

## PMOLED display power supply

### Feature summary

- Inductor switcher boost controller.
- PFM mode control.
- High efficiency over wide range of load (1mA to 40mA).
- Integrated Load disconnect switch.
- Over voltage protection with automatic restart
- Soft start with adjustable peak current limit
- Enable pin
- Low shutdown current.
- Small external inductor.
- Supply voltage from 3.0V to 5.5V

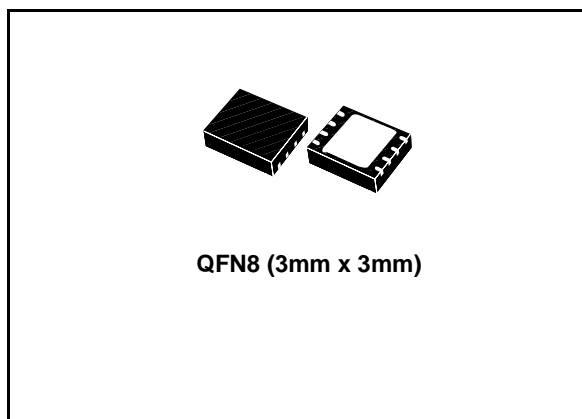
### Application

- PMOLED display driver

### Description

STOD2540 is dedicated to Passive Matrix OLED (PMOLED) display for portable handset and is used to provide the precharge and biasing voltage of the column matrix driver as shown on the Fig.3.

The current capability of STOD2540 allows feeding a 1", 1.3" or 1.5" color PMOLED.



STOD2540 is a boost converter that operates from 3.0V to 5.5V and can provide an output voltage as high as 25V. The output current capability is maximum 40mA up to 25V output voltage. The regulation is done by sensing the output voltage through a resistor divider network as shown on the [Figure 3](#).

In state of the art boost converter, a DC current path exists between the battery source and the load. In order to reduce the consumption in shutdown mode a high side load isolation switch is necessary to cut this DC current path in stand by mode. The Load Disconnect Switch (LDS) acts as an isolation switch in shutdown mode.

### Order codes

| Part number | Package          | Comments            |
|-------------|------------------|---------------------|
| STOD2540PMR | QFN8 (3mm x 3mm) | 4500 parts per reel |

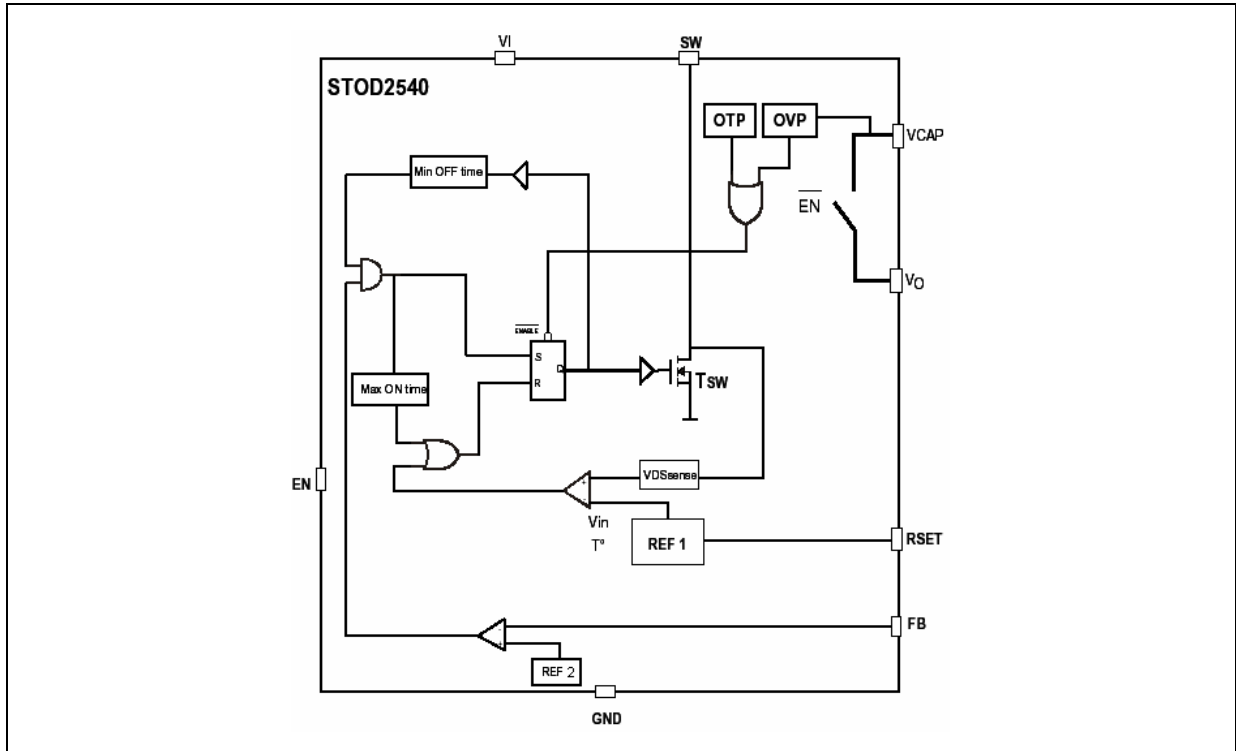
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# 1 Schematic diagram

Figure 1. Block diagram



## 2 Pin configuration

Figure 2. Pin connections (top view)

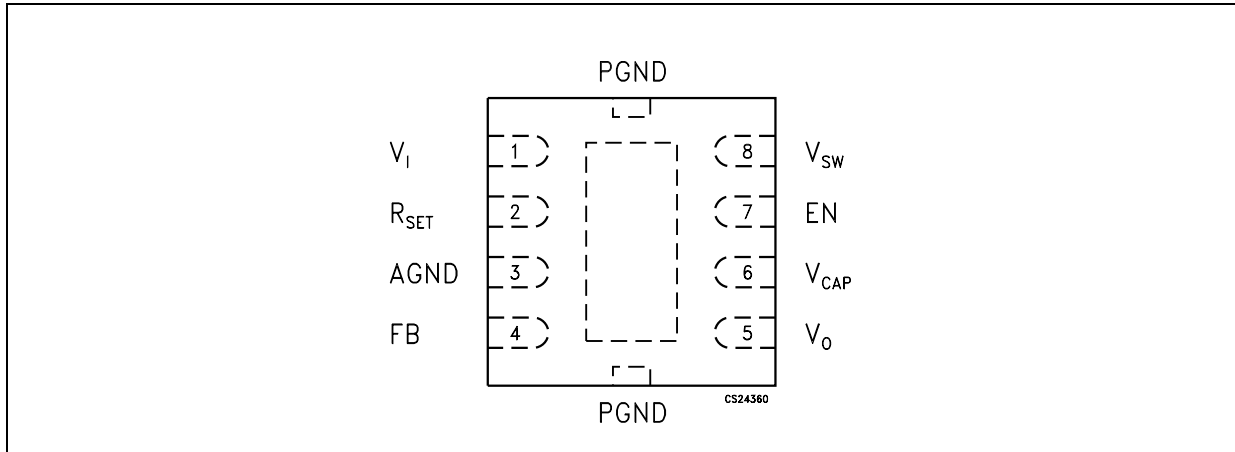


Table 1. Pin description

| PIN N° | SYMBOL | NOTE                                    |
|--------|--------|---|
| 1      | $V_I$  | Supply voltage                          |
| 2      | RSET   | Peak inductor current adjust            |
| 3      | AGND   | Analog Ground                           |
| 4      | FB     | Feedback for the LED current regulation |
| 5      | $V_O$  | Output voltage for LED supply           |
| 6      | VCAP   | Load Disconnect Switch input            |
| 7      | ENABLE | IC enable signal                        |
| 8      | VSW    | Boost switch drain                      |
| 9      | PGND   | Power Ground                            |

### 3 Maximum ratings

**Table 2. Absolute maximum ratings**

| Symbol            | Parameter                            | Value       | Unit |
|-------------------|--------------------------------------|-------------|------|
| $V_{BSW}, V_{BO}$ | Breakdown voltage at OUT and SW pin  | 40          | V    |
| $V_I$             | Supply voltage range                 | 6           | V    |
| $R_{SET}$         | $R_{SET}$ pin                        | $V_I + 0.3$ | V    |
| EN                | Enable pin                           | $V_I + 0.3$ | V    |
| $V_{ESD}$         | ESD ratings, HBM MIL STD 883C        | 2           | kV   |
| $T_{STG}$         | Storage Temperature Range            | -65 to 150  | °C   |
| $T_{OP}$          | Operating Junction Temperature Range | -40 to 85   | °C   |

**Table 3. Thermal Data**

| Symbol     | Parameter                           | Value | Unit |
|------------|-------------------------------------|-------|------|
| $R_{thJA}$ | Thermal Resistance Junction-Ambient | 52    | °C/W |

## 4 Electrical characteristics

**Table 4. Electrical characteristics**

( $T_J = 40^\circ\text{C}$  to  $85^\circ\text{C}$ ,  $V_I = 3.6\text{V}$ ,  $V_{EN} = 3\text{V}$ ,  $C_I = C_O = 4.7\mu\text{F}$ ,  $L = 4.7\mu\text{H}$ ,  $R_1 = 180\text{k}\Omega$ ,  $R_2 = 10\text{k}\Omega$ ,  $V_O = 24\text{V}$ , Typ. values @  $25^\circ\text{C}$ , unless otherwise specified).

| Symbol         | Parameter                                       | Test  | Min.        | Typ. | Max. | Unit          |
|----------------|---|---|-------------|------|------|---------------|
| $V_I$          | Input voltage range                             |   | 3.0         |      | 5.5  | V             |
| $V_O$          | Regulated output voltage                        | $V_I = 3\text{V}$ to $5.5\text{V}$                              | $V_I + 0.5$ | 25   | 35   | V             |
| $V_{OVP}$      | Over voltage protection on output               |   | 35          |      |      | V             |
| $I_O$          | Continuous output current                       | $V_O = 25\text{V}$  | 1           |      | 40   | mA            |
| $I_{SD}$       | Stand-by current                                | $V_{EN} = \text{Low}$ , $V_I = 3.6\text{V}$                     |             |      | 3    | $\mu\text{A}$ |
|                |   | $V_{EN} = \text{Low}$ , $V_I = 3\text{V}$ to $4.2\text{V}$      |             |      | 10   |               |
| $I_Q$          | Quiescent current consumption                   | $V_I = 3\text{V}$ to $4.2\text{V}$ @ $25^\circ\text{C}$         |             | 0.4  | 0.8  | mA            |
|                |   | $V_I = 5.5\text{V}$ @ $25^\circ\text{C}$                        |             | 0.8  | 1.2  |               |
| $R_{DSON-SW}$  | Boost switch $R_{DSON}$ <i>Note: 1</i>          | $V_I = 4.2\text{V}$ , $I_{SW} = 100\text{mA}$                   |             | 0.4  |      | $\Omega$      |
|                | BVDS Breakdown voltage                          |   | 40          |      |      | V             |
| $R_{DSON-LDS}$ | $R_{DSON}$ <i>Note: 1</i>                       | $V_O = 25\text{V}$ , $I_O = 30\text{mA}$                        |             | 2    |      | $\Omega$      |
|                | BVDS Breakdown voltage                          |   | 40          |      |      | V             |
| $I_{LIM-ADJ}$  | Peak inductor limit range<br><i>Note: 1</i>     | $R_{SET} = 2\text{k}\Omega$ to $100\text{k}\Omega$              | 0.1         |      | 1.5  | A             |
| $I_{LIM-MAX}$  | Maximum peak inductor current<br><i>Note: 1</i> | $V_I = 3\text{V}$ to $5.5\text{V}$ , $R_{SET} = V_I$            | 0.75        |      | 1.2  | A             |
| FB             | Feedback voltage                                | 5% @ $25^\circ\text{C}$   | 1.18        | 1.24 | 1.30 | V             |
| $T_{ON\_MAX}$  | Maximum ON Time                                 | $V_I = 4.2\text{V}$   |             | 5.5  |      | $\mu\text{s}$ |
| $T_{OFF\_MIN}$ | Minimum OFF Time                                | $V_I = 4.2\text{V}$   |             | 300  |      | ns            |
| Eff            | Efficiency, $V_I = 3.6\text{V}$ <i>Note: 1</i>  | $I_O = 1\text{ mA}$ to $5\text{mA}$                             | 65          |      |      | %             |
|                |   | $I_O = 5\text{ mA}$ to $40\text{mA}$                            | 70          |      |      |               |
|                | Efficiency, $V_I = 4.2\text{V}$ <i>Note: 1</i>  | $I_O = 1\text{ mA}$ to $5\text{mA}$                             | 65          |      |      |               |
|                |   | $I_O = 5\text{ mA}$ to $40\text{mA}$                            | 70          |      |      |               |
| Ripple         | Output ripple and noise                         | $V_I = 3.6\text{V}$ , $I_O = 5\text{ mA}$ , $V_O = 24\text{V}$  |             | 1.3  |      | %             |
|                |   | $V_I = 3.6\text{V}$ , $I_O = 30\text{ mA}$ , $V_O = 24\text{V}$ |             | 1.3  |      |               |
|                |   | $V_I = 3.6\text{V}$ , $I_O = 5\text{ mA}$ , $V_O = 24\text{V}$  |             | 1.3  |      |               |
|                |   | $V_I = 3.6\text{V}$ , $I_O = 30\text{ mA}$ , $V_O = 24\text{V}$ |             | 1.3  |      |               |
| $OV_{HYST}$    | Overvoltage hysteresis                          |   |             | 2    |      | V             |

**Table 4. Electrical characteristics**

( $T_J = 40^\circ\text{C}$  to  $85^\circ\text{C}$ ,  $V_I = 3.6\text{V}$ ,  $V_{\text{EN}} = 3\text{V}$ ,  $C_I = C_O = 4.7\mu\text{F}$ ,  $L = 4.7\mu\text{H}$ ,  $R_1 = 180\text{k}\Omega$ ,  $R_2 = 10\text{k}\Omega$ ,  $V_O = 24\text{V}$ , Typ. values @  $25^\circ\text{C}$ , unless otherwise specified).

| Symbol                | Parameter                       | Test   | Min. | Typ. | Max. | Unit |
|-----------------------|---------------------------------|--|------|------|------|------|
| $V_{\text{EN}}$       | Enable input logic low          | Disable Low $V_{\text{IL}}$                              |      |      | 0.3  | V    |
|                       | Enable input logic high         | Enable High $V_{\text{IH}}$                              | 1.2  |      |      |      |
| Line_ $V_{\text{FB}}$ | Line regulation $V_{\text{FB}}$ | $V_I = 3\text{V}$ to $5.5\text{V}$ , $I_O = 5\text{ mA}$ |      | 5    | 35   | mV   |
| Load_ $V_{\text{FB}}$ | Line regulation $V_{\text{FB}}$ | $V_I = 3\text{V}$ to $5.5\text{V}$ , $I_O = 5\text{ mA}$ |      | 5    | 35   | mV   |

Note: 1 *Guaranteed by design.*

## 5 Functional description

### 5.1 Boost controller

STOD2540 is a Boost converter operating in PFM (pulsed frequency modulation) mode. The converter monitors the output voltage through the bridge resistor divider  $R_1$  and  $R_2$  and when the feedback voltage falls below the reference voltage, REF2, the boost switch  $T_{SW}$  turns ON and the current ramps up. The inductor current is measured by sensing the temperature compensated drain voltage of the boost MOSFET. The boost turns off when its drain voltage reaches the internally reference REF1, the main switch remains off until the minimum off time (300ns typical) has passed and the feedback voltage is below the reference again. A maximum ON time of 4 $\mu$ s prevent the switch  $T_{SW}$  to stay ON during a too long period of time.

In order to well calculate the bridge resistors values with a fixed  $V_O$ , the following formula can be used:

$$\frac{V_{out}}{1,24} - 1 = \frac{R_1}{R_2}$$

### 5.2 Adjustable peak inductor current limit

The peak inductor current is monitored by sensing the drain voltage of the switch  $T_{SW}$ .

Since it exceeds the temperature compensated and supply voltage compensated reference REF1, the RS Flip flop is reset and  $T_{SW}$  is turned OFF.

By connecting a resistance between the pin RSET and GND, the peak current limit can be adjusted from 200mA to 1.5A ( $R_{SET}$  from 2k $\Omega$  to 100k $\Omega$ ). When the pin  $R_{SET}$  is directly connected to  $V_I$ , the default value is 1A.

### 5.3 Enable

The ENABLE pin is a high logic input signal and allows turning on/off the controller without cutting the input voltage from the boost regulator circuit. With a high input voltage ( $1.2V < V_{EN} < V_I + 0.3V$ ) on this pin, the device is allowed to work normally. No pull-up or pull down is present on this pin.

### 5.4 OVP

If the regulation loop is cut, there is no signal at the feedback pin, the PFM controller will then continue to switch without control and generate an output voltage at the SW,  $V_{CAP}$  and  $V_O$  pin exceeding the breakdown value  $V_{BSW}$ ,  $V_{BCAP}$  and  $V_{BO}$ .

The Over Voltage Protection (OVP) senses the voltage at the  $V_{CAP}$  pin. When the voltage exceed the breakdown voltage of the device the controller is automatically turned Off.

A hysteresis control allows the device restarting automatically since the output voltage drops down below a 2V typical value.



## 5.5 Load isolation switch

When the device is in shutdown mode it exists always a DC current path from the power source to the load that contributes to increase the stand by consumption. A high side switch LDS isolates the load from the source when the STOD2540 is disabled.

## 5.6 Efficiency

The total consumption of some PMOLED display can be as low as 1mA. In order to increase the battery run time of the device, STOD2540 offers a high efficiency over a wide range of load and input voltage range.

## 6 Typical application

Figure 3. Basic Connection

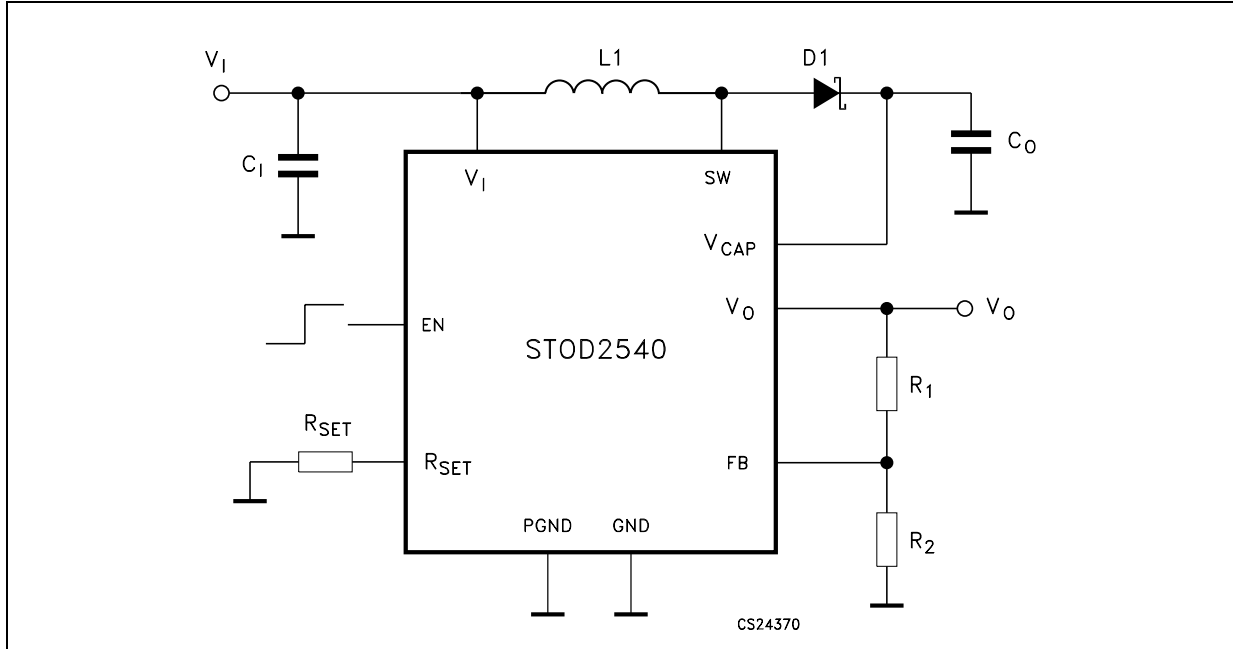


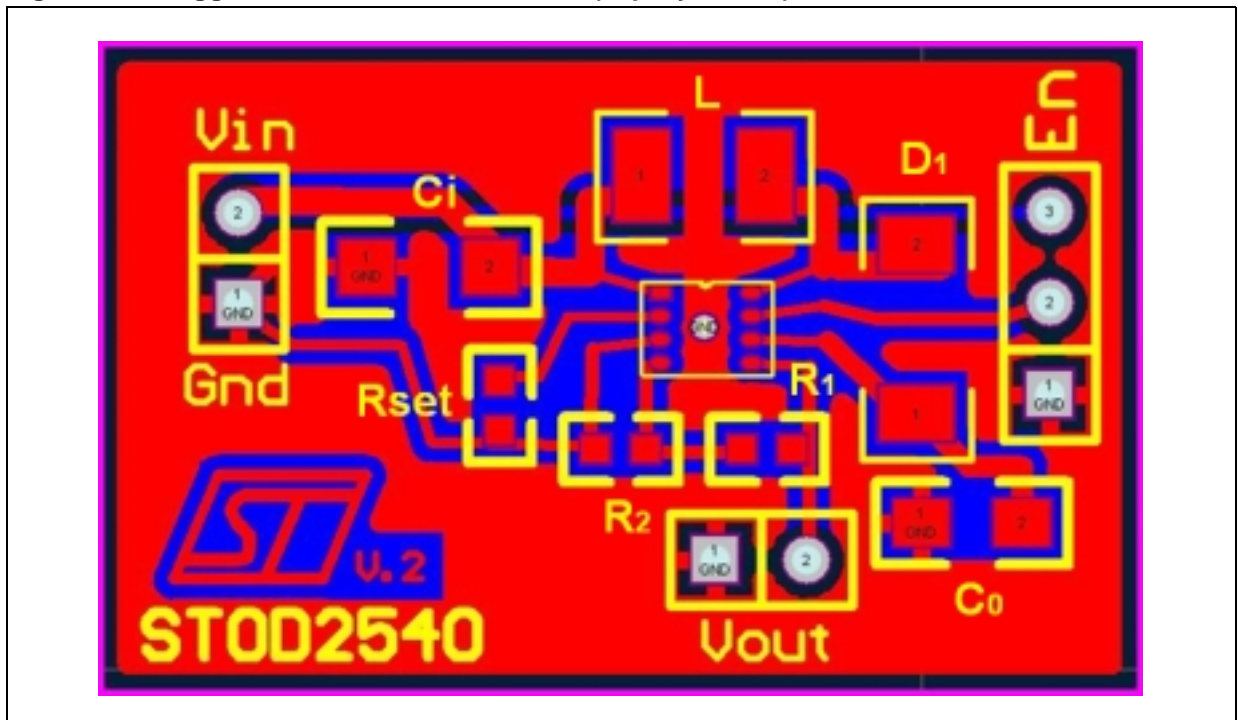
Table 5. External components (see fig. 3 and note)

| Symbol           | Parameter                           | Test   | Min. | Typ. | Max. | Unit          |
|------------------|-------------------------------------|--|------|------|------|---------------|
| D                | Boost schottky diode                | VRRM   | 30   |      |      | V             |
|                  |                                     | $V_F$ at $I_F = 300\text{mA}$ , $T_J = 25^\circ\text{C}$ |      |      | 0.5  | V             |
|                  |                                     | $I_R$ at $V_R = 10\text{V}$ , $T_J = 25^\circ\text{C}$   |      |      | 30   | $\mu\text{A}$ |
| R <sub>1</sub>   | Feedback resistor                   |  |      | 180  |      | k $\Omega$    |
| R <sub>2</sub>   | Feedback resistor                   |  |      | 10   |      |               |
| R <sub>SET</sub> | Peak current limit adjust           | $I_{PK} = 100\text{mA to } 1.5\text{A}$                  | 2    |      | 100  |               |
| C <sub>O</sub>   | Output capacitance: ceramic low ESR | Capacitance  | 4.7  |      |      | $\mu\text{F}$ |
|                  |                                     | Voltage  | 42   |      |      | V             |
|                  |                                     | ESR  |      |      | 1.6  | $\Omega$      |
| L                | Boost inductor (height < 2mm)       | Inductance   |      |      | 4.7  | $\mu\text{H}$ |
|                  |                                     | $I_{SAT}$ , R <sub>SET</sub> pin to V <sub>I</sub>       |      |      | 1    | A             |

Note: The external components proposal should be considered as a design reference guide. The performances mentioned in the electrical characteristics table are not guaranteed for all the possible electrical parameters of the components included in this list. On other hand the operation of STOD2540 is not limited with the use of components included in this list.

## 6.1 Demoboard

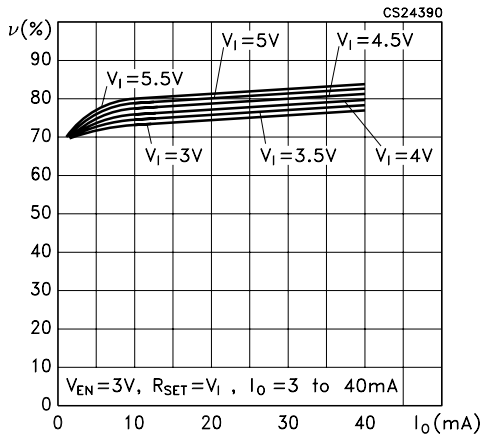
Figure 4. Suggested demoboard schematic (Top layer view)



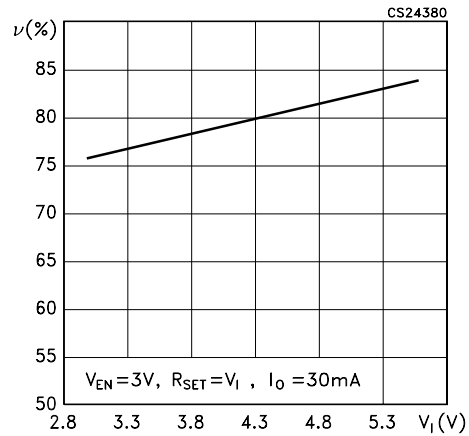
# 7 Typical performance characteristics

( $T_J = 40^\circ\text{C}$  to  $85^\circ\text{C}$ ,  $V_I = 3.6\text{V}$ ,  $V_{EN} = 3\text{V}$ ,  $C_I = C_O = 4.7\mu\text{F}$ ,  $L = 4.7\mu\text{H}$ ,  $R_1 = 180\text{k}\Omega$ ,  $R_2 = 10\text{k}\Omega$ ,  $V_O = 24\text{V}$ , Typ. values @  $25^\circ\text{C}$ , unless otherwise specified)

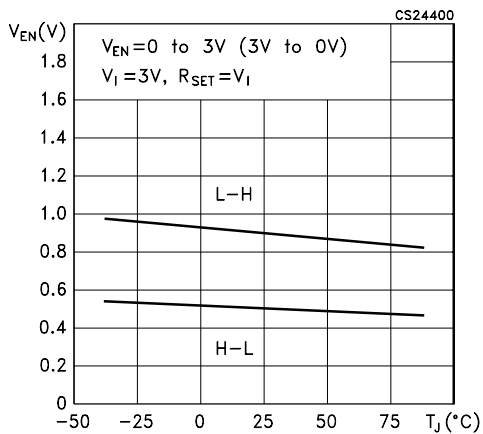
**Figure 5. Efficiency vs output current**



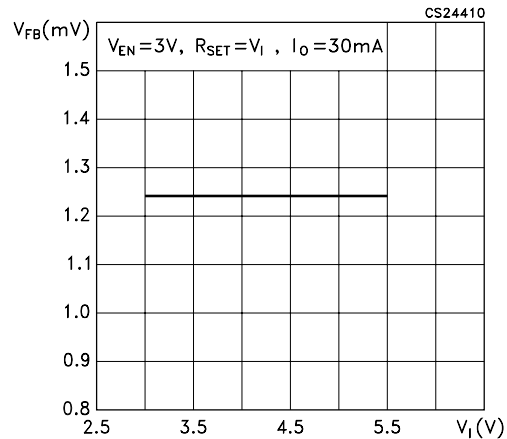
**Figure 6. Efficiency vs input voltage**



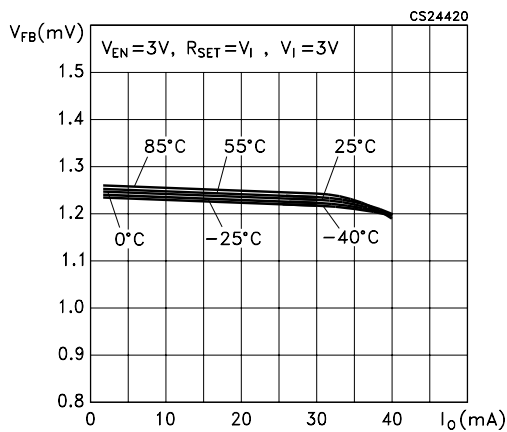
**Figure 7. V\_EN vs temperature**



**Figure 8. V\_FB vs input voltage**



**Figure 9. V\_FB vs output current**



**Figure 10. V\_FB vs output current**

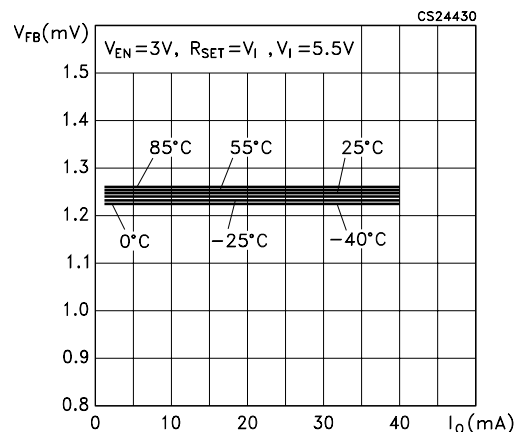


Figure 11.  $V_{OVP}$  vs temperature

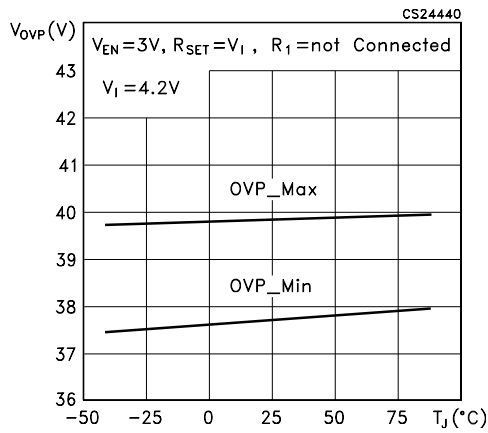


Figure 12.  $V_{RIPPLE}$  vs input voltage

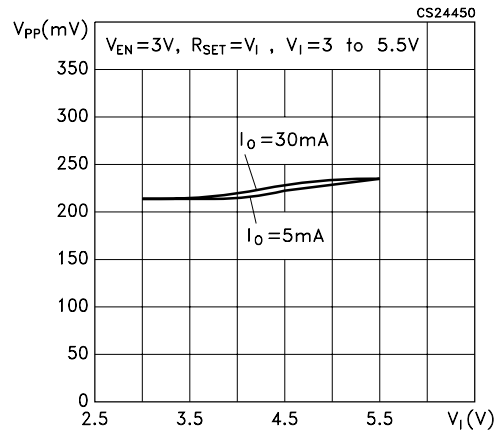


Figure 13.  $I_{LIM\_MAX}$  vs input voltage

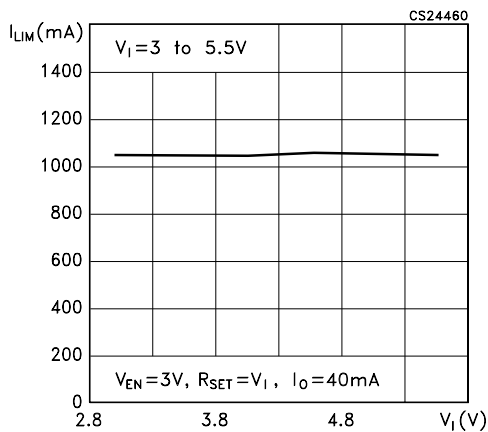


Figure 14.  $I_{LIM\_MAX}$  vs temperature

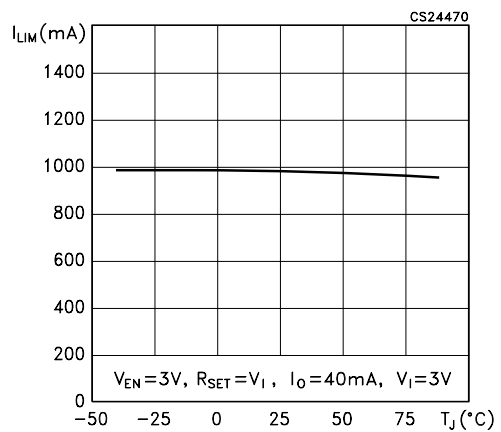


Figure 15.  $I_{LIM\_MAX}$  vs  $R_{SET}$

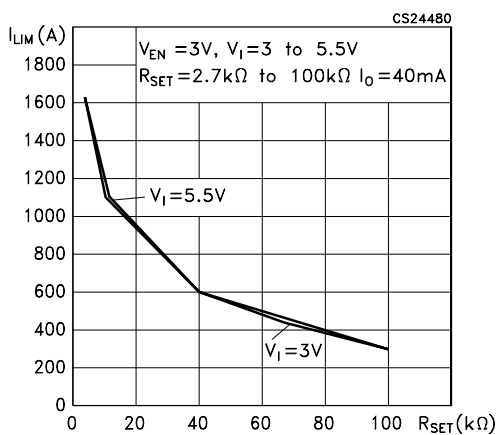


Figure 16.  $I_Q$  vs temperature

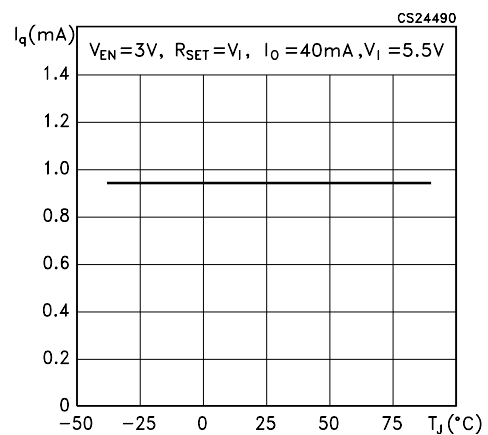


Figure 17.  $T_{ON\_MAX}$  vs temperature

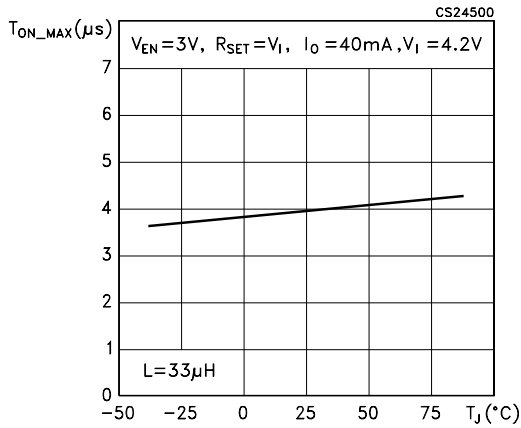


Figure 18.  $T_{OFF\_MIN}$  vs temperature

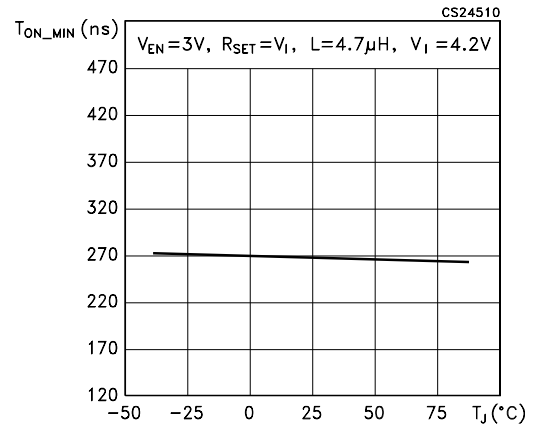


Figure 19. Line  $V_{FB}$  vs temperature

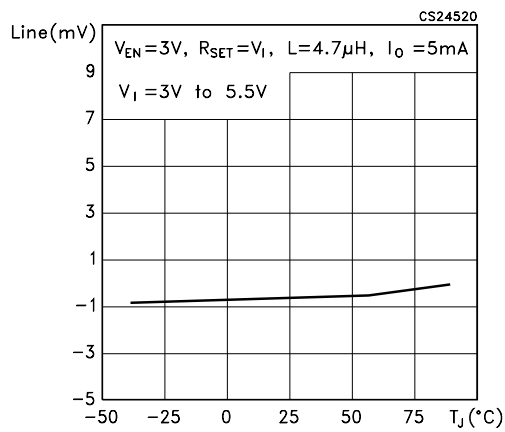
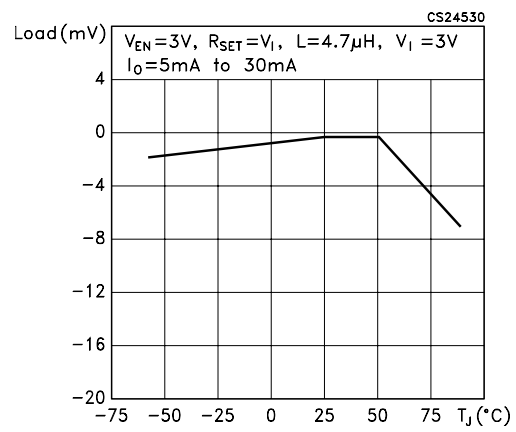


Figure 20. Load  $V_{FB}$  vs temperature

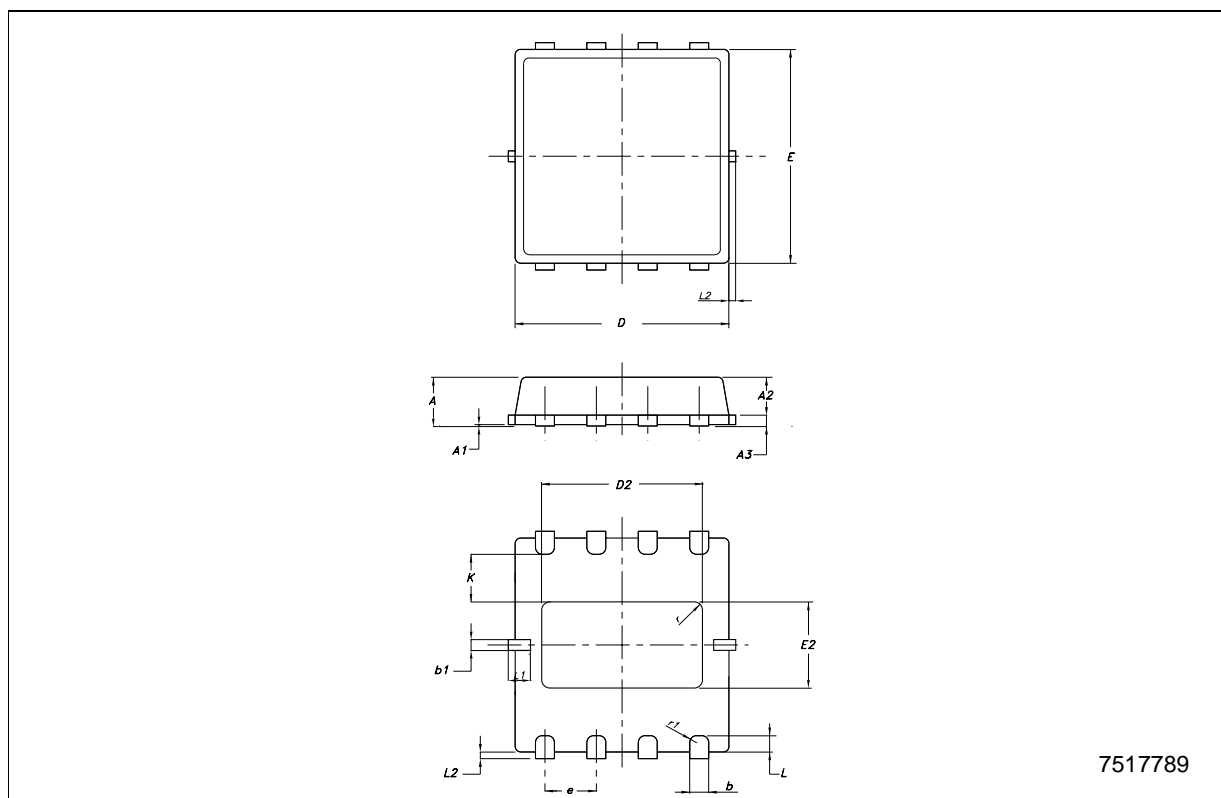


## 8 Package mechanical data

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](http://www.st.com).

**QFN8 (3x3) MECHANICAL DATA**

| DIM. | mm.  |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 0.80 | 0.90 | 1.00 | 0.032 | 0.035 | 0.039 |
| A1   |      | 0.03 | 0.05 |       | 0.001 | 0.002 |
| A2   | 0.65 | 0.70 | 0.75 | 0.026 | 0.028 | 0.030 |
| A3   | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 |
| b    | 0.29 | 0.31 | 0.39 | 0.011 | 0.012 | 0.015 |
| b1   | 0.17 |      | 0.30 | 0.007 |       | 0.012 |
| D    |      | 3.00 |      |       | 0.118 |       |
| D2   | 1.92 | 2.02 | 2.12 | 0.076 | 0.080 | 0.084 |
| E    |      | 3.00 |      |       | 0.118 |       |
| E2   | 1.11 | 1.21 | 1.31 | 0.044 | 0.048 | 0.052 |
| e    |      | 0.65 |      |       | 0.026 |       |
| K    | 0.20 |      |      | 0.008 |       |       |
| L    | 0.20 | 0.29 | 0.45 | 0.008 | 0.011 | 0.018 |
| L1   | 0.16 | 0.24 | 0.40 | 0.006 | 0.009 | 0.016 |
| L2   |      |      | 0.13 |       |       | 0.005 |
| r    |      | 0.15 |      |       | 0.006 |       |
| r1   |      | 0.15 |      |       | 0.006 |       |

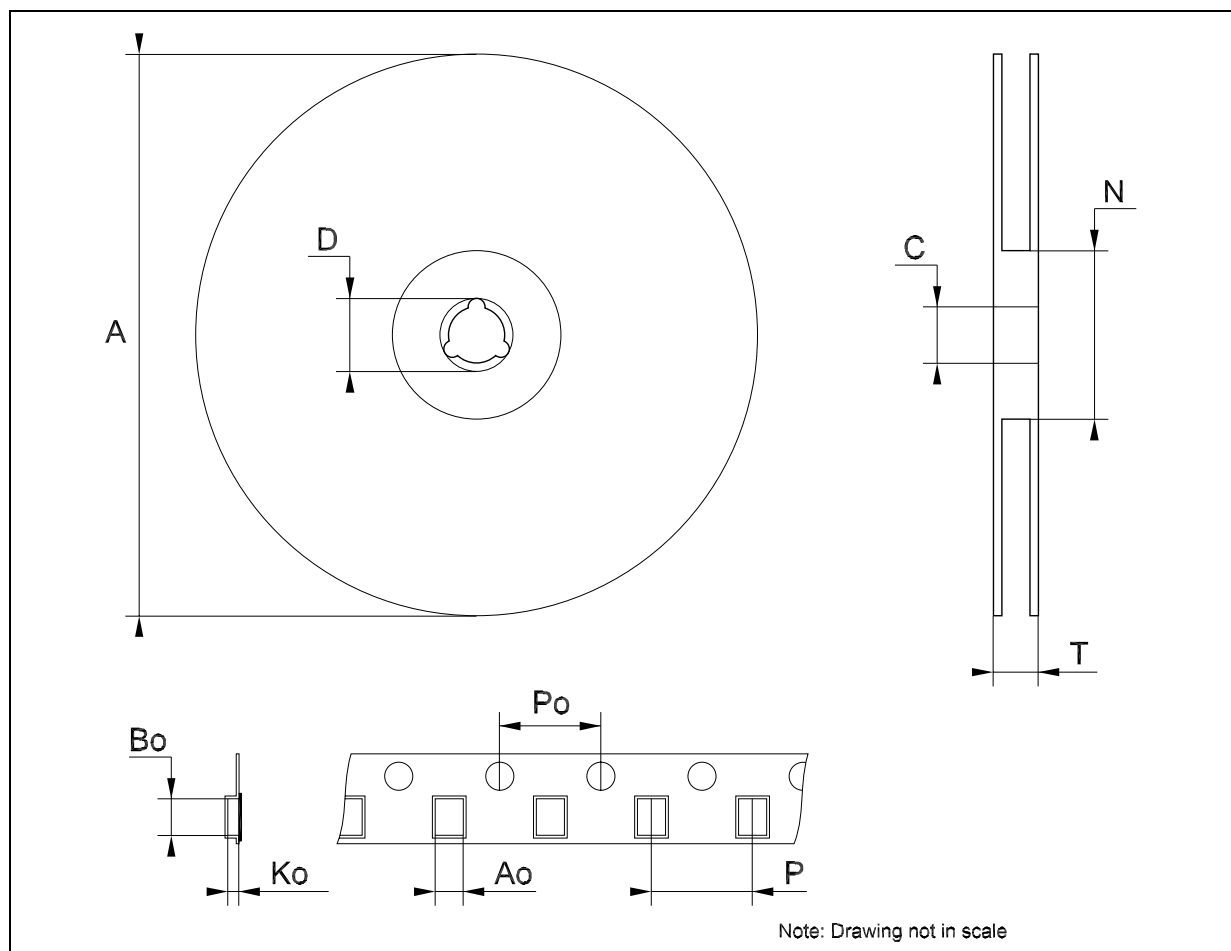


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**Tape & Reel QFNxx/DFNxx (3x3) MECHANICAL DATA**

| DIM. | mm.  |     |      | inch  |       |        |
|------|------|-----|------|-------|-------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP.  | MAX.   |
| A    |      |     | 330  |       |       | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |       | 0.519  |
| D    | 20.2 |     |      | 0.795 |       |        |
| N    | 60   |     |      | 2.362 |       |        |
| T    |      |     | 18.4 |       |       | 0.724  |
| Ao   |      | 3.3 |      |       | 0.130 |        |
| Bo   |      | 3.3 |      |       | 0.130 |        |
| Ko   |      | 1.1 |      |       | 0.043 |        |
| Po   |      | 4   |      |       | 0.157 |        |
| P    |      | 8   |      |       | 0.315 |        |



## 9 Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes                         |
|-------------|----------|---------------------------------|
| 22-Mar-2006 | 1        | Initial release.                |
| 03-Apr-2006 | 2        | Add fig. 2 demoboard on page 3. |

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