DATA SHEET

GRF2040

Broadband Linear Gain Block with Bypass 0.05 to 5 GHz

RELEASE Ø DATA SHEET

FEATURES

- Flexible Bias
- Internally Matched to 50 Ω
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package
- RoHS Compliant

Gain Mode Reference: 5 V / 90 mA / 2 GHz

- Gain: 10.2 dB
- OP1dB: 20.9 dBm
- OIP3: 35.3 dBm
- Evaluation Board Noise Figure: 3.4 dB

Bypass Mode Reference: 5 V / 0.5 mA / 2 GHz

- Gain: -1.6 dB
- OP1dB: 25.2 dBm
- OIP3: 43.4 dBm

APPLICATIONS

- Systems Requiring Flat Gain
- Linear Driver Amplifier
- Small Cells and Cellular Repeaters
- IF Amplifier

ORDERING INFORMATION

Buy it Now

DESCRIPTION

The GRF2040 is a broadband gain block with exceptional gain flatness for small cell, wireless infrastructure and other high-performance applications. It exhibits outstanding broadband noise figure (NF) and linearity from 400 to 4000 MHz with a single match and can be optimized for applications from 50 MHz to 5 GHz.

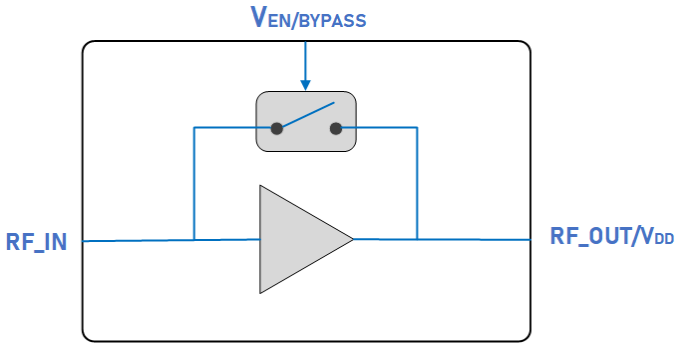
The device can be operated from a supply voltage of 2.7 to 8 V with a selectable I_{DDQ} range of 15 to 90 mA for optimal efficiency and linearity.

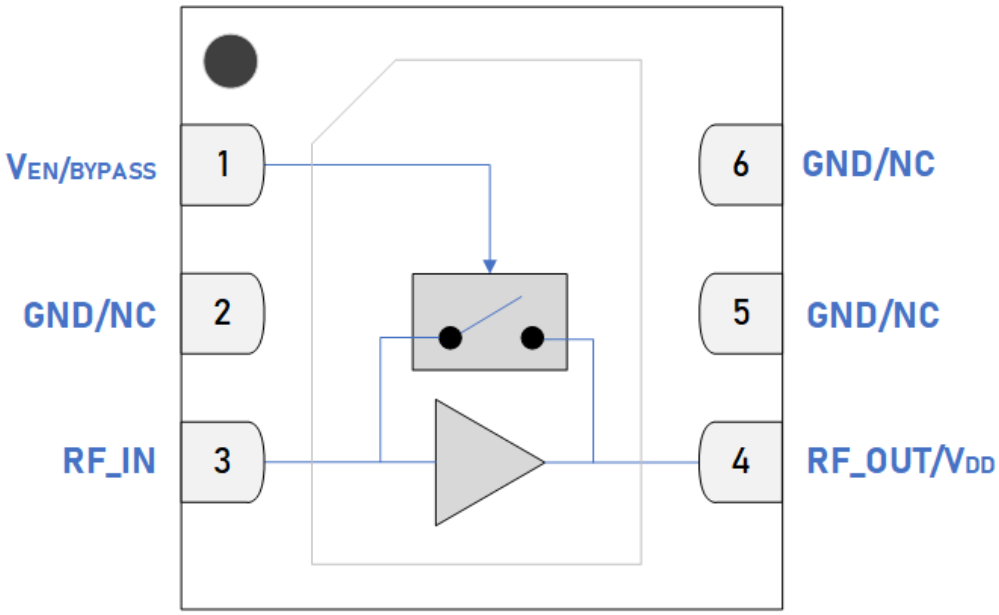
The GRF2040 is internally matched to 50 Ω at the input and output ports requiring only external DC blocks and a bias choke on the output.

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 GRF2040 "Custom Tunes" product page: GRF2040 Custom Tunes

BLOCK DIAGRAM





Pin Out (Top View)

Pin Assignments

Pin	Name	Description	Note
1	V_{ENABLE}	Enable Voltage Input	V_{ENABLE} and series resistor set I_{DDQ}. $V_{ENABLE} \leq 0.2$ volts disables device. On-die pull-down resistor will turn the device off if this node is allowed to float. Note: Pin 1 voltage should not exceed 3.0 V due to excessive resulting I_{ENABLE}.
2, 5, 6	GND/NC	Ground or No Connect	No internal connection to die.
3	RF_IN	RF Input	Internally matched to 50 Ω. An external DC blocking capacitor must be used.
4	RF_OUT/V_{DD}	RF Output	Internally matched to 50 Ω. V_{DD} must be applied through an RF choke to this pin.
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.

Absolute Ratings

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	V_{DD}	0	9	V
RF Input Power: Load VSWR < 2:1, $V_{DD} \leq 8$ V	$P_{IN\ MAX}$		27	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	W

Electrostatic Discharge

Human Body Model	HBM	200		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 - Packaging and Manufacturing Information.

All Guerrilla RF products are provided in RoHS compliant lead (Pb)-free packaging. For additional information, please refer to the Certificate of RoHS Compliance.

Recommended Operating Conditions

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{DD}	2.7	5	9	V	
Operating Temperature Range	$T_{PKG\ BASE}$	-40		105	°C	
RF Frequency Range	F_{RF}	0.05	2	5	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: GRF2040 Custom Tunes

Note 2: Contact the GRF applications team for guidance on optimizing the tuning of the device for alternative bands.

Nominal Operating Parameters - General

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Switching Rise Time	T_{RISE}		80		ns	Disabled Mode to Gain Mode. Pout = 0 dBm **(note 3)**.
Switching Fall Time	T_{FALL}		30		ns	Gain Mode to Disabled Mode. Pout = 0 dBm **(note 4)**.
Supply Current	I_{DD}		90		mA	V_{DD} = 5 V, V_{ENABLE} = 5 V.
Enable Current	I_{ENABLE}		5		mA	V_{DD} = 5 V, V_{ENABLE} = 5 V.

Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		75		°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 $T_j \leq 170$ °C.

Nominal Operating Parameters - RF

The following conditions apply unless noted otherwise; Typical Application Schematic, V_{DD} = 5 V, F_{TEST} = 2 GHz, 50 Ω system impedance, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

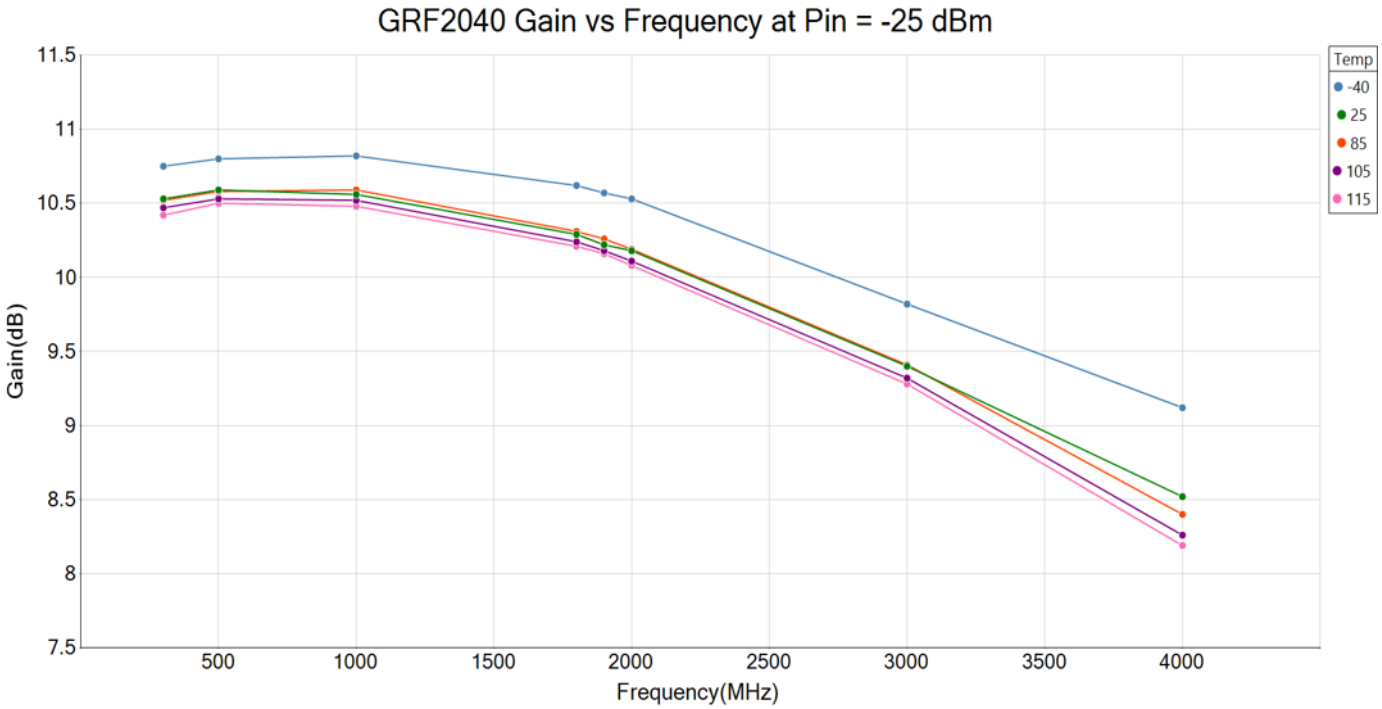
Gain Mode

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Current	I_{DD}		90		mA	V_{DD} = 5 V, V_{ENABLE} = 5 V.
Gain	S21		10.2		dB	
Noise Figure	NF		3.4		dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		35.3		dBm	2 dBm P_{OUT} per tone at 2 MHz spacing (2000 and 2002 MHz).
Output 1 dB Compression Power	OP1dB		20.9		dBm	

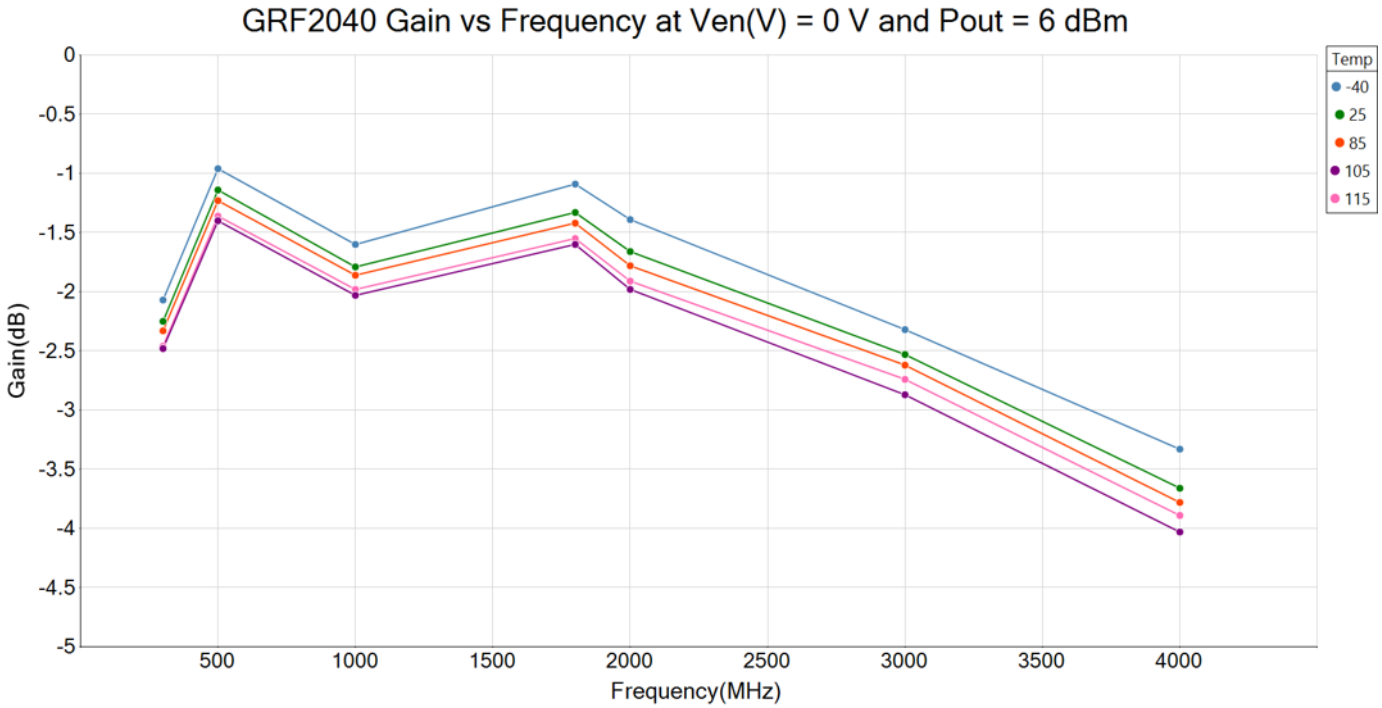
Bypass Mode

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Current	I_{DD}		0.5		mA	V_{DD} = 5 V, V_{ENABLE} = 0 V.
Gain	S21		-1.6		dB	
Output 3rd Order Intercept Point	OIP3		43.4		dBm	2 dBm P_{OUT} per tone at 2 MHz spacing (2000 and 2002 MHz).
Output 1 dB Compression Power	OP1dB		25.2		dBm	

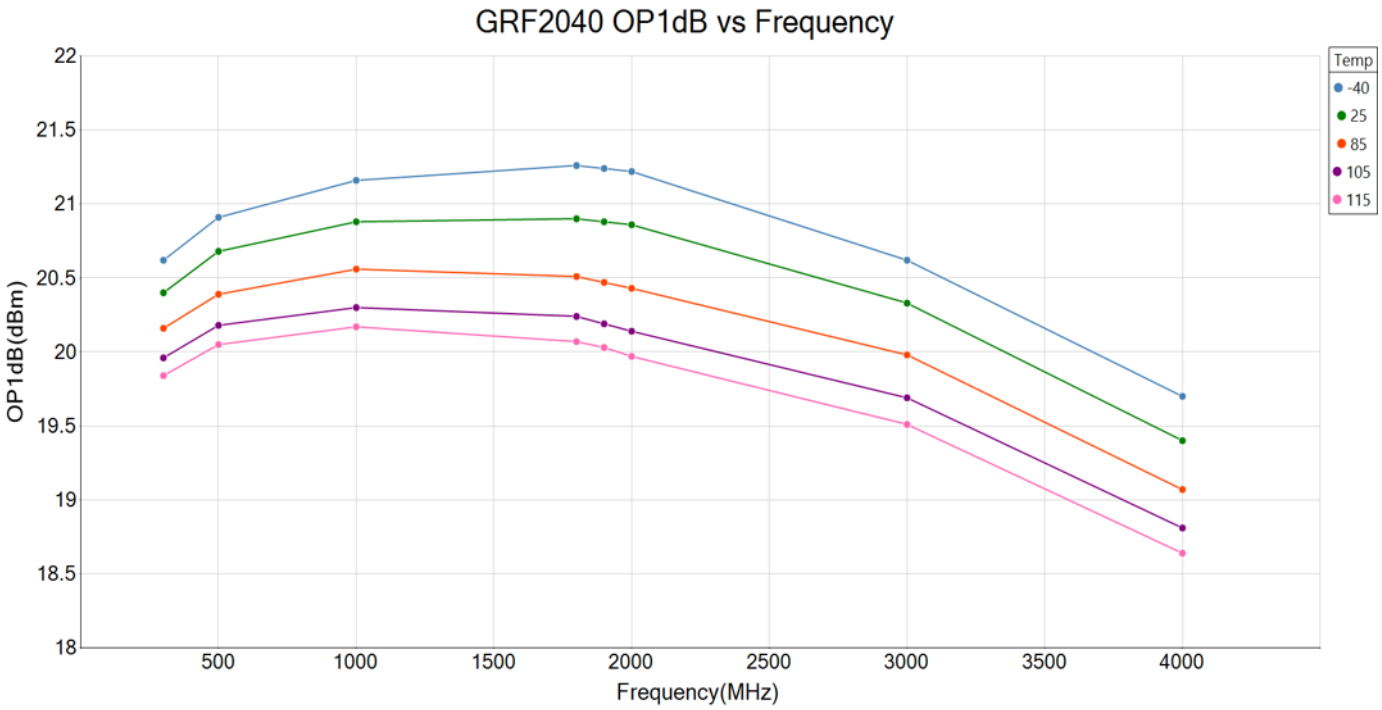
GRF2040 Typical Operating Curves: 0.4 to 4 GHz Tune



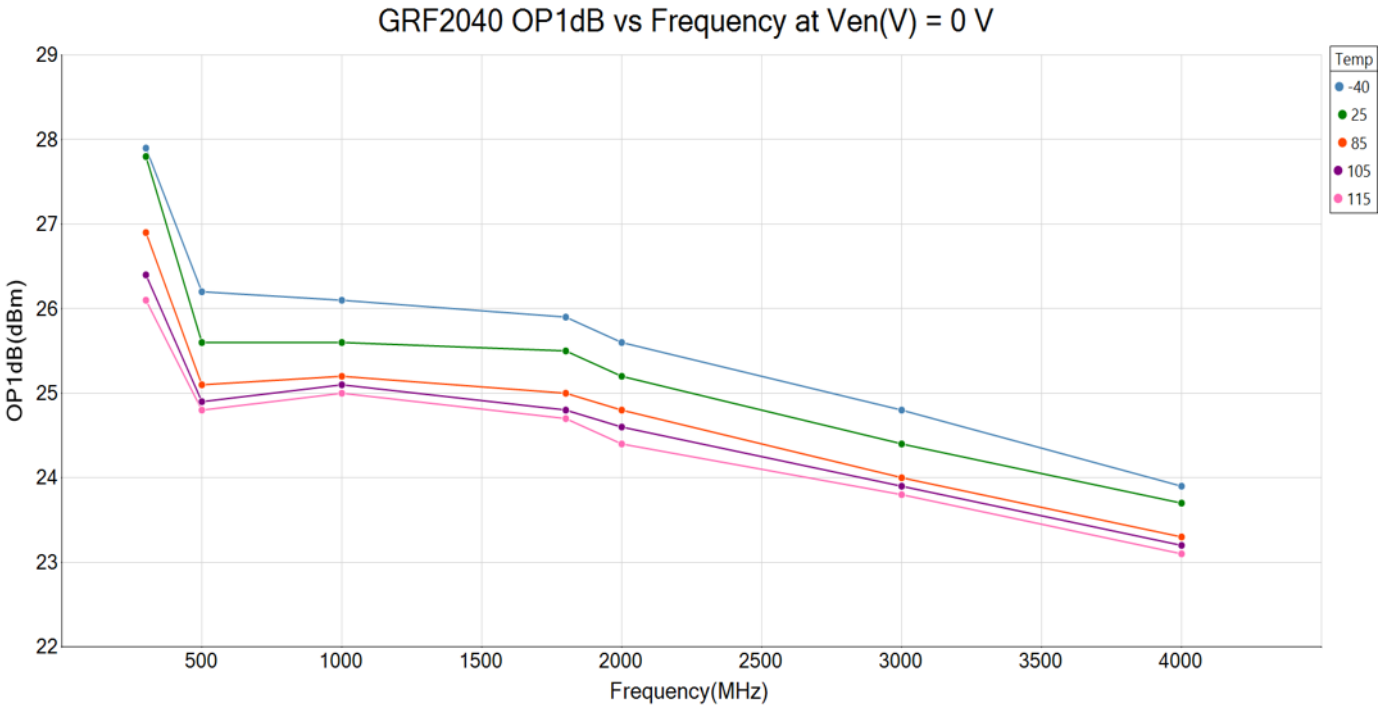
Bypass Mode Gain



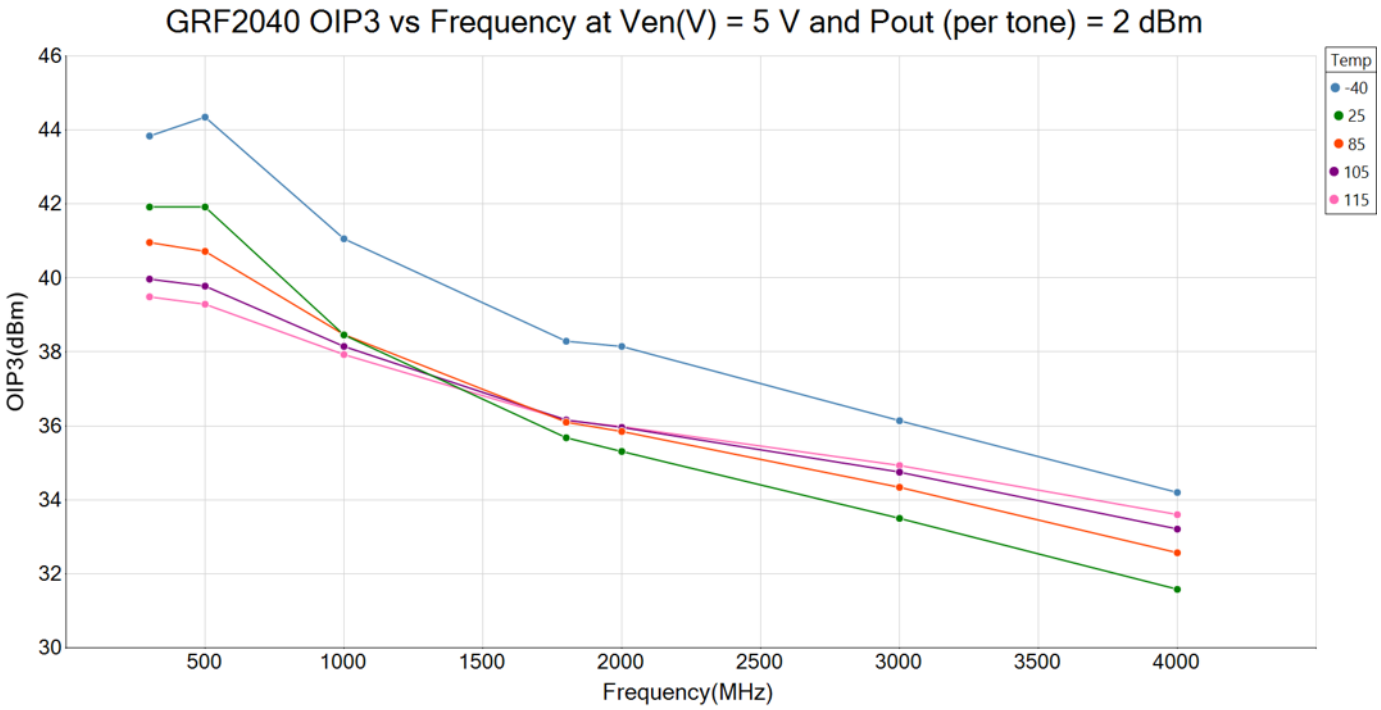
GRF2040 Typical Operating Curves: 0.4 to 4 GHz Tune



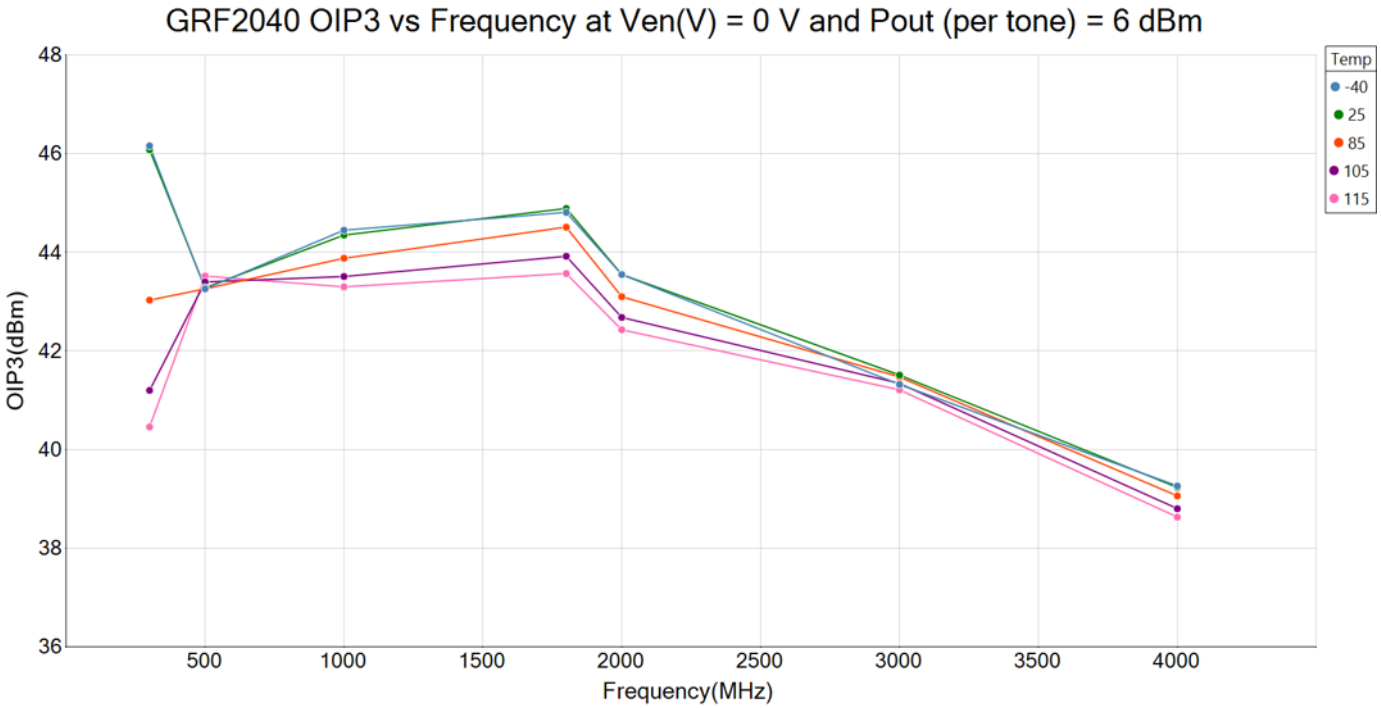
Bypass Mode OP1dB



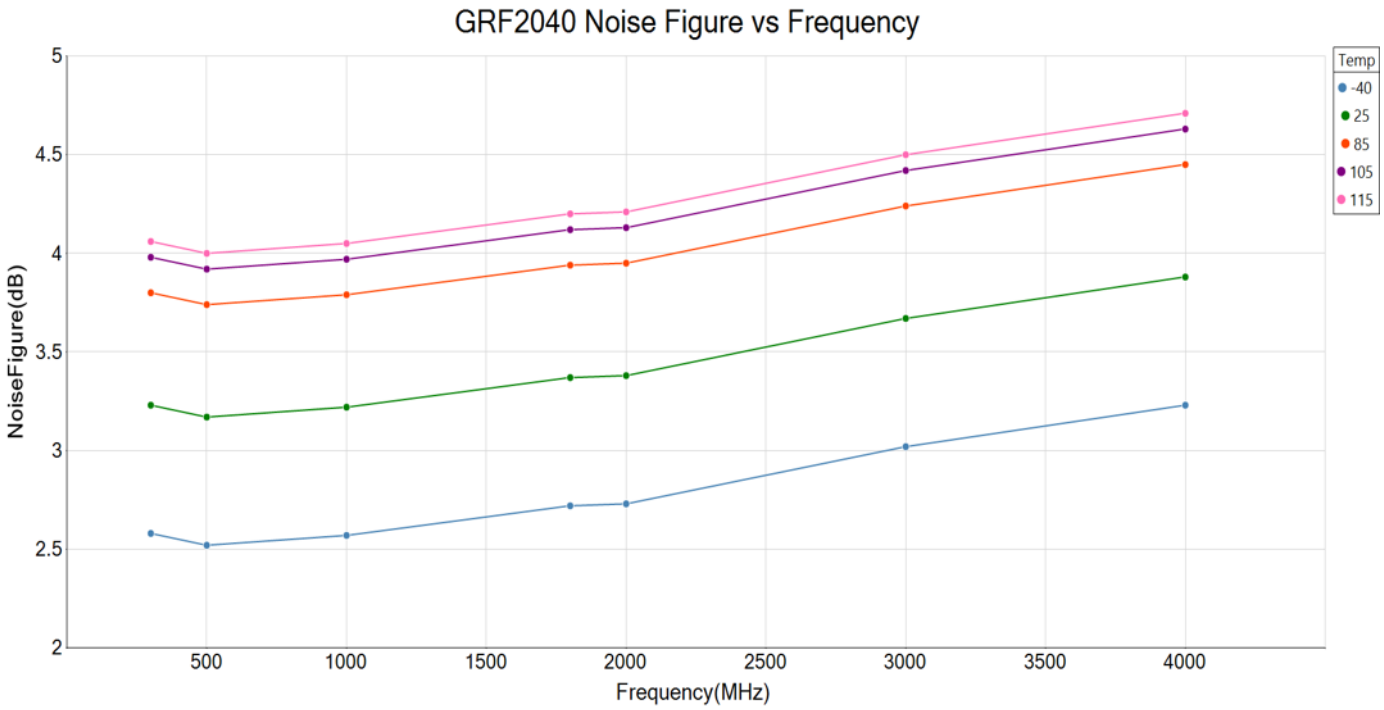
GRF2040 Typical Operating Curves: 0.4 to 4 GHz Tune

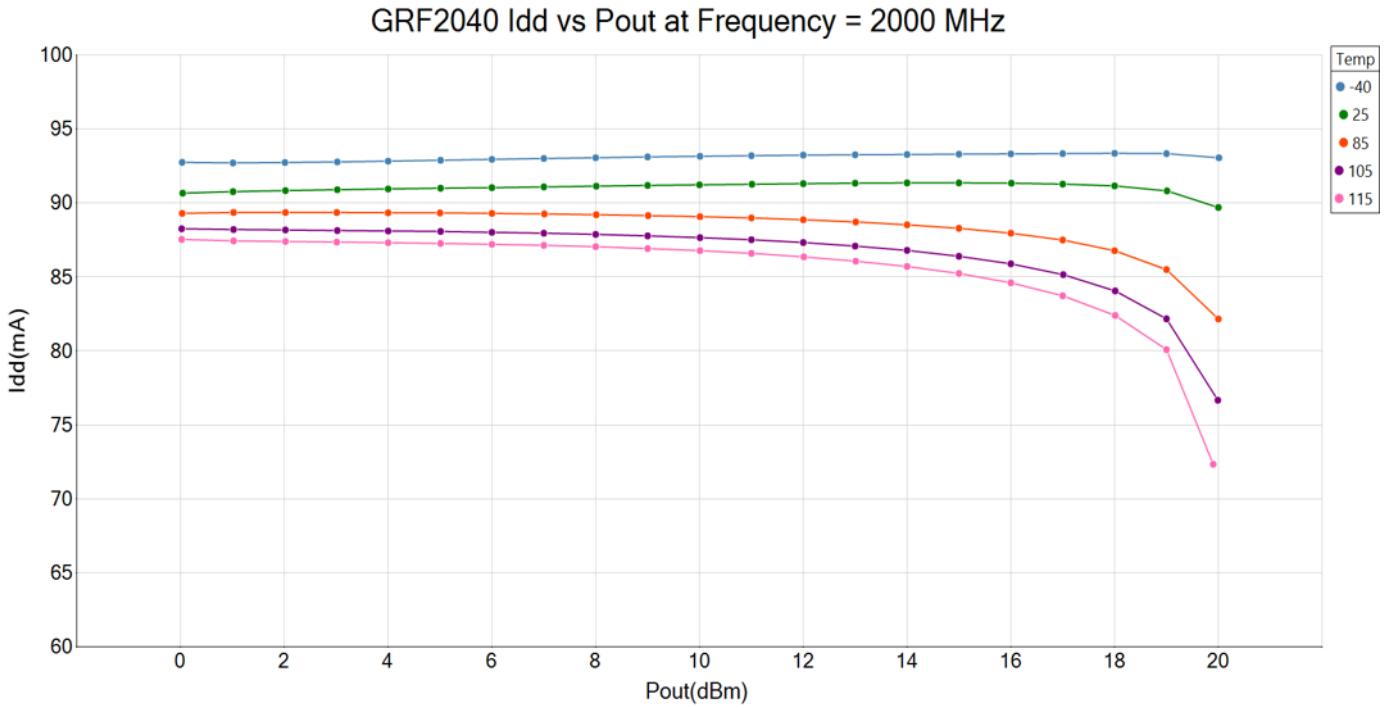


Bypass Mode OIP3

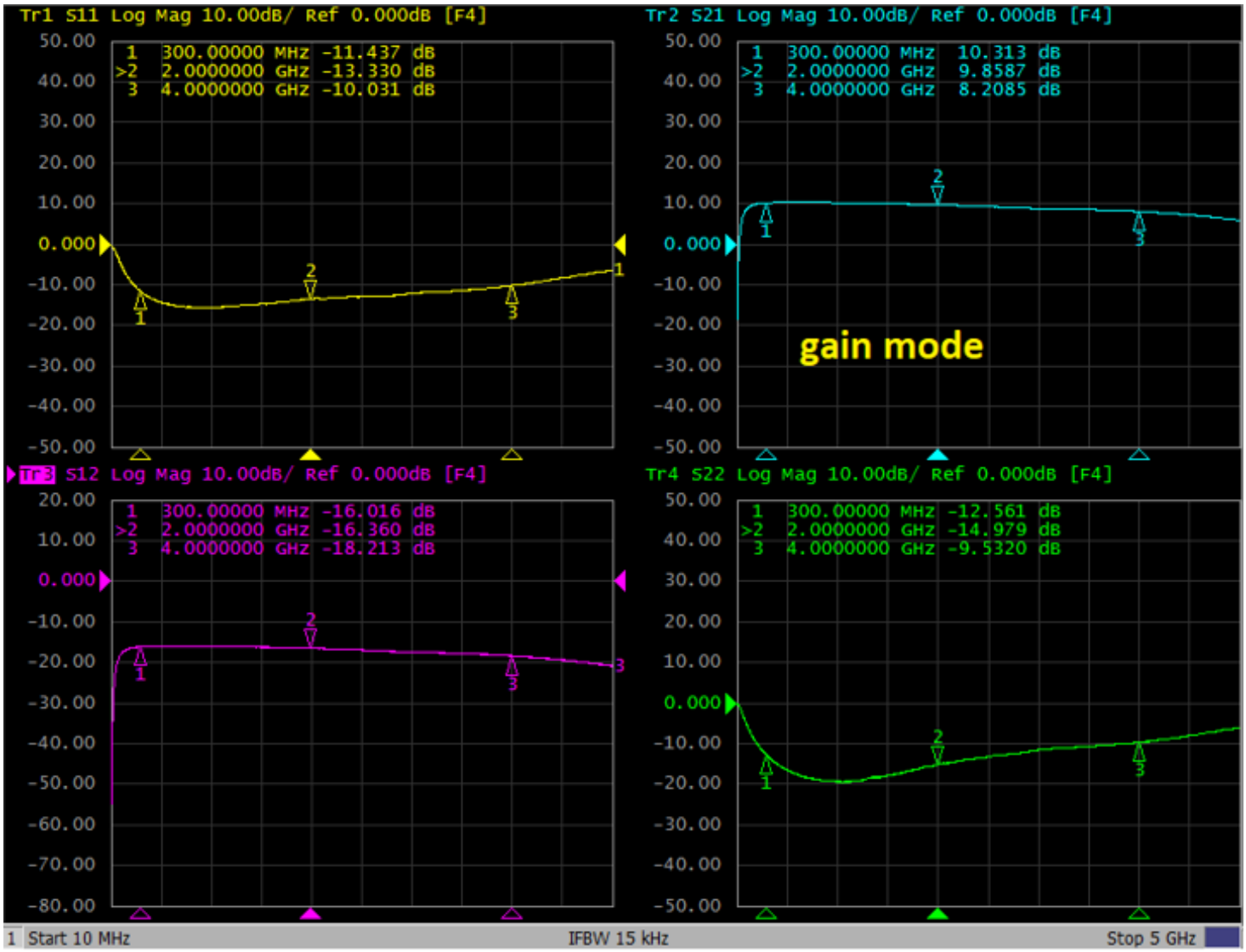


GRF2040 Typical Operating Curves: 0.4 to 4 GHz Tune

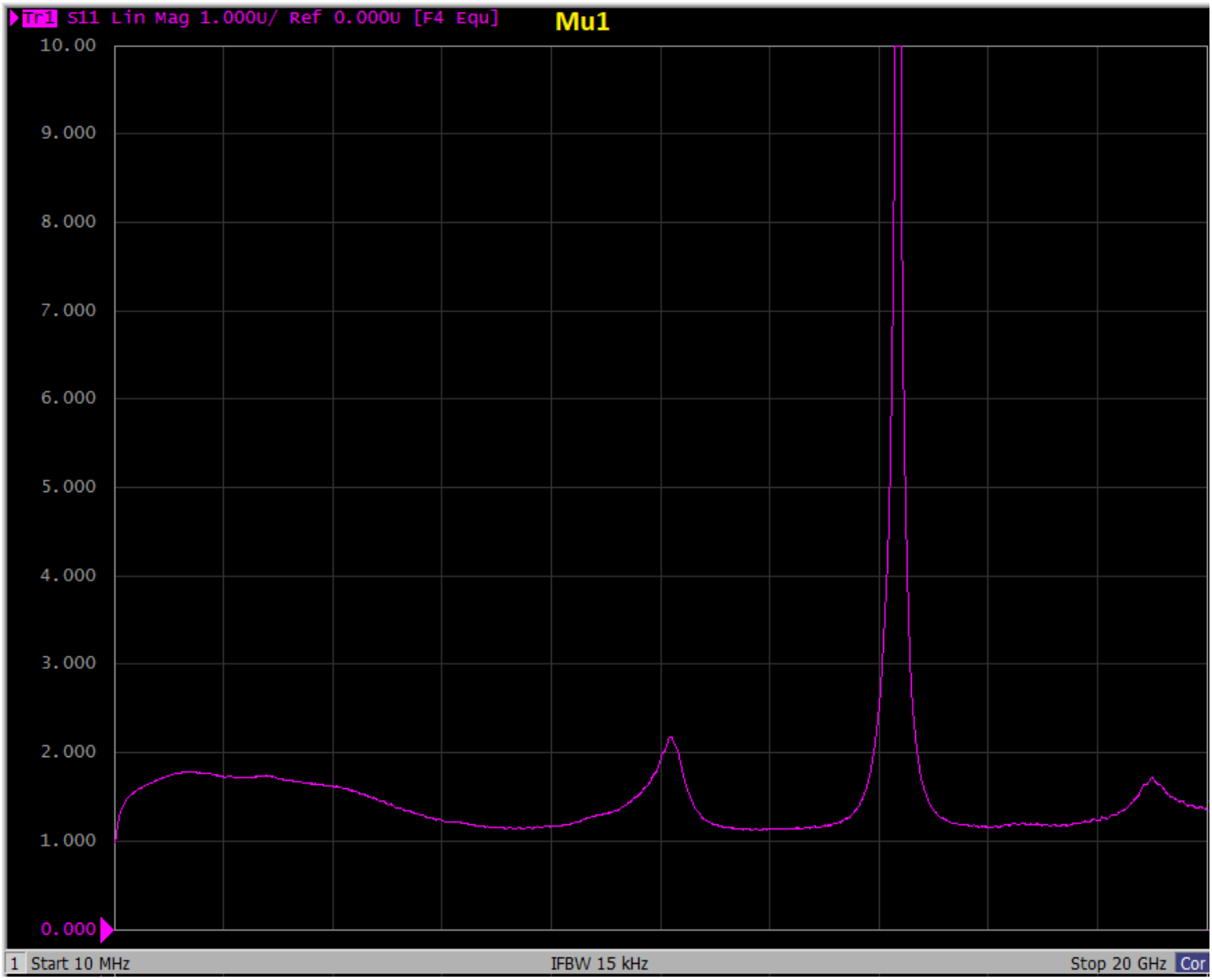




GRF2040 Typical Operating Curves: S-Parameters (300 MHz to 4 GHz)

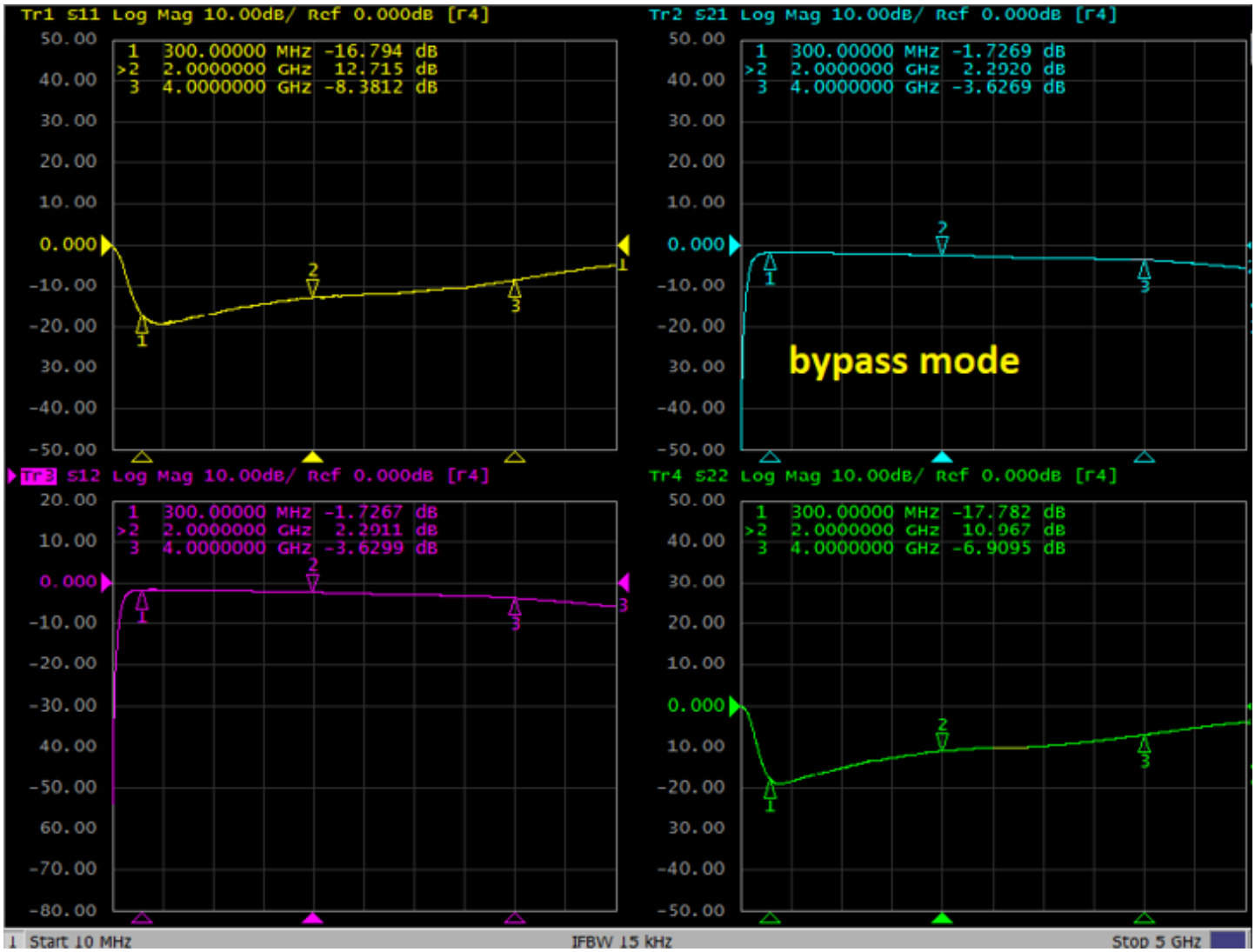


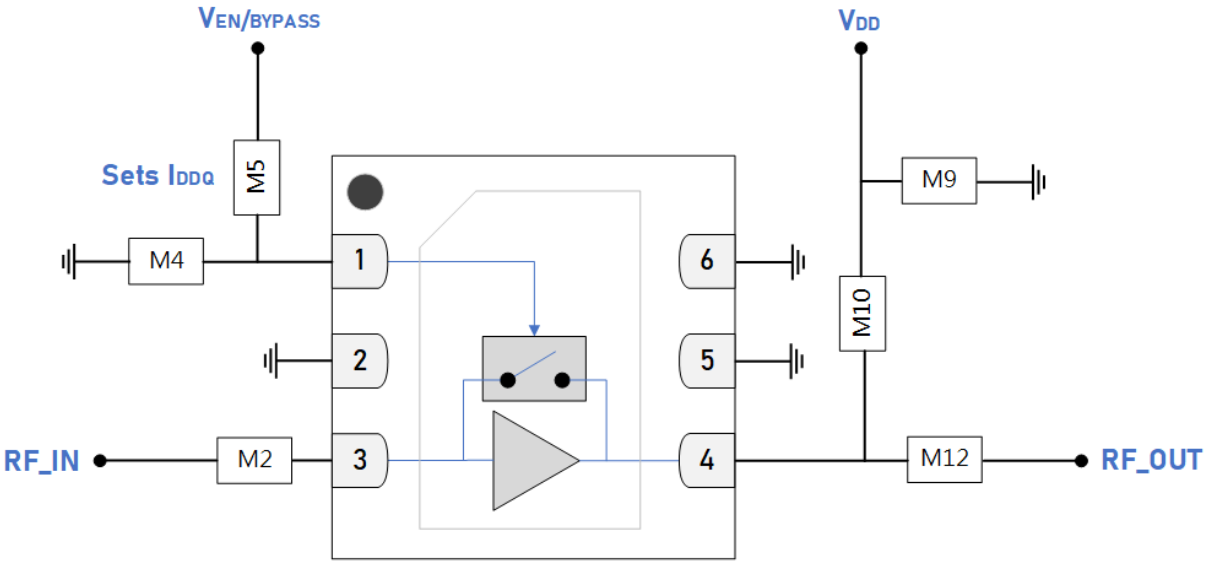
GRF2040 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



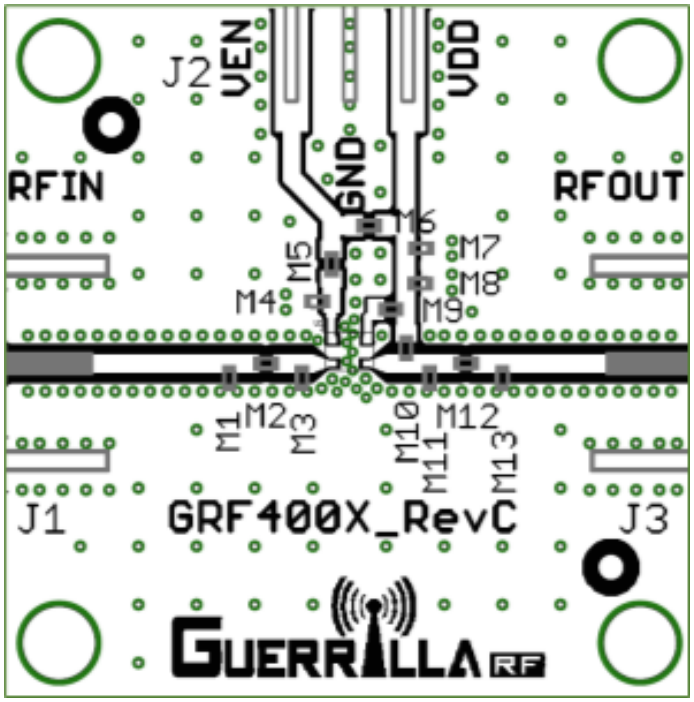
Note: Mu Factor ≥ 1.0 implies unconditional stability.

GRF2040 Typical Operating Curves: S-Parameters (300 MHz to 4 GHz)





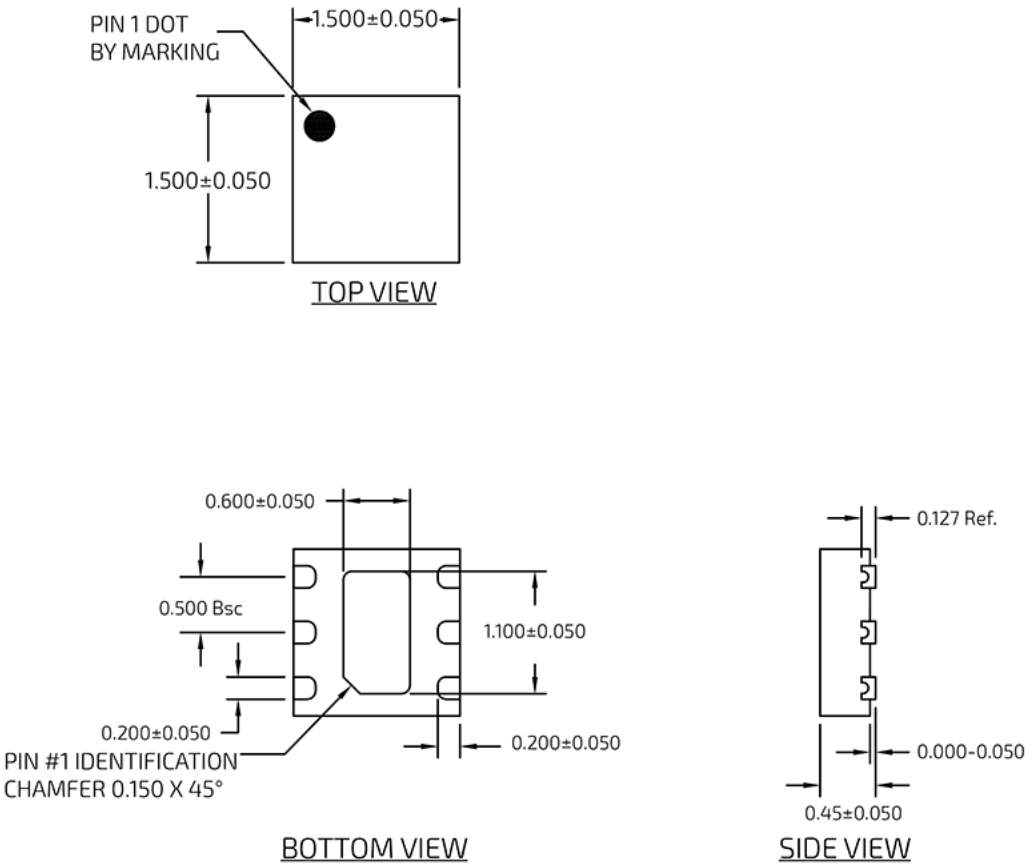
GRF2040 Standard Evaluation Board Schematic



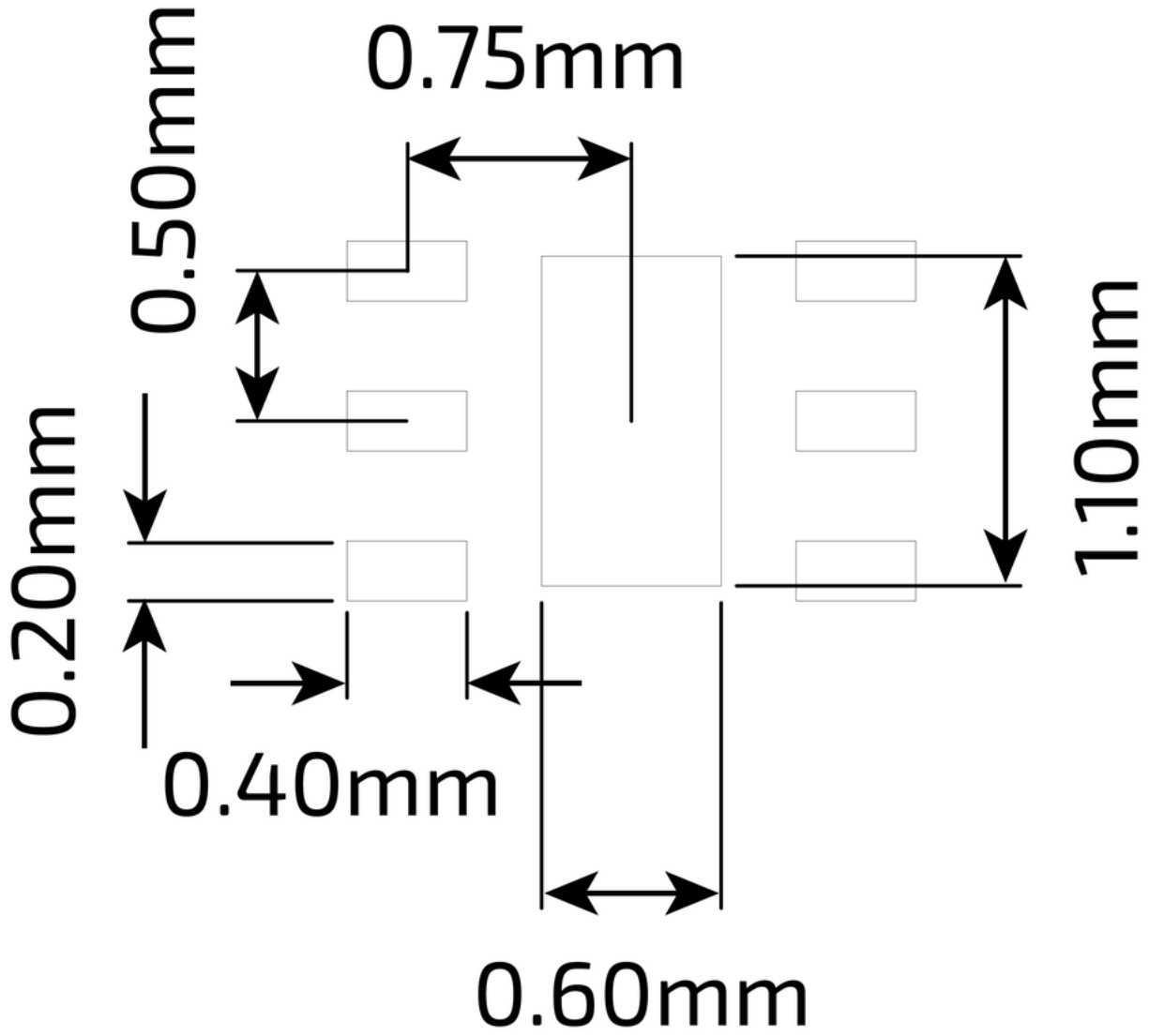
GRF2040 Evaluation Board Assembly Diagram

GRF2040 Evaluation Board Assembly Diagram Reference (0.4 to 4 GHz Tune)

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M2	Capacitor	Murata	GRM	100 pF	0402	ok
M4	Capacitor	Murata	GRM	100 pF	0402	ok
M5 (sets I_{DDQ})	Resistor	Various	5%	500 Ω	0402	ok
M9	Capacitor	Murata	GRM	0.1 µF	0402	ok
M10	Inductor	Murata	LQG	47 nH	0402	ok
M12	Capacitor	Murata	GRM	100 pF	0402	ok
Evaluation Board	GRF400X_ RevC					



DFN 6 1.5x1.5mm Package Dimensions



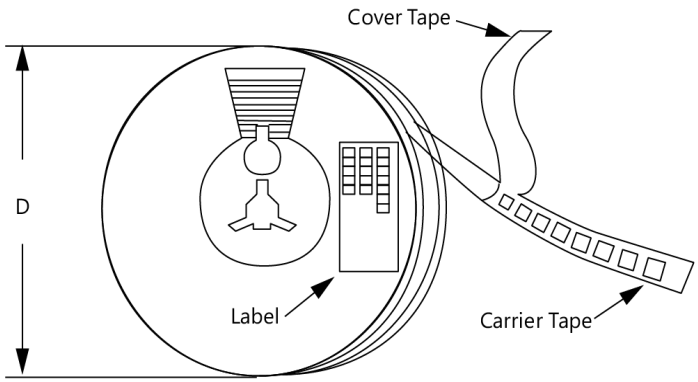
DFN 6 1.5x1.5mm Suggested PCB Footprint (Top View)

Package Marking Diagram

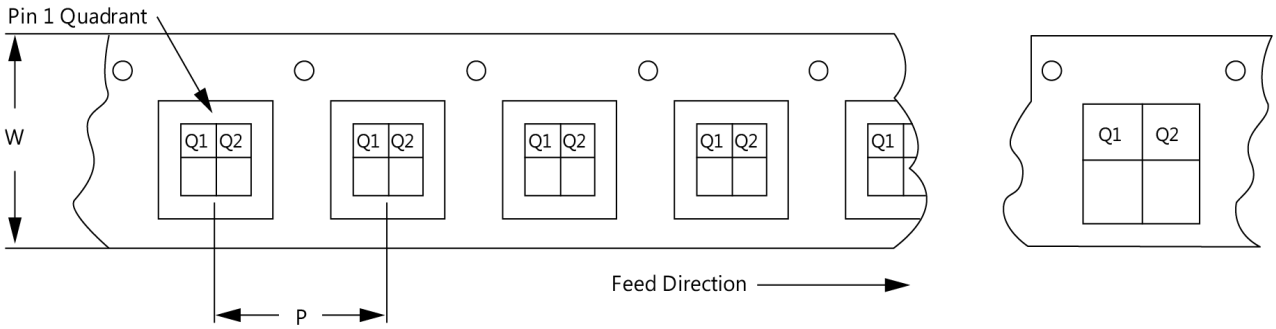
Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
Line 2: "XXXX" = Device Part Number.

Tape and Reel Information

Guerrilla RF's tape and reel specification complies with Electronics Industries Association (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). 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 latest reel specifications and package information (including units/reel), please visit 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
October 12, 2023	Preliminary Data Sheet.
May 31, 2024	Updated HBM specification.
September 9, 2024	Release Ø Data Sheet. Updated RF specifications and plots. Changed HBM from 125 to 200 volts.

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.

www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Road, Greensboro, NC 27455