NCP511, NCV511

Voltage Regulator - CMOS, Low Iq, Low-Dropout

150 mA

The NCP511 series of fixed output low dropout linear regulators are designed for handheld communication equipment and portable battery powered applications which require low quiescent current. The NCP511 series features an ultra−low quiescent current of 40 μA. Each device contains a voltage reference unit, an error amplifier, a PMOS power transistor, resistors for setting output voltage, current limit, and temperature limit protection circuits.

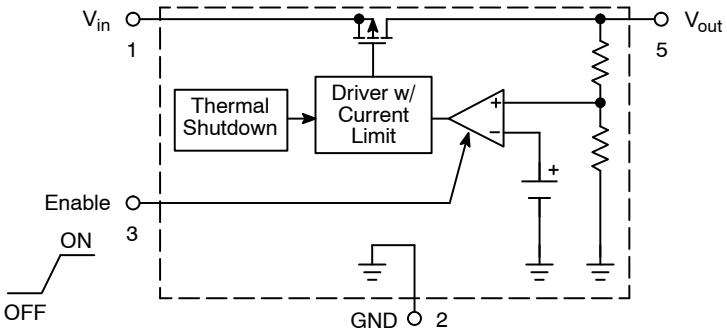
The NCP511 has been designed to be used with low cost ceramic capacitors and requires a minimum output capacitor of 1.0 μF. The device is housed in the micro−miniature TSOP−5 surface mount package. Standard voltage versions are 1.5 V, 1.8 V, 2.5 V, 2.7 V, 2.8 V, 3.0 V, 3.3 V, and 5.0 V. Other voltages are available in 100 mV steps.

Features

- Low Quiescent Current of 40 μA Typical
- Low Dropout Voltage of 100 mV at 100 mA
- Excellent Line and Load Regulation
- Maximum Operating Voltage of 6.0 V
- Low Output Voltage Option
- High Accuracy Output Voltage of 2.0%
- Industrial Temperature Range of −40°C to 85°C
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These are Pb−Free Devices

Typical Applications

- Cellular Phones
- Battery Powered Instruments
- Hand−Held Instruments
- Camcorders and Cameras

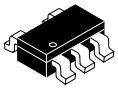


This device contains 82 active transistors

Figure 1. Representative Block Diagram

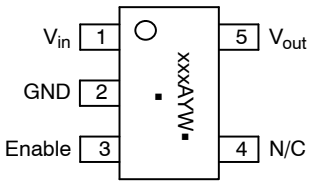
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TSOP−5
SN SUFFIX
CASE 483

PIN CONNECTIONS AND MARKING DIAGRAM



(Top View)

xxx = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

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PIN FUNCTION DESCRIPTION

Pin No.	Pin Name	Description
1	V_{in}	Positive power supply input voltage.
2	GND	Power supply ground.
3	Enable	This input is used to place the device into low−power standby. When this input is pulled low, the device is disabled. If this function is not used, Enable should be connected to V_{in}.
4	N/C	No internal connection.
5	V_{out}	Regulated output voltage.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage	V_{in}	0 to 6.0	V
Enable Voltage	Enable	−0.3 to V_{in} +0.3	V
Output Voltage	V_{out}	−0.3 to V_{in} +0.3	V
Power Dissipation and Thermal Characteristics Power Dissipation Thermal Resistance, Junction to Ambient	 P_D $R_{\theta JA}$	 Internally Limited 250	 W °C/W
Operating Junction Temperature	T_J	+150	°C
Operating Ambient Temperature	T_A	−40 to +85	°C
Storage Temperature	T_{stg}	−55 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. This device series contains ESD protection and exceeds the following tests:
   Human Body Model 2000 V per MIL−STD−883, Method 3015
   Machine Model Method 200 V
2. Latch up capability (85°C) ±100 mA DC with trigger voltage.

ELECTRICAL CHARACTERISTICS

(V_{in} = $V_{out(nom.)}$ + 1.0 V, V_{enable} = V_{in}, C_{in} = 1.0 μF, C_{out} = 1.0 μF, T_J = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage (T_A = 25°C, I_{out} = 1.0 mA)	V_{out}				V
1.5 V		1.455	1.5	1.545	
1.8 V		1.746	1.8	1.854	
2.5 V		2.425	2.5	2.575	
2.7 V		2.646	2.7	2.754	
2.8 V		2.744	2.8	2.856	
3.0 V		2.94	3.0	3.06	
3.3 V		3.234	3.3	3.366	
5.0 V		4.900	5.0	5.100	
Output Voltage (T_A = −40°C to 85°C, I_{out} = 1.0 mA)	V_{out}				V
1.5 V		1.455	1.5	1.545	
1.8 V		1.746	1.8	1.854	
2.5 V		2.425	2.5	2.575	
2.7 V		2.619	2.7	2.781	
2.8 V		2.716	2.8	2.884	
3.0 V		2.910	3.0	3.09	
3.3 V		3.201	3.3	3.399	
5.0 V		4.900	5.0	5.100	
Line Regulation (I_{out} = 10 mA)	Reg_{line}				mV/V
1.5 V–4.4 V (V_{in} = $V_{out(nom.)}$ + 1.0 V to 6.0 V)		–	1.0	3.5	
4.5 V–5.0 V (V_{in} = 5.5 V to 6.0 V)		–	1.0	3.5	
Load Regulation (I_{out} = 1.0 mA to 150 mA)	Reg_{load}	–	0.3	0.8	mV/mA
Output Current (V_{out} = (V_{out} at I_{out} = 150 mA) −3%)	$I_{out(nom.)}$				mA
1.5 V–1.8 V (V_{in} = 4.0 V)		150	–	–	
1.9 V–3.0 V (V_{in} = 5.0 V)		150	–	–	
3.1 V–5.0 V (V_{in} = 6.0 V)		150	–	–	
Dropout Voltage (I_{out} = 100 mA, Measured at V_{out} −3.0%)	V_{in}–V_{out}				mV
1.5 V		–	245	350	
1.8 V		–	160	200	
2.5 V		–	110	200	
2.7 V		–	100	200	
2.8 V		–	100	200	
3.0 V		–	100	200	
3.3 V		–	90	200	
5.0 V		–	75	200	
Quiescent Current	I_Q				μA
(Enable Input = 0 V)		–	0.1	1.0	
(Enable Input = V_{in}, I_{out} = 1.0 mA to $I_{o(nom.)}$)		–	40	100	
Output Voltage Temperature Coefficient	T_C	–	±100	–	ppm/°C
Enable Input Threshold Voltage	$V_{th(en)}$				V
(Voltage Increasing, Output Turns On, Logic High)		1.3	–	–	
(Voltage Decreasing, Output Turns Off, Logic Low)		–	–	0.3	
Output Short Circuit Current (V_{out} = 0 V)	$I_{out(max)}$				mA
1.5 V–1.8 V (V_{in} = 4.0 V)		200	400	800	
1.9 V–3.0 V (V_{in} = 5.0 V)		200	400	800	
3.1 V–5.0 V (V_{in} = 6.0 V)		200	400	800	
Ripple Rejection (f = 1.0 kHz, I_o = 60 mA)	RR	–	50	–	dB
Output Noise Voltage (f = 20 Hz to 100 kHz, I_{out} = 60 mA)	V_n	–	110	–	μV_{RMS}

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. Maximum package power dissipation limits must be observed.

$$PD = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

4. Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.

TYPICAL CHARACTERISTICS

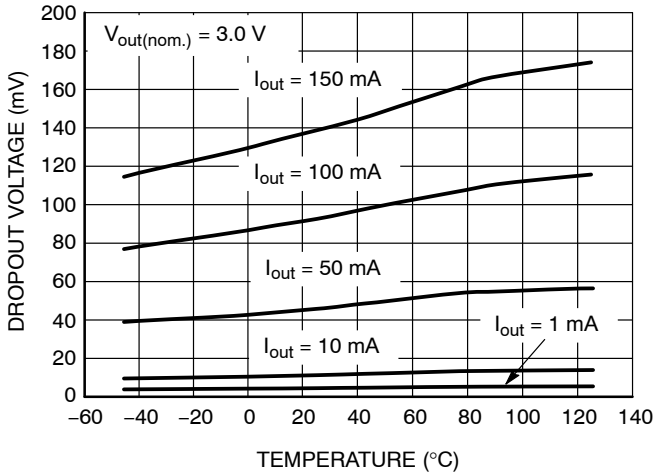


Figure 2. Dropout Voltage vs. Temperature

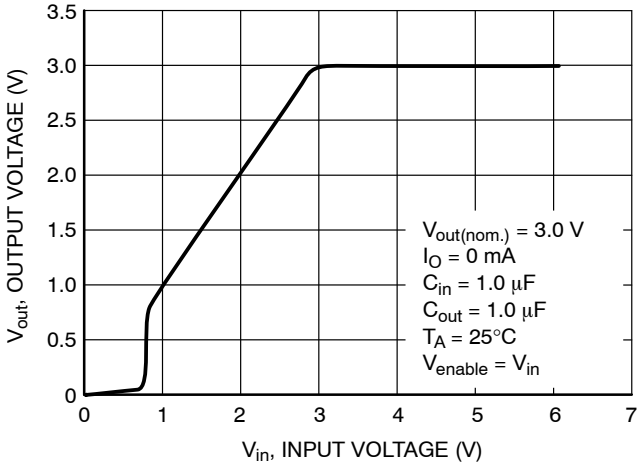


Figure 3. Output Voltage vs. Input Voltage

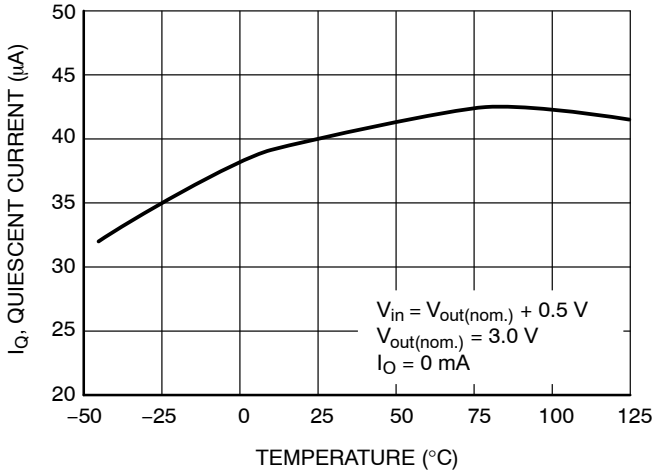


Figure 4. Quiescent Current vs. Temperature

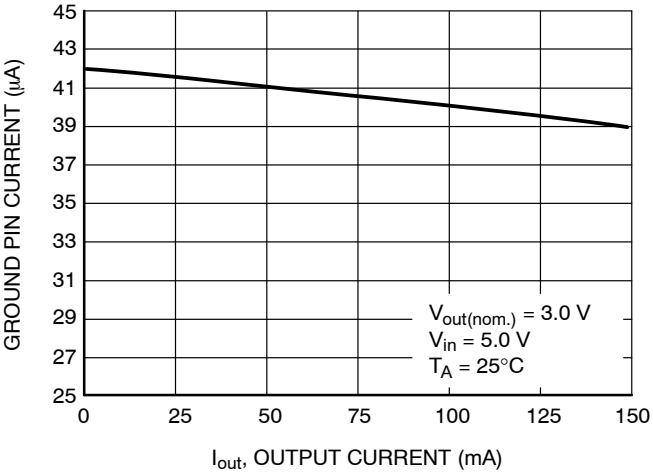


Figure 5. Ground Pin Current vs. Output Current

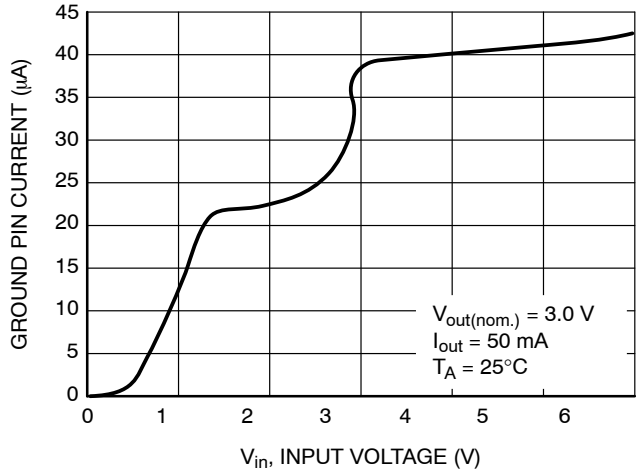


Figure 6. Ground Pin Current vs. Input Voltage

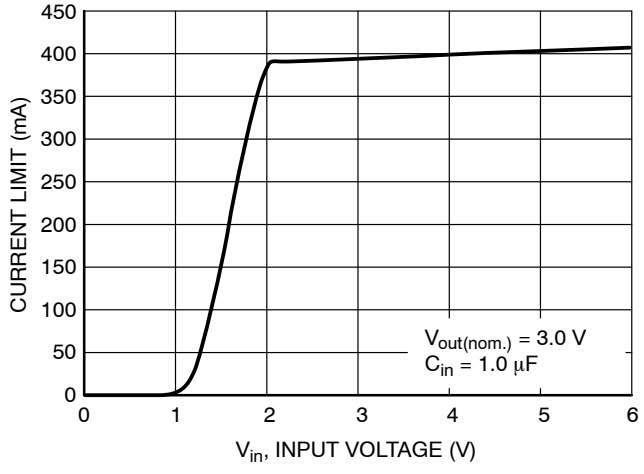


Figure 7. Current Limit vs. Input Voltage

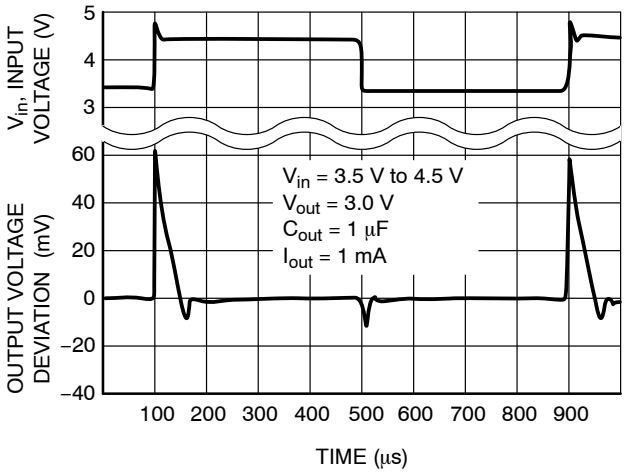


Figure 8. Line Transient Response

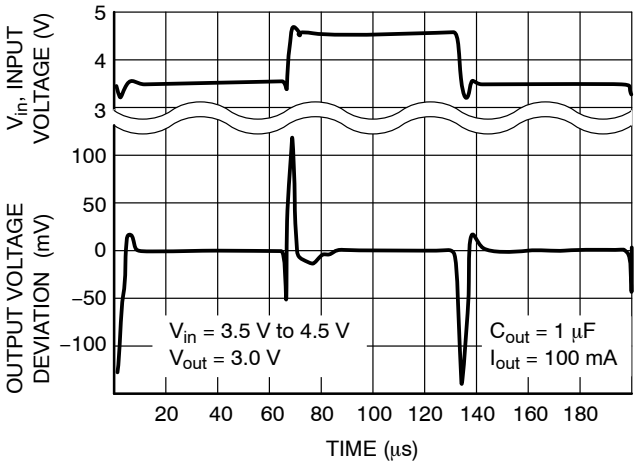


Figure 9. Line Transient Response

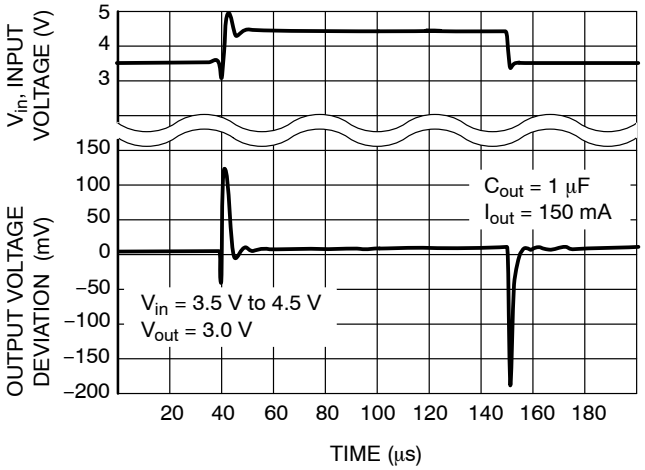


Figure 10. Line Transient Response

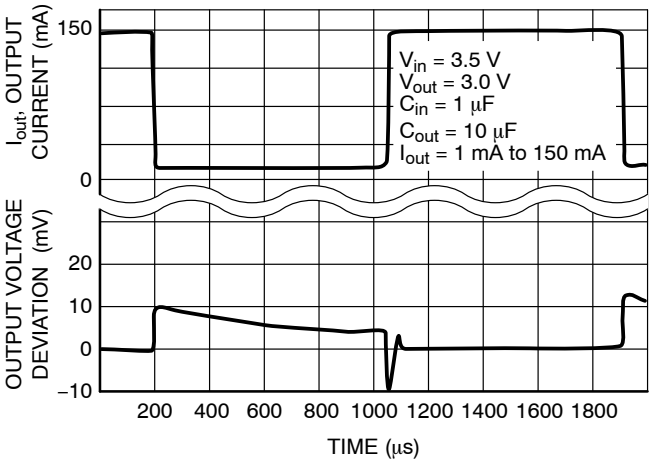


Figure 11. Load Transient Response

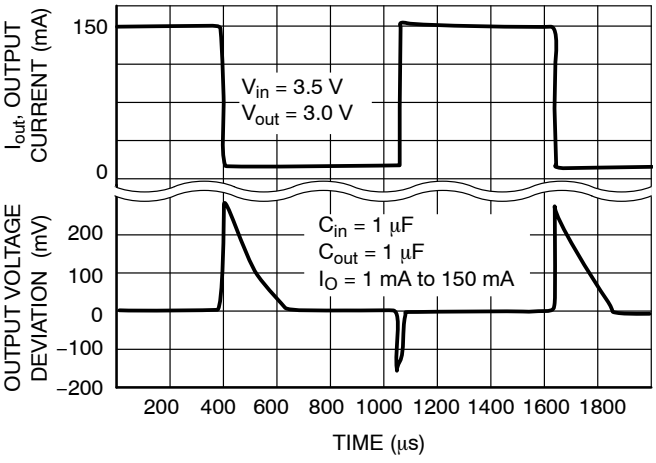


Figure 12. Load Transient Response

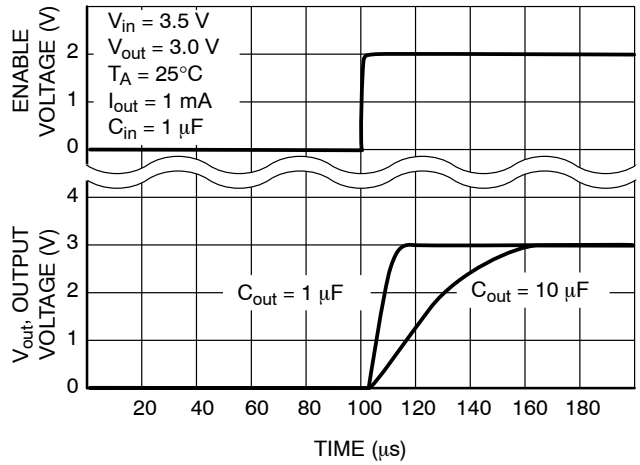


Figure 13. Turn−On Response

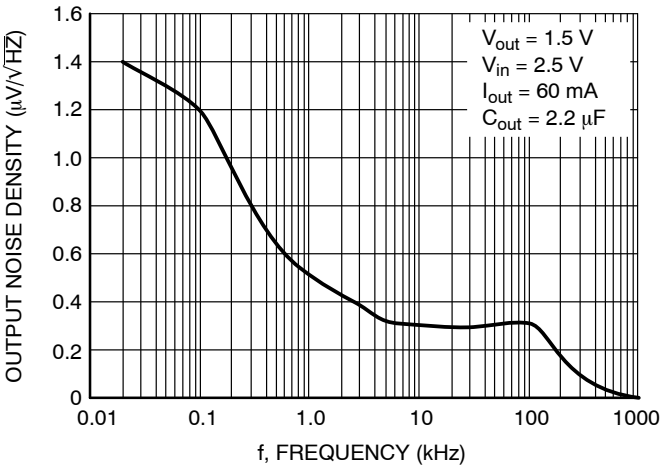


Figure 14. Output Noise Density

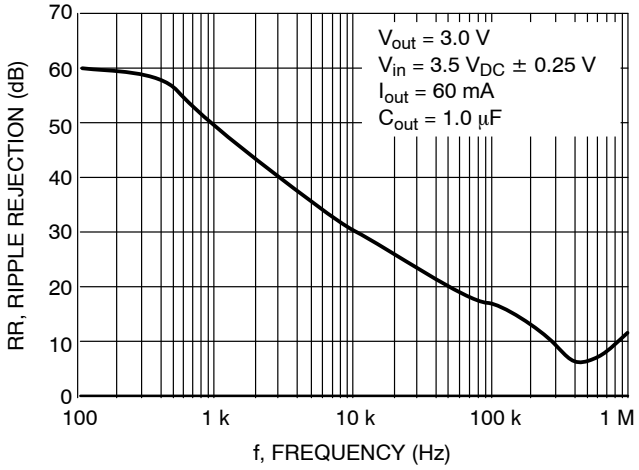


Figure 15. Ripple Rejection vs. Frequency

DEFINITIONS

Load Regulation

The change in output voltage for a change in output current at a constant temperature.

Dropout Voltage

The input/output differential at which the regulator output no longer maintains regulation against further reductions in input voltage. Measured when the output drops 3.0% below its nominal. The junction temperature, load current, and minimum input supply requirements affect the dropout level.

Maximum Power Dissipation

The maximum total dissipation for which the regulator will operate within its specifications.

Quiescent Current

The quiescent current is the current which flows through the ground when the LDO operates without a load on its output: internal IC operation, bias, etc. When the LDO becomes loaded, this term is called the Ground current. It is actually the difference between the input current (measured through the LDO input pin) and the output current.

Line Regulation

The change in output voltage for a change in input voltage. The measurement is made under conditions of low dissipation or by using pulse technique such that the average chip temperature is not significantly affected.

Line Transient Response

Typical over and undershoot response when input voltage is excited with a given slope.

Thermal Protection

Internal thermal shutdown circuitry is provided to protect the integrated circuit in the event that the maximum junction temperature is exceeded. When activated at typically 160°C, the regulator turns off. This feature is provided to prevent failures from accidental overheating.

Maximum Package Power Dissipation

The maximum power package dissipation is the power dissipation level at which the junction temperature reaches its maximum operating value, i.e. 125°C. Depending on the ambient power dissipation and thus the maximum available output current.

APPLICATIONS INFORMATION

A typical application circuit for the NCP511 series is shown in Figure 16.

Input Decoupling (C1)

A 1.0 μF capacitor either ceramic or tantalum is recommended and should be connected close to the NCP511 package. Higher values and lower ESR will improve the overall line transient response.

Output Decoupling (C2)

The NCP511 is a stable Regulator and does not require any specific Equivalent Series Resistance (ESR) or a minimum output current. Capacitors exhibiting ESRs ranging from a few mΩ up to 3.0 Ω can thus safely be used. The minimum decoupling value is 1.0 μF and can be augmented to fulfill stringent load transient requirements. The regulator accepts ceramic chip capacitors as well as tantalum devices. Larger values improve noise rejection and load regulation transient response.

Enable Operation

The enable pin will turn on or off the regulator. These limits of threshold are covered in the electrical specification section of this data sheet. If the enable is not used then the pin should be connected to V_{in}.

Hints

Please be sure the V_{in} and GND lines are sufficiently wide. When the impedance of these lines is high, there is a chance to pick up noise or cause the regulator to malfunction.

Set external components, especially the output capacitor, as close as possible to the circuit, and make leads a short as possible.

Thermal

As power across the NCP511 increases, it might become necessary to provide some thermal relief. The maximum power dissipation supported by the device is dependent upon board design and layout. Mounting pad configuration on the PCB, the board material and also the ambient temperature effect the rate of temperature rise for the part. This is stating that when the NCP511 has good thermal conductivity through the PCB, the junction temperature will be relatively low with high power dissipation applications.

The maximum dissipation the package can handle is given by:

$$PD = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

If junction temperature is not allowed above the maximum 125°C, then the NCP511 can dissipate up to 400 mW @ 25°C.

The power dissipated by the NCP511 can be calculated from the following equation:

$$P_{tot} = [V_{in} * I_{gnd}(I_{out})] + [V_{in} - V_{out}] * I_{out}$$

or

$$V_{inMAX} = \frac{P_{tot} + V_{out} * I_{out}}{I_{gnd} + I_{out}}$$

If a 150 mA output current is needed then the ground current from the data sheet is 40 μA. For an NCP511SN30T1 (3.0 V), the maximum input voltage will then be 5.6 V.

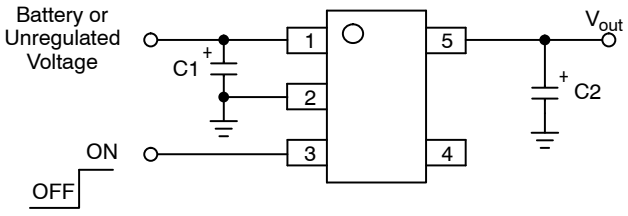


Figure 16. Typical Application Circuit

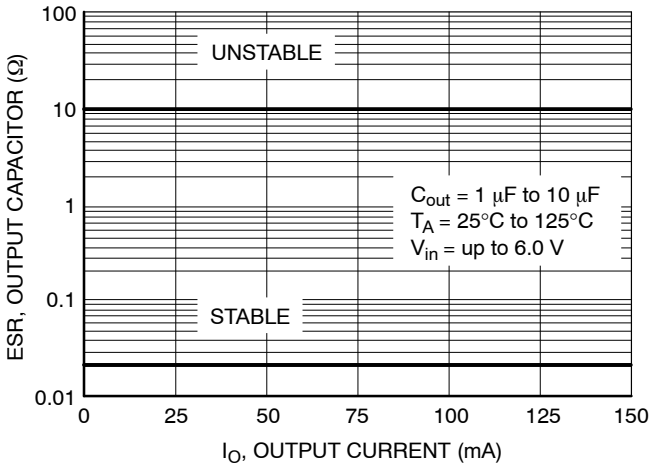


Figure 17. Output Capacitor vs. Output Current

APPLICATION CIRCUITS

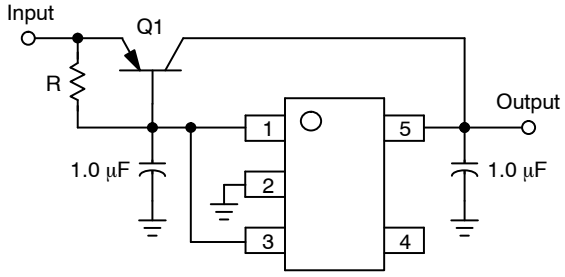


Figure 18. Current Boost Regulator

The NCP511 series can be current boosted with a PNP transistor. Resistor R in conjunction with V_{BE} of the PNP determines when the pass transistor begins conducting; this circuit is not short circuit proof. Input/Output differential voltage minimum is increased by V_{BE} of the pass resistor.

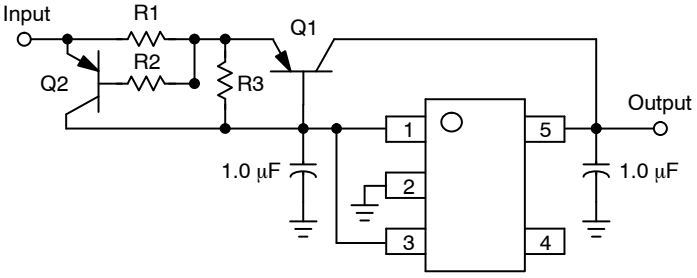


Figure 19. Current Boost Regulator with Short Circuit Limit

Short circuit current limit is essentially set by the V_{BE} of Q2 and R1. $I_{SC} = ((V_{BEQ2} - ib * R2) / R1) + I_{O(max)\ Regulator}$

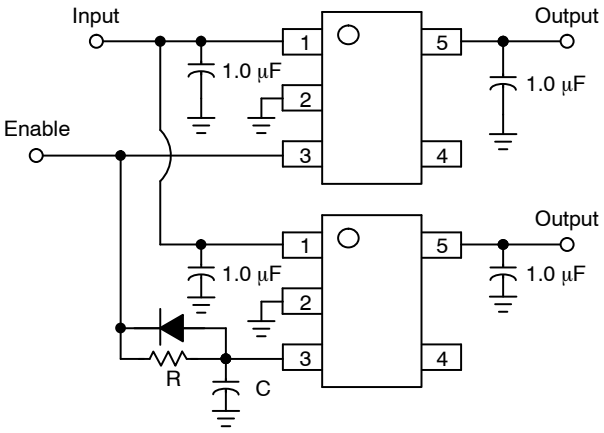


Figure 20. Delayed Turn−on

If a delayed turn−on is needed during power up of several voltages then the above schematic can be used. Resistor R, and capacitor C, will delay the turn−on of the bottom regulator. A few values were chosen and the resulting delay can be seen in Figure 21.

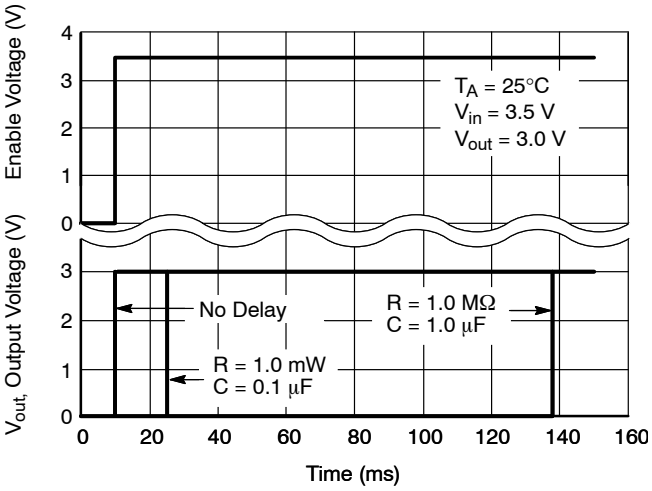


Figure 21. Delayed Turn−on

The graph shows the delay between the enable signal and output turn−on for various resistor and capacitor values.

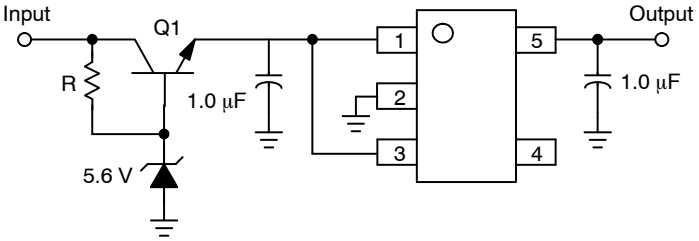


Figure 22. Input Voltages Greater than 6.0 V

A regulated output can be achieved with input voltages that exceed the 6.0 V maximum rating of the NCP511 series with the addition of a simple pre−regulator circuit. Care must be taken to prevent Q1 from overheating when the regulated output (V_{out}) is shorted to GND.

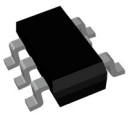
ORDERING INFORMATION

Device	Nominal Output Voltage	Marking	Package	Shipping†
NCP511SN15T1G	1.5	LBU	TSOP−5	3000 Units/ 7″ Tape & Reel
NCP511SN18T1G	1.8	LBV		
NCP511SN25T1G	2.5	LBW		
NCP511SN27T1G	2.7	LBX		
NCP511SN28T1G	2.8	LBY		
NCP511SN30T1G	3.0	LBZ		
NCP511SN33T1G	3.3	LCA		
NCP511SN50T1G	5.0	LCB		
NCV511SN15T1G	1.5	LBU		
NCV511SN25T1G	2.5	LBW		

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

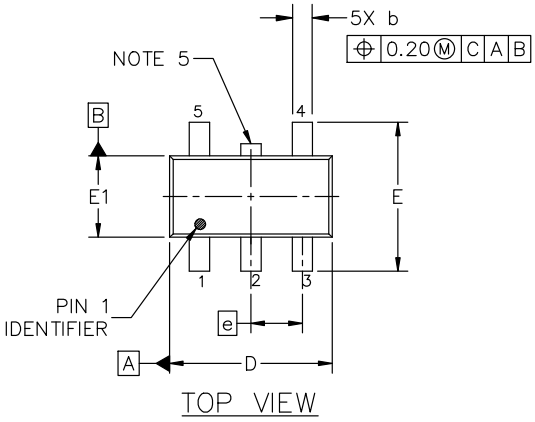
NOTE: Additional voltages in 100 mV steps are available upon request by contacting your ON Semiconductor representative.

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

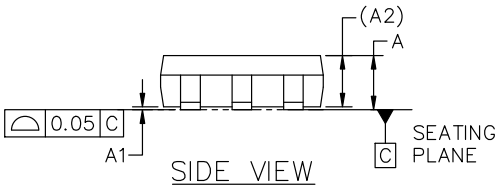


TSOP−5 3.00x1.50x0.95, 0.95P
CASE 483
ISSUE P

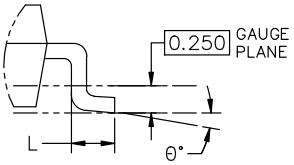
DATE 01 APR 2024



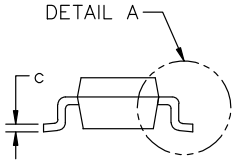
TOP VIEW



SIDE VIEW



DETAIL "A"
SCALE 2:1

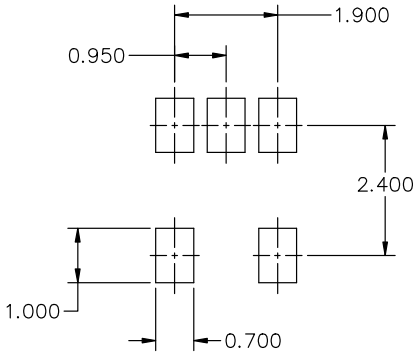


END VIEW

NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5−2018.
2. ALL DIMENSION ARE IN MILLIMETERS (ANGLES IN DEGREES).
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OF GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE. DIMENSION D.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

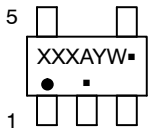
DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.900	1.000	1.100
A1	0.010	0.055	0.100
A2		0.950 REF.	
b	0.250	0.375	0.500
c	0.100	0.180	0.260
D	2.850	3.000	3.150
E	2.500	2.750	3.000
E1	1.350	1.500	1.650
e		0.950 BSC	
L	0.200	0.400	0.600
θ	0°	5°	10°



RECOMMENDED MOUNTING FOOTPRINT*

* FOR ADDITIONAL INFORMATION ON OUR Pb−FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

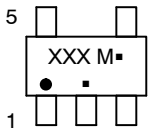
GENERIC
MARKING DIAGRAM*



Analog

XXX = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)



Discrete/Logic

XXX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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DESCRIPTION:	**TSOP−5 3.00x1.50x0.95, 0.95P**	**PAGE 1 OF 1**

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