

3.3V power supply, up to 256 nodes, 12Mbps half-duplex, RS485/RS422 transceiver

## Features:

- ◆ 3.3V power supply, half-duplex;
- ◆ 1/8 unit load allows up to 256 devices on the bus;
- ◆ Driver output short-circuit protection function;
- ◆ Over temperature protection function;
- ◆ Low power shutdown function;
- ◆ Receiver open circuit protection function;
- ◆ Strong anti-noise ability;
- ◆ Integrated transient voltage resistance function;
- ◆ Transmission rate up to 12Mbps in an electrical noise environment;

## Description

The ADM3485E is a 3.3V powered, half-duplex, low-power RS-485 transceiver that fully meets the requirements of the TIA/EIA-485 standard.

The ADM3485E includes a driver and a receiver, both of which can be independently enabled and disabled. When both are disabled, both the driver and the receiver output a high impedance state. The ADM3485E has a 1/8 load that allows 256 ADM3485E transceivers to be connected to the same communication bus. Error-free data transfer of up to 12Mbps is possible.

The ADM3485E operates from a voltage range of 3.0 to 3.6V and features fail-safe, over temperature protection, current limit protection, over-voltage protection, and other functions.

## Pin configuration

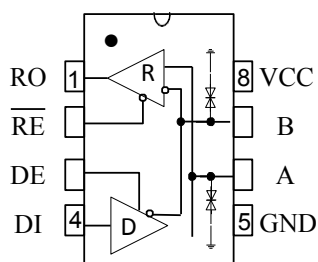


Figure 1 ADM3485E pin configuration

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### Limiting values

| Parameter                    | Symbol             | Value   | Unit |
|------------------------------|--------------------|---------|------|
| Supply voltage               | VCC                | +7      | V    |
| Voltage of control port      | /RE, DE, DI        | -0.3~+7 | V    |
| Bus side input voltage       | A, B               | -7~13   | V    |
| Receiver output voltage      | RO                 | -0.3~+7 | V    |
| Operating temperature range  |                    | -40~85  | °C   |
| Storage temperature range    |                    | -60~150 | °C   |
| Welding temperature          |                    | 300     | °C   |
| Continuous power dissipation | SOP8               | 400     | mW   |
|                              | MSOP8/8μMAX/VSSOP8 | 830     | mW   |
|                              | DIP8               | 700     | mW   |

The maximum limit parameter value means that exceeding these values may cause irreversible damage to the device. Under these conditions, it is not conducive to the normal operation of the device. Continuous operation of the device under the maximum allowable rating may affect the reliability of the device. The reference point of all voltages is ground.

### Pin functions

| Pin number | Pin name | Pin function                                                                                                                                                                                                                                                                                             |
|------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1          | RO       | Receiver output<br>When /RE is low level: if $A-B \geq 200\text{mV}$ , RO = high;<br>if $A-B \leq -200\text{mV}$ , RO = low                                                                                                                                                                              |
| 2          | /RE      | Receiver output enable control<br>When /RE is low level, receiver output is enabled, and RO output is available.<br>When /RE is high level, receiver output is disabled, and RO is in high impedance state.<br>When /RE is high level and DE is low level, the device enters low power consumption mode. |
| 3          | DE       | Driver output enable control<br>When DE is high level, driver output is available; when DE is low level, the output is in high impedance state.<br>When /RE is high level and DE is low level, the device enters low power consumption mode.                                                             |
| 4          | DI       | Driver input<br>When DE is high level, the DI low level forces the non-inverting driver output A low and inverting driver output B high;<br>The DI high level forces the non-inverting driver output A high and inverting driver output B 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          | VCC      | Power supply                                                                                                                                                                                                                                                                                             |

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## Driver electrical characteristics

| Parameter                                                  | Symbol          | Test Conditions              | Min  | Typ | Max | Unit        |
|------------------------------------------------------------|-----------------|------------------------------|------|-----|-----|-------------|
| Differential output voltage (no load)                      | $V_{OD1}$       |                              |      | 3.3 |     | V           |
| Differential output voltage                                | $V_{OD2}$       | Figure 2, $R_L = 54 \Omega$  | 1.5  |     | VCC | V           |
|                                                            |                 | Figure 2, $R_L = 100 \Omega$ | 2    |     | VCC |             |
| Change in magnitude of differential output voltage (NOTE1) | $\Delta V_{OD}$ | Figure 2, $R_L = 54 \Omega$  |      |     | 0.2 | V           |
| Common mode output voltage                                 | $V_{OC}$        | Figure 2, $R_L = 54 \Omega$  |      |     | 3   | V           |
| Change in magnitude of common mode output voltage (NOTE1)  | $\Delta V_{OC}$ | Figure 2, $R_L = 54 \Omega$  |      |     | 0.2 | V           |
| Input high voltage                                         | $V_{IH}$        | DE, DI, /RE                  | 2.0  |     |     | V           |
| Input low voltage                                          | $V_{IL}$        | DE, DI, /RE                  |      |     | 0.8 | V           |
| Logic input current                                        | $I_{IN1}$       | DE, DI, /RE                  | -2   |     | 2   | $\mu A$     |
| Output short-circuit current, short-circuit to high        | $I_{OSD1}$      | Short-circuit to 0V~12V      |      |     | 250 | mA          |
| Output short-circuit current, short-circuit to low         | $I_{OSD2}$      | Short-circuit to -7V~0V      | -250 |     |     | mA          |
| Thermal shutdown threshold                                 |                 |                              |      | 140 |     | $^{\circ}C$ |
| Thermal shutdown hysteresis                                |                 |                              |      | 20  |     | $^{\circ}C$ |

(unless otherwise stated VCC=3.3V±10%, Temp= $T_{MIN}$ ~ $T_{MAX}$ , typical value is VCC=+3.3V, Temp=25 $^{\circ}C$ )

NOTE1:  $\Delta V_{OD}$  and  $\Delta V_{OC}$  are the changes in  $V_{OD}$  and  $V_{OC}$  amplitude caused by a change of DI state of the input signal.

## Receiver electrical characteristics

| Parameter            | Symbol    | Test Conditions                          | Min  | Typ | Max | Unit    |
|----------------------|-----------|------------------------------------------|------|-----|-----|---------|
| Input current (A, B) | $I_{IN2}$ | DE = 0 V,<br>VCC=0 or 3.3V<br>VIN = 12 V |      |     | 125 | $\mu A$ |
|                      |           | DE = 0 V,<br>VCC=0 or 3.3V<br>VIN = -7 V | -100 |     |     | $\mu A$ |

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|                                        |           |                                                   |              |    |          |            |
|----------------------------------------|-----------|---------------------------------------------------|--------------|----|----------|------------|
| Positive-going input threshold voltage | $V_{IT+}$ | $-7V \leq V_{CM} \leq 12V$                        |              |    | +200     | mV         |
| Negative-going input threshold voltage | $V_{IT-}$ | $-7V \leq V_{CM} \leq 12V$                        | -200         |    |          | mV         |
| Hysteresis voltage                     | $V_{hys}$ | $-7V \leq V_{CM} \leq 12V$                        | 10           | 30 |          | mV         |
| High level output voltage              | $V_{OH}$  | $I_{OUT} = -2.5mA$ ,<br>$V_{ID} = +200\text{ mV}$ | $V_{CC}-1.5$ |    |          | V          |
| Low level output voltage               | $V_{OL}$  | $I_{OUT} = +2.5mA$ ,<br>$V_{ID} = -200\text{ mV}$ |              |    | 0.4      | V          |
| Tristate leakage current               | $I_{OZR}$ | $0.4V < V_O < 2.4V$                               |              |    | $\pm 1$  | $\mu A$    |
| Receiver input resistance              | $R_{IN}$  | $-7V \leq V_{CM} \leq 12V$                        | 96           |    |          | k $\Omega$ |
| Receiver short-circuit current         | $I_{OSR}$ | $0V \leq V_O \leq V_{CC}$                         | $\pm 8$      |    | $\pm 60$ | mA         |

(unless otherwise stated  $V_{CC}=3.3V \pm 10\%$ ,  $Temp=T_{MIN} \sim T_{MAX}$ , typical value is  $V_{CC}=+3.3V$ ,  $Temp=25^{\circ}C$ )

## Supply current

| Parameter      | Symbol    | Test conditions     | Min | Typ | Max | Unit    |
|----------------|-----------|---------------------|-----|-----|-----|---------|
| Supply current | $I_{CC1}$ | /RE = 0V, DE = 0V   |     | 520 | 800 | $\mu A$ |
|                | $I_{CC2}$ | /RE = VCC, DE = VCC |     | 540 | 700 | $\mu A$ |

## Driver switching characteristics

| Parameter                                  | Symbol    | Test conditions                                                                   | Min | Typ | Max | Unit |
|--------------------------------------------|-----------|-----------------------------------------------------------------------------------|-----|-----|-----|------|
| Driver differential output delay           | $t_{DD}$  | $R_{DIFF} = 60\ \Omega$ ,<br>$C_{L1}=C_{L2}=100pF$<br>(see Figure 3 and Figure 4) |     | 10  | 35  | ns   |
| Driver differential output transition time | $t_{TD}$  |                                                                                   |     | 12  | 25  | ns   |
| Driver propagation delay, low-to-high      | $t_{PLH}$ | $R_{DIFF} = 27\ \Omega$ ,<br>(see Figure 3 and Figure 4)                          |     | 8   | 35  | ns   |
| Driver propagation delay, high-to-low      | $t_{PHL}$ |                                                                                   |     | 8   | 35  | ns   |

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|                                            |           |                                          |  |     |     |    |
|--------------------------------------------|-----------|------------------------------------------|--|-----|-----|----|
| $ t_{PLH} - t_{PHL} $                      | $t_{PDS}$ |                                          |  | 1   | 8   | ns |
| Driver enable to output high               | $t_{PZH}$ | $R_L = 110\Omega$ ,<br>(see Figure 5, 6) |  | 20  | 90  | ns |
| Driver enable to output low                | $t_{PZL}$ |                                          |  | 20  | 90  | ns |
| Driver disable time from low               | $t_{PLZ}$ | $R_L = 110\Omega$ ,<br>(see Figure 5,6)  |  | 20  | 80  | ns |
| Driver disable time from high              | $t_{PHZ}$ |                                          |  | 20  | 80  | ns |
| Driver enable from shutdown to output high | $t_{DSH}$ | $R_L = 110\Omega$ ,<br>(see Figure 5,6)  |  | 500 | 900 | ns |
| Driver enable from shutdown to output low  | $t_{DSL}$ | $R_L = 110\Omega$ ,<br>(see Figure 5,6)  |  | 500 | 900 | ns |

## Receiver switching characteristics

| Parameter                                    | Symbol     | Test Conditions                         | Min | Typ | Max  | Unit |
|----------------------------------------------|------------|-----------------------------------------|-----|-----|------|------|
| Receiver input to output delay (low to high) | $t_{RPLH}$ | $C_L=15pF$<br>See Figure 7 and Figure 8 |     | 80  | 150  | ns   |
| Receiver input to output delay (high to low) | $t_{RPHL}$ |                                         |     | 80  | 150  | ns   |
| $ t_{RPLH} - t_{RPHL} $                      | $t_{RPDS}$ |                                         |     | 7   | 10   | ns   |
| Receiver enable to output low                | $t_{RPZL}$ | $C_L=15pF$<br>See Figure 7 and Figure 8 |     | 20  | 50   | ns   |
| Receiver enable to output high               | $t_{RPZH}$ | $C_L=15pF$<br>See Figure 7 and Figure 8 |     | 20  | 50   | ns   |
| Receiver disable time from low               | $t_{PRLZ}$ | $C_L=15pF$<br>See Figure 7 and Figure 8 |     | 20  | 45   | ns   |
| Receiver disable time from high              | $t_{PRHZ}$ | $C_L=15pF$<br>See Figure 7 and Figure 8 |     | 20  | 45   | ns   |
| Receiver enable from shutdown to output high | $t_{RPSH}$ | $C_L=15pF$<br>See Figure 7 and Figure 8 |     | 200 | 1400 | ns   |
| Receiver enable from shutdown to output low  | $t_{RPSL}$ | $C_L=15pF$<br>See Figure 7 and Figure 8 |     | 200 | 1400 | ns   |
| Time to shutdown                             | $t_{SHDN}$ | NOTE2                                   | 80  |     | 300  | ns   |

NOTE2: The device is put into shutdown by bringing RE high and DE low. If the enable inputs are in this state for less than 80ns, the device is guaranteed not to enter shutdown. If the enable inputs are in this state for at least 300ns, the device is guaranteed to have entered shutdown.

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## Function table

**Driver**

| Control                          |    | Input | Output       |   |
|----------------------------------|----|-------|--------------|---|
| /RE                              | DE | DI    | A            | B |
| X                                | 1  | 1     | H            | L |
| X                                | 1  | 0     | L            | H |
| 0                                | 0  | X     | Z            | Z |
| 1                                | 0  | X     | Z (shutdown) |   |
| X: don't care; Z: high impedance |    |       |              |   |

**Receiver**

| Control                          |    | Input                | Output |
|----------------------------------|----|----------------------|--------|
| /RE                              | DE | A-B                  | RO     |
| 0                                | X  | $\geq 200\text{mV}$  | H      |
| 0                                | X  | $\leq -200\text{mV}$ | L      |
| 0                                | X  | Open/short-circuit   | H      |
| 1                                | X  | X                    | Z      |
| X: don't care; Z: high impedance |    |                      |        |

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## Test circuit

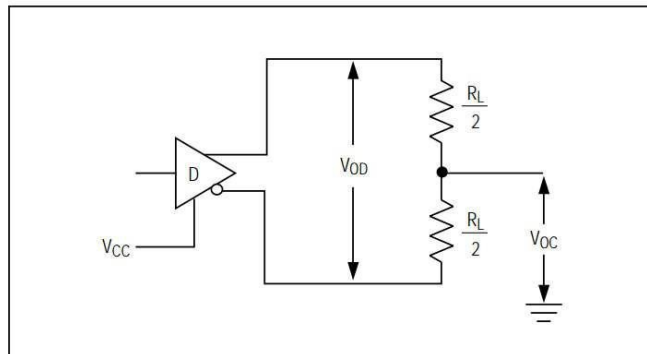


Fig. 2 Driver DC test load

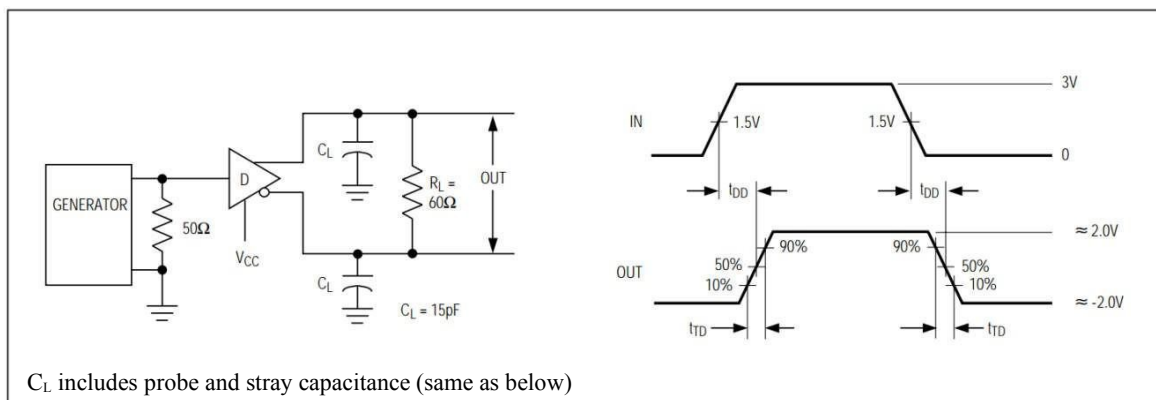


Fig. 3 Driver differential output delay and transition times

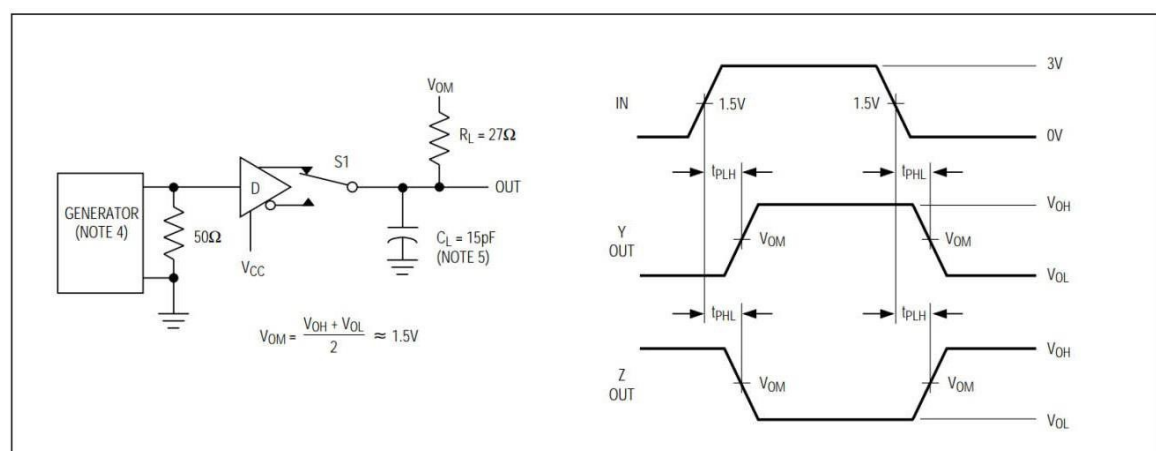


Fig. 4 Driver propagation times

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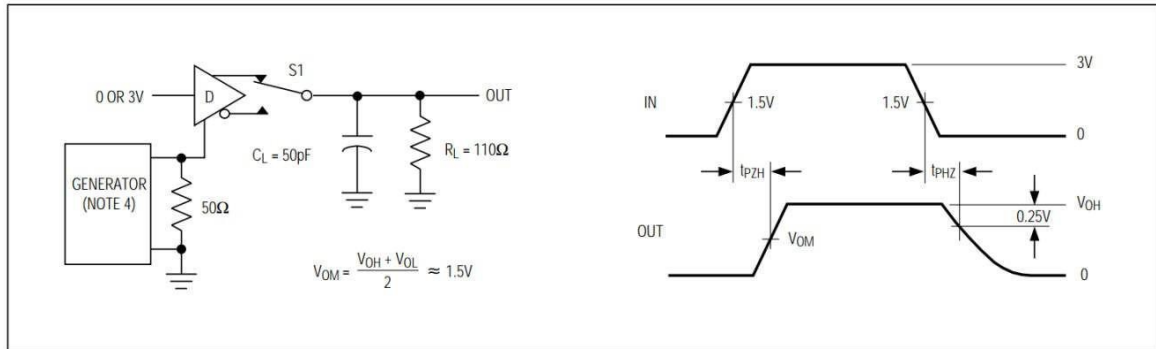


Fig. 5 Driver enable and disable times

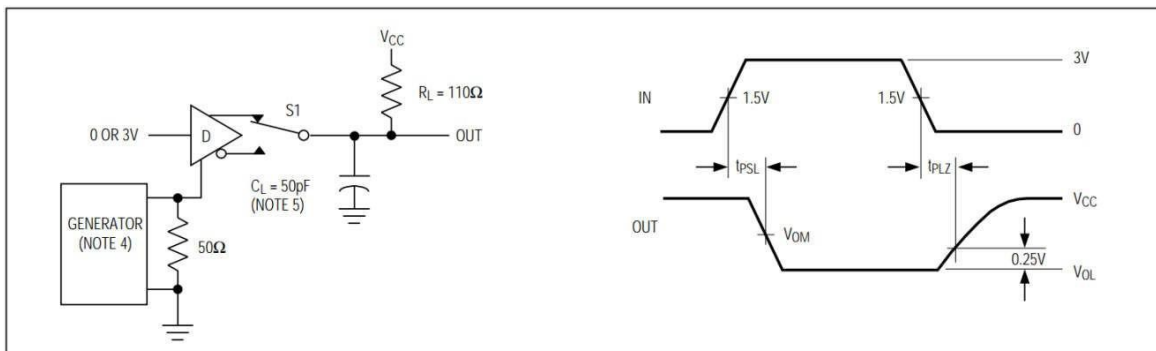


Fig. 6 Driver enable and disable times

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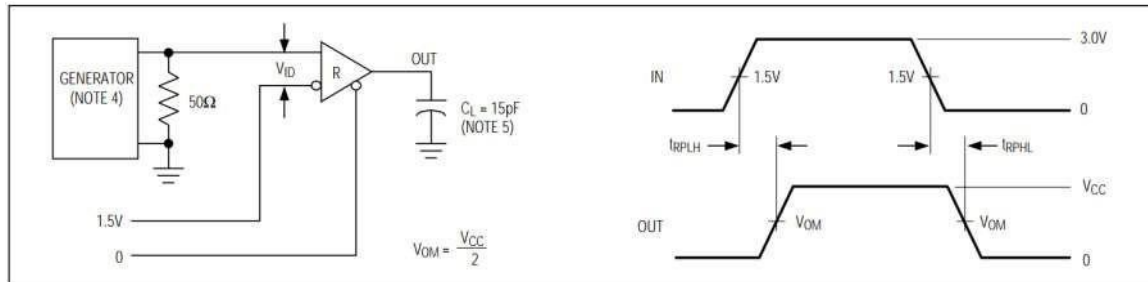


Fig. 7 Receiver propagation delay

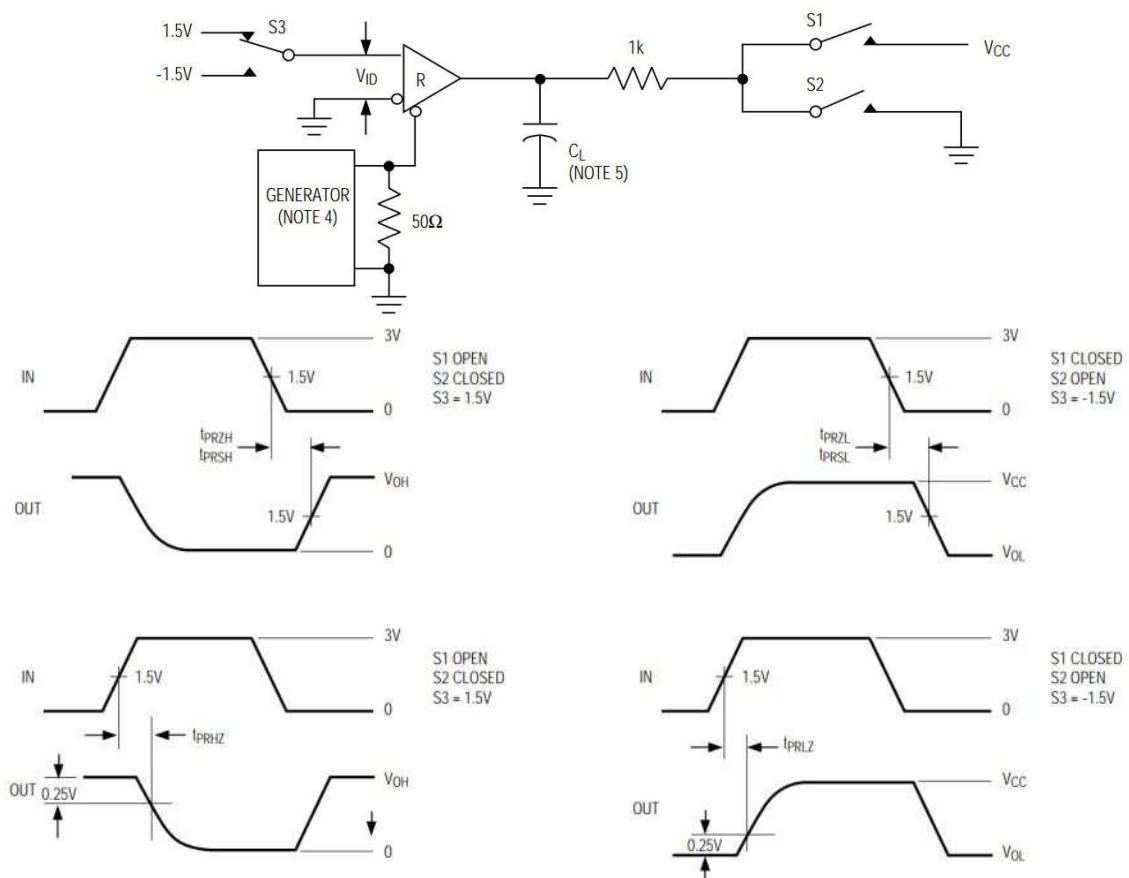


Fig. 8 Receiver enable and disable times

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## General description

### 1 Brief description

The ADM3485E is a half-duplex high-speed transceiver for RS-485/RS-422 communication, and includes one driver and one receiver. It has fail-safe, over-voltage protection and over-current protection. The ADM3485E allows error-free data transmission up to 12Mbps.

### 2 Allowing up to 256 transceivers on the bus

The standard RS-485 receiver has an input impedance of 12k $\Omega$  (1 unit load), and the standard driver can drive up to 32 unit loads. The receiver of the ADM3485E transceiver has a 1/8 unit load receiver input impedance (96k $\Omega$ ), allowing up to 256 transceivers to be connected in parallel on one bus. These devices can be combined arbitrarily, or combined with other RS-485 transceivers, as long as the total load does not exceed 32 units.

### 3 Driver output protection

Two mechanisms are used to avoid faults or bus collisions that cause excessive output current and excessive power consumption. First, over-current protection provides fast short-circuit protection over the entire common-mode voltage range (refer to the typical operating characteristics). Second, the thermal shutdown circuit forces the driver output into a high-impedance state when the die temperature exceeds 140°C.

### 4 Typical applications

**4.1 Bus networking:** The ADM3485E RS485 transceiver is designed for bidirectional data communication on multi-point bus transmission lines. Figure 9 shows a typical network application circuit. These devices can also be used as linear repeaters with cables longer than 4000 feet. In order to reduce reflections, terminal matching should be done at both ends of the transmission line with their characteristic impedance, and the length of the branch wires other than the main line should be as short as possible.

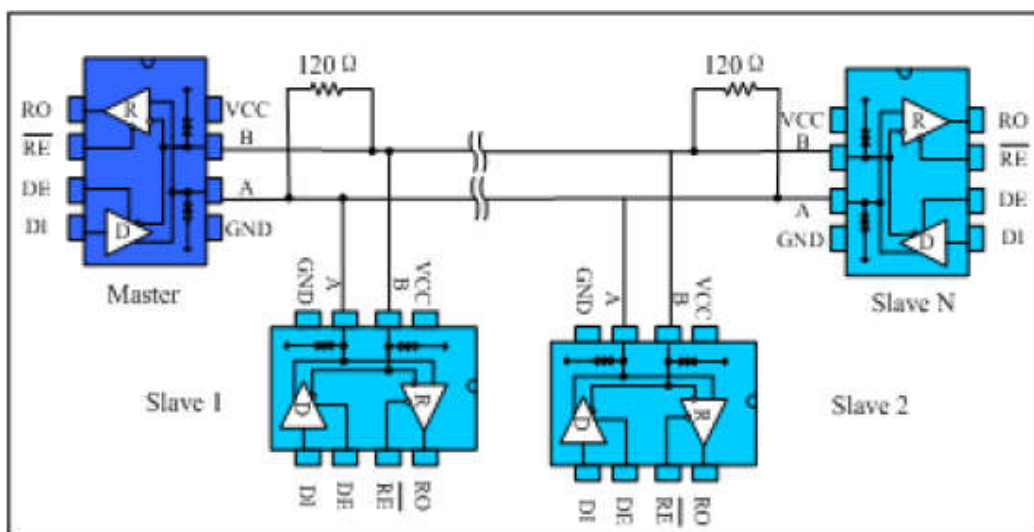


Fig. 9 Bus-type RS485 half-duplex communication network

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**4.2 Hand-in-hand networking:** Also known as daisy chain topology, it is the standard and specification of RS485 bus wiring, and is the RS485 bus topology recommended by organizations such as TIA. The wiring method is that the master control device and multiple slave devices form a hand-in-hand connection, as shown in Figure 10, the hand-in-hand way is to leave no branches. This wiring method has the advantages of low signal reflection and high communication success rate.

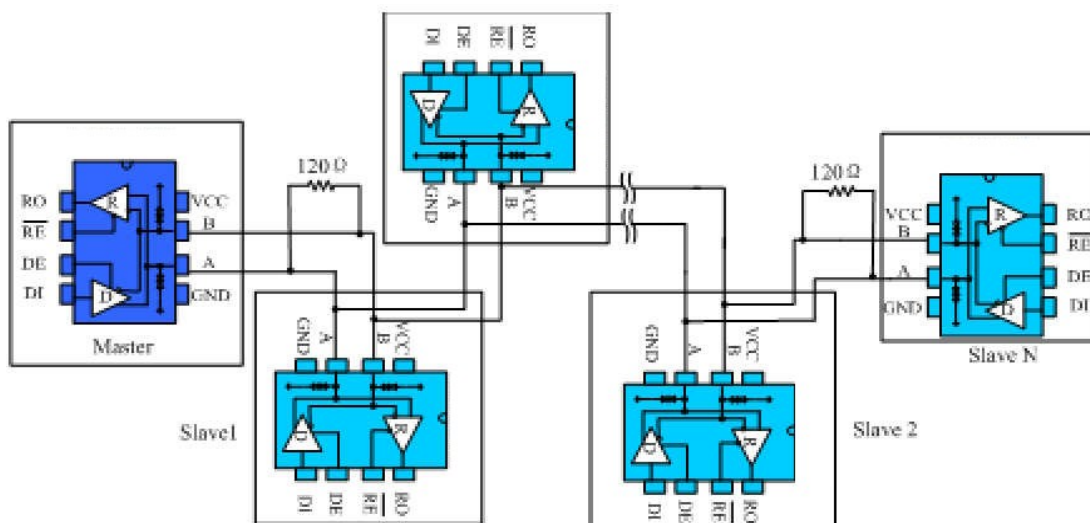


Fig. 10 Hand-in-hand type RS485 half-duplex communication network

**4.3 Bus port protection :** In harsh environments, RS485 communication ports are usually protected against static electricity, lightning and surge protection, etc. and it is even necessary to prevent 380V power supply access to avoid damage of smart meters and industrial control hosts. Figure 11 shows 3 common kinds of RS485 bus port protection schemes. The first scheme is to connect the TVS device to the protection ground in parallel with the AB port, the TVS device in parallel with the AB port, the thermistor in series with the AB port and the gas discharge tube is connected to the protection ground to form a three-level protection scheme. The second scheme is a three-level protection scheme including TVS connected to the ground in parallel with AB, the thermistor in series and the varistor in parallel with AB. The third one includes pull-down resistors connected to the power supply and ground respectively for AB, TVS between AB and the thermistor connected to A or B port.

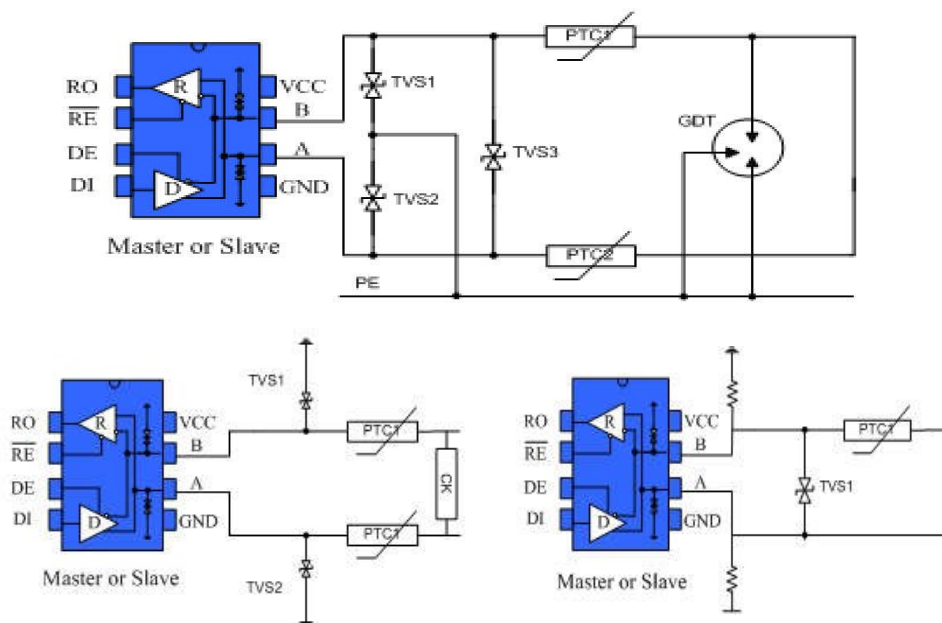
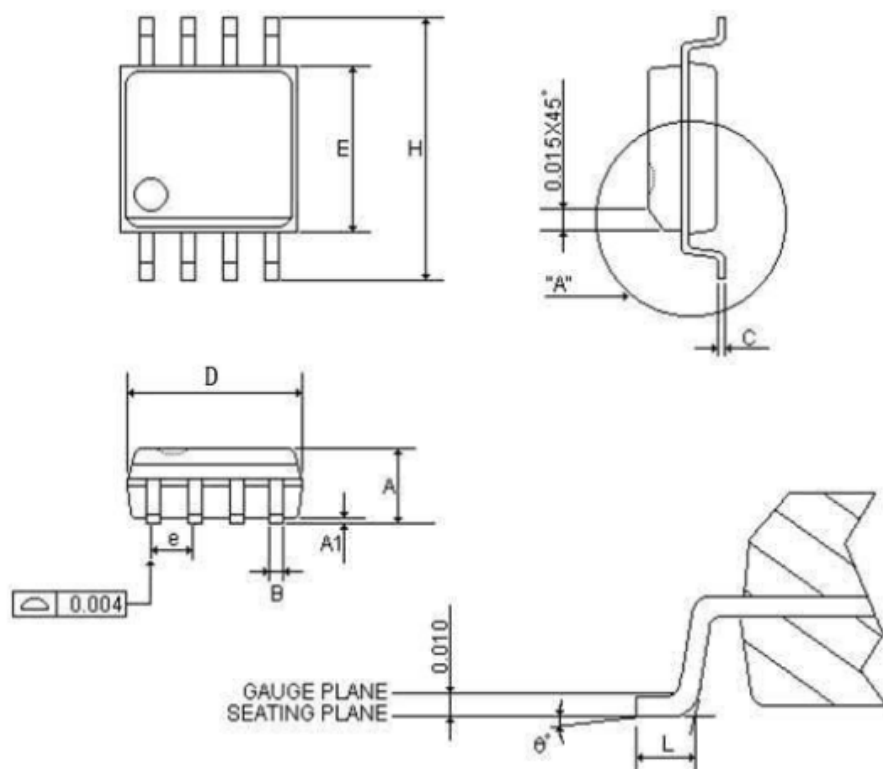


Fig. 11 Port protection scheme

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SOP 8



| SYMBOLS | MIN    | NOR   | MAX    | MIN    | NOR    | MAX    |
|---------|--------|-------|--------|--------|--------|--------|
|         | (inch) |       |        | (mm)   |        |        |
| A       | 0.058  | 0.064 | 0.068  | 1.4732 | 1.6256 | 1.7272 |
| A1      | 0.004  | -     | 0.010  | 0.1016 | -      | 0.254  |
| B       | 0.013  | 0.016 | 0.020  | 0.3302 | 0.4064 | 0.508  |
| C       | 0.0075 | 0.008 | 0.0098 | 0.1905 | 0.2032 | 0.2490 |
| D       | 0.186  | 0.191 | 0.196  | 5.9944 | 6.1214 | 6.1976 |
| E       | 0.150  | 0.154 | 0.157  | 3.81   | 3.9116 | 3.9878 |
| e       | -      | 0.050 | -      | -      | 1.27   | -      |
| H       | 0.228  | 0.236 | 0.244  | 5.7912 | 5.9944 | 6.1976 |
| L       | 0.015  | 0.025 | 0.050  | 0.381  | 0.635  | 1.27   |
| 0°      | 0°     | -     | 8°     | 0°     | -      | 8°     |