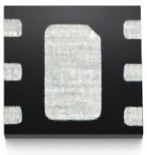
Data Sheet

RELEASE A DATA SHEET



GRF4002

BROADBAND LNA / LINEAR DRIVER 0.1 to 3.8 GHz

FEATURES

- Flexible Bias Voltage and Current
- Process: GaAs pHEMT
- Internally Matched to 50 Ω
- 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

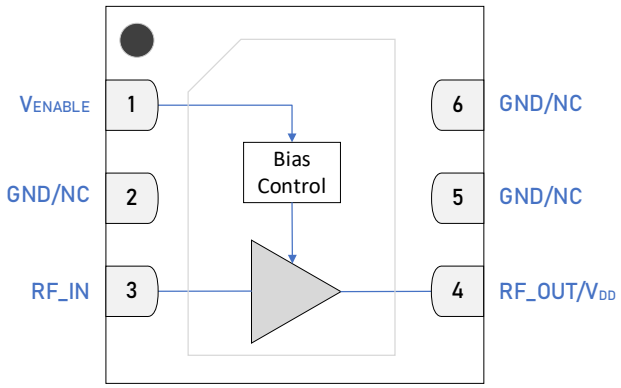
The GRF4002 is a broadband low noise gain block designed for small cell, wireless infrastructure and other high performance applications. It exhibits outstanding broad-band NF, linearity and return losses over 700 to 3800 MHz with a single match.

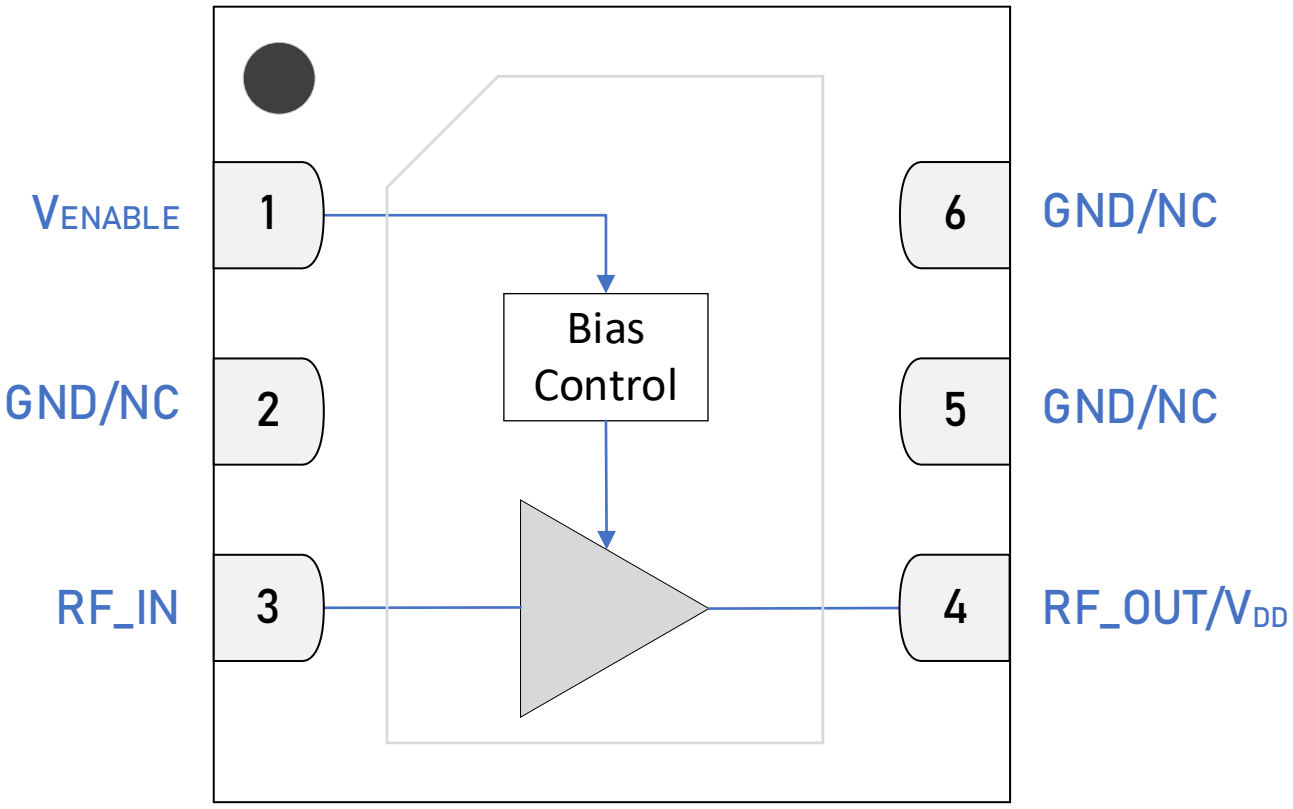
Configured as a first stage LNA, linear driver or cascaded gain block, GRF4002 offers high levels of reuse both within a design and across platforms. The device is operated from a supply voltage (V_{DD}) of 1.8 to 5 V with a selectable I_{DDQ} range of 20 to 80 mA for optimal efficiency and linearity.

GRF4002 is internally matched to 50 Ω 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)

www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Road. Greensboro, NC 27455

Pin Assignments

Pin	Name	Description	Note
1	V_{ENABLE}	Enable Voltage Input	V_{ENABLE} and series resistor set I_{DDQ}. $V_{ENABLE} \leq 0.2$ 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_{DD}	LNA RF Output	Internally matched 50 Ω. V_{DD} 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 >10^6 Hours)	T_{MAX}		170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		500	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*

www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Road. Greensboro, NC 27455

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 **(note 1 & 2)**.
RF_IN Port Impedance	Z_{RFIN}		50		Ω	
RF_OUT Port Impedance	Z_{RFOUT}		50		Ω	

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 kΩ, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 70 mA. F_{TEST} = 2.5 GHz. $T_{PKG\ HEAT\ SINK}$ = 25 °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 V
Enable Current	I_{ENABLE}		2.2	3	mA	V_{DD} = V_{ENABLE} = 5 V
Switching Rise Time	T_{RISE}		500		ns	
Switching Fall Time	T_{FALL}		500		ns	
Disabled Mode						
Leakage Current	$I_{LEAKAGE}$		1	5	µA	V_{DD} = 5 V, V_{ENABLE} = 0 V
Thermal Data						
Thermal Resistance: (Infrared Scan)	Θ_{JC}		131		°C/W	On Standard Evaluation Board **(note 3)**.

Note 3: MTTF >10^6 hours for $T_{CHANNEL}$ ≤170 °C.

www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Road. Greensboro, NC 27455

Nominal Operating Parameters – RF

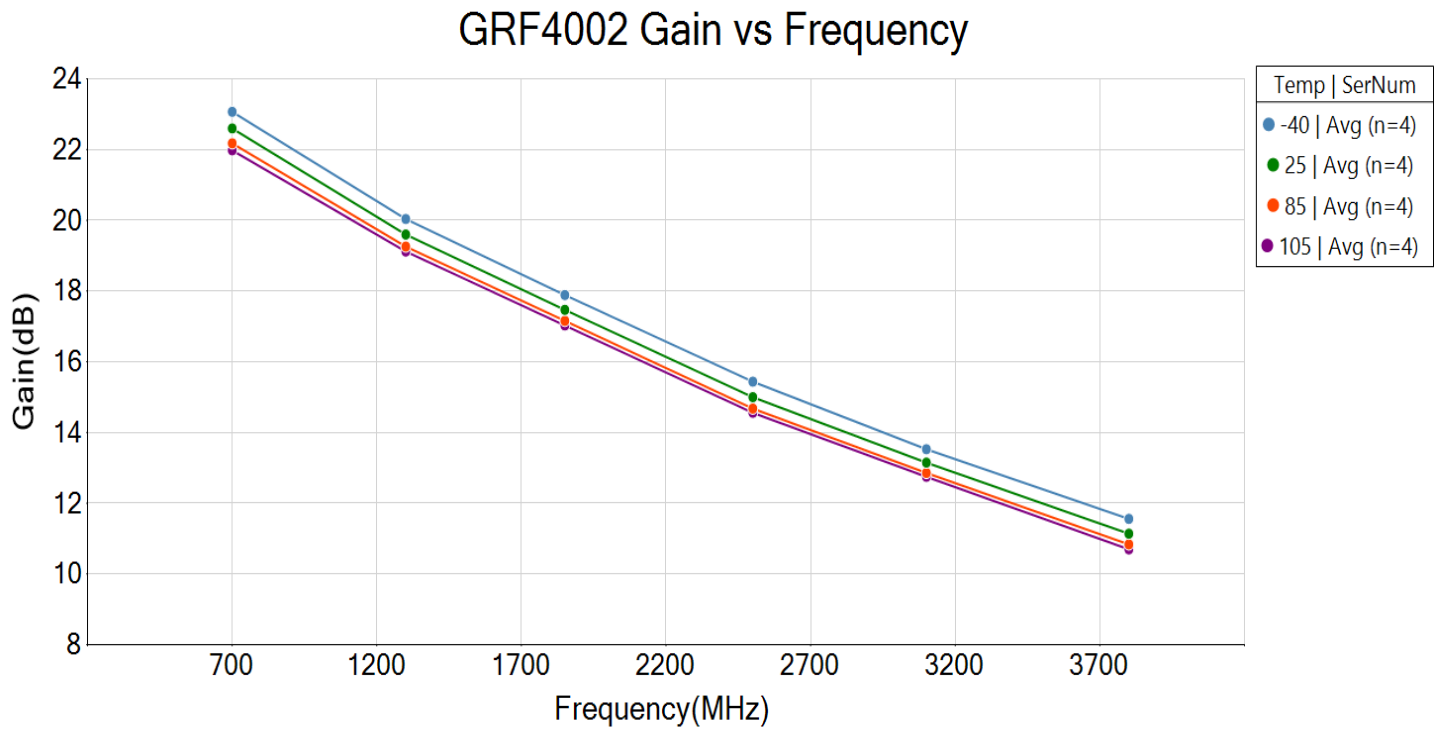
The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.7 to 3.8 GHz tuning set. M5 = 1.5 kΩ, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 70 mA. F_{TEST} = 2.5 GHz. $T_{PKG\ HEAT\ SINK}$ = 25 °C. Evaluation board losses are included within the specifications.

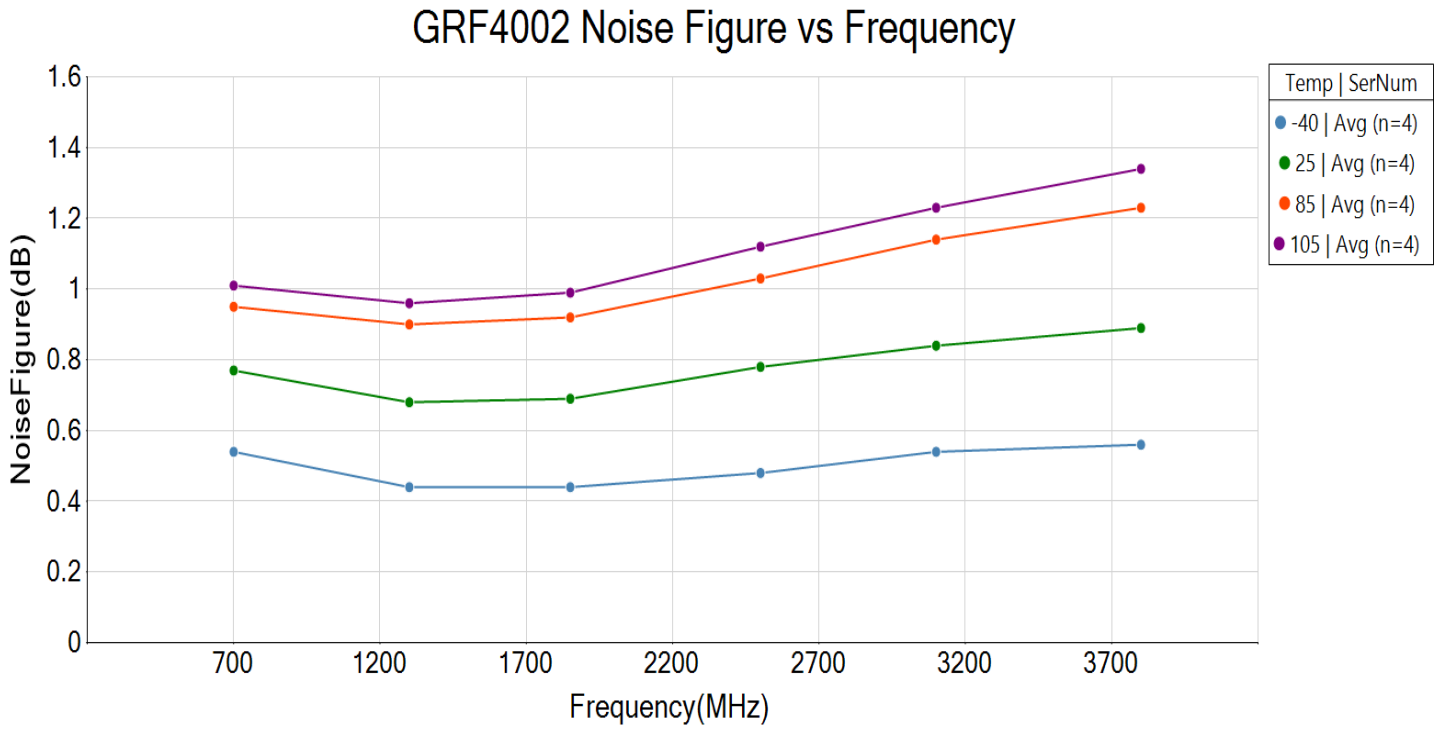
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21	*14*	15		dB	
Reverse Isolation	S12		> 23		dB	SDARS Tune
Evaluation Board Noise Figure	NF		0.85	*1*	dB	
Output 3rd Order Intercept	OIP3		36.5		dBm	2 dBm P_{OUT} per tone at 2 MHz Spacing (2499 and 2501 MHz).
Output 1 dB Compression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

Typical Operating Curve Conditions

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

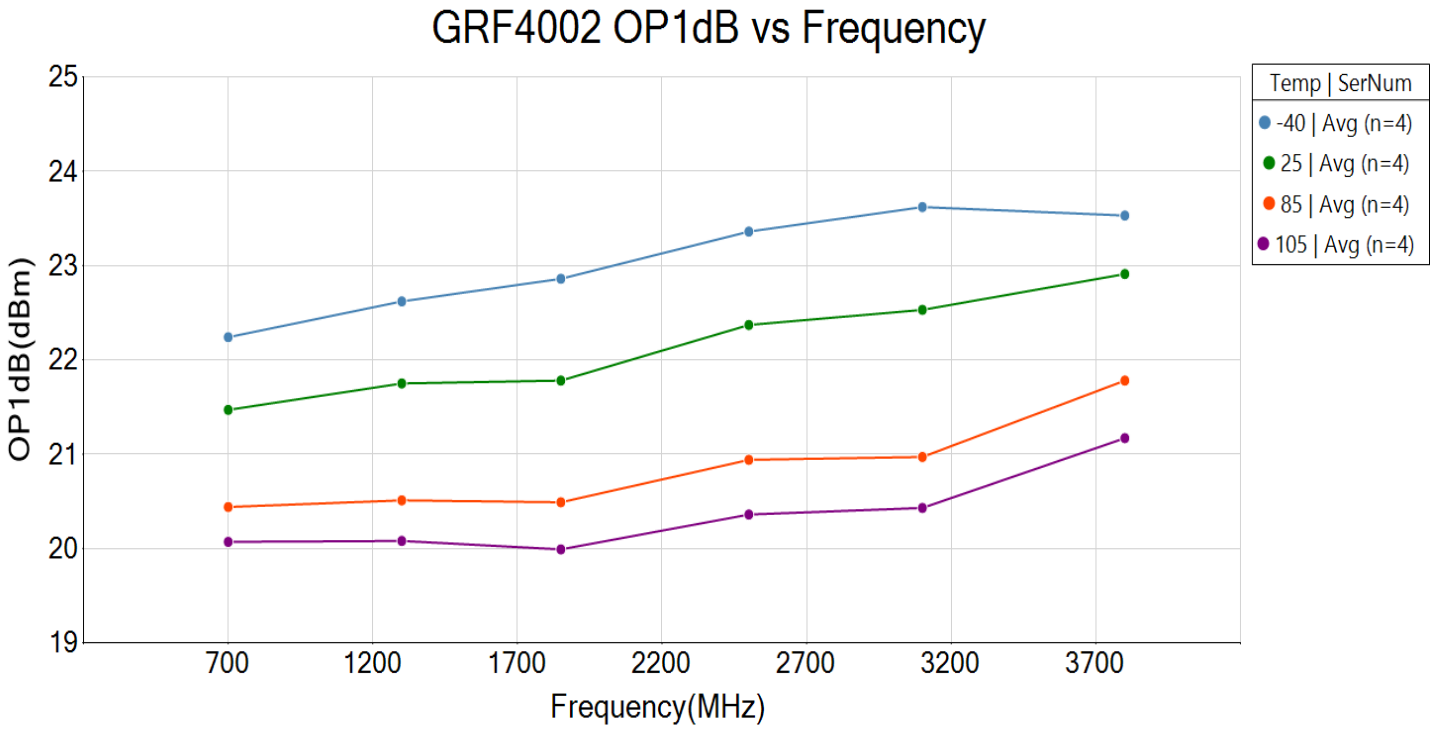
GRF4002 Typical Operating Curves: 0.7 to 3.8 GHz Tune

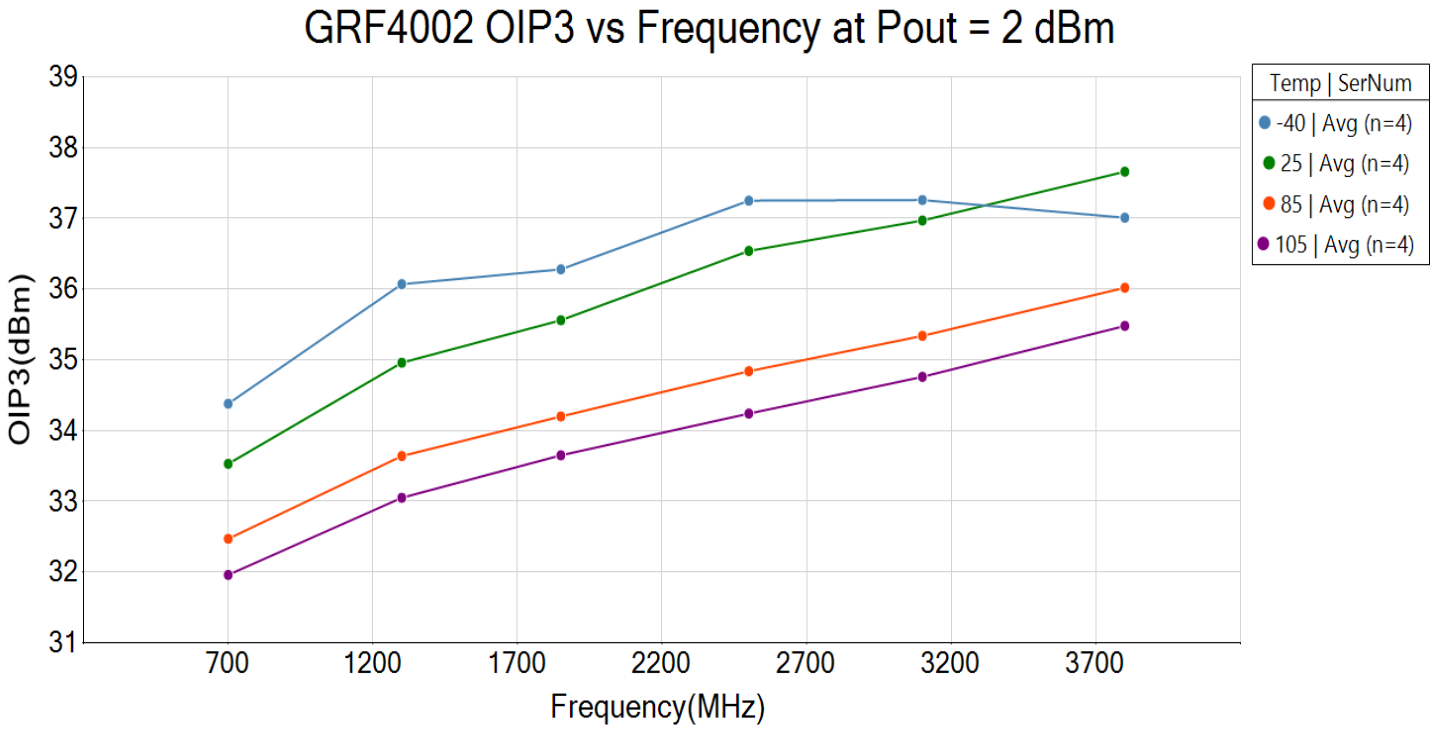




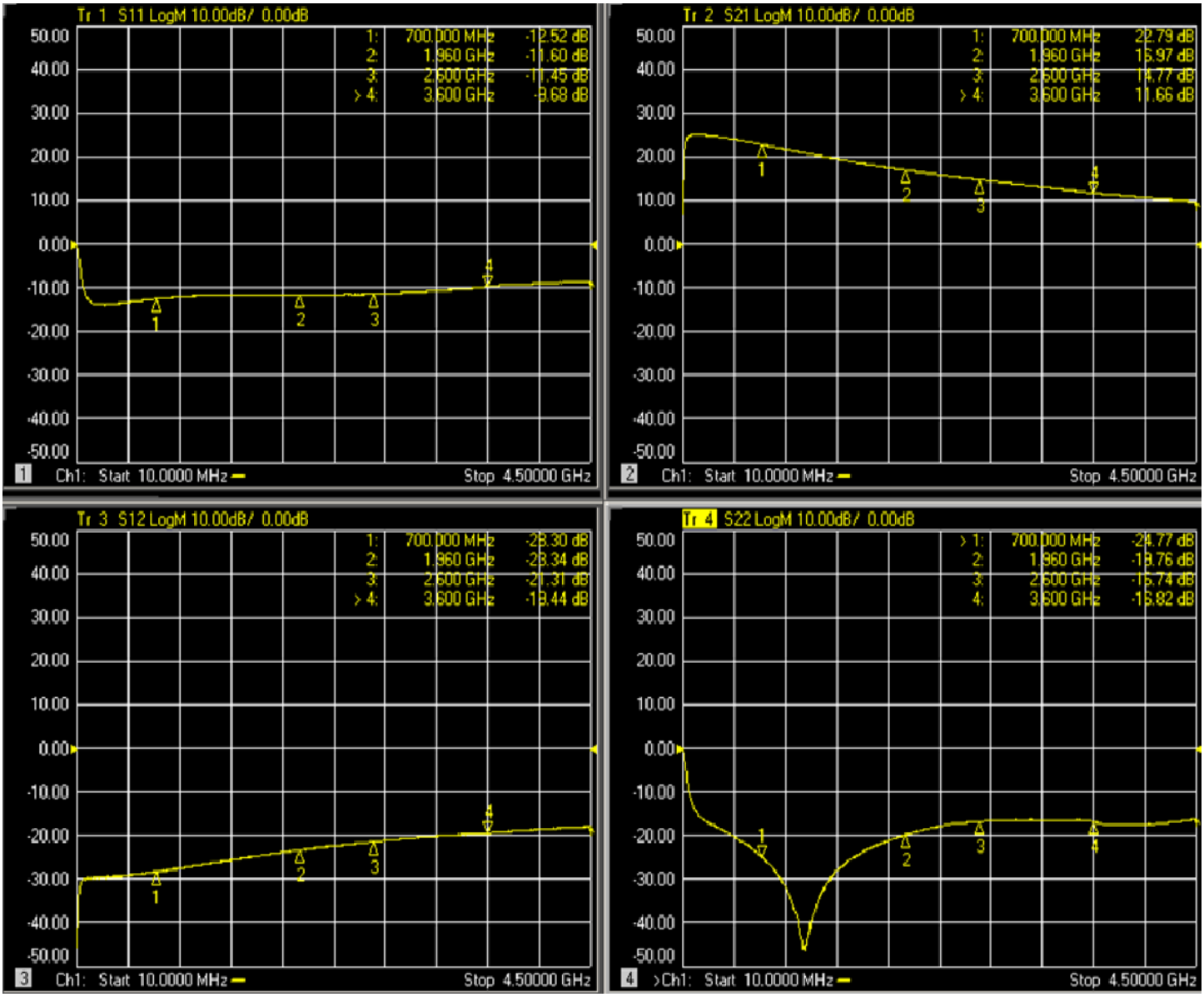
www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Road. Greensboro, NC 27455

GRF4002 Typical Operating Curves: 0.7 to 3.8 GHz Tune



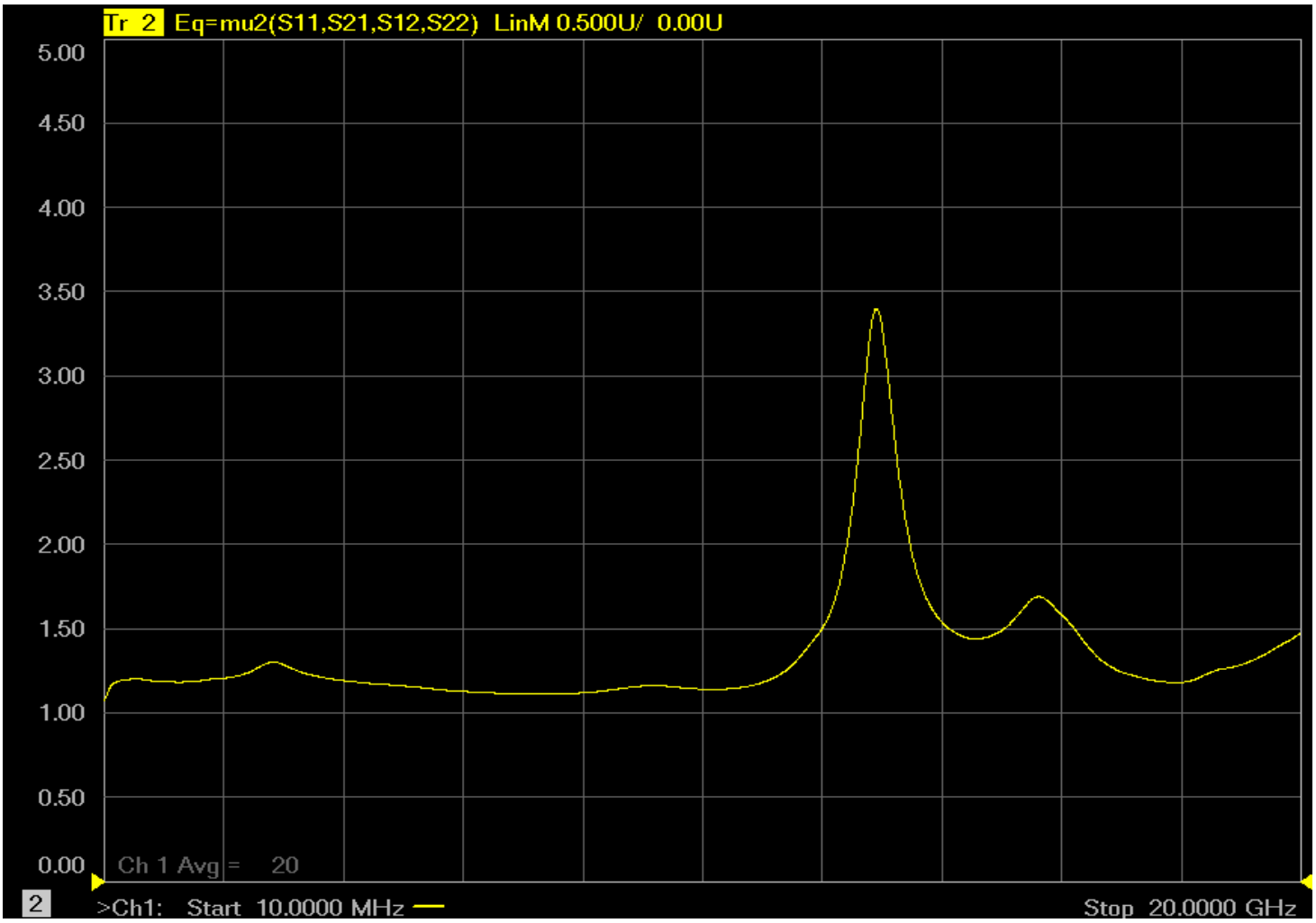


GRF4002 Typical Operating Curves: S-Parameters (0.7 to 3.8 GHz Tune)

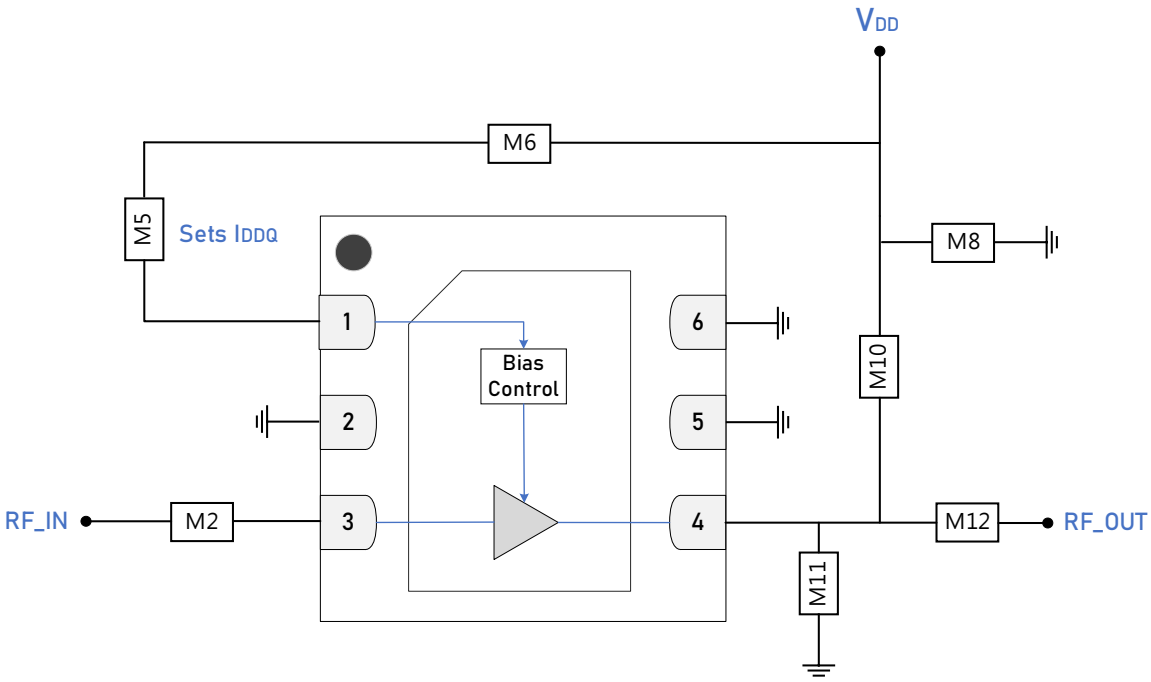


www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Road. Greensboro, NC 27455

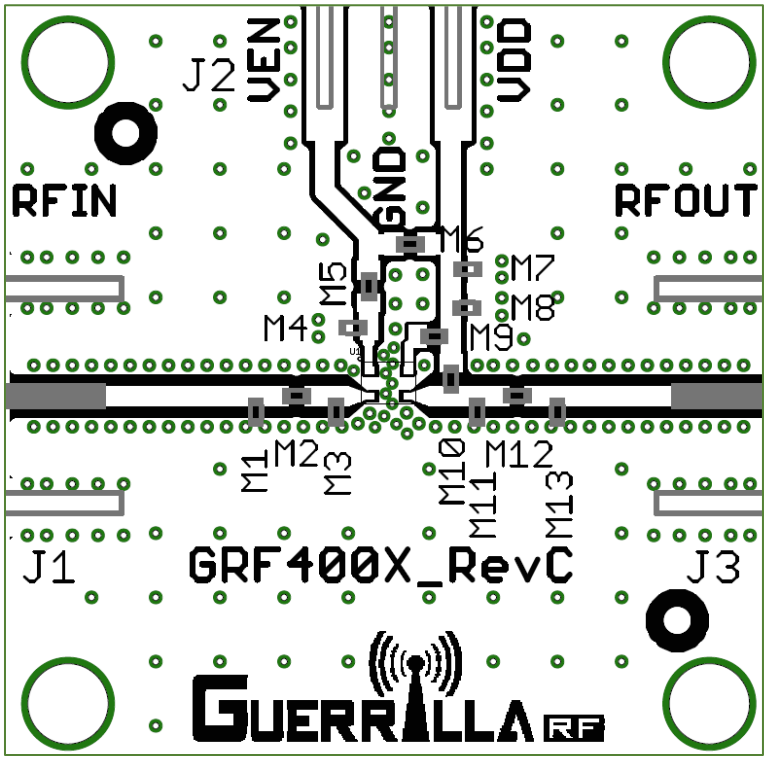
GRF4002 Typical Operating Curves: Stability Mu Factor (0.7 to 3.8 GHz Tune)



Note: Mu ≥ 1 implies unconditional stability.



GRF4002 Standard Test Schematic

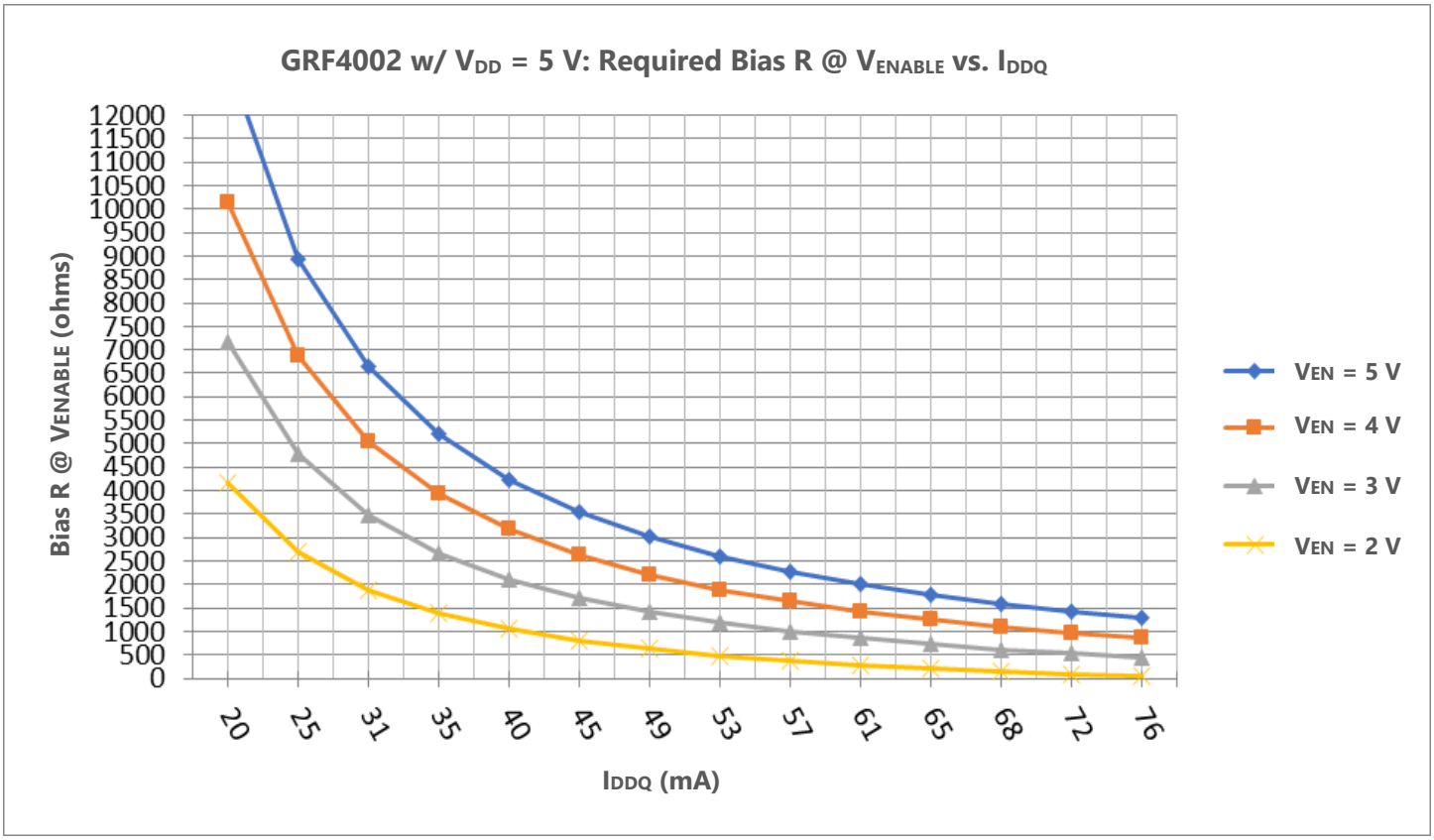


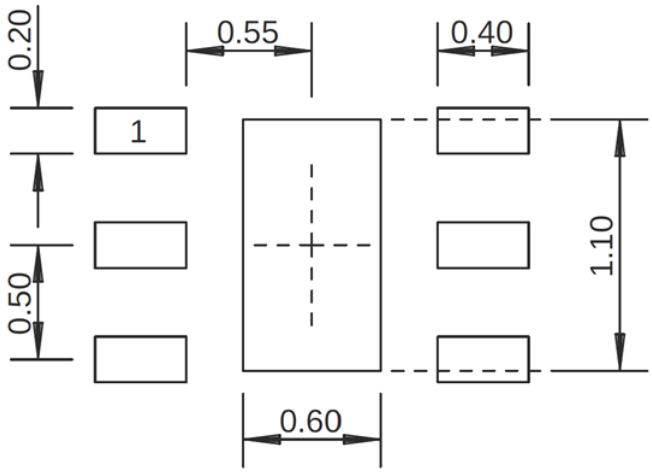
GRF4002 Evaluation Board Assembly Diagram

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

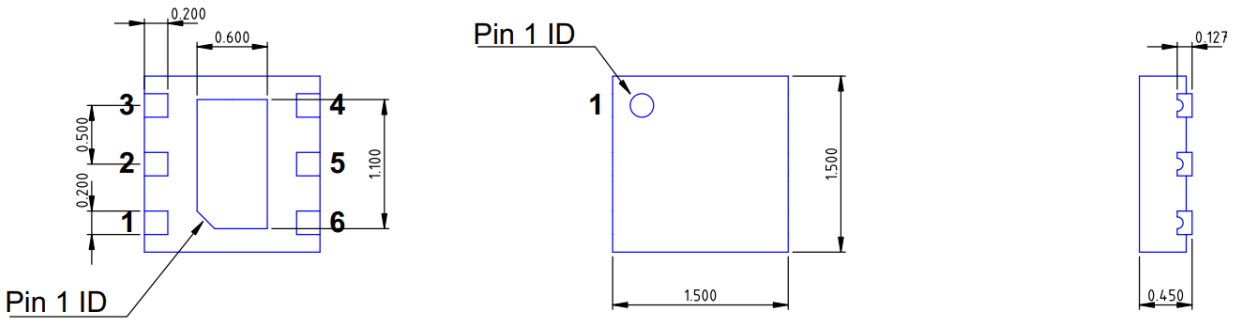
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M2	Capacitor	Murata	GJM	100 pF	0402	ok
M5 (Sets I_{DDQ})	Resistor	Various	5%	See Curves	0402	ok
M6	Resistor (Jumper)	Various	--	0 Ω	0402	ok
M8	Capacitor	Murata	GJM	0.1 µF	0402	ok
M10	Inductor	Coilcraft	HP	100 nH	0402	ok
M11	Capacitor	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)

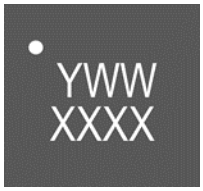


Bottom View **Top View** **Side View**

DFN6 1.5x1.5mm
Dimensions in millimeters
Dimensional Tolerance: ±0.05

1.5 x 1.5 mm DFN-6 Package Dimensions

Package Marking Diagram



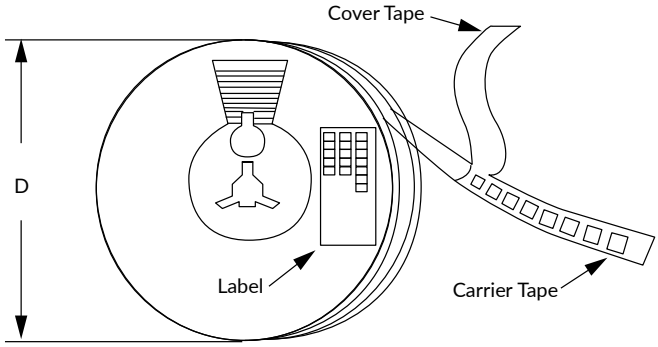
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

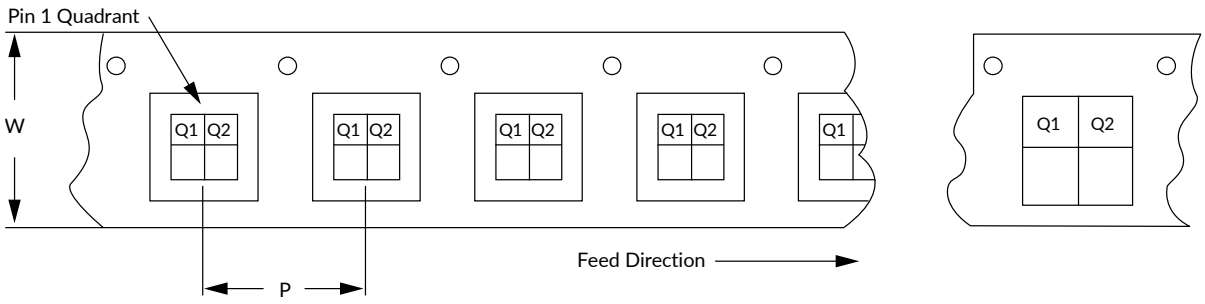
Guerrilla RF's tape and reel specification complies with Electronics Industries Association (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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 µA to 1 µA and Max value from 100 µA to 5 µA to match PTP. Added M6 Resistor (jumper) to EVB BOM and updated EVB schematic. Updated Gain, Noise Figure, OP1dB and OIP3 Characterization Plots.

www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Road. Greensboro, NC 27455

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 *estimated* 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 *production-released* material. TYP values are based on a combination of ATE and bench-level measurements, with MIN/MAX limits defined using *modelled estimates* 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 *derived from multiple lots which have been fabricated over an extended period of time*. MIN/MAX limits may be refined over previous releases as more statistically significant data is collected to account for process spreads.