CLF3H0060-10; CLF3H0060S-10

Broadband RF power GaN HEMT

AMPLEON

Rev. 1 — 17 July 2023

Product data sheet

1. Product profile

1.1 General description

The CLF3H0060-10 and CLF3H0060S-10 are 10 W general purpose, unmatched broadband GaN-SiC HEMT transistors that are usable in the frequency range from DC to 6.0 GHz. The device utilizes a thermally enhanced package which supports both CW and pulsed applications.

Table 1. Typical performance

RF performance at T_{case} = 25 °C; V_{DS} = 50 V; I_{Dq} = 30 mA; in a class-AB narrowband production circuit.

Test signal	V_{DS}	f	P_L	G_p	η_D
	(V)	(MHz)	(W)	(dB)	(%)
pulsed CW [1]	50	2500	10	20.1	63

[1] t_p = 100 μs; δ = 10 %.

Table 2. Typical performance

RF performance at T_{case} = 25 °C; V_{DS} = 50 V; I_{Dq} = 30 mA; in a common source class-AB test circuit.

Test signal	f	P_L	VSWR	Test voltage	Result
	(MHz)	(W)		(V)	
pulsed CW [1]	2500	10	15 : 1 at all phase angles	50	no device degradation

[1] t_p = 100 μs; δ = 10 %.

1.2 Features and benefits

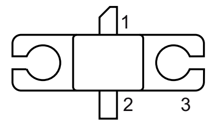
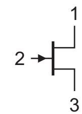
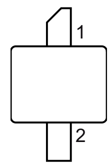
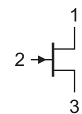
- 10 W general purpose broadband RF power GaN HEMT
- High efficiency
- Low thermal resistance
- Excellent ruggedness
- Designed for broadband operation in the frequency range from DC to 6.0 GHz
- 50 V capable 10 W GaN-SiC HEMT in an unmatched configuration in an air-cavity ceramic package
- Offers agile performance in an easy to apply package
- For RoHS compliance see the product details on the Ampleon website
- Large signal models in ADS and MWO are available on the Ampleon website

1.3 Applications

- Broadband tactical communication
- Broadband countermeasures
- Instrumentation amplifiers
- Radar for UHF, L- and S-band

2. Pinning information

Table 3. Pinning

Pin	Description		Simplified outline	Graphic symbol
CLF3H0060-10 (SOT1227A)				
1	drain			 amp01464
2	gate			
3	source	[1]		
CLF3H0060S-10 (SOT1227B)				
1	drain			 amp01464
2	gate			
3	source	[1]		

[1] Connected to flange.

3. Ordering information

Table 4. Ordering information

Package name	Orderable part number	12NC	Packing description	Min. orderable quantity (pieces)
SOT1227A	CLF3H0060-10U	9349 606 01112	Tray; 20-fold; non-dry pack	60
SOT1227B	CLF3H0060S-10U	9349 606 02112	Tray; 20-fold; non-dry pack	60

4. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage		-	150	V
V_{GS}	gate-source voltage		−8	+2	V
I_{GF}	forward gate current	external R_G= 5 Ω	-	4.4	mA
T_{stg}	storage temperature		−65	+150	°C
T_{ch}	active die channel temperature	[1]	-	300	°C

[1] Continuous use at maximum temperature will affect the reliability, for details refer to the online MTF calculator.

5. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(s-c)(IR)}$ [1]	thermal resistance from active die surface to case by Infrared measurement	T_{case} = 85 °C; V_{DS} = 50 V; I_{Dq} = 30 mA; P_{dis} = 7.5 W	4.1	K/W
$R_{th(ch-c)(FEA)}$ [2]	thermal resistance from active die channel to case by Finite Element Analysis	T_{case} = 85 °C; V_{DS} = 50 V; I_{Dq} = 30 mA; P_{dis} = 7.5 W	9.0	K/W

[1] Infrared (IR) thermal values are for reference only and cannot be used to determine performance or reliability.

[2] Finite Element Analysis (FEA) thermal values have been used for the online MTF calculator.

6. Characteristics

Table 7. DC characteristics

T_{case} = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{(BR)DSS}$	drain-source breakdown voltage	V_{GS} = –8 V; I_D = 2 mA	150	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	V_{DS} = 6 V; I_D = 2 mA	–3.5	–2.7	–2.2	V
I_{DSX}	drain cut-off current	V_{GS} = 2 V; V_{DS} = 6 V	-	1.57	-	A
I_{GSS}	gate leakage current	V_{GS} = –8 V; V_{DS} = 10 V	-	-	120	μA
g_{fs}	forward transconductance	V_{GS} = 0 V; V_{DS} = 6 V	-	0.44	-	S
$R_{DS(on)}$	drain-source on-state resistance	V_{GS} = 0 V; V_{DS} = 100 mV	-	2.0	-	Ω

Table 8. AC characteristics

T_j = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{iss}	input capacitance	V_{GS} = –8 V; V_{DS} = 50 V; f = 1 MHz [1]	-	2.92	-	pF
C_{oss}	output capacitance	V_{GS} = –8 V; V_{DS} = 50 V; f = 1 MHz [1]	-	1.78	-	pF
C_{rss}	reverse transfer capacitance	V_{GS} = –8 V; V_{DS} = 50 V; f = 1 MHz [1]	-	0.25	-	pF

[1] Include package.

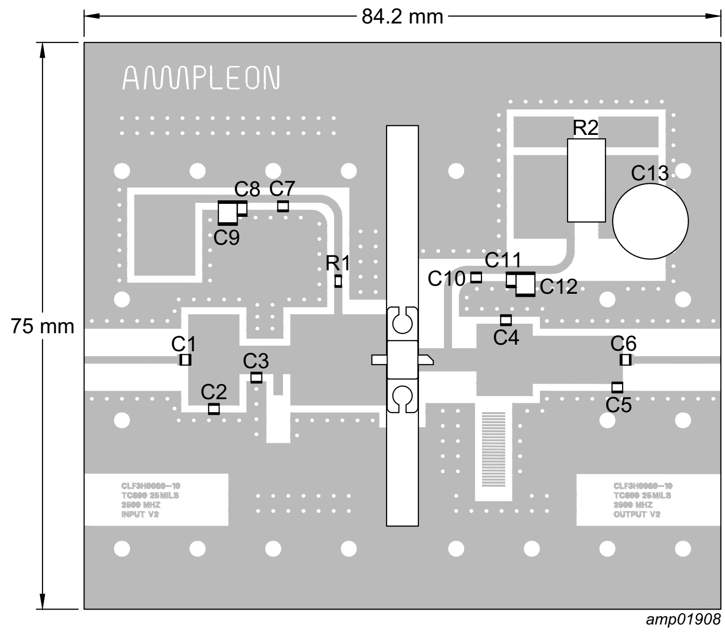
Table 9. RF characteristics

Test signal: pulsed CW; t_p = 100 μs; δ = 10 %; V_{DS} = 50 V; I_{Dq} = 30 mA; T_{case} = 25 °C; unless otherwise specified; in a class-AB production circuit measured at 2500 MHz.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
G_p	power gain	P_L = 10 W	18.8	20.1	-	dB
RL_{in}	input return loss	P_L = 10 W	-	–15	-	dB
η_D	drain efficiency	P_L = 10 W	57	63	-	%

7. Application information

7.1 Production circuit information (f = 2500 MHz)



Printed-Circuit Board (PCB): Rogers TC600; thickness = 0.635 mm.
See Table 10 for list of components.

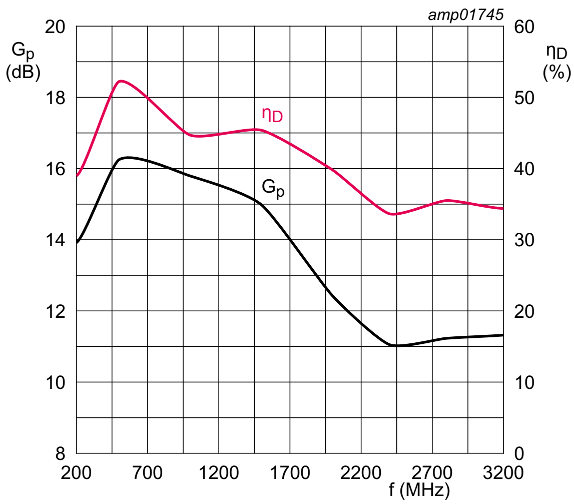
Fig 1. Component layout for narrowband production circuit f = 2500 MHz

Table 10. List of components
For test circuit see Figure 1.

Component	Description	Value	Remarks
C1	multilayer ceramic chip capacitor	8.2 pF	ATC 100A
C2	multilayer ceramic chip capacitor	33 pF	ATC 100A
C3	multilayer ceramic chip capacitor	56 pF	ATC 100A
C4	multilayer ceramic chip capacitor	51 pF	ATC 100A
C5	multilayer ceramic chip capacitor	20 pF	ATC 100A
C6	multilayer ceramic chip capacitor	15 pF	ATC 100A
C7, C10	multilayer ceramic chip capacitor	22 pF	ATC 100A
C8, C11	multilayer ceramic chip capacitor	0.1 μF	GRM21BR71H104KA01L
C9, C12	multilayer ceramic chip capacitor	1 μF	GRM32RR71H105KA01L
C13	electrolytic capacitor	1000 μF, 63 V	
R1	resistor	10 Ω	0805
R2	shunt resistor	100 mΩ	CRA2512 R100E

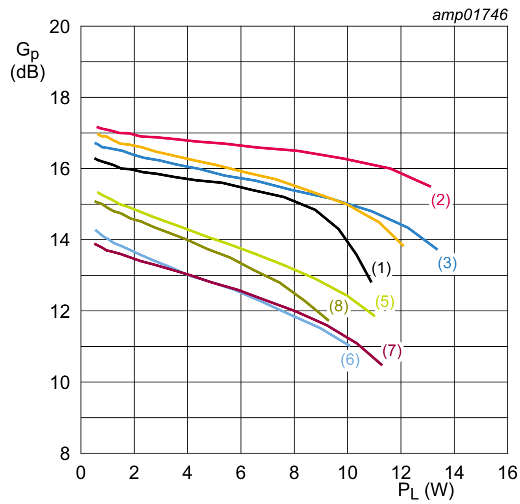
7.2 Graphical data (f = 200 MHz to 3200 MHz)

7.2.1 CW performance (V_{DS} = 40 V)



V_{DS} = 40 V; I_{Dq} = 40 mA; P_L = 10 W.

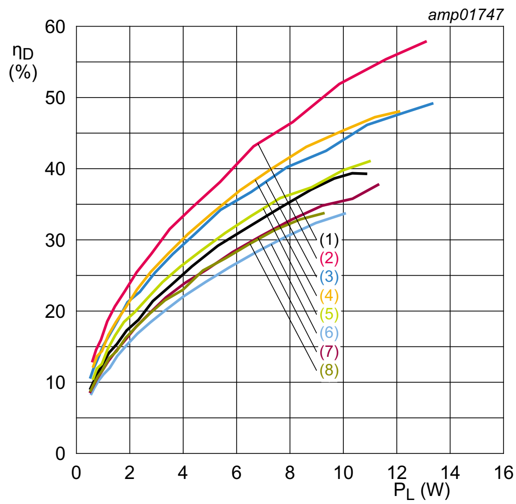
Fig 2. Power gain and drain efficiency as function of frequency; typical values



V_{DS} = 40 V; I_{Dq} = 40 mA.

(1) f = 200 MHz
(2) f = 500 MHz
(3) f = 1000 MHz
(4) f = 1500 MHz
(5) f = 2000 MHz
(6) f = 2400 MHz
(7) f = 2800 MHz
(8) f = 3200 MHz

Fig 3. Power gain as a function of output power; typical values



V_{DS} = 40 V; I_{Dq} = 40 mA.

(1) f = 200 MHz

(2) f = 500 MHz

(3) f = 1000 MHz

(4) f = 1500 MHz

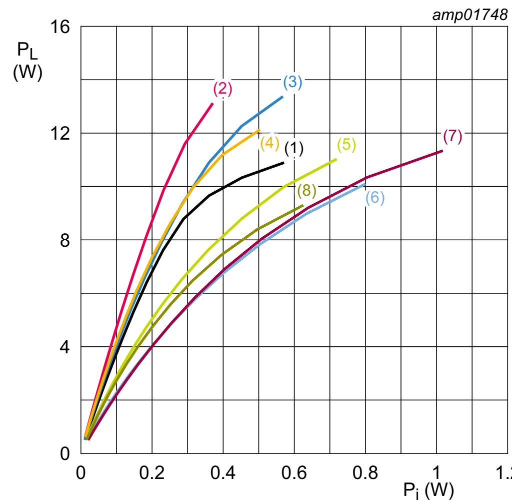
(5) f = 2000 MHz

(6) f = 2400 MHz

(7) f = 2800 MHz

(8) f = 3200 MHz

Fig 4. Drain efficiency as a function of output power; typical values



V_{DS} = 40 V; I_{Dq} = 40 mA.

(1) f = 200 MHz

(2) f = 500 MHz

(3) f = 1000 MHz

(4) f = 1500 MHz

(5) f = 2000 MHz

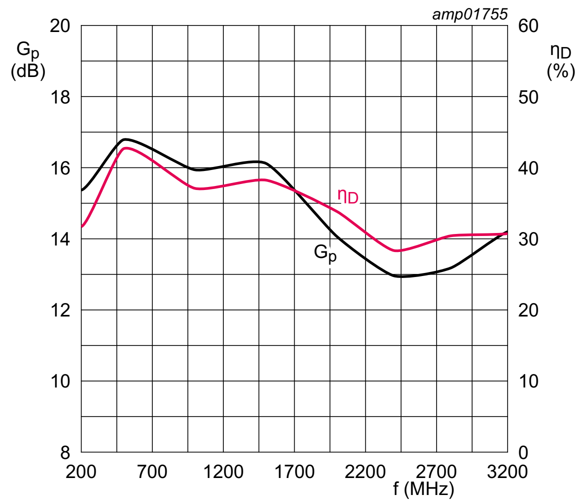
(6) f = 2400 MHz

(7) f = 2800 MHz

(8) f = 3200 MHz

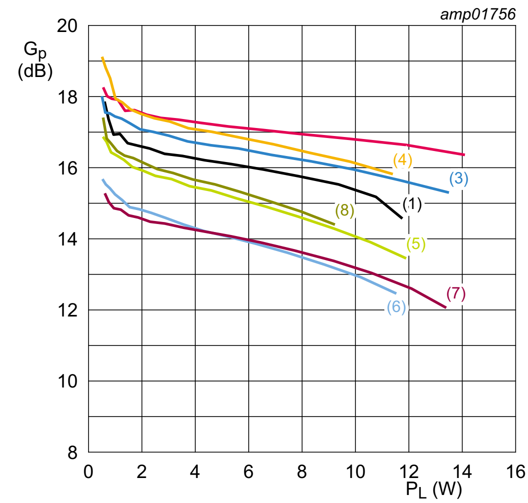
Fig 5. Output power as a function of input power; typical values

7.2.2 Pulsed CW performance (V_{DS} = 50 V)



V_{DS} = 50 V; I_{Dq} = 40 mA; P_L = 10 W; t_p = 100 μs; δ = 10 %

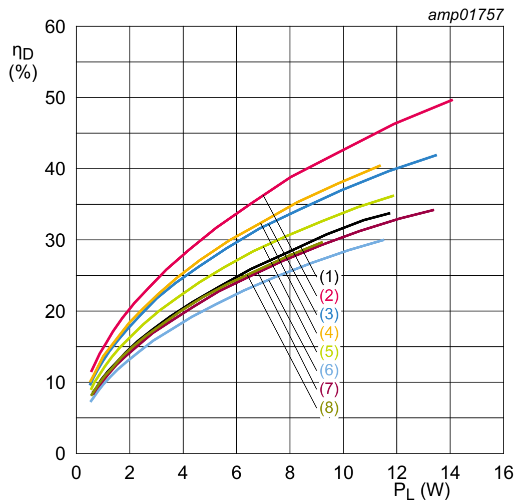
Fig 6. Power gain and drain efficiency as function of frequency; typical values



V_{DS} = 50 V; I_{Dq} = 40 mA; t_p = 100 μs; δ = 10 %.

(1) f = 200 MHz
(2) f = 500 MHz
(3) f = 1000 MHz
(4) f = 1500 MHz
(5) f = 2000 MHz
(6) f = 2400 MHz
(7) f = 2800 MHz
(8) f = 3200 MHz

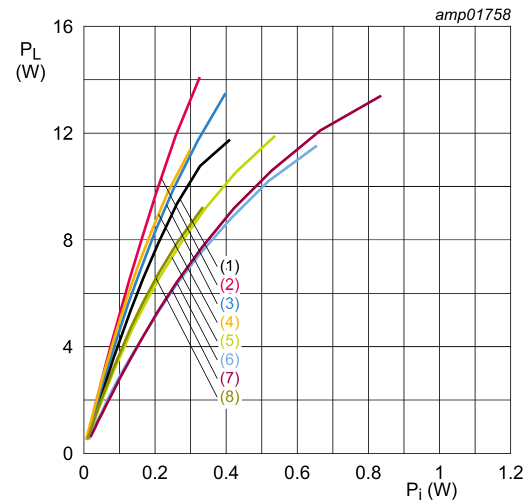
Fig 7. Power gain as a function of output power; typical values



V_{DS} = 50 V; I_{Dq} = 40 mA; t_p = 100 μs; δ = 10 %.

(1) f = 200 MHz
(2) f = 500 MHz
(3) f = 1000 MHz
(4) f = 1500 MHz
(5) f = 2000 MHz
(6) f = 2400 MHz
(7) f = 2800 MHz
(8) f = 3200 MHz

Fig 8. Drain efficiency as a function of output power; typical values



V_{DS} = 50 V; I_{Dq} = 40 mA; t_p = 100 μs; δ = 10 %.

(1) f = 200 MHz
(2) f = 500 MHz
(3) f = 1000 MHz
(4) f = 1500 MHz
(5) f = 2000 MHz
(6) f = 2400 MHz
(7) f = 2800 MHz
(8) f = 3200 MHz

Fig 9. Output power as a function of input power; typical values

8. Test information

8.1 Load-pull impedance information

The measured load-pull impedances are shown below. Impedance reference plane defined at device leads. Measurements performed with Ampleon test fixtures. Test temperature set at 25 °C with a pulsed CW signal; t_p = 100 μs; δ = 10 %; RF performance at V_{DS} = 50 V; I_{Dq} = 30 mA.

Table 11. Typical impedance
Typical values unless otherwise specified.

f	Z_S	Z_L (maximum $P_{L(M)}$)	Z_L (maximum η_D)
(MHz)	(Ω)	(Ω)	(Ω)
1000	3.2 + j28.7	46 + j10	67 + j86
2000	3.2 + j7.3	30 + j24	18 + j41
3000	3.1 – j2.4	16 + j19	11 + j25
5000	6.9 – j22.0	13 + j2.2	8.7 + j4.0
6000	18.1 – j39.2	13 – j2.6	7.1 – j5.2

[1] Z_S and Z_L defined in Figure 10.

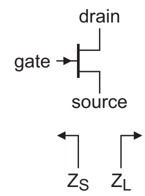
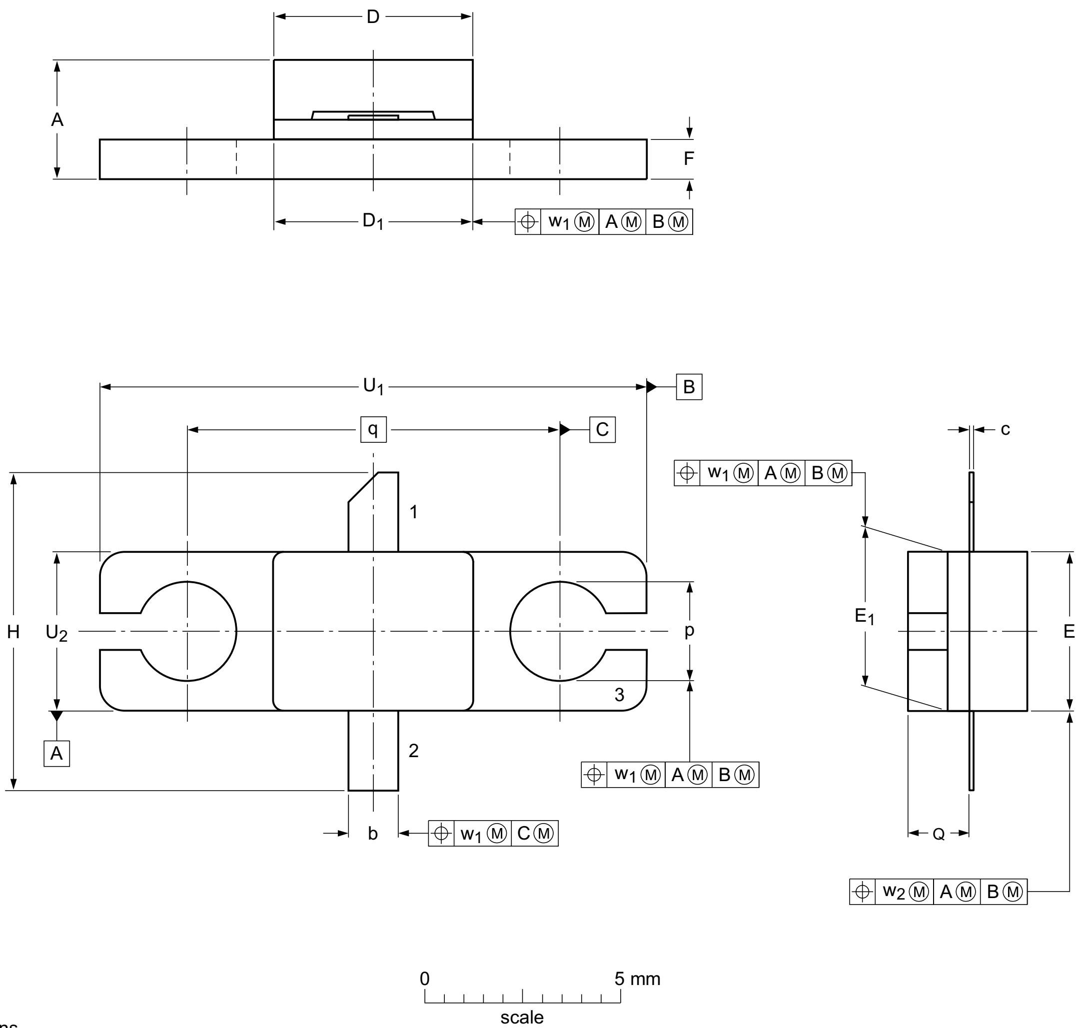


Fig 10. Definition of transistor impedance

Z_S is the measured source pull impedance presented to the device. Z_L is the measured load pull impedance presented to the device.

9. Package outline

Flanged ceramic package; 2 mounting holes; 2 leads **SOT1227A**



Dimensions

Unit(1)		A	b	c	D	D_1	E	E_1	F	H	p	Q	q	U_1	U_2	w_1	w_2
mm	max	3.68	1.40	0.15	5.18	5.21	4.17	4.19	1.14	8.64	2.67	1.70		14.10	4.19		
	nom												9.53			0.25	0.380
	min	2.84	1.14	0.08	4.98	4.95	3.96	3.94	0.89	7.62	2.41	1.45		13.84	3.94		
inches	max	0.145	0.055	0.006	0.204	0.205	0.164	0.165	0.045	0.340	0.105	0.067		0.555	0.165		
	nom												0.375			0.01	0.015
	min	0.112	0.045	0.003	0.196	0.195	0.156	0.155	0.035	0.300	0.095	0.057		0.545	0.155		

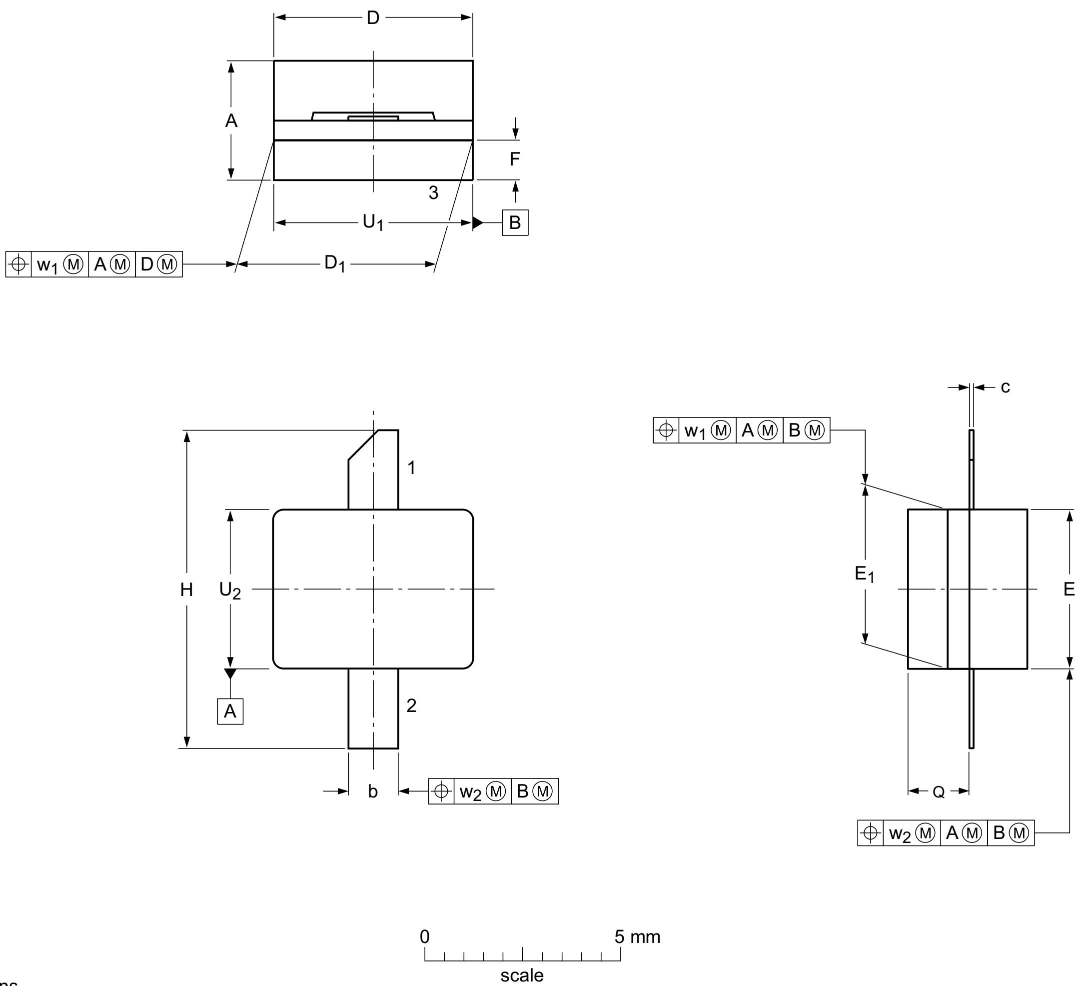
Note
1. Millimeter dimensions are derived from the original inch dimensions.

sot1227a_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1227A						~~12-06-08~~ 13-10-14

Fig 11. Package outline SOT1227A

Earless Flanged ceramic package; 2 leads **SOT1227B**



Dimensions

Unit[1]		A	b	c	D	D_1	E	E_1	F	H	Q	U_1	U_2	w_1	w_2
mm	max	3.68	1.40	0.15	5.18	5.21	4.17	4.19	1.07	8.64	1.70	5.21	4.19		
	nom													0.25	0.380
	min	2.84	1.14	0.08	4.98	4.95	3.96	3.94	0.97	7.62	1.45	4.95	3.94		
inches	max	0.145	0.055	0.006	0.204	0.205	0.164	0.165	0.042	0.340	0.067	0.205	0.165		
	nom													0.01	0.015
	min	0.112	0.045	0.003	0.196	0.195	0.156	0.155	0.038	0.300	0.057	0.195	0.155		

Note
1. Millimeter dimensions are derived from the original inch dimensions.

sot1227b_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1227B						~~12-06-08~~ 13-10-15

Fig 12. Package outline SOT1227B

10. Handling information

CAUTION

This device is sensitive to ElectroStatic Discharge (ESD). Observe precautions for handling electrostatic sensitive devices.

Such precautions are described in the *ANSI/ESD S20.20*, *IEC/ST 61340-5*, *JESD625-A* or equivalent standards.

Table 12. ESD sensitivity

ESD model	Class
Charged Device Model (CDM); According to ANSI/ESDA/JEDEC standard JS-002	C2A [1]
Human Body Model (HBM); According to ANSI/ESDA/JEDEC standard JS-001	0B [2]

[1] CDM classification C2A is granted to any part that passes after exposure to an ESD pulse of 500 V.

[2] HBM classification 0B is granted to any part that passes after exposure to an ESD pulse of 125 V.

11. Abbreviations

Table 13. Abbreviations

Acronym	Description
ADS	Advanced Design System
CW	Continuous Wave
ESD	ElectroStatic Discharge
GaN	Gallium Nitride
HEMT	High Electron Mobility Transistor
L-band	Long wave band
MTF	Median Time to Failure
MWO	Microwave Office
RoHS	Restriction of Hazardous Substances
S-band	Short wave band
SiC	Silicon Carbide
UHF	Ultra High Frequency
VSWR	Voltage Standing Wave Ratio

12. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
CLF3H0060-10_3H0060S-10 v.1	20230717	Product data sheet	-	-

13. Legal information

13.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.ampleon.com.

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For sales office addresses, please visit: **http://www.ampleon.com/sales**

15. Contents

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For more information, please visit: http://www.ampleon.com
For sales office addresses, please visit: http://www.ampleon.com/sales

Date of release: 17 July 2023
Document identifier: CLF3H0060-10_3H0060S-10