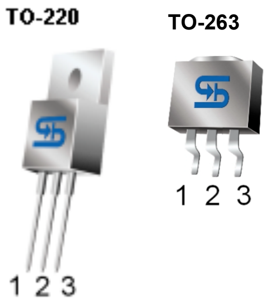
TS39300

3A Ultra Low Dropout Positive Voltage Regulator



Pin Assignment:
1. Input
2. Ground
3. Output

Low Dropout Voltage 0.4V (typ.)
Output Current 3A
Low Ground Current

General Description

The TS39300 series are 3A ultra low dropout linear voltage regulators that provide low voltage, high current output with a minimum of external components. The TS39300 offers extremely low dropout (typically 400mV at 3A) and low ground current (typically 36mA at 3A).

The TS39300 is ideal for PC add-in cards that need to convert from standard 3.3V to 2.5V or 2.5V to 1.8V. A guaranteed maximum dropout voltage of 500mV over all operating conditions allows the TS39300 to provide 2.5V from a supply as low as 3V, and 1.8V from a supply as low as 2.5V. The TS39300 also has fast transient response for heavy switching applications. The device requires only 47uF of output capacitor to maintain stability and achieve fast transient response.

Features

- ✧ Dropout voltage typically 0.4V @Io=3A
- ✧ Output current up to 3A
- ✧ Low ground current
- ✧ Current limiting and Thermal shutdown
- ✧ Extremely fast transient response
- ✧ Reversed leakage protection
- ✧ Reverse battery protection

Ordering Information

Part No.	Operating Temp.	Package
TS39300CZ**xx**	-40 ~ +125 °C	TO-220
TS39300CM**xx**		TO-263

Note: Where **xx** denotes voltage option, available are
50 = 5.0V
33 = 3.3V
25 = 2.5V
18 = 1.8V

Applications

- ✧ Battery power equipment
- ✧ LDO linear regulator for PC add-in cards
- ✧ PowerPC™ power supplies
- ✧ Multimedia and PC processor supplies
- ✧ High efficiency linear power supplies
- ✧ High efficiency post regulator for switching supply
- ✧ Low-voltage microcontrollers and digital logic
- ✧ SMPS post regulator

Absolute Maximum Rating (Note 1)

Supply Voltage	Vin	-20V ~ +20	V
Enable Voltage	Ven	+20	V
Storage Temperature Range	T_{STG}	-65 ~ +150	°C
Lead Soldering Temperature (260 °C)		5	S
ESD		(Note 3)	

Operating Rating (Note 2)

Operation Input Voltage	Vin (operate)	+2.5 ~ +16	V
Operation Enable Voltage	Ven (operate)	+16	V
Power Dissipation (Note 4)	P_D	Internally Limited	W
Operating Junction Temperature Range	T_J	-40 ~ +125	°C

Electrical Characteristics

Vin = Vout + 1V, Venable= 2.4V, Tj = 25 °C, unless otherwise specified.

Parameter	Conditions		Min	Typ	Max	Unit
Output Voltage	I_L=10mA		0.990|Vo|	5.0/3.3 2.5/1.8	1.010|Vo|	V
Output Voltage	10mA ≤ I_L ≤ 3A, Vo+1V ≤ Vin ≤ 16V		0.980|Vo|		1.020|Vo|	
Line Regulation	I_L=10mA, Vo+1V ≤Vin≤ 16V		--	0.06	0.5	%
Load Regulation	Vin=Vout+1V, 10mA≤I_L≤3A		--	0.2	1.0	%
Output Voltage Temp. Coefficient	Note 5		--	40	100	ppm/°C
Dropout Voltage (Note 6 & 8)	ΔVout= -1%	I_L=100mA	--	65	200	mV
		I_L=750mA	--	185	--	
		I_L=1.5A	--	250	--	
		I_L=3A	--	400	550	
Quiescent Current (Note 7)	Vin=Vout+1V	I_L=100mA	--	6	10	mA
		I_L=750mA	--	10	20	
		I_L=1.5A	--	17	--	
		I_L=3A	--	45	--	
Current Limited	Vout=0, Vin=Vout+1V		--	4.5	--	A

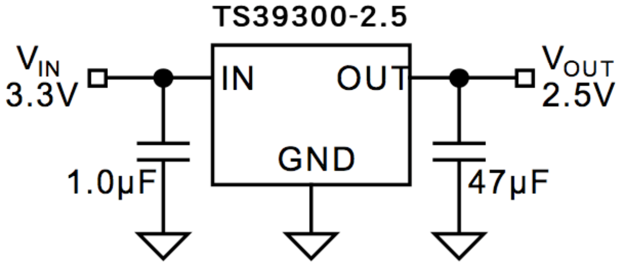
Thermal Performance

Condition	Package type	Typ	Unit
Thermal Resistance Junction to Case	TO-220	2	°C/W
	TO-263	2	

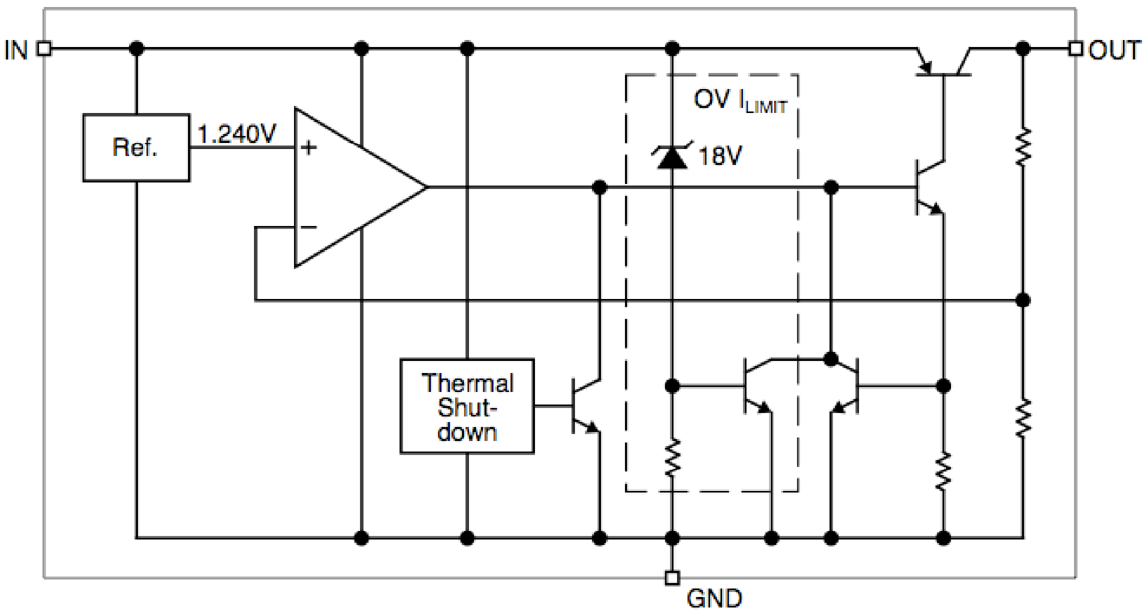
Note:

1. Exceeding the absolute maximum ratings may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. Devices are ESD sensitive. Handling precautions recommended.
4. $Pd_{(max)} = (Tj_{(max)} - Ta) + \Theta ja$, where Θja depends upon the printed circuit layout. See "Applications Information".
5. Output voltage temperature coefficient is $\Delta Vout_{(worst\ case)} + (Tj_{(max)} - Tj_{(min)})$ where $Tj_{(max)}$ is +125 °C and $Tj_{(min)}$ is -40 °C.
6. Vdrop = Vin - Vout when Vout decreases to 99% of its nominal output voltage with Vin =Vout – Vin + 1. For output voltages below 2.5V, dropout voltage is the input-to-output voltage differential with the minimum input voltage being 2.5V. Minimum input operating voltage is 2.5V
7. Ignd is the quiescent current. Iin = Ignd + Iout
8. For 2.5V device, Vin = 2.25V (device is in dropout)

Typical Application Circuit



Block Diagram



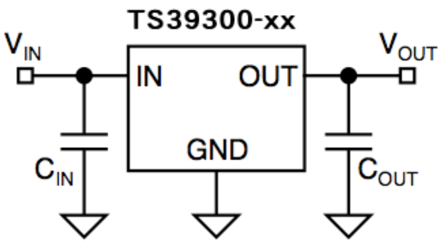
Application Information

Application Information

The TS39300 is a high performance low dropout voltage regulator suitable for moderate to high-current voltage regulator applications. Its 500mV dropout voltage at full load makes it especially valuable in battery-powered systems and a high-efficiency noise filter in post-regulator applications. Unlike older NPN-pass transistor designs, where the minimum dropout voltage is limited by the base-to-emitter voltage drop and collector-to-emitter saturation voltage, dropout performance of PNP output of these devices is limited only by the low V_{CE} saturation voltage.

A trade-off for the low dropout voltage is a varying base drive requirement.

The TS39300 regulator is fully protected from damage due to fault conditions. Current limiting is provided. This limiting is linear, output current during overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the mzximum safe operating temperature. Transient proection allows device (and load) survival even when the input voltage spikes above and below nominal. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow.



Output Capacitor Requirement

The TS39300 requires an output capacitor to maintain stability and improve transient reponse. Proper capacitor selection is important to ensure proper operation. The TS39300 output capacitor selection is dependent upon the ESR (equivalent series resistance) of the output capacitor to maintain stability. When the output capacitor is 47uF or greater, the output capacitor should have less than 1Ω of ESR. This will improve transient response as well as promote instability. The very low ESR levels may cause an oscillation and/or underdamped transient response. A low-ESR solid tantalum capacitor works extremely well and provides good transient response and stability over temperature. Aluminum electrolytics can also be used, as long as the ESR of the capacitor is ≤1Ω.

The value of the output capacitor can be increased without limit. Higher capacitance values help to improve transient response and ripple rejection and reduce output noise.

Input Capacitor Requirement

An input capacitor of 1uF or greater is recommended when the device is more than 4 inches away from the bulk as supply capacitance, or when the supply is a battery. Small, surface-mount, ceramic chip capacitors can be is used for the bypassing. Larger values will help to improve ripple rejection by bypassing the input to the regulator, further improving the integrity of the output voltage..

Minimum Load Current

The TS39300 regulator is specified between finite loads. If the output current is too small, leakage dominate and the output voltage rises. A 10mA minimum load current is necessary for proper regulator.

Transient Response and 3.3V to 2.5V or 2.5V to 1.8V Conversion

The TS39300 has excellent transient response to variationis in input voltage and load current. The device has been designed to respond quickly to load current variations and input voltage variations. Large output capacitors are not required to obtain this performance. A standard 47uF output capacitor, preferably tantalum, is all that is required. Larger values help to improve performance even further.

By virtue of its low-dropout voltage, this device does not saturate into dropout as readily as similar NPN-based designs. When converting from 3.3V to 2.5V or 2.5V to 1.8V, the NPN-base regulators are already operating in dropout, with typical dropout requirements of 1.2V or greater. To convert down to 2.5V without operating in dropout, NPN-based regulators require an input voltage of 3.7V at the very least.

The TS39300 regulator will provide excellent performance with an input as low as 3.0V or 2.5V. This gives the PNP-based regulators a distinct advantage over older, NPN-base linear regulators.

Application Information (continues)

Thermal Design

Linear regulators are simple to use. The most complicated design parameters to consider are thermal characteristics.

Thermal design requires four application-specific parameters:

Maximum ambient temperature (Ta)

Output Current (Iout)

Output Voltage (Vout)

Input Voltage (Vin)

Ground Current (Ignd)

Calculate the power dissipation of the regulator from these numbers and the device parameters from this datasheet, where the ground current is taken from data sheet.

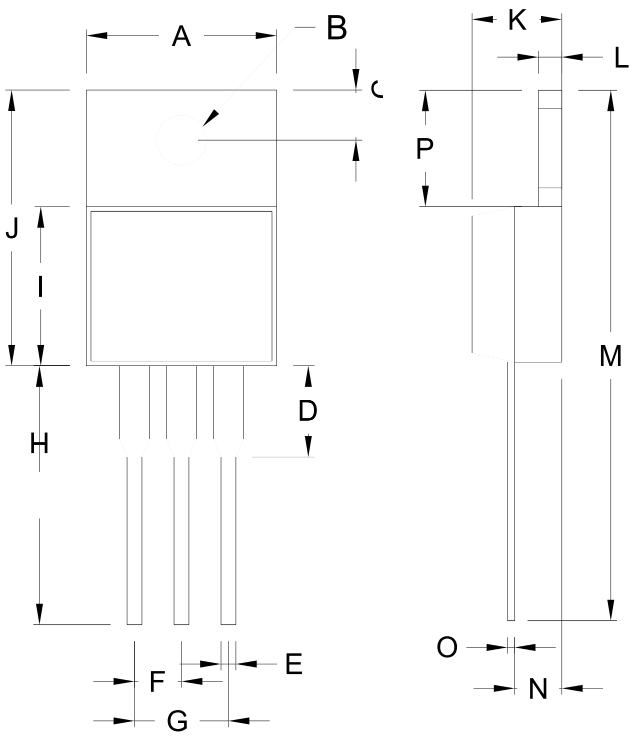
$$Pd = (Vin - Vout) \times Iout + Vin \times Ignd$$

The heat sink thermal resistance is determined by:

$$\Theta sa = (Tj_{(max)} - Ta) / Pd - (\Theta jc + \Theta cs)$$

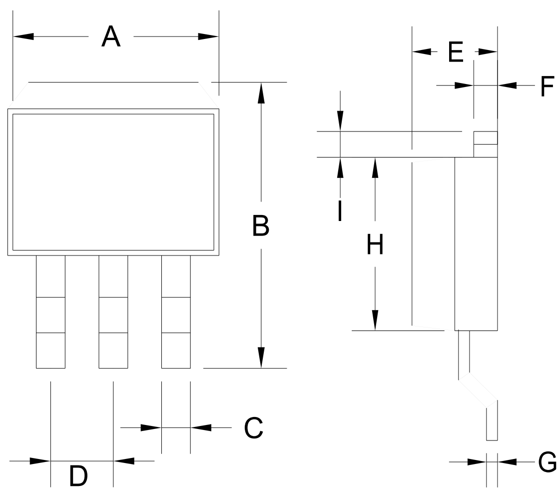
Where $Tj_{(max)} \leq 125\,^{o}C$ and Θcs is between $0\,^{o}C$ and $2^{o}C/W$. The heat sink may by significantly reduced in applications where the minimum input voltage is know and is large compared with the dropout voltage and distribute the heat between this resistor and the regulator. The low dropout properties of vertical PNP regulators allow significant reductions in regulator power dissipation and the associated heat sink without compromising performance. When this technique is employed, a capacitor of at least 1.0uF is needed directly between the input and regulator ground.

TO-220 Mechanical Drawing



TO-220 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.000	10.500	0.394	0.413
B	3.240	4.440	0.128	0.175
C	2.440	2.940	0.096	0.116
D	-	6.350	-	0.250
E	0.381	1.106	0.015	0.040
F	2.345	2.715	0.092	0.058
G	4.690	5.430	0.092	0.107
H	12.700	14.732	0.500	0.581
I	8.382	9.017	0.330	0.355
J	14.224	16.510	0.560	0.650
K	3.556	4.826	0.140	0.190
L	0.508	1.397	0.020	0.055
M	27.700	29.620	1.060	1.230
N	2.032	2.921	0.080	0.115
O	0.255	0.610	0.010	0.024
P	5.842	6.858	0.230	0.270

TO-263 Mechanical Drawing



TO-263 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.000	10.500	0.394	0.413
B	14.605	15.875	0.575	0.625
C	0.508	0.991	0.020	0.039
D	2.420	2.660	0.095	0.105
E	4.064	4.830	0.160	0.190
F	1.118	1.400	0.045	0.055
G	0.450	0.730	0.018	0.029
H	8.280	8.800	0.325	0.346
I	1.140	1.400	0.044	0.055
J	1.480	1.520	0.058	0.060