

NCP4515

100 mA CMOS LDO with Shutdown and Reference Bypass

The NCP4515 is a high accuracy (typically $\pm 0.5\%$) CMOS upgrade for older (bipolar) low dropout regulators such as the LP2980. Designed specifically for battery-operated systems, the devices' CMOS construction eliminates wasted ground current, significantly extending battery life. Total supply current is typically 50 μA at full load (20 to 60 times lower than in bipolar regulators).

Key features for the devices include ultra low-noise operation (plus optional Bypass input), fast response to step changes in load, and very low dropout voltage, typically 180 mV at full load. Supply current is reduced to 0.5 μA (max) and V_{OUT} falls to zero when the shutdown input is low. The devices also incorporate both over-temperature and over-current protection.

The NCP4515 is stable with an output capacitor of only 1.0 μF and has a maximum output current of 50 mA, 100 mA, and 150 mA, respectively. For higher output versions, see the NCP4569 ($I_{\text{OUT}} = 300 \text{ mA}$) data sheet.

Features

- Extremely Low Supply Current (50 μA , Typ.)
- Very Low Dropout Voltage
- Guaranteed 100 mA Output
- High Output Voltage Accuracy
- Standard or Custom Output Voltages
- Power-Saving Shutdown Mode
- Reference Bypass Input for Ultra Low-Noise Operation
- Over-Current and Over-Temperature Protection
- Space-Saving 5-Pin SOT-23A Package
- Pin Compatible Upgrades for Bipolar Regulators

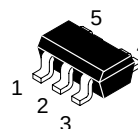
Applications

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



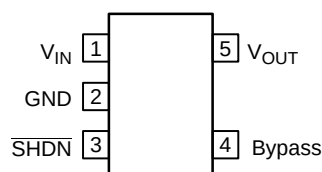
ON Semiconductor™

<http://onsemi.com>



SOT-23
SN SUFFIX
CASE 1212

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 14 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 14 of this data sheet.

NCP4515

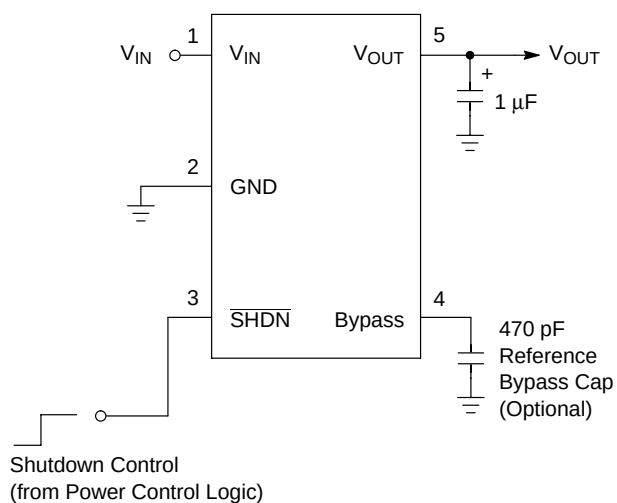


Figure 1. Typical Application

ABSOLUTE MAXIMUM RATINGS*

Rating	Symbol	Value	Unit	
Input Voltage	–	6.5	V	
Output Voltage	–	–0.3 to V _{IN} + 0.3	V	
Power Dissipation	–	Internally Limited	–	
Operating Temperature	T _A	–40 < T _J < 125	°C	
Storage Temperature	T _{stg}	–65 to +150	°C	
Maximum Voltage on any Pin	–	V _{IN} + 0.3 to – 0.3	V	
Lead Temperature (Soldering, 10 Sec.)	–	+260	°C	
ESD Withstand Voltage	Human Body Model (Note 1.)	V _{ESD}	> 2000	V
Latch–Up Performance (Note 2.)	I _{LATCH–UP}		mA	
Positive		> 250		
Negative	> 250			

*Stresses beyond 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 beyond 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.

1. Tested to EIA/JESD22–A114–A
2. Tested to EIA/JESD78

NCP4515

ELECTRICAL CHARACTERISTICS ($V_{IN} = V_R + 1.0\text{ V}$, $I_L = 100\text{ }\mu\text{A}$, $C_L = 3.3\text{ }\mu\text{F}$, $\overline{\text{SHDN}} > V_{IH}$, $T_A = 25^\circ\text{C}$, unless otherwise noted. **Boldface** type specifications apply for junction temperatures of -40°C to $+125^\circ\text{C}$.)

Characteristics	Test Conditions	Symbol	Min	Typ	Max	Unit
Input Operating Voltage	Note 3.	V_{IN}	2.7	–	6.0	V
Maximum Output Current	–	I_{OUTMAX}	100	–	–	mA
Output Voltage	Note 4.	V_{OUT}	$V_R - 2.5\%$	$V_R \pm 0.5\%$	$V_R + 2.5\%$	V
V_{OUT} Temperature Coefficient	Note 5.	TCV_{OUT}	– –	20 40	– –	ppm/ $^\circ\text{C}$
Line Regulation	$(V_R + 1.0\text{ V}) \leq V_{IN} \leq 6.0\text{ V}$	$\Delta V_{OUT}/\Delta V_{IN}$	–	0.05	0.35	%
Load Regulation	$I_L = 0.1\text{ mA}$ to I_{OUTMAX} Note 6.	$\Delta V_{OUT}/V_{OUT}$	–	0.5	2.0	%
Dropout Voltage	$I_L = 100\text{ }\mu\text{A}$ $I_L = 20\text{ mA}$ $I_L = 50\text{ mA}$ $I_L = 100\text{ mA}$ Note 7.	$V_{IN} - V_{OUT}$	– – – –	2.0 65 85 180	– – 120 250	mV
Supply Current (Note 10.)	$\overline{\text{SHDN}} = V_{IH}$, $I_L = 0$	I_{IN}	–	50	80	μA
Shutdown Supply Current	$\overline{\text{SHDN}} = 0\text{ V}$	I_{INSD}	–	0.05	0.5	μA
Power Supply Rejection Ratio	$F_{RE} \leq 1.0\text{ kHz}$	PSRR	–	64	–	dB
Output Short Circuit Current	$V_{OUT} = 0\text{ V}$	I_{OUTSC}	–	300	450	mA
Thermal Regulation	Note 8., 9.	$\Delta V_{OUT}/\Delta P_D$	–	0.04	–	V/W
Thermal Shutdown Die Temperature	–	T_{SD}	–	160	–	$^\circ\text{C}$
Thermal Shutdown Hysteresis	–	ΔT_{SD}	–	10	–	$^\circ\text{C}$
Output Noise	$I_L = I_{OUTMAX}$, $F = 10\text{ kHz}$ 470 pF from Bypass to GND	eN	–	600	–	nV/ $\sqrt{\text{Hz}}$

SHDN Input

$\overline{\text{SHDN}}$ Input High Threshold	$V_{IN} = 2.5\text{ V}$ to 6.5 V	V_{IH}	45	–	–	% V_{IN}
$\overline{\text{SHDN}}$ Input Low Threshold	$V_{IN} = 2.5\text{ V}$ to 6.5 V	V_{IL}	–	–	15	% V_{IN}

- The minimum V_{IN} has to meet two conditions: $V_{IN} \geq 2.7\text{ V}$ and $V_{IN} \geq V_R + V_{DROPOUT}$.
- V_R is the regulator output voltage setting. For example: $V_R = 1.8\text{ V}$, 2.5 V , 2.7 V , 2.8 V , 2.85 V , 3.0 V , 3.3 V , 3.6 V , 4.0 V , 5.0 V .
- $T_C V_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$
- 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.
- Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value at a 1.0 V differential.
- 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_{LMAX} at $V_{IN} = 6.0\text{ V}$ for $T = 10\text{ msec}$.
- 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}). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown. Please see *Thermal Considerations* section of this data sheet for more details.
- Apply for Junction Temperatures of -40°C to $+85^\circ\text{C}$.

PIN DESCRIPTION

Pin Number	Symbol	Description
1	V_{IN}	Unregulated supply input.
2	GND	Ground terminal.
3	$\overline{\text{SHDN}}$	Shutdown control input. The regulator is fully enabled when a logic high is applied to this input. The regulator enters shutdown when a logic low is applied to this input. During shutdown, output voltage falls to zero, and supply current is reduced to 0.5 μA (max).
4	Bypass	Reference bypass input. Connecting a 470 pF to this input further reduces output noise.
5	V_{OUT}	Regulated voltage output.

DETAILED DESCRIPTION

The NCP4515 is a precision fixed output voltage regulator. Unlike bipolar regulators, the NCP4515 supply current does not increase with load current. In addition, V_{OUT} remains stable and within regulation at very low load currents (an important consideration in RTC and CMOS RAM battery back-up applications).

Figure 2 shows a typical application circuit. The regulator is enabled any time the shutdown input ($\overline{\text{SHDN}}$) is at or above V_{IH} , and shutdown (disabled) when $\overline{\text{SHDN}}$ is at or below V_{IL} . $\overline{\text{SHDN}}$ may be controlled by a CMOS logic gate, or I/O port of a microcontroller. If the $\overline{\text{SHDN}}$ input is not required, it should be connected directly to the input supply. While in shutdown, supply current decreases to 0.05 μA (typical) and V_{OUT} falls to zero volts.

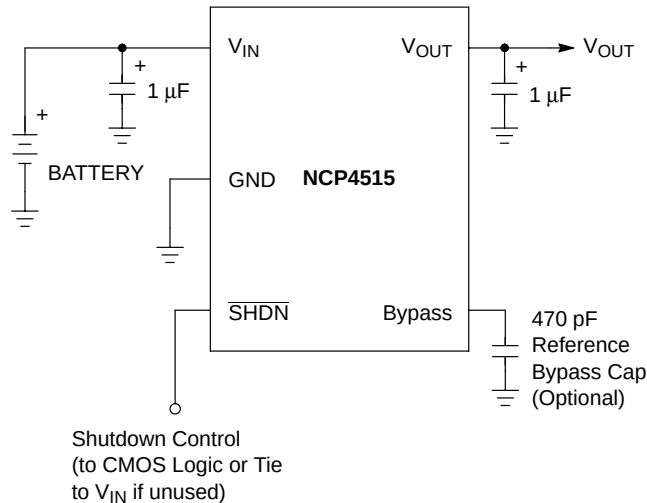


Figure 2. Typical Application Circuit

Bypass Input

A 470 pF 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 results in a longer time period to rated output voltage when power is initially applied.

Output Capacitor

A 1.0 μF (min) capacitor from V_{OUT} to ground is required. The output capacitor should have an effective series resistance of 5.0 Ω or less. A 1.0 μF capacitor should be connected from V_{IN} to GND if there is more than 10 inches of wire between the regulator and the AC filter capacitor, or if a battery is used as the power source.

Aluminum electrolytic or tantalum capacitor types can be used. (Since many aluminum electrolytic capacitors freeze at approximately -30°C , solid tantalums 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.

Thermal Considerations

Thermal Shutdown

Integrated thermal protection circuitry shuts the regulator off when die temperature exceeds 160°C . The regulator remains off until the die temperature drops to approximately 150°C .

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:

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

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

(eq. 1)

The maximum *allowable* power dissipation (Equation 2) is a function of the maximum ambient temperature (T_{AMAX}), the maximum allowable die temperature (125°C), and the thermal resistance from junction-to-air (θ_{JA}). The 5-Pin SOT-23 package has a θ_{JA} of approximately **200°C/Watt** when mounted on a single layer FR4 dielectric copper clad PC board.

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

Where all terms are previously defined. (eq. 2)

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

GIVEN : $V_{INMAX} = 3.0 \text{ V} \pm 10\%$
 $V_{OUTMIN} = 2.7 \text{ V} - 2.5\%$
 $I_{LOADMAX} = 40 \text{ mA}$
 $T_{JMAX} = 125^{\circ}\text{C}$
 $T_{AMAX} = 55^{\circ}\text{C}$

- FIND : 1. Actual power dissipation.
 2. Maximum allowable dissipation.

Actual power dissipation :

$$\begin{aligned} P_D &\approx (V_{INMAX} - V_{OUTMIN})I_{LOADMAX} \\ &= [(3.0 \times 1.1) - (2.7 \times .975)] 40 \times 10^{-3} \\ &= \underline{26.7 \text{ mW}} \end{aligned}$$

Maximum allowable power dissipation :

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

In this example, the NCP4515 dissipates a maximum of only 26.7 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

(Unless otherwise specified, all parts are measured at Temperature = 25°C)

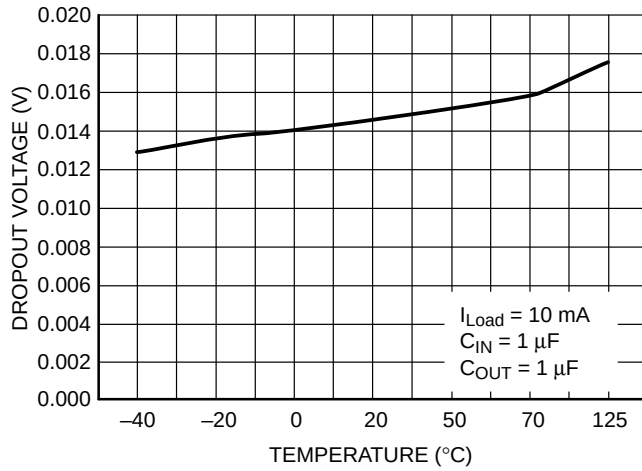


Figure 3. Dropout Voltage vs. Temperature
($V_{OUT} = 3.3\text{ V}$)

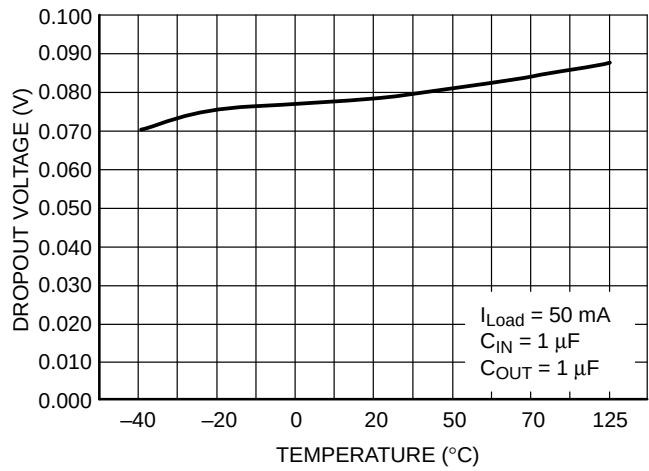


Figure 4. Dropout Voltage vs. Temperature
($V_{OUT} = 3.3\text{ V}$)

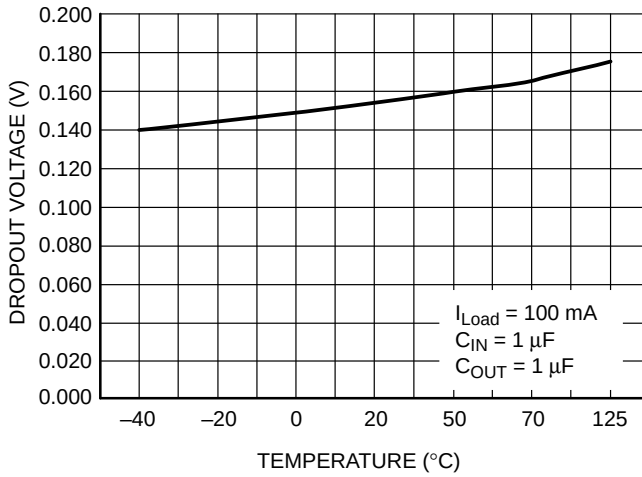


Figure 5. Dropout Voltage vs. Temperature
($V_{OUT} = 3.3\text{ V}$)

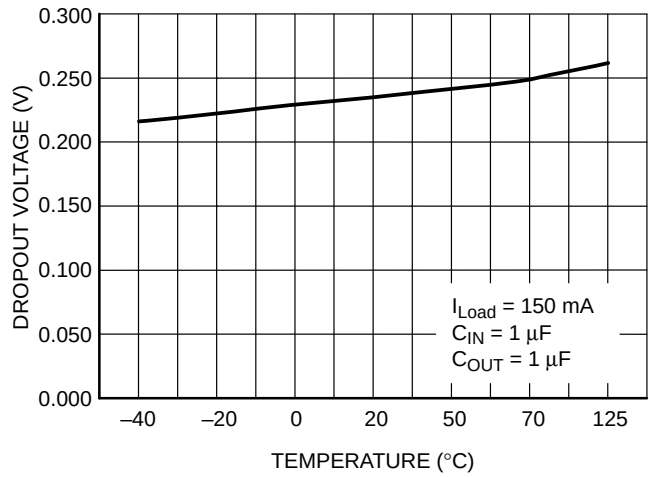


Figure 6. Dropout Voltage vs. Temperature
($V_{OUT} = 3.3\text{ V}$)

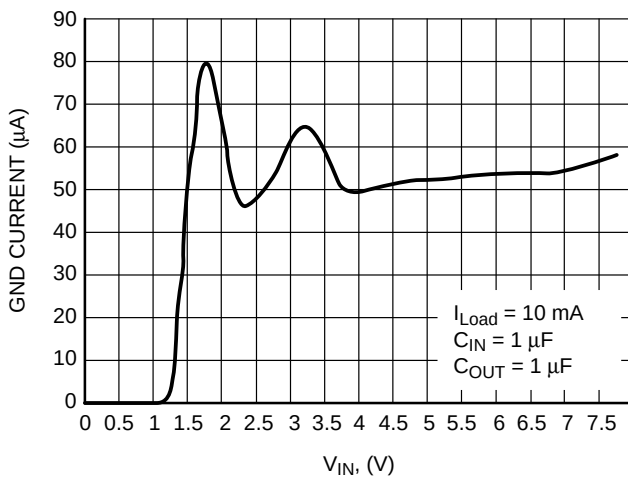


Figure 7. Ground Current vs. V_{IN} ($V_{OUT} = 3.3\text{ V}$)

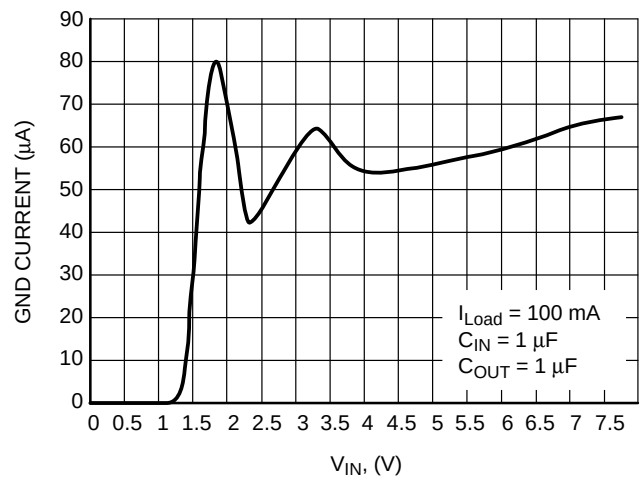


Figure 8. Ground Current vs. V_{IN} ($V_{OUT} = 3.3\text{ V}$)

TYPICAL CHARACTERISTICS

(Unless otherwise specified, all parts are measured at Temperature = 25°C)

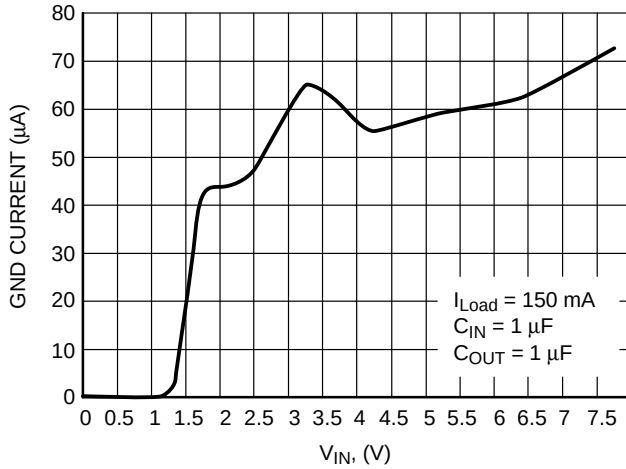


Figure 9. Ground Current vs. V_{IN} ($V_{OUT} = 3.3\text{ V}$)

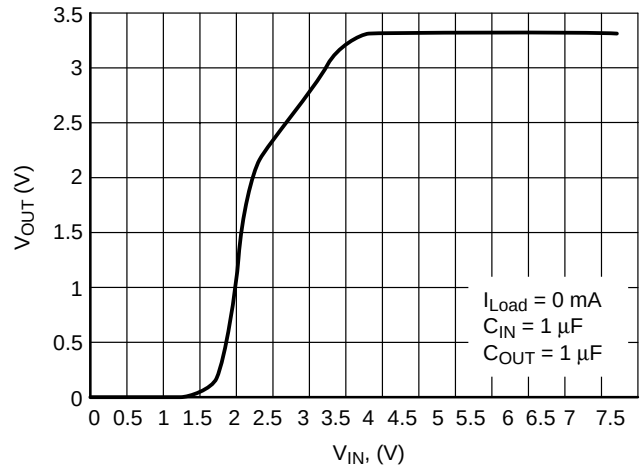


Figure 10. V_{OUT} vs. V_{IN} ($V_{OUT} = 3.3\text{ V}$)

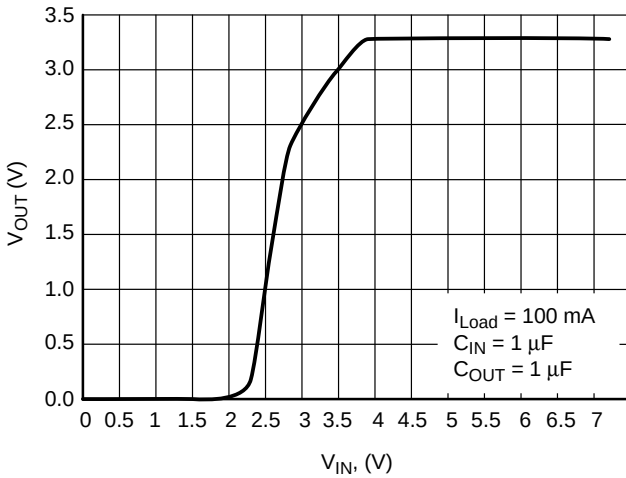


Figure 11. V_{OUT} vs. V_{IN} ($V_{OUT} = 3.3\text{ V}$)

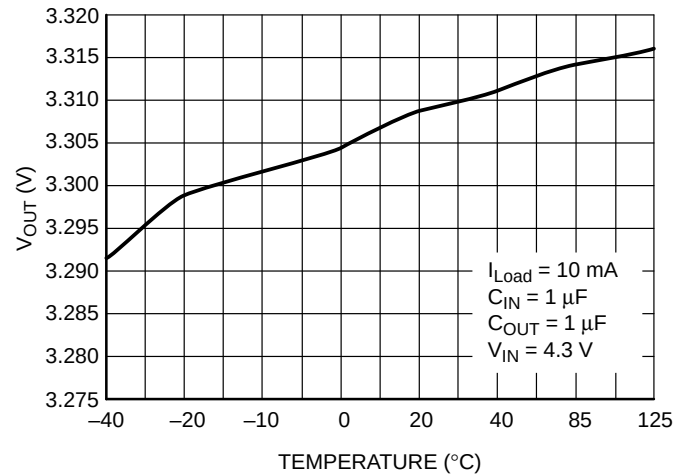


Figure 12. Output Voltage vs. Temperature ($V_{OUT} = 3.3\text{ V}$)

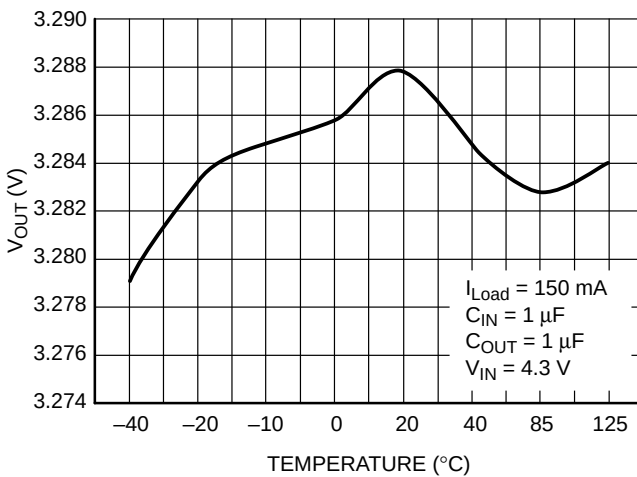


Figure 13. Output Voltage vs. Temperature ($V_{OUT} = 3.3\text{ V}$)

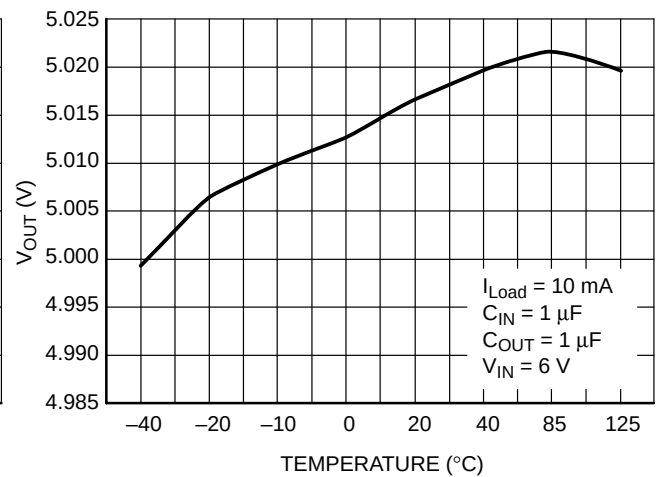


Figure 14. Output Voltage vs. Temperature ($V_{OUT} = 5\text{ V}$)

TYPICAL CHARACTERISTICS

(Unless otherwise specified, all parts are measured at Temperature = 25°C)

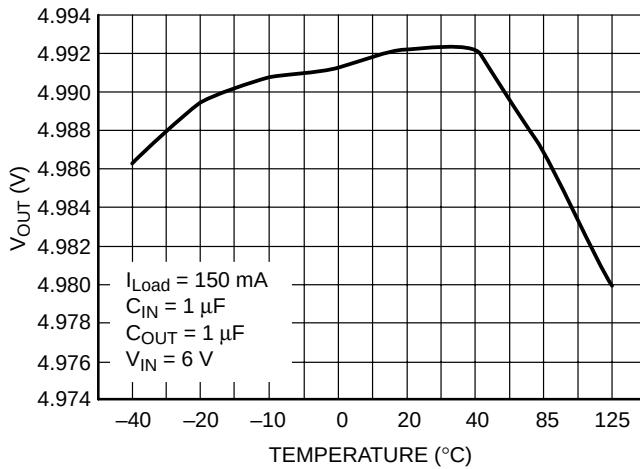


Figure 15. Output Voltage vs. Temperature
($V_{OUT} = 5\text{ V}$)

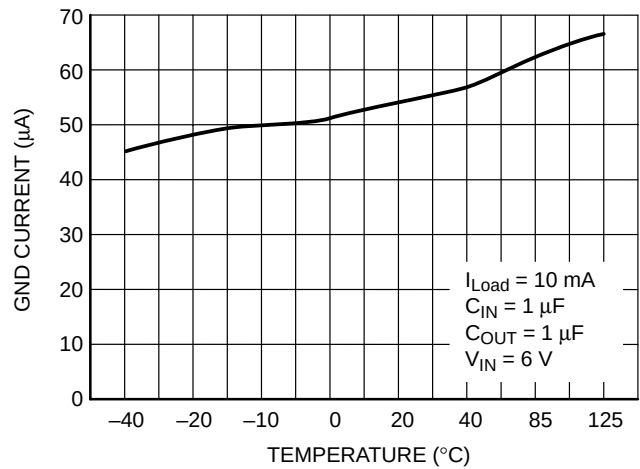


Figure 16. Temperature vs. Quiescent Current
($V_{OUT} = 5\text{ V}$)

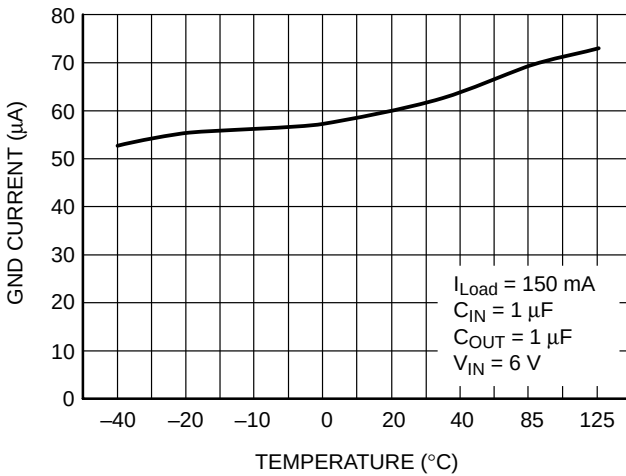


Figure 17. Temperature vs. Quiescent Current
($V_{OUT} = 5\text{ V}$)

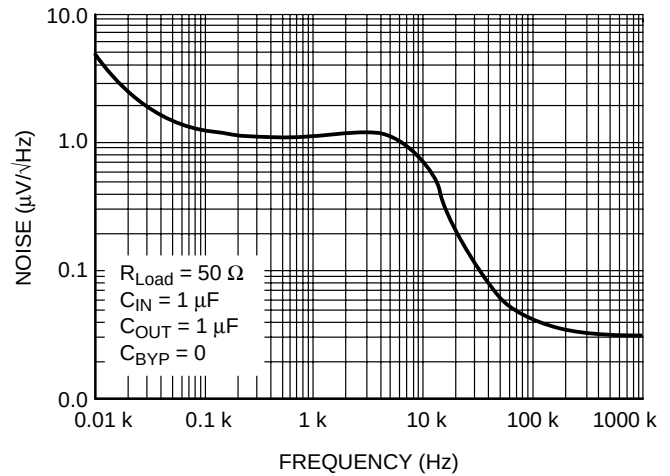


Figure 18. Output Noise vs. Frequency

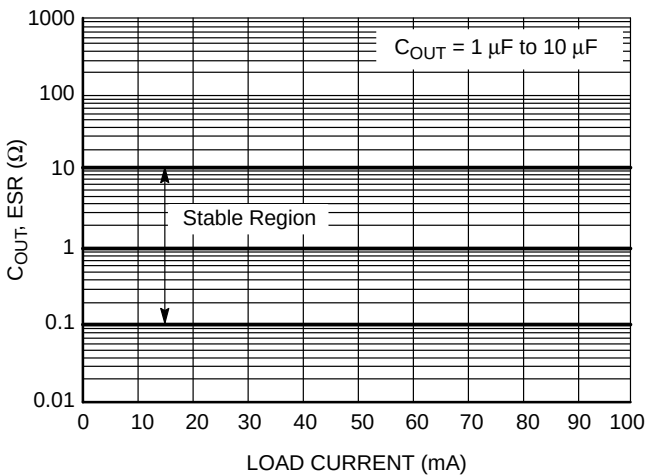


Figure 19. Stability Region vs. Load Current

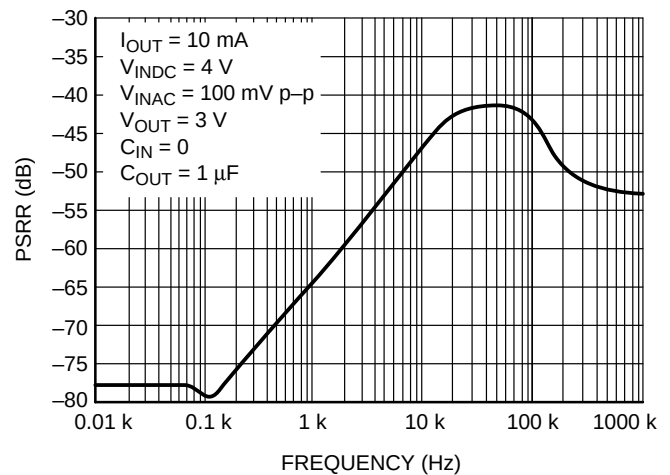
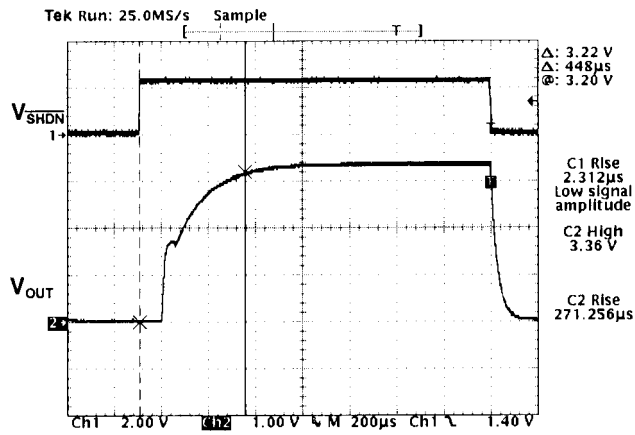
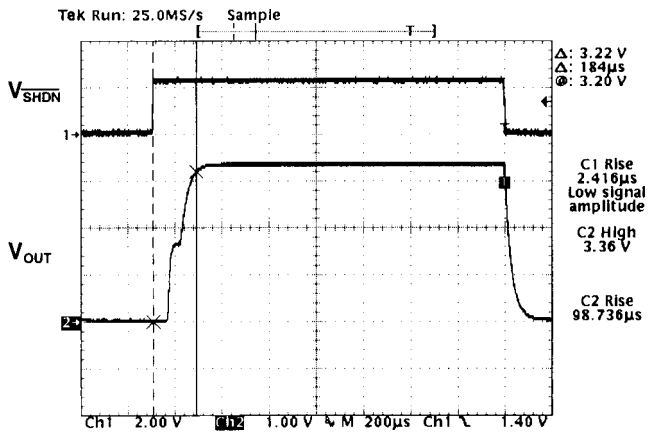


Figure 20. Power Supply Rejection Ratio



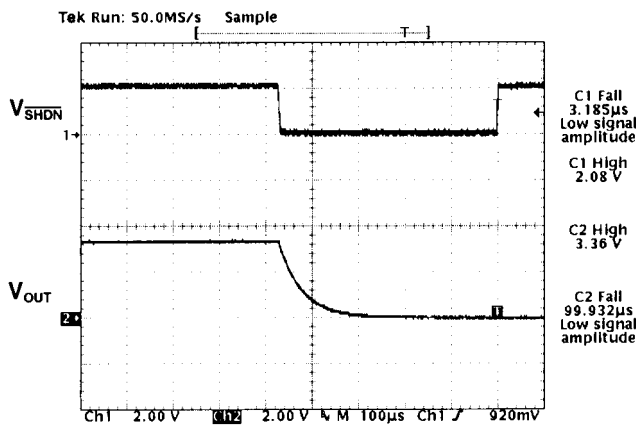
Conditions:
 $C_{IN} = 1 \mu F$, $C_{OUT} = 1 \mu F$, $C_{BYP} = 470 \text{ pF}$
 $I_{LOAD} = 100 \text{ mA}$, $V_{IN} = 4.3 \text{ V}$, Temp = 25°C
 Rise Time = 448 µs

Figure 21. Measure Rise Time of 3.3 V LDO with Bypass Capacitor



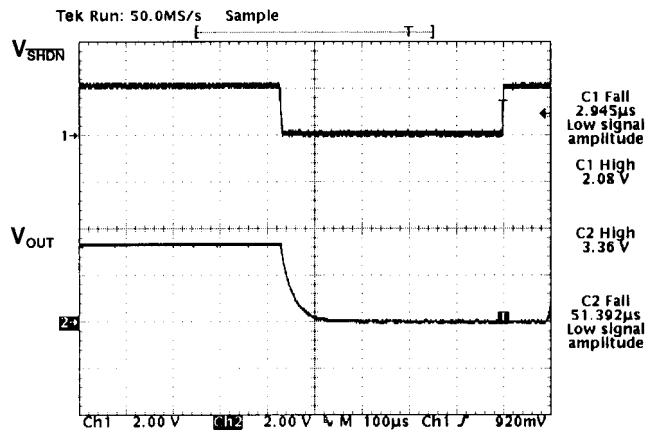
Conditions:
 $C_{IN} = 1 \mu F$, $C_{OUT} = 1 \mu F$, $C_{BYP} = 0 \text{ pF}$
 $I_{LOAD} = 100 \text{ mA}$, $V_{IN} = 4.3 \text{ V}$, Temp = 25°C
 Rise Time = 184 µs

Figure 22. Measure Rise Time of 3.3 V LDO without Bypass Capacitor



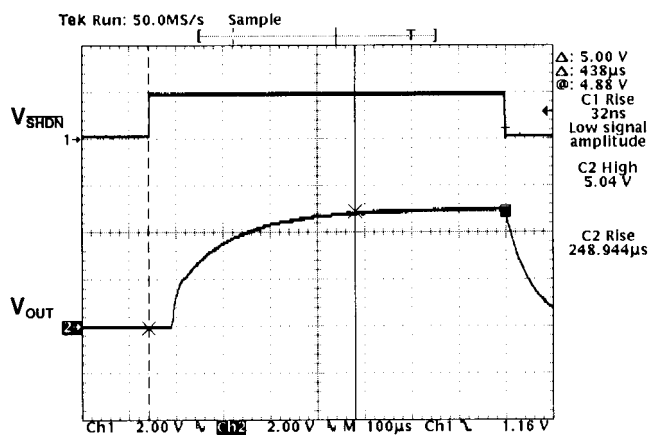
Conditions:
 $C_{IN} = 1 \mu F$, $C_{OUT} = 1 \mu F$, $C_{BYP} = 470 \text{ pF}$
 $I_{LOAD} = 50 \text{ mA}$, $V_{IN} = 4.3 \text{ V}$, Temp = 25°C
 Fall Time = 100 µs

Figure 23. Measure Fall Time of 3.3 V LDO with Bypass Capacitor



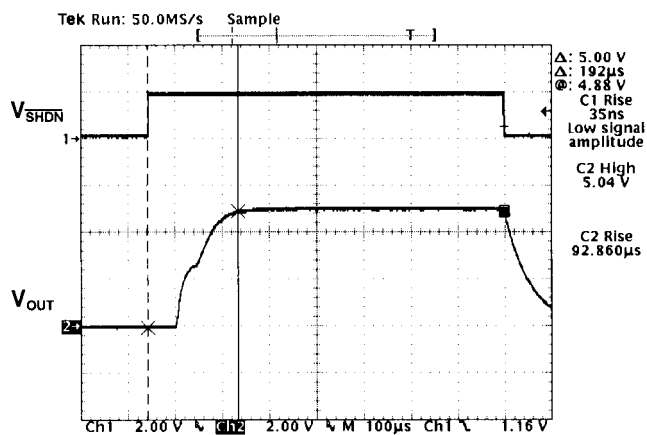
Conditions:
 $C_{IN} = 1 \mu F$, $C_{OUT} = 1 \mu F$, $C_{BYP} = 0 \text{ pF}$
 $I_{LOAD} = 100 \text{ mA}$, $V_{IN} = 4.3 \text{ V}$, Temp = 25°C
 Fall Time = 52 µs

Figure 24. Measure Fall Time of 3.3 V LDO without Bypass Capacitor



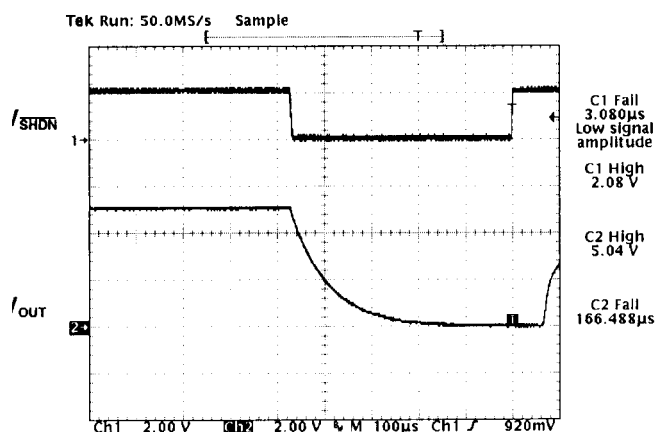
Conditions:
 $C_{IN} = 1 \mu F$, $C_{OUT} = 1 \mu F$, $C_{BYP} = 470 \text{ pF}$
 $I_{LOAD} = 100 \text{ mA}$, $V_{IN} = 6 \text{ V}$, Temp = 25°C
 Rise Time = 390 µs

Figure 25. Measure Rise Time of 5.0 V LDO with Bypass Capacitor



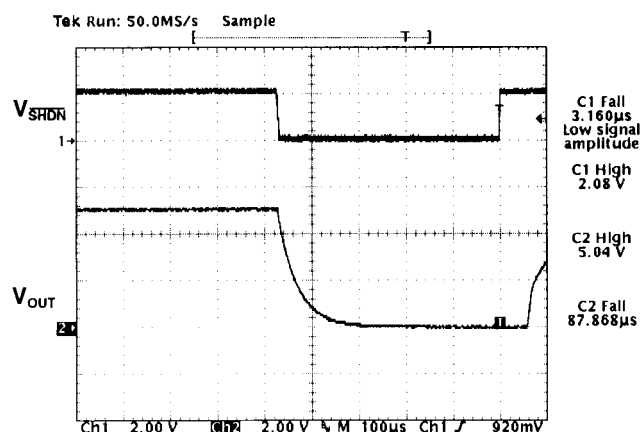
Conditions:
 $C_{IN} = 1 \mu F$, $C_{OUT} = 1 \mu F$, $C_{BYP} = 0 \text{ pF}$
 $I_{LOAD} = 100 \text{ mA}$, $V_{IN} = 6 \text{ V}$, Temp = 25°C
 Rise Time = 192 µs

Figure 26. Measure Rise Time of 5.0 V LDO without Bypass Capacitor



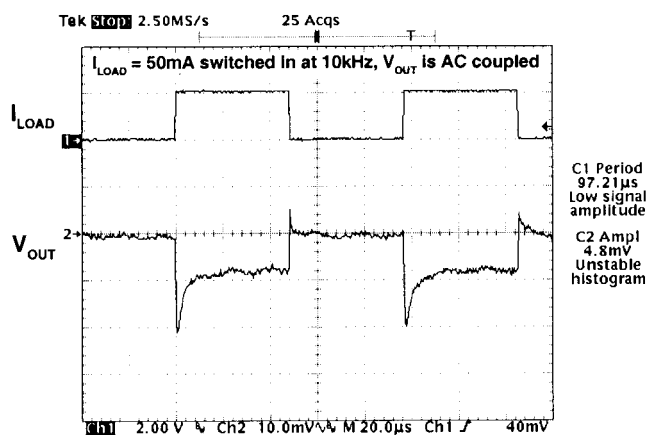
Conditions:
 $C_{IN} = 1 \mu F$, $C_{OUT} = 1 \mu F$, $C_{BYP} = 470 \text{ pF}$
 $I_{LOAD} = 50 \text{ mA}$, $V_{IN} = 6 \text{ V}$, Temp = 25°C
 Fall Time = 167 µs

Figure 27. Measure Fall Time of 5.0 V LDO with Bypass Capacitor



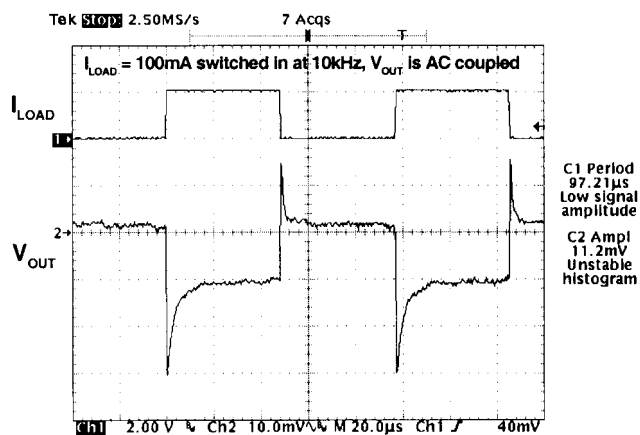
Conditions:
 $C_{IN} = 1 \mu F$, $C_{OUT} = 1 \mu F$, $C_{BYP} = 0 \text{ pF}$
 $I_{LOAD} = 100 \text{ mA}$, $V_{IN} = 6 \text{ V}$, Temp = 25°C
 Fall Time = 88 µs

Figure 28. Measure Fall Time of 5.0 V LDO without Bypass Capacitor



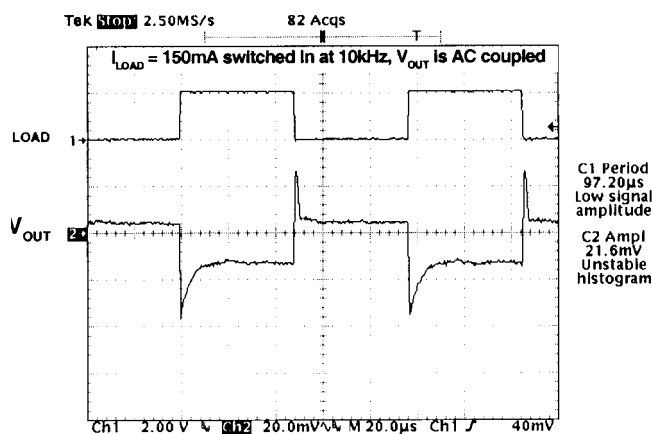
Conditions:
 $C_{IN} = 1\text{ }\mu\text{F}$, $C_{OUT} = 2.2\text{ }\mu\text{F}$, $C_{BYP} = 470\text{ pF}$
 $V_{IN} = V_{OUT} + 0.25\text{ V}$, Temp = 25°C

Figure 29. Load Regulation of 3.3 V LDO



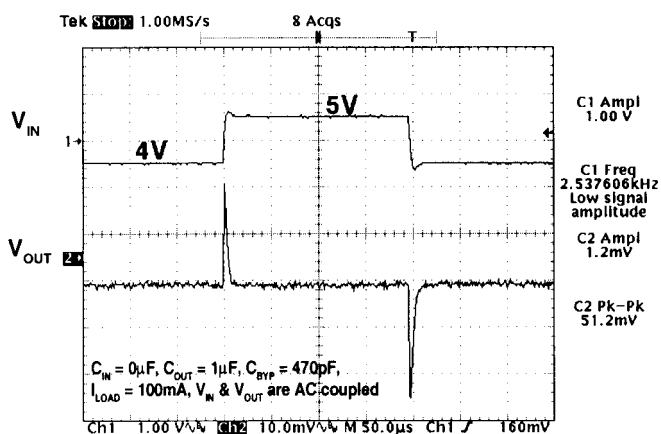
Conditions:
 $C_{IN} = 1\text{ }\mu\text{F}$, $C_{OUT} = 2.2\text{ }\mu\text{F}$, $C_{BYP} = 470\text{ pF}$
 $V_{IN} = V_{OUT} + 0.25\text{ V}$, Temp = 25°C

Figure 30. Load Regulation of 3.3 V LDO



Conditions:
 $C_{IN} = 1\text{ }\mu\text{F}$, $C_{OUT} = 2.2\text{ }\mu\text{F}$, $C_{BYP} = 470\text{ pF}$
 $V_{IN} = V_{OUT} + 0.25\text{ V}$, Temp = 25°C

Figure 31. Load Regulation of 3.3 V LDO



Conditions:
 $V_{IN} = 4\text{ V}$, + 1 V Squarewave @ 2.5 kHz

Figure 32. Line Regulation of 3.3 V LDO

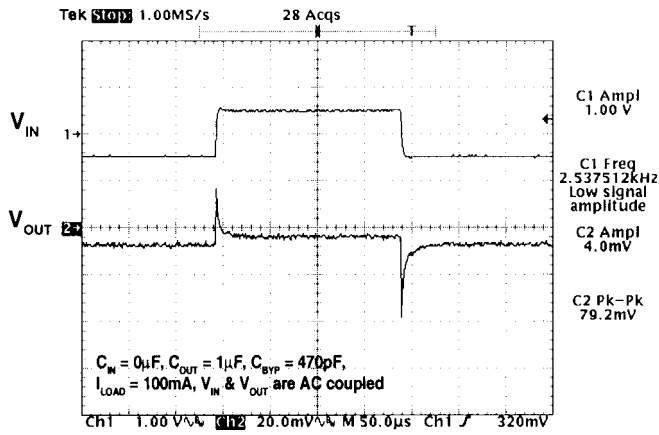


Figure 33. Line Regulation of 5.0 V LDO

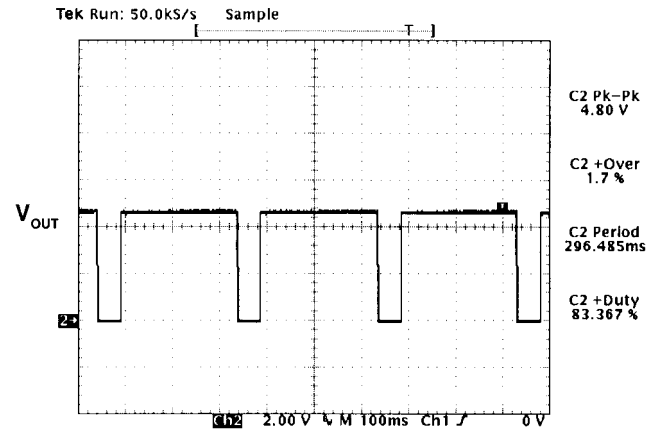
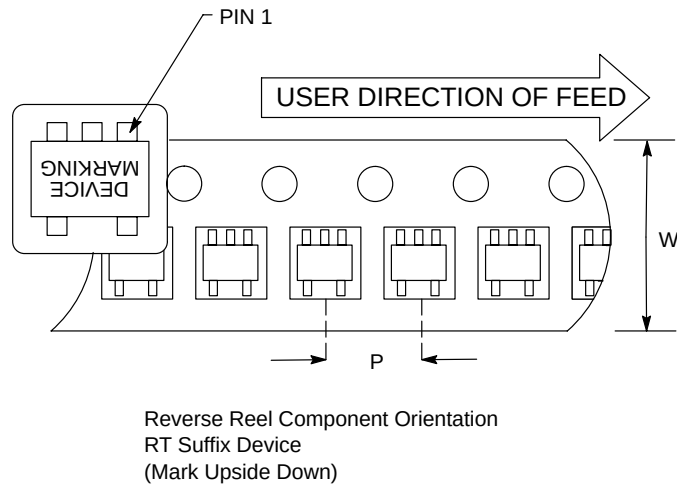
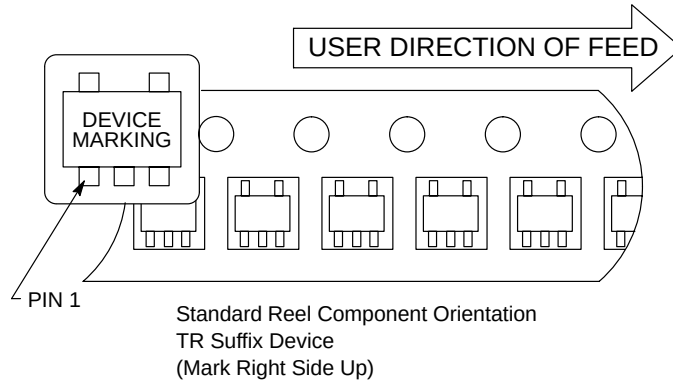


Figure 34. Thermal Shutdown Response of 5.0 V LDO

I_{LOAD} was increased until temperature of die reached about 160°C, at which time integrated thermal protection circuitry shuts the regulator off when die temperature exceeds approximately 160°C. The regulator remains off until die temperature drops to approximately 150°C

NCP4515

Component Taping Orientation for 5-Pin SOT-23 Devices

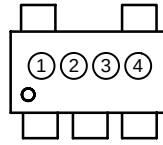


Carrier Tape, Number of Components Per Reel and Reel Size

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

NCP4515

MARKING DIAGRAM



- ① and ② = Two Letter Part Number Codes
+ Temperature Range and Voltage
③ = Date Code
④ = Lot ID Number

ORDERING INFORMATION

Device	Voltage Option*	Marking ① and ②	Package	Junction Temperature Range	Shipping
NCP4515SNxxT1	1.8 2.8 2.85 3.0 3.3	BY BZ B8 B3 B5	SOT-23	-40°C to + 125°C	3000 Tape & Reel

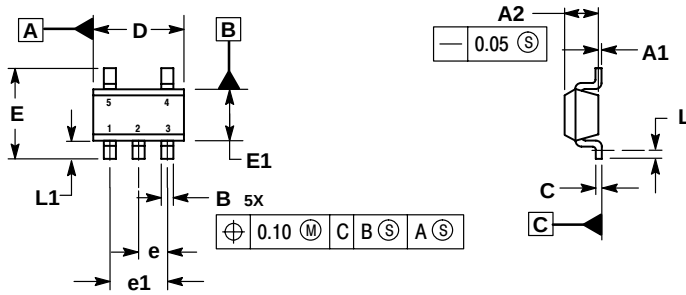
xx Indicates Output Voltages

*Other output voltages are available. Please contact ON Semiconductor for details.

NCP4515

PACKAGE DIMENSIONS

SOT-23
SN SUFFIX
CASE 1212-01
ISSUE O



NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DATUM C IS A SEATING PLANE.

MILLIMETERS		
DIM	MIN	MAX
A1	0.00	0.10
A2	1.00	1.30
B	0.30	0.50
C	0.10	0.25
D	2.80	3.00
E	2.50	3.10
E1	1.50	1.80
e	0.95 BSC	
e1	1.90 BSC	
L	0.20	---
L1	0.45	0.75

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer.

PUBLICATION ORDERING INFORMATION

NORTH AMERICA Literature Fulfillment:

Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: ONlit@hibbertco.com
Fax Response Line: 303-675-2167 or 800-344-3810 Toll Free USA/Canada

N. American Technical Support: 800-282-9855 Toll Free USA/Canada

EUROPE: LDC for ON Semiconductor – European Support

German Phone: (+1) 303-308-7140 (Mon-Fri 2:30pm to 7:00pm CET)
Email: ONlit-german@hibbertco.com

French Phone: (+1) 303-308-7141 (Mon-Fri 2:00pm to 7:00pm CET)
Email: ONlit-french@hibbertco.com

English Phone: (+1) 303-308-7142 (Mon-Fri 12:00pm to 5:00pm GMT)
Email: ONlit@hibbertco.com

EUROPEAN TOLL-FREE ACCESS*: 00-800-4422-3781

*Available from Germany, France, Italy, UK, Ireland

CENTRAL/SOUTH AMERICA:

Spanish Phone: 303-308-7143 (Mon-Fri 8:00am to 5:00pm MST)

Email: ONlit-spanish@hibbertco.com

Toll-Free from Mexico: Dial 01-800-288-2872 for Access –
then Dial 866-297-9322

ASIA/PACIFIC: LDC for ON Semiconductor – Asia Support

Phone: 303-675-2121 (Tue-Fri 9:00am to 1:00pm, Hong Kong Time)

Toll Free from Hong Kong & Singapore:

001-800-4422-3781

Email: ONlit-asia@hibbertco.com

JAPAN: ON Semiconductor, Japan Customer Focus Center

4-32-1 Nishi-Gotanda, Shinagawa-ku, Tokyo, Japan 141-0031

Phone: 81-3-5740-2700

Email: r14525@onsemi.com

ON Semiconductor Website: <http://onsemi.com>

For additional information, please contact your local
Sales Representative.