1A LOW- VOLTAGE LOW-DROPOUT REGULATOR

Features

- Fixed and adjustable (to 1.24V) output voltages
- 410mV typical dropout at 1A
  Ideal for 3.0V to 2.5V conversion
  Ideal for 2.5V to 1.8V 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

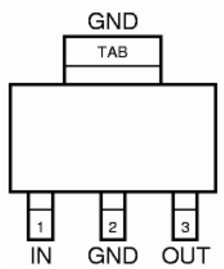
Applications

- LDO linear regulators for PC add-in cards
- High-efficiency linear power supplies
- SMPS post regulator
- Multimedia and PC processor supplies
- Battery chargers
- Low-voltage microcontrollers and digital logic

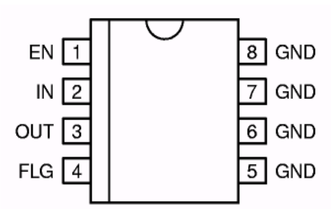
General Description

The LD6353 are 1A low-dropout linear voltage regulators that provide low-voltage, high-current output from an extremely small package. The LD6353 offers extremely low dropout (typically 410mV at 1A) and low ground current (typically 12mA at 1A).
The LD6353 is a fixed output regulator offered in the SOT-223 package. The LD6353 are fixed and adjustable regulators, respectively, in a thermally enhanced power 8-lead SOP (small outline package).
The LD6353 is ideal for PC add-in cards that need to convert standard 5V to 3.3V, 3.3V to 2.5V or 2.5V to 1.8V. A guaranteed maximum dropout voltage of 630mV over all operating conditions allows the LD6353 to provide 2.5V from a supply as low as 3.13V and 1.8V from a supply as low as 2.43V.
The LD6353 is fully protected with overcurrent limiting, thermal shutdown, and reversed-battery protection. Fixed voltages of 5.0V, 3.3V, 2.5V, 1.8 and 1.5V are available on LD6353, while the adjustable output voltages to 1.24V - on LD6353.

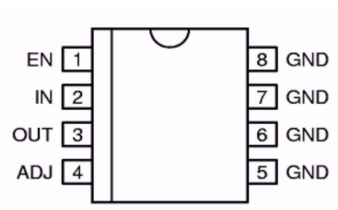
Package Pin Out



LD6353 fixed SOT-23



LD6353 fixed SOP-8



LD6353 adjustable SOP-8

Ordering Information

		Packing Options	
Part No.	Package	Tube (TU)	Tape & Reel (TR)
LD6353	SOT-223	LD6353L8-TU	LD6353L8-TR
	SOP-8	LD6353S1-TU	LD6353S1-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
Supply voltage (V_{IN})	-20 to +20	V
Enable voltage (V_{EN})	+20	V
Storage temperature (T_{STG})	-65 to +150	°C
Lead temperature (soldering, 5 sec.)	260	°C
ESD,Note 3		

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

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

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Output voltage	V_{OUT}	10mA	-1	–	+1	%
		$10mA \leq I_{OUT} \leq 1A$, $V_{OUT}+1V \leq V_{IN} \leq 8V$ *10	-2	–	+2	
Line regulation	R_{LINE}	$I_{OUT} = 10mA$, $V_{OUT}+1V \leq V_{IN} \leq 16V$	–	0.06	0.5	%
Load regulation	R_{LOAD}	$V_{IN} = V_{OUT}+1V$, $10mA \leq I_{OUT} \leq 1A$	–	0.2	1	%
Output voltage temperature coefficient*5	$\Delta V_{OUT}/\Delta T$		–	40	100	ppm/°C
Dropout voltage*6	V_{DO}	$I_{OUT} = 100mA$, $\Delta V_{OUT} = -1\%$	–	150	200	mV
		$I_{OUT} = 100mA$, $\Delta V_{OUT} = -1\%$ *10	–	–	250	
		$I_{OUT} = 500mA$, $\Delta V_{OUT} = -1\%$	–	275	–	
		$I_{OUT}=750mA$, $\Delta V_{OUT} = -1\%$	–	330	500	
		$I_{OUT} = 1A$, $\Delta V_{OUT} = -1\%$	–	410	550	
		$I_{OUT} = 1A$, $\Delta V_{OUT} = -1\%$ *10	–	–	630	
Ground current*7	I_{GND}	$I_{OUT} = 100mA$, $V_{IN} = V_{OUT}+1V$	–	700	–	μA
		$I_{OUT} = 500mA$, $V_{IN} = V_{OUT}+1V$	–	4	–	mA
		$I_{OUT} = 750mA$, $V_{IN} = V_{OUT}+1V$	–	7	–	
		$I_{OUT} = 1A$, $V_{IN} = V_{OUT}+1V$ *10	–	12	20	
Current limit	$I_{OUT (lim)}$	$V_{OUT} = 0V$, $V_{IN} = V_{OUT}+1V$	–	1.8	2.5	A
Turn-on time	t_{ON}		–	1.3	5	ms
Enable input						
Enable input voltage	V_{EN}	Logic Low (off) *10	–	–	0.8	V
		Logic High (on) *10	2.25	–	–	
Enable input current	I_{EN}	$V_{EN}=2.25V$	1	15	30	μA
		$V_{EN}=2.25V$ *10	–	–	75	
		$V_{EN}=0.8V$	–	–	2	
		$V_{EN}=0.8V$ *10	–	–	4	
Flag output						
Output leakage current	$I_{FLG (leak)}$	$V_{OH}=16V$ *10	–	0.01	1	μA
		$V_{OH}=16V$ *10	–	–	2	
Output low voltage*8	$V_{FLG (do)}$	$V_{IN}=16V$ *10	–	240	300	mV
		$V_{IN}=0.9xV_{OUT}$, $I_{OL}=250\mu A$, *10	–	–	400	
Low threshold	V_{FLG}	% of V_{OUT}	93	–	–	%
High threshold		% of V_{OUT}	–	–	99.2	
Hysteresis		% of V_{OUT}	–	1	–	
LD6353 only						
Reference voltage	V_{REF}		1.228	1.240	1.252	V
		*10	1.215	–	1.265	
		*9*10	1.203	–	1.277	
ADJ pin bias current	$I_{ADJBIAS}$		–	40	80	nA
		*10	–	–	120	
Reference voltage temperature coefficient*5	$\Delta V_{REF}/\Delta T$		–	20	–	ppm/°C
ADJ pin bias current temperature coefficient	$\Delta I_{ADJ}/\Delta T$		–	0.1	99.2	nA/°C

Notes: *1. Exceeding the absolute maximum ratings may damage the device. *2. The device is not guaranteed to function outside its operating rating. *3. Devices are ESD sensitive. Handling precautions are recommended. *4. PD_Max = (TJ_Max - TA) x θJA, where θJA is junction-to-ambient thermal resistance. *5. Output voltage temperature coefficient is VOUT (worst case) x (TJ_Max - TJ_Min) where TJ_Max is +125°C and TJ_Min is -40°C. *6. VDO = VIN - VOUT when VOUT decreases to 99% of its nominal output voltage with VIN = VOUT+1V. For output voltages below 2.25V, the dropout voltage is the input-to-output voltage differential with the minimum input voltage being 2.25V. The minimum input operating voltage is 2.25V. * 7. IGND is the quiescent current. IIN = IGND + IOUT *8. For adjustable device and fixed device with VOUT 2.5V. *9. VREF≦VOUT≦(VIN - 1V), 2.25V≦VIN≦16V, 10mA≦ IL≦1A. *10. -40°C ≦TJ≦+125°C.

Pin Description

Name	Description
EN	Enable (input): CMOS compatible control input. Logic High = enable; Logic Low or Open = shut-down.
IN	Supply (input)
OUT	Regulator output
FLG	Flag (output): Open collector error flag output. Active Low = output under voltage.
ADJ	Adjustment input: feedback input. Connect to resistive voltage-divider network.
GND	Ground

Block Diagram

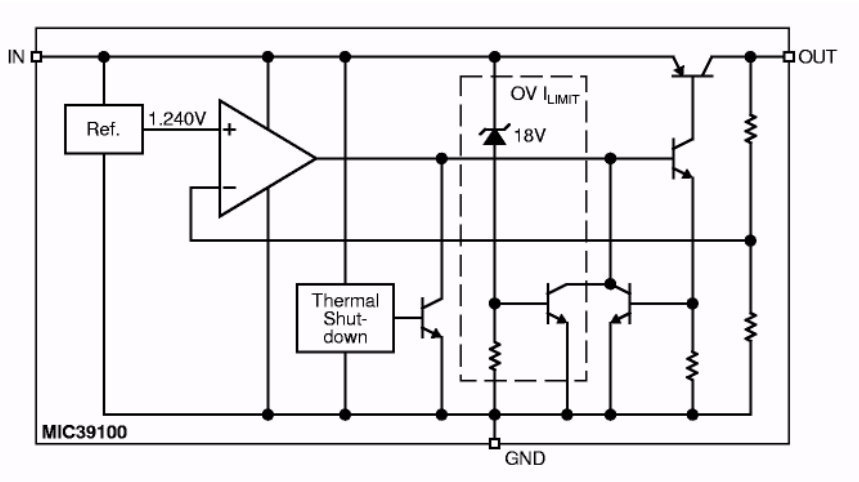


Fig.3. Block-diagram of LD6353 fixed regulator

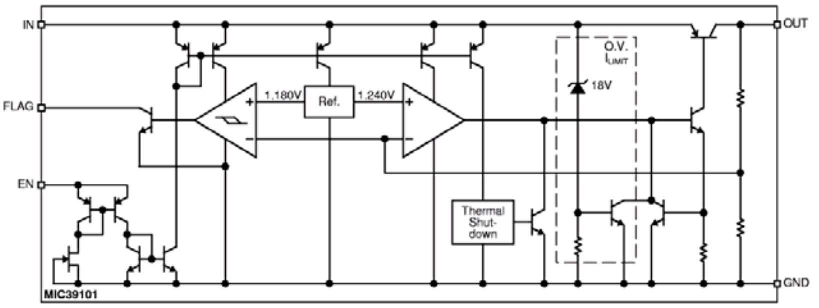


Fig.4. Block-diagram of LD6353 fixed regulator with Flag and Enable Block

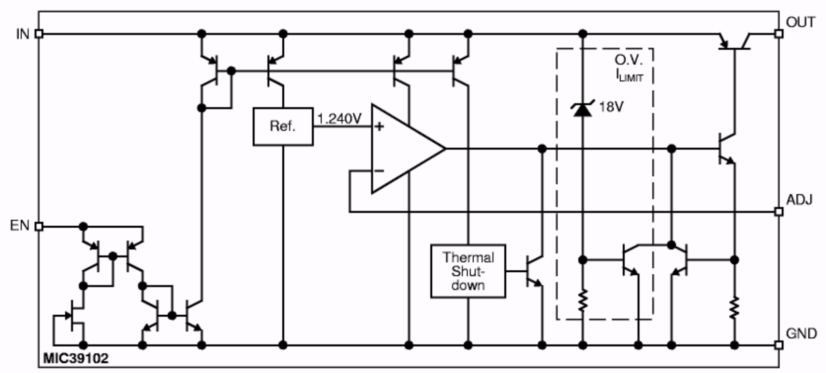


Fig.5. Block-diagram of LD6353 adjustable regulator

Typical Application Circuit and OTP Function Chart

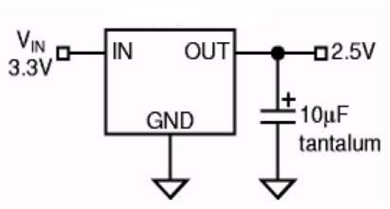


Fig.1a. 2.5V/1A regulator

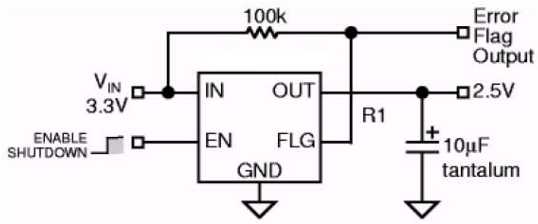


Fig.1b. 2.5V/1A regulator with an Error Flag

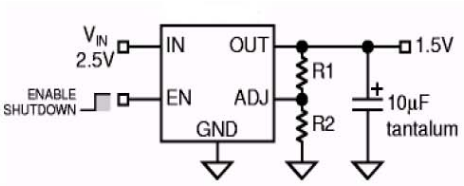


Fig.1c. 1.5V/1A adjustable regulator

APPLICATION INFORMATION

The LD6353 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 the older NPN-pass transistor designs, where the minimum dropout voltage is limited by the base-to-emitter voltage drop and collector-to-emitter saturation voltage, the dropout performance of the PNP output of these devices is limited only by the low V_{CE} saturation voltage.

The LD6353 regulator is fully protected from damage due to fault conditions. The linear current limiting is provided. The output current during the overload conditions is constant. The thermal shutdown disables the device when the die temperature exceeds the maximum safe operating temperature. The transient protection allows device (and load) survival even when the input voltage spikes above and below the 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 LD6353 requires an output capacitor to maintain stability and improve transient response. Proper selection of a capacitor is important to ensure proper operation.

Selection of the LD6353 output capacitor is dependent upon the ESR (equivalent series resistance)of the output capacitor to maintain the stability.

When the output capacitor is 10µF or greater, the output capacitor should have an ESR less than 2Ω. This will improve the transient response and promote the 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.

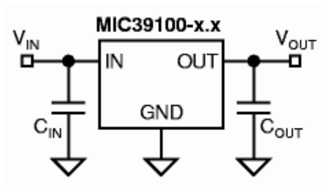


Fig.5. Capacitor requirements

Input Capacitor

An input capacitor of 1µF or greater is recommended when the device is more than 10 cm away from the bulk AC supply capacitance, or when the supply is a battery. Small, surface-mounted, ceramic chip capacitors can be used for the bypassing. Larger values will help one to improve the ripple rejection by bypassing the input to the regulator, further improving the integrity of the output voltage.

Error Flag

The LD6353 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. A low output voltage signifies a number of possible problems, including an overcurrent fault (the device is in current limit) or low input voltage. The FLG output is inoperative in over-temperature conditions. A pull-up resistor from FLG to either V_{IN} or V_{OUT} is required for proper operation. For the information regarding the minimum and maximum values of pull-up resistance, refer to the graph in the typical characteristics section of the data sheet.

Enable Input

The LD6353 versions feature an active High enable (EN) input that allows on-off control of the regulator. The current drain reduces to "zero" when the device is shut down, with only microamperes 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 LD6353 has an excellent transient response to variations in the input voltage and load current. The device has been designed to respond quickly to the load current 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 one to improve performance even further.

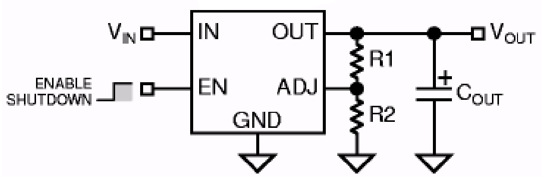
By virtue of its low-dropout voltage, this device does not saturate into dropout as readily as similar NPN-based designs. When converting 3.3V to 2.5V or 2.5V to 1.8V, the NPN-based regulators are already operating in the dropout, with typical dropout requirements of 1.2V or greater. To convert down to 2.5V or 1.8V without operating in the dropout, NPN- based regulators require an input voltage of 3.7V at the very least.

The LD6353 regulator will provide an excellent performance with an input as low as 3.0V or 2.5V, respectively. This gives the PNP-based regulators a distinct advantage over the older, NPN-based linear regulators.

Minimum Load Current

The LD6353 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



$$V_{OUT} = 1.240V\left(1+\frac{R1}{R2}\right)$$

Fig.6. The adjustable regulator with resistors

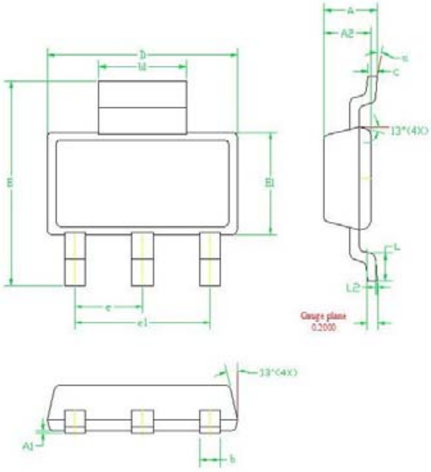
The LD6353 allows programming the output voltage anywhere between 1.24V and 16V (the maximum operating rating of the family). Two resistors are used. The resistor values are calculated by:

$$R1 = R2\left(\frac{V_{OUT}}{1.240} - 1\right)$$

where V_{OUT} is the desired output voltage. Fig.6 shows the component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see above).

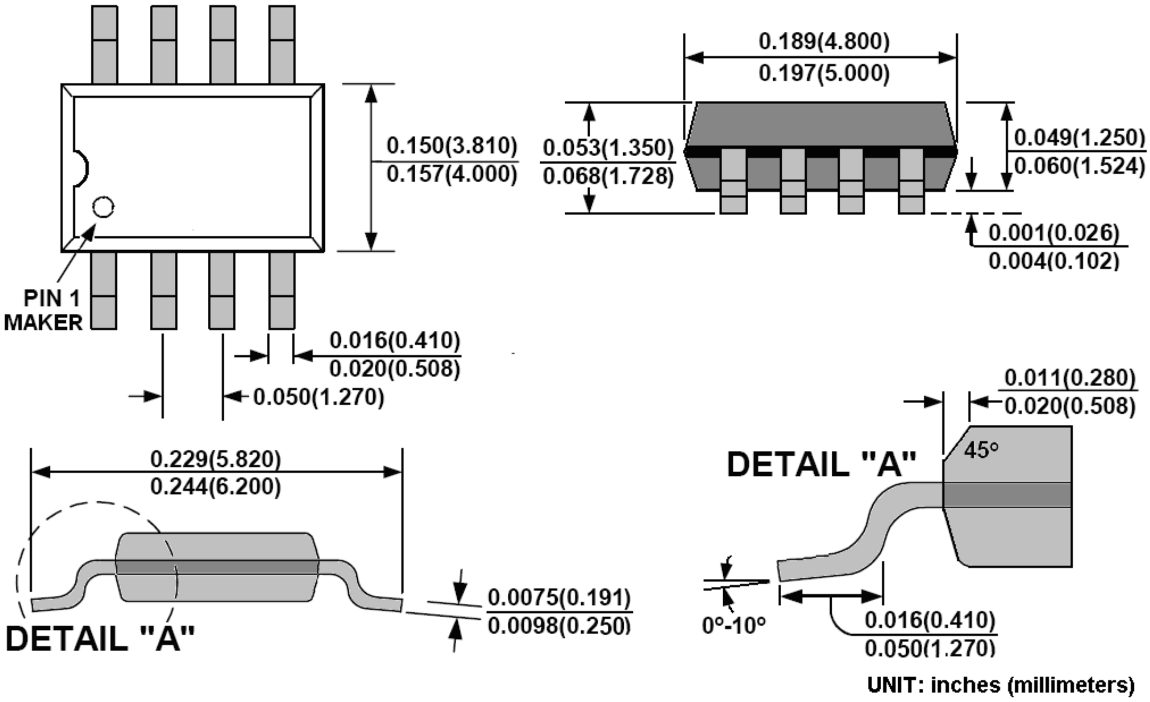
Package Outline

SOT-223:



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.52	1.80	0.061	0.071
A1	0.02	0.10	0.0008	0.0040
A2	1.50	1.70	0.059	0.067
b	0.60	0.80	0.024	0.031
b1	2.90	3.10	0.114	0.122
c	0.24	0.32	0.009	0.013
D	6.30	6.80	0.248	0.268
E1	3.30	3.70	0.130	0.146
e	2.30 BSC		0.090 BSC	
e1	4.60 BSC		0.181 BSC	
E	6.70	7.30	0.264	0.287
L	0.90 MIN		0.036 MIN	
L2	0.06 BSC		0.0024BSC	
α	0°	10°	0°	10°

SOP-8:



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