



## DESCRIPTION

The MAX1487ESA are low-power transceivers for RS-485 and RS-422 communications in harsh environments. Each driver output and receiver input is protected against  $\pm 15\text{kV}$  electro-static discharge (ESD) shocks, without latchup. These parts contain one driver and one receiver.

The MAX1487ESA feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, thus allowing error-free data transmission up to 2.5Mbps.

These transceivers draw as little as  $120\mu\text{A}$  supply current when unloaded or when fully loaded with disabled drivers. All parts operate from a single +5V supply.

Drivers are short-circuit current limited, and are protected against excessive power dissipation by thermal shutdown circuitry that places their outputs into a high-impedance state.

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

The MAX1487ESA feature quarter-unit-load receiver input impedance, allowing up to 128 transceivers on the bus. The MAX1487ESA is designed for half-duplex applications.

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage ( $V_{CC}$ ) 12V

Control Input Voltage -0.5V to ( $V_{CC} + 0.5\text{V}$ )

Driver Input Voltage (DI) -0.5V to ( $V_{CC} + 0.5\text{V}$ )

Driver Output Voltage (A, B) -8V to +12.5V

Receiver Input Voltage (A, B) -8V to +12.5V

Receiver Output Voltage (RO) -0.5V to ( $V_{CC} + 0.5\text{V}$ )

Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )

8-Pin SO (derate 5.88mW/ $^\circ\text{C}$  above  $+70^\circ\text{C}$ )

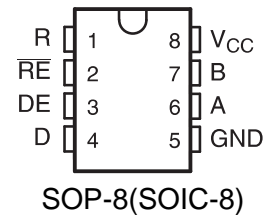
471mW

Operating Temperature Ranges  $0^\circ\text{C}$  to  $+70^\circ\text{C}$

Storage Temperature Range  $-65^\circ\text{C}$  to  $+150^\circ\text{C}$

Lead Temperature (soldering, 10sec)  $+300^\circ\text{C}$

## PIN CONFIGURATION



## FEATURES

- Provide low current shutdown mode
- Provide industry standard SOP-8(SOIC-8) package
- Up to 256 transceivers are allowed to be mounted on the bus
- True fail safe receiver compatible with EIA/TIA-485
- The powerful swing rate control function helps achieve error free data transmission
- Provide enhanced ESD protection for RS-485/RS-422 A/B pins
- HBM human mode:  $\pm 15\text{kV}$   
IEC 61000-4-2: Contact discharge +12kV  
Air discharge  $\pm 15\text{kV}$

## APPLICATIONS

- industrial control
- Electricity, water, and gas meters
- EMI sensitive transceivers
- Application security system
- lighting system
- Instrumentation



### DC ELECTRICAL CHARACTERISTICS

( $V_{CC} = 5V \pm 5\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Differential Driver Output (no load)	$V_{OD1}$				5	V
Differential Driver Output (with load)	$V_{OD2}$	$R = 50\Omega$ (RS-422)	2			V
		$R = 27\Omega$ (RS-485)	1.5		5	
Change in Magnitude of Driver Differential Output Voltage for Complementary Output States	$\Delta V_{OD}$	$R = 27\Omega$ or $50\Omega$			0.2	V
Driver Common-Mode Output Voltage	$V_{OC}$	$R = 27\Omega$ or $50\Omega$			3	V
Change in Magnitude of Driver Common-Mode Output Voltage for Complementary Output States	$\Delta V_{OD}$	$R = 27\Omega$ or $50\Omega$			0.2	V
Input High Voltage	$V_{IH}$	DE, DI, $\overline{RE}$	2.0			V
Input Low Voltage	$V_{IL}$	DE, DI, $\overline{RE}$			0.8	V
Input Current	$I_{IN1}$	DE, DI, RE			$\pm 2$	$\mu A$
Input Current (A, B)	$I_{IN2}$	DE = 0V; $V_{CC} = 0V$ or $5.25V$ ,	$V_{IN} = 12V$		1.0	mA
			$V_{IN} = -7V$		-0.8	
Receiver Differential Threshold Voltage	$V_{TH}$	$-7V \leq V_{CM} \leq 12V$	-0.2		0.2	V
Receiver Input Hysteresis	$\Delta V_{TH}$	$V_{CM} = 0V$		70		mV
Receiver Output High Voltage	$V_{OH}$	$I_O = -4mA$ , $V_{ID} = 200mV$	3.5			V
Receiver Output Low Voltage	$V_{OL}$	$I_O = 4mA$ , $V_{ID} = -200mV$			0.4	V
Three-State (high impedance) Output Current at Receiver	$I_{OZR}$	$0.4V \leq V_O \leq 2.4V$			$\pm 1$	$\mu A$
Receiver Input Resistance	$R_{IN}$	$-7V \leq V_{CM} \leq 12V$	48			k $\Omega$

### DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = 5V \pm 5\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
No-Load Supply Current	$I_{CC}$	DE = $V_{CC}$		300	500	$\mu A$
		$\overline{RE} = 0V$ or $V_{CC}$		230	400	
		DE = 0V				
Driver Short-Circuit Current,						
	$I_{OSD1}$	$-7V \leq V_O \leq 12V$	35		250	mA
$V_O =$ High						
Driver Short-Circuit Current,						
	$I_{OSD2}$	$-7V \leq V_O \leq 12V$	35		250	mA
$V_O =$ Low						
Receiver Short-Circuit Current	$I_{OSR}$	$0V \leq V_O \leq V_{CC}$	7		95	mA



### SWITCHING CHARACTERISTICS

( $V_{CC} = 5V \pm 5\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Input to Output	t <sub>PLH</sub>	R <sub>DIFF</sub> = 54Ω	10	40	60	ns
	t <sub>PHL</sub>	C <sub>L1</sub> = C <sub>L2</sub> = 100pF	10	40	60	
Driver Output Skew to Output	t <sub>SKEW</sub>	R <sub>DIFF</sub> = 54Ω, C <sub>L1</sub> = C <sub>L2</sub> = 100pF		5	10	ns
Driver Enable to Output High	t <sub>ZH</sub>	C <sub>L</sub> = 100pF, S2 closed		45	70	ns
Driver Enable to Output Low	t <sub>ZL</sub>	C <sub>L</sub> = 100pF, S1 closed		45	70	ns
Driver Disable Time from Low	t <sub>LZ</sub>	C <sub>L</sub> = 15pF, S1 closed		45	70	ns
Driver Disable Time from High	t <sub>HZ</sub>	C <sub>L</sub> = 15pF, S2 closed		45	70	ns
t <sub>PLH</sub> - t <sub>PHL</sub>   Differential	t <sub>SKD</sub>	R <sub>DIFF</sub> = 54Ω		5		ns
Receiver Skew		C <sub>L1</sub> = C <sub>L2</sub> = 100pF				
Receiver Enable to Output Low	t <sub>ZL</sub>	C <sub>RL</sub> = 15pF, S1 closed		20	50	ns
Receiver Enable to Output High	t <sub>ZH</sub>	C <sub>RL</sub> = 15pF, S2 closed		20	50	ns
Receiver Disable Time from Low	t <sub>LZ</sub>	C <sub>RL</sub> = 15pF, S1 closed		20	50	ns
Receiver Disable Time from High	t <sub>HZ</sub>	C <sub>RL</sub> = 15pF, S2 closed		20	50	ns
Maximum Data Rate	f <sub>MAX</sub>		2.5			Mbps

### TABLE OF MAX1487ESA OPERATION

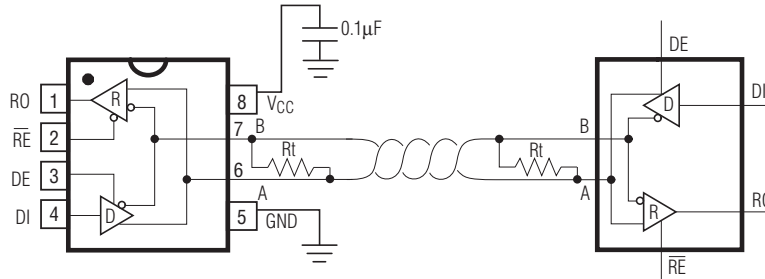
Transmission					Receipt			
Inputs			Outputs X		Inputs			Outputs
RE	DE	DI	A	B	RE	DE	A-B	RO
X	1	1	H	L	0	X	+0.2V	H
X	1	0	L	H	0	X	-0.2V	L
0	0	X	Z	Z	0	X	Inputs open	H
1	0	X	Z(shutdown)		1	X	X	Z

X-Any level

Z-High resistance



## Typical Operating Circuit



## Applications Information

The MAX1487ESA is low-power transceivers for RS-485 and RS-422 communications. The MAX1487ESA is intended for harsh environments where high-speed communication is important. The device eliminates the need for transient suppressor diodes and the associated high capacitance loading.

The MAX1487ESA can transmit and receive at data rates up to 2.5Mbps. The MAX1487ESA is half-duplex. In addition, driver-enable (DE) and receiver-enable (RE) pins are included on the MAX1487ESA. When disabled, the driver and receiver outputs are high impedance.

## Applications Information

The transmitter outputs and receiver inputs of this product family is characterized for protection to  $\pm 15\text{kV}$  using the Human Body Model.

## 128 Transceivers on the Bus

The  $48\text{k}\Omega$ , 1/4-unit-load receiver input impedance of the MAX1487ESA allows up to 128 transceivers on a bus, compared to the 1-unit load ( $12\text{k}\Omega$  input impedance) of standard RS-485 drivers (32 transceivers maximum). Any combination of MAX1487ESA and other RS-485 transceivers with a total of 32 unit loads or less can be put on the bus.

It takes the drivers and receivers longer to become enabled from the low-power shutdown state ( $t_{ZH}(\text{SHDN})$ ,  $t_{ZL}(\text{SHDN})$ ) than from the operating mode ( $t_{ZH}$ ,  $t_{ZL}$ ). (The parts are in operating mode if the RE, DE inputs equal a logical 0, 1 or 1, 1 or 0, 0.)

## Driver Output Protection

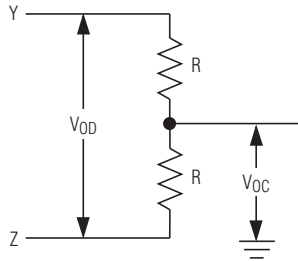
Excessive output current and power dissipation caused by faults or by bus contention are prevented by two mechanisms. A foldback current limit on the output stage provides immediate protection against short circuits over the whole common-mode voltage range (see Typical Operating Characteristics). In addition, a thermal shut-down circuit forces the driver outputs into a high-impedance state if the die temperature rises excessively.

## Propagation Delay

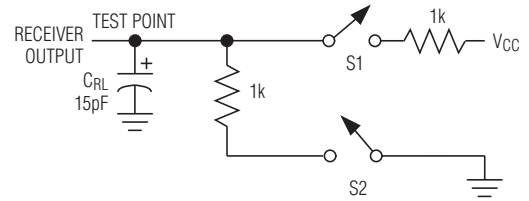
The difference in receiver delay times,  $t_{PLH} - t_{PHL}$ , is typically under 13ns for the MAX1487ESA. The driver skew times are typically 5ns (10ns max).



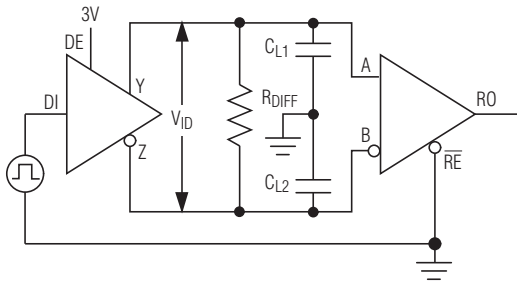
### Driver DC Test Load



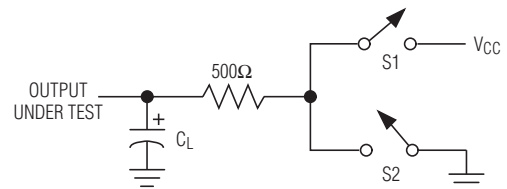
### Receiver Timing Test Load



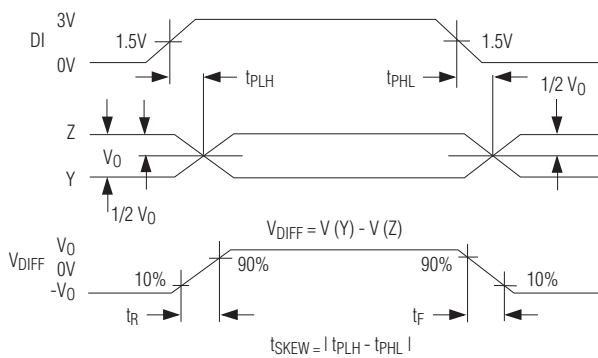
### Driver/Receiver Timing Test Circuit



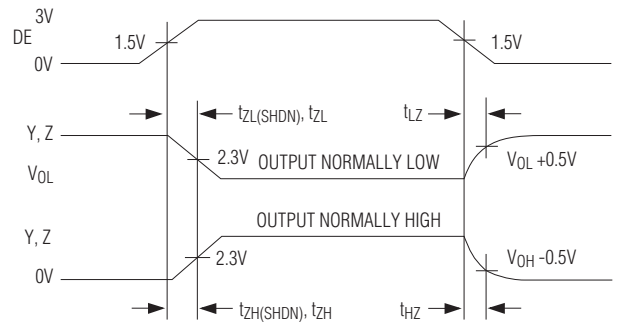
### Driver Timing Test Load



### Driver Propagation Delays

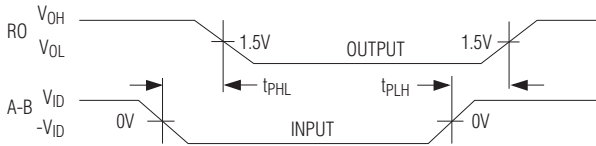


### Driver Enable and Disable Times

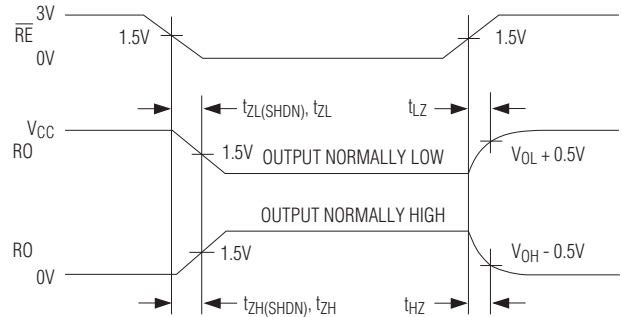




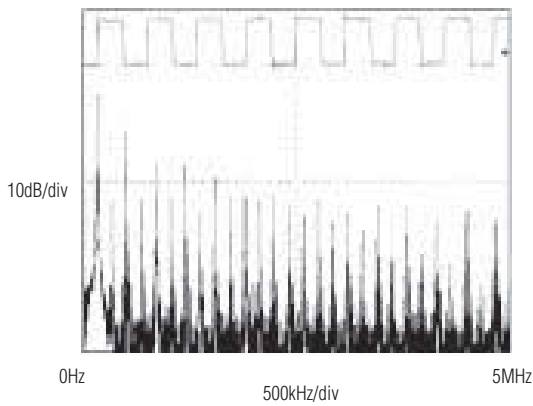
### Receiver Propagation Delays



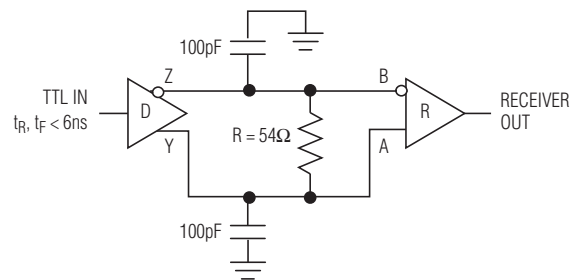
### Receiver Enable and Disable Times



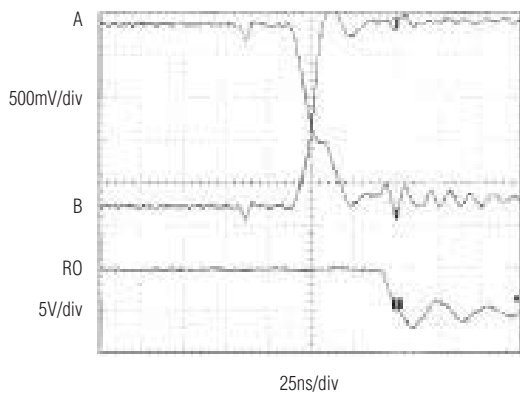
### Driver Output Waveform and FFT Plot Transmitting a 150kHz Signal



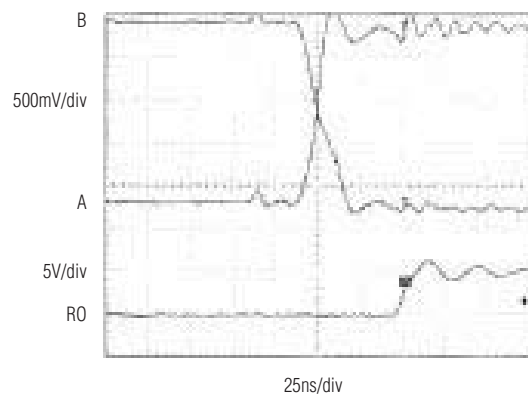
### Receiver Propagation Delay Test Circuit



### Receiver tPHL

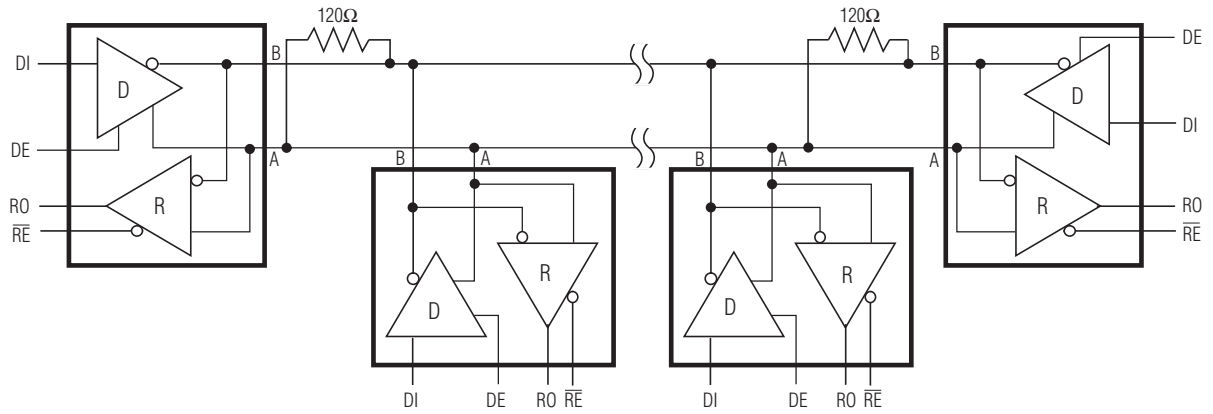


### Receiver tPLH





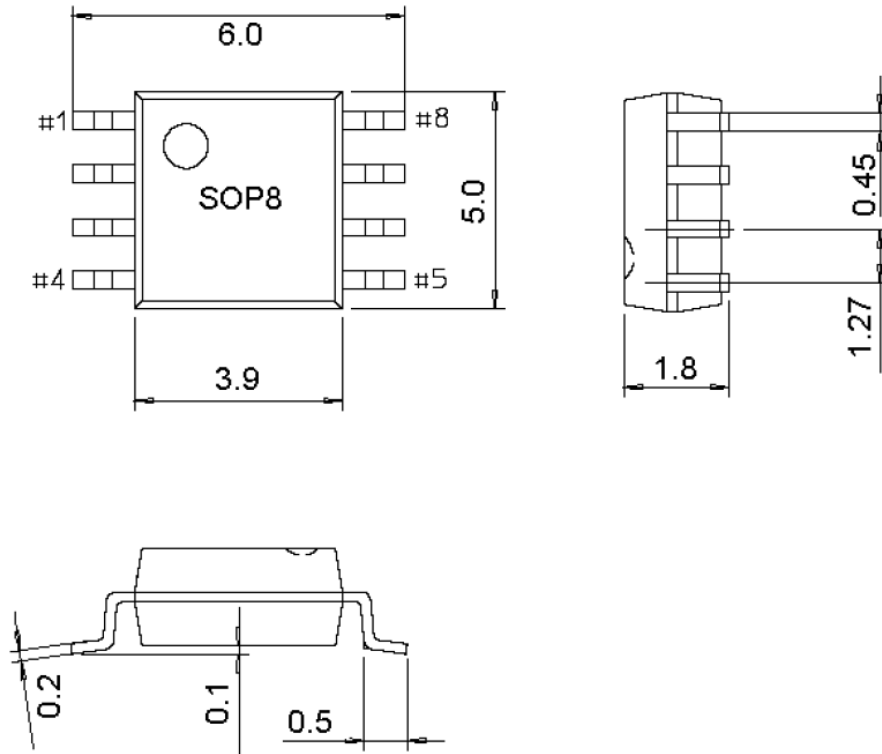
### Typical Half-Duplex RS-485 Network





## PACKAGE OUTLINE DIMENSIONS

### SOP-8(SOIC-8)







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