58V, 0.3A, Step Down COT Switching Regulator TD1558C

General Description

The TD1558C Step Down Switching Regulator features all of the functions needed to implement a low cost, efficient, buck bias regulator capable of supplying 0.3A to the load. This buck regulator contains an N-Channel Buck Switch. The constant on-time feedback regulation scheme requires no loop compensation, results in fast load transient response, and simplifies circuit implementation. The operating frequency remains constant with line and load variations due to the inverse relationship between the input voltage and the on-time.

The TD1558C requires a minimal number of readily-available external components. The TD1558C is available in a SOT23-6 package.

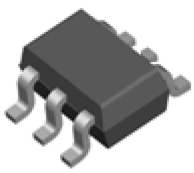
Features

- 0.3A Peak Output Current
- 1.3Ω Internal Power MOSFET
- 0.1µA Shutdown Mode
- Thermal Shutdown
- Cycle-by-Cycle Over-Current Protection
- 10V to 58V Operating Input Range
- Available in a SOT23-6 Package

Applications

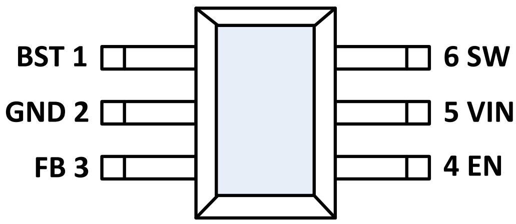
- Power Meters
- Distributed Power Systems
- Battery Chargers
- Pre-Regulator for Linear Regulators
- WLED Drivers

Package Type



SOT23-6

Pin Configurations

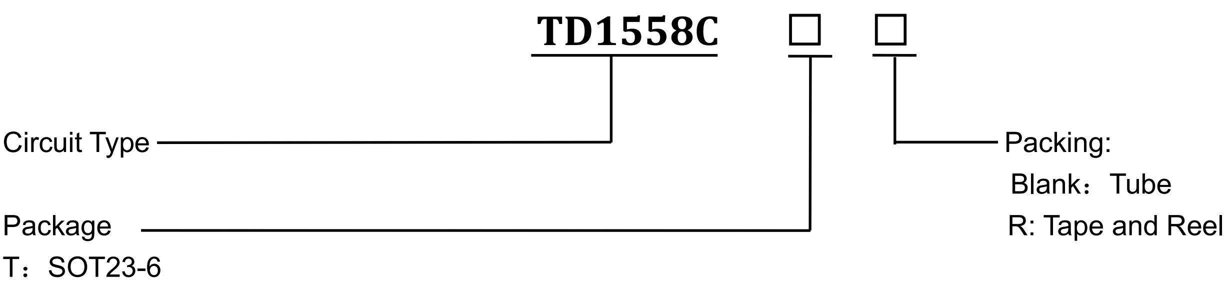


(Top view)

Pin Description

Pin Number	Pin Name	Description
1	BST	Bootstrap. Connect a capacitor between the SW and BS pins to form a floating supply across the power switch driver. This capacitor drives the power switch's gate above the supply voltage.
2	GND	Ground. Voltage reference for the regulated output voltage. Requires special layout considerations. Isolate this node from the D1 to C1 ground path to prevent switching current spikes from inducing.
3	FB	Feedback. Sets the output voltage. Connect to the tap of an external resistor divider from the output to GND.
4	EN	On/Off. Pull EN above 1.8V to turn the device ON. For automatic enable, connect to V_{IN} using a 1MΩ resistor.
5	VIN	Supply Voltage. The TD1558C operates from a 10V-to-58V unregulated input. Requires C1 to prevent large voltage spikes from appearing at the input.
6	SW	Power Switching Output.

Ordering Information



Function Block

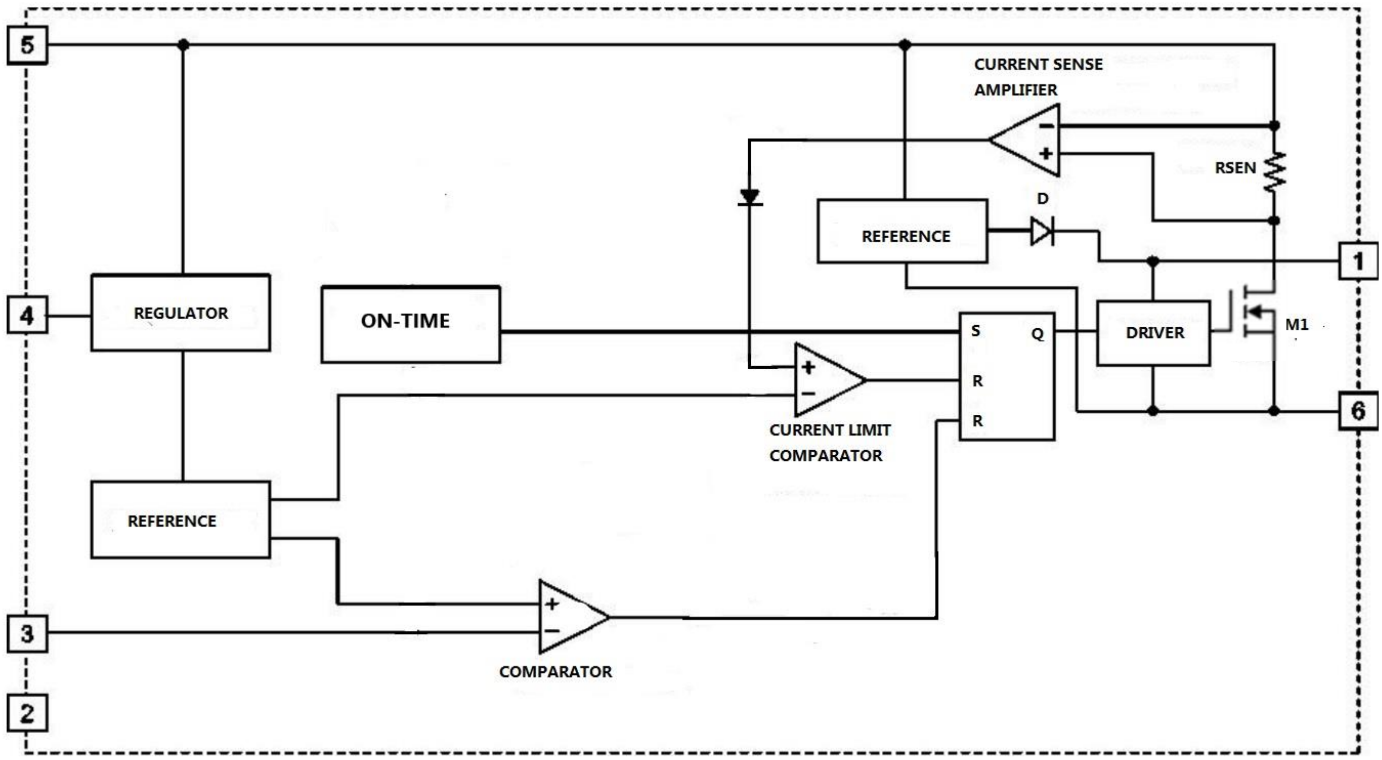


Figure1 Function Block Diagram of TD1558C

Absolute Maximum Ratings (Note1)

Symbol	Parameter	Rating	Unit
V_{IN}	VIN Supply Voltage（VIN to Gnd）	-0.3 ~ 60	V
V_{SW}	SW to GND Voltage	-0.3 to V_{IN}+0.3	V
V_{BS}	BS to GND Voltage	V_{SW} - 0.3 ~ V_{SW} +6	V
	All Other Pins	-0.3 ~ 6	V
P_D	Power Dissipation	Internally Limited	W
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 ~ 150	°C
T_{SDR}	Maximum Lead Soldering Temperature (10 Seconds)	260	°C

Note1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Characteristics

Symbol	Parameter	Typical Value	Unit
θ_{JA}	Junction-to-Ambient Resistance in free air (Note 2) SOT-23-6	250	°C/W

Note 2: θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air.

Recommended Operation Conditions (Note3)

Symbol	Parameter	Range	Unit
V_{IN}	VIN Supply Voltage	10 ~ 58	V
	Operating Junction Temp	-40 ~ 125	°C

Note 3: Refer to the typical application circuit

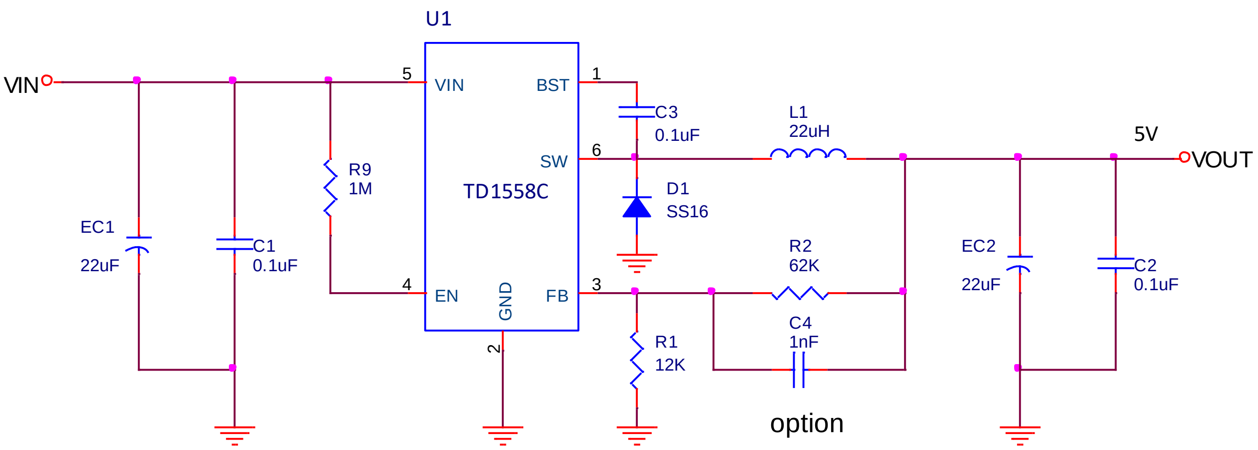
Electrical Characteristics

Unless otherwise specified, these specifications apply over V_{IN}=12V, V_{EN}=3V and T_A = 25°C.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{FB}	Feedback Voltage	10V ≤ V_{IN} ≤ 58V	0.787	0.812	0.836	V
I_{FB}	Feedback Current	V_{FB} = 0.9V	-	-	0.1	μA
$R_{DS(ON)}$	Switch-On Resistance		-	1.3	-	Ω
I_Q	V_{IN} current	No load	-	0.9	-	mA
I_{LIM}	Current Limit		-	0.5	-	A
f_{SW}	Switching Frequency	V_{OUT}=5V	-	600	-	kHz
T_{OFF}	Minimum OFF-Time		-	160	-	ns
T_{ON}	Minimum ON-Time		-	160	-	ns
V_{UVLO_R}	Under-Voltage Lockout Threshold, Rising		-	8.45	-	V
V_{UVLO_F}	Under-Voltage Lockout Threshold, Falling		-	8.25	-	V
V_{UVLO_HYS}	Under-Voltage Lockout Threshold,Hysteresis		-	0.2	-	V
V_{EN_R}	EN Threshold, Rising		-	1.8	-	V
V_{EN_F}	EN Threshold, Falling		-	1.5	-	V
V_{EN_HYS}	EN Threshold, Hysteresis		-	300	-	mv

I_{EN}	EN Input Current	V_{EN}=2V	-	2	-	μA
		V_{EN}=0V	-	0.1	-	μA
I_S	Supply Current (Shutdown)	V_{EN}=0V	-	0.1	1	μA
T_{SD}	Thermal Shutdown		-	165	-	°C
T_{SD_HYS}	Thermal Shutdown Hysteresis		-	20	-	°C

Typical Application Circuit



OPERATION

The TD1558C Step Down Switching Regulator features all the functions needed to implement a low cost, efficient buck bias power converter capable of supplying at least 0.3A to the load. This high voltage regulator contains an N-Channel buck switch, is easy to implement, and is available in SOT23-6 package. The regulator's operation is based on a constant on-time control scheme, where the on-time is determined by V_{IN}. This feature allows the operating frequency to remain relatively constant with load and input voltage variations. The feedback control requires no loop compensation resulting in very fast load transient response. The valley current limit detection circuit, internally set at 0.5A, holds the buck switch off until the high current level subsides. This scheme protects against excessively high current if the output is short-circuited when V_{IN} is high.

The TD1558C can be applied in numerous applications to efficiently regulate down higher voltages.

Application Information

Setting Output Voltage

The external resistor divider sets the output voltage (see the Typical Application schematic).

R1 is:

$$R1 = \frac{R2}{\frac{V_{OUT}}{0.812V} - 1}$$

Selecting the Inductor

Use an inductor with a DC current rating at least 25% percent higher than the maximum load current for most applications. For best efficiency, the inductor's DC resistance should be less than 200mΩ.

For most designs, the required inductance value can be derived from the following equation.

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{SW}}$$

Where ΔI_L is the inductor ripple current.

Choose the inductor ripple current to be 30% of the maximum load current. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light-load conditions (below 100mA), use a larger inductance to improve efficiency.

Selecting the Input Capacitor

The input capacitor reduces the surge current drawn from the input supply and the switching noise from the device. The input capacitor impedance at the switching frequency should be less than the input source impedance to prevent high-frequency-switching current from passing through the input. Use ceramic capacitors with X5R or X7R dielectrics for their low ESRs and small temperature coefficients. For most applications, a 4.7µF capacitor will sufficient.

Selecting the Output Capacitor

The output capacitor keeps the output voltage ripple small and ensures feedback loop stability. The output capacitor should use electrolytic capacitor for high ESR characteristics, and it's ESR should be higher than 200mΩ.

PCB Layout Guide

PCB layout is very important to stability. Please follow these guidelines and use Figure 2 as reference.

1) Keep the path of switching current short and minimize the loop area formed by the input capacitor, high-side MOSFET, and Schottky diode.

2) Keep the connection from the power ground→Schottky diode→SW pin as short and wide as possible.

3) Ensure all feedback connections are short and direct. Place the feedback resistors and compensation components as close to the chip as possible.

4) Route SW away from sensitive analog areas such as FB.

5) Connect IN, SW, and especially GND to large copper areas to cool the chip for improved thermal performance and long-term reliability. For single layer PCBs, avoid soldering the exposed pad.

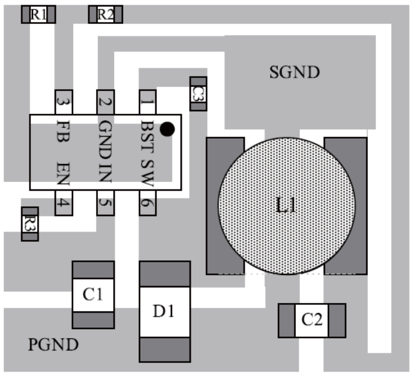
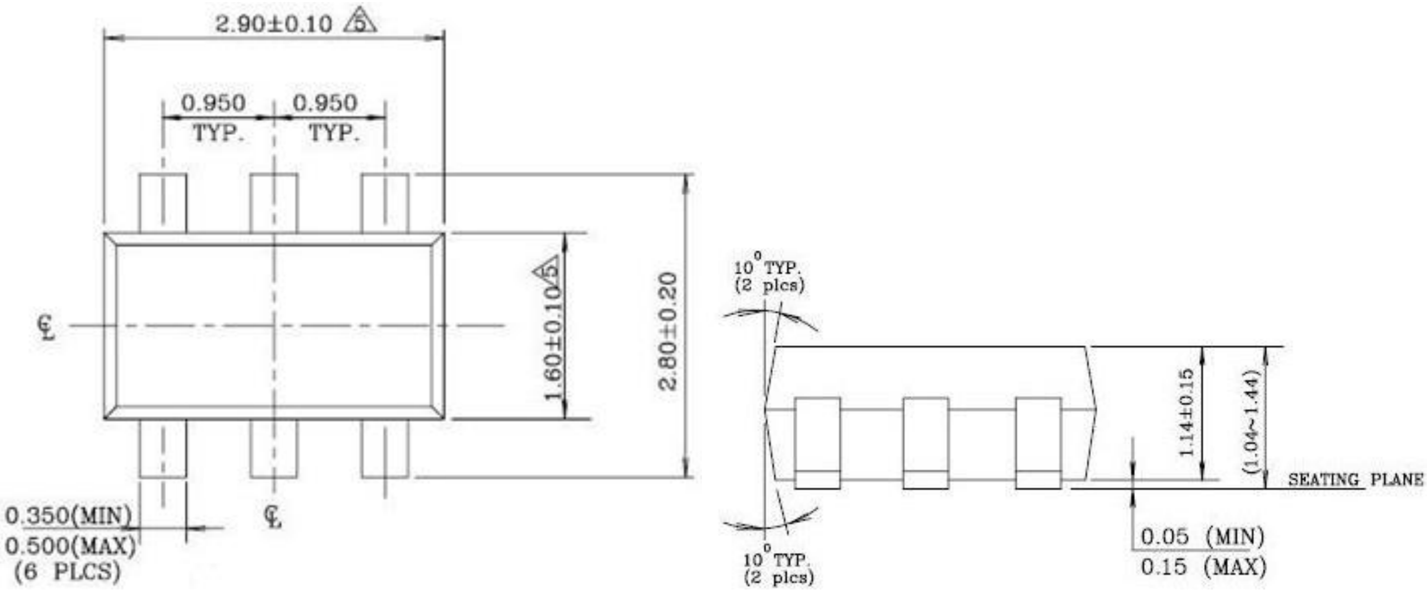
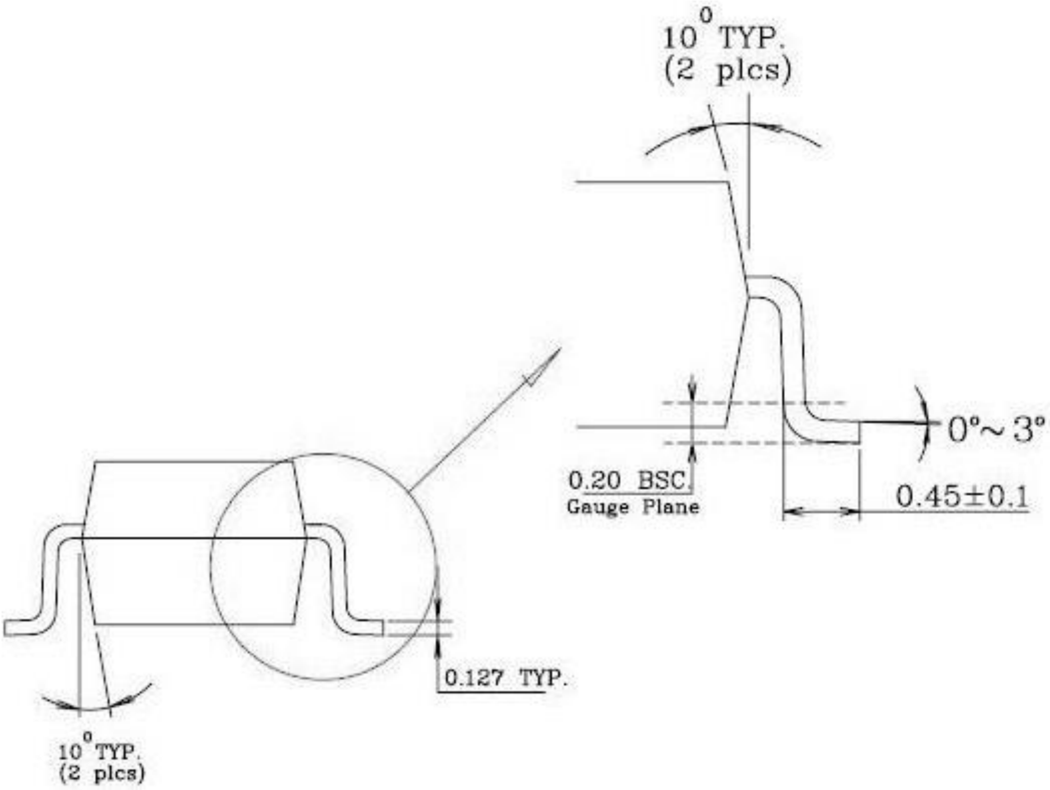


Figure 2: PCB Layout

Package Information

SOT23-6 Package Outline Dimensions





Design Notes