THE DATASHEET OF

NCP612SQ15T1

NCP612, NCV612

100 mA CMOS Low Iq Voltage Regulator in an SC70-5

The NCP612/NCV612 series of fixed output linear regulators are designed for handheld communication equipment and portable battery powered applications which require low quiescent. The NCP612/NCV612 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.

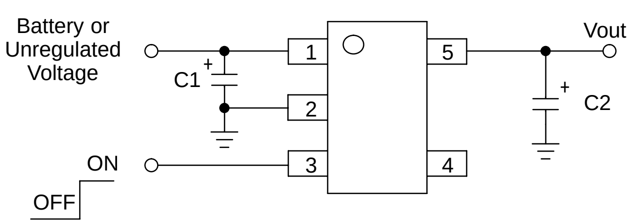
The NCP612/NCV612 has been designed to be used with low cost ceramic capacitors. The device is housed in the micro−miniature SC70−5 surface mount package. Standard voltage versions are 1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.1, 3.3, 3.7, and 5.0 V.

Features

- Low Quiescent Current of 40 μA Typical
- Low Dropout Voltage of 230 mV at 100 mA and 3.0 V V_{out}
- Low Output Voltage Option
- Output Voltage Accuracy of 2.0%
- Temperature Range of −40°C to 85°C (NCP612)
  Temperature Range of −40°C to 125°C (NCV612)
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- Pb−Free Packages are Available

Typical Applications

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



This device contains 86 active transistors

Figure 1. Typical Application Diagram

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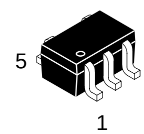
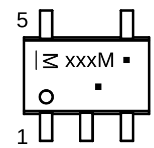
http://onsemi.com

MARKING DIAGRAM



SC70−5
(SC−88A/SOT−353)
SQ SUFFIX
CASE 419A

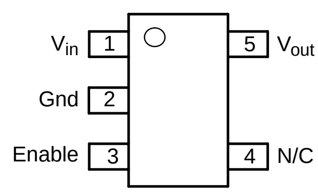


xxx = Specific Device Code
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

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

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

PIN FUNCTION DESCRIPTION

Pin No.	Pin Name	Description
1	Vin	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 Vin.
4	N/C	No internal connection.
5	Vout	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 300	 W °C/W
Operating Junction Temperature	T_J	+150	°C
Operating Ambient Temperature	T_A	−40 to +125	°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. 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) ±200 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} = 10 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		2.940	3.0	3.060	
3.1 V		3.038	3.1	3.162	
3.3 V		3.234	3.3	3.366	
3.7 V		3.626	3.7	3.774	
5.0 V		4.900	5.0	5.100	
Output Voltage (T_A = −40°C to 85°C, I_{out} = 10 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	3.090	
3.1 V		3.007	3.1	3.193	
3.3 V		3.201	3.3	3.399	
3.7 V		3.626	3.7	3.774	
5.0 V		4.900	5.0	5.100	
Output Voltage (T_A = −40°C to 125°C, I_{out} = 10 mA) NCV612 Only	V_{out}				V
1.5 V		1.440	1.5	1.560	
1.8 V		1.728	1.8	1.872	
2.5 V		2.400	2.5	2.600	
2.7 V		2.592	2.7	2.808	
2.8 V		2.688	2.8	2.912	
3.0 V		2.880	3.0	3.120	
3.1 V		2.976	3.1	3.224	
3.3 V		3.201	3.3	3.399	
5.0 V		4.850	5.0	5.150	
Output Voltage (T_A = −40°C to 85°C, I_{out} = 100 mA)	V_{out}				V
1.5 V		1.440	1.5	1.560	
1.8 V		1.728	1.8	1.872	
2.5 V		2.400	2.5	2.600	
2.7 V		2.592	2.7	2.808	
2.8 V		2.688	2.8	2.912	
3.0 V		2.880	3.0	3.120	
3.1 V		2.976	3.1	3.224	
3.3 V		3.201	3.3	3.399	
3.7 V		3.589	3.7	3.811	
5.0 V		4.850	5.0	5.150	
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	3.0	
4.5 V−5.0 V (V_{in} = 5.5 V to 6.0 V)		−	1.0	3.0	
Load Regulation (I_{out} = 1.0 mA to 100 mA)	Reg_{load}	−	0.3	0.8	mV/mA
Output Current (V_{out} = (V_{out} at I_{out} = 100 mA) −3%)	$I_{o(nom.)}$				mA
1.5 V−3.9 V (V_{in} = $V_{out(nom.)}$ + 2.0 V)		100	200	−	
4.0 V−5.0 V (V_{in} = 6.0 V)		100	200	−	

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_J = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Dropout Voltage (T_A = −40°C to 85°C, I_{out} = 100 mA, Measured at $V_{out(nom)}$ −3.0%)	V_{in}−V_{out}				mV
1.5 V		−	530	680	
1.8 V		−	420	560	
2.5 V		−	270	380	
2.7 V		−	270	380	
2.8 V		−	250	380	
3.0 V		−	230	380	
3.1 V		−	210	380	
3.3 V		−	200	380	
3.7 V		−	180	380	
5.0 V		−	160	300	
Ground Current (Enable Input = V_{in}, I_{out} = 1.0 mA to $I_{o(nom.)}$)	I_{GND}	−	40	90	μA
Quiescent Current (T_A = −40°C to 85°C)	I_Q				μA
(Enable Input = 0 V)		−	0.03	1.0	
(Enable Input = V_{in}, I_{out} = 1.0 mA to $I_{o(nom.)}$)		−	40	90	
Output Short Circuit Current (V_{out} = 0 V)	$I_{out(max)}$				mA
1.5 V−3.9 V (V_{in} = $V_{out(nom.)}$ + 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) I_{out} = 30 mA, C_{out} = 1 μF	V_n	−	100	−	μVrms
Enable Input Threshold Voltage	$V_{th(en)}$				V
(Voltage Increasing, Output Turns On, Logic High)		0.95	−	−	
(Voltage Decreasing, Output Turns Off, Logic Low)		−	−	0.3	
Output Voltage Temperature Coefficient	T_C	−	±100	−	ppm/°C

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

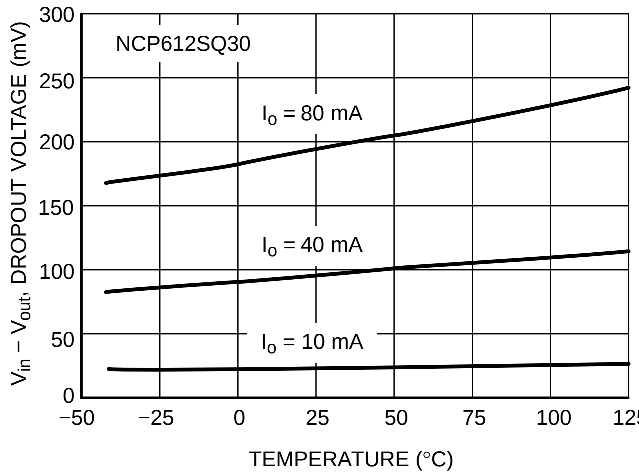


Figure 2. Dropout Voltage vs. Temperature

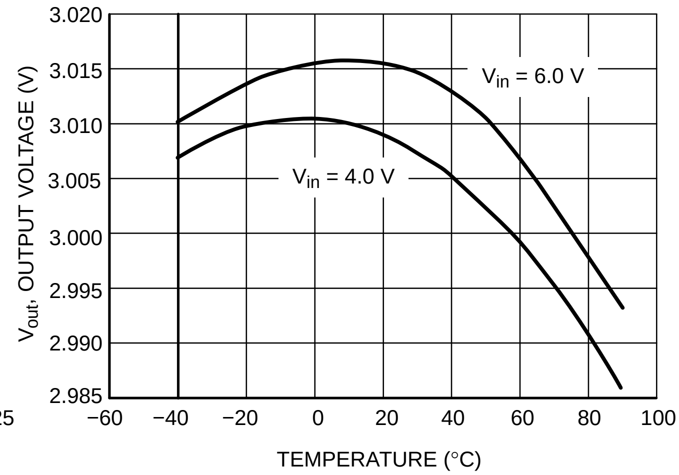


Figure 3. Output Voltage vs. Temperature

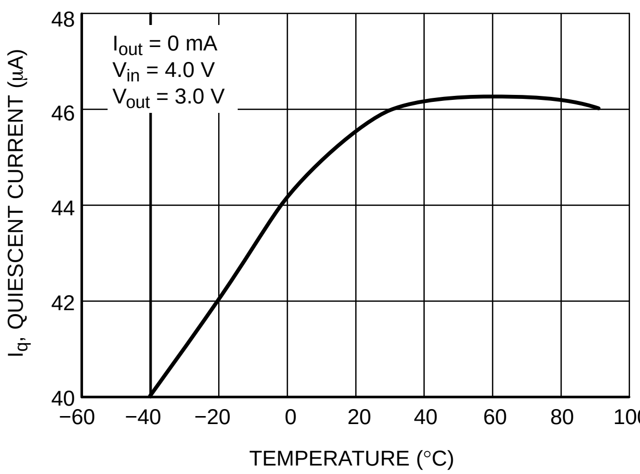


Figure 4. Quiescent Current vs. Temperature

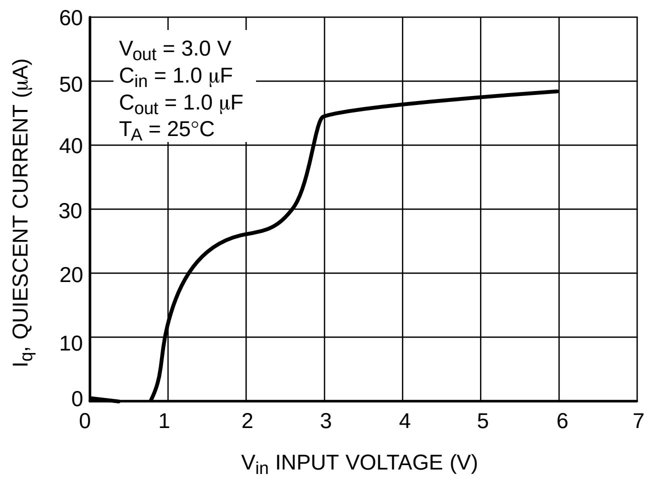


Figure 5. Quiescent Current vs. Input Voltage

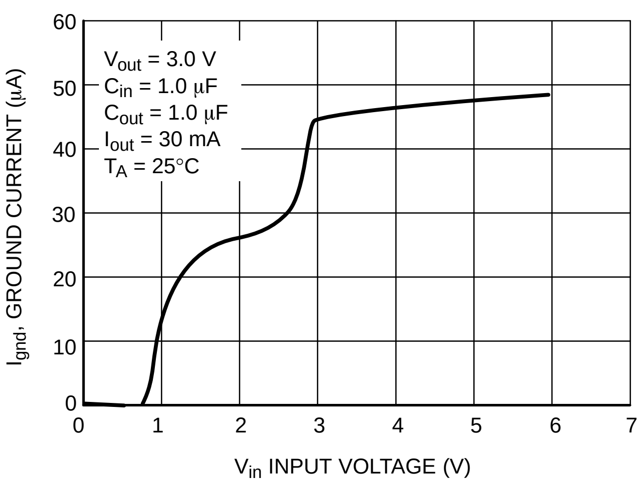


Figure 6. Ground Pin Current vs. Input Voltage

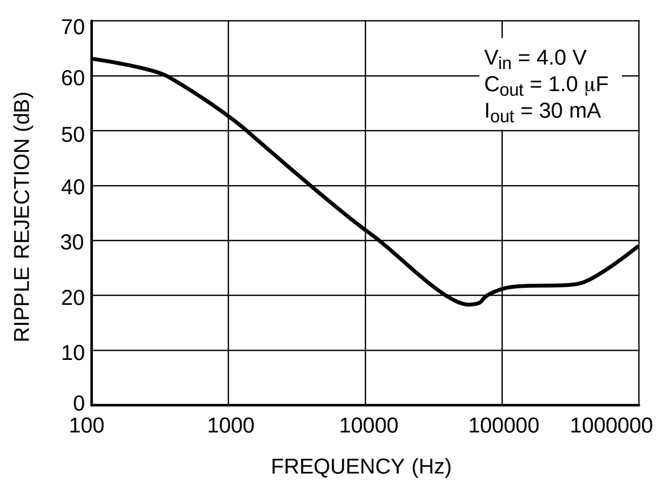


Figure 7. Ripple Rejection vs. Frequency

TYPICAL CHARACTERISTICS

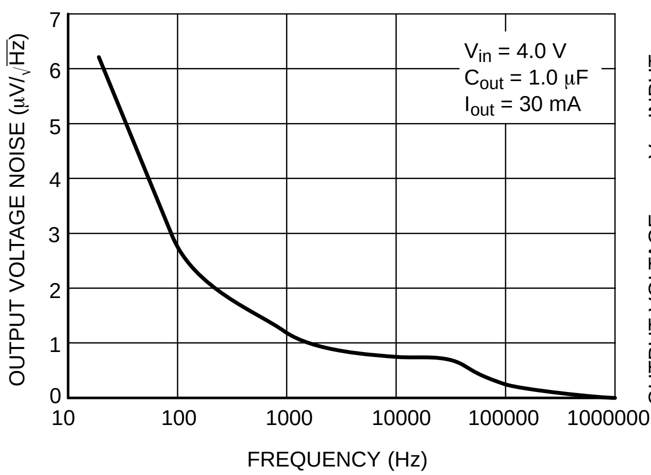


Figure 8. Output Noise Density

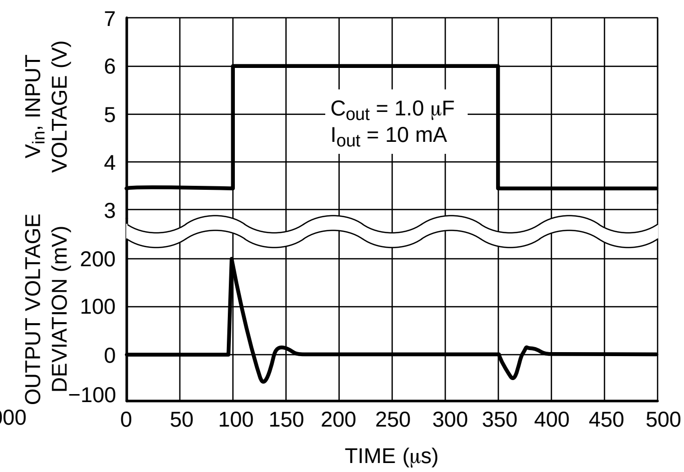


Figure 9. Line Transient Response

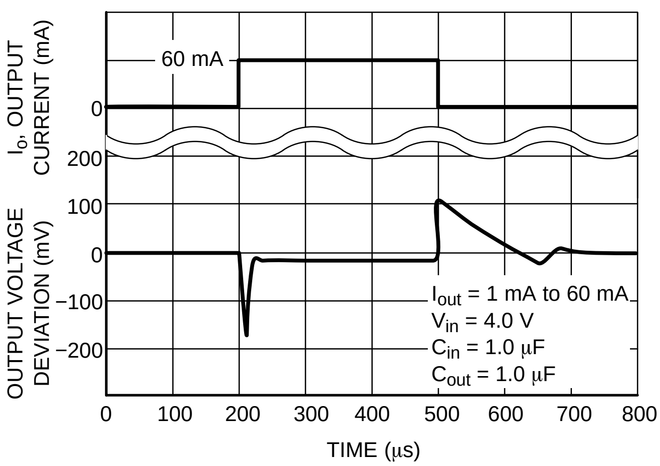


Figure 10. Load Transient Response

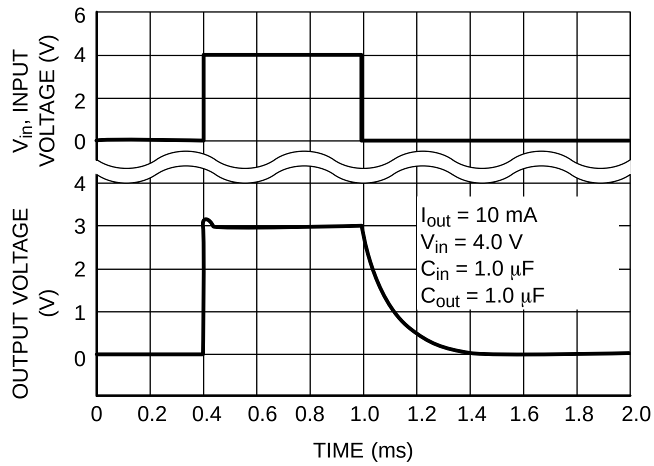


Figure 11. Turn−on Response

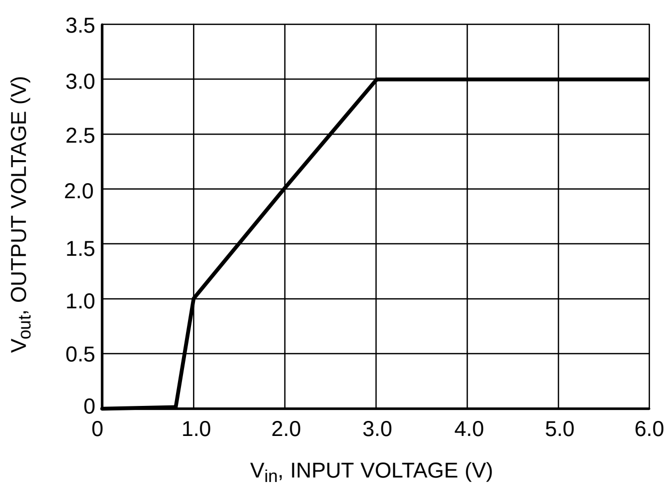


Figure 12. Output Voltage vs. Input Voltage

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. 150°C. Depending on the ambient power dissipation and thus the maximum available output current.

APPLICATIONS INFORMATION

A typical application circuit for the NCP612/NCV612 is shown in Figure 1, front page.

Input Decoupling (C1)

A 1.0 μF capacitor either ceramic or tantalum is recommended and should be connected close to the NCP612/NCV612 package. Higher values and lower ESR will improve the overall line transient response.
TDK capacitor: C2012X5R1C105K, or C1608X5R1A105K

Output Decoupling (C2)

The NCP612/NCV612 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 5.0 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 capacitors. 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.

Set 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 NCP612/NCV612 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 NCP612/NCV612 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 NCP612/NCV612 can dissipate up to 330 mW @ 25°C.

The power dissipated by the NCP612/NCV612 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 100 mA output current is needed then the ground current from the data sheet is 40 μA. For an NCP612/NCV612 (3.0 V), the maximum input voltage will then be 6.0 V (Limited by maximum input voltage).

ORDERING INFORMATION

Device	Nominal Output Voltage	Marking	Package	Shipping†
NCP612SQ15T1	1.5	LHO	SC70−5	3000 Units/Tape & Reel
NCP612SQ15T1G			SC70−5 (Pb−Free)	
NCP612SQ18T1	1.8	LHP	SC70−5	
NCP612SQ18T1G			SC70−5 (Pb−Free)	
NCP612SQ25T1	2.5	LHQ	SC70−5	
NCP612SQ25T1G			SC70−5 (Pb−Free)	
NCP612SQ27T1	2.7	LHR	SC70−5	
NCP612SQ27T1G			SC70−5 (Pb−Free)	
NCP612SQ28T1	2.8	LHS	SC70−5	
NCP612SQ28T1G			SC70−5 (Pb−Free)	
NCP612SQ30T1	3.0	LHT	SC70−5	
NCP612SQ30T1G			SC70−5 (Pb−Free)	
NCP612SQ31T1	3.1	LHU	SC70−5	
NCP612SQ31T1G			SC70−5 (Pb−Free)	
NCP612SQ33T1	3.3	LHV	SC70−5	
NCP612SQ33T1G			SC70−5 (Pb−Free)	
NCP612SQ37T1G	3.7	LKH	SC70−5 (Pb−Free)	
NCP612SQ50T1	5.0	LHW	SC70−5	
NCP612SQ50T1G			SC70−5 (Pb−Free)	
NCV612SQ15T1*	1.5	LHO	SC70−5	
NCV612SQ15T1G*			SC70−5 (Pb−Free)	
NCV612SQ18T1*	1.8	LHP	SC70−5	
NCV612SQ18T1G*			SC70−5 (Pb−Free)	
NCV612SQ25T1*	2.5	LHQ	SC70−5	
NCV612SQ25T1G*			SC70−5 (Pb−Free)	
NCV612SQ27T1*	2.7	LHR	SC70−5	
NCV612SQ27T1G*			SC70−5 (Pb−Free)	
NCV612SQ28T1*	2.8	LHS	SC70−5	
NCV612SQ28T1G*			SC70−5 (Pb−Free)	

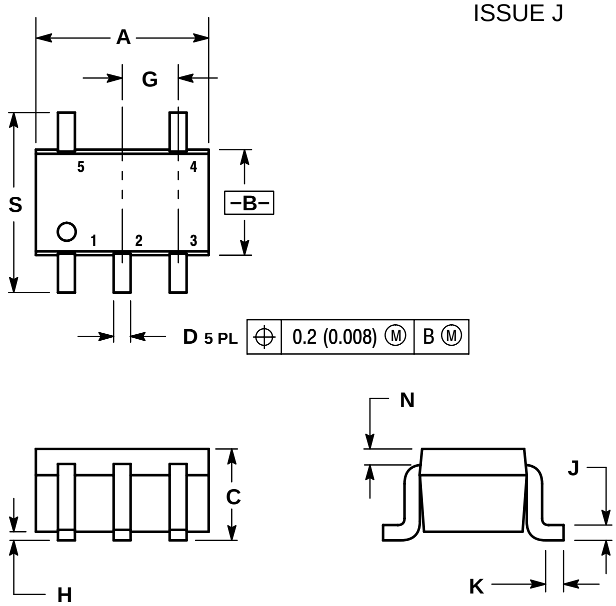
ORDERING INFORMATION

Device	Nominal Output Voltage	Marking	Package	Shipping†
NCV612SQ30T1*	3.0	LHT	SC70−5	3000 Units/Tape & Reel
NCV612SQ30T1G*			SC70−5 (Pb−Free)	
NCV612SQ31T1*	3.1	LHU	SC70−5	
NCV612SQ31T1G*			SC70−5 (Pb−Free)	
NCV612SQ33T1*	3.3	LHV	SC70−5	
NCV612SQ33T1G*			SC70−5 (Pb−Free)	
NCV612SQ50T1*	5.0	LHW	SC70−5	
NCV612SQ50T1G*			SC70−5 (Pb−Free)	

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.
*NCV prefix for automotive and other applications requiring site and control changes.

PACKAGE DIMENSIONS

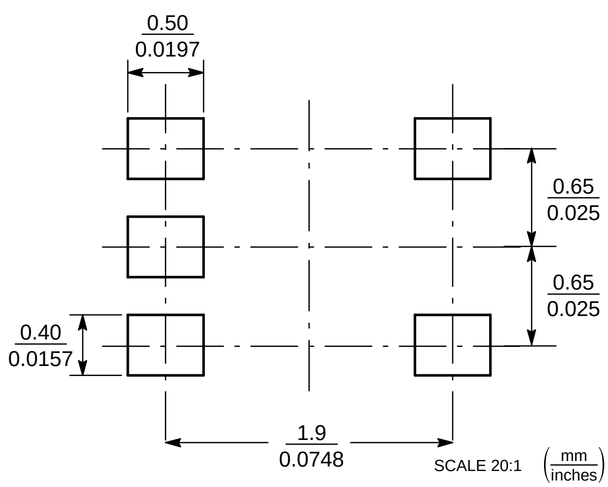
SC−88A, SOT−353, SC−70
CASE 419A−02
ISSUE J



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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20

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
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Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

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