One Stop Analog Solution
Power IC Ltd.

PS1518

High Efficiency, Fixed Frequency WLED Driver

FEATURES

- On Board Power MOSFET
- Drives up to 8 Series White LEDs
- Up to 87% Efficiency
- Over 645 KHz Fixed Switching Frequency
- Open Load Shutdown
- Low 100mV Feedback Voltage
- Soft Start/PWM Dimming
- UVLO, Thermal Shutdown
- Internal Current Limit
- Available in 6L-SOT26 and QFN-8 Packages

APPLICATIONS

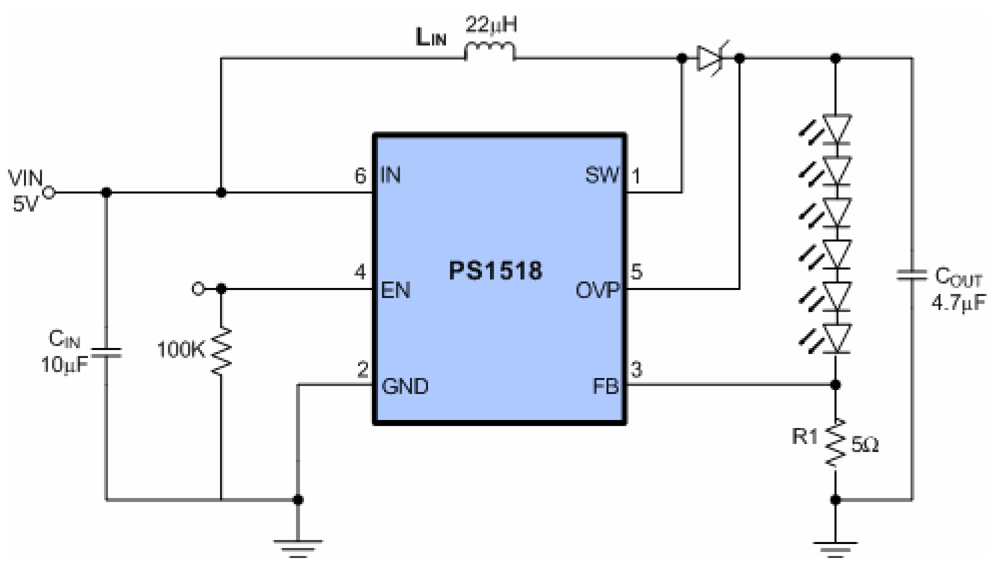
- Cell Phones
- Handheld Computers and PDAs.
- Digital Still Cameras.
- Small LCD Displays

DESCRIPTION

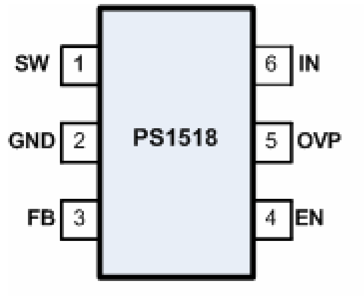
The PS1518 is a step up converter designed for driving up to 8 series white LEDs from 5V input. The PS1518 uses current mode, fixed frequency architecture to regulate the LED current, which is measured through an external current sense resistor. Its low 100mV feedback voltage reduces power loss and improves efficiency. The OV pin monitors the output voltage and turns off the converter if an over-voltage condition is present due to an open circuit condition.

The PS1518 includes under-voltage lockout, current limiting and thermal overload protection preventing damage in the event of an output overload. The PS1518 is available in small 6-pin TSOT23.

TYPICAL APPLICATION CIRCUIT



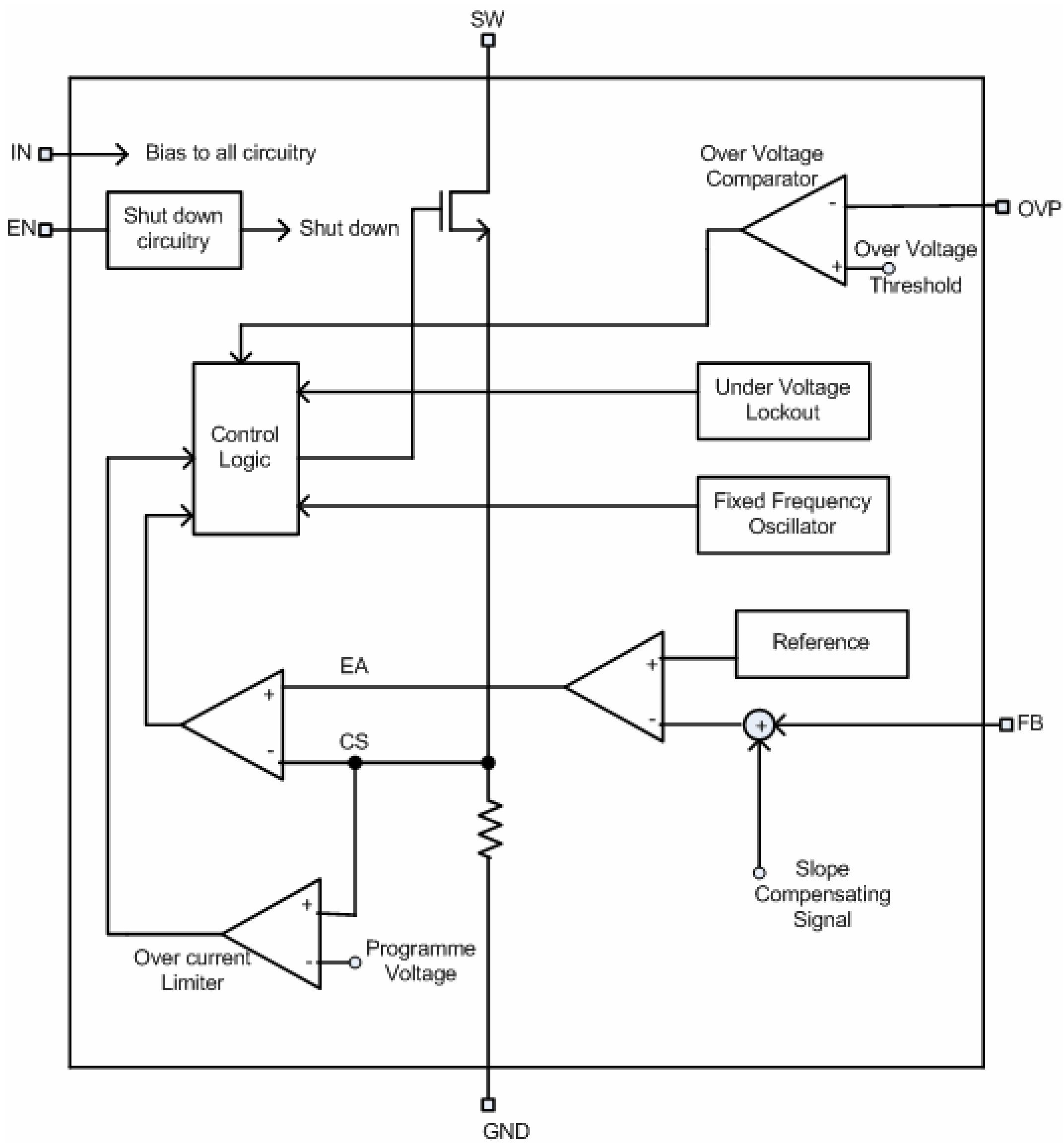
PIN CONFIGURATION



PIN DESIGNATOR

Name	Pin	Type	Function
SW	1	Switch	Connect inductor between SW and IN.
GND	2	Ground	Ground pin
FB	3	Feedback	Adjustable feedback input, connect to resistor voltage divider.
EN	4	Enable input.	EN=High: normal operation. (Supports both TTL and CMOS Logic).
OVP	5	Over voltage input.	Measures the output voltage for over voltage protection.
IN	6	Battery input.	Boost regulator input.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{SW}	DC Voltage at Pin 1	-0.5 to +30	V
V_{EN}	Enable Input Voltage at Pin 2	-0.3 to +6.0	V
P_D	Continuous Power Dissipation	Internally limited	W
T_{STG}	Storage Temperature Range	-65 to +150	℃
$R_{\theta JA}$	Thermal Resistance, Junction-To-Air	235	℃/W
$T_{J,MAX}$	Operating Junction Temperature	-40 to +125	℃
T_L	Lead Temperature (Soldering, 5sec)	260	℃
ESD	ESD Capability, HBM model	2.0	kV

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{IN}	DC Supply Voltage at Pin 1	+2.5 to 6	V
V_{EN}	Enable Input Voltage at Pin 2	0 to V_{IN}	V
T_J	Operating Junction Temperature	-40 to +125	℃

ELECTRICAL CHARACTERSTICS:

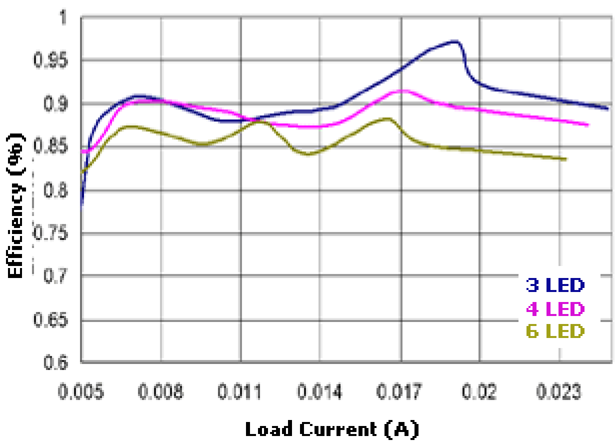
(All specifications are at T_A = +25°C. V_{IN} = 5.0V, unless otherwise specified.)

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{IN}	Operating Input Voltage		2.5		6	V
UVLO	Under Voltage Lock-out	Vin going Lo		2.35	2.4	V
	UVLO Hysteresis			20		mV
$V_{OUT-max}$	Maximum Output Voltage			25		V
I_q	Supply Current (quiescent)	No Switching (Vin =5V, V_{FB}=125mV)		150	260	µA
	Supply Current	Switching Fb=0		540	750	µA
I_{SH}	Supply Current (shut-down)	V_{EN} =0		0.1	1	µA
F_{OSC}	Operation Frequency			645		KHz
D_{MAX}	Maximum Duty Cycle		80	90		%
V_{FB}	Feedback Voltage		90	100	110	mV
	Feedback Input Bias Current	V_{FB}=125mV		2		nA
$R_{DS(ON)}$	MOSFET ON resistance	Vin=2.5, Isw= 800mA		0.65		Ω
I_{LIM}	Current Limit			690		mA
V_{EN}	Enable Threshold	Turn ON	1			V
		Turn OFF			0.4	V
I_{EN}	Enable Input Bias Current	V_{EN} = 5V			1	µA
	Thermal Shut-down			160		^{0}C

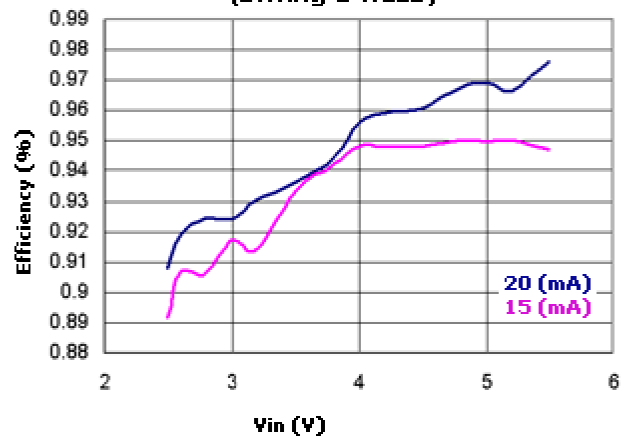
TYPICAL OPERATING CHARACTERSTICS

(All specifications are at T_A = +25°C, V_{IN} = 5.0V, unless otherwise specified.)

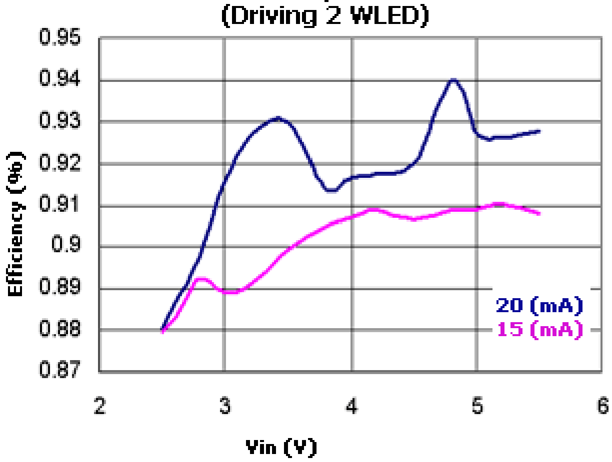
Efficiency vs LED Current with Vin=3.6V



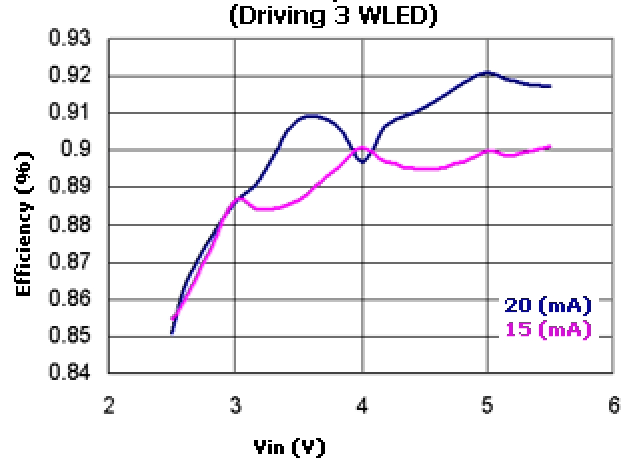
Efficiency vs Vin (with diff. load)
(Driving 1 WLED)



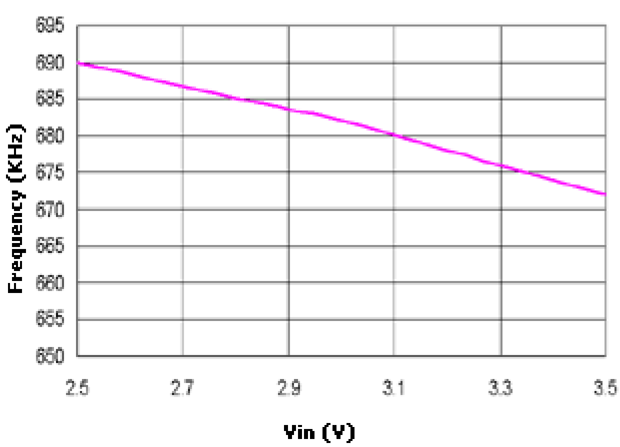
Efficiency vs Vin
(Driving 2 WLED)



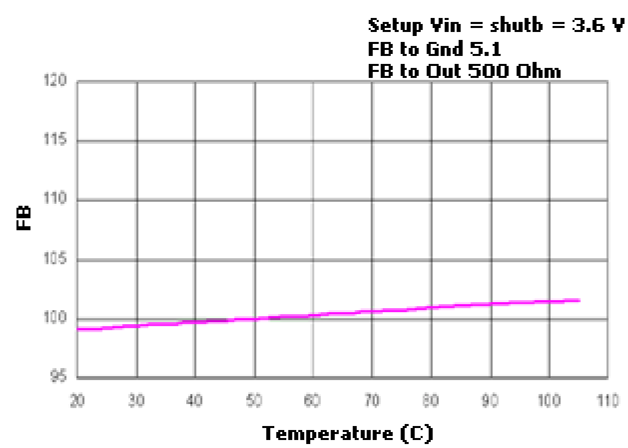
Efficiency vs Vin
(Driving 3 WLED)



Frequency vs Vin

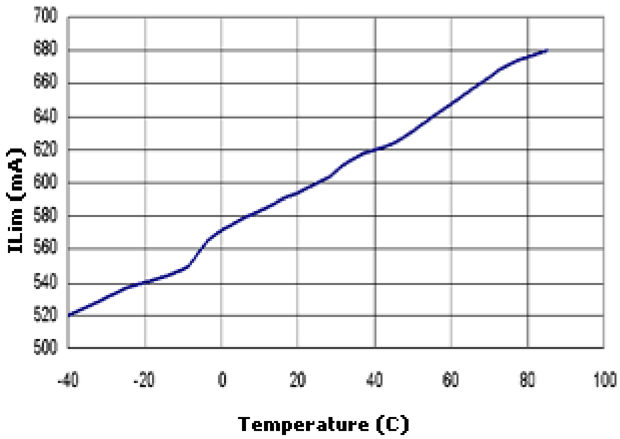


FB vs Temperature

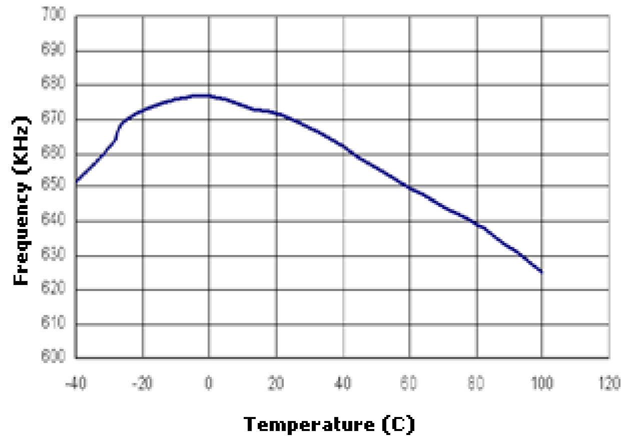


TYPICAL OPERATING CHARACTERSTICS (continued)

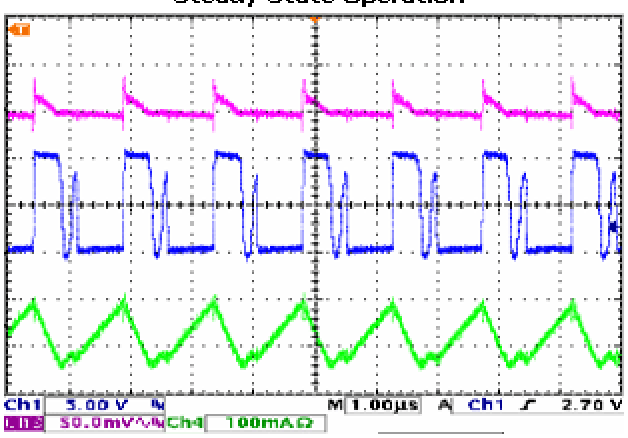
ILim vs Temperature



Frequency vs Temperature

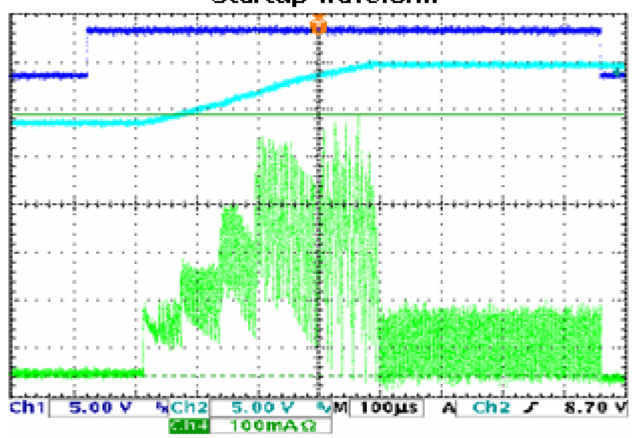


Steady State Operation



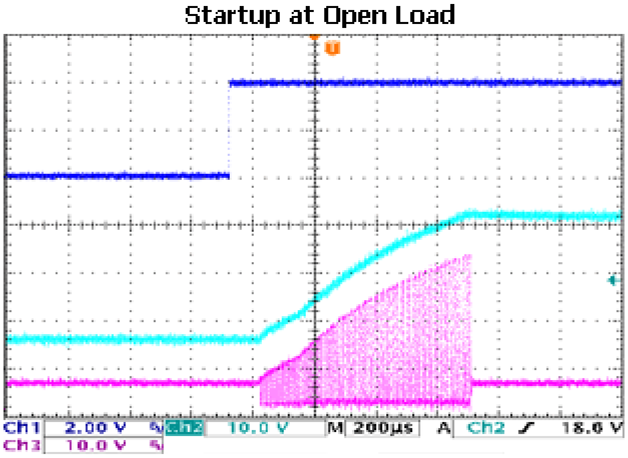
ch1: SW, ch3: OV ch4: I (ind)

Startup waveform



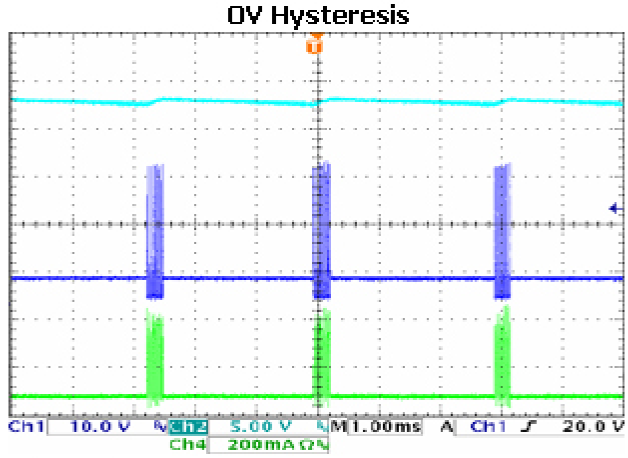
ch1: EN ch2: VOUT ch4: I (IND)

Startup at Open Load



ch1: EN ch2: OV, ch3: SW

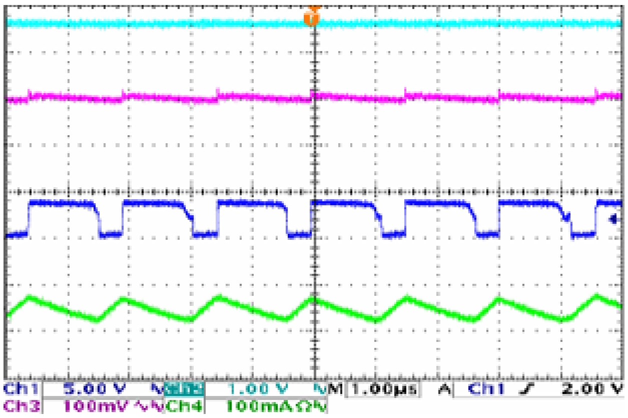
OV Hysteresis



Ch2: OV, Ch1: SW

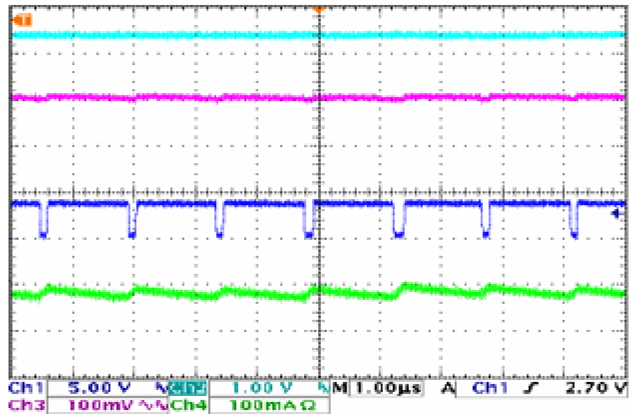
TYPICAL OPERATING CHARACTERSTICS (continued)

Stability for Driving 1 WLED at Vin=2.5v



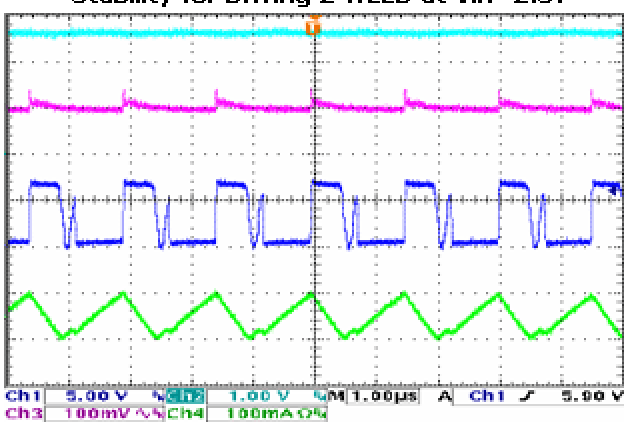
ch1: SW 5v/div, ch2: vin 1v/div
ch3: vout AC coupled 100mV/div, ch4: i(ind) 100mA/div

Stability for Driving 1 WLED at Vin=3.2v



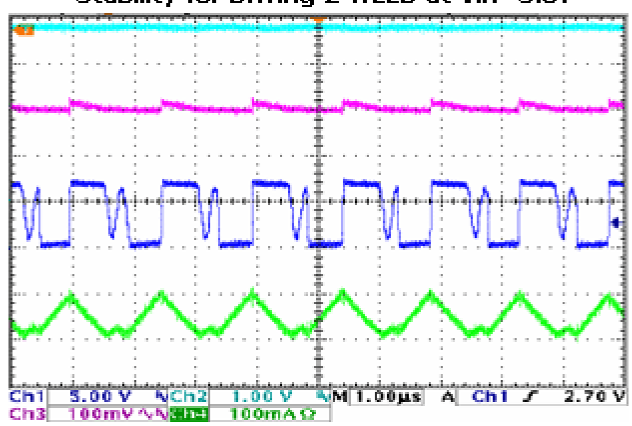
ch1: SW 5v/div, ch2: vin 1v/div
ch3: vout AC coupled 100mV/div, ch4: i(ind) 100mA/div

Stability for Driving 2 WLED at Vin=2.5v



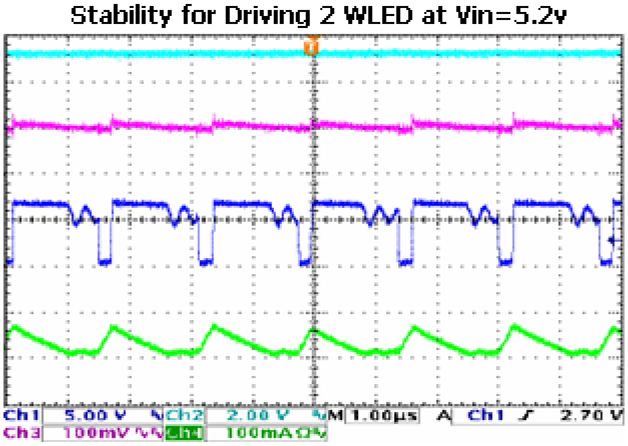
ch1: SW 5v/div, ch2: vin 1v/div
ch3: vout AC coupled 100mV/div, ch4: i(ind) 100mA/div

Stability for Driving 2 WLED at Vin=3.6v



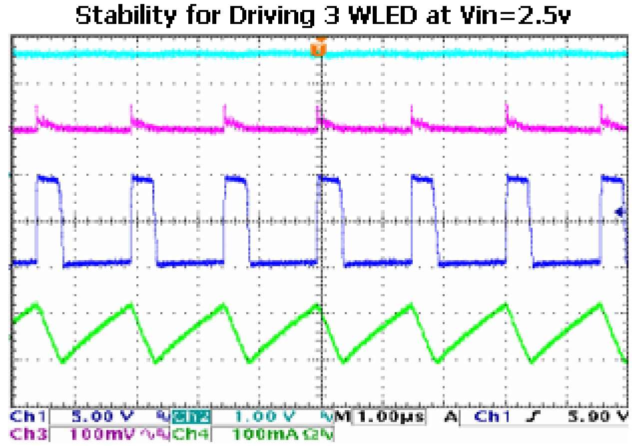
ch1: SW 5v/div, ch2: vin 1v/div
ch3: vout AC coupled 100mV/div, ch4: i(ind) 100mA/div

Stability for Driving 2 WLED at Vin=5.2v



ch1: SW 5v/div, ch2: vin 2v/div
ch3: vout AC coupled 100mV/div, ch4: i(ind) 100mA/div

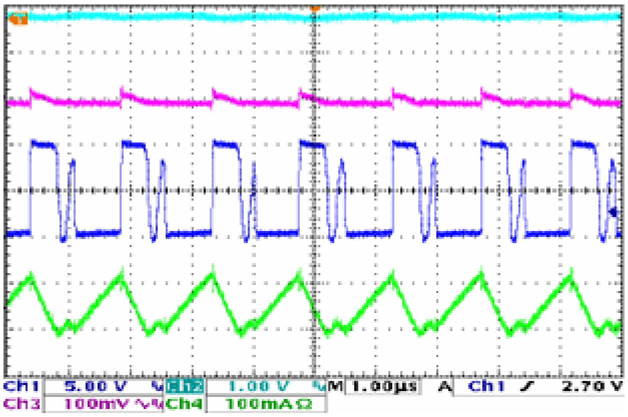
Stability for Driving 3 WLED at Vin=2.5v



ch1: SW 5v/div, ch2: vin 1v/div
ch3: vout AC coupled 100mV/div, ch4: i(ind) 100mA/div

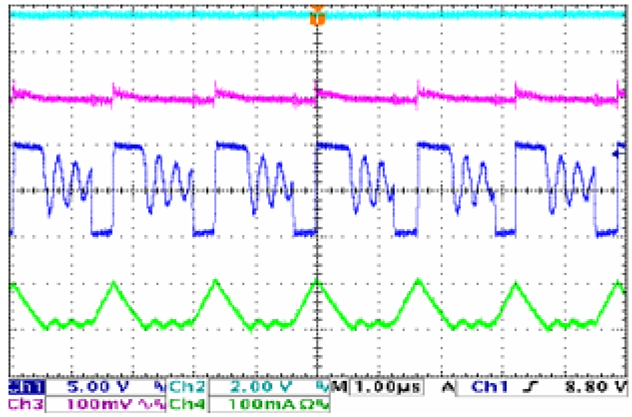
TYPICAL OPERATING CHARACTERSTICS (continued)

Stability for Driving 3 WLED at Vin=3.6v



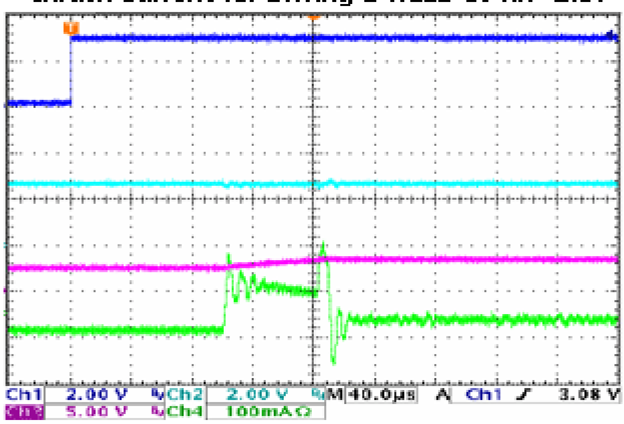
ch1: SW 5v/div, ch2: vin 1v/div
ch3: vout AC coupled 100mV/div, ch4: i(ind) 100mA/div

Stability for Driving 3 WLED at Vin=6.0v



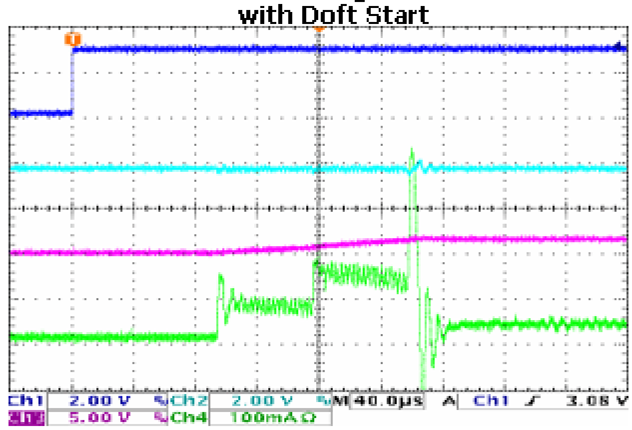
ch1: SW 5v/div, ch2: vin 2v/div
ch3: vout AC coupled 100mV/div, ch4: i(ind) 100mA/div

Inrush Current for Driving 1 WLED at vin=2.5v



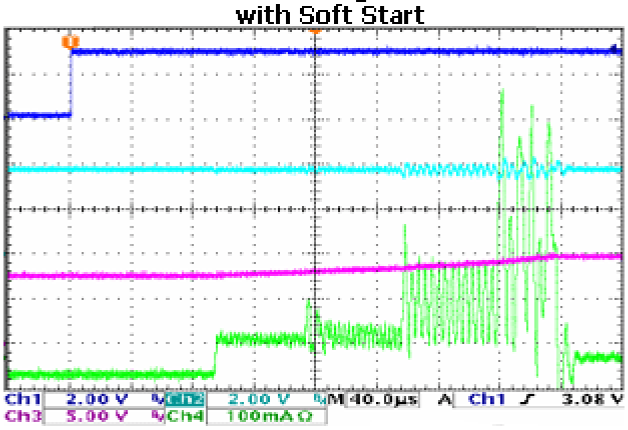
ch1: EN 2v/div ch2:vin 2v/div ch3:OV 5v/div
ch4: I(IND), 100mA/div

Inrush Current for Driving 2 WLED at vin=3.6v with Doft Start



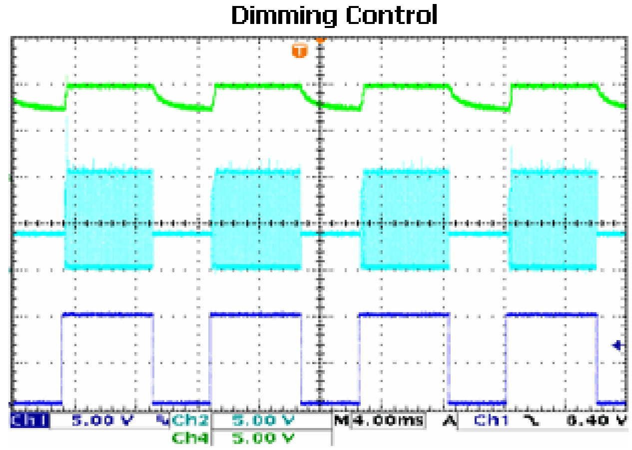
ch1: EN 2v/div ch2:vin 2v/div ch3:OV 5v/div
ch4: I(IND), 100mA/div

Inrush Current for Driving 3 WLED at vin 2.5v with Soft Start



ch1: EN 2v/div ch2:vin 2v/div ch3:OV 5v/div
ch4: I(IND), 100mA/div

Dimming Control



ch4: OV, ch2: SW, ch1: EN
frequency=100Hz

OPERATION DESCRIPTION

The PS1518 is a high efficiency, fixed frequency, peak current mode boost regulator. It has the architecture to regulate the voltage at the feedback pin, so that a regulated fixed current is achieved to drive white LEDs. The power MOS is turned ON through the control circuitry, at the start of each oscillator cycle and thus the charging phase is initiated. The error amplifier, consisting of a voltage comparator and current sense amplifier, is basically, a PWM comparator. The voltage comparator amplifies the difference between the reference and feed back voltage. When the output of the current sense amplifier, reaches the output of the voltage comparator, the POWER MOS is turned OFF and thus the charging phase is terminated. To prevent sub-harmonic oscillations at duty cycles greater than 50 percent, a stabilizing nonlinear ramp is added to the current sense signal. In this way the peak current level keeps the output in regulation. The PS1518 has internal soft start mechanism, to limit the inrush current at startup and to limit the amount of overshoot on the output, also. An internal blanking time is provided during start up, to prevent the start of switching before all the circuitry become ready for operation. The current limit is increased by around a fourth every 15µs giving a total soft start time of 70µs.

Setting the LED current :

The LED current can be set, according to the requirement, by feedback resistor, R1. The current through the LEDs is selected by the following equation:

$$I_{LED}=100mV/R1$$

Current Limit :

The PS1518 includes a current limiter. It monitors the peak current through the inductor and controls gate of the power device.

Enable Input :

The PS1518 features an active-high Enable input (EN) pin that allows on/off control of the regulator. The PS1518 bias current reduces to less than microampere when it is shutdown. The output remains at a schottky forward voltage lower than the SW pin, if a schottky diode is connected between SW and OV pin, at shut. The Enable input is TTL/CMOS compatible.

Under Voltage Lockout:

When the input supply goes too low (below 2.35V) the PS1518 produces an internal UVLO (under voltage lockout) signal that shuts down the chip. This mechanism protects the chip from producing false logic due to low input supply.

Thermal Overload Protection:

Thermal-overload protection limits total power dissipation in the PS1518. When the junction temperature exceeds T_j= +160°C, the thermal sensor signals the shutdown logic and turning off most of the internal circuitry. The thermal sensor turns internal circuitry on again after the IC's junction temperature drops by 20°C. The regulator then starts functioning in the required mode based on the supply voltage.
Thermal-Overload protection is designed to protect the PS1518 in the event of a fault condition. For continual operation, do not exceed the absolute maximum junction temperature rating of Tj = +150°C.

Open Load Protection:

Open load protection in PS1518, protects the chip from destruction, due to excessive high voltage. When, in any case, one or more LEDs in the LED string fails, the feedback pin is pulled down to zero. As a result, the chip runs at maximum duty cycle, boosting the output voltage higher and higher. The open load protection mechanism, checks this condition, if OV pin is tied to the top of the LED string. If the output voltage exceeds the OV threshold (28V), the switching stops, allowing the output to discharge. The open load protection mechanism includes a hysteretic comparator. The switching is enabled again, when the output voltage has fallen to a certain level. Because the chip doesn't turn OFF fully, no power recycling is necessary, when this condition takes place. But it's highly recommended, not to use the chip in that mode of operation for longer span of time.

Dimming Control:

LED is a current driven device. Hence, current through the LED needs to be controlled to have dimming control. Different ways are there to control dimming for PS1518, in the normal mode of operation. In the first way, the feedback voltage is controlled using an external voltage source. As shown in the figure 8, current starts flowing down R1, R2 and R3, as the external voltage increases. The loop will continue to regulate the feedback voltage to 110mV, and as a result, the current through the LEDs has to decrease as the same amount of that being injected from the external source. With the external voltage from 0 to 2V, the resistor values shown for R2 and R3 can control LED current from 0 to 20mA.

Dimming can also be achieved using logic signal to EN pin. As shown in Figure 9, the PWM signal can be applied to the EN pin of PS1518. The LEDs will switch between full load to completely shut down state. The average current through the LEDs will be proportional to the duty cycle of PWM. The PWM signal in figure 9 should be of 1 KHz or less, because of the presence of the soft-start mechanism.

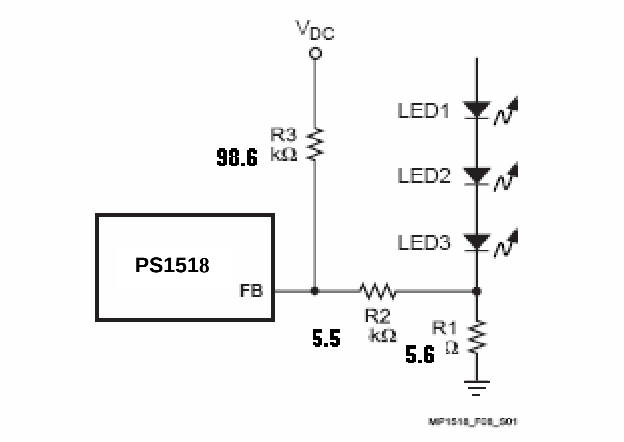


Figure 8: Dimming control using a DC voltage

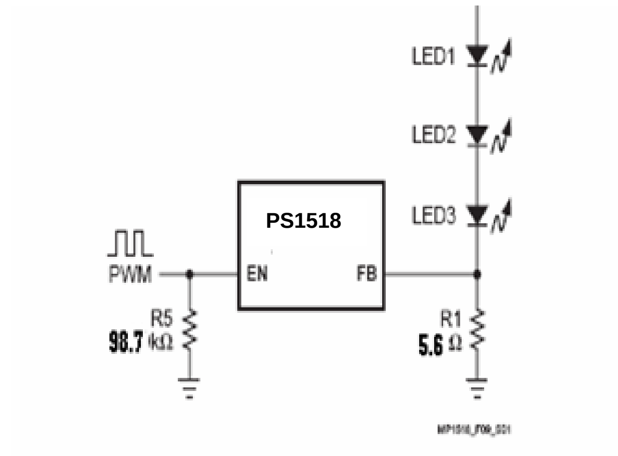


Figure 9: PWM dimming control using Logic signal

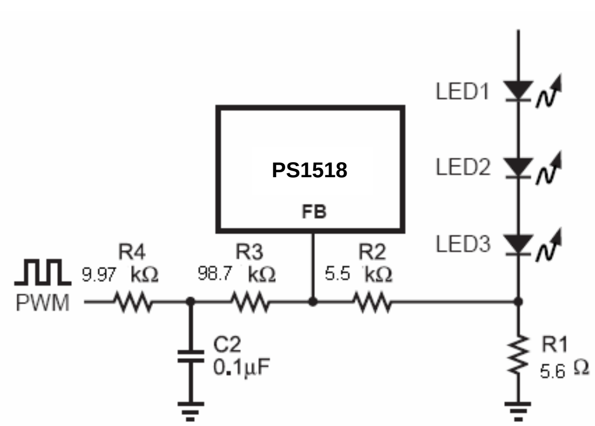


Figure 10: Dimming control using a filtered PWM signal.

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