

GRF5020

30.5 dBm Power-LNA™ 0.03 to 6 GHz

FEATURES

- Excellent OP1dB, OIP3, and NF Performance
- Flexible Bias Voltage and Current
- 95 mA Native Mode Quiescent Current Consumption
- -40 to 115 °C Operating Temperature Range
- Process: GaAs pHEMT
- Compact 3 x 3 mm QFN-16 Package

Reference: 8 V / 95 mA / 2.5 GHz

- Gain: 18 dB
- OIP3: 43 dBm
- OP1dB: 29 dBm
- Noise Figure: 0.85 dB

Reference: 5 V / 65 mA / 2.5 GHz

- Gain: 17.3 dB
- OIP3: 37.2 dBm
- OP1dB: 24.5 dBm
- Noise Figure: 0.8 dB

APPLICATIONS

- Multi-Stage LNA
- Linear Driver Amplifier for High PAR Waveforms
- Distributed Antenna Systems
- Microwave Backhaul

DESCRIPTION

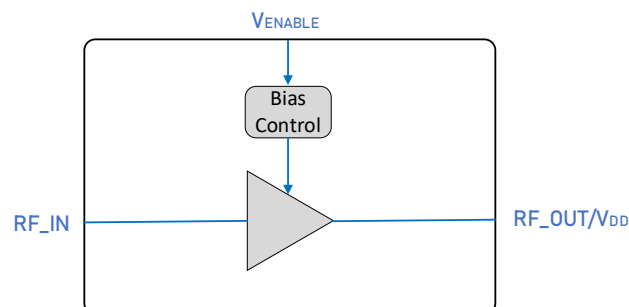
The GRF5020 is a high linearity Power-LNA with ultra-low noise figure (NF). The primary tune for this device covers 1.7 to 2.7 GHz. It achieves outstanding P1dB, IP3 and NF over the band. The device can be tuned to deliver outstanding performance over 0.03 GHz to 6.0 GHz with fractional bandwidths > 30%. With a 10 volt supply, the device can deliver broadband OP1dB values > 30 dBm.

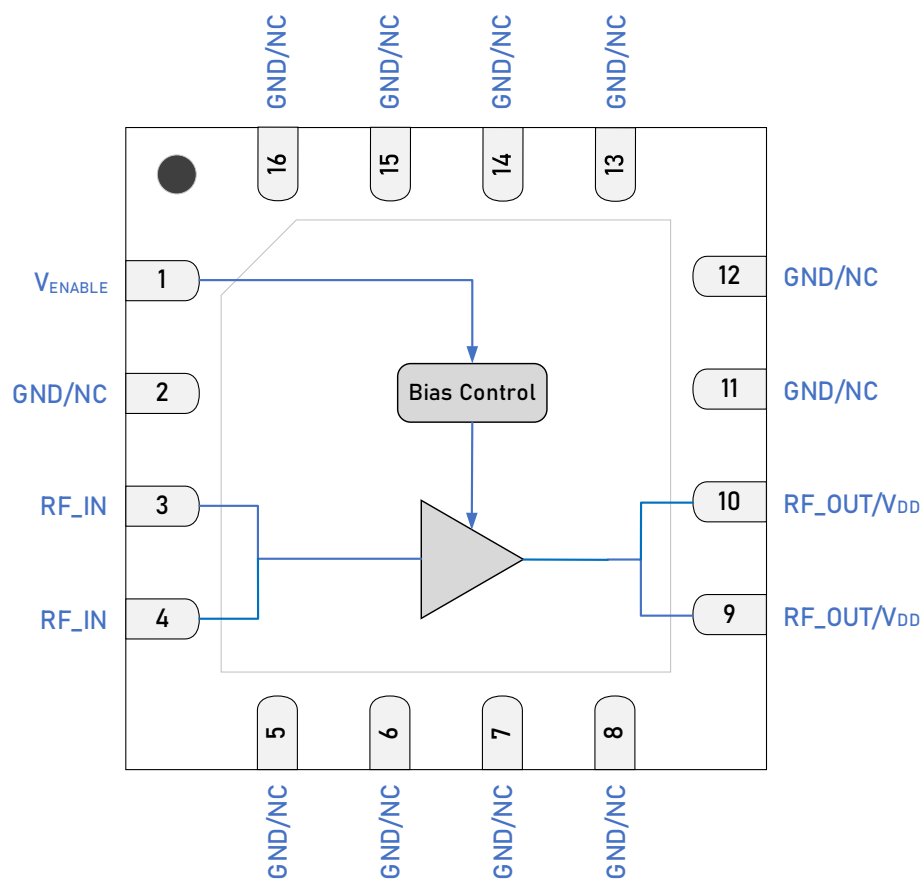
In addition to use as a PA or linear driver, GRF5020 is well suited to demanding first, second or third stage LNA applications requiring high linearity, ruggedness, and low NF.

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 GRF5020 "Custom Tunes" product page: [GRF5020 Custom Tunes](#)

BLOCK DIAGRAM





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

Pin Assignments

Pin	Name	Description	Note
1	V _{ENABLE}	Enable Voltage Input	V _{ENABLE} and series resistor set I _{DDQ} . V _{ENABLE} ≤ 0.2 V disables device.
2, 5, 6, 7, 8, 11, 12, 13, 14, 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. V _{DD} must be applied to this pin via an RF choke.
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}	0	12	V
Transient Average RF Input Power CW: Load VSWR < 2:1; Duration: < 1 hour	$P_{IN\ MAX}$		22	dBm
Operating Temperature (Package Base)	$T_{PKG\ BASE}$	-40	115	°C
Maximum Channel Temperature (MTTF > 10 ⁶ hours)	T_{MAX}		170	°C
Maximum Dissipated Power at 105 °C	$P_{DISS\ MAX}$		1.9	W
Maximum Dissipated Power at 115 °C	$P_{DISS\ MAX}$		1.6	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 to the device.

Note: For additional information, please refer to [Package Manufacturing Information | Guerrilla RF \(guerrilla-rf.com\)](https://www.guerrilla-rf.com/package-manufacturing-information)



All Guerrilla RF products are provided in RoHS compliant lead (Pb)-free packaging. For additional information, please refer to the [ROHS Compliance | Guerrilla RF \(guerrilla-rf.com\)](https://www.guerrilla-rf.com/rohs-compliance)

Recommended Operating Conditions

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Voltage	V _{DD}	2.7	8	12	V	
Operating Temperature (Package Base)	T _{PKG BASE}	-40		115	°C	
RF Frequency Range	F _{RF}	0.03	2.5	6	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: [GRF5020 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 0.1 to 3.8 GHz tuning set, $V_{DD} = 8\text{ V}$, $I_{DDQ} = 95\text{ mA}$, $M1 = 5\text{ k}\Omega$, $F_{TEST} = 2.5\text{ GHz}$, $50\text{ }\Omega$ system impedance, $T_{PKG\text{ BASE}} = 25\text{ }^{\circ}\text{C}$. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Quiescent Current	I_{DDQ}		95		mA	
Enable Current	I_{ENABLE}		2.0		mA	
Operating Temperature Range	$T_{PKG\text{ BASE}}$	-40		115	$^{\circ}\text{C}$	
Switching Rise Time	T_{RISE}		200		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_{DD}		300	600	μA	
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Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		43		$^{\circ}\text{C}/\text{W}$	On standard evaluation board (note 5).
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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} .

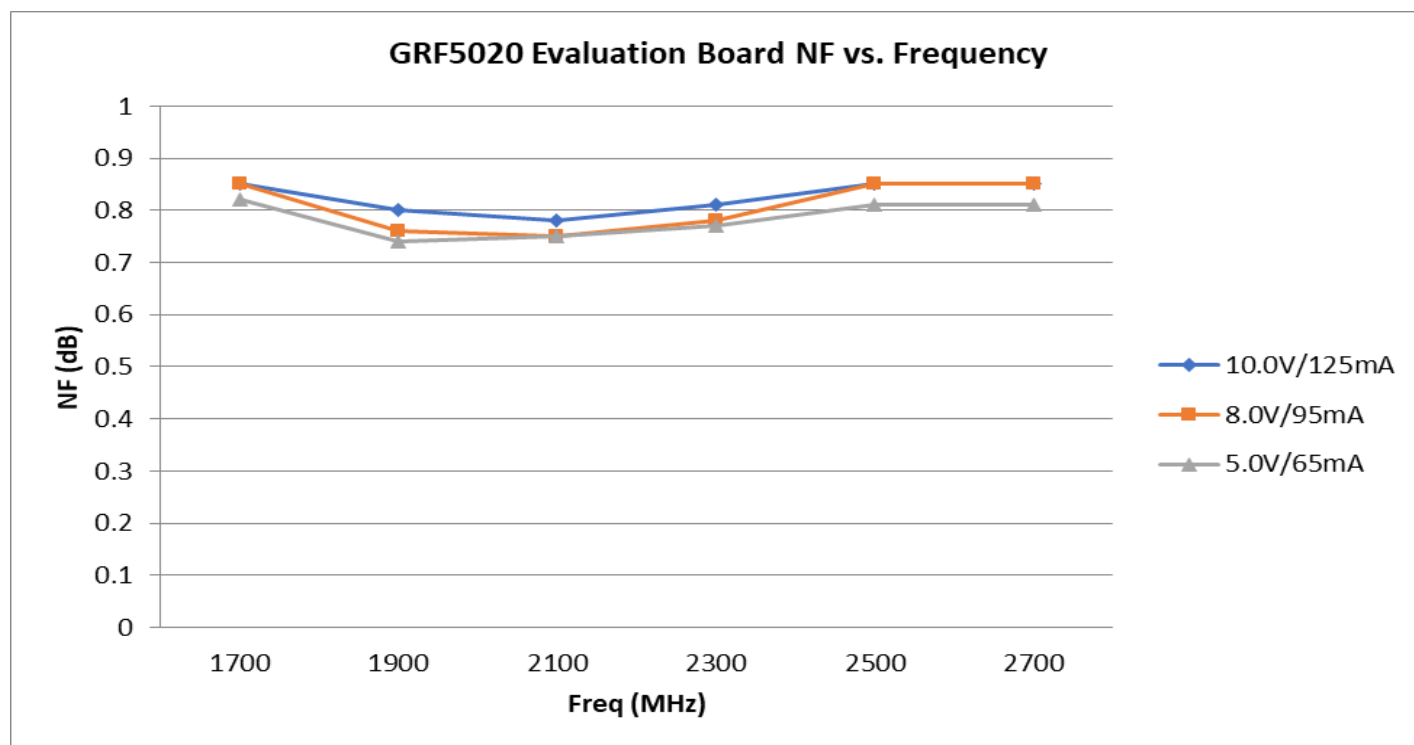
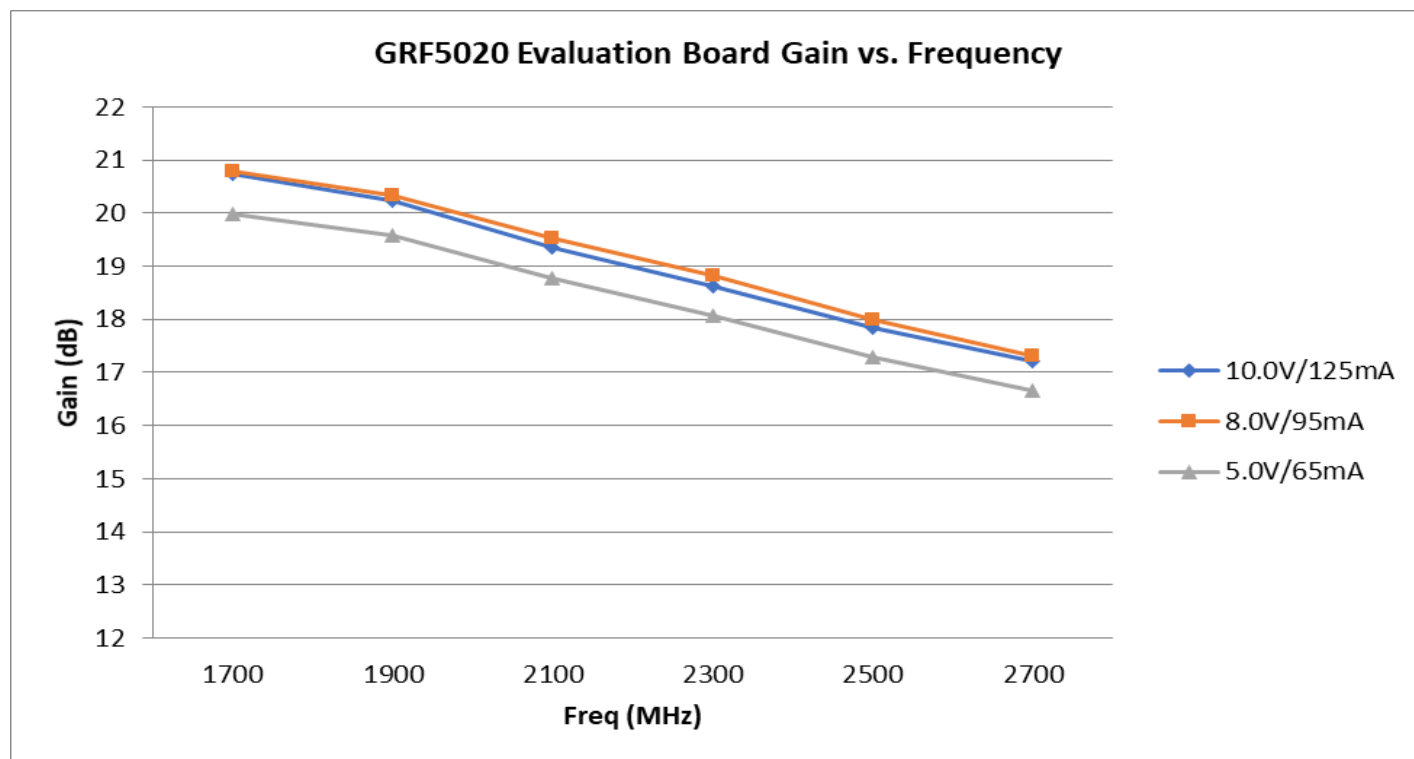
Note 5: MTTF > 10^6 hours for $T_{CHANNEL} \leq 170\text{ }^{\circ}\text{C}$.

Nominal Operating Parameters – RF

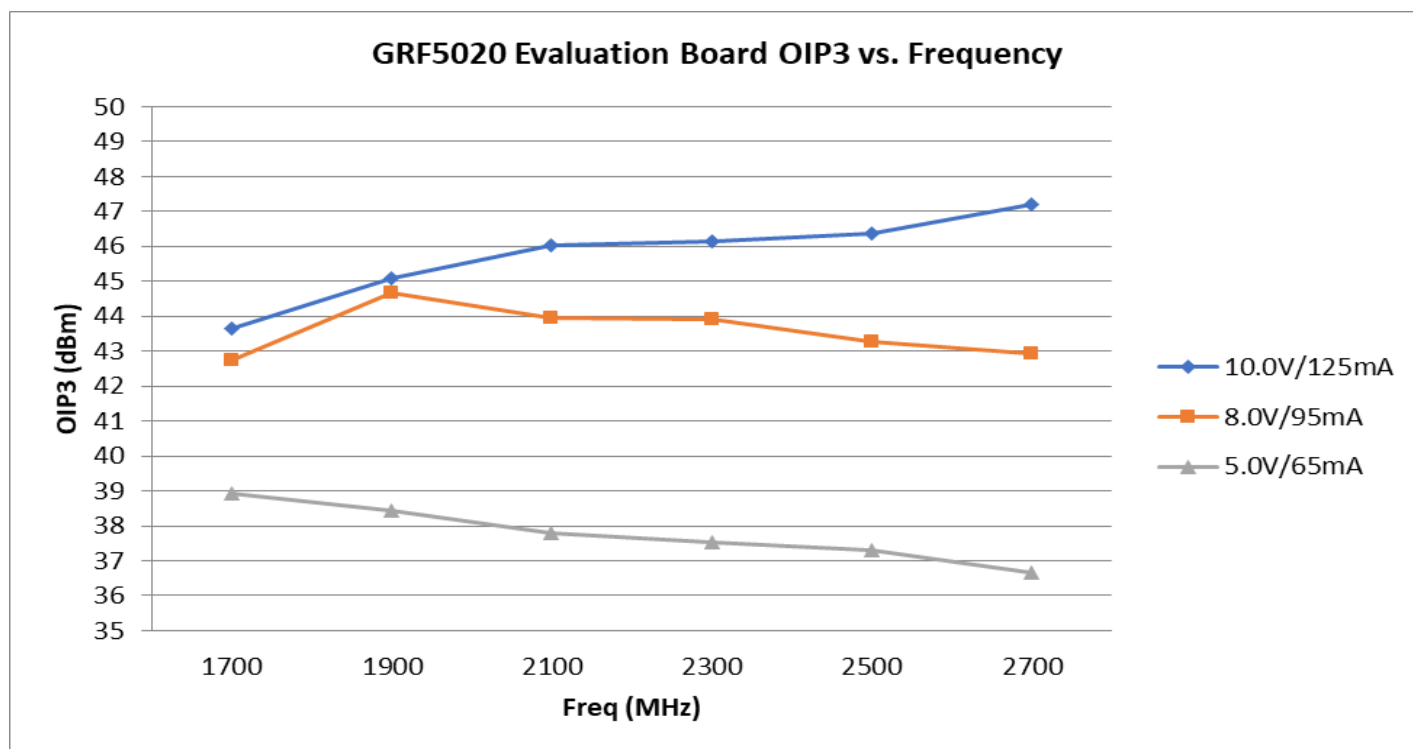
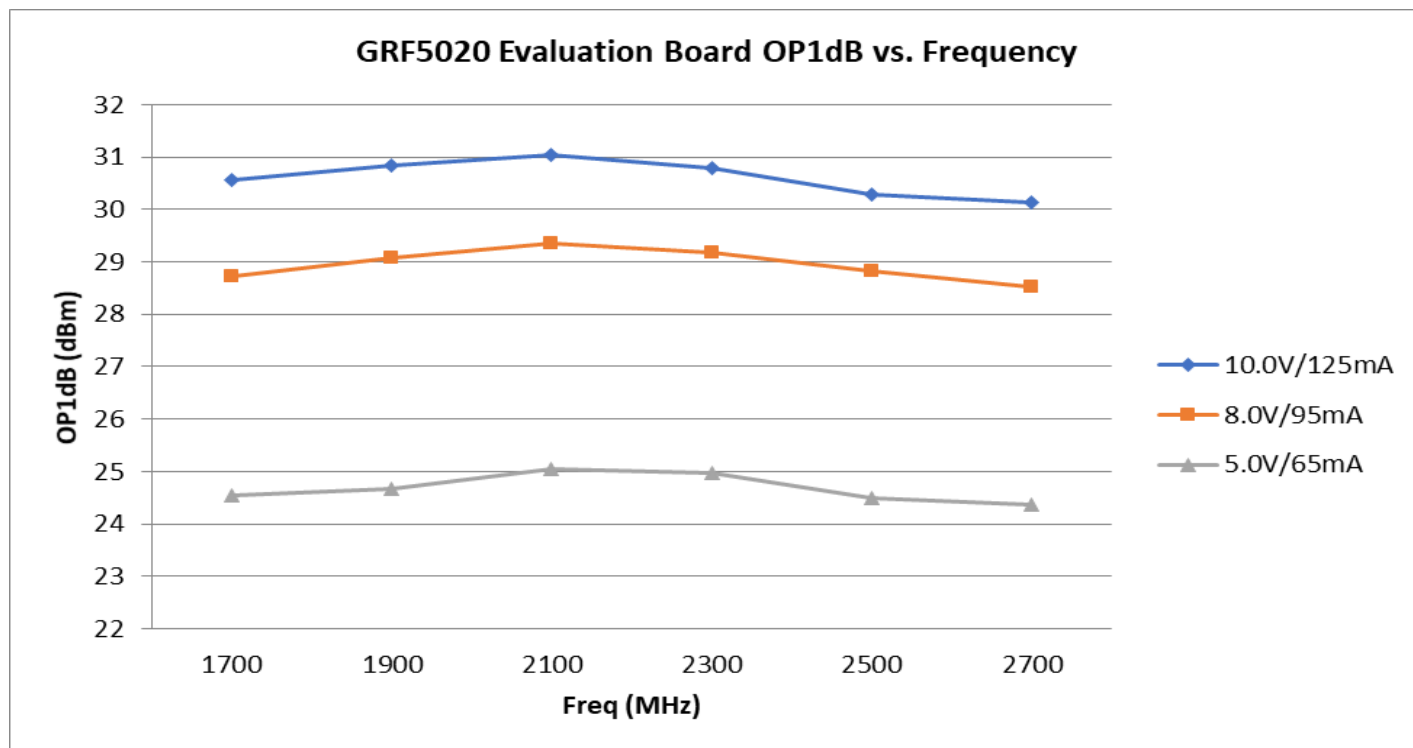
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Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Small Signal Gain	S21	16	17.5		dB	
Reverse Isolation	S12		< -25		dB	$F_{RF} = 1.7\text{ to }2.7\text{ GHz}$.
Noise Figure	NF		0.85	1.05	dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		43		dBm	8 dBm P_{OUT} per tone at 2 MHz spacing (2499 and 2501 MHz).
Output 1 dB Compression Power	OP1dB	27.5	29		dBm	

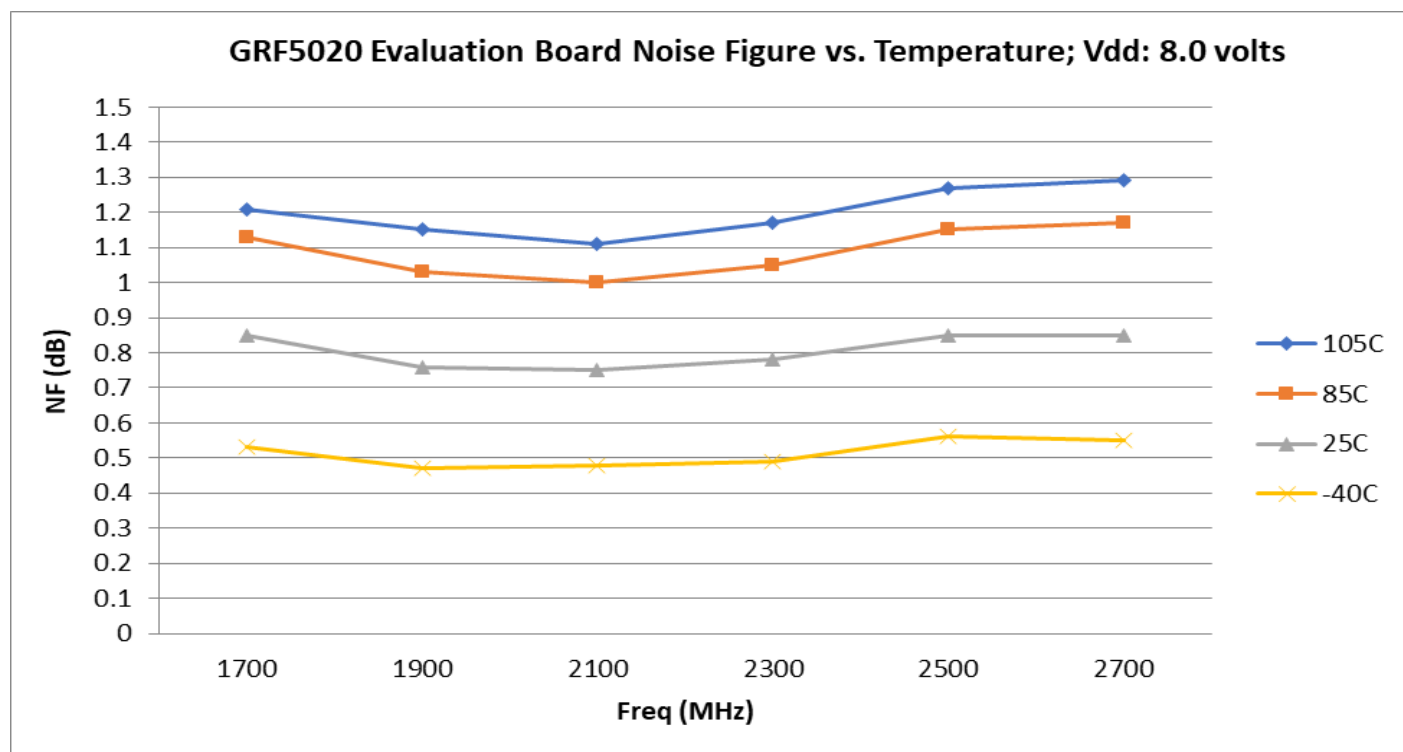
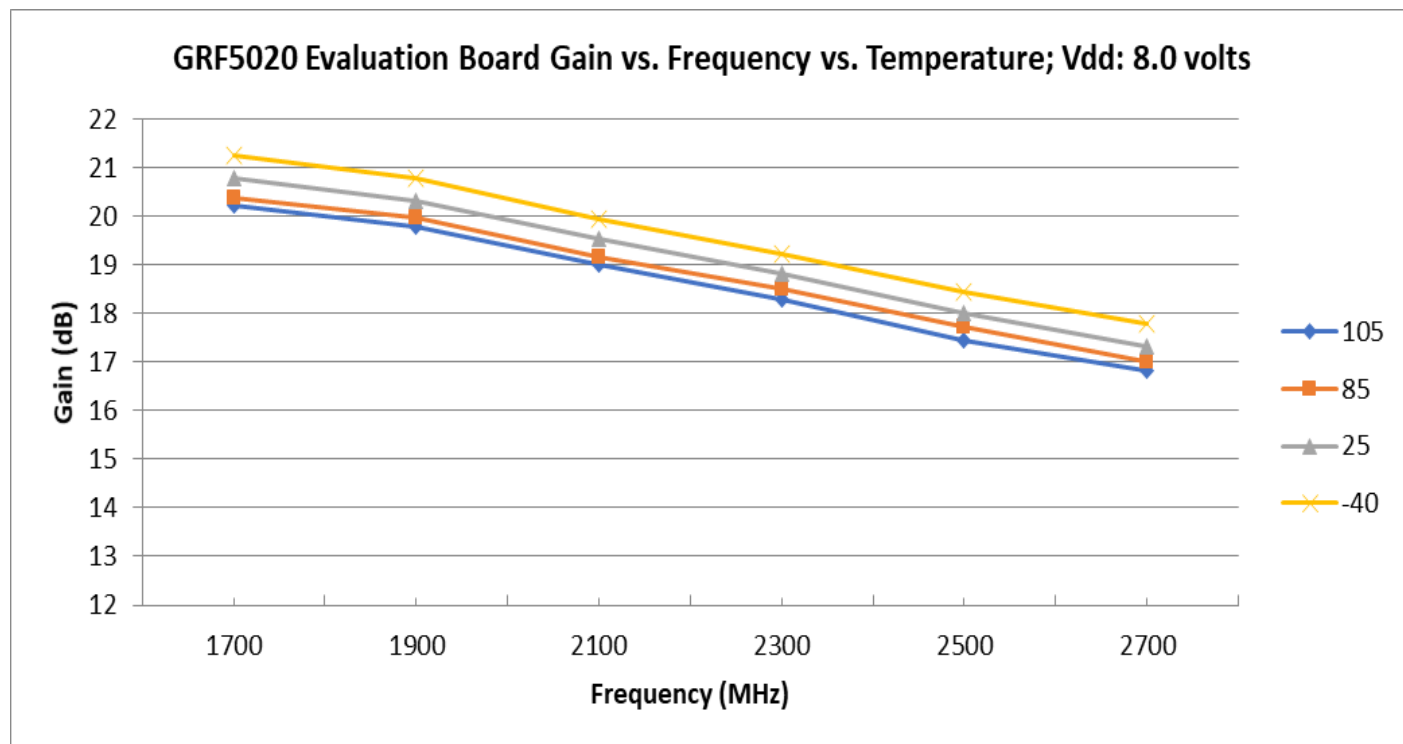
GRF5020 Typical Operating Curves: 1.7 to 2.7 GHz Tune



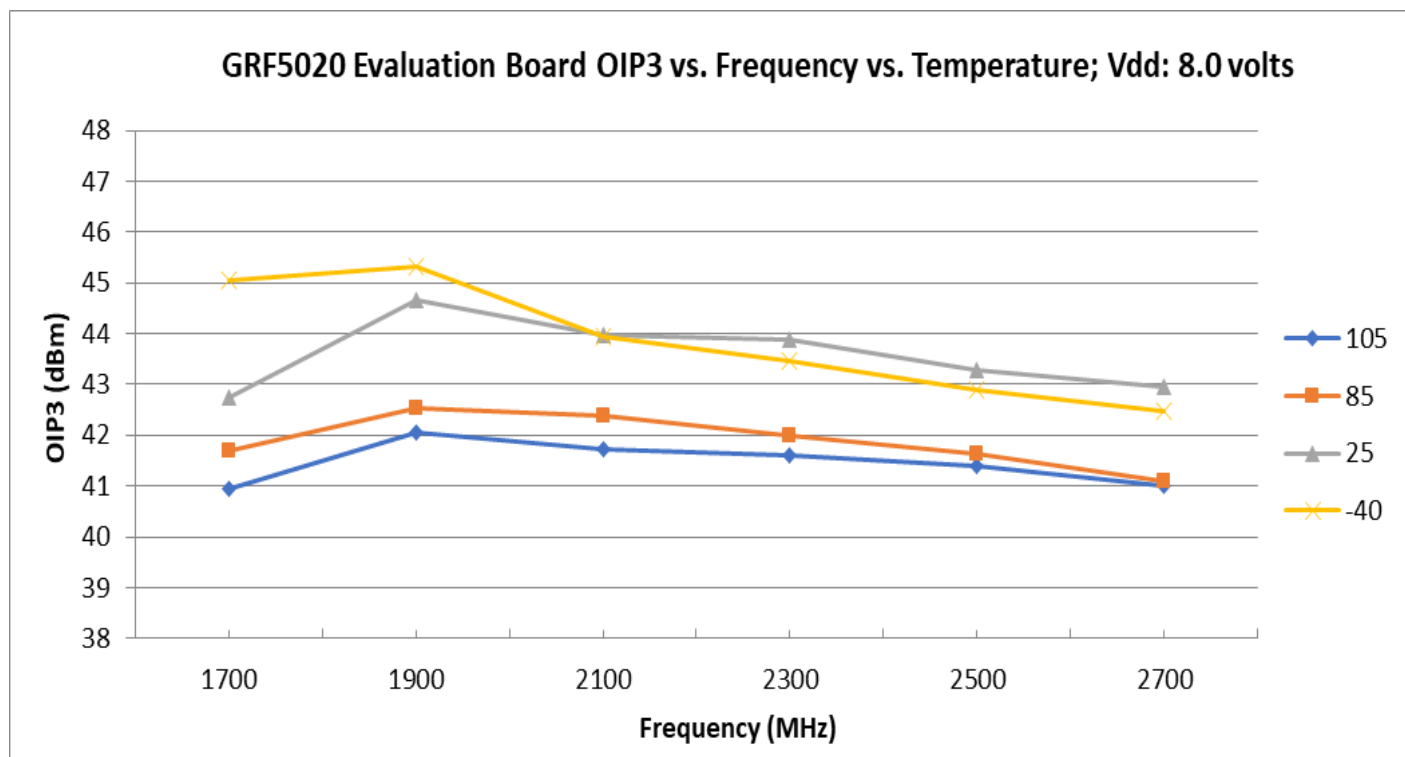
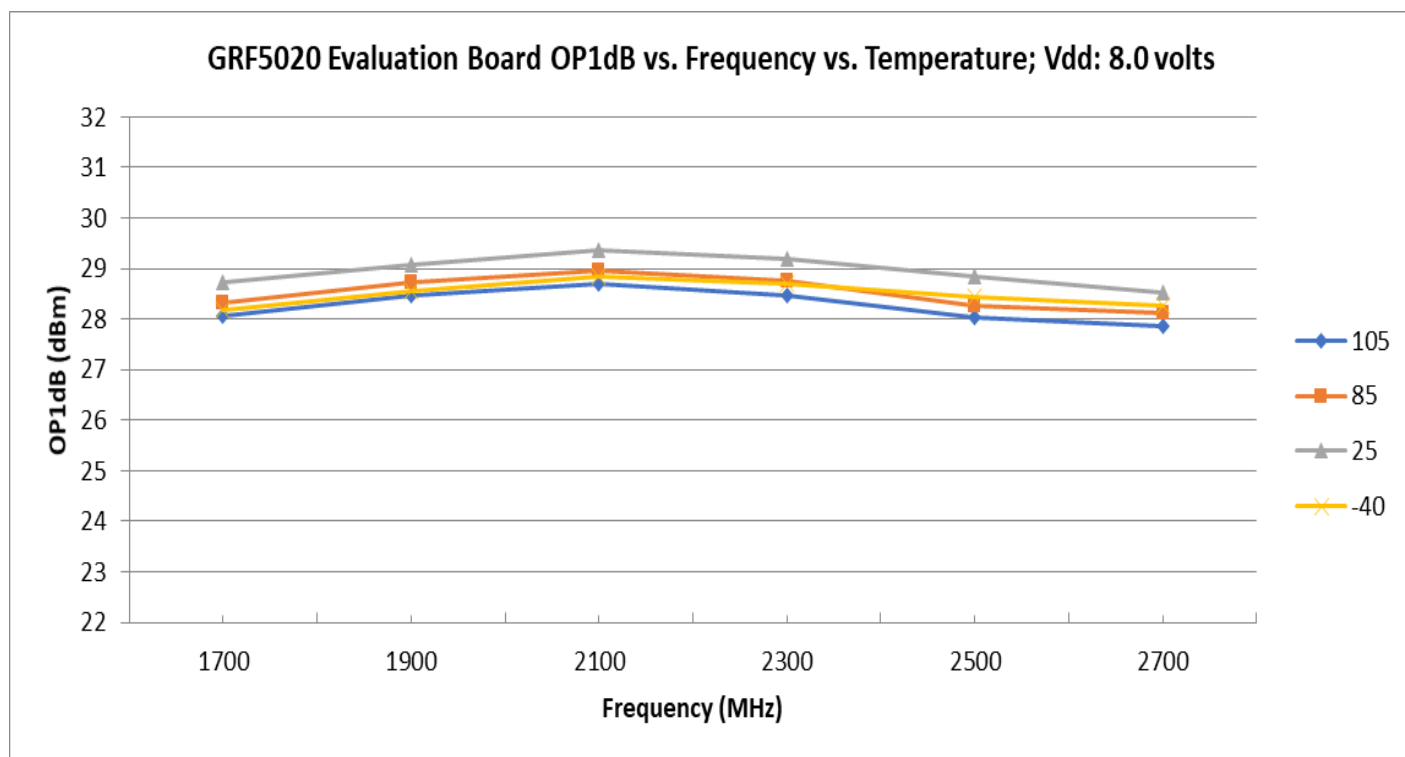
GRF5020 Typical Operating Curves: 1.7 to 2.7 GHz Tune



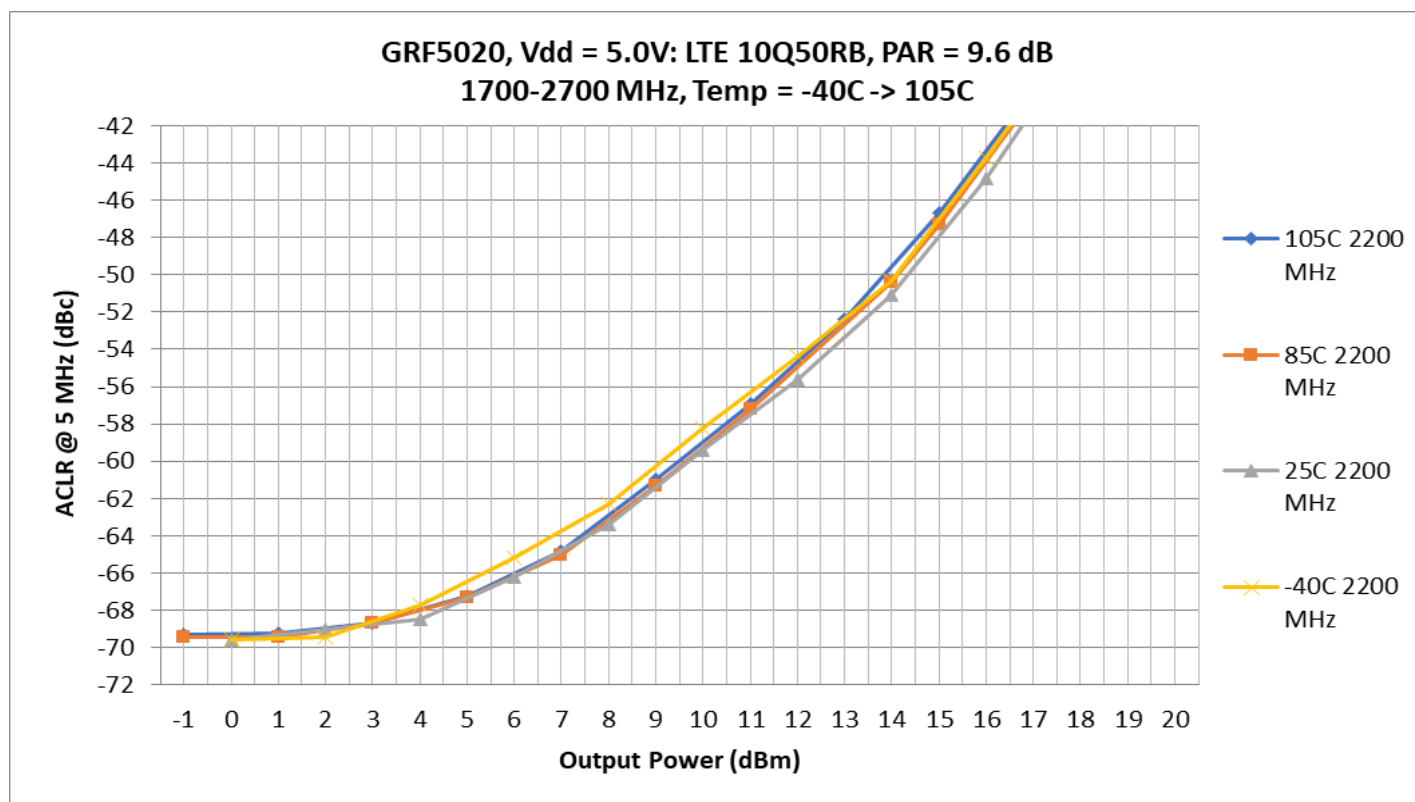
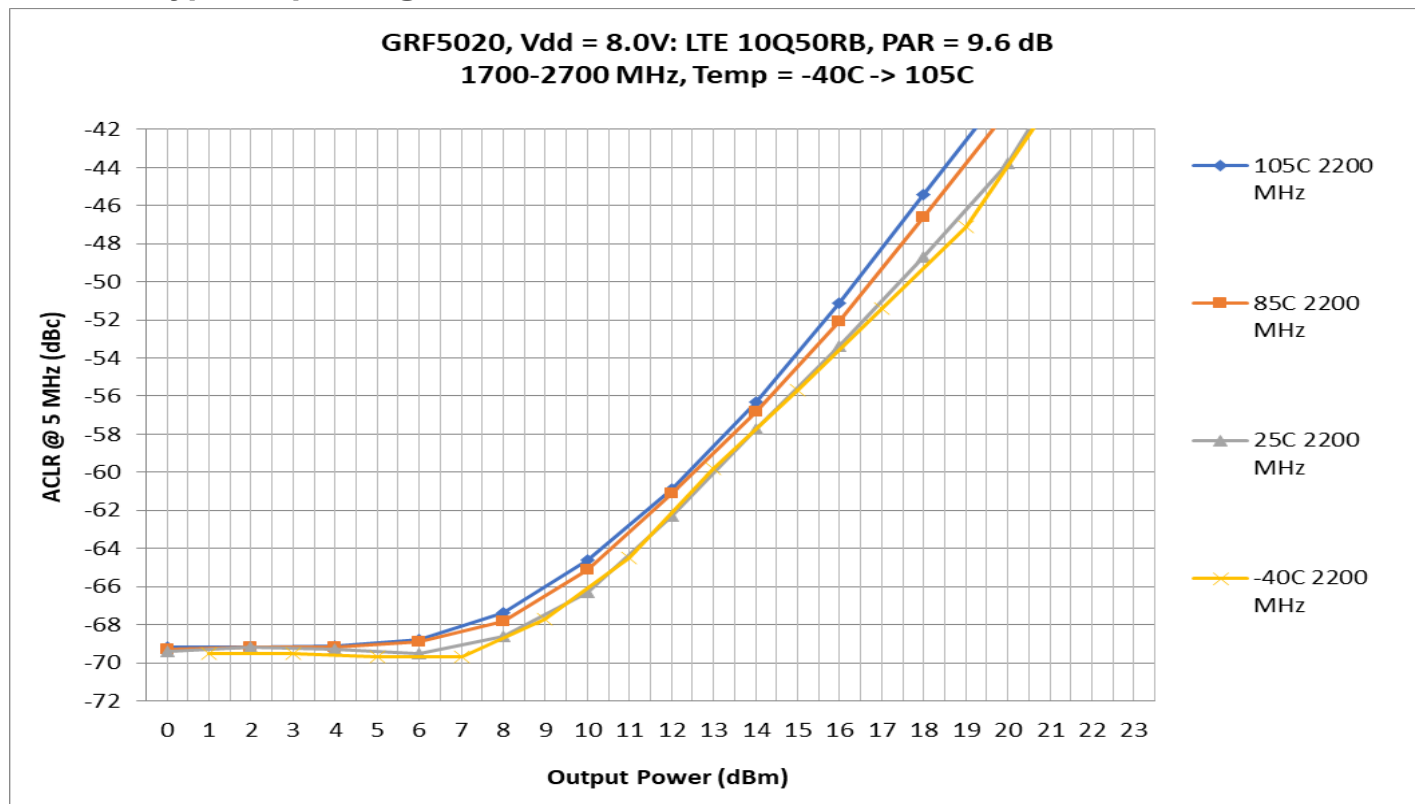
GRF5020 Typical Operating Curves: 1.7 to 2.7 GHz Tune



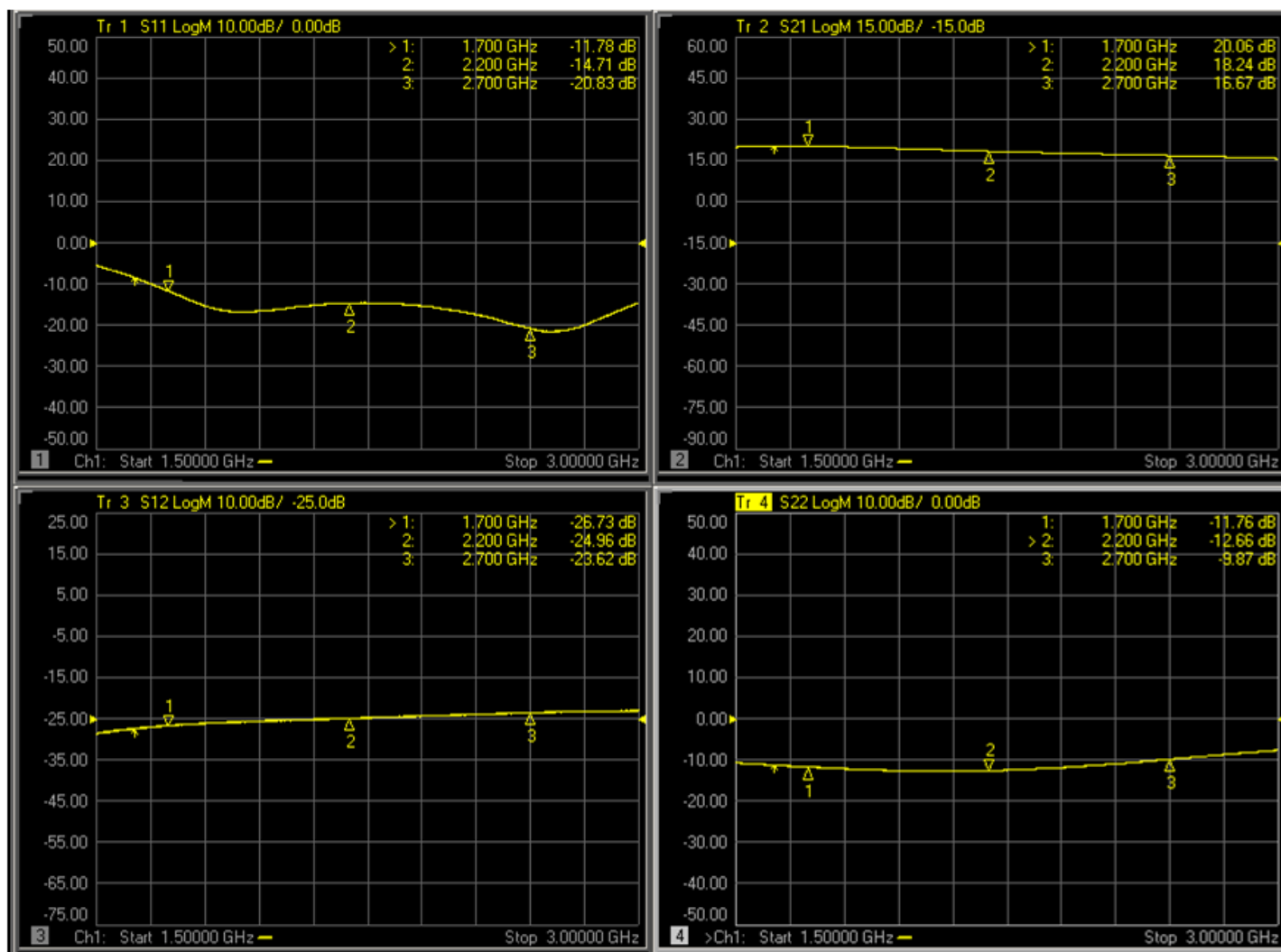
GRF5020 Typical Operating Curves: 1.7 to 2.7 GHz Tune

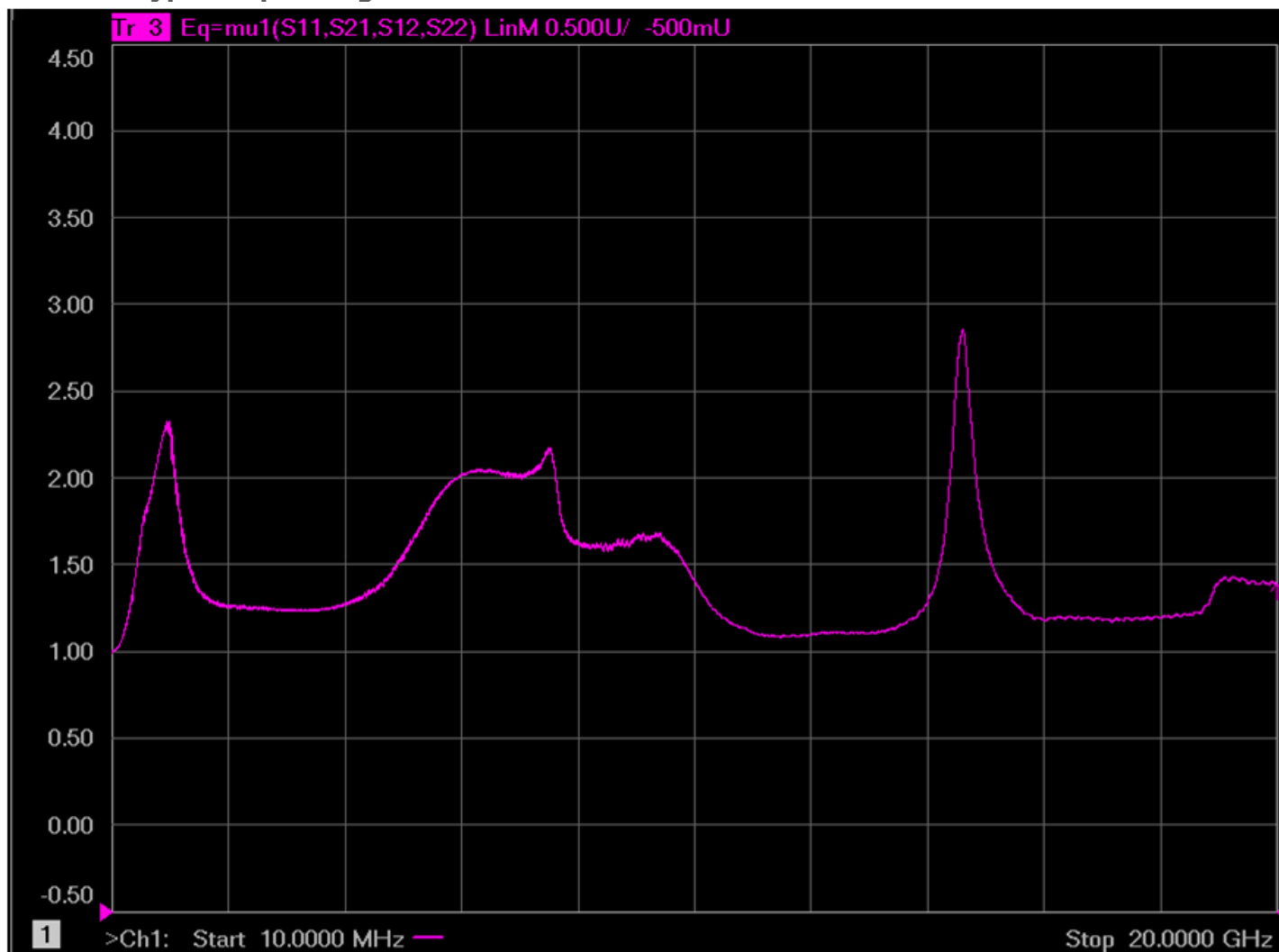


GRF5020 Typical Operating Curves: 1.7 to 2.7 GHz Tune

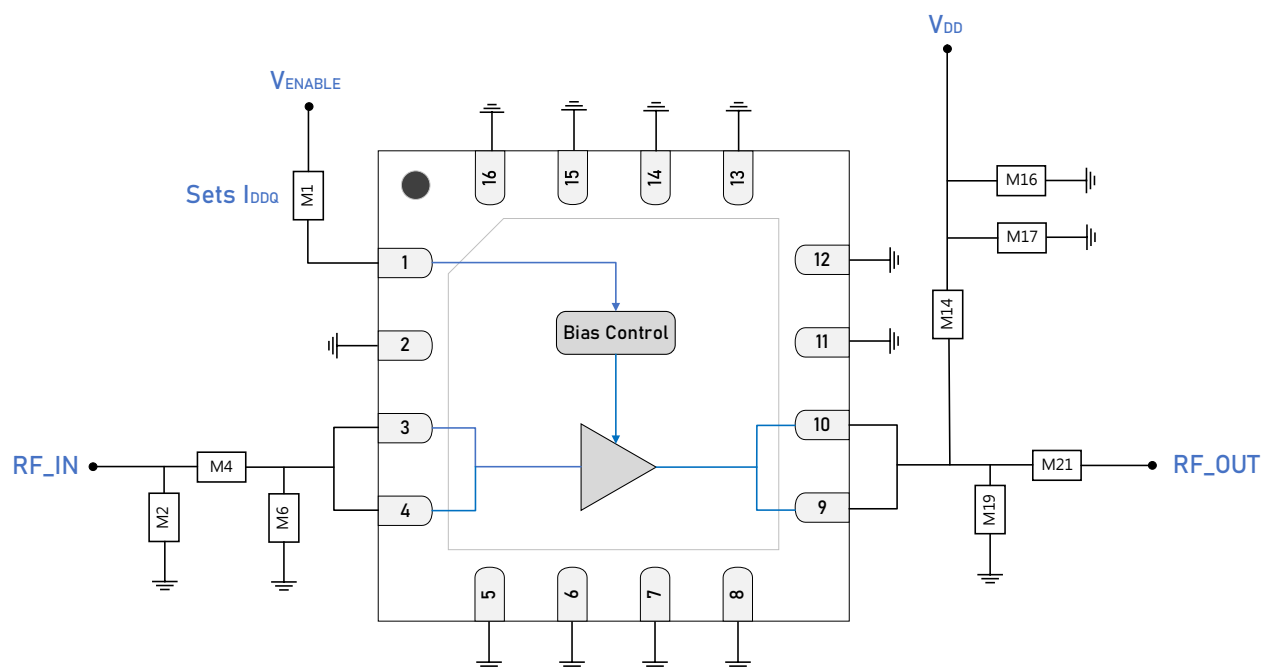


GRF5020 Typical Operating Curves: S-Parameters (1.7 to 2.7 GHz Tune)

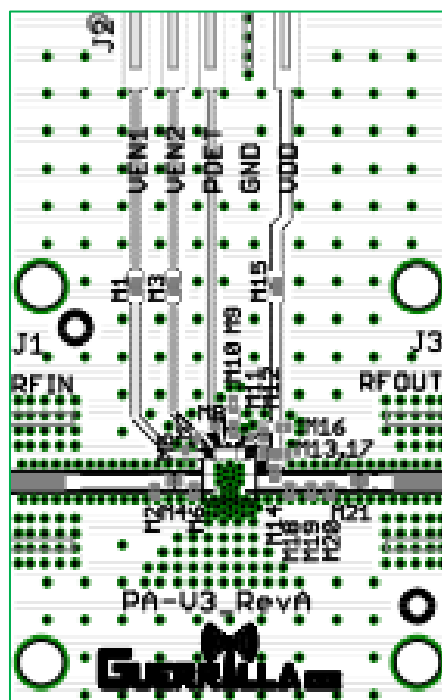


GRF5020 Typical Operating Curves: Mu Factor (10 MHz to 20 GHz)


Note: Mu factor ≥ 1.0 implies unconditional stability



GRF5020 Standard Evaluation Board Schematic

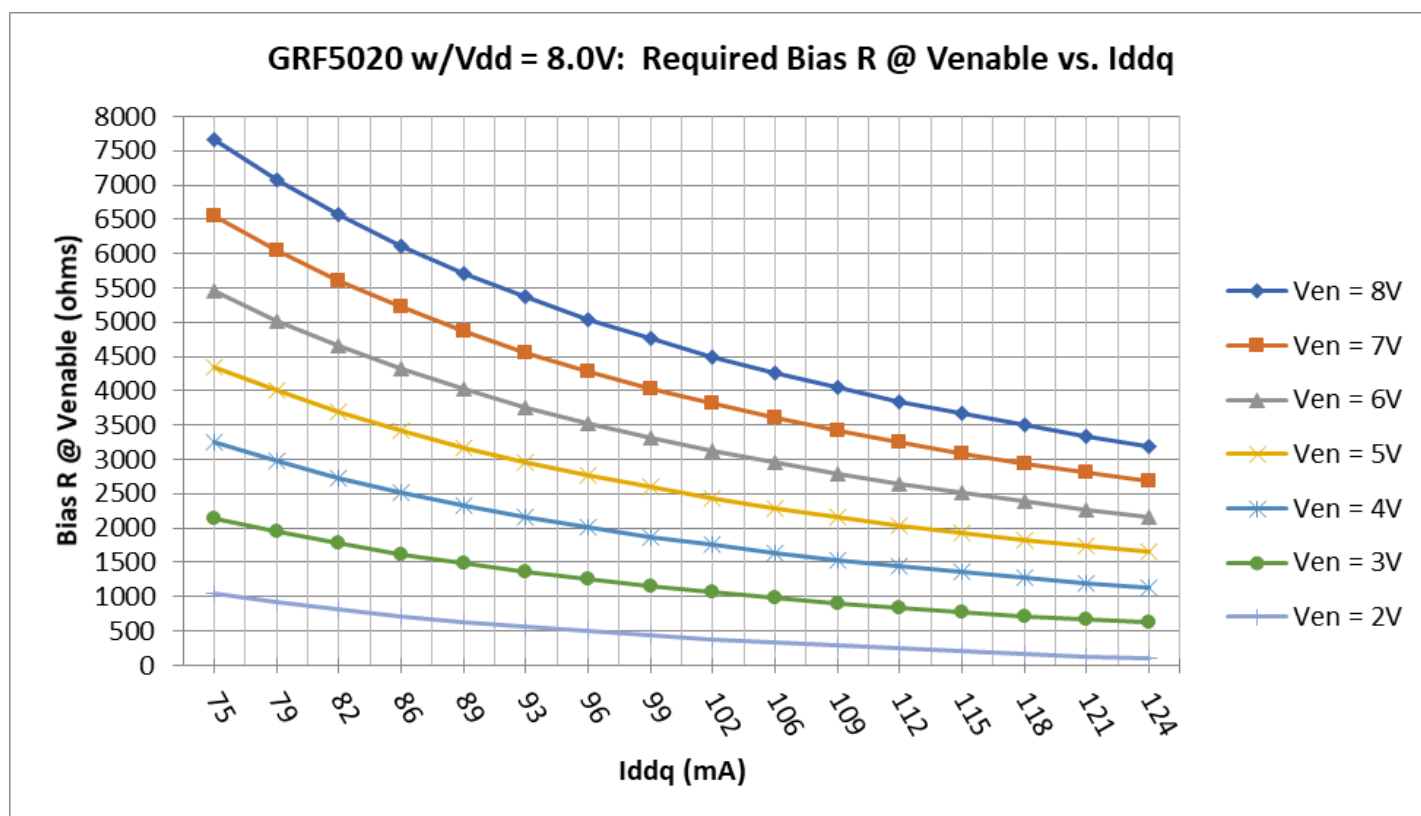
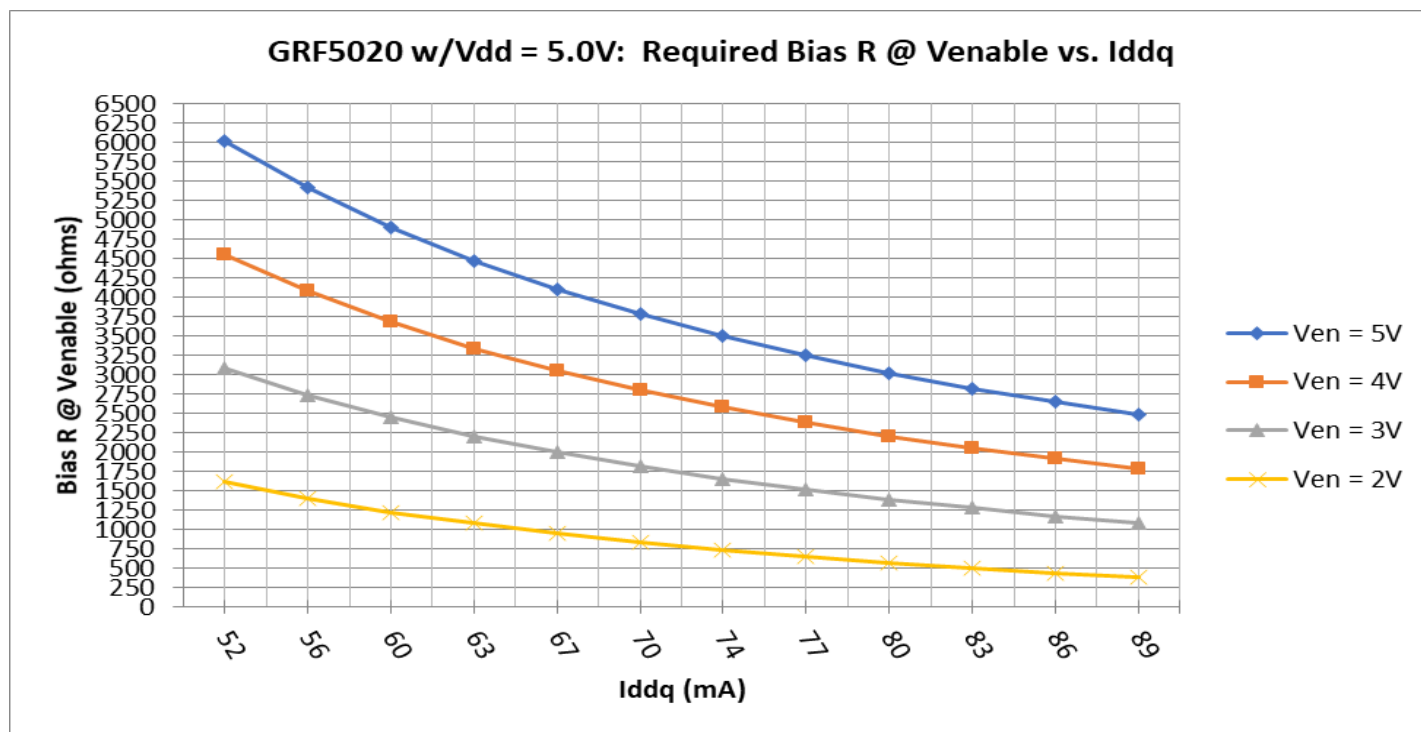


GRF5020 Evaluation Board Assembly Diagram

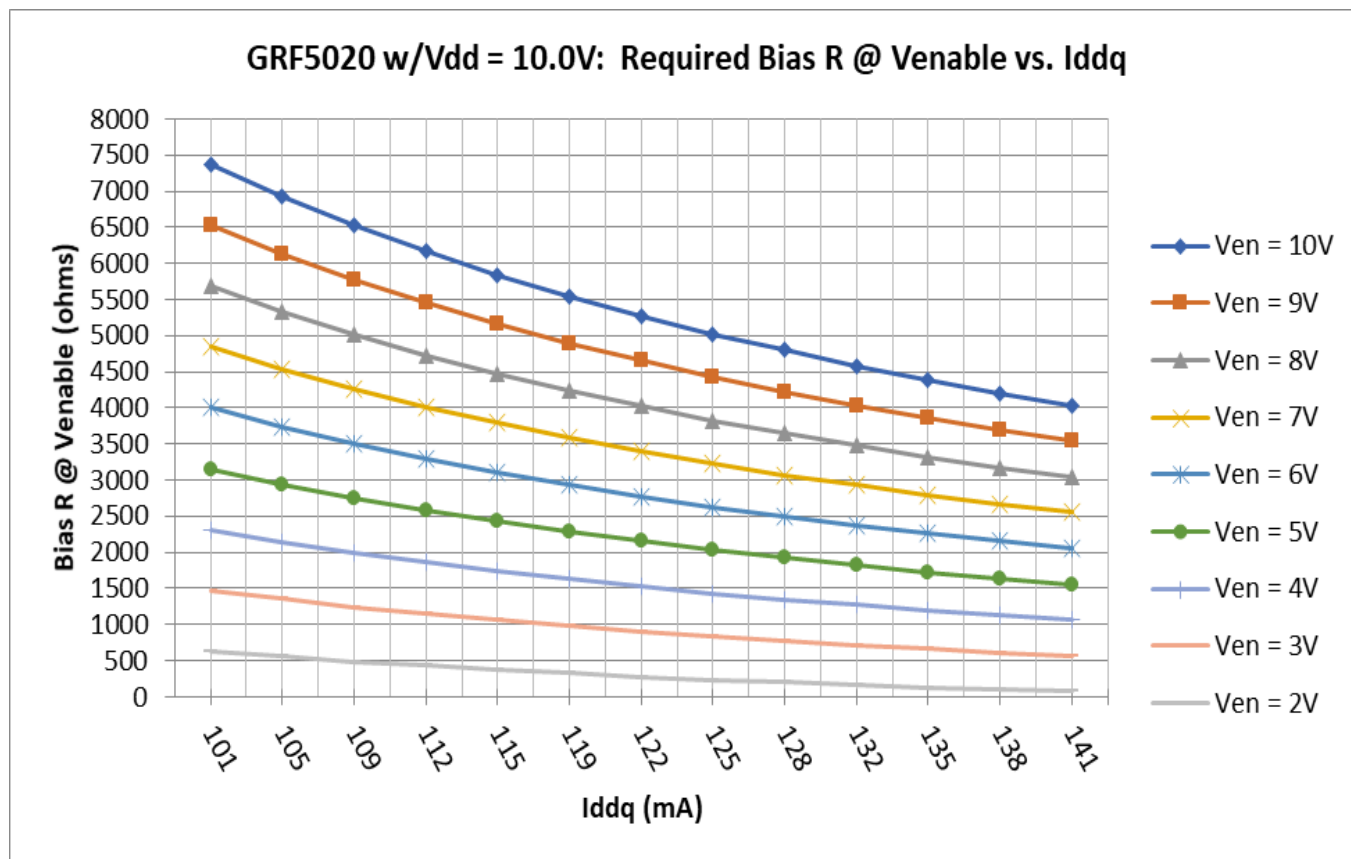
GRF5020 Evaluation Board Assembly Diagram Reference: 1.7 to 2.7 GHz Tune

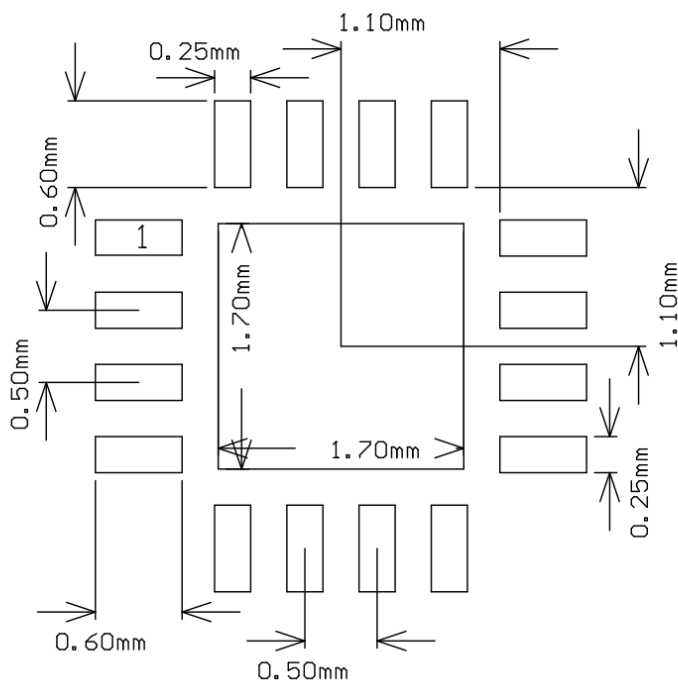
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1 (sets I_{DDQ})	Resistor	Various	5%	see curves	0402	ok
M2	Inductor: High Q	Coilcraft	HP	3.3 nH	0402	ok
M4	Capacitor: High Q	Murata	GJM	2.0 pF	0402	ok
M6	Capacitor: High Q	Murata	GJM	1.8 pF	0402	ok
M14	Inductor: High Q	Coilcraft	HP	15 nH	0402	ok
M16	Capacitor	Murata	GRM	0.1 μ F	0402	ok
M17	Capacitor	Murata	GRM	100 pF	0402	ok
M19	DNP					
M21	Capacitor	Murata	GJM	18 pF	0402	ok
Evaluation Board	PA-V3_RevA					

GRF5020 Bias Resistor Curves:

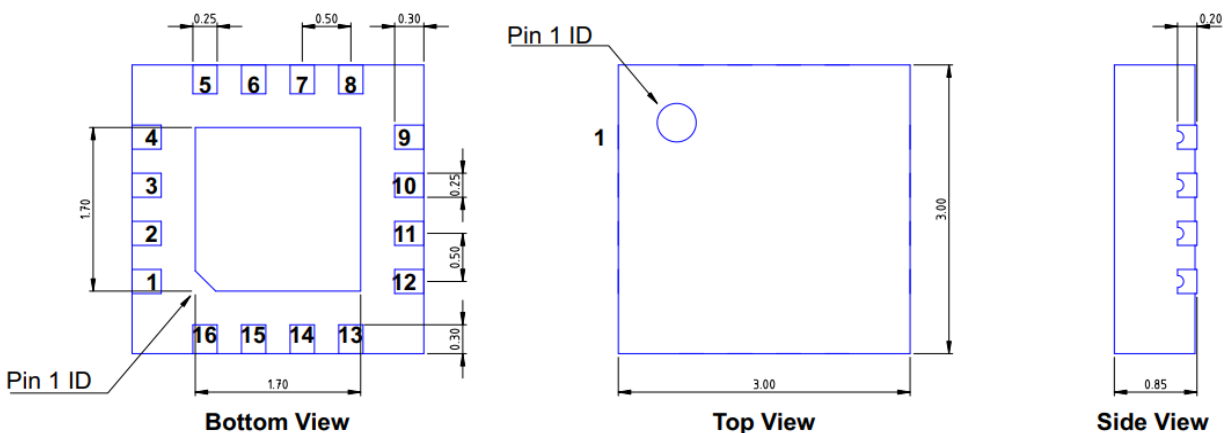


GRF5020 Bias Resistor Curves:





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



QFN16 3x3mm

Dimensions in millimeters
Dimensional Tolerance: ± 0.05

3 x 3 mm QFN-16 Package Dimensions

Package Marking Diagram



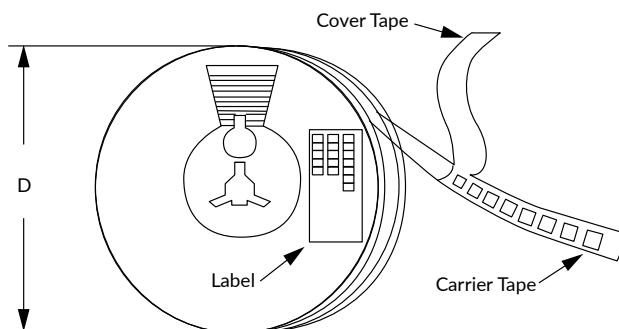
- Line 1: "YY" = YEAR. "WW" = WORK WEEK the device was assembled.
- Line 2: "GRF" = Guerrilla RF.
- Line 3: "XXXX" = Device PART NUMBER.

Tape and Reel Information

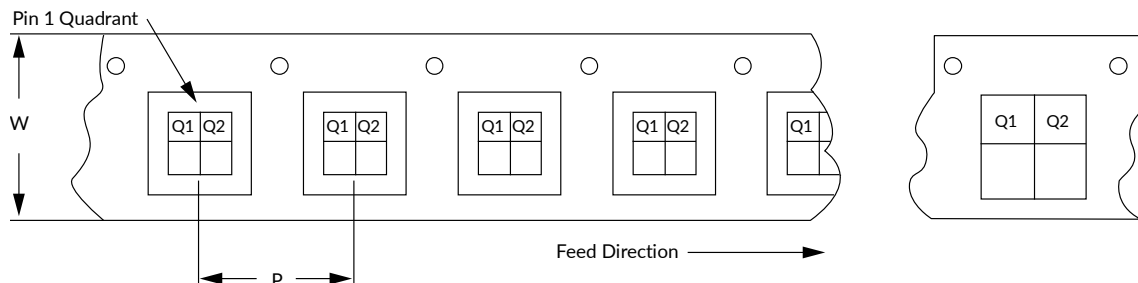
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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 \(guerrilla-rf.com\)](https://www.guerrilla-rf.com/package-manufacturing-information)



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
January 13, 2017	Preliminary Data Sheet.
June 21, 2021	Release 0 Data Sheet. Upgraded Data Sheet to new format.
April 24, 2025	Raised Frequency Range from 3.8 to 6 GHz.
April 30, 2025	Raised Maximum Operating Temperature from 105 to 115 °C. Added Maximum Dissipated Power at 105 and 115 °C. Lowered Frequency Range from 0.1 to 0.03 GHz.



Datasheet 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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