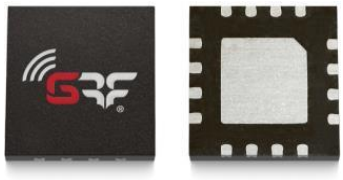
GUERRILLA RF

DATA SHEET

FEATURES

- Operating Frequency Range: DC to 8.0GHz
- Operating Drain Voltage: 28V & 50V
- Maximum Output Power (PSAT): 15W
- Surface Mount Plastic Package
- Suitable for Pulsed, Linear applications
- 100% DC & RF Production Tested



16 Pin 3x3 mm QFN Package

DESCRIPTION

The GRF0010 is a 15W (P3dB) unmatched discrete GaN-on-SiC HEMT which operates from DC to 8.0GHz on a 50V supply rail. The wide bandwidth of the GRF0010 makes it suitable for a variety of applications including cellular infrastructure, radar, communications, and test instrumentation, and can support both linear and pulse operations. The device is housed in an industry-standard 3x3 mm surface mount QFN-16 package. Lead-free and RoHS compliant.

Typical Performances 1 Tone pulsed CW (10% duty cycle, 100µs width), *2nd Harmonics NOT optimized*

(1) Optimum Peak Power at 2.5dB in compression
(2) Optimum Peak Efficiency at 2.5dB in compression

Vds = 50V, Idq = 15mA, T_A = 25°C

Frequency (MHz)	Pout(1) (dBm)	Gain(2) (dB)	Eff(2) (%)
1000	41.4	21.9	58.3
1400	41.7	20.3	66
1800	41.6	19.6	60.2
2200	41.3	17.2	54.4
2600	41.6	18.4	57
3000	42	17.3	61.3
4000	42.1	16.6	64.8
5000	42	15	61
5500	41.7	13.8	58.8
6000	42	13.3	62.3

Vds = 28V, Idq = 15mA, T_A = 25°C

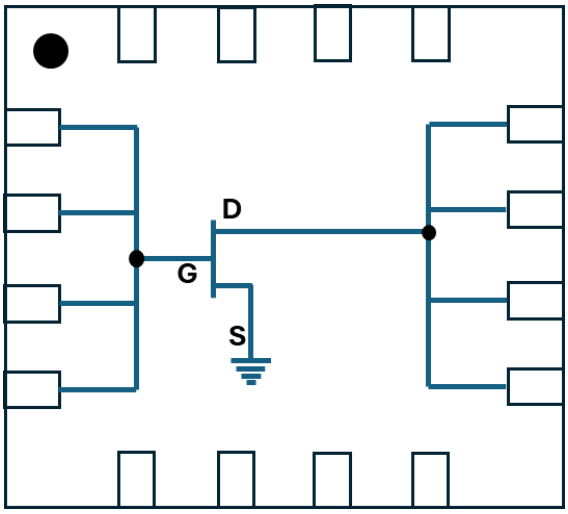
Frequency (MHz)	Pout(1) (dBm)	Gain(2) (dB)	Eff(2) (%)
1000	38.9	20.4	63.7
1400	39.1	18.4	67.4
1800	39	16.9	67.6
2200	38.7	16.2	53.6
2600	39.1	16.2	58.7
3000	39.4	15.4	63.2
4000	39.4	14.9	66.5
5000	39.3	12.4	61.4
5500	39.1	11.7	61.7
6000	39.5	11	63.7

ABSOLUTE MAXIMUM RATINGS(1,2)

Parameter	Rating	Symbols / Units
Drain Source Voltage	150	V_{DS} (V)
Gate Source Voltage	-8 to +2	V_{GS} (V)
Operating Voltage	55	V_{dsq} (V)
Junction Temperature	+225	T_{JUNC}(°C)
Storage Temperature	-65 to +150	$T_{STORAGE}$(°C)
Case Temperature	-40 to +105	T_{CASE}(°C)

Notes: 1. Exceeding any of these limits may cause permanent damage to the device or reduce the lifetime (MTTF). 2. GRF does not recommend sustained operation above maximum operating conditions

BLOCK DIAGRAM



ELECTRICAL SPECIFICATIONS: T_A = 25°C

Parameter	Min	Typ	Max	Symbols/Units	Test Conditions
Frequency Range	DC		8000	MHz	
DC Characteristics					
Drain Source Breakdown Voltage	150			V_{BDSS} (V)	
Drain Source Leakage Current		50		I_{DLK} (uA)	V_{GS} = -8V, V_{DS} = 50V
Gate Threshold Voltage	-3.4		-1.5	V_{GS} (V)	V_{DS} = 50V
Operating Conditions					
Gate Bias Voltage		-2.5		V_{GS} (V)	
Drain Voltage		50		V_{DS} (V)	
Quiescent Drain Current		15		I_{DQ} (mA)	

RF ELECTRICAL SPECIFICATIONS[1,2]: T_A = 25°C, VDS = 50V, IDQ = 15mA, Freq = 3500MHz

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Small Signal Gain	G_{ss}		15		dB	@ $I_{DS} \leq 1.1*I_{DQ}$
Power Gain	G_{MAX}		17.0		dB	Max gain vs. power
Saturated Gain	G_{SAT}		14.5		dB	@2.5dB compression referenced to G_{MAX}
Saturated Drain Efficiency	$DEff_{SAT}$		62		%	
Saturated Output Power	P_{SAT}		42		dBm	
Ruggedness	Ψ	@2.5dB compression; Output VSWR = 10:1, all angles				No damage or shift in performance

1. 1 Tone Pulsed CW, pulse width 100us, duty cycle 10%
2. Performance based on GRF EVB, 50Ω system

THERMAL AND RELABILITY INFORMATION - CW [1, 2, 3]: T_c = 85°C

Parameter	Test Condition	Value	Units
Channel Temperature	Pdiss 9W	TBD	ºC
Rth		TBD	ºC/W
Rsur		TBD	ºC/W
MTTF		TBD	Hrs

LOADPULL MEASUREMENT, Vds = 50V Idq = 15mA

1 Tone Pulse CW, pulse width 100us, duty cycle 10%

For Optimum Peak Power @ 2.5dB Compression

Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	6.8 j -32.6	48.2 j 15.0	22.6	41.4	14	53.8	-2.4
1200	7.3 j -27.8	45.1 j 15.1	20.8	41.7	14.9	56.3	-1.1
1400	6.8 j -22.2	43.2 j 31.1	20.6	41.7	15	63.3	-1.9
1600	6.6 j -19.7	42.7 j 23.3	19.9	41.8	14.9	53.7	2.2
1800	6.4 j -16.5	35.7 j 24.0	18.9	41.6	14.3	53.8	1.1
2000	6.6 j -14.3	42.6 j 27.1	17.1	41.2	13	49.1	-1.1
2200	5.7 j -12.5	38.6 j 24.3	16.8	41.3	13.4	45.9	1
2400	4.0 j -9.8	24.4 j 30.0	17.7	41.2	13.1	49.6	5.7
2600	3.5 j -8.6	27.3 j 21.4	17.7	41.6	14.5	48.7	4.1
2800	4.3 j -6.0	31.0 j 28.9	16.7	41.9	15.3	51.1	5.1
3000	3.5 j -3.7	28.9 j 22.4	17.2	42	15.7	52.3	2.5
3500	3.3 j 1.0	16.1 j 17.2	16	41.9	15.8	51.5	1.3
4000	3.7 j 6.6	15.6 j 18.5	15.3	42.1	16.4	58.6	0.1
4500	4.4 j 11.0	13.1 j 12.4	14.2	41.8	15.1	50.5	-0.6
5000	5.6 j 17.2	16.0 j 9.9	12.9	42	15.7	51.2	-0.5
5500	7.5 j 24.9	12.0 j 6.2	12.9	41.7	15	52.9	-1.1
6000	12.6 j 38.2	14.4 j 4.5	12.1	42	16.1	54.9	-0.1

For Optimum Peak Efficiency @ 2.5dB Compression

Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	8.2 j -30.0	81.2 j 30.2	21.9	40.9	12.3	58.3	-1.7
1200	7.0 j -23.1	49.8 j 44.9	21.9	40.7	11.9	64.7	-2.9
1400	7.3 j -21.3	47.7 j 40.8	20.3	41.4	14.2	66	-0.6
1600	6.0 j -17.0	32.6 j 36.4	20.2	41.6	14.7	67.2	-2.6
1800	5.9 j -14.3	28.2 j 35.7	19.6	41.1	12.7	60.2	0
2000	6.2 j -12.2	29.8 j 39.8	18.1	40.3	11	54.1	-0.9
2200	5.3 j -11.1	27.8 j 33.7	17.2	41.1	13.1	54.4	2
2400	3.8 j -8.7	18.9 j 34.7	18.3	40.4	10.9	51	5.9
2600	3.6 j -6.1	19.0 j 36.4	18.4	40.7	11.6	57	6.1
2800	3.4 j -4.0	16.3 j 35.2	17.9	41.1	12.8	59.8	7.7
3000	3.4 j -2.0	21.8 j 37.3	17.3	41.4	13.7	61.3	6.1
3500	3.4 j 3.3	9.1 j 23.7	16.5	40.9	12.2	59.3	2.6
4000	3.2 j 8.9	7.9 j 20.1	16.6	40.7	12	64.8	0.3
4500	4.0 j 13.7	6.3 j 13.8	15.5	40.8	12.2	60	-1
5000	4.8 j 20.1	7.5 j 10.9	15	40.8	12.2	61	-2.2
5500	7.3 j 27.9	6.9 j 6.8	13.8	41	12.5	58.8	-1.6
6000	12.2 j 42.8	7.8 j 4.5	13.3	41.2	13.1	62.3	-1.5

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LOADPULL MEASUREMENT, Vds = 28V Idq = 15mA

1 Tone Pulse CW, pulse width 100us, duty cycle 10%

For Optimum Peak Power @ 2.5dB Compression

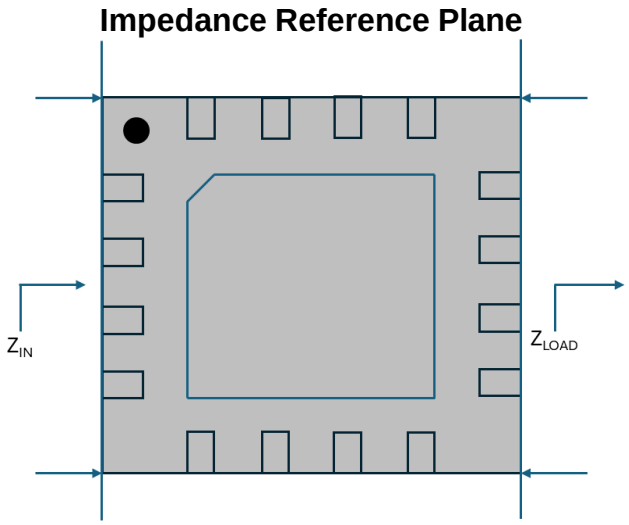
Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	7.2 j -31.5	33.2 j 2.2	19.9	38.9	7.8	57.8	-3.8
1200	6.8 j -27.4	26.7 j 0.7	19.1	38.9	7.8	54.9	-1.9
1400	7.3 j -21.8	37.2 j 8.9	18.4	39.1	8.1	64.4	-1.8
1600	7.2 j -18.7	42.2 j 3.5	17	39	8	55.9	2.5
1800	7.3 j -15.6	39.1 j 8.1	16.2	39	8	56.3	2.7
2000	6.5 j -14.0	39.7 j 5.2	14.8	38.2	6.6	44.7	2.7
2200	5.5 j -11.5	39.2 j 9.8	14.8	38.7	7.4	48.8	4.2
2400	4.4 j -9.6	38.3 j 14.8	14.9	38.7	7.3	47.7	7.7
2600	3.5 j -7.4	31.8 j 13.9	16	39.1	8.1	53.2	5.6
2800	3.7 j -5.7	31.0 j 10.3	15	39.4	8.8	52.6	4
3000	3.5 j -2.6	34.3 j 14.3	14.9	39.4	8.7	57	3.1
3500	3.8 j 2.2	21.3 j 14.6	14.1	39.4	8.6	57	0.6
4000	3.7 j 6.8	22.8 j 8.0	13.5	39.4	8.7	55.3	-1.1
4500	4.8 j 12.9	15.4 j 11.8	12.1	39.3	8.4	57.7	-1.9
5000	6.7 j 18.0	23.9 j 5.6	11	39.3	8.5	51.6	-0.1
5500	8.0 j 26.1	19.7 j 2.4	10.7	39.1	8.2	53.3	-2.5
6000	12.1 j 40.2	23.2 j -1.7	10.3	39.5	8.9	55.3	-2.2

For Optimum Peak Efficiency @ 2.5dB Compression

Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	7.6 j -28.3	53.8 j 9.7	20.4	38.3	6.8	63.7	-1.6
1200	8.4 j -21.0	59.5 j 36.1	19	36.7	4.8	66.3	1.6
1400	7.2 j -20.6	43.3 j 15.6	18.4	38.8	7.6	67.4	-0.8
1600	7.6 j -11.5	29.7 j 44.1	17.4	36.3	4.3	72	-2.8
1800	6.6 j -13.1	32.0 j 24.2	16.9	38.3	6.9	67.6	1.3
2000	5.9 j -11.7	36.6 j 32.1	15.7	37.3	5.4	48.7	6.7
2200	4.5 j -8.6	21.0 j 31.1	16.2	37.1	5.1	53.6	5.1
2400	3.6 j -8.3	26.2 j 27.4	16	38.1	6.4	52.4	8.9
2600	3.3 j -5.8	25.6 j 28.1	16.2	38.4	6.9	58.7	8.7
2800	2.9 j -3.5	20.3 j 25.2	16.7	38.4	6.9	61.1	5.7
3000	3.0 j -0.3	20.5 j 30.6	15.4	37.8	6	63.2	6
3500	3.2 j 4.7	10.6 j 19.1	14.6	37.8	6.1	63.9	2
4000	2.9 j 10.3	9.0 j 14.3	14.9	37.6	5.8	66.5	-1.9
4500	4.2 j 14.7	9.3 j 10.2	13.3	38.2	6.8	62.7	-2.8
5000	5.4 j 21.4	10.4 j 7.3	12.4	38	6.3	61.4	-3.9
5500	7.3 j 31.9	6.6 j 1.8	11.7	37	5	61.7	-6.8
6000	12.7 j 47.1	9.3 j -0.8	11	37.8	6.1	63.7	-4.9

LOADPULL MEASUREMENT NOTES

Source and Load impedance @ 2nd Harmonic are set to 10 Ohms
With proper 2nd Harmonic termination, expect +5% Efficiency for Source and similar with Drain 2nd Harmonic.
Z_{LOAD}: Measured Impedance presented to the output of the device in the reference plane
Z_{IN}: Measured input Impedance at the input of the device in the reference plane

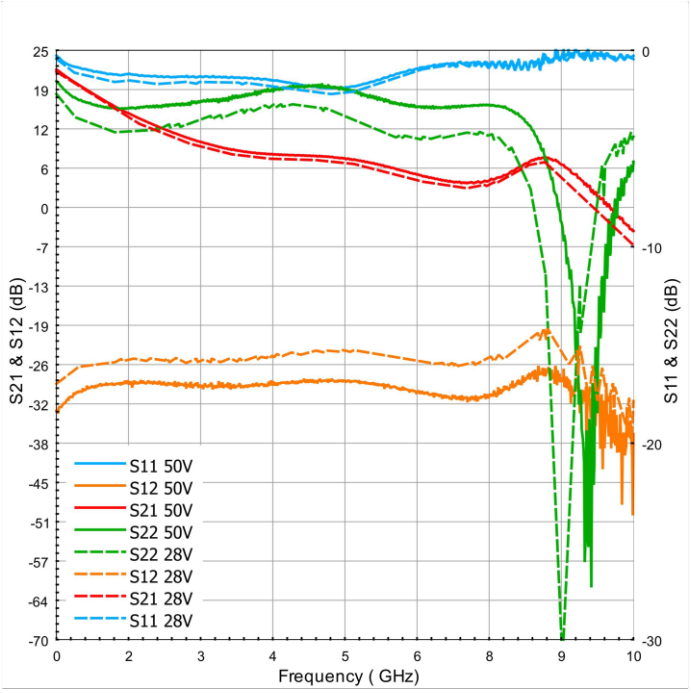


Raw data and full Loadpull measurement report available at request: sales@guerrilla-rf.com

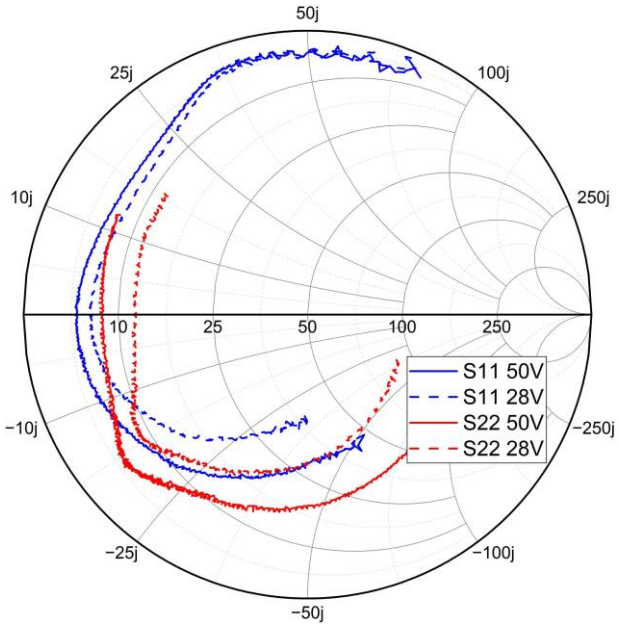
BROADBAND S-PARAMETERS MEASUREMENT, Vds = 28 & 50V Idq = 15mA

1 Tone CW

S-Parameters (Mag-dB)



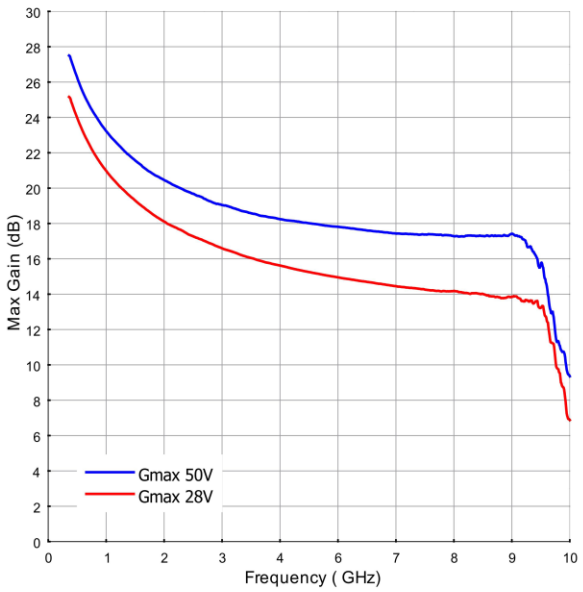
S11 & S22 0.4-8 GHz



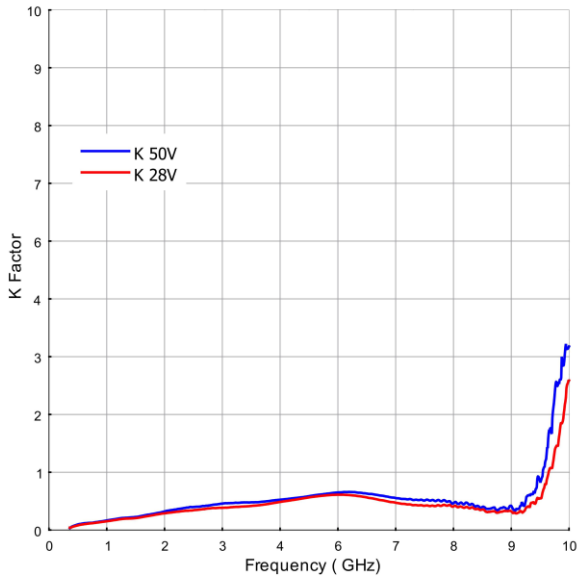
BROADBAND S-PARAMETERS MEASUREMENT, Vds = 28 & 50V Idq = 15mA

1 Tone CW

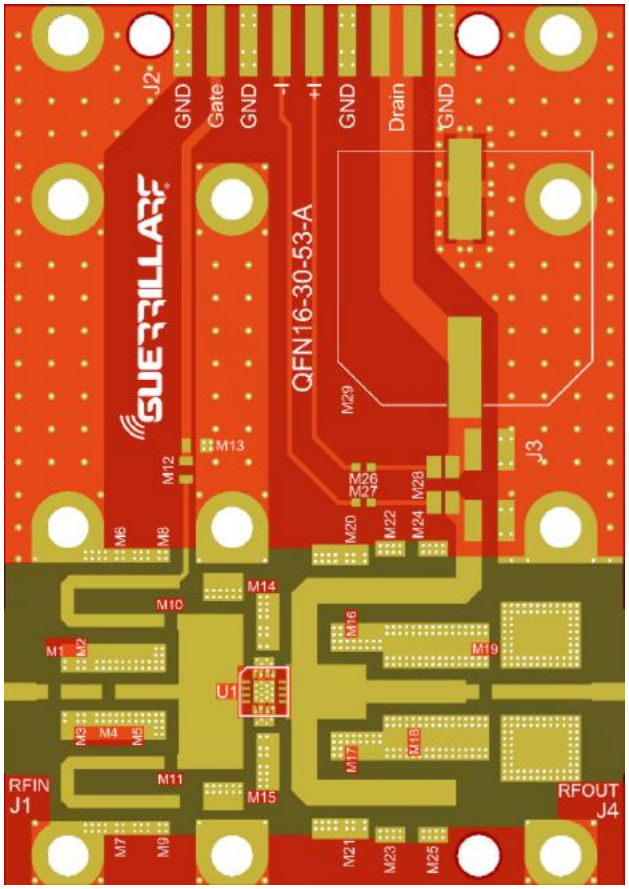
Maximum Available Gain



K Factor



EVALUATION TEST FIXTURE 3.3 - 3.7 GHZ

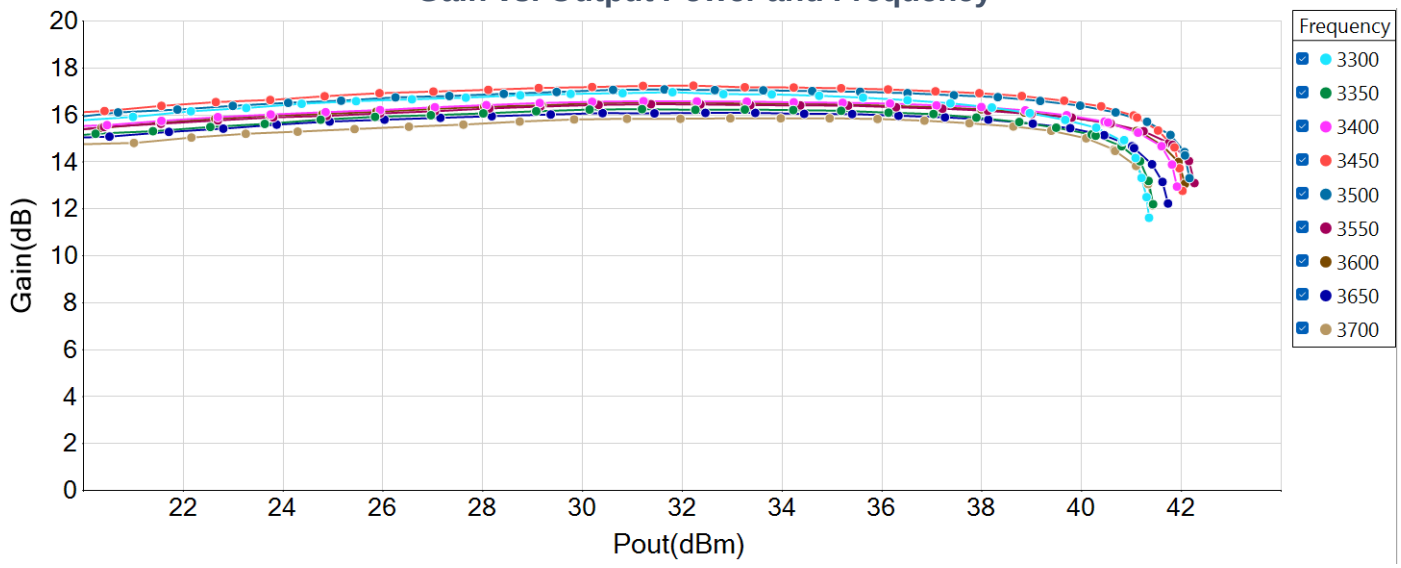


REFERENCE DESIGNATOR	TYPE	VALUE	SIZE	MANUFACTURER	ALTERNATE
EVB	PCB			Guerrilla-RF	Yes
U1	GaN PA GRF0010		3x3mm	Guerrilla-RF	No
M1	Resistor	2Ω	0805	Various	
M2/M3	Resistor	1kΩ	0805	Various	
M4	Capacitor	3.9pF	0805	ATC	Ok (Murata)
M5	Capacitor	1.5pF	0805	ATC	Ok (Murata)
M6	Capacitor	6.8pF	0805	ATC	Ok (Murata)
M7/M9/M11	DNP				
M8	Capacitor	10nF	0805	Murata	Ok
M10	Resistor	5.1Ω	0805	Various	
M12	Resistor	0Ω	0805	Various	
M13	Capacitor	10uF	0805	Murata	Ok
M14/M15	Capacitor	0.5pF	0805	ATC	Ok (Murata)
M16/M17	Capacitor	0.3pF	0805	ATC	Ok (Murata)
M18	Capacitor	1.0pF	0805	ATC	Ok (Murata)
M19	Capacitor	6.8pF	0805	ATC	Ok (Murata)
M20/M21	Capacitor	3.0pF	0805	ATC	Ok (Murata)
M22/M23/M24/M25	Capacitor	10uF	1210	Murata	Ok
M26/M27	Resistor	1kΩ	0603	Various	
M28	Resistor	10mΩ	1206	Ohmite	Ok
M29	Electrolytic Capacitor	220uF	12.5mm	Various	
J3	DNP				
J2	DC Connector	NA		Various	
J1/J4	SMA	NA		Various	

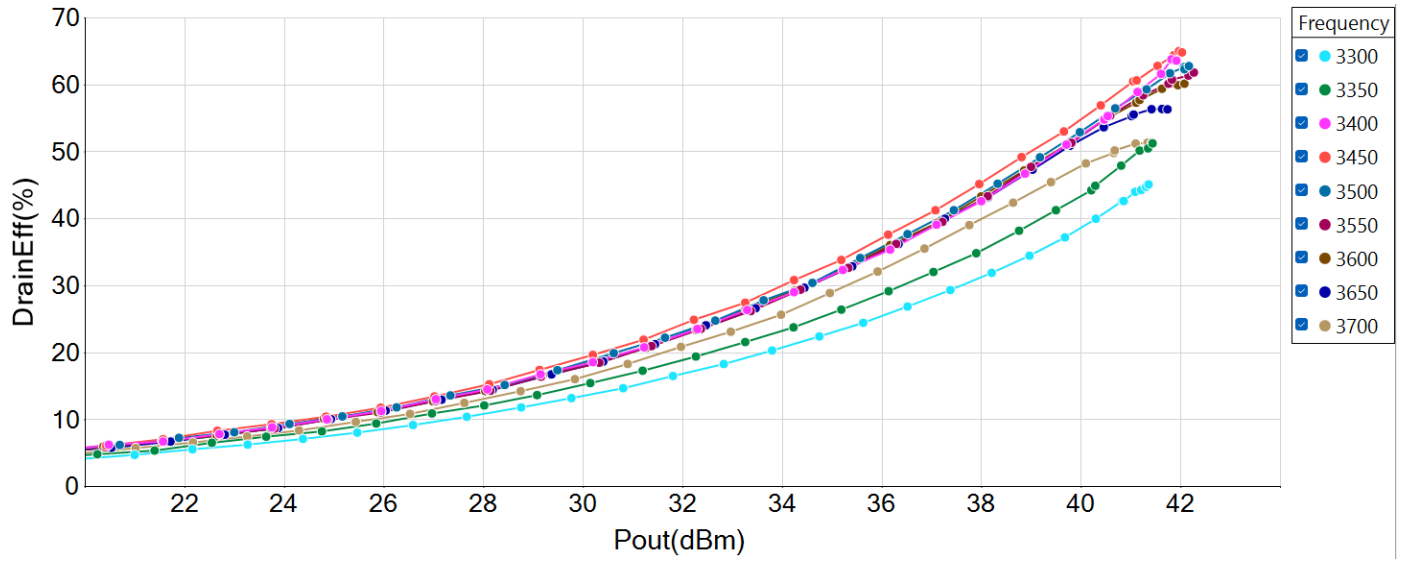
Typical Performance Curves as Measured in the 2.3 - 3.8 GHz Evaluation Test Fixture:

Pulsed CW (10% duty cycle, 100µs width), VDS = 50V, IDQ = 15mA, TC = 25°C (Unless Otherwise Noted)

Gain vs. Output Power and Frequency

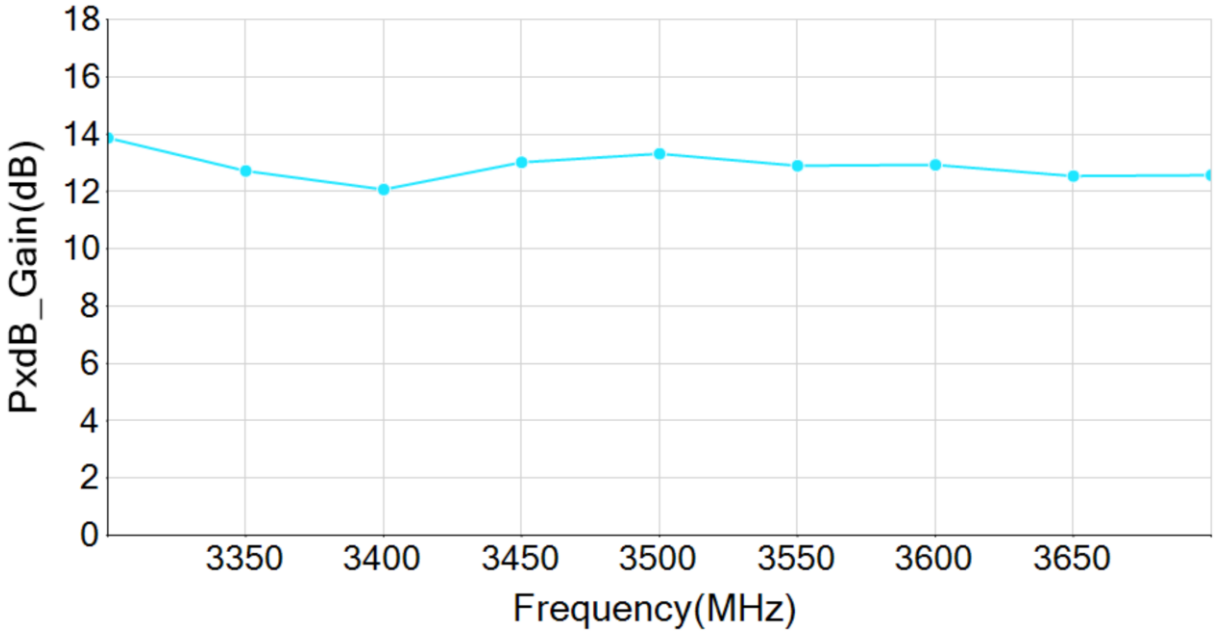


Drain Efficiency vs. Output Power and Frequency

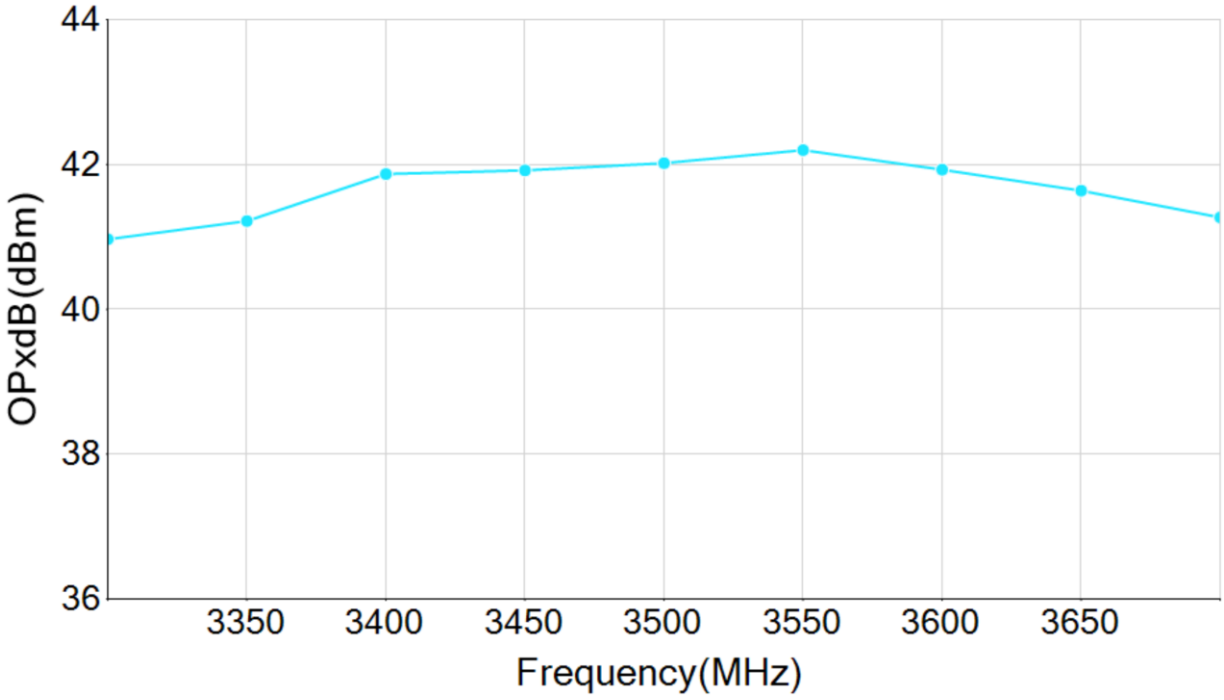


Typical Performance Curves as Measured in the 3.3 - 3.7 GHz Evaluation Test Fixture:
Pulsed CW (10% duty cycle, 100µs width), VDS = 50V, IDQ = 15mA, TC = 25°C (Unless Otherwise Noted)

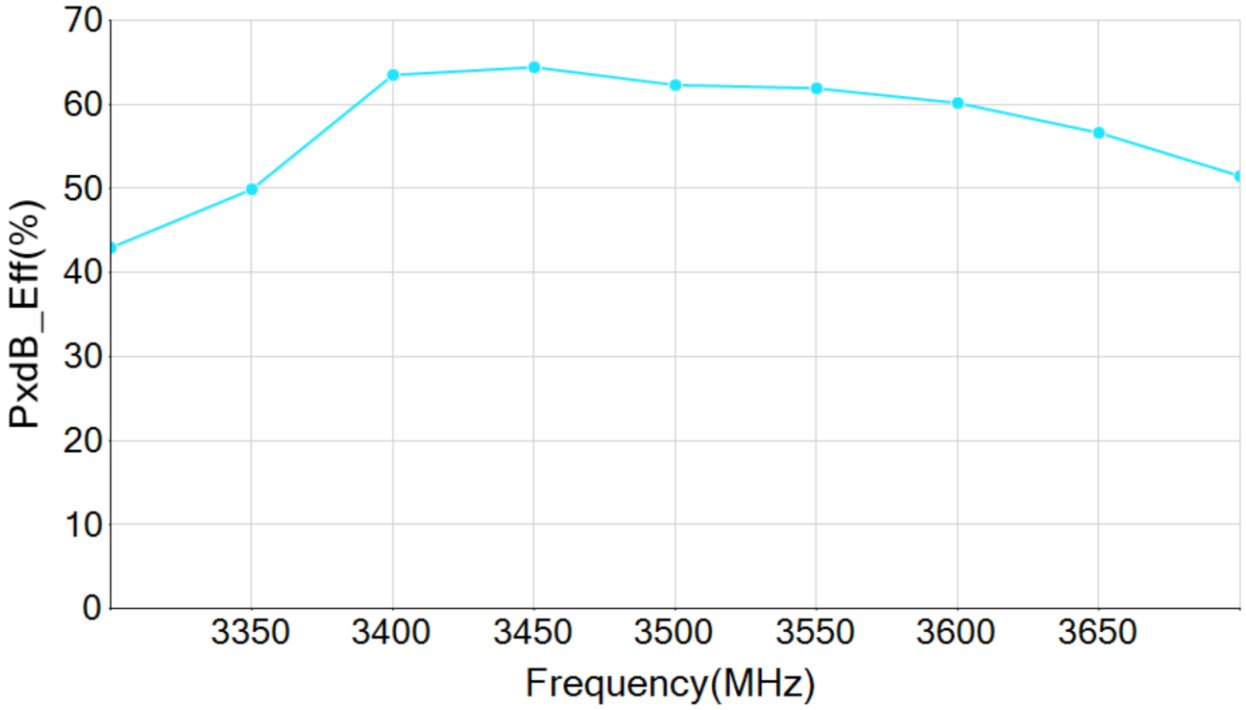
Gain vs. Frequency, 2.5dB Compression



Pout vs. Frequency, 2.5dB Compression



Drain Efficiency vs. Frequency, 2.5dB Compression



GaN HEMT BIASING SEQUENCE

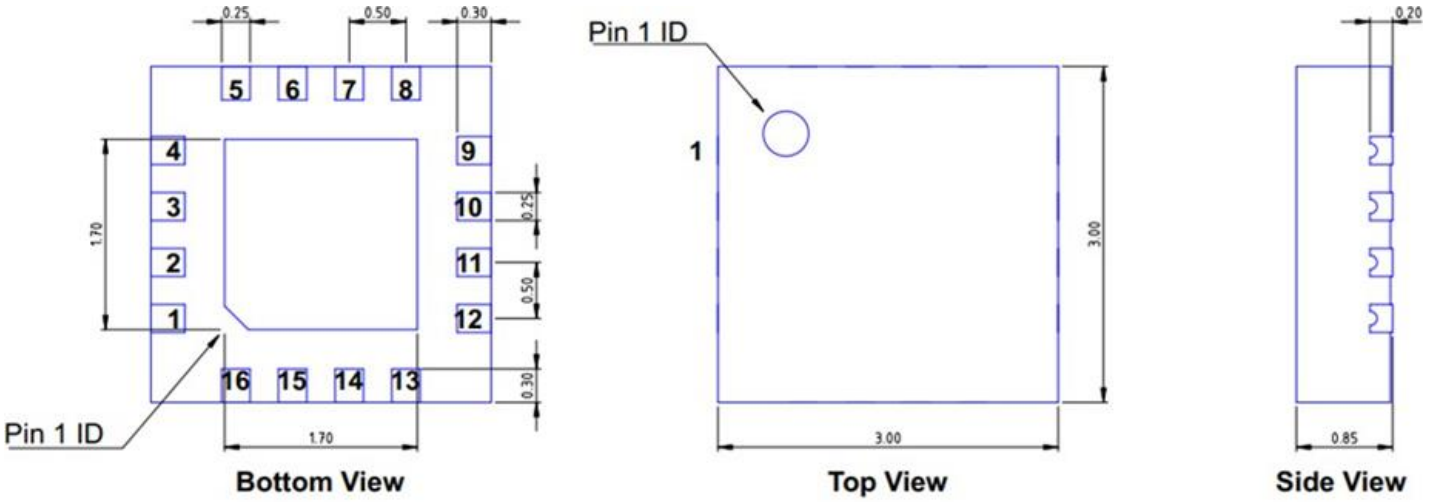
To turn the transistor ON

1. Set V_{GS} to -5V
2. Turn on V_{DS} to normal operation voltage (50V)
3. Slowly increase V_{GS} to set I_{DQ} current (15mA)
4. Apply RF power

To turn the transistor OFF

1. Turn the RF power off
2. Decrease V_{GS} to -5V
3. Turn off $V_{D.}$ Wait a few seconds for drain capacitor to discharge
4. Turn off V_{GS}

PACKAGE DIMENSIONS



QFN16 3x3mm

Dimensions in millimeters
Dimensional Tolerance: ±0.05

PIN CONFIGURATION

Pin	Input/Output
1, 2, 3, 4	RF Input / Gate Voltage
5, 6, 7, 8,	Ground
9, 10, 11, 12	RF Output / Drain Voltage
13, 14, 15, 16	Ground
17 (Paddle)	Ground

DEVICE LABEL

Line 1: “YYWW” = Year & Work Week
Line 2: “GRF” = Guerrilla RF
Line 3: “XXXX” = Device Part Number

HANDLING PRECAUTIONS

Parameter	Symbol	Class	Test Methodology
ESD – Human Body Model	HBM	TBD	ANSI/ESDA/JEDEC Standard JS-001
ESD – Charged Device Model	CDM	TBD	ANSI/ESDA/JEDEC Standard JS-002
MSL – Moisture Sensitivity Level	MSL	MSL 1	IPC/JEDEC Standard J-STD-020

RoHS COMPLIANCE

Guerrilla-RF Policy on EU RoHS available online:

https://www.guerrilla-rf.com/_files/ugd/3748d3_1107b9788f9845f78f45d424097c4c97.pdf

REVISION HISTORY

Revision	Date	Data Sheet Status	Modifications
1	09/23/2024	Preliminary	Initial
2	10/23/2024	Preliminary	Updated plots on pages 10, 11 & 12

CONTACT INFORMATION

To request latest information and samples, please contact us at:

Web: https://www.guerrilla-rf.com/

Email: sales@guerrilla-rf.com

IMPORTANT NOTICE

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