

# BLF988; BLF988S

Power LDMOS transistor

Rev. 2 — 1 August 2013

Product data sheet

## 1. Product profile

### 1.1 General description

A 600 W LDMOS RF power transistor for transmitter applications and industrial applications. The excellent ruggedness of this device makes it ideal for digital and analog transmitter applications.

Table 1. Application information

Test signal	f (MHz)	$P_{L(AV)}$ (W)	$P_{L(M)}$ (W)	$G_p$ (dB)	$\eta_D$ (%)	IMD3 (dBc)
<b>RF performance in a common source 860 MHz narrowband test circuit</b>						
2-tone, class-AB	$f_1 = 860; f_2 = 860.1$	250	-	20.8	46	-32
pulsed, class-AB	860	-	600	19.8	58	-

### 1.2 Features and benefits

- Excellent ruggedness ( $V_{SWR} \geq 40 : 1$  through all phases)
- Optimum thermal behavior and reliability,  $R_{th(j-c)} = 0.15$  K/W
- High power gain
- High efficiency
- Designed for broadband operation (400 MHz to 1000 MHz)
- Internal input matching for high gain and optimum broadband operation
- Excellent reliability
- Easy power control
- Compliant to Directive 2002/95/EC, regarding Restriction of Hazardous Substances (RoHS)

### 1.3 Applications

- Communication transmitter applications
- Industrial applications



## 2. Pinning information

**Table 2. Pinning**

Pin	Description	Simplified outline	Graphic symbol
<b>BLF988 (SOT539A)</b>			
1	drain1		 sym117
2	drain2		
3	gate1		
4	gate2		
5	source		
<b>BLF988S (SOT539B)</b>			
1	drain1		 sym117
2	drain2		
3	gate1		
4	gate2		
5	source		

[1] Connected to flange.

## 3. Ordering information

**Table 3. Ordering information**

Type number	Package		
	Name	Description	Version
BLF988	-	flanged balanced ceramic package; 2 mounting holes; 4 leads	SOT539A
BLF988S	-	earless flanged balanced ceramic package; 4 leads	SOT539B

## 4. Limiting values

**Table 4. Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage		-	110	V
$V_{GS}$	gate-source voltage		-0.5	+11	V
$T_{stg}$	storage temperature		-65	+150	°C
$T_j$	junction temperature	[1]	-	225	°C

[1] Continuous use at maximum temperature will affect the reliability. For details refer to the on-line MTF calculator.

## 5. Thermal characteristics

**Table 5. Thermal characteristics**

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-c)}$	thermal resistance from junction to case	$T_{case} = 80\text{ °C}$ ; $P_{L(AV)} = 250\text{ W}$	[1] 0.15	K/W

[1]  $R_{th(j-c)}$  is measured under RF conditions.

## 6. Characteristics

**Table 6. DC characteristics**

$T_j = 25\text{ °C}$ ; per section unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{(BR)DSS}$	drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ ; $I_D = 2.4\text{ mA}$	[1] 110	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$V_{DS} = 10\text{ V}$ ; $I_D = 240\text{ mA}$	[1] 1.4	1.9	2.4	V
$I_{DSS}$	drain leakage current	$V_{GS} = 0\text{ V}$ ; $V_{DS} = 50\text{ V}$	-	-	2.8	$\mu\text{A}$
$I_{DSX}$	drain cut-off current	$V_{GS} = V_{GS(th)} + 3.75\text{ V}$ ; $V_{DS} = 10\text{ V}$	-	36	-	A
$I_{GSS}$	gate leakage current	$V_{GS} = 10\text{ V}$ ; $V_{DS} = 0\text{ V}$	-	-	280	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = V_{GS(th)} + 3.75\text{ V}$ ; $I_D = 8.5\text{ A}$	[1] -	143	-	$\text{m}\Omega$

[1]  $I_D$  is the drain current.

**Table 7. AC characteristics**

$T_j = 25\text{ °C}$ ; per section unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$C_{iss}$	input capacitance	$V_{GS} = 0\text{ V}$ ; $V_{DS} = 50\text{ V}$ ; $f = 1\text{ MHz}$	[1] -	220	-	pF
$C_{oss}$	output capacitance	$V_{GS} = 0\text{ V}$ ; $V_{DS} = 50\text{ V}$ ; $f = 1\text{ MHz}$	-	74	-	pF
$C_{rss}$	reverse transfer capacitance	$V_{GS} = 0\text{ V}$ ; $V_{DS} = 50\text{ V}$ ; $f = 1\text{ MHz}$	-	1.2	-	pF

[1] Capacitance values without internal matching.

**Table 8. RF characteristics**

RF characteristics in NXP production narrowband test circuit;  $T_{case} = 25\text{ °C}$  unless otherwise specified.

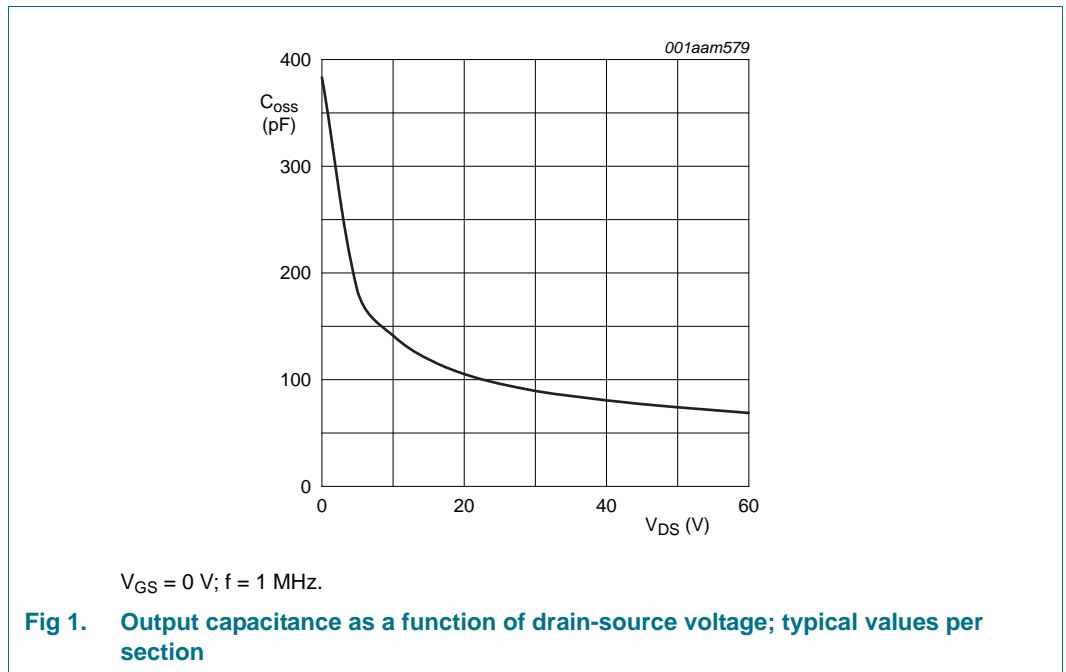
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>2-Tone, class-AB</b>						
$V_{DS}$	drain-source voltage		-	50	-	V
$I_{Dq}$	quiescent drain current		[1] -	1.3	-	A
$P_{L(AV)}$	average output power	$f_1 = 860\text{ MHz}$ ; $f_2 = 860.1\text{ MHz}$	250	-	-	W
$G_p$	power gain	$f_1 = 860\text{ MHz}$ ; $f_2 = 860.1\text{ MHz}$	19.8	20.8	-	dB
$\eta_D$	drain efficiency	$f_1 = 860\text{ MHz}$ ; $f_2 = 860.1\text{ MHz}$	42	46	-	%
IMD3	third-order intermodulation distortion	$f_1 = 860\text{ MHz}$ ; $f_2 = 860.1\text{ MHz}$	-	-32	-28	dBc

**Table 8. RF characteristics ...continued**

RF characteristics in NXP production narrowband test circuit;  $T_{case} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Pulsed, class-AB</b>						
$V_{DS}$	drain-source voltage		-	50	-	V
$I_{Dq}$	quiescent drain current		[1]	1.3	-	A
$P_{L(M)}$	peak output power	$f = 860\text{ MHz}$	-	600	-	W
$G_p$	power gain	$f = 860\text{ MHz}$	17.2	19.8	-	dB
$\eta_D$	drain efficiency	$f = 860\text{ MHz}$	54	58	-	%
$t_p$	pulse duration		-	100	-	$\mu\text{s}$
$\delta$	duty cycle		-	20	-	%

[1]  $I_{Dq}$  for total device



## 7. Test information

### 7.1 Ruggedness in class-AB operation

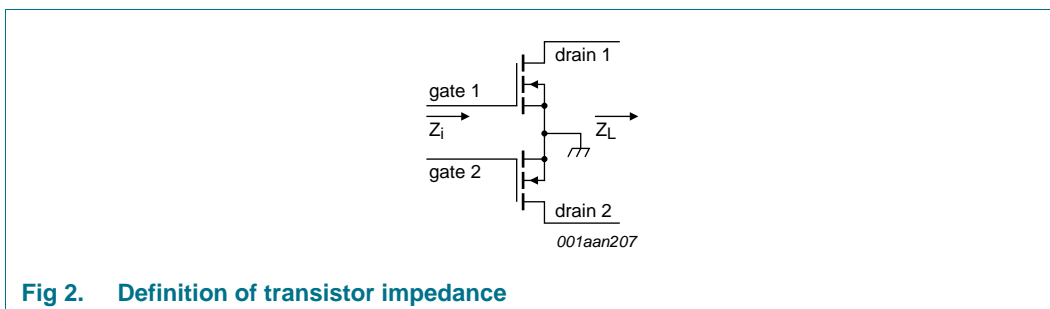
The BLF988 and BLF988S are capable of withstanding a load mismatch corresponding to  $V_{SWR} \geq 40 : 1$  through all phases under the following conditions:  $V_{DS} = 50\text{ V}$ ;  $I_{Dq} = 1.3\text{ A}$ ;  $P_L = 600\text{ W}$  (pulsed);  $f = 860\text{ MHz}$ .

## 7.2 Impedance information

**Table 9. Typical push-pull impedance**

Simulated  $Z_i$  and  $Z_L$  device impedance; impedance info at  $V_{DS} = 50$  V and  $P_{L(AV)} = 600$  W (pulsed CW). See [Figure 2](#) for definition of transistor impedance.

f MHz	$Z_i$ $\Omega$	$Z_L$ $\Omega$
300	0.607 + j0	5.495 + j1.936
325	0.622 – j1.441	5.324 + j2.008
350	0.639 – j1.121	5.151 + j2.065
375	0.658 – j0.826	4.977 + j2.107
400	0.679 – j0.551	4.805 + j2.136
425	0.703 – j0.291	4.634 + j2.153
450	0.73 – j0.044	4.466 + j2.157
475	0.76 + j0.194	4.301 + j2.151
500	0.793 + j0.424	4.14 + j2.134
525	0.83 + j0.648	3.984 + j2.109
550	0.872 + j0.869	3.833 + j2.075
575	0.919 + j1.088	3.687 + j2.033
600	0.972 + j1.305	3.546 + j1.985
625	1.032 + j1.523	3.411 + j1.931
650	1.101 + j1.741	3.281 + j1.871
675	1.179 + j1.963	3.156 + j1.807
700	1.268 + j2.187	3.036 + j1.738
725	1.371 + j2.416	2.922 + j1.666
750	1.49 + j2.651	2.813 + j1.591
775	1.629 + j2.891	2.708 + j1.512
800	1.792 + j3.138	2.609 + j1.432
825	1.984 + j3.39	2.514 + j1.349
850	2.212 + j3.649	2.423 + j1.264
875	2.484 + j3.91	2.336 + j1.178
900	2.812 + j4.17	2.254 + j1.091
925	3.209 + j4.421	2.175 + j1.003
950	3.689 + j4.648	2.1 + j0.913
975	4.27 + j4.829	2.029 + j0.823
1000	4.967 + j4.927	1.96 + j0.733



**Fig 2. Definition of transistor impedance**

### 7.3 Test circuit information

**Table 10. List of components**

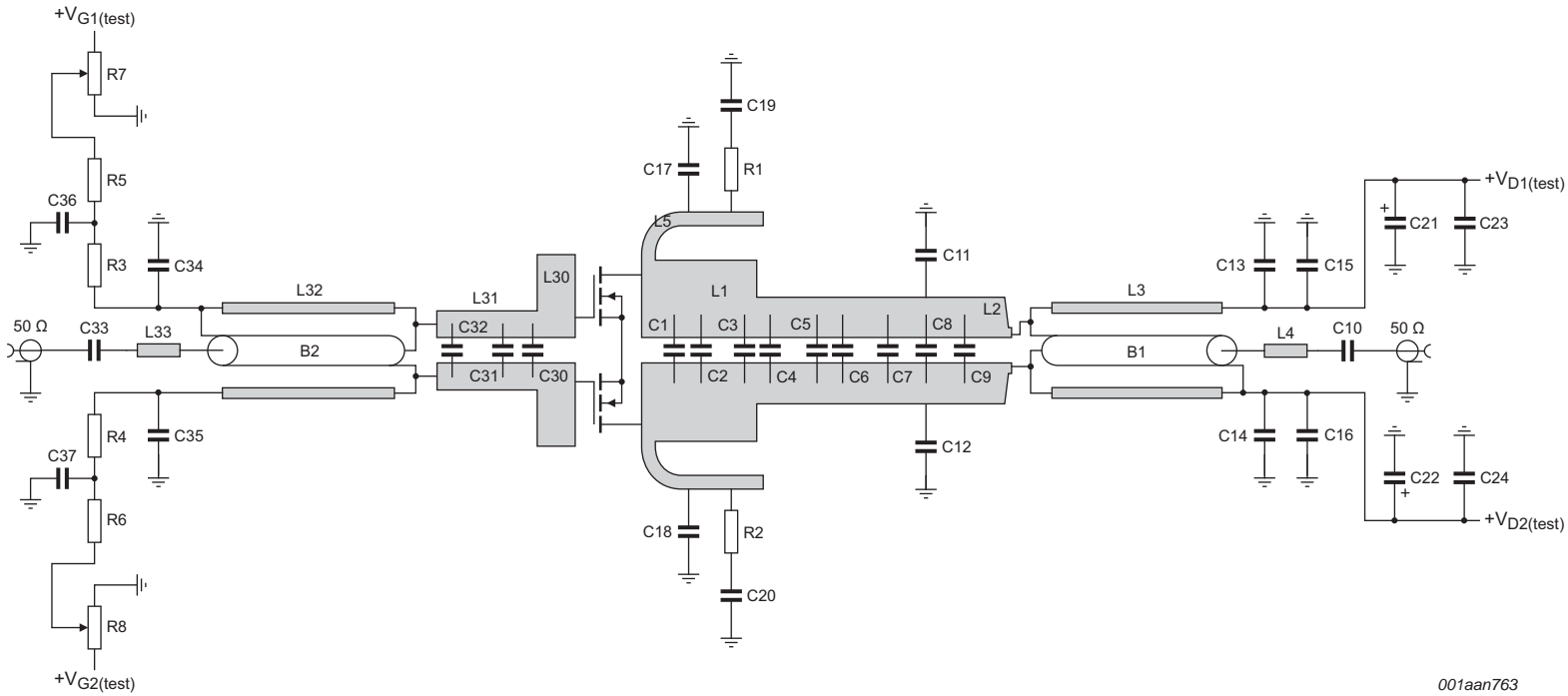
For test circuit, see [Figure 3](#), [Figure 4](#) and [Figure 5](#).

Component	Description	Value	Remarks
B1, B2	semi rigid coax	25 Ω; 49.5 mm	UT-090C-25 (EZ 90-25)
C1	multilayer ceramic chip capacitor	12 pF	[1]
C2, C3, C4, C5, C6	multilayer ceramic chip capacitor	8.2 pF	[1]
C7	multilayer ceramic chip capacitor	6.8 pF	[2]
C8	multilayer ceramic chip capacitor	2.7 pF	[2]
C9	multilayer ceramic chip capacitor	2.2 pF	[2]
C10, C13, C14	multilayer ceramic chip capacitor	100 pF	[3]
C11, C12	multilayer ceramic chip capacitor	10 pF	[2]
C15, C16	multilayer ceramic chip capacitor	4.7 μF, 50 V	Kemet C1210X475K5RAC-TU or capacitor of same quality.
C17, C18, C23, C24	multilayer ceramic chip capacitor	100 pF	[2]
C19, C20	multilayer ceramic chip capacitor	10 μF, 50 V	TDK C570X7R1H106KT000N or capacitor of same quality.
C21, C22	electrolytic capacitor	470 μF; 63 V	
C30	multilayer ceramic chip capacitor	10 pF	[4]
C31	multilayer ceramic chip capacitor	9.1 pF	[4]
C32	multilayer ceramic chip capacitor	3.9 pF	[4]
C33, C34, C35	multilayer ceramic chip capacitor	100 pF	[4]
C36, C37	multilayer ceramic chip capacitor	4.7 μF, 50 V	TDK C4532X7R1E475MT020U or capacitor of same quality.
L1	microstrip	-	[5] (W × L) 15 mm × 13 mm
L2	microstrip	-	[5] (W × L) 5 mm × 26 mm
L3, L32	microstrip	-	[5] (W × L) 2 mm × 49.5 mm
L4	microstrip	-	[5] (W × L) 1.7 mm × 3.5 mm
L5	microstrip	-	[5] (W × L) 2 mm × 9.5 mm
L30	microstrip	-	[5] (W × L) 5 mm × 13 mm
L31	microstrip	-	[5] (W × L) 2 mm × 11 mm
L33	microstrip	-	[5] (W × L) 2 mm × 3 mm
R1, R2	wire resistor	10 Ω	

**Table 10.** List of components ...continued  
For test circuit, see [Figure 3](#), [Figure 4](#) and [Figure 5](#).

Component	Description	Value	Remarks
R3, R4	SMD resistor	5.6 $\Omega$	0805
R5, R6	wire resistor	100 $\Omega$	
R7, R8	potentiometer	10 k $\Omega$	

- [1] American technical ceramics type 800R or capacitor of same quality.
- [2] American technical ceramics type 800B or capacitor of same quality.
- [3] American technical ceramics type 180R or capacitor of same quality.
- [4] American technical ceramics type 100A or capacitor of same quality.
- [5] Printed-Circuit Board (PCB): Taconic RF35;  $\epsilon_r = 3.5$  F/m; height = 0.762 mm; Cu (top/bottom metallization); thickness copper plating = 35  $\mu\text{m}$ .

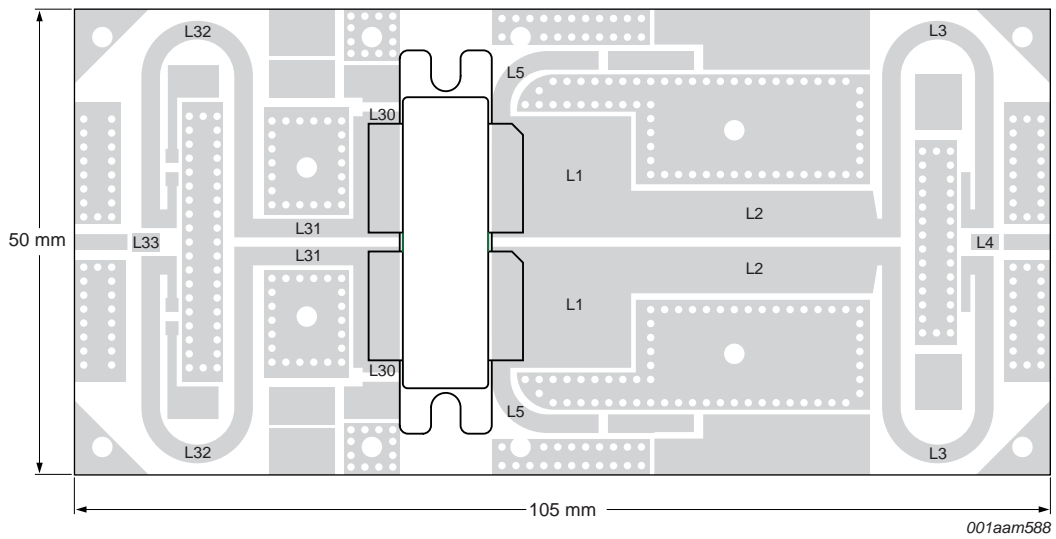


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See [Table 10](#) for a list of components.

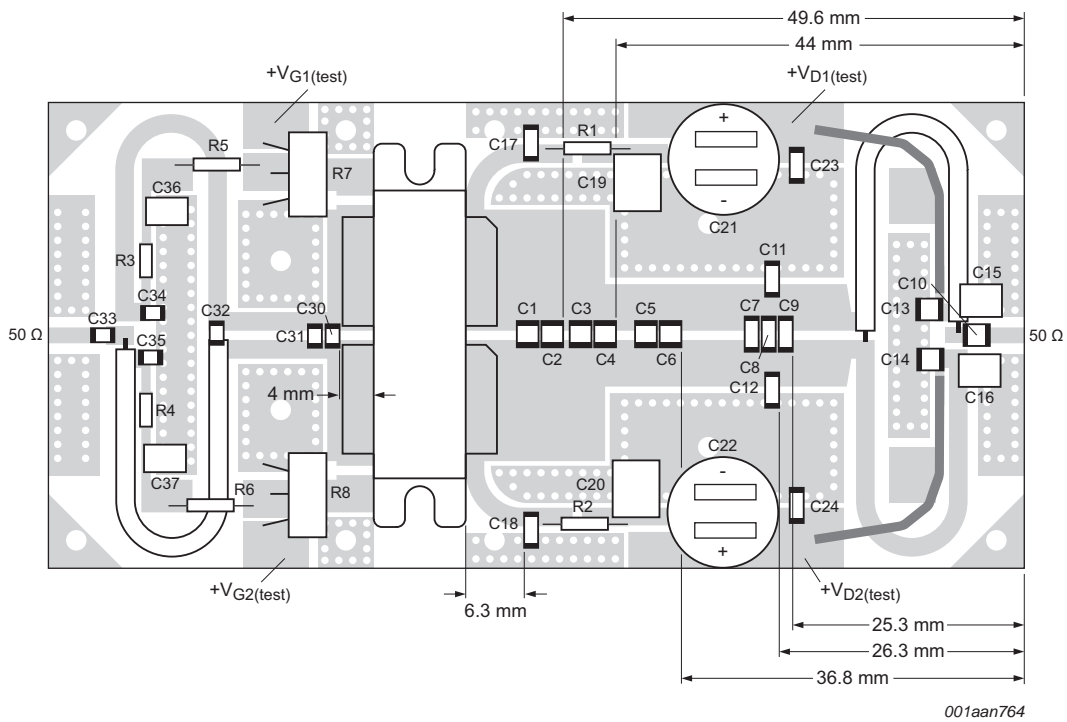
**Fig 3. Class-AB common source broadband amplifier;  $V_{D1(test)}$ ,  $V_{D2(test)}$ ,  $V_{G1(test)}$  and  $V_{G2(test)}$  are drain and gate test voltages**





See [Table 10](#) for a list of components.

**Fig 4. Printed-Circuit Board (PCB) for class-AB common source amplifier**

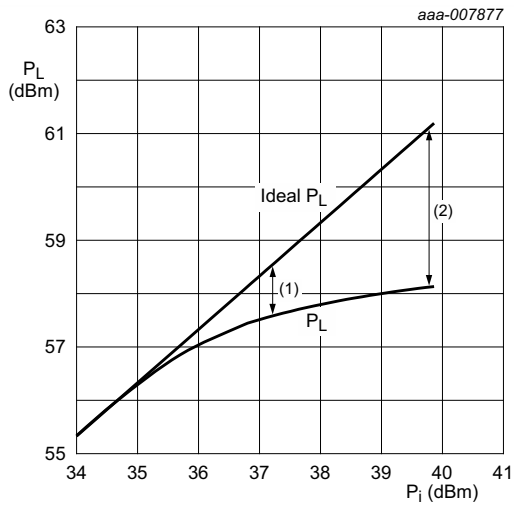


See [Table 10](#) for a list of components.

**Fig 5. Component layout for class-AB common source amplifier**

**7.4 Graphical data**

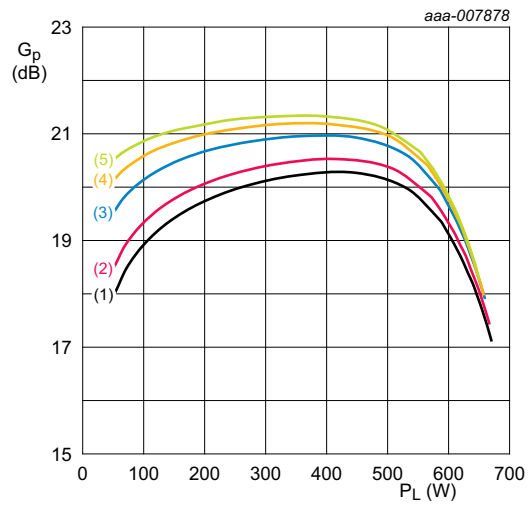
**7.4.1 Pulsed**



$V_{DS} = 50\text{ V}$ ;  $I_{Dq} = 1300\text{ mA}$ ;  $f = 860\text{ MHz}$ ;  $t_p = 100\text{ }\mu\text{s}$ ;  
 $\delta = 20\text{ }\%$ .

(1)  $P_{L(1dB)} = 57.6\text{ dBm}$  (575 W)  
 (2)  $P_{L(3dB)} = 58.1\text{ dBm}$  (649 W)

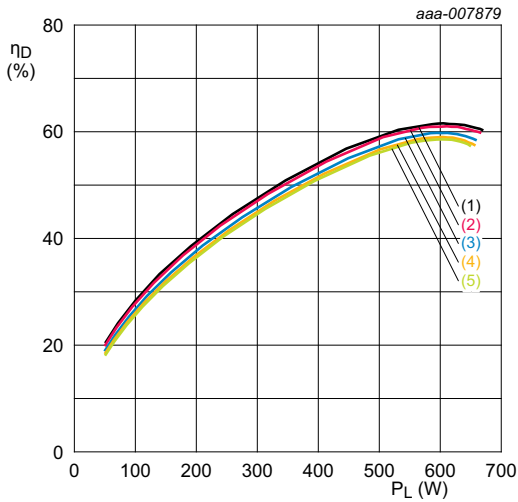
**Fig 6. Output power as a function of input power; typical values**



$V_{DS} = 50\text{ V}$ ;  $f = 860\text{ MHz}$ ;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 20\text{ }\%$ .

(1)  $I_{Dq} = 100\text{ mA}$   
 (2)  $I_{Dq} = 200\text{ mA}$   
 (3)  $I_{Dq} = 600\text{ mA}$   
 (4)  $I_{Dq} = 1000\text{ mA}$   
 (5)  $I_{Dq} = 1300\text{ mA}$

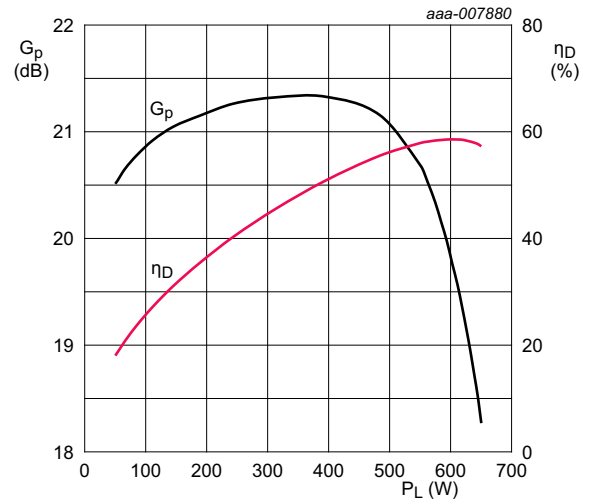
**Fig 7. Power gain as a function of output power; typical values**



$V_{DS} = 50\text{ V}$ ;  $f = 860\text{ MHz}$ ;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 20\text{ }\%$ .

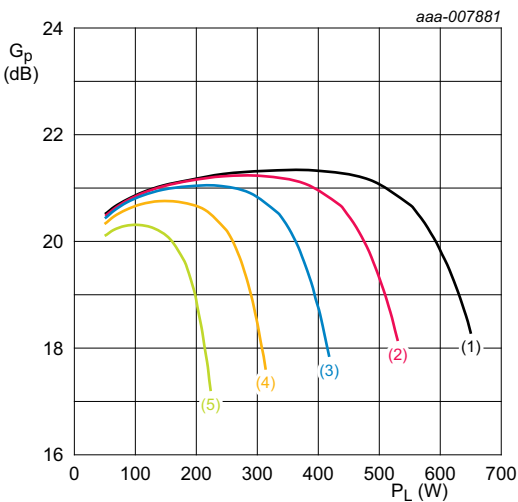
- (1)  $I_{Dq} = 100\text{ mA}$
- (2)  $I_{Dq} = 200\text{ mA}$
- (3)  $I_{Dq} = 600\text{ mA}$
- (4)  $I_{Dq} = 1000\text{ mA}$
- (5)  $I_{Dq} = 1300\text{ mA}$

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



$V_{DS} = 50\text{ V}$ ;  $I_{Dq} = 1300\text{ mA}$ ;  $f = 860\text{ MHz}$ ;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 20\text{ }\%$ .

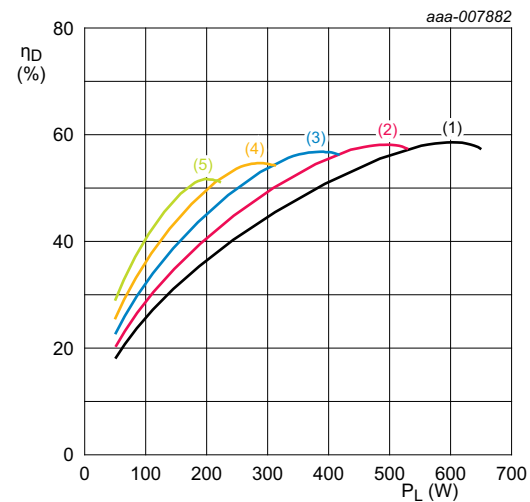
**Fig 9. Power gain and drain efficiency as function of output power; typical values**



$I_{Dq} = 1300\text{ mA}$ ;  $f = 860\text{ MHz}$ ;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 20\text{ }\%$ .

- (1)  $V_{DS} = 50\text{ V}$
- (2)  $V_{DS} = 45\text{ V}$
- (3)  $V_{DS} = 40\text{ V}$
- (4)  $V_{DS} = 35\text{ V}$
- (5)  $V_{DS} = 30\text{ V}$

**Fig 10. Power gain as a function of output power; typical values**

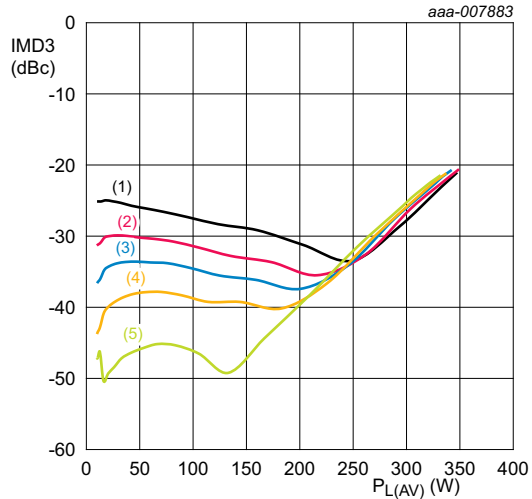


$I_{Dq} = 1300\text{ mA}$ ;  $f = 860\text{ MHz}$ ;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 20\text{ }\%$ .

- (1)  $V_{DS} = 50\text{ V}$
- (2)  $V_{DS} = 45\text{ V}$
- (3)  $V_{DS} = 40\text{ V}$
- (4)  $V_{DS} = 35\text{ V}$
- (5)  $V_{DS} = 30\text{ V}$

**Fig 11. Drain efficiency as a function of output power; typical values**

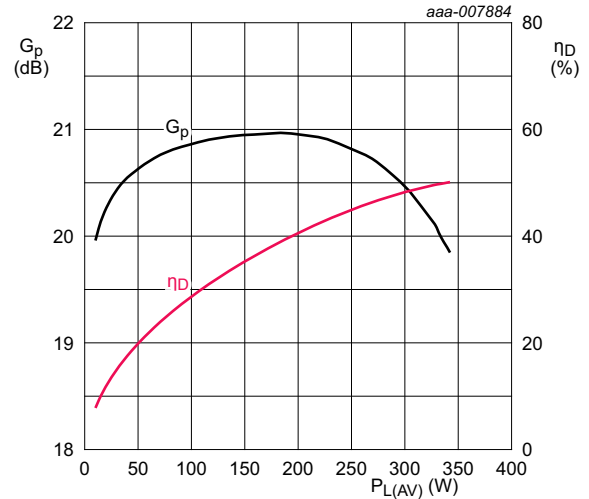
**7.4.2 2-Tone CW**



$V_{DS} = 50 \text{ V}; f_1 = 860.0 \text{ MHz}; f_2 = 860.1 \text{ MHz}.$

- (1)  $I_{Dq} = 600 \text{ mA}$
- (2)  $I_{Dq} = 1000 \text{ mA}$
- (3)  $I_{Dq} = 1300 \text{ mA}$
- (4)  $I_{Dq} = 1600 \text{ mA}$
- (5)  $I_{Dq} = 2000 \text{ mA}$

**Fig 12. Third-order intermodulation distortion as a function of average output power; typical values**



$V_{DS} = 50 \text{ V}; I_{Dq} = 1300 \text{ mA}; f_1 = 860.0 \text{ MHz}; f_2 = 860.1 \text{ MHz}.$

**Fig 13. Power gain and drain efficiency as function of average output power; typical values**

**8. Package outline**

Flanged balanced ceramic package; 2 mounting holes; 4 leads

SOT539A

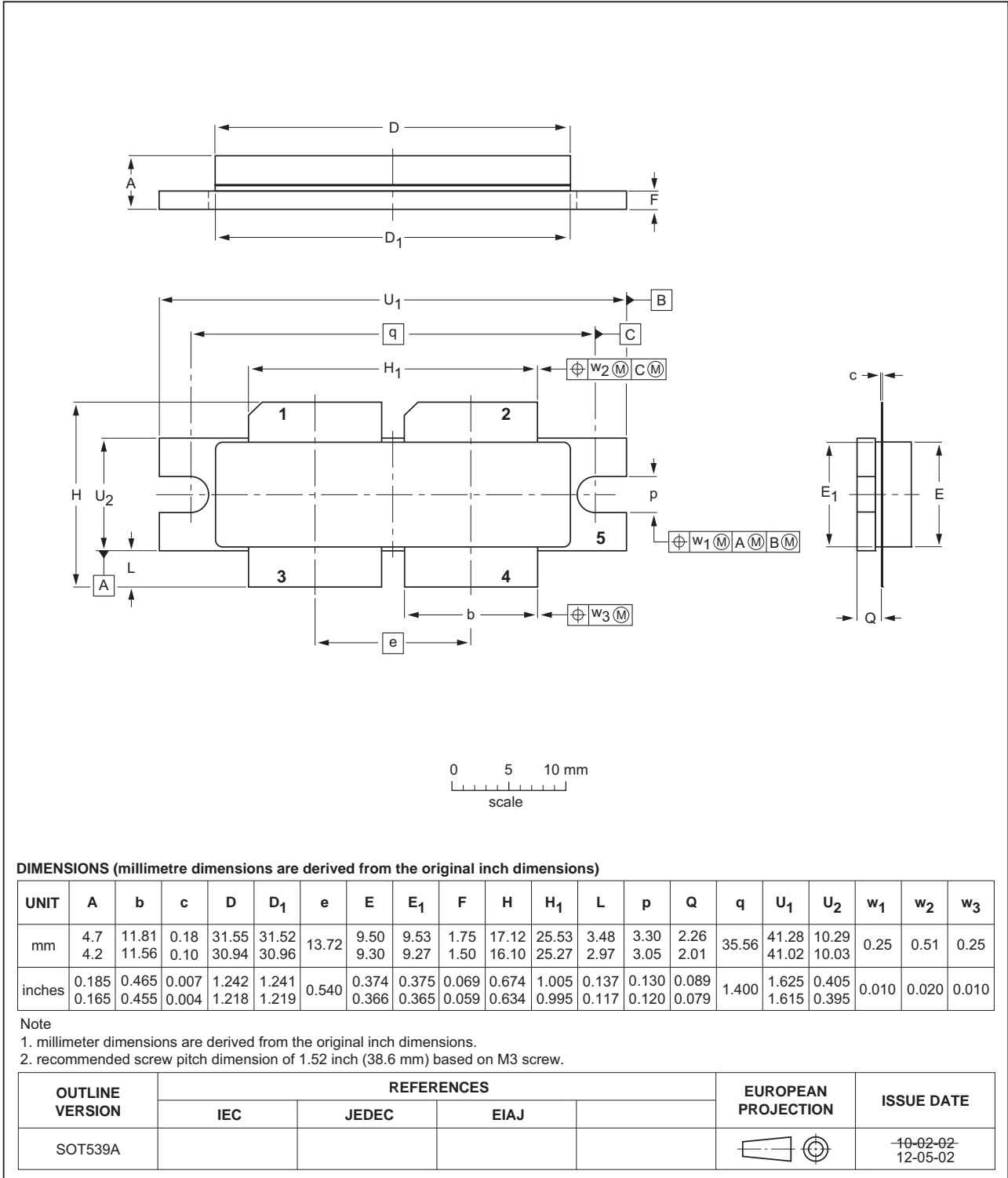


Fig 14. Package outline SOT539A

Earless flanged balanced ceramic package; 4 leads

SOT539B

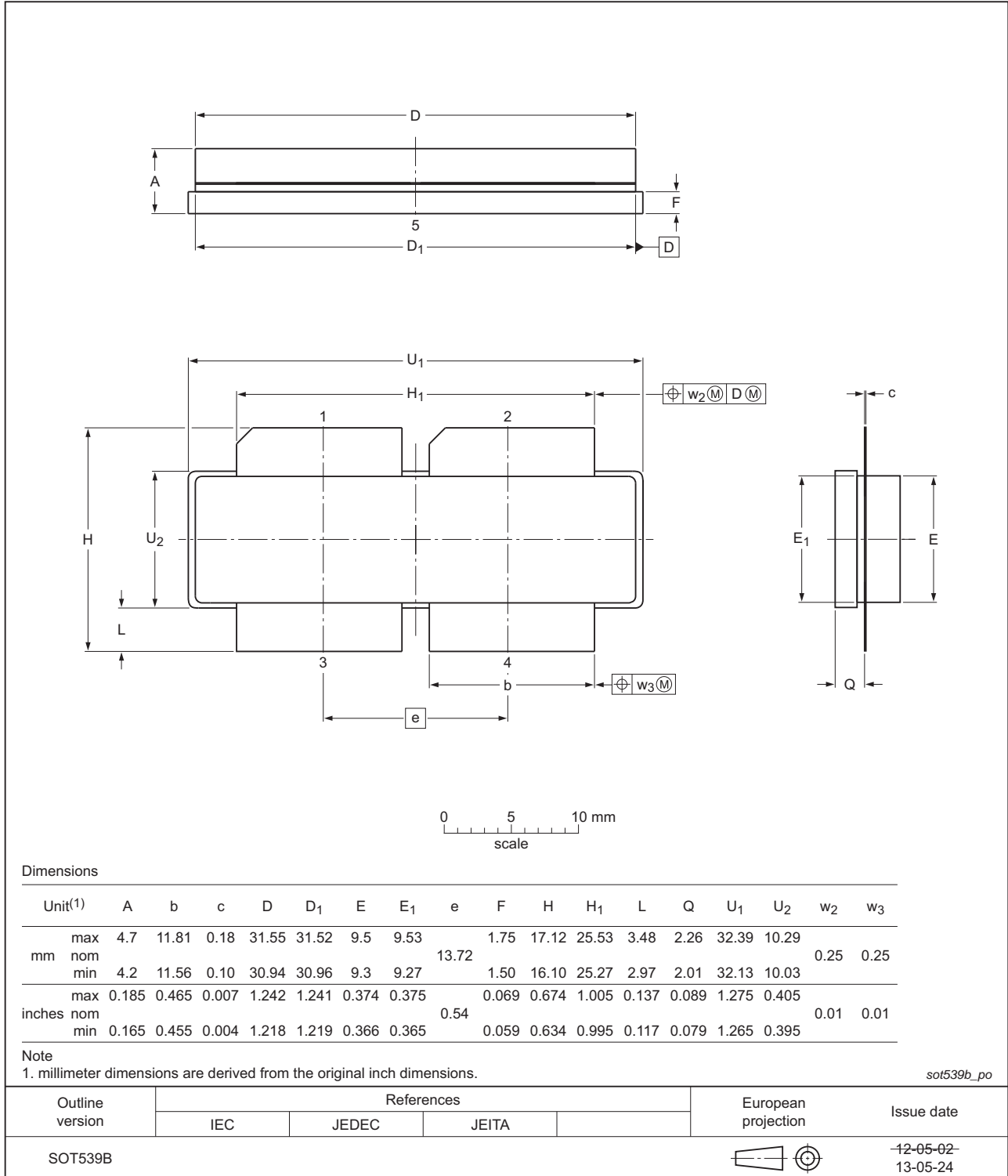


Fig 15. Package outline SOT539B

## 9. 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.

## 10. Abbreviations

**Table 11. Abbreviations**

Acronym	Description
CCDF	Complementary Cumulative Distribution Function
CW	Continuous Wave
LDMOS	Laterally Diffused Metal-Oxide Semiconductor
SMD	Surface Mounted Device
VSWR	Voltage Standing-Wave Ratio

## 11. Revision history

**Table 12. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
BLF988_BLF988S v.2	20130801	Product data sheet	-	BLF988_BLF988S v.1
Modifications:	<ul style="list-style-type: none"> <li>• <a href="#">Table 1 on page 1</a>: table updated</li> <li>• <a href="#">Section 1.2 on page 1</a>: list item number 5, 500 MHz changed to 400 MHz</li> <li>• <a href="#">Table 4 on page 2</a>: table updated</li> <li>• <a href="#">Table 8 on page 3</a>: table updated</li> <li>• <a href="#">Section 7.1 on page 4</a>: section added</li> <li>• <a href="#">Section 7.4 on page 10</a>: section added</li> <li>• <a href="#">Figure 15 on page 14</a>: figure updated</li> </ul>			
BLF988_BLF988S v.1	20121009	Objective data sheet	-	-

## 12. Legal information

### 12.1 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.

[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.nxp.com>.

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