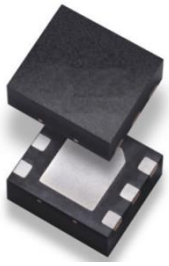
HTH1D38S015P
15 W, 2.3-4.0 GHz GaN Amplifier

Product Datasheet

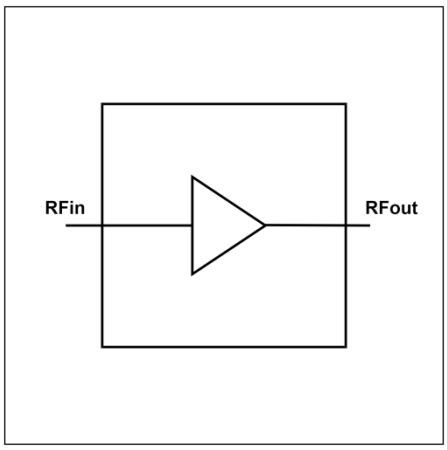
Description

The HTH1D38S015P is a GaN Power Transistor designed for cellular base station applications with 15W saturation output power covering frequency range from 2.3 to 4.0 GHz.



RoHS compliant

Block Diagram



Features

- Operating Frequency Range: 2.3 to 4.0 GHz
- Operating Drain Voltage: +48 V
- Saturation Output Power: 15 W
- Advanced Linearity Performance
- High Efficiency
- High Gain over the Frequency Range
- Small footprint package, DFN 4x4

Applications

- 3GPP 5G NR FR1 n41/n78 and 4G/LTE band B40/41/42/43.
- Active antenna array for 5G mMIMO.
- Power Amplifier for Small cells.
- Driver Amplifier for macro base stations.
- Repeaters/DAS.

Order Information

Part Number	Description
HTH1D38S015P	Reel Package
HTH1D38S015P EVB	2500-2700 MHz EVB 3450-3900 MHz EVB

Typical Performances

Freq(MHz)	P3dB(dBm)	Gain(dB)	Eff(%)	IRL(dB)
2500	43.1	19.1	61.1	8
2600	43.2	19.8	66.0	12
2700	43.4	19.2	67.8	9

Test conditions unless otherwise noted: 25 °C, VDD = 48 Vdc, IDQ = 35 mA, Pulsed CW, 100 us, Duty Cycle = 10%, test on Watech EVB.

Freq(MHz)	Gain(dB)	Eff(%)	ACPR 5MHz(dBc)	ACPR 10MHz(dBc)
2500	19.0	14.8	-44.4	-51.9
2600	19.5	15.6	-45.1	-52.0
2700	18.8	15.6	-45.9	-52.2

Test conditions unless otherwise noted: 25 °C, VDD = 48 Vdc, IDQ = 35 mA, Pout = 29 dBm, WCDMA signal with 9.9 dB PAR @ 0.01%, test on Watech EVB.

Freq(MHz)	P3dB(dBm)	Gain(dB)	Eff(%)	IRL(dB)
3450	42.5	18.5	67.6	8
3700	42.4	18.5	64.5	10
3900	42.2	18.4	62.9	8

Test conditions unless otherwise noted: 25 °C, VDD = 48 Vdc, IDQ = 35 mA, Pulsed CW, 100 us, Duty Cycle = 10%, test on Watech EVB.

Freq(MHz)	Gain(dB)	Eff(%)	ACPR 5MHz(dBc)	ACPR 10MHz(dBc)
3450	18.0	16.9	-43.6	-57.3
3700	18.1	16.2	-43.6	-56.4
3900	18.1	16.2	-43.8	-57.1

Test conditions unless otherwise noted: 25 °C, VDD = 48 Vdc, IDQ = 35 mA, Pout = 29 dBm, WCDMA signal with 9.9 dB PAR @ 0.01%, test on Watech EVB.

Load Pull Performance

Max Output Power						
Freq (MHz)	Z_source (Ω)	Z_load [1](Ω)	Gain (dB)	P3dB (dBm)	P3dB (W)	Eff (%)
2300	2.3-j*4.3	26.5+j*23.8	21.0	43.1	20.5	63.7
2500	3.4-j*6.9	28.2+j*20.6	19.7	43.2	20.8	64.8
2700	3.5-j*8.7	29.9+j*19.5	19.3	43.3	21.2	62.9
3300	8.7-j*19.2	25.4+j*15.3	17.9	43.3	21.3	61.2
3500	11.9-j*25.1	24.3+j*15.5	17.9	43.3	21.4	63.9
3700	17.4-j*30.2	20.7+j*12.6	17.8	43.3	21.3	62.6
3900	28.6-j*33.4	20.1+j*11.3	17.8	43.1	20.4	61.8
4000	38.0-j*30.0	20.8+j*11.9	17.8	43.1	20.3	62.9
4100	43.7-j*21.8	19.5+j*9.6	17.9	43.2	20.7	63.0
4200	45.8-j*6.8	17.3+j*8.9	18.0	43.0	20.1	62.2

Test conditions unless otherwise noted: 25 °C, VDD = 48Vdc, Idq= 35mA, Pulsed CW, 100 us, Duty Cycle = 10%, test on Watech EVB.

[1] Load impedance for optimum P3dB pout

Max Drain Efficiency						
Freq (MHz)	Z_source (Ω)	Z_load [1](Ω)	Gain (dB)	P3dB (dBm)	P3dB (W)	Eff (%)
2300	2.3-j*4.3	29.0+j*44.6	22.0	41.5	14.1	73.2
2500	3.4-j*6.9	26.9+j*34.7	20.7	42.3	17.0	73.0
2700	3.5-j*8.7	29.9+j*38.5	20.3	42.2	16.6	70.8
3300	8.7-j*19.2	20.6+j*28.5	19.4	42.2	16.6	69.6
3500	11.9-j*25.1	15.3+j*24.1	19.5	42.3	17.0	70.9
3700	17.4-j*30.2	15.0+j*22.7	19.4	42.2	16.6	72.1
3900	28.6-j*33.4	17.0+j*21.0	18.9	42.2	16.6	69.2
4000	38.0-j*30.0	14.2+j*18.7	19.2	42.1	16.2	70.0
4100	43.7-j*21.8	12.6+j*18.2	19.6	41.7	14.8	71.5
4200	45.8-j*6.8	11.4+j*16.6	19.5	41.6	14.5	69.8

Test conditions unless otherwise noted: 25 °C, VDD = 48Vdc, Idq= 35mA, Pulsed CW, 100 us, Duty Cycle = 10%, test on Watech EVB.

[2] Load impedance for optimum P3dB efficiency.

Absolute Maximum Ratings

Parameter	Range/Value	Units
Drain voltage (VDSS)	150	V
Gate voltage (VGS)	-10 to 2	V
Storage Temperature (TSTG)	-55 to 150	°C
Case Temperature (TC)	-40 to 150	°C
Junction Temperature (TJ)	225	°C

Electrical Specification

DC Characteristics

Parameter	Conditions	Min	Typ	Max	Units
Breakdown Voltage V(BR)DSS	VGS=-8V; IDS=1.8mA	-	150	-	V
Gate-Source threshold Voltage VGS(th)	VDS=6V; IDS=1.8mA	-3	-2.6	-2.3	V
Drain leakage Current IDSS	VDS=50V; VGS=-10V	-	-	0.72	mA
Gate leakage Current IGSS	VDS=0V; VGS=-10V	-	-	0.36	mA

RF Characteristics (Pulsed CW)

Parameter	Min	Typ	Max	Units
Frequency Range	3.45	-	3.9	GHz
P3dB	-	42.3	-	dBm
Gain@29dBm	-	18	-	dB
Eff@P3dB	-	60	-	%
IRL	-	10	-	dB

Test conditions, unless otherwise noted: 25 °C, V_{DD} = 48 Vdc, I_{DQ} = 35 mA, Pulse Width = 100 us, Duty Cycle = 10%, test on 3450-3900MHz FT board.

RF Characteristics (WCDMA)

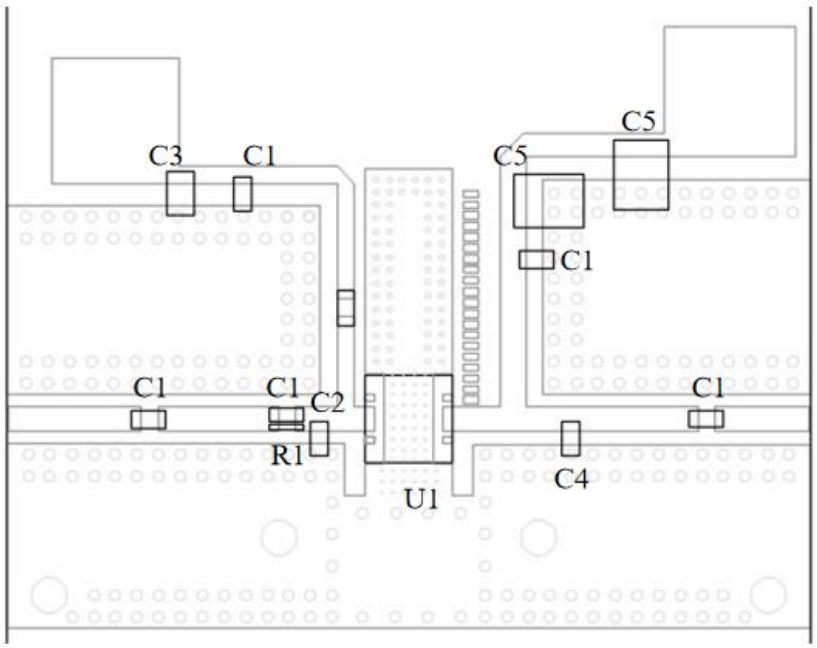
Parameter	Min	Typ	Max	Units
Frequency Range	3.45	-	3.9	GHz
Gain@29dBm	-	18	-	dB
Eff@29dBm	-	15	-	%
IRL	-	10	-	dB
ACLR@5MHz	-	-40	-	dBc

Test conditions, unless otherwise noted: 25 °C, V_{DD} = 48 Vdc, I_{DQ} = 35 mA, Pout = 29 dBm, 5MHz WCDMA signal with 9.9 dB PAR @ 0.01% CCDF Based on 3450-3900MHz FT board

Thermal Information

Symbol	Parameter	Condition	Value (Typ)	Units
Rth(s-c)(IR)	thermal resistance from active die surface to case by Infrared measuredment	T-Case = 105℃, Pdiss = 4.2W	8.9	K/W
Rth(ch-c)(FEA)	thermal resistance from active die channel to case by Finite Element Analysis	T-Case = 105℃, Pdiss = 4.2W	14.9	K/W

HTH1D38S015P 2.5-2.7 GHz Reference Design



EVB Layout

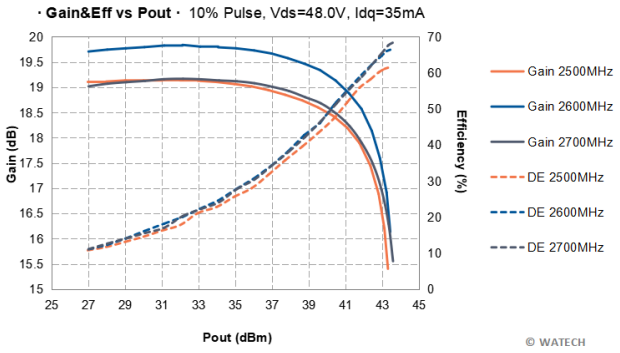
- Rogers 4350B, ε = 3.66; thickness = 20 mil (0.508 mm);Thickness copper plating = 35 µm (1oz)

- PCB is soldered on a 47 mm by 47 mm copper base plate with 8 mm thickness

BOM-HTH1D38S015P 2.5-2.7 GHz Reference Design

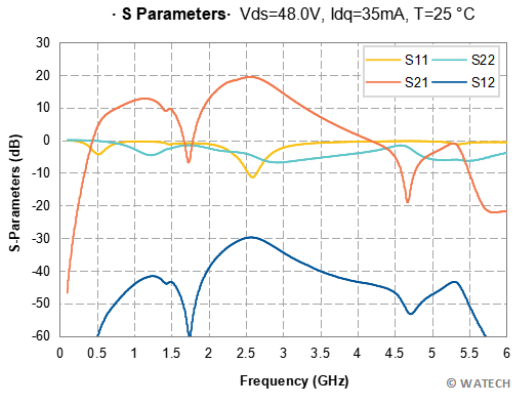
Component	Type	Value	Description	Manufacturer	P/N
C1	Capacitor	7.5 pF	0603 SMD	Murata	GQM1875C2E7R5BB12D
C2	Capacitor	2.4 pF	0603 SMD	Murata	GQM1875C2E2R4BB12D
C3	Capacitor	1 uF	0805 SMD	Murata	GRM219R61H105KA3D
C4	Capacitor	0.5 pF	0603 SMD	Murata	GQM1875C2E0R5BB12D
C5	Capacitor	10 uF	1210 SMD	Murata	GRM32EC72A106KE05L

Performance Plots



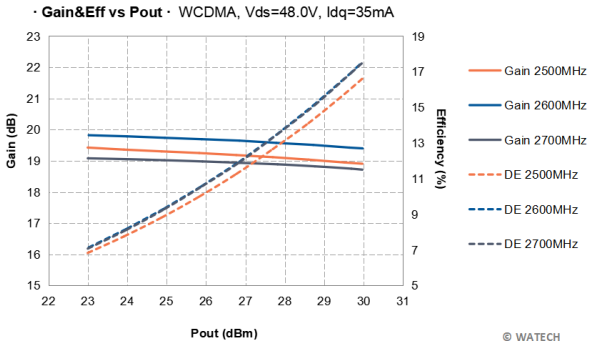
Pulsed-CW performance(Gain+Eff)

Test conditions, unless otherwise noted: 25 °C, V_{DD} = 48 Vdc, I_{DQ} = 35 mA, Pulse Width = 100 us, Duty Cycle = 10%, test on WATECH EVB.

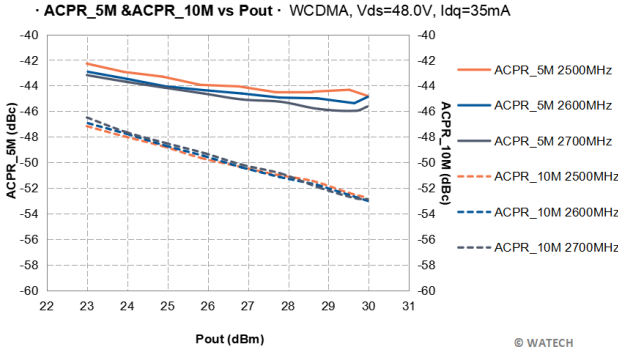


S-Parameter

Test conditions, unless otherwise noted: 25 °C, V_{DD} = 48 Vdc, I_{DQ} = 35 mA, CW signal with -20dBm channel base power, test on WATECH EVB.



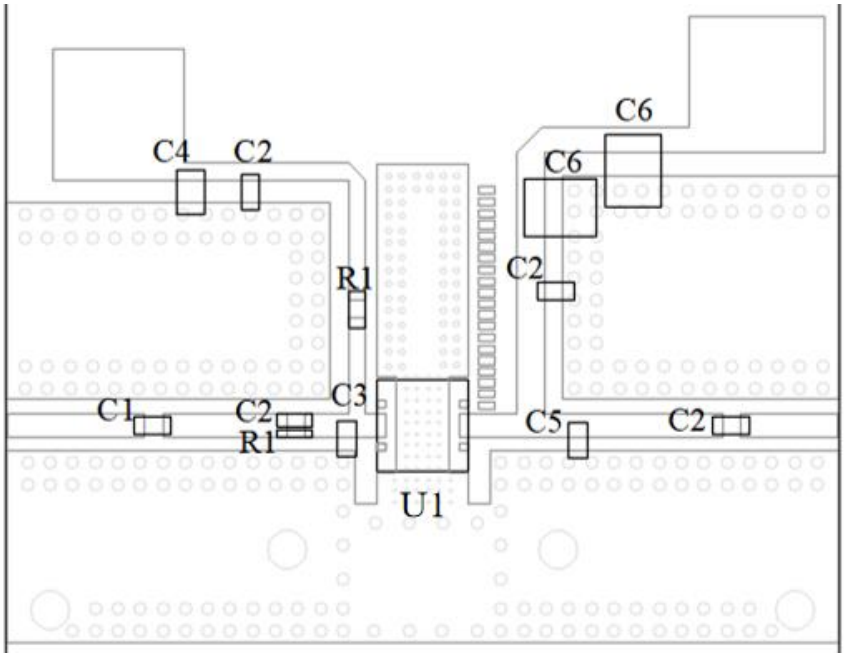
WCDMA performance(Gain+Eff)



ACPR

Test conditions, unless otherwise noted: 25 °C, V_{DD} = 48 Vdc, I_{DQ} = 35 mA, 5MHz WCDMA signal with 9.9 dB PAR @ 0.01%, test on WATECH EVB.

HTH1D38S015P 3.45-3.9 GHz Reference Design



EVB Layout

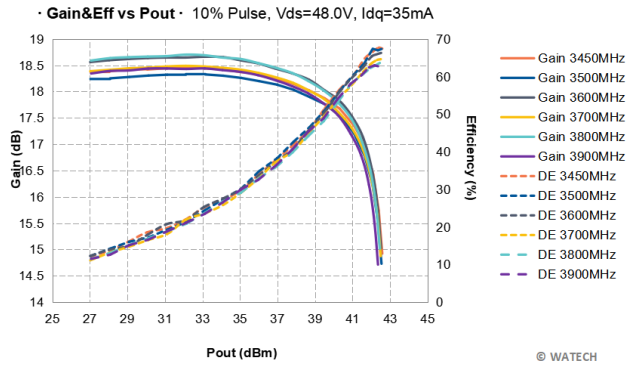
- Rogers 4350B, ε = 3.66; thickness = 20 mil (0.508 mm);Thickness copper plating = 35 µm (1oz)

- PCB is soldered on a 47 mm by 47 mm copper base plate with 8 mm thickness

BOM-HTH1D38S015P 3.45-3.9 GHz Reference Design

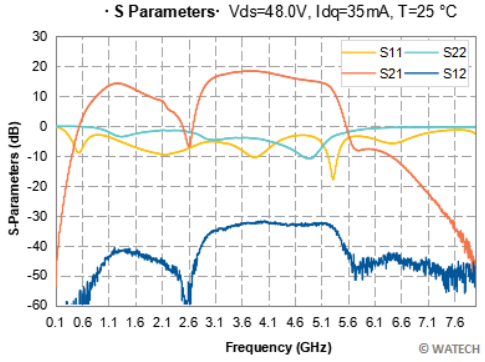
Component	Type	Value	Description	Manufacturer	P/N
C1	Capacitor	5 pF	0603 SMD	Murata	GQM1875C2E5R0BB12D
C2	Capacitor	3.6 pF	0603 SMD	Murata	GQM1875C2E3R6BB12D
C3	Capacitor	0.5 pF	0603 SMD	Murata	GQM1875C2E0R5BB12D
C4	Capacitor	1 uF	0805 SMD	Murata	GRM219R61H105KA3D
C5	Capacitor	0.9 pF	0603 SMD	Murata	GQM1875C2E0R9BB12D
C6	Capacitor	10 uF	1210 SMD	Murata	GRM32EC72A106KE05L
R1	Resistor	10 Ohm, 1/8W	0603 SMD	Arbitraty	-
U1	Transistor	-	DFN 4X4	Watech	HTH1D38S015P

Performance Plots



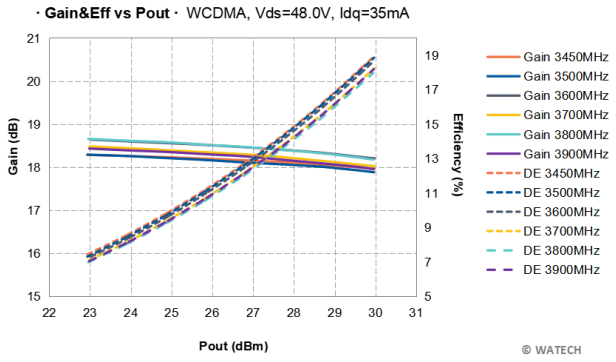
Pulsed-CW performance(Gain+Eff)

Test conditions, unless otherwise noted: 25 °C, V_{DD} = 48 Vdc, I_{DQ} = 30 mA, Pulse Width = 100 us, Duty Cycle = 10%, test on WATECH EVB.

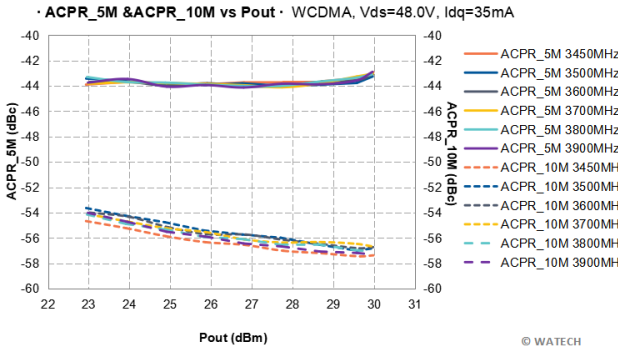


S-Parameter

Test conditions, unless otherwise noted: 25 °C, V_{DD} = 48 Vdc, I_{DQ} = 35 mA, CW signal with -20dBm channel base power, test on WATECH EVB.



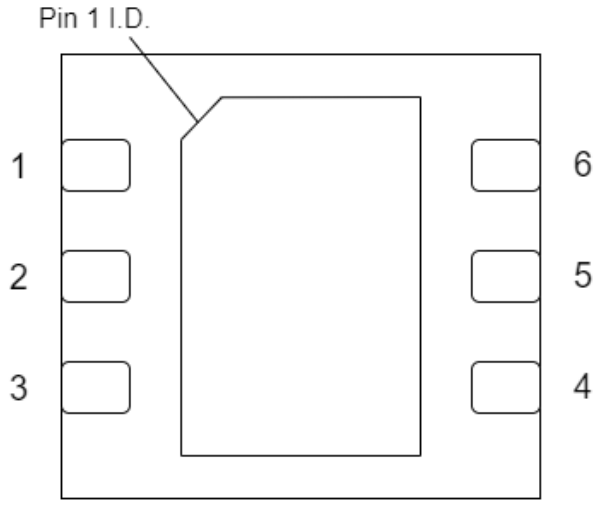
WCDMA performance(Gain+Eff)



ACPR

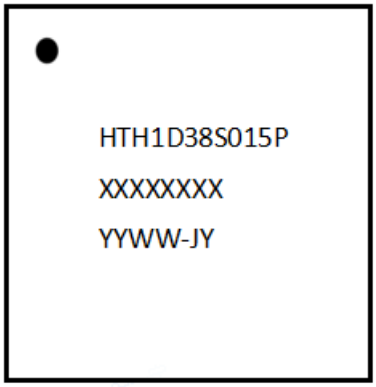
Test conditions, unless otherwise noted: 25 °C, V_{DD} = 48 Vdc, I_{DQ} = 35 mA, 5MHz WCDMA signal with 9.9 dB PAR @ 0.01%, test on WATECH EVB.

Pin Configuration and Description



Pin Configuration		
Pin Number	**Label**	**Description**
1	NC	
2	RFin+Vgs	RF Input/Vgs
3	NC	
4	NC	
5	RFout+Vdd	RF Output/Vdd
6	NC	

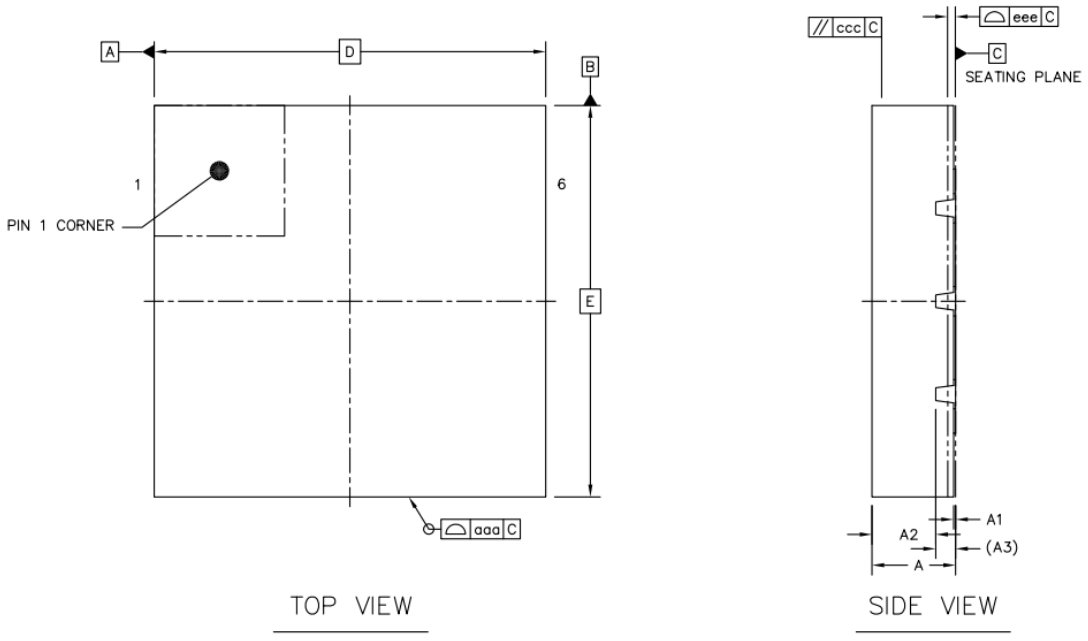
Package Marking and Dimensions

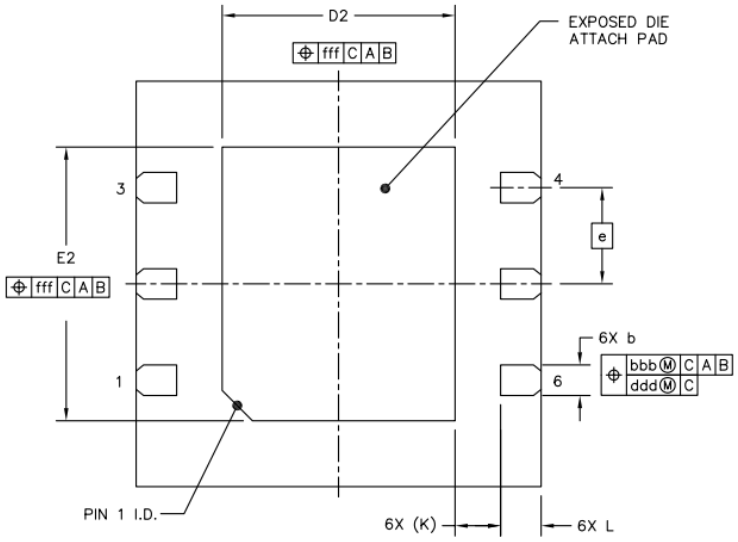


- Line1 (fixed): Device name in work order
- Line2 (unfixed): Take the last 8 digits of Mark Lot number in W/O
(Sample: E596-20140001, just take "20140001")
- Line3 (unfixed): Date Code + JY

This Marking SPEC only stipulates the content of Marking. For marking requirements such as font and size, please refer to the latest version of "Watech Product Printing Specification"

Marking





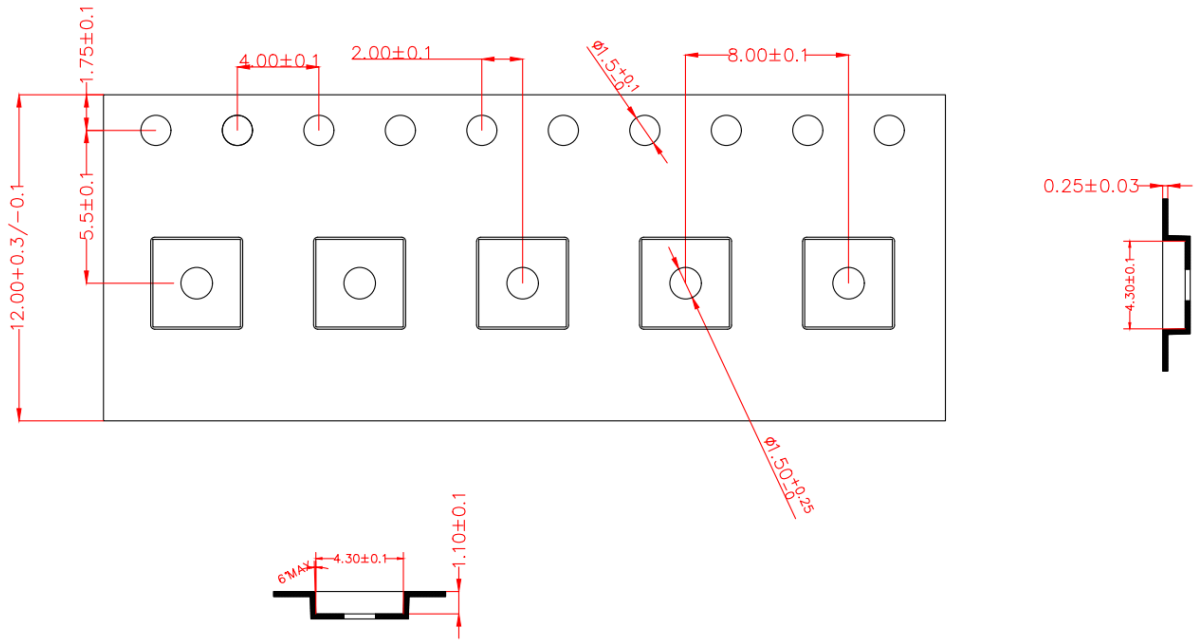
BOTTOM VIEW

		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.8	0.85	0.9
STAND OFF		A1	0	0.02	0.05
MOLD THICKNESS		A2	---	0.65	---
L/F THICKNESS		A3		0.203 REF	
LEAD WIDTH		b	0.25	0.3	0.35
BODY SIZE	X	D		4 BSC	
	Y	E		4 BSC	
LEAD PITCH		e		0.95 BSC	
EP SIZE	X	D2	2.2	2.3	2.4
	Y	E2	2.6	2.7	2.8
LEAD LENGTH		L	0.3	0.4	0.5
LEAD TIP TO EXPOSED PAD EDGE		K		0.45 REF	
PACKAGE EDGE TOLERANCE		aaa		0.1	
MOLD FLATNESS		ccc		0.1	
COPLANARITY		eee		0.08	
LEAD OFFSET		bbb		0.1	
		ddd		0.05	
EXPOSED PAD OFFSET		fff		0.1	

Package Dimensions

Packaging Information

Package Type	Reel Size(inch)	Qty/Reel(pcs)	Qty/Box(pcs)	Qty/Carton(pcs)
DFN4*4	13	3000	3000	15000



Tape & Reel

Handling Precautions

Parameter	Rating	Standard	
ESD – Human Body Model (HBM)	1A	ANSI/ESDA/JEDEC Standard JS-001	
ESD – Charged Device Model (CDM)	C2B	ANSI/ESDA/JEDEC Standard JS-002	
MSL – 260°C Convection Reflow	MSL3	IPC/JEDEC Standard J-STD-020	

RoHS Compliance

This product is compliant with the 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment), as amended by Directive 2015/863/EU.

Datasheet Status

Document status	Product status	Definition
Objective datasheet	Design simulation	Product objective specification
Preliminary datasheet	Customer sample	Engineering samples and first test results
Product datasheet	Mass production	Final product specification

Revision history

Document ID	Datasheet status	Release date	Version revision record
Rev.1.0	Preliminary	2023-4-23	Initial Version
Rev.2.0	Preliminary	Mar.2024	Preliminary
Rev.3.0	Product	Jun.2024	Product

Abbreviations

Acronym	Definition
LDMOS	Laterally-diffused metal-oxide semiconductor
GaN	Gallium Nitride
CW	Continuous Waveform
VSWR	Voltage Standing Wave Ratio

Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations and information about WATECH:

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- Email: MKT@watechelectronics.com

For technical questions and application information:

- Email: MKT@watechelectronics.com

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