# BLF888

## UHF power LDMOS transistor

Rev. 5 — 21 January 2011 Product data sheet

## 1. Product profile

### 1.1 General description

A 500 W LDMOS RF power transistor for broadcast transmitter applications and industrial applications. The transistor is optimized for digital applications and can deliver 110 W average DVB-T broadband over the full UHF band from 470 MHz to 860 MHz. The excellent ruggedness of this device makes it ideal for digital transmitter applications.

**Table 1. Application information**

*RF performance at $V_{DS}$ = 50 V in a common source 860 MHz narrowband test circuit unless otherwise specified.*

| Mode of operation | f (MHz) | $P_{L(PEP)}$ (W) | $P_{L(AV)}$ (W) | $G_p$ (dB) | $\eta_D$ (%) | IMD3 (dBc) | $IMD_{shldr}$ (dBc) |
|---|---|---|---|---|---|---|---|
| 2-Tone, class AB | $f_1$ = 860; $f_2$ = 860.1 | 500 | 250 | 19 | 46 | –32 | - |
| DVB-T (8k OFDM) | 858 | - | 110 | 19 | 31 | - | –31 [1] |

[1] Measured [dBc] with delta marker at 4.3 MHz from center frequency.

**CAUTION**

This device is sensitive to ElectroStatic Discharge (ESD). Therefore care should be taken during transport and handling.

### 1.2 Features and benefits

- 2-Tone performance at 860 MHz, a drain-source voltage $V_{DS}$ of 50 V and a quiescent drain current $I_{Dq}$ = 1.3 A:
  - Peak envelope power load power = 500 W
  - Power gain = 19 dB
  - Drain efficiency = 46 %
  - Third order intermodulation distortion = –32 dBc
- DVB performance at 858 MHz, a drain-source voltage $V_{DS}$ of 50 V and a quiescent drain current $I_{Dq}$ = 1.3 A:
  - Average output power = 110 W
  - Power gain = 19 dB
  - Drain efficiency = 31 %
  - Shoulder distance = –31 dBc (4.3 MHz from center frequency)
- Integrated ESD protection
- Advanced flange material for optimum thermal behavior and reliability

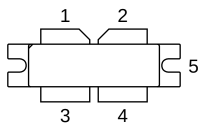
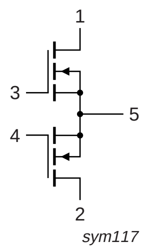
- Excellent ruggedness
- High power gain
- High efficiency
- Designed for broadband operation (470 MHz to 860 MHz)
- Excellent reliability
- Internal input matching for high gain and optimum broadband operation
- Easy power control
- Compliant to Directive 2002/95/EC, regarding Restriction of Hazardous Substances (RoHS)

### 1.3 Applications

- Communication transmitter applications in the UHF band
- Industrial applications in the UHF band

## 2. Pinning information

**Table 2. Pinning**

| Pin | Description | Simplified outline | Graphic symbol |
|---|---|---|---|
| 1 | drain1 |  |  |
| 2 | drain2 | | |
| 3 | gate1 | | |
| 4 | gate2 | | |
| 5 | source [1] | | |





[1] Connected to flange.

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BLF888 | - | flanged LDMOST ceramic package; 2 mounting holes; 4 leads | SOT979A |

## 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 | | - | 104 | V |
| $V_{GS}$ | gate-source voltage | | –0.5 | +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 | $T_{case}$ = 80 °C; $P_{L(AV)}$ = 110 W | [1] | 0.24 | K/W |

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

## 6. Characteristics

**Table 6. DC characteristics**

*$T_j$ = 25 °C unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $V_{GS}$ = 0 V; $I_D$ = 2.7 mA | [1] | 104 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $V_{DS}$ = 10 V; $I_D$ = 270 mA | [1] | 1.4 | 1.9 | 2.4 | V |
| $I_{DSS}$ | drain leakage current | $V_{GS}$ = 0 V; $V_{DS}$ = 50 V | | - | - | 2.8 | μA |
| $I_{DSX}$ | drain cut-off current | $V_{GS}$ = $V_{GS(th)}$ + 3.75 V; $V_{DS}$ = 10 V | | - | 43 | - | A |
| $I_{GSS}$ | gate leakage current | $V_{GS}$ = 10 V; $V_{DS}$ = 0 V | | - | - | 280 | nA |
| $g_{fs}$ | forward transconductance | $V_{DS}$ = 10 V; $I_D$ = 13.5 A | [1] | - | 17 | - | S |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS}$ = $V_{GS(th)}$ + 3.75 V; $I_D$ = 9.5 A | [1] | - | 105 | - | mΩ |
| $C_{iss}$ | input capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 50 V; f = 1 MHz | [2] | - | 205 | - | pF |
| $C_{oss}$ | output capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 50 V; f = 1 MHz | [2] | - | 65 | - | pF |
| $C_{rss}$ | reverse transfer capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 50 V; f = 1 MHz | [2] | - | 2.2 | - | pF |

[1] $I_D$ is the drain current.

[2] Capacitance values without internal matching.

**Table 7. RF characteristics**

*$T_h$ = 25 °C unless otherwise specified.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **2-Tone, class AB** | | | | | | |
| $V_{DS}$ | drain-source voltage | | - | 50 | - | V |
| $I_{Dq}$ | quiescent drain current | total device | - | 1.3 | - | A |
| $P_{L(PEP)}$ | peak envelope power load power | | 500 | - | - | W |
| $P_{L(AV)}$ | average output power | | 250 | - | - | W |
| $G_p$ | power gain | | 18 | 19 | - | dB |
| $\eta_D$ | drain efficiency | | 42 | 46 | - | % |
| IMD3 | third-order intermodulation distortion | | - | −32 | −28 | dBc |
| **DVB-T (8k OFDM)** | | | | | | |
| $V_{DS}$ | drain-source voltage | | - | 50 | - | V |
| $I_{Dq}$ | quiescent drain current | total device | - | 1.3 | - | A |
| $P_{L(AV)}$ | average output power | | 110 | - | - | W |
| $G_p$ | power gain | | 18 | 19 | - | dB |

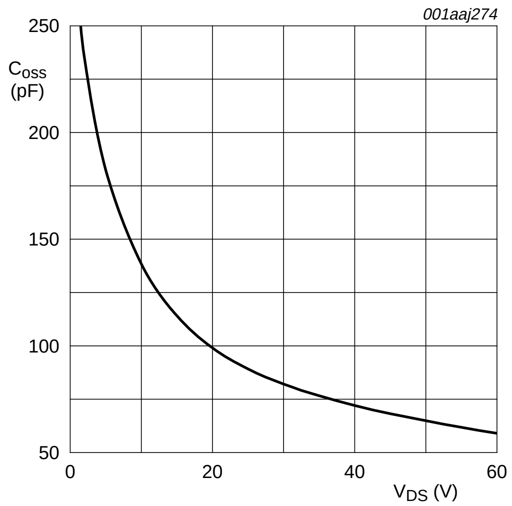
**Table 7. RF characteristics** *...continued*

*$T_h$ = 25 °C unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $\eta_D$ | drain efficiency | | | 28 | 31 | - | % |
| $IMD_{shldr}$ | intermodulation distortion shoulder | | [1] | - | –31 | –28 | dBc |
| PAR | peak-to-average ratio | | [2] | - | 8.3 | - | dB |

[1] Measured [dBc] with delta marker at 4.3 MHz from center frequency.

[2] PAR (of output signal) at 0.01 % probability on CCDF; PAR of input signal = 9.5 dB at 0.01 % probability on CCDF.




$V_{GS}$ = 0 V; f = 1 MHz.

**Fig 1. Output capacitance as a function of drain-source voltage; typical values per section; capacitance value without internal matching**

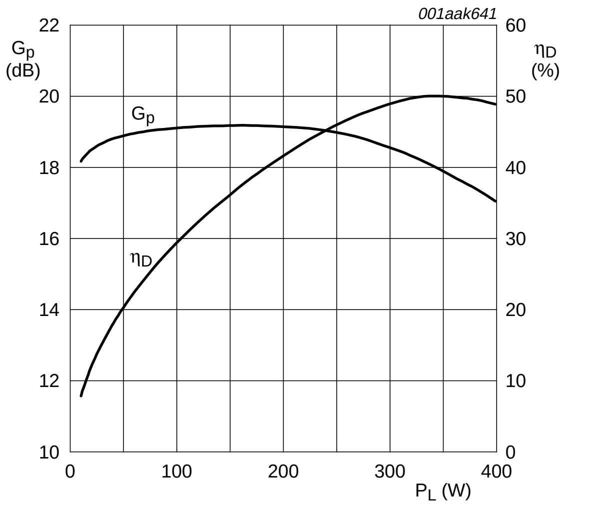
## 6.1 Ruggedness in class-AB operation

The BLF888 is capable of withstanding a load mismatch corresponding to VSWR = 10 : 1 through all phases under the following conditions: $V_{DS}$ = 50 V; f = 860 MHz at rated power. Ruggedness is measured in the application circuit as described in Section 8.

# 7. Application information

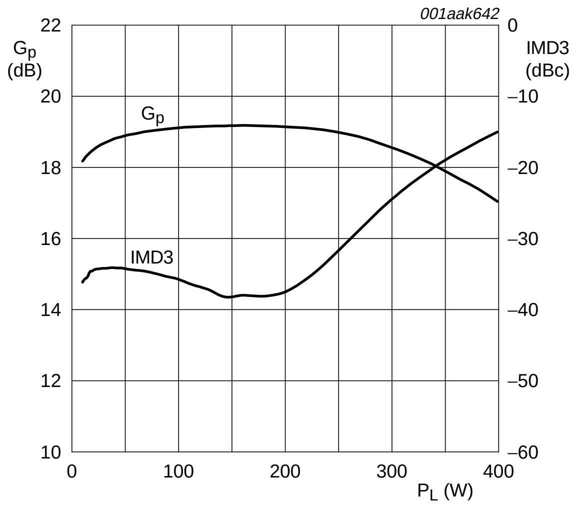
## 7.1 Narrowband RF figures

### 7.1.1 2-Tone




$V_{DS}$ = 50 V; $I_{Dq}$ = 1.3 A; measured in a common source narrowband 860 MHz test circuit.

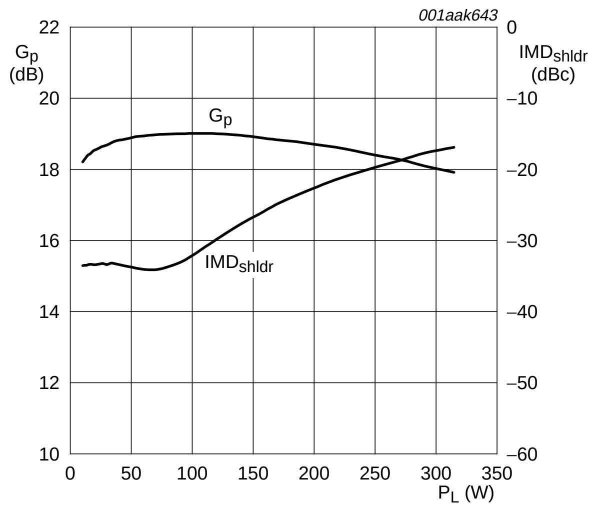
**Fig 2. 2-Tone power gain and drain efficiency as function of load power; typical values**




$V_{DS}$ = 50 V; $I_{Dq}$ = 1.3 A; measured in a common source narrowband 860 MHz test circuit.

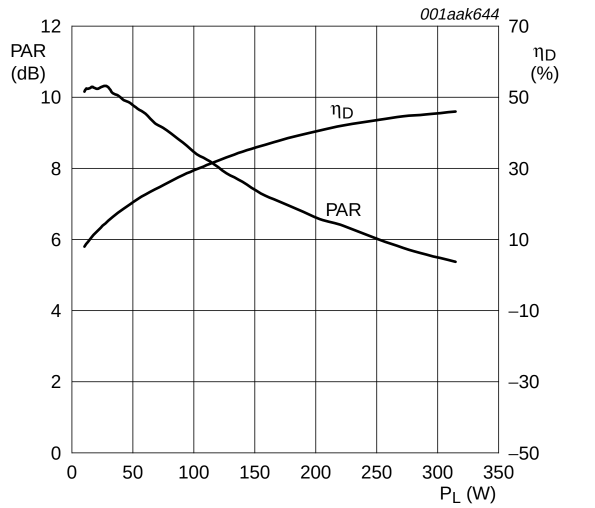
**Fig 3. 2-Tone power gain and third order intermodulation distortion as function of load power; typical values**

### 7.1.2 DVB-T




$V_{DS}$ = 50 V; $I_{Dq}$ = 1.3 A; measured in a common source narrowband 860 MHz test circuit.

**Fig 4. DVB-T power gain and intermodulation distortion shoulder as function of load power; typical values**

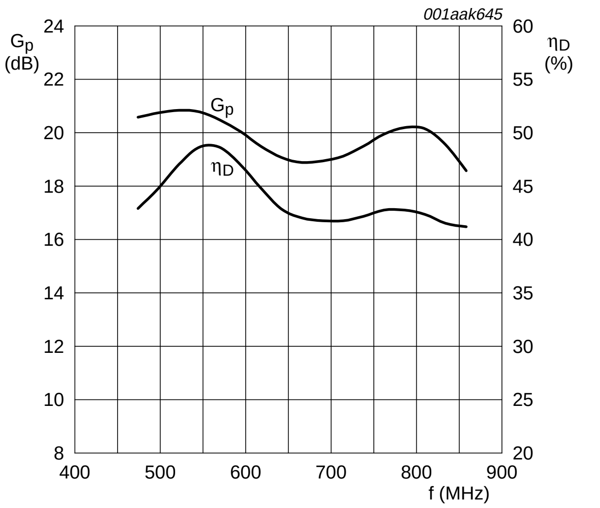



$V_{DS}$ = 50 V; $I_{Dq}$ = 1.3 A; measured in a common source narrowband 860 MHz test circuit.

**Fig 5. DVB-T peak-to-average ratio and drain efficiency as function of load power; typical values**

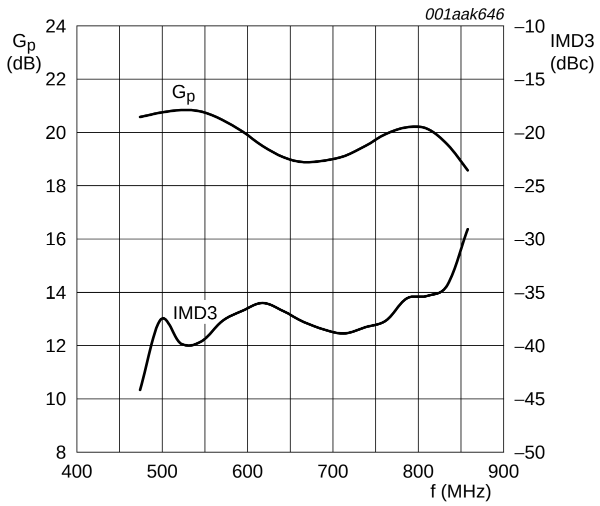
## 7.2 Broadband RF figures

### 7.2.1 2-Tone




$P_{L(AV)}$ = 250 W; $V_{DS}$ = 50 V; $I_{Dq}$ = 1.3 A; measured in a common source broadband test circuit as described in Section 8.

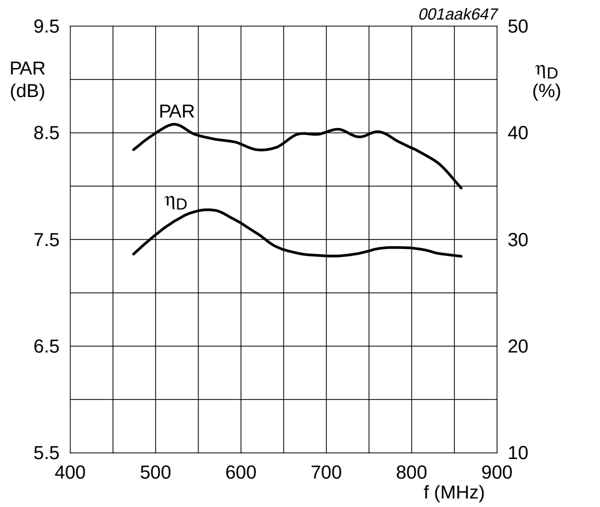
**Fig 6. 2-Tone power gain and drain efficiency as function of frequency; typical values**




$P_{L(AV)}$ = 250 W; $V_{DS}$ = 50 V; $I_{Dq}$ = 1.3 A; measured in a common source broadband test circuit as described in Section 8.

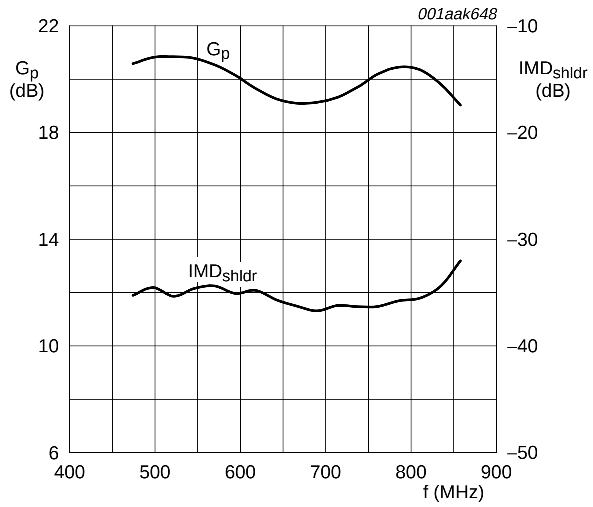
**Fig 7. 2-Tone power gain and third order intermodulation distortion as function of frequency; typical values**

### 7.2.2 DVB-T




$P_{L(AV)}$ = 110 W; $V_{DS}$ = 50 V; $I_{Dq}$ = 1.3 A; measured in a common source broadband test circuit as described in Section 8.

**Fig 8. DVB-T peak-to-average ratio and drain efficiency as function of frequency; typical values**




$P_{L(AV)}$ = 110 W; $V_{DS}$ = 50 V; $I_{Dq}$ = 1.3 A; measured in a common source broadband test circuit as described in Section 8.

**Fig 9. DVB-T power gain and intermodulation distortion shoulder as a function of frequency; typical values**

## 7.3 Impedance information

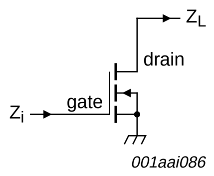



**Fig 10. Definition of transistor impedance**

**Table 8. Typical push-pull impedance**
*Simulated $Z_i$ and $Z_L$ device impedance; impedance info at $V_{DS}$ = 50 V and $P_{L(PEP)}$ = 600 W (DVB-T).*

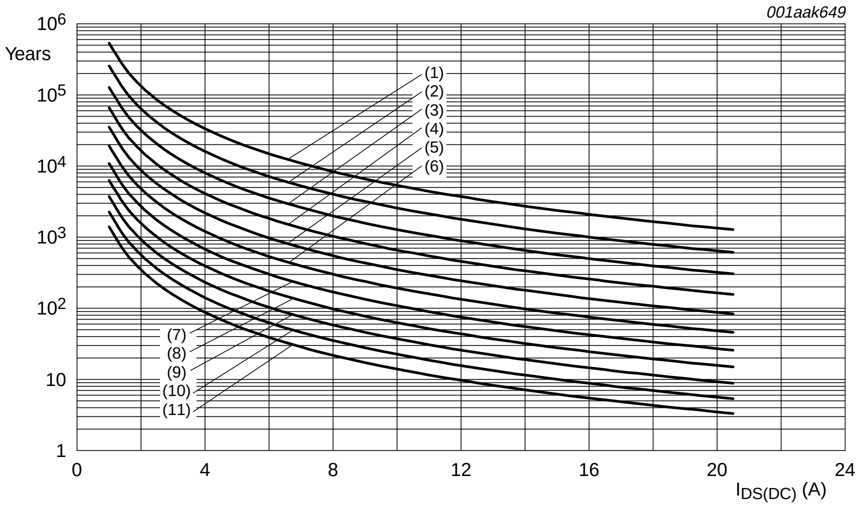
| f<br>MHz | $Z_i$<br>Ω | $Z_L$<br>Ω |
|---|---|---|
| 300 | 1.018 − j1.350 | 5.565 + j0.747 |
| 325 | 1.045 − j1.022 | 5.435 + j0.752 |
| 350 | 1.076 − j0.722 | 5.303 + j0.746 |
| 375 | 1.110 − j0.444 | 5.167 + j0.730 |
| 400 | 1.148 − j0.183 | 5.030 + j0.704 |
| 425 | 1.190 + j0.064 | 4.892 + j0.668 |
| 450 | 1.238 + j0.299 | 4.754 + j0.622 |
| 475 | 1.291 + j0.526 | 4.617 + j0.567 |
| 500 | 1.351 + j0.746 | 4.481 + j0.504 |

**Table 8. Typical push-pull impedance** *…continued*

*Simulated $Z_i$ and $Z_L$ device impedance; impedance info at $V_{DS}$ = 50 V and $P_{L(PEP)}$ = 600 W (DVB-T).*

| f<br>MHz | $Z_i$<br>Ω | $Z_L$<br>Ω |
|---|---|---|
| 525 | 1.417 + j0.961 | 4.346 + j0.432 |
| 550 | 1.492 + j1.171 | 4.214 + j0.353 |
| 575 | 1.577 + j1.378 | 4.084 + j0.266 |
| 600 | 1.672 + j1.582 | 3.958 + j0.173 |
| 625 | 1.779 + j1.783 | 3.834 + j0.074 |
| 650 | 1.901 + j1.983 | 3.713 – j0.031 |
| 675 | 2.039 + j2.180 | 3.596 – j0.142 |
| 700 | 2.196 + j2.373 | 3.482 – j0.257 |
| 725 | 2.376 + j2.563 | 3.372 – j0.377 |
| 750 | 2.581 + j2.745 | 3.266 – j0.501 |
| 775 | 2.817 + j2.918 | 3.163 – j0.628 |
| 800 | 3.087 + j3.076 | 3.064 – j0.759 |
| 825 | 3.395 + j3.212 | 2.968 – j0.893 |
| 850 | 3.746 + j3.317 | 2.876 – j1.030 |
| 875 | 4.142 + j3.377 | 2.787 – j1.170 |
| 900 | 4.583 + j3.374 | 2.701 – j1.312 |
| 925 | 5.063 + j3.288 | 2.619 – j1.455 |
| 950 | 5.566 + j3.094 | 2.540 – j1.601 |
| 975 | 6.064 + j2.770 | 2.464 – j1.749 |
| 1000 | 6.514 + j2.299 | 2.391 – j1.898 |

### 7.4 Reliability




TTF (0.1 % failure fraction).

The reliability at pulsed conditions can be calculated as follows: TTF (0.1 %) × 1 / δ.

(1) $T_j$ = 100 °C

(2) $T_j$ = 110 °C

(3) $T_j$ = 120 °C

(4) $T_j$ = 130 °C

(5) $T_j$ = 140 °C

(6) $T_j$ = 150 °C

(7) $T_j$ = 160 °C

(8) $T_j$ = 170 °C

(9) $T_j$ = 180 °C

(10) $T_j$ = 190 °C

(11) $T_j$ = 200 °C

**Fig 11. BLF888 electromigration ($I_{DS(DC)}$, total device)**

## 8. Test information

**Table 9. List of components**

*For test circuit, see Figure 12, Figure 13 and Figure 14.*

| Component | Description | Value | | Remarks |
|---|---|---|---|---|
| B1, B2 | semi rigid coax | 25 Ω; 49.5 mm | | EZ90-25-TP |
| C1 | multilayer ceramic chip capacitor | 12 pF | [1] | |
| C2, C9, C10 | multilayer ceramic chip capacitor | 10 pF | [1] | |
| C3 | multilayer ceramic chip capacitor | 4.7 pF | [2] | |
| C4, C5, C6 | multilayer ceramic chip capacitor | 8.2 pF | [1] | |
| C7 | multilayer ceramic chip capacitor | 5.6 pF | [2] | |
| C8, C13, C14 | multilayer ceramic chip capacitor | 100 pF | [1] | |
| C11, C12 | multilayer ceramic chip capacitor | 2.0 pF | [2] | |

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

*For test circuit, see Figure 12, Figure 13 and Figure 14.*

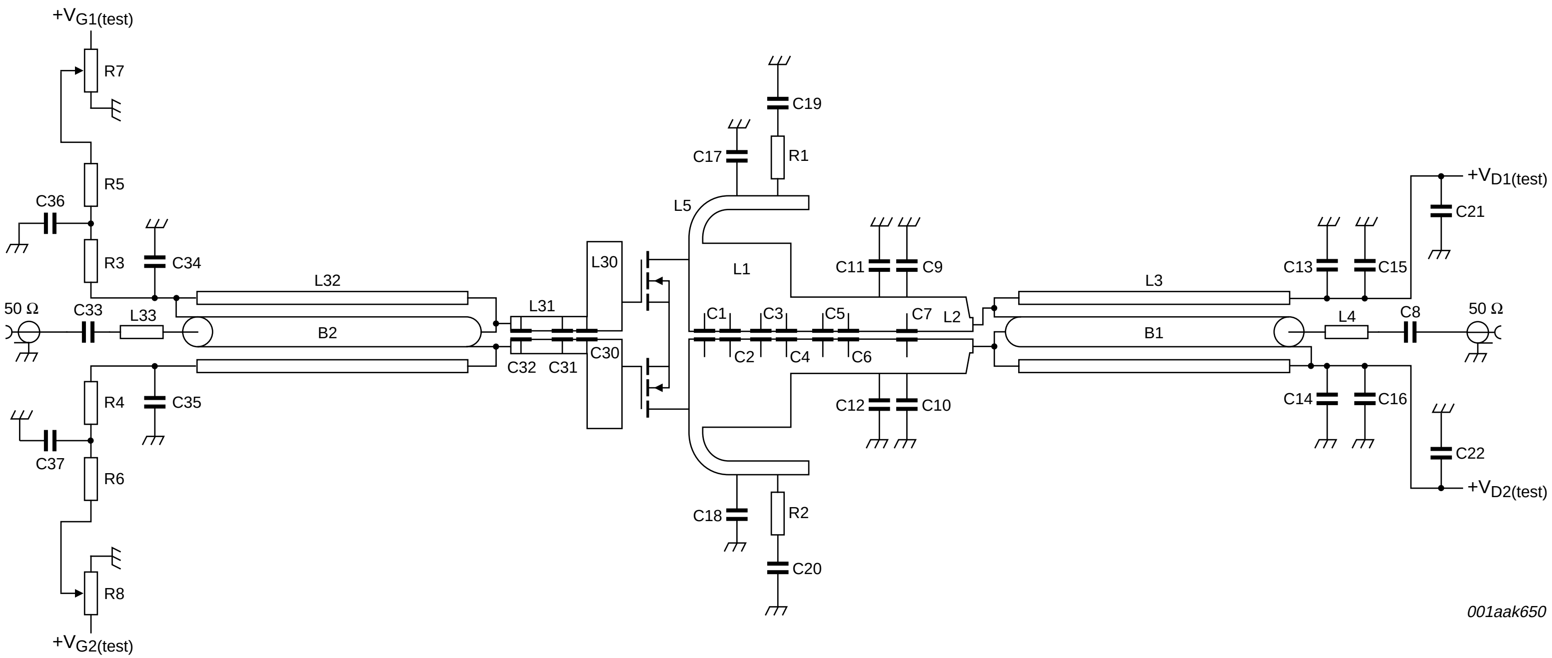
| Component | Description | Value | | Remarks |
|---|---|---|---|---|
| C15, C16 | multilayer ceramic chip capacitor | 4.7 μF, 50 V | | TDK C4532X7R1E475MT020U or capacitor of same quality. |
| C17, C18 | multilayer ceramic chip capacitor | 100 pF | [2] | |
| C19, C20 | multilayer ceramic chip capacitor | 10 μF, 50 V | | TDK C570X7R1H106KT000N or capacitor of same quality. |
| C21, C22 | electrolytic capacitor | 470 μF; 63 V | | |
| C30, C31 | multilayer ceramic chip capacitor | 10 pF | [3] | |
| C32 | multilayer ceramic chip capacitor | 5.6 pF | [3] | |
| C33, C34, C35 | multilayer ceramic chip capacitor | 100 pF | [3] | |
| C36, C37 | multilayer ceramic chip capacitor | 4.7 μF | | TDK C4532X7R1E475MT020U or capacitor of same quality. |
| L1 | microstrip | - | [4] | (W × L) 15 mm × 13 mm |
| L2 | microstrip | - | [4] | (W × L) 5 mm × 26 mm |
| L3, L32 | microstrip | - | [4] | (W × L) 2 mm × 49.5 mm |
| L4 | microstrip | - | [4] | (W × L) 1.7 mm 3.5 mm |
| L5 | microstrip | - | [4] | (W × L) 2 mm × 9.5 mm |
| L30 | microstrip | - | [4] | (W × L) 5 mm × 13 mm |
| L31 | microstrip | - | [4] | (W × L) 2 mm × 11 mm |
| L33 | microstrip | - | [4] | (W × L) 2 mm × 3 mm |
| R1, R2 | resistor | 10 Ω | | |
| R3, R4 | resistor | 5.6 Ω | | |
| R5, R6 | resistor | 100 Ω | | |
| R7, R8 | potentiometer | 1 kΩ | | |

[1] American technical ceramics type 180R or capacitor of same quality.

[2] American technical ceramics type 100B or capacitor of same quality.

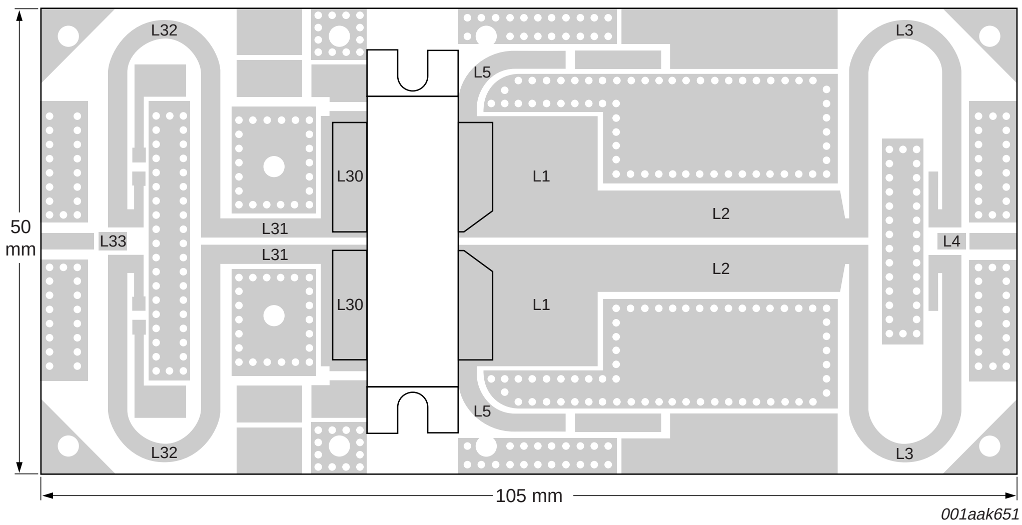
[3] American technical ceramics type 100A or capacitor of same quality.

[4] Printed-Circuit Board (PCB): Taconic RF35; $\varepsilon_r$ = 3.5 F/m; height = 0.76 mm; Cu (top/bottom metallization); thickness copper plating = 35 μm.



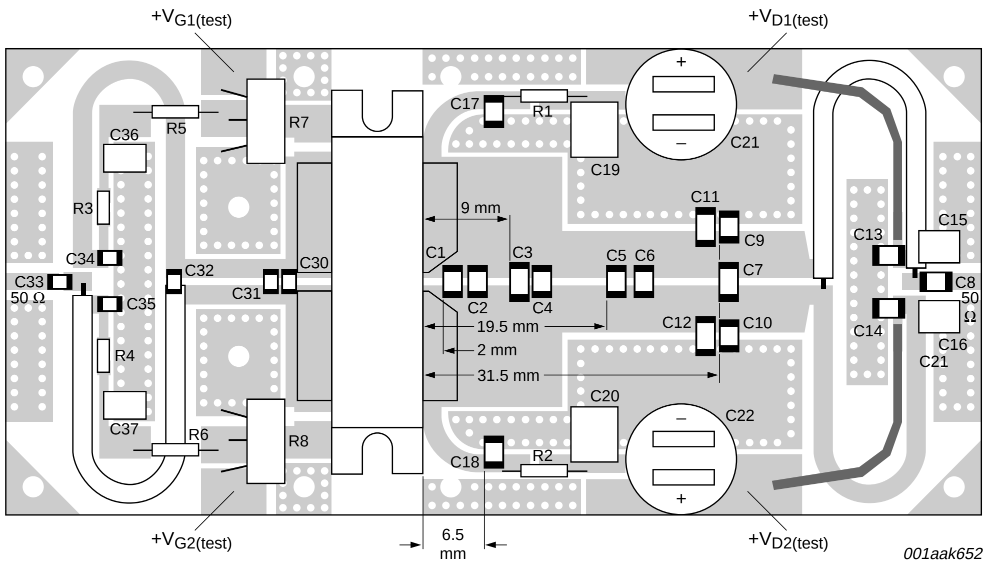

See Table 9 for a list of components.

**Fig 12. 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 9 for a list of components.

**Fig 13. Printed-Circuit Board (PCB) for class-AB common source amplifier**

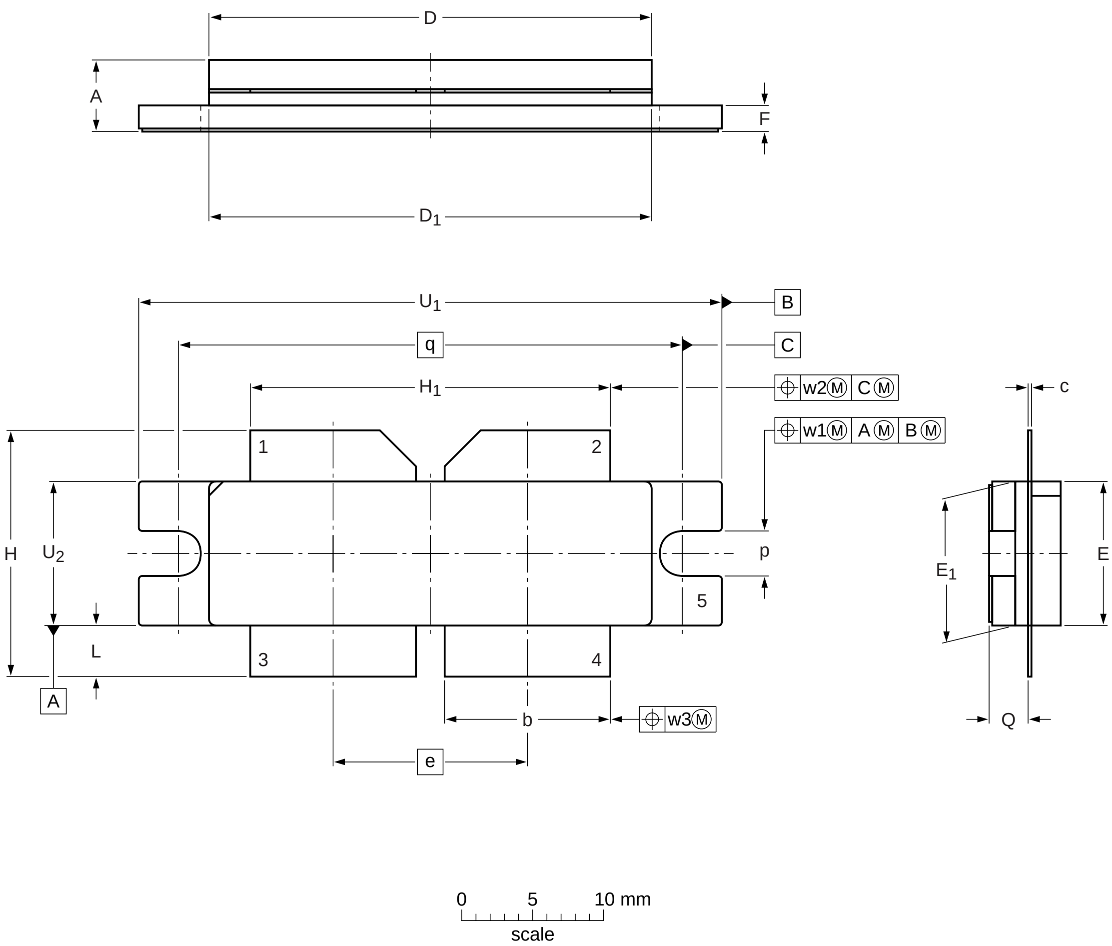



See Table 9 for a list of components.

**Fig 14. Component layout for class-AB common source amplifier**

# 9. Package outline

**Flanged LDMOST ceramic package; 2 mounting holes; 4 leads** **SOT979A**




Dimensions

| Unit[1] | | A | b | c | D | $D_1$ | E | $E_1$ | e | F | H | $H_1$ | L | p | Q | q | $U_1$ | $U_2$ | $w_1$ | $w_2$ | $w_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 5.77 | 11.81 | 0.15 | 31.55 | 31.37 | 10.29 | 10.29 | | 1.969 | 17.50 | 25.53 | 3.86 | 3.30 | 3.02 | | 41.28 | 10.29 | | | |
| | nom | | | | | | | | 13.72 | | | | | | | 35.56 | | | 0.25 | 0.51 | 0.25 |
| | min | 4.80 | 11.56 | 0.10 | 30.94 | 31.12 | 10.03 | 10.03 | | 1.689 | 17.25 | 25.27 | 3.35 | 3.05 | 2.77 | | 41.02 | 10.03 | | | |
| inches | max | 0.227 | 0.465 | 0.006 | 1.242 | 1.235 | 0.405 | 0.405 | | 0.078 | 0.689 | 1.005 | 0.152 | 0.130 | 0.119 | | 1.625 | 0.405 | | | |
| | nom | | | | | | | | 0.540 | | | | | | | 1.400 | | | 0.010 | 0.020 | 0.010 |
| | min | 0.189 | 0.455 | 0.004 | 1.218 | 1.225 | 0.395 | 0.395 | | 0.067 | 0.679 | 0.995 | 0.132 | 0.120 | 0.109 | | 1.615 | 0.395 | | | |

Note

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

*sot979a_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT979A | | | | | | ~~08-04-24~~<br>08-09-04 |

**Fig 15. Package outline SOT979A**

## 10. Abbreviations

**Table 10. Abbreviations**

| Acronym | Description |
|---|---|
| CCDF | Complementary Cumulative Distribution Function |
| DVB | Digital Video Broadcast |
| DVB-T | Digital Video Broadcast - Terrestrial |
| LDMOS | Laterally Diffused Metal-Oxide Semiconductor |
| LDMOST | Laterally Diffused Metal-Oxide Semiconductor Transistor |
| OFDM | Orthogonal Frequency Division Multiplexing |
| PAR | Peak-to-Average power Ratio |
| RF | Radio Frequency |
| TTF | Time To Failure |
| UHF | Ultra High Frequency |
| VSWR | Voltage Standing-Wave Ratio |

## 11. Revision history

**Table 11. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| BLF888 v.5 | 20110121 | Product data sheet | - | BLF888 v.4 |
| Modifications: | • Table 6 on page 3: in the conditions column of $g_{fs}$ the symbol $V_{GS}$ has been changed to $V_{DS}$. | | | |
| BLF888 v.4 | 20100429 | Product data sheet | - | BLF888 v.3 |
| BLF888 v.3 | 20100211 | Product data sheet | - | BLF888 v.2 |
| BLF888 v.2 | 20091022 | Preliminary data sheet | - | BLF888 v.1 |
| BLF888 v.1 | 20081216 | Objective data sheet | - | - |

# 12. Legal information

## 12.1 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.nxp.com.

## 12.2 Definitions

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| ICs with DVB-T or DVB-T2 functionality |
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## 13. Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

## 14. Contents





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