



+5V, Fail-Safe, 20Mbps, Profibus RS-485/ RS-422 Transceivers

MAX3460-MAX3464

General Description

The MAX3460–MAX3464 are high-speed differential bus transceivers for RS-485 and RS-422 communications. They are designed to meet TIA/EIA-422-B, TIA/EIA-485-A, V.11, and X.27 standards. The transceiver complies with the Profibus specification providing +2.1V output level with a 54Ω load, 20Mbps data rate, and output skew less than 2ns. Each part contains one three-state differential line driver and one differential input line receiver. The devices operate from a +5V supply and feature true fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted. This enables all receiver outputs on a terminated bus to output logic highs when all transmitters are disabled.

All devices feature a 1/4 standard unit load receiver input impedance that allows 128 transceivers on the bus. Driver and receiver propagation delays are guaranteed under 20ns for multidrop, clock distribution applications. Drivers are short-circuit current limited and are protected against excessive power dissipation by thermal shutdown circuitry. The driver and receiver feature active-high and active-low enables, respectively, that can be connected together externally to serve as a direction control.

Applications

High-Speed RS-485 Communications
High-Speed RS-422 Communications
Level Translators
Industrial-Control Local Area Networks
Profibus Applications

Features

- ◆ Recommended for Profibus Applications
- ◆ Guaranteed 20Mbps Data Rate
- ◆ 20ns Transmitter and Receiver Propagation Delay
- ◆ 2ns Transmitter and Receiver Skew
- ◆ High Differential Driver Output Level (2.1V on 54Ω)
- ◆ Hot-Swap Versions
- ◆ 1μA Shutdown Supply Current
- ◆ Low Supply Current Requirements (2.5mA typ)
- ◆ Allow Up to 128 Transceivers on the Bus
- ◆ True Fail-Safe Receiver while Maintaining EIA/TIA-485 Compatibility
- ◆ Designed for Multipoint Transmissions on Long or Noisy Bus Lines
- ◆ Full Duplex and Half Duplex Versions Available
- ◆ Phase Controls to Correct for Twisted-Pair Reversal for 14-Pin Versions
- ◆ Current-Limiting and Thermal Shutdown for Driver Overload Protection

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX3460CSD	0°C to +70°C	14 SO
MAX3460CPD	0°C to +70°C	14 Plastic DIP
MAX3460ESD	-40°C to +85°C	14 SO
MAX3460EPD	-40°C to +85°C	14 Plastic DIP

Ordering Information continued at end of data sheet.

Pin Configurations appear at end of data sheet.

Selector Guide

PART NUMBER	HALF/FULL DUPLEX	RECEIVER/DRIVER ENABLE	LOW-POWER SHUTDOWN	HOT SWAP	RECEIVER/DRIVER PHASE SELECT	INDEPENDENT SHDN PIN	PIN COUNT
MAX3460	Full	Yes	Yes	Yes	Yes	Yes	14
MAX3461	Full	Yes	Yes	No	Yes	Yes	14
MAX3462	Full	No	No	No	No	No	8
MAX3463	Half	Yes	Yes	Yes	No	No	8
MAX3464	Half	Yes	Yes	No	No	No	8



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ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC}) to GND	-0.3V to +6V	Continuous Power Dissipation ($T_A = +70^\circ\text{C}$)	
Control Input Voltage (\overline{RE} , DE, DI, SHDN, TXP, RXP) to GND.....	-0.3V to ($V_{CC} + 0.3V$)	8-Pin SO (derate 5.88mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....	471mW
Driver Output Voltage (Y, Z) to GND.....	-8V to +13V	8-Pin DIP (derate 9.09mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....	727mW
Receiver Input Voltage (A, B) to GND.....	-8V to +13V	14-Pin SO (derate 8.33mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....	667mW
Differential Driver Output Voltage (Y - Z).....	$\pm 8V$	14-Pin DIP (derate 10mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....	800mW
Differential Receiver Input (A - B).....	$\pm 8V$	Operating Temperature Range	
Receiver Output Voltage (RO).....	-0.3V to ($V_{CC} + 0.3V$)	MAX346_C_.....	0°C to $+70^\circ\text{C}$
Output Driver Current (Y, Z)	$\pm 250\text{mA}$	MAX346_E_.....	-40°C to $+85^\circ\text{C}$
		Junction Temperature	$+150^\circ\text{C}$
		Storage Temperature Range	-65°C to $+150^\circ\text{C}$
		Lead Temperature (soldering, 10s)	$+300^\circ\text{C}$

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

($V_{CC} = +5V \pm 5\%$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $V_{CC} = +5V$ and $T_A = +25^\circ\text{C}$.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Power-Supply Range	V_{CC}		4.75		5.25	V	
DRIVER							
Differential Driver Output (no load)	V_{OD}	Figure 5, $R = \infty$			V_{CC}	V	
Differential Driver Output	V_{OD}	Figure 5, $R = 27\Omega$	2.1			V	
Change in Magnitude of Differential Output Voltage	ΔV_{OD}	Figure 5, $R = 50\Omega$ or 27Ω (Note 2)			0.2	V	
Driver Common-Mode Output Voltage	V_{OC}	Figure 5, $R = 50\Omega$ or 27Ω			3	V	
Change in Magnitude of Common-Mode Voltage	ΔV_{OC}	Figure 5, $R = 50\Omega$ or 27Ω (Note 2)			0.2	V	
Input High Voltage	V_{IH}	DE, DI, \overline{RE} , SHDN	2.0			V	
Input Low Voltage	V_{IL}	DE, DI, \overline{RE} , SHDN			0.8	V	
Input Hysteresis	V_{HYS}	DE, DI, \overline{RE} , SHDN		50		mV	
Output Leakage (Y and Z) Full Duplex	I_O	DE = GND, $V_{CC} =$ GND or +5.25V	$V_{IN} = +12V$ $V_{IN} = -7V$		+125	μA	
Input Current	I_{IN}	DI, \overline{RE} , DE, SHDN			± 1	μA	
Pulldown Current		RXP = TXP = V_{CC}	5	15	30	μA	
Driver Short-Circuit Output Current (Note 3)	I_{OSD}	$0 \leq V_{OUT} \leq 12V$, output low $-7V \leq V_{OUT} \leq V_{CC}$, output high			+250	mA	
Driver Short-Circuit Foldback Output Current (Note 3)	I_{OSFD}	$(V_{CC} - 1V) \leq V_{OUT} \leq 12V$, output low $-7V \leq V_{OUT} \leq 1V$, output high	+25		-25	mA	
Thermal Shutdown Threshold				140		$^\circ\text{C}$	
RECEIVER							
Differential Input Capacitance	$C_{A, B}$			8		pF	
Input Current (A and B) Full Duplex	$I_{A, B}$	DE = GND, $V_{CC} =$ GND or 5.25V	$V_{IN} = +12V$ $V_{IN} = -7V$		250	μA	
Receiver Differential Threshold Voltage	V_{TH}	$-7V \leq V_{CM} \leq 12V$		-200	-125	-50	mV

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ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} = +5V \pm 5\%$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $V_{CC} = +5V$ and $T_A = +25^\circ C$.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Input Hysteresis	ΔV_{TH}	$V_A + V_B = 0$		20		mV
Receiver Output High Voltage	V_{OH}	$I_O = -4mA$, $V_A - V_B = V_{TH}$	$V_{CC} - 1.5$			V
Receiver Output Low Voltage	V_{OL}	$I_O = 4mA$, $V_B - V_A = V_{TH}$			0.4	V
Three-State Output Current at Receiver	I_{OZR}	$0 \leq V_O \leq V_{CC}$			± 1	μA
Receiver Input Resistance	R_{IN}	$-7V \leq V_{CM} \leq 12V$	48			$k\Omega$
Receiver Output Short-Circuit Current	I_{OSR}	$0 \leq V_{RO} \leq V_{CC}$	± 7		± 95	mA
SUPPLY CURRENT						
Normal Operation (static condition)	I_Q	No load, $DI = V_{CC}$ or $DI = GND$		2.5	4	mA
Supply Current in SHDN	I_{SHDN}	$DE = GND$ and $\overline{RE} = V_{CC}$, or $SHDN = V_{CC}$		1	10	μA
SWITCHING CHARACTERISTICS						
Driver Propagation Delay	t_{PLH}	Figures 6 and 7, $R_{DIFF} = 54\Omega$, $C_L = 50pF$			20	ns
	t_{PHL}					
Driver Differential Output Rise or Fall Time	t_R	Figures 6 and 7, $R_{DIFF} = 54\Omega$, $C_L = 50pF$			20	ns
	t_F					
Driver Output Skew $ t_{PLH} - t_{PHL} $	t_{SKEW}	Figures 6 and 7, $R_{DIFF} = 54\Omega$, $C_L = 50pF$, $TXP = GND$ or floating			2	ns
Maximum Data Rate			20			Mbps
Driver Enable to Output High	t_{ZH}	Figures 8 and 9, S2 closed, $R_L = 500\Omega$, $C_L = 50pF$			100	ns
Driver Enable to Output Low	t_{ZL}	Figures 8 and 9, S1 closed, $R_L = 500\Omega$, $C_L = 50pF$			100	ns
Driver Disable Time from Low	t_{LZ}	Figures 8 and 9, S1 closed, $R_L = 500\Omega$, $C_L = 50pF$			100	ns
Driver Disable Time from High	t_{HZ}	Figures 8 and 9, S2 closed, $R_L = 500\Omega$, $C_L = 50pF$			100	ns
Receiver Propagation Delay	t_{PLH}	Figure 10, $C_L = 15pF$ (Note 4)			20	ns
	t_{PHL}					
Receiver Output Skew $ t_{PLH} - t_{PHL} $	t_{SKEW}	Figure 10, $C_L = 15pF$, $RXP = GND$ or floating (Note 4)			2	ns
Receiver Enable to Output Low	t_{ZL}	Figures 8 and 11, $R_L = 1k\Omega$, $C_L = 15pF$, S1 closed (Note 4)			100	ns
Receiver Enable to Output High	t_{ZH}	Figures 8 and 11, $R_L = 1k\Omega$, $C_L = 15pF$, S2 closed (Note 4)			100	ns
Receiver Disable Time from Low	t_{LZ}	Figures 8 and 11, $R_L = 1k\Omega$, $C_L = 15pF$, S1 closed (Note 4)			100	ns
Receiver Disable Time from High	t_{HZ}	Figures 8 and 11, $R_L = 1k\Omega$, $C_L = 15pF$, S2 closed (Note 4)			100	ns

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ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} = +5V \pm 5\%$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $V_{CC} = +5V$ and $T_A = +25^\circ C$.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Time to Shutdown	t_{SHDN}	(Note 5)	50		800	ns
Driver Enable from Shutdown to Output High	$t_{ZH} (SHDN)$	Figures 8 and 9, $R_L = 500\Omega$, $C_L = 50pF$, S2 closed (Note 5)			4	μs
Driver Enable from Shutdown to Output Low	$t_{ZL} (SHDN)$	Figures 8 and 9, $R_L = 500\Omega$, $C_L = 50pF$, S1 closed (Note 5)			4	μs
Receiver Enable from Shutdown to Output High	$t_{ZH} (SHDN)$	Figures 8 and 11, $R_L = 1k\Omega$, $C_L = 15pF$, S2 closed (Notes 4, 5)			4	μs
Receiver Enable from Shutdown to Output Low	$t_{ZL} (SHDN)$	Figures 8 and 11, $R_L = 1k\Omega$, $C_L = 15pF$, S1 closed (Notes 4, 5)			4	μs

Note 1: All currents into the device are positive; all currents out of the device are negative. All voltages are referenced to device ground, unless otherwise noted.

Note 2: ΔV_{OD} and ΔV_{OC} are the changes in V_{OD} and V_{OC} , respectively, when the DI input changes state.

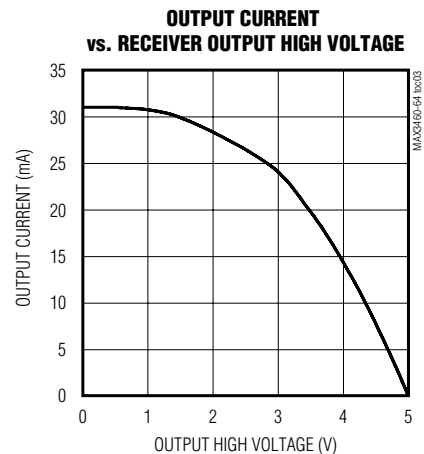
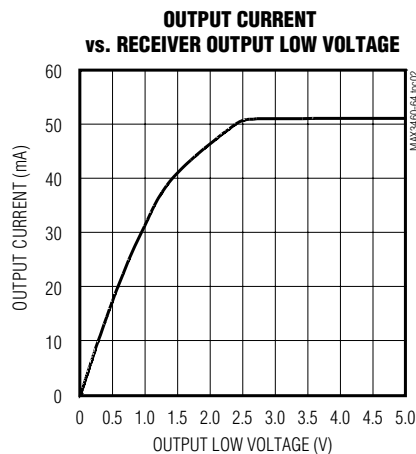
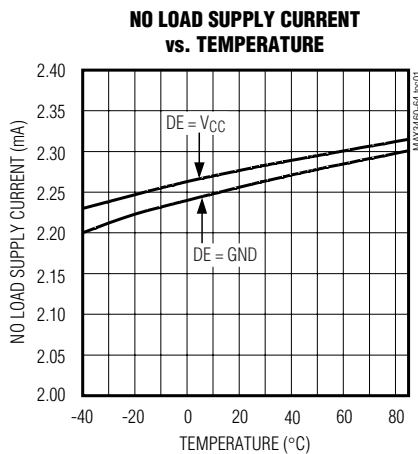
Note 3: The short-circuit output current applies to peak current just prior to foldback-current limiting; the short-circuit foldback output current applies during current limiting to allow a recovery from bus contention.

Note 4: Capacitive load includes test probe and fixture capacitance.

Note 5: Shutdown is enabled by bringing \overline{RE} high and DE low or by bringing SHDN high. If the enable inputs are in this state for less than 50ns, the device is guaranteed not to enter shutdown. If the enable inputs are in this state for at least 800ns, the device is guaranteed to have entered shutdown.

Typical Operating Characteristics

($V_{CC} = +5V$, $T_A = +25^\circ C$, unless otherwise noted.)

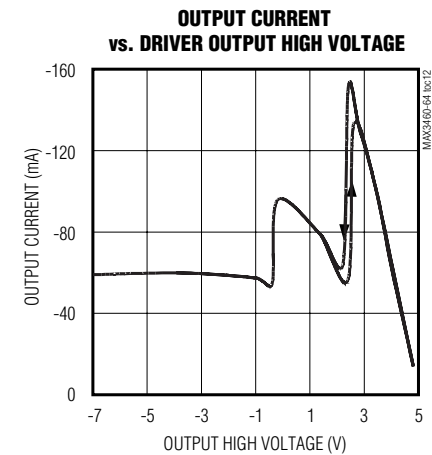
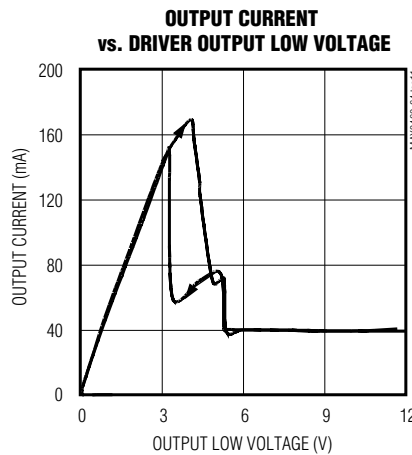
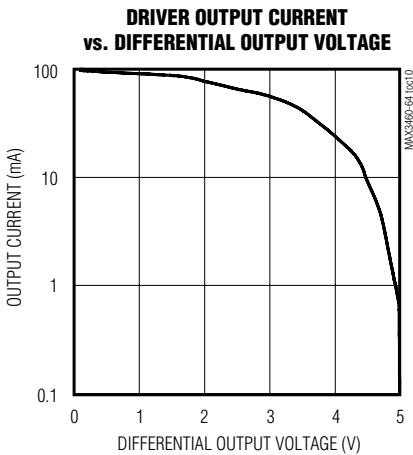
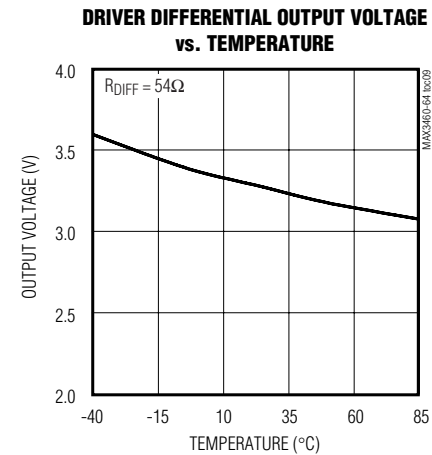
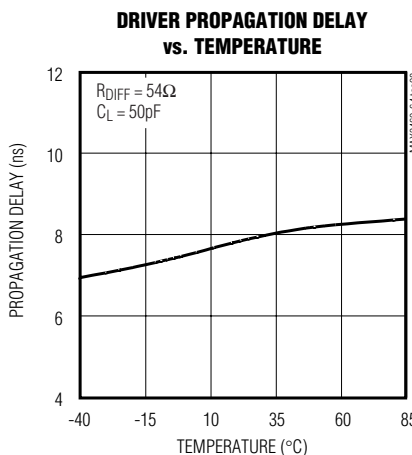
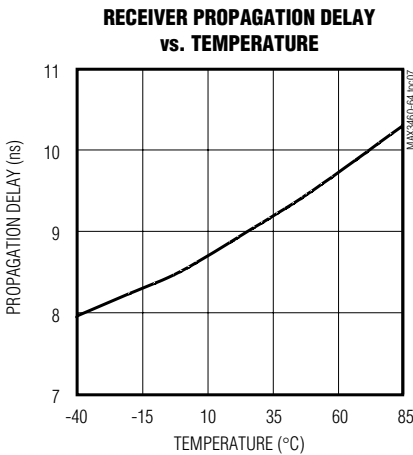
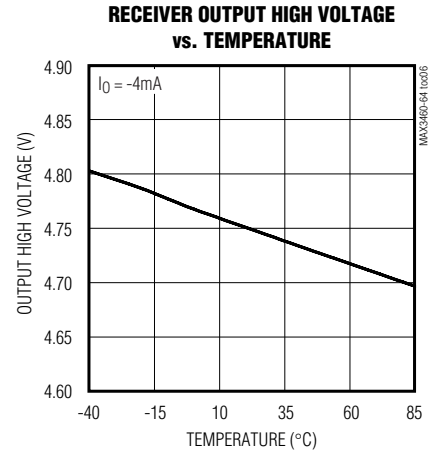
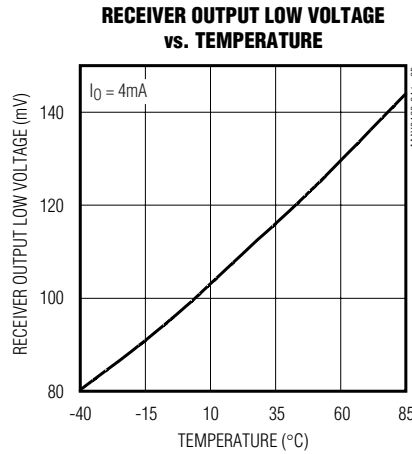
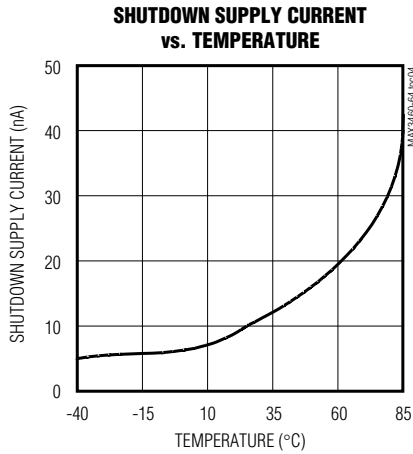


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Typical Operating Characteristics (continued)

($V_{CC} = +5V$, $T_A = +25^\circ C$, unless otherwise noted.)

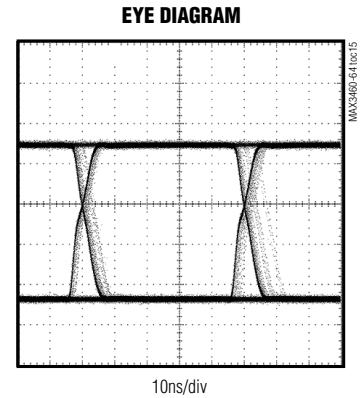
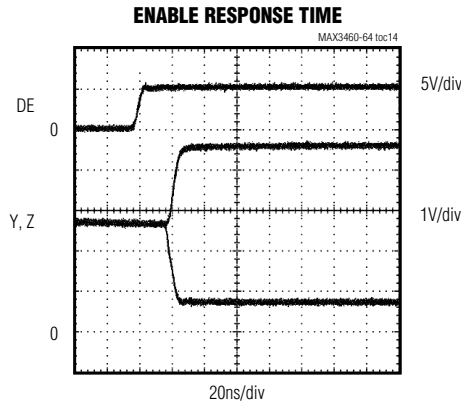
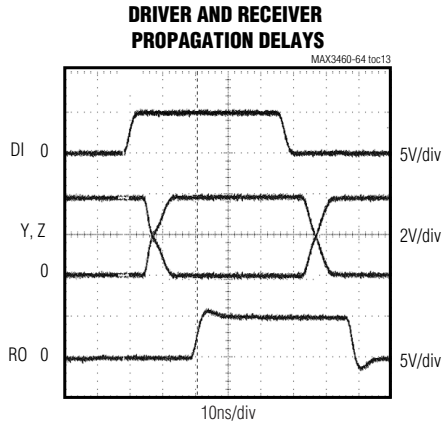
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Typical Operating Characteristics (continued)

(V_{CC} = +5V, T_A = +25°C, unless otherwise noted.)



Pin Description

PIN			NAME	FUNCTION
MAX3460/ MAX3461	MAX3462	MAX3463/ MAX3464		
FULL DUPLEX		HALF DUPLEX		
1	—	—	SHDN	Shutdown. Drive SHDN high to enter low-power shutdown mode.
2	2	1	RO	Receiver Output. When \overline{RE} is low and $(A - B) \geq -50\text{mV}$, RO is high; if $(A - B) \leq -200\text{mV}$, RO is low.
3	—	2	\overline{RE}	Receiver Output Enable. Drive \overline{RE} low to enable RO; RO is high impedance when \overline{RE} is high. Drive \overline{RE} high and DE low to enter low-power shutdown mode.
4	—	3	DE	Driver Output Enable. Drive DE high to enable driver output. These outputs are high impedance when DE is low. Drive \overline{RE} high and DE low to enter low-power shutdown mode.
5	3	4	DI	Driver Input. With DE high, a low on DI forces the noninverting output low and the inverting output high. Similarly, a high on DI forces the noninverting output high and the inverting output low.
6, 7	4	5	GND	Ground
8	—	—	TXP	Transmitter Phase. Connect TXP to GND, or leave unconnected for normal transmitter phase/polarity. Connect TXP to V _{CC} to invert the transmitter phase/polarity. TXP has an internal 15 μA pulldown.
9	5	—	Y	Noninverting Driver Output
10	6	—	Z	Inverting Driver Output
11	7	—	B	Inverting Receiver Input
12	8	—	A	Noninverting Receiver Input
13	—	—	RXP	Receiver Phase. Connect RXP to GND, or leave unconnected for normal receiver phase/polarity. Connect RXP to V _{CC} to invert the receiver phase/polarity. RXP has an internal 15 μA pulldown.
14	1	8	V _{CC}	Positive Supply: $+4.75\text{V} \leq V_{CC} \leq +5.25\text{V}$. Bypass V _{CC} to GND with a 0.1 μF capacitor.
—	—	7	B	Inverting Receiver Input and Inverting Driver Output
—	—	6	A	Noninverting Receiver Input and Noninverting Driver Output

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Function Tables

MAX3460-MAX3464

MAX3460/MAX3461

TRANSMITTING					
INPUTS				OUTPUTS	
\overline{RE}	DE	DI	SHDN	Z	Y
X	1	1	0	0	1
X	1	0	0	1	0
0	0	X	0	High-Z	High-Z
1	0	X	X	Shutdown	
X	X	X	1	Shutdown	
RECEIVING					
INPUTS				OUTPUT	
\overline{RE}	DE	A-B	SHDN	RO	
0	X	$\geq -0.05V$	0	1	
0	X	$\leq -0.2V$	0	0	
0	X	Open/Shorted	0	1	
1	1	X	0	High-Z	
1	0	X	X	Shutdown	
X	X	X	1	Shutdown	

MAX3462

TRANSMITTING		
INPUT	OUTPUTS	
DI	Z	Y
1	0	1
0	1	0
RECEIVING		
INPUTS	OUTPUT	
A-B	RO	
$\geq -0.05V$	1	
$\leq -0.2V$	0	
Open/Shorted	1	

MAX3463/MAX3464

TRANSMITTING				
INPUTS			OUTPUTS	
\overline{RE}	DE	DI	B	A
X	1	1	0	1
X	1	0	1	0
0	0	X	High-Z	High-Z
1	0	X	Shutdown	
RECEIVING				
INPUTS			OUTPUT	
\overline{RE}	DE	A-B	RO	
0	X	$\geq -0.05V$	1	
0	X	$\leq -0.2V$	0	
0	X	Open/Shorted	1	
1	1	X	High-Z	
1	0	X	Shutdown	

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Pin Configurations and Typical Operating Circuit

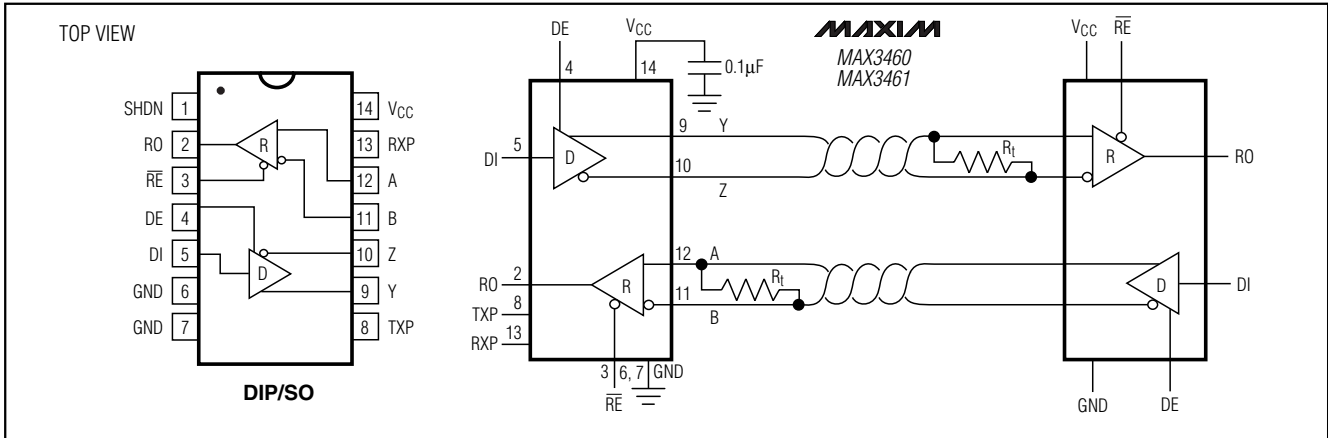


Figure 1. MAX3460/MAX3461 Pin Configuration and Typical Full-Duplex Operating Circuit

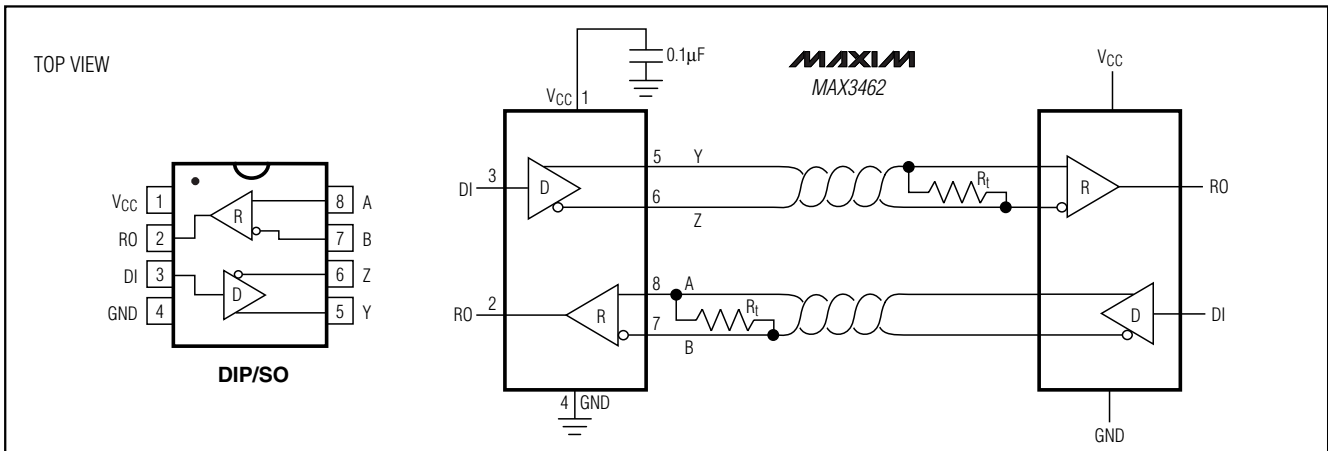


Figure 2. MAX3462 Pin Configuration and Typical Full-Duplex Operating Circuit

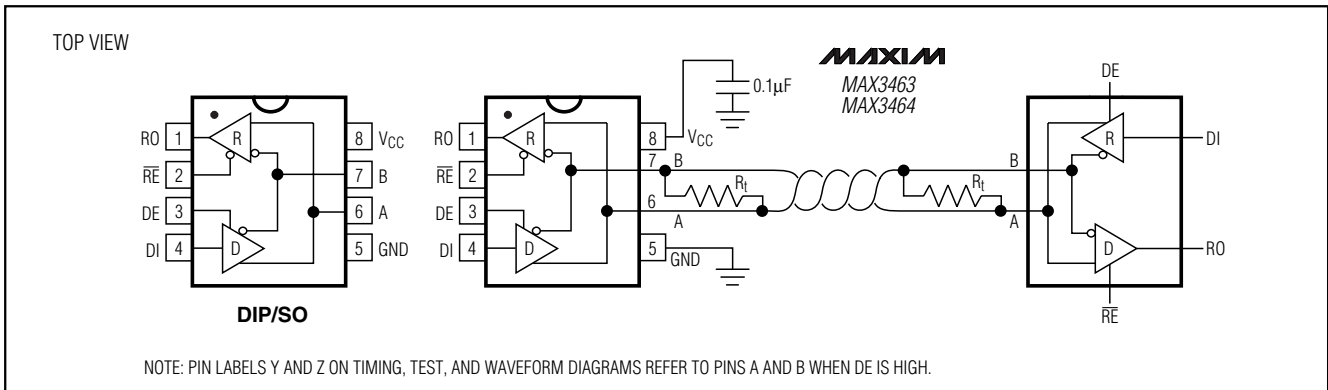


Figure 3. MAX3463/MAX3464 Pin Configuration and Typical Full-Duplex Operating Circuit

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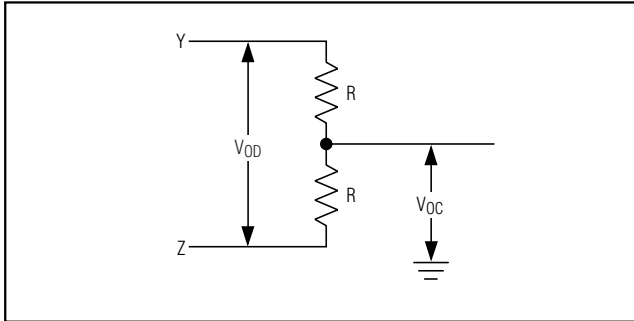


Figure 5. Driver DC Test Load

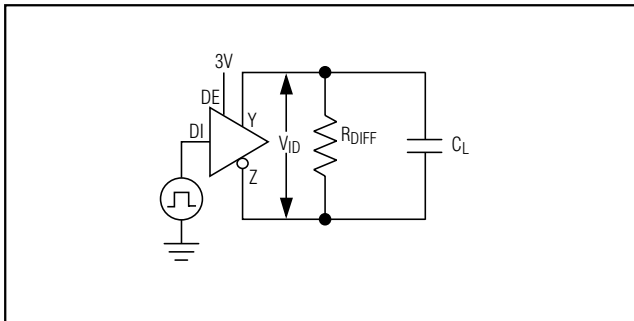


Figure 6. Driver Timing Test Circuit

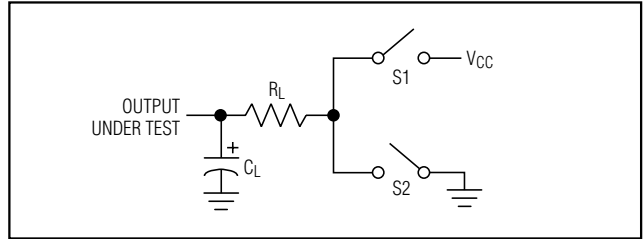


Figure 8. Enable/Disable Timing Test Load

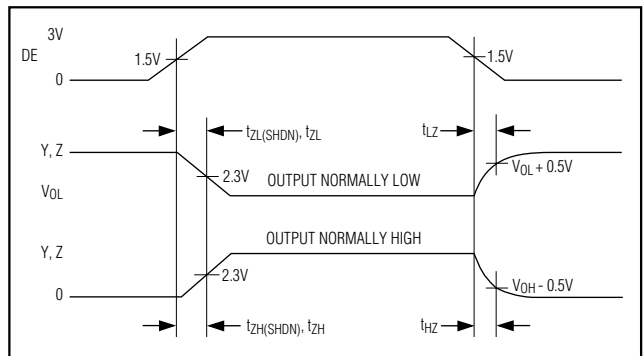


Figure 9. Driver Enable and Disable Times

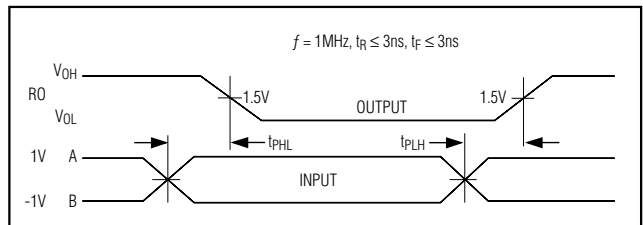


Figure 10. Receiver Propagation Delays

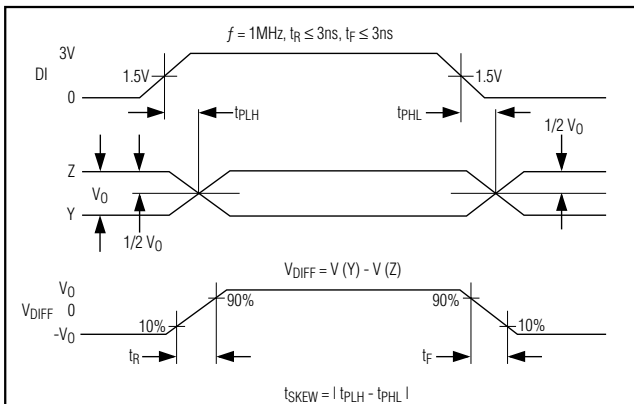


Figure 7. Driver Propagation Delays

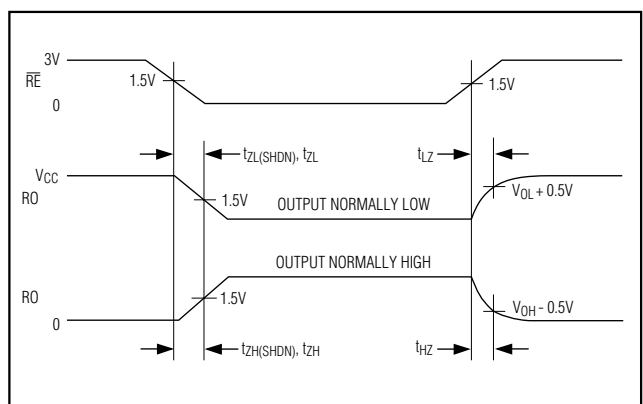


Figure 11. Receiver Enable and Disable Times

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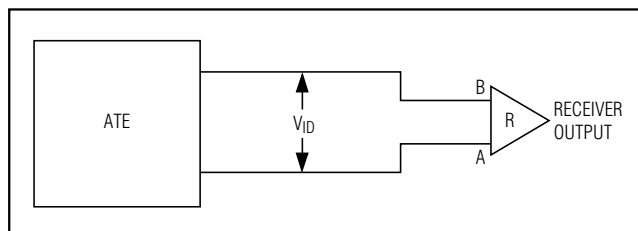


Figure 12. Receiver Propagation Delay Test Circuit

Applications Information

128 Transceivers on the Bus

The standard RS-485 receiver input impedance is $12k\Omega$ (one-unit load), and the standard driver can drive up to 32 unit loads. The MAX3460-MAX3464 family of transceivers has a 1/4-unit-load receiver input impedance ($48k\Omega$), allowing up to 128 transceivers to be connected in parallel on one communication line. Any combination of these devices and/or other RS-485 transceivers with a total of 32 unit loads or less can be connected to the line.

Low-Power Shutdown Mode (except MAX3462)

Low-power shutdown mode is initiated by bringing SHDN high (MAX3460/MAX3461), or both \overline{RE} high and DE low. In shutdown, the devices typically draw only $1\mu A$ of supply current. \overline{RE} and DE can be driven simultaneously; the parts are guaranteed not to enter shutdown if \overline{RE} is high and DE is low for less than 50ns. If the inputs are in this state for at least 800ns, the parts are guaranteed to enter shutdown.

Driver Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or by bus contention. The first, 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*). The second, a thermal shutdown circuit, forces the driver outputs into a

high-impedance state if the die temperature exceeds $+140^\circ C$.

Propagation Delay

Many digital encoding schemes depend on the difference between the driver and receiver propagation delay times. Typical propagation delays are shown in the *Typical Operating Characteristics*. The difference in receiver delay times, $t_{PLH} - t_{PHL}$, is a maximum of 2ns. The driver skew time $t_{PLH} - t_{PHL}$ is also a maximum of 2ns.

Typical Applications

The MAX3460-MAX3464 transceivers are designed for bidirectional data communications on multipoint bus transmission lines. Figures 13 and 14 show typical network applications circuits. To minimize reflections, the line should be terminated at both ends in its characteristic impedance, and stub lengths off the main line should be kept as short as possible.

Profibus Termination

The MAX3460-MAX3464 are designed for driving Profibus termination networks. With a worst-case loading of two termination networks with 220Ω termination impedance and 390Ω pullups and pulldowns, the drivers can drive $V_{A-B} > 2.1V$ output.

Chip Information

TRANSISTOR COUNT: 610

PROCESS: BiCMOS

Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE
MAX3461CSD	$0^\circ C$ to $+70^\circ C$	14 SO
MAX3461CPD	$0^\circ C$ to $+70^\circ C$	14 Plastic DIP
MAX3461ESD	$-40^\circ C$ to $+85^\circ C$	14 SO
MAX3461EPD	$-40^\circ C$ to $+85^\circ C$	14 Plastic DIP
MAX3462CSA	$0^\circ C$ to $+70^\circ C$	8 SO
MAX3462CPA	$0^\circ C$ to $+70^\circ C$	8 Plastic DIP
MAX3462ESA	$-40^\circ C$ to $+85^\circ C$	8 SO
MAX3462EPA	$-40^\circ C$ to $+85^\circ C$	8 Plastic DIP
MAX3463CSA	$0^\circ C$ to $+70^\circ C$	8 SO
MAX3463CPA	$0^\circ C$ to $+70^\circ C$	8 Plastic DIP
MAX3463ESA	$-40^\circ C$ to $+85^\circ C$	8 SO
MAX3463EPA	$-40^\circ C$ to $+85^\circ C$	8 Plastic DIP
MAX3464CSA	$0^\circ C$ to $+70^\circ C$	8 SO
MAX3464CPA	$0^\circ C$ to $+70^\circ C$	8 Plastic DIP
MAX3464ESA	$-40^\circ C$ to $+85^\circ C$	8 SO
MAX3464EPA	$-40^\circ C$ to $+85^\circ C$	8 Plastic DIP

+5V, Fail-Safe, 20Mbps, Profibus RS-485/ RS-422 Transceivers

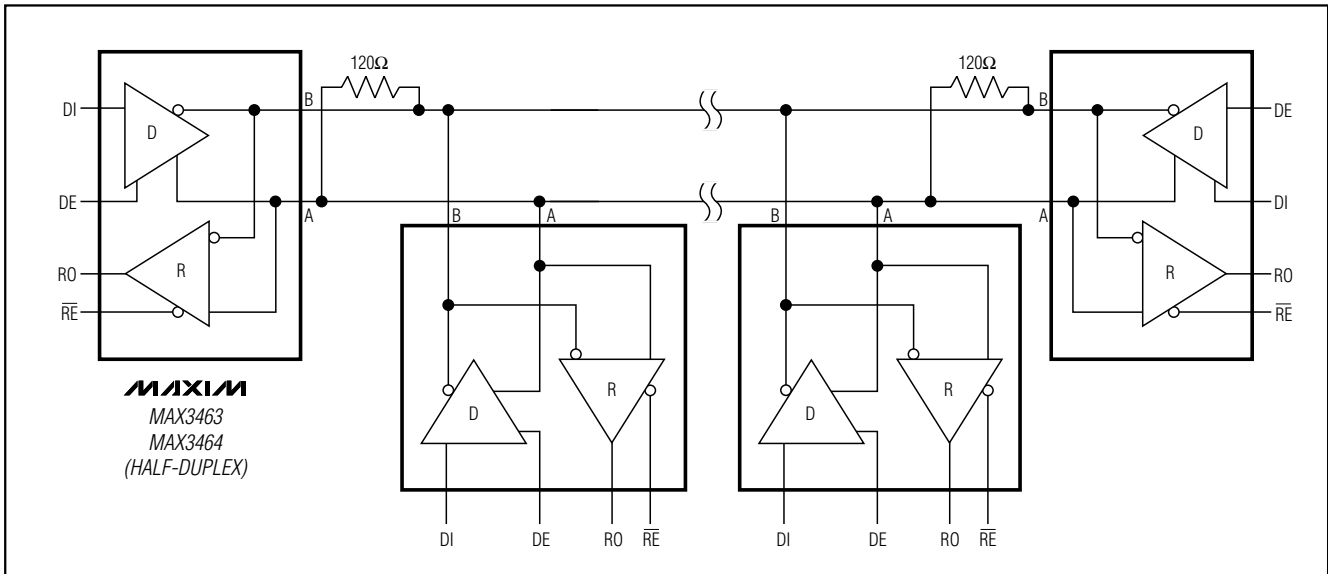


Figure 13. Typical Half-Duplex RS-485 Network

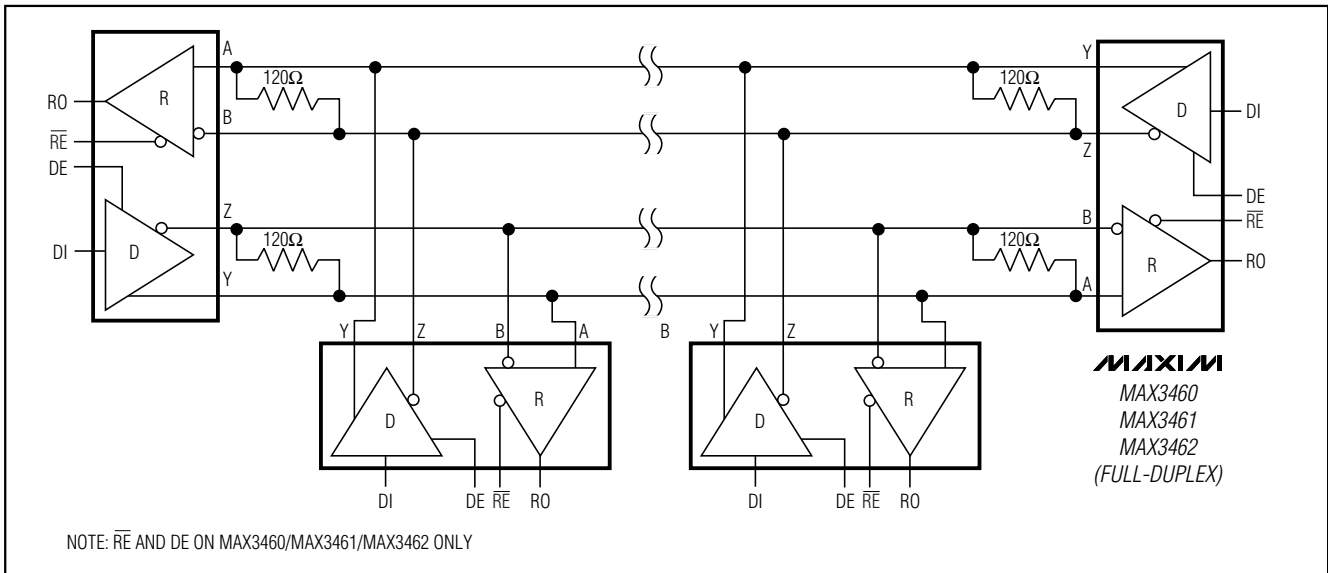


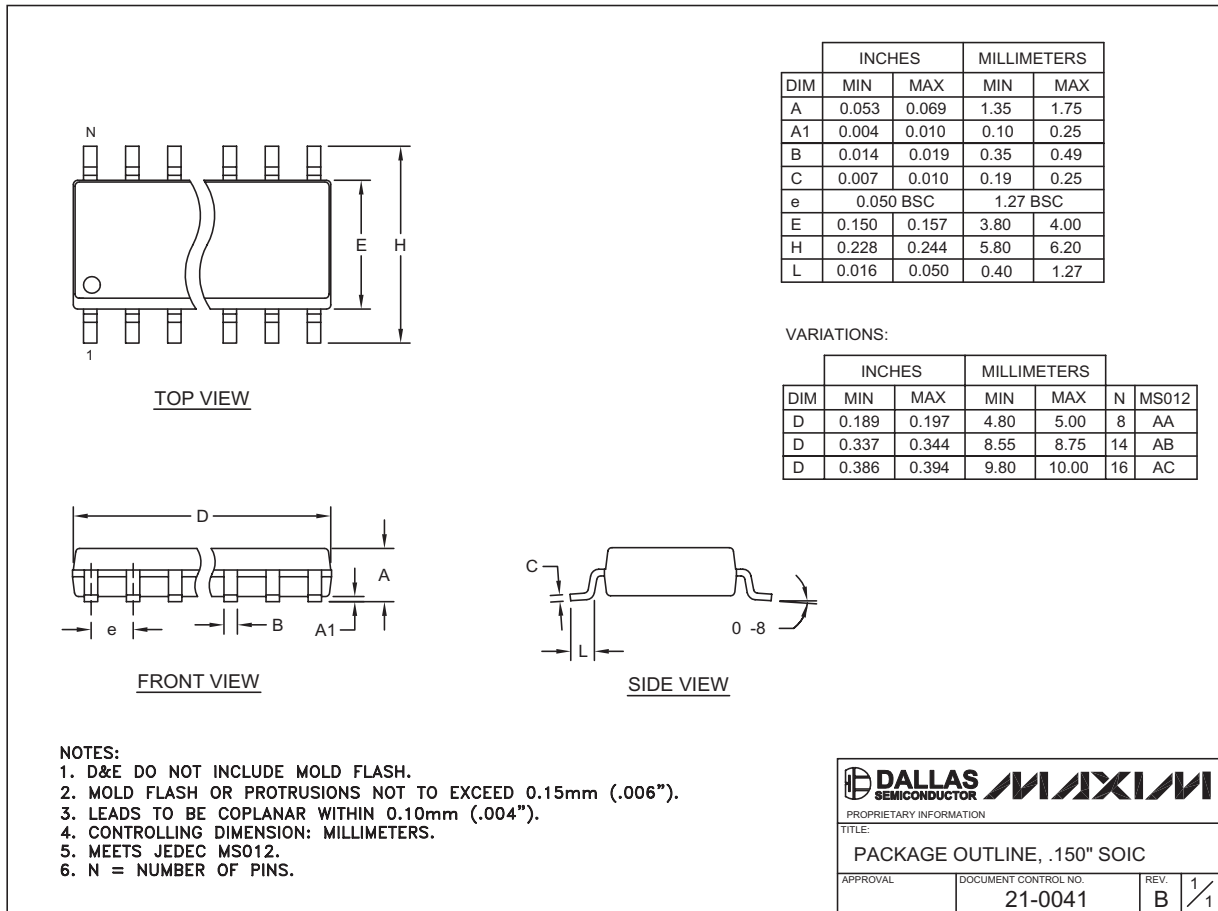
Figure 14. Typical Full-Duplex RS-485 Network

+5V, Fail-Safe, 20Mbps, Profibus RS-485/ RS-422 Transceivers

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to www.maxim-ic.com/packages.)

MAX3460-MAX3464

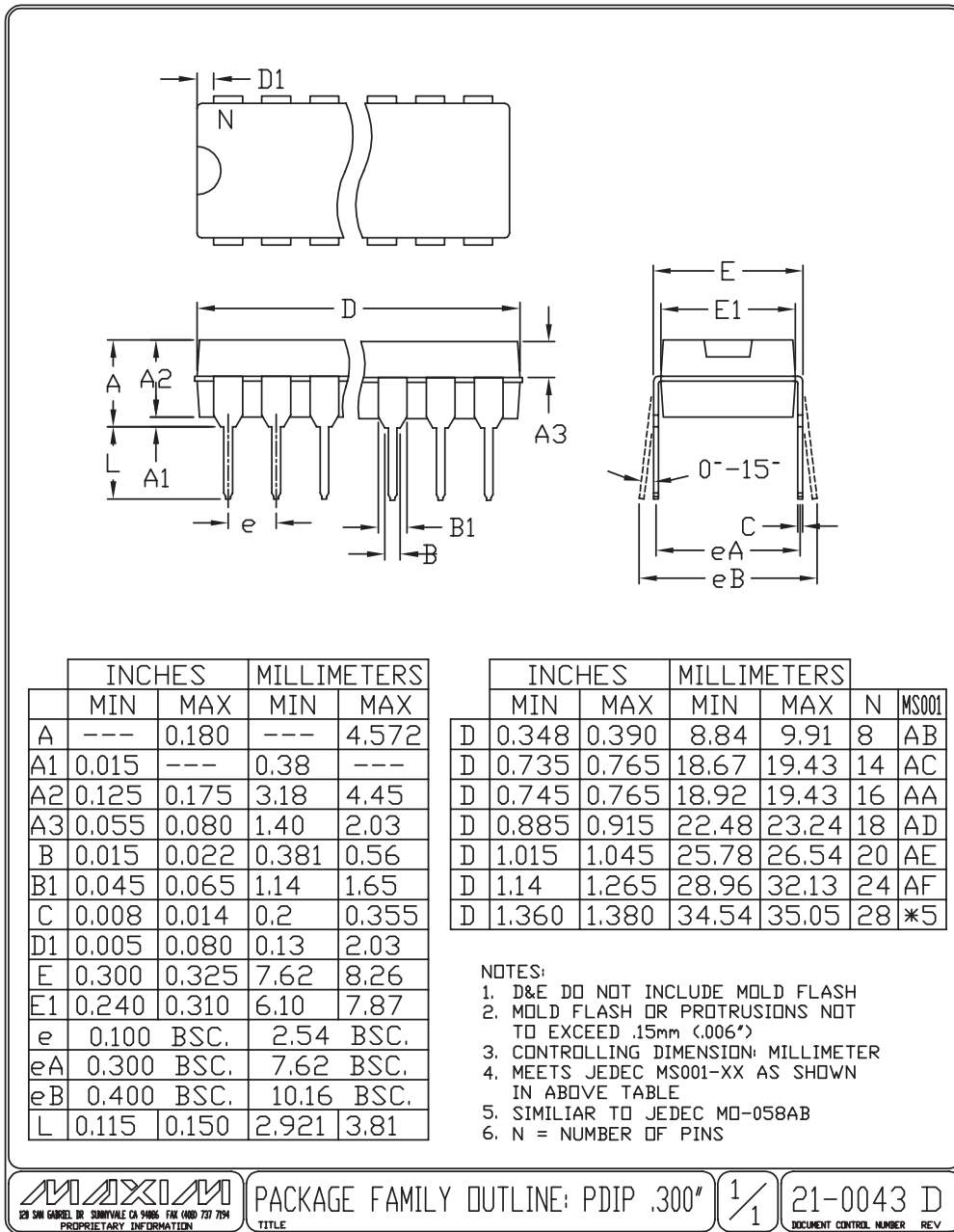


SOICN EPSS

+5V, Fail-Safe, 20Mbps, Profibus RS-485/ RS-422 Transceivers

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to www.maxim-ic.com/packages.)



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