ ,  $50\ \Omega$  system impedance,  $T_{PKG\ BASE} = 25\ ^\circ\text{C}$ . Evaluation board losses are included within the specifications.

| Parameter           | Symbol     | Specification |      |      | Unit | Condition                                               |
|---------------------|------------|---------------|------|------|------|---------------------------------------------------------|
|                     |            | Min.          | Typ. | Max. |      |                                                         |
| Supply Current      | $I_{DD}$   |               | 45   |      | mA   | $V_{DD} = 3.3\text{ V}$ , $V_{ENABLE} = 3.3\text{ V}$ . |
| Switching Rise Time | $T_{RISE}$ |               | 700  |      | ns   | Gain mode to Disabled mode ( <b>note 3</b> ).           |
| Switching Fall Time | $T_{FALL}$ |               | 500  |      | ns   | Disabled mode to Gain mode ( <b>note 4</b> ).           |

### Disabled Mode

|                 |               |  |   |    |               |                                                       |
|-----------------|---------------|--|---|----|---------------|-------------------------------------------------------|
| Leakage Current | $I_{LEAKAGE}$ |  | 2 | 20 | $\mu\text{A}$ | $V_{DD} = 3.3\text{ V}$ , $V_{ENABLE} = 0\text{ V}$ . |
|-----------------|---------------|--|---|----|---------------|-------------------------------------------------------|

### Thermal Data

|                                    |               |  |     |  |                           |                                                 |
|------------------------------------|---------------|--|-----|--|---------------------------|-------------------------------------------------|
| Thermal Resistance (Infrared Scan) | $\Theta_{JC}$ |  | 225 |  | $^\circ\text{C}/\text{W}$ | On standard evaluation board ( <b>note 5</b> ). |
|------------------------------------|---------------|--|-----|--|---------------------------|-------------------------------------------------|

**Note 3:** Switching Time: 50% of  $V_{ENABLE}$  to 90% of  $P_{OUT}$ .

**Note 4:** Switching Time: 50% of  $V_{ENABLE}$  to 10% of  $P_{OUT}$ .

**Note 5:** MTTF >  $10^6$  hours for  $T_{CHANNEL} \leq 170\ ^\circ\text{C}$ .

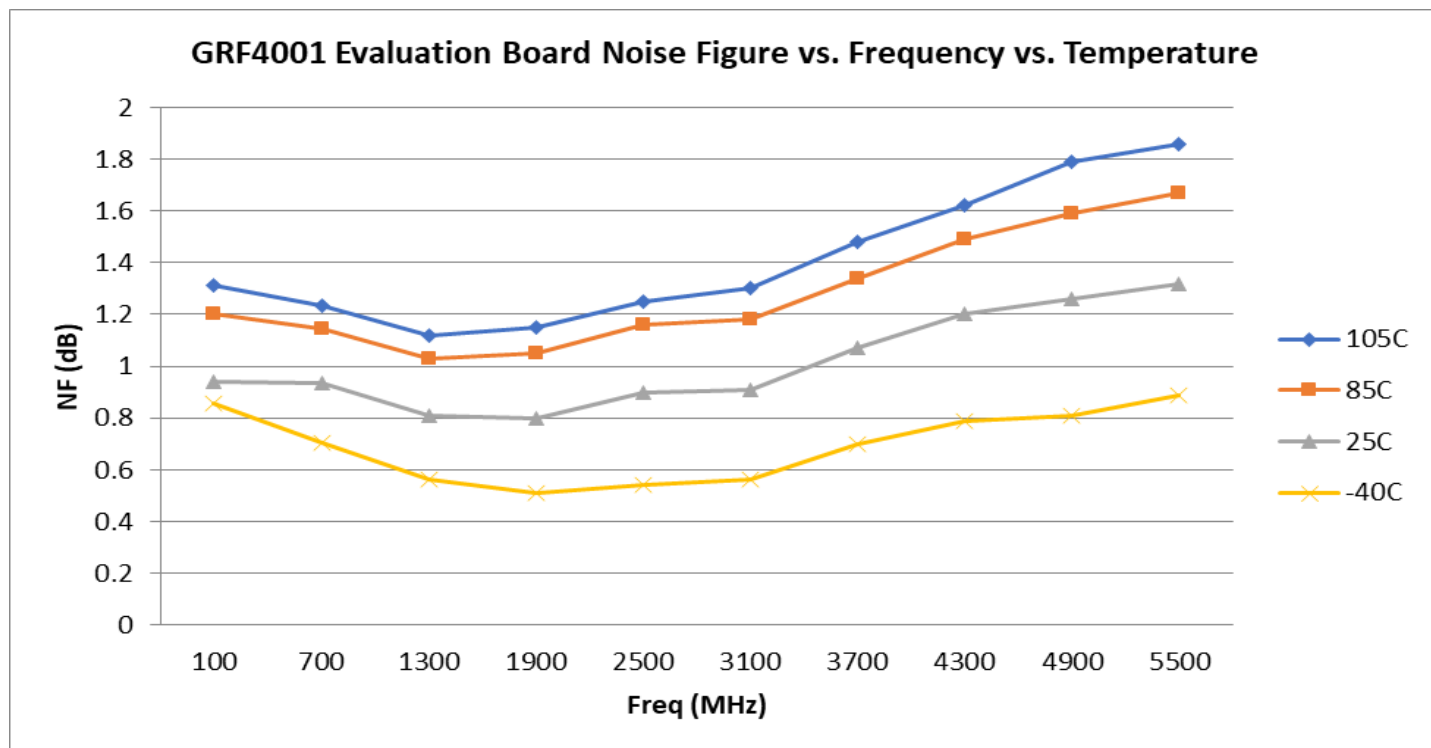
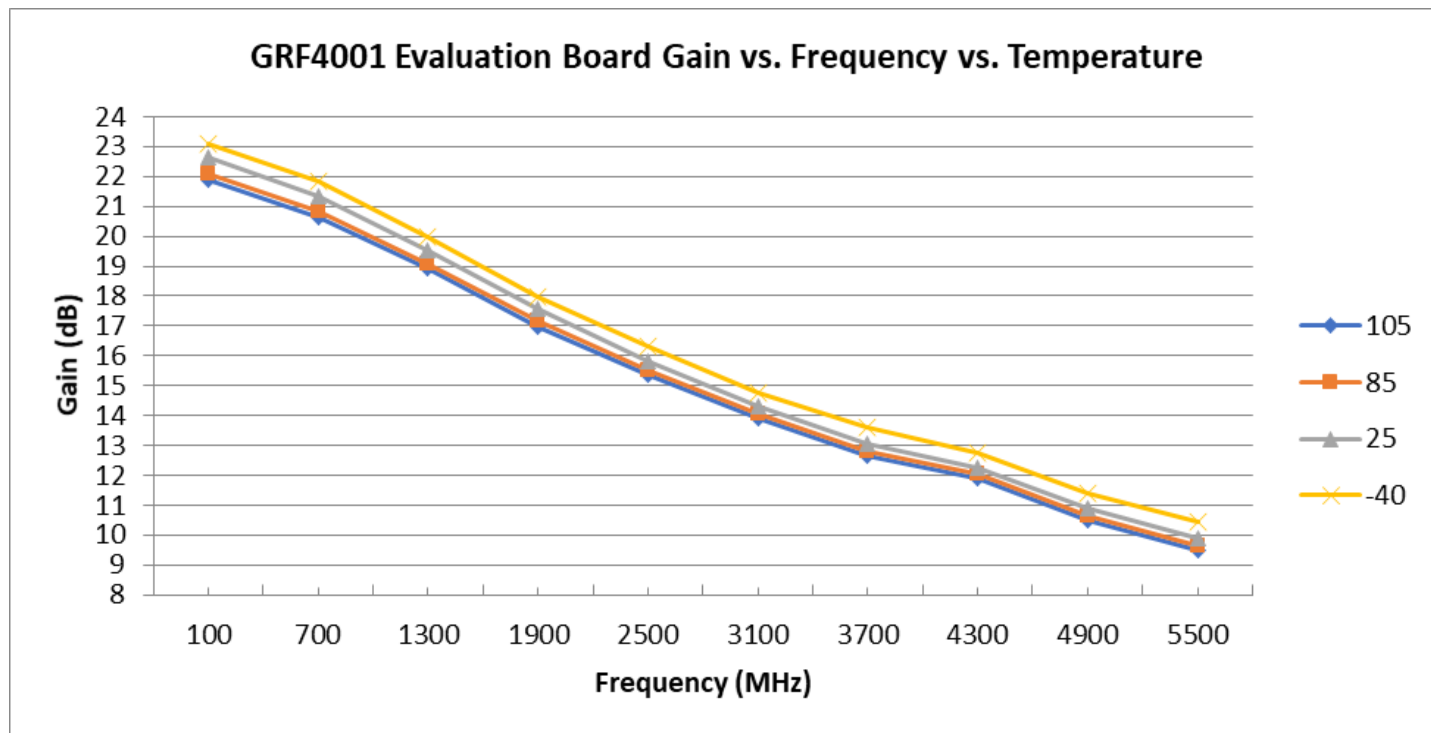
**Note 6:** GRF4001 is not recommended for applications below 700 MHz with  $V_{DD} > 3.6\text{ V}$ .

## Nominal Operating Parameters – RF

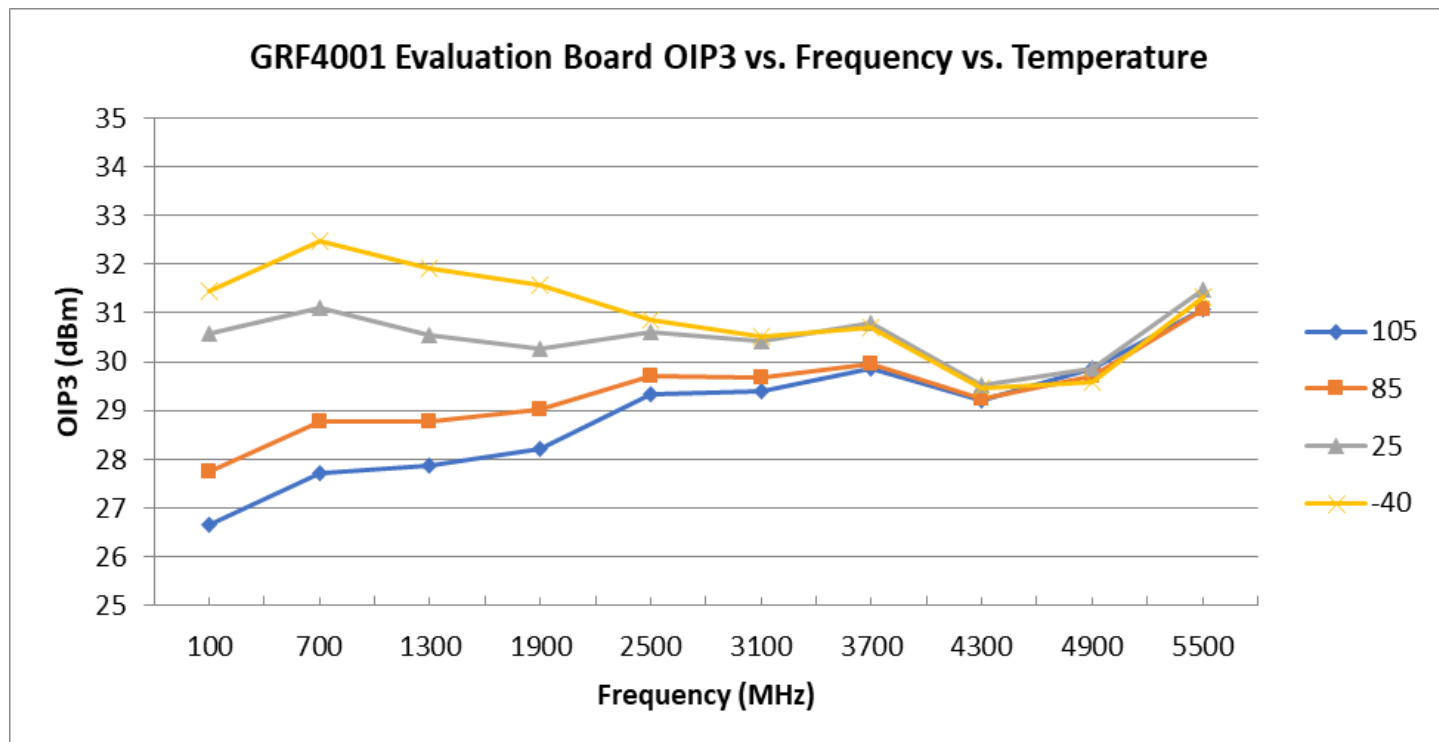
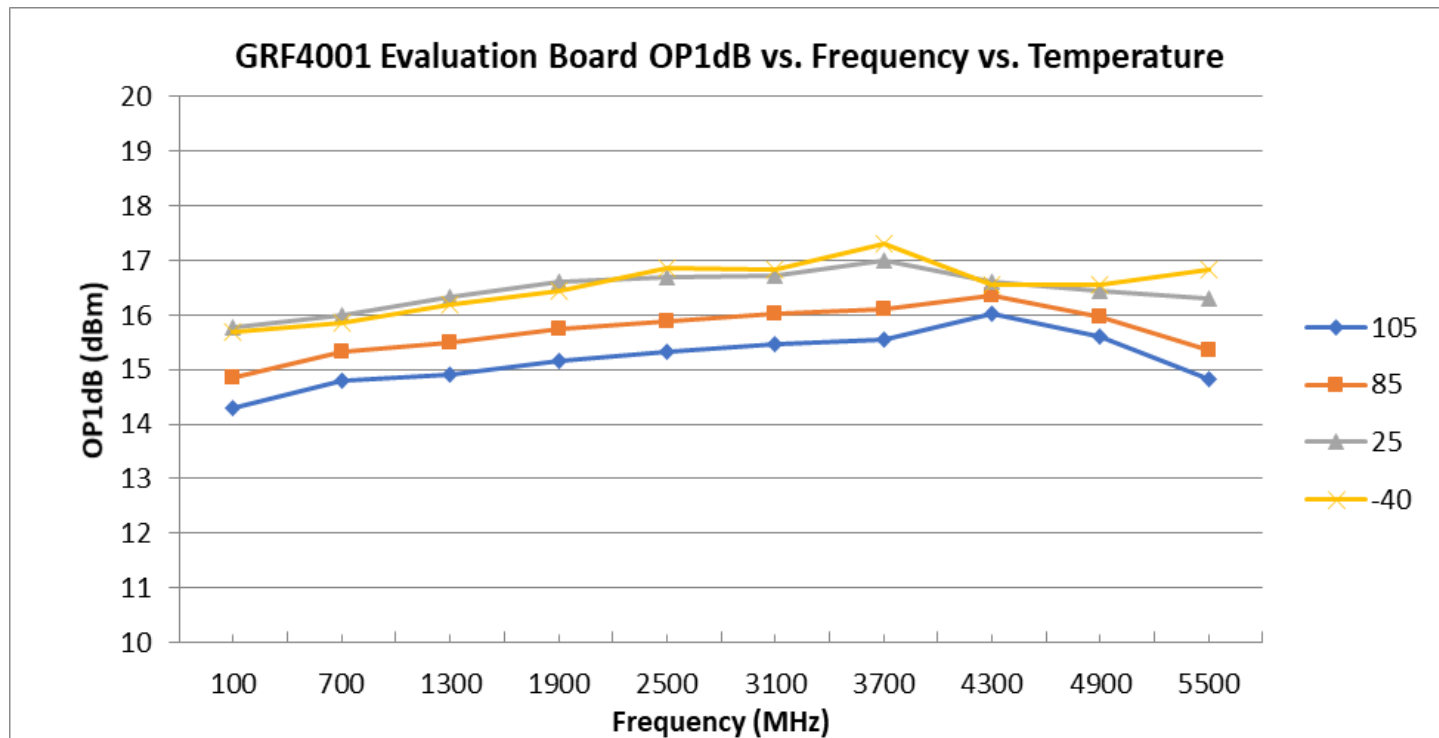
The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.1 to 6 GHz tuning set.  $V_{DD} = 3.3\text{ V}$ ,  $F_{TEST} = 2.5\text{ GHz}$ ,  $50\ \Omega$  system impedance,  $T_{PKG\ BASE} = 25\ ^\circ\text{C}$ . Evaluation board losses are included within the specifications.

| Parameter                                    | Symbol | Specification |      |      | Unit | Condition                                                      |
|----------------------------------------------|--------|---------------|------|------|------|----------------------------------------------------------------|
|                                              |        | Min.          | Typ. | Max. |      |                                                                |
| Gain                                         | S21    | 14.5          | 15.5 |      | dB   |                                                                |
| Noise Figure                                 | NF     |               | 0.9  |      | dB   | On standard evaluation board.                                  |
| Output 3 <sup>rd</sup> Order Intercept Point | OIP3   |               | 30.5 |      | dBm  | 0 dBm $P_{OUT}$ per tone at 2 MHz spacing (2499 and 2501 MHz). |
| Output 1 dB Compression Power                | OP1dB  | 14.5          | 16.5 |      | dBm  |                                                                |

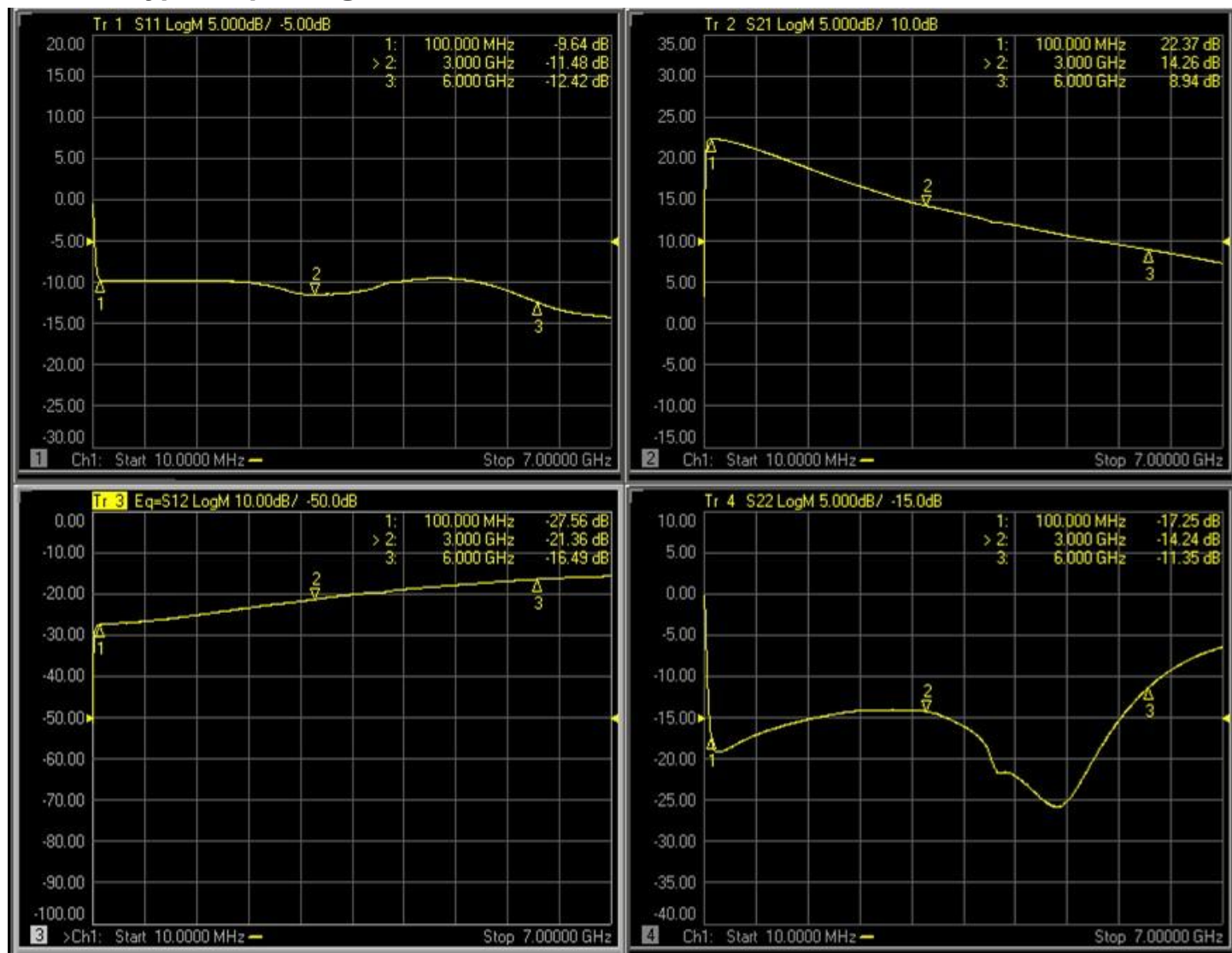
## GRF4001 Typical Operating Curves: 0.1 to 6 GHz Tune



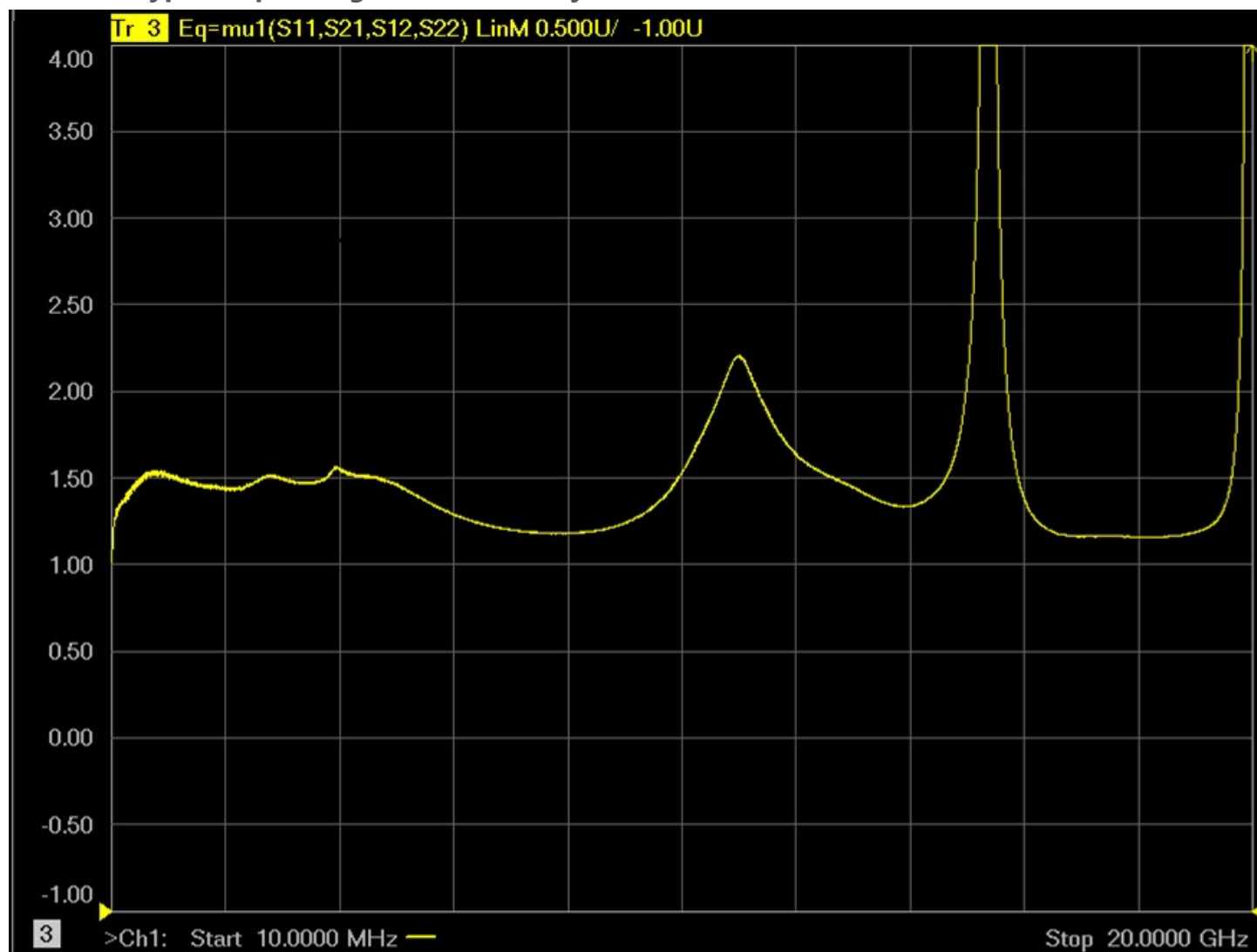
## GRF4001 Typical Operating Curves: 0.1 to 6 GHz Tune



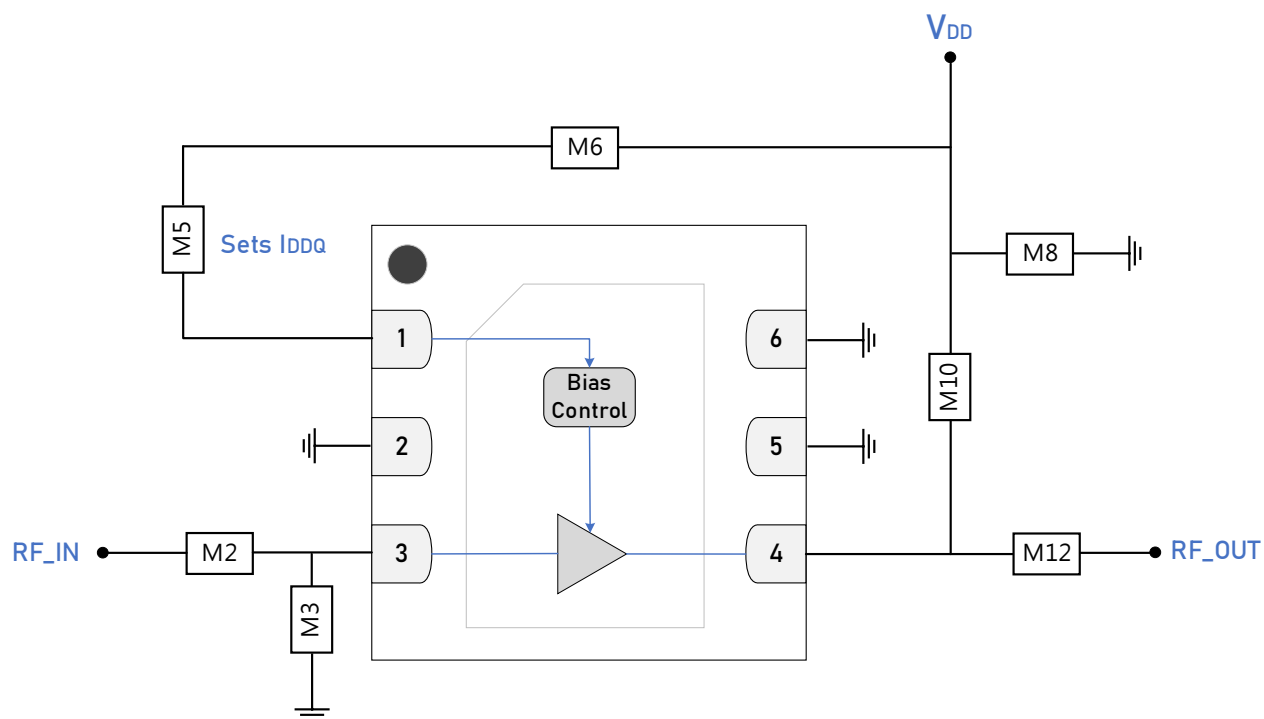
## GRF4001 Typical Operating Curves: S-Parameters (0.1 to 6 GHz Tune)



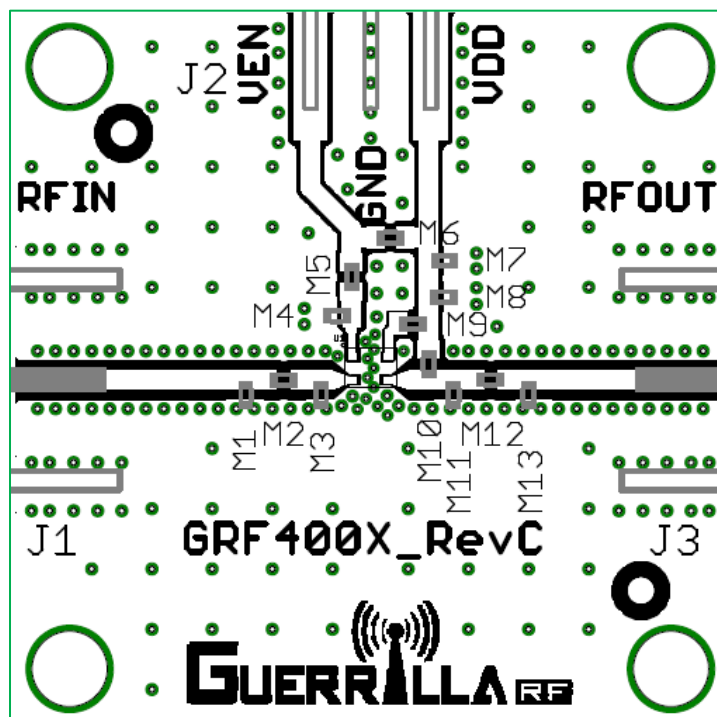
### GRF4001 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



Note:  $\mu \geq 1.0$  implies unconditional stability.



GRF4001 Standard Evaluation Board Schematic

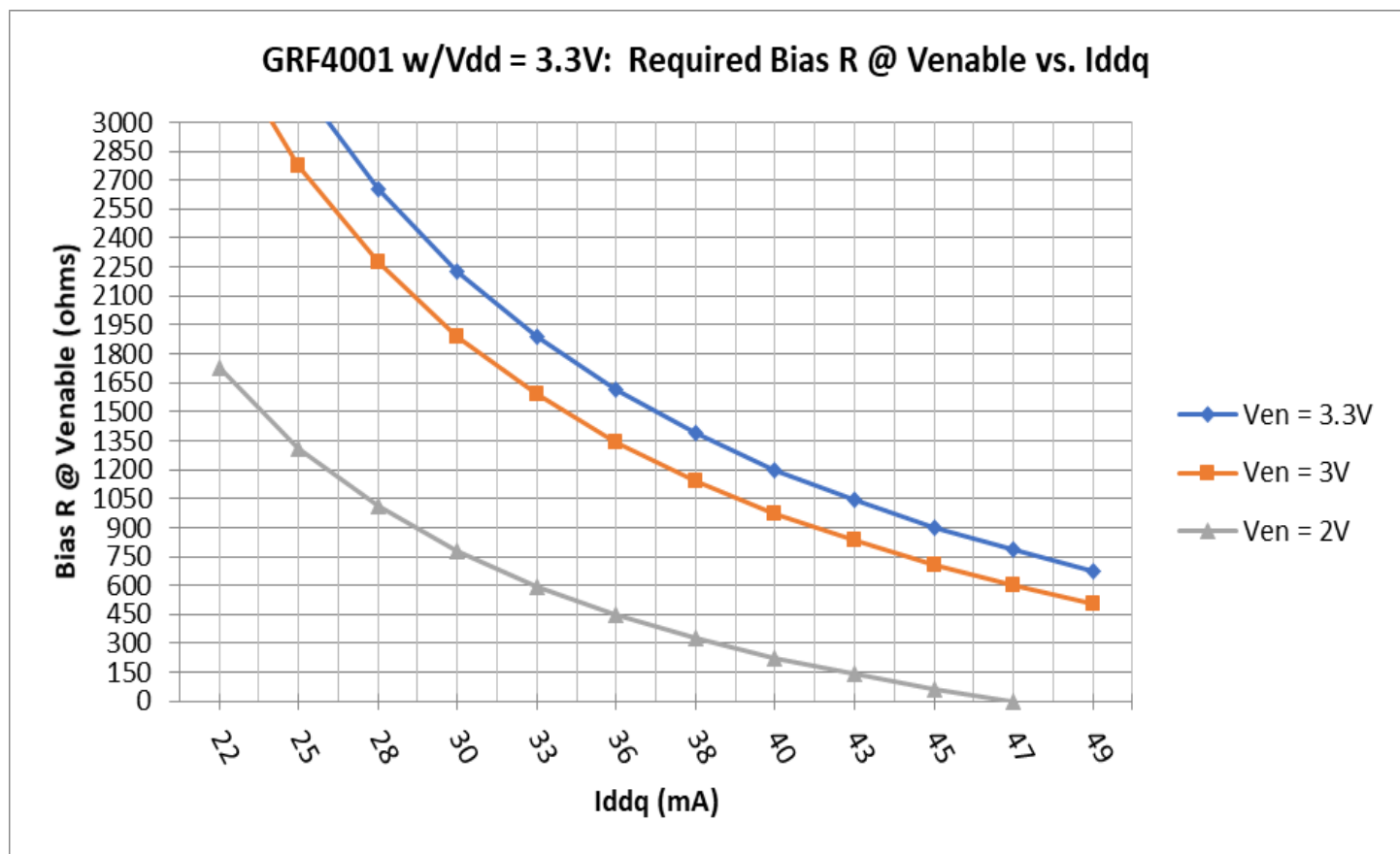


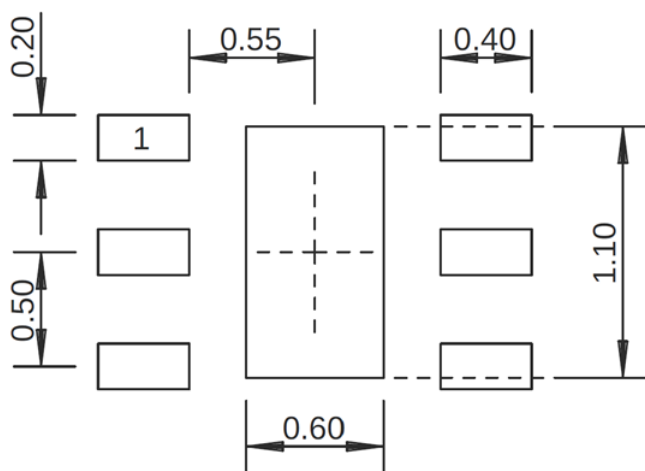
GRF4001 Evaluation Board Assembly Diagram

### GRF4001 Evaluation Board Assembly Diagram Reference: 0.1 to 6 GHz Tune

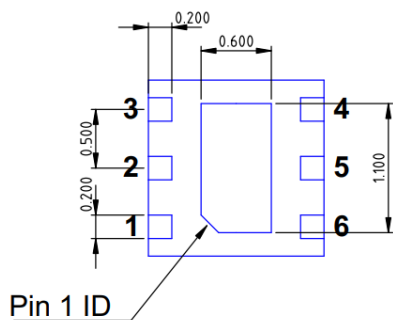
| Component            | Type              | Manufacturer | Family | Value       | Package Size | Substitution |
|----------------------|-------------------|--------------|--------|-------------|--------------|--------------|
| M2                   | Capacitor         | Murata       | GRM    | 100 pF      | 0402         | ok           |
| M3                   | Capacitor         | Murata       | GJM    | 0.2 pF      | 0402         | ok           |
| M5 (sets $I_{DDQ}$ ) | Resistor          | Various      | 5%     | see curves  | 0402         | ok           |
| M6                   | Resistor (jumper) | Various      | 5%     | 0 $\Omega$  | 0402         | ok           |
| M8                   | Capacitor         | Murata       | GRM    | 0.1 $\mu$ F | 0402         | ok           |
| M10                  | Inductor          | Coilcraft    | HP     | 220 nH      | 0402         | ok           |
| M12                  | Capacitor         | Murata       | GRM    | 100 pF      | 0402         | ok           |
| Evaluation Board     | GRF400X_RevC      |              |        |             |              |              |

### GRF4001 Bias Resistor Selection Curves

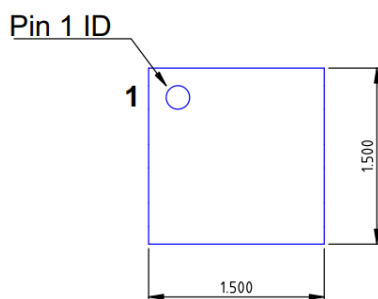




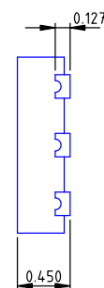
**1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)**



**Bottom View**



**Top View**



**Side View**

### DFN6 1.5x1.5mm

Dimensions in millimeters  
Dimensional Tolerance:  $\pm 0.05$

### 1.5 x 1.5 mm DFN-6 Package Dimensions

## Package Marking Diagram



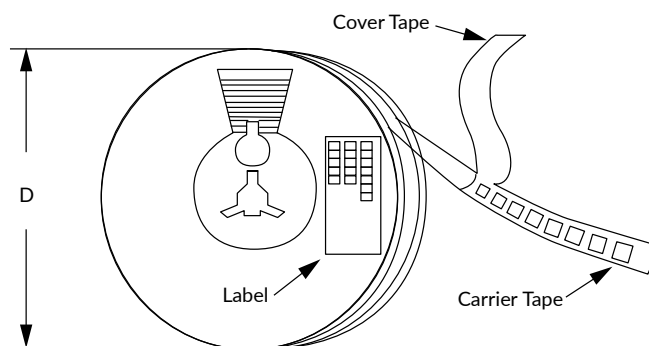
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

## Tape and Reel Information

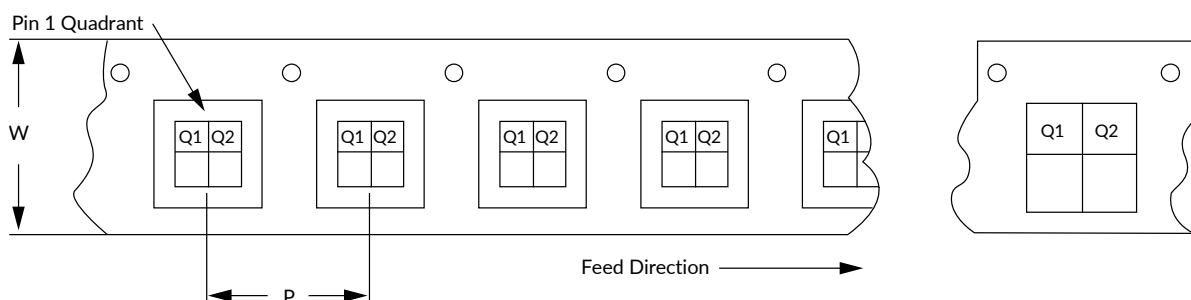
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, which includes units per reel.

Devices are loaded with pins down into the carrier pocket with protective cover tape and reeled onto a plastic reel. Each reel is packaged in a cardboard box. There are product labels on the reel, the protective ESD bag and the outside surface of the box.

For the Tape and Reel Reference Table, please refer to: [Package Manufacturing Information | Guerrilla RF \(guerrilla-rf.com\)](#)



Tape and Reel Packaging with Reel Diameter Noted (D)



Carrier Tape Width (W), Pitch (P), Feed Direction and Pin 1 Quadrant Information

## Revision History

| Revision Date     | Description of Change                                                                 |
|-------------------|---------------------------------------------------------------------------------------|
| March 29, 2018    | Release A Data Sheet.                                                                 |
| February 18, 2025 | Upgraded Data Sheet to new format only. No change to device or device specifications. |
| January 6, 2026   | Changed evaluation board to GRF400X_RevC.                                             |



## Data Sheet Classifications

| Data Sheet Status | Notes                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance           | S-parameter and NF data based on EM simulations for the fully packaged device using foundry-supplied transistor S-parameters. Linearity estimates based on device size, bias condition and experience with related devices.                                                                                                                                                                                                      |
| Preliminary       | All data based on limited evaluation board measurements taken within the Guerrilla RF Applications Lab. All parametric values are subject to change pending the collection of additional data.                                                                                                                                                                                                                                   |
| Release Ø         | All data based on measurements taken with <i>production-released</i> material. TYP values are based on a combination of ATE and bench-level measurements, with MIN/MAX limits defined using <i>modelled estimates</i> that account for part-to-part variations and expected process spreads. Although unlikely, future refinements to the TYP/MIN/MAX values may be in order as multiple lots are processed through the factory. |
| Release A-Z       | All data based on measurements taken with production-released material <i>derived from multiple lots which have been fabricated over an extended period of time</i> . MIN/MAX limits may be refined over previous releases as more statistically significant data is collected to account for process spreads.                                                                                                                   |

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