

GRF2101

HIGH GAIN, ULTRA-LNA

4 to 10 GHz

FEATURES

- Flexible Bias Voltage and Current
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package

Reference: 3.3 V / 18 mA / 5.5 GHz

- Gain: 18 dB
- OIP3: 22 dBm
- OP1dB: 10 dBm
- Evaluation Board Noise Figure: 0.9 dB

APPLICATIONS

- WiFi Access Points
- Mobile WiFi Devices
- 802.11p Vehicle Communications
- Microwave Backhaul

DESCRIPTION

The GRF2101 is an ultra-low noise amplifier (LNA) designed for IEEE 802.11a/n/ac/p applications (5.1 GHz to 5.925 GHz). Over this band, the device exhibits outstanding evaluation board noise figure (NF) of 0.9 dB. The high gain, superior NF, and directivity of its design allows designers to create receiver architectures with outstanding cascaded NF and unconditional stability.

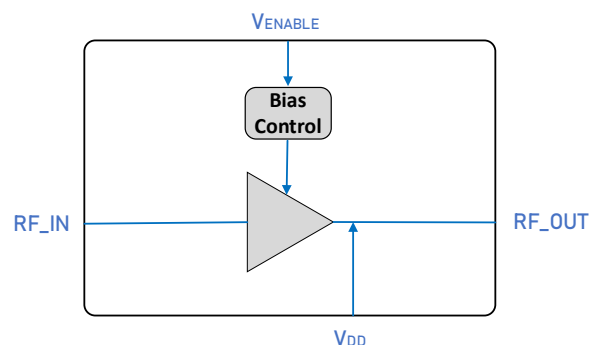
The device can also be tuned up to 10 GHz delivering high gain and low NF.

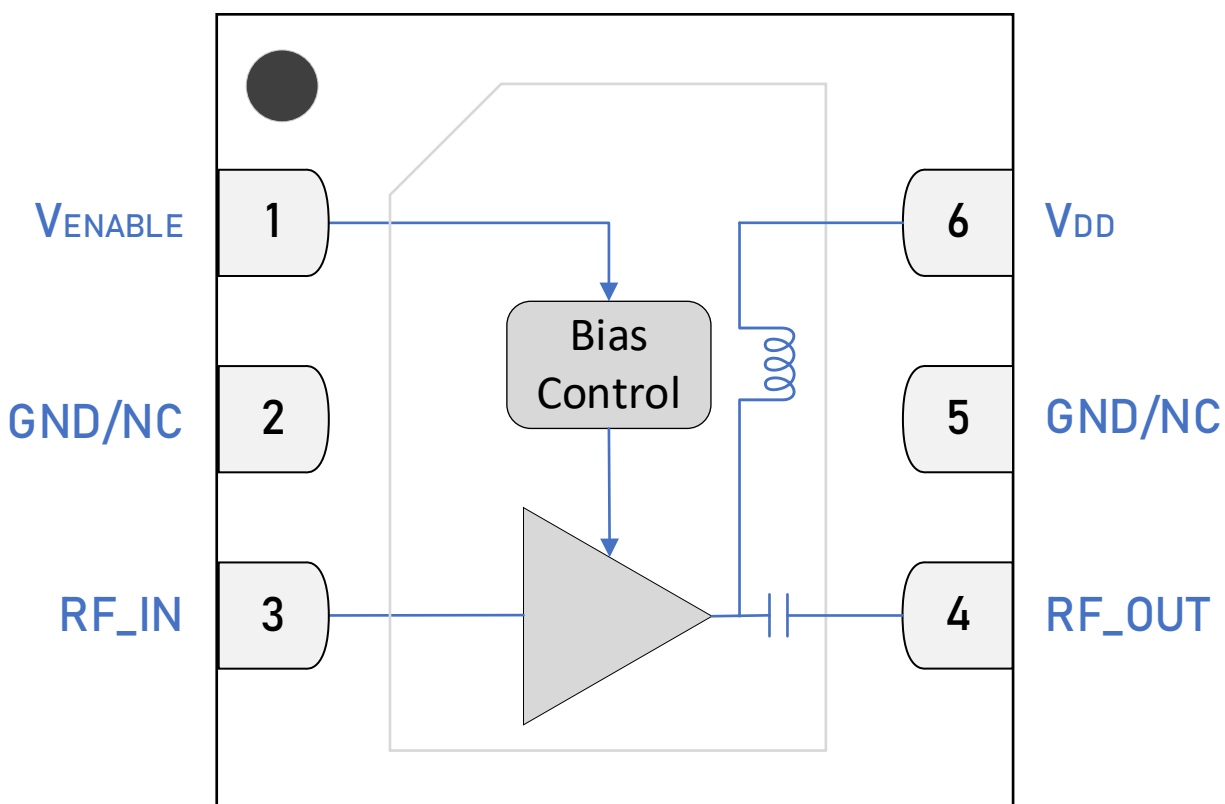
The LNA is operated from a single positive supply of 2.7 to 5 V with a typical bias condition of 3.3 V and 18 mA.

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

Additional tunes can be found on the GRF2101 "Custom Tunes" product page: [GRF2101 Custom Tunes](#)

BLOCK DIAGRAM





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

Pin Assignments

| Pin | Name | Description | Note |
|----------|---------------------|----------------------------|---|
| 1 | V _{ENABLE} | LNA Enable Input | V _{ENABLE} and series resistor set I _{DDQ} . V _{ENABLE} < 0.2 volts disables device. On-die pull-down resistor will turn the part off if this node is allowed to float. |
| 2, 5 | NC | No Connect or Ground | No internal connection to die. These pins can be left unconnected or connected to ground (recommended). Use a via as close to the pin as possible if grounded. |
| 3 | RF_IN | RF Input | An external DC blocking capacitor must be used. |
| 4 | RF_OUT | RF Output | Internally DC blocked. Do not apply DC voltage > 0.2 volts to this node. |
| 6 | V _{DD} | Supply Voltage for the LNA | Distance of cap at M7 to pin 6 strongly influences the device match. Consult evaluation board Gerber files for an effective method of placing this cap that allows tuning flexibility. The value of this cap also affects the gain notch at 2.45 GHz. |
| 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. |

V_{ENABLE} Truth Table:

| V _{DD} | V _{ENABLE} | Mode |
|-----------------|---------------------|---------|
| HIGH | ≥ 1.8 V | LNA ON |
| HIGH | < 0.2 V | LNA OFF |

Absolute Ratings

| Parameter | Symbol | Min. | Max. | Unit |
|--|-----------------|------|------|------|
| Supply Voltage | V_{DD} | 0 | 6 | V |
| RF Input Power: Load VSWR < 2:1, V_{DD} = 3.3 V | $P_{IN\ MAX}$ | | 20 | dBm |
| Operating Temperature (Package Base) | $T_{PKG\ BASE}$ | -40 | 105 | °C |
| Maximum Channel Temperature (MTTF > 10 ⁶ Hours) | T_{MAX} | | 170 | °C |
| Maximum Dissipated Power | $P_{DISS\ MAX}$ | | 200 | 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 to the device.

Note: For additional information, please refer to [Manufacturing Note MN-001 — Package and Manufacturing Information](#).



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} | 2.7 | 3.3 | 6 | V | |
| Operating Temperature (Package Base) | $T_{PKG\ BASE}$ | -40 | | 105 | °C | |
| RF Frequency Range | F_{RF} | 4 | | 10 | GHz | Typical application schematic with external matching components (notes 1 & 2). |
| RF_IN Port Impedance | Z_{RFIN} | | 50 | | Ω | Single-ended. |
| RF_OUT Port Impedance | Z_{RFOUT} | | 50 | | Ω | Single-ended. |

Note 1: Operation outside of this range is supported by using different custom tunes. Examples of other optimized tunes can be found here: [GRF2101 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 5.1 to 5.9 GHz tuning set. $V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = 3.3\text{ V}$, $I_{DDQ} = 18\text{ mA}$, $M4 = 2.9\text{ k}\Omega$, $F_{TEST} = 5.5\text{ GHz}$, $50\text{ }\Omega$ system impedance, $T_{PKG\text{ BASE}} = 25\text{ }^{\circ}\text{C}$. Evaluation board losses are included within the specifications.

| Parameter | Symbol | Specification | | | Unit | Condition |
|----------------------------|--------------|---------------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Supply Current (Quiescent) | I_{DD} | | 18 | | mA | |
| Enable Current | I_{ENABLE} | | 2 | | mA | |
| Switching Rise Time | T_{RISE} | | 500 | | ns | Disabled mode to Gain mode (note 3). |
| Switching Fall Time | T_{FALL} | | 200 | | ns | Gain mode to Disabled mode (note 4). |

Disabled Mode

| | | | | | | |
|-----------------|---------------|--|-----|--|---------------|---|
| Leakage Current | $I_{LEAKAGE}$ | | 250 | | μA | $V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = 0\text{ V}$. |
|-----------------|---------------|--|-----|--|---------------|---|

Thermal Data

| | | | | | | |
|------------------------------------|---------------|--|-----|--|-----------------------------|---|
| Thermal Resistance (Infrared Scan) | Θ_{JC} | | 100 | | $^{\circ}\text{C}/\text{W}$ | On standard evaluation board (note 5). |
|------------------------------------|---------------|--|-----|--|-----------------------------|---|

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} .

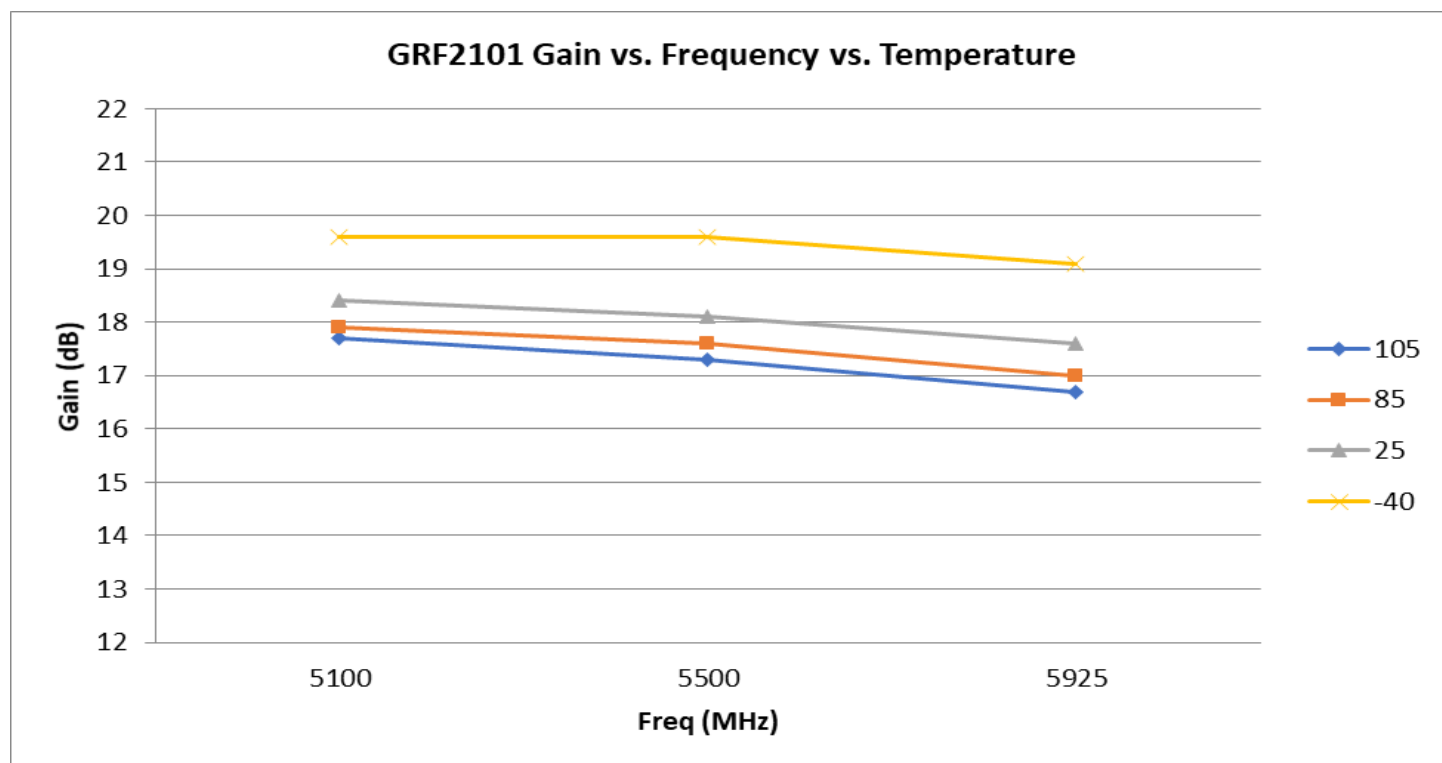
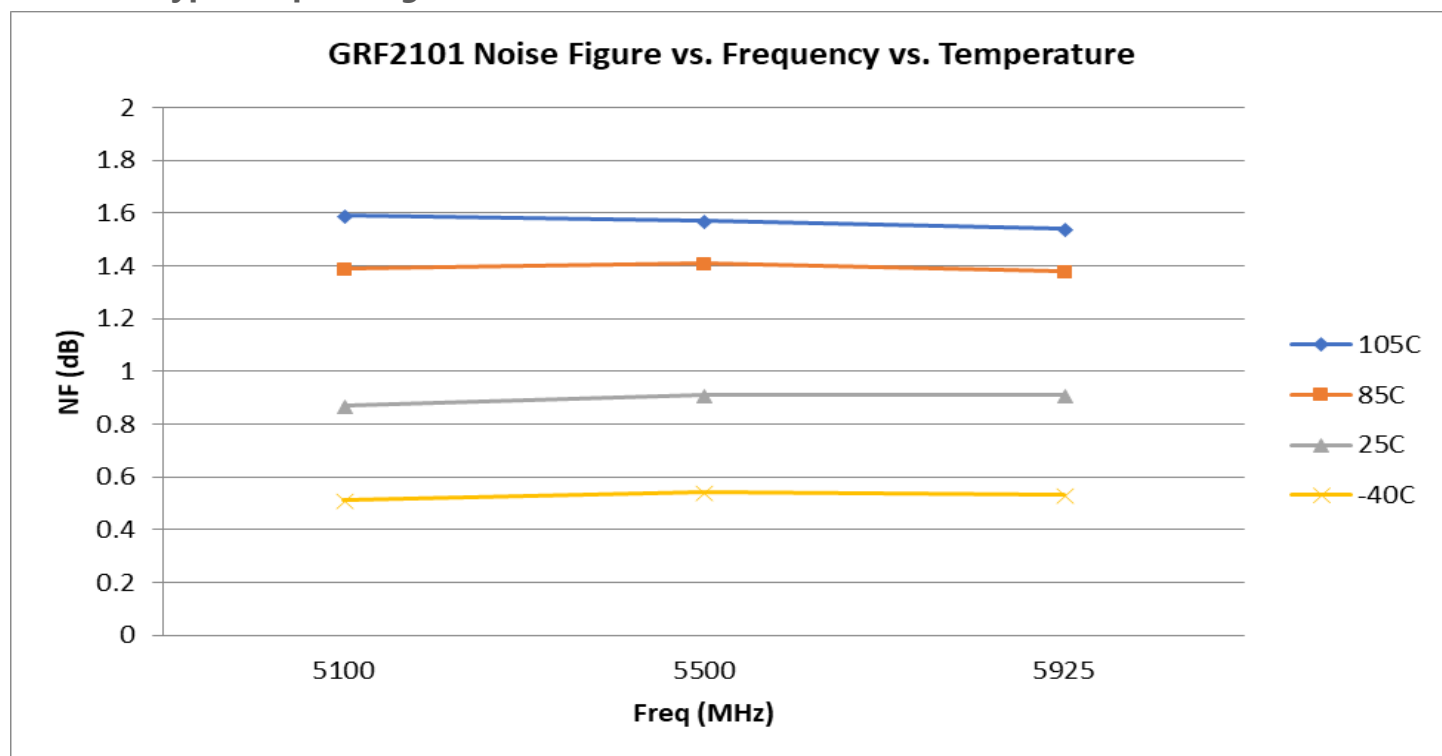
Note 5: MTTF > 10^6 hours for $T_{CHANNEL} < 170\text{ }^{\circ}\text{C}$.

Nominal Operating Parameters – RF

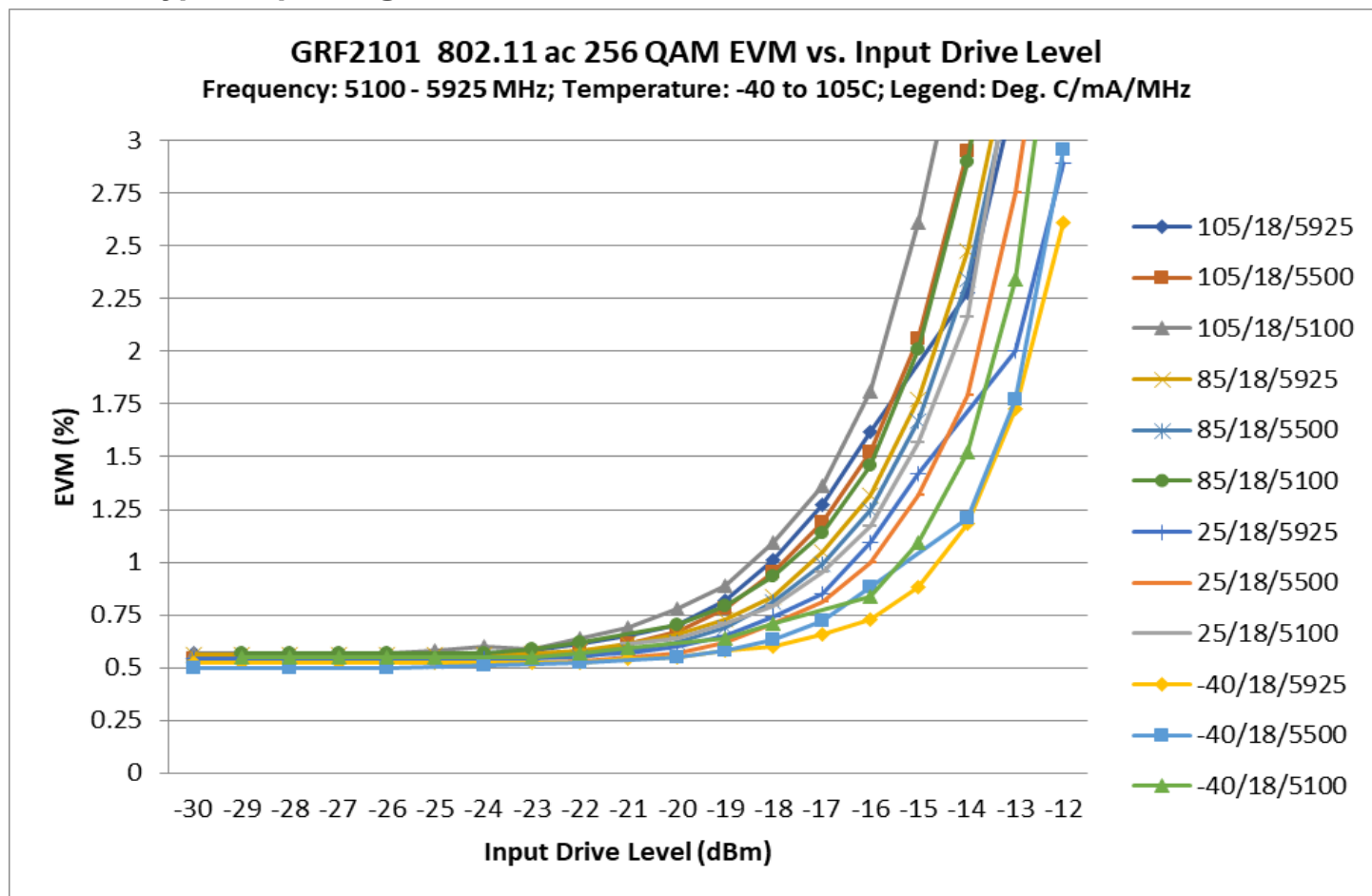
The following conditions apply unless noted otherwise: Typical application schematic using the 5.1 to 5.9 GHz tuning set. $V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = 3.3\text{ V}$, $I_{DDQ} = 18\text{ mA}$, $M4 = 2.9\text{ k}\Omega$, $F_{TEST} = 5.5\text{ GHz}$, $50\text{ }\Omega$ system impedance, $T_{PKG\text{ BASE}} = 25\text{ }^{\circ}\text{C}$. Evaluation board losses are included within the specifications.

| Parameter | Symbol | Specification | | | Unit | Condition |
|----------------------------------|--------|---------------|-------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gain | S21 | 16 | 17.5 | | dB | |
| Reverse Isolation | S12 | | < -30 | | dB | $F_{RF} = 4\text{ to }10\text{ GHz}$. |
| Noise Figure | NF | | 0.9 | 1.1 | dB | On standard evaluation board. |
| Output 3rd Order Intercept Point | OIP3 | | 22 | | dBm | -5 dBm P_{OUT} per Tone at 2 MHz Spacing (5499 and 5501 MHz). |
| Output 1 dB Compression Power | OP1dB | 7.5 | 10 | | dBm | |

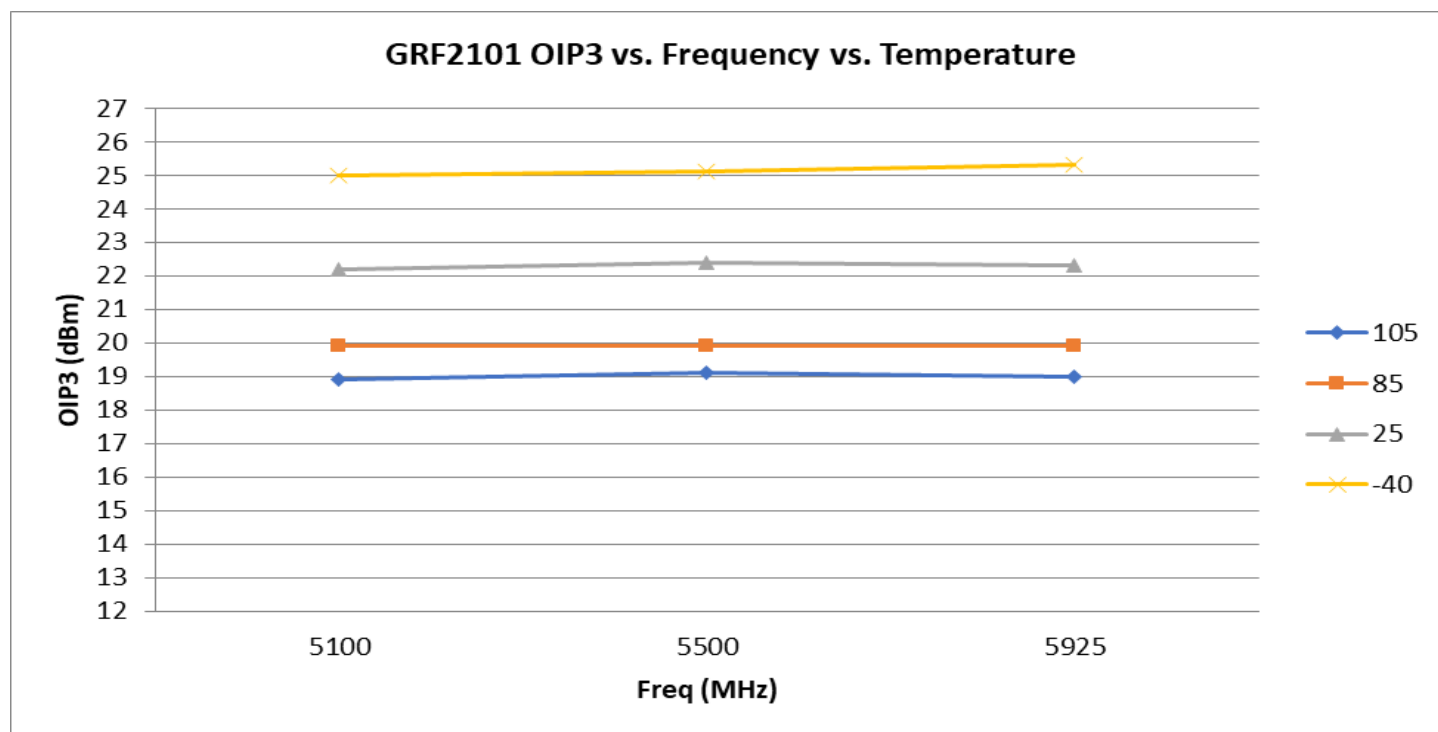
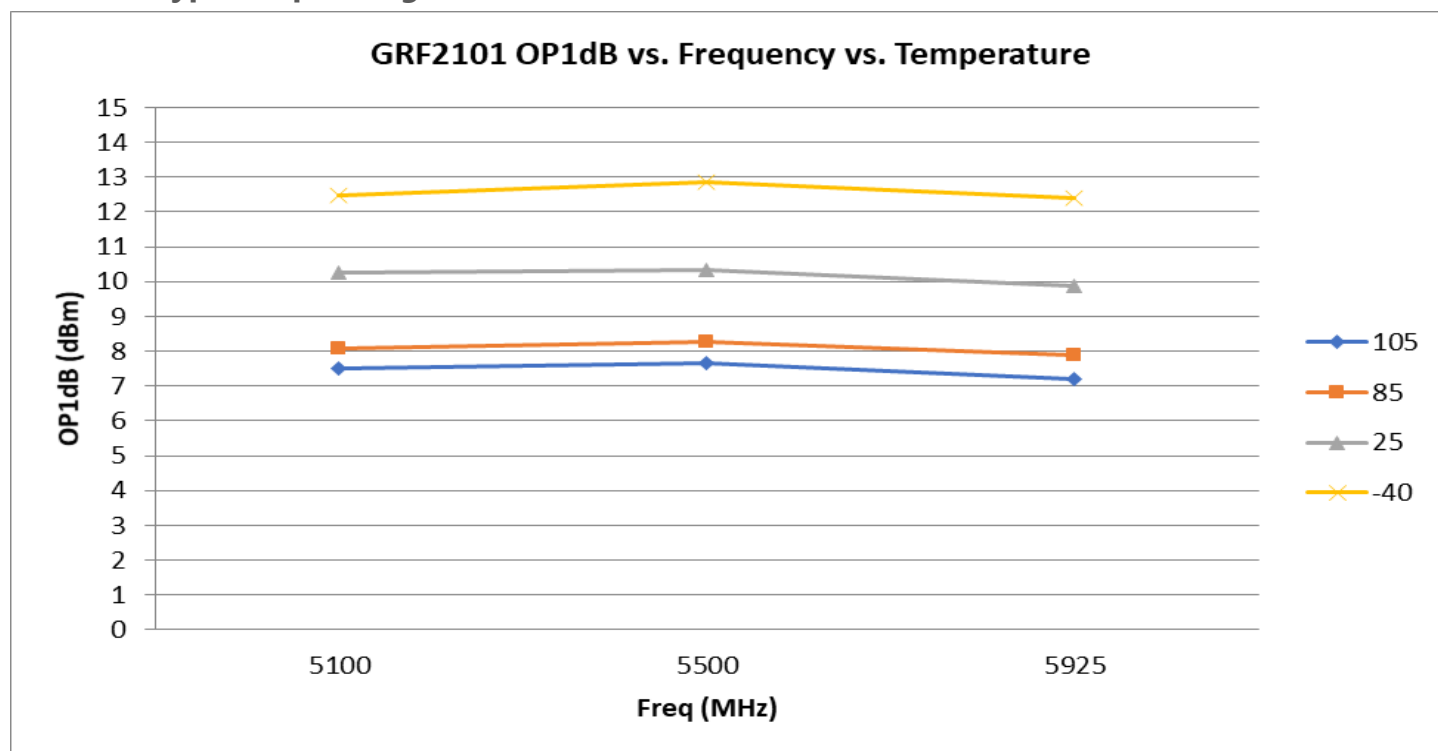
GRF2101 Typical Operating Curves



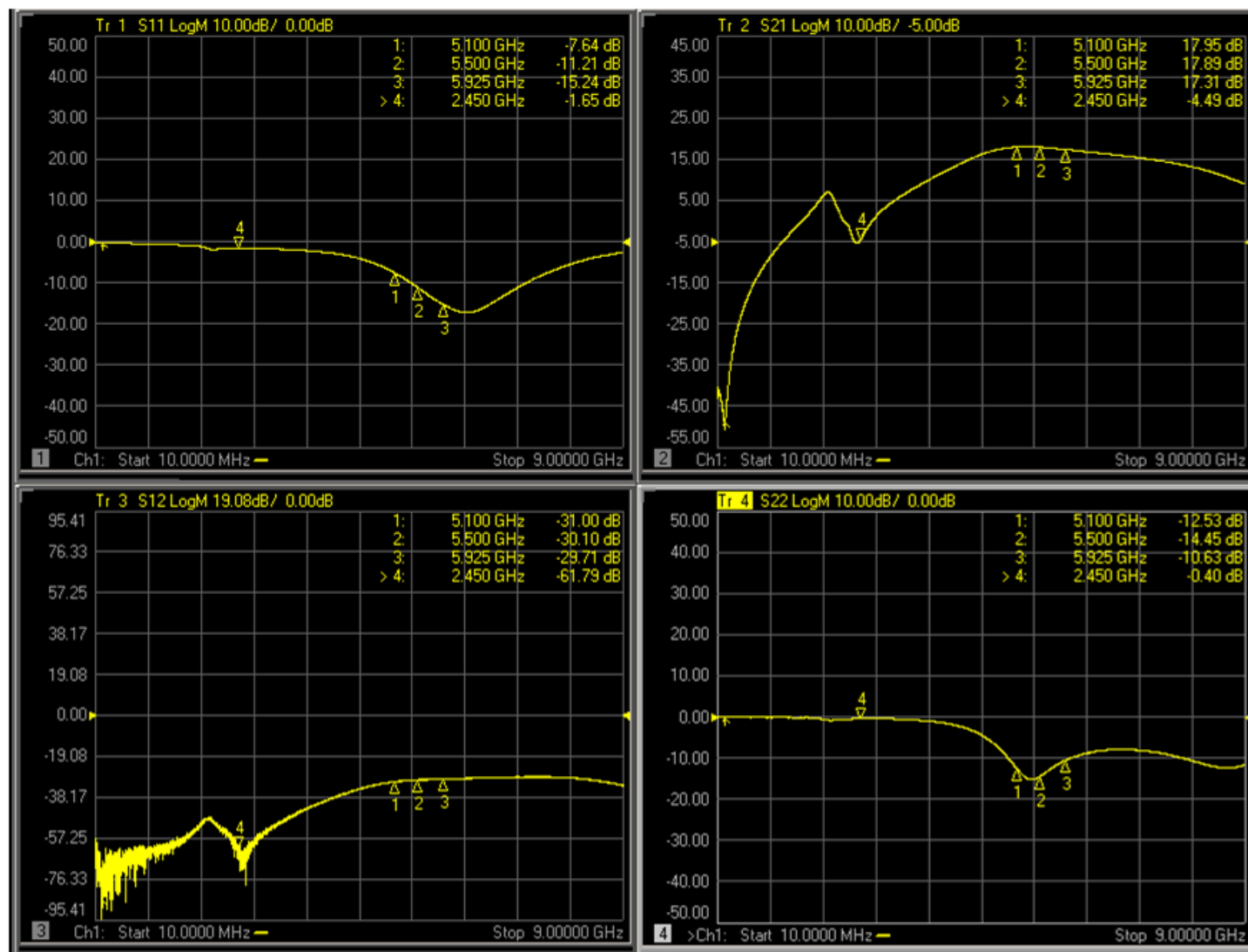
GRF2101 Typical Operating Curves



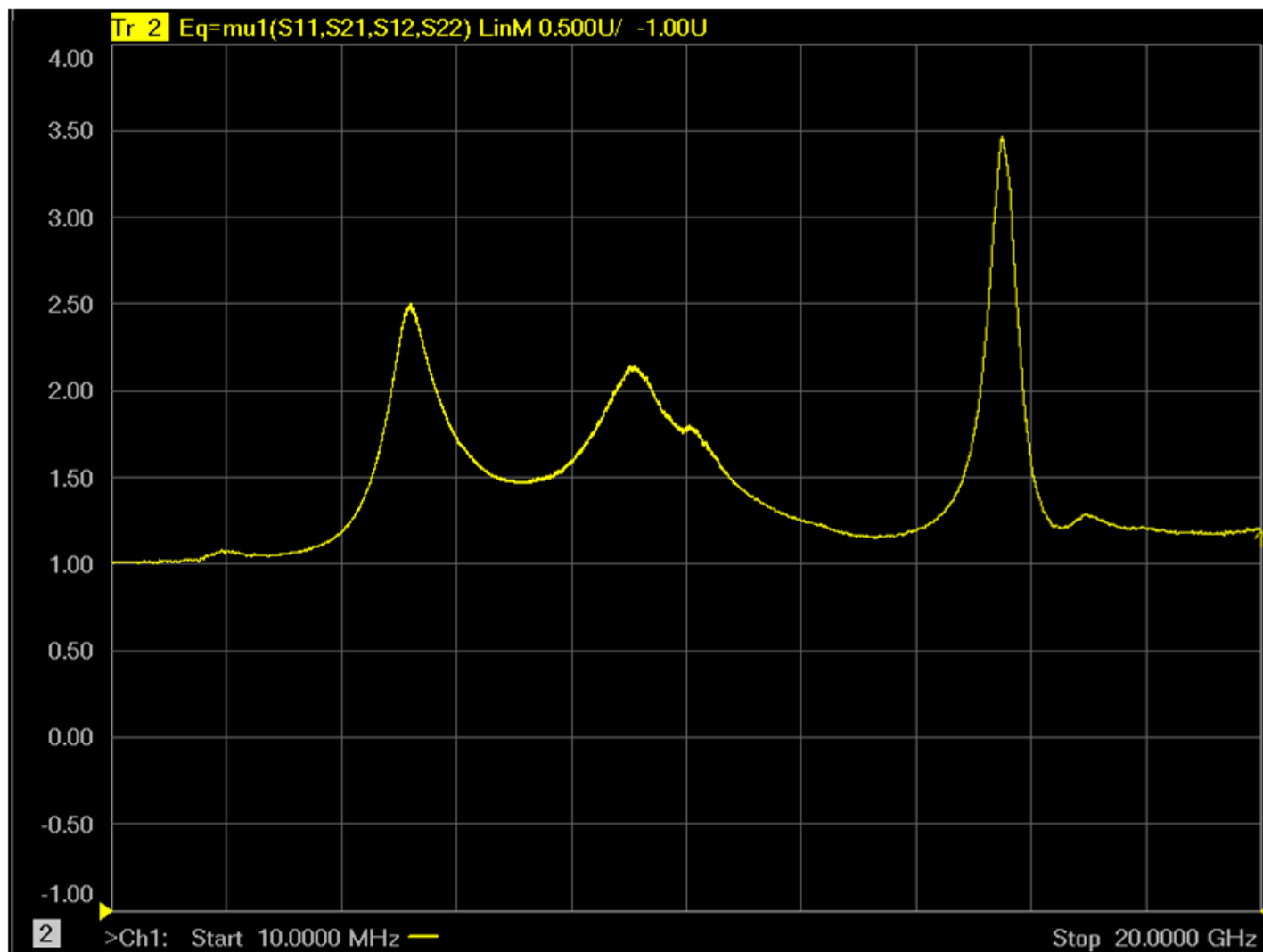
GRF2101 Typical Operating Curves



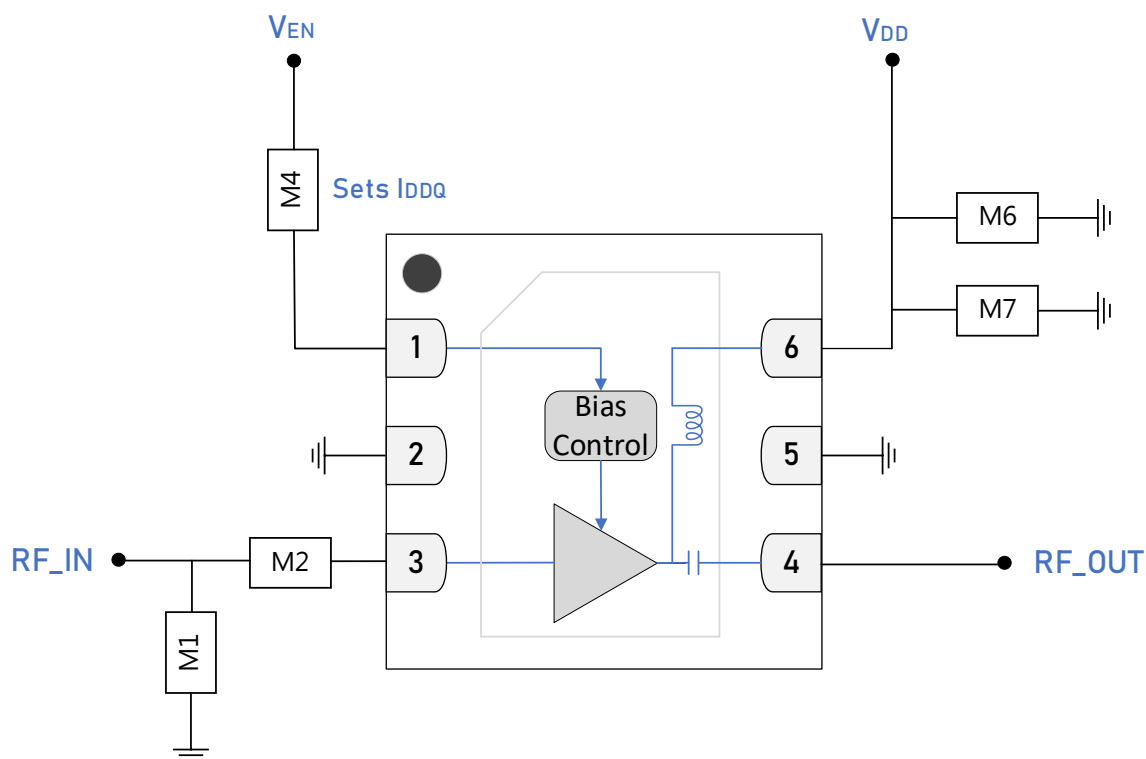
GRF2101 Typical Operating Curves: S-Parameters (5.1 to 5.9 GHz Tune)



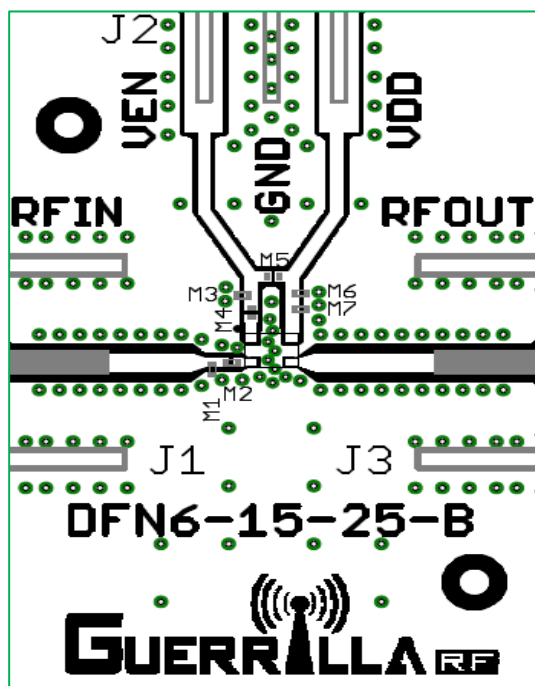
GRF2101 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



Note: Mu factor ≥ 1 implies unconditional stability.



GRF2101 Standard Evaluation Board Schematic



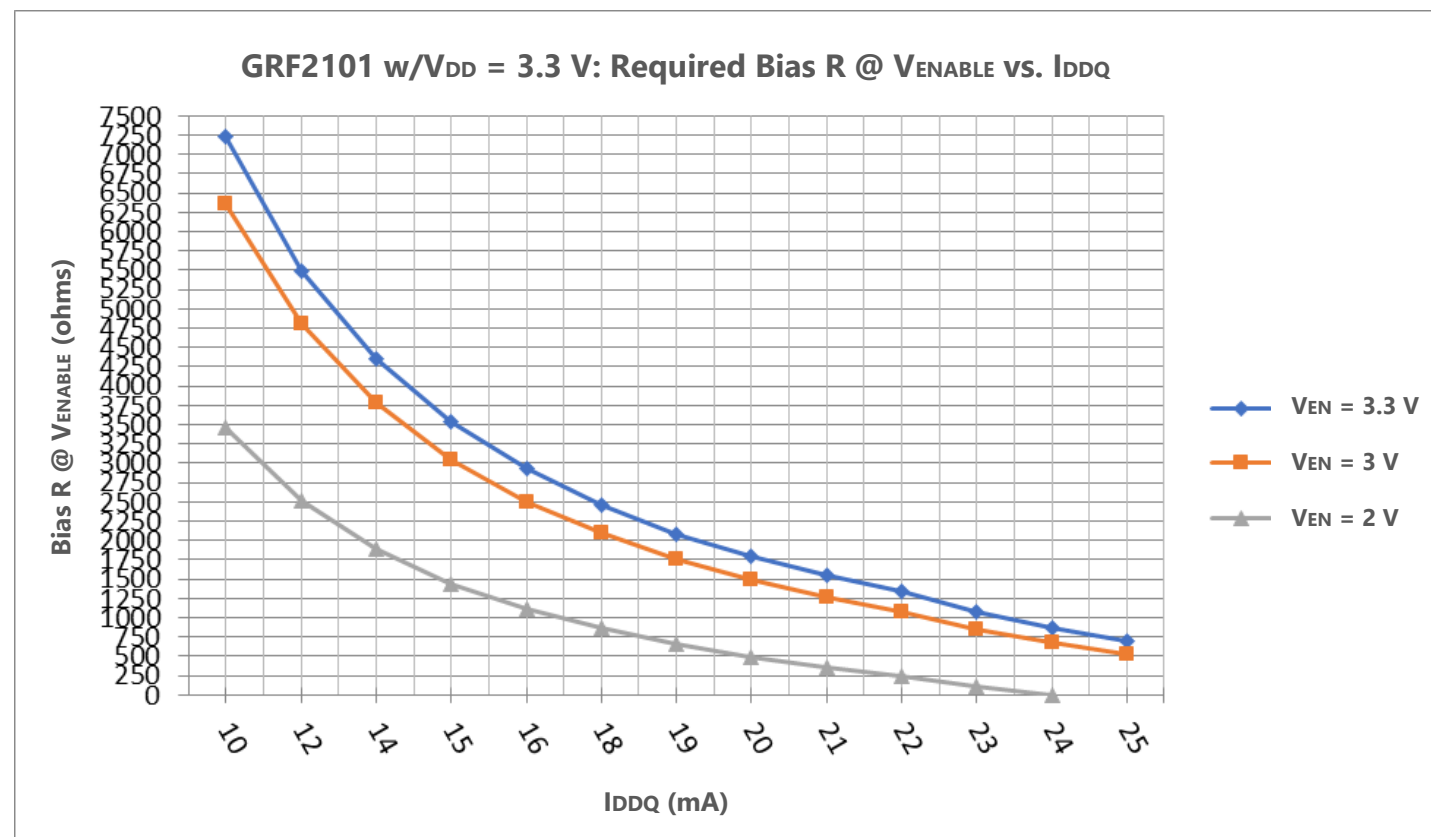
GRF2101 Evaluation Board Assembly Diagram

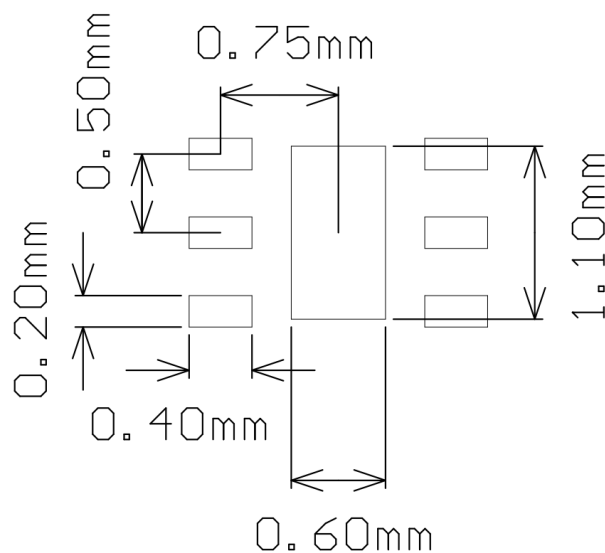
GRF2101 Evaluation Board Assembly Diagram Reference: 5.1 to 5.9 GHz Tune

| Component | Type | Manufacturer | Family | Value | Package Size | Substitution |
|------------------|--------------|--------------|--------|-------------|--------------|--------------|
| M1 | Capacitor | Murata | GJM | 0.5 pF | 0201 | Ok (High Q) |
| M2 | Capacitor | Murata | GJM | 22 pF | 0201 | Ok (High Q) |
| M4 | Resistor: 5% | Various | -- | See Curves | 0201 | Ok |
| M6 | Capacitor | Murata | GRM | 0.1 μ F | 0201 | Ok |
| M7 (See Note) | Capacitor | Murata | GJM | 8.2 pF | 0201 | OK |
| Evaluation Board | DFN6-15-25-B | | | | | |

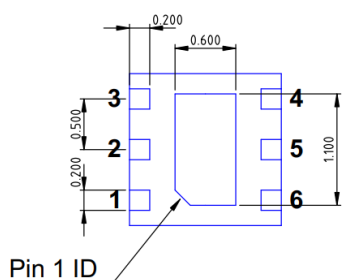
Note: Distance of M7 from pin 6 is critical for in-band matching. The value of M7 influences the location of the gain notch around 2.4 GHz. Recommend that customer application boards allow for some flexibility in the placement of M7 to optimize tuning the device.

GRF2101 Bias Resistor Selection Curves:

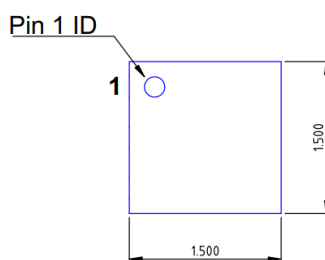




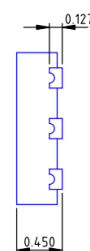
1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)



Bottom View



Top View



Side View

DFN6 1.5x1.5mm

Dimensions in millimeters
Dimensional Tolerance: ± 0.05

1.5 x 1.5 mm DFN-6 Package Dimensions

Package Marking Diagram



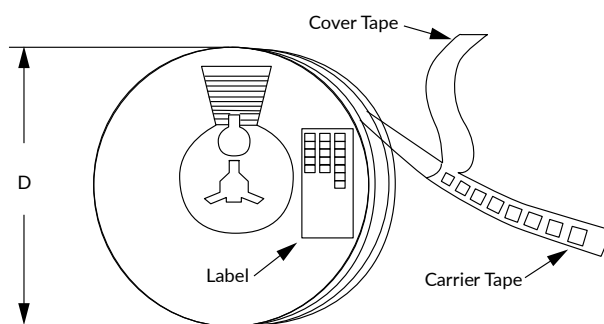
- Line 1: "YWW" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

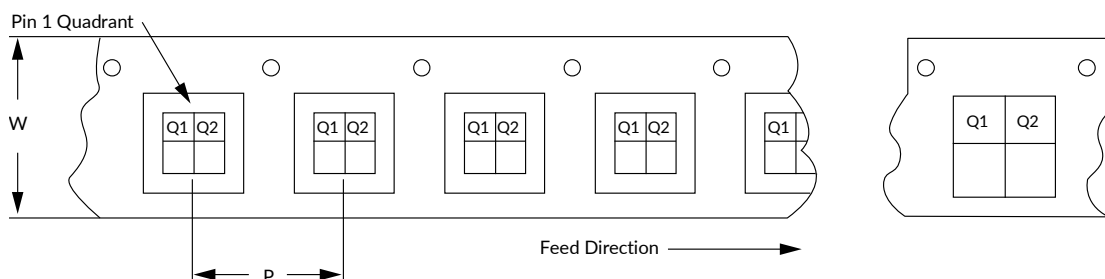
Guerrilla RF's tape and reel specification complies with Electronics Industries Association (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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: <https://www.guerrilla-rf.com/prodFiles/Manufacturing/MN001.pdf>



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 |
|-----------------|--|
| June 19, 2018 | Release Ø Data Sheet. |
| May 3, 2022 | Release A Data Sheet. Upgraded Data Sheet to new format. |
| January 9, 2025 | Changed Venable voltage to 3.3 volts for Gain mode. |



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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