



June 2005

LMS1585A/LMS1587

5A and 3A Low Dropout Fast Response Regulators

General Description

The LMS1585A and LMS1587 are low dropout positive regulators with output load current of 5A and 3A respectively. Their low dropout voltage (1.2V) and fast transient response make them an excellent solution for low voltage microprocessor applications.

The LMS1585A/87 are available in adjustable versions, which can set the output voltage with only two external resistors. In addition, they are also available in 1.5V and 3.3V fixed voltage versions (Note 9).

The LMS1585A/87 circuits include a zener trimmed bandgap reference, current limiting and thermal shutdown.

The LMS1585A/87 series are available in TO-220 and TO-263 packages.

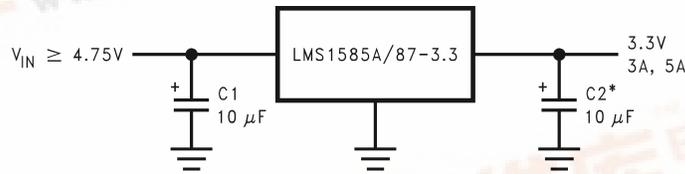
Features

- Fast transient response
- Available in Adjustable, 1.5V, and 3.3V versions
- Current limiting and thermal protection
- Commercial temp. range 0°C to 125°C
- Industrial temp. range -40°C to 125°C
- Line regulation 0.005% (typical)
- Load regulation 0.05% (typical)
- Direct replacement for LT™1585A/87

Applications

- Pentium™ processor supplies
- PowerPC™ supplies
- Other microprocessor supplies
- Low voltage logic supplies

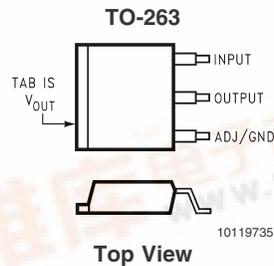
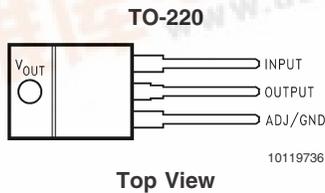
Typical Application



* REQUIRED FOR STABILITY

10119701

Connection Diagrams



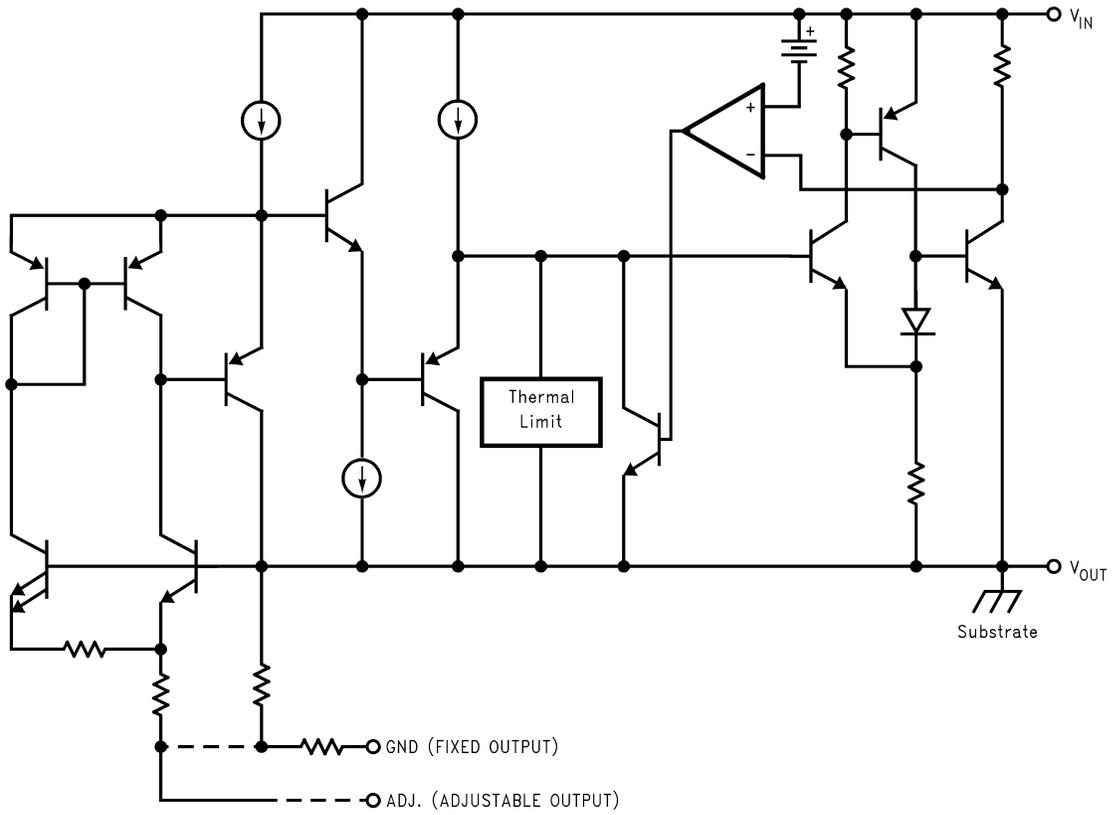
LMS1585A/LMS1587 5A Low Dropout Fast Response Regulators



Ordering Information

| Output Current | Package | Temperature Range | Part Number | Transport Media | NSC Drawing |
|----------------|---------|-------------------|-----------------|-----------------|-------------|
| 3A | TO-263 | 0°C to 125°C | LMS1587CS-ADJ | Rails | TS3B |
| | | | LMS1587CSX-ADJ | Tape and Reel | |
| | | | LMS1587CS-1.5 | Rails | |
| | | | LMS1587CSX-1.5 | Tape and Reel | |
| | | | LMS1587CS-3.3 | Rails | |
| | | | LMS1587CSX-3.3 | Tape and Reel | |
| | | -40°C to 125°C | LMS1587IS-ADJ | Rails | |
| | | | LMS1587ISX-ADJ | Tape and Reel | |
| | | | LMS1587IS-1.5 | Rails | |
| | | | LMS1587ISX-1.5 | Tape and Reel | |
| | | | LMS1587IS-3.3 | Rails | |
| | | | LMS1587ISX-3.3 | Tape and Reel | |
| | TO-220 | 0°C to 125°C | LMS1587CT-ADJ | Rails | T03B |
| | | | LMS1587CT-1.5 | Rails | |
| LMS1587CT-3.3 | | | Rails | | |
| -40°C to 125°C | | LMS1587IT-ADJ | Rails | | |
| | | LMS1587IT-1.5 | Rails | | |
| | | LMS1587IT-3.3 | Rails | | |
| 5A | TO-263 | 0°C to 125°C | LMS1585ACS-ADJ | Rails | TS3B |
| | | | LMS1585ACSX-ADJ | Tape and Reel | |
| | | | LMS1585ACS-1.5 | Rails | |
| | | | LMS1585ACSX-1.5 | Tape and Reel | |
| | | | LMS1585ACS-3.3 | Rails | |
| | | | LMS1585ACSX-3.3 | Tape and Reel | |
| | | -40°C to 125°C | LMS1585AIS-ADJ | Rails | |
| | | | LMS1585AISX-ADJ | Tape and Reel | |
| | | | LMS1585AIS-1.5 | Rails | |
| | | | LMS1585AISX-1.5 | Tape and Reel | |
| | | | LMS1585AIS-3.3 | Rails | |
| | | | LMS1585AISX-3.3 | Tape and Reel | |
| | TO-220 | 0°C to 125°C | LMS1585ACT-ADJ | Rails | T03B |
| | | | LMS1585ACT-1.5 | Rails | |
| | | | LMS1585ACT-3.3 | Rails | |
| | | -40°C to 125°C | LMS1585AIT-ADJ | Rails | |
| | | | LMS1585AIT-1.5 | Rails | |
| | | | LMS1585AIT-3.3 | Rails | |

Simplified Schematic



10119714

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Maximum Input to Output Voltage
(V_{IN} to GND) 13V

Power Dissipation (Note 2)

Junction Temperature (T_J) (Note 2)

Storage Temperature Range

Lead Temperature

ESD Tolerance (Note 3)

Internally Limited

150°C

-65°C to 150°C

260°C, 10 sec

2000V

Electrical Characteristics

Typicals and limits appearing in normal type apply for $T_J = 25^\circ\text{C}$. Limits appearing in **Boldface** type apply over the entire junction temperature range for operation, 0°C to 125°C for commercial grade and -40°C to 125°C for industrial grade.

| Symbol | Parameter | Conditions | Min (Note 5) | Typ (Note 4) | Max (Note 5) | Units |
|------------------|-----------------------------|--|-----------------|-----------------|-----------------|-------|
| V_{REF} | Reference Voltage | LMS1585A-ADJ $V_{IN}-V_{OUT} = 3V$, $I_{OUT} = 10mA$ $10mA \leq I_{OUT} \leq 5A$, $1.5V \leq V_{IN}-V_{OUT} \leq 5.75V$ | 1.238 | 1.25 | 1.262 | V |
| | | | 1.225 | 1.250 | 1.275 | V |
| | | LMS1587-ADJ $10mA \leq I_{OUT} \leq 3A$, $1.5V \leq V_{IN}-V_{OUT} \leq 5.75V$ | 1.225 | 1.250 | 1.275 | V |
| V_{OUT} | Output Voltage | LMS1585A-1.5 $I_{OUT} = 0mA$, $V_{IN} = 5V$ $0 \leq I_{OUT} \leq 5A$, $3V \leq V_{IN} \leq 7V$ | 1.485 | 1.500 | 1.515 | V |
| | | | 1.470 | | 1.530 | V |
| | | LMS1585A-3.3 $I_{OUT} = 0mA$, $V_{IN} = 5V$ $0 \leq I_{OUT} \leq 5A$, $4.75V \leq V_{IN} \leq 7V$ | 3.267 | 3.300 | 3.333 | V |
| | | | 3.235 | 3.300 | 3.365 | V |
| | | LMS1587-1.5 $V_{IN} = 5V$, $I_{OUT} = 0mA$, $T_J = 25^\circ\text{C}$ $0 \leq I_{OUT} \leq 3A$, $3V \leq V_{IN} \leq 7V$ | 1.485 | 1.500 | 1.515 | V |
| | 1.470 | 1.500 | 1.530 | V | | |
| ΔV_{OUT} | Line Regulation (Note 6) | LMS1585A/87-ADJ $I_{OUT} = 10mA$, $2.75V \leq V_{IN} \leq 7V$ | | 0.005 | 0.2 | % |
| | | LMS1585A/87-3.3 $I_{OUT} = 0mA$, $4.75V \leq V_{IN} \leq 7V$ | | 0.005 | 0.2 | % |
| | | LMS1585A/87-1.5 $I_{OUT} = 0mA$, $3V \leq V_{IN} \leq 7V$ | | 0.005 | 0.2 | % |
| | | | | | | |
| ΔV_{OUT} | Load Regulation (Note 6) | LMS1585A-ADJ $V_{IN}-V_{OUT} = 3V$, $10mA \leq I_{OUT} \leq 5A$ | | 0.05 | 0.3 | % |
| | | | | 0.05 | 0.5 | |
| | | LMS1585A-1.5/LMS1585A-3.3 $V_{IN} = 5V$, $0 \leq I_{OUT} \leq 5A$ | | 0.05 | 0.3 | % |
| | | | | 0.05 | 0.5 | |
| | | LMS1587-ADJ $V_{IN}-V_{OUT} = 3V$, $10mA \leq I_{OUT} \leq 3A$ | | 0.05 | 0.3 | % |
| | | 0.05 | 0.5 | % | | |
| $V_{IN}-V_{OUT}$ | Dropout Voltage | LMS1585A-ADJ/LMS1587-ADJ $\Delta V_{REF} = 1\%$, $I_{OUT} = 3A$ | | 1.15 | 1.3 | V |
| | | LMS1585A-3.3/LMS1587-3.3/ LMS1585A-1.5/LMS1587-1.5 $\Delta V_{OUT} = 1\%$, $I_{OUT} = 3A$ | | 1.15 | 1.3 | V |
| | | LMS1585A-ADJ $\Delta V_{REF} = 1\%$, $I_{OUT} = 5A$ | | 1.2 | 1.4 | V |
| | | LMS1585A-1.5/LMS1585A-3.3 $\Delta V_{OUT} = 1\%$, $I_{OUT} = 5A$ | | 1.2 | 1.4 | V |
| | | | | | | |

Electrical Characteristics (Continued)

Typicals and limits appearing in normal type apply for $T_J = 25^\circ\text{C}$. Limits appearing in **Boldface** type apply over the entire junction temperature range for operation, 0°C to 125°C for commercial grade and -40°C to 125°C for industrial grade.

| Symbol | Parameter | Conditions | Min (Note 5) | Typ (Note 4) | Max (Note 5) | Units |
|-------------|--|--|-----------------|-----------------|-----------------|---------------------------|
| I_{LIMIT} | Current Limit | LMS1585A-ADJ/LMS1585A-3.3/LMS1585A-1.5 $V_{IN}-V_{OUT} = 5.5\text{V}$ | 5.0 | 6.6 | | A |
| | | LMS1587-ADJ/LMS1587-3.3/LMS1587-1.5 $V_{IN}-V_{OUT} = 5.5\text{V}$ | 3.1 | 4.3 | | A |
| | Minimum Load Current (Note 7) | LMS1585A/87-ADJ $1.5\text{V} \leq V_{IN}-V_{OUT} \leq 5.75\text{V}$ | | 2.0 | 10.0 | mA |
| | Quiescent Current | LMS1585A-3.3/LMS1587-3.3/ LMS1585A-1.5/LMS1587-1.5 $V_{IN} = 5\text{V}$ | | 7.0 | 13.0 | mA |
| | Thermal Regulation | $T_A = 25^\circ\text{C}$, 30ms Pulse | | 0.003 | | %/W |
| | Ripple Rejection | LMS1585A-ADJ $f_{RIPPLE} = 120\text{Hz}$, $V_{IN}-V_{OUT} = 3\text{V}$, $I_{OUT} = 5\text{A}$, $C_{OUT} = 25\mu\text{F}$ Tantalum | | 72 | | dB |
| | | LMS1585A-1.5 $f_{RIPPLE} = 120\text{Hz}$, $C_{OUT} = 25\mu\text{F}$ Tantalum, $I_{OUT} = 5\text{A}$, $V_{IN} = 4.5\text{V}$ | 60 | 72 | | dB |
| | | LMS1585A-3.3 $f_{RIPPLE} = 120\text{Hz}$, $C_{OUT} = 25\mu\text{F}$ Tantalum, $I_{OUT} = 5\text{A}$, $V_{IN} = 6.3\text{V}$ | | 72 | | dB |
| | | LMS1587-ADJ $f_{RIPPLE} = 120\text{Hz}$, $V_{IN}-V_{OUT} = 3\text{V}$, $I_{OUT} = 3\text{A}$ $C_{OUT} = 25\mu\text{F}$ Tantalum | | 72 | | dB |
| | | LMS1587-1.5 $f_{RIPPLE} = 120\text{Hz}$, $C_{OUT} = 25\mu\text{F}$ Tantalum, $I_{OUT} = 3\text{A}$, $V_{IN} = 4.5\text{V}$ | 60 | 72 | | dB |
| | | LMS1587-3.3 $f_{RIPPLE} = 120\text{Hz}$, $C_{OUT} = 25\mu\text{F}$ Tantalum, $I_{OUT} = 3\text{A}$, $V_{IN} = 6.3\text{V}$ | | 72 | | dB |
| | Adjust Pin Current | | | 55 | 120 | μA |
| | Adjust Pin Current | $10\text{mA} \leq I_{OUT} \leq I_{FULLLOAD}$, $1.5\text{V} \leq V_{IN}-V_{OUT} \leq 5.75\text{V}$ (Note 8) | | 0.2 | | μA |
| | Temperature Stability | | | 0.5 | | % |
| | Long Term Stability | $T_A = 125^\circ\text{C}$, 1000Hrs | | 0.03 | | % |
| | RMS Output Noise (% of V_{OUT}) | $10\text{Hz} \leq f \leq 10\text{kHz}$ | | 0.003 | | % |
| | Thermal Resistance Junction-to-Case | 3-Lead TO-263: Control/Output Section | | | 0.65/2.7 | $^\circ\text{C}/\text{W}$ |
| | | 3-Lead TO-220: Control/Output Section | | | 0.65/2.7 | $^\circ\text{C}/\text{W}$ |

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

Note 2: The maximum power dissipation is a function of $T_{J(max)}$, θ_{JA} , and T_A . The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(max)} - T_A) / \theta_{JA}$. All numbers apply for packages soldered directly into a PC board.

Note 3: For testing purposes, ESD was applied using human body model, $1.5\text{k}\Omega$ in series with 100pF .

Note 4: Typical Values represent the most likely parametric norm.

Note 5: All limits are guaranteed by testing or statistical analysis.

Note 6: Load and line regulation are measured at constant junction temperature, and are guaranteed up to the maximum power dissipation of 30W . Power dissipation is determined by the input/output differential and the output current. Guaranteed maximum power dissipation will not be available over the full input/output range.

Note 7: The minimum output current required to maintain regulation.

Note 8: $I_{FULLLOAD}$ is 5A for LMS1585A and 3A for LMS1587.

Note 9: Consult factory for other fixed voltage options.

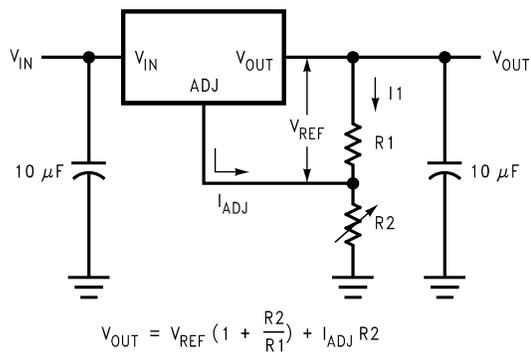
Application Note

OUTPUT VOLTAGE

The adjustable version develops at 1.25V reference voltage, (V_{REF}), between the output and the adjust terminal. As shown in *Figure 1*, this voltage is applied across resistor R1 to generate a constant current I1. This constant current then flows through R2. The resulting voltage drop across R2 adds to the reference voltage to sets the desired output voltage.

The current I_{ADJ} from the adjustment terminal introduces an output error. But since it is small (120 μ A max), it becomes negligible when R1 is in the 100 Ω range.

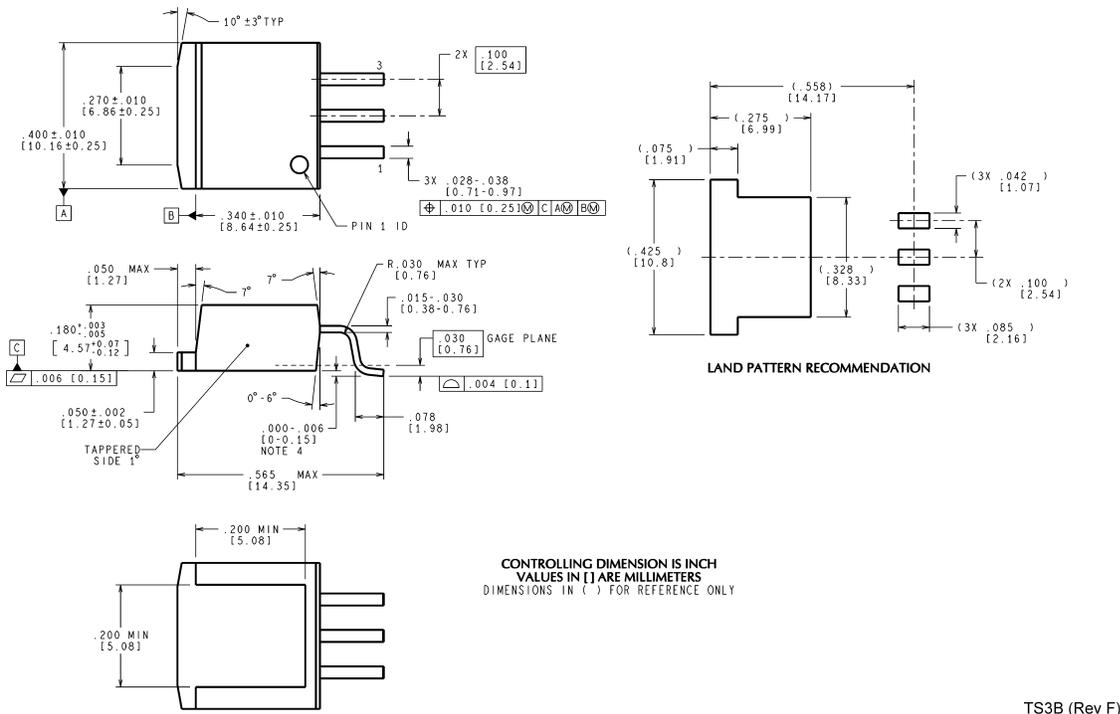
For fixed voltage devices, R1 and R2 are integrated inside the devices.



10119772

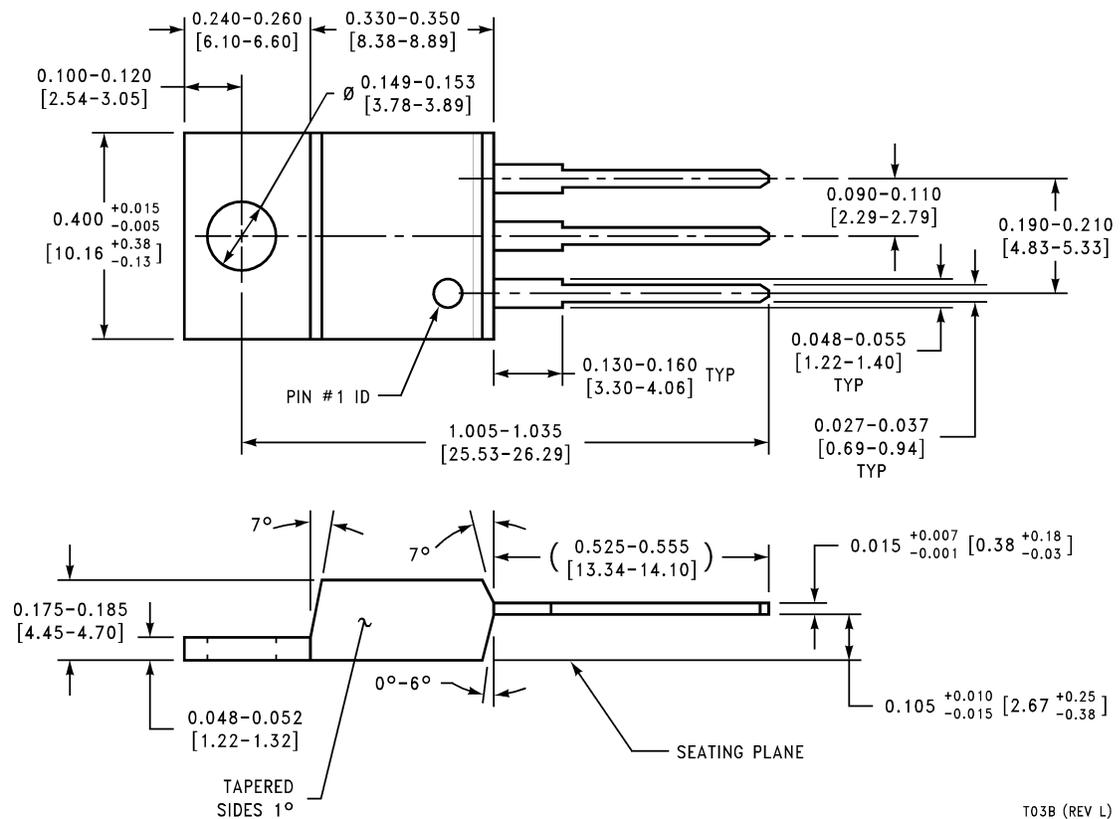
FIGURE 1. Basic Adjustable Regulator

Physical Dimensions inches (millimeters)
unless otherwise noted



3-Pin TO-263
NS Package Number TS3B

TS3B (Rev F)



3-Pin TO-220
NS Package Number T03B

T03B (REV L)

Notes

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

For the most current product information visit us at www.national.com.

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

BANNED SUBSTANCE COMPLIANCE

National Semiconductor manufactures products and uses packing materials that meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no "Banned Substances" as defined in CSP-9-111S2.

Leadfree products are RoHS compliant.



**National Semiconductor
Americas Customer
Support Center**
Email: new.feedback@nsc.com
Tel: 1-800-272-9959

**National Semiconductor
Europe Customer Support Center**
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

**National Semiconductor
Asia Pacific Customer
Support Center**
Email: ap.support@nsc.com

**National Semiconductor
Japan Customer Support Center**
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com
Tel: 81-3-5639-7560