

50 mA, 100 mA, 150 mA CMOS LDOs with Shutdown and Reference Bypass

Features

- Low Supply Current: 80 μ A (Max)
- Low Dropout Voltage: 140 mV (Typ.) @ 150 mA
- High-Output Voltage Accuracy: $\pm 0.4\%$ (Typ.)
- Standard or Custom Output Voltages
- Power-Saving Shutdown Mode
- Reference Bypass Input for Ultra Low-Noise Operation
- Fast Shutdown Response Time: 60 μ sec (Typ.)
- Overcurrent Protection
- Space-Saving 5-Pin SOT-23A Package
- Pin-Compatible Upgrades for Bipolar Regulators
- Wide Operating Temperature Range: -40°C to +125°C

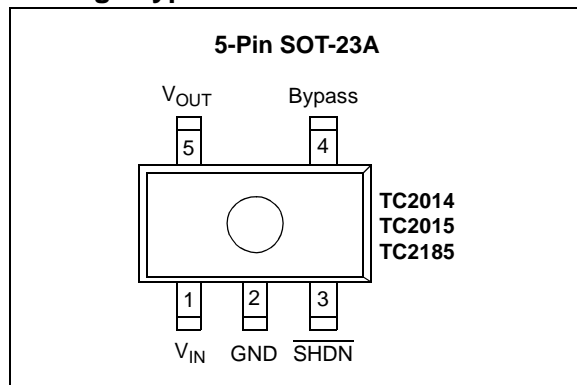
Applications

- Battery-Operated Systems
- Portable Computers
- Medical Instruments
- Instrumentation
- Cellular/GSM/PHS Phones
- Linear Post-Regulator for SMPS
- Pagers

Related Literature

- Application Notes: AN765, AN766, AN776 and AN792

Package Type



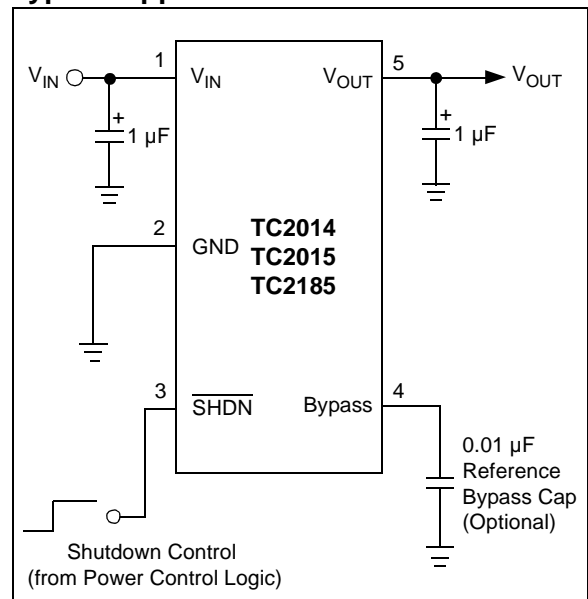
General Description

The TC2014, TC2015 and TC2185 are high-accuracy (typically $\pm 0.4\%$) CMOS upgrades for bipolar Low Drop-out Regulators (LDOs), such as the LP2980. Total supply current is typically 55 μ A; 20 to 60 times lower than in bipolar regulators.

The key features of the device include low noise operation (plus bypass reference), low dropout voltage – typically 45 mV for the TC2014, 90 mV for the TC2015, and 140 mV for the TC2185, at full load – and fast response to step changes in load. Supply current is reduced to 0.5 μ A (max) and V_{OUT} falls to zero when the shutdown input is low. These devices also incorporate overcurrent protection.

The TC2014, TC2015 and TC2185 are stable with an output capacitor of 1 μ F and have maximum output currents of 50 mA, 100 mA and 150 mA, respectively. For higher-output versions, see the TC1107 (DS21356), TC1108 (DS21357) and TC1173 (DS21362) (I_{OUT} = 300 mA) data sheets.

Typical Application



TC2014/2015/2185

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage 7.0V
 Output Voltage (-0.3) to (V_{IN} + 0.3)
 Operating Temperature -40°C < T_J < 125°C
 Storage Temperature..... -65°C to +150°C
 Maximum Voltage on Any Pin V_{IN} +0.3V to -0.3V
 Maximum Junction Temperature..... 150°C

† **Notice:** Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

PIN FUNCTION TABLE

Name	Function
V _{IN}	Unregulated Supply Input
GND	Ground Terminal
SHDN	Shutdown Control Input
Bypass	Reference Bypass Input
V _{OUT}	Regulated Voltage Output

ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise specified, V_{IN} = V_R + 1V, I_L = 100 μA, C_{OUT} = 3.3 μF, SHDN > V_{IH}, T_A = +25°C.
BOLDFACE type specifications apply for junction temperature of -40°C to +125°C.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input Operating Voltage	V _{IN}	2.7	—	6.0	V	Note 1
Maximum Output Current	I _{OUTMAX}	50	—	—	mA	TC2014
		100	—	—		TC2015
		150	—	—		TC2185
Output Voltage	V _{OUT}	V_R - 2.0%	V _R ± 0.4%	V_R + 2.0%	V	Note 2
V _{OUT} Temperature Coefficient	TCV _{OUT}	—	20	—	ppm/°C	Note 3
		—	40	—		
Line Regulation	ΔV _{OUT} /ΔV _{IN}	—	0.05	0.5	%	(V _R + 1V) ≤ V _{IN} ≤ 6V
Load Regulation (Note 4)	ΔV _{OUT} /V _{OUT}	-1.0	0.33	+1.0	%	TC2014;TC2015: I _L = 0.1 mA to I _{OUTMAX}
		-2.0	0.43	+2.0		TC2185: I _L = 0.1 mA to I _{OUTMAX} (Note 4)
Dropout Voltage	V _{IN} - V _{OUT}	—	2	—	mV	Note 5 I _L = 100 μA
		—	45	70		I _L = 50 mA
		—	90	140		TC2015; TC2185 I _L = 100 mA
		—	140	210		TC2185 I _L = 150 mA
Supply Current	I _{IN}	—	55	80	μA	SHDN = V _{IH} , I _L = 0

- Note 1:** The minimum V_{IN} has to meet two conditions: V_{IN} = 2.7V and V_{IN} = V_R + V_{DROPOUT}.
2: V_R is the regulator output voltage setting. For example: V_R = 1.8V, 2.7V, 2.8V, 2.85V, 3.0V, 3.3V.
3:

$$TCV_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^{-6}}{V_{OUT} \times \Delta T}$$

- 4:** Regulation is measured at a constant junction temperature using low duty cycle pulse testing. Load regulation is tested over a load range from 1.0 mA to the maximum specified output current. Changes in output voltage due to heating effects are covered by the Thermal Regulation specification.
5: Dropout Voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal value.
6: Thermal Regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a current pulse equal to I_{MAX} at V_{IN} = 6V for T = 10 msec.
7: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction-to-air (i.e. T_A, T_J, θ_{JA}).
8: Time required for V_{OUT} to reach 95% of V_R (output voltage setting), after V_{SHDN} is switched from 0 to V_{IN}.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise specified, $V_{IN} = V_R + 1V$, $I_L = 100 \mu A$, $C_{OUT} = 3.3 \mu F$, $\overline{SHDN} > V_{IH}$, $T_A = +25^\circ C$. BOLDFACE type specifications apply for junction temperature of $-40^\circ C$ to $+125^\circ C$.						
Parameters	Sym	Min	Typ	Max	Units	Conditions
Shutdown Supply Current	I_{INSD}	—	0.05	0.5	μA	$\overline{SHDN} = 0V$
Power Supply Rejection Ratio	PSRR	—	55	—	dB	$F \leq 1 \text{ kHz}$, $C_{bypass} = 0.01 \mu F$
Output Short Circuit Current	I_{OUTSC}	—	160	300	mA	$V_{OUT} = 0V$
Thermal Regulation	$\Delta V_{OUT}/\Delta P_D$	—	0.04	—	V/W	Note 6, Note 7
Output Noise	eN	—	200	—	nV/ \sqrt{Hz}	$I_L = I_{OUTMAX}$, $F = 10 \text{ kHz}$ 470 pF from Bypass to GND
Response Time, (Note 8) (from Shutdown Mode)	T_R	—	60	—	μsec	$V_{IN} = 4V$, $I_L = 30 \text{ mA}$, $C_{IN} = 1 \mu F$, $C_{OUT} = 10 \mu F$
SHDN Input						
SHDN Input High Threshold	V_{IH}	60	—	—	% V_{IN}	$V_{IN} = 2.5V$ to $6.0V$
SHDN Input Low Threshold	V_{IL}	—	—	15	% V_{IN}	$V_{IN} = 2.5V$ to $6.0V$

- Note** 1: The minimum V_{IN} has to meet two conditions: $V_{IN} = 2.7V$ and $V_{IN} = V_R + V_{DROPOUT}$.
 2: V_R is the regulator output voltage setting. For example: $V_R = 1.8V, 2.7V, 2.8V, 2.85V, 3.0V, 3.3V$.
 3:

$$TCV_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^{-6}}{V_{OUT} \times \Delta T}$$

- 4: Regulation is measured at a constant junction temperature using low duty cycle pulse testing. Load regulation is tested over a load range from 1.0 mA to the maximum specified output current. Changes in output voltage due to heating effects are covered by the Thermal Regulation specification.
 5: Dropout Voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal value.
 6: Thermal Regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a current pulse equal to I_{MAX} at $V_{IN} = 6V$ for $T = 10 \text{ msec}$.
 7: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction-to-air (i.e. T_A , T_J , θ_{JA}).
 8: Time required for V_{OUT} to reach 95% of V_R (output voltage setting), after V_{SHDN} is switched from 0 to V_{IN} .

2.0 TYPICAL PERFORMANCE CURVES

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.

Note: Unless otherwise indicated, $V_{IN} = V_R + 1V$, $I_L = 100 \mu A$, $C_{OUT} = 3.3 \mu F$, $\overline{SHDN} > V_{IH}$, $T_A = +25^\circ C$.

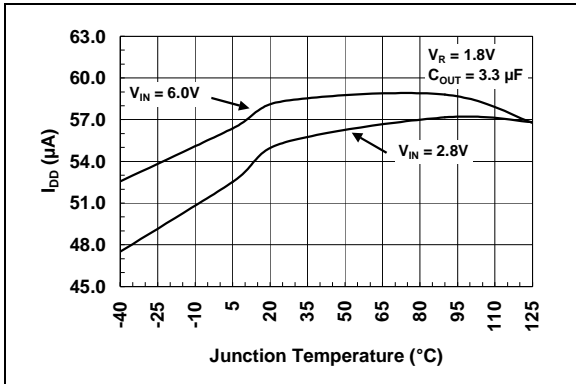


FIGURE 2-1: Supply Current vs. Junction Temperature.

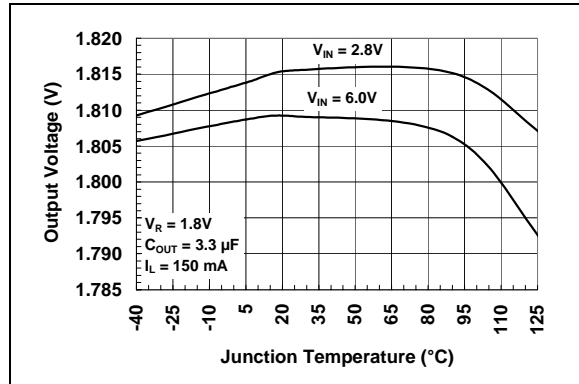


FIGURE 2-4: Output Voltage vs. Junction Temperature.

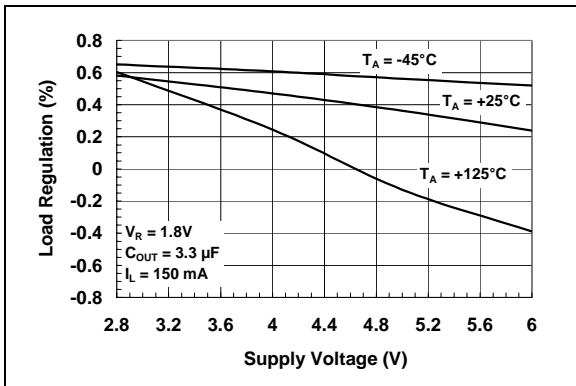


FIGURE 2-2: Load Regulation vs. Supply Voltage.

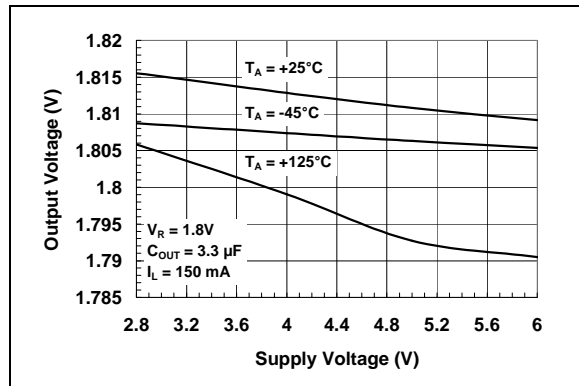


FIGURE 2-5: Output Voltage vs. Supply Voltage.

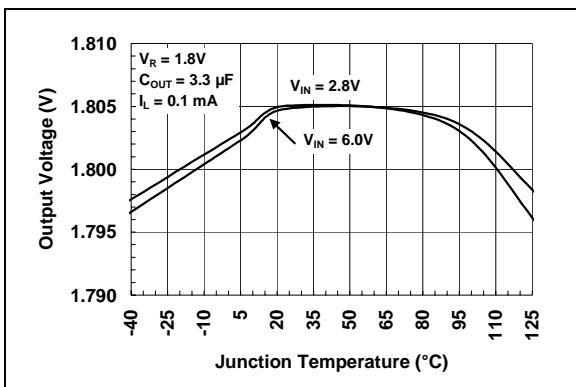


FIGURE 2-3: Output Voltage vs. Junction Temperature.

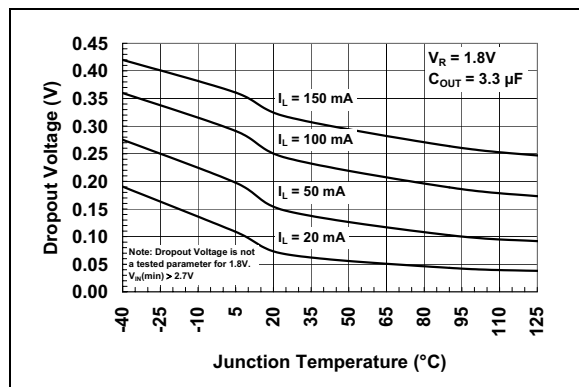


FIGURE 2-6: Dropout Voltage vs. Junction Temperature.

Note: Unless otherwise indicated, $V_{IN} = V_R + 1V$, $I_L = 100 \mu A$, $C_{OUT} = 3.3 \mu F$, $\overline{SHDN} > V_{IH}$, $T_A = +25^\circ C$.

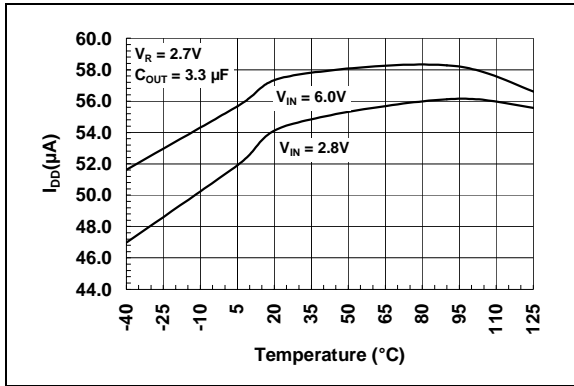


FIGURE 2-7: Supply Current vs. Junction Temperature.

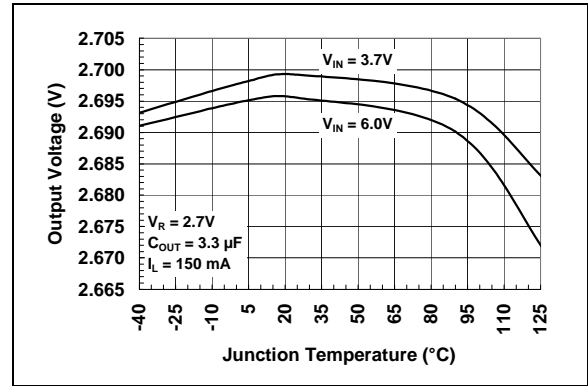


FIGURE 2-10: Output Voltage vs. Junction Temperature.

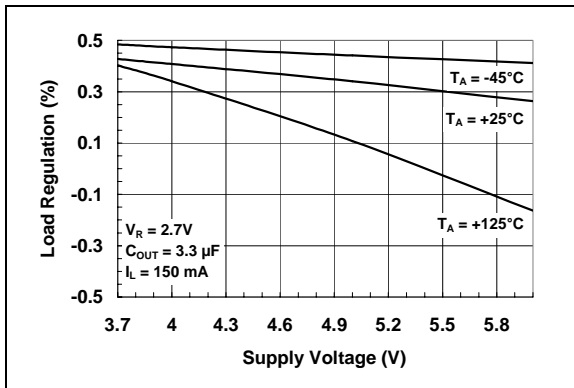


FIGURE 2-8: Load Regulation vs. Supply Voltage.

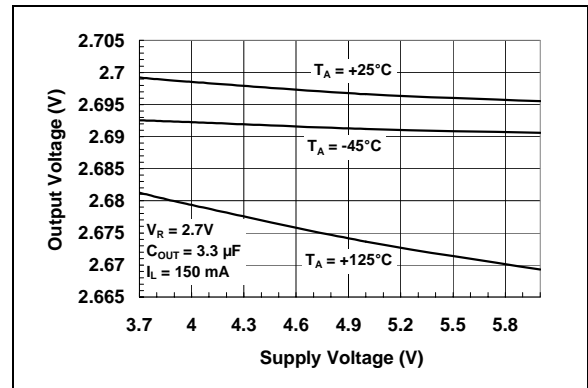


FIGURE 2-11: Output Voltage vs. Supply Voltage.

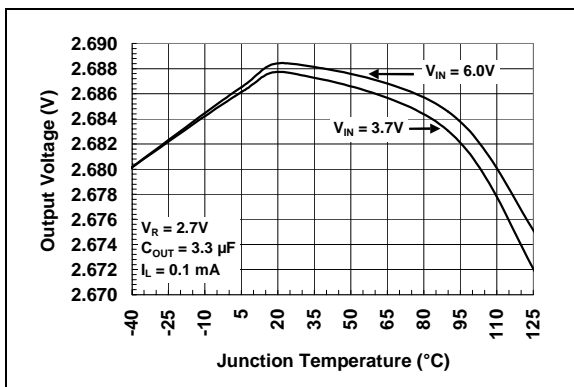


FIGURE 2-9: Output Voltage vs. Junction Temperature.

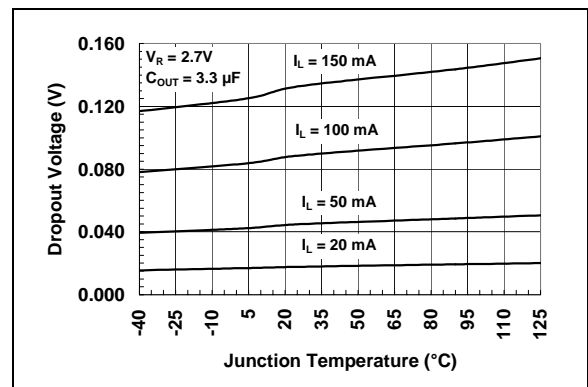


FIGURE 2-12: Dropout Voltage vs. Junction Temperature.

TC2014/2015/2185

Note: Unless otherwise indicated, $V_{IN} = V_R + 1V$, $I_L = 100 \mu A$, $C_{OUT} = 3.3 \mu F$, $\overline{SHDN} > V_{IH}$, $T_A = +25^\circ C$.

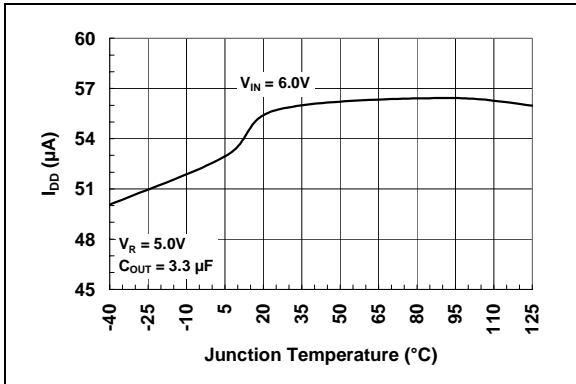


FIGURE 2-13: Supply Current vs. Junction Temperature.

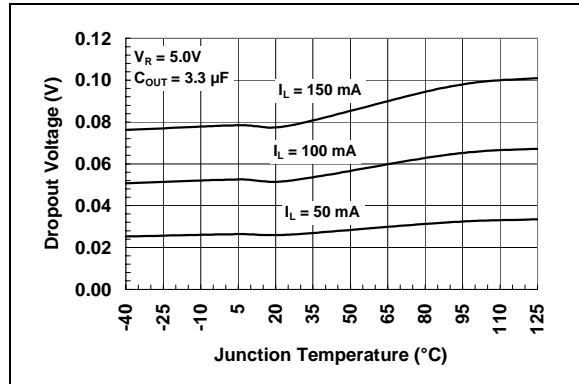


FIGURE 2-16: Dropout Voltage vs. Junction Temperature.

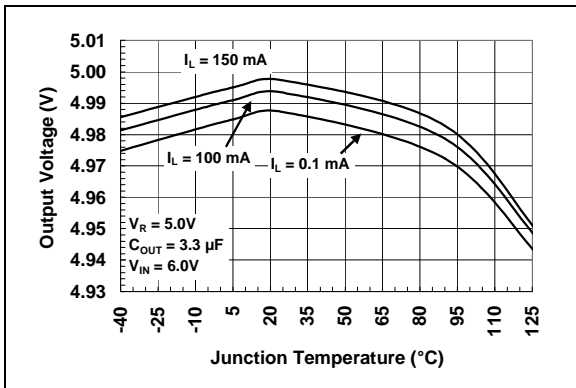


FIGURE 2-14: Output Voltage vs. Junction Temperature.

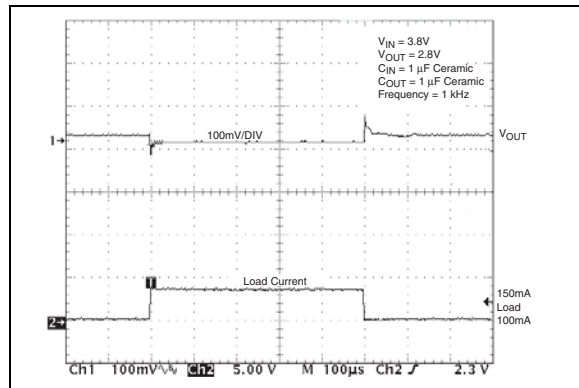


FIGURE 2-17: Load Transient Response. ($C_{OUT} = 1 \mu F$).

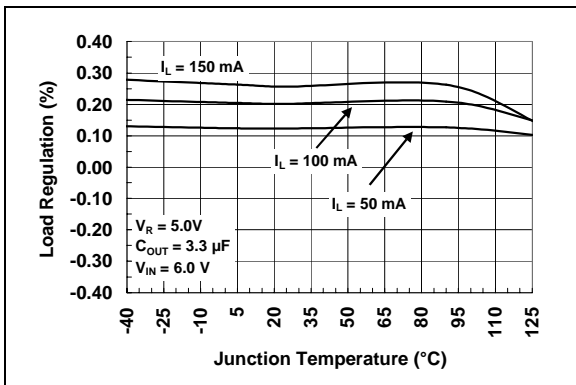


FIGURE 2-15: Load Regulation vs. Junction Temperature.

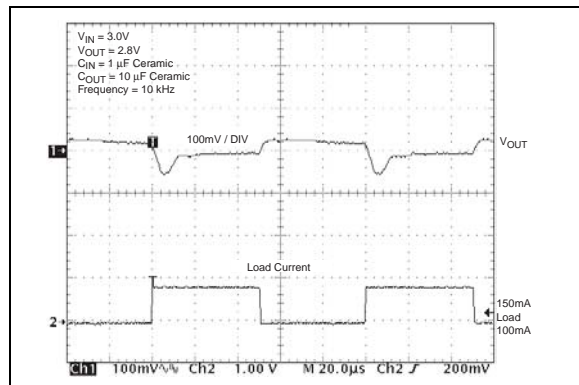


FIGURE 2-18: Load Transient Response. ($C_{OUT} = 10 \mu F$).

Note: Unless otherwise indicated, $V_{IN} = V_R + 1V$, $I_L = 100 \mu A$, $C_{OUT} = 3.3 \mu F$, $\overline{SHDN} > V_{IH}$, $T_A = +25^\circ C$.

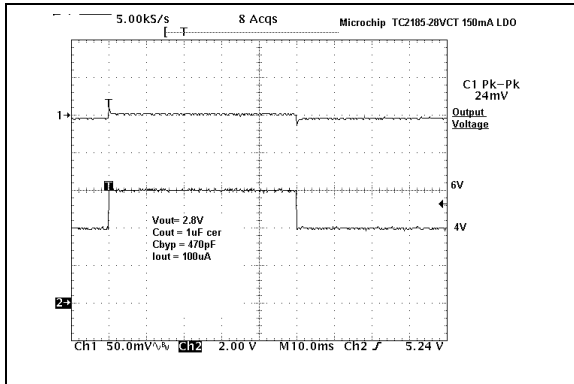


FIGURE 2-19: Line Transient Response. ($C_{OUT} = 1 \mu F$).

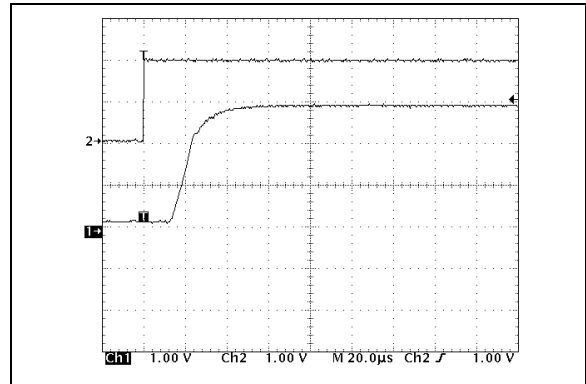


FIGURE 2-22: Wake-Up Response.

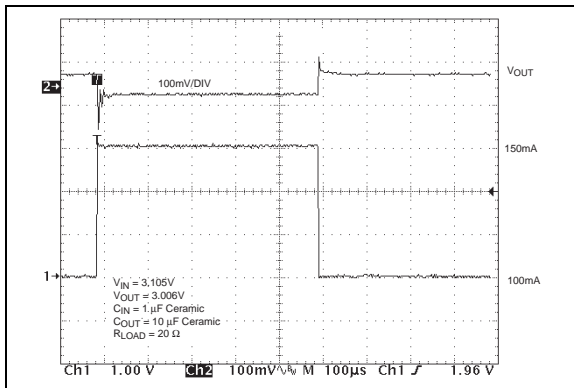


FIGURE 2-20: Load Transient Response in Dropout. ($C_{OUT} = 10 \mu F$).

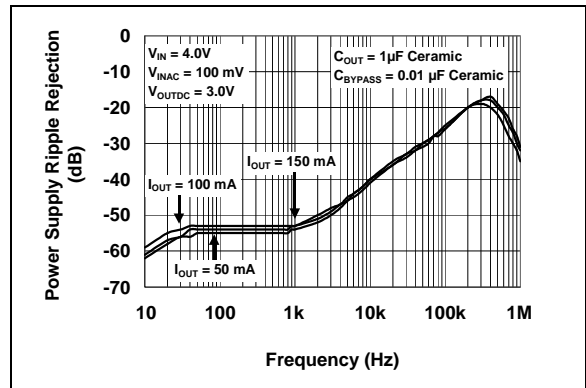


FIGURE 2-23: PSRR vs. Frequency ($C_{OUT} = 1 \mu F$ Ceramic).

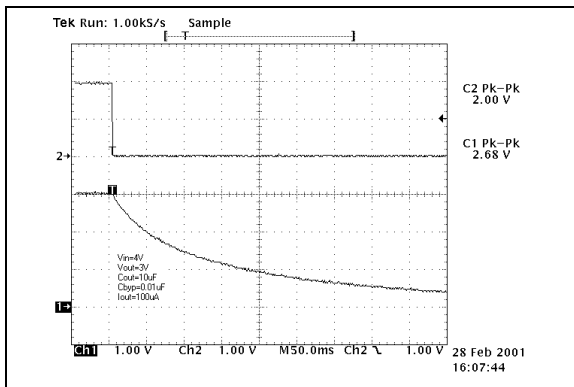


FIGURE 2-21: Shutdown Delay Time.

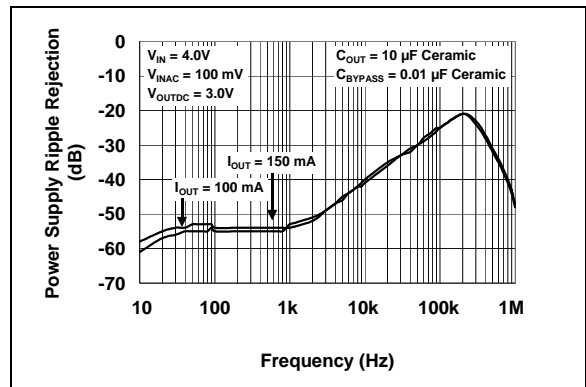


FIGURE 2-24: PSRR vs. Frequency ($C_{OUT} = 10 \mu F$ Ceramic).

TC2014/2015/2185

Note: Unless otherwise indicated, $V_{IN} = V_R + 1V$, $I_L = 100 \mu A$, $C_{OUT} = 3.3 \mu F$, $\overline{SHDN} > V_{IH}$, $T_A = +25^\circ C$.

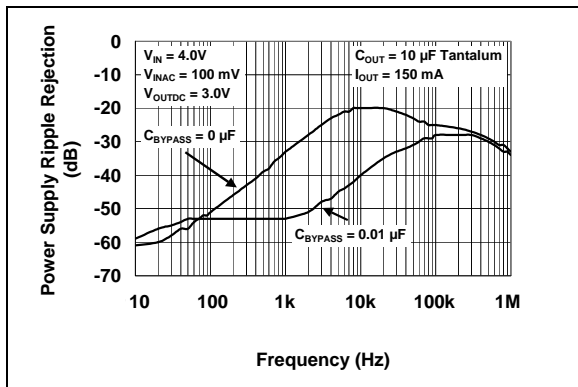


FIGURE 2-25: PSRR vs. Frequency ($C_{OUT} = 10 \mu F$ Tantalum).

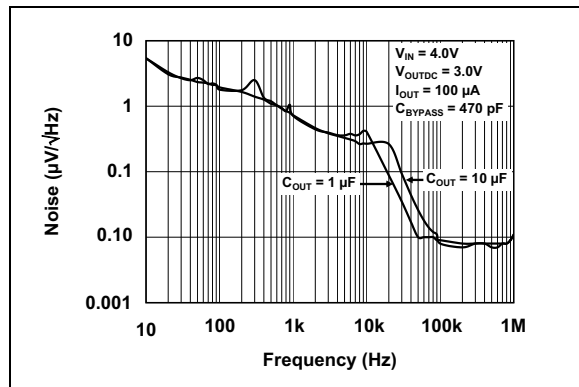


FIGURE 2-26: Output Noise vs. Frequency.

3.0 PIN DESCRIPTIONS

The descriptions of the pins are described in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin No.	Symbol	Description
1	V_{IN}	Unregulated supply input
2	GND	Ground terminal
3	$\overline{\text{SHDN}}$	Shutdown control input
4	Bypass	Reference bypass input
5	V_{OUT}	Regulated voltage output

3.1 Unregulated Supply Input (V_{IN})

Connect the unregulated input supply to the V_{IN} pin. If there is a large distance between the input supply and the LDO regulator, some input capacitance is necessary for proper operation. A 1 μF capacitor, connected from V_{IN} to ground, is recommended for most applications.

3.2 Ground Terminal (GND)

Connect the unregulated input supply ground return to GND. Also connect one side of the 1 μF typical input decoupling capacitor close to this pin and one side of the output capacitor C_{OUT} to this pin.

3.3 Shutdown Control Input ($\overline{\text{SHDN}}$)

The regulator is fully enabled when a logic-high is applied to $\overline{\text{SHDN}}$. The regulator enters shutdown when a logic-low is applied to this input. During shutdown, the output voltage falls to zero and the supply current is reduced to 0.5 μA (max).

3.4 Reference Bypass Input (Bypass)

Connecting a low-value ceramic capacitor to Bypass will further reduce output voltage noise and improve the Power Supply Ripple Rejection (PSRR) performance of the LDO. Typical values from 470 pF to 0.01 μF are suggested. While smaller and larger values can be used, these affect the speed at which the LDO output voltage rises when input power is applied. The larger the bypass capacitor, the slower the output voltage will rise.

3.5 Regulated Voltage Output (V_{OUT})

Connect the output load to V_{OUT} of the LDO. Also connect one side of the LDO output de-coupling capacitor as close as possible to the V_{OUT} pin.

TC2014/2015/2185

4.0 DETAILED DESCRIPTION

The TC2014, TC2015 and TC2185 are precision fixed-output voltage regulators (if an adjustable version is needed, see the TC1070, TC1071 and TC1187 (DS21353) data sheet). Unlike bipolar regulators, the TC2014, TC2015 and TC2185 supply current does not increase with load current. In addition, the LDO's output voltage is stable using 1 μF of ceramic or tantalum capacitance over the entire specified input voltage range and output current range.

Figure 4-1 shows a typical application circuit. The regulator is enabled anytime the shutdown input (SHDN) is at or above V_{IH} , and disabled (shutdown) when SHDN is at or below V_{IL} . SHDN may be controlled by a CMOS logic gate or I/O port of a microcontroller. If the SHDN input is not required, it should be connected directly to the input supply. While in shutdown, the supply current decreases to 0.05 μA (typical) and V_{OUT} falls to zero volts.

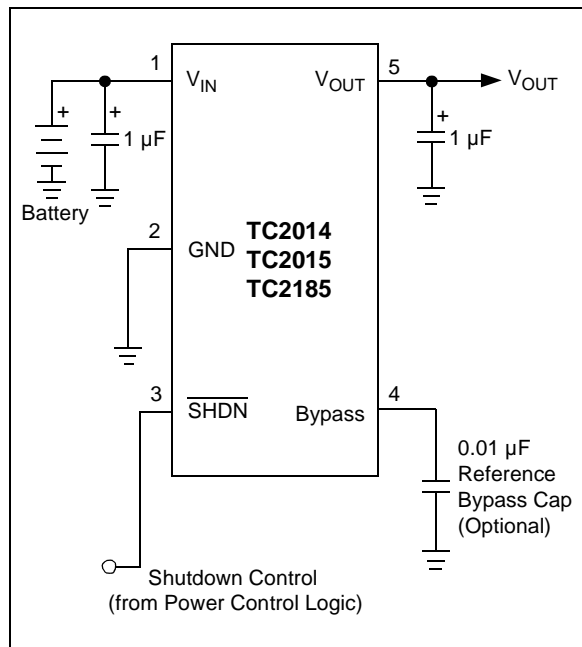


FIGURE 4-1: Typical Application Circuit.

4.1 Bypass Input

A 0.01 μF ceramic capacitor, connected from the Bypass input to ground, reduces noise present on the internal reference, which, in turn, significantly reduces output noise. If output noise is not a concern, this input may be left unconnected. Larger capacitor values may be used, but the result is a longer time period to rated output voltage when power is initially applied.

4.2 Output Capacitor

A 1 μF (min) capacitor from V_{OUT} to ground is required. The output capacitor should have an Effective Series Resistance (ESR) of 0.01 Ω to 5 Ω for $V_{OUT} \geq 2.5\text{V}$, and 0.05 Ω to 5 Ω for $V_{OUT} < 2.5\text{V}$. Ceramic, tantalum or aluminum electrolytic capacitors can be used. When using ceramic capacitors, X5R and X7R dielectric material are recommended due to their stable tolerance over temperature. However, other dielectrics can be used as long as the minimum output capacitance is maintained.

4.3 Input Capacitor

A 1 μF capacitor should be connected from V_{IN} to GND if there is more than 10 inches of wire between the regulator and this AC filter capacitor, or if a battery is used as the power source. Aluminum electrolytic or tantalum capacitors can be used (since many aluminum electrolytic capacitors freeze at approximately -30°C , solid tantalum are recommended for applications operating below -25°C). 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.

5.0 THERMAL CONSIDERATIONS

5.1 Power Dissipation

The amount of power the regulator dissipates is primarily a function of input voltage, output voltage and output current.

The following equation is used to calculate worst-case power dissipation.

EQUATION 5-1:

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

Where:

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

The maximum allowable power dissipation (P_{DMAX}) is a function of the maximum ambient temperature (T_{AMAX}), the maximum allowable die temperature (T_{JMAX}) (+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 typical two-layer FR4 dielectric copper-clad PC board.

EQUATION 5-2:

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

Where all terms are previously defined.

The P_D equation can be used in conjunction with the P_{DMAX} equation to ensure that regulator thermal operation is within limits. For example:

Given:

V_{INMAX}	=	3.0V +10%
V_{OUTMIN}	=	2.7V - 2.5%
$I_{LOADMAX}$	=	40 mA
T_{JMAX}	=	+125°C
T_{AMAX}	=	+55°C

Find:

1. Actual power dissipation
2. Maximum allowable dissipation

Actual power dissipation:

$$\begin{aligned} P_D &= (V_{INMAX} - V_{OUTMIN})I_{LMAX} \\ &= \frac{[(3.0 \times 1.1) - (2.7 \times 0.975)]40 \times 10^{-3}}{220} \\ &= 26.7mW \end{aligned}$$

Maximum allowable power dissipation:

$$\begin{aligned} P_{DMAX} &= \frac{T_{JMAX} - T_{AMAX}}{\theta_{JA}} \\ &= \frac{125 - 55}{220} \\ &= 318mW \end{aligned}$$

In this example, the TC2014 dissipates a maximum of only 26.7 mW; far below the allowable limit of 318 mW. In a similar manner, the P_D and P_{DMAX} equations can be used to calculate maximum current and/or input voltage limits.

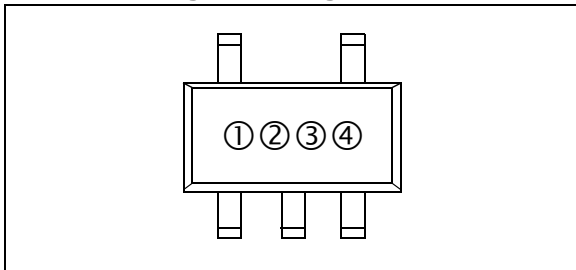
5.2 Layout Considerations

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.

TC2014/2015/2185

6.0 PACKAGING INFORMATION

6.1 Package Marking Information



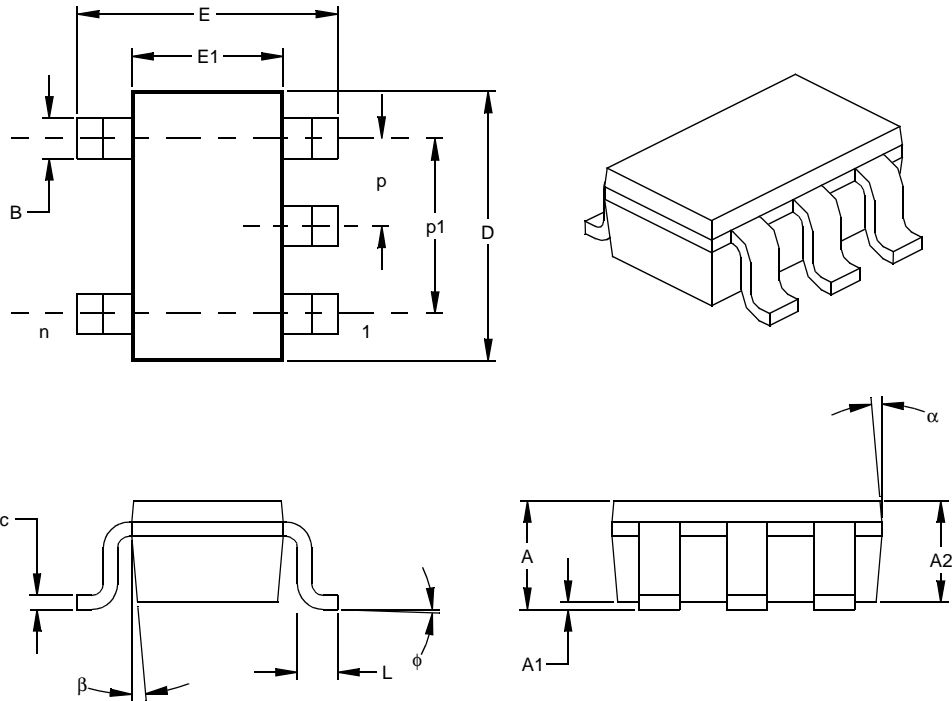
① & ② represents part number code + temperature range and voltage

(V)	TC2014	TC2015	TC2185
1.8	PA	RA	UA
2.5	PB	RB	UB
2.6	PH	RH	UH
2.7	PC	RC	UC
2.8	PD	RD	UD
2.85	PE	RE	UE
3.0	PF	RF	UF
3.3	PG	RG	UG
5.0	PJ	RJ	UJ

③ represents year and 2-month period code

④ represents lot ID number

5-Lead Plastic Small Outline Transistor (OT) (SOT23)



Dimension Limits	Units	INCHES*			MILLIMETERS		
		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		5			5	
Pitch	p		.038			0.95	
Outside lead pitch (basic)	p1		.075			1.90	
Overall Height	A	.035	.046	.057	0.90	1.18	1.45
Molded Package Thickness	A2	.035	.043	.051	0.90	1.10	1.30
Standoff §	A1	.000	.003	.006	0.00	0.08	0.15
Overall Width	E	.102	.110	.118	2.60	2.80	3.00
Molded Package Width	E1	.059	.064	.069	1.50	1.63	1.75
Overall Length	D	.110	.116	.122	2.80	2.95	3.10
Foot Length	L	.014	.018	.022	0.35	0.45	0.55
Foot Angle	φ	0	5	10	0	5	10
Lead Thickness	c	.004	.006	.008	0.09	0.15	0.20
Lead Width	B	.014	.017	.020	0.35	0.43	0.50
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

* Controlling Parameter

§ Significant Characteristic

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MO-178

Drawing No. C04-091

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

<u>PART NO.</u>	<u>-XX</u>	<u>X</u>	<u>XXXX</u>	Examples:
Device	Output Voltage	Temperature Range	Package	
Device:	TC2014:	50 mA LDO with Shutdown and VREF Bypass		a) TC2014-1.8VCTTR: 5LD SOT-23-A, 1.8V, Tape and Reel.
	TC2015:	100 mA LDO with Shutdown and VREF Bypass		b) TC2014-2.85VCTTR: 5LD SOT-23-A, 2.85V, Tape and Reel.
	TC2185:	150 mA LDO with Shutdown and VREF Bypass		c) TC2014-3.3VCTTR: 5LD SOT-23-A, 3.3V, Tape and Reel.
Output Voltage:	XX = 1.8V			a) TC2015-1.8VCTTR: 5LD SOT-23-A, 1.8V, Tape and Reel.
	XX = 2.5V			b) TC2015-2.85VCTTR: 5LD SOT-23-A, 2.85V, Tape and Reel.
	XX = 2.6V			c) TC2015-3.0VCTTR: 5LD SOT-23-A, 3.0V, Tape and Reel.
	XX = 2.7V			a) TC2185-1.8VCTTR: 5LD SOT-23-A, 1.8V, Tape and Reel.
	XX = 2.8V			b) TC2185-2.8VCTTR: 5LD SOT-23-A, 2.8V, Tape and Reel.
	XX = 2.85V			
	XX = 3.0V			
	XX = 3.3V			
	XX = 5.0V			
Temperature Range:	V	= -40°C to +125°C		
Package:	CTTR	= Plastic Small Outline Transistor (SOT-23), 5-lead, Tape and Reel		

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:

1. Your local Microchip sales office
2. The Microchip Worldwide Site (www.microchip.com)

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

Customer Notification System

Register on our web site (www.microchip.com) to receive the most current information on our products.

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, KEELOQ, microID, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, PowerSmart, rfPIC, and SmartShunt are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.


AmpLab, FilterLab, MXDEV, MXLAB, PICMASTER, SEEVAL, SmartSensor and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, dsPICDEM, dsPICDEM.net, dsPICworks, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, PICkit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, rLAB, rfPICDEM, Select Mode, Smart Serial, SmartTel and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2004, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949:2002 ==

Microchip received ISO/TS-16949:2002 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.



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:
<http://support.microchip.com>
Web Address:
www.microchip.com

Atlanta
Alpharetta, GA
Tel: 770-640-0034
Fax: 770-640-0307

Boston
Westford, MA
Tel: 978-692-3848
Fax: 978-692-3821

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo
Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

San Jose
Mountain View, CA
Tel: 650-215-1444
Fax: 650-961-0286

Toronto
Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8676-6200
Fax: 86-28-8676-6599

China - Fuzhou
Tel: 86-591-8750-3506
Fax: 86-591-8750-3521

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Shunde
Tel: 86-757-2839-5507
Fax: 86-757-2839-5571

China - Qingdao
Tel: 86-532-502-7355
Fax: 86-532-502-7205

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-2229-0061
Fax: 91-80-2229-0062

India - New Delhi
Tel: 91-11-5160-8631
Fax: 91-11-5160-8632

Japan - Kanagawa
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Kaohsiung
Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan - Taipei
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Taiwan - Hsinchu
Tel: 886-3-572-9526
Fax: 886-3-572-6459

EUROPE

Austria - Weis
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

Denmark - Ballerup
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Massy
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Ismaning
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

England - Berkshire
Tel: 44-118-921-5869
Fax: 44-118-921-5820

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Microchip:

[TC2185-2.7VCTTR](#) [TC2015-3.0VCTTR](#) [TC2014-2.7VCTTR](#) [TC2015-2.7VCTTR](#) [TC2185-2.85VCTTR](#) [TC2014-2.85VCTTR](#) [TC2185-2.8VCTTR](#) [TC2015-3.3VCTTR](#) [TC2015-2.85VCTTR](#) [TC2014-3.3VCTTR](#) [TC2185-3.3VCTTR](#) [TC2015-2.8VCTTR](#) [TC2015-1.8VCTTR](#) [TC2185-3.0VCTTR](#) [TC2014-3.0VCTTR](#) [TC2185-1.8VCTTR](#) [TC2014-1.8VCTTR](#) [TC2014-2.8VCTTR](#) [TC2185-5.0VCTTR](#)