RoHS COMPLIANCE

SOT-25

Pin Definition:
1. SW
2. Ground
3. Feedback
4. CTRL
5. Input

General Description

The TS1518 is a step-up DC-DC converter; operates as current source to drive up to 6 white LEDs(V_{IN} at 3.0V) or 8 LEDs(V_{IN} at 3.5V) or 9 LEDs(V_{IN} at 3.5V) in series. Series connecting of the LEDs provides identical LED currents resulting in uniform brightness and eliminating the need for ballast resistors. The light intensity of these LEDs is proportional to the current passing through them. The TS1518 switches at a fixed frequency of ~930KHz, allowing the use of tiny, low profile inductors and capacitors to minimize footprint and cost in space consideration applications for cellular phone backlighting or other hand held equipment. The TS1518 can drive up to 9 white LEDs from a single Li-Ion battery. The wide input voltage range from 2.7V to 7V is ideal for portable with higher conversion efficiency. To control LED brightness, the LED current can be pulsed by applying a PWM (pulse width modulated) signal with a frequency range of 100Hz to 1KHz to the CTRL pin.

TS1518 has integrated Latched Over Voltage Protection that prevents damage to the device in case of a high impedance output due to faulty LED or open circuit caused by abnormal conditions.

Features

● Built-in Internal Switch

● PWM dimming control 100Hz to 1KHz

● Analog dimming control

● 2.7V to 7V input range

● <1uA shutdown current

● Internal Soft Start

● Drives up to 9 White LEDs (V_{IN} at 3.5V)

● Over Voltage Protection 34V

● 100mV Low Reference Voltage

Application

● Cellular Phones

● Digital Still Cameras

● Portable Electronics

● LCD Display Module

● White LED Backlighting

● PDAs, GPS terminals

Ordering Information

Part No.	Package	Packing
TS1518CX5 RF	SOT-25	3Kpcs / 7" Reel

Typical Application Circuit

L1 : 33uH
C1 : 1uF
C2 : 4.7uF

TAIWAN SEMICONDUCTOR

Step-Up DC-DC Converter, White LED Driver
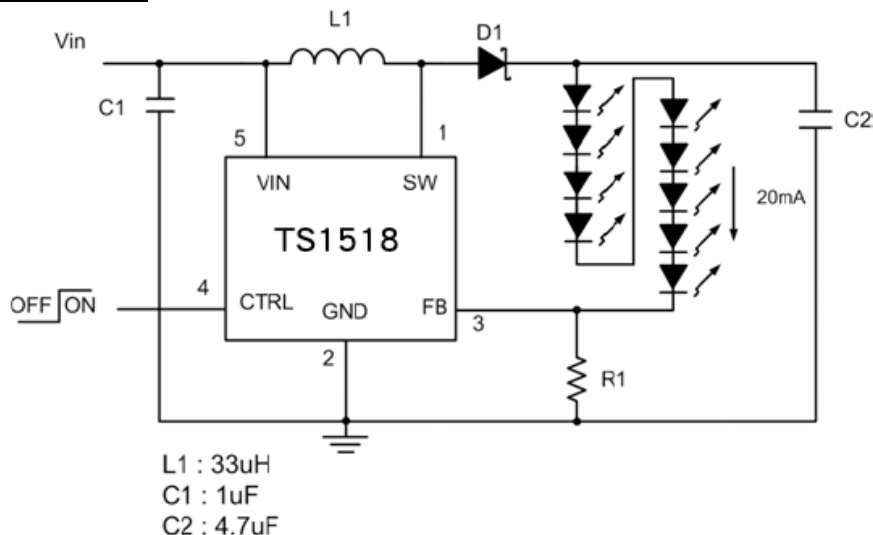
Absolute Maximum Rating

Parameter	Symbol	Limit	Unit
Input Voltage	V_{IN}	9	V
Supply Voltage (Recommended)	V_{IN}	2.7 ~ 7	V
FB Voltage	V_{FB}	5	V
SW Voltage	V_{SW}	32	V
CTRL Voltage	V_{CTRL}	5	V
Ambient Temperature Range	T_A	-40 to +85	^{o}C
Junction Temperature Range	T_J	-40 to +125	^{o}C

Electrical Specifications (Ta = 25°C, V_{IN}=3.3V, C_{IN}=1uF, C_{OUT}=10uF unless otherwise noted)

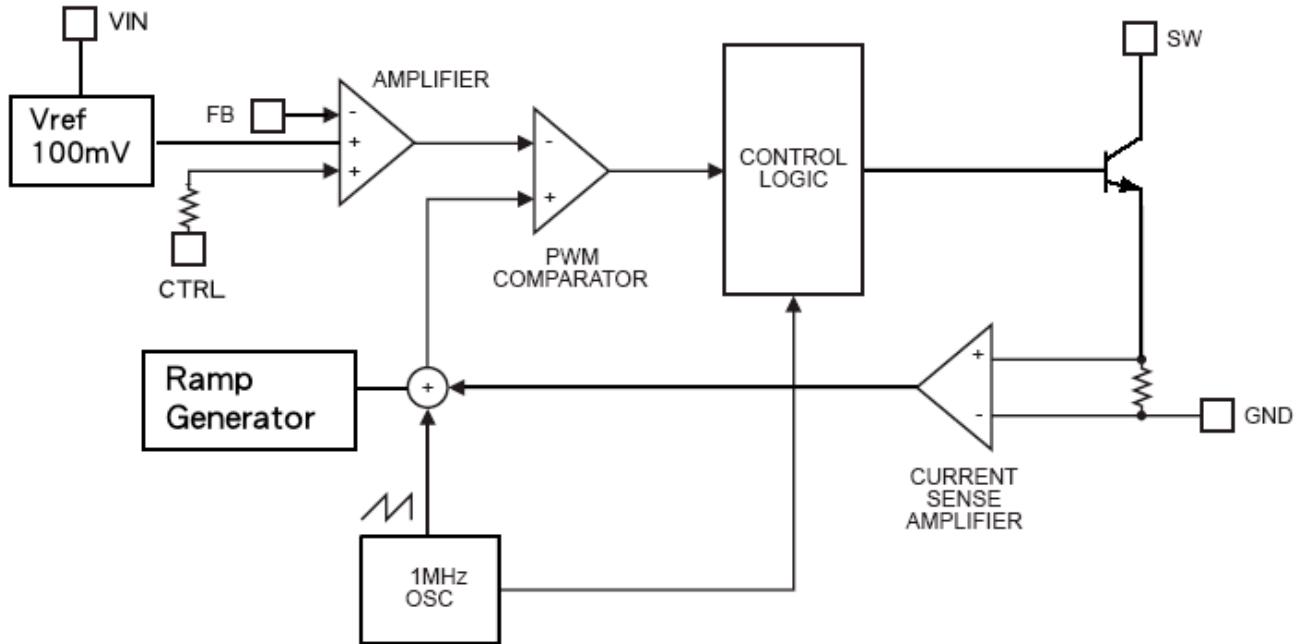| Function Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Input Voltage Range	V_{IN}		2.7	--	7	V
Quiescent Current (Not Switching)	I_Q	VFB = 0.3V	1.2	1.5	1.7	mA
Quiescent Current (Shutdown)		CTRL = 0V	--	0.3	1	uA
Feedback Voltage	V_{FB}	Iout=20mA,Vout=12.5V Circuit of Figure 1	90	100	110	mV
Switch Current Limit	I_{CL}	100% duty cycle	200	230	--	mA
	I_{LIM}	40% duty cycle	--	180	--	mA
FB Pin Bias Current	I_B	VFB=200mV	--	--	1	uA
Switching Frequency	F_{RSW}		900	930	960	KHz
Maximum Duty Cycle	D_{TMX}		--	--	85	%
Minimum Duty Cycle	D_{TMN}		20	--	25	%
Switch Vcesat	V_{SAT}	At Isw = 200mA	--	120	180	mV
Switch Leakage Current	I_{LKG}	Ctrl = 0.3V	--	1	--	µA
V_{CTRL} for Full LED Current	V_{CTL}	Full On	1.7	--	--	V
		Full Off	--	--	0.3	V
CTRL Pin Bias Current	I_{CTL}	Ctrl = 2V	--	40	--	µA
Over Voltage Protection	OVP		--	34	--	V
Thermal Resistance	θ_{JA}		--	220	--	°C/W

Note:

Absolute maximum ratings are limits beyond which damage to the device may occur.

The maximum allowable power dissipation is a function of maximum function temperature , TJ(max), the junction to ambient thermal resistance, θJA , and the ambient temperature. The maximum allowable, power dissipation at any ambient temperature is calculated using: PD(MAX)= [TJ(max)-TA]/θJA . Exceeding the maximum allowable power dissipation will cause excessive die temperature. All limits at temperature extremes are guaranteed via correlation using standard statistical methods

Functional Block

Pin Description

Pin	Function	Description
1	SW	Switching Pin. This is the collector of the internal NPN power switch. Connect to inductor and diode. Minimize the metal trace area connected to this pin to reduce EMI.
2	Ground	Ground Pin. Connect directly to local ground plane.
3	Feedback	Feedback Pin. Reference voltage is 200mV. Connect LEDs and a resistor at this pin. LED current is determined by the resistance and CTRL voltage.
4	CTRL	Shutdown Pin and Dimming Control Pin. VCTRL > 1.8V generates full-scale LED current VCTRL < 0.4V chip is off Switching from 04V to 2.0V, PWM duty cycle controls the LED current
5	Input	Input Supply Pin. Bypass this pin with a capacitor as close to the device as possible

Application Information

Operation

The TS1518 uses a constant frequency, current mode control scheme to regulate the output LED current. Its operation can be understood by referring to the block diagram in Figure 3. At the start of each oscillator cycle, a voltage proportional to the switch current is added to a ramp output and the resulting sum is fed into the positive terminal of the PWM comparator (comparator-1). When this voltage exceeds the level of the comparator negative input, the peak current has been reached, and the SR latch (in Control Logic) is reset and turns off the power switch. The voltage at the negative input of the comparator comes from the output of the error amplifier. The error amplifier sets the correct peak current level to keep the output in regulation. If the error amplifier's output increases, more current is delivered to the output; if it decreases, less current is delivered.

Soft Start and Current Limit

The internal soft start circuit minimizes the inrush current during turning on TS1518. The maximum switch current is limited to about 450 mA by the chip.

Open Circuit Protection

The TS1518 has an internal latched off open-circuit protection circuit. When the LEDs are disconnected from the circuit or fail open, the TS1518 will shutdown automatically until input condition changes to bring it out of the shutdown mode.

Inductor Selection

A 22uH inductor is recommended for most applications to drive more than 5 LEDs. Although small size and high efficiency are major concerns, the inductor should have low core losses at 1MHz and low DCR (copper wire resistance).

Diode Selection

To maintain high efficiency, the average current rating of the Schottky diode should be large than the peak inductor current, IPK. Schottky diode with a low forward drop and fast switching speeds are ideal for increase efficiency in portable application. Choose a reverse breakdown of the Schottky diode large than the output voltage.

Capacitor Selection

Choose low ESR capacitors for the output to minimize output voltage ripple. Multilayer capacitors are a good choice for this as well. A 1uF capacitor is sufficient for 2~6 LEDs, 2.2uF is for 7~8 LEDs and 4.7uF is for 9 LEDs applications. For additional bypassing, a 100nF ceramic capacitor can be used to shunt high frequency ripple on the input.

The input bypass capacitor Cin, as shown in Figure 1, must be placed close to the IC. This will reduce copper trace resistance which affects input voltage ripple of the IC. For additional input voltage filtering, a 100nF bypass capacitor can be placed in parallel with Cin to shunt any high frequency noise to ground. The output capacitor, Cout, should also be placed close to the IC. Any copper trace connections for the Cout capacitor can increase the series resistance, which directly effect output voltage ripple.

The feedback network, resister R2 should be kept close to the FB pin to minimize copper trace connections that can inject noise into the system. The ground connection for the feedback resistor network should connect directly to an analog ground plane. The analog ground plane should tie directly to the GND pin. If no analog ground plane is available, the ground connection for the feedback network should tie directly to the GND pin. Trace connections made to the inductor and Schottky diode should be minimized to reduce power dissipation and increase overall efficiency.

Application Information (Continue)

LED Current and Dimming Control

The LED's current is set by a resistor connected at FB pin to GND using:

$$I_{LED} = \frac{100mV}{R_{LED}}$$

The maximum LED current set initially can be reduced by pulse width modulating the CTRL voltage from 0.4V to 1.8V. A better approach is to adjust the feedback voltage for dimming control. Either a DC level signal or a filtered PWM signal can be used to control the LED current as illustrated in below figures respectively. Using the above different scheme, the LED current can be controlled from 0% to 100% to its maximum value.
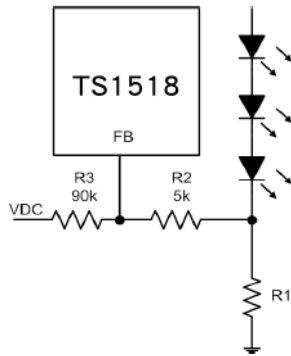
Dimming Control using a DC Voltage

VDC(V)	VFB	Iout(mA)
2	0	0
1.8	2.2	0.43
1.6	9.2	1.8
1.4	19.6	3.6
1.2	31.1	6
1	43.4	8.5
0.8	63	12.3
0.6	74	14.5
0.4	86.4	16.9
0.2	96.9	19
0	102	20
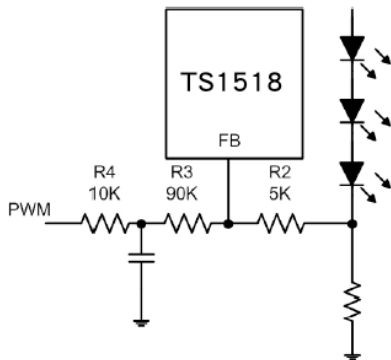
Dimming Control using a Filtered PWM Signal

Duty	Iout (mA)
0%	20
20%	17.4
30%	15
40%	12.4
50%	10
60%	8
70%	6.4
80%	4.07
100%	0
PWM : 2V ; 1KHz ; Vin=3.6V	

SOT-25 Mechanical Drawing

Front View
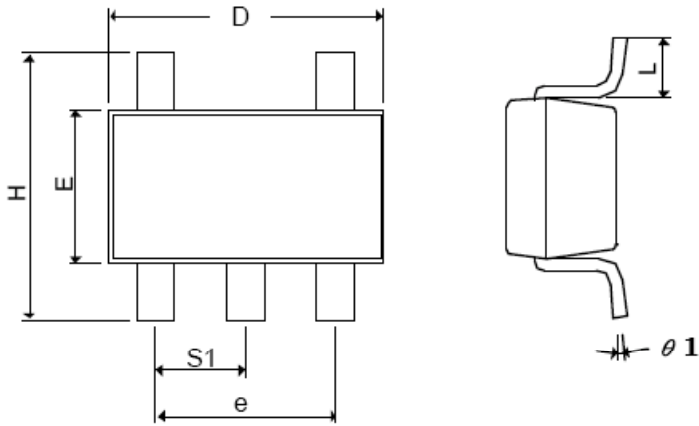
SOT-25 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A+A1	0.09	1.25	0.0354	0.0492
B	0.30	0.50	0.0118	0.0197
C	0.09	0.25	0.0035	0.0098
D	2.70	3.10	0.1063	0.1220
E	1.40	1.80	0.0551	0.0709
E	1.90 BSC		0.0748 BSC	
H	2.40	3.00	0.09449	0.1181
L	0.35 BSC		0.0138 BSC	
Ө1	0º	10º	0º	10º
S1	0.95 BSC		0.0374 BSC	

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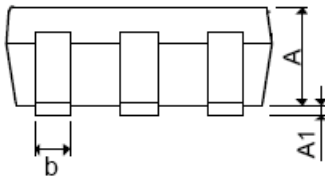
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