# LD59030

Datasheet

## 300 mA very low dropout linear regulator IC

DFN4 1x1

| Maturity status link |
| --- |
| LD59030 |

## Features

- Input voltage from 1.5 to 5.5 V
- Ultra low dropout voltage (135 mV typ. at 300 mA load)
- Very low quiescent current (28 µA typ. at no load, 0.03 µA typ. in off mode)
- Internal current fold-back
- Output voltage tolerance: ± 1 % @ 25 °C
- 300 mA guaranteed output current
- High PSRR: 75 dB@1 kHz
- Wide range of output voltages available on request: from 0.8 V up to 5.0 V in 50 mV step
- Logic-controlled electronic shutdown
- Internal soft-start
- Optional output voltage discharge feature
- Compatible with ceramic capacitor $C_{OUT}$ = 0.47 µF
- Thermal protection
- Available in DFN4 1x1
- Operating temperature range: -40 °C to 125 °C

## Description

The LD59030 high accuracy voltage regulator provides 300 mA of maximum current from an input voltage ranging from 1.5 V to 5.5 V, with a typical dropout voltage of 135 mV at $V_{OUT}$ = 3.3 V.

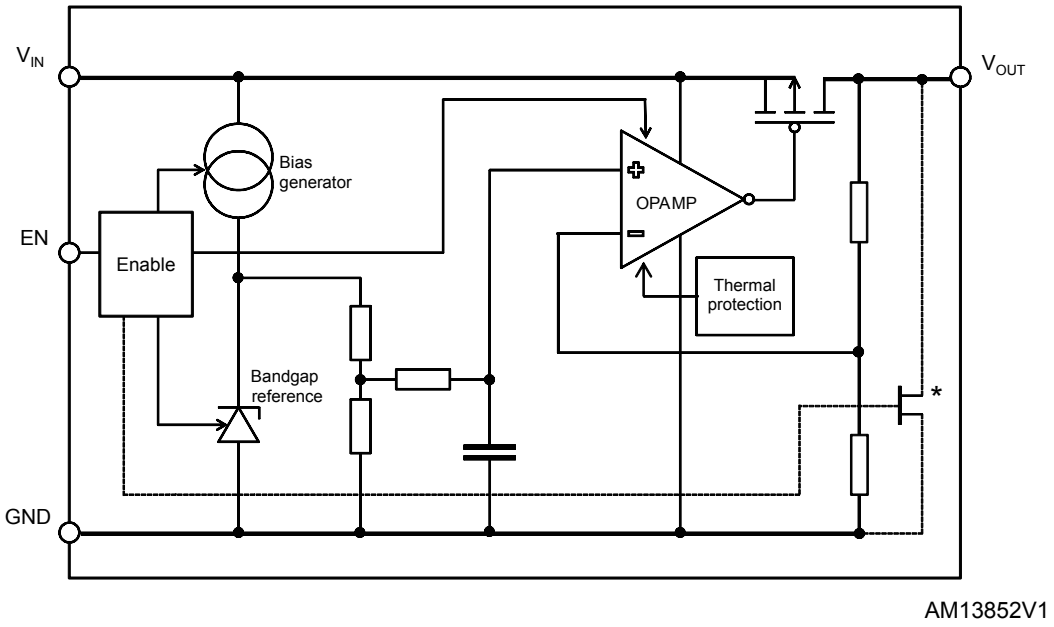
It is available in DFN4 1x1 package, allowing the maximum space saving.

The device works with a ceramic capacitor on the output. The ultra-low drop voltage, low quiescent current and low noise features, together with the internal soft-start circuit and output current fold-back protection, make the LD59030 suitable for low power battery-operated applications.

An enable logic control function puts the LD59030 in shutdown mode allowing a total current consumption lower than 0.03 µA.

# 1 Diagram

**Figure 1. Block diagram**

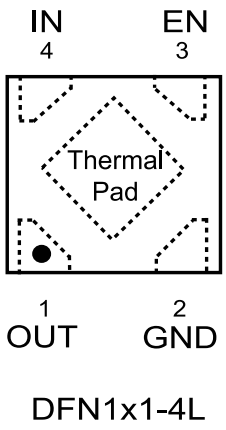



AM13852V1

*Note: The output discharge MOSFET is optional.*

# 2 Pin configuration

Figure 2. **Pin connection (top view)**



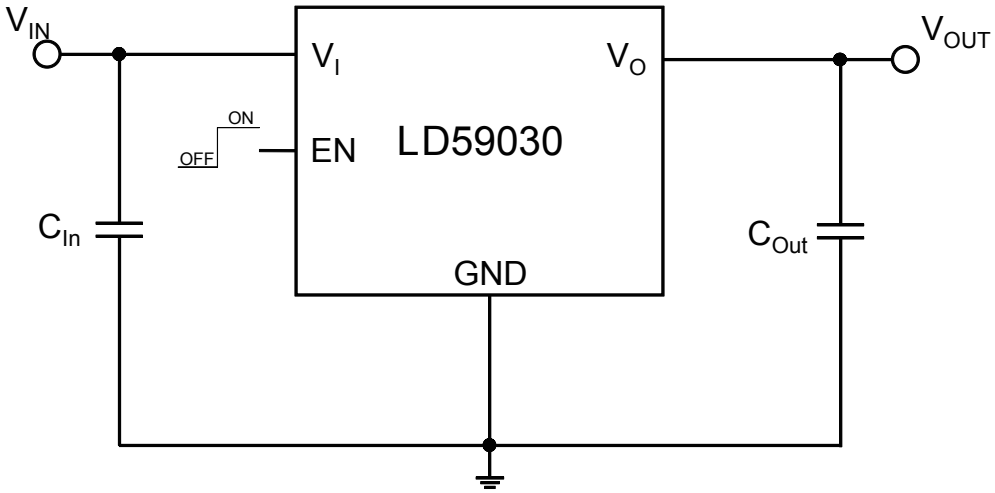

DFN1x1-4L

Table 1. **Pin description**

| Pin n° DFN4 1x1 | Symbol | Function |
|---|---|---|
| 1 | OUT | Output voltage |
| 2 | GND | Common ground |
| 3 | EN | Enable pin logic input: Low = shutdown, High = active |
| 4 | IN | Input voltage |
| Thermal pad | - | Connect to GND or floating |

# 3 Typical application

Figure 3. **Typical application circuit**



# 4 Maximum ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{IN}$ | Input voltage | - 0.3 to 7 | V |
| $V_{OUT}$ | Output voltage | - 0.3 to $V_{IN}$ + 0.3 | V |
| $V_{EN}$ | Enable input voltage | - 0.3 to 7 | V |
| $I_{OUT}$ | Output current | Internally limited | mA |
| $P_D$ | Power dissipation | Internally limited | mW |
| $T_{STG}$ | Storage temperature range | - 40 to 150 | °C |
| $T_{OP}$ | Operating junction temperature range | - 40 to 125 | °C |

*Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. All values are referred to GND.*

**Table 3. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJA}$ | Thermal resistance junction-ambient | 140 | °C/W |

**Table 4. ESD Performance**

| Symbol | Parameter | Test conditions | Value | Unit |
|---|---|---|---|---|
| ESD | ESD Protection voltage | HBM | 2 | kV |
| | | CDM | 500 | V |

# 5 Electrical characteristics

$T_J$ = 25 °C, $V_{IN}$ = $V_{OUT(NOM)}$ + 1 V , $C_{IN}$ = $C_{OUT}$ = 1 µF, $I_{OUT}$ = 1 mA, $V_{EN}$ = $V_{IN}$, unless otherwise specified.

**Table 5. Electrical characteristics**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{IN}$ | Operating input voltage | | 1.5 | | 5.5 | V |
| $V_{OUT}$ | $V_{OUT}$ accuracy | $I_{OUT}$ = 1 mA, $T_J$ = 25 °C | -1 | | 1 | % |
| | | $I_{OUT}$ = 1 mA, -40 °C < $T_J$ < 85 °C | -2 | | 2 | % |
| $\Delta V_{OUT}$ | Static line regulation (1) | $V_{OUT(NOM)}$ + 1 V ≤ $V_{IN}$ ≤ 5.5 V, $I_{OUT}$ = 10 mA | | 0.015 | | %/V |
| | | -40 °C < $T_J$ < 85 °C | | | 0.05 | |
| $\Delta V_{OUT}$ | Static load regulation | $I_{OUT}$ = 0 mA to 300 mA | | -20 | | mV |
| | | $I_{OUT}$ = 0 mA to 300 mA -40 °C < $T_J$ < 85 °C | | -0.004 | -0.01 | %/mA |
| $V_{DROP}$ | Dropout voltage | $I_{OUT}$ = 30 mA,$V_{OUT}$ = 2.8 V | | 20 | | mV |
| | | $I_{OUT}$ = 300 mA, $V_{OUT}$ = 2.8 V -40 °C < $T_J$ < 85 °C | | 155 | 230 | |
| $e_N$ | Output noise voltage | 10 Hz to 100 kHz, $I_{OUT}$ = 10 mA, $V_{OUT}$ = 1.8 V | | 70 | | $\mu V_{RMS}$ |
| SVR | Supply voltage rejection | $V_{IN}$ = $V_{OUT(NOM)}$+ 1 V +/- $V_{RIPPLE}$ $V_{RIPPLE}$ = 0.2 V Freq .=1 kHz $I_{OUT}$ = 30 mA | | 75 | | dB |
| | | $V_{IN}$ = $V_{OUT(NOM)}$+ 1 V +/- $V_{RIPPLE}$ $V_{RIPPLE}$ = 0.2 V Freq. = 100 kHz $I_{OUT}$ = 30 mA | | 55 | | |
| $I_Q$ | Quiescent current | $I_{OUT}$ = 0 mA | | 28 | 40 | µA |
| | | $I_{OUT}$ = 300 mA | | 305 | | |
| $I_{Standby}$ | Standby current | $V_{IN}$ input current in OFF MODE: $V_{EN}$ = GND | | 0.03 | 1 | µA |
| $I_{LIM}$ | Current limit | $V_{OUT}$ = 0.9 x $V_{OUT(NOM)}$ | | 500 | | mA |
| $I_{SC}$ | Short circuit current | $V_{OUT}$ = 0 (foldback protection) | 120 | 170 | | mA |
| $R_{ON}$ | Output voltage discharge MOSFET | (LD59030DT version) $I_{OUT}$ = 1 mA | | 120 | | Ω |
| $V_{EN}$ | Enable input logic low | $V_{IN}$ = 1.5 V to 5.5 V -40 °C < $T_J$ < 85 °C | | | 0.4 | V |
| | Enable input logic high | $V_{IN}$ = 1.5 V to 5.5 V -40 °C < $T_J$ < 85 °C | 1 | | | |
| $I_{EN}$ | Enable pin input current | $V_{EN}$ = $V_{IN}$ | | | 100 | nA |
| $T_{ON}$ (2) | Turn on time | | | 145 | | µs |
| $T_{SHDN}$ | Thermal shutdown | | | 160 | | °C |
| | Hysteresis | | | 20 | | |

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{OUT}$ | Output capacitor | Capacitance (see Figure 15. Stability area vs. ($C_{OUT}$, ESR)) | 0.47 | | 22 | µF |

1. *Not applicable for $V_{OUT(NOM)}$ > 4.5 V*
2. *Turn-on time is time measured between the enable input just exceeding VEN high value and the output voltage just reaching 95 % of its nominal value*

# 6 Application information

## 6.1 Soft-start function

The LD59030 has an internal soft start circuit. By increasing the startup time up to 145 µs, without the need of any external soft start capacitor, this feature is able to keep the regulator inrush current at startup under control.

## 6.2 Output discharge function

The LD59030 integrates a MOSFET connected between $V_{OUT}$ and GND. This transistor is activated when the EN pin goes to low logic level and has the function to quickly discharge the output capacitor when the device is disabled by the user.

The device is available with or without auto-discharge feature.

See Section 9 Ordering information for more details.

## 6.3 Dropout voltage

**Table 6. Dropout voltage at $I_{OUT}$ = 300 mA**

| Output voltage [V] | Typical value [mV] $T_J$ = 25°C | Max value [mV] -40 °C < $T_J$ < 85 °C |
|---|---|---|
| 1.05 | 400 | 550 |
| 1.2 | 330 | 490 |
| 1.5 | 260 | 390 |
| 1.8 | 180 (1) | 210 (1) |
| 2.5 | 165 | 253 |
| 2.8 | 155 | 230 |
| 3.0 | 145 | 220 |
| 3.1 | 140 | 210 |
| 3.3 | 135 | 200 |

1. *Measured value.*

## 6.4 Input and output capacitors

The LD59030 requires external capacitors to assure the regulator control loop stability.

Any good quality ceramic capacitor can be used but, the X5R and the X7R are suggested since they guarantee a very stable combination of capacitance and ESR over the whole temperature range.

Locating the input/output capacitors as close as possible to the relative pins is recommended.

The LD59030 requires an input capacitor with a minimum value of 1 µF. This capacitor must be located as close as possible to the input pin of the device and returned to a clean analog ground.

The control loop of the LD59030 is designed to work with an output ceramic capacitor.

This capacitor must meet the requirements of minimum capacitance and equivalent series resistance (ESR), as shown in Figure 15. Stability area vs. ($C_{OUT}$, ESR). To assure stability, the output capacitor must maintain its ESR and capacitance in the stable region, over the full operating temperature range.

In order to keep stability in all operating conditions (temperature, input voltage and load variations), a minimum output capacitor of 0.47 µF is recommended.

The suggested combination of 1 µF input and output capacitors offers a good compromise among the stability of the regulator, optimum transient response and total PCB area occupation.

# 7 Typical characteristics

($C_{IN}$ = $C_{OUT}$ = 1 µF, $V_{EN}$ to $V_{IN}$, $T_J$ = 25°C unless otherwise specified)

**Figure 4. Output voltage vs. temperature ($V_{OUT}$ = 1.8 V; $I_{OUT}$ = 1 mA)**

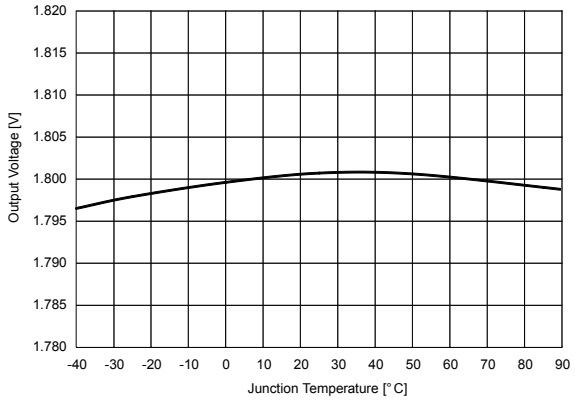



**Figure 5. Output voltage vs. temperature ($V_{OUT}$ = 1.8 V; $I_{OUT}$ = 300 mA)**

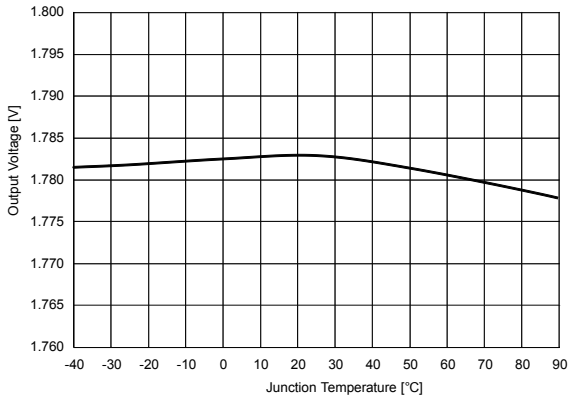



**Figure 6. Line regulation vs. temperature ($V_{IN}$ = 2.8 V to 5.5 V; $V_{OUT}$ = 1.8 V; $I_{OUT}$ = 10 mA)**

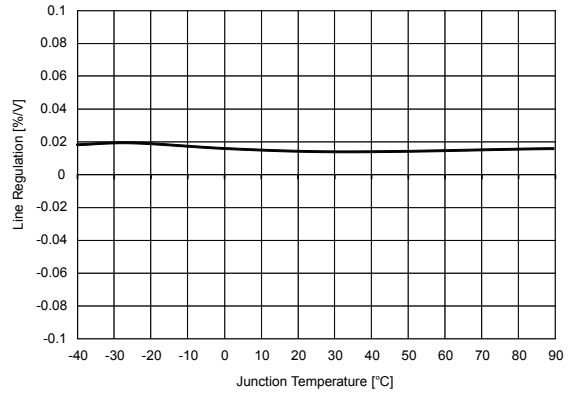



**Figure 7. Load regulation vs. temperature ($V_{OUT}$ = 1.8 V; $I_{OUT}$ = 0 to 300 mA)**

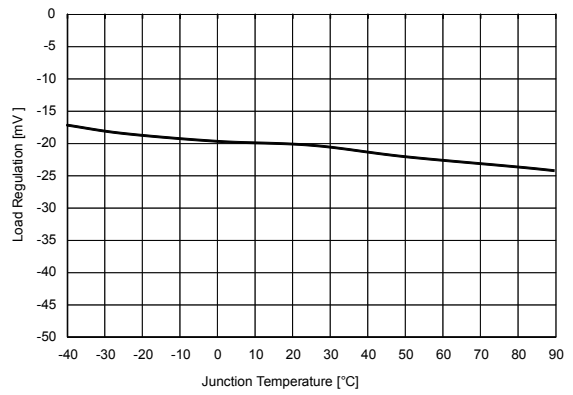


**Figure 8. Quiescent current vs. temperature ($I_{OUT}$ = 0 mA)**

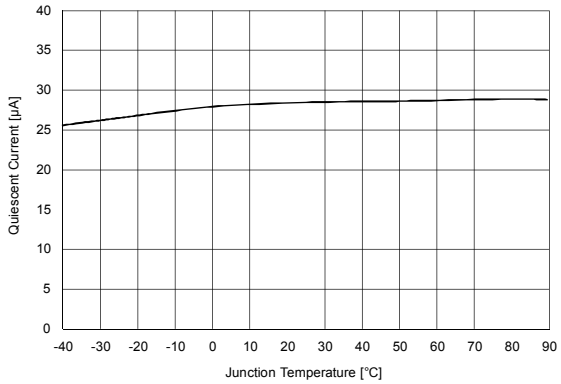



**Figure 9. Quiescent current vs. temperature ($I_{OUT}$ = 300 mA)**

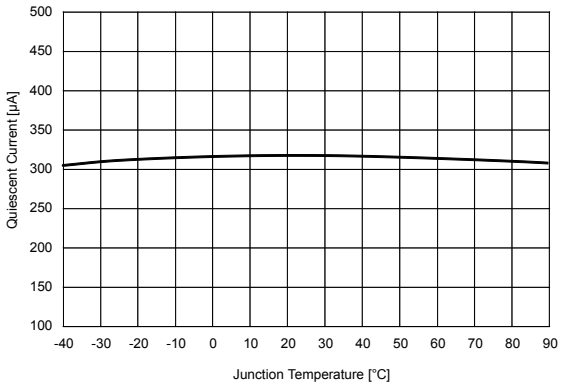



**Figure 10. Shutdown current vs. temperature**

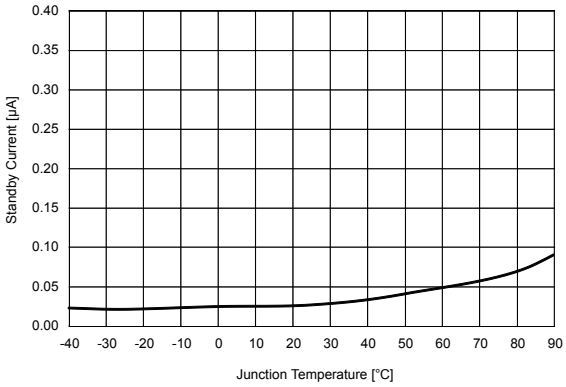



**Figure 11. Dropout voltage vs. load current**

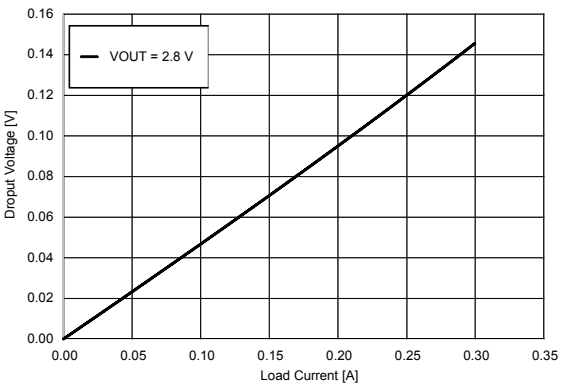



**Figure 12. Quiescent current vs. output current ($V_{IN}$ = 2.8 V; $V_{OUT}$ = 1.8 V)**

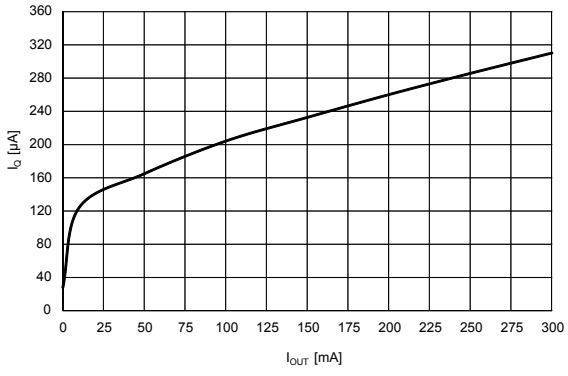



**Figure 13. Dropout voltage vs. temperature ($V_{OUT}$ = 1.8 V; $I_{OUT}$ = 300 mA)**

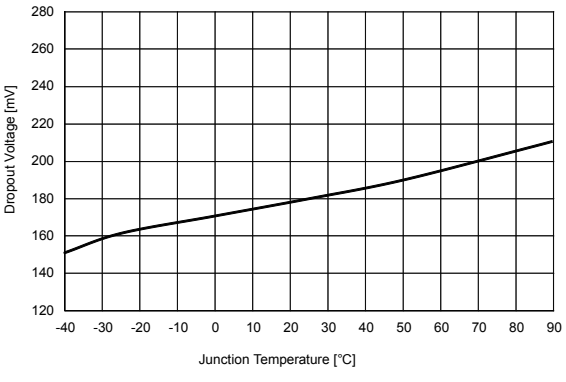


**Figure 14. Supply voltage rejection vs. frequency**

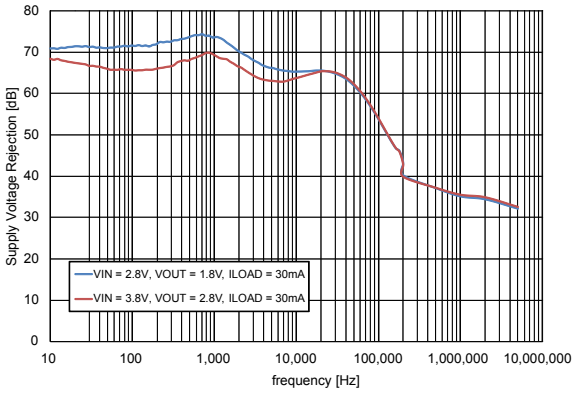



**Figure 15. Stability area vs. ($C_{OUT}$, ESR)**

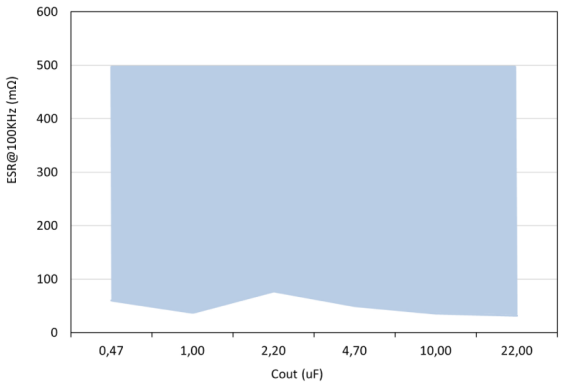



**Figure 16. Output noise spectral density ($V_{OUT}$ = 1.8 V)**

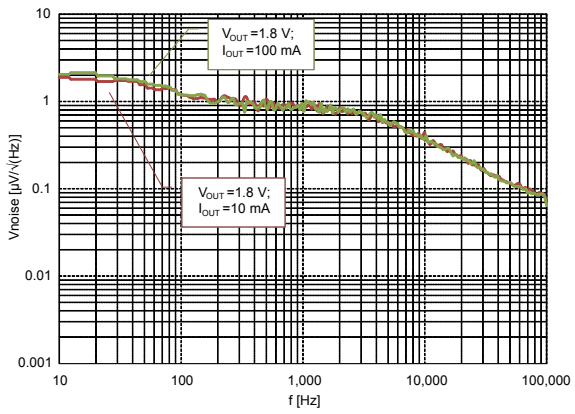



**Figure 17. Output noise spectral density ($V_{OUT}$ = 2.8 V)**

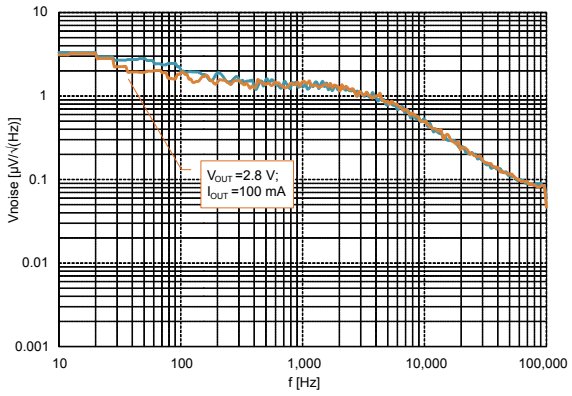


**Figure 18.** Turn-on Time ($V_{OUT}$ = 1.8 V; $I_{OUT}$ = 0 A, $V_{IN}$ = 2.8 V, $t_r = t_f$ = 1 µs)

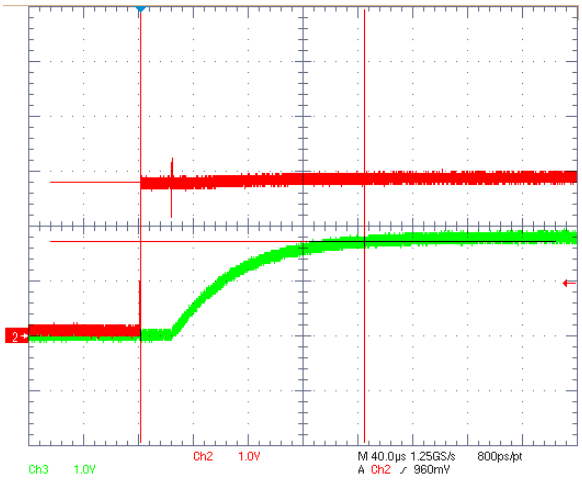



**Figure 19.** Line transient ($V_{OUT}$ = 1.8 V; $I_{OUT}$ = 10 mA, $t_r = t_f$ = 1 µs)

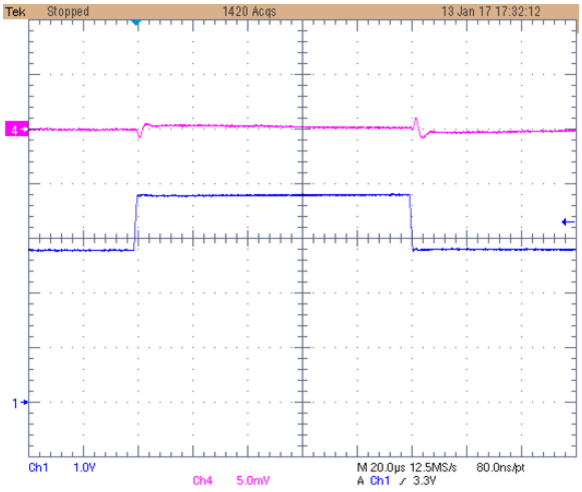



**Figure 20.** Output voltage vs. input voltage

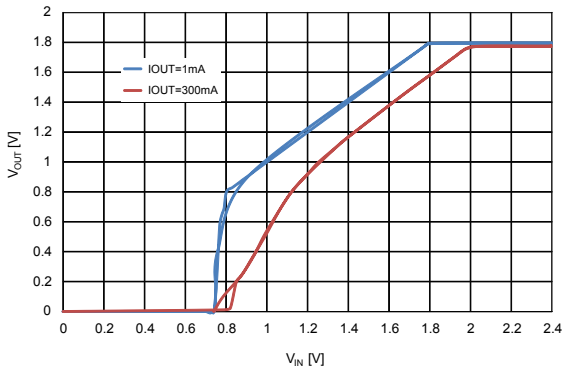
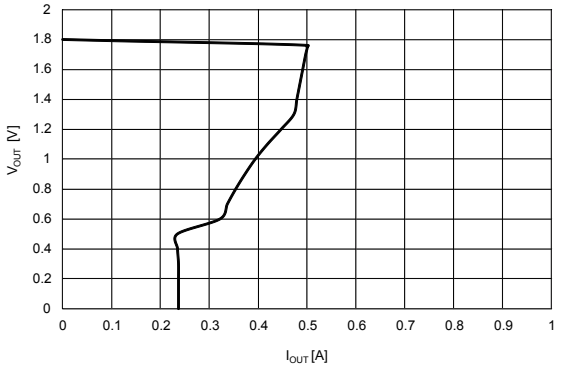



**Figure 21.** Output voltage vs. output current



# 8 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

## 8.1 DFN4 1x1 package info

Figure 22. **DFN4 1x1 package outline**

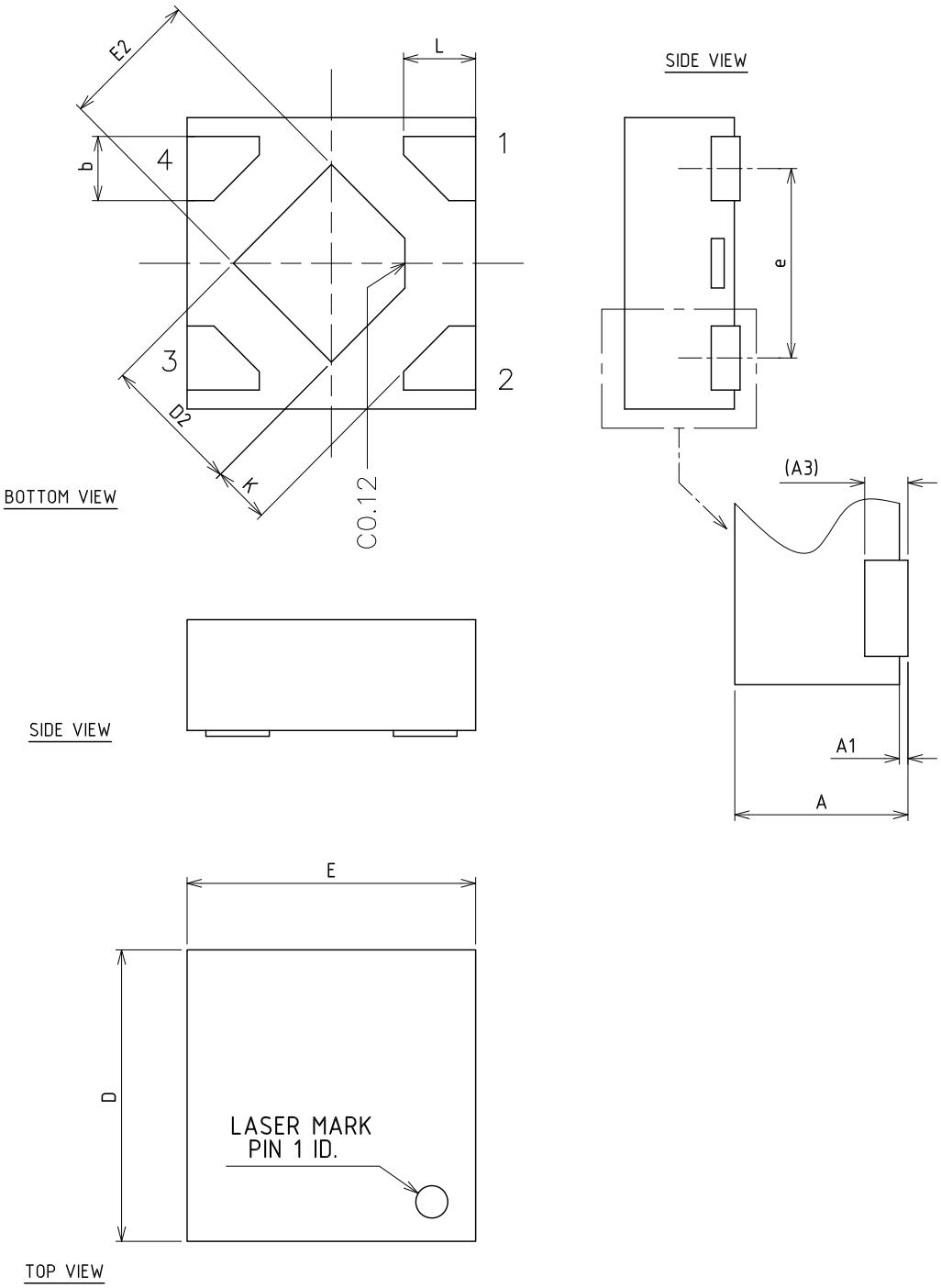



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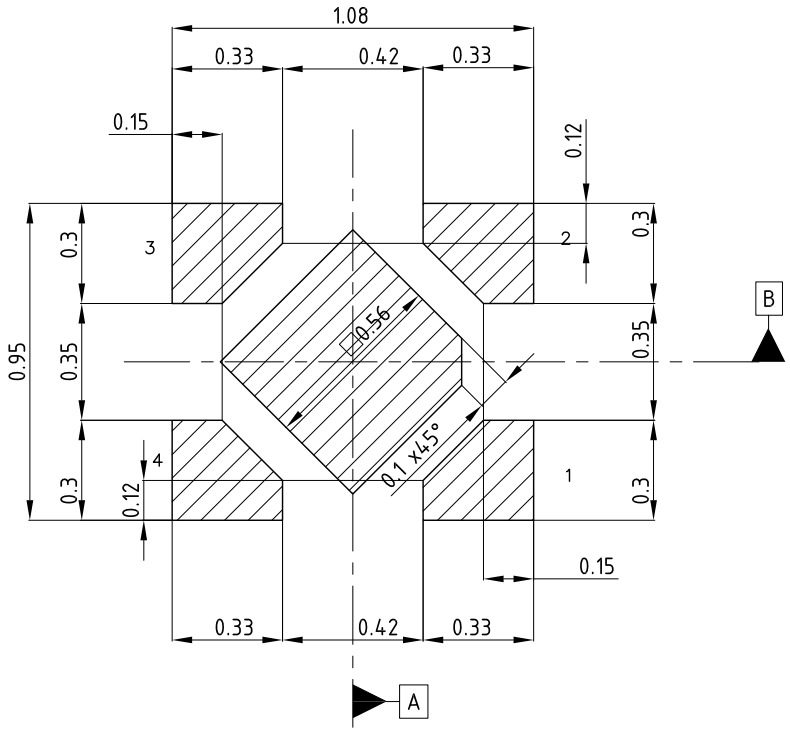
Table 7. **DFN4 1x1 mechanical data**

| Dim. | mm. | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 0.34 | 0.37 | 0.40 |
| A1 | 0 | 0.02 | 0.05 |
| A3 | | 0.10 | |
| b | 0.17 | 0.22 | 0.27 |
| D | 0.95 | 1.00 | 1.05 |
| D2 | 0.43 | 0.48 | 0.53 |
| E | 0.95 | 1.00 | 1.05 |
| E2 | 0.43 | 0.48 | 0.53 |
| e | | 0.65 | |
| L | 0.20 | 0.25 | 0.30 |
| K | 0.15 | | |

**Figure 23. DFN4 1x1 recommended footprint**




Notes:

1) This footprint is able to ensure insulation up to 10 Vrms (according to CEI IEC 664-1)

2) The device must be positioned within ⌖ 0.02 A B

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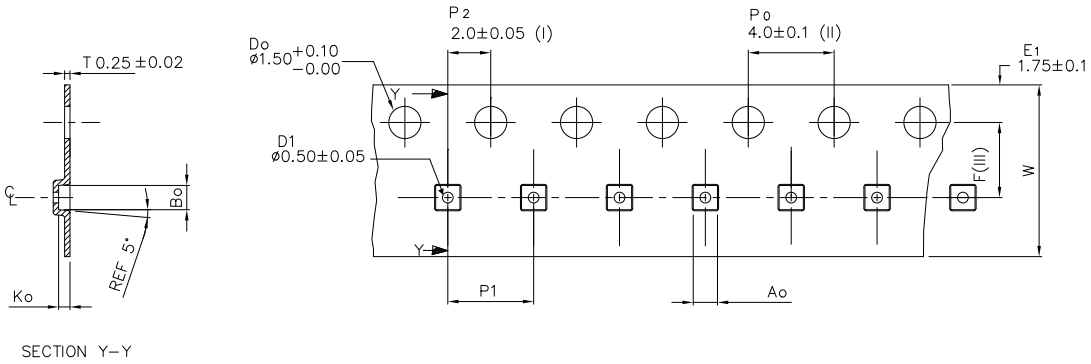
## 8.2 DFN4 1x1 packing information

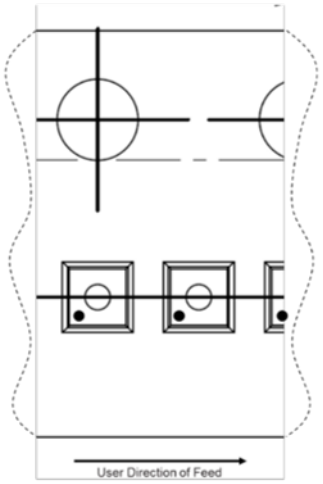
Figure 24. **Tape dimensions**




| | |
|---|---|
| Ao | 1.13 +/−0.05 |
| Bo | 1.13 +/−0.05 |
| Ko | 0.53 +/−0.05 |
| F | 3.50 +/−0.05 |
| P1 | 4.00 +/−0.10 |
| W | 8.00 +0.3/−0.1 |

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.
(V) Typical SR of form tape Max. $10^9$ OHM/SR

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.



# 9 Ordering information

Table 8. **Order code**

| Order code | Output voltage (V) | Auto-discharge | Marking |
|---|---|---|---|
| LD59030DTPU105R | 1.05 | Yes | JQ |
| LD59030TPU105R | | No | KQ |
| LD59030DTPU12R | 1.2 | Yes | J5 |
| LD59030TPU12R | | No | K5 |
| LD59030DTPU18R | 1.8 | Yes | J7 |
| LD59030TPU18R | | No | K7 |
| LD59030DTPU25R | 2.5 | Yes | JA |
| LD59030TPU25R | | No | KA |
| LD59030DTPU28R | 2.8 | Yes | JC |
| LD59030TPU28R | | No | KC |
| LD59030DTPU30R | 3.0 | Yes | JF |
| LD59030TPU30R | | No | KF |
| LD59030DTPU33R | 3.3 | Yes | JJ |
| LD59030TPU33R | | No | KJ |

## Revision history

Table 9. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 28-Aug-2017 | 1 | Initial release. |
| 03-Nov-2017 | 2 | Datasheet promoted from preliminary data to datasheet. Update Figure 15: "Stability area vs. (COUT, ESR)". |
| 01-Jun-2018 | 3 | Updated: Figure 24. Tape dimensions. |
| 31-Jul-2018 | 4 | Updated: output voltage in Table 6. Dropout voltage at $I_{OUT}$ = 300 mA. |

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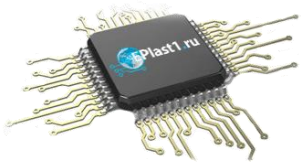


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