



TO-252-4L  
(PPAK)



**Pin Definition:**

1. Enable
2. Input
3. Ground
4. Output
5. Adjustable

### General Description

TS39154 is 1.5A ultra low dropout linear voltage regulators that provide low voltage, high current output from an extremely small package. This regulator offers extremely low dropout (typically 400mV at 1.5A) and very low ground current (typically 25mA at 1.5A). TS39154 is fully protected against over current faults, reversed input polarity, reversed lead insertion, over temperature operation, positive and negative transient voltage spikes, logic level enable control. On the TS39154, the enable pin may be tied to  $V_{IN}$  if it is not required for enable control.

### Features

- Dropout voltage typically 0.4V @  $I_o=1.5A$
- Output Current up to 1.5A
- Low Ground Current
- Extremely Fast Transient Response
- Reversed Leakage & Reverse Battery Protection
- Internal Current Limit
- Thermal Shutdown Protection

### Ordering Information

Part No.	Package	Packing
TS39154CP4 RO	TO-252-4L	2,500pcs / 13" Reel

### Application

- PowerPC™ Power Supplies
- Battery Powered Equipment
- Consumer and Personal Electronics
- High Efficiency Linear Power Supplies
- SMPS Post Regulator and DC to DC Modules
- High-efficiency Post Regulator for Switching Supply
- Low-Voltage microcontrollers and Digital Logic

### Absolute Maximum Rating (Note 1)

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

### Operating Rating (Note 2)

Operation Input Voltage	$V_{IN}$ (operate)	+2.25 ~ +16	V
Operation Enable Voltage	$V_{EN}$ (operate)	+2.25 ~ +16	V
Power Dissipation (Note 4)	$P_D$	Internally Limited	W
Operating Junction Temperature Range	$T_J$	-40 ~ +125	°C

### Electrical Characteristics

$V_{IN} = V_{OUT} + 1V$ ,  $V_{IN} = 2.5V$  for fixed reference output voltage,  $V_{enable} = 2.25V$ ,  $T_a = 25^\circ C$ , unless otherwise specified.

Parameter	Conditions	Min	Typ	Max	Unit	
Reference Output Voltage	$I_L = 10mA$	0.980 Vo	1.24 ( $V_{REF}$ )	1.020 Vo	V	
Reference Output Voltage (Note 7)	$10mA \leq I_L \leq 1.5A$ , $2.5V \leq V_{IN} \leq 8V$	0.970 Vo		1.030 Vo		
Line Regulation	$I_L = 10mA$ , $V_O + 1V \leq V_{IN} \leq 16V$	--	0.05	0.5	%	
Load Regulation	$V_{IN} = V_{out} + 1V$ , $10mA \leq I_L \leq 1.5A$	--	0.2	1.0	%	
Output Voltage Temp. Coefficient		--	40	100	ppm/ $^\circ C$	
Adjust Pin Bias Current		--	40	120	nA	
Adjust Pin Bias Current Temp. Coefficient (Note 8)		--	0.1	--	nA/ $^\circ C$	
Dropout Voltage (Note 5)	$\Delta V_{OUT} = -1\%$	$I_L = 100mA$	--	100	250	mV
		$I_L = 750mA$	--	275	350	
		$I_L = 1.5A$	--	400	700	
Quiescent Current (Note 6)	$V_{IN} = V_{OUT} + 1V$	$I_L = 100mA$	--	5	18	mA
		$I_L = 750mA$	--	7	20	
		$I_L = 1.5A$	--	25	--	
Current Limited	$V_{OUT} = 0$ , $V_{IN} = V_{OUT} + 1V$	1.8	2.0	--	A	
Input Logic Voltage	Low (OFF)	--	--	0.8	V	
	High (ON)	2.25	--	--		
Enable Pin Input Current	$V_{EN} = 2.25V$	--	--	75	uA	
	$V_{EN} = 0.8V$	--	--	4		

### Thermal Performance

Condition	Symbol	Typ	Unit
Thermal Resistance Junction to Case	$R_{\theta_{JC}}$	10	$^\circ C/W$
Thermal Resistance Junction to Ambient	$R_{\theta_{JA}}$	100	$^\circ C/W$

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

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

Note 3: Devices are ESD sensitive. Handling precautions recommended.

Note 4: The maximum allowable power dissipation is a function of the maximum junction temperature,  $T_J$ , the junction to ambient thermal resistance,  $\theta_{JA}$ , and the ambient temperature,  $T_a$ . Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. The effective value of  $\theta_{JA}$  can be reduced by using a heat sink,  $P_{d(max)} = (T_{J(max)} - T_a) / \theta_{JA}$ .

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops -1% below its nominal value measured at 1V differential.

Note 6: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the ground pin current and output load current,  $I_{GND} = I_{IN} - I_{OUT}$  for fix output voltage,  $I_{GND} = I_{IN} - I_{OUT} + 10mA$  for fix reference output voltage in full load regulation.

Note 7:  $V_{REF} \leq V_{OUT} \leq (V_{IN} - 1V)$ ,  $2.25V \leq V_{IN} \leq 16V$ ,  $10mA \leq I_L \leq 1.0A$ .

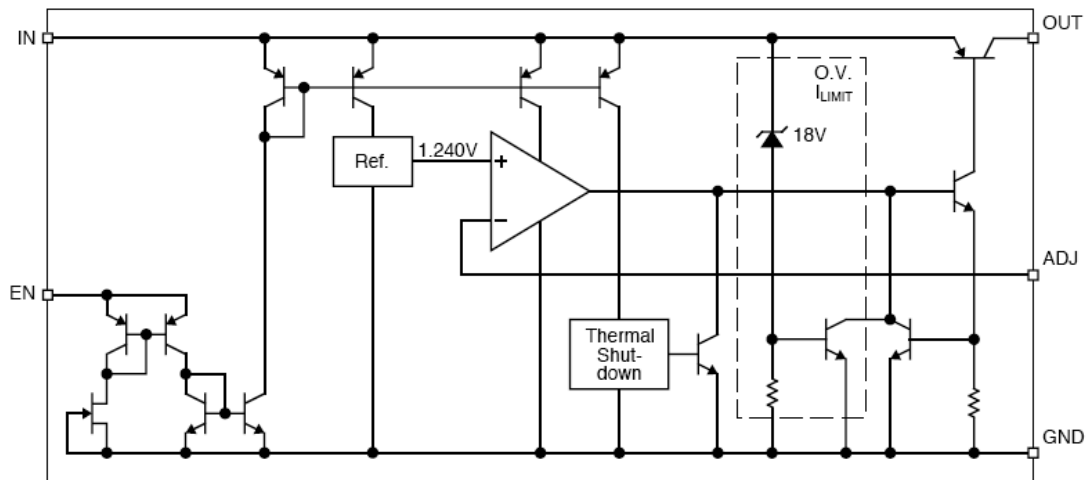
Note 8: Output voltage temperature coefficient is  $\Delta V_{OUT}$  (worse cast) /  $(T_{J(max)} - T_{J(MIN)})$  where is  $T_{J(max)} + 125^\circ C$  and  $T_{J(MIN)}$  is  $0^\circ C$ .

Note 9: For adjustable device and fixed device with  $V_{OUT} > 2.25V$ .

### Pin Description

Pin Configuration	Pin Description
Enable	TTL/COMS compatible input. Logic high is enable; logic low or open is shutdown
Input	Unregulated input: +16V maximum supply
Ground	Ground: Ground pin and TAB / heat sink are internally connected.
Output	Regulator output
Feed Back ( <b>adjustable</b> )	Adjustment input: Feedback input. Connect to resistive voltage-divider network.

### Functional Diagram



### Application Information

The TS39154 is high performance with low dropout voltage regulator suitable for moderate to high current and voltage regulator application. Its 700mV dropout voltage at full load and over temperature makes it especially valuable in battery power systems and as high efficiency noise filters in post regulator applications. Unlike normal NPN transistor design, where the base to emitter voltage drop and collector to emitter saturation voltage limit the minimum dropout voltage, dropout performance of the PNP output of these devices is limited only by low  $V_{CE}$  saturation voltage.

The TS39154 is fully protected from damage due to fault conditions. Linear current limiting is provided. Output current during overload conditions is constant. Thermal shutdown the device when the die temperature exceeds the maximum safe operating temperature. Transient protection allows device survival even when the input voltage spikes above and below nominal. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow.

### Output Capacitor Requirement

The TS39154 requires an output capacitor to maintain stability and improve transient response is necessary. The value of this capacitor is dependent upon the output current, lower currents allow smaller capacitors. TS39154 output capacitor selection is dependent upon the ESR of the output capacitor to maintain stability. When the output capacitor is 10uF 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 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 electrolytes can also be used, as long as the ESR of the capacitor is <2Ω. 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.

### Application Information (Continue)

#### Input Capacitor Requirement

An input capacitor of 1uF or greater is recommended when the device is more than 4” away from the bulk AC supply capacitance or when the supply is a battery. Small, surface mount, ceramic chip capacitors can be used for 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 TS39154 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 TS39154 is allowed to programming the output voltage anywhere between 1.25 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:

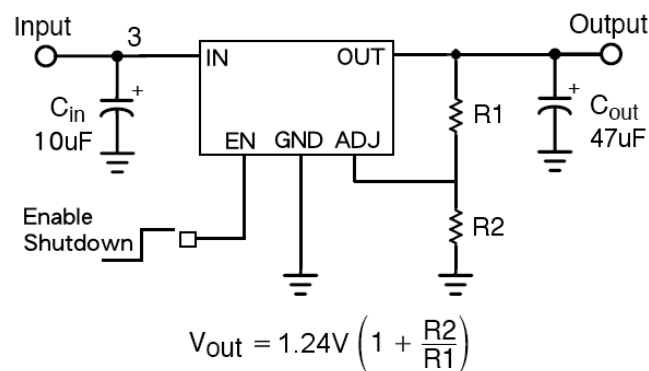


Table 1: Resistor select for output voltage setting

V <sub>OUT</sub>	R1	R2
5V	470kΩ	155kΩ
3.3V	470kΩ	290kΩ
2.5V	470kΩ	460kΩ
1.8V	210kΩ	470kΩ
1.5V	100kΩ	470kΩ

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

#### Enable Input

TS39154 feature an active-high enable (EN) input 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 interfacing with logic interfacing. EN may be directly tied to V<sub>IN</sub> and pulled up to the maximum supply voltage.

## Application Information (Continue)

### Thermal Characteristics

TS39154 linear regulators are simple to use, the most complicated design parameters to consider are thermal characteristics, thermal design requires the following application specification parameters:

- Maximum ambient temperature,  $T_A$
- Output current,  $I_{OUT}$
- Output voltage,  $V_{OUT}$
- Input voltage,  $V_{IN}$

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

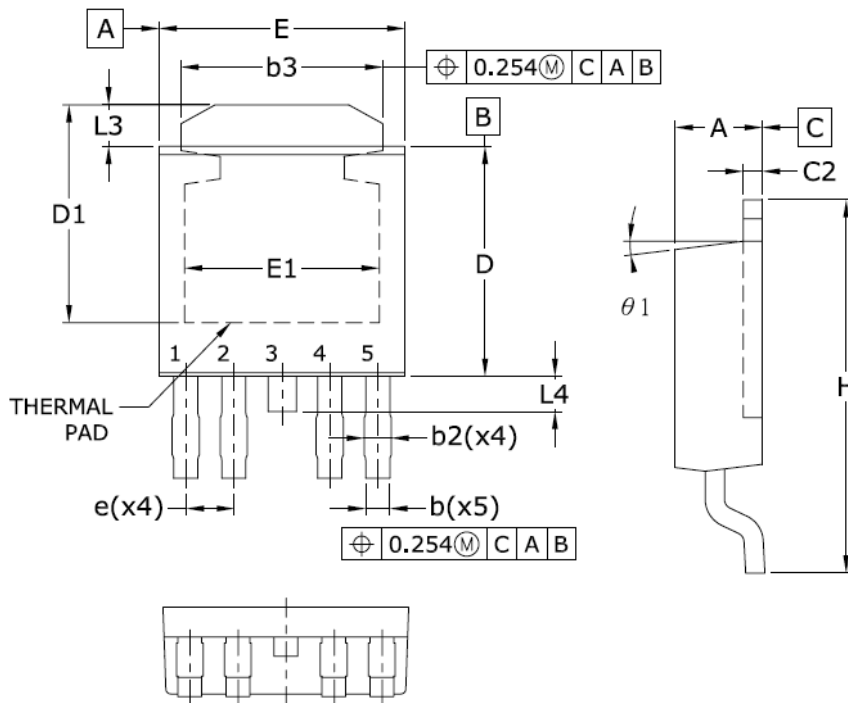
$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

The heat sink thermal resistance is determined by:

$$\Theta_{SA} = (T_{J(MAX)} - T_A) / P_D - (\Theta_{JC} + \Theta_{CS})$$

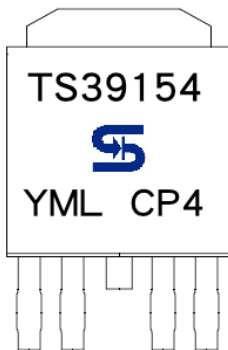
Where  $T_{J(MAX)} \leq 125^\circ\text{C}$  and  $\Theta_{CS}$  is between  $0^\circ\text{C/W}$  and  $2^\circ\text{C/W}$ . The heat sink may be significantly reduced in applications where the minimum input voltage is known and is large compared with the dropout voltage and distribute the heat between this resistor and the regulator. The low dropout properties of vertical PNP regulators allow significant reductions in regulator power dissipation and the associated heat sink without compromising performance. When this technique is employed, a capacitor of at least 1uF is needed directly between the input and regulator ground.

### TO-252-4L Mechanical Drawing



TO-252-4L DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A	2.210	2.387	0.087	0.093
A1	0.010	0.127	0.000	0.005
b	0.584	0.660	0.023	0.026
b1	0.559	0.635	0.022	0.025
b2	0.500	0.510	0.020	0.020
b3	5.232	5.436	0.206	0.214
C	0.509	0.559	0.020	0.022
C1	0.457	0.533	0.018	0.021
C2	0.483	0.584	0.019	0.023
D	6.000	6.200	0.236	0.244
D1	5.415	5.515	0.213	0.217
E	6.400	6.604	0.252	0.260
E1	4.902	5.004	0.193	0.197
e	1.27 BSC		0.05 BSC	
H	9.601	10.21	0.377	0.402
L	1.397	1.651	0.055	0.065
L1	2.743 REF		0.108 REF	
L2	0.508 REF		0.02 REF	
L3	1.100 REF		0.043 REF	
L4	0.660	0.940	0.025	0.037
$\theta$	0°	8°	0°	8°
$\theta 1$	7° REF		7° REF	

### Marking Diagram



- Y** = Year Code
- M** = Month Code  
(A=Jan, B=Feb, C=Mar, D=Apl, E=May, F=Jun, G=Jul, H=Aug, I=Sep, J=Oct, K=Nov, L=Dec)
- L** = Lot Code

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