National Semiconductor

October 1996

DS485
Low Power RS-485/RS-422 Multipoint Transceiver

General Description

The DS485 is a low-power transceiver for RS-485 and RS-422 communication. The device contains one driver and one receiver. The drivers slew rate allows for operation up to 2.5 Mbps (see Applications Information section).

The transceiver draws 200 μA of supply current when unloaded or fully loaded with the driver disabled and operates from a single +5V supply.

The driver is short-circuit current limited and is protected against excessive power dissipation by thermal shutdown circuitry that places the driver outputs into TRI-STATE® (High Impedance state) under fault conditions. The driver guarantees a minimum of 1.5V differential output voltage with maximum loading across the common mode range (V_{OD3}).

The receiver has a failsafe feature that guarantees a logic-high output if the input is open circuit.

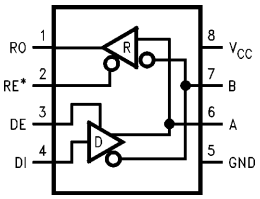
The DS485 is available in surface mount and DIP packages and is characterized for Industrial and Commercial temperature range operation.

Features

- Meets TIA/EIA RS-485 multipoint standard
- Guaranteed full load output voltage (V_{OD3})
- Low quiescent current 200 μA typ
- −7V to +12V common-mode input voltage range
- TRI-STATE outputs on driver and receiver
- AC performance:
  - — Driver transition time 25 ns typ
  - — Driver propagation delay 40 ns typ
  - — Driver skew 1 ns typ
  - — Receiver propagation delay 200 ns typ
  - — Receiver skew 20 ns typ
- Half-duplex flow through pinout
- Operates from a single 5V supply
- Allows up to 32 transceivers on the bus
- Current-limiting and thermal shutdown for driver overload protection
- Industrial temperature range operation
- Pin and functional compatible with MAX485 and LTC485

Connection and Logic Diagram

DIP and SOIC



TL/F/12880–1

Order Number	Temp. Range	Package/# # #
DS485N	0°C to +70°C	DIP/N08E
DS485M	0°C to +70°C	SOP/M08A
DS485TN	−40°C to +85°C	DIP/N08E
DS485TM	−40°C to +85°C	SOP/M08A

Truth Table

DRIVER SECTION				
RE*	**DE**	**DI**	**A**	**B**
X	H	H	H	L
X	H	L	L	H
X	L	X	Z	Z
RECEIVER SECTION				
RE*	**DE**	**A-B**		**RO**
L	L	≥ +0.2V		H
L	L	≤ −0.2V		L
H	X	X		Z
L	L	OPEN*		H

*Note: Non Terminated, Open Input only

X = indeterminate

Z = TRI-STATE

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

Absolute Maximum Ratings (Note 1)

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

Supply Voltage (V_{CC})	+12V
Enable Input Voltage (RE*, DE)	−0.5V to (V_{CC} + 0.5V)
Driver Input Voltage (DI)	−0.5V to (V_{CC} + 0.5V)
Driver Output Voltage (A, B)	−14V to +14V
Receiver Input Voltage (A, B)	−14V to +14V
Receiver Output Voltage (RO)	−0.5V to (V_{CC} + 0.5V)
Maximum Package Power Dissipation @ +25°C	
M Package	1.19W
N Package	0.74W
Derate M Package 9.5 mW/°C above +25°C	
Derate N Package 6.0 mW/°C above +25°C	
Maximum Package Power Dissipation @ +70°C	
M Package	0.76W
N Package	0.47W
Storage Temperature Range	−65°C to +150°C
Lead Temperature Range (Soldering, 4 sec.)	+260°C
ESD (HBM)	≥2 kV

Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage (V_{CC})	+4.75	+5.0	+5.25	V
Operating Free Air Temperature (T_A)				
DS485	0	+25	+70	°C
DS485T	−40	+25	+85	°C
Bus Common Mode Voltage	−7		+12	V

Electrical Characteristics

Over Supply Voltage and Operating Temperature Ranges, unless otherwise specified (Notes 2, 3)

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units
V_{OD1}	Differential Driver Output Voltage	(No Load)	A, B			5	V
V_{OD2}	Differential Driver Output Voltage with Load	R_L = 50Ω, (RS422), *Figure 1*		2	2.8		V
		R_L = 27Ω, (RS485), *Figure 1*		1.5	2.3	5	V
ΔV_{OD}	Change in Magnitude of Output Differential Voltage	R_L = 27Ω or 50Ω (Note 4)				0.2	|V|
V_{OD3}	Differential Driver Output Voltage—Full Load with Max V_{CM}	R1 = 54Ω, R2 = 375Ω V_{TEST} = −7V to +12V, *Figure 2*		1.5	2.0	5	V
V_{OC}	Driver Common-Mode Output Voltage	R_L = 27Ω or 50Ω, *Figure 1*				3	V
ΔV_{OC}	Change in Magnitude of Common-Mode Output Voltage	R_L = 27Ω or 50Ω, *Figure 1* (Note 4)				0.2	|V|
V_{IH}	Input High Voltage		DI, DE, RE*	2.0			V
V_{IL}	Input Low Voltage					0.8	V
I_{IN1}	Input Current	V_{IN} = 0V or V_{CC}				±2	μA
I_{IN2}	Input Current (Note 5) DE = 0V, V_{CC} = 0V or 5.25V	V_{IN} = +12V	A, B			1.0	mA
		V_{IN} = −7V				−0.8	mA
V_{TH}	Receiver Differential Threshold Voltage	−7V ≤ V_{CM} ≤ +12V		−0.2		0.2	V
ΔV_{TH}	Receiver Input Hysteresis	V_{CM} = 0V			70		mV
V_{OH}	Receiver Output High Voltage	I_O = −4 mA, V_{ID} = 0.2V	RO	3.5			V
V_{OL}	Receiver Output Low Voltage	I_O = 4 mA, V_{ID} = −0.2V				0.4	V
I_{OZR}	TRI-STATE Output Current at Receiver	0.4V ≤ V_O ≤ 2.4V				±1	μA
R_{IN}	Receiver Input Resistance	−7V ≤ V_{IN} ≤ +12V	A, B	12			kΩ
I_{CC}	No-Load Supply Current (Note 6)	DE = V_{CC}, RE* = 0V or V_{CC}	V_{CC}		200	900	μA
		DE = 0V, RE* = 0V or V_{CC}			200	500	μA
I_{OSD1}	Driver Short Circuit Current, V_O = HIGH	−7V ≤ V_O ≤ +12V	A, B	35		250	mA
I_{OSD2}	Driver Short Circuit Current, V_O = LOW	−7V ≤ V_O ≤ +12V		35		250	mA
I_{OSR}	Receiver Short Circuit Current	0V ≤ V_O ≤ V_{CC}	RO	7		85	mA

Switching Characteristics

Over Supply Voltage and Operating Temperature Ranges, unless otherwise specified (Notes 3, 7 and 8)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PLHD}	Driver Differential Propagation Delay—Low to High	$R_L = 54\Omega$, $C_L = 100$ pF	10	40	65	ns
t_{PHLD}	Driver Differential Propagation Delay—High to Low		10	39	65	ns
t_{SKEW}	Differential Skew $\lvert t_{PHLD} - t_{PLHD} \rvert$			1	10	ns
t_r	Driver Rise Time		3	25	40	ns
t_f	Driver Fall Time		3	25	40	ns
t_{ZH}	Driver Enable to Output High	$C_L = 100$ pF			170	ns
t_{ZL}	Driver Enable to Output Low	$C_L = 100$ pF			170	ns
t_{LZ}	Driver Disable from Output Low	$C_L = 15$ pF			170	ns
t_{HZ}	Driver Disable from Output High	$C_L = 15$ pF			170	ns
t_{PLHD}	Receiver Differential Propagation Delay—Low to High	$C_L = 15$ pF (RO)	70	190	320	ns
t_{PHLD}	Receiver Differential Propagation Delay—High to Low		70	210	320	ns
t_{SKEW}	Differential Skew $\lvert t_{PHLD} - t_{PLHD} \rvert$			20	50	ns
t_{ZH}	Receiver Enable to Output High	$C_L = 15$ pF			110	ns
t_{ZL}	Receiver Enable to Output Low				110	ns
t_{LZ}	Receiver Disable from Output Low				110	ns
t_{HZ}	Receiver Disable from Output High				110	ns
f_{max}	Maximum Data Rate	(Note 9)	2.5			Mbps

Note 1: "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 table of "Electrical Characteristics" specifies conditions of device operation.

Note 2: Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except $V_{OD1/2/3}$ and V_{ID}.

Note 3: All typicals are given for: $V_{CC} = +5.0$V, $T_A = +25$°C.

Note 4: $\Delta|V_{OD}|$ and $\Delta|V_{OC}|$ are changes in magnitude of V_{OD} and V_{OC} respectively, that occur when the input changes state.

Note 5: I_{IN2} includes the receiver input current and driver TRI-STATE leakage current.

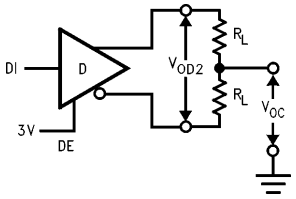
Note 6: Supply current specification is valid for loaded transmitters when DE = 0V or enabled (DE = H) with no load.

Note 7: f = 1 MHz, t_r and $t_f \leq 6$ ns, $Z_O = 50\Omega$.

Note 8: C_L includes jig and probe capacitance.

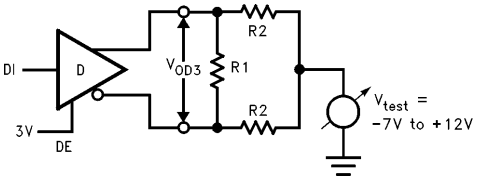
Note 9: f_{max} is the guaranteed data rate for 50 ft of twisted pair cable. f_{max} may be conservatively determined from the ratio of driver transition time (t_r) to the data rate unit interval ($1/f_{max}$). Using a 10% ratio yields $f_{max} = (0.1)/40$ ns = 2.5 Mb/s. Higher data rates may be supported by allowing larger ratios.

Parameter Measurement Information



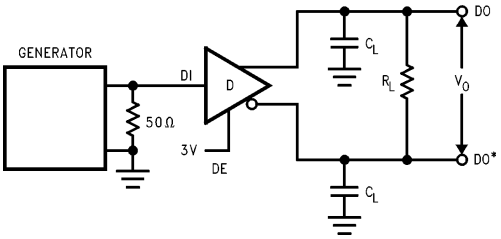
TL/F/12880–2

FIGURE 1. V_{OD}



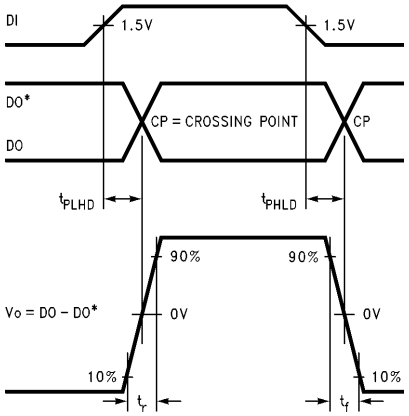
TL/F/12880–3

FIGURE 2. V_{OD3}



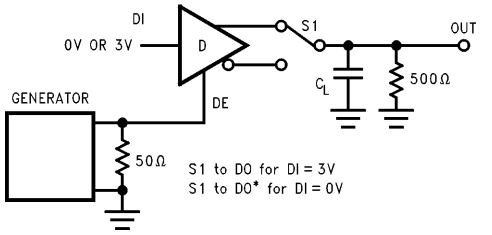
TL/F/12880–4

FIGURE 3



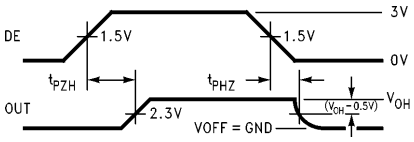
TL/F/12880–5

FIGURE 4



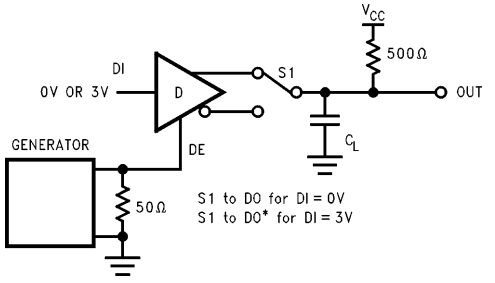
TL/F/12880–6

FIGURE 5



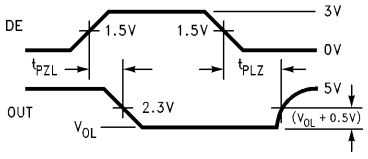
TL/F/12880–7

FIGURE 6



TL/F/12880–8

FIGURE 7



TL/F/12880–9

FIGURE 8

Parameter Measurement Information (Continued)

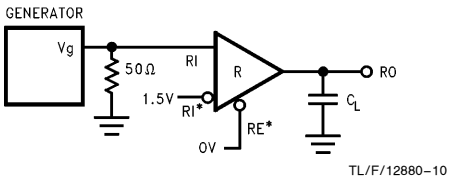


FIGURE 9

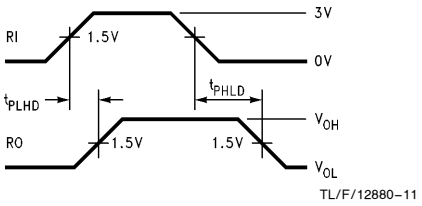


FIGURE 10

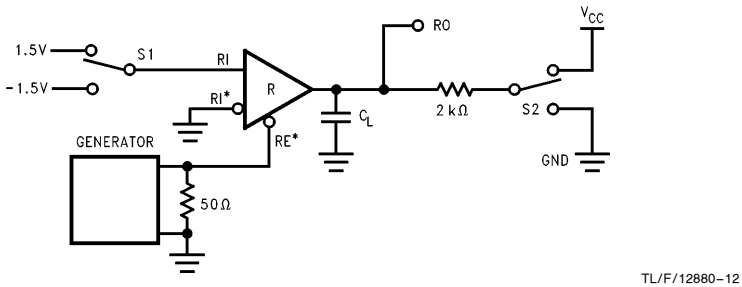


FIGURE 11

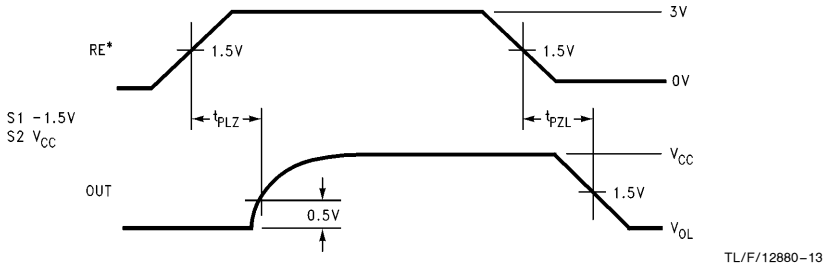


FIGURE 12

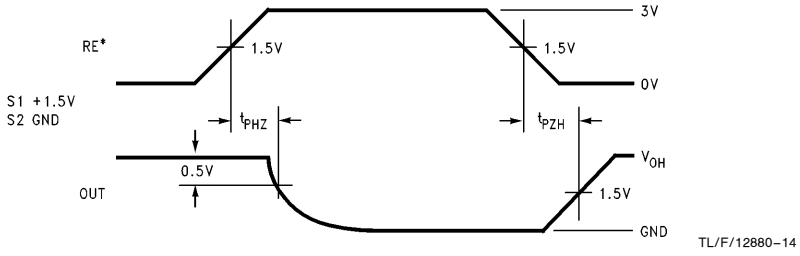


FIGURE 13

Pin Descriptions

Pin #	I/O	Name	Function
1	O	RO	Receiver Output: If A > B by 200 mV, RO will be high; If A < B by 200 mV, RO will be low. RO will be high also if the inputs (A and B) are open (non-terminated).
2	I	RE*	Receiver Output Enable: RO is enabled when RE* is low; RO is in TRI-STATE when RE* is high.
3	I	DE	Driver Output Enable: The driver outputs (A and B) are enabled when DE is high; they are in TRI-STATE when DE is low. Pins A and B also function as the receiver input pins (see below).
4	I	DI	Driver Input: A low on DI forces A low and B high while a high on DI forces A high and B low when the driver is enabled.
5	NA	GND	Ground
6	I/O	A	Non-inverting Driver Output and Receiver Input pin. Driver output levels conform to RS-485 signaling levels.
7	I/O	B	Inverting Driver Output and Receiver Input pin. Driver output levels conform to RS-485 signaling levels.
8	NA	V_{CC}	Power Supply: 4.75V $\leq V_{CC} \leq$ 5.25V

Related National Low Power RS-485 Transceivers

Part Number	Temperature Range	Number of XCVRs on Bus	Comments
DS36C278	0°C to +70°C	128	Ultra Low Power Transceiver
DS36C278T	−40°C to +85°C	64	Ultra Low Power Transceiver
DS36C279	0°C to +70°C	128	Auto-Sleep Mode
DS36C279T	−40°C to +85°C	64	Auto-Sleep Mode
DS36C280	0°C to +70°C	128	Adjustable Slew Rate Control
DS36C280T	−40°C to +85°C	64	Adjustable Slew Rate Control

Applications Information

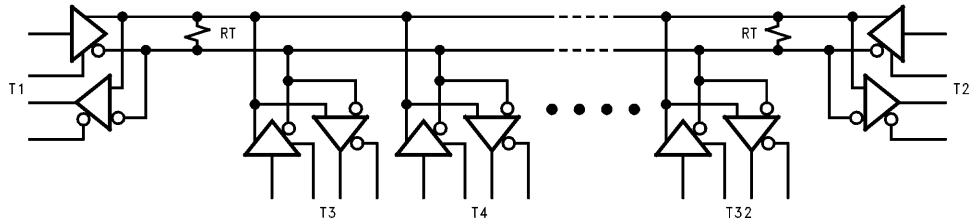
The DS485 is a low power transceiver designed for use in RS-485 multipoint applications. The DS485 can transmit data up to 2.5 Mbps based on a ratio of driver transition time to the unit interval (bit time) of 10%. This maximum data rate may be further limited by the interconnecting media. The DS485 provides a standard unit load to the RS-485 bus across the common mode range of −7V to +12V. This allows up to 32 transceivers (standard unit load) to be connected to the bus. More transceivers may be connected to the bus if they support a reduced unit load (see DS36C278). The DS485 also guarantees the driver's output differential voltage into a worst case load that models standard termination loads and 32 unit loads referenced to the maximum common mode voltage extremes. With a minimum of 1.5V swing into this load, a 1.3V differential noise margin is supported along with the standard common mode rejection range of the receivers.

Due to the multipoint nature of the bus, contention between drivers may occur. This will not cause damage to the drivers since they feature short-circuit protection and also thermal shutdown protection. Thermal shutdown senses die temperature and puts the driver outputs into TRI-STATE if a fault condition occurs that causes excessive power dissipation which can elevate the junction temperature to +150°C.

A typical multipoint application is shown in the following figure. Note that termination is typically required but is only located at the two ends of the cable (not on every node). Commonly pull up and pull down resistors may be required at one end of the bus to provide a failsafe bias. These resistors provide a bias to the line when all drivers are in TRI-STATE. See National Application Note 847 for a complete discussion of failsafe biasing of differention buses.

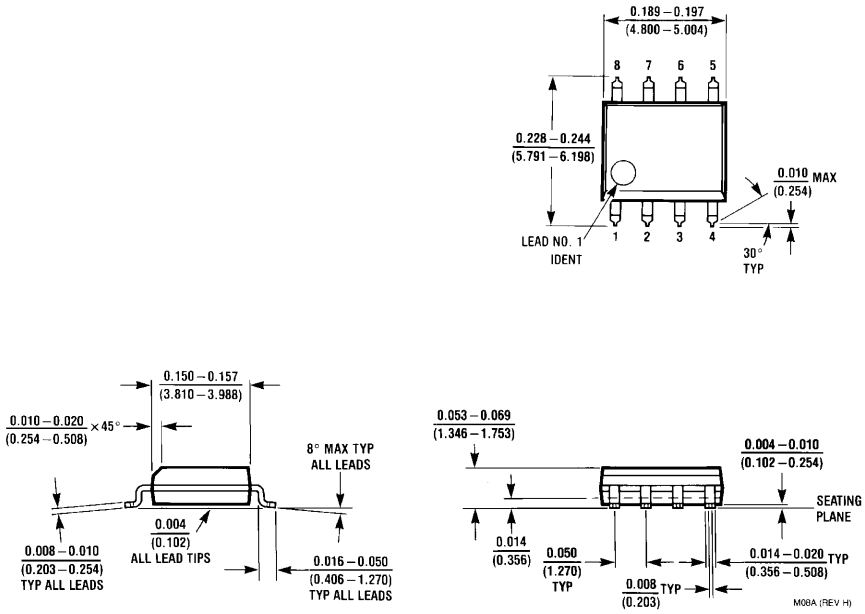
Applications Information (Continued)

Multipoint RS-485 Application



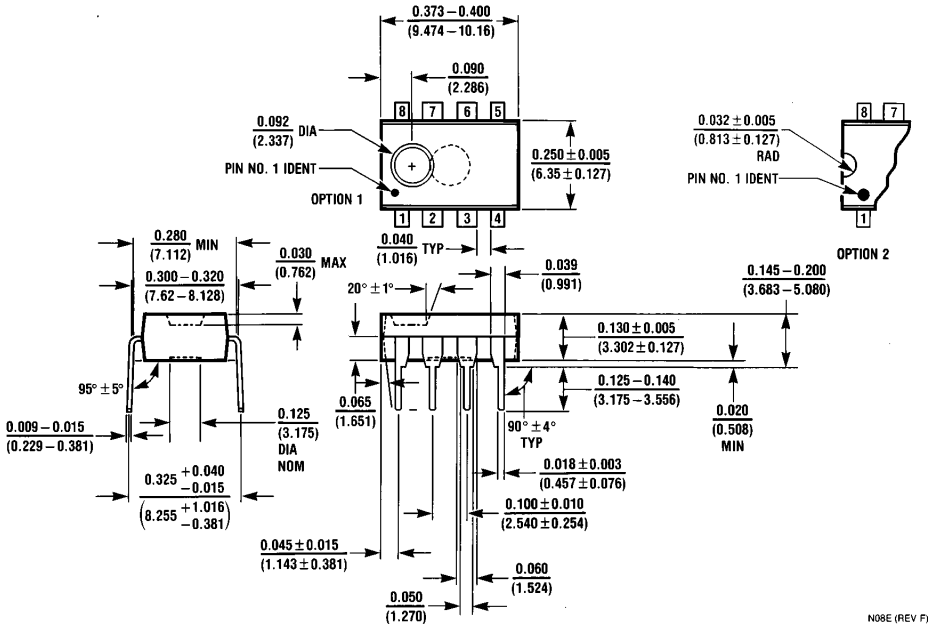
TL/F/12880–16

Physical Dimensions inches (millimeters) unless otherwise noted



Order Number DS485M or DS485TM
NS Package Number M08A

Physical Dimensions inches (millimeters) unless otherwise noted



Order Number DS485N or DS485TN
NS Package Number N08E

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 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.

National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

http://www.national.com

National Semiconductor Europe
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 180-530 85 85
English Tel: +49 (0) 180-532 78 32
Français Tel: +49 (0) 180-532 93 58
Italiano Tel: +49 (0) 180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2308
Fax: 81-043-299-2408