150mA, 10V LDO with Shutdown

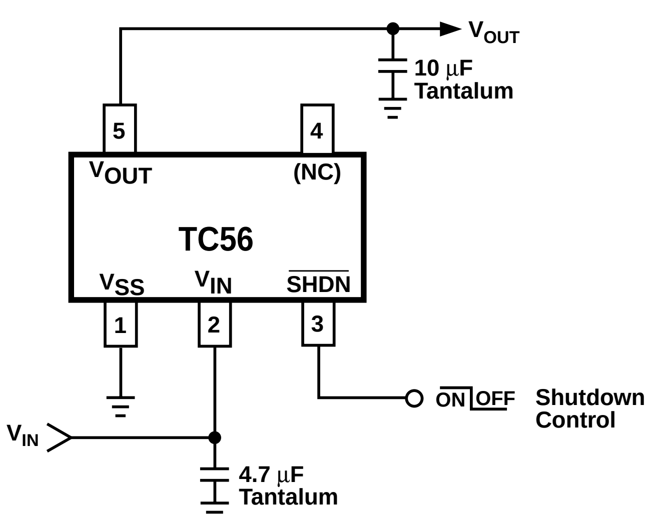
FEATURES

- **Low Dropout Voltage .... 200 mV typ at 80 mA**
  380 mV typ at 160 mA
- **High Output Current .... 180 mA (V_{OUT} = 5.0V)**
- **High Accuracy Output Voltage .... ± 2%**
- **Low Power Consumption .... 11 µA (Oper.)**
  .. 0.1 µA (Shutdown)
- **Low Temperature Drift .... ±100 ppm/°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**
- **Voltage Outputs Available from 2.1V to 5.0V in 100 mV Steps**

APPLICATIONS

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

TYPICAL APPLICATION



GENERAL DESCRIPTION

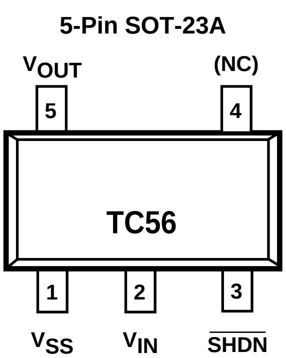
The TC56 is a low supply current (11 µA typ at V_{OUT} = 3V), low dropout CMOS linear regulator, with a 10V maximum input voltage range. CMOS construction eliminates wasted ground current typical of bipolar regulators for greater system efficiencies, and longer operating time in battery-powered systems. 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. The TC56 is available in factory-programmed output voltage settings between 2.1V and 5.0V in 100 mV increments. Low current consumption, 10V supply tolerance and space-saving 5-pin SOT-23A packaging make the TC56 ideal for a wide variety of applications.

ORDERING INFORMATION

Part No.	Output Voltage (V)*	Package	Temperature Range (T_A)
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

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

PIN CONFIGURATIONS



ABSOLUTE MAXIMUM RATINGS*

Input Voltage (V_{IN}) .... +12V
Output Current (I_{OUT}) ....500 mA
Output Voltage (V_{OUT})................ V_{SS} – 0.3V to V_{IN} + 0.3V
$\overline{SHDN}$ Input Voltage ($V_{\overline{SHDN}}$) ..... V_{SS} – 0.3V to V_{IN} + 0.3V
Operating Temperature Range ....–40°C to +85°C
Storage Temperature Range ....–40°C to +125°C
Power Dissipation
SOT-23 ....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: $V_{IN} = V_{OUT}$ + 1V, T_A = 25°C, C_{IN} = 4.7 µF, C_{OUT} = 10 µF unless otherwise specified.

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

PIN DESCRIPTION

Pin Number	Name	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

DETAILED DESCRIPTION

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

Output Capacitor

A 10 µF capacitor from V_{OUT} to ground is recommended. The output capacitor should have an effective series resistance of 5Ω or less, and a resonant frequency above 1MHz. It is recommended that a 4.7 µF capacitor be connected from V_{IN} to GND. Tantalum capacitors are recommended. 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.

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 0.1 µA. Normal operation is restored when $\overline{SHDN}$ is driven high. If not required, the $\overline{SHDN}$ input can be tied to V_{IN}.

Thermal Considerations

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:

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

Equation 1.

Where:
P_D = Worst case actual power dissipation
$V_{IN(MAX)}$ = Maximum voltage on V_{IN}
$V_{OUT(MIN)}$ = Minimum regulator output voltage
$I_{LOAD(MAX)}$ = Maximum output (load) current

The maximum allowable power dissipation (Equation 2) is a function of the maximum ambient temperature ($T_{A(MAX)}$), the maximum allowable die temperature (125°C) 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 when mounted on a single layer FR4 dielectric copper clad PC board.

$$P_{D(MAX)} = \frac{(T_{J(MAX)} - T_{A(MAX)})}{\theta_{JA}}$$

Equation 2.

Where all terms are previously defined.

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

Given:
$V_{IN(MAX)}$ = 3.0V ±10%
$V_{OUT(MIN)}$ = 2.7V – 2%
I_{LOAD} = 98 mA
$T_{A(MAX)}$ = 55°C

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

Actual power dissipation:
$P_D \approx (V_{IN(MAX)} - V_{OUT(MIN)})I_{LOAD(MAX)}$
$= [(3.0 \times 1.1) - (2.7 \times .98)]98 \times 10^{-3}$
= 64 mW

Maximum allowable power dissipation:

$$P_{D(MAX)} = \frac{(T_{J(MAX)} - T_{A(MAX)})}{\theta_{JA}}$$

$$= \frac{(125 - 55)}{220}$$

= 318 mW

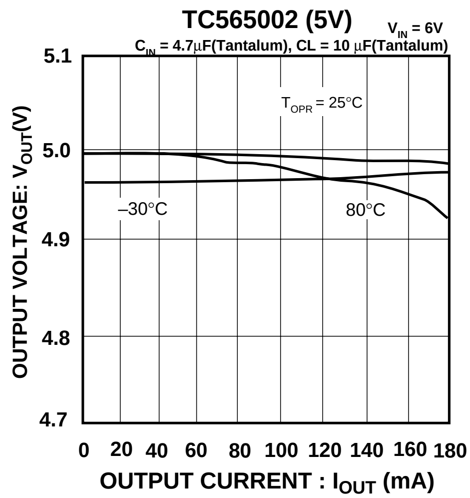
In this example, the TC56 dissipates a maximum of only 64 mW — far below the allowable limit of 318 mW. In a similar manner, Equation 1 and Equation 2 can be used to calculate maximum current and/or input voltage limits.

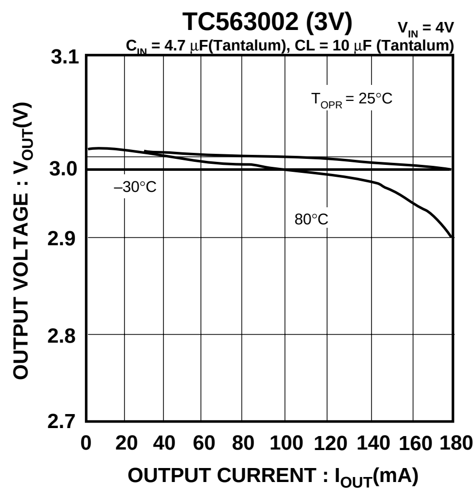
Layout Considerations

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.

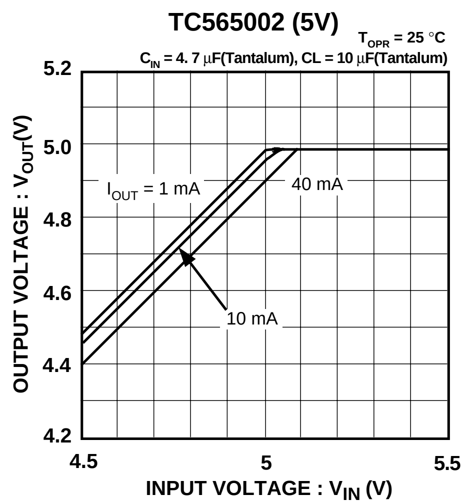
TYPICAL CHARACTERISTICS

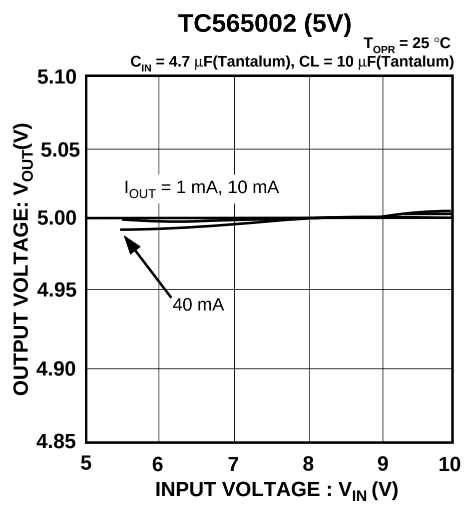
1. OUTPUT VOLTAGE vs. OUTPUT CURRENT

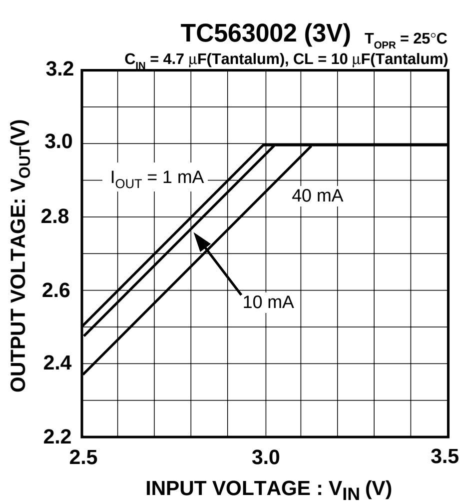


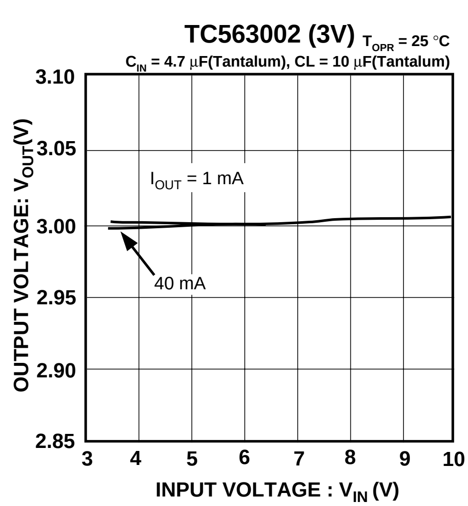


2. OUTPUT VOLTAGE vs. INPUT VOLTAGE





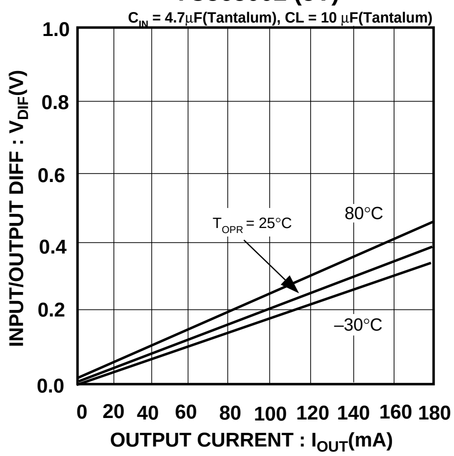




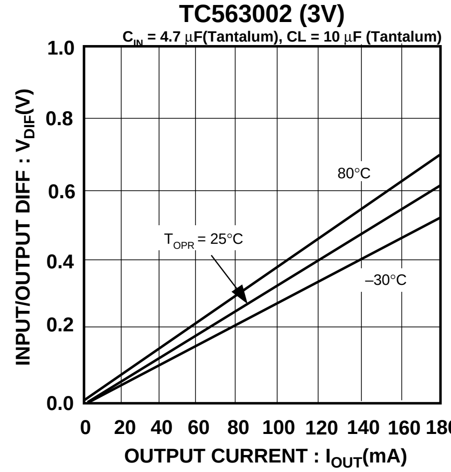
TYPICAL CHARACTERISTICS

3. INPUT/OUTPUT VOLTAGE DIFFERENTIAL vs. OUTPUT CURRENT

TC565002 (5V)

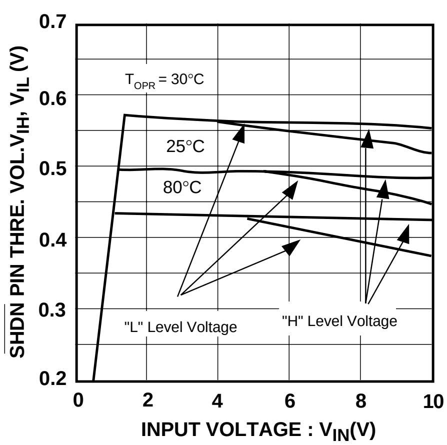


TC563002 (3V)

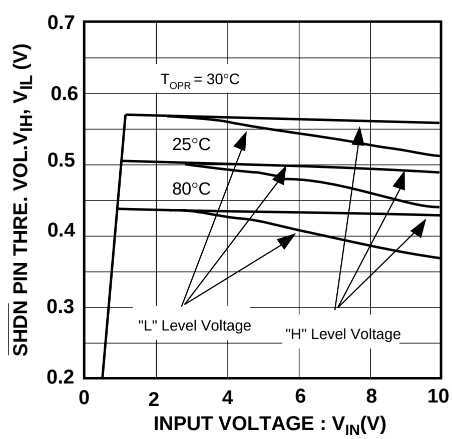


4. $\overline{\text{SHDN}}$ PIN THRESHOLD VOLTAGE vs. INPUT VOLTAGE

TC565002 (5V)

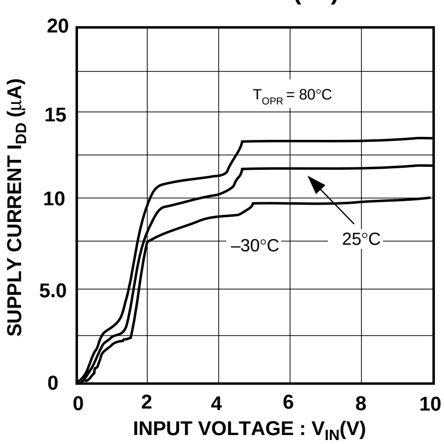


TC563002 (3V)

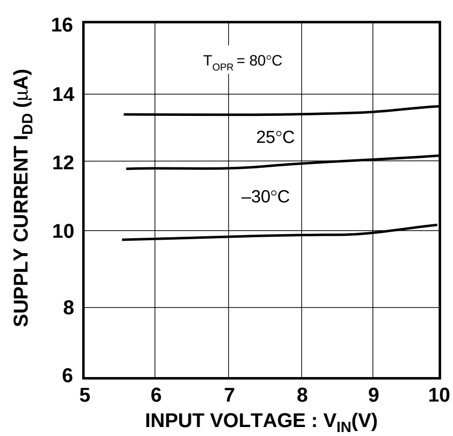


5. SUPPLY CURRENT vs. INPUT VOLTAGE

TC565002 (5V)



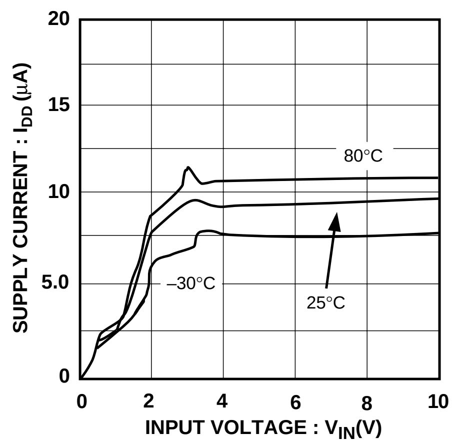
TC565002 (5V)



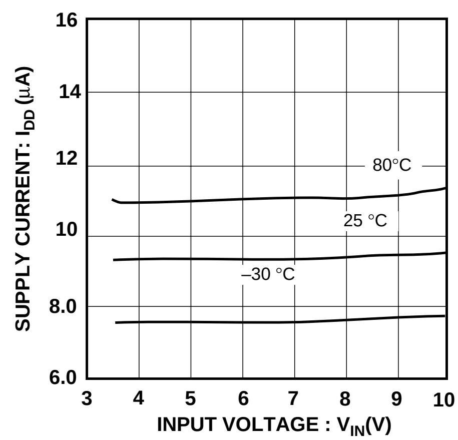
TYPICAL CHARACTERISTICS (CONT.)

5. SUPPLY CURRENT vs. INPUT VOLTAGE (CONTINUED)

TC563002 (3V)

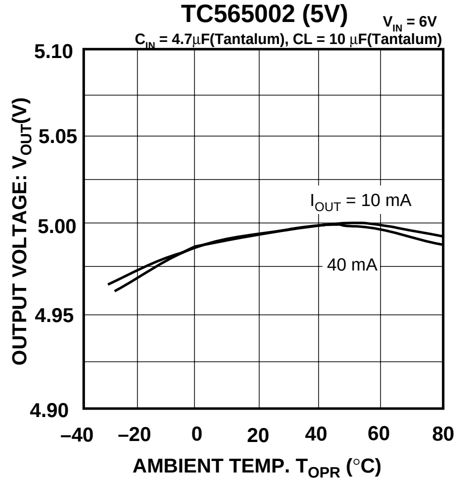


TC563002 (3V)

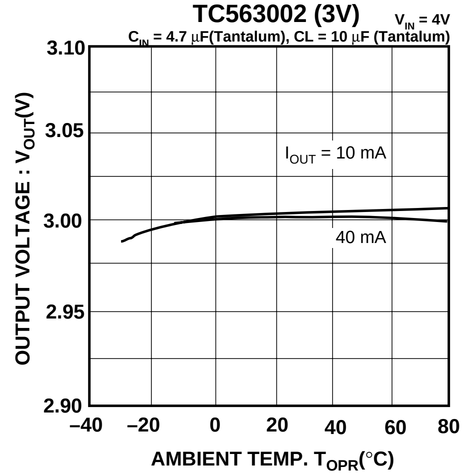


6. OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE

TC565002 (5V)

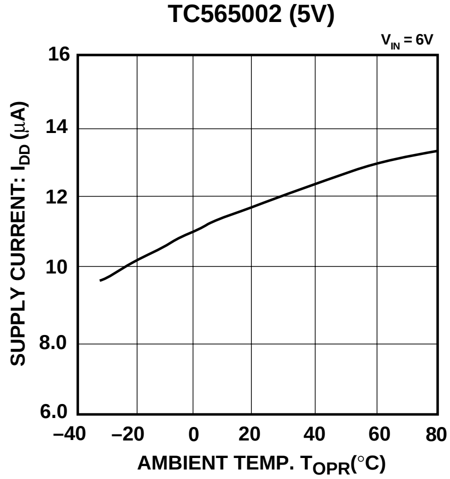


TC563002 (3V)

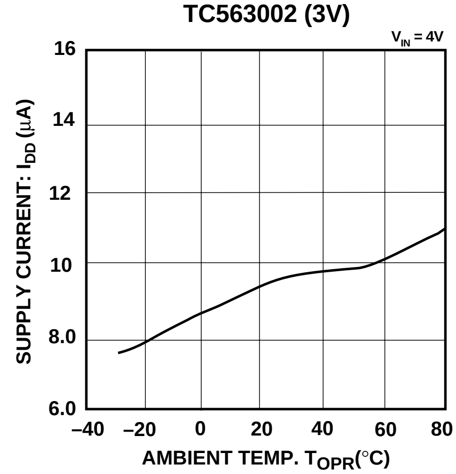


7. SUPPLY CURRENT vs. AMBIENT TEMPERATURE

TC565002 (5V)

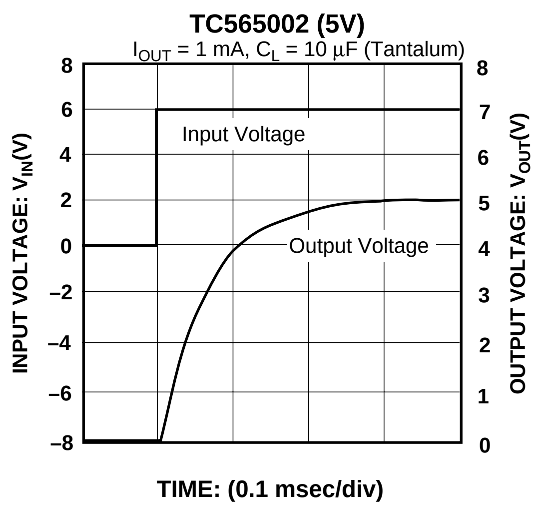


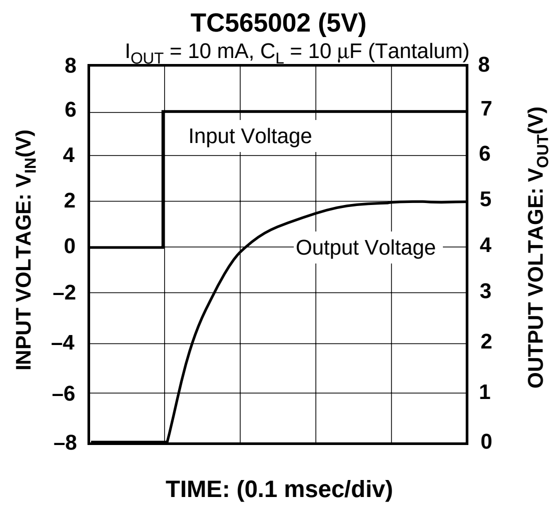
TC563002 (3V)

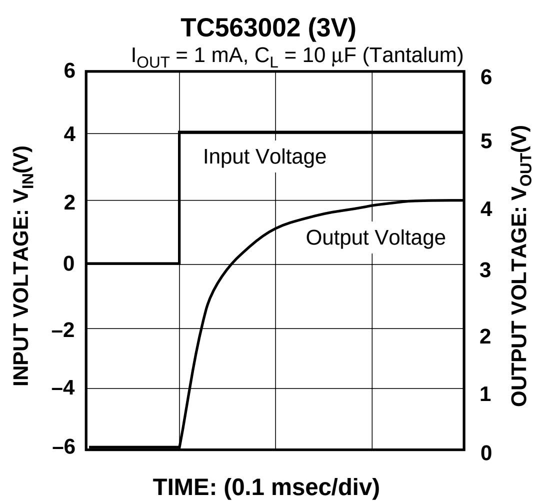


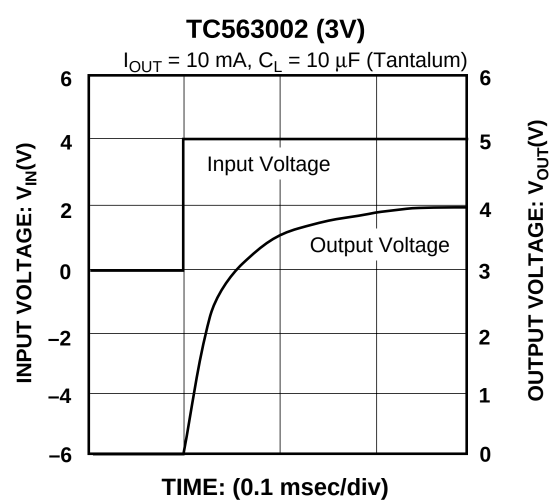
TYPICAL CHARACTERISTICS (CONT.)

8. INPUT TRANSIENT RESPONSE 1

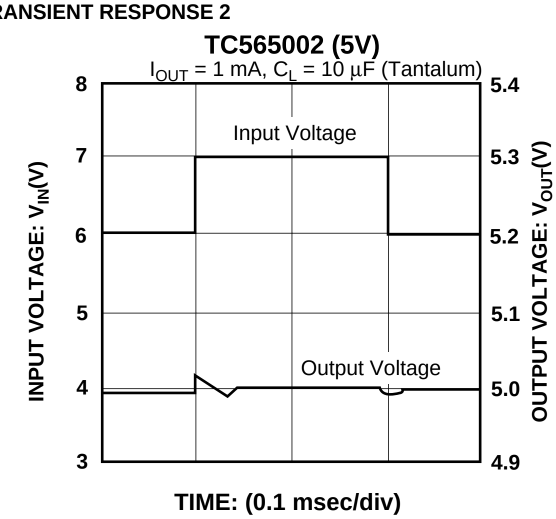


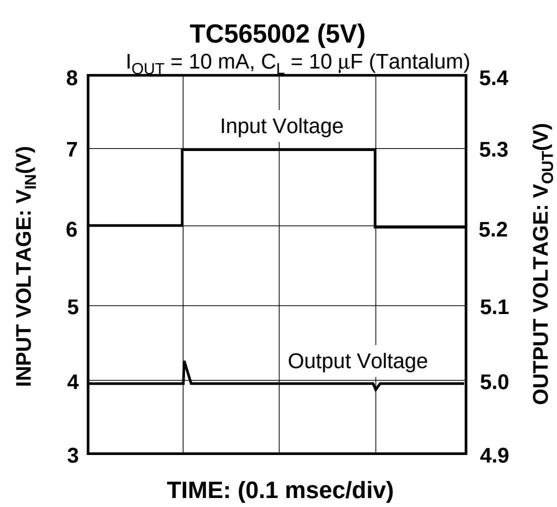






9. INPUT TRANSIENT RESPONSE 2



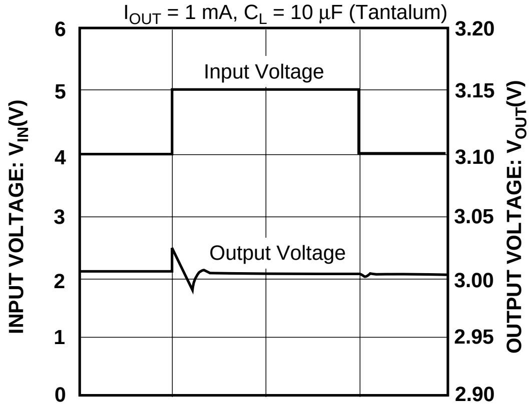


TYPICAL CHARACTERISTICS (CONT.)

9. INPUT TRANSIENT RESPONSE 2 (CONTINUED)

TC563002 (3V)

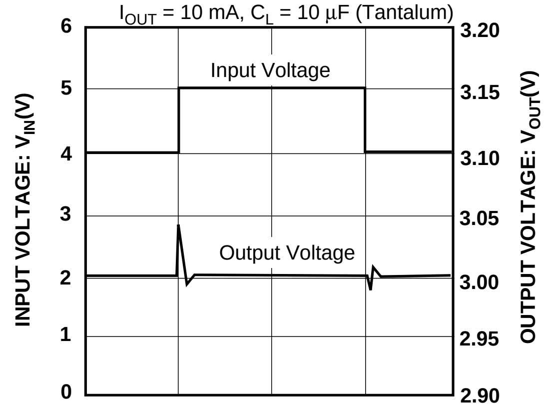
I_{OUT} = 1 mA, C_L = 10 µF (Tantalum)



TIME: (1 msec/div)

TC563002 (3V)

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

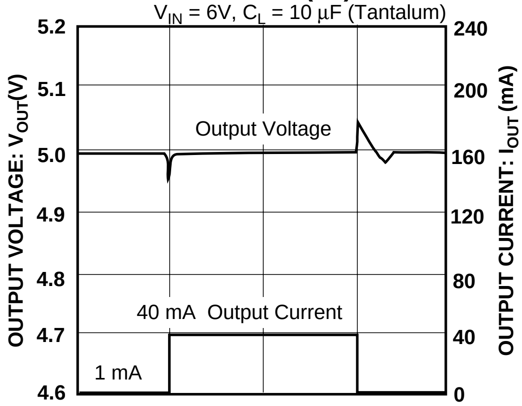


TIME: (1 msec/div)

10. LOAD TRANSIENT RESPONSE

TC565002 (5V)

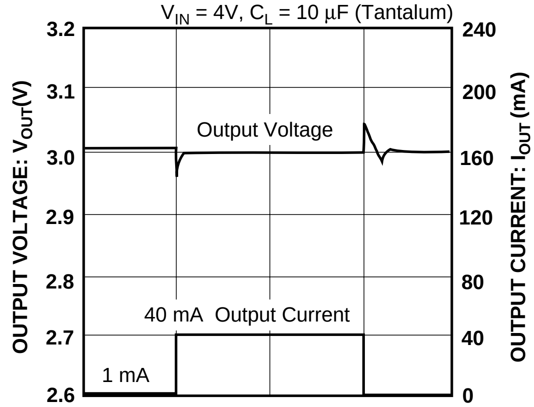
V_{IN} = 6V, C_L = 10 µF (Tantalum)



TIME: (2 msec/div)

TC563002 (3V)

V_{IN} = 4V, C_L = 10 µF (Tantalum)

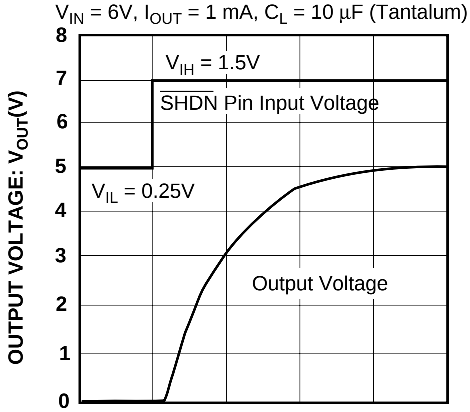


TIME: (2 msec/div)

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

TC565002 (5V)

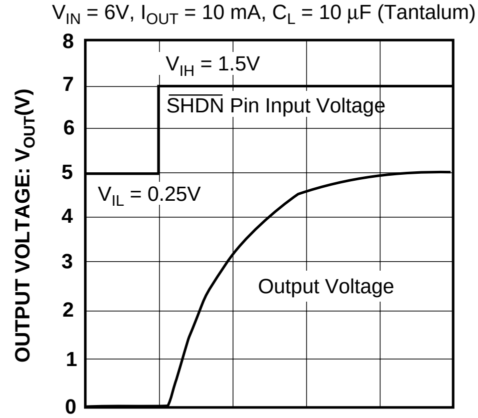
V_{IN} = 6V, I_{OUT} = 1 mA, C_L = 10 µF (Tantalum)



TIME: (0.1 msec/div)

TC565002 (5V)

V_{IN} = 6V, I_{OUT} = 10 mA, C_L = 10 µF (Tantalum)



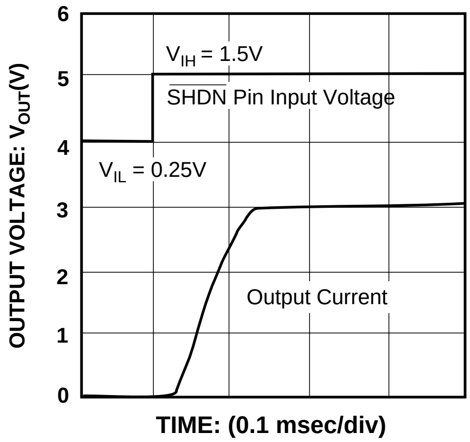
TIME: (0.1 msec/div)

TYPICAL CHARACTERISTICS (CONT.)

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

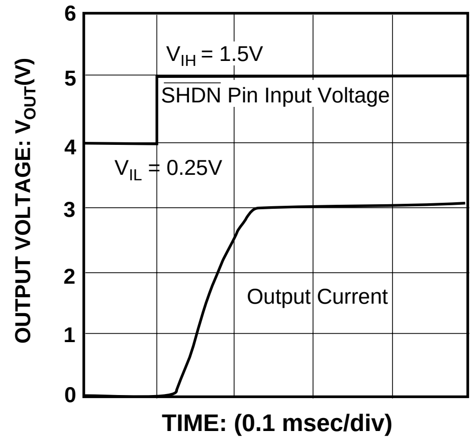
TC563002 (3V)

V_{IN} = 4V, I_{OUT} = 1 mA, C_L = 10 µF (Tantalum)



TC563002 (3V)

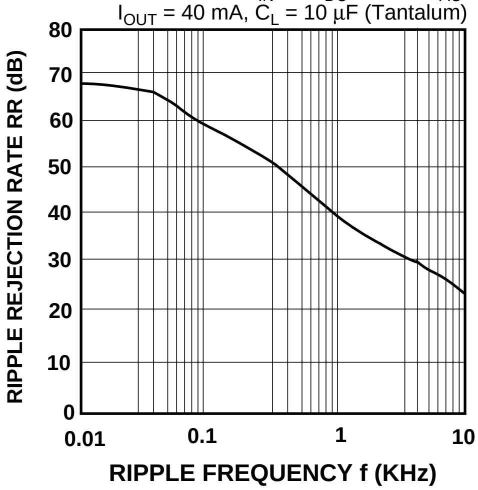
V_{IN} = 4V, I_{OUT} = 10 mA, C_L = 10 µF (Tantalum)



12. RIPPLE REJECTION RATE

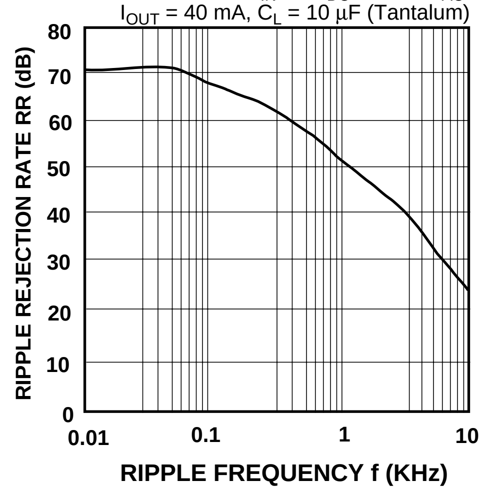
TC565002 (5V)

V_{IN} = 6V_{DC} + 1 Vp–p_{AC},
I_{OUT} = 40 mA, C_L = 10 µF (Tantalum)



TC563002 (3V)

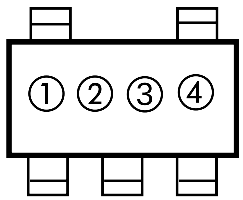
V_{IN} = 6V_{DC} + 1 Vp–p_{AC},
I_{OUT} = 40 mA, C_L = 10 µF (Tantalum)



TC56

MARKINGS

5-Pin SOT-23A



① represents the the interger of the output voltage

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

② represents the interger 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

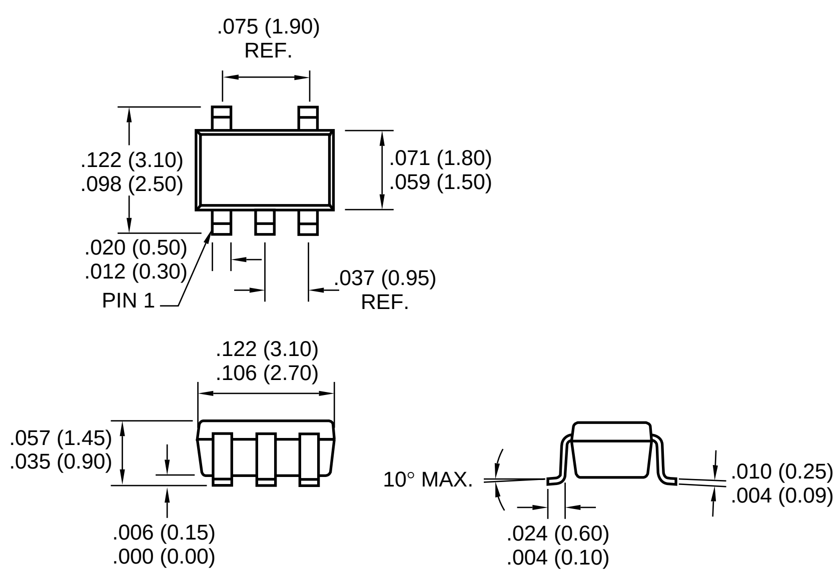
③ represents the transition response

Symbol	
–	REGULAR

④ represents assembly lot code

PACKAGE DIMENSIONS

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



Dimensions: inches (mm)

WORLDWIDE SALES AND SERVICE

AMERICAS

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Web Address: http://www.microchip.com

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Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

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Westford, MA 01886
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Dallas
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Addison, TX 75001
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Dayton
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Miamisburg, OH 45342
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Detroit
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