STLD20D

ASD™

WHITE LED POWER SUPPLY

PRELIMINARY DATA

FEATURES

- High efficiency above 80%
- Can drive up to 4 LEDs in series from 2.8V supply
- Constant LED current regulation
- Integrated LED disconnect switch that cuts the LEDs branch in shutdown mode
- Constant switching frequency
- Stable current regulation across the total input voltage range
- Supply voltage rejection
- Inherent soft start by limiting the peak inductor current
- Peak inductor current adjustability (STLD20D-C8 only)
- Shutdown pin with possibility of PWM dimming control
- Over voltage and over temperature protection with automatic restart
- Low shutdown current < 1µA
- Small external inductor (10µH, height < 2mm)
- Tiny ceramic external capacitor
- Can be supplied by a Li-ion battery - V_{IN} range: 2.5Vdc to 5Vdc

APPLICATION

- White Led supply for LCD backlight
- Mobile phone
- PDA and organizers
- Any handsets powered from 2.8V to 4.2V

DESCRIPTION

The STLD20D is a constant switching frequency boost regulator with specific features to supply up to 4 white LEDs in series. A stable LED current regulation, from 2.8V to 4.2V, is achieved by sensing the LED current through a low ohmic shunt resistor R_{LED} (see figure 1). The device also includes a supply rejection circuit that prevent any kind of flickering effect on the display during dynamic supply voltage variation. A LED disconnect switch cut the LED branch to reduce the current consumption in shutdown mode. The maximum peak inductor current can be programmed. The STLD20D includes often numerous features and innovative design circuit that allows getting an efficiency above 80% across the total supply voltage range.

Figure 1: Basic connection

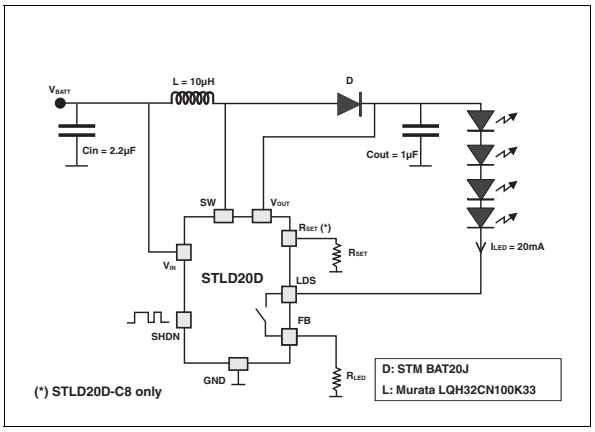


Figure 2: Efficiency versus input voltage (I_{LED}=20mA; T_{amb}=25°C)

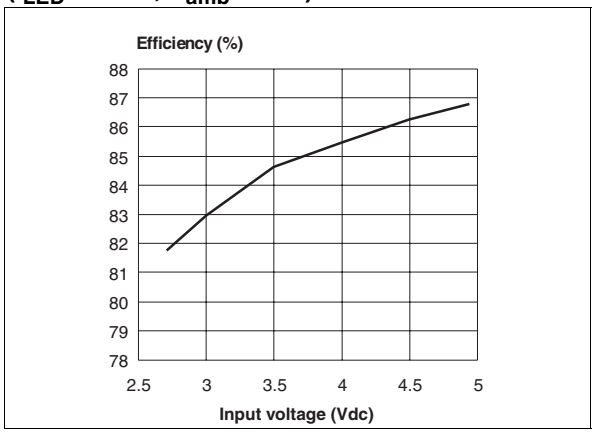
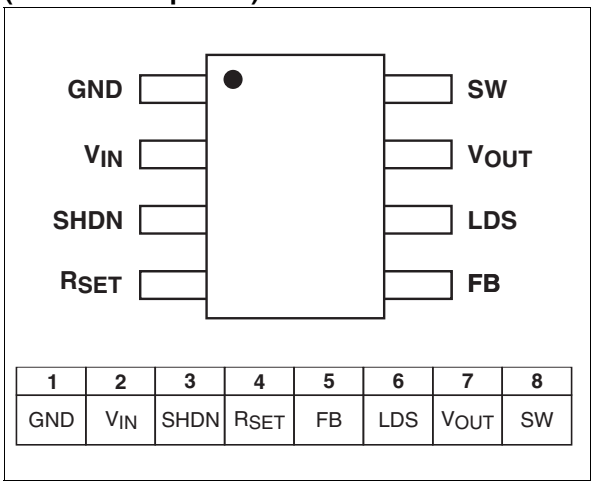


Table 1: Order Codes

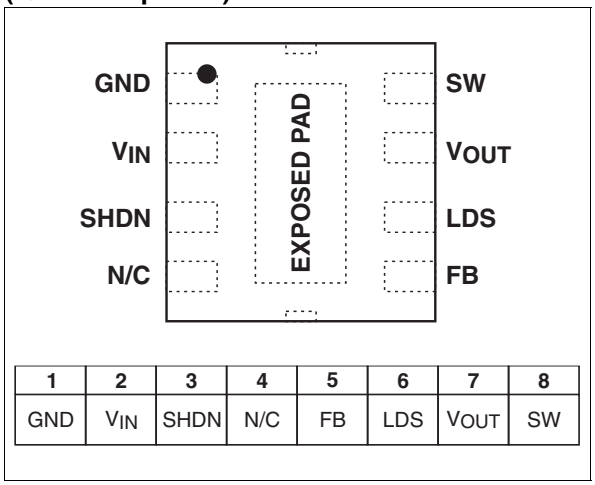
Part Number	Marking	Package
STLD20D-C8	L2D	SOT23-8L
STLD20D-DEF	L2D	QFN 3x3 8L

Figure 3: STLD20D-C8 Pin-Out Designation (SOT23-8L top view)



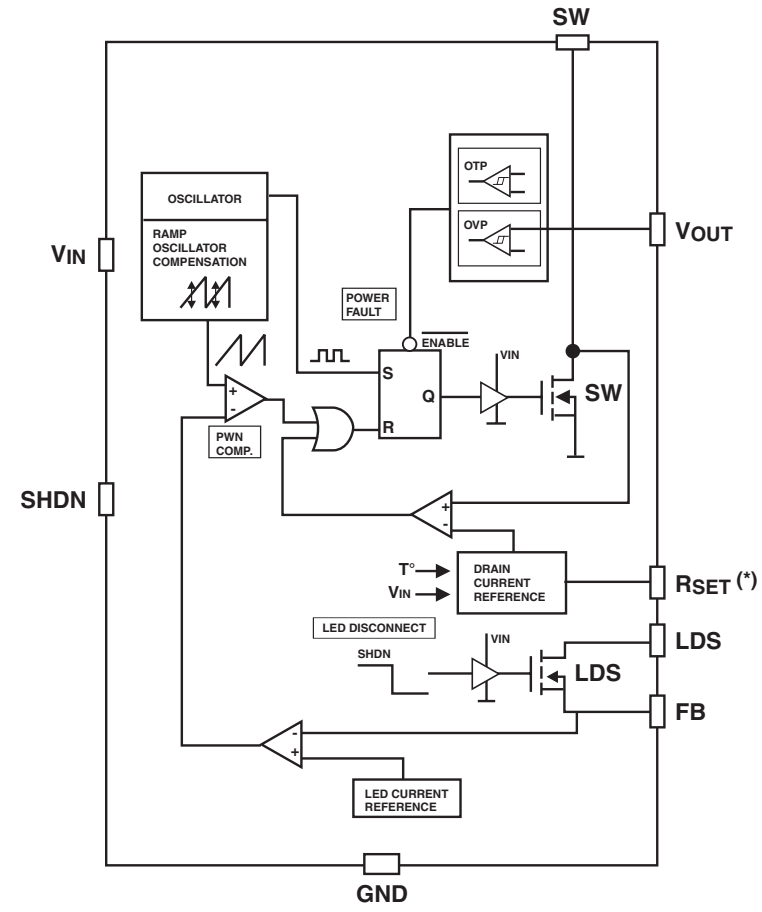
1	2	3	4	5	6	7	8
GND	V_{IN}	SHDN	R_{SET}	FB	LDS	V_{OUT}	SW

Figure 4: STLD20D-DEF Pin-Out Designation (QFN 8L top view)



1	2	3	4	5	6	7	8
GND	V_{IN}	SHDN	N/C	FB	LDS	V_{OUT}	SW

Figure 5: Block Diagram



(*) STLD20D-C8 only

Table 2: External Components Pproposal (note 1) - Referred basic connection (figure 1)

Symbol	Parameter	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
R_{LED}	LED current resistance			15		Ω
C_{IN}	Input filtering capacitor	Ceramic type		2.2		µF
C_{OUT}	Output capacitance			1		
L	Boost inductor (height < 2mm)	Inductance		10		µH
		Resistance at 500kHz			1	Ω
		Isat (R_{SET} = 100kΩ)	300			mA
D	Boost diode (STMicroelectronics BAT20J type)	V_{RRM}	23			Vdc
		I_F (peak forward current)		1		A
		V_F @ I_F = 0.1A Tj = 25°C		0.35	0.4	V
		I_R @ Tj = 25°C V_R = 15V		3	12	µA
		I_R @ Tj = 85°C V_R = 15V		120	250	

Note 1: 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 an other hand the operation of STLD20D is not limited with the use of components included in this list.

Table 3: Absolute Maximum Ratings

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
V_{IN}	Supply voltage range		2.5		5	V
V_{ESD}	ESD ratings	HBM MIL STD 883C	2			kV
T_{OP}	Operating temperature		- 40		+ 85	°C
T_{stg}	Storage temperature		- 65		150	°C
B_{VDS}	Breakdown voltage at pin SW and TSS and V_{OUT}		20			V
SHDN	Maximum voltage applied on SHDN pin				V_{IN}	V

Table 4: Electrical Characteristics (for V_{IN} = 2.8 to 4.2V and Tj = 25°C)

Symbol	Parameter		Test conditions		Value			Unit
					Min.	Typ.	Max.	
V_{IN}	Operating Input voltage range				2.8		4.2	V
I_{OUT}	Average regulated current I_{OUT} = 20mA R_{LED} = 15Ω				19	20	21	mA
I_{SD}	Stand-by current		SHDN = low V_{IN} = 4.2V				1	µA
I_Q	Quiescent current consumption		SHDN = high V_{IN} = 4.2V			0.43	0.6	mA
SW	Boost switch RDSON	SOT23-8L	Tj = 25°C I_{SW} = 250mA	V_{IN} = 2.8V		0.51	0.6	Ω
				V_{IN} = 4.2V		0.45	0.49	
		QFN	Tj = 25°C I_{SW} = 250mA	V_{IN} = 2.8V			0.65	
				V_{IN} = 4.2V			0.55	
LDS	Load disconnect switch R_{DSON}	SOT23-8L	Tj = 25°C I_{LDS} = 20mA	V_{IN} = 2.8V		5.5	6.1	Ω
				V_{IN} = 4.2V		4.7	5.2	
		QFN	Tj = 25°C I_{LDS} = 20mA	V_{IN} = 2.8V			6.2	
				V_{IN} = 4.2V			5.3	
FB	Feedback voltage				0.285	0.300	0.315	V
Line	Variation of the LED current versus the input voltage: R_{LED} = 15Ω						0.9	mA/V
Eff	Efficiency with 4 LEDS Vout = 16V		Circuit configuration (figure 1) L: Murata LQH32CN100K33 Diode: BAT20J	V_{IN} = 2.8V	80			%
				V_{IN} = 4.2V		85		
Switching frequency					400	500	600	kHz
DC_{MIN}	Minimum duty cycle					22	25	%
I_{LIM}	Peak current boost switch		L = 10µH R_{SET} = GND (STLD20D-C8)				640	mA
OVP	Overvoltage protection				17.5	18.5	20	Vdc
$Hyst_{OV}$	Overvoltage hysteresis					0.7		Vdc
OTP	Over temperature protection				110			°C
$Hyst_{OT}$	Over temperature protection hysteresis					5		°C
SHDN	Shutdown signal logic		Disable Low V_{IL}				0.3	V
			Enable high V_{IH}		1.2			

Table 5: Thermal Characteristics

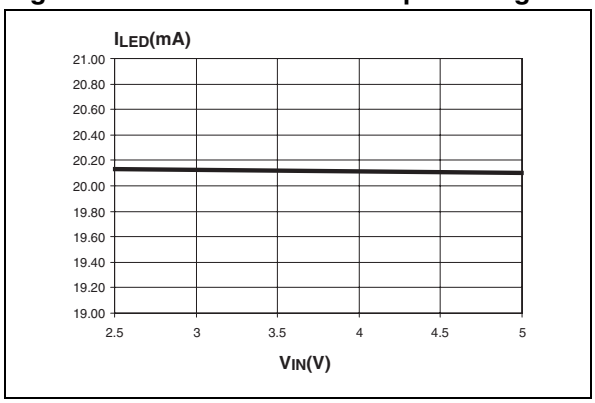
Symbol	Parameter		Value			Unit
			Min.	Typ.	Max.	
Rth(j-a)	Mounted on epoxy board without copper heatsink	SOT23-8L			300	°C/W
		QFN			350	

FUNCTIONAL DESCRIPTION

1. BOOST CONTROLLER:

The STLD20D is a PWM mode control boost converter operating at 500kHz in discontinuous mode. An automatic compensation of the oscillation ramp allows rejection of the battery voltage transient. The LED constant regulation (referred *figure 4*) is done by sensing the LED current through the resistance R_{LED} (*figure 1*). The voltage across R_{LED} is used by the feedback loop of the controller (pin FB).

Figure 6: LED current versus input voltage



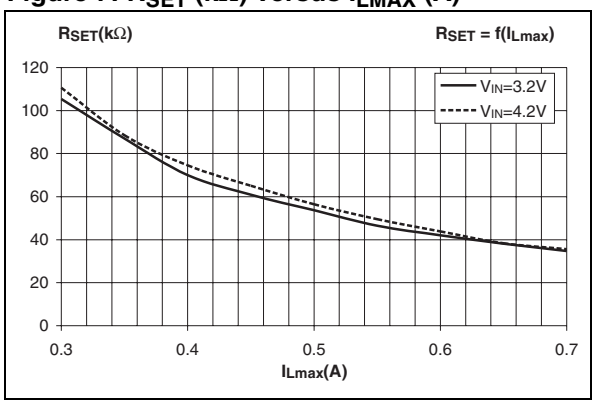
2. PEAK INDUCTOR CURRENT LIMITATION AND SOFT START FUNCTION:

An integrated current sensor senses the peak drain current of the switch SW in order to keep the inductor current below its saturation level. Since the peak drain current exceeds 590mA (if R_{SET} = GND for STLD20D-C8), the RS flip flop turns off the switch SW. During start up, this peak drain current limitation acts inherently like a soft start function .

3. PEAK INDUCTOR CURRENT ADJUSTABILITY (STLD20D-C8 ONLY)

The peak current of the boost inductor should always be below the saturation current. In order to provide flexibility in the selection of the inductor, the maximum peak inductor current can be adjusted by connecting a resistor at the pin R_{SET}. The *figure 5* gives the value of the resistance R_{SET} versus the peak inductor current limit I_{LMAX} at 25°C. If a low ripple is espected on the battery voltage bus, then the maximum peak inductor current should be reduced.

Figure 7: R_{SET} (kΩ) versus I_{LMAX} (A)



4. SHUTDOWN:

The SHDN pin is a low logic input signal and allows turning off the controller without cutting the input voltage from the boost regulator circuit. An integrated LED disconnect switch LDS disconnects the LEDs branch in shutdown mode .This arrangement allows eliminating the DC current path that normally exists with traditional boost regulator in shutdown mode.

5. BRIGHTNESS CONTROL:

The brightness of the Led is adjusted by pulsing the shutdown pin with a low frequency PWM signal.
By using such a PWM signal the controller is alternatively ON and OFF and the LED current changes from full current to zero. The duty cycle allows to regulate the average LED current .
This scheme ensures that when the LEDs are ON they are driven at the full current without risk of color change.

6. OTP:

An integrated temperature sensor senses the temperature of the junction of the controller. when this temperature exceeds 110°C min fixed internally the controller is automatically turned OFF . When the temperature is reduced the operation of the device automatically recovers.

7. OVER VOLTAGE PROTECTION (OVP):

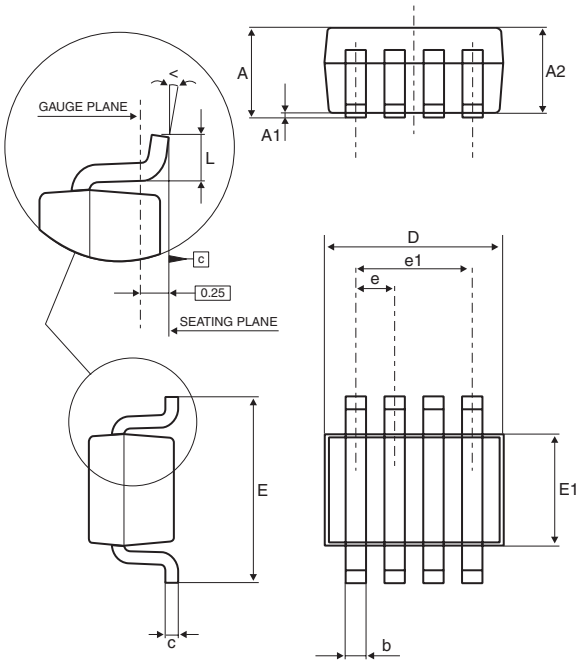
In case of failure and if the LED branch is cut, then there is no signal at the feedback pin FB (*figure 1*), the PWM controller will then switches with a maximum duty cycle. This will generate a voltage at the pin SW and V_{OUT} that can exceed the maximum rating of the device. The overvoltage protection bloc senses the output voltage at the pin V_{OUT} (*figure* 1). If the voltage exceeds 18.5Vdc typical the controller is automatically turned OFF. When the voltage is reduced of 0.7V, the operation of the device automatically recovers.

8. EFFICIENCY (*Figure 1 & 2*)

The efficiency takes into account these following losses:

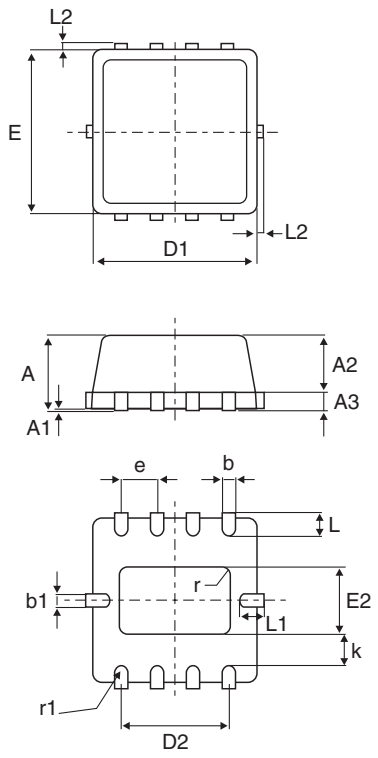
- R_{LED} ohmic losses
- Boost switch SW losses
- LED disconnect switch LDS
- Boost inductor losses
- Boost diode losses
- Total driver consumption.

Figure 8: SOT23-8L Package Mechanical Data



REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A		1.45		0.057
A1		0.15		0.006
A2	0.90	1.30	0.035	0.051
b	0.22	0.38	0.008	0.015
c	0.08	0.22	0.003	0.008
D	2.80	3	0.110	0.118
E	2.60	3	1.102	0.118
E1	1.50	1.75	0.059	0.069
e	0.65 typ.		0.026 typ.	
e1	1.95 typ.		0.077 typ.	
L	0.30	0.60	0.012	0.024
<	0°	8°	0°	8°

Figure 9: QFN 3x3 8L Package Mechanical Data



REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80	0.90	1.00	0.031	0.035	0.039
A1		0.03	0.03		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	0.079	0.083
E		3.00			0.118	
E2	1.11	1.21	1.31	0.044	0.048	0.051
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	

Figure 10: QFN Foot Print Dimensions
(in millimeters)

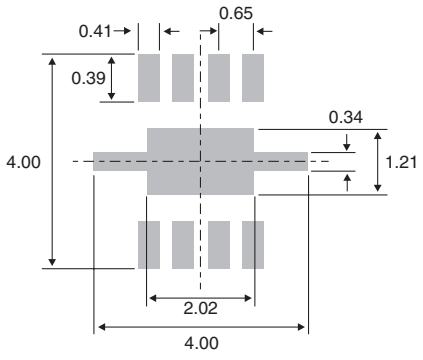


Table 6: Ordering Information

Part Number	Marking	Package	Weight	Base qty	Delivery mode
STLD20D-C8	L2D	SOT23-8L	0.2 g	3000	Tape & reel
STLD20D-DEF	L2D	QFN 3x3 8L	0.22 g	3000	Tape & reel

Table 7: Revision History

Date	Revision	Description of Changes
August-2004	1	First issue
12-Oct-2004	2	Table 4 on page 4 following parameters values updated: . I_{OUT} (min), I_Q (min), SW (QFN max), LDS (QFN max), I_{LIM}, $Hyst_{OT}$. FB VAR symbol changed to Line and value changed from 0.7 to 0.9 mA/V