THE DATASHEET OF

DS485TN/NOPB

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

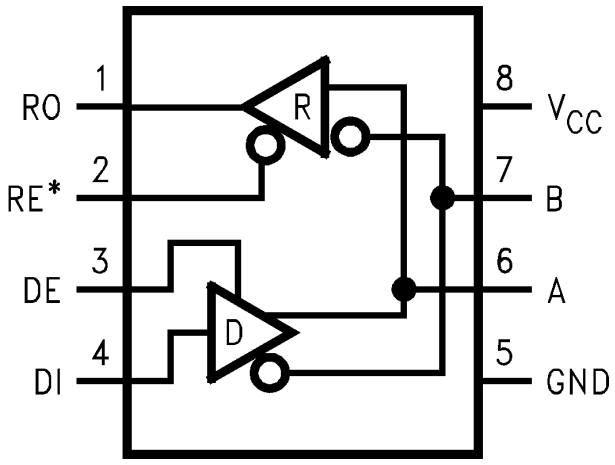


Figure 1. 8-Pin SOIC or PDIP
See D or P Package

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

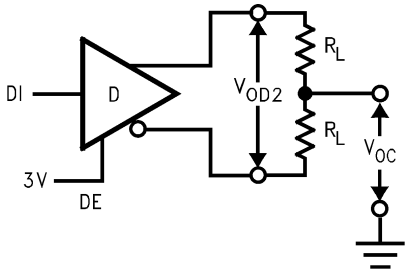


Figure 2. V_{OD}

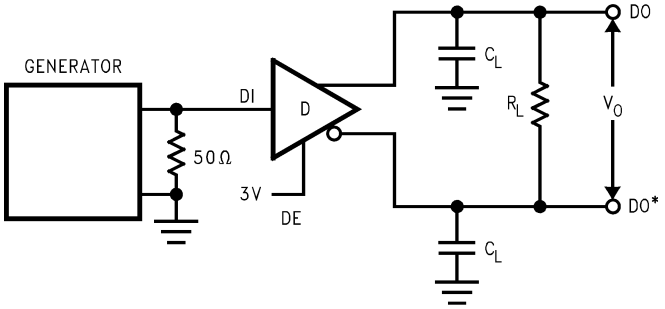


Figure 3.

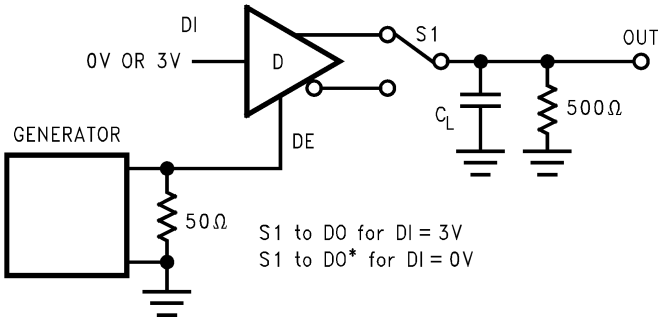


Figure 4.

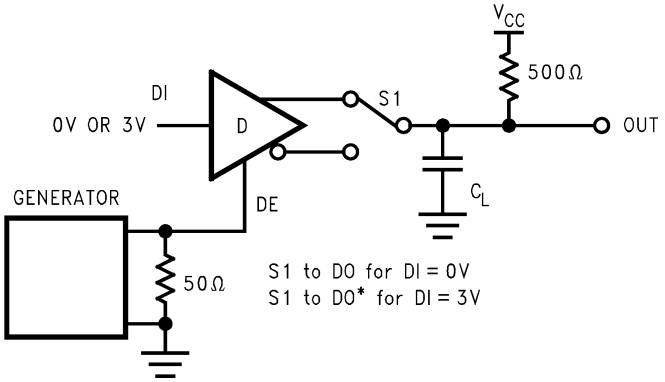


Figure 5.

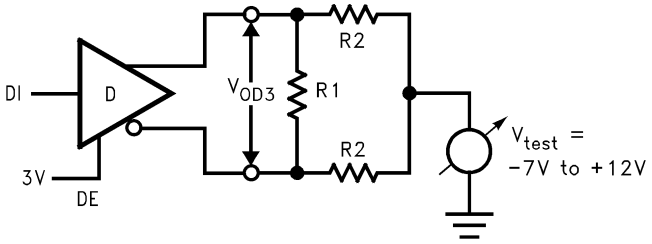
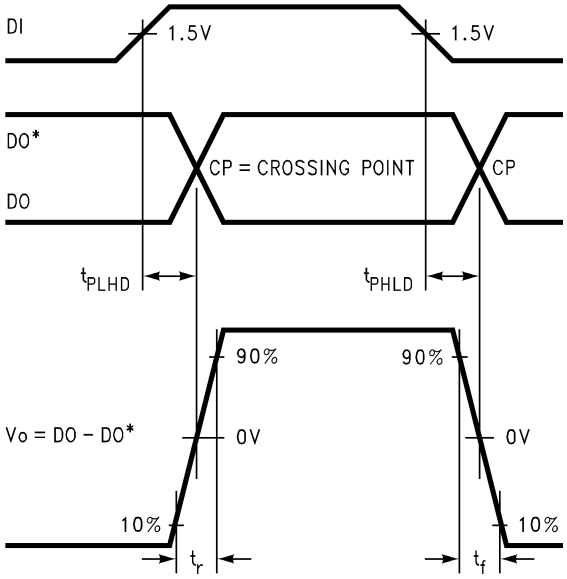


Figure 6. V_{OD3}



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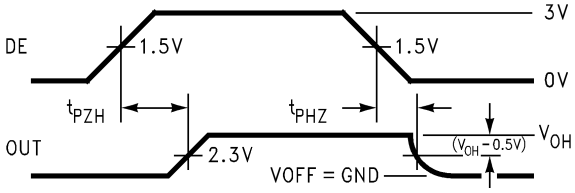


Figure 8.

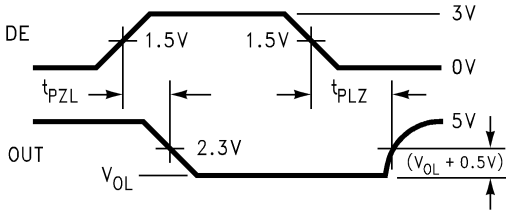


Figure 9.

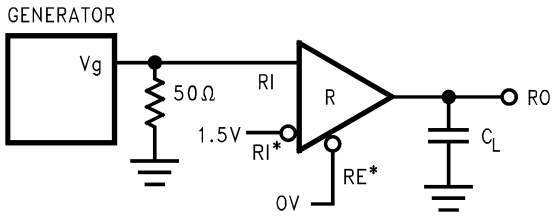


Figure 10.

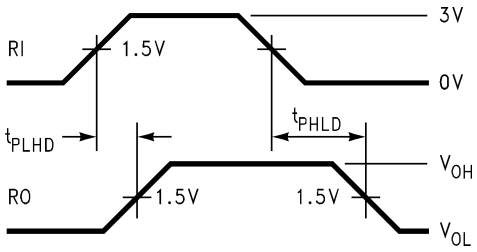


Figure 11.

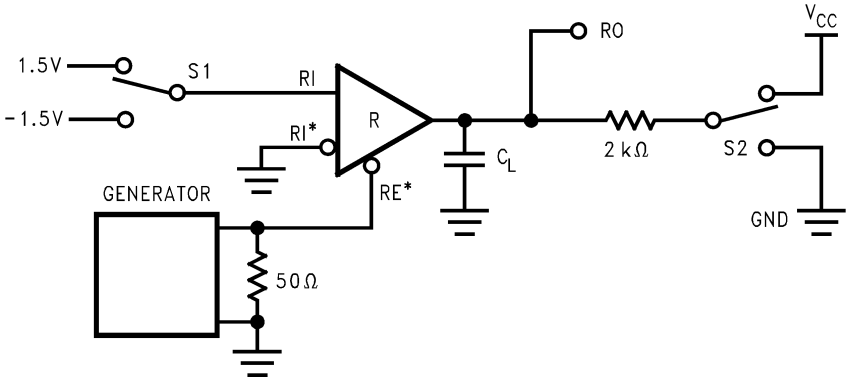


Figure 12.

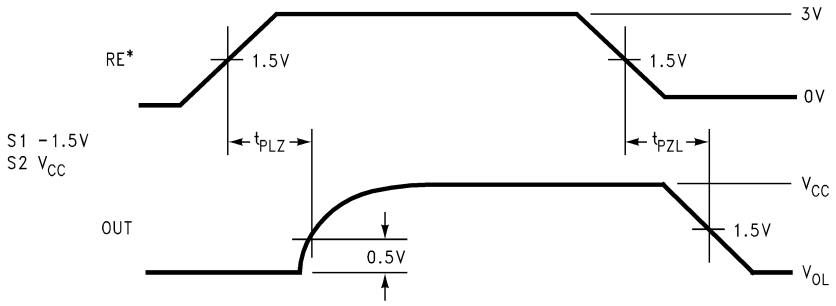


Figure 13.

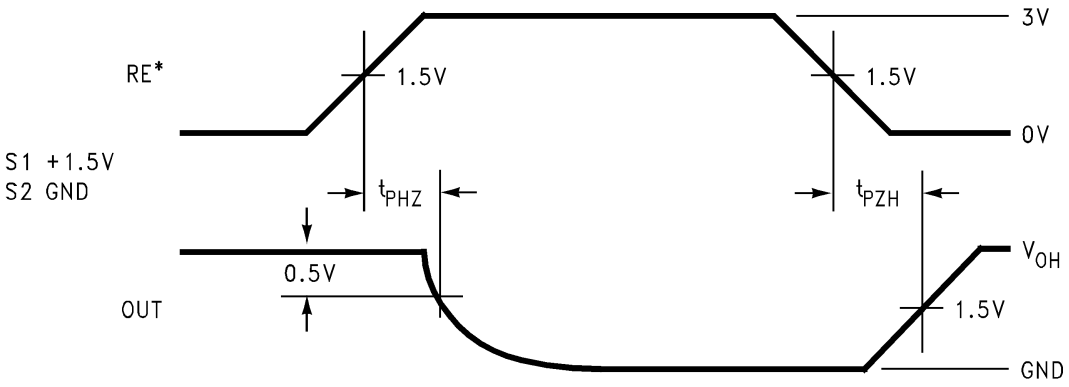


Figure 14.

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.

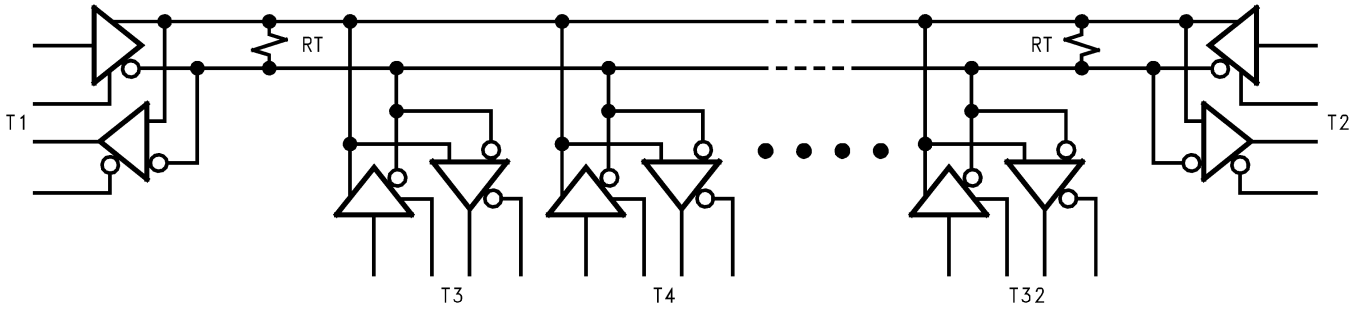


Figure 15. Multipoint RS-485 Application

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	LIFEBUY	SOIC	D	8	95	TBD	Call TI	Call TI	0 to 70	DS485 M	
DS485M/NOPB	LIFEBUY	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	DS485 M	
DS485MX/NOPB	LIFEBUY	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	DS485 M	
DS485N/NOPB	LIFEBUY	PDIP	P	8	40	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	0 to 70	DS485 N	
DS485TM	LIFEBUY	SOIC	D	8	95	TBD	Call TI	Call TI	-40 to 85	DS485 TM	
DS485TM/NOPB	LIFEBUY	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS485 TM	
DS485TMX/NOPB	LIFEBUY	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS485 TM	

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

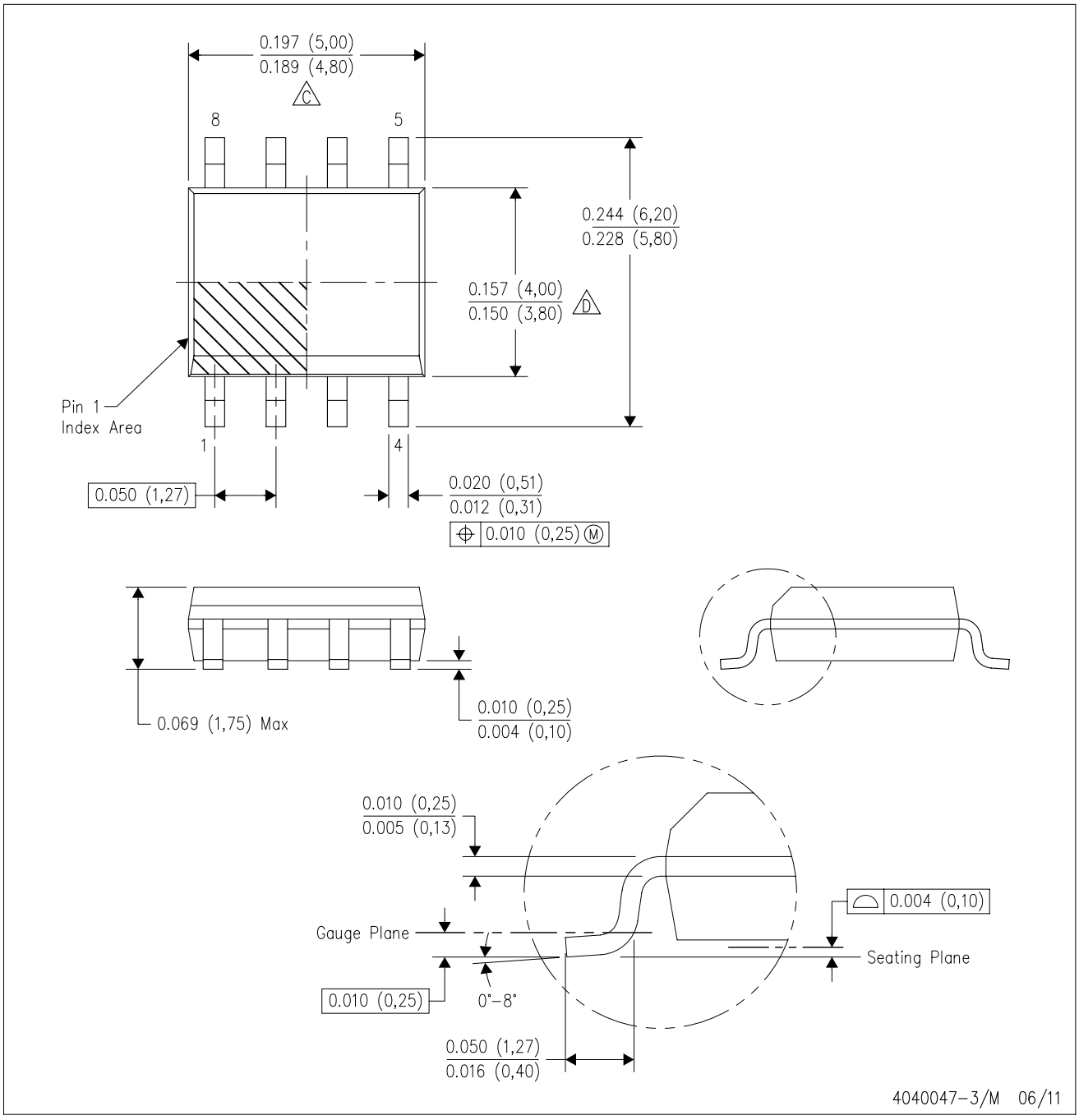
(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(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.

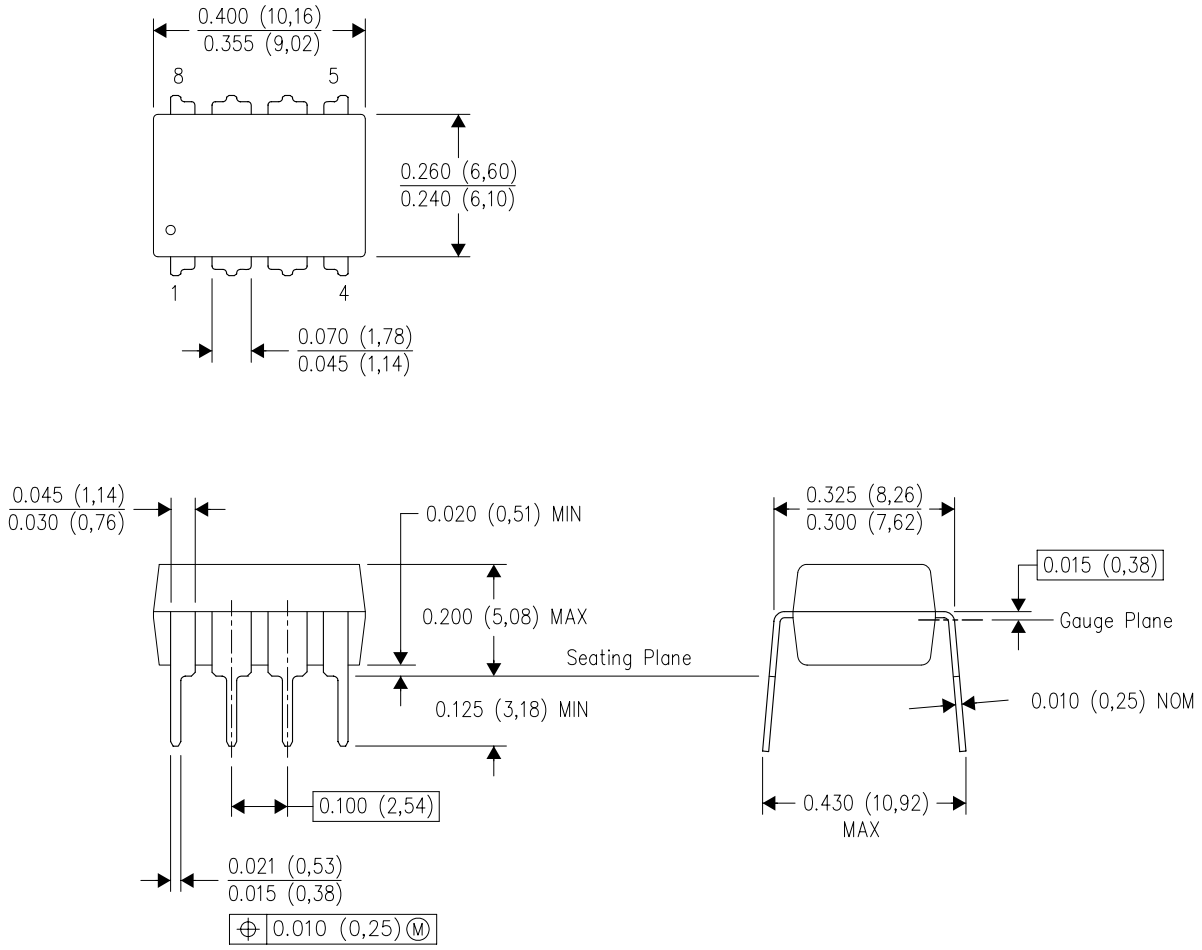
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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.

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.

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