

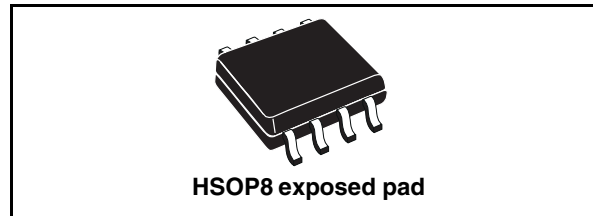
2.5 A switch step down switching regulator

Features

- 2.5 A internal switch
- Operating input voltage from 4 V to 36 V
- 3.3 V / ($\pm 2\%$) reference voltage
- Output voltage adjustable from 1.235 V to 35 V
- Low dropout operation: 100 % duty cycle
- 250 kHz internally fixed frequency
- Voltage feedforward
- Zero load current operation
- Internal current limiting
- Inhibit for zero current consumption
- Synchronization
- Protection against feedback disconnection
- Thermal shutdown

Applications

- Consumer: STB, DVD, TV, VCR, car radio, LCD monitors
- Networking: XDSL, modems, DC-DC modules
- Computer: printers, audio/graphic cards, optical storage, hard disk drive
- Industrial: changers, car battery, DC-DC converters



Description

The L5973D is a step down monolithic power switching regulator with a minimum switch current limit of 2.5 A so it is able to deliver more than 2 A DC current to the load depending on the application conditions.

The output voltage can be set from 1.235 V to 35 V. The high current level is also achieved thanks to an SO8 package with exposed frame, that allows to reduce the $R_{th}(j-amb)$ down to approximately 40 °C/W.

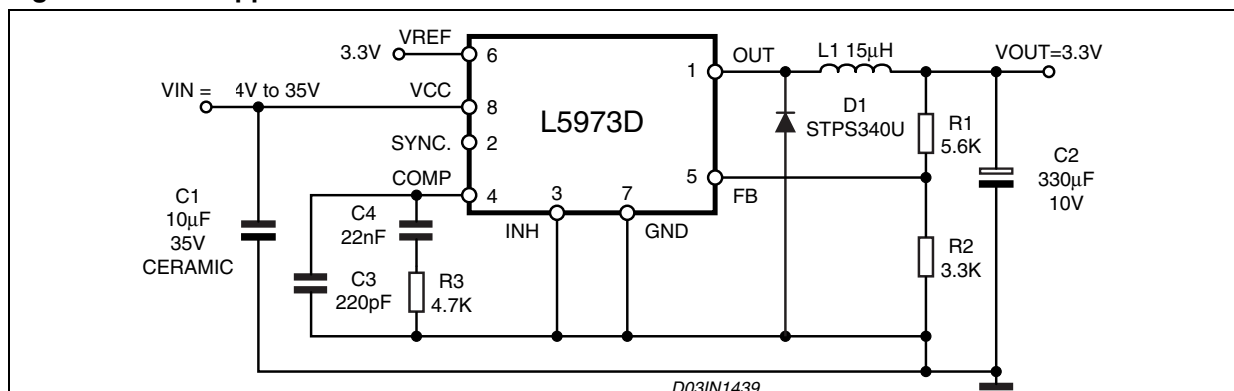
The device uses an internal P-channel D-MOS transistor (with a typical R_{dson} of 250 m Ω) as switching element to minimize the size of the external components.

An internal oscillator fixes the switching frequency at 250 kHz.

Having a minimum input voltage of 4 V only, it is particularly suitable for 5 V bus, available in all computer related applications.

Pulse by pulse current limit with the internal frequency modulation offers an effective constant current short circuit protection.

Figure 1. Test application circuit



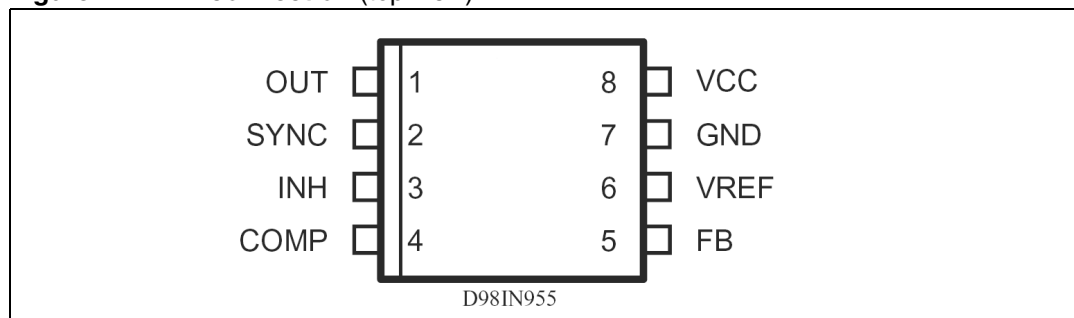
Contents

| | | |
|----------|---|-----------|
| 1 | Pin settings | 3 |
| 1.1 | Pin connection | 3 |
| 1.2 | Pin description | 3 |
| 2 | Electrical data | 4 |
| 2.1 | Maximum ratings | 4 |
| 2.2 | Thermal data | 4 |
| 3 | Electrical characteristics | 5 |
| 4 | Typical characteristics | 7 |
| 5 | Application circuit | 9 |
| 6 | Application ideas | 11 |
| 7 | Package mechanical data | 13 |
| 8 | Order code | 15 |
| 9 | Revision history | 16 |

1 Pin settings

1.1 Pin connection

Figure 2. Pin connection (top view)



1.2 Pin description

Table 1. Pin description

| N° | Type | Description |
|----|------|---|
| 1 | OUT | Regulator output. |
| 2 | SYNC | Master/slave synchronization. |
| 3 | INH | A logical signal (active high) disables the device. If INH not used the pin must be grounded. When it is open an internal pull-up disable the device. |
| 4 | COMP | E/A output for frequency compensation. |
| 5 | FB | Feedback input. Connecting directly to this pin results in an output voltage of 1.23 V. An external resistive divider is required for higher output voltages. |
| 6 | VREF | 3.3 V V_{REF} No cap is requested for stability. |
| 7 | GND | Ground. |
| 8 | VCC | Unregulated DC input voltage. |

2 Electrical data

2.1 Maximum ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------|---|--------------------|------------------|
| V_8 | Input voltage | 40 | V |
| V_1 | Output DC voltage | -1 to 40 | V |
| | Output peak voltage at $t = 0.1 \mu\text{s}$ | -5 to 40 | V |
| I_1 | Maximum output current | int. limit. | |
| V_4, V_5 | Analog pins | 4 | V |
| V_3 | INH | -0.3 V to V_{CC} | |
| V_2 | SYNC | -0.3 to 4 | V |
| P_{TOT} | Power dissipation at $T_A \leq 60 \text{ }^\circ\text{C}$ | 2.25 | W |
| T_J | Operating junction temperature range | -40 to 150 | $^\circ\text{C}$ |
| T_{STG} | Storage temperature range | -55 to 150 | $^\circ\text{C}$ |

2.2 Thermal data

Table 3. Thermal data

| Symbol | Parameter | HSOP8 Exposed Pad | Unit |
|------------|---|-------------------|--------------------|
| R_{thJA} | Maximum thermal resistance junction-ambient | 40 ⁽¹⁾ | $^\circ\text{C/W}$ |

1. Package mounted on board

3 Electrical characteristics

Table 4. Electrical characteristics
($T_J = 25\text{ }^\circ\text{C}$, $V_{CC} = 12\text{ V}$, unless otherwise specified)

| Symbol | Parameter | Test condition | Min | Typ | Max | Unit | |
|--|-----------------------------------|--|-----------|-------|-------|---------------|---|
| V_{CC} | Operating input voltage range | $V_O = 1.235\text{ V}$; $I_O = 2\text{ A}$ | (1) 4 | | 36 | V | |
| $R_{DS(on)}$ | Mosfet on Resistance | | (1) | 0.250 | 0.5 | Ω | |
| I_l | Maximum limiting current | $V_{CC} = 4.4\text{ V to }36\text{ V}$ | 2.5 | 3 | 3.5 | A | |
| f_s | Switching frequency | | (1) 212 | 250 | 280 | kHz | |
| | | | 225 | 250 | 275 | kHz | |
| | Duty cycle | | 0 | | 100 | % | |
| Dynamic characteristics (see test circuit). | | | | | | | |
| V_5 | Voltage feedback | $4.4\text{ V} < V_{CC} < 36\text{ V}$, $20\text{ mA} < I_O < 2\text{ A}$ | | 1.220 | 1.235 | 1.25 | V |
| | | | (1) 1.198 | 1.235 | 1.272 | V | |
| h | Efficiency | $V_O = 5\text{ V}$, $V_{CC} = 12\text{ V}$ | | 90 | | % | |
| DC characteristics | | | | | | | |
| I_{qop} | Total operating quiescent current | | (1) | 3 | 5 | mA | |
| I_q | Quiescent current | Duty Cycle = 0; $V_{FB} = 1.5\text{ V}$ | | | 2.5 | mA | |
| I_{qst-by} | Total stand-by quiescent current | $V_{inh} > 2.2\text{ V}$ | (1) | 50 | 100 | μA | |
| | | $V_{CC} = 36\text{ V}$; $V_{inh} > 2.2\text{ V}$ | (1) | 80 | 150 | μA | |
| Inhibit | | | | | | | |
| | INH threshold voltage | Device ON | | | 0.8 | V | |
| | | Device OFF | | 2.2 | | V | |
| Error amplifier | | | | | | | |
| V_{OH} | High level output voltage | $V_{FB} = 1\text{ V}$ | | 3.5 | | V | |
| V_{OL} | Low level output voltage | $V_{FB} = 1.5\text{ V}$ | | | 0.4 | V | |
| $I_{o\text{ source}}$ | Source output current | $V_{COMP} = 1.9\text{ V}$; $V_{FB} = 1\text{ V}$ | | 200 | 300 | μA | |
| $I_{o\text{ sink}}$ | Sink output current | $V_{COMP} = 1.9\text{ V}$; $V_{FB} = 1.5\text{ V}$ | | 1 | 1.5 | mA | |

Table 4. Electrical characteristics (continued)
 (T_J = 25 °C, V_{CC} = 12 V, unless otherwise specified)

| Symbol | Parameter | Test condition | Min | Typ | Max | Unit | |
|--------------------------|-------------------------|---|-------|------|------------------|-------|---|
| I _b | Source bias current | | | 2.5 | 4 | μA | |
| | DC open loop gain | R _L = ∞ | 50 | 57 | | dB | |
| gm | Transconductance | I _{comp} = -0.1 mA to 0.1 mA V _{COMP} = 1.9 V | | 2.3 | | mS | |
| Sync function | | | | | | | |
| | High input voltage | V _{CC} = 4.4 V to 36 V | 2.5 | | V _{REF} | V | |
| | Low input voltage | V _{CC} = 4.4 V to 36 V | | | 0.74 | V | |
| | Slave sink current | V _{sync} = 0.74 V ⁽²⁾ V _{sync} = 2.33 V | 0.11 | | 0.25 | mA | |
| | | | 0.21 | | 0.45 | mA | |
| | Master output amplitude | I _{source} = 3 mA | 2.75 | 3 | | V | |
| | Output pulse width | no load, V _{sync} = 1.65 V | 0.20 | 0.35 | | μs | |
| Reference section | | | | | | | |
| | Reference voltage | | 3.234 | 3.3 | 3.366 | V | |
| | | I _{REF} = 0 to 5 mA V _{CC} = 4.4 V to 36 V | (1) | 3.2 | 3.3 | 3.399 | V |
| | Line regulation | I _{REF} = 0 mA V _{CC} = 4.4 V to 36 V | | 5 | 10 | mV | |
| | Load regulation | I _{REF} = 0 to 5 mA | | 8 | 15 | mV | |
| | Short circuit current | | 10 | 18 | 30 | mA | |

1. Specification Referred to T_J from -40 to 125 °C. Specification over the -40 to +125 T_J Temperature range are assured by design, characterization and statistical correlation.
2. Guaranteed by design.

4 Typical characteristics

Figure 3. Line regulation

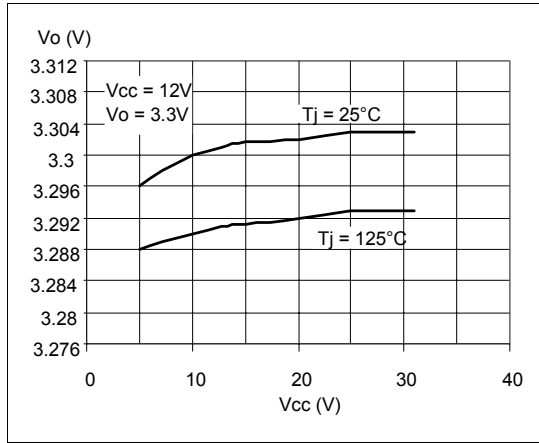


Figure 4. Shutdown current vs junction temperature

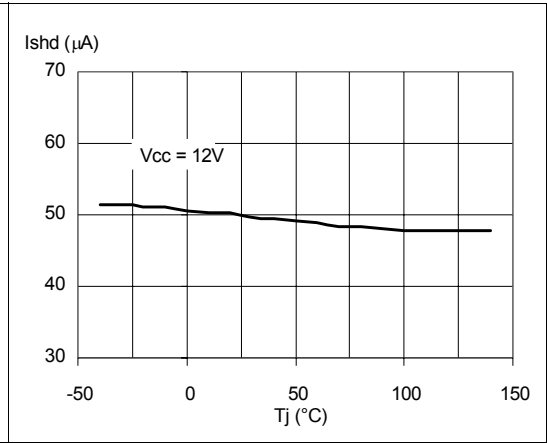


Figure 5. Output voltage vs junction temperature

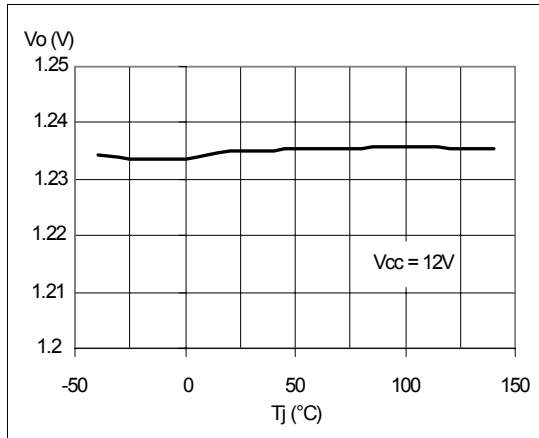


Figure 6. Switching frequency vs junction temperature

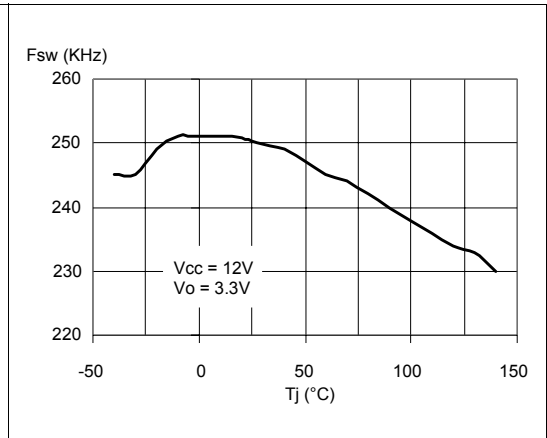


Figure 7. Quiescent current vs junction temperature

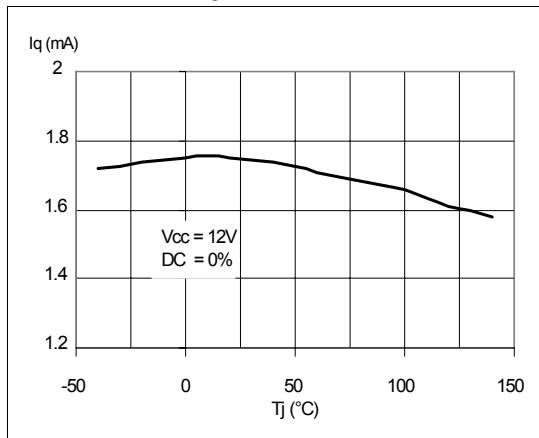


Figure 8. Junction temperature vs output current

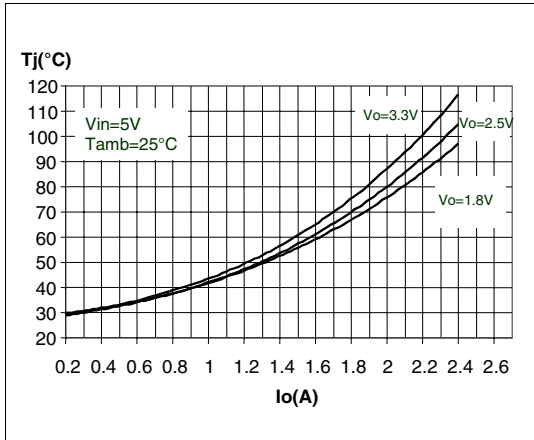


Figure 9. Junction temperature vs output current

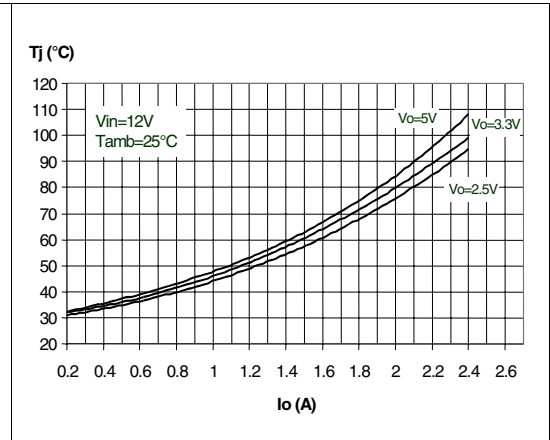


Figure 10. Efficiency vs output current

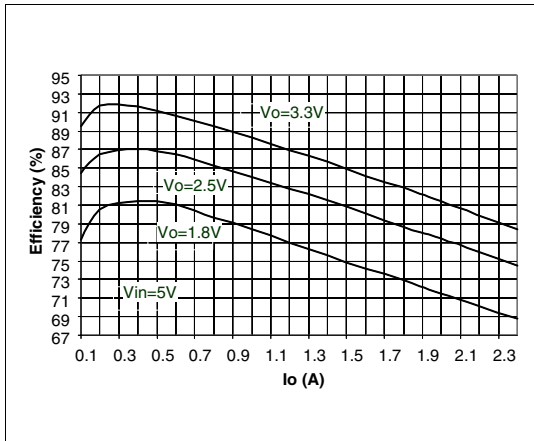
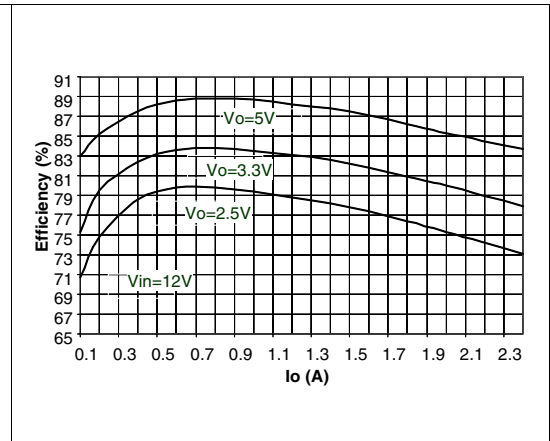


Figure 11. Efficiency vs output current



5 Application circuit

In figure 6 is shown the demonstration board application circuit, where the input supply voltage, V_{CC} , can range from 4 V to 25 V due to the rated voltage of the input capacitor and the output voltage is adjustable from 1.235 V to V_{CC} .

Figure 12. Demonstration board application circuit

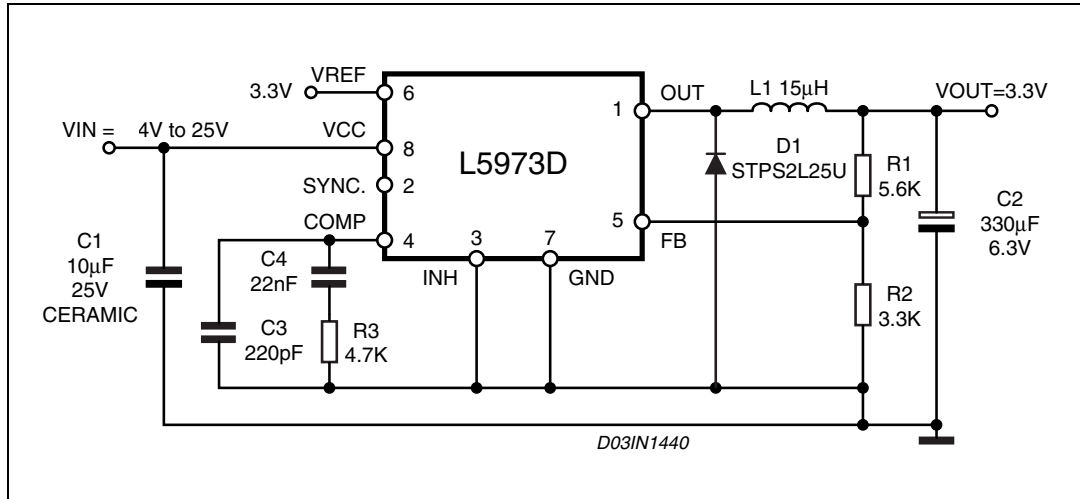


Table 5. Component list

| Reference | Part number | Description | Manufacturer |
|-----------|--------------------|-----------------------|--------------|
| C1 | GRM32DR61E106KA12L | 10 µF, 25 V | Murata |
| C2 | POSCAP 6TPB330M | 330 µF, 6.3 V | Sanyo |
| C3 | C1206C221J5GAC | 220 pF, 5%, 50 V | KEMET |
| C4 | C1206C223K5RAC | 22 nF, 10%, 50 V | KEMET |
| R1 | | 5.6 K, 1%, 0.1 W 0603 | Neohm |
| R2 | | 3.3 K, 1%, 0.1 W 0603 | Neohm |
| R3 | | 4.7 K, 1%, 0.1 W 0603 | Neohm |
| D1 | STPS2L25U | 2 A, 25 V | ST |
| L1 | DO3316P-153 | 15 µH, 3 A | COILCRAFT |

Figure 13. PCB layout (component side)

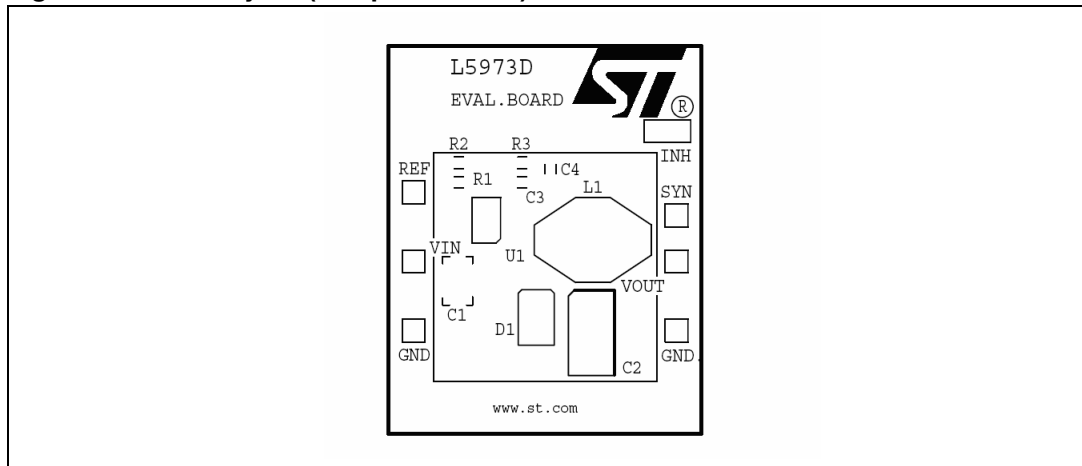


Figure 14. PCB layout (bottom side)

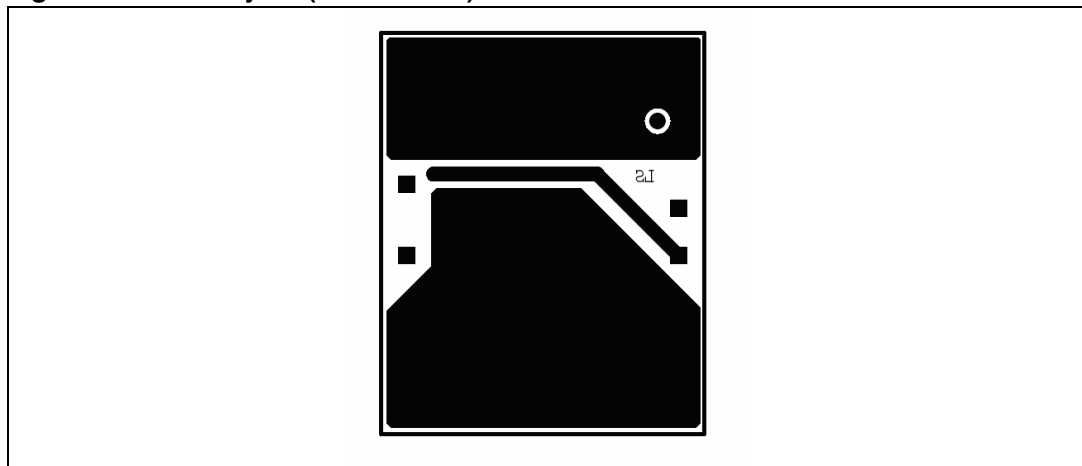
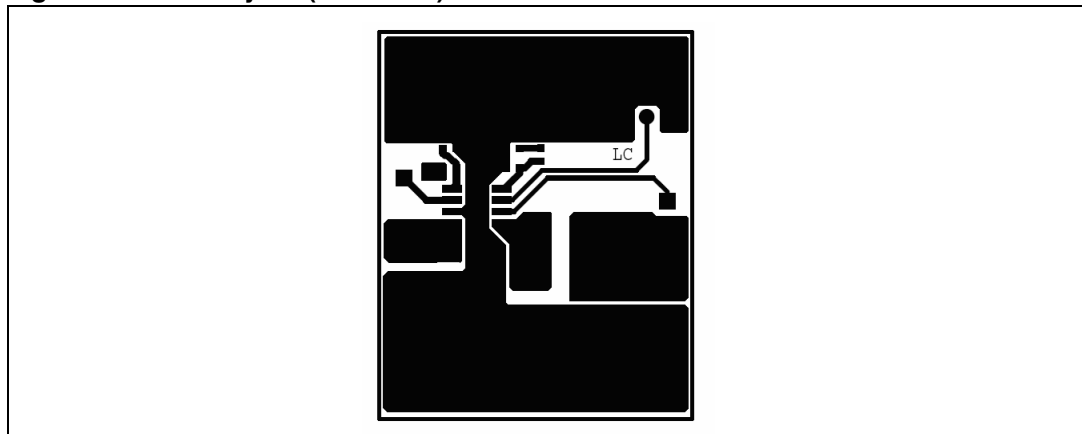


Figure 15. PCB layout (front side)



Below some graphs show the T_J versus output current in different conditions of the input and output voltage and some efficiency measurements.

6 Application ideas

Figure 16. Positive buck-boost regulator

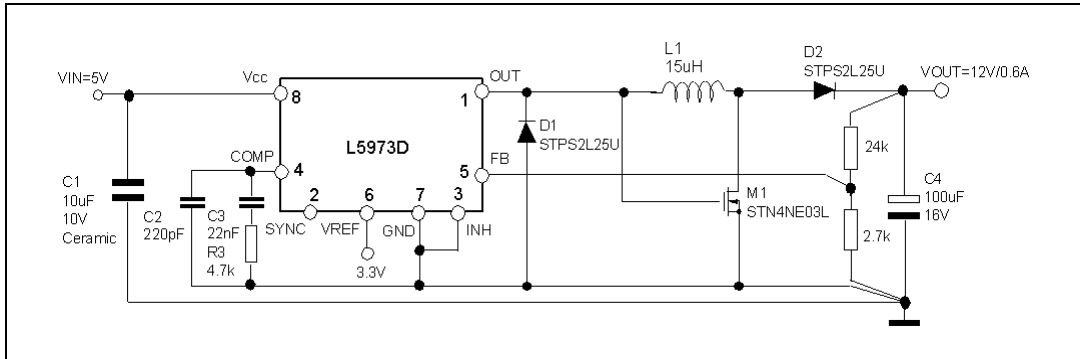


Figure 17. Buck-boost regulator

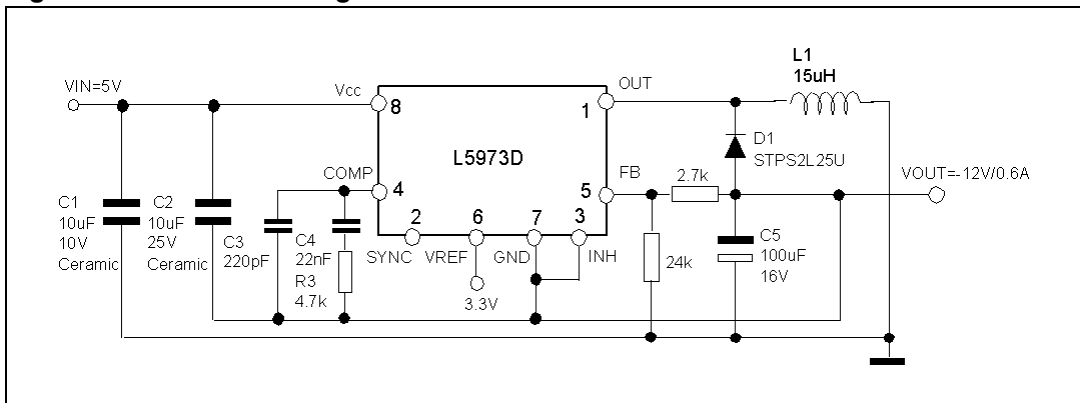
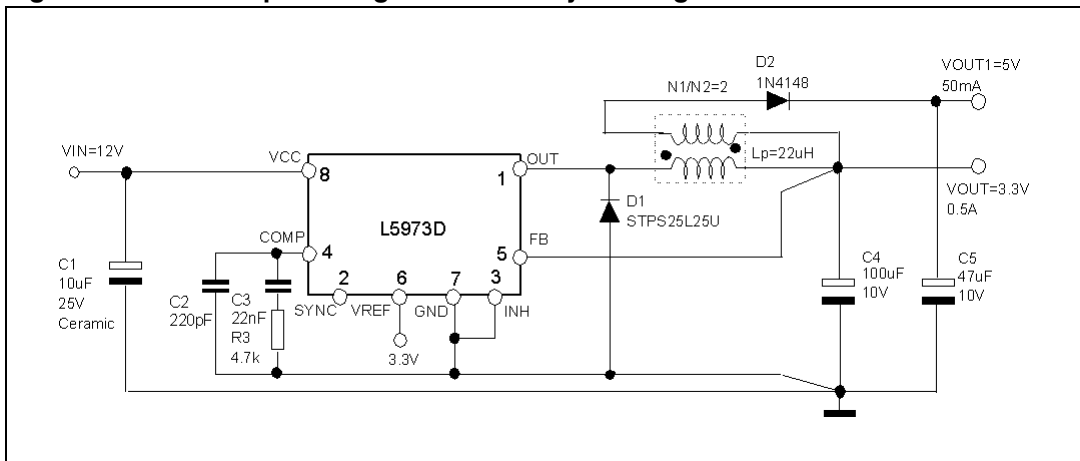


Figure 18. Dual output voltage with auxiliary winding



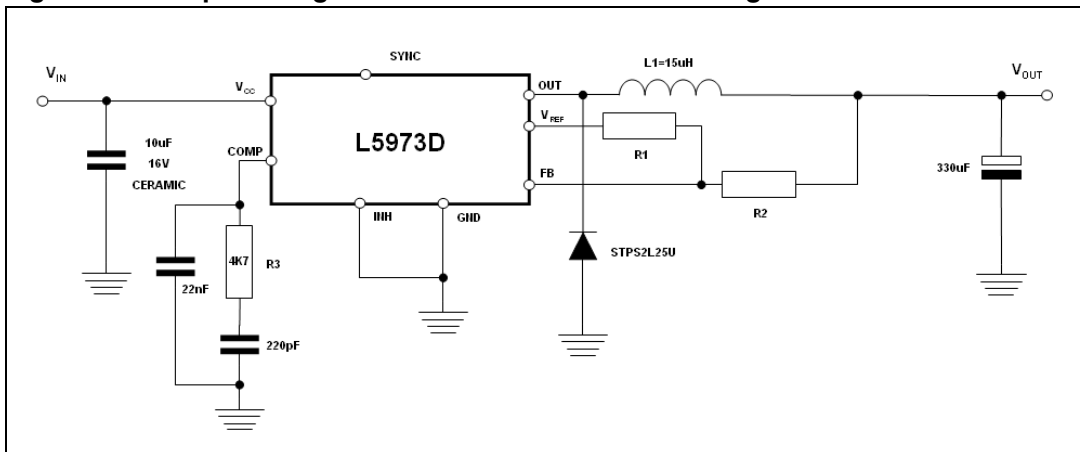
When an output voltage below the internal reference (1.235 V) is required, the circuit reported in the figure 18 can be used. In this case the minimum voltage reachable is 0.6 V and can be easily calculated with the following formula:

$$V_{OUT} = V_{FB} - [(V_{REF} - V_{FB}) \times (R_2 / R_1)]$$

If the load is not present, a resistor connected between V_{OUT} and GND is required in order to avoid that the voltage across C_{OUT} increases.

The value of this resistor has to be calculated taking into account that the current flowing through this resistance has to be higher than the current flowing through R_2 .

Figure 19. Output voltage below the 1.235 V internal voltage reference



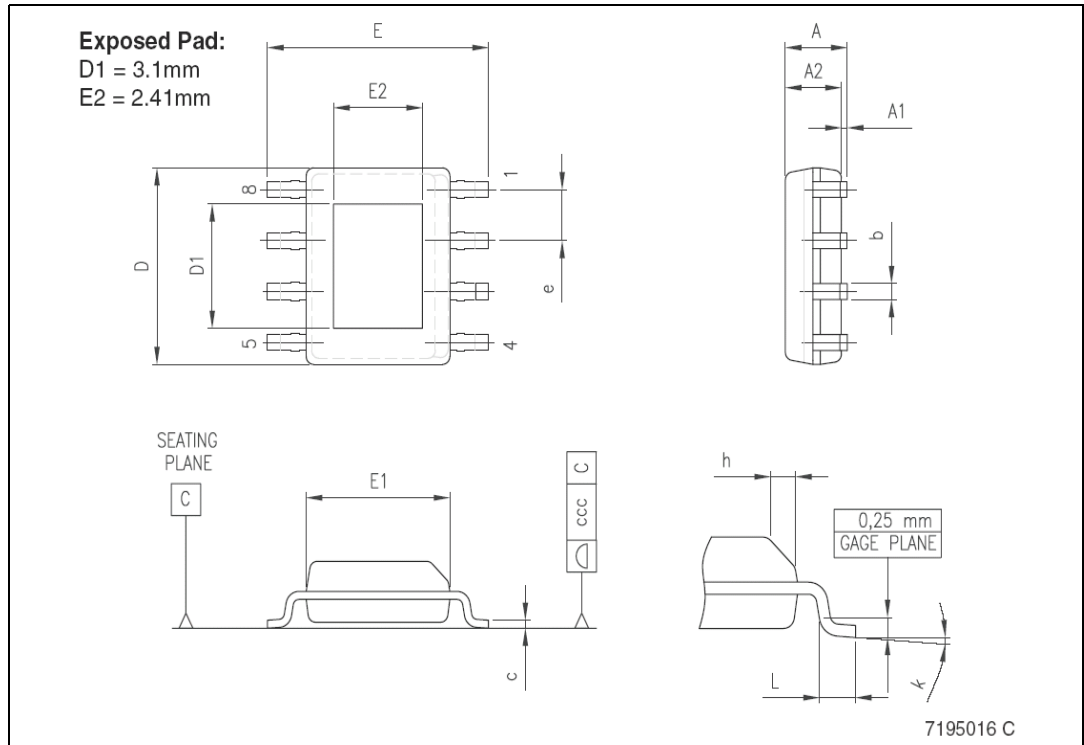
7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com

Table 6. HSOP8 mechanical data

| Dim | mm | | | inch | | |
|-----|--------------------|------|------|--------|--------|--------|
| | Min | Typ | Max | Min | Typ | Max |
| A | | | 1.70 | | | 0.0669 |
| A1 | 0.00 | | 0.10 | | 0.00 | 0.0039 |
| A2 | 1.25 | | | 0.0492 | | |
| b | 0.31 | | 0.51 | 0.0122 | | 0.0201 |
| c | 0.17 | | 0.25 | 0.0067 | | 0.0098 |
| D | 4.80 | 4.90 | 5.00 | 0.1890 | 0.1929 | 0.1969 |
| D1 | 3 | 3.1 | 3.2 | 0.118 | 0.122 | 0.126 |
| E | 5.80 | 6.00 | 6.20 | 0.2283 | | 0.2441 |
| E1 | 3.80 | 3.90 | 4.00 | 0.1496 | | 0.1575 |
| E2 | 2.31 | 2.41 | 2.51 | 0.091 | 0.095 | 0.099 |
| e | | 1.27 | | | | |
| h | 0.25 | | 0.50 | 0.0098 | | 0.0197 |
| L | 0.40 | | 1.27 | 0.0157 | | 0.0500 |
| k | 0° (min), 8° (max) | | | | | |
| ccc | | | 0.10 | | | 0.0039 |

Figure 20. Package dimensions



8 Order code

Table 7. Order code

| Part number | Package | Packaging |
|--------------------|---------------------|------------------|
| L5973D | HSOP8 (Exposed pad) | Tube |
| L5973D013TR | HSOP8 (Exposed pad) | Tape and reel |

9 Revision history

Table 8. Revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 01-Nov-2005 | 10 | Updated package information |
| 22-May-2006 | 11 | Electrical characteristic Table 4 updated, new application idea Figure 19 added, new template |
| 13-Nov-2006 | 12 | Typo in order codes |
| 26-Jan-2007 | 13 | Updated Table 4 on page 5 |
| 17-Oct-2007 | 14 | Updated Section 5: Application circuit on page 9 |
| 24-Oct-2007 | 15 | Updated Table 6 on page 14 |
| 07-Jan-2008 | 16 | Updated Table 6 on page 14 |

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2008 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com

