

## 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  $\mu$ A 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 ( $V_{OD3}$ ).

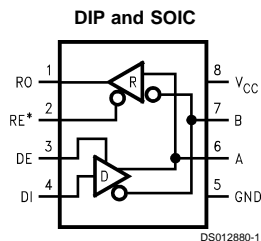
The receiver has a failsafe feature that guarantees a logic-high output if the input is open circuit.

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  $\mu$ A 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



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	$\geq +0.2V$		H
L	L	$\leq -0.2V$		L
H	X	X		Z
L	L	OPEN*		H

\*Note: Non Terminated, Open Input only  
 X = indeterminate  
 Z = TRI-STATE

## 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	$R_L = 50\Omega$ , (RS422), Figure 1		2	2.8		V
		$R_L = 27\Omega$ , (RS485), Figure 1		1.5	2.3	5	V
$\Delta V_{OD}$	Change in Magnitude of Output Differential Voltage	$R_L = 27\Omega$ or $50\Omega$ (Note 4)				0.2	V
$V_{OD3}$	Differential Driver Output Voltage — Full Load with Max $V_{CM}$	$R_1 = 54\Omega$ , $R_2 = 375\Omega$ $V_{TEST} = -7V$ to +12V, Figure 5		1.5	2.0	5	V
$V_{OC}$	Driver Common-Mode Output Voltage	$R_L = 27\Omega$ or $50\Omega$ , Figure 1	DI, DE, RE*			3	V
$\Delta V_{OC}$	Change in Magnitude of Common-Mode Output Voltage	$R_L = 27\Omega$ or $50\Omega$ , Figure 1 (Note 4)				0.2	V
$V_{IH}$	Input High Voltage			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	$-7V \leq V_{CM} \leq +12V$		-0.2		0.2	V
$\Delta V_{TH}$	Receiver Input Hysteresis	$V_{CM} = 0V$			70		mV
$V_{OH}$	Receiver Output High Voltage	$I_O = -4\text{ mA}$ , $V_{ID} = 0.2V$	RO	3.5			V
$V_{OL}$	Receiver Output Low Voltage	$I_O = 4\text{ mA}$ , $V_{ID} = -0.2V$				0.4	V
$I_{OZR}$	TRI-STATE Output Current at Receiver	$0.4V \leq V_O \leq 2.4V$				±1	μA
$R_{IN}$	Receiver Input Resistance	$-7V \leq V_{IN} \leq +12V$	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, $V_O = \text{HIGH}$	$-7V \leq V_O \leq +12V$	A, B	35		250	mA
$I_{OSD2}$	Driver Short Circuit Current, $V_O = \text{LOW}$	$-7V \leq V_O \leq +12V$		35		250	mA
$I_{OSR}$	Receiver Short Circuit Current	$0V \leq V_O \leq V_{CC}$	RO	7		85	mA

## Switching Characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{PLHD}$	Driver Differential Propagation Delay — Low to High	$R_L = 54\Omega$ , $C_L = 100\text{ pF}$	10	40	65	ns
$t_{PHLD}$	Driver Differential Propagation Delay — High to Low		10	39	65	ns
$t_{SKEW}$	Differential Skew $ t_{PHLD} - t_{PLHD} $			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	$C_L = 100\text{ pF}$			170	ns
$t_{ZL}$	Driver Enable to Output Low	$C_L = 100\text{ pF}$			170	ns
$t_{LZ}$	Driver Disable from Output Low	$C_L = 15\text{ pF}$			170	ns
$t_{HZ}$	Driver Disable from Output High	$C_L = 15\text{ pF}$			170	ns
$t_{PLHD}$	Receiver Differential Propagation Delay — Low to High	$C_L = 15\text{ pF (RO)}$	70	190	320	ns
$t_{PHLD}$	Receiver Differential Propagation Delay — High to Low		70	210	320	ns
$t_{SKEW}$	Differential Skew $ t_{PHLD} - t_{PLHD} $			20	50	ns
$t_{ZH}$	Receiver Enable to Output High	$C_L = 15\text{ pF}$			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:  $V_{CC} = +5.0\text{V}$ ,  $T_A = +25^\circ\text{C}$ .

**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  $DE = 0\text{V}$  or enabled ( $DE = H$ ) with no load.

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

**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  $f_{max} = (0.1)/40\text{ ns} = 2.5\text{ Mb/s}$ . Higher data rates may be supported by allowing larger ratios.

## Parameter Measurement Information

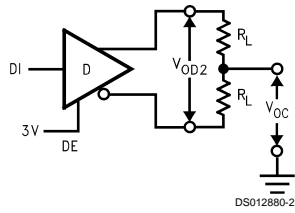


FIGURE 1.  $V_{OD}$

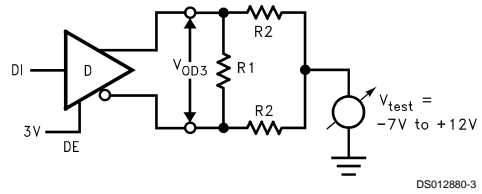


FIGURE 5.  $V_{OD3}$

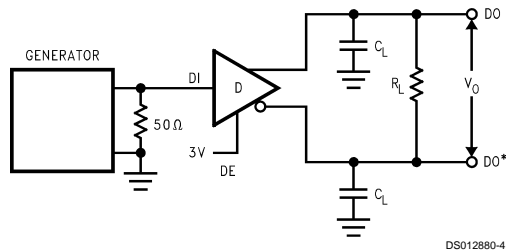


FIGURE 2.

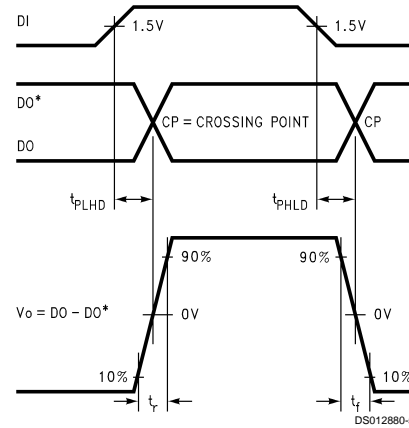


FIGURE 6.

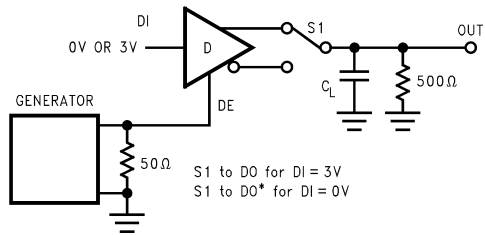


FIGURE 3.

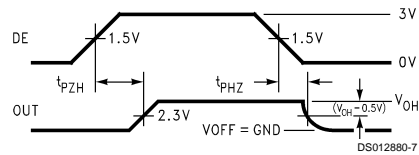


FIGURE 7.

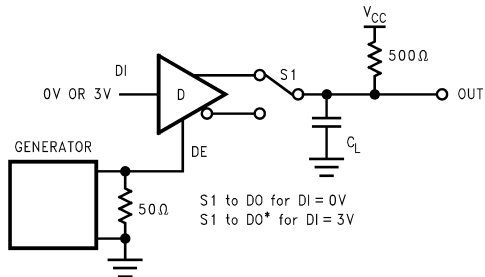


FIGURE 4.

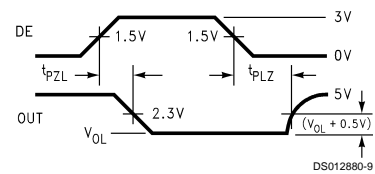


FIGURE 8.

## Parameter Measurement Information (Continued)

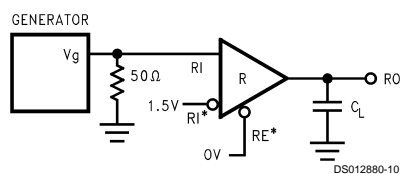


FIGURE 9.

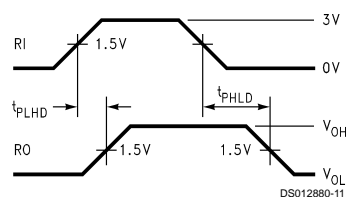


FIGURE 10.

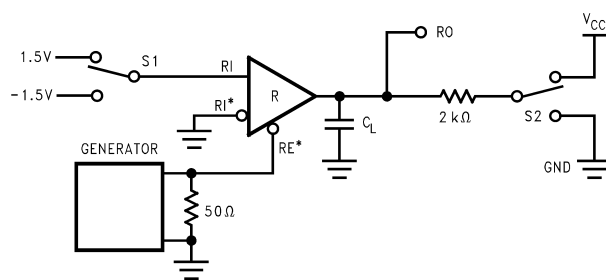


FIGURE 11.

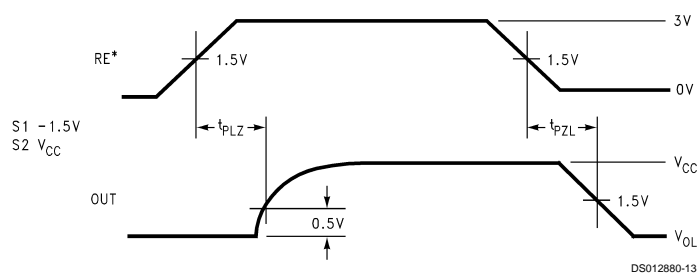


FIGURE 12.

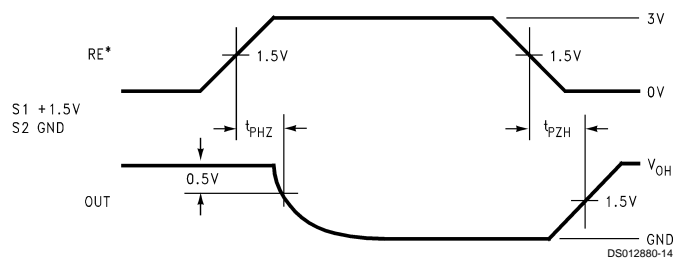


FIGURE 13.

## Parameter Measurement Information (Continued)

### 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 <sub>CC</sub>	Power Supply: $4.75V \leq V_{CC} \leq 5.25V$

### Related National Low Power RS-485 Transceivers

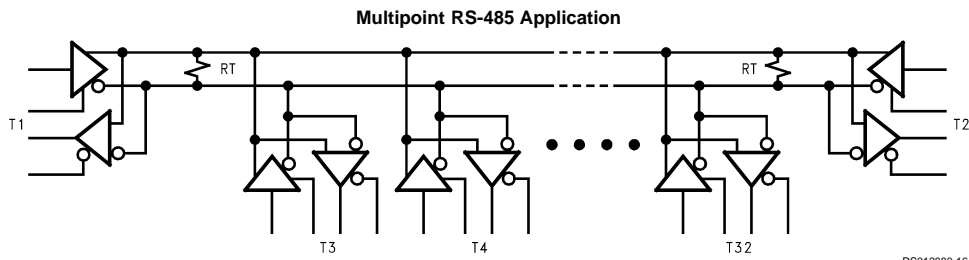
Part Number	Temperature Range	Number of XCVRs on Bus	Comments
DS36C278	0°C to +70°C	128	Ultra Low Power Transceiver
DS36C278T	-40°C to +85°C	64	Ultra Low Power Transceiver
DS36C279	0°C to +70°C	128	Auto-Sleep Mode
DS36C279T	-40°C to +85°C	64	Auto-Sleep Mode
DS36C280	0°C to +70°C	128	Adjustable Slew Rate 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  $+150^{\circ}C$ .

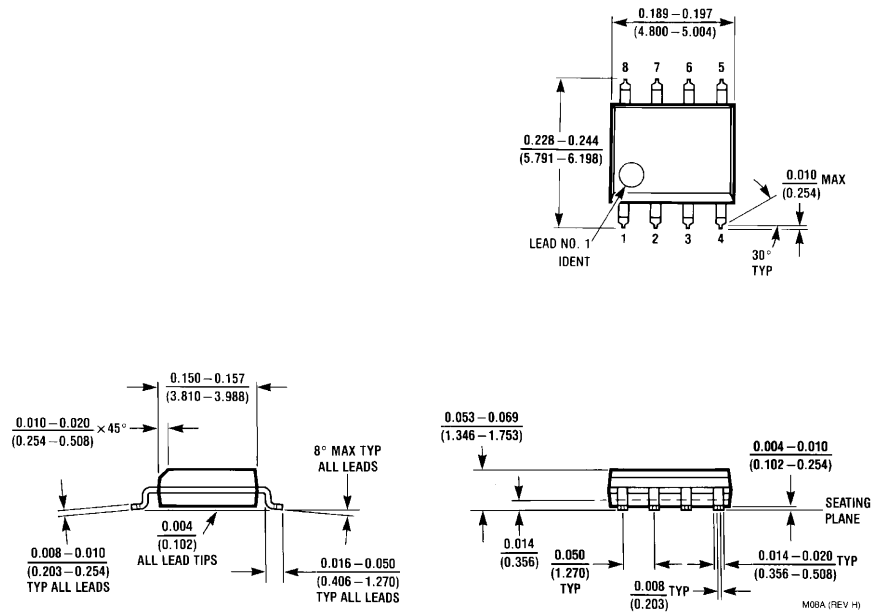
A typical multipoint application is shown in the following figure. Note that termination is typically required but is only located at the two ends of the cable (not on every node). Commonly pull up and pull down resistors may be required at one end of the bus to provide a failsafe bias. These resistors 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 differential buses.



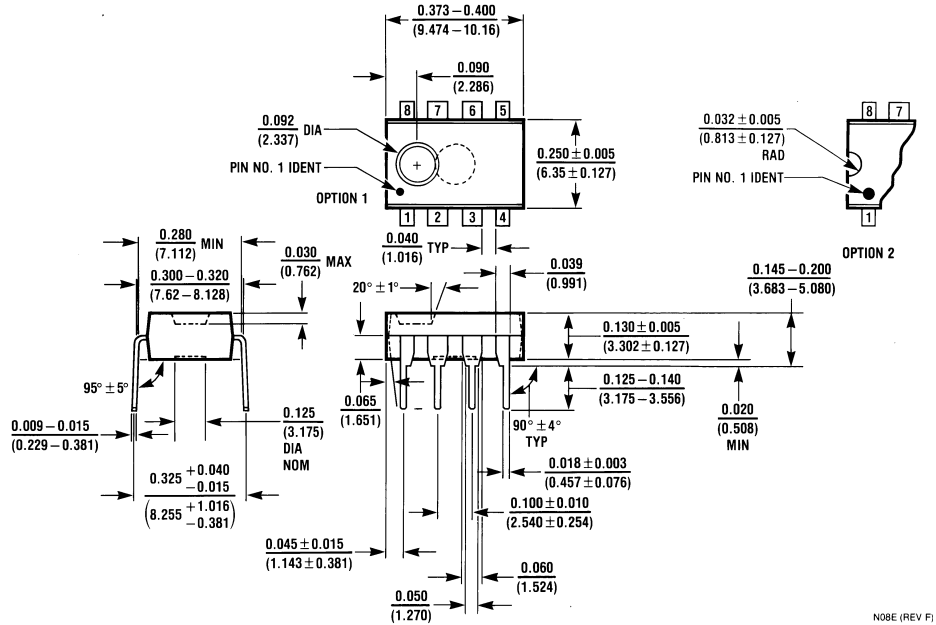




# Physical Dimensions inches (millimeters) unless otherwise noted



Order Number DS485M or DS485TM  
NS Package Number M08A



Order Number DS485N or DS485TN  
NS Package Number N08E

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