Data Sheet

RELEASE A DATA SHEET

GRF2012

BROADBAND LINEAR GAIN BLOCK
0.05 to 6 GHz

FEATURES

- Flexible Bias
- Internally Matched to 50 Ω
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package

Reference: 5 V / 90 mA / 0.9 GHz

- Gain: 14.8 dB
- OIP3: 40 dBm
- OP1dB: 23 dBm
- EVB Noise Figure: 2.7 dB

Reference: 8 V / 100 mA / 0.9 GHz

- Gain: 14.9 dB
- OIP3: 40 dBm
- OP1dB: 25 dBm
- EVB Noise Figure: 2.8 dB

APPLICATIONS

- High Performance Gain Block
- Linear Driver Amplifier
- Small Cells and Cellular Repeaters
- IF Amplifier

DESCRIPTION

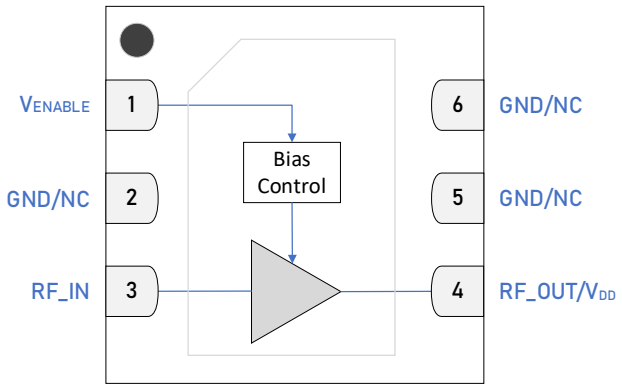
The GRF2012 is a broadband gain block with low noise figure and industry leading linearity designed for small cell, wireless infrastructure, and other high-performance applications. It exhibits outstanding broadband NF, linearity over 700 to 3800 MHz with a single match.

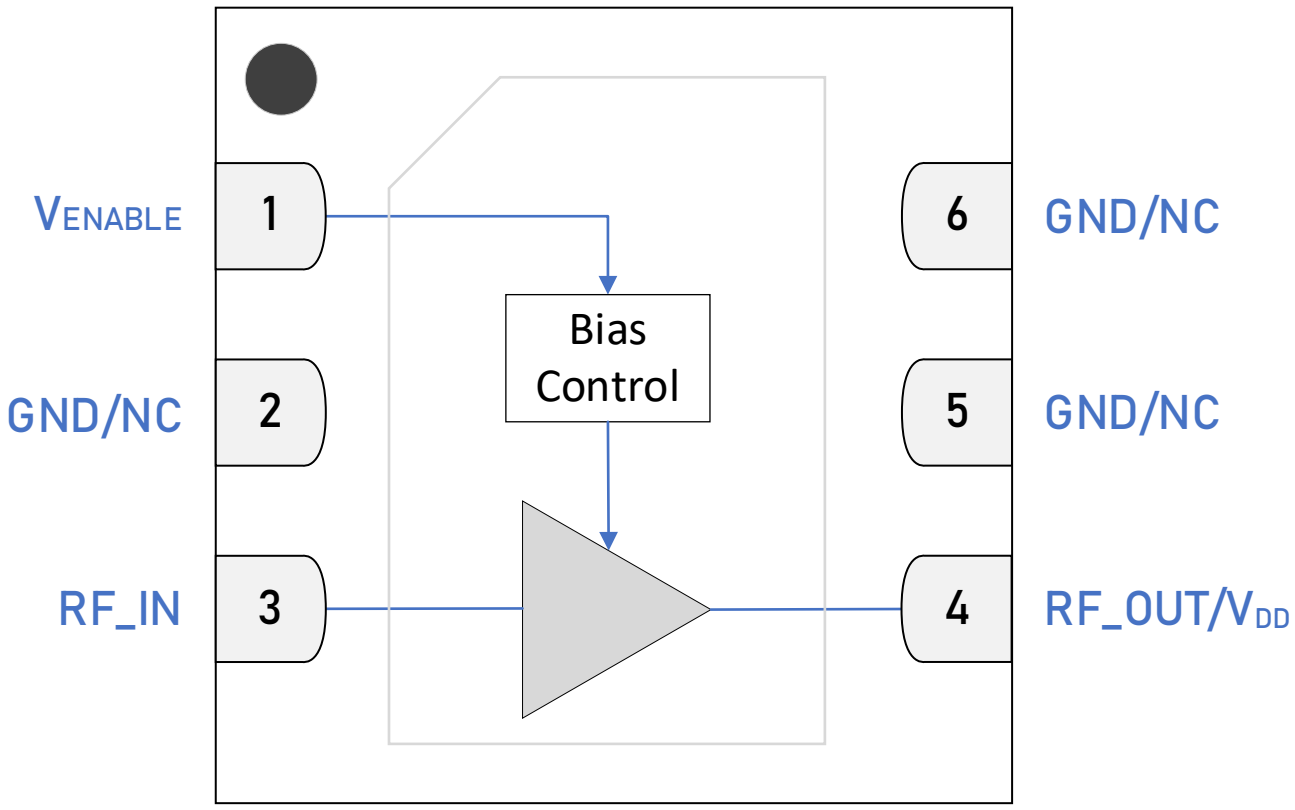
The device is operated from a supply voltage of 2.7 to 8 V with a selectable I_{DDQ} range of 15 to 100 mA for optimal efficiency and linearity.

The GRF2012 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 and device S-parameters.

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.
2	GND/NC	Ground or No Connect	No internal connection to die.
3	RF_IN	LNA RF Input	Internally matched to 50 Ω. An external DC blocking capacitor must be used.
4	RF_OUT	LNA RF Output	Internally matched to 50 Ω. V_{DD} must be applied through an RF choke to this pin.
5	GND/NC	Ground or No Connect	No internal connection to die.
6	GND/NC	Ground or No Connect	No internal connection to die.
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	9	V
RF Input Power (Load VSWR < 2:1, $V_{DD} \leq 8$ V)	$P_{IN\ MAX}$		22	dBm
Operating Temperature (Package Heat Sink)	T_{AMB}	-40	105	°C
Maximum Channel Temperature (MTTF >10^6 Hours)	T_{MAX}		170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		1	W

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 *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}	0	5	9	V	
Operating Temperature (Package Heat Sink)	$T_{PKG\ HEAT\ SINK}$	-40		105	°C	
RF Frequency Range	F_{TEST}	0.05	0.9	6	GHz	Typical Application Schematic with external matching components **(note 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 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 Measurement Schematic using the 0.05 to 6 GHz tuning set, 50 Ω system impedance, M5 = 300 Ω, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 90 mA, F_{TEST} = 0.9 GHz, $T_{PKG\ HEAT\ SINK}$ = 25 °C. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Switching Rise Time	T_{RISE}		200		ns	
Switching Fall Time	T_{FALL}		300		ns	
Supply Current	I_{DD}	80	94	108	mA	V_{DD} = V_{ENABLE} = 5 V, R_{BIAS} = 300 Ω.
Enable Current	I_{ENABLE}		5	8	mA	

Disabled Mode

Leakage Current	$I_{LEAKAGE}$		110	300	µA	V_{DD} = 5 V, V_{ENABLE} = 0 V.

Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		55		°C/W	On Standard Evaluation Board. No RF applied **(note 3).**

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

Nominal Operating Parameters – RF

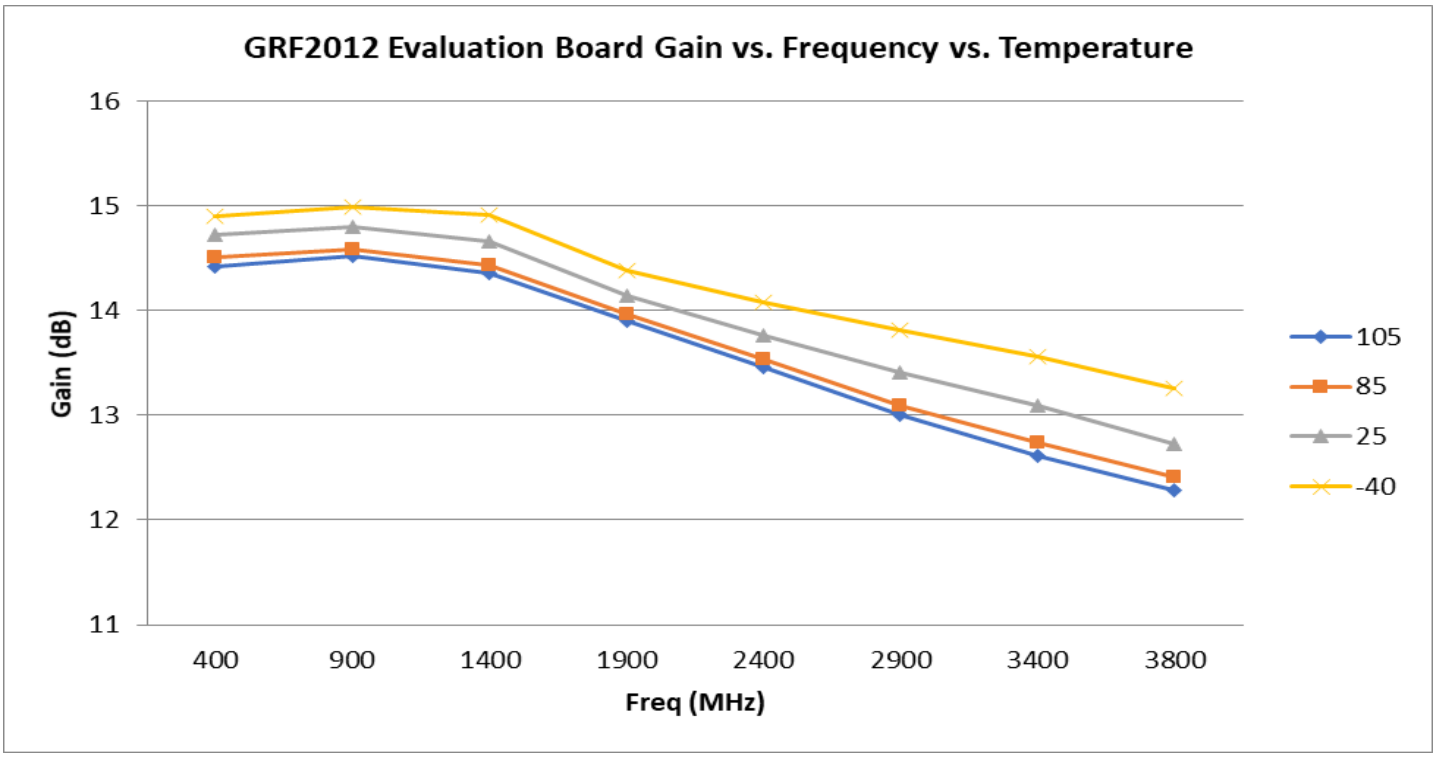
The following conditions apply unless noted otherwise: Typical Measurement Schematic using the 0.05 to 6 GHz tuning set, 50 Ω system impedance, M5 = 300 Ω, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 90 mA, F_{TEST} = 0.9 GHz, $T_{PKG\ HEAT\ SINK}$ = 25 °C. Evaluation board losses are included within the specifications.

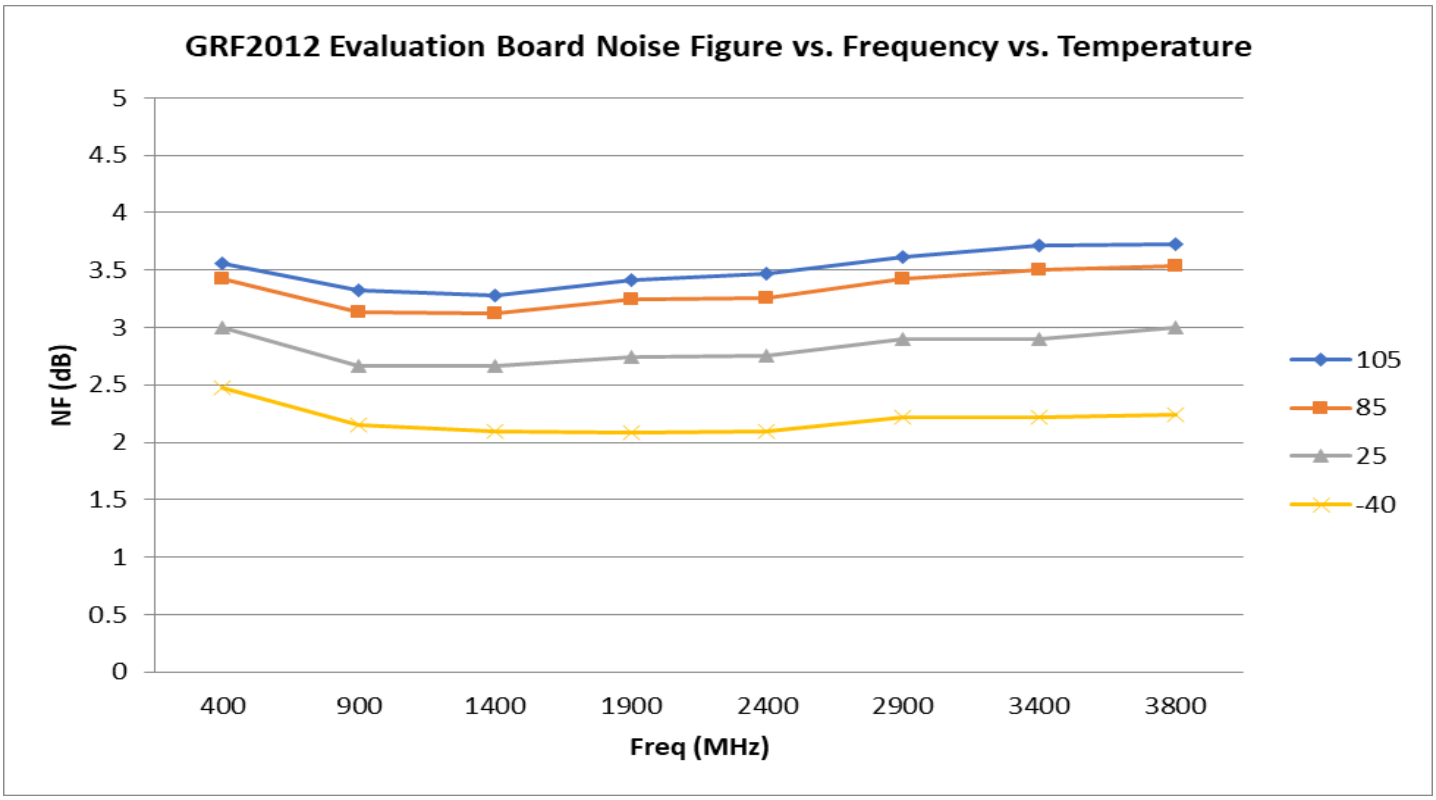
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21	*13.8*	14.8	*16.5*	dB	
Reverse Isolation	S12		> 20		dB	F_{RF} = 0.4 to 3.8 GHz.
Evaluation Board Noise Figure	NF		2.7	*2.95*	dB	
Output 3rd Order Intercept	OIP3		40		dBm	+2 dBm P_{OUT} per tone at 2 MHz Spacing (899 and 901 MHz).
Output 1 dB Compression Power	OP1dB	*21.5*	23		dBm	

Typical Operating Curve Conditions

The following conditions apply unless noted otherwise: Typical Measurement Schematic using the 0.05 to 6 GHz tuning set, 50 Ω system impedance, M5 = 300 Ω, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 90 mA, F_{TEST} = 0.9 GHz, $T_{PKG\ HEAT\ SINK}$ = 25 °C. Evaluation board losses are included within the plots.

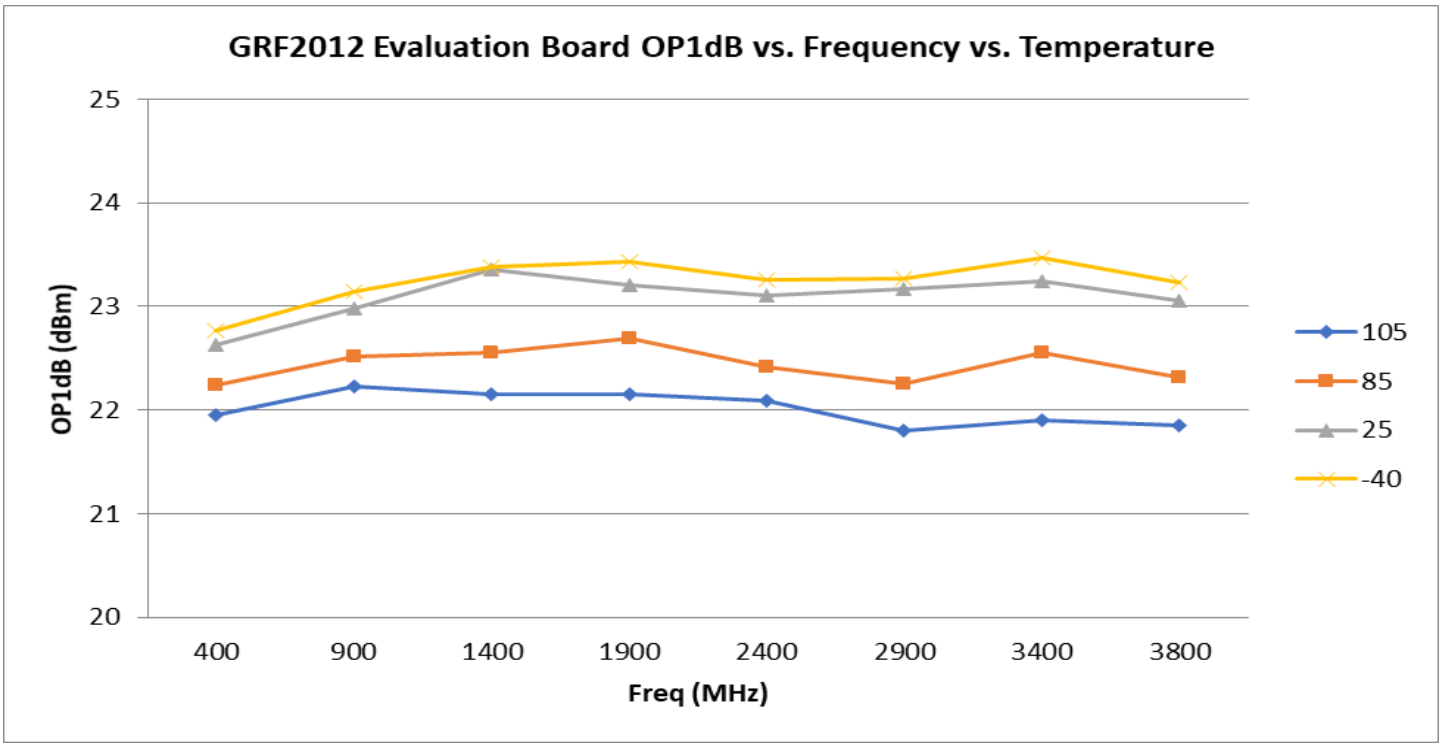
GRF2012 Typical Operating Curves: Evaluation Board Data (0.4 to 3.8 GHz Tune)

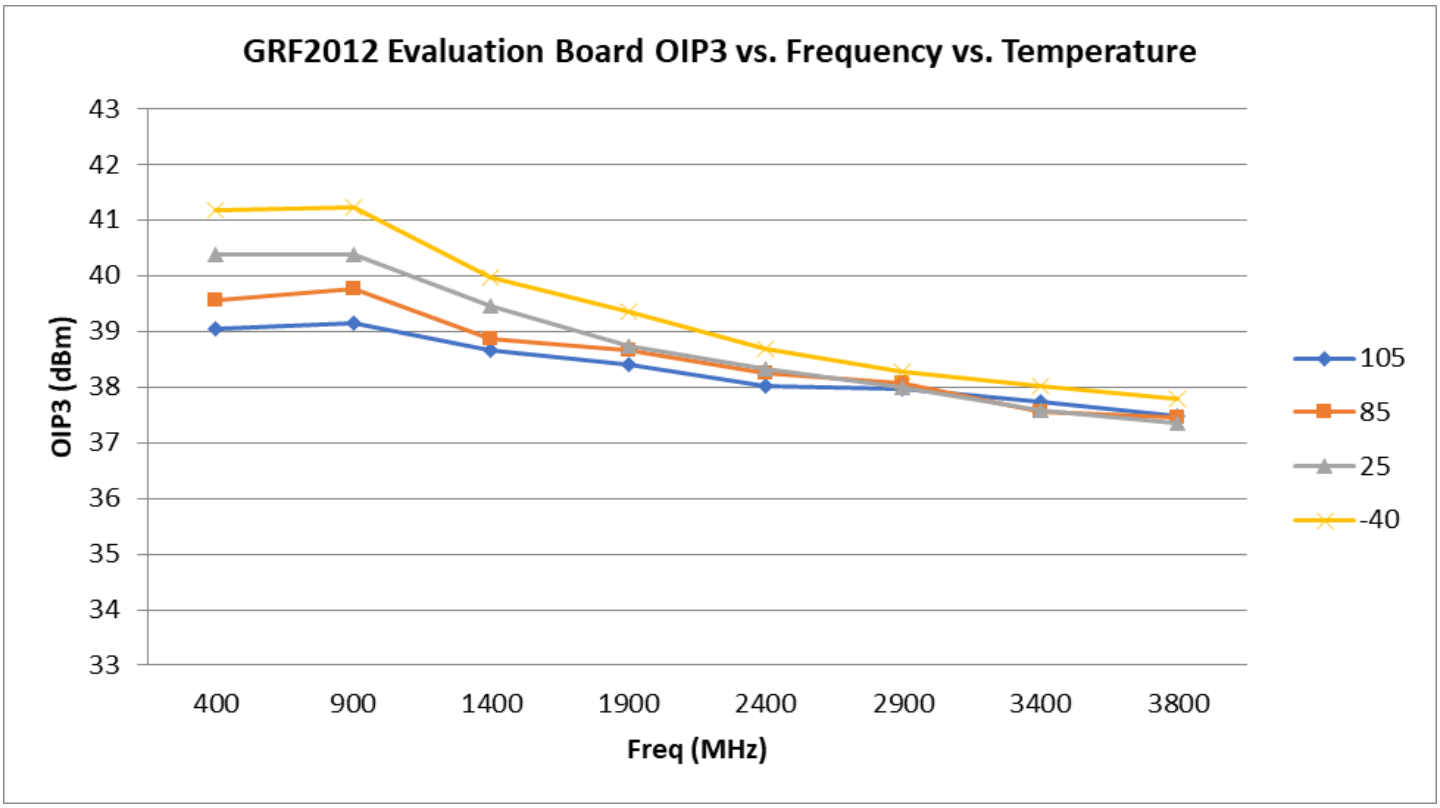




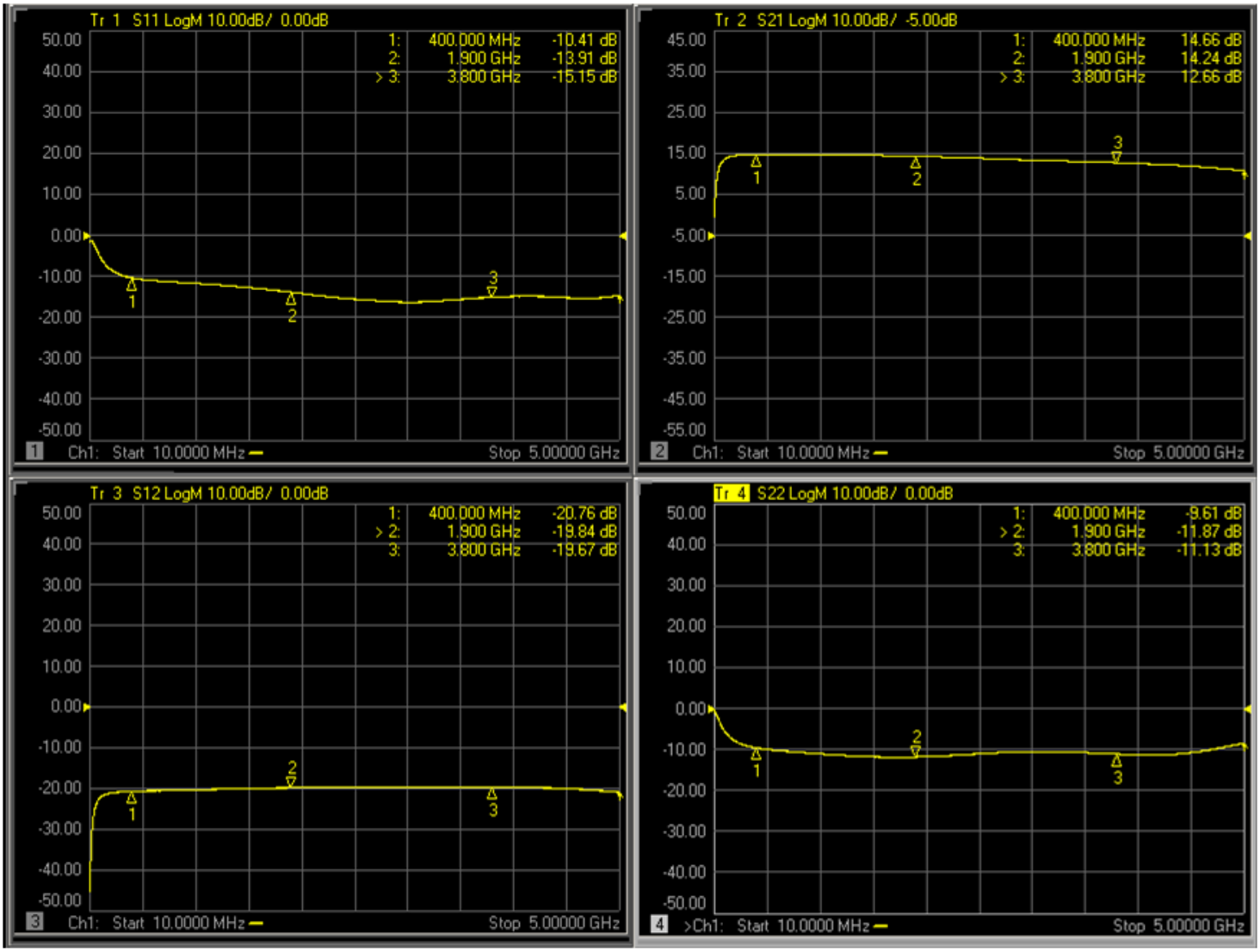
www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Road. Greensboro, NC 27455

GRF2012 Typical Operating Curves: Evaluation Board Data (0.4 to 3.8 GHz Tune)

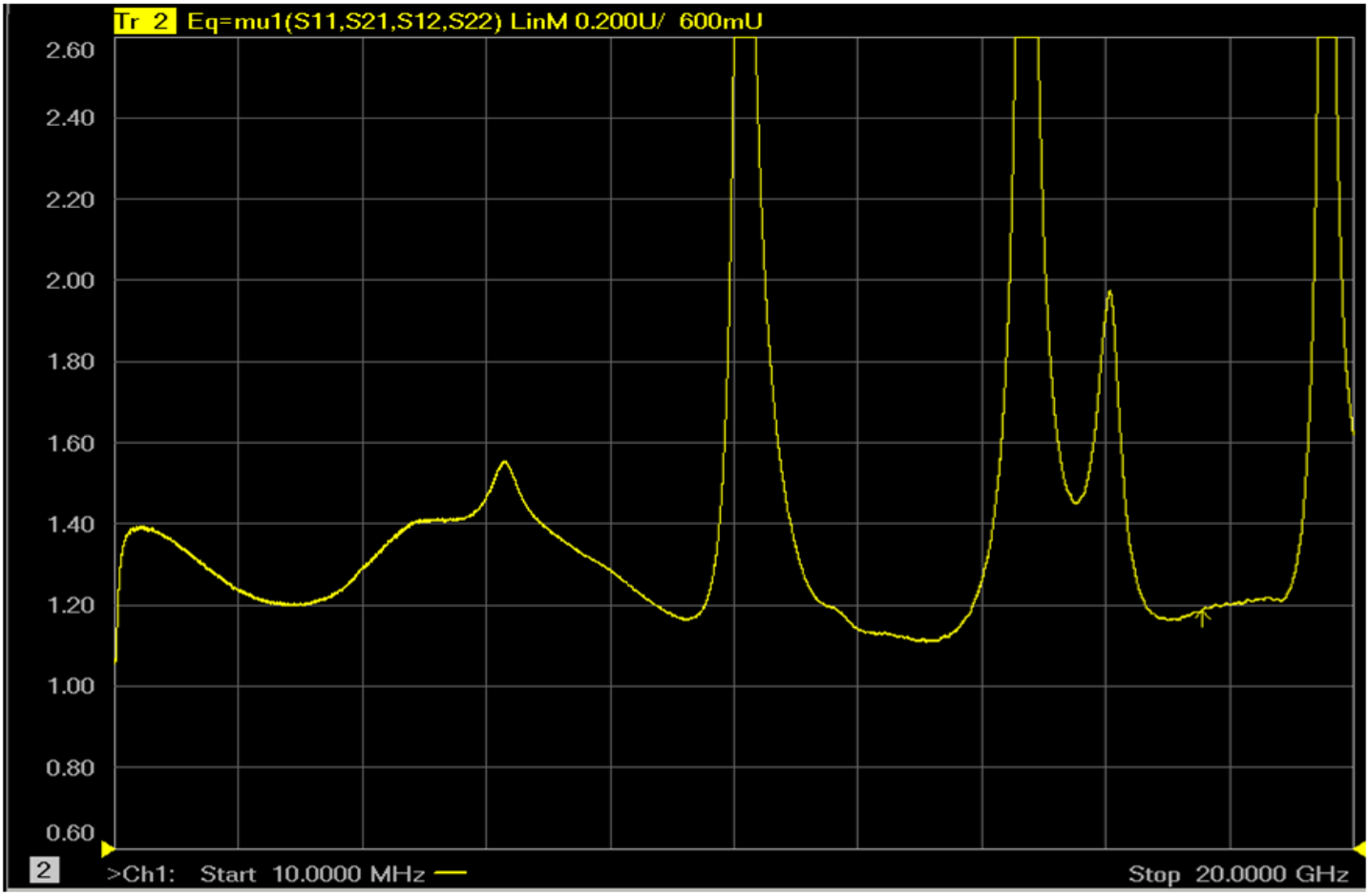




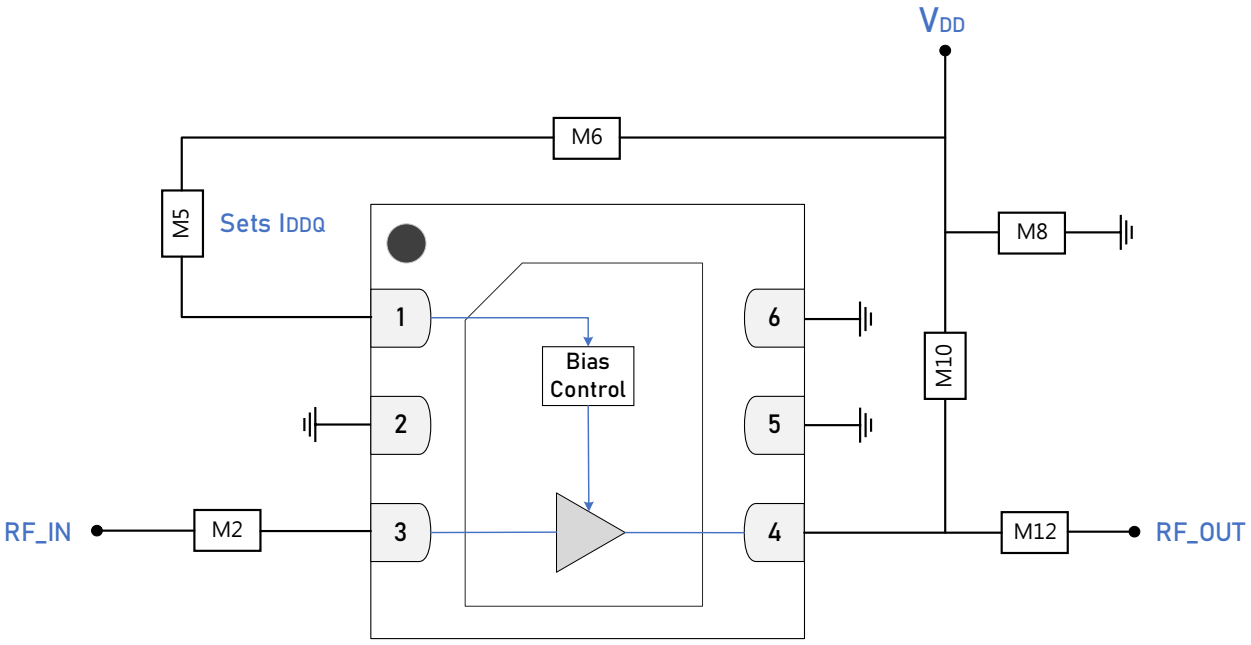
GRF2012 Typical Operating Curves: S-Parameters (0.4 to 3.8 GHz Tune)



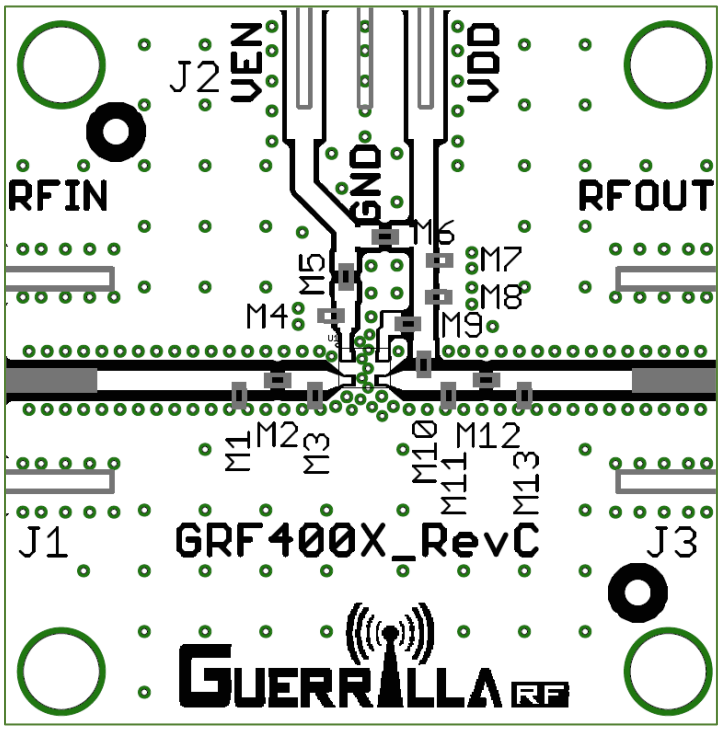
GRF2012 Typical Operating Curves: Stability Mu Factor (0.4 to 3.8 GHz Tune)



Note: Mu Prime factor ≥ 1.0 implies unconditional stability.



GRF2012 Standard Test Schematic

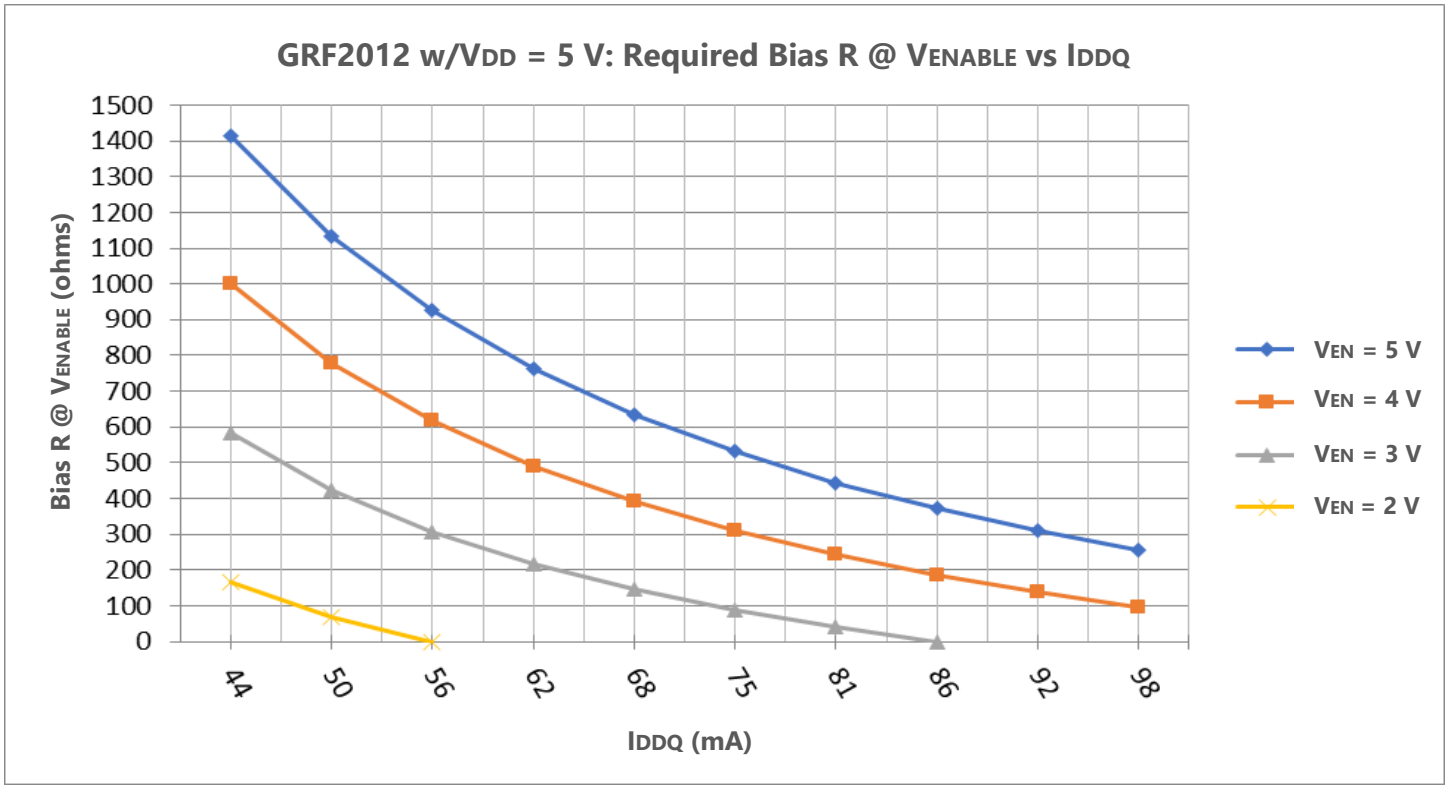


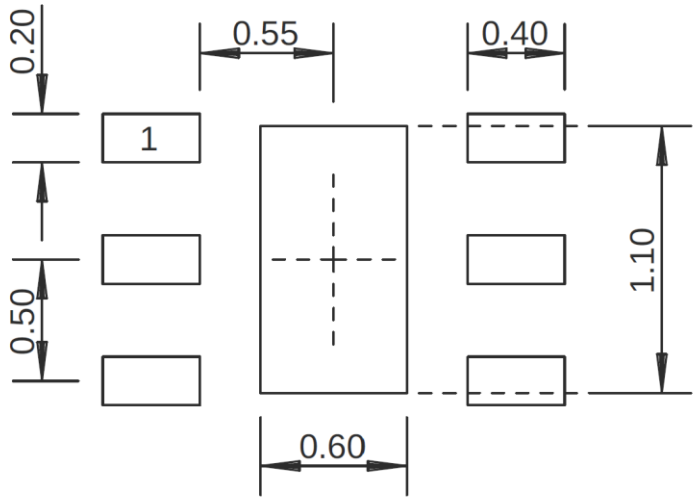
GRF2012 Evaluation Board Assembly Diagram

GRF2012 Measurement Board Assembly Diagram Reference (0.7 to 3.8 GHz Tune)

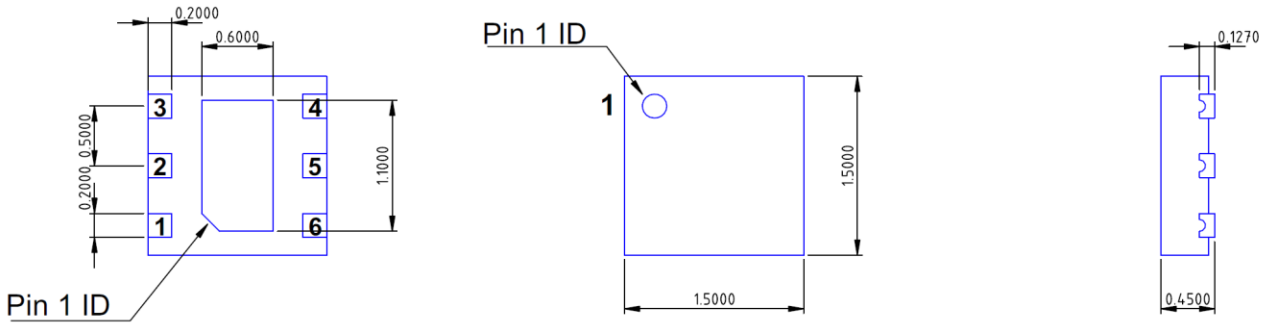
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M2	Capacitor	Murata	GRM	100 pF	0402	ok
M5 (sets I_{DQQ})	Resistor	Various	5%	See Curves	0402	ok
M6	Resistor (Jumper)	Various	--	0 Ω	0402	ok
M8	Capacitor	Murata	GRM	0.1 uF	0402	ok
M10	Inductor	Murata	LQG	47 nH	0402	ok
M12	Capacitor	Murata	GRM	1000 pF	0402	ok
Evaluation Board	GRF400X_RevC					

GRF2012 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

1.5 x 1.5 mm DFN-6 Package Dimensions

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

Package Marking Diagram

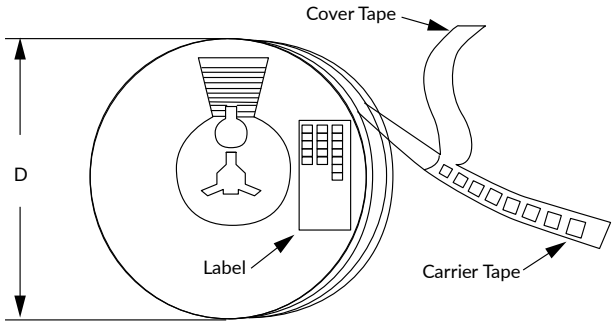
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

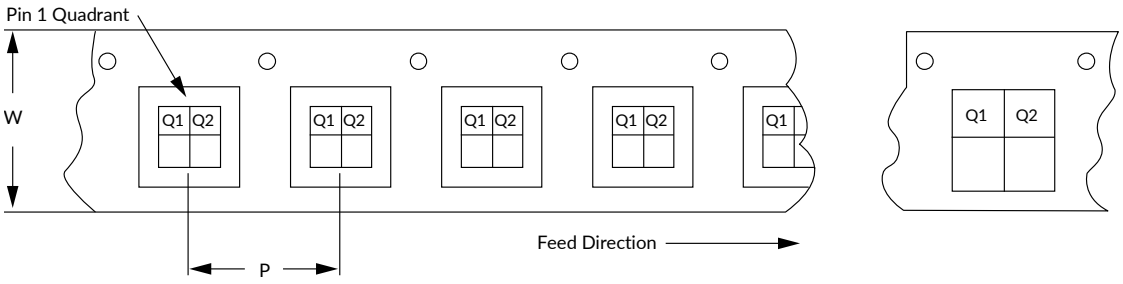
Guerrilla RF's tape and reel specification complies with Electronics Industries Association (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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
June 29, 2021	Release A update. Updated to new format.
February 14, 2022	Removed CDM parameter from Absolute Ratings Table.

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.