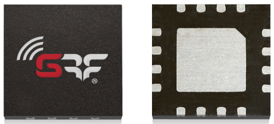
DATA SHEET



GRF5611

PRELIMINARY DATA SHEET

HIGH LINEARITY POWER AMPLIFIER
902 MHz to 960 MHz

FEATURES

- Excellent OP1dB, OIP3, ACLR and IM3 Performance
- Native Linearity Provides up to 26 dBm P_{OUT} with > 45 dBc ACLR Without the Need for Digital Predistortion Correction
- 25.5 dBm Linear Output Power Maintained at 85 °C
- Flexible Biasing Provides Latitude for Linearity Optimization
- 207 mA Native Mode Quiescent Current Consumption
- 5 V Supply Voltage
- 50 Ω Single-Ended Input and Output Impedance
- Digital Shutdown
- Rugged Design is Extremely Resilient to Mismatched Loads
- -40 to 85 °C Operating Temperature Range
- Compact 3 x 3 mm QFN Package
- RoHS Compliant

Reference: 5 V / 207 mA I_{CCQ} / 925 MHz

- Gain: 26.3 dBm
- OIP3: 46.9 dBm @ 25 dBm P_{OUT}/tone
- OP1dB: 34.9 dBm
- Evaluation Board Noise Figure: 4.1 dB

APPLICATIONS

- Celluar Boosters
- Automotive Compensators
- Picocells/Femtocells
- Customer Premise Equipment
- RFID

ORDERING INFORMATION

Buy it Now

DESCRIPTION

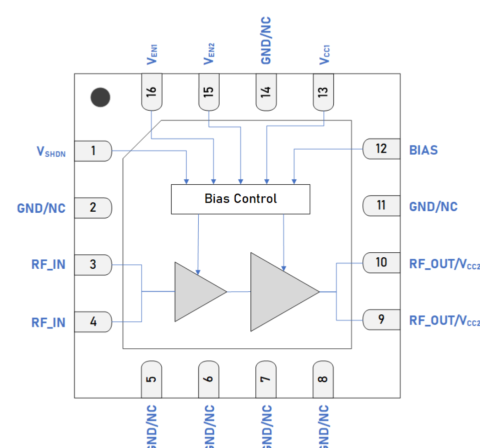
The GRF5611 is a high gain, two-stage InGaP HBT Power Amplifier designed to deliver excellent P1dB, ACLR and IM3 performance over the 902 to 960 MHz band. Its exceptional native linearity makes it an ideal choice for transmitter applications that typically do not employ digital predistortion correction schemes.

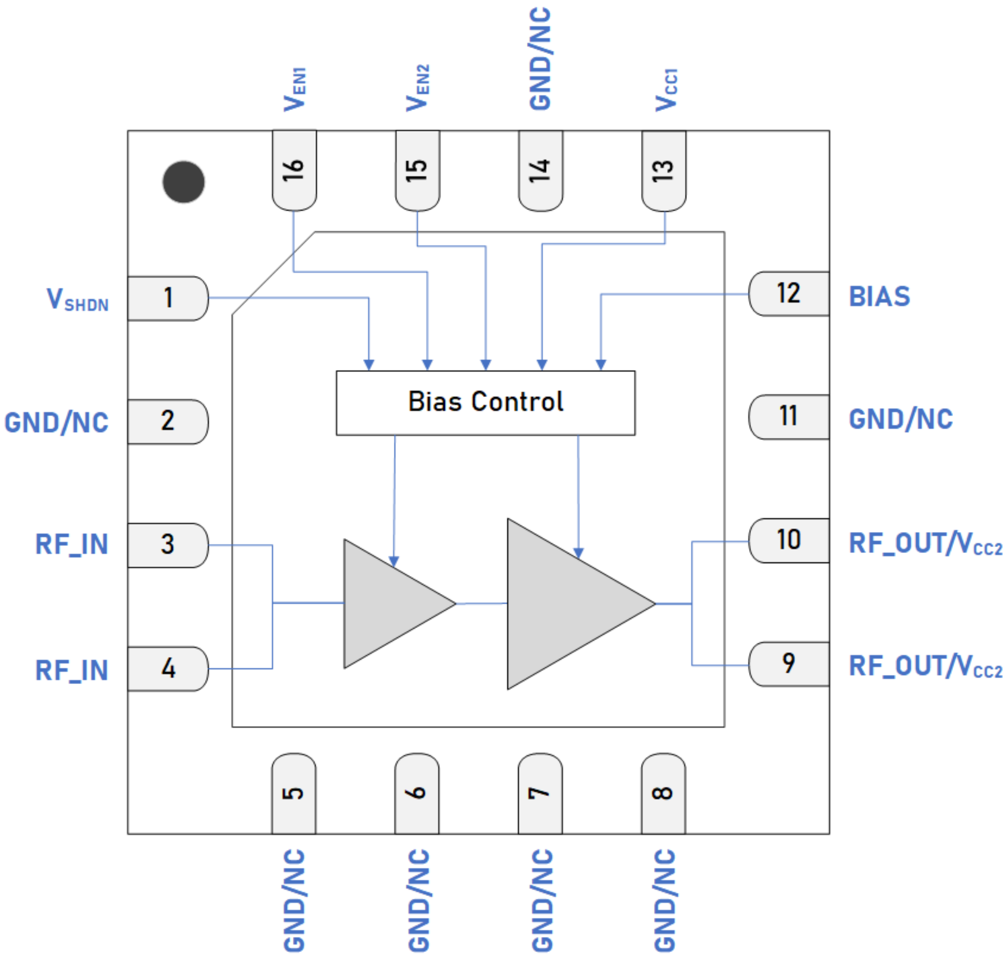
This device is part of a complete family of externally matched linear amplifiers that cover the following frequency ranges:

GRF5605: 617 - 652 MHz	GRF5611: 902 - 960 MHz
GRF5606: 663 - 716 MHz	GRF5616: 1625 - 1675 MHz
GRF5607: 703 - 748 MHz	GRF5617: 1710 - 1785 MHz
GRF5608: 746 - 830 MHz	GRF5618: 1800 - 1920 MHz
GRF5609: 814 - 862 MHz	GRF5626: 2500 - 2700 MHz
GRF5610: 865 - 928 MHz	GRF5636: 3400 – 3800 MHz

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

BLOCK DIAGRAM





Pin Out (Top View)

Pin Assignments

Pin	Name	Description	Note
1	V_{SHDN}	Digital Shutdown Pin	V_{SHDN} ≥ 1.5 V (Logic HIGH) disables device. V_{SHDN} ≤ 0.9 V (Logic LOW) 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 and 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 and 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 inductor or 0 Ω 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 de-coupling capacitor to ground is required for optimal NF performance.
PKG BASE	GND	Ground	Provides DC and RF ground for the amplifier, 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.

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

Truth Table

Pin	Logic Level	Condition
V_{SHDN}	LOW	Full Operation
	HIGH	All Amplifiers OFF
V_{EN1}	LOW	Stage 1 Amplifier OFF
	HIGH	Stage 1 Amplifier ON
V_{EN2}	LOW	Stage 2 Amplifier OFF
	HIGH	Stage 2 Amplifier ON

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

Absolute Ratings

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	V_{CC}		TBD	V
RF Input Power: 50 Ω, V_{CC} = 5 V, CW tone, 100 % duty cycle, $T_{PKG\ BASE}$ = 25 °C.	$P_{IN\ MAX:\ 1:1}$		TBD	dBm
RF Input Power: Load VSWR ≤ 8:1, all phase angles, V_{CC} = 5 V, CW tone, 100% duty cycle, $T_{PKG\ BASE}$ = -40 to 85 °C.	$P_{IN\ MAX:\ 8:1}$		TBD	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)	$P_{DISS\ MAX}$		TBD	mW
Maximum Dissipated Power (Stage 2)	$P_{DISS\ MAX}$		TBD	mW
Shutdown Voltage	V_{SHDN}		TBD	V

Electrostatic Discharge

Charged Device Model	CDM	750		V
Human Body Model	HBM	1000		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_{CC}	TBD	5	TBD	V	
Operating Temperature Range	$T_{PKG\ BASE}$	-40		85	°C	
RF Frequency Range	F_{RF}	902	925	960	MHz	Typical application schematic using the 902 to 960 MHz tuning set **(note1)**.
RF_IN Port Impedance	Z_{RFIN}		50		Ω	
RF_OUT Port Impedance	Z_{RFOUT}		50		Ω	

Note1: Operation outside of this range is possible, but with degraded performance of some parameters.

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

Nominal Operating Parameters - General

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Quiescent Current	I_{CCQ}		207		mA	I_{CCQ1} + I_{CCQ2}. No RF applied.
Supply Current with RF Applied	I_{CC}		420		mA	I_{CC1}+ I_{CC2}. RF applied. P_{OUT} = 25 dBm.
Enable Current 1	$I_{ENABLE1}$		2.5		mA	V_{CC} = 5 V.
Enable Current 2	$I_{ENABLE2}$		0.3		mA	V_{CC} = 5 V.
Operating Temperature Range	$T_{PKG\ BASE}$	-40		85	°C	Measured on Package Heat Sink.
Logic Input Low	V_{IL}	0		0.9	V	Applies to V_{SHDN} Input.
Logic Input High	V_{IH}	1.7		V_{CC}	V	Applies to V_{SHDN} Input.
Logic Current Low	I_{IL}		1.3		nA	Applies to V_{SHDN} Input. V_{IL} = 0.9 V.
Logic Current High	I_{IH}		65		µA	Applies to V_{SHDN} Input, V_{IH} = 1.8 V.
			285			Applies to V_{SHDN} Input, V_{IH} = 3.3 V.
Switching Rise Time	T_{RISE}		500			Applies to V_{SHDN} Input.
Switching Fall Time	T_{FALL}		500			Applies to V_{SHDN} Input.

Disabled Mode

Supply Quiescent Current	$I_{CCQ\text{-}SHDN}$		15		µA	V_{CC} = 5 V, $V_{SHDN}/V_{EN1}/V_{EN2}$ = HIGH.
Enable Current 1	$I_{ENABLE1\text{-}SHDN}$		3		µA	V_{CC} = 5 V, $V_{SHDN}/V_{EN1}/V_{EN2}$ = HIGH.
Enable Current 2	$I_{ENABLE2\text{-}SHDN}$		0.75			V_{CC} = 5 V, $V_{SHDN}/V_{EN1}/V_{EN2}$ = HIGH.

Thermal Data (Stage 1 and Stage 2)

See Plot of Die Temp vs. Output Power			TBD			On Standard Evaluation Board.

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

Nominal Operating Parameters - RF

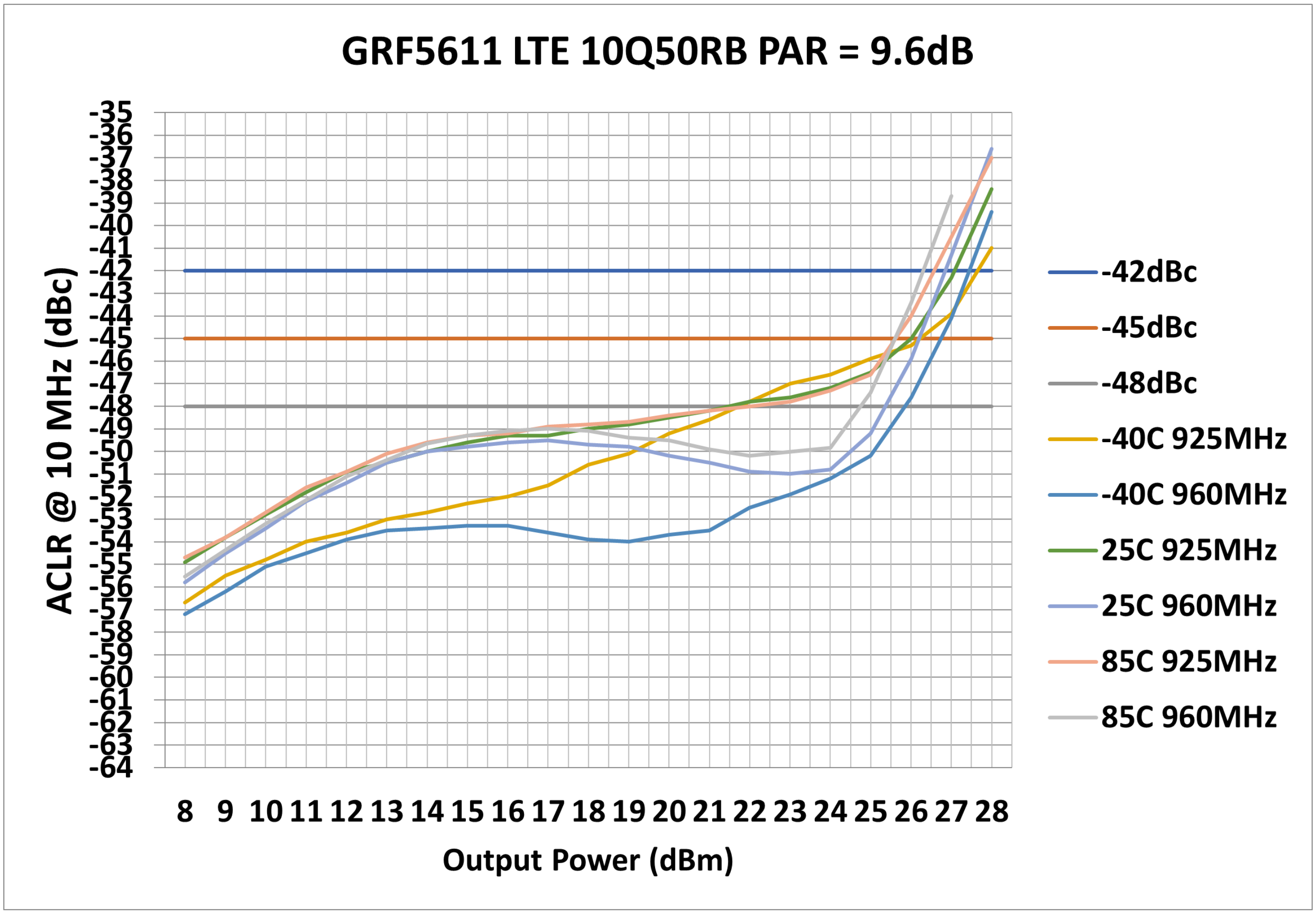
The following conditions apply unless noted otherwise; Typical Application Schematic, V_{CC} = 5 V, 50 Ω system impedance, F_{TEST} = 925 MHz, $T_{PKG\ HEAT\ SINK}$ = 25 °C. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Small Signal Gain	S21		26.3		dB	F_{TEST} = 925 MHz. V_{CC} = 5 V. P_{IN} = -25 dBm.
Standby Mode Gain	$S21_{STBY}$		-33		dB	Disabled Mode, V_{SHDN}/V_{EN1}/V_{EN2} = HIGH, Pin = 0 dBm.
Input Return Loss	S11		> 10		dB	F_{RF} = 902 to 960 MHz.
Output Return Loss	S22		> 6.5		dB	F_{RF} = 902 to 960 MHz.
Reverse Isolation	S12		> 42		dB	F_{RF} = 902 to 960 MHz.
Evaluation Board Noise Figure	NF		4.1		dB	
Output 3rd Order Intercept Point	OIP3		46.9		dBm	25 dBm P_{OUT} per tone at 600 kHz Spacing.
Output 1 dB Compression Power	OP1dB		34.9		dBm	Sinewave Input, V_{CC} = 5 V.
Adjacent Channel Leakage Ratio	ACLR		-46.5		dBc	P_{OUT} = 25 dBm, LTE 10MHz 50RB TM1.1 Downlink Waveform with 9.6 dB PAR, V_{CC} = 5 V, F_{TEST} = 925 MHz **(note 2)**.

Note 2: Min/Max limits defined using *modelled estimates* that account for part-to-part variations and expected process spreads. As additional production lots are fabricated, accumulated test data will be used to refine the Min/Max limits.

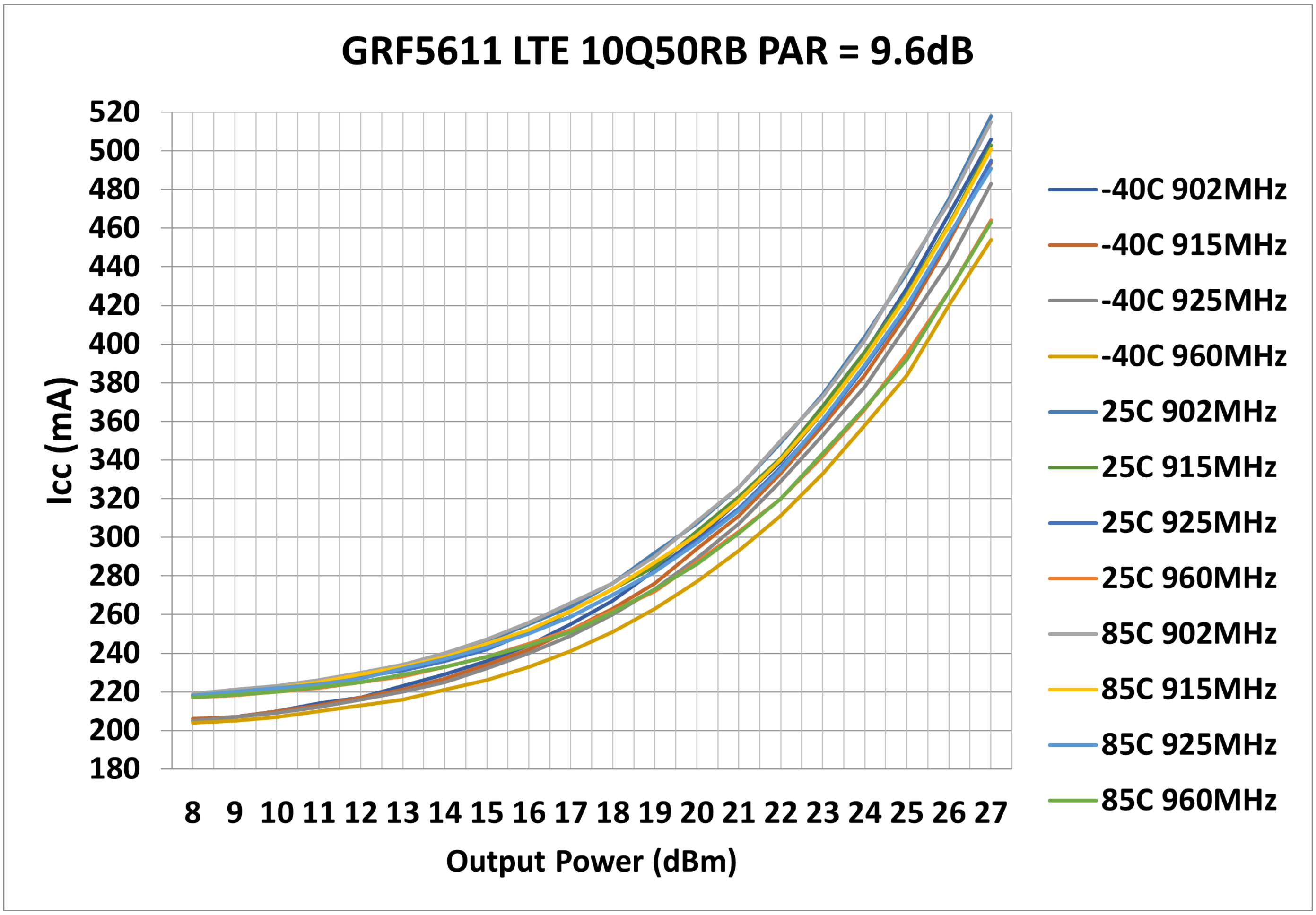
www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Rd., Greensboro, NC 27455

GRF5611 Typical Operating Curves: ACLR vs. P_{OUT} (LTE 9.6 dB PAR)

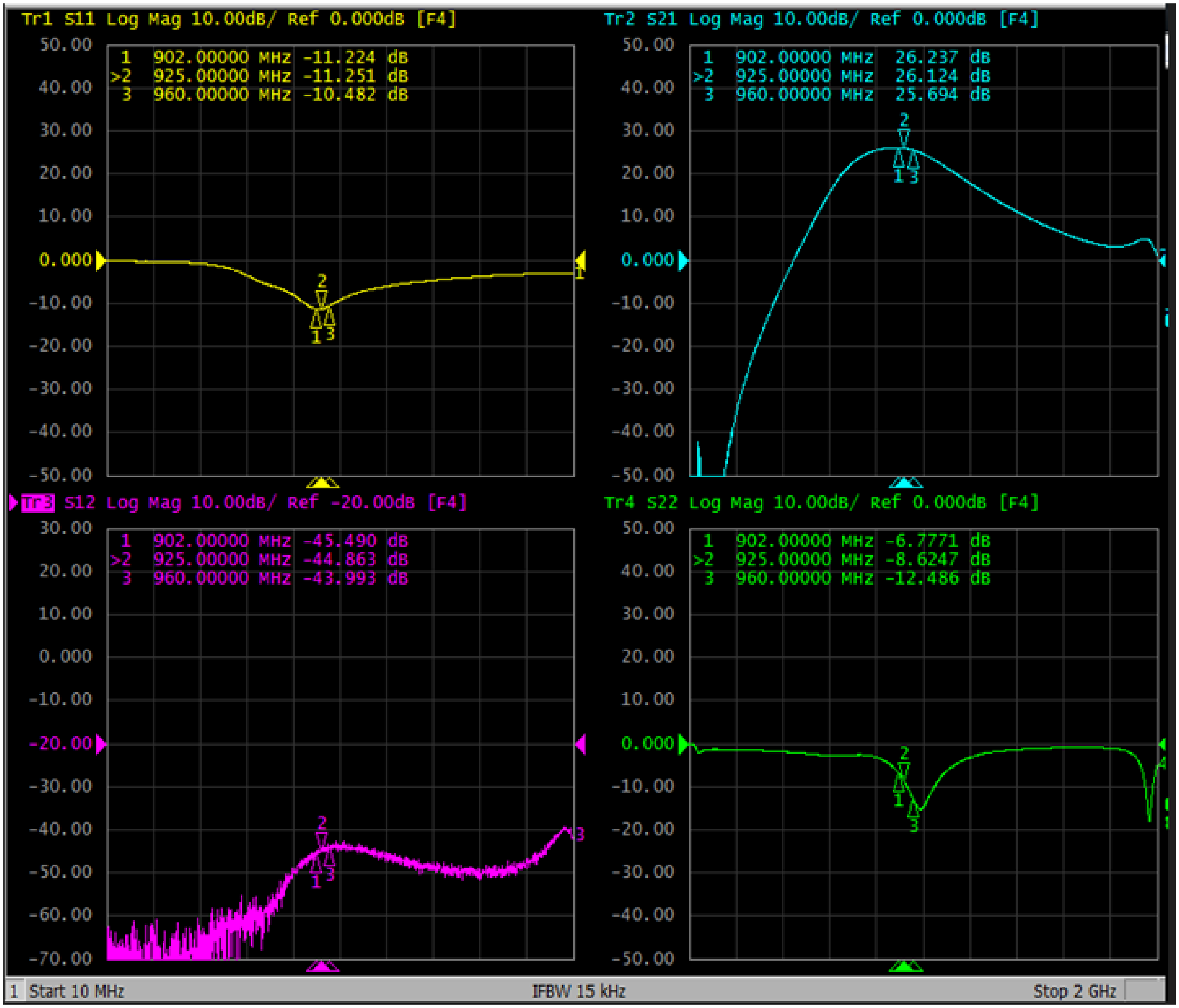


www.guerrilla-rf.com • (336) 510-7840 • sales@guerrilla-rf.com • 2000 Pisgah Church Rd., Greensboro, NC 27455

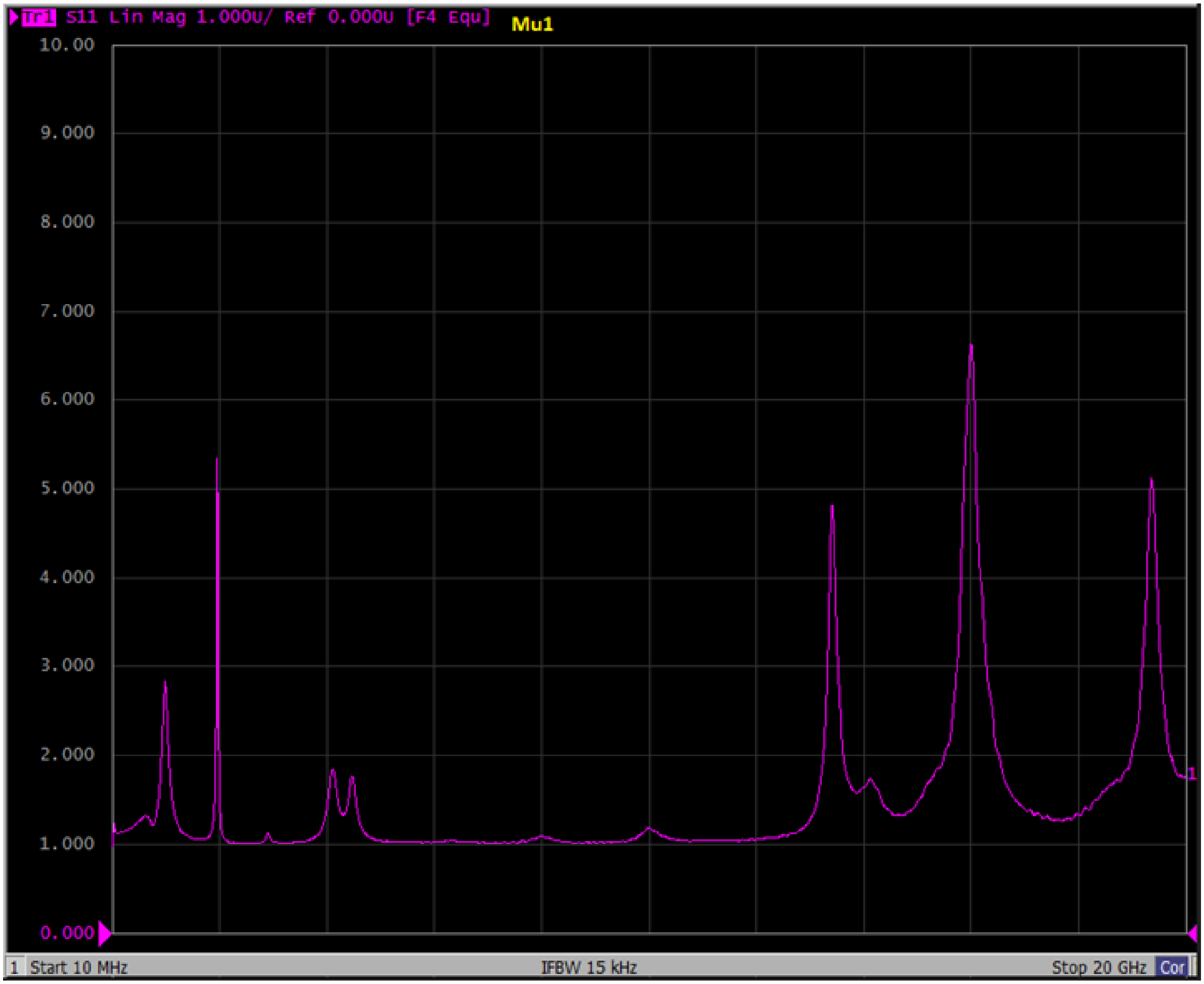
GRF5611 Typical Operating Curves: Stage1 + Stage2 I_{CC} vs. P_{OUT} (LTE 9.6 dB PAR)



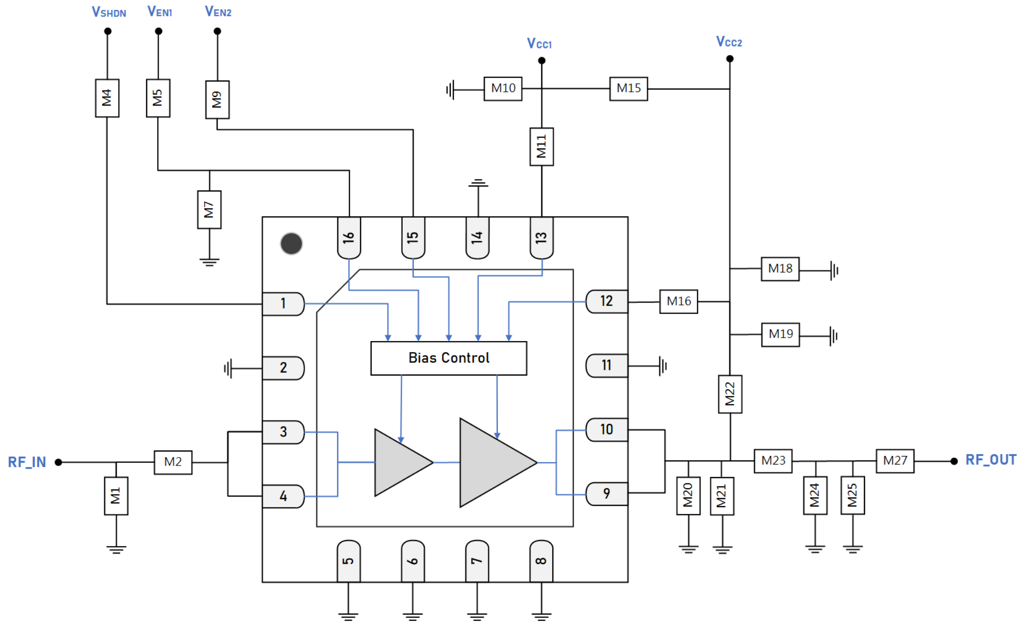
GRF5611 Typical Operating Curves: S-Parameters (902 to 960 MHz Tune)



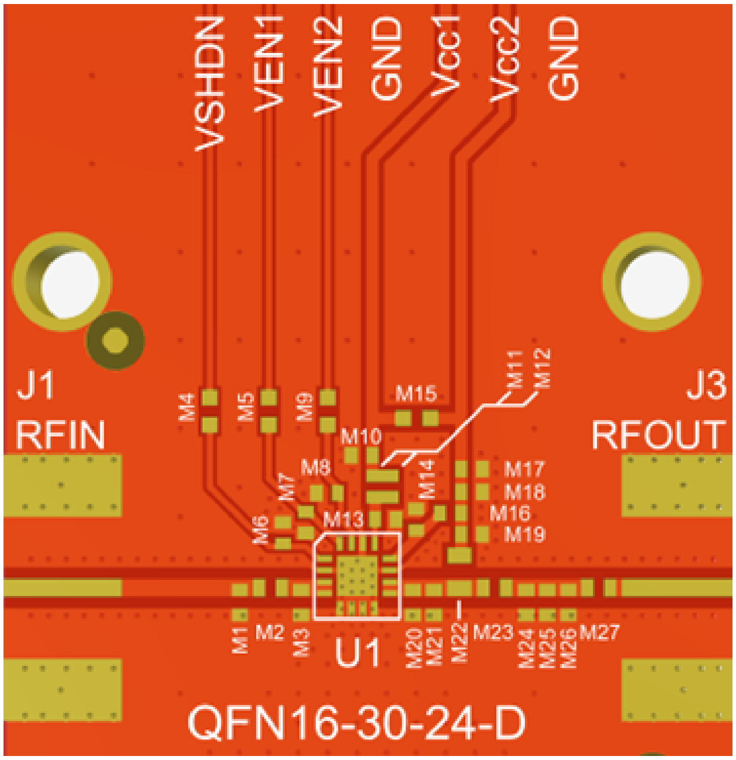
GRF5611 Typical Operating Curves: Stability Mu (10 MHz to 20 GHz)



Note: Mu factor ≥ 1.0 implies unconditional stability.



GRF5611 Standard Test Schematic



GRF5611 Evaluation Board Assembly Diagram

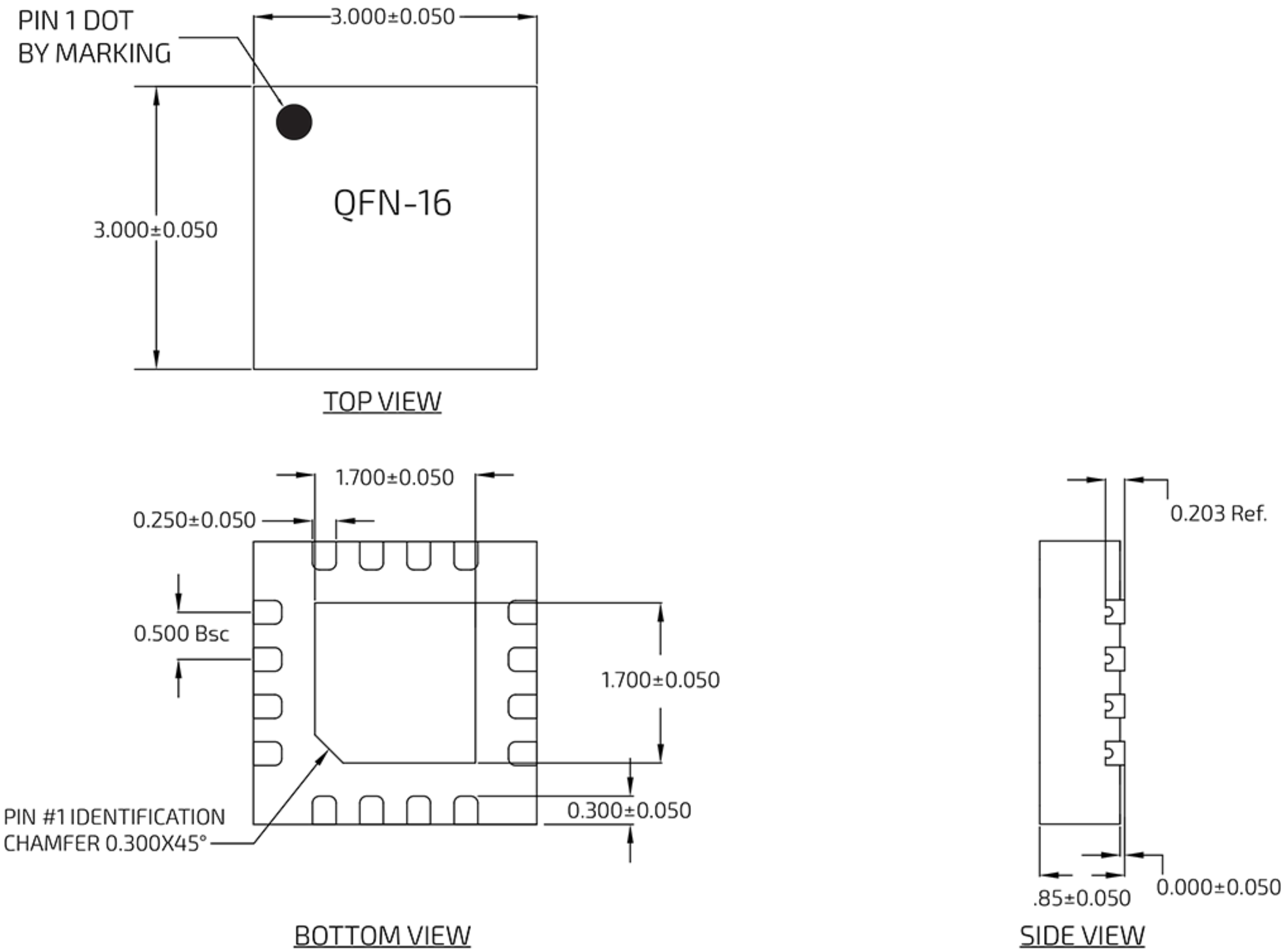
GRF5611 Evaluation Board Assembly Diagram Reference

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1	Inductor	Murata	LQG	5.6 nH	0402	ok
M2	Capacitor	Murata	GJM	5.6 pF	0402	ok
M4	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M5	Resistor	Various	1%	1.58 kΩ	0402	ok
M7	Capacitor	Murata	GRM	100 pF	0402	ok
M9	Resistor	Various	1%	6.04 kΩ	0402	ok
M10	Capacitor	Murata	GRM	0.1 µF	0402	ok
M11	Inductor	Coilcraft	0402HP	47 nH	0402	ok
M15	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M16	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M18	Capacitor	Murata	**GRM	10 µF	0402	ok
M19	Capacitor	Murata	GRM	100 pF	0402	ok
M20	Capacitor	Murata	GJM	5.1 pF	0402	ok
M21	Capacitor	Murata	GJM	4.3 pF	0402	ok
M22	Inductor	Murata	LQW	24 nH	0402	ok
M23	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M24	Capacitor	Murata	GJM	5.6 pF	0402	ok
M25	Capacitor	Murata	GJM	2.7 pF	0402	ok
M27	Capacitor	Murata	GRM	47 pF	0402	ok
Evaluation Board	QFN16-30-24-D					

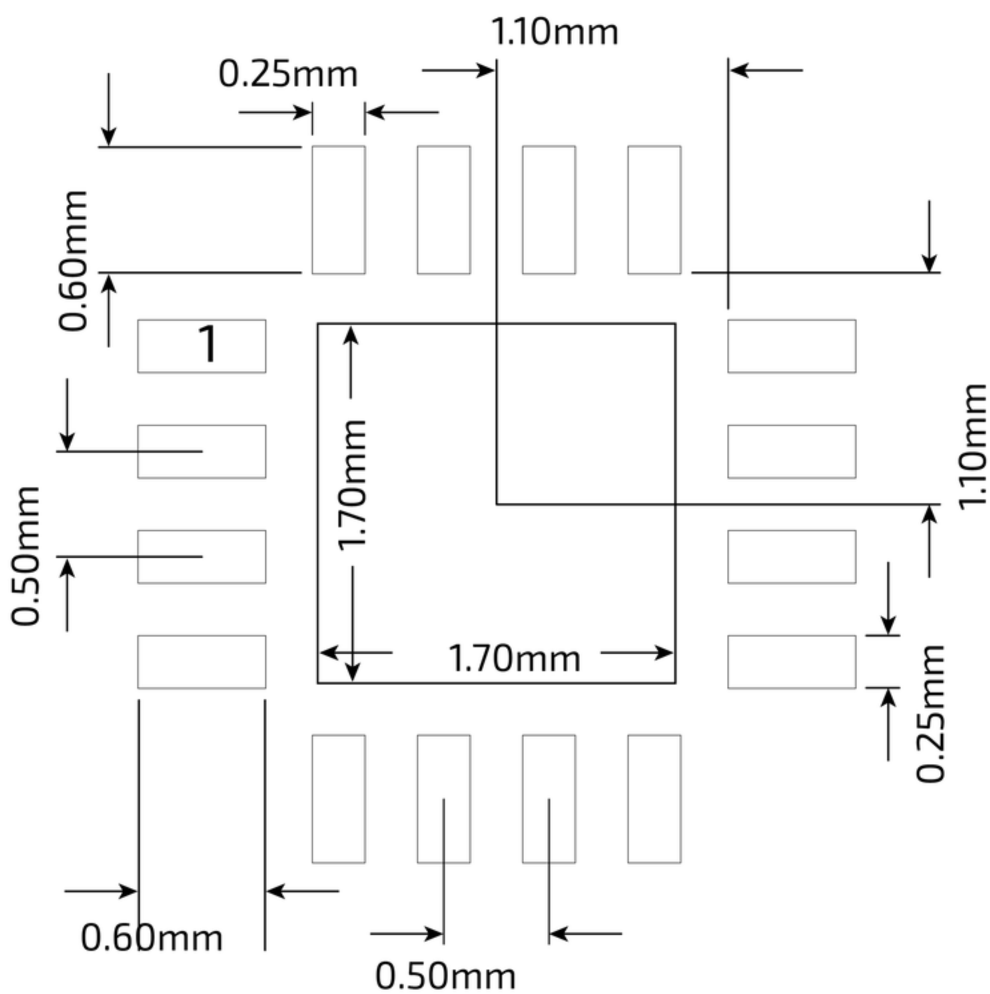
Notes:

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

** 10 µF must be rated for > 5 V at maximum ambient temperature. Manufacturer Part Number in this case = GRM155C80J106ME11D.



QFN 16 3x3mm Package Dimensions



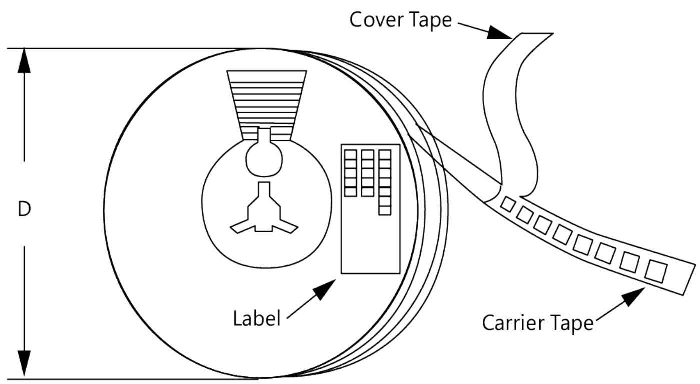
QFN 16 3x3mm Suggested PCB Footprint (Top View)

Package Marking Diagram

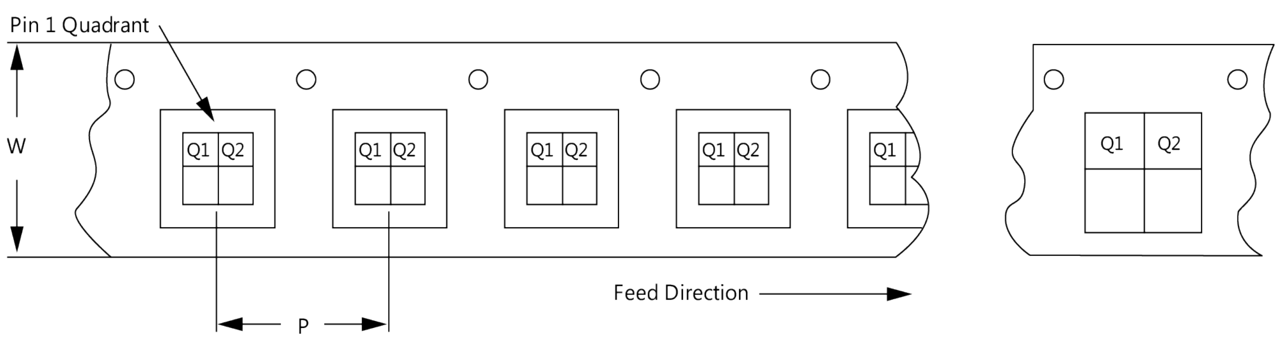
Line 1: “YY” = Year. “WW” = WORK WEEK the Device was assembled.
Line 2: “GRF” = Guerrilla RF
Line 3: “XXXX” = Device Part Number.

Tape and Reel Information

Guerrilla RF's tape and reel specification complies with 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
September 20, 2023	Upgraded to new Data Sheet format.

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

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 Gurerrilla 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