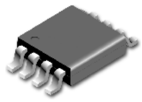
1A Low-Voltage Low-Dropout Regulator — LM37102C

FEATURES

- Fixed and adjustable output voltages to 1.24V
- Stable with MLCC and Ceramic Capacitors
- 500mV typical dropout at 1A
  Ideal for 3.0V to 2.5V conversion
  Ideal for 2.5V to 1.8V or 1.5V conversion
- 1A minimum guaranteed output current
- 1% initial accuracy
- Low ground current
- Current limiting and thermal shutdown
- Reversed-battery protection
- Reversed-leakage protection
- Fast transient response
- Moisture Sensitivity Level 3

SOP-8 & SOP-8PP PKG



APPLICATION

- Battery Powered Equipments
- Motherboards and Graphic Cards
- Microprocessor Power Supplies
- Peripheral Cards
- High Efficiency Linear Regulators
- Battery Chargers

ORDERING INFORMATION

Device	Package
LM37102CGD	SOP-8
LM37102CGDP	SOP-8PP

DESCRIPTION

The LM37102C is 1A low-dropout linear voltage regulators that provide low-voltage, high-current output. The LM37102C offers extremely low dropout (typically 500mV at 1A). The LM37102C is adjustable regulators, SOP-8 and SOP-8PP.

The LM37102C is ideal for PC add-in cards that need to convert from standard 5V to 3.3V, 3.3V to 2.5V or 2.5V to1.8V. A guaranteed maximum dropout voltage of 630mV overall operating conditions allows the LM37102C to provide 2.5V from a supply as low as 3.13V and 1.8V from a supply as low as 2.5V. The LM37102C is fully protected with over current limiting, thermal shutdown, and reversed-battery protection.

Absolute Maximum Ratings (Note 1)

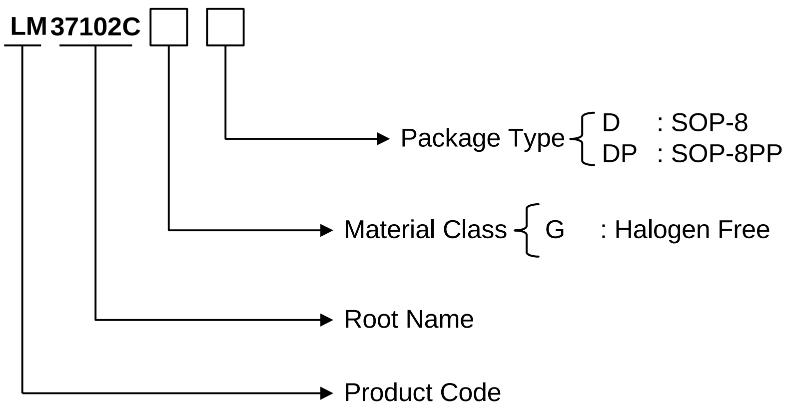
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage	V_{IN}	- 0.3	+ 20	V
Enable Voltage	V_{EN}	-	+ 20	V
Lead Temperature (Soldering, 5 sec)	T_{SOL}	-	260	℃
Storage Temperature Range	T_{STG}	-65	+ 150	℃

Operating Ratings (Note 2)

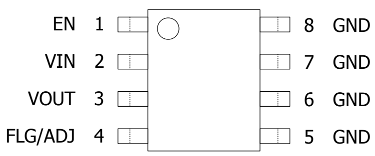
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage	V_{IN}	+ 2.5	+ 16	V
Enable Voltage	V_{EN}		+ 16	V
Junction Temperature	T_J	-40	+ 125	℃

Ordering Information

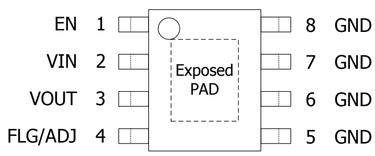
V_{OUT}	Package	Order No.	Description	Supplied As	Status
ADJ	SOP-8	LM37102CGD	1A, Adjustable, Enable	Reel	Active
	SOP-8PP	LM37102CGDP	1A, Adjustable, Enable	Reel	Active



PIN CONFIGURATION



SOP-8

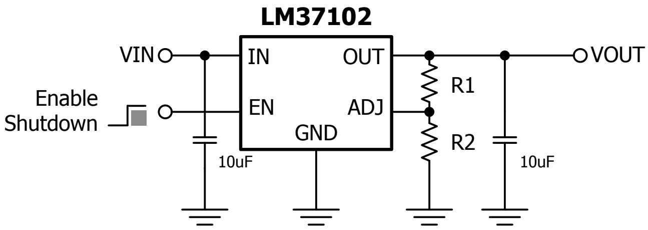


SOP-8PP

PIN DESCRIPTION

Pin No.	SOP-8 PKG	
	Name	Function
1	EN	Chip Enable
2	VIN	Input Supply
3	VOUT	Output Voltage
4	FLG / ADJ	Error Flag Output or Output Adjust
5 / 6 / 7 / 8	GND	Ground
	Thermal Exposed PAD	Connect to Ground.

TYPICAL APPLICATION



1.5V / 1A Adjustable Regulator

ELECTRICAL CHARACTERISTICS

T_J = 25°C, **bold** values indicate -40°C ≤ T_J ≤ +125°C; unless noted otherwise.

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	10mA 10mA ≤ I_{OUT} ≤ 1A, V_{OUT}+1V ≤ V_{IN} ≤16V	-1 **-2**		1 **2**	% %
V_{ADJ}	Adjustable Pin Voltage		1.228 **1.215**	1.24	1.252 **1.265**	V
		(Note 8)	**1.203**		**1.277**	
I_{ADJ}	Adjust Pin Bias Current			3	**20**	uA
	Line Regulation	I_{OUT}=1mA, V_{OUT} +1V ≤ V_{IN} ≤ 16V		0.06	0.5	%
	Load Regulation	V_{IN}= V_{OUT} +1V, 1mA ≤ I_{OUT} ≤ 1A		0.2	1	%
V_{DO}	Dropout Voltage (Note 5)	I_{OUT}=100mA, ΔV_{OUT} = -1%		100	**250**	mV mV
		I_{OUT}=1A, ΔV_{OUT} = -1%		500	**630**	mV mV
I_{GND}	Ground Current (Note 6)	I_{OUT}=100mA, V_{IN}= V_{OUT}+1V		3.8		mA
		I_{OUT}=1A, V_{IN}= V_{OUT}+1V		25		mA
$I_{OUT(lim)}$	Current Limit	V_{OUT}=0V, V_{IN}=V_{OUT}+1V		1.4	2.5	A
$\Delta V_{OUT}/\Delta T$	Output Voltage Temp. Coefficient (Note 4)				**100**	ppm/ °C
V_{EN}	Enable Input Voltage	logic low (off)			**0.25**	V
		logic high (on)	**2.0**			V
I_{EN}	Enable Input Current	V_{EN}=16V		3	30 **75**	μA μA
		V_{EN}=0.0V		0.01	1 **4**	μA μA
T_{EN}	Delay time to Nominal Output Voltage (Note 7)	I_{OUT} =10mA, V_{IN} =V_{OUT} +1V, V_{EN} =0V to V_{IN}		50		μs
		I_{OUT} =500mA, V_{IN} =V_{OUT} +1V, V_{EN} =0V to V_{IN}		250		
		I_{OUT} =1.0A, V_{IN} =V_{OUT} +1V, V_{EN} =0V to V_{IN}		350		

Note 1. Exceeding the absolute maximum ratings may damage the device.

Note 2. The device is not guaranteed to function outside its operating rating.

Note 3. PD (max)= ($T_{J\,(max)}$ - T_A) ÷ θ_{JA}, where θ_{JA} -junction-to-ambient thermal resistance.

Note 4. Output voltage temperature coefficient is ΔV_{OUT} (worst case) ÷ ($T_{J(max)}$ - $T_{J(min)}$) where $T_{J(max)}$ is +125°C and $T_{J(min)}$ is 0°C.

Note 5. V_{DO} = V_{IN} - V_{OUT} when V_{OUT} decreases to 99% of its nominal output voltage with V_{IN} = V_{OUT} + 1V. 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.

Note 6. I_{GND} is the quiescent current. I_{IN} = I_{GND} + I_{OUT}.

Note 7. Delay time is measured after V_{EN}=V_{IN}. C_{IN}=C_{OUT}=10μF.

Note 8. V_{ADJ} ≤ V_{OUT} ≤ (V_{IN} - 1V), 2.5V ≤ V_{IN} ≤ 16V, 10mA ≤ I_L ≤ 1 A.

APPLICATION INFORMATION

Output Capacitor

The LM37102C regulators are designed to be stable with a wide range of output capacitors. The ESR of the output capacitor affects stability, most notably with small capacitors. A minimum output capacitor of 2.2uF is recommended to prevent oscillations. Larger values of output capacitance can decrease the peak deviations and provide improved transient response for larger load current changes. Bypass capacitors, used to decouple individual components powered by the LM37102C, will increase the effective output capacitor value.

Extra consideration must be given to the use of ceramic capacitors. Ceramic capacitors are manufactured with a variety of dielectrics, each with different behavior over temperature and applied voltage.

X7R-type capacitors change capacitance by 15% over their operating temperature range and are the most stable type of ceramic capacitors. Z5U and Y5V dielectric capacitors change value by as much as 50% and 60% respectively over their operating temperature ranges. To use a ceramic chip capacitor with Y5V dielectric, the value must be much higher than an X7R ceramic capacitor to ensure the same minimum capacitance over the equivalent operating temperature range.

Input Capacitor

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

Enable Input

The LM37102C features an active-high enable input (EN) that allows on-off control of the regulator. Current drain reduces to "zero" when the device is shutdown, with only micro amperes of leakage current. The EN input has TTL/CMOS compatible thresholds for simple logic interfacing. EN may be directly tied to V_{IN} and pulled up to the maximum supply voltage.

Minimum Load Current

The LM37102C regulator 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 is necessary for proper regulation.

Adjustable Regulator Design

The LM37102C allows programming the output voltage any-where between 1.24V and the 16V 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/1.240-1) Where Vout is the desired output voltage. Figure 1 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see below). The current consumed by feedback resisters R1 and R2 is calculated by: I_{res} = Vout / (R1+ R2).

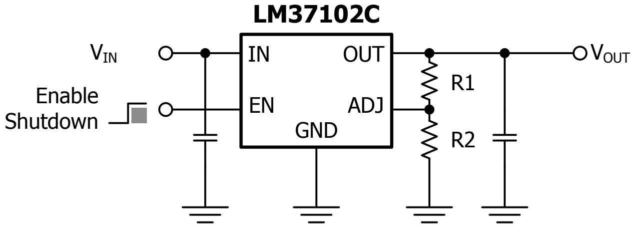


Figure 1. Adjustable Regulator with Resistors

Maximum Output Current Capability

The LM37102C can deliver a continuous current of 1A over the full operating junction temperature range. However, the output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 1A may be still undeliverable due to the restriction of the power dissipation of LM37102C. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The temperatures over the device are given by:

$$T_C = T_A + P_D \times \theta_{CA} \;/\quad T_J = T_C + P_D \times \theta_{JC} \;/\quad T_J = T_A + P_D \times \theta_{JA}$$

where T_J is the junction temperature, T_C is the case temperature, T_A is the ambient temperature, P_D is the total power dissipation of the device, θ_{CA} is the thermal resistance of case-to-ambient, θ_{JC} is the thermal resistance of junction-to-case, and θ_{JA} is the thermal resistance of junction to ambient. The total power dissipation of the device is given by:

$$P_D = P_{IN} - P_{OUT} = (V_{IN} \times I_{IN}) - (V_{OUT} \times I_{OUT})$$
$$= (V_{IN} \times (I_{OUT} + I_{GND})) - (V_{OUT} \times I_{OUT}) = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

where I_{GND} is the operating ground current of the device which is specified at the Electrical Characteristics. The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} - T_{Amax}$$

The maximum allowable value for junction-to-ambient thermal resistance, θ_{JA}, can be calculated using the formula:

$$\theta_{JA} = T_{Rmax} / P_D = (T_{Jmax} - T_{Amax}) / P_D$$

LM37102C is available in SOP-8 and SOP-8PP package. The thermal resistance depends on amount of copper area or heat sink, and on air flow. If the maximum allowable value of θ_{JA} calculated above is over 75°C/W for SOP-8PP package and 130°C/W for SOP-8, no heat sink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable θ_{JA} falls near or below these limits, a heat sink or proper area of copper plane is required. In summary, the absolute maximum ratings of thermal resistances are as follow:

Absolute Maximum Ratings of Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal Resistance Junction-To-Ambient / SOP-8	$\theta_{JA\text{-}SOP\text{-}8}$	130	°C/W
Thermal Resistance Junction-To-Ambient / SOP-8PP	$\theta_{JA\text{-}SOT\text{-}8PP}$	75	°C/W

No heat sink / No air flow / No adjacent heat source / 20 mm^2 copper area. (T_A=25°C)

REVISION NOTICE

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

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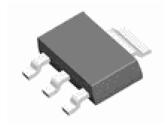
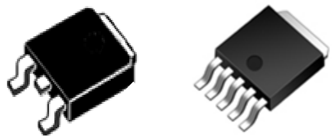
FEATURES

- Fixed and adjustable output voltages to 1.24V
- 410mV typical dropout at 1A
  Ideal for 3.0V to 2.5V conversion
  Ideal for 2.5V to 1.8V or 1.5V conversion
- 1A minimum guaranteed output current
- 1% initial accuracy
- Low ground current
- Current limiting and thermal shutdown
- Reversed-battery protection
- Reversed-leakage protection
- Fast transient response
- Low-profile SOT-223 package
- Moisture Sensitivity Level 3

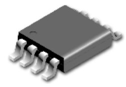
SOT-223 PKG



TO-252 3L / 5L PKG



SOP-8 PKG



APPLICATION

- Battery Powered Equipments
- Motherboards and Graphic Cards
- Microprocessor Power Supplies
- Peripheral Cards
- High Efficiency Linear Regulators
- Battery Chargers

ORDERING INFORMATION

Device	Package
LM39100S-X.X	SOT-223
LM39100GS-X.X	
LM39100RS-X.X	TO-252 3L
LM39100GRS-X.X	
LM39101RS-X.X	TO-252 5L
LM39101GRS-X.X	
LM39102RS	
LM39102GRS	
LM39101D-X.X	SOP-8
LM39102D	

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

DESCRIPTION

The LM39100/1/2 is 1A low-dropout linear voltage regulators that provide low-voltage, high-current output.
The LM39100/1/2 offers extremely low dropout (typically 410mV at 1A) and low ground current (typically 12mA at 1A). The LM39100 is a fixed output regulator offered in the SOT-223 package. The LM39101 and LM39102 are fixed and adjustable regulators, respectively, in SOP-8 and TO-252 Packages.
The LM39100/1/2 is ideal for PC add-in cards that need to convert from standard 5V to 3.3V, 3.3V to 2.5V or 2.5V to1.8V. A guaranteed maximum dropout voltage of 630mV overall operating conditions allows the LM39100/1/2 to provide2.5V from a supply as low as 3.13V and 1.8V from a supply as low as 2.43V. The LM39100/1/2 is fully protected with over current limiting, thermal shutdown, and reversed-battery protection. Fixed voltages of 5.0V, 3.3V, 2.5V, 1.8V and 1.5V are available on LM39100/1 with adjustable output voltages to 1.24V on LM39102.

Absolute Maximum Ratings (Note 1)

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage	V_{IN}	- 0.3	+ 20	V
Enable Voltage	V_{EN}	-	+ 20	V
Output Voltage	V_{OUT}	-0.3	V_{IN} +0.3	V
Lead Temperature (Soldering, 5 sec)	T_{SOL}	-	260	℃
Storage Temperature Range	T_{STG}	-65	+ 150	℃

Operating Ratings (Note 2)

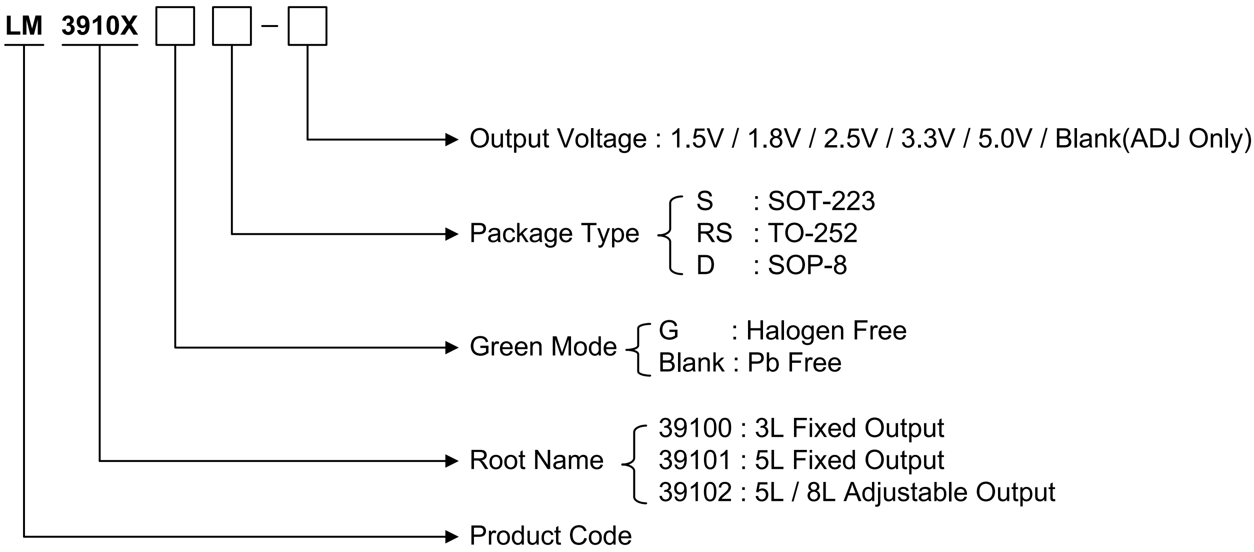
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage	V_{IN}	+ 2.25	+ 16	V
Enable Voltage	V_{EN}	+ 2.25	+ 16	V
Maximum Power Dissipation	$PD_{(max)}$	(Note 3)	(Note 3)	
Junction Temperature	T_J	-40	+ 125	℃
Package Thermal Resistance	$\theta_{JA\text{-}SOT\text{-}223}$	115		℃/W
	$\theta_{JA\text{-}TO252}$	95		℃/W
	$\theta_{JA\text{-}SOP\text{-}8}$	130		℃/W

Ordering Information

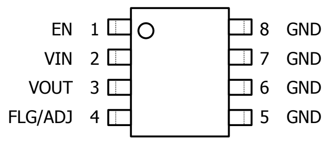
V_{OUT}	Package	Order No.	Description	Supplied As	Status
1.5 V	SOT-223	LM39100S-1.5V	1A, Fixed	Reel	Active
	SOT-223	LM39100GS-1.5V	1A, Fixed	Reel	Contact us
	TO-252 3L	LM39100RS-1.5V	1A, Fixed	Reel	Active
	TO-252 3L	LM39100GRS-1.5V	1A, Fixed	Reel	Active
	TO-252 5L	LM39101RS-1.5V	1A, Fixed, Enable	Reel	Active
	TO-252 5L	LM39101GRS-1.5V	1A, Fixed, Enable	Reel	Active
	SOP-8	LM39101D-1.5V	1A, Fixed, Enable	Reel	Active
1.8 V	SOT-223	LM39100S-1.8V	1A, Fixed	Reel	Active
	SOT-223	LM39100GS-1.8V	1A, Fixed	Reel	Contact us
	TO-252 3L	LM39100RS-1.8V	1A, Fixed	Reel	Active
	TO-252 3L	LM39100GRS-1.8V	1A, Fixed	Reel	Active
	TO-252 5L	LM39101RS-1.8V	1A, Fixed, Enable	Reel	Active
	TO-252 5L	LM39101GRS-1.8V	1A, Fixed, Enable	Reel	Active
	SOP-8	LM39101D-1.8V	1A, Fixed, Enable	Reel	Active
2.5 V	SOT-223	LM39100S-2.5V	1A, Fixed	Reel	Active
	SOT-223	LM39100GS-2.5V	1A, Fixed	Reel	Contact us
	TO-252 3L	LM39100RS-2.5V	1A, Fixed	Reel	Active
	TO-252 3L	LM39100GRS-2.5V	1A, Fixed	Reel	Active
	TO-252 5L	LM39101RS-2.5V	1A, Fixed, Enable	Reel	Active
	TO-252 5L	LM39101GRS-2.5V	1A, Fixed, Enable	Reel	Active
	SOP-8	LM39101D-2.5V	1A, Fixed, Enable	Reel	Active
3.3 V	SOT-223	LM39100S-3.3V	1A, Fixed	Reel	Active
	SOT-223	LM39100GS-3.3V	1A, Fixed	Reel	Contact us
	TO-252 3L	LM39100RS-3.3V	1A, Fixed	Reel	Active
	TO-252 3L	LM39100GRS-3.3V	1A, Fixed	Reel	Active
	TO-252 5L	LM39101RS-3.3V	1A, Fixed, Enable	Reel	Active
	TO-252 5L	LM39101GRS-3.3V	1A, Fixed, Enable	Reel	Active
	SOP-8	LM39101D-3.3V	1A, Fixed, Enable	Reel	Active

Ordering Information

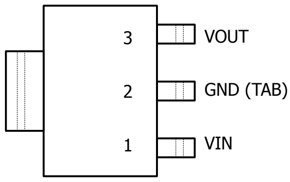
V_{OUT}	Package	Order No.	Description	Supplied As	Status
5.0 V	SOT-223	LM39100S-5.0V	1A, Fixed	Reel	Active
	SOT-223	LM39100GS-5.0V	1A, Fixed	Reel	Contact us
	TO-252 3L	LM39100RS-5.0V	1A, Fixed	Reel	Active
	TO-252 3L	LM39100GRS-5.0V	1A, Fixed	Reel	Active
	TO-252 5L	LM39101RS-5.0V	1A, Fixed, Enable	Reel	Active
	TO-252 5L	LM39101GRS-5.0V	1A, Fixed, Enable	Reel	Active
	SOP-8	LM39101D-5.0V	1A, Fixed, Enable	Reel	Active
ADJ	TO-252 5L	LM39102RS	1A, Adjustable, Enable	Reel	Active
	TO-252 5L	LM39102GRS	1A, Adjustable, Enable	Reel	Active
	SOP-8	LM39102D	1A, Adjustable, Enable	Reel	Active



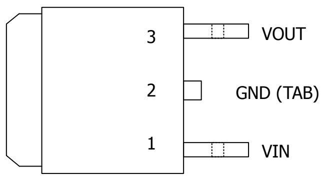
PIN CONFIGURATION



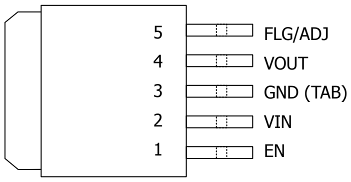
SOP-8



SOT-223



TO-252 3L



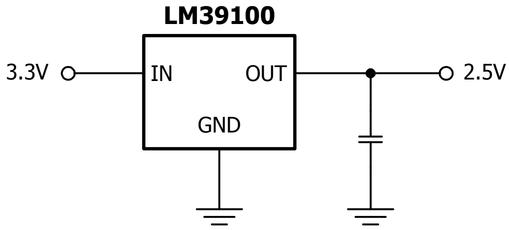
TO-252 5L

PIN DESCRIPTION

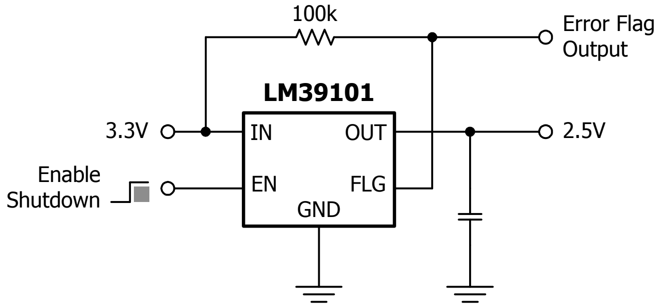
Pin No.	SOT-223 & TO-252 3L **(for 39100)**	
	Name	Function
1	VIN	Input Supply
2	GND	Ground
3	VOUT	Output Voltage

Pin No.	TO-252 5L **(for 39101/2)**		SOP-8 **(for 39101/2)**	
	Name	Function	Name	Function
1	EN	Chip Enable	EN	Chip Enable
2	VIN	Input Supply	VIN	Input Supply
3	GND	Ground	VOUT	Output Voltage
4	VOUT	Output Voltage	FLG / ADJ	Error Flag Output or Output Adjust
5	FLG / ADJ	Error Flag Output or Output Adjust	GND	Ground
6 / 7 / 8	-	-	GND	Ground

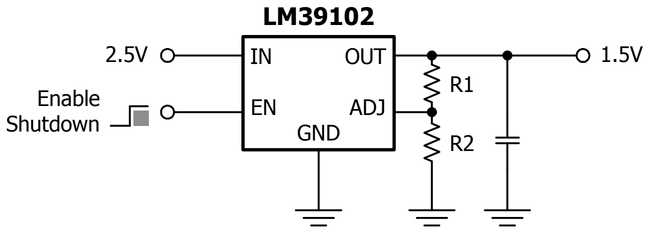
TYPICAL APPLICATION



2.5V / 1A Regulator



2.5V / 1A Regulator with Error Flag



1.5V / 1A Adjustable Regulator

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ELECTRICAL CHARACTERISTICS

V_{IN}= V_{OUT} +1V; V_{EN} = 2.25V; T_J = 25°C, **bold** values indicate -40°C ≤ T_J ≤ +125°C; unless noted

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	10mA 10mA ≤ I_{OUT} ≤ 1A, V_{OUT}+1V ≤ V_{IN} ≤8V	-1 **-2**		1 **2**	% %
	Line Regulation	I_{OUT}=10mA, V_{OUT} +1V ≤ V_{IN} ≤ 16V		0.06	0.5	%
	Load Regulation	V_{IN}= V_{OUT} +1V, 10mA ≤ I_{OUT} ≤ 1A		0.2	1	%
$\Delta V_{OUT}/\Delta T$	Output Voltage Temp. Coefficient (Note 4)			**40**	**100**	ppm/ °C
V_{DO}	Dropout Voltage (Note 5)	I_{OUT}=100mA, ΔV_{OUT} = -1%		150	200 **250**	mV mV
		I_{OUT}=500mA, ΔV_{OUT} = -1%		275		mV
		I_{OUT}=750mA, ΔV_{OUT} = -1%		330	**500**	mV
		I_{OUT}=1A, ΔV_{OUT} = -1%		410	550 **630**	mV mV
I_{GND}	Ground Current (Note 6)	I_{OUT}=100mA, V_{IN}= V_{OUT}+1V		700		μA
		I_{OUT}=500mA, V_{IN}= V_{OUT}+1V		4		mA
		I_{OUT}=750mA, V_{IN}= V_{OUT}+1V		7		mA
$I_{OUT(lim)}$	Current Limit	V_{OUT}=0V, V_{IN}=V_{OUT}+1V	1.3	2.5	3.5	A
Enable Input						
V_{EN}	Enable Input Voltage	logic low (off)			0.8	V
		logic high (on)	**2.25**			V
I_{EN}	Enable Input Current	V_{EN}=2.25V	1	15	30 **75**	μA μA
		V_{EN}=0.8V			2 **4**	μA μA
T_{EN}	Delay time to Nominal Output Voltage (Note 7)	I_{OUT} =10mA, V_{IN} =V_{OUT} +1V, V_{EN} =0V to V_{IN}		50	500	μs
		I_{OUT} =500mA, V_{IN} =V_{OUT} +1V, V_{EN} =0V to V_{IN}		250	2000	μs
		I_{OUT} =1.0A, V_{IN} =V_{OUT} +1V, V_{EN} =0V to V_{IN}		350	3000	μs
Flag Output						
$I_{FLG\ (leak)}$	Output Leakage Current	V_{OH}=16V		0.01	1 **2**	μA μA
$V_{FLG\ (do)}$	Output Low Voltage (Note 8)	V_{IN}=0.9.V_{OUT} NOMINAL, I_{OL}=250μA		240	300 400	mV mV
V_{FLG}	Low Threshold	% of V_{OUT}	93			%
	High Threshold	% of V_{OUT}			99.2	%
	Hysteresis			1		%

LM39102 Only

	Reference Voltage		1.228 **1.215**	1.24	1.252 **1.265**	V V
		(Note 9)	**1.203**		**1.277**	V
	Adjust Pin Bias Current			40	80 **120**	nA nA
	Reference Voltage Temp. Coefficient (Note 4)			20		ppm/ °C
	Adjust Pin Bias Current Temp. Coefficient			0.1	99.2	nA/ °C

Note 1. Exceeding the absolute maximum ratings may damage the device.

Note 2. The device is not guaranteed to function outside its operating rating.

Note 3. PD (max)= ($T_{J\,(max)}$ - T_A) ÷ θ_{JA}, where θ_{JA} -junction-to-ambient thermal resistance.

Note 4. Output voltage temperature coefficient is ΔV_{OUT} (worst case) ÷ ($T_{J(max)}$ - $T_{J(min)}$) where $T_{J(max)}$ is +125°C and $T_{J(min)}$ is 0°C.

Note 5. V_{DO} = V_{IN} - V_{OUT} when V_{OUT} decreases to 99% of its nominal output voltage with V_{IN} = V_{OUT} + 1V. For output voltages below 2.25V, dropout voltage is the input-to-output voltage differential with the minimum input voltage being 2.25V. Minimum input operating voltage is 2.25V.

Note 6. I_{GND} is the quiescent current. I_{IN} = I_{GND} + $I_{OUT.}$

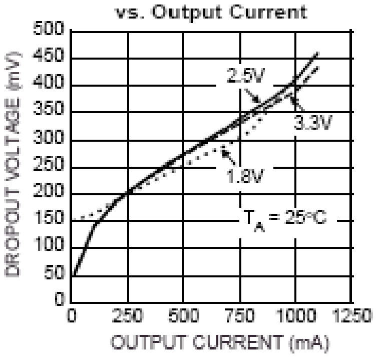
Note 7. Delay time is measured after V_{EN}=V_{IN}. C_{IN}=C_{OUT}=10μF.

Note 8. For adjustable device and fixed device with V_{OUT} ≥ 2.5V

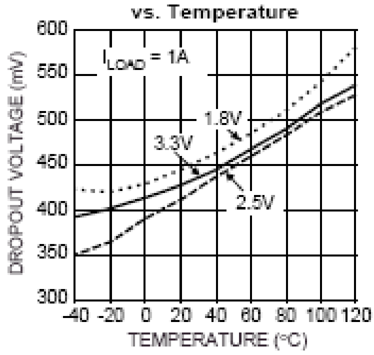
Note 9. V_{REF} ≤ V_{OUT} ≤ (V_{IN} - 1V), 2.25V ≤ V_{IN} ≤ 16V, 10mA ≤ I_L ≤ 1 A.

TYPICAL OPERATING CHARACTERISTICS

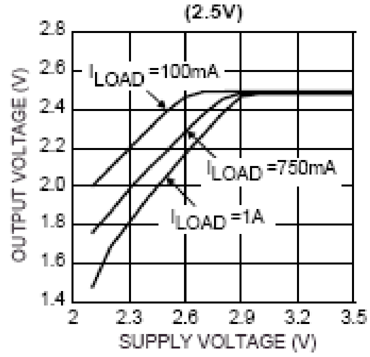
Dropout Voltage vs. Output Current



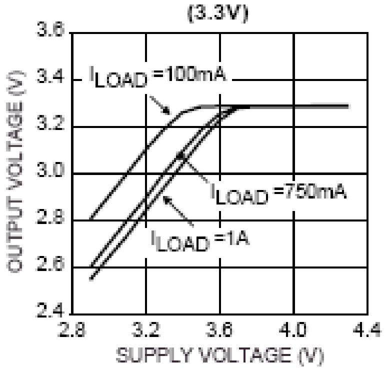
Dropout Voltage vs. Temperature



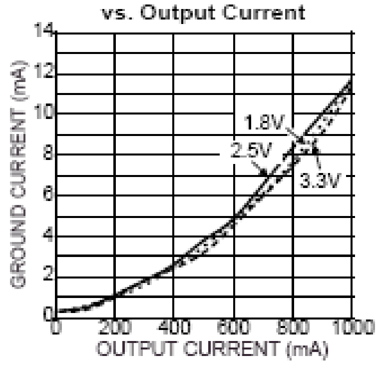
Dropout Characteristics (2.5V)



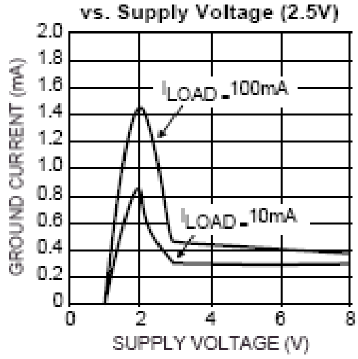
Dropout Characteristics (3.3V)



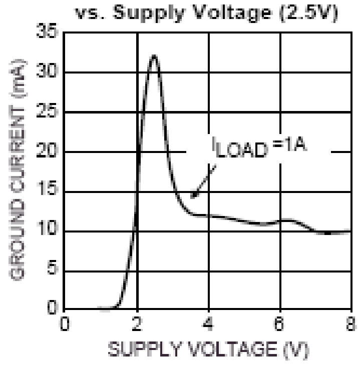
Ground Current vs. Output Current



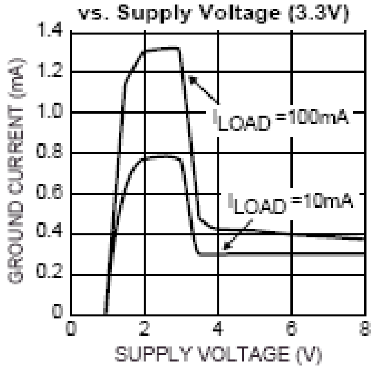
Ground Current vs. Supply Voltage (2.5V)



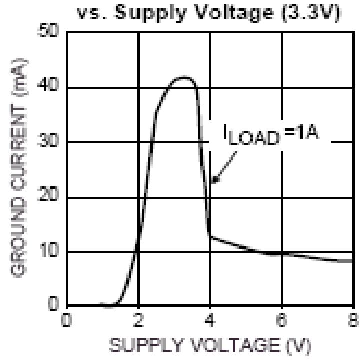
Ground Current vs. Supply Voltage (2.5V)



Ground Current vs. Supply Voltage (3.3V)



Ground Current vs. Supply Voltage (3.3V)



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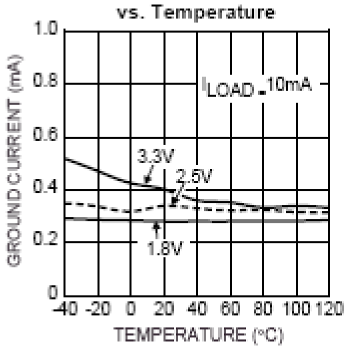
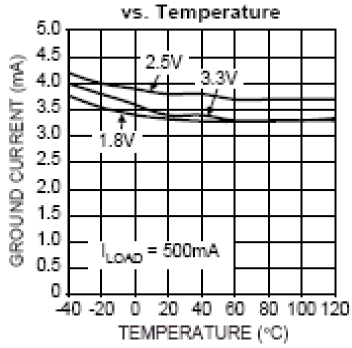
TYPICAL OPERATING CHARACTERISTICS

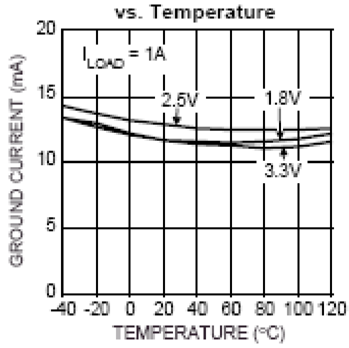
Ground Current
vs. Temperature



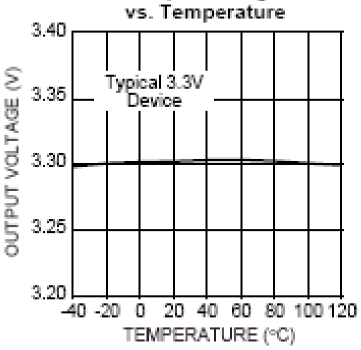
Ground Current
vs. Temperature



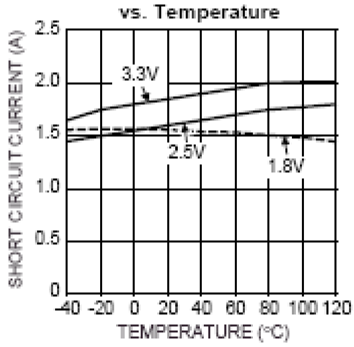
Ground Current
vs. Temperature



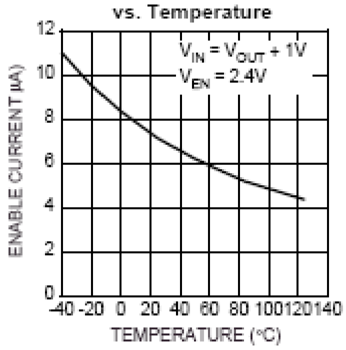
Output Voltage
vs. Temperature



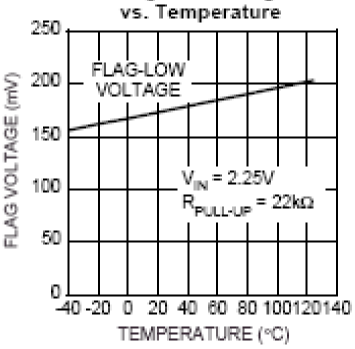
Short Circuit
vs. Temperature



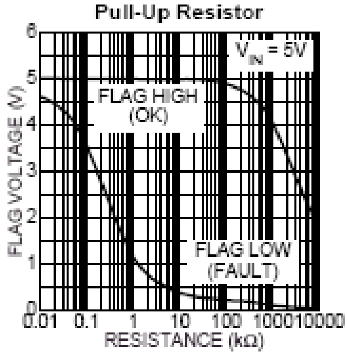
Enable Current
vs. Temperature



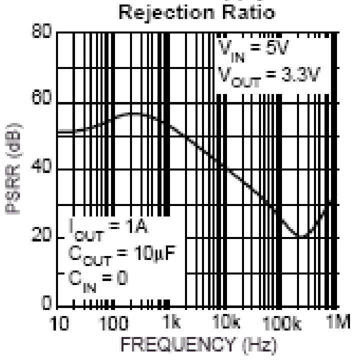
Flag-Low Voltage
vs. Temperature



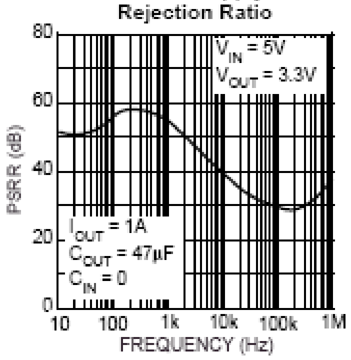
Error Flag
Pull-Up Resistor



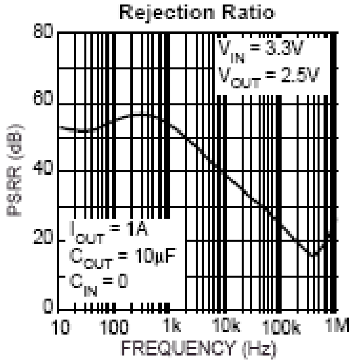
Power Supply
Rejection Ratio



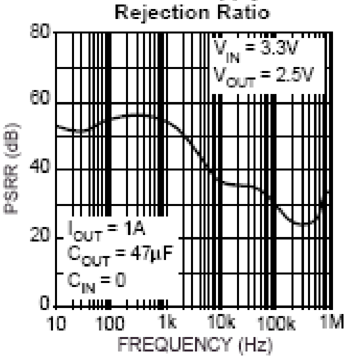
Power Supply
Rejection Ratio



Power Supply
Rejection Ratio



Power Supply
Rejection Ratio



APPLICATION INFORMATION

The LM39100/1/2 is a high-performance low-dropout voltage regulator suitable for moderate to high-current voltage regulator applications. Its 630mV dropout voltage at full load and over temperature makes it especially valuable in battery-powered systems and as high-efficiency noise filters in post-regulator applications. Unlike older NPN-pass transistor de-signs, where the minimum dropout voltage is limited by the base-to-emitter voltage drop and collector-to-emitter saturation voltage, dropout performance of the PNP output of these devices is limited only by the low VCE saturation voltage. A trade-off for the low dropout voltage is a varying base drive requirement.

The LM39100/1/2 regulator is fully protected from damage due to fault conditions. Linear current limiting is provided. Output current during overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the maximum safe operating temperature. Transient protection 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

The LM39100/1/2 requires an output capacitor to maintain stability and improve transient response. Proper capacitor selection is important to ensure proper operation. The LM39100/1/2 output capacitor selection is dependent upon the ESR (equivalent series resistance) of the output capacitor to maintain stability. When the output capacitor is 10μF or greater, the output capacitor should have an ESR less than 2Ω. This will improve transient response as well as promote stability. Ultra-low ESR capacitors (<100mΩ), such as ceramic chip capacitors, may promote the instability. These very low ESR levels may cause an oscillation and/or underdamped transient response. A low ESR solid tantalum capacitor works extremely well and provides a good transient response and the stability over the temperature range. Aluminum electrolytes can also be used, as long as the capacitor ESR is <2Ω. The value of the output capacitor can be increased without limit. Higher capacitance values help one to improve transient response and ripple rejection and reduce an output noise.

Input Capacitor

An input capacitor of 1μF or greater is recommended when the device is more than 4 inches away from the bulk ac supply capacitance or when the supply is a battery. In the case of ceramic chip capacitor, 10uF capacitance is recommended. Larger values will help to improve ripple rejection by bypassing the input to the regulator, further improving the integrity of the output voltage.

Error Flag

The LM39101 features an error flag (FLG), which monitors 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 and may sink up to 10mA. Low output voltage signifies a number of possible problems, including an over current fault (the device is in current limit) or low input voltage. The flag output is inoperative during over temperature conditions. A pull-up resistor from FLG to either V_{IN} or V_{OUT} is required for proper operation. For information regarding the minimum and maximum values of pull-up resistance, refer to the graph in the typical characteristics section of the data sheet.

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Enable Input

The LM39101 and LM39102 versions feature an active-high enable input (EN) that allows on-off control of the regulator. Current drain reduces to “zero” when the device is shutdown, with only micro amperes of leakage current. The EN input has TTL/CMOS compatible thresholds for simple logic interfacing. EN may be directly tied to V_{IN} and pulled up to the maximum supply voltage

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

The LM39100/1/2 has excellent transient response to variations 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 10µF 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 de-signs. When converting from 3.3V to 2.5V or 2.5V to 1.8V, the NPN based regulators are already operating in dropout, with typical dropout requirements of 1.2V or greater. To convert down to 2.5V or 1.8V without operating in dropout, NPN-based regulators require an input voltage of 3.7V at the very least. The LM39100 regulator will provide excellent performance with an input as low as 3.0V or 2.5V respectively. This gives the PNP based regulators a distinct advantage over older, NPN based linear regulators.

Minimum Load Current

The LM39100/1/2 regulator 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 is necessary for proper regulation.

Adjustable Regulator Design

The LM39102 allows programming the output voltage any-where between 1.24V and the 16V 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/1.240-1) Where Vout is the desired output voltage. Figure 1 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see below). The current consumed by feedback resisters R1 and R2 is calculated by: Ires = Vout / (R1+ R2).

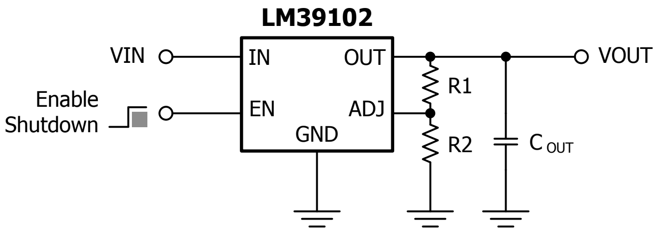

Figure 1. Adjustable Regulator with Resistors

Maximum Output Current Capability

The LM39100/1/2 can deliver a continuous current of 1A over the full operating junction temperature range. However, the output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 1A may be still undeliverable due to the restriction of the power dissipation of LM39100/1/2. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The temperatures over the device are given by:

$T_C = T_A + P_D \times \theta_{CA}$ / $T_J = T_C + P_D \times \theta_{JC}$ / $T_J = T_A + P_D \times \theta_{JA}$

Where T_J is the junction temperature, T_C is the case temperature, T_A is the ambient temperature, P_D is the total power dissipation of the device, θ_{CA} is the thermal resistance of case-to-ambient, θ_{JC} is the thermal resistance of junction-to-case, and θ_{JA} is the thermal resistance of junction to ambient. The total power dissipation of the device is given by:

$$P_D = P_{IN} - P_{OUT} = (V_{IN} \times I_{IN}) - (V_{OUT} \times I_{OUT})$$
$$= (V_{IN} \times (I_{OUT} + I_{GND})) - (V_{OUT} \times I_{OUT}) = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

Where I_{GND} is the operating ground current of the device which is specified at the Electrical Characteristics. The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} - T_{Amax}$$

The maximum allowable value for junction-to-ambient thermal resistance, θ_{JA}, can be calculated using the formula:

$$\theta_{JA} = T_{Rmax} / P_D = (T_{Jmax} - T_{Amax}) / P_D$$

LM39100/1/2 is available in SOT-223, TO-252, and SOP-8 package. The thermal resistance depends on amount of copper area or heat sink, and on air flow. If the maximum allowable value of θ_{JA} calculated above is over 115°C/W for SOT-223 package, 95°C/W for TO-252 package, 130°C/W for SOP-8 package, no heat sink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable θ_{JA} falls near or below these limits, a heat sink or proper area of copper plane is required. In summary, the absolute maximum ratings of thermal resistances are as follow:

Absolute Maximum Ratings of Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal Resistance Junction-To-Ambient / SOT-223	$\theta_{JA-SOT-223}$	115	°C/W
Thermal Resistance Junction-To-Ambient / TO-252	$\theta_{JA-TO-252}$	95	°C/W
Thermal Resistance Junction-To-Ambient / SOP-8	$\theta_{JA-SOP-8}$	130	°C/W

No heat sink / No air flow / No adjacent heat source / 20 mm^2 copper area. (T_A=25°C)

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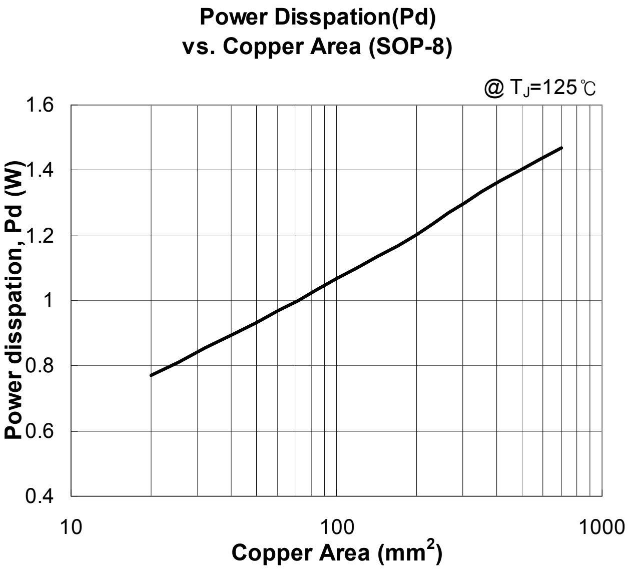

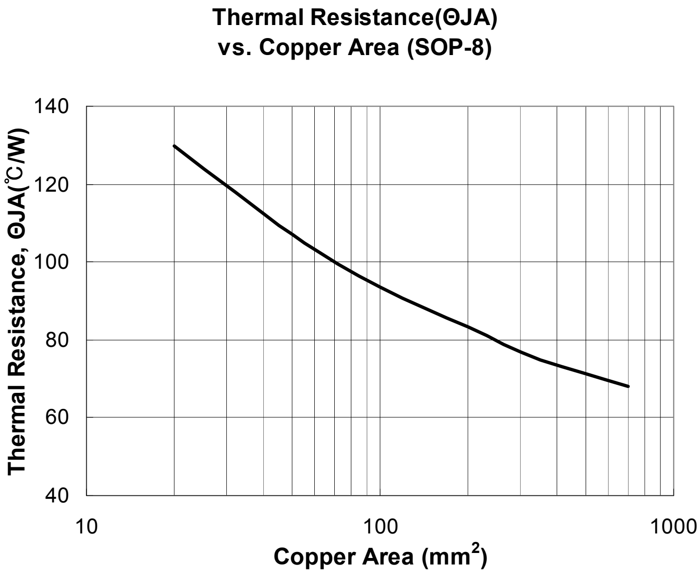

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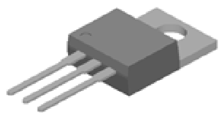
1A LOW DROPOUT REGULATOR LM2940

FEATURES

- Guaranteed Output Current of 1A
- Maximum Input Voltage 26V
- Low Dropout Voltage 400mV
- Low Ground Current
- Accurate 1% Guaranteed Tolerance
- Extremely Fast Transient Response
- Reverse Battery Protection
- Over-Temperature / Over-Current Protection
- Available in SOT-223-3L and TO-220-3L Package

SOT-223-3L

TO-220-3L



APPLICATION

- Battery Powered Equipment
- High-Efficiency “Green” Computer Systems
- Automotive Electronics
- High-Efficiency Linear Power Supplies
- High-Efficiency Post-Regulator For Switching Supply

ORDERING INFORMATION

Device	Package
LM2940S-X.X	SOT-223-3L
LM2940T-X.X	TO-220-3L

X.X = Output Voltage = 3.3V, 5.0V

DESCRIPTION

The LM2940 regulator features the ability to source 1A of output current with a dropout voltage of typically 0.4V and maximum of 0.63V over the entire temperature range. The device also finds applications in lower current, low dropout-critical systems, where their tiny dropout voltage and ground current values are important attributes. LM2940 is available as fixed 3.3V, 5.0V output voltages. The LM2940 is offered in a SOT-223-3L and TO-220-3L.

ABSOLUTE MAXIMUM RATINGS (Note 1)

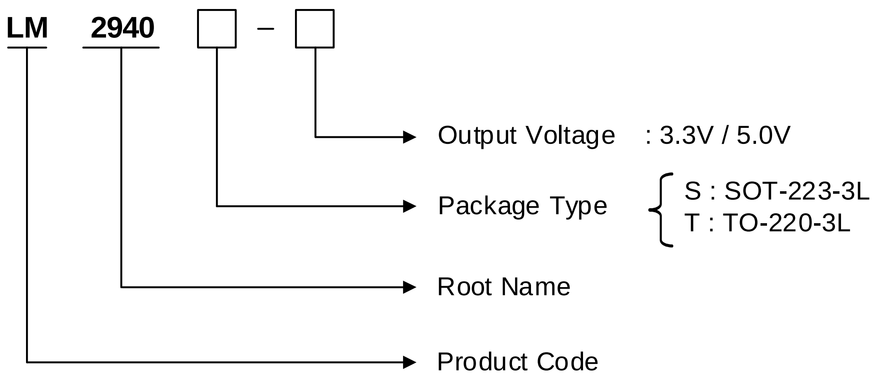
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Input Supply Voltage (Survival)	V_{IN}	-20	30	V
Maximum Output Current	I_{OUT_MAX}	-	1	A
Lead Temperature	T_{SOL}	-	260	°C
Storage Temperature Range	T_{STG}	-65	150	°C
Operating Junction Temperature Range	T_{OPR}	-40	125	°C

RECOMMENDED OPERATING RATINGS (Note 2)

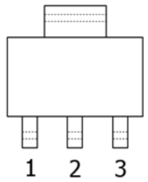
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Input Supply Voltage	V_{IN}	-	26	V
Operating Junction Temperature Range	T_{OPR}	-40	85	°C

ORDERING INFORMATION

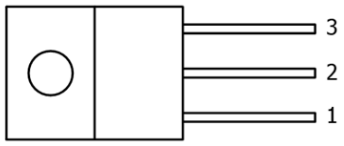
V_{OUT}	Package	Order No.	Supplied As	Status
3.3V	SOT-223-3L	LM2940S-3.3	Reel	Active
	TO-220-3L	LM2940T-3.3	Tube	Active
5.0V	SOT-223-3L	LM2940S-5.0	Reel	Active
	TO-220-3L	LM2940T-5.0	Tube	Active



PIN CONFIGURATION



SOT-223-3L

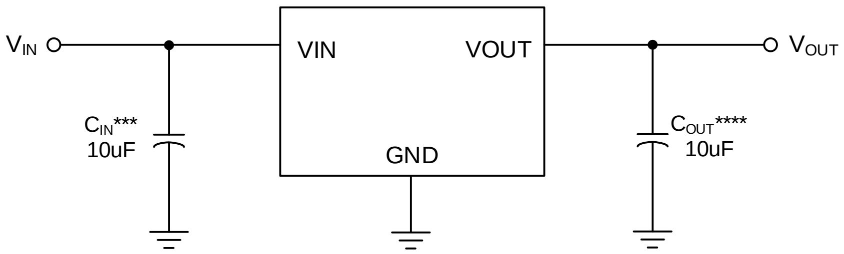


TO-220-3L

PIN DESCRIPTION

Pin No.	SOT-223-3L / TO-220-3L	
	Name	**Function**
1	VIN	Input Voltage
2	GND	Ground
3	VOUT	Output Voltage

TYPICAL CIRCUIT



* LM2940 can deliver a continuous current of 1A over the full operating temperature. However, the output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 1A may be still undeliverable.

** See Application Information.

*** C_{IN} : C_{IN} must be at least 1uF or large to maintain stability.

**** C_{OUT} : C_{OUT} must be at least 10uF or large to maintain stability.

ELECTRICAL CHARACTERISTICS (Note 3)

Limits in standard typeface are for T_J = 25°C, and limits in **boldface type** apply over the **full operating temperature range**.
Unless otherwise specified: V_{IN} (Note 4) = $V_{O(NOM)}$ + 1V, I_{OUT} = 5 mA, C_{IN} = 10 μF, C_{OUT} = 10 μF

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage Tolerance	V_O	I_{OUT} = 5mA	-1	-	1	%
		5 mA ≤ I_{OUT} ≤ 1A, (V_{OUT}+1V) ≤ V_{IN} ≤ 26V	**-2**	-	**2**	%
Line Regulation	ΔV_{LINE}	I_{OUT} = 5mA, (V_{OUT}+1V) ≤ V_{IN} ≤ 26V	-	0.06	0.5	%
Load Regulation	ΔV_{LOAD}	V_{IN} = V_{OUT} +1V, 5 mA ≤ I_{OUT} ≤ 1A	-	0.2	1	%
Output Voltage Temperature Coefficient (Note 5)	$\Delta V_{OUT} / \Delta T$		-	-	100	ppm/°C
Dropout Voltage (Note 6)	V_{DROP}	I_{OUT} = 5mA	-	60	**180**	mV
		I_{OUT} = 100mA	-	170	-	mV
		I_{OUT} = 1A	-	400	**630**	mV
Ground Pin Current (Note 7)	I_{GND}	I_{OUT} = 5mA	-	250	**500**	μA
		I_{OUT} = 1A	-	16	**25**	mA
Ground Pin Current at Dropout	I_{GNDDO}	V_{IN} = 0.5V less than specified V_{OUT}, I_{OUT} = 5mA	-	1	-	mA
Current Limit	I_{CL}	V_{OUT} = 0V	-	1.5	-	A

Note 1. Exceeding the absolute maximum ratings may damage the device.
Note 2. The device is not guaranteed to function outside its operating ratings.
Note 3. Stresses listed as the absolute maximum ratings may cause permanent damage to the device. These are for stress ratings. Functional operating of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibly to affect device reliability.
Note 4. The minimum operating value for input voltage is equal to either ($V_{OUT,NOM}$ + V_{DROP}), whichever is greater.
Note 5. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
Note 6. Dropout voltage is defined as the minimum input to output differential voltage at which the output drops 1% below the nominal value.
Note 7. Ground current, or quiescent current, is the difference between input and output currents. It's defined by $I_{GND} = I_{IN} - I_{OUT}$ under the given loading condition. The total current drawn from the supply is the sum of the load current plus the ground pin current.

APPLICATION INFORMATION

Maximum Output Current Capability

The LM2940 can deliver a continuous current of 1A over the full operating junction temperature range. However, the output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 1A may be still undeliverable due to the restriction of the power dissipation of LM2940. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The temperatures over the device are given by:

$T_C = T_A + P_D \times \theta_{CA}$ / $T_J = T_C + P_D \times \theta_{JC}$ / $T_J = T_A + P_D \times \theta_{JA}$

where T_J is the junction temperature, T_C is the case temperature, T_A is the ambient temperature, P_D is the total power dissipation of the device, θ_{CA} is the thermal resistance of case-to-ambient, θ_{JC} is the thermal resistance of junction-to-case, and θ_{JA} is the thermal resistance of junction to ambient. The total power dissipation of the device is given by:

$$P_D = P_{IN} – P_{OUT} = (V_{IN} \times I_{IN})–(V_{OUT} \times I_{OUT})$$
$$= (V_{IN} \times (I_{OUT}+I_{GND})) – (V_{OUT} \times I_{OUT}) = (V_{IN} - V_{OUT}) \times I_{OUT} + (V_{IN} \times I_{GND})$$

where I_{GND} is the operating ground current of the device which is specified at the Electrical Characteristics. The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} – T_{Amax}$$

The maximum allowable value for junction-to-ambient thermal resistance, θ_{JA}, can be calculated using the formula:

$$\theta_{JA} = T_{Rmax} / P_D = (T_{Jmax} – T_{Amax}) / P_D$$

LM2940 is available in SOT-223-3L package. The thermal resistance depends on amount of copper area or heat sink, and on air flow. If the maximum allowable value of θ_{JA} calculated above is over 137°C/W for SOT-223-3L package, no heat sink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable θ_{JA} falls near or below these limits, a heat sink or proper area of copper plane is required. In summary, the absolute maximum ratings of thermal resistances are as follow:

Absolute Maximum Ratings of Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal Resistance Junction-To-Ambient / SOT-223-3L	$\theta_{JA\text{-}SOT\text{-}223\text{-}3L}$	137	°C/W
Thermal Resistance Junction-To-Ambient / TO-220-3L	$\theta_{JA\text{-}TO\text{-}220\text{-}3L}$	70	°C/W

No heat sink / No air flow / No adjacent heat source / T_A=25°C

REVISION NOTICE

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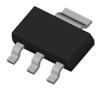
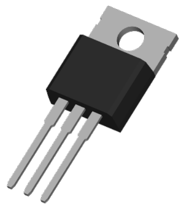
1.0A Low Dropout Voltage Regulator — LM2940H

FEATURES

- Operational VIN up to +26V
- +60V/−20V Voltage Transients
- Output Current in Excess 1.0A
- Dropout Voltage typically 0.4V @ I_{OUT} = 1.0A
- Reverse Battery Protection
- Internal Short Circuit Current Limit
- Available with 3.3V and 5.0V Output Voltage



SOT-223-3



TO-220-3

DESCRIPTION

The LM2940H fixed positive voltage regulator features the ability to source 1.0A of output current with a dropout voltage of typically 0.4V and a maximum of 0.7V over the entire temperature range.

Designed also for vehicular applications, the LM2940H and all regulated circuitry are protected from reverse battery installations or 2-battery jumps. During line transients, such as load dump when the input voltage can momentarily exceed the specified maximum operating voltage, the regulator will automatically shut down to protect both the internal circuits and load. Short circuit and thermal overload protection are also provided.

ORDERING INFORMATION

Device	Package
LM2940HS-x.x	SOT-223-3L
LM2940HT-x.x	TO-220-3L

xx: Output Voltage

ABSOLUTE MAXIMUM RATINGS (Note 1)

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
Input Voltage (Note 2)	V_{IN}	−20	60	V
Maximum Junction Temperature	T_J	-	150	°C
Storage Temperature	T_{STG}	−65	150	°C

Note 1. 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-rated conditions for extended periods may affect device reliability.

Note 2. Maximum positive supply voltage of 60V must be limited duration (< 100ms) and duty cycle (≤ 1%). The maximum continuous supply voltage is 26V.

RECOMMENDED OPERATING RATINGS (Note 3)

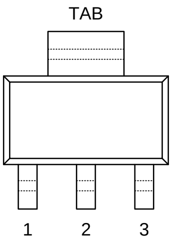
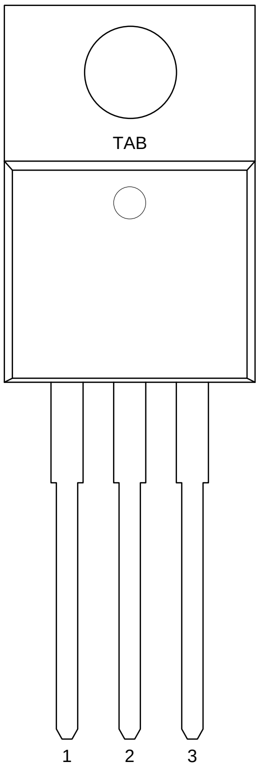
CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
Maximum Operating Input Voltage (Continuous)	V_{IN}	-	26	V
Operating Ambient Temperature Range	T_A	−40	85	°C
Operating Junction Temperature Range	T_J	−40	125	°C

Note 3. The device is not guaranteed to function outside its operating ratings.

ORDERING INFORMATION

VOUT	Package	Order No.	Supplied As	Status
3.3V	SOT-223-3L	LM2940HS-3.3	Tape & Reel	Active
	TO-220-3L	LM2940HT-3.3	Tube	Contact us
5.0V	SOT-223-3L	LM2940HS-5.0	Tape & Reel	Contact us
	TO-220-3L	LM2940HT-5.0	Tube	Contact us

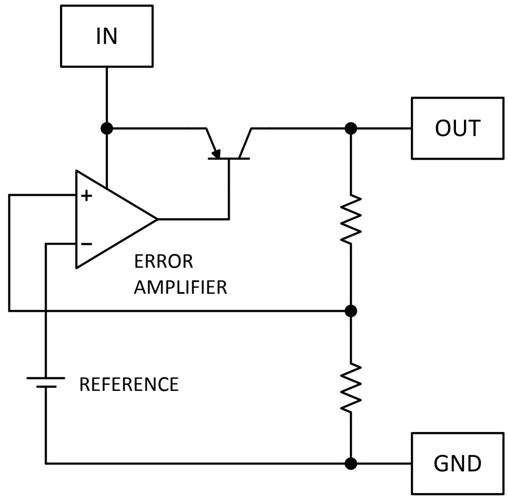
PIN CONFIGURATION

SOT-223	TO-220
	

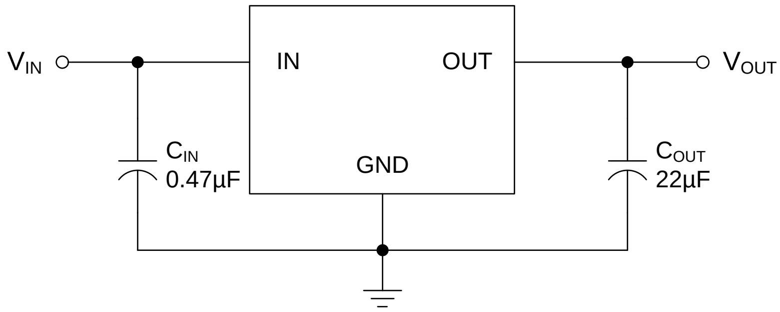
PIN DESCRIPTION

Pin No.		Pin Name	Pin Function
SOT-223	TO-220		
1	1	IN	Input Voltage
2	2	GND	Ground
3	3	OUT	Output Voltage
TAB	TAB	TAB	Connect to GND

BLOCK DIAGRAM



TYPICAL APPLICATION CIRCUITS



* C_{IN} required if regulator is located far from power supply filter.

** C_{OUT} must be at least 22µF to maintain stability. May be increased without bound to maintain regulation during transients. Located as close as possible to the regulator. This capacitor must be rated over the same operating temperature range as the regulator.

*** For the details, refer to the Application Information.

ELECTRICAL CHARACTERISTICS

The following specifications apply for T_J = 25°C; V_{IN} = V_{OUT} + 5.0V; I_{OUT} = 1.0A; C_{OUT} = 22µF, unless otherwise specified. **Boldface** type specifications apply over the full operating temperature range.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage (Note 4)	V_{OUT}	5.0mA ≤ I_{OUT} ≤ 1.0A,	−2.0	-	2.0	%
		(V_{OUT} + 1.0V) ≤ V_{IN} ≤ 26V	**−3.0**	-	**3.0**	
Line Regulation	LNR	I_{OUT} = 5.0mA, (V_{OUT} + 1.0V) ≤ V_{IN} ≤ 26V	-	0.06	0.5	%
Load Regulation (Note 4)	LDR	V_{IN} = V_{OUT} + 5.0V, 5.0mA ≤ I_{OUT} ≤ 1.0A		0.2	1.0	%
			-	-	**1.8**	
Quiescent Current	I_Q	I_{OUT} = 5.0mA	-	0.3	0.4	mA
			-	-	**0.5**	
		I_{OUT} = 1.0A	-	11	16	mA
			-	-	**20**	
Dropout Voltage	V_{DO}	I_{OUT} = 100mA	-	110	150	mV
			-	-	**230**	
		I_{OUT} = 1.0A	-	400	550	mV
			-	-	**700**	
Short Circuit Current	I_{SC}	V_{IN} = $V_{OUT(NOM)}$ + 1.0V, V_{OUT} = 0V	-	1.5	2.4	A
Output Noise Voltage	e_n	f= 10Hz to 100kHz	-	150	-	µVrms
Ripple Rejection	PSRR	f = 120Hz (1.0Vrms), I_{OUT} = 100mA	60	72	-	dB
Long Term Stability	$\Delta V_{OUT}/\Delta t$	t = 1000 hr	-	0.4	-	%
Reverse Polarity Transient Input Voltage		R_{OUT} = 100Ω, t ≤ 1ms	−35	-	-	V

Note 4. Parameters are measured at a constant junction temperature by low duty cycle pulse testing.

TYPICAL OPERATING CHARACTERISTICS

T.B.D.

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APPLICATION INFORMATION

The LM2940H regulator is suitable for Automotive and Industrial applications where continuous connection to a battery supply is required.

INPUT CAPACITOR

The LM2940H requires a low source impedance to maintain regulator stability because critical portions of the internal bias circuitry are connected to directly to IN pin. In general, a 0.47µF electrolytic capacitor, located within two inches of the regulator, is adequate for a majority of applications. Additionally, and at a minimum, a 0.1µF ceramic capacitor would be located between the LM2940H IN pin and GND pin, and as close as is physically possible to the regulator itself.

OUTPUT CAPACITOR

An output bypass capacitor is required for stability. This capacitance must be placed between the OUT pin and GND pin, as close as is physically possible, using traces that are not part of the load current path.
The output capacitor must meet the requirements for minimum capacitance across the entire operating ambient temperature range. There is no limit to the maximum output capacitance.
The minimum bypass capacitance for the output is 22µF. A 22µF, or larger output bypass capacitor is recommended for typical applications.
Solid tantalums capacitors are recommended as they generally maintain capacitance over a wide temperature range.

THERMAL PROTECTION

Device operational range is limited by the maximum junction temperature (T_J). The junction temperature is influenced by the ambient temperature (T_A), package selection, input voltage (V_{IN}), and the output load current. When operating with maximum load currents the input voltage and/or ambient temperature will be limited.
Even though the LM2940H is equipped with circuitry to protect itself from excessive thermal dissipation, it is not recommended that the LM2940H be operated at, or near, the maximum recommended die junction temperature (T_J) as this may impair long term device reliability.
The thermal protection circuitry monitors the temperature at the die level. When the die temperature exceeds typically 160°C the voltage regulator output will be switched off.

MAXIMUM OUTPUT CURRENT CAPABILITY

The LM2940H can deliver a continuous current of 1.0A over the full operating temperature range. However, the output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 1A may be still undeliverable due to the restriction of the power dissipation of LM2940H. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The temperatures over the device are given by:

$$T_C = T_A + P_D \times \theta_{CA} \quad / \quad T_J = T_C + P_D \times \theta_{JC} \quad / \quad T_J = T_A + P_D \times \theta_{JA}$$

where T_J is the junction temperature, T_C is the case temperature, T_A is the ambient temperature, P_D is the total power dissipation of the device, θ_{CA} is the thermal resistance of case-to-ambient, θ_{JC} is the thermal resistance of junction-to-case, and θ_{JA} is the thermal resistance of junction to ambient. The total power dissipation of the device is given by:

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$P_D = P_{IN} - P_{OUT} = (V_{IN} \times I_{IN}) - (V_{OUT} \times I_{OUT})$

$= (V_{IN} \times (I_{OUT} + I_{GND})) - (V_{OUT} \times I_{OUT}) = (V_{IN} - V_{OUT}) \times I_{OUT} + (V_{IN} \times I_{GND})$

where I_{GND} is the operating ground current of the device which is specified at the Electrical Characteristics. The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$T_{Rmax} = T_{Jmax} - T_{Amax}$

The maximum allowable value for junction-to-ambient thermal resistance, θ_{JA}, can be calculated using the formula:

$\theta_{CA} = T_{Rmax} / P_D = (T_{Jmax} - T_{Amax}) / P_D$

The thermal resistance depends on amount of copper area or heat sink, and on air flow. If the maximum allowable value of θ_{JA} calculated above is over its rating of a package, no heat sink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable θ_{JA} falls near or below these limits, a heat sink or proper area of copper plane is required. The absolute maximum ratings of thermal resistances are as follow:

CHARACTERISTICS	SYMBOL	RATING	UNIT
Thermal Resistance Junction-To-Ambient / SOT-223-3L	$\theta_{JA\text{-}SOT\text{-}223\text{-}3L}$	137	°C/W
Thermal Resistance Junction-To-Ambient / TO-220-3L	$\theta_{JA\text{-}TO\text{-}220\text{-}3L}$	70	°C/W

No heat sink / No air flow / No adjacent heat source / T_A=25°C

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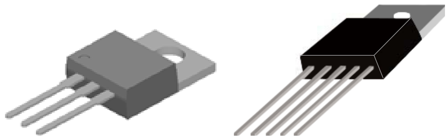
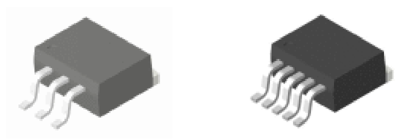
FEATURES

- 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

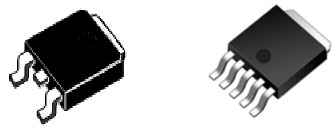
TO-220 3L / 5L PKG



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

APPLICATION

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

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)

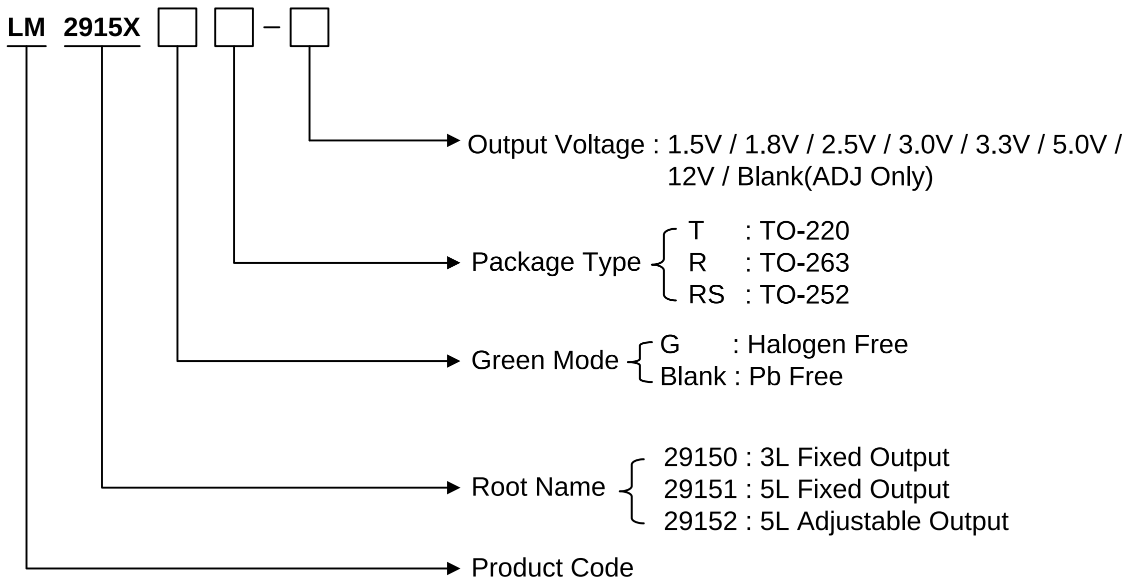
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Operating Input Voltage	V_{IN}	-	+ 26	V
Operating Enable Input Voltage	V_{EN}	-	+ 26	V
Junction Temperature	T_J	- 40	+ 125	℃

Ordering Information

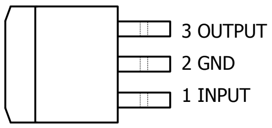
V_{OUT}	Package	Order No.	Description	Supplied As	Status
1.5 V	TO-220 3L	LM29150T-1.5	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-1.5	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-1.5	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-1.5	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-1.5	1.5A,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

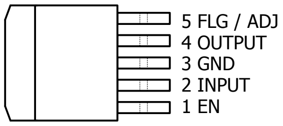
V_{OUT}	Package	Order No.	Description	Supplied As	Status
5.0 V	TO-220 3L	LM29150T-5.0	1.5A, Fixed	Tube	Active
	TO-220 5L	LM29151T-5.0	1.5A, Fixed, Enable	Tube	Active
	TO-263 3L	LM29150R-5.0	1.5A, Fixed	Reel	Active
	TO-263 5L	LM29151R-5.0	1.5A, Fixed, Enable	Reel	Active
	TO-252 3L	LM29150RS-5.0	1.5A, 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



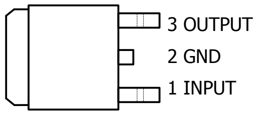
PIN CONFIGURATION



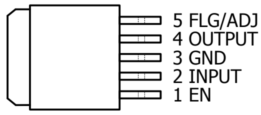
TO-263 3L



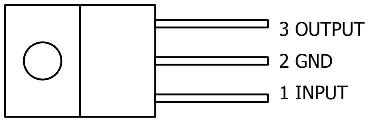
TO-263 5L



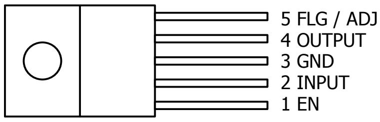
TO-252 3L



TO-252 5L



TO-220 3L



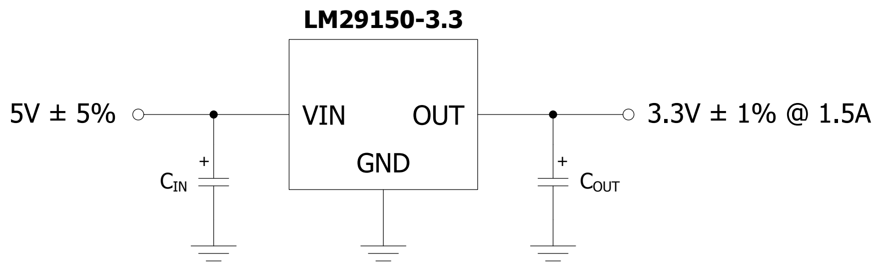
TO-220 5L

PIN DESCRIPTION

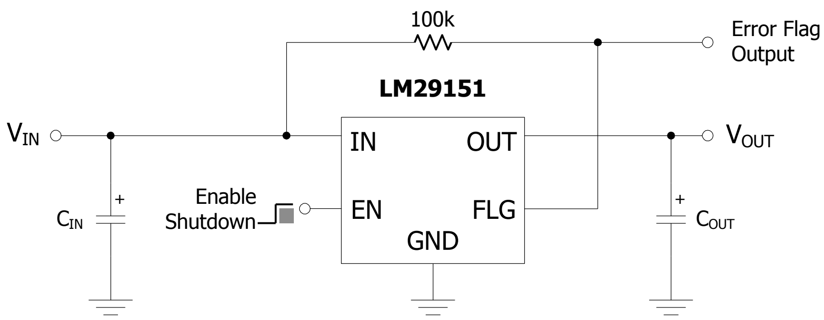
Pin No.	TO-220 / TO-263 / TO-252 3L **(for LM29150)**		TO-220 / TO-263 / TO-252 5L **(for LM29151/2)**	
	Name	Function	Name	Function
1	V_{IN}	Input Supply	EN	Chip Enable
2	GND	Ground	V_{IN}	Input Supply
3	V_{OUT}	Output Voltage	GND	Ground
4	-	-	V_{OUT}	Output Voltage
5	-	-	FLG / ADJ	Error Flag Output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

TYPICAL APPLICATION

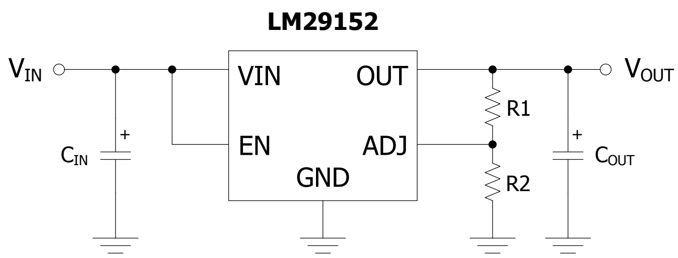
– Typical Fixed Output Application



– Typical Fixed Output Application with Error Flag



– Typical Adjustable Output Application



$V_{OUT} = V_{REF}$ x [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.

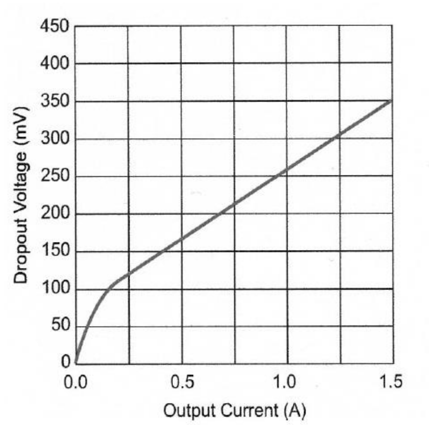
Note 8. $V_{REF} \leq V_{OUT} \leq (V_{IN} -1V)$, 2.3V $\leq V_{IN} \leq$ 26V, 10mA < I_L < I_{FL}, T_J < T_J Max.

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.

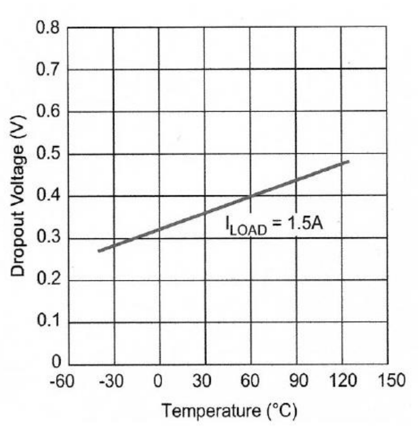
Note 10. $V_{EN} \leq$ 0.8V and $V_{IN} \leq$26V, V_{OUT} =0.

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.

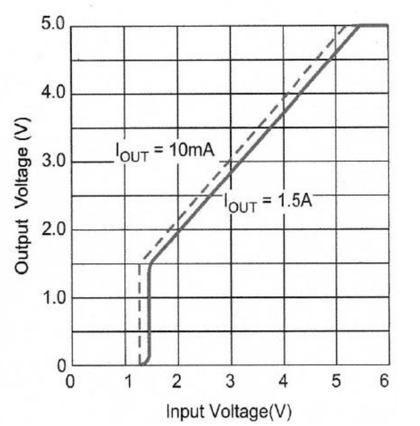
TYPICAL OPERATING CHARACTERISTICS



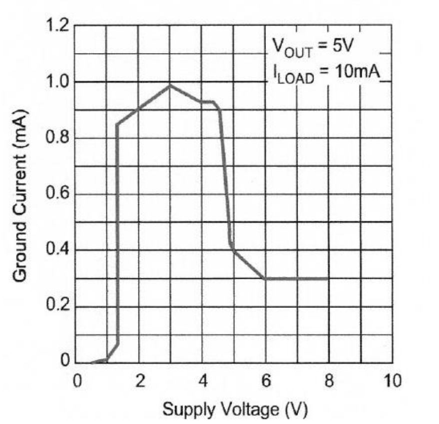
LM29150 Dropout Voltage vs, Output



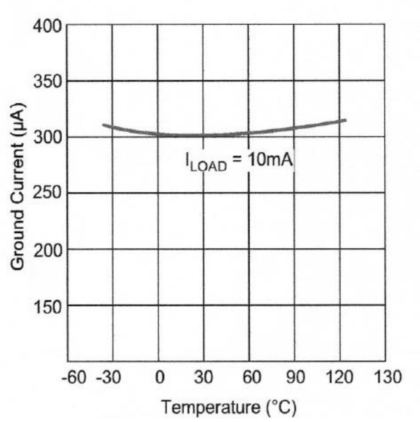
LM29150 Dropout Voltage vs, Temperature



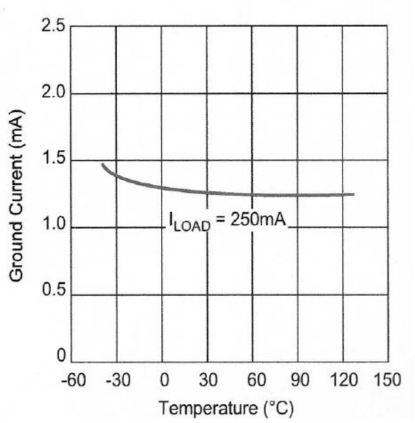
LM29150-5.0 Dropout Characteristics



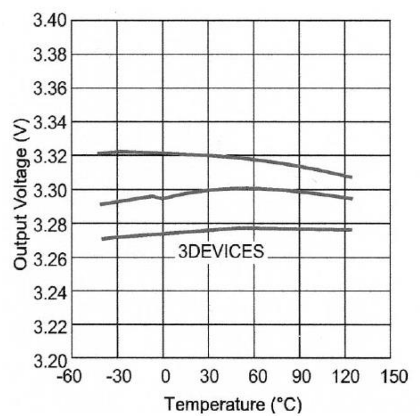
LM29150 Ground Current vs, Supply Voltage



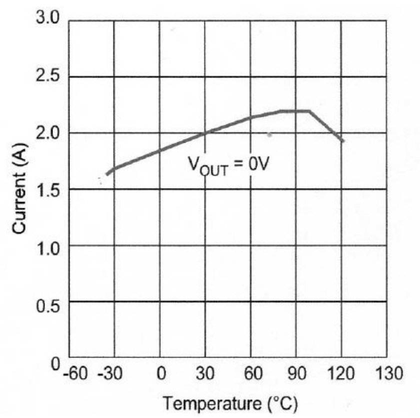
LM29150 Ground Current vs, Temperature



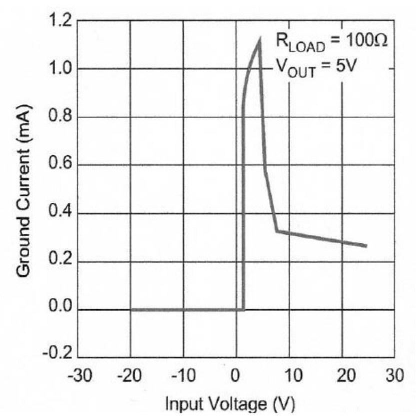
LM29150 Ground Current vs, Temperature



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.

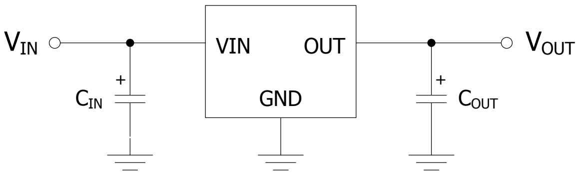


Figure 1. Linear regulators require only two capacitors for operation.

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.

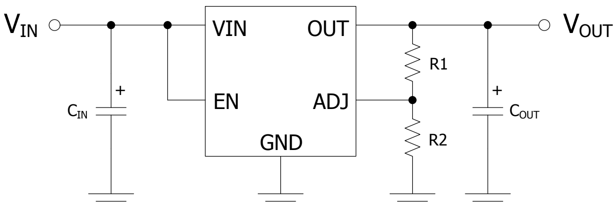
Adjustable Regulator Design

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

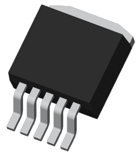
LM29151 and LM29152 versions feature and enable (EN) input that allows ON/OFF control of the device. Special design allows "zero" current drain when the device is disabled-only microamperes of leakage current flows. The EN input has TTL/CMOS compatible thresholds for simple interfacing with logic, or may be directly tied to ≤ 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.

FEATURES

- Guaranteed Output Current of 1.5A
- Very Low Dropout Voltage
- Accurate 1% Initial Tolerance
- Good Line and Load Regulation
- Extremely Fast Transient Response
- Reverse-Battery/ Load-Dump Protection
- Adjustable Output Voltage up to 25V
- TTL/CMOS Compatible Enable Logic
- Over-Temperature/Over-Current Protection
- Available in TO-263-5L Package
- Moisture Sensitivity Level 3



TO-263-5

APPLICATIONS

- Battery Powered Equipment
- Automotive Electronics
- High Efficiency Linear Power Supplies
- High Efficiency Post Regulator for Switching Supply

ORDERING INFORMATION

Device	Package
TPS7A4501R	TO-263-5L

DESCRIPTION

The TPS7A4501 is a high current, high accuracy, and low-dropout voltage regulator. 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.

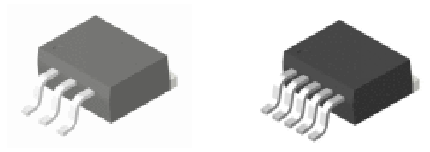
The TPS7A4501 is fully protected against over current faults, reversed input polarity, reversed lead insertion, over temperature operation, and positive and negative transient voltage spikes. TPS7A4501 features logic level enable control and an error flag which signals whenever the output falls out of regulation. The EN pin may be tied to VIN if it is not required for On/Off control.

Please contact us for more information about this product.

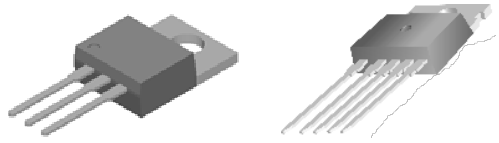
FEATURES

- Guaranteed Output Current of 3.0A
- Fixed Output Voltage: 1.5V, 1.8V, 2.5V, 3.3V and 5.0V
- 1% initial accuracy
- Low ground current
- Over-Temperature/Over-Current Protection
- Fast transient response
- TTL/CMOS compatible enable pin ➔ LM39301
- Error flag output - LM39301 only
- Available in TO-263 and TO-220 packages
- - 40℃ to 125℃ Junction Temperature Range
- Moisture Sensitivity Level 3

TO-263 3L/ 5L PKG



TO-220 3L/ 5L PKG



ORDERING INFORMATION

Device	Package
LM39300R-X.X	TO-263 3L
LM39300T-X.X	TO-220 3L
LM39301R-X.X	TO-263 5L
LM39301T-X.X	TO-220 5L
LM39302R-ADJ	TO-263 5L
LM39302T-ADJ	TO-220 5L

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

APPLICATION

- Battery Powered Equipments
- Motherboards and Graphic Cards
- Microprocessor Power Supplies
- Peripheral Cards
- High Efficiency Linear Regulators
- Battery Chargers

DESCRIPTION

The LM39300, LM39301 and LM39302 are 3.0A low-dropout linear voltage regulators that provide a low voltage, high-current output with a minimum of external components. The LM39300/1 offers extremely low dropout (typically 400mV at 3.0A) and low ground current (typically 36mA at 3.0A). The LM39300/1/2 is ideal for PC add-in cards that need to convert from standard 5V or 3.3V down to new, lower core voltages. A guaranteed maximum dropout voltage of 500mV over all operating conditions allows the LM39300/1/2 to provide 2.5V from a supply as low as 3V. The LM39300/1/2 also has fast transient response for heavy switching applications. The device requires only 47uF of output capacitance to maintain stability and achieve fast transient response. The LM39300/1 is fully protected with over current limiting, thermal shutdown, reversed-battery protection, reversed-leakage protection, and reversed-lead insertion. The LM39301 offers a TTL-logic compatible enable pin and an error flag that indicates under voltage and over current conditions. Offered in fixed voltages, the LM39300/1/2 comes in the TO-220 and TO-263 packages and is an ideal upgrade to older, NPN-based linear voltage regulators.

ABSOLUTE MAXIMUM RATINGS (Note 1)

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage	V_{IN}	- 0.3	+ 20	V
Enable Voltage	V_{EN}	-	+ 20	V
Output Voltage	V_{OUT}	-0.3	V_{IN} +0.3	V
Lead Temperature (Soldering, 5 sec)	T_{SOL}	-	260	℃
Storage Temperature Range	T_{STG}	-65	+ 150	℃

OPERATING RATINGS (Note 2)

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage	V_{IN}	+ 2.5	+ 16	V
Enable Voltage	V_{EN}	+ 2.5	+ 16	V
Maximum Power Dissipation	$PD_{(max)}$	(Note 3)	(Note 3)	
Junction Temperature	T_J	-40	+ 125	℃
Package Thermal Resistance	$\theta_{JA\text{-}TO\text{-}263}$	80		℃/W
	$\theta_{JA\text{-}TO\text{-}220}$	70		℃/W

ORDERING INFORMATION

V_{OUT}	Package	Order No.	Description	Supplied As	Status
1.5 V	TO-263 3L	LM39300R-1.5	3A, Fixed	Reel	Active
	TO-263 3L	LM39300GR-1.5	3A, Fixed	Reel	Obsolete
	TO-263 5L	LM39301R-1.5	3A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39301GR-1.5	3A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39300T-1.5	3A, Fixed	Reel	Active
	TO-220 5L	LM39301T-1.5	3A, Fixed, Enable	Reel	Obsolete
1.8V	TO-263 3L	LM39300R-1.8	3A, Fixed	Reel	Active
	TO-263 3L	LM39300GR-1.8	3A, Fixed	Reel	Obsolete
	TO-263 5L	LM39301R-1.8	3A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39301GR-1.8	3A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39300T-1.8	3A, Fixed	Reel	Active
	TO-220 5L	LM39301T-1.8	3A, Fixed, Enable	Reel	Active
2.5 V	TO-263 3L	LM39300R-2.5	3A, Fixed	Reel	Active
	TO-263 3L	LM39300GR-2.5	3A, Fixed	Reel	Obsolete
	TO-263 5L	LM39301R-2.5	3A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39301GR-2.5	3A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39300T-2.5	3A, Fixed	Reel	Active
	TO-220 5L	LM39301T-2.5	3A, Fixed, Enable	Reel	Active
3.3 V	TO-263 3L	LM39300R-3.3	3A, Fixed	Reel	Active
	TO-263 3L	LM39300GR-3.3	3A, Fixed	Reel	Obsolete
	TO-263 5L	LM39301R-3.3	3A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39301GR-3.3	3A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39300T-3.3	3A, Fixed	Reel	Active
	TO-220 5L	LM39301T-3.3	3A, Fixed, Enable	Reel	Active
5.0 V	TO-263 3L	LM39300R-5.0	3A, Fixed	Reel	Active
	TO-263 3L	LM39300GR-5.0	3A, Fixed	Reel	Obsolete
	TO-263 5L	LM39301R-5.0	3A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39301GR-5.0	3A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39300T-5.0	3A, Fixed	Reel	Active
	TO-220 5L	LM39301T-5.0	3A, Fixed, Enable	Reel	Active
ADJ	TO-263 5L	LM39302R	3A, Adjustable, Enable	Reel	Active
	TO-263 5L	LM39302GR	3A, Adjustable, Enable	Reel	Obsolete
	TO-220 5L	LM39302T	3A, Adjustable, Enable	Reel	Active

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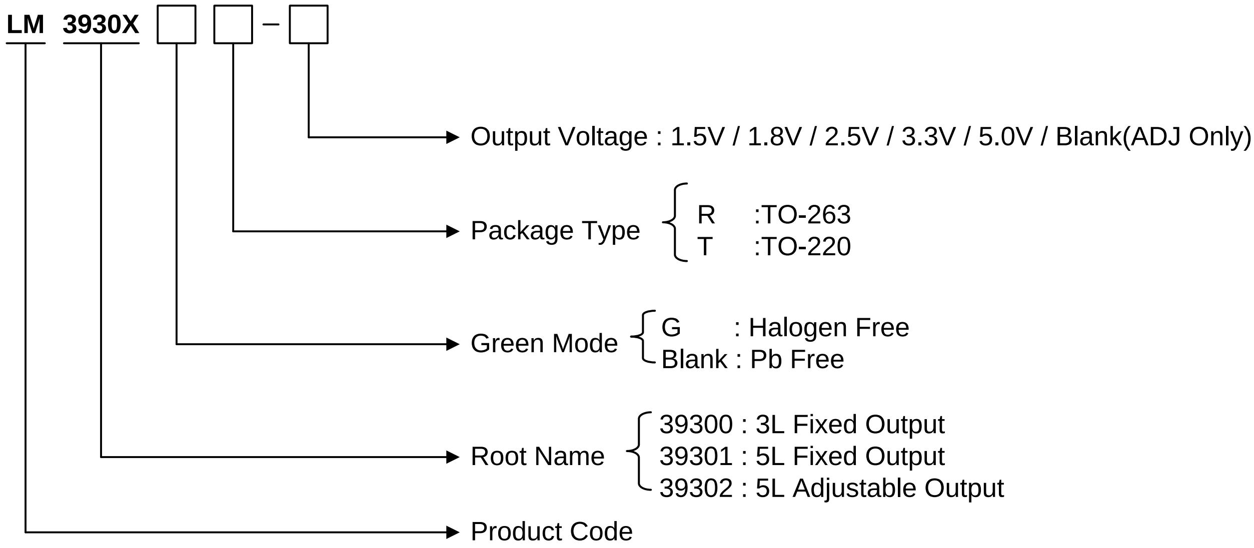
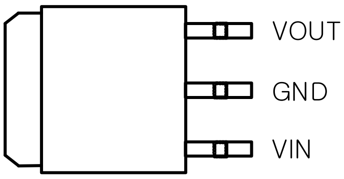
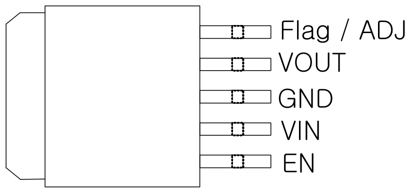


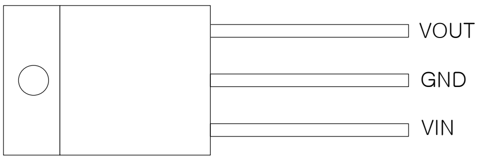
PIN CONFIGURATION



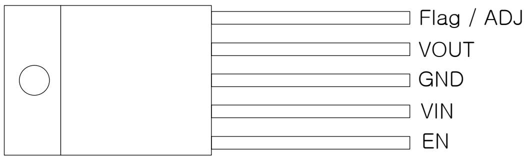
TO263-3L



TO263-5L



TO220-3L

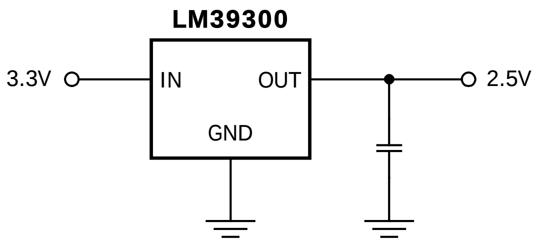


TO220-5L

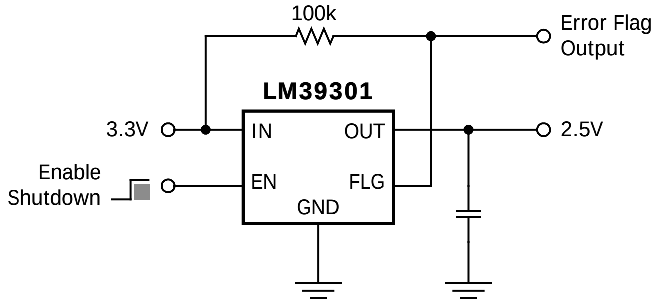
PIN DESCRIPTION

Pin No.	TO-263 3L / TO-220 3L **(for 39300)**		TO-263 5L / TO-220 5L **(for 39301/2)**	
	Name	Function	Name	Function
1	VIN	Input Supply	EN	Chip Enable
2	GND	Ground	VIN	Input Supply
3	VOUT	Output Voltage	GND	Ground
4			VOUT	Output Voltage
5			FLG / ADJ	Error Flag Output or Output Adjust

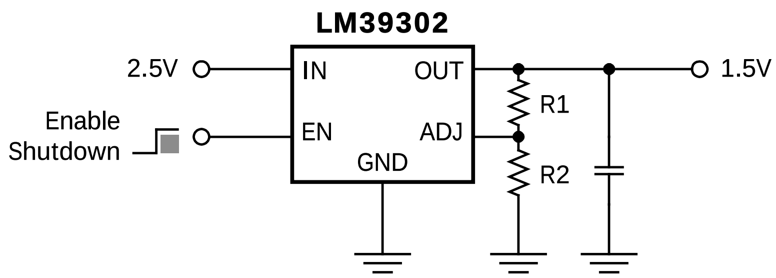
TYPICAL APPLICATION



2.5V / 3A Regulator



2.5V / 3A Regulator with Error Flag



1.5V / 3A Adjustable Regulator

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Site Web : www.es-france.com

ELECTRICAL CHARACTERISTICS

$V_{IN}= V_{OUT}$ +1V; V_{EN} = 2.5V; T_J = 25°C, **bold** values indicate -40°C ≤ T_J ≤ +125°C; unless noted

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	10mA 10mA ≤ I_{OUT} ≤ 3A, V_{OUT}+1V ≤ V_{IN} ≤8V	-1 **-2**		1 **2**	% %
	Line Regulation	I_{OUT}=10mA, V_{OUT} +1V ≤ V_{IN} ≤ 8V		0.06	0.5	%
	Load Regulation	$V_{IN}= V_{OUT}$ +1V, 10mA ≤ I_{OUT} ≤ 3A		0.2	1	%
$\Delta V_{OUT}/\Delta T$	Output Voltage Temp. Coefficient (Note 4)			**20**	**100**	ppm/ °C
V_{DO}	Dropout Voltage (Note 5)	I_{OUT}=100mA, ΔV_{OUT} = -1%		80	**200**	mV mV
		I_{OUT}=750mA, ΔV_{OUT} = -1%		200		mV
		I_{OUT}=1.5A, ΔV_{OUT} = -1%		320		mV
		I_{OUT}=3.0A, ΔV_{OUT} = -1%		400	**500**	mV mV
I_{GND}	Ground Current (Note6)	I_{OUT}=750mA, $V_{IN}= V_{OUT}$+1V		10	20	mA
		I_{OUT}=1.5A, $V_{IN}= V_{OUT}$+1V		17		mA
		I_{OUT}=3.0A, $V_{IN}= V_{OUT}$+1V		45		mA
$I_{OUT(lim)}$	Current Limit	V_{OUT}=0V, V_{IN}=V_{OUT}+1V		4.5		A

Enable Input

V_{EN}	Enable Input Voltage	logic low (off)			**0.8**	V
		logic high (on)	**2.5**			V
I_{EN}	Enable Input Current	$V_{EN}= V_{IN}$		15	30 **75**	μA μA
		V_{EN}=0.8V			2 **4**	μA μA
$I_{OUT(shdn)}$	Shutdown Output Current	(Note7)		10	20	uA

Flag Output

$I_{FLG\ (leak)}$	Output Leakage Current	V_{OH}=16V		0.01	1 **2**	μA μA
$V_{FLG\ (do)}$	Output Low Voltage	V_{IN}=2.5V, I_{OL}=250μA, (Note8)		220	300 **400**	mV mV
V_{FLG}	Low Threshold	% of V_{OUT}	93			%
	High Threshold				99.2	%
	Hysteresis			1		%

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LM39302 Only

	Reference Voltage	(Note9)	1.228 **1.215**	1.240	1.252 **1.265**	V V
	Adjust Pin Bias Current			40	80 **120**	nA nA
	Reference Voltage Temp. Coefficient			20		ppm/ °C
	Adjust Pin Bias Current Temp. Coefficient			0.1		nA/ °C

Note 1. Exceeding the absolute maximum ratings may damage the device.

Note 2. The device is not guaranteed to function outside its operating rating.

Note 3. PD (max)= ($T_{J\ (max)}$ - T_A) ÷ θ_{JA}, where θ_{JA} -junction-to-ambient thermal resistance.

Note 4. Output voltage temperature coefficient is ΔV_{OUT} (worst case) ÷ ($T_{J(max)}$ - $T_{J(min)}$) where $T_{J(max)}$ is +125°C and $T_{J(min)}$ is 0°C.

Note 5. V_{DO} = V_{IN} - V_{OUT} when V_{OUT} decreases to 99% of its nominal output voltage with V_{IN} = V_{OUT} + 1V. 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.

Note 6. I_{GND} is the quiescent current. I_{IN} = I_{GND} + I_{OUT}.

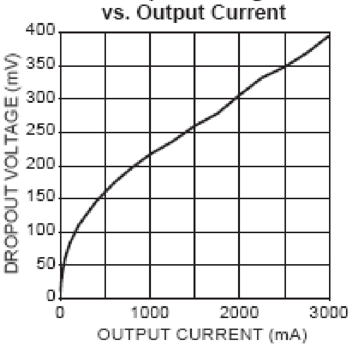
Note 7. V_{EN} =0.8V, V_{IN} = 8V, V_{OUT} = 0V

Note 8. For a 2.5V device, V_{IN} = 2.5V (device is in dropout).

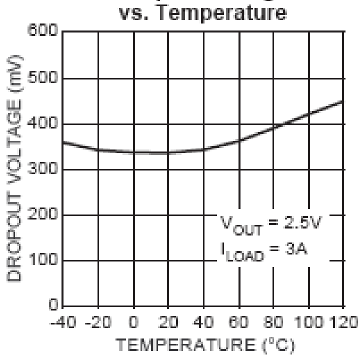
Note 9. $V_{REF} \le V_{OUT} \le (V_{IN} - 1V)$, $2.5V \le V_{IN} \le 16V$, $10mA \le I_L \le 3A$.

TYPICAL OPERATING CHARACTERISTICS

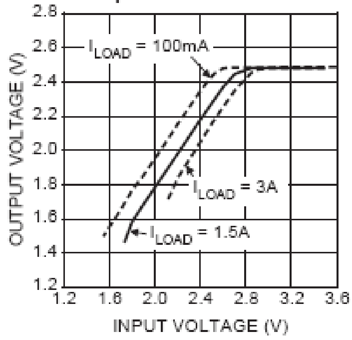
Dropout Voltage vs. Output Current



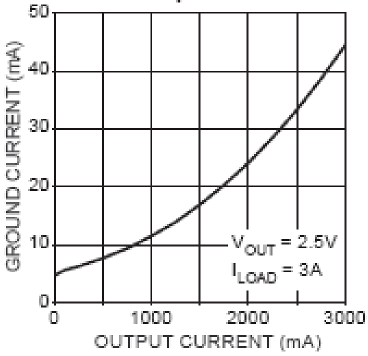
Dropout Voltage vs. Temperature



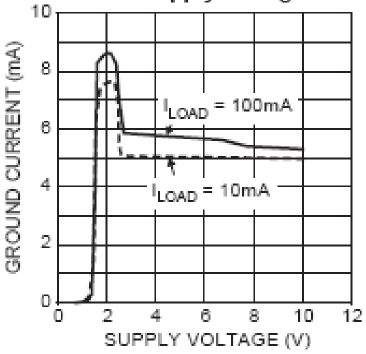
Dropout Characteristics



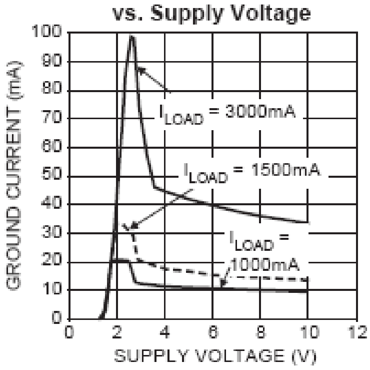
Ground Current vs. Output Current



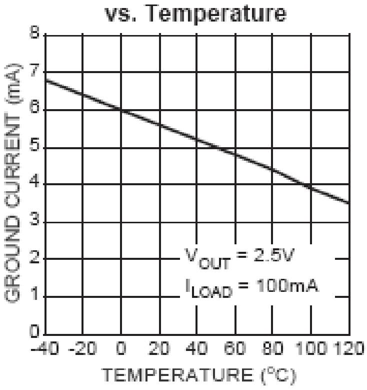
Ground Current vs. Supply Voltage



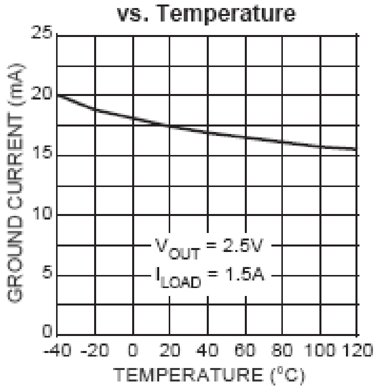
Ground Current vs. Supply Voltage



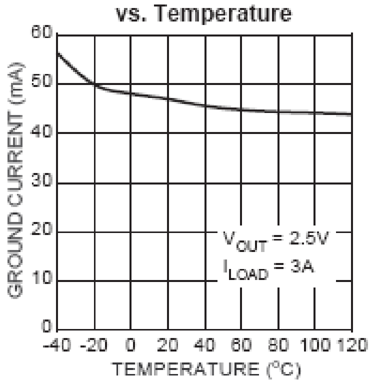
Ground Current vs. Temperature



Ground Current vs. Temperature



Ground Current vs. Temperature



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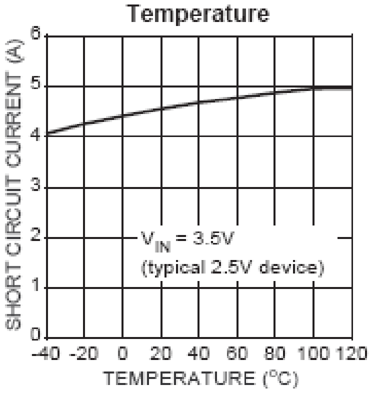
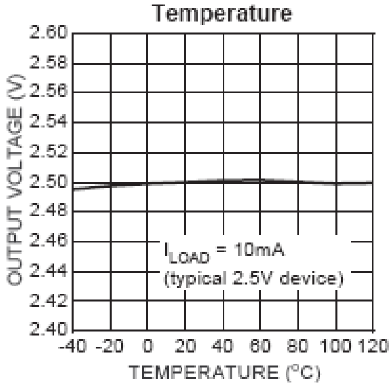
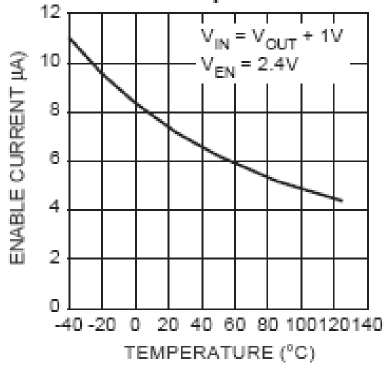
Short Circuit vs. Temperature



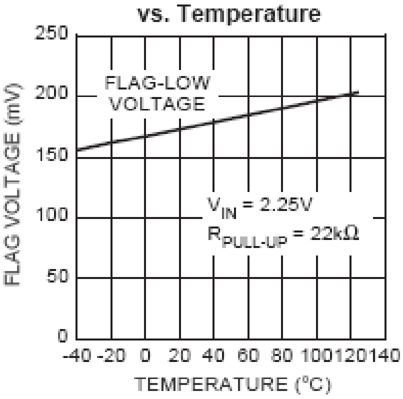
Output Voltage vs. Temperature



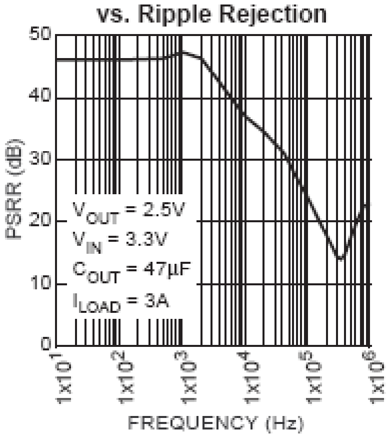
Enable Current vs. Temperature



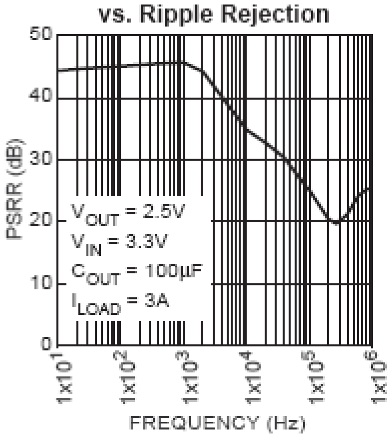
Flag-Low Voltage vs. Temperature



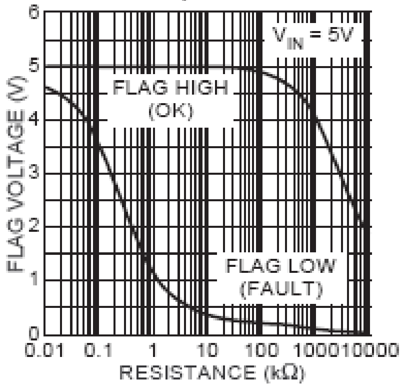
Power Supply vs. Ripple Rejection



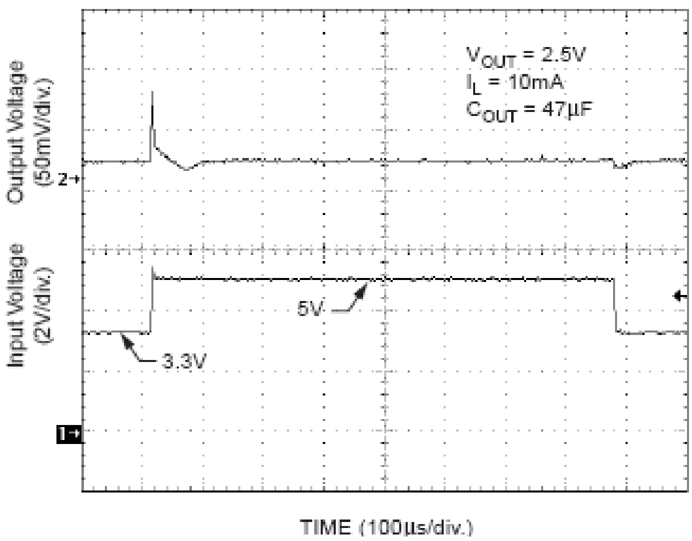
Power Supply vs. Ripple Rejection



Error Flag Pull-Up Resistor



Line Transient Response



APPLICATION INFORMATION

The LM39300/1 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 as a high-efficiency noise filter in post-regulator applications. Unlike older NPN-pass transistor designs, where the mini-mum dropout voltage is limited by the base-to-emitter voltage drop and collector-to-emitter saturation voltage, dropout performance of the PNP output of these devices is limited only by the low VCE saturation voltage. A trade-off for the low dropout voltage is a varying base drive requirement. The LM39300/1/2 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 maximum safe operating temperature. Transient protection 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

The LM39300/1/2 requires an output capacitor to maintain stability and improve transient response. Proper capacitor selection is important to ensure proper operation. The LM39300/1/2 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 1 of ESR. This will improve transient response as well as promote stability. Ultralow ESR capacitors, such as ceramic chip capacitors may promote instability. These very low ESR levels may cause an oscillation and/or under damped transient response. A low-ESR solid tantalum capacitor works extremely well and provides good transient response and stability over temperature. Aluminum electrolytic can also be used, as long as the ESR of the capacitor is < 1.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

An input capacitor of 1uF or greater is recommended when the device is more than 4 inches away from the bulk ac supply capacitance, or when the supply is a battery. Small, surface-mount, ceramic chip capacitors can be 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 LM39300/1/2 regulator 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 is necessary for proper regulation.

Transient Response and 3.3V to 2.5V Conversion

The LM39300/1/2 has excellent transient response to variations 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 de-signs. When converting from 3.3V to 2.5V, the NPN-based 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 LM39300/1/2 regulator will provide excellent performance with an input as low as 3.0V. This gives the PNP-based regulators a distinct advantage over older, NPN-based linear regulator.

Error Flag

The LM39301 version features an error flag circuit which monitors the output voltage and signals an error condition when the voltage drops 5% below the nominal output voltage. The error flag is an open-collector output that can sink 10mA during a fault condition. Low output voltage can be caused by a number of problems, including an over current fault (device in current limit) or low input voltage. The flag is inoperative during over temperature shutdown.

Enable Input

The LM39301 version features an enable input for on/off control of the device. Its shutdown state draws “zero” current (only microamperes of leakage). The enable input is TTL/ CMOS compatible for simple logic interface, but can be connected to up to 20V. When enabled, it draws approximately 15A.

Adjustable Regulator Design

The LM39302 allows programming the output voltage any-where between 1.24V and the 16V 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/1.240-1)
Where VO is desired output voltage. Figure 1 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see below).

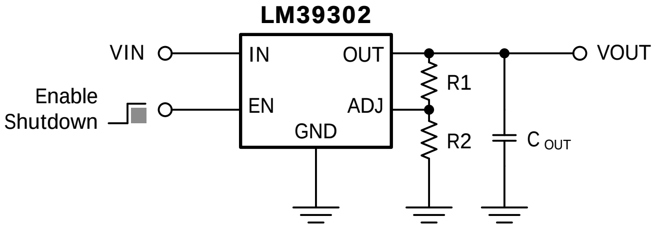


Figure 1. Adjustable Regulator with Resistors

Maximum Output Current Capability

The LM39300/1/2 can deliver a continuous current of 3A over the full operating junction temperature range. However, the output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 3A may be still undeliverable due to the restriction of the power dissipation of LM39300/1/2. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The temperatures over the device are given by:

$T_C = T_A + P_D \times \theta_{CA}$ / $T_J = T_C + P_D \times \theta_{JC}$ / $T_J = T_A + P_D \times \theta_{JA}$

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Where T_J is the junction temperature, T_C is the case temperature, T_A is the ambient temperature, P_D is the total power dissipation of the device, θ_{CA} is the thermal resistance of case-to-ambient, θ_{JC} is the thermal resistance of junction-to-case, and θ_{JA} is the thermal resistance of junction to ambient. The total power dissipation of the device is given by:

$$P_D = P_{IN} - P_{OUT} = (V_{IN} \times I_{IN}) - (V_{OUT} \times I_{OUT})$$
$$= (V_{IN} \times (I_{OUT}+I_{GND})) - (V_{OUT} \times I_{OUT}) = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

Where I_{GND} is the operating ground current of the device which is specified at the Electrical Characteristics. The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} - T_{Amax}$$

The maximum allowable value for junction-to-ambient thermal resistance, θ_{JA}, can be calculated using the formula:

$$\theta_{JA} = T_{Rmax} / P_D = (T_{Jmax} - T_{Amax}) / P_D$$

LM39300/1/2 is available in TO-263 and TO-220 package. The thermal resistance depends on amount of copper area or heat sink, and on air flow. If the maximum allowable value of θ_{JA} calculated above is over 80°C/W for TO-263 package, 70°C/W for TO-220 package, no heat sink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable θ_{JA} falls near or below these limits, a heat sink or proper area of copper plane is required. In summary, the absolute maximum ratings of thermal resistances are as follow:

Absolute Maximum Ratings of Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal Resistance Junction-To-Ambient / TO-263	$\theta_{JA\text{-}TO\text{-}263}$	80	°C/W
Thermal Resistance Junction-To-Ambient / TO-220	$\theta_{JA\text{-}TO\text{-}220}$	70	°C/W

No heat sink / No air flow / No adjacent heat source / 20 mm^2 copper area. (T_A=25°C)

3A Very Low Dropout Voltage Regulator TPS75701

FEATURES

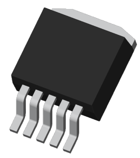
- Guaranteed Output Current of 3.0A
- Very Low Dropout Voltage
- 1% Initial Accuracy
- Good Line and Load Regulation
- Fast Transient Response
- Adjustable Output Voltage up to 15V
- TTL/CMOS Compatible Enable Logic
- Over-Temperature/Over-Current Protection
- −40°C to 125°C Junction Temperature Range
- Available in TO-263-5L Package
- Moisture Sensitivity Level 3

APPLICATIONS

- Battery Powered Equipment
- Motherboards and Graphic Cards
- Microprocessor Power Supplies
- Peripheral Cards
- High Efficiency Linear Regulators
- Battery Chargers

DESCRIPTION

The TPS75701 is 3.0A low-dropout linear voltage regulators that provide a low voltage, high-current output with a minimum of external components. The TPS75701 offers extremely low dropout (typically 400mV at 3.0A) and low ground current (typically 36mA at 3.0A). The TPS75701 is ideal for PC add-in cards that need to convert from standard 5V or 3.3V down to new, lower core voltages. A guaranteed maximum dropout voltage of 500mV over all operating conditions allows the TPS75701 to provide 2.5V from a supply as low as 3V. The TPS75701 also has fast transient response for heavy switching applications. The device requires only 47µF of output capacitance to maintain stability and achieve fast transient response. The TPS75701 is fully protected with over current limiting, thermal shutdown, reversed-battery protection, reversed-leakage protection, and reversed-lead insertion. The TPS75701 offers a TTL-logic compatible enable pin. The TPS75701 comes in the TO-263 package and is an ideal upgrade to older, NPN-based linear voltage regulators.



TO-263-5

ORDERING INFORMATION

Device	Package
TPS75701R	TO-263-5L

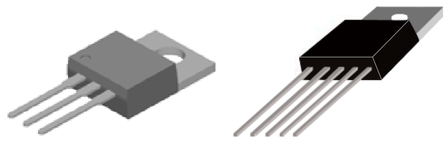
Please contact us for more information about this product.

3.0A Very Low Dropout Linear Regulator LM29300/29301/29302

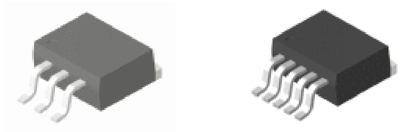
FEATURES

- High Current Capability 3.0A
- Low Dropout Voltage 370mV (Typical)
- 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 (LM29301)
- Also Characterized for Smaller Loads with Industry Leading Performance specifications
- Fixed Voltage and Adjustable Versions
- Moisture Sensitivity Level 3

TO-220 3L/ 5L PKG



TO-263 3L/ 5L PKG



APPLICATION

- Battery Powered Equipment
- High-Efficiency “Green” Computer System
- Automotive Electronics
- High-Efficiency Linear Power Supplies
- High-Efficiency Post-Regulator for Switching Supply

ORDERING INFORMATION

Device	Package
LM29300T-X.X	TO-220 3L / 5L
LM29301T-X.X	
LM29302T	
LM29300R-X.X	TO-263 3L / 5L
LM29301R-X.X	
LM29302R	

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

DESCRIPTION

The LM29300, LM29301 and LM29302 are high current, high accuracy, and low-dropout voltage regulators. Using process with a PNP pass element, these regulators feature 370mV (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 LM29300, LM29301 and LM29302 are fully protected against over current faults, reversed input polarity, reversed lead insertion, over temperature operation, and positive and negative transient voltage spikes. LM29301 features logic level enable control and an error flag which signals whenever the output falls out of regulation. On the LM29301 and LM29302, 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	°C
Storage Temperature Range	T_{STG}	-65	150	°C

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.

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
Operating Junction Temperature	T_J	-40	125	°C

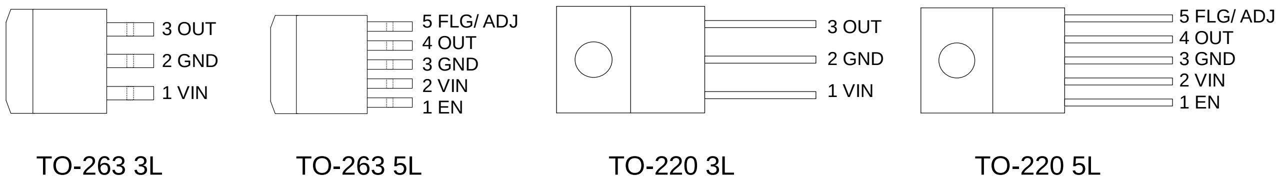
ORDERING INFORMATION

VOUT	Package	Order No.	Description	Supplied As	Status
ADJ	TO-220 5L	LM29302T	3.0A, Adjustable, Enable	Tube	Active
	TO-263 5L	LM29302R	3.0A, Adjustable, Enable	Reel	Active
1.5 V	TO-220 3L	LM29300T-1.5	3.0A, Fixed	Tube	Contract Us
	TO-220 5L	LM29301T-1.5	3.0A, Fixed, Enable, Flag	Tube	Contract Us
	TO-263 3L	LM29300R-1.5	3.0A, Fixed	Reel	Contract Us
	TO-263 5L	LM29301R-1.5	3.0A, Fixed, Enable, Flag	Reel	Contract Us
1.8 V	TO-220 3L	LM29300T-1.8	3.0A, Fixed	Tube	Contract Us
	TO-220 5L	LM29301T-1.8	3.0A, Fixed, Enable, Flag	Tube	Contract Us
	TO-263 3L	LM29300R-1.8	3.0A, Fixed	Reel	Contract Us
	TO-263 5L	LM29301R-1.8	3.0A, Fixed, Enable, Flag	Reel	Contract Us
2.5 V	TO-220 3L	LM29300T-2.5	3.0A, Fixed	Tube	Contract Us
	TO-220 5L	LM29301T-2.5	3.0A, Fixed, Enable, Flag	Tube	Contract Us
	TO-263 3L	LM29300R-2.5	3.0A, Fixed	Reel	Contract Us
	TO-263 5L	LM29301R-2.5	3.0A, Fixed, Enable, Flag	Reel	Contract Us
3.0 V	TO-220 3L	LM29300T-3.0	3.0A, Fixed	Tube	Contract Us
	TO-220 5L	LM29301T-3.0	3.0A, Fixed, Enable, Flag	Tube	Contract Us
	TO-263 3L	LM29300R-3.0	3.0A, Fixed	Reel	Contract Us
	TO-263 5L	LM29301R-3.0	3.0A, Fixed, Enable, Flag	Reel	Contract Us
3.3 V	TO-220 3L	LM29300T-3.3	3.0A, Fixed	Tube	Active
	TO-220 5L	LM29301T-3.3	3.0A, Fixed, Enable, Flag	Tube	Contract Us
	TO-263 3L	LM29300R-3.3	3.0A, Fixed	Reel	Contract Us
	TO-263 5L	LM29301R-3.3	3.0A, Fixed, Enable, Flag	Reel	Contract Us
5.0 V	TO-220 3L	LM29300T-5.0	3.0A, Fixed	Tube	Contract Us
	TO-220 5L	LM29301T-5.0	3.0A, Fixed, Enable, Flag	Tube	Contract Us
	TO-263 3L	LM29300R-5.0	3.0A, Fixed	Reel	Contract Us
	TO-263 5L	LM29301R-5.0	3.0A, Fixed, Enable, Flag	Reel	Contract Us
12 V	TO-220 3L	LM29300T-12	3.0A, Fixed	Tube	Contract Us
	TO-220 5L	LM29301T-12	3.0A, Fixed, Enable, Flag	Tube	Contract Us
	TO-263 3L	LM29300R-12	3.0A, Fixed	Reel	Contract Us
	TO-263 5L	LM29301R-12	3.0A, Fixed, Enable, Flag	Reel	Contract Us

LM 2930X □ □ – □

- 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
- Green Mode
  - G : Halogen Free
  - Blank : Pb Free
- Root Name
  - 29300 : 3L Fixed Output
  - 29301 : 5L Fixed Output, Enable, Flag
  - 29302 : 5L Adjustable Output, Enable
- Product Code

PIN CONFIGURATION

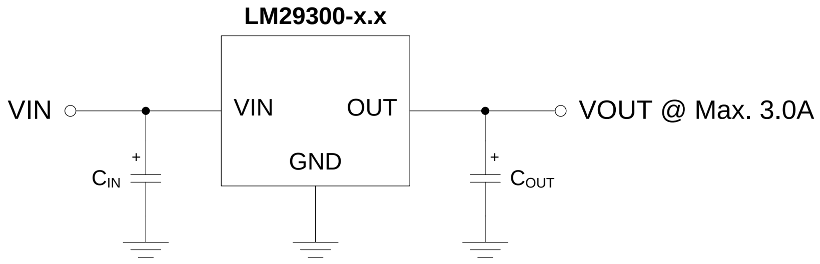


PIN DESCRIPTION

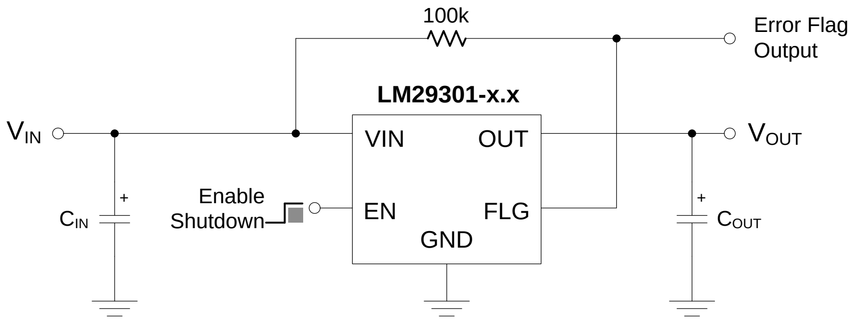
Pin No.			Pin Name	Pin Function
LM29300 (TO-220-3L/ TO-263-3L)	LM29301 (TO-220-5L/ TO-263-5L)	LM29302 (TO-220-5L/ TO-263-5L)		
-	1	1	EN	Chip Enable
1	2	2	VIN	Input Supply
2	3	3	GND	Ground
3	4	4	OUT	Output Voltage
-	5	-	FLG	Error Flag Output
-	-	5	ADJ	Output Adjust

TYPICAL APPLICATION CIRCUITS

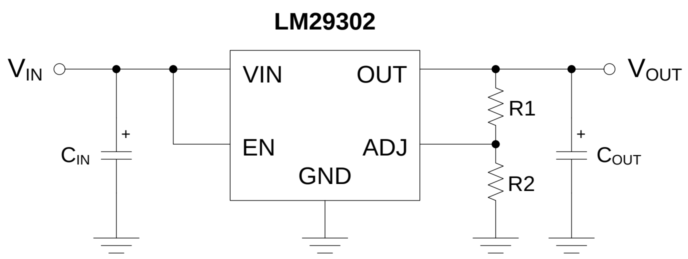
- Typical Fixed Output Application



- Typical Fixed Output Application with Error Flag



- Typical Adjustable Output Application



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

* 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°C, unless otherwise specified. **Bold** values are guaranteed across the operating temperature range. Adjustable versions are programmed to 5.0V.

LM29300/29301/29302 Common Specification

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OUT}	Output Voltage	I_O = 10mA	-1		1	%
		10mA≤I_O≤ $I_{FULLLOAD}$ (Note 2), (V_{OUT}+1V)≤V_{IN}≤26V	**-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	%
ΔVo/ΔT	Output Voltage Temp. Coefficient	Output Voltage (Note 6), Temp. Coefficient		**20**	**100**	ppm/°C
V_{DROP}	Dropout Voltage	ΔV_{OUT} = -1%, (Note 3) I_O =100mA I_O =1.5A I_O =3.0A		80 250 370	**175** **600**	mV
I_{GND}	Ground Current	I_O =1.5A, V_{IN} =V_{OUT}+1V I_O =3.0A		10 37	**35**	mA
I_{GND_DO}	Ground Pin Current at Dropout	V_{IN} =0.5V less than specified V_{OUT}, I_{OUT} =10mA		1.7		mA
I_{LIMIT}	Current Limit	V_{OUT} = 0V (Note 4)		4.5	**5.0**	A
e_n	Output Noise Voltage (10Hz to 100kHz) I_L = 100mA	C_L =10μF C_L =33μF		400 260		μV_{RMS}

Flag Output (Error Comparator) LM29301

$I_{FLG\ (leak)}$	Output Leakage Current	V_{OH} =26V		0.01	1.0 **2.0**	μA
V_{FLG_LOW}	Output Low Voltage	V_{IN} = 0.5V less than specified V_{OUT}, I_{FL} =250μA		220	300 **400**	mV
V_{FLG_TH}	Upper Threshold Voltage				99.2	% of V_{OUT}
V_{FLG_TL}	Lower Threshold Voltage		93			% of V_{OUT}
ΔV_{FLG}	Hysteresis			1		% of V_{OUT}

Reference LM29302

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
$\Delta V_{REF}/\Delta T$	Reference Voltage Temp. Coefficient	(Note 7)		20		ppm/°C
$\Delta I_{ADJ}/\Delta T$	Adjust Pin Bias Current Temp. Coefficient			0.1		nA/°C

Enable Input LM29301 / LM29302

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			2.0 **4**	μA
I_{OUT_SD}	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 3.0A.

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 < $I_{FULLLOAD}$, $T_J <$ 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.

APPLICATION INFORMATION

The LM29300 are high performance low-dropout voltage regulators suitable for all moderate to high current voltage regulator applications. Their 370mV 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 LM29300 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°C 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 28V to 35V, the over voltage sensor temporarily disables the regulator.

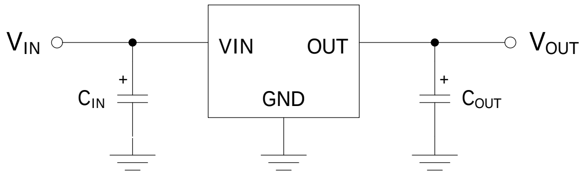


Figure 1. Linear regulators require only two capacitors for operation.

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 $T_{JMAX} \leq 125°C$ and θ_{CS} is between 0 and 2°C /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. LM29300 regulators are stable with the 10μF minimum capacitor values at full load. Where the regulator is powered from a source with a high AC impedance, a 0.1μF capacitor connected between input and GND is recommended. This capacitor should have good characteristics to above 250kHz.

Minimum Load Current

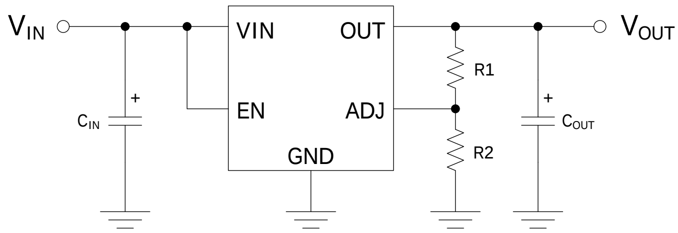
The LM29300 regulators are specified between finite loads. If the output is too small, leakage currents is too small, leakage currents dominate and the output voltage rises. The 7mA minimum load current swamps any expected leakage current across the operating temperature range.

Adjustable Regulator Design

The adjustable regulator versions, LM29302 allows programming the output voltage anywhere between 1.24V and the 25V maximum operating rating of the family.
Two resistors are used and their 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 x [1 + (R1/R2)]

Figure 2. Adjustable Regulator with Resistors

Error Flag

LM29301 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.

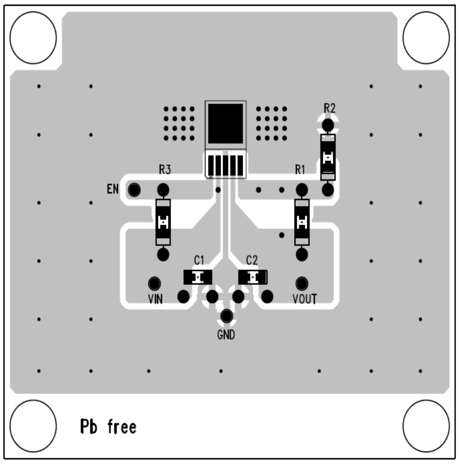
Enable input

LM29301 and LM29302 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 ≤ 30V. Enabling the regulator requires approximately 20μA of current.

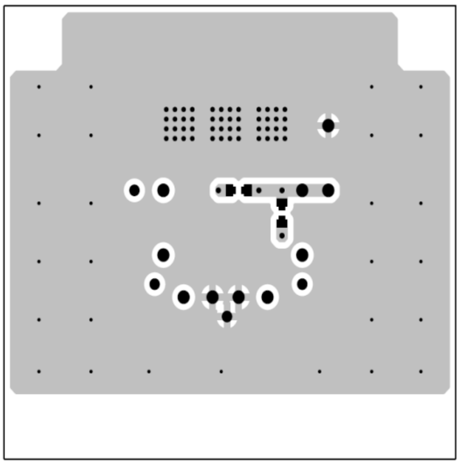
PCB Guide

- Layout example

Top Layout



Bottom Layout



TYPICAL OPERATING CHARACTERISTICS

T.B.D.

ES France - Département Composants & Modules
127 rue de Buzenval BP 26 - 92380 Garches
Tél. 01 47 95 99 89
Fax. 01 47 01 16 22
e-mail : comp@es-france.com
Site Web : www.es-france.com

REVISION NOTICE

The description in this datasheet is subject to change without any notice to describe its electrical characteristics properly.

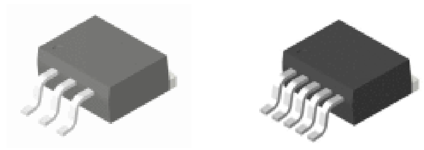
ES France - Département Composants & Modules
127 rue de Buzenval BP 26 - 92380 Garches
Tél. 01 47 95 99 89
Fax. 01 47 01 16 22
e-mail : comp@es-france.com
Site Web : www.es-france.com

5A Low-Voltage Low-Dropout Regulator LM39500/39501/39502

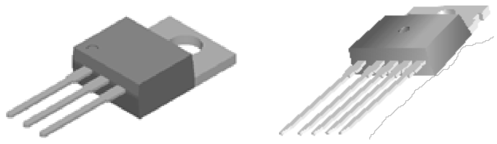
FEATURES

- Guaranteed Output Current of 5.0A
- Fixed Output Voltage: 1.5V, 1.8V, 2.5V, 3.3V and 5.0V
- 1% initial accuracy
- Low ground current
- Over-Temperature/Over-Current Protection
- Fast transient response
- TTL/CMOS compatible enable pin => LM39501
- Error flag output - LM39501 only
- Available in TO-263 and TO-220 packages
- - 40℃ to 125℃ Junction Temperature Range
- Moisture Sensitivity Level 3

TO-263 3L/ 5L PKG



TO-220 3L/ 5L PKG



ORDERING INFORMATION

Device	Package
LM39500R-X.X	TO-263 3L
LM39500T-X.X	TO-220 3L
LM39501R-X.X	TO-263 5L
LM39501T-X.X	TO-220 5L
LM39502R	TO-263 5L
LM39502T	TO-220 5L

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

APPLICATION

- Battery Powered Equipments
- Motherboards and Graphic Cards
- Microprocessor Power Supplies
- Peripheral Cards
- High Efficiency Linear Regulators
- Battery Chargers

DESCRIPSION

The LM39500, LM39501 and LM39502 are 5.0A low-dropout linear voltage regulators that provides a low voltage, high-current output with a minimum of external components. The LM39500/1 offers extremely low dropout (typically 400mV at 5.0A) and low ground current (typically 70mA at 3.0A). The LM39500/1/2 is ideal for PC add-in cards that need to convert from standard 5V or 3.3V down to new, lower core voltages. A guaranteed maximum dropout voltage of 500mV over all operating conditions allows the LM39500/1/2 to provide 2.5V from a supply as low as 3V. The LM39300/1/2 also has fast transient response for heavy switching applications. The device requires only 47F of output capacitance to maintain stability and achieve fast transient response. The LM39500/1 is fully protected with over current limiting, thermal shutdown, reversed-battery protection, reversed-leakage protection, and reversed-lead insertion. The LM39501 offers a TTL-logic compatible enable pin and an error flag that indicates under voltage and over current conditions. Offered in fixed voltages, the LM39500/1/2 comes in the TO-220 and TO-263 packages and is an ideal upgrade to older, NPN-based linear voltage regulators.

Absolute Maximum Ratings (Note 1)

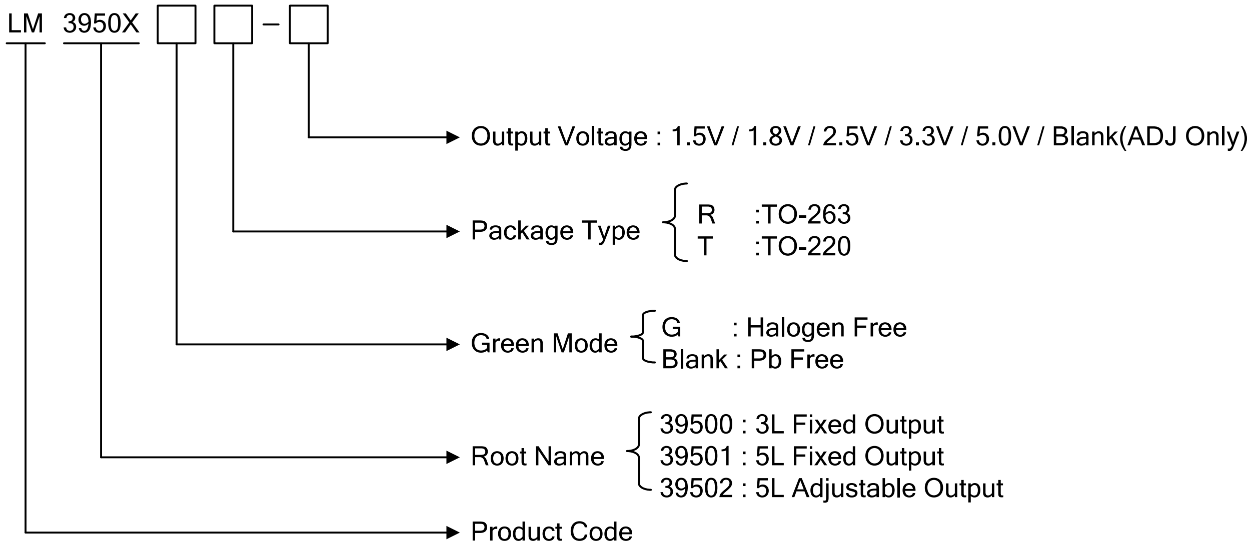
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage	V_{IN}	- 0.3	+ 20	V
Enable Voltage	V_{EN}	-	+ 20	V
Output Voltage	V_{OUT}	-0.3	V_{IN} +0.3	V
Lead Temperature (Soldering, 5 sec)	T_{SOL}	-	260	℃
Storage Temperature Range	T_{STG}	-65	+ 150	℃

Operating Ratings (Note 2)

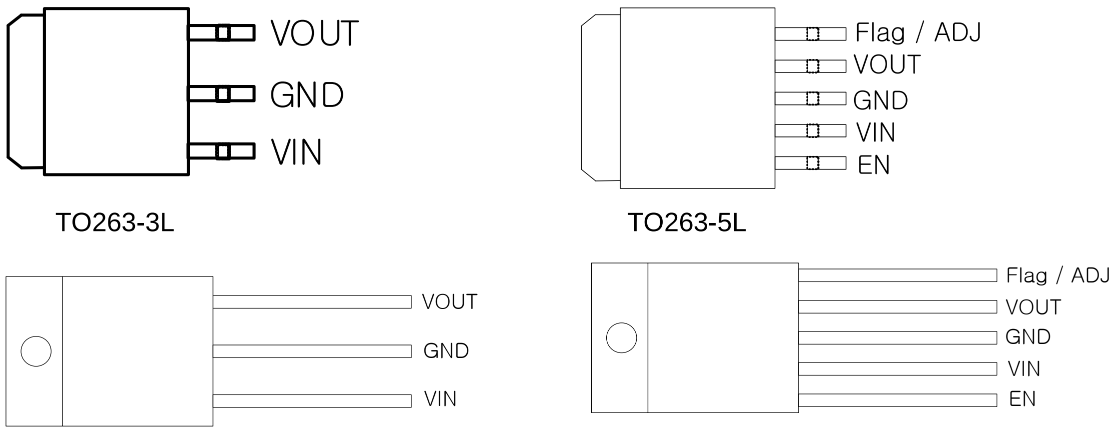
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage	V_{IN}	+ 2.25	+ 16	V
Enable Voltage	V_{EN}	+ 2.25	+ 16	V
Maximum Power Dissipation	$PD_{(max)}$	(Note 3)	(Note 3)	
Junction Temperature	T_J	-40	+ 125	℃
Package Thermal Resistance	$\theta_{JA\text{-}TO\text{-}263}$	80		℃/W
	$\theta_{JA\text{-}TO\text{-}220}$	70		℃/W

Ordering Information

V_{OUT}	Package	Order No.	Description	Supplied As	Status
1.5 V	TO-263 3L	LM39500R-1.5	5A, Fixed	Reel	Active
	TO-263 3L	LM39500GR-1.5	5A, Fixed	Reel	Obsolete
	TO-263 5L	LM39501R-1.5	5A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39501GR-1.5	5A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39500T-1.5	5A, Fixed	Reel	Active
	TO-220 5L	LM39501T-1.5	5A, Fixed, Enable	Reel	Obsolete
1.8V	TO-263 3L	LM39500R-1.8	5A, Fixed	Reel	Active
	TO-263 3L	LM39500GR-1.8	5A, Fixed	Reel	Obsolete
	TO-263 5L	LM39501R-1.8	5A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39501GR-1.8	5A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39500T-1.8	5A, Fixed	Reel	Active
	TO-220 5L	LM39501T-1.8	5A, Fixed, Enable	Reel	Active
2.5 V	TO-263 3L	LM39500R-2.5	5A, Fixed	Reel	Active
	TO-263 3L	LM39500GR-2.5	5A, Fixed	Reel	Obsolete
	TO-263 5L	LM39501R-2.5	5A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39501GR-2.5	5A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39500T-2.5	5A, Fixed	Reel	Active
	TO-220 5L	LM39501T-2.5	5A, Fixed, Enable	Reel	Active
3.3 V	TO-263 3L	LM39500R-3.3	5A, Fixed	Reel	Active
	TO-263 3L	LM39500GR-3.3	5A, Fixed	Reel	Obsolete
	TO-263 5L	LM39501R-3.3	5A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39501GR-3.3	5A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39500T-3.3	5A, Fixed	Reel	Active
	TO-220 5L	LM39501T-3.3	5A, Fixed, Enable	Reel	Active
5.0 V	TO-263 3L	LM39500R-5.0	5A, Fixed	Reel	Active
	TO-263 3L	LM39500GR-5.0	5A, Fixed	Reel	Obsolete
	TO-263 5L	LM39501R-5.0	5A, Fixed, Enable	Reel	Active
	TO-263 5L	LM39501GR-5.0	5A, Fixed, Enable	Reel	Obsolete
	TO-220 3L	LM39500T-5.0	5A, Fixed	Reel	Active
	TO-220 5L	LM39501T-5.0	5A, Fixed, Enable	Reel	Active
ADJ	TO-263 5L	LM39502R	5A, Adjustable, Enable	Reel	Active
	TO-263 5L	LM39502GR	5A, Adjustable, Enable	Reel	Obsolete
	TO-220 5L	LM39502T	5A, Adjustable, Enable	Reel	Active



PIN CONFIGURATION



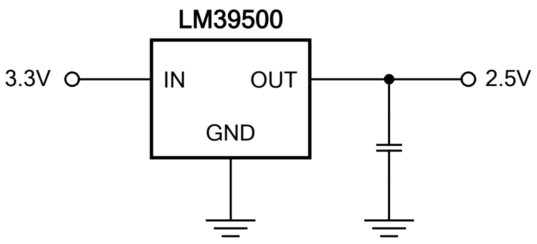
TO263-3L TO263-5L

TO220-3L TO220-5L

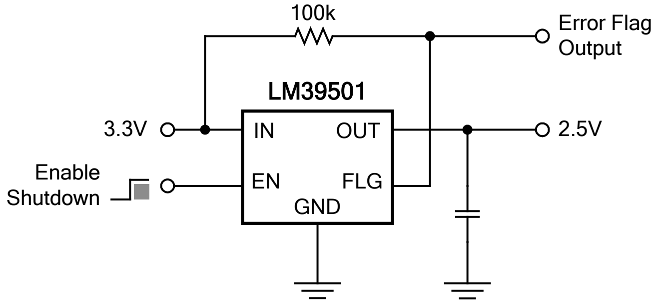
PIN DESCRIPTION

Pin No.	TO-263 3L / TO-220 3L **(for 39500)**		TO-263 5L / TO-220 5L **(for 39501/2)**	
	Name	Function	Name	Function
1	VIN	Input Supply	EN	Chip Enable
2	GND	Ground	VIN	Input Supply
3	VOUT	Output Voltage	GND	Ground
4			VOUT	Output Voltage
5			FLG / ADJ	Error Flag Output or Output Adjust

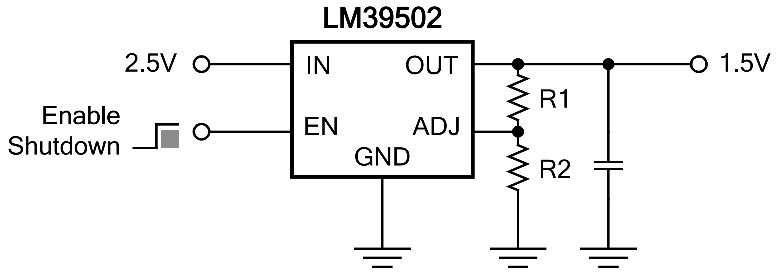
TYPICAL APPLICATION



2.5V / 5A Regulator

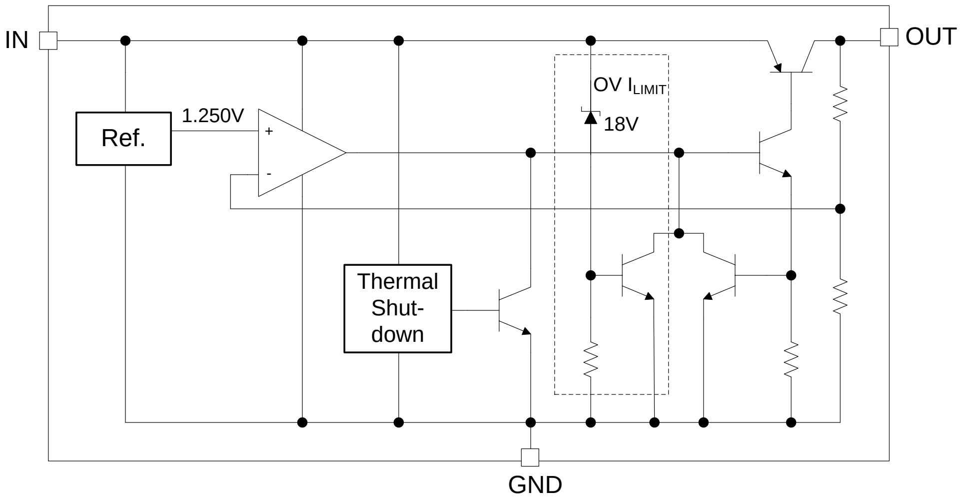


2.5V / 5A Regulator with Error Flag

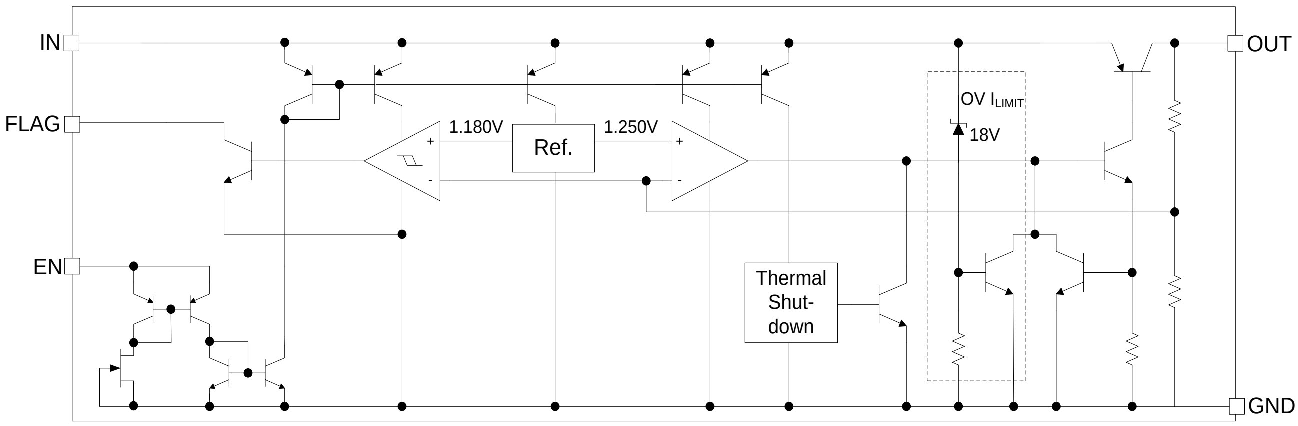


1.5V / 5A Adjustable Regulator

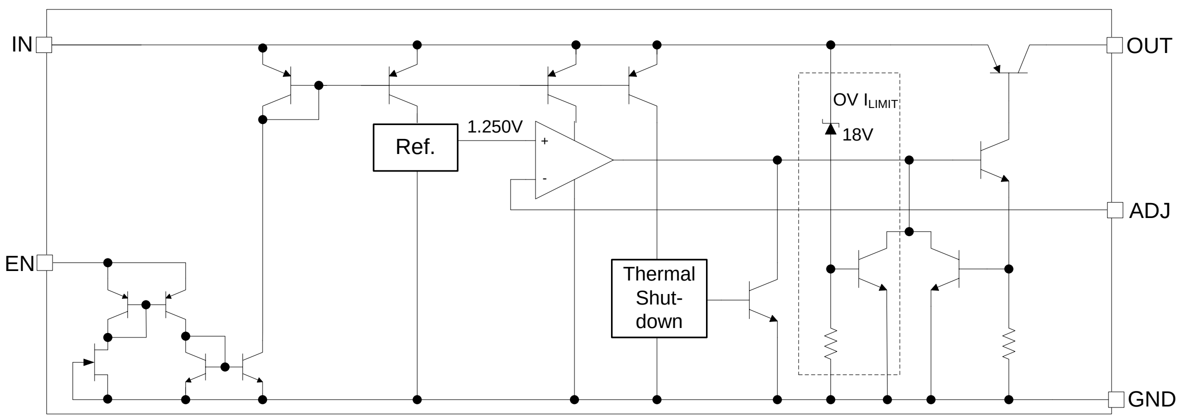
Block Diagram



LM39500 Fixed (1.5V, 1.8V, 2.5V, 3.3V, 5.0V)



LM39501 Fixed with Flag and Enable



LM39502 Adjustable

ELECTRICAL CHARACTERISTICS

V_{IN}= V_{OUT} +1V; V_{EN} = 2.25V; T_J = 25°C, **bold** values indicate -40°C ≤ T_J ≤ +125°C; unless noted

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	10mA 10mA ≤ I_{OUT} ≤ 5A, V_{OUT}+1V ≤ V_{IN} ≤8V	-1 **-2**		1 **2**	% %
	Line Regulation	I_{OUT}=10mA, V_{OUT} +1V ≤ V_{IN} ≤ 16V		0.06	0.5	%
	Load Regulation	V_{IN}= V_{OUT} +1V, 10mA ≤ I_{OUT} ≤ 5A		0.2	1	%
$\Delta V_{OUT}/\Delta T$	Output Voltage Temp. Coefficient (Note 4)			**20**	**100**	ppm/ °C
V_{DO}	Dropout Voltage (Note 5)	I_{OUT}=250mA, ΔV_{OUT} = -2%		125	**200**	mV mV
		I_{OUT}=2.5A, ΔV_{OUT} = -2%		320		mV
		I_{OUT}=5A, ΔV_{OUT} = -2%		400	**575**	mV
I_{GND}	Ground Current (Note6)	I_{OUT}=2.5A, V_{IN}= V_{OUT}+1V		15		mA
		I_{OUT}=5A, V_{IN}= V_{OUT}+1V		70		mA
$I_{OUT(lim)}$	Current Limit	V_{OUT}=0V, V_{IN}=V_{OUT}+1V		7.5		A
e_n	Output Noise Voltage	C_{OUT}=47uF, I_{OUT}=100mA, 10Hz to 100kHz		260		uV(rms)

Enable Input

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V_{EN}	Enable Input Voltage	logic low (off)			**0.8**	V
		logic high (on)	**2.5**			V
I_{EN}	Enable Input Current	V_{EN}= V_{IN}		30	35 **75**	μA μA
		V_{EN}=0.8V			2 **4**	μA μA
$I_{OUT(shdn)}$	Shutdown Output Current	(Note7)		10		uA

Flag Output

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
$I_{FLG\ (leak)}$	Output Leakage Current	V_{OH}=16V		0.01	1 **2**	μA μA
$V_{FLG\ (do)}$	Output Low Voltage	V_{IN}=2.25=V, I_{OL}=250μA, (Note8)		220	300 400	mV mV

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LM39502 Only

	Reference Voltage	(Note9)	1.238 **1.225**	1.250	1.262 **1.275**	V V
			1.213		**1.277**	V
	Adjust Pin Bias Current			40	80 **120**	nA nA
	Reference Voltage Temp. Coefficient			20		ppm/ °C
	Adjust Pin Bias Current Temp. Coefficient			0.1		nA/ °C

Note 1. Exceeding the absolute maximum ratings may damage the device.

Note 2. The device is not guaranteed to function outside its operating rating.

Note 3. PD (max)= ($T_{J\ (max)}$ - T_A) ÷ θ_{JA}, where θ_{JA} -junction-to-ambient thermal resistance.

Note 4. Output voltage temperature coefficient is ΔV_{OUT} (worst case) ÷ ($T_{J(max)}$ - $T_{J(min)}$) where $T_{J(max)}$ is +125°C and $T_{J(min)}$ is 0°C.

Note 5. V_{DO} = V_{IN} - V_{OUT} when V_{OUT} decreases to 99% of its nominal output voltage with V_{IN} = V_{OUT} + 1V. For output voltages below 2.25V, dropout voltage is the input-to-output voltage differential with the minimum input voltage being 2.25V. Minimum input operating voltage is 2.25V.

Note 6. I_{GND} is the quiescent current. I_{IN} = I_{GND} + I_{OUT}.

Note 7. V_{EN} =0.8V, V_{IN} = 8V, V_{OUT} = 0V

Note 8. For a 2.5V device, V_{IN} = 2.250V (device is in dropout).

Note 9. V_{REF} ≤ V_{OUT} ≤ (V_{IN} - 1V), 2.25V ≤ V_{IN} ≤ 16V, 10mA ≤ I_L ≤ 5A.

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APPLICATION INFORMATION

The LM39500/1 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 as a high-efficiency noise filter in post-regulator applications. Unlike older NPN-pass transistor designs, where the mini-mum dropout voltage is limited by the base-to-emitter voltage drop and collector-to-emitter saturation voltage, dropout performance of the PNP output of these devices is limited only by the low VCE saturation voltage. A trade-off for the low dropout voltage is a varying base drive requirement. The LM39500/1/2 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 maximum safe operating temperature. Transient protection 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

The LM39500/1/2 requires an output capacitor to maintain stability and improve transient response. Proper capacitor selection is important to ensure proper operation. The LM39500/1/2 output capacitor selection is dependent upon the ESR (equivalent series resistance) of the output capacitor to maintain stability. When the output capacitor is 47F or greater, the output capacitor should have less than 1 of ESR. This will improve transient response as well as promote stability. Ultralow ESR capacitors, such as ceramic chip capacitors may promote instability. These very low ESR levels may cause an oscillation and/or under damped transient response. A low-ESR solid tantalum capacitor works extremely well and provides good transient response and stability over temperature. Aluminum electrolytic can also be used, as long as the ESR of the capacitor is < 1.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

An input capacitor of 1F or greater is recommended when the device is more than 4 inches away from the bulk ac supply capacitance, or when the supply is a battery. Small, surface-mount, ceramic chip capacitors can be 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 LM39500/1/2 regulator 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 is necessary for proper regulation.

Transient Response and 3.3V to 2.5V Conversion

The LM39500/1/2 has excellent transient response to variations 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 47F 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 de-signs. When converting from 3.3V to 2.5V, the NPN-based 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 LM39500/1/2 regulator will provide excellent performance with an input as low as 3.0V. This gives the PNP-based regulators a distinct advantage over older, NPN-based linear regulator.

Error Flag

The LM39501 version features an error flag circuit which monitors the output voltage and signals an error condition when the voltage drops 5% below the nominal output voltage. The error flag is an open-collector output that can sink 10mA during a fault condition. Low output voltage can be caused by a number of problems, including an over current fault (device in current limit) or low input voltage. The flag is inoperative during over temperature shutdown.

Enable Input

The LM39501 version features an enable input for on/off control of the device. Its shutdown state draws “zero” current (only microamperes of leakage). The enable input is TTL/ CMOS compatible for simple logic interface, but can be connected to up to 20V. When enabled, it draws approximately 15A.

Adjustable Regulator Design

The LM39502 allows programming the output voltage any-where between 1.25V and the 16V 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/1.250-1)

Where VO is desired output voltage. Figure 1 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see below).

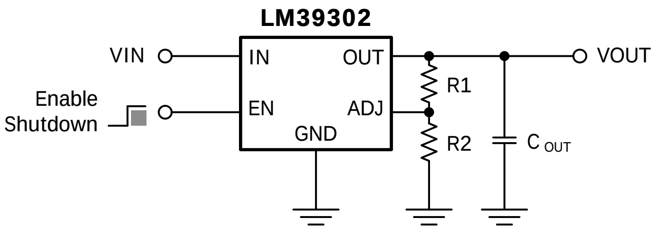

Figure 1. Adjustable Regulator with Resistors

Maximum Output Current Capability

The LM39500/1/2 can deliver a continuous current of 5A over the full operating junction temperature range. However, the output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 5A may be still undeliverable due to the restriction of the power dissipation of LM39500/1/2. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The temperatures over the device are given by:

$T_C = T_A + P_D \times \theta_{CA}$ / $T_J = T_C + P_D \times \theta_{JC}$ / $T_J = T_A + P_D \times \theta_{JA}$

Where T_J is the junction temperature, T_C is the case temperature, T_A is the ambient temperature, P_D is the total power dissipation of the device, θ_{CA} is the thermal resistance of case-to-ambient, θ_{JC} is the thermal resistance of junction-to-case, and θ_{JA} is the thermal resistance of junction to ambient. The total power dissipation of the device is given by:

$$P_D = P_{IN} – P_{OUT} = (V_{IN} \text{ X } I_{IN})–(V_{OUT} \text{ X } I_{OUT})$$
$$= (V_{IN} \text{ X } (I_{OUT}+I_{GND})) – (V_{OUT} \text{ X } I_{OUT}) = (V_{IN} - V_{OUT}) \text{ X } I_{OUT} + V_{IN} \text{ X } I_{GND}$$

Where I_{GND} is the operating ground current of the device which is specified at the Electrical Characteristics. The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} – T_{Amax}$$

The maximum allowable value for junction-to-ambient thermal resistance, θ_{JA}, can be calculated using the formula:

$$\theta_{JA} = T_{Rmax} / P_D = (T_{Jmax} – T_{Amax}) / P_D$$

LM39500/1/2 is available in TO-263 and TO-220 package. The thermal resistance depends on amount of copper area or heat sink, and on air flow. If the maximum allowable value of θ_{JA} calculated above is over 80°C/W for TO-263 package, 70°C/W for TO-220 package, no heat sink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable θ_{JA} falls near or below these limits, a heat sink or proper area of copper plane is required. In summary, the absolute maximum ratings of thermal resistances are as follow:

Absolute Maximum Ratings of Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal Resistance Junction-To-Ambient / TO-263	$\theta_{JA\text{-}TO\text{-}263}$	80	°C/W
Thermal Resistance Junction-To-Ambient / TO-220	$\theta_{JA\text{-}TO\text{-}220}$	70	°C/W

No heat sink / No air flow / No adjacent heat source / 20 mm^2 copper area. (T_A=25°C)

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FEATURES

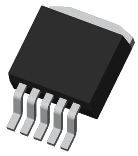
- Guaranteed Output Current of 5.0A
- Very Low Dropout Voltage
- 1% Initial Accuracy
- Good Line and Load Regulation
- Fast Transient Response
- Adjustable Output Voltage up to 15V
- TTL/CMOS Compatible Enable Logic
- Over-Temperature/Over-Current Protection
- −40°C to 125°C Junction Temperature Range
- Available in TO-263-5L Package
- Moisture Sensitivity Level 3

APPLICATIONS

- Battery Powered Equipment
- Motherboards and Graphic Cards
- Microprocessor Power Supplies
- Peripheral Cards
- High Efficiency Linear Regulators
- Battery Chargers

DESCRIPTION

The TPS75501 is 5.0A low-dropout linear voltage regulators that provide a low voltage, high-current output with a minimum of external components. The TPS75501 offers extremely low dropout (typically 400mV at 5.0A) and low ground current (typically 70mA at 5.0A). The TPS75501 is ideal for PC add-in cards that need to convert from standard 5V or 3.3V down to new, lower core voltages. A guaranteed maximum dropout voltage of 500mV over all operating conditions allows the TPS75501 to provide 2.5V from a supply as low as 3V. The TPS75501 also has fast transient response for heavy switching applications. The device requires only 47µF of output capacitance to maintain stability and achieve fast transient response. The TPS75501 is fully protected with over current limiting, thermal shutdown, reversed-battery protection, reversed-leakage protection, and reversed-lead insertion. The TPS75501 offers a TTL-logic compatible enable pin. The TPS75501 comes in the TO-263 package and is an ideal upgrade to older, NPN-based linear voltage regulators.



TO-263-5

ORDERING INFORMATION

Device	Package
TPS75501R	TO-263-5L

Please contact us for more information about this product.

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