TC57

Line Regulator Controller

Features

- Low Dropout Voltage: 100mV @ 650mA with FZT749 PNP Transistor
- 2.7V to 8V Supply Range
- Low Operating Current: 50μA Operating, 0.2μA Shutdown
- Low True Chip Enable
- Output Accuracy < ±2%
- Small Package: 5-Pin SOT-23A

Applications

- Battery Operated Systems
- Portable Instruments
- High-Efficiency Linear Regulator
- Post-Regulator for SMPS
- Power Supply or Battery Back-Up Supply for Memory

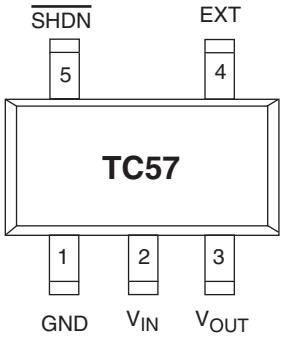
Device Selection Table

Part Number	Output Voltage	Package	Temperature Range
TC572502ECT	2.5V	5-Pin SOT-23A	-40°C to +85°C
TC573002ECT	3.0V	5-Pin SOT-23A	-40°C to +85°C
TC573302ECT	3.3V	5-Pin SOT-23A	-40°C to +85°C

Other output voltages and package options are available. Please contact Microchip Technology Inc. for details.

Package Type

5-Pin SOT-23A



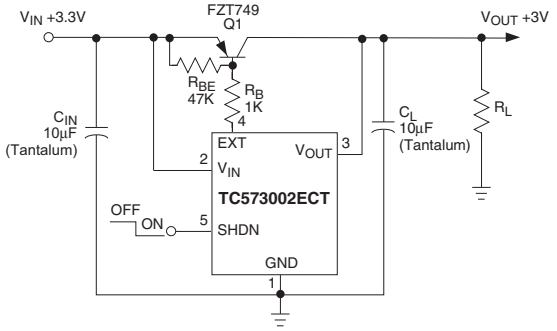
NOTE: 5-Pin SOT-23A is equivalent to the EIAJ SC-74A.

General Description

The TC57 is a low dropout regulator controller that operates with an external PNP pass transistor, allowing the user to tailor the LDO characteristics to suit the application at hand. This results in lower dropout operation (and often lower cost) compared with traditional linear regulators with on-board pass transistors. The maximum output current of a TC57-based regulator circuit is limited only by the characteristics of the external pass transistor. For example, a maximum output current of 650mA (with a dropout voltage of 100mV) results when an FZT749 pass transistor is used, while a Darlington configuration can deliver up to 4A.

Flexibility, and superior performance make this family of regulator controllers the ideal choice in applications where low dropout voltage and low installed cost are key.

Functional Block Diagram



3.3V Line Input, 3.0V, 500mA Output LDO

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1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

Input Voltage .....+12V
Output Current 50mA
Output Voltage..... -0.3V to (V_{IN} + 0.3V)
Power Dissipation.....150mW
Operating Temperature Range.....-40°C to +85°C
Storage Temperature Range.....-40°C to +150°C

*Stresses above 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 above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

TC55 ELECTRICAL SPECIFICATIONS

TC57EP3002 Electrical Characteristics: $\overline{SHDN}$ = GND, $V_{IN} = V_{OUT}$ + 1V, V_{OUT} = 3V to 5V, I_{OUT} = 0, T_A = 25°C, Test Circuit of Figure 3-1, unless otherwise noted. **(Note 2)**

Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
V_{IN}	Input Voltage	—	—	8	V	
V_{EXT}	Voltage on EXT Output	—	—	8	V	
V_{OUT}	Output Voltage	0.98 x V_R	V_R ±0.5%	1.02 x V_R	V	I_{OUT} = 50mA **(Note 1)**
ΔV_{OUT}	Load Regulation	-60	—	60	mV	1mA ≤ I_{OUT} ≤ 100mA **(Note 3)**
V_{IN} - V_{OUT}	Dropout Voltage	—	100	—	mV	I_{OUT} = 100mA **(Note 2)**
I_{DD}	Supply Current	—	50	80	µA	$V_{\overline{SHDN}} = V_{IN}$ = 5V
I_{SHDN}	Shutdown Supply Current	—	—	0.6	µA	$V_{\overline{SHDN}}$ = GND
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	—	0.1	0.3	%/V	I_{OUT} = 50mA, 4V ≤ V_{IN} ≤ 8V **(Note 3**)
$\Delta V_{OUT}/\Delta T$	V_{OUT} Temperature Coefficient	—	±100	—	ppm/°C	I_{OUT} = 10mA, -40°C < T_J < +85°C **(Note 3)**
I_{LEXT}	EXT Pin Leakage Current	—	—	0.5	µA	
I_{EXT}	EXT Sink Current	—	—	25	mA	**Note 4**
V_{IH}	SHDN Input High Logic Threshold	1.5	—	—	V	
V_{IL}	SHDN Input Low Logic Threshold	—	—	0.25	V	
I_{IH}	SHDN Input Current @ V_{IH}	—	—	0.1	µA	$V_{\overline{SHDN}} = V_{IN}$ = 5V
I_{IL}	SHDN Input Current @ V_{IL}	-0.2	-0.05	0	µA	$V_{\overline{SHDN}}$ = GND

Note 1: V_R is the regulator output voltage setting.
2: Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at a 1V differential.
3: Varies with type of pass transistor used. Numbers shown are for the test circuit of Figure 3-1.
4: The product of I_{EXT} x V_{EXT} must be less than the maximum allowable power dissipation.

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2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

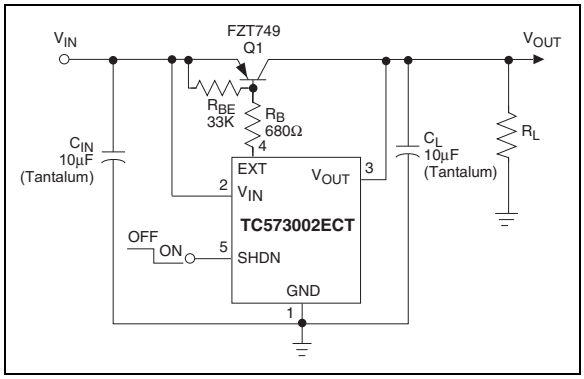
Pin No. (5-Pin SOT-23A)	Symbol	Description
1	GND	Ground terminal.
2	V_{IN}	Supply voltage input. Positive input voltage of 2.7V to 8.0V.
3	V_{OUT}	Regulator voltage sense input. Connects to the collector of the external PNP pass transistor.
4	EXT	Base Drive for the external PNP pass transistor.
5	SHDN	Shutdown Input. The device is enabled when SHDN $\leq V_{IL}$. The device enters a low power shutdown state when SHDN $\geq V_{IH}$. During shutdown, the output is disabled, and supply current falls to less than 1μA.

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3.0 DETAILED DESCRIPTION

The TC57 series of precision low dropout regulator controllers use an external PNP transistor to accommodate a wide range of output currents. A series resistor (R_B) limits the maximum base current drawn from the PNP transistor. Limiting the base drive both determines the regulator's output current capability, as well as limits ground current when the device is operated in dropout. The PNP transistor's $V_{CE(SAT)}$ is the only factor limiting dropout voltage.

FIGURE 3-1: TEST CIRCUIT



3.1 Transistor Selection

The PNP pass transistor must have satisfactory power dissipation, current gain, and collector current specifications to suit the application at hand. The maximum output current the circuit can deliver is influenced by h_{FE}. The highest guaranteed output current is given by:

EQUATION 3-1:

$$I_{LOAD(MAX)} = 25\ mA \times h_{FE(MIN)}$$

The transistor's actual power dissipation (PD) is equal to the maximum load current times the maximum input/output voltage differential, or:

EQUATION 3-2:

$$P_D \approx I_{LOAD(MAX)} \times (V_{IN(MAX)} - V_{OUT(MIN)})$$

The ideal transistor has a minimum h_{FE} of 100, and a $V_{CE(SAT)}$ of less than 0.6V at full output current. For example, the Zetex FZT749 has an h_{FE} of 170 at a collector current of 1A, and a guaranteed $V_{CE(SAT)}$ of 0.3V at a base current of 100mA. It is packaged in a SOT-223 and is recommended for use with the TC57. Other transistors are also suitable, depending on the required input and output voltages and output current (Table 3-1).

3.2 Base-Current Limiting Resistor

Base current limiting resistor R_B can be estimated using:

EQUATION 3-3:

$$R_B = \frac{h_{FE}\,(V_{IN} - V_{BE})}{I_{OUT}}$$

Where:

h_{FE} is the current gain of the pass transistor

V_{IN} is the input voltage (in volts)

V_{BE} is the base-emitter voltage at the desired output current (in volts)

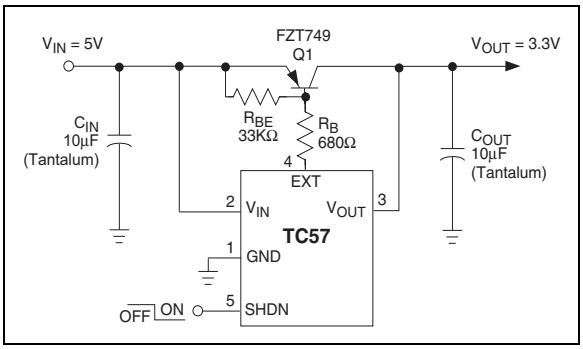
I_{OUT} is the output current (in Amps)

For example, assume a desired continuous output current of 1.0A, an input voltage of 5V, and an FZT749 pass transistor. The FZT749 has a typical h_{FE} of 170, and a V_{BE} of 0.8V; both specified at a collector current of 1.0A. Substituting these values into the equation above results in an R_B value of 704Ω (closest standard value = 680Ω).

3.3 Pull-Up Resistor and Output Capacitor

A pull-up resistor (R_{BE}, installed between the base and emitter of the pass transistor) facilitates rapid turn-off of the pass transistor in the event of a sudden decrease in load (Figure 3-2). Recommended values for this resistor are between 20KΩ and 47KΩ. A Tantalum output capacitor of at least 10µF must be used to guarantee stability. Higher values decrease output noise and eliminate power-on overshoot, but extend power-up times. Table 3-1 lists several capacitor choices.

FIGURE 3-2: 3.3V, 1A REGULATOR USING 5V SUPPLY INPUT



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3.4 Input Capacitor

The addition of an input capacitor further reduces output noise, and negates the effects of power supply input impedance. A 10μF (min) Tantalum capacitor is recommended.

3.5 Shutdown Mode

The TC57 enters a low power shutdown mode when the shutdown input (SHDN) is high. During shutdown, the regulator is disabled, the output capacitor is discharged through the load, and supply current to the TC57 decreases to less than 1μA. Normal operation resumes when SHDN is brought low. If the shutdown mode is not used, SHDN should be tied to V_{IN}.

TABLE 3-1: COMPONENT SUPPLIERS

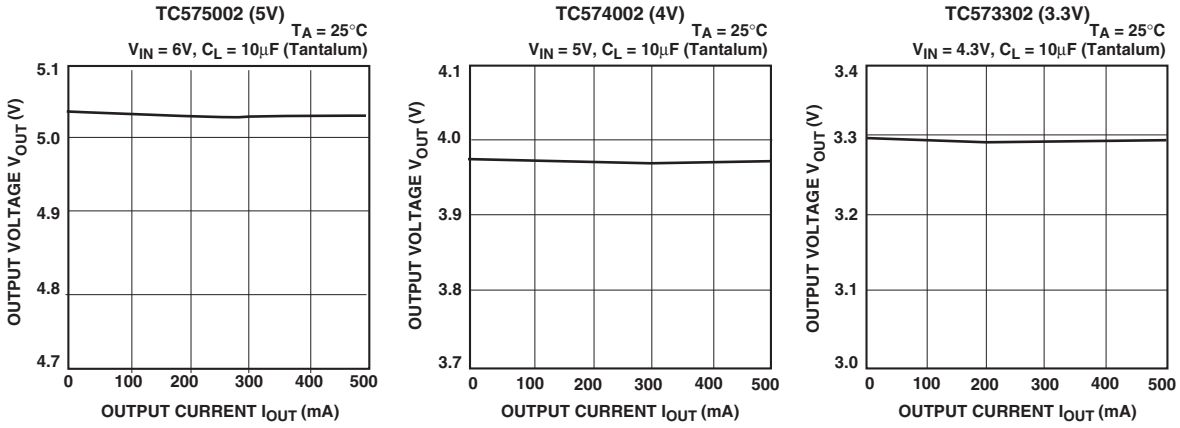
Device	Mounting Method	Manufacturer	Website
CAPACITORS			
267 Series	Surface Mount	Matsuo	http://www.matsuoelectronics.com
F95 Tantalum Series	Surface Mount	Nichicon	http://www.nichicon-us.com
595 Tantalum Series	Surface Mount	Sprague	http://www.vishay.com/brands/sprague
OS-CON Series	Through-Hole	Sanyo	http://www.sanyovideo.com
LXF Series	Through-Hole	United Chemi-Con	http://chemi-con.com
TRANSISTORS			
ZTX749	Through-Hole	Zetex	http://www.zetex.com
2N4403	Through-Hole	ON SEMI	http://www.onsemi.com/home
2N2907A	Through-Hole	ON SEMI	http://www.onsemi.com/home
FZT749	Surface Mount	Zetex	http://www.zetex.com

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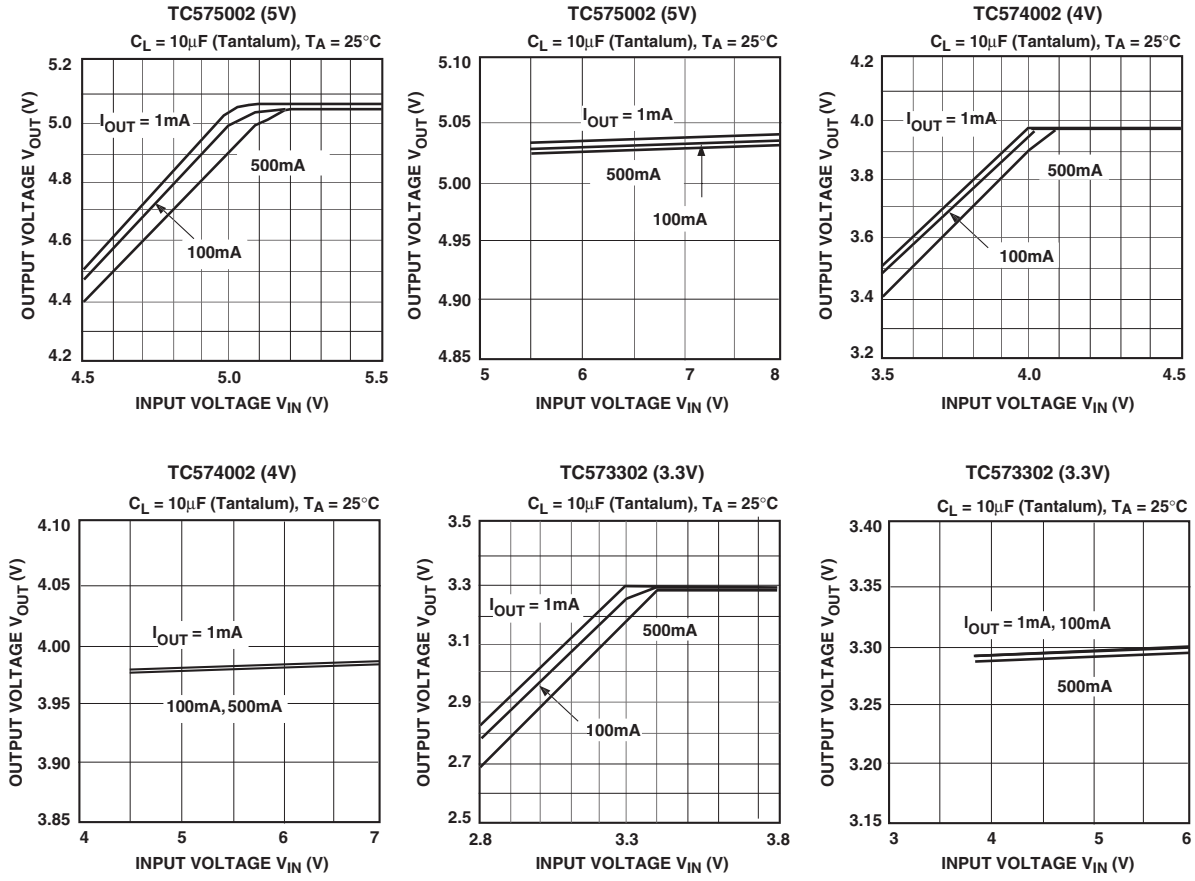
4.0 TYPICAL CHARACTERISTICS

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

1. OUTPUT VOLTAGE vs. OUTPUT CURRENT



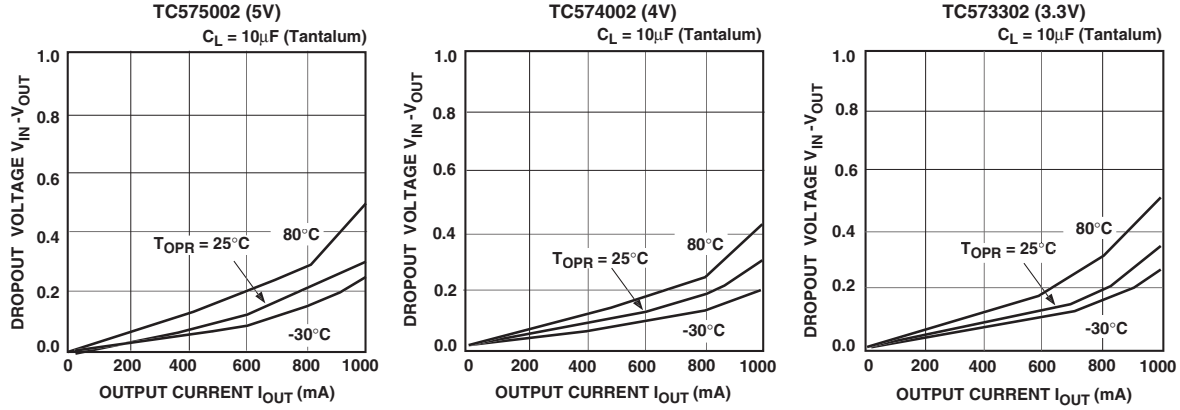
2. OUTPUT VOLTAGE vs. INPUT VOLTAGE



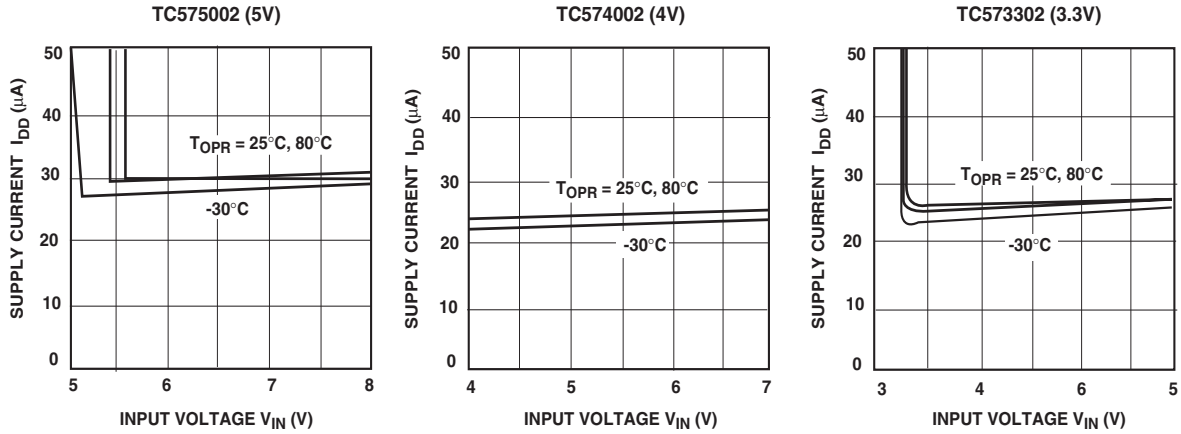
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4.0 TYPICAL CHARACTERISTICS (CONTINUED)

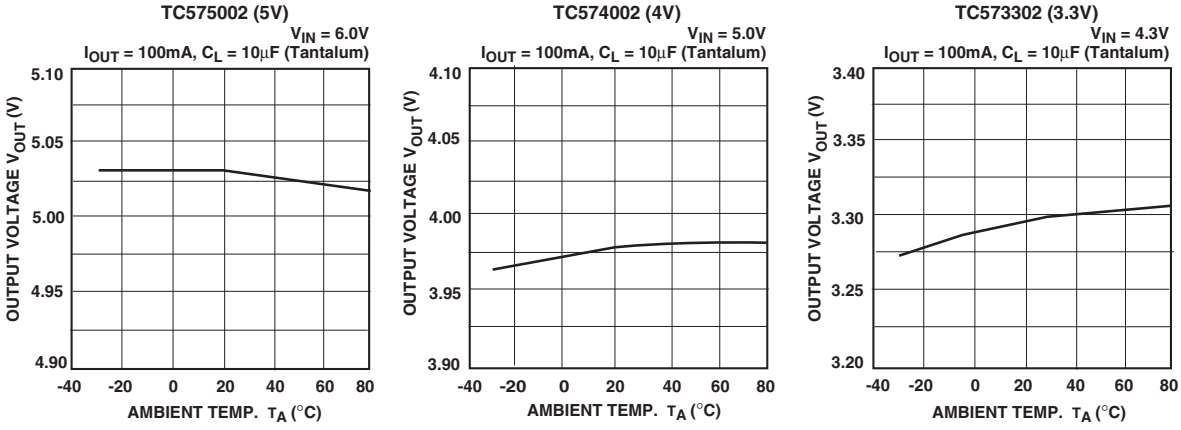
3. DROPOUT VOLTAGE vs. OUTPUT CURRENT



4. SUPPLY CURRENT vs. INPUT VOLTAGE

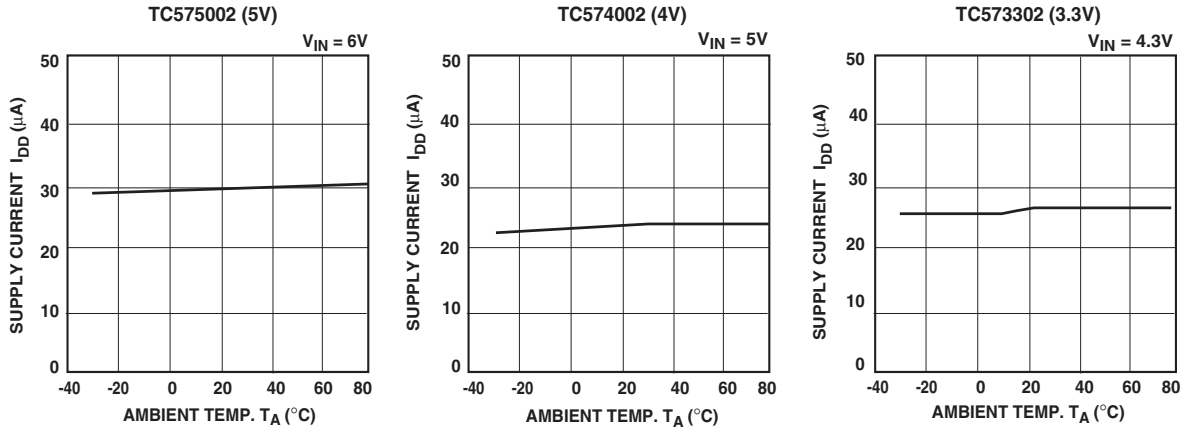


5. OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE

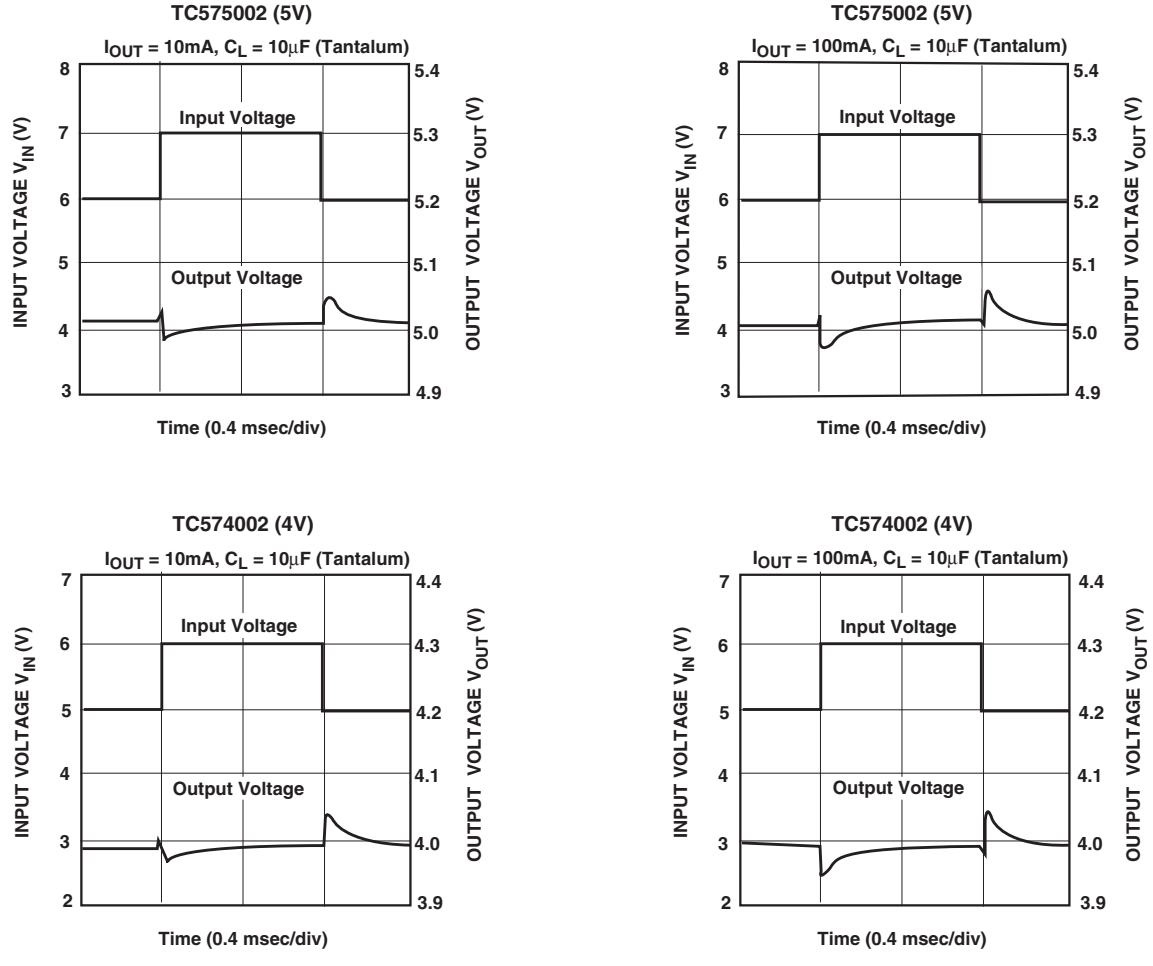


4.0 TYPICAL CHARACTERISTICS (CONTINUED)

6. SUPPLY CURRENT vs. AMBIENT TEMPERATURE



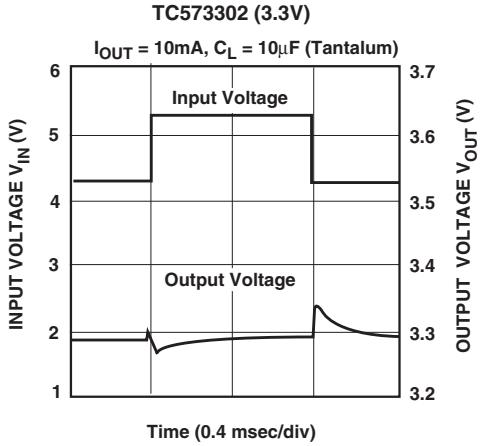
7. INPUT TRANSIENT RESPONSE

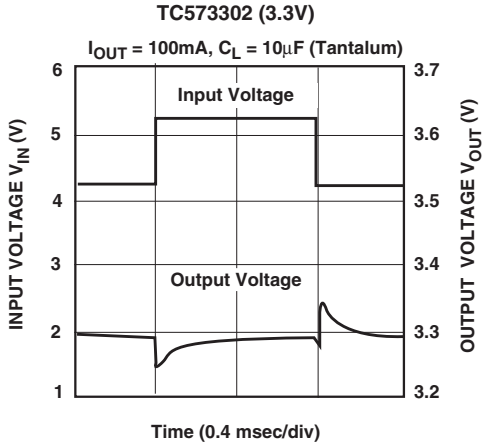


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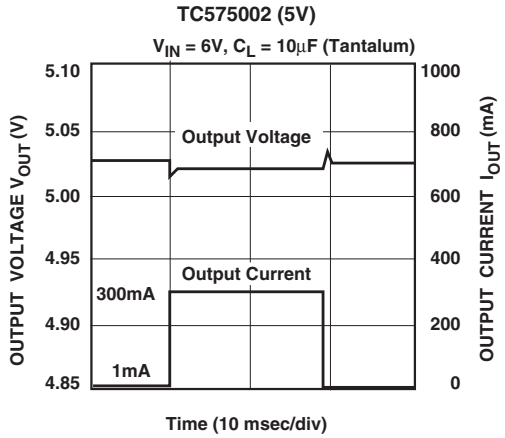
4.0 TYPICAL CHARACTERISTICS (CONTINUED)

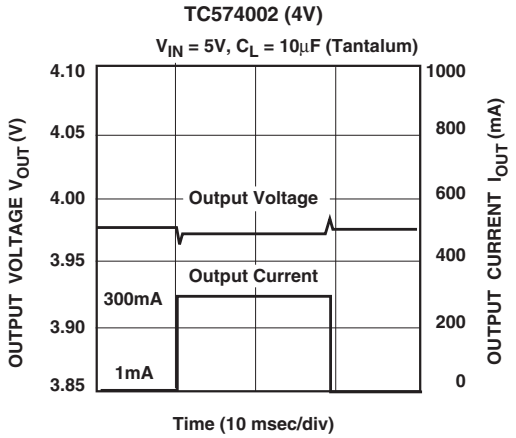
7. INPUT TRANSIENT RESPONSE (CONT.)

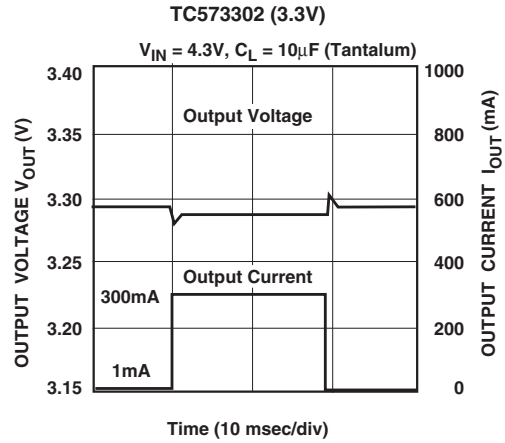




8. LOAD TRANSIENT RESPONSE

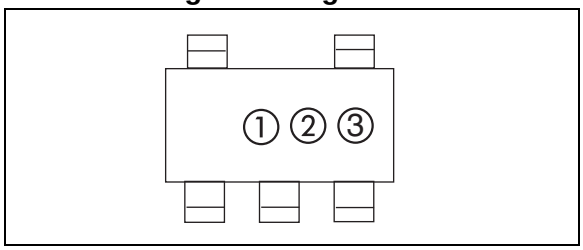






5.0 PACKAGING INFORMATION

5.1 Package Marking Information



① represents integer part of output voltage

Symbol	Voltage
2	2.
3	3.
4	4.
5	5.
6	6.

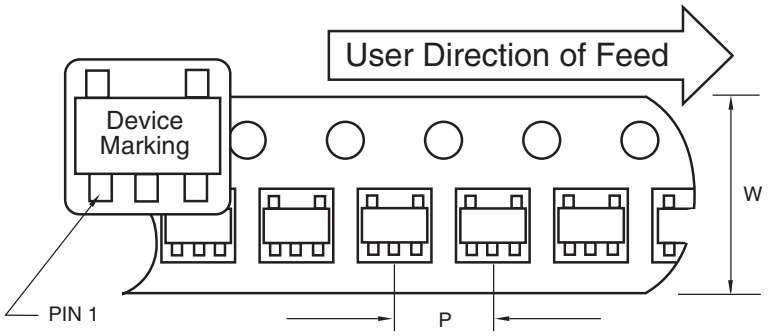
② represents first decimal of output voltage

Symbol	Voltage	Symbol	Voltage
0	.0	5	.5
1	.1	6	.6
2	.2	7	.7
3	.3	8	.8
4	.4	9	.9

③ represents production lot ID code

5.2 Taping Form

Component Taping Orientation for 5-Pin SOT-23A (EIAJ SC-74A) Devices



Standard Reel Component Orientation
TR Suffix Device
(Mark Right Side Up)

Carrier Tape, Number of Components Per Reel and Reel Size

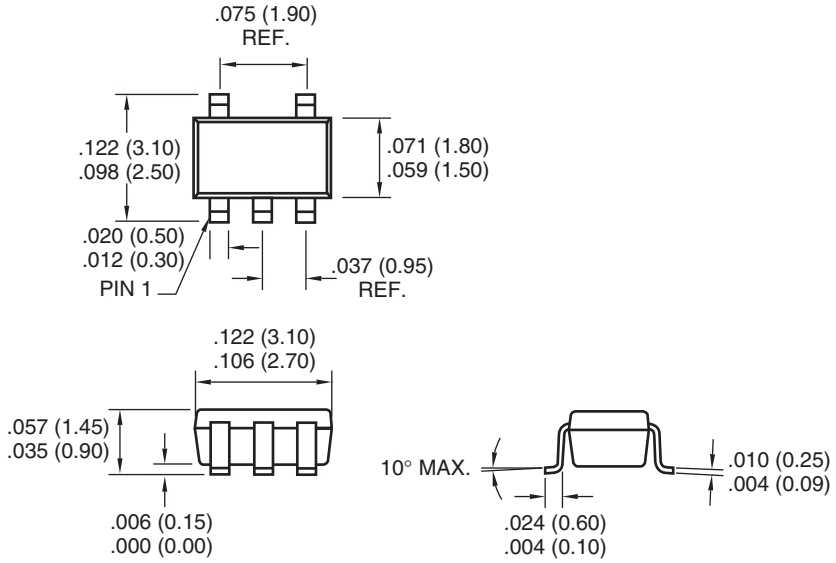
Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
5-Pin SOT-23A	8 mm	4 mm	3000	7 in

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5.3 Package Dimensions

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

SOT-23A-5



Dimensions: inches (mm)

6.0 REVISION HISTORY

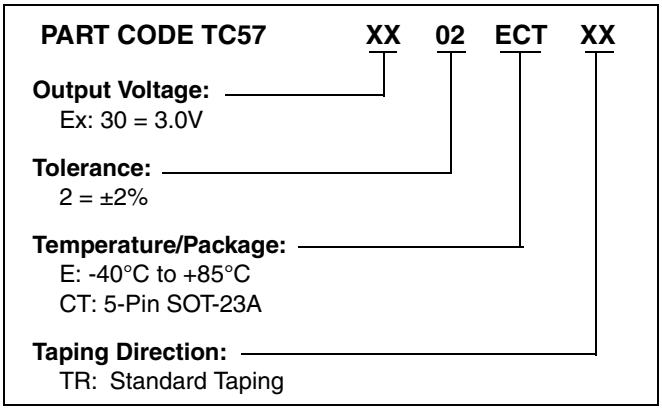
Revision C (November 2012)

Added a note to the package outline drawing.

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PRODUCT IDENTIFICATION SYSTEM

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ISBN: 9781620767436

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Fax: 86-10-8528-2104

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