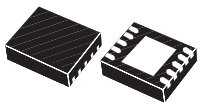
STCF01

Step-up converter for cell phone camera flash LEDs

General features

- Supply voltage range: 2.6V to 5.5V
- 17V Maximum output voltage
- Two current levels 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



DFN10L (3x3)

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 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.

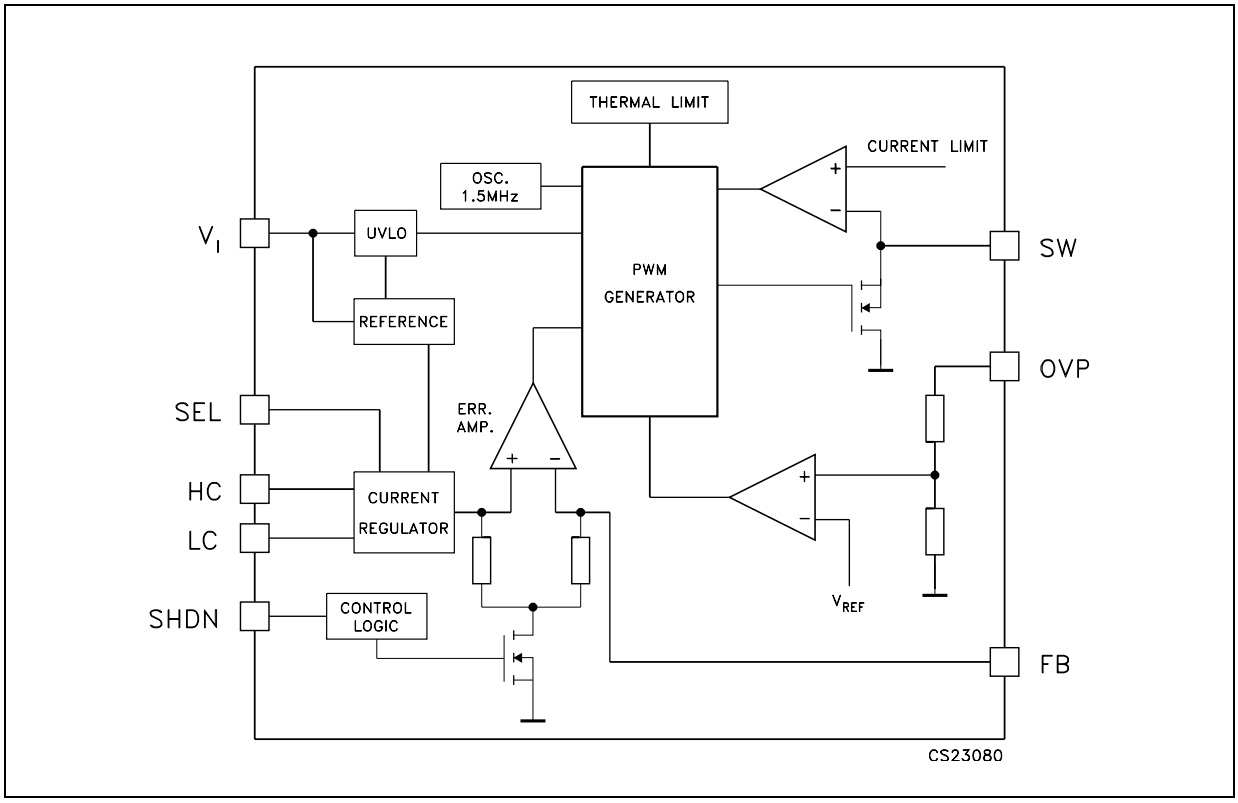
Order code

Part number	Package	Packaging
STCF01PMR	DFN10L (3mm x 3mm)	4500 parts per reel

Contents

1 Diagram

Figure 1. Block diagram



2 Pin configuration

Figure 2. Pin connections (top view)

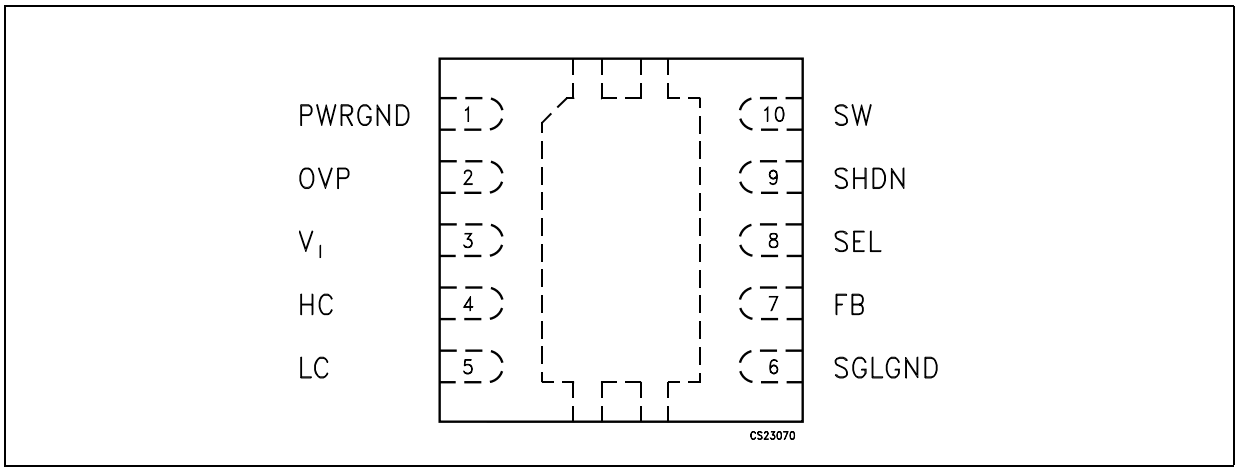
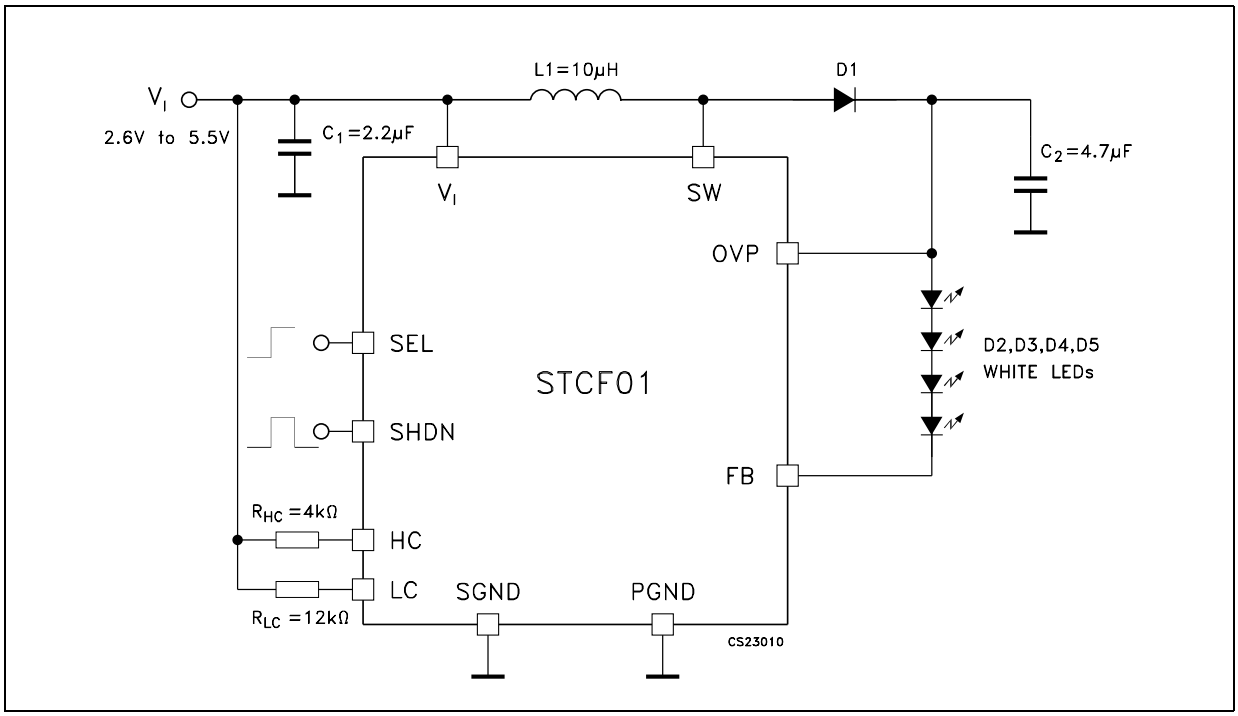


Table 1. Pin description

Pln 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°C)	500	mW
T_{OP}	Operating Junction Temperature Range	-40 to 85	°C
T_J	Junction Temperature	-40 to 125	°C
T_{STG}	Storage Temperature Range	-65 to 150	°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	°C/W
R_{thJC}	Thermal Resistance Junction-Case	2.96	°C/W

5 Electrical characteristics

Table 4. DC Electrical characteristics

(T_J = -40°C to 85°C, V_I = 3.6V, C_I = 2.2µF, C_O = 4.7µF, L = 10µH, R_{LC} = 12kΩ, R_{HC} = 4kΩ, V_{OVP} = 8V, 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
$R_{ON}FB$	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 *Note: 1*		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 from two up to four white LEDs with a constant current. It needs few external components: two ceramic capacitors (C_I=2.2µF C_O=4.7µF), one inductor L=10µH and one schottky diode. The device works with a minimum V_I=2.6V, 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=2.6V at V_{OVP}=8V (typical value of two LEDs) it is possible to obtain I_O=270mA, while at V_{OVP}=11V (typical value of three LEDs) it is possible obtain I_O=180mA (*Figure 4*). The maximum IO current is limited by inductor peak current internally set at Typ 1.2A. This feature allows for a longer battery life as it reduces intensive use of the flash. The SEL pin allows selection of high and low current values flowing on the White LEDs.

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

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

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

A High logic level on SHDN pin puts the device in shutdown mode; if it is held at LOW the flash or torch mode is activated. When the SHDN pin is LOW the device provides the requested current in less than 200µs (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°C to 85°C, V_I = 3.6V, C_I = 2.2µF, C_O = 4.7µF, L = 10µH, R_{LC} = 12kΩ, R_{HC} = 4kΩ, V_{OVP} = 8V, Typ. values @ 25°C, unless otherwise specified).

Figure 4. Maximum output current vs input voltage

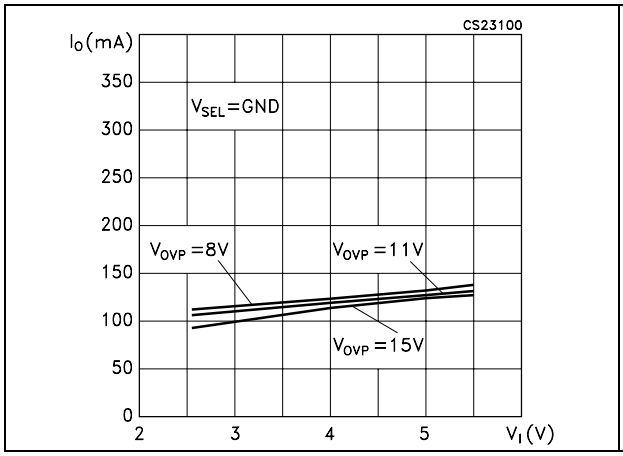


Figure 5. Maximum output current vs input voltage

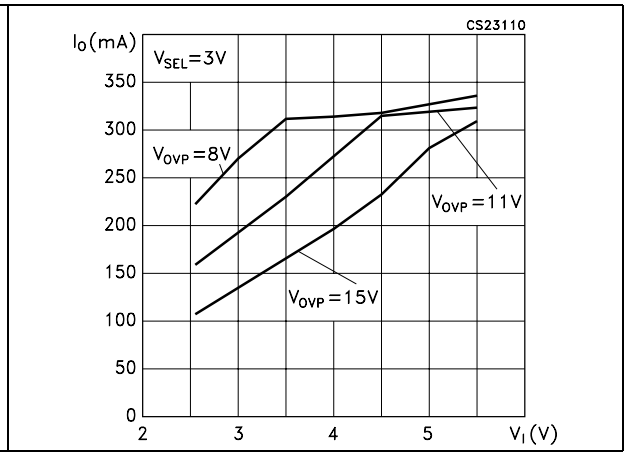


Figure 6. Efficiency vs temperature

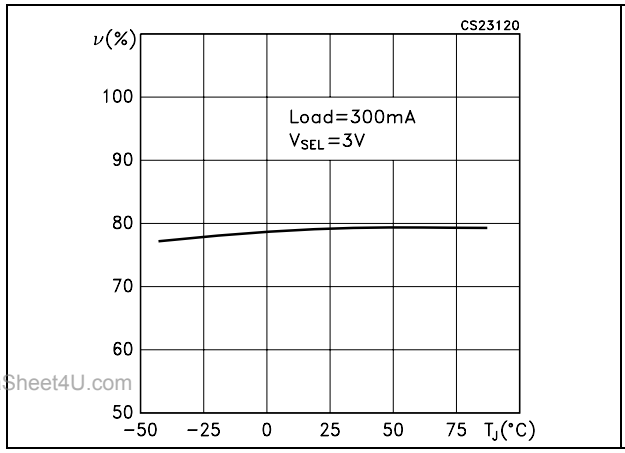


Figure 7. Efficiency vs temperature

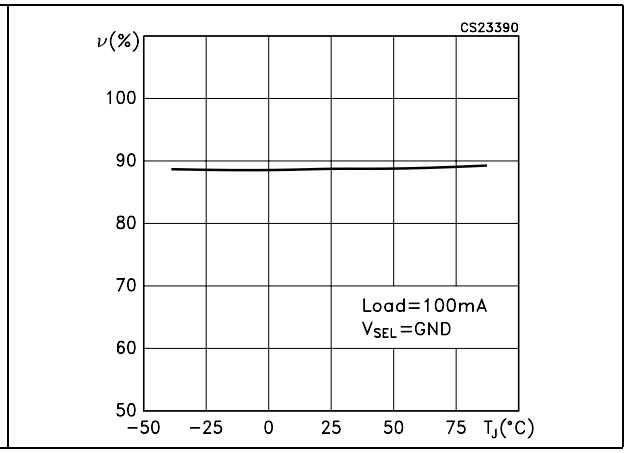


Figure 8. Efficiency vs temperature

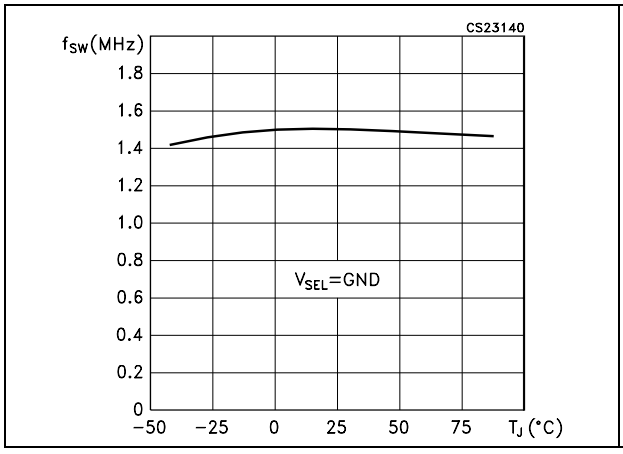


Figure 9. Quiescent current at full operation vs. temperature

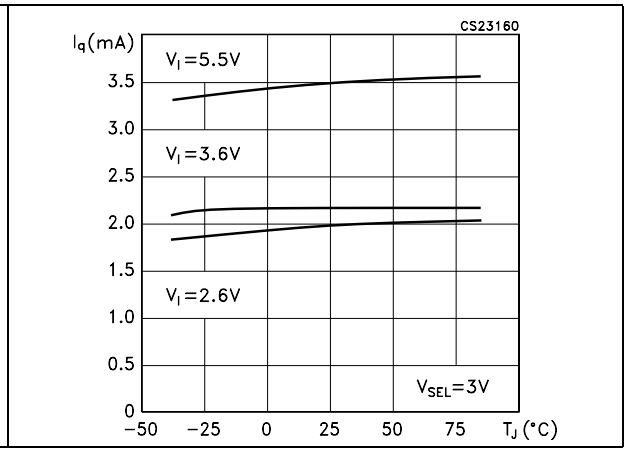


Figure 10. Feedback voltage vs temperature

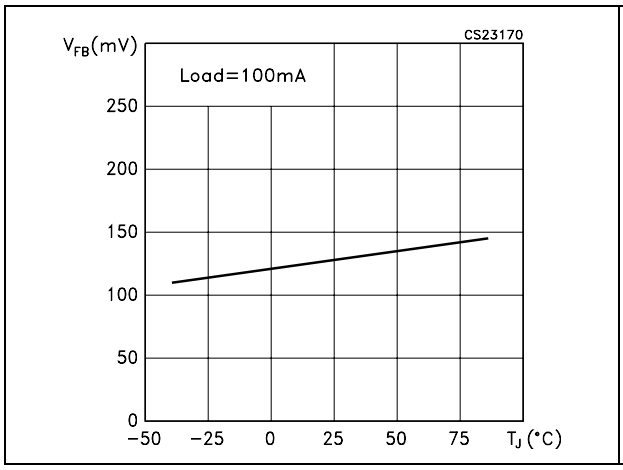


Figure 11. Current feedback leakage vs temperature

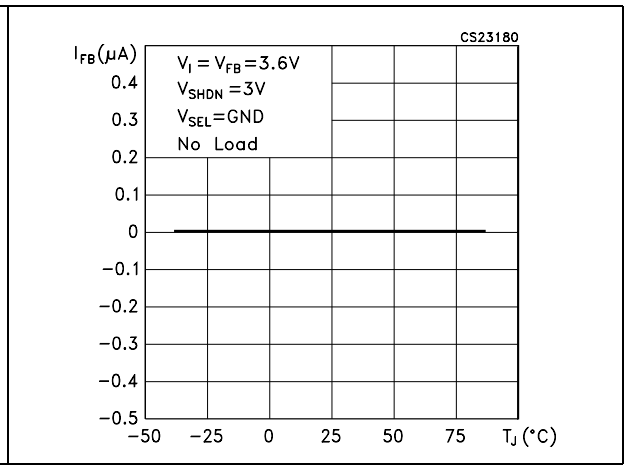


Figure 12. V_I-V_{LC} vs temperature

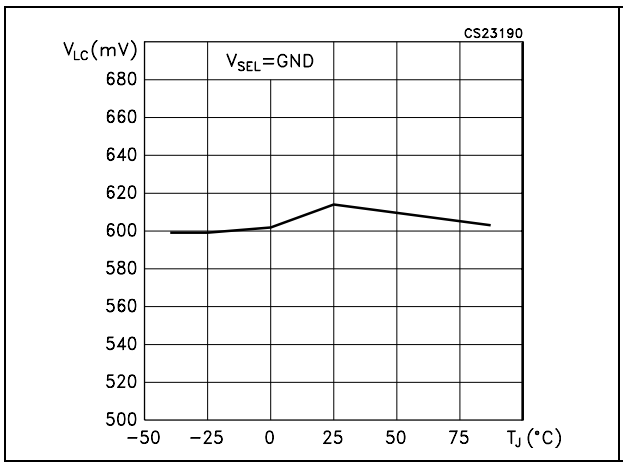


Figure 13. V_I-V_{HC} vs temperature

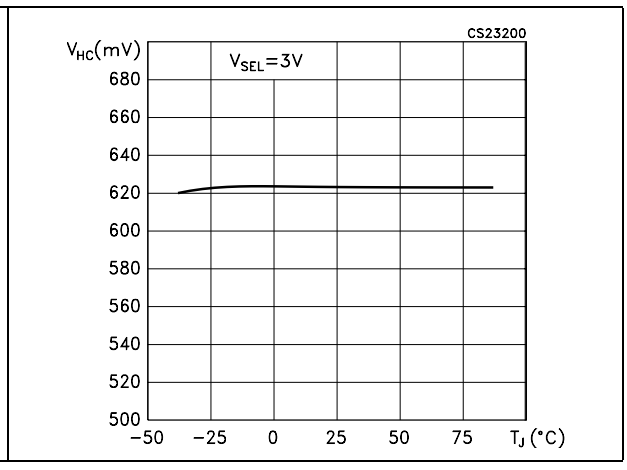


Figure 14. Peak inductor current vs temperature

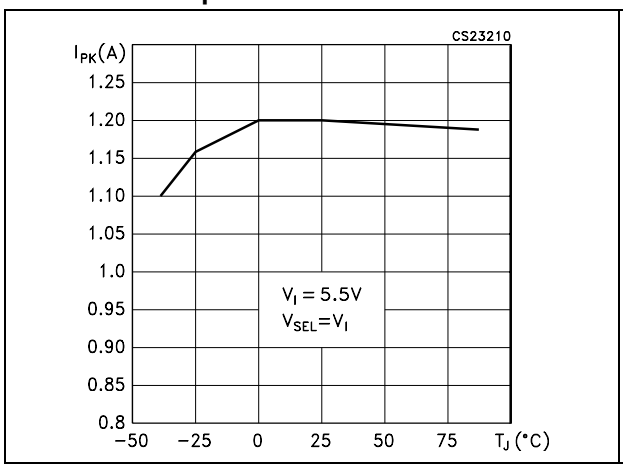


Figure 15. R_{ONFB} vs temperature

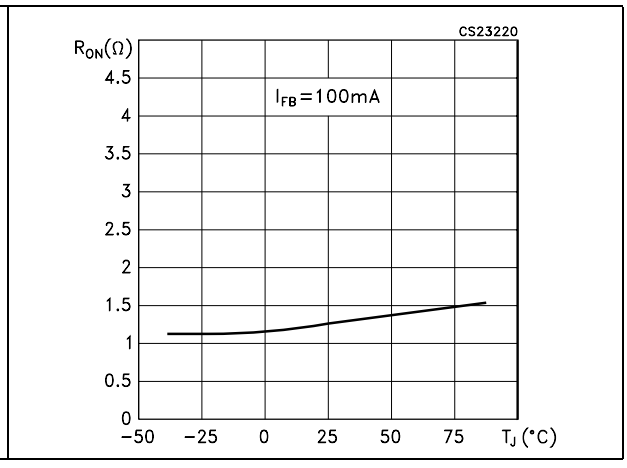


Figure 16. Maximum duty cycle vs temperature

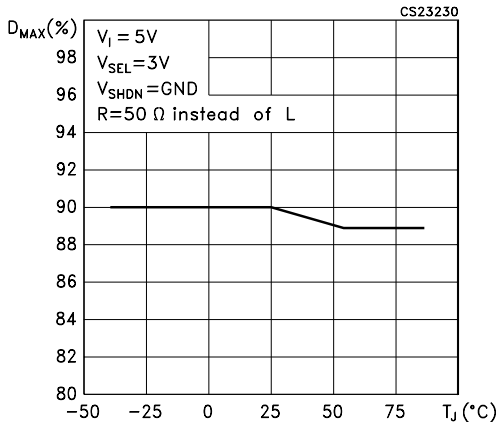
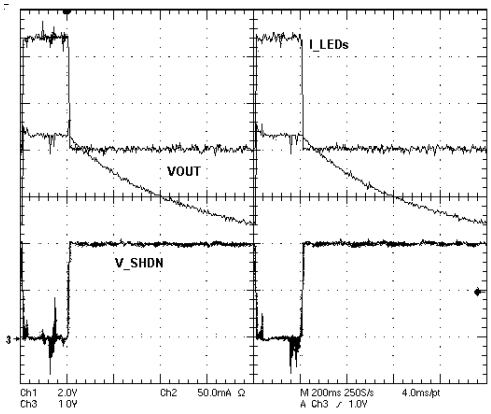
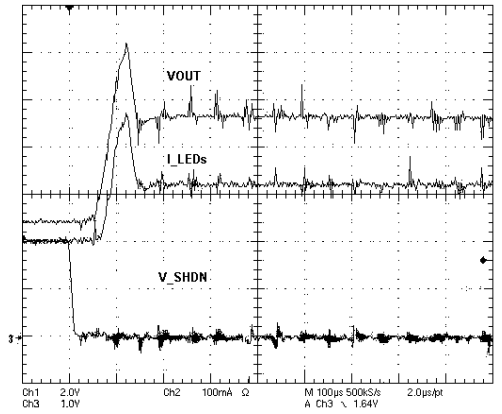


Figure 17. Turn on and off response



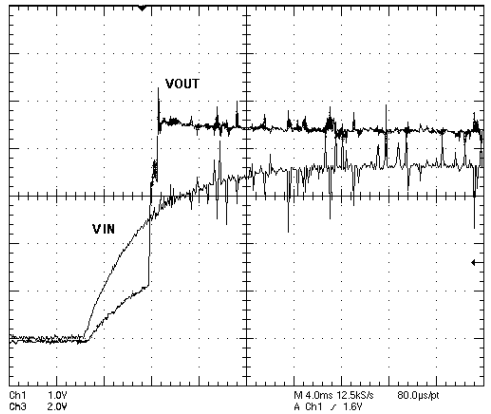
V_{SHDN}=pulse, FREQ.=1Hz, T_r=T_f=10µs

Figure 18. Turn on time



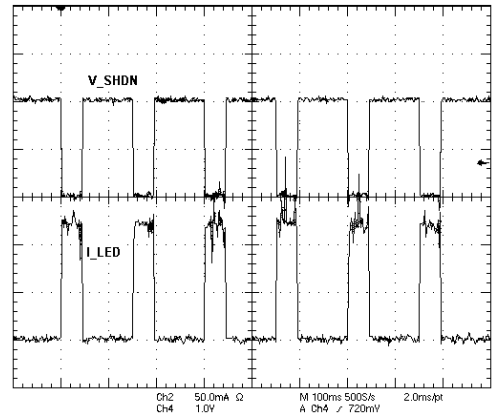
V_{SHDN}=pulse, FREQ.=1Hz, T_r=T_f=10µs

Figure 19. Start up transient



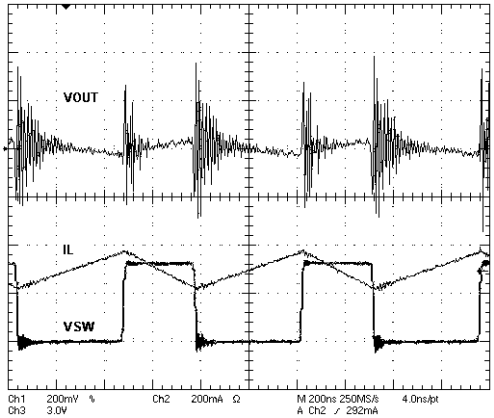
V_I=0 to 3.6V, V_{SEL}=GND, V_{SHDN}=GND

Figure 20. Multi shoot mode



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

Figure 21. Torch mode behavior



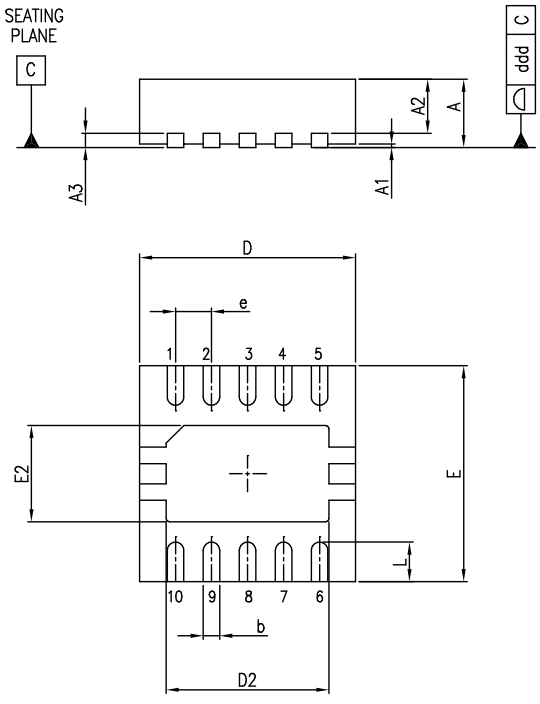
V_{SEL}=GND, V_{SHDN}=GND

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



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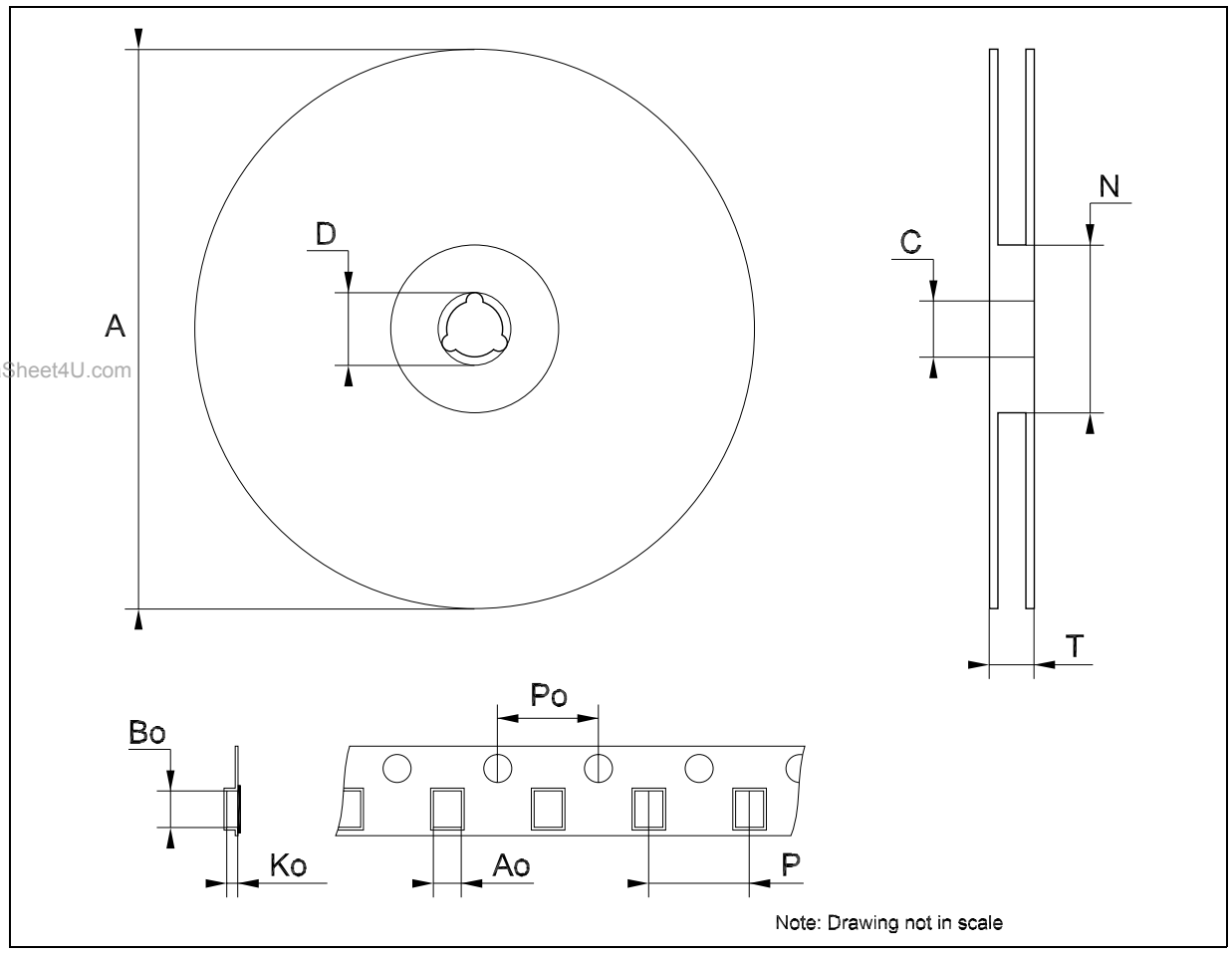
Tape & Reel QFNxx/DFNxx (3x3) MECHANICAL DATA

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	



Note: Drawing not in scale

9 Revision history

Table 5. Revision history

Date	Revision	Changes
10-Oct-2005	1	First release.
28-Apr-2006	2	Maturity code has been changed.
27-Jul-2006	3	Change value in table 2 P_{TOT}.
18-Oct-2006	4	Text updates.

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