



GRF2541

HIGH GAIN, ULTRA-LNA WITH BYPASS 802.11ac: 4.9 to 6 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: 16.4 dB
- IP1dB: -10.2 dBm
- Evaluation Board Noise Figure: 1.2 dB

APPLICATIONS

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

DESCRIPTION

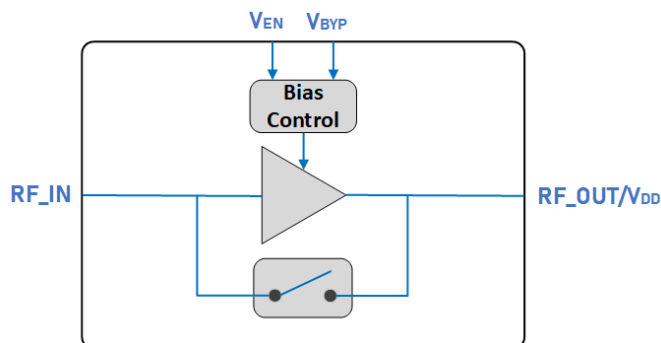
The GRF2541 is an ultra-low noise amplifier (LNA) with bypass designed for IEEE 802.11a/n/ac/p applications in the 5 GHz band (5.1 GHz to 5.925 GHz). The device exhibits outstanding de-embedded noise figure (NF) of 1 dB along with a high gain of approximately 16.4 dB.

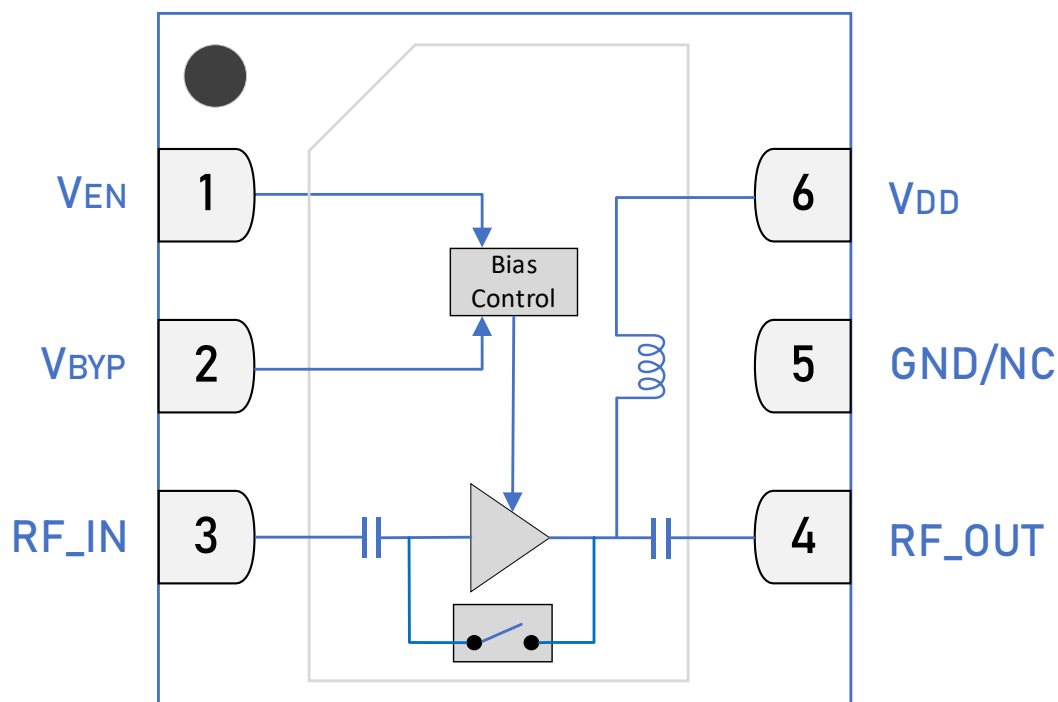
Guerrilla Armor™ technology provides exceptional off-state isolation in the presence of high RF input signal levels in LNA disabled mode. The LNA is operated from a single positive supply of 2.7 to 5 V with typical bias condition of 3.3 volts and 18 mA.

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 GRF2541 "Custom Tunes" product page: [GRF2541 Custom Tunes](#)

BLOCK DIAGRAM





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

Pin Assignments

Pin	Name	Description	Note
1	V _{EN}	V _{ENABLE}	V _{ENABLE} and series resistor set I _{DDQ} . V _{ENABLE} ≤ 0.2 volts disables device. On-die pull-down resistor will turn the device off if this node is allowed to float.
2	V _{BYP}	Bypass Function Enable	Logic high invokes the LNA Bypass mode.
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.
5	GND/NC	Ground or No Connect	No internal connection to die. We recommend connecting these pins to GND.
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} / V_{BYPASS} Truth Table:

Mode	Description	V _{ENABLE}	V _{BYPASS}
High Gain	High LNA Gain	1	0
Bypass	High Linearity Bypass	0 or 1	1
Disabled	LNA Powered Down	0	0
Logic Level "0"	Logic Low	0 V to 0.1 V	0 V to 0.2 V
Logic Level "1"	Logic High	1.5 V to V _{DD}	1.5 V to V _{DD}

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
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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}	4.9	5.5	6	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: [GRF2541 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, $V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = \text{High}$, $I_{DD} = 18\text{ mA}$, $F_{TEST} = 5.5\text{ GHz}$, $M8 = 15\ \Omega$, $T_{PKG\ BASE} = 25\ ^\circ\text{C}$. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		

High Gain Mode

 $V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = \text{High}$, $V_{BYPASS} = 0\text{ V}$

Supply Current	I_{DD}		18		mA	
Enable Current (Logic High)	I_{EN}		700		μA	
Enable Current (Logic Low)	I_{EN}		0		mA	Pin 1 will pull itself to logic low if allowed to float.
Switching Rise Time	T_{RISE}		450		ns	Disabled mode to Gain mode (note 3).
Switching Fall Time	T_{FALL}		50		ns	Gain mode to Disabled mode (note 4).

Bypass Mode

 $V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = \text{High}$, $V_{BYPASS} = \text{High}$

Bypass Current (Logic High)	I_{BYPASS}		150		μA	
Bypass Current (Logic Low)	I_{BYPASS}		0		mA	Pin 2 will pull itself to logic low if allowed to float.
Switching Rise Time	T_{RISE}		450		ns	Bypass mode to Gain mode (note 5).
Switching Fall Time	T_{FALL}		50		ns	Gain mode to Bypass mode (note 6).
Leakage Current	$I_{LEAKAGE}$		600		μA	

Disabled Mode (Guerrilla Armor™)

 $V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = V_{BYPASS} = 0\text{ V}$

Leakage Current	$I_{LEAKAGE}$		600		μA	
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Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		150		$^\circ\text{C}/\text{W}$	On standard evaluation board (note 7).
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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: Switching Time: 50% of V_{BYPASS} mode to 90% of P_{out} .

Note 6: Switching Time: 50% of V_{BYPASS} mode to 10% of P_{out} .

Note 7: MTTF > 10^6 hours for $T_{CHANNEL} \leq 170\ ^\circ\text{C}$.

Nominal Operating Parameters – RF

The following conditions apply unless noted otherwise: typical application schematic using the 5.1 to 5.925 GHz tuning set, $V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = \text{High}$, $I_{DD} = 18\text{ mA}$, $F_{TEST} = 5.5\text{ GHz}$, $M8 = 15\ \Omega$, $T_{PKG\ BASE} = 25\ ^\circ\text{C}$. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		

High Gain Mode

$V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = \text{High}$, $V_{BYPASS} = 0\text{ V}$

Gain	S21		16.4		dB	
Reverse Isolation	S12		> 35		dB	
Noise Figure	NF		1.2		dB	On standard evaluation board.
Input Power for 1% EVM (Gain Mode)	1P1%		-22		dBm	Waveform: 802.11a/g, PAR: 11.6.
Input Power for 1% EVM (Bypass Mode)	1P1%		-9		dBm	Waveform: 802.11a/g, PAR: 11.6.
Input 1 dB Compression Power	IP1dB		-10.2		dBm	

Bypass Mode

$V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = \text{High}$, $V_{BYPASS} = \text{High}$

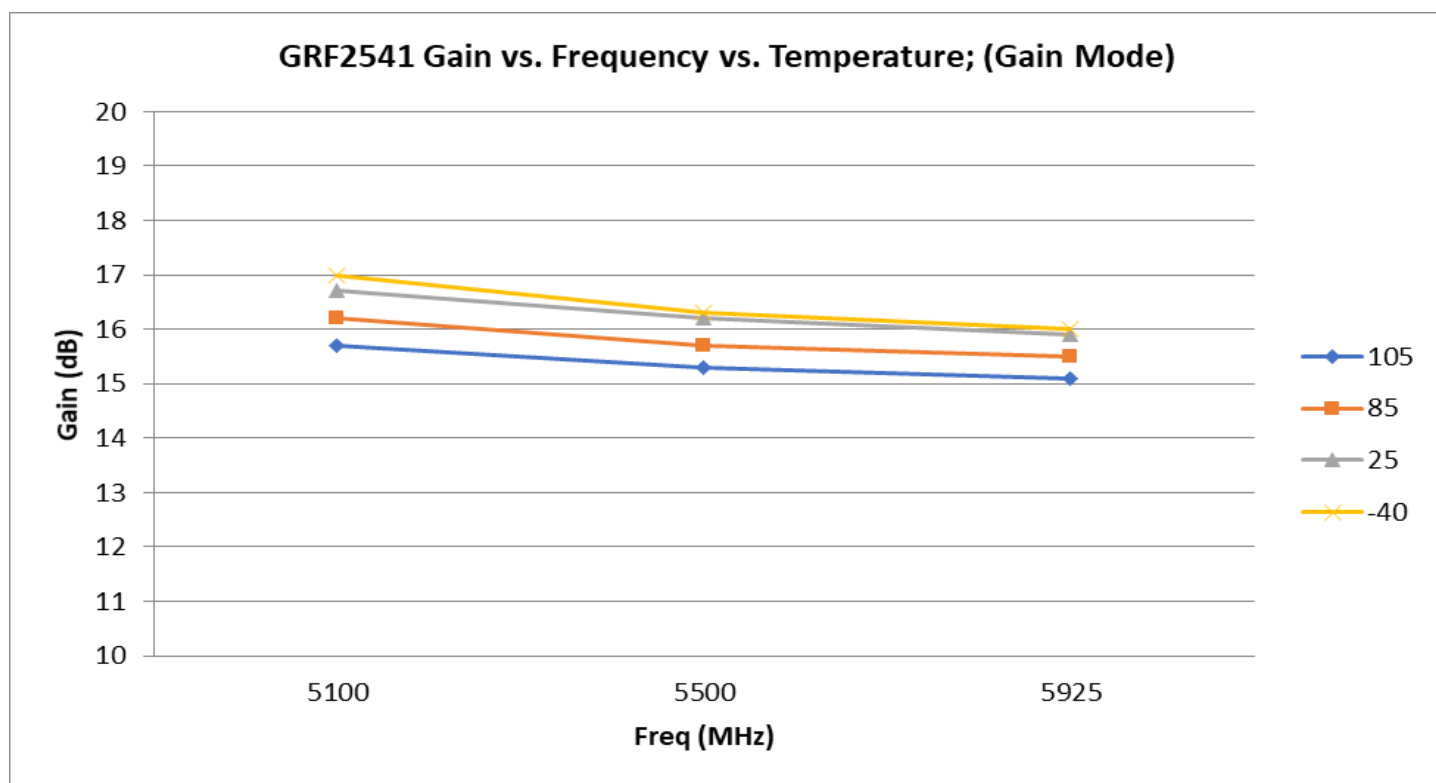
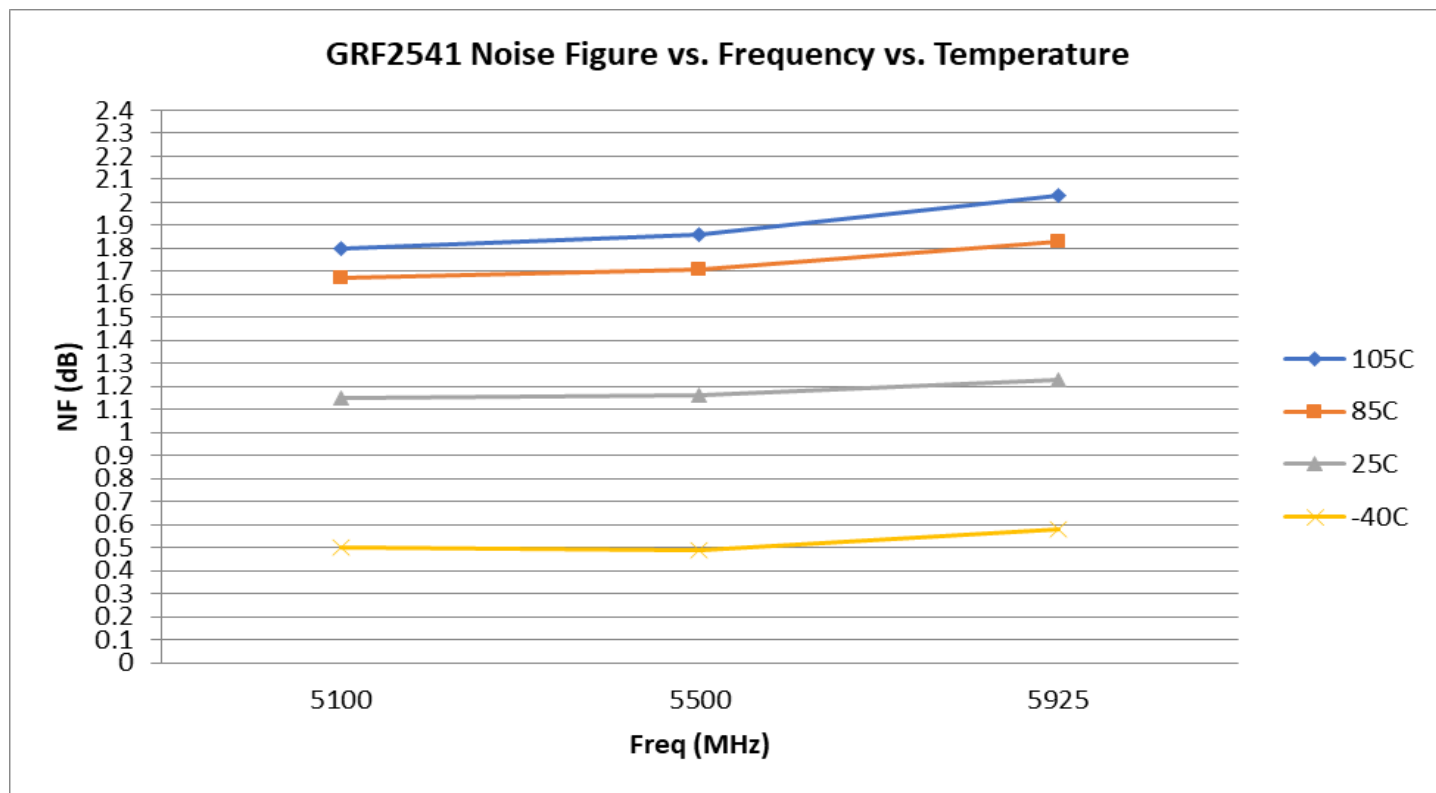
Gain	S21		-5.1		dB	
Reverse Isolation	S12		> 5		dB	
Input 1 dB Compression Power	IP1dB		5		dBm	

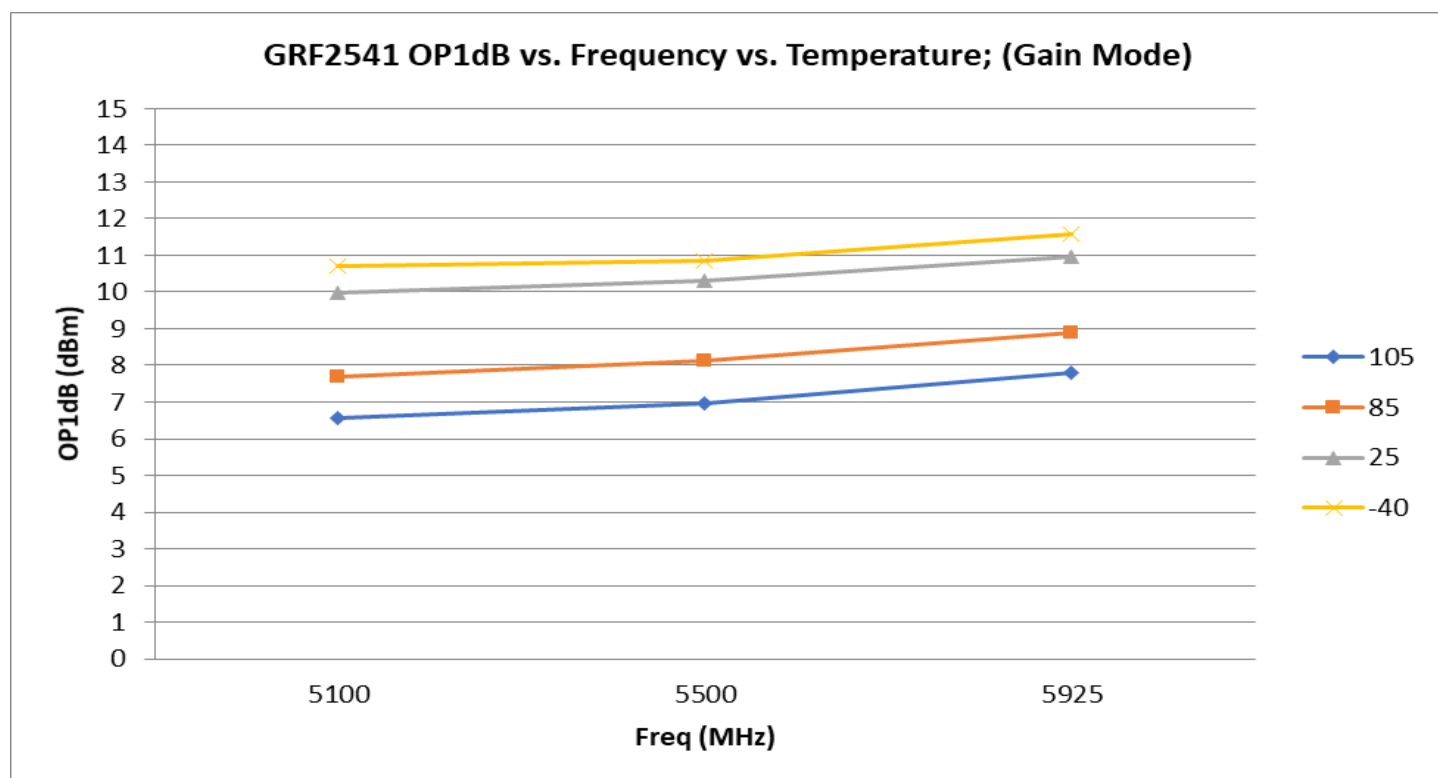
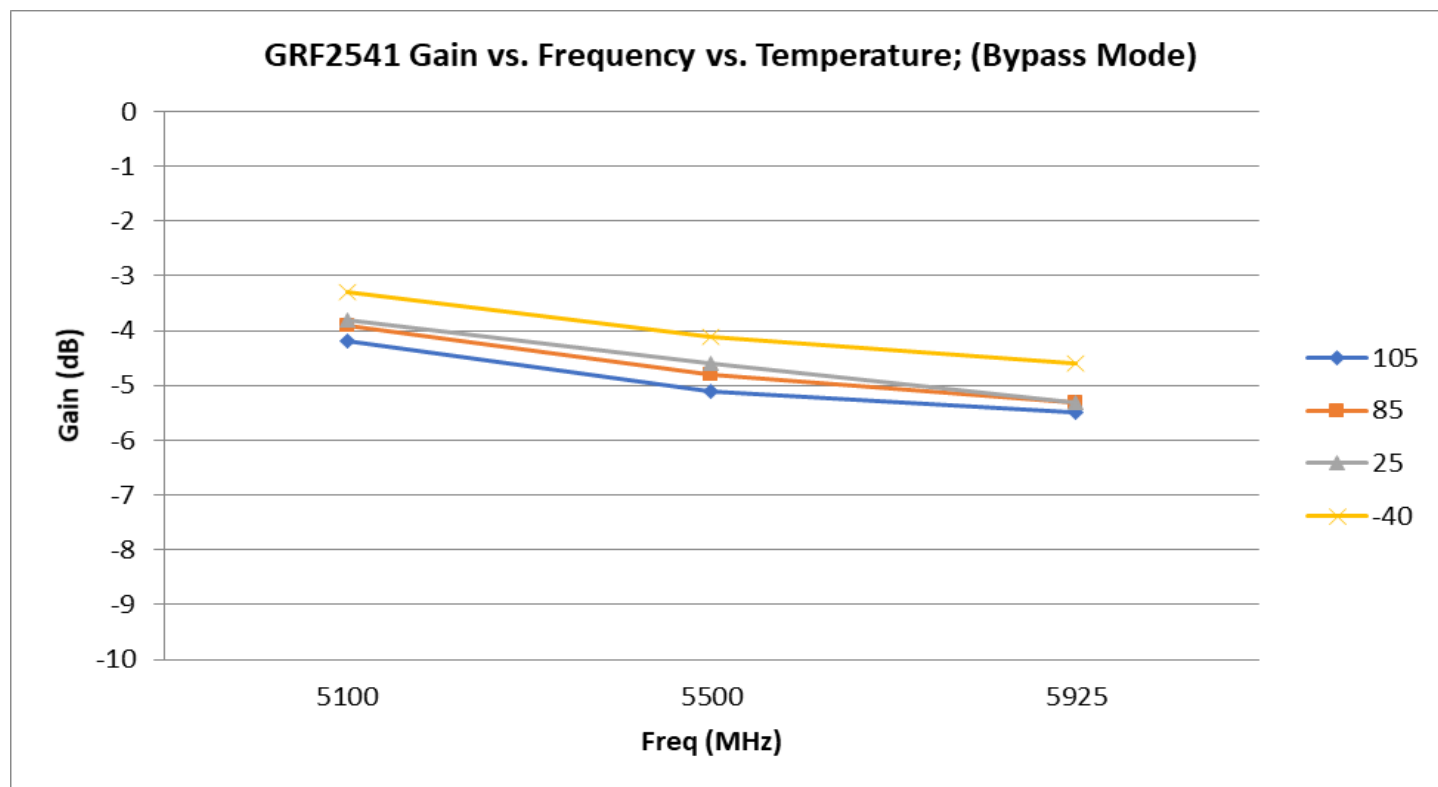
Disabled Mode (Guerrilla Armor™)

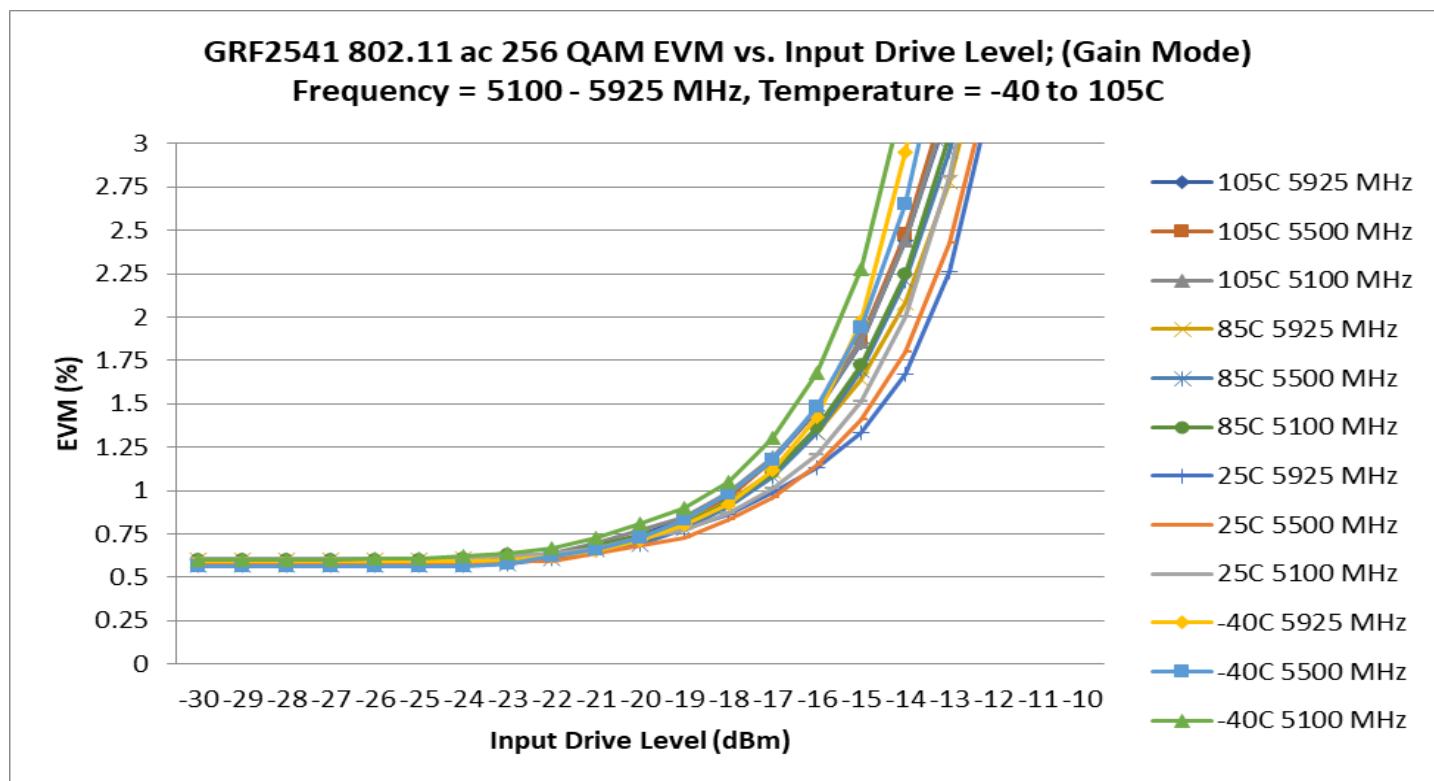
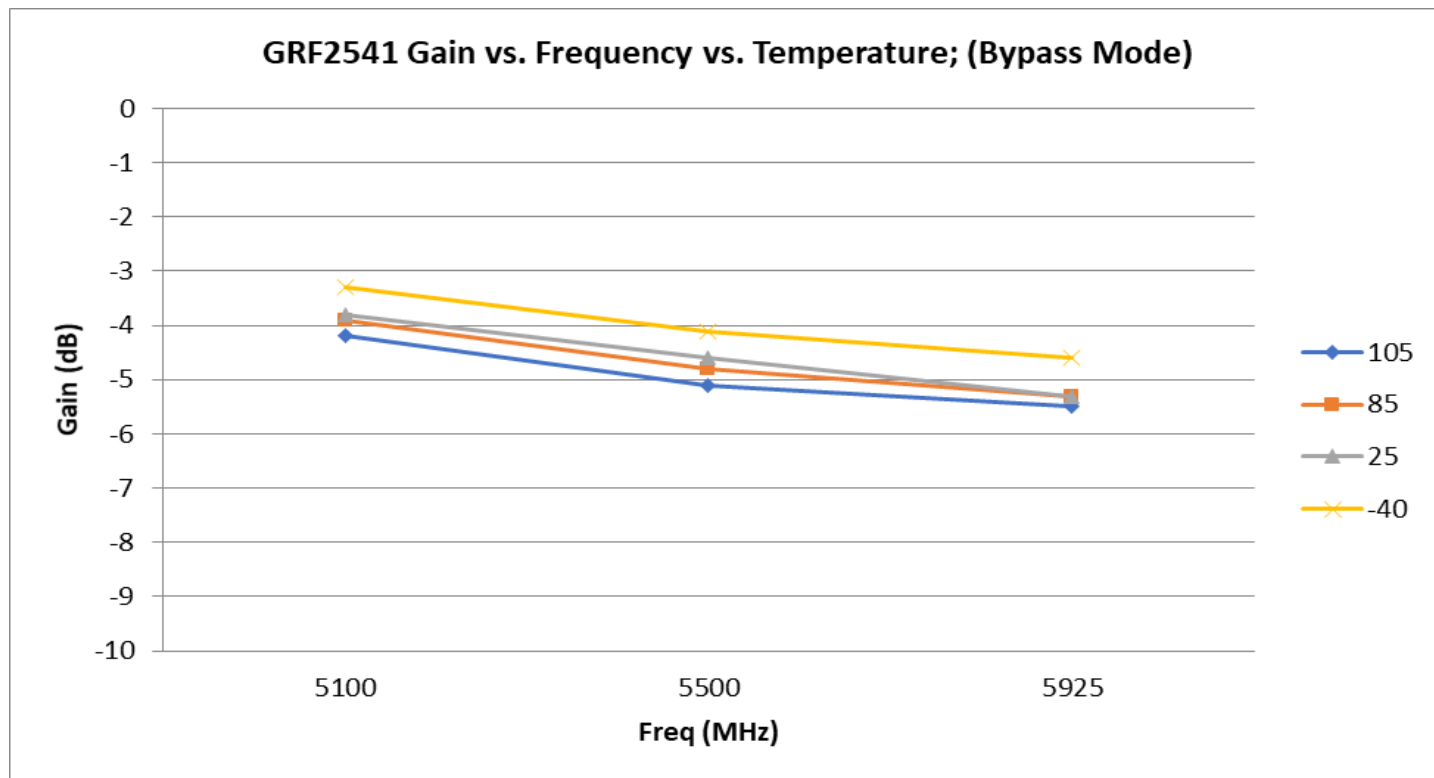
$V_{DD} = 3.3\text{ V}$, $V_{ENABLE} = V_{BYPASS} = 0\text{ V}$

Gain	S21		-32		dB	RF input power: +20 dBm.
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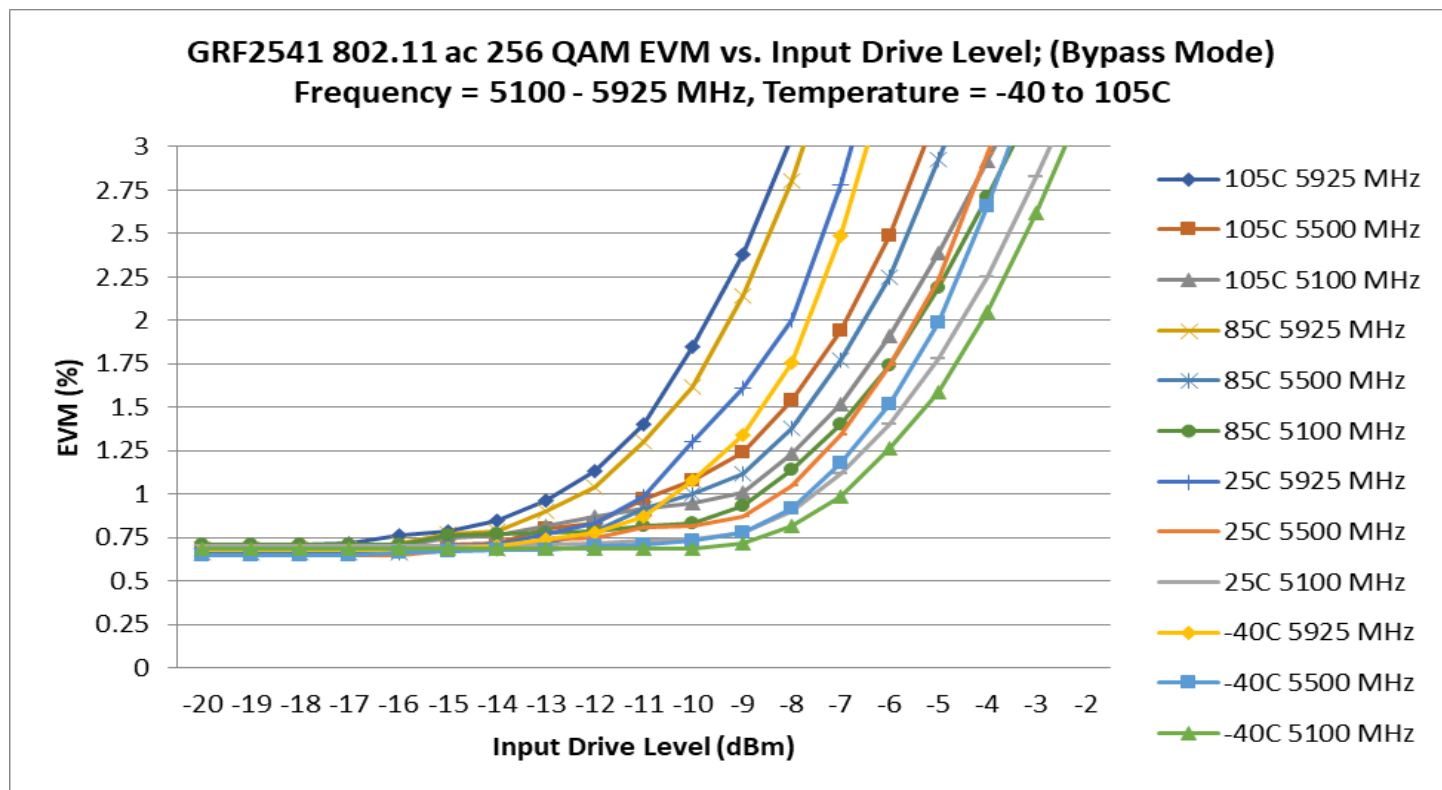
GRF2541 Typical Operating Curves: 5.1 to 5.925 GHz Tune

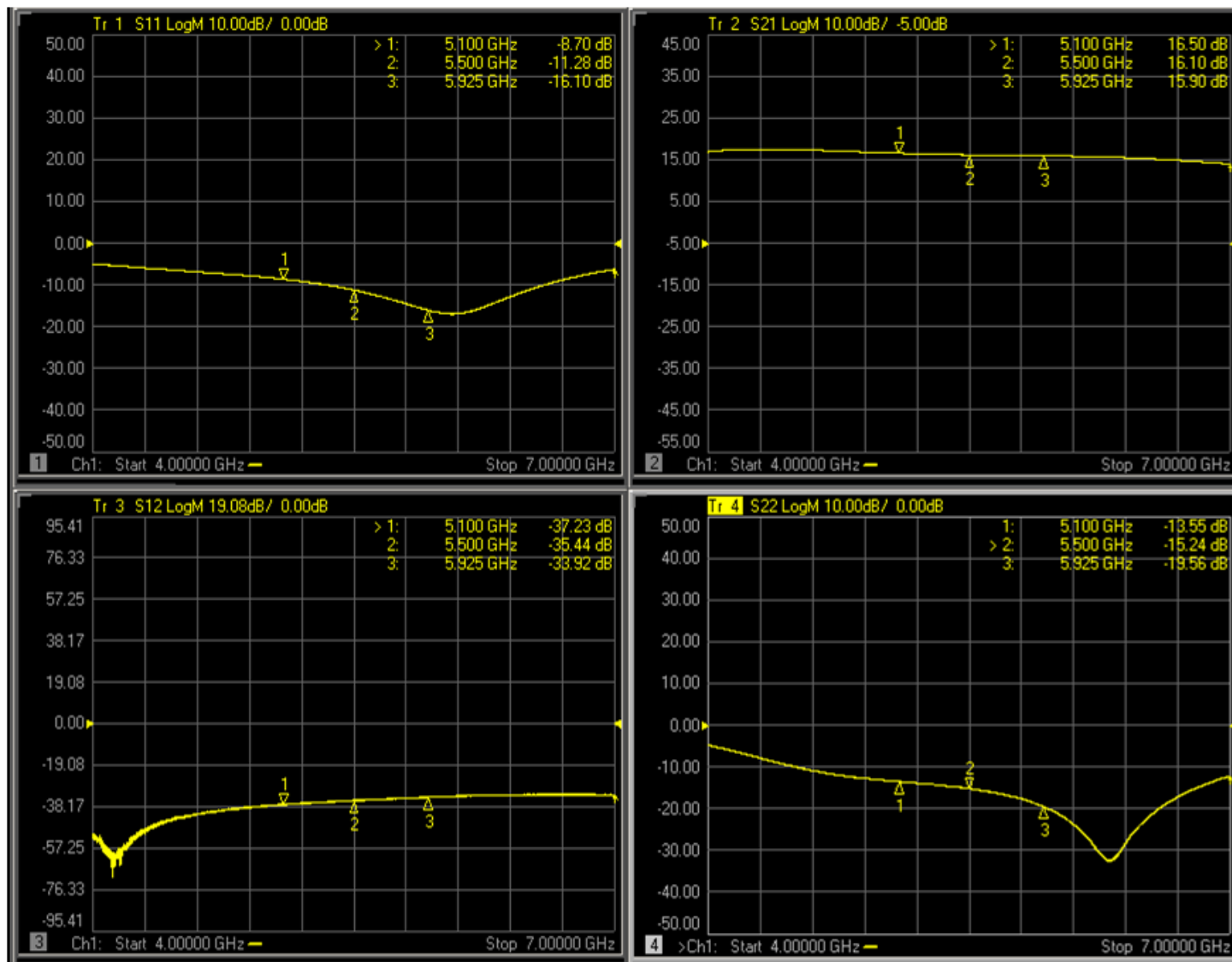


GRF2541 Typical Operating Curves: 5.1 to 5.925 GHz Tune


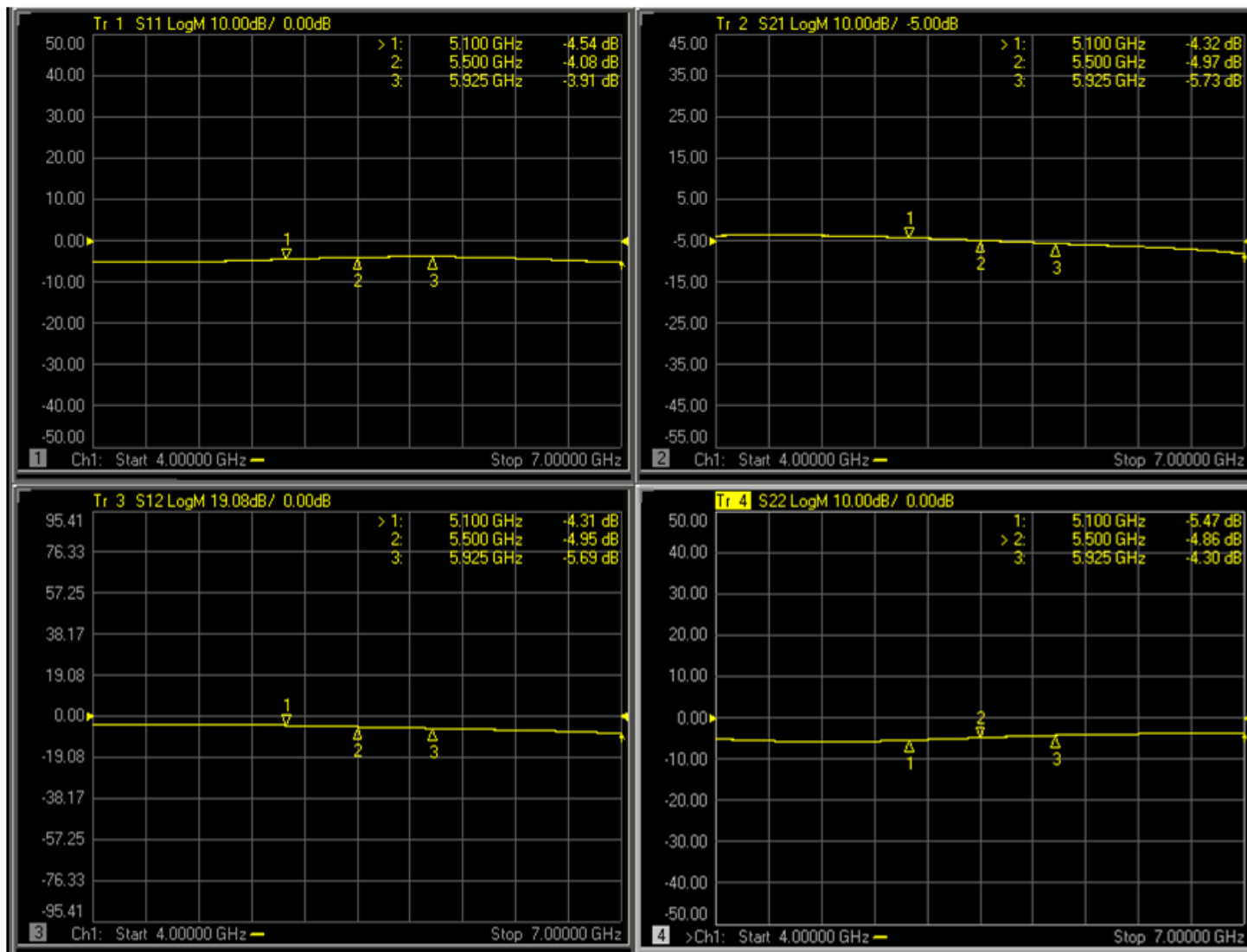
GRF2541 Typical Operating Curves: 5.1 to 5.925 GHz Tune


GRF2541 Typical Operating Curves: 5.1 to 5.925 GHz Tune

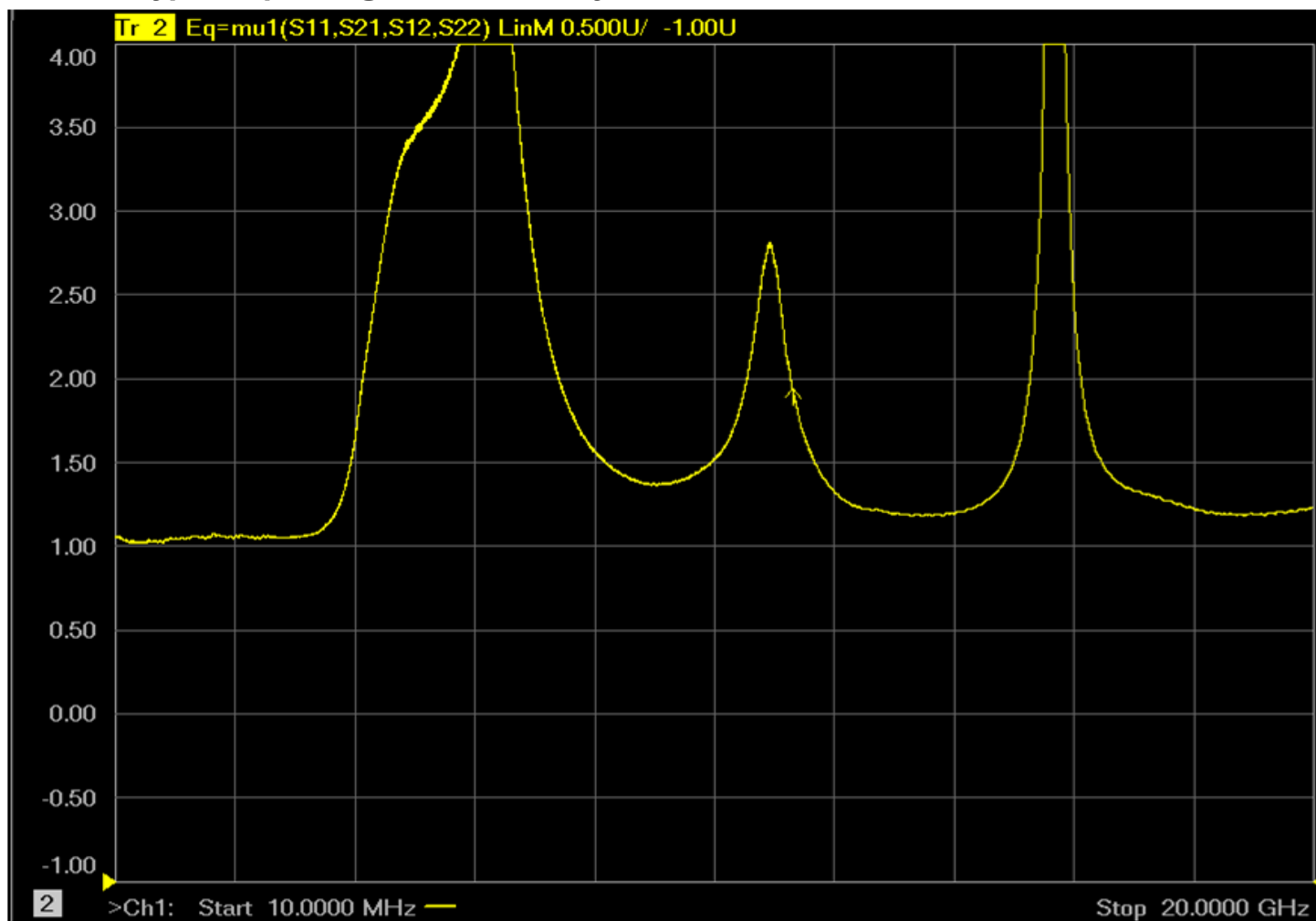


GRF2541 Typical Operating Curves: S-Parameters: 5.1 to 5.925 GHz Tune (Gain Mode)


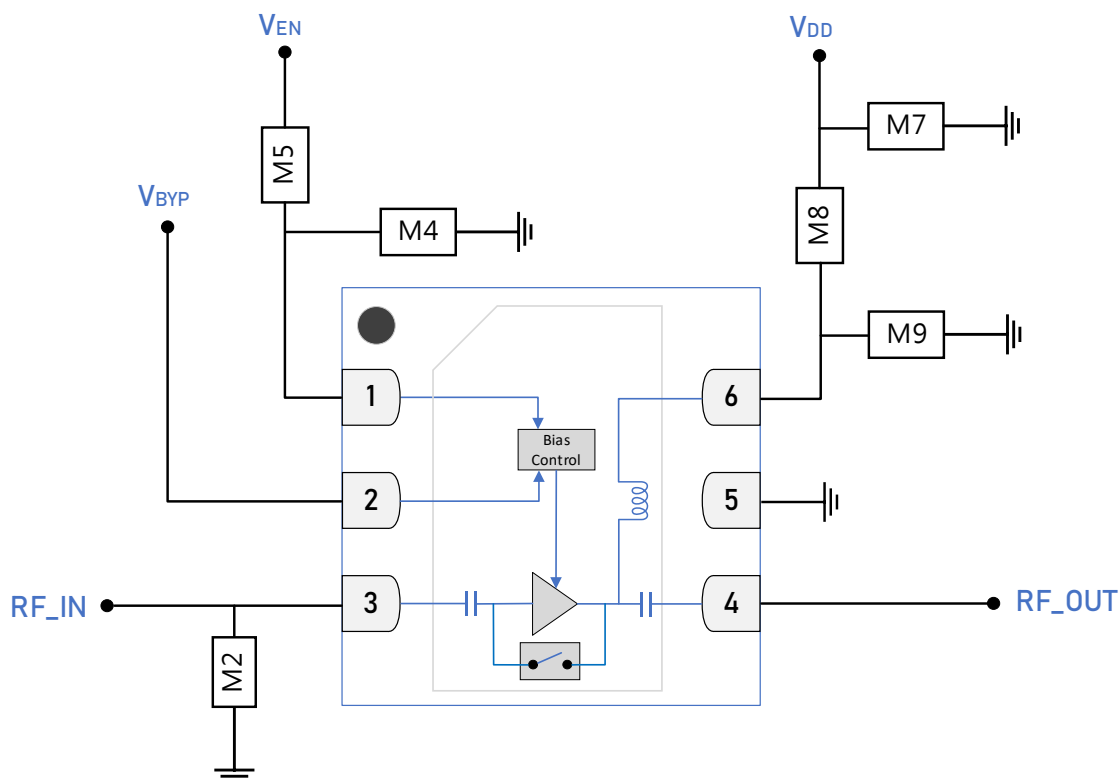
GRF2541 Typical Operating Curves: S-Parameters: 5.1 to 5.925 GHz Tune (Bypass Mode)



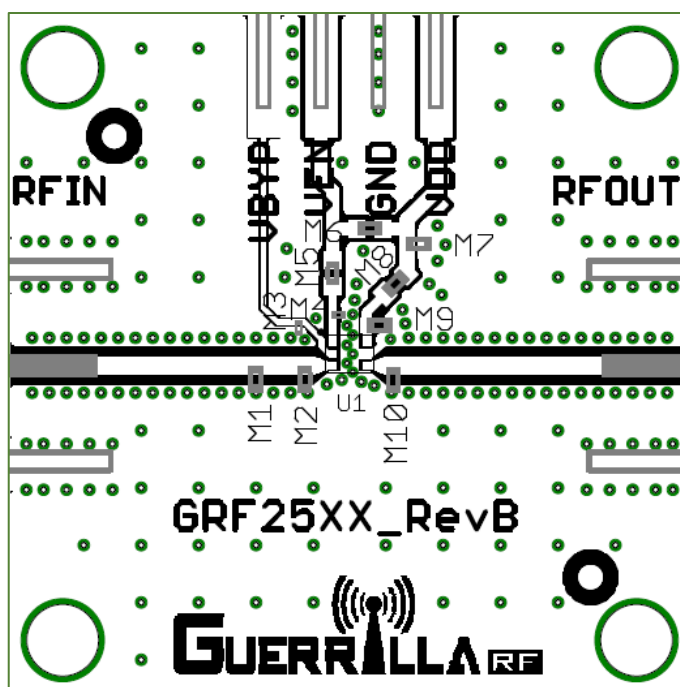
GRF2541 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



Note: $\mu \geq 1.0$ implies unconditional stability.



GRF2541 Standard Evaluation Board Schematic

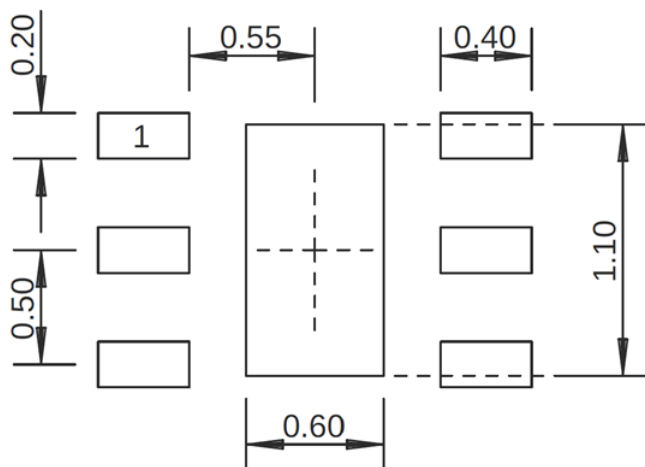


GRF2541 Evaluation Board Assembly Diagram

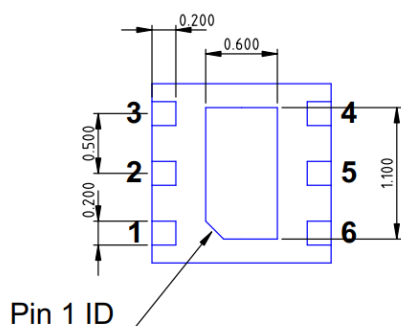
GRF2541 Evaluation Board Assembly Diagram Reference: 5.1 to 5.925 GHz Tune

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M2	Capacitor	Murata	GJM	0.2 pF	0402	ok
M4	Capacitor	Murata	GRM	100 pF	0402	ok
M5	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M7	Capacitor	Murata	GRM	0.1 μ F	0402	ok
M8	Ferrite Bead	Murata	BLM15AG121SN1D	--	0402	ok
M8 (see note)	Resistor	Various	--	15 Ω	0402	ok
M9	Capacitor	Murata	GJM	2 pF	0402	ok
Evaluation Board	GRF25XX_RevB					

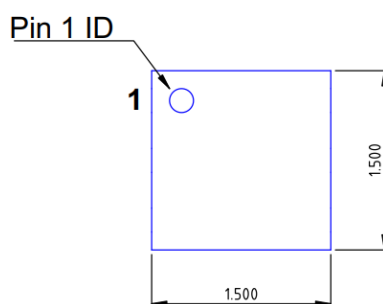
Note: 15 Ω resistor can be used instead of ferrite bead at position M8. Ferrite bead will provide better gain suppression below 2 GHz.



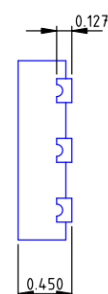
1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)



Bottom View



Top View



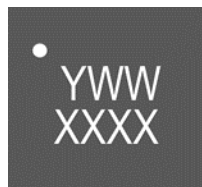
Side View

DFN6 1.5x1.5mm

Dimensions in millimeters
Dimensional Tolerance: ± 0.05

1.5 x 1.5 mm DFN-6 Package Dimensions

Package Marking Diagram



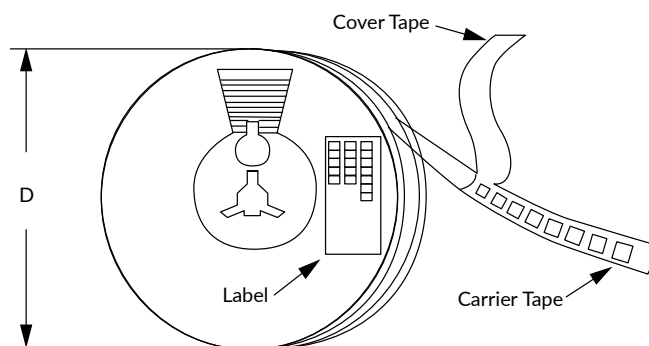
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

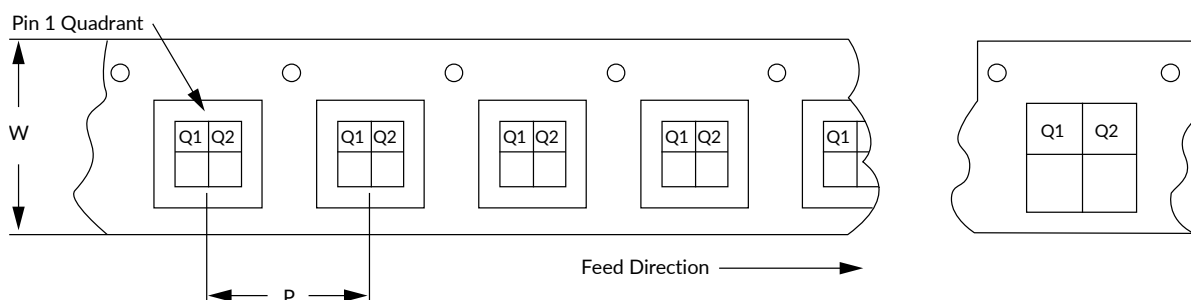
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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
December 21, 2017	Preliminary Data Sheet.
September 23, 2022	Converted format to new template. Updated Switching Times to current specifications.
February 10, 2025	In Truth Table: changed V _{ENABLE} Bypass Logic Level from 0 to 0 or 1.



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 <i>production-released</i> material. TYP values are based on a combination of ATE and bench-level measurements, with MIN/MAX limits defined using <i>modelled estimates</i> 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 <i>derived from multiple lots which have been fabricated over an extended period of time</i> . 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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