

# CS8481

## 3.3 V/250 mA, 5.0 V/100 mA Micropower Low Dropout Regulator with ENABLE

The CS8481 is a precision, dual Micropower linear voltage regulator. The switched 3.3 V primary output ( $V_{OUT1}$ ) supplies up to 250 mA while the secondary 5.0 V ( $V_{OUT2}$ ) is capable of supplying 100 mA. Both outputs have a maximum dropout voltage of 600 mV and low reverse current. Quiescent current drain is typically 150  $\mu$ A when supplying 100  $\mu$ A from each output.

The ENABLE input provides logic level control of the primary output. With the primary output disabled, quiescent current drain is typically 100  $\mu$ A when supplying 100  $\mu$ A from the secondary output.

The CS8481 is extremely robust with protection provided for reverse battery, short circuit, overvoltage, and overtemperature on both outputs.

The CS8481 is available in a D<sup>2</sup>PAK-5.

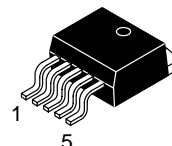
### Features

- 3.3 V/250 mA Primary Output
- 5.0 V/100 mA Secondary Output
- 3.0% Tolerance, Both Outputs
- ON/OFF Control for Primary Output
- Low Quiescent Current Drain (100  $\mu$ A  $V_{OUT2}$ )
- Low Reverse Current
- Protection Features
  - Reverse Battery (–15 V)
  - 74 V Peak Transient Voltage
  - Short Circuit
  - Overtemperature
  - Overvoltage (34 V)



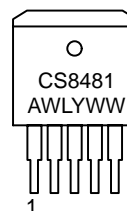
ON Semiconductor®

<http://onsemi.com>



D<sup>2</sup>PAK-5  
DP SUFFIX  
CASE 936AC

### PIN CONNECTIONS AND MARKING DIAGRAM



Tab = GND  
Pin 1.  $V_{IN}$   
2.  $V_{OUT1}$   
3. GND  
4.  $V_{OUT2}$   
5. ENABLE

A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week

### ORDERING INFORMATION\*

| Device      | Package              | Shipping†       |
|-------------|----------------------|-----------------|
| CS8481YDP5  | D <sup>2</sup> PAK-5 | 50 Units/Rail   |
| CS8481YDPR5 | D <sup>2</sup> PAK-5 | 750 Tape & Reel |

\*Consult your local sales representative for SO-8, SO-16, DIP-8, DIP-16, TO-220-5, and D<sup>2</sup>PAK-7 packaging options.

†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.

# CS8481

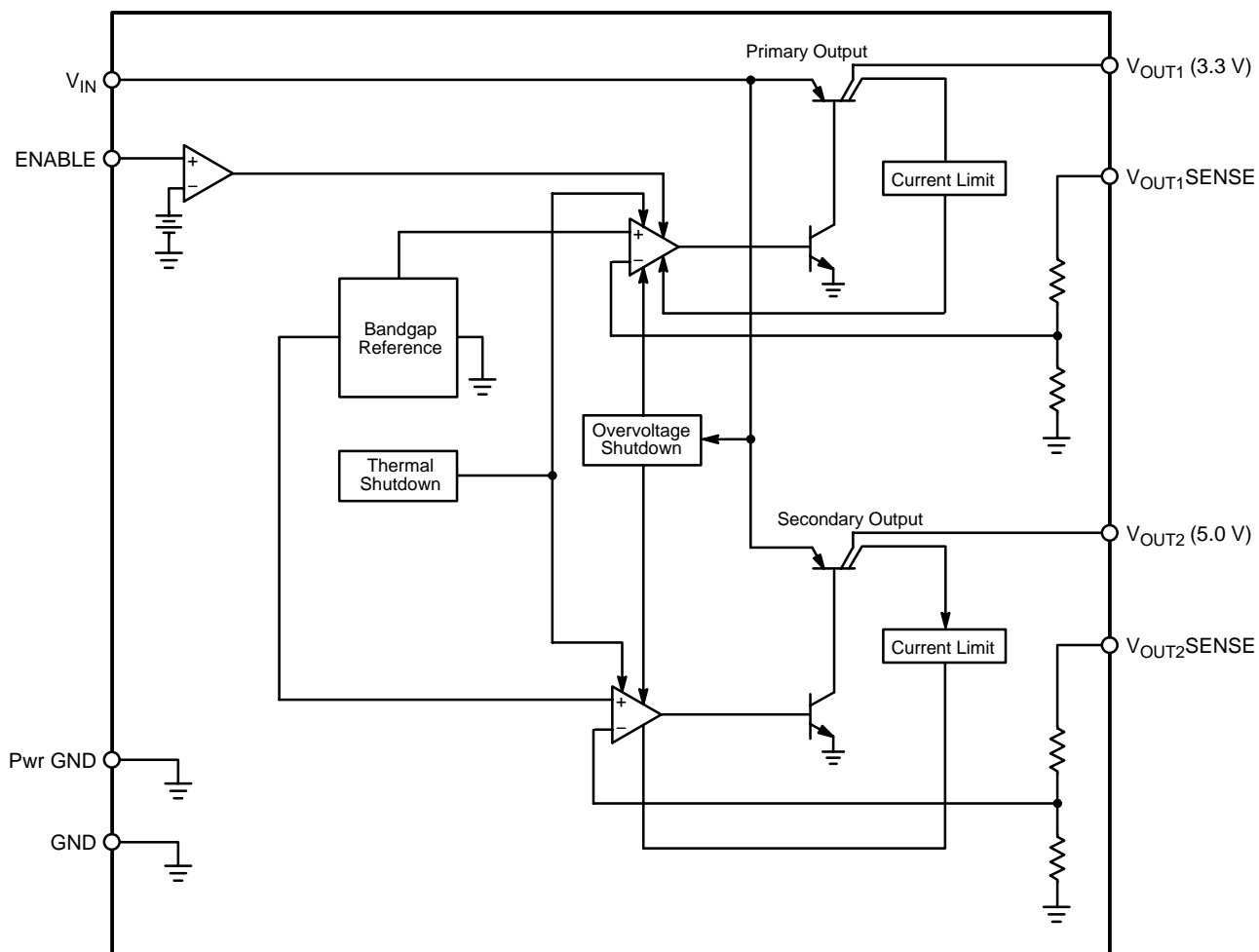


Figure 1. Block Diagram

## MAXIMUM RATINGS\*

| Rating                                     | Value  | Unit        |
|--|--|-------------|
| Input Voltage ( $V_{IN}$ )                 | Operating Range  | 30 V        |
|  | Reverse Battery  | -15 V       |
|  | Peak Transient Voltage (60 V Load Dump @ 14 V $V_{IN}$ ) | 74 V        |
| ENABLE                                     | 10   | V           |
| Power Dissipation                          | Internally Limited                                       | -           |
| Maximum Junction Temperature               | -40 to +150  | °C          |
| Storage Temperature Range                  | -55 to +150  | °C          |
| Electrostatic Discharge (Human Body Model) | 4.0  | kV          |
| Lead Temperature Soldering                 | Reflow (SMD styles only) (Note 1)                        | 230 peak °C |

1. 60 second maximum above 183°C

\*The maximum package power dissipation must be observed.

# CS8481

**ELECTRICAL CHARACTERISTICS:** ( $6.0\text{ V} \leq V_{IN} \leq 26\text{ V}$ ,  $I_{OUT1} = I_{OUT2} = 100\ \mu\text{A}$ ,  $-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ ,  $-40^\circ\text{C} \leq T_C \leq 125^\circ\text{C}$ ; unless otherwise specified.)

| Characteristic | Test Conditions | Min | Typ | Max | Unit |
|----------------|-----------------|-----|-----|-----|------|
|----------------|-----------------|-----|-----|-----|------|

## Primary Output Stage ( $V_{OUT1}$ )

|                             |  |     |     |      |               |
|-----------------------------|--|-----|-----|------|---------------|
| Output Voltage, $V_{OUT1}$  | $100\ \mu\text{A} \leq I_{OUT1} \leq 250\ \text{mA}$   | 3.2 | 3.3 | 3.4  | V             |
| Line Regulation             | $6.0\text{ V} \leq V_{IN} \leq 26\text{ V}$  | –   | 5.0 | 50   | mV            |
| Load Regulation             | $1.0\ \text{mA} \leq I_{OUT1} \leq 250\ \text{mA}$ , $V_{IN} = 14\text{ V}$                      | –   | 5.0 | 50   | mV            |
| Quiescent Current           | ENABLE = HIGH, $V_{IN} = 16\text{ V}$ , $I_{OUT1} = 250\ \text{mA}$                              | –   | 22  | 50   | mA            |
| Ripple Rejection            | $f = 120\ \text{Hz}$ , $I_{OUT1} = 125\ \text{mA}$ , $7.0\text{ V} \leq V_{IN} \leq 17\text{ V}$ | 60  | 70  | –    | dB            |
| Current Limit               | $9.0\text{ V} \leq V_{IN} \leq 26\text{ V}$  | 260 | 400 | –    | mA            |
| Short Circuit Current Limit | $V_{OUT1} = 0\text{ V}$ , $V_{IN} = 16\text{ V}$   | 25  | –   | –    | mA            |
| Reverse Current             | $V_{OUT1} = 3.3\text{ V}$ , $V_{IN} = 0\text{ V}$  | –   | 100 | 1500 | $\mu\text{A}$ |

## Secondary Output ( $V_{OUT2}$ )

|                                |   |        |            |            |                     |
|--------------------------------|---|--------|------------|------------|---------------------|
| Output Voltage, ( $V_{OUT2}$ ) | $100\ \mu\text{A} \leq I_{OUT2} \leq 100\ \text{mA}$  | 4.85   | 5.00       | 5.15       | V                   |
| Dropout Voltage                | $I_{OUT2} = 100\ \text{mA}$<br>$I_{OUT2} = 100\ \mu\text{A}$  | –      | 400<br>100 | 600<br>150 | mV<br>mV            |
| Line Regulation                | $6.0\text{ V} \leq V_{IN} \leq 26\text{ V}$   | –      | 5.0        | 50         | mV                  |
| Load Regulation                | $100\ \mu\text{A} \leq I_{OUT2} \leq 100\ \text{mA}$ , $V_{IN} = 14\text{ V}$                                 | –      | 5.0        | 50         | mV                  |
| Quiescent Current              | ENABLE = LOW, $V_{IN} = 12.8\text{ V}$<br>ENABLE = HIGH, $V_{IN} = 16\text{ V}$ , $I_{OUT2} = 100\ \text{mA}$ | –<br>– | 100<br>8.0 | 150<br>30  | $\mu\text{A}$<br>mA |
| Ripple Rejection               | $f = 120\ \text{Hz}$ ; $I_{OUT2} = 10\ \text{mA}$ , $7.0\text{ V} \leq V_{IN} \leq 17\text{ V}$               | 60     | 70         | –          | dB                  |
| Current Limit                  | $9.0\text{ V} \leq V_{IN} \leq 26\text{ V}$   | 105    | 200        | –          | mA                  |
| Short Circuit Current Limit    | $V_{OUT2} = 0\text{ V}$ , $V_{IN} = 16\text{ V}$ , $I_{OUT1} = 0\text{ A}$                                    | 25     | –          | –          | mA                  |
| Reverse Current                | $V_{OUT2} = 5.0\text{ V}$ , $V_{IN} = 0\text{ V}$   | –      | 100        | 250        | $\mu\text{A}$       |

## ENABLE Function (ENABLE)

|                    |   |          |            |          |               |
|--------------------|---|----------|------------|----------|---------------|
| Input Threshold    | ENABLE = LOW, $6.0\text{ V} \leq V_{IN} \leq 26\text{ V}$<br>ENABLE = HIGH, $6.0\text{ V} \leq V_{IN} \leq 26\text{ V}$ | –<br>2.0 | 1.2<br>1.2 | 0.8<br>– | V<br>V        |
| Input Bias Current | $0\text{ V} \leq V_{ENABLE} \leq 5.0\text{ V}$  | –2.0     | 0          | 2.0      | $\mu\text{A}$ |

## Protection Circuits

|                           |        |     |     |    |                  |
|---------------------------|--------|-----|-----|----|------------------|
| Overtemperature Threshold | Note 2 | 150 | 180 | –  | $^\circ\text{C}$ |
| Overvoltage Shutdown      | –      | 30  | 34  | 38 | V                |

2. Guaranteed by Design.

## PACKAGE PIN DESCRIPTION

| PACKAGE LEAD #       | LEAD SYMBOL | FUNCTION   |
|----------------------|-------------|--|
| D <sup>2</sup> PAK–5 |             |  |
| 1                    | $V_{IN}$    | Supply voltage to IC, usually direct from battery.   |
| 2                    | $V_{OUT1}$  | 3.3 V regulated output which is activated by ENABLE input.                                   |
| 3                    | GND         | Ground connection.   |
| 4                    | $V_{OUT2}$  | Standby output 5.0 V, 100 mA capability; always on.  |
| 5                    | ENABLE      | CMOS compatible input lead; switches $V_{OUT1}$ . When ENABLE is high, $V_{OUT1}$ is active. |

## DEFINITION OF TERMS

**Current Limit** – Peak current that can be delivered to the output.

**Dropout Voltage** – The input–output voltage differential at which the circuit ceases to regulate against further reduction in input voltage. Measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V input, dropout voltage is dependent upon load current and junction temperature.

**Input Output Differential** – The voltage difference between the unregulated input voltage and the regulated output voltage for which the regulator will operate.

**Input Voltage** – The DC voltage applied to the input terminals with respect to ground.

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

**Load Regulation** – The change in output voltage for a change in load current at constant chip temperature.

**Long Term Stability** – Output voltage stability under accelerated life–test conditions after 1000 hours with maximum rated voltage and junction temperature.

**Quiescent Current** – The part of the positive input current that does not contribute to the positive load current, i.e., the regulator ground lead current.

**Ripple Rejection** – The ratio of the peak–to–peak input ripple voltage to the peak–to–peak output ripple voltage.

**Short Circuit Current Limit** – Peak current that can be delivered by the outPut when forced to 0 V.

**Temperature Stability of  $V_{OUT}$**  – The percentage change in output voltage for a thermal variation from room temperature to either temperature extreme.

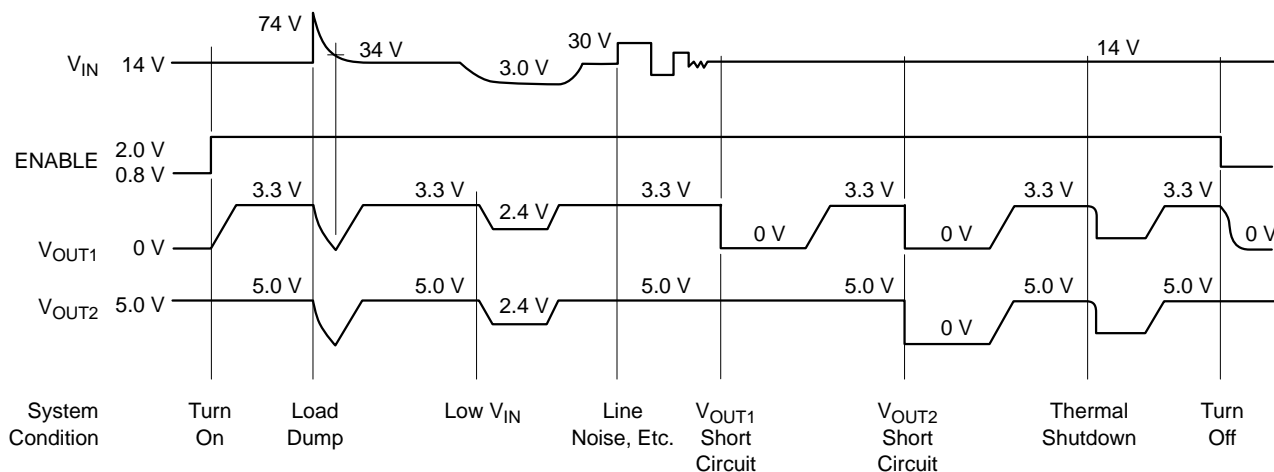


Figure 2. Typical Circuit Waveform

## APPLICATION NOTES

**General**

The CS8481 is a Micropower dual regulator. All bias required to operate the internal circuitry is derived from the standby output,  $V_{OUT2}$ . If this output experiences an over current situation and collapses, then  $V_{OUT1}$  will also collapse (see Figure 2).

If there is critical circuitry that must remain active under most conditions it should be connected to  $V_{OUT2}$ . Any circuitry that is likely to be subjected to a short circuit, e.g., circuitry outside the module, should be connected to  $V_{OUT1}$ .

**External Capacitors**

Output capacitors are required for stability with the CS8481. Without them, the regulator outputs will oscillate. Actual size and type may vary depending upon the application load and temperature range. Capacitor effective series resistance (ESR) is also a factor in the IC stability.

Worst–case is determined at the minimum ambient temperature and maximum load expected.

Output capacitors can be increased in size to any desired value above the minimum. One possible purpose of this would be to maintain the output voltages during brief conditions of negative input transients that might be characteristic of a particular system.

Capacitors must also be rated at all ambient temperatures expected in the system. To maintain regulator stability down to  $-40^{\circ}\text{C}$ , capacitors rated at that temperature must be used.

More information on capacitor selection for SMART REGULATOR®s is available in the SMART REGULATOR application note, “Compensation for Linear Regulators,” document number SR003AN/D, available through the Literature Distribution Center or via our website at <http://www.onsemi.com>.

**ENABLE**

The ENABLE function controls V<sub>OUT1</sub>. When ENABLE is high, V<sub>OUT1</sub> is on. When ENABLE is low, V<sub>OUT1</sub> is off.

**Calculating Power Dissipation in a Dual Output Linear Regulator**

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

$$P_{D(max)} = (V_{IN(max)} - V_{OUT1(min)})I_{OUT1(max)} + (V_{IN(max)} - V_{OUT2(min)})I_{OUT2(max)} + V_{IN(max)}I_Q \quad (1)$$

where:

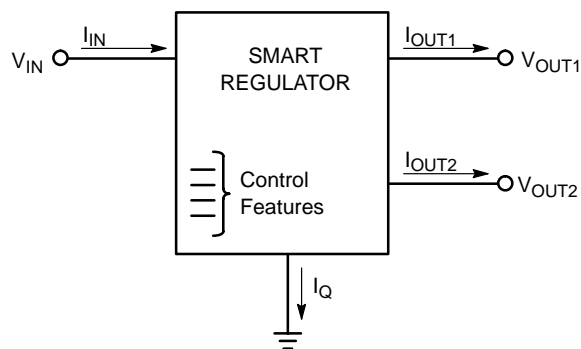
- V<sub>IN(max)</sub> is the maximum input voltage,
- V<sub>OUT1(min)</sub> is the minimum output voltage from V<sub>OUT1</sub>,
- V<sub>OUT2(min)</sub> is the minimum output voltage from V<sub>OUT2</sub>,
- I<sub>OUT1(max)</sub> is the maximum output current, for the application,
- I<sub>OUT2(max)</sub> is the maximum output current, for the application, and
- I<sub>Q</sub> is the quiescent current the regulator consumes at both I<sub>OUT1(max)</sub> and I<sub>OUT2(max)</sub>.

Once the value of P<sub>D(max)</sub> is known, the maximum permissible value of R<sub>θJA</sub> can be calculated:

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

The value of R<sub>θJA</sub> can be compared with those in the package section of the data sheet. Those packages with R<sub>θJA</sub>'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 heatsink will be required.



**Figure 3. Dual Output Regulator With Key Performance Parameters Labeled.**

**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.

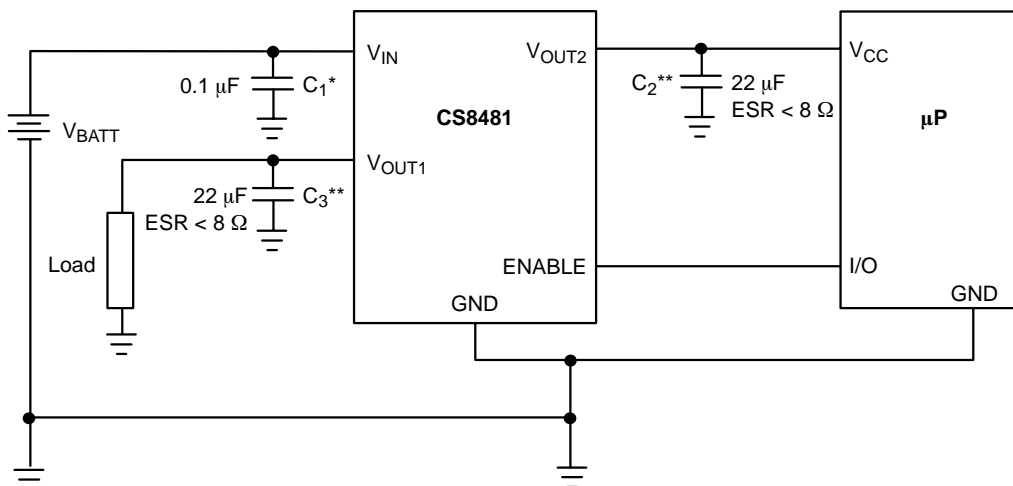
Each material in the heat flow path between the IC and the outside environment will have a thermal resistance. Like series electrical resistances, these resistances are summed to determine the value of R<sub>θJA</sub>:

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

where:

- R<sub>θJC</sub> = the junction-to-case thermal resistance,
- R<sub>θCS</sub> = the case-to-heatsink thermal resistance, and
- R<sub>θSA</sub> = the heatsink-to-ambient thermal resistance.

R<sub>θJC</sub> appears in the package section of the data sheet. Like R<sub>θJA</sub>, it too is a function of package type. R<sub>θCS</sub> and R<sub>θSA</sub> are functions of the package type, heatsink and the interface between them. These values appear in heat sink data sheets of heat sink manufacturers.



\* C<sub>1</sub> required if regulator is located far from power supply filter.

\*\* C<sub>2</sub> and C<sub>3</sub> required for stability. Capacitor must operate at minimum temperature expected during system operations.

**Figure 4. Test and Application Circuit**

PACKAGE DIMENSIONS

D<sup>2</sup>PAK-5  
 DP SUFFIX  
 CASE 936AC-01  
 ISSUE O


# For D<sup>2</sup>PAK Outline and Dimensions – Contact Factory

PACKAGE THERMAL DATA

| Parameter        |         | D <sup>2</sup> PAK-5 | Unit |
|------------------|---------|----------------------|------|
| R <sub>θJC</sub> | Typical | 2.4                  | °C/W |
| R <sub>θJA</sub> | Typical | 10-50*               | °C/W |

\* Depending on thermal properties of substrate.  $R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$

SMART REGULATOR is a registered trademark of Semiconductor Components Industries, LLC (SCILLC).

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  
**Japan:** ON Semiconductor, Japan Customer Focus Center  
 2-9-1 Kamimeguro, Meguro-ku, Tokyo, Japan 153-0051  
**Phone:** 81-3-5773-3850

**ON Semiconductor Website:** <http://onsemi.com>  
**Order Literature:** <http://www.onsemi.com/litorder>  
 For additional information, please contact your local Sales Representative.