

## Up to 1 A switching regulator with adjustable current limit

### Features

- Up to 1 A output current
- Operating input voltage from 8 V to 36 V
- Precise 3.3 V ( $\pm 2\%$ ) reference voltage
- 5 % output current accuracy
- Output voltage adjustable from 1.235 V to 34 V
- 250 kHz internally fixed frequency
- Voltage feedforward
- Zero load current operation
- Adjustable current limit
- Protection against feedback Disconnection
- Thermal shutdown

### Applications

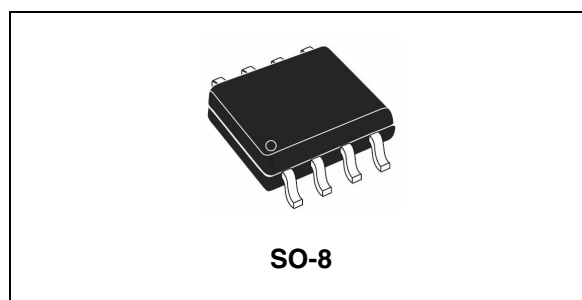
- Chargers for NiCd, NiMH batteries and preregulator for lithium-ion batteries
- Adjustable current generator
- Simple step-down converters with adjustable current limit
- Battery equipped systems
- Distributed power supply
- Mobile PC and subnotebook

### Description

The L6902D is a complete and simple step down switching regulator with adjustable current limit.

Based on a voltage mode structure it integrates a current error amplifier to have a constant voltage and constant current control.

By means of an on board current sense resistor and the availability of the current sense pins (both compatible to Vcc and for Cs- compatible with GND too) a current limit programming is very simple and accurate ( $\pm 5\%$ ). Moreover constant



current control can be used to charge NiMH and NiCd batteries.

The device can be used as a standard DC/DC converter with adjustable current limit (set by using the external sense resistor).

The internal robust P-channel DMOS transistor with a typical of 250 m $\Omega$  assures high efficiency and a minimum dropout even at high output current level. The internal limiting current (latched function) of typical value of 2.5 A protects the device from accidental output short circuit avoiding dangerous loads damage.

If the temperature of the chip goes higher than a fixed internal threshold (150°C with 20°C hysteresis), the power stage is turned off.

Other protections beside thermal shutdown complete the device for a safe and reliable application: overvoltage protection, frequency folback overcurrent protection and protection vs. feedback disconnection.

The internal fixed switching frequency of 250KHz, and the SO-8 package pin allow to built an ultra compact DC/ DC converter with a minimum board space.

**Table 1. Device summary**

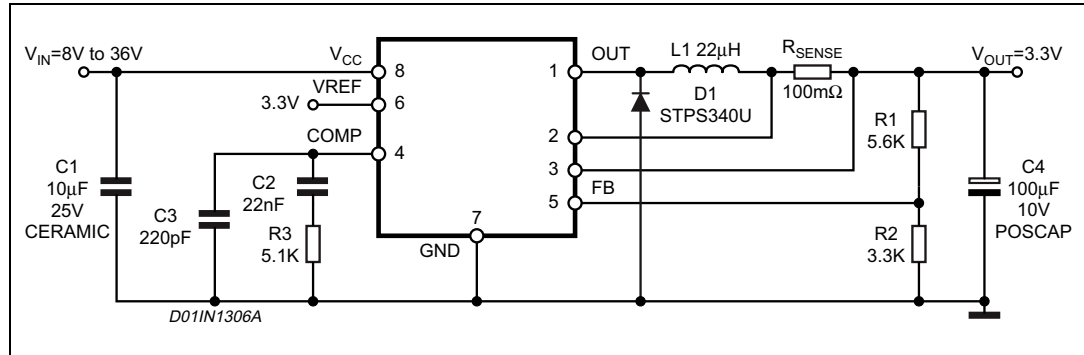
| Order codes | Package | Packaging     |
|-------------|---------|---------------|
| L6902D      | SO-8    | Tube          |
| L6902D013TR |         | Tape and reel |

# Content

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# 1 Test and application circuit

Figure 1. Test and application circuit



# 2 Pin connection

Figure 2. Pin connection

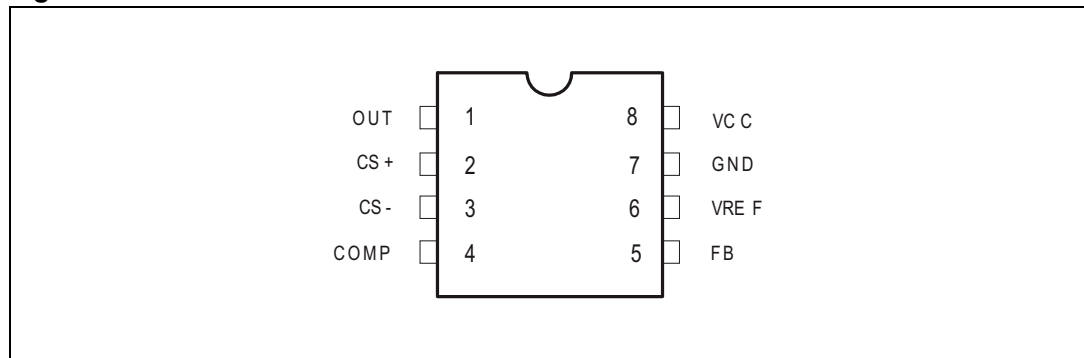


Table 2. Pin description

| N° | Pin  | Function   |
|----|------|--|
| 1  | OUT  | Regular output   |
| 2  | CS+  | Current error amplifier input (current sense at higher voltage)  |
| 3  | CS-  | Current error amplifier input (current sense at lower voltage)   |
| 4  | COMP | E/A output to be used for frequency compensation   |
| 5  | FB   | Stepdown feedback input. Connecting directly to this pin results in an output voltage of 1.235 V. An external resistive divider is required for higher output voltages. In this case:<br>$V_{out} = V_{FB} \cdot \left(1 + \frac{R1}{R2}\right) = 1.235V \left(1 + \frac{R1}{R2}\right)$ |
| 6  | VREF | 3.3 V VREF. No cap is need for stability.  |
| 7  | GND  | Ground   |
| 8  | VCC  | Unregulated DC input voltage.  |

### 3 Maximum ratings

**Table 3. Absolute maximum ratings**

| Symbol           | Parameter  | Value              | Unit             |
|------------------|--|--------------------|------------------|
| $V_8$            | Input voltage  | 40                 | V                |
| $V_1$            | Output DC voltage output peak voltage at $t = 0.1 \mu\text{s}$       | -1 to 40 -5 to 40  | V V              |
| $I_1$            | Maximum output current   | Internally limited |                  |
| $V_4, V_5$       | Analog pins  | 4                  | V                |
| $V_2, V_3$       | Analog pins  | -0.3V to VCC       | V                |
| $P_{\text{tot}}$ | Power dissipation at $T_{\text{amb}} \leq 70 \text{ }^\circ\text{C}$ | 0.7                | W                |
| $T_j$            | Operating junction temperature range                                 | -40 to 150         | $^\circ\text{C}$ |
| $T_{\text{stg}}$ | Storage temperature range  | -55 to 150         | $^\circ\text{C}$ |

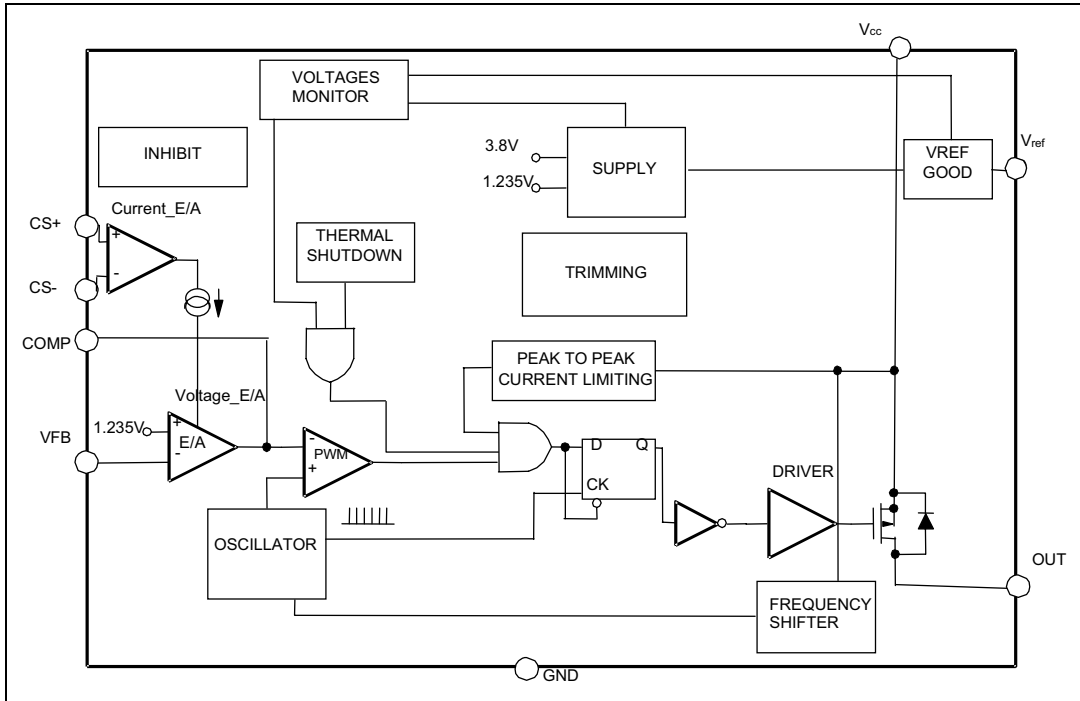
**Table 4. Thermal data**

| Symbol                | Parameter                                   | Value              | Unit               |
|-----------------------|---|--------------------|--------------------|
| $R_{\text{th-j-amb}}$ | Thermal Resistance Junction to Ambient Max. | 110 <sup>(1)</sup> | $^\circ\text{C/W}$ |

1. Package mounted on board.

# 4 Internal block diagram

Figure 3. Block diagram



## 5 Electrical characteristics

$T_j = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{V}$ , unless otherwise specified.

**Table 5. Electrical characteristics**

| Symbol                         | Parameter                         | Test condition  | Min. | Typ.  | Max.  | Unit  |               |
|--------------------------------|-----------------------------------|---|------|-------|-------|-------|---------------|
| $V_{CC}$                       | Operating input voltage range     | $V_O = 1.235\text{V}$ ; $I_O = 1\text{A}$   | 8    |       | 36    | V     |               |
| $V_d$                          | Dropout voltage                   | $V_{CC} = 8\text{V}$ ; $I_O = 1\text{A}$  |      | 0.25  | 0.5   | V     |               |
| $I_O$                          | Operating charging current        | $R_{\text{sense}} = 0.1\Omega$  |      | 0.95  | 1     | 1.05  | A             |
|                                |                                   |   | (1)  | 0.92  |       | 1.08  | A             |
| $I_l$                          | Maximum limiting current          | $V_{CC} = 8\text{V to } 36\text{V}$   | 2    | 2.5   | 3.2   | A     |               |
| $f_s$                          | Switching frequency               |   | (1)  | 212   | 250   | 287   | kHz           |
|                                |                                   |   |      | 225   | 250   | 275   | kHz           |
| d                              | Duty cycle                        |   | 0    |       | 100   | %     |               |
| <b>Dynamic characteristics</b> |                                   |   |      |       |       |       |               |
| $V_5$                          | Voltage feedback (FB)             | $8\text{V} < V_{CC} < 36\text{V}$ , $20\text{mA} < I_O < 1\text{A}$                                   |      | 1.21  | 1.235 | 1.259 | V             |
|                                |                                   |   | (1)  | 1.198 | 1.235 | 1.272 | V             |
| $\eta$                         | Efficiency                        | $V_O = 5\text{V}$ , $V_{CC} = 12\text{V}$   |      | 90    |       | %     |               |
| <b>DC characteristics</b>      |                                   |   |      |       |       |       |               |
| $I_{\text{qop}}$               | Total operating quiescent current |   | (1)  |       | 3     | 5     | mA            |
| $I_q$                          | Quiescent current                 | Duty cycle = 0; $V_{\text{FB}} = 1.5\text{V}$   |      |       | 3     |       | mA            |
| <b>Voltage error amplifier</b> |                                   |   |      |       |       |       |               |
| $V_{\text{OH}}$                | High level output voltage         | $V_{\text{FB}} = 1\text{V}$   |      | 3.6   |       |       | V             |
| $V_{\text{OL}}$                | Low level output voltage          | $V_{\text{FB}} = 1.5$   |      |       | 0.4   |       | V             |
| $I_{\text{O source}}$          | Source output current             | $V_{\text{comp}} = 1.9\text{V}$ ; $V_{\text{FB}} = 1\text{V}$   |      | 200   | 300   |       | $\mu\text{A}$ |
| $I_{\text{O sink}}$            | Sink output current               | $V_{\text{comp}} = 1.9\text{V}$ ; $V_{\text{FB}} = 1.5\text{V}$                                       |      | 1     | 1.5   |       | mA            |
| $I_b$                          | Source bias current               |   |      | 2.5   | 4     |       | $\mu\text{A}$ |
|                                | DC open loop gain                 | $R_L = 0$   |      | 50    | 58    |       | dB            |
| $g_m$                          | Transconductance                  | $I_{\text{comp}} = -0.1$ to $0.1\text{mA}$ , $V_{\text{comp}} = 1.9\text{V}$                          |      |       | 2.3   |       | mS            |
| <b>Current error amplifier</b> |                                   |   |      |       |       |       |               |
| $V_{\text{offs}}$              | Input offset voltage              | $V_{\text{CS-}} = 1.8\text{V}$ ; $V_{\text{CS+}} = V_{\text{comp}}$                                   |      | 95    | 100   | 105   | mV            |
| $I_{\text{CS+}}$               | CS+ output current                | $I_O = 1\text{A}$ , $R_{\text{sense}} = 100\text{m}\Omega$ ,<br>$V_{\text{out}} < V_{CC} - 2\text{V}$ |      |       | 1.5   | 3     | $\mu\text{A}$ |
| $I_{\text{CS-}}$               | CS- output current                | $I_O = 1\text{A}$ , $R_{\text{sense}} = 100\text{m}\Omega$ ,<br>$V_{\text{out}} < V_{CC} - 2\text{V}$ |      |       | 1.5   | 3     | $\mu\text{A}$ |

Table 5. Electrical characteristics (continued)

| Symbol                   | Parameter             | Test condition   | Min.               | Typ. | Max.  | Unit |
|--------------------------|-----------------------|--|--------------------|------|-------|------|
| <b>Reference section</b> |                       |  |                    |      |       |      |
|                          | Reference voltage     |  | 3.234              | 3.3  | 3.366 | V    |
|                          |                       | $I_{REF} = 0 \text{ to } 5\text{mA}$ $V_{CC} = 8\text{V to } 36\text{V}$ | <sup>(1)</sup> 3.2 | 3.3  | 3.399 | V    |
|                          | Line regulation       | $I_{REF} = 0\text{mA}$ , $V_{CC} = 8\text{V to } 36\text{V}$             |                    | 5    | 10    | mV   |
|                          | Load regulation       | $I_{REF} = 0 \text{ to } 5 \text{ mA}$                                   |                    | 8    | 15    | mV   |
|                          | Short circuit current |  | 10                 |      |       | mA   |

1. Specification Referred to T<sub>J</sub> from -40 to 125°C. Specification over the -40 to +125 T<sub>J</sub> Temperature range are assured by design, characterization and statistical correlation

## 6 Package mechanical data

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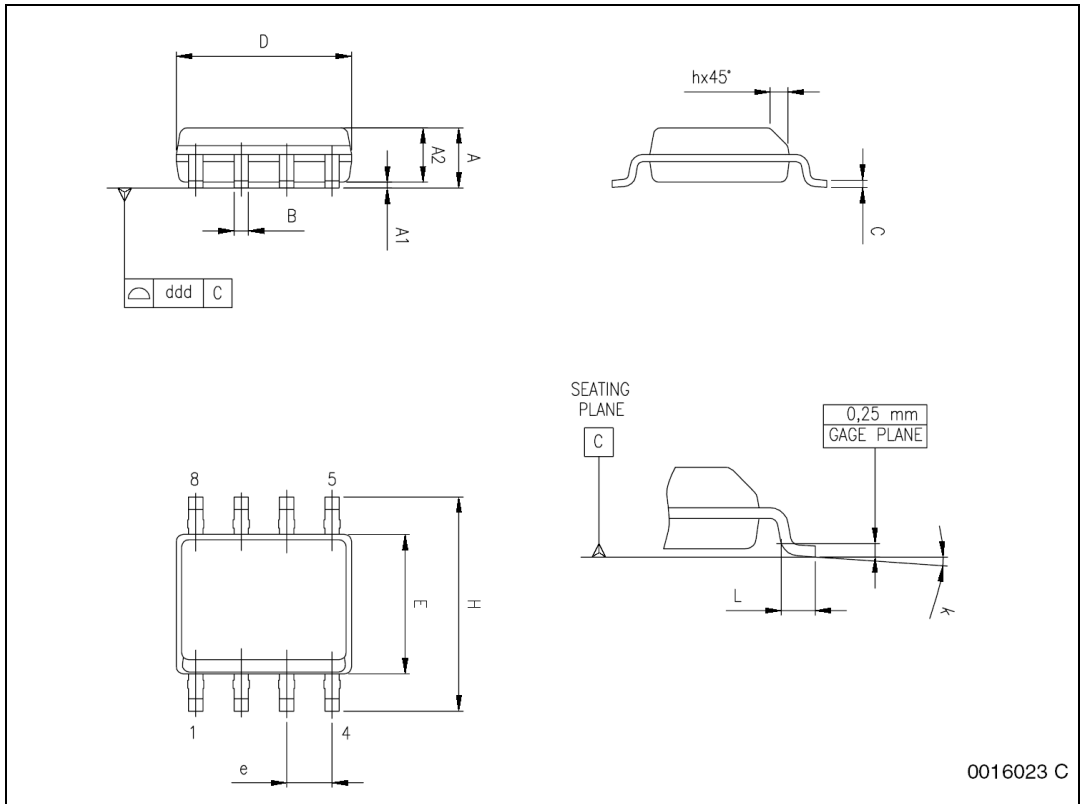
**Table 1. SO-8 mechanical data**

| Dim.             | mm.                  |      |      | inch  |       |       |
|------------------|----------------------|------|------|-------|-------|-------|
|                  | Min                  | Typ  | Max  | Min   | Typ   | Max   |
| A                | 1.35                 |      | 1.75 | 0.053 |       | 0.069 |
| A1               | 0.10                 |      | 0.25 | 0.004 |       | 0.010 |
| A2               | 1.10                 |      | 1.65 | 0.043 |       | 0.065 |
| B                | 0.33                 |      | 0.51 | 0.013 |       | 0.020 |
| C                | 0.19                 |      | 0.25 | 0.007 |       | 0.010 |
| D <sup>(1)</sup> | 4.80                 |      | 5.00 | 0.189 |       | 0.197 |
| E                | 3.80                 |      | 4.00 | 0.15  |       | 0.157 |
| e                |                      | 1.27 |      |       | 0.050 |       |
| H                | 5.80                 |      | 6.20 | 0.228 |       | 0.244 |
| h                | 0.25                 |      | 0.50 | 0.010 |       | 0.020 |
| L                | 0.40                 |      | 1.27 | 0.016 |       | 0.050 |
| k                | 0° (min.), 8° (max.) |      |      |       |       |       |
| ddd              |                      |      | 0.10 |       |       | 0.004 |

1. Dimensions D does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15mm (.006inch) in total (both side).



Figure 4. Package dimensions



## 7 Revision history

**Table 6. Document revision history**

| Date         | Revision | Changes                                     |
|--------------|----------|---|
| January 2004 | 7        | Technical migration from ST-PRESS to EDOCS. |
| October 2004 | 8        | Changed style look and feel.                |
| 26-Nov-2010  | 9        | Updated <a href="#">Note 1 on page 7</a>    |

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