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# Precision, Adjustable Shunt Regulator (600 mV Reference)



## FEATURES

- 600 mV low voltage reference
- ±6 mV initial accuracy
- High PSRR: 45 dB at 300 kHz
- Better line regulation: 1 mV ( $V_{IN}$  from 2.2 V to 18 V)
- Low supply current: 90  $\mu$ A
- Open drain output
- Directly drives optocouplers
- Industrial temperature range of -40°C to 85°C
- RoHS-compliant 5-lead TSOT23 package

## APPLICATION

- SMPS control loop
- Low temperature coefficient voltage reference
- Power management
- Replaces zener diodes
- Isolated DC-to-DC converters
- Network, telecom and cellular base station
- Adjustable voltage reference

## DESCRIPTION

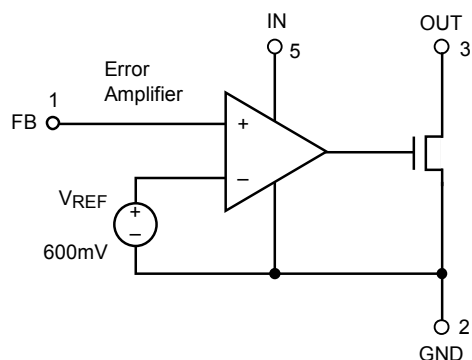
The CAT102 is a low-voltage reference and amplifier. Designed for the control loop of low-voltage power supplies, the reference voltage has been designed for 600 mV. Over a temperature from -40°C to 85°C, the reference voltage is within 8 mV of the nominal 600mV. In addition, the error amplifier output and the supply voltage pin (IN) are on separate pins.

Power supply rejection is a high 45 dB at 300 kHz. The output, OUT, can sink 20 mA at a maximum saturation voltage of 250 mV.

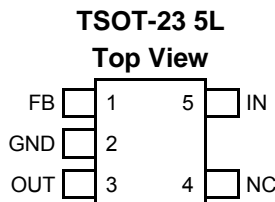
When combined with an optocoupler, the CAT102 can be used as an error amplifier that controls the feedback loop in isolated low-output voltage switching power supplies.

For Ordering Information details, see page 7.

## FUNCTIONAL DIAGRAM



## PIN CONFIGURATION



## PIN DESCRIPTION

Pin Name	Function
FB	Inverting input to error amplifier
GND	Ground
OUT	Output of error amplifier. Source & sink current capability is 20 mA.
NC	No connection
IN	Positive supply

ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>

Parameters	Ratings	Units
V <sub>IN</sub> Voltage	20	V
OUT Voltage	20	V
FB Voltage	20	V
V <sub>IN</sub> , OUT, FB Current	50	mA
Operating Junction Temperature (10 seconds)	150	°C
Lead Soldering Temperature (10 seconds)	260	°C
Storage Temperature Range	-65 to +150	°C

## ELECTRICAL CHARACTERISTICS

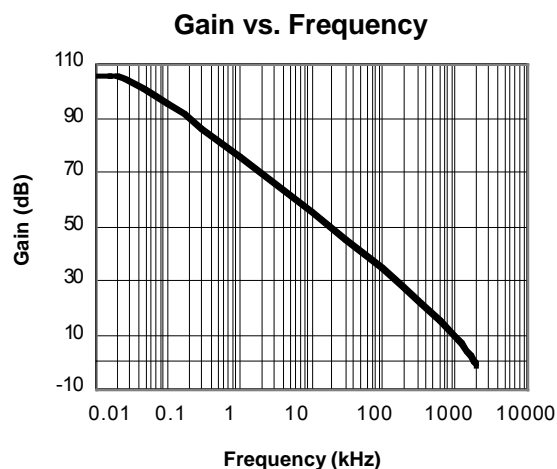
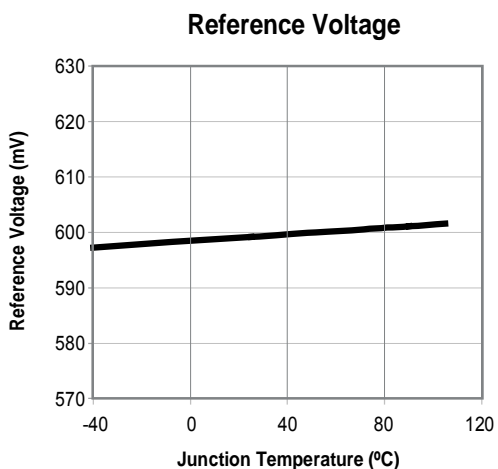
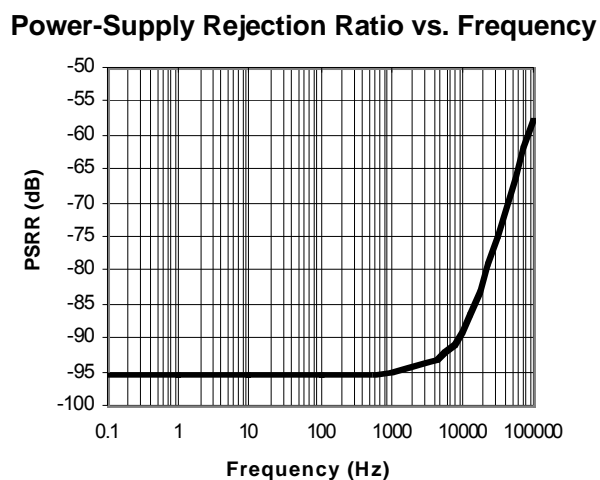
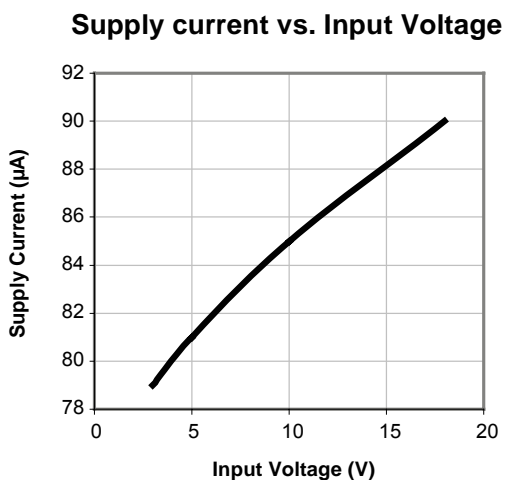
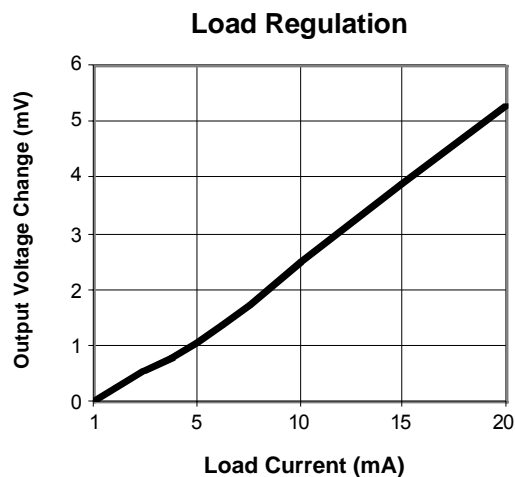
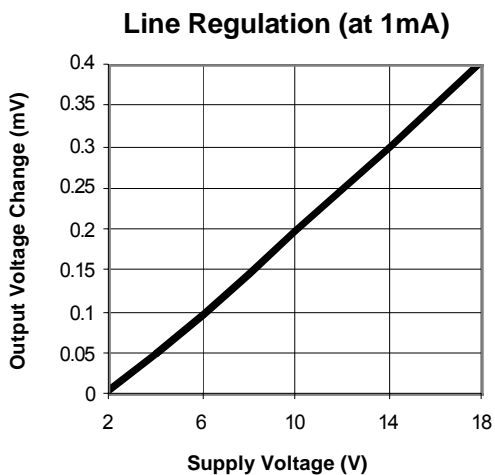
Electrical characteristics are guaranteed over the full operating temperature range of -40°C to +85°C unless otherwise specified. Ambient temperature must be de-rated based upon power dissipation and package thermal characteristics.<sup>1</sup> Unless otherwise stated, test conditions are V<sub>IN</sub> = 3 V, FB = OUT, I<sub>OUT</sub> = 1 mA.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V <sub>IN</sub>	Supply Voltage Range		2.2		18	V
I <sub>IN</sub>	Quiescent Supply Current	V <sub>OUT</sub> = 1 V		90	500	μA
V <sub>FB</sub>	FB Threshold Reference Voltage	T <sub>J</sub> = 25°C	594	600	606	mV
		-40°C < T <sub>J</sub> < 85°C	592		608	
	Line Regulation	V <sub>IN</sub> = 2.2 V to V <sub>IN</sub> = 18 V V <sub>OUT</sub> = 0.6 V		0.5	1	mV
	Load Regulation	I <sub>OUT</sub> = 1 mA to 10 mA V <sub>OUT</sub> = 0.6 V		3	8	mV
I <sub>FB</sub>	FB Input Current		-500		500	nA
PSRR <sup>(3)</sup>	Reference Power Supply Rejection	Frequency = 300 kHz	35	65		dB
A <sub>V</sub>	Error Amplifier Open Loop Gain	I <sub>OUT</sub> = 2 mA, V <sub>OUT</sub> = 1 V	60	80		dB
BW <sup>(3)</sup>	Unity Gain Frequency	I <sub>OUT</sub> = 2 mA, V <sub>OUT</sub> = 1 V	1	2		MHz
V <sub>OUT</sub>	Output Saturation voltage	I <sub>OUT</sub> = 20 mA, V <sub>FB</sub> = HIGH		130	250	mV
TRANSC <sup>(3)</sup>	Output Transconductance	I <sub>OUT</sub> = 1 mA to 20 mA		2.5		mA/mV
I <sub>LEAK</sub>	Output Leakage Current	V <sub>OUT</sub> = 16 V, V <sub>FB</sub> = 0		0.5	2	μA
I <sub>OUT(MAX)</sub>	Maximum Output Current	V <sub>OUT</sub> = 0.3 V	20			mA

**Notes:**

- (1) These are stress ratings only and functional operation is not implied. Exposure to absolute maximum ratings for prolonged time periods may affect device reliability. All voltages are with respect to ground.
- (2) Thermal Characteristics (Θ<sub>JA</sub>) of TSOT-23 5-lead: 255°C/W
- (3) This parameter is controlled by design and verified during product evaluation. It is not production tested.

TYPICAL PERFORMANCE CHARACTERISTICS



**APPLICATIONS INFORMATION**

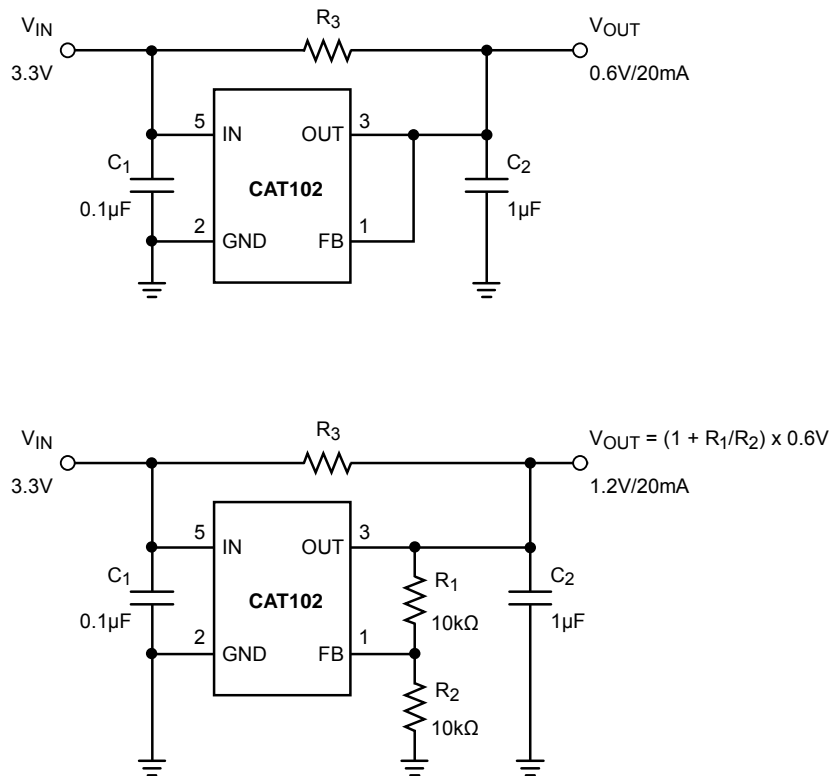
The CAT102 adjustable shunt regulator features isolated supply inputs and outputs, ideal for isolated power-supply applications using an optocoupler in the feedback path. The CAT102 sinks 20 mA with  $V_{OUT}$  at 0.3 V. The wide input supply range allows the device to operate from 2.2 V to 18 V. The CAT102 compares the FB input to a precision 600mV reference. If the FB input is low, the OUT pin sinks no current. If FB rises above 600 mV, the OUT pin sinks up to 20 mA.

The current limit can be adjusted by using a resistor R3 connected between the IN and OUT pins. For example, a 3.3 V supply  $V_{IN}$  is associated with  $R_3 = 135 \Omega$ , and a 10 V supply works best with  $R_3 = 470 \Omega$ . The CAT102 shunt regulator is limited to low-current applications with the OUT pin capable of sinking up to 20 mA max.

Figure 1 shows the CAT102 configured as a shunt regulator. To generate an output voltage of 0.6 V, the FB pin has to be directly connected to the OUT pin. A 1.0  $\mu$ F capacitor from OUT to GND is recommended when the output voltage is 0.6 V. A resistor-divider connected from OUT to GND is used to produce a higher output voltage as set by the following equation:

$$V_{OUT} = (1 + R_1/R_2) \times 0.6 \text{ V}$$

**Figure 1. Application circuits for 0.6 V output and 1.2 V output voltages**



## TYPICAL APPLICATION

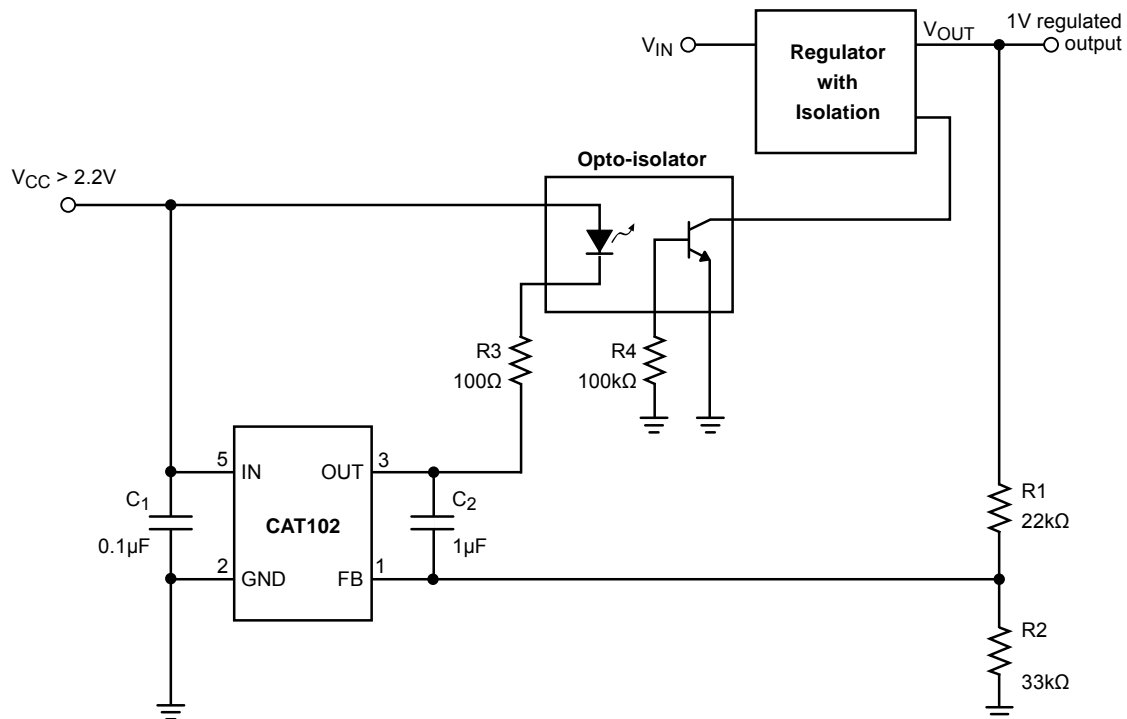
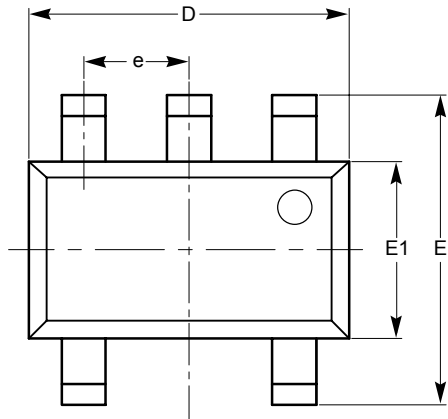


Figure 2. Opto-Feedback Application Circuit

In order to allow proper operation of the optocoupler and the CAT102, the supply voltage  $V_{CC}$  must be greater than 2.2 V.

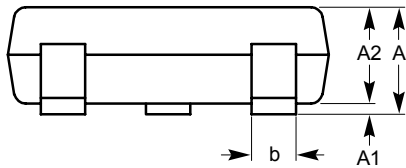
PACKAGE OUTLINE DRAWING

TSOT-23 5-Lead (TD)

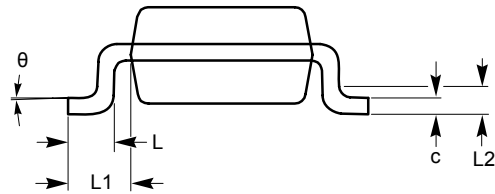


TOP VIEW

SYMBOL	MIN	NOM	MAX
A			1.00
A1	0.01	0.05	0.10
A2	0.80	0.87	0.90
b	0.30		0.45
c	0.12	0.15	0.20
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
e	0.95 TYP		
L	0.30	0.40	0.50
L1	0.60 REF		
L2	0.25 BSC		
$\theta$	0°		8°



SIDE VIEW

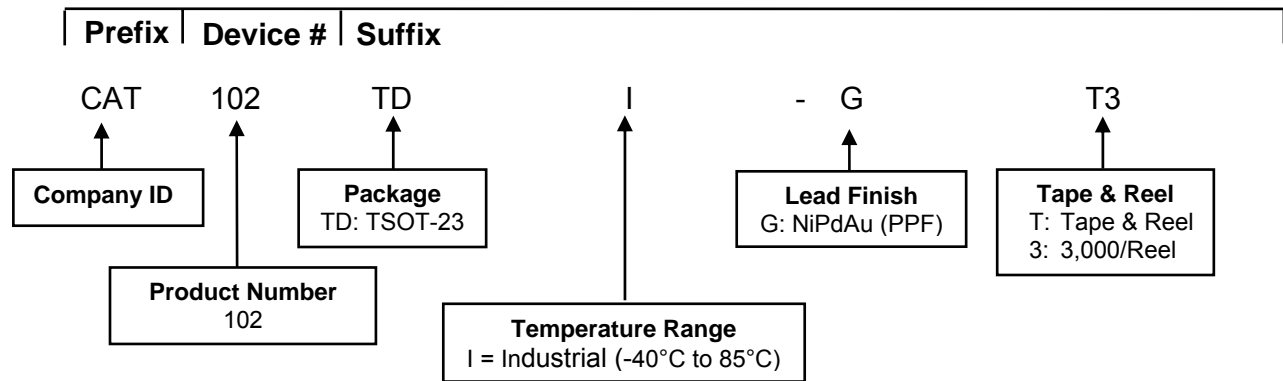


END VIEW

Notes:

- (1) All dimensions in millimeters. Angles in degrees.
- (2) Complies with JEDEC standard MO-193.

EXAMPLE OF ORDERING INFORMATION



<b>ORDERING PART NUMBER</b>
CAT102TDI-G


Notes:

- (1) All packages are RoHS-compliant (Lead-free, Halogen-free)
- (2) The device used in the above example is a CAT102TDI-GT3 (TSOT-23, Industrial Temperature, NiPdAu, Tape & Reel, 3,000/Reel)



**REVISION HISTORY**

Date	Rev.	Description
29-Jan-07	M	Added Ordering Information
16-Jun-07	N	Changed package from SOT-23 to TSOT-23 Updated Features Updated Functional Diagram Updated Electrical Characteristics Updated Typical Performance Characteristics Changed termination from SnPb to NiPdAu Added MD- to document Number
19-Nov-08	O	Change logo and fine print to ON Semiconductor
05-Feb-09	P	Updated Electrical Characteristics Table

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