

GRF2584

High Gain Low Noise Amplifier Tunable Range 3 to 9 GHz

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
- Process: GaAs pHEMT
- Compact 1.5 x 1.5 mm DFN-6 Package

Reference: 5 V / 50 mA / 5.9 GHz

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

APPLICATIONS

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

DESCRIPTION

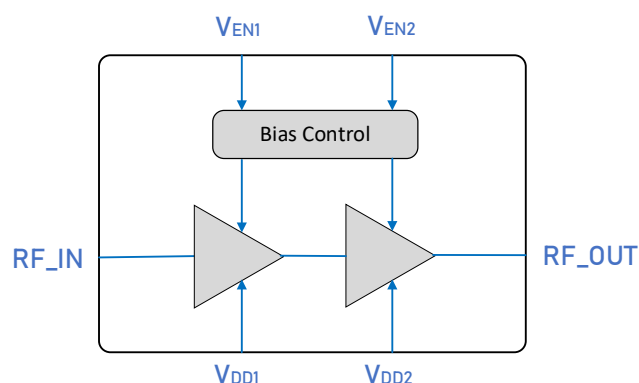
The GRF2584 is a two-stage GaAs pHEMT low noise amplifier targeting high-performance wireless infrastructure applications. The device can be tuned to operate over narrow or wide bandwidths over a range of 3 to 9 GHz while delivering up to 36 dB of gain and noise figures as low as 1 dB.

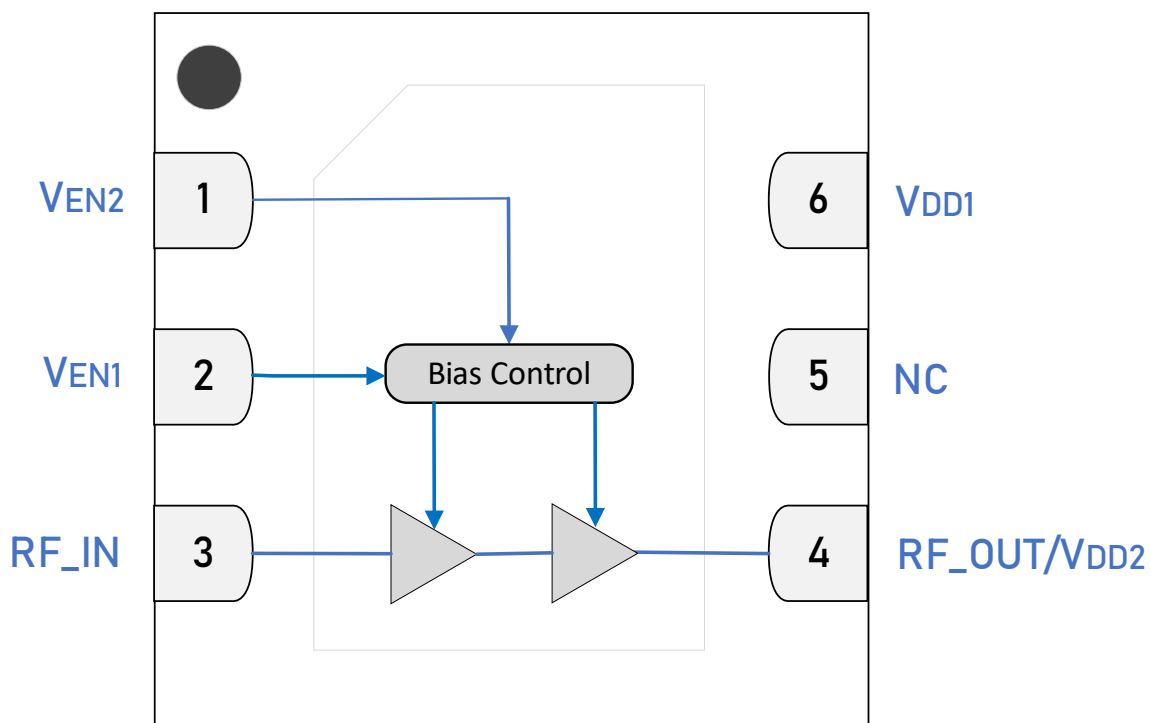
For optimal efficiency and linearity, the amplifier was designed to operate with a single 5 volt supply voltage while using only 50 mA of quiescent current. Supply voltages ranging from 2.7 to 6 volts are also supported. Similarly, I_{DDQ} can be increased beyond the native biasing point for enhanced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

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 GRF2584 "Custom Tunes" product page: [GRF2584 Custom Tunes](#)

BLOCK DIAGRAM





DFN-6 1.5 x 1.5 mm Pin Out (Top View)

Pin Assignments

Pin	Name	Description	Note
1	V _{EN2}	2 nd Stage Enable	V _{EN2} ≤ 0.2 volts disables the 2 nd stage. V _{EN2} and external series resistor control the 2 nd stage I _{DDQ} when V _{EN2} is high.
2	V _{EN1}	1 st Stage Enable	V _{EN1} ≤ 0.2 volts disables the 1 st stage. V _{EN1} and external series resistor control the 1 st stage I _{DDQ} when V _{EN1} is high.
3	RF_IN	RF Input	Internally matched to 50 Ω. An external DC blocking capacitor must be used.
4	RF_OUT/V _{DD2}	RF Output/2 nd Stage Bias	Internally matched to 50 Ω. V _{DD} must be applied through an RF choke to this pin.
5	NC	No Connect	No internal connection to die. This pin can be left unconnected or be connected to ground (recommend). Use a via as close to the pin as possible if grounded.
6	V _{DD1}	1 st 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 1 st 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 device's 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.

Truth Table

Mode	Pin Logic	
	V _{EN1}	V _{EN2}
Device ON	HIGH	HIGH
Standby (Device OFF)	LOW	LOW

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
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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 [Package Manufacturing Information | Guerrilla RF \(guerrilla-rf.com\)](#)



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_{DD}	4.75	5	6	V	
RF Frequency Range	F_{RF}	5.855	5.9	5.925	GHz	5.9 GHz tuning set (automotive V2X Band n47). Notes 1 & 2.
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40		115	°C	
RF_IN Port Impedance	Z_{RF_IN}		50		Ω	Single-ended with respective matching elements from each tuning set.
RF_OUT Port Impedance	Z_{RF_OUT}		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

The following conditions apply unless noted otherwise: typical application schematic using the 5.7 to 6.2 GHz tuning set. $V_{DD} = 5\text{ V}$, $V_{EN1} = 5\text{ V}$, $V_{EN2} = 5\text{ V}$, $R_{BIAS1} = 4.75\text{ k}\Omega$, $R_{BIAS2} = 2\text{ k}\Omega$, $P_{OUT} = 0\text{ dBm}$, $F_{TEST} = 5.9\text{ GHz}$, $50\text{ }\Omega$ system impedance, $T_{PKG\text{ BASE}} = 25\text{ }^{\circ}\text{C}$. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Test Frequency	F_{TEST}		5.9		GHz	
Supply Quiescent Current	I_{DDQ}		50		mA	I_{BIAS1} and I_{BIAS2} . $R_{BIAS1} = 4.75\text{ k}\Omega$, $R_{BIAS2} = 2\text{ k}\Omega$.
Enable Current	I_{EN}		2.4		mA	$I_{EN1} + I_{EN2}$. $V_{DD} = \text{High}$, V_{EN1} and $V_{EN2} = \text{High}$.
Logic Input Low	V_{IL}	0		0.2	V	V_{EN1} and V_{EN2} .
Logic Input High	V_{IH}	1.5		V_{DD}	V	$V_{DD} = 5\text{ V}$, $V_{EN1} = 5\text{ V}$, $V_{EN2} = 5\text{ V}$.
Turn On (Rise) Time	t_{ON}		40		ns	V_{EN1} and V_{EN2} Low to High.
Turn Off (Fall) Time	t_{OFF}		30		ns	V_{EN1} and V_{EN2} High to Low.
VBIAS	V_{BIAS}		5.0		V	V_{BIAS1} and V_{BIAS2} .

Disabled Mode

Standby Current	I_{STBY}		400		μA	$V_{DD} = 5\text{ V}$, $V_{EN1} = \text{Low}$, $V_{EN2} = \text{Low}$.
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Thermal Data

Thermal Resistance (Infrared Scan)	Θ_{JC}		TBD		$^{\circ}\text{C}/\text{W}$	On standard evaluation board.
Channel Temperature at 115 $^{\circ}\text{C}$ (reference package base)	$T_{CHANNEL}$		TBD		$^{\circ}\text{C}$	$V_{DD} = 5\text{ V}$, $I_{DDQ} = 47\text{ mA}$, $P_{DISS} = \text{TBD}$. No RF applied (note 3).

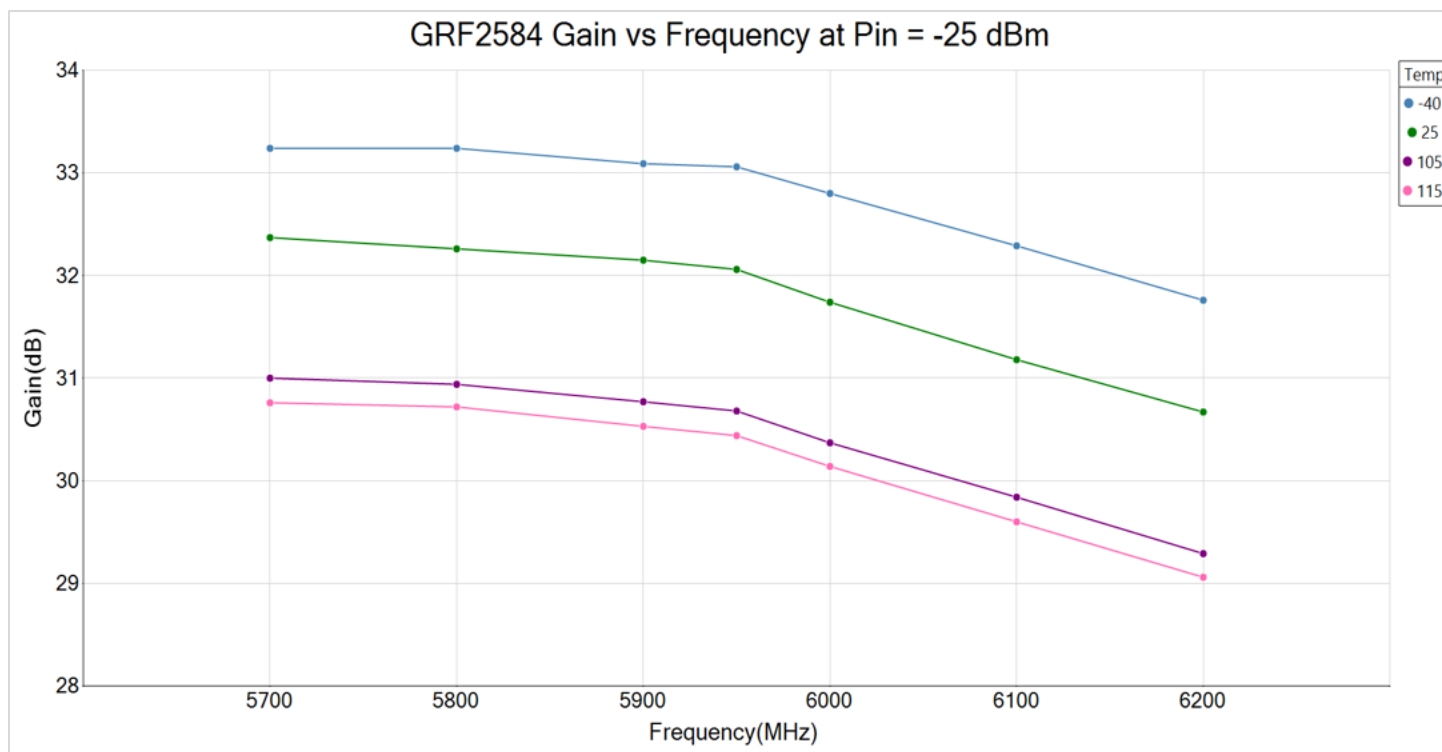
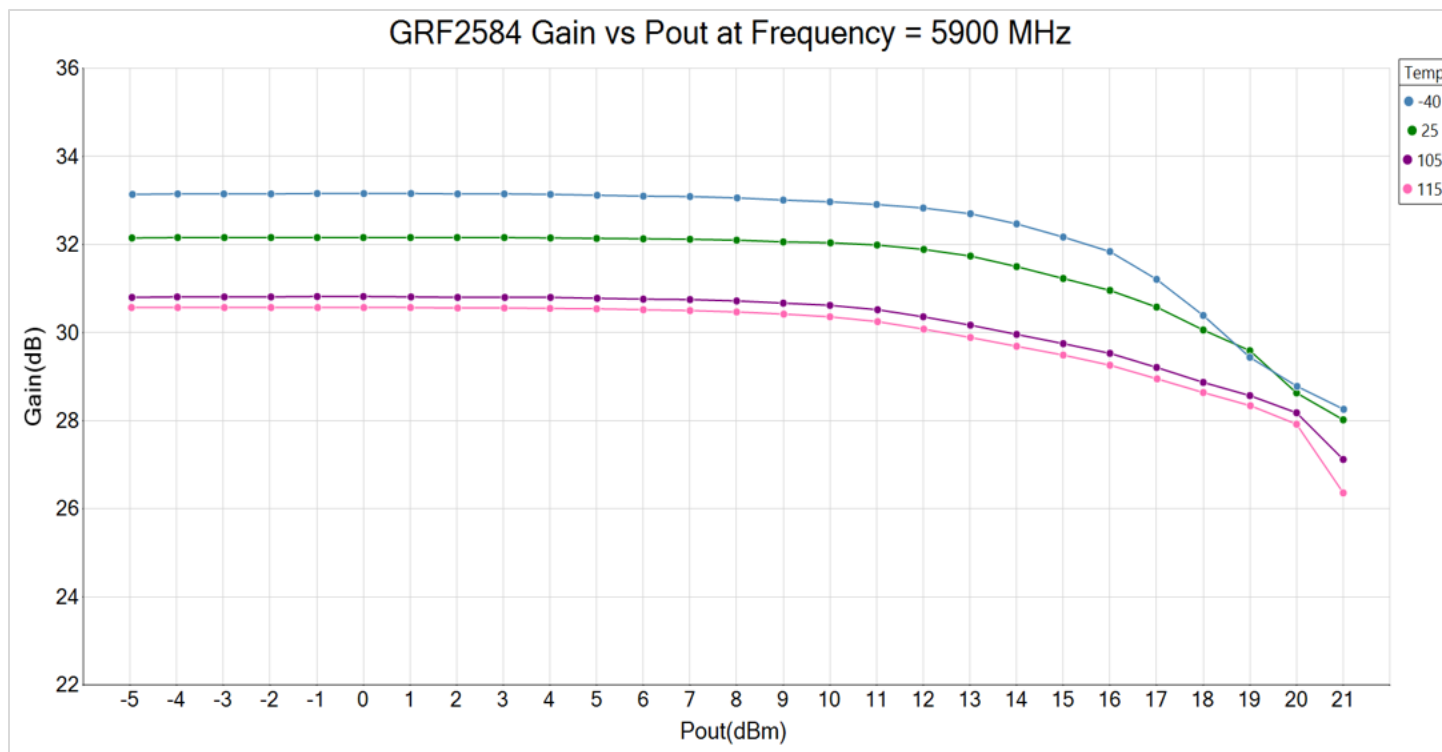
Note 3: MTTF > 10^6 hours for $T_{CHANNEL} \leq 170\text{ }^{\circ}\text{C}$.

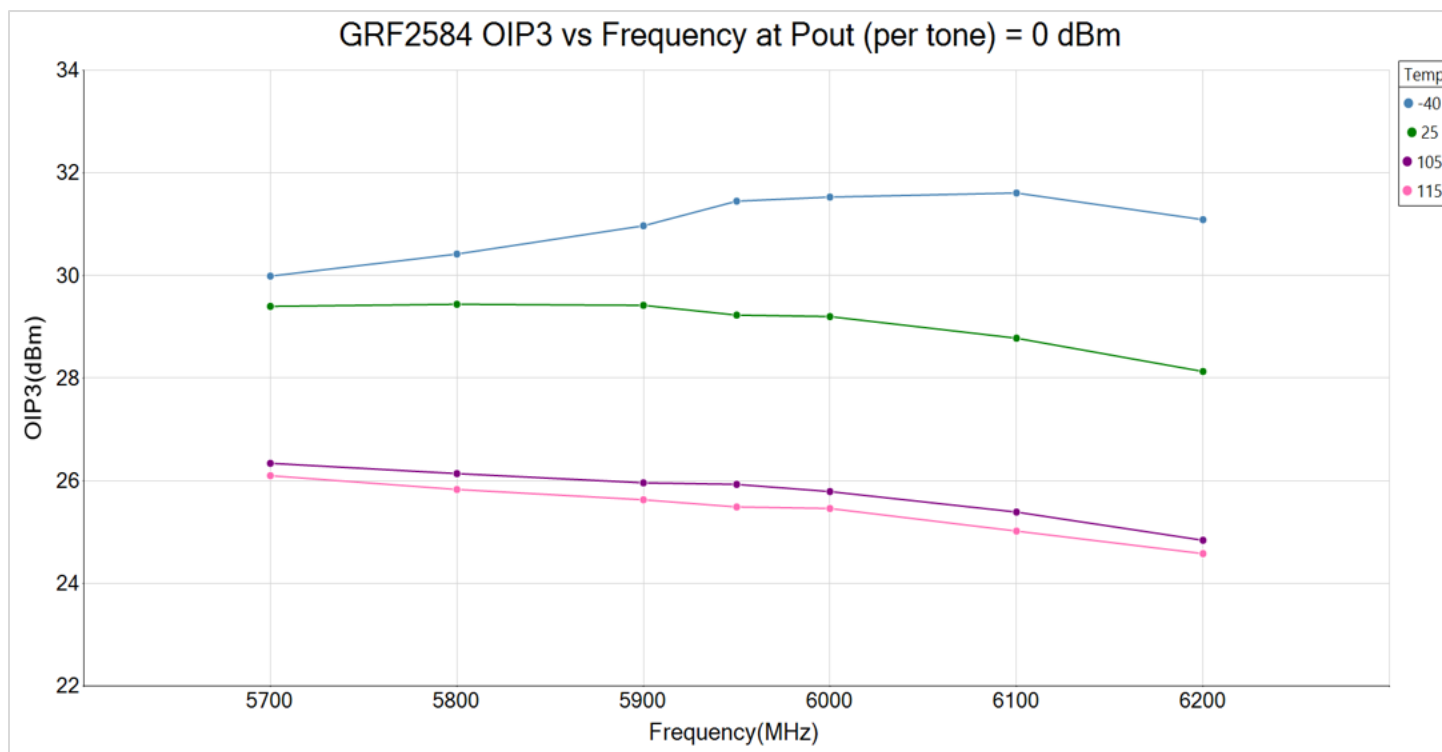
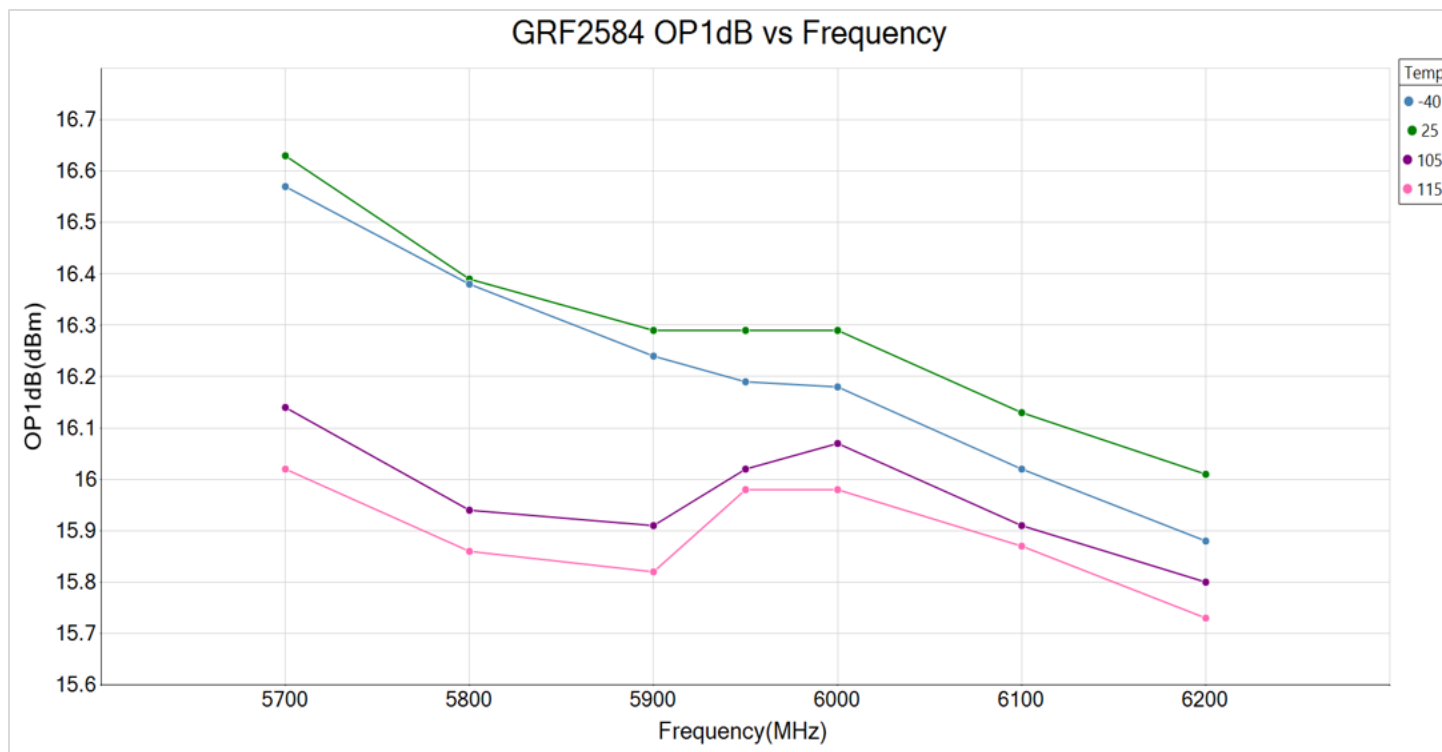
Nominal Operating Parameters – RF

The following conditions apply unless noted otherwise: typical application schematic using the 5.7 to 6.2 GHz tuning set. $V_{DD} = 5\text{ V}$, $V_{EN1} = 5\text{ V}$, $V_{EN2} = 5\text{ V}$, $R_{BIAS1} = 4.75\text{ k}\Omega$, $R_{BIAS2} = 2\text{ k}\Omega$, $P_{OUT} = 0\text{ dBm}$, $F_{TEST} = 5.9\text{ GHz}$, $50\text{ }\Omega$ system impedance, $T_{PKG\text{ BASE}} = 25\text{ }^{\circ}\text{C}$. Evaluation board losses are included within the specifications.

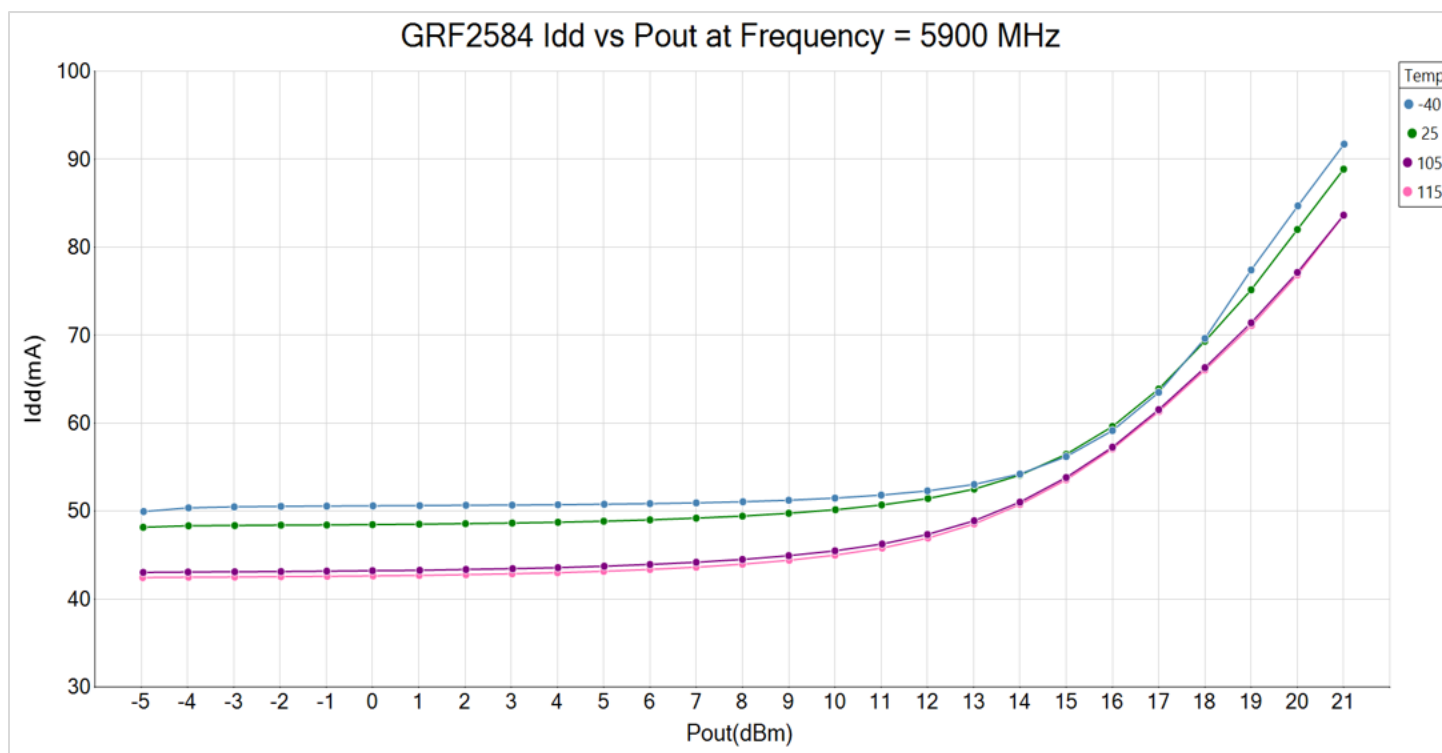
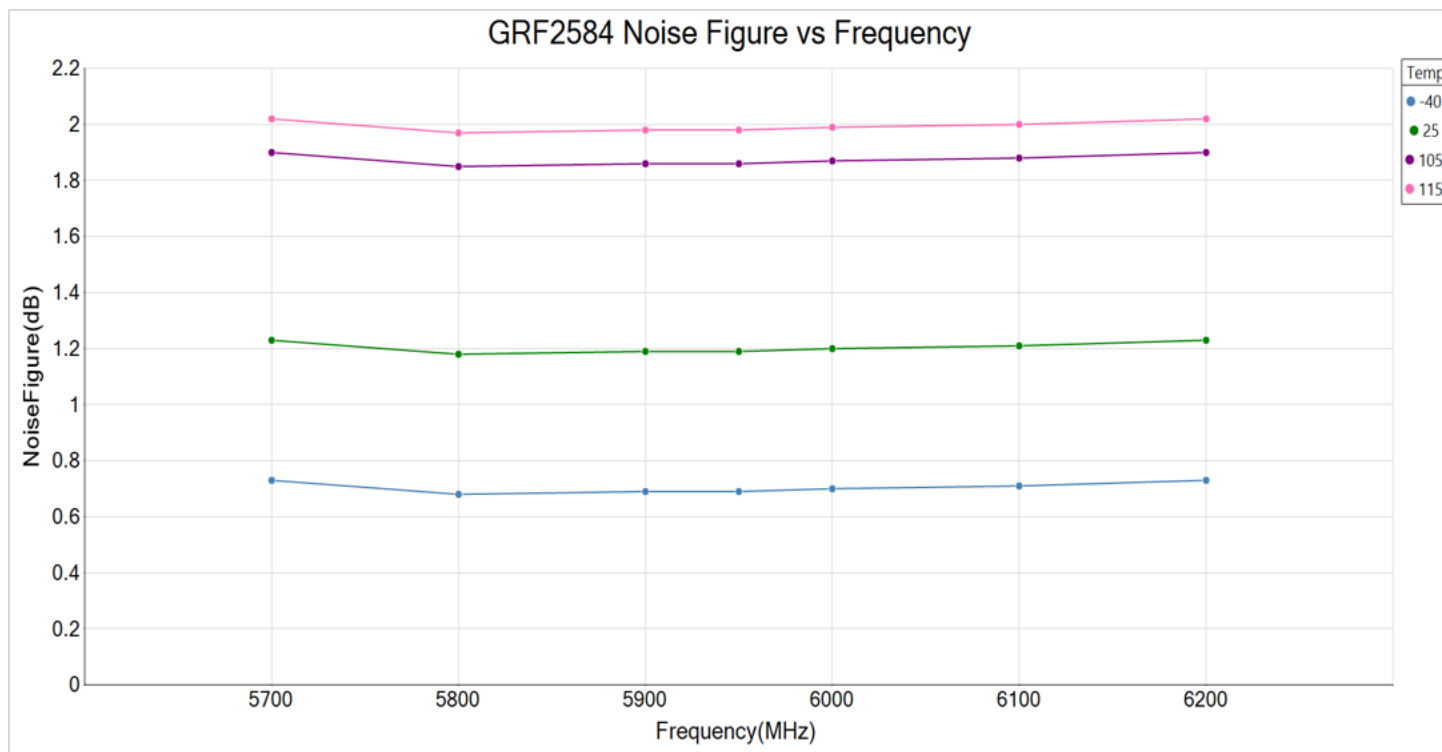
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain	S21		32.2		dB	$F_{RF} = 5.89\text{ GHz}$.
Gain Flatness	S21 _{FLAT}		0.02		dB	$F_{RF} = 5.855\text{ to }5.925\text{ GHz}$.
Gain Variation Over Temp	S21 _{TEMP}		+0.8/-1.5		dB	$T_{PKG\text{ BASE}} = -40\text{ to }115\text{ }^{\circ}\text{C}$ (reference $T_{PKG\text{ BASE}} = 25\text{ }^{\circ}\text{C}$).
Gain (Standby Mode)	S21 _{STBY}		-32		dB	V_{EN1} and $V_{EN2} = \text{Low}$.
Input Return Loss	S11		< -11		dB	$F_{RF} = 5.855\text{ to }5.925\text{ GHz}$.
Output Return Loss	S22		< -13		dB	$F_{RF} = 5.855\text{ to }5.925\text{ GHz}$.
Reverse Isolation	S12		-38		dB	$F_{RF} = 5.855\text{ to }5.925\text{ GHz}$.
Noise Figure (de-embedded)	NF		1.0		dB	
Noise Figure (evaluation board)	NF		1.2		dB	
Output 3 rd Order Intercept Point	OIP3		29.4		dBm	$P_{OUT} = 0\text{ dBm}$ per tone at 2 MHz spacing.
Output 1 dB Compression Power	OP1dB		16.3		dBm	

GRF2584 Typical Operating Curves: 5.7 to 6.2 GHz Tune

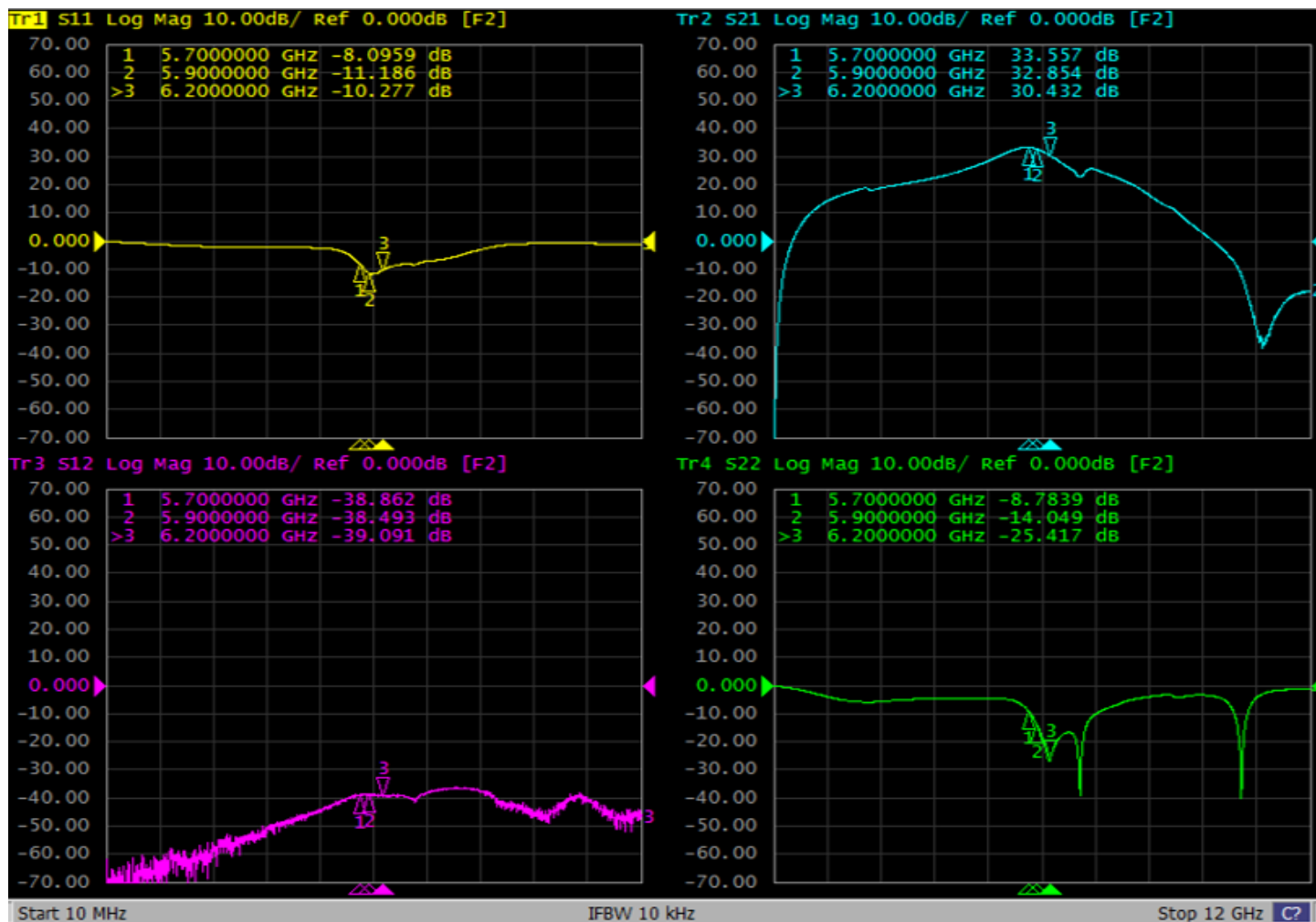


GRF2584 Typical Operating Curves: 5.7 to 6.2 GHz Tune


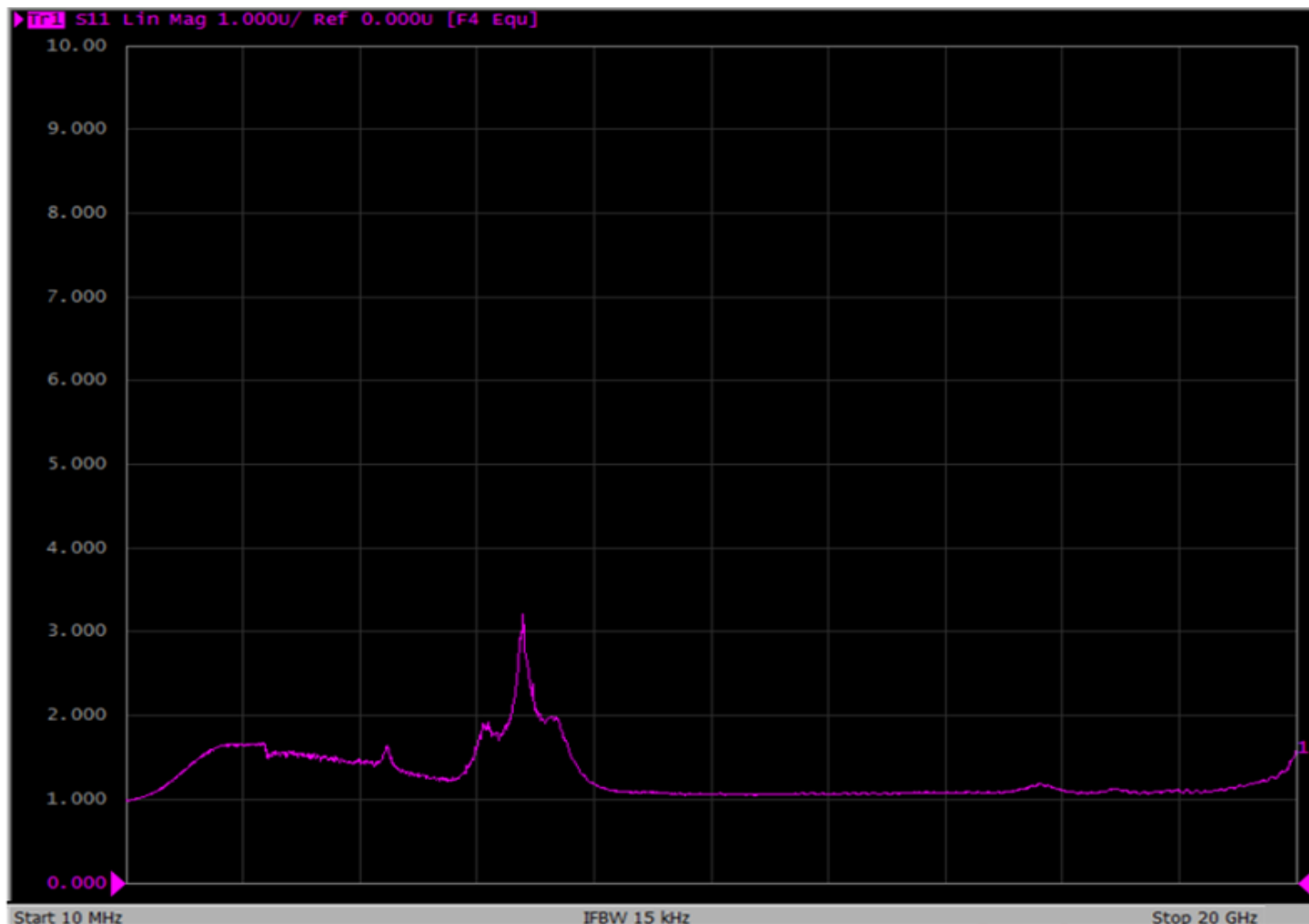
GRF2584 Typical Operating Curves: 5.7 to 6.2 GHz Tune



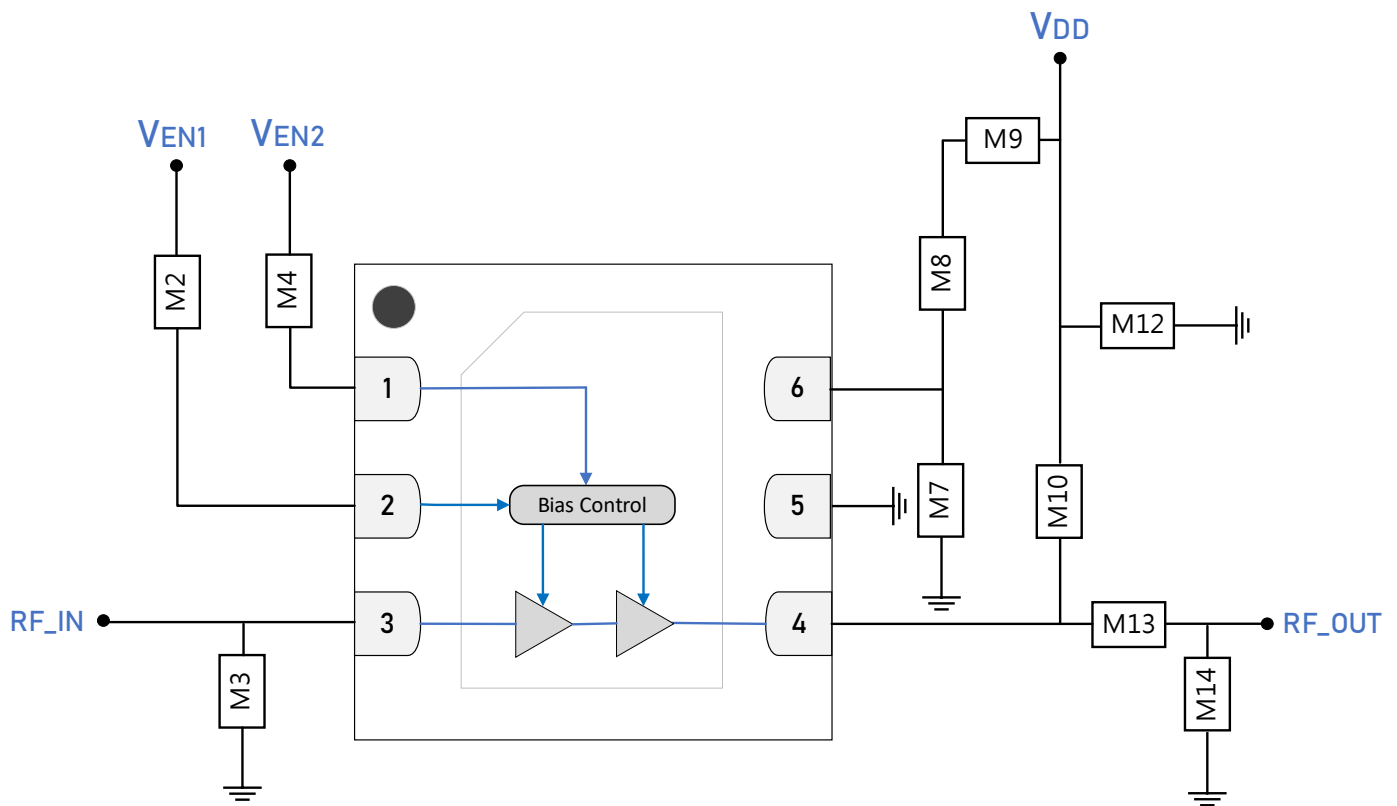
GRF2584 Typical Operating Curves: S-Parameters (5.7 to 6.2 GHz Tune)



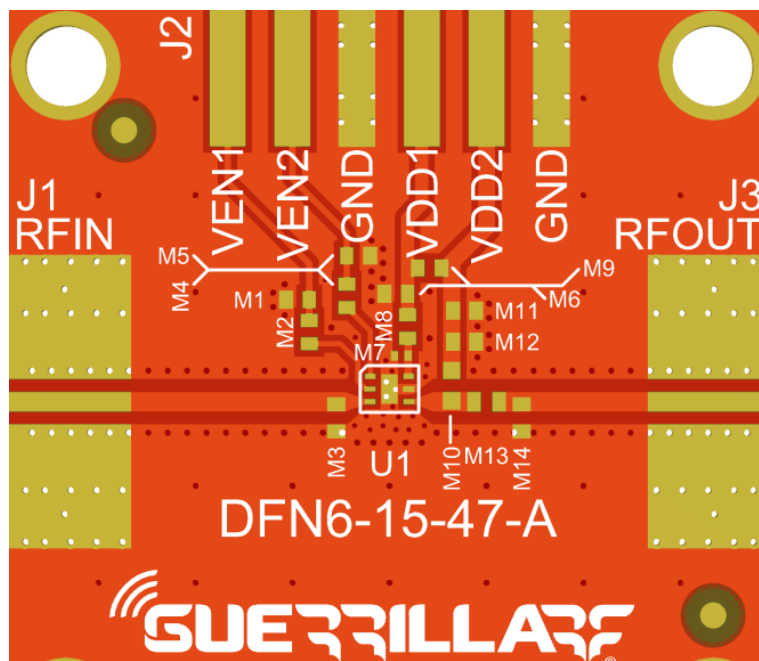
GRF2584 Typical Operating Curves: Stability Mu Factor (10 MHz to 20 GHz)



Note: $\mu \geq 1.0$ implies unconditional stability.



GRF2584 Standard Evaluation Board Schematic

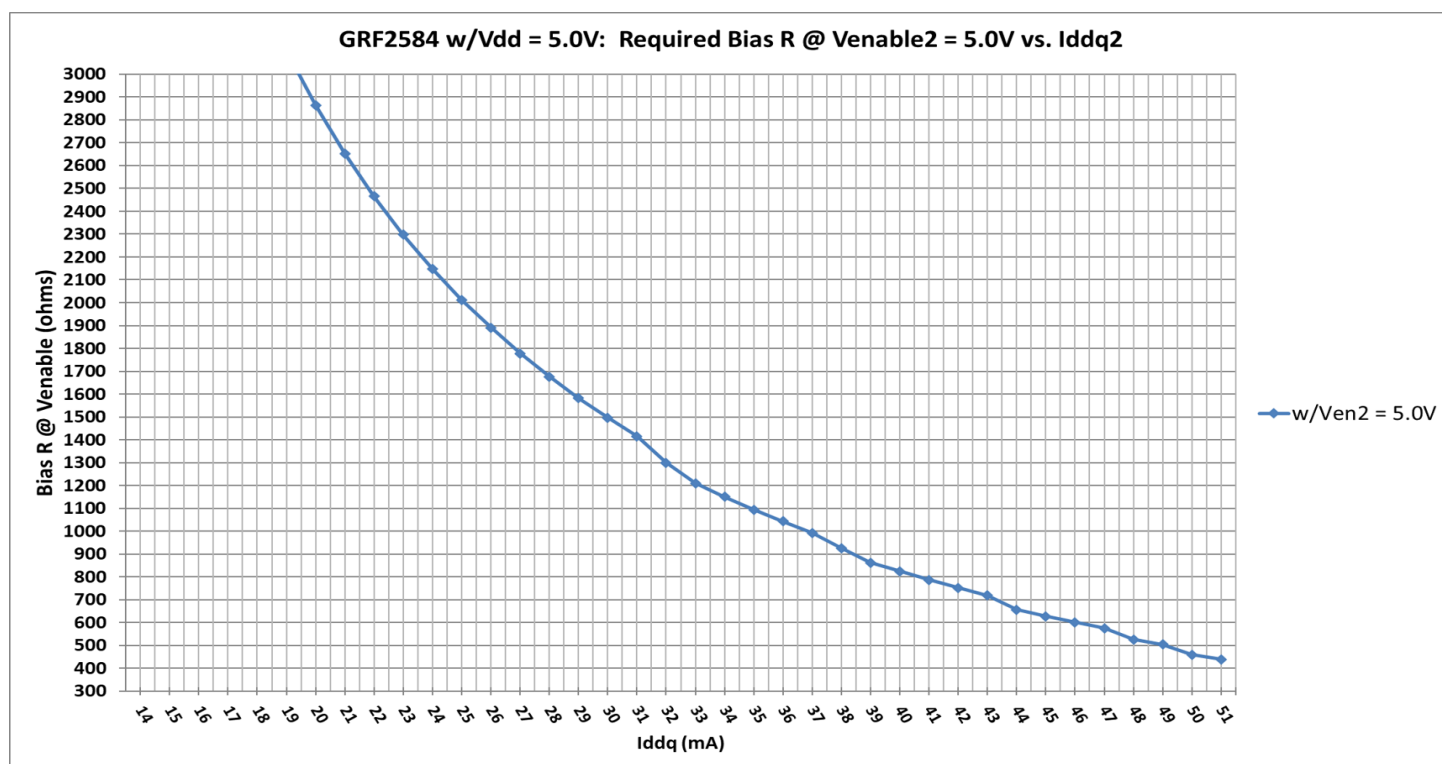
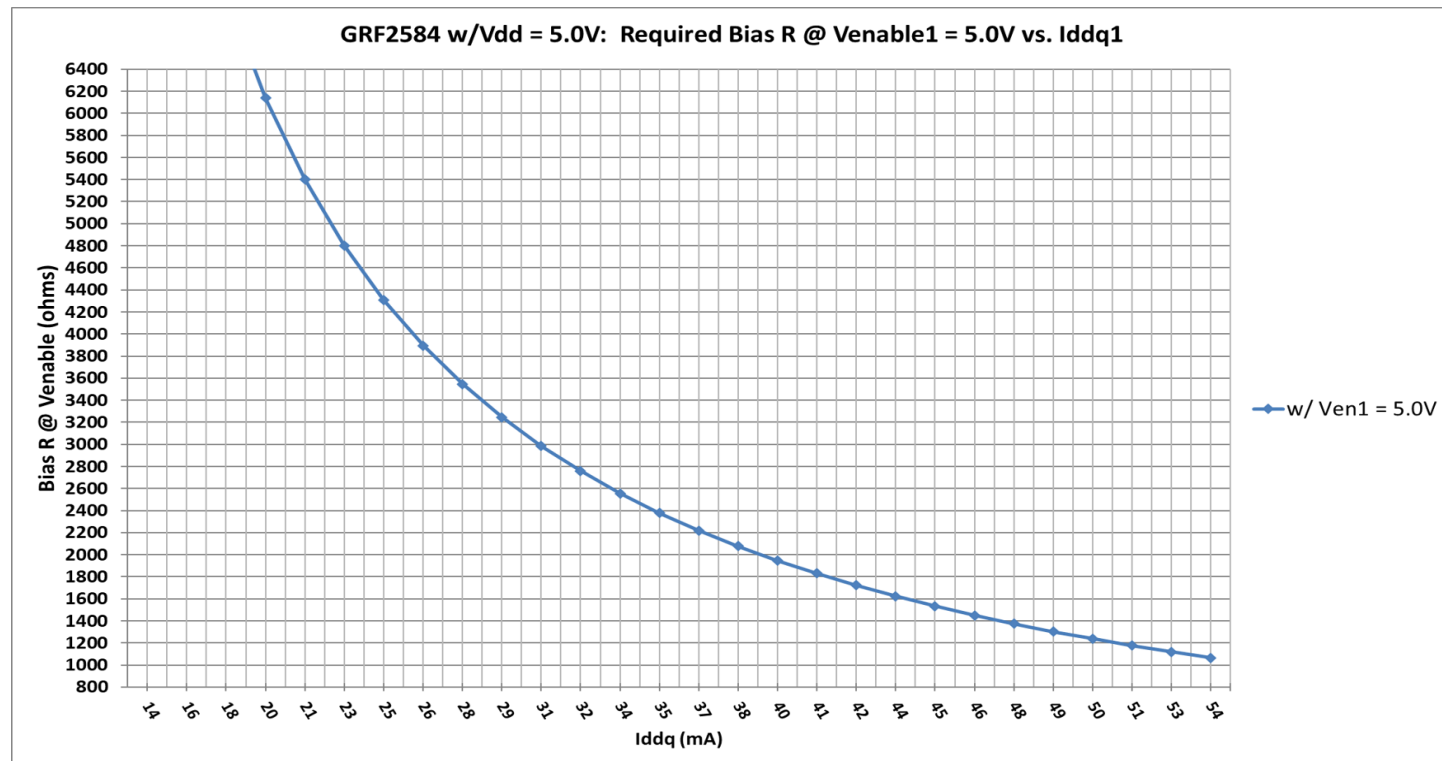


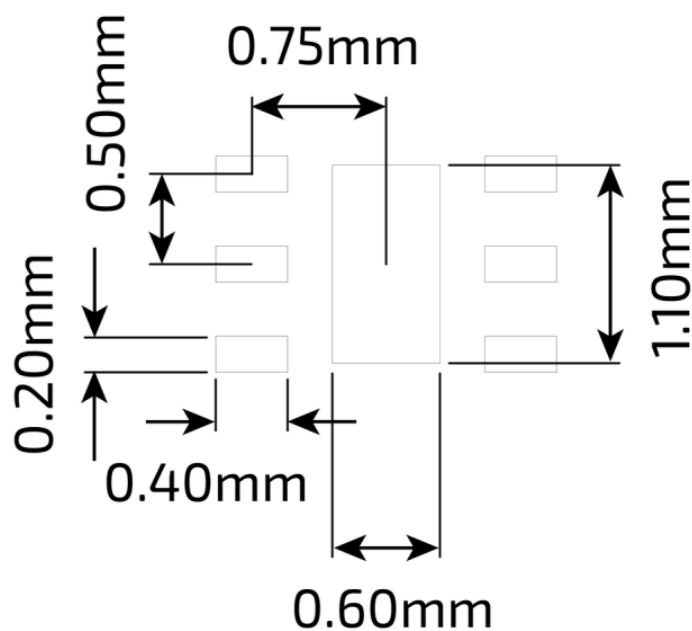
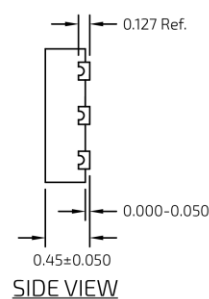
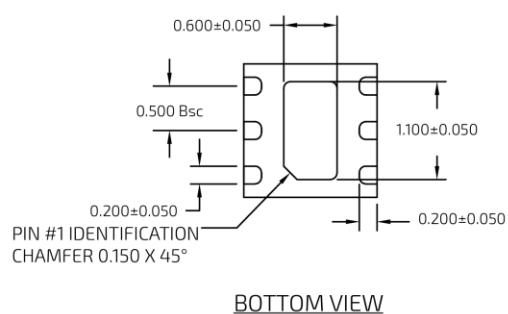
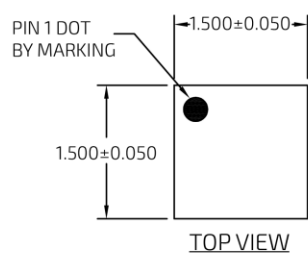
GRF2584 Evaluation Board Assembly Diagram

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

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M2	Resistor	Various	5%	4.75 k Ω	0402	ok
M3	Capacitor	Murata	GJM	0.6 pF	0402	ok
M4	Resistor	Various	5%	2 k Ω	0402	ok
M7	Capacitor	Murata	GRM	0.1 μ F	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 μ F	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 1.5 x 1.5 mm Suggested PCB Footprint (Top View)

DFN-6 1.5 x 1.5 mm Package Dimensions

Package Marking Diagram



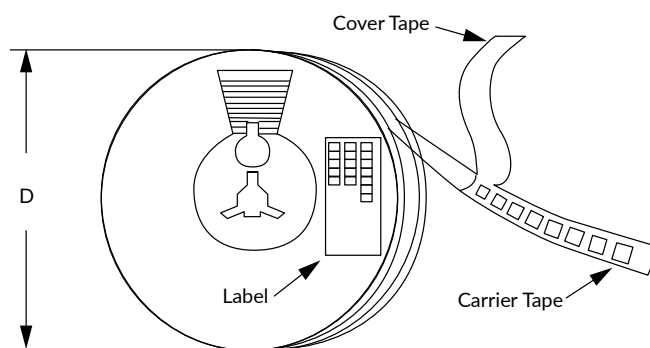
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

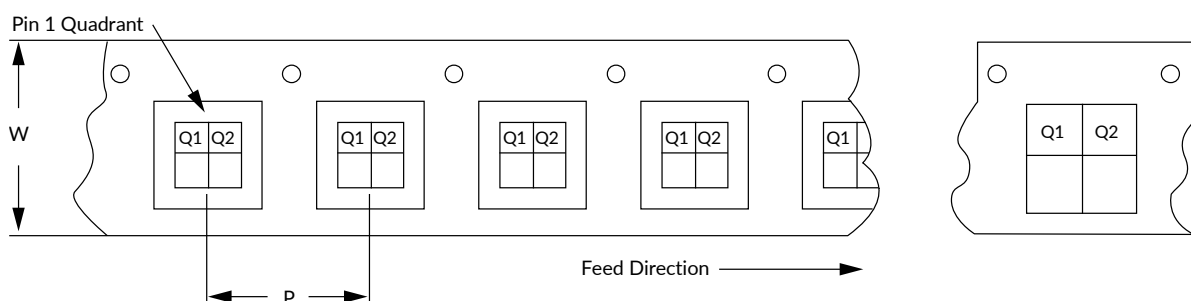
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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: [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.
September 25, 2024	Release Ø Data Sheet.
March 6, 2025	Changed Max Channel Temperature from TBD to 170 °C.
December 10, 2025	Upgraded Data Sheet to new format only. No change to device or device specifications.



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 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 <i>production-released</i> material. TYP values are based on a combination of ATE and bench-level measurements, with MIN/MAX limits defined using <i>modelled estimates</i> 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 <i>derived from multiple lots which have been fabricated over an extended period of time</i> . 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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