

NCV4264

150 mA Low Dropout Linear Regulator

The NCV4264 is a wide input range, precision fixed output, low dropout integrated voltage regulator with a full load current rating of 150 mA.

The output voltage is accurate within $\pm 2.0\%$, and maximum dropout voltage is 500 mV at 100 mA load current.

It is internally protected against 45 V input transients, input supply reversal, output overcurrent faults, and excess die temperature. No external components are required to enable these features.

Features

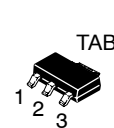
- 5.0 V Fixed Output
- $\pm 2.0\%$ Output Accuracy, Over Full Temperature Range
- Quiescent Current 400 μA at $I_{\text{OUT}} = 1.0 \text{ mA}$
- 500 mV Maximum Dropout Voltage at 100 mA Load Current
- Wide Input Voltage Operating Range of 5.5 V to 45 V
- Internal Fault Protection
 - ◆ -42 V Reverse Voltage
 - ◆ Short Circuit/Overcurrent
 - ◆ Thermal Overload
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- AEC-Q100 Qualified
- This is a Pb-Free Device



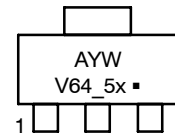
ON Semiconductor[®]

<http://onsemi.com>

MARKING DIAGRAM

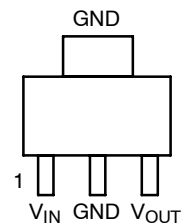


**SOT-223
ST SUFFIX
CASE 318E**



A = Assembly Location
Y = Year
W = Work Week
V64_5x = Specific Device Code
x = 5 (5.0 V)
■ = Pb-Free Package

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

NCV4264

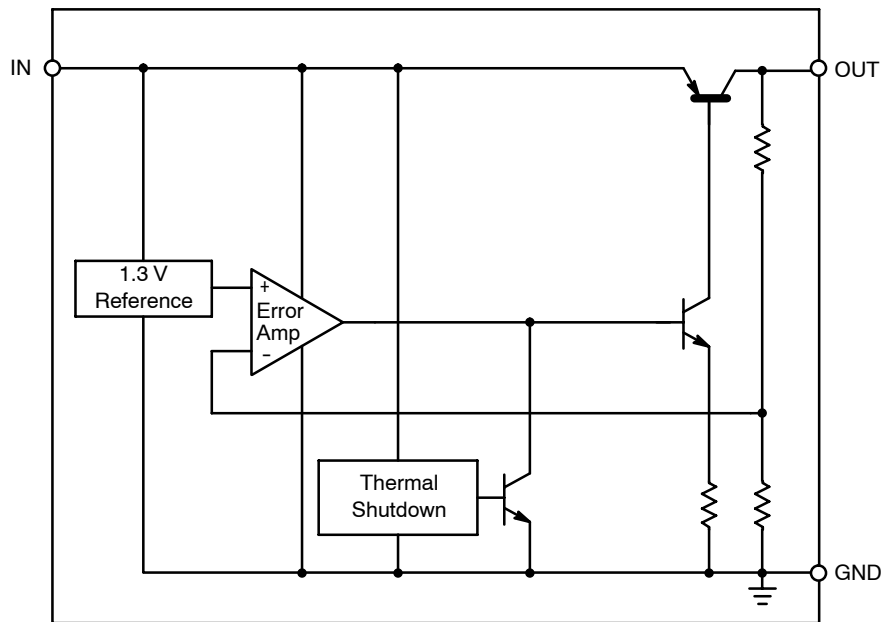


Figure 1. Block Diagram

PIN FUNCTION DESCRIPTION

| Pin No. | Symbol | Function |
|---------|-----------|--|
| 1 | V_{IN} | Unregulated input voltage; 5.5 V to 45 V. |
| 2 | GND | Ground; substrate. |
| 3 | V_{OUT} | Regulated output voltage; collector of the internal PNP pass transistor. |
| TAB | GND | Ground; substrate and best thermal connection to the die. |

MAXIMUM RATINGS

| Rating | Symbol | Min | Max | Unit |
|--|--------------|------|--------|------|
| V_{IN} , DC Input Voltage | V_{IN} | -42 | +45 | V |
| V_{OUT} , DC Voltage | V_{OUT} | -0.3 | +16 | V |
| Storage Temperature | T_{stg} | -55 | +150 | °C |
| Moisture Sensitivity Level | MSL | 1 | | - |
| ESD Capability, Human Body Model (Note 1) | V_{ESDHB} | 4000 | - | V |
| ESD Capability, Machine Model (Note 1) | V_{ESDMIM} | 200 | - | V |
| Lead Temperature Soldering Reflow (SMD Styles Only), Lead Free (Note 2) | T_{sld} | - | 265 pk | °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.

OPERATING RANGE

| Pin Symbol, Parameter | Symbol | Min | Max | Unit |
|---------------------------------------|----------|-----|------|------|
| V_{IN} , DC Input Operating Voltage | V_{IN} | 5.5 | +45 | V |
| Junction Temperature Operating Range | T_J | -40 | +150 | °C |

- This device series incorporates ESD protection and is tested by the following methods:
ESD HBM tested per AEC-Q100-002 (EIA/JESD22-A 114C)
ESD MM tested per AEC-Q100-003 (EIA/JESD22-A 115C)
- Lead Free, 60 sec – 150 sec above 217°C, 40 sec max at peak.

NCV4264

THERMAL RESISTANCE

| Parameter | Symbol | Condition | Min | Max | Unit |
|---------------------|---------|-----------------|-----|-------------|-----------------------------|
| Junction-to-Ambient | SOT-223 | $R_{\theta JA}$ | - | 99 (Note 3) | $^{\circ}\text{C}/\text{W}$ |
| Junction-to-Case | SOT-223 | $R_{\theta JC}$ | - | 17 | |

ELECTRICAL CHARACTERISTICS ($V_{IN} = 13.5\text{ V}$, $T_j = -40^{\circ}\text{C}$ to $+150^{\circ}\text{C}$, unless otherwise noted.)

| Characteristic | Symbol | Test Conditions | Min | Typ | Max | Unit |
|--------------------------------|--------------------------------|---|-------|-------|-------|---------------------------|
| Output Voltage | V_{OUT} | $5.0\text{ mA} \leq I_{OUT} \leq 100\text{ mA}$ (Note 4) $6.0\text{ V} \leq V_{IN} \leq 28\text{ V}$ | 4.900 | 5.000 | 5.100 | V |
| Line Regulation | ΔV_{OUT} vs. V_{IN} | $I_{OUT} = 5.0\text{ mA}$ $6.0\text{ V} \leq V_{IN} \leq 28\text{ V}$ | -30 | 5.0 | +30 | mV |
| Load Regulation | ΔV_{OUT} vs. I_{OUT} | $5.0\text{ mA} \leq I_{OUT} \leq 100\text{ mA}$ (Note 4) | -40 | 5.0 | +40 | mV |
| Dropout Voltage | $V_{IN} - V_{OUT}$ | $I_{OUT} = 100\text{ mA}$ (Notes 4 & 5) | - | 275 | 500 | mV |
| Quiescent Current | I_q | $I_{OUT} = 1.0\text{ mA}$ | - | 83 | 400 | μA |
| Active Ground Current | $I_{G(ON)}$ | $I_{OUT} = 50\text{ mA}$ (Note 4) | - | 1.5 | 15 | mA |
| Power Supply Rejection | PSRR | $V_{RIPPLE} = 0.5\text{ V}_{P-P}$, $F = 100\text{ Hz}$ | - | 67 | - | dB |
| Output Capacitor for Stability | C_{OUT} ESR | $I_{OUT} = 1.0\text{ mA}$ to 100 mA (Notes 4) | 10 | - | 9.0 | μF Ω |

PROTECTION

| | | | | | | |
|-----------------------------|----------------|-----------------------------------|-----|---|-----|--------------------|
| Current Limit | $I_{OUT(LIM)}$ | $V_{OUT} = 4.5\text{ V}$ (Note 4) | 150 | - | 500 | mA |
| Short Circuit Current Limit | $I_{OUT(SC)}$ | $V_{OUT} = 0\text{ V}$ (Note 4) | 40 | - | 500 | mA |
| Thermal Shutdown Threshold | T_{TSD} | (Note 6) | 150 | - | 200 | $^{\circ}\text{C}$ |

- 1 oz., 100 mm² copper area.
- Use pulse loading to limit power dissipation.
- Dropout voltage = $(V_{IN} - V_{OUT})$, measured when the output voltage has dropped 100 mV relative to the nominal value obtained with $V_{IN} = 13.5\text{ V}$.
- Not tested in production. Limits are guaranteed by design.

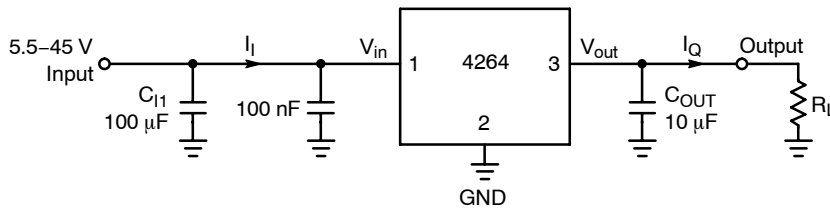


Figure 2. Measurement Circuit

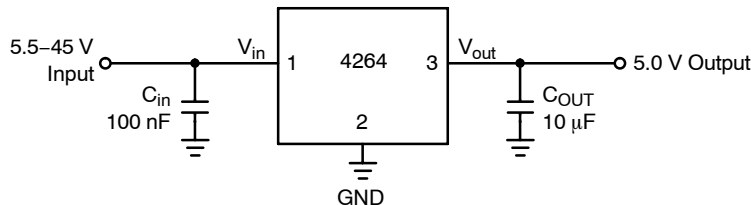


Figure 3. Applications Circuit

TYPICAL CHARACTERISTIC CURVES

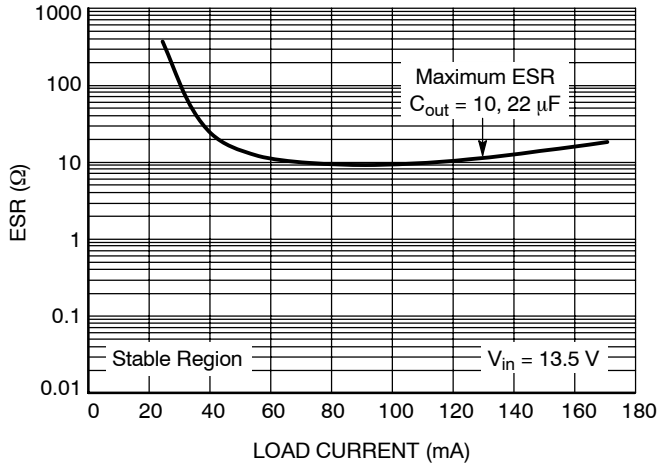


Figure 4. ESR Characterization

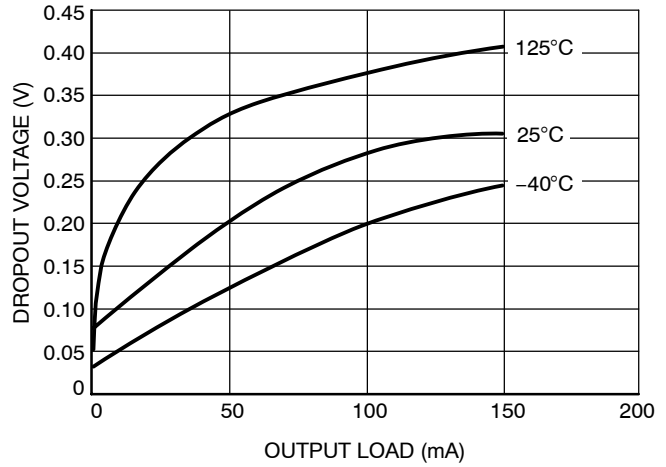


Figure 5. Dropout Voltage vs. Output Load

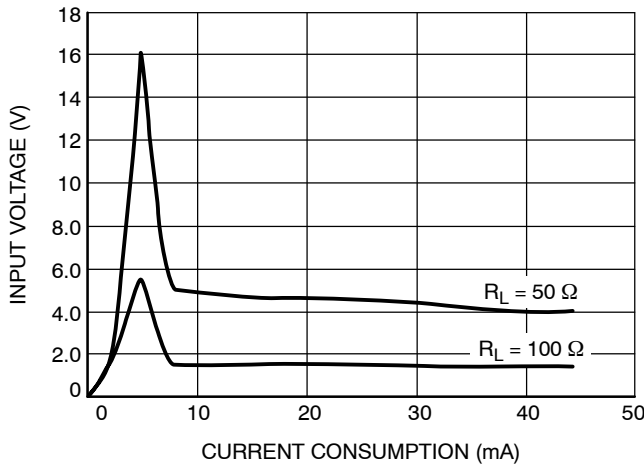


Figure 6. Current Consumption vs. Input Voltage

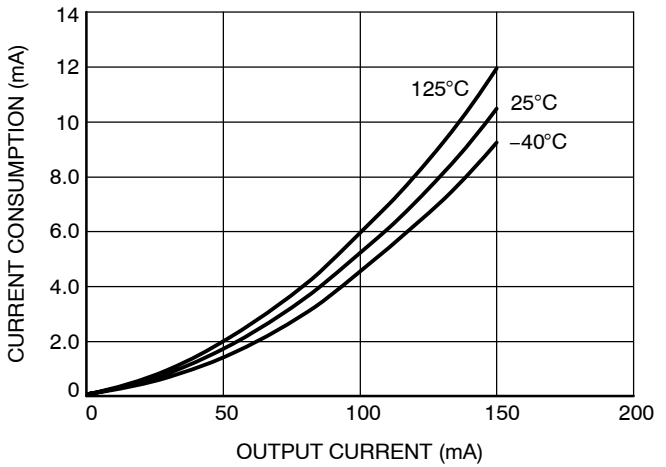


Figure 7. Current Consumption vs. Output Current

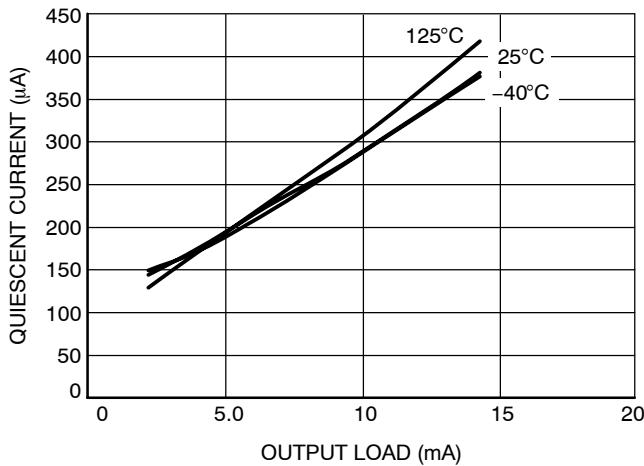


Figure 8. Quiescent Current vs. Output Load

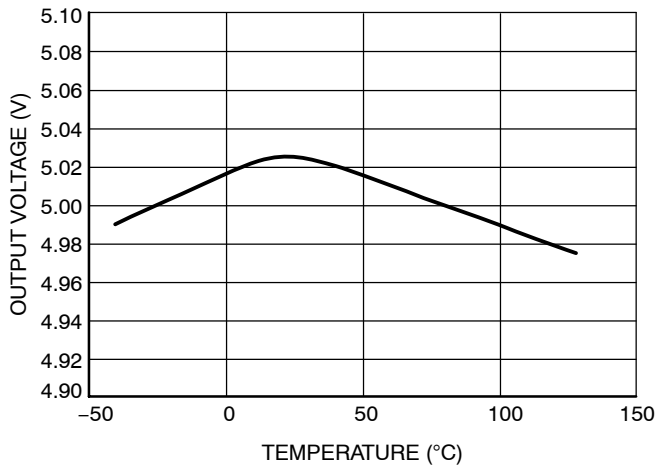


Figure 9. Output Voltage vs. Temperature

NCV4264

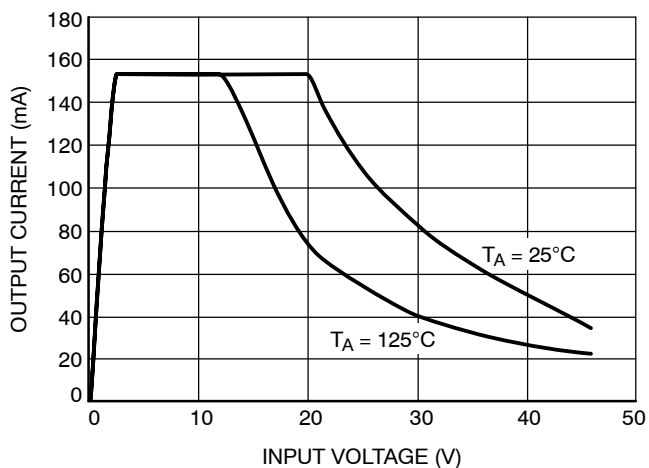


Figure 10. Output Current vs. Input Voltage

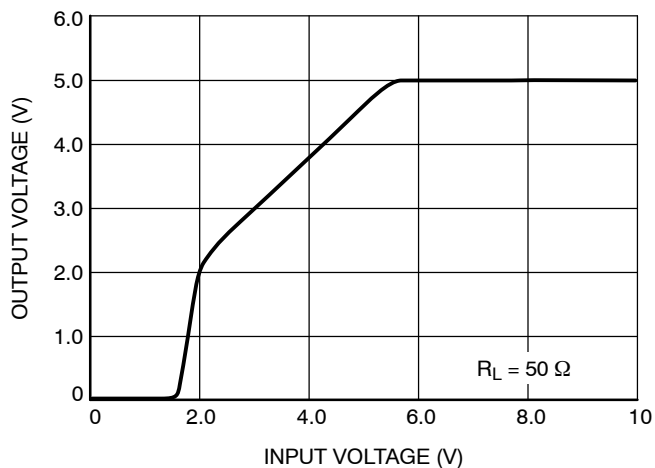


Figure 11. Input Voltage vs. Output Voltage

Circuit Description

The NCV4264 is a precision trimmed 5.0 V fixed output regulator. The device has current capability of 150 mA, with 500 mV of dropout voltage at 100 mA of current. The regulation is provided by a PNP pass transistor controlled by an error amplifier with a bandgap reference. The regulator is protected by both current limit and short circuit protection. Thermal shutdown occurs above 150°C to protect the IC during overloads and extreme ambient temperatures.

Regulator

The error amplifier compares the reference voltage to a sample of the output voltage (V_{out}) and drives the base of a PNP series pass transistor by a buffer. The reference is a bandgap design to give it a temperature-stable output. Saturation control of the PNP is a function of the load current and input voltage. Over saturation of the output power device is prevented, and quiescent current in the ground pin is minimized.

Regulator Stability Considerations

The input capacitor C_{IN1} in Figure 2 is necessary for compensating input line reactance. Possible oscillations caused by input inductance and input capacitance can be damped by using a resistor of approximately 1 Ω in series with C_{IN2} . The output or compensation capacitor, C_{OUT} helps determine three main characteristics of a linear regulator: startup delay, load transient response and loop stability. The capacitor value and type should be based on cost, availability, size and temperature constraints. A tantalum or aluminum electrolytic capacitor is best, since a film or ceramic capacitor with almost zero ESR can cause instability. The aluminum electrolytic capacitor is the least expensive solution, but, if the circuit operates at low temperatures (-25°C to -40°C), both the value and ESR of the capacitor will vary considerably. The capacitor manufacturer's data sheet usually provides this information. The value for the output capacitor C_{OUT} shown in Figure 2 should work for most applications; however, it is not necessarily the optimized solution. Stability is guaranteed at values $CQ = 10 \mu F$ and an ESR = 9 Ω within the operating temperature range. Actual limits are shown in a graph in the Typical Performance Characteristics section.

Calculating Power Dissipation in a Single Output Linear Regulator

The maximum power dissipation for a single output regulator (Figure 3) is:

$$P_{D(max)} = [V_{IN(max)} - V_{OUT(min)}] \cdot I_{Q(max)} + V_{I(max)} \cdot I_q \quad (eq. 1)$$

Where:

$V_{IN(max)}$ is the maximum input voltage,

$V_{OUT(min)}$ is the minimum output voltage,

$I_{Q(max)}$ is the maximum output current for the application, and I_q is the quiescent current the regulator consumes at $I_{Q(max)}$.

Once the value of $P_{D(Max)}$ is known, the maximum permissible value of $R_{\theta JA}$ can be calculated:

$$P_{\theta JA} = \frac{150^\circ C - T_A}{P_D} \quad (eq. 2)$$

The value of $R_{\theta JA}$ can then be compared with those in the package section of the data sheet. Those packages with $R_{\theta JA}$'s less than the calculated value in Equation 2 will keep the die temperature below 150°C. In some cases, none of the packages will be sufficient to dissipate the heat generated by the IC, and an external heat sink will be required. The current flow and voltages are shown in the Measurement Circuit Diagram.

Heat Sinks

A heat sink effectively increases the surface area of the package to improve the flow of heat away from the IC and into the surrounding air. Each material in the heat flow path between the IC and the outside environment will have a thermal resistance. Like series electrical resistances, these resistances are summed to determine the value of $R_{\theta JA}$:

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CS} + R_{\theta SA} \quad (eq. 3)$$

Where:

$R_{\theta JC}$ = the junction-to-case thermal resistance,

$R_{\theta CS}$ = the case-to-heat sink thermal resistance, and

$R_{\theta SA}$ = the heat sink-to-ambient thermal resistance.

$R_{\theta JA}$ appears in the package section of the data sheet.

Like $R_{\theta JA}$, it too is a function of package type. $R_{\theta CS}$ and $R_{\theta SA}$ are functions of the package type, heat sink and the interface between them. These values appear in data sheets of heat sink manufacturers. Thermal, mounting, and heat sinking are discussed in the ON Semiconductor application note AN1040/D, available on the ON Semiconductor Website.

NCV4264

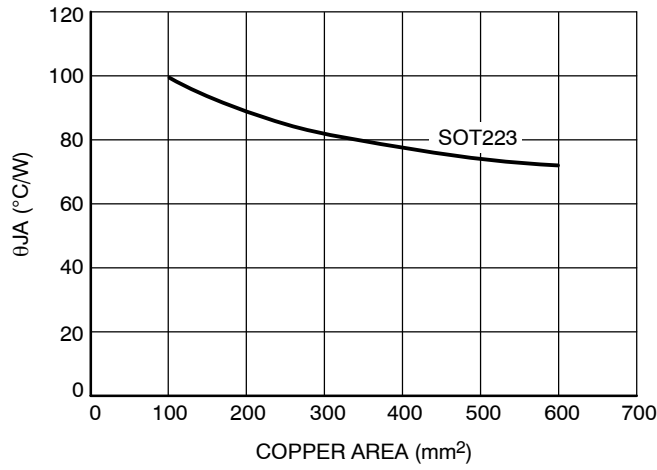


Figure 12.

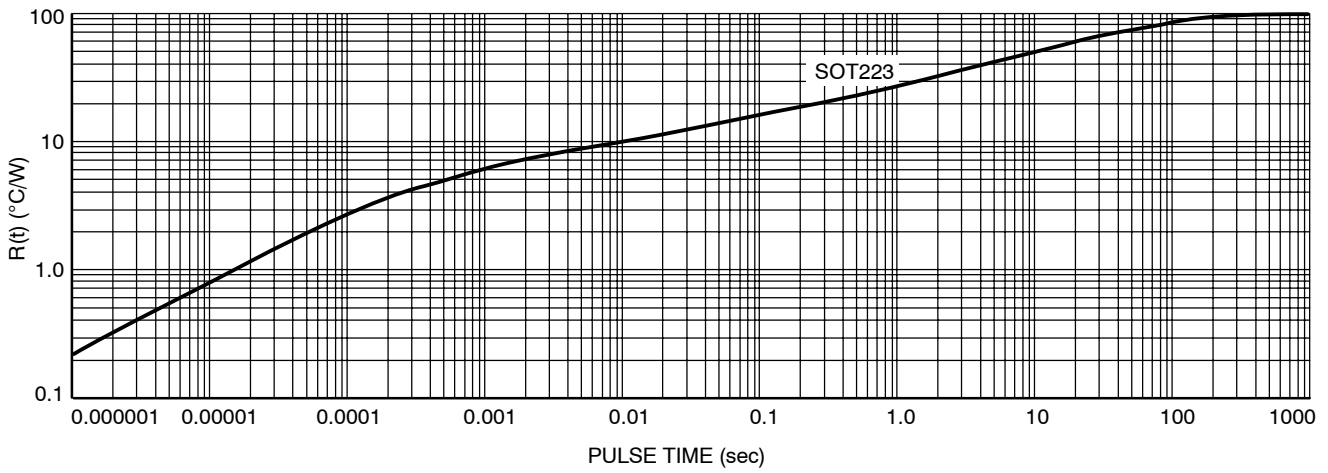


Figure 13.

ORDERING INFORMATION

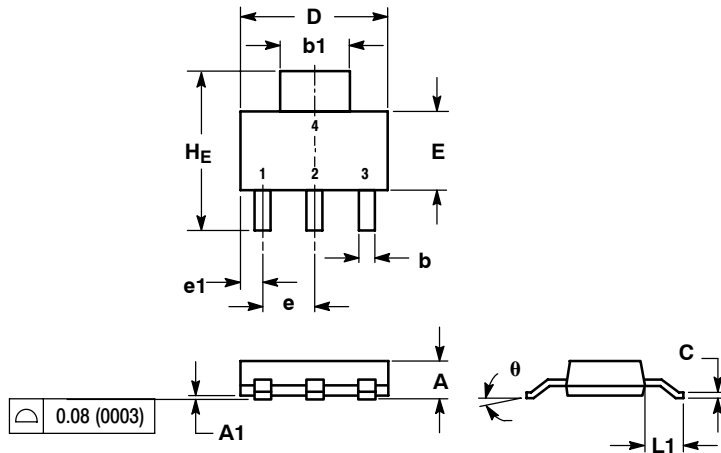
| Device | Marking | Package | Shipping† |
|----------------|---------|---------|------------------|
| NCV4264ST50T3G | V64_5 | SOT-223 | 4000 Tape & Reel |

†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.

NCV4264

PACKAGE DIMENSIONS

SOT-223 (TO-261)
ST SUFFIX
CASE 318E-04
ISSUE L

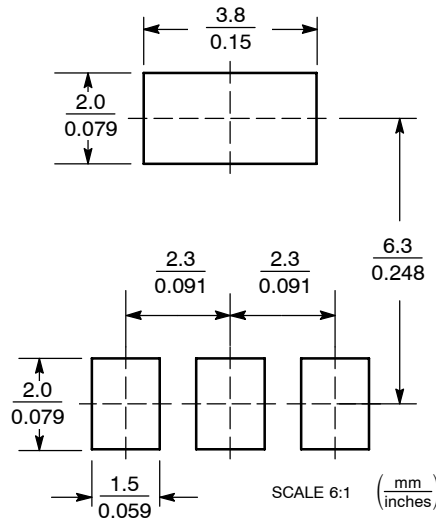


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| DIM | MILLIMETERS | | | INCHES | | |
|-----|-------------|------|------|--------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.50 | 1.63 | 1.75 | 0.060 | 0.064 | 0.068 |
| A1 | 0.02 | 0.06 | 0.10 | 0.001 | 0.002 | 0.004 |
| b | 0.60 | 0.75 | 0.89 | 0.024 | 0.030 | 0.035 |
| b1 | 2.90 | 3.06 | 3.20 | 0.115 | 0.121 | 0.126 |
| c | 0.24 | 0.29 | 0.35 | 0.009 | 0.012 | 0.014 |
| D | 6.30 | 6.50 | 6.70 | 0.249 | 0.256 | 0.263 |
| E | 3.30 | 3.50 | 3.70 | 0.130 | 0.138 | 0.145 |
| e | 2.20 | 2.30 | 2.40 | 0.087 | 0.091 | 0.094 |
| e1 | 0.85 | 0.94 | 1.05 | 0.033 | 0.037 | 0.041 |
| L1 | 1.50 | 1.75 | 2.00 | 0.060 | 0.069 | 0.078 |
| HE | 6.70 | 7.00 | 7.30 | 0.264 | 0.276 | 0.287 |
| θ | 0° | - | 10° | 0° | - | 10° |

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.

ON Semiconductor and are registered 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. This literature is subject to all applicable copyright laws and is not for resale in any manner.

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

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81-3-5773-3850

ON Semiconductor Website: www.onsemi.com
Order Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local Sales Representative

NCV4264/D