

# BLF578XR; BLF578XRS

Power LDMOS transistor

Rev. 5 — 1 September 2015

AMPLEON

Product data sheet

## 1. Product profile

### 1.1 General description

A 1400 W extremely rugged LDMOS power transistor for broadcast and industrial applications in the HF to 500 MHz band. This product is an enhanced version of the BLF578 using Ampleon's XR process to provide maximum ruggedness capability in the most severe applications without compromising the RF performance.

Table 1. Application information

| Test signal | f<br>(MHz) | V <sub>DS</sub><br>(V) | P <sub>L</sub><br>(W) | G <sub>p</sub><br>(dB) | $\eta_D$<br>(%) |
|-------------|------------|------------------------|-----------------------|------------------------|-----------------|
| pulsed RF   | 225        | 50                     | 1400                  | 23.5                   | 69              |

### 1.2 Features and benefits

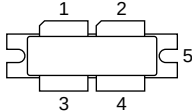
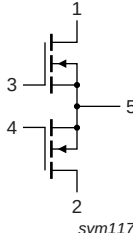
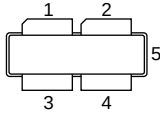
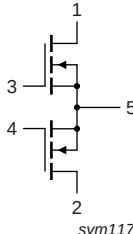
- Typical pulsed performance at frequency of 225 MHz, a supply voltage of 50 V and an I<sub>DQ</sub> of 40 mA, a t<sub>p</sub> of 100  $\mu$ s with  $\delta$  of 20 %:
  - ◆ Output power = 1400 W
  - ◆ Power gain = 23.5 dB
  - ◆ Efficiency = 69 %
- Easy power control
- Integrated ESD protection
- Excellent ruggedness
- High efficiency
- Excellent thermal stability
- Designed for broadband operation (HF to 500 MHz)
- Compliant to Directive 2002/95/EC, regarding Restriction of Hazardous Substances (RoHS)

### 1.3 Applications

- Industrial, scientific and medical applications
- Broadcast transmitter applications

## 2. Pinning information

Table 2. Pinning

| Pin                        | Description | Simplified outline                                                                  | Graphic symbol                                                                       |
|----------------------------|-------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>BLF578XR (SOT539A)</b>  |             |                                                                                     |                                                                                      |
| 1                          | drain1      |  |   |
| 2                          | drain2      |                                                                                     |                                                                                      |
| 3                          | gate1       |                                                                                     |                                                                                      |
| 4                          | gate2       |                                                                                     |                                                                                      |
| 5                          | source      |                                                                                     |                                                                                      |
| <b>BLF578XRS (SOT539B)</b> |             |                                                                                     |                                                                                      |
| 1                          | drain1      |  |  |
| 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 |
| BLF578XR    | -       | flanged balanced LDMOST ceramic package;<br>2 mounting holes; 4 leads | SOT539A |
| BLF578XRS   | -       | earless flanged balanced LDMOST ceramic package;<br>4 leads           | SOT539B |

## 4. Limiting values

Table 4. Limiting values

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

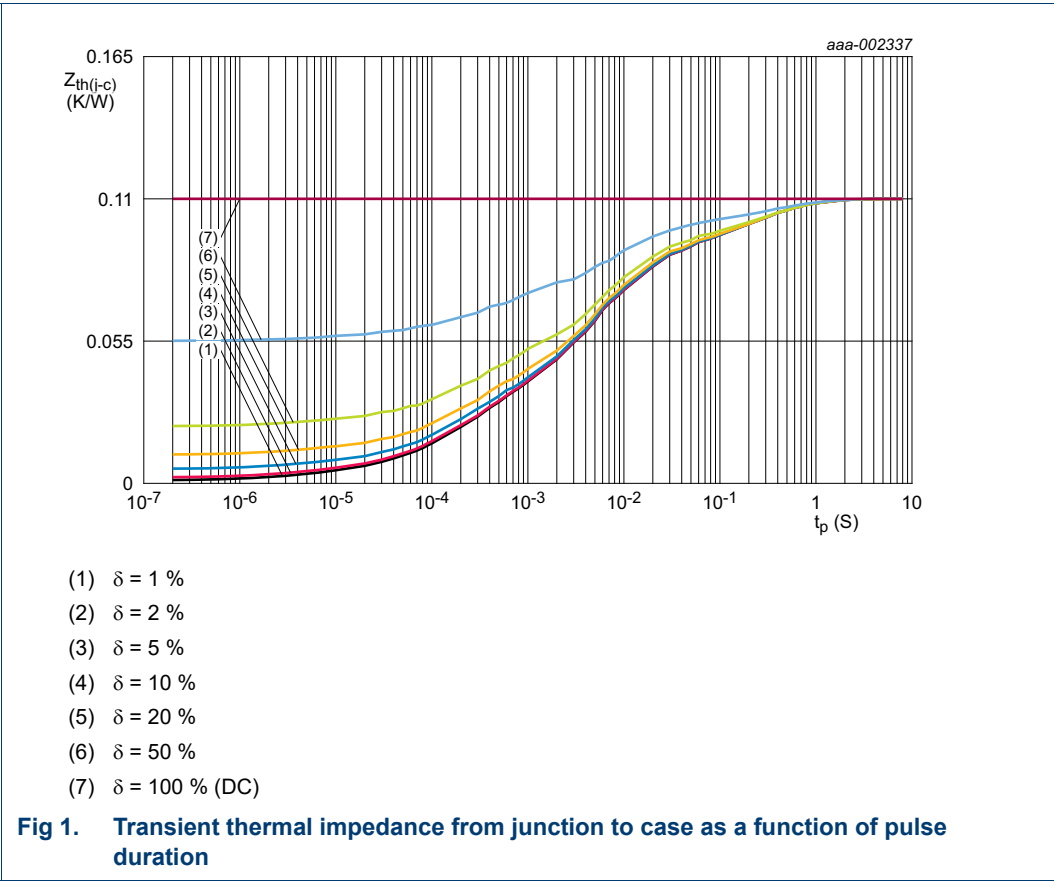
| Symbol    | Parameter            | Conditions | Min | Max  | Unit |
|-----------|----------------------|------------|-----|------|------|
| $V_{DS}$  | drain-source voltage |            | -   | 110  | V    |
| $V_{GS}$  | gate-source voltage  |            | -6  | +11  | V    |
| $T_{stg}$ | storage temperature  |            | -65 | +150 | °C   |
| $T_j$     | junction temperature |            | -   | 200  | °C   |

5. Thermal characteristics

Table 5. Thermal characteristics

| Symbol        | Parameter                                         | Conditions                                                                                     | Typ         | Unit |
|---------------|---------------------------------------------------|------------------------------------------------------------------------------------------------|-------------|------|
| $R_{th(j-c)}$ | thermal resistance from junction to case          | $T_j = 150\text{ }^{\circ}\text{C}$                                                            | [1][2] 0.11 | K/W  |
| $Z_{th(j-c)}$ | transient thermal impedance from junction to case | $T_j = 150\text{ }^{\circ}\text{C}$ ; $t_p = 100\text{ }\mu\text{s}$ ; $\delta = 20\text{ }\%$ | [3] 0.033   | K/W  |

- [1]  $T_j$  is the junction temperature.  
[2]  $R_{th(j-c)}$  is measured under RF conditions.  
[3] See [Figure 1](#).



## 6. Characteristics

**Table 6. DC characteristics**

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

| Symbol        | Parameter                        | Conditions                                                        | Min  | Typ  | Max  | Unit          |
|---------------|----------------------------------|-------------------------------------------------------------------|------|------|------|---------------|
| $V_{(BR)DSS}$ | drain-source breakdown voltage   | $V_{GS} = 0\text{ V}$ ; $I_D = 5.5\text{ mA}$                     | 110  | -    | -    | V             |
| $V_{GS(th)}$  | gate-source threshold voltage    | $V_{DS} = 10\text{ V}$ ; $I_D = 550\text{ mA}$                    | 1.25 | 1.7  | 2.25 | V             |
| $V_{GSq}$     | gate-source quiescent voltage    | $V_{DS} = 50\text{ V}$ ; $I_D = 20\text{ mA}$                     | 0.8  | 1.3  | 1.8  | 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            | $V_{GS} = V_{GS(th)} + 3.75\text{ V}$ ;<br>$V_{DS} = 10\text{ V}$ | -    | 77   | -    | A             |
| $I_{GSS}$     | gate leakage current             | $V_{GS} = 11\text{ V}$ ; $V_{DS} = 0\text{ V}$                    | -    | -    | 280  | nA            |
| $R_{DS(on)}$  | drain-source on-state resistance | $V_{GS} = V_{GS(th)} + 3.75\text{ V}$ ;<br>$I_D = 19.25\text{ A}$ | -    | 0.07 | -    | $\Omega$      |

**Table 7. AC characteristics**

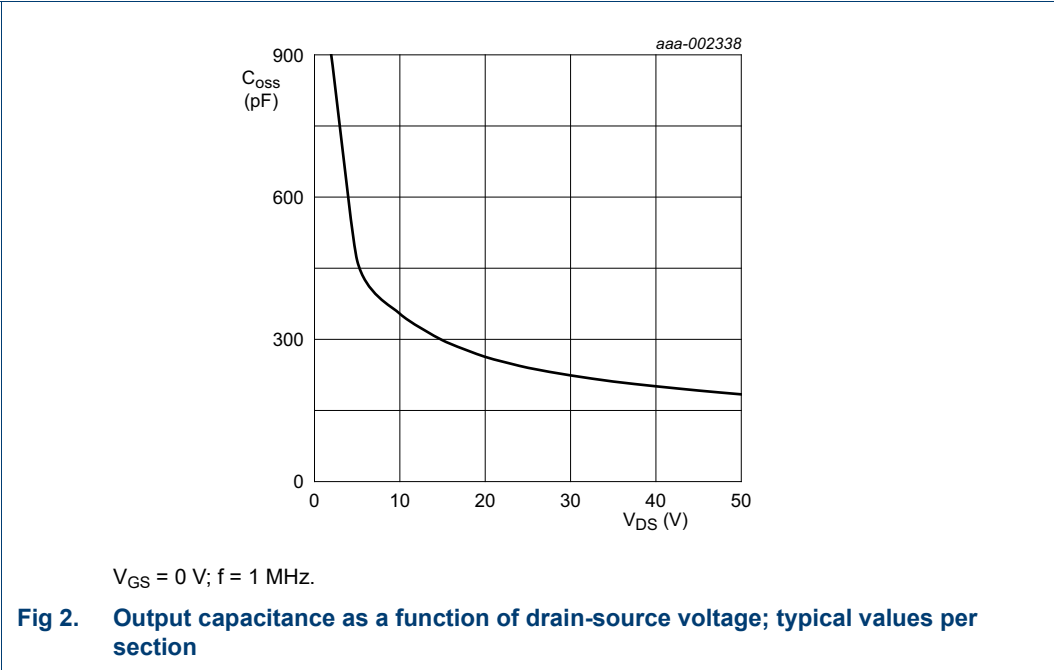
$T_j = 25\text{ }^{\circ}\text{C}$ ; per section unless otherwise specified.

| Symbol    | Parameter            | Conditions                                                          | Min | Typ | Max | Unit |
|-----------|----------------------|---------------------------------------------------------------------|-----|-----|-----|------|
| $C_{rs}$  | feedback capacitance | $V_{GS} = 0\text{ V}$ ; $V_{DS} = 50\text{ V}$ ; $f = 1\text{ MHz}$ | -   | 5.5 | -   | pF   |
| $C_{iss}$ | input capacitance    | $V_{GS} = 0\text{ V}$ ; $V_{DS} = 50\text{ V}$ ; $f = 1\text{ MHz}$ | -   | 414 | -   | pF   |
| $C_{oss}$ | output capacitance   | $V_{GS} = 0\text{ V}$ ; $V_{DS} = 50\text{ V}$ ; $f = 1\text{ MHz}$ | -   | 184 | -   | pF   |

**Table 8. RF characteristics**

Test signal: pulsed RF;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 20\%$ ;  $f = 225\text{ MHz}$ ; RF performance at  $V_{DS} = 50\text{ V}$ ;  $I_{DQ} = 40\text{ mA}$ ;  $T_{case} = 25\text{ }^{\circ}\text{C}$ ; unless otherwise specified; in a class-AB production test circuit.

| Symbol    | Parameter         | Conditions            | Min | Typ  | Max | Unit |
|-----------|-------------------|-----------------------|-----|------|-----|------|
| $G_p$     | power gain        | $P_L = 1400\text{ W}$ | 22  | 23.5 | -   | dB   |
| $RL_{in}$ | input return loss | $P_L = 1400\text{ W}$ | -   | -17  | -13 | dB   |
| $\eta_D$  | drain efficiency  | $P_L = 1400\text{ W}$ | 65  | 69   | -   | %    |

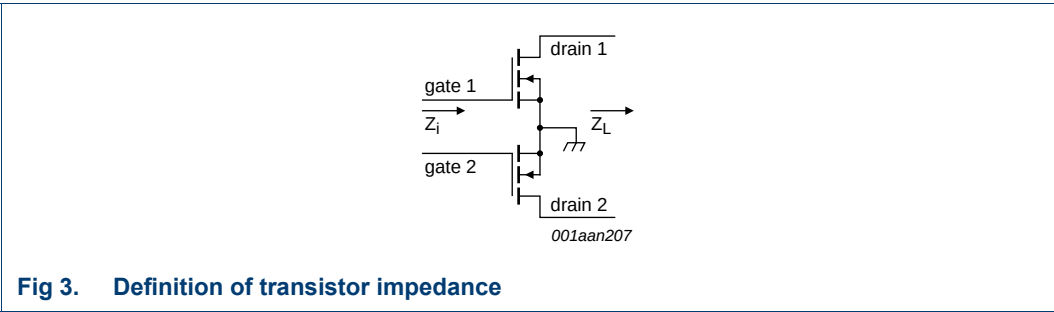


7. Test information

7.1 Ruggedness in class-AB operation

The BLF578XR and BLF578XRS are capable of withstanding a load mismatch corresponding to  $V_{SWR} > 65 : 1$  through all phases under the following conditions:  $V_{DS} = 50\text{ V}; I_{Dq} = 40\text{ mA}; P_L = 1400\text{ W}$  pulsed;  $f = 225\text{ MHz}.$

7.2 Impedance information

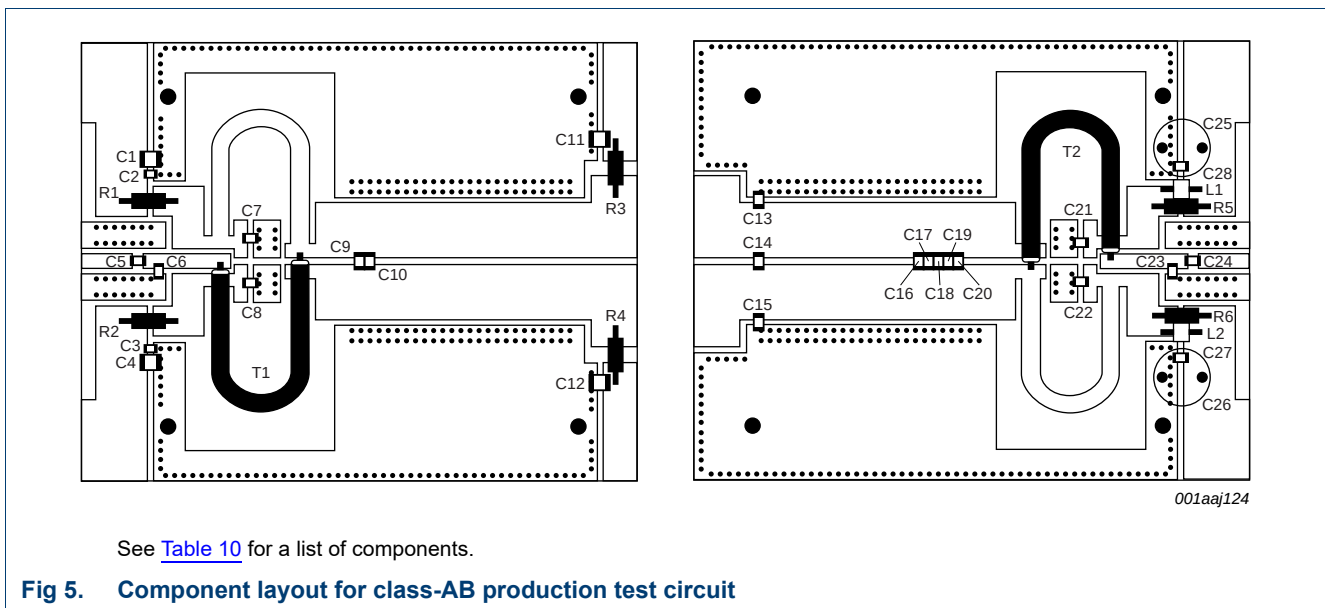
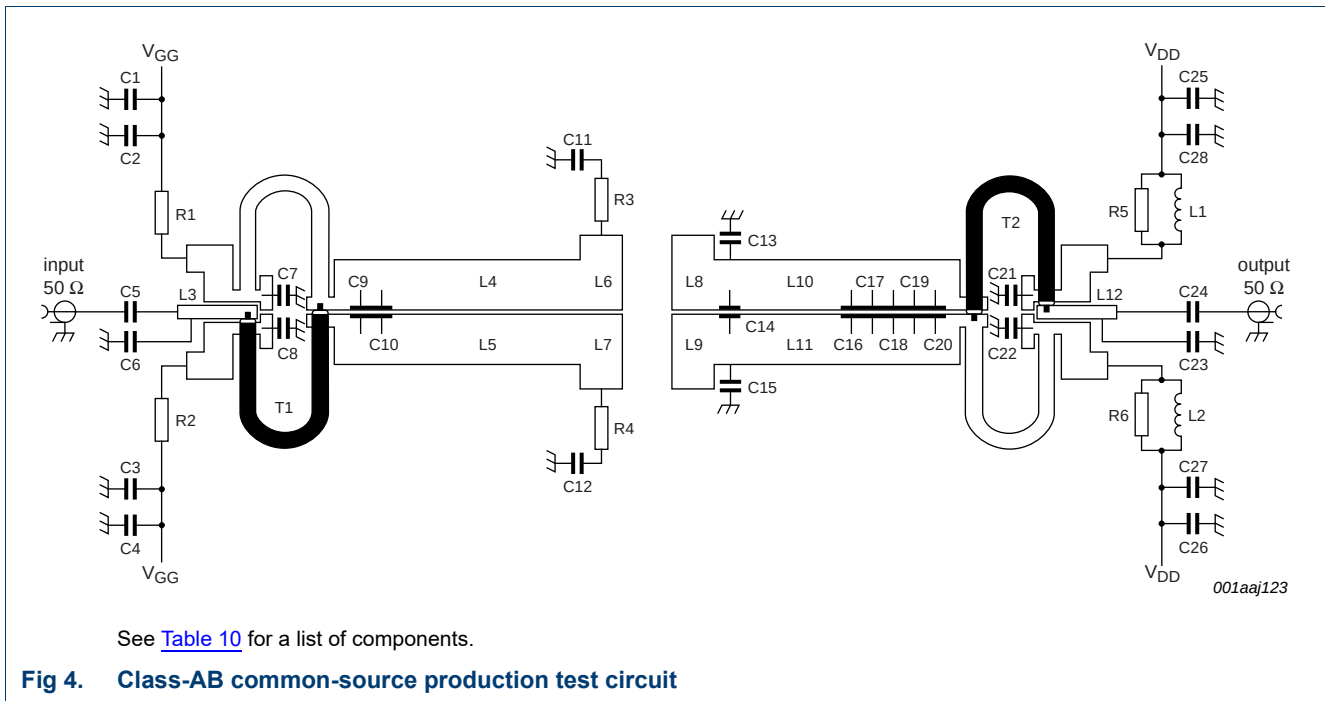


**Table 9. Typical push-pull impedance**

Simulated  $Z_i$  and  $Z_L$  device impedance; impedance info at  $V_{DS} = 50\text{ V}$  and  $P_L = 1400\text{ W}.$

| f<br>(MHz) | $Z_i$<br>( $\Omega$ ) | $Z_L$<br>( $\Omega$ ) |
|------------|-----------------------|-----------------------|
| 225        | $2.36 - j2.78$        | $2.45 + j0.86$        |

### 7.3 Test circuit



**Table 10. List of components**

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

Printed-Circuit Board (PCB): Rogers 5880;  $\epsilon_r = 2.2$  F/m; height = 0.79 mm; Cu (top/bottom metallization); thickness copper plating = 35  $\mu$ m.

| Component            | Description                       | Value                   | Remarks                              |
|----------------------|-----------------------------------|-------------------------|--------------------------------------|
| C1, C2, C11, C12     | multilayer ceramic chip capacitor | 4.7 $\mu$ F             | TDK4532X7R1E475Mt020U                |
| C2, C3, C27, C28     | multilayer ceramic chip capacitor | 100 nF                  | Murata X7R 250 V                     |
| C5, C7, C8, C21, C22 | multilayer ceramic chip capacitor | 1 nF                    | <a href="#">[1]</a>                  |
| C6                   | multilayer ceramic chip capacitor | 30 pF                   | <a href="#">[1]</a>                  |
| C9, C13, C15         | multilayer ceramic chip capacitor | 62 pF                   | <a href="#">[1]</a>                  |
| C10                  | multilayer ceramic chip capacitor | 51 pF                   | <a href="#">[1]</a>                  |
| C14                  | multilayer ceramic chip capacitor | 36 pF                   | <a href="#">[1]</a>                  |
| C16, C17             | multilayer ceramic chip capacitor | 24 pF                   | <a href="#">[1]</a>                  |
| C18                  | multilayer ceramic chip capacitor | 30 pF                   | <a href="#">[1]</a>                  |
| C19                  | multilayer ceramic chip capacitor | 27 pF                   | <a href="#">[1]</a>                  |
| C20                  | multilayer ceramic chip capacitor | 9.1 pF                  | <a href="#">[1]</a>                  |
| C23                  | multilayer ceramic chip capacitor | 13 pF                   | <a href="#">[1]</a>                  |
| C24                  | multilayer ceramic chip capacitor | 16 pF                   | <a href="#">[1]</a>                  |
| C25, C26             | electrolytic capacitor            | 220 $\mu$ F; 63 V       |                                      |
| L1, L2               | 3 turns 1 mm copper wire          | D = 2 mm; length = 3 mm |                                      |
| L3, L12              | stripline                         | -                       | (L $\times$ W) 15 mm $\times$ 2.4 mm |
| L4, L5, L10, L11     | stripline                         | -                       | (L $\times$ W) 47 mm $\times$ 10 mm  |
| L6, L7, L8, L9       | stripline                         | -                       | (L $\times$ W) 8 mm $\times$ 15 mm   |
| R1, R2               | metal film resistor               | 2 $\Omega$ ; 0.6 W      |                                      |
| R3, R4               | metal film resistor               | 20 $\Omega$ ; 0.6 W     |                                      |
| R5, R6               | metal film resistor               | 1 $\Omega$ ; 0.6 W      |                                      |
| T1, T2               | semi rigid coax                   | 50 $\Omega$ ; 58 mm     | EZ-141-AL-TP-M17                     |

[1] American Technical Ceramics type 100B or capacitor of same quality.

7.4 Graphical data

The following figures are measured in a class-AB production test circuit.

7.4.1 1-Tone CW pulsed

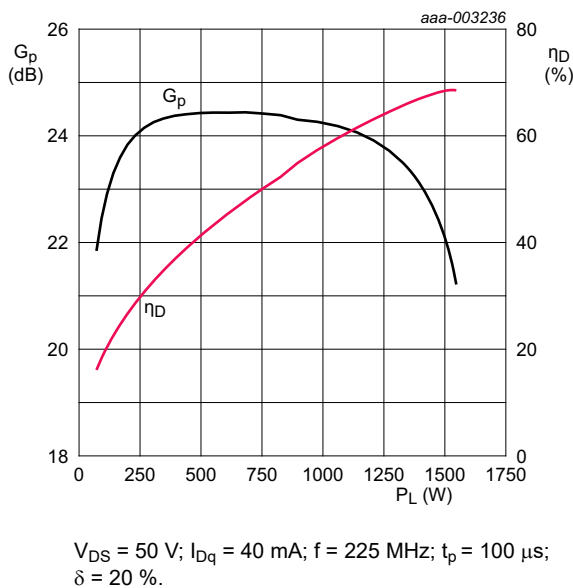


Fig 6. Power gain and drain efficiency as function of output power; typical values

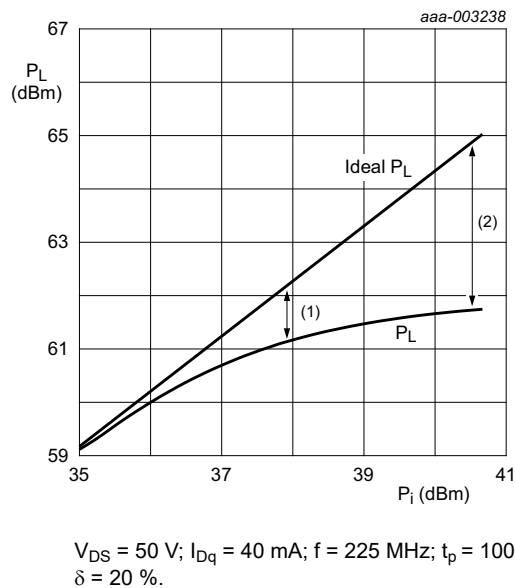
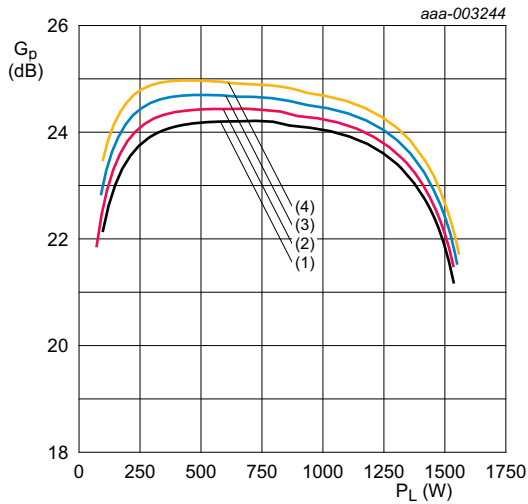


Fig 7. Output power as a function of input power; typical values

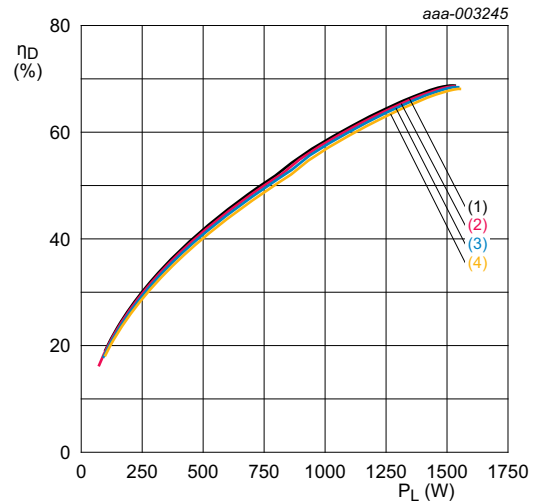




$V_{DS} = 50 \text{ V}$ ;  $f = 225 \text{ MHz}$ ;  $t_p = 100 \text{ } \mu\text{s}$ ;  $\delta = 20 \text{ } \%$ .

- (1)  $I_{Dq} = 20 \text{ mA}$
- (2)  $I_{Dq} = 40 \text{ mA}$
- (3)  $I_{Dq} = 80 \text{ mA}$
- (4)  $I_{Dq} = 160 \text{ mA}$

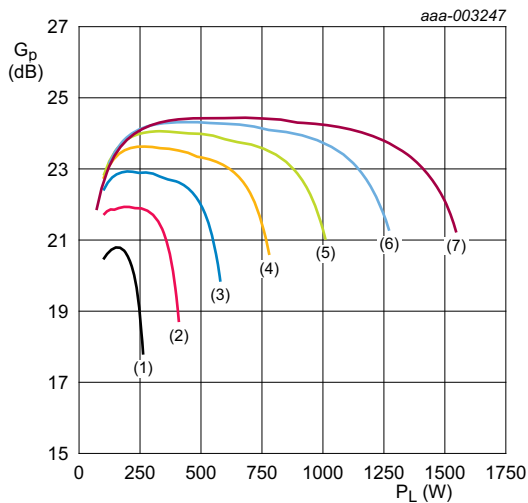
**Fig 8. Power gain as a function of output power; typical values**



$V_{DS} = 50 \text{ V}$ ;  $f = 225 \text{ MHz}$ ;  $t_p = 100 \text{ } \mu\text{s}$ ;  $\delta = 20 \text{ } \%$ .

- (1)  $I_{Dq} = 20 \text{ mA}$
- (2)  $I_{Dq} = 40 \text{ mA}$
- (3)  $I_{Dq} = 80 \text{ mA}$
- (4)  $I_{Dq} = 160 \text{ mA}$

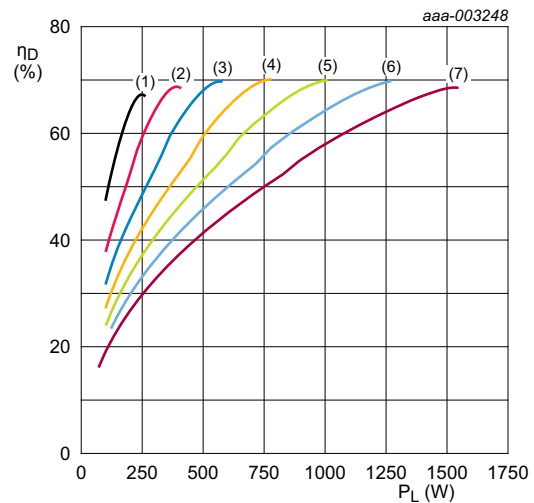
**Fig 9. Drain efficiency as a function of output power; typical values**



$I_{Dq} = 40 \text{ mA}$ ;  $f = 225 \text{ MHz}$ ;  $t_p = 100 \text{ } \mu\text{s}$ ;  $\delta = 20 \text{ } \%$ .

- (1)  $V_{DS} = 20 \text{ V}$
- (2)  $V_{DS} = 25 \text{ V}$
- (3)  $V_{DS} = 30 \text{ V}$
- (4)  $V_{DS} = 35 \text{ V}$
- (5)  $V_{DS} = 40 \text{ V}$
- (6)  $V_{DS} = 45 \text{ V}$
- (7)  $V_{DS} = 50 \text{ V}$

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



$I_{Dq} = 40 \text{ mA}$ ;  $f = 225 \text{ MHz}$ ;  $t_p = 100 \text{ } \mu\text{s}$ ;  $\delta = 20 \text{ } \%$ .

- (1)  $V_{DS} = 20 \text{ V}$
- (2)  $V_{DS} = 25 \text{ V}$
- (3)  $V_{DS} = 30 \text{ V}$
- (4)  $V_{DS} = 35 \text{ V}$
- (5)  $V_{DS} = 40 \text{ V}$
- (6)  $V_{DS} = 45 \text{ V}$
- (7)  $V_{DS} = 50 \text{ V}$

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

8. Package outline

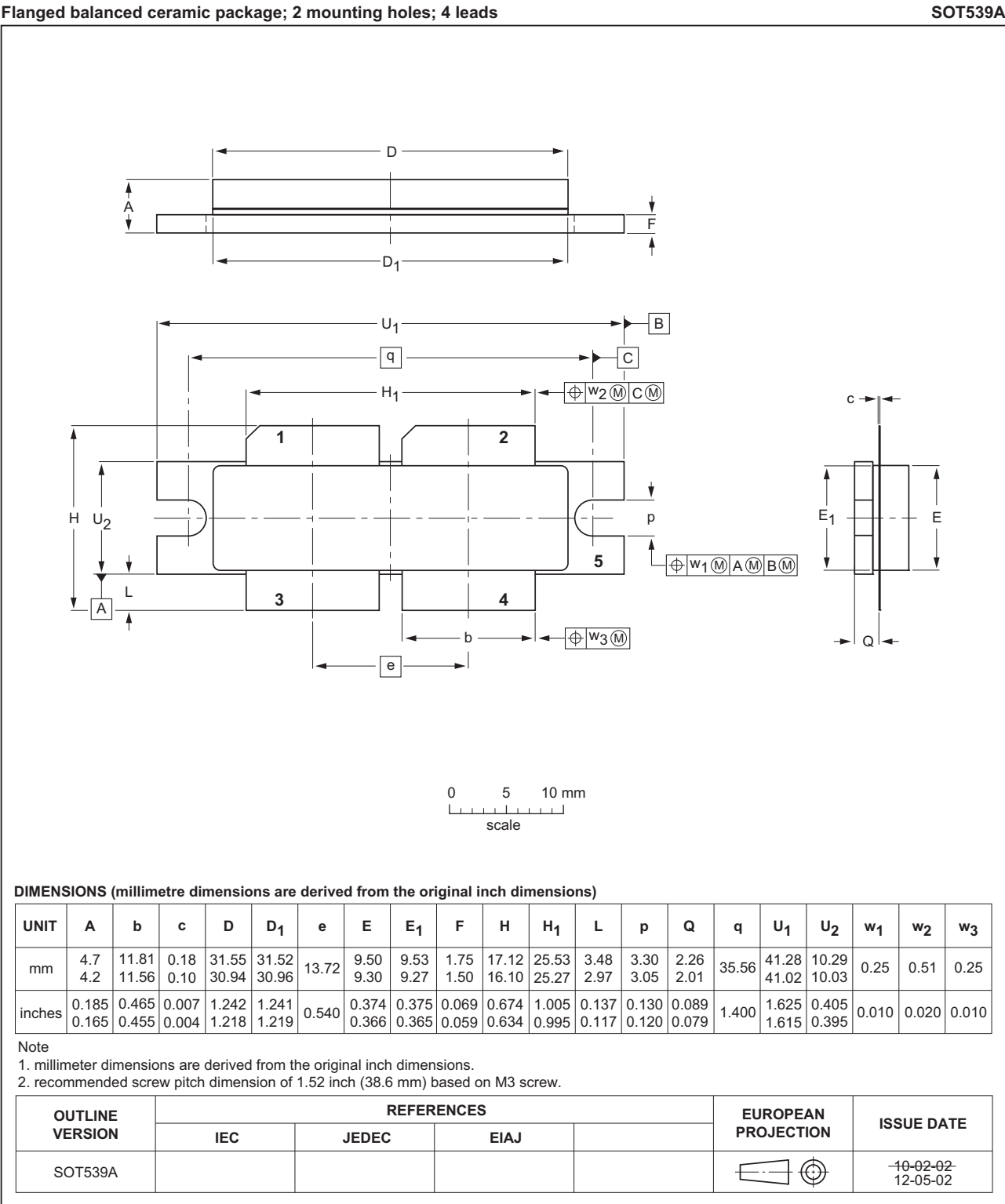
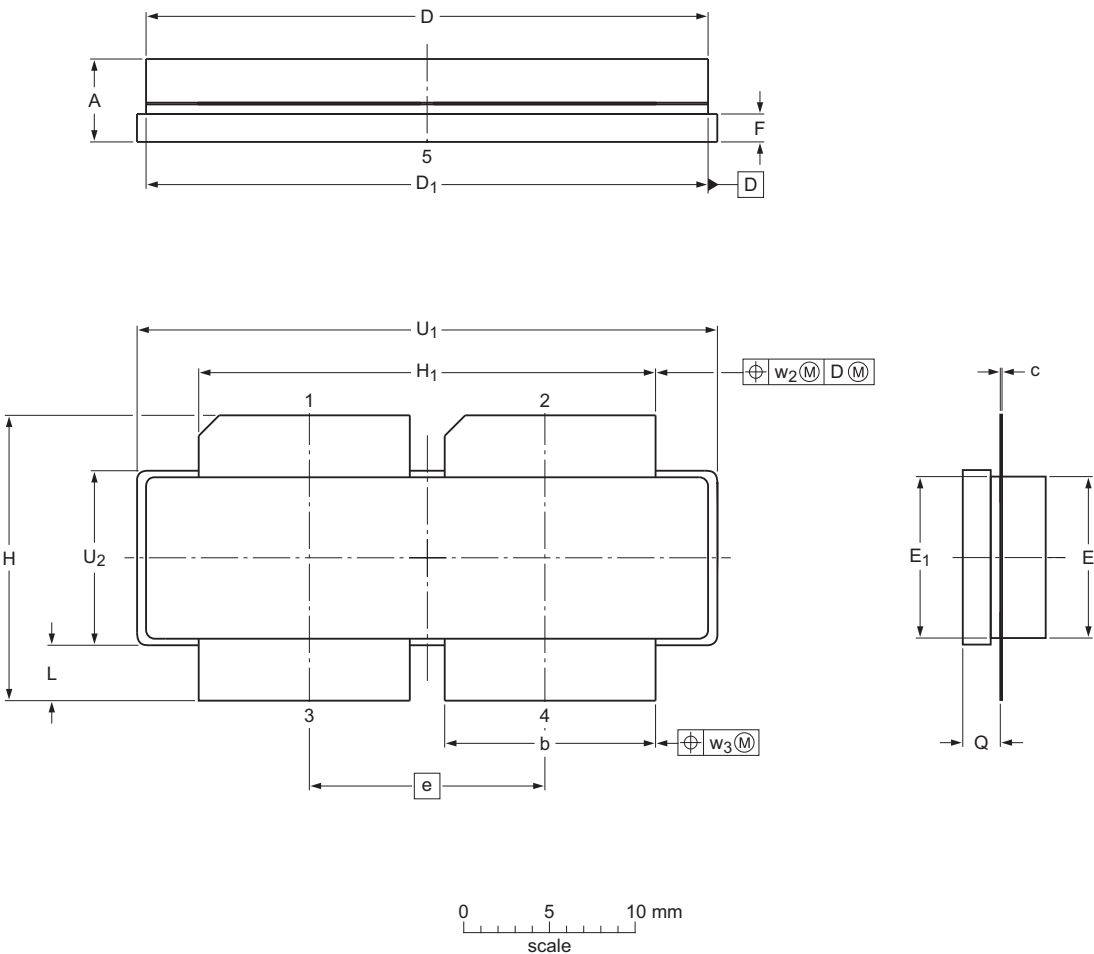


Fig 12. Package outline SOT539A

Earless flanged balanced ceramic package; 4 leads

SOT539B



Dimensions

| Unit <sup>(1)</sup> | A   | b     | c     | D     | D <sub>1</sub> | E     | E <sub>1</sub> | e     | F     | H     | H <sub>1</sub> | L     | Q     | U <sub>1</sub> | U <sub>2</sub> | w <sub>2</sub> | w <sub>3</sub> |
|---------------------|-----|-------|-------|-------|----------------|-------|----------------|-------|-------|-------|----------------|-------|-------|----------------|----------------|----------------|----------------|
| mm                  | max | 4.7   | 11.81 | 0.18  | 31.55          | 31.52 | 9.5            | 9.53  | 1.75  | 17.12 | 25.53          | 3.48  | 2.26  | 32.39          | 10.29          |                |                |
|                     | nom |       |       |       |                |       |                | 13.72 |       |       |                |       |       |                |                | 0.25           | 0.25           |
|                     | min | 4.2   | 11.56 | 0.10  | 30.94          | 30.96 | 9.3            | 9.27  | 1.50  | 16.10 | 25.27          | 2.97  | 2.01  | 32.13          | 10.03          |                |                |
| inches              | max | 0.185 | 0.465 | 0.007 | 1.242          | 1.241 | 0.374          | 0.375 | 0.069 | 0.674 | 1.005          | 0.137 | 0.089 | 1.275          | 0.405          |                |                |
|                     | nom |       |       |       |                |       |                | 0.54  |       |       |                |       |       |                |                | 0.01           | 0.01           |
|                     | min | 0.165 | 0.455 | 0.004 | 1.218          | 1.219 | 0.366          | 0.365 | 0.059 | 0.634 | 0.995          | 0.117 | 0.079 | 1.265          | 0.395          |                |                |

Note

1. millimeter dimensions are derived from the original inch dimensions.

sot539b\_po

| Outline version | References |       |       |  | European projection                                                                   | Issue date           |
|-----------------|------------|-------|-------|--|---------------------------------------------------------------------------------------|----------------------|
|                 | IEC        | JEDEC | JEITA |  |                                                                                       |                      |
| SOT539B         |            |       |       |  |  | 12-05-02<br>13-05-24 |

Fig 13. 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                                             |
|---------|---------------------------------------------------------|
| CW      | Continuous Wave                                         |
| ESD     | ElectroStatic Discharge                                 |
| HF      | High Frequency                                          |
| LDMOS   | Laterally Diffused Metal-Oxide Semiconductor            |
| LDMOST  | Laterally Diffused Metal-Oxide Semiconductor Transistor |
| VSWR    | Voltage Standing-Wave Ratio                             |
| XR      | eXtremely Rugged                                        |

## 11. Revision history

Table 12. Revision history

| Document ID            | Release date                                                                                                                                                                                                                               | Data sheet status      | Change notice | Supersedes             |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------|------------------------|
| BLF578XR_BLF578XRS#5   | 20150901                                                                                                                                                                                                                                   | Product data sheet     | -             | BLF578XR_BLF578XRS v.4 |
| Modifications:         | <ul style="list-style-type: none"> <li>The format of this document has been redesigned to comply with the new identity guidelines of Ampleon.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> </ul> |                        |               |                        |
| BLF578XR_BLF578XRS v.4 | 20130712                                                                                                                                                                                                                                   | Product data sheet     | -             | BLF578XR_BLF578XRS v.3 |
| BLF578XR_BLF578XRS v.3 | 20120625                                                                                                                                                                                                                                   | Product data sheet     | -             | BLF578XR_BLF578XRS v.2 |
| BLF578XR_BLF578XRS v.2 | 20120514                                                                                                                                                                                                                                   | Preliminary data sheet | -             | BLF578XR_BLF578XRS v.1 |
| BLF578XR_BLF578XRS v.1 | 20120130                                                                                                                                                                                                                                   | 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.ampleon.com>.

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