

## GRF5526W

### HIGH LINEARITY POWER AMPLIFIER

#### 2.2 to 2.7 GHz

#### FEATURES

- Excellent OP1dB, OIP3, ACLR and IM3 Performance
- Native Linearity Provides up to +23 dBm  $P_{OUT}$  with > 45 dBc ACLR – Without the Need for Digital Predistortion Correction
- +23 dBm Linear Output Power Maintained at 105 °C
- Flexible Biasing Provides Latitude for Linearity Optimization
- 150 mA Native Mode Quiescent Current Consumption
- 5 V Supply Voltage
- 50  $\Omega$  Single-ended Input and Output Impedances
- Digital Shutdown
- Rugged Design is Extremely Resilient to Mismatched Loads
- -40 to 105 °C Operating Temperature Range
- Compact 3 x 3 mm QFN-16 Package

#### Tested to AEC-Q100 Grade 2 Qualification

- 100% Device Reflow at Assembly
- 100% Optical Die Inspection

#### Reference: 5 V / 150 mA $I_{CCQ}$ / 2.6 GHz

- Gain: 28.5 dB
- OIP3: 45 dBm @ 23 dBm  $P_{OUT}/\text{tone}$
- OP1dB: 32 dBm
- Noise Figure: 3 dB

#### APPLICATIONS

- Cellular Boosters/Repeaters
- Automotive Compensators
- Picocells/Femtocells
- Customer Premise Equipment
- Cellular DAS
- Wireless Infrastructure

#### DESCRIPTION

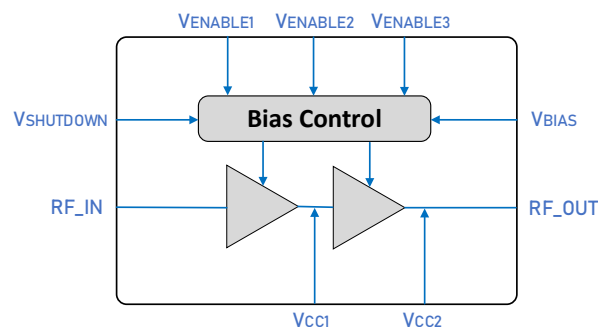
The GRF5526W is a high gain, two-stage InGaP HBT power amplifier designed to deliver excellent P1dB, ACLR and IM3 performance over the 2.2 to 2.7 GHz band. Its exceptional native linearity makes it an ideal choice for transmitter applications that typically do not employ digital predistortion correction schemes.

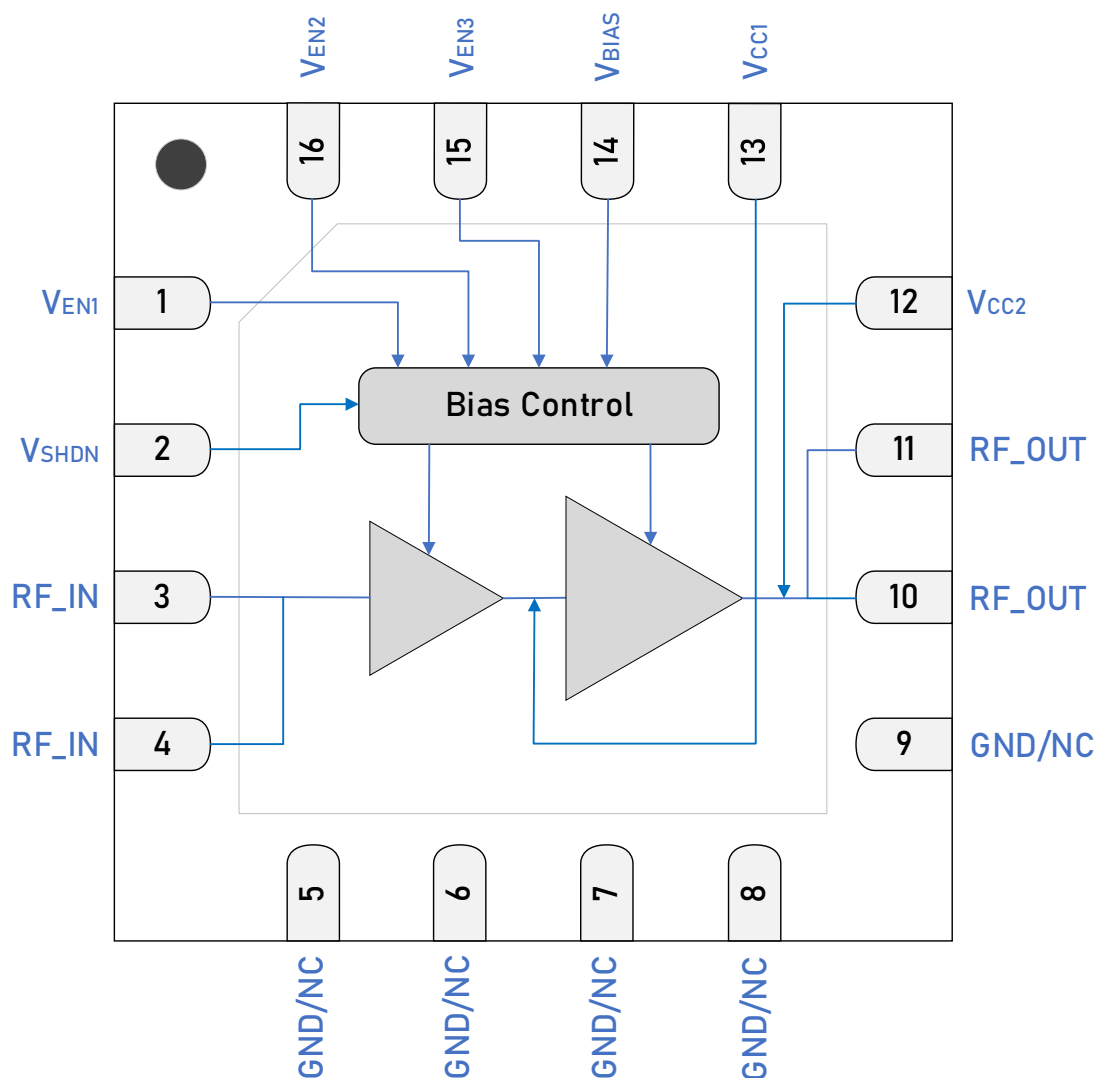
This device is part of a complete family of externally matched linear amplifiers that cover the following frequency ranges:

GRF5506: 0.66 - 0.72 GHz	GRF5518: 1.8 - 2.0 GHz
GRF5507: 0.7 - 0.91 GHz	GRF5519: 1.92 - 2.2 GHz
GRF5508: 0.777 - 0.96 GHz	GRF5521: 2.11 - 2.17 GHz
GRF5510: 0.88 - 0.96 GHz	GRF5526: 2.2 - 2.7 GHz
GRF5517: 1.6 - 1.92 GHz	GRF5536: 3.3 - 4.2 GHz

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

#### BLOCK DIAGRAM





3 x 3 mm QFN-16 Pin Out (Top View)

## Pin Assignments

Pin	Name	Description	Note
1	V <sub>EN1</sub>	Enable1 Voltage Input	V <sub>EN1</sub> and series resistor set I <sub>CCQ</sub> for the input stage. V <sub>EN1</sub> ≤ 0.2 V disables stage 1.
2	V <sub>SHDN</sub>	Digital Shutdown Pin	V <sub>SHDN</sub> ≥ 1.7 V (Logic HIGH) disables device. V <sub>SHDN</sub> ≤ 0.9 V (Logic LOW) enables device.
3, 4	RF_IN	RF Input	Pins 3 & 4 tied together on system board. An external DC blocking cap must be used.
5, 6, 7, 8, 9	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.
10, 11	RF_OUT	PA Output	Pins 10 & 11 tied together on system board.
12	V <sub>CC2</sub>	Bias Voltage	V <sub>CC2</sub> must be applied to this pin via an RF choke.
13	V <sub>CC1</sub>	Bias Voltage	V <sub>CC1</sub> must be applied to this pin via L-C interstage match.
14	V <sub>BIAS</sub>	Bias Circuit Supply	Connect to V <sub>CC2</sub> through external resistor.
15	V <sub>EN3</sub>	Enable3 Voltage Input	Bias Voltage applied via series resistor.
16	V <sub>EN2</sub>	Enable2 Voltage Input	V <sub>EN2</sub> and series resistor set I <sub>CCQ</sub> for the output stage. V <sub>EN2</sub> ≤ 0.2 V disables stage 2.
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.

**Note 1:** GRF5526W and GRF5536W have a common pinout that is slightly different from the pinout shared by all the other GRF55XXW PAs. Please see page 2.

## Truth Table

Pin	Logic	Condition
V <sub>SHDN</sub>	LOW	Full Operation
	HIGH	All Amplifiers Off
V <sub>EN1</sub>	LOW	Stage 1 Amplifier Off
	HIGH	Stage 1 Amplifier On
V <sub>EN2</sub>	LOW	Stage 2 Amplifier Off
	HIGH	Stage 2 Amplifier On
V <sub>EN3</sub>	LOW	Stage 2 Amplifier Off
	HIGH	Stage 2 Amplifier On

## Absolute Ratings

Parameter		Symbol	Min.	Max.	Unit
Supply Voltage		$V_{CC}$	4	5.5	V
RF Input Power	50 $\Omega$ , $V_{CC} = 5$ V, CW Tone, 100% Duty Cycle, $T_{PKG\ BASE} = 25$ °C	$P_{IN\ MAX - 1:1}$		20	dBm
	Load VSWR $\leq 8:1$ , all phase angles, $V_{CC} = 5$ V, CW Tone, 100% Duty Cycle, $T_{PKG\ BASE} = -40$ to 105 °C	$P_{IN\ MAX - 8:1}$		17	
Operating Temperature (package base)		$T_{PKG\ BASE}$	-40	105	°C
Maximum Junction Temperature (MTTF > 10 <sup>6</sup> hours)		$T_{J\ MAX}$		170	°C
Maximum Dissipated Power (Stage 1). DC only (no RF applied).		$P_{DISS\ MAX}$		* 300	mW
Maximum Dissipated Power (Stage 2). DC only (no RF applied).		$P_{DISS\ MAX}$		* 1000	mW
Shutdown Voltage		$V_{SHDN}$		** 5.5	V

## Electrostatic Discharge

Human Body Model	HBM	500		V
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## Storage

Storage Temperature	$T_{STG}$	-65	150	°C
Moisture Sensitivity Level	MSL		1	--

\* Bias resistors M2/M4 have been empirically optimized for linearity. Thus, there will be no benefit in decreasing resistance (thereby increasing  $I_{CCQ}$ ).

\*\* With  $M1 = 0$   $\Omega$ ,  $I_{SHDN}$  increases linearly from  $V_{SHDN}/I_{SHDN} = 1.8V/82\mu A$  to  $4.2V/489\mu A$ .

Said linear relationship can be used to scale M1 for higher  $V_{SHDN}$  voltage: use pin condition  $V_{SHDN\_pin}/I_{SHDN} = 2.4V/178\mu A$ .

Calculate M1 for  $V_{SHDN}/I_{SHDN} = 5V/178\mu A$ :  $M1 = (5-2.4)/(0.000178) = 14.6$  k $\Omega$ .



**Caution! ESD Sensitive Device.**

**Exceeding Absolute Maximum Rating conditions may cause permanent damage.**

Note: For additional information, please refer to [Manufacturing Note MN-001 — Package and Manufacturing Information](#).



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	$V_{CC}$	4	5	5.5	V	
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40		105	°C	
RF Frequency Range	$F_{RF}$	2.2		2.5	GHz	Typical application schematic using the 2.3 to 2.5 GHz tuning set ( <b>note 2</b> ).
	$F_{RF}$	2.5		2.7	GHz	Typical application schematic using the 2.5 to 2.7 GHz tuning set ( <b>note 2</b> ).
RF_IN Port Impedance	$Z_{RFIN}$		50		$\Omega$	Single-ended with 2-element match.
RF_OUT Port Impedance	$Z_{RFOUT}$		50		$\Omega$	Single-ended with 2-element match.

**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 2.5 to 2.7 GHz tuning set.  $V_{CC} = +4.75$  to  $+5.25$  V,  $V_{SHDN} =$  LOW,  $I_{CCQ} = 150$  mA,  $P_{OUT} = +23$  dBm,  $F_{TEST} = 2.6$  GHz,  $M2 = 6810\ \Omega$ ,  $M4 = 4750\ \Omega$ ,  $M10 = 1200\ \Omega$ ,  $50\ \Omega$  system impedance,  $T_{PKG\ BASE} = -40$  to  $105\ ^\circ\text{C}$ . Typical values are at  $V_{CC} = 5$  V,  $I_{CCQ} = 150$  mA,  $P_{OUT} = +23$  dBm,  $F_{TEST} = 2.6$  GHz,  $T_{PKG\ BASE} = 25\ ^\circ\text{C}$ . Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Quiescent Current	$I_{CCQ}$		150		mA	$I_{CCQ1} + I_{CCQ2}$ . No RF applied.
Supply Current with RF Applied	$I_{CC}$		250		mA	$I_{CC1} + I_{CC2}$ . RF Applied with $P_{OUT} = +23$ dBm.
Enable Current 1	$I_{ENABLE1}$		0.2		mA	$V_{CC} = 5$ V.
Enable Current 2	$I_{ENABLE2}$		0.35		mA	$V_{CC} = 5$ V.
Enable Current 3	$I_{ENABLE3}$		0.8		mA	$V_{CC} = 5$ V.
Operating Temperature Range	$T_{PKG\ BASE}$	-40		105	$^\circ\text{C}$	Measured on package base.
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	$I_{IL}$		3		nA	Applies to $V_{SHDN}$ Input, $V_{IL} = 0.9$ V.
Logic Current High	$I_{IH}$		80		$\mu\text{A}$	Applies to $V_{SHDN}$ Input, $V_{IH} = 1.8$ V.
			320			Applies to $V_{SHDN}$ Input, $V_{IH} = 3.3$ V.
Switching Rise Time	$T_{RISE}$		80		ns	Applies to $V_{SHDN}$ Input.
Switching Fall Time	$T_{FALL}$		10		ns	Applies to $V_{SHDN}$ Input.

### Disabled Mode

Supply Quiescent Current	$I_{CCQ-SHDN}$		240		$\mu\text{A}$	$V_{CC} = 5$ V, $V_{SHDN}/V_{EN1}/V_{EN2}/V_{EN3} = \text{HIGH}$ .
Enable Current 1	$I_{ENABLE1-SHDN}$		0.45		mA	$V_{CC} = 5$ V, $V_{SHDN}/V_{EN1}/V_{EN2}/V_{EN3} = \text{HIGH}$ .
Enable Current 2	$I_{ENABLE2-SHDN}$		0.8		mA	$V_{CC} = 5$ V, $V_{SHDN}/V_{EN1}/V_{EN2}/V_{EN3} = \text{HIGH}$ .
Enable Current 3	$I_{ENABLE3-SHDN}$		3.4		mA	$V_{CC} = 5$ V, $V_{SHDN}/V_{EN1}/V_{EN2}/V_{EN3} = \text{HIGH}$ .

### Thermal Data (Stage 1 and Stage 2)

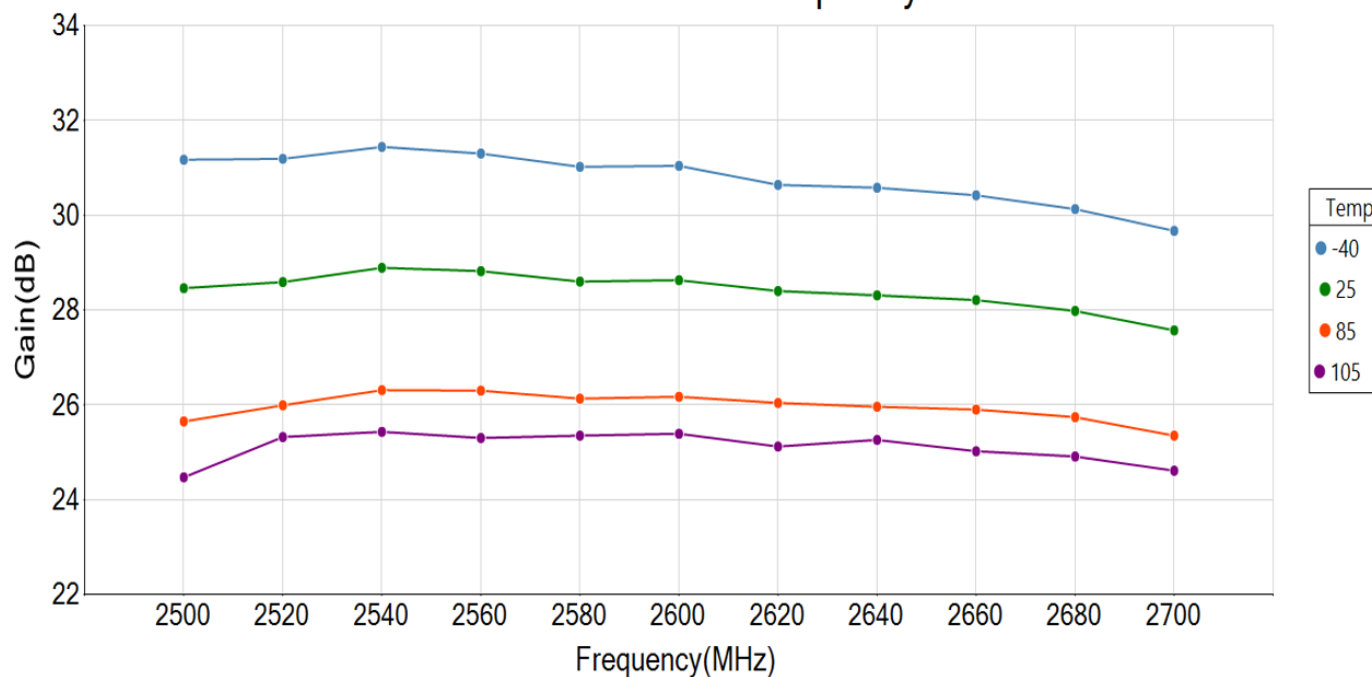
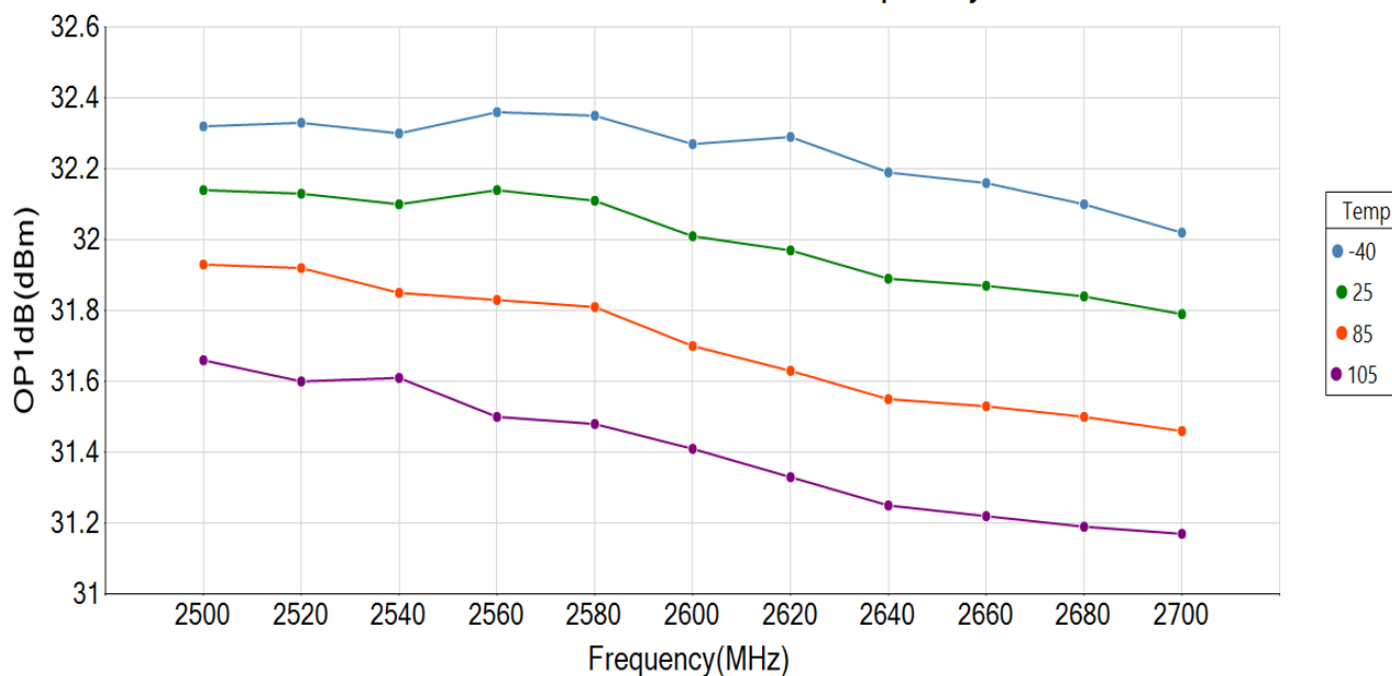
See plot of junction temperature vs. output power						On standard evaluation board.
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## Nominal Operating Parameters – RF: 2.5 to 2.7 GHz, 5 V

The following conditions apply unless noted otherwise: typical application schematic using the 2.5 to 2.7 GHz tuning set.  $V_{CC} = +4.75$  to  $+5.25$  V,  $V_{SHDN} = \text{LOW}$ ,  $I_{CCQ} = 150$  mA,  $P_{OUT} = +23$  dBm,  $F_{TEST} = 2.6$  GHz,  $M2 = 6810\ \Omega$ ,  $M4 = 4750\ \Omega$ ,  $M10 = 1200\ \Omega$ ,  $50\ \Omega$  system impedance,  $T_{PKG\ BASE} = -40$  to  $105\ ^\circ\text{C}$ . Typical values are at  $V_{CC} = 5$  V,  $I_{CCQ} = 150$  mA,  $P_{OUT} = +23$  dBm,  $F_{TEST} = 2.6$  GHz,  $T_{PKG\ BASE} = 25\ ^\circ\text{C}$ . Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Small Signal Gain	S21	27	28.5		dB	LTE 20MHz 100RB TM1.1 Downlink Waveform with 9.6 dB PAR, $F_{TEST} = 2.6$ GHz, $V_{CC} = 5$ V, $P_{IN} = -25$ dBm.
Standby Mode Gain	S21 <sub>STBY</sub>		-33.5		dB	Disabled Mode, LTE 20MHz 100RB TM1.1 Downlink Waveform with 9.6 dB PAR, $V_{SHDN}/V_{EN1}/V_{EN2} = \text{HIGH}$ , $P_{IN} = 0$ dBm.
Input Return Loss	S11		< -7		dB	$F_{RF} = 2.5$ to $2.7$ GHz
Output Return Loss	S22		< -5		dB	$F_{RF} = 2.5$ to $2.7$ GHz
Reverse Isolation	S12		< -40		dB	$F_{RF} = 2.5$ to $2.7$ GHz
Noise Figure	NF		3		dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		45		dBm	+23 dBm $P_{OUT}$ per tone using 600 kHz spacing.
Output 1 dB Compression Power	OP1dB		32		dBm	$V_{CC} = 5$ V, Sine wave input.
2 <sup>nd</sup> Harmonic	2f <sub>0</sub>			-23	dBc	$P_{OUT} = 26$ dBm. <b>Note 3.</b>
3 <sup>rd</sup> Harmonic	3f <sub>0</sub>			-43	dBc	$P_{OUT} = 26$ dBm. <b>Note 3.</b>
Adjacent Channel Leakage Ratio	ACLR		-45		dBc	$P_{OUT} = +23$ dBm, LTE 20MHz 100RB TM1.1 Downlink Waveform with 9.6 dB PAR, $F_{TEST} = 2.6$ GHz, $V_{CC} = 5$ V.

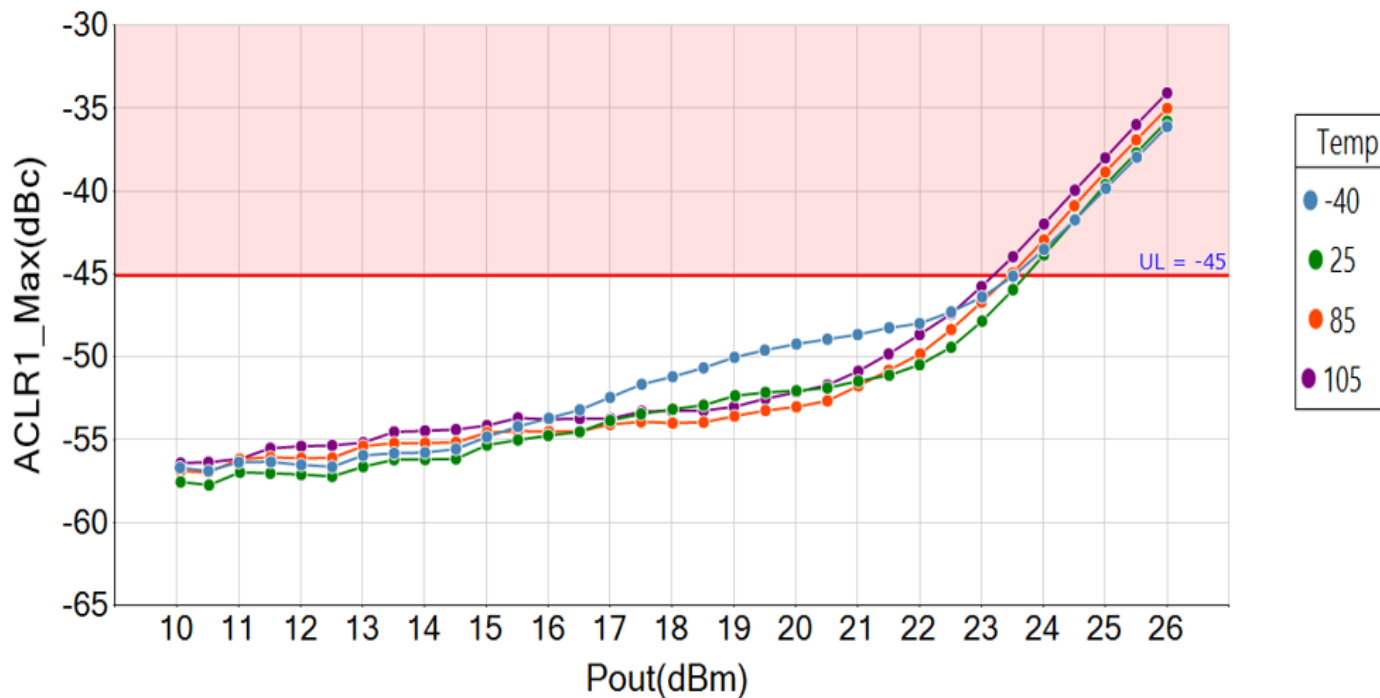
**Note 3:** Min/Max limits defined using *modelled estimates* that account for part-to-part variations and expected process spreads. As additional production lots are fabricated, accumulated test data will be used to refine the Min/Max limits.

**GRF5526W Typical Operating Curves: 2.5 to 2.7 GHz Tune**
**GRF5526 Gain vs Frequency**

**GRF5526 OP1dB vs Frequency**




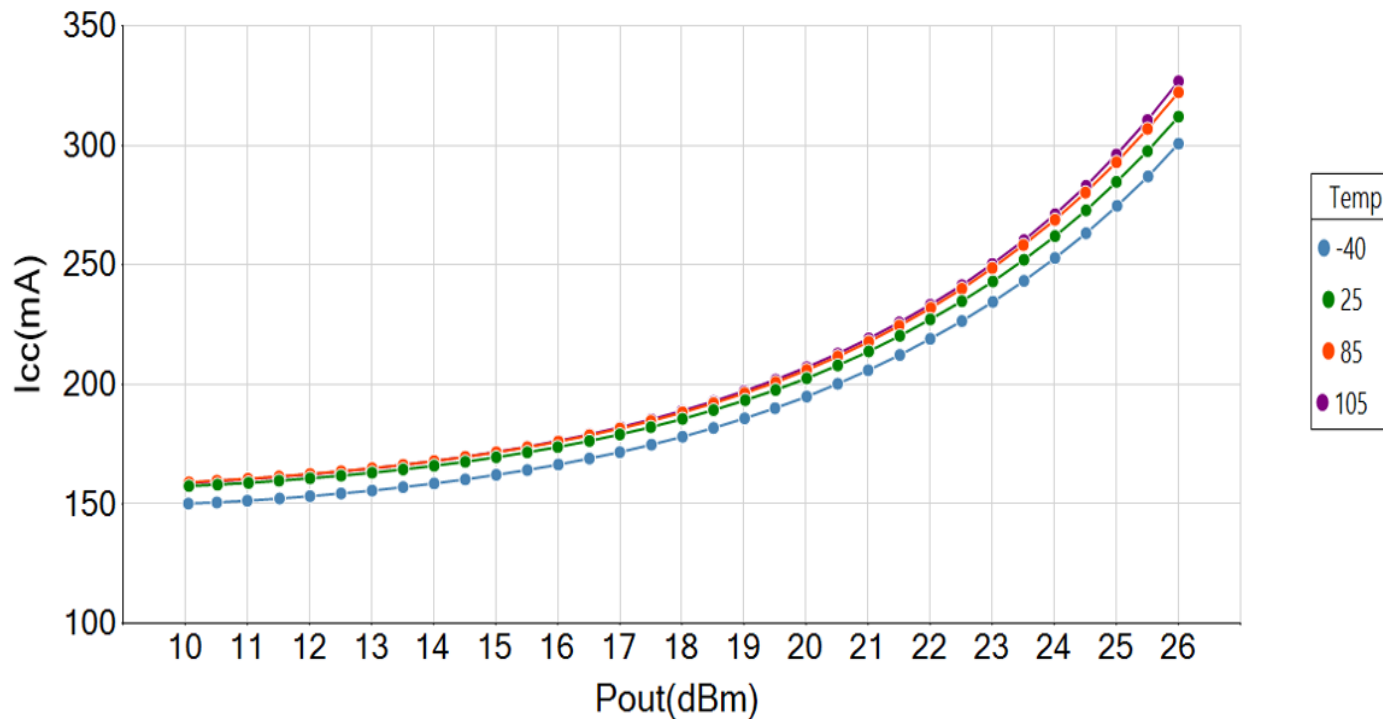
**GRF5526W Typical Operating Curves: ACLR vs.  $P_{OUT}$  (LTE 20Q100RB TM1.1 9.6 dB PAR)**

GRF5526 ACLR1 vs Pout at Frequency = 2570 MHz and Modulation = LTE\_20MHz\_100RB



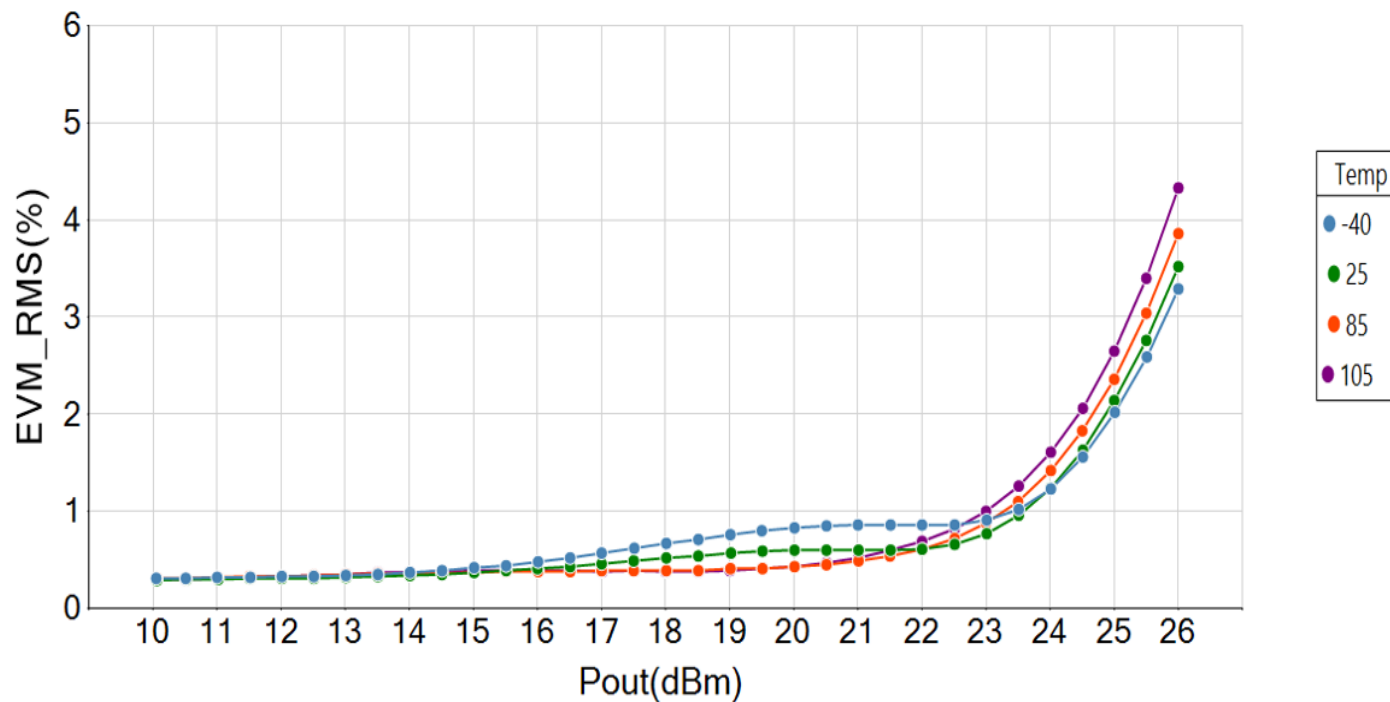
**GRF5526W Typical Operating Curves: Stage 1 + Stage 2  $I_{CC}$  vs.  $P_{OUT}$  (LTE 20Q100RB TM1.1 9.6 dB PAR)**

GRF5526  $I_{CC}$  vs  $P_{OUT}$  at Frequency = 2570 MHz and Modulation = LTE\_20MHz\_100RB

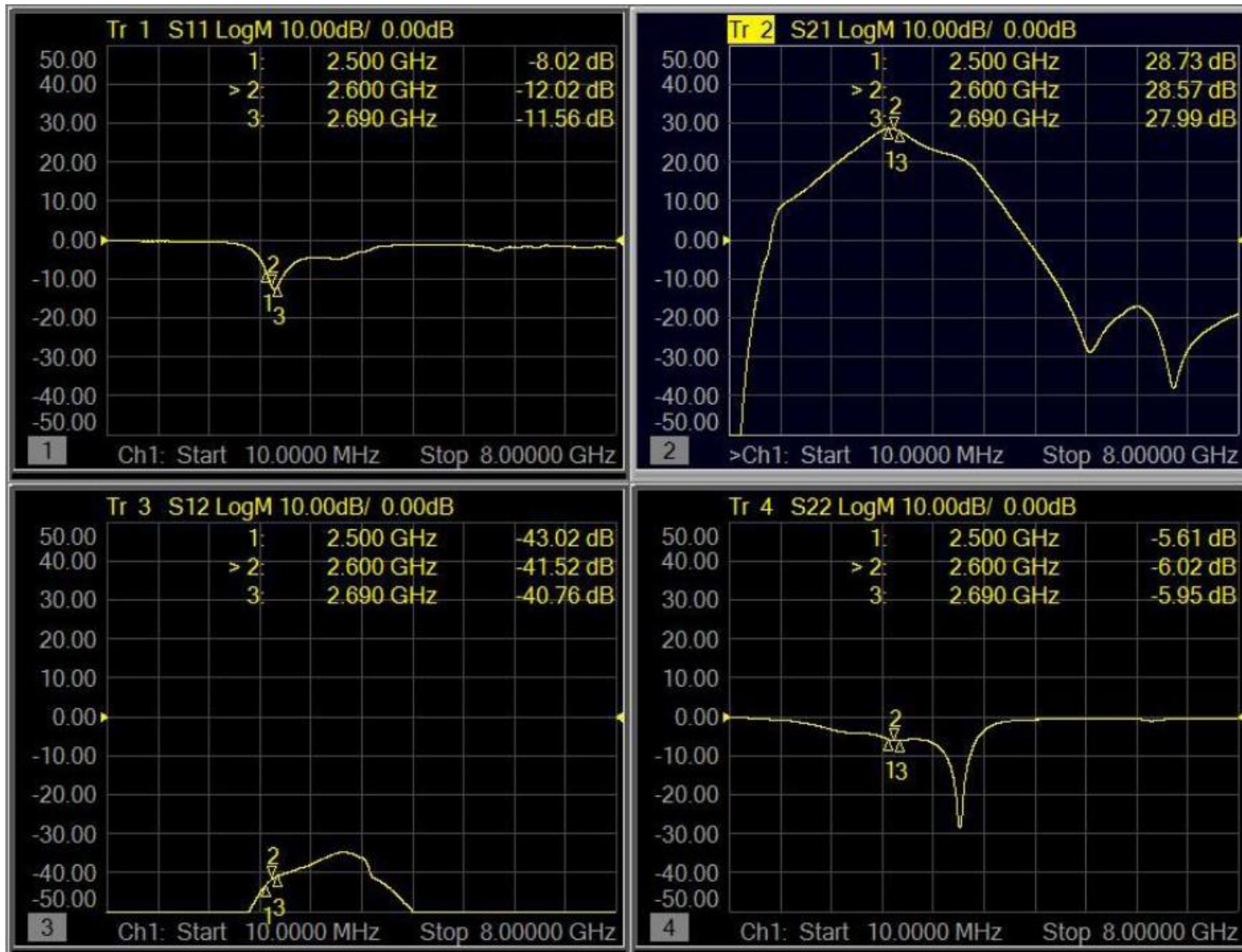


**GRF5526W Typical Operating Curves: EVM vs. P<sub>OUT</sub> (LTE 20Q100RB TM1.1 9.6 dB PAR)**

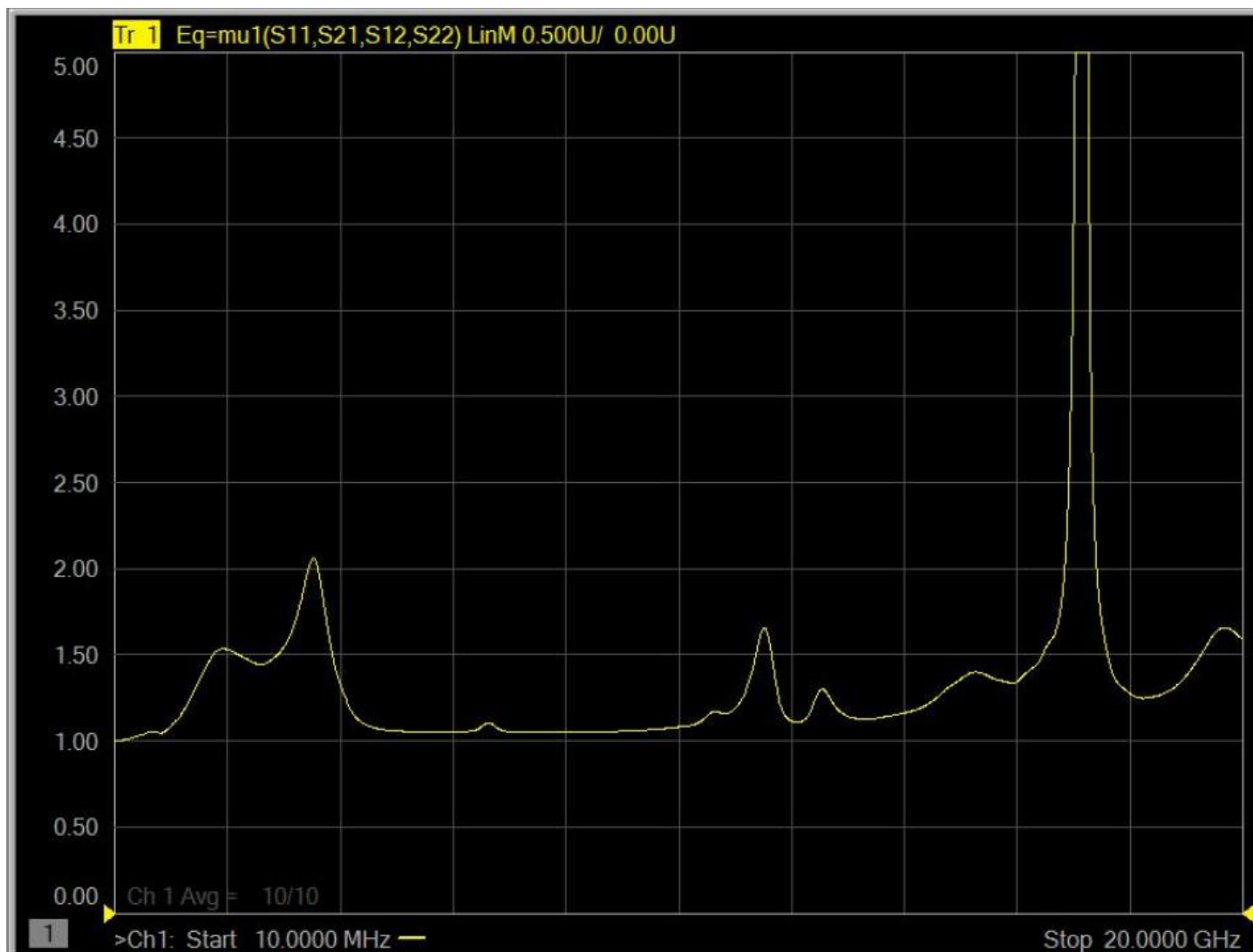
GRF5526 EVM\_RMS vs Pout at Frequency = 2570 MHz and Modulation = LTE\_20MHz\_100RB



### GRF5526W Typical Operating Curves: S-Parameters (2.5 to 2.7 GHz Tune)



**GRF5526W Typical Operating Curves: Stability Mu (10 MHz to 20 GHz)**



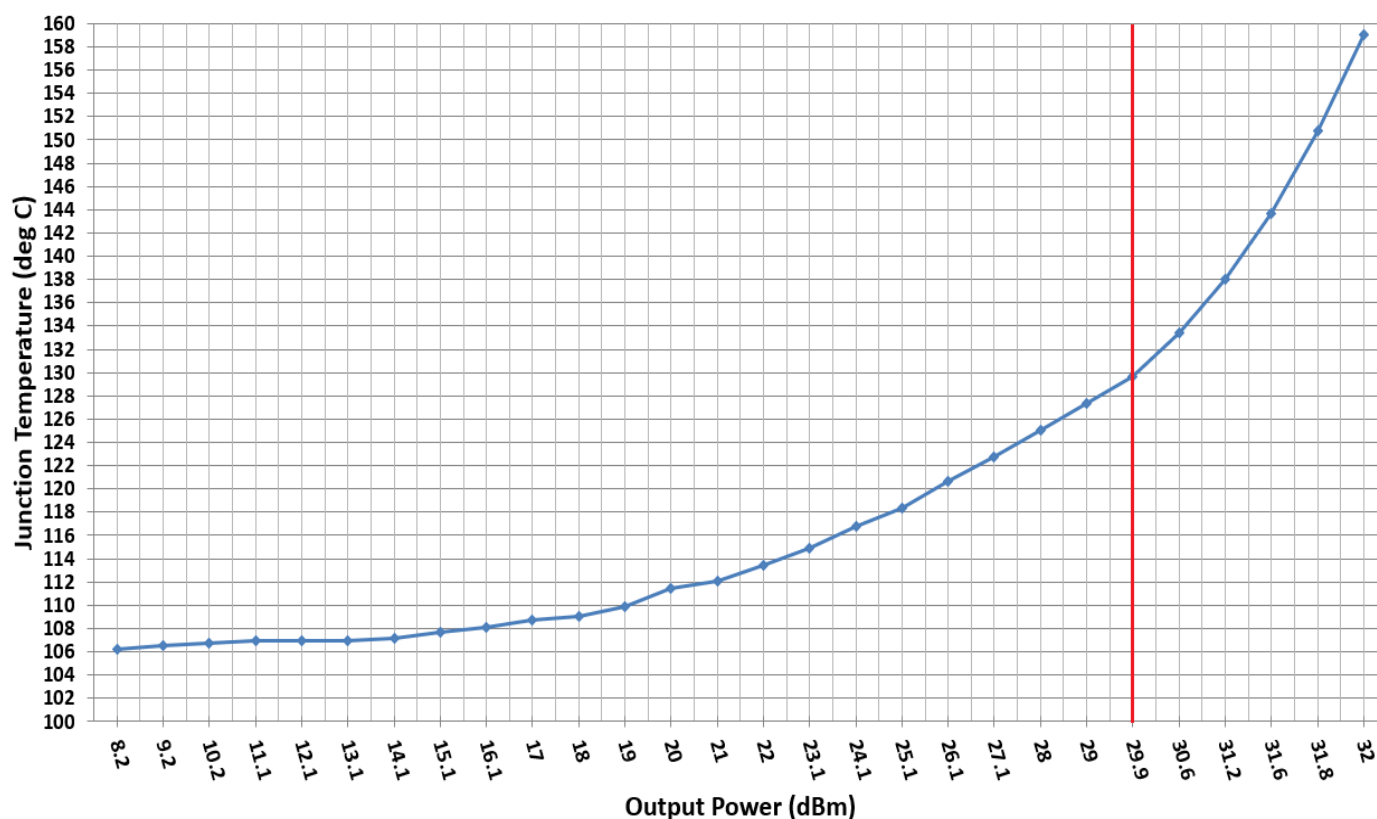
**Note:** Mu factor  $\geq 1.0$  implies unconditional stability

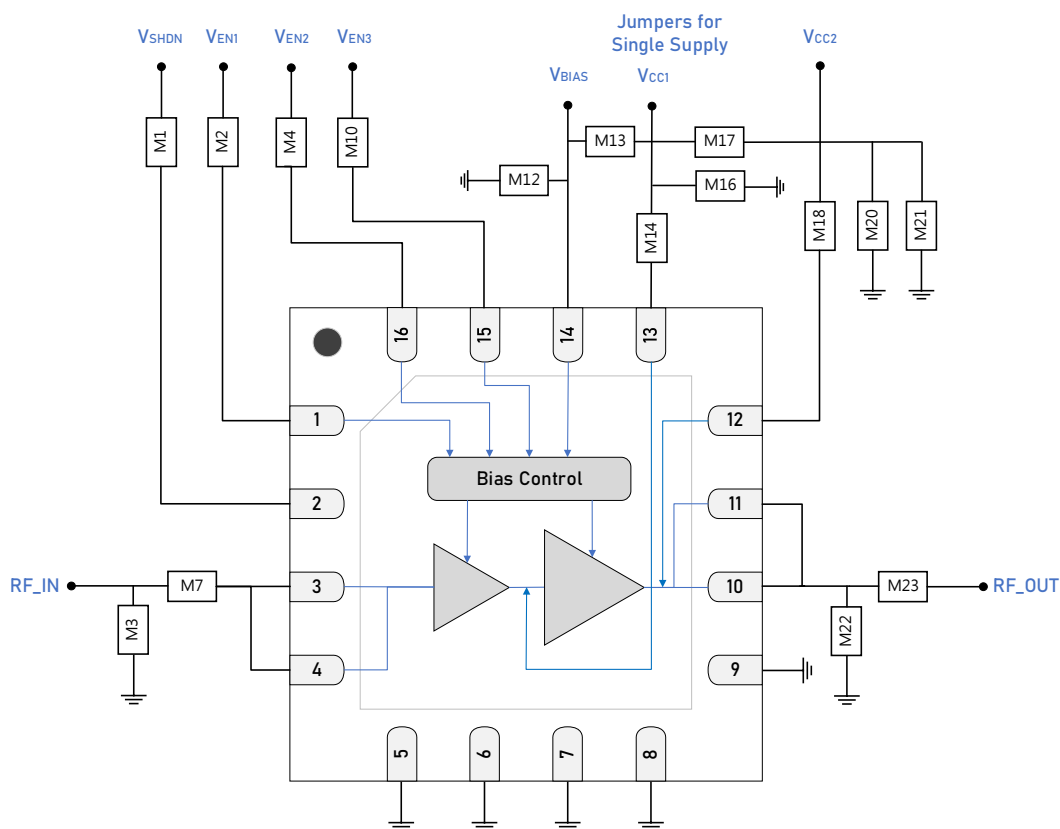
## GRF5526W Typical Operating Curves: Junction Temperature (per application schematic @ 85 °C)

GRF5526W, being a 2-stage device, sees one of the stages governing junction temperature over power sweep. Red line = 30 dBm shows where  $T_J$  is equivalent in both stages. At left of red line, stage 2 governs  $T_J$  ( $Q_2 T_J$  is higher). To the right of red line, stage 1 governs  $T_J$  ( $Q_1 T_J$  is higher).

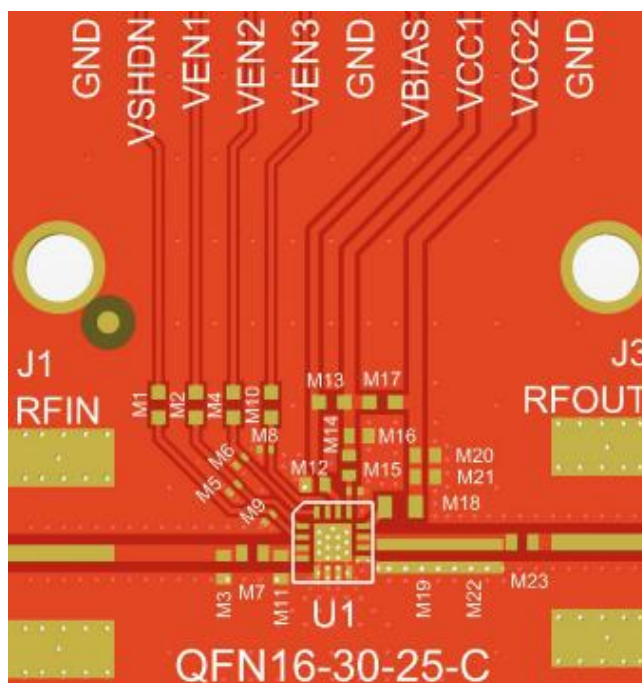
Setting bias resistor M2/M4 per application schematic ensures best linearity and yields thermal performance shown in the plot. If the application does not require high IMD3/ACLR linearity, bias resistor can be adjusted higher. This will lower bias point(s) and junction temperature will be contained within/below that shown in the plot.

GRF5526





**GRF5526W Standard Evaluation Board Schematic**



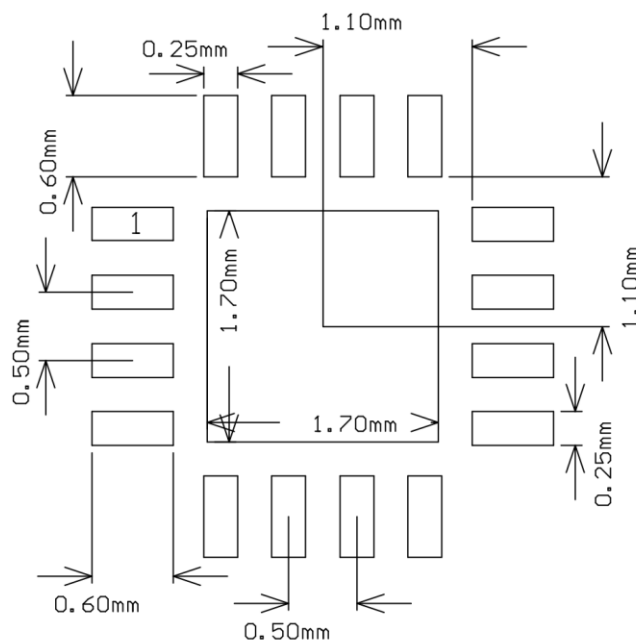
**GRF5526W Evaluation Board Assembly Diagram**

**GRF5526W Evaluation Board Assembly Diagram Reference**

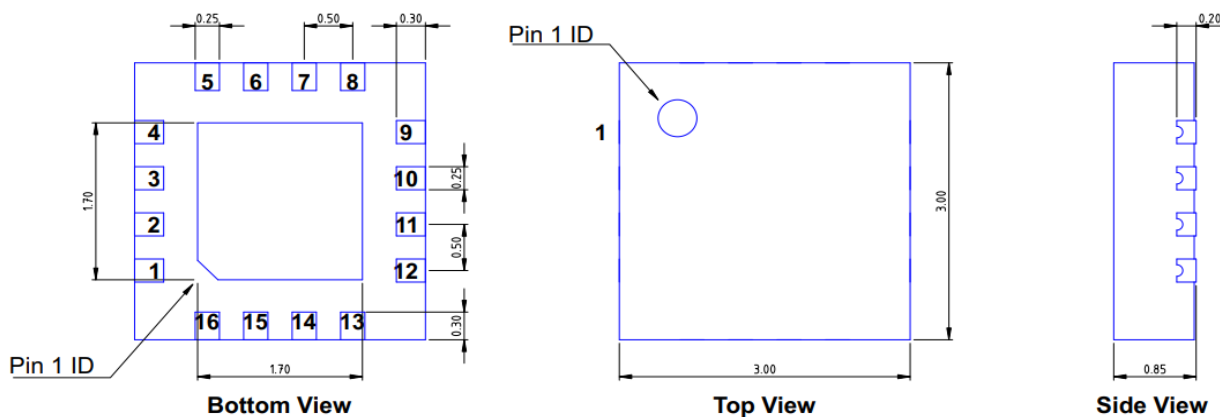
Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M1	Resistor	Various	--	0 $\Omega$	0402	ok
M2	Resistor	Various	1%	6810 $\Omega$	0402	ok
M3	Inductor	Murata	LQGWH	1.1 nH	0402	ok
M4	Resistor	Various	1%	4750 $\Omega$	0402	ok
M7	Capacitor	Murata	GJM	1.3 pF	0402	ok
M10	Resistor	Various	1%	1200 $\Omega$	0402	ok
M12	Capacitor	Murata	GRM	4.7 $\mu$ F	0402	ok
M13	Resistor (jumper)	Various	--	0 $\Omega$	0402	ok
M14	Inductor	Murata	LQW	1.7 nH	0402	ok
M16	Capacitor	Murata	GRM	4.7 $\mu$ F	0402	ok
M17	Resistor (jumper)	Various	--	0 $\Omega$	0402	ok
M18	Inductor	Murata	LQW	4.3 nH	0603	ok
M20	Capacitor	Murata	GRM	4.7 $\mu$ F	0402	ok
M21	Capacitor	Murata	GRM	100 pF	0402	ok
M22	Capacitor	Murata	GJM	1.3 pF	0402	ok
M23	Capacitor	Murata	GJM	10 pF	0402	ok
Evaluation Board	QFN16-30-25-C					

**Note 4:** Standard evaluation board bias:  $V_{CC} = 5$  V,  $V_{ENABLE} = 5$  V.





**3 x 3 mm QFN-16 Suggested PCB Footprint (Top View)**



**QFN16 3x3mm**  
Dimensions in millimeters  
Dimensional Tolerance:  $\pm 0.05$

**3 x 3 mm QFN-16 Package Dimensions**

## Package Marking Diagram



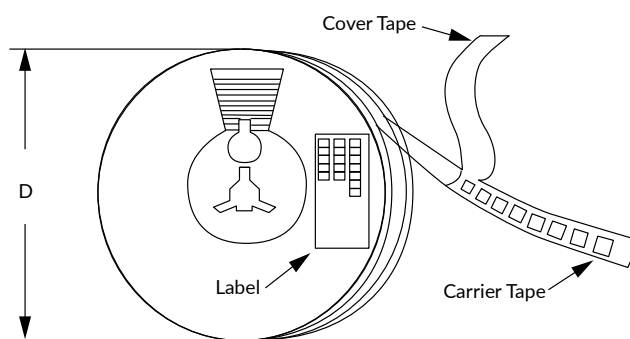
- Line 1: "YY" = YEAR. "WW" = WORK WEEK the device was assembled.
- Line 2: "GRF" = Guerrilla RF.
- Line 3: "XXXX" = Device PART NUMBER and "W" = W for automotive.

## Tape and Reel Information

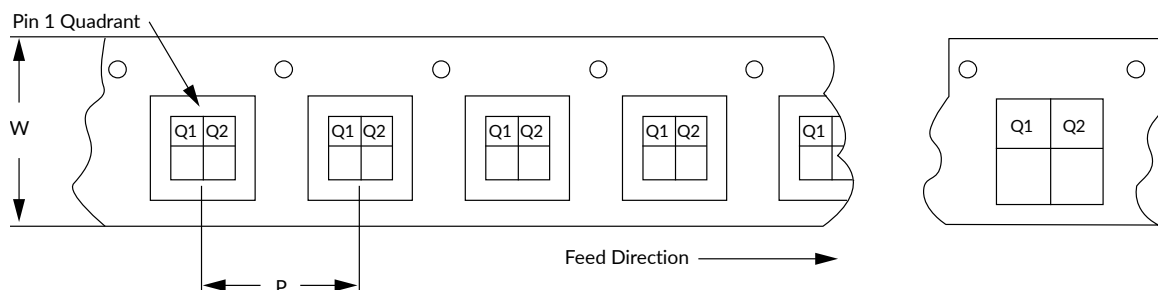
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, 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: <https://www.guerrilla-rf.com/prodFiles/Manufacturing/MN001.pdf>



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
October 3, 2022	Preliminary Data Sheet.
November 1, 2022	Added Characterization Plots, Added new S-parameter and Mu Plots.
January 27, 2023	In Absolute Ratings Table: Added the following condition to Maximum Dissipated Power for Stage 1 & 2: DC only (no RF applied). Changed Stage 1 Maximum Dissipated Power from TBD to 500 mW. Changed Stage 2 Maximum Dissipated Power from TBD to 1400 mW.
June 6, 2023	Release Ø Data Sheet.
September 19, 2023	Release A Data Sheet. AEC-Q100 Grade 2 Qualification completed.
October 12, 2023	Release B Data Sheet. Added 2 <sup>nd</sup> and 3 <sup>rd</sup> Harmonics specifications.
January 17, 2025	Updated Data Sheet with cosmetic changes only. No change to device or device specifications.
May 12, 2025	Extended lower frequency range from 2.3 to 2.2 GHz. Updated frequency of family of part numbers listed on page 1.



## 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.

Information in this data sheet is specific to the Guerrilla RF, Inc. ("Guerrilla RF") product identified.

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