

## GRF4002 BROADBAND LNA / LINEAR DRIVER 0.1 to 3.8 GHz

### FEATURES

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

### Reference: 5 V / 2.5 GHz / 70 mA

- Gain: 15 dB
- OIP3: 36.5 dBm
- OP1dB: 23.5 dBm
- Evaluation Board Noise Figure: 0.85 dB

### APPLICATIONS

- Linear Driver Amplifier
- Small Cells and Cellular Repeaters
- Distributed Antenna Systems
- Microwave Backhaul

### DESCRIPTION

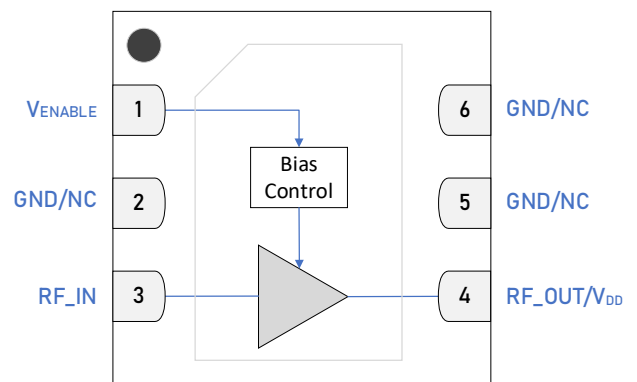
The GRF4002 is a broadband low noise gain block designed for small cell, wireless infrastructure and other high performance applications. It exhibits outstanding broad-band NF, linearity and return losses over 700 to 3800 MHz with a single match.

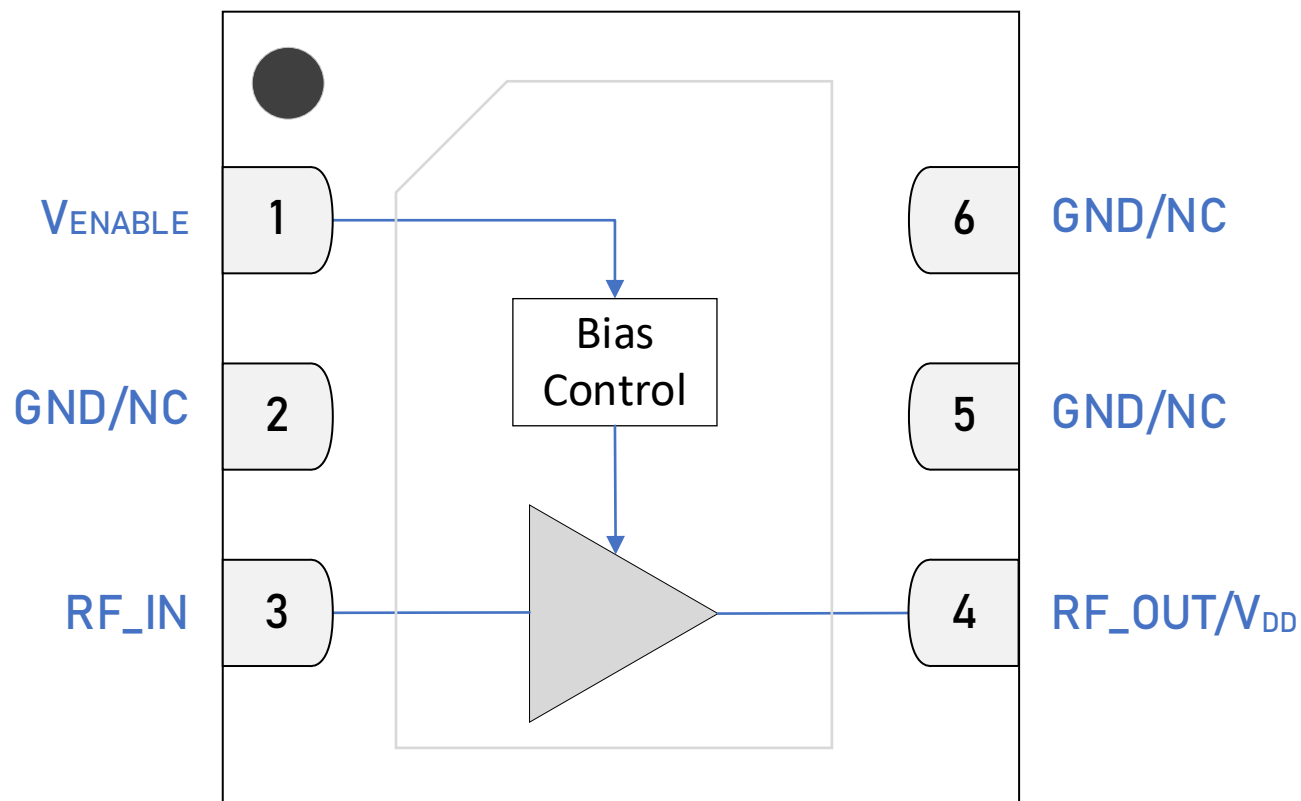
Configured as a first stage LNA, linear driver or cascaded gain block, GRF4002 offers high levels of reuse both within a design and across platforms. The device is operated from a supply voltage ( $V_{DD}$ ) of 1.8 to 5 V with a selectable  $I_{DDQ}$  range of 20 to 80 mA for optimal efficiency and linearity.

GRF4002 is internally matched to 50  $\Omega$  at the input and output ports, needing only external DC blocks and a bias choke on the output.

Consult with the GRF applications engineering team for custom tuning/evaluation board data. Packaged device S-Parameters are available on the website landing page.

### 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 part 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 GND.
3	RF_IN	LNA RF Input	Internally matched 50 Ω. An external DC blocking capacitor must be used.
4	RF_OUT/V <sub>DD</sub>	LNA RF Output	Internally matched 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)	$P_{IN\ MAX}$		22	dBm
Operating Temperature (Package Heat Sink)	$T_{PKG\ HEAT\ SINK}$	-40	105	°C
Maximum Channel Temperature (MTTF > 10 <sup>6</sup> Hours)	$T_{MAX}$		170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		500	mW

## Electrostatic Discharge

Human Body Model	HBM	250		V
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## 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](http://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	5	6	V	
Operating Temperature (Package Heat Sink)	$T_{PKG\ HEAT\ SINK}$	-40		105	°C	
RF Frequency Range	$F_{RF}$	0.1	2.5	3.8	GHz	Typical Application Schematic with external matching components ( <b>note 1 &amp; 2</b> ).
RF_IN Port Impedance	$Z_{RFIN}$		50		$\Omega$	
RF_OUT Port Impedance	$Z_{RFOUT}$		50		$\Omega$	

**Note 1:** Operation outside of this range is possible, but with degraded performance of some parameters.

**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 0.7 to 3.8 GHz tuning set.  $M5 = 1.5 \text{ k}\Omega$ ,  $V_{DD} = 5 \text{ V}$ ,  $V_{ENABLE} = 5 \text{ V}$ ,  $I_{DD} = 70 \text{ mA}$ .  $F_{TEST} = 2.5 \text{ GHz}$ .  $T_{PKG \text{ HEAT SINK}} = 25 \text{ }^\circ\text{C}$ . Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Current	$I_{DD}$		70		mA	$V_{DD} = V_{ENABLE} = 5 \text{ V}$
Enable Current	$I_{ENABLE}$		2.2	3	mA	$V_{DD} = V_{ENABLE} = 5 \text{ V}$
Switching Rise Time	$T_{RISE}$		500		ns	
Switching Fall Time	$T_{FALL}$		500		ns	

### Disabled Mode

Leakage Current	$I_{LEAKAGE}$		1	5	$\mu\text{A}$	$V_{DD} = 5 \text{ V}$ , $V_{ENABLE} = 0 \text{ V}$
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### Thermal Data

Thermal Resistance: (Infrared Scan)	$\Theta_{JC}$		131		$^\circ\text{C}/\text{W}$	On Standard Evaluation Board ( <b>note 3</b> ).
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**Note 3:** MTTF >  $10^6$  hours for  $T_{CHANNEL} \leq 170 \text{ }^\circ\text{C}$ .

## Nominal Operating Parameters – RF

The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.7 to 3.8 GHz tuning set.  $M5 = 1.5\text{ k}\Omega$ ,  $V_{DD} = 5\text{ V}$ ,  $V_{ENABLE} = 5\text{ V}$ ,  $I_{DD} = 70\text{ mA}$ .  $F_{TEST} = 2.5\text{ GHz}$ .  $T_{PKG\ HEAT\ SINK} = 25\text{ }^{\circ}\text{C}$ . Evaluation board losses are included within the specifications.

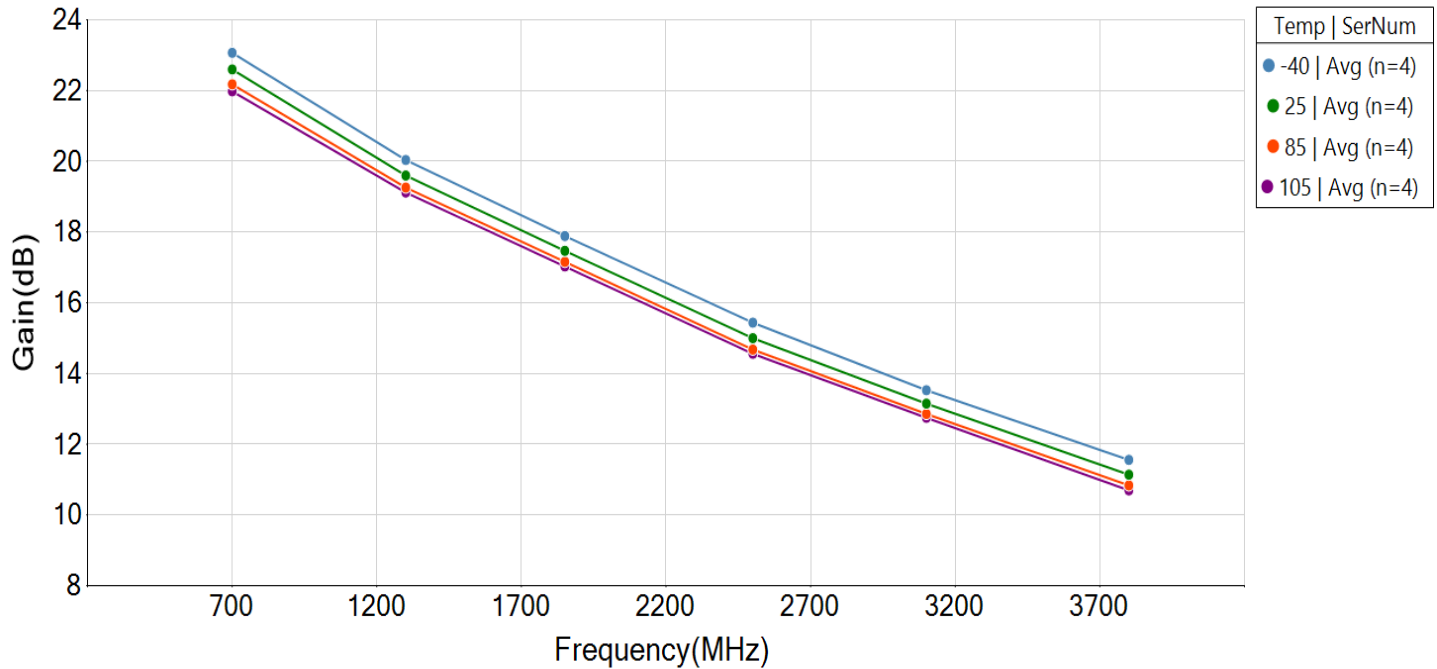
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21	14	15		dB	
Reverse Isolation	S12		> 23		dB	SDARS Tune
Evaluation Board Noise Figure	NF		0.85	1	dB	
Output 3 <sup>rd</sup> Order Intercept	OIP3		36.5		dBm	2 dBm $P_{OUT}$ per tone at 2 MHz Spacing (2499 and 2501 MHz).
Output 1 dB Compression Power	OP1dB	22	23.5		dBm	

## Typical Operating Curve Conditions

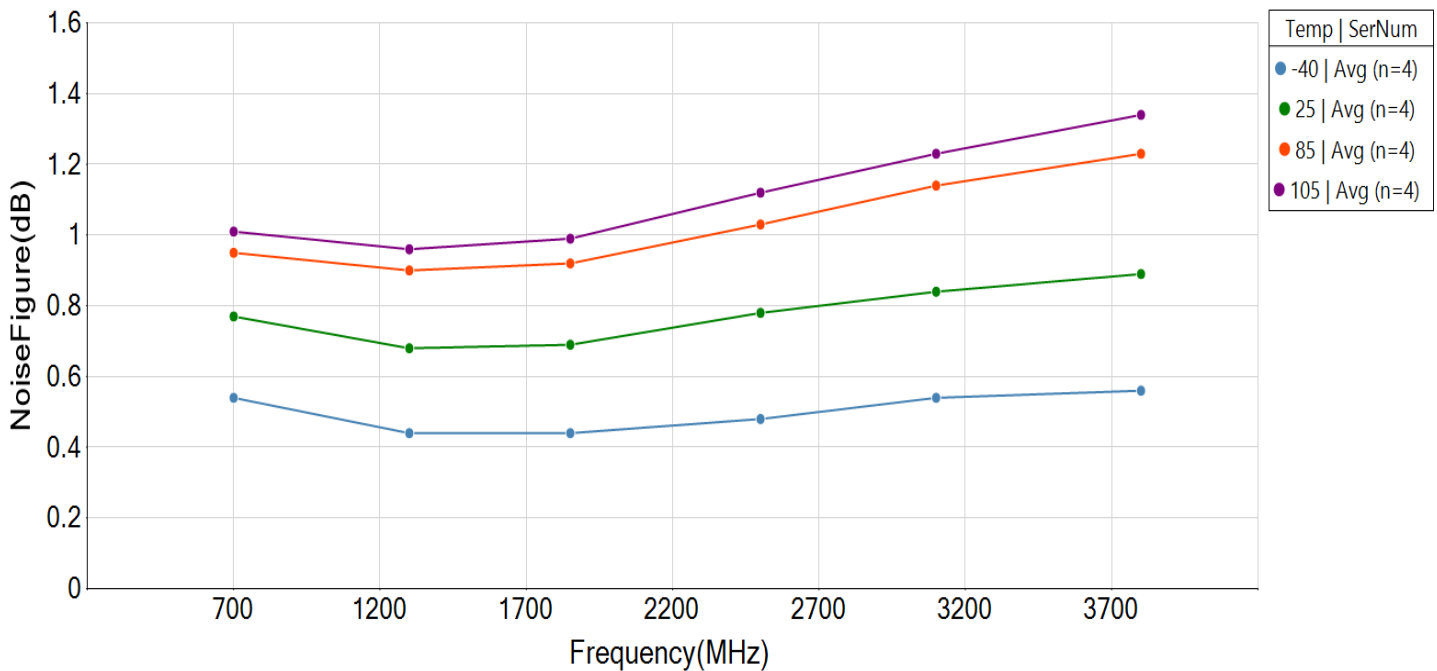
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GRF4002 Typical Operating Curves: 0.7 to 3.8 GHz Tune

GRF4002 Gain vs Frequency



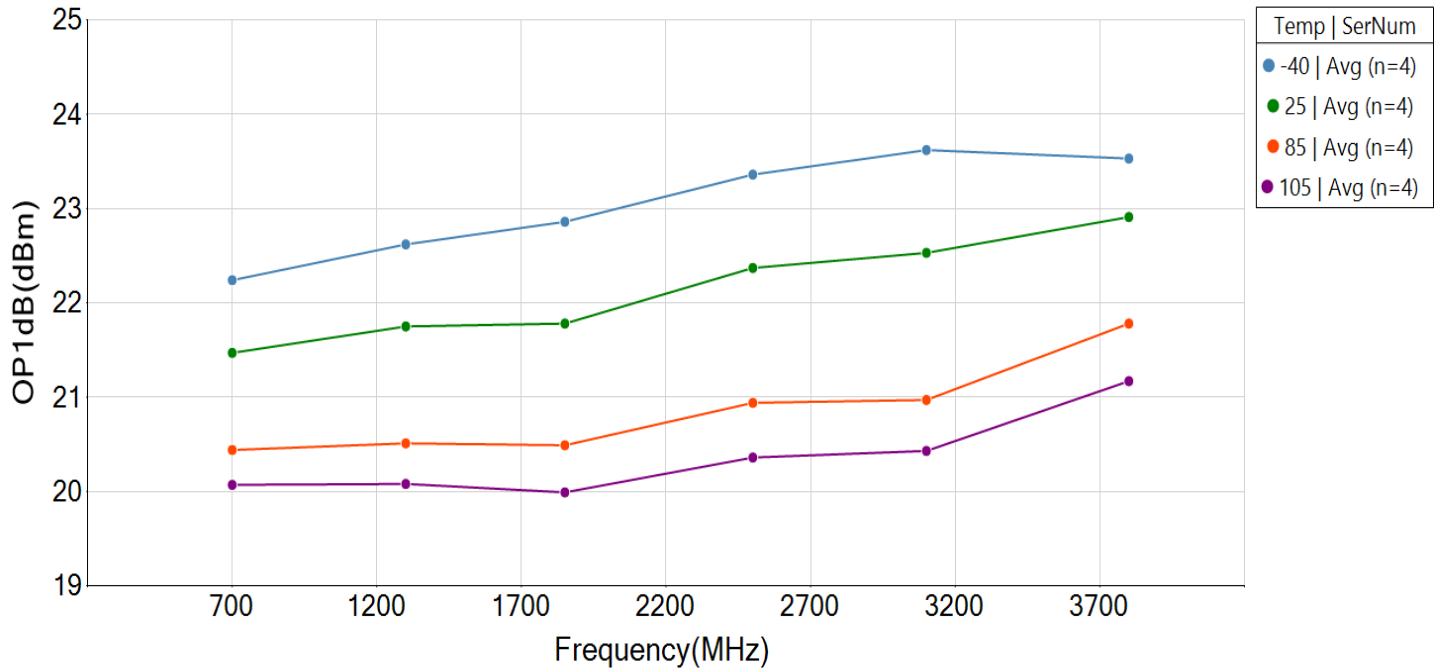
GRF4002 Noise Figure vs Frequency



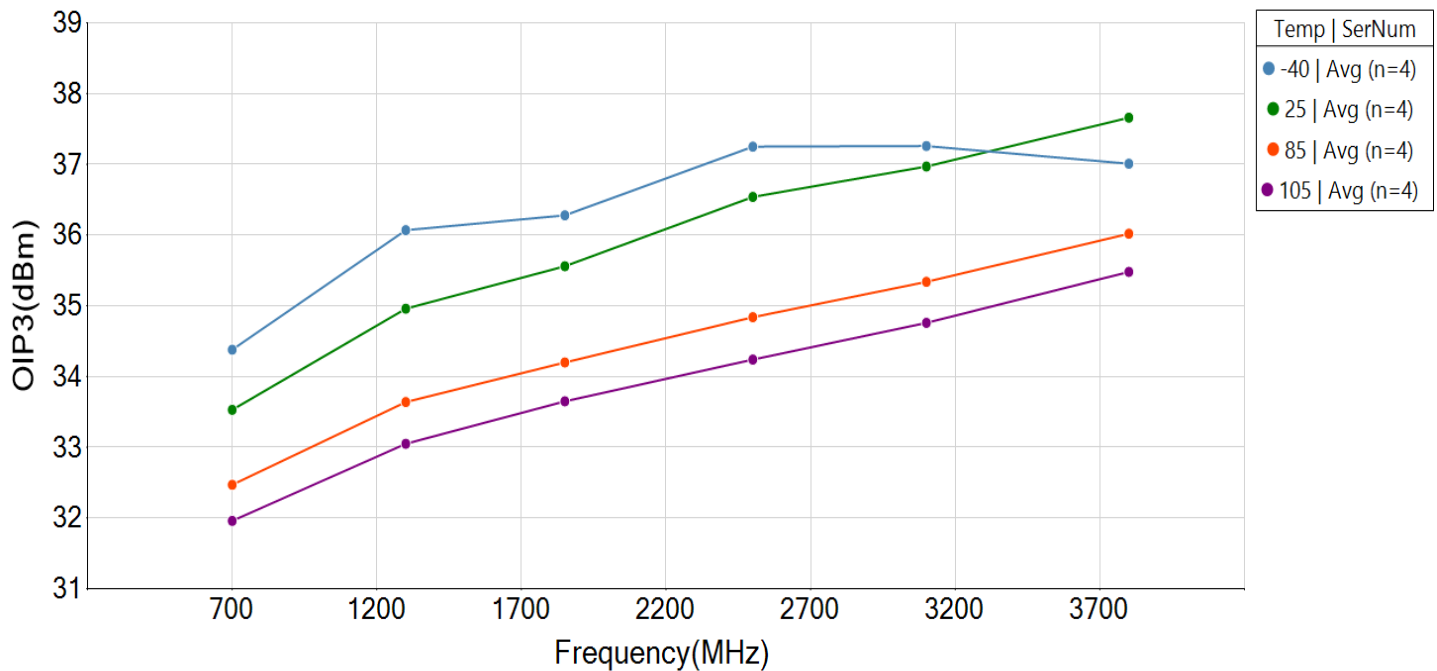


GRF4002 Typical Operating Curves: 0.7 to 3.8 GHz Tune

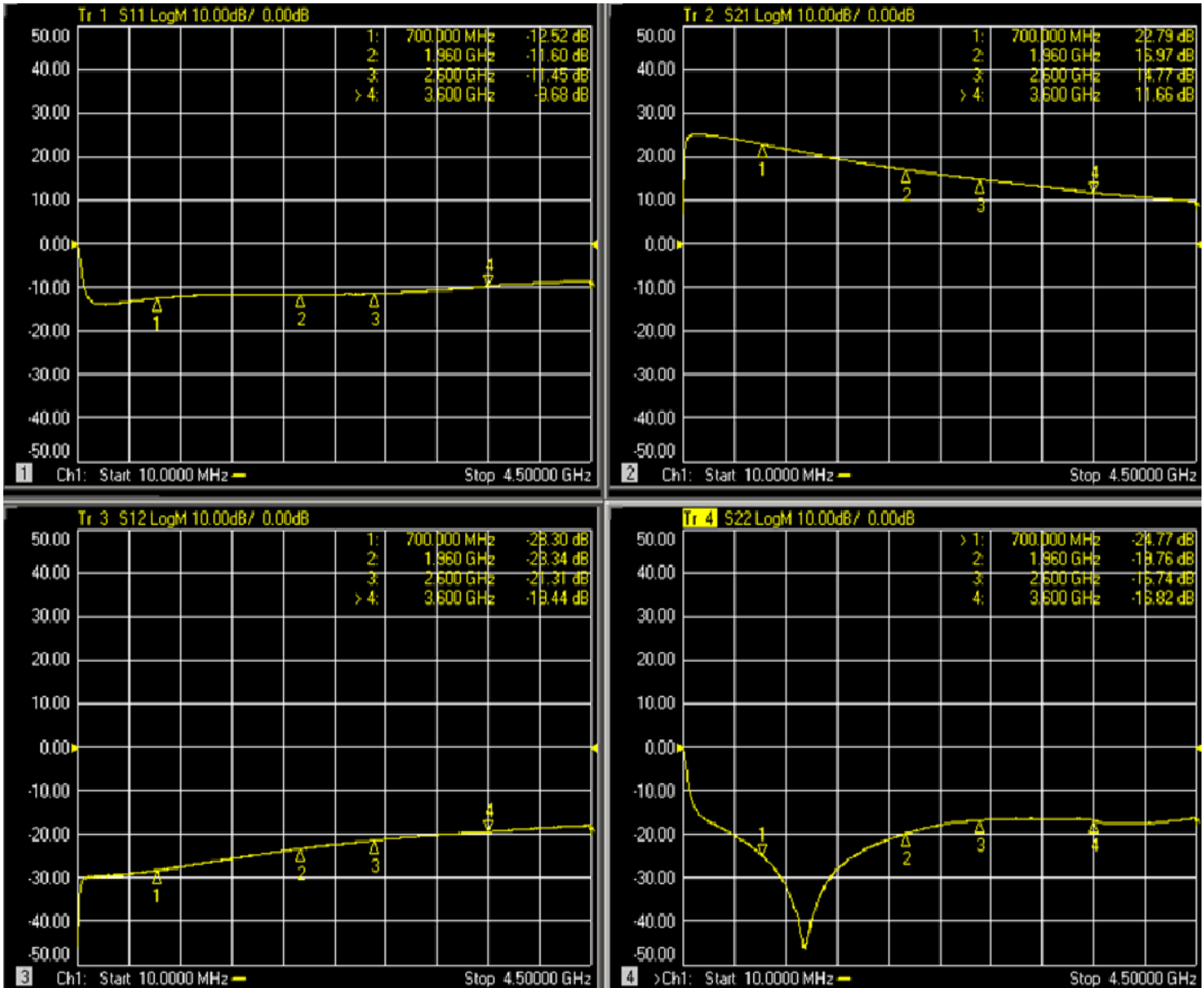
GRF4002 OP1dB vs Frequency



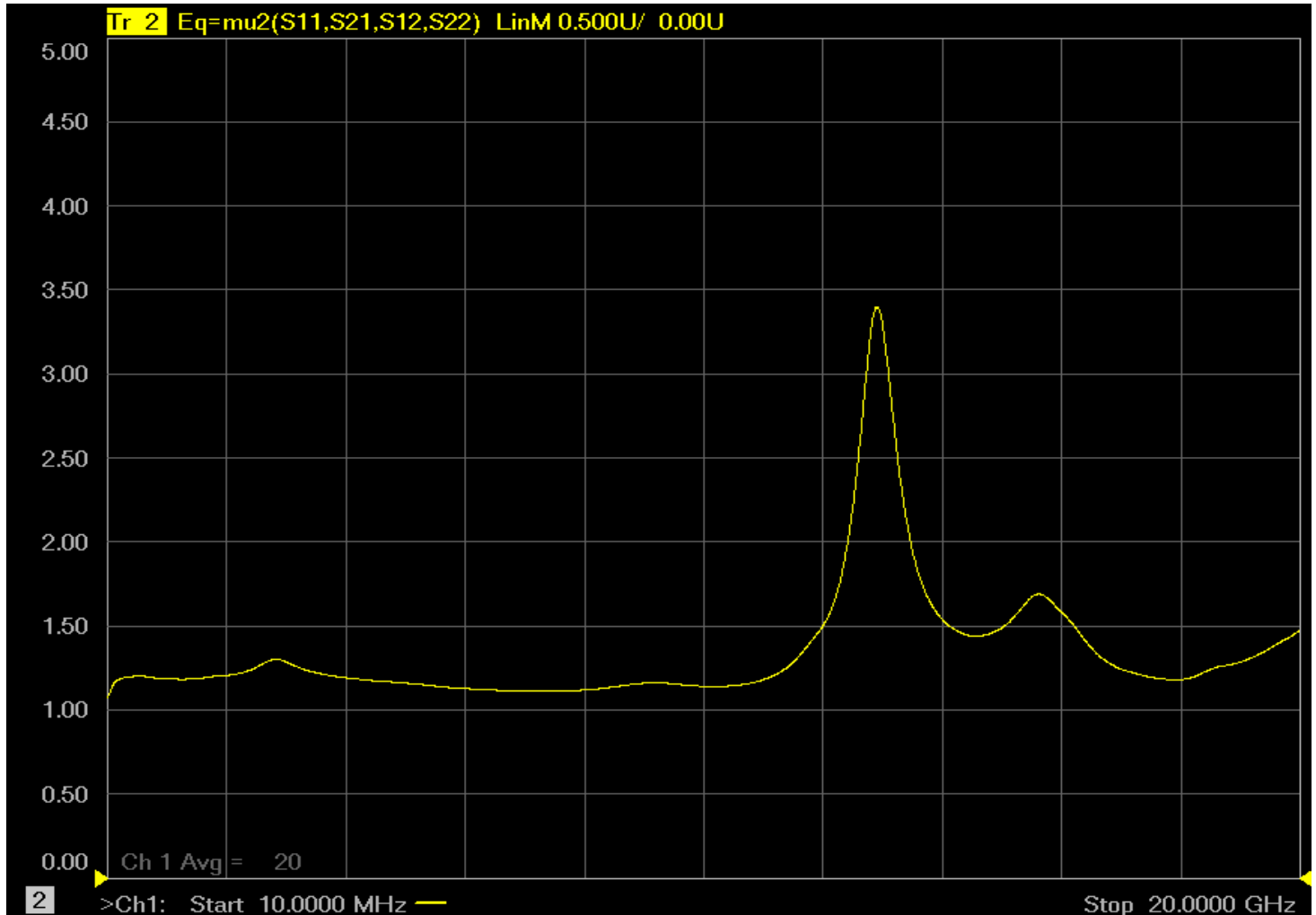
GRF4002 OIP3 vs Frequency at Pout = 2 dBm



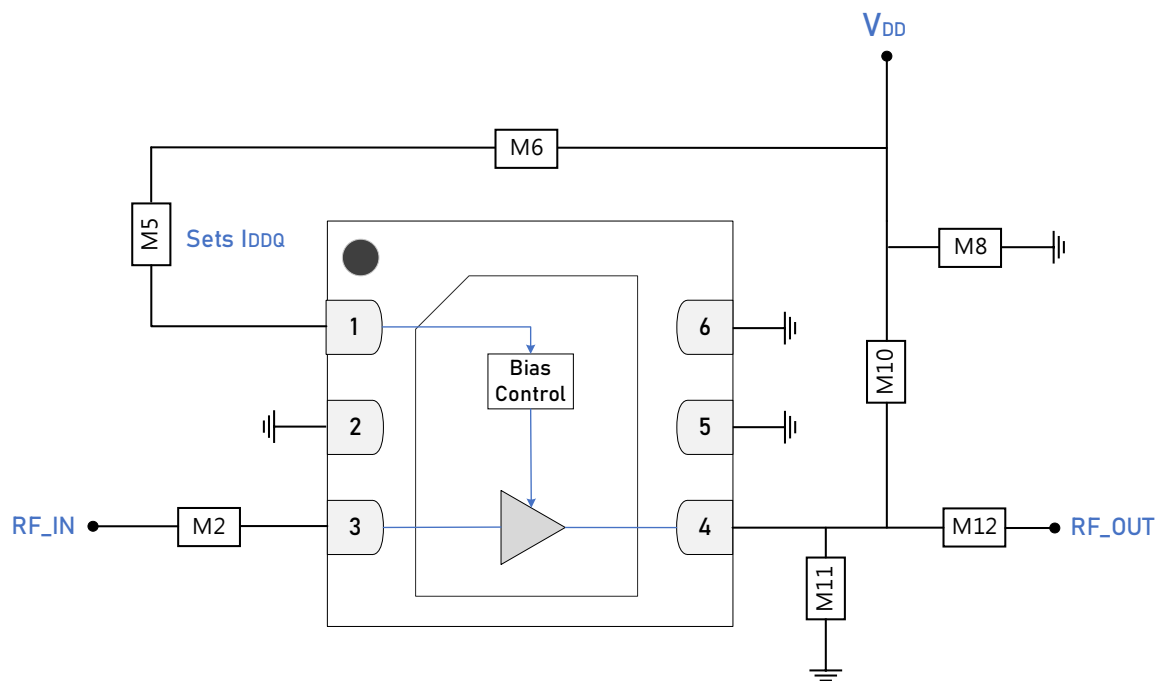
GRF4002 Typical Operating Curves: S-Parameters (0.7 to 3.8 GHz Tune)



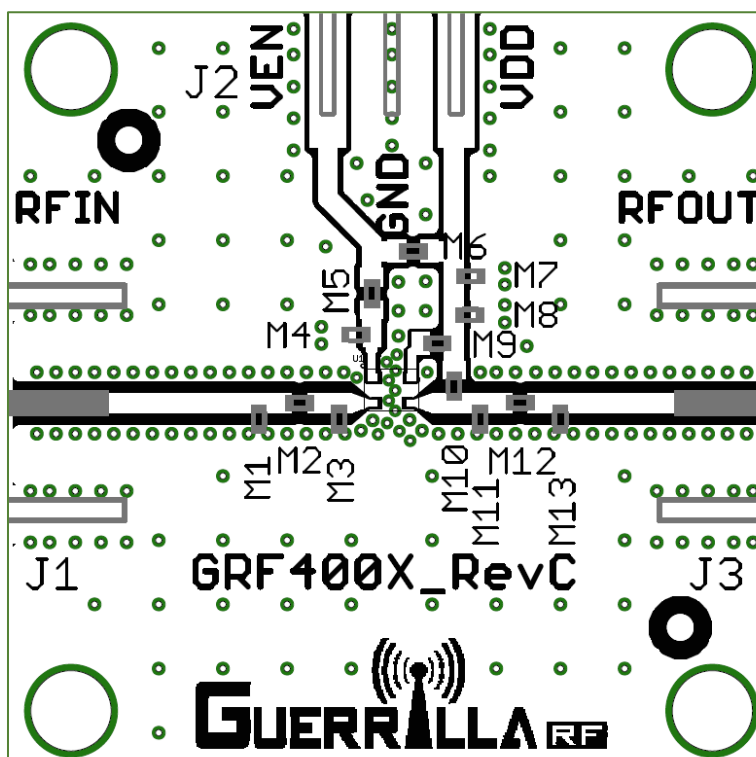
**GRF4002 Typical Operating Curves: Stability Mu Factor (0.7 to 3.8 GHz Tune)**



Note:  $\mu \geq 1$  implies unconditional stability.



GRF4002 Standard Test Schematic

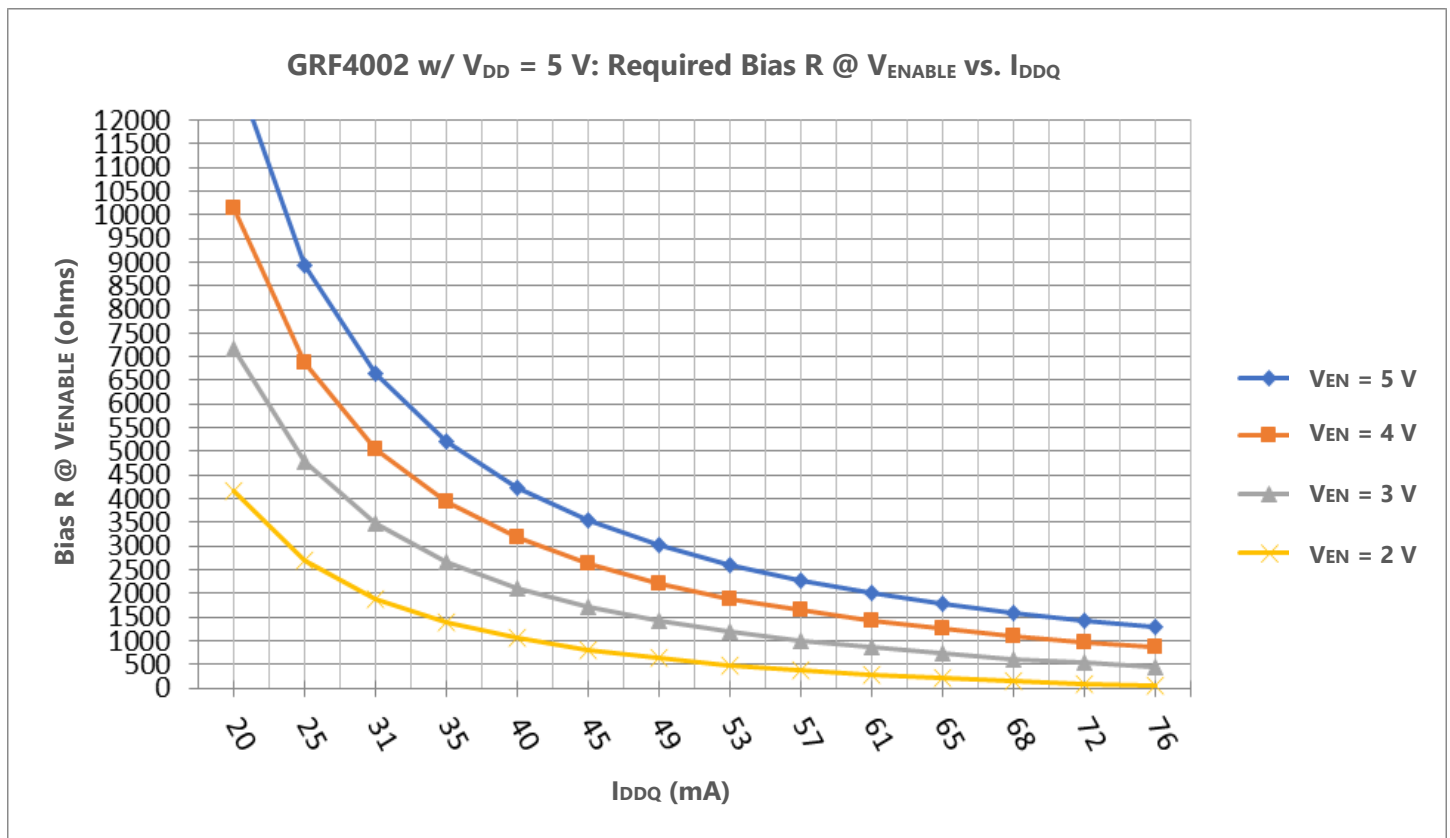


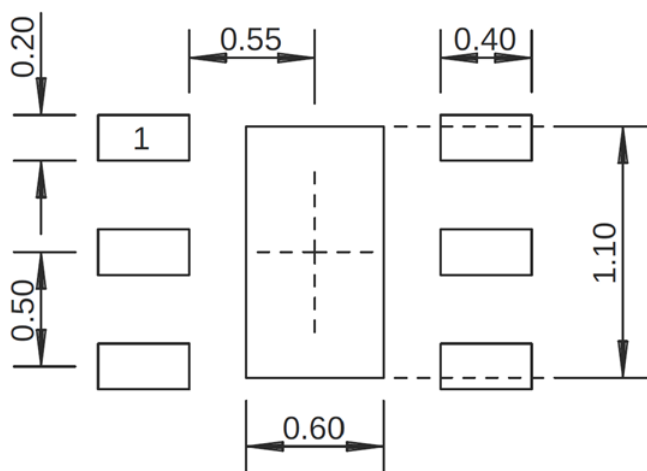
GRF4002 Evaluation Board Assembly Diagram

### GRF4002 Evaluation Board Assembly Diagram Reference: 0.1 to 3.8 GHz Tune

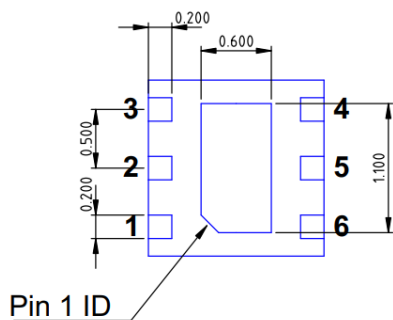
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M2	Capacitor	Murata	GJM	100 pF	0402	ok
M5 (Sets I <sub>DDQ</sub> )	Resistor	Various	5%	See Curves	0402	ok
M6	Resistor (Jumper)	Various	--	0 Ω	0402	ok
M8	Capacitor	Murata	GJM	0.1 μF	0402	ok
M10	Inductor	Coilcraft	HP	100 nH	0402	ok
M11	Capacitor	Murata	GJM	0.5 pF	0402	ok
M12	Capacitor	Murata	GJM	100 pF	0402	ok
Evaluation Board	GRF400X_RevC					

### GRF4002 Bias Resistor Selection Chart

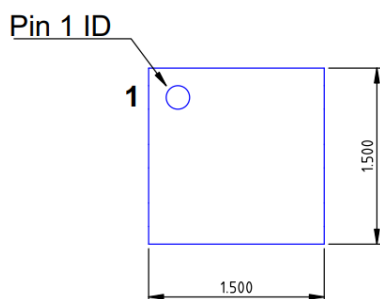




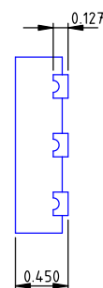
1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)



Bottom View



Top View



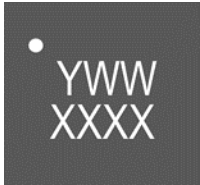
Side View

### 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



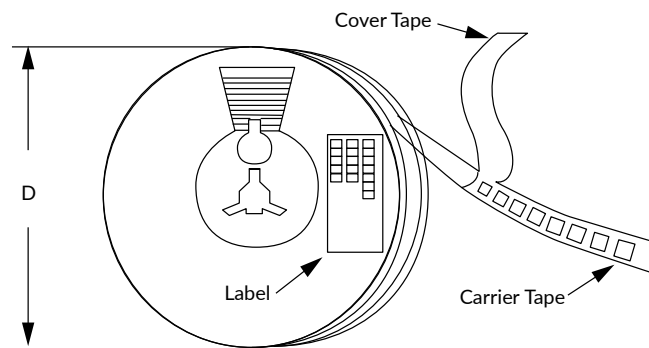
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

## Tape and Reel Information

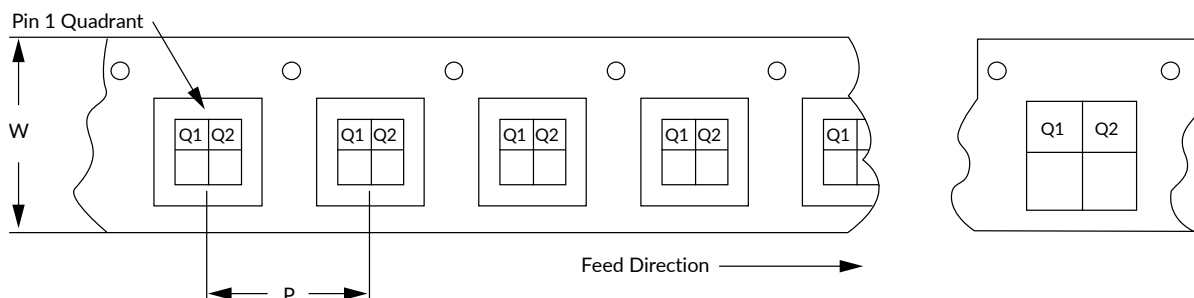
Guerrilla RF's tape and reel specification complies with Electronics Industries Association (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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: [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
September 14, 2022	Converted format to new template. Lowered Enable Current typical value from 3 mA to 2.2 mA and Max value from 6 mA to 3 mA to match PTP. Lowered Leakage Current typical value from 40 $\mu$ A to 1 $\mu$ A and Max value from 100 $\mu$ A to 5 $\mu$ A to match PTP. Added M6 Resistor (jumper) to EVB BOM and updated EVB schematic. Updated Gain, Noise Figure, OP1dB and OIP3 Characterization Plots.





### 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 evaluation board measurements taken within the Guerrilla RF Applications Lab. Any MIN/MAX limits represented within the data sheet are based solely on <i>estimated</i> part-to-part variations and process spreads. 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.

Information in this data sheet is specific to the Guerrilla RF, Inc. ("Guerrilla RF") product identified.

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