DATA SHEET

GRF2013

BROADBAND LINEAR GAIN BLOCK
0.01 to 9 GHz

RELEASE A DATA SHEET

FEATURES

- Low Noise Figure
- Flat Gain
- Flexible Biasing
- Internally Matched to 50 Ω
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package

Reference: 5 V / 90 mA / 1.9 GHz

- Gain: 18.5 dB
- OIP3: 38.5 dBm
- OP1dB: 22.5 dBm
- Evaluation Board Noise Figure: 1.3 dB

Reference: 8 V / 100 mA / 1.9 GHz

- Gain: 18.5 dB
- OIP3: 41 dBm
- OP1dB: 25.3 dBm
- Evaluation Board Noise Figure: 1.4 dB

APPLICATIONS

- Linear Driver Amplifier
- Small Cells and Cellular Repeaters
- IF Amplifiers
- Wireless Backhaul

ORDERING INFORMATION

Buy it Now

DESCRIPTION

The GRF2013 is a broadband gain block with a low noise figure (NF) and high linearity designed for small cell, wireless infrastructure, and other high-performance applications. It exhibits outstanding broadband NF, linearity, and return loss over 700 to 3800 MHz with a single match.

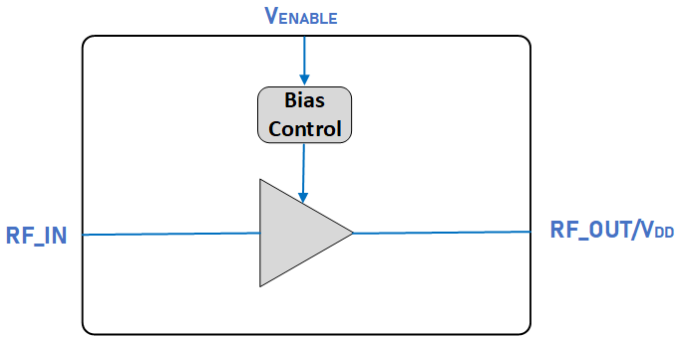
Optimizing the bias inductor and coupling capacitors for lower frequency operation will yield strong performance down to 10 MHz. For applications above 4 GHz, the addition of simple external matching yields outstanding linearity and gain performance up to 9 GHz.

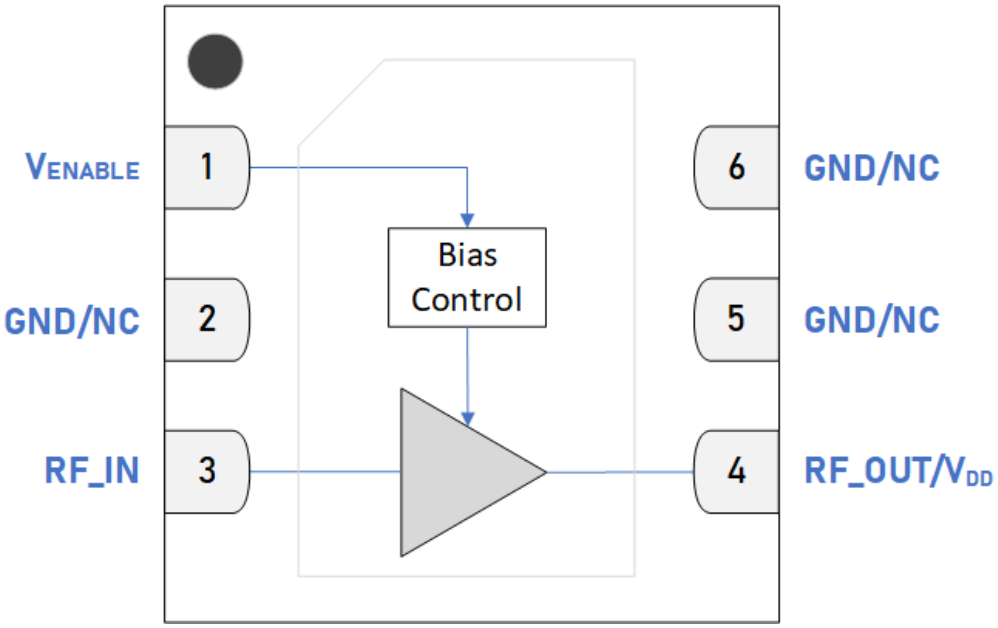
The device can be operated from a supply voltage of 2.7 to 8 V with a selectable I_{DDQ} range of 15 to 100 mA for optimal efficiency and linearity.

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

Additional tunes can be found on the GRF2013 "Custom Tunes" product page: GRF2013 Custom Tunes

BLOCK DIAGRAM





Pin Out (Top View)

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 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	RF Input	Internally matched to 50 Ω. An external DC blocking capacitor must be used.
4	RF_OUT/V_{DD}	RF Output	Internally matched to 50 Ω. V_{DD} must be applied through a RF choke to this pin. 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.

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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 base)	$T_{PKG\ BASE}$	-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.

Note: For additional information, please refer to Manufacturing Note MN-001 - Packaging and Manufacturing Information.

All Guerrilla RF products are provided in RoHS compliant lead (Pb)-free packaging. For additional information, please refer to the Certificate of RoHS Compliance.

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Recommended Operating Conditions

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{DD}	2.7	5	8	V	
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40		105	°C	
RF Frequency Range	F_{TEST}	0.01	1.9	9	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 of this range is supported by using different custom tunes. Examples of other optimized tunes can be found here: GRF2013 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 0.7 to 3.8 GHz tuning set, 50 Ω system impedance, M5 = 500 Ω, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 90 mA, F_{TEST} = 1.9 GHz, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Current	I_{DD}		90		mA	V_{DD} = 5 V, V_{ENABLE} = 5 V.
Enable Current	I_{ENABLE}		5		mA	
Switching Rise Time	T_{RISE}		500		ns	Disabled mode to Gain mode **(note 3)**.
Switching Fall Time	T_{FALL}		500		ns	Gain mode to Disabled mode **(note 4)**.

Disabled Mode

Leakage Current	$I_{LEAKAGE}$		100		µA	V_{DD} = 5 V, V_{ENABLE} = 0 V.

Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		66.5		°C/W	On standard evaluation board **(note 5)**.

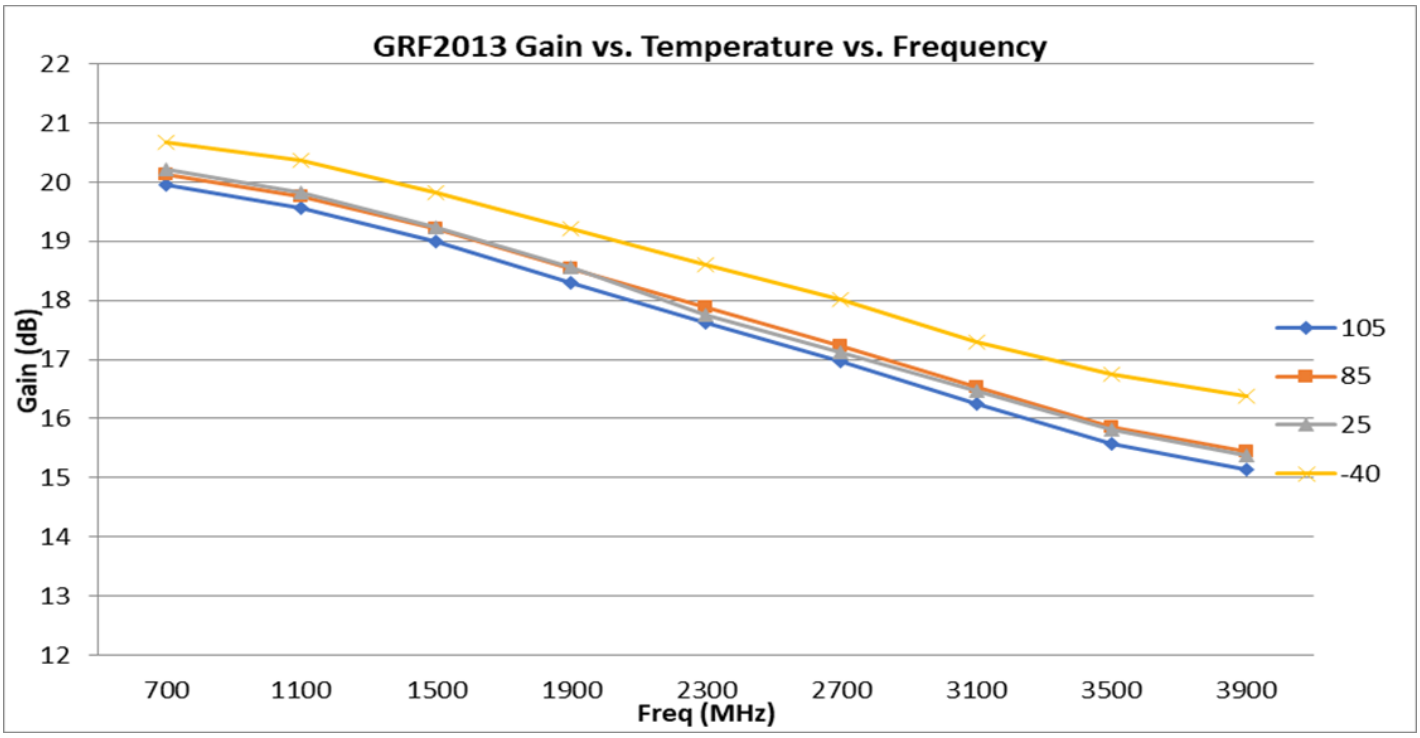
Note 3: Switching Time: 50% of V_{ENABLE} to 90% of P_{OUT}.
Note 4: Switching Time: 50% of V_{ENABLE} to 10% of P_{OUT}.
Note 5: MTTF > 10^6 hours for $T_{CHANNEL}$ < 170 °C.

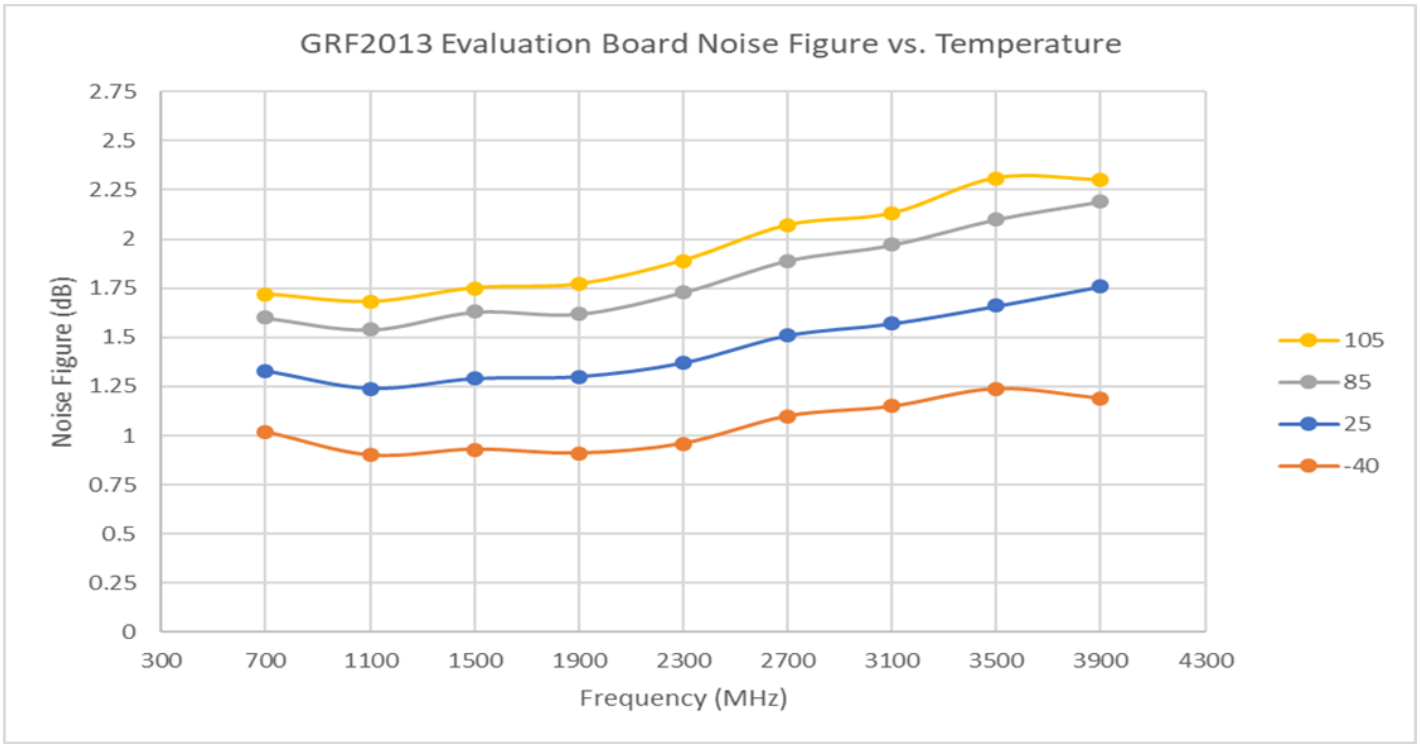
Nominal Operating Parameters - RF

The following conditions apply unless noted otherwise: typical application schematic using the 0.7 to 3.8 GHz tuning set, 50 Ω system impedance, M5 = 500 Ω, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 90 mA, F_{TEST} = 1.9 GHz, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21	17.5	18.5		dB	V_{DD} = 5 V, V_{ENABLE} = 5 V
Noise Figure	NF		1.3	1.5	dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		38.5		dBm	+4 dBm P_{OUT} per tone at 2 MHz Spacing (1899 and 1901 MHz)
Output 1 dB Compression Power	OP1dB	21	22.5		dBm	

GRF2013 Typical Operating Curves: 5 V, 90 mA (0.7 to 3.8 GHz Tune)





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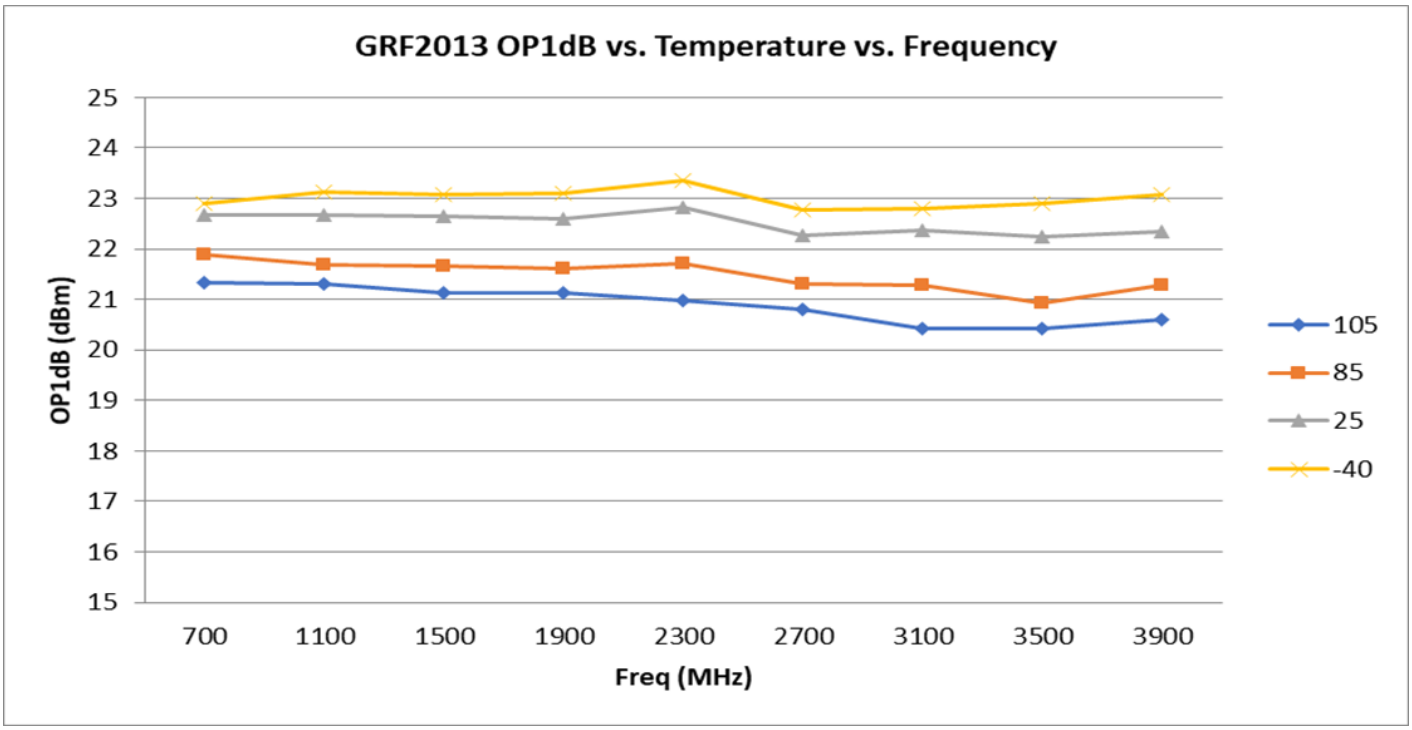

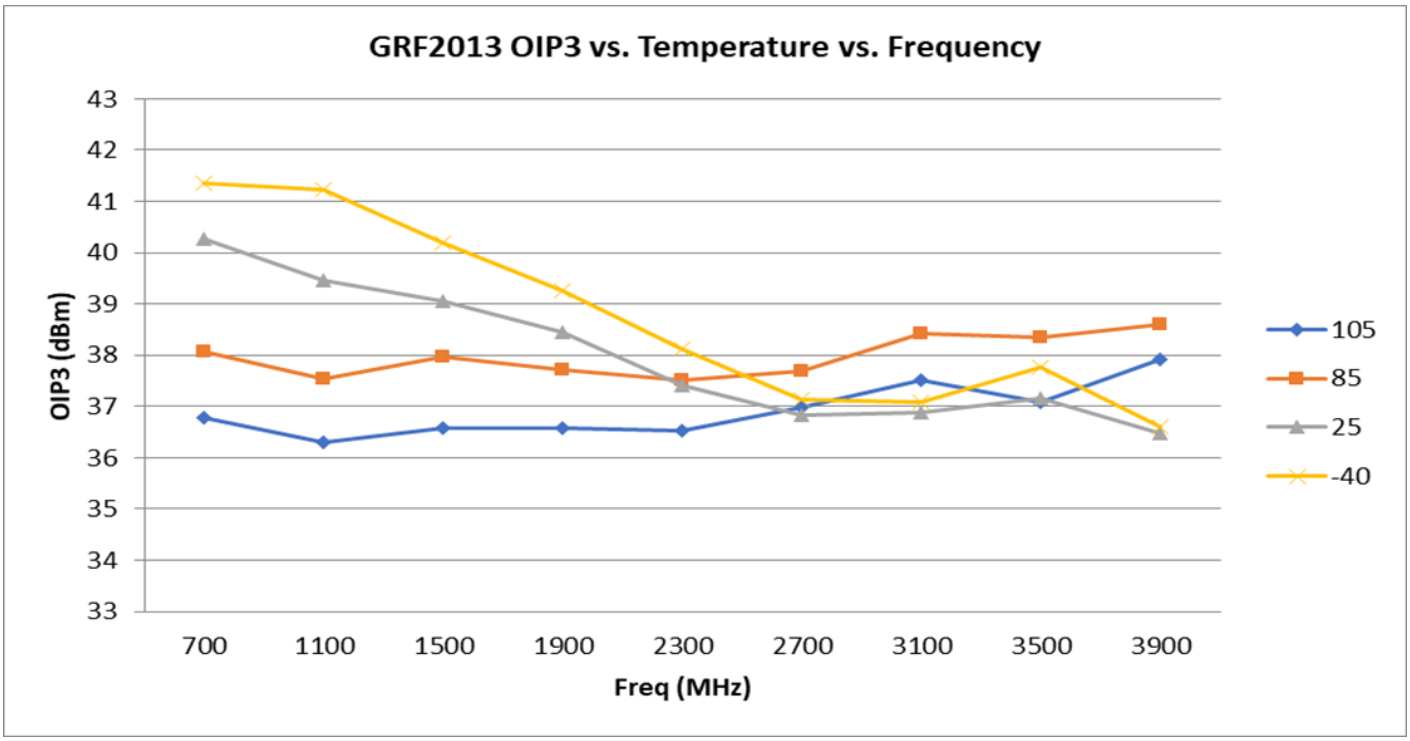

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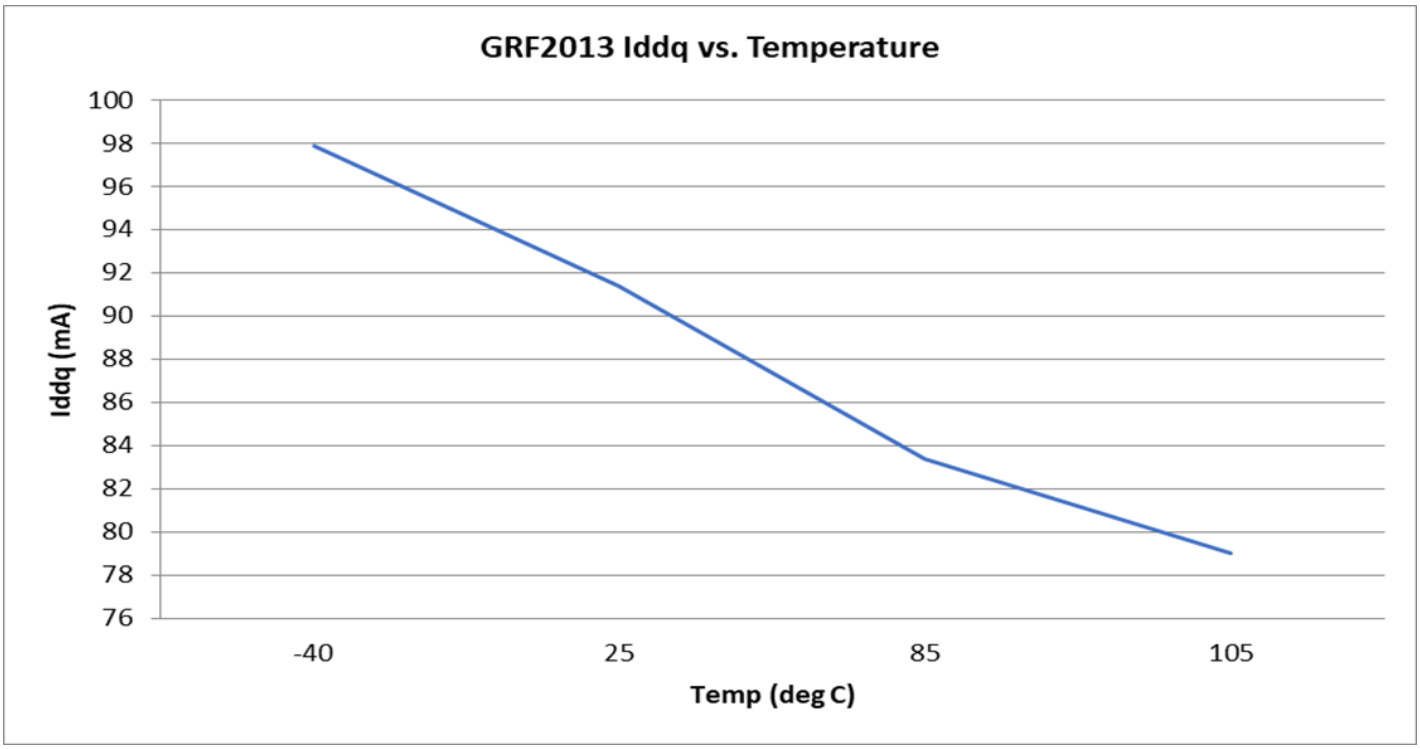
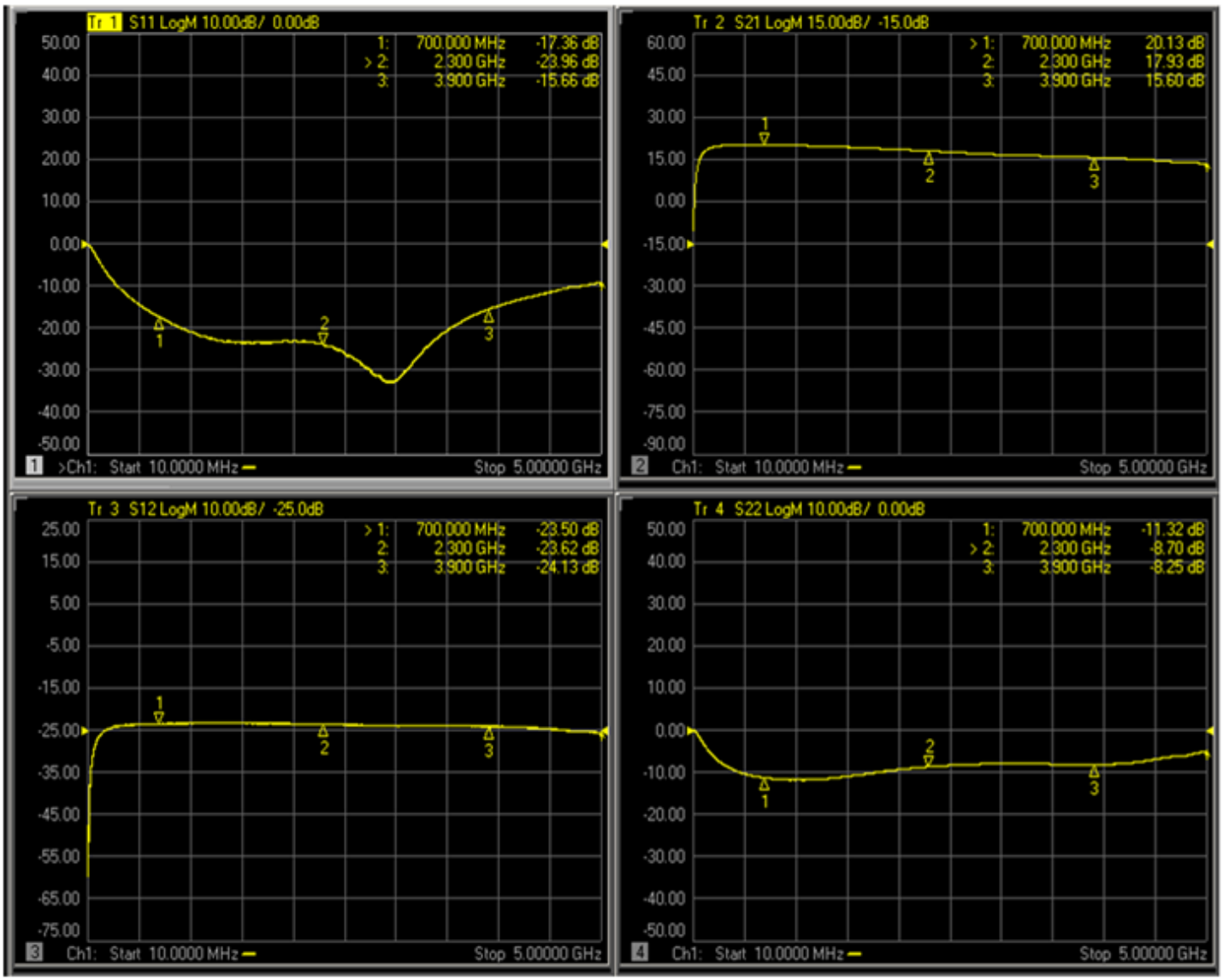
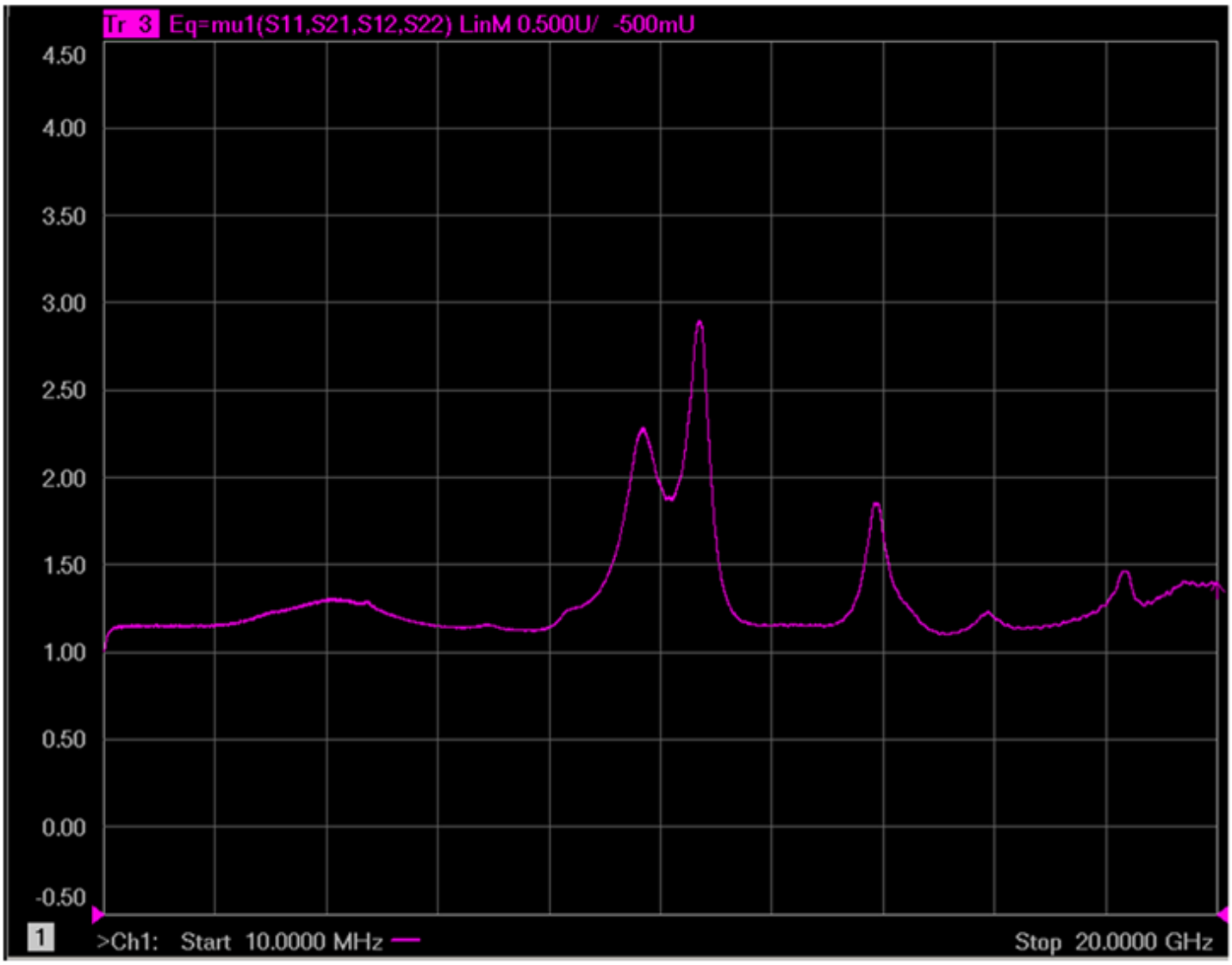


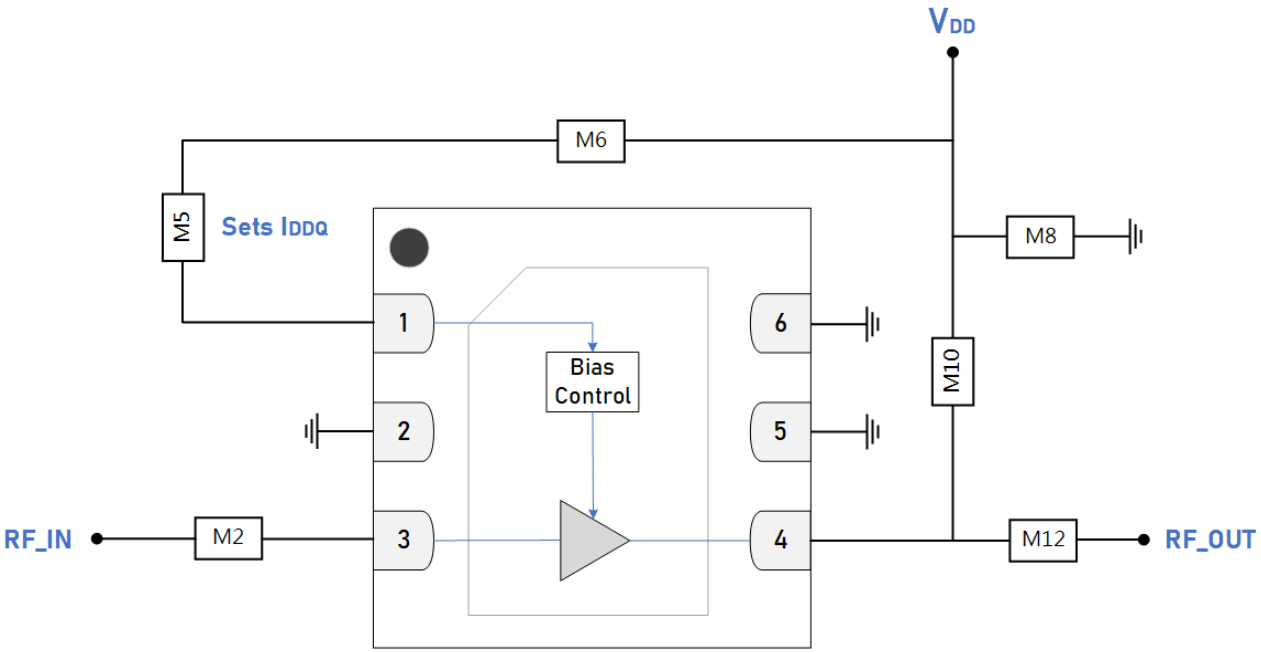
GRF2013 Typical Operating Curves: S-parameters (0.7 to 3.8 GHz Tune)



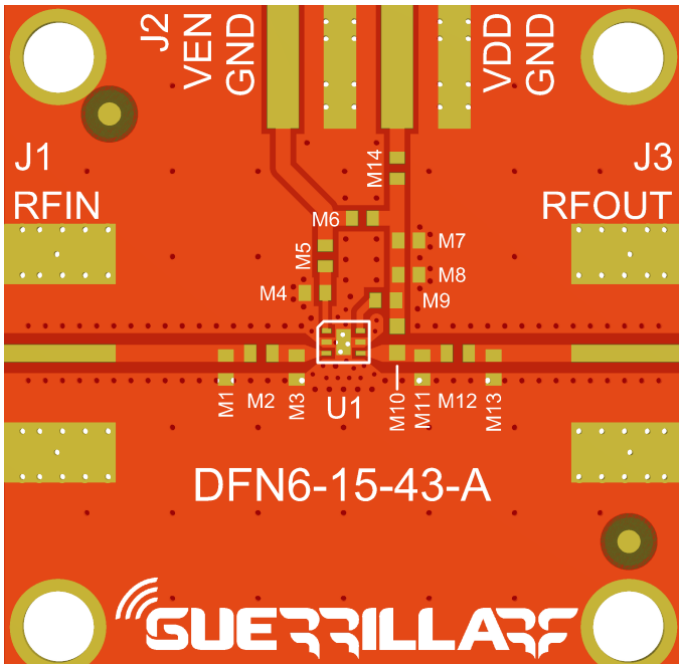
GRF2013 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



Note: Mu Factor ≥ 1.0 implies unconditional stability.



GRF2013 Standard Evaluation Board Schematic

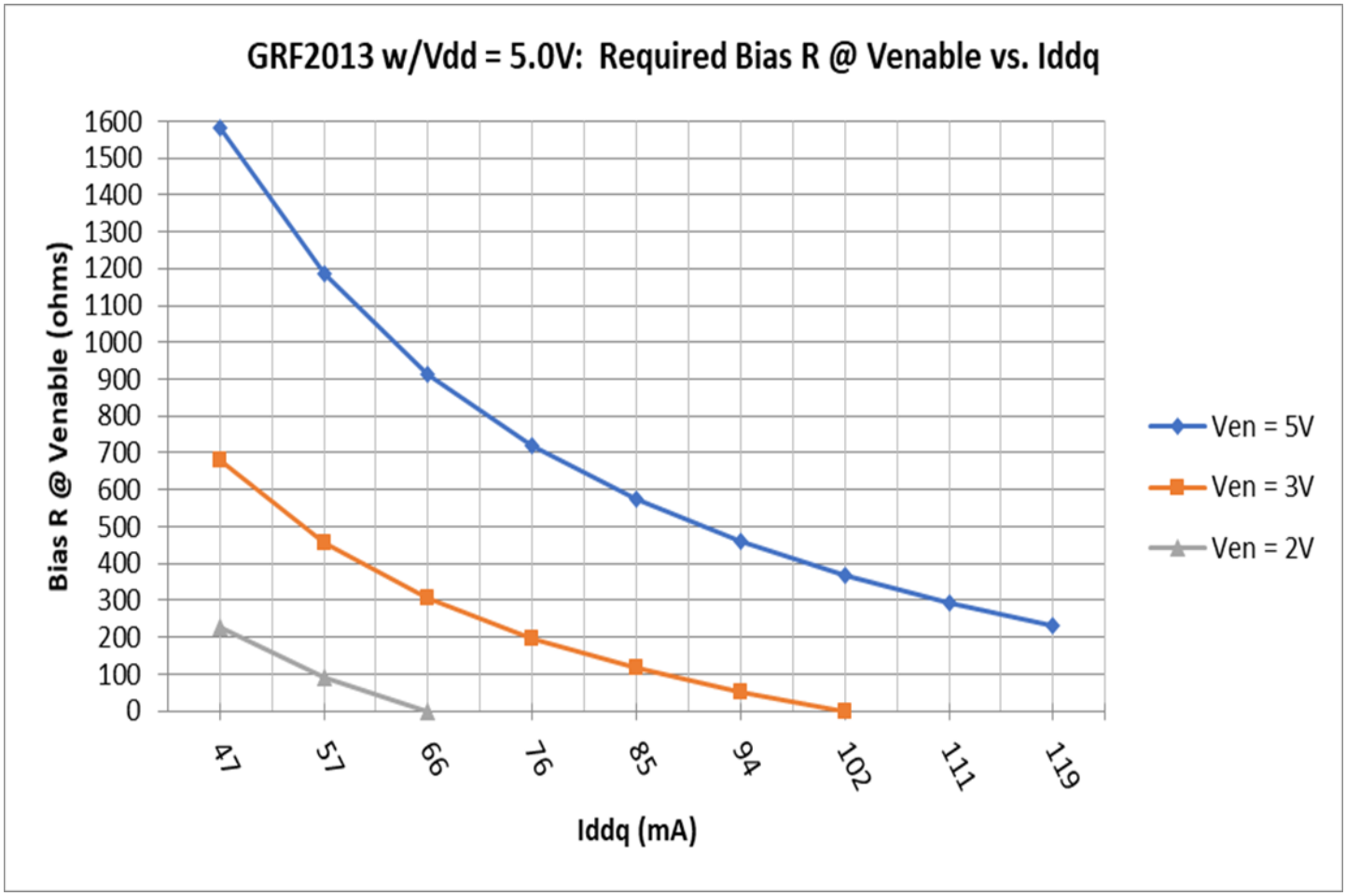


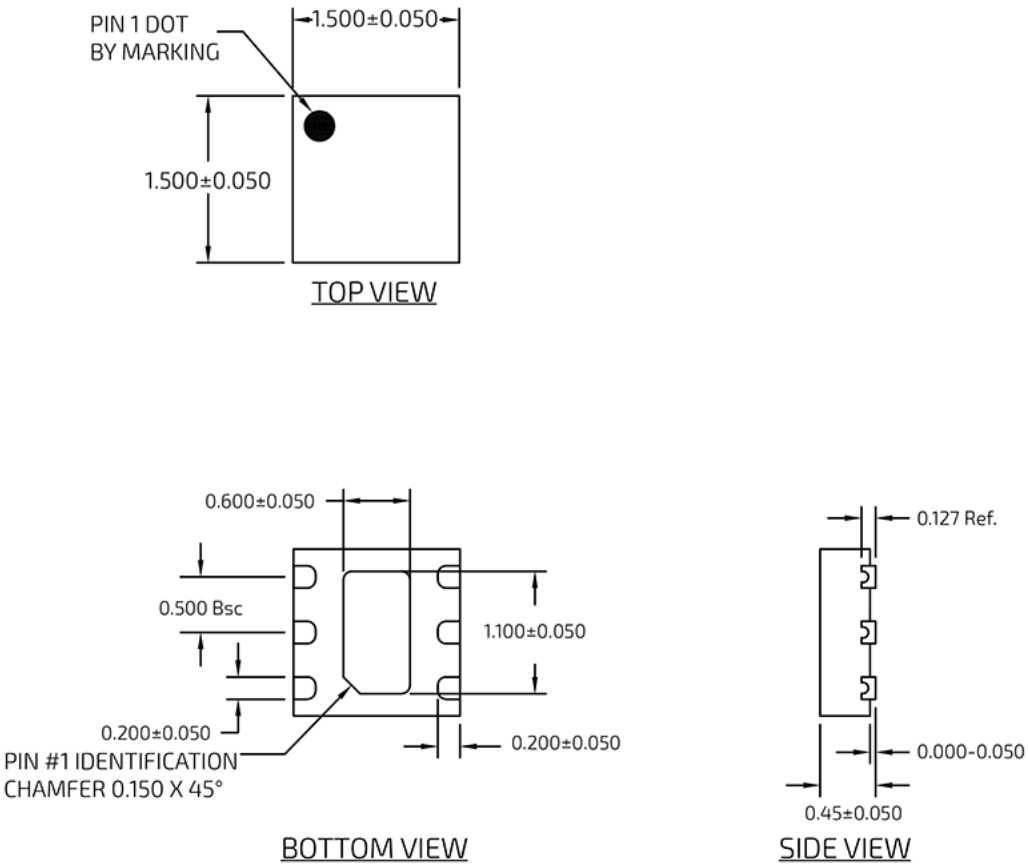
GRF2013 Evaluation Board Assembly Diagram

GRF2013 Evaluation Board Assembly Diagram Reference (0.7 to 3.8 GHz Tune)

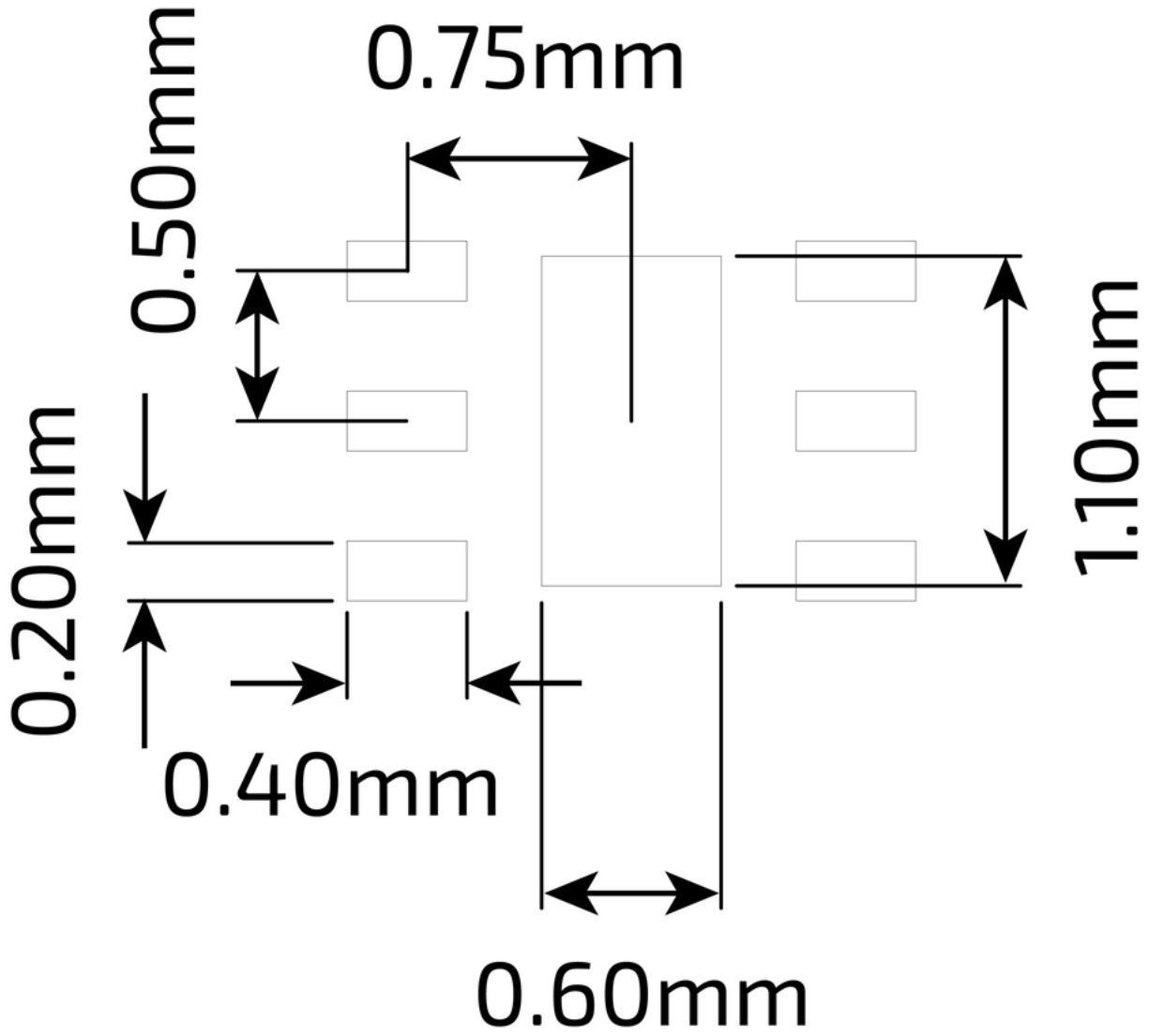
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M2	Capacitor	Murata	GRM	100 pF	0402	ok
M5 (Sets I_{DDQ})	Resistor	Various	5%	see curves	0402	ok
M6	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M8	Capacitor	Murata	GRM	0.1 µF	0402	ok
M10	Inductor	Murata	MLC	33 nH	0402	ok
M12	Capacitor	Murata	GRM	100 pF	0402	ok
Evaluation Board	DFN6-15-43-A					

GRF2013 Bias Resistor Selection Curves





DFN 6 1.5x1.5mm Package Dimensions



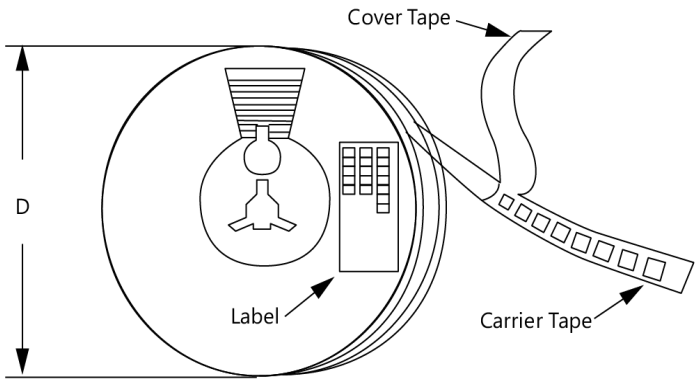
DFN 6 1.5x1.5mm Suggested PCB Footprint (Top View)

Package Marking Diagram

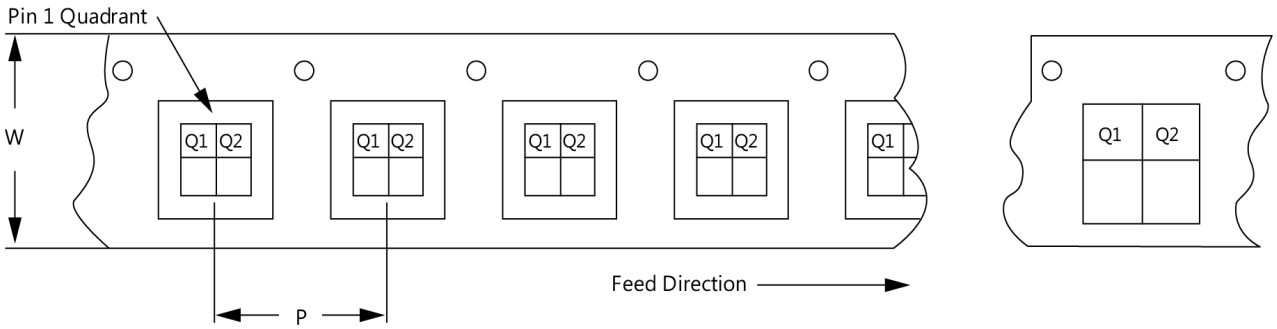
Line 1: “Y” = YEAR (single digit). “WW” = WORK WEEK the Device was assembled.
Line 2: “XXXX” = Device Part Number.

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). 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 latest reel specifications and package information (including units/reel), please visit 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
May 12, 2017	Release Ø Data Sheet.
April 19, 2023	Upgraded to new Data Sheet format only.
May 17, 2023	Release A Data Sheet.
March 13, 2024	Upgraded to newest Data Sheet format only.
May 29, 2025	Extended frequency range from 50 - 8000 MHz to 10 - 9000 MHz.

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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.

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