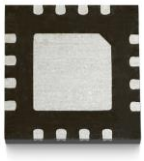
DATA SHEET

RELEASE Ø DATA SHEET



GRF5529

HIGH EFFICIENCY POWER AMPLIFIER 2.9 to 3 GHz

FEATURES

- Flexible Biasing Voltage and Current
- 5 V Supply Voltage
- Digital Shutdown
- High Ruggedness
- Process: InGaP HBT
- -40 to 85 °C Operating Temperature Range
- Compact 3 x 3 mm QFN-16 Package

Reference: 5 V / 110 mA I_{CCQ} / 2.95 GHz

- Gain: 29.5 dB
- P_{SAT}: 34 dBm CW Mode, PAE: 57%
- Evaluation Board Noise Figure: 3.4 dB

APPLICATIONS

- Civilian Radar
- Military Radar
- Radio Location
- Repeaters/Boosters

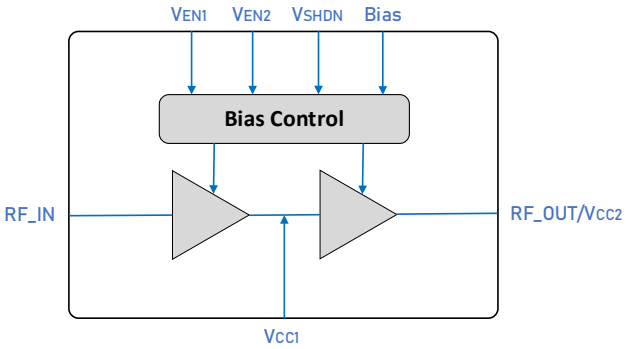
DESCRIPTION

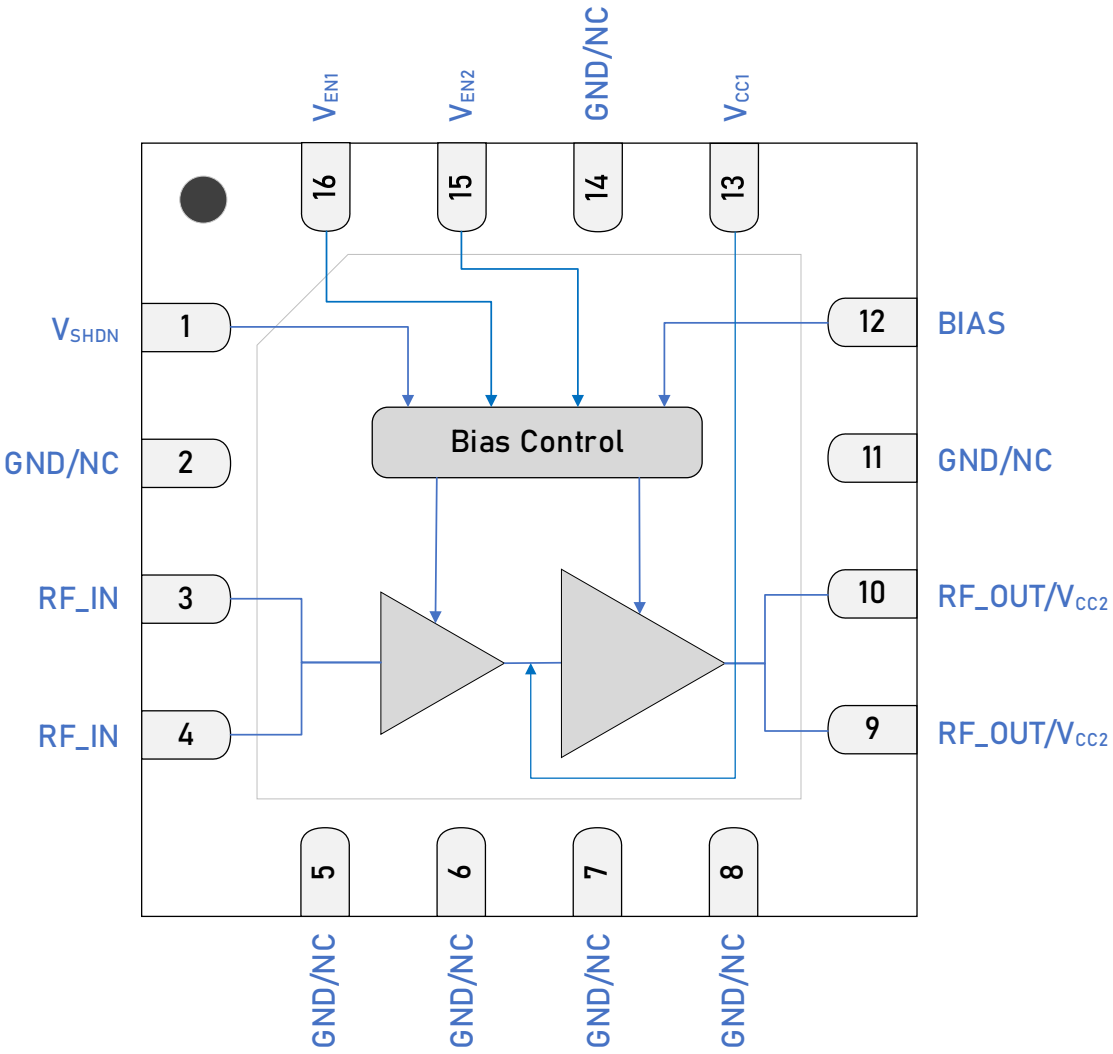
The GRF5529 is a high-efficiency power amplifier designed for saturated applications at 2.95 GHz. It is capable of 34 dBm saturated output power when in CW mode and is ideal for pulsed operation.

Please consult with the GRF applications engineering team for custom tuning/evaluation board data.

Additional tunes can be found on the GRF5529 "Custom Tunes" product page: GRF5529 Custom Tunes

BLOCK DIAGRAM





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

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Pin Assignments

Pin	Name	Description	Note
1	V_{SHDN}	Digital Shutdown Pin	V_{SHDN} ≥ 1.5 V disables device. V_{SHDN} ≤ 0.2 V enables device.
2, 5, 6, 7, 8, 11, 14	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. An external DC blocking capacitor must be used.
9, 10	RF_OUT/V_{CC2}	PA Output/Bias Voltage	Pins 9 & 10 tied together on system board. V_{CC2} must be applied to this pin via an RF choke.
12	Bias	Bias Circuit Supply	Connect to V_{CC2} through external resistor.
13	V_{CC1}	Bias Voltage	Connect to V_{CC1} through external resistor.
15	V_{EN2}	Enable2 Voltage Input	V_{EN2} and series resistor set I_{CCQ} for the output stage. V_{EN2} ≤ 0.2 volts disables stage 2.
16	V_{EN1}	Enable1 Voltage Input	V_{EN1} and series resistor set I_{CCQ} for the input stage. V_{EN1} ≤ 0.2 volts disables stage 1. Connecting an external decoupling capacitor to ground is required for optimal NF performance.
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
Supply Voltage	V_{CC}		5.5	V
Maximum Average RF Input Power: Load VSWR: 2.0:1, all phase angles, $T_{PKG\ BASE}$ = 25°C	$P_{IN\ MAX}$		10	dBm
Maximum Average RF Input Power: Load VSWR: 1.5:1, all phase angles, $T_{PKG\ BASE}$ = -40°C	$P_{IN\ MAX}$		10	dBm
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40	85	°C
Maximum Junction Temperature (MTTF >10^6 Hours)	$T_{J\ MAX}$		170	°C
Maximum Dissipated Power Stage 1: DC only (no RF applied).	$P_{DISS\ MAX}$		500	mW
Maximum Dissipated Power Stage 2: DC only (no RF applied).	$P_{DISS\ MAX}$		850	mW

Electrostatic Discharge

Charged Device Model	CDM	1000		V
Human Body Model	HBM	1500		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 — Package and Manufacturing Information.*

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*

Recommended Operating Conditions

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{CC}	3	5	5.5	V	
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40		85	°C	
RF Frequency Range	F_{RF}	2.9		3	GHz	Typical application schematic using the 2.95 GHz tuning set **(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: GRF5529 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 2.95 GHz tune, V_{CC} = 5 V, I_{CCQ} = 110 mA, F_{TEST} = 2.95 GHz, M5 = 6.65 kΩ, M9 = 4.75 kΩ, 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.		
Supply Quiescent Current	I_{CCQ}	80	110	150	mA	I_{CCQ1} + I_{CCQ2} (no RF applied).
Enable Current 1	$I_{ENABLE1}$		0.5		mA	
Enable Current 2	$I_{ENABLE2}$		0.83		mA	
Operating Temperature Range	$T_{PKG\ BASE}$	-40		85	°C	Measured on package base.
Switching Rise Time	T_{RISE}		40		ns	Disabled mode to Gain mode **(note 3).**
Switching Fall Time	T_{FALL}		8		ns	Gain mode to Disabled mode **(note 4).**

Disabled Mode

Supply Current (Leakage)	I_{CC}		1		µA	

Thermal Data

Thermal Resistance: (IR Scan Method)	Θ_{JC}		38		°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 > 106 hours for $T_{CHANNEL}$ ≤ 170 °C.

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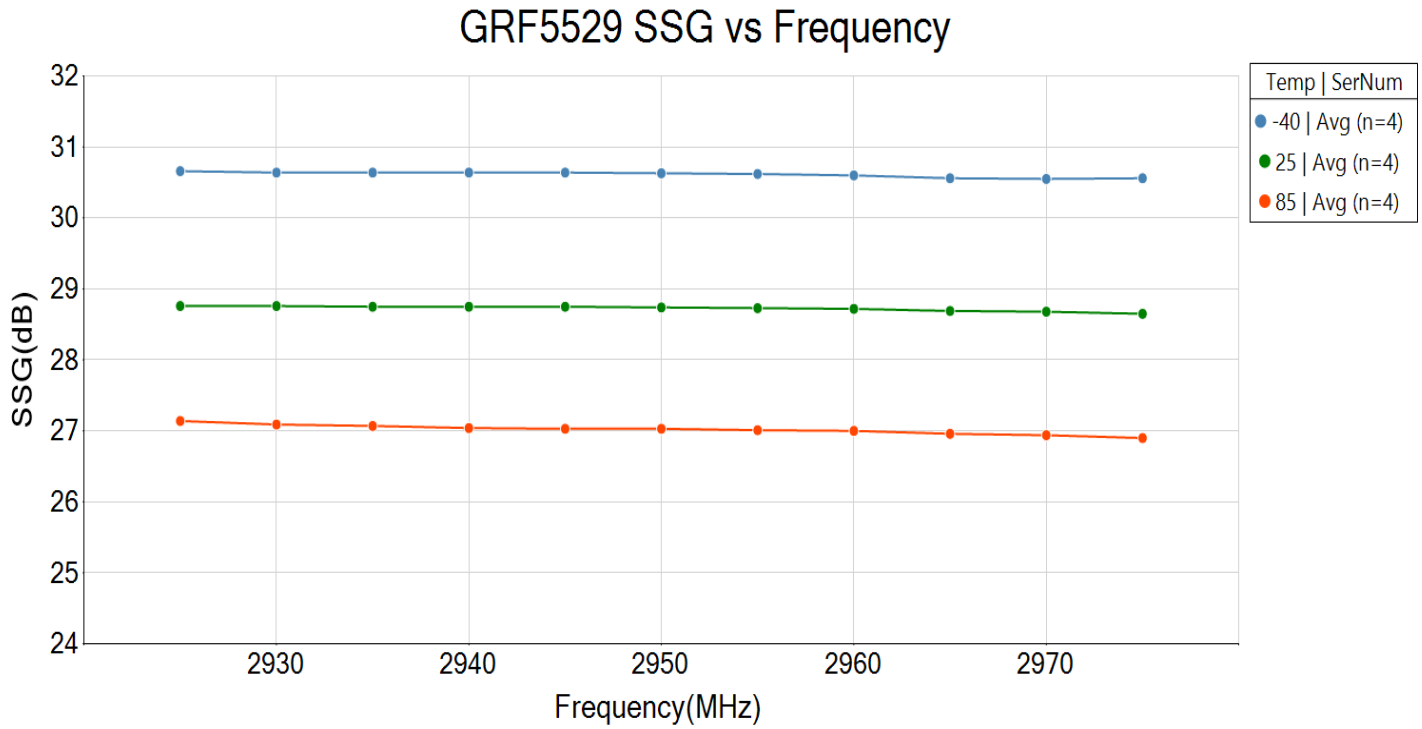
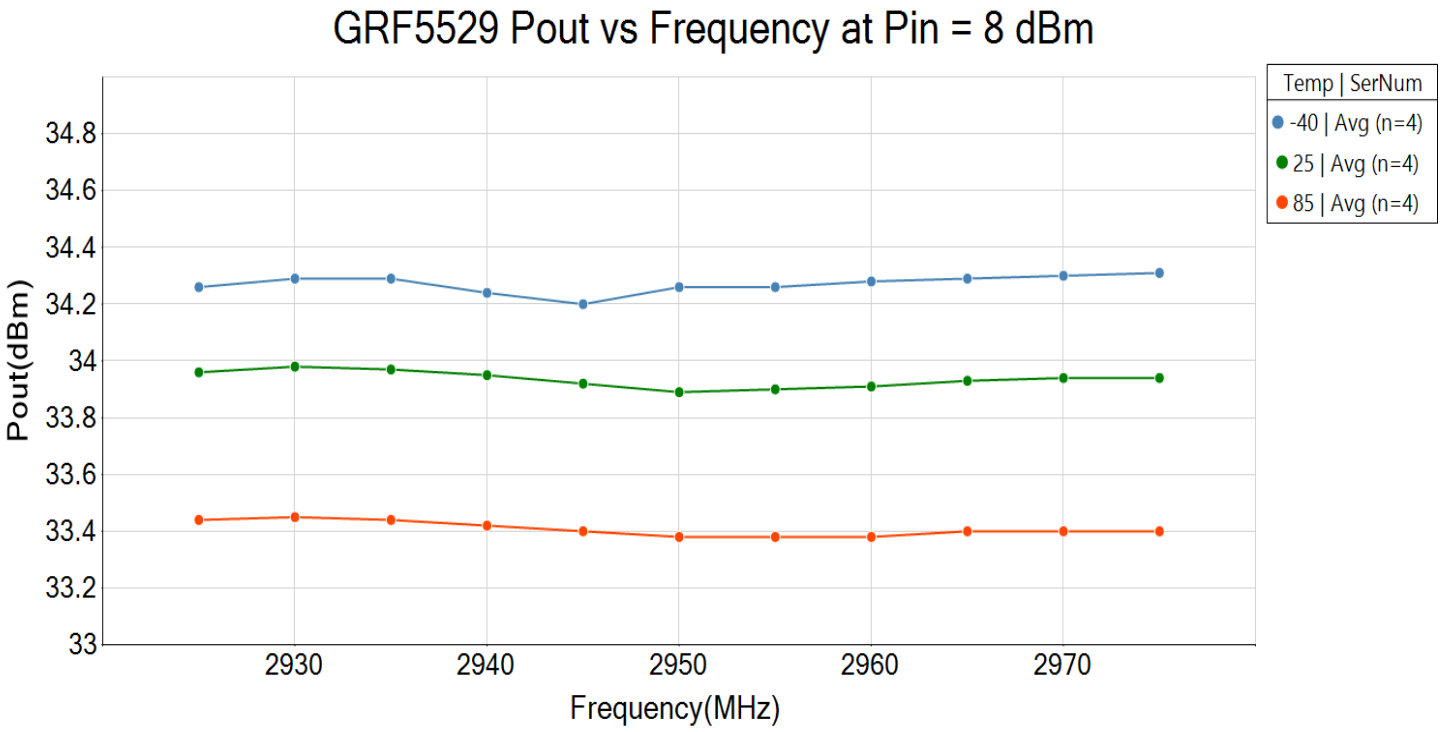
Nominal Operating Parameters – RF: 2.95 GHz, 5 V Operation

The following conditions apply unless noted otherwise: typical application schematic using the 2.95 GHz tune, V_{CC} = 5 V, I_{CCQ} = 110 mA, F_{TEST} = 2.95 GHz, M5 = 6.65 kΩ, M9 = 4.75 kΩ 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	27.5	29.5		dB	
Input Return Loss	S11		< -20		dB	
Output Return Loss	S22		< -6		dB	
Reverse Isolation	S12		< -38		dB	
Noise Figure	NF		3.4		dB	On standard evaluation board.
Saturated Output Power	P_{SAT}		34		dBm	RF input power: 8 dBm CW.
Power Added Efficiency	PAE		57		%	RF input power: 8 dBm CW.

GRF5529 Typical Operating Curves: 2.95 GHz Tune





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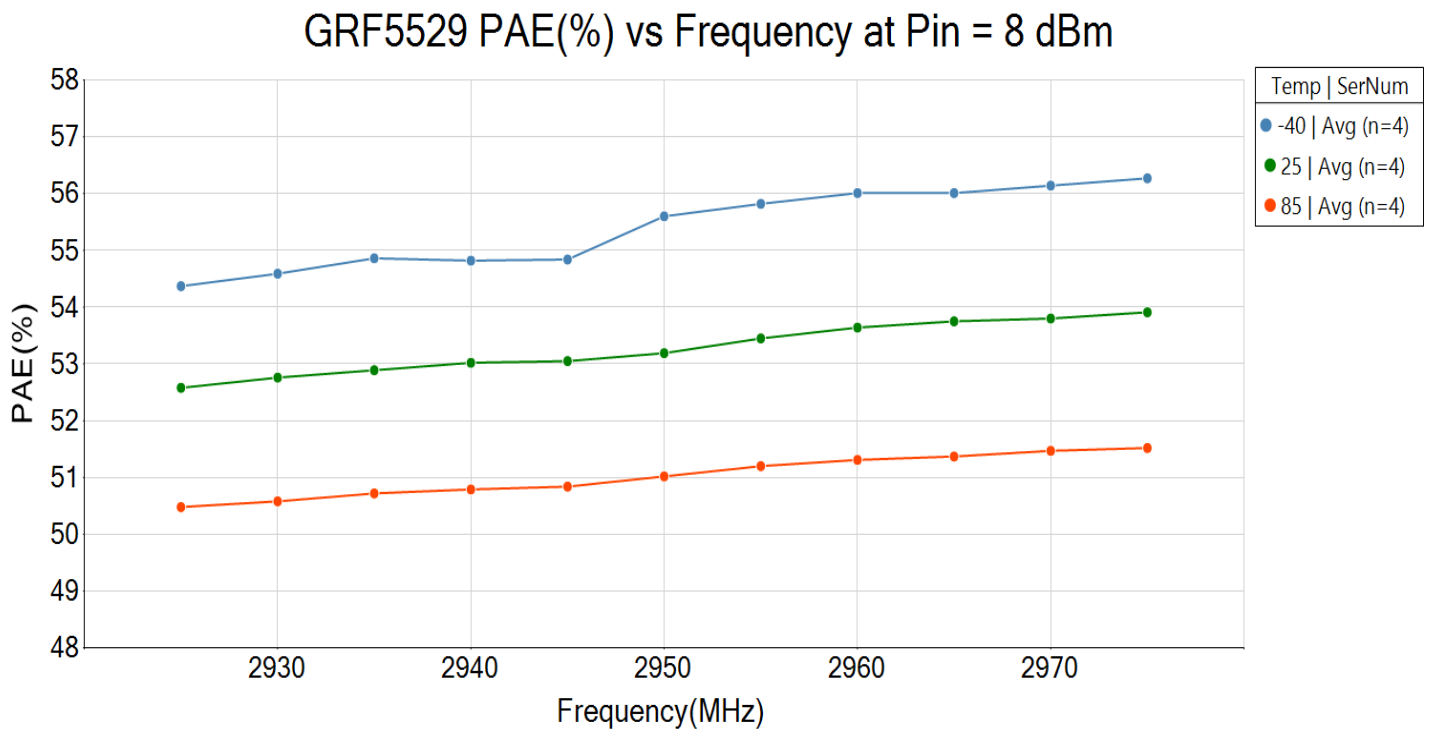
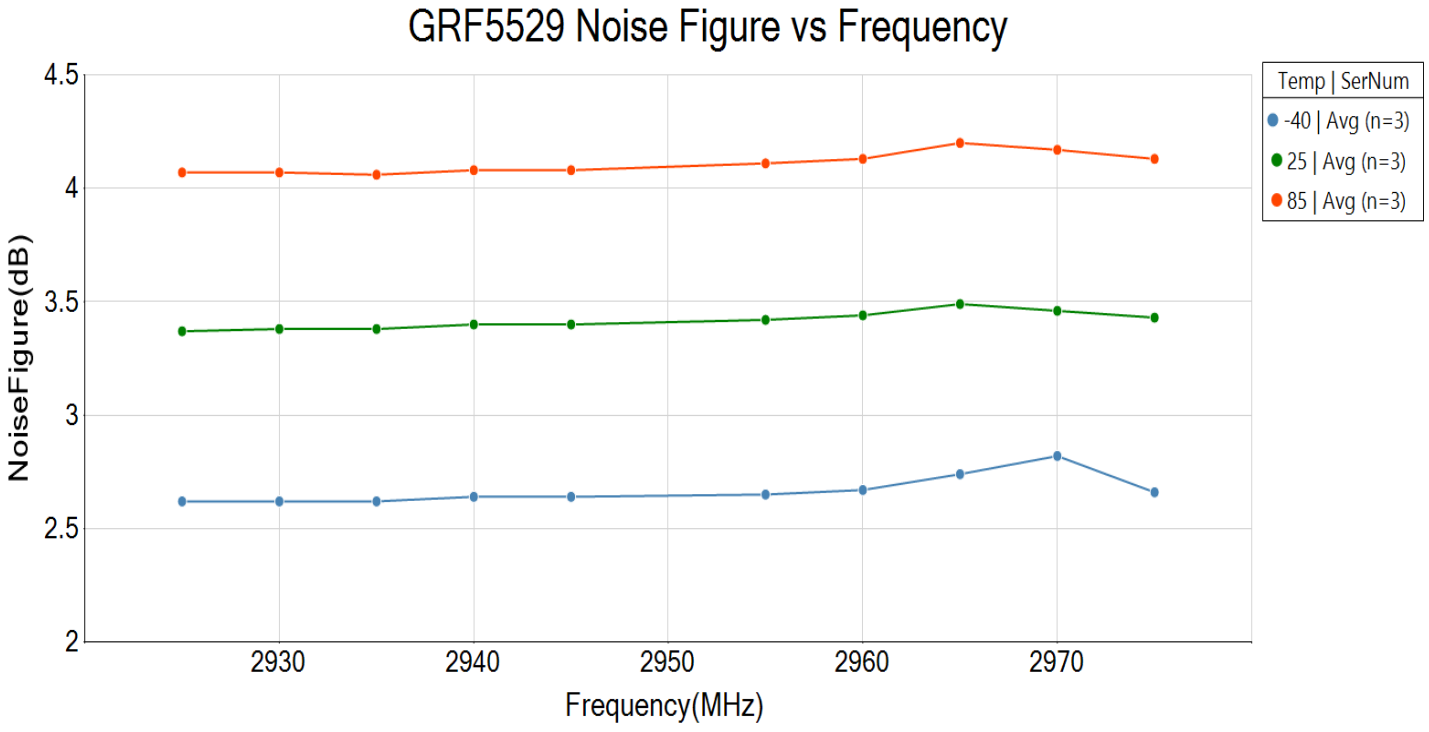
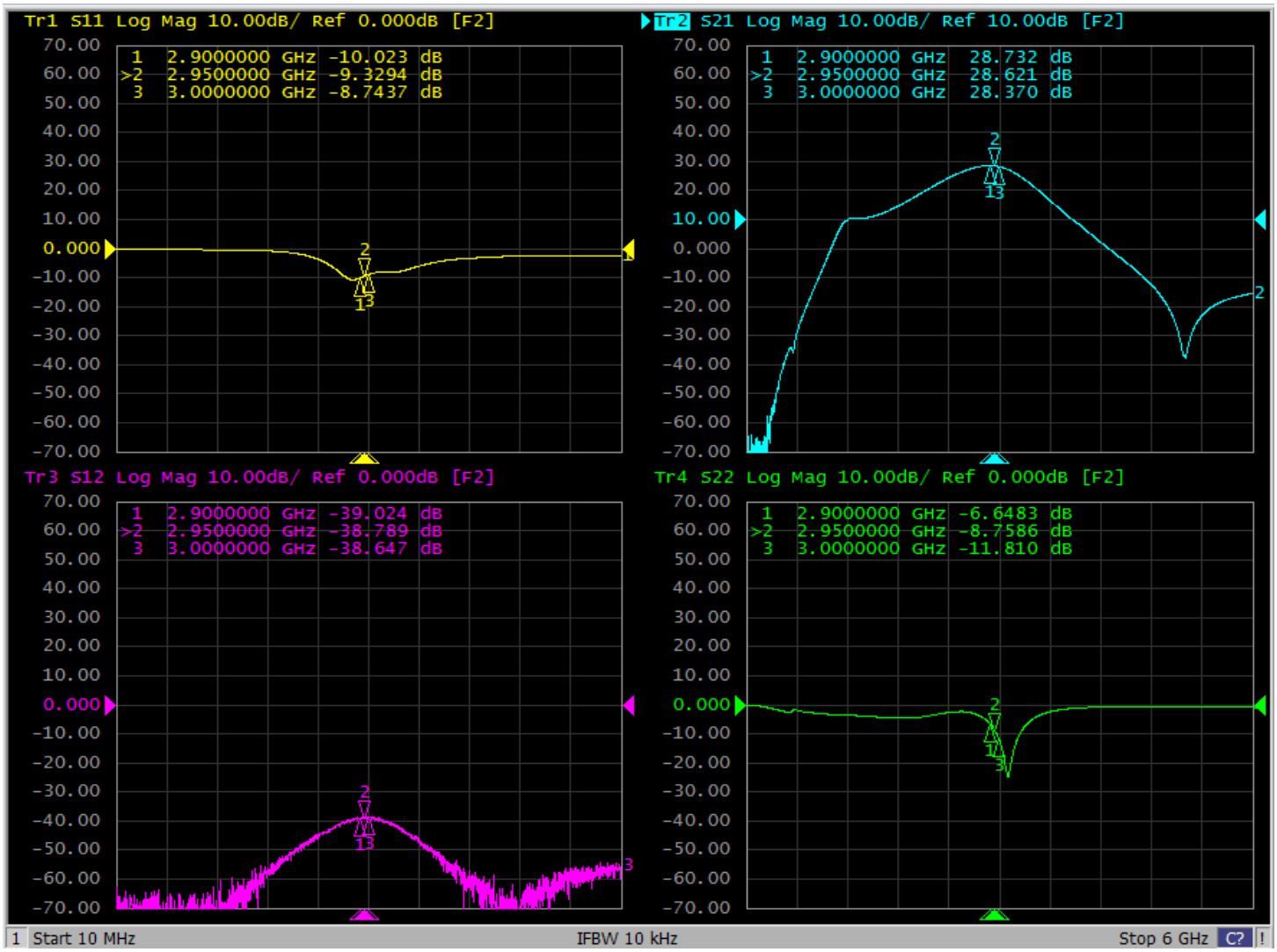
GRF5529 Typical Operating Curves: 2.95 GHz Tune





GRF5529 Typical Operating Curves: Small Signal S-Parameters (2.9 to 3.0 GHz Tune)



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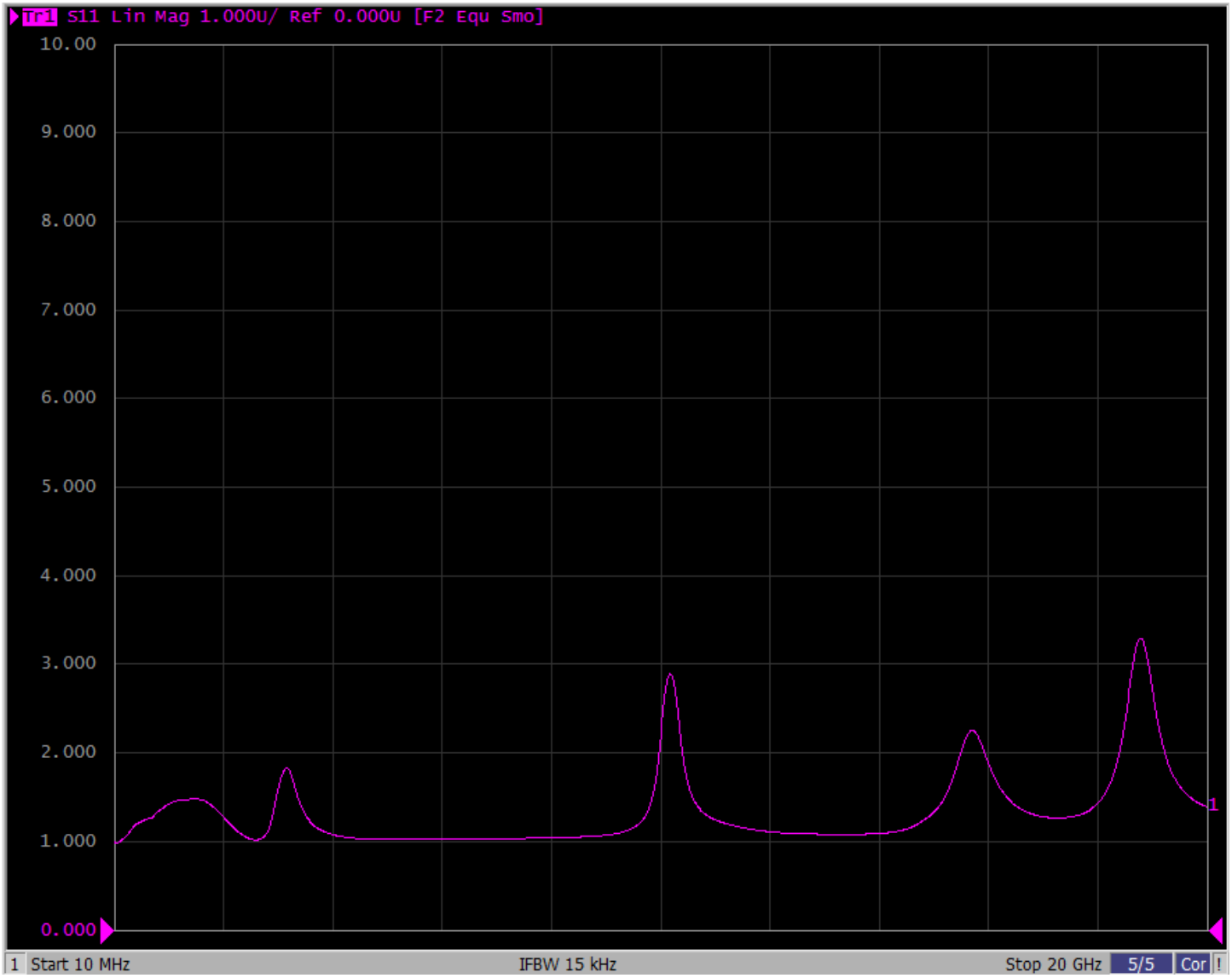
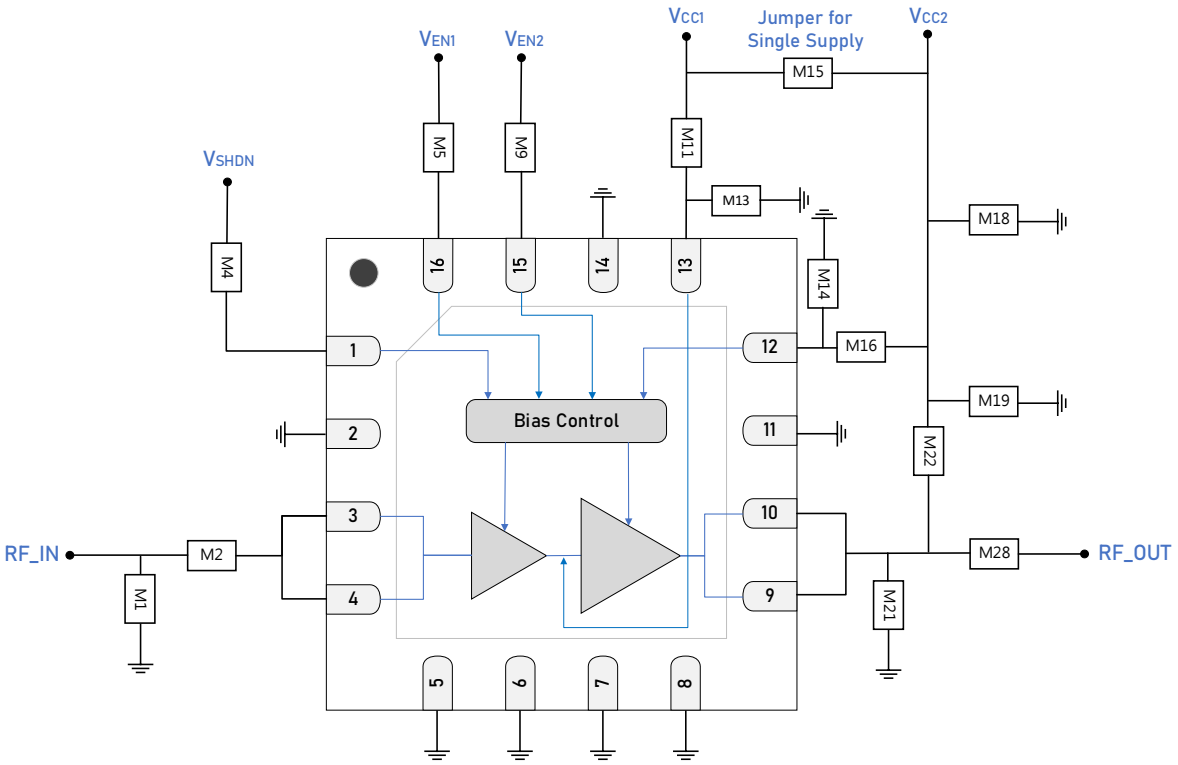
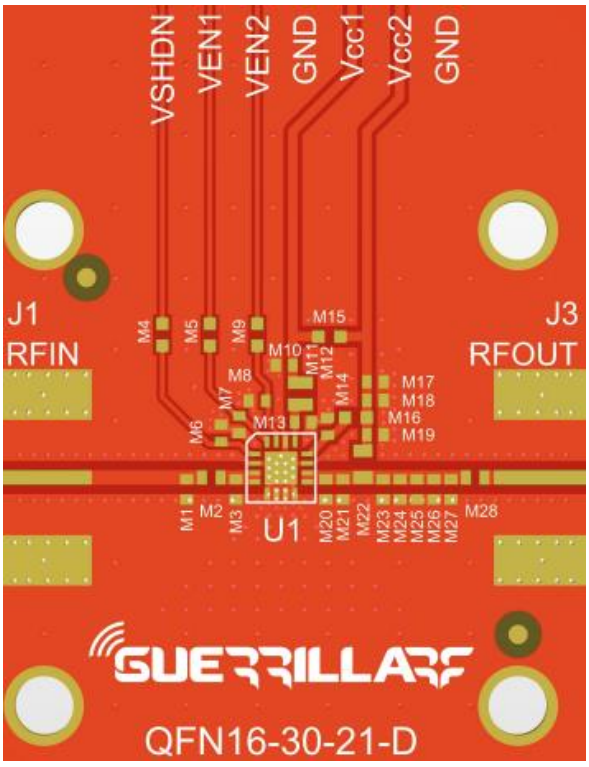
GRF5529 Typical Operating Curves: Stability Mu - Small Signal (10 MHz to 20 GHz)



Note: Mu factor ≥ 1.0 implies unconditional stability.



GRF5529 Standard Evaluation Board Schematic

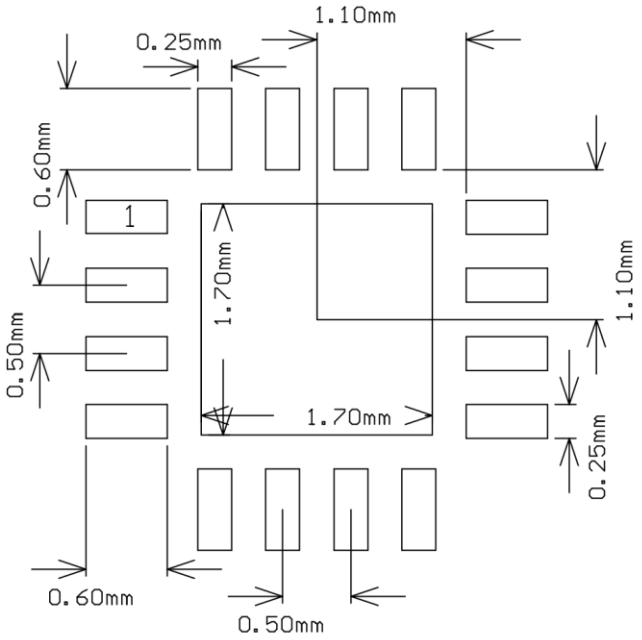


GRF5529 Evaluation Board Assembly Diagram

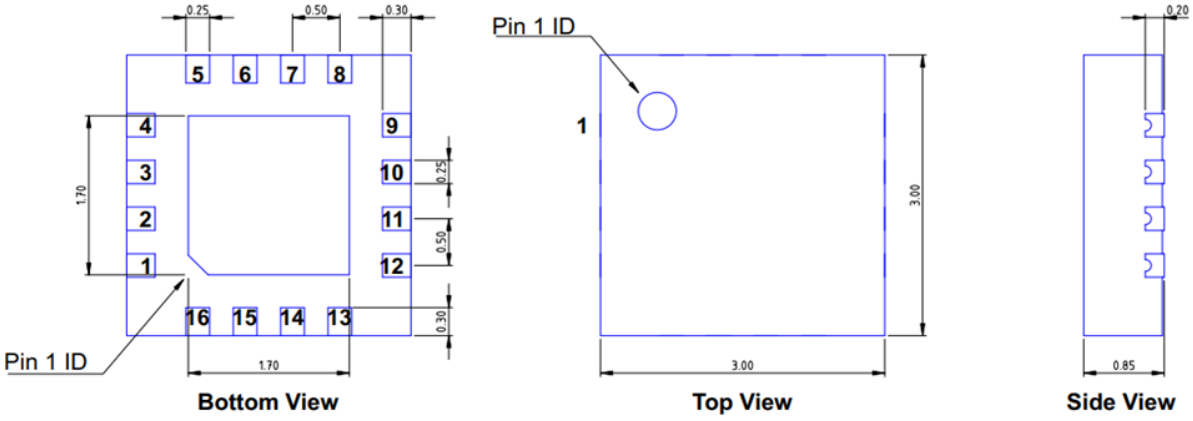
GRF5529 Evaluation Board Assembly Diagram Reference: 2.95 GHz Tune

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1	Inductor	Murata	LQP	1.5 nH	0402	ok
M2	Capacitor	Murata	GJM	1.0 pF	0402	ok
M4	Resistor	Various	--	0 Ω	0402	ok
M5	Resistor	Various	5%	6.65 kΩ	0402	ok
M9	Resistor	Various	5%	4.75 kΩ	0402	ok
M11	Resistor	Various	--	0 Ω	0402	ok
M13	Capacitor	Murata	GRM	0.1 µF	0402	ok
M14	Capacitor	Murata	GRM	10 µF	0402	ok
M15	Resistor (Jumper)	Various	--	0 Ω	0402	ok
M16	Resistor	Various	--	0 Ω	0402	ok
M18	Capacitor	Murata	GRM	10 µF	0402	ok
M19	Capacitor	Murata	GRM	100 pF	0402	ok
M21	Capacitor	Murata	GJM	2.2 pF	0402	ok
M22	Inductor: High-Q	Murata	LQW	3.9 nH	0603	ok
M28	Capacitor	Murata	GJM	10 pF	0402	ok
Evaluation Board	QFN16-30-21-D					

Note: Standard evaluation board bias: V_{CC} = 5 V, V_{ENABLE} = 5 V.



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

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Package Marking Diagram

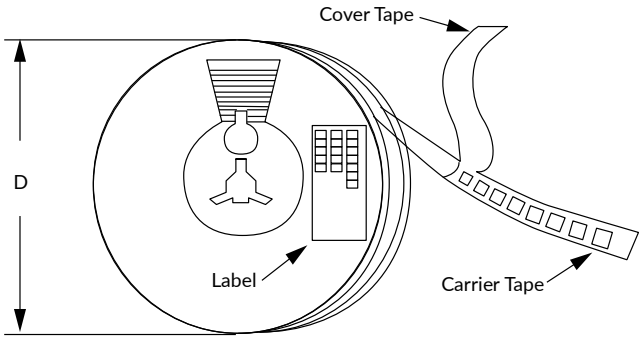
- Line 1: "YY" = YEAR. "WW" = WORK WEEK the device was assembled.
- Line 2: "GRF" = Guerrilla RF.
- Line 3: "XXXX" = Device PART NUMBER.

Tape and Reel Information

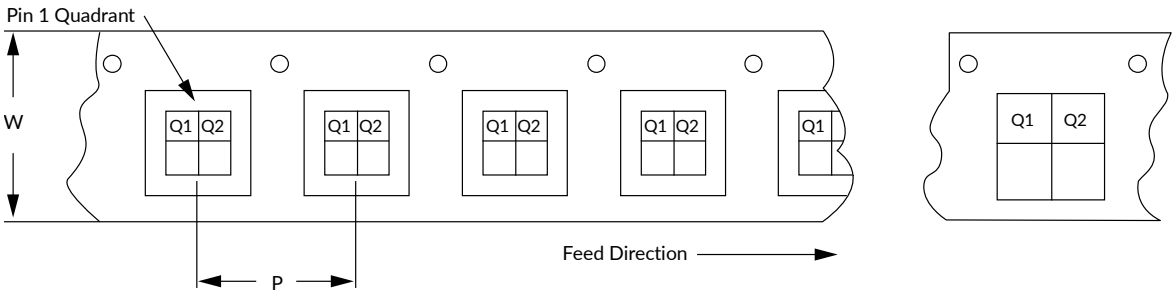
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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: *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
December 13, 2021	Preliminary Data Sheet.
March 8, 2022	Updated Package Marking Diagram.
May 10, 2022	Changed HBM Minimum Specification from TBD to 1500 V.
January 23, 2023	Added Characterization Plots. In the Absolute Ratings Table: Added the following condition to Maximum Dissipated Power for Stage-1 & 2: DC only. No RF applied. Changed Maximum Dissipated Power Stage-2 specification from 1400 to 850 mW.
September 20, 2024	Release Ø Data Sheet. Updated specifications. Added new Spar & Mu Plots.
January 17, 2025	Updated Data Sheet with minor cosmetic changes only. No change to device or device specifications.

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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 *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.