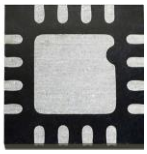
Data Sheet

RELEASE A DATA SHEET



GRF5109

28.5 dBm POWER-LNA™
0.1 to 2.2 GHz

FEATURES

- Excellent P1dB, IP3, ACLR and NF Performance
- Flexible Biasing Provides Latitude for Linearity Optimization
- 160 mA Native Mode Quiescent Current Consumption
- 5 V Supply Voltage
- 50 Ω Single-ended Input and Output Impedances
- -40 to 105 °C Operating Temperature Range
- Process: GaAs pHEMT
- Compact 3 x 3 mm QFN-16 Package

Reference: 5 V / 830 MHz / 160 mA I_{DDQ}

- Gain: 19 dB
- OIP3: 43.5 dBm
- OP1dB: 28.5 dBm
- Evaluation Board Noise Figure: 1.3 dB

APPLICATIONS

- Power Amplifier
- Linear Driver Amplifier for High PAR Waveforms
- Multi-stage LNA

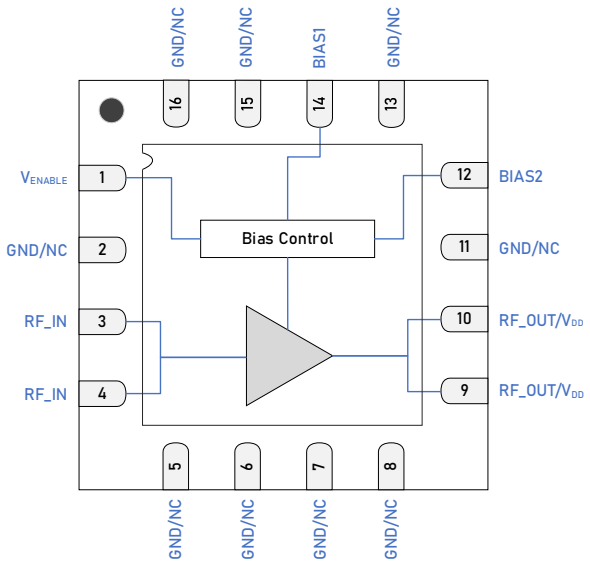
DESCRIPTION

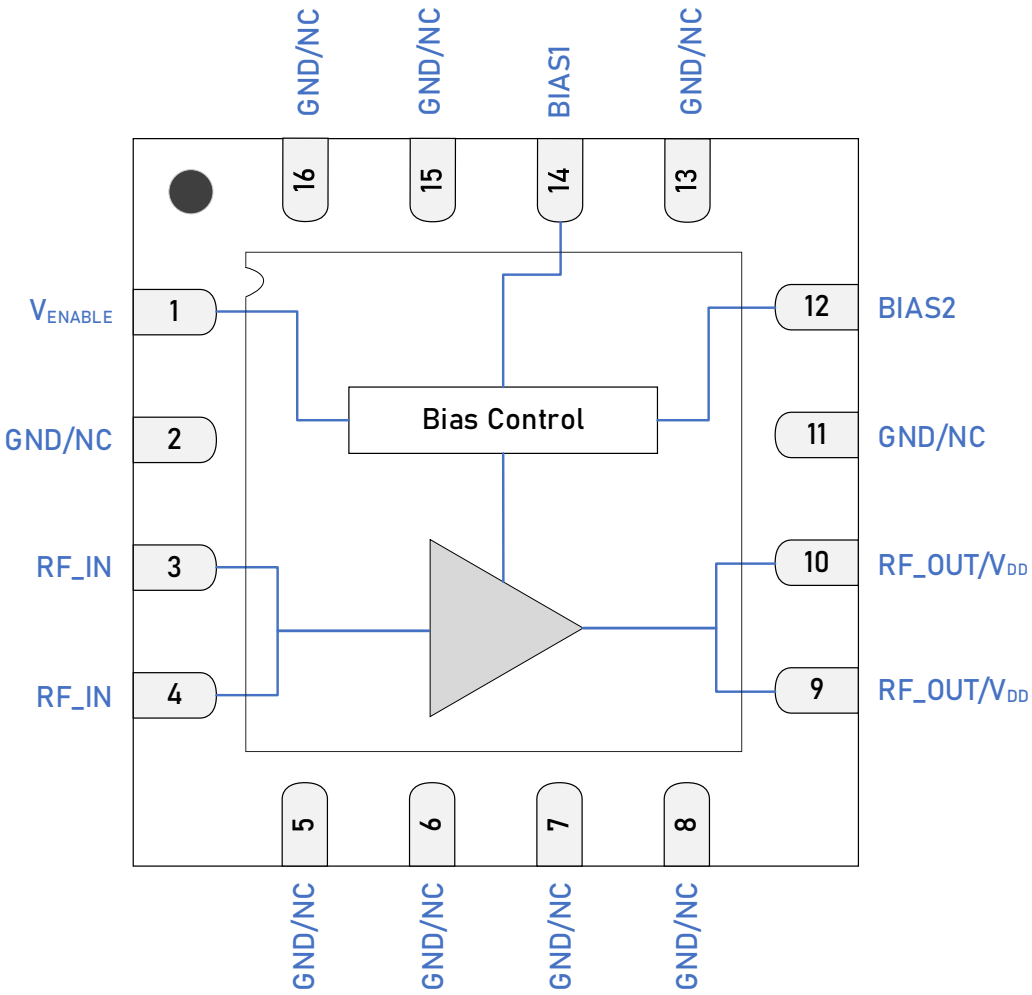
The GRF5109 is a high linearity PA/Linear Driver with low noise figure (NF). It delivers excellent P1dB, IP3 and NF over a wide range of frequencies with fractional bandwidths of roughly 5 to 10%.

This device can be tuned over a wide range of frequencies from around 0.1 GHz up to 2.2 GHz.

Please consult with the GRF applications engineering team for custom tuning/evaluation board data.

BLOCK DIAGRAM





3 x 3 mm QFN-16 Pin Out (Top View)

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Pin Assignments

Pin	Name	Description	Note
1	V_{ENABLE}	Enable Voltage Input	V_{ENABLE} and series resistor sets I_{DDQ}. $V_{ENABLE} \leq 0.2$ V disables device. On-die pull-down resistor will turn the part off if this node is allowed to float.
2, 5, 6, 7, 8, 11, 13, 15, 16	GND/NC	Ground or No Connect	No internal connection to die. These pins can be left unconnected, or be connected to ground (recommended). Use a via as close to the pin as possible if grounded.
3, 4	RF_IN	RF Input	Pins 3 & 4 tied together on system board.
9, 10	RF_OUT/V_{DD}	PA Output/Bias	Pins 9 & 10 tied together on system board. Supply V_{DD} here.
12	Bias2	Bias Circuit Supply	Connect to V_{DD} through external resistor.
14	Bias1	Bias Circuit Ground	Consult application schematic.
PKG BASE	GND	Ground	Provides DC and RF ground for the 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
Drain Voltage	V_{DD}		6	V
Transient Average RF Input Power CW: Load VSWR < 2:1; Duration: <1 hour)	$P_{IN\ MAX}$		24	dBm
Operating Temperature (Package Heat Sink)	$T_{PKG\ HEAT\ SINK}$	-40	105	°C
Maximum Channel Temperature (MTTF >10^6 Hours)	T_{MAX}		170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		1.0	W

Electrostatic Discharge

Charged Device Model	CDM	1500		V
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 — 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}	3	5	6	V	
Operating Temperature (Package Heat Sink)	$T_{PKG\ HEAT\ SINK}$	-40		105	°C	
RF Frequency Range	F_{RF}	0.1		2.2	GHz	Typical Application Schematic Using the 0.7 to 0.96 GHz Tuning Set **(note 1)**.
RF_IN Port Impedance	Z_{RFIN}		50		Ω	Single Ended with 2-element Match.
RF_OUT Port Impedance	Z_{RFOUT}		50		Ω	Single Ended with 3-element Match.

Note 1: Operation outside this range is possible, but with degraded performance of some parameters.

Nominal Operating Parameters – General

The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.7 to 0.96 GHz tuning set, M1 = 5.5 kΩ, M10 = 230 Ω, M13 = 475 Ω, I_{DDQ} = 160 mA, 50 Ω system impedance, F_{TEST} = 0.83 GHz, $T_{PKG\ HEAT\ SINK}$ = -40 to +105 °C. Typical values are at V_{DD} = 5 V, I_{DDQ} = 160 mA, $T_{PKG\ HEAT\ SINK}$ = 25 °C. MIN/MAX specifications listed in italics are guaranteed via production test screening. All other parameters are guaranteed by design and characterization. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Quiescent Current	I_{DDQ}		160	*190*	mA	V_{DD} = V_{ENABLE} = 5 V, R_{BIAS} = 5.5 kΩ.
Operating Temperature Range	$T_{PKG\ HEAT\ SINK}$	-40		+105	°C	Measured on Package Heat Sink.
Switching Rise Time	T_{RISE}		100		ns	
Switching Fall Time	T_{FALL}		800		ns	
Enable Current	I_{ENABLE}		0.7		mA	
Disabled Mode						
Supply Current (Leakage)	I_{DD}		100	*500*	µA	
Thermal Data						
Thermal Resistance: (IR Scan Method)	Θ_{JC}		80		°C/W	On Standard Evaluation Board **(note 2).**

Note 2: MTTF > 10^6 hours for $T_{CHANNEL}$ ≤ 170 °C.

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Nominal Operating Parameters – RF (0.7 to 0.96 GHz, 5 V Operation)

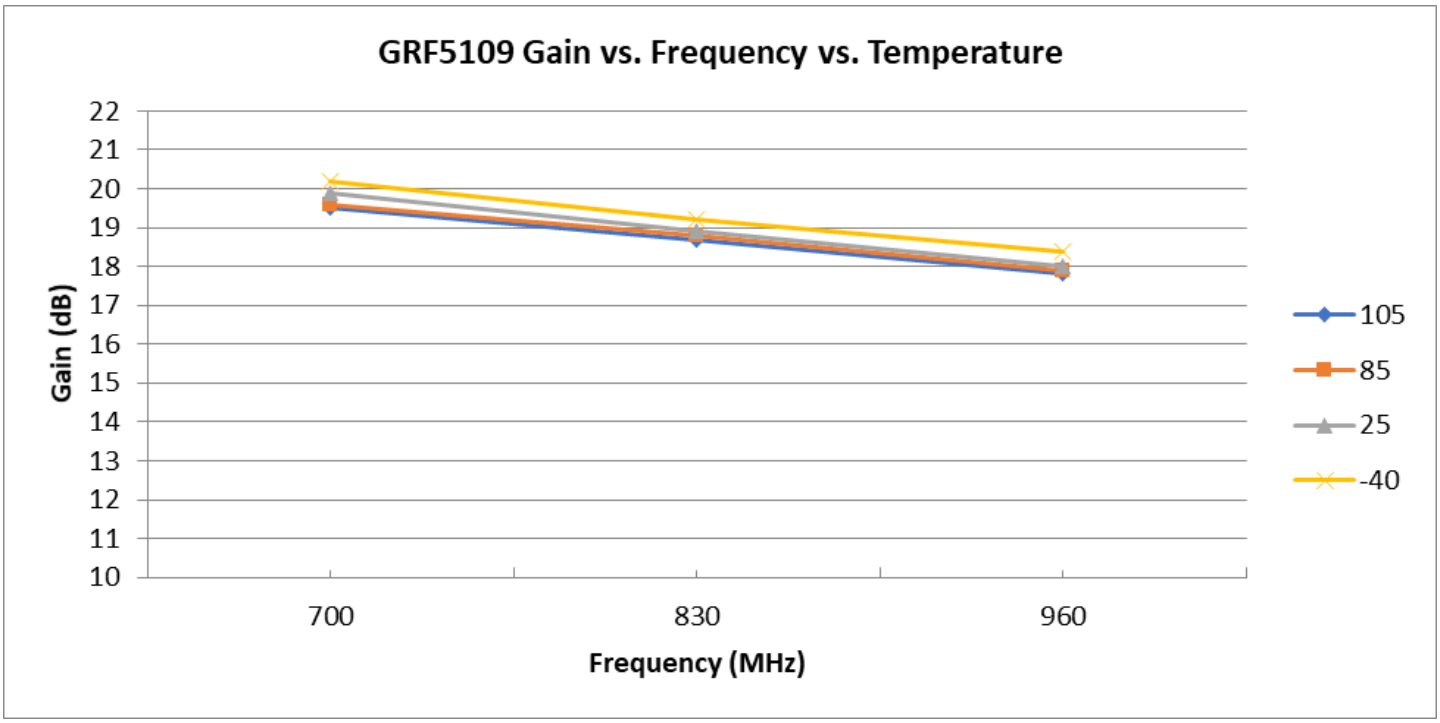
The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.7 to 0.96 GHz tuning set, M1 = 5.5 kΩ, M10 = 230 Ω, M13 = 475 Ω, I_{DDQ} = 160 mA, 50 Ω system impedance, F_{TEST} = 0.83 GHz, $T_{PKG\ HEAT\ SINK}$ = -40 to +105 °C. Typical values are at V_{DD} = 5 V, I_{DDQ} = 160 mA, $T_{PKG\ HEAT\ SINK}$ = 25 °C. MIN/MAX specifications listed in italics are guaranteed via production test screening. All other parameters are guaranteed by design and characterization. Evaluation board losses are included within the specifications.

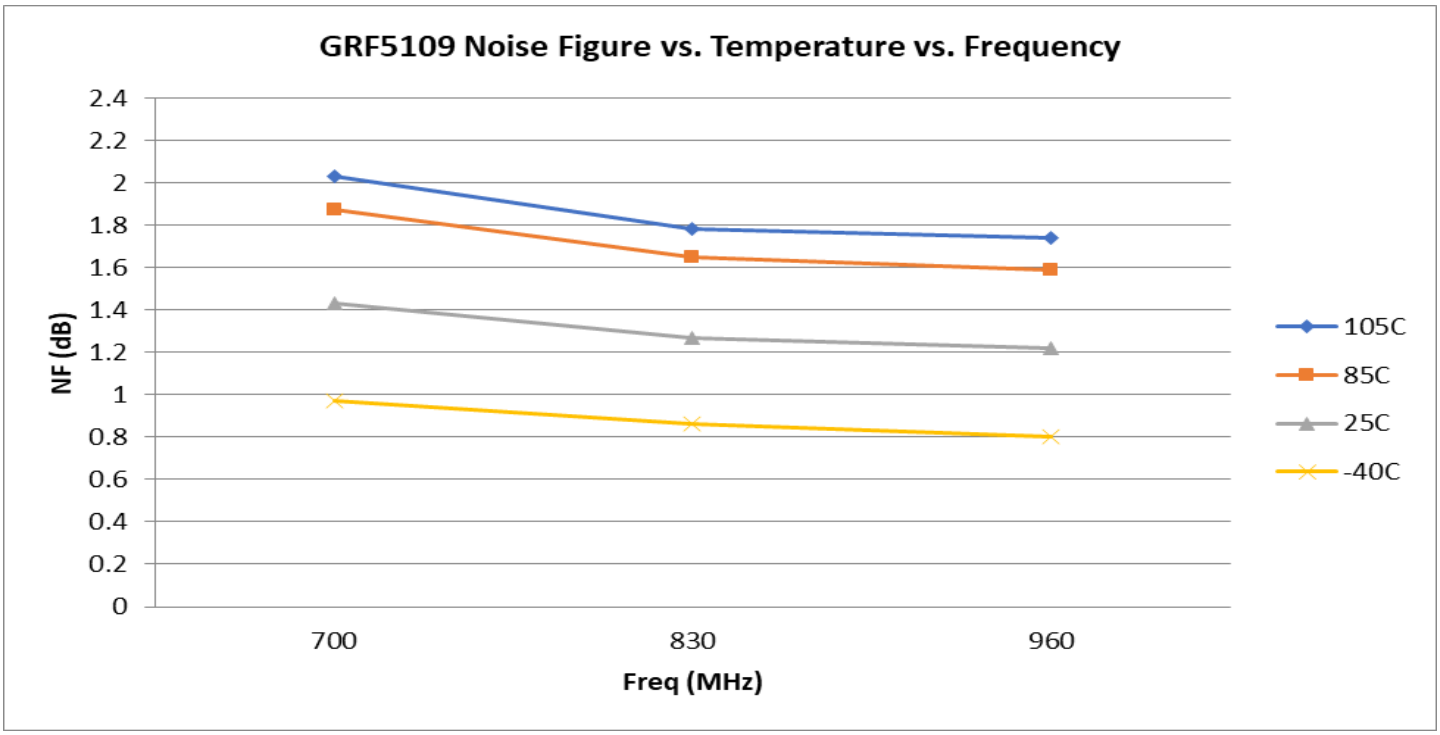
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Small Signal Gain	S21	*18*	19		dB	F_{RF} = 0.7 to 0.96 GHz.
Input Return Loss	S11		>8		dB	F_{RF} = 0.7 to 0.96 GHz.
Output Return Loss	S22		>15		dB	F_{RF} = 0.7 to 0.96 GHz.
Reverse Isolation	S12		>26		dB	F_{RF} = 0.7 to 0.96 GHz.
Evaluation Board Noise Figure	NF		1.3		dB	
Output 3rd Order Intercept	OIP3		43.5		dBm	
Output 1 dB Compression Power	OP1dB	*26.8*	28.5		dBm	

Typical Operating Curve Conditions

The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.7 to 0.96 GHz tuning set, M1 = 5.5 kΩ, M10 = 230 Ω, M13 = 475 Ω, I_{DDQ} = 160 mA, 50 Ω system impedance, F_{TEST} = 0.83 GHz, $T_{PKG\ HEAT\ SINK}$ = -40 to +105 °C. Evaluation board losses are included within the plots.

GRF5109 Typical Operating Curves: *0.7 to 0.96 GHz Tune*





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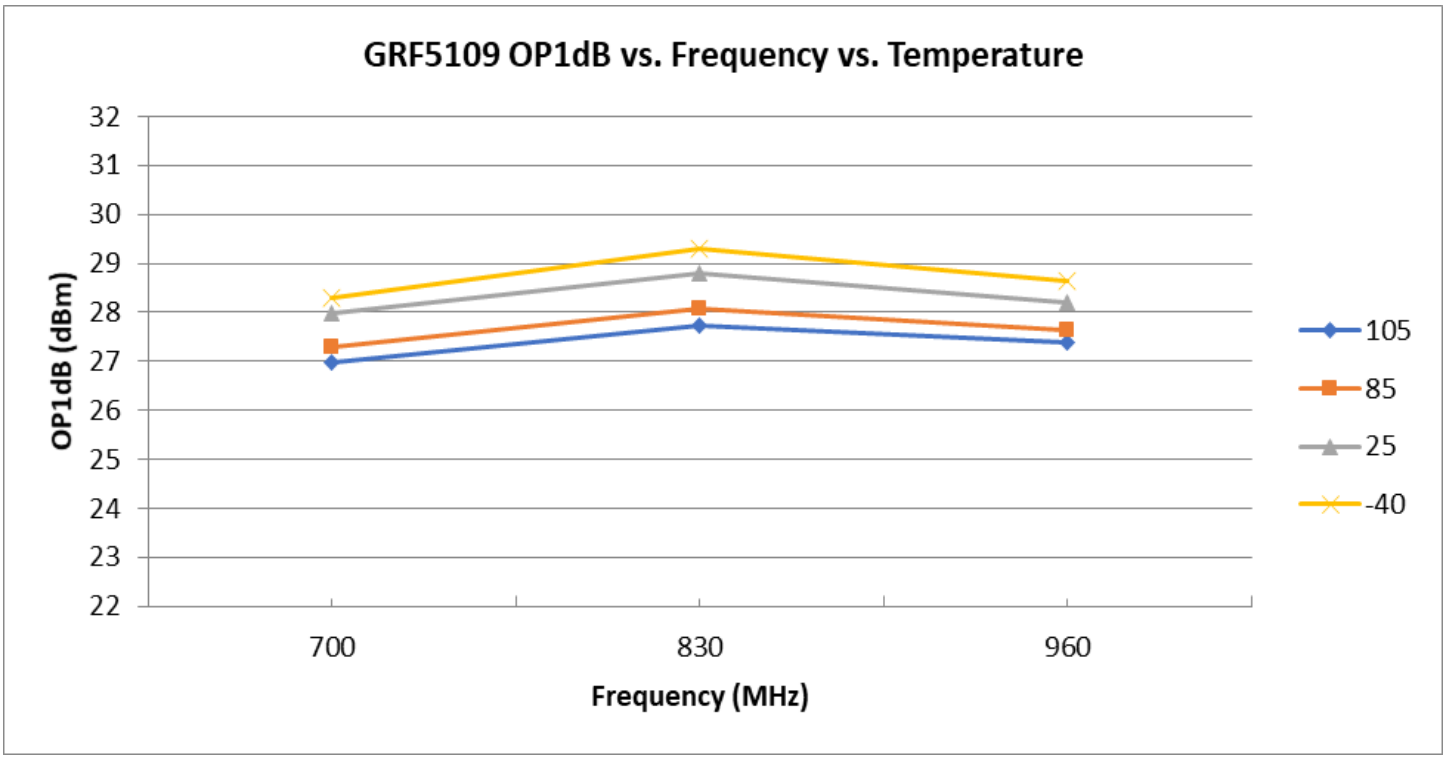
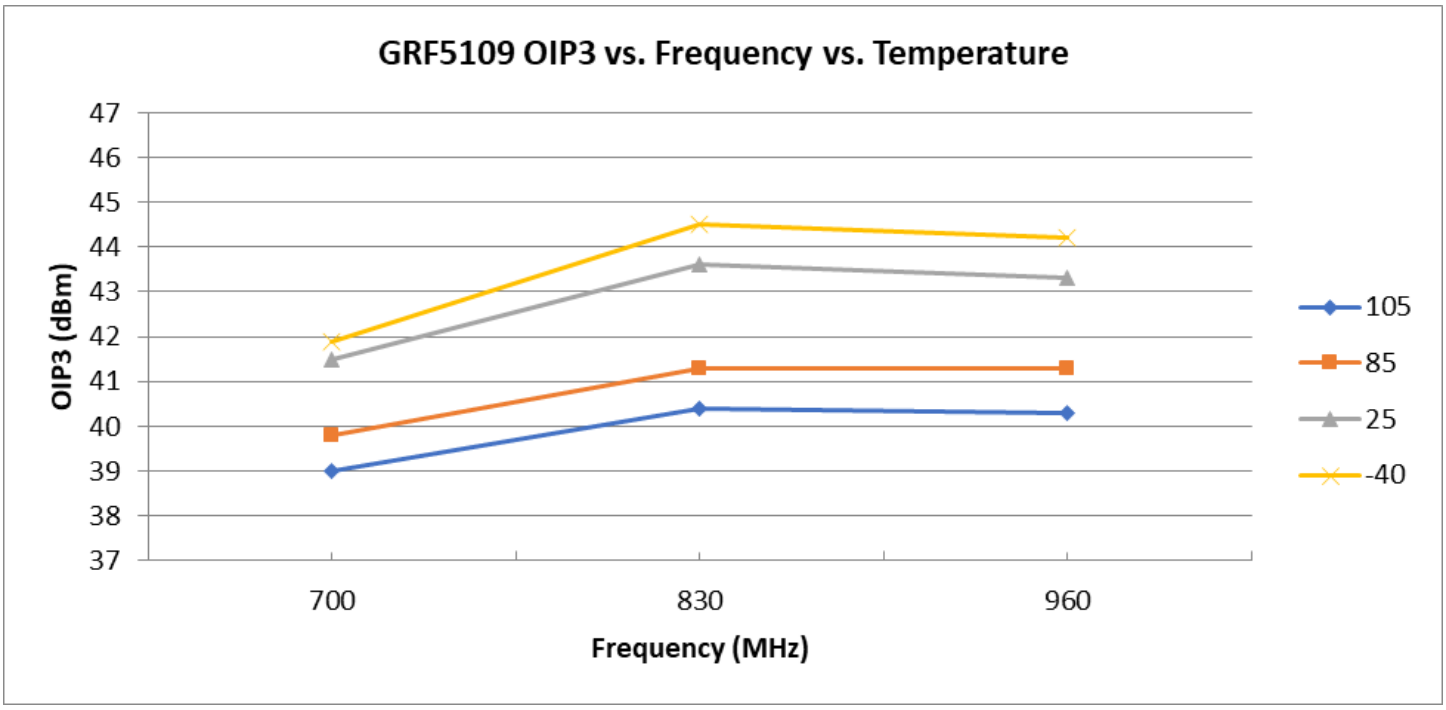
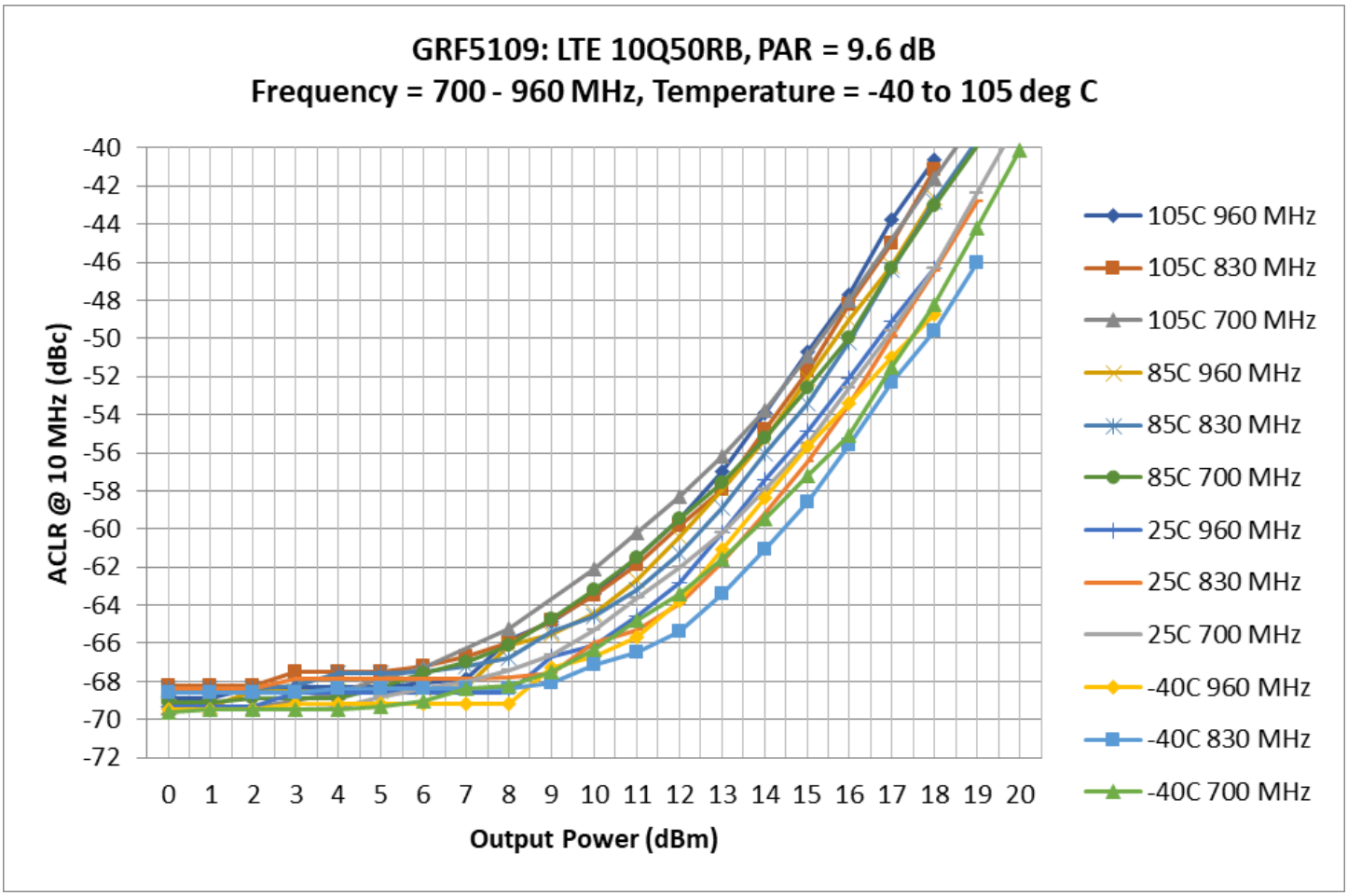
GRF5109 Typical Operating Curves: *0.7 to 0.96 GHz Tune*





GRF5109 Typical Operating Curves: *0.7 to 0.96 GHz Tune*



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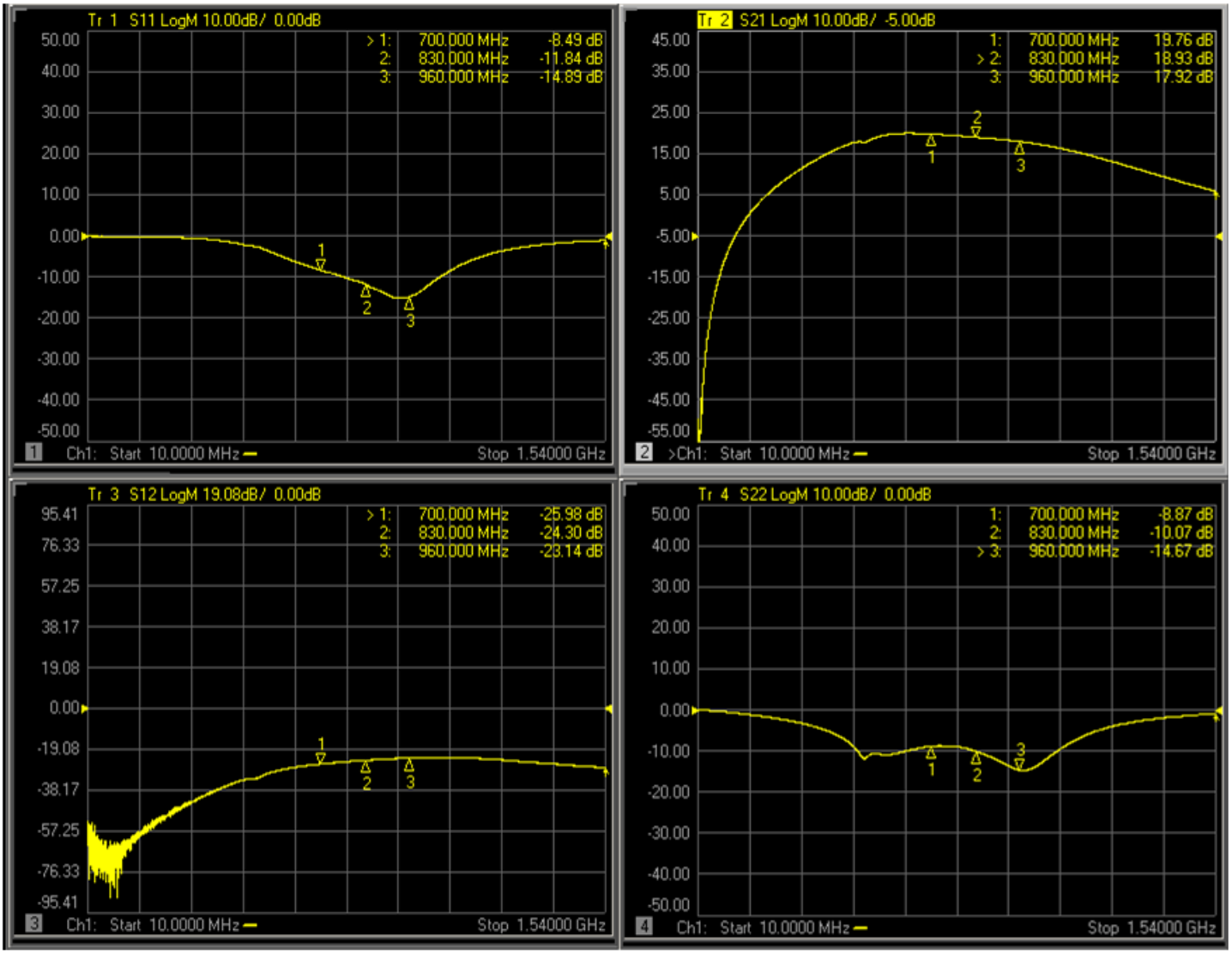
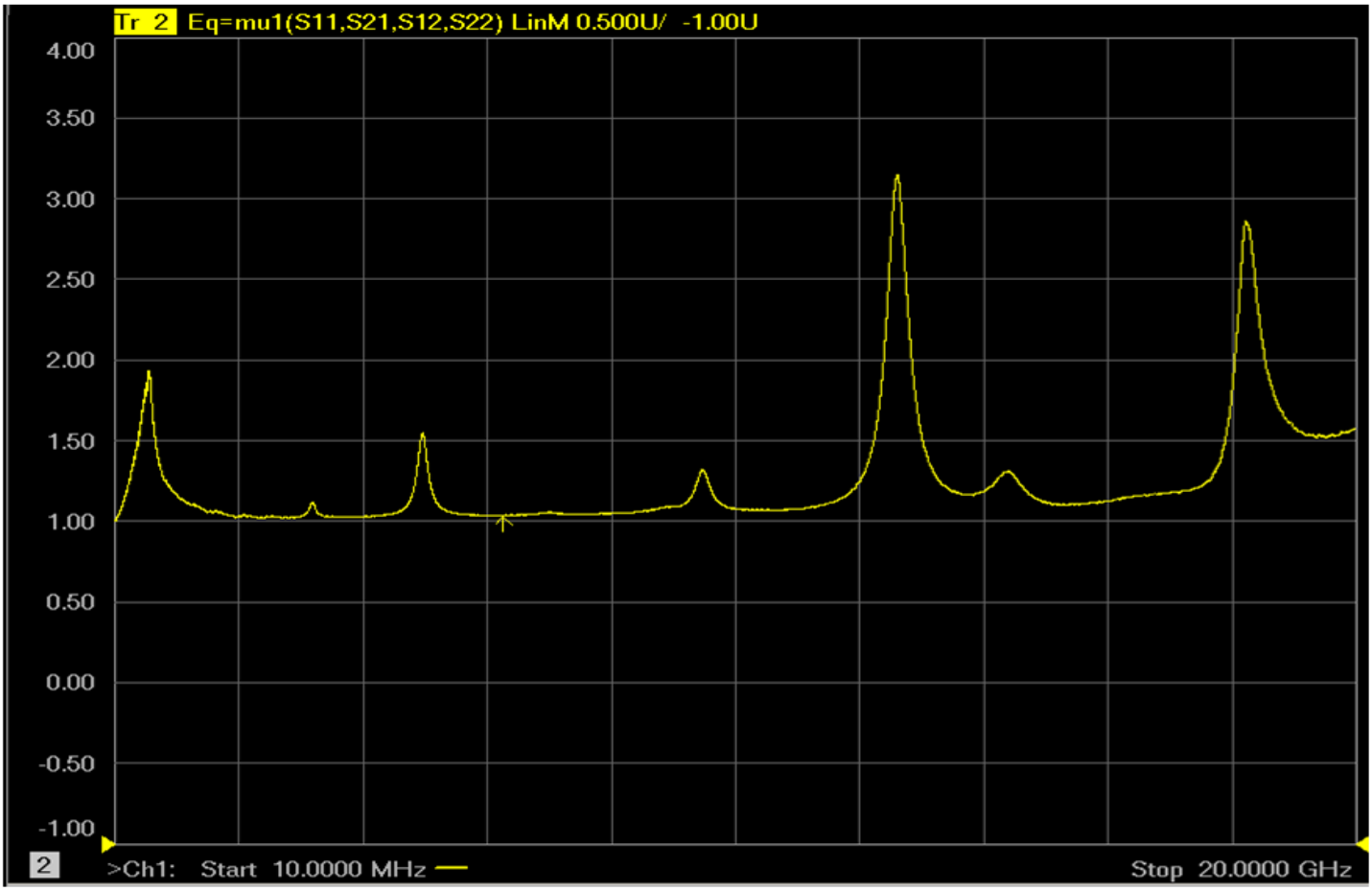
GRF5109 Typical Operating Curves: S-Parameters (0.7 to 0.96 GHz Tune)



GRF5109 Typical Operating Curves: Stability Mu (0.7 to 0.96 GHz Tune)



Note: Mu factor ≥ 1.0 implies unconditional stability

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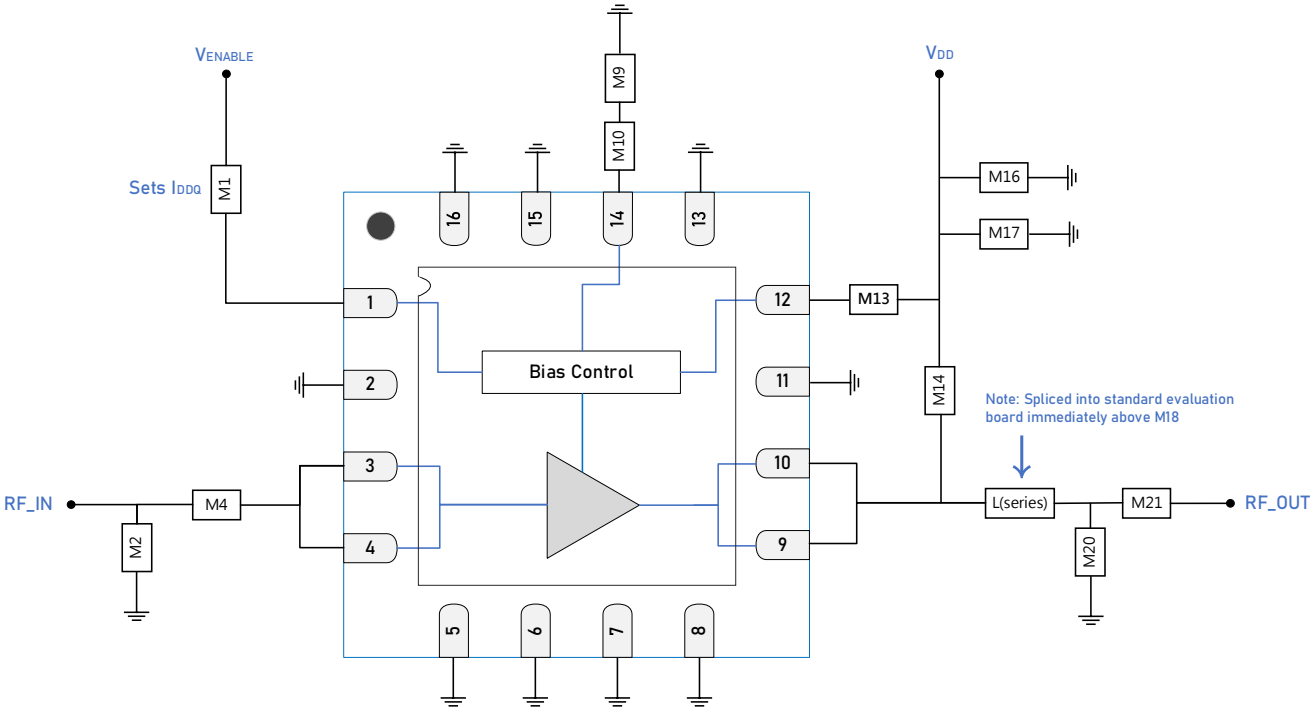
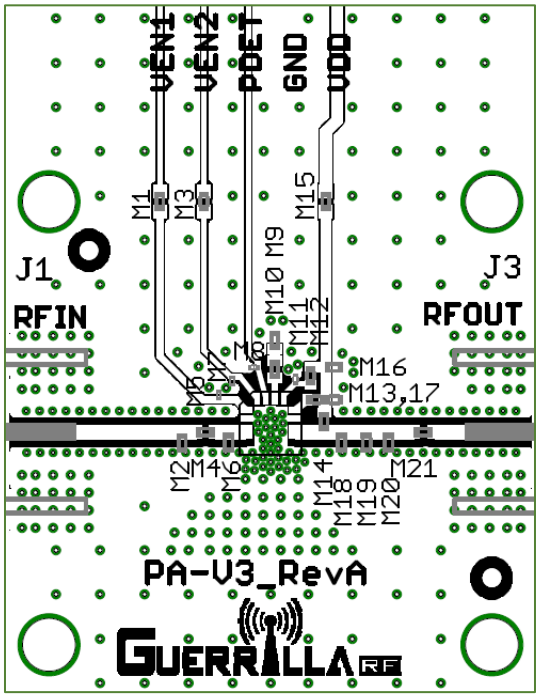


GRF5109 Standard Test Schematic



GRF5109 Evaluation Board Assembly Diagram

GRF5109 Evaluation Board Assembly Diagram Reference: 0.7 to 0.96 GHz Tune

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1 (See Curves)	Resistor	Various	5%	Sets I_{DDQ}	0402	ok
M2	Inductor: High Q	Coilcraft	HP	5.1 nH	0402	ok
M4	Capacitor: High Q	Murata	GJM	12.0 pF	0402	ok
M9	Inductor	Murata	LQG	39 nH	0402	ok
M10	Resistor	Various	5%	230 Ω	0402	ok
M13	Resistor	Various	5%	475 Ω	0402	ok
M14	Inductor: High Q	Coilcraft	HP	18 nH	0402	ok
M16	Capacitor	Murata	GRM	0.1 µF	0402	ok
M17	Capacitor	Murata	GRM	100 pF	0402	ok
M20	Capacitor	Murata	GJM	5.1 pF	0402	ok
M21	Capacitor	Murata	GJM	39 pF	0402	ok
L(series)	Inductor: High Q	Coilcraft	HP	3.3 nH	0402	ok
Evaluation Board	PA-V3_RevA					

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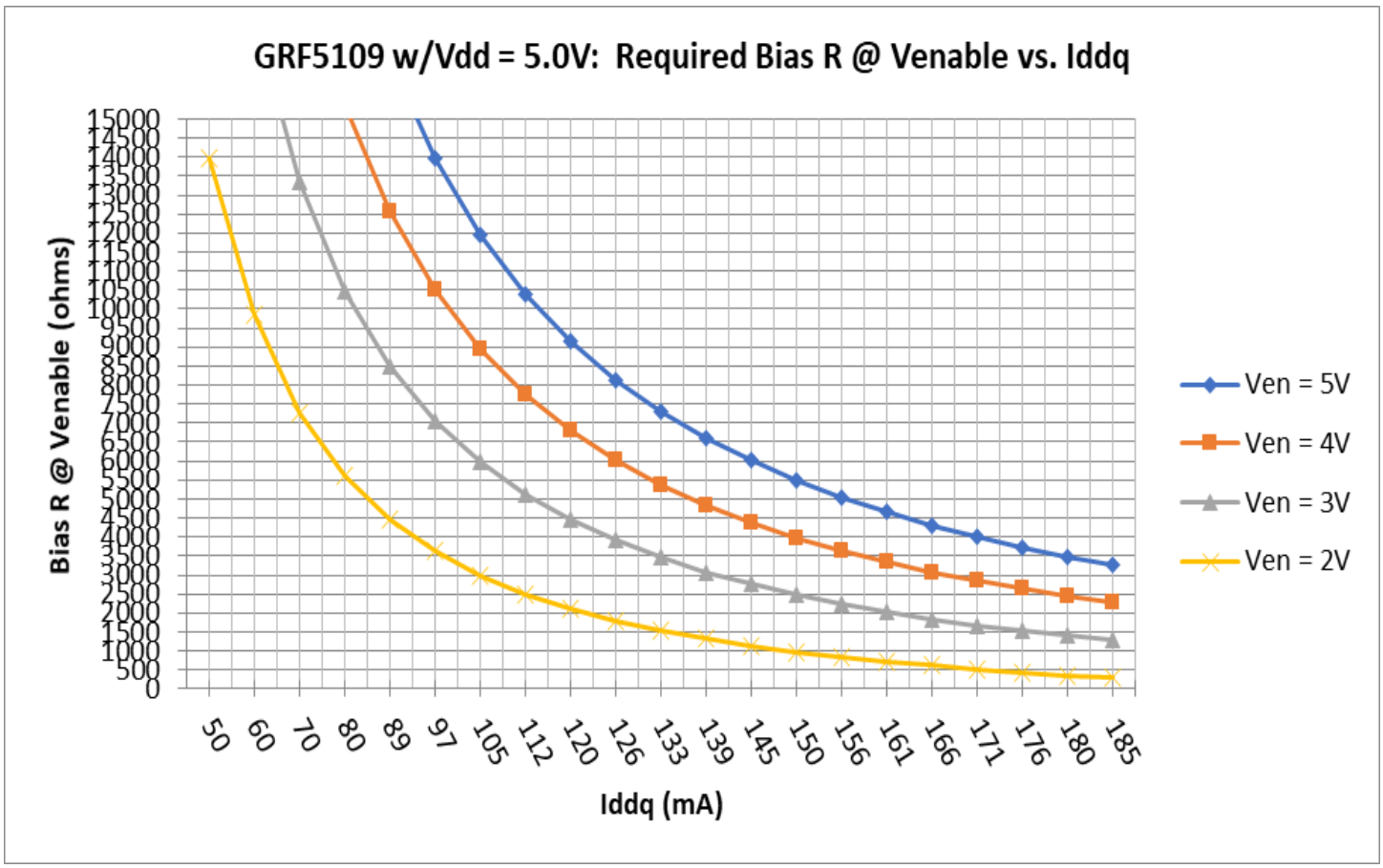
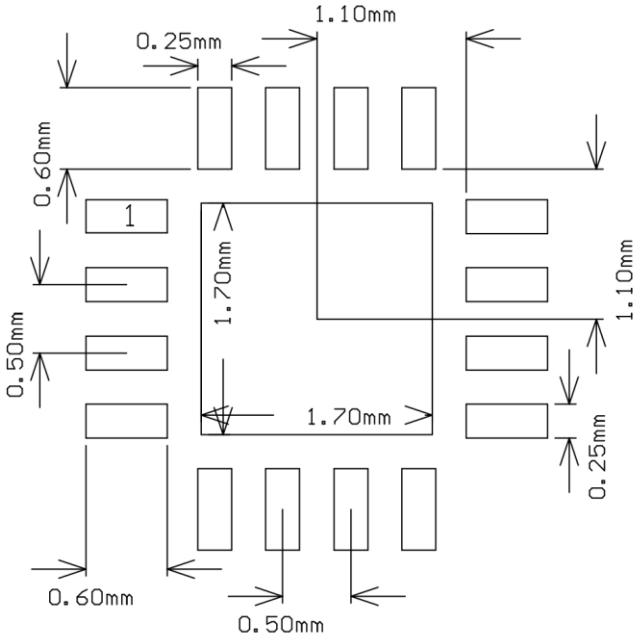
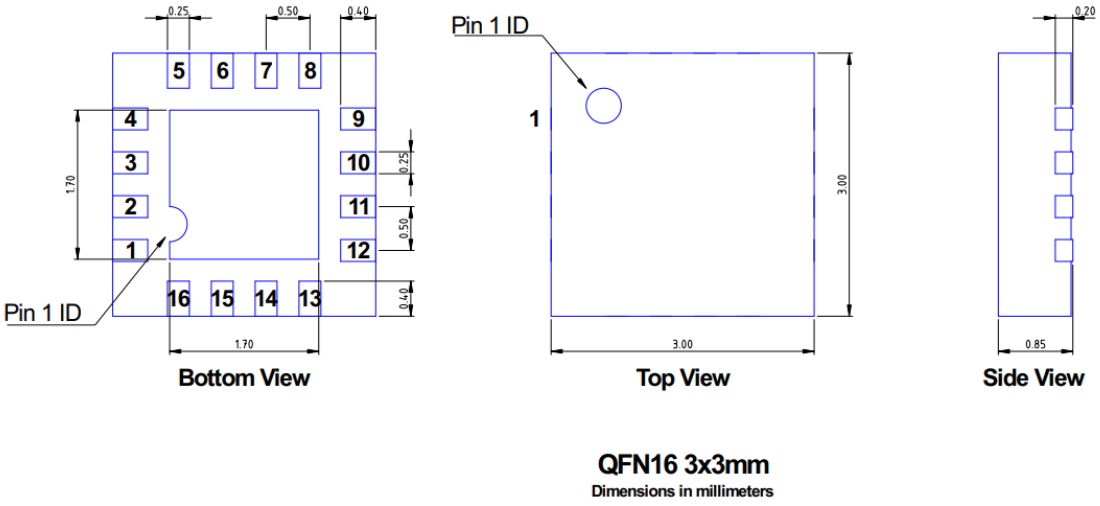
GRF5109 Bias Resistor Selection Curves





3 x 3 mm QFN-16 Suggested PCB Footprint (Top View)



3 x 3 mm QFN-16 Package Dimensions

Package Marking Diagram

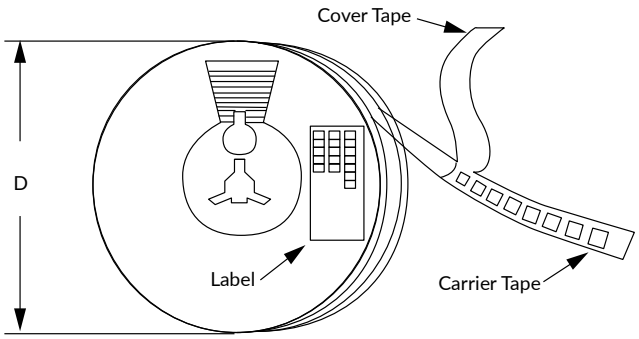
- Line 1: "XXXX" = Device PART NUMBER.
- Line 2: "YY" = YEAR. "WW" = WORK WEEK the Device was assembled.

Tape and Reel Information

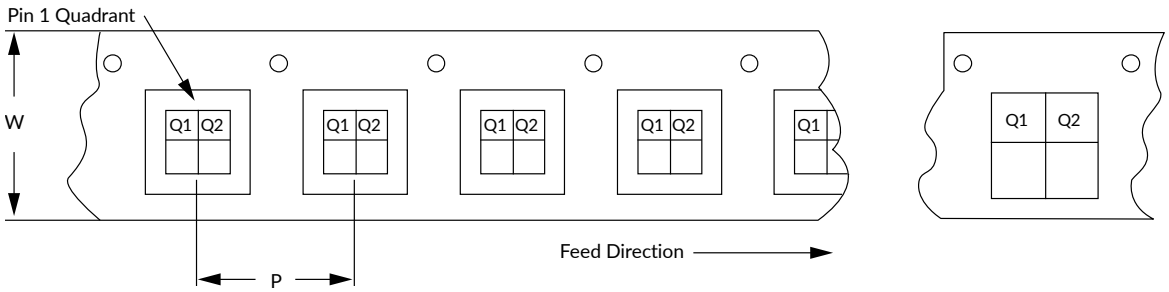
Guerrilla RF's tape and reel specification complies with Electronics Industries Association (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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
March 7, 2022	Updated to New Format. Updated Package Marking Diagram. Changed Revision from "Released" to "Release A".
March 18, 2022	Raised Supply Current (Leakage) "Max" from 150µA to 500µA. Raised Supply Current (Leakage) "Typical" from 30µA to 100µA.
March 24, 2023	Lowered I_{ENABLE} current typical value from 2.0 mA to 0.7 mA.

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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.