DATA SHEET

GRF4015

High Frequency Power-LNA 0.7 to 9 GHz

RELEASE Ø DATA SHEET

FEATURES

- Flexible Bias Voltage and Current
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package

Reference: 5 V / 165 mA / 2.5 GHz

- Gain: 21 dB
- OP1dB: 25.4 dBm
- OIP3: 41 dBm
- Evaluation Board Noise Figure: 1.5 dB

APPLICATIONS

- Linear Driver/PA/LNA
- Small Cells and Cellular Repeaters
- Multi-stage LNA
- Microwave Backhaul

ORDERING INFORMATION

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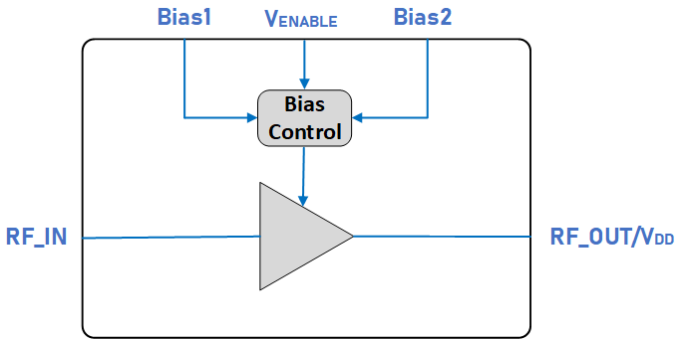
DESCRIPTION

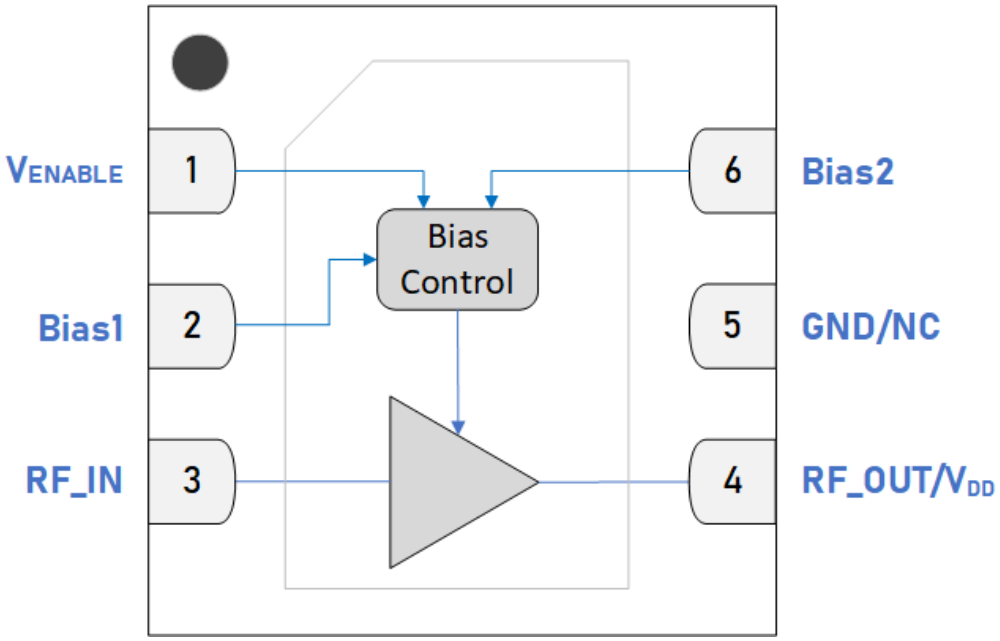
The GRF4015 is a high linearity PA/Linear Driver with low Noise Figure (NF). It delivers excellent P1dB, IP3 and NF over a wide range of frequencies with fractional bandwidths > 15 % and is well suited to demanding 802.11ac 5 GHz PA/Driver applications. The device offers flexible biasing to achieve optimal linearity and efficiency and can be tuned over a wide range of frequencies from 0.7 to 9 GHz.

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 GRF4015 “Custom Tunes” product page: GRF4015 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 device. On-die pull-down resistor will turn the device off if this node is allowed to float.
2	Bias1	Bias1 Circuit Supply	Connect to ground via R-L network for linearity optimization.
3	RF_IN	LNA RF Input	An external DC blocking capacitor must be used.
4	RF_OUT/V_{DD}	LNA RF Output	V_{DD} must be applied through a choke to this Pin.
5	GND/NC	Ground or No Connect	No internal connection to die. We recommend connecting these pins to ground.
6	Bias2	Bias2 Circuit Supply	Connect to V_{DD} through an external resistor.
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
Drain Voltage	V_{DD}	3	9	V
Transient Average RF Input Power CW: Load VSWR < 2:1	$P_{IN\ MAX}$		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 (DC only, no RF applied)	$P_{DISS\ MAX}$		1.3	W

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.

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.		
Drain Voltage	V_{DD}	3.3	5	8	V	
Operating Temperature Range	$T_{PKG\ BASE}$	-40		105	°C	
RF Frequency Range	F_{RF}	0.7	2.5	9	GHz	Typical application schematic with external matching components **(note 1 & 2)**.
RF_IN Port Impedance	Z_{RFIN}		50		Ω	Single-ended, 3 element match.
RF_Out Port Impedance	Z_{RFOUT}		50		Ω	Single-ended, 3 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: GRF4015 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

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Current	I_{DD}		165		mA	V_{DD} = 5 V, V_{ENABLE} = 5 V. Adjustable for optimal IP3.
Enable Current	I_{ENABLE}		4.5		mA	V_{DD} = 5 V, V_{ENABLE} = 5 V.
Switching Rise Time	T_{RISE}		20		ns	Disabled mode to Gain mode **(note 3)**.
Switching Fall Time	T_{FALL}		30		ns	Gain mode to Disabled mode **(note 4)**.

Disabled Mode

Leakage Current	$I_{LEAKAGE}$		490		µA	V_{DD} = 5 V, V_{ENABLE} = 0 V.

Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		68		°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}.

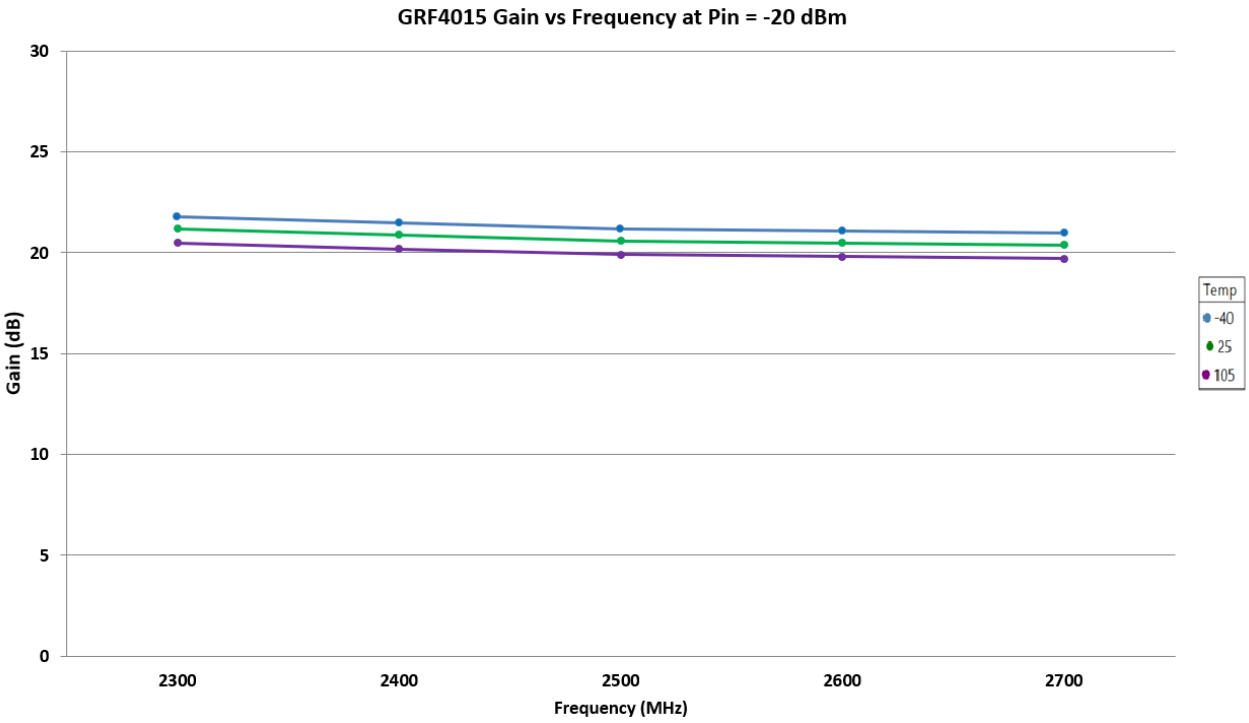
Note 5: MTTF >10^6 hours for $T_{CHANNEL}$ ≤170 °C.

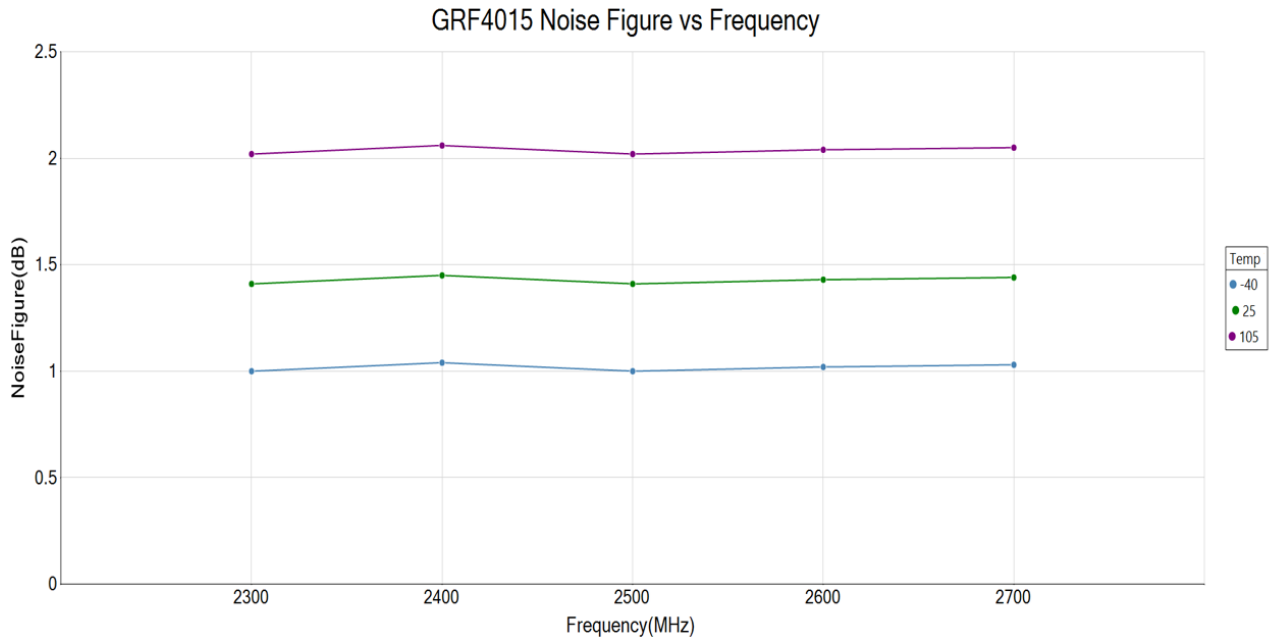
Nominal Operating Parameters - RF

The following conditions apply unless noted otherwise: typical application schematic, V_{DD} = V_{ENABLE} = 5 V, I_{DD} = 165 mA, F_{TEST} = 2.5 GHz, 50 Ω system impedance, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

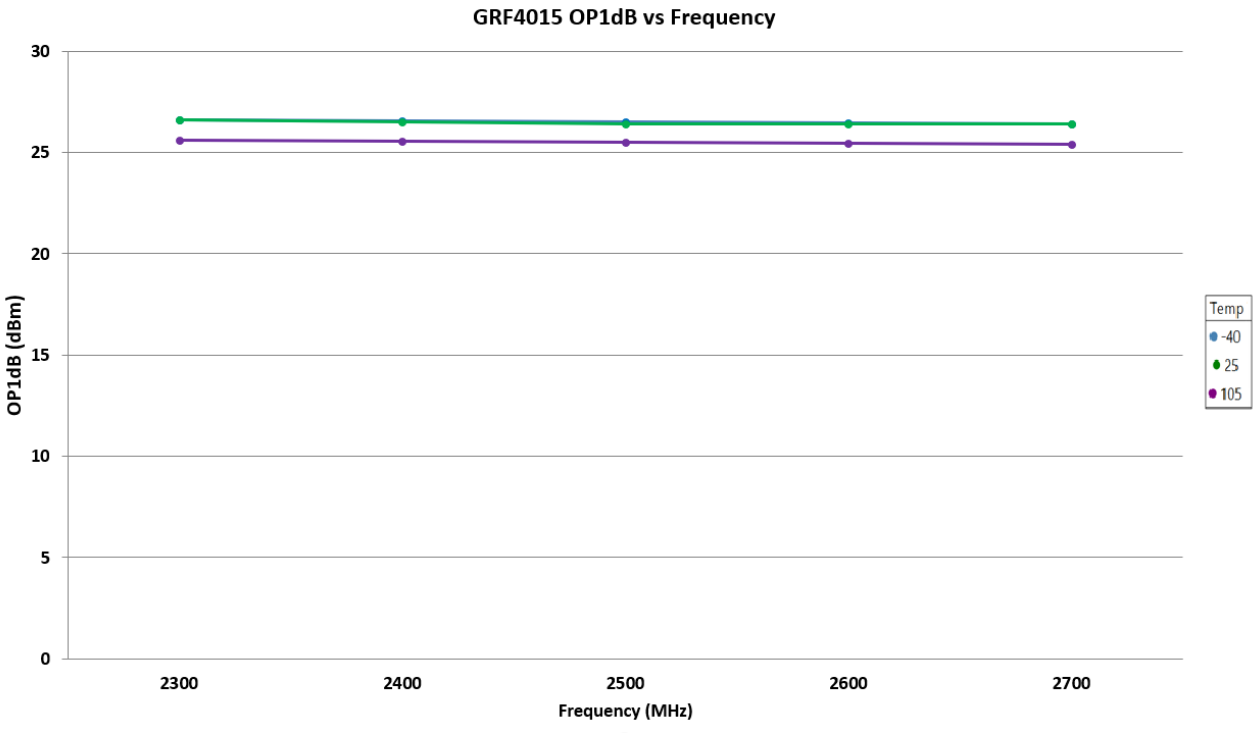
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21		21		dB	
Noise Figure	NF		1.5		dB	On standard evaluation board (includes board losses).
Output 3rd Order Intercept Point	OIP3		41		dBm	+8 dBm P_{OUT} per tone at 2 MHz spacing (2499 and 2501 MHz).
Output 1 dB Compression Power	OP1dB		25.4		dBm	

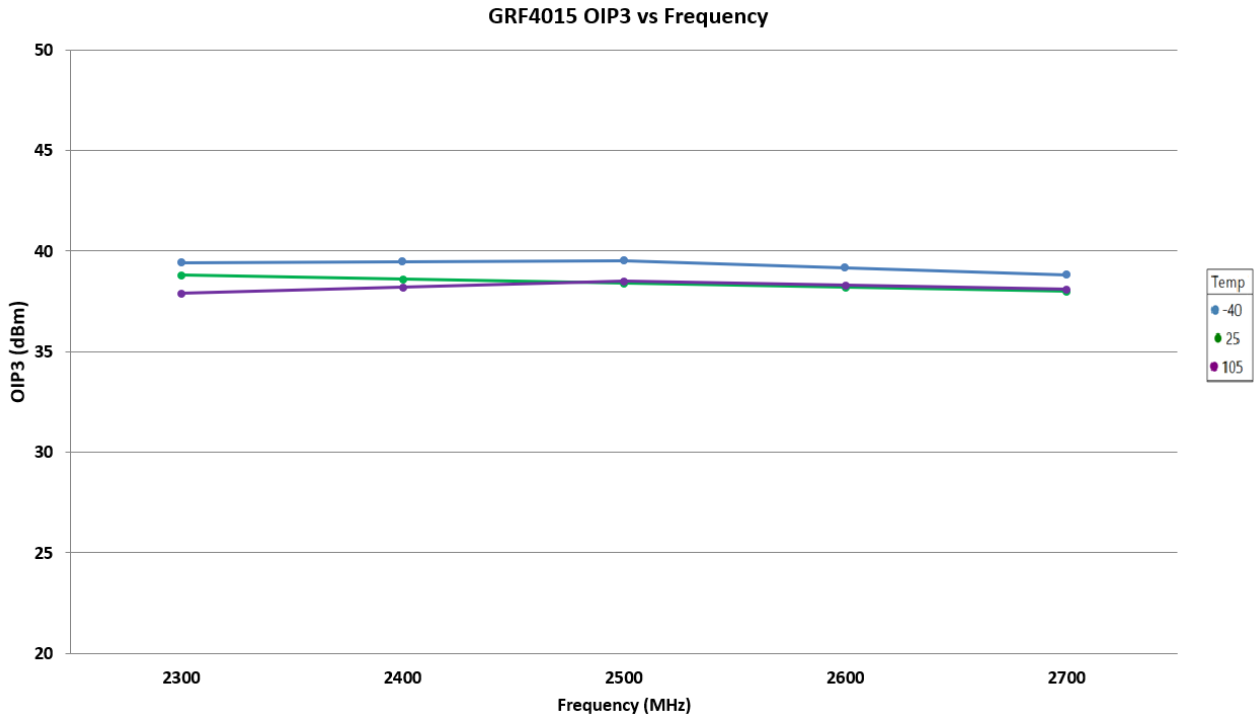
GRF4015 Typical Operating Curves: 2.3 to 2.7 GHz Tune



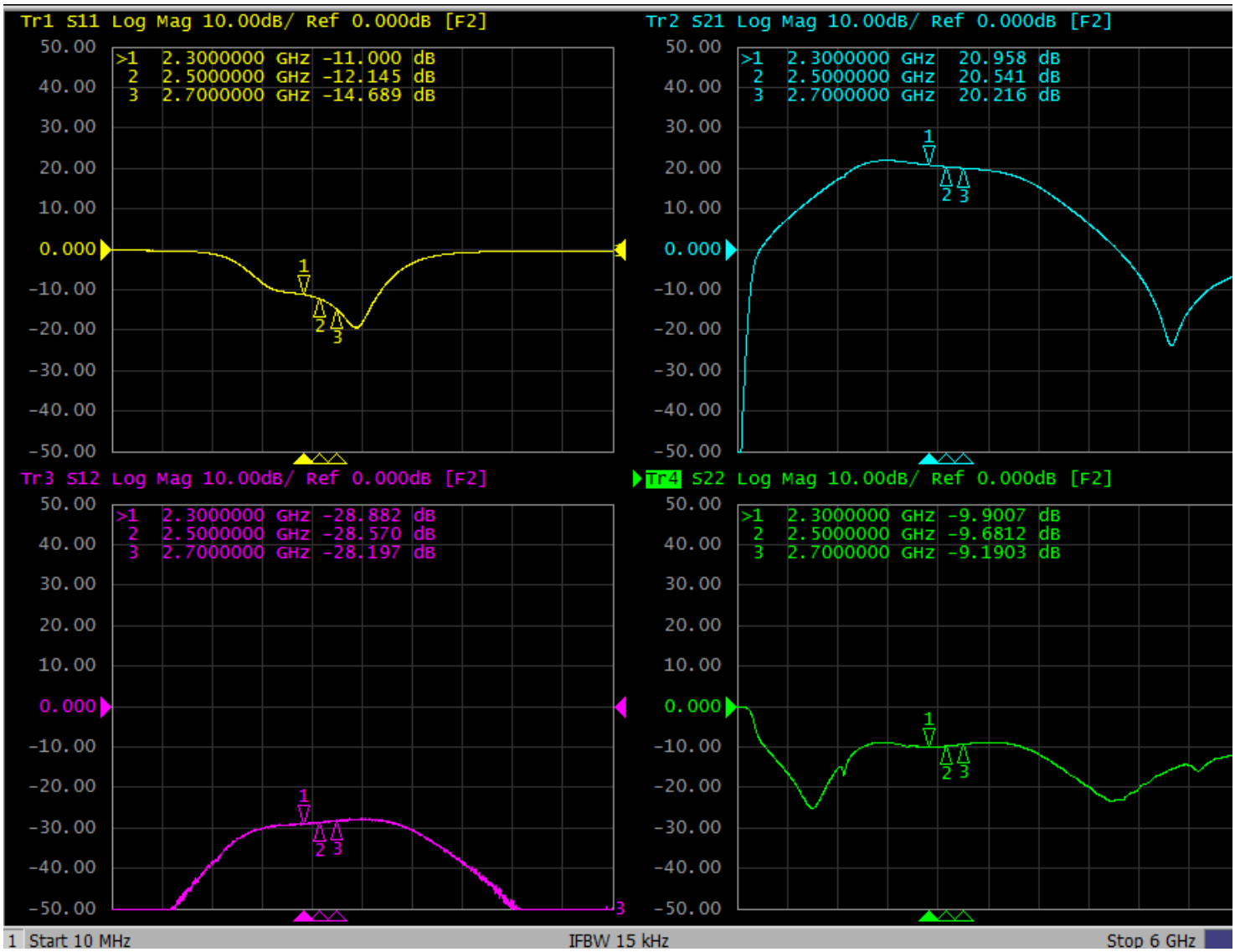


GRF4015 Typical Operating Curves: 2.3 to 2.7 GHz Tune

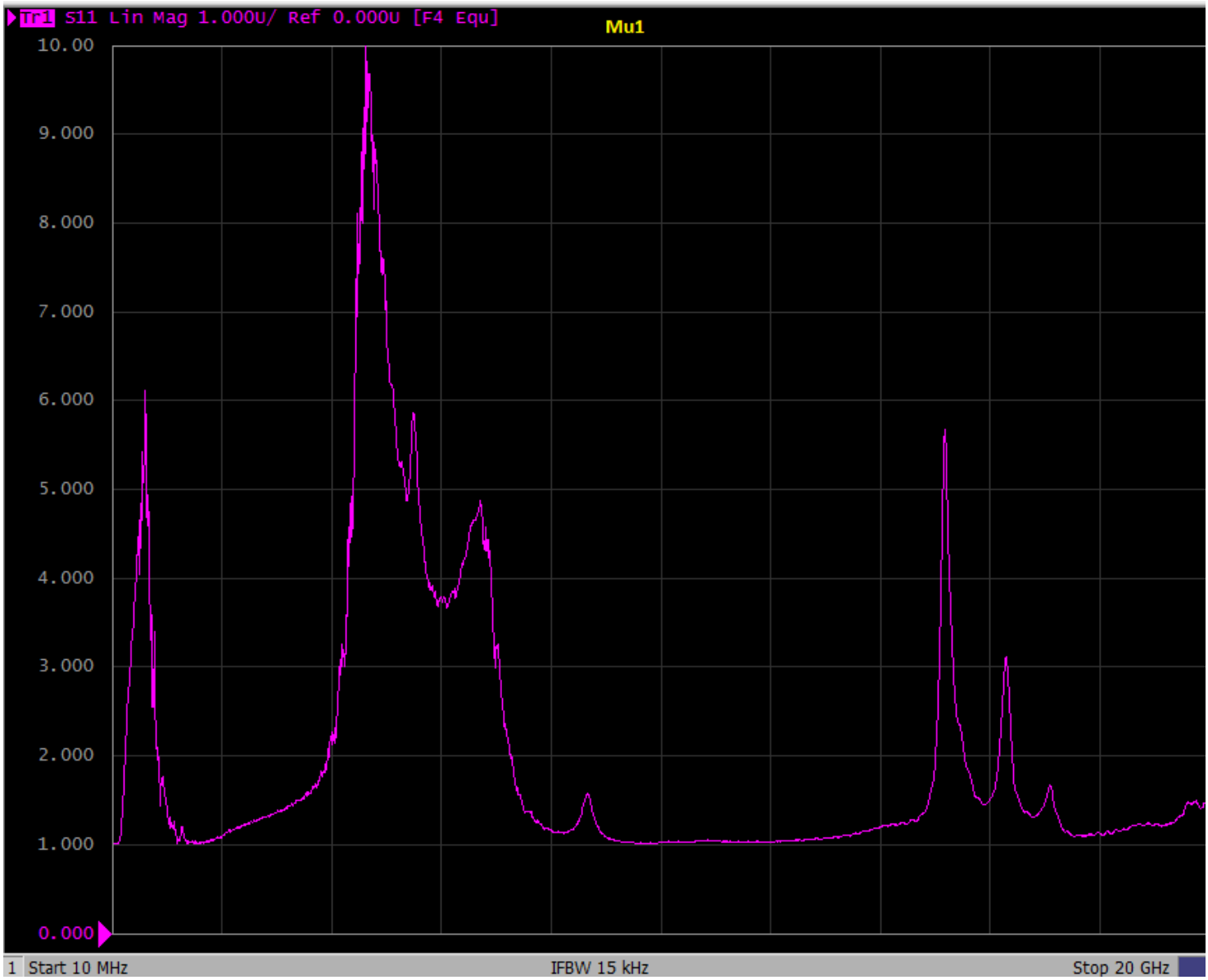




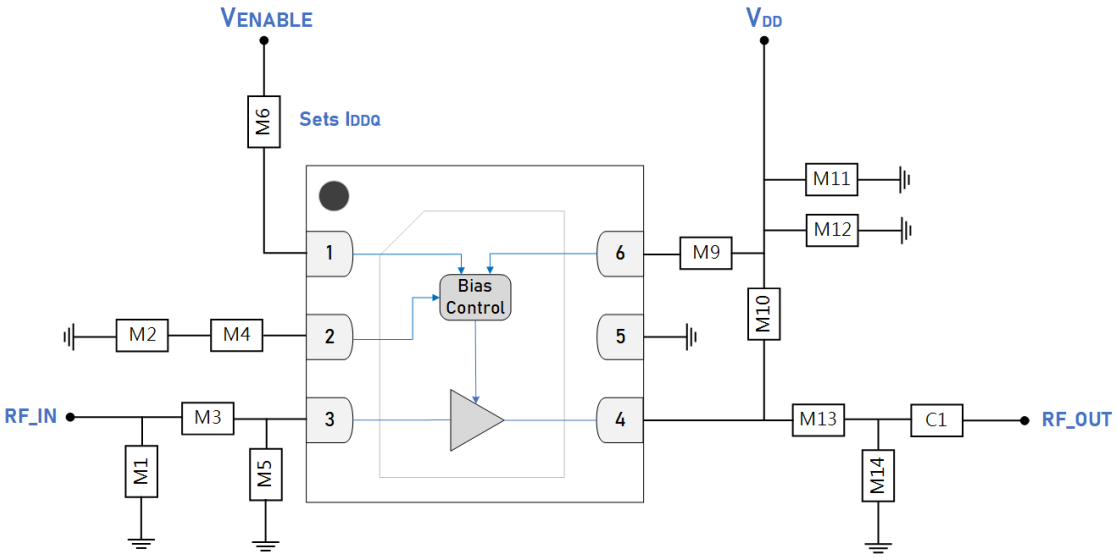
GRF4015 Typical Operating Curves: S-Parameters (2.3 to 2.7 GHz Tune)



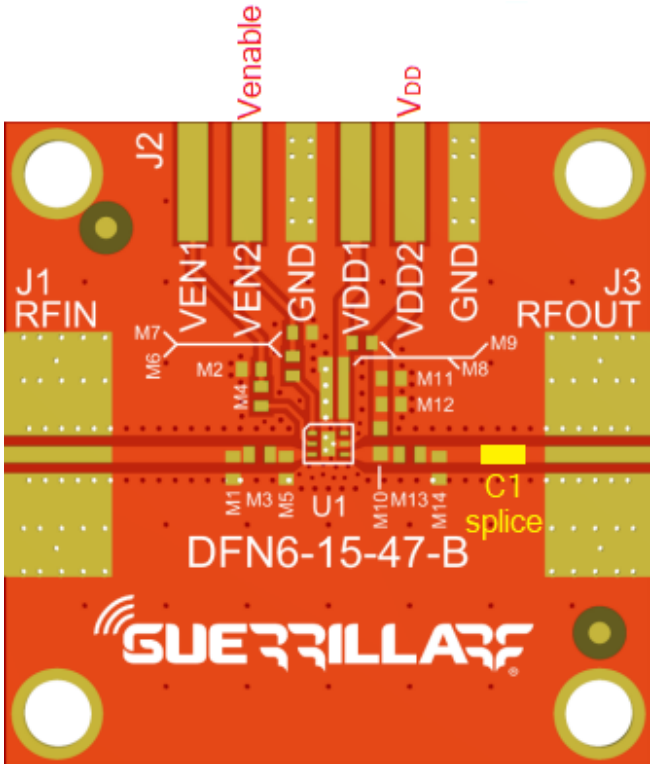
GRF4015 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



Note: Mu ≥ 1.0 implies unconditional stability.



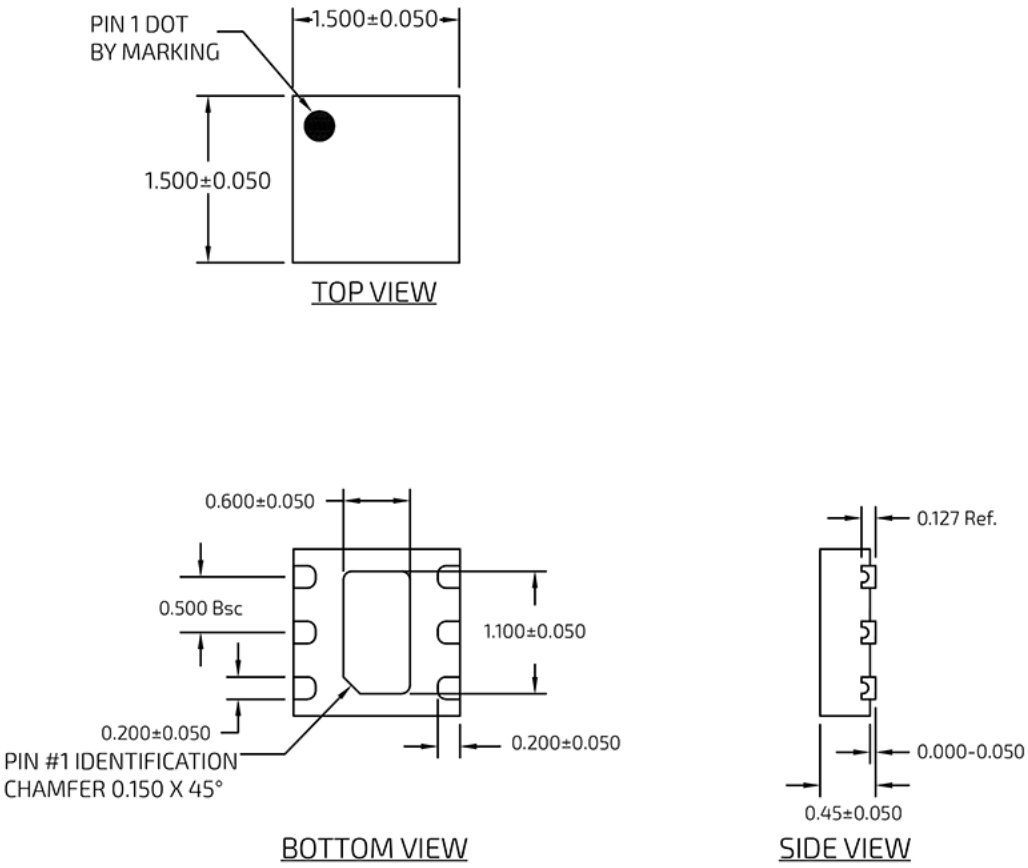
GRF4015 Standard Evaluation Board Schematic



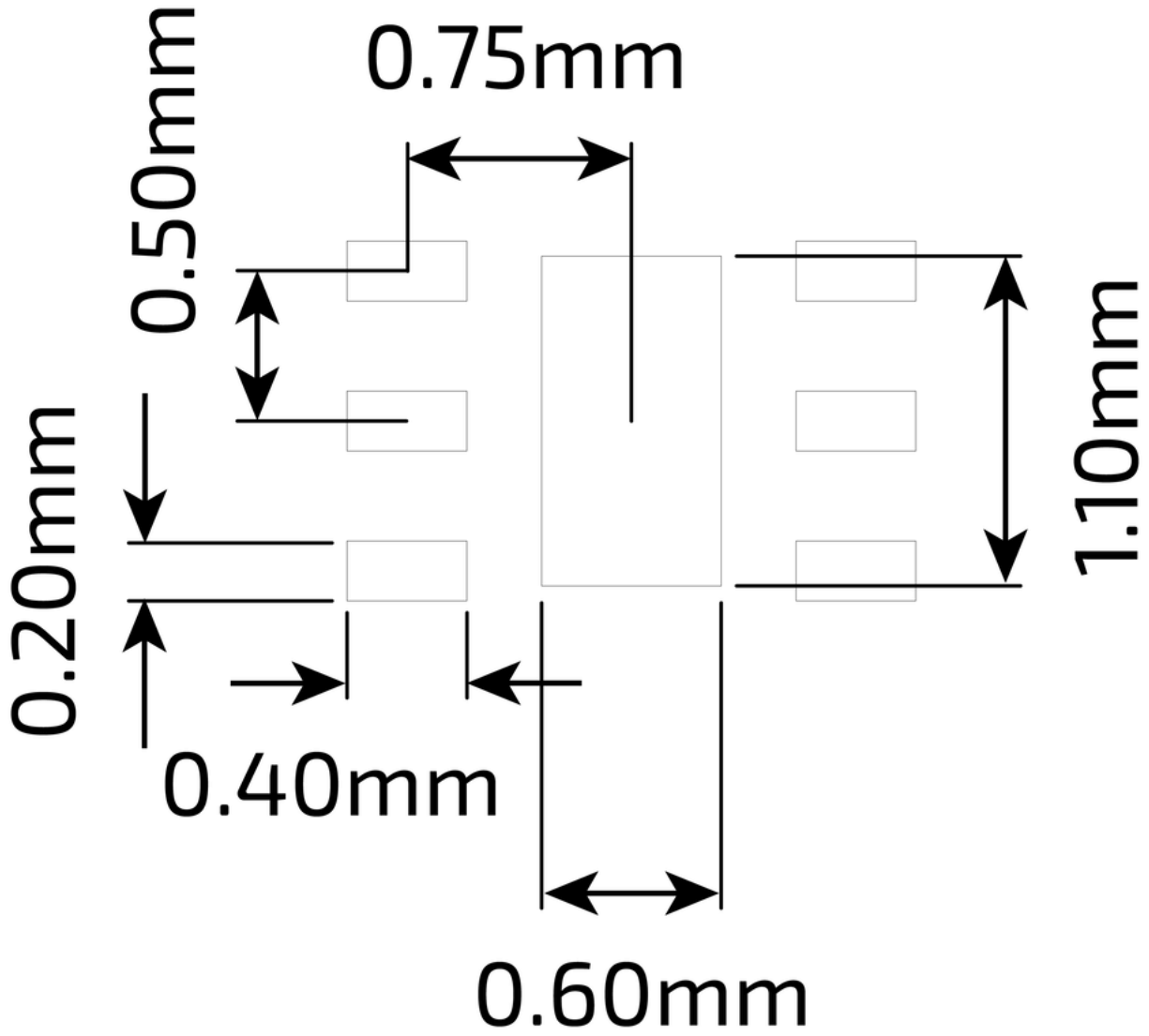
GRF4015 Evaluation Board Assembly Diagram

GRF4015 Evaluation Board Assembly Diagram Reference: 5 V, 2.3 to 2.7 GHz Tune

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1	Inductor	Murata	LQGWH	3.3 nH	0402	ok
M2	Resistor	Various	5%	50 Ω	0402	ok
M3	Capacitor	Murata	GJM	2.2 pF	0402	ok
M4	Resistor	Various	5%	0 Ω	0402	ok
M5	Capacitor	Murata	GJM	2.7 pF	0402	ok
M6	Resistor	Various	5%	300 Ω	0402	ok
M9	Resistor	Various	5%	500 Ω	0402	ok
M10	Inductor	Murata	LQGWH	15 nH	0402	ok
M11	Capacitor	Murata	GRM	10 µF	0603	ok
M12	Capacitor	Murata	GRM	22 pF	0402	ok
M13	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M14	Capacitor	Murata	GJM	0.5 pF	0402	ok
C1	Capacitor	Murata	GJM	15 pF	0402	ok
Evaluation Board	DFN6-15-47-B					



DFN 6 1.5x1.5mm Package Dimensions



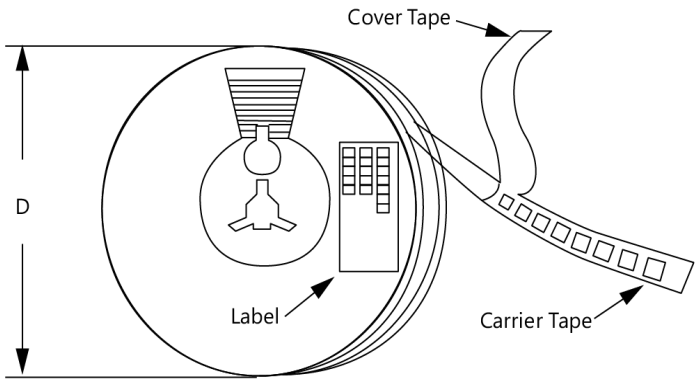
DFN 6 1.5x1.5mm Suggested PCB Footprint (Top View)

Package Marking Diagram

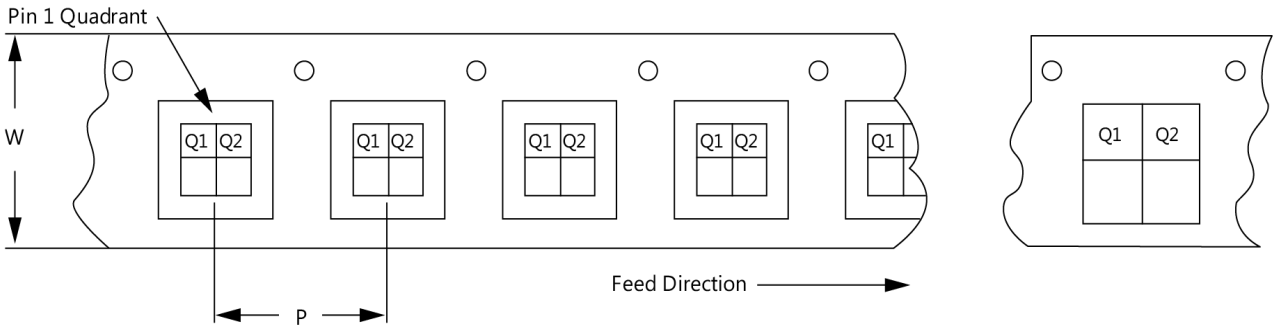
Line 1: “Y” = YEAR (single digit). “WW” = WORK WEEK the Device was assembled.
Line 2: “XXXX” = Device Part Number.

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
February 21, 2024	Advance Data Sheet.
April 10, 2024	Preliminary Data Sheet.
March 5, 2025	Release Ø Data Sheet.

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.

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