DATA SHEET

RELEASE Ø DATA SHEET

GRF5112

High Linearity Power Amplifier 0.03 to 3 GHz

FEATURES

- Excellent OIP3 and ACLR Performance
- Native Linearity Provides up to 20 dBm P_{OUT} with > 45 dBc ACLR Without the Need for Digital Predistortion Correction
- 20 dBm Linear Output Power Maintained at 105 °C
- Flexible Biasing Provides Latitude for Linearity Optimization
- 212 mA Native Mode Quiescent Current Consumption
- 5 V Supply Voltage
- 50 Ω Single-Ended Input and Output Impedances
- Rugged Design is Extremely Resilient to Mismatched Loads
- -40 to 105 °C Operating Temperature Range
- Compact 3 x 3 mm QFN-16 Package
- Process: GaAs pHEMT

Reference: 5 V / 212 mA / 1805 MHz

- Gain: 17.1 dB
- OIP3: 40 dBm at 18 dBm P_{OUT}/tone
- OP1dB: 32.2 dBm
- Evaluation Board Noise Figure: 1.7 dB

APPLICATIONS

- Cellular Boosters
- Automotive Compensators
- Picocells/Femtocells
- Customer Premise Equipment

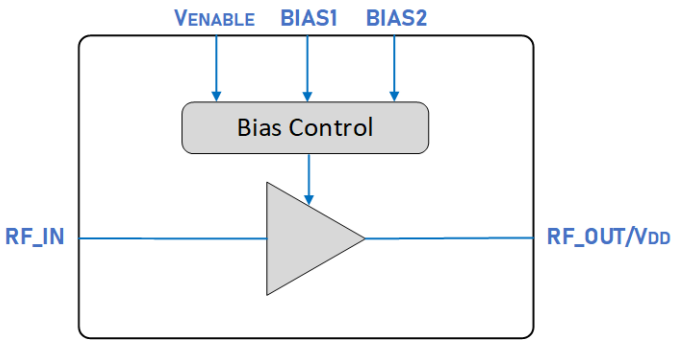
DESCRIPTION

The GRF5112 is a GaAs pHEMT power amplifier that can be tuned to deliver excellent ACLR and OIP3 performance over the 30 to 3000 MHz band. Its exceptional native linearity makes it an ideal choice for transmitter applications that do not typically employ digital predistortion correction schemes.

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 GRF5112 "Custom Tunes" product page: GRF5112 Custom Tunes

BLOCK DIAGRAM



ORDERING INFORMATION

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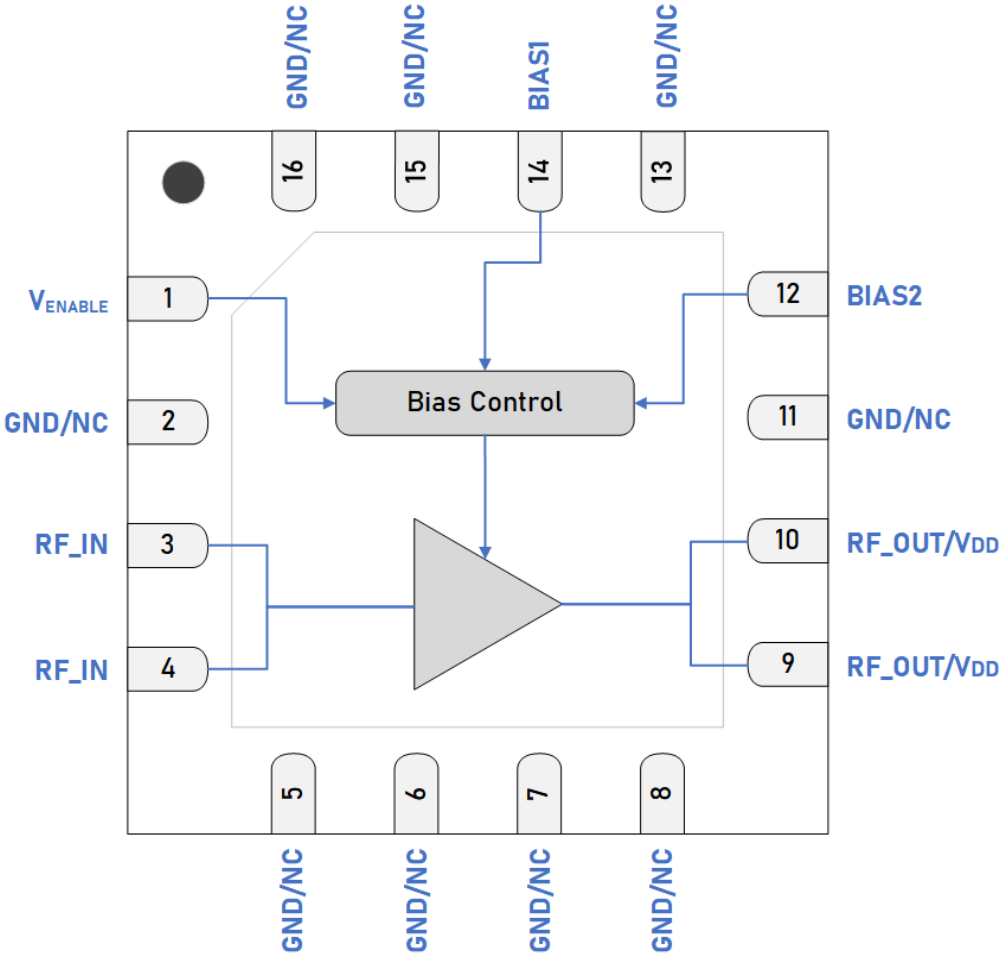


Pin Out (Top View)

Pin Assignments

Pin	Name	Description	Note
1	V_{ENABLE}	Enable Voltage Input	V_{ENABLE} and series resistor set I_{DDQ}. $V_{ENABLE} \leq 0.2$ volts disables the device. On-die pull-down resistor turns the device off if this node is allowed to float.
2, 5, 6, 7, 8, 11, 13, 15, 16	GND/NC	Ground or No Connect	No internal connection to die. We recommend connecting these pins to ground. 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_{DD}	PA Output/Bias Voltage	Pins 9 & 10 tied together on system board. V_{DD} must be applied to this pin via an RF choke.
12	Bias2	Bias Circuit Supply	Connect to V_{DD} through an external resistor.
14	Bias1	Bias Circuit Ground	Connect to ground through R-L network for linearity optimization.
PKG BASE	GND	Ground	Provides DC and RF ground for amplifiers, as well as thermal heat sink. In order to match the device's rated performance, it is strongly recommended to use multiple 8mil 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}	1.8	5.25	V
RF Input Power: 50 Ω, V_{DD} = 5 V, CW tone, 100% duty cycle, $T_{PKG\ BASE}$ = 25 °C.	$P_{IN\ MAX\ -\ 1:1}$		20	dBm
RF Input Power: Load VSWR ≤ 8:1, all phase angles, V_{DD} = 5 V, CW tone, 100% duty cycle, $T_{PKG\ BASE}$ = -40 to 105 °C.	$P_{IN\ MAX\ -\ 8:1}$		15	
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40	105	°C
Maximum Junction Temperature	T_{MAX}		170	°C
Maximum Dissipated Power. DC only (no RF applied).	$P_{DISS\ MAX}$		1750	mW
Electrostatic Discharge				
Charged Device Model	CDM	500		V
Human Body Model	HBM	500		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}	1.8	5	5.25	V	
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40		105	°C	
RF Frequency Range	F_{RF}	30		3000	MHz	**Notes 1 & 2.**
RF_IN Port Impedance	Z_{RF_IN}		50		Ω	Single-ended.
RF_OUT Port Impedance	Z_{RF_OUT}		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: GRF5112 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 1710 to 1920 MHz tuning set, V_{DD} = 5 V, I_{DDQ} = 212 mA, M1 = 6 kΩ, F_{TEST} = 1805 MHz, 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_{DDQ}		212		mA	I_{DDQ} (no RF applied).
Supply Current	I_{DD}		293		mA	RF applied (P_{OUT} = 21 dBm).
Enable Current	I_{ENABLE}		0.7		mA	V_{DD} = 5 V.
Switching Rise Time	T_{RISE}		90		ns	Disabled mode to Gain mode **(note 3)**.
Switching Fall Time	T_{FALL}		70		ns	Gain mode to Disabled mode **(note 4)**.

Disabled Mode

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

Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		37		°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}.

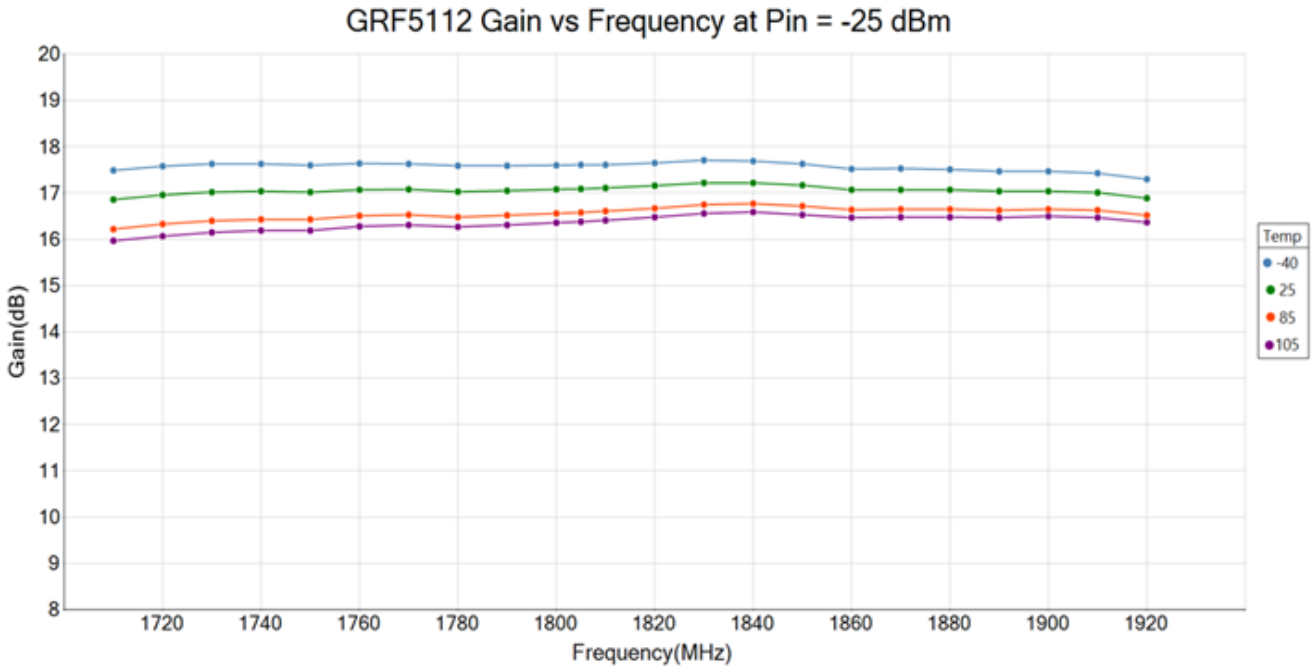
Note 5: MTTF > 10^6 hours for $T_j \leq 170$ °C. Listed thermal resistance = Θ_{JC} pertains to DC only case (no RF applied). Thermal resistance is not constant vs. output power (see thermal resistance and junction temperature plots).

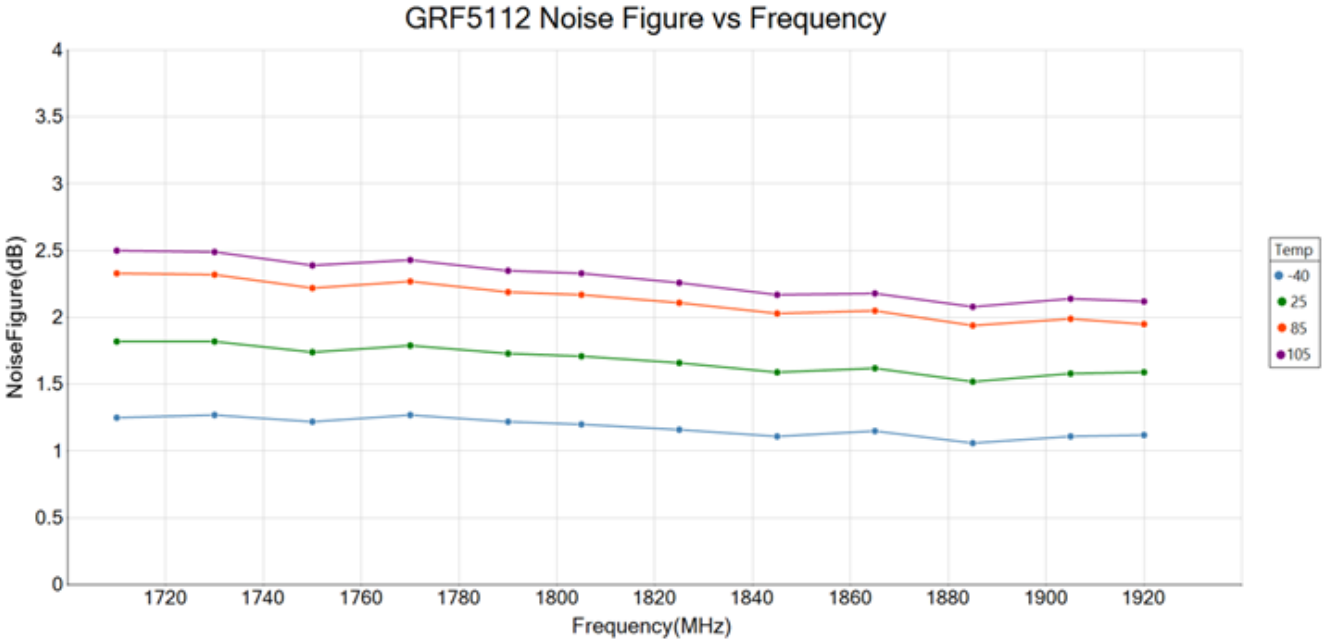
Nominal Operating Parameters - RF

The following conditions apply unless noted otherwise; typical application schematic using the 1710 to 1920 MHz tuning set, V_{DD} = 5 V, I_{DDQ} = 212 mA, M1 = 6 kΩ, F_{TEST} = 1805 MHz, 50 Ω system impedance, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

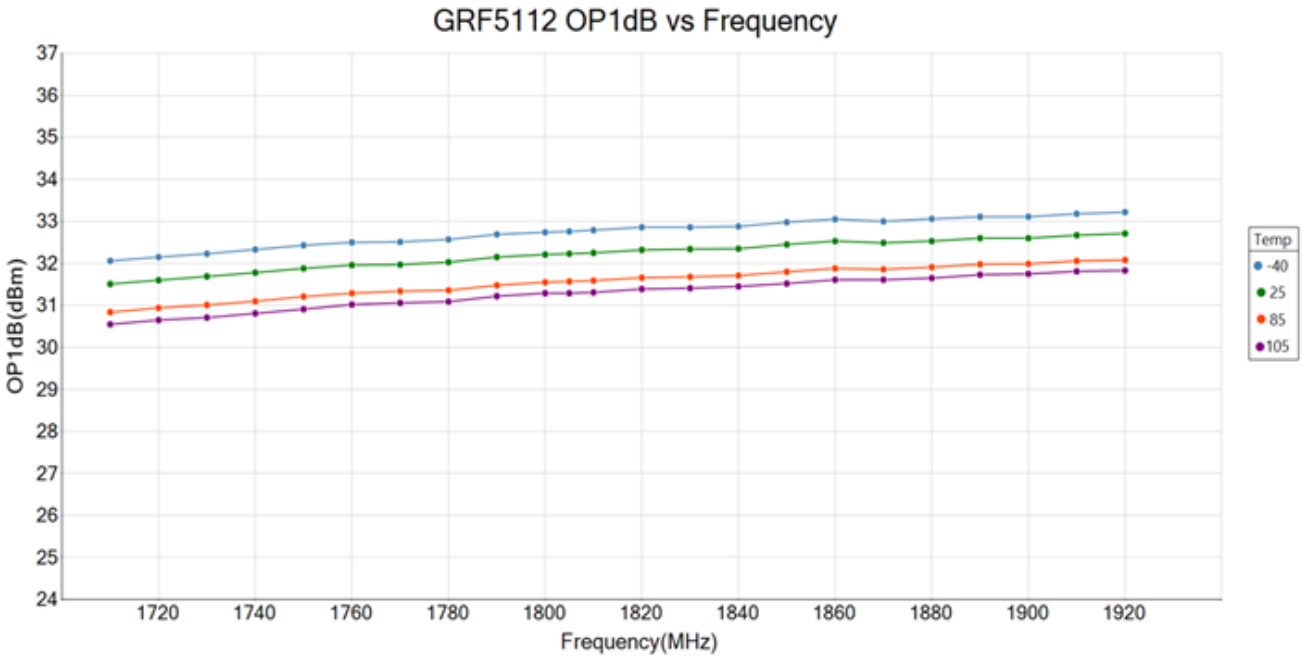
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Small Signal Gain	S21		17.1		dB	V_{DD} = 5 V, F_{TEST} = 1805 MHz, P_{IN} = -25 dBm.
Input Return Loss	S11		< -11		dBm	F_{RF} = 1710 to 1920 MHz small signal.
Output Return Loss	S22		< -6		dBm	F_{RF} = 1710 to 1920 MHz small signal.
Reverse Isolation	S12		< -21		dBm	F_{RF} = 1710 to 1920 MHz small signal.
Output 1 dB Compression Power	OP1dB		32.2		dBm	V_{DD} = 5 V, sine wave input.
Output 3rd Order Intercept Point	OIP3		40		dBm	18 dBm P_{OUT} per tone at 600 kHz spacing.
Noise Figure	NF		1.7		dB	On standard evaluation board.
Adjacent Channel Leakage Ratio	ACLR		-45		dBc	V_{DD} = 5 V, P_{OUT} = 20 dBm, LTE 20MHz 100RB TM1.1 Downlink Waveform with 9.6dB PAR, F_{TEST} = 1805 MHz, $T_{PKG\ BASE}$ = 25 °C.

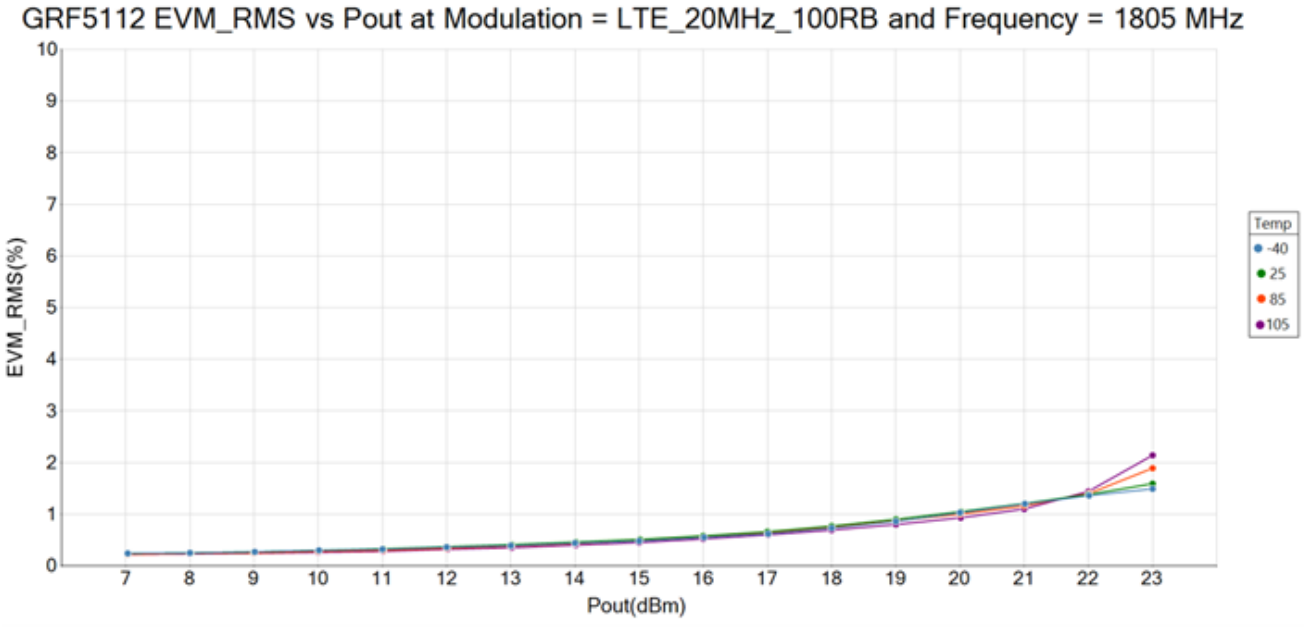
GRF5112 Typical Operating Curves: 1710 to 1920 MHz Tune



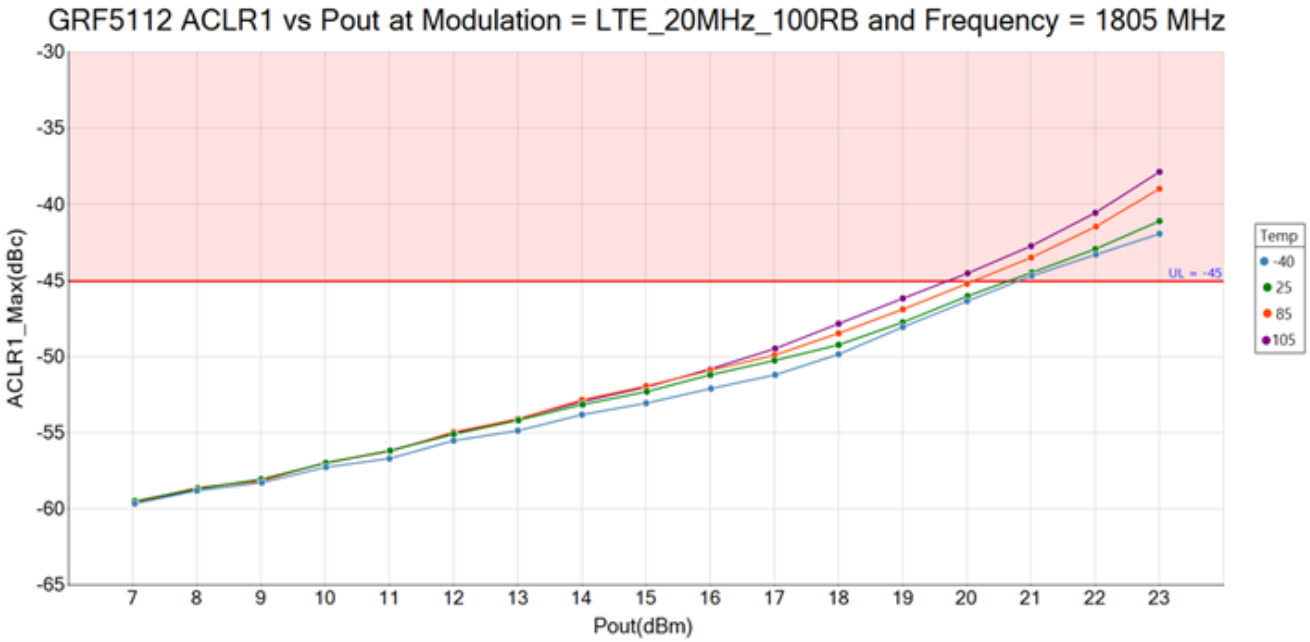


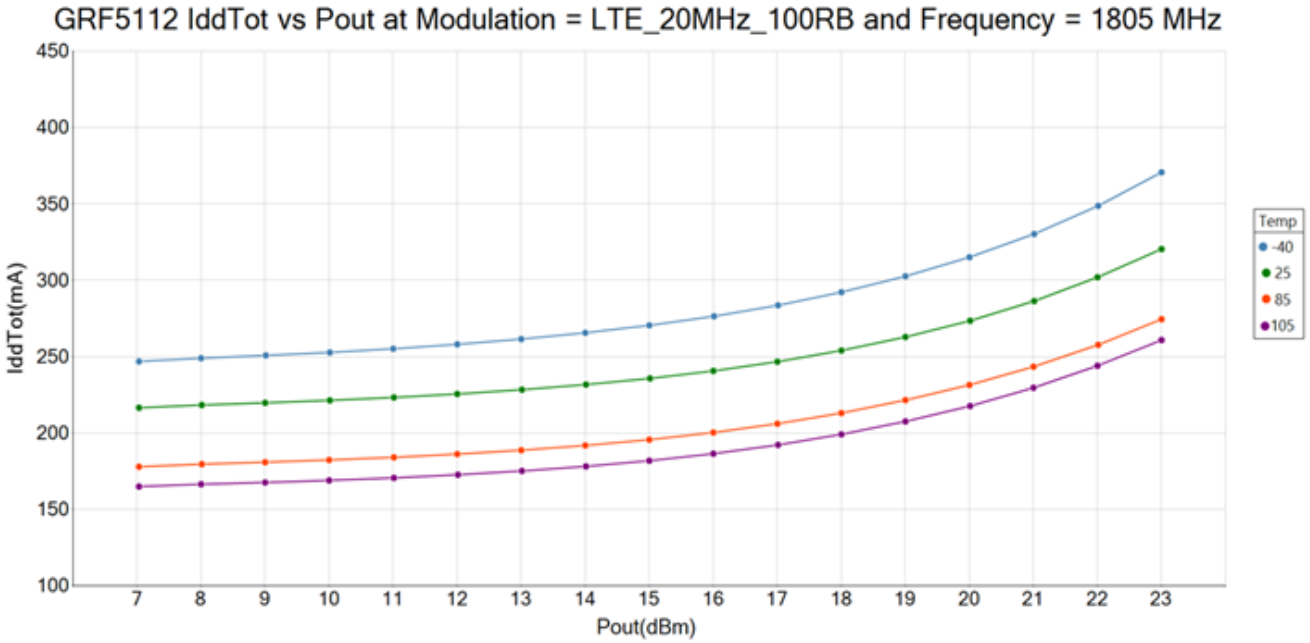
GRF5112 Typical Operating Curves: 1710 to 1920 MHz Tune



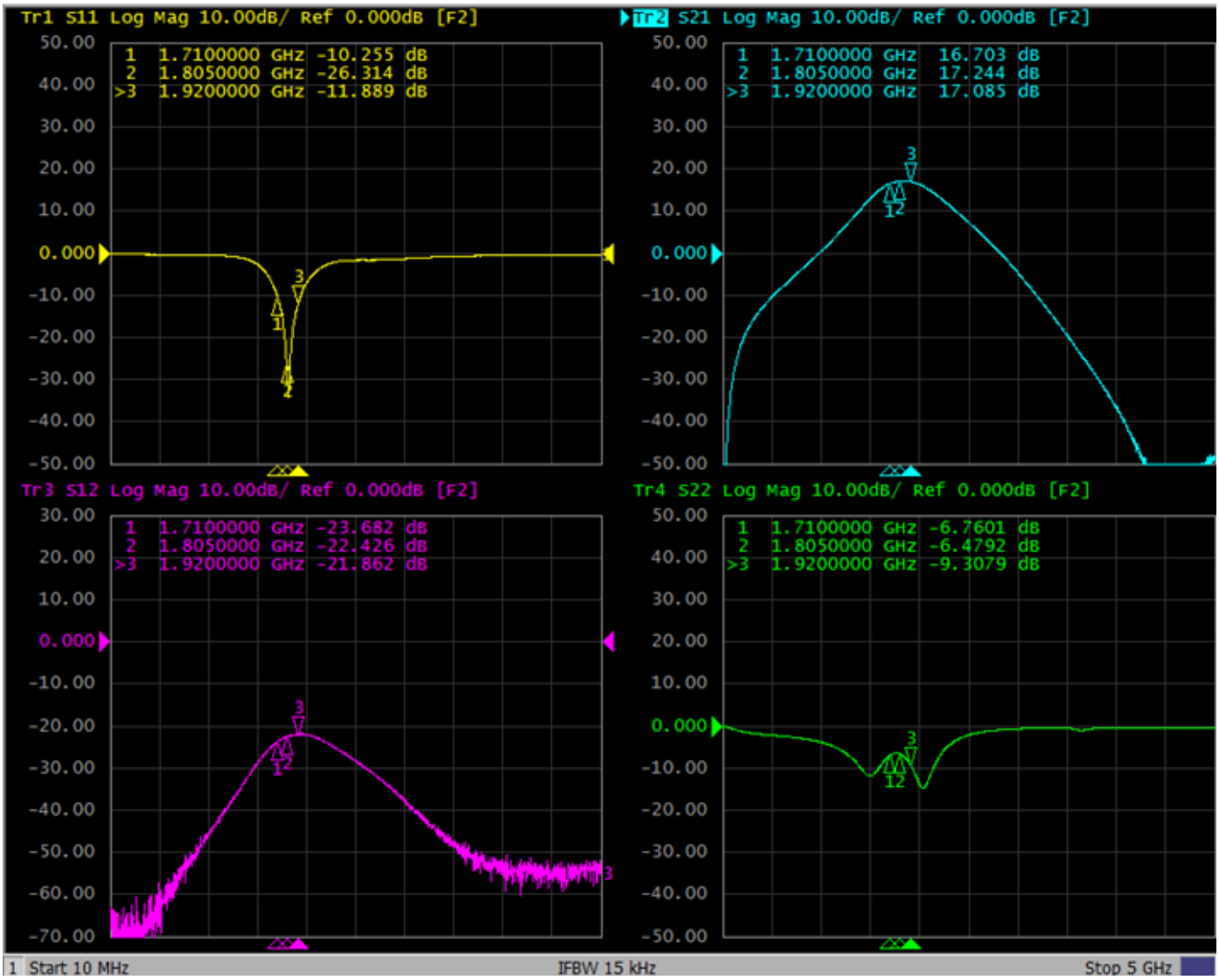


GRF5112 Typical Operating Curves: 1710 to 1920 MHz Tune

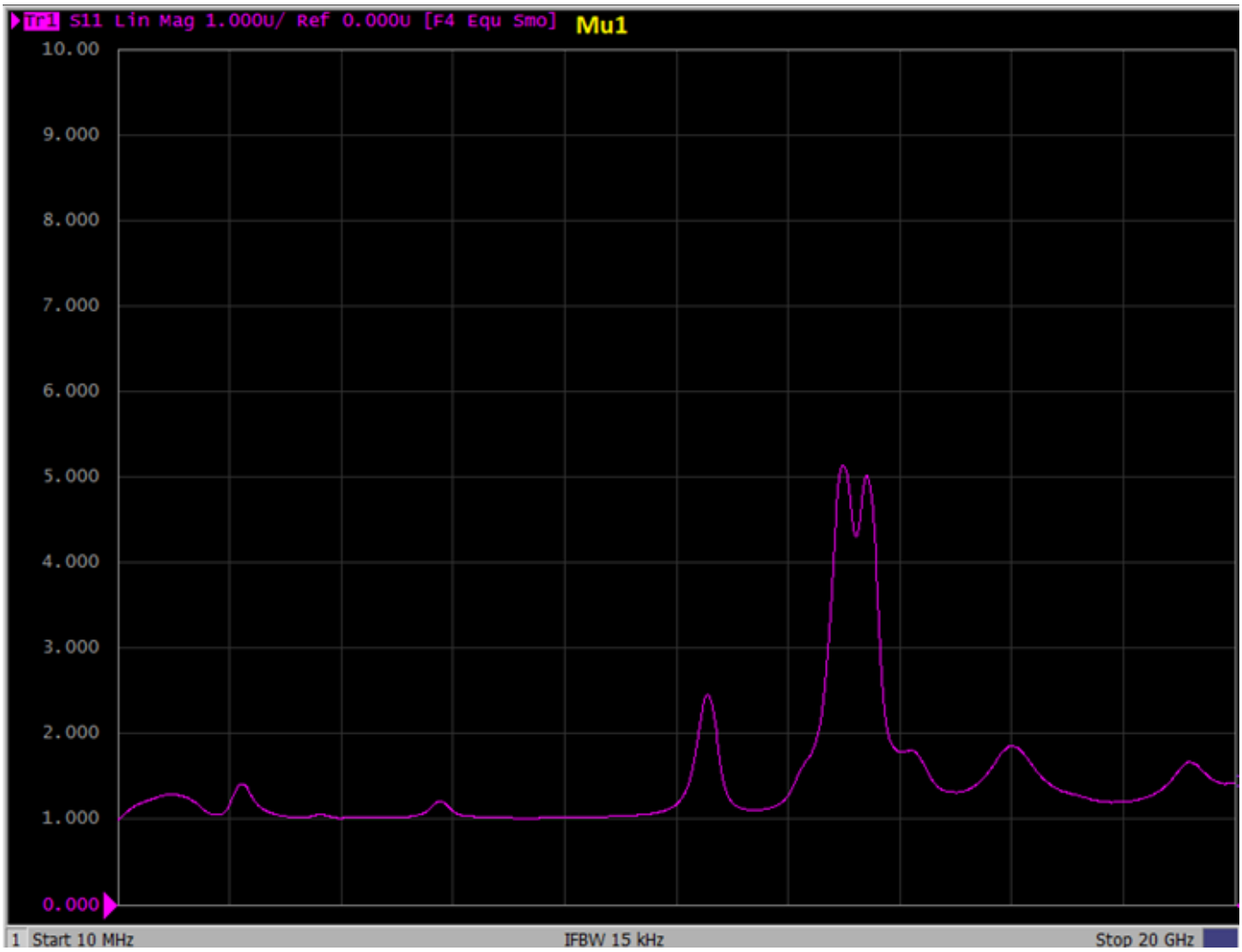




GRF5112 Typical Operating Curves: S-Parameters (1710 to 1920 MHz Tune)



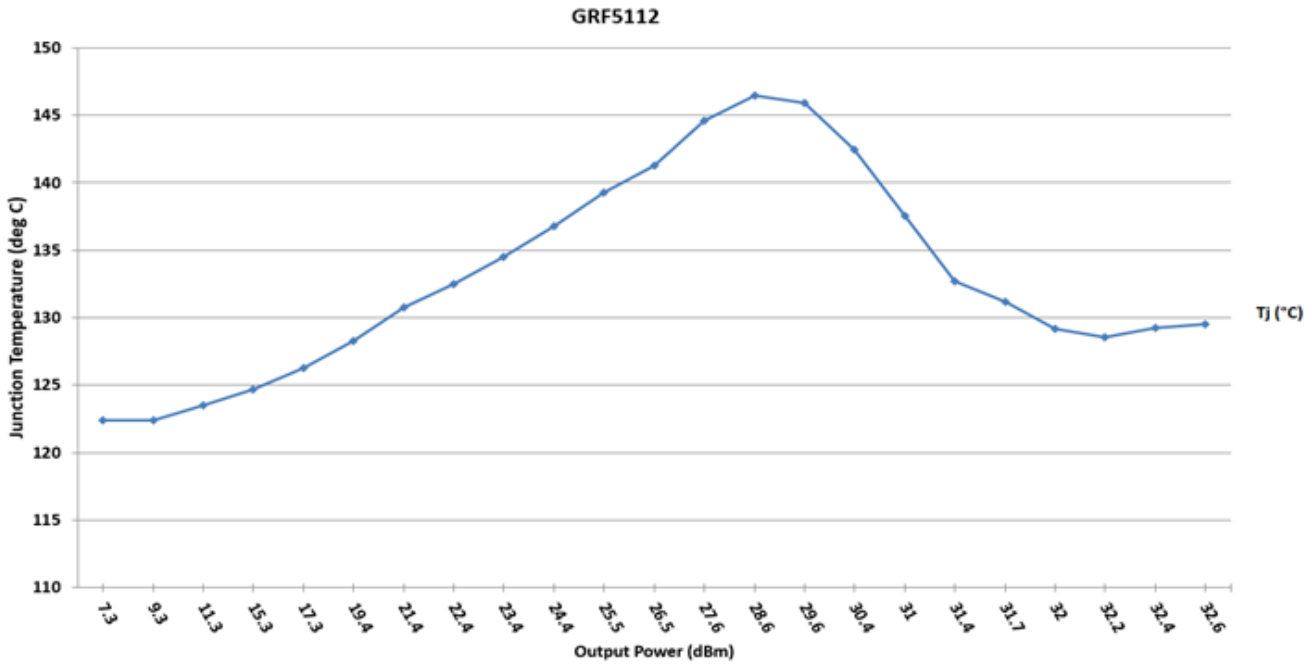
GRF5112 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



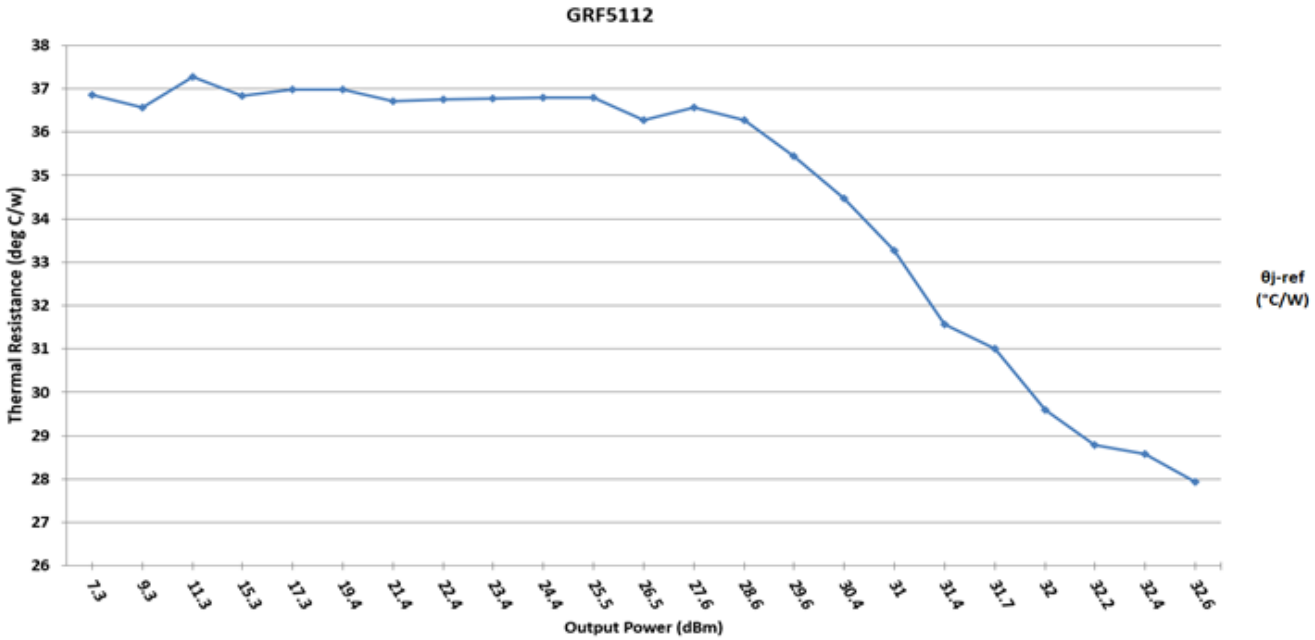
Note: Mu Factor ≥ 1.0 implies unconditional stability.

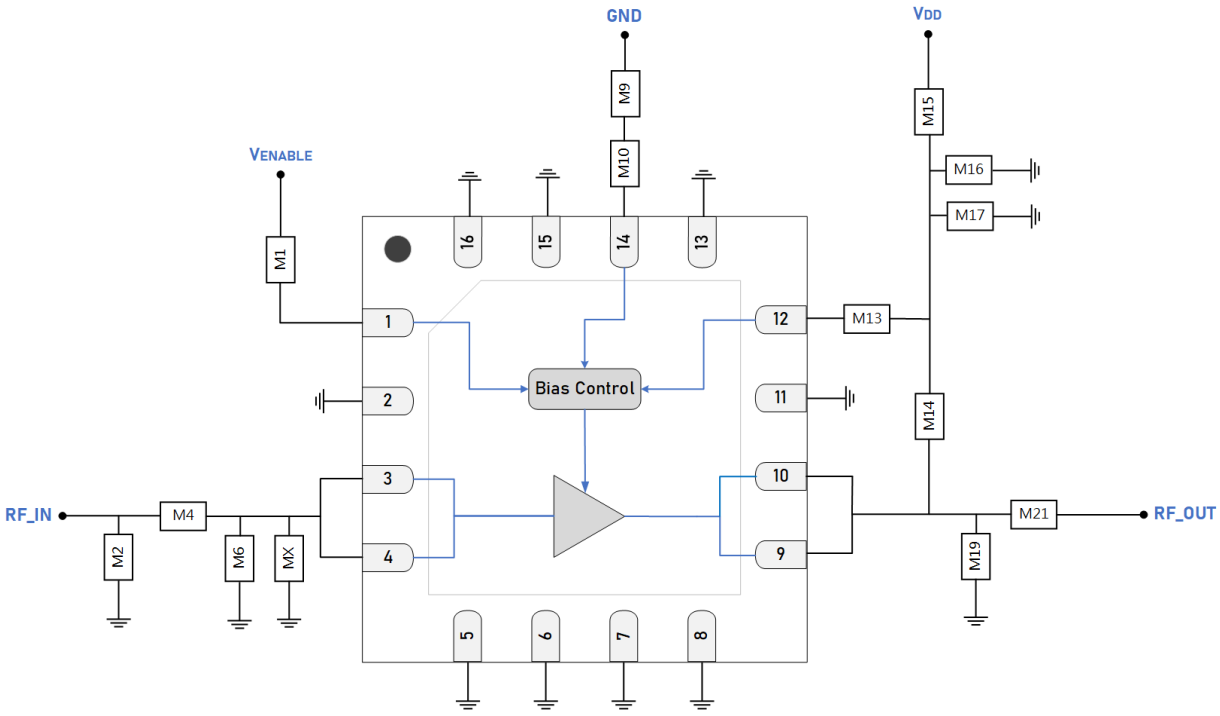
GRF5112 Typical Operating Curves: Per Application Schematic @ 85 °C

Junction Temperature vs. Output Power:

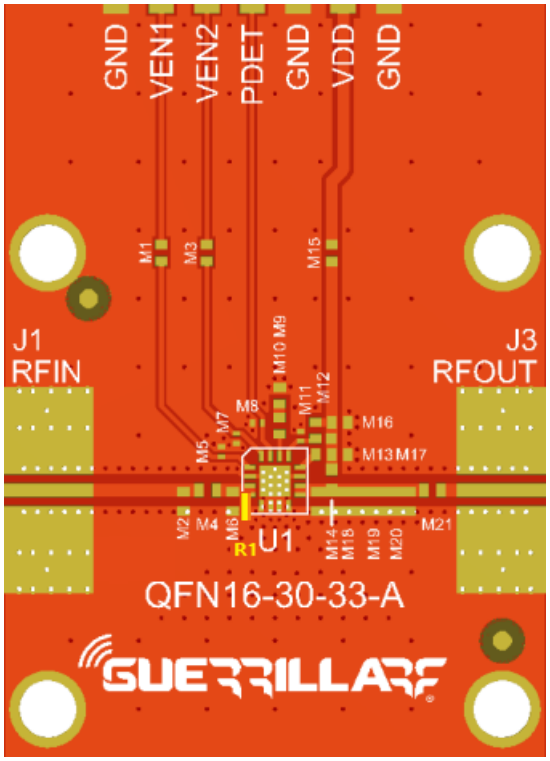


Thermal Resistance vs. Output Power:





GRF5112 Standard Evaluation Board Schematic



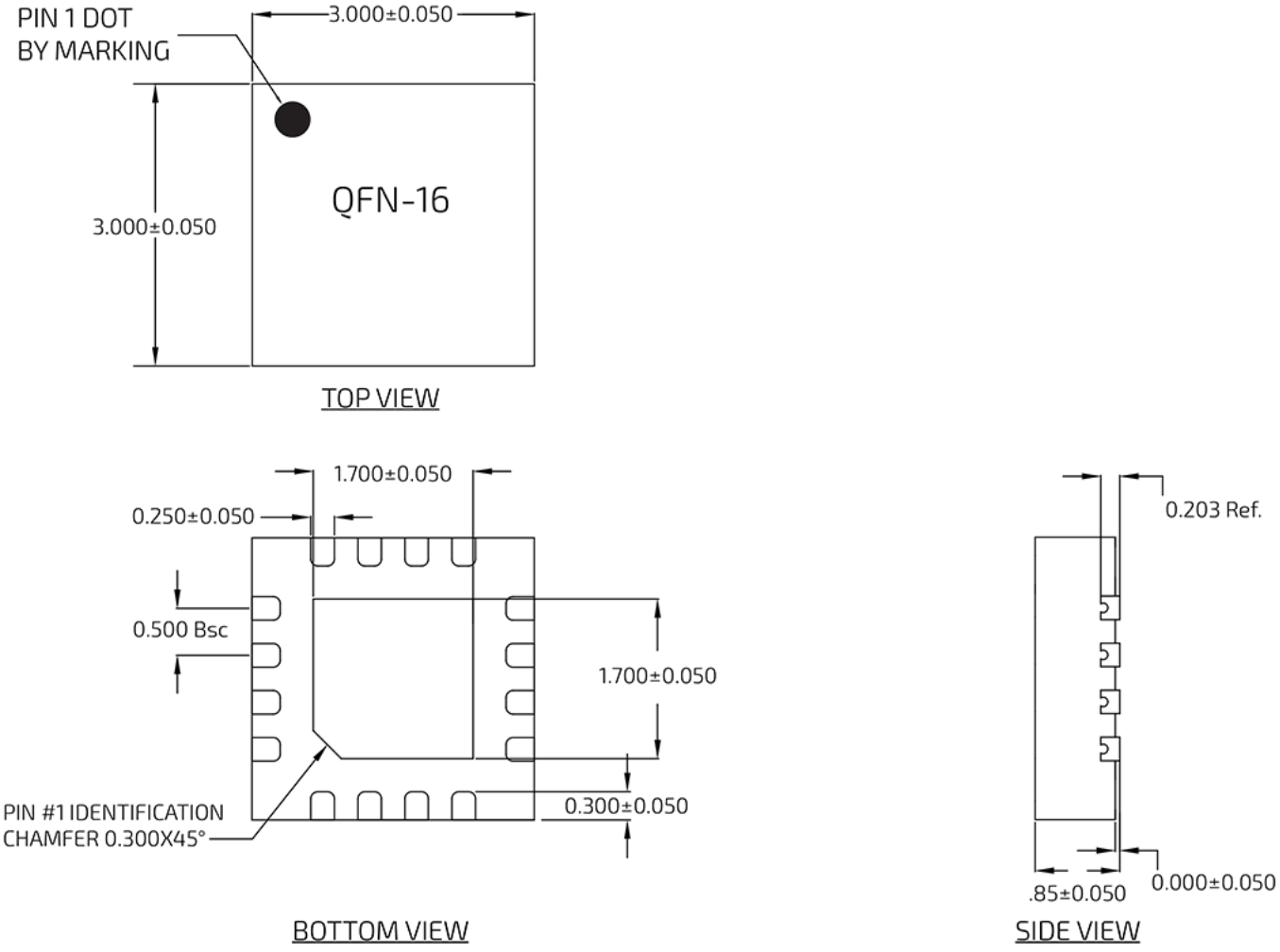
GRF5112 Evaluation Board Assembly Drawing

GRF5112 Evaluation Board Assembly Diagram Reference:

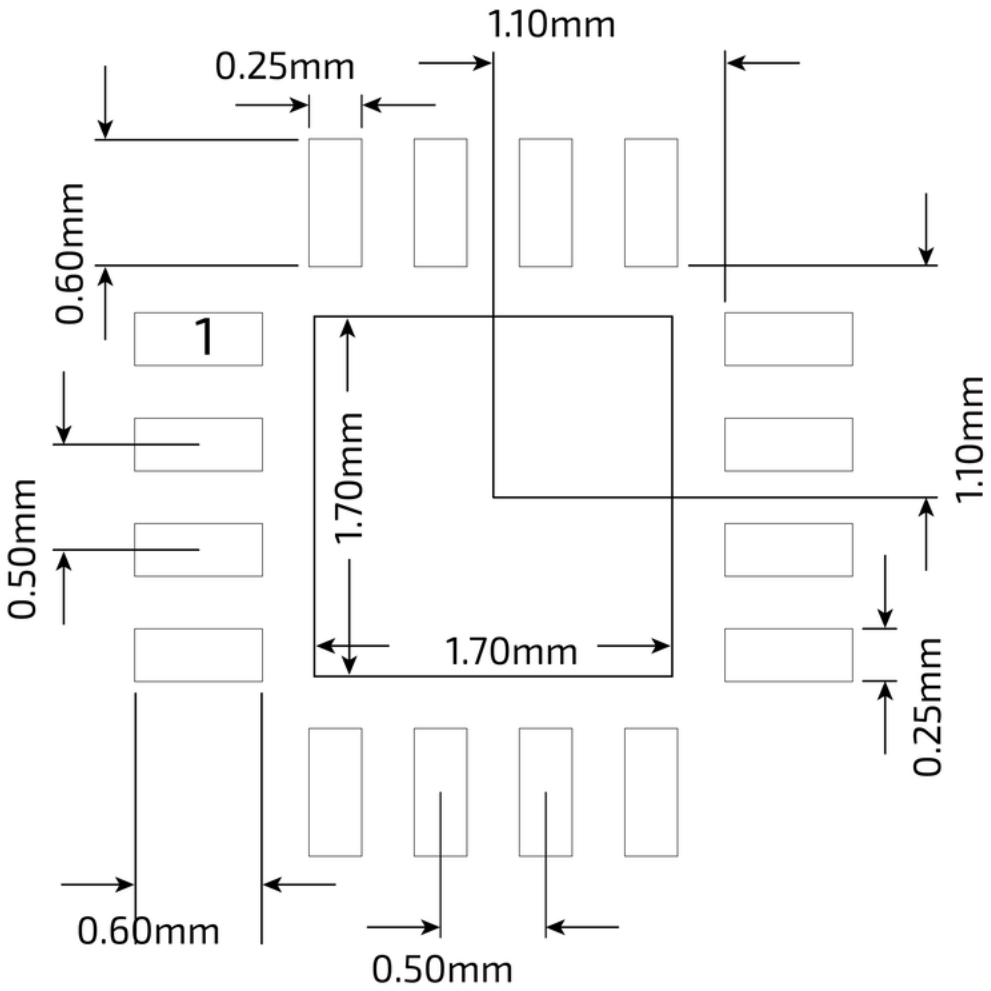
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1 (sets I_{DDQ})	Resistor	Various	5%	6 kΩ	0402	ok
M2	Inductor	Murata	LQG	2.0 nH	0402	ok
M4	Capacitor	Murata	GJM	1.8 pF	0402	ok
M6	Capacitor	Murata	GJM	3.0 pF	0402	ok
MX	Resistor	Various	5%	15 kΩ	0402	ok
M9	Inductor	Various	LQG	3.0 nH	0402	ok
M10	Resistor	Various	5%	0 Ω	0402	ok
M13	Resistor	Various	5%	0 Ω	0402	ok
M14	Inductor: high Q	Murata	LQW18AN 80	10 nH	0402	ok
M15	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M16	Capacitor	Murata	GRM	**10 µF	0402	ok
M17	Capacitor	Murata	GRM	100 pF	0402	ok
M19	Capacitor	Murata	GJM	3.3 pF	0402	ok
M21	Capacitor	Murata	GJM	33 pF	0402	ok
Evaluation Board	QFN-16-30-33-A					

Note: Standard evaluation board bias: V_{DD} = 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



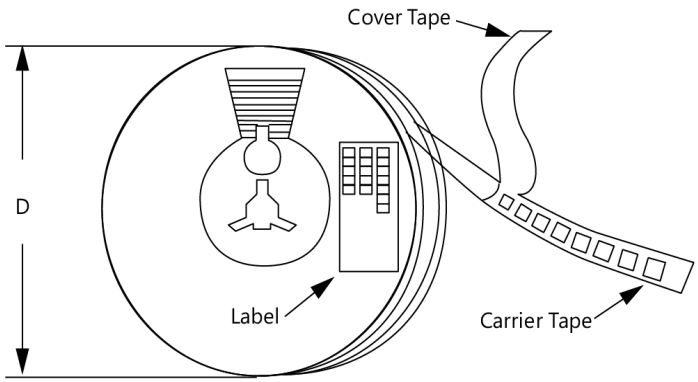
QFN 16 3x3mm Suggested PCB Footprint (Top View)

Package Marking Diagram

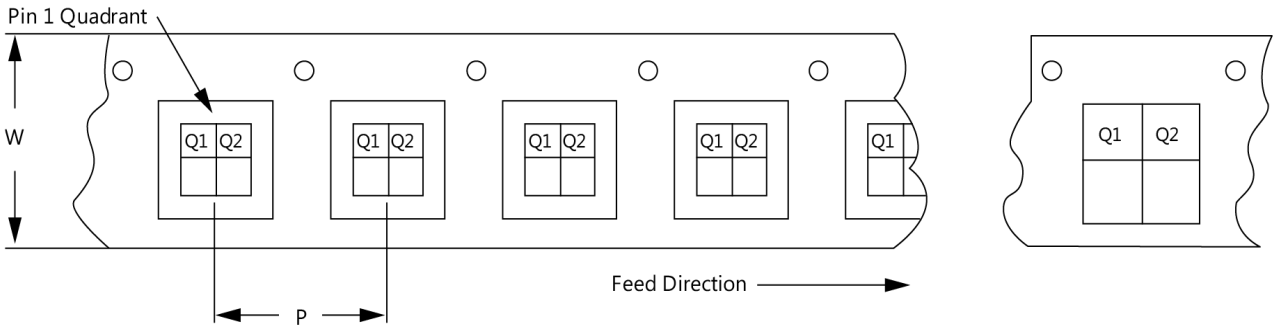
Line 1: “YY” = Year. “WW” = WORK WEEK the Device was assembled.
Line 2: “GRF” = Guerrilla RF
Line 3: “XXXX” = Device Part Number.

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
February 4, 2022	Preliminary Data Sheet.
March 1, 2022	Updated package marking diagram.
January 22, 2024	Added Thermal Resistance, HBM and CDM specifications.
February 19, 2024	Release Ø Data Sheet.
July 22, 2024	Upgraded Data Sheet to new format. Added new Evaluation Board.
June 19, 2025	Extended upper frequency range from 2700 MHz to 3000 MHz.

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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