GTH0-0006050S 50V, DC – 6.0GHz, 50W GaN HEMT

FEATURES

- Operating Frequency Range: DC to 6.0GHz
- Operating Drain Voltage: 28V & 50V
- Maximum Output Power (P_{SAT}): 50W
- Air Cavity Ceramic package
- Suitable for CW, Pulsed, Linear applications
- 100% DC & RF Production Tested

NI-360 Ceramic Package

DESCRIPTION

The GTH0-0006050S is a 50W (P3dB) unmatched discrete GaN-on-SiC HEMT which operates from DC to 6.0GHz on a 50V supply rail. The wide bandwidth of the GTH0-0006050S makes it suitable for a variety of applications including cellular infrastructure, radar, communications, and test instrumentation, and can support CW, linear and pulse operations.

The device is housed in an industry-standard NI-360 Air Cavity Ceramic 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= 47 mA, T_A = 25°C

Frequency (MHz)	Pout(1) (dBm)	Gain(2) (dB)	Eff(2) (%)
800	46.2	23.1	71.2
1000	47	22.8	64.2
1500	46.8	21.4	67.1
2000	47.2	20	68.6
2500	47.1	17.7	64.4
3000	47	16.3	66
3500	47.2	16	66.6
4000	47.1	15.4	67.6
4500	47.3	15.1	66.4
5000	47.4	14.4	67.3

Vds=28V, Idq= 47 mA, T_A = 25°C

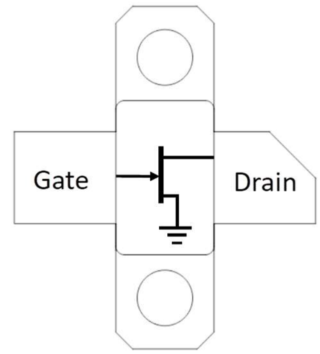
Frequency (MHz)	Pout(1) (dBm)	Gain(2) (dB)	Eff(2) (%)
800	43.7	21.8	71.4
1000	44.5	19.4	69.2
1500	44.4	19.3	66.8
2000	44.6	17.8	69.7
2500	44.6	16	66.7
3000	44.6	14.7	68.3
3500	44.7	14	68.6
4000	44.6	13.1	69.7
4500	44.7	12.5	69.6
5000	44.8	12.3	69.8

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		6000	MHz	
DC Characteristics					
Drain Source Breakdown Voltage	150			V_{BDSS} (V)	
Drain Source Leakage Current		4		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		47		I_{DQ} (mA)	

RF ELECTRICAL SPECIFICATIONS: T_A = 25°C, VDS = 50 V, IDQ = 47 mA, Freq= 3600MHz
Note: Performance(1) in GalliumSemi Production Test Fixture, 50 Ω system

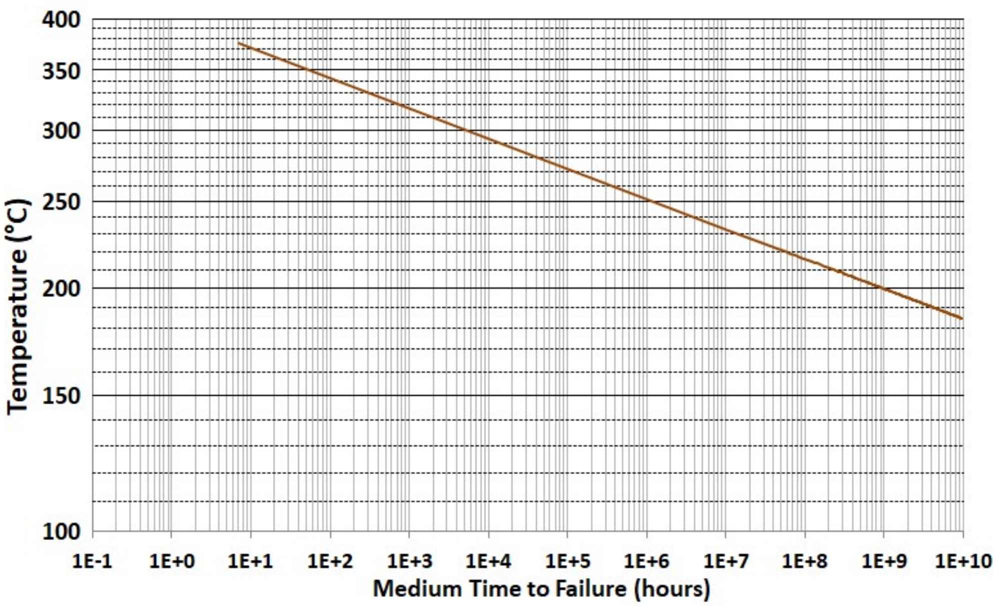
Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Small Signal Gain	G_{ss}		tbd		dB	
Power Gain	G_{SAT}		tbd		dB	
Saturated Drain Efficiency	$DEff_{SAT}$		tbd		%	
Saturated Output Power	P_{SAT}		tbd		dBm	
Ruggedness Output mismatch	Ψ	VSWR = 10:1, all angles				No damage or shift in performances

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

THERMAL AND RELABILITY INFORMATION -CW (1, 2, 3): T_C = 85°C

Parameter	Test condition	Value	Units	Notes
Channel Temperature, Tch	Pdiss 9 W	142	°C	
Rth		6.3	ºC/W	
MTTF		>1.0E10	Hrs	
Channel Temperature, Tch	Pdiss 18 W	207	°C	
Rth		6.8	ºC/W	
MTTF		4.0E8	Hrs	
Channel Temperature, Tch	Pdiss 28 W	290	°C	
Rth		7.3	ºC/W	
MTTF		1.4E4	Hrs	

1.Using 5um thermal grease - 4W/m-K.
2.Thermal Resistance using Finite Element Analysis (FEA) simulation, calibrated with Infrared measurement on surface temperature.
3.Rth vs Dissipated Power can be generalized with the following equation: Rth(ºC/W) = 0.0547x Pdiss(W) + 5.7951

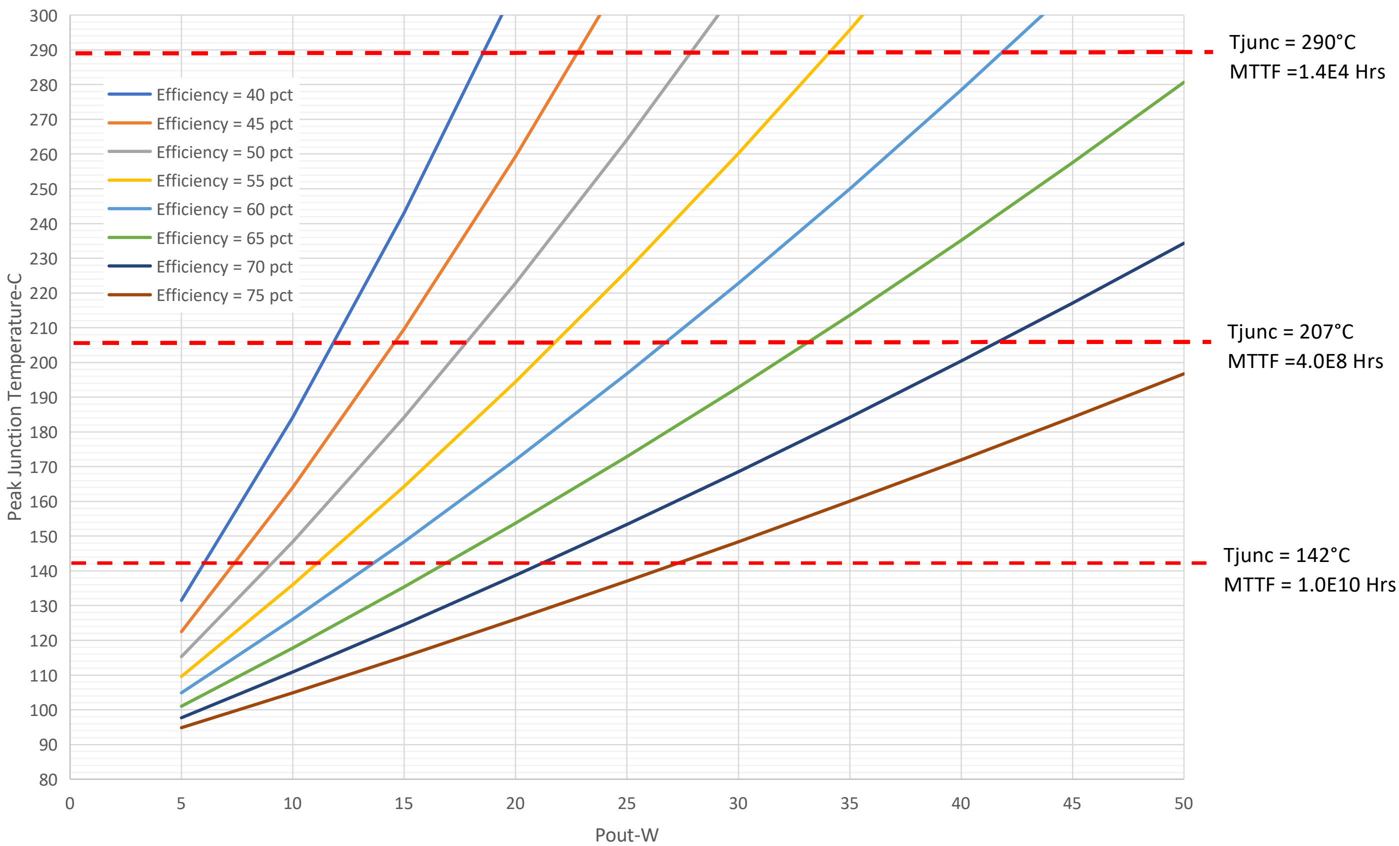


CW OPERATION

The device can withstand CW operation with respect to the application's MTTF (Life time vs. Peak Junction Temperature).

The graph(1,2) below shows the Peak Junction Temperature vs. the Output Power & Efficiency trade-off, using the following equations:
- Tjunc(ºC) = Pdiss(w) x Rth(ºC/W)
- Pdiss(W) = (Pout(w)/ Efficiency(%)) - Pout(w)

E.g.: The device can be used for Pout =34W CW with Efficiency of 55%, Tjunc will be 290ºC, leading to a LifeTime (MTTF) of 1.4E4 Hrs.



Notes:
5um thermal grease - 4W/m-K
Back of pkg is 85°C infinite heat sink

LOADPULL MEASUREMENT, Vds= 50V Idq = 47 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
800	4.4 j -14.8	17.3 j 2.2	21.9	46.2	42.5	53.9	2.9
1000	3.9 j -12.1	16.7 j 2.2	21.1	47	50.2	53.6	0.6
1500	2.6 j -6.1	14.9 j 7.2	19.6	46.8	48.8	58.6	2
2000	2.4 j -2.3	12.7 j 5.3	18	47.2	51.9	56.9	0
2500	2.0 j 1.0	10.1 j 5.5	16.9	47.1	51.3	58.2	-0.5
3000	2.5 j 3.4	8.8 j 2.1	14.7	47	50	54.6	-0.3
3500	2.6 j 6.1	8.0 j 2.2	14.6	47.2	52.3	59.2	-0.8
4000	3.4 j 9.5	7.1 j -0.1	13.9	47.1	51.6	60.5	-1.9
4500	5.0 j 14.4	7.4 j -1.7	13.4	47.3	53.3	59.4	-2.7
5000	8.9 j 22.8	7.7 j -3.5	12.8	47.4	54.9	60.8	-3

For Optimum Peak Efficiency @ 2.5dB Compression

Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
800	3.4 j -12.2	31.7 j 18.3	23.1	45.3	34.5	71.2	1
1000	2.5 j -9.1	19.4 j 17.7	22.8	45.4	35.6	64.2	0.5
1500	1.6 j -4.7	11.4 j 15.4	21.4	45.8	38.4	67.1	-1
2000	1.5 j -0.5	7.1 j 13.2	20	45.1	32.5	68.6	-0.8
2500	1.6 j 1.8	6.2 j 10.6	17.7	45.6	36.4	64.4	1.3
3000	2.0 j 4.9	5.2 j 7.2	16.3	45.8	38.2	66	-1.8
3500	2.2 j 7.1	4.6 j 4.7	16	46	39.8	66.6	-1.9
4000	2.8 j 10.7	3.7 j 1.7	15.4	45.7	37	67.6	-4.5
4500	3.8 j 16.5	3.5 j -0.4	15.1	45.7	36.9	66.4	-5
5000	7.6 j 25.8	3.6 j -3.1	14.4	45.9	38.6	67.3	-7.1

LOADPULL MEASUREMENT, Vds= 28V Idq = 47 mA

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

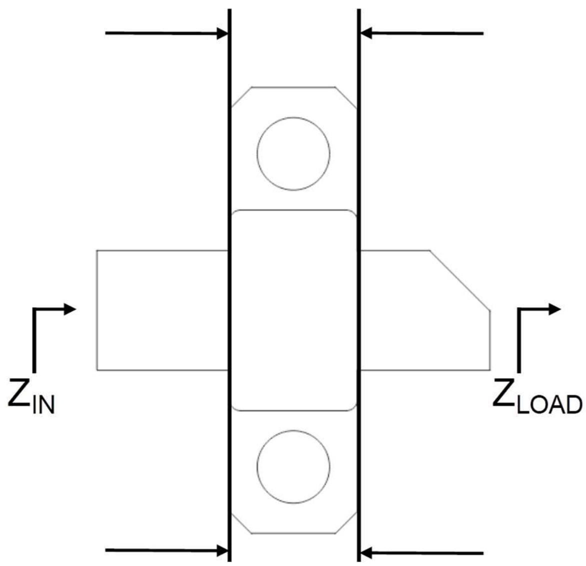
For Optimum Peak Power @ 2.5dB Compression							
Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
800	4.5 j -15.1	9.6 j -1.1	20.2	43.7	24	55.1	-0.2
1000	3.5 j -11.5	12.7 j -1.2	19.7	44.5	28	58.5	-0.6
1500	2.7 j -6.2	10.8 j -0.1	17.6	44.4	27.2	55.9	1.2
2000	2.2 j -2.0	11.4 j -0.1	16.1	44.6	29.2	59.2	-0.4
2500	2.1 j 1.2	9.9 j -0.0	15	44.6	29	60.8	-0.9
3000	2.5 j 4.4	9.3 j -0.6	13.7	44.6	28.6	62.7	-1.2
3500	2.8 j 7.1	9.1 j -2.6	12.8	44.7	29.7	60.8	-1.9
4000	3.7 j 10.9	9.2 j -3.7	12.1	44.6	29.1	62.7	-2.3
4500	5.4 j 14.8	9.7 j -7.3	11.2	44.7	29.5	59.1	-3.1
5000	11.2 j 26.7	11.0 j -7.2	11.1	44.8	30.1	62.5	-3.7

For Optimum Peak Efficiency @ 2.5dB Compression							
Freq-MHz	Zin_F0	Zl_F0	Gain-dB	Pout-dBm	Pout-W	Eff-%	AMPM-deg
800	2.9 j -10.2	27.4 j 19.4	21.8	40.5	11.4	71.4	0.4
1000	2.9 j -8.6	29.5 j 14.5	19.4	41.7	14.7	69.2	5.2
1500	1.7 j -4.5	12.8 j 9.2	19.3	43	20.1	66.8	0.5
2000	1.5 j -0.8	9.1 j 7.1	17.8	43.2	21	69.7	-0.5
2500	1.7 j 1.7	8.2 j 4.3	16	43.8	23.9	66.7	-1.8
3000	2.0 j 5.0	6.3 j 3.0	14.7	43.3	21.5	68.3	-3
3500	2.2 j 7.9	6.3 j 1.7	14	43.5	22.2	68.6	-3.1
4000	3.1 j 12.0	6.1 j -1.1	13.1	43.7	23.1	69.7	-4.1
4500	4.8 j 16.7	5.6 j -3.8	12.5	43.6	23.1	69.6	-6.3
5000	9.3 j 29.9	5.3 j -6.1	12.3	43.1	20.6	69.8	-8.1

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

Impedance Reference Plane

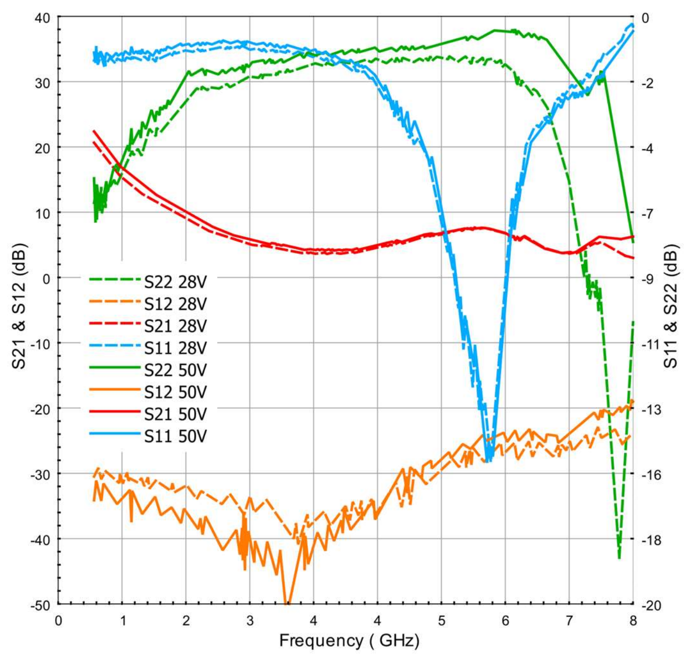


Raw data and full Loadpull measurement report available at request: sales@galliumsemi.com

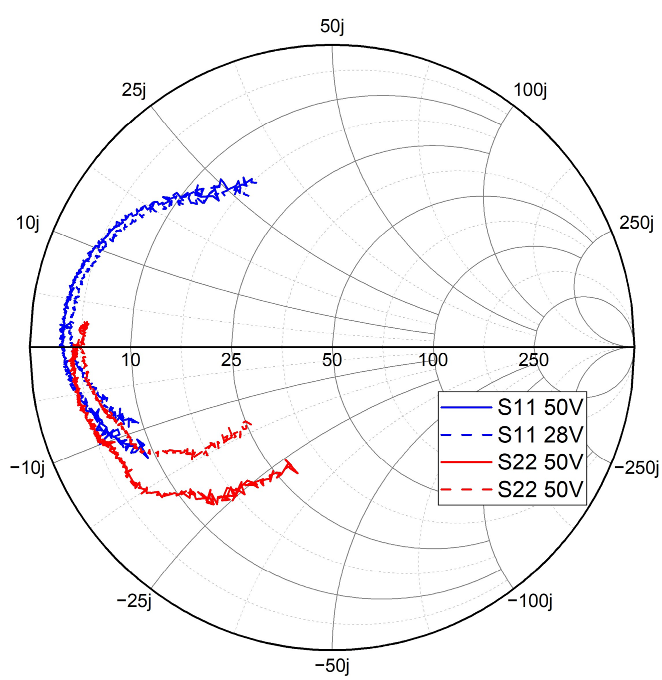
BROADBAND S-PARAMETERS MEASUREMENT, Vds= 28 & 50V Idq = 47 mA

1 Tone CW

S Parameters (Mag-dB)



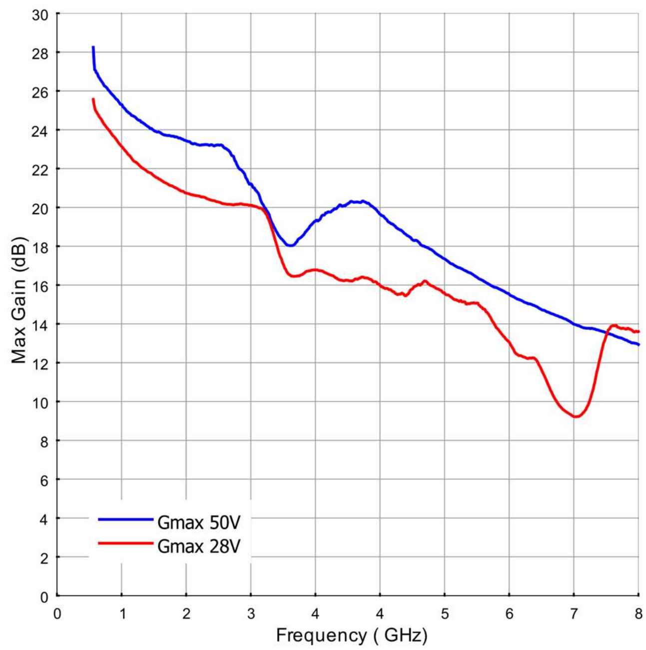
S11 & S22 0.4-8 GHz



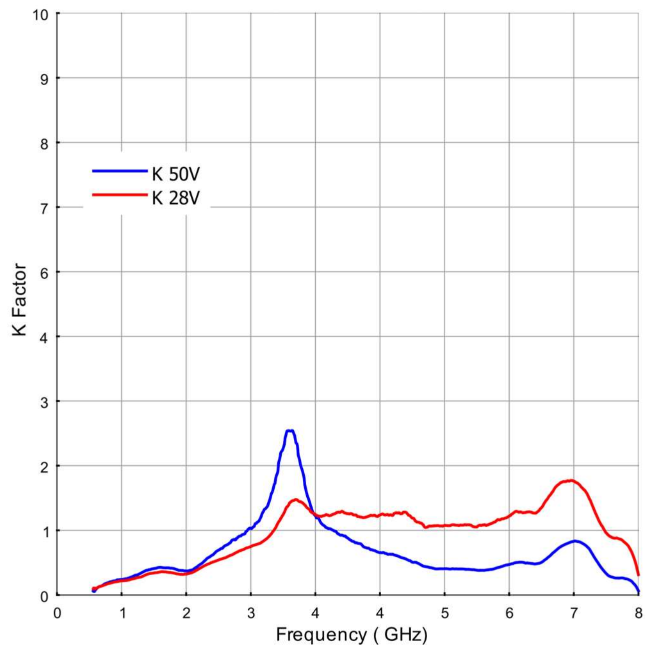
BROADBAND S-PARAMETERS MEASUREMENT, Vds= 28 & 50V Idq = 47 mA

1 Tone CW

Maximum Available Gain



K Factor



GaN HEMT BIASING SEQUENCE

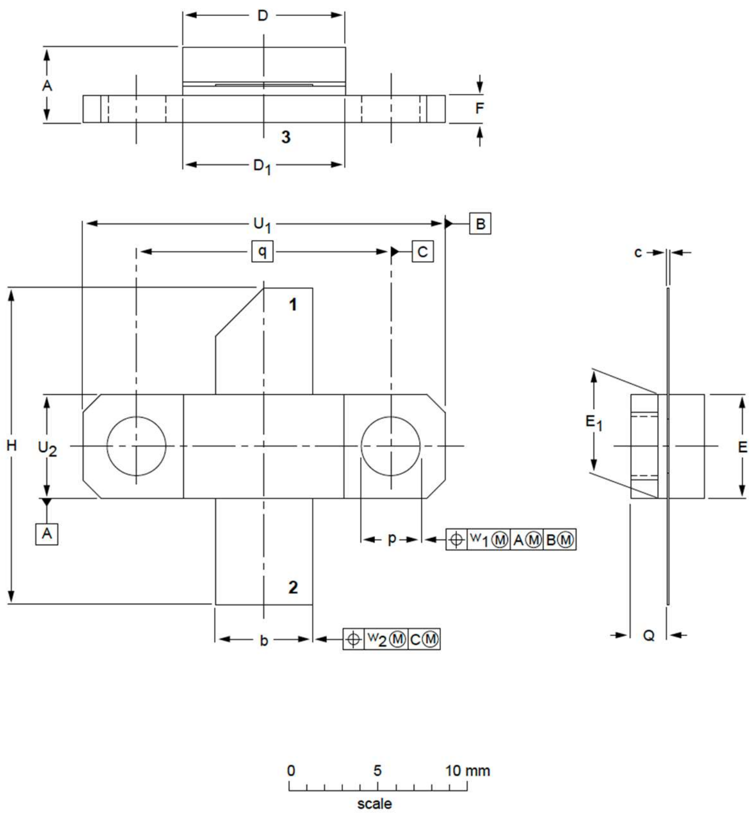
To turn the transistor ON

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 (47 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



DIMENSIONS (millimetre dimensions are derived from the original inch dimensions)

UNIT	A	b	c	D	D_1	E	E_1	F	H	p	Q	q	U_1	U_2	w_1	w_2
mm	4.67 3.94	5.59 5.33	0.15 0.10	9.25 9.04	9.27 9.02	5.92 5.77	5.97 5.72	1.65 1.40	18.54 17.02	3.43 3.18	2.21 1.96	14.27	20.45 20.19	5.97 5.72	0.25	0.51
inch	0.184 0.155	0.220 0.210	0.006 0.004	0.364 0.356	0.365 0.355	0.233 0.227	0.235 0.225	0.065 0.055	0.73 0.67	0.135 0.125	0.087 0.077	0.562	0.805 0.795	0.235 0.225	0.010	0.020

PIN CONFIGURATION

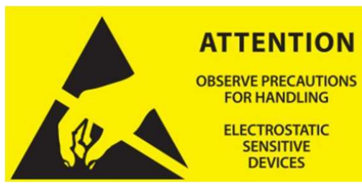
Pin	Input/Output
1	RF Output / Drain Voltage
2	RF Input / Gate Voltage
3 (flange)	Ground

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

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