GT090D 50V, DC – 3.7GHz, 90W GaN HEMT

FEATURES

- Operating Frequency Range: DC to 3.7GHz
- Operating Drain Voltage: 28V & 50V
- Maximum Output Power (P_{SAT}): 110W
- Surface Mount Plastic Package
- Suitable for Pulsed, Linear applications
- 100% DC & RF Production Tested

14 Pin 6x3 mm DFN Package

DESCRIPTION

The GT090D is a 110W (P3dB) unmatched discrete GaN-on-SiC HEMT which operates from DC to 3.7GHz on a 50V supply rail. The wide bandwidth of the GT090D 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 6x3 mm surface mount DFN 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= 109 mA, T_A = 25°C

Frequency (MHz)	Pout(1) (dBm)	Gain(2) (dB)	Eff(2) (%)
1000	50.4	25.5	66.3
1200	50.6	24.1	67
1400	50.7	23.5	67.7
1600	50.7	21.9	66
1800	50.8	21.9	67.6
2000	50.6	21.2	64.3
2200	50.6	21	64.4
2400	50.6	19.8	63.2
2600	50.8	19.1	67.8
2800	50.8	19.1	66.3

Vds=28V, Idq= 109 mA, T_A = 25°C

Frequency (MHz)	Pout(1) (dBm)	Gain(2) (dB)	Eff(2) (%)
1000	47.6	22.6	66.3
1200	47.8	22.9	68.4
1400	47.9	21.9	68.2
1600	47.9	20.3	67.4
1800	48	20.5	68.7
2000	48	19.3	66.3
2200	48	19.1	66.8
2400	47.8	18.2	65.3
2600	48.2	18	68.6
2800	48	17.6	67.1

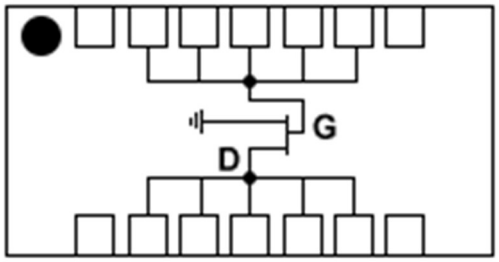
GT090D 50V, DC – 3.7GHz, 90W GaN HEMT

ABSOLUTE MAXIMUM RATINGS(1, 2)

Parameter	Rating	Symbols and 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 Operating Temperature	-40 to +105	T_{CASE}(°C)

1. Exceeding any of these limits may cause permanent damage to this device or seriously limit the life time (MTTF)
2. GalliumSemi does not recommend sustained operation above maximum operating conditions.

BLOCK DIAGRAM



ELECTRICAL SPECIFICATIONS: T_A = 25°C

Parameter	Min.	Typ.	Max.	Symbols and Units	Test conditions
Frequency Range	DC		3700	MHz	
DC Characteristics					
Drain Source Breakdown Voltage	150			V_{BDSS} (V)	
Drain Source Leakage Current		9		I_{DLK} (mA)	Vgs = -8V, Vds = 50V
Gate Threshold Voltage	-3.4		-1.5	V_{GS} (V)	Vds = 50V
Operating Conditions					
Gate Bias Voltage		-2.5		V_{GSQ} (V)	
Drain Voltage		50		V_{DSQ} (V)	
Quiescent Drain Current		109		I_{DQ} (mA)	

RF ELECTRICAL SPECIFICATIONS: T_A = 25°C, VDS = 50 V, IDQ = 109 mA, Freq= 3600MHz
Note: Performance(1) in GalliumSemi Production Test Fixture, 50 Ω system

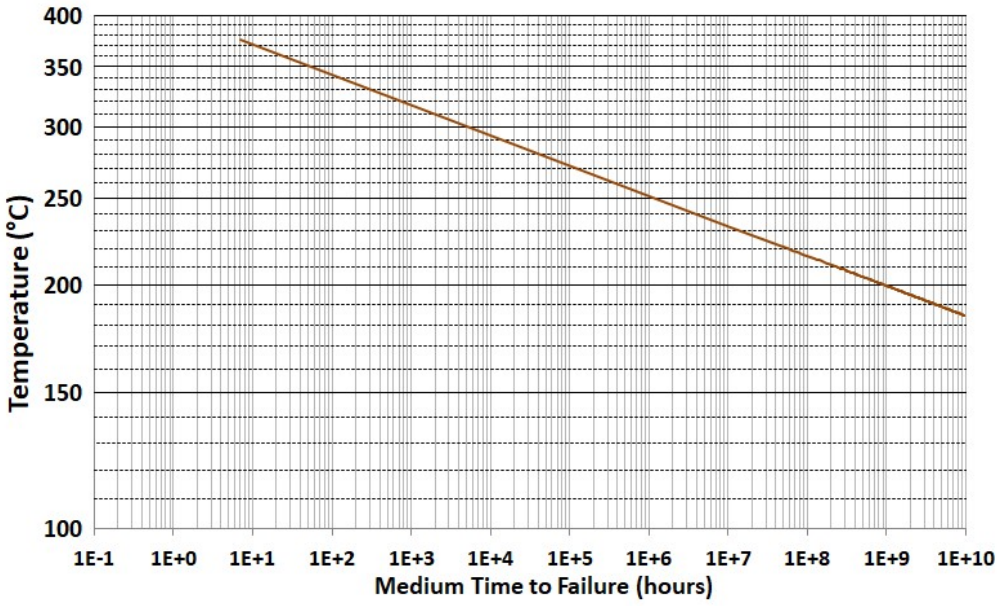
Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Small Signal Gain	G_{ss}		13.1		dB	
Power Gain	G_{SAT}		13.5		dB	
Saturated Drain Efficiency	$DEff_{SAT}$		58		%	
Saturated Output Power	P_{SAT}		49.8		dBm	
Ruggedness Output mismatch	Ψ	VSWR = 10:1, all angles				No damage or shift in performances

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

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

Parameter	Test condition	Value	Units	Notes
Channel Temperature, Tch	Pdiss 22 W	138.2	°C	
Rth		2.42	ºC/W	
MTTF		>1.0E+10	Hrs	
Channel Temperature, Tch	Pdiss 44 W	199.4	°C	
Rth		2.6	ºC/W	
MTTF		1.0E+09	Hrs	
Channel Temperature, Tch	Pdiss 66 W	272.5	°C	
Rth		2.84	ºC/W	
MTTF		1.0E+05	Hrs	

1. Assumes eutectic attach using 1mil low temp solder.
2. Thermal Resistance using Finite Element Analysis (FEA) simulation, calibrated with Infrared measurement on surface temperature.



LOADPULL MEASUREMENT, Vds= 50V Idq = 109 mA

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	1.4 j -5.7	7.3 j 0.9	22.6	50.4	112	52.8	3.6
1200	1.1 j -4.2	9.0 j 1.4	22.5	50.6	114.8	59.1	2.8
1400	0.9 j -3.3	6.6 j 1.4	21.8	50.7	118.1	55.4	2
1600	0.8 j -2.3	6.4 j 2.0	21.2	50.7	119.7	56.8	1.2
1800	0.9 j -1.5	6.4 j 1.8	20.4	50.8	121.2	57.1	1.2
2000	0.7 j -1.0	6.4 j 1.8	19.6	50.6	116.9	56.1	0.9
2200	0.8 j -0.6	5.1 j 1.4	19.2	50.6	116.9	54.7	0.5
2400	0.8 j -0.0	5.4 j 1.4	18.2	50.6	116.1	55.4	0.4
2600	0.8 j 0.6	5.6 j 1.7	18	50.8	121.4	60.3	-0.3
2800	0.8 j 1.0	5.1 j 1.4	17.5	50.8	121.3	58.5	-0.2

For Optimum Peak Efficiency @ 2.5dB Compression

Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	0.8 j -4.5	14.4 j 9.0	25.5	48.8	75.3	66.3	0.5
1200	0.8 j -3.4	13.2 j 9.4	24.1	48.8	76.1	67	1.7
1400	0.7 j -2.5	10.6 j 9.9	23.5	48.7	73.6	67.7	1.5
1600	0.7 j -1.4	9.2 j 10.2	21.9	48.4	68.3	66	1.1
1800	0.6 j -0.9	8.2 j 8.6	21.9	49	80	67.6	-0.1
2000	0.5 j -0.5	6.1 j 6.4	21.2	49.5	88.9	64.3	-2.6
2200	0.5 j -0.1	5.7 j 5.3	21	49.6	92.3	64.4	-2
2400	0.5 j 0.5	5.1 j 5.7	19.8	49.1	81.3	63.2	-2
2600	0.6 j 1.0	5.0 j 5.2	19.1	49.7	92.7	67.8	-2.2
2800	0.5 j 1.4	4.2 j 4.8	19.1	49.4	86.1	66.3	-2.3

LOADPULL MEASUREMENT, Vds= 28V Idq = 109 mA

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

For Optimum Peak Power @ 2.5dB Compression

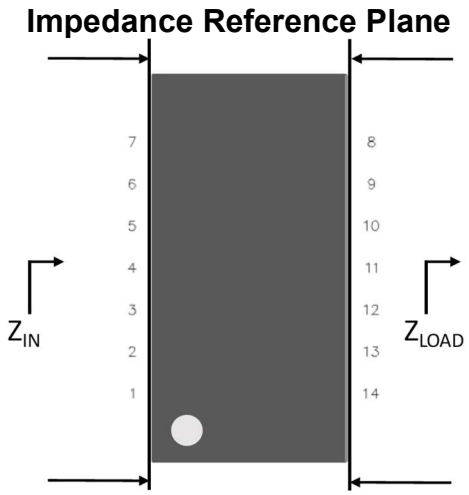
Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	1.3 j -5.3	6.1 j -0.2	22.4	47.6	57.8	59.6	1.5
1200	1.2 j -4.4	4.7 j -0.5	20.9	47.8	61.6	55.5	1
1400	0.8 j -3.3	4.3 j -0.1	20.5	47.9	62.4	56.2	0.4
1600	0.8 j -2.1	5.5 j 0.3	20	47.9	62.9	62.4	0.1
1800	0.8 j -1.4	5.4 j -0.1	19.3	48	63.2	61.5	-0.2
2000	0.8 j -1.0	5.1 j -1.1	17.2	48	62.4	56	0.6
2200	0.7 j -0.5	4.2 j -0.3	17.5	48	64.2	58.8	0.3
2400	0.6 j 0.1	4.4 j 0.0	17.5	47.8	60.4	60.2	-1.2
2600	0.7 j 0.6	4.7 j -1.1	15.7	48.2	65.5	59.1	-0.1
2800	0.7 j 1.1	4.4 j -0.3	16.5	48	62.6	62.1	-1.7

For Optimum Peak Efficiency @ 2.5dB Compression

Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	1.0 j -4.5	8.9 j 2.1	22.6	46.8	47.3	66.3	-0.5
1200	0.7 j -3.5	7.9 j 2.6	22.9	47	50.6	68.4	0.2
1400	0.6 j -2.1	7.8 j 4.7	21.9	46.1	41.9	68.2	-1.6
1600	0.7 j -1.4	7.8 j 3.9	20.3	46.4	44.3	67.4	-1.3
1800	0.5 j -0.9	6.2 j 2.9	20.5	47	51.3	68.7	-1.9
2000	0.5 j -0.5	6.2 j 2.9	19.3	46.9	49.1	66.3	-1.8
2200	0.5 j -0.0	5.1 j 2.6	19.1	46.7	47.9	66.8	-2.2
2400	0.5 j 0.4	4.6 j 2.1	18.2	46.9	49.3	65.3	-2.5
2600	0.5 j 1.1	4.0 j 2.3	18	46.8	48.6	68.6	-3.9
2800	0.5 j 1.4	3.8 j 2.0	17.6	46.7	47.3	67.1	-3.7

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

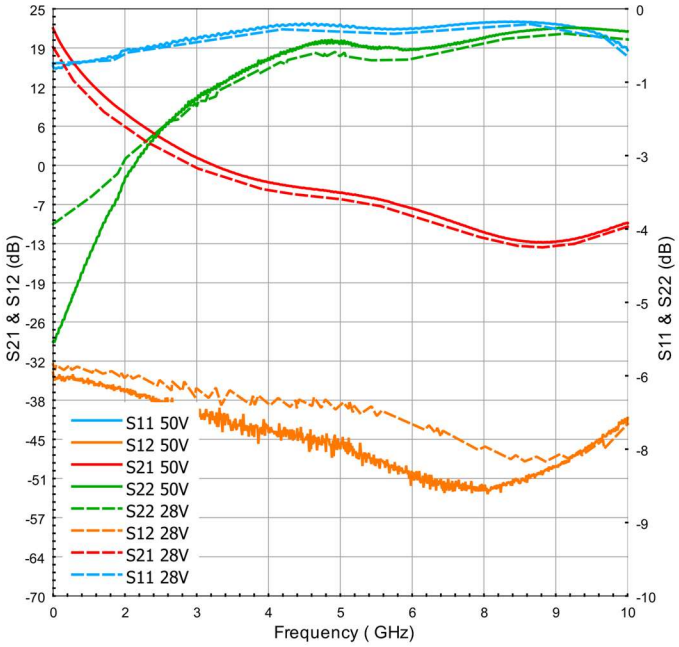


Raw data and full Loadpull measurement report available at request: sales@galliumsemi.com

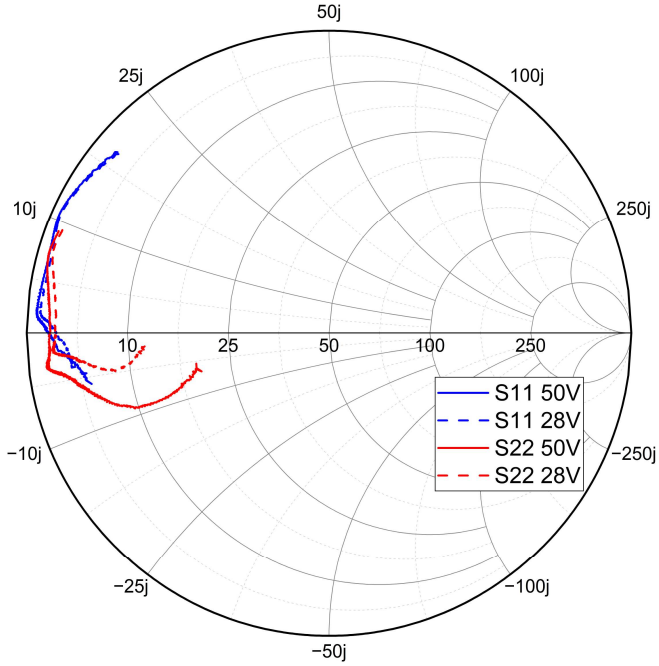
BROADBAND S-PARAMETERS MEASUREMENT, Vds= 28 & 50V Idq = 109 mA

1 Tone CW

S Parameters (Mag-dB)



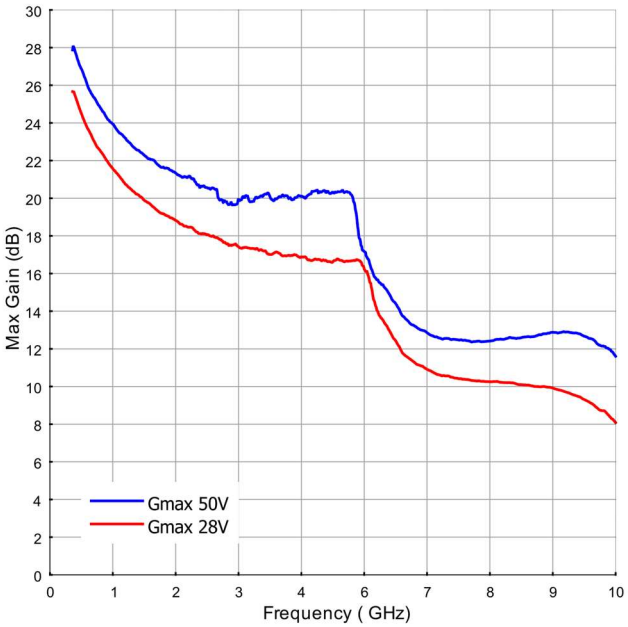
S11 & S22 0.4-10 GHz



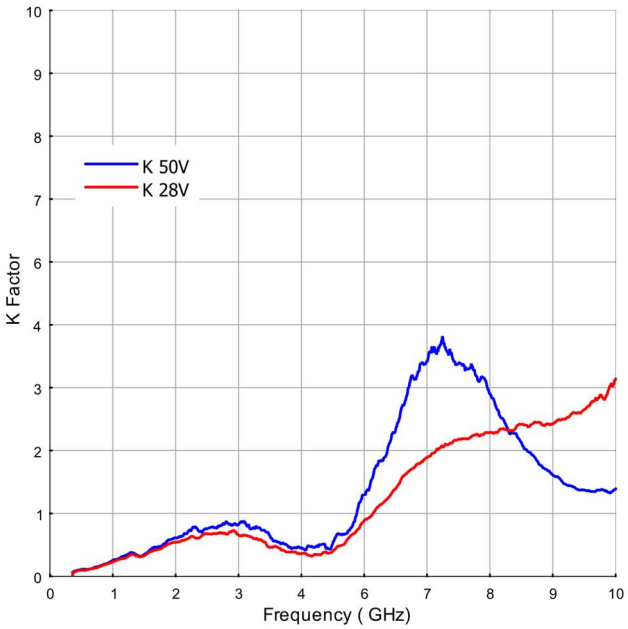
BROADBAND S-PARAMETERS MEASUREMENT, Vds= 28 & 50V Idq = 109 mA

1 Tone CW

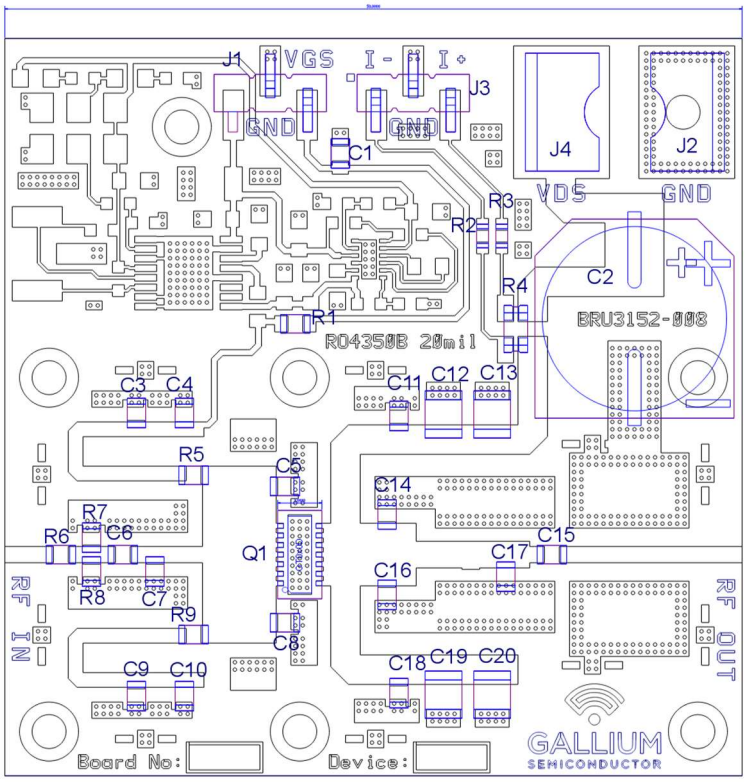
Maximum Available Gain



K Factor



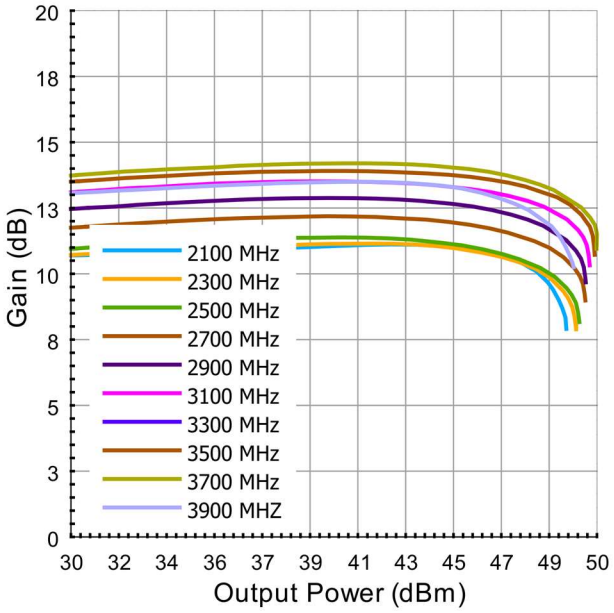
EVALUATION TEST FIXTURE 2.1-3.7 GHZ



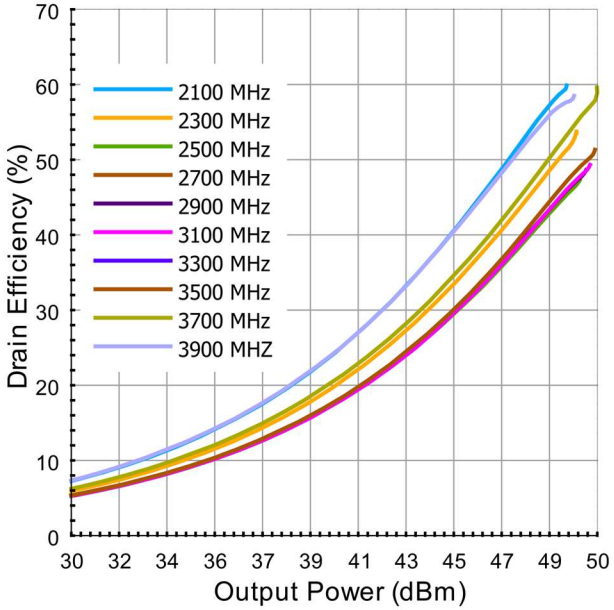
COMPONENT DESIGNATOR	VALUE	SIZE	PART NUMBER	REMARKS
Q1	GT090D	6 x 3 mm DFN	Gallium GT090D	
C1	10 µF	0805	Murata GRM21BC71E106K	-
C2	220 µF	12.5 mm	Nichicon UCZ1J221MN1Z	63 V
C3, C6 C9, C11, C15, C18	6.8 pF	0805	ATC 600F6R8BT250XT	ATC 600F series
C4, C10	10 nF	0805	Murata GRM2165C2A103J	-
C5	0.6 pF	0805	ATC 600F0R6AT250XT	ATC 600F series
C8	0.7 pF	0805	ATC 600F0R7AT250XT	ATC 600F series
C7	0.5 pF	0805	ATC 600F0R7AT250XT	ATC 600F series
C12, C13, C19, C20	10 µF	1210	Murata GRM32EC72A106K	100V
C14, C16	1.1pF	0805	ATC 600F1R1AT250XT	ATC 600F series
C17	0.4 pF	0805	ATC 600F0R4AT250XT	ATC 600F series
J1	Pin header	5.1 mm	Samtec TSM-103-01-L-SV	Gate circuit supply
J3	Pin header	5.1 mm	Samtec TSM-103-01-L-SV	Current sense resistor outputs
J4	Faston connector	6.3 x 0.8 mm	-	Drain supply
J5	Faston connector	6.3 x 0.8 mm	-	Drain supply ground reference
PCB	PCB	50.0 x 50.0 mm	-	Rogers RO4350B, 20 mill thickness
R1	DNP	0805	-	0 Ω
R2, R3	1.0 kΩ	0603	-	-
R4	10 mΩ	1206	Ohmite LVK12R010C	0.5 W, 0.25 %
R5	5.1 Ω	0805	Yageo RT0805DRD075R1L	-
R6	2.0 Ω	0805	Vishay PCAN0805K2R00F	1 W, 1 %
R7, R8	1.0 kΩ	0805	Vishay PCAN0805E1001B	1 W, 0.1 %
R9	DNP	0805	-	-

Typical Performance Curves as Measured in the 2.1-3.7 GHz Evaluation Test Fixture:
Pulsed CW (10% duty cycle, 100µs width) , VDS = 50 V, IDQ =109 mA, TC = 25°C (Unless Otherwise Noted)

Gain vs. Output Power and Frequency

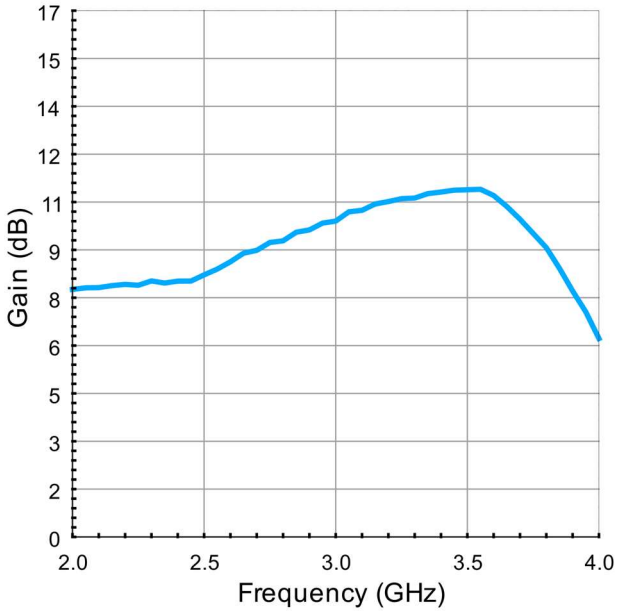


Drain Efficiency vs. Output Power and Frequency

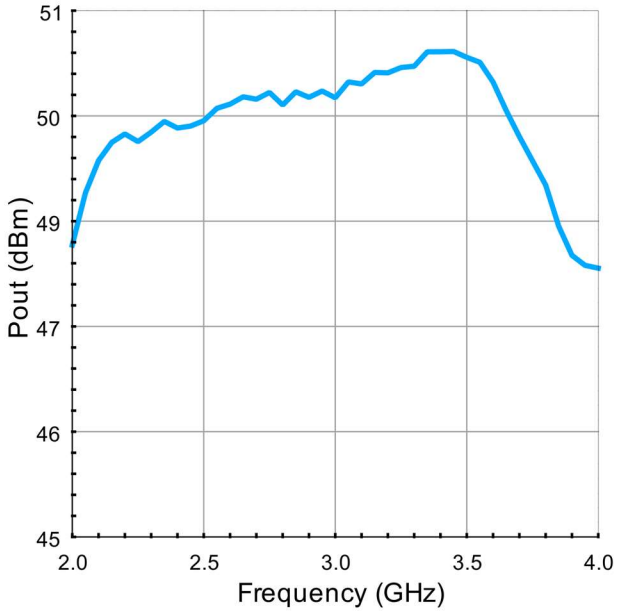


Typical Performance Curves as Measured in the 2.1-3.7 GHz Evaluation Test Fixture:
Pulsed CW (10% duty cycle, 100µs width) , VDS = 50 V, IDQ =109 mA, TC = 25°C (Unless Otherwise Noted)

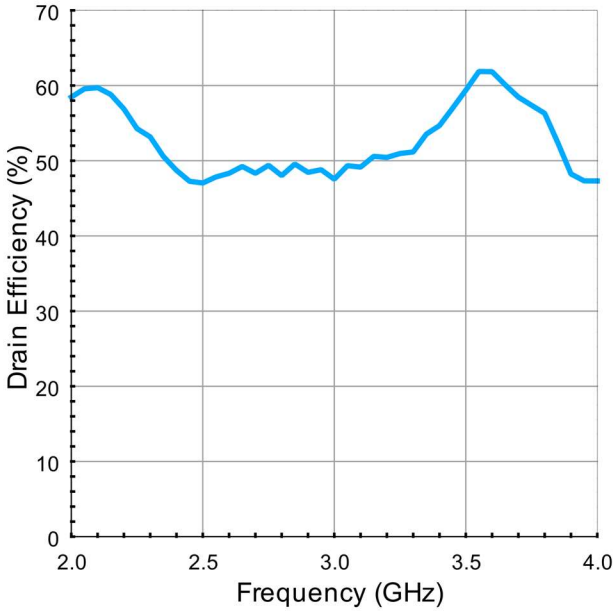
Gain vs. Frequency, 2.5dB Compression



Pout vs. Frequency, 2.5dB Compression



Drain Efficiency vs. Frequency, 2.5dB Compression



GaN HEMT BIASING SEQUENCE

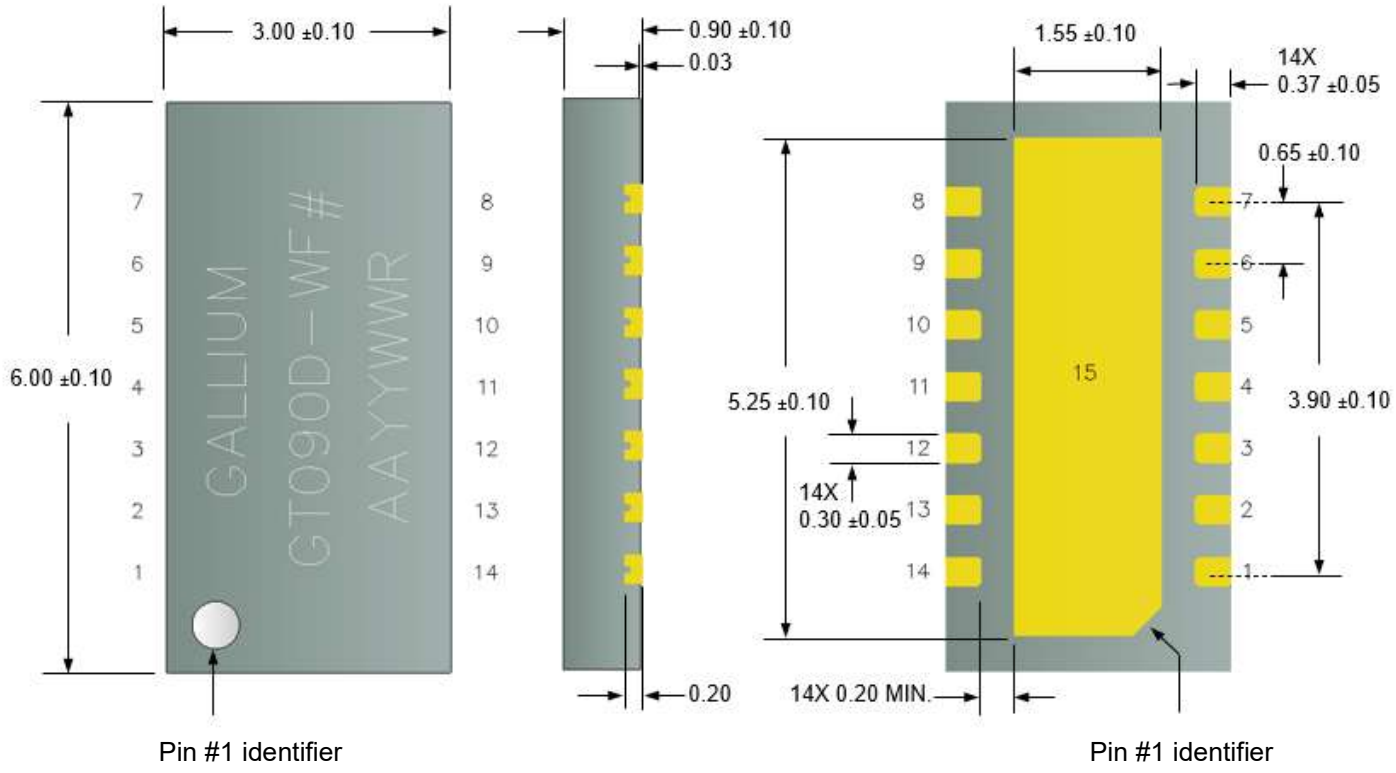
To turn the transistor ON

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 (109 mA)
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



Pin #1 identifier

Pin #1 identifier

Note: Dimension in mm

PIN CONFIGURATION

Pin	Input/Output
1	Not connected
2, 3, 4, 5, 6	RF Input / Gate Voltage
7, 8	Not connected
9, 10, 11, 12, 13	RF Output / Drain Voltage
14	Not connected
15 (Paddle)	Ground

DEVICE LABEL

Line 1:	COMPANY NAME:	GALLIUM
Line 2:	PART NUMBER - WAFER #	
Line 3:	AA:	Assembly Code
	YYWW:	Assembly Date Code
	R:	Reserved code

HANDLING PRECAUTIONS

Parameter	Symbol	Class	Test Methodology
ESD – Human Body Model	HBM	Class 1A (250 V)	ANSI/ESDA/JEDEC Standard JS-001
ESD – Charged Device Model	CDM	Class C3 (1500 V)	ANSI/ESDA/JEDEC Standard JS-002
MSL – Moisture Sensitivity Level	MSL	MSL 1	IPC/JEDEC Standard J-STD-020

RoHS COMPLIANCE

Gallium Semiconductor's Policy on EU RoHS available online:
https://www.galliumsemi.com/_files/ugd/3748d3_1107b9788f9845f78f45d424097c4c97.pdf

CONTACT INFORMATION

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

Web: https://www.galliumsemi.com/

Email: sales@galliumsemi.com

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