National Semiconductor

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DS1487
Low Power RS-485 ¼ Unit Load Multipoint Transceiver

General Description

The DS1487 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 2.0 Mbps (see Applications Information section). The transceiver presents ¼ unit loading to the RS-485 bus allowing up to 128 nodes to be connected together without the use of repeaters.

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.

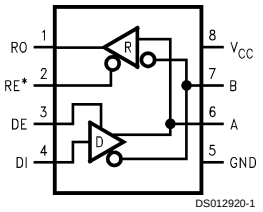
The DS1487 is available in surface mount and DIP packages.

Features

- Meets TIA/EIA RS-485 multipoint standard
- Allows up to 128 transceivers on the bus (¼ U.L.)
- 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
- Current-limiting and thermal shutdown for driver overload protection
- Pin and functional compatible with MAX1487

Connection and Logic Diagram

DIP and SOIC



DS012920-1

*Note: Non Terminated, Open Input only

Order Number	Temp. Range	Package/###
DS1487N	0˚C to +70˚C	DIP/N08E
DS1487M	0˚C to +70˚C	SOP/M08A

Truth Table

DRIVER SECTION				
RE (Note 1)	**DE**	**DI**	**A**	**B**
X	H	H	H	L
X	H	L	L	H
X	L	X	Z	Z
RECEIVER SECTION				
RE (Note 1)	**DE**	**A-B**		**RO**
L	L	≥+0.2V		H
L	L	≤−0.2V		L
H	X	X		Z
L	L	OPEN (Note 1)		H

X = indeterminate

Z = TRI-STATE

Note 1: Non Terminated, Open Input only

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Absolute Maximum Ratings (Note 2)

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 (Note 1), 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)				
DS1487	0	+25	+70	˚C
Bus Common Mode Voltage	−7		+12	V

Electrical Characteristics

Over Supply Voltage and Operating Temperature Ranges, unless otherwise specified (Notes 3, 4)

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units
V_{OD1}	Differential Driver Output Voltage	(No Load)	A, B	1.5		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 5)				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*		0		3	V
ΔV_{OC}	Change in Magnitude of Common-Mode Output Voltage	R_L = 27Ω or 50Ω, *Figure 1* (Note 5)				0.2	|V|
V_{IH}	Input High Voltage		DI, DE, RE (Note 1)	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 6)	V_{IN} = +12V	A, B	0	190	250	µA
	DE = 0V, V_{CC} = 0V or 5.25V	V_{IN} = −7V		0	−100	−200	µA
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				0.5	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	48	68		kΩ
I_{CC}	No-Load Supply Current (Note 7)	DE = V_{CC}, RE (Note 1) = 0V or V_{CC}	V_{CC}		200	500	µA
		DE = 0V, RE (Note 1) = 0V or V_{CC}			200	500	µA
I_{OSD1}	Driver Short Circuit Current, V_O = HIGH	−7V ≤ V_O ≤ +12V	A, B			250	mA
I_{OSD2}	Driver Short Circuit Current, V_O = LOW	−7V ≤ V_O ≤ +12V				−250	mA
I_{OSR}	Receiver Short Circuit Current	V_O = GND	RO	7		85	mA

Switching Characteristics

Over Supply Voltage and Operating Temperature Ranges, unless otherwise specified (Notes 4, 8, 9)

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	80	ns
t_{PHLD}	Driver Differential Propagation Delay — High to Low		10	39	80	ns
t_{SKEW}	Differential Skew $\|t_{PHLD} - t_{PLHD}\|$		0	1	10	ns
t_r	Driver Rise Time		3	25	50	ns
t_f	Driver Fall Time		3	25	50	ns
t_{ZH}	Driver Enable to Output High	C_L = 100 pF		50	200	ns
t_{ZL}	Driver Enable to Output Low	C_L = 100 pF		65	200	ns
t_{LZ}	Driver Disable from Output Low	C_L = 15 pF		80	200	ns
t_{HZ}	Driver Disable from Output High	C_L = 15 pF		80	200	ns
t_{PLHD}	Receiver Differential Propagation Delay — Low to High	C_L = 15 pF (RO)	30	190	400	ns
t_{PHLD}	Receiver Differential Propagation Delay — High to Low		30	210	400	ns
t_{SKEW}	Differential Skew $\|t_{PHLD} - t_{PLHD}\|$		0	20	50	ns
t_{ZH}	Receiver Enable to Output High	C_L = 15 pF		45	150	ns
t_{ZL}	Receiver Enable to Output Low			40	150	ns
t_{LZ}	Receiver Disable from Output Low			50	150	ns
t_{HZ}	Receiver Disable from Output High			55	150	ns
f_{max}	Maximum Data Rate	(Note 10)	2.0			Mbps

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 table of "Electrical Characteristics" specifies conditions of device operation.

Note 3: 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 4: All typicals are given for: V_{CC} = +5.0V, T_A = +25˚C.

Note 5: $\Delta|V_{OD}|$ and $\Delta|V_{OC}|$ are changes in magnitude of V_{OD} and V_{OC} respectively, that occur when the input changes state.

Note 6: I_{IN2} includes the receiver input current and driver TRI-STATE leakage current.

Note 7: Supply current specification is valid for loaded transmitters when DE = 0V or enabled (DE = H) with no load.

Note 8: f = 1 MHz, t_r and $t_f \leq 6$ ns, Z_O = 50Ω.

Note 9: C_L includes jig and probe capacitance.

Note 10: 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)/50 ns = 2.0 Mb/s. Higher data rates may be supported by allowing larger ratios.

Parameter Measurement Information

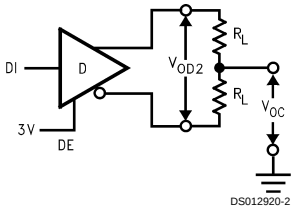


FIGURE 1. V_{OD}

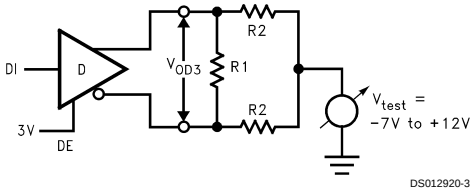


FIGURE 2. V_{OD3}

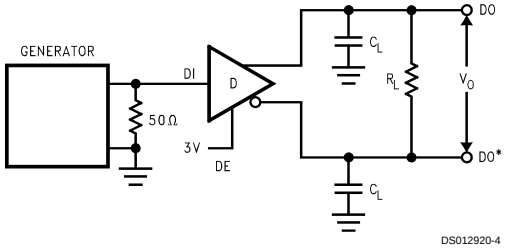


FIGURE 3.

Parameter Measurement Information (Continued)

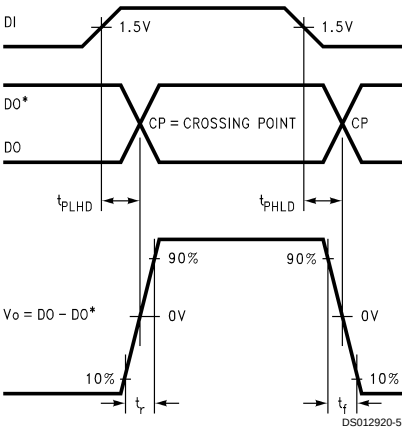


FIGURE 4.

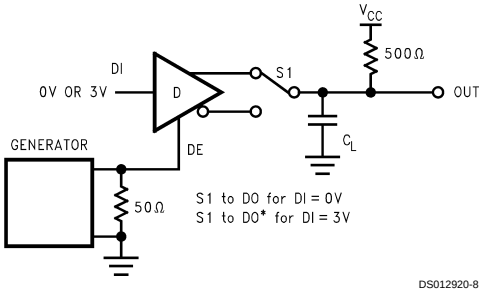


FIGURE 7.

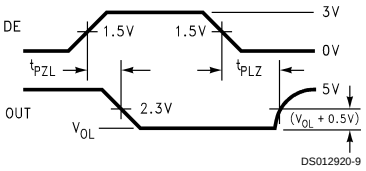


FIGURE 8.

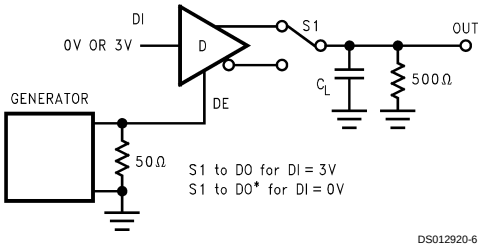
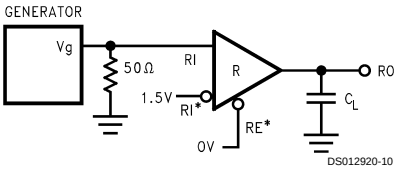


FIGURE 5.



*Note: Non Terminated, Open Input only

FIGURE 9.

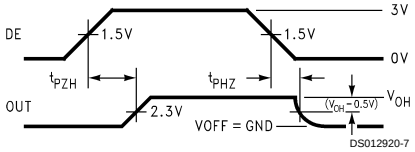


FIGURE 6.

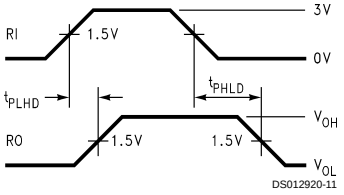
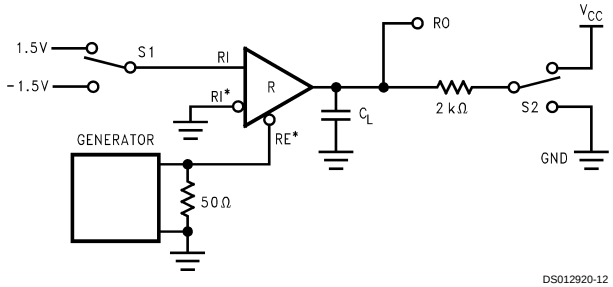


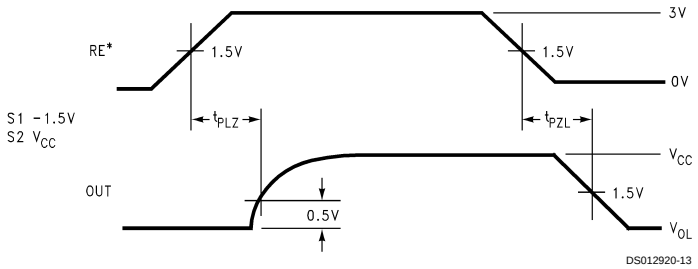
FIGURE 10.



*Note: Non Terminated, Open Input only

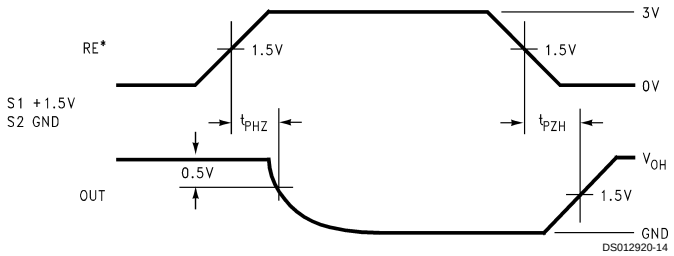
FIGURE 11.

Parameter Measurement Information (Continued)



*Note: Non Terminated, Open Input only

FIGURE 12.



*Note: Non Terminated, Open Input only

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 (Note 1)	Receiver Output Enable: RO is enabled when RE (Note 1) is low; RO is in TRI-STATE when RE (Note 1) 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: $4.75V \le V_{CC} \le 5.25V$

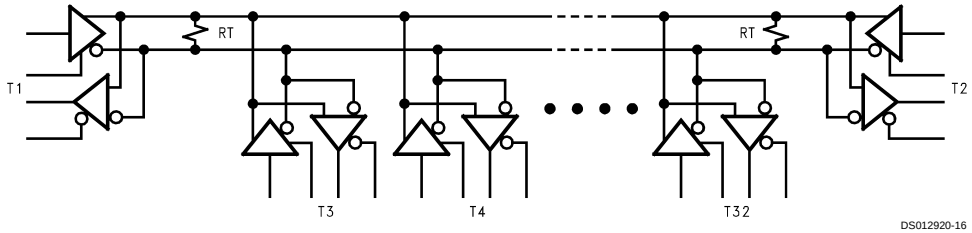
Applications Information

The DS1487 is a low power transceiver designed for use in RS-485 multipoint applications. The DS1487 can transmit data up to 2.0 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 DS1487 provides a ¼ unit load to the RS-485 bus across the common mode range of −7V to +12V. This allows up to 128 transceivers (¼ unit load) to be connected to the bus. The DS1487 also guarantees the driver's output differential voltage into a worst case load that models standard termination loads and 32 unit loads (=128 DS1487's) 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.

Applications Information (Continued)

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.



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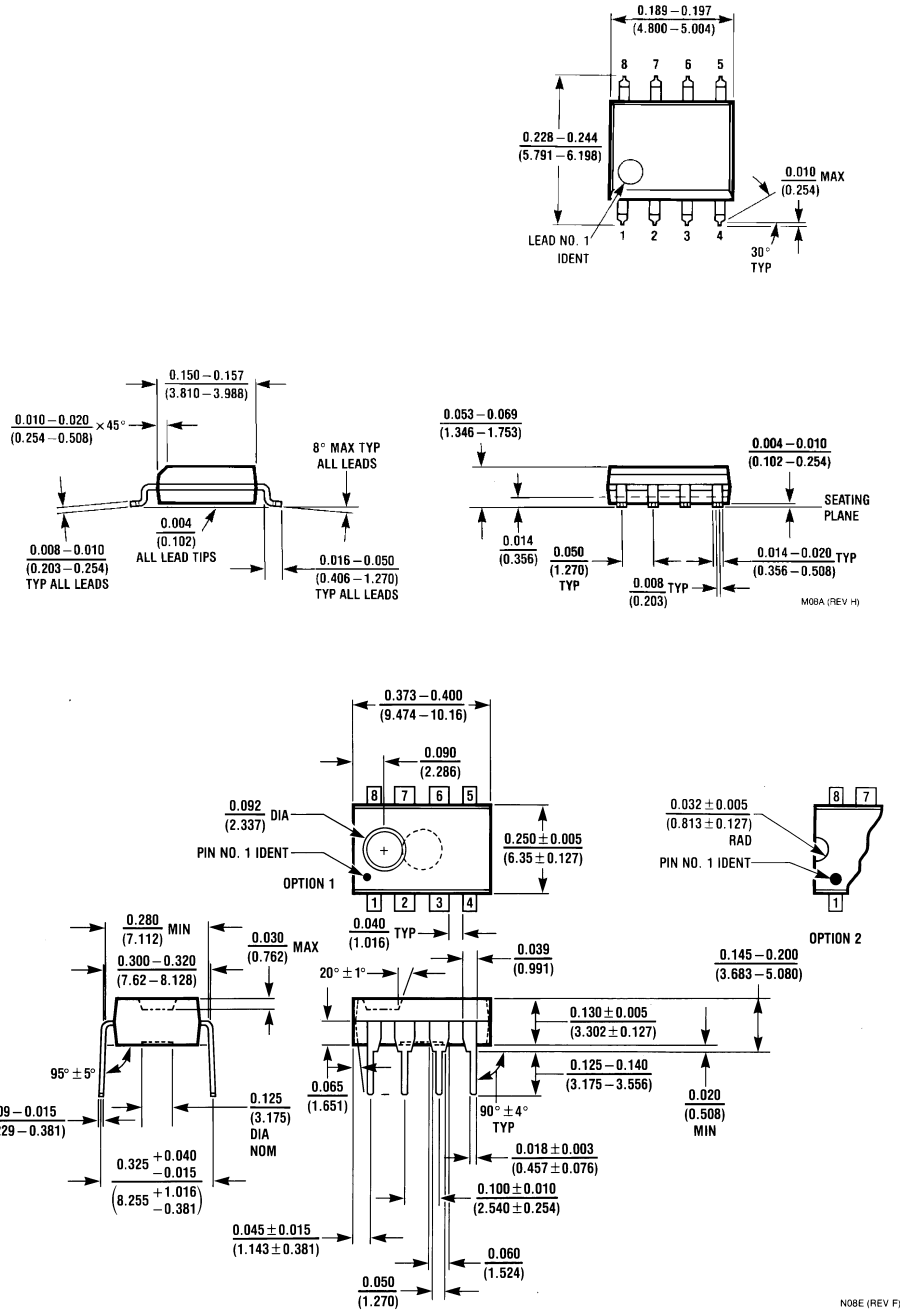
Physical Dimensions inches (millimeters) unless otherwise noted



Order Number DS1487N
NS Package Number N08E

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