

# CLF1G0060-30; CLF1G0060S-30

Broadband RF power GaN HEMT

AMPLEON

Rev. 6 — 18 February 2016

Product 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  $T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $I_{Dq} = 70\text{ mA}$ ;  $V_{DS} = 50\text{ V}$  in a class-AB broadband demo board.

Test signal	f	$P_L$	$G_p$	$\eta_D$
	(MHz)	(W)	(dB)	(%)
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;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 10\text{ }\%$ .

**Table 2. 2-Tone CW application information**

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

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

[1] 2-Tone CW;  $\Delta f = 1\text{ MHz}$ .

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
<b>CLF1G0060-30 (SOT1227A)</b>			
1	drain		 aaa-003693
2	gate		
3	source <span style="color: blue;">[1]</span>		
<b>CLF1G0060S-30 (SOT1227B)</b>			
1	drain		 aaa-003693
2	gate		
3	source <span style="color: blue;">[1]</span>		

[1] Connected to flange.

3. Ordering information

Table 4. Ordering information

Type number	Package		Version
	Name	Description	
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	$T_j = 200 \text{ °C}$	[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**

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

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

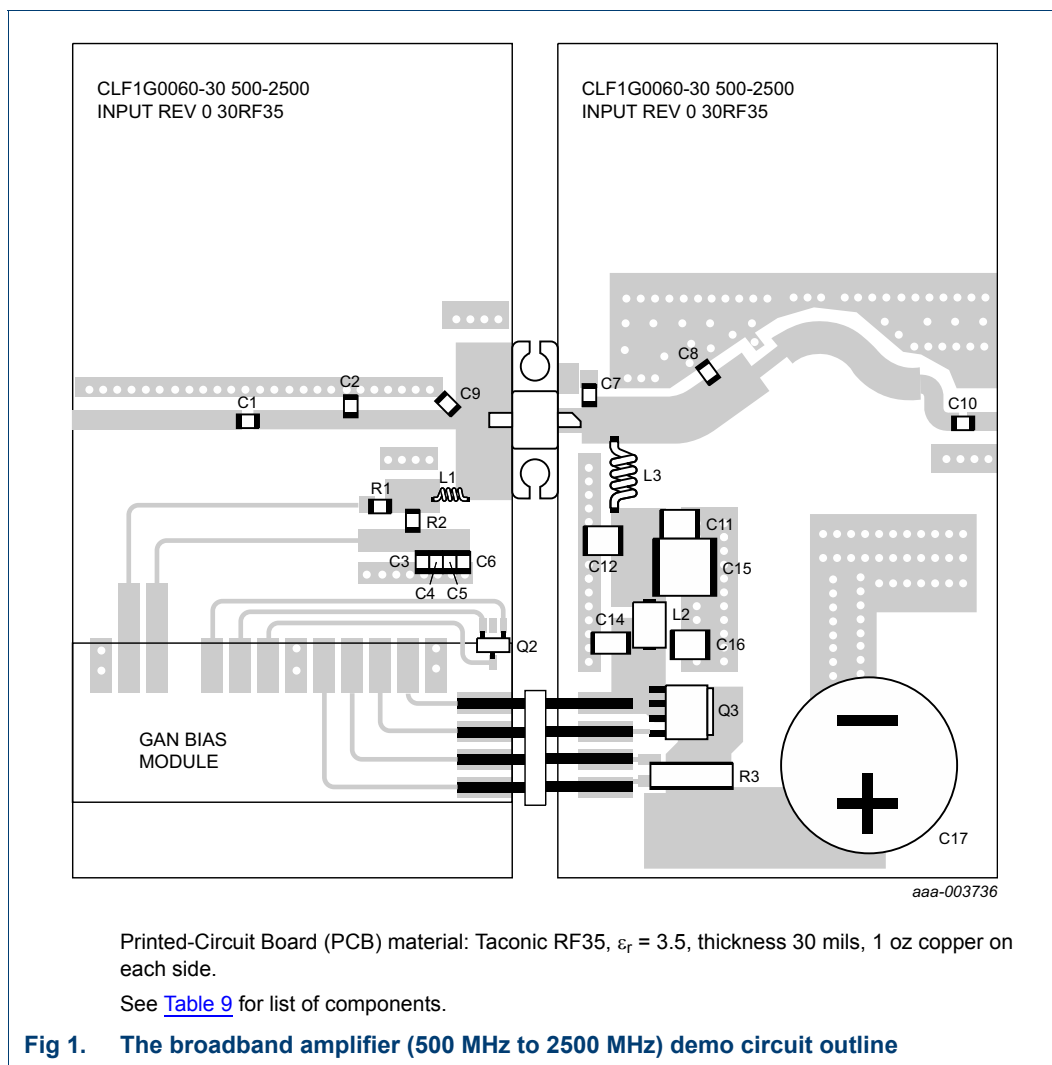
**Table 8. RF Characteristics**

Test signal: pulsed RF;  $f = 3 \text{ GHz}$ ;  $t_p = 100 \mu\text{s}$ ;  $\delta = 10 \%$ ; RF performance at  $V_{DS} = 50 \text{ V}$ ;  
 $I_{DQ} = 70 \text{ mA}$ ;  $T_{case} = 25 \text{ °C}$ ; unless otherwise specified in a class-AB production circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\eta_D$	drain efficiency	$P_L = 30 \text{ W}$	46	54	-	%
$G_p$	power gain	$P_L = 30 \text{ W}$	11.8	13.5	-	dB
$RL_{in}$	input return loss	$P_L = 30 \text{ W}$	-	-7	-	dB
$P_{droop(pulse)}$	pulse droop power	$P_L = 30 \text{ W}$	-	0.04	-	dB
$t_r$	rise time	$P_L = 30 \text{ W}$	-	5	-	ns
$t_f$	fall time	$P_L = 30 \text{ W}$	-	5	-	ns

## 7. Application information

### 7.1 Demo circuit



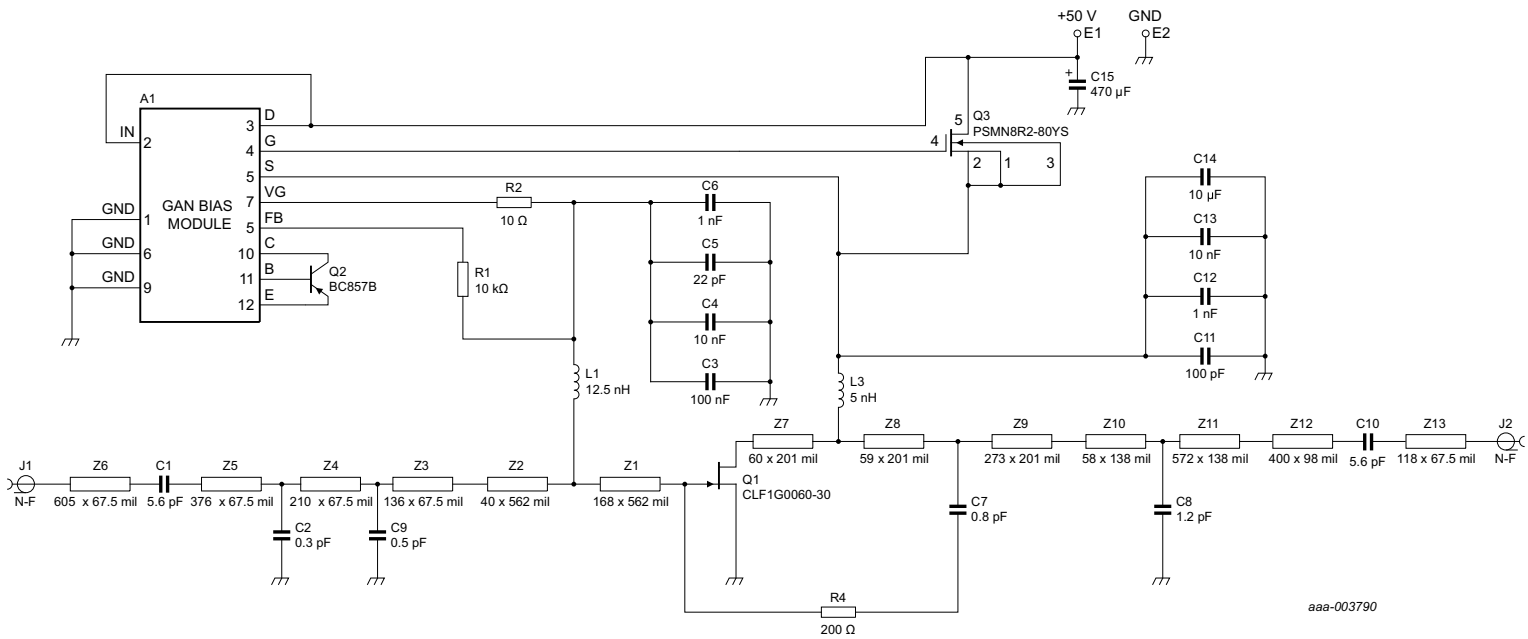
**Table 9. List of components**

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 $\mu$ F, 100V	SMD 1206
C15	electrolytic capacitor	10 $\mu$ F, 100 V	SMD 2220
C16	electrolytic capacitor	10 nF, 200 V	SMD 1210
C17	electrolytic capacitor	470 $\mu$ F, 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	-	CLF1G0060-30
Q2	transistor	-	NXP BC857B
Q3	transistor	-	NXP PSMN8R2-80YS
R1	resistor	10 k $\Omega$	Vishay Dale
R2	resistor	10 $\Omega$	Vishay Dale
R3	resistor	0.005 $\Omega$	RL7520WT-R005-F
Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9, Z10, Z11, Z12, Z13	microstrip lines	-	



aaa-003790

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  $T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $I_{Dq} = 70\text{ mA}$ ;  $V_{DS} = 50\text{ V}$  in a class-AB broadband demo board.

Test signal	f	P <sub>L</sub>	G <sub>p</sub>	η <sub>D</sub>
	(MHz)	(W)	(dB)	(%)
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;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 10\text{ }\%$ .

**Table 11. 2-Tone CW application information**

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

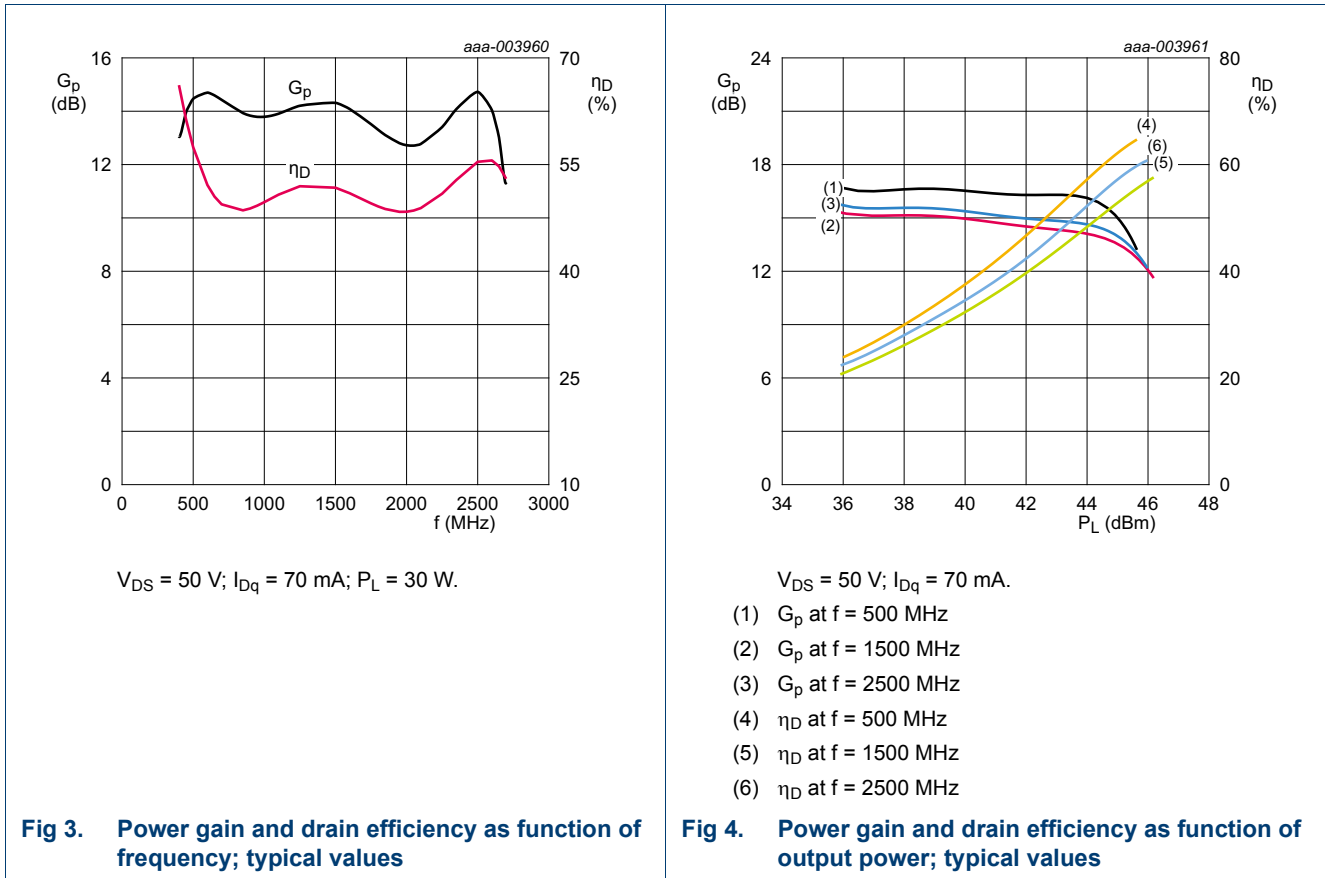
Test signal	f	P <sub>L(PEP)</sub>	IMD3
	(MHz)	(W)	(dBc)
2-Tone CW [1]	500	10	-38
	1000	10	-50
	1500	10	-45
	2000	10	-50
	2500	10	-43

[1] 2-Tone CW;  $\Delta f = 1\text{ MHz}$ .

7.3 Graphical data

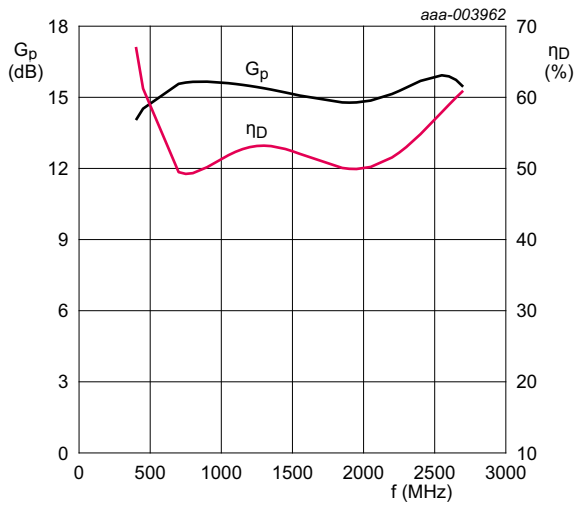
The following figures are measured in a broadband amplifier demo board from 500 MHz to 2500 MHz.

7.3.1 1-Tone CW RF performance



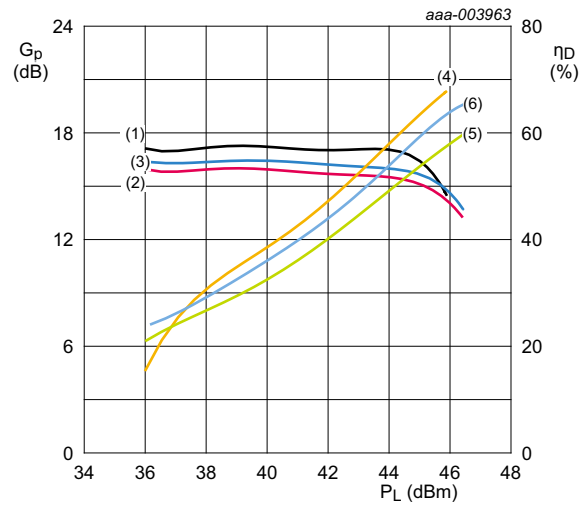


7.3.2 1-Tone pulsed RF performance



$V_{DS} = 50 \text{ V}$ ;  $I_{Dq} = 70 \text{ mA}$ ;  $P_L = 30 \text{ W}$ ;  $t_p = 100 \text{ }\mu\text{s}$ ;  
 $\delta = 10 \text{ \%}$ .

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

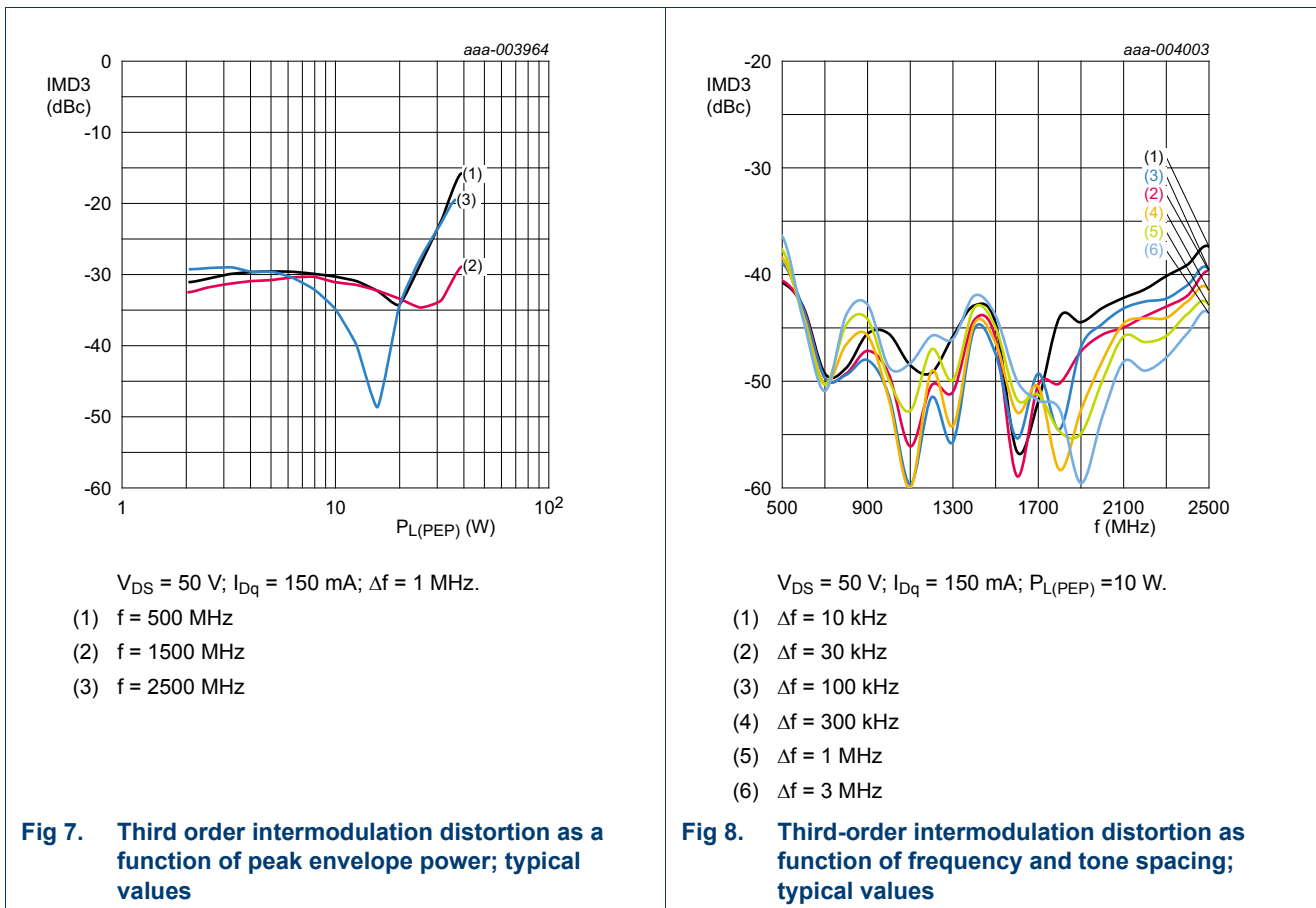


$V_{DS} = 50 \text{ V}$ ;  $I_{Dq} = 70 \text{ mA}$ ;  $t_p = 100 \text{ }\mu\text{s}$ ;  $\delta = 10 \text{ \%}$ .

- (1)  $G_p$  at  $f = 500 \text{ MHz}$
- (2)  $G_p$  at  $f = 1500 \text{ MHz}$
- (3)  $G_p$  at  $f = 2500 \text{ MHz}$
- (4)  $\eta_D$  at  $f = 500 \text{ MHz}$
- (5)  $\eta_D$  at  $f = 1500 \text{ MHz}$
- (6)  $\eta_D$  at  $f = 2500 \text{ MHz}$

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

7.3.3 2-Tone CW performance



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

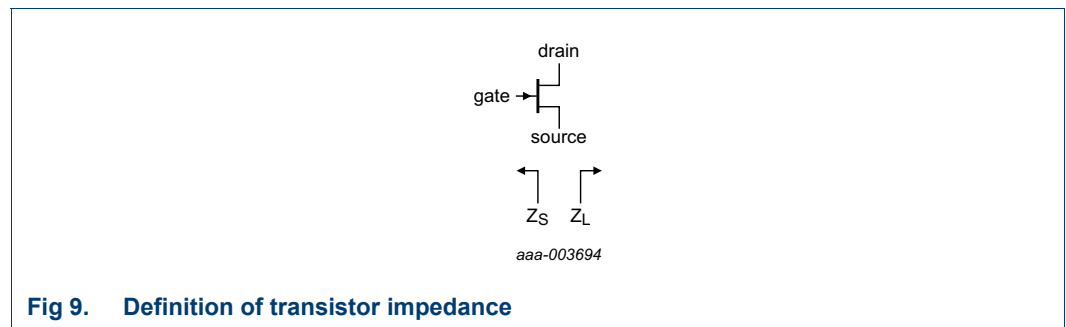
The CLF1G0060-30 and CLF1G0060S-30 are capable of withstanding a load mismatch corresponding to VSWR = 10 : 1 through all phases under the following conditions:  $V_{DS} = 50 \text{ V}; P_L = 30 \text{ W}$  (pulsed RF),  $f = 3000 \text{ MHz}.$

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;  $t_p = 100 \mu\text{s}; \delta = 10 \%;$  RF performance at  $V_{DS} = 50 \text{ V}; I_{Dq} = 50 \text{ mA}.$

**Table 12. Typical impedance**  
*Typical values unless otherwise specified.*

f (MHz)	Z <sub>S</sub> (Ω)	Z <sub>L</sub> (maximum P <sub>L(M)</sub> ) (Ω)	Z <sub>L</sub> (maximum η <sub>D</sub> ) (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<sub>S</sub> is the measured source pull impedance presented to the device. Z<sub>L</sub> is the measured load pull impedance presented to the device.

8.3 Packaged S-parameter data

Table 13. S-parameter

Small signal;  $V_{DS} = 50\text{ V}$ ;  $I_{Dq} = 50\text{ mA}$ ;  $Z_S = Z_L = 50\ \Omega$ .

f (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	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;  $V_{DS} = 50\text{ V}$ ;  $I_{Dq} = 50\text{ mA}$ ;  $Z_S = Z_L = 50\ \Omega$ .

f (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	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

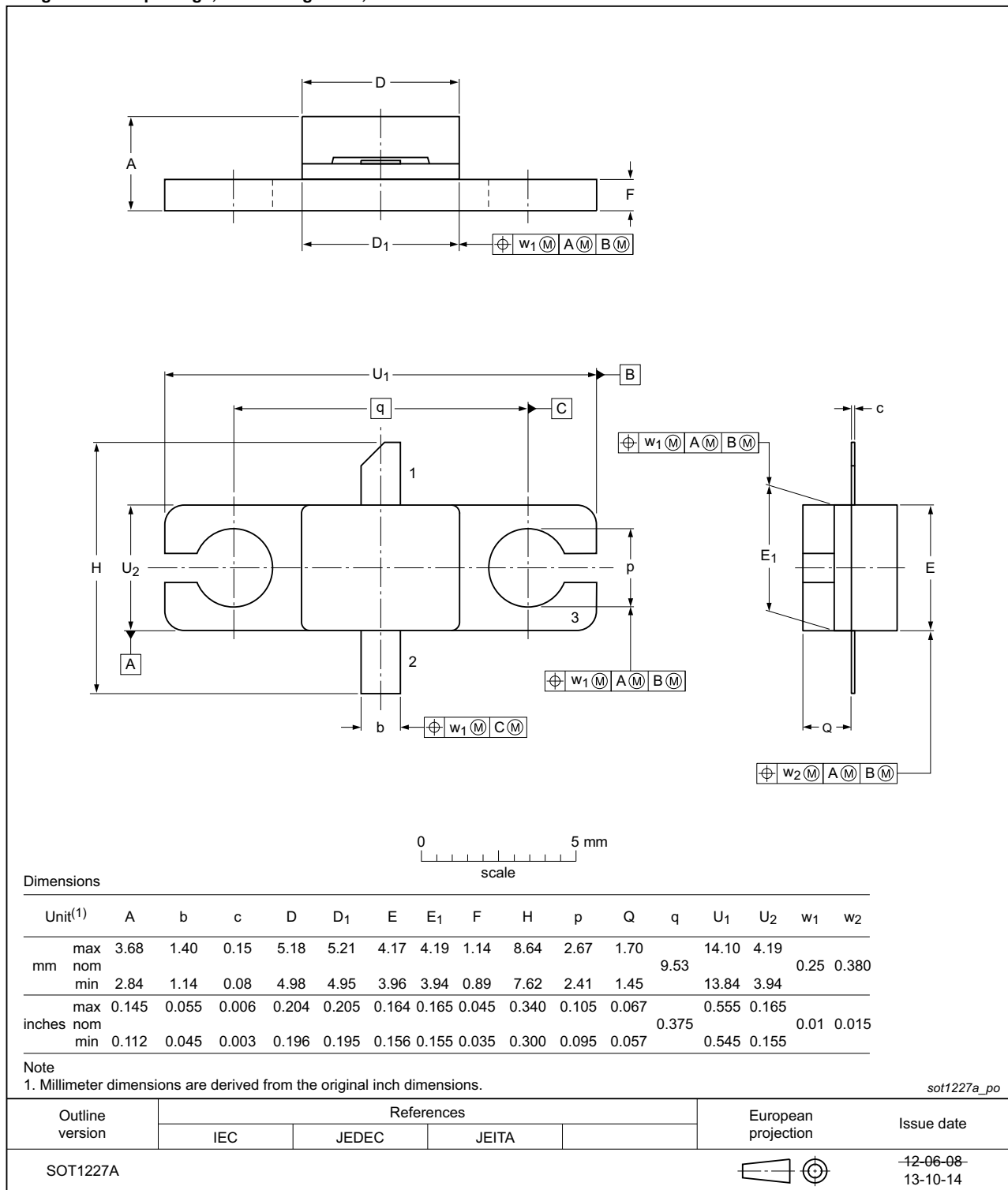


Fig 10. Package outline SOT1227A

Earless Flanged ceramic package; 2 leads

SOT1227B

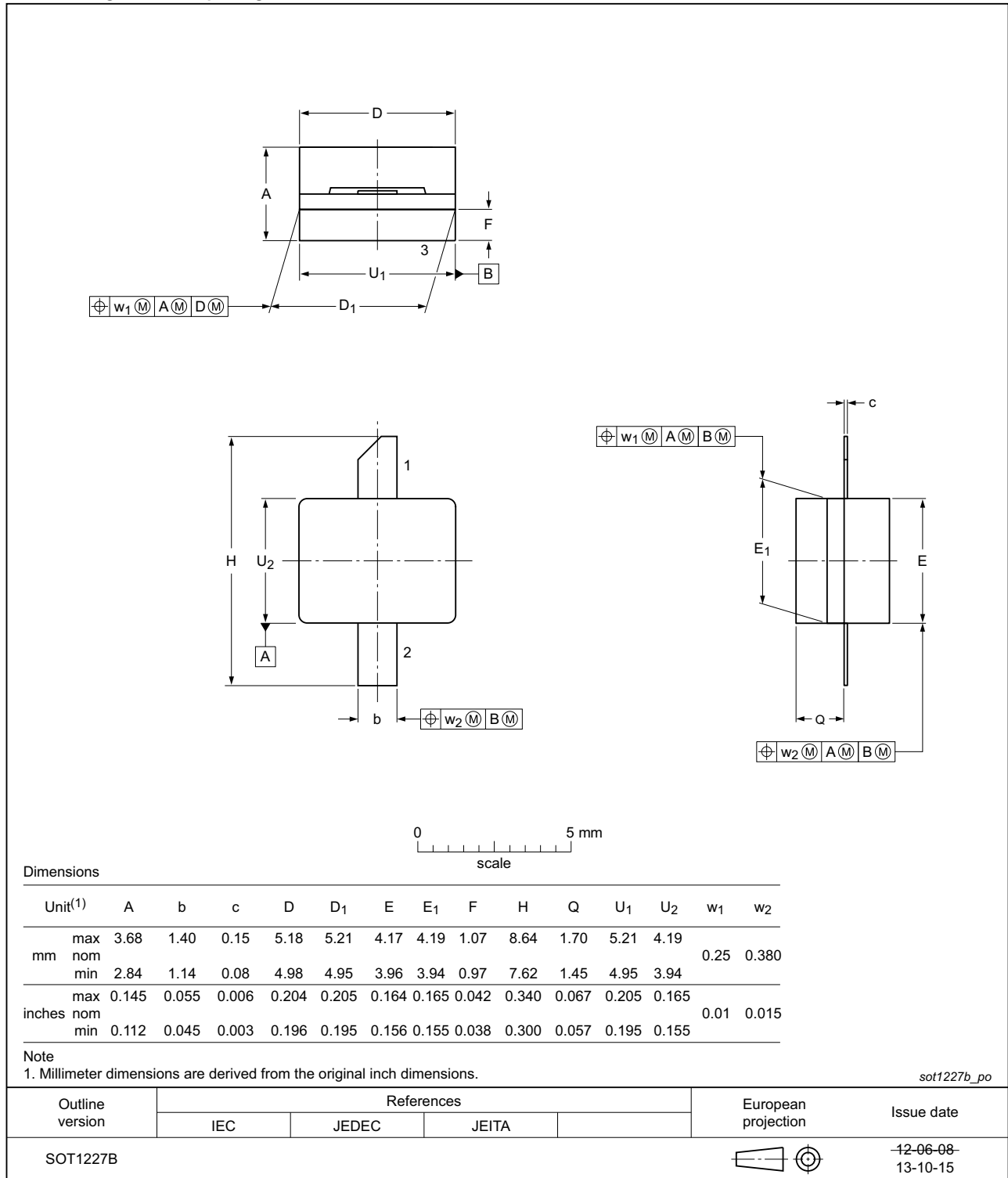


Fig 11. Package outline SOT1227B

## 10. Handling information

### 10.1 ESD Sensitivity

Table 14. ESD sensitivity

ESD model	Class
Human Body Model (HBM); According JEDEC standard JESD22-A114F	1B <a href="#">[1]</a>

[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 v.6	20160218	Product data sheet	-	CLF1G0060-30_1G0060S-30#5
Modifications:	<ul style="list-style-type: none"> <li>• <a href="#">Table 8 on page 3</a>: table updated</li> <li>• <a href="#">Section 8.1 on page 10</a>: section updated</li> <li>• <a href="#">Figure 10 on page 14</a>: figure updated</li> <li>• <a href="#">Figure 11 on page 15</a>: figure updated</li> </ul>			
CLF1G0060-30_1G0060S-30#5	20150901	Objective data sheet	-	CLF1G0060-30_1G0060S-30 v.4
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 <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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.

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

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