



STCF01

Step-up Converter for Cell Phone Camera Flash LEDs

Preliminary Data

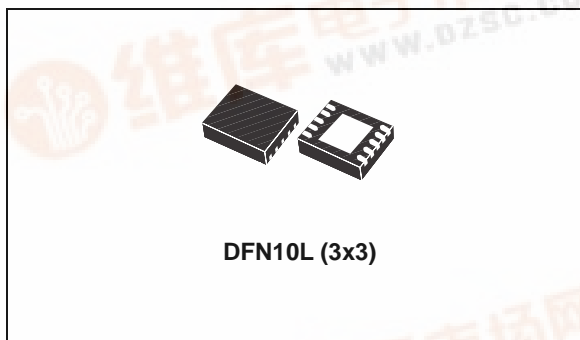
Features

- Supply voltage range: 2.6V to 5.5V
- 17V Maximum Output Voltage
- Two levels of current up to 300mA set with external resistors
- Dedicated pin to select the required level of current
- Operating frequency: 1.5MHz: PWM Controller
- Torch mode supported
- Shutdown pin with true load disconnection
- Efficiency: 90% at 100mA; 80% at 300mA
- DFN10L (3mm x 3mm) Package

Description

The STCF01 is a dedicated IC designed to drive two, three, or four white, cell phone camera flash LEDs with constant current. The step-up (boost) converter input is connected directly to the battery, and its converter output voltage is automatically determined using current feedback-based duty cycle control.

The STCF01 has a dedicated pin for two levels of LED current selection. An external resistor is used



DFN10L (3x3)

to set the required current for each level. Compared to the linear current control technique, this method allows designers to achieve the best and most efficient performance possible with the selected current, thereby avoiding linear element losses.

The Shutdown (SHDN) pin saves power when the camera flash is not used by consuming less than 0.1µA of current. When the SHDN pin is high (logic '1'), the device is turned OFF and there is no DC current path from the supply to the white LEDs (Load Disconnect). If it is held to GND, the output current continuously flows through the LEDs (Torch mode). The SHDN pin, when it is set to low (logic '0'), is also used to set the flash function time duration.

Order Codes

| Type | Package | Comments |
|-----------|--------------------|---------------------|
| STCF01PMR | DFN10L (3mm x 3mm) | 4500 parts per reel |

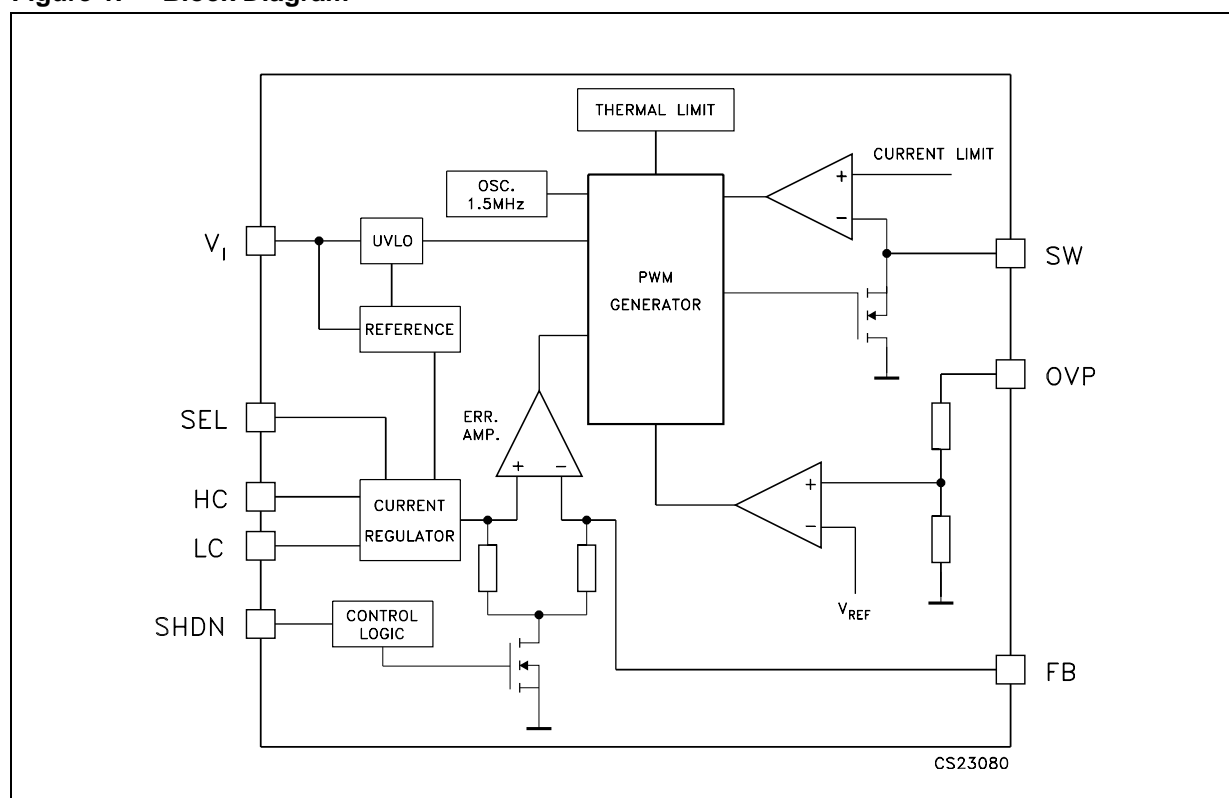


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1 Diagram

Figure 1. Block Diagram



2 Pin Configuration

Figure 2. Pin Connections (Top View)

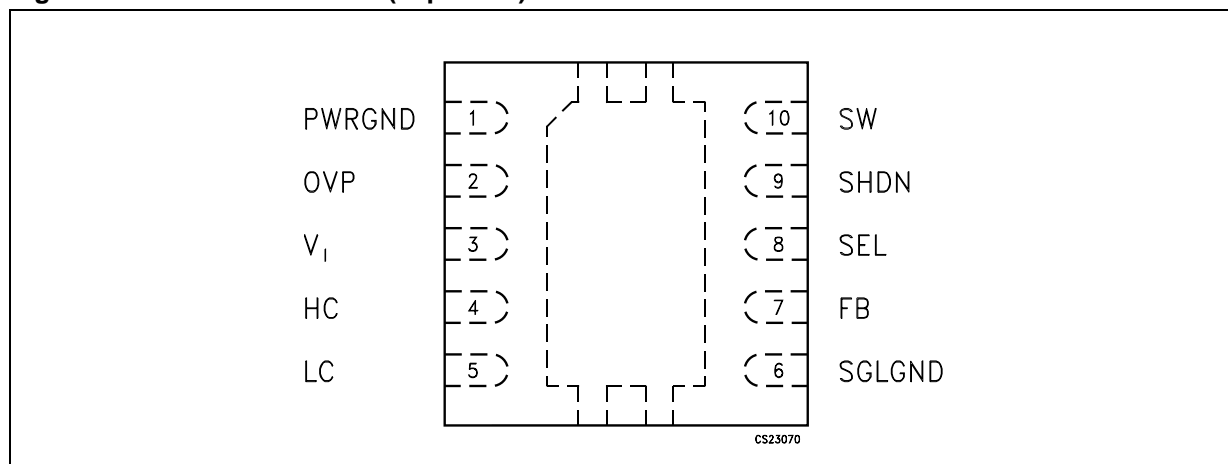
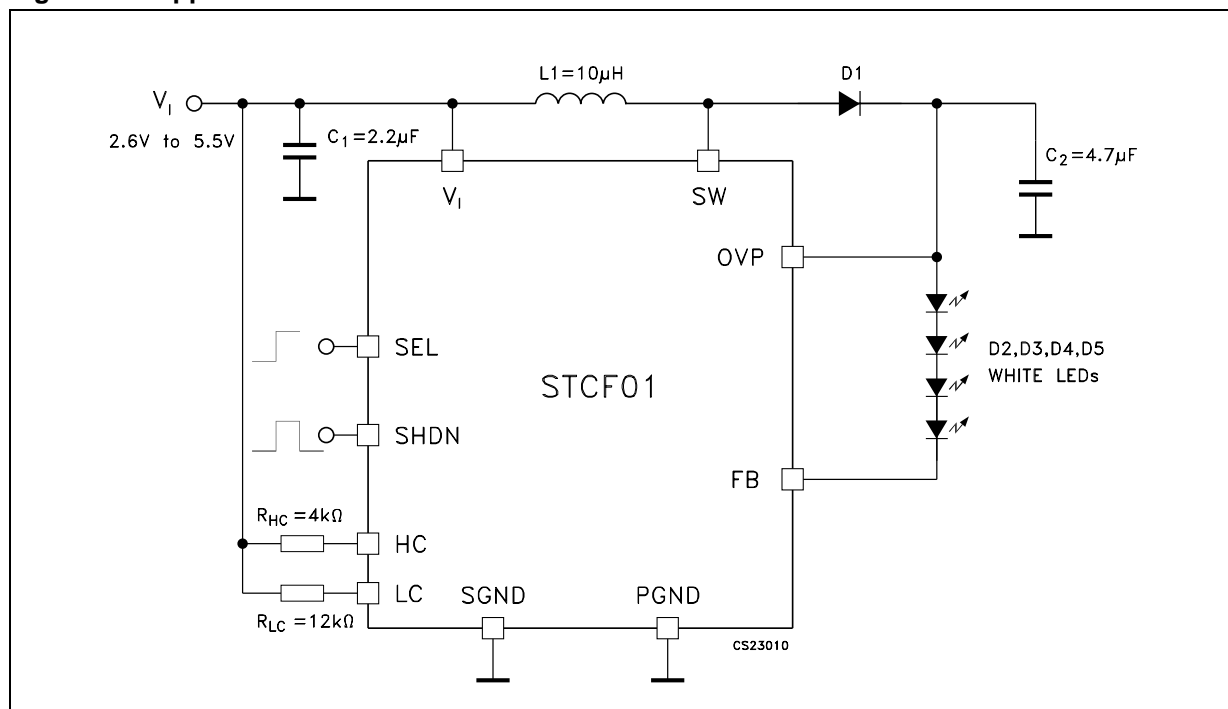


Table 1. Pin Description

| PIN N° | SYMBOL | NOTE |
|--------|--------|---|
| 1 | PWRGND | This is the application power signal reference. Connect the input and output capacitors to this pin. |
| 2 | OVP | This pin senses step-up output voltage, which provides overvoltage protection in the event that the output voltage exceeds the OVP threshold |
| 3 | V_I | This pin supplies the input voltage for the step-up stage as well as the supply voltage for the overall device. |
| 4 | HC | This pin sets the high level current for the white LEDs with a resistor that is connected between this pin and V_I . |
| 5 | LC | This pin sets the low level current for the white LEDs with a resistor that is connected between this pin and V_I . |
| 6 | SGLGND | This pin is the logic signal reference for the IC. |
| 7 | FB | This pin senses the current flowing through the white LEDs and uses this feedback to provide current regulation. |
| 8 | SEL | This pin is used to select the signal level of the white LEDs; a low level signal sets the low level LED current, while the high level signal sets the high level LED current. |
| 9 | SHDN | This pin enables or disables the Shutdown mode. A high level signal enables device Shutdown mode, where most of the device internal logic is turned OFF. If this pin is held to GND, the output current flows through the LEDs continuously (Torch mode). |
| 10 | SW | This is the switch node pin, which is connected to the internal N-channel MOSFET drain. |

3 Application Information

Figure 3. Application Circuit



4 Maximum Ratings

Table 2. Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit |
|--------------------------|---|---------------------|------------------|
| V_I | DC Input Voltage to SGLGND | -0.3 to 6 | V |
| V_{SW} | Switch Voltage | -0.3 to 20 | V |
| FB, SEL, SHDN, LC, HC | Voltage Range | -0.3 to $V_I + 0.3$ | V |
| OVP | Over Voltage Protection | -0.3 to 20 | V |
| ESD | Human Body Model | ± 2 | kV |
| P_{TOT} | Continuous Power Dissipation (at $T_A = 70^\circ\text{C}$) | 1.5 | mW |
| T_{OP} | Operating Junction Temperature Range | -40 to 85 | $^\circ\text{C}$ |
| T_J | Junction Temperature | -40 to 125 | $^\circ\text{C}$ |
| T_{STG} | Storage Temperature Range | -65 to 150 | $^\circ\text{C}$ |

Note: Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional Operation under these conditions is not implied.

Table 3. Thermal Data

| Symbol | Parameter | Value | Unit |
|------------|-------------------------------------|-------|--------------------|
| R_{thJA} | Thermal Resistance Junction-Ambient | 30.9 | $^\circ\text{C/W}$ |
| R_{thJC} | Thermal Resistance Junction-Case | 2.96 | $^\circ\text{C/W}$ |

5 Electrical Characteristics

Table 4. DC Electrical Characteristics

($T_J = -40^{\circ}\text{C}$ to 85°C , $V_I = 3.6\text{V}$, $C_I = 2.2\mu\text{F}$, $C_O = 4.7\mu\text{F}$, $L = 10\mu\text{H}$, $R_{LC} = 12\text{k}\Omega$, $R_{HC} = 4\text{k}\Omega$, $V_{OVP} = 8\text{V}$, Typ. values @ 25°C , unless otherwise specified)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|--------------------------------------|---|----------------------|---------------------|----------------------|------|
| General Section | | | | | | |
| V _I | Max Operation Supply Voltage | | | | 5.5 | V |
| V _{UVLO} | Under Voltage lockout threshold | V _{SEL} = 0V, V _{SHDN} = 0V, Min. duty cycle | 2.3 | 2.45 | 2.6 | V |
| I _Q | Quiescent Current | V _{SEL} = 0V | | 2.3 | 3 | mA |
| | | Shutdown Mode | | 0.1 | 0.5 | μA |
| f _{SW} | Switching Frequency | V _{SEL} = 0V, V _{SHDN} = 0V | 1.2 | 1.5 | 1.8 | MHz |
| V _{OVP} | Over Voltage Threshold | No Load | 17 | 18 | 19 | V |
| I _{PKMax} | Maximum Inductor Current | V _{SHDN} = 0V | | 1.2 | | A |
| Current Control | | | | | | |
| V _{HC} | HC Pin Voltage | V _{SEL} = 3V, V _{SHDN} = 0V | V _I -0.65 | V _I -0.6 | V _I -0.55 | V |
| V _{LC} | LC Pin Voltage | V _{SEL} = 0V, V _{SHDN} = 0V | V _I -0.65 | V _I -0.6 | V _I -0.55 | V |
| I _{LED} /I _{HC} | High Level Current Multiplier | V _{SEL} = 3V, V _{SHDN} = 0V (25°C) | 1900 | 2100 | 2300 | A/A |
| I _{LED} /I _{LC} | Low Level Current Multiplier | V _{SEL} = 0V, V _{SHDN} = 0V (25°C) | 2200 | 2400 | 2600 | A/A |
| R _{ONFB} | Resistance ON Feedback | I _{FB} = 100mA | | 1.2 | | Ω |
| I _{FB(LEAK)} | Current Feedback Leakage | V _{SHDN} = 3V, V _{FB} = V _I | | 0.1 | 1 | μA |
| Switch Section | | | | | | |
| R _{ON} | Internal Switch ON-Resistance | I _{SW} = 1A <i>Note: 1</i> | | 0.3 | | Ω |
| I _{SW(LEAK)} | Internal Switch Leakage Current | V _{SHDN} = 3V, V _{SW} = 16.5V | | 0.1 | 1 | μA |
| D _{MAX} | Maximum Duty Cycle | I _{FB} = 0mA | | 90 | | % |
| D _{MIN} | Minimum Duty Cycle | I _{FB} = 200mA; V _{SEL} = 0V Pulse Skipping | | 0 | | % |
| Control Input Section | | | | | | |
| V _{H(SEL)} V _{H(SHDN)} | SEL and SHDN Input High Threshold | V _I = 2.6V | 1.2 | | | V |
| | | V _I = 3.6V | 1.4 | | | |
| | | V _I = 5.5V | 1.6 | | | |
| V _{L(SEL)} V _{L(SHDN)} | SEL and SHDN Input Low Threshold | V _I = 2.6V | | | 0.4 | V |
| | | V _I = 3.6V | | | 0.5 | |
| | | V _I = 5.5V | | | 0.6 | |
| Thermal Shutdown | | | | | | |
| T _{SD} | Thermal Shutdown | | | 145 | | °C |
| T _{HS} | Thermal Shutdown Hysteresis | | | 15 | | °C |

Note: 1 Typical value, not production tested

6 Detailed Description

The STCF01 white Led boost converter drives two up to four white LEDs with a constant current. It needs few external components: two ceramic capacitors ($C_I=2.2\mu\text{F}$ $C_O=4.7\mu\text{F}$), one inductor $L=10\mu\text{H}$ and one schottky diode. The device works with a minimum $V_I=2.6\text{V}$, and it has an Over Voltage Protection on the output guaranteed at minimum value equal to 17V. This value ensures proper operation with a maximum of four White LEDs in series. In the worst case of $V_I=2.6\text{V}$ at $V_{OVP}=8\text{V}$ (typical value of two LEDs) it is possible to obtain $I_O=270\text{mA}$, while at $V_{OVP}=11\text{V}$ (typical value of three LEDs) it is possible obtain $I_O=180\text{mA}$ ([Figure 4: Maximum Output Current Vs Input Voltage](#)). The maximum IO current is limited by inductor peak current internally set at Typ 1.2A. This feature allows saving the battery life from intensive use of the flash. The SEL pin allows to select high and low current value flowing on the White LEDs.

The two current values are set through external resistors R_{HC} and R_{LC} according the following formula:

$$I_{LED(FLASH)} = 2100 * (V_I - V_{HC}) / R_{HC}$$

$$I_{LED(TORCH)} = 2400 * (V_I - V_{LC}) / R_{LC}$$

An High logic level on SHDN pin puts the device in shutdown mode; if it is hold to Low the flash or torch mode is activated. When the SHDN pin is LOW the device provides the requested current in less than 200 μs (see TURN ON TIME plot). This fast turn-on time makes the device suitable for single shoot and multiple shoot operation modes.

7 Typical Operating Characteristics

($T_J = -40^\circ\text{C}$ to 85°C , $V_I = 3.6\text{V}$, $C_I = 2.2\mu\text{F}$, $C_O = 4.7\mu\text{F}$, $L = 10\mu\text{H}$, $R_{LC} = 12\text{k}\Omega$, $R_{HC} = 4\text{k}\Omega$, $V_{OVP} = 8\text{V}$, Typ. values @ 25°C , unless otherwise specified).

Figure 4. Maximum Output Current Vs Input Voltage

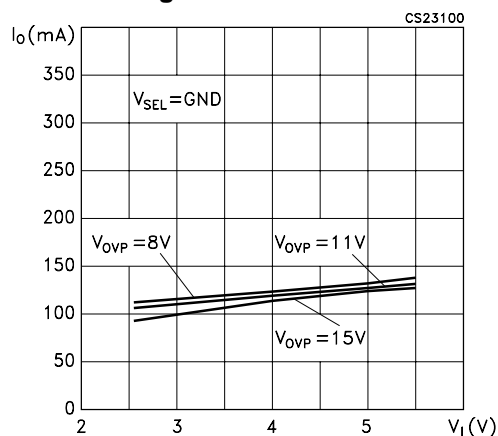


Figure 5. Maximum Output Current Vs Input Voltage

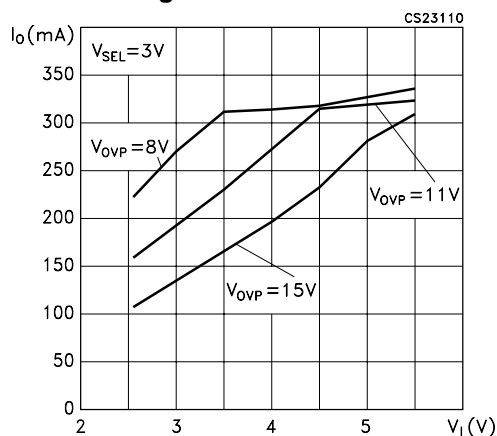


Figure 6. Efficiency Vs Temperature

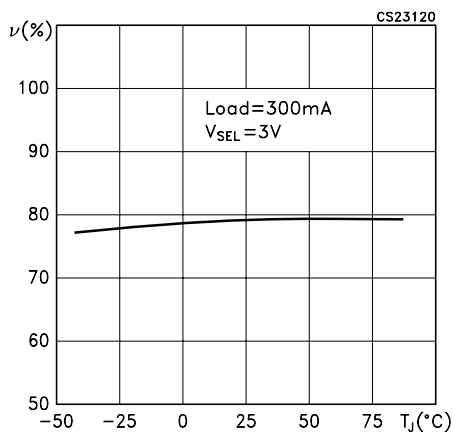


Figure 7. Efficiency Vs Temperature

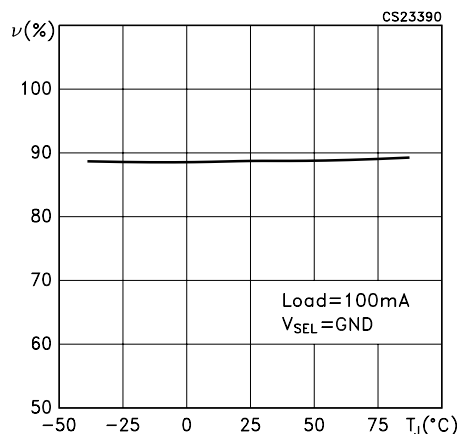


Figure 8. Efficiency vs Temperature

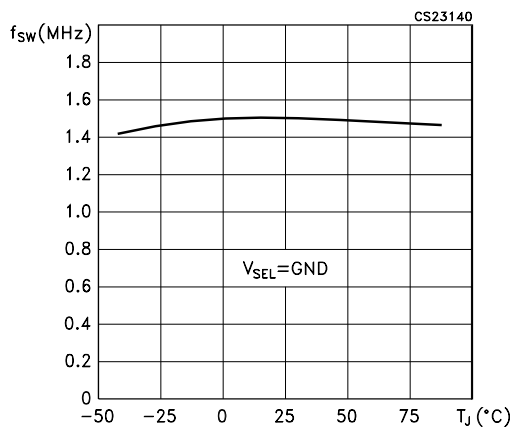


Figure 9. Quiescent Current at Full Operation Vs Temperature

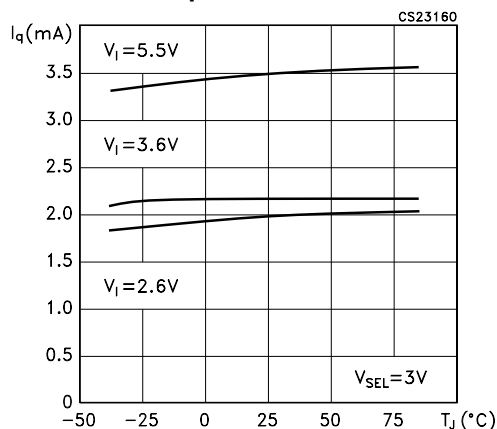


Figure 10. Feedback Voltage Vs Temperature

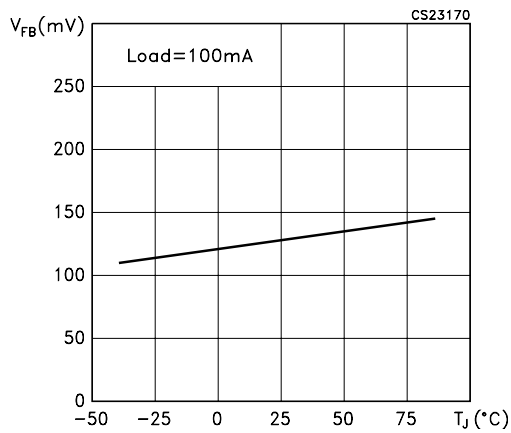


Figure 11. Current Feedback Leakage Vs Temperature

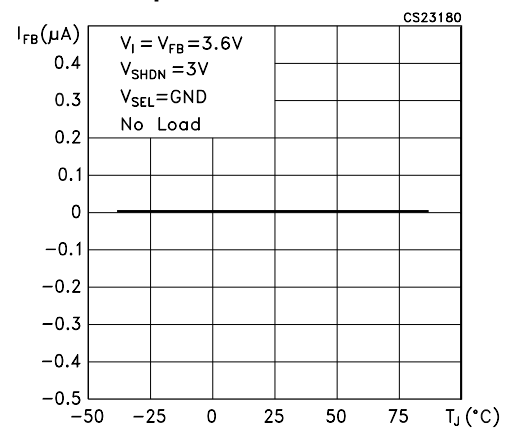
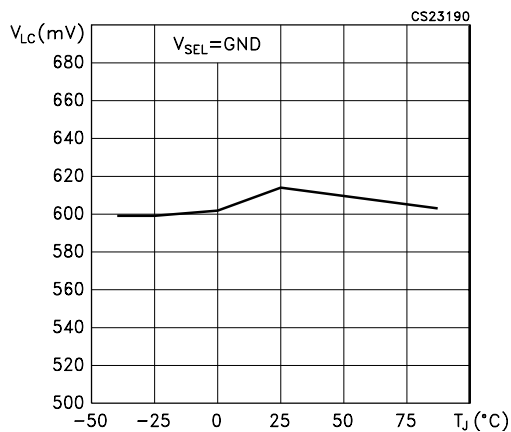
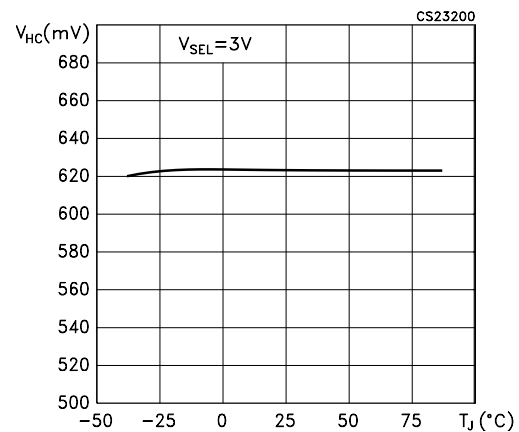
Figure 12. V_I - V_{LC} Vs TemperatureFigure 13. V_I - V_{HC} Vs Temperature

Figure 14. Peak Inductor Current Vs Temperature

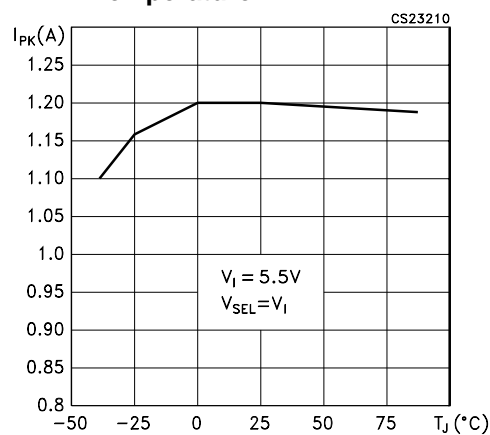
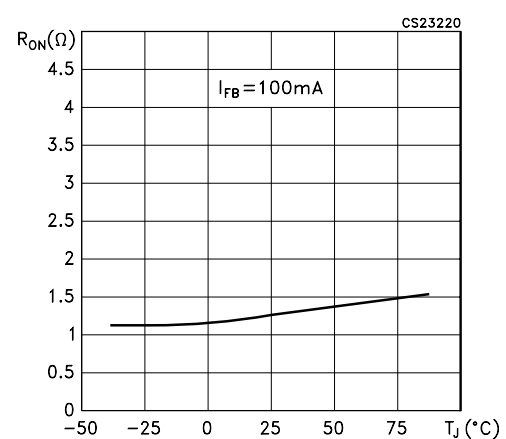
Figure 15. R_{ONFB} Vs Temperature

Figure 16. Maximum Duty Cycle Vs Temperature

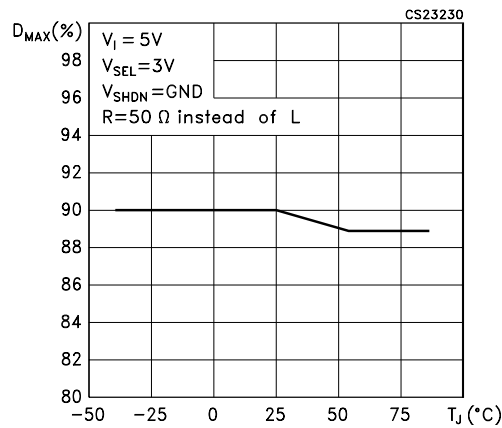


Figure 17. Turn On and Off Response

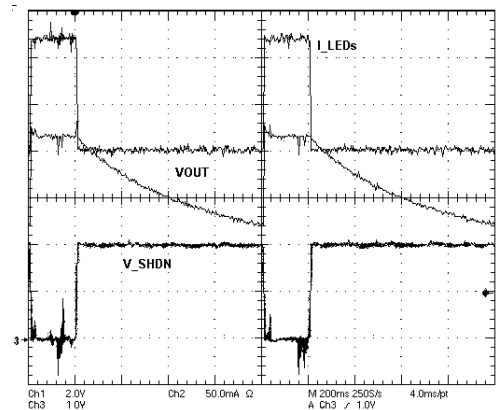
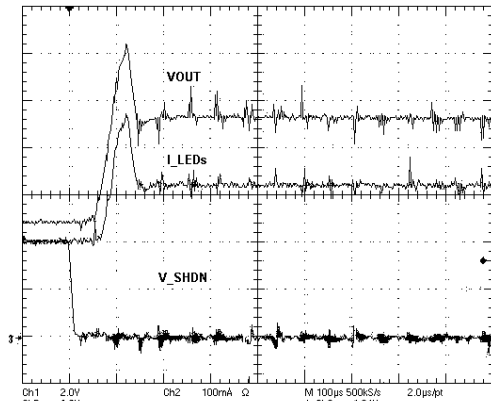
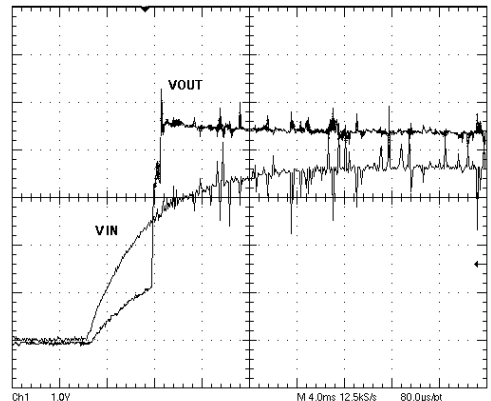


Figure 18. Turn On Time



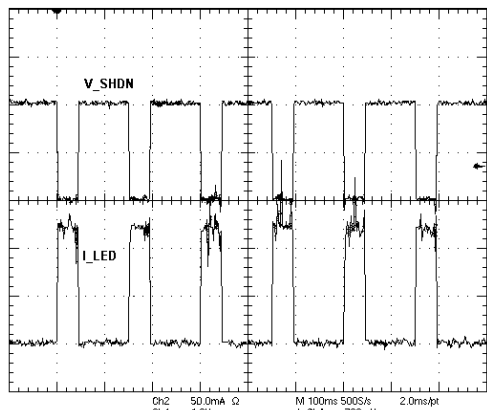
$V_{SHDN} = \text{pulse}$, $FREQ. = 1Hz$, $T_r = T_f = 10\mu s$

Figure 19. Start Up Transient



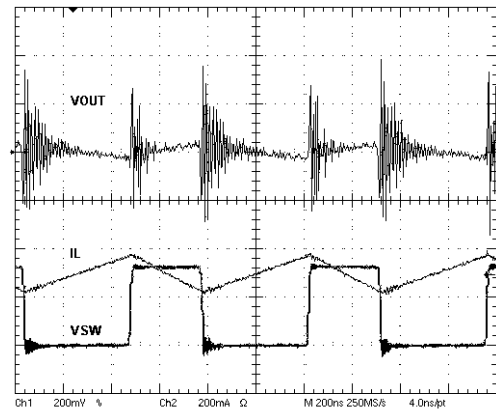
$V_I = 0$ to 3.6V, $V_{SEL} = GND$, $V_{SHDN} = GND$

Figure 20. Multi Shoot Mode



$V_{SEL} = GND$, $V_{SHDN} = \text{pulse}$

Figure 21. Torch Mode Behavior



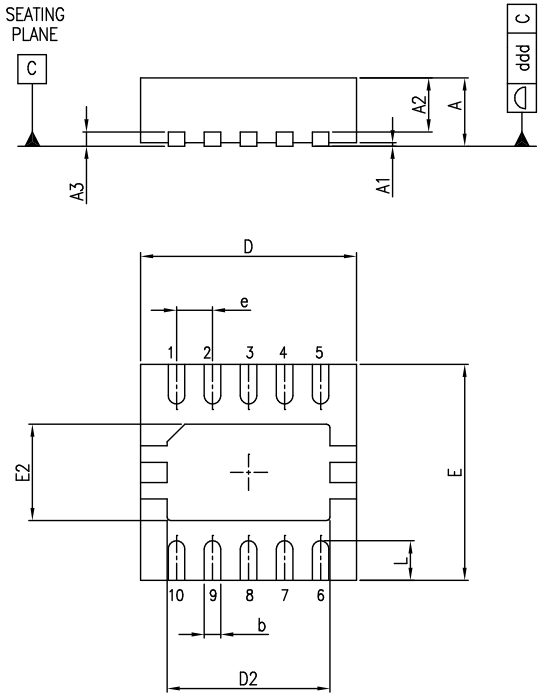
$V_{SEL} = GND$, $V_{SHDN} = GND$

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.

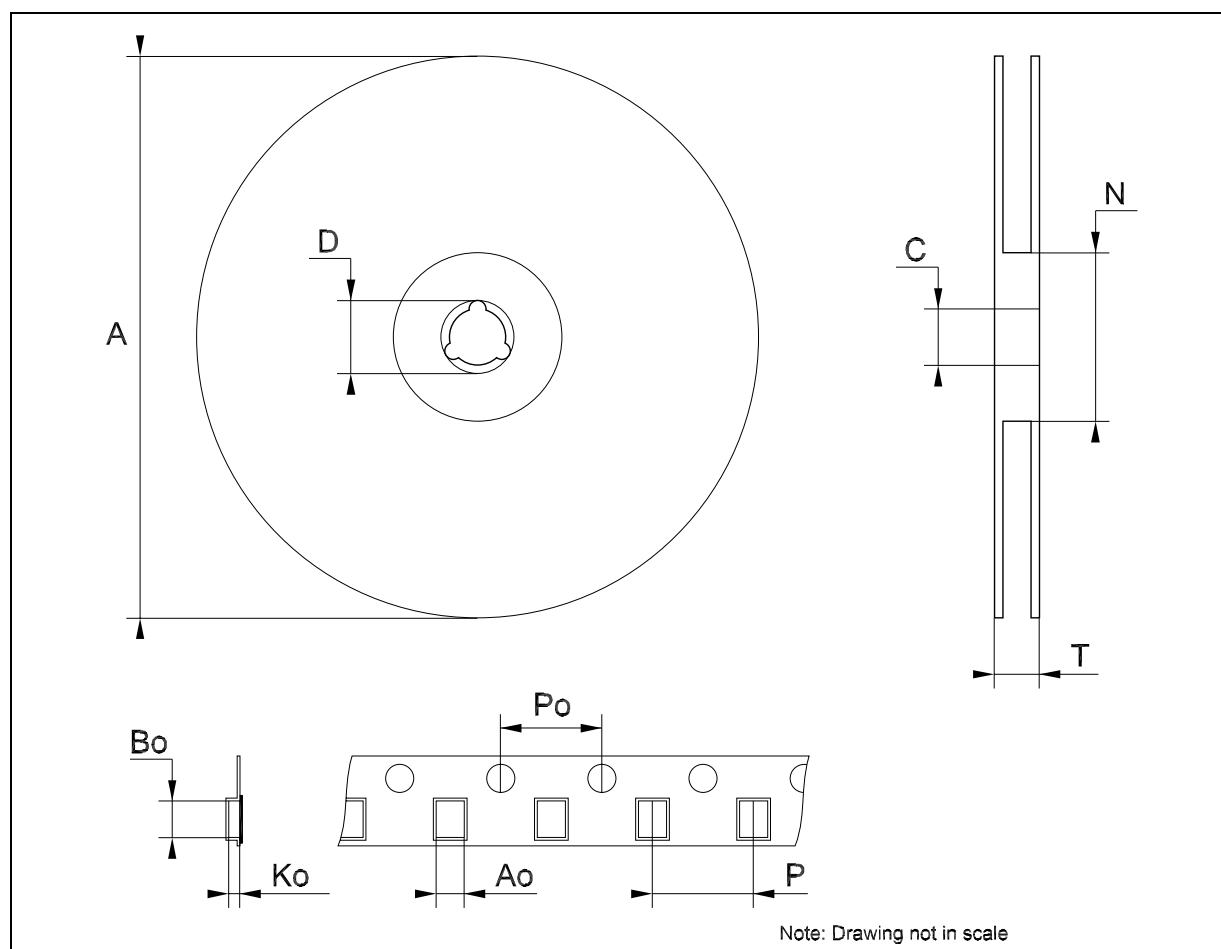
DFN10 (3x3) MECHANICAL DATA

| DIM. | mm. | | | mils | | |
|------|------|------|------|------|-------|------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 0.80 | 0.90 | 1.00 | 31.5 | 35.4 | 39.4 |
| A1 | | 0.02 | 0.05 | | 0.8 | 2.0 |
| A2 | | 0.70 | | | 25.6 | |
| A3 | | 0.20 | | | 7.9 | |
| b | 0.18 | 0.23 | 0.30 | 7.1 | 9.1 | 11.8 |
| D | | 3.00 | | | 118.1 | |
| D2 | 2.21 | 2.26 | 2.31 | 87.0 | 89.0 | 91.0 |
| E | | 3.00 | | | 118.1 | |
| E2 | 1.29 | 1.34 | 1.39 | 50.8 | 52.8 | 54.8 |
| e | | 0.50 | | | 19.7 | |
| L | 0.45 | 0.55 | 0.65 | 17.7 | 21.7 | 25.6 |



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

| Date | Revision | Description of Change |
|-------------|----------|-----------------------|
| 10-Oct-2005 | 1 | First Release. |

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