1.5A Very L.D.O Voltage Regulator

LM29150/29151/29152

FEATURES

- High Current Capability 1.5A
- Low Dropout Voltage 350mV
- Low Ground Current
- Accurate 1% Guaranteed Initial Tolerance
- Extremely Fast Transient Response
- Reverse-Battery and "Load Dump" Protection
- Zero-Current Shutdown Mode(5-Pin Version)
- Error Flag Signals Output out-of-Regulation
  (5-Pin Version)
- Also Characterized For Smaller Loads With Industry
  -Leading Performance specifications
- Fixed Voltage and Adjustable Versions
- Moisture Sensitivity Level 3
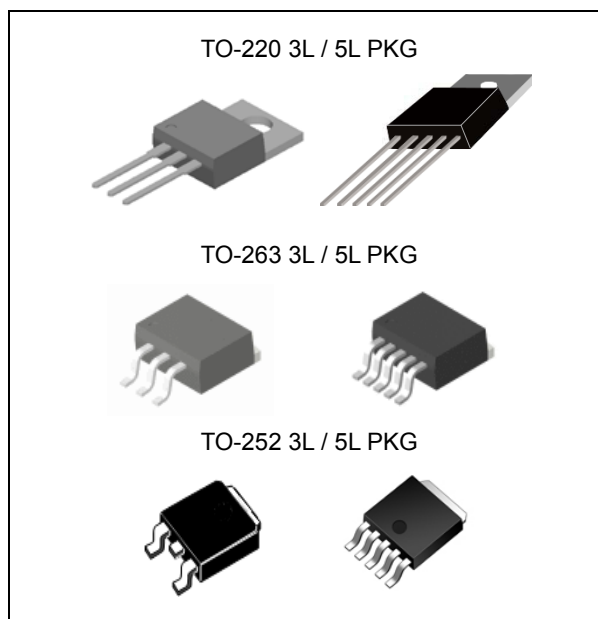
APPLICATION

- Battery Powered Equipment
- High-Efficiency " Green" Computer System
- Automotive Electronics
- High-Efficiency Linear Power Supplies
- High-Efficiency Post-Regulator For Switching Supply

TO-220 3L / 5L PKG

TO-263 3L / 5L PKG

TO-252 3L / 5L PKG

ORDERING INFORMATION

Device	Package
LM29150T-X.X	TO-220 3L / 5L
LM29151T-X.X	
LM29152T	
LM29150R-X.X	TO-263 3L / 5L
LM29151R-X.X	
LM29152R	
LM29150RS-X.X	TO-252 3L / 5L
LM29151RS-X.X	
LM29152RS	
LM29152GRS	

X.X = Output Voltage = 1.5, 1.8, 2.5, 3.0, 3.3, 5.0, 12

DESCRIPTION

The LM29150, LM29151 and LM29152 are high current, high accuracy, and low-dropout voltage regulators. Using process with a PNP pass element, these regulators feature 350mV (full load) dropout voltages and very low ground current. These devices also find applications in lower current, low dropout-critical systems, where their tiny dropout voltage and ground current values are important attributes.

The LM29150, LM29151 and LM29152 are fully protected against over current faults, reversed input polarity, reversed lead insertion, over temperature operation, and positive and negative transient voltage spikes. LM29151 features logic level enable control and an error flag which signals whenever the output falls out of regulation. On the LM29151 and LM29152, the ENABLE pin may be tied to Vin if it is not required for ON/OFF control.

Absolute Maximum Ratings

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Input Supply Voltage[Note 1]	V_{IN}	- 20	+ 60	V
Enable Input Voltage[Note 1]	V_{EN}	- 20	+ 60	V
Lead Temperature(Soldering, 5 sec)	T_{SOL}	-	260	℃
Storage Temperature Range	T_{STG}	- 65	+ 150	℃

Recommended Operating Ratings (Note 2)

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Operating Input Voltage	V_{IN}	-	+ 26	V
Operating Enable Input Voltage	V_{EN}	-	+ 26	V
Junction Temperature	T_J	- 40	+ 125	℃

Ordering Information

V_{OUT}	Package	Order No.	Description	Supplied As	Status
1.5 V	TO-220 3L	LM29150T-1.5	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-1.5	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-1.5	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-1.5	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-1.5	1.5A, Fixed	Reel	Active
	TO-252 5L	LM29151RS-1.5	1.5A, Fixed, Enable	Reel	Active
1.8 V	TO-220 3L	LM29150T-1.8	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-1.8	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-1.8	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-1.8	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-1.8	1.5A, Fixed	Reel	Active
	TO-252 5L	LM29151RS-1.8	1.5A, Fixed, Enable	Reel	Active
2.5 V	TO-220 3L	LM29150T-2.5	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-2.5	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-2.5	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-2.5	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-2.5	1.5A, Fixed	Reel	Active
	TO-252 5L	LM29151RS-2.5	1.5A, Fixed, Enable	Reel	Active
3.0 V	TO-220 3L	LM29150T-3.0	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-3.0	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-3.0	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-3.0	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-3.0	1.5A, Fixed	Reel	Active
	TO-252 5L	LM29151RS-3.0	1.5A, Fixed, Enable	Reel	Active
3.3 V	TO-220 3L	LM29150T-3.3	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-3.3	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-3.3	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-3.3	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-3.3	1.5A, Fixed	Reel	Active
	TO-252 5L	LM29151RS-3.3	1.5A, Fixed, Enable	Reel	Active

Ordering Information

V$_{OUT}$	Package	Order No.	Description	Supplied As	Status
5.0 V	TO-220 3L	LM29150T-5.0	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-5.0	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-5.0	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-5.0	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-5.0	1.5A, Fixed	Reel	Active
	TO-252 5L	LM29151RS-5.0	1.5A, Fixed, Enable	Reel	Active
12 V	TO-220 3L	LM29150T-12	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-12	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-12	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-12	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-12	1.5A, Fixed	Reel	Active
	TO-252 5L	LM29151RS-12	1.5A, Fixed, Enable	Reel	Active
ADJ	TO-220 5L	LM29152T	1.5A, Adjustable, Enable	Tube	Active
	TO-263 5L	LM29152R	1.5A, Adjustable, Enable	Reel	Active
	TO-252 5L	LM29152RS	1.5A, Adjustable, Enable	Reel	Active
	TO-252 5L	LM29152GRS	1.5A, Adjustable, Enable	Reel	Active

LM 2915X ☐ ☐ – ☐

Output Voltage : 1.5V / 1.8V / 2.5V / 3.0V / 3.3V / 5.0V /
12V / Blank(ADJ Only)

Package Type　{ T　: TO-220
R　: TO-263
RS　: TO-252

Green Mode　{ G　: Halogen Free
Blank : Pb Free

Root Name　{ 29150 : 3L Fixed Output
29151 : 5L Fixed Output
29152 : 5L Adjustable Output

Product Code
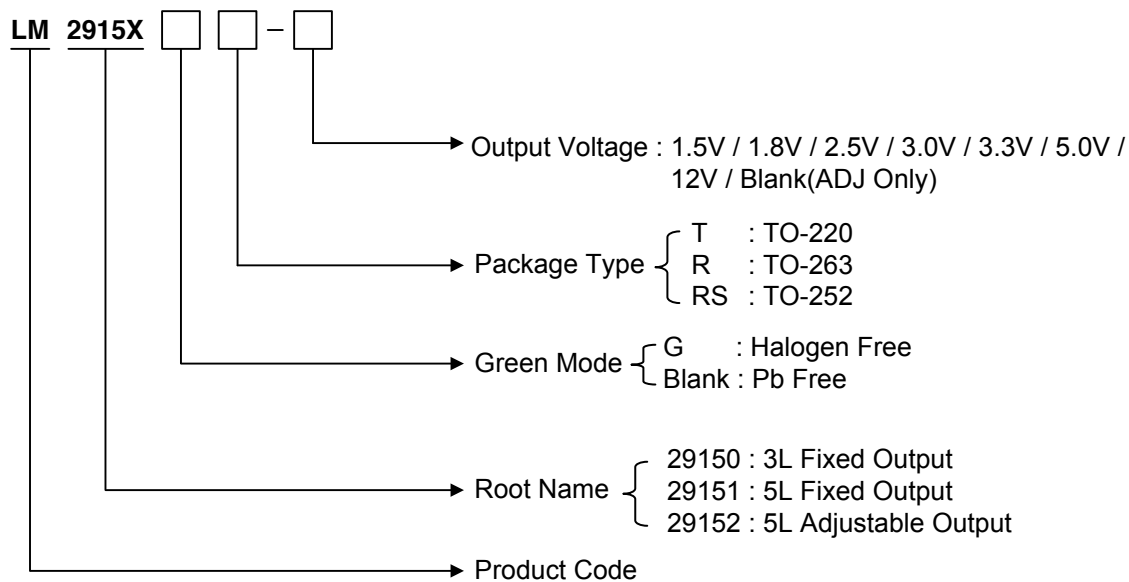
PIN CONFIGURATION

TO-263 3L

3 OUTPUT
2 GND
1 INPUT

TO-263 5L

5 FLG / ADJ
4 OUTPUT
3 GND
2 INPUT
1 EN

TO-252 3L

3 OUTPUT
2 GND
1 INPUT

TO-252 5L

5 FLG/ADJ
4 OUTPUT
3 GND
2 INPUT
1 EN

TO-220 3L

3 OUTPUT
2 GND
1 INPUT

TO-220 5L

5 FLG / ADJ
4 OUTPUT
3 GND
2 INPUT
1 EN
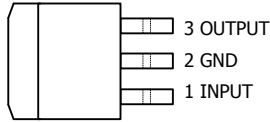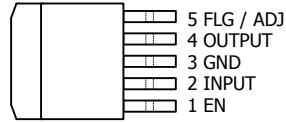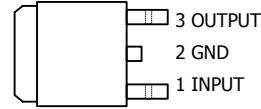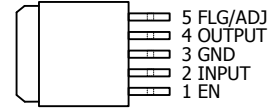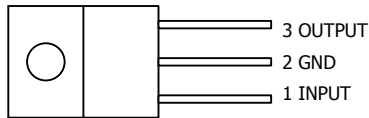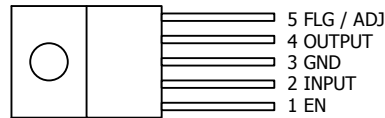
PIN DESCRIPTION

Pin No.	TO-220 / TO-263 / TO-252 3L **(for LM29150)**		TO-220 / TO-263 / TO-252 5L **(for LM29151/2)**	
	Name	Function	Name	Function
1	V_{IN}	Input Supply	EN	Chip Enable
2	GND	Ground	V_{IN}	Input Supply
3	V_{OUT}	Output Voltage	GND	Ground
4	-	-	V_{OUT}	Output Voltage
5	-	-	FLG / ADJ	Error Flag Output or Output Adjust

TYPICAL APPLICATION

– Typical Fixed Output Application

LM29150-3.3

5V ± 5% ——[VIN   OUT]—— 3.3V ± 1% @ 1.5A

C_{IN} GND C_{OUT}
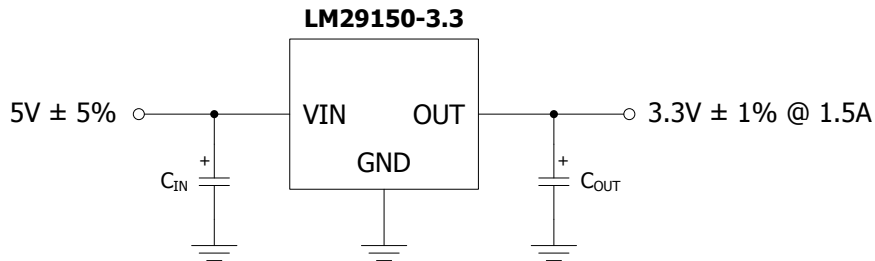
– Typical Fixed Output Application with Error Flag

100k

LM29151

V_{IN} ——[IN   OUT]—— V_{OUT}

Enable
Shutdown ——[EN   FLG]

C_{IN} GND C_{OUT}

Error Flag
Output
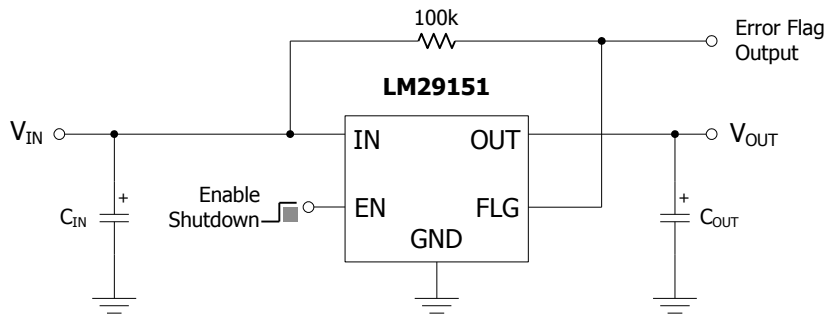
– Typical Adjustable Output Application

LM29152

V_{IN} ——[VIN   OUT]—— V_{OUT}

——[EN   ADJ]

C_{IN} GND   R1   R2 C_{OUT}
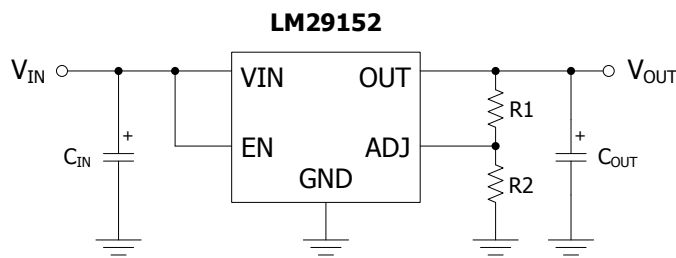
$$V_{OUT} = V_{REF} \times [1 + (R1/R2)]\ *$$

* For best results, the total series resistance should be small enough to pass the minimum regulator load current.

ELECTRICAL CHARACTERISTICS

I_{OUT} =100mA, T_J=25℃, unless otherwise specified. **Bold** values are guaranteed across the operating temperature range. Adjustable versions are programmed to 5.0V.

LM29150/29151/29152 Common Specification

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OUT}	Output Voltage	I_O = 10mA	-1		1	%
		10mA≤I_O≤ I_{FL}, (V_{OUT}+1V)≤V_{IN}≤26V [Note 2]	**-2**		**2**	
ΔV_{LINE}	Line Regulation	I_O = 10mA, (V_{OUT}+1V)≤V_{IN}≤26V		0.06	0.5	%
ΔV_{LOAD}	Load Regulation	V_{IN}=V_{OUT}+5V, 10mA≤I_{OUT}≤$I_{FULLOAD}$ [Note 2,6]		0.2	1	%
$\Delta V_O/\Delta T$	Output Voltage Temp. Coefficient	Output Voltage [Note 6], Temp. Coefficient		**20**	**100**	ppm/℃
V_{DO}	Dropout Voltage	ΔV_{OUT} = -1%, [Note 3] I_O =100mA I_O =750mA I_O =1.5A		80 220 350	**200** **600**	mV
I_{GND}	Ground Current	I_O =750mA, V_{IN} =V_{OUT}+1V I_O =1.5A		8 22	**20**	mA
I_{GNDDO}	Ground Pin Current at Dropout	V_{IN} =0.5V less than specified V_{OUT}, I_{OUT} =10mA		2		mA
I_{LIMIT}	Current Limit	LM29150, V_{OUT} = 0V [Note 4]		2.1	**3.5**	A
e_n	Output Noise Voltage (10Hz to 100kHz) I_L = 100mA	C_L =10µF C_L =33µF		400 260		µVRMS

Flag Output (Error Comparator) LM29151

$I_{FLG (leak)}$	Output Leakage Current	V_{OH} =26V		0.01	1.00 **2.00**	µA
$V_{FLG (do)}$	Output Low Voltage	Device set for 5V. V_{IN} =4.5V I_{OL} =250µA		220	300 **400**	mV
V_{FLG}	Upper Threshold Voltage	Device set for 5V [Note 9]	40 **25**	60		mV
	Lower Threshold Voltage	Device set for 5V [Note 9]		75	95 **140**	mV
	Hysteresis	Device set for 5V [Note 9]		15		mV

Reference LM29152

V_{REF}	Reference Voltage			1.228 **1.215**	1.24	1.252 **1.265**	V
		(Note 8)		1.203		1.277	V
I_{ADJ}	Adjust Pin Bias Current				40	80 120	nA
	Reference Voltage Temp. Coefficient	(Note 7)			20		ppm/℃
	Adjust Pin Bias Current Temp. Coefficient				0.1		nA/℃

Enable Input LM29151 / LM29152

V_{EN}	Enable Input Voltage	Logic Low (Off) Logic High (On)	**2.4**		**0.8**	V
I_{EN}	Enable Pin Input Current	V_{EN} =26V		100	600 750	µA
		V_{EN} =0.8V			2.5 **5**	µA
	Regulator Output Current in Shutdown	(Note 10)		10	**500**	µA

Note 1. Maximum positive supply voltage of 60V must be of limited duration (<100msec) and duty cycle(≤1%). The maximum continuous supply voltage is 26V.

Note 2. Full load current (I_{FL}) is defined as 1.5A.

Note 3. Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99% of its nominal value with V_{OUT} to V_{IN}.

Note 4. V_{IN} = V_{OUT}(nominal) +1V. For example, use V_{IN} = 4.3V for a 3.3V regulator or use 6V for a 5V regulator. Employ pulse-testing procedures to minimize temperature rise.

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

Note 6. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

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. Specifications are for a 200mA load pulse at V_{IN} = 20V (a 4W pulse) for T= 10ms.

Note 8. $V_{REF} \leq V_{OUT} \leq (V_{IN}$ -1V), 2.3V $\leq V_{IN} \leq$ 26V, 10mA < I_L < I_{FL}, $T_J <$ T_J Max.

Note 9. 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 = V_{OUT} / V_{REF} = (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/ 1.240V - 384mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warining occurring at typically 5% below nominal, 7.7% guaranteed.
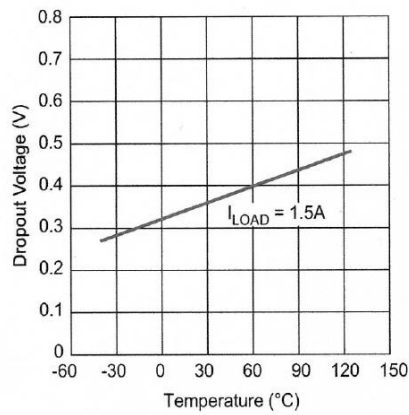
Note 10. $V_{EN} \leq$ 0.8V and $V_{IN} \leq$ 26V, V_{OUT} =0.

Note 11. When used in dual supply system where the regulator load is returned to a negative supply, the output voltage must be diode clamped to ground.
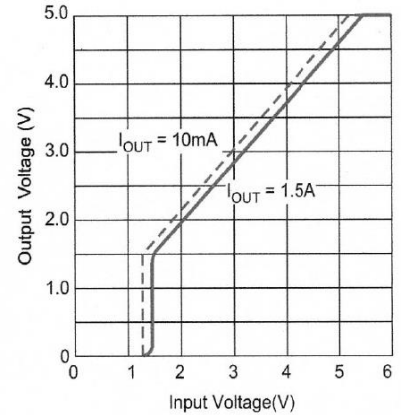
LM29150/29151/29152

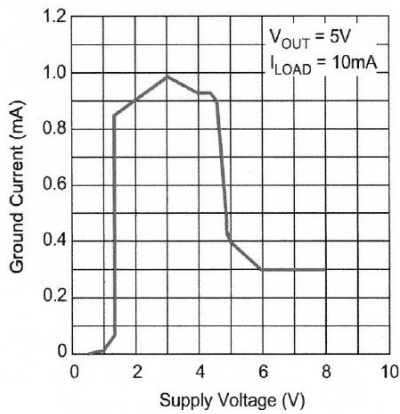## TYPICAL OPERATING CHARACTERISTICS
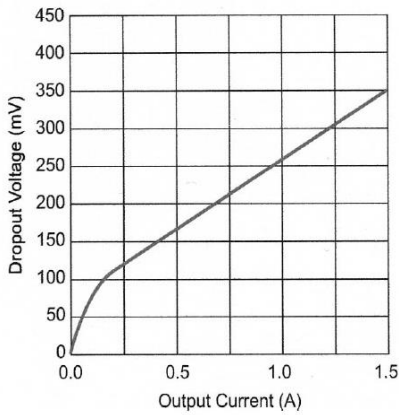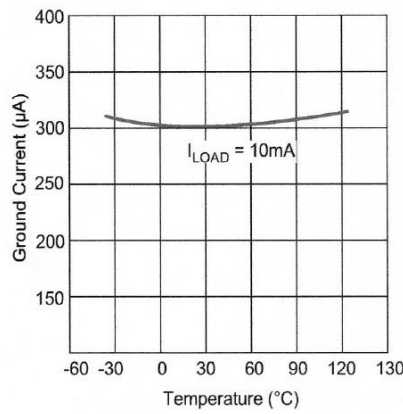
LM29150 Dropout Voltage vs, Output
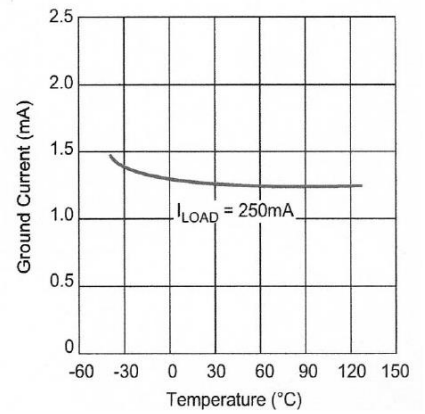
LM29150 Dropout Voltage vs, Temperature

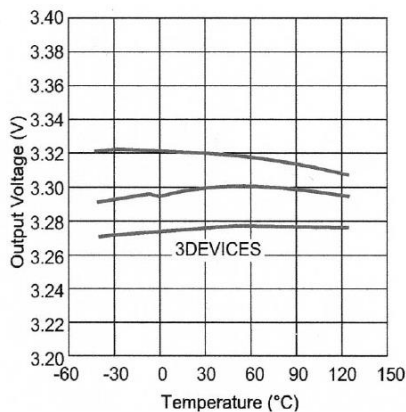LM29150-5.0 Dropout Characteristics
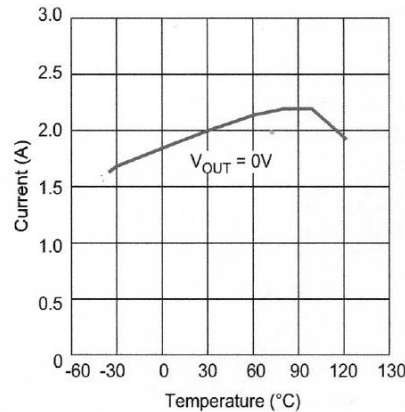
LM29150 Ground Current vs, Supply Voltage

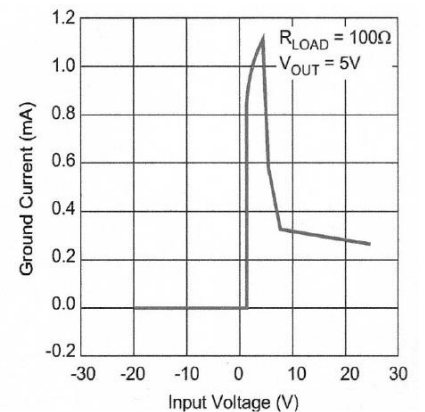LM29150 Ground Current vs, Temperature

LM29150 Ground Current vs, Temperature

LM29150-3.3 Output Voltage vs. Temperature

LM29150-3.3 Short Circuit Current vs. Temperature

LM29150 Ground Current vs. Input Voltage

APPLICATION INFORMATION

The LM29150 are high performance low-dropout voltage regulators suitable for all moderate to high current voltage regulator applications. Their 350mV dropout voltage at full load makes them especially valuable in battery powered systems and as high efficiency noise filters in "post-regulator" applications. Unlike older NPN-pass transistor designs, dropout performance of the PNP output of these devices is limited merely by the low V_{CE} saturation voltage.

The LM29150 family of regulators is fully protected from damage due to fault conditions. Current Limiting is provided. This limiting is linear; output current under overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the 125℃ maximum safe operating temperature. Transient protection allows device survival even when the input voltage spikes between -20V and +60V. When the input voltage exceeds about 35V to 40V, the over voltage sensor temporarily disables the regulator.
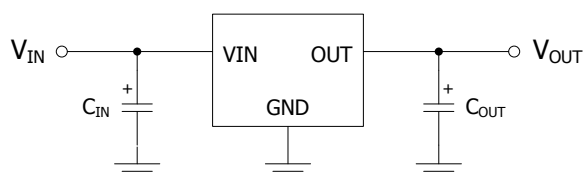

Figure 1. Linear regulators require only two capacitors for operation.

Thermal Design

Linear regulators are simple to use. The most complicated design parameters to consider are thermal characteristics. Thermal design requires the following application-specific parameters:

- Maximum ambient temperature, T_A
- Output Current, I_{OUT}
- Output Voltage, V_{OUT}
- Input Voltage, V_{IN}

First, we calculate the power dissipation of the regulator from these numbers and the device parameters from this datasheet.

$$P_D = I_{OUT}(1.01V_{IN} - V_{OUT})$$

Where the ground current is approximated by 1% of I_{OUT}. Then the heat sink thermal resistance is determined with this formula:

$$\theta_{SA} = \frac{T_{JMAX} - T_A}{P_D} - (\theta_{JC} + \theta_{CS})$$

Where $T_{JMAX} \leq 125℃$ and θ_{CS} is between 0 and 2℃/W.

Capacitor Requirements

For stability and minimum output noise, a capacitor on the regulator output is necessary. The value of this capacitor is dependent upon the output current; lower currents allow smaller capacitors. LM29150 regulators are stable with the 10uF minimum capacitor values at full load. Where the regulator is powered from a source with a high AC impedance, a 0.1uF capacitor connected between input and GND is recommended. This capacitor should have good characteristics to above 250kHz.

Minimum Load Current

The LM29150 regulators are specified between finite loads. If the output is too small, leakage currents is too small, leakage currents dominate and the output voltage rises. The 5mA minimum load current swamps any expected leakage current across the operating temperature range.
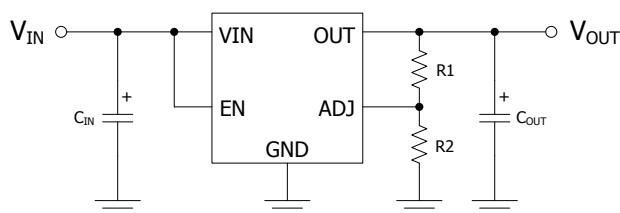
Adjustable Regulator Design

The adjustable regulator versions, LM29152 allows programming the output voltage anywhere between 1.25V and the 25V 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:

$$R1 = R2 \left(\frac{V_{OUT}}{V_{REF}} - 1 \right)$$

Where V_{OUT} is desired output voltage, Figure 2 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation.

$$V_{OUT} = 1.240 \times [1 + (R1/R2)]$$

Figure 2. Adjustable Regulator with Resistors

Error Flag

LM29151 versions feature and Error Flag, which looks at the output voltage and signals and error condition when this 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

LM29151 and LM29152 versions feature and 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 flows. The EN input has TTL/CMOS compatible thresholds for simple interfacing with logic, or may be directly tied to $\leq$ 30V. Enabling the regulator requires approximately 20uA of current.

REVISION NOTICE

The description in this datasheet can be revised without any notice to describe its electrical characteristics properly.