DATA SHEET

GRF2584

High Gain Low Noise Amplifier
Tunable Range 3 to 9 GHz

RELEASE Ø DATA SHEET

FEATURES

- Gain Levels Up to 36.5 dB
- Noise Figure Levels as Low as 1 dB
- Excellent Linearity Performance
- Supports Tuning Over Wide Bands
- 2.7 to 6 V Supply Voltage
- Flexible Biasing Provides Latitude for Linearity Optimization
- 50 mA Native Mode Quiescent Current Consumption
- 50 Ω Single-Ended Input and Output Impedances
- RoHS Compliant

Reference: 5 V / 50 mA / 5.9 GHz

- Gain: 32.2 dB
- OP1dB: 16.3 dBm
- OIP3: 29.4 dBm
- Evaluation Board NF: 1.2 dB

APPLICATIONS

- 5G n48, n77, n78 & n79 Massive MIMO Base Stations
- Automotive V2X Band n47 Front Ends and Compensators
- High-Performance RF Infrastructure
- 5G Bands n96 n102 n104

ORDERING INFORMATION

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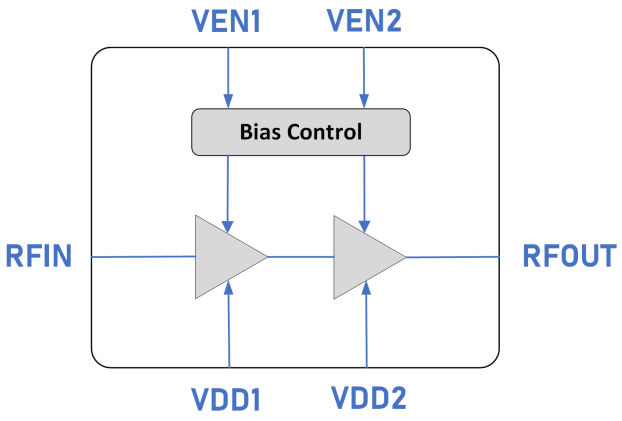
DESCRIPTION

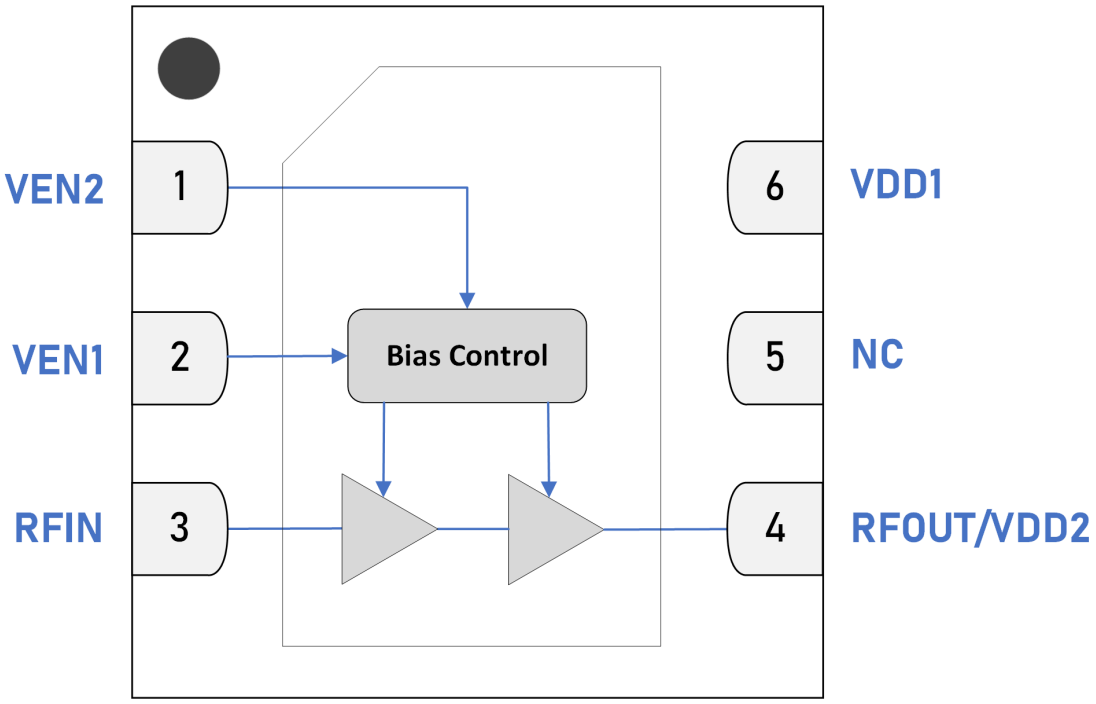
The GRF2584 is a two-stage GaAs pHEMT low noise amplifier targeting high-performance wireless infrastructure applications. The device can be tuned to operate over narrow or wide bandwidths over a range of 3 to 9 GHz while delivering up to 36 dB of gain and noise figures as low as 1 dB.

For optimal efficiency and linearity, the amplifier was designed to operate with a single 5 V supply voltage while using only 50 mA of quiescent current. Supply voltages ranging from 2.7 to 6 V are also supported. Similarly, I_{DDQ} can be increased beyond the native biasing point for enhanced linearity performance.

Additional tunes can be found on the GRF2584 "Custom Tunes" product page: GRF2584 Custom Tunes

BLOCK DIAGRAM





Pin Out (Top View)

Pin Assignments

Pin	Name	Description	Note
1	VEN2	2nd Stage Enable	VEN2 ≤ 0.2 volts disables the second stage. VEN2 and external series resistor controls the second stage I_{DDQ} when VEN2 is high.
2	VEN1	1st Stage Enable	VEN1 ≤ 0.2 volts disables the first stage. VEN1 and external series resistor controls the first stage I_{DDQ} when VEN1 is high.
3	RFIN	RF Input	Internally matched 50 Ω. An external DC blocking cap must be used.
4	RFOUT/VDD2	RF Output/2nd Stage Bias	Internally matched 50 Ω. V_{DD} must be applied through a choke to this pin.
5	NC	No Connect	No internal connection. This pin can be left unconnected, or be connected to the ground (recommended). Use a via as close to the pin as possible if grounded.
6	VDD1	1st Stage Bias	Pull up to V_{DD} through the inductor and use bypass capacitors as close to the pin as possible. In addition to supplying the first stage of the device with a DC voltage, there is also an RF signal present.
PKG BASE	GND	Ground	Provides DC and RF ground for amplifiers, as well as thermal heat sink. **In order to match the devices rated performance, it is strongly recommended to use 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_{DD}	0	6	V
RF Input Power: Load VSWR < 2:1, V_{DD} < 6 V.	$P_{IN\ MAX}$		27	dBm
Operating Temperature (Package Base)	$T_{PKG\ BASE}$	-40	115	°C
Maximum Channel Temperature (MTTF > 10^6 Hours)	T_{MAX}		170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		TBD	W
Electrostatic Discharge				
Human Body Model	HBM	250		V
Storage				
Storage Temperature	T_{STG}	-65	150	°C
Moisture Sensitivity Level			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}	4.75	5	6	V	
Operating Temperature Range	$T_{PKG\ BASE}$	-40		115	°C	
Frequency Range **(note 1 & 2)**	F_{RF}	5.855	5.9	5.925	GHz	5.9 GHz tuning set (Automotive V2X Band n47)
RF_IN Port Impedance	Z_{RFIN}		50		Ω	Single ended, with respective matching elements from each tuning set.
RF_OUT Port Impedance	Z_{RFOUT}		50		Ω	Single ended, with respective matching elements from each tuning set.

Note 1: Operation outside of this range is supported by using different custom tunes. Examples of other optimized tunes can be found here: GRF2584 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.		
Test Frequency	F_{TEST}		5.9		GHz	
Logic Input Low	V_{IL}	0		0.2	V	VEN1 & VEN2
Logic Input High	V_{IH}	1.5		V_{DD}	V	VDD = VEN1 = VEN2 = 5 V
Turn On (Rise) Time	t_{ON}		40		ns	VEN1 & VEN2 Low to High
Turn Off (Fall) Time	t_{OFF}		30		ns	VEN1 & VEN2 High to Low
VBIAS	V_{BIAS}		5.0		V	VBIAS1 & VBIAS2
Supply Quiescent Current	I_{DDQ}		50		mA	IBIAS1 & IBIAS2, R_{BIAS1} = 4.75 kΩ, R_{BIAS2} = 2 kΩ
Enable Current	I_{EN}		2.4		mA	IEN1 + IEN2. V_{DD} = High, VEN1 & VEN2 = High
Disabled Mode						
Standby Current	I_{STBY}		400		µA	V_{DD} = 5 V, VEN1 & VEN2 = Low
Thermal Data						
Thermal Resistance (Infrared Scan)	Θ_{JC}		TBD		°C/W	On standard evaluation board
Channel Temperature @ 115 °C Reference (Package Base)	$T_{CHANNEL}$		TBD		°C	V_{DD} = 5 V, I_{DDQ}= 47 mA, P_{DISS} = TBD mW, No RF **(note 3)**

Note 3: 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 5.7 to 6.2 GHz tuning set, V_{DD} = 5 V, VEN1 = VEN2 = 5 V, R_{BIAS1} = 4.75 kΩ, R_{BIAS2} = 2 kΩ, P_{OUT} = 0 dBm, F_{TEST} = 5.9 GHz, 50 Ω system impedance, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

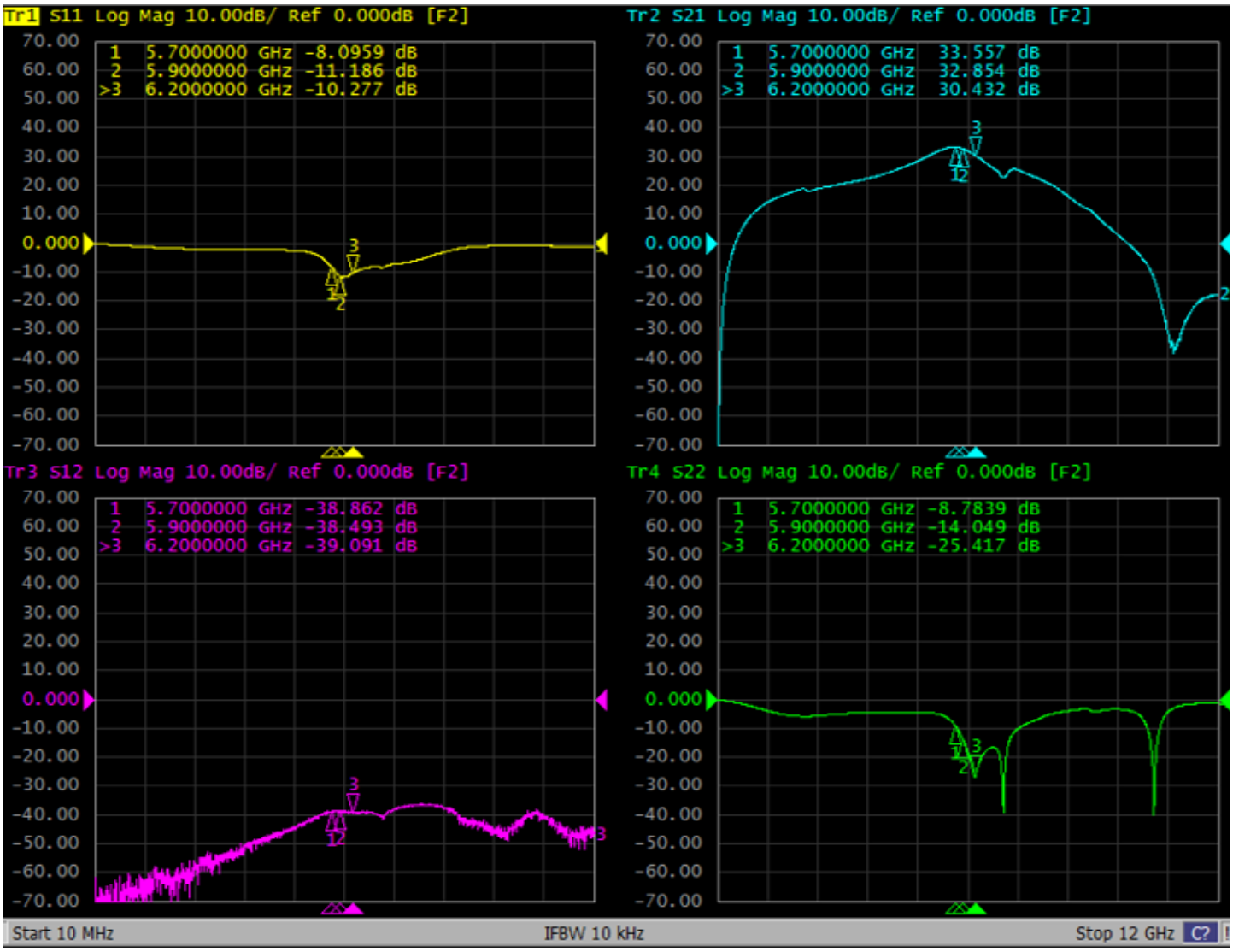
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21		32.2		dB	F_{RF} = 5.89 GHz
Gain Flatness	$S21_{FLAT}$		0.02		dB	F_{RF} = 5.855 to 5.925 GHz
Gain Variation Over Temp	$S21_{TEMP}$		+0.8/-1.5		dB	$T_{PKG\ BASE}$ = -40 to 115 °C, referenced to $T_{PKG\ BASE}$ = 25 °C.
Standby Mode Gain	$S21_{STBY}$		-32		dB	VEN1 & VEN2 = LOW
Input Return Loss	S11		< -11		dB	F_{RF} = 5.855 to 5.925 GHz
Output Return Loss	S22		< -13		dB	F_{RF} = 5.855 to 5.925 GHz
Reverse Isolation	S12		-38		dB	F_{RF} = 5.855 to 5.925 GHz
De-Embedded Noise Figure	NF		1.0		dB	
Eval Board Noise Figure			1.2			
Output 3rd Order Intercept Point	OIP3		29.4		dBm	0 dBm P_{OUT} per tone at 2 MHz Spacing.
Output 1dB Compression Power	OP1dB		16.3		dBm	

GRF2584 Typical Operating Curves: 5.7 to 6.2 GHz Tune

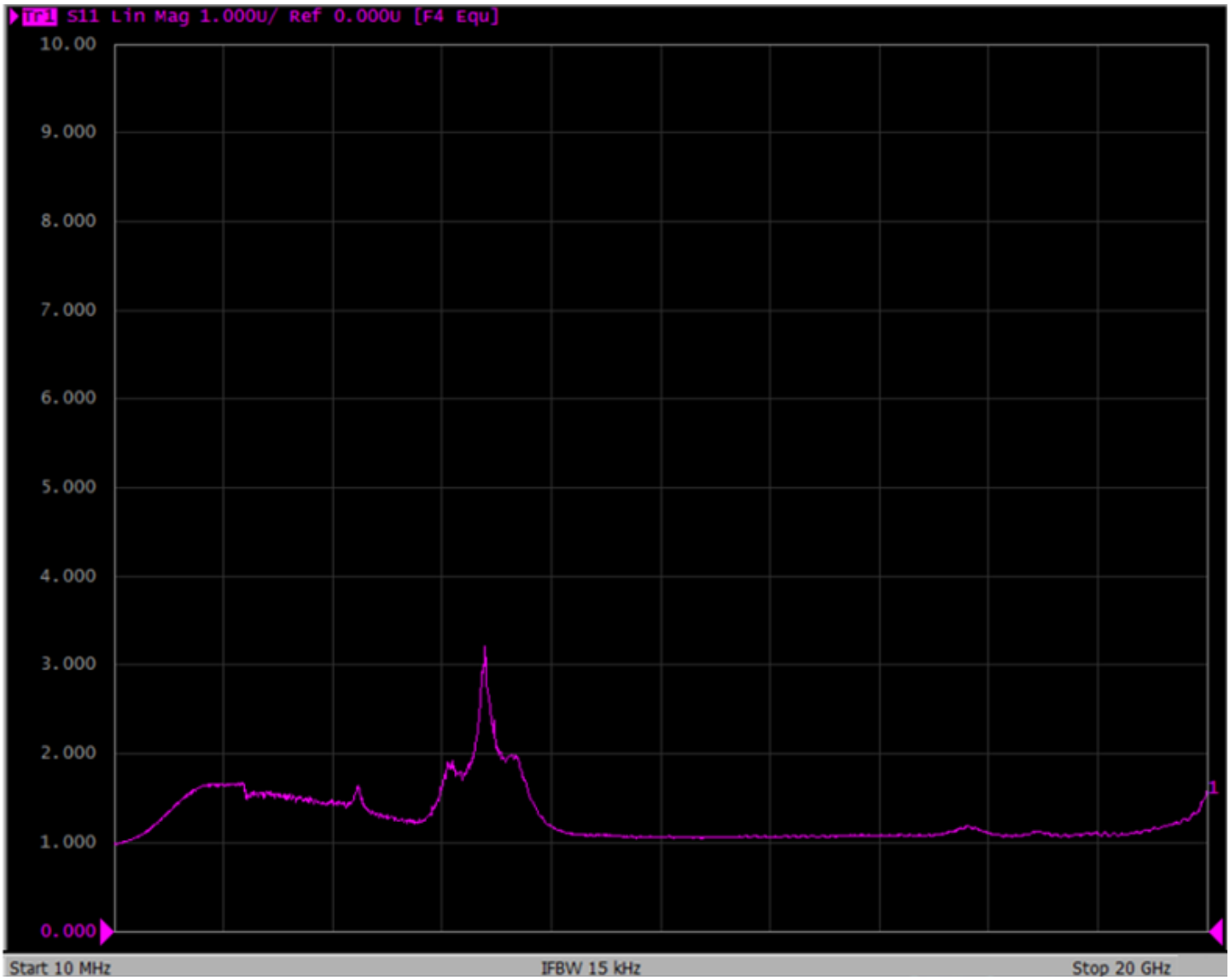
Truth Table

Mode	Pin Logic	
	VEN1	VEN2
Device ON	HIGH	HIGH
Standby (Device OFF)	LOW	LOW

S-Parameters

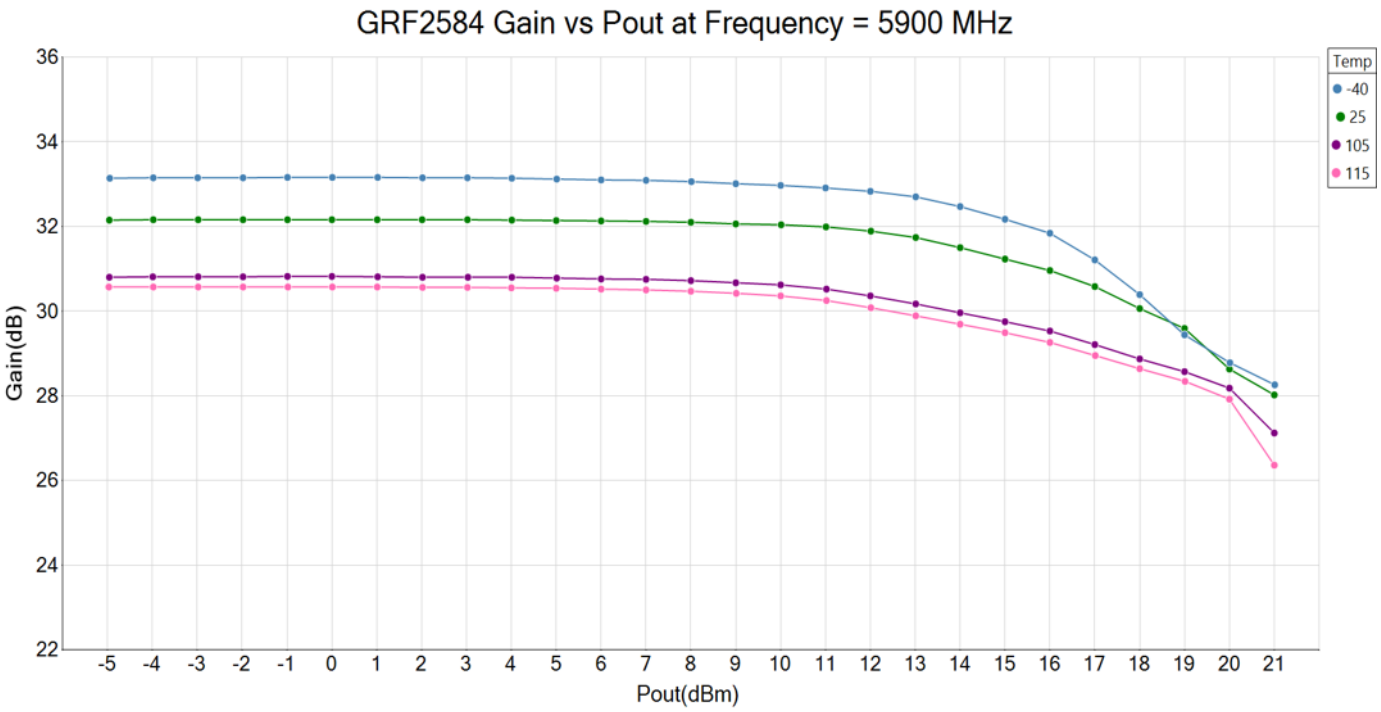


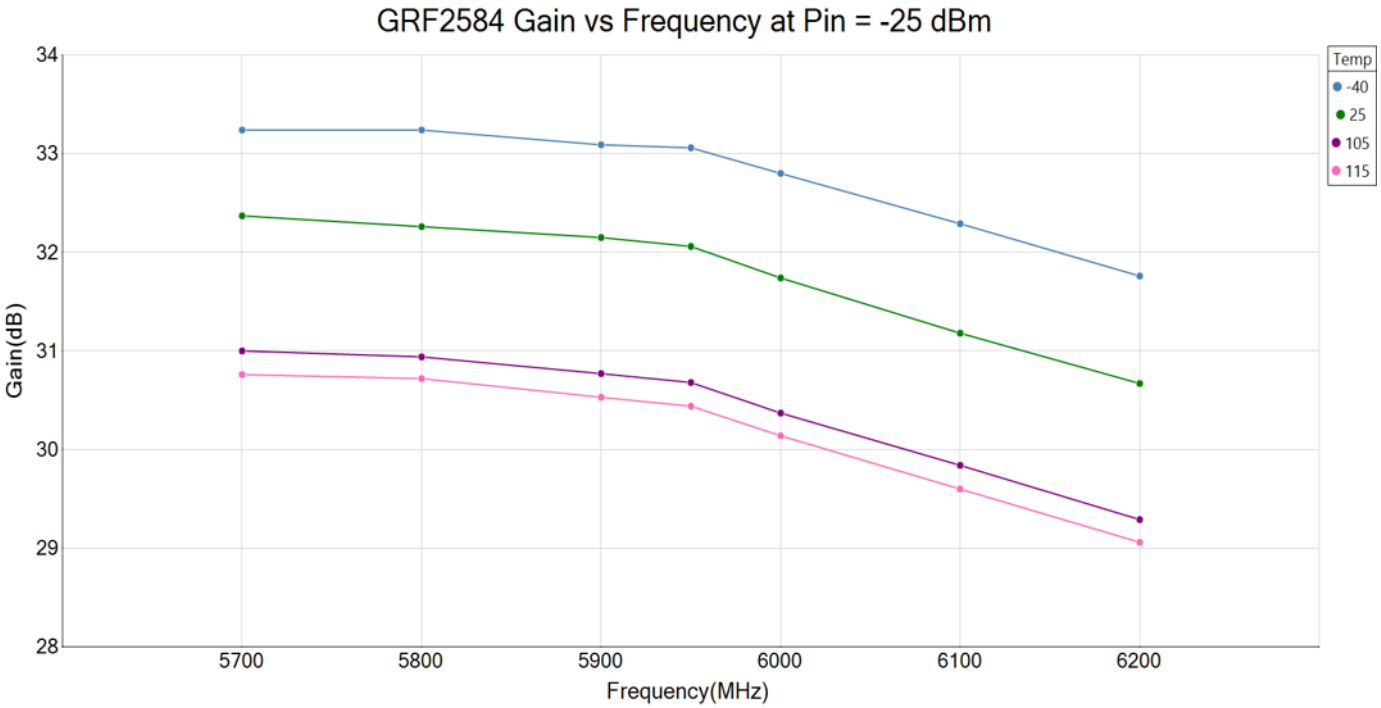
GRF2584 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



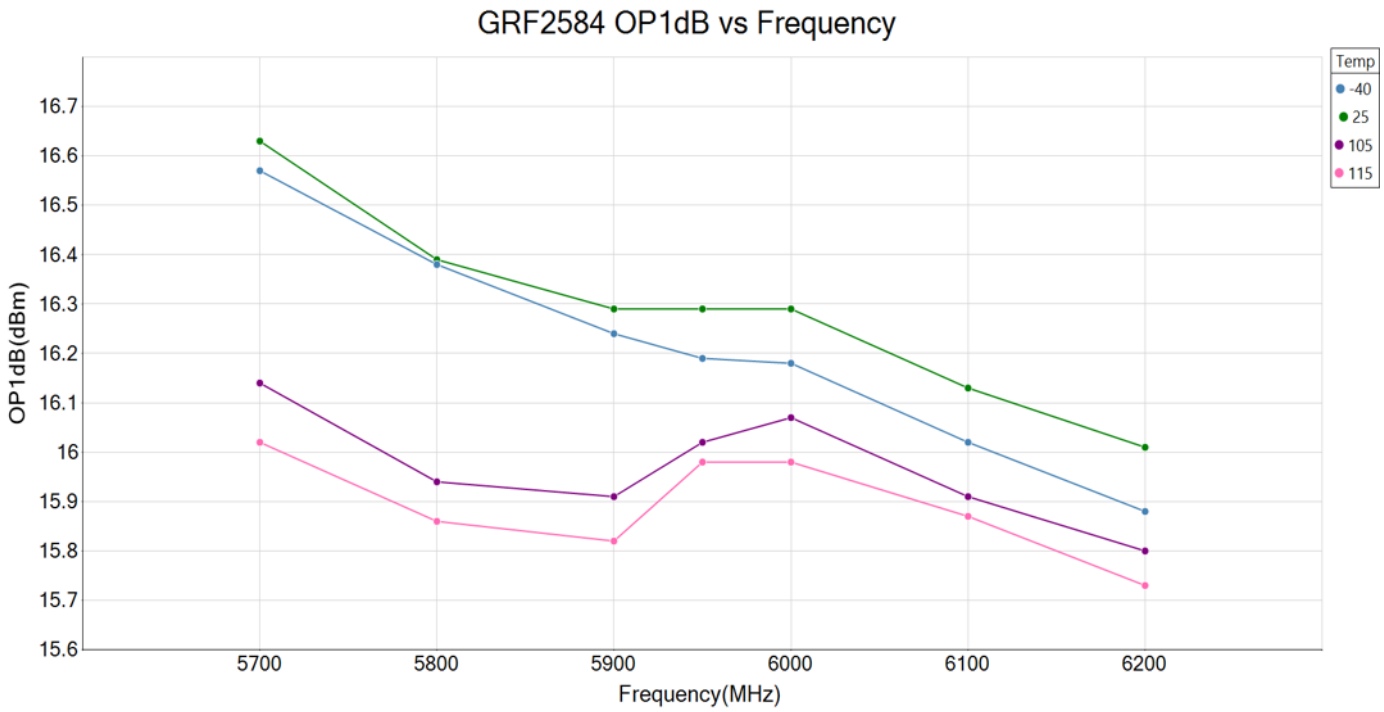
Note: Mu factor ≥ 1.0 implies unconditional stability

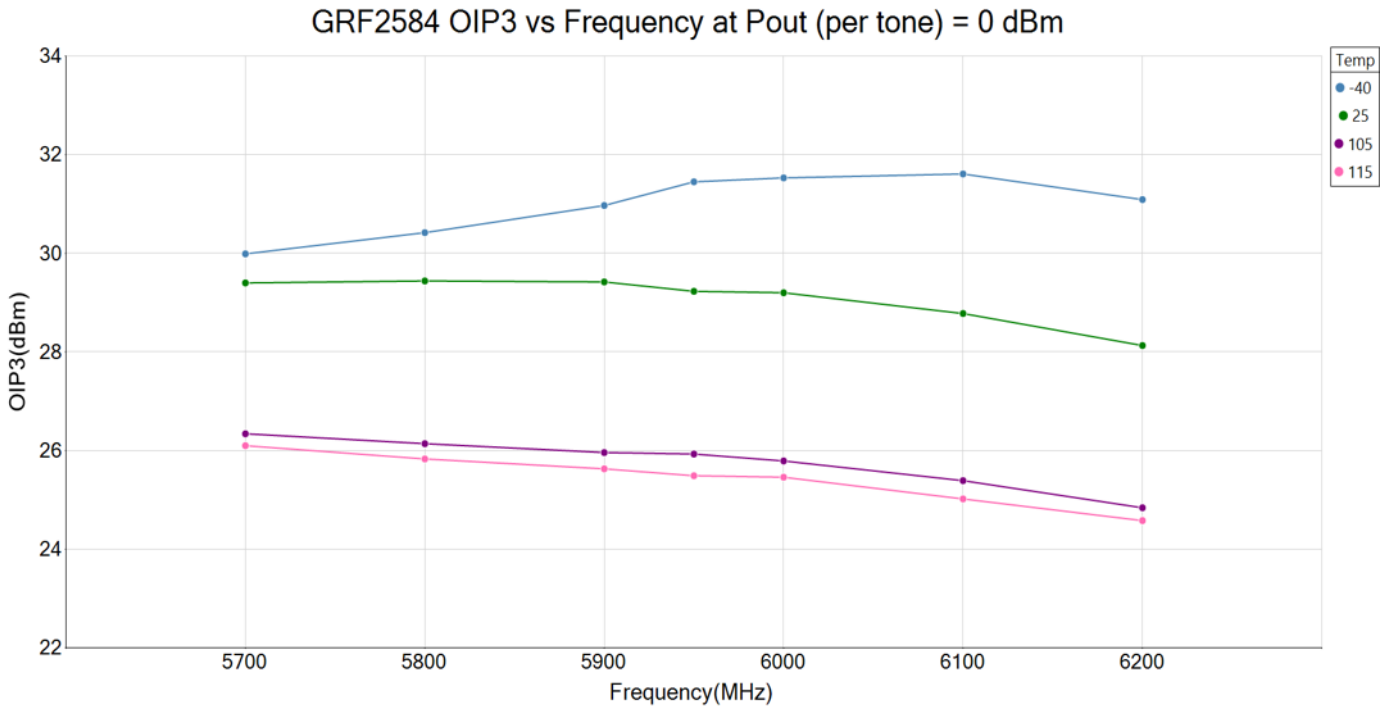
GRF2584 Typical Operating Curves: 5.7 to 6.2 GHz Tune



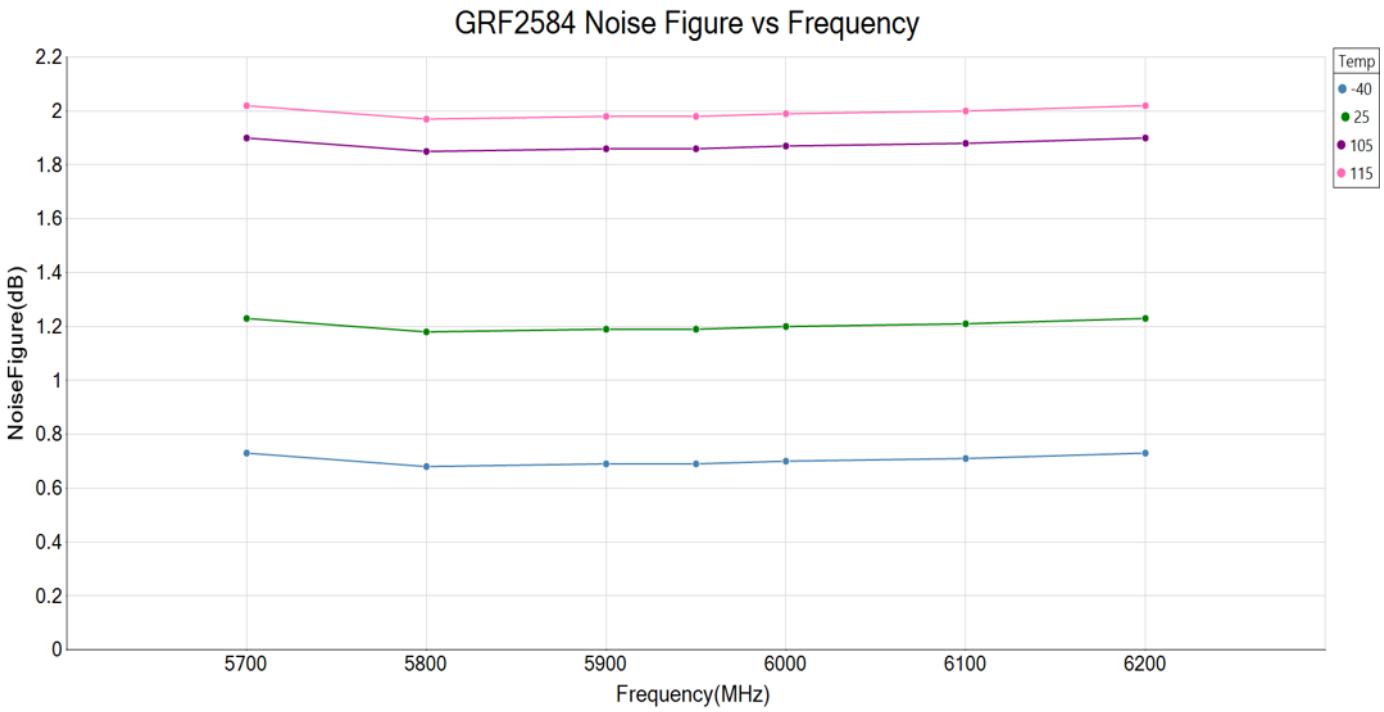


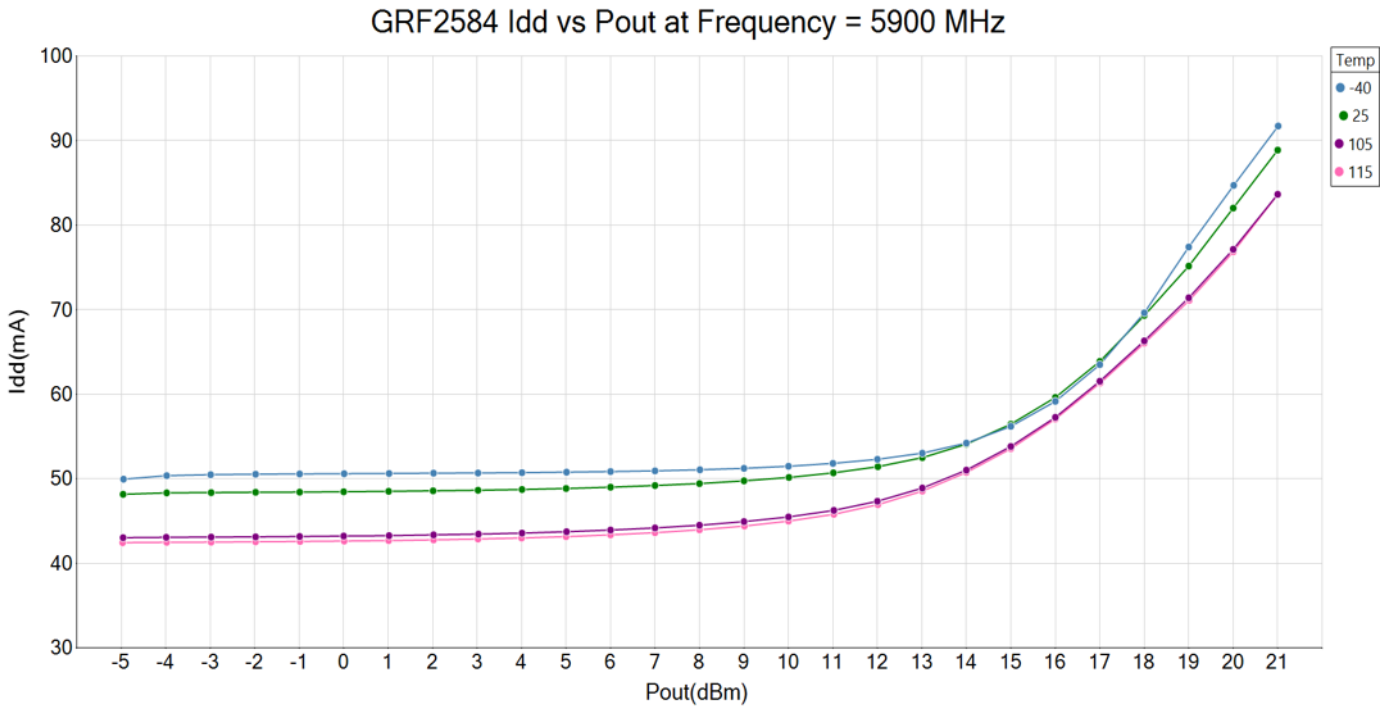
GRF2584 Typical Operating Curves: 5.7 to 6.2 GHz Tune

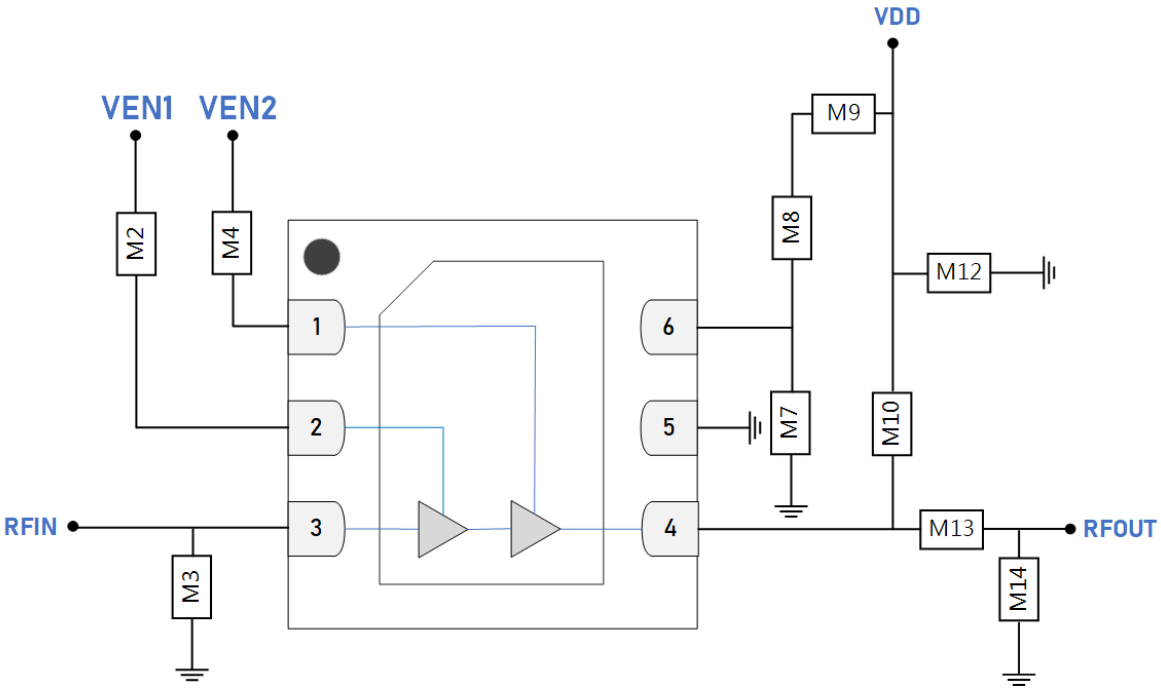




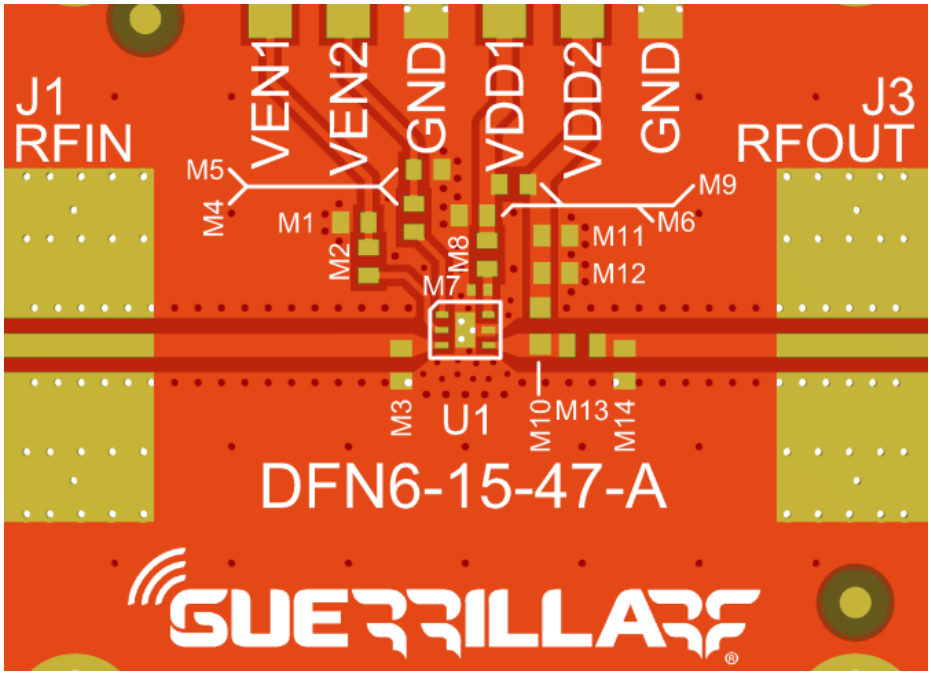
GRF2584 Typical Operating Curves: 5.7 to 6.2 GHz Tune







Standard Evaluation Board Schematic

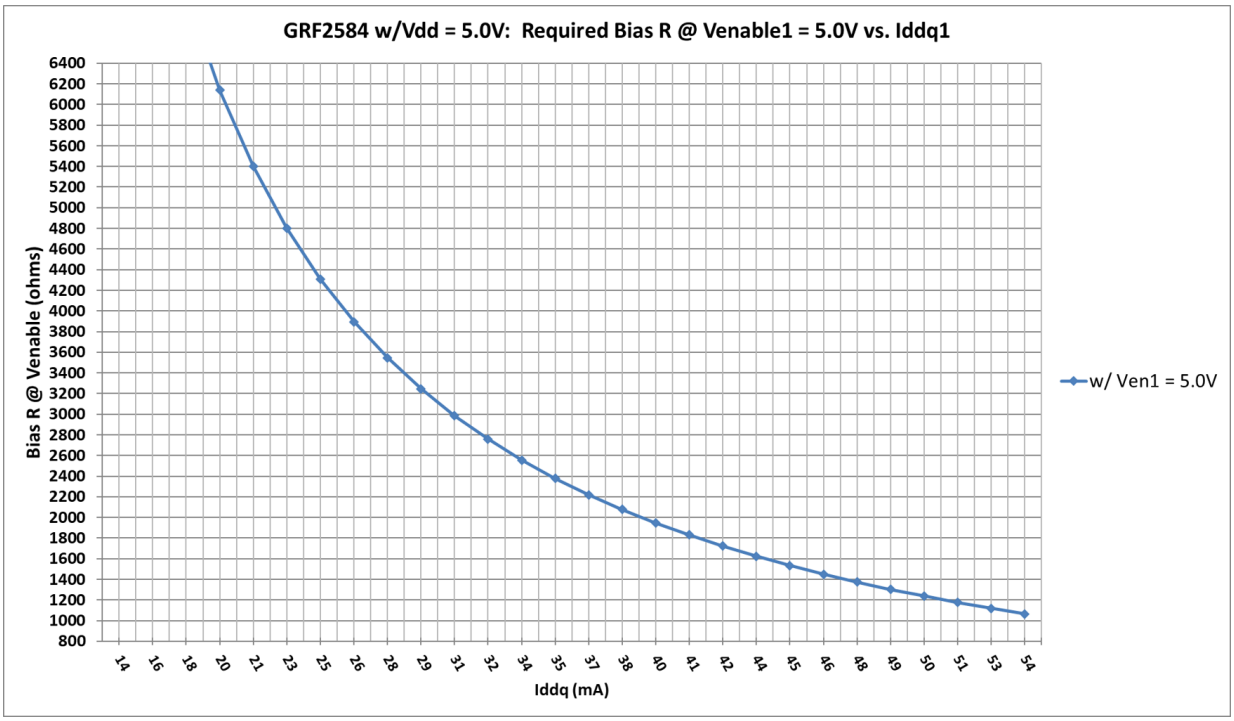


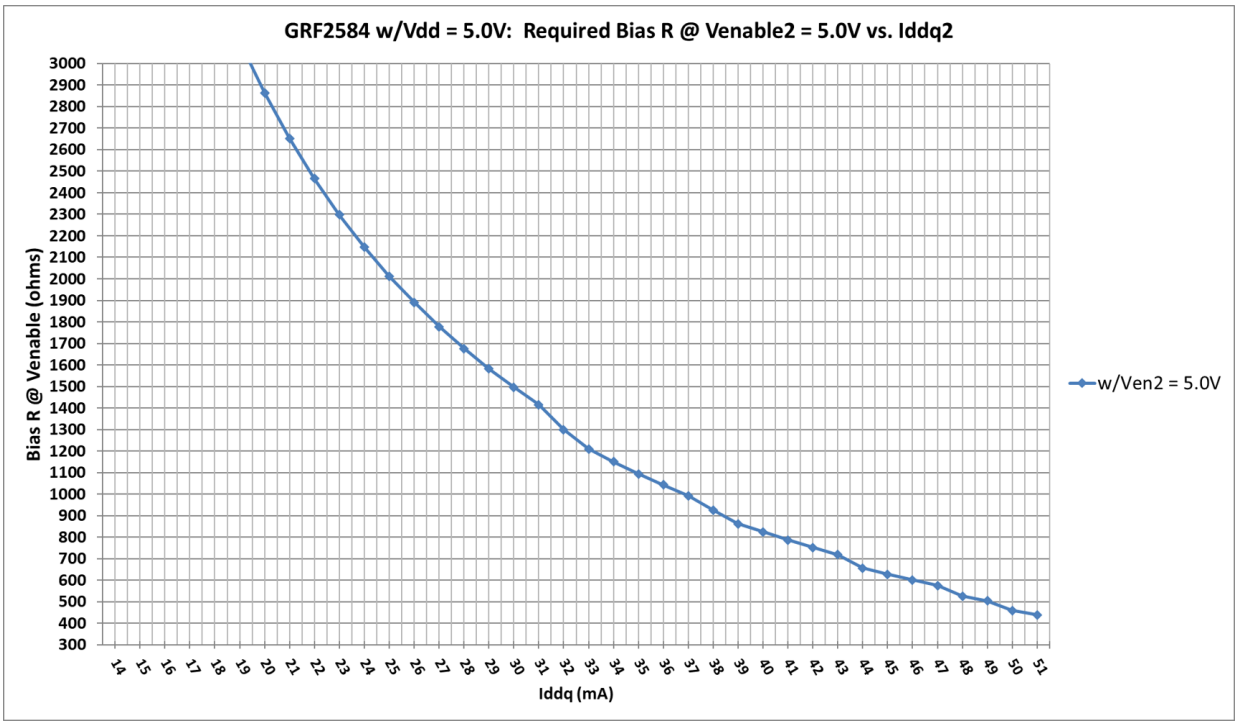
GRF2584 Evaluation Board Assembly Diagram

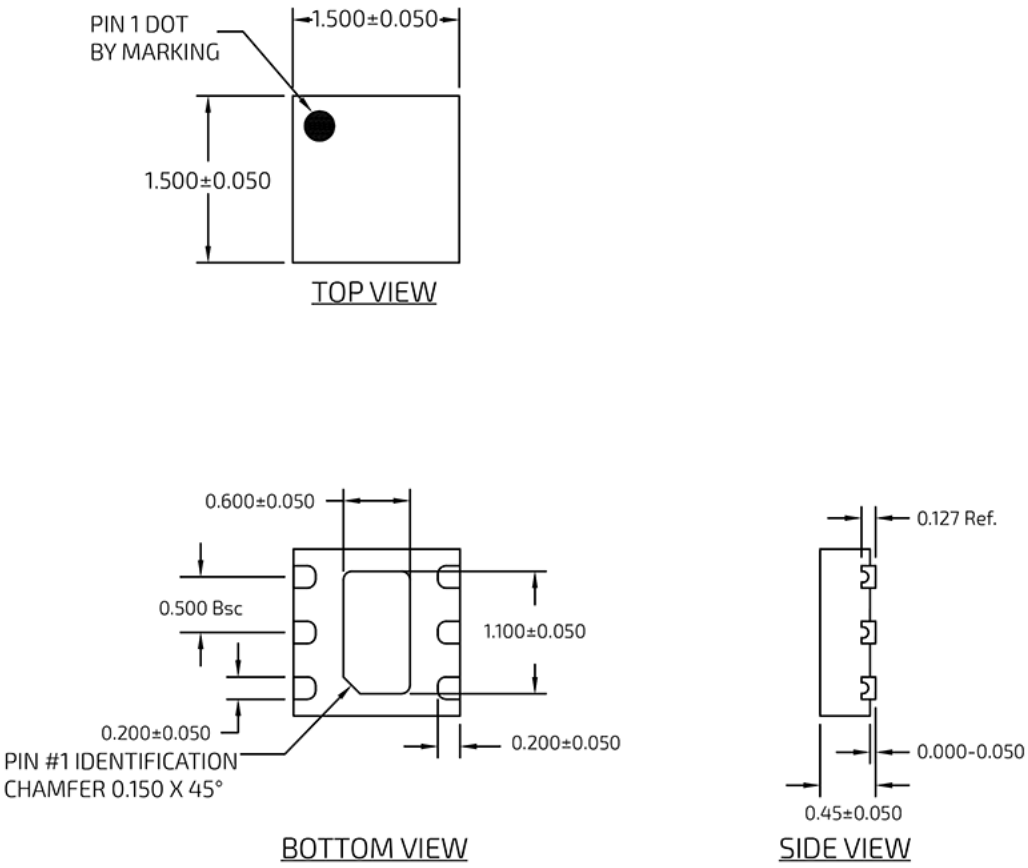
GRF2584 Evaluation Board Assembly Diagram Reference: 5.7 to 6.2 GHz Tune

Component	Type	Manufacturer	Family	Value	Package	Substitution
M2	Resistor	Various	5%	4.75 kΩ	0402	ok
M3	Capacitor	Murata	GJM	0.6 pF	0402	ok
M4	Resistor	Various	5%	2 kΩ	0402	ok
M7	Capacitor	Murata	GRM	0.1 µF	0201	ok
M8	Resistor	Various	5%	3 Ω	0402	ok
M9	Inductor	Murata	LQG	6.8 nH	0402	ok
M10	Inductor	Murata	LQG	5.1 nH	0402	ok
M12	Capacitor	Murata	GRM	0.1 µF	0402	ok
M13	Capacitor	Murata	GJM	20 pF	0402	ok
M14	Capacitor	Murata	GJM	0.2 pF	0402	ok
Evaluation Board	DFN6-15-47-A					

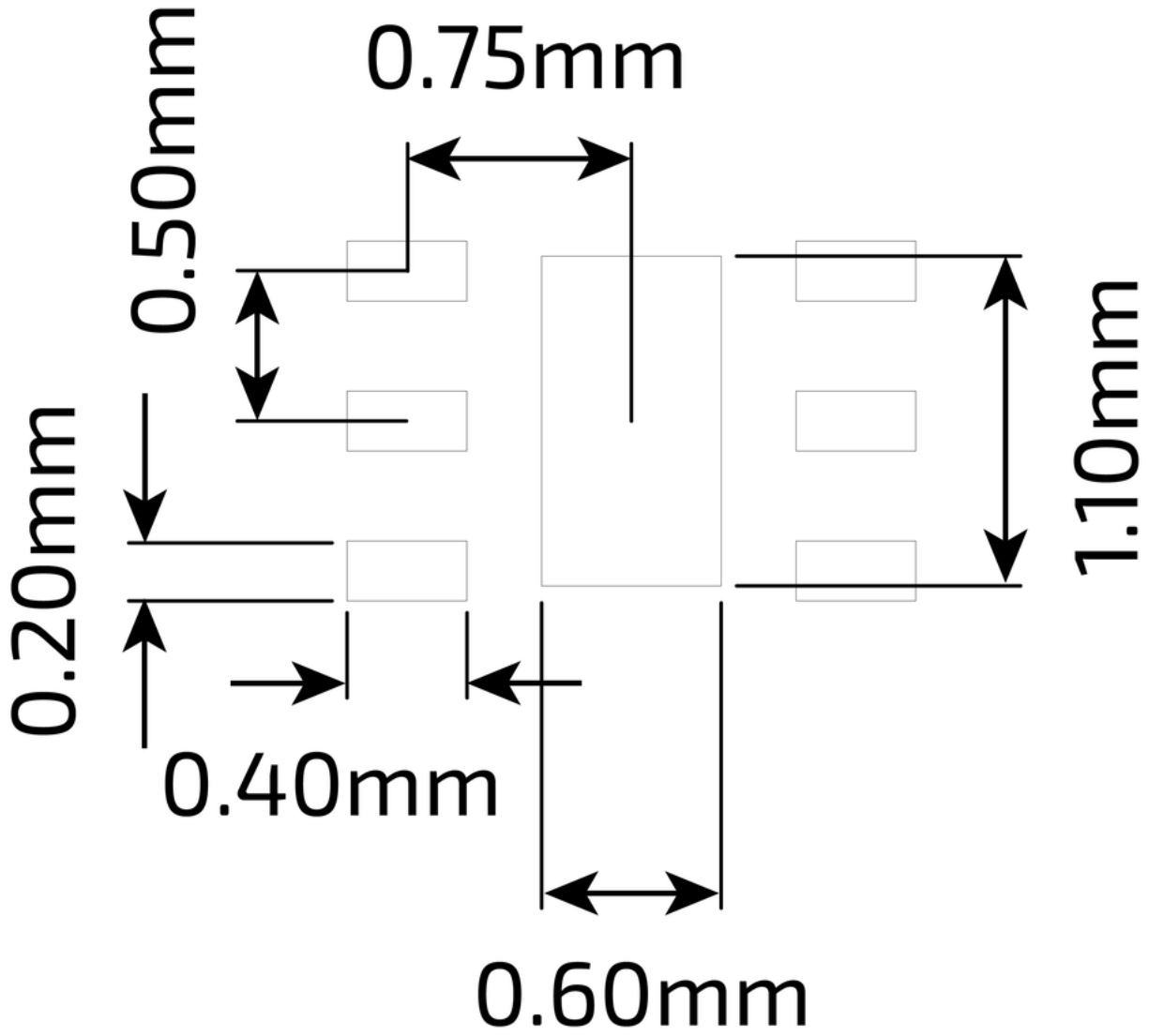
GRF2584 Bias Resistor Selection Curves







DFN 6 1.5x1.5mm Package Dimensions



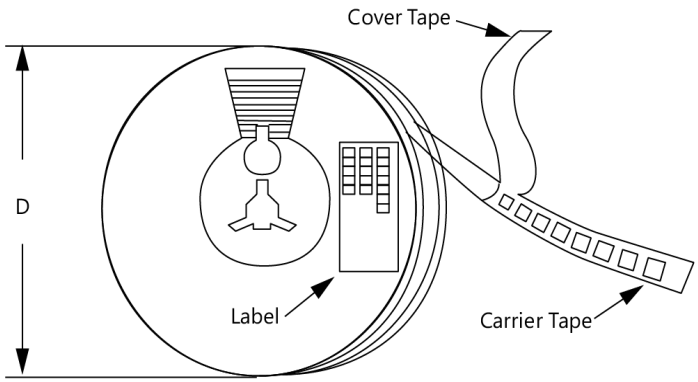
DFN 6 1.5x1.5mm Suggested PCB Footprint (Top View)

Package Marking Diagram

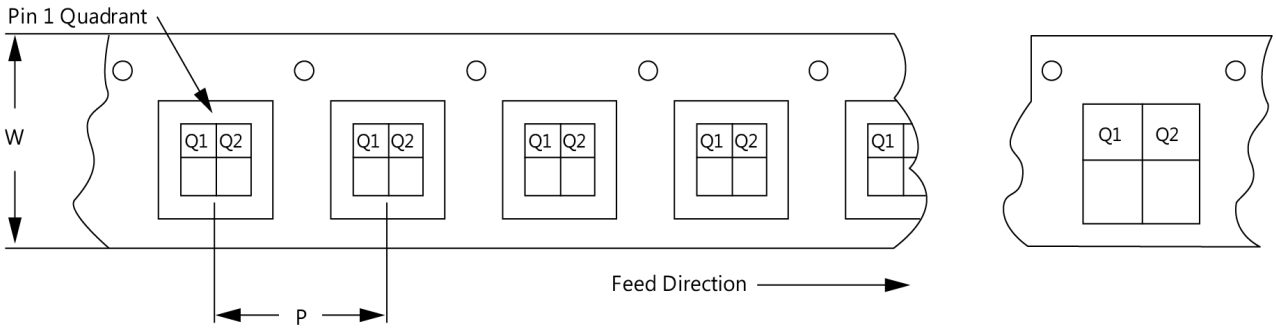
Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
Line 2: "XXXX" = Device Part Number.

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 21, 2023	Preliminary Data Sheet - Initial Release.
September 25, 2024	Release Ø Data Sheet.
March 6, 2025	Changed Max Channel Temperature from TBD to 170 °C.

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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