

GRF5040

31 dBm Power-LNA 0.025 to 3.8 GHz

FEATURES

- Flexible Bias Voltage and Current
- Process: GaAs pHEMT
- Compact 3 x 3 mm QFN-16 Package

Reference: 8 V / 200 mA / 2.5 GHz

- Gain: 15 dB
- OIP3: 46.3 dBm
- OP1dB: 29.8 dBm
- Evaluation Board Noise Figure: 0.85 dB

Reference: 10 V / 180 mA / 2.5 GHz

- Gain: 15 dB
- OIP3: 47 dBm
- OP1dB: 31.5 dBm
- Evaluation Board Noise Figure: 0.85 dB

APPLICATIONS

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

DESCRIPTION

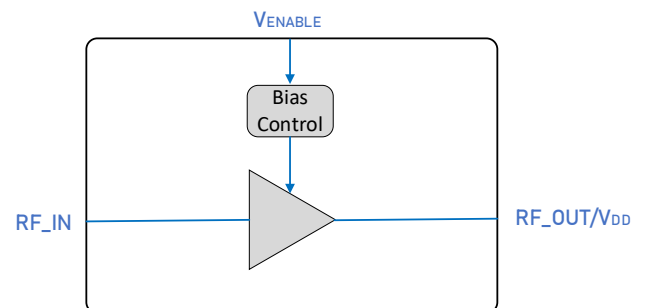
The GRF5040 is a high linearity Power-LNA with ultra-low noise figure (NF). The primary tune for this device covers 1700 to 2700 MHz. It achieves outstanding P1dB, IP3 and noise figure (NF) over the band. The device can be tuned to deliver outstanding performance from 25 MHz to 3800 MHz with fractional bandwidths > 30%. With a 10 volt supply, the device can deliver broadband OP1dB of 31 dBm.

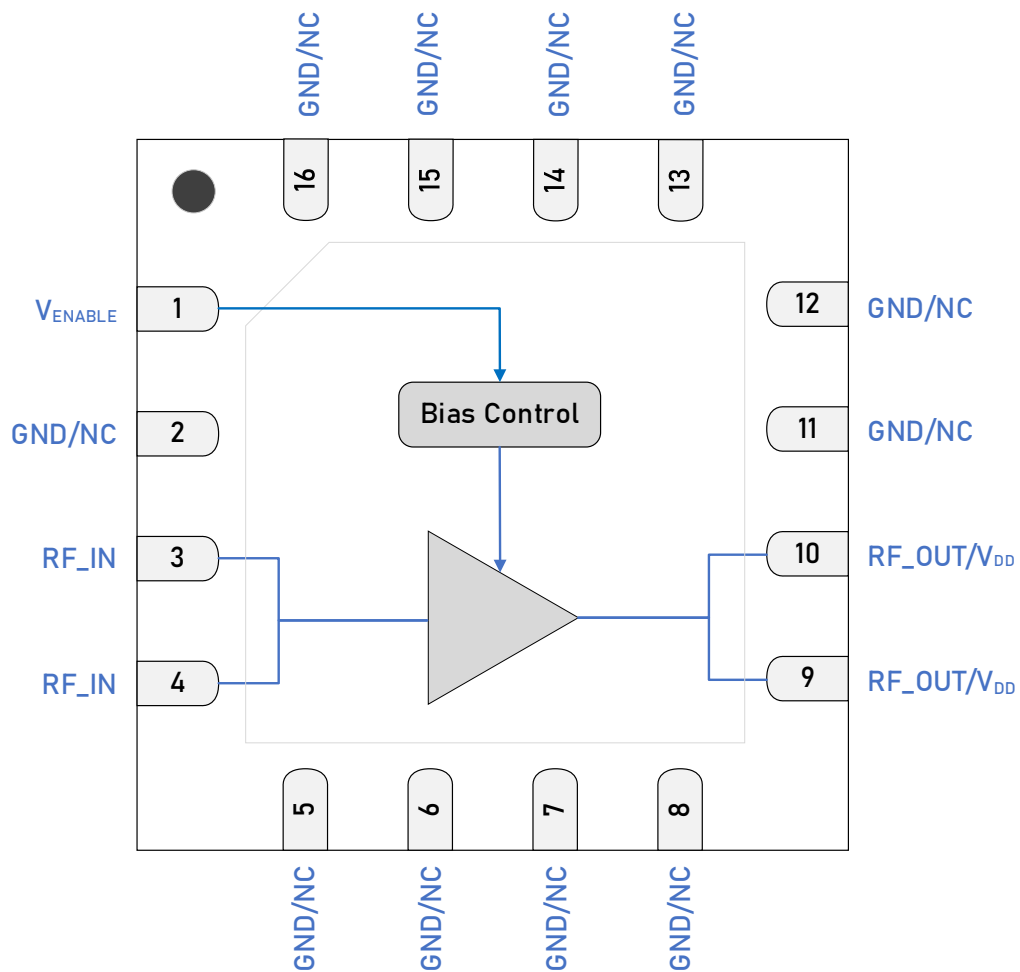
In addition to its use as a PA or linear driver, GRF5040 is well suited to demanding first, second or third stage LNA applications requiring high linearity, ruggedness, and low NF.

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 GRF5040 "Custom Tunes" product page: [GRF5040 Custom Tunes](#)

BLOCK DIAGRAM





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



Pin Assignments

Pin	Name	Description	Note
1	V _{ENABLE}	Enable Voltage Input	V _{ENABLE} and series resistor sets I _{DDQ} . V _{ENABLE} ≤ 0.2 V disables the device. On-die pull-down resistor turns the device off if this node is allowed to float.
2, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16	GND/NC	Ground or No Connect	No internal connection to die. We recommend connecting these pins to ground.
3, 4	RF_IN	RF Input	Pins 3 & 4 tied together on system board.
9, 10	RF_OUT/V _{DD}	RF Output	Pins 9 & 10 tied together on system board.
PKG BASE	GND	Ground	Provides DC and RF ground 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
Supply Voltage	V _{DD}	0	12	V
RF Input Power	P _{IN MAX}		22	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}		1.8	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}	3.3	5	9	V	
RF Frequency Range	F _{RF}	0.7		4	GHz	Typical application schematic with external matching components (notes 1 & 2).
Operating Temperature (package base)	T _{PKG BASE}	-40	25	105	°C	
RF_IN Port Impedance	Z _{RF_IN}		50		Ω	Single-ended with 4 element match.
RF_OUT Port Impedance	Z _{RF_OUT}		50		Ω	Single-ended with 2 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: [GRF5040 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. $V_{DD} = 8\text{ V}$, $V_{ENABLE} = 8\text{ V}$, $I_{DD} = 200\text{ mA}$, $M1 = 1.54\text{ k}\Omega$, $F_{TEST} = 2.5\text{ GHz}$, $50\ \Omega$ system impedance, $T_{PKG\ BASE} = 25\text{ }^\circ\text{C}$. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Target Performance		1.7		3.8	GHz	
Supply Current (quiescent)	I_{DDQ}		200		mA	$V_{DD} = 8\text{ V}$, $V_{ENABLE} = 8\text{ V}$.
Enable Current	I_{ENABLE}		4		mA	$V_{DD} = 8\text{ V}$, $V_{ENABLE} = 8\text{ V}$.
Operating Temperature Range	$T_{PKG\ BASE}$	-40		105	$^\circ\text{C}$	
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}		370		μA	$V_{DD} = 8\text{ V}$, $V_{ENABLE} = 0\text{ V}$.
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Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		35		$^\circ\text{C}/\text{W}$	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} .

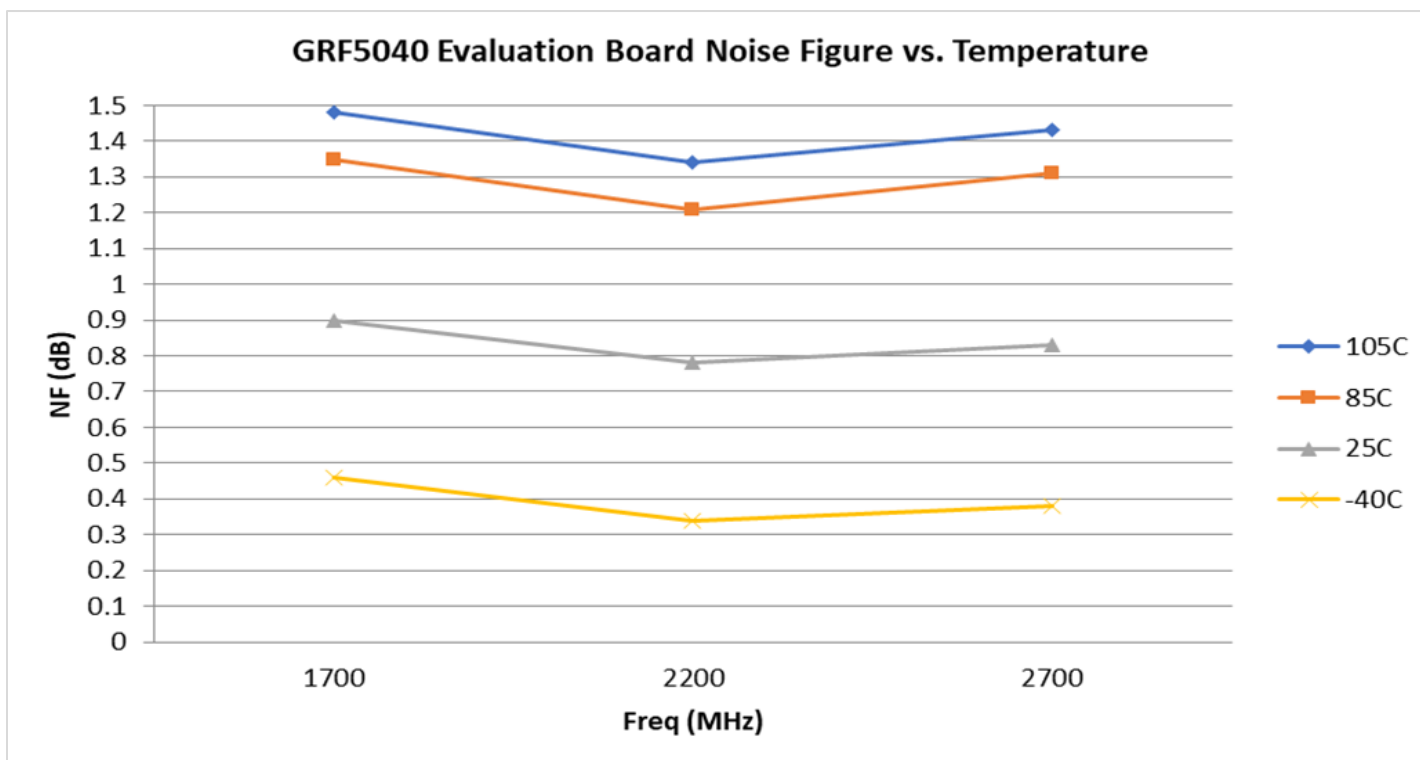
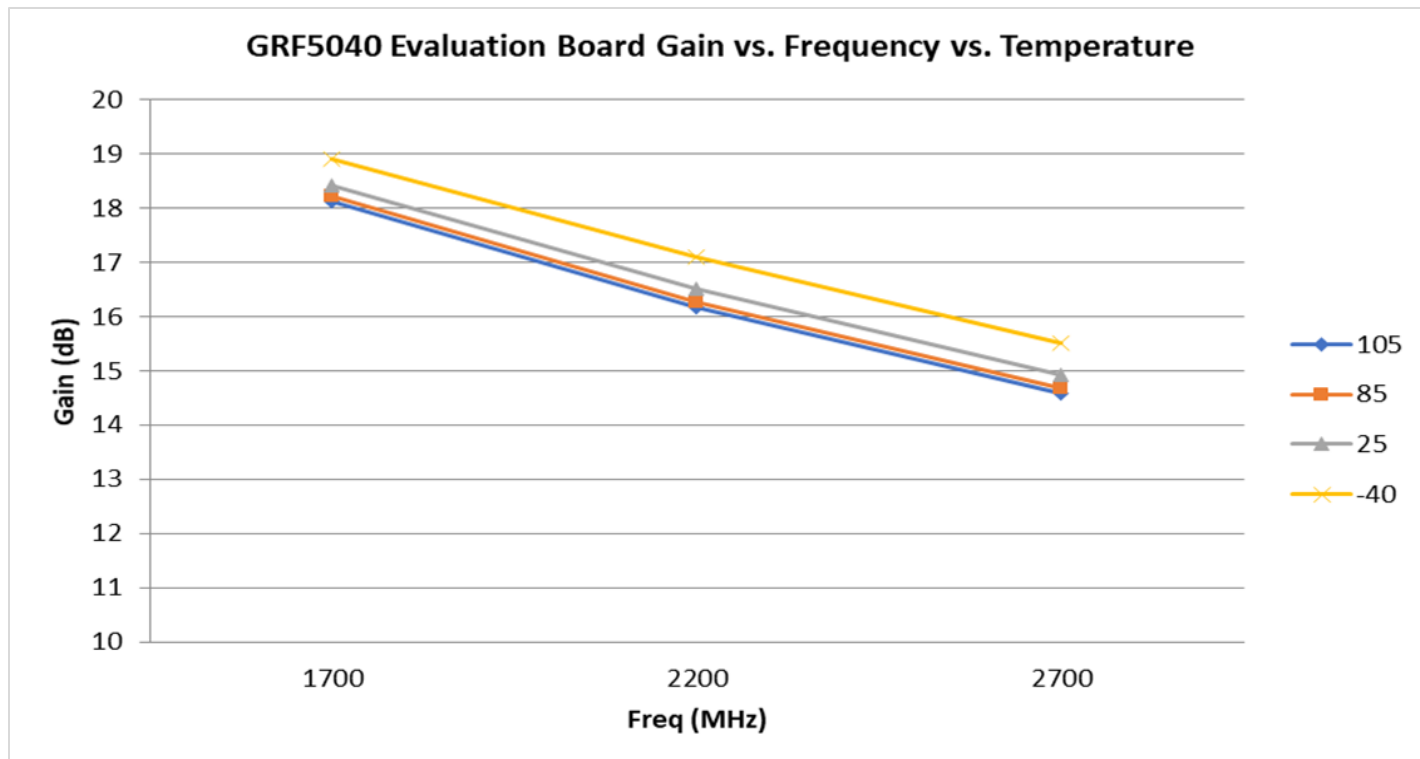
Note 5: MTTF > 10^6 hours for $T_{CHANNEL} \leq 170\text{ }^\circ\text{C}$.

Nominal Operating Parameters – RF

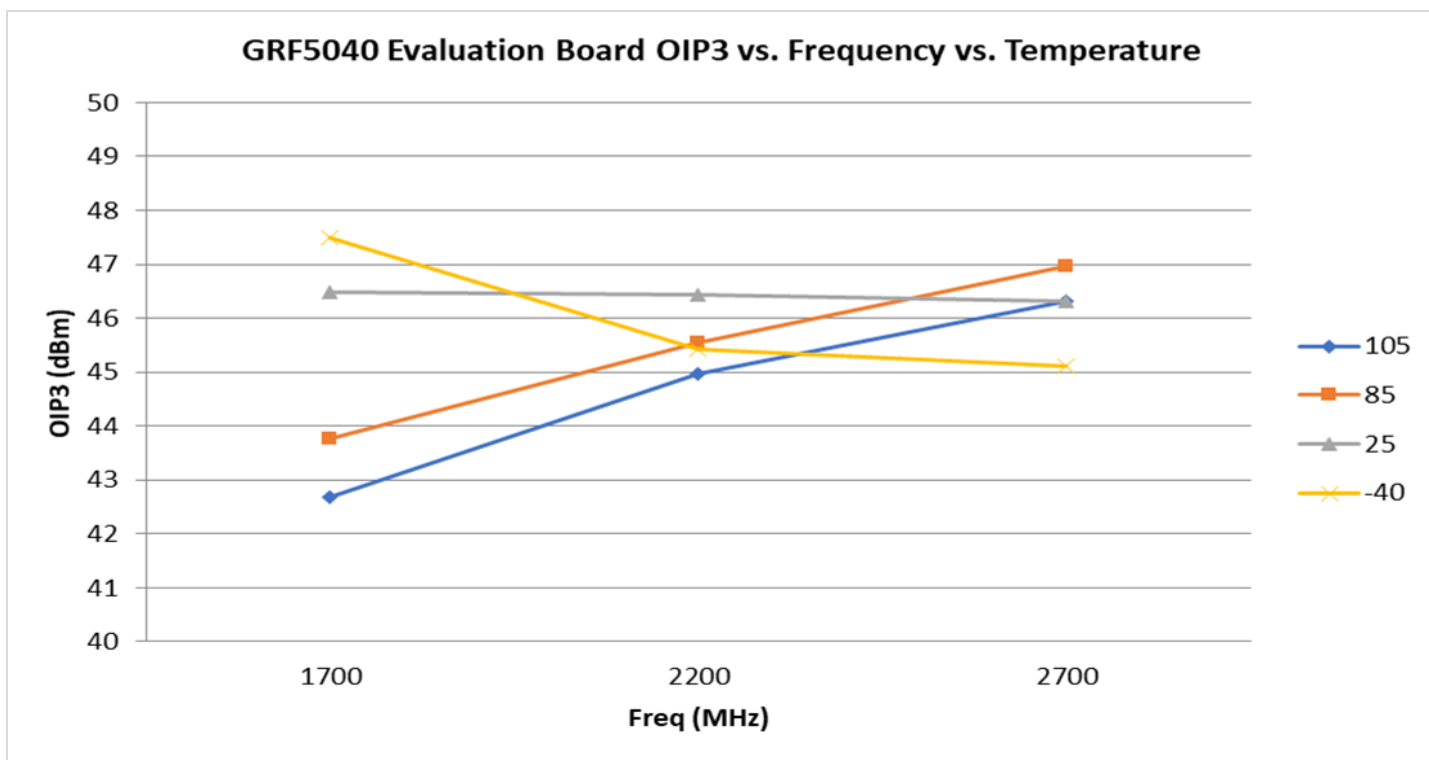
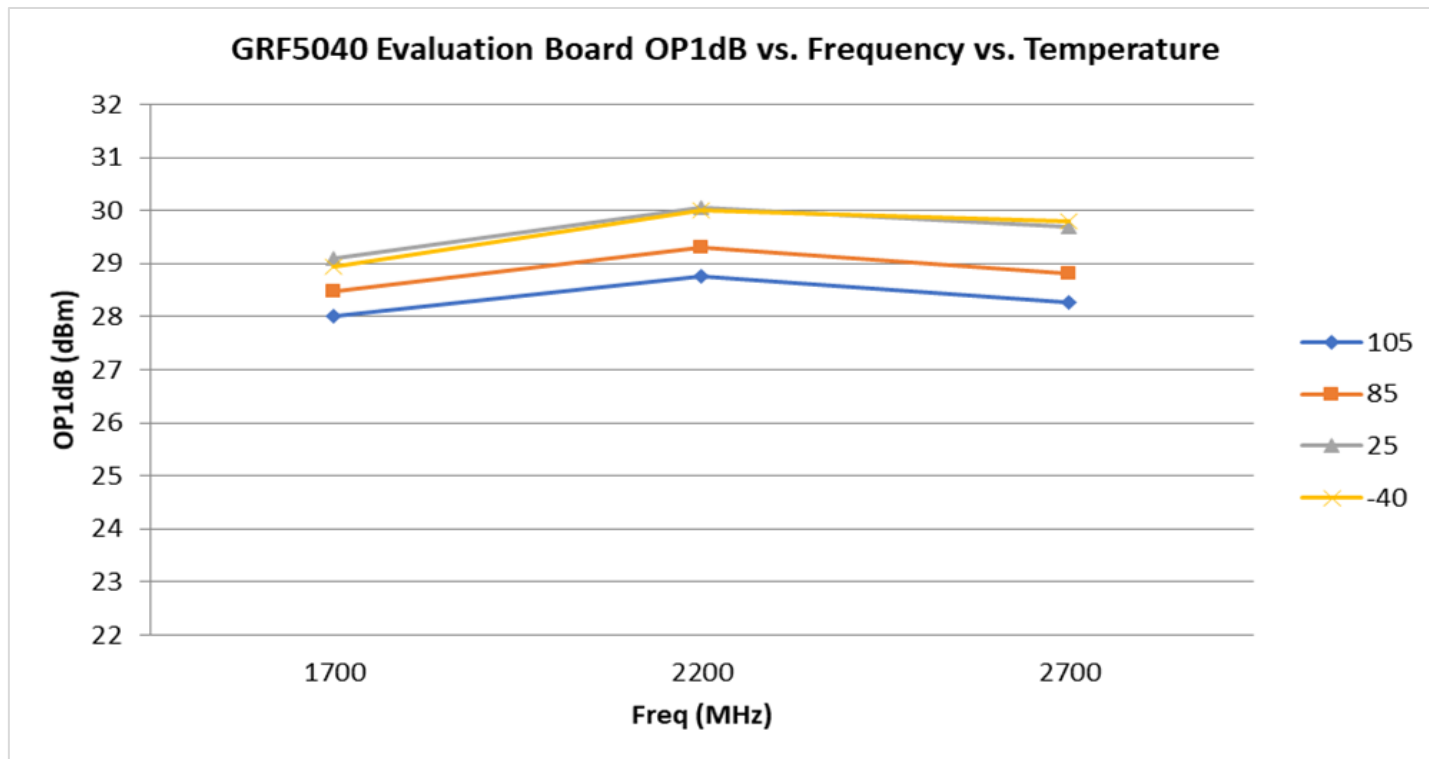
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Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Small Signal Gain	S21	14	15		dB	
Noise Figure	NF		0.85	1.05	dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		46.3		dBm	+8 dBm P_{OUT} per tone at 2 MHz spacing (2499 and 2501 MHz).
Output 1 dB Compression Power	OP1dB	28.3	29.8		dBm	

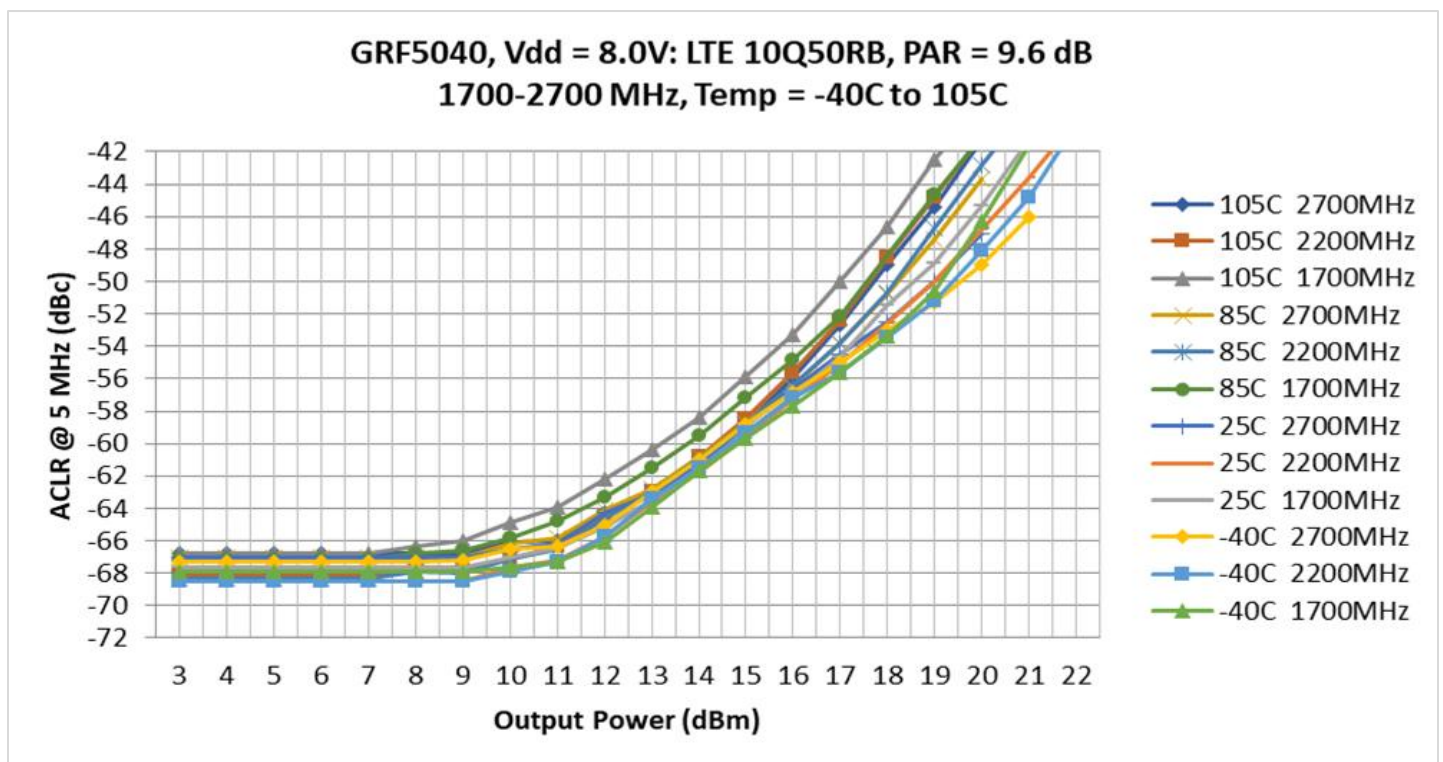
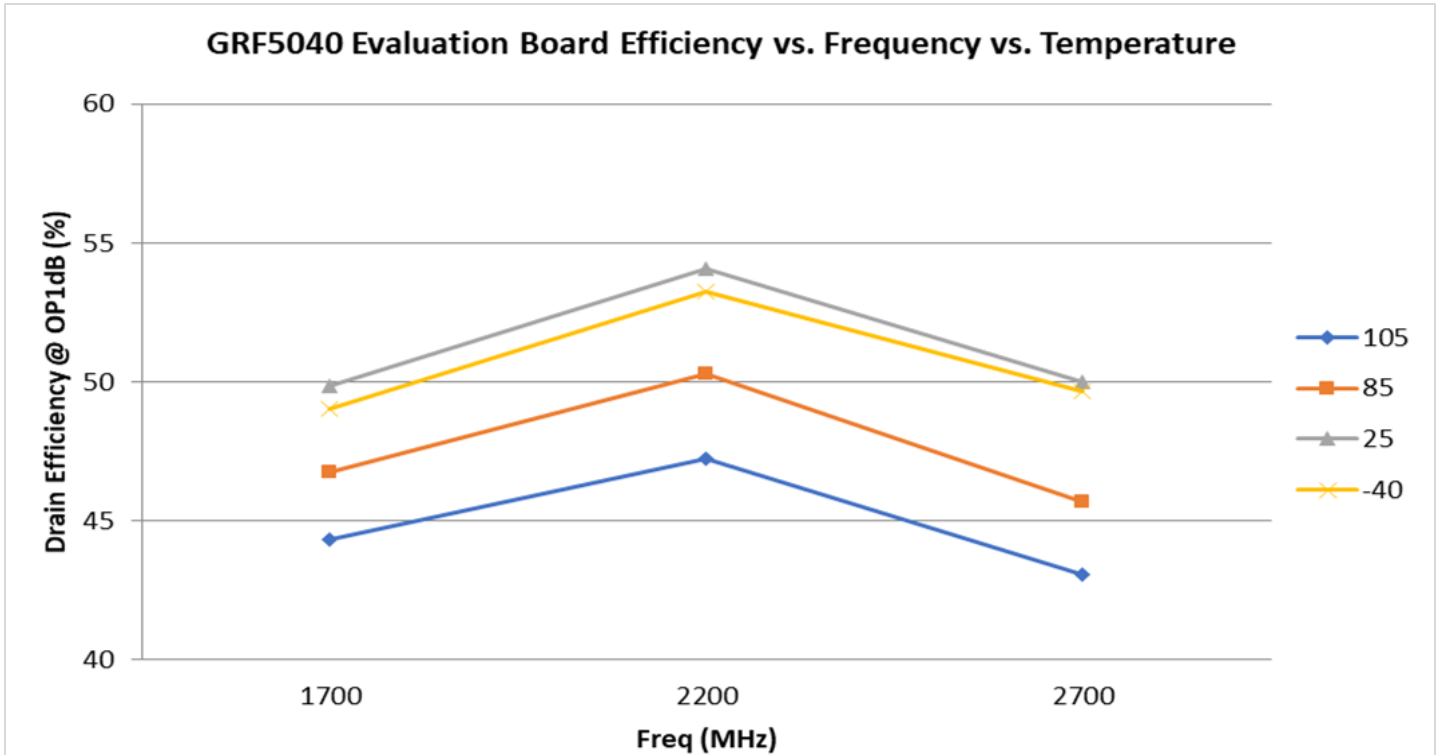
GRF5040 Typical Operating Curves: 8 V, 200 mA (1.7 to 2.7 GHz Tune)



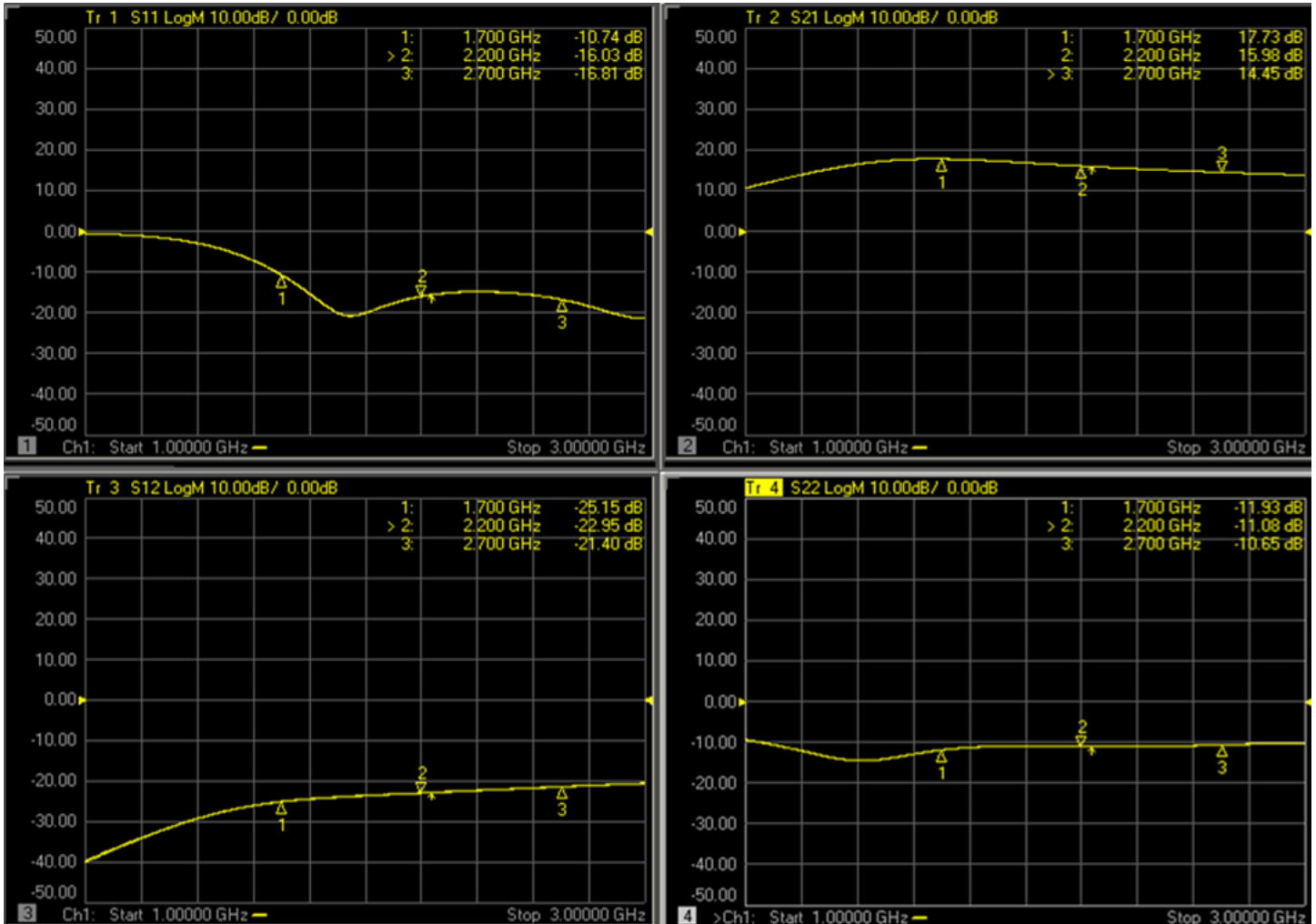
GRF5040 Typical Operating Curves: 8 V, 200 mA (1.7 to 2.7 GHz Tune)



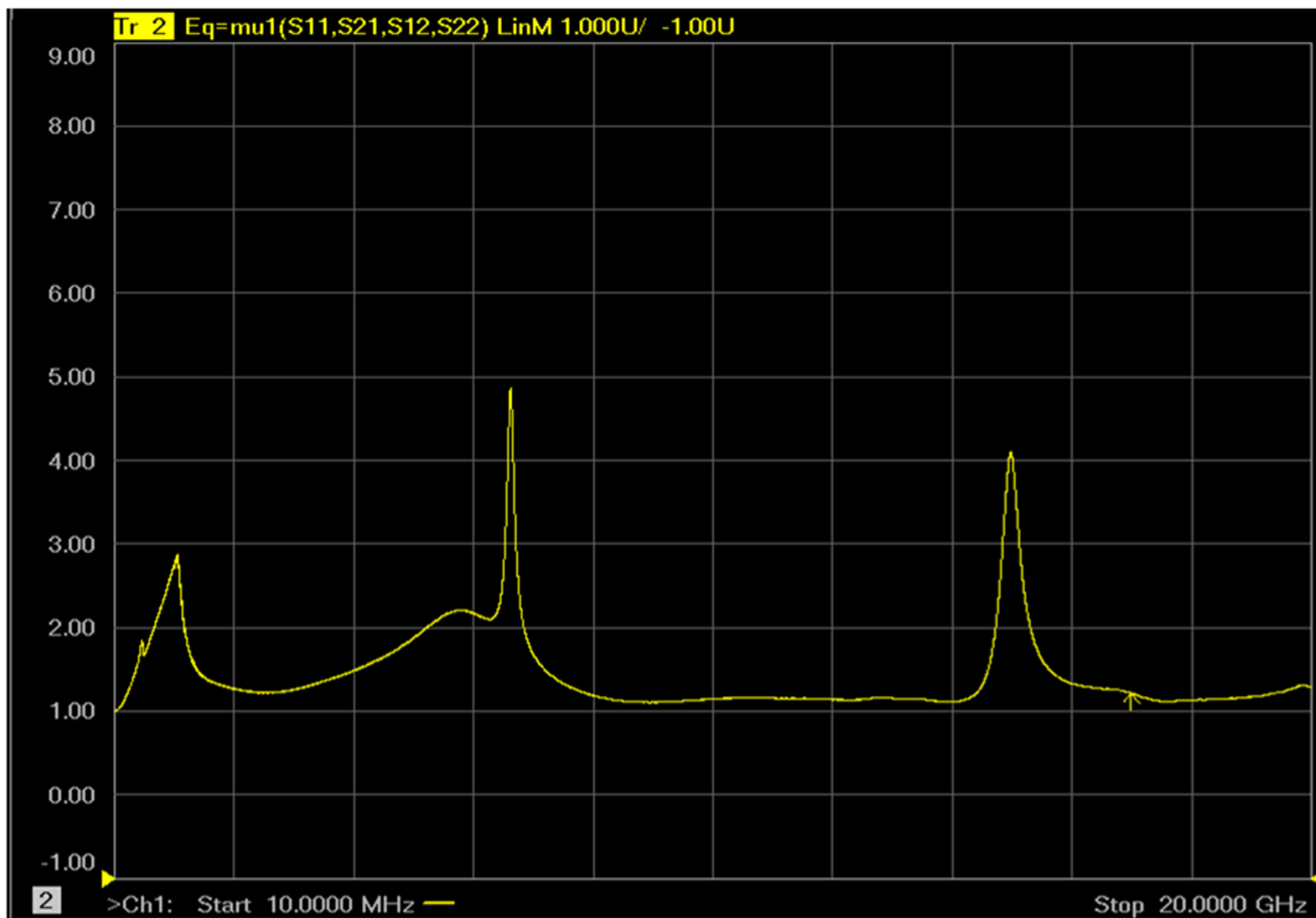
GRF5040 Typical Operating Curves: 8 V, 200 mA (1.7 to 2.7 GHz Tune)



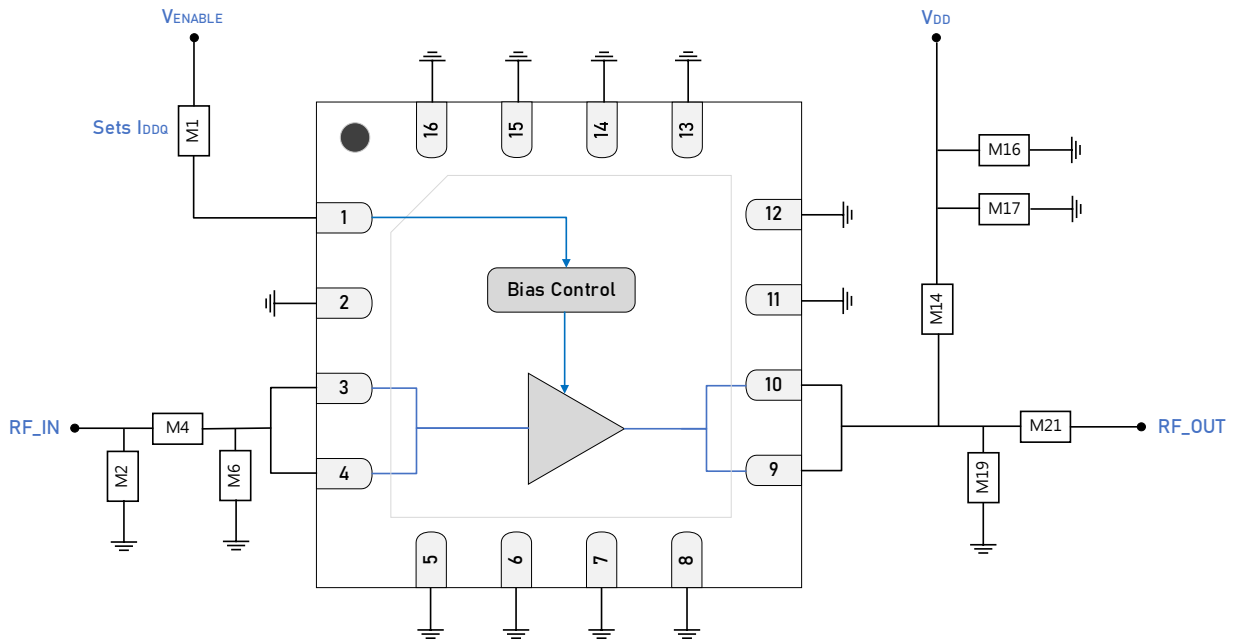
GRF5040 Typical Operating Curves: S-Parameters (8 V, 200 mA, 1.7 to 2.7 GHz Tune)



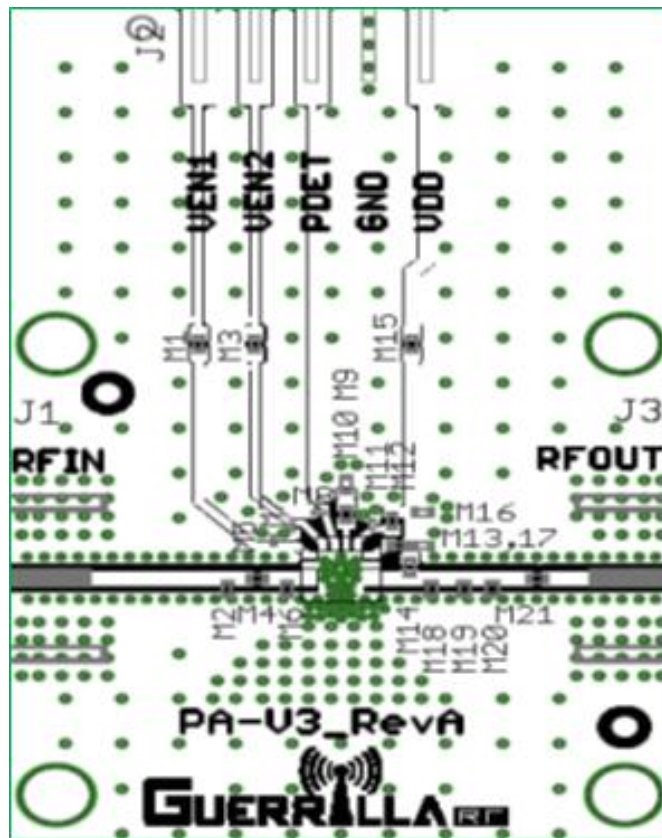
GRF5040 Typical Operating Curves: Mu Factor (8 V, 200 mA, 1.7 to 2.7 GHz Tune)



Note: Mu factor ≥ 1.0 implies unconditional stability



GRF5040 Standard Evaluation Board Schematic



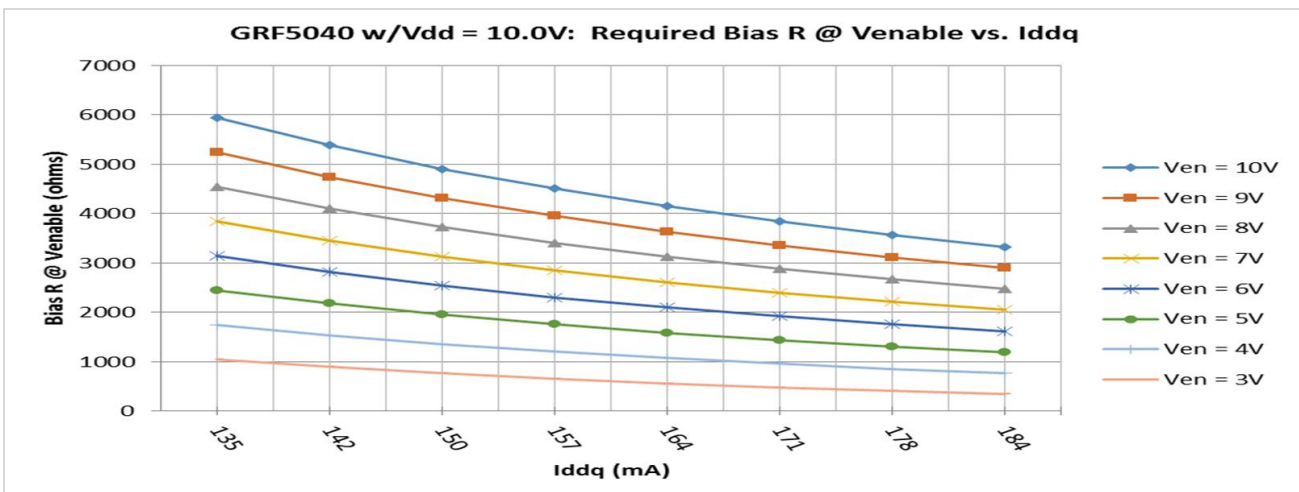
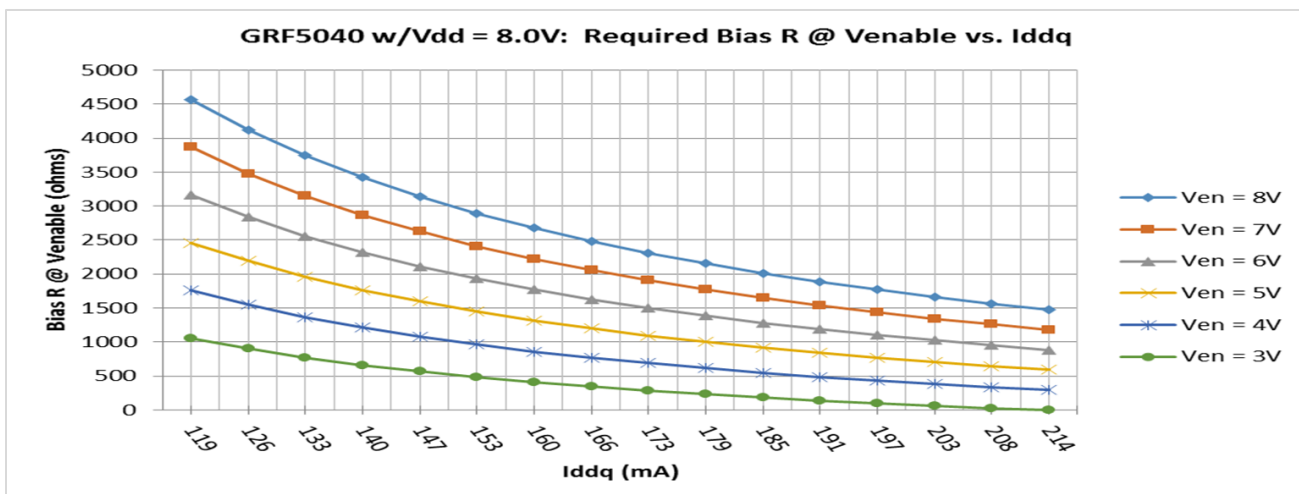
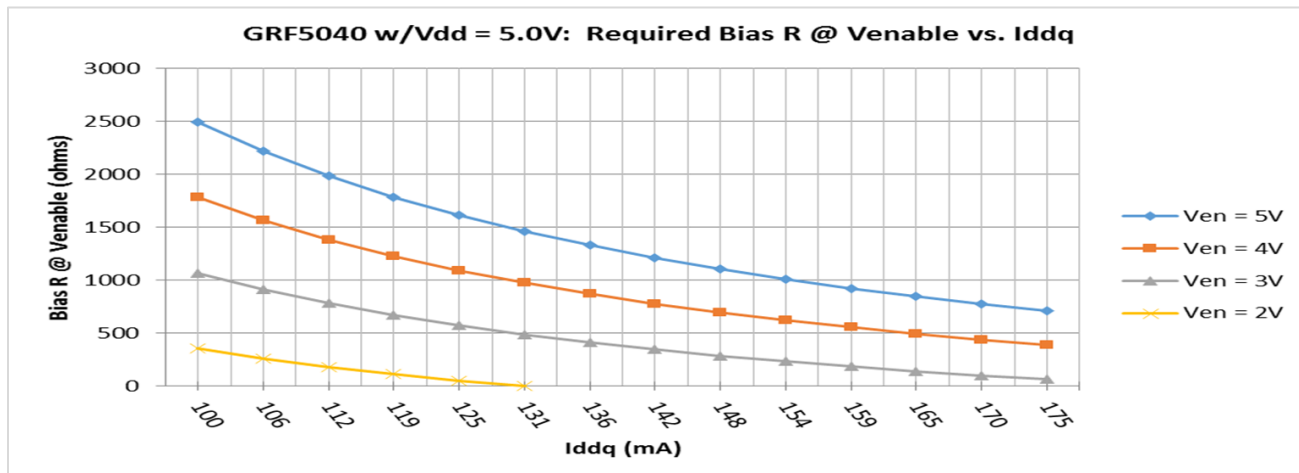
GRF5040 Evaluation Board Assembly Diagram

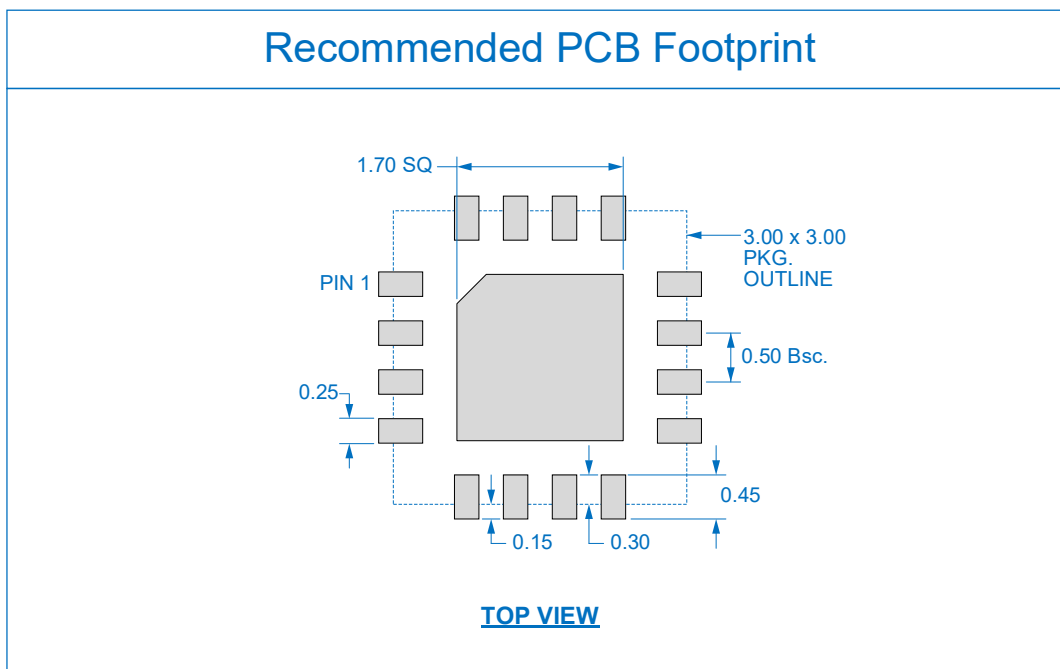
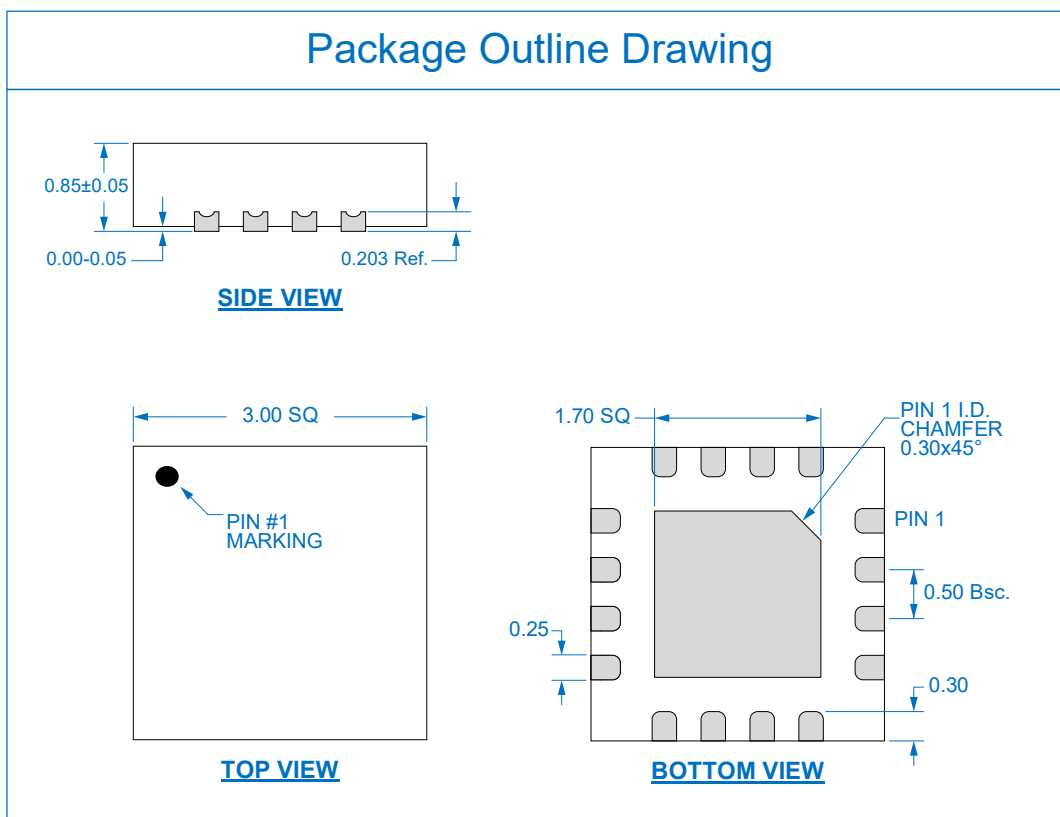


GRF5040 Evaluation Board Assembly Diagram Reference: 1.7 to 2.7 GHz Tune

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1 (sets I _{DDQ})	Resistor	Various	5%	See Curves	0402	ok
M2	Inductor	Coilcraft	HP	3.3 nH	0402	ok
M4	Capacitor	Murata	GJM	1.8 pF	0402	ok
M6	Capacitor	Murata	GJM	1.5 pF	0402	ok
M14	Inductor	Coilcraft	HP	15 nH	0402	ok
M16	Capacitor	Murata	GRM	0.1 µF	0402	ok
M17	Capacitor	Murata	GRM	100 pF	0402	ok
M19	Capacitor	Murata	GJM	0.5 pF	0402	ok
M21	Capacitor	Murata	GJM	18 pF	0402	ok
Evaluation Board	PA-V3_RevA					

GRF5040 Bias Resistor Curves:





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

Package Marking Diagram



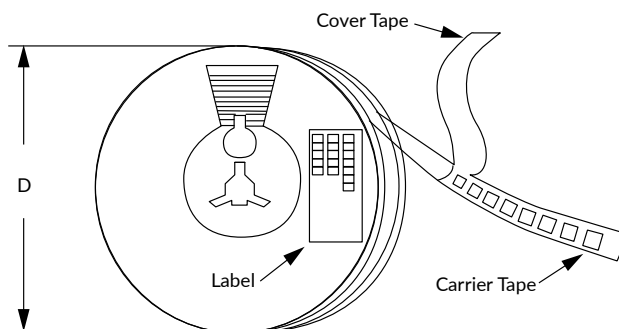
- Line 1: "YY" = YEAR. "WW" = WORK WEEK the device was assembled.
- Line 2: "GRF" = Guerrilla RF.
- Line 3: "XXXX" = Device PART NUMBER.

Tape and Reel Information

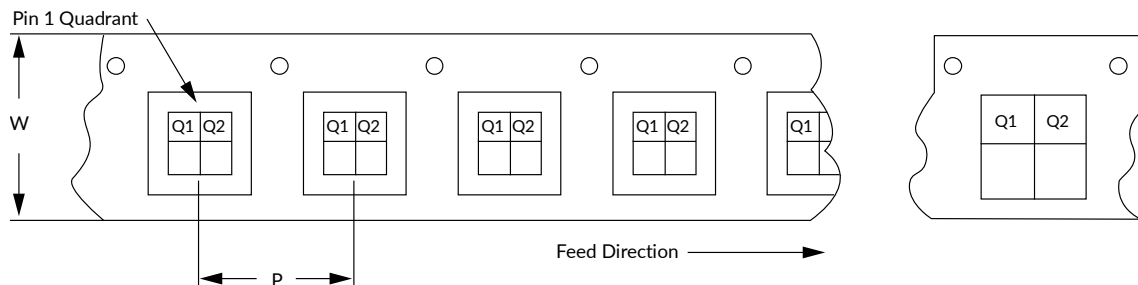
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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 \(guerrilla-rf.com\)](http://www.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
January 13, 2017	Release 0 Data Sheet.
May 6, 2024	Upgraded Data Sheet to new format. Raised 8 V I _{DDQ} from 130 to 200 mA to match production test plan. Added M1 resistor (R _{ENABLE}) 1.54 kΩ. Raised 10 V I _{DDQ} from 170 to 180 mA. Lowered Maximum Dissipated Power from 2.2 to 1.8 W. Removed Channel Temperature specification from Nominal Operating Parameters table.
September 30, 2024	Changed M1 resistor (R _{ENABLE}) to 3.75 kΩ.
June 19, 2025	Extended lower frequency range from 100 MHz to 25 MHz.
September 22, 2025	Changed M1 resistor (R _{ENABLE}) to 1.54 kΩ.
October 16, 2025	Upgraded Data Sheet to new format only. No change to device or device specifications.



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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