# BLD6G21L-50; BLD6G21LS-50

## TD-SCDMA 2010 MHz to 2025 MHz fully integrated Doherty transistor

Rev. 2 — 17 August 2010 Product data sheet

## 1. Product profile

### 1.1 General description

The BLD6G21L-50 and BLD6G21LS-50 incorporate a fully integrated Doherty solution using NXP's state of the art GEN6 LDMOS technology. This device is perfectly suited for TD-SCDMA base station applications at frequencies from 2010 MHz to 2025 MHz. The main and peak device, input splitter and output combiner are integrated in a single package. This package consists of one gate and drain lead and two extra leads of which one is used for biasing the peak amplifier and the other is not connected. It only requires the proper input/output match and bias setting as with a normal class-AB transistor.

**Table 1. Typical performance**

*RF performance at $T_h$ = 25 °C.*

| Mode of operation | f (MHz) | $V_{DS}$ (V) | $P_{L(AV)}$ (W) | $G_p$ (dB) | $\eta_D$ (%) | ACPR (dBc) | $P_{L(3dB)}$ (W) |
|---|---|---|---|---|---|---|---|
| TD-SCDMA [1][2] | 2010 to 2025 | 28 | 8 | 14.5 | 43 | –24 | 53 |

[1] Test signal: 6-carrier TD-SCDMA; PAR = 10.8 dB at 0.01 % probability on CCDF.

[2] $I_{Dq}$ = 170 mA (main); $V_{GS(amp)peak}$ = 0 V.

**CAUTION**

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

### 1.2 Features and benefits

- Typical TD-SCDMA performance at frequencies from 2010 MHz to 2025 MHz:
  - Average output power = 8 W
  - Power gain = 14.5 dB
  - Efficiency = 43 %
- Fully optimized integrated Doherty concept:
  - integrated asymmetrical power splitter at input
  - integrated power combiner
  - peak biasing down to 0 V
  - low junction temperature
  - high efficiency
- 100 % peak power tested for guaranteed output power capability

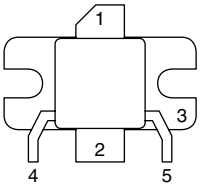
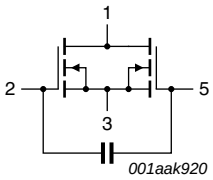
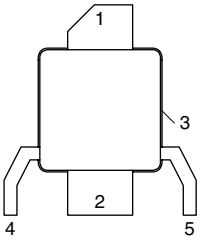
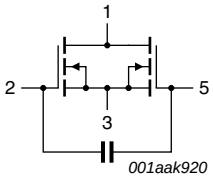
- Integrated ESD protection
- Good pair match (main and peak on the same chip)
- Independent control of main and peak bias
- Internally matched for ease of use
- Excellent ruggedness
- Compliant to Directive 2002/95/EC, regarding Restriction of Hazardous Substances (RoHS)

### 1.3 Applications

- High efficiency RF power amplifiers with digital pre-distortion for TD-SCDMA multi carrier applications in the 2010 MHz to 2025 MHz range.

## 2. Pinning information

**Table 2. Pinning**

| Pin | Description | | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| **BLD6G21L-50 (SOT1130A)** | | | | |
| 1 | drain | |  |  |
| 2 | gate + bias main | | | |
| 3 | source | [1] | | |
| 4 | n.c. | | | |
| 5 | bias peak | | | |
| **BLD6G21LS-50 (SOT1130B)** | | | | |
| 1 | drain | |  |  |
| 2 | gate + bias main | | | |
| 3 | source | [1] | | |
| 4 | n.c. | | | |
| 5 | bias peak | | | |

[1] Connected to flange.

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BLD6G21L-50 | - | flanged ceramic package; 2 mounting holes; 4 leads | SOT1130A |
| BLD6G21LS-50 | - | earless flanged ceramic package; 4 leads | SOT1130B |

## 4. Block diagram

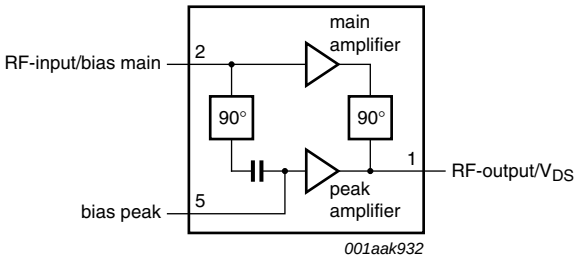



**Fig 1. Block diagram of BLD6G21L-50 and BLD6G21LS-50**

## 5. Limiting values

**Table 4. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*
*Valid for both main and peak device.*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | | - | 65 | V |
| $V_{GS(amp)main}$ | main amplifier gate-source voltage | | –0.5 | +13 | V |
| $V_{GS(amp)peak}$ | peak amplifier gate-source voltage | | –0.5 | +13 | V |
| $I_D$ | drain current | | - | 10.2 | A |
| $T_{stg}$ | storage temperature | | –65 | +150 | °C |
| $T_j$ | junction temperature | | - | 200 | °C |

## 6. Thermal characteristics

**Table 5. Thermal characteristics**

| Symbol | Parameter | Conditions | | Typ | Unit |
|---|---|---|---|---|---|
| $R_{th(j\text{-}case)}$ | thermal resistance from junction to case | $T_{case}$ = 80 °C; $P_L$ = 8 W | [1] | 2.1 | K/W |

[1] When operated with a 6-carrier TD-SCDMA modulated signal with PAR = 10.8 dB at 0.01 % probability on CCDF.

## 7. Characteristics

**Table 6. Characteristics**

*Valid for both main and peak device.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $V_{GS}$ = 0 V; $I_D$ = 0.62 mA | 65 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $V_{DS}$ = 10 V; $I_D$ = 31 mA | 1.4 | 1.8 | 2.4 | V |
| $V_{GSq}$ | gate-source quiescent voltage | $V_{DS}$ = 28 V; $I_D$ = 170 mA | 1.55 | 2.05 | 2.55 | V |
| $I_{DSS}$ | drain leakage current | $V_{GS}$ = 0 V; $V_{DS}$ = 28 V | - | - | 1.4 | µA |
| $I_{DSX}$ | drain cut-off current | $V_{GS}$ = $V_{GS(th)}$ + 3.75 V; $V_{DS}$ = 10 V | 4.95 | 5.5 | - | A |

**Table 6. Characteristics** *...continued*

*Valid for both main and peak device.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{GSS}$ | gate leakage current | $V_{GS}$ = 11 V; $V_{DS}$ = 0 V | - | - | 140 | nA |
| $g_{fs}$ | forward transconductance | $V_{DS}$ = 10 V; $I_D$ = 1.55 A | 1.4 | 2.2 | - | S |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS}$ = $V_{GS(th)}$ + 3.75 V; $I_D$ = 1.085 A | - | 0.52 | 0.736 | Ω |

# 8. Application information

**Table 7. Application information**

*Mode of operation: 6-carrier TD-SCDMA; PAR 10.8 dB at 0.01 % probability on CCDF; f = 2017.5 MHz; RF performance at $V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA; $V_{GS(amp)peak}$ = 0 V; $T_{case}$ = 25 °C; unless otherwise specified; in a production circuit.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $P_{L(AV)}$ | average output power | | - | 8 | - | W |
| $G_p$ | power gain | $P_{L(AV)}$ = 8 W | 13 | 14.5 | - | dB |
| $\eta_D$ | drain efficiency | $P_{L(AV)}$ = 8 W | 39 | 43 | - | % |
| $PAR_O$ | output peak-to-average ratio | $P_{L(AV)}$ = 8 W | - | 9.4 | - | dB |
| $RL_{in}$ | input return loss | $P_{L(AV)}$ = 8 W | 8 | 23 | - | dB |
| ACPR | adjacent channel power ratio | $P_{L(AV)}$ = 8 W | - | –24 | –20 | dBc |

**Table 8. Application information**

*Mode of operation: Pulsed CW; $\delta$ = 10 %; $t_p$ = 100 μs; RF performance at $V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA; $V_{GS(amp)peak}$ = 0 V; $T_{case}$ = 25 °C; unless otherwise specified; in a production circuit.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $P_{L(3dB)}$ | output power at 3 dB gain compression | | 46 | 53 | - | W |

## 8.1 Ruggedness in Doherty operation

The BLD6G21L-50 and BLD6G21LS-50 are capable of withstanding a load mismatch corresponding to VSWR = 10 : 1 through all phases under the following conditions: $V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA; $P_L$ = 8 W (TD-SCDMA); f = 2017.5 MHz.

## 8.2 Impedance information

**Table 9. Typical impedance**

*Measured Load Pull data; typical values unless otherwise specified.*

| f | $Z_S$ | $Z_L$ |
|---|---|---|
| MHz | Ω | Ω |
| 1995 | 3.5 – 12.3j | 6.7 – 6.1j |
| 2010 | 3.6 – 12.7j | 6.7 – 6.1j |
| 2017.5 | 3.6 – 12.7j | 6.7 – 5.7j |
| 2025 | 3.7 – 12.7j | 6.4 – 5.2j |
| 2040 | 4.0 – 12.9j | 5.7 – 4.8j |

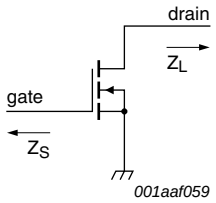
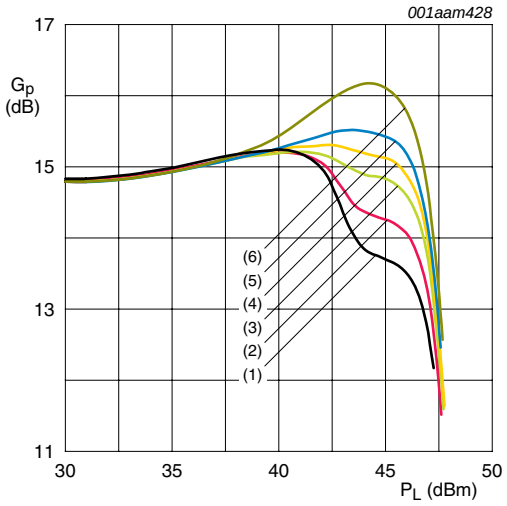



**Fig 2. Definition of transistor impedance**

## 8.3 Performance curves

Performance curves are measured in a BLD6G21L-50 application circuit.

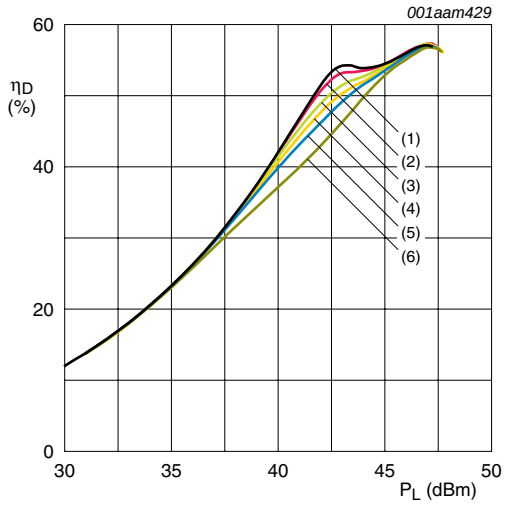
### 8.3.1 CW pulsed




$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA (main); $T_{case}$ = 25 °C; f = 2017.5 MHz; δ = 10 %; $t_p$ = 100 µs on 1 ms period.

(1) $V_{GS(amp)peak}$ = 0 V
(2) $V_{GS(amp)peak}$ = 0.2 V
(3) $V_{GS(amp)peak}$ = 0.4 V
(4) $V_{GS(amp)peak}$ = 0.5 V
(5) $V_{GS(amp)peak}$ = 0.6 V
(6) $V_{GS(amp)peak}$ = 0.8 V

**Fig 3. Power gain as a function of load power; typical values**




$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA (main); $T_{case}$ = 25 °C; f = 2017.5 MHz; δ = 10 %; $t_p$ = 100 µs on 1 ms period.

(1) $V_{GS(amp)peak}$ = 0 V
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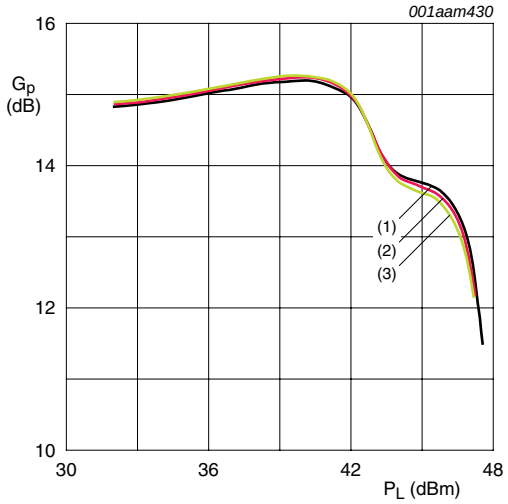
(3) $V_{GS(amp)peak}$ = 0.4 V
(4) $V_{GS(amp)peak}$ = 0.5 V
(5) $V_{GS(amp)peak}$ = 0.6 V
(6) $V_{GS(amp)peak}$ = 0.8 V

**Fig 4. Drain efficiency as a function of load power; typical values**



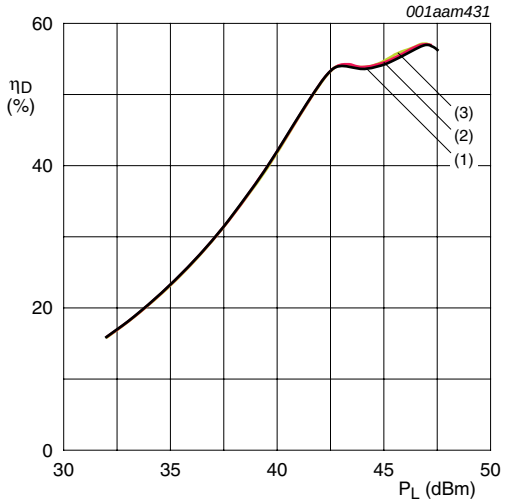

$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA (main); $T_{case}$ = 25 °C; $V_{GS(amp)peak}$ = 0 V; δ = 10 %; $t_p$ = 100 μs on 1 ms period.

(1) f = 2010 MHz

(2) f = 2018 MHz

(3) f = 2025 MHz

**Fig 5. Power gain as a function of load power; typical values**



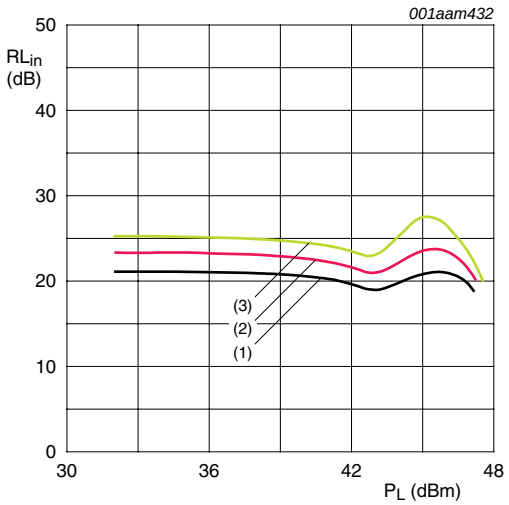

$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA (main); $T_{case}$ = 25 °C; $V_{GS(amp)peak}$ = 0 V; δ = 10 %; $t_p$ = 100 μs on 1 ms period.

(1) f = 2010 MHz

(2) f = 2018 MHz

(3) f = 2025 MHz

**Fig 6. Drain efficiency as a function of load power; typical values**




$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA; $V_{GS(amp)peak}$ = 0 V; $T_{case}$ = 25 °C; δ = 10 %; $t_p$ = 100 μs on 1 ms period.

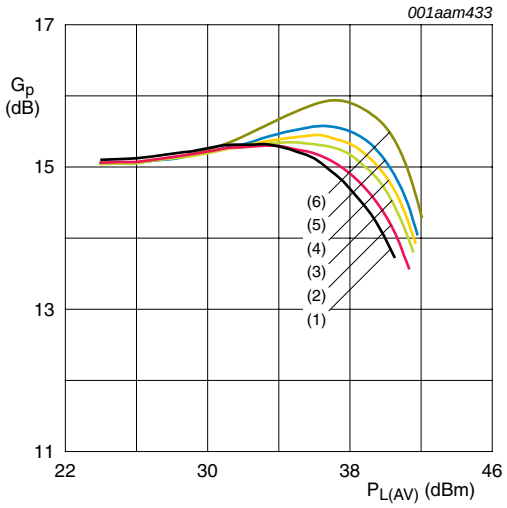
(1) f = 2010 MHz

(2) f = 2018 MHz

(3) f = 2025 MHz

**Fig 7. Input return loss as a function of load power; typical values**

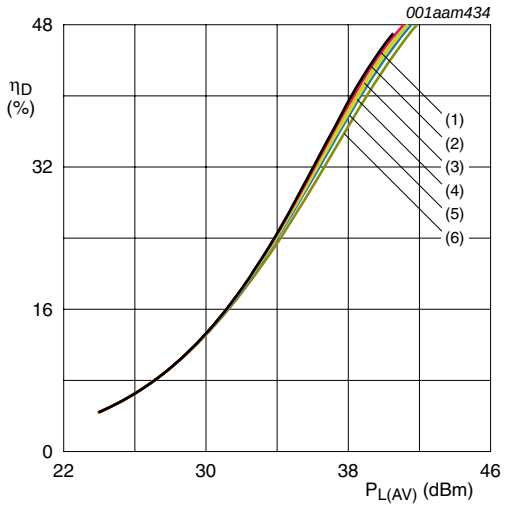
### 8.3.2 TD-SCDMA




$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA (main); $T_{case}$ = 25 °C; f = 2017.5 MHz; 6-carrier TD-SCDMA; PAR = 10.8 dB at 0.01 % probability on CCDF.

(1) $V_{GS(amp)peak}$ = 0 V
(2) $V_{GS(amp)peak}$ = 0.2 V
(3) $V_{GS(amp)peak}$ = 0.4 V
(4) $V_{GS(amp)peak}$ = 0.5 V
(5) $V_{GS(amp)peak}$ = 0.6 V
(6) $V_{GS(amp)peak}$ = 0.8 V

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




$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA (main); $T_{case}$ = 25 °C; f = 2017.5 MHz; 6-carrier TD-SCDMA; PAR = 10.8 dB at 0.01 % probability on CCDF.

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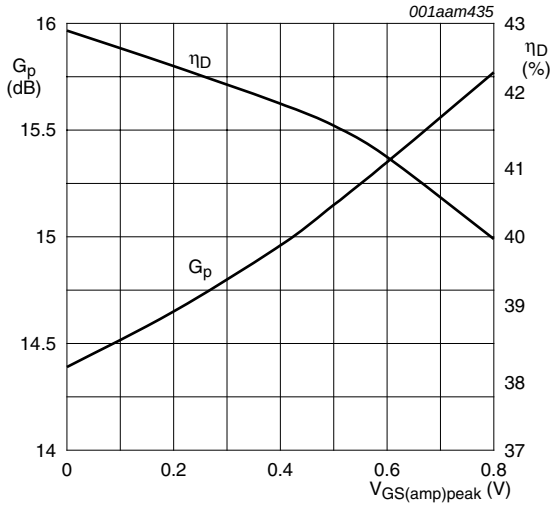
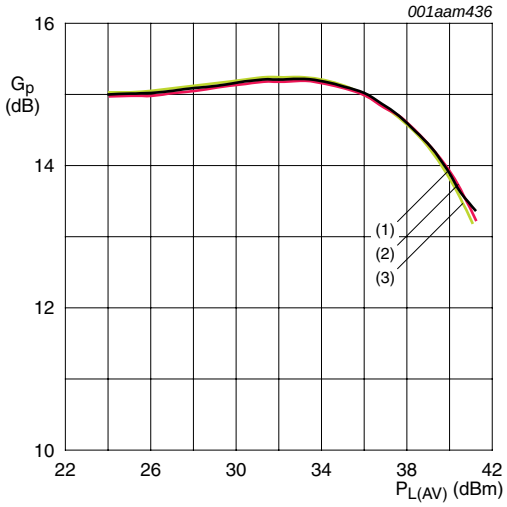
(3) $V_{GS(amp)peak}$ = 0.4 V
(4) $V_{GS(amp)peak}$ = 0.5 V
(5) $V_{GS(amp)peak}$ = 0.6 V
(6) $V_{GS(amp)peak}$ = 0.8 V

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




$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA; $P_{L(AV)}$ = 8 W; $T_{case}$ = 25 °C; f = 2017.5 MHz; 6-carrier TD-SCDMA; PAR = 10.8 dB at 0.01 % probability on CCDF.

**Fig 10. Power gain and drain efficiency as function of peak amplifier gate-source voltage; typical values**



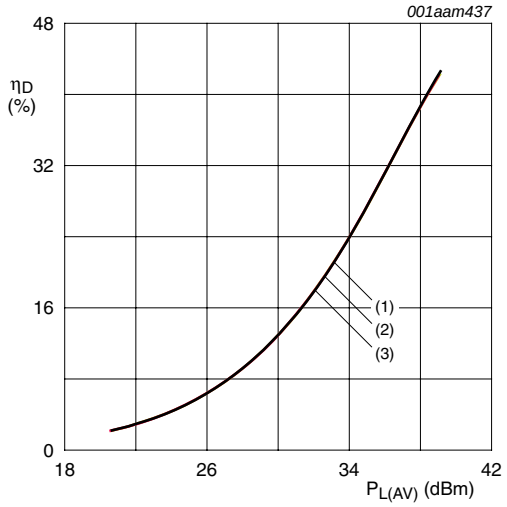

$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA (main); $T_{case}$ = 25 °C; $V_{GS(amp)peak}$ = 0 V; 6-carrier TD-SCDMA; PAR = 10.8 dB at 0.01 % probability on CCDF.

(1) f = 2010 MHz

(2) f = 2018 MHz

(3) f = 2025 MHz

**Fig 11. Power gain as a function of average load power; typical values**




$V_{DS}$ = 28 V; $I_{Dq}$ = 170 mA (main); $T_{case}$ = 25 °C; $V_{GS(amp)peak}$ = 0 V; 6-carrier TD-SCDMA; PAR = 10.8 dB at 0.01 % probability on CCDF.

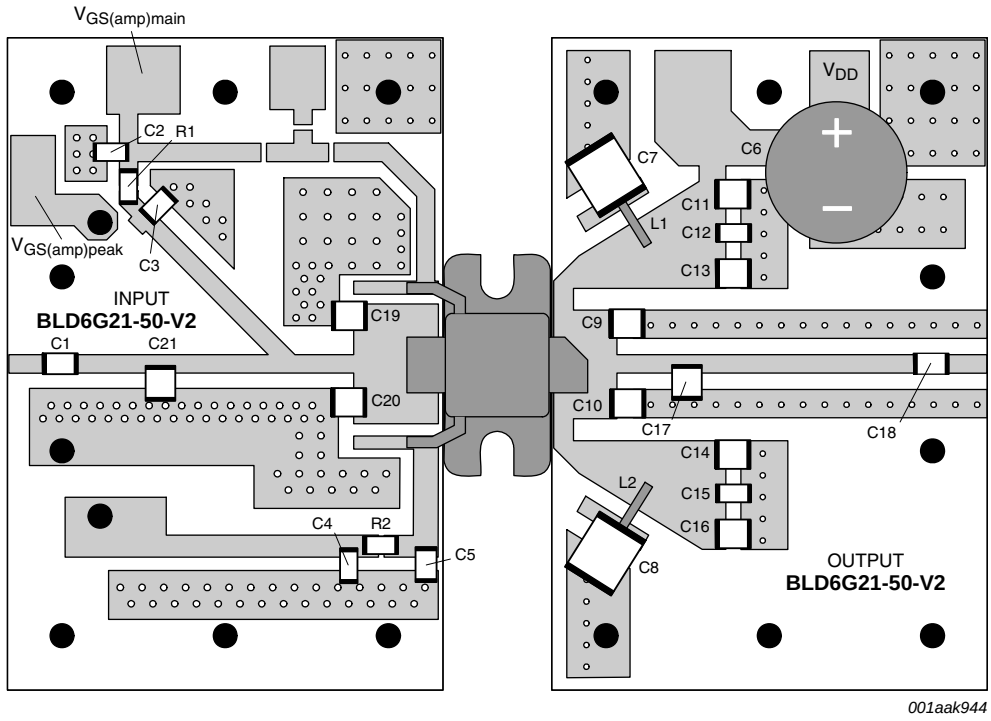
(1) f = 2010 MHz

(2) f = 2018 MHz

(3) f = 2025 MHz

**Fig 12. Drain efficiency as a function of average load power; typical values**

# 9. Test information




The striplines are on a double copper-clad gold plated Rogers 4350B Printed-Circuit Board (PCB) with $\varepsilon_r$ = 3.5 and thickness = 0.76 mm.

See Table 10 for list of components.

**Fig 13. Component layout**

**Table 10. List of components**

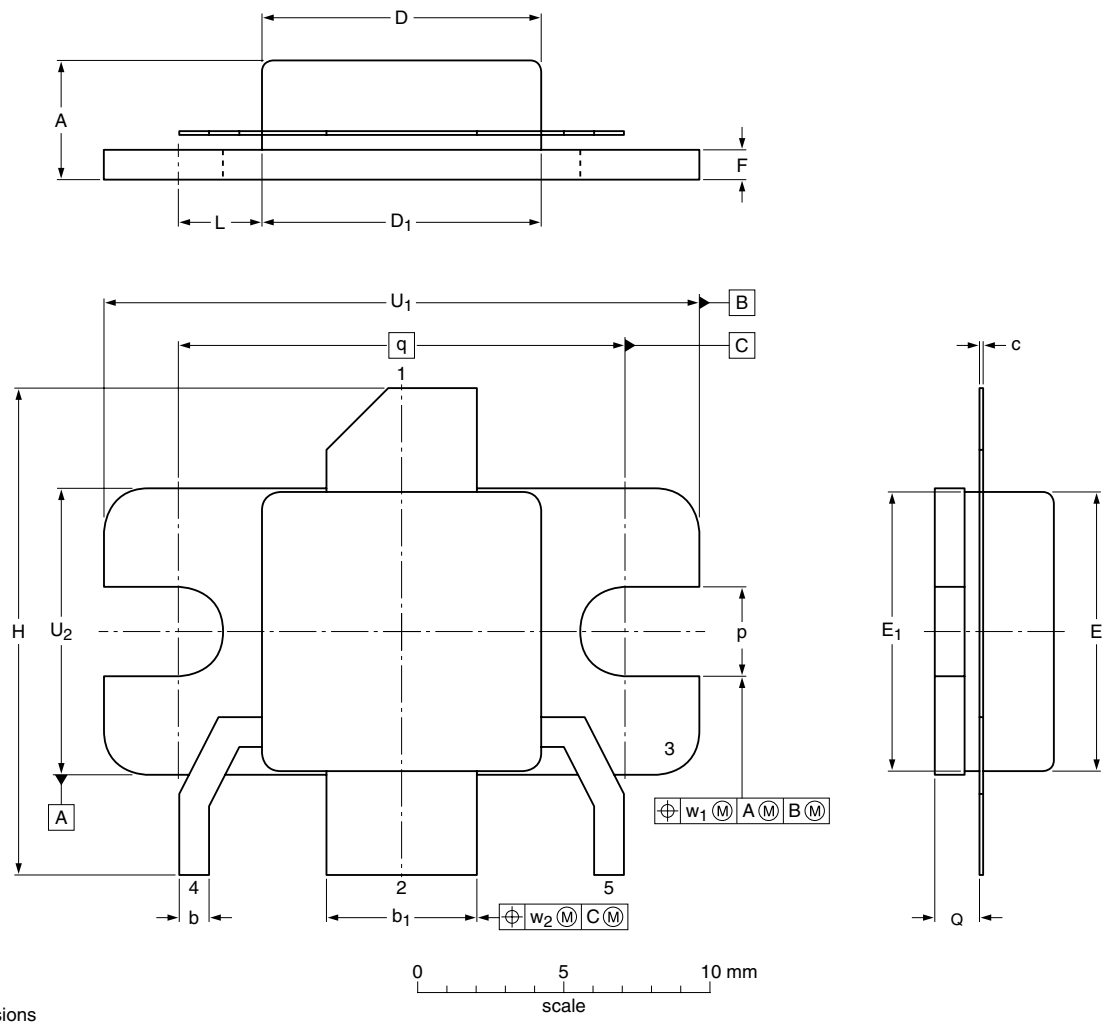
*See Figure 13 for component layout.*

| Component | Description | Value | | Dimensions |
|---|---|---|---|---|
| C1, C3, C5, C18 | multilayer ceramic chip capacitor | 9.1 pF | [1] | |
| C2, C4, C12, C15 | multilayer ceramic chip capacitor | 100 nF | | |
| C6 | electrolytic capacitor | 470 μF; 63 V | | |
| C7, C8 | multilayer ceramic chip capacitor | 10 μF | | |
| C9, C10 | multilayer ceramic chip capacitor | 1.5 pF | [1] | |
| C11, C13, C14, C16 | multilayer ceramic chip capacitor | 8.2 pF | [1] | |
| C17 | multilayer ceramic chip capacitor | 1.2 pF | [1] | |
| C19, C20 | multilayer ceramic chip capacitor | 0.7 pF | [1] | |
| C21 | multilayer ceramic chip capacitor | 1.2 pF | [1] | |
| L1, L2 | copper wire | - | | diameter = 0.8 mm; length = 8 mm |
| R1 | SMD resistor | 3.6 Ω | | 1206 |
| R2 | SMD resistor | 33 Ω | | 1206 |

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

## 10. Package outline

**Flanged ceramic package; 2 mounting holes; 4 leads** **SOT1130A**




Dimensions

| Unit[1] | | A | b | $b_1$ | c | D | $D_1$ | E | $E_1$ | F | H | L | p | Q[2] | q | $U_1$ | $U_2$ | $w_1$ | $w_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 4.65 | 1.14 | 5.26 | 0.18 | 9.65 | 9.65 | 9.65 | 9.65 | 1.14 | 17.12 | 3.00 | 3.30 | 1.70 | | 20.45 | 9.91 | | |
| | nom | | | | | | | | | | | | | | 15.24 | | | 0.25 | 0.51 |
| | min | 3.76 | 0.89 | 5.00 | 0.10 | 9.40 | 9.40 | 9.40 | 9.40 | 0.89 | 16.10 | 2.69 | 2.92 | 1.45 | | 20.19 | 9.65 | | |
| inches | max | 0.183 | 0.045 | 0.207 | 0.007 | 0.38 | 0.38 | 0.38 | 0.38 | 0.045 | 0.674 | 0.118 | 0.130 | 0.067 | | 0.805 | 0.39 | | |
| | nom | | | | | | | | | | | | | | 0.6 | | | 0.01 | 0.02 |
| | min | 0.148 | 0.035 | 0.197 | 0.004 | 0.37 | 0.37 | 0.37 | 0.37 | 0.035 | 0.634 | 0.106 | 0.115 | 0.057 | | 0.795 | 0.38 | | |

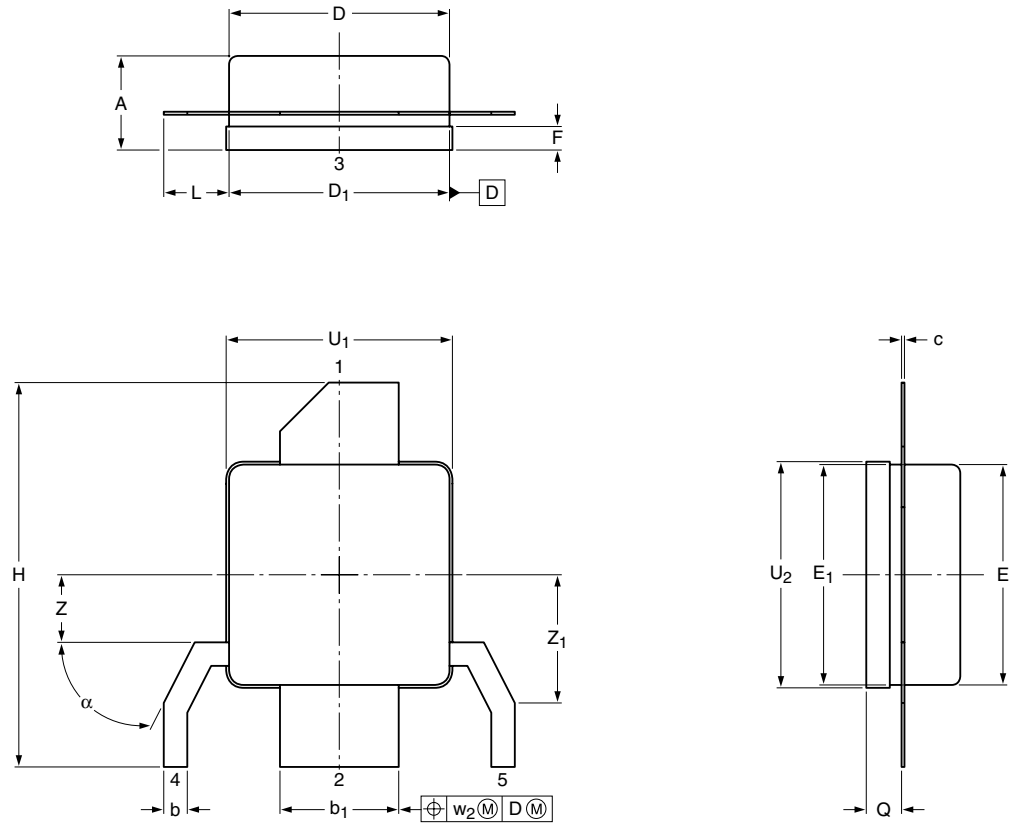
Note
1. millimeter dimensions are derived from the original inch dimensions.
2. dimension is measured 0.030 inch (0.76 mm) from the body.

*sot1130a_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT1130A | | | | | | ~~09-10-12~~ 10-02-02 |

**Fig 14. Package outline SOT1130A**

**Earless flanged ceramic package; 4 leads** **SOT1130B**




Dimensions

| Unit[1] | | A | b | $b_1$ | c | D | $D_1$ | E | $E_1$ | F | H | L | Q | $U_1$ | $U_2$ | $w_2$ | Z | $Z_1$ | α |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 4.65 | 1.14 | 5.26 | 0.18 | 9.65 | 9.65 | 9.65 | 9.65 | 1.14 | 17.12 | 3.00 | 1.70 | 9.91 | 9.91 | | 3.05 | 5.66 | 64° |
| | nom | | | | | | | | | | | | | | | 0.51 | | | |
| | min | 3.76 | 0.89 | 5.00 | 0.10 | 9.40 | 9.40 | 9.40 | 9.40 | 0.89 | 16.10 | 2.69 | 1.45 | 9.65 | 9.65 | | 2.79 | 5.41 | 62° |
| inches | max | 0.183 | 0.045 | 0.207 | 0.007 | 0.38 | 0.38 | 0.38 | 0.38 | 0.045 | 0.674 | 0.118 | 0.069 | 0.39 | 0.39 | | 0.120 | 0.223 | 64° |
| | nom | | | | | | | | | | | | | | | 0.02 | | | |
| | min | 0.148 | 0.035 | 0.197 | 0.004 | 0.37 | 0.37 | 0.37 | 0.37 | 0.035 | 0.634 | 0.106 | 0.059 | 0.38 | 0.38 | | 0.110 | 0.213 | 62° |

Note
1. millimeter dimensions are derived from the original inch dimensions.
2. dimension is measured 0.030 inch (0.76 mm) from the body.

*sot1130b_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT1130B | | | | | | ~~09-10-12~~ 09-12-14 |

**Fig 15. Package outline SOT1130B**

## 11. Abbreviations

Table 11. Abbreviations

| Acronym | Description |
|---|---|
| CCDF | Complementary Cumulative Distribution Function |
| CW | Continuous Wave |
| LDMOS | Laterally Diffused Metal-Oxide Semiconductor |
| PAR | Peak-to-Average power Ratio |
| RF | Radio Frequency |
| SMD | Surface Mounted Device |
| TD-SCDMA | Time Division-Synchronous Code Division Multiple Access |
| VSWR | Voltage Standing-Wave Ratio |

## 12. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| BLD6G21L-50_BLD6G21LS-50 v.2 | 20100817 | Product data sheet | - | BLD6G21L-50_ BLD6G21LS-50 v.1 |
| Modifications: | • Figure 1 on page 3: Some corrections have been made.<br>• Table 5 on page 3: The typical value of $R_{th(j\text{-}case)}$ has been changed.<br>• Table 6 on page 3: The values of $I_{DSX}$ have been changed.<br>• Table 7 on page 4: Several values have been changed or added.<br>• Table 8 on page 4: Table has been added.<br>• Section 8.3 on page 5: Figures have been updated. | | | |
| BLD6G21L-50_BLD6G21LS-50 v.1 | 20091028 | 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.nxp.com.

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**Date of release: 17 August 2010**

**Document identifier: BLD6G21L-50_BLD6G21LS-50**