CLF1G0060-30; CLF1G0060S-30

Broadband RF power GaN HEMT

AMPLEON

Rev. 5 — 1 September 2015 **Objective data sheet**

1. Product profile

1.1 General description

The CLF1G0060-30 and CLF1G0060S-30 are 30 W general purpose broadband GaN HEMTs usable from DC to 6.0 GHz.

Table 1. CW and pulsed RF application information

Typical RF performance at T_{case} = 25 °C; I_{Dq} = 70 mA; V_{DS} = 50 V in a class-AB broadband demo board.

Test signal	f (MHz)	P_L (W)	G_p (dB)	η_D (%)
1-Tone CW	500	30	15.6	60.7
	1000	30	13.9	50.3
	1500	30	13.7	50.8
	2000	30	12.6	49
	2500	30	14.2	55.6
1-Tone pulsed [1]	500	30	16.6	61
	1000	30	15.8	50
	1500	30	15.5	52.5
	2000	30	14.5	50
	2500	30	15.9	59

[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} = 150 mA; V_{DS} = 50 V in a class-AB broadband demo board.

Test signal	f (MHz)	$P_{L(PEP)}$ (W)	IMD3 (dBc)
2-Tone CW [1]	500	10	–38
	1000	10	–50
	1500	10	–45
	2000	10	–50
	2500	10	–43

[1] 2-Tone CW; Δf = 1 MHz.

1.2 Features and benefits

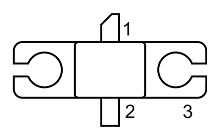
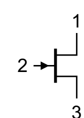
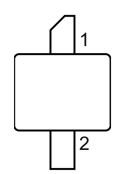
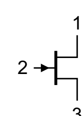
- Frequency of operation is from DC to 6.0 GHz
- 30 W general purpose broadband RF Power GaN HEMT
- Excellent ruggedness (VSWR = 10 : 1)
- High voltage operation (50 V)
- Thermally enhanced package

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
CLF1G0060-30 (SOT1227A)			
1	drain		 aaa-003693
2	gate		
3	source [1]		
CLF1G0060S-30 (SOT1227B)			
1	drain		 aaa-003693
2	gate		
3	source [1]		

[1] Connected to flange.

3. Ordering information

Table 4. Ordering information

Type number	Package		
	Name	Description	Version
CLF1G0060-30	-	flanged ceramic package; 2 mounting holes; 2 leads	SOT1227A
CLF1G0060S-30	-	earless flanged ceramic package; 2 leads	SOT1227B

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 $R_G = 5\ \Omega$	-	11	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]	3.1	K/W

[1] T_j is measured via IR scan with case temperature of 85 °C and power dissipation of 34 W.

6. Characteristics

Table 7. DC Characteristics
$T_{case} = 25$ °C; unless otherwise specified.

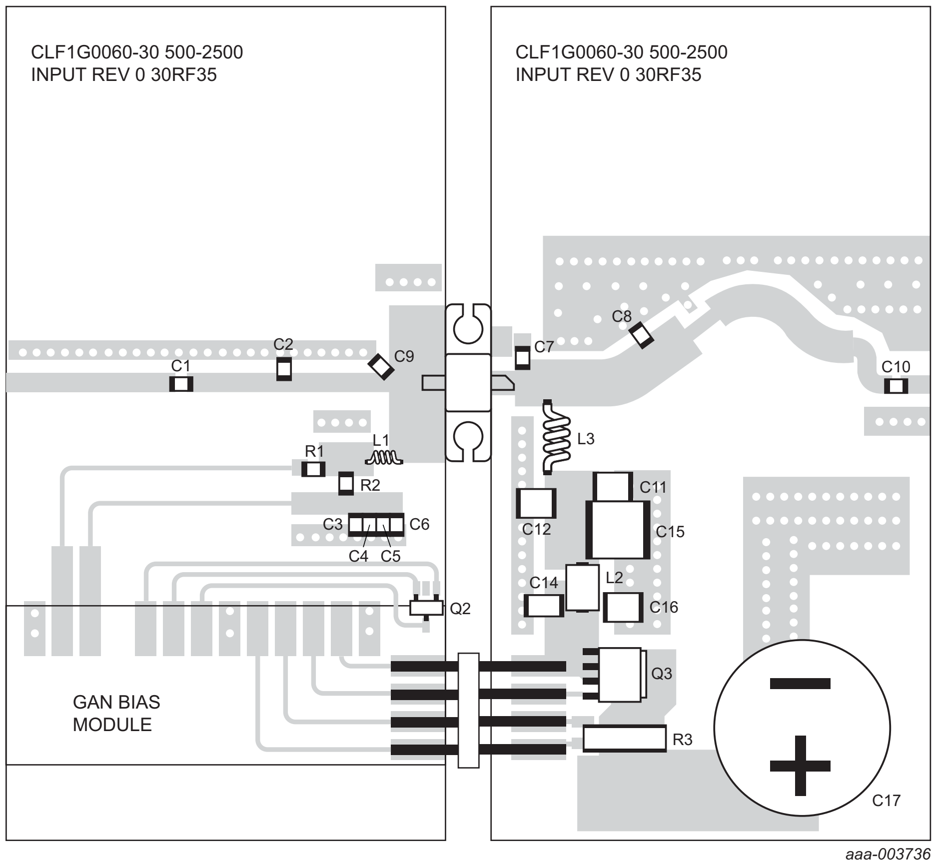
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{(BR)DSS}$	drain-source breakdown voltage	$V_{GS} = -7$ V; $I_{DS} = 7.2$ mA	150	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$V_{DS} = 0.1$ V; $I_{DS} = 7.2$ mA	–2.4	–2	–1.6	V
I_{DSX}	drain cut-off current	$V_{DS} = 10$ V; $V_{GS} = 3$ V	-	5.1	-	A
g_{fs}	forward transconductance	$V_{DS} = 10$ V; $V_{GS} = 0$ V	-	1.1	-	S

Table 8. RF Characteristics
Test signal: pulsed RF; $t_p = 100\ \mu s$; $\delta = 10$ %; RF performance at $V_{DS} = 50$ V; $I_{Dq} = 70$ mA; $T_{case} = 25$ °C; unless otherwise specified in a class-AB production circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f	frequency		3	-	3.5	GHz
η_D	drain efficiency	$P_L = 30$ W	-	50	-	%
G_p	power gain	$P_L = 30$ W	-	13	-	dB
RL_{in}	input return loss	$P_L = 30$ W	-	–7	-	dB
$P_{droop(pulse)}$	pulse droop power	$P_L = 30$ W	-	0.04	-	dB
t_r	rise time	$P_L = 30$ W	-	5	-	ns
t_f	fall time	$P_L = 30$ W	-	5	-	ns

7. Application information

7.1 Demo circuit



Printed-Circuit Board (PCB) material: Taconic RF35, ε_r = 3.5, thickness 30 mils, 1 oz copper on each side.

See Table 9 for list of components.

Fig 1. The broadband amplifier (500 MHz to 2500 MHz) demo circuit outline

Table 9. List of components

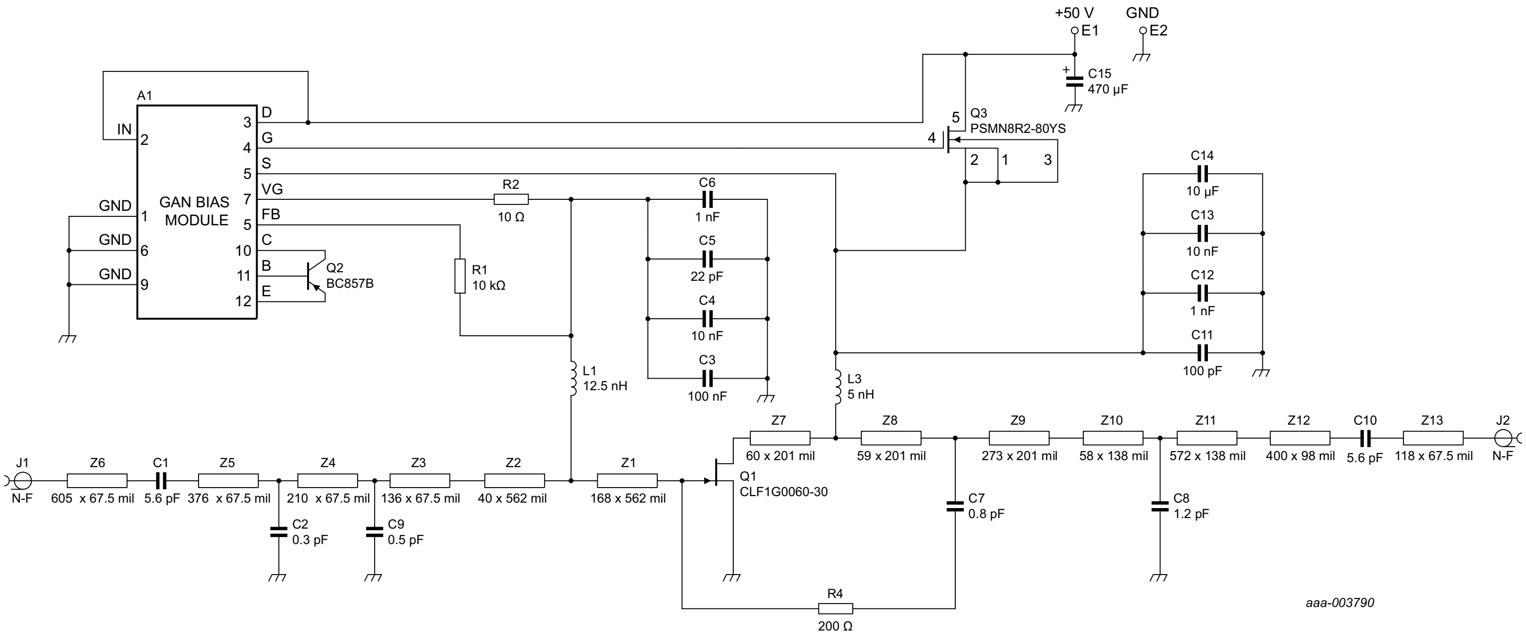
See Figure 1.

Component	Description	Value	Remarks
A1	GaN bias module v2	-	Ampleon
C1, C10	multilayer ceramic chip capacitor	8.2 pF	ATC 600F
C2, C7	multilayer ceramic chip capacitor	0.8 pF	ATC 600F
C3	electrolytic capacitor	100 nF, 50 V	SMD 0805
C4	electrolytic capacitor	10 nF, 50 V	SMD 0805
C5	electrolytic capacitor	22 pF, 100 V	SMD 0805
C6	electrolytic capacitor	1 nF, 100 V	SMD 1206
C8	multilayer ceramic chip capacitor	1.2 pF	ATC 600F
C9	multilayer ceramic chip capacitor	0.5 pF	ATC 600F

Table 9. List of components *...continued*

See Figure 1.

Component	Description	Value	Remarks
C11	multilayer ceramic chip capacitor	100 pF	ATC 100B
C12	multilayer ceramic chip capacitor	1 nF	ATC 700B
C14	electrolytic capacitor	1 μF, 100V	SMD 1206
C15	electrolytic capacitor	10 μF, 100 V	SMD 2220
C16	electrolytic capacitor	10 nF, 200 V	SMD 1210
C17	electrolytic capacitor	470 μF, 63 V	PCE3667CT-ND
E1, E2	drain voltage connection	-	
J1	RF in connector	-	
J2	RF out connector	-	
L1	inductor	330 nH	1008CS-100XJB
L2	ferrite bead	-	2743019447
L3	inductor	-	1 turn, 18 AWG, inner diameter = 4.06 mm
Q1	transistor	-	Ampleon CLF1G0060-30
Q2	transistor	-	NXP BC857B
Q3	transistor	-	NXP PSMN8R2-80YS
R1	resistor	10 kΩ	Vishay Dale
R2	resistor	10 Ω	Vishay Dale
R3	resistor	0.005 Ω	RL7520WT-R005-F
Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9, Z10, Z11, Z12, Z13	microstrip lines	-	



See Table 9 for a list of components.

Fig 2. The broadband amplifier (500 MHz to 2500 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} = 70 mA; V_{DS} = 50 V in a class-AB broadband demo board.

Test signal	f (MHz)	P_L (W)	G_p (dB)	η_D (%)
1-Tone CW	500	30	15.6	60.7
	1000	30	13.9	50.3
	1500	30	13.7	50.8
	2000	30	12.6	49
	2500	30	14.2	55.6
1-Tone pulsed [1]	500	30	16.6	61
	1000	30	15.8	50
	1500	30	15.5	52.5
	2000	30	14.5	50
	2500	30	15.9	59

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

Table 11. 2-Tone CW application information

Typical 2-Tone performance at T_{case} = 25 °C; I_{Dq} = 150 mA; V_{DS} = 50 V in a class-AB broadband demo board.

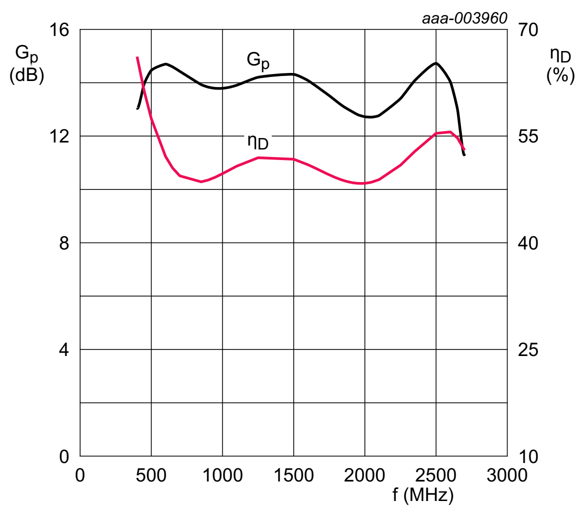
Test signal	f (MHz)	$P_{L(PEP)}$ (W)	IMD3 (dBc)
2-Tone CW [1]	500	10	–38
	1000	10	–50
	1500	10	–45
	2000	10	–50
	2500	10	–43

[1] 2-Tone CW; Δf = 1 MHz.

7.3 Graphical data

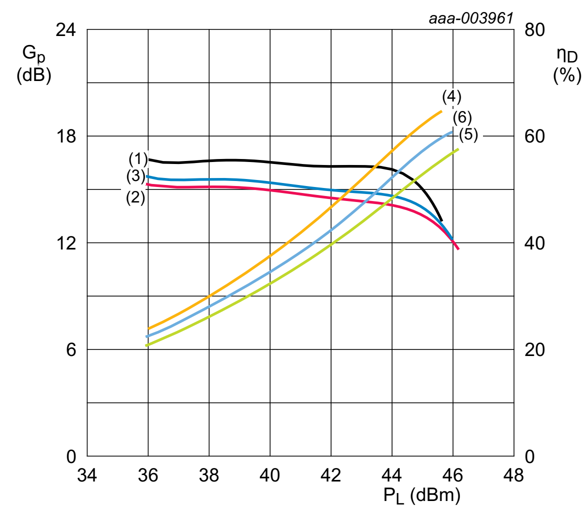
The following figures are measured in a broadband amplifier demo board from 500 MHz to 2500 MHz.

7.3.1 1-Tone CW RF performance



V_{DS} = 50 V; I_{Dq} = 70 mA; P_L = 30 W.

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



V_{DS} = 50 V; I_{Dq} = 70 mA.

(1) G_p at f = 500 MHz

(2) G_p at f = 1500 MHz

(3) G_p at f = 2500 MHz

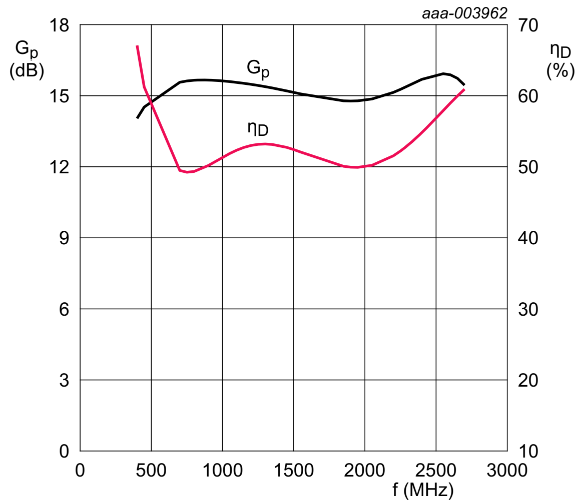
(4) η_D at f = 500 MHz

(5) η_D at f = 1500 MHz

(6) η_D at f = 2500 MHz

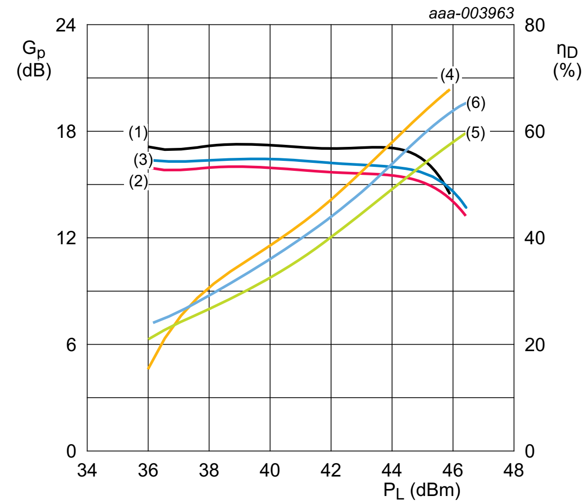
Fig 4. Power gain and drain efficiency as function of output power; typical values

7.3.2 1-Tone pulsed RF performance



V_{DS} = 50 V; I_{Dq} = 70 mA; P_L = 30 W; t_p = 100 μs; δ = 10 %.

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



V_{DS} = 50 V; I_{Dq} = 70 mA; t_p = 100 μs; δ = 10 %.

(1) G_p at f = 500 MHz

(2) G_p at f = 1500 MHz

(3) G_p at f = 2500 MHz

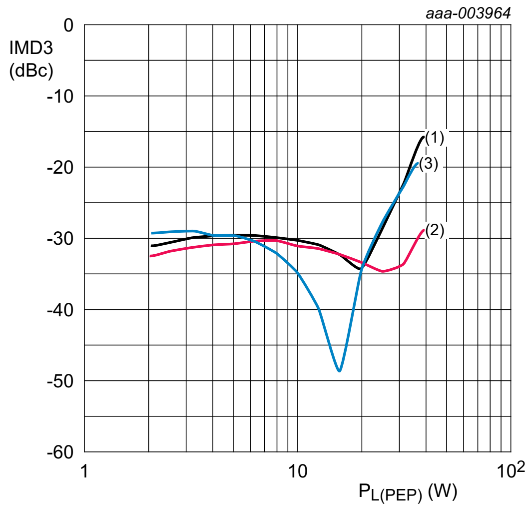
(4) η_D at f = 500 MHz

(5) η_D at f = 1500 MHz

(6) η_D at f = 2500 MHz

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

7.3.3 2-Tone CW performance



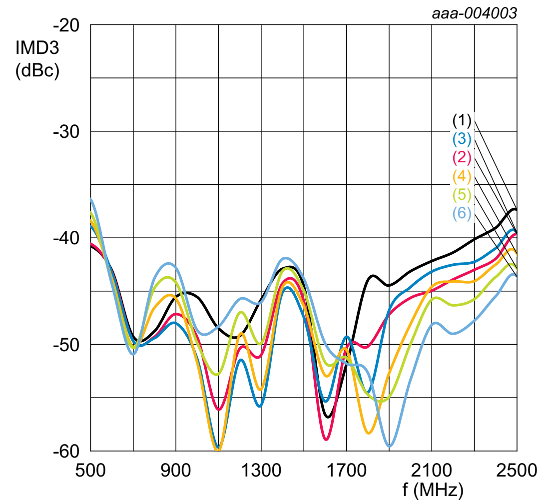
V_{DS} = 50 V; I_{Dq} = 150 mA; Δf = 1 MHz.

(1) f = 500 MHz

(2) f = 1500 MHz

(3) f = 2500 MHz

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



V_{DS} = 50 V; I_{Dq} = 150 mA; $P_{L(PEP)}$ =10 W.

(1) Δf = 10 kHz

(2) Δf = 30 kHz

(3) Δf = 100 kHz

(4) Δf = 300 kHz

(5) Δf = 1 MHz

(6) Δf = 3 MHz

Fig 8. Third-order intermodulation distortion as function of frequency and tone spacing; typical values

7.4 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 CLF1G0060-30 and CLF1G0060S-30 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 = 30 W (pulsed RF), f = <tbd> MHz.

8.2 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} = 50 mA.

Table 12. 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
2140	1.4 – 4j	14 + 5.4j	12.5 + 9.7j
2500	2.8 – 6j	10.5 + 2.5j	7.6 + 5.6j
2700	2.8 – 7.5j	10.7 + 1.3j	7.6 + 4.3j
3000	3.0 – 10j	9.1 + 3.5j	7.7 + 4.2j
3300	3.0 – 11.5j	9.4 + 1.2j	7.6 + 2.5j
3500	3.0 – 13j	9.5	7.2 + 1.35j
3700	3.5 – 14.4j	9.4 – 1.1j	7.3 – 0.05j
4000	3.7 – 20.3j	9.3 – 2.4j	7.7 – 1.2j

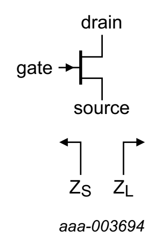


Fig 9. Definition of transistor impedance

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

f (MHz)	S_{11} Magnitude (ratio)	S_{11} Angle (degree)	S_{21} Magnitude (ratio)	S_{21} Angle (degree)	S_{12} Magnitude (ratio)	S_{12} Angle (degree)	S_{22} Magnitude (ratio)	S_{22} Angle (degree)
100	0.9302	−76.396	44.515	135.22	0.016195	46.871	0.7376	−43.407
200	0.87436	−115.47	29.415	111.96	0.021253	25.279	0.55438	−65.523
300	0.8537	−134.97	21.02	98.876	0.022516	13.903	0.47582	−77.762
400	0.8464	−146.22	16.096	89.855	0.02261	6.6529	0.44954	−86.181
500	0.8446	−153.57	12.919	82.761	0.022198	1.4192	0.44849	−92.826
600	0.84548	−158.81	10.71	76.739	0.021498	−2.6237	0.46041	−98.482
700	0.84785	−162.82	9.0883	71.392	0.020604	−5.8352	0.47921	−103.5
800	0.85112	−166.05	7.8465	66.516	0.019567	−8.375	0.50159	−108.06
900	0.85494	−168.77	6.8655	61.995	0.018424	−10.302	0.5256	−112.27
1000	0.85908	−171.15	6.0713	57.758	0.017205	−11.612	0.5501	−116.19
1100	0.86338	−173.27	5.4157	53.759	0.015936	−12.256	0.57433	−119.86
1200	0.86774	−175.22	4.866	49.966	0.014644	−12.138	0.59785	−123.33
1300	0.87206	−177.04	4.3993	46.356	0.01336	−11.113	0.62038	−126.6
1400	0.8763	−178.75	3.9988	42.911	0.012117	−8.9845	0.64176	−129.7
1500	0.88039	179.61	3.6521	39.616	0.010958	−5.505	0.66191	−132.65
1600	0.88432	178.03	3.3496	36.459	0.0099386	−0.40868	0.68081	−135.46
1700	0.88806	176.49	3.0841	33.428	0.0091267	6.4893	0.69846	−138.14
1800	0.8916	175	2.8497	30.514	0.0085991	15.099	0.7149	−140.7
1900	0.89493	173.53	2.6416	27.709	0.008424	24.853	0.73019	−143.15
2000	0.89806	172.09	2.4562	25.005	0.0086339	34.74	0.74438	−145.5
2100	0.90098	170.67	2.2902	22.395	0.0092114	43.73	0.75755	−147.76
2200	0.9037	169.26	2.1411	19.872	0.0101	51.208	0.76975	−149.93
2300	0.90622	167.87	2.0067	17.429	0.011233	57.053	0.78106	−152.02
2400	0.90856	166.48	1.8852	15.062	0.012549	61.439	0.79154	−154.04
2500	0.91072	165.11	1.775	12.766	0.014001	64.635	0.80125	−155.99
2600	0.91272	163.74	1.6748	10.534	0.015556	66.902	0.81025	−157.88
2700	0.91455	162.37	1.5835	8.3639	0.017191	68.455	0.8186	−159.71
2800	0.91623	161	1.5001	6.2502	0.01889	69.459	0.82634	−161.49
2900	0.91777	159.63	1.4237	4.1894	0.020642	70.039	0.83353	−163.22
3000	0.91917	158.27	1.3535	2.1779	0.022441	70.288	0.8402	−164.91
3100	0.92044	156.89	1.289	0.21252	0.024281	70.278	0.84641	−166.55
3200	0.9216	155.52	1.2296	−1.71	0.02616	70.06	0.85218	−168.16
3300	0.92264	154.14	1.1748	−3.5925	0.028076	69.675	0.85755	−169.73
3400	0.92357	152.75	1.1241	−5.4376	0.030027	69.154	0.86255	−171.27
3500	0.92441	151.35	1.0771	−7.2479	0.032015	68.521	0.8672	−172.78
3600	0.92515	149.94	1.0336	−9.0257	0.034039	67.795	0.87155	−174.26
3700	0.92579	148.53	0.99314	−10.773	0.036099	66.989	0.87559	−175.72

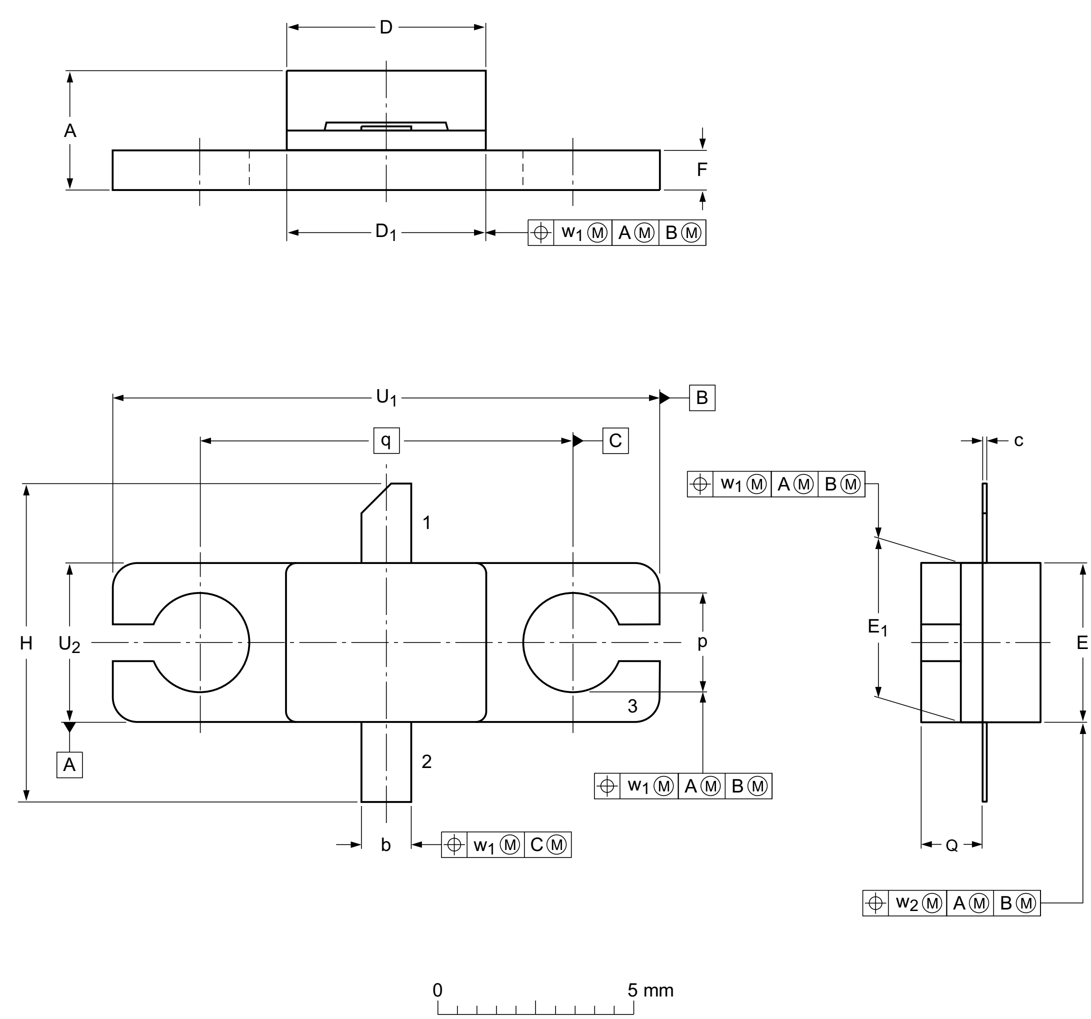
Table 13. S-parameter *...continued*

Small signal; V_{DS} = 50 V; I_{Dq} = 50 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	0.92635	147.1	0.95551	−12.493	0.038198	66.115	0.87937	−177.15
3900	0.92683	145.65	0.92046	−14.186	0.040336	65.183	0.8829	−178.57
4000	0.92723	144.2	0.88777	−15.855	0.042516	64.2	0.88619	−179.97
4100	0.92756	142.73	0.85724	−17.501	0.044737	63.171	0.88927	178.65
4200	0.92781	141.24	0.82871	−19.126	0.047003	62.101	0.89215	177.28
4300	0.928	139.73	0.802	−20.732	0.049315	60.994	0.89484	175.93
4400	0.92812	138.2	0.77698	−22.32	0.051676	59.853	0.89735	174.58
4500	0.92818	136.66	0.75351	−23.891	0.054087	58.68	0.8997	173.25
4600	0.92818	135.09	0.73149	−25.447	0.05655	57.477	0.9019	171.92
4700	0.92812	133.5	0.71079	−26.99	0.059068	56.245	0.90396	170.6
4800	0.928	131.89	0.69133	−28.519	0.061644	54.986	0.90588	169.28
4900	0.92783	130.25	0.67301	−30.038	0.064279	53.699	0.90767	167.97
5000	0.92761	128.59	0.65576	−31.546	0.066975	52.387	0.90935	166.66
5100	0.92734	126.9	0.63949	−33.046	0.069736	51.047	0.91092	165.35
5200	0.92701	125.17	0.62415	−34.537	0.072563	49.682	0.91238	164.04
5300	0.92664	123.42	0.60968	−36.022	0.075459	48.291	0.91375	162.73
5400	0.92622	121.64	0.596	−37.501	0.078426	46.874	0.91502	161.42
5500	0.92576	119.83	0.58307	−38.975	0.081467	45.43	0.9162	160.1
5600	0.92525	117.98	0.57085	−40.446	0.084583	43.959	0.9173	158.78
5700	0.9247	116.1	0.55929	−41.914	0.087778	42.461	0.91832	157.45
5800	0.92411	114.18	0.54834	−43.38	0.091053	40.935	0.91927	156.12
5900	0.92348	112.22	0.53797	−44.846	0.094411	39.381	0.92014	154.77
6000	0.92282	110.23	0.52814	−46.311	0.097853	37.797	0.92095	153.42

9. Package outline

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



Dimensions

Unit(1)		A	b	c	D	D1	E	E1	F	H	p	Q	q	U1	U2	w1	w2
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		

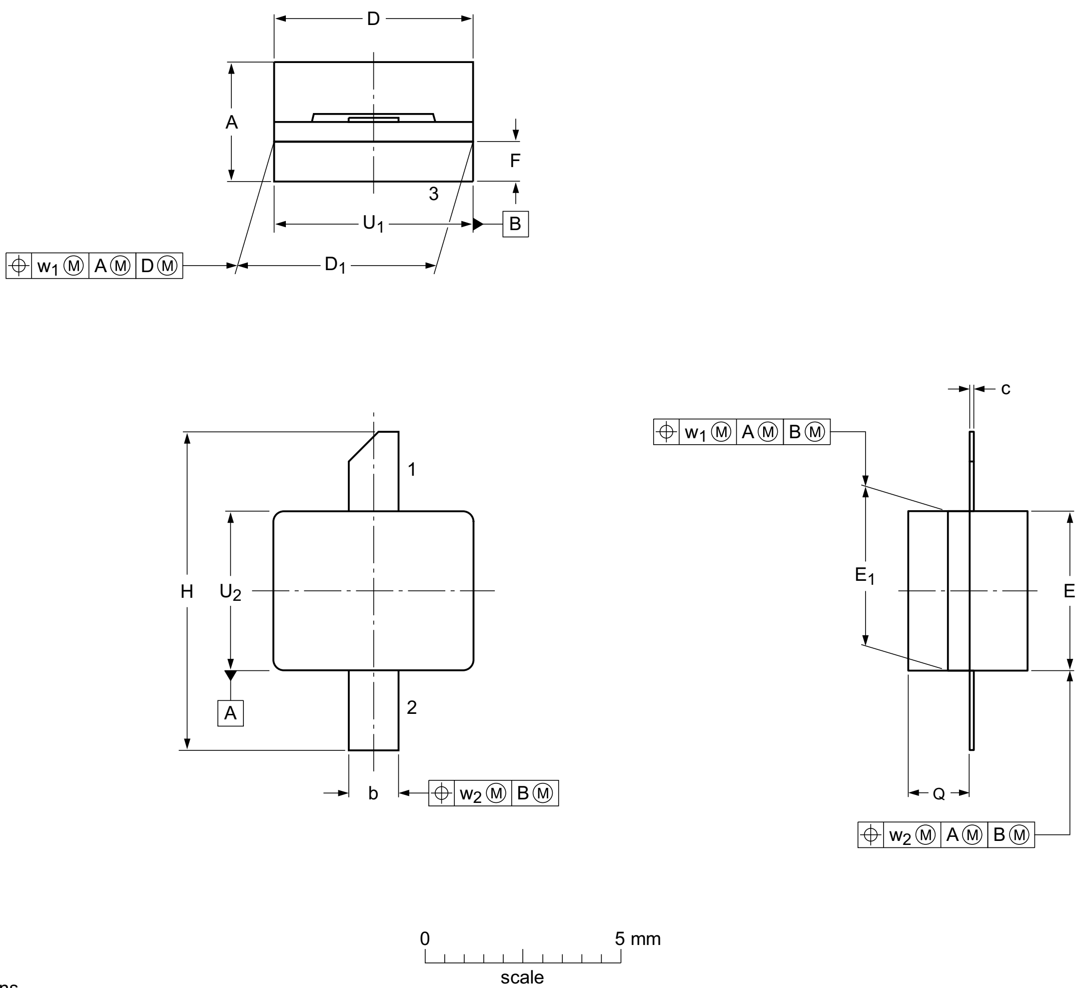
Note
1. Millimeter dimensions are derived from the original inch dimensions.

sot1227a_po

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

Fig 10. 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	0.25	0.380
	nom														
	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	0.01	0.015
	nom														
	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 11. Package outline SOT1227B

10. Handling information

10.1 ESD Sensitivity

Table 14. ESD sensitivity

ESD model	Class
Human Body Model (HBM); According JEDEC standard JESD22-A114F	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
AWG	American Wire Gauge
CW	Continuous Wave
EMC	ElectroMagnetic Compatibility
ESD	ElectroStatic Discharge
GaN	Gallium Nitride
HEMT	High Electron Mobility 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
CLF1G0060-30_1G0060S-30#5	20150901	Objective data sheet		CLF1G0060-30_1G0060S-30 v.4
Modifications:	• The format of this document has been redesigned to comply with the new identity guidelines of Ampleon. • Legal texts have been adapted to the new company name where appropriate.			
CLF1G0060-30_1G0060S-30 v.4	20130620	Objective data sheet	-	CLF1G0060-30_1G0060S-30 v.3
CLF1G0060-30_1G0060S-30 v.3	20130327	Objective data sheet	-	CLF1G0060-30_1G0060S-30 v.2
CLF1G0060-30_1G0060S-30 v.2	20130129	Objective data sheet	-	CLF1G0060-30_1G0060S-30 v.1
CLF1G0060-30_1G0060S-30 v.1	20121008	Objective 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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15. Contents

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