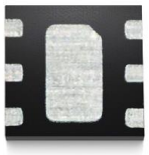
DATA SHEET

RELEASE A DATA SHEET



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.

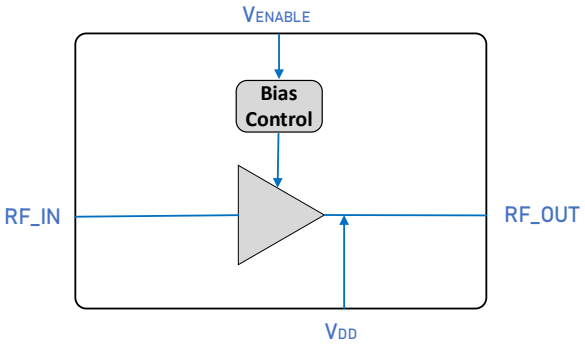
The device can also be tuned up to 10 GHz delivering high gain and low NF.

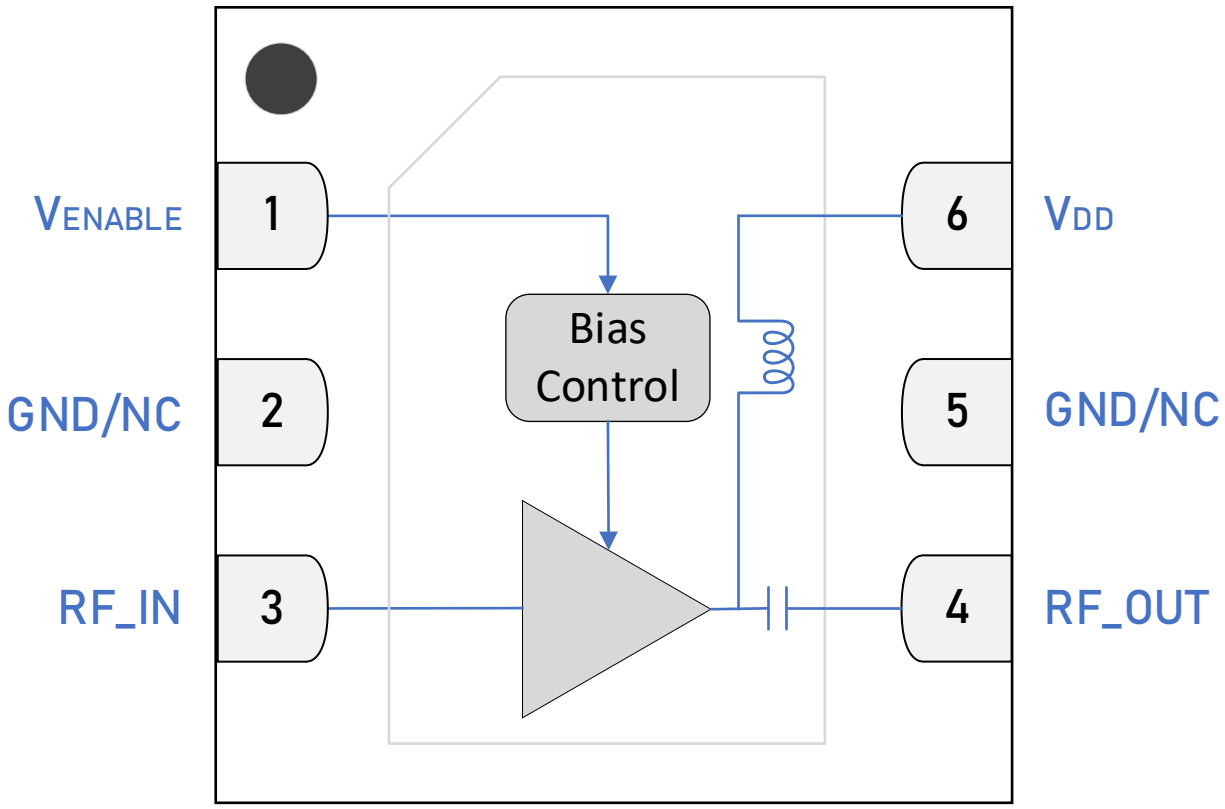
The LNA is operated from a single positive supply of 2.7 to 5 V with a typical bias condition of 3.3 V and 18 mA.

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)

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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.*

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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 V, V_{ENABLE} = 3.3 V, I_{DDQ} = 18 mA, M4 = 2.9 kΩ, F_{TEST} = 5.5 GHz, 50 Ω system impedance, $T_{PKG\ BASE}$ = 25 °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 V, V_{ENABLE} = 0 V.
Thermal Data						
Thermal Resistance (Infrared Scan)	Θ_{JC}		100		°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.

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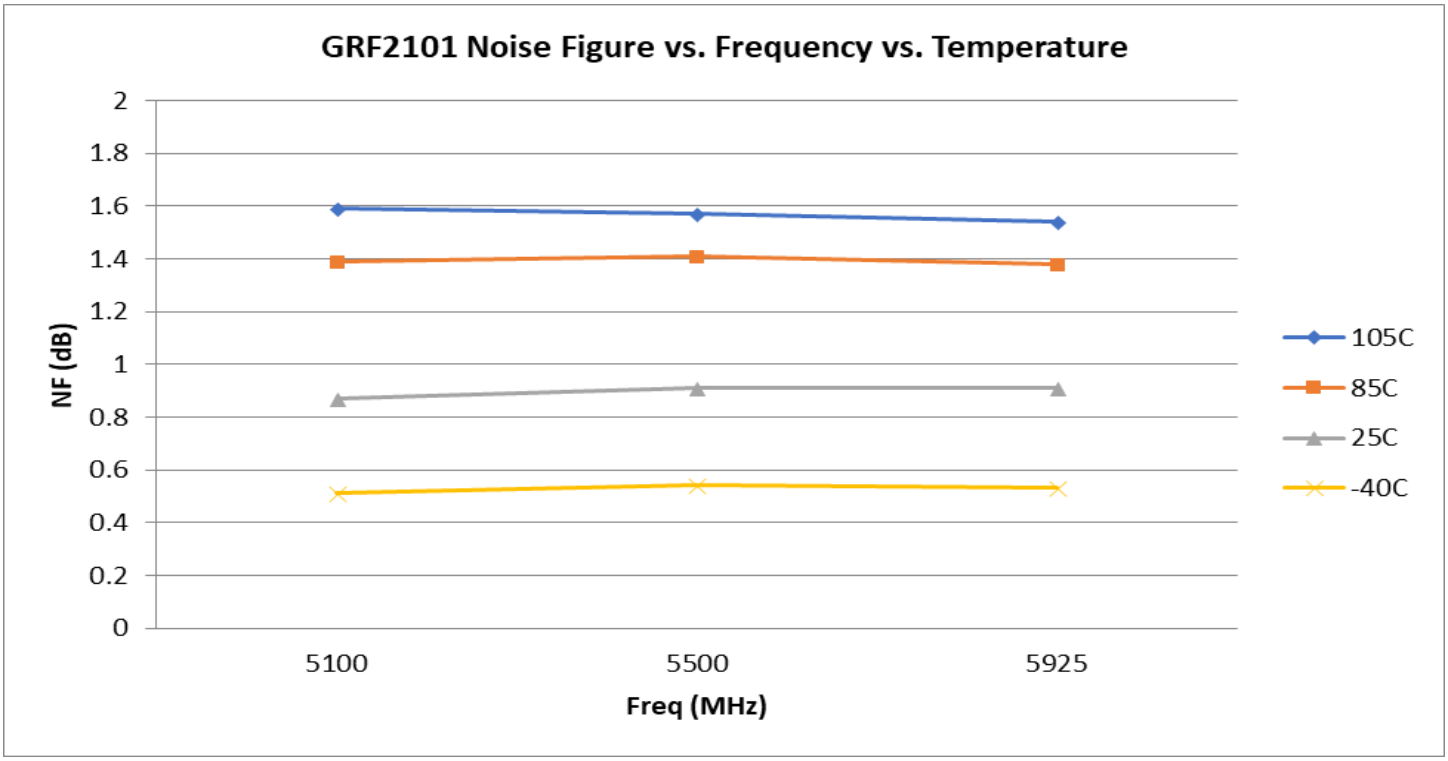
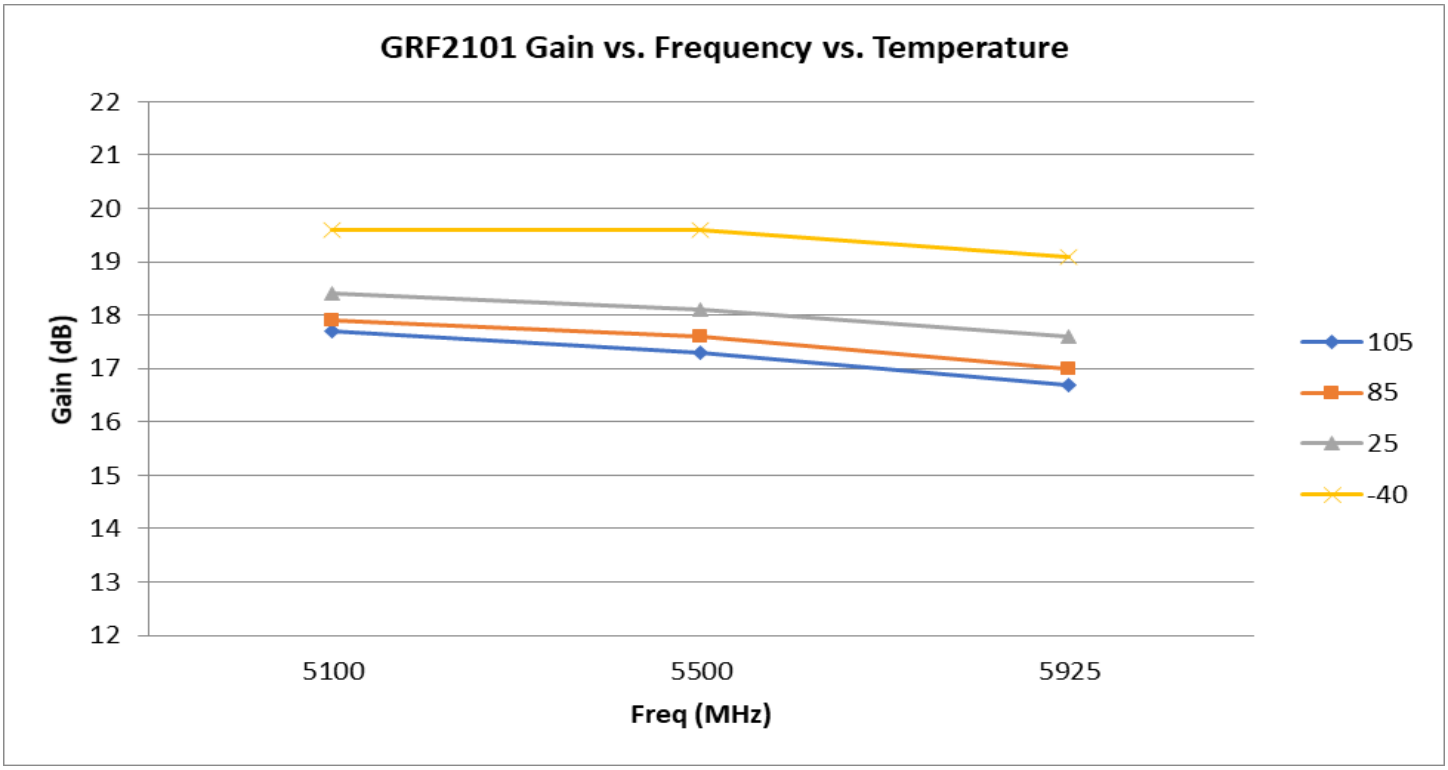
Nominal Operating Parameters – RF

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

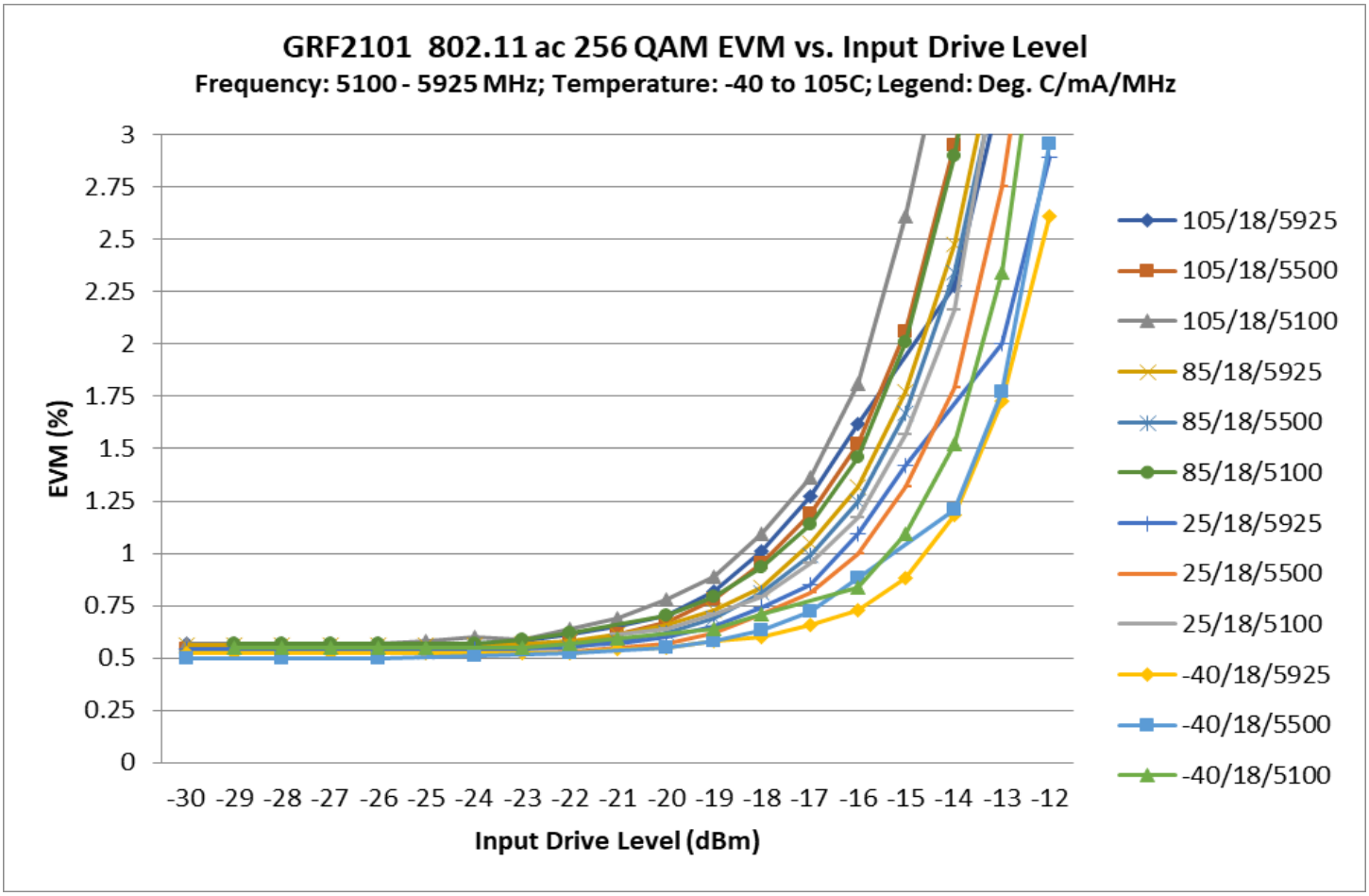
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21	16	17.5		dB	
Reverse Isolation	S12		< -30		dB	F_{RF} = 4 to 10 GHz.
Noise Figure	NF		0.9	1.1	dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		22		dBm	-5 dBm P_{OUT} per Tone at 2 MHz Spacing (5499 and 5501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

GRF2101 Typical Operating Curves

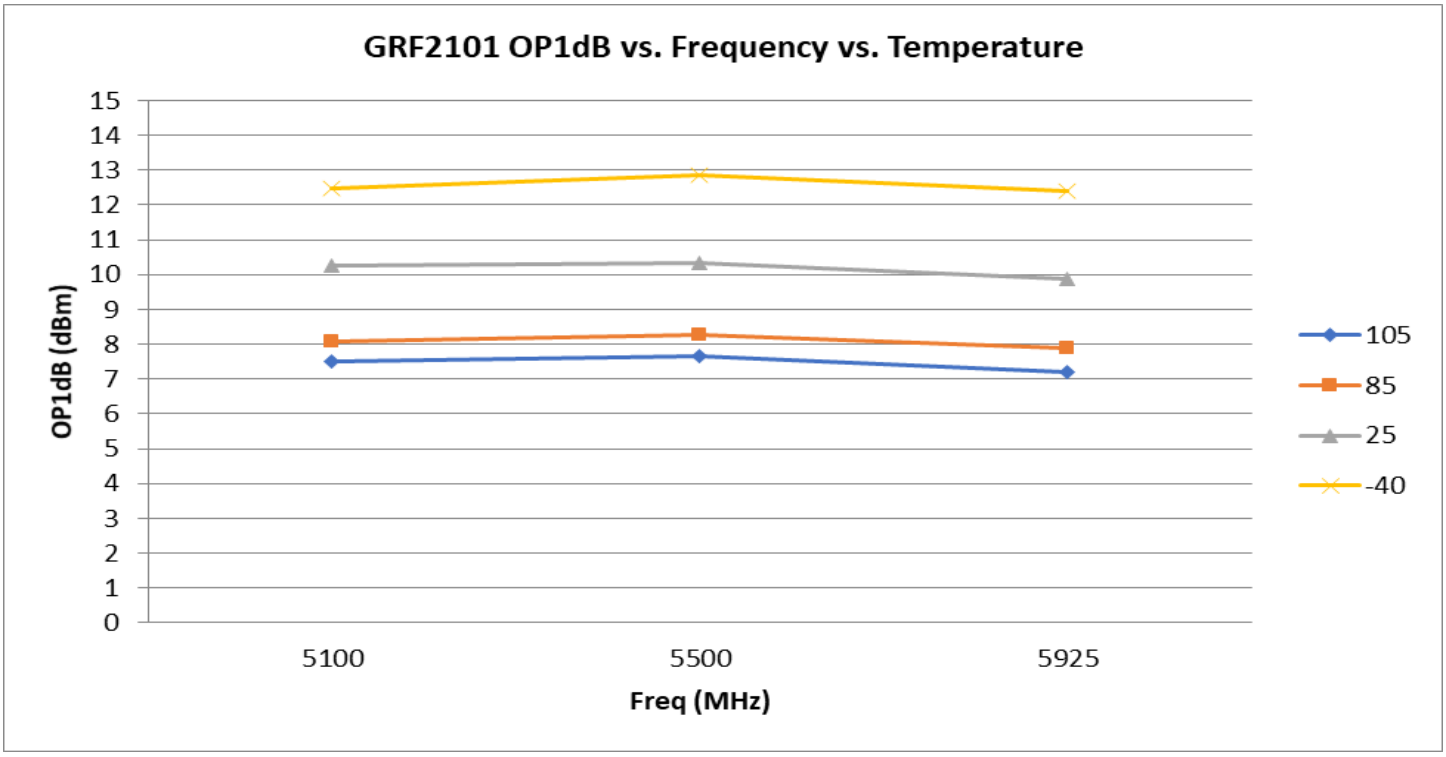


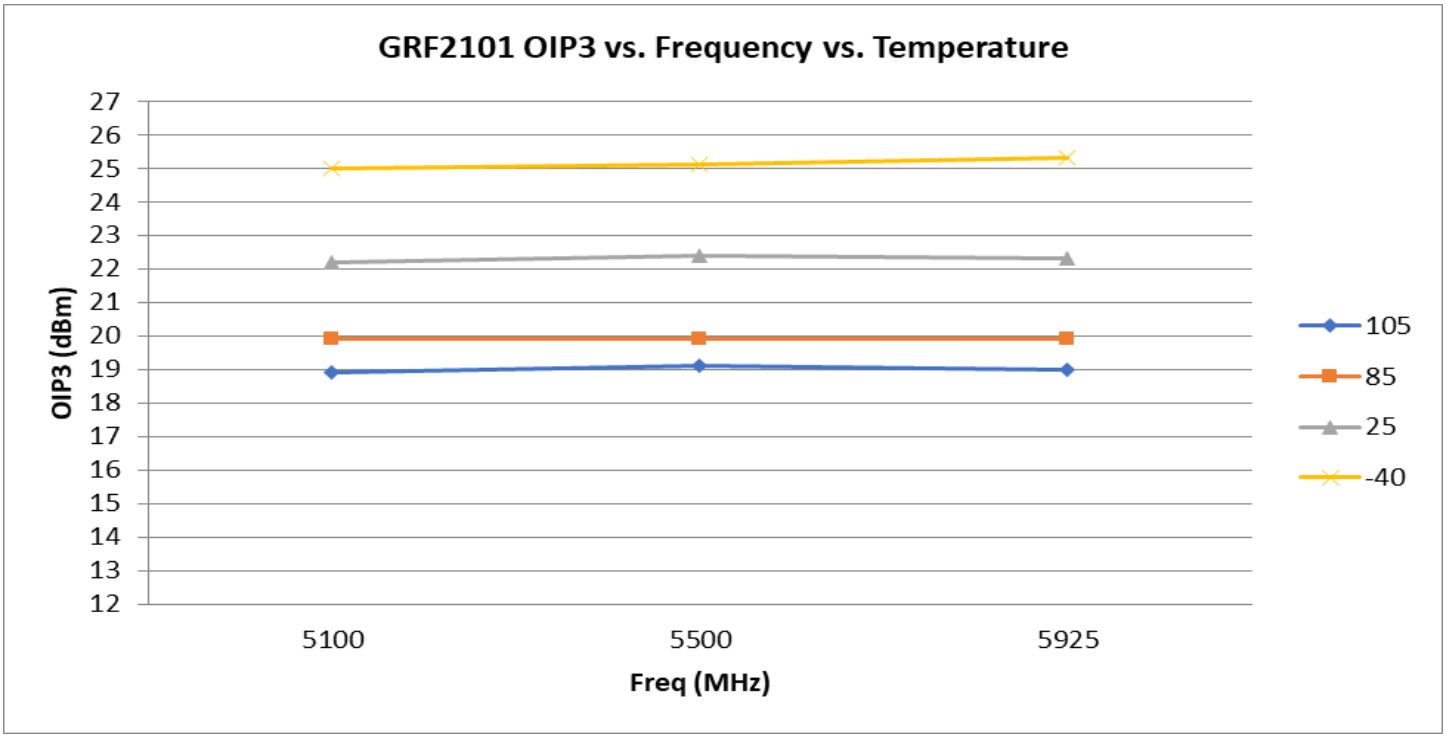


GRF2101 Typical Operating Curves



GRF2101 Typical Operating Curves





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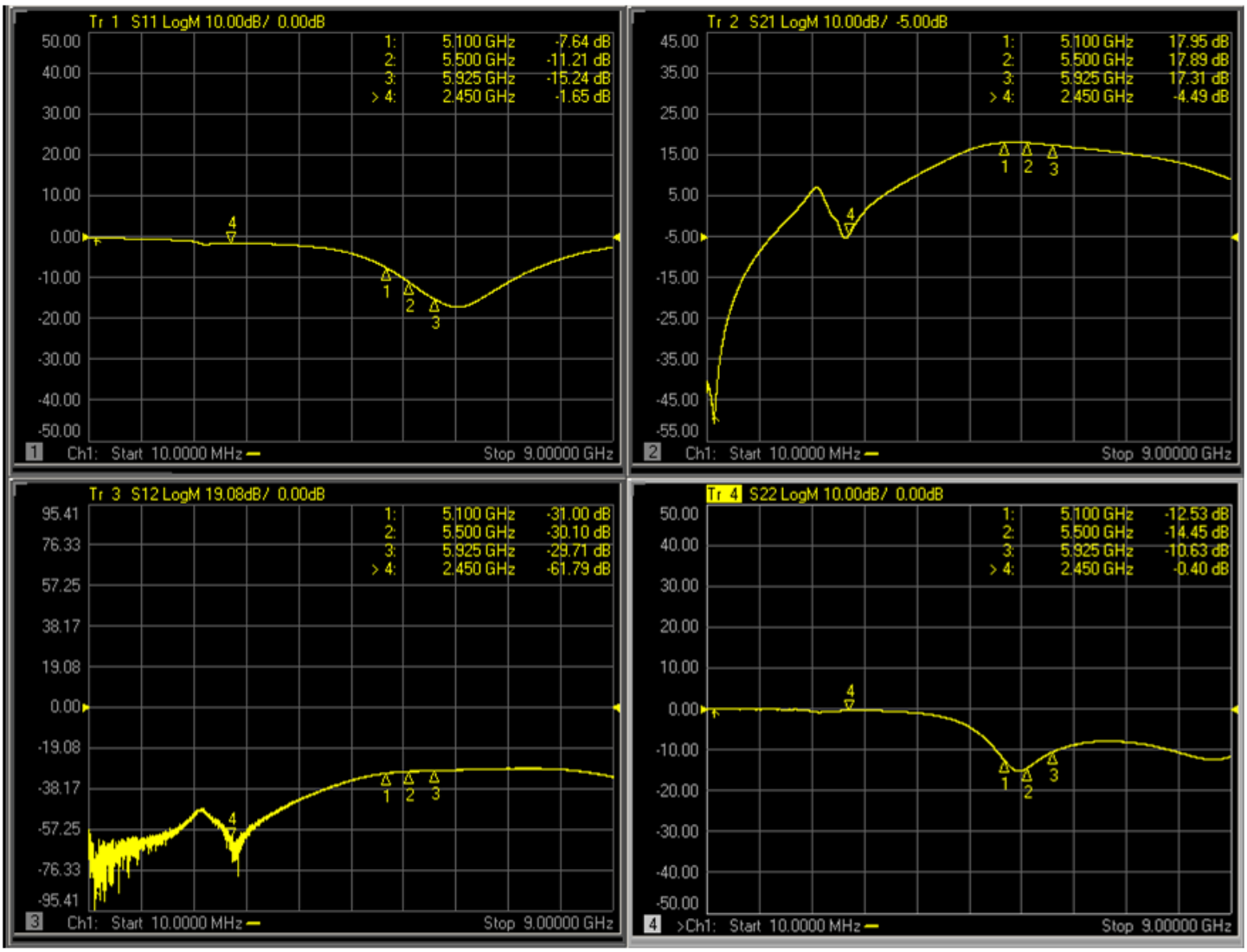
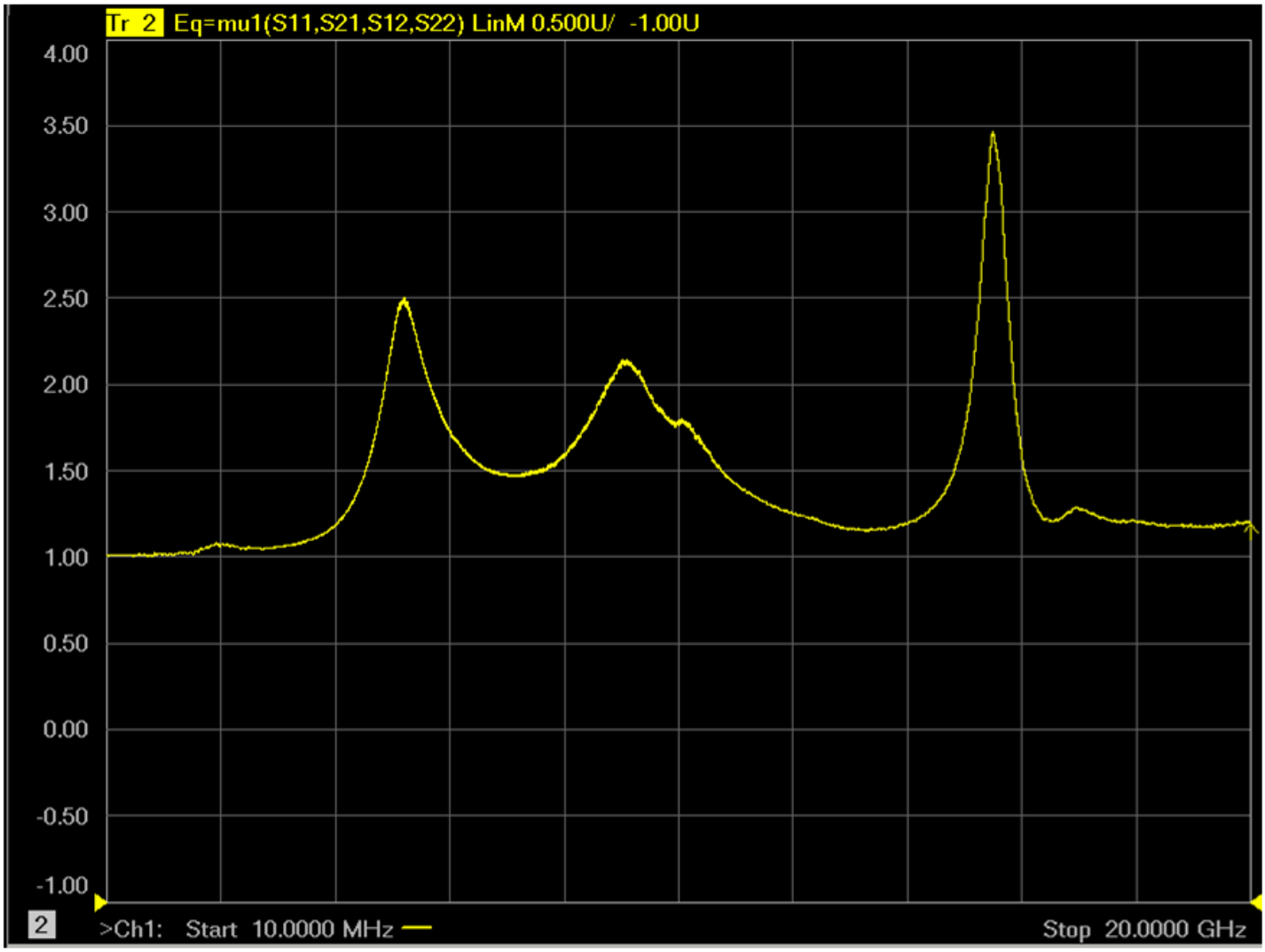
GRF2101 Typical Operating Curves: S-Parameters (5.1 to 5.9 GHz Tune)



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



Note: Mu factor ≥ 1 implies unconditional stability.

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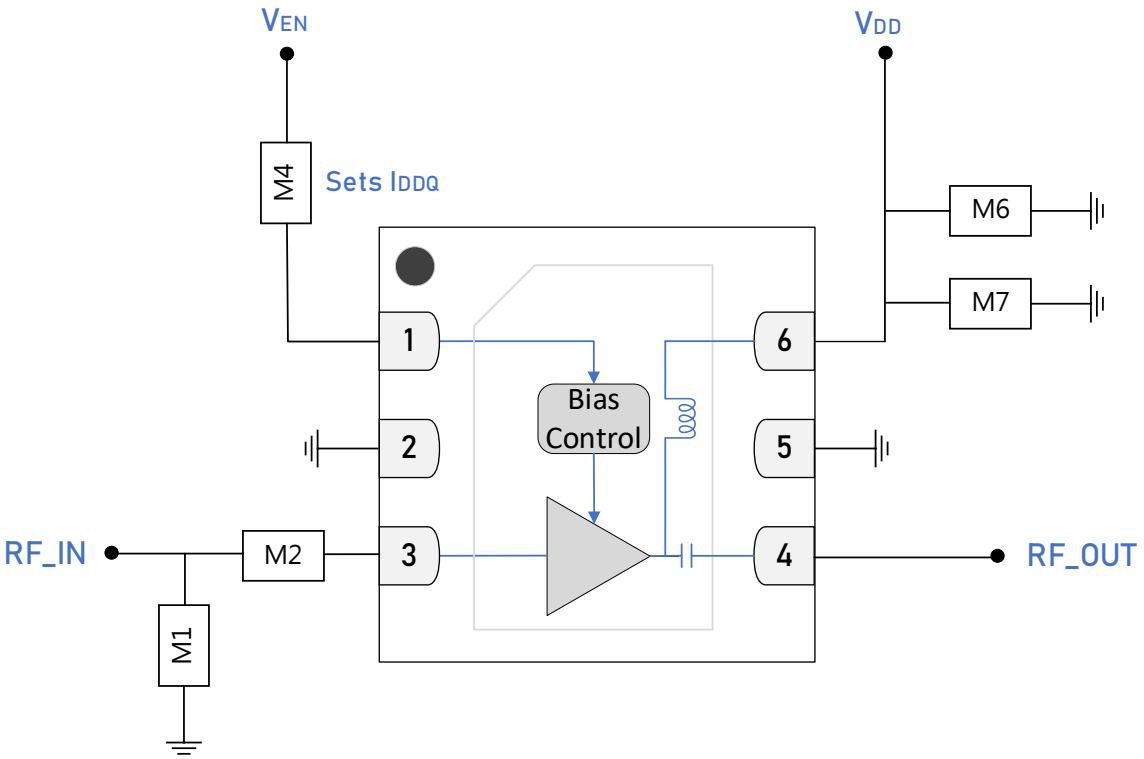
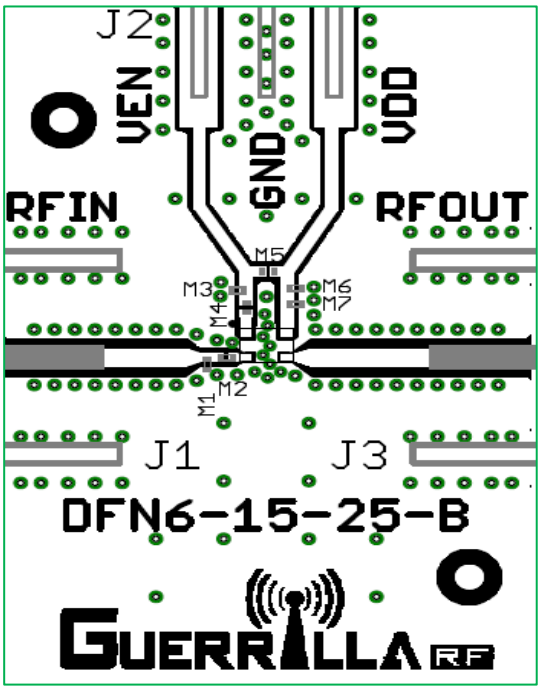


GRF2101 Standard Evaluation Board Schematic



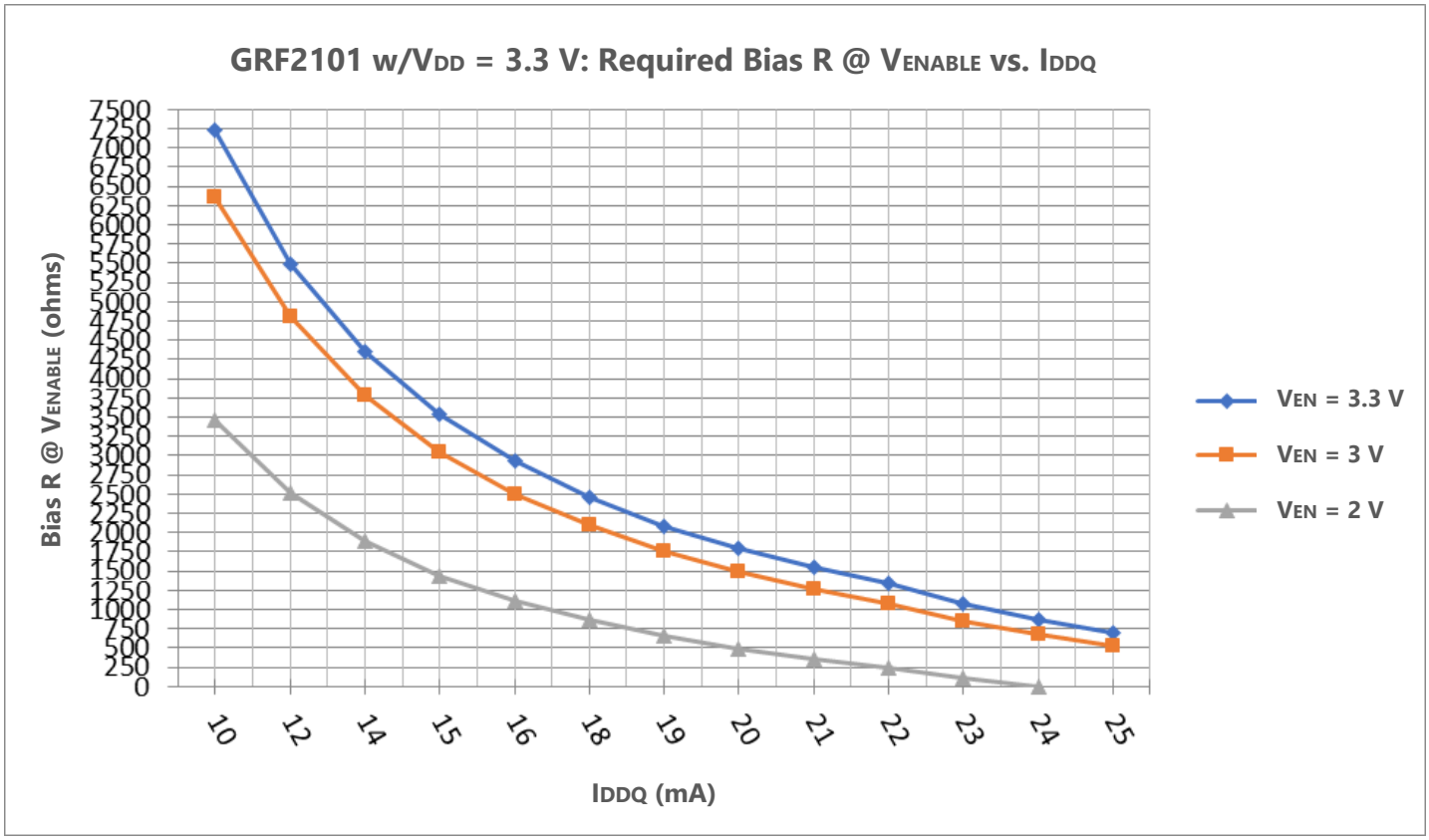
GRF2101 Evaluation Board Assembly Diagram

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 µF	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:



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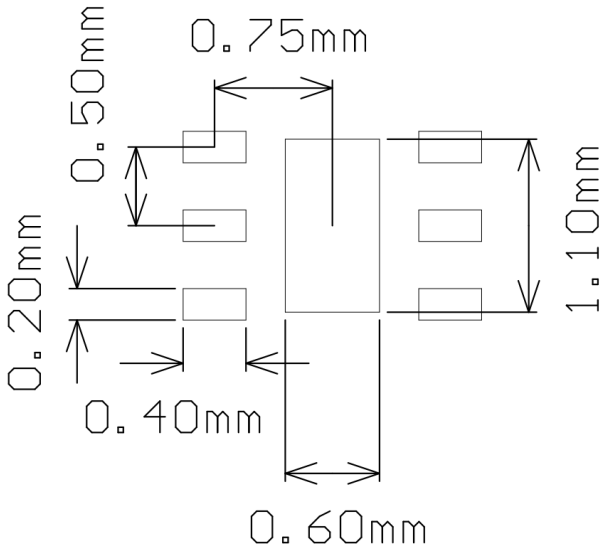
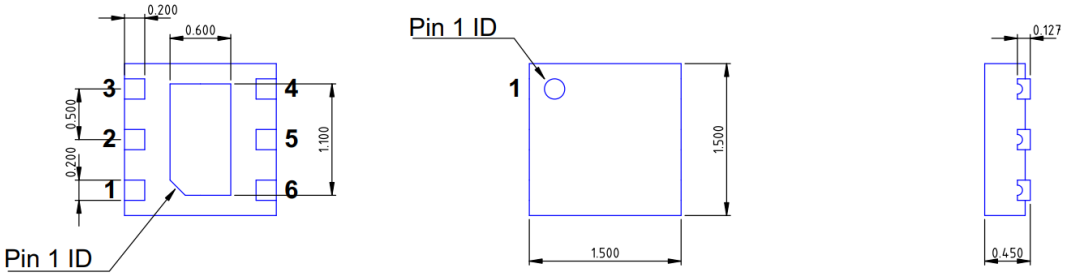


1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)



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

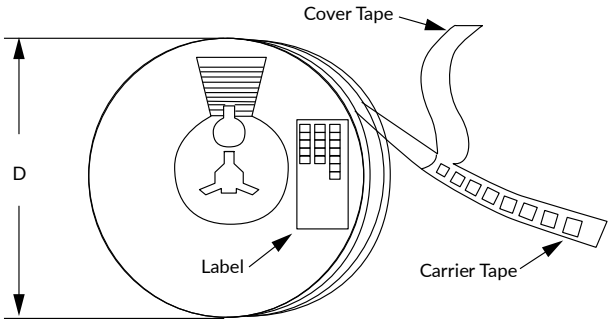
- Line 1: "YWW" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

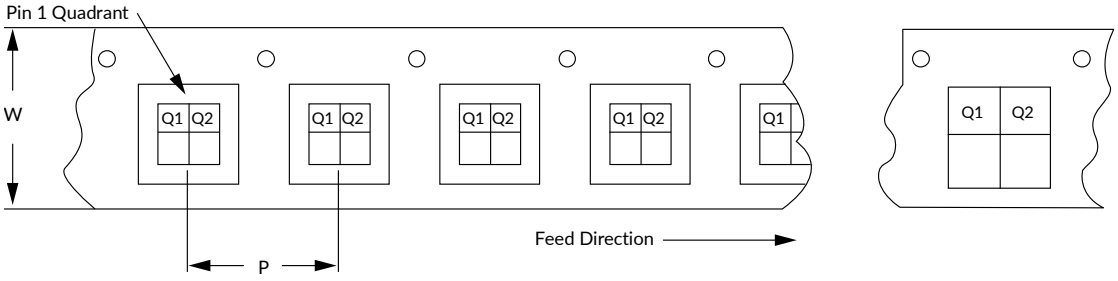
Guerrilla RF's tape and reel specification complies with Electronics Industries Association (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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 *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.