TC57 Series

Linear Regulator Controller

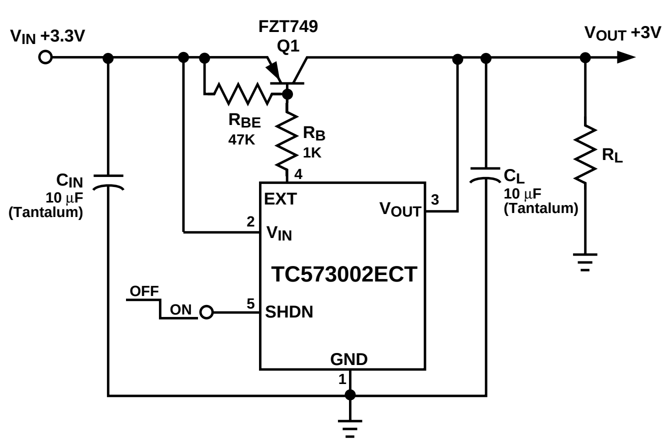
FEATURES

- **Low Dropout Voltage: 100 mV @ 650 mA with FZT749 PNP Transistor**
- **Output Voltage: 2V to 6V in 0.1V Increments**
- **2.7V to 8V Supply Range**
- **Low Operating Current: .... 50 µAOperating; 0.2 µA Shutdown**
- **Low-True Chip Enable**
- **Output Accuracy < ±2%**
- **Small Package: 5-Pin SOT-23A**

TYPICAL APPLICATIONS

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

TYPICAL APPLICATION



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

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 650 mA (with a dropout voltage of 100 mV) 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.

ORDERING INFORMATION

PART CODE TC57 XX 02 ECT XX

Output Voltage:
Ex: 30 = 3.0V

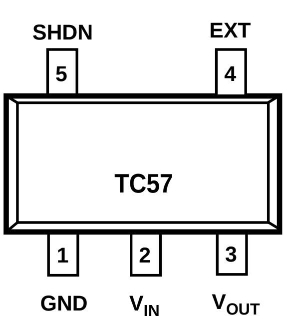
Tolerance:
2 = ±2%

Temperature/Package:
E: –40°C to +85°C
CT: 5-Pin SOT-23A

Taping Direction:
TR: Standard Taping
RT: Reverse Taping

PIN CONFIGURATION

***5-Pin SOT-23A**



Note: * 5-Pin SOT-23A is equivalent to the EIAJ SC-74A

ABSOLUTE MAXIMUM RATINGS*

Voltage on V_{IN} and EXT Pins .... +12V
Voltage on V_{OUT} and SHDN Pins ..... –0.3V to (V_{IN} + 0.3V)
EXT Pin Current .... 50 mA
Operating Temperature Range (T_C) .... – 40°C to +85°C
Storage Temperature (T_{STG}) .... – 40°C to +150°C
Power Dissipation .... 150 mW

*Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. 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 operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS TC57EP3002 (NOTE 2): (SHDN = GND, $V_{IN} = V_{OUT}$ + 1V, V_{OUT} = 3V to 5V, I_{OUT} = 0, T_A = 25°C, Test Circuit of Figure 1, unless otherwise noted.)

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

NOTES:
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 1.
4. The product of I_{EXT} x V_{EXT} must be less than the maximum allowable power dissipation.

PIN DESCRIPTION

Pin Number	Name	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 ≤ V_{IL}. The device enters a low power shutdown state when SHDN ≥ V_{IH}. During shutdown, the output is disabled, and supply current falls to less than 1 µA.

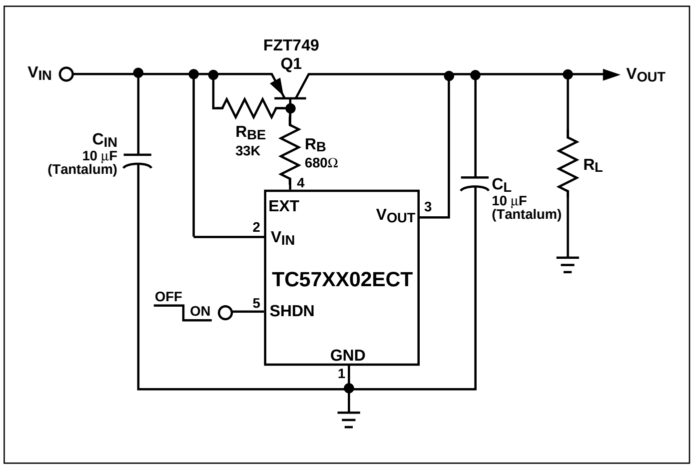


Figure 1. Test Circuit

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.

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:

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

Equation 1.

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

$$P_D = I_{LOAD(MAX)} \times (V_{IN(MAX)} - V_{OUT(min)})$$

Equation 2.

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 100 mA. It is packaged in a SOT223 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 2a).

Base-Current Limiting Resistor (Figure 2)

Base current limiting resistor R_B can be estimated using:

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

Equation 3.

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).

Pull-Up Resistor and Output Capacitor (Figure 2)

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. Recommended values for this resistor are between 20 KΩ and 47 KΩ. A Tantalum output capacitor of at least 10 μF must be used to guarantee stability. Higher values decrease output noise and eliminate power-on overshoot, but extend power-up times. Table 2a lists several capacitor choices.

Input Capacitor (Figure 2)

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

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}.

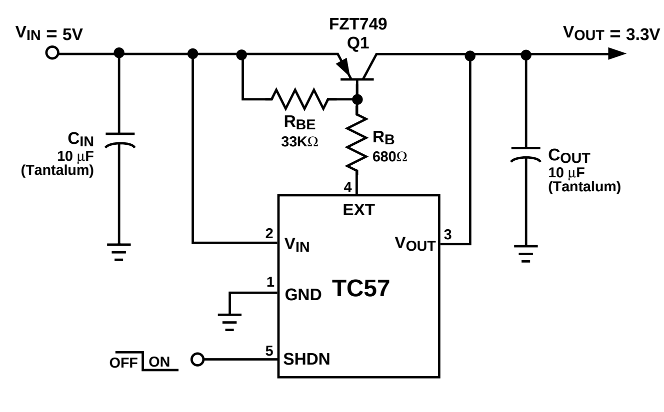


Figure 2. 3.3V, 1A Regulator Using 5V Supply Input

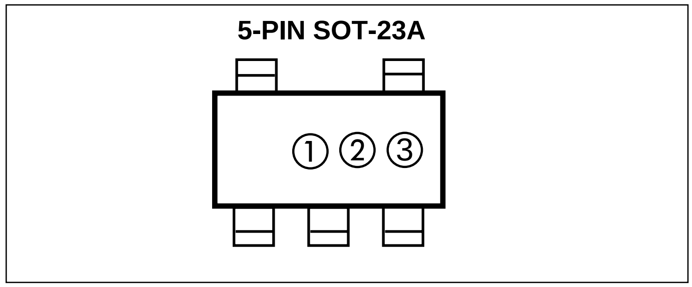
Table 2a. Component Suppliers

Device	Manufacturer	Product Method
CAPACITORS		
267 Series	Matsuo	Surface Mount
F95 Tantalum Series	Nichicon	Surface Mount
595 Tantalum Series	Sprague	Surface Mount
OS-CON Series Low-ESR Organic Semiconductor	Sanyo	Through-Hole
LXF Series	United Chemi-Con	Through-Hole
BIPOLAR TRANSISTORS		
ZTX749	Zetex	Through-Hole
T1P42	Motorola	Through-Hole
2N4403	Motorola	Through-Hole
2N2907A	Motorola	Through-Hole
CMPT2907A	Central Semiconductor	Surface Mount
PZT2907AT1	Motorola	Surface Mount
FZT749	Zetex	Surface Mount

Table 2b. Manufacturers' Phone and Fax Numbers

Manufacturer	Country	Telephone	Fax
Central Semiconductor	USA	(516) 435-1110	(516) 435-1824
Matsuo	USA	(714) 969-2491	(714) 960-6492
Motorola	USA	(602) 244-3370	(602) 244-4015
Nichicon	USA Japan	(847) 843-7500 81-7-5231-8461	(847) 843-2798 81-7-5256-4158
Sanyo	USA Japan	(619) 661-6835 81-7-2070-6306	(619) 661-1055 81-7-2070-1174
Sprague	USA	(603) 224-1961	(603) 224-1430
United Chemi-Con	USA	(714) 255-9500	(714) 255-9400
Zetex	USA UK	(516) 543-7100 44-61-627-5105	(516) 864-7630 44-61-627-5467

MARKINGS



① represents integer part of output voltage

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

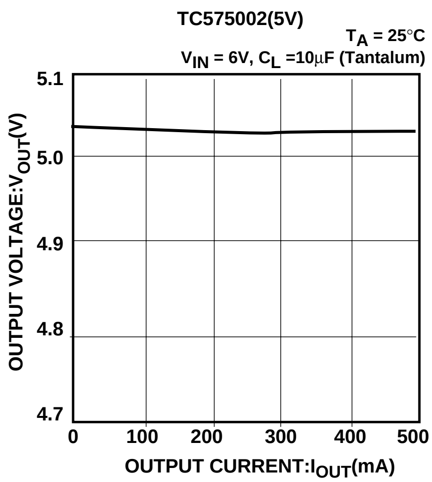
② represents 1st decimal of output voltage

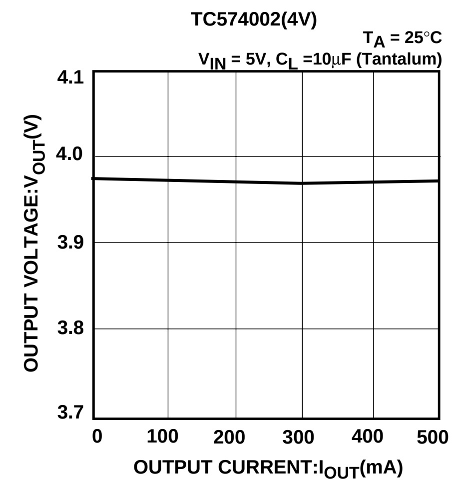
Symbol	Voltage	Symbol	Voltage
0	.0	5	.5
1	.1	6	.6
2	.2	7	.7
3	.3	8	.8
4	.4	9	.9

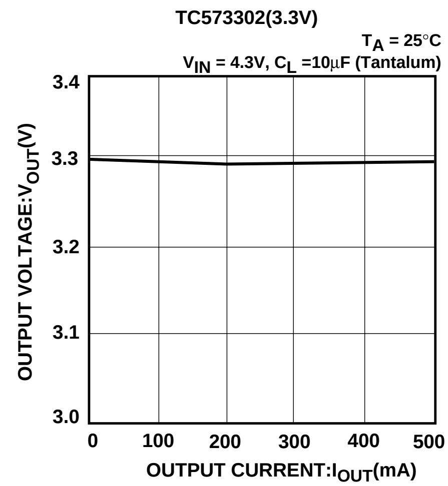
③ represents production lot ID code

TYPICAL CHARACTERISTICS CURVES

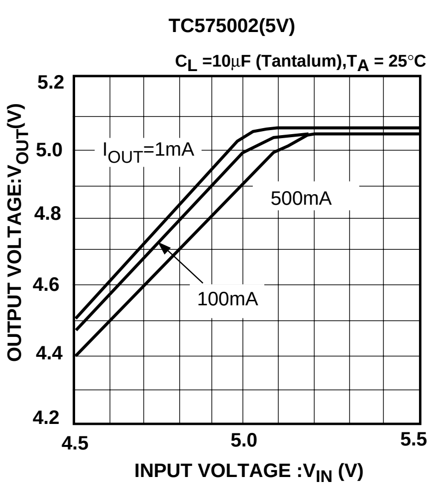
1. OUTPUT VOLTAGE vs. OUTPUT CURRENT

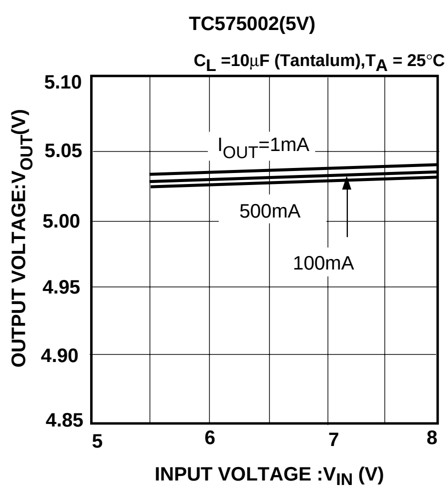


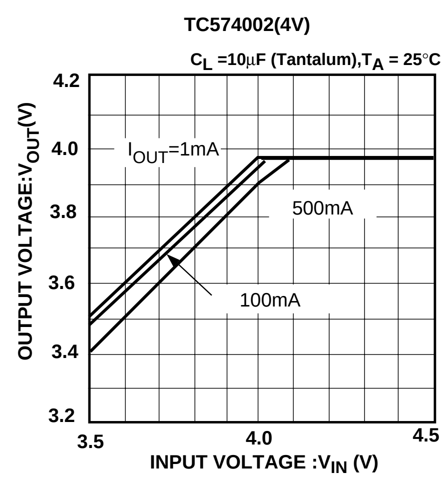


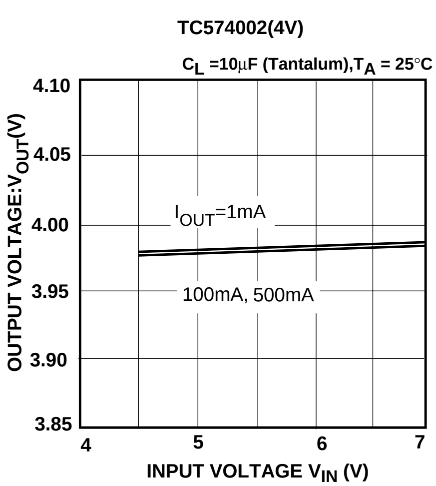


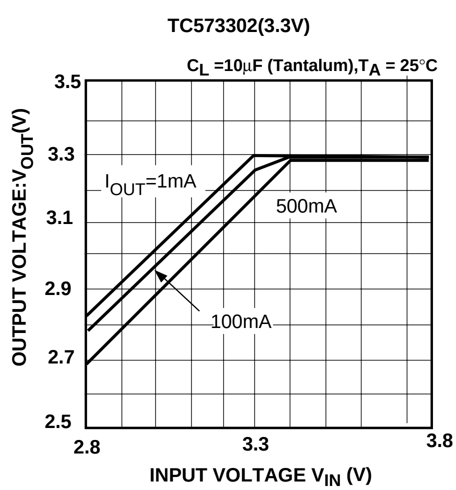
2. OUTPUT VOLTAGE vs. INPUT VOLTAGE

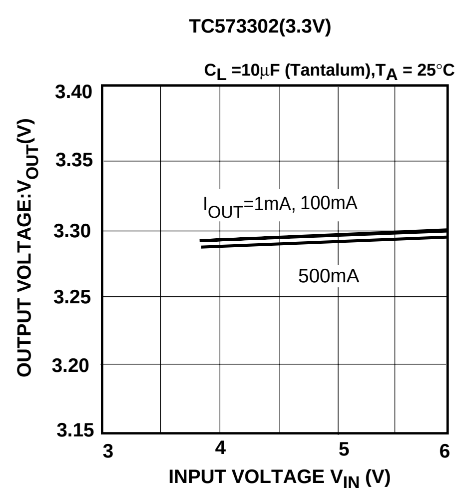








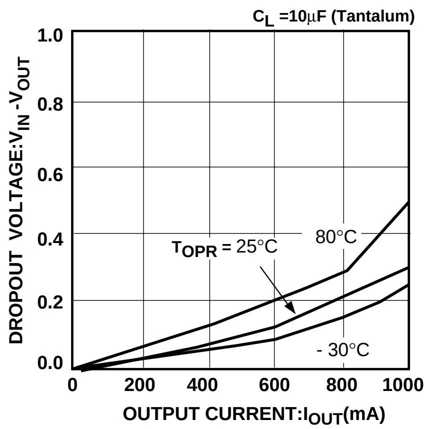




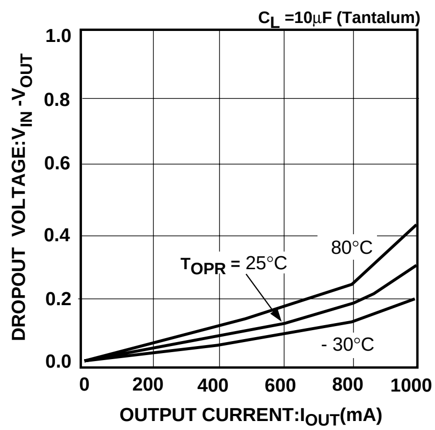
TYPICAL CHARACTERISTICS CURVES (CONT.)

3. DROPOUT VOLTAGE vs. OUTPUT CURRENT

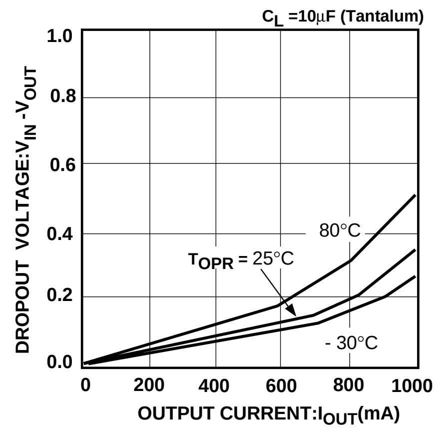
TC575002(5V)



TC574002(4V)

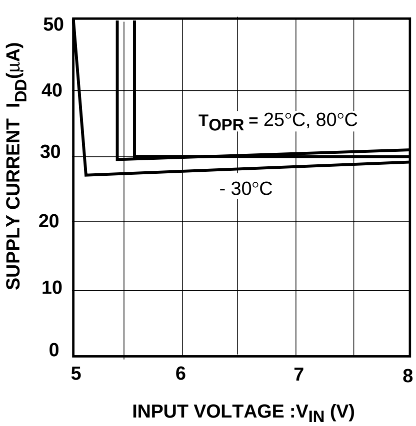


TC573302(3.3V)

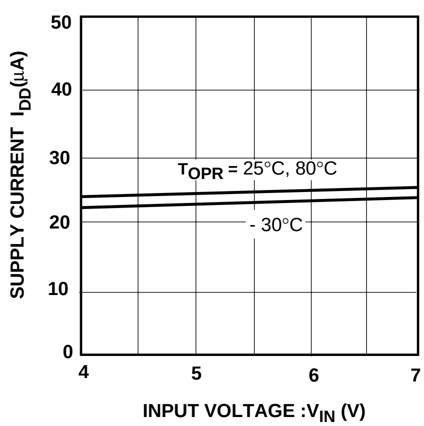


4. SUPPLY CURRENT vs. INPUT VOLTAGE

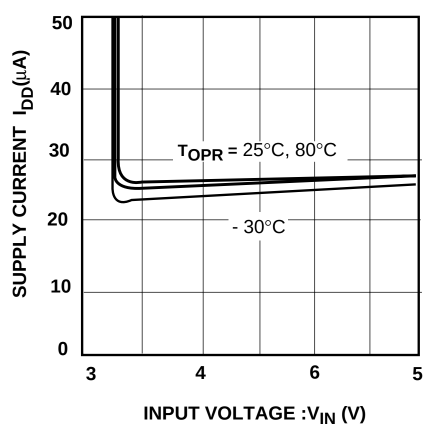
TC575002(5V)



TC574002(4V)

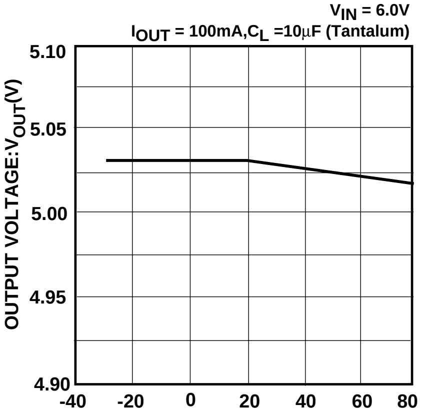


TC573302(3.3V)

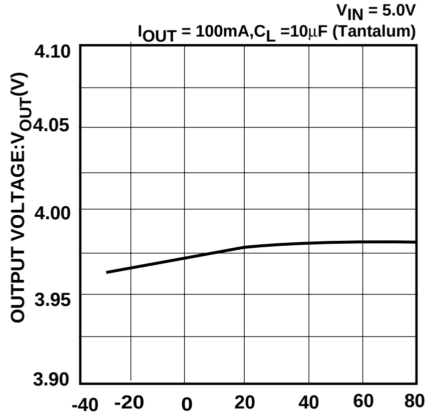


5. OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE

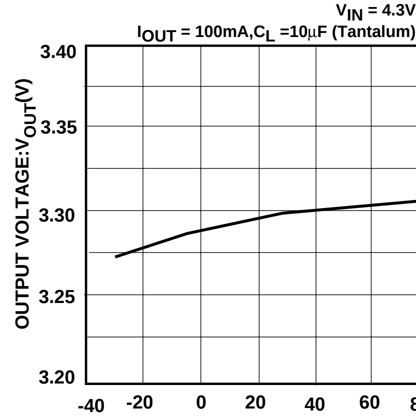
TC575002(5V)



TC574002(4V)



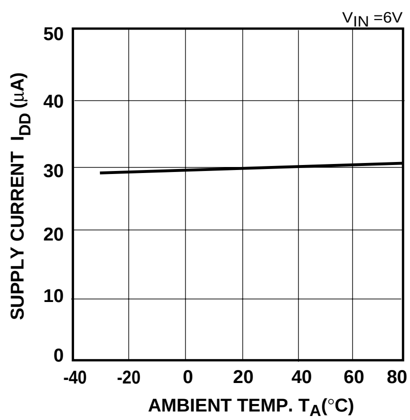
TC573302(3.3V)



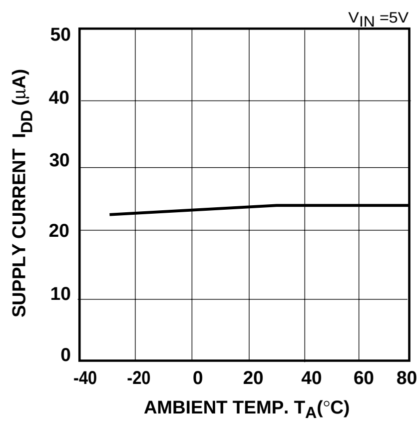
TYPICAL CHARACTERISTICS CURVES (CONT.)

6. SUPPLY CURRENT vs. AMBIENT TEMPERATURE

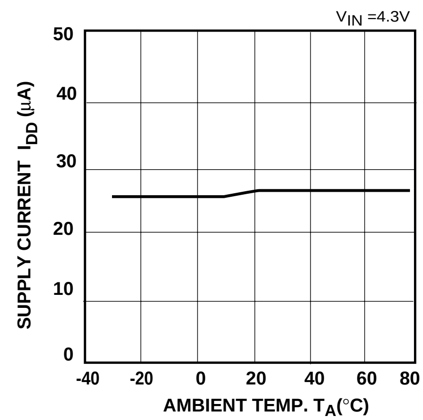
TC575002(5V)



TC574002(4V)

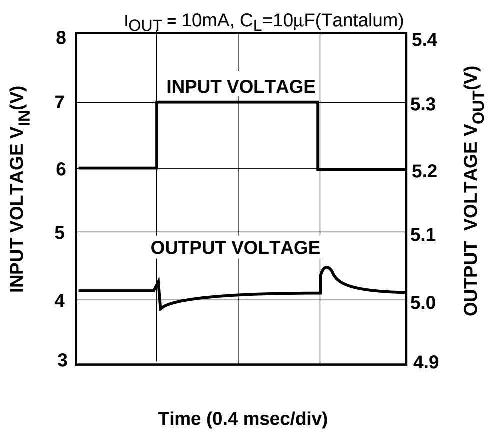


TC573302(3.3V)

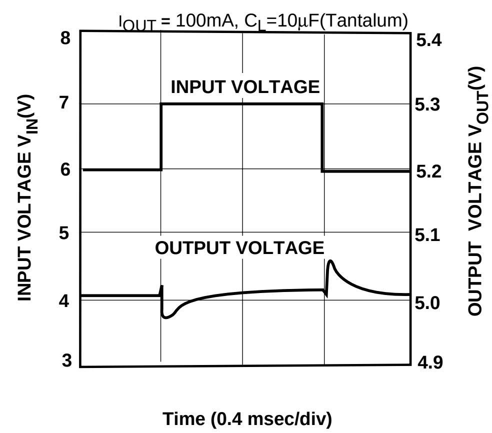


7. INPUT TRANSIENT RESPONSE

TC575002(5V)



TC575002(5V)



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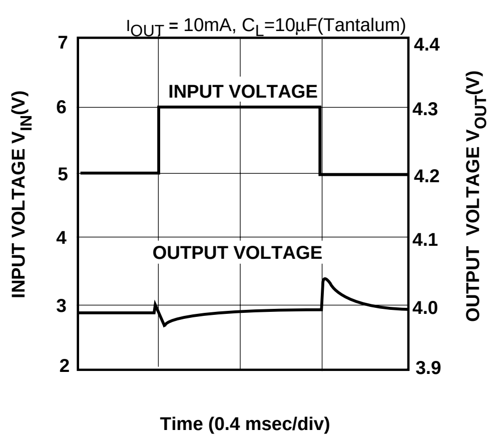
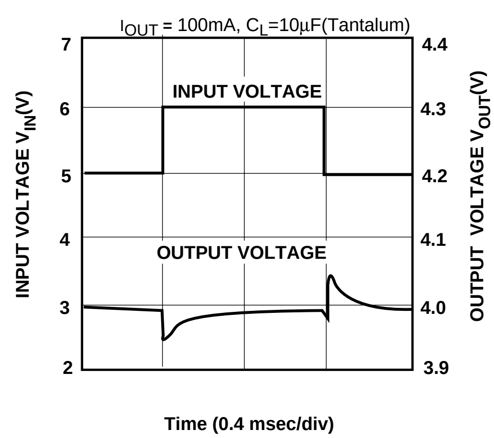
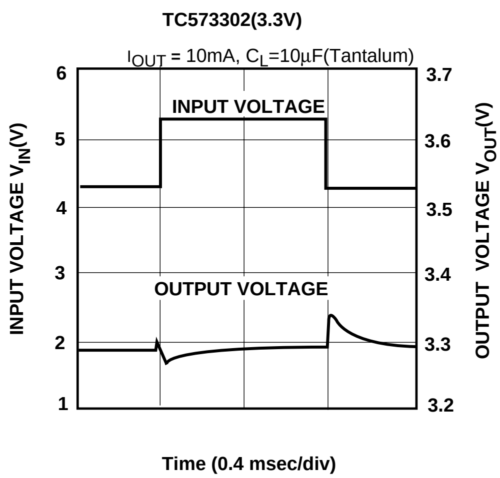


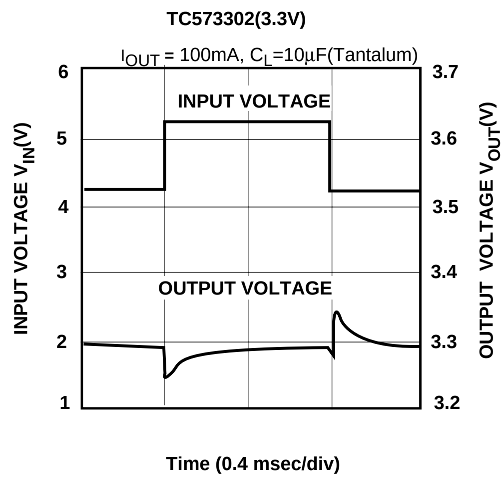
TC574002(4V)



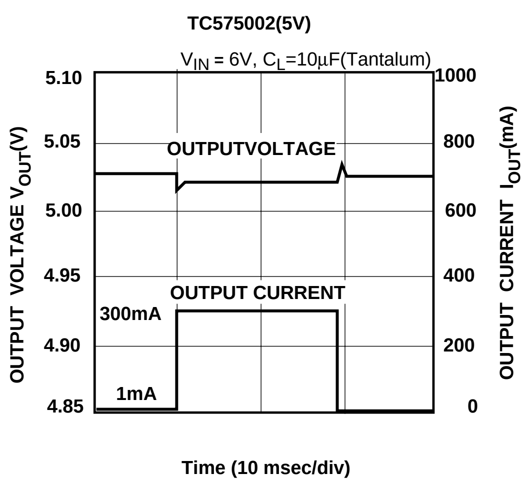
TYPICAL CHARACTERISTICS CURVES (CONT.)

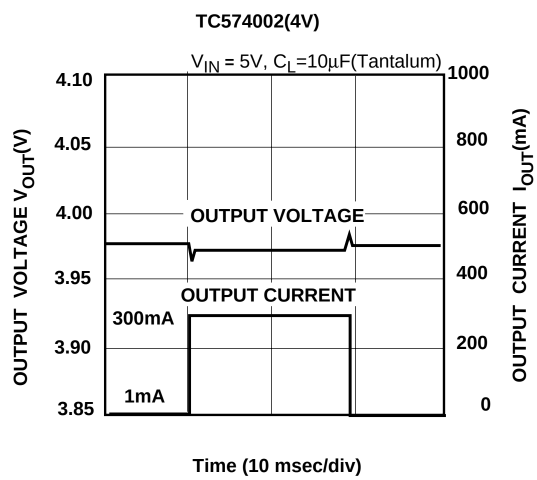
7. INPUT TRANSIENT RESPONSE (CONT.)

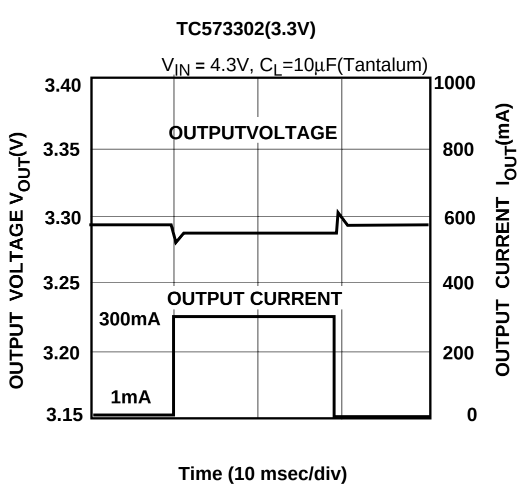




8. LOAD TRANSIENT RESPONSE



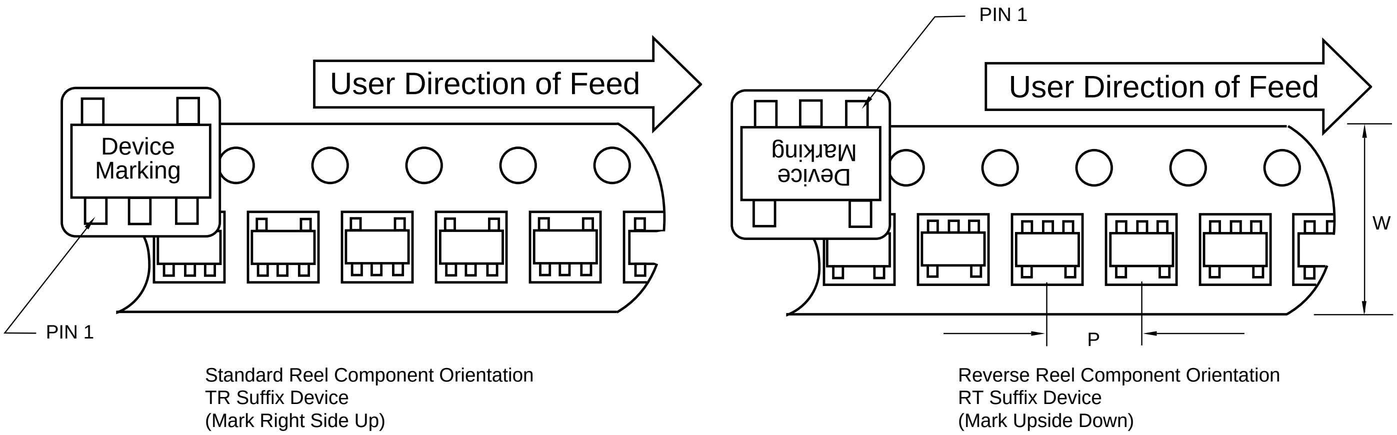




TC57 Series

TAPING FORM

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

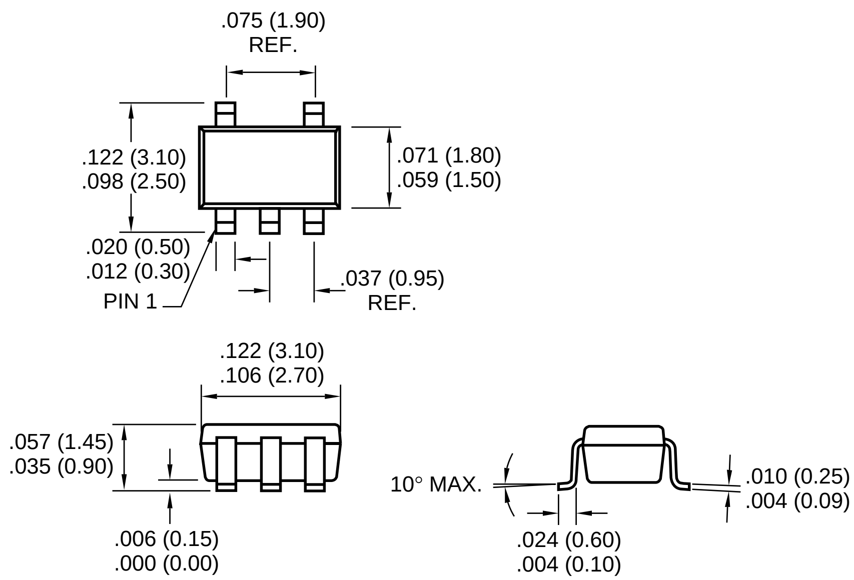


Carrier Tape, Number of Components Per Reel and Reel Size

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

PACKAGE DIMENSIONS

5-Pin SOT-23A (EIAJ SC-74A)



Dimensions: inches (mm)

WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200 Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: http://www.microchip.com

Rocky Mountain
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

Atlanta
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Austin
Analog Product Sales
8303 MoPac Expressway North
Suite A-201
Austin, TX 78759
Tel: 512-345-2030 Fax: 512-345-6085

Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Boston
Analog Product Sales
Unit A-8-1 Millbrook Tarry Condominium
97 Lowell Road
Concord, MA 01742
Tel: 978-371-6400 Fax: 978-371-0050

Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Dayton
Two Prestige Place, Suite 130
Miamisburg, OH 45342
Tel: 937-291-1654 Fax: 937-291-9175

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

Mountain View
Analog Product Sales
1300 Terra Bella Avenue
Mountain View, CA 94043-1836
Tel: 650-968-9241 Fax: 650-967-1590

New York
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Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

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