NCP698

150 mA CMOS Ultra Low Iq and I_{GND} LDO Regulator with Enable

This series of fixed output low-dropout linear regulators are designed for handheld communication equipment and portable battery powered applications which require low quiescent and ground current. This series features an ultra-low quiescent current of 2.5 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 NCP698 series provides an enable pin for ON/OFF control.

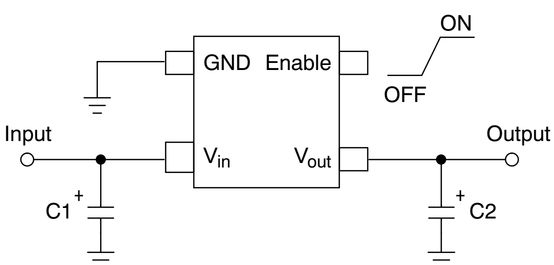
The NCP698 has been designed to be used with low cost ceramic capacitors and requires a minimum output capacitor of 0.1 μF. The device is housed in the micro-miniature SC82-AB surface mount package. Standard voltage versions are 1.3, 1.5, 1.8, 2.5, 2.8, 3.0, 3.3, 3.5 and 5.0 V. Other voltages are available in 100 mV steps.

Features

- Ultra Low Quiescent Current of 2.5 μA Typical
- Output Voltage Accuracy of 2.0%
- Operating Temperature Range of -40°C to 85°C
- Enable Function
- This is a Pb-Free Device

Typical Applications

- Battery Powered Instruments
- Hand-Held Instruments
- Camcorders and Cameras



This device contains 28 active transistors

Figure 1. Typical Application Diagram

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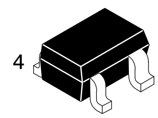
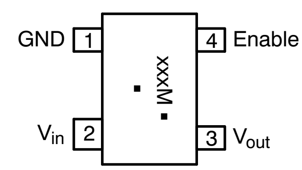


SC82-AB (SC70-4)
SQ SUFFIX
CASE 419C

PIN CONNECTIONS & MARKING DIAGRAMS



Top View)

xxx = Specific Device Code
M = Month Code*
▪ = Pb-Free Package

(Note: Microdot may be in either location)

*Date Code orientation and/or position and underbar may vary depending upon manufacturing location.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

PIN FUNCTION DESCRIPTION

Pin No.	Pin Name	Description
1	GND	Power supply ground.
2	Vin	Positive power supply input voltage.
3	Vout	Regulated output voltage.
4	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 Vin.
–	N/C	No internal connection.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage	V_{in}	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 (Note 1) Power Dissipation Thermal Resistance, Junction-to-Ambient (1 oz copper, 1 in^2 copper area)	P_D $R_{\theta JA}$	Internally Limited 235	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 Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Refer to Electrical Characteristics and Application Information for Safe Operating Area.
2. 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
3. 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_A = 25°C, unless otherwise noted. Note 4)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage (I_{out} = 1.0 mA)	V_{out}				V
1.3 V		1.261	1.3	1.339	
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	
2.8 V		2.744	2.8	2.856	
3.0 V		2.940	3.0	3.060	
3.3 V		3.234	3.3	3.366	
3.5 V		3.430	3.5	3.570	
5.0 V		4.900	5.0	5.100	
Output Voltage (T_A = −40 to +85°C, I_{out} = 1.0 mA)	V_{out}				V
1.3 V		1.261	1.3	1.339	
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	
2.8 V		2.716	2.8	2.884	
3.0 V		2.910	3.0	3.090	
3.3 V		3.201	3.3	3.399	
3.5 V		3.430	3.5	3.570	
5.0 V		4.900	5.0	5.100	
Line Regulation	Reg_{line}				mV
1.5 V−4.4 V (V_{in} = $V_{o(nom.)}$ + 1.0 V to 6.0 V		−	10	20	
4.5 V−5.0 V (V_{in} = 5.5 V to 6.0 V)		−	10	20	
Load Regulation (I_{out} = 10 mA to 150 mA)	Reg_{load}	−	20	60	mV
Output Current (V_{out} = (V_{out} at I_{out} = 150 mA) −3.0%)	$I_{o(nom.)}$				mA
1.3 V to 3.9 V (V_{in} = $V_{out(nom.)}$ + 2.0 V)		150	280	−	
4.0 V−5.0 V (V_{in} = 6.0 V)		150	280	−	
Dropout Voltage (T_A = −40°C to 85°C, I_{out} = 80 mA, Measured at V_{out} −3.0%)	V_{in}−V_{out}				mV
1.3 V		−	750	1200	
1.5 V		−	550	800	
1.8 V		−	400	550	
2.5 V−2.8 V		−	250	400	
3.0 V−3.5 V		−	200	350	
5.0 V		−	140	200	
Dropout Voltage (T_A = −40°C to 85°C, I_{out} = 150 mA, Measured at V_{out} −3.0%)	V_{in}−V_{out}				mV
1.3 V		−	1050	1500	
1.5 V		−	870	1070	
1.8 V		−	700	900	
2.5 V−2.8 V		−	520	700	
3.0 V−3.5 V		−	370	525	
5.0 V		−	280	400	
Disable Current (Enable Input = 0 V)	I_{DIS}	−	0.1	1.0	μA
Quiescent Current (Enable Input = V_{in}, I_{out} = 0 mA)	I_Q	−	2.5	−	μA
Ground Current (Enable Input = V_{in}, I_{out} = 1.0 mA to 150 mA)	I_{GND}	−	2.5	6.0	μA
Output Short Circuit Current	$I_{out(max)}$				mA
1.3 V to 3.9 V (V_{in} = V_{nom} + 2.0 V)		150	300	600	
4.0 V−5.0 V (V_{in} = 6.0 V)		150	300	600	
Output Voltage Noise (f = 100 Hz to 100 kHz, V_{out} = 3.0 V)	V_n	−	100	−	μVrms

ELECTRICAL CHARACTERISTICS (continued)
($V_{in} = V_{out(nom.)} + 1.0$ V, $V_{enable} = V_{in}$, $C_{in} = 1.0$ µF, $C_{out} = 1.0$ µF, $T_A = 25°C$, unless otherwise noted. Note 4)

Enable Input Threshold Voltage (Voltage Increasing, Output Turns On, Logic High) (Voltage Decreasing, Output Turns Off, Logic Low)	$V_{th(en)}$	 1.3 –	 – –	 – 0.3	V
Output Voltage Temperature Coefficient	T_C	–	±100	–	ppm/°C

4. Performance guaranteed over the indicated operating temperature range by design and/or characterization, production tested at $T_J = T_A = 25°C$. Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.
5. Maximum package power dissipation limits must be observed.

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

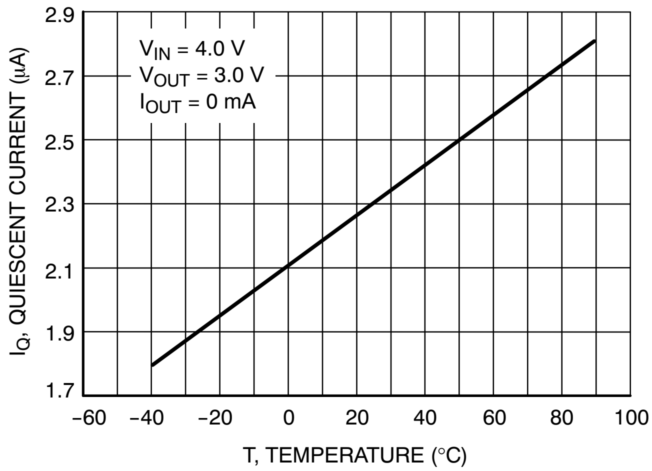


Figure 2. Quiescent Current versus Temperature

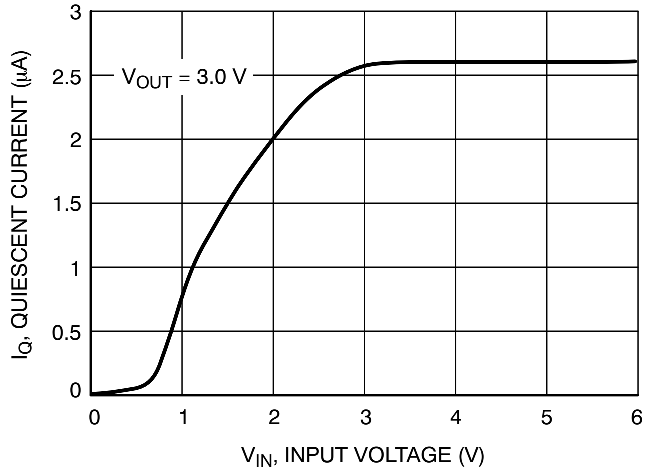


Figure 3. Quiescent Current versus Input Voltage

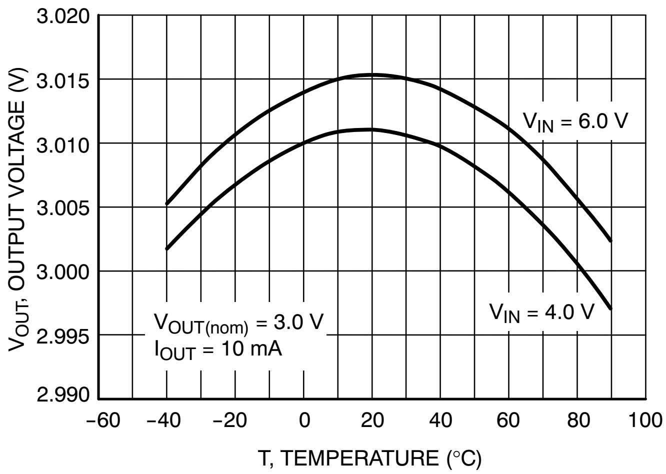


Figure 4. Output Voltage versus Temperature

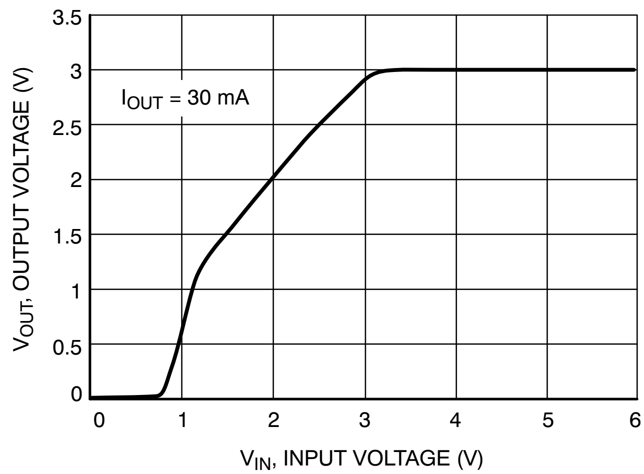


Figure 5. Output Voltage versus Input Voltage

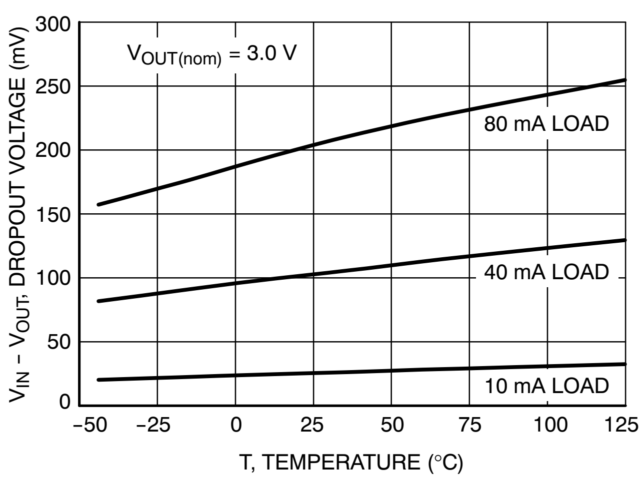


Figure 6. Dropout Voltage versus Temperature

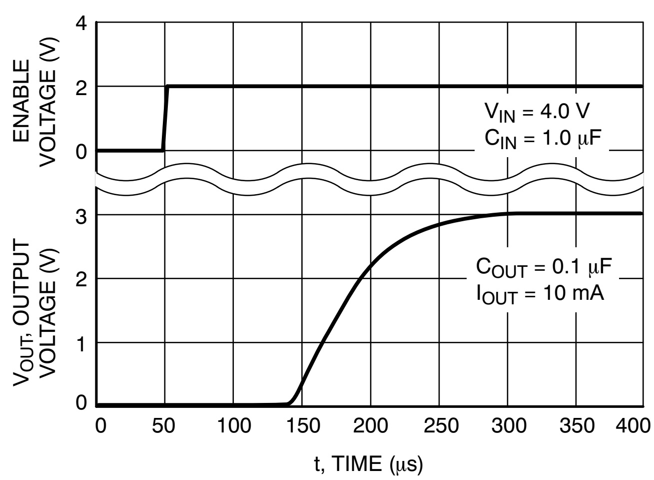


Figure 7. Turn−On Response

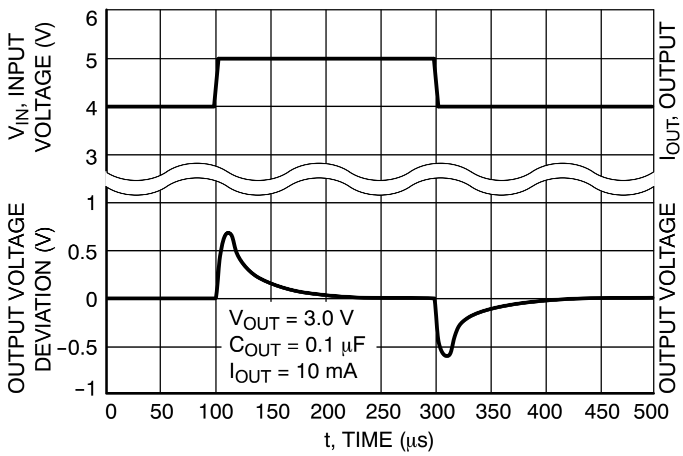


Figure 8. Line Transient Response

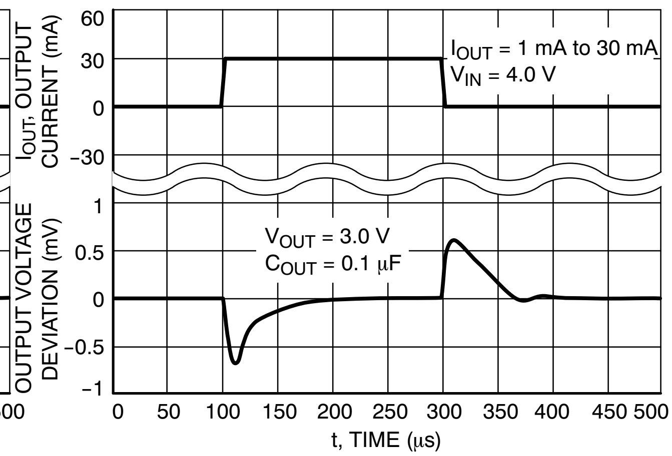


Figure 9. Load Transient Response

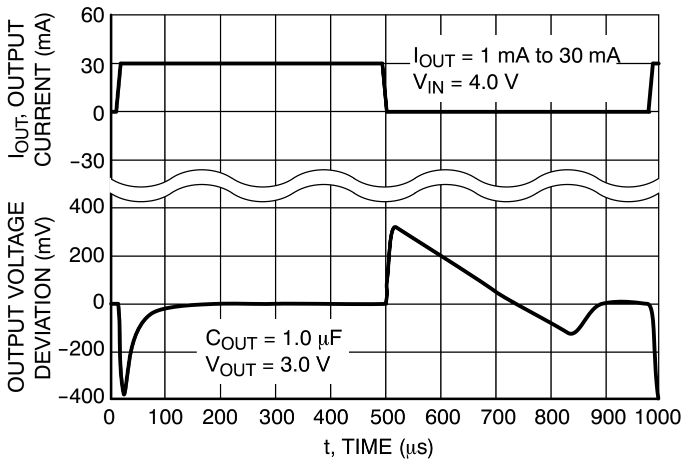


Figure 10. Load Transient Response

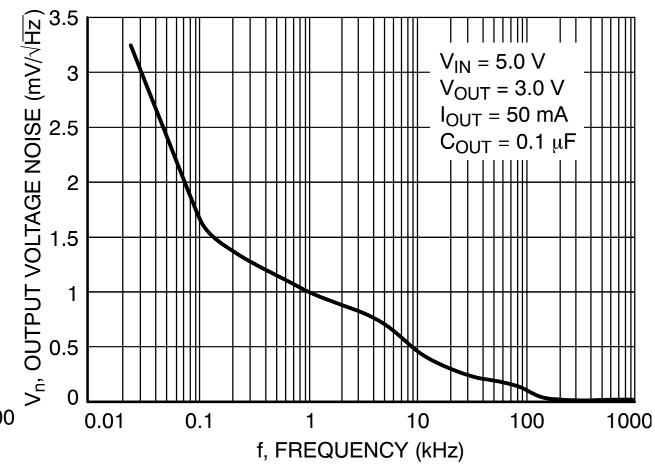


Figure 11. Output Voltage Noise

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 NCP698 is shown in Figure 1.

Input Decoupling (C1)

A 1.0 μF capacitor either ceramic or tantalum is recommended and should be connected close to the NCP698 package. Higher values and lower ESR will improve the overall line transient response.
TDK capacitor: C2012X5R1C105K, or C1608X5R1A105K

Output Decoupling (C2)

The NCP698 is a very 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 10 Ω can thus safely be used. The minimum decoupling value is 0.1 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.
TDK capacitor: C2012X5R1C105K, C1608X5R1A105K, or C3216X7R1C105K

Enable Operation

The enable pin will turn on the regulator when pulled high and turn off the regulator when pulled low. 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 Vin 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.

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

Thermal

As power across the NCP698 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 devices have 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 NCP698 can dissipate up to 250 mW @ 25°C.

The power dissipated by the NCP698 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 an 80 mA output current is needed then the ground current from the data sheet is 2.5 μA. For an NCP698 (3.0 V), the maximum input voltage will then be 6.0 V.

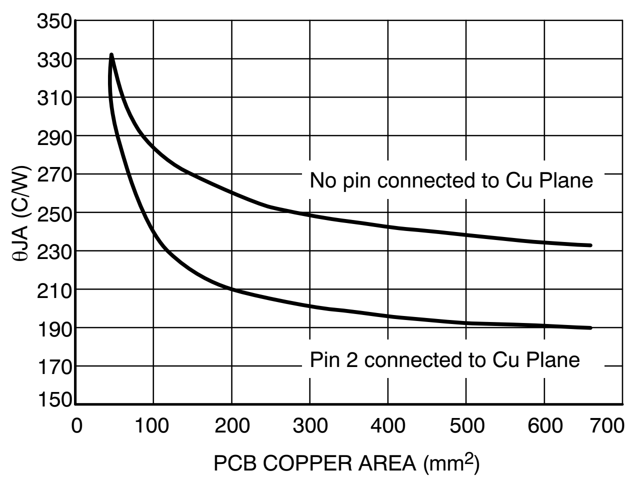


Figure 12. $R_{\theta JA}$ vs. Pad Copper Area (1 oz Cu thickness)

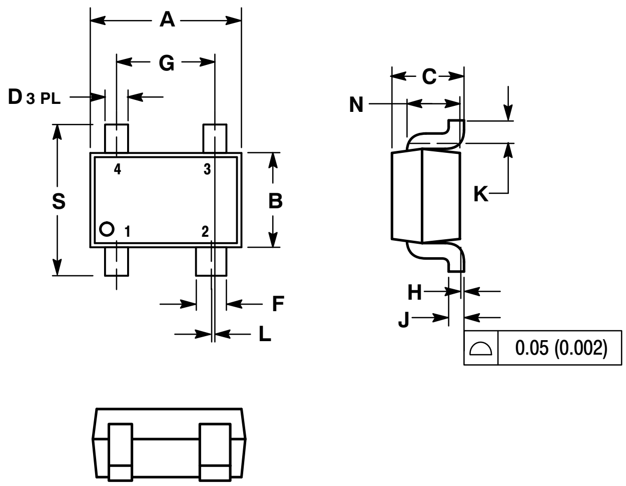
ORDERING INFORMATION

Device	Nominal Output Voltage	Marking	Package	Shipping†
NCP698SQ13T1G	1.3	LJW	SC82−AB	3000 / Tape & Reel
NCP698SQ15T1G	1.5	LJX		
NCP698SQ18T1G	1.8	LJY		
NCP698SQ25T1G	2.5	LJZ		
NCP698SQ28T1G	2.8	LKD		
NCP698SQ30T1G	3.0	LKA		
NCP698SQ33T1G	3.3	LKB		
NCP698SQ35T1G	3.5	LKE		
NCP698SQ50T1G	5.0	LKC		

†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.

PACKAGE DIMENSIONS

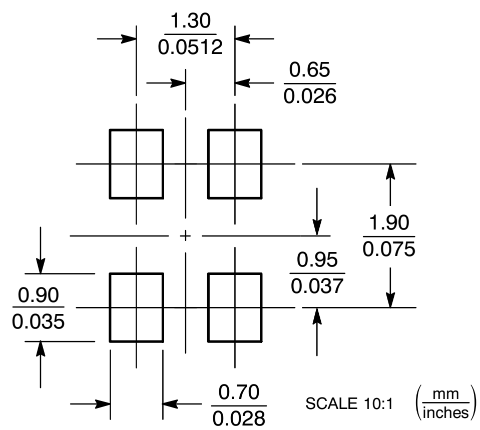
SC−82AB
CASE 419C−02
ISSUE E



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. 419C−01 OBSOLETE. NEW STANDARD IS 419C−02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	1.8	2.2	0.071	0.087
B	1.15	1.35	0.045	0.053
C	0.8	1.1	0.031	0.043
D	0.2	0.4	0.008	0.016
F	0.3	0.5	0.012	0.020
G	1.1	1.5	0.043	0.059
H	0.0	0.1	0.000	0.004
J	0.10	0.26	0.004	0.010
K	0.1	−−−	0.004	−−−
L	0.05 BSC		0.002 BSC	
N	0.2 REF		0.008 REF	
S	1.8	2.4	0.07	0.09

SOLDERING 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.

PUBLICATION ORDERING INFORMATION

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: orderlit@onsemi.com

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