

**GT135D****50V, DC – 3.2GHz, 135W GaN HEMT****FEATURES**

- Operating Frequency Range: DC to 3.2GHz
- Operating Drain Voltage: 28V & 50V
- Maximum Output Power ( $P_{SAT}$ ): 150W
- Surface Mount Plastic Package
- Suitable for Pulsed, Linear applications
- 100% DC & RF Production Tested



14 Pin 6x3 mm DFN Package

**DESCRIPTION**

The GT135D is a 150W (P3dB) unmatched discrete GaN-on-SiC HEMT which operates from DC to 3.2GHz on a 50V supply rail. The wide bandwidth of the GT135D 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, 100 $\mu$ s width), 2<sup>nd</sup> Harmonics NOT optimized

(1) Optimum Peak Power at 2.5dB in compression

(2) Optimum Peak Efficiency at 2.5dB in compression

**V<sub>ds</sub>=50V, I<sub>dq</sub>= 150 mA, T<sub>A</sub> = 25°C**

Frequency (MHz)	P <sub>out</sub> <sup>(1)</sup> (dBm)	Gain <sup>(2)</sup> (dB)	Eff <sup>(2)</sup> (%)
1000	51.4	24.2	64.4
1200	51.8	22.7	67.3
1400	51.8	21.8	66.1
1600	51.8	20.4	66.1
1800	51.9	19.6	66.1
2000	51.7	18.4	63.8
2200	51.7	17.9	64.3
2400	51.7	17	62.3
2600	51.9	16.3	66.1
2800	51.7	16	64.2

**V<sub>ds</sub>=28V, I<sub>dq</sub>= 150 mA, T<sub>A</sub> = 25°C**

Frequency (MHz)	P <sub>out</sub> <sup>(1)</sup> (dBm)	Gain <sup>(2)</sup> (dB)	Eff <sup>(2)</sup> (%)
1000	48.5	23.5	64.1
1200	49.4	20.2	64.7
1400	49	19.7	67.3
1600	49.4	18.6	67.1
1800	49.4	17.4	68.5
2000	49.3	16.6	66.3
2200	49.3	15.9	66.5
2400	49.3	15	63.7
2600	49.4	14.2	67.4
2800	49.1	13.8	65.5

## GT135D

## 50V, DC – 3.2GHz, 135W GaN HEMT

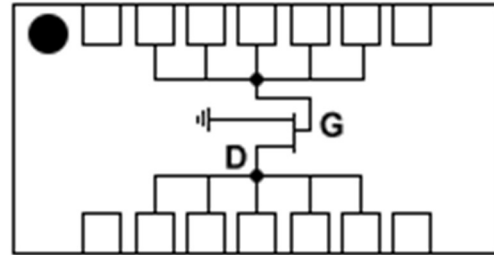
## ABSOLUTE MAXIMUM RATINGS (1, 2)

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:  $T_A = 25^\circ\text{C}$ 

Parameter	Min.	Typ.	Max.	Symbols and Units	Test conditions
Frequency Range	DC		3200	MHz	
<b>DC Characteristics</b>					
Drain Source Breakdown Voltage	150			$V_{BDSS}$ (V)	
Drain Source Leakage Current		13		$I_{DLK}$ (mA)	$V_{gs} = -8V, V_{ds} = 50V$
Gate Threshold Voltage	-3.4		-1.5	$V_{GS}$ (V)	$V_{ds} = 50V$
<b>Operating Conditions</b>					
Gate Bias Voltage	-3.4	-2.5		$V_{GSQ}$ (V)	
Drain Voltage		50		$V_{DSQ}$ (V)	
Quiescent Drain Current		150		$I_{DQ}$ (mA)	

**GT135D****50V, DC – 3.2GHz, 135W GaN HEMT**
**RF ELECTRICAL SPECIFICATIONS:  $T_A = 25^\circ\text{C}$ ,  $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 150\text{ mA}$ , Freq= 3200MHz**
**Note: Performance<sup>(1)</sup> in GalliumSemi Production Test Fixture, 50  $\Omega$  system**

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Small Signal Gain	$G_{SS}$		12.8		dB	
Power Gain	$G_{SAT}$		13.3		dB	
Saturated Drain Efficiency	$DEff_{SAT}$		57		%	
Saturated Output Power	$P_{SAT}$		51.8		dBm	
Ruggedness Output mismatch	$\Psi$	VSWR = 10:1, all angles				No damage or shift in performances

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

GT135D

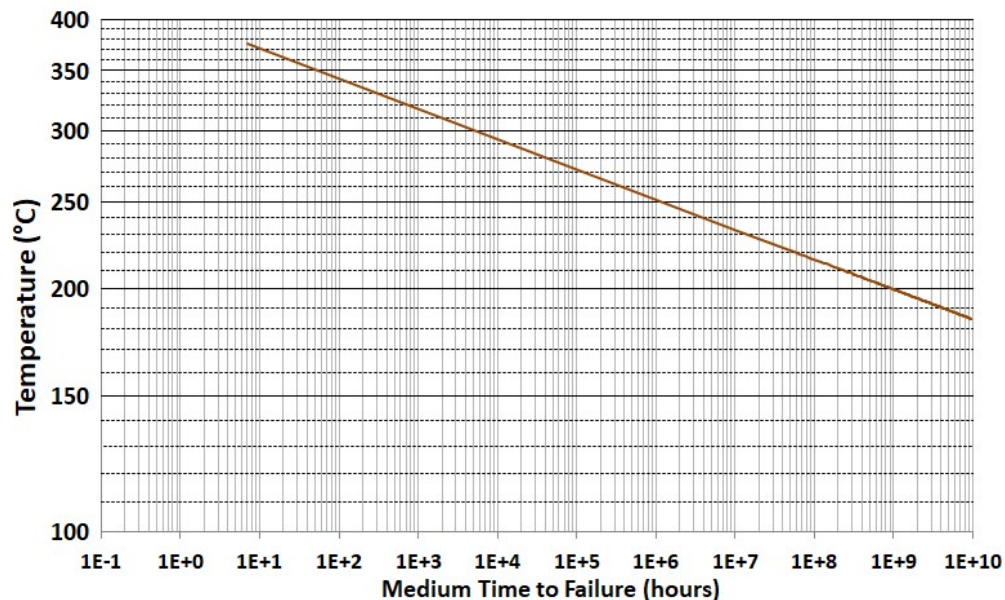
50V, DC – 3.2GHz, 135W GaN HEMT

**THERMAL AND RELIABILITY INFORMATION -CW <sup>(1, 2)</sup>: T<sub>c</sub> = 85°C**

Parameter	Test condition	Value	Units	Notes
Channel Temperature, T <sub>ch</sub>		143.6	°C	
R <sub>th</sub>	P <sub>diss</sub> 30 W	1.95	°C/W	
MTTF		>1.0E+10	Hrs	
Channel Temperature, T <sub>ch</sub>		211.3	°C	
R <sub>th</sub>	P <sub>diss</sub> 60 W	2.11	°C/W	
MTTF		2.30E+08	Hrs	
Channel Temperature, T <sub>ch</sub>		288.5	°C	
R <sub>th</sub>	P <sub>diss</sub> 90 W	2.26	°C/W	
MTTF		18000	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.



## GT135D

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LOADPULL MEASUREMENT,  $V_{ds} = 50V$   $I_{dq} = 150$  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 -4.0	6.5 j 0.9	22	51.4	142.1	54.4	3.2
1200	1.4 j -3.1	5.6 j -0.0	19.7	51.8	150.8	54	4.7
1400	1.1 j -2.0	5.7 j 1.7	20.5	51.8	153.1	60.7	2.1
1600	1.0 j -1.3	4.9 j 1.7	19	51.8	154	58.9	1.6
1800	1.1 j -0.7	5.4 j 0.9	18	51.9	155.2	58.4	1.8
2000	1.0 j -0.3	5.4 j 1.1	17	51.7	149.1	57.7	1.7
2200	1.0 j 0.1	4.3 j 0.4	16.1	51.7	150.6	55.4	2.4
2400	1.0 j 0.5	4.4 j 0.3	14.9	51.7	148.2	54.7	2.6
2600	1.0 j 1.0	3.8 j -0.2	14.5	51.9	153.1	54.6	1.8
2800	1.0 j 1.5	4.2 j 0.5	14.8	51.7	148.3	57.9	-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	0.8 j -3.0	9.7 j 7.8	24.2	49.6	92.9	64.4	-0.2
1200	0.7 j -2.4	7.3 j 5.3	22.7	50.9	125.2	67.3	-1.1
1400	0.7 j -1.5	6.2 j 5.7	21.8	50.4	111.7	66.1	-1.7
1600	0.7 j -0.7	5.8 j 6.4	20.4	49.9	97.7	66.1	-1.9
1800	0.7 j -0.2	5.0 j 5.2	19.6	50.3	109.3	66.1	-2.8
2000	0.7 j 0.1	4.5 j 4.4	18.4	50.4	112.2	63.8	-2.3
2200	0.7 j 0.4	4.0 j 3.5	17.9	50.7	117.7	64.3	-2.4
2400	0.8 j 0.8	3.4 j 3.2	17	50.4	109	62.3	-2.9
2600	0.7 j 1.4	2.8 j 3.0	16.3	50.4	109.6	66.1	-4
2800	0.7 j 1.6	2.8 j 2.4	16	50.6	113.2	64.2	-3.3

## GT135D

## 50V, DC – 3.2GHz, 135W GaN HEMT

## LOADPULL MEASUREMENT, Vds= 28V Idq = 150 mA

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

## For Optimum Peak Power @ 2.5dB Compression

Freq-MHz	Zin_F0	ZI_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	0.9 j -3.8	3.9 j 0.1	21.8	48.5	72.8	55.9	2.6
1200	0.9 j -3.0	3.3 j -0.4	20.3	49.4	86.3	55.6	1
1400	0.9 j -2.0	2.9 j -0.6	18.2	49	78.9	54	5.8
1600	1.0 j -1.3	2.9 j -0.9	16.6	49.4	87.5	52.7	0.2
1800	1.0 j -0.7	3.1 j -1.4	15.6	49.4	87.6	54.6	1.9
2000	0.9 j -0.3	3.1 j -1.3	15.1	49.3	85.8	55.1	1
2200	0.8 j 0.2	2.9 j -1.3	14.7	49.3	86.9	56.5	1.3
2400	1.0 j 0.6	3.0 j -1.8	13.5	49.3	84.9	53.5	0.7
2600	1.0 j 1.1	2.6 j -1.5	13.6	49.4	87.8	57.1	-0.5
2800	0.8 j 1.5	2.5 j -1.8	12.9	49.1	83.7	54	0.2

## For Optimum Peak Efficiency @ 2.5dB Compression

Freq-MHz	Zin_F0	ZI_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
1000	0.6 j -2.5	6.4 j 3.6	23.5	46.7	47.7	64.1	0
1200	0.9 j -1.8	7.3 j 3.2	20.2	46.9	49.7	64.7	0.6
1400	0.8 j -1.4	5.4 j 1.3	19.7	48.1	64.4	67.3	1.6
1600	0.7 j -0.5	5.0 j 3.0	18.6	47.3	54.2	67.1	-2.5
1800	0.7 j -0.1	4.7 j 2.0	17.4	47.9	62.3	68.5	-1.9
2000	0.6 j 0.2	3.9 j 1.5	16.6	48.1	64.6	66.3	-3
2200	0.7 j 0.5	3.6 j 1.4	15.9	47.8	60.3	66.5	-2.7
2400	0.7 j 1.1	3.0 j 1.6	15	47	51.4	63.7	-3.6
2600	0.7 j 1.5	3.2 j 0.7	14.2	48.1	66.2	67.4	-4
2800	0.7 j 1.8	3.0 j 0.5	13.8	47.9	61.7	65.5	-3.5

## LOADPULL MEASUREMENT NOTES

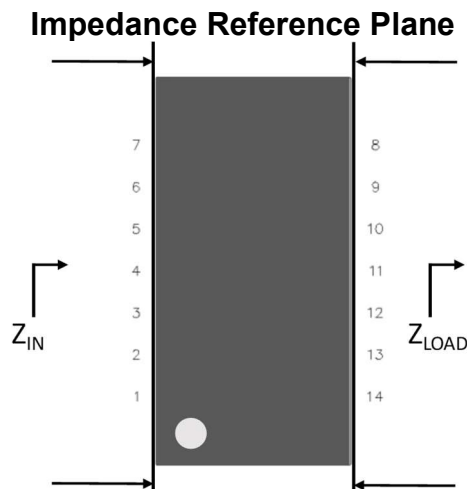
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Source and Load impedance @ 2nd Harmonic are set to 10 Ohms

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

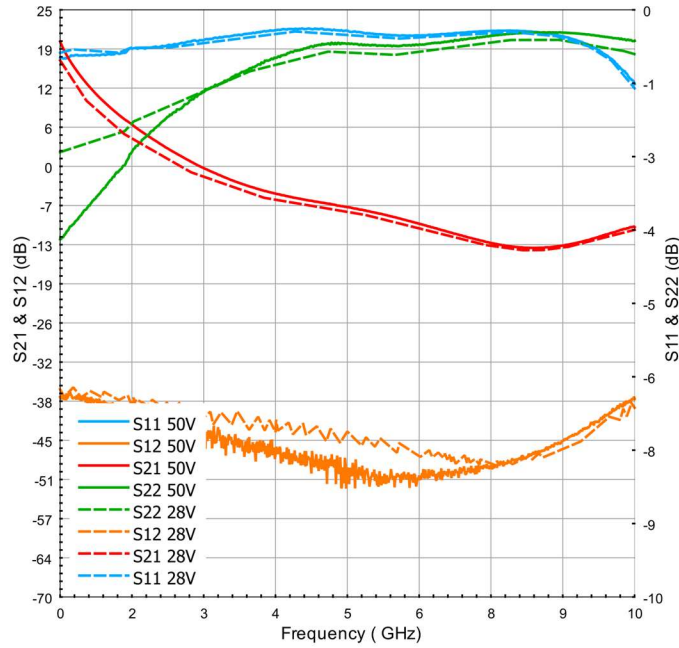


Raw data and full Loadpull measurement report available at request: [sales@galliumsemi.com](mailto:sales@galliumsemi.com)

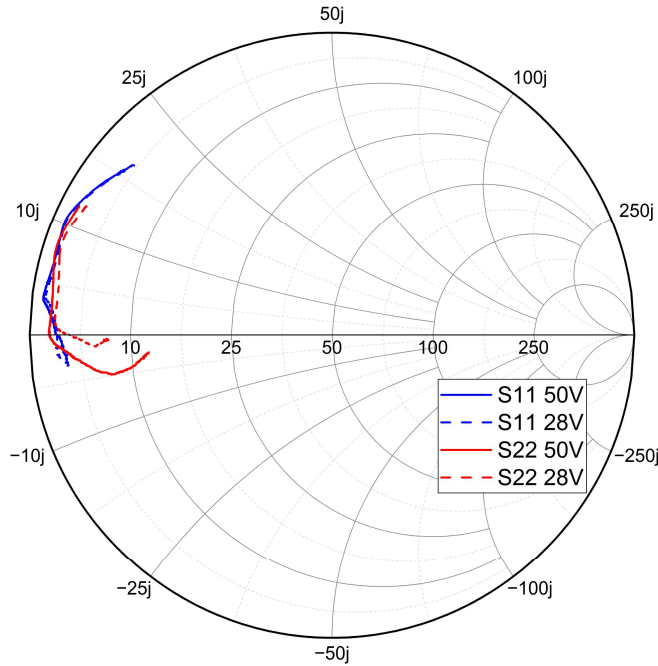
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**BROADBAND S-PARAMETERS MEASUREMENT,  $V_{ds}= 28 \text{ \& 50V}$   $I_{dq} = 150 \text{ mA}$**   
**1 Tone CW**

**S Parameters (Mag-dB)**



**S11 & S22 0.4-10 GHz**

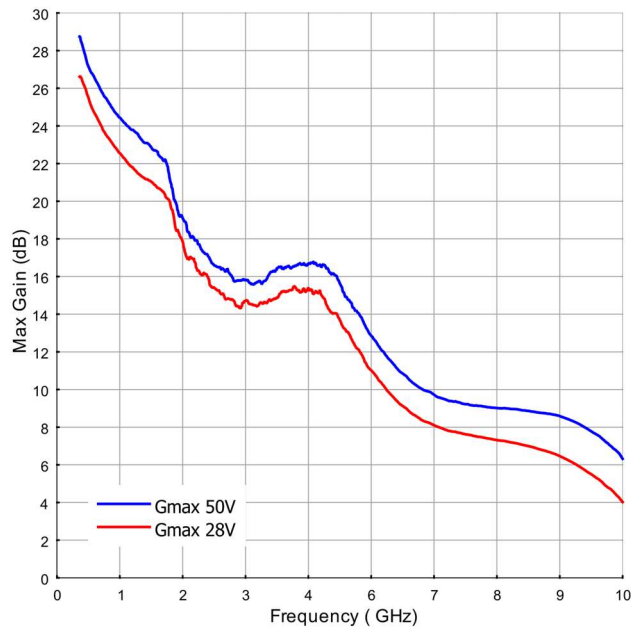




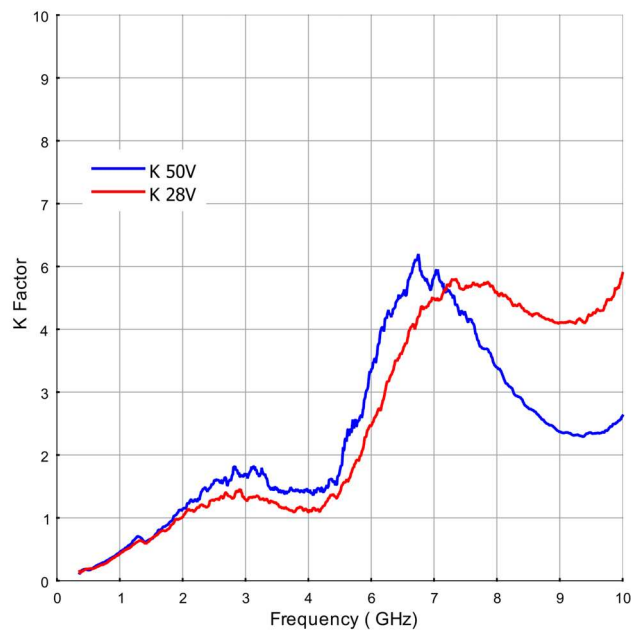
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**BROADBAND S-PARAMETERS MEASUREMENT,  $V_{ds} = 28$  &  $50V$   $I_{dq} = 153$  mA**  
**1 Tone CW**

**Maximum Available Gain**



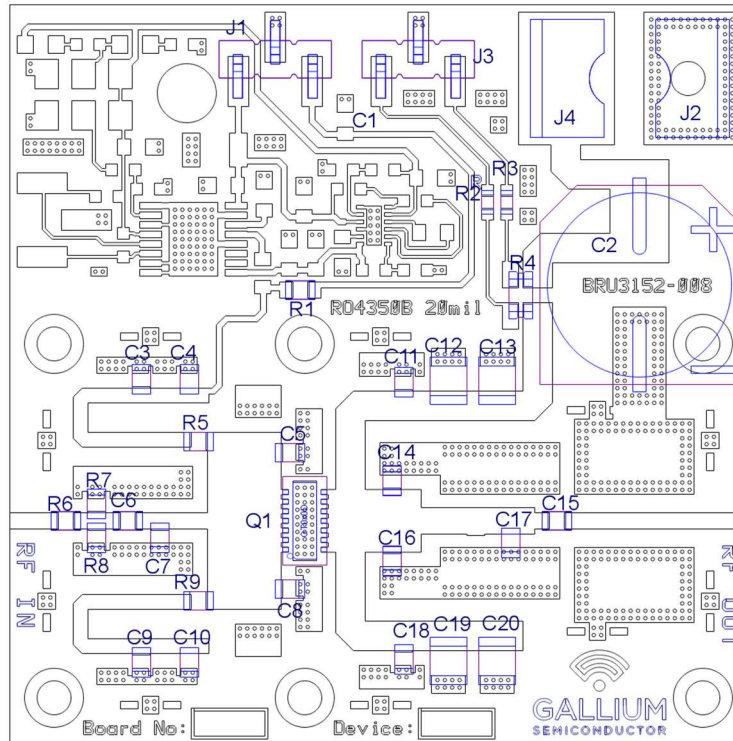
**K Factor**



## GT135D

## 50V, DC – 3.2GHz, 135W GaN HEMT

## EVALUATION TEST FIXTURE 2.3-3.2 GHZ

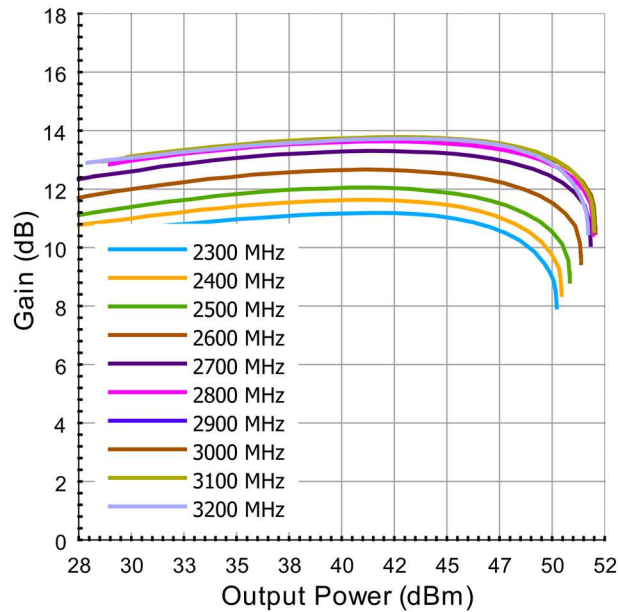


COMPONENT DESIGNATOR	VALUE	SIZE	PART NUMBER	REMARKS
Q1	GT1350D	6 x 3 mm DFN	Gallium GT135D	
C1	10 $\mu$ F	0805	Murata GRM21BC71E106K	-
C2	220 $\mu$ F	12.5 mm	Nichicon UCZ1J221MN1Z	63 V
C3, C9, C11, C15, C18	6.8 pF	0805	ATC 600F6R8BT250XT	ATC 600F series
C4, C10	10 nF	0805	Murata GRM2165C2A103J	-
C6	3.3 pF	0805	ATC 600F3R3BT250XT	ATC 600F series
C5	1.2 pF	0805	ATC 600F1R2AT250XT	ATC 600F series
C8	1.2 pF	0805	ATC 600F1R2AT250XT	ATC 600F series
C7	0.7 pF	0805	ATC 600F0R7AT250XT	ATC 600F series
C12, C13, C19, C20	10 $\mu$ F	1210	Murata GRM32EC72A106K	100V
C14, C16	1.5pF	0805	ATC 600F1R5AT250XT	ATC 600F series
C17	0.1 pF	0805	ATC 600F0R7AT250XT	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 $\Omega$
R2, R3	1.0 k $\Omega$	0603	-	-
R4	10 m $\Omega$	1206	Ohmite LVK12R010C	0.5 W, 0.25 %
R5	5.1 $\Omega$	0805	Yageo RT0805DRD075R1L	-
R6	2.0 $\Omega$	0805	Vishay PCAN0805K2R00F	1 W, 1 %
R7, R8	1.0 k $\Omega$	0805	Vishay PCAN0805E1001B	1 W, 0.1 %
R9	DNP	0805	-	-

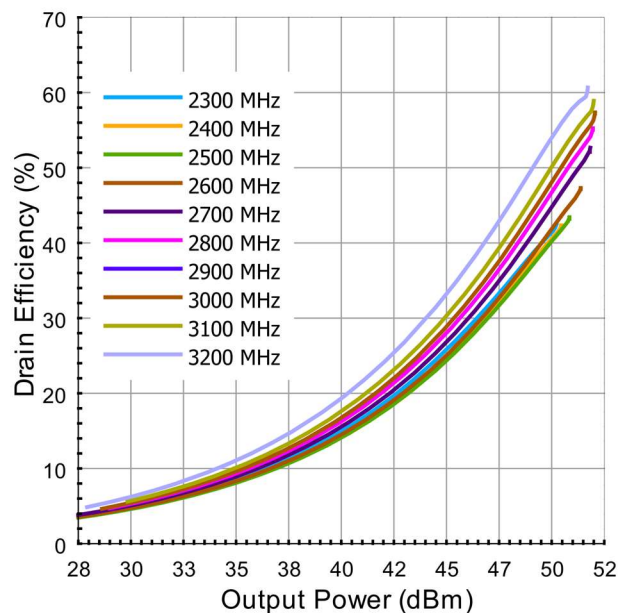
**GT135D** **50V, DC – 3.2GHz, 135W GaN HEMT**

**Typical Performance Curves as Measured in the 2.3-3.2 GHz Evaluation Test Fixture:**  
 Pulsed CW (10% duty cycle, 100µs width) , VDS = 50 V, IDQ =153 mA, TC = 25°C (Unless  
 Otherwise Noted)

**Gain vs. Output Power and Frequency**



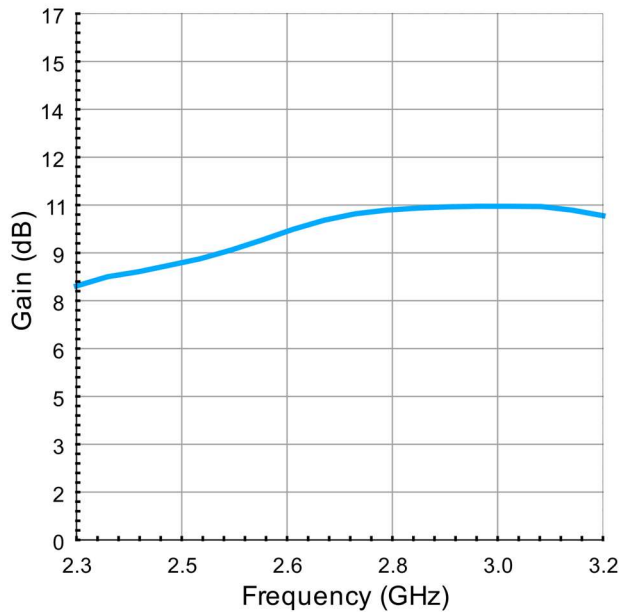
**Drain Efficiency vs. Output Power and Frequency**



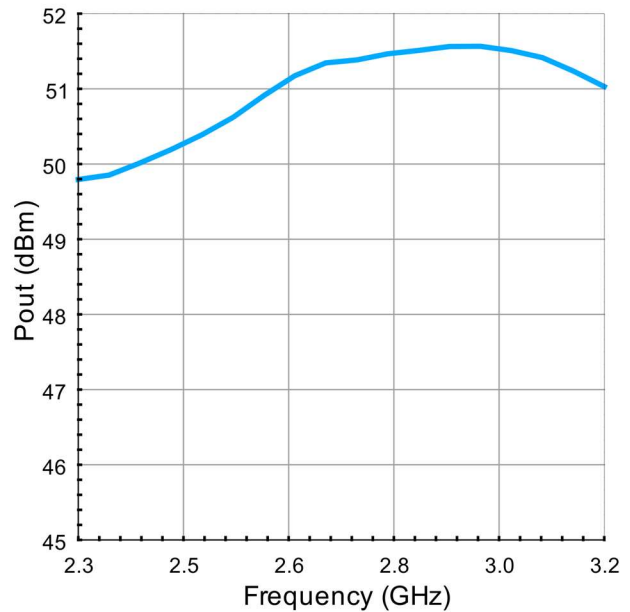
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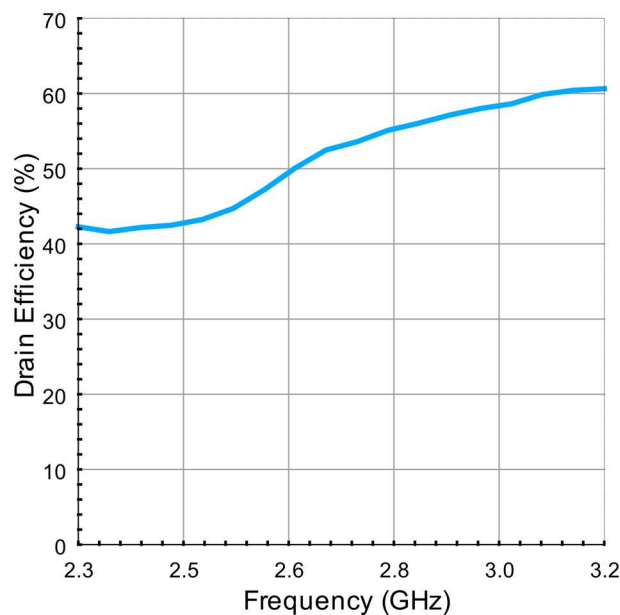
**Gain vs. Frequency, 2.5dB Compression**



**Pout vs. Frequency, 2.5dB Compression**



**Drain Efficiency vs. Frequency, 2.5dB Compression**



**GT135D****50V, DC – 3.2GHz, 135W GaN HEMT****GaN HEMT BIASING SEQUENCE**

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**To turn the transistor ON**

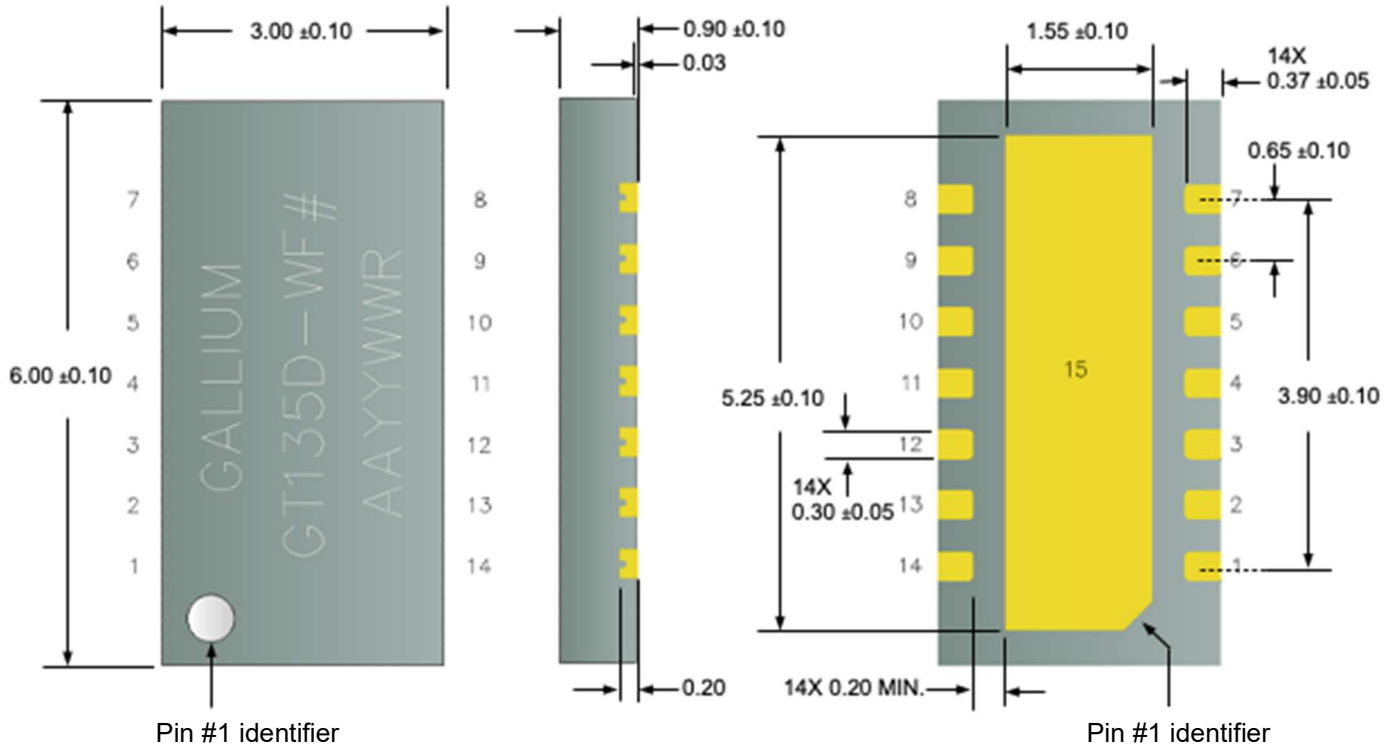
1. Set  $V_{GS}$  to -5V
2. Turn on  $V_{DS}$  to normal operation voltage (50V)
3. Slowly increase  $V_{GS}$  to set  $I_{DQ}$  current (153 mA)
4. Apply RF power

**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  $V_{GS}$

**GT135D** **50V, DC – 3.2GHz, 135W GaN HEMT**

**PACKAGE DIMENSIONS**



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

**GT135D****50V, DC – 3.2GHz, 135W GaN HEMT****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](https://www.galliumsemi.com/files/ugd/3748d3_1107b9788f9845f78f45d424097c4c97.pdf)

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## CONTACT INFORMATION

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

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

Email: [sales@galliumsemi.com](mailto:sales@galliumsemi.com)

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