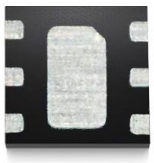
Data Sheet

PRELIMINARY DATA SHEET



GRF2133W

ULTRA-HIGH GAIN LNA
0.1 to 2.7 GHz

FEATURES

- Internally Matched
- Unconditionally Stable
- Flexible Biasing
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package

AEC-Q100 Grade 2 Qualification Pending

Reference: 5 V / 60 mA / 700 MHz
- Gain: 40 dB
- OP1dB: 20 dBm
- OIP3: 31 dBm
- Evaluation Board Noise Figure: 0.7

Reference: 5 V / 60 mA / 1950 MHz
- Gain: 28 dB
- OP1dB: 20 dBm
- OIP3: 31 dBm
- Evaluation Board Noise Figure: 0.6 dB

Reference: 5 V / 60 mA / 2500 MHz
- Gain: 23.5 dB
- OP1dB: 20 dBm
- OIP3: 30 dBm
- Evaluation Board Noise Figure: 0.75 dB

APPLICATIONS

- High Gain LNA
- Cellular Boosters/Repeaters
- Linear Driver Amplifiers

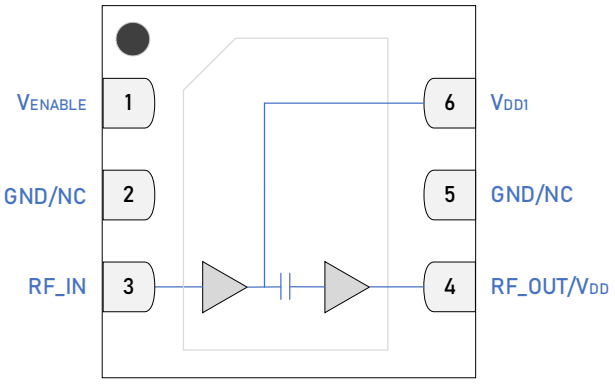
DESCRIPTION

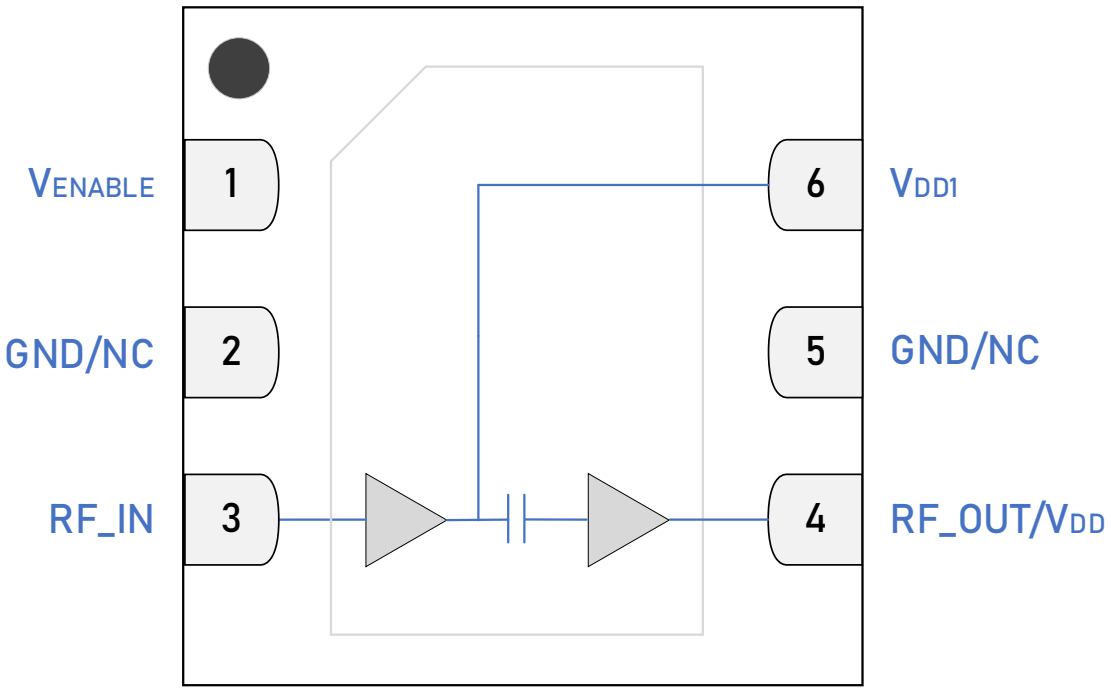
The GRF2133W is a broadband linear gain block featuring ultra-high gain and sub 0.85 dB noise figure for small cell, cellular booster, wireless infrastructure and other high performance applications.

Configured as a linear driver, LNA or cascaded gain block, it offers high levels of reuse both within a design and across high levels of reuse both within a design and across platforms. The device is operated from a supply voltage of 1.8 to 5 V with a selectable I_{DDQ} range of 35 to 120 mA for optimal efficiency and linearity.

Consult with the GRF applications engineering team for custom tuning/evaluation board data, device S-parameters and for applications with V_{DD} < 2.7 V.

BLOCK DIAGRAM





1.5 x 1.5 mm DFN-6 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 set I_{DDQ}. V_{ENABLE} < 0.2 volts disables device. On-die pull-down resistor will turn the device off if this node is allowed to float.
2, 5	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	RF_IN	RF Input	External DC block required.
4	RF_OUT/V_{DD}	RF Output	V_{DD} applied to this pin. External DC block required.
6	V_{DD1}	Bias Supply	Typically tied to V_{DD} via an external resistor or an inductor (for V_{DD} < 4 volts). Tying to V_{DD} allows for the reuse of M8 for the required decoupling.
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	6	V
RF Input Power (Load VSWR < 2:1, V_{DD} = 5 V)	$P_{IN\ MAX}$		23	dBm
Operating Temperature (Package Heat Sink)	T_{AMB}	-40	105	°C
Maximum Channel Temperature (MTTF >10^6 Hours)	T_{MAX}		170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		700	mW

Electrostatic Discharge

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 *Manufacturing Note MN-001 — Package and Manufacturing Information.*

RoHS compliant

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}	0	5	6	V	
Operating Temperature (Package Heat Sink)	$T_{PKG\ HEAT\ SINK}$	-40		105	°C	
RF Frequency Range	F_{RF}	0.1	1.95	2.7	GHz	Typical Application Schematic with external matching components **(note 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 this range is possible, but with degraded performance of some parameters.

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 2.7 GHz tuning set. V_{DD} = 5 V, I_{DDQ} = 60 mA. 50 Ω system impedance. F_{TEST} = 1.95 GHz. $T_{PKG\ HEAT\ SINK}$ = 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.		
Switching Rise Time	T_{RISE}		10		µs	
Switching Fall Time	T_{FALL}		200		ns	
Supply Current (Quiescent)	I_{DDQ}		60		mA	
Enable Current	I_{ENABLE}		2		mA	

Disabled Mode

Leakage Current	$I_{LEAKAGE}$		1		µA	V_{DD} = 5 V, V_{ENABLE} = 0 V

Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		65		°C/W	On standard evaluation board.
Channel Temperature @ +85 C reference (Package Heat Sink)	$T_{CHANNEL}$		105		°C	V_{DD} = 5 V, I_{DDQ} = 60 mA, No RF applied, P_{DISS} = 300 mW **(note 3).**

Note 3: MTTF >10^6 hours for $T_{CHANNEL}$ <170 °C.

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Nominal Operating Parameters – RF

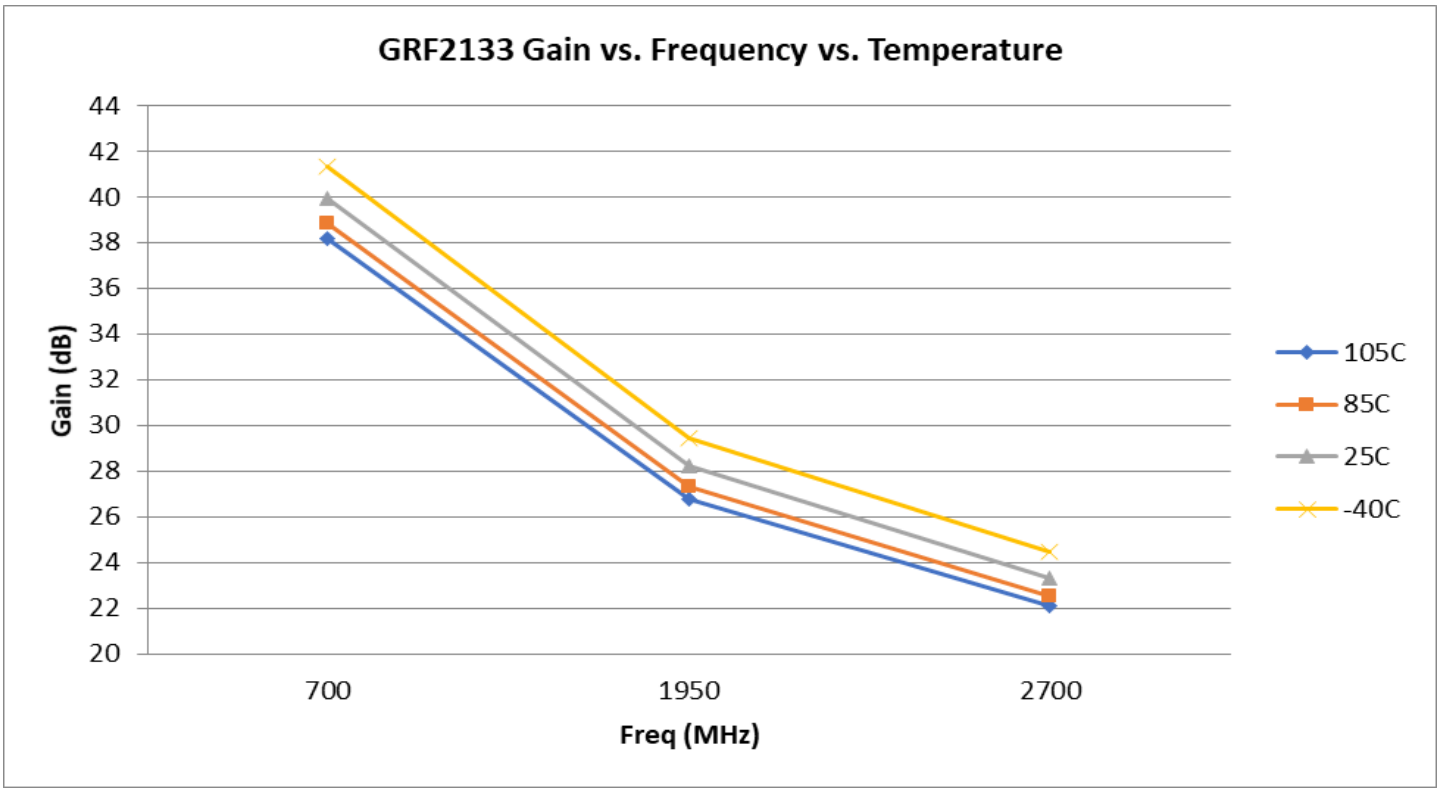
The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.1 to 2.7 GHz tuning set. V_{DD} = 5 V, I_{DDQ} = 60 mA. 50 Ω system impedance. F_{TEST} = 1.95 GHz. $T_{PKG\ HEAT\ SINK}$ = 25 °C. MIN/MAX specifications listed in italics are guaranteed via production test screening. All other parameters are guaranteed by design and characterization. Evaluation board losses are included within the specifications.

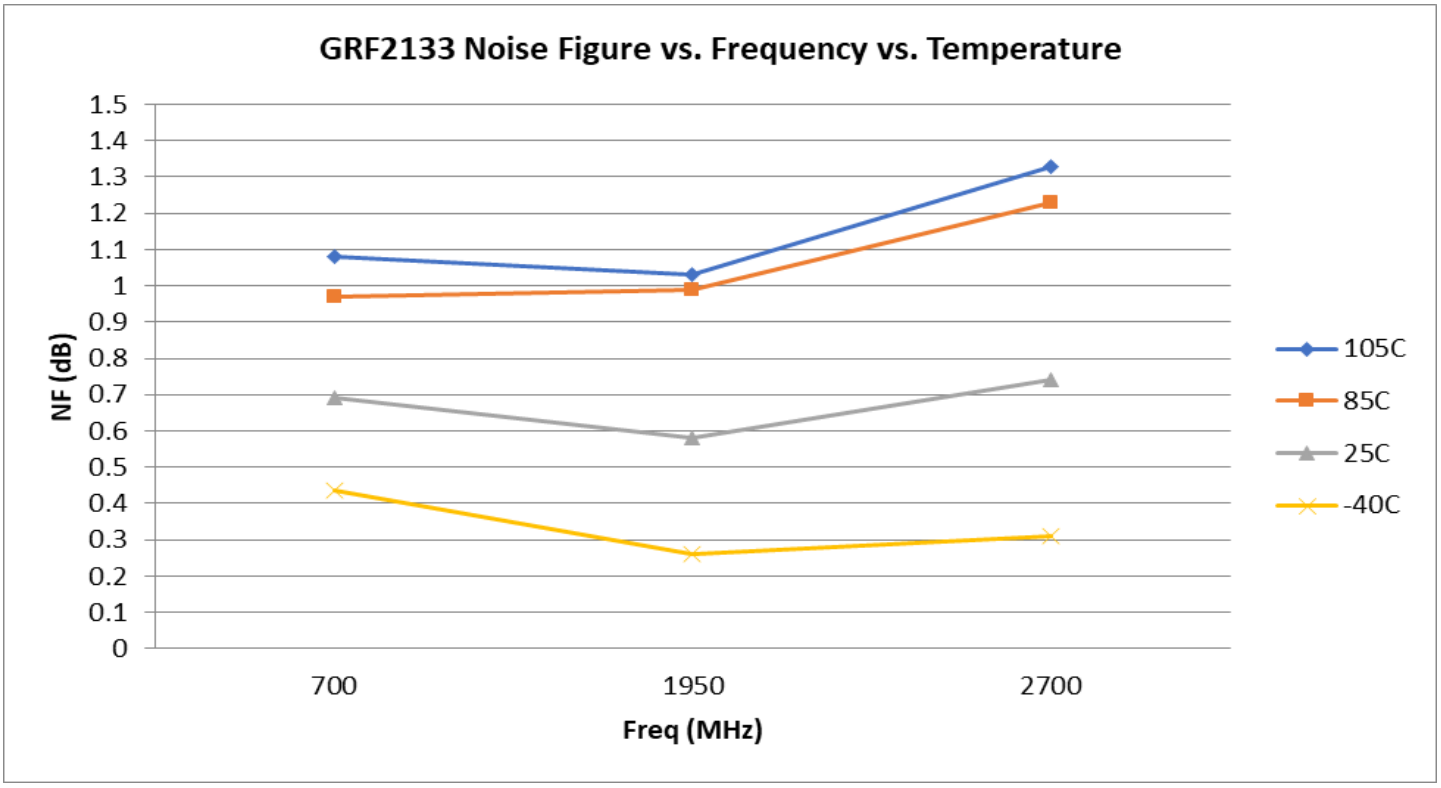
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21	*26.5*	28		dB	
Evaluation Board Noise Figure	NF		0.6	*0.8*	dB	
Output 3rd Order Intercept	OIP3		31		dBm	2 dBm P_{OUT} per Tone. 2 MHz Spacing (1.949 and 1.951 GHz).
Output 1 dB Compression Power	OP1dB	*18*	20		dBm	

Typical Operating Curve Conditions

The following conditions apply unless noted otherwise: Typical Application Schematic using the 0.1 to 2.7 GHz tuning set. V_{DD} = 5 V, I_{DDQ} = 60 mA. 50 Ω system impedance. F_{TEST} = 1.95 GHz. $T_{PKG\ HEAT\ SINK}$ = 25 °C. Evaluation board losses are included within the plots.

GRF2133W Typical Operating Curves: 0.1 to 2.7 GHz Tune





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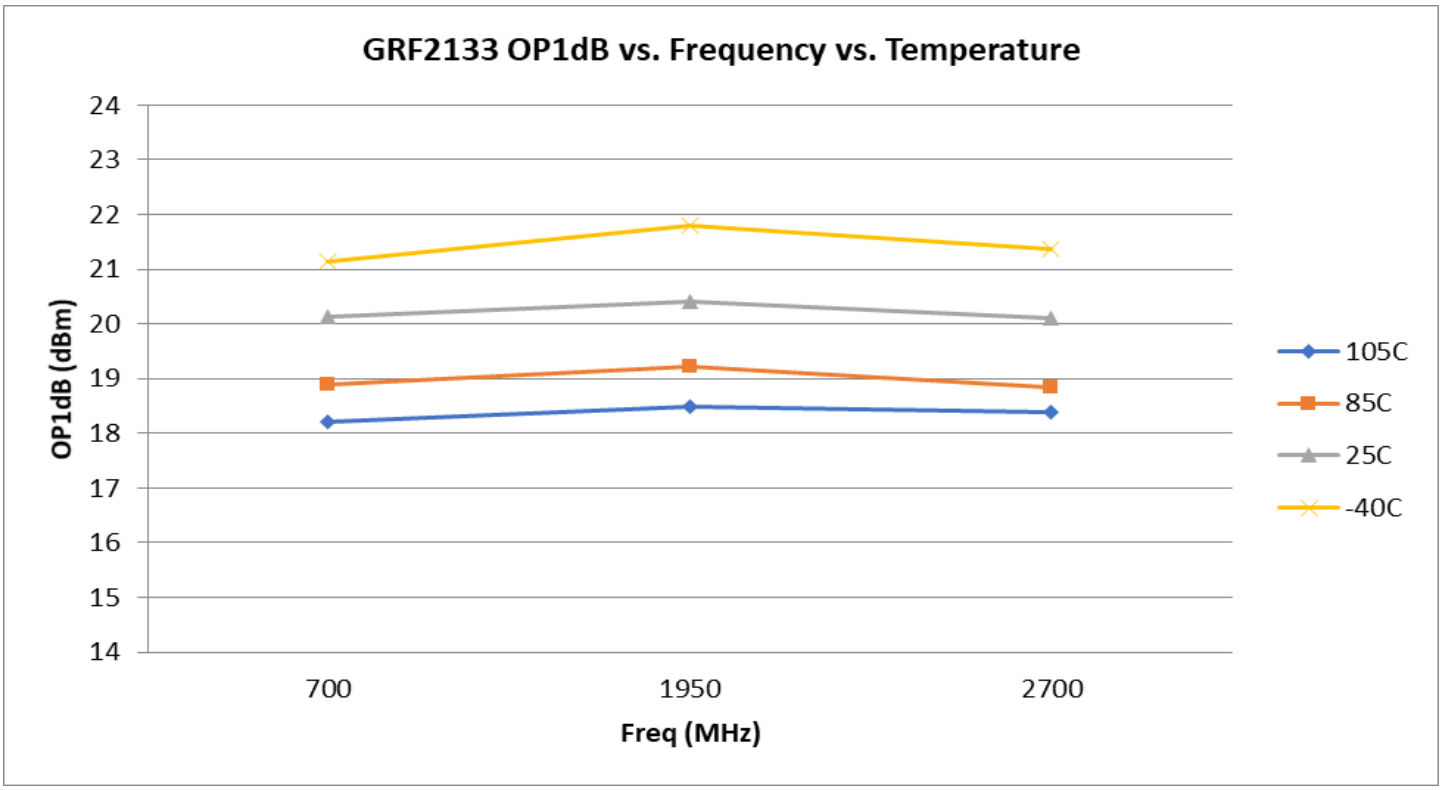
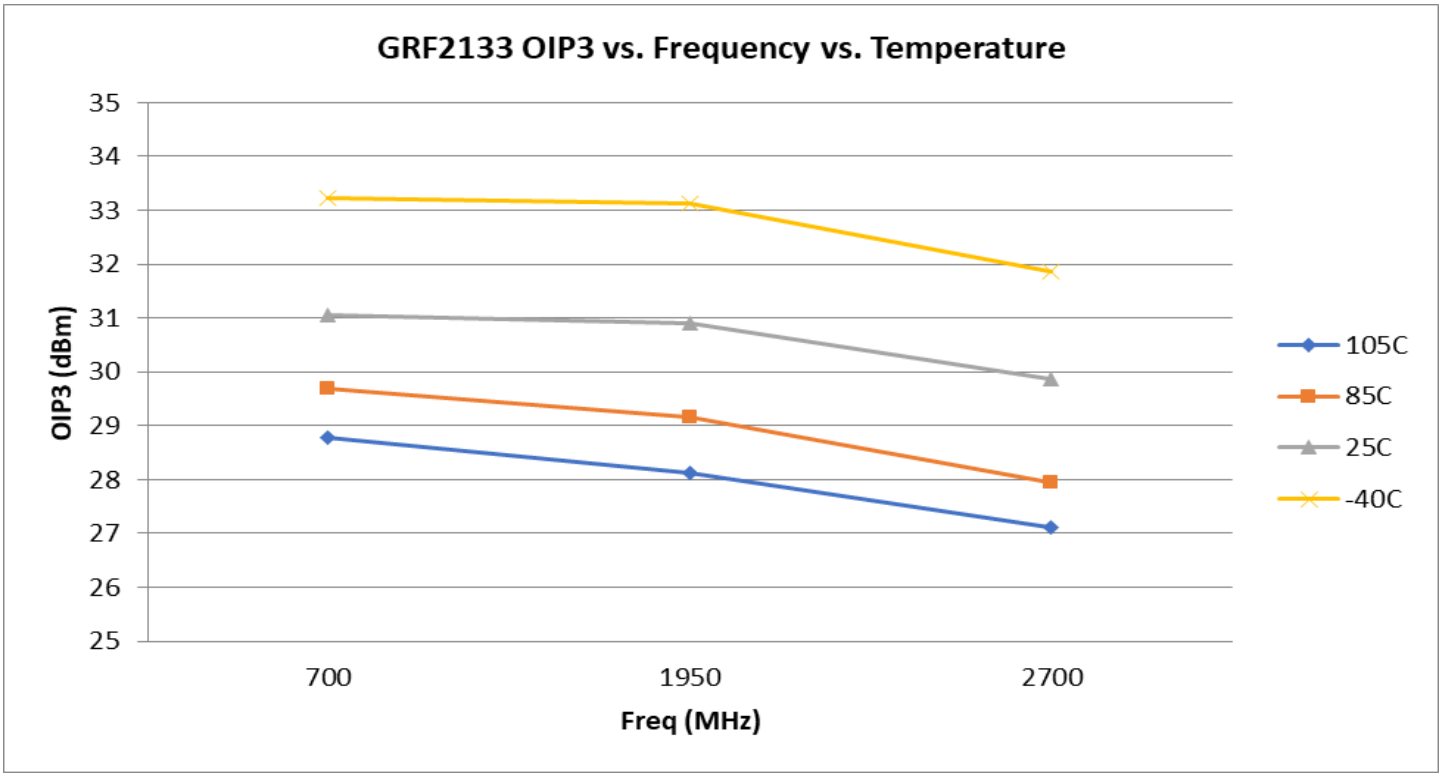
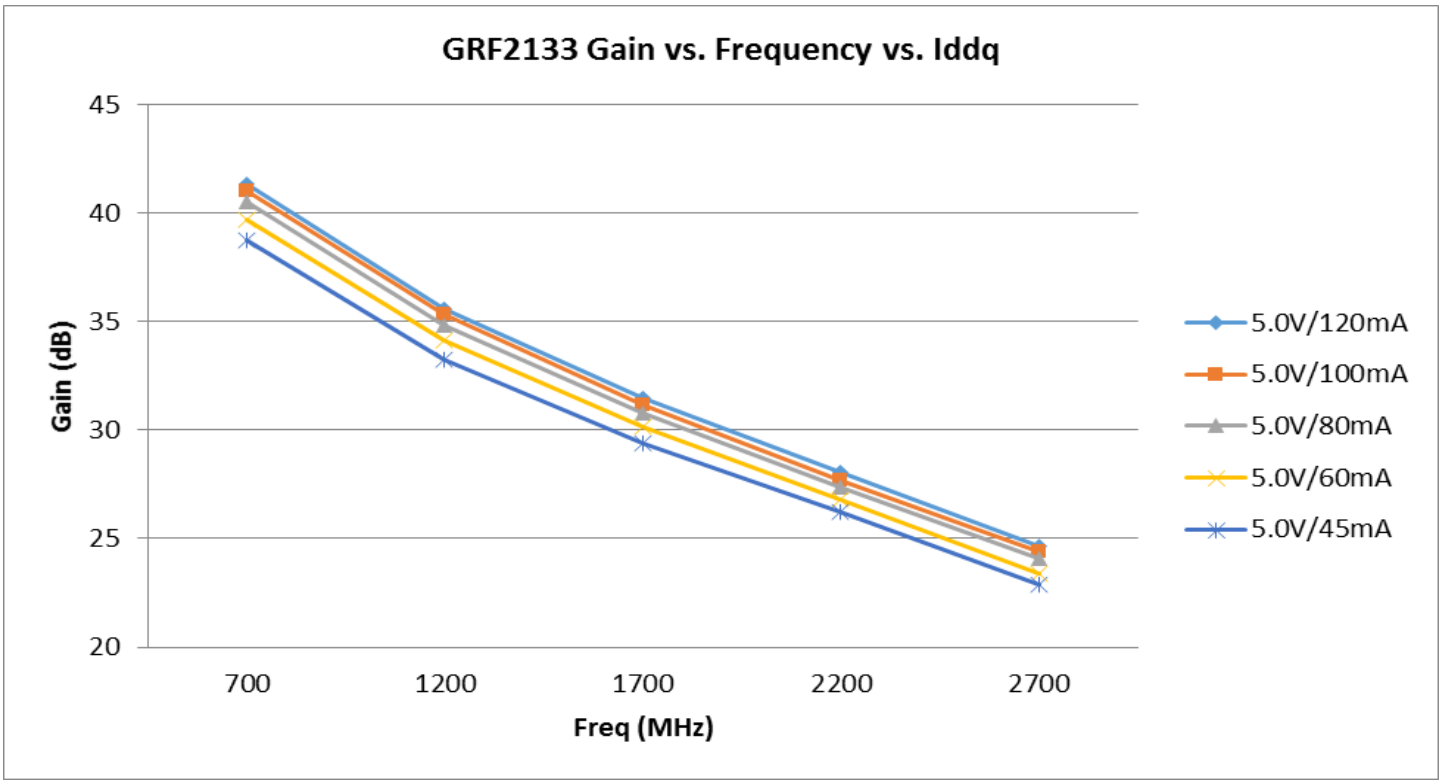
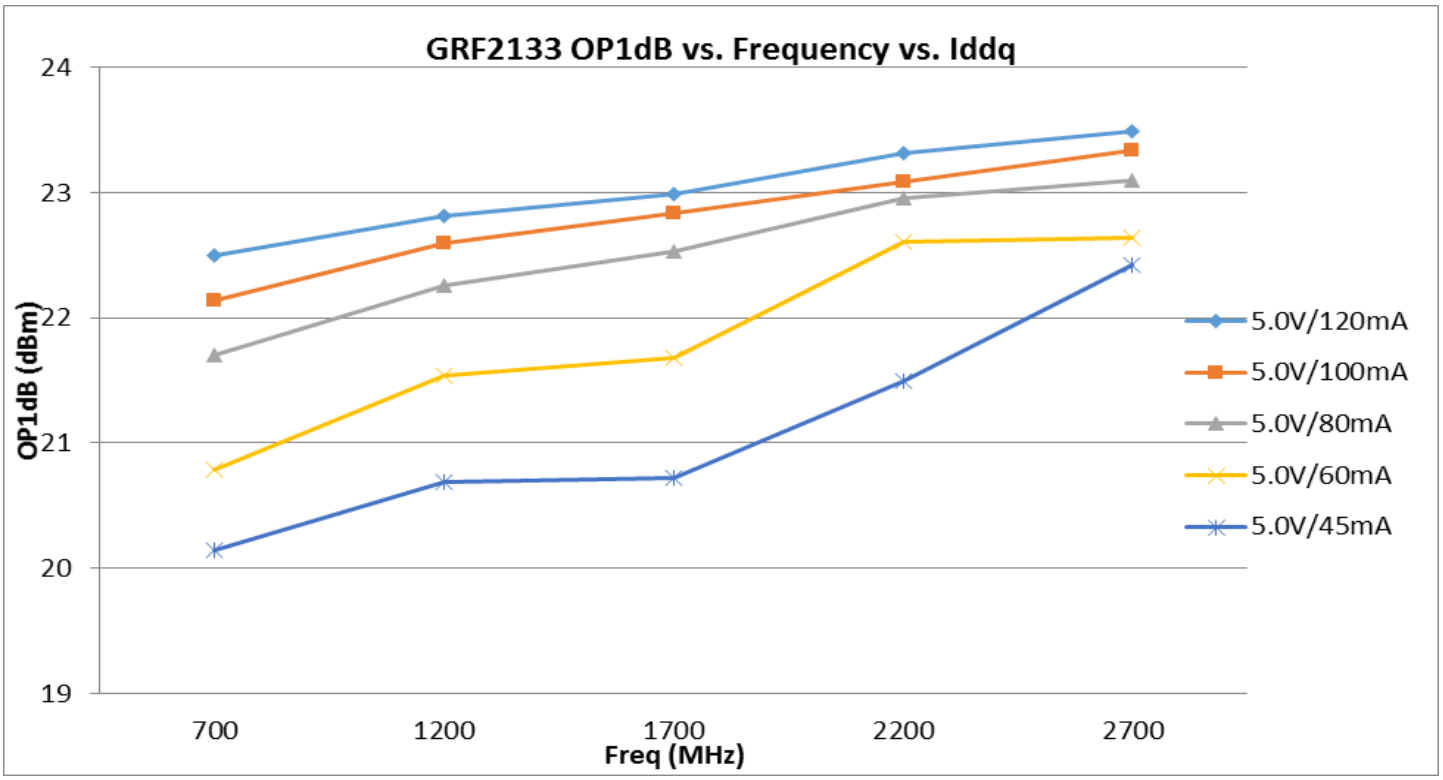
GRF2133W Typical Operating Curves: 0.1 to 2.7 GHz Tune





GRF2133W Typical Operating Curves: 0.1 to 2.7 GHz Tune





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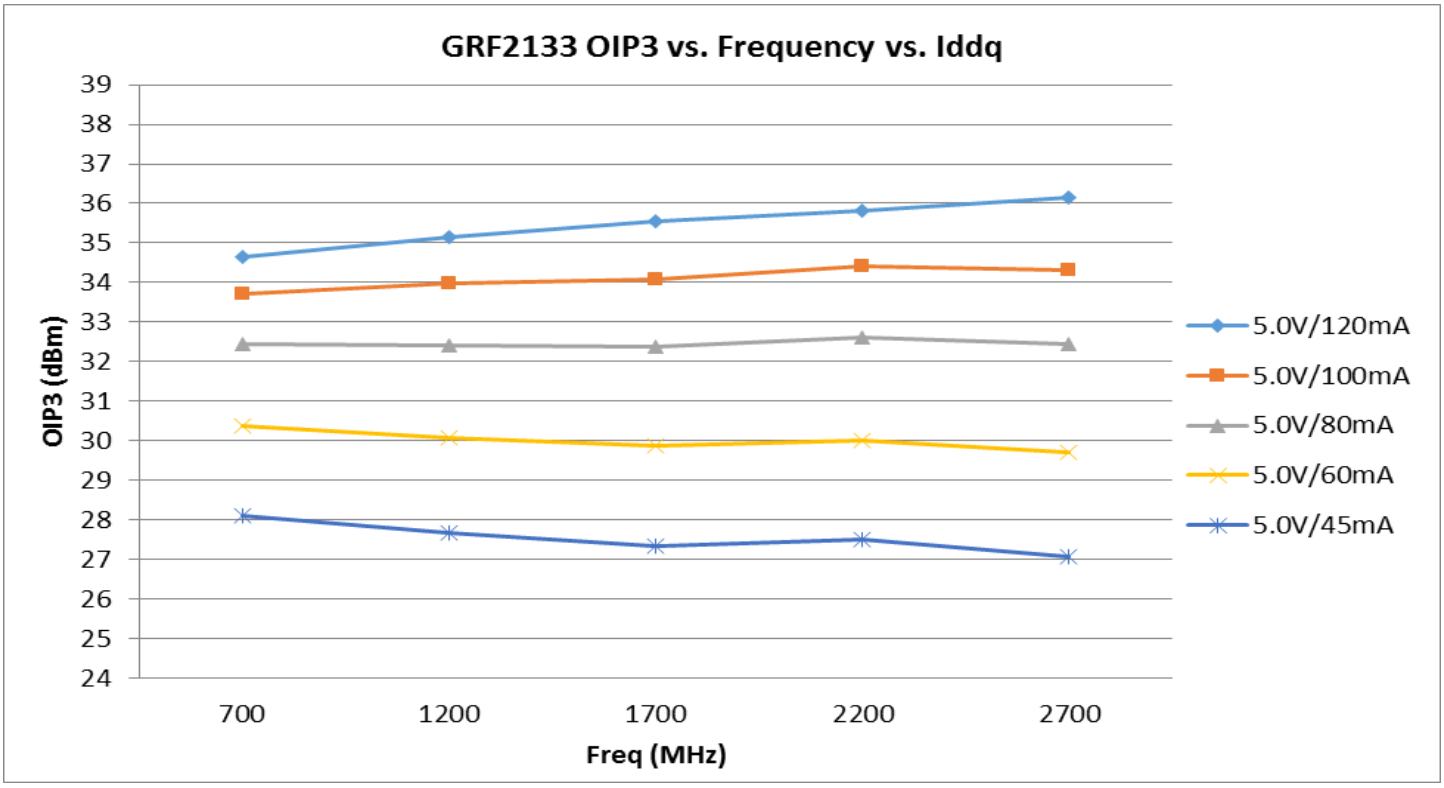
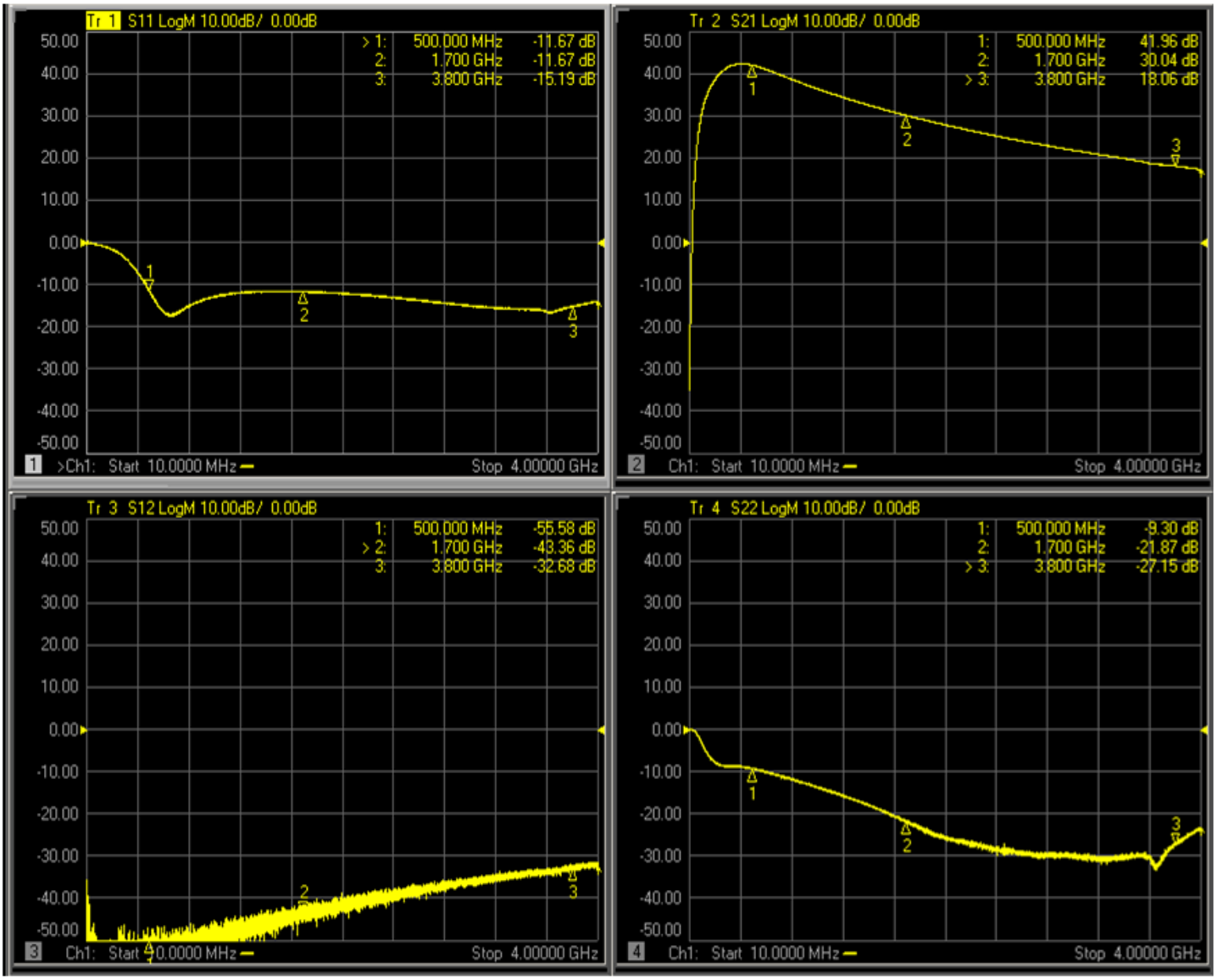
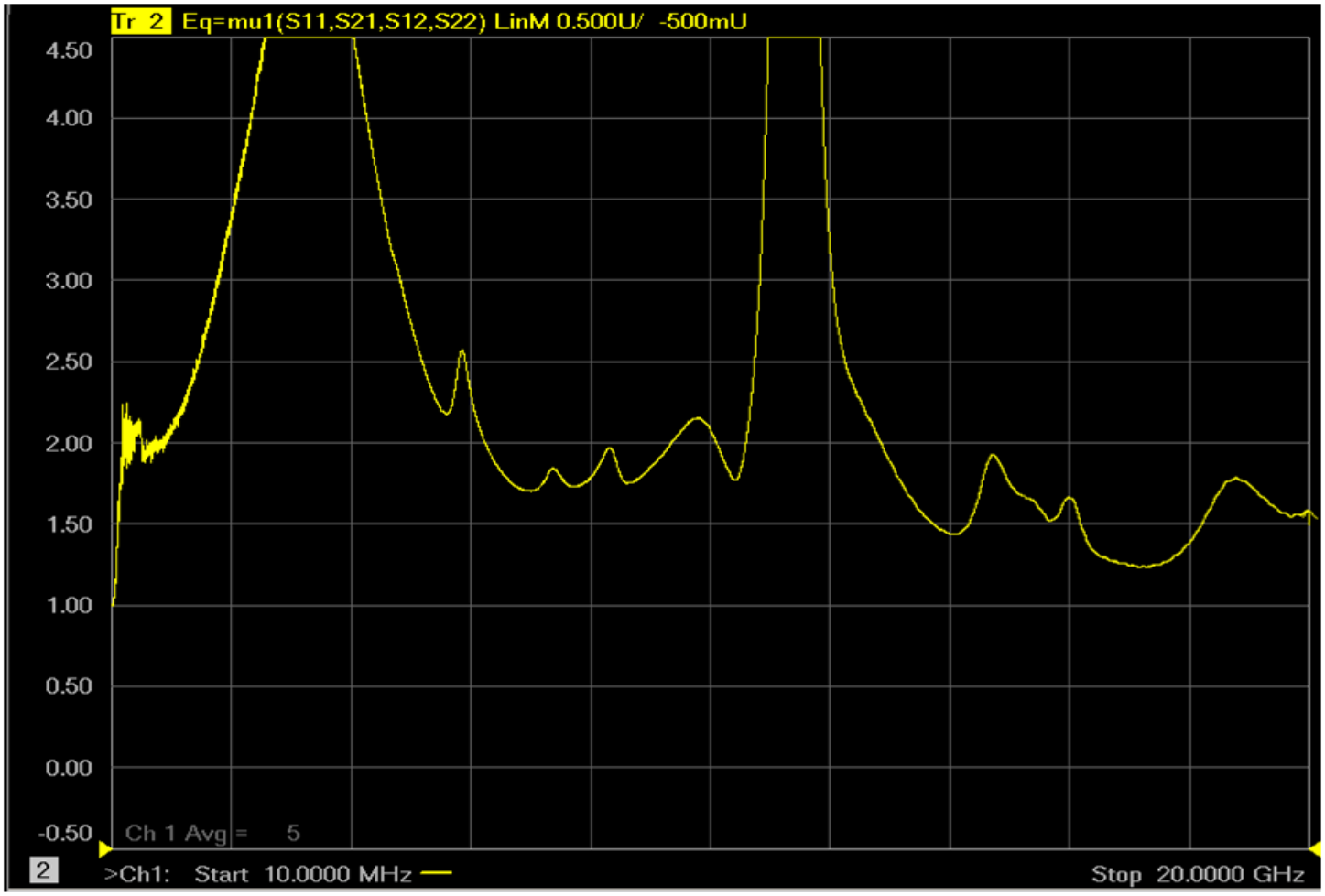
GRF2133W Typical Operating Curves: 0.1 to 2.7 GHz Tune



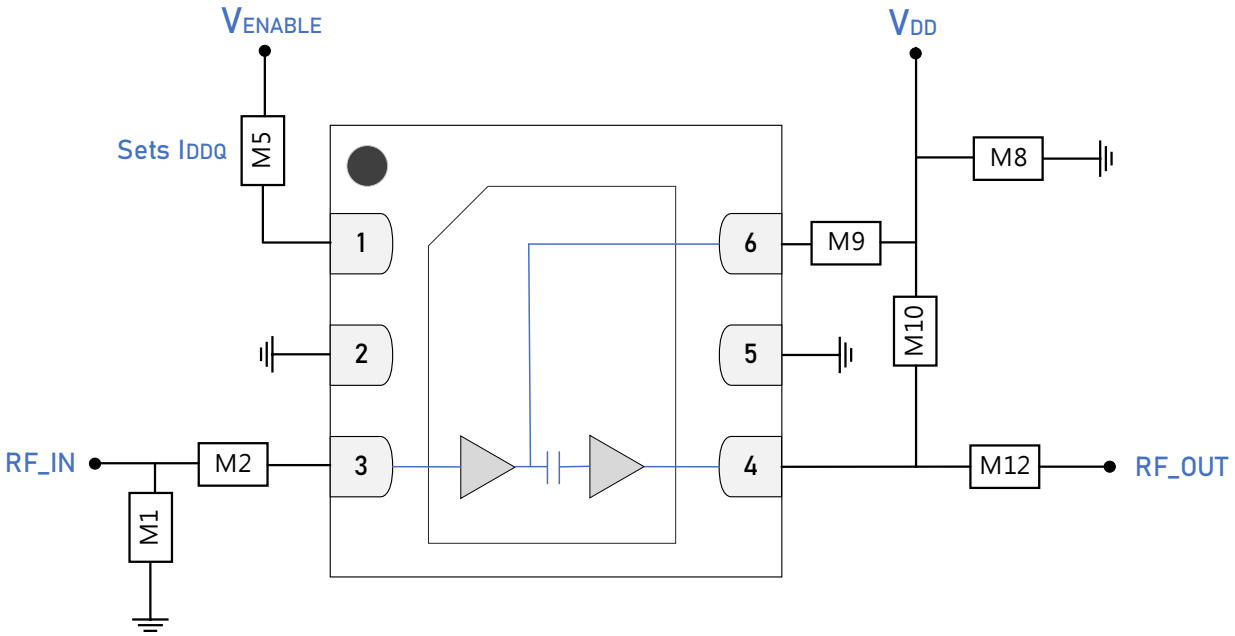
GRF2133W Typical Operating Curves: S-Parameters (0.1 to 2.7 GHz Tune)



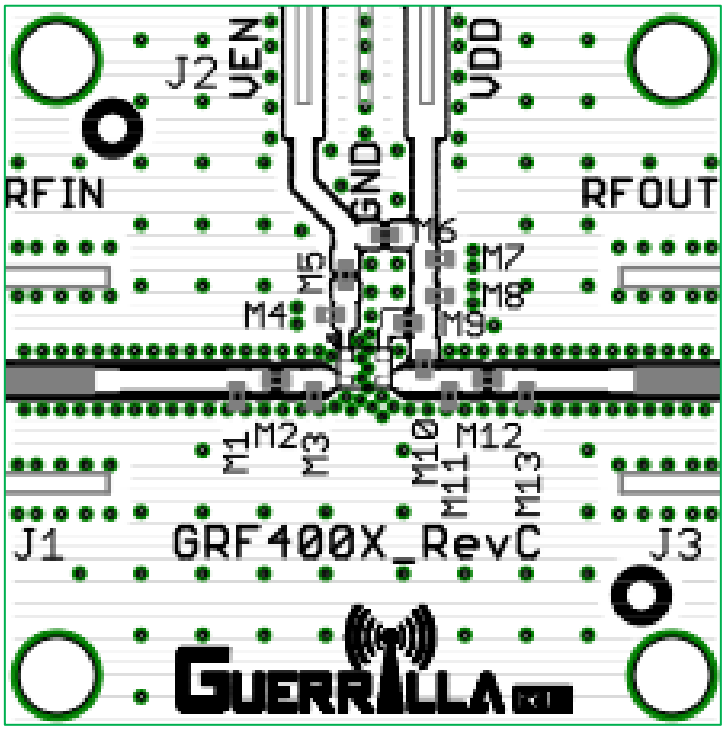
GRF2133W Typical Operating Curves: Stability Mu Factor (0.1 to 2.7 GHz Tune)



Note: Mu factor ≥ 1 implies unconditional stability.



GRF2133W Standard Test Schematic



GRF2133W Evaluation Board Assembly Diagram

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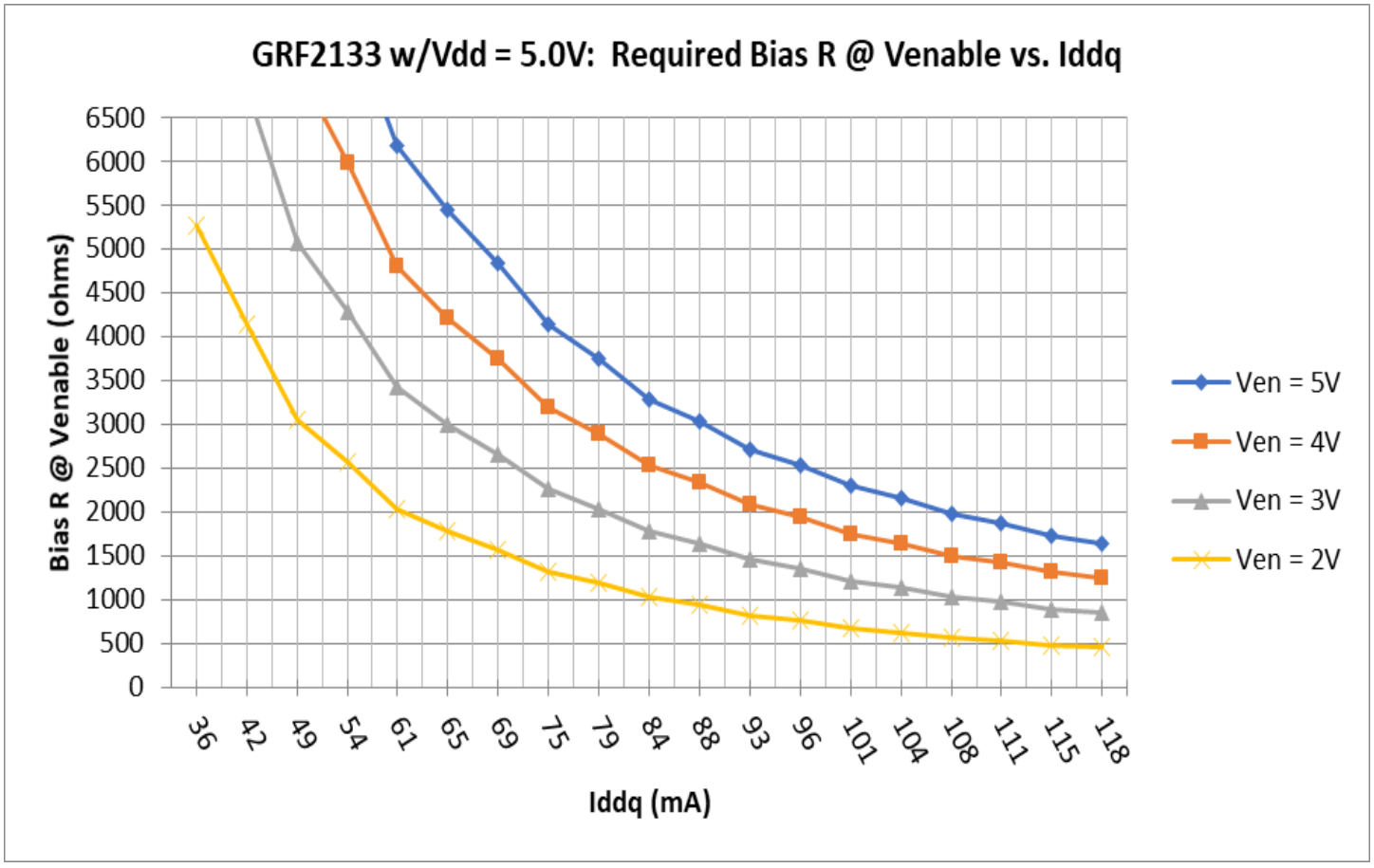
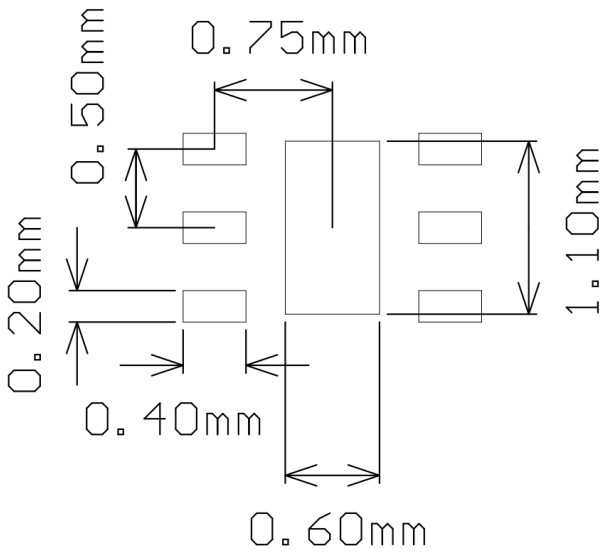
GRF2133W Evaluation Board Assembly Diagram Reference: 0.1 to 2.7 GHz Tune

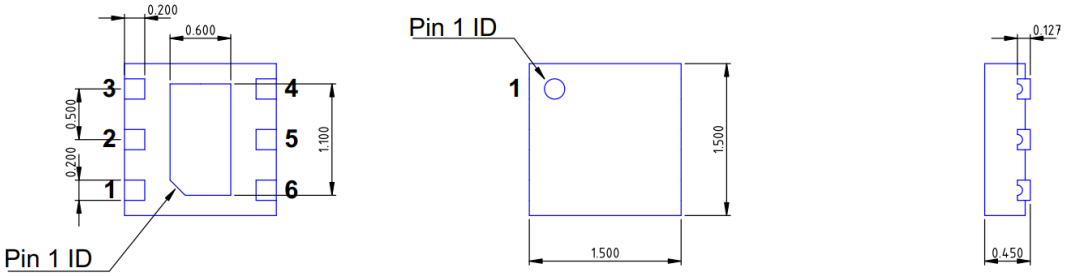
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1	Inductor	Murata	LQG	18 nH	0402	Ok
M2	Capacitor	Murata	GJM	33 pF	0402	Ok
M5 (See Curves)	Resistor	Various	5%	Set I_{DDQ}	0402	Ok
M8	Capacitor	Murata	GRM	0.1 µF	0402	Ok
M9	Resistor	Various	5%	75 Ω	0402	Ok
M10	Inductor	Murata	LQG	33 nH	0402	Ok
M12	Capacitor	Murata	GJM	33 pF	0402	Ok
Evaluation Board	GRF400X_RevC					

GRF2133W Bias Resistor Selection Curves





1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)



Bottom View **Top View** **Side View**

DFN6 1.5x1.5mm
Dimensions in millimeters
Dimensional Tolerance: ±0.05

1.5 x 1.5 mm DFN-6 Package Dimensions

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Package Marking Diagram

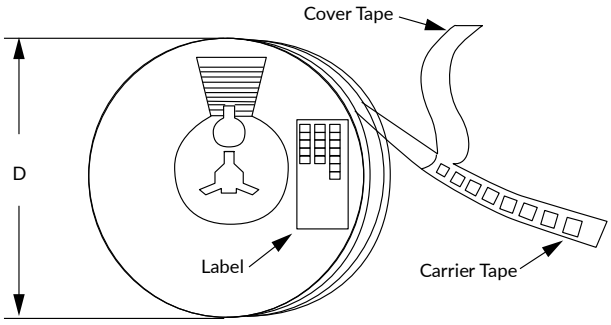
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK and "w" = W for automotive.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

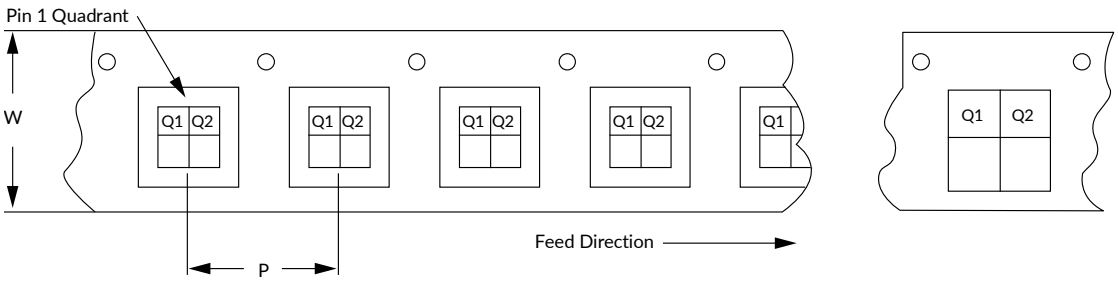
Guerrilla RF's tape and reel specification complies with Electronics Industries Association (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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 4, 2023	Updated to new format.

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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.