DATA SHEET

GRF5226
HIGH GAIN LINEAR DRIVER
2.3 to 2.7 GHz

PRELIMINARY DATA SHEET

FEATURES

- Gain Flatness < 1 dB
- Excellent Linearity Performance Over Wide Bandwidths
- Flexible Biasing Provides Latitude for Linearity Optimization
- 105 mA Native Mode Quiescent Current Consumption
- 50 Ω Single-ended Input and Output Impedances
- -40 to 115 °C Operating Temperature Range
- Compact 3 x 3 mm QFN-16 Package

Reference: 5 V / 105 mA / 2.5 GHz

- Gain: 41.5 dB
- OP1dB: 29.8 dBm
- OIP3: 37 dBm
- NF: 4.1 dB

APPLICATIONS

- Linear Driver / Pre-Driver Amplifiers
- 5G Sub-6 GHz Massive MIMO Base Stations
- Small Cells and Cellular Repeaters
- Millimeter Wave IF Stages
- High-Performance RF Infrastructure

ORDERING INFORMATION

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DESCRIPTION

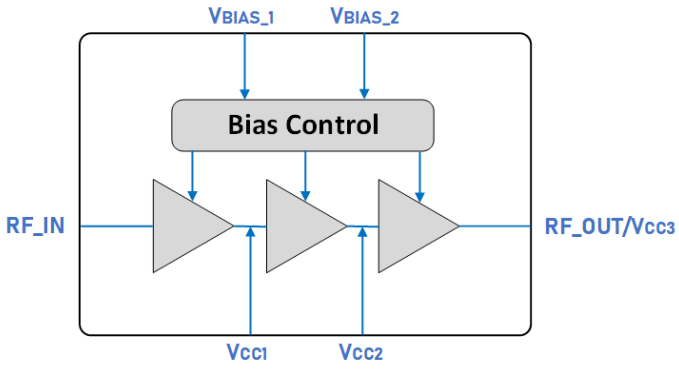
The GRF5226 is a high-gain, three-stage driver amplifier targeting 2.3 to 2.7 GHz wireless infrastructure applications. The device delivers up to 29.8 dBm of OP1dB, 37 dBm of OIP3, and a low noise figure (NF) of less than 4.1 dB over its targeted band of operation.

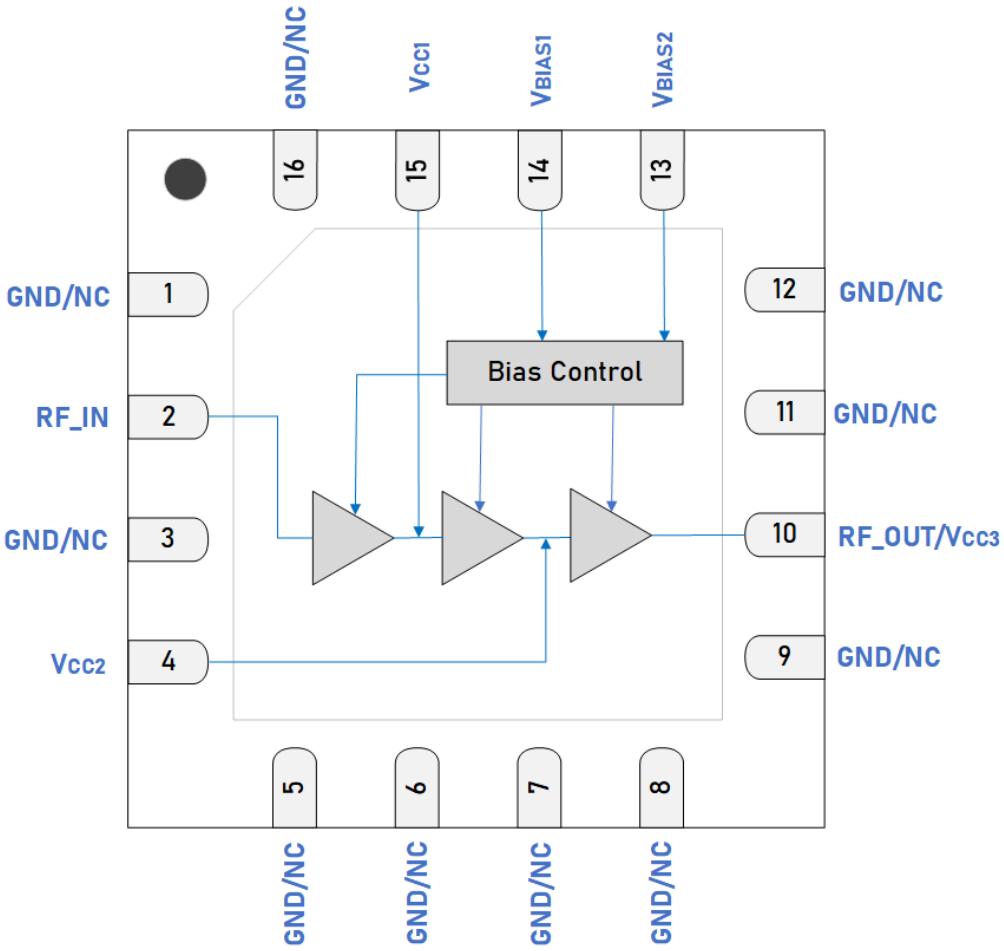
For optimal efficiency and linearity, the amplifier was designed to operate with a single 5 V supply voltage while using only 85-105 mA of quiescent current. 3.3 V supplies can also be used while still yielding 26.3 dBm of OP1dB. If desired, I_{CCQ} can be increased beyond the native biasing point for enhanced linearity performance.

The GRF5226 is designed for 50 Ω systems, typically needing only a two-element shunt-series match on the output port.

Additional tunes can be found on the GRF5226 “Custom Tunes” product page: GRF5226 Custom Tunes

BLOCK DIAGRAM





Pin Out (Top View)

Pin Assignments

Pin	Name	Description	Note
2	RF_IN	RF Input	The RF input is fully matched to 50Ω, and it contains internal DC blocking capacitor.
1, 3, 5, 6, 7, 8, 9, 11,12, 16	GND/NC	Ground or No Connect	No internal connection. These pins can be left unconnected, or be connected to the ground (recommended). Use a via as close to the pin as possible if grounded.
4	V_{CC2}	V_{CC} Bias Voltage	Pull up to V_{CC} through inductor and use bypass capacitors as close to the pin as possible. In addition to supplying the device with a DC voltage, there is also an RF signal present.
10	RF_OUT/V_{CC3}	RF Output/V_{CC3} Bias Voltage	V_{CC} must be applied through a choke to this pin.
13	V_{BIAS2}	Second Bias Set	Connect via resistor to a common V_{CC}. V_{BIAS2} and series resistor sets I_{CCQ3}. Setting $V_{BIAS2} \leq 0.2$ V will disable the final stage of the device.
14	V_{BIAS1}	First Bias Set	Connect via resistor to a common V_{CC}. V_{BIAS1} and series resistor set I_{CCQ1} and I_{CCQ2}. Setting $V_{BIAS1} \leq$ 0.2 V will disable the 1st and 2nd stage of the device.
15	V_{CC1}	V_{CC} Bias Voltage	Connect to a common V_{CC}. Place bypass capacitors as close to the pin as possible.
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 the schematic page.

Absolute Ratings

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	V_{CC}	3	5.5	V
RF Input Power: Load VSWR ≤ 2:1, all phase angles, V_{CC} = 5 V, CW Tone, 100% Duty Cycle, $T_{PKG\ BASE}$ = -40 to 115 °C	$P_{IN\ MAX}$		21	dBm
Operating Temperature (Package Base)	$T_{PKG\ BASE}$	-40	115	°C
Maximum Channel Temperature (MTTF > 10^6 Hours)	T_{MAX}		190	°C
Maximum Dissipated Power Stage 1 (DC only, no RF applied)	$P_{DISS\ MAX}$		TBD	mW
Maximum Dissipated Power Stage 2 (DC only, no RF applied)	$P_{DISS\ MAX}$		TBD	mW
Maximum Dissipated Power Stage 3 (DC only, no RF applied)	$P_{DISS\ MAX}$		TBD	mW
Electrostatic Discharge				
Human Body Model	HBM	500		V
Charged Device Model	CDM	750		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.

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Recommended Operating Conditions

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{CC}	3	5	5.5	V	
Operating Temperature (Package Base)	$T_{PKG\ BASE}$	-40		115	°C	
RF Frequency Range	F_{RF}	2.3		2.7	GHz	**Notes 1 & 2.**
RF_IN Port Impedance	Z_{RFIN}		50		Ω	
RF_OUT Port Impedance	Z_{RFOUT}		50		Ω	

Note 1: Operation outside of this range is supported by using different custom tunes. Examples of other optimized tunes can be found here: GRF5226 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 2.3 to 2.7 GHz tuning set. R_{BIAS1} = 453 Ω and R_{BIAS2} = 2940 Ω, V_{CC} = 5 V, 50 Ω system impedance, P_{OUT} = 4 dBm, F_{TEST} = 2.5 GHz, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
V_{BIAS1} Logic Input Low	V_{IL}	0		0.2	V	Measured at V_{BIAS1} node (with bias-setting resistor in line between node and pin 14).
V_{BIAS1} Logic Input High	V_{IH}	1.5		V_{CC}	V	
V_{BIAS2} Logic Input Low	V_{IL}	0		0.2	V	Measured at V_{BIAS2} node (with bias-setting resistor in line between node and pin 13).
V_{BIAS2} Logic Input High	V_{IH}	1.5		V_{CC}	V	
V_{BIAS1} Logic Low Current	I_{IL}		20		nA	V_{BIAS1}=0.2 V.
V_{BIAS1} Logic High Current	I_{IH}		5.7		mA	V_{BIAS1}=5 V.
V_{BIAS2} Logic Low Current	I_{IL}		30		nA	V_{BIAS2}=0.2 V.
V_{BIAS2} Logic High Current	I_{IH}		0.7		mA	V_{BIAS2}=5 V.
Switching Rise Time	$t_{STBY-RISE}$		200		ns	Turn ON time: V_{BIAS1} & V_{BIAS2} LOW to HIGH **(note 3).**
Switching Fall Time	$t_{STBY-FALL}$		20		ns	Turn OFF time: V_{BIAS1} & V_{BIAS2} HIGH to LOW **(note 4).**

Note 3: Switching Time: 50% of V_{BIAS} to 90% of P_{OUT}.

Note 4: Switching Time: 50% of V_{BIAS} to 10% of P_{OUT}.

Disabled Mode

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Standby Current	I_{STBY}		150		nA	V_{CC}=5 V. V_{BIAS1}=V_{BIAS2}=0.2 V.

Nominal Operating Parameters - General (continued)

Thermal Data

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
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_{CC}=5 V. I_{CCQ}=115 mA. P_{DISS}= 600 mW. No RF applied **(note 5)**.

Note 5: MTTF >10^6 hours for $T_{CHANNEL}$ ≤190 °C.

Nominal Operating Parameters - RF

2.3 to 2.7 GHz, 5 V Supply

The following conditions apply unless noted otherwise: typical application schematic using the 2.3 to 2.7 GHz tuning set, V_{CC} = 5 V, R_{BIAS1} = 453 Ω and R_{BIAS2} = 2940 Ω, F_{TEST} = 2.5 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.		
Supply Quiescent Current	I_{CCQ}		105		mA	
Supply Current with RF Applied	I_{CC}		127		mA	P_{OUT}=14 dBm.
Gain	S21		41.2		dB	
Gain Flatness	$S21_{FLAT}$		1		dB	F_{RF}=2.3 to 2.7 GHz
Standby Mode Gain	$S21_{STBY}$		-46		dB	V_{BIAS1} < 0.2 V, V_{BIAS2} < 0.2 V.
Input Return Loss	S11		-13		dB	F_{RF}=2.3 to 2.7 GHz
Output Return Loss	S22		-7		dB	F_{RF}=2.3 to 2.7 GHz
Reverse Isolation	S12		-55		dB	F_{RF}=2.3 to 2.7 GHz
Noise Figure	NF		4.1		dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		37		dBm	4 dBm P_{OUT} per tone at 2 MHz spacing.
Output 1 dB Compression Power	OP1dB		29.8		dBm	

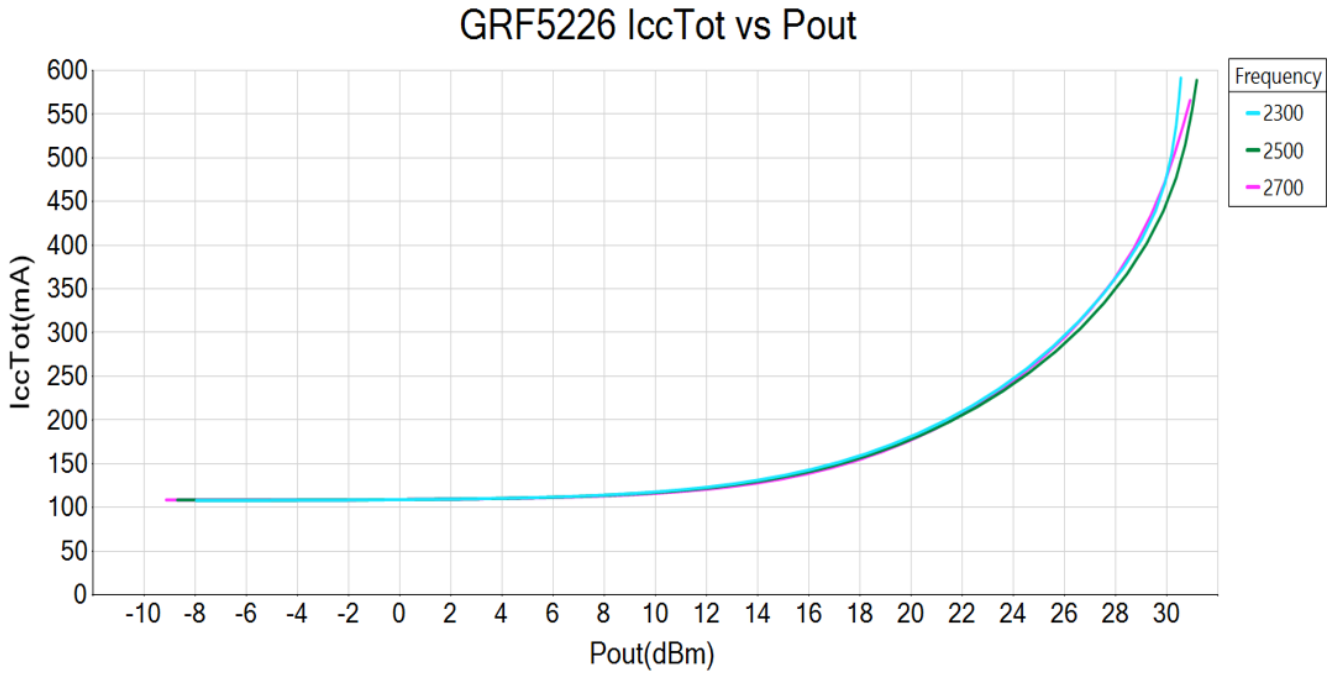
Nominal Operating Parameters - RF

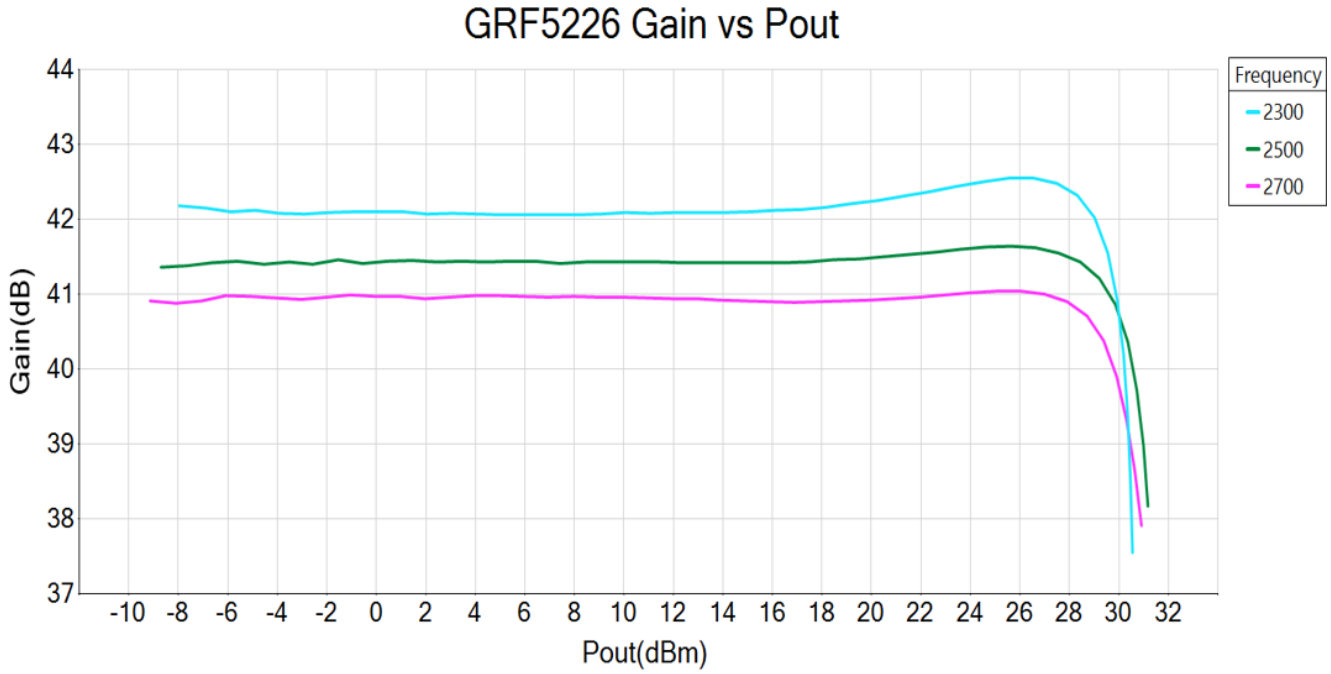
2.3 to 2.7 GHz, 3.3 V Supply

The following conditions apply unless noted otherwise: typical application schematic using the 2.3 to 2.7 GHz tuning set, V_{CC} = 3.3 V, R_{BIAS1} = 453 Ω and R_{BIAS2} = 2940 Ω, F_{TEST} = 2.5 GHz, 50 Ω system impedance, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

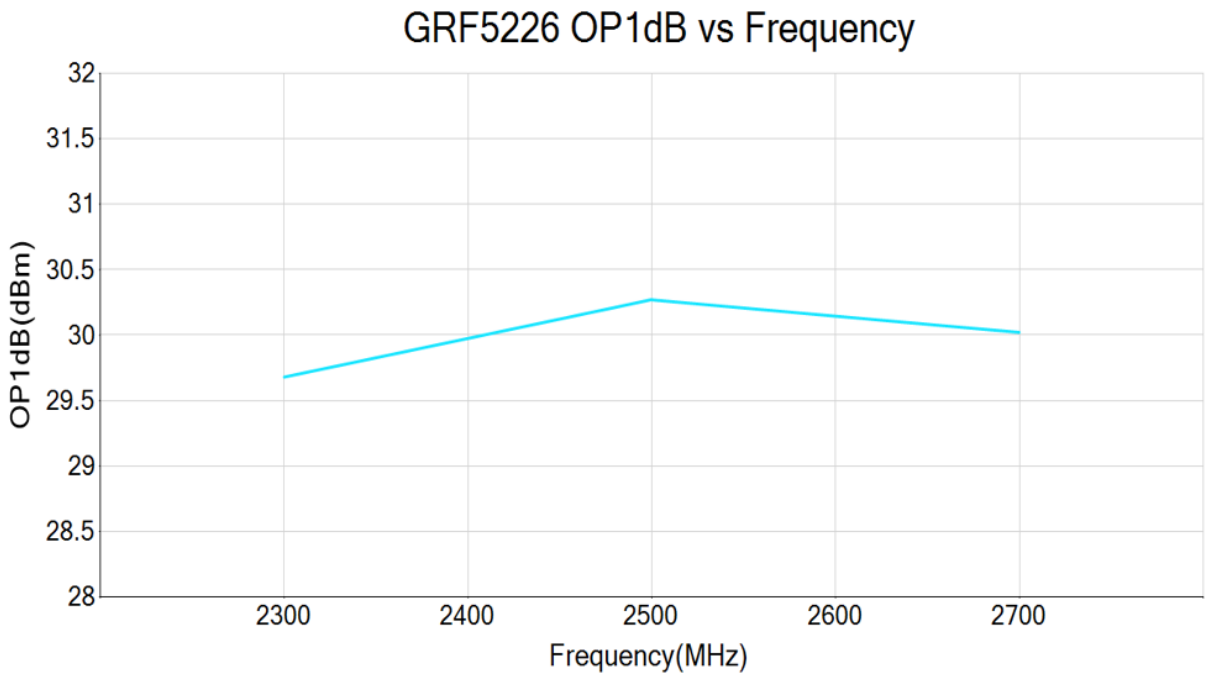
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Quiescent Current	I_{CCQ}		96		mA	
Supply Current with RF Applied	I_{CC}		116		mA	P_{OUT}=14 dBm
Gain	S21		41.8		dB	
Gain Flatness	$S21_{FLAT}$		1		dB	F_{RF}=2.3 to 2.7 GHz
Standby Mode Gain	$S21_{STBY}$		-46		dB	V_{BIAS1} < 0.2 V, V_{BIAS2} < 0.2 V.
Input Return Loss	S11		-13		dB	F_{RF}=2.3 to 2.7 GHz
Output Return Loss	S22		-7		dB	F_{RF}=2.3 to 2.7 GHz
Reverse Isolation	S12		-55		dB	F_{RF}=2.3 to 2.7 GHz
Noise Figure	NF		4.1		dB	On standard evaluation board.
Output 3rd Order Intercept Point	OIP3		38.5		dBm	4 dBm P_{OUT} per tone at 2 MHz spacing.
Output 1 dB Compression Power	OP1dB		26.2		dBm	

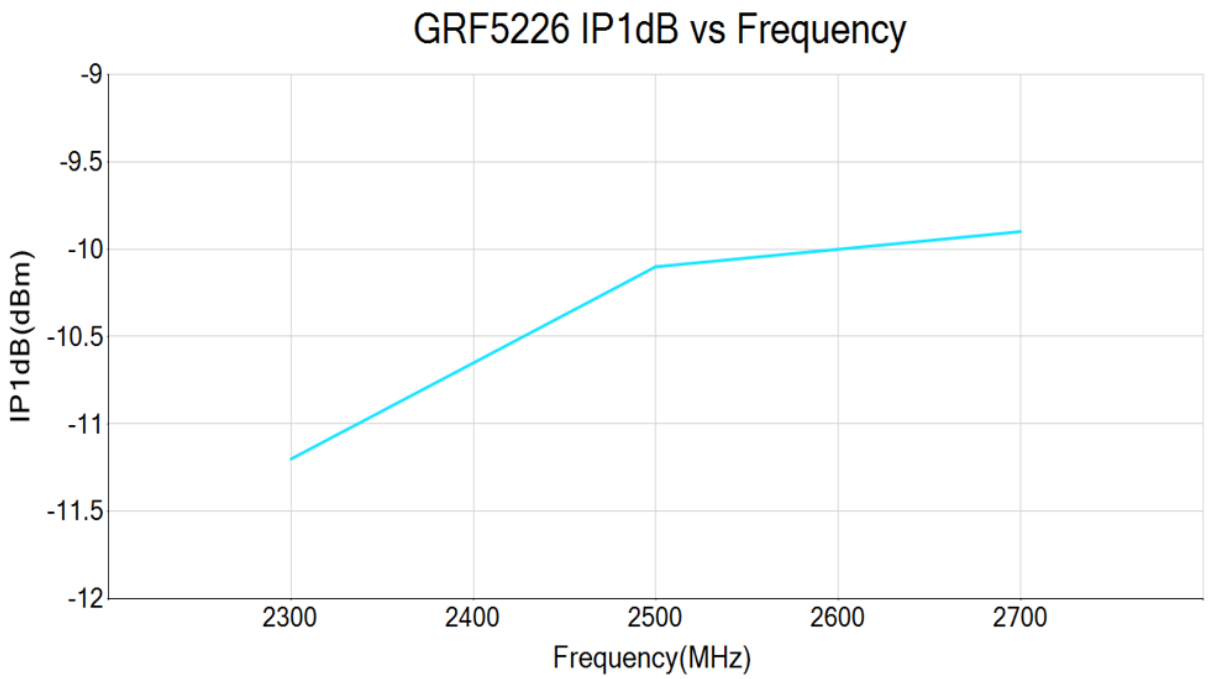
GRF5226 Typical Operating Curves: 2.3 - 2.7 GHz Tune, 5 V



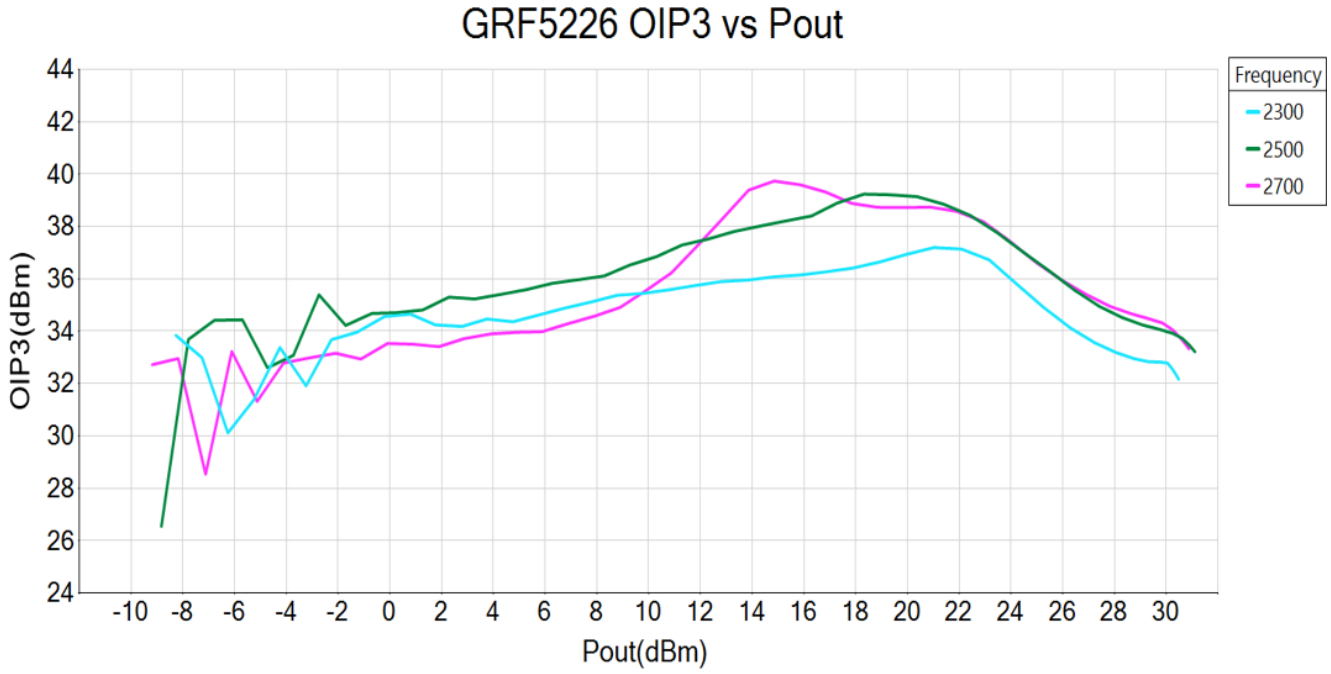


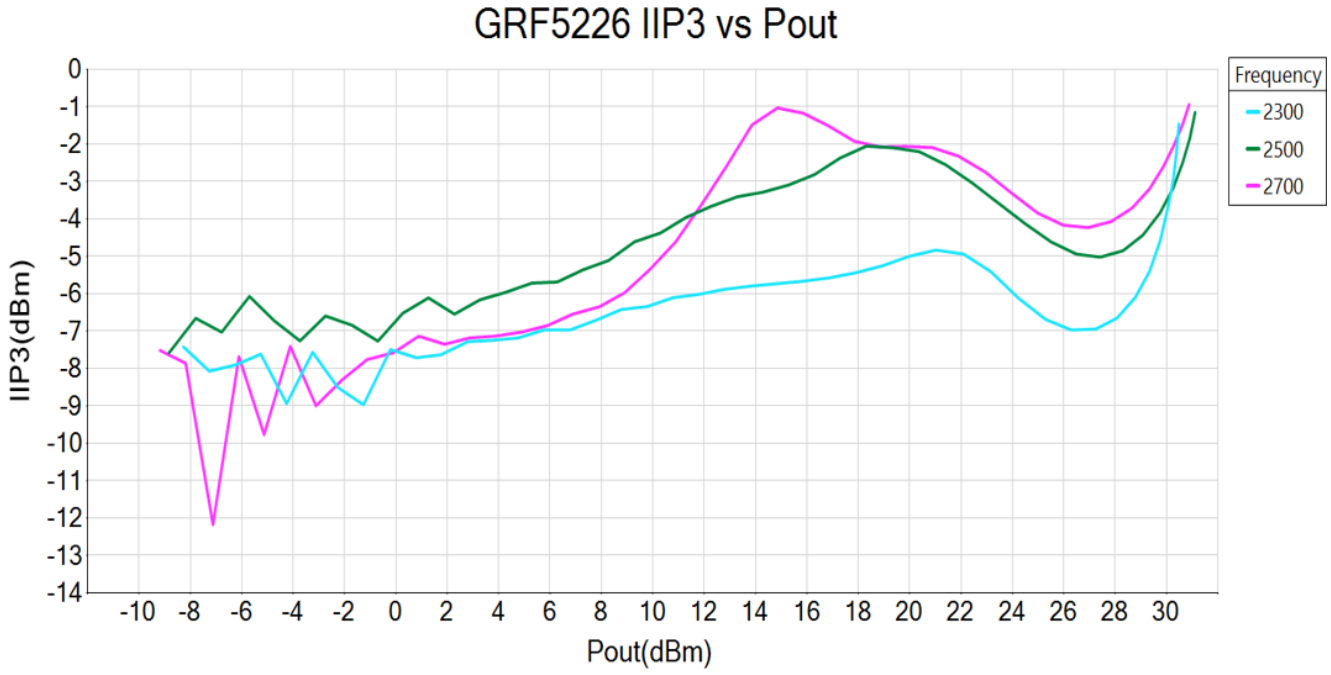
GRF5226 Typical Operating Curves: 2.3 - 2.7 GHz Tune, 5 V



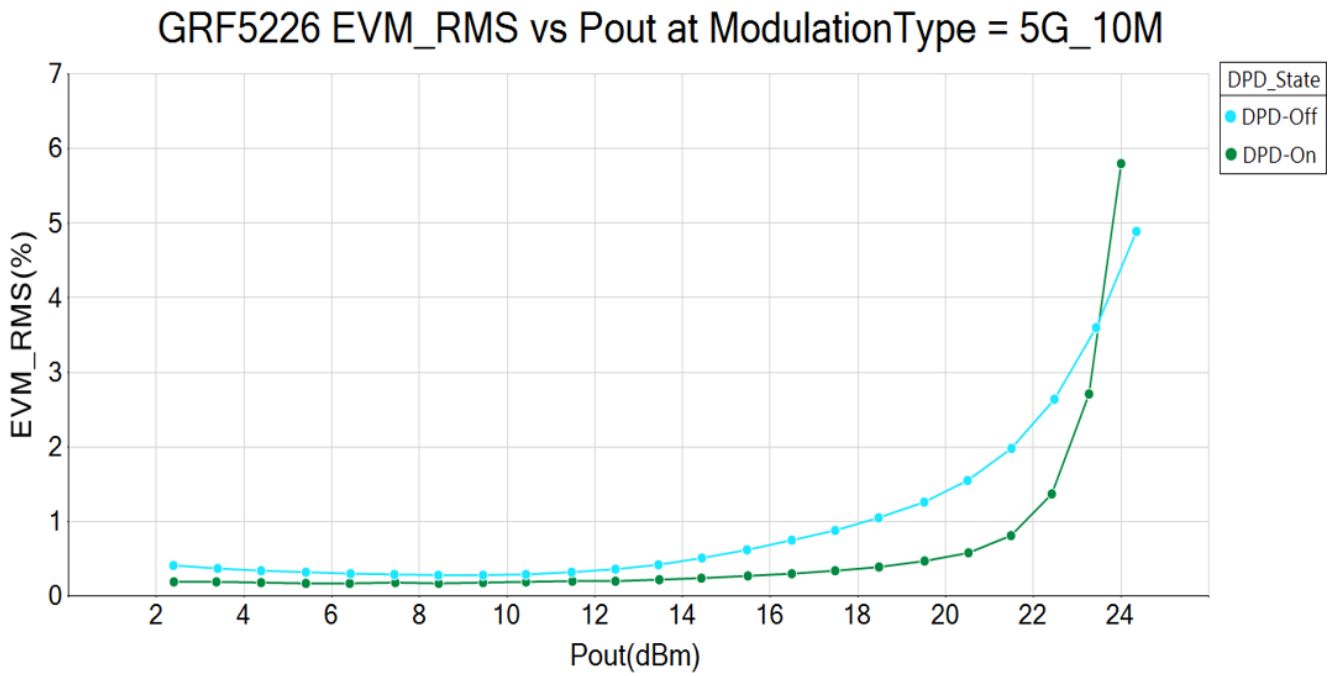


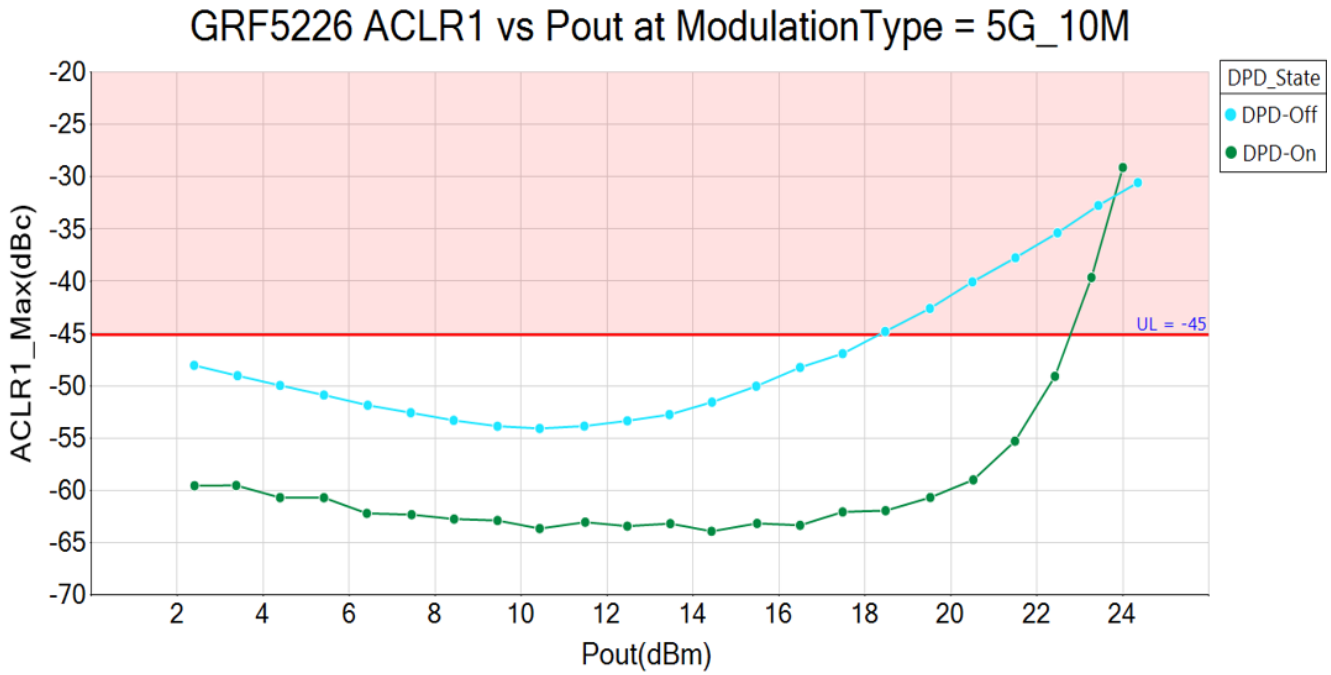
GRF5226 Typical Operating Curves: 2.3 - 2.7 GHz Tune, 5 V



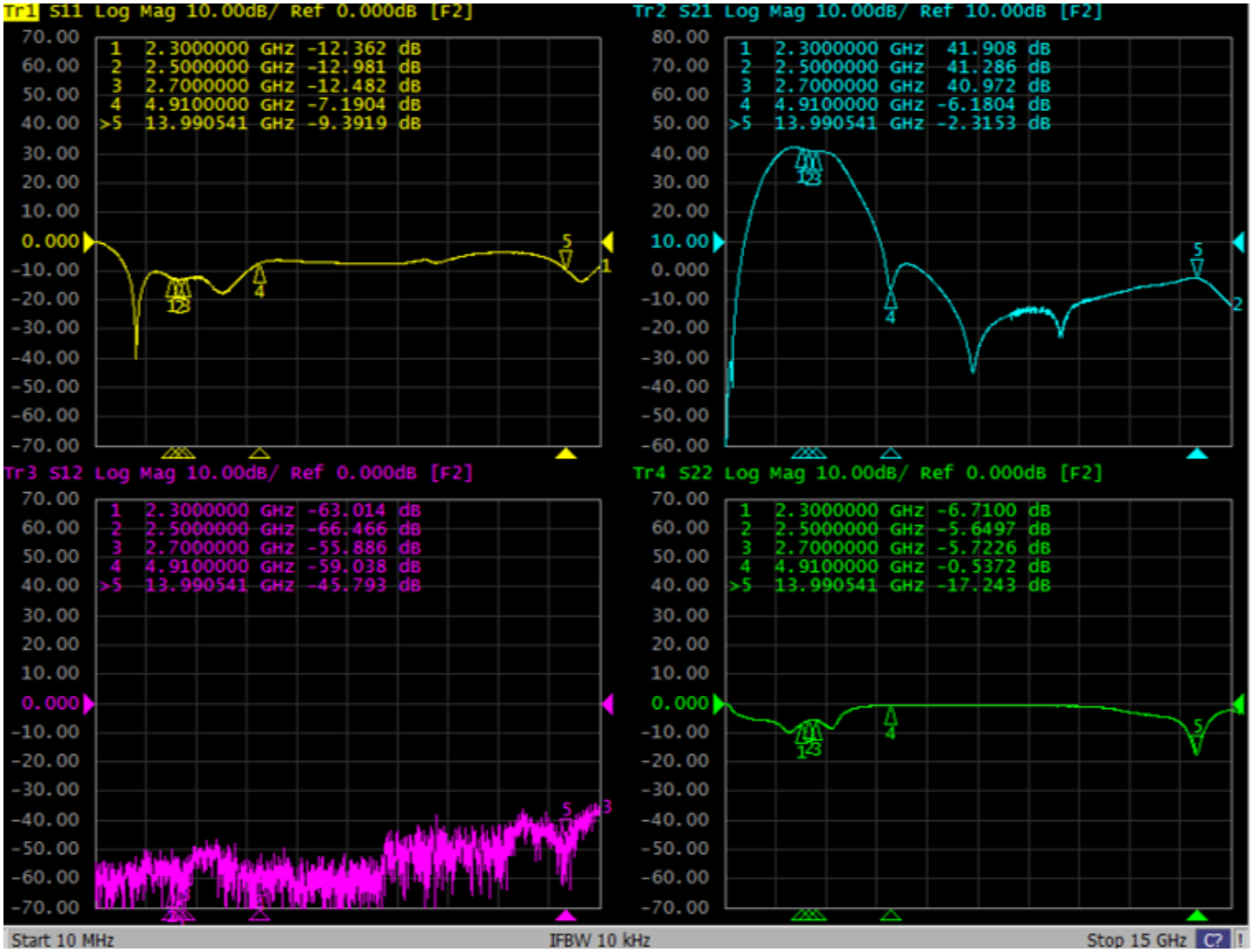


GRF5226 Typical Operating Curves: 2.3 - 2.7 GHz Tune, 5 V

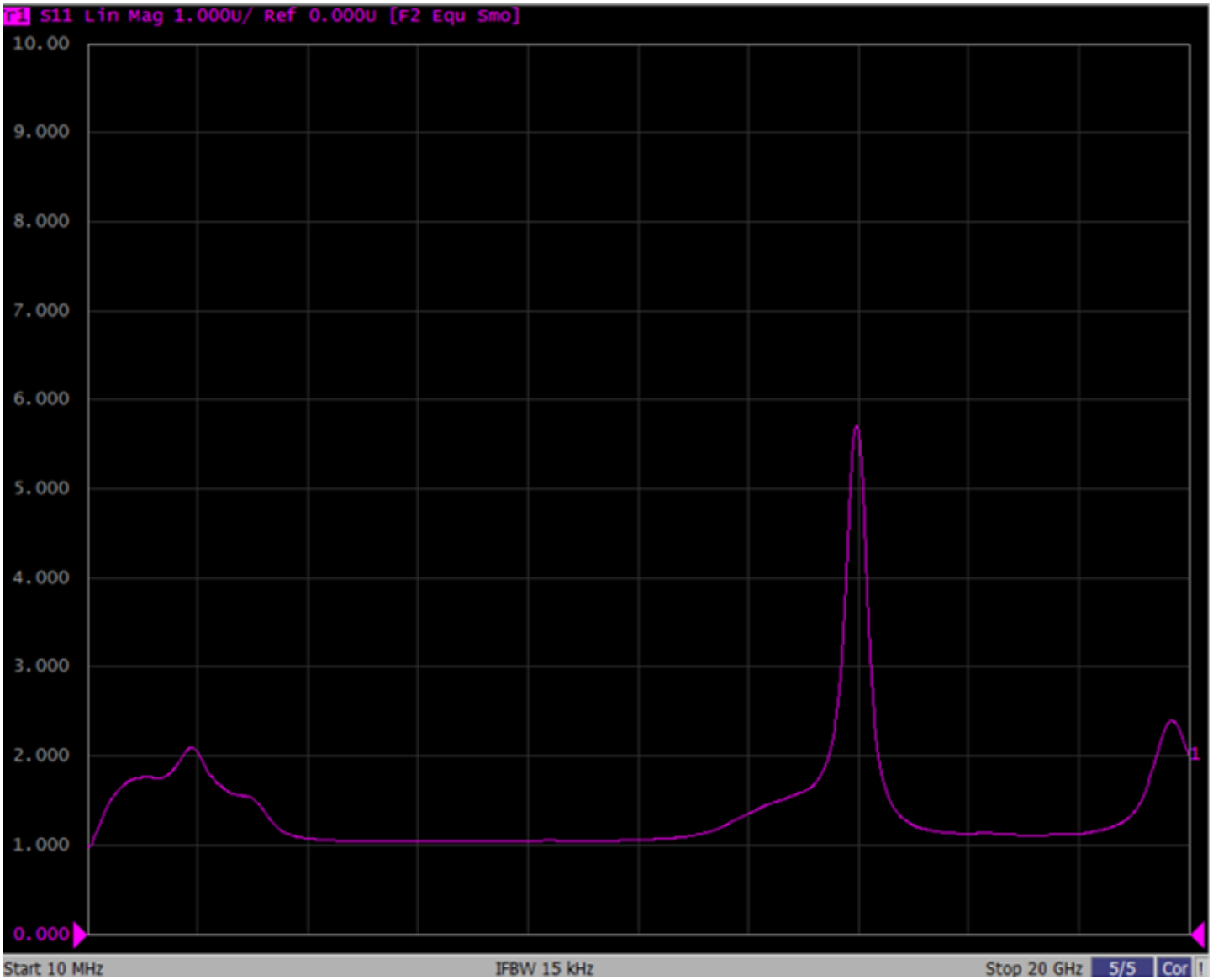




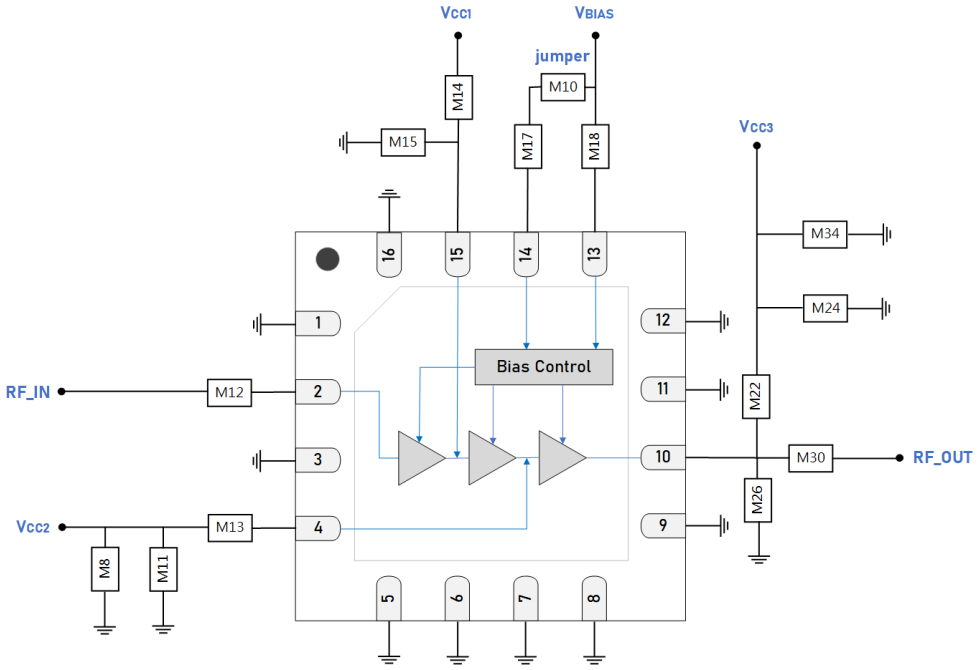
GRF5226 Typical Operating Curves: S-Parameters (2.3 - 2.7 GHz Tune, 5 V)



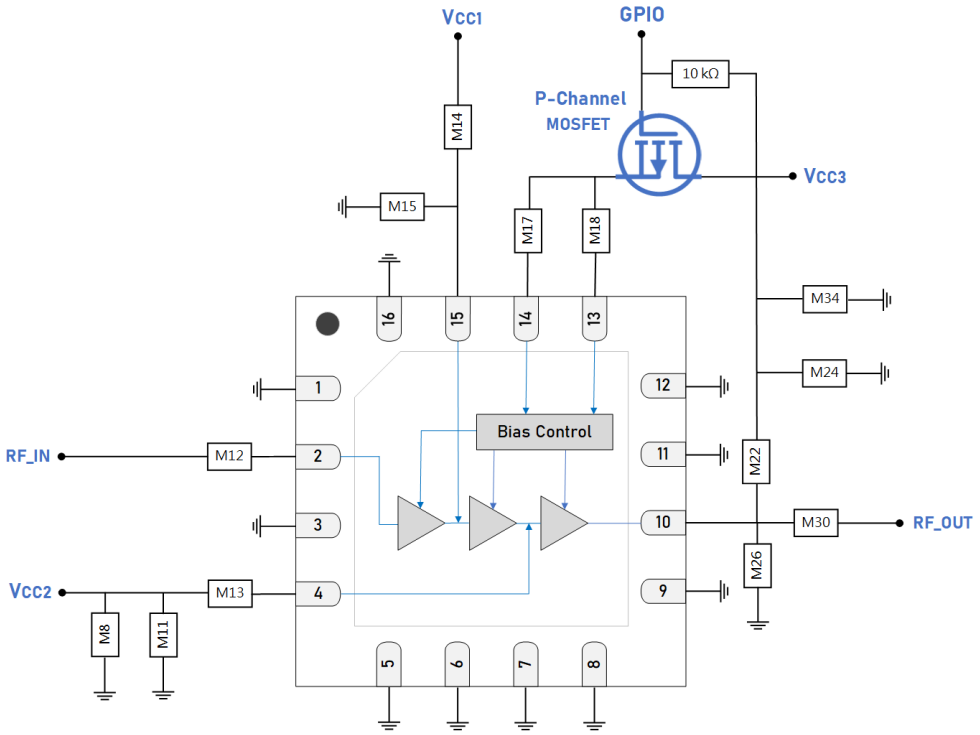
GRF5226 Typical Operating Curves: Stability Mu Factor (10 MHz - 20 GHz)



Note: Mu factor ≥ 1.0 implies unconditional stability.

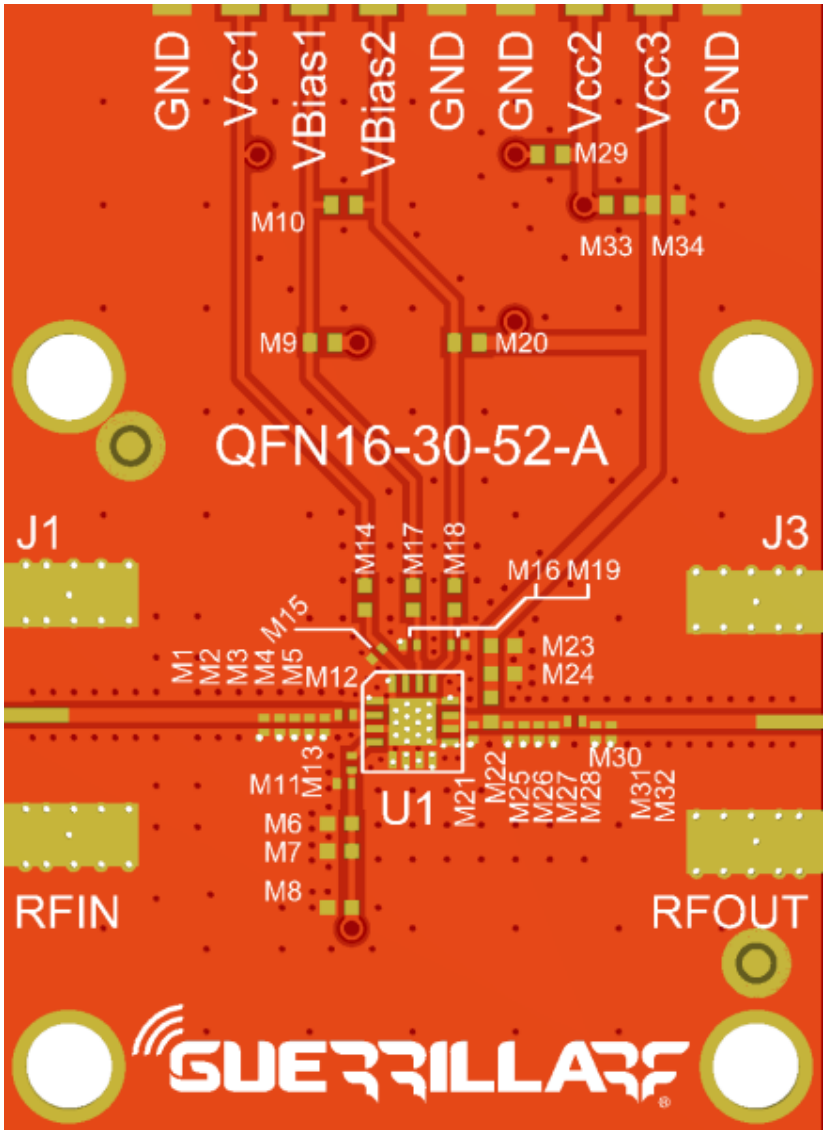


GRF5226 Standard Evaluation Board Schematic



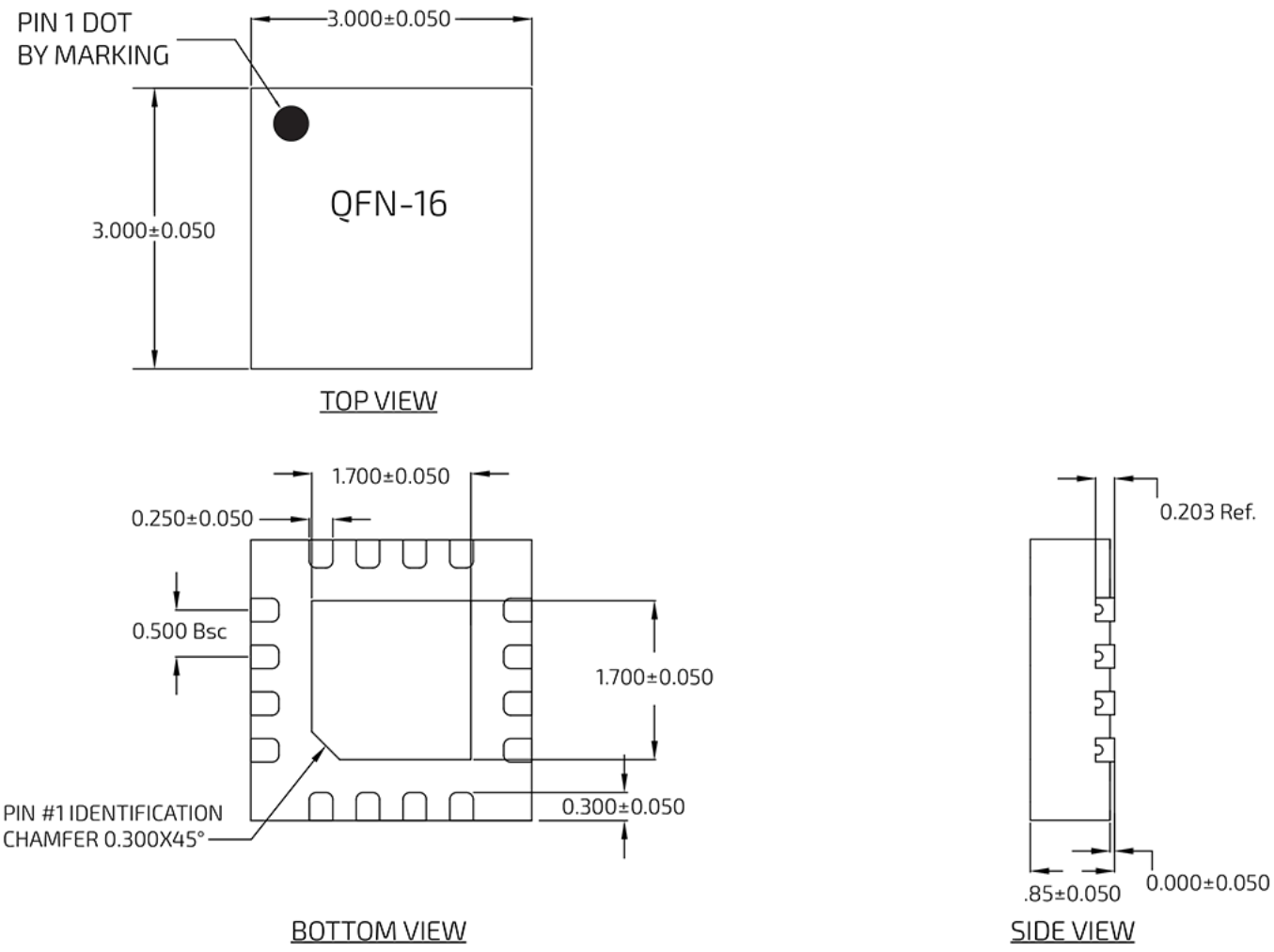
GRF5226 Recommended schematic for applications using low current GPIO to toggle V_{BIAS1} and V_{BIAS2}

GRF5226 Evaluation Board Assembly Diagram

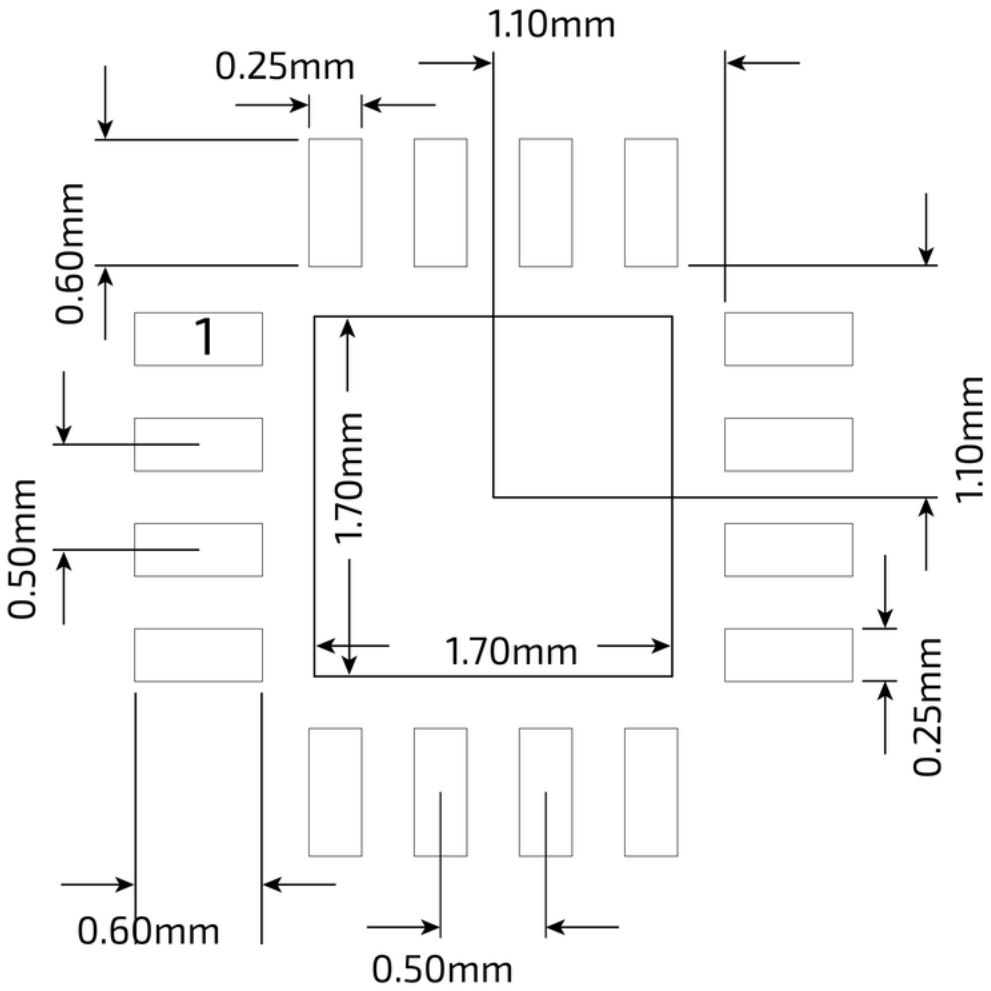


GRF5226 Evaluation Board Assembly Diagram Reference: 2.3 - 2.7 GHz Tune

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M8	Capacitor	Murata	GRM	10 µF	0402	ok
M10	Resistor (jumper)	Various	5%	0 Ω	0402	ok
M11	Capacitor	Murata	GRM	0.1 µF	0201	ok
M12	Resistor	Various	5%	0 Ω	0201	ok
M13	Inductor	Murata	LQP-TN	10 nH	0201	ok
M14	Resistor	Various	5%	0 Ω	0402	ok
M15	Capacitor	Murata	GRM	0.1 µF	0201	ok
M17	Resistor	Various	5%	453 Ω	0402	ok
M18	Resistor	Various	5%	2940 Ω	0402	ok
M22	Inductor	Coilcraft	HP High-Q	10 nH	0402	ok
M24	Capacitor	Murata	GRM	0.1 µF	0402	ok
M26	Capacitor	Murata	GJM	1.8 pF	0201	ok
M30	Capacitor	Murata	GRM	10 pF	0201	ok
M34	Capacitor	Murata	GRM	10 µF	0402	ok
Evaluation Board	QFN16-30-52-A					



QFN 16 3x3mm Package Dimensions



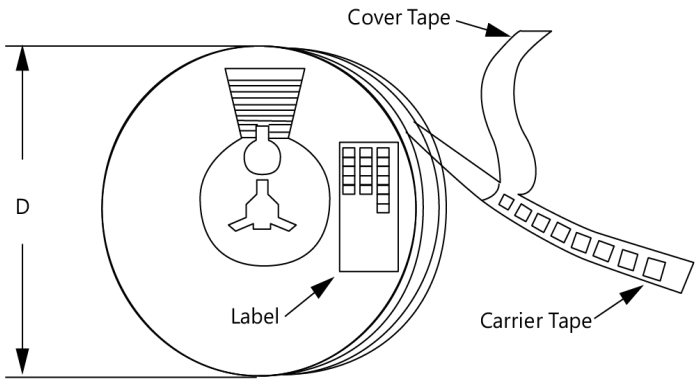
QFN 16 3x3mm Suggested PCB Footprint (Top View)

Package Marking Diagram

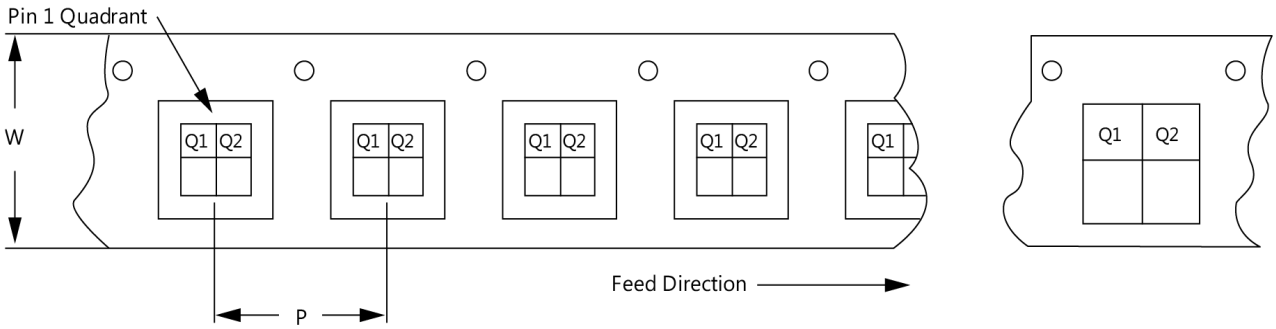
Line 1: “YY” = Year. “WW” = WORK WEEK the Device was assembled.
Line 2: “GRF” = Guerrilla RF
Line 3: “XXXX” = Device Part Number.

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
August 28, 2024	Preliminary Data Sheet.
June 9, 2025	Added new ACLR and EVM plots. Updated HBM and CDM 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 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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