CLF1G0035-200P; CLF1G0035S-200P

Broadband RF power GaN HEMT

AMPLEON

Rev. 1 — 22 April 2016

Product data sheet

1. Product profile

1.1 General description

The CLF1G0035-200P and CLF1G0035S-200P are 200 W general purpose broadband GaN HEMTs usable from DC to 3.5 GHz.

Table 1. CW and pulsed RF application information

Typical RF performance at T_{case} = 25 °C; I_{Dq} = 300 mA; V_{DS} = 50 V in a class-AB broadband demo board.

Test signal	f	P_L	G_p	η_D
	(MHz)	(W)	(dB)	(%)
1-Tone CW	1700	200	11	47
	2000	200	10	52
	2300	200	9	58
1-Tone pulsed [1]	1700	200	14	46
	2000	200	14	48
	2300	200	13	51

[1] Pulsed RF; t_p = 100 µs; δ = 10 %.

Table 2. 2-Tone CW application information

Typical 2-Tone performance at T_{case} = 25 °C; I_{Dq} = 600 mA; V_{DS} = 50 V in a class-AB broadband demo board.

Test signal	f	$P_{L(PEP)}$	IMD3
	(MHz)	(W)	(dBc)
2-Tone CW [1]	1700	120	–40
	2000	120	–45
	2300	120	–43

[1] 2-Tone CW; Δf = 100 kHz.

1.2 Features and benefits

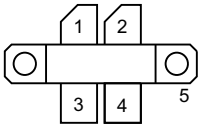
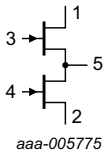
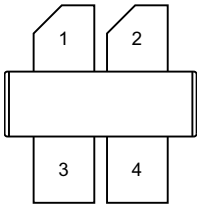
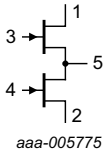
- Frequency of operation is from DC to 3.5 GHz
- 200 W general purpose broadband RF Power GaN HEMT
- Excellent ruggedness (VSWR = 10 : 1)
- High voltage operation (50 V)
- Thermally enhanced package

1.3 Applications

- Commercial wireless infrastructure (cellular, WiMAX)
- Radar
- Broadband general purpose amplifier
- Public mobile radios
- Industrial, scientific, medical
- Jammers
- EMC testing
- Defense application

2. Pinning information

Table 3. Pinning

Pin	Description	Simplified outline	Graphic symbol
CLF1G0035-200P (SOT1228A)			
1	drain1		
2	drain2		
3	gate1		
4	gate2		
5	source [1]		
CLF1G0035S-200P (SOT1228B)			
1	drain1		
2	drain2		
3	gate1		
4	gate2		
5	source [1]		

[1] Connected to flange.

3. Ordering information

Table 4. Ordering information

Type number	Package		
	Name	Description	Version
CLF1G0035-200P	-	flanged ceramic package; 2 mounting holes; 4 leads	SOT1228A
CLF1G0035S-200P	-	earless flanged ceramic package; 4 leads	SOT1228B

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	+3	V
I_{GF}	forward gate current	external R_G = 5 Ω	-	72	mA
T_{stg}	storage temperature		−65	+150	°C
T_j	junction temperature	measured via IR scan	-	250	°C

5. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-c)}$	thermal resistance from junction to case	T_j = 200 °C [1]	0.52	K/W

[1] T_j is measured via IR scan with case temperature of 85 °C and power dissipation of 220 W.

6. Characteristics

Table 7. DC Characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{(BR)DSS}$	drain-source breakdown voltage	V_{GS} = −7 V; I_{DS} = 24 mA	150	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	V_{DS} = 0.1 V; I_{DS} = 24 mA	−2.4	−2	−1.3	V
I_{DSX}	drain cut-off current	V_{DS} = 10 V; V_{GS} = 3 V	-	17.5	-	A
g_{fs}	forward transconductance	V_{DS} = 10 V; V_{GS} = 0 V	-	4	-	S

Table 8. RF Characteristics

Test signal: pulsed RF; f = 3000 MHz; t_p = 100 μs; δ = 10 %; RF performance at V_{DS} = 50 V; I_{Dq} = 660 mA; T_{case} = 25 °C; unless otherwise specified in a class-AB production circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
η_D	drain efficiency	P_L = 200 W	39	44	-	%
G_p	power gain	P_L = 200 W	9	11	-	dB
RL_{in}	input return loss	P_L = 200 W	-	−10	-	dB
t_r	rise time	P_L = 200 W	-	9	-	ns
t_f	fall time	P_L = 200 W	-	9	-	ns

7. Application information

7.1 Demo circuit

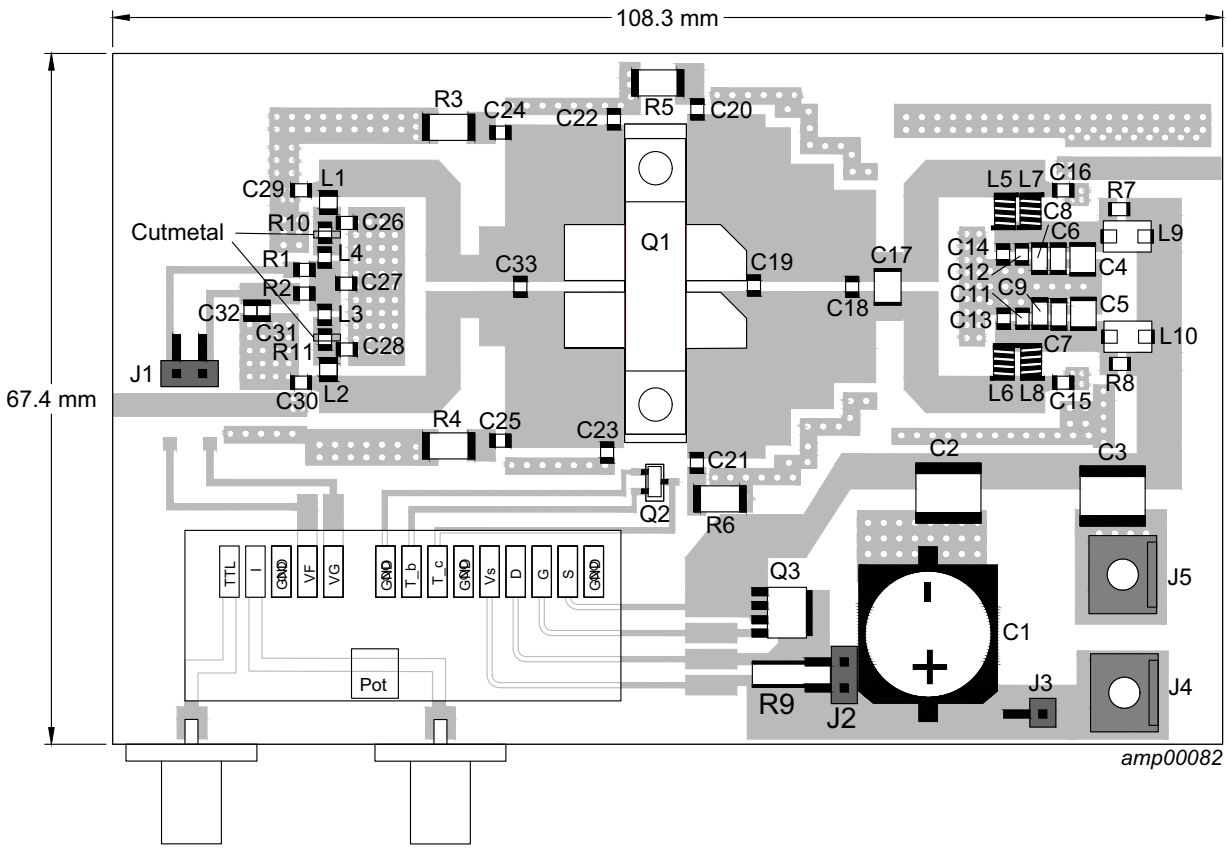


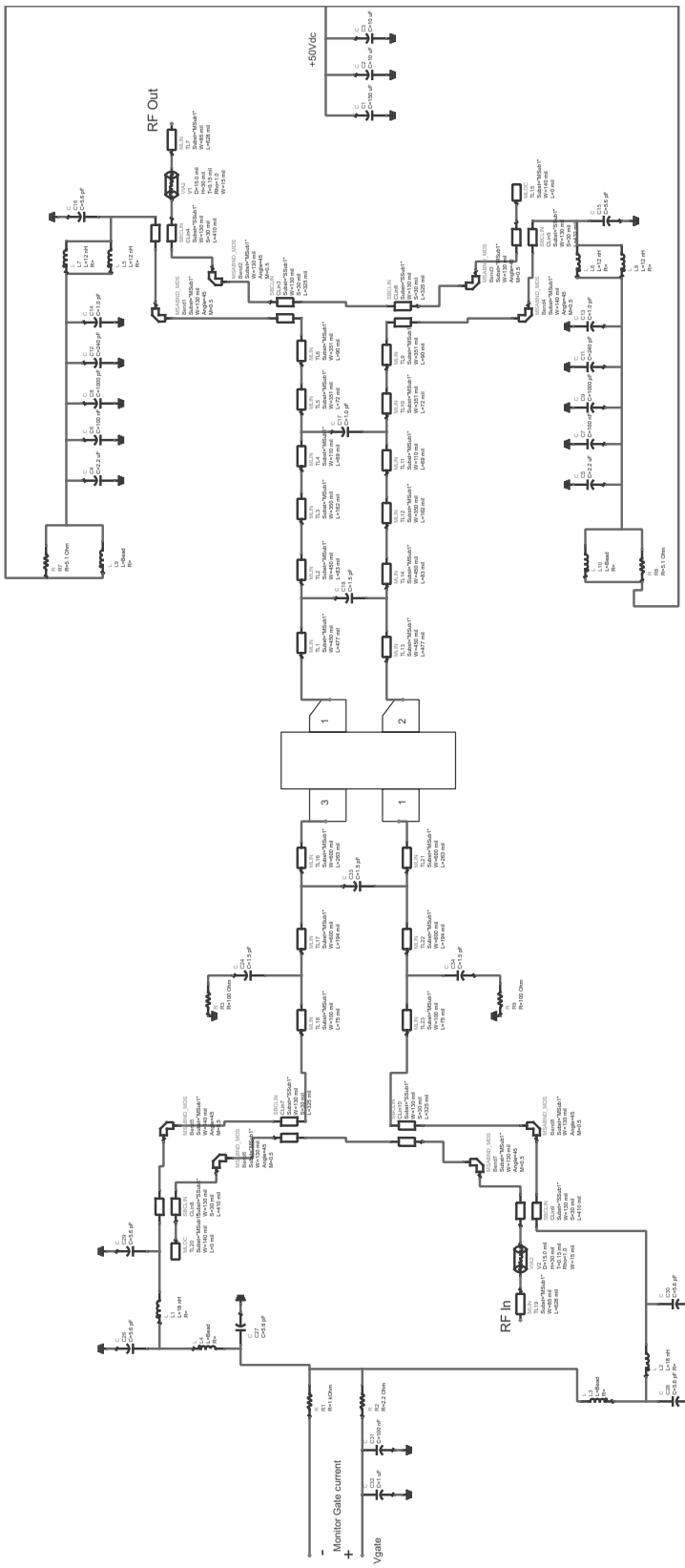
Fig 1. The broadband amplifier (1700 to 2300 MHZ) demo circuit outline

Table 9. List of components
See Figure 1 and Figure 2.

Component	Description	Value	Remarks
C1	electrolytic capacitor		Panasonic EEE-TK1J471AM
C2, C3	multilayer ceramic chip capacitor	10 μF, 100 V	TDK C5750X7S2A106M
C4, C5	multilayer ceramic chip capacitor	2.2 μF, 100 V	Murata GRM32ER72A225KA35L
C6, C7	multilayer ceramic chip capacitor	0.1 μF, 250 V	Murata GRM32DR72E104KW01L
C8, C9	multilayer ceramic chip capacitor	1000 pF	PassivePlus 1111N
C11, C12	multilayer ceramic chip capacitor	240 pF	Passive Plus 0805N
C13, C14	multilayer ceramic chip capacitor	1.8 pF	Passive Plus 0805N
C15, C16, C26, C27, C28, C29, C30	multilayer ceramic chip capacitor	5.6 pF	Passive Plus 0805N
C17	multilayer ceramic chip capacitor	0.9 pF	ATC 100B
C18	multilayer ceramic chip capacitor	0.2 pF	Passive Plus 0805N
C19	multilayer ceramic chip capacitor	1.6 pF	Passive Plus 0805N

Table 9. List of components *…continued*
See Figure 1 and Figure 2.

Component	Description	Value	Remarks
C20, C21, C24, C25	multilayer ceramic chip capacitor	0.2 pF	Passive Plus 0805N
C22, C23	multilayer ceramic chip capacitor	0.5 pF	Passive Plus 0805N
C31	multilayer ceramic chip capacitor	100 nF, 50 V	Multicomp U0805W104K1HRN-P4
C32	multilayer ceramic chip capacitor	1 μF, 100 V	Murata GRM31CR72A105KA01L
C33	multilayer ceramic chip capacitor	0.6 pF	Passive Plus 0805N
J1, J2	header	2 pin 0.1”	
J3	header	1 pin 0.1”	
J4, J5	spade connector	-	
L1, L2	inductor	18 nH, 1.4 A	Coil-Craft 0805HQ-18NX L
L3, L4	ferrite chip bead	600 Ω	Laird MI0805K601R-10
L5, L6, L7, L8	inductor	12 nH, 4.4 A	Coil-Craft 0908SQ-8N1 L
L9, L10	ferrite chip bead	-	Fair-Rite 2743019447
Q1	transistor	-	CLF1G0035-200P
Q2	transistor	-	NXP BC857B
Q3	transistor	-	NXP PSMN8R2-80YS
R1	resistor	1 Ω	SMD 0805
R2	resistor	2.2 kΩ	SMD 0805
R3, R4	resistor	100 Ω	SMD 2010
R5, R6	resistor	50 Ω	SMD 2010
R7, R8, R10, R11	resistor	5.1 Ω	SMD 0805
R9	resistor	0.010 Ω	Susumu RL7520WT-R010-F



See Table 9 for a list of components.

Fig 2. The broadband amplifier (1700 to 2300 MHz) demo circuit schematic

7.2 Application test results

Table 10. CW and pulsed RF application information

Typical RF performance at T_{case} = 25 °C; I_{Dq} = 300 mA; V_{DS} = 50 V in a class-AB broadband demo board.

Test signal	f	P_L	G_p	η_D
	(MHz)	(W)	(dB)	(%)
1-Tone CW	1700	200	11	47
	2000	200	10	52
	2300	200	9	58
1-Tone pulsed [1]	1700	200	14	46
	2000	200	14	48
	2300	200	13	51

[1] Pulsed RF: t_p = 100 μs; δ = 10 %.

Table 11. 2-Tone CW application information

Typical RF performance at T_{case} = 25 °C; I_{Dq} = 600 mA; V_{DS} = 50 V in a class-AB broadband demo board.

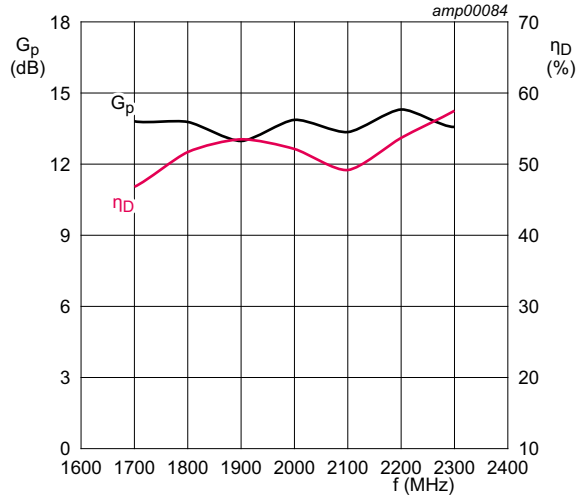
Test signal	f	$P_{L(PEP)}$	IMD3
	(MHz)	(W)	(dBc)
2-Tone CW [1]	1700	120	–40
	2000	120	–45
	2300	120	–43

[1] 2-Tone CW; Δf = 1 MHz.

7.3 Graphical data

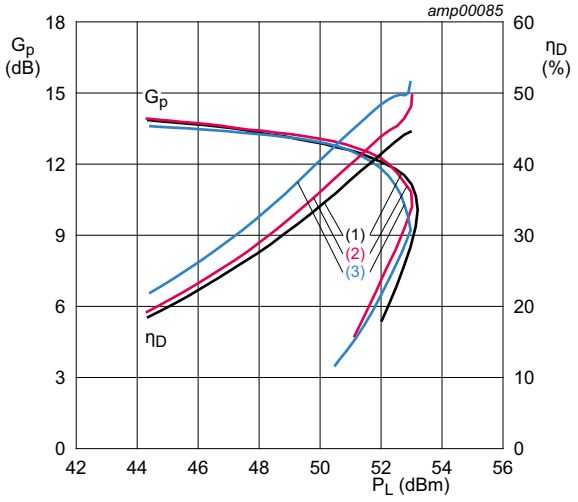
The following figures are measured in a broadband amplifier demo board from 1700 MHz to 2300 MHz.

7.3.1 1-Tone CW RF performance



V_{DS} = 50 V; I_{Dq} = 300 mA; P_L = 200 W.

Fig 3. Power gain and drain efficiency as function of frequency; typical values



V_{DS} = 50 V; I_{Dq} = 300 mA.

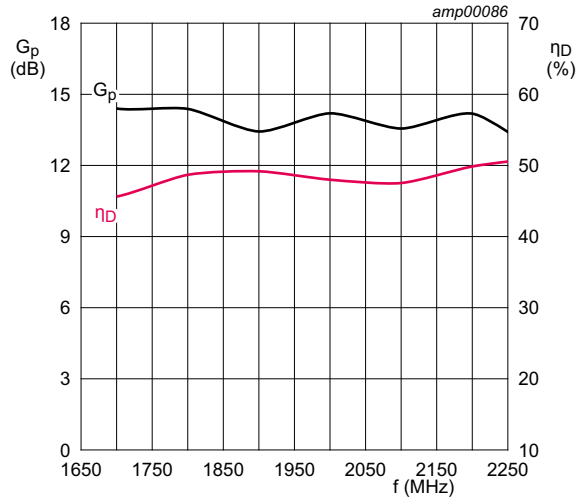
(1) f = 1700 MHz

(2) f = 2000 MHz

(3) f = 2300 MHz

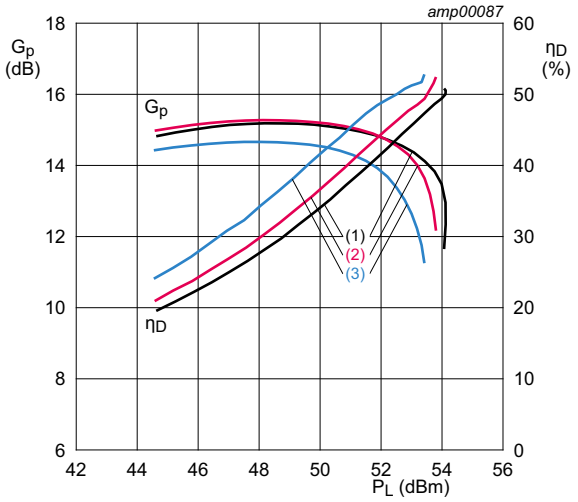
Fig 4. Power gain and drain efficiency as function of output power; typical values

7.3.2 1-Tone pulsed RF performance



V_{DS} = 50 V; I_{Dq} = 300 mA; t_p = 100 μs; δ = 10 %; P_L = 200 W.

Fig 5. Power gain and drain efficiency as function of frequency; typical values



V_{DS} = 50 V; I_{Dq} = 300 mA; t_p = 100 μs; δ = 10 %.

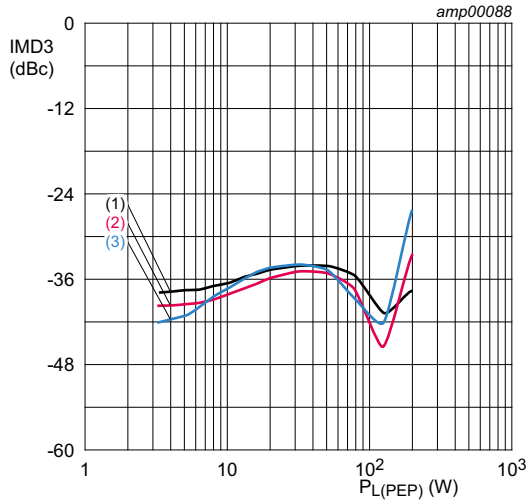
(1) f = 1700 MHz

(2) f = 2000 MHz

(3) f = 2300 MHz

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

7.3.3 2-Tone CW performance



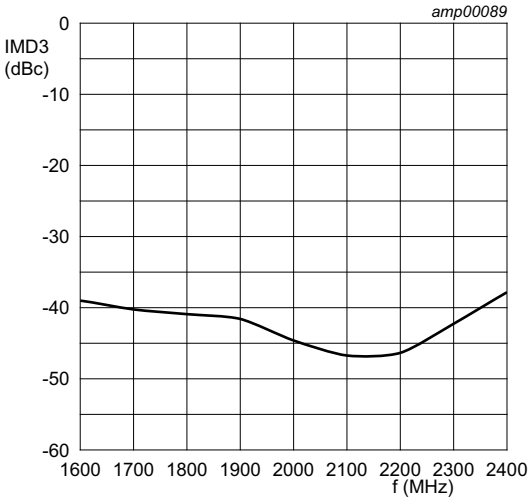
Δf = 1 MHz; V_{DS} = 50 V; I_{Dq} = 600 mA.

(1) f = 1700 MHz

(2) f = 2000 MHz

(3) f = 2300 MHz

Fig 7. Third-order intermodulation distortion as a function of peak envelope power load power; typical values



V_{DS} = 50 V; I_{Dq} = 600 mA; $P_{L(PEP)}$ = 120 W.

(1) f = 1700 MHz

(2) f = 2000 MHz

(3) f = 2300 MHz

Fig 8. Third-order intermodulation distortion as a function of frequency; typical values

7.3.4 Bias module

The bias module information for the GaN HEMT amplifier is described in application note *AN11130*.

8. Test information

8.1 Ruggedness in class-AB operation

The CLF1G0035-200P and CLF1G0035S-200P are capable of withstanding a load mismatch corresponding to VSWR = 10 : 1 through all phases under the following conditions: V_{DS} = 50 V; P_L = 175 W (CW), f = 2140 MHz in a broadband application circuit.

8.2 Load pull impedance information

The measured half section load pull impedances are shown below. Impedance reference plane defined at device leads at each half section. 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} = 330 mA.

Table 12. Typical impedance

Measured load-pull data half device. Typical values unless otherwise specified. I_{Dq} = 330 mA; V_{DS} = 50 V. Z_S and Z_L defined in Figure 9.

f	Z_S [1]	Z_L (maximum $P_{L(M)}$) [2]	Z_L (maximum η_D) [2]
(MHz)	(Ω)	(Ω)	(Ω)
500	6 + 6.5j	5.8 + 1.9j	7.6 + 5j
1000	1.7 + 2j	6 + 0.7j	6.5 + 5.2j
2000	1.2 – 2.8j	4.5 – 0.5j	3.8 + 1.6j
2600	1 – 4.2j	4 – 1.2j	3 + 0j
3000	1.7 – 5.2j	3.8 – 2.5j	3.1 – 1.3j
3500	2.7 – 8.9j	4.2 – 4.8j	3.3 – 3.7j

[1] measured at gate1 and gate2

[2] measured at drain1 and drain2

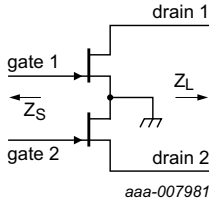


Fig 9. Definition of transistor impedance

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

8.3 Packaged S-parameter data

Table 13. S-parameter data half device

Small signal; V_{DS} = 50 V; I_{Dq} = 330 mA; $Z_S = Z_L$ = 50 Ω

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)
100	0.89132	−156.66	34.068	94.493	0.012475	7.7032	0.52196	−147.24
200	0.89073	−168.26	17.043	82.662	0.012315	−0.83012	0.53166	−156.66
300	0.89427	−172.3	11.153	74.641	0.011818	−5.3714	0.55825	−158.1
400	0.89924	−174.48	8.1416	67.823	0.011142	−8.4181	0.59137	−158.32
500	0.90493	−175.96	6.3028	61.71	0.010348	−10.333	0.62678	−158.56
600	0.91086	−177.14	5.0617	56.145	0.009484	−11.104	0.66181	−159.08
700	0.91671	−178.17	4.1699	51.054	0.008599	−10.584	0.69485	−159.87
800	0.92224	−179.13	3.5016	46.389	0.007737	−8.5461	0.72507	−160.86
900	0.92735	179.94	2.9855	42.108	0.006948	−4.7126	0.75217	−161.98
1000	0.93196	179.04	2.578	38.172	0.006285	1.1721	0.77617	−163.17
1100	0.93606	178.16	2.2506	34.546	0.005806	9.1609	0.79724	−164.39
1200	0.93966	177.28	1.9837	31.195	0.005568	18.833	0.81567	−165.61
1300	0.94281	176.4	1.7635	28.089	0.005606	29.182	0.83174	−166.82
1400	0.94552	175.53	1.5801	25.2	0.005918	38.964	0.84575	−168
1500	0.94785	174.66	1.4259	22.504	0.006469	47.302	0.85796	−169.15
1600	0.94982	173.78	1.2952	19.978	0.00721	53.919	0.86862	−170.26
1700	0.95148	172.9	1.1837	17.603	0.008097	58.951	0.87793	−171.34
1800	0.95285	172.02	1.088	15.361	0.009097	62.687	0.88608	−172.38
1900	0.95397	171.13	1.0053	13.239	0.010189	65.418	0.89322	−173.38
2000	0.95484	170.23	0.93366	11.223	0.011359	67.384	0.89949	−174.36
2100	0.9555	169.32	0.87121	9.2996	0.012601	68.77	0.905	−175.31
2200	0.95595	168.39	0.81661	7.4599	0.013912	69.711	0.90983	−176.23
2300	0.95622	167.44	0.76871	5.6942	0.015292	70.306	0.91408	−177.14
2400	0.9563	166.48	0.7266	3.9939	0.016745	70.629	0.91781	−178.02
2500	0.9562	165.49	0.68949	2.3514	0.018273	70.735	0.92108	−178.88
2600	0.95593	164.48	0.65676	0.7596	0.019885	70.661	0.92394	−179.72
2700	0.95549	163.44	0.62788	−0.788	0.021586	70.439	0.92643	179.44
2800	0.95487	162.36	0.60239	−2.2976	0.023385	70.091	0.92858	178.62
2900	0.95408	161.25	0.57994	−3.775	0.025294	69.632	0.93042	177.81
3000	0.9531	160.1	0.56021	−5.226	0.027321	69.075	0.93198	177
3100	0.95192	158.9	0.54294	−6.656	0.029482	68.427	0.93328	176.2
3200	0.95053	157.65	0.52791	−8.0708	0.03179	67.696	0.93433	175.4
3300	0.94892	156.35	0.51495	−9.4758	0.034261	66.885	0.93514	174.6
3400	0.94706	154.98	0.5039	−10.877	0.036915	65.995	0.93573	173.81
3500	0.94493	153.54	0.49464	−12.28	0.039772	65.028	0.93611	173.01
3600	0.9425	152.02	0.48708	−13.692	0.042855	63.98	0.93627	172.2
3700	0.93974	150.42	0.48113	−15.12	0.046193	62.851	0.93622	171.4

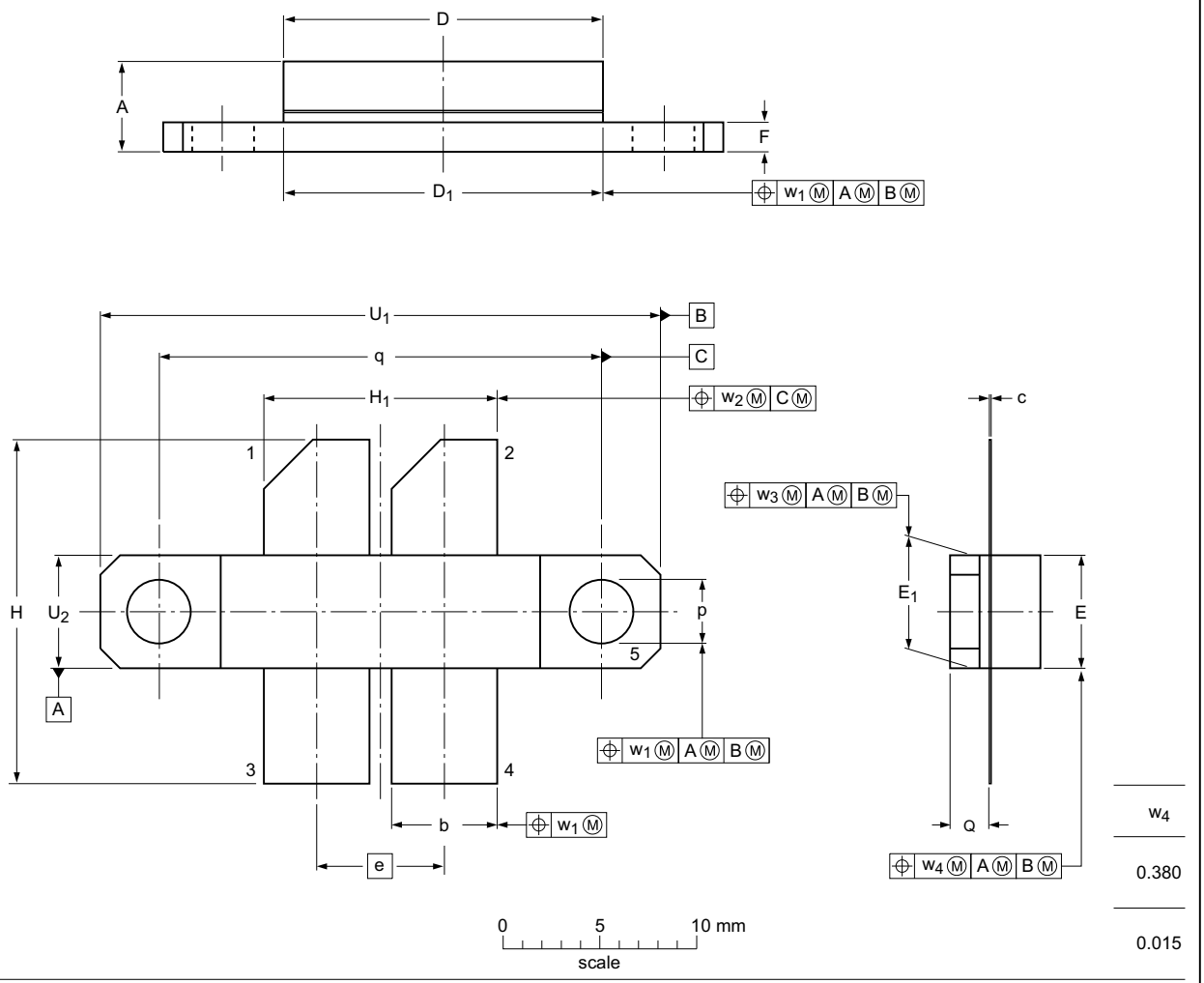
Table 13. S-parameter data half device *…continued*

Small signal; V_{DS} = 50 V; I_{Dq} = 330 mA; Z_S = Z_L = 50 Ω

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)
3800	0.93661	148.72	0.47676	−16.57	0.049816	61.637	0.93596	170.58
3900	0.93304	146.91	0.47391	−18.052	0.053758	60.331	0.93549	169.76
4000	0.92899	144.97	0.47258	−19.574	0.05806	58.928	0.9348	168.93
4100	0.92439	142.9	0.47276	−21.147	0.062766	57.42	0.93389	168.09
4200	0.91915	140.66	0.47446	−22.781	0.067929	55.796	0.93276	167.24
4300	0.91317	138.25	0.47772	−24.491	0.073607	54.046	0.93138	166.37
4400	0.90633	135.63	0.48257	−26.289	0.079867	52.157	0.92976	165.49
4500	0.89849	132.78	0.48907	−28.193	0.086783	50.112	0.9279	164.6
4600	0.88949	129.66	0.49729	−30.221	0.094441	47.895	0.92577	163.69
4700	0.87914	126.23	0.50729	−32.395	0.10293	45.484	0.92339	162.77
4800	0.8672	122.45	0.51914	−34.739	0.11237	42.857	0.92076	161.83
4900	0.85343	118.25	0.53291	−37.279	0.12284	39.988	0.91791	160.88
5000	0.83755	113.57	0.54862	−40.045	0.13448	36.847	0.91488	159.92
5100	0.81926	108.32	0.56627	−43.069	0.14738	33.402	0.91174	158.95
5200	0.79827	102.42	0.58578	−46.386	0.16163	29.62	0.9086	157.98
5300	0.77437	95.758	0.60694	−50.029	0.1773	25.468	0.90565	156.99
5400	0.74749	88.197	0.62942	−54.032	0.19438	20.912	0.90312	156
5500	0.7178	79.599	0.65267	−58.42	0.2128	15.928	0.90132	155
5600	0.68594	69.815	0.67591	−63.21	0.23234	10.5	0.90063	153.96
5700	0.65314	58.706	0.69815	−68.399	0.25267	4.6305	0.90147	152.86
5800	0.62143	46.181	0.71818	−73.964	0.2733	−1.6555	0.90421	151.66
5900	0.59357	32.261	0.73479	−79.853	0.29362	−8.3064	0.90909	150.31
6000	0.57266	17.159	0.7469	−85.99	0.31299	−15.244	0.9161	148.75

9. Package outline

Flanged LDMOST ceramic package; 2 mounting holes; 4 leads **SOT1228A**



	w4
	0.380
	0.015

Dimensions

Unit(1)		A	b	c	D	D_1	e	E	E_1	F	H	H_1	p	Q(2)	q	U_1	U_2	w_1	w_2	w_3
mm	max	5.2	5.59	0.15	16.66	16.69		5.92	5.97	1.65	18.29	12.19	3.43	2.21		29.08	5.97			
	nom						6.60								22.86			0.25	0.51	0.125
	min	4.5	5.33	0.08	16.36	16.33		5.77	5.72	1.40	17.27	11.94	3.18	1.96		28.83	5.72			
inches	max	0.205	0.220	0.006	0.656	0.657		0.233	0.235	0.065	0.720	0.480	0.135	0.087		1.145	0.235			
	nom						0.26								0.900			0.01	0.02	0.005
	min	0.177	0.210	0.003	0.644	0.643		0.227	0.225	0.055	0.680	0.470	0.125	0.077		1.135	0.225			

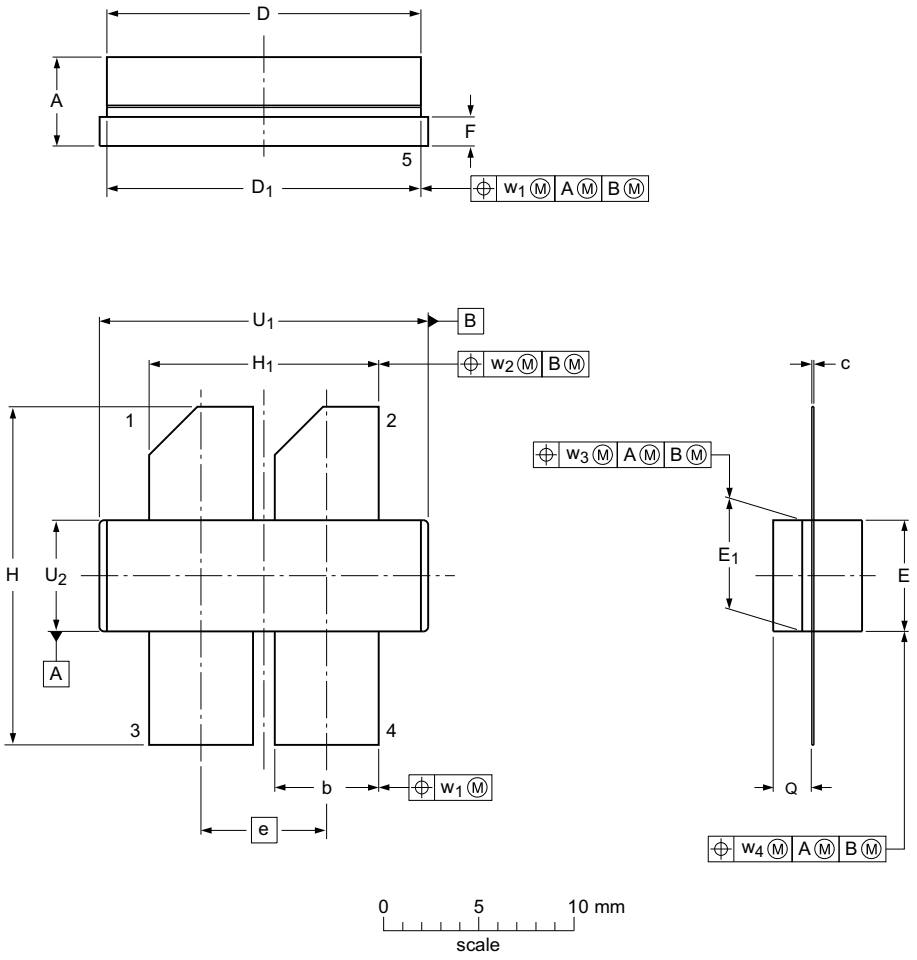
Note
1. Millimeter dimensions are derived from the original inch dimensions.
2. Dimension is measured 0.030 inch (0.76 mm) from body.

sot1228a_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1228A						~~12-06-11~~ 13-05-16

Fig 10. Package outline SOT1228A

Earless flanged LDMOST ceramic package; 4 leads **SOT1228B**



Dimensions

Unit(1)		A	b	c	D	D_1	e	E	E_1	F	H	H_1	Q(2)	U_1	U_2	w_1	w_2	w_3	w_4
mm	max	5.2	5.59	0.15	16.66	16.69		5.92	5.97	1.65	18.29	12.19	2.21	17.40	5.97				
	nom						6.60									0.25	0.51	0.125	0.38
	min	4.5	5.33	0.08	16.36	16.33		5.77	5.72	1.40	17.27	11.94	1.96	17.15	5.72				
inches	max	0.205	0.220	0.006	0.656	0.657		0.233	0.235	0.065	0.720	0.480	0.087	0.685	0.235				
	nom						0.26									0.01	0.02	0.005	0.01
	min	0.177	0.210	0.003	0.644	0.643		0.227	0.225	0.055	0.680	0.470	0.077	0.675	0.225				

Note
1. Millimeter dimensions are derived from the original inch dimensions.
2. Dimension is measured 0.030 inch (0.76 mm) from body.

sot1228b_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1228B						~~13-05-15~~ 13-05-23

Fig 11. Package outline SOT1228B

10. Handling information

10.1 ESD Sensitivity

Table 14. ESD sensitivity

ESD model	Class
Human Body Model (HBM); According JEDEC standard 22-A114E	1B [1]

[1] Classification 1B is granted to any part that passes after exposure to an ESD pulse of 500 V, but fails after exposure to an ESD pulse of 1000 V.

11. Abbreviations

Table 15. Abbreviations

Acronym	Description
CW	Continuous Wave
EMC	ElectroMagnetic Compatibility
ESD	ElectroStatic Discharge
GaN	Gallium Nitride
HEMT	High Electron Mobility Transistor
LDMOST	Laterally Diffused Metal Oxide Semiconductor Transistor
SMD	Surface Mounted Device
VSWR	Voltage Standing-Wave Ratio
WiMAX	Worldwide Interoperability for Microwave Access

12. Revision history

Table 16. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
CLF1G0035-200P_1G0035S-200P v.1	20160422	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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