TS29151/52/53

1.5A Ultra Low Dropout Positive Voltage Regulator

TO-220-5L



TO-263-5L



Low Dropout Voltage 0.6V max.
Enable Input Control
Adjustable Output
Error Flag Detection

General Description

The TS29151/52/53 series are using process with a PNP pass element for high current, high accuracy and low dropout voltage regulators. These regulator s feature 350mV(typ) dropout voltages and very low ground current, these devices also find applications in lower current and low dropout critical systems, where their tiny dropout voltage and ground current values are important attributes.

The TS29151/52/53 series are fully protected against over current faults, reversed input polarity, reversed lead insertion, over temperature operation, positive and negative transient voltage spikes, logic level enable control and error flag which signals whenever the output falls out of regulation.

On the TS29151 and TS29152, the enable pin may be tied to Vin if it is not required for enable control. This series are offered in 5-pin TO-263, TO-220 package.

Features

- ✧ Dropout voltage typically 0.6V @Io=1.5A
- ✧ Output current up to 1.5A
- ✧ Low ground current
- ✧ Output voltage trimmed before assembly
- ✧ Extremely fast transient response
- ✧ +60V Transient peak voltage
- ✧ -20V Reverse peak voltage
- ✧ Zero current shutdown mode
- ✧ Error flag signals output out of regulation
- ✧ Internal current limit
- ✧ Thermal shutdown protection

Ordering Information

Part No.	Operating Temp. (Junction)	Package
TS29151CZ5-xx	-40 ~ +125 °C	TO-220-5L
TS29152CZ5		
TS29153CZ5		
TS29151CM5-xx		TO-263-5L
TS29152CM5		
TS29153CM5		

Note: Where xx denotes voltage option, available are 12V, 5.0V, 3.3V and 2.5V. Leave blank for adjustable version. Contact factory for additional voltage options.

Applications

- ✧ Battery power equipment
- ✧ Automotive electronics
- ✧ High efficiency “Green” computer system
- ✧ High efficiency linear power supplies
- ✧ High efficiency post regulator for switching supply

Absolute Maximum Rating (Note 1)

Input Supply Voltage (Note 2)	Vin	-20V ~ +60	V
Operation Input Voltage	Vin (operate)	26	V
Power Dissipation (Note 3)	P_D	Internally Limited	W
Operating Junction Temperature Range	T_J	-25 ~ +125	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C
Lead Soldering Temperature (260 °C)		5	S

Electrical Characteristics

Vin = Vout + 1V, Venable= 2.4V, I_L = 10mA, C_o = 10uF, Adjustable versions are programmed to 5V output, Tj = 25 °C unless otherwise specified.

Parameter	Conditions	Min	Typ	Max	Unit
Output Voltage		0.990|Vo|	12 / 5.0	1.010|Vo|	V
Output Voltage	10mA ≤ I_L ≤ 1.5A, Vo+1V ≤ Vin ≤ 26V	0.980|Vo|	3.3/ 2.5	1.020|Vo|	
Input Supply Voltage		--	--	26	V
Output Voltage Temperature Coefficient		--	20	100	ppm/ °C
Line Regulation	Vo+1V ≤ Vin ≤ 26V	--	0.05	0.5	%
Load Regulation	10mA ≤ I_L ≤ 1.5A	--	0.2	1.0	%
Dropout Voltage (Note 4)	I_L=100mA I_L=750mA I_L=1.5A	-- -- --	80 200 350	200 600	mV
Quiescent Current (Note 5)	I_L=750mA I_L=1.5A	-- --	8 22	-- --	mA
Short Circuit Current (Note 6)	Vout=0	--	2.1	3.5	A
Output Noise, 10Hz to 100KHz, I_L=100mA	C_L=2.2uF C_L=10uF C_L=33uF	-- -- --	600 400 260	-- -- --	uVrms
Reference (TS29152 / TS29153)					
Reference Voltage		0.980|Vo|	1.24	1.020|Vo|	
Reference Voltage	10mA ≤ I_L ≤ 1.5A, 2.3V ≤ Vin ≤ 26V	0.970|Vo|		1.030|Vo|	V
Adjust Pin Bias Current		--	40	80	nA
Reference Voltage Temperature Coefficient	(Note 7)	--	20	--	ppm/ °C
Adjust Pin Bias Current Temperature Coefficient		--	0.1	--	nA/ °C
Flag Output (TS29151 / TS29153)					
Output Leakage Current	V_{OH}=26V	--	--	2	uA
Output Low Voltage	Vin=4.5V, I_{OL}=250uA	--	--	300	mV
Upper Threshold Voltage	(Note 8)	40	60	--	mV
Lower Threshold Voltage	(Note 8)	--	75	95	mV
Hysteresis	(Note 8)	--	15	--	mV
Enable Input (TS29151 / TS29152)					
Input Logic Voltage	Low (OFF)	--	--	0.8	V
	High (ON)	2.4	--	--	
Enable Pin Input Current	Ven=26V	--	--	750	uA
	Ven=0.8V	--	--	5	
Regulator Output Current Shutdown	Ven ≤ 0.8V, Vin ≤ 26V, Vout=0	--	10	500	uA

Thermal Performance

Condition	Package type	Typ	Unit
Thermal Resistance	TO-220-5L	60	°C/W
Junction to Ambient	TO-263-5L	80	

Note 1: Absolute Maximum Rating is limits beyond which damage to the device may occur. For guaranteed specifications and test conditions see the Electrical Characteristics.

Note 2: Maximum positive supply voltage of 60V must be limited duration (<100mS) and duty cycle (<1%).

Note 3: The maximum allowable power dissipation is a function of the maximum junction temperature, Tj, the junction to ambient thermal resistance, θja, and the ambient temperature , Ta. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. The effective value of θja can be reduced by using a heatsink.

Note 4: Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at 1V differential.

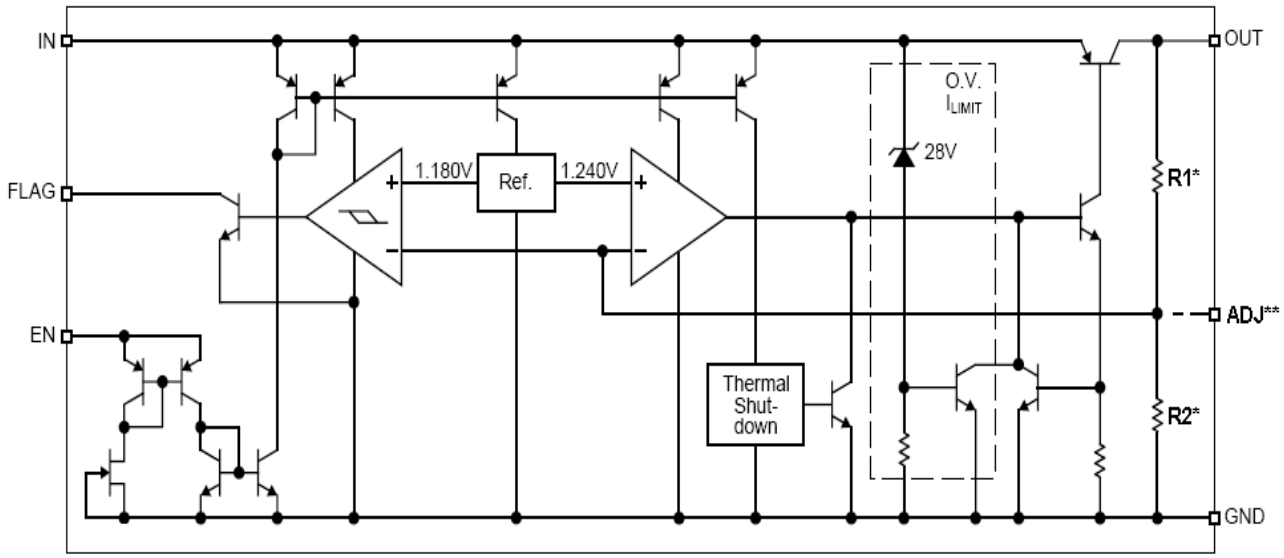
Note 5: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the ground pin current and output load current.

Note 6: Output current will decrease with increasing temperature, but it will be not dropped below 1.5A at the maximum specified temperature.

Note 7: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specification are for a 200mA load pulse at Vin=20V(a 4W pulse) for T=10mS

Note 8: Comparator thresholds are expressed in terms of a voltage differential at the adjust terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = Vout / Vref = (R1+R2) / R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95mV x 5V / 1.24V = 384mV. Thresholds remain constant as a percent of Vout as Vout is varied, with the dropout warning occurring at typically 5% below nominal, 7.7% guaranteed.

Block Diagram



* Feedback network is fixed output versions only (TS29151)

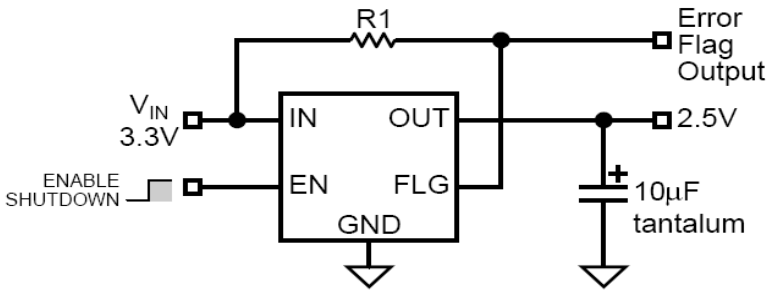
** Adjustable output version only (TS29152 / TS29153)

Pin Assignment

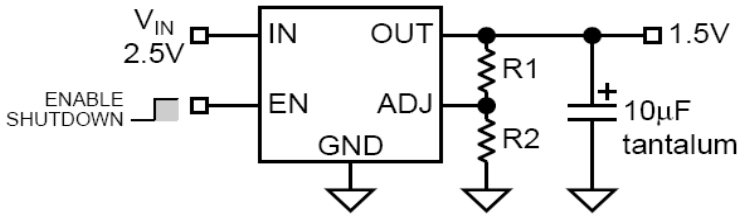
Pin No.			Pin Configuration	Pin Description
TS29151	TS29152	TS29153		
1	**1**		Enable	Enable (input): TTL/COMS compatible input. Logic high is enable; logic low or open is shutdown
2	**2**	**2**	Input	Unregulated input: +26V maximum supply
3	**3**	**3**	Ground	Ground: Ground pin and TAB/heatsink are internally connected.
4	**4**	**4**	Output	Regulator output
5		**1**	Flag	Error Flag (output): Open-collector output. Active low indicates an output fault condition.
	5	**5**	Adjust	Adjustment input: Feedback input. Connect to resistive voltage-divider network.

Typical Application Circuit

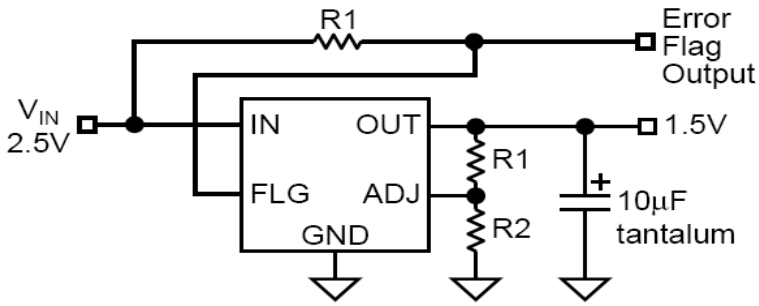
TS29151



TS29152



TS29153



Application Information

Application Information

The TS29151/52/53 series are high performance with low dropout voltage regulator suitable for moderate to high current and voltage regulator application. Its 350mA(typ) dropout voltage at full load and over temperature makes it especially valuable in battery power systems and as high efficiency noise filters in post regulator applications. Unlike normal NPN transistor design, where the base to emitter voltage drop and collector to emitter saturation voltage limit the minimum dropout voltage, dropout performance of the PNP output of these devices is limited only by low Vce saturation voltage.

The TS29151/52/53 series is fully protected from damage due to fault conditions. Linear current limiting is provided. Output current during overload conditions is constant. Thermal shutdown the device when the die temperature exceeds the maximum safe operating temperature. Transient protection allows device 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.

Capacitor Requirement

The TS29151/52/53 series requires an output capacitor to maintain stability and improve transient response is necessary. The value of this capacitor is dependent upon the output current, lower currents allow smaller capacitors. TS29151/52/53 series regulators are stable with the 10uF minimum capacitor value at full load. Where the regulator is powered from a source with high AC impedance, a 0.1uF capacitor connected between input and ground is recommended. The capacitor should have good characteristics to above 250KHz. The capacitance values will be help to improved transient response, ripple rejection and output noise.

Minimum Load Current

The TS29151/52/53 series is specified between finite loads. If the output current is too small leakage currents dominate and the output voltage rises. A 10mA minimum load current swamps any expected leakage current across the operating temperature range.

Thermal Characteristics

TS29151/52/53 series linear regulators are simple to use, the most complicated design parameters to consider are thermal characteristics, thermal design requires the following application specification parameters:

Maximum ambient temperature, Ta
Output current, Iout
Output voltage, Vout
Input voltage, Vin

We calculate the power dissipation of the regulator from these numbers and the device parameters from this data sheet. A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application. Under all possible operating conditions, the junction temperature must be within the range specified under absolute maximum ratings. To determine if the heatsink is required, the power dissipated by the regulator, P_D must be calculated.

The below formula shows the voltages and currents for calculating the P_D in the regulator:

$Iin = I_L / I_G$

$P_D = (Vin-Vout) * I_L + (Vin) * I_G$

Ex. $P_D = (3.3V-2.5V) * 0.5A + 3.3V * 11mA$
$= 400mW + 36mW$
$= 436mW$

Remark: I_L is output load current,
I_G is ground current.
Vin is input voltage
Vout is output voltage

The next parameter which must be calculated is the maximum allowable temperature rise, $T_R(max)$. this is calculated by the using to formula:

$T_R(max) = T_J(max) – T_A(max)$

Where: $T_J(max)$ is the maximum allowable junction temperature, which is 125 ^oC for commercial grade parts.

$T_A(max)$ is the maximum ambient temperature which will be encountered in the application. Using the calculated values for $T_R(max)$ and P_D, the maximum allowable value for the junction to ambient thermal resistance, θja, can now be found:

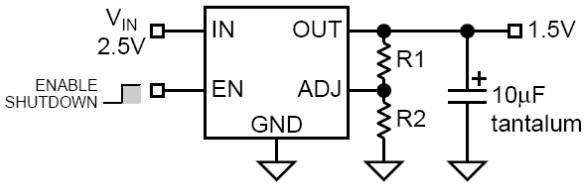
$θja = T_R(max) / P_D$

Application Information (continues)

Adjustable Regulator Design

The adjustable regulator versions (TS29152/53) is allow to programming the output voltage anywhere between 1.25 and the 26V maximum operating rating of the family.

Two resistors are used. Resistors can be quite large up to 1MΩ, because of the very high input impedance and low bias current of the sense comparator, the resistor values are calculated by:



$$R1 = R2 * [(Vout / 1.24) – 1]$$

Where is Vout the desired output voltage. Above application circuit shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation.

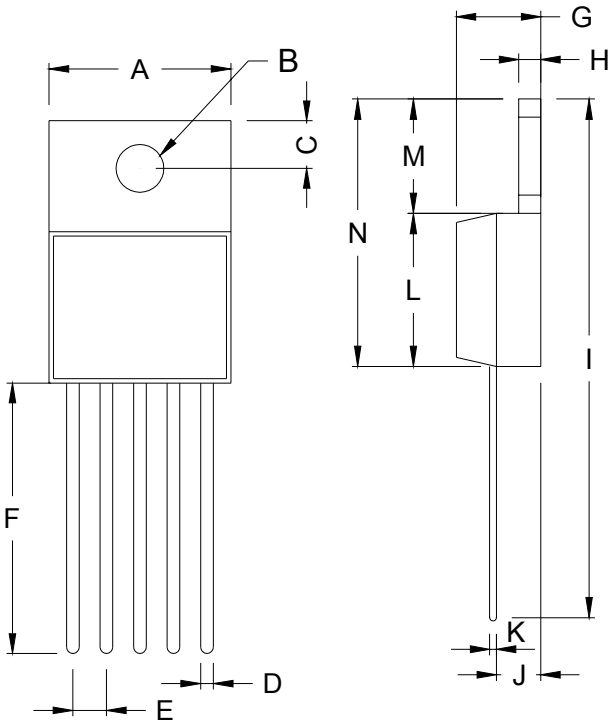
Error Flag

TS29151 and TS29153 versions feature an Error Flag, which looks at the output voltage and signals an error condition when this voltage drops 5% below its expected value. The error flag is an open-collector output that pulls low under fault conditions. It may sink 10mA. Low output voltage signifies a number of possible problems, including an over-current fault (the device is in current limit) and low input voltage. The flag output is inoperative during over temperature shutdown conditions.

Enable Input

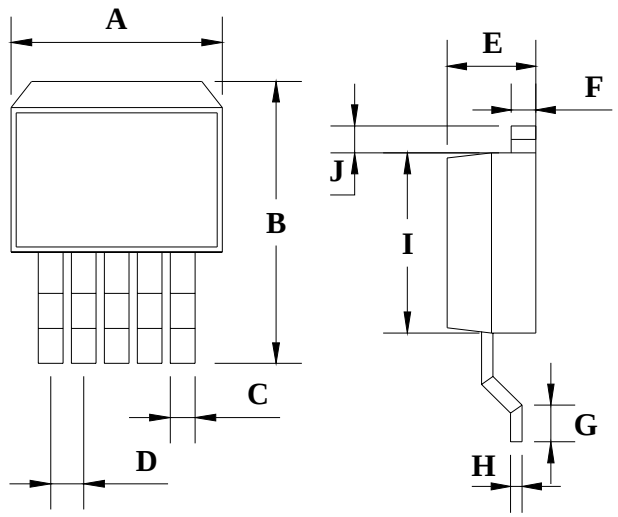
TS29151 and TS29152 versions feature an enable (EN) input that allows ON/OFF control of the device. Special design allows “zero” current drain when the device is disabled–only microamperes of leakage current flow. The EN input has TTL/CMOS compatible thresholds for simple interfacing with logic, or may be directly tied to ≤30V. Enabling the regulator requires approximately 20uA of current.

TO-220-5L Mechanical Drawing



TO-220 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.00	10.50	0.394	0.413
B	3.240	4.440	0.128	0.175
C	2.440	2.940	0.096	0.116
D	0.260	1.020	0.010	0.040
E	1.570	1.830	0.062	0.072
F	13.31	14.13	0.524	0.556
G	4.475	5.225	0.176	0.206
H	1.170	1.370	0.046	0.054
I	27.60	29.44	1.087	1.159
J	2.175	2.925	0.086	0.115
K	0.297	0.477	0.012	0.019
L	8.280	8.800	0.326	0.346
M	6.010	6.510	0.237	0.256
N	14.29	15.31	0.563	0.603

TO-263-5L Mechanical Drawing



TO-263 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.220	10.260	0.402	0.404
B	14.600	15.870	0.575	0.625
C	0.750	0.770	0.030	0.030
D	1.573	1.827	0.062	0.072
E	4.560	4.570	0.179	0.180
F	1.240	1.270	0.049	0.050
G	2.280	2.790	0.090	0.110
H	0.280	0.320	0.011	0.013
I	8.240	8.280	0.324	0.326
J	1.540	1.800	0.060	0.071