

National Semiconductor is now part of
Texas Instruments.

Search <http://www.ti.com/> for the latest technical
information and details on our current products and services.

RS-485/RS-422 Quad Differential Line Drivers

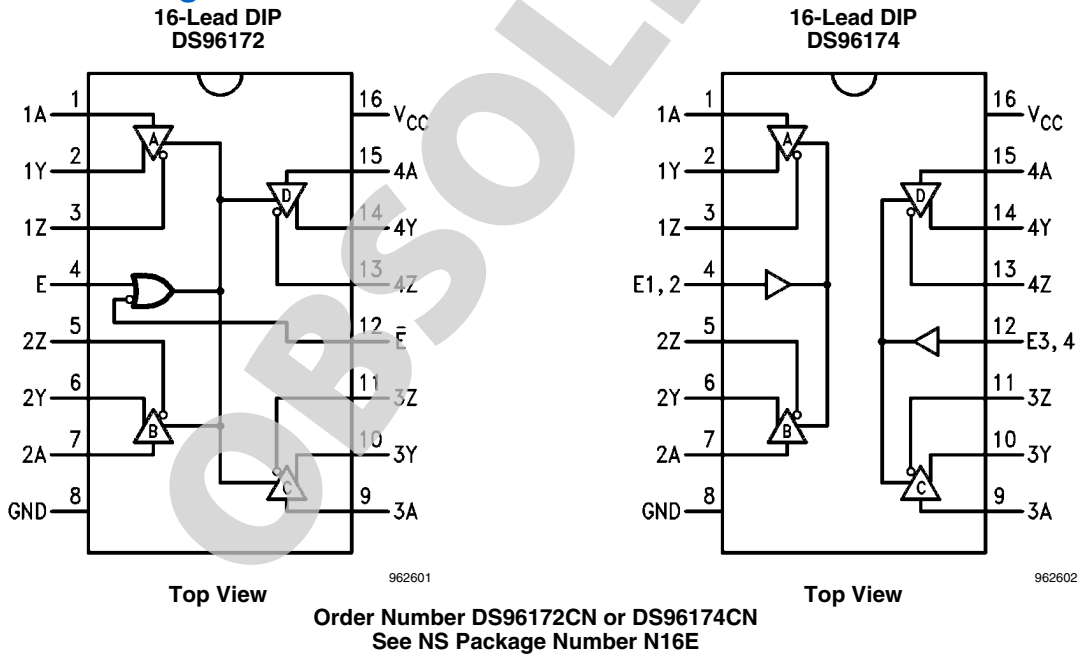
General Description

The DS96172 and DS96174 are high speed quad differential line drivers designed to meet EIA Standard RS-485. The devices have TRI-STATE® outputs and are optimized for balanced multipoint data bus transmission at rates up to 10 Mbps. The drivers have wide positive and negative common mode range for multipoint applications in noisy environments. Positive and negative current-limiting is provided which protects the drivers from line fault conditions over a +12V to -7.0V common mode range. A thermal shutdown feature is also provided and occurs at junction temperature of approximately 160°C. The DS96172 features an active high and active low Enable, common to all four drivers. The DS96174 features separate active high Enables for each driver pair. Compatible RS-485 receivers, transceivers, and repeaters are also offered to provide optimum bus performance. The respective device types are DS96173, DS96175, DS96176 AND DS96177.

Features

- Meets EIA Standard RS-485 and RS-422A
- Monotonic differential output switching
- Transmission rate to 10 Mbps
- TRI-STATE outputs
- Designed for multipoint bus transmission
- Common mode output voltage range: -7V to +12V
- Operates from single +5V supply
- Thermal shutdown protection
- DS96172/DS96174 are lead and function compatible with the SN75172/75174 or the AM26LS31/MC3487 respectively

Connection Diagrams



TRI-STATE® is a registered trademark of National Semiconductor Corporation.

Absolute Maximum Ratings (Note 2)

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

| | |
|---------------------------------|-----------------|
| Storage Temperature Range | |
| Molded DIP | -65°C to +150°C |
| Operating Temperature Range | 0°C to +70°C |
| Lead Temperature | |
| Molded DIP (soldering, 10 sec.) | 265°C |
| Supply Voltage | 7V |
| Enable Input Voltage | 5.5V |

Maximum Power Dissipation
(Note 1)

N-Molded Package

25°C

1.98W

Recommended Operating Conditions

| | Min | Typ | Max | Units |
|---|------|-----|------|-------|
| Supply Voltage (V_{CC}) | 4.75 | 5 | 5.25 | V |
| Common Mode Output Voltage (V_{OC}) | -7 | | +12 | V |
| Output Current HIGH (I_{OH}) | | | -60 | mA |
| Output Current LOW (I_{OL}) | | | 60 | mA |
| Operating Temperature (T_A) | 0 | 25 | 70 | °C |

Note 1: Derate molded DIP package 16mW/°C above 25°C.

Electrical Characteristics (Note 3, Note 4)

over recommended temperature and supply voltage ranges, unless otherwise specified

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|------------------|---|--|-----|----------|-----------|---------|
| V_{IH} | Input Voltage HIGH | | 2 | | | V |
| V_{IL} | Input Voltage LOW | | | | 0.8 | V |
| V_{OH} | Output Voltage HIGH | $I_{OH} = -20$ mA | | 3.1 | | V |
| V_{OL} | Output Voltage LOW | $I_{OL} = 20$ mA | | 0.8 | | V |
| V_{IC} | Input Clamp Voltage | $I_I = -18$ mA | | | -1.5 | V |
| $ V_{OD1} $ | Differential Output Voltage | $I_O = 0$ mA | | | 6 | V |
| $ V_{OD2} $ | Differential Output Voltage | $R_L = 54\Omega$, Figure 1 | 1.5 | 2 | | V |
| | | $R_L = 100\Omega$, Figure 1 | 2 | 2.3 | | V |
| $\Delta V_{OD} $ | Change in Magnitude of Differential Output Voltage (Note 5) | $R_L = 54\Omega$ or 100Ω , Figure 1 | | | ± 0.2 | V |
| V_{OC} | Common Mode Output Voltage (Note 6) | $R_L = 54\Omega$, Figure 1 | | | 3 | V |
| $\Delta V_{OC} $ | Change in Magnitude of Common Mode Output Voltage (Note 5) | | | | ± 0.2 | V |
| I_O | Output Current with Power Off | $V_{CC} = 0V$, $V_O = -7.0V$ to $12V$ | | | ± 100 | μA |
| I_{OZ} | High Impedance State Output Current | $V_O = -7.0V$ to $12V$ | | ± 50 | ± 200 | μA |
| I_{IH} | Input Current HIGH | $V_I = 2.7V$ | | | 20 | μA |
| I_{IL} | Input Current LOW | $V_I = 0.5V$ | | | -100 | μA |
| I_{OS} | Short Circuit Output Current (Note 7) | $V_O = -7.0V$ | | | -250 | mA |
| | | $V_O = 0V$ | | | -150 | |
| | | $V_O = V_{CC}$ | | | 150 | |
| | | $V_O = 12V$ | | | 250 | |
| I_{CC} | Supply Current (All Drivers) | No Load | | | | mA |
| | | Outputs Enabled | | 50 | 70 | |
| | | Output Disabled | | 50 | 60 | |

Switching Characteristics

$V_{CC} = 5V$, $T_A = 25^\circ C$

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------|---|-------------------------------------|-----|-----|-----|-------|
| t_{DD} | Differential Output Delay Time | $R_L = 60\Omega$, <i>Figure 2</i> | | 15 | 25 | ns |
| t_{TD} | Differential Output Transition Time | | | 15 | 25 | ns |
| t_{PLH} | Propagation Delay Time, Low-to-High Level Output | $R_L = 27\Omega$, <i>Figure 3</i> | | 12 | 20 | ns |
| t_{PHL} | Propagation Delay Time, High-to-Low Level Output | | | 12 | 20 | ns |
| t_{PZH} | Output Enable Time to High Level | $R_L = 110\Omega$, <i>Figure 4</i> | | 30 | 45 | ns |
| t_{PZL} | Output Enable Time to Low Level | $R_L = 110\Omega$, <i>Figure 5</i> | | 30 | 45 | ns |
| t_{PHZ} | Output Disable Time from High Level | $R_L = 110\Omega$, <i>Figure 4</i> | | 25 | 35 | ns |
| t_{PLZ} | Output Disable Time from Low Level | $R_L = 110\Omega$, <i>Figure 5</i> | | 30 | 45 | ns |

Note 2: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.

Note 3: Unless otherwise specified min/max limits apply across the $0^\circ C$ to $+70^\circ C$ range for the DS96172/DS96174. All typicals are given for $V_{CC} = 5V$ and $T_A = 25^\circ C$.

Note 4: All currents into the device pins are positive; all currents out of the device pins are negative. All voltages are referenced to ground unless otherwise specified.

Note 5: $\Delta |V_{OD}|$ and $\Delta |V_{OC}|$ are the changes in magnitude of V_{OD} and V_{OC} respectively, that occur when the input is changed from a high level to a low level.

Note 6: In EIA Standards RS-422A and RS-485, V_{OC} , which is the average of the two output voltages with respect to ground, is called output offset voltage, V_{OS} .

Note 7: Only one output at a time should be shorted.

Parameter Measurement Information

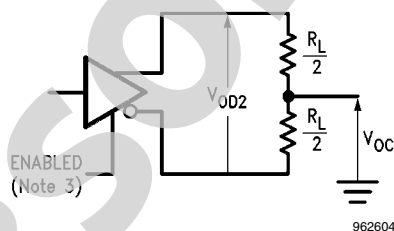


FIGURE 1. Differential and Common Mode Output Voltage

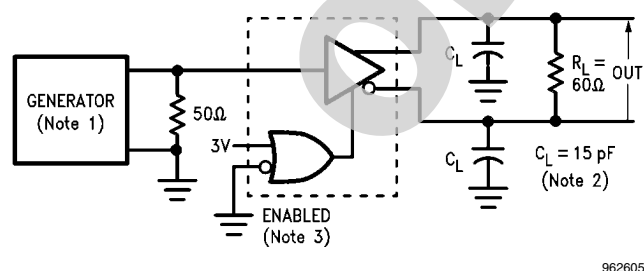
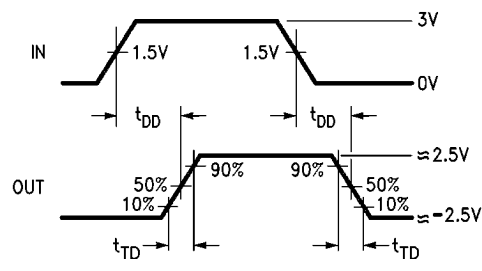


FIGURE 2. Differential Output Delay and Transition Times



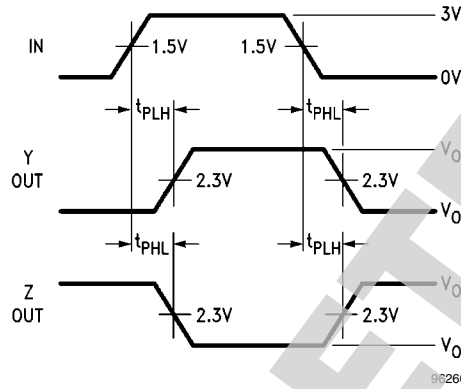
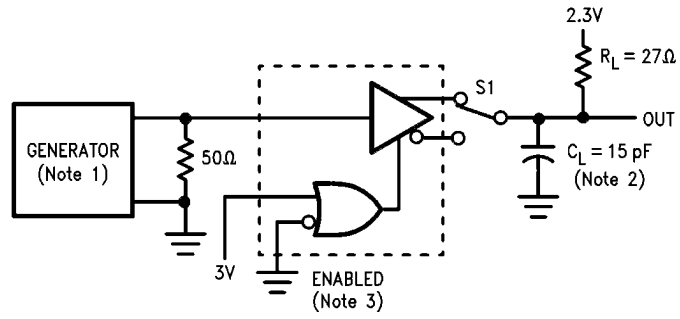


FIGURE 3. Propagation Delay Times

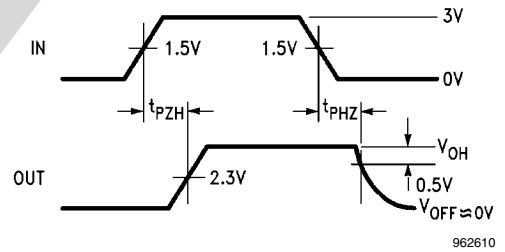
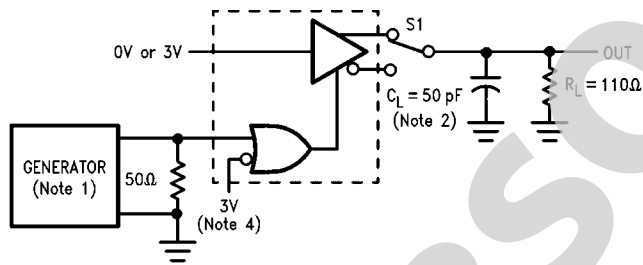


FIGURE 4. t_{PZH} and t_{PHZ}

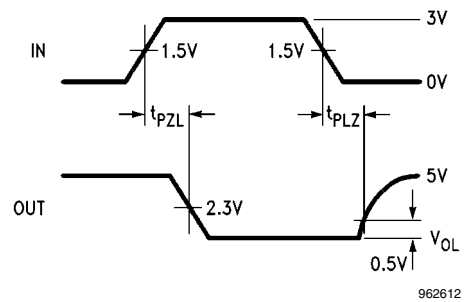
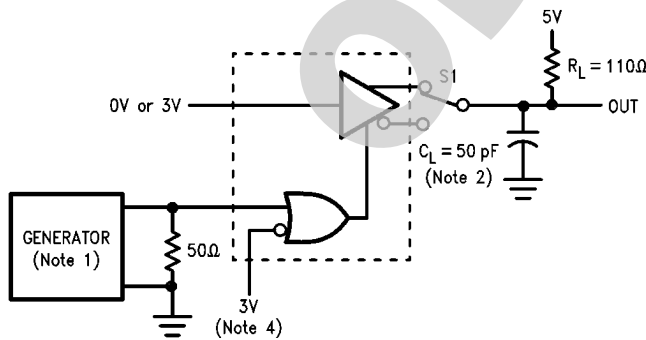


FIGURE 5. t_{PZL} and t_{PLZ}

- Note 8:** The input pulse is supplied by a generator having the following characteristics: PRR = 1.0 MHz, duty cycle = 50%, $t_r \leq 5.0$ ns, $t_f \leq 5.0$ ns, $Z_0 = 50\Omega$.
- Note 9:** C_L includes probe and jig capacitance.
- Note 10:** DS96172 with active high and active low Enables is shown here. DS96174 has active high Enable only.
- Note 11:** To test the active low Enable \bar{E} of DS96172, ground E and apply an inverted waveform to \bar{E} . DS96174 has active high Enable only.

Function Tables

DS96172

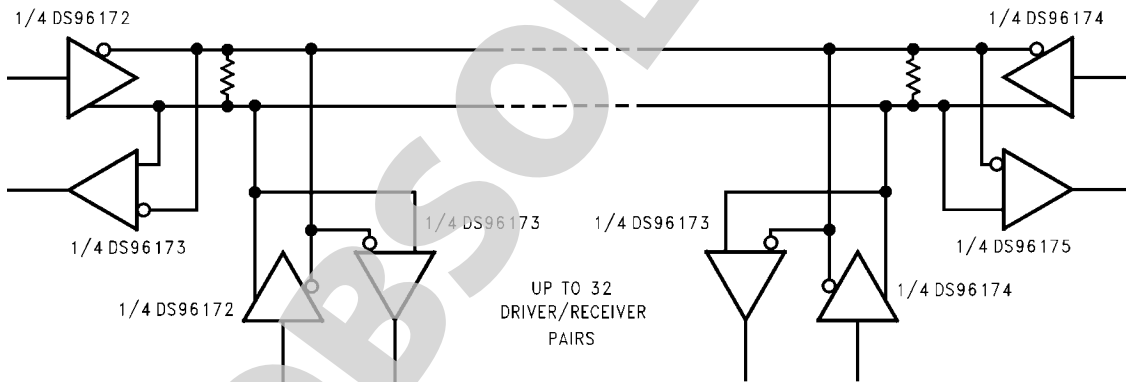
| Input A | Enables | | Outputs | |
|------------|---------|-----------|---------|---|
| | E | \bar{E} | Y | Z |
| H | H | X | H | L |
| L | H | X | L | H |
| H | X | L | H | L |
| L | X | L | L | H |
| X | L | H | Z | Z |

DS96174

| Input | Enable | Outputs | |
|-------|--------|---------|---|
| | | Y | Z |
| H | H | H | L |
| L | H | L | H |
| X | L | Z | Z |

H = High Level
 X = Immaterial
 L = Low Level
 Z = High Impedance (off)

Typical Application

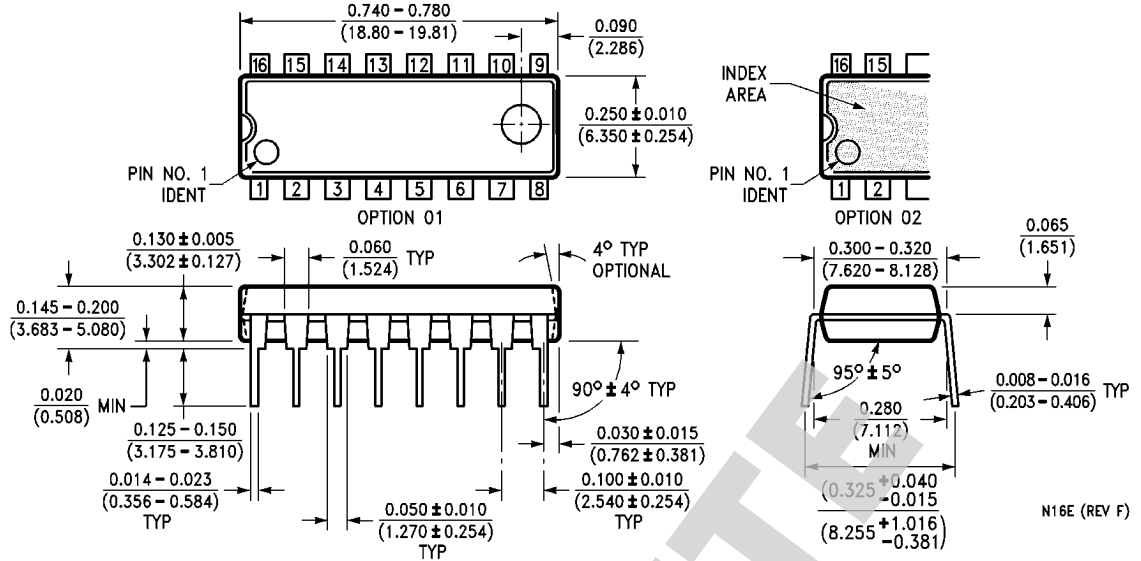


Note: The line length should be terminated at both ends in its characteristic impedance. Stub lengths off the main line should be kept as short as possible.

962613

FIGURE 6.

Physical Dimensions inches (millimeters) unless otherwise noted



Molded Dual-In-Line Package (N)
Order Number DS96172CN or DS96174CN
NS Package Number N16E

N16E (REV F)

OBSOLETE

OBSOLETE

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:
www.national.com

| Products | | Design Support | |
|--------------------------------|--|------------------------------|--|
| Amplifiers | www.national.com/amplifiers | WEBENCH® Tools | www.national.com/webench |
| Audio | www.national.com/audio | App Notes | www.national.com/appnotes |
| Clock and Timing | www.national.com/timing | Reference Designs | www.national.com/refdesigns |
| Data Converters | www.national.com/adc | Samples | www.national.com/samples |
| Interface | www.national.com/interface | Eval Boards | www.national.com/evalboards |
| LVDS | www.national.com/lvds | Packaging | www.national.com/packaging |
| Power Management | www.national.com/power | Green Compliance | www.national.com/quality/green |
| Switching Regulators | www.national.com/switchers | Distributors | www.national.com/contacts |
| LDOs | www.national.com/ldo | Quality and Reliability | www.national.com/quality |
| LED Lighting | www.national.com/led | Feedback/Support | www.national.com/feedback |
| Voltage References | www.national.com/vref | Design Made Easy | www.national.com/easy |
| PowerWise® Solutions | www.national.com/powerwise | Applications & Markets | www.national.com/solutions |
| Serial Digital Interface (SDI) | www.national.com/sdi | Mil/Aero | www.national.com/milaero |
| Temperature Sensors | www.national.com/tempensors | SolarMagic™ | www.national.com/solarmagic |
| PLL/VCO | www.national.com/wireless | PowerWise® Design University | www.national.com/training |

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

LIFE SUPPORT POLICY

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

Life support devices or systems are devices 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. A critical component is any component in 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.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2011 National Semiconductor Corporation

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



www.national.com

**National Semiconductor
Americas Technical
Support Center**
Email: support@nsc.com
Tel: 1-800-272-9959

**National Semiconductor Europe
Technical Support Center**
Email: europe.support@nsc.com

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

**National Semiconductor Japan
Technical Support Center**
Email: jpn.feedback@nsc.com