1 FEATURES

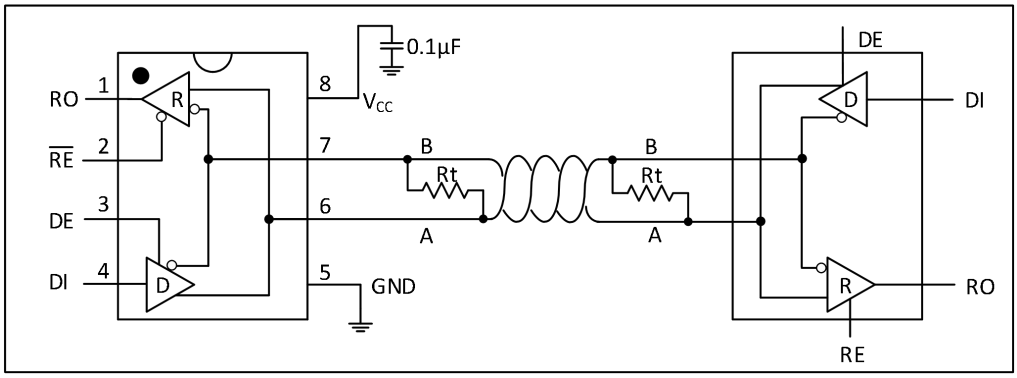
- 3.0~5.5V Operation
- Extended ESD Protection for RS-485/RS-422 I/O Pins ±15kV Human Body Model
- True Fail-Safe Receiver While Maintaining EIA/TIA-485 Compatibility
- Guaranteed 10Mbps Data Rate
- Low-Current Shutdown Mode
- Allow Up to 32 Transceivers on the Bus
- Available in Industry-Standard SOP8 Package

2 APPLICATIONS

- RS-485 Communications
- Level Translators
- Motor Controller
- Industrial Control Local Area Networks
- Energy Meter Networks
- Power Inverters
- Building Automation Networks
- Telecommunications Equipment

3 DESCRIPTION

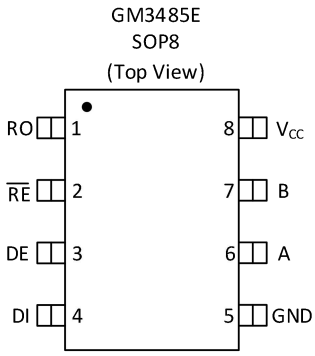
The GM3485E is ±15kV electrostatic discharge (ESD) protected, high-speed transceiver for RS-485 communication that contain one driver and one receiver. The device features fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted. This means that the receiver output will be logic-high even if all transmitters on a terminated bus are disabled. The GM3485E driver slew rate is not limited, making transmit speeds up to 10Mbps possible. All transmitter outputs and receiver inputs are protected to ±15kV using the Human Body Model. The transceiver typically draws 500 micron ampere of supply current when unloaded, or when fully loaded with the driver disabled. This device has a 1-unit-load receiver input impedance that allows up to 32 transceivers on the bus. The GM3485E is intended for half-duplex communications.



TYPICAL HALF-DUPLES APPLICATION CIRCUIT

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4 PIN CONFIGURATION AND FUNCTIONS



No.	Name	Description
1	RO	Receiver Output. When $\overline{RE}$ is low and if (A-B)≥-50mV, RO is high; if (A-B)≤-200mV, RO is low.
2	$\overline{RE}$	Receiver Output Enable.Drive $\overline{RE}$ low to enable the RO;Drive $\overline{RE}$ high to let the RO in high-impedance;Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode.
3	DE	Driver Output Enable.Drive DE high to enable driver outputs;These outputs are high-impedance when DE is low;Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode.
4	DI	Driver Input. With DE high, a low on DI forces non-inverting output low and inverting output high. Similarly, a high on DI forces non-inverting output high and inverting output low.
5	GND	Ground
6	A	Non-inverting Receiver Input and Non-inverting Driver Output
7	B	Inverting Receiver Input and Inverting Driver Output
8	V_{CC}	Positive Supply Vcc =3.0~5.5V.Bypass Vcc to GND with a 0.1μF capacitor.

5 ABSOLUTE MAXIMUM RATINGS(1)

Parameter	Parameter	Rating	UNIT
V_{CC}	Supply Voltage	+6	V
$\overline{RE}$,DE	Control Input Voltage	-0.3 to V_{CC}+0.3	V
DI	Driver Input voltage	-0.3 to V_{CC}+0.3	V
A,B	Receiver Input Voltage	±13	V
A,B	Driver Output Voltage	±13	V
RO	Receiver Output Voltage	-0.3 to (V_{CC}+0.3)	V
P	SO(derate 5.9mW/°C above +70°C)	471	mW
T_{OP}	Operating Temperature Range	-40 to +85	°C
T_J	Junction Temperature	+150	°C
T_{STO}	Storage Temperature Range	-65 to +150	°C
T_L	Lead Temperature(soldering,10s)	+300	°C

1.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.

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6 DC ELECTRICAL CHARACTERISTICS

(V_{CC} = 5V ±5%, T_A = T_{MIN} to T_{MAX}.Typical values are at V_{CC}=+5V,T_A=25°C, unless otherwise noted.) (1)

Symbol	Parameter	Test Conditions		MIN	TYP	MAX	UNIT
Driver							
V_{CC}	Supply voltage			3.0		5.5	V
V_{OD1}	Differential Driver Output(No load)	No load		4.0		5.0	V
V_{OD2}	Differential Driver Output	RL=54Ω,V_{CC}=5V,Figure 1		2.5	3.1	4.0	V
		RL=54Ω,V_{CC}=3.3V,Figure 1		1.5	1.7	2.0	V
ΔV_{OD}	Change in Magnitude of Differential Output Voltage(2)	RL=54Ω,Figure 1				0.2	V
V_{OC}	Driver Common- Mode Output Voltage	RL=54Ω,Figure 1		1.0		3	V
ΔV_{OC}	Change in Magnitude of Common- Mode Voltage(2)	RL=54Ω,Figure 1				0.2	V
V_{IH1}	Input-High Voltage	DE,DI, $\overline{RE}$		2.0			V
V_{IL1}	Input-Low Voltage	DE,DI, $\overline{RE}$				0.8	V
V_{HYS}	Input Hysteresis	DI			100		mV
I_{IN1}	Input Current(A,B)	DE=GND,V_{CC}=GND or 5V	V_{IN}=12V			500	μA
			V_{IN}=-7V	-500			
I_{OSD}	Driver Short-Circuit Output Current(3)	0≤V_{OUT}≤+12V(3)				250	mA
		-7V≤V_{OUT}≤V_{CC}(3)		-250			
		0≤V_{OUT}≤V_{CC}(3)		±25			
Receiver							
V_{TH}	Receiver Differential Threshold Voltage	-7V≤V_{CM}≤12V		-200	-110	-50	mV
ΔV_{TH}	Receiver Input Hysteresis	V_A+V_B=0V			30		mV
V_{OH}	Receiver Output-High Voltage	I_O= -4mA,V_{ID}=-50mV		V_{CC}-0.4			V
V_{OL}	Receiver Output-Low Voltage	I_O= 1mA,V_{ID}=-200mV				0.4	V
I_{OZR}	Three-State Output Current at Receiver	0.4V≤V_O≤2.4V				±1	μA
R_{IN}	Receiver Input Resistance	-7V≤V_{CM}≤12V		12			kΩ
I_{OSR}	Receiver Output Short-Circuit Current	0V≤V_{RO}≤V_{CC}		±7		±95	mA
Supply Current							
I_{CC}	Supply current	No load, $\overline{RE}$ =DI=V_{CC}, DE=V_{CC}			0.5	0.9	mA
		No load, $\overline{RE}$ =DI=GND, DE=GND			0.4	0.6	
I_{SHDN}	Supply Current in Shutdown Mode	$\overline{RE}$ =V_{CC}, DE=GND,DI=V_{CC} or GND			20	30	μA
ESD Protection							
ESD	ESD Protection (A, B)	Human Body Mode			±15		kV
		Machine Mode			±800		V
		Contact Discharge IEC 61000-4-2			±12		kV
		Air-Gap Discharge IEC 61000-4-2			±15		

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7 DRIVER SWITCHING CHARACTERISTICS

(V_{CC}=+5V±5%,T_A=T_{MIN}~T_{MAX},Typical values are at V_{CC}=+5V and T_A=25°C;unless otherwise noted.)(1)

Symbol	Parameter	Conditions	MIN	TYP	MAX	UNITS
t_{DPLH}	Driver Propagation Delay	R_L=54Ω,C_L=50pF,Figure 2 and Figure 3		20	40	ns
t_{DPHL}				20	40	
t_{DHKEW}	Driver Output Skew $\lvert t_{DPLH} - t_{DPHL} \rvert$	R_L=54Ω,C_L=50pF,Figure 2 and Figure 3		-3	±10	ns
t_R , t_F	Driver Differential Output Rise or Fall Time	R_L=54Ω,C_L=50pF,Figure 2 and Figure 3		12	25	ns
F_{MAX}	Maximum Data Rate		10			Mbps
t_{DZH}	Driver Enable to Output High	Figure 4			150	ns
t_{DZL}	Driver Enable to Output Low	Figure 4			150	ns
t_{DLZ}	Driver Disable Time from Low	Figure 4			100	ns
t_{DHZ}	Driver Disable Time from High	Figure 4			100	ns
$T_{DZH(SHDN)}$	Driver Enable from Shutdown to Output High	Figure 4			250	ns
$t_{DZL(SHDN)}$	Driver Enable from Shutdown to Output Low	Figure 4			250	ns
t_{SHDN}	Time to Shutdown		50	200	600	ns

8 RECEIVER SWITCHING CHARACTERISTICS

(V_{CC}=+5V±5%,T_A=T_{MIN}~T_{MAX},Typical values are at V_{CC}=+5V and T_A=25°C;unless otherwise noted.)(1)

Symbol	Parameter	Conditions	MIN	TYP	MAX	UNITS
t_{RPLH}	Receiver Propagation Delay	Figure 5		50		ns
t_{RPHL}				50		
t_{RSkEW}	Receiver Output Skew $\lvert t_{DPLH} - t_{DPHL} \rvert$	Figure 5		0	±10	ns
F_{MAX}	Maximum Data Rate		10			Mbps
t_{RHZ}	Receiver Disable Time from High	Figure 6		20	50	ns
t_{RLZ}	Receiver Disable Time from Low	Figure 6		20	50	ns
t_{RZH}	Receiver Enable to Output High	Figure 6		20	50	ns
t_{RZL}	Receiver Enable to Output Low	Figure 6		20	50	ns
$t_{RZH(SHDN)}$	Receiver Enable from Shutdown to Output High	Figure 6			3500	ns
$t_{RZL(SHDN)}$	Receiver Enable from Shutdown to Output Low	Figure 6			3500	ns
t_{SHDN}	Time to Shutdown		50	200	600	ns

1.All currents into the device are positive. All currents out of the device are negative. All voltages are referred to device ground, unless otherwise noted.

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

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.

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9 TEST CIRCUITS AND WAVEFORMS

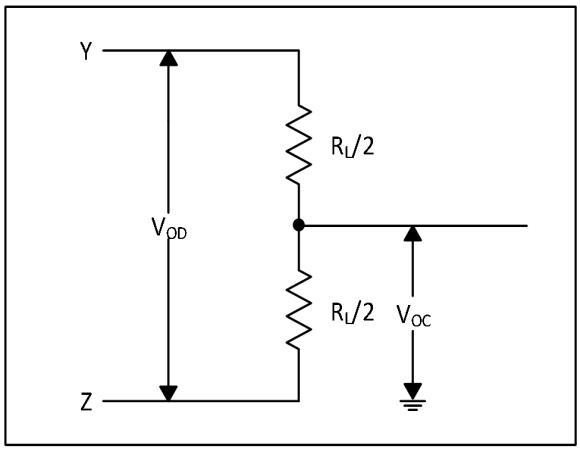


Figure 1. Driver DC Test Load

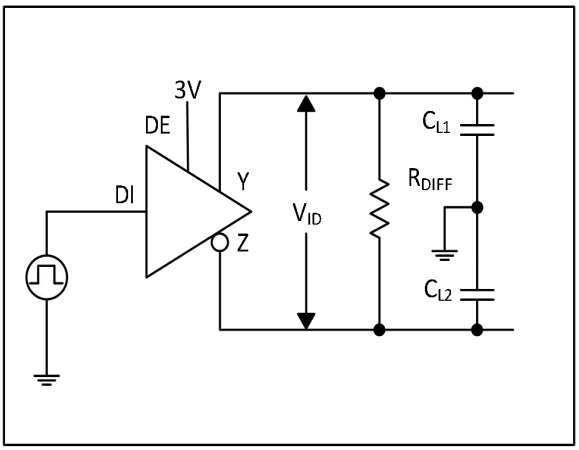


Figure 2.Driver timing test load

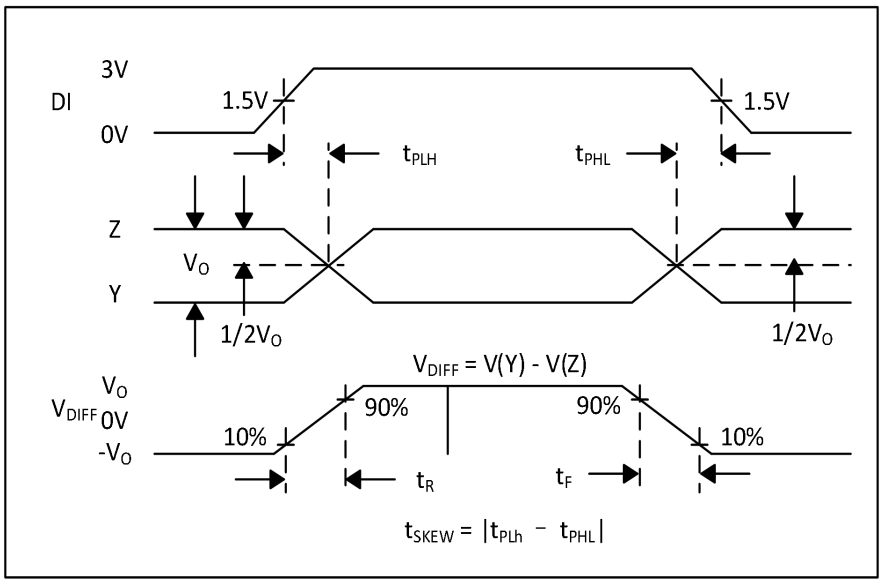


Figure 3.Driver Propagation Delays

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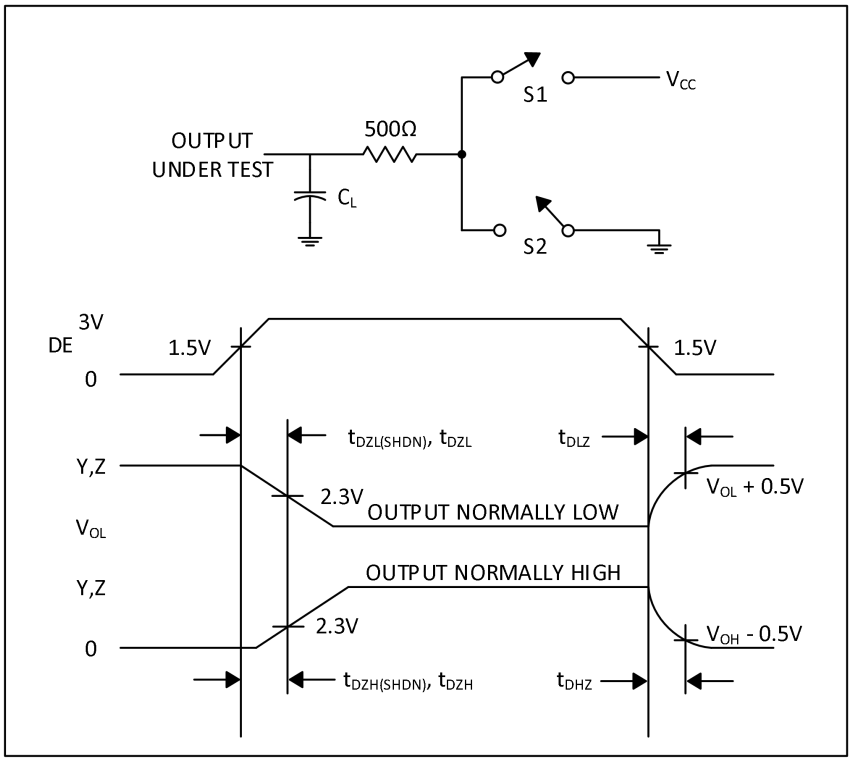


Figure 4. Driver Enable and Disable Times

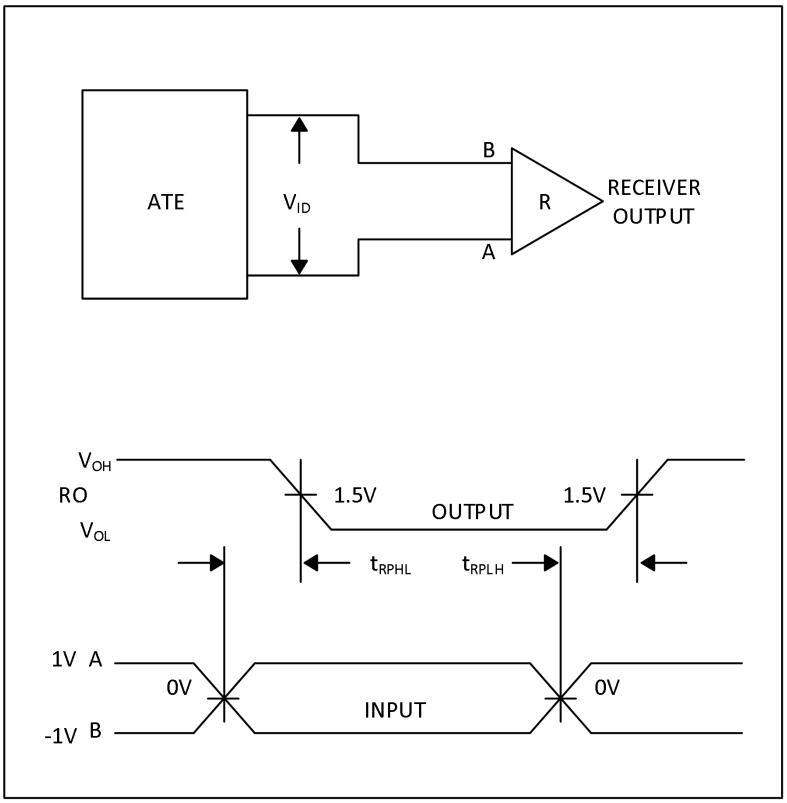


Figure 5. Receiver Propagation Delays

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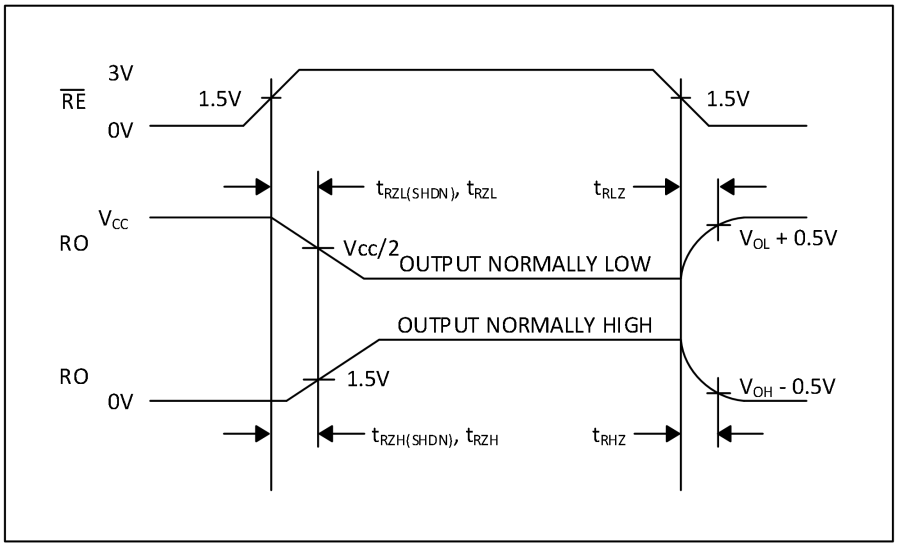
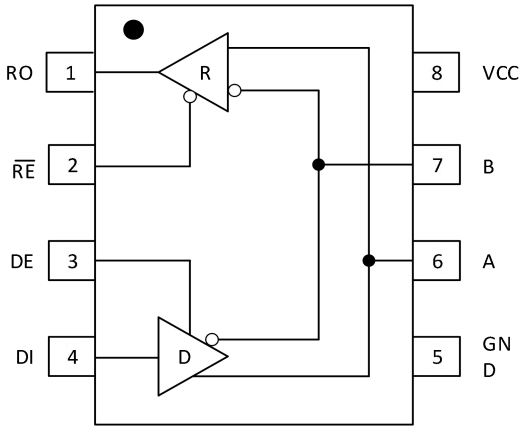


Figure 6. Receiver Enable and Disable Times

10 FUNCTION TABLES



TRANSMITTING				
CONTROL		INPUTS	OUTPUTS	
$\overline{RE}$	DE	DI	A	B
X	1	1	1	0
X	1	0	0	1
0	0	X	Z	Z
1	0	X	Shutdown	
RECEIVING				
CONTROL		INPUTS	OUTPUTS	
$\overline{RE}$	DE	A - B	RO	
0	X	≥ -50mV	1	
0	X	≤ -200mV	0	
0	X	Open/Shorted	1	
1	1	X	Z	
1	0	X	Shutdown	

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11 Detailed Description

11.1 Overview

The GM3485E high - speed transceiver for RS-485 communication contains one driver and one receiver. These devices feature fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted, or when they are connected to a terminated transmission line with all drivers disabled (see the Fail-Safe section). The GM3485E driver slew rate is not limited, making transmit speeds up to 10Mbps possible.The GM3485E is a half-duplex transceiver. The voltage operates from a single +3.0~+5.5V supply. Drivers are output short-circuit current limited. Thermal shutdown circuitry protects drivers against excessive power dissipation. When activated, the thermal shutdown circuitry places the driver outputs into a high impedance state.

11.2 ESD Protection

ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver output and receiver input of the GM3485E has extra protection against static electricity. The ESD-protected pins are tested with reference to the ground pin in a powered-down condition. They are tested to ±15kV using the Human Body Model.

11.3 Fail-Safe

The GM3485E guarantees a logic-high receiver output when the receiver inputs are shorted or open, or when they are connected to a terminated transmission line with all drivers disabled. This is done by setting the receiver threshold between -50mV and -200mV. If the differential receiver input voltage (A - B) is greater than or equal to -50mV, RO is logic high. If A - B is less than or equal to -200mV, RO is logic low. In the case of a terminated bus with all transmitters disabled, the receiver's differential input voltage is pulled to 0V by the termination. With the receiver thresholds of the GM3485E , this results in a logic high with a 50mV minimum noise margin. Unlike previous fail-safe devices, the -50mV to -200mV threshold complies with the ±200mV EIA/TIA-485 standard.

11.4 32 Transceivers on the Bus

The standard RS-485 receiver input impedance is 12kΩ (one-unit load), and the standard driver can drive up to 32 unit loads. The GM3485E has a one-unit-load receiver input impedance(12kΩ), allowing up to 32 transceivers to be connected in parallel on one communication line. Any combination of this device and/or other RS-485 transceivers with a total of 32 unit loads or less can be connected to the line.

11.5 Reduced EMI and Reflections

The GM3485E, driver slew rate is not limited, High-frequency harmonic components with large amplitudes are evident. transmitting under the same conditions.In general, a transmitter's rise time relates directly to the length of an unterminated stub, which can be driven with only minor waveform reflections. The following equation expresses this relationship conservatively: Length = $T_{RISE}/(10\times1.5ns/F_t)$, where T_{RISE} is the transmitter's rise time. For example, the GM3485E's rise time is typically 12ns, which results in excellent waveforms with a stub length up to 1 feet. A system can work well with longer unterminated stubs, even with severe reflections, if the waveform settles out before the UART samples them.

11.6 Machine Model

The Machine Model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. The objective is to emulate the stress caused when I/O pins are contacted by handling equipment during test and assembly. All pins require this protection, not just RS-485 inputs and outputs.

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11.7 Human Body Model

Figure 7a shows the Human Body Model, and Figure 7b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

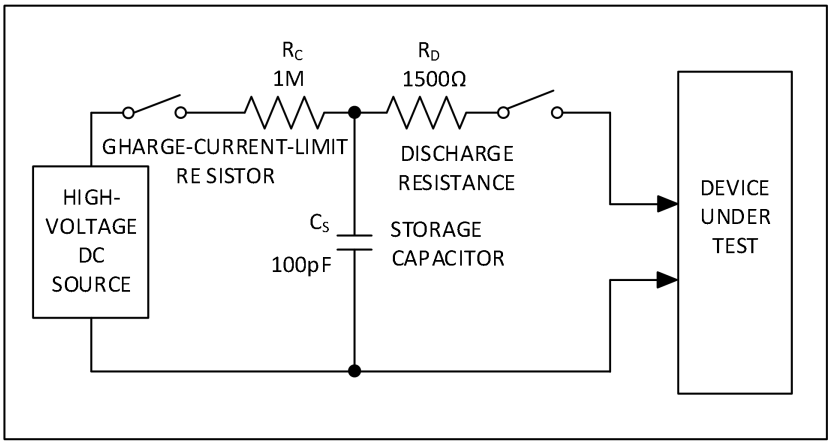


Figure 7a. Human Body ESD Test Model

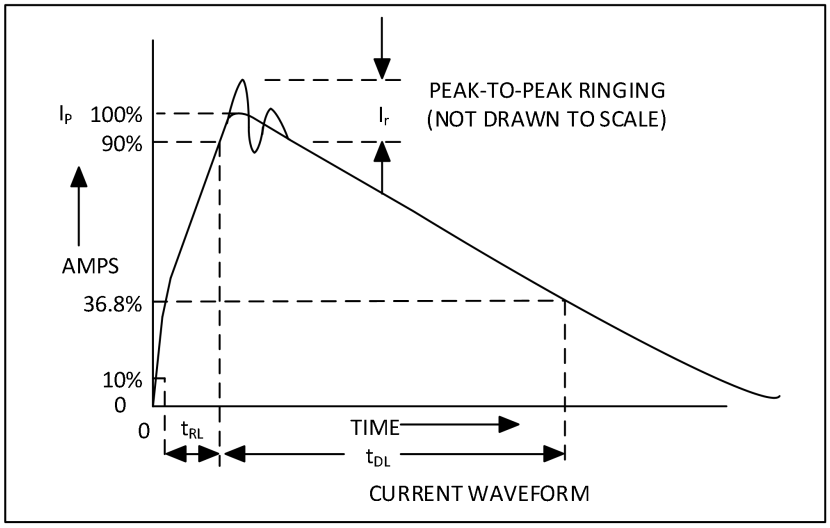


Figure 7b. Human Body Current Waveform

11.8 Line Length vs Data Rate

The RS-485/RS-422 standard covers line lengths up to 4000 feet. For line lengths greater than 4000 feet, use the repeater application shows in Figure 8.

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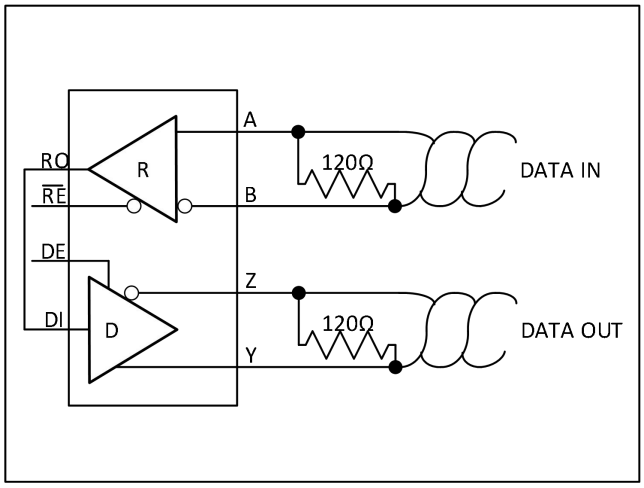


Figure 8. Line repeater for GM3485E

12 TYPICAL APPLICATION

The standard RS-485 receiver input impedance is 12kΩ (1-unit load), and the standard driver can drive up to 32-unit loads. The GM3485E has a 1/8-unit load receiver input impedance (96kΩ), allowing up to 256 transceivers to be connected in parallel on one communication line. Any combination of the GM3485E, as well as other RS-485 transceivers with a total of 32-unit loads or fewer, can be connected to the line.

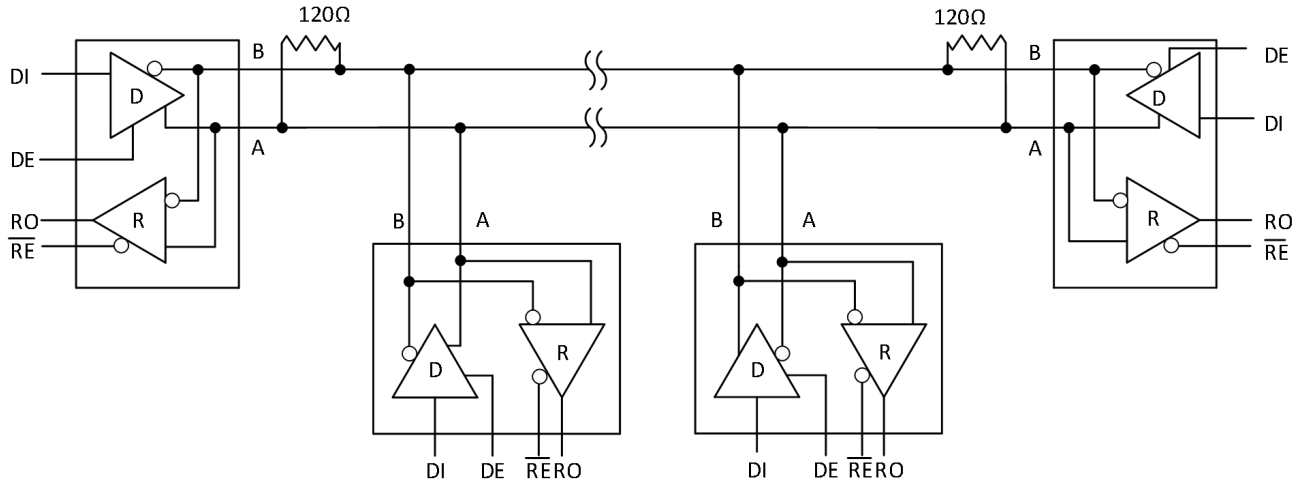
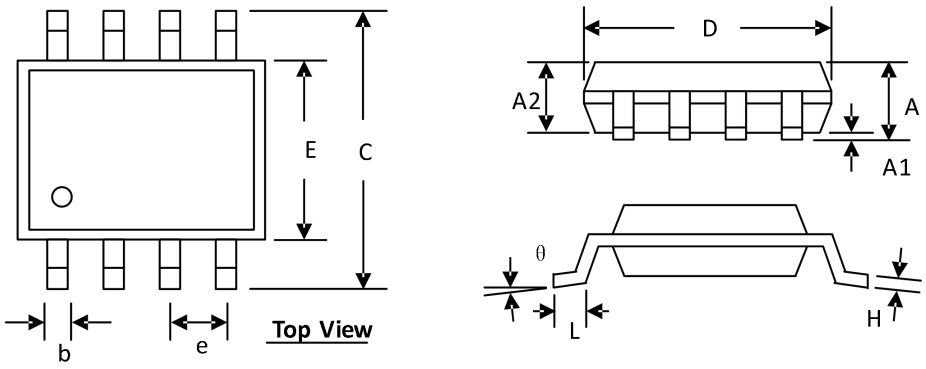


Figure 9. Typical half-duplex RS-485 Network

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PACKAGE DIMENSION SOP8



SYMBOLS	DIMENSION (MM)		DIMENSION (INCH)	
	MIN	MAX	MIN	MAX
A	1.300	1.752	0.051	0.069
A1	0.000	0.203	0.000	0.008
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
C	5.790	6.200	0.228	0.244
D	4.700	5.110	0.185	0.201
E	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
H	0.170	0.254	0.007	0.010
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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Order Information

Order number	Package	Marking information	Operation Temperature Range	MSL Grade	Ship, Quantity	Green
GM3485E	SOP8	GM3485E	-40 to 85°C	3	T&R, 4000	Rohs

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