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

Check for Samples: DS485

FEATURES

- **Meets TIA/EIA RS-485 Multipoint Standard**
- **ensured 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**

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 ensures 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 ensures a logic-high output if the input is open circuit.

The DS485 is available in 8-pin SOIC and PDIP packages and is characterized for Industrial and Commercial temperature range operation.

Connection and Logic Diagram

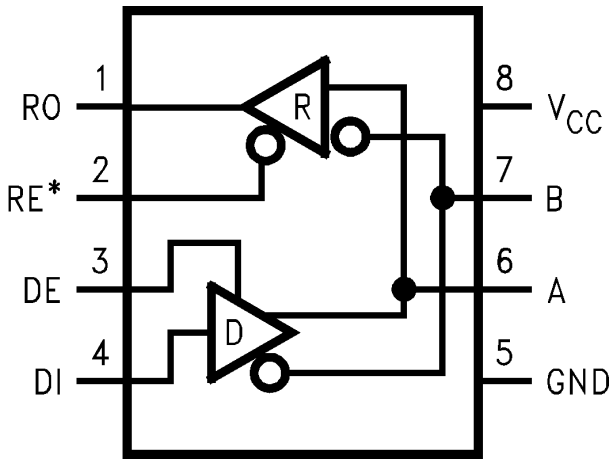


Figure 1. 8-Pin SOIC or PDIP
See D or P Package

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*(1)		H

(1) Non Terminated, Open Input only
X = indeterminate
Z = TRI-STATE

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ABSOLUTE MAXIMUM RATINGS(1)(2)

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	SOIC Package	1.19W
	PDIP Package	0.74W
Derate SOIC Package 9.5 mW/°C above +25°C		
Derate PDIP Package 6.0 mW/°C above +25°C		
Maximum Package Power Dissipation @ +70°C	SOIC Package	0.76W
	PDIP Package	0.47W
Storage Temperature Range		−65°C to +150°C
Lead Temperature Range	Soldering, 4 sec	+260°C
ESD (HBM)		≥2 kV

(1) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.

(2) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. 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.

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(1)(2)

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), See Figure 2		2	2.8		V
		R_L = 27Ω, (RS485), See Figure 2		1.5	2.3	5	V
ΔV_{OD}	Change in Magnitude of Output Differential Voltage	R_L = 27Ω or 50Ω(3)				0.2	|V|
V_{OD3}	Differential Driver Output Voltage—Full Load with Max V_{CM}	R1 = 54Ω, R2 = 375Ω V_{TEST} = −7V to +12V, See Figure 6		1.5	2.0	5	V
V_{OC}	Driver Common-Mode Output Voltage	R_L = 27Ω or 50Ω, See Figure 2				3	V
ΔV_{OC}	Change in Magnitude of Common-Mode Output Voltage	R_L = 27Ω or 50Ω, See Figure 2(3)				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(4) 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(5)	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

(1) 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}.
(2) All typicals are given for: V_{CC} = +5.0V, T_A = +25°C.
(3) $\Delta|V_{OD}|$ and $\Delta|V_{OC}|$ are changes in magnitude of V_{OD} and V_{OC} respectively, that occur when the input changes state.
(4) I_{IN2} includes the receiver input current and driver TRI-STATE leakage current.
(5) Supply current specification is valid for loaded transmitters when DE = 0V or enabled (DE = H) with no load.

SWITCHING CHARACTERISTICS

Over Supply Voltage and Operating Temperature Ranges, unless otherwise specified(1)(2)(3)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PLHD}	Driver Differential Propagation Delay—Low to High	R_L = 54Ω, 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 $\|t_{PHLD} - t_{PLHD}\|$			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 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 $\|t_{PHLD} - t_{PLHD}\|$			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	See (4)	2.5			Mbps

(1) All typicals are given for: V_{CC} = +5.0V, T_A = +25°C.
(2) f = 1 MHz, t_r and t_f ≤ 6 ns, Z_O = 50Ω.
(3) C_L includes jig and probe capacitance.
(4) f_{max} is the ensured 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

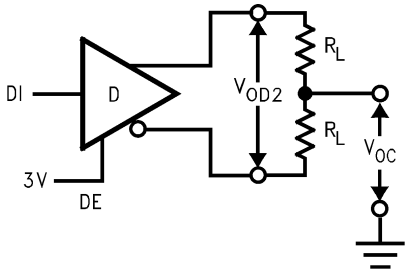


Figure 2. V_{OD}

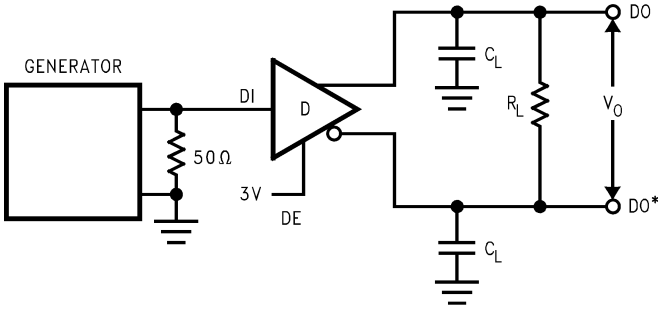


Figure 3.

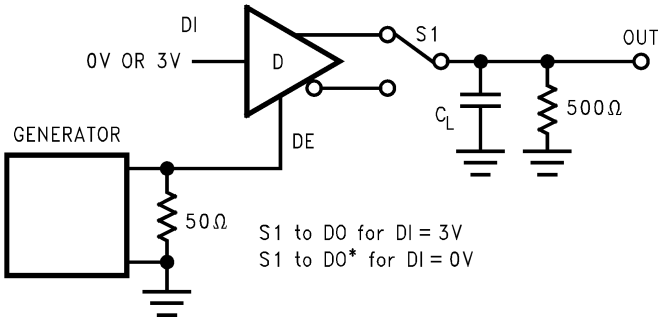


Figure 4.

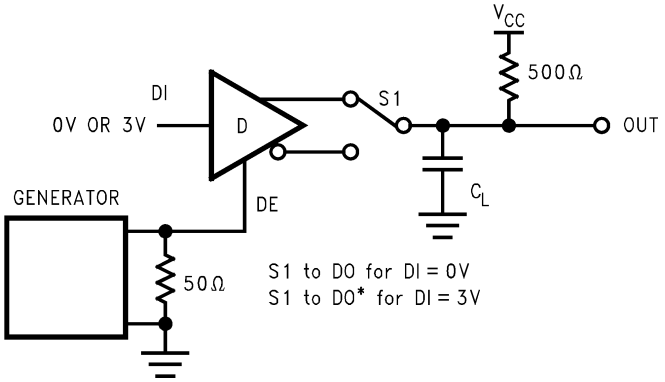


Figure 5.

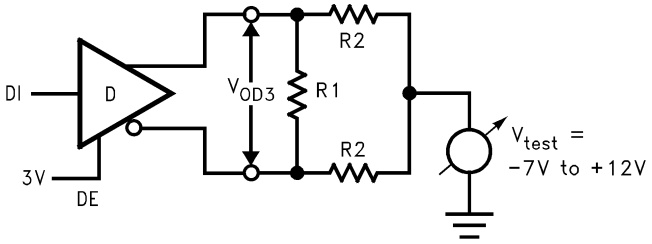


Figure 6. V_{OD3}

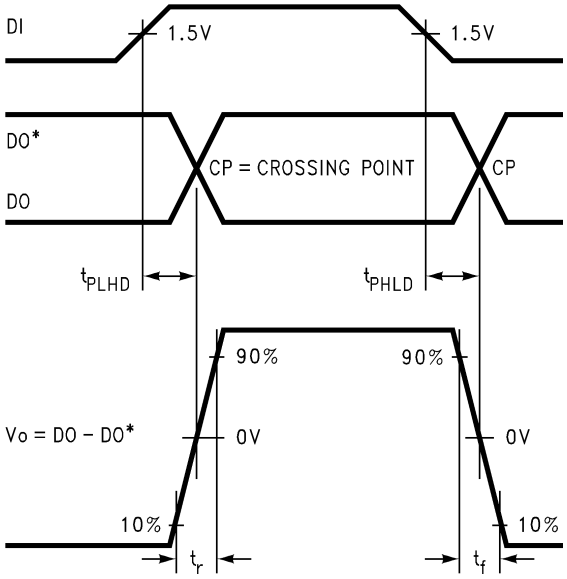


Figure 7.

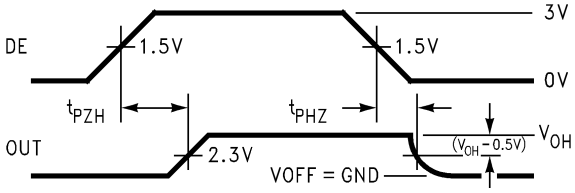


Figure 8.

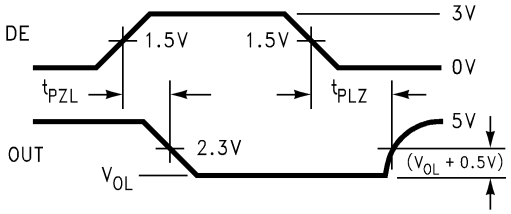


Figure 9.

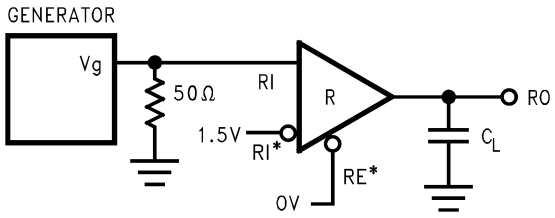


Figure 10.

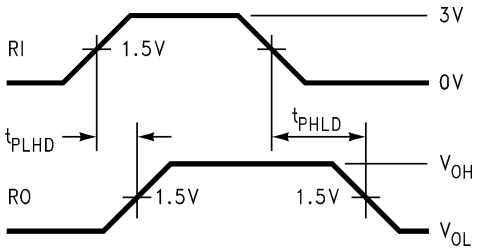


Figure 11.

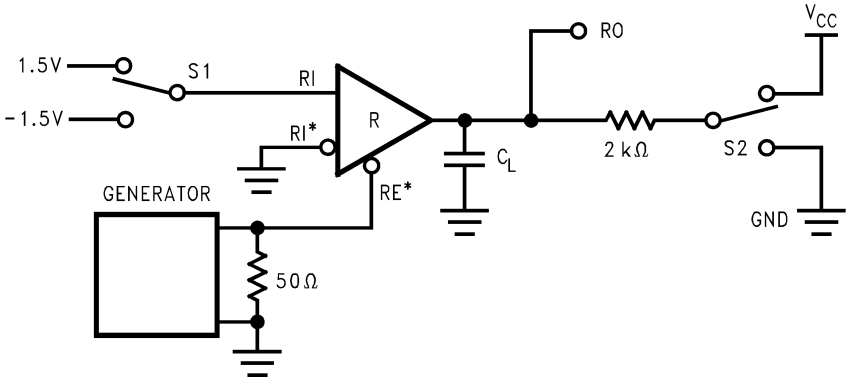


Figure 12.

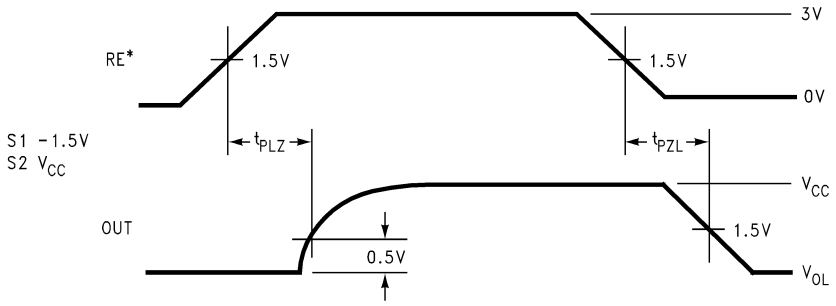


Figure 13.

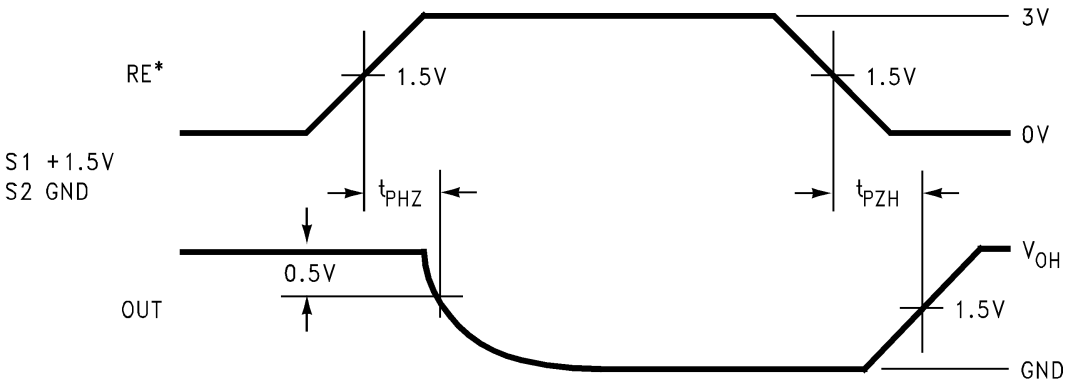


Figure 14.

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 ≤ V_{CC} ≤ 5.25V

Related TI 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 Related TI Low Power RS-485 Transceivers). The DS485 also ensures 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 Application Note AN-847(SNLA031) for a complete discussion of failsafe biasing of differention buses.

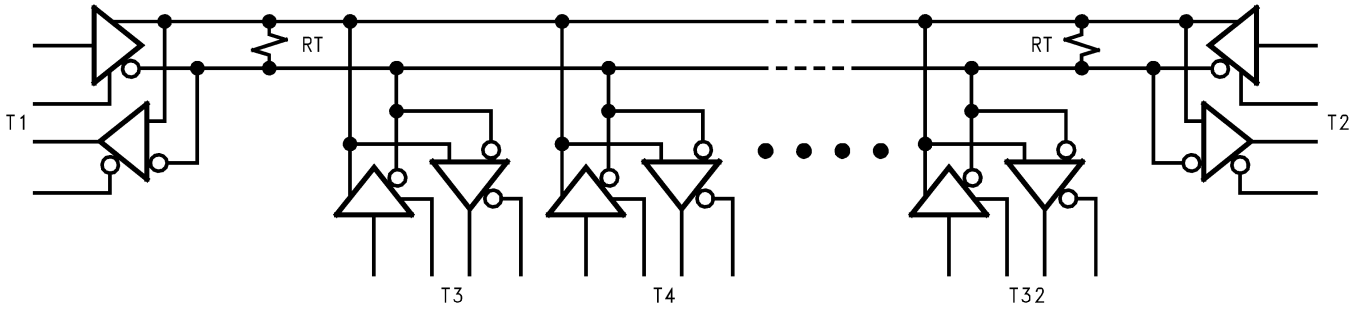


Figure 15. Multipoint RS-485 Application

REVISION HISTORY

Changes from Revision B (April 2013) to Revision C	Page
• Changed layout of National Data Sheet to TI format	8

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DS485M	NRND	SOIC	D	8	95	TBD	Call TI	Call TI	0 to 70	DS485 M	
DS485M/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	SN | CU SN	Level-1-260C-UNLIM	0 to 70	DS485 M	Samples
DS485MX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	SN | CU SN	Level-1-260C-UNLIM	0 to 70	DS485 M	Samples
DS485N	LIFEBUY	PDIP	P	8	40	TBD	Call TI	Call TI	0 to 70	DS485 N	
DS485N/NOPB	ACTIVE	PDIP	P	8	40	Green (RoHS & no Sb/Br)	SN | CU SN	Level-1-NA-UNLIM	0 to 70	DS485 N	Samples
DS485TM	NRND	SOIC	D	8	95	TBD	Call TI	Call TI	-40 to 85	DS485 TM	
DS485TM/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS485 TM	Samples
DS485TMX	NRND	SOIC	D	8	2500	TBD	Call TI	Call TI	-40 to 85	DS485 TM	
DS485TMX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	SN | CU SN	Level-1-260C-UNLIM	-40 to 85	DS485 TM	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

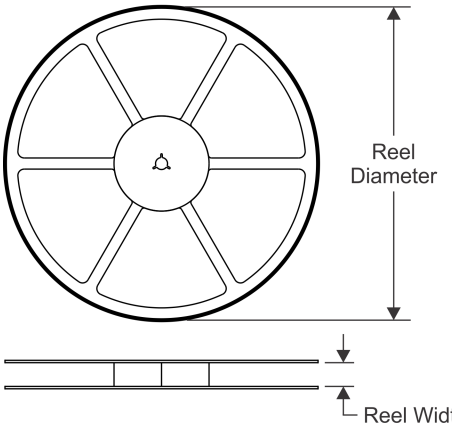
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

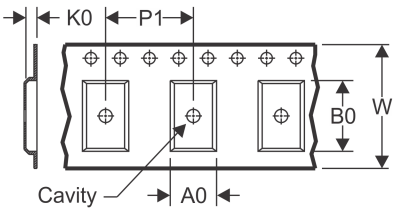
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

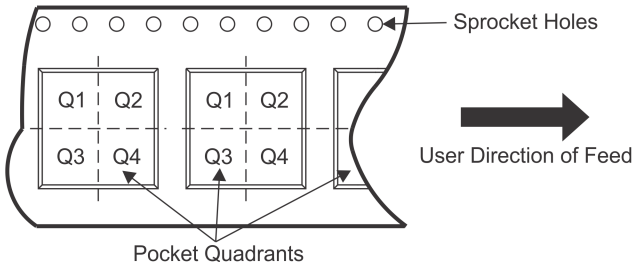


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

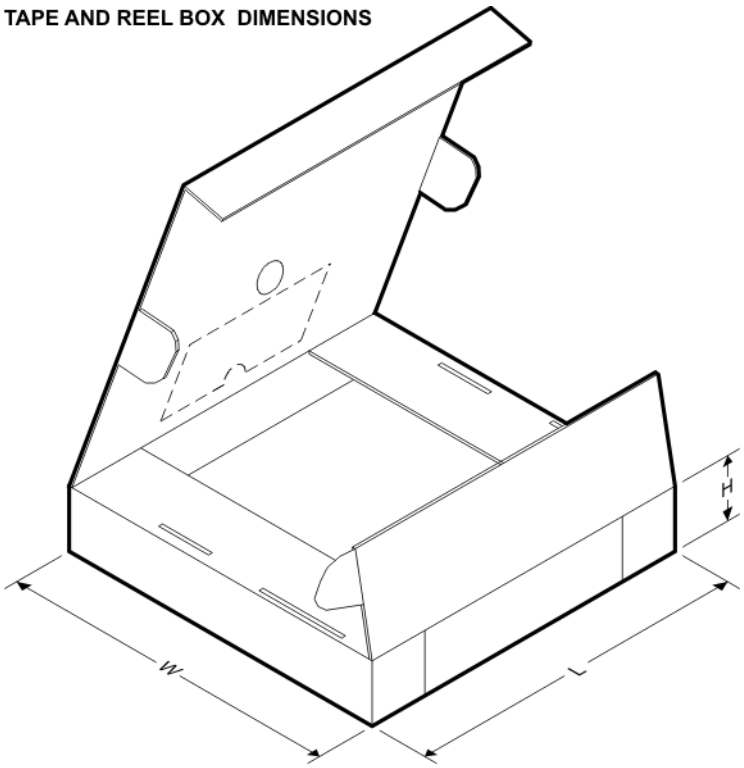
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DS485MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
DS485TMX	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
DS485TMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

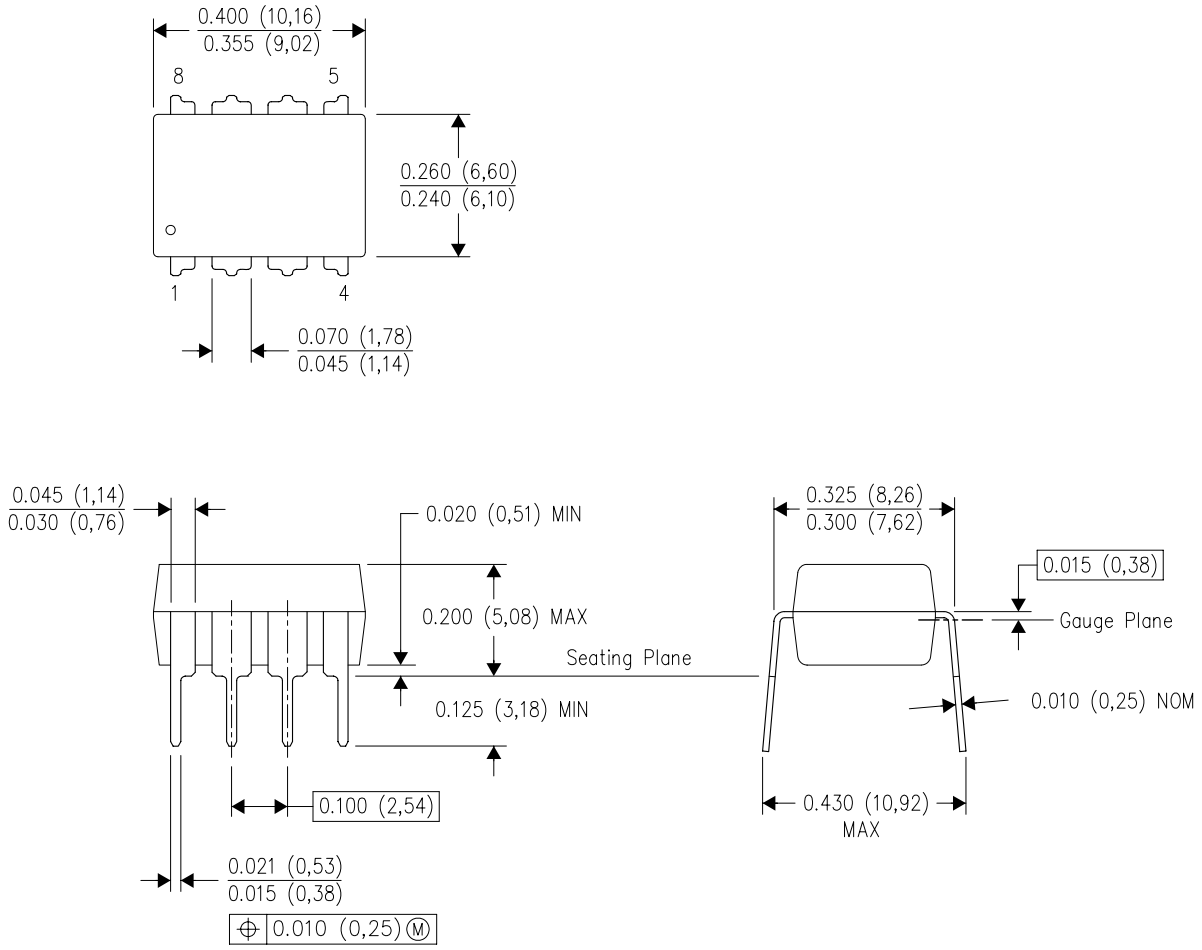
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

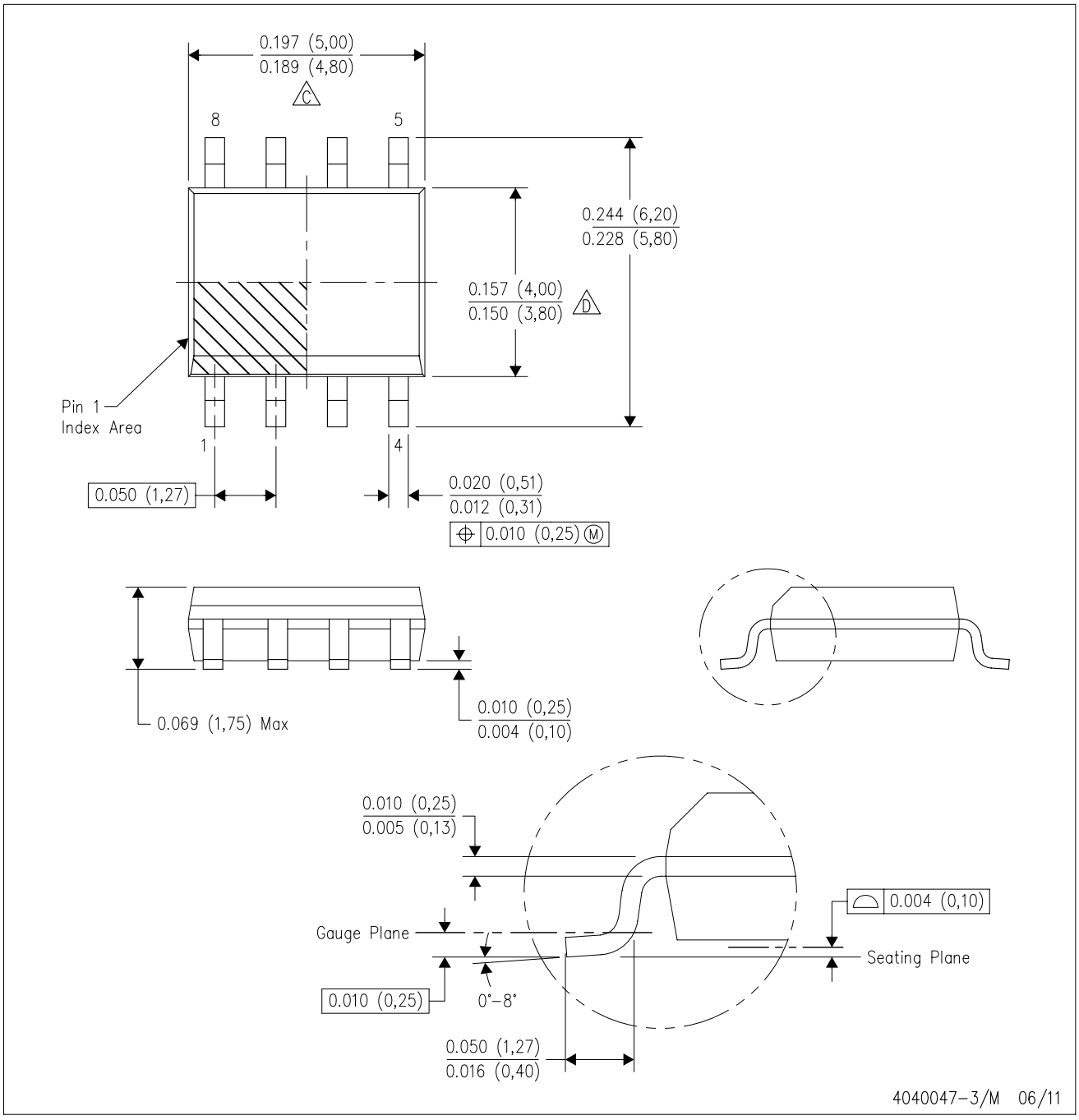
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS485MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
DS485TMX	SOIC	D	8	2500	367.0	367.0	35.0
DS485TMX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

D (R–PDSO–G8) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AA.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265