Features

- High current capability: 1A
- Low-dropout voltage: 400mV
- Low ground current
- Accurate 1% guaranteed tolerance
- Extremely fast transient response
- Reverse-battery protection
- Zero-current shutdown mode (5-pin versions)
- Also characterized for smaller loads with industry-leading performance specifications
- Fixed voltage and adjustable versions

Applications

- Battery powered equipment
- High-efficiency "green" computer systems
- Automotive electronics
- High-efficiency linear power supplies
- High-efficiency post-regulator for switching supply

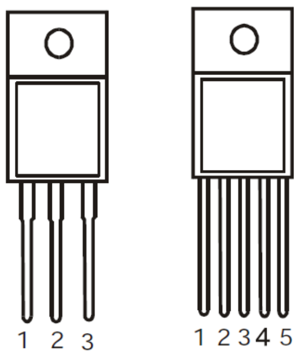
General Description

The LD6352 are high current, high accuracy, low-dropout voltage regulators. Using process with a PNP pass element, these regulators feature 400mV (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 LD6352 are fully protected against over current faults, reversed input polarity, and reversed lead insertion, over temperature operation and negative transient voltage spikes.

On the LD6352-Adj the ENABLE pin may be tied to V_{IN} if it is not required for ON/OFF control. The LD6352 are available in 3-pin (fixed version, 3.3V, 5V, others) and 5- pin (adjustable version) TO-220 and surface mount TO-263 packages.

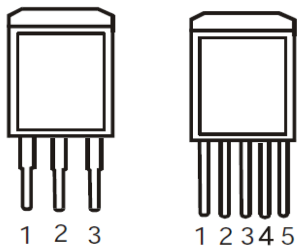
Package Pin Out

TO220



LD6352-XX LD6352-Adj

TO263



LD6352-XX LD6352-Adj

3 Terminal Devices:
Pin 1 =Input, 2 =Ground, 3 =Output

5 Terminal Devices: (adjustable with ON/OFF Control)
Pin 1 =Enable, 2 =Input, 3 =Ground, 4 =Output, 5 =Adjust

Ordering Information

		Packing Options	
Part No.	Package	Tube (TU)	Tape & Reel (TR)
LD6352	TO220	LD6352T4-TU	LD6352T4-TR
	TO263	LD6352T9-TU	LD6352T9-TR

- Package material default is "Green" package.

Product Marking

LD8888
SSSSS…
●

- ✧ Line 1 – "LD" is a fixed character
  8888: product name
- ✧ Line 2 – SSSSS…: lot number

Absolute Maximum Ratings

Parameter	Maximum	Unit
Power dissipation	Internally Limited	
Operating input voltage	26	V
Input supply voltage	-20 to +30	V
Operating junction temperature range	-40 to +125	°C
Storage temperature range	-65 to +150	°C
Lead Temperature (Soldering, 5 seconds)	260	°C

The values beyond the boundaries of absolute maximum rating may cause the damage to the device. Functional operation in this context is not implied. Continuous use of the device at the absolute rating level might influence device reliability. All voltages have their reference to device ground.

Electrical Characteristics

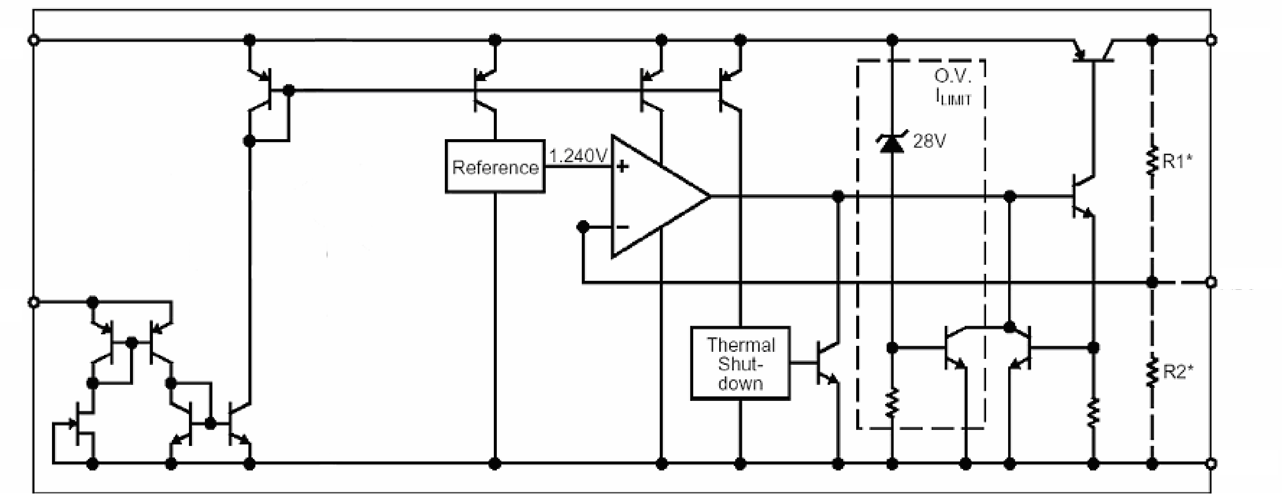
T_J = 25°C, I_O = 5mA, V_{IN} = V_{OUT} + 1V, V_{EN} = 2.3V, unless otherwise noted. Adjustable versions are programmed to 5.0V.

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Output voltage	V_{OUT}	I_O=5mA	-1	–	1	%
		5mA≤I_O≤1A, (V_{OUT}+1V)≤V_{IN}≤26V *8	-2	–	2	
Line regulation	R_{LINE}	I_O=5mA, (V_{OUT}+1V)≤V_{IN}≤26V	–	0.06	0.5	%
Load regulation	R_{LOAD}	V_{IN}=V_{OUT}+1V, 5mA≤I_{OUT}≤1A	–	0.2	1	%
Output voltage temperature coefficient *1	ΔVOUT/ΔT	–	–	–	100	ppm/°C
Dropout voltage	V_{DO}	ΔV_{OUT}=-1%, I_O=5mA *2*8	–	60	180	mV
		ΔV_{OUT}=-1%, I_O=100mA *2	–	170	–	–
		ΔV_{OUT}=-1%, I_O=1A *2*8	–	400	630	–
Ground current *3	I_{GND}	V_{IN}=V_{OUT} +1V, I_O=5mA	–	250	500	µA
		I_O=1A *8	–	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	$I_{OUT (lim)}$	V_{OUT}=0V *4*8	–	1.5	2.5	A
Reference LD6352-Adj						
Reference voltage	V_{REF}	–	1.228	1.210	1.252	V
		*8	1.215	–	1.265	
		*5*8	1.203	–	1.277	
Adjust pin bias current	I_{ADJ}	–	–	20	40	nA
		*8	–	–	60	
Adjust pin bias current temperature coefficient	ΔI_{ADJ}/ΔT	–	–	0.1	–	nA/°C
ENABLE Input (LD6352-Adj)						
Input logic voltage	V_{EN}	Low (OFF) *8	–	–	0.8	V
		High (ON) *8	2.3	–	–	
Enable pin input current	I_{EN}	V_{EN}=26V	–	20	60	µA
		V_{EN}=26V *8	–	–	75	
		V_{EN}=0.8V	–	–	2.5	
		V_{EN}=0.8V *8	–	–	5	
Regulator output current shutdown *6	I_{SD}	–	–	10	–	µA
		*8	–	–	500	

Notes

1: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range. **2:** Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99% of its nominal value with V_{OUT} + 1V applied to V_{IN}. **3:** 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. **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. **5:** V_{REF} ≤ V_{OUT} ≤ (V_{IN}-1V), 2.3V ≤ V_{IN} ≤ 26V, 5mA ≤ I_L≤1A, T_J ≤ T_J MAX. **6:** V_{EN} ≤0.8V and V_{IN} ≤26V, V_{OUT}=0. **7:** When used in dual supply systems where the regulator load is returned to a negative supply, the output voltage must be diode clamped to ground. **8:** values are guaranteed across the operating temperature range..

Block Diagram



*Feedback network in fixed versions only
**Adjustable version only

Typical Application Circuit and OTP Function Chart

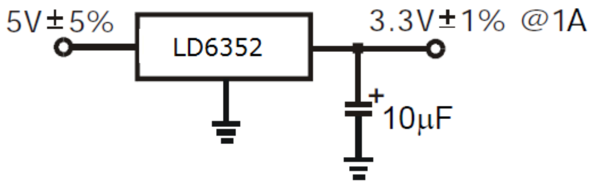
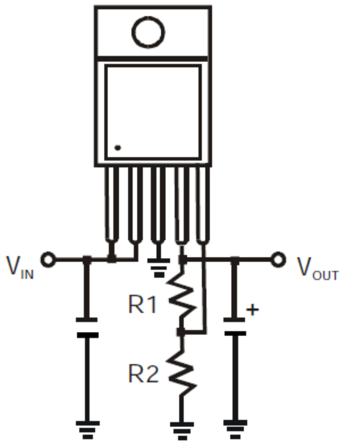


Figure1. Fixed output voltage



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

Figure2. Adjustable output voltage configuration. For best results, the total series resistance should be small enough to pass the minimum regulator load current.

Applications Information

The LD6352 are high performance low-dropout voltage regulators suitable for all moderate to high-current voltage regulator applications. Their 350mV dropout voltage at full load make 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 MIC2940 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 125^0C maximum safe operating temperature. Transient protection allows device survival even when the input voltage spikes between –20V and +30V.

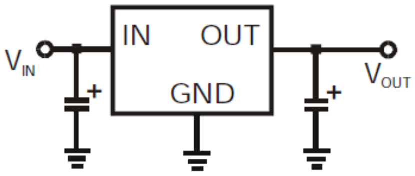


Figure 3. Linear regulators require only two capacitors for operation.

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:

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

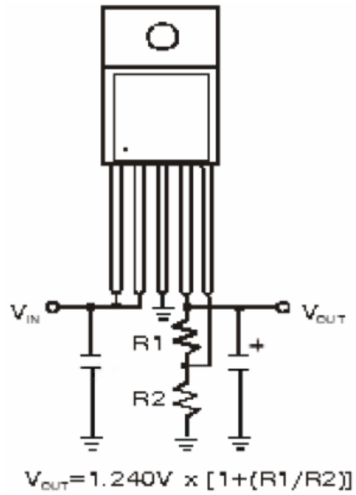
Where $T_{J\ MAX} \leq 125^0C$ and θ_{CS} is between 0 and $2^0C/W$.

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. LD6352 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 LD6352 regulators are specified between finite loads. If the output current 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

Figure 4. Adjustable Regulator with Resistors

The adjustable regulator version, LD6352-Adj allow programming the output voltage anywhere between 1.25V and the 26V maximum operating rating of the family.

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

$$R_1 = R_2\left(\frac{V_{OUT}}{1.240} - 1\right)$$

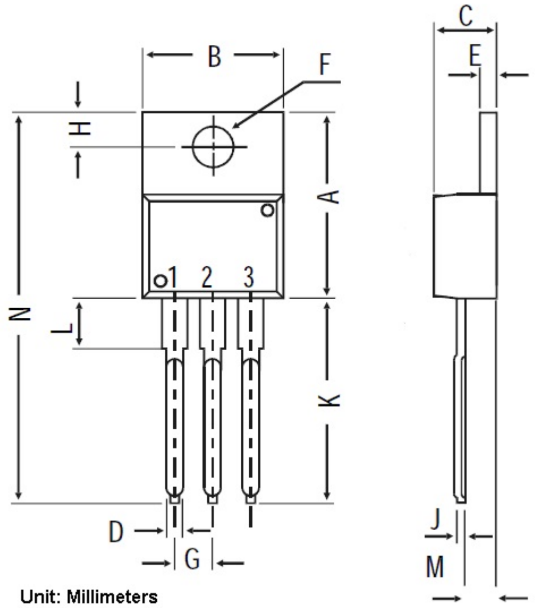
Where is V_O the desired output voltage. Figure 4 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation.

Enable Input

LD6352-Adj version feature an enable (EN) input that allows ON/OFF control of the device. Special design allows “zero” current drain when the device is disabled—only microamperes of leakage current 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.

Package Outline

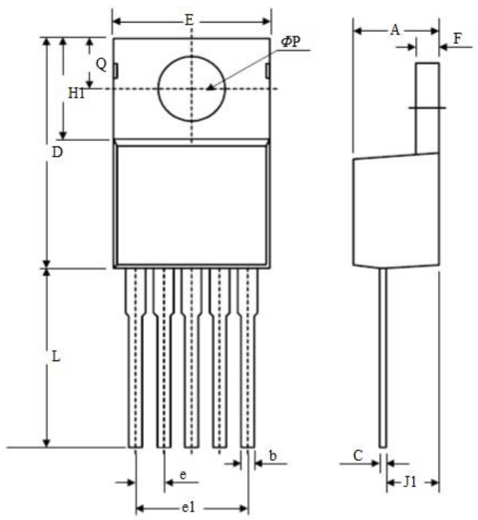
TO-220-3:



Unit: Millimeters

Symbols	Minimum	Normal	Maximum
A	14.42	15.47	16.51
B	9.63	10.15	10.67
C	3.56	4.20	4.83
D	-	0.90	-
E	1.15	1.28	1.4
F	3.75	3.82	3.88
G	2.29	2.54	2.79
H	2.54	2.99	3.43
J	-	0.56	-
K	12.7	13.72	14.73
L	2.8	3.44	4.07
M	2.03	2.48	2.92
N	-	31.24	-

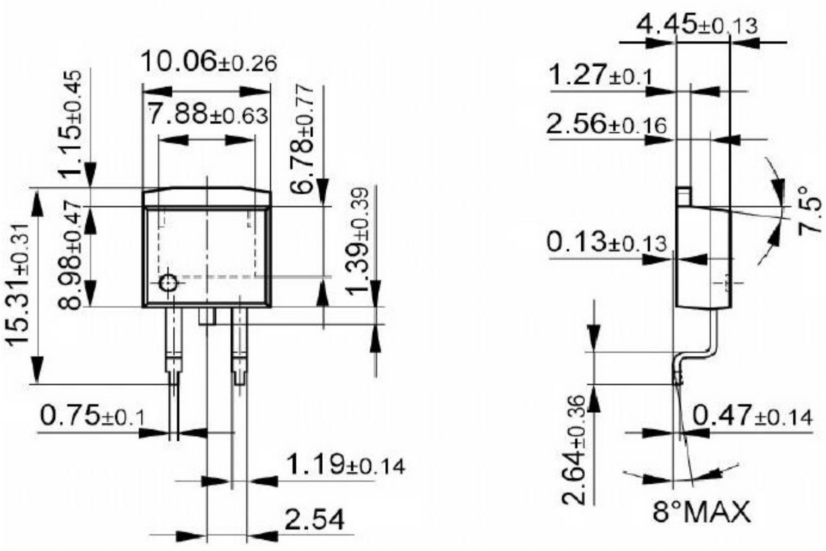
TO-220-5:



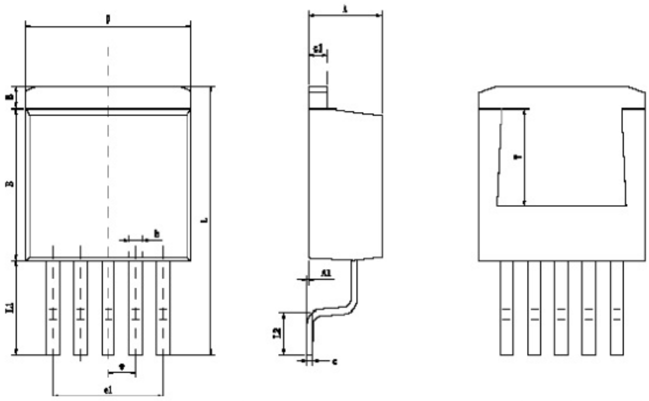
Symbols	Dimensions in Millimeters		
	Minimum	Normal	Maximum
A	4.07	4.45	4.82
b	0.76	0.89	1.02
C	0.36	0.5	0.64
D	14.22	14.86	15.5
E	9.78	10.16	10.54
e	1.57	1.71	1.85
e1	6.68	6.81	6.93
F	1.14	1.27	1.4
H1	5.46	6.16	6.86
J1	2.29	2.74	3.18
L	13.21	13.97	14.73
ΦP	3.68	3.81	3.94
Q	2.54	2.73	2.92

Package Outline (Cont')

TO-263-3:



TO-263-5:



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.470	4.670	0.176	0.184
A1	0.000	0.150	0.000	0.006
B	1.560	1.760	0.061	0.069
b	0.710	0.910	0.028	0.036
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	9.880	10.180	0.389	0.401
E	8.200	8.600	0.323	0.339
e	1.700TYP		0.067TYP	
e1	6.700	6.900	0.264	0.272
L	15.140	15.540	0.596	0.612
L1	5.080	5.480	0.200	0.216
L2	2.340	2.740	0.092	0.108

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