TAIWAN SEMICONDUCTOR

RoHS COMPLIANCE

TS1520

Step-Up DC-DC Converter, White LED Driver

SOT-25

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

General Description

The TS1520 is a step-up DC-DC converter; operates as current source to drive up to 18 white LEDs in parallel/series configuration. 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 TS1520 switches at a fixed frequency of 700KHz, 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 TS1520 can drive up to 18 white LEDs form 4.5V supply. The wide input voltage range from 2.7V to7V is ideal for portable (5V) applications 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 50KHz to the CTRL pin. TS1520 has integrated 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
- 2.7V to 7V input range
- <1uA shutdown current
- High Efficiency
- Drives up to 3S2P to 3S6P White LEDs (V_{IN} at 3.5V to 5V)
- Over Voltage Protection 30V

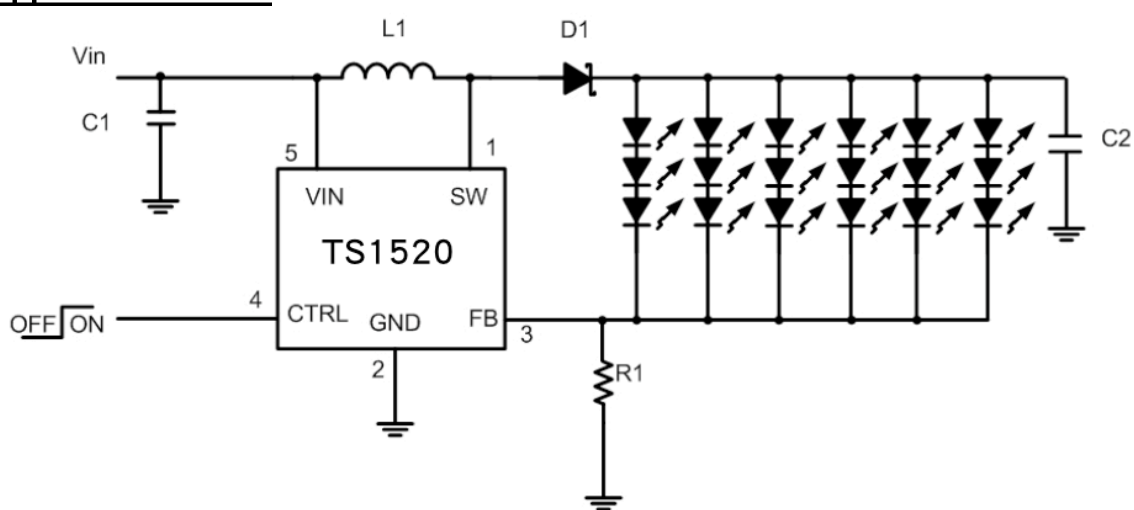
Application

- Cellular Phones
- Digital Still Cameras
- Portable Electronics
- LCD Display Module
- White LED Backlighting
- PDAs, GPS terminals

Ordering Information

Part No.	Package	Packing
TS1520CX5 RF	SOT-25	3Kpcs / 7" Reel

Typical Application Circuit



Absolute Maximum Rating

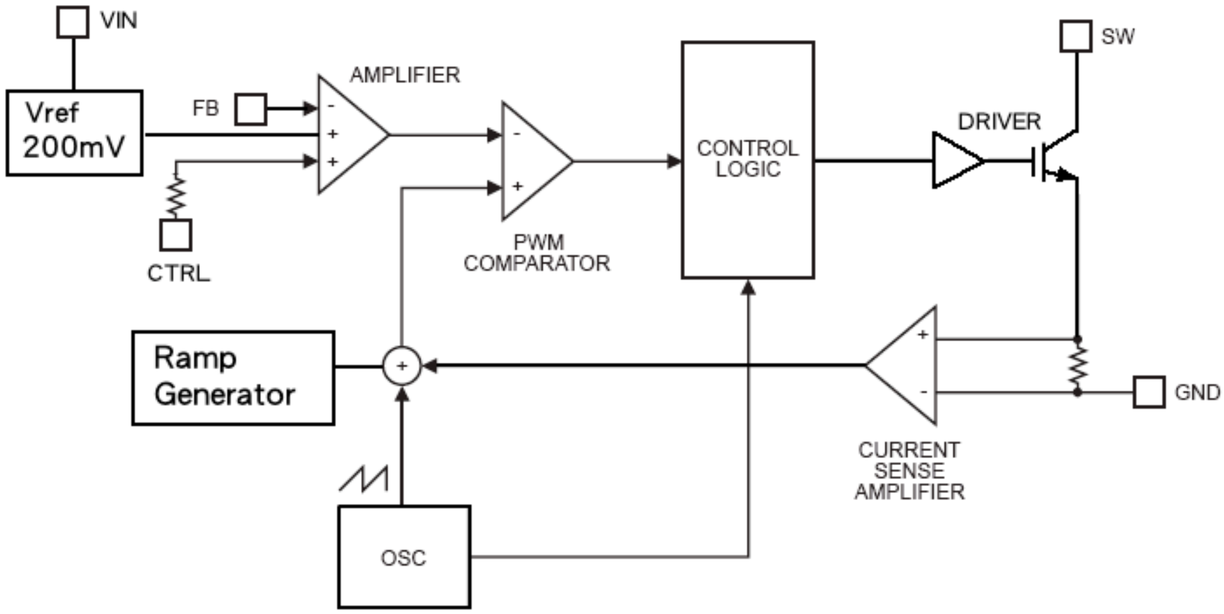
Parameter	Symbol	Limit	Unit
Input Voltage	V_{IN}	10	V
Supply Voltage (Recommended)	V_{IN}	2.7 ~ 7	V
FB Voltage	V_{FB}	5	V
SW Voltage	V_{SW}	32	V
CTRL Voltage	V_{CTRL}	5	V
Ambient Temperature Range	T_A	-40 to +85	°C
Junction Temperature Range	T_J	-40 to +125	°C

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	180	200	220	mV
Switch Current Limit	I_{CL}	100% duty cycle	420	450	--	mA
	I_{LIM}	40% duty cycle	--	250	--	
FB Pin Bias Current	I_B	VFB=200mV	2	10	20	uA
Switching Frequency	F_{RSW}		680	700	720	KHz
Maximum Duty Cycle	D_{TMX}		--	--	85	%
Minimum Duty Cycle	D_{TMN}		20	--	25	%
Switch Vcesat	V_{SAT}	At Isw = 200mA	--	120	--	mV
Switch Leakage Current	I_{LKG}	Ctrl = 0.3V	--	1	--	μA
V_{CTRL} for Full LED Current	V_{CTL}	Full On	--	1.7	1.8	V
		Full Off	--	0.2	0.3	V
CTRL Pin Bias Current	I_{CTL}	Ctrl = 2V	--	20	--	μA
Over Voltage Protection	OVP		--	30	--	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 TS1520 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. When this voltage exceeds the level of the comparator negative input, the peak current has been reached, and the SR latch 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.

Inrush Current

The maximum switch current is limited to about 900mA by the chip Typically, this large current will occur for about 40us during start up. A larger C_{OUT} will increase the duration of high current. However, when V_{IN} is first connected, an even larger current can flow into C_{OUT}. This occurs when the SW pin is open circuit and the C_{OUT} voltage changes from 0V to V_{IN} in a few microseconds. Because the duration of this large current is short, it will usually not cause problems. If this current is not desirable, an external soft-start circuit can be added to significantly reduce this inrush current.

LED Current and Dimming Control

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 Figure 1 and Figure 2 respectively. Using the above different scheme, the LED current can be controlled from 0% to 100% to its maximum value.

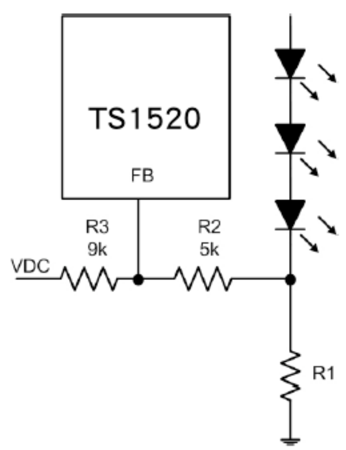


Figure 1. Dimming Control Using a DC Voltage

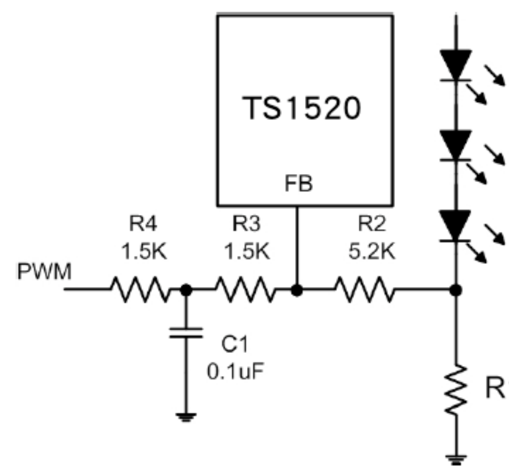


Figure 2. Dimming Control Using a Filtered PWM Signal (1kHz, 2Vp-p, duty 20%~80%)

Open Circuit Protection

The TS1520 has an internal open-circuit protection circuit. When the LEDs are disconnected from the circuit or fail open, the TS1520 will shutdown automatically until input condition changes to bring it out of the shutdown mode.

Inductor Selection

A 47uH inductor is recommended for most applications to drive more than 10 LEDs in serials and 33Uh inductor is recommended for drive 30 LEDs in serials/parallel. 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

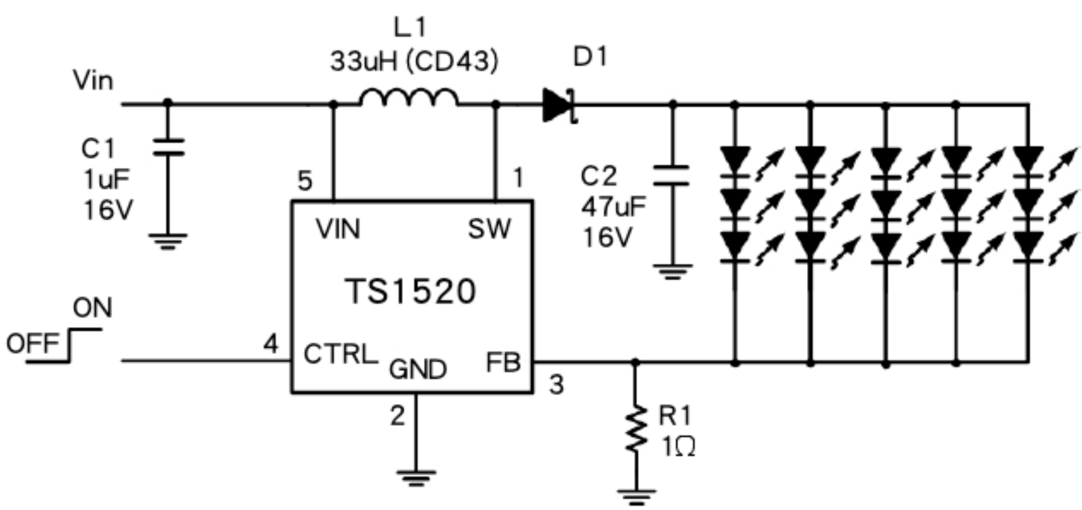
To maintain high efficiency, the average current rating of the Schottky diode should be large than the peak inductor current, IPK. Schottky diode with a low forward drop and fast switching speeds are ideal for increase efficiency in portable application. Choose a reverse breakdown of the Schottky diode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

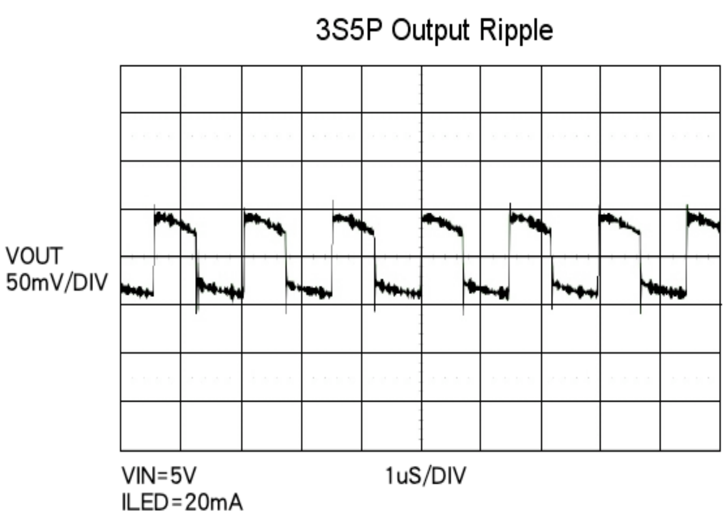
Application Information (Continue)

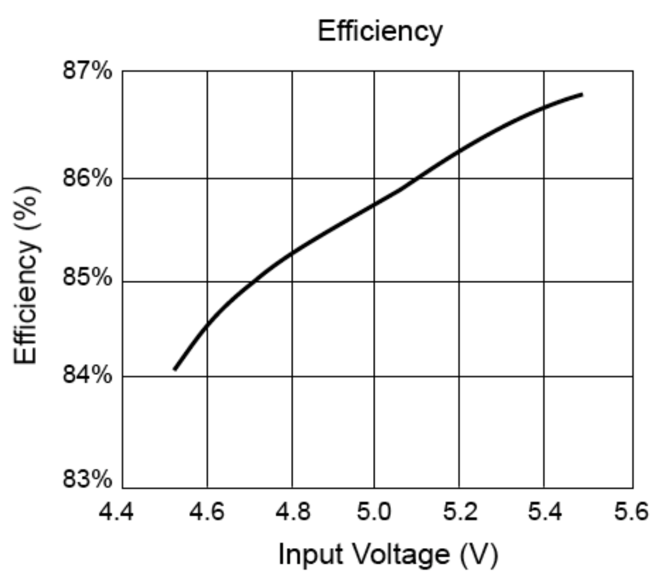
Capacitor Selection

Choose low ESR capacitors for the output to minimize output voltage ripple. Multilayer capacitors are a good choice for this as well. A 47uF capacitor is sufficient for most applications. For additional bypassing, a 100nF ceramic capacitor can be used to shunt high frequency ripple on the input. The input bypass capacitor C_{IN}, 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 C_{IN} to shunt any high frequency noise to ground. The output capacitor, C_{OUT}, should also be placed close to the IC. Any copper trace connections for the C_{OUT} 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.

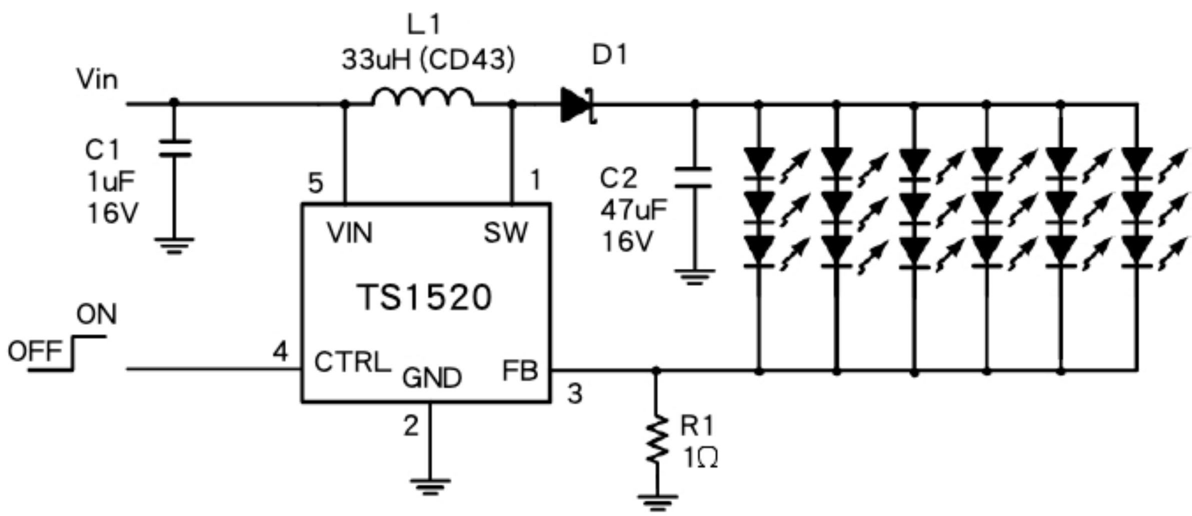
Typical Performance Characteristics

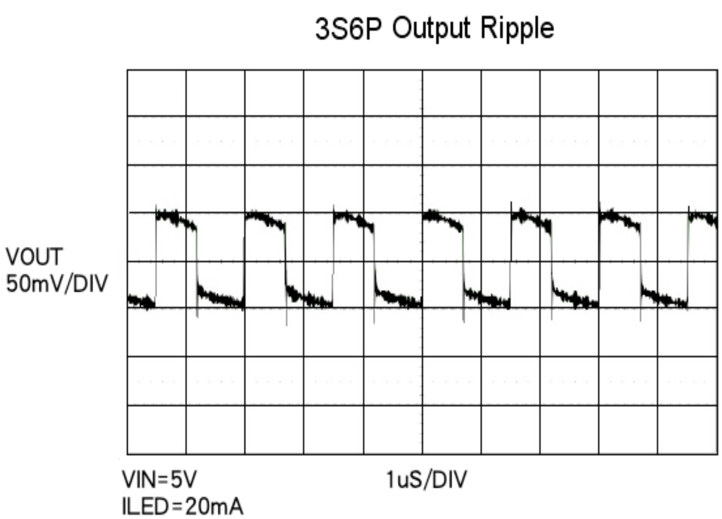


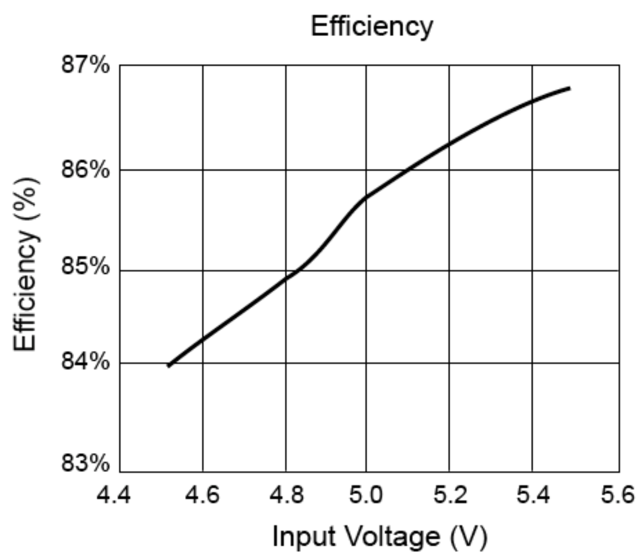




Typical Performance Characteristics (Continue)







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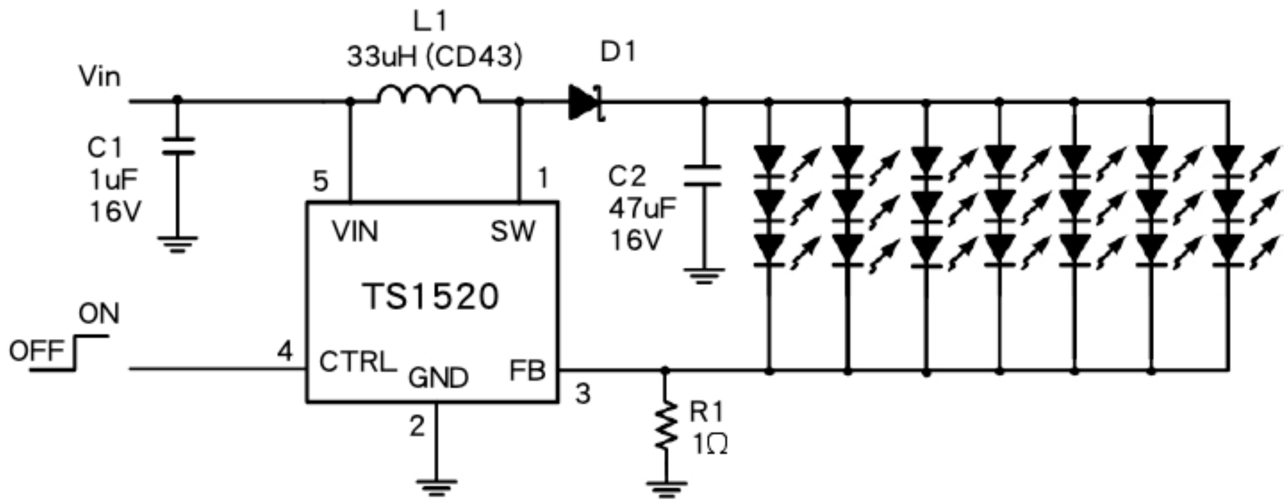

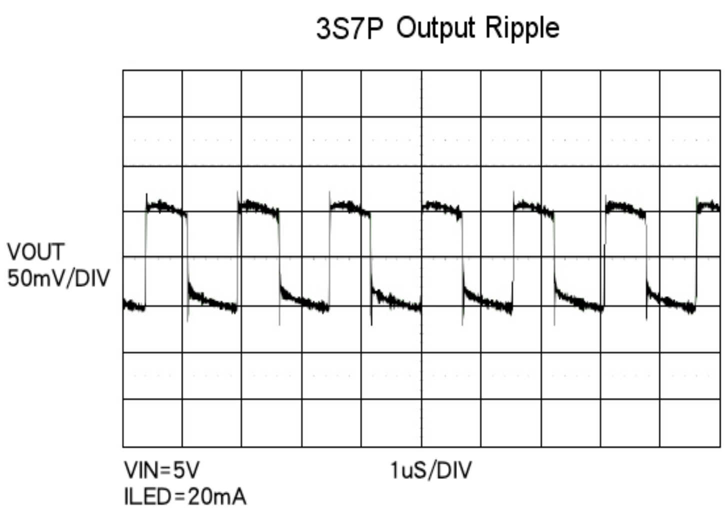

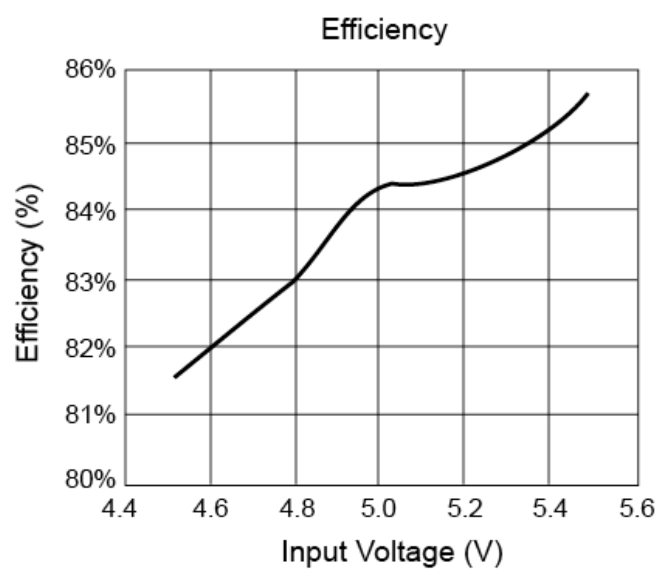

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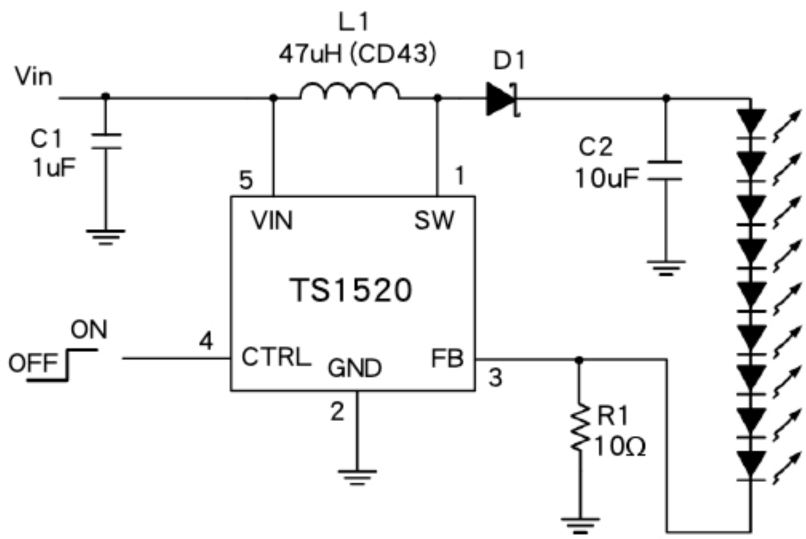

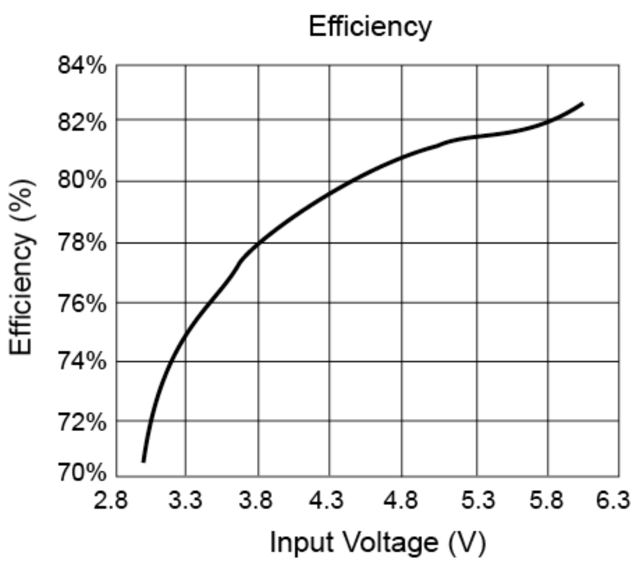

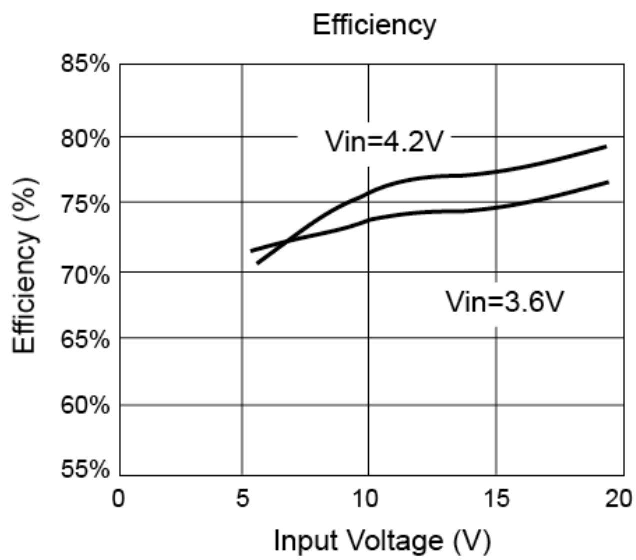

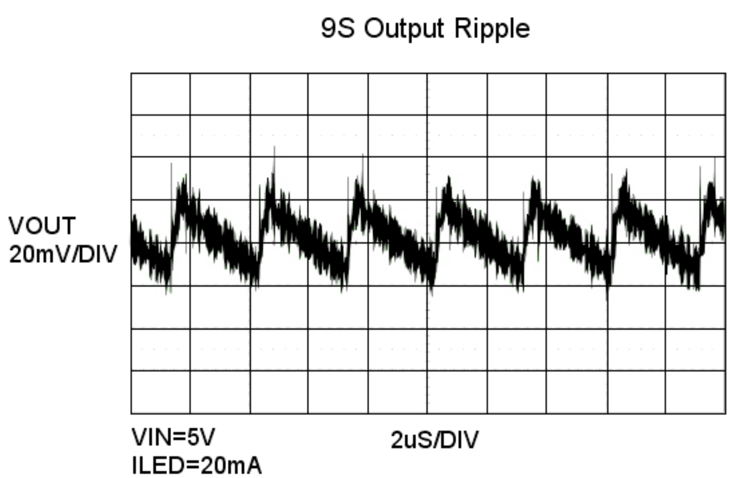

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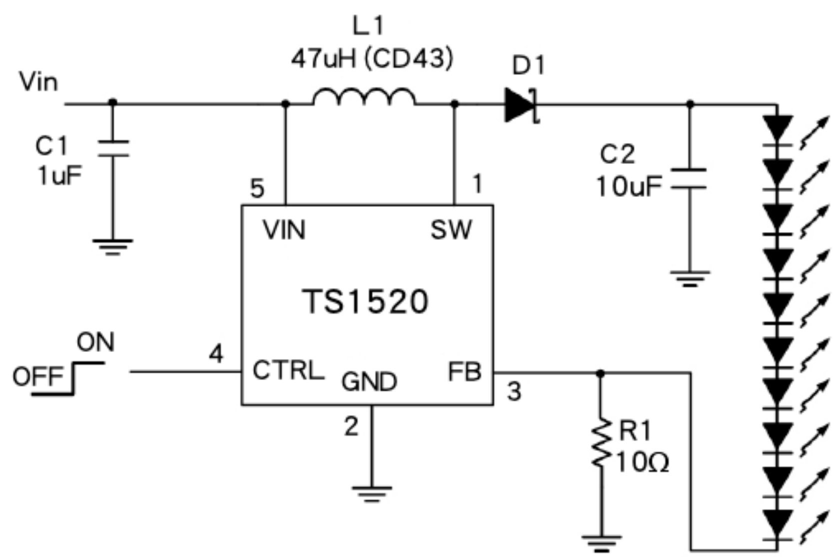

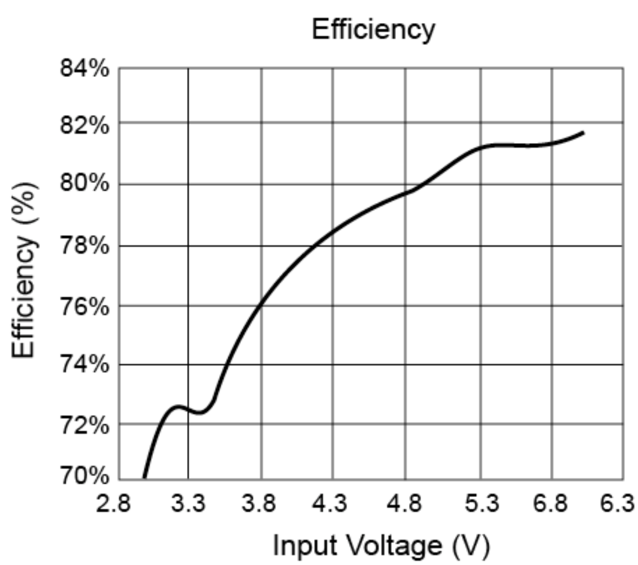

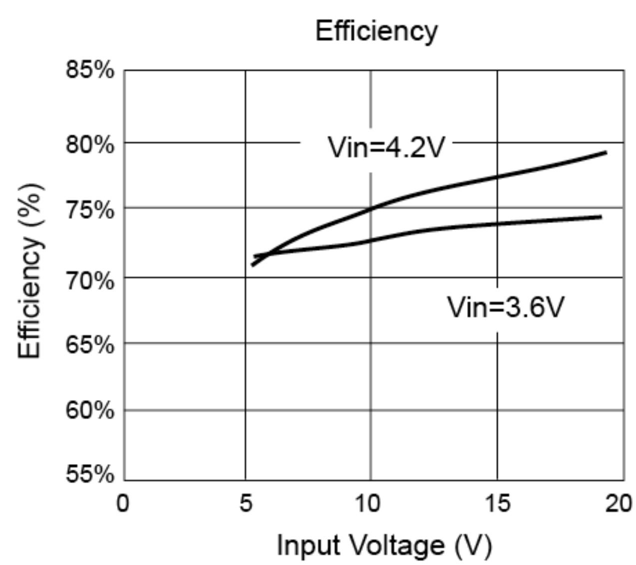

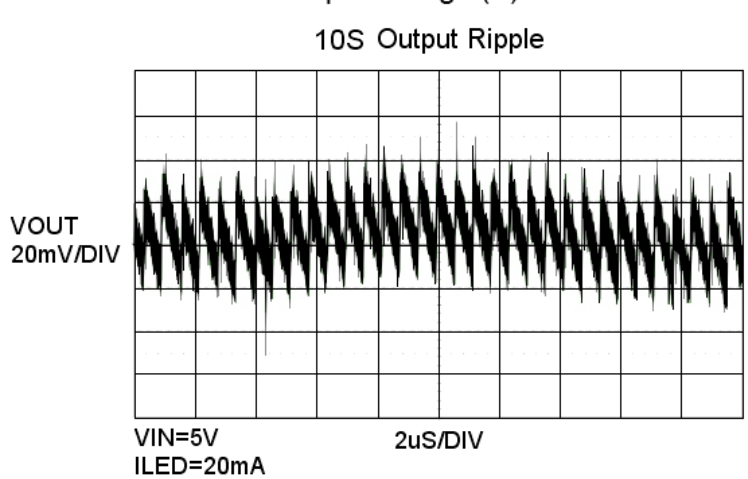

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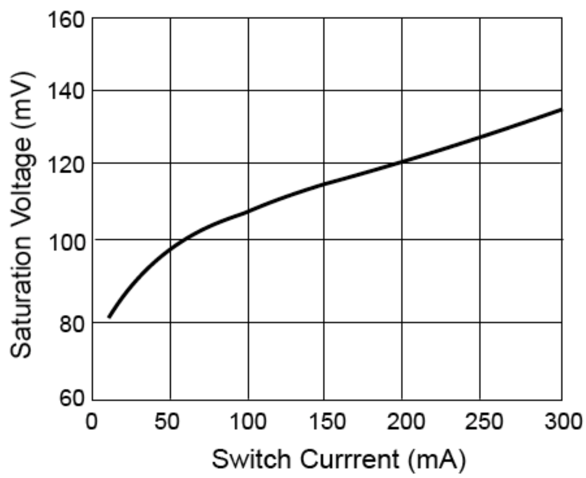


Figure 1. Saturation Voltage vs. Switch Current

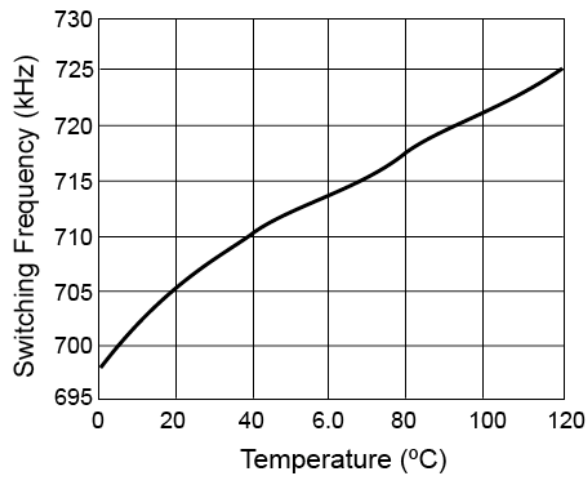


Figure 2. Switching Frequency vs. Temperature

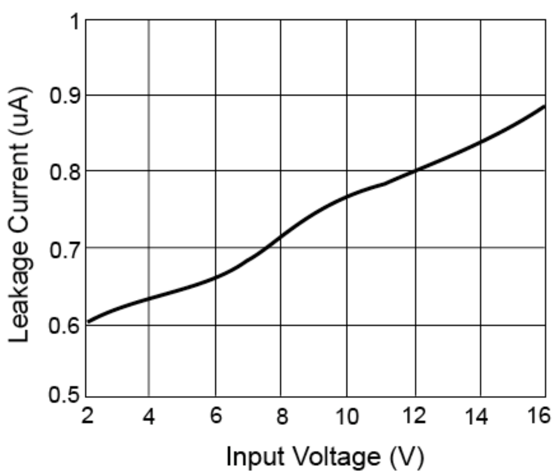


Figure 3. Leakage Current vs. Input Voltage

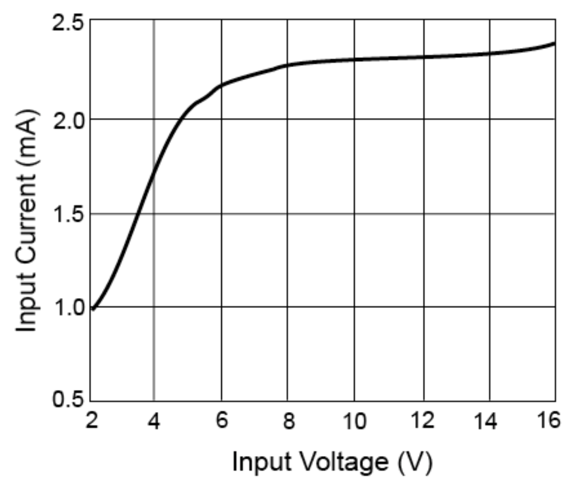
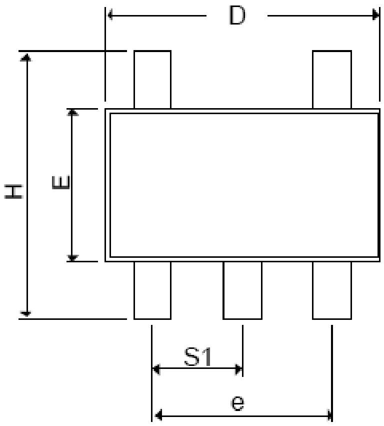
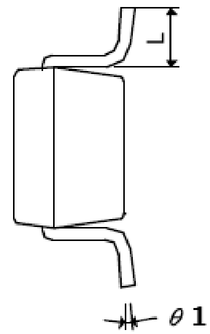


Figure 4. Input Current vs. Input Voltage

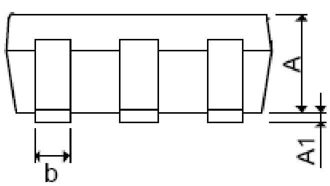
SOT-25 Mechanical Drawing





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	
Θ1	0º	10º	0º	10º
S1	0.95 BSC		0.0374 BSC	

Front View



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