DESCRIPTION

PT6973 is a boost DC/DC converter with one channel constant current regulator, which provides 10mA to 30mA current for up to 8 LEDs in series. The power supply is from 4V to 15V and the max output voltage is 28V. PT6973 provides both PWM dimming and analog dimming functions. The minimum PWM dimming on time is 125ns, which means 0.25% dimming duty-cycle at 20KHz is available.

PT6973 also provides much protections, such as under voltage lockout, cycle by cycle input current limit, output over voltage protection, flywheel diode open protection, feedback over voltage protection, thermal shutdown protection and so on.

PT6973 default operates at 600KHz. Furthermore, it can be synchronized by external clock for different frequency operation.

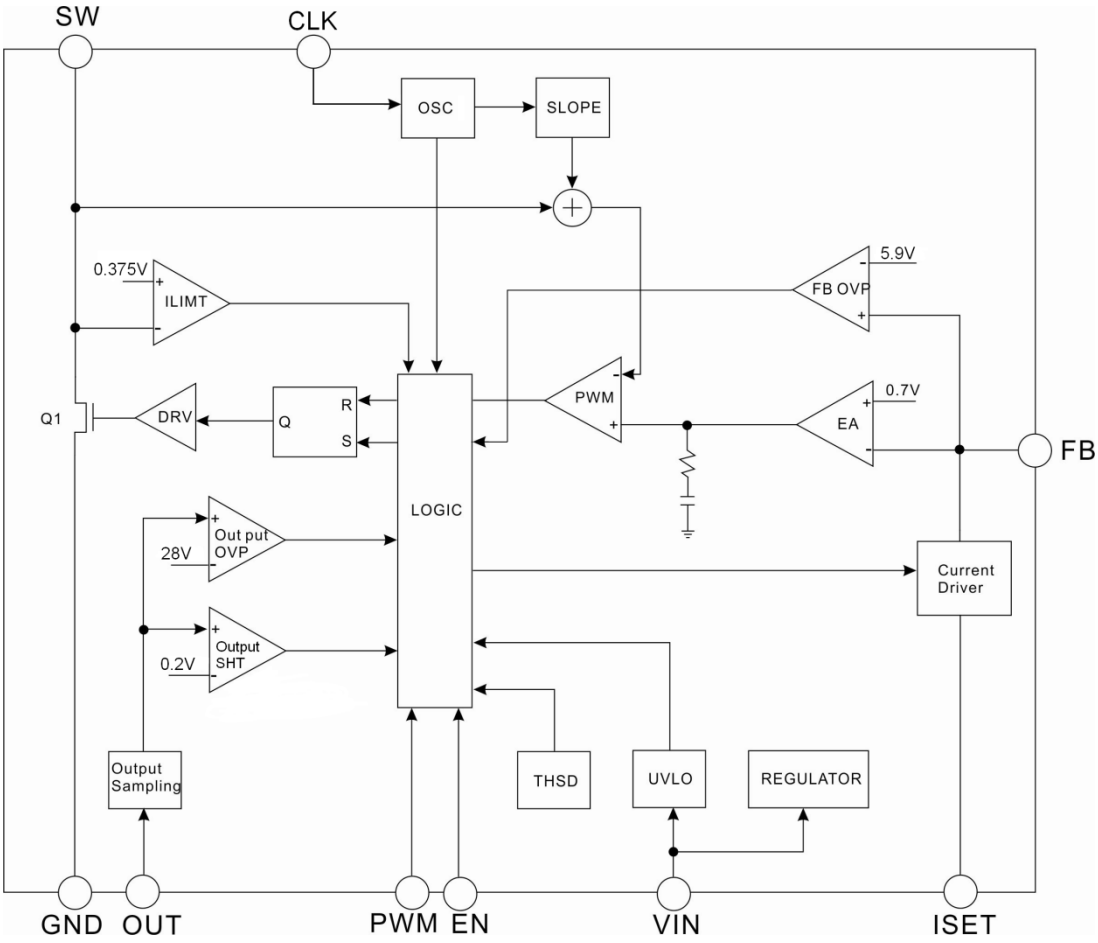
FEATURES

- 4~15V Input Voltage
- 10mA~30mA LED Current with ±3% matching
- Drive Up to 8 LEDs
- 600kHz Switching Frequency
- Typical less than 1uA Standby Current
- 28V Output Over Voltage Protection
- LED Open/Short Protection
- Flywheel Diode Open Protection
- Output Short to GND Protection
- 20kHz 0.25% PWM Dimming Available
- External Clock Synchronize available
- DFN8 Package

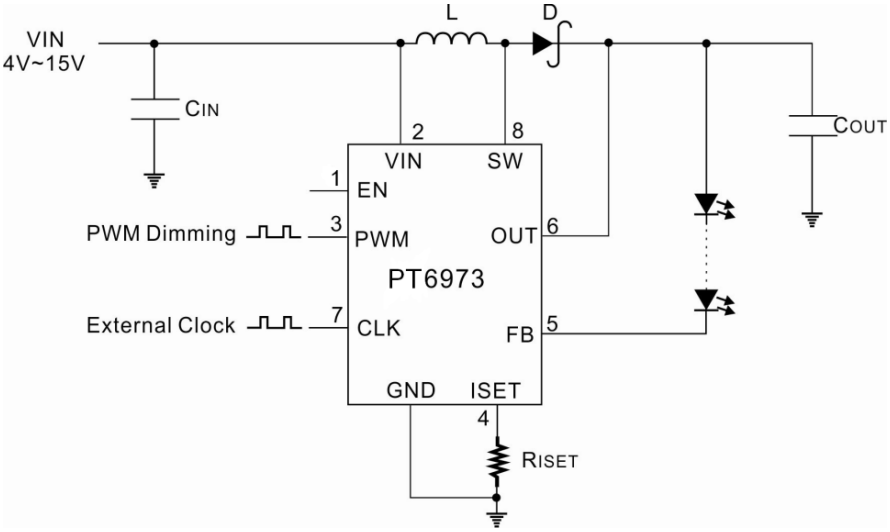
APPLICATIONS

- Digital Cameras Monitor Backlighting
- Cell Phones Monitor Backlighting
- PDAs, Handheld Computers Monitor Backlighting
- Small LCD Displays Backlighting

BLOCK DIAGRAM



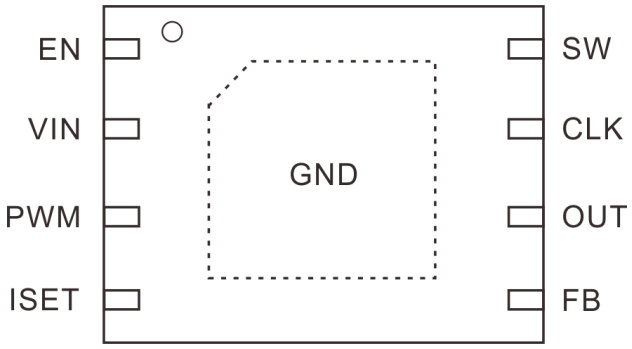
TYPICAL APPLICATIONS



ORDER INFORMATION

Valid Part Number	Package Type	Top Code
PT6973	8 Pins, DFN (2mm*3mm)	PT6973

PIN CONFIGURATION



PIN DESCRIPTION

Pin Name	Description	Pin No.
EN	Enable control.	1
VIN	Power supply pin.	2
PWM	PWM dimming signal input.	3
ISET	LED Current setting terminal, connect a resistor between ISET and GND for LED Current setting.	4
FB	Feedback Voltage input.	5
OUT	Over Voltage Protection input.	6
CLK	External Clock input.	7
SW	Switching terminal.	8
GND	Ground.	Exposed PAD

APPLICATION INFORMATION

OPERATION

PT6973 integrates a dc-dc boost convertor and a linear current driver to regulate the current of white LED cluster. Peak current mode topology and fixed switching frequency operation provide excellent line and load regulation. It converts the input voltage to a higher output voltage to driving LEDs. The LED strings are connected to a linear current driver where the current level is set by an external resistor between ISET and GND. The boost output voltage is controlled by the FB pin voltage, which is equal to an internal reference voltage (0.7V typical).

To control the brightness of LED string, PT6973 provides both PWM and analog dimming functions. Fast current driver ON/OFF response allows minimum 125ns PWM pulse width operating, which means 0.25% duty cycle on 20 kHz dimming frequency is available.

SETTING THE LED CURRENT

The LED current can be adjusted by the resistor R_{ISET} between ISET pin and GND. The current through the LEDs is given by the equation:

$$I_{LED} = \frac{1000 \times 0.6V}{R_{ISET}}$$

Where, 1000 is a constant, 0.6V is the fixed reference voltage of ISET pin. In order to get accurate LED current, 1% precision resistor is recommended.

SOFT-START

PT6973 integrates an internal soft-start circuit, which clamp the output of the Error Amplifier effectively during start-up. The soft-start function prevents rush current at turning on. The soft-start time is approximately equal to 1ms.

OUTPUT OVER-VOLTAGE PROTECTION

In some cases the LEDs may fail and the load is open, this resulting in the feedback voltage always remains zero. The power MOSFET will switch at maximum duty cycle and boost the output voltage exceeding the absolute maximum ratings. To avoid destroying the IC, PT6973 integrates Output Overvoltage Protection function. If the output exceeds 28V, the power MOSFET will stop switch until the output falls back to 26V.

OUTPUT OVER-CURRENT PROTECTION

In case of setting wrong R_{ISET} value or ISET pin short to GND, PT6973 will turn off the convertor and constant current driver, to protect LED string and IC from overheat or damage. The threshold of the R_{ISET} value is 5kΩ in typical case. Once the abnormal condition removed, PT6973 will continue working automatically.

FLYWHEEL DIODE OPEN PROTECTION

In the case of external flywheel diode opened, the coil or internal power MOS may be destroyed. Therefore, as such an error happens and VOUT falls below 0.2V, PT6973 turns off the converter and constant current driver, to prevent the coil and the IC from damaging. Similarly, when the output shorted to ground, there will be the same reaction as above.

FB OVER-VOLTAGE PROTECTION

When the voltage of FB is higher than 5.9V, PT6973 will turns off the converter and constant current driver after 100us delay. Therefore, PT6973 is prevented from overheating even if OUT and FB are shorted.
When one LED is shorted, PT6973 will regulate the FB voltage to 0.7V. Therefore the output voltage will decrease by the value of which drops on the shorted LED, and the converter still operate normally.
If the FB pin shorted to OUT, there are two different reactions according to the VIN voltage. If VIN is higher than 5.9V,

the converter and constant current driver will turn off. If VIN is below 5.9V, IC works normally.

THERMAL SHUT DOWN

In order to prevent damage from high junction temperature, PT6973 integrates thermal shutdown function. When the junction temperature of device rises up to 150℃(typical), PT6973 will disable the boost converter and output constant current driver. The devices will automatically recovery when the junction temperature falls below 120℃ (typical).

ENABLE FUNCTION

PT6973 provides enable function. When the voltage of EN pin is higher than 1.4V, PT6973 is active, and when the voltage is lower than 0.5V, the device is turned off and the shutdown current is lower than 1μA. Additionally, EN pin is pulled low by an internal 100KΩ resistor.

DIMMING CONTROL

There are two dimming method available in PT6973. One method is PWM dimming that inputs digital signal to PWM terminal. Another method is analog dimming by applying an analog voltage to ISET terminal.

PWM DIMMING

With an external PWM signal applied at PWM, the converter is turned on or off following the PWM signal. The average LED current increases proportionally with the duty cycle of the PWM signal. The minimum on-time of PWM signal is 125ns, which means 0.25% dimming ratio at 20 kHz is available.

ANALOG DIMMING

Analog dimming is implemented by applying a dc voltage to ISET pin via a resistor as the below figure shows. The voltage of ISET pin is fixed at 0.6V by internal circuit. When the DC voltage increases, the current flowing into ISET pin will decrease, so the LED current also decrease. The LED current can be calculated as below.

$$I_{LED} = \frac{1000 \times 0.6V}{R1} + \frac{1000 \times (0.6V - V_{DC})}{R2}$$

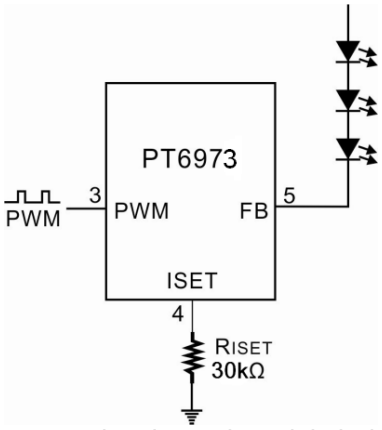


Fig 1 PWM Dimming Using Digital Signals

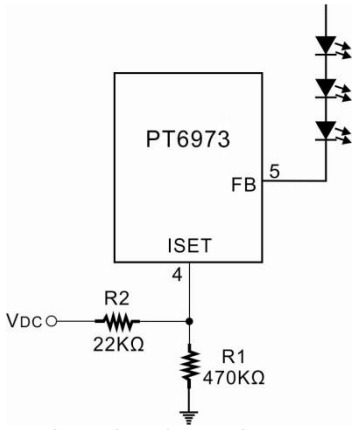


Fig 2 Analog Dimming Using DC Voltage

EXTERNAL CLOCK SYNCHRONIZE

PT6973 provides external clock synchronization function. The internal boost converter can be synchronized by an external clock added to the CLK pin. Pulling low the CLK pin will shift PT6973 to internal clock mode automatically.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
VIN, SW, OUT, FB to GND	-	-0.3~+36	V
EN, ISET, PWM, CLK to GND	-	-0.3~+6	V
Operating temperature	T_{OPR}	-40~+105	℃
Storage temperature	T_{STG}	-40~+150	℃

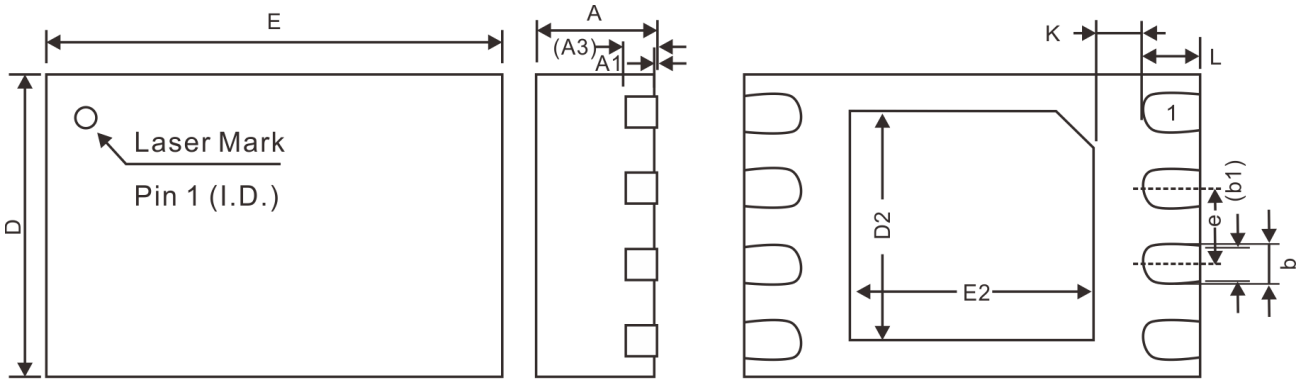
ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{IN}=V_{EN}=5V, Ta=25℃)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating input voltage	V_{IN}	DC input voltage	4	-	15	V
Supply shutdown current	I_{INSD}	V_{EN}=0V	-	0.1	10	μA
Supply quiescent current	I_{INQS}	V_{EN}=H ,V_{PWM}=0V	-	1.5	-	mA
Supply active current	I_{INAC}	V_{EN}=H ,V_{PWM}=H	-	2.5	-	mA
VIN under voltage lockout	UVLO	V_{IN} falling	2.3	3.5	3.7	V
Under voltage lockout hysteresis	-	-	-	200	-	mV
ISET voltage	V_{ISET}	-	582	600	618	mV
LED current range	I_{LED}	-	10	-	30	mA
LED current accuracy	-	I_{LED}=10mA~30mA	-	-	±3	%
Feedback voltage	V_{FB}	-	-	0.7	-	V
Switching frequency	f_{SW}	-	500	600	700	KHz
Maximum duty cycle	D_{MAX}	V_{FB}=0V	-	90	-	%
Switch on-resistance	R_{ON}	-	-	0.5	-	Ω
Switch current limit	I_{SW}	-	-	750	-	mA
Switch leakage current	I_{SW_LC}	V_{SW}=30V	-	0.1	10	μA
EN high input voltage	V_{ENH}	V_{EN} rising	1.4	-	-	V
EN low input voltage	V_{ENL}	V_{EN} falling	-	-	0.5	V
EN pin pull down resistance	R_{EN}	-	-	100		KΩ
PWM high input voltage	V_{PWMH}	V_{PWM} rising	1.4	-	-	V
PWM low input voltage	V_{PWML}	V_{PWM} falling	-	-	0.5	V
PWM pin pull down resistance	R_{PWM}	-	-	100	-	KΩ
Minimum PWM on time	$T_{PWM\_ON\_MIN}$	-	-	125	-	ns
Over current protection threshold	R_{OCP}	R between ISET and GND	-	5	-	KΩ
Output over voltage protection	V_{OVP}	V_{OUT} rising	-	28	-	V
VOUT OVP hysteresis	-	-	-	2	-	V
FB over voltage protection	V_{FB_OVP}	V_{FB} rising	-	5.9	-	V
FB Over voltage protection hysteresis	-	-	-	0.5	-	V
Thermal shutdown	T_{SD}	-	-	150	-	℃
Thermal shutdown hysteresis temperature	T_{HYS}	-	-	30	-	℃
Flywheel diode open protection	V_{FOP}	V_{OUT} Falling	-	0.2V	-	V
Output short to GND protection	V_{SHT}	V_{OUT} Falling	-	0.2V	-	V
CLK high input voltage	V_{CLKH}	V_{CLK} rising	1.4	-	-	V
CLK low input voltage	V_{CLKL}	V_{CLK} falling	-	-	0.5	V
Maximum external clock frequency	F_{CLK_MAX}	-	-	1	-	MHz

PACKAGE INFORMATION

8 PINS, DFN



Top View Side View Bottom View

Side View

Symbol	Dimensions		
	Min.	Nom.	Max.
A	0.70	0.75	0.80
A1	0	0.02	0.05
A3		0.20 REF	
b	0.20	0.25	0.30
b1		0.20 REF	
D	1.90	2.00	2.10
E	2.90	3.00	3.10
e	0.40	0.50	0.60
D2	1.40	1.50	1.60
E2	1.50	1.60	1.70
L	0.35	0.40	0.45
K	0.20	-	-

Note :Unit: mm

IMPORTANT NOTICE

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