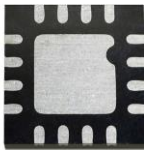
DATA SHEET

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 / 160 mA I_{DDQ} / 830 MHz

- 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

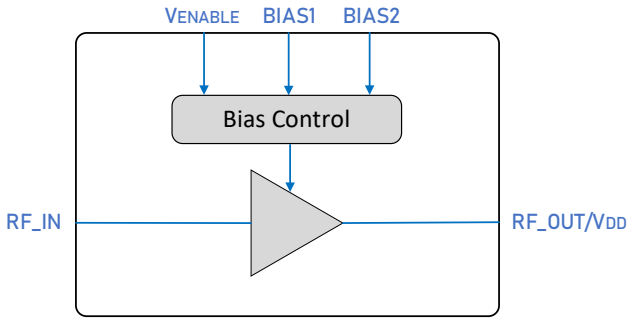
The GRF5109 is a high linearity PA/Linear Driver with low noise figure (NF). It delivers excellent P1dB, IP3 and noise figure (NF) over a wide range of frequencies with fractional bandwidths of roughly 5 to 10%.

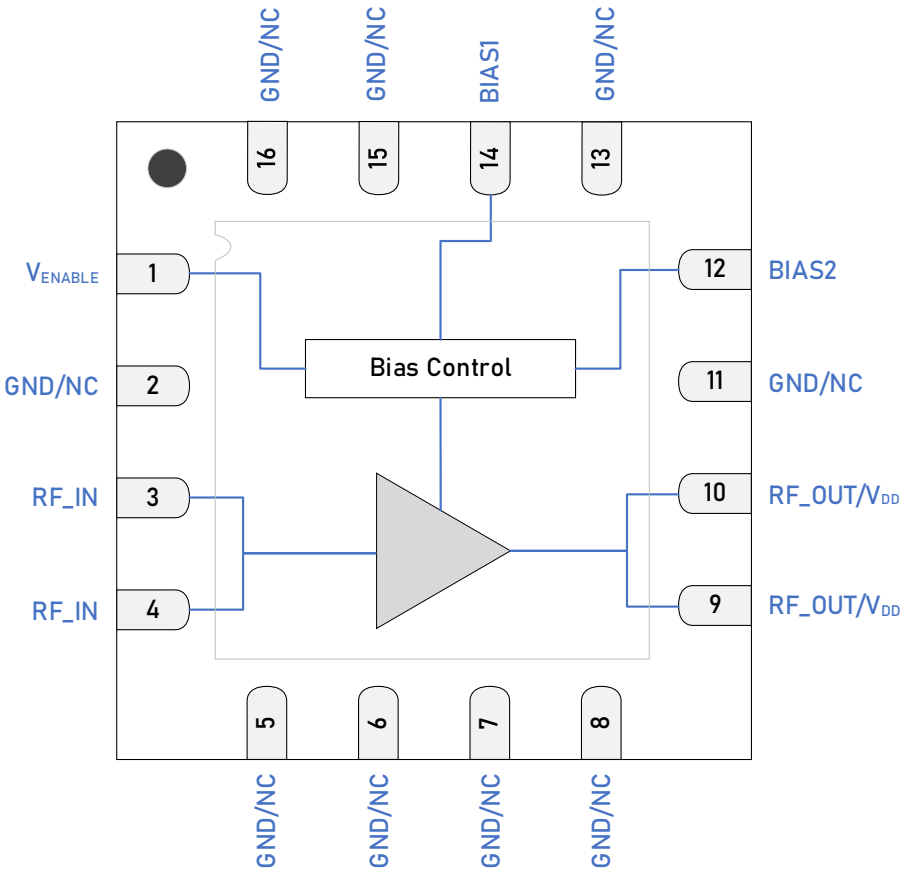
This device can be tuned over a wide range of frequencies from around 0.1 GHz up to 2.2 GHz.

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

Additional tunes can be found on the GRF5109 "Custom Tunes" product page: GRF5109 Custom Tunes

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 base)	$T_{PKG\ BASE}$	-40	105	°C
Maximum Channel Temperature (MTTF >10^6 Hours)	T_{MAX}		170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		1.0	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 base)	$T_{PKG\ BASE}$	-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 **(notes 1 & 2)**.
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 of this range is supported by using different custom tunes. Examples of other optimized tunes can be found here: GRF5109 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 0.96 GHz tuning set, I_{DDQ} = 160 mA, F_{TEST} = 0.83 GHz, M1 = 5.5 kΩ, M10 = 230 Ω, M13 = 475 Ω, 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 Quiescent Current	I_{DDQ}		160	190	mA	V_{DD} = V_{ENABLE} = 5 V, R_{BIAS} = 5.5 kΩ.
Operating Temperature Range	$T_{PKG\ BASE}$	-40		+105	°C	Measured on package base.
Switching Rise Time	T_{RISE}		100		ns	Bypass mode to Gain mode **(note 3)**.
Switching Fall Time	T_{FALL}		800		ns	Gain mode to Bypass mode **(note 4)**.
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 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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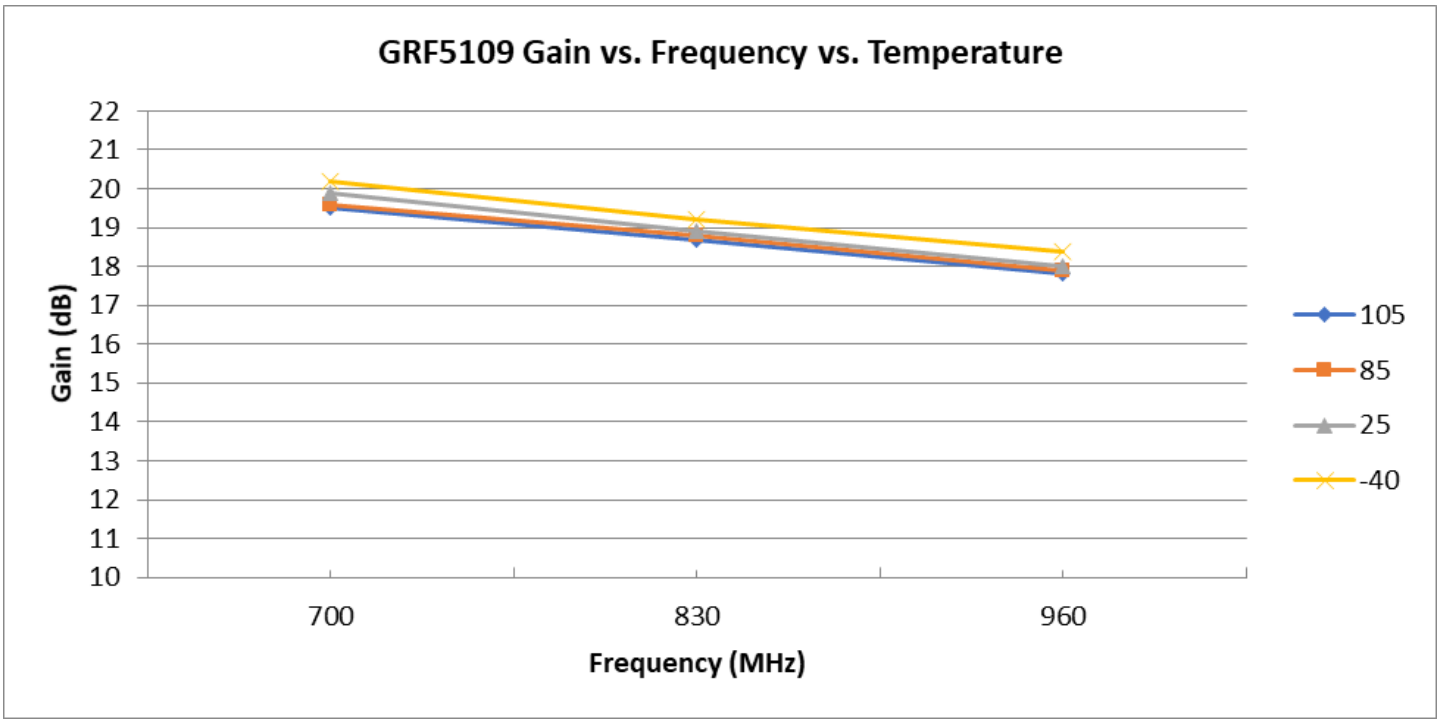
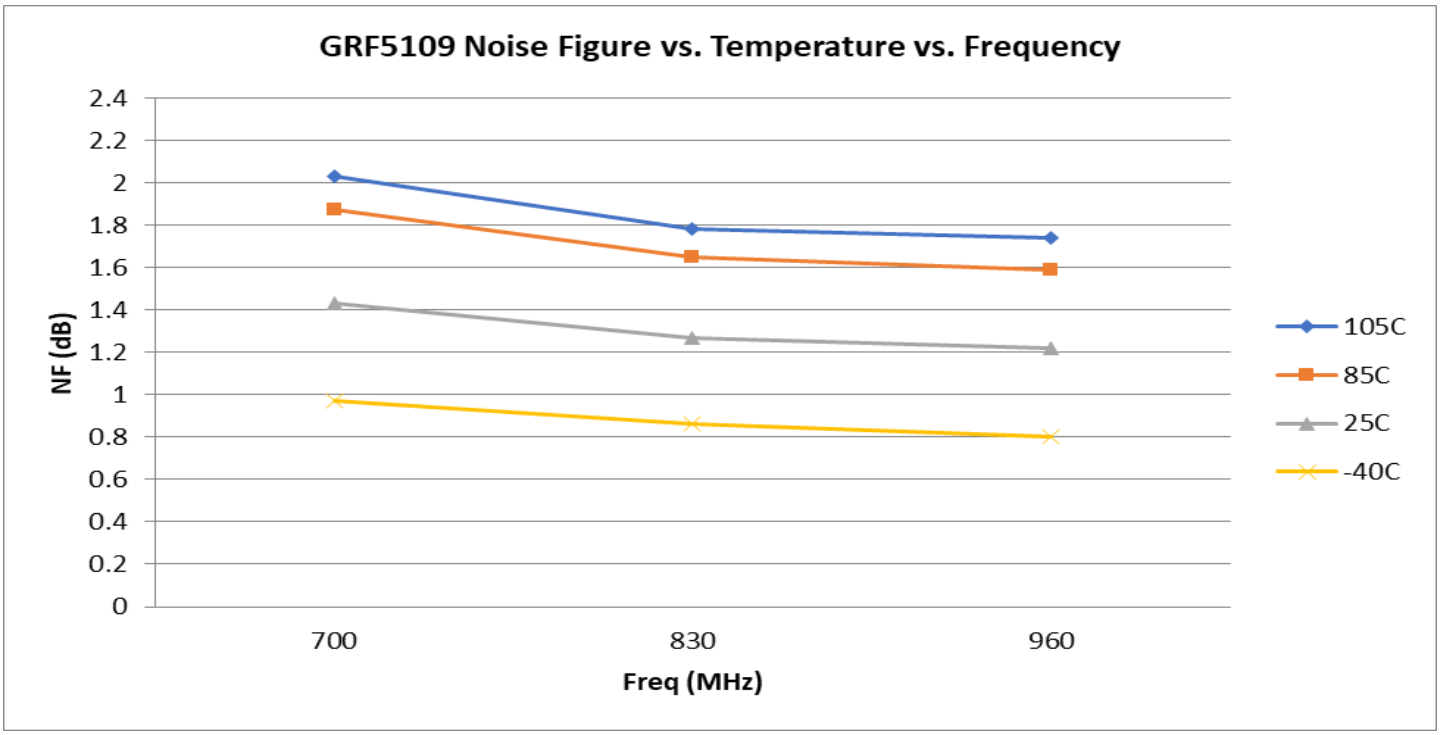
Nominal Operating Parameters – RF: 0.7 to 0.96 GHz, 5 V

The following conditions apply unless noted otherwise: typical application schematic using the 0.7 to 0.96 GHz tuning set, I_{DDQ} = 160 mA, F_{TEST} = 0.83 GHz, M1 = 5.5 kΩ, M10 = 230 Ω, M13 = 475 Ω, 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.		
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.
Noise Figure	NF		1.3		dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		43.5		dBm	
Output 1 dB Compression Power	OP1dB	26.8	28.5		dBm	

GRF5109 Typical Operating Curves: 0.7 to 0.96 GHz Tune





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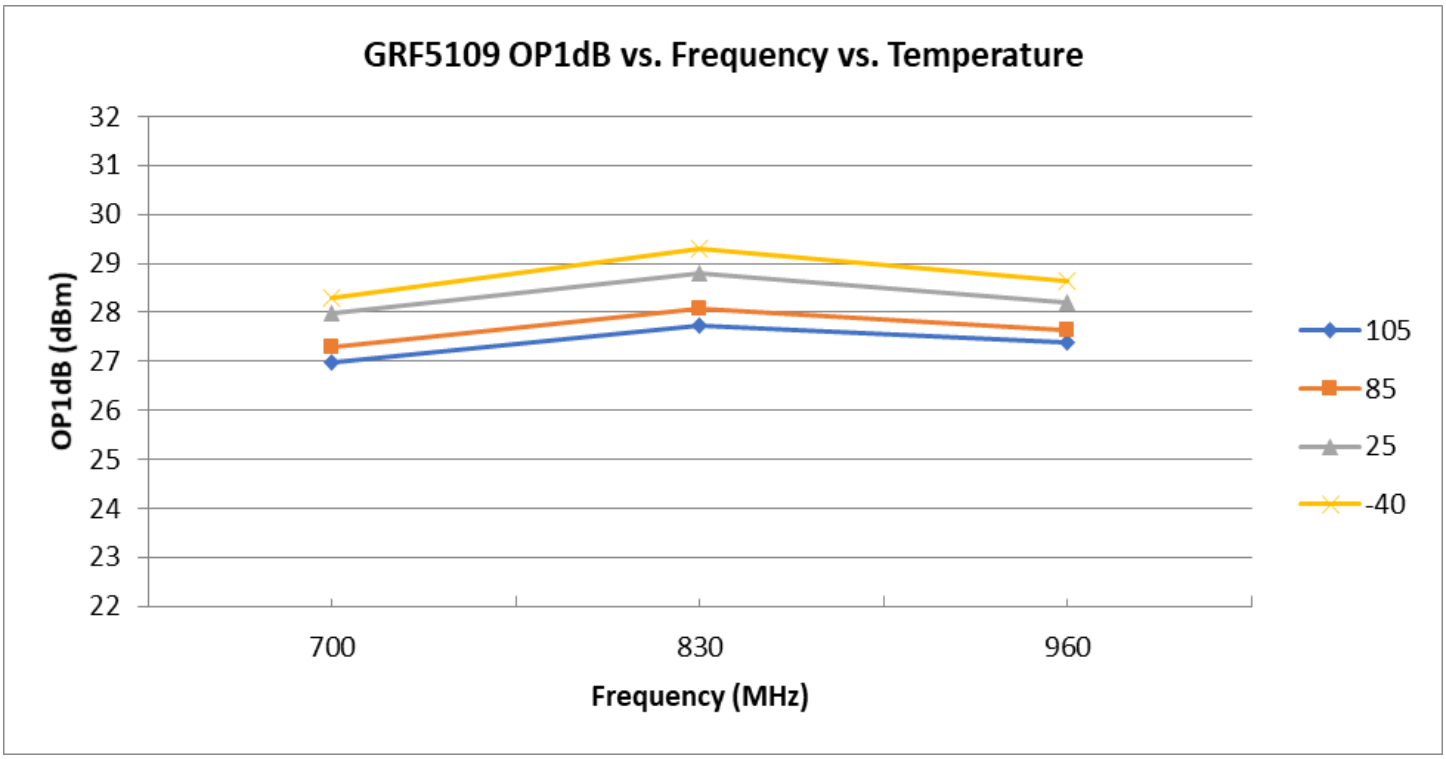
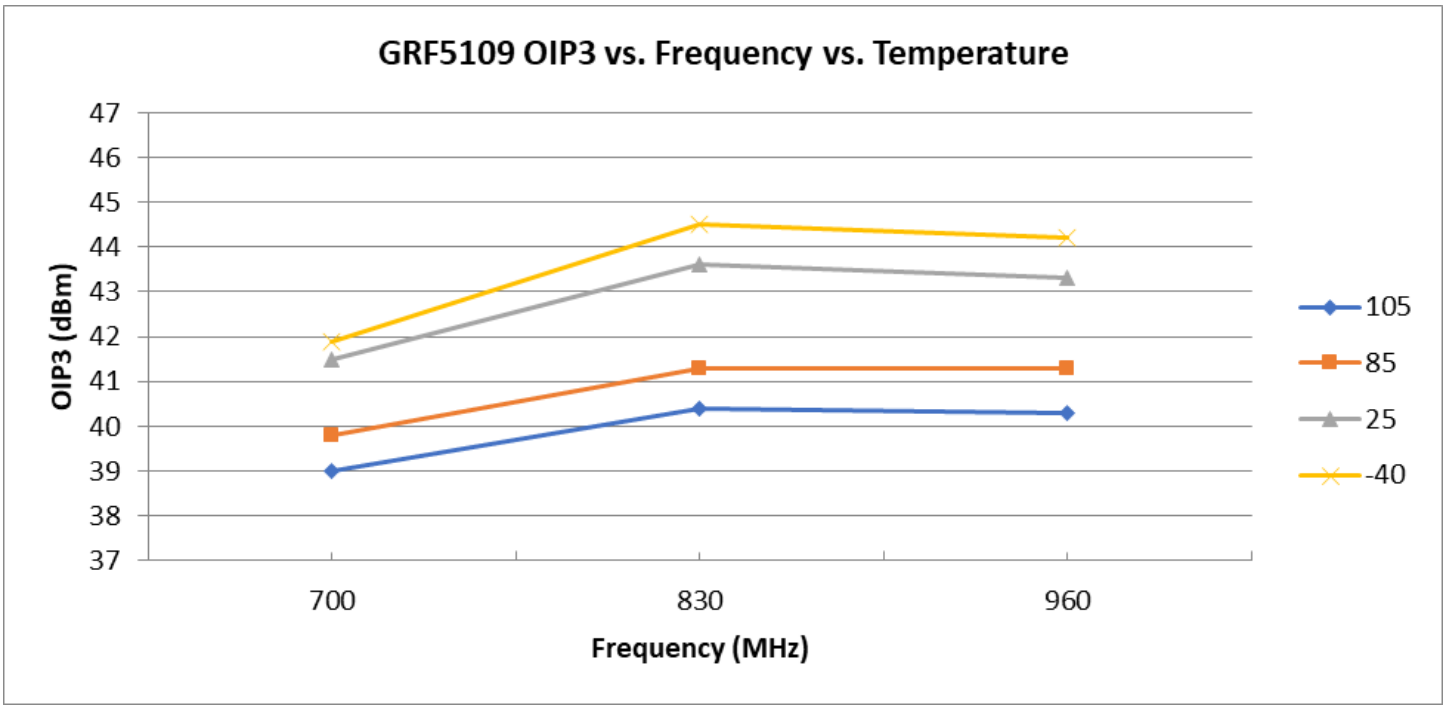
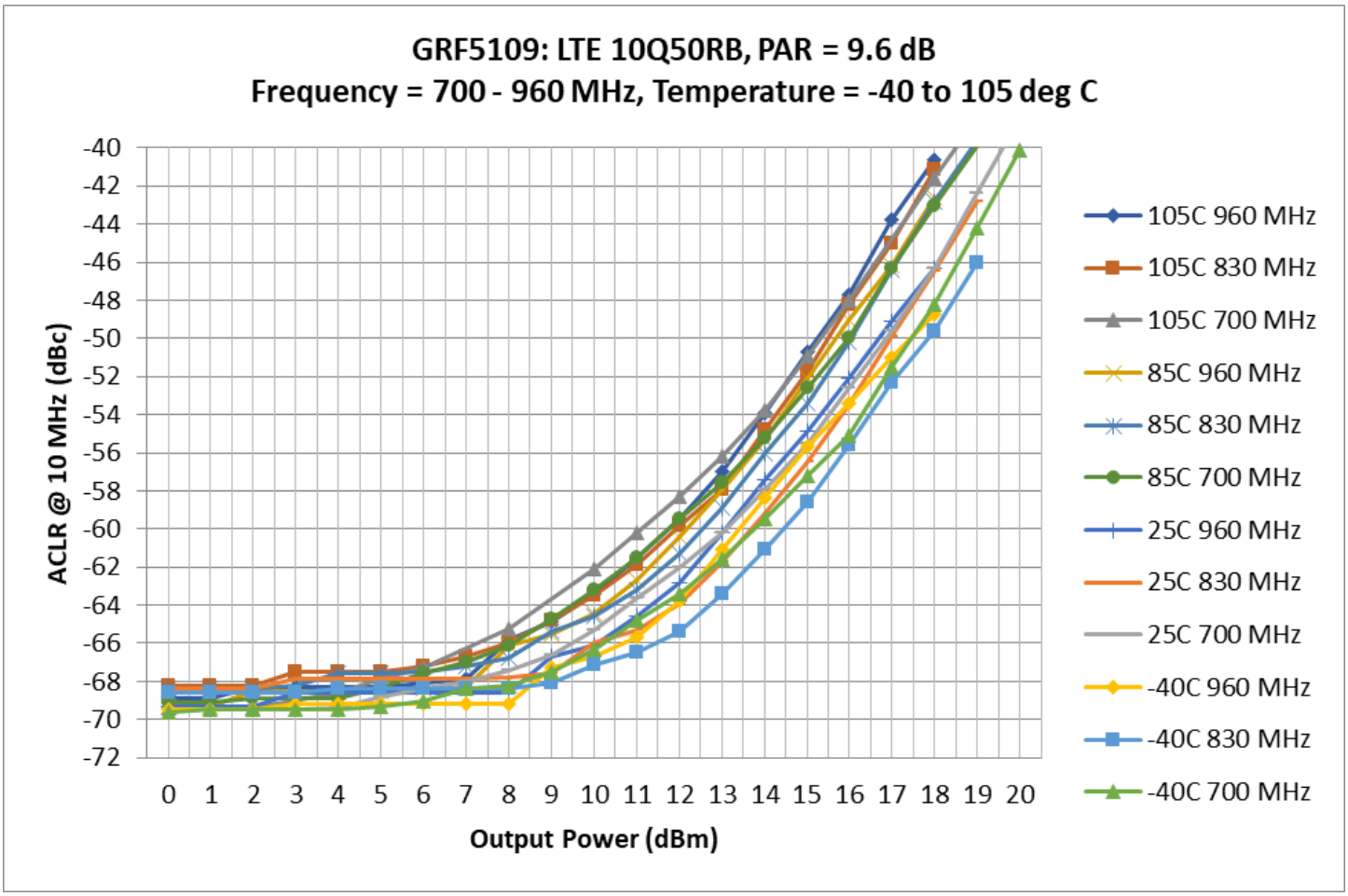
GRF5109 Typical Operating Curves: 0.7 to 0.96 GHz Tune





GRF5109 Typical Operating Curves: 0.7 to 0.96 GHz Tune



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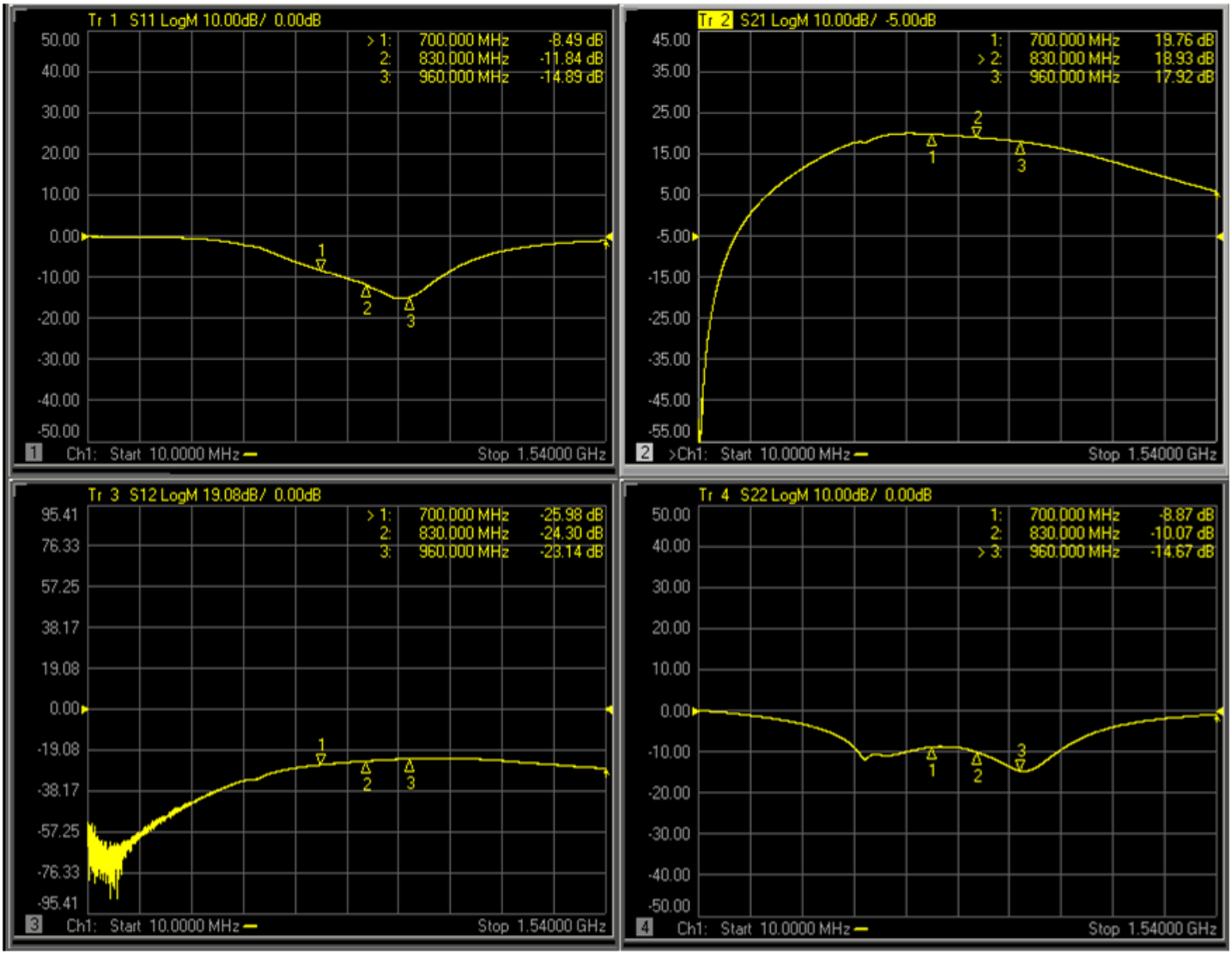
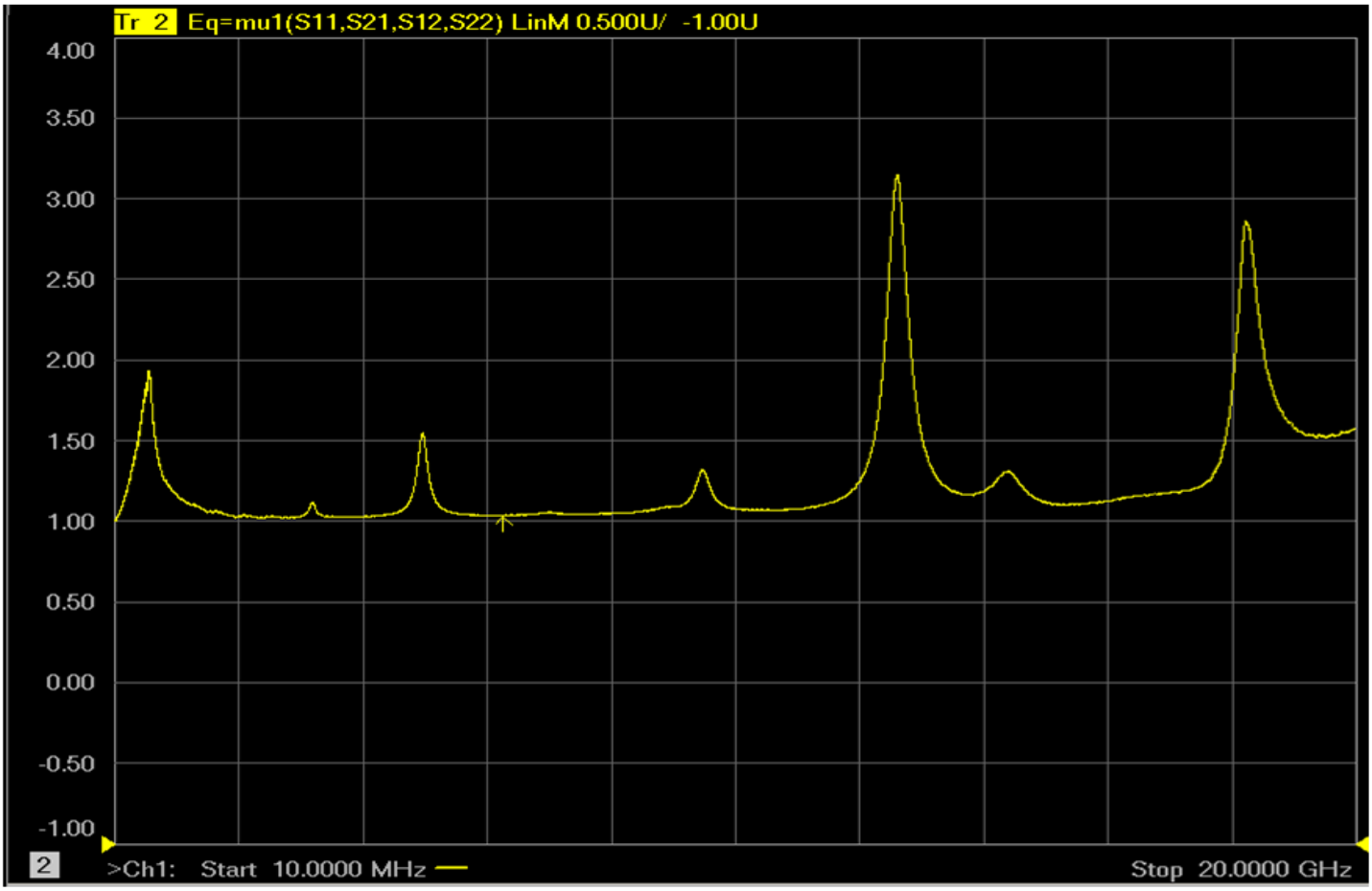
GRF5109 Typical Operating Curves: S-Parameters (0.7 to 0.96 GHz Tune)



GRF5109 Typical Operating Curves: Stability Mu (10 MHz to 20 GHz)



Note: Mu factor ≥ 1.0 implies unconditional stability

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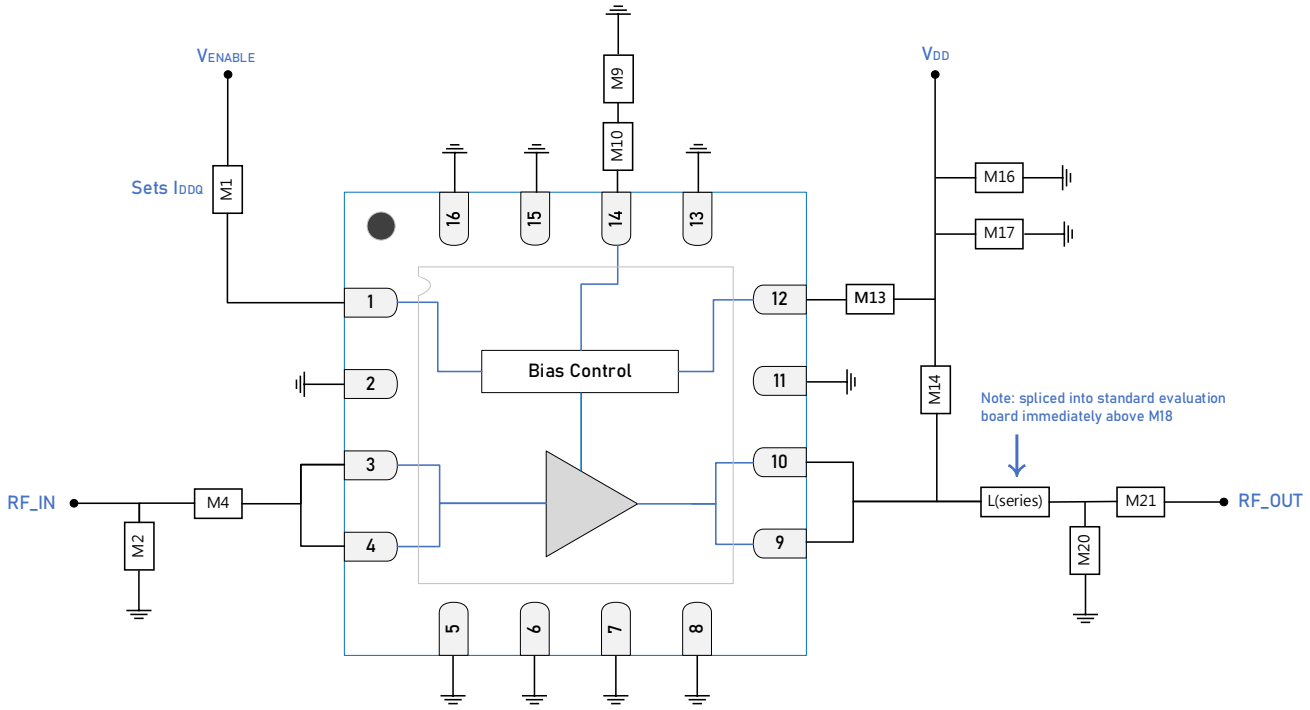
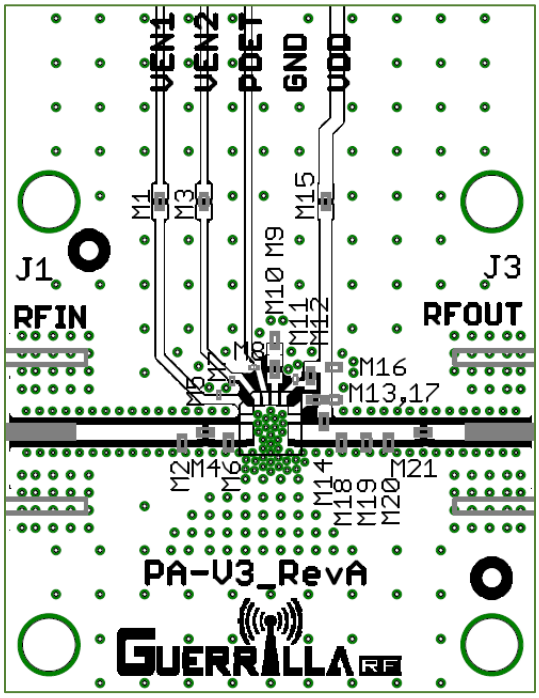


GRF5109 Standard Evaluation Board Schematic

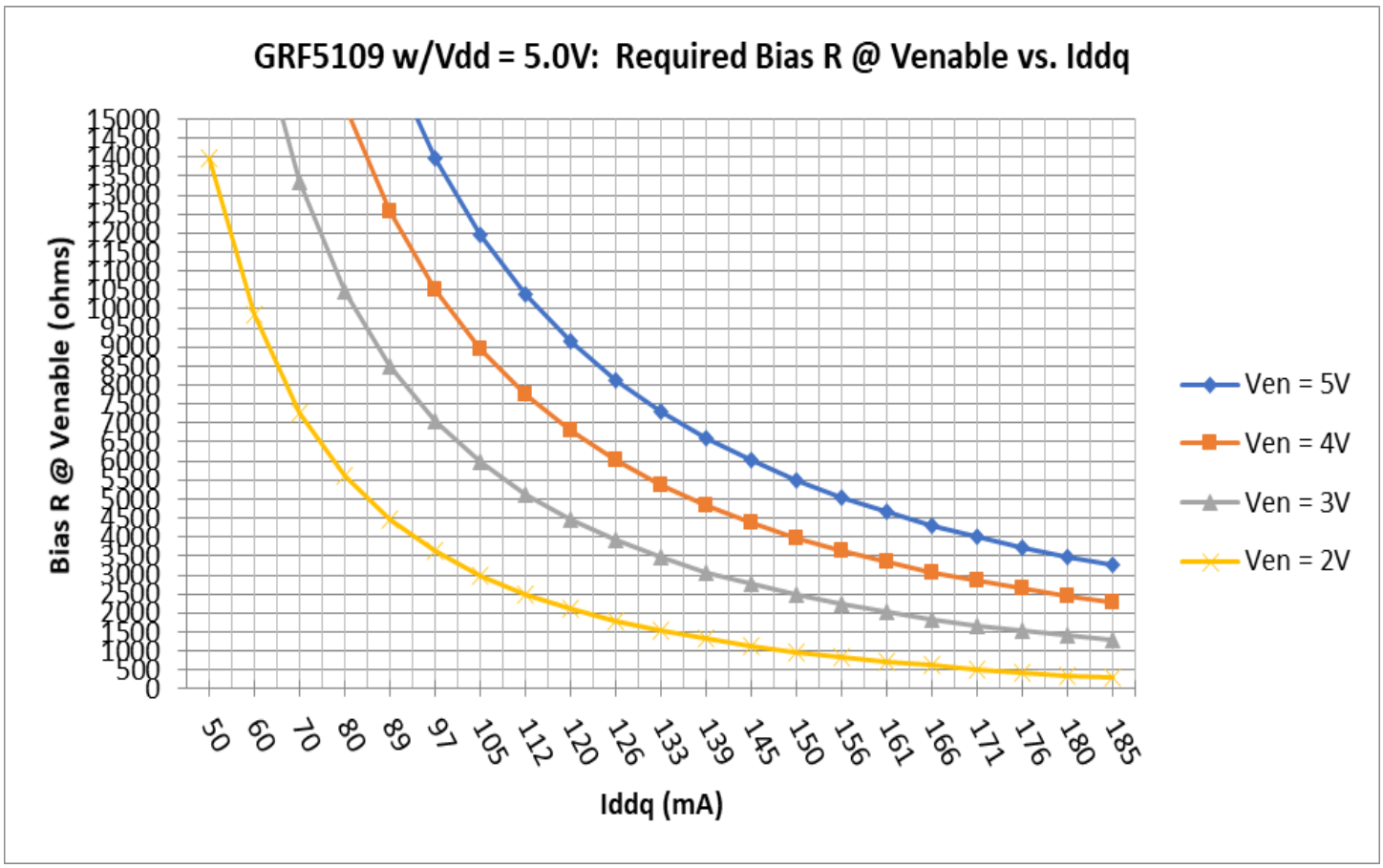


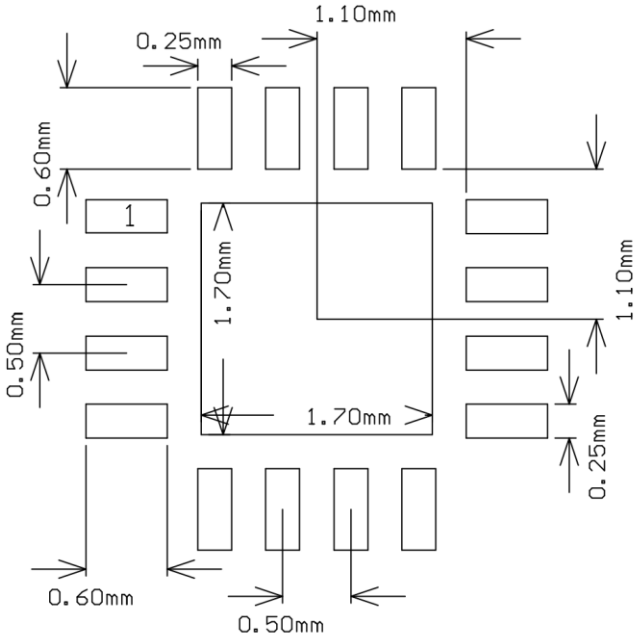
GRF5109 Evaluation Board Assembly Diagram

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

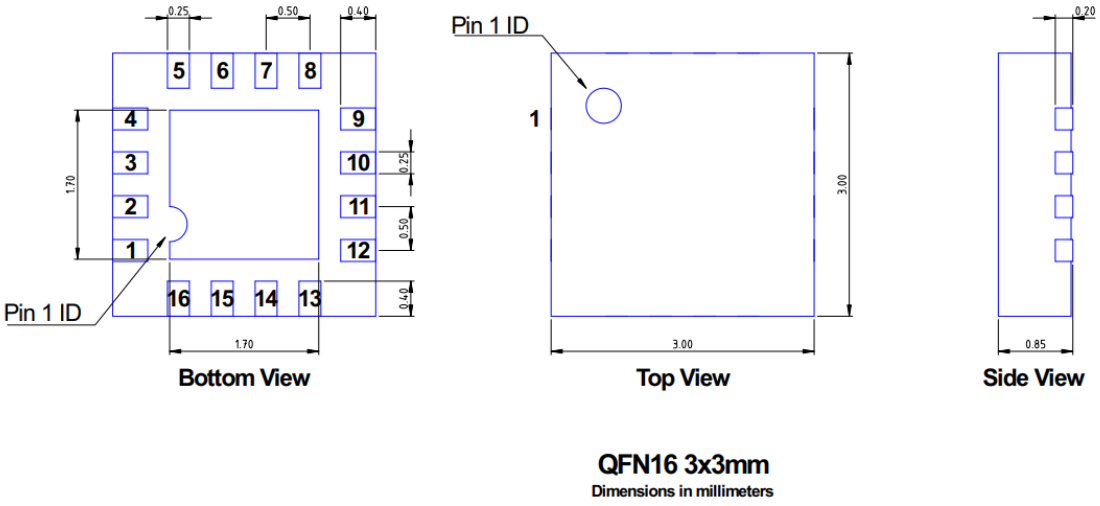
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1 (sets I_{DDQ})	Resistor	Various	5%	see curves	0402	ok
M2	Inductor: High Q	Coilcraft	HP	5.1 nH	0402	ok
M4	Capacitor: High Q	Murata	GJM	12.0 pF	0402	ok
M9	Inductor	Murata	LQG	39 nH	0402	ok
M10	Resistor	Various	5%	230 Ω	0402	ok
M13	Resistor	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					

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

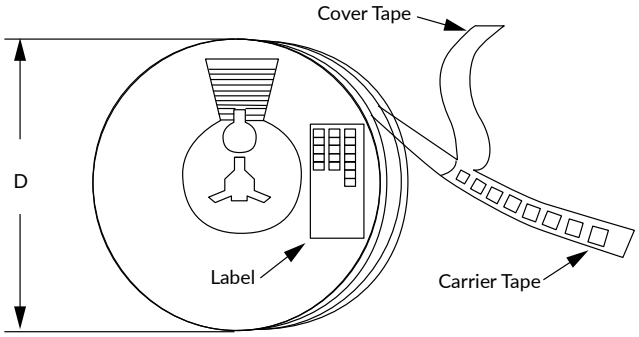
- Line 1: "XXXX" = Device PART NUMBER.
- Line 2: "YY" = YEAR. "WW" = WORK WEEK the Device was assembled.

Tape and Reel Information

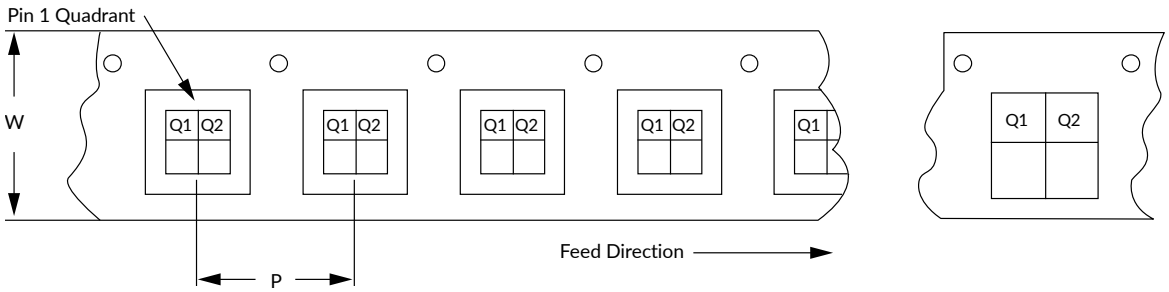
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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: *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
April 10, 2018	Releaase Ø Data Sheet.
March 7, 2022	Releasae A Data Sheet. Upgraded Data Sheet to new format. Updated Package Marking Diagram.
March 18, 2022	Raised Supply Current (Leakage) "Max" from 150 µA to 500 µA. Raised Supply Current (Leakage) "Typical" from 30 µA to 100 µA.
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 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.