DATA SHEET

GRF2004

Broadband Gain Block
0.05 to 10 GHz

RELEASE B DATA SHEET

FEATURES

- Flexible Bias Voltage and Current
- Internally Matched to 50 Ω
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package

Reference: 5 V / 120 mA / 5.5 GHz

- Gain: 14.5 dB
- OIP3: 25.5 dBm
- OP1dB: 16 dBm
- Evaluation Board Noise Figure: 1.9 dB

APPLICATIONS

- Microwave Backhaul
- C/X-Band Amplifier
- General Purpose Amplifier
- Instrumentation

ORDERING INFORMATION

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DESCRIPTION

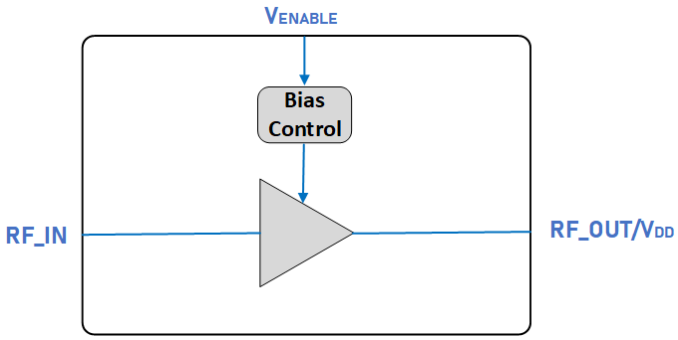
GRF2004 is a broadband, low-noise linear gain block designed for small cell, wireless infrastructure, and other high-performance RF applications. Due to the extreme broadband nature of the device, data is presented for wideband RF measurements using a Network Analyzer Bias-T. Under these conditions, the device exhibits good performance from 50 MHz to 10 GHz with minimal external components.

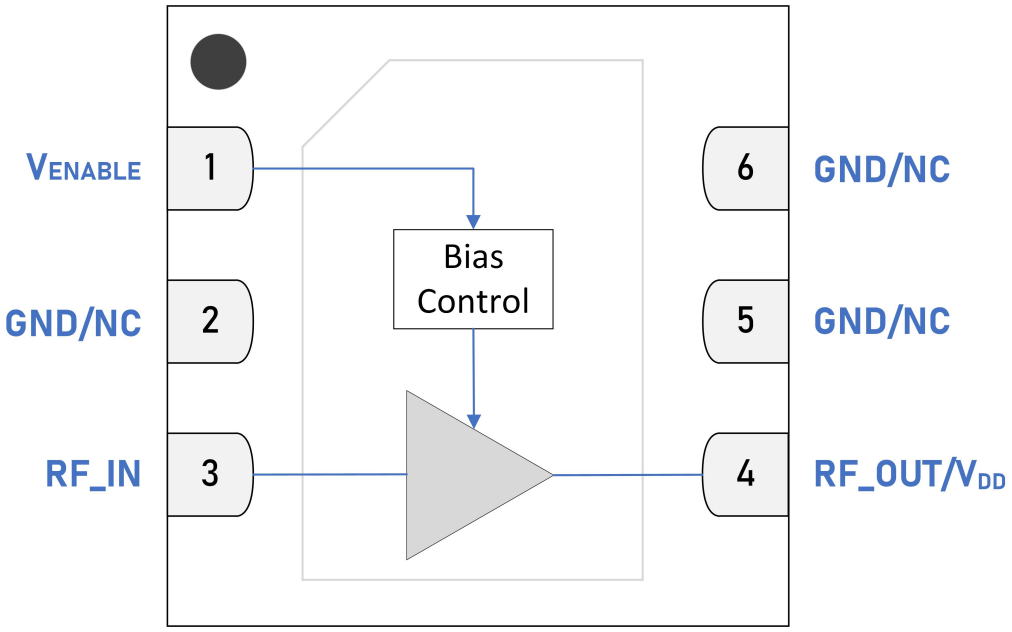
The device can be operated over a range of supply voltages from 1.8 to 5 V with selectable I_{DDQ} for optimal efficiency and linearity.

Consult with the GRF applications engineering team for custom tuning/evaluation board data and device S-parameters.

Additional tunes can be found on the GRF2004 "Custom Tunes" product page: GRF2004 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} < 0.2 volts disables the device.
2, 5, 6	GND/NC	Ground or No Connect	No internal connection to die. We recommend connecting these pins to ground.
3	RF_IN	LNA RF Input	Internally matched to 50 Ω. An external DC blocking capacitor must be used.
4	RF_OUT/V_{DD}	LNA 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 and thermal heat sink. Recommend multiple 8 mil vias beneath the package for optimal RF and thermal performance. Refer to the evaluation board top layer graphic on the 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.	$P_{IN\ MAX}$	--	15	dBm
RF Input Power: Load VSWR < 2:1; V_{DD} = < 4 V.	$P_{IN\ MAX}$	--	20	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	$P_{DISS\ MAX}$	--	600	mW

Electrostatic Discharge

Human Body Model	HBM	175	--	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}	0	5	6	V	
Operating Temperature (Package Base)	$T_{PKG\ BASE}$	-40		105	°C	
RF Frequency Range	F_{RF}	0.05		10	GHz	Typical application schematic using band-specific tunes **(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: GRF2004 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 10 GHz tuning set, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 120 mA, F_{TEST} = 5.5 GHz, 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.		
Switching Rise Time	T_{RISE}		800		ns	Disabled mode to Gain mode **(note 3)**.
Switching Fall Time	T_{FALL}		600		ns	Gain mode to Disabled mode **(note 4)**.
Supply Current	I_{DD}		120		mA	
Enable Current	I_{ENABLE}		1.8		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}		104		°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}.

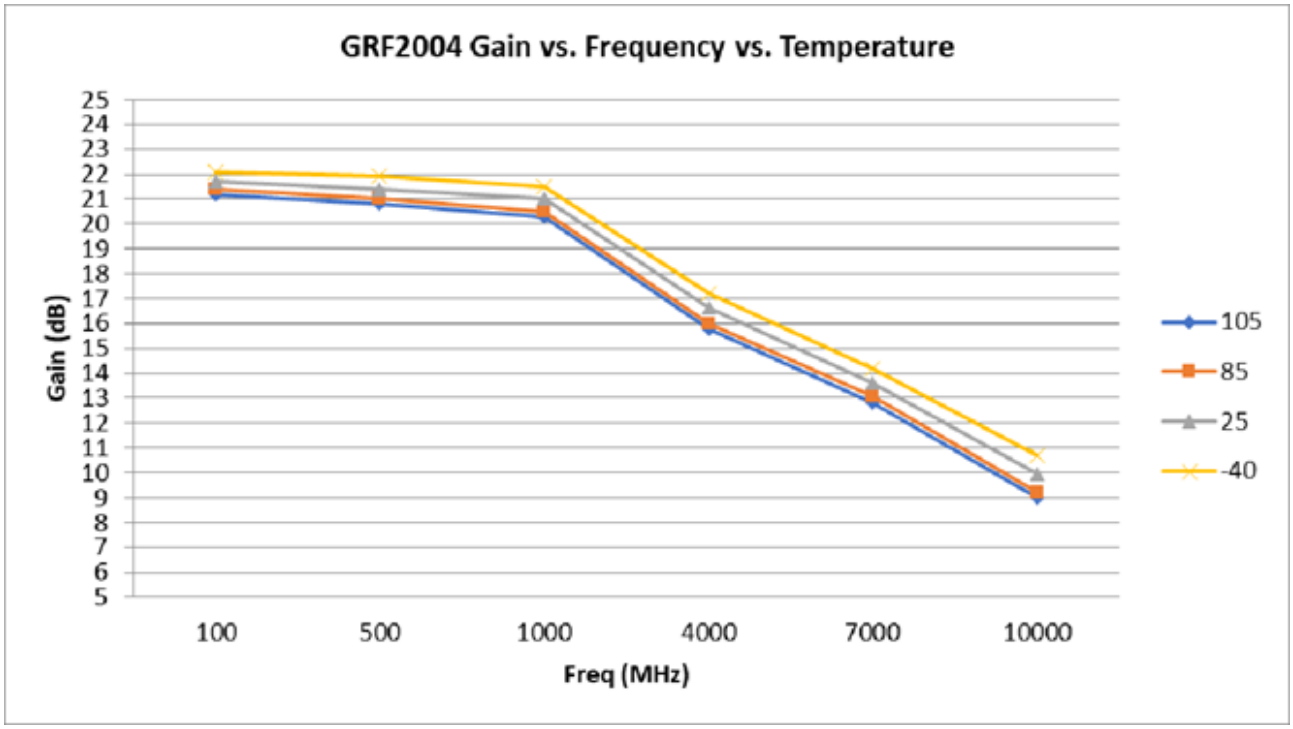
Note 5: MTTF > 10^6 hours for $T_{CHANNEL}$ ≤ 170 °C.

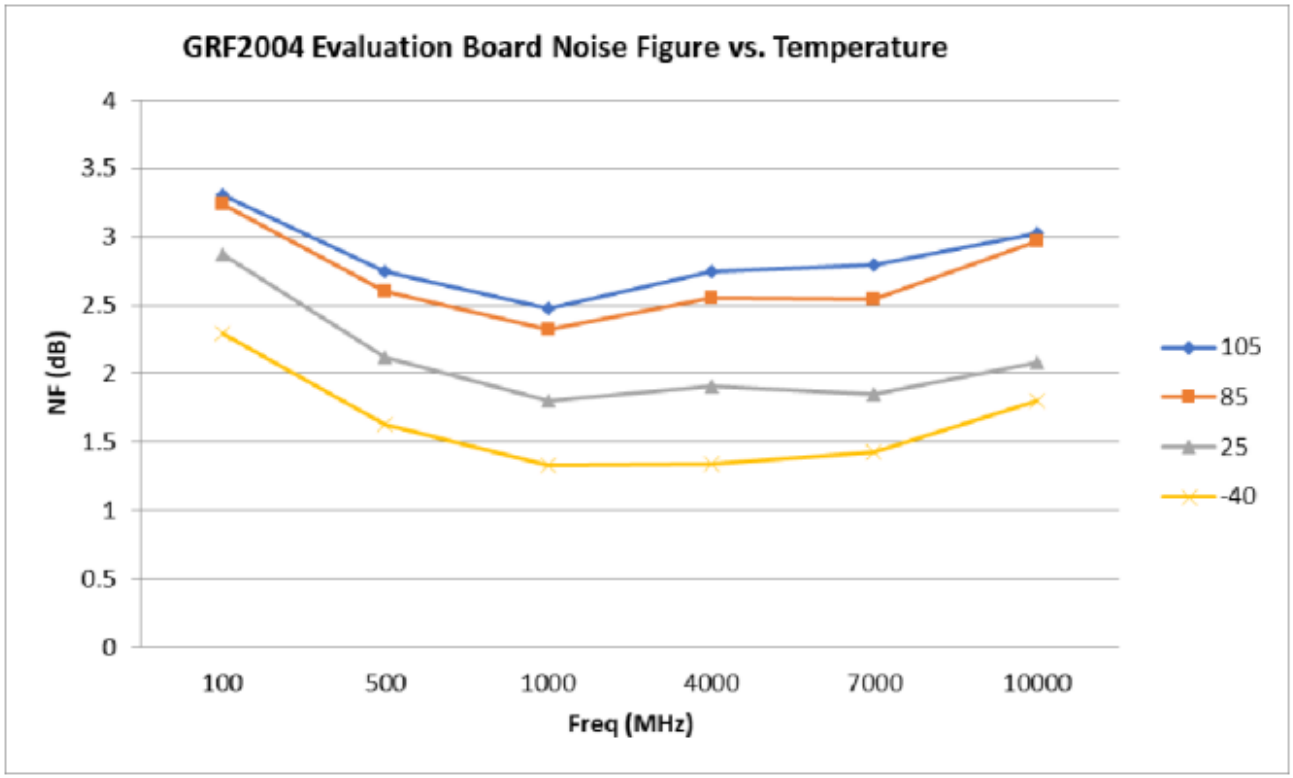
Nominal Operating Parameters - RF

The following conditions apply unless noted otherwise: typical application schematic using the 0.1 to 10 GHz tuning set, V_{DD} = 5 V, V_{ENABLE} = 5 V, I_{DD} = 120 mA, F_{TEST} = 5.5 GHz, 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	13.5	14.5		dB	
Reverse Isolation	S12		< -27		dB	
Noise Figure	NF		1.9		dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		25.5		dBm	0 dBm P_{OUT} per tone at 2 MHz spacing.
Output 1 dB Compression Power	OP1dB	14.5	16		dBm	

GRF2004 Typical Operating Curves: 5 V, 120 mA (0.1 to 10 GHz Tune)





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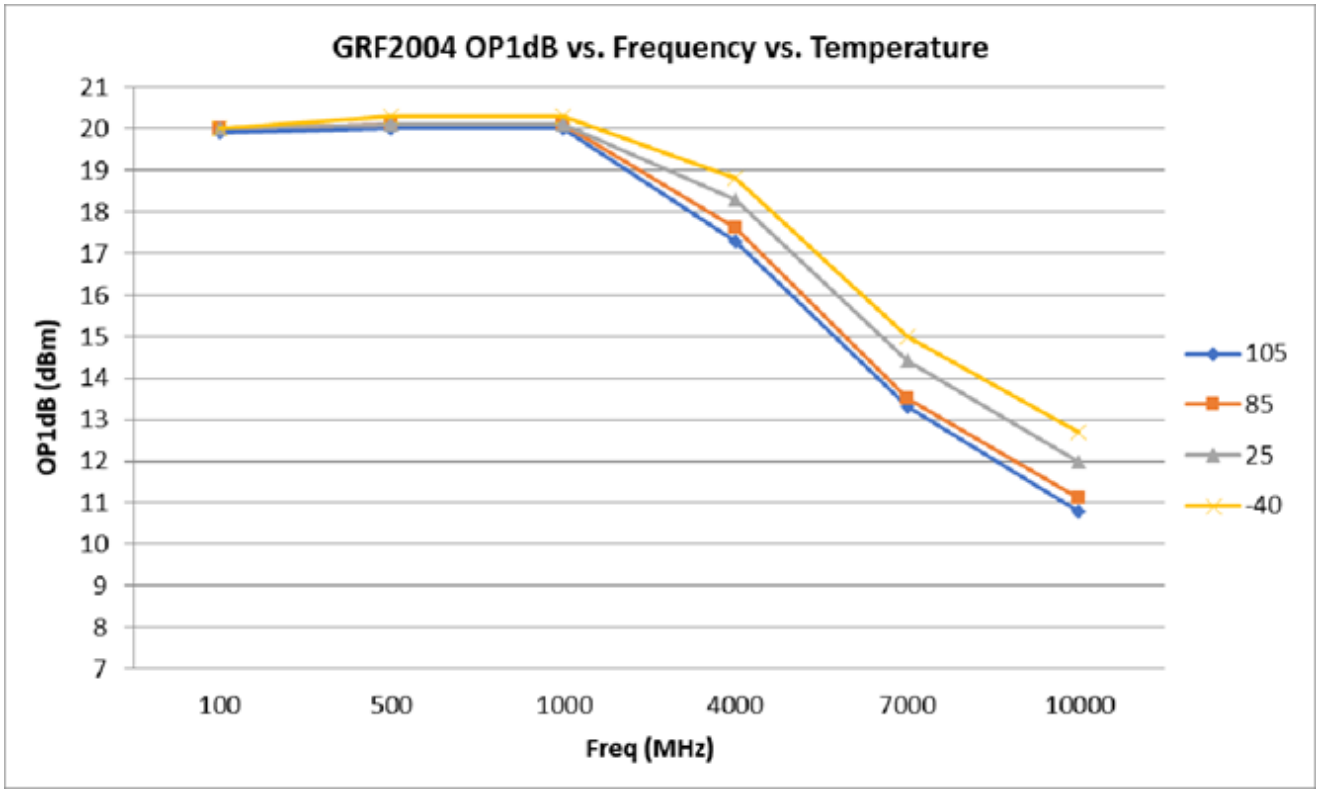
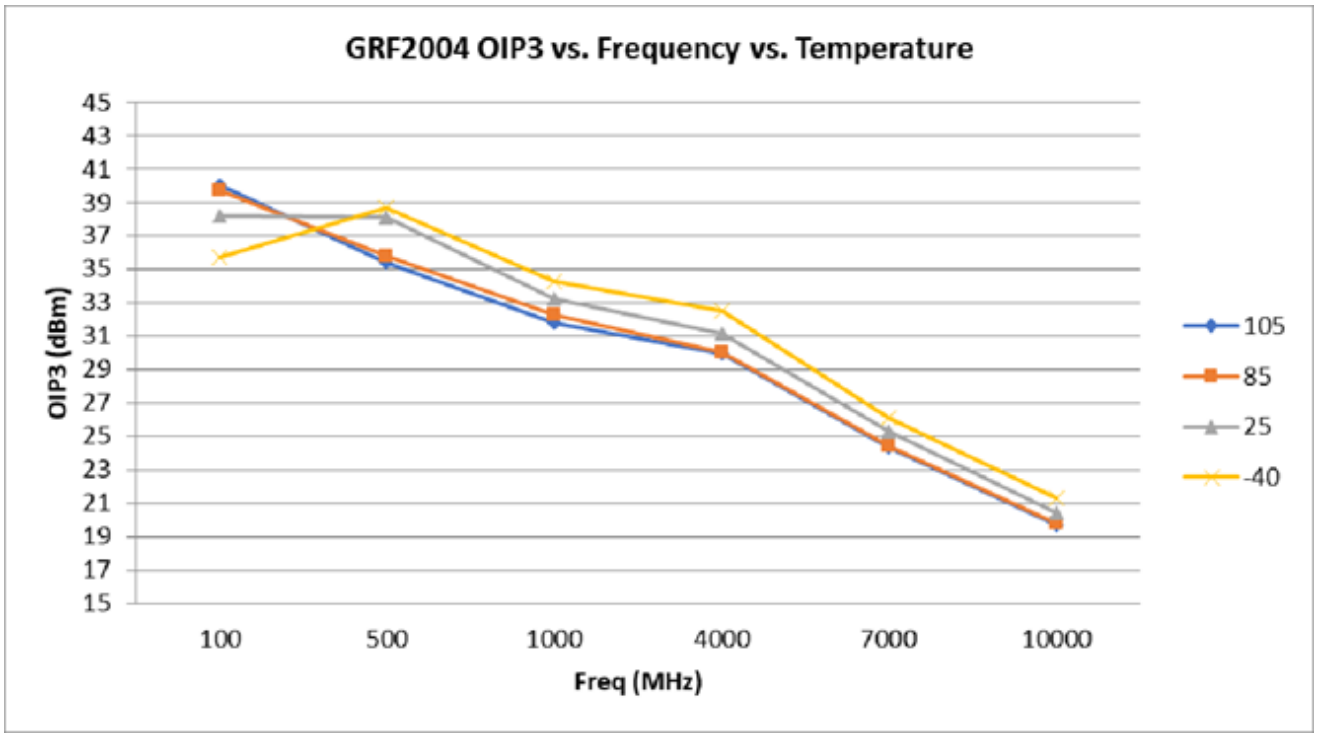
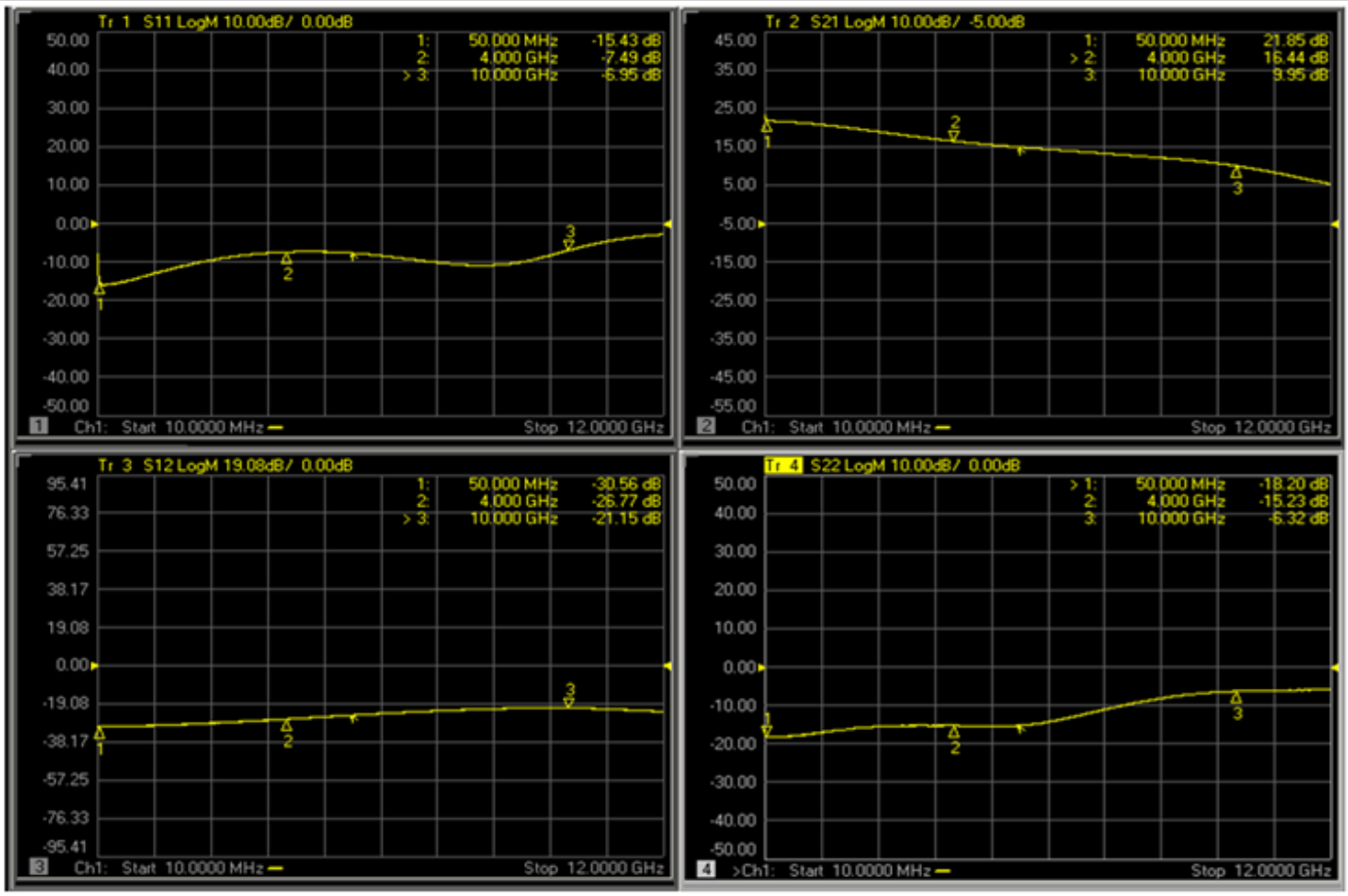
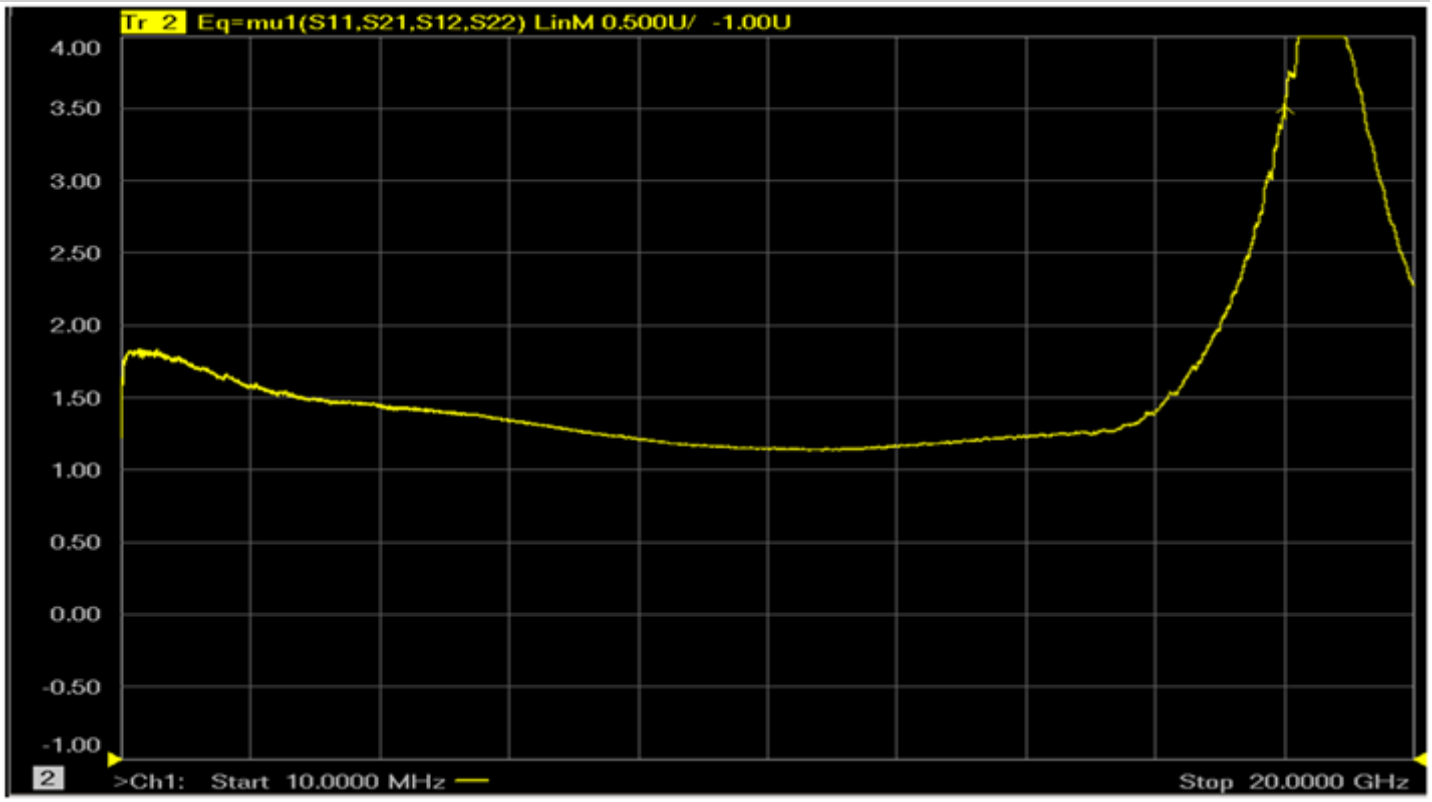




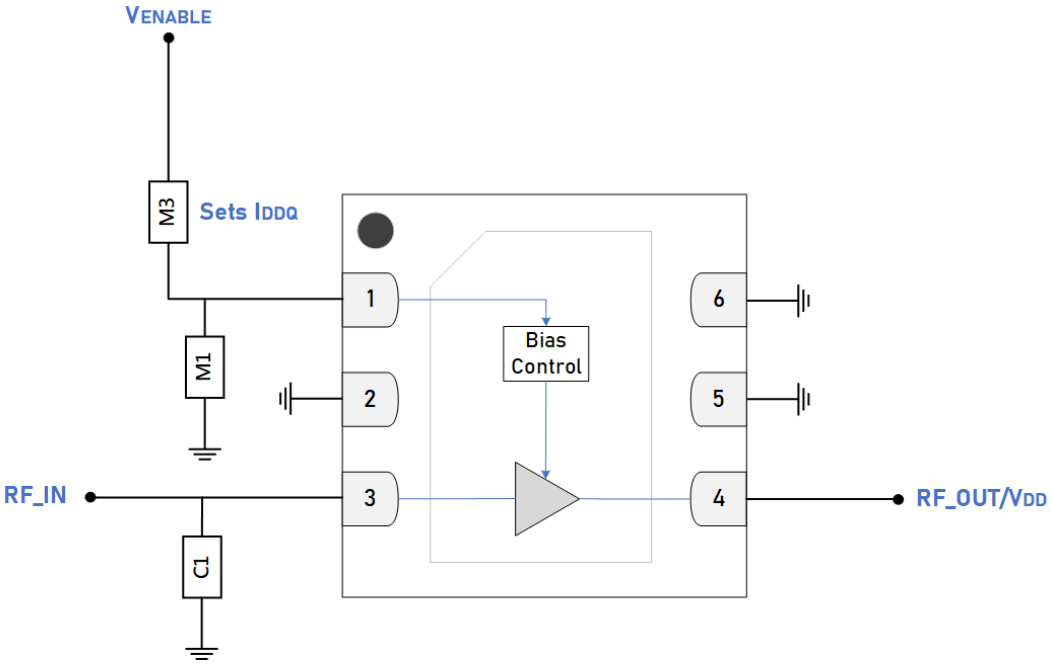
GRF2004 Typical Operating Curves: S-Parameters (0.05 to 10 GHz, VNA Bias-T)



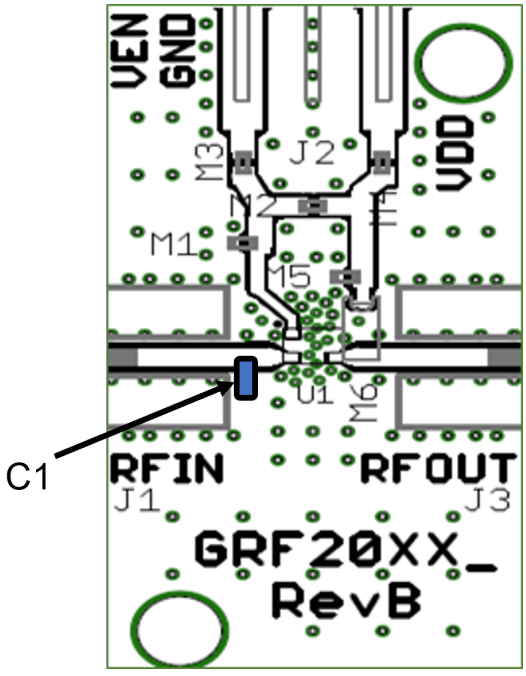
GRF2004 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz, VNA Bias-T)



Note: Mu Factor ≥ 1.0 implies unconditional stability.



GRF2004 Standard Evaluation Board Schematic



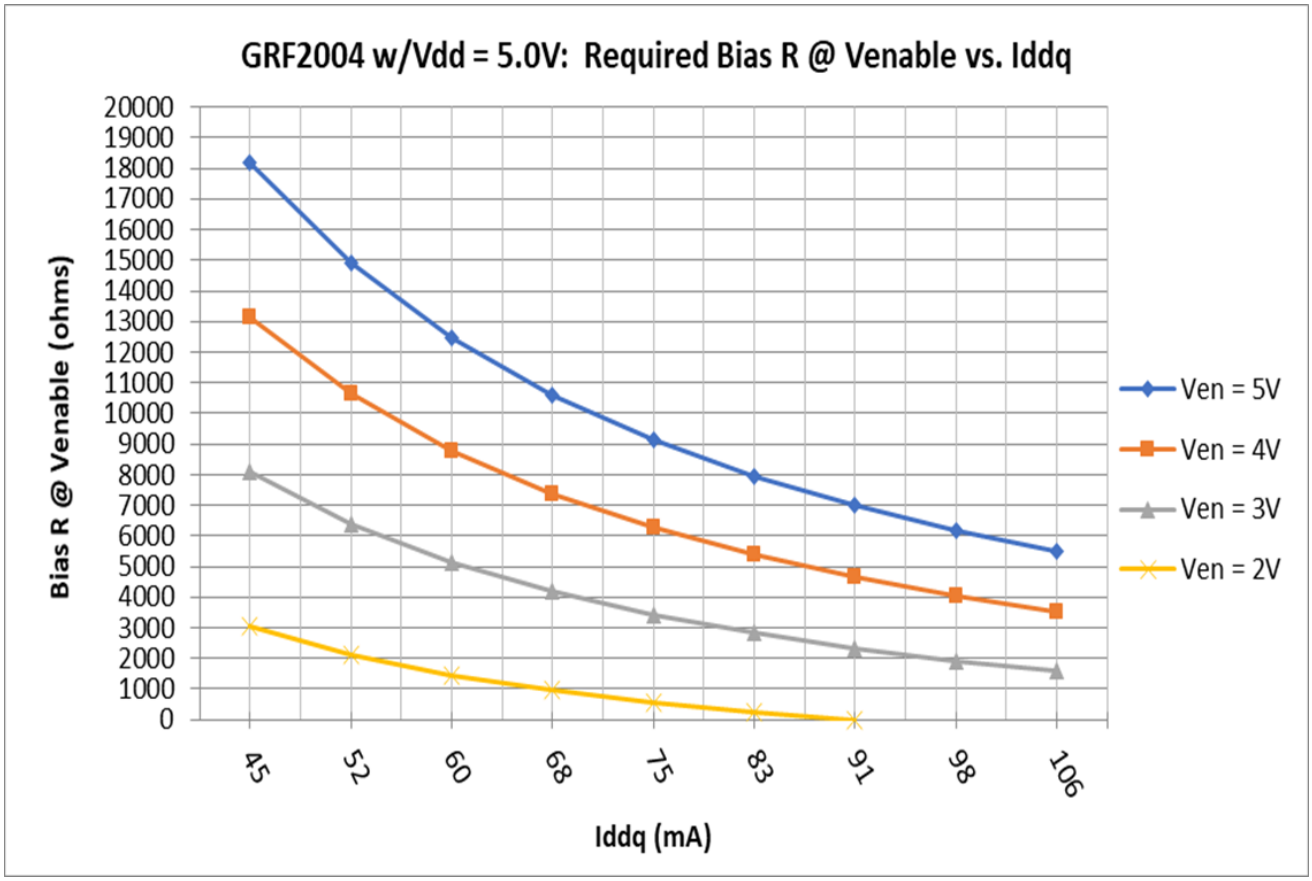
GRF2004 Evaluation Board Assembly Diagram

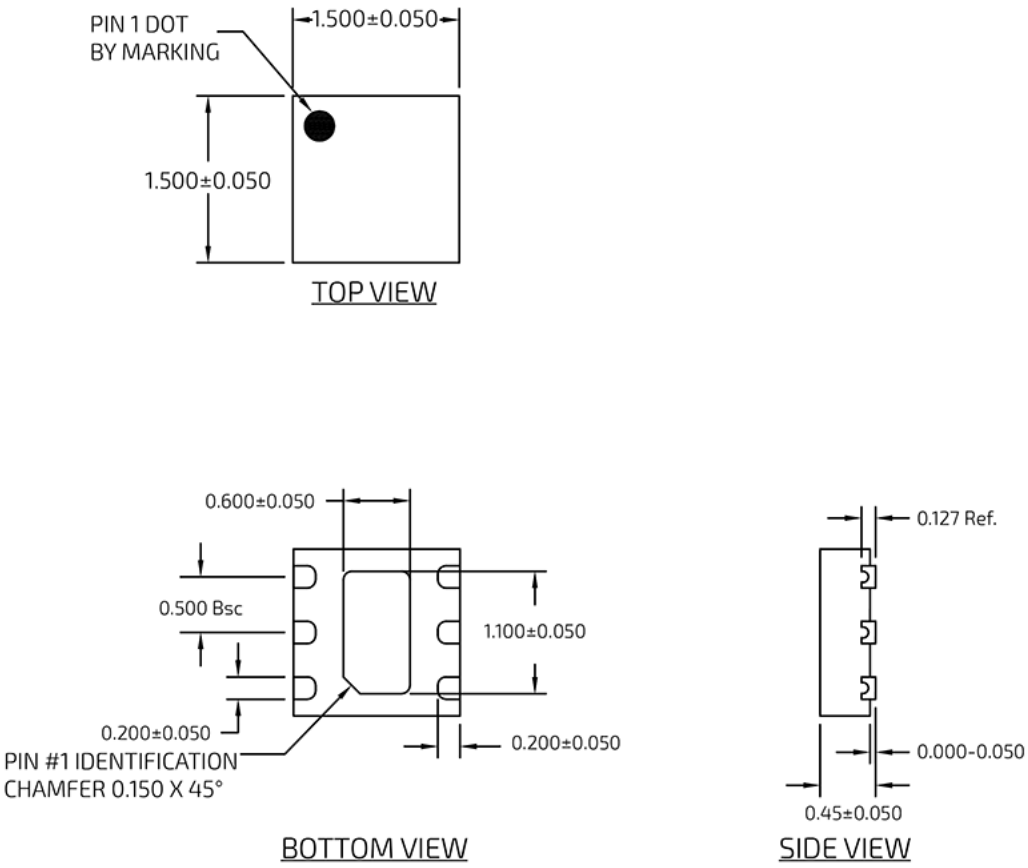
GRF2004 Evaluation Board Assembly Diagram Reference: 0.1 to 10 GHz Tune

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1	Capacitor	Murata	GRM	1000 pF	0402	ok
M3	Resistor	Various	5%	6.0 kΩ	0402	ok
C1	Capacitor	Murata	GJM	0.2 pF	0402	ok
Evaluation Board	GRF20XX_RevB					

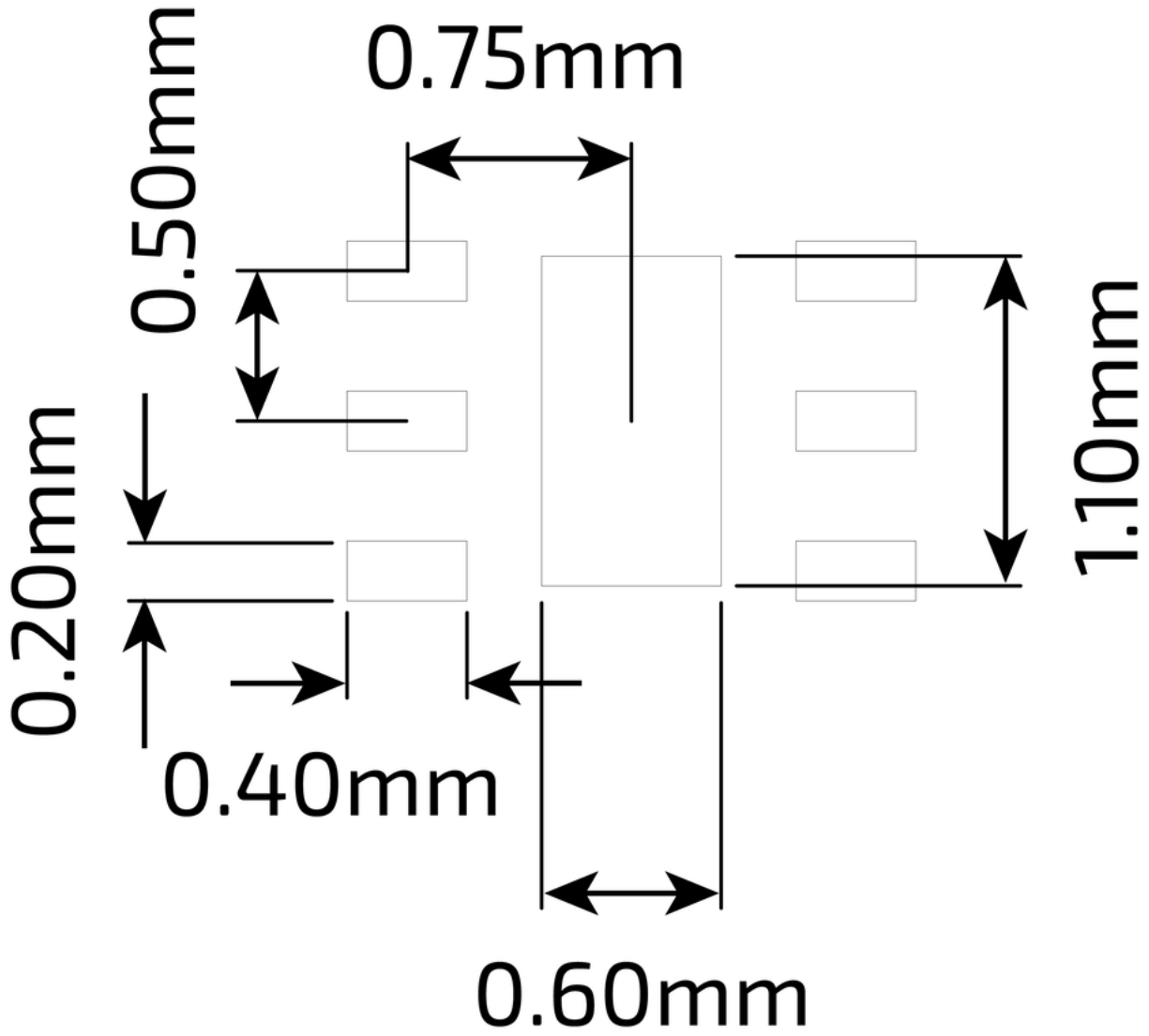
Note: C1 is added to evaluation board input to enhance high frequency gain of the device.

Bias Resistor Selection Curves:





DFN 6 1.5x1.5mm Package Dimensions



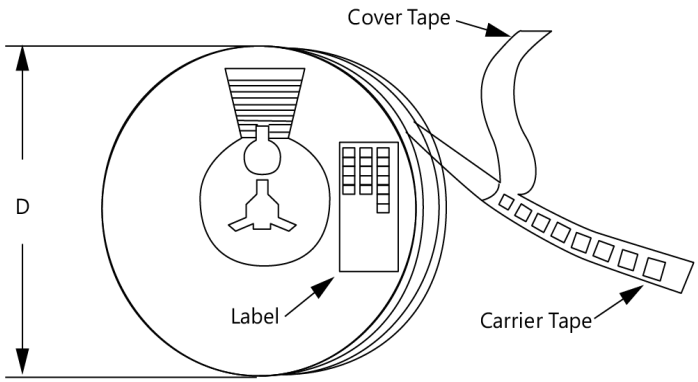
DFN 6 1.5x1.5mm Suggested PCB Footprint (Top View)

Package Marking Diagram

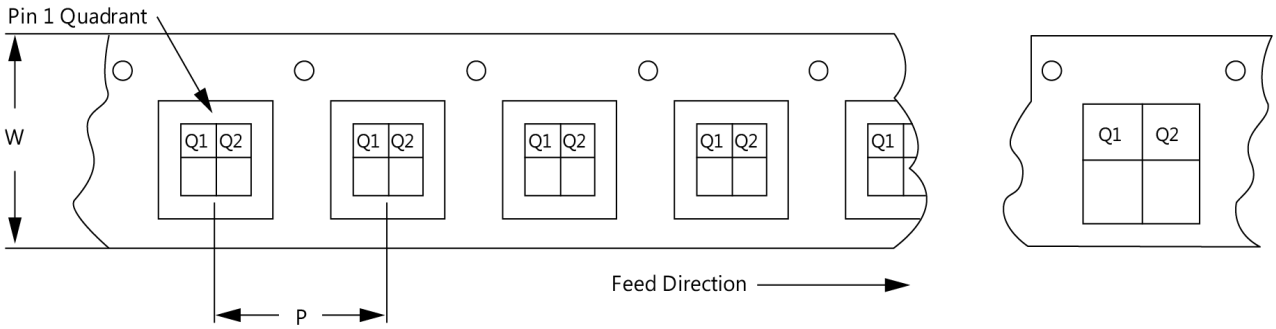
Line 1: “Y” = YEAR (single digit). “WW” = WORK WEEK the Device was assembled.
Line 2: “XXXX” = Device Part Number.

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
December 14, 2017	Release A Data Sheet.
June 9, 2021	Upgraded Data Sheet to new format only.
February 14, 2022	Removed CDM parameter from Absolute Ratings.
July 26, 2024	Release B Data Sheet. Upgraded Data Sheet to newest format. Changed F_{TEST}, I_{DD}, Gain and OP1dB specifications to match PTP. Changed OIP3 specification to correlate with application's test data.
May 28, 2025	Extended lower frequency range from 100 MHz to 50 MHz.

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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.