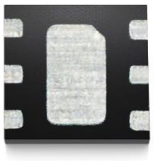
DATA SHEET

RELEASE A DATA SHEET



GRF2501

HIGH GAIN, ULTRA-LNA 802.11ac: 4.3 to 9 GHz

FEATURES

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

Reference: 3.3 V / 18 mA / 5.5 GHz

- Gain: 17 dB
- OP1dB: 9 dBm
- Evaluation Board Noise Figure: 1 dB

APPLICATIONS

- WiFi Access Points
- Mobile WiFi Devices
- 802.11p Vehicle Communications
- Microwave Backhaul

DESCRIPTION

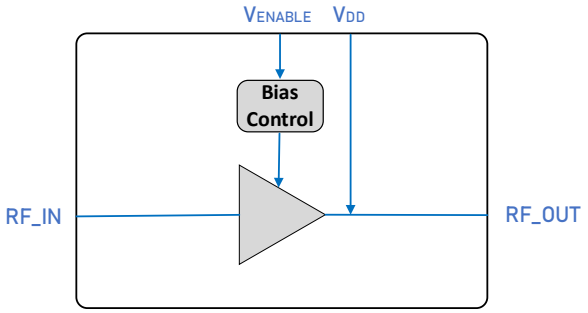
The GRF2501 is an ultra-low noise amplifier (LNA) designed for IEEE 802.11a/n/ac/p applications in the 4 GHz band and up to 9 GHz with appropriate matching.

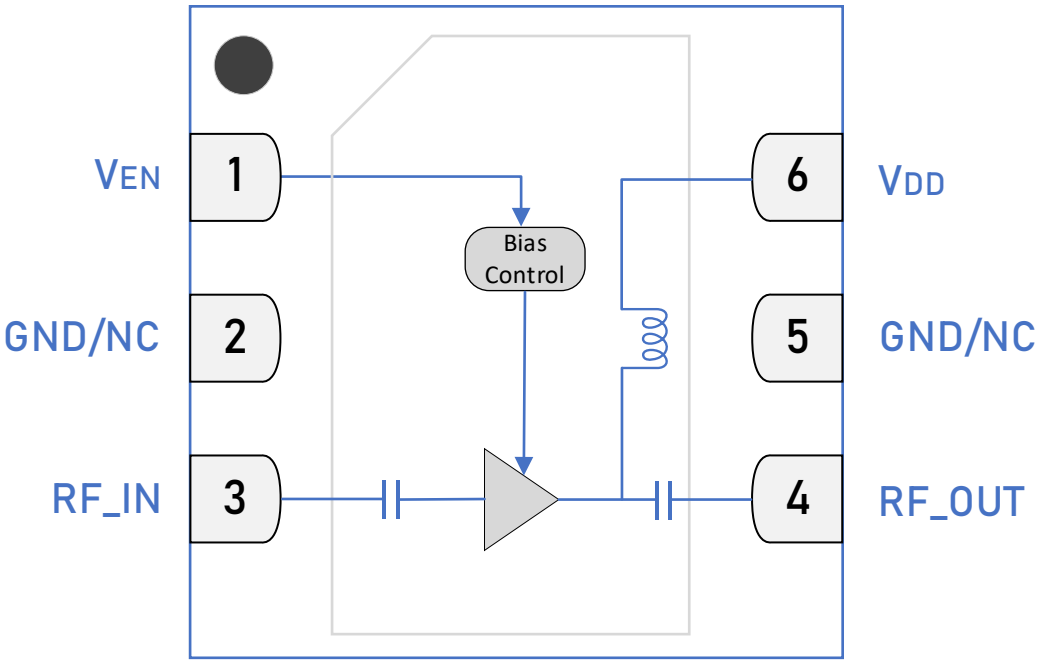
The LNA is operated from a single positive supply of 2.7 to 5 V with a typical bias condition of 3.3 V, 18 mA and is internally matched to 50 Ω at the input and output ports.

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 GRF2501 "Custom Tunes" product page: GRF2501 Custom Tunes

BLOCK DIAGRAM





1.5 x 1.5 mm DFN-6 Pin Out (Top View)

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Pin Assignments

Pin	Name	Description	Note
1	V_{EN}	LNA Enable	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	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 to 50 Ω. These ports may be DC connected to ground externally but no DC > 0.2 volts should be applied to these ports.
4	RF_OUT	LNA RF Output	Internally matched to 50 Ω. These ports may be DC connected to ground externally but no DC > 0.2 volts should be applied to these ports.
6	V_{DD}	Supply Voltage for the LNA	Requires Bypass capacitance as close as possible to pin on PCB.
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	< 0.1 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} = 5 V	$P_{IN\ MAX}$		15	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.

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.*

Recommended Operating Conditions

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{DD}	2.7	3.3	5	V	
Operating Temperature (Package Base)	$T_{PKG\ BASE}$	-40		105	°C	
RF Frequency Range	F_{RF}	4.3	5.5	9	GHz	Typical application schematic with external matching components (**notes 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 supported by using different custom tunes. Examples of other optimized tunes can be found here: GRF2501 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 5.925 GHz tuning set, V_{DD} = 3.3 V, V_{ENABLE} = 3.3 V, M5 = 1 kΩ, I_{DD} = 18 mA, F_{TEST} = 5.5 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}	12	18	28	mA	Rbias = 1 kΩ.
Enable Current	I_{ENABLE}		1.5	3	mA	

Disabled Mode

Supply Current (leakage)	$I_{LEAKAGE}$		200	500	µA	V_{DD} = 3.3 V, V_{ENABLE} = 0 V.

Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		150		°C/W	On Standard Evaluation Board **(note 3)**.
Channel Temperature at 85 °C reference (Package Base)	$T_{CHANNEL}$		99			V_{DD} = 3.3 V, I_{DDQ} = 28 mA, No RF applied. P_{DISS} = 92 mW **(note 3)**.

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

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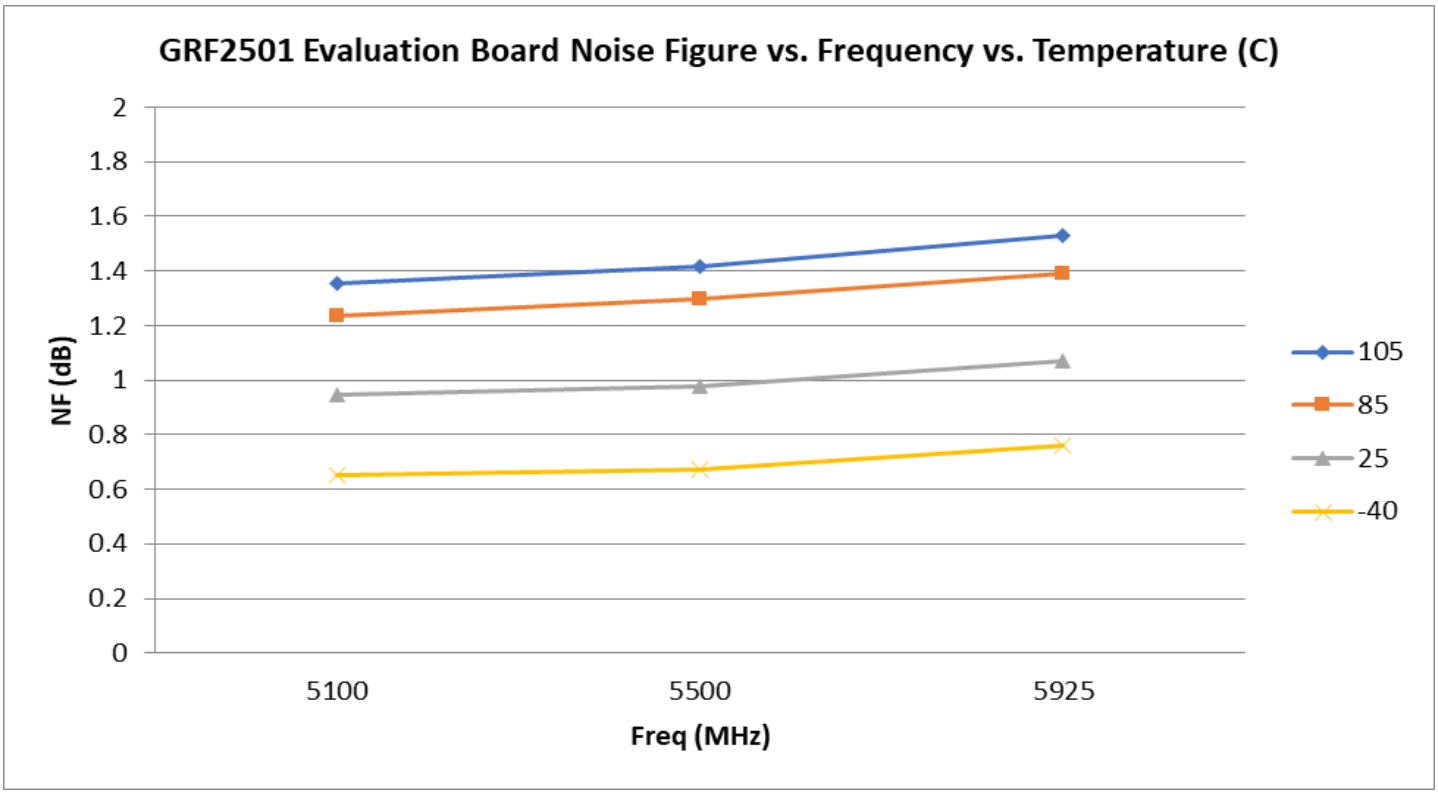
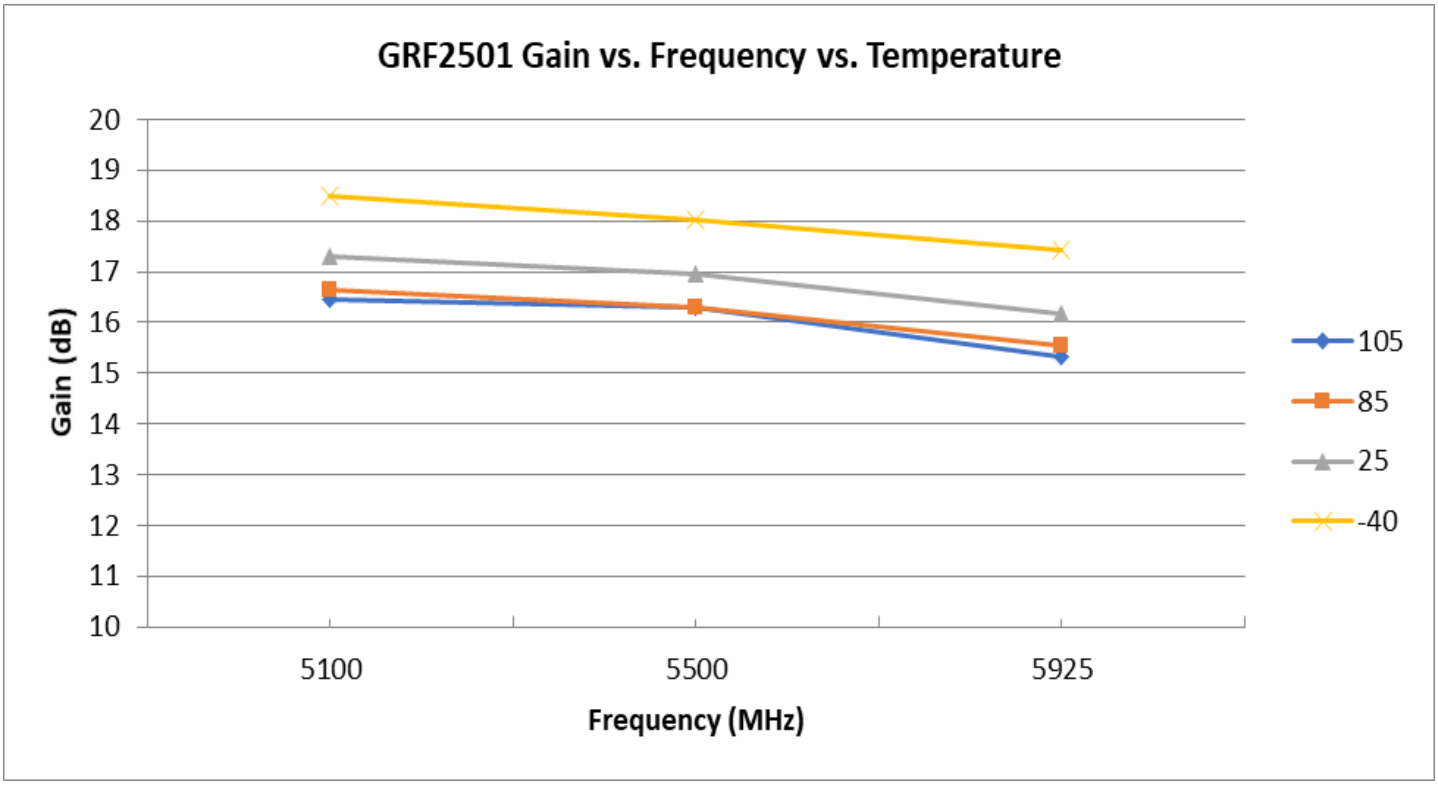
Nominal Operating Parameters – RF

The following conditions apply unless noted otherwise: typical application schematic using the 5.1 to 5.925 GHz tuning set, V_{DD} = 3.3 V, V_{ENABLE} = 3.3 V, M5 = 1 kΩ, I_{DD} = 18 mA, F_{TEST} = 5.5 GHz, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21	15	17		dB	
Noise Figure	NF		1	1.2	dB	On standard evaluation board.
Input Power at 1% EVM	IP1%		-19		dBm	802.11ac modulation.
Output 1 dB Compression Power	OP1dB	6	9		dBm	

GRF2501 Typical Operating Curves: 3.3 V, 18 mA, 5.1 to 5.925 GHz Tune





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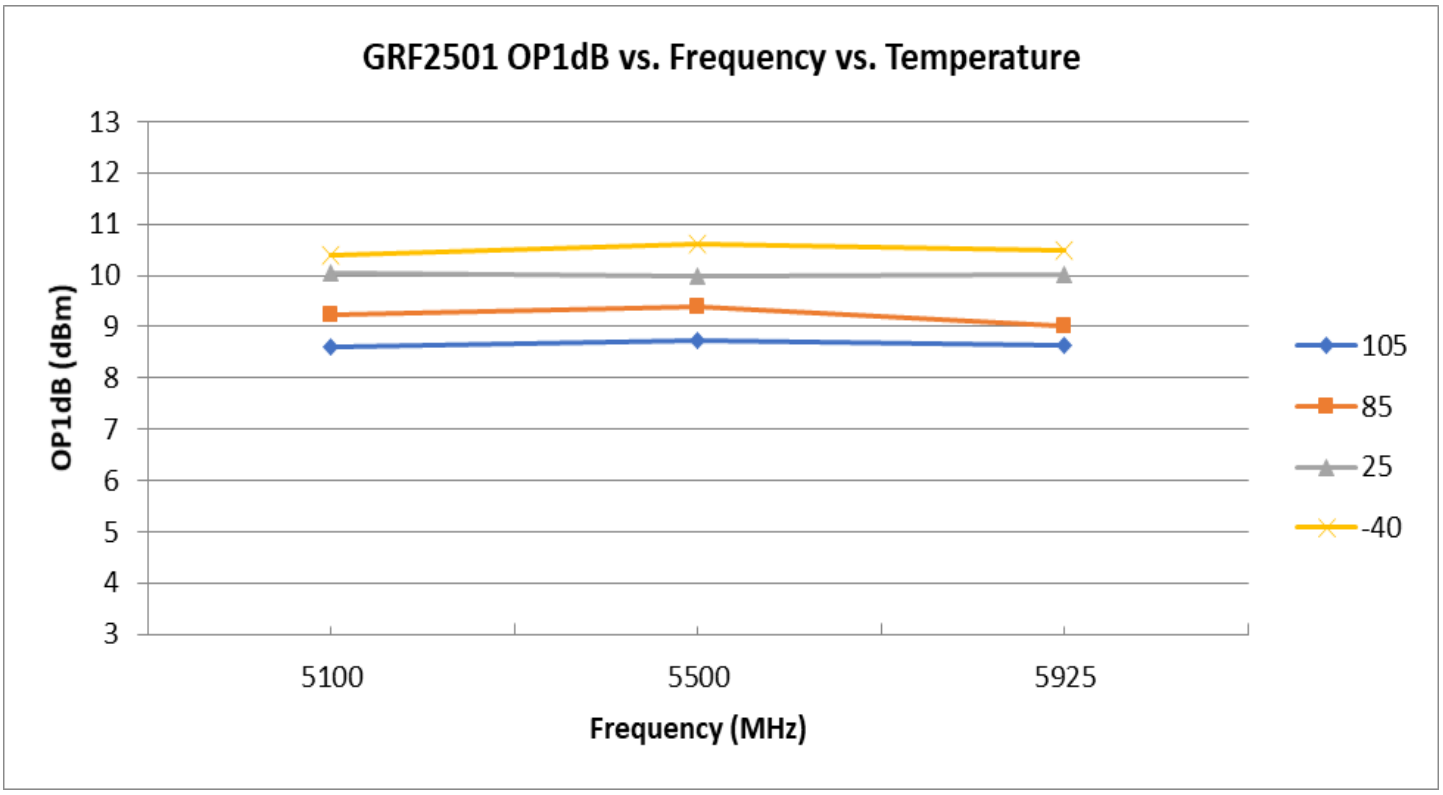
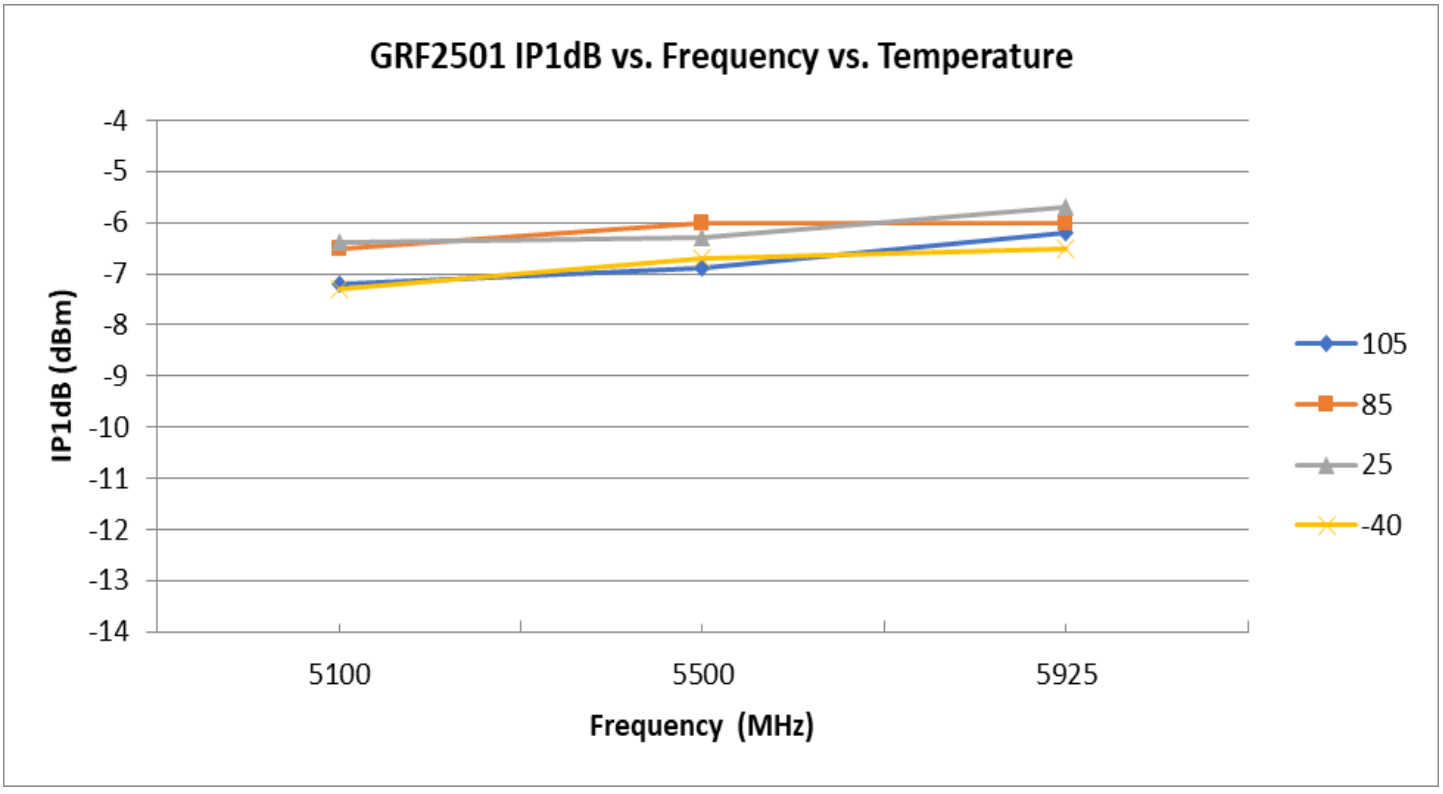
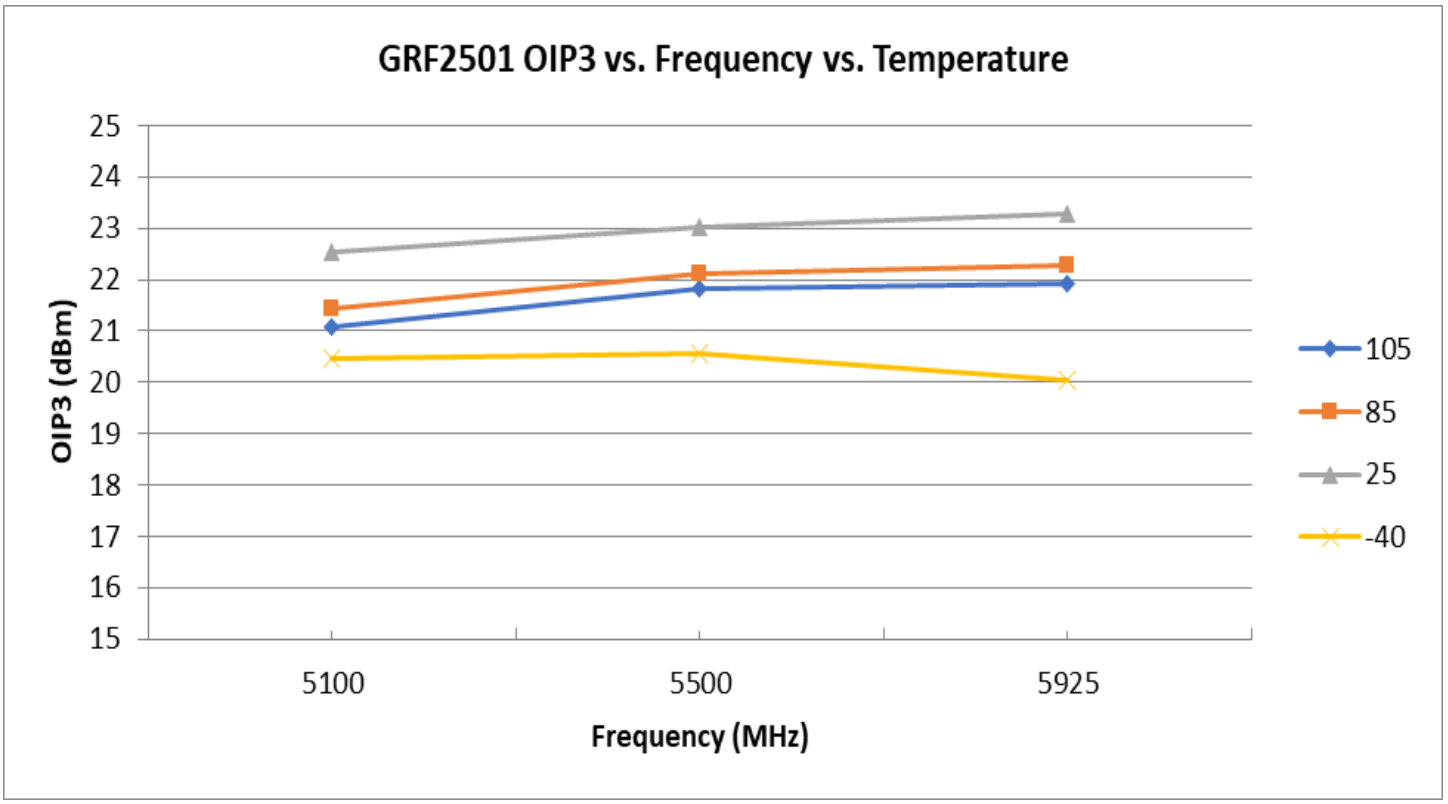
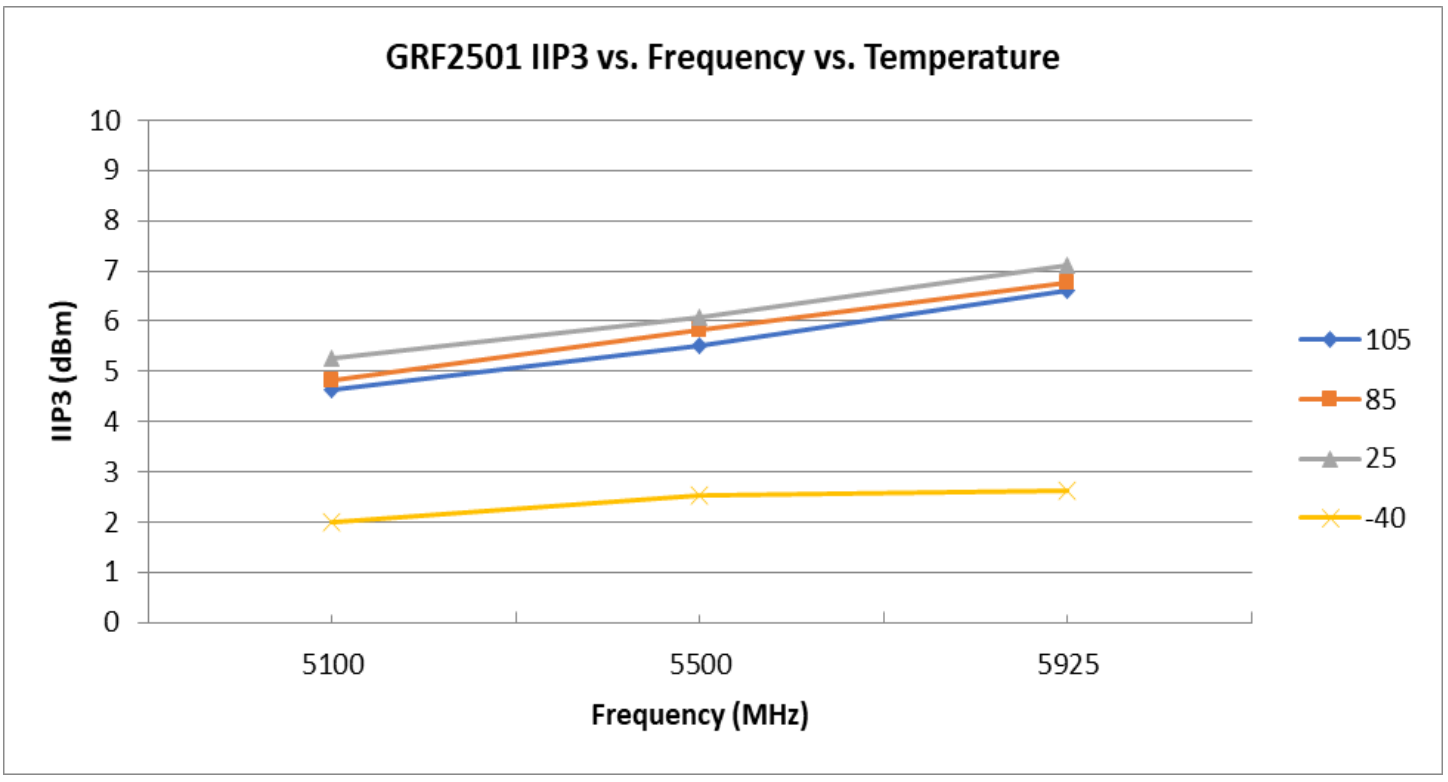
GRF2501 Typical Operating Curves: 3.3 V, 18 mA, 5.1 to 5.925 GHz Tune





GRF2501 Typical Operating Curves: 3.3 V, 18 mA, 5.1 to 5.925 GHz Tune





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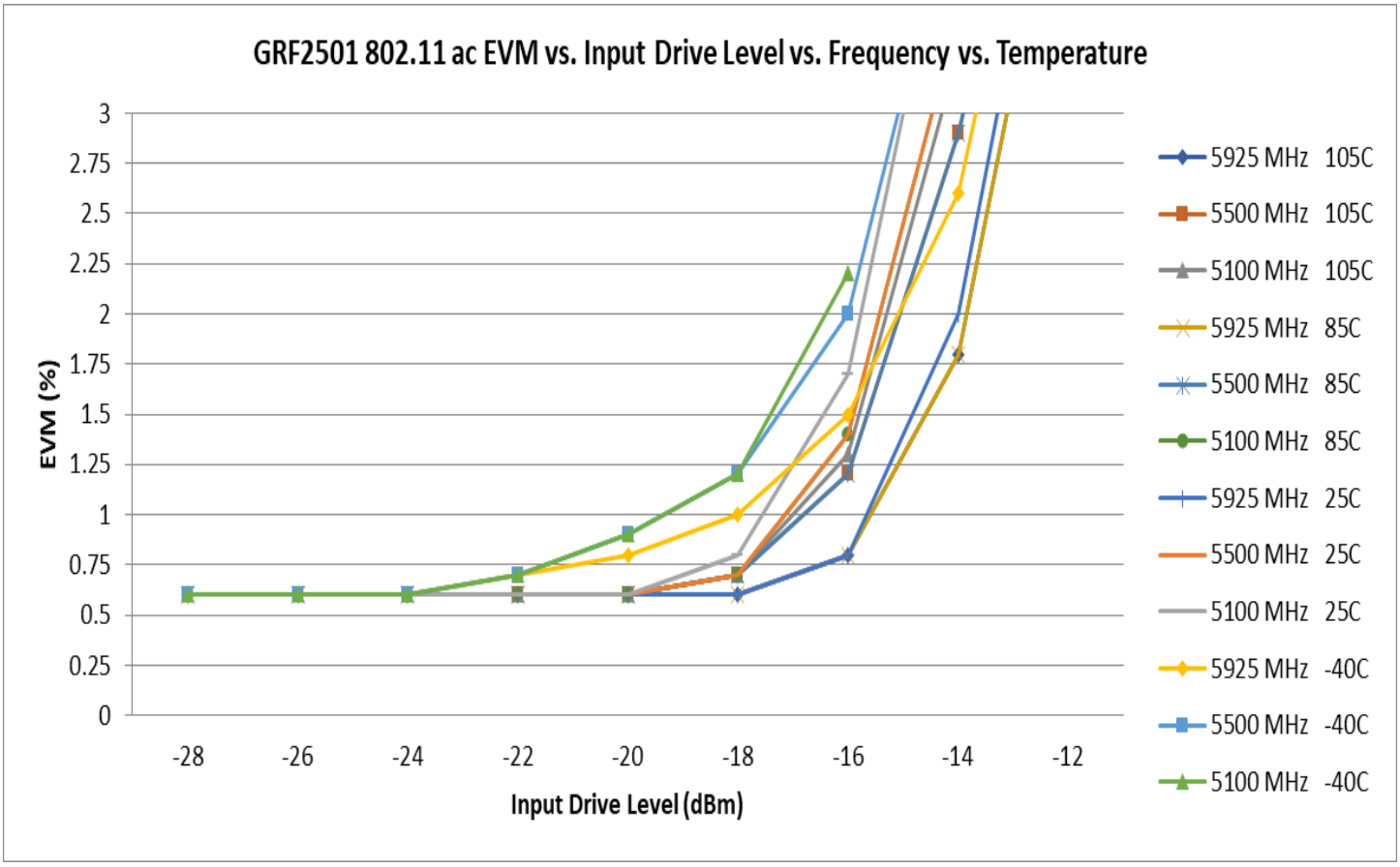
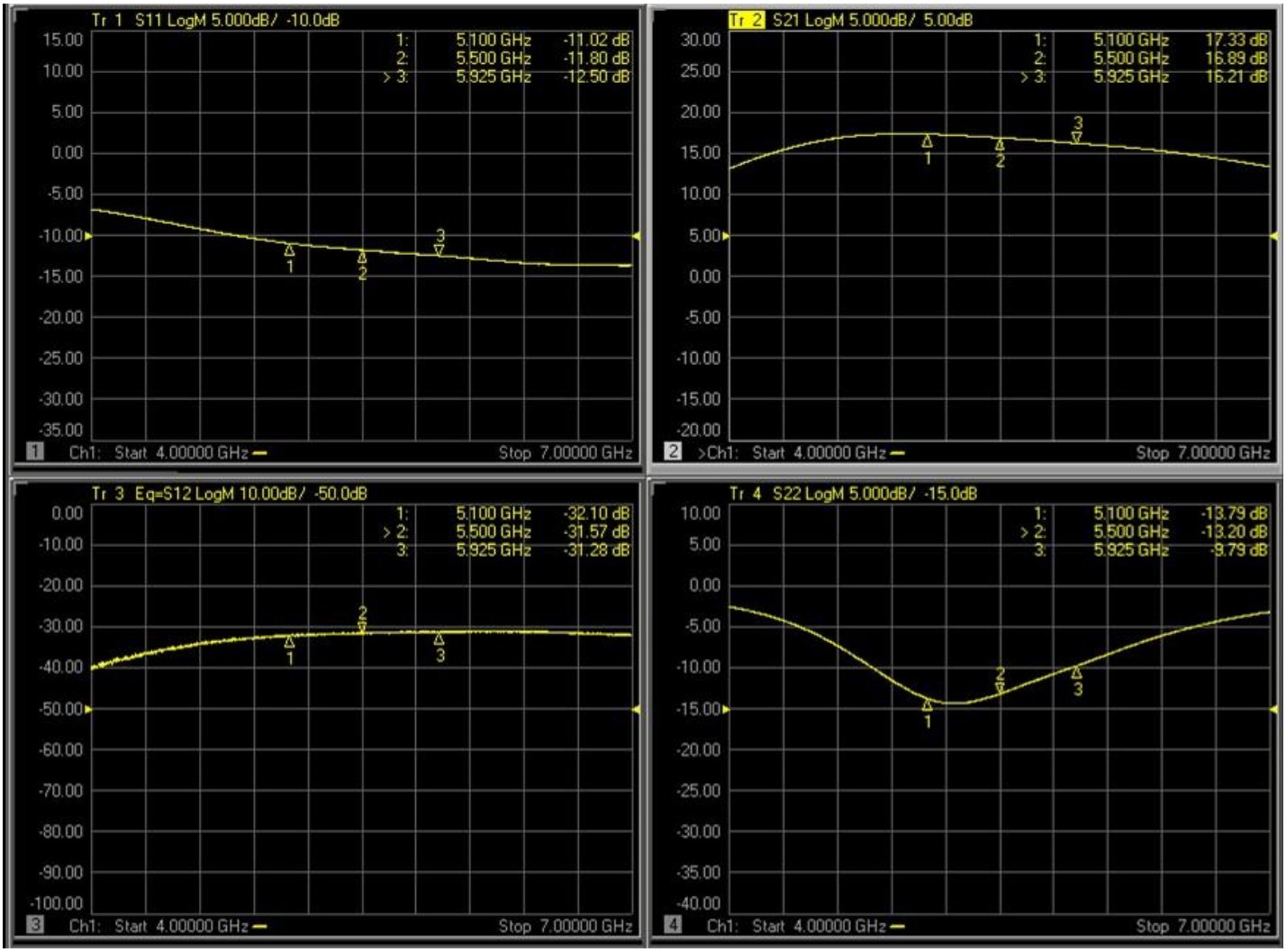
GRF2501 Typical Operating Curves: 3.3 V, 18 mA, 5.1 to 5.925 GHz Tune



GRF2501 Typical Operating Curves: S-Parameters (5.1 to 5.925 GHz Tune)



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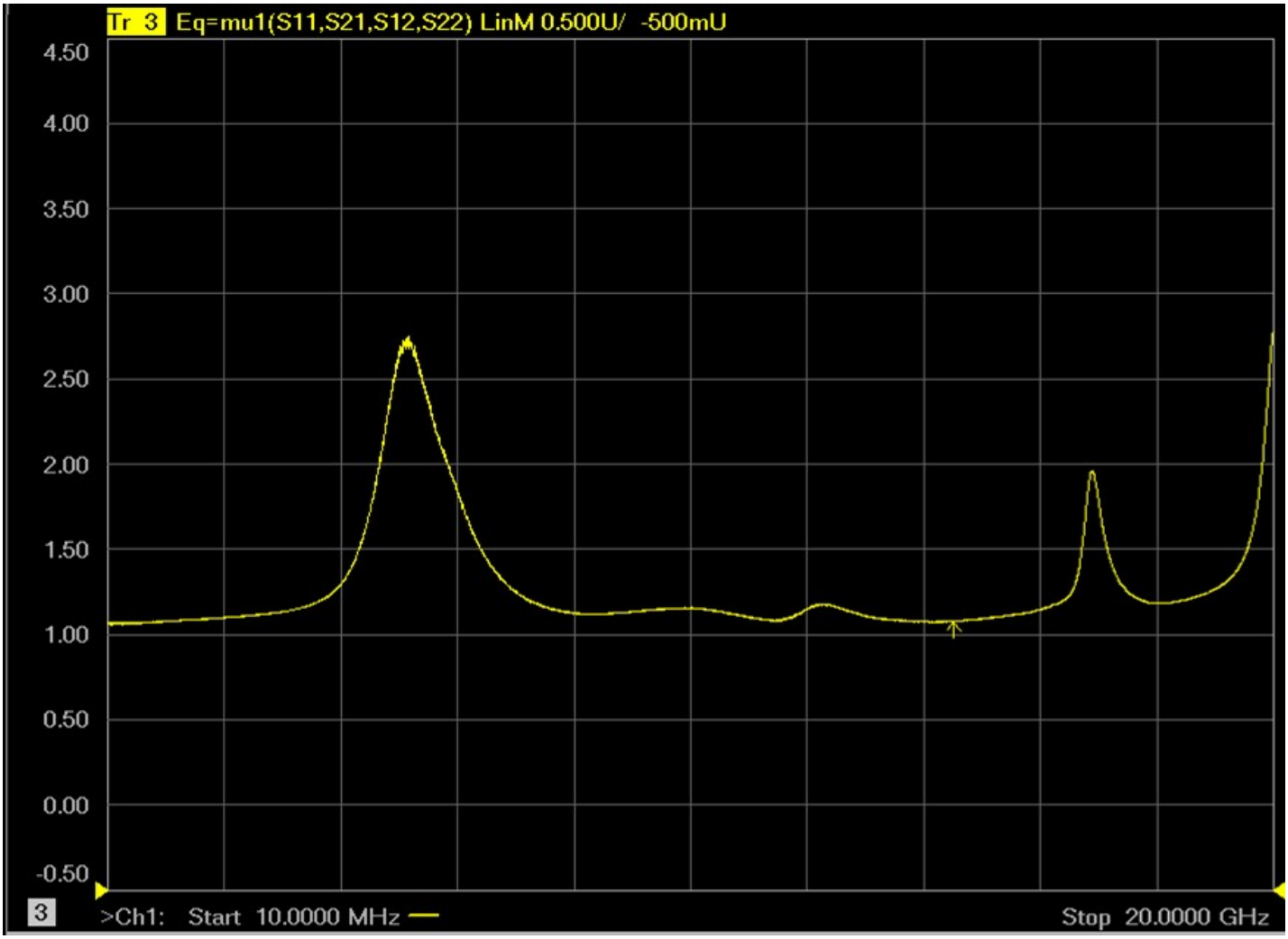
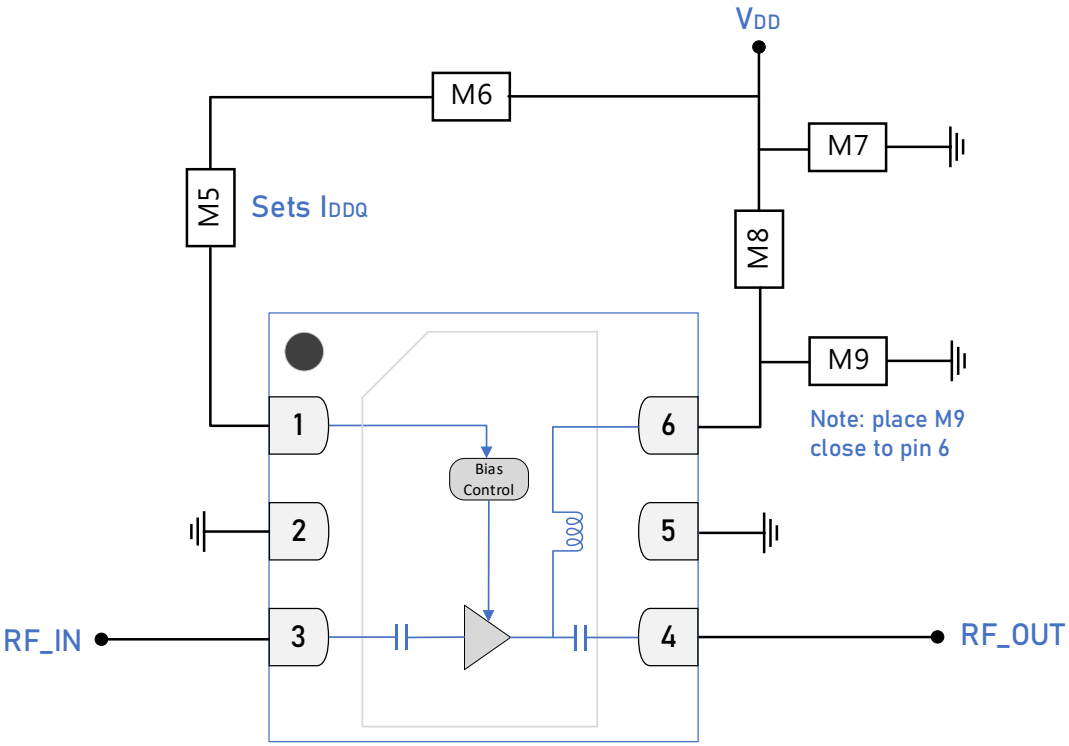
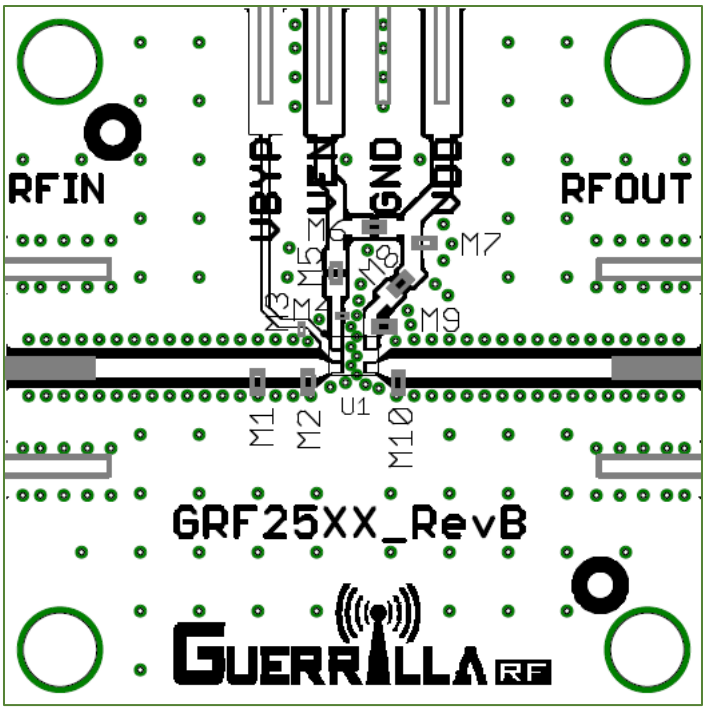
GRF2501 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



Note: Mu ≥ 1.0 implies unconditional stability.



GRF2501 Standard Evaluation Board Schematic



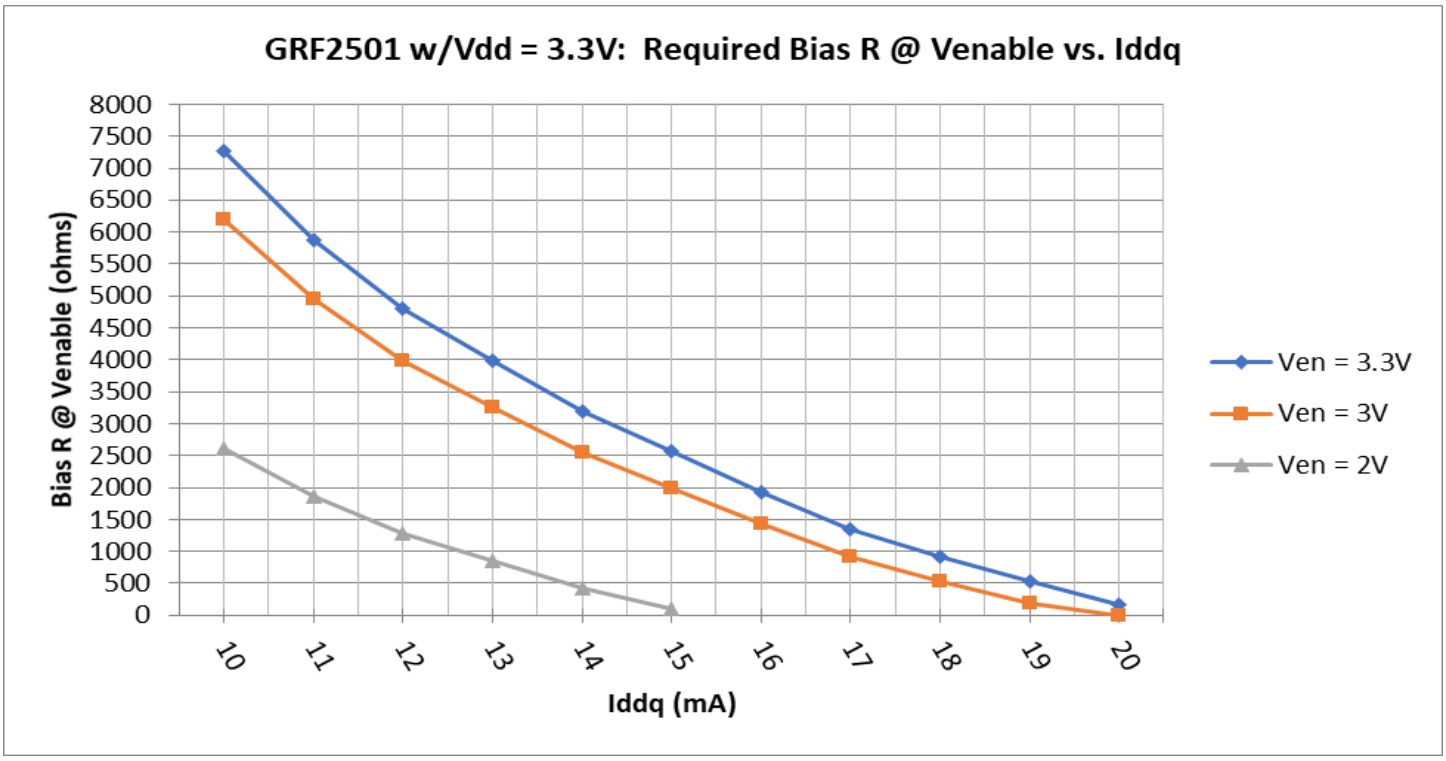
GRF2501 Evaluation Board Assembly Diagram

GRF2501 Evaluation Board Assembly Diagram Reference: 5.1 to 5.9 GHz Tune

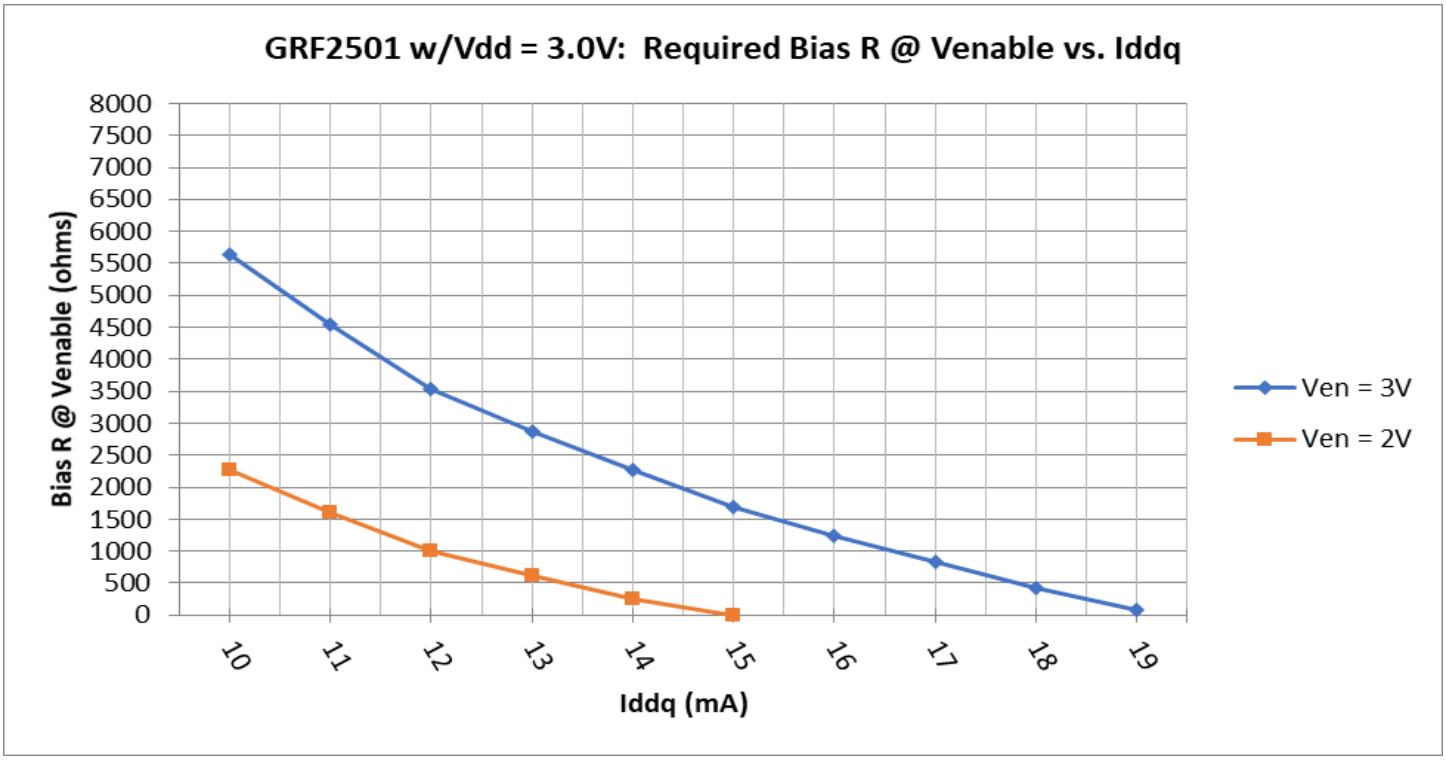
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M5	Resistor (sets I_{DDQ})	Various	5%	1 kΩ	0201	ok
M6	Resistor (jumper)	Various	5%	0 Ω	0201	ok
M7	Capacitor	Murata	GRM	0.1 µF	0201	ok
M8	Ferrite Bead	Murata	BLM15AG121SN1D	120 Ω	0201	ok
M9 (see note)	Capacitor	Murata	GJM	1.0 pF	0201	ok
Evaluation Board	GRF25XX_RevB					

Note: Place M9 close to Pin 6. The position of this component affects the device matching.

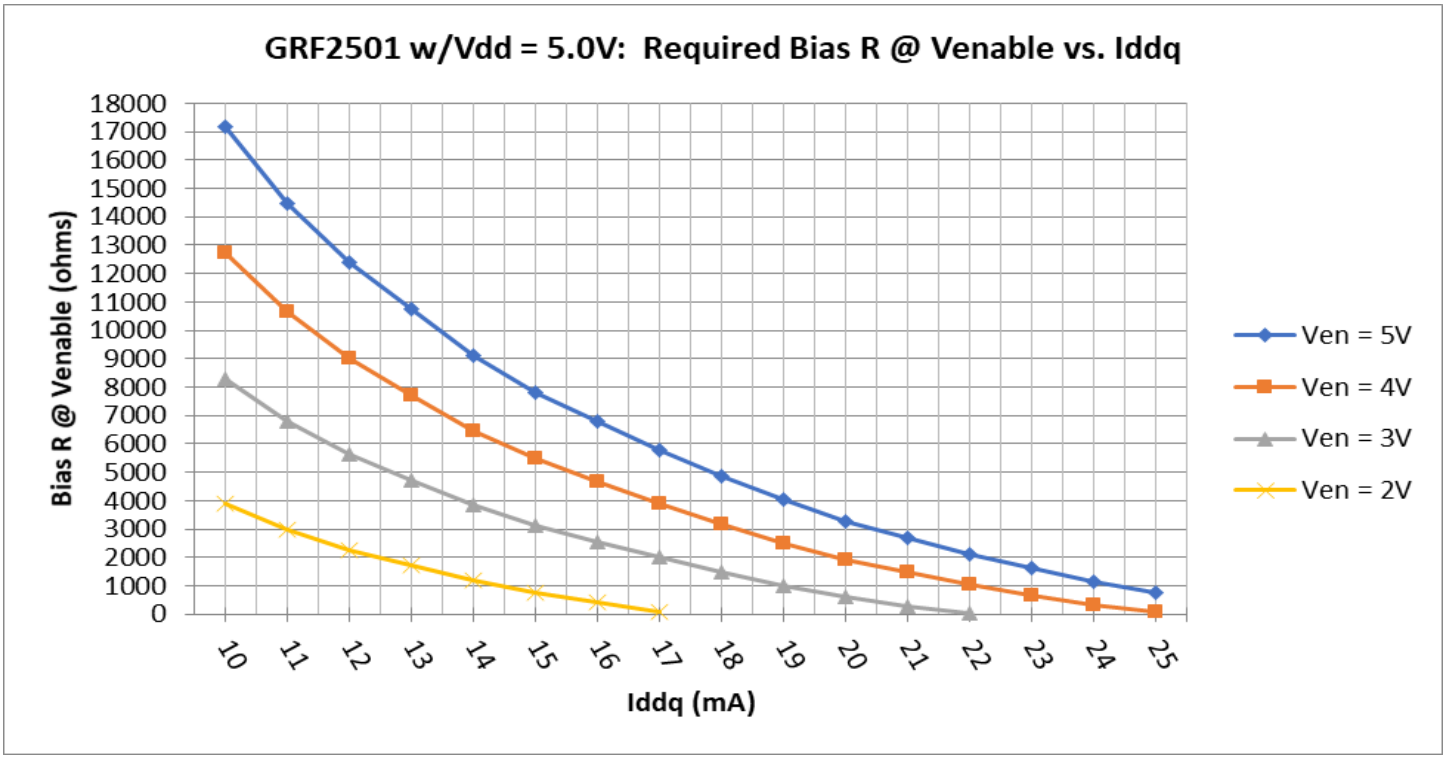
GRF2501 Bias Resistor Selection Table: V_{DD} = 3.3 V



GRF2501 Bias Resistor Selection Table: V_{DD} = 3 V



GRF2501 Bias Resistor Selection Table: V_{DD} = 5 V



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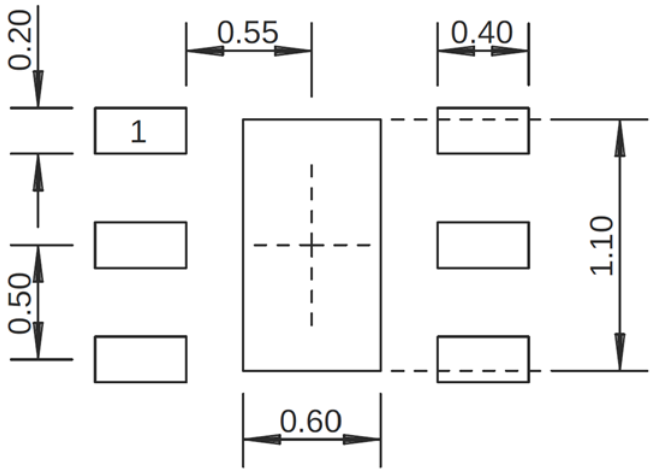
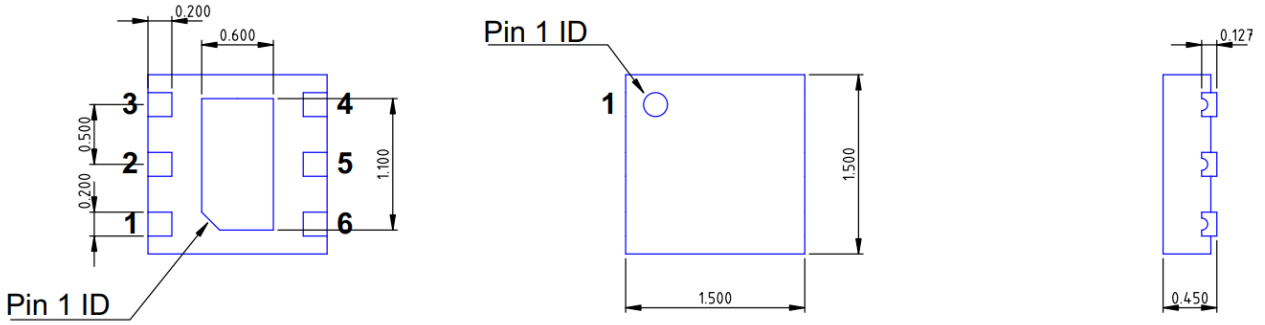


1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)

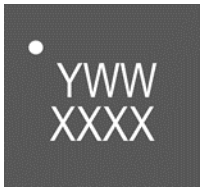


Bottom View **Top View** **Side View**

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

1.5 x 1.5 mm DFN-6 Package Dimensions

Package Marking Diagram



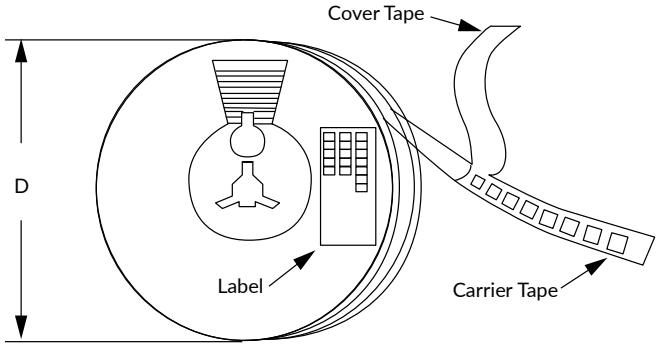
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

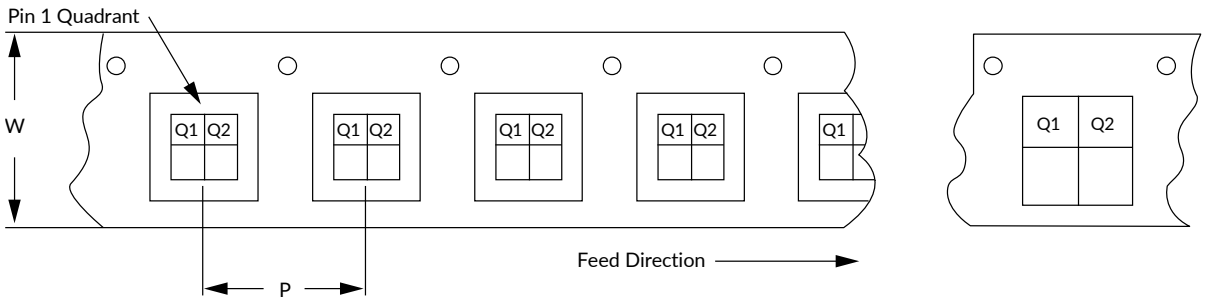
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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
May 10, 2017	Release Ø Data Sheet.
May 5, 2023	Release A Data Sheet. Upgraded Data Sheet to new format.
May 7, 2025	Extended minimum frequency from 4.9 GHz to 4.3 GHz.

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.