TC56

150mA, 10V LDO with Shutdown

Features

- Low Dropout Voltage: 200mV typ. at 80mA, 380mV typ. at 160mA
- High Output Current: 180mA (V_{OUT} = 5.0V)
- High Accuracy Output Voltage (±2%)
- Low Power Consumption: 11µA (Oper.), 0.1µA (Shutdown)
- Low Temperature Drift (±100ppm/°C typ.)
- Excellent Line Regulation (0.2%/V typ.)
- Space Saving 5-Pin SOT-23A Package
- Short Circuit Protection
- Standard 2.5V, 3.0V and 3.3V Output Voltages

Applications

- Battery Powered Devices
- Cameras and Portable Video Equipment
- Pagers and Cellular Phones
- Solar Powered Instruments
- Consumer Products

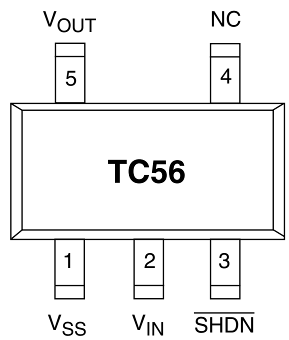
Device Selection Table

Part Number	Output Voltage (V)*	Package	Temperature Range
TC562502ECT	2.5	5-Pin SOT-23A	-40°C to +85°C
TC563002ECT	3.0	5-Pin SOT-23A	-40°C to +85°C
TC563302ECT	3.3	5-Pin SOT-23A	-40°C to +85°C

*Other output voltages are available. Please contact Microchip Technology Inc. for details.

Package Type

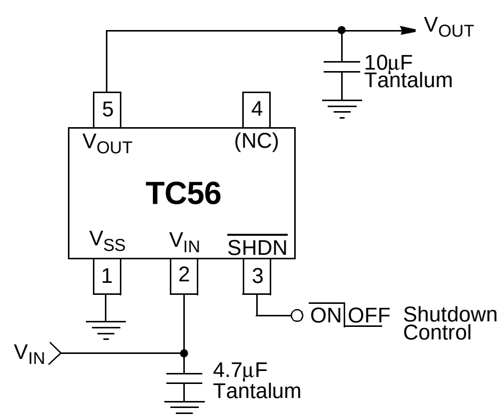
5-Pin SOT-23A



General Description

The TC56 is a low supply current (11µA typical at V_{OUT} = 3V), low dropout CMOS linear regulator, with a 10V maximum input voltage range. CMOS construction eliminates wasted ground current, typical of bipolar regulators, for greater system efficiencies and longer operating time in battery-powered systems. The TC56 enters shutdown mode when the shutdown control input ($\overline{SHDN}$) is low. During shutdown, the regulator is shut off, and supply current falls to 0.1µA maximum. Normal operation is restored when $\overline{SHDN}$ is returned to a logic high. Low current consumption, 10V supply tolerance and space-saving 5-Pin SOT-23A packaging makes the TC56 ideal for a wide variety of applications.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

Input Voltage ....+12V
Output Current 500mA
Output Voltage........................V_{SS} – 0.3V to V_{IN} + 0.3V
$\overline{SHDN}$ Input Voltage ....V_{SS} – 0.3V to V_{IN} + 0.3V
Power Dissipation (SOT-23).............................150mW
Operating Temperature Range.............-40°C to +85°C
Storage Temperature Range ....-40°C to +125°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.

TC56 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: $V_{IN} = V_{OUT}$ +1V, T_A = 25°C, C_{IN} = 4.7µF, C_{OUT} = 10µF, unless otherwise noted.

Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
V_{IN}	Input Voltage	—	—	10	V	
V_{OUT}	Output Voltage	0.98 x V_R	V_R ±0.5%	1.02 x V_R	V	I_{OUT} = 40mA **(Note 1)**
I_{OUTMAX}	Maximum Output Current	150 180	— —	— —	mA	$V_R \geq$ 2.7V, V_{OUT} = 3V **(Note 1)** $V_R \geq$ 4.5V, V_{OUT} = 5V **(Note 1)**
ΔV_{OUT}	Load Regulation	— —	45 40	90 80	mV	1mA $\leq I_{OUT} \leq$ 80mA, V_{OUT} = 3V 1mA $\leq I_{OUT} \leq$ 80mA, V_{OUT} = 5V
V_{IN} - V_{OUT}	Dropout Voltage	— — — —	200 380 165 330	395 770 330 660	mV	I_{OUT} = 80mA, V_{OUT} = 3V I_{OUT} = 160mA, V_{OUT} = 3V I_{OUT} = 100mA, V_{OUT} = 5V I_{OUT} = 200mA, V_{OUT} = 5V **(Note 2)**
I_{DD}	Supply Current	— —	11 13	19 21	µA	$V_{\overline{SHDN}} = V_{IN}$ = 4V $V_{\overline{SHDN}} = V_{IN}$ = 6V
I_{SHDN}	Shutdown Supply Current	—	—	0.1	µA	$V_{\overline{SHDN}}$ = GND
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	—	0.2	0.3	%/V	I_{OUT} = 40mA, 4V $\leq V_{IN} \leq$ 10V
$\Delta V_{OUT}/\Delta T$	V_{OUT} Temperature Coefficient	—	±100	—	ppm/°C	I_{OUT} = 10mA, -40°C < T_J < +85°C
V_{IH}	$\overline{SHDN}$ Input High Logic Threshold	1.5	—	—	V	
V_{IL}	$\overline{SHDN}$ Input Low Logic Threshold	—	—	0.25	V	
I_{IH}	$\overline{SHDN}$ Input Current @V_{IH}	—	—	5.0	µA	$V_{\overline{SHDN}} = V_{IN}$
I_{IL}	$\overline{SHDN}$ 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.

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	V_{SS}	Ground.
2	V_{IN}	Supply voltage input.
3	$\overline{SHDN}$	Shutdown input.
4	(NC)	No connection.
5	V_{OUT}	Regulated voltage output.

3.0 DETAILED DESCRIPTION

The TC56 is a precision, fixed output LDO. Unlike bipolar regulations, the TC56 supply current does not increase with load current.

3.1 Output Capacitor

A 10µF tantalum capacitor from V_{OUT} to ground is recommended. The output capacitor should have an effective series resistance greater than 0.1Ω and less than 5.0Ω, and a resonant frequency above 1MHz. It is recommended that a 4.7µF capacitor be connected from V_{IN} to GND. When operating from sources other than batteries, supply noise rejection and transient response can be improved by increasing the value of the input and output capacitors and employing passive filtering techniques.

3.2 Shutdown Input

The TC56 enters a low power shutdown mode when the shutdown control input ($\overline{SHDN}$) is low. During shutdown, the regulator is disabled and supply current is reduced to 0.1µA (max). Normal operation is restored when $\overline{SHDN}$ is driven high. If not required, the $\overline{SHDN}$ input can be tied to V_{IN}.

4.0 THERMAL CONSIDERATIONS

4.1 Power Dissipation

The amount of power the regulator dissipates is primarily a function of input and output voltage, and output current. The following equation is used to calculate worst case actual power dissipation.

EQUATION 4-1:

$$P_D \approx (V_{INMAX} - V_{OUTMIN})I_{LOADMAX}$$

Where:

P_D = Worst case actual power dissipation
V_{INMAX} = Maximum voltage on V_{IN}
V_{OUTMIN} = Minimum regulator output voltage
$I_{LOADMAX}$ = Maximum output (load) current

The maximum allowable power dissipation (Equation 4-2) is a function of the maximum ambient temperature (T_{AMAX}), the maximum allowable die temperature (T_{JMAX}) and the thermal resistance from junction-to-air (θ_{JA}). The 5-Pin SOT-23A package has a θ_{JA} of approximately 220°C/Watt.

EQUATION 4-2:

$$P_{DMAX} = \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}}$$

Where all terms are previously defined.

Equation 4-1 can be used in conjunction with Equation 4-2 to ensure regulator thermal operation is within limits. For example:

Given:

V_{INMAX} = 3.0V ±10%
V_{OUTMIN} = 2.7V – 2%
$I_{LOADMAX}$ = 98mA
T_{JMAX} = 125°C
T_{AMAX} = 55°C

Find: 1. Actual power dissipation
2. Maximum allowable dissipation

Actual power dissipation:

$$P_D \approx (V_{INMAX} - V_{OUTMIN})I_{LOADMAX}$$
$$= [(3.0 \times 1.1) - (2.7 \times .98)]98 \times 10^{-3}$$
$$= 64mW$$

Maximum allowable power dissipation:

$$P_{DMAX} = \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}}$$
$$= \frac{(125 - 55)}{220}$$
$$= 318mW$$

In this example, the TC56 dissipates a maximum of 64mW; below the allowable limit of 318mW. In a similar manner, Equation 4-1 and Equation 4-2 can be used to calculate maximum current and/or input voltage limits.

4.2 Layout Considerations

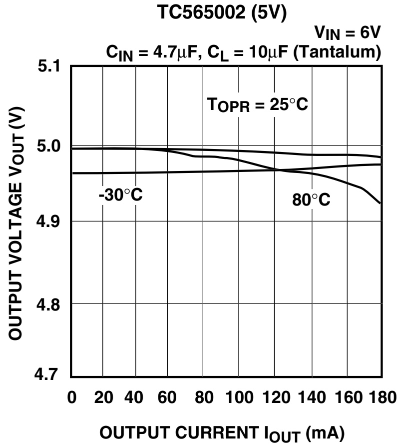
The primary path of heat conduction out of the package is via the package leads. Therefore, layouts having a ground plane, wide traces at the pads, and wide power supply bus lines combine to lower θ_{JA} and therefore, increase the maximum allowable power dissipation limit.

5.0 TYPICAL CHARACTERISTICS

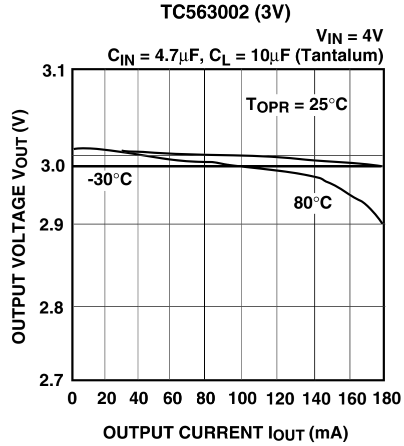
Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside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

1. OUTPUT VOLTAGE vs. OUTPUT CURRENT

TC565002 (5V)

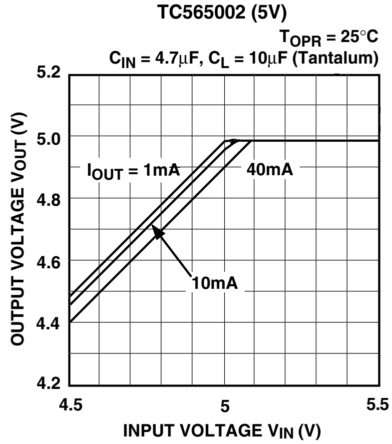


TC563002 (3V)

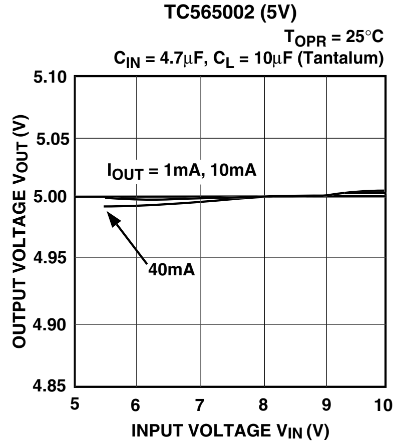


2. OUTPUT VOLTAGE vs. INPUT VOLTAGE

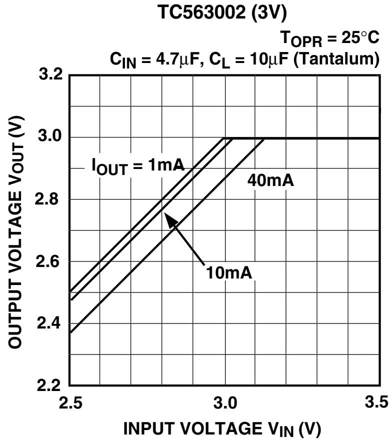
TC565002 (5V)



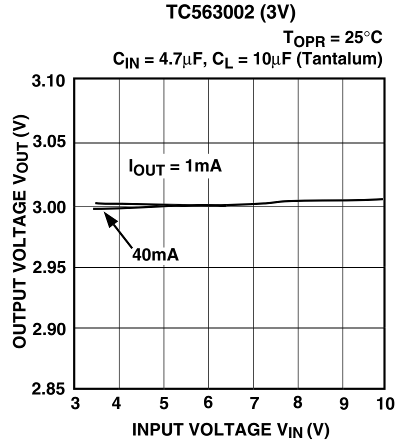
TC565002 (5V)



TC563002 (3V)



TC563002 (3V)

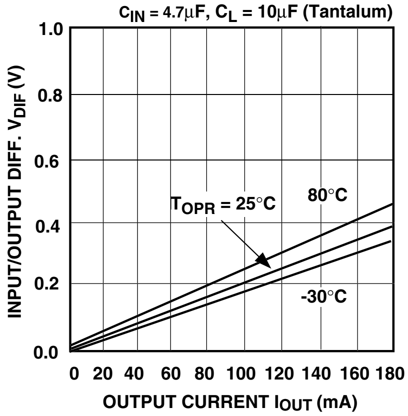


5.0 TYPICAL CHARACTERISTICS (CONTINUED)

3. INPUT/OUTPUT VOLTAGE DIFFERENTIAL vs. OUTPUT CURRENT

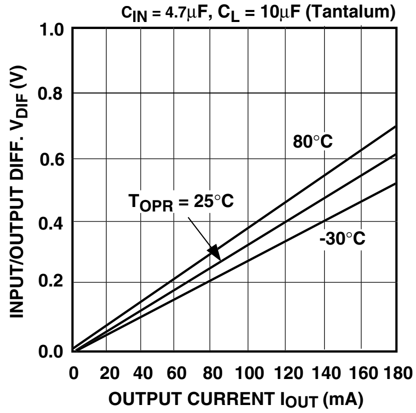
TC565002 (5V)

C_{IN} = 4.7µF, C_L = 10µF (Tantalum)



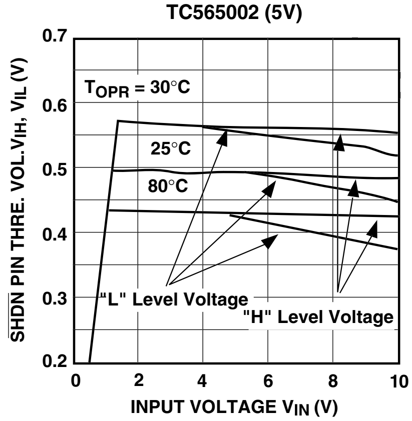
TC563002 (3V)

C_{IN} = 4.7µF, C_L = 10µF (Tantalum)

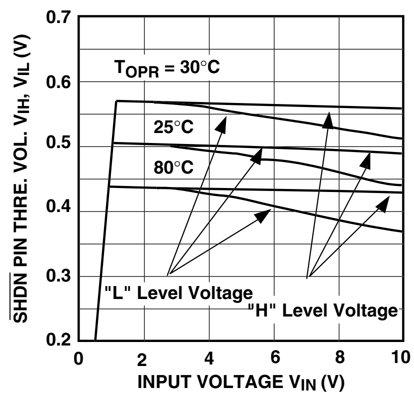


4. $\overline{\text{SHDN}}$ PIN THRESHOLD VOLTAGE vs. INPUT VOLTAGE

TC565002 (5V)

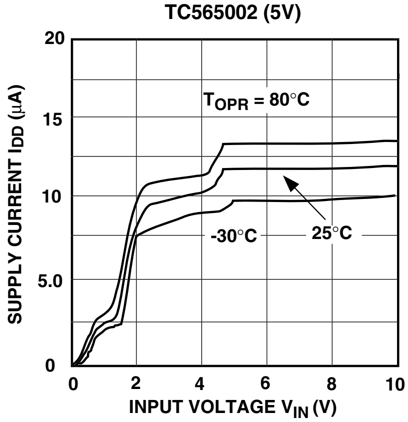


TC563002 (3V)

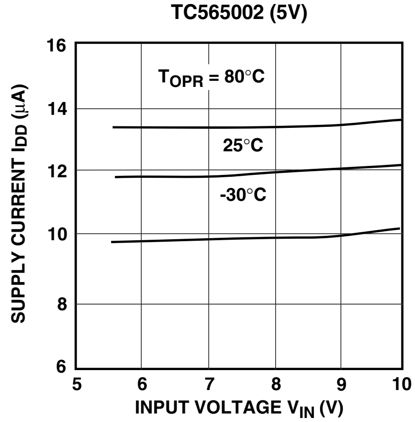


5. SUPPLY CURRENT vs. INPUT VOLTAGE

TC565002 (5V)



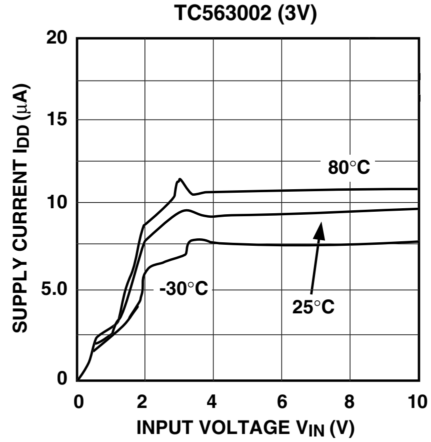
TC565002 (5V)



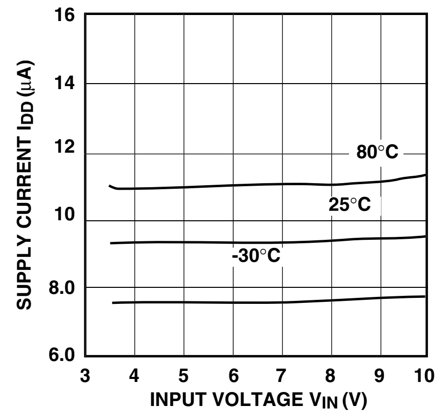
5.0 TYPICAL CHARACTERISTICS (CONTINUED)

5. SUPPLY CURRENT vs. INPUT VOLTAGE (CONT.)

TC563002 (3V)

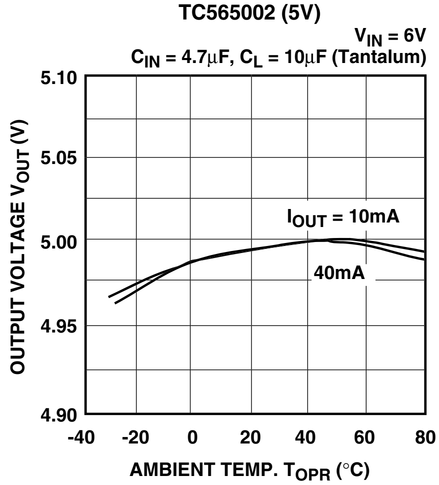


TC563002 (3V)

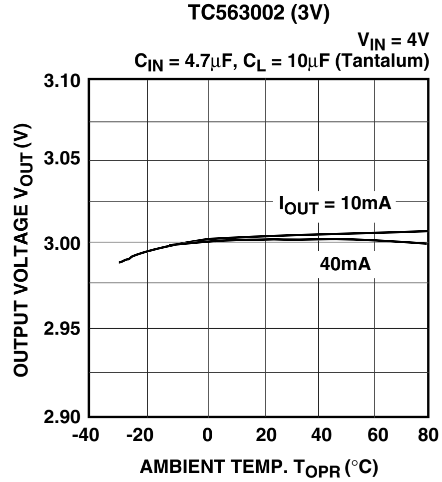


6. OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE

TC565002 (5V)

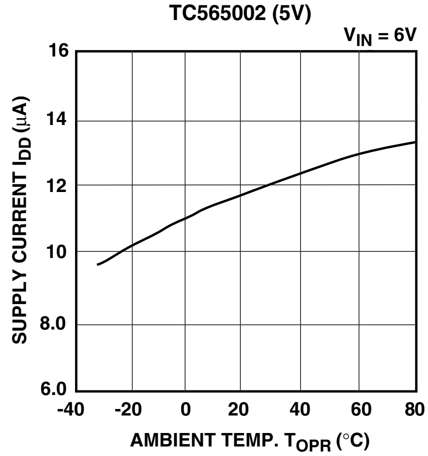


TC563002 (3V)

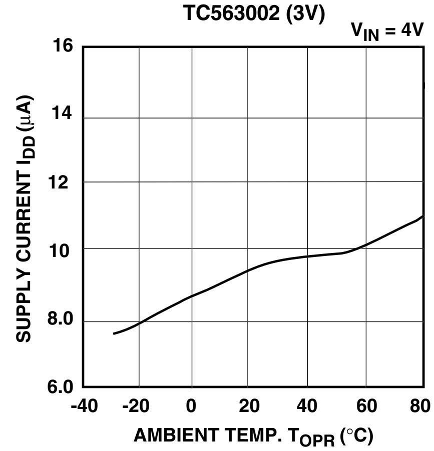


7. SUPPLY CURRENT vs. AMBIENT TEMPERATURE

TC565002 (5V)



TC563002 (3V)

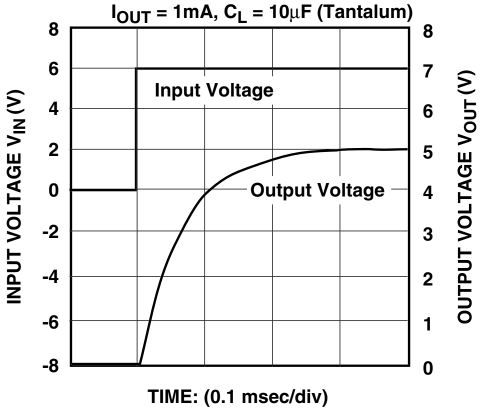


5.0 TYPICAL CHARACTERISTICS (CONTINUED)

8. INPUT TRANSIENT RESPONSE 1

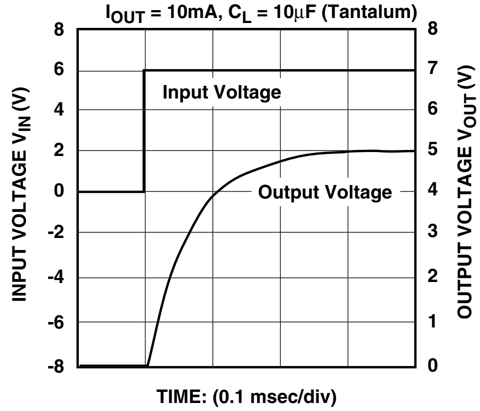
TC565002 (5V)

I_{OUT} = 1mA, C_L = 10μF (Tantalum)



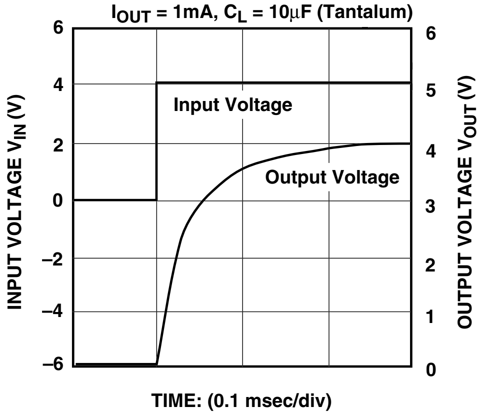
TC565002 (5V)

I_{OUT} = 10mA, C_L = 10μF (Tantalum)



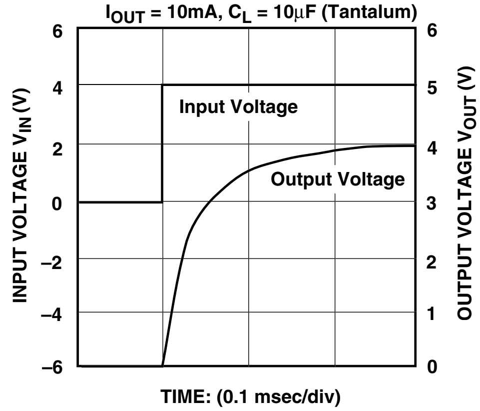
TC563002 (3V)

I_{OUT} = 1mA, C_L = 10μF (Tantalum)



TC563002 (3V)

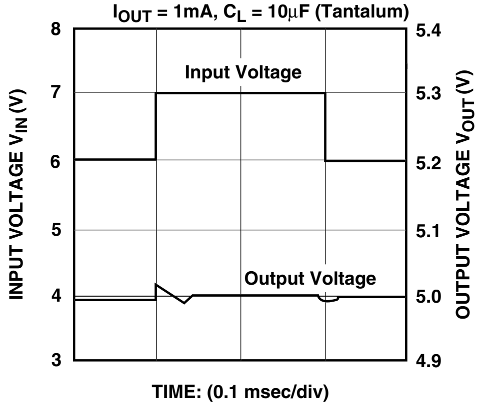
I_{OUT} = 10mA, C_L = 10μF (Tantalum)



9. INPUT TRANSIENT RESPONSE 2

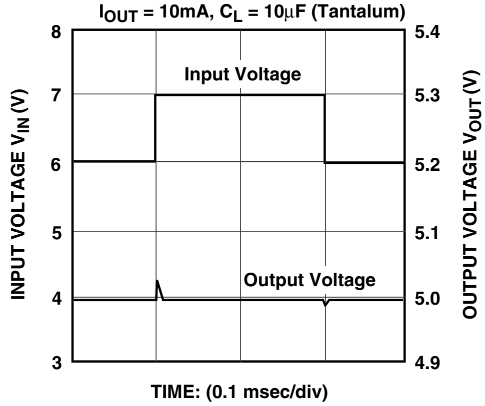
TC565002 (5V)

I_{OUT} = 1mA, C_L = 10μF (Tantalum)



TC565002 (5V)

I_{OUT} = 10mA, C_L = 10μF (Tantalum)

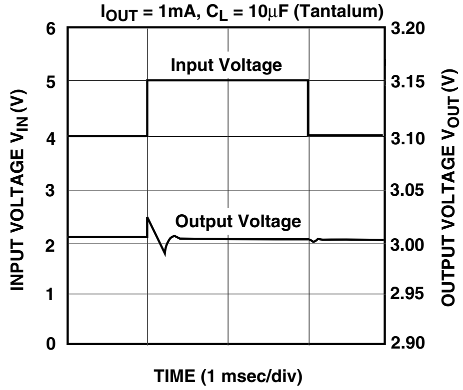


5.0 TYPICAL CHARACTERISTICS (CONTINUED)

9. INPUT TRANSIENT RESPONSE 2 (CONT.)

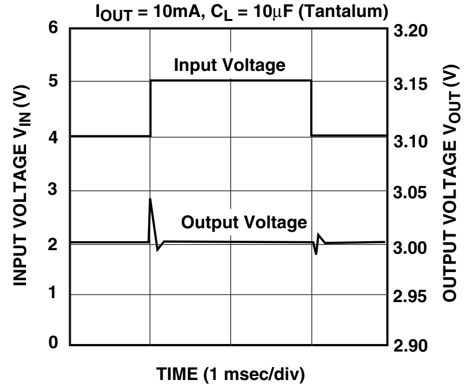
TC563002 (3V)

I_{OUT} = 1mA, C_L = 10µF (Tantalum)



TC563002 (3V)

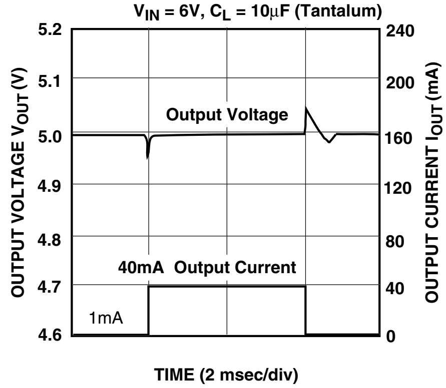
I_{OUT} = 10mA, C_L = 10µF (Tantalum)



10. LOAD TRANSIENT RESPONSE

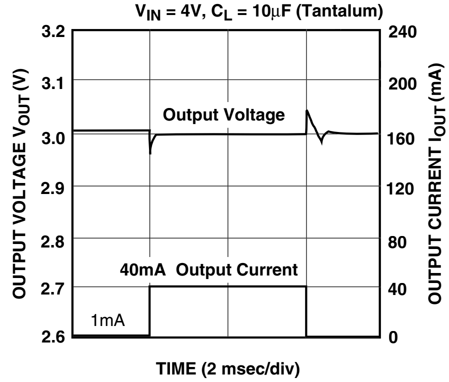
TC565002 (5V)

V_{IN} = 6V, C_L = 10µF (Tantalum)



TC563002 (3V)

V_{IN} = 4V, C_L = 10µF (Tantalum)

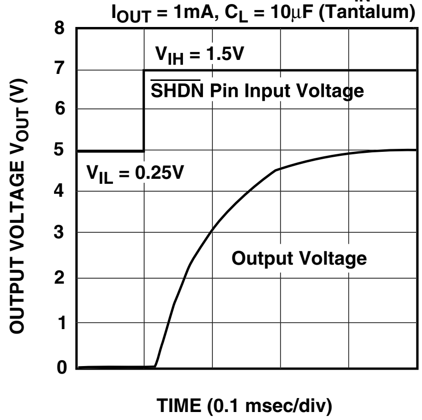


11. $\overline{\text{SHDN}}$ PIN TRANSIENT RESPONSE

TC565002 (5V)

V_{IN} = 6V

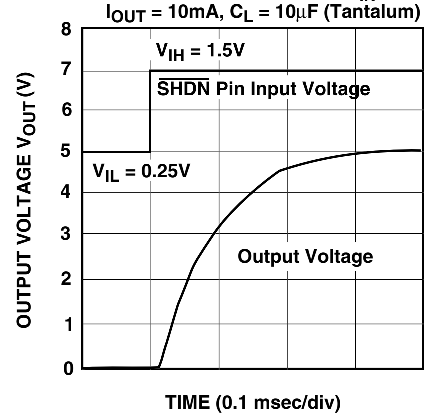
I_{OUT} = 1mA, C_L = 10µF (Tantalum)



TC565002 (5V)

V_{IN} = 6V

I_{OUT} = 10mA, C_L = 10µF (Tantalum)

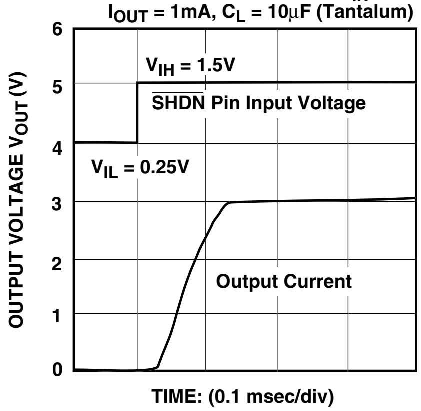


5.0 TYPICAL CHARACTERISTICS (CONTINUED)

11. $\overline{SHDN}$ PIN TRANSIENT RESPONSE (CONT.)

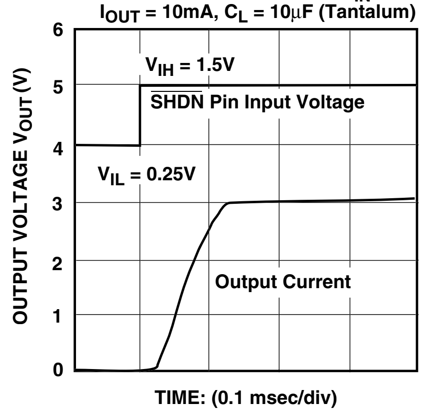
TC563002 (3V)

$V_{IN} = 4V$
$I_{OUT} = 1mA$, $C_L = 10\mu F$ (Tantalum)



TC563002 (3V)

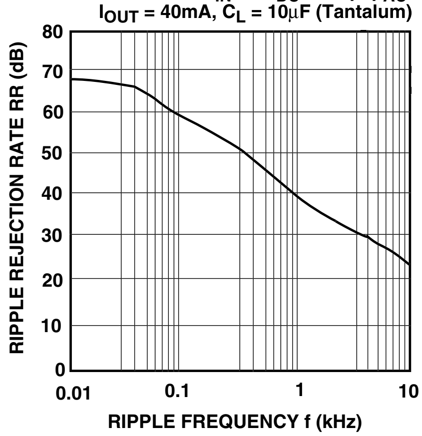
$V_{IN} = 4V$
$I_{OUT} = 10mA$, $C_L = 10\mu F$ (Tantalum)



12. RIPPLE REJECTION RATE

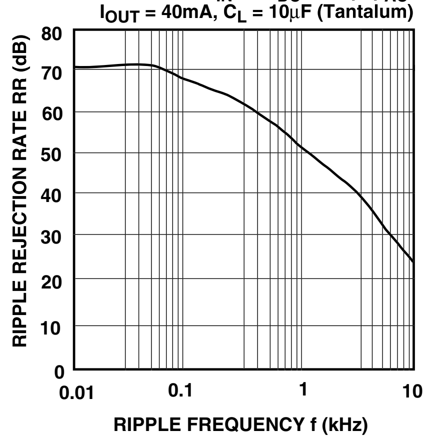
TC565002 (5V)

$V_{IN} = 6V_{DC} + 1\ Vp\text{–}p_{AC}$,
$I_{OUT} = 40mA$, $C_L = 10\mu F$ (Tantalum)



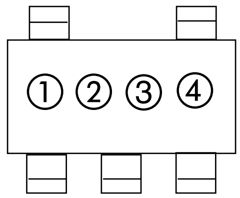
TC563002 (3V)

$V_{IN} = 6V_{DC} + 1\ Vp\text{–}p_{AC}$,
$I_{OUT} = 40mA$, $C_L = 10\mu F$ (Tantalum)



6.0 PACKAGING INFORMATION

6.1 Package Marking Information



① represents the integer of the output voltage

Symbol	Voltage
A	0.
B	1.
C	2.
D	3.
E	4.
F	5.
H	6.

② represents the integer of the output voltage

Symbol	Voltage	Symbol	Voltage
A	.0	F	.5
B	.1	H	.6
C	.2	K	.7
D	.3	L	.8
E	.4	M	.9

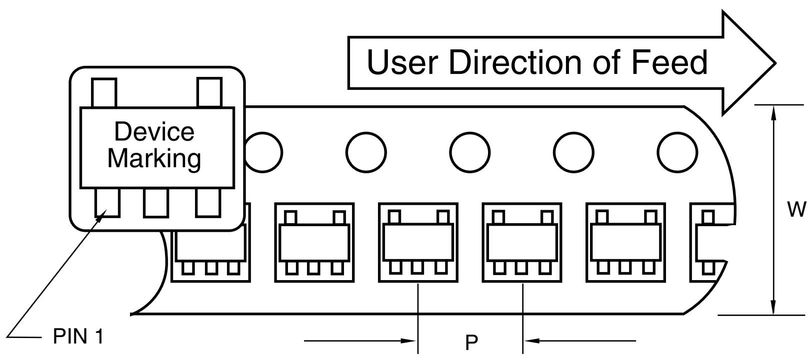
③ represents the transition response

Symbol	
—	REGULAR

④ represents assembly lot code

6.2 Taping Form

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

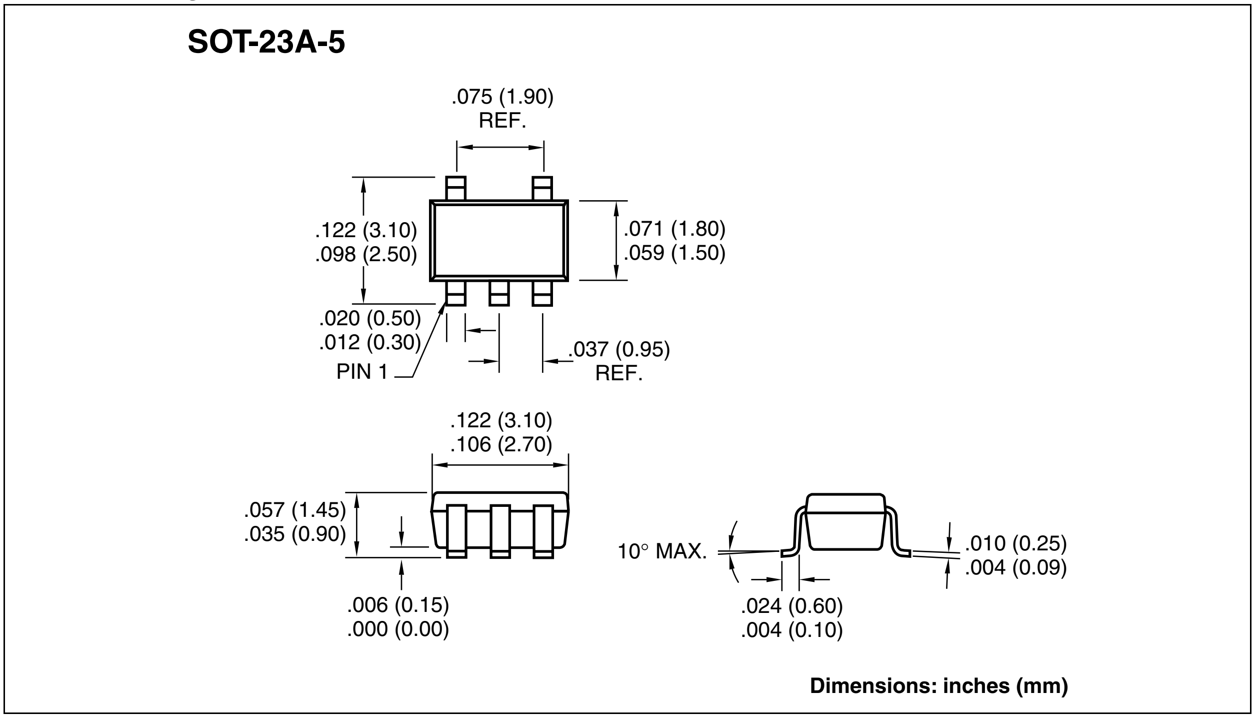


Standard Reel Component Orientation
TR Suffix Device
(Mark Right Side Up)

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

6.3 Package Dimensions



Sales and Support

Data Sheets
Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

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